Atlantic States Marine Fisheries Commission

American Eel Management Board

February 4, 2016
10:30 a.m. – 12:00 p.m.
Alexandria, Virginia

Draft Agenda

The times listed are approximate; the order in which these items will be taken is subject to change; other items may be added as necessary.

1.	Welcome/Call to Order (*J. Clark*)	10:30 a.m.
2.	Board Consent • Approval of Agenda • Approval of Proceedings from November 2015	10:30 a.m.
3.	Public Comment	10:35 a.m.
4.	Review and Consider North Carolina's Aquaculture Plan **Action** • Technical Committee Report (*S. Eyler*) • Advisory Panel Report (*M-B. Delucia*) • Law Enforcement Committee Report (*M. Robson*)	10:45 a.m.
5.	Consider South Carolina's Survey Sampling Proposal **Action** • Technical Committee Report (*S. Eyler*)	11:30 a.m.
6.	Consider Conservation Equivalent Management Proposal from Maine **Action** • Technical Committee Report (*S. Eyler*)	11:35 a.m.
7.	Initiate Discussion to Consider Changes to Addendum IV Yellow Eel Allocations (*J. Gilmore*) **Possible Action**	11:40 a.m.
8.	Other Business/Adjourn	12:00 p.m.

The meeting will be held at The Westin Alexandria, 400 Courthouse Square, Alexandria, Virginia; 703.253.8600

Atlantic States Marine Fisheries Commission

MEETING OVERVIEW

American Eel Management Board Meeting
February 4, 2016
10:30 a.m. – 12:00 p.m.
Alexandria, Virginia

Chair: John Clark Assumed Chairmanship: 8/15	Technical Committee Chair: Sheila Eyler (USFWS)	Law Enforcement Committee Representative: Cornish
Vice Chair: Martin Gary	Advisory Panel Chair: Mari-Beth Delucia	Previous Board Meeting: November 3, 2015

Voting Members: **ME, NH, MA, RI, CT, NY, NJ, PA, DE, MD, VA, NC, SC, GA, FL, D.C., PRFC, USFWS, NMFS (19 votes)**

2. Board Consent:

- Approval of Agenda
- Approval of Proceedings from November 2015 Board Meeting

3. Public Comment:

At the beginning of the meeting, public comment will be taken on items not on the Agenda. Individuals that wish to speak at this time must sign-up at the beginning of the meeting. For agenda items that have already gone out for public hearing and/or have had a public comment period that has closed, the Board Chair may determine that additional public comment will not provide additional information. In this circumstance the Board Chair will not allow additional public comment. For agenda items that the public has not had a chance to provide input, the Board Chair may allow limited opportunity for comment. The Board Chair has the discretion to limit the number of speakers and/or the length of each comment.

4. Review and Consider North Carolina's Aquaculture Plan (10:45 – 11:30 a.m.)

Background

- Addendum IV allows states to submit Aquaculture plans that if approved would allow harvest of a maximum of 200 pounds of glass eel annually from within their waters for use in domestic aquaculture facilities provided they can objectively show that the harvest will occur from a watershed that minimally contributes to the spawning stock of American eel.
- The Board granted a deadline waiver to allow North Carolina the ability to submit an Aquaculture Plan by December 1, 2015 to be reviewed by the Technical Committee, Law Enforcement Committee and Advisory Panel, and considered by the Board at its February 2016 meeting with potential implementation in 2016 if approved.
- North Carolina submitted an aquaculture plan by the revised December 1 deadline. (**Briefing Materials**)

- The Technical Committee reviewed the plan to provide input on its biological implications. (**Supplemental Material**)
- The Advisory Panel reviewed the plan to provide industry perspective. (**Supplemental Materials**)
- The Law Enforcement Committee reviewed the plan to provide input on its enforceability (**Briefing Materials**)

Presentation

- Technical Committee Report by S. Eyler
- Advisory Panel Report by M-B. Delucia
- Law Enforcement Committee Report by M. Robson

Board Actions for Consideration

- Consider approval of North Carolina's Aquaculture Plan for Implementation in 2016

5. Consider South Carolina's Survey Sampling Change Proposal (11:30 – 11:35 a.m.) Action

Background

- South Carolina is requesting to change its young-of-year (YOY) sampling gear from fyke nets to collection ramps at Goose Creek dam. (**Briefing Materials**)
- The TC met to formulate recommendations on South Carolina's proposal and agreed by consensus that the new gear would be more appropriate for YOY sampling given the inconsistency and inadequacies of the fyke nets. (**Briefing Materials**)

Presentation

- Technical Committee Report by S. Eyler

Board Actions for Consideration

- Consider approval of South Carolina's Sampling Proposal

6. Consider Conservation Equivalent Management Proposal from Maine (11:35 – 11:40 a.m.) Action

Background

- Maine is requesting to eliminate the current requirement for two closed days (Saturday/Sunday) because they have recently implemented quota based management and are moving away from the use of input controls. (**Briefing Materials**)
- The TC met to formulate recommendations on Maine's proposal and agreed by consensus that eliminating the two closed days will likely not impact the stock considering Maine has implemented a quota management program. (**Briefing Materials**)

Presentation

- Technical Committee Report by S. Eyler

Board Actions for Consideration

- Consider approval of Maine's Conservation Equivalent Management Proposal

7. Initiate Discussion to Consider Changes to Addendum IV Yellow Eel Allocations

(11:40 a.m. – 12:00 p.m.) Possible Action
Background • At its November 2015 meeting, the Board approved a motion to discuss potentially revisiting Addendum IV yellow eel allocation at its February Board meeting.
Presentations • Preliminary Review of 2015 Yellow Eel Landings by M. Waine • Discussion of Revisiting Addendum IV Yellow Eel Allocation by J. Gilmore
Board actions for consideration at this meeting • Consider Revisiting Addendum IV Yellow Eel Allocation

8. Other Business/ Adjourn

DRAFT PROCEEDINGS OF THE

ATLANTIC STATES MARINE FISHERIES COMMISSION

AMERICAN EEL MANAGEMENT BOARD

World Golf Village Renaissance
St. Augustine, Florida
November 3, 2015

These minutes are draft and subject to approval by the American Eel Management Board.
The Board will review the minutes during its next meeting.

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INDEX OF MOTIONS

ATTENDANCE

Board Members

Pat Keliher, ME (AA)
Terry Stockwell, ME, Administrative Proxy
Sen. Brian Langley, ME (LA)
Dennis Abbott, NH, proxy for Sen. Watters (LA)
Doug Grout, NH (AA)
G. Ritchie White, NH (GA)
Rep. Sarah Peake, MA (LA)
Dan McKiernan, MA, proxy for D. Pierce (AA)
William Adler, MA (GA)
Robert Ballou, RI, proxy for J. Coit (AA)
David Borden, RI (GA)
Eric Reid, RI, proxy for S. Sosnowski (LA)
Rep. Craig Miner, CT (LA)
Lance Stewart, CT (GA)
Dave Simpson, CT (AA)
James Gilmore, NY (AA)
Emerson Hasbrouck, NY (GA)
Pat Augustine, NY, proxy for P. Boyle (LA)
Adam Nowalsky, NJ, proxy for R. Andrzejczak (LA)
Russ Allen, NJ, proxy for D. Chanda (AA)
Tom Fote, NJ (GA)
J. Thomas Moore, PA, proxy for Rep. Vereb (LA)
Loren Lustig, PA (GA)
Leroy Young, PA, proxy for J. Arway (AA)
John Clark, DE, proxy for D. Saveikis (AA)
Roy Miller, DE (GA)
Bill Goldsborough, MD (GA)
Ed O'Brien, MD, proxy for Del. Stein (LA)
Lynn Fegley, MD, proxy for D. Blazer (AA)
Rob O'Reilly, VA, proxy for J. Bull (AA)
Kyle Schick, VA, proxy for R. Stuart (LA)
Louis Daniel, NC (AA)
Doug Brady, NC (GA)
Sen. Ronnie Cromer, SC (LA)
Robert Boyles, Jr., SC (AA)
Malcolm Rhodes, SC (GA)
Pat Geer, GA, proxy for Rep. Burns (LA)
Spud Woodward, GA (AA)
Jim Estes, FL, proxy for J. McCawley (AA)
Thad Altman, FL (LA)
Mike Millard, USFWS
Chris Wright, NMFS
Martin Gary, PRFC

(AA = Administrative Appointee; GA = Governor Appointee; LA = Legislative Appointee)

Ex-Officio Members

Staff

Bob Beal
Toni Kerns
Mike Waine
Kirby Rootes-Murdy

Guests

Jay Jacobs, House of Delegates, MD
Steve Anthony, NC Marine Patrol
Shaun Gehan, Omega Protein
Jeff Pierce, MEFA
Darrel Young, MEFA
Abden Simmons, MEFA
Arnold Leo, E. Hampton, NY
David Bush, NC Fisheries Assn.
Bill Quincy, Mayflower, SC
Victoria Brown, MD Watermens Assn.
Robert Brown, MD Watermens Assn.

The Atlantic Eel Management Board of the Atlantic States Marine Fisheries Commission convened in the St. Augustine Ballroom of the World Golf Village Renaissance, St. Augustine, Florida, November 3, 2015, and was called to order at 10:15 o'clock a.m. by Chairman John Clark.

CALL TO ORDER

CHAIRMAN JOHN CLARK: Good morning. The American Eel Board is now in session.

APPROVAL OF AGENDA AND PROCEEDINGS

CHAIRMAN CLARK: I would like to start with the approval of the agenda and the approval of the minutes. Do any of the commissioners have any comments or edits to the agenda or the minutes?

PUBLIC COMMENT

CHAIRMAN CLARK: Seeing none there, we will proceed on to public comment. We have been asked by a member of the public to be given the opportunity to speak on an item that is not on the agenda this morning, so I'll now ask Mr. Bill Quimby to come to the public comment microphone.

MR. BILL QUIMBY: Good morning. Thank you very much, Chairman. I will try to keep my comments to a couple of minutes here. I've written some letters to Robert Beal and so forth. Basically as I said earlier, I was going to give you a little history, a chronology about how four people came to visit me in South Carolina in 2009 and wanted to have an eel farm. We've been writing to the state DNR, and we had meetings with them and so forth, and it has really been going nowhere; obviously.

I'm sort of asking really what to do. One of the solutions or one of the ideas that keeps coming up is to help ASMFC learn more about the resource. If there was some way to not allow another five years to pass with no activity, to give a research quota, perhaps, to different states, and have them work with the respective authorities there; to find out really what's going on.

I remember last year, and I didn't speak last year because I'm use to the federal management system, where you can comment during the discussion here. Paul Diodati brought up the fact that the European management system is very interesting. ICES had a big 200 page study, which people from 20 different countries participated in.

These are all things that we can learn from, I think in this management system here. These eels are sustainable. It is really an economic development situation, as far as I can see. I was going to bring up letters. Bill Hogarth has written lately, his frustrations with the whole management system of fisheries in general.

South Carolina had an article in yesterday's paper talking about panning for gold and all the usual things here. But I see on your agenda that you've got a proposal again from North Carolina, and I would think other states also should be able to come and not be handicapped with a multiple year expensive study about the year classes and the status of the eels. I know you've got a lot to cover here, and I thank you for the opportunity to speak, but I think you can sense there has been a little frustration here from people. As I said, I really feel like in a shark tank sometimes with a lot of foreign people coming and saying, where can we build our eel plant? We import, I think two hundred million dollars worth of eels, and we export about 5 million dollars worth of eels. There is a great trade imbalance.

There is a resource here that we can utilize sustainably. Do like Europe and put half of your

catch back in the rivers, then you know what we're working with. Anyway, I see you looking at your watch and I could go on. Thank you for listening.

UPDATE ON THE ENDANGERED SPECIES ACT

CHAIRMAN CLARK: Thank you, Mr. Quimby. Our next agenda item is an update on the Endangered Species Act Listing Determination by the U.S. Fish and Wildlife Service, and that will be given by Mike Millard of the U.S. Fish and Wildlife Service.

MR. MICHAEL MILLARD: I would like to start out by making it clear that in my agency I am not a member of that cadre of endangered species biologists who are well versed in the nuances of the law, but I'll give it my best shot here. As most of you, I'm sure, know by now, on October 8, the Service rendered its decision in response to a petition to list the American Eel under the Endangered Species Act; and that decision, as you know, was not warranted.

If you'll indulge me, I would like to read two sentences out of the listing language, which I think are relevant largely to this group. And I quote, "In terms of recreational and commercial harvest, we continue to acknowledge that sometimes large numbers of individual American eel are recreationally or commercially harvested for food, bait, or aquaculture.

But we conclude that harvest and trade are not threats to the American eel. That harvest is being managed and monitored via existing harvest quotas, licenses, and reporting requirements to insure the species conservation." It goes on, of course. There are notions there that I suspect many of you agree with. There may be a few notions that some of you don't agree with. The finding in total resulted in not warranted. With that, I would be happy to take any questions. That concludes my report.

CHAIRMAN CLARK: Are there any questions for Mike on the determination of not warranted for the ESA listing?

MR. ROB O'REILLY: We're familiar with Atlantic sturgeon, and how in 1998 it was not warranted to be listed, and then by 2012 it was. My question is, what does it take now that there has been this finding to revive it? Can that just occur or is there a time period where that has to occur before another petition could come forward?

MR. MILLARD: I'm unaware, Rob, of any set time period. I think the notion now is that this concludes our response to that petition. To us for now the case is closed, until such time as well, one someone can legally challenge that decision that we just made. Two, another petition could arise.

We could choose to take it up or not, and I'm not quite sure about that decision process; or three, we can internally take the issue up again, if we are convinced that conditions or situations have changed to the extent that it needs revisited again. But until some of those triggers start for us, I believe now that the decision is made and the case is closed for now. I don't know if that helps. There is no automatic time clock that would start that would say, well in five years we're going to take this up again.

CHAIRMAN CLARK: Thank you, any other questions?

MR. O'REILLY: Understanding that there is no automatic reconsideration, are there actions that we can continue to look at that might be helpful to the federal government not going through this process again if petitioned? For instance, if we chose within the next couple of days to open this fishery right up, is that a signal in terms of how the agency might view a future application?

The converse being if we continue to take serious steps to manage this fishery, and if states continue to take serious steps to improve habitat, are those the kind of things that might help keep this fishery open as opposed to having it listed?

MR. MILLARD: I am out of my comfort zone here with respect to the technicalities of the ESA. But as you know there are five factors that ESA biologists consider when they take up a decision like this; one of which is the inadequacy of existing regulatory mechanisms. Regulatory mechanisms are weighted and investigated heavily during the decision process.

I would guess, again I'm guessing; that if those regulatory mechanisms differ or take on a completely different flavor from the ones that existed when they just went through this process, yes, that will be noted. But as long as those, I guess, mechanisms are thoughtful and prudent I don't see where it would be a problem. I think those two sentences I read speak to the confidence and the good work of this board. I don't see why that would change, I guess.

TECHNICAL COMMITTEE REPORT

REVIEW RECOMMENDATIONS ON MAINE LIFE CYCLE SURVEY DESIGN

CHAIRMAN CLARK: Are there any further questions? Seeing none; we will move on to the next item of our agenda which is Technical Committee report. Mike Waine will take that.

MR. MICHAEL WAINE: Good morning, everybody. I'm filling in for TC Chair, Sheila Eyler so that we could save our trip down here for a short presentation. On the TC report per Maine's Life Cycle Survey, so a little bit of background on where we're at with this. Addendum IV, which is the most recent addendum, requires this Life Cycle Survey for states of the glass eel fishery that exceeds 750 pounds; that currently is the state of Maine.

In June they originally developed a design, reviewed it with the Technical Committee and there were a few challenges with the design, and so ultimately, at the last board meeting we sent the Technical Committee back to review those challenges and try to update the survey design that addressed some of the issues the TC had.

Here we are back again after the TC has done that. A little bit of background on the actual proposal. Maine is planning a 17-year survey on glass, yellow and silver eel life stages. They can commit funding for three years right now, but the plan is to conduct this for a life cycle; which is why you have that longer timeframe.

This is the upstream drainage in Maine, and various field sampling and tagging techniques are going to be used. This table is a little bit hard to read, but the take-home point is this is a very intensive sampling survey. The columns that you see across the table represent the months from April through October. You can see that a lot of these boxes are filled in daily, which means that sampling will occur frequently. In terms of what this life cycle survey intends to do, we're hoping it will create estimates of index of abundance, biomass mortality, and the average length and weight of eels. These are all metrics that are important for us to evaluate the various life stages for eel. Then there are a couple additional estimates for yellow and silver eel stages, which is age structure and presence of a parasitic nematode.

After the state of Maine worked with some of the TC members to get an updated proposal, it went back to the full TC, and they had the following recommendations: first of all commending Maine for the willingness to modify the survey design based on TC input. There are a few other issues that are relatively minor,

which the Technical Committee believes can be addressed after the first field season.

In short, basically the TC is comfortable with where the current survey design stands; and after the first year the TC can revisit sort of how the implementation went. As many of us know, a lot of these survey designs look great on paper. When you go to implement them in the field you are going to encounter some challenges you didn't actually expect.

The last slide here is talking about TC recommendations, and just mentioning that the survey design was specifically designed for this stream in Maine, and may not be directly transferable to another stream. The Technical Committee is recommending that if there are additional life cycle proposals put forth, that they need to be reviewed and approved by the TC.

This is not a one-size-fits-all for all life cycle surveys across the management unit. Like I mentioned, the TC just requests an update from Maine after the first study season so that we can evaluate, sort of the implementation of all the different methods that they are looking at to do this life cycle survey. Just to wrap it up, what we're looking for here is just a board approval for Maine to implement this life cycle survey, noting the TC recommendations in this report.

CHAIRMAN CLARK: Are there any questions for Mike about the Maine survey or the TC review of the survey? Yes, Ritchie.

MR. RICHARD WHITE: I just wanted to make sure that Mike gave us the name of the stream.

MR. WAINE: You know, I purposely avoided saying that; and Pat, I know you put him up to that.

CHAIRMAN CLARK: Are there any other questions?

MR. PAT KELIHER: Mr. Chairman, I would like to make a motion that the board accepts Maine's Life Cycle Survey.

CHAIRMAN CLARK: We have a motion to accept the survey by Mr. Keliher of Maine, and it is seconded by Mr. Abbot of New Hampshire. Would the maker of the motion care to discuss it?

MR. KELIHER: Just for the record, Mr. Chairman, it is called the Cobboseecontee Stream, in case anybody was wondering.

CHAIRMAN CLARK: Any discussion of this motion? Seeing none; do we need to caucus or is there any opposition to this motion; let's put it that way. **Seeing no opposition; the motion will be considered passed by unanimous consent.**

We'll move on then to the next item, which is to consider the Addendum IV Implementation Plans.

MR. KELIHER: I just want, for the record, to know that the state of Maine will be bringing information to the Technical Committee regarding conservation credits for efforts the state has done. It is clearly laid out within the addendum that we can identify projects that have been done and completed in the state of Maine, and we have many that we have looked at. We are gathering that information right now, and we'll be submitting it to the Technical Committee. Hopefully, we'll be able to have a discussion regarding that issue at the February meeting.

CONSIDER THE ADDENDUM IV IMPLEMENTATION PLANS

CHAIRMAN CLARK: Okay, now I'll turn it over to Mike for Addendum IV Implementation.

MR. WAINE: Thanks for calling me out, Pat. I'm going to walk through Addendum IV Implementation Plan. It is just a little background on this. Through Addendum IV we implemented a coast wide quota of approximately 907,000 pounds for the yellow eel commercial fishery; which is starting in the current fishing year.

There are two management triggers in the addendum which say if the quota is exceeded by more than 10 percent in a given year, or if the quota is exceeded by any amount for two consecutive years, there is the trigger to implement automatic state-by-state quotas that have already been decided in that allocation for the quotas already in the addendum.

In preparation for the potential triggering of state-by-state quotas, the state submitted implementation plans that basically reported on the following six topics. I'm going to go through these. Sort of bear with me, I contemplated just mentioning them, but I think it is important to highlight a few things.

Just to orient you to this table, which is going to be present in the next couple of slides, the first column is state; the second is the rule making process that occurs in the state. The third is the timeframe of which that rule making occurs; the fourth is the reporting structure that the states plan to use to monitor their quota.

The next column is whether they have a mechanism for overages and transfers, and the following is whether the state has any additional management measures that they plan to use if we end up going with state-by-state allocation. Now, remember that this is a build-on of Addendum III, which we've talked about at a couple meetings now; which implemented the new size limit and some gear restrictions.

There have already been some measures that have impacted the yellow and silver eel fisheries prior to this quota. I'll just try to work through this relatively quickly, sort of highlighting the additional measures that the states are planning. Maine is looking at possible seasons and days out.

The state of Massachusetts is potentially considering closing out hook and line gear over this time period. I'll get into that a little more in another agenda topic. All the others are basically going with what they've already implemented on that side. In terms of New York, there was quite a bit of concern brought up in their implementation plan for a need for an adjustment to the quota through transfers or a management addendum; noting that essentially, the quota that they've been allocated through Addendum IV if we end up triggering it would be inadequate for their fishery.

Connecticut doesn't plan any additional measures at this time. New Jersey is considering limited entry based on the 2007 through 2014 harvest, and possibly some other measures that would control catch within the state; and no additional measures from Delaware at this time. Maryland is going to have a harvester permit by early spring 2016 with a follow up reporting requirement.

That is where this daily harvester reporting is coming from. Nothing more planned in PRC. Virginia is looking at possible seasonal closures and possession limits, and they also have a quota trigger to implement weekly/daily reporting; so basically, a trigger that would say as we get closer to our quota we'll basically increase the timeliness of monitoring.

North Carolina has a pretty proactive program with that same trigger as I described for Virginia that can go to weekly or daily, and they have a good mechanism in place where they can monitor what their catch is in the spring to see if

it is going to be a big year for harvest. We're able to identify that.

Then our south reach states, so South Carolina has possible gear restrictions, catch limits or closure, and Georgia is likely to close the commercial fishery if state-by-state quotas are implemented. Their harvest is very small. To the state of Georgia it seems more appropriate to close than to monitor such a small quota.

Then Florida has no additional plans for right now, and there is this issue that I'll talk about in the next slide. Ultimately, what happened was the TC reviewed all these plans that I just quickly ran through; and they recommended the use of harvester reporting to monitor the quota. There is a concern that harvesters in one state could be selling to dealers in another state, and that would result in a potential double counting situation.

The recommendation there was to use harvester reporting so that that doesn't become an issue, and if all states are using harvester reporting there is no possibility for the double counting. Harvester reporting gets at the use of eels for personal use, basically. If a harvester ends up using yields for bait in the striped bass fishery, for example, personally, those eels would not be counted if this was a dealer- based reporting structure.

That was another reason to recommend the harvester reporting. Then in terms of the board's ability to evaluate whether this trigger has been met, because remember, that we're only going to state-by-state quotas if we meet one of those two triggers, which is in the addendum.

Ultimately, one of the challenges here is getting the landings data early enough within the year so that we can establish whether that trigger has been met or not. The TC recommendation on this was for states to provide an update on what their landings are on February 1st of every year, so that is much earlier than we have been reporting on this fishery, because our compliance reports aren't due until September.

The idea was to get an update in February and preliminary landings being delivered March 1st. The intent of that timeline is so that the FMP and myself could basically compile all these landings and present it to the board at the May meeting, so that we could establish whether that trigger has been met and identify whether we're going to state-by-state quotas. Ultimately, what we're looking for from the board is an acceptance of the implementation plans for Addendum IV, and I would be happy to answer any questions.

CHAIRMAN CLARK: Any questions for Mike?

MR. O'REILLY: I'm very familiar with North Carolina and Virginia's reporting schedules, and when it went over to the dealer based reporting, that was accomplished as well. I just want to make sure that the board thinks that the mechanisms are there throughout the coast to adequately monitor these landings.

We already know that sometimes surprises happen once regulations are put in, and once they change; especially once quotas are adopted. I would just like to get a sense from Mike or even other board members whether they feel after listening to this presentation, are we really ready for a quota? Maybe we have to be ready, but we still want to know whether it is going to be sound; as far as the monitoring.

MR. WAINE: I'll jump in, but if states want to comment on their individual plans I definitely would recommend that. I'll just remind the board that through my experiences when we've implemented a quota for the first time, there are challenges that we didn't expect and there is a little bit of a learning curve the first year.

I think some of the mechanisms that the Plan has in place to address that is quota overages, so there is a requirement of payback of quota overages. There is also a mechanism for quota transfers. I'm just highlighting, basically, that there is the accountability with the payback of overages and there is flexibility with the quotas, given the transfer mechanism that is also allowed.

Rob, I realize that doesn't specifically get to, is every state ready for this if it comes down the pipeline, but there are some mechanisms in the plan. This will help us deal with some of the challenges that we've seen when we've gone to a state-by-state allocation for fisheries for the first time.

CHAIRMAN CLARK: Are you okay, Rob?

MR. O'REILLY: That's fine and that is sort of an after the fact situation in a lot of ways. But I guess the other part is what sense of non-reporting exists right now? Harvesters have been under a system where if they haven't been captured as a data point, then how long is it going to take a lot of those harvesters to know in states that haven't institutionalized some type of harvester reporting program previously? That is probably going to be the challenge. But after the fact, I understand what Mike is saying. The surprises will end up with paybacks and other mechanisms request for transfer. It is just a reality of where we stand, I think.

MR. KELIHER: Mike, I would remind the Technical Committee, if you would please, that going to a harvester based reporting to monitor quota would eliminate the ability to use a swipe card. If this system gets developed and other states use it, that is a dealer reporting system; even though the harvester has the card, it is a dealer reporting process to get that daily information. It would eliminate our ability. We've got a small quota, it is not like it would impact us, but the TC should keep that in mind.

MR. WAINE: Pat, just sort of thinking through the intent of this, so sort of accounting for what the harvesters end up harvesting. I will specifically reference your program and the elver swipe card program. I think that the states could easily use sort of a combination of both dealer and harvester reports to do this.

I think that if there is a good mechanism to match up, sort of identifying harvester from dealer reports, I think that that would sort of satisfy the concerns that the Technical Committee had with the idea that getting at the personal use issue and being able to identify the potential dealing of eels from a harvester in another state. I think there is sort of the intent is there and I think that there is more than one mechanism to get at that intent. But I will obviously bring that feedback back to the Technical Committee, so thanks for that.

CHAIRMAN CLARK: Next question is Dan.

MR. DAN McKIERNAN: Yes, Mike, I'm curious about this concern about harvest in one state being sold to a dealer in another. We have many quota managed species in the commission with state-by-state quotas and challenges of accounting for where the fish are landed and where they come in. This might represent an opportunity for us to open up that issue, kind of universally across the species.

In Massachusetts if a fisherman tends to sell fish to a Massachusetts dealer, trucking it across state lines, we tell them if we catch them; you have to have a dealer's permit to do that. We don't allow a harvester coming from another state to take product from that state and put it against our quota. That's for all species. I don't know how other states are dealing with fluke and sea bass and scup and all that but this isn't

new. I guess I'm kind of surprised that the TC raised concerns about that; because we should have figured this out for all the species.

CHAIRMAN CLARK: Dan, if I could take a crack at that. I think the unique nature of the eel business, being that we have for the most part one big buyer of live eels that goes up and down the coast. It is the concern that I've seen that there might be some weird things going on with the reporting, for example in 2014 the final landings as reported through NMFS are over a million pounds, which, of course, would put us into this state-by-state quota had that happened this year.

I asked Mitch what Delaware Valley's landings were last year, or their sales rather, and they had 463,000 pounds of eels that they sold last year. This year they're only up to about 260,000 pounds. They said they have just tons of frozen eels left over from last year; the market has really gone south.

I know, in Delaware, we typically let 20 to 30 percent of the eels that we land go to the bait market. But you put those together with what we know that Delaware Valley is buying, and what we think is going to the bait market. It just seems like a million pounds might be more than is actually being landed. That was, I know one of the curious things there.

MR. McKIERNAN: John, I appreciate that but in New Bedford we have a lot of processing facilities, and many fishermen want to bring their product into New Bedford; so I deal with this all the time and surf clams or fluke and other species. I guess my point is, maybe it is time the Commission and the Policy Board examined what the standards are for transporting product across state lines in a quota managed species. It would help if every state had a uniform policy across states that governed the transport of quota managed species across state lines. I mean it's really ripe for discussion. I take your point though.

CHAIRMAN CLARK: The next question we have is from Jim.

MR. JAMES GILMORE: Just a clarification on New York's implementation plan and well, sort of echoing what Mike said about, I guess maybe I can paraphrase it – some bumps in the road every time we implement quota management. Well, the reason why we put in some concerns about maybe reevaluating transfers and allocations is because if you look at the 2014 landings, and based upon transfer rules and the way the fishery was in 2014.

If we get to this year and the same thing happens, New York will not have an eel fishery, which was not, I think, an intended consequence of this FMP. That really goes back to the fact that we based it on 2010 landings, and in that time New York did not have mandatory landings. At this point in time we did institute mandatory reporting.

We've got four years of data that pretty much shows what our landings are, instead of 15,000 pounds it is closer to 50,000 pounds. We can document that very clearly, but unfortunately right now, that is irrelevant in terms of the way the Plan is. I understand some of the other states the landings or the data is somewhat suspect, whatever. There are a lot of concerns about this whole thing. Something we're not going to resolve today and I think we need to implement this and see the implementation plans.

I'm not sure if it is the right time to request it now, Mr. Chairman, but I think at the February meeting we need to have a much more in-depth discussion about the allocations and the transfers, and maybe some of the dates that we implemented on this so that we could possibly

put on a discussion for either a possible addendum to try to correct some of the issues with this. Is that something that we'll need to formally request now or later? What's your pleasure, Mr. Chairman?

CHAIRMAN CLARK: That's a good question. I'll ask you, Mike. Would that be something, I mean should we wait until we actually get to implementation plans here before we start trying to iron out some of these potential problems?

MR. WAINE: It's really at the will of the board. If the board wants to revisit this topic at the February meeting, from a personal standpoint, I think that would be the best approach, given the limited time that we have on this agenda at this meeting. I think Jim had mentioned he wants to look into the issue and talk through with some of the states before this gets brought up as a formal topic. But ultimately yes, that would be sort of the will of the board to add that to the February agenda.

CHAIRMAN CLARK: I guess what I meant; this would probably require a new addendum wouldn't it, if we're going to bring up some of the issues that Jim is discussing, because they weren't in Addendum IV?

MR. WAINE: I'll try to make my answer really simple. If the board wants to change the allocations that are in Addendum IV, it would require another addendum to do so.

CHAIRMAN CLARK: Okay, so I think that either way it is best we wait until February to follow up on this.

MR. GILMORE: The only request, just so I understood, was not to initiate an addendum; just to make sure that we include this on the February addendum and we give sufficient time to discuss it, Mr. Chairman.

MR. O'REILLY: This is a little bit of a sore point with Virginia, and it is not a complaint. I understand with the allocation that there were three different attempts to get the best allocation system. But I, too, would like to see that revisited, and for a different reason than Jim, but nonetheless it is important for us to look at that again.

But at the same time I'd hate to wait until February to find out at that point that the board is not interested in looking at that; because some work has to be done to prepare for that. It would make sense to know there was a consensus of the board for that item, so that those states that wanted to have information to provide could do so, and be prepared. The transfer system as well, I understand what Jim is asking and I support that.

CHAIRMAN CLARK: Is there any objection from the board to adding this to the agenda for February for further consideration? Russ, were you the one that had a hand up about this same issue?

MR. RUSS ALLEN: I'm just curious to the board members that want to revisit the allocation is, where are we going with that? We spent a lot of time coming up with those options for a while with different allocation aspects to them. I'm just curious on what we're trying to do as we move forward. I have no problem going forward with the discussion.

I would like to get an idea of where we're going, because are we just looking at it because some state allocations are too low or they think some other states are too high? Where are we headed with that? That is my question, because we did spend a lot of time going through that. Those members that were on the working group got kind of tired of talking about it, so any help you could give me on that would be appreciated.

CHAIRMAN CLARK: The next question is Bob Ballou.

MR. ROBERT BALLOU: I am not sure if I'm out of order here. I want to return back to this harvester versus dealer reporting recommendation. Is that appropriate?

MR. GILMORE: Just to answer Russ's question. It is very simple. I can even go back to some of the commission's policies or whatever. We're supposed to be using the best data we've got. We used that 2010 data because it was the best we had when we went through this whole effort. Now some of those allocations didn't change much, but we really used one year because it was the terminal year of the stock assessment. Now we've got new data, and I've looked at that data, Russ. Most of it is pretty close in terms of the percentages, but there are a couple of states, because of just using that one year that were problematic.

New York's intent is very clearly to use the four years of landing data that would increase our quota, or allocations or whatever or percentage of allocations, because that is what we probably should have had, because it really reflects our fishery. We tried to make the argument back when we passed this, is that our estimate was that it was about 40 to 50,000 pounds. But we had to base it on one year's data. Now we can document that that actually is accurate, and that is what we would be looking for through this addendum.

CHAIRMAN CLARK: Rob, is this on the same issue?

MR. O'REILLY: I think my request is based on not the hard work of the working group, I don't doubt that one bit and I know how that must have been. But with the first iteration of what we saw as quotas, by the time we sat down at the next meeting that was swept away, and we had another set. Then we had yet another set.

I will say that each time, speaking for Virginia, there was a lower quota. But my real issue is that I'm not sure everyone saw all three iterations just to really compare and say, yes the last decision by the working group is solid; or was it a case that everyone was worn out with the whole process and wanted to say, you know what, let's go with this. That is my contention with it and that is why I'm making the request.

MR. WHITE: Someone that served on the committee with Russ, we spent a lot of time and a lot of effort and a lot of agony on this. There was a lot of compromise. I think this is way premature to dig this back up again. Allocation is never easy. There are always winners and losers, and we wrestled with that. The committee believed they limited the winners and losers to the least possible amount. I certainly wouldn't support going back into this at this point.

CHAIRMAN CLARK: Thank you, Ritchie.

MS. LYNN FEGLY: This is probably part of the discussion that we would have in February, but we are under this plan right now where if we fire a trigger, we have to almost immediately, well we have to immediately revert to these state-by-state quotas. I just want to place some cautions so that our industries aren't blindsided if we are going to revisit allocation at the same time that we're getting ready to revisit allocation. They kind of need to know what's coming at them. We just need to consider carefully why we're under this trigger scenario, how that's all going to play.

CHAIRMAN CLARK: I think we're starting to have the discussion we would have in February. Let me just hear from the board, should we wait until February if we want to pursue this further? At this point, since there does not seem to be full

consent to just put this on the agenda for February, in that case we would need a motion to add this to the agenda for February, or shall we just see how the agenda develops as we get to that point?

MR. O'REILLY: **I don't mind making a motion to add this to the February agenda to revisit, which may not end up being changed necessarily, but I think we all need to know what happened. Revisit the allocation and the transfer systems.** I have one comment to go along with that and that is, when we compile the allocation schemes, we also at the same time were very aware that with a coast wide cap, we didn't necessarily expect the trigger at that time to be pulled. Now we're sitting in a situation where there is going to be action.

I think that flavors this whole situation a little bit to take a look. Again, it doesn't mean change but I for one am very curious to see how we got from the first stage of allocation to the last stage. I could collect all the data and do it myself, but I think it would be good for everyone to see that. I do recognize New York's situation throughout the process.

CHAIRMAN CLARK: You made a motion and Jim, you seconded the motion. Who would like to speak to the motion? Do we have any in favor? Okay, well, we have a question?

MR. McKIERNAN: My question is are we talking about New York making a logical case for bringing forward estimates of unreported catch and therefore raising the overall quota, or are we talking about New York and other states trying to reconfigure the pie shares of the allocation scheme.

CHAIRMAN CLARK: I believe it's the latter, Dan, to reallocate what's there. I mean changing the pie; obviously it's in the board's purview to do that also. But I believe the current discussion is about reallocating what we set as a cap. Does anybody wish to speak to the motion, in favor or against?

MR. PATRICK AUGUSTINE: This is a case where our state did not collect the data or have it collected and evaluated and we're bringing it to the table at a later date, so it is a fairness issue. It is not a matter of whether or not some state, in this case New York, is trying to get more than a fair share.

I do think in all fairness it should be put back on the table to revisit it, and as a part of it have the Technical Committee, one of the options in this would be to have the Technical Committee go back and revisit the distribution. As a second option I think I would like to put on there that we go back and look at a possible state-by-state reallocation as a different issue.

MR. KELIHER: Knowing how much work went into the subcommittee discussions and then if my recollection is right, a day and a half of arm wrestling here at this table. It concerns me to open this up, and I think I will remind the board that we're talking about yellow eels here. This was all done in context with all life stages of the species, including elvers. I would certainly like a little bit more elver quota while we're talking about this. I mean is that where we want to go, I don't think so. I'm very concerned about this approach, and would not support the motion.

MR. GILMORE: Well, maybe this will serve as the poster child of one of the things we need to do, is if we're going down quota management for many of our species, we're going to have to be able to adjust them. We have too many species that we – quota management isn't something that is set in stone, it violates the substance and the basis of fisheries management.

You have to be able to get new data and be able to adjust stuff. As much as I agree, and I know the working group went through a lot of hell

trying to get these allocations identified. But we're talking about valid data. It is actually what Dan had said. I think it was actually Option 1. If we had a new stock assessment it would be nice to be able to increase the total of the coast wide quota and then reallocate, and maybe we'll get to that point. But we're going to have to figure out when we get new data, how we're going to be able to use that to adjust things over time. We just can't leave it; well, we did it we're never changing it again, because it is difficult. I'm very much in favor of the motion.

DR. DANIEL: I had to step out for just a minute so if it has already been said, I apologize. But certainly we were happy with the allocation in North Carolina. I know that if it changes then ours is going to absolutely go down. I think we have a bigger issue here aside from just eels, and that is with these quota managed species and the problems that it is creating for us at the end of the year in trying to do allocations.

We get asked a lot for different species, and we're always willing to provide bluefish and other species to other states. But we run the risk of getting the fishery shut down. One of the policy decisions that I think is even more important than this one, is to somehow reassess and refigure how we do our quotas, so that we come to the end of the year and if we're whole and we haven't gone over the quota we're good.

That way you don't have to do all these transfers of quotas that take up a lot of staff time to develop, when we know we're probably going to end up with under harvesting eels this year and next year, based on the market conditions and yet New York is going to have to close their fishery, because they feel like they might not have had the best shot at the last allocation.

I think it is a bigger issue than just eels. I certainly think with summer flounder, it's a mess. With bluefish, it is a mess. With spiny dogfish it can be. Maybe it is a bigger issue. I'm going to vote against the motion, just because I'm going to lose about 25 percent of my quota if they change it, and that's just a selfish reason. But I think the bigger issue is the quota management.

MR. WHITE: I have a question for Jim. In your looking at the data and what you think your quota should be increased, have you determined then where that quota will come out of? What state then do you feel had an unfair amount, and then you would be asking that state to give up quota for you, because that is what the committee dealt with. It is a give or take. Someone has got to give up something for you to gain something.

MR. GILMORE: Well, I think the problem we got into and why we didn't fight as hard was that we thought the transfers were going to cover this, in fact I believe the states of Maryland and North Carolina both committed at the board meeting that they would cover New York. But then again, you look at 2014, and they weren't going to have enough to cover and there wasn't enough on the coast to cover us.

The two anomalies in 2010, I think, were New York and North Carolina. Louis is right. I mean, Louis would be, since he won the lottery that year in terms of eels; he just got a lot of extra quota anyways. He would probably lose, but again it wasn't anything one state against the other. It is a matter of the data of one year to a determinant allocation was probably not the right way to go on this.

MR. BALLOU: I would note that we're currently carrying out the thrust of this motion, we're having a discussion; and that's all the motion seeks to do. It really is a motion to continue the discussion in February, as I see it. I don't see any downside to continuing the discussion. I guess I'm just wondering though, with regard to menhaden I'm well aware that we're about to

look at allocation, because the amendment called for a revisiting, I believe, two years after the adoption. Is there any such provision in the eel plan? The question really is if we don't have this discussion now or continue it in February, is there a provision for circling back to it at some point?

MR. WAINE: Off the top of my head I don't believe there is a revisit provision in the addendum, but remember to the adoptive management process the board could revisit allocation at any point. But there is no specific provision like there is in Amendment 2 for menhaden.

CHAIRMAN CLARK: We've started going into a lot of discussion we would be having in February anyhow, but at this point it is probably a good idea that we vote on this motion. Do states need a few seconds to caucus on this? Oh excuse me, let me read the motion.

The motion is; Move to add to the February agenda a discussion to potentially revisit the Addendum IV allocation; the motion by Mr. O'Reilly, second by Mr. Gilmore. All those in favor; please vote by raising your hands. All those opposed. Abstentions? Are there any null votes? One null vote; all right, the motion carries 11 to 3 to 2 to 1. Circling back, Bob, you had a question not on this issue.

MR. BALLOU: Yes, my question is on this TC recommendation that states implement harvester reporting. That would certainly be inconsistent with Rhode Island's dealer based reporting. I believe Massachusetts and maybe some other states are in the same boat. There were a lot of good comments on the issue.

I guess I'm trying to understand how it might play out. Would that become a compliance issue, or could it become a compliance issue? There are a series of implementation plans that have been submitted. I believe the board is about to vote on those. I think that is a pending action. Rhode Island has put forward its current program of dealer-based reporting.

I understand there is not a compliance issue now. Would there be or could there be if we moved into quota management? I'm just trying to understand the way forward. Then my last point would be, maybe this is an item that we should also put on the February agenda to circle back to.

CHAIRMAN CLARK: I think it's just a recommendation from the TC, Bob. But I'll let Mike -

MR. WAINE: I think the cleanest way to do this, Bob, is that in the motion that approves the addendum implementation plans the board would deal with the TC recommendations, basically; whether approving them with the harvester-only reporting and the other TC recommendation, which is sort of getting the landings data available in early spring.

I think that is the cleanest way to track this is through the motion, approving in the addendum implementation plans for all the states. The board can either include the TC recommendations in that motion or exclude them based on the discussion that happened this morning. Does that make sense?

CHAIRMAN CLARK: Well, maybe at this point then we're ready for a motion to consider the Addendum IV implementation plans, and whoever makes the motion can decide whether to add the TC recommendations or not.

MR. AUGUSTINE: Move to approve the implementation of Amendment IV today. Bear with me for one moment, Mr. Chairman. Withdraw my motion.

MR. DOUG GROUT: I would move to approve the Addendum IV Implementation Plans with the recommendations of the Technical Committee.

CHAIRMAN CLARK: Is there a second? Second, Roy Miller. I'll open it up for discussion now. Doug, did you want to speak to the motion?

MR. GROUT: No, I'll pass on that.

CHAIRMAN CLARK: Anybody have any comments they would like to make on this?

MR. GILMORE: I suspect that Florida was one of the flies in the ointment here. I called Mike one day and I said, here's how it works in Florida. First of all, American eels are freshwater fish in Florida, and so they are not part of our reporting system. We have a permit system that the freshwater folks have for the harvest of yellow eels.

What happens is the fishermen catch the eels, they store them for a long time in tanks, maybe up to a month; and they wait for somebody out of state to come get them. That happens some years. In other years we have a few dealers, two or three dealers that actually buy the eels. We were stuck with the problem of - first of all, we don't have any rules or laws that compel the dealers to report freshwater fish.

We're kind of stuck with how we're going to do it. I don't like the fact that we have to consider using our harvester reporting system, because we have a lot of them; and when we come close to reaching our allocation we're going to have to make a bunch of telephone calls. For us this is a problem. It is probably worse, frankly, than it was for menhaden. But I think at least we have somewhat accurate reporting.

CHAIRMAN CLARK: Any other discussion? Seeing none; are we ready to vote on this motion?

MR. WAINE: I was just sort of thinking about this motion and I'm wondering if with the TC recommendation creating some heartburn for some of the commissioners around the table. Remember the process here. The TC is recommending harvester reporting and getting our landings together in early spring. I think some of the issues might be with the harvester reporting component of that.

I'll just reference back to the question that Pat asked about sort of it being them using dealer reporting to be able to adequately account for their landings and having a mechanism in place that they can account for the harvester reporting as well. Just remember that I don't think this means if you don't have harvester reporting that you're out of compliance. You just need to demonstrate that ultimately you have a mechanism in place that is capable of dealing with the concerns that the Technical Committee has raised. Hopefully that provides a little bit of clarification where we're at.

CHAIRMAN CLARK: I'll read the motion. **It is move to approve the Addendum IV implementation plans with the recommendations from the Technical Committee; motion by Mr. Grout, seconded by Mr. Miller. With that, let's vote. Those in favor; please raise your hands. Those opposed; any abstentions? Any null votes? Okay, the motion carries unanimously.**

CONSIDER APPROVAL OF 2015 AND 2014 FMP REVIEWS AND STATE COMPLIANCE

CHAIRMAN CLARK: That closes that item, which was Agenda Item 6; now we move on to consider approval of 2015 and 2014 FMP Reviews and

state compliance. Mike Waine will walk us through it.

MR. WAINE: In the interest of time I'm going to focus on the 2015 FMP Review, which is a review of the 2014 fishing season. Just starting on the fishery, the state reported landings for yellow and silver eels were just over a million pounds in '13 and a slight bit higher in '14. The biggest harvesters are New Jersey, Maryland, and Virginia.

In terms of glass eels the landings, the total just over 20,000 pounds in '13 and about 12,500 pounds in '14. I just want to highlight that there are new glass eel harvests in Florida that amounted to 343 pounds in 2013 and 965 pounds in 2014. But since the state of Florida has closed that fishery and if you are wondering why there was harvest in Florida, the board had exempted Florida from implementing the minimum size requirements until a fishery was documented.

Once that fishery was documented, it was closed. In terms of recreational harvest, the recreational data on eels is quite uncertain for the obvious reasons of the active fishing sites along the coastal not being able to really characterize eel recreational harvest; so just a note about that.

Where we stand in terms of stock status, we had a 2012 assessment. The stock is currently depleted. There was a DBSRA model, but that model did not produce useable reference points for management. However, given the depleted status the board acted to reduce fishing mortality on all life stages, and they implemented an Addendum III and Addendum IV, which I'm going to quickly walk us through.

This is just to give you an idea of where we're at. We had a plan originally in 2000 and then the most recent two addenda that ultimately really created some change that is worth noting, so I'll sort of focus on those. When I go into each of these regulations I've separated this out by life stage to make it a little bit easier to follow.

The measure you'll see is associated with a date. That date relates back to whether it was part of the original FMP or subsequent addenda. In terms of the glass eel fishery, when we implemented the fishery management plan all states had to implement a YOY survey and all states must maintain their current regulations which they had in place at that time.

Since that point through Addendum 3, there was a measure for a maximum of 25 pigmented eels to be per pound of glass eels caught. That was through the use of a one-eighth inch mesh to grade the eels to eliminate pigmented eels from the harvest of glass eels. Noting in 2014 that that was a year that Maine self-imposed voluntary quota as shown on the screen. I've grayed out these other measures, which came in Addendum IV, which is implemented in 2015; so that will be part of next year's review. This is focusing on 2014 review. In terms of the PRTs review of glass eel fishery regulations, I'll highlight again the harvest of the glass eels that occurred in Florida. The board had exempted the implementation of regulations until Florida demonstrated that fishery, and Florida has since closed through the implementation of a 9 inch minimum size.

Moving to yellow eels, as everybody is aware, we've increased the minimum size to 9 inches. There is a half-by-half inch mesh size requirement for yellow eel pots. There is allowance of an escapement for three years of a half-by-half inch four inch panel. In that addendum there was also the implementation of a recreational bag limit of 25 fish with that size limit as mentioned earlier; with the exception of the crew and captain of for-hire vessels can possess 50 fish for charter uses.

PRT review of the fishery regulations, a couple things to note here, Connecticut's implementation of the escape panel was delayed but they expected to have that in place by very recently, so maybe an update on that. Then D.C. implemented an implementation of a 9-inch minimum size was also delayed. They have since implemented that 9 inch minimum size.

As we all know, Delaware had not implemented any of these measures and we went through the out of compliance process. Ultimately, there will be a moratorium on March 18, 2016, unless Delaware comes back into compliance with the plan. In terms of silver eel fishery regulations, there was a seasonal closure from September 1st through December 31st. There is no take allowed except from baited pots, traps, and spears.

The other gears can be fished but you cannot harvest from those gears, those eels need to be released. There was also one year exemption for the Weir fishery in Delaware River and its tributaries in New York, and remember that the grayed out portion of this slide is what happened in '15, which New York basically got the nine permits to be to manage that silver eel fishery in the Catskills.

In terms of the PRT reviews of the silver eel component, the state of Massachusetts does not prohibit hook and line gear from September 1st through December 31st, but questions the need. The idea here is that the silver eels are not feeding on their out migration, which was the intent of that regulation to limit the harvest of those silver eels, which is why you're only allowed baited pots.

Ultimately Massachusetts is questioning, are these eels going to even be caught with hook and line, because they're not feeding to begin with. Then Florida does not prohibit pound nets from September 1st through December 31st, but non-active fishery has existed in the state for the last 10 to 15 years.

There are a few other management measures that are in the addendum. Actually mostly in Addendum IV are the sustainable fishery plans, but there is also trip level reporting that is required at least monthly. To go into that a little further the PRT's review of that is that New Hampshire and New Jersey do not have dealer reporting, but harvesters report some information on dealers.

The states of Delaware jurisdiction PRFC and Florida do not have dealer reporting at this current time. Those are the regulations. This is the de minimis status request, which allows states to apply if their preceding two year average is less than 1 percent of the coast wide commercial landings for that life stage. For eels, we do it by life stage. New Hampshire, Massachusetts, Pennsylvania, D.C., South Carolina and Georgia all requested de minimis status for their yellow eel fisheries, and all those states and jurisdictions have met the 1 percent landing criteria. Just a quick note that South Carolina requested de minimis status for glass eels, but they did not meet the 1 percent landings criteria for that life stage.

In terms of sort of wrapping this report up, the PRT recommendations are that the board considers the state compliance as mentioned; the glass eels, Florida having closed that fishery, the yellow eels with the delayed implementation and the note that Delaware has already been found out of compliance on this by the board, and the silver eel measures the gear closures that I mentioned on the previous slide and the reporting of the states as mentioned.

The other thing is that the PRT recommends that the board approve the de minimis request for New Hampshire, Mass., Pennsylvania, D.C., South Carolina, and Georgia. That was a very

quick run through of this report. I would be happy to answer any questions that the board has. Ultimately, we would be looking for a motion to accept the review and approve de minimis status for the states as listed.

CHAIRMAN CLARK: Do we have any questions or is there a motion?

DR. DANIEL: **Move approval of the PRT recommendations with all the de minimis and caveats as presented.**

MR. GROUT: Yes, move approval; second.

CHAIRMAN CLARK: All right, we have the motion up. The motion is to move to accept and approve the compliance reports, FMP Review and de minimis request. The motion was by Dr. Daniel and seconded by Mr. Grout. Is there any discussion of this motion? Yes, Emerson.

MR. EMERSON HASBROUCK: I have a question. During the review I think it was stated that South Carolina did not meet de minimis status, yet the recommendation is to include South Carolina with de minimis; or maybe I misunderstood. Could you clarify, please?

MR. WAINE: Sorry, I blazed through that report. It is based on life stage, so they qualify for yellow eels but they don't qualify for glass eels. I think really all these de minimis requests are for the yellow eel stage; either the board can accept that understanding or we could improve the motion by stating that.

MR. ROY MILLER: If this motion is approved I am curious as to the discussion we held earlier today concerning the desirability of harvester reporting as opposed to dealer reporting. The review points out that I think there were four jurisdictions that don't have dealer reporting. Is the importance of that limitation now eliminated by the emphasis on harvester reporting?

MR. WAINE: I wish it was straightforward, but let me try to walk you through it. The addendum requires harvester and dealer reporting; that is trip level information reported at least on a monthly basis. Then subsequently upon Addendum IV implementation plan review, the Technical Committee recommended using harvester reporting. But that action was separate from the original implementation to require both dealer and harvester reporting. I think, ultimately, this is a board decision about whether the requirement as listed in Addendum 3, how to interpret that requirement relative to the recommendation that the Technical Committee made. I think just to try to take a step back from deep in the weeds. The intent here is to get the most accurate information for the harvest of eels across all life stages.

Just remember that I think that the requirement for harvester and dealer reporting was to get to that goal. I think, ultimately, the question as Plan Review Team Chair that I would have is the board comfortable with everything we've talked about relative to reporting in the structure? Do they feel comfortable that that captures the intent of getting the best, most accurate harvest information for eels moving forward?

MR. MILLER: If I may follow up just briefly. Then it is not really a compliance measure as to whether a jurisdiction has done dealer or harvester reporting at this point in time. Is that what you're suggesting?

MR. WAINE: Well, I'm not trying to suggest that at all, because that is ultimately a board decision; that's all I'm trying to say is this is a board decision. I'm just trying to provide a little more context and say that as I talked earlier, there are mechanisms that can be put in place that achieve the goal that aren't necessarily exactly what is written in the plan. I don't know if that helps, Roy.

MR. O'REILLY: Roy brings up a good question there. If we are headed towards quotas and monitoring everything else, I can't believe that it is not going to be important to have the harvester and the dealer reporting. That is the way we set ourselves up in Virginia to take care of that.

As a matter of fact what we do, we have harvester reporting, we have dealer reporting, and we have self-marketer reporting. In certain states you may call it something else, but harvesters who market their product have to have a permit as well. There are all sorts of loopholes we're all looking forward to, and regardless of any thinking by any other committee member, it is going to be pretty tough if you don't have some checks on the system. Typically, in our system when there is a harvest reporting system, the dealers are involved because they can be audited.

They have to hold on to what they have for a year so that what they buy can be matched up to what is sold to them. The wrinkle that developed about 15 years ago is this self-marketer, this harvester who however he wants to retail those fish or get rid of those fish. There are really three components to this and if we're going to cut out any of the components at the board, then be leary because it is going to come back and be a problem, I think.

MR. McKIERNAN: Mike, you had a slide in red that talked about Massachusetts looking for clarification on the occasional take of eels by hook and line in the fall. I just want to get clarity as to whether or not that would be allowed; otherwise, we have to go to rule making. I'm concerned that somebody fishing the banks of the Charles River may catch an eel on Labor Day weekend, and I don't want to make them a criminal.

MR. WAINE: It's a board decision. Maybe we can think about how to either have the board acknowledge that that is something that they will allow moving forward, or potentially try to perfect the motion to include that. But I appreciate you bringing it up, because it is something that the PRT brought up as a recommendation to consider. I'll also note it is not just Massachusetts, but Florida has a pound net regulation as well that is not consistent with the Plan.

CHAIRMAN CLARK: Well, given this discussion are there any modifications to the motion that we have there or would the board like to move ahead with voting on the motion as is? Seeing none; let's call this motion. Oh I'm sorry, Dan.

MR. McKIERNAN: If I could make a friendly or a substitute motion to exempt hook and line fisheries from those gears banned under the silver eel regulations as part of the plan. Would that make sense? My motion would be, move to accept and approve the compliance reports, FMP Review and de minimis requests, in addition, exempt hook and line gear from the silver eel conservation measures.

CHAIRMAN CLARK: Is that acceptable to the maker of the motion? It would have to be a substitute. Okay, this is now a substitute motion and it needs a second. Is there a second? Dave Simpson. We have a question, Tom Fote.

MR. TOM FOTE: I think this is out of order. All we're doing is accepting a report. After we accept the report then you make a motion whether you want to do things; that's a board action. But all we're doing here is to accept the report that was made to us. We don't have to implement everything in the report, so I think that is kind of out of order. If you want to make a motion after we pass accepting the report that is a whole different ball game.

CHAIRMAN CLARK: In that case, we're back to the original motion. We're going to vote on the original motion, and then add the next - okay got it. **Is everybody ready to vote then on the motion on the board; which is move to accept and approve the compliance reports, FMP Review and de minimis requests? The motion was by Dr. Daniel and second by Mr. Grout. All in favor; all opposed; the motion passes unanimously.** I guess at this point then, Dan.

MR. McKIERNAN: If I could make a motion to exempt hook and line gear from the silver eel conservation requirements.

CHAIRMAN CLARK: After the previous discussion, there is no need for this motion?

MR. WHITE: Point of order, Mr. Chair. I believe that we don't have the ability to do this; that this would take an addendum. This is changing the fisheries management plan, I believe.

MR. WAINE: Let me give this a shot. As the PRT outlined, there are a couple compliance issues with the current plan, as written. Ultimately, I think the board has the option to deal with those compliance issues as brought up by the PRT. This is a board decision, remember. If the board deems that the compliance issues are not issues because they essentially meet the intent of the core requirements as listed in the addendum, then they could ultimately decide that yes.

We understand that meets the intent and there is no need to move forward with a motion from Dan or a motion from another state that deals with the PRT recommendation. But if the board feels that that is not consistent with the intent of the plan, then I think that there needs to be some action taken to address that.

MR. WHITE: Wouldn't the correct motion then be to exempt Massachusetts from the hook regulation, not exempting the hook regulations from the FMP.

MR. WAINE: My interpretation would be to try to simplify this even further is that the board accepting the FMP review, and in doing that they acknowledge that the PRT has raised these concerns, but the board feels like that still matches the intent of the plan and there is no reason to move forward with further action as addressed. If the board understands that, then I think the simplest way out of this would just be to acknowledge that, and there is no need for us to get sort of "down the rabbit hole" on the specific motions.

CONSIDER APPROVAL OF A DEADLINE WAIVER FOR THE AQUACULTURE PLAN

CHAIRMAN CLARK: I am going to take that as a let's just proceed, get back to the agenda. We have a final action item; it is to consider approval of a deadline waiver for the aquaculture plan under Sustainable Fishery Management Plan Section of Addendum IV. This request is coming from North Carolina, so I'll turn it over to Louis Daniel to explain this.

DR. DANIEL: Here we are again. The issue that has arisen in North Carolina, as many of you may have known we've been trying to secure an aquaculture permit for American eel farm for, gosh, now three years. We feel like we've got a good plan to present, but keep waiting until June to submit it in a September action which is what is required in the addendum.

We're going to lose another year of the potential to be able to harvest these glass eels. I am not asking for approval of obviously the plan; that has to be reviewed by the Technical Committee and the Law Enforcement Committee. If the board is willing to allow me to submit that plan December 1, we could act on it at our February meeting, and that gives the Technical Committee basically the same amount of review time as it would in the addendum.

I could go on and on and probably bore you to death with all the specifics of the aquaculture plan. Our main thing right now is trying to find those locations where harvest could occur that would meet the Technical Committee's requirements. We'll have that information available December 1. I don't know if I need a motion, Mr. Chairman or just by consensus of the board if they would agree to allow me. **But if a motion would be better, I'll make that motion to accept North Carolina's aquaculture plan on December 1, 2015 for board action in February.**

CHAIRMAN CLARK: First of all, any questions about the motion that Louis is making? Again, this under the Aquaculture Plan of Addendum IV, which allows the take of up to 200 pounds of glass eels from an area that would not - I forget what the wording is, but it is essentially not very productive to eels. Any questions for Dr. Daniel?

MR. WHITE: The question would be, is that adequate time for the Technical Committee? Do they have the ability to have an answer for us at the February meeting?

MR. WAINE: I will say that I haven't had a chance to check with the TC on this, but as Louis mentioned, it is essentially the timeframe between June and September that they would have. I think from my perspective, now I'm talking from the coordinator perspective not the TC perspective.

It will really depend on how solid this aquaculture plan is that will enable the Technical Committee to review it relative to the criteria that is required in this aquaculture plan. Basically, what I'm saying is that the better the plan is from North Carolina's sampling, the easier the Technical Committee will be able to turn this thing around.

MR. BALLOU: I am fine with this motion, but to the maker of the motion, Louis, I believe one of the standards of review is that all permits are in place. Correct me if I'm wrong, but if that's the case I just want to make sure you don't proceed. I guess the question is, is it likely that permits would be in place prior to the February meeting?

DR. DANIEL: That's what we're asking for is the permit. I mean I can't issue a permit without the concurrence from the board that I can allow the harvest. I'm prepared. I've got my Law Enforcement Plan, I've got my Technical Plan, we've got all the criteria that are outlined in the Aquaculture Plan will be crystal clear for the Technical Committee's review.

Really from my perspective, the main question really is going to be how do those 200 pounds affect the coast wide population? That is going to be a tough question to answer. But I think as long as we do due diligence to find those locations that aren't in major watersheds, then there shouldn't be a problem, I would hope.

But no, I've got the permit would be issued. There has never been one of these so I've got to create the permit through my commission. But as if I get the approval from the board I will issue the permit to Mr. Allen and American Eel Farm, and then do all the reporting requirements and everything that's required in the Aquaculture Plan and report back obviously. I don't think it says we have to report back to the board, but I would expect you would want those reports back on probably a semiannual or annual basis on what we're doing and how things are progressing.

CHAIRMAN CLARK: Is there any further discussion of this?

MR. FOTE: From what I understand we are just approving that Louis can issue a permit, but the

permit doesn't allow him to fish until the board approves it, if that is my correct understanding.

CHAIRMAN CLARK: Correct. We're not approving this plan at all. This is to change the timetable essentially so that Louis would be submitting the plan to the Technical Committee by December 1st, and then the board would consider it in February. Okay, seeing no further questions, I'll read the motion and then we'll vote.

Move to accept North Carolina's aquaculture plan for submission on December 1st, and board consideration at the February, 2016 Meeting. The motion was by Dr. Daniel and seconded by Mr. Gilmore. Is there any opposition to this motion? Seeing none; then I guess we'll just consider it passed by consent.

ADJOURNMENT

Is there any further business to come before the board here? Seeing none; I will say that we are adjourned.

(Whereupon, the meeting was adjourned at 11:50 o'clock a.m., November 3, 2015.)

North Carolina Aquaculture Plan for American Eel Pursuant to Addendum IV to the ASMFC Interstate Fishery Management Plan for American Eel

North Carolina Department of Environmental Quality
Division of Marine Fisheries
PO Box 769
Morehead City, NC 28557

January 2016

BACKGROUND

In October 2014 the Atlantic States Marine Fisheries Commission (ASMFC) adopted Addendum IV to the Interstate Fishery Management Plan for American Eel (http://www.asmfc.org/uploads/file//55318062Addendum_IV_American_Eel_oct2014.pdf). Addendum IV implemented a provision allowing states and jurisdictions to submit an Aquaculture Plan to allow for the limited harvest of American eel glass eels (hereinafter "glass eels"). Specifically Addendum IV states:

> *"Under an approved Aquaculture Plan, states and jurisdictions may harvest a maximum of 200 pounds of glass eel annually from within their waters for use in domestic aquaculture facilities provided the state can objectively show the harvest will occur from a watershed that minimally contributes to the spawning stock of American eel. The request shall include: pounds requested; location, method, and dates of harvest; duration of requested harvest; prior approval of any applicable permits; description of the facility, including the capacity of the facility the glass eels will be held, and husbandry methods; description of the markets the eels will be distributed to; monitoring program to ensure harvest is not exceeded; and adequate enforcement capabilities and penalties for violations."*

Pursuant to Addendum IV to the Interstate Fishery Management Plan for American Eel, the North Carolina Division of Marine Fisheries (NCDMF) is submitting the following Aquaculture Plan for approval. The NCDMF has selected tributaries in watersheds where the state can objectively show American eels in these areas minimally contribute to the spawning stock of American eel. Only one aquaculture operation, the American Eel Farm (AEF), has requested to be included in the Aquaculture Plan for consideration.

POUNDS REQUESTED

North Carolina requests to harvest 200 lb. of glass eels, the maximum amount allowed under the Aquaculture Plan provision of Addendum IV to the Interstate Fishery Management Plan for American Eel.

DATES OF HARVEST

Glass eels shall be harvested from February 22, 2016 through May 31, 2016 or until 200 lb. of glass eels are harvested, whichever occurs first.

DURATION OF HARVEST

Since the initial Aquaculture Plan is only valid for one year the duration of harvest requested is limited to the 2016 glass eel harvest season. A renewal plan will be submitted by June 1, 2016 and at that time additional harvest years will be requested along with any modifications deemed necessary to ensure the success and continued approval of the plan.

METHOD OF HARVEST

NCDMF will limit the number of individuals authorized to harvest under this plan (3 individuals including the permittee). Glass eels shall be harvested using either fyke nets or dip nets. Fyke nets shall be constructed as follows:

- Shall be thirty (30) feet or less in length from cod end to either wing tip
- Shall be fitted with netting that measures 1/8-inch bar mesh or less
- Shall contain a ½-inch or less bar mesh excluder panel that covers the entrance of the net
- Shall have no more than one funnel, two cod ends, and two wings

Dip nets shall be constructed as follows:

- Shall be no more than 30 inches wide at the widest point of the net mouth
- Shall be fitted with netting that measures 1/8-inch bar mesh or less

To mitigate the harvest of elvers (fully pigmented eels), all captured eels shall be graded upon capture on the water using a 1/8-inch bar mesh non-stretchable grading screen and any eels that fail to pass through the screen will be immediately returned to the water where captured. Any eels that pass through the screen will be harvested and count toward the 200 lb. annual glass eel harvest limit.

MINIMAL CONTRIBUTION JUSTIFICATION

While we have no quantitative data on the abundance of glass eels, it could be argued the harvest of 200 lb. of glass eels in itself is small enough to have a minimal impact on the spawning stock of American eel (see Appendix 1).

The ASMFC allows the harvest of adult females migrating to the Sargasso Sea in the Chesapeake Bay watershed. The Chesapeake Bay watershed contains more than 150 major rivers and streams that flow into the Chesapeake Bay's 64,299 square mile drainage basin, covering parts of six states NY, PA, DE, MD, VA, WV, and the District of Columbia. Approximately 75% of the coast-wide yellow eel harvest occurs in this watershed. The entire North Carolina yellow eel harvest (all watersheds combined) accounts for approximately 7% of the total annual coast-wide yellow eel harvest.

The harvest of adult females migrating to the Sargasso Sea to spawn from the Chesapeake Bay watershed compared to the harvest of 200 lb. of glass eels in North Carolina where approximately 195 lb. would otherwise die if left alone is comparatively harmless to the spawning stock of American eel (assuming a mortality rate of ~97-98% for glass eels).

To further mitigate the impact to the spawning stock, proposed harvest sites will be located in areas that have been impacted by human activity. Development in and along estuaries, rivers, and streams may have a negative impact on eel health, growth, and survival. Machut et al. (2007) found the condition (weight) of American eels in six tributaries of the Hudson River in New York was significantly lowered with increasing riparian urbanization. Intense urbanization in the watersheds of these creeks and rivers has hardened the natural landscape, limiting their capacity to infiltrate and store rainfall as they did prior to development. Mallin et al. (1998) conducted a four year review of the tidal creeks of New Hanover County, NC where the authors

demonstrated a very close parallel between water quality in the creeks and the amount of impervious surfaces in the watershed. Water quality in coastal waters is negatively impacted when the natural landscape is changed by drainage, hardened surfaces, and vegetation removal. Altering the land cover in an area by adding roofs, driveways, parking lots, yards, ditching, cutting down trees and underbrush all drastically change the hydrology of a watershed. Contaminations of heavy metals, dioxins, chlordane, and polychlorinated biphenyls as well as pollutants from nonpoint source can bioaccumulate within the fat tissues of the eels, causing dangerous toxicity and reduced productivity (Hodson et al. 1994). Unlike discharge from "point sources," such as water treatment plants, nonpoint source pollution is becoming increasingly difficult to control and regulate as populations in coastal North Carolina continue to increase.

The Shellfish Sanitation and Recreational Water Quality Section of the Division of Marine Fisheries is responsible for monitoring coastal waters as to their suitability for shellfish harvest and monitoring and issuing advisories for coastal recreational swimming areas. All of the proposed sites occur in creeks or rivers that are fully or partially closed to shellfish harvest due to unacceptably high levels of fecal bacteria (http://portal.ncdenr.org/web/mf/shellfish-closure-maps) and often suffer from chronic, stream-wide oxygen problems. Despite being able to live in a wide range of temperatures and different levels of salinity, American eel are very sensitive to low dissolved oxygen levels (Hill 1969, Sheldon 1974). Shellfish closures and swimming advisories are indicators of poor water quality and some of these waters are classified as "impaired" (Category 4 or 5) under Section 303(d) of the Clean Water Act by the North Carolina Division of Water Resources (NCDWR; http://portal.ncdenr.org/web/wq/ps/bpu/watershed-plan-map). These designations were considered when choosing primary and alternate harvest sites as eels in these waters are likely to experience greater physiological stress and potentially higher mortality compared to eels in other areas.

In addition, North Carolina will direct harvest away from protected areas such as National Wildlife Refuges, National Estuarine Reserves, National Forests, National Seashores, North Carolina Coastal Reserves, North Carolina State Parks, North Carolina Preserves, North Carolina Strategic Habitat Areas, and Natural Heritage Natural Areas.

LOCATION OF HARVEST

North Carolina's internal waters are classified as either inland, joint or coastal fishing waters. The North Carolina Marine Fisheries Commission (NCMFC) and NCDMF have jurisdiction of coastal waters while the North Carolina Wildlife Resources Commission (NCWRC) has jurisdiction of inland waters and both agencies (NCWRC and NCMFC/NCDMF) have authority within joint waters. Other than a few specific regulations, none of which pertain to American eel, commercial activities and recreational activities using commercial gear (devices) occurring in joint waters is under the jurisdiction of the NCMFC/NCDMF.

Glass eels actively migrate toward land and freshwater and ascend rivers during the winter and spring. It has been demonstrated, in European glass eel, that this change in behavior was caused by the detection of the odor of freshwater, as well as temperature gradients (Facey and Van Den Avyle 1987). By limiting the proposed harvest sites to small coastal systems, large areas of freshwater habitat were removed from consideration, thus lessening the potential impact to the overall spawning stock of American eel. North Carolina will approve ten (10) primary sites and three (3) alternate sites should there be little or no success harvesting glass eels at the primary sites. Alternate sites will only be used if attempts have been made to harvest from all primary sites and they are found to be unproductive. This will be determined at

the discretion of the NCDMF and will take into account the amount of effort put forth at the primary sites, the number of pounds of glass eels harvested, and the timing within the recruitment season.

No sites are located within the Albemarle Sound estuary system. The region's watershed contains the Chowan, Roanoke, and Pasquotank river basins and is approximately 8,000 square miles, encompasses over 5,000 miles of freshwater rivers and streams and over 930,000 acres of brackish, estuarine waters. The Chowan, Roanoke, and Pasquotank are three major rivers that flow into the Albemarle Sound estuary (APNEP 2016). On average, the Albemarle Sound area has accounted for approximately 96% of yellow eel landings from 2010 – 2014. By directing glass eel harvest away from this area there should be little impact to the existing yellow eel fishery. In addition, no sites are located within the Tar-Pamlico River Basin. This basin is approximately 6,000 square miles and encompasses over 2,500 miles of freshwater rivers and streams and over 660,000 acres of brackish, estuarine waters.

Primary Sites

North Carolina proposes to direct glass eel harvest to areas likely to minimally contribute to the spawning stock based on criteria such as basin size, waterbody length, habitat condition, and proximity to the Atlantic Ocean (distance from an inlet). Specifically, primary harvest sites will be located in two small coastal river basins, the Lumber and White Oak (Figure 1). These river basins contain smaller watersheds which include; creeks, streams, lakes, reservoirs, and sections of rivers. Proposed primary harvest sites meet one or more of the following conditions: 1) drainage basin includes residential areas, 2) drainage basin includes industrial areas, 3) drainage basin includes agricultural areas 4) small waterbody less than 7 miles in length, 5) proximity to the Atlantic Ocean, or 6) classified as “impaired” by the NCDWR (Table 1).

Directing glass eel harvest to waterbodies in close proximity to the Atlantic Ocean (via inlets) increases the likelihood of harvesting newly recruited glass eels versus elvers compared to more inland areas. In addition, the number of glass eels per pound is higher compared to the number of elvers in a pound. Therefore, if only glass eels are harvested, the aquaculture facility would have a higher yield (in number of eels) available for grow out. Other benefits from directing glass eel harvest to smaller coastal systems include:

1) Decrease potential interaction with parasitic swim bladder nematode (Hein et.al., 2015)
2) Increased survival in the aquaculture facility if harvested before first feeding event
3) Harvested eels coming from impaired areas have not started to feed and bioaccumulate contaminants

Primary Glass Eel Harvest Sites (~ 2.9 miles average length):

1.) Bradley Creek, New Hanover County (~2.5 miles; Figure 2, Figure 13)
2.) Futch Creek, New Hanover and Pender counties (~2.1 miles; Figure 3, Figure 13)
3.) Goose Creek, Carteret County (~1.2 miles; Figure 4, Figure 14)
4.) Howe Creek, New Hanover County (~2.8 miles; Figure 5, Figure 13)
5.) Mill Creek, Pender County (~0.9 miles; Figure 6, Figure 15)
6.) Queen Creek, Onslow County (~6.8 miles; Figure 7, Figure 16)
7.) Sanders Creek, Carteret County (~0.9 miles; Figure 8, Figure 14)
8.) Saucepan Creek, Brunswick County (~3.2 miles; Figure 9, Figure 17)
9.) Shallotte River, Brunswick County (~6.9 miles; Figure 9, Figure 18)
10.) Whiskey Creek, New Hanover County (~1.3 miles; Figure 10, Figure 13)

Alternate Sites

Proposed alternate harvest sites are small creek systems located near the mouth of the Neuse River (Figure 1) and meet one or more of the following conditions: 1) drainage basin includes residential areas, 2) drainage basin includes industrial areas, 3) drainage basin includes agricultural areas, 4) small waterbody less than 7 miles in length or 5) classified as "impaired" by the NCDWR (Table 1).

Alternate Glass Eel Harvest Sites (~3.0 miles average length):

1.) Dawson Creek, Pamlico County (~5.4 miles; Figure 11, Figure 19)
2.) Orchard Creek, Pamlico County (~1.9 miles; Figure 12, Figure 20)
3.) Pierce Creek, Pamlico County (~1.7 miles; Figure 12, Figure 21)

MONITORING PROGRAM

To monitor and regulate the harvest of glass eels the NCDMF will issue an Aquaculture Collection Permit (ACP) to the AEF. To aid in monitoring and enforcement the NCDMF will limit the number of individuals authorized to harvest under the ACP (3 individuals including the permittee). All individuals listed on the ACP must possess a valid North Carolina Standard Commercial Fishing License (SCFL) or Retired Standard Commercial Fishing License (RSCFL) issued by the NCDMF. Only individuals listed on the ACP shall participate in the harvest of glass eels. Any vessels used for glass eel harvest under the ACP shall have a valid North Carolina Commercial Fishing Vessel Registration (CFVR) issued by the NCDMF. Restrictions will be placed on the ACP requiring certain conditions and procedures to be followed, such as:

General Conditions

- No more than three (3) individuals (including the permittee) shall be authorized to harvest under the ACP
- Individuals must agree to warrantless inspections and searches of any gear, vessels, equipment, vehicles, and their person
- Individuals and vessels participating in the glass eel harvest must be properly licensed by the NCDMF and abide by all fisheries rules and permit conditions
- Fyke nets and dip nets are the only gear authorized to use for glass eel harvest under the ACP
- No more than five (5) fyke nets and/or dip nets (five pieces of gear total) may be fished by an individual designee under the ACP
- A fyke net may not be placed within fifty (50) feet of any part of another fyke net
- Fyke nets and dip nets for glass eel harvest may only be fished and the cod ends closed from two hours before sunset to two hours after sunrise
- From two hours after sunrise through two hours before sunset the gear may remain in the water and the terminal portion of a fyke net cod end contain a rigid device with an opening not less than three (3) inches in diameter and not exceeding six (6) inches in length that is not obstructed by any other portion of the net
- Tamper evident tags shall be used to secure the cod ends of the net closed while the gear is fishing

- Tamper evident tags shall be used to secure the cod ends open when the gear is not fishing
- Immediately report to NCDMF if a net is tampered with including the location of the net and the date and time it was noticed
- All gear shall be removed from the water from 11:59 pm on Friday through 12:01 am on Monday (similar to South Carolina regulation). This creates a 48-hour rest period to allow glass eels to migrate up these smaller systems to help minimize the impact to the spawning stock.
- All gear and harvest restrictions detailed in the Method of Harvest section will be listed as conditions under the ACP

Before Harvest

- Fishermen harvesting glass eels under the ACP shall call-in to NCDMF the following information:
    - Weekly: GPS coordinates of each net once they are set, if nets are moved during the week the new coordinates must be immediately reported once the nets are reset
    - Daily:
        - Landing site they will be leaving from and returning to once fishing activity is complete
        - Names of individual(s) involved
        - Number of fyke nets and dip nets that will be used
        - Description and registration number of the boat(s) to be used for harvest
        - Description and license plate number of the vehicle(s) to be used for transport

During Harvest

- Require the use of a 1/8-inch bar mesh non-stretchable mesh grading screen to cull the glass eels at the harvest site to limit the harvest of elvers
- Record the time the gear began and ended fishing and the estimated number of pounds of glass eels harvested from each piece of gear (individual fyke or dip net)

After Harvest

- Require each fisherman harvesting glass eels under the ACP to call-in to NCDMF the estimated harvest in pounds to the nearest 0.25 lb. prior to leaving the harvest site and report an estimated time of arrival at the landing site. Zero pounds shall only be reported if no glass eels are harvested.
- Once all gear is fished, the fisherman must travel directly to the designated landing site
- Once at the designated landing site all eels must be offloaded and transported directly to the AEF facility
- Require AEF to hold all glass eels that perish during transport to the facility and all eels that perish in the facility for inspection
- All glass eels that perish during transport will count against the 200 lb. harvest limit
- Require AEF to call-in to NCDMF by noon each day the total harvest in pounds to the nearest 0.25 lb. of glass eels received (including those days when no glass eel harvest occurred). Zero pounds shall only be reported if no glass eels are harvested and received.

The above conditions and procedures will allow the NCDMF to limit the effort (amount of gear and number of individuals) involved in glass eel harvest under the Aquaculture Plan. Dual reporting by the fishermen on the water and by the AEF will allow the NCDMF to monitor the 200 lb. glass eel harvest limit. These controls will allow the NCDMF to ensure the glass eel harvest does not exceed what is authorized in the Aquaculture Plan. Any harvest that exceeds the 200 lb. harvest limit shall be immediately returned to the water where captured.

ENFORCEMENT CAPABILITIES AND PENALTIES FOR VIOLATIONS

The North Carolina Marine Patrol has four officers stationed in Brunswick County, three officers in New Hanover County, two officers in Pender County, three officers in Onslow County, six officers in Carteret County, two officers in Craven County, and two officers in Pamlico County.

Violations of the ACP permit conditions will be addressed according to the NCDMF SOP for Permit Violations and suspensions will be carried out in accordance with NCMFC Rule 15A NCAC 03O .0504 (see Appendix II).

All charges for violations will be charged under N.C. General Statute § 113-187 (d) (4): Violating the provisions of a special permit or gear license issued by the Department. All fines will be at the discretion of the court, however fines may not always be levied for the first offense.

The call-in requirements under the Monitoring Program section will allow enforcement officers to know when and where lawful harvest is occurring. It will also allow for random inspections to take place at the harvest and landing sites to ensure the conditions of the permit and all applicable NCMFC rules and regulations are being followed. Random inspections will also be performed at the aquaculture facility to ensure the proper records are being kept to account for all eels in the facility as required under N.C. General Statute § 113-170.3 and NCMFC Rule 15A NCAC 03O .0502 (8) (see Appendix III).

SIZE LIMIT EXEMPTION

The intent is to raise the eels as close as possible to the legal minimum size of 9 inches total length prior to sale. Given the difficulty in measuring live eels, prior to sale, all eels shall be graded using a ½-inch by ½-inch non-stretchable mesh grading screen. Any eels that do not pass through the grading screen may be sold and any that pass through the grading screen shall remain in the possession of the AEF until such time as the eels are large enough to not pass through the grading screen. On inspection, a 10% tolerance by number will be allowed for eels that pass through the grading screen.

PRIOR APPROVAL OF PERMITS

The AEF has all necessary permit approvals in place with the exception of an Aquaculture Collection Permit from the NCDMF. This permit will be issued upon approval of the Aquaculture Plan by the ASMFC American Eel Management Board. The permits currently held by the AEF are:

- North Carolina Department of Agriculture Aquaculture Operation Permit valid until 2017

- North Carolina Division of Marine Fisheries Aquaculture Operation Permit renewed annually. To be eligible for an ACP, an Aquaculture Operation Permit is required (see Appendix IV: NC Marine Fisheries Commission (NCMFC) Rule 15A NCAC 03O .0501 (e))
- US Fish & Wildlife Import / Export permit renewed annually
- North Carolina Division of Marine Fisheries Standard Commercial Fishing License
- North Carolina Division of Marine Fisheries Dealer License
- North Carolina Farmer Tax Exempt Permit

As noted in NCMFC Rule 15A NCAC 03O .0501 the appropriate licenses from the Division of Marine Fisheries must be held by the permittee or designees. A North Carolina Standard Commercial Fishing license is required to fish commercial gear such as fyke nets, a Commercial Fishing Vessel Registration (CFVR) is required for vessels used to harvest seafood and a Dealer License is required to sell fish taken from the coastal fishing waters. The AEF will need to secure these licenses before the ACP is granted.

DESCRIPTION OF THE MARKET

The AEF indicated they have identified clients for food and bait markets domestically as well as overseas. The long-term intent is to develop and expand the US domestic market as much as possible. For proprietary business reasons specific details were not provided.

DESCRIPTION OF THE FACILITY

American Eel Farm

Design, Capacities and Technical Facts

The AEF, located in Trenton, North Carolina, is a state-of-the-art Recirculated Aquaculture System (RAS) which has been operating since 2003 (https://www.youtube.com/watch?v=4YnQn7aivw4). It is a proven Danish system designed overseas for eel grow-out and imported to the US. The AEF was initially operated in North Carolina as the North Carolina Eel Farm (corporate filing date May 21, 2002). The facility has a 13-year operation history. There is no other facility specifically designed to grow out glass eels to yellow eels at a commercial level in the US. The facility has the capacity to grow out in excess of 900 pounds of glass eels. There is historical proprietary data on a large scale commercial level that no current fish farm, University, or government agency in the US can match.

The facility has three separate closed recirculating systems. The two main systems are identical RAS units each containing twelve (12) 1,000 gallon tanks and independent water treatment systems for both RAS units. Each RAS contains twelve (12) raceway tanks with 900 US usable gallons. The tanks are not operated at full capacity since eels are capable of escaping the tanks. Each raceway tank is equipped with a fine mesh screen outlet cover with a motorized brush system, to keep the mesh clean. In each tank there are also water level switches that activate an alarm if the water level gets too high. Each tank is outfitted with aeration and back-up emergency oxygen lines which automatically activate in case of a power

outage. Each tank also has the ability to be isolated from the system and individually cleaned if necessary without draining entire system.

There are three automatic feeders for the first three tanks that are ideal for the small eels. As they are graded the larger eels can be fed by hand or additional automatic feeders can be installed.

There is a new (1 year old) Pacific Oxyguard water quality monitoring system that monitors pH and oxygen saturation levels. The system has the ability to send alarms remotely and is programmed to call to a farm manager's cell phone if oxygen levels drop or the pH levels fluctuate. The system can be expanded by adding more test probes and programming if desired.

This system design is based on proven *Anguilla anguilla*, *A. mossambica*, *A. bicolor* and *A. marmorata* aquaculture techniques. The systems are technically sound, energy efficient, and easy to operate. The system has been successful with American eels as proven by recorded growth rates, low food conversions and low incidence of disease and mortality.

Attached to those 24 tanks is a complete water treatment unit equipped with a HydroTech drum filter type 803 / 40 micron mechanical filtration unit. This unit has a max flow of 31,500 gal/hour or 63,000 gal/hour if both sections are in operation. The two drum filters sieve feces and other large particles out of the water. The filters are continuously sprayed (adjustable timing possible) with water to self-clean. The waste water runoff from this event drains into a small channel within the drum filter and then drains into a system pipe which gravity feeds into the main channel in the tank room that runs the full distance from tank #1 to tank #24 where the waste water is then pumped into a small pond on the property by a sump pump through a 12" PVC drain pipe.

After mechanical filtration, water is gravity fed into 2 parallel 18 foot tall silos (four total for both sections) with patented Inter Aqua Advance (IAA) A/S Moving Bed Bio Reactor (MBBR) technology for biological treatment of the water (removal of ammonia and dissolved organic matter). Each silo has a volume of 1,300 gallons and is 55 % filled with IAA bio-curler bio media. This technology is superior to simple trickling filter bioreactors in that the attached blower motors run constantly to keep the media moving. This also acts as a self-cleaning process within the silos and contributes to the CO_2 stripping process.

With an optimum temperature for the growth of the eel at 24 degree C. or 74 degree F. The water treatment unit will be able to handle up to 250 lb. dry feed per day per section (500 lb. per day total). After the MBBR water flows by gravity into a common pump sump.

The water can be circulated with 3 separate pumps (per section, 6 pumps total), one 3 HP Low Head main pump and two 3 HP medium pressure pumps with 20 psi into two oxygen-cones (per section 4 total) for supersaturating of liquid oxygen into the water. In total the 3 pumps give a minimum flow capacity of 31,500 gal/hour (63,000 gal/hour total).

There is a carbon dioxide stripper for tanks #1 - #24 which has counter flow packed tower technology and utilizes structured packing of vacuum formed sheets of PVC. These packing's will provide maximum wettability, thereby maximizing the stripping effort.

The UV system has recently had the bulbs updated. The water passes through the device and the UV lighting assists in disinfecting the water by destabilizing the DNA of germicidal bacteria.

However there have been reports that a UV disinfection system is not needed with eels so this system may be reconsidered.

There is a back-up liquid oxygen system tied into the main oxygen source with two air stones per raceway as a safety net. It is serviced simply by attaching the flow meter to a large liquid oxygen tanks. Should there be the need, the main liquid oxygen source would back feed the tanks with 150 PSI automatically.

The system is supported by three deep water wells all of which are operable and are wired with three phase wiring for better conservation as well as on independent breakers so as to always allow for a water source to be actively supplying water. One is about 300' deep and the other two about 200'. Additionally, there is public water tied into the facility. There is a heating system that can heat the water entering from the wells prior to entering the main water source if needed by passing heated water through several tubes mounted in the well reserve tanks for both sections. These well reserve tanks are equipped with automated on/off valves allowing water to be called automatically from the well when the water level reaches a preset level.

The water is distributed back to the raceway tanks via a common pipe manifold situated on the wall at the end of the tanks, with a separate valve to each tank for maintenance. A flow rate of 31,500 gal/hour (per system or 63,000 gal/hour total) will give an exchange rate of 3 to 5 times/hour to maintain self-cleaning and an adequate oxygen level in the raceway.

There is a third system which has two large 9,000 gallon tanks supported by similar filtration, aeration and small bio-reactors. This system is separate from the other two. Total capacity for AEF is about 50,000 gallons with about 40,000 being usable. Additionally, there is plenty of room to expand on the flat 2 acre site on which the facility is located. With 226 days a year of sun and a mean annual temperature of 70 degrees there is also a great opportunity to develop a medium to large scale aquaponics system on site.

In addition to the main tank room and the state-of-the-art water treatment room there is a main office area, sales office area, a furnished residential area, a full bathroom with laundry, a feed room, packaging room, a mechanical room, an electrical room, storage rooms and two large covered exterior areas one @ 15' X 85' and the other @ 15' X 50'. The grounds are gated and there is a security system with 16 infrared cameras capable of being viewed remotely. The facility has cable connections for internet and TV as well as two satellites for backup. The steel building construction is insulated with pressed foam to help minimize temperature fluctuations on hot or cool days. There is a heating system but it is not necessary to use when system is running due to local climate and the ground water temp of 68 degrees.

With the general geographic location being the Southeast USA along with the well-insulated building the water temperature for maximum growth rate could be efficiently maintained. Trenton, NC has a climate that is very suitable to aquaculture/agriculture in general. The annual average mean temperature is 70 degrees where the ideal temp for grow-out of eels is 74 degrees. There is no snow fall (very rare) and few days below freezing (very rare).

Eel Grow Out

Eels can be stocked in high densities in the raceway tanks. Stocking densities of 300 kg/m^3 or 2(+) lb./gal are often seen in eel farms. It is estimated that juvenile eels have an oxygen demand of 300 mg/kg/hour. The liquid oxygen system at the AEF is sufficient to reduce mortality and sustain eels in high densities. Estimated grow out time from the glass eel phase

to 9 inches averages around 210 days. Individual eels grow at different rates so total grow out time will be longer. Due to the varying growth rates it is estimated that one-third of the eels will be harvested in 5 - 7 months, another group will be harvested at 8 - 10 months, and the rest will be harvested at 11 - 12 months after harvest.

A large mobile stainless steel grading machine in the main tank room will be used to grade the eels every four to six weeks. A well-managed RAS eel farm can expect a weaning rate of 80 - 90%. Eels feed ratio is greater than 1:1 in most studies depending on the amount of protein in the feed. There are studies in Japan and China that show a faster grow out however this outline is one the AEF is comfortable with.

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TABLES

Table 1. Sub Basin and stream characteristics for proposed primary and alternate harvest sites.

			Sub Basin					Stream						
Sub Basin Unit 14-Digit HUC*	Site Name	Site Type	Acres	Square Miles	Percent Urban	Percent Agricultural	Percent Developed	Stream Length (approx. miles)	Surface Water Acres	Shellfish Harvest Prohibited - Prohibited Territory Map	Distance to Atlantic Ocean (miles)	Overall Category	Reason Impaired	Coastal/Joint/Inland Waters
03020106020060	Queen Creek (entrence)	Primary	22,549	35.3	18	13	31	6.8	915	small area not prohibited (entrance)	2.9	Impaired (Cat 5)	Shellfish, Fish Tissue (Hg)	coastal (main stem)
	Queen Creek (lower)							6.8		small area not prohibited (entrance)		Impaired (Cat 4)	Shellfish, Fish Tissue (Hg)	
	Queen Creek (mid)									prohibited		Impaired (Cat 4)	Shellfish, Fish Tissue (Hg)	
	Queen Creek (upper)									prohibited		Impaired (Cat 4)	Shellfish, Fish Tissue (Hg)	
03020106020040	Sanders Creek (lower)	Primary	8,146	12.8	31	8	39	0.9	73	lower section not prohibited	9.3	Impaired (Cat 5)	Shellfish, Fish Tissue (Hg)	coastal (main stem)
	Sanders Creek (mid)									prohibited		Impaired (Cat 5)	Shellfish, Fish Tissue (Hg)	
	Sanders Creek (upper)									prohibited		Impaired (Cat 5)	Shellfish, Fish Tissue (Hg)	
	Goose Creek (lower)	Primary						1.2	233	lower section not prohibited	6.9	Impaired (Cat 5)	Shellfish, Fish Tissue (Hg)	coastal (main stem)
	Goose Creek (upper)									prohibited		Impaired (Cat 5)	Shellfish, Fish Tissue (Hg), Enterrococcus	
03030001040010*	Mill Creek (lower)	Primary	51,667	80.8	18	6	24	0.9	112	prohibited	3.2	Impaired (Cat 5)	Shellfish, Fish Tissue (Hg)	coastal (main stem)
	Mill Creek (upper)									prohibited		Impaired (Cat 5)	Shellfish, Fish Tissue (Hg)	
03030001040020*	Futch Creek (lower)	Primary	44,860	70.2	43	1	44	2.1	155	prohibited	2.6	Impaired (Cat 5)	Shellfish, Fish Tissue (Hg)	
	Futch Creek (upper)									prohibited		Impaired (Cat 5)	Shellfish, Fish Tissue (Hg)	
	Howe Creek (Moore Creek)	Primary						2.8	305	prohibited	1.3	Impaired (Cat 5)	Shellfish, Fish Tissue (Hg), Enterrococcus, Dissolved Oxygen, pH, Turbidity, Chlorophyll a	coastal (main stem)
	Bradley Creek (lower)	Primary						2.5	275	prohibited	2.2	no data, Category 4 Hg Only	Fish Tissue (Hg)	coastal (main stem)
	Bradley Creek (upper)									prohibited		Inconclusive Data (Cat 3)	Fish Tissue (Hg)	
	Whiskey Creek	Primary						1.3	72	prohibited	3.5	Impaired (Cat 5)	Shellfish, Fish Tissue (Hg), Enterrococcus	coastal (main stem)
03040207020060	Shallotte River (lower)	Primary	41,271	64.6	17	10	27	6.9	795	lower section not prohibited	1.3	Impaired (Cat 4)	Shellfish, Fecal Coliform, Fish Tissue (Hg), Mercury, Lead, Nickel, Copper, Zinc, Chromium, Cadmium, Arsenic, Dissolved Oxygen, Water Temperature, pH, Turbidity	coastal (main stem)
	Shallotte River (mid)									prohibited		Impaired (Cat 4)	Shellfish, Fecal Coliform, Fish Tissue (Hg)	
	Shallotte River (upper)									prohibited		Impaired (Cat 4)	Shellfish, Fecal Coliform, Fish Tissue (Hg)	
03040207020090	Saucepan Creek	Primary	6,488	10.2	17	3	20	3.2	86	prohibited	0.7	Impaired (Cat 4)	Shellfish, Fecal Coliform, Fish Tissue (Hg)	coastal (main stem)
03020204060020*	Orchard Creek	Alternate	30,685	48.0	1	4	5	1.9	123	prohibited	35.3	Impaired (Cat 5)	Shellfish, Fish Tissue (Hg)	coastal
03020204060010*	Pierce Creek	Alternate	20,349	31.8	4	12	16	1.7	59	prohibited	36.8	Impaired (Cat 5)	Shellfish, Fish Tissue (Hg)	coastal
03020204040010	Dawson Creek (lower)	Alternate	21,288	33.3	5	25	30	5.4	355	prohibited	42.6	Impaired (Cat 5)	Shellfish, Fish Tissue (Hg), Enterococcus, Recreation Advisory	coastal (lower)
	Dawson Creek (mid)									prohibited		Supporting (Cat 2)		inland (upper)
	Dawson Creek (upper)									prohibited		Impaired (Cat 5)	Fish Tissue (Hg), Benthos Severe	inland (upper)

*Indicates the sub-basin contains multiple waterbodies (streams) and the numbers presented are for the sub-basin as whole and not the individual harvest site.

FIGURES

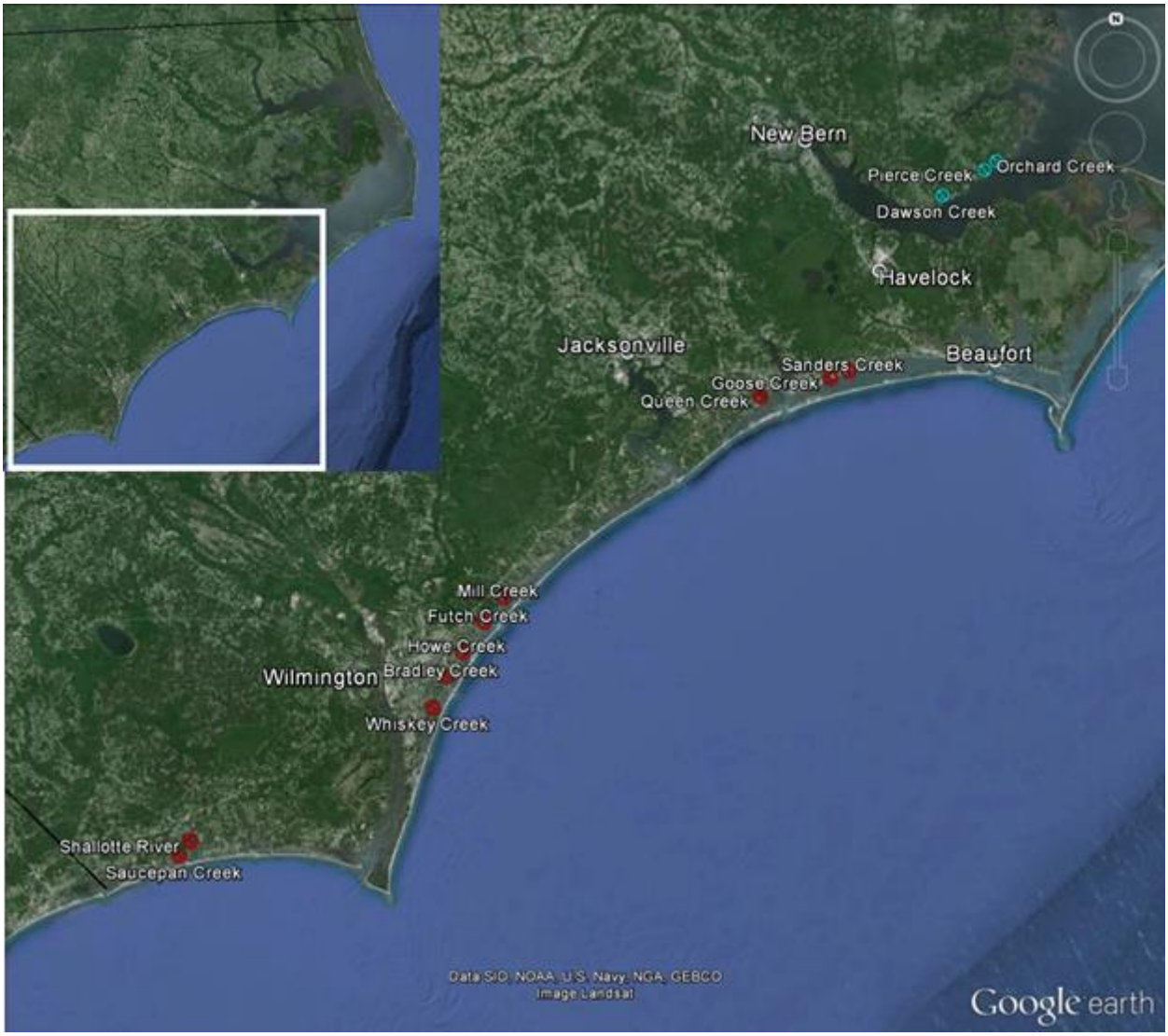


Figure 1. General location of proposed primary (red circles) and alternate (blue circles) harvest sites along the North Carolina coast.

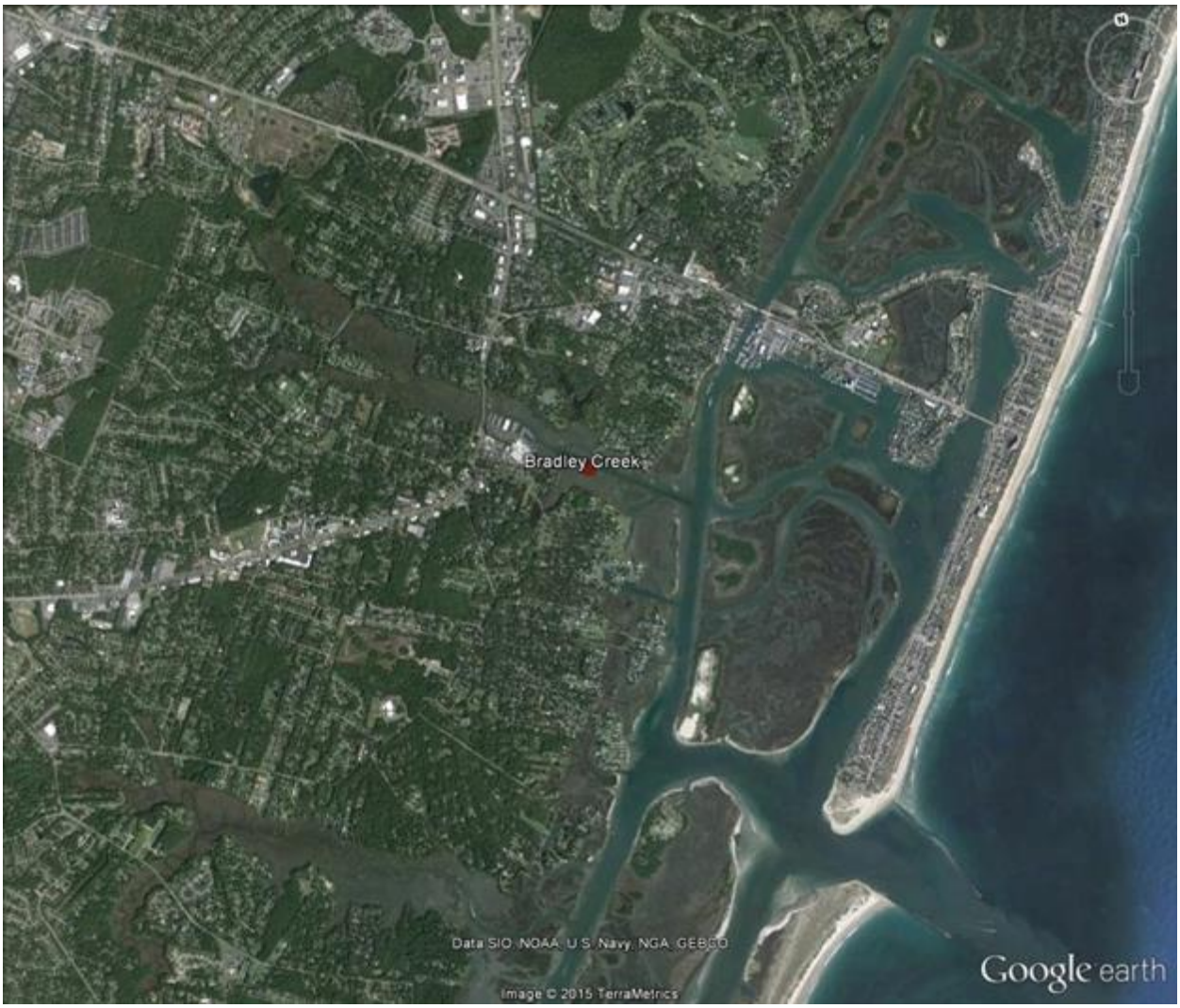


Figure 2. Bradley Creek harvest site.

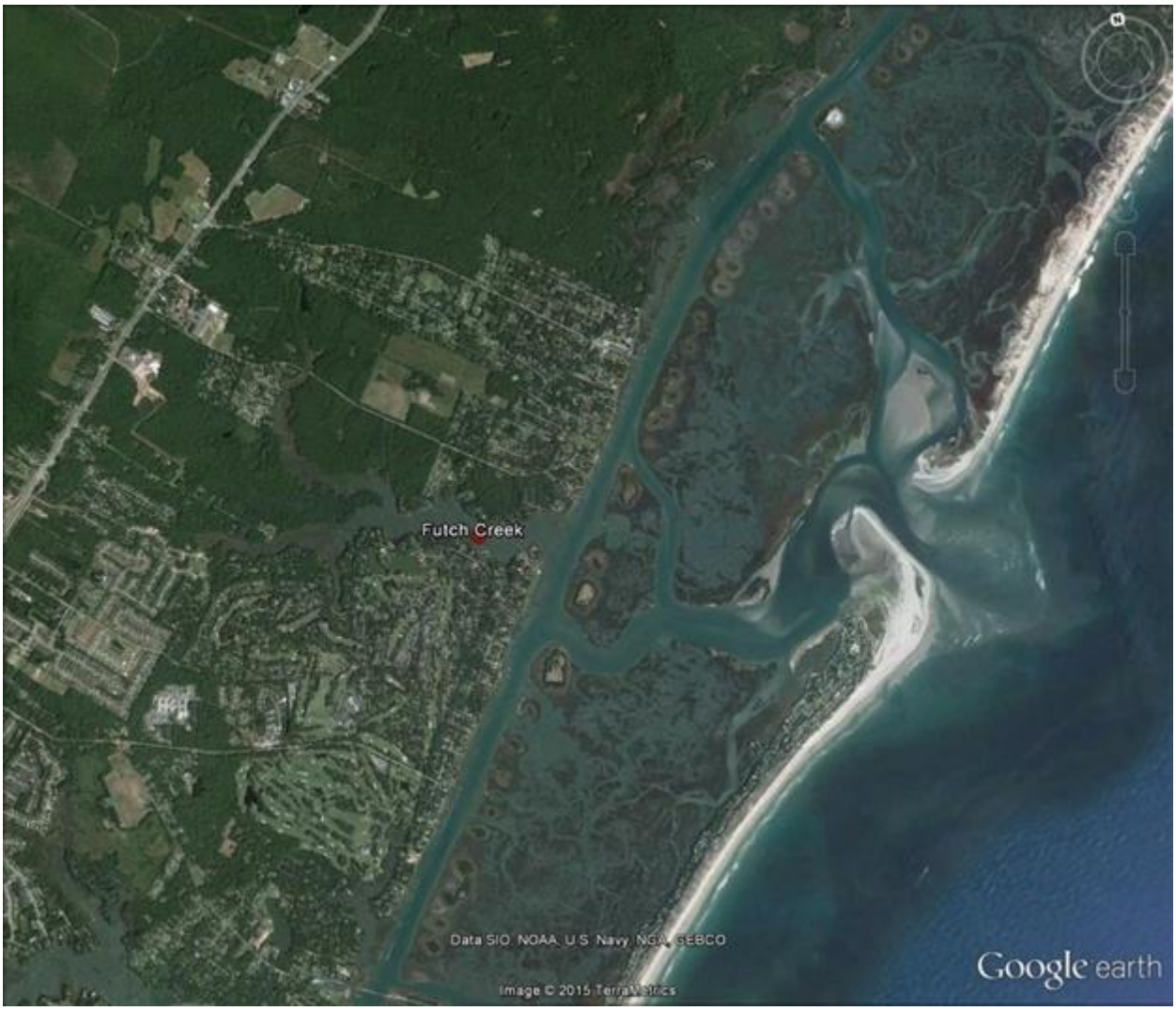


Figure 3. Futch Creek harvest site.

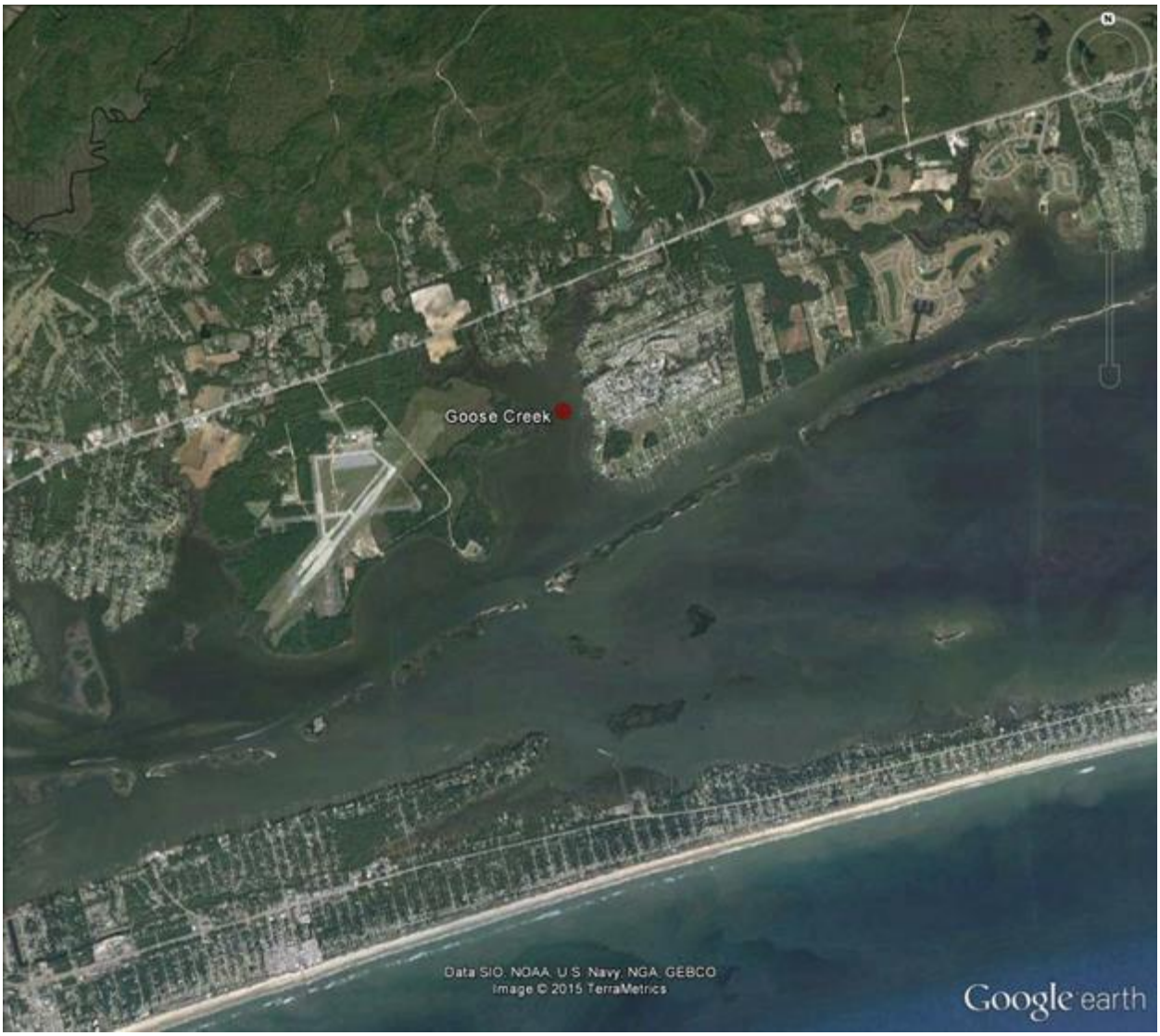


Figure 4. Goose Creek harvest site.

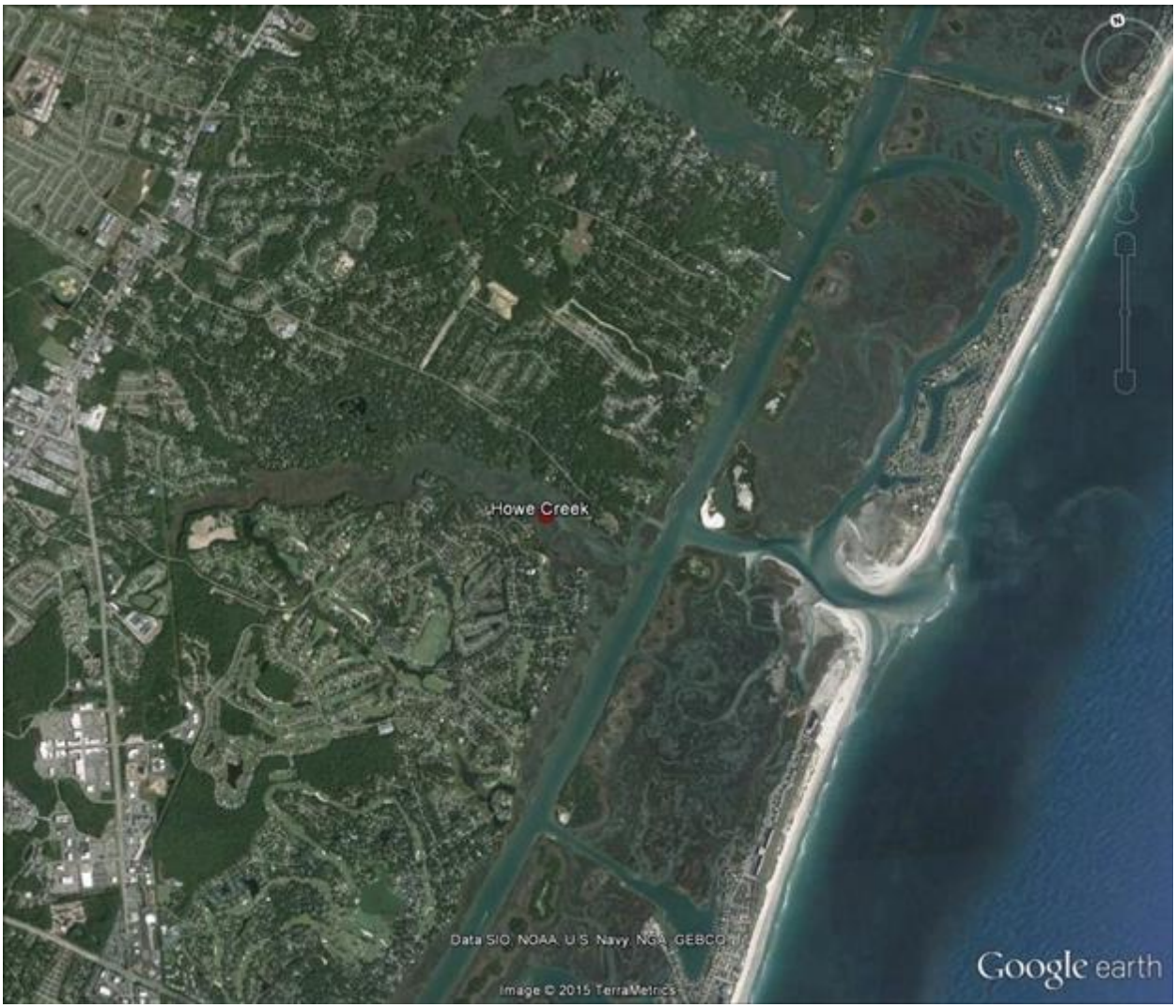


Figure 5. Howe Creek harvest site.

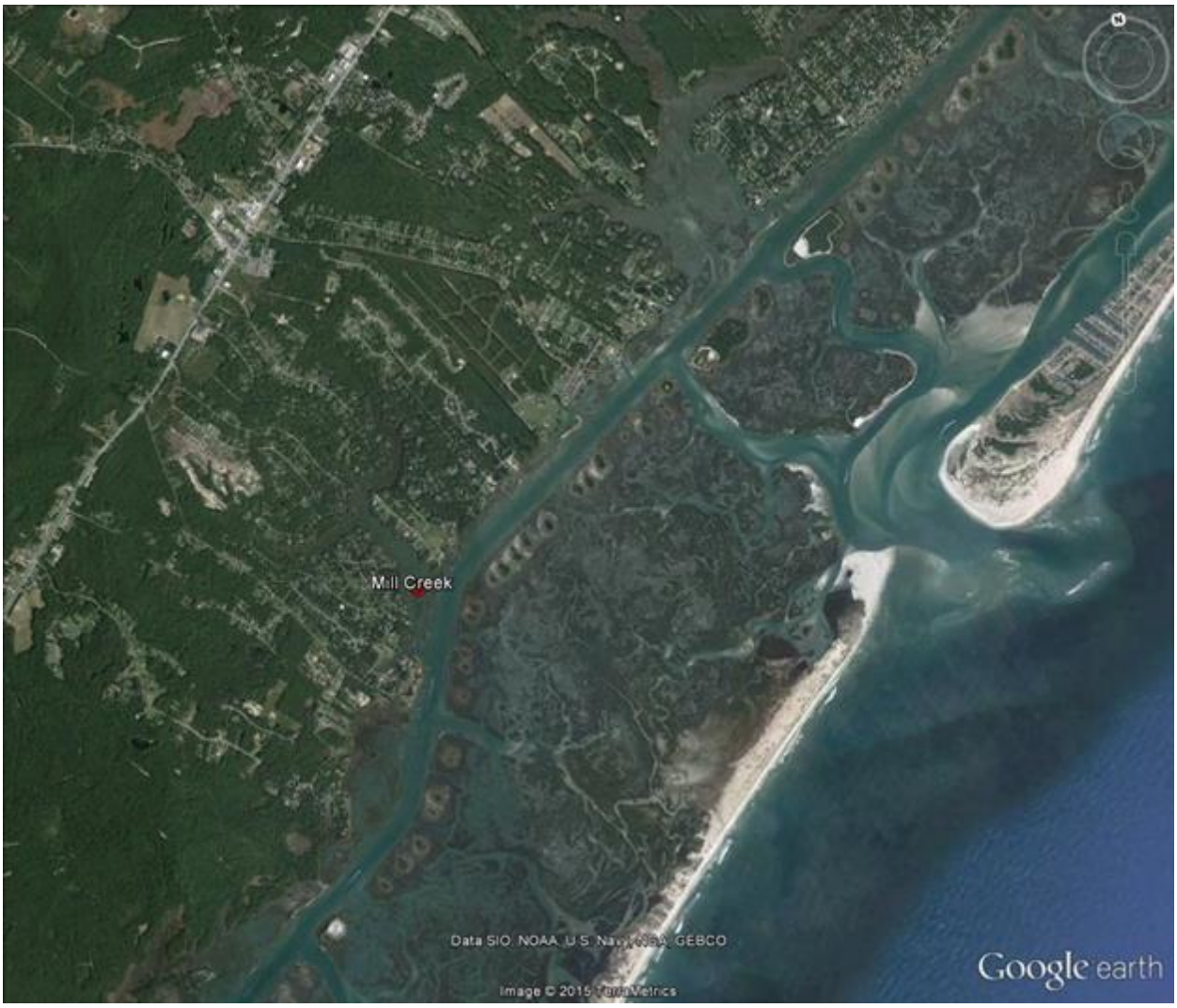


Figure 6. Mill Creek harvest site.

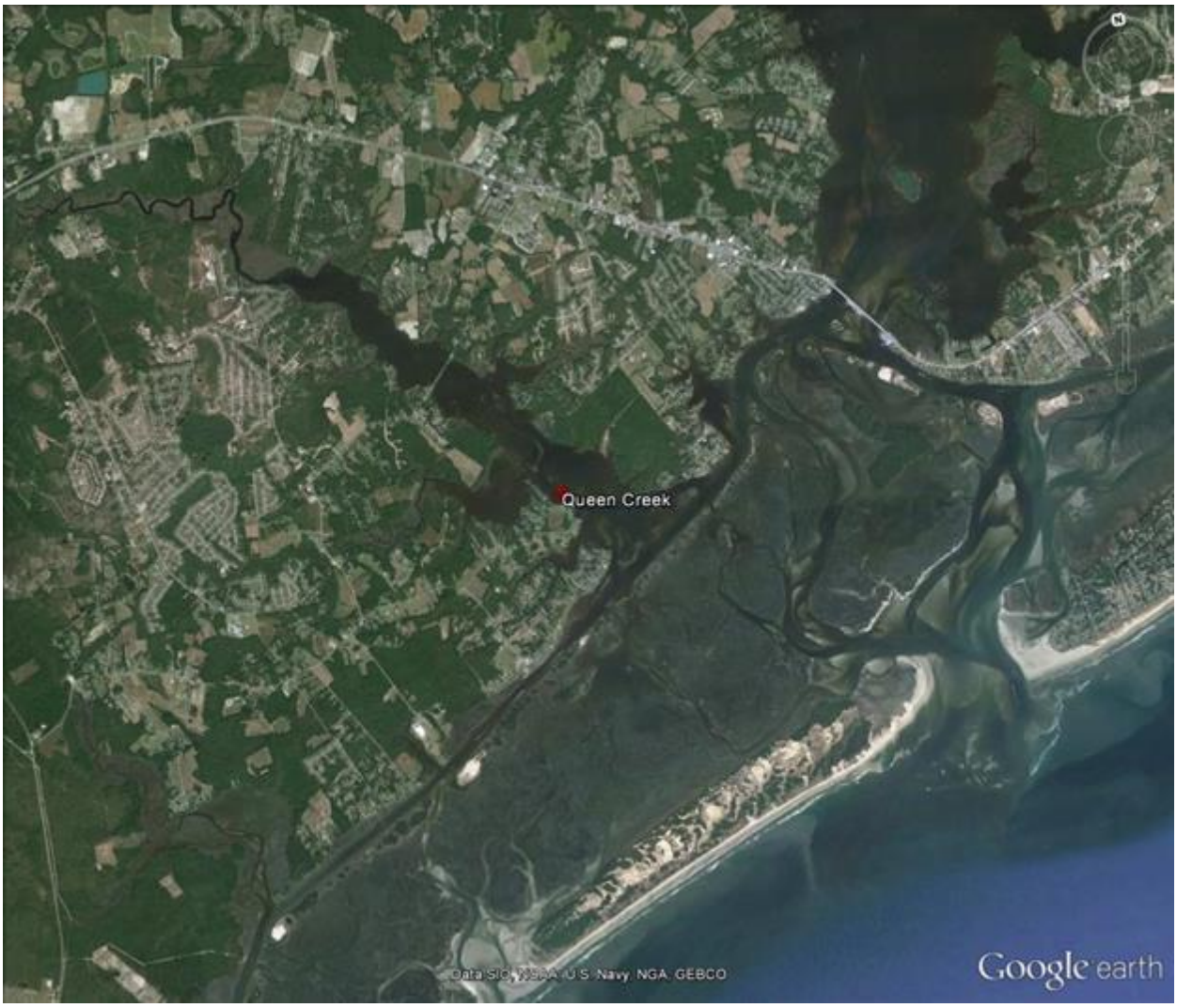


Figure 7. Queen Creek harvest site.

Figure 8. Sanders Creek harvest site.

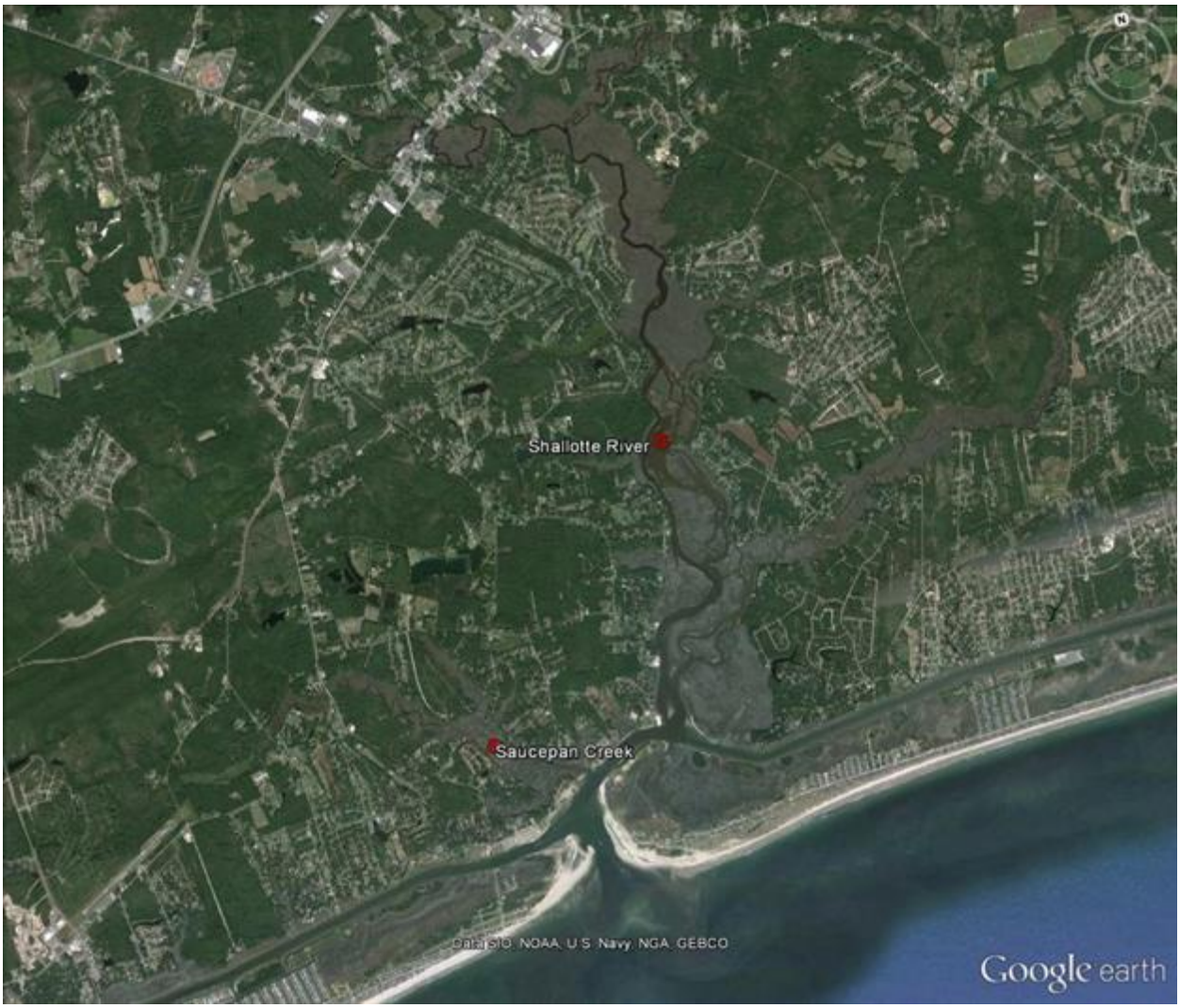


Figure 9. Saucepan Creek and Shallotte River harvest sites.

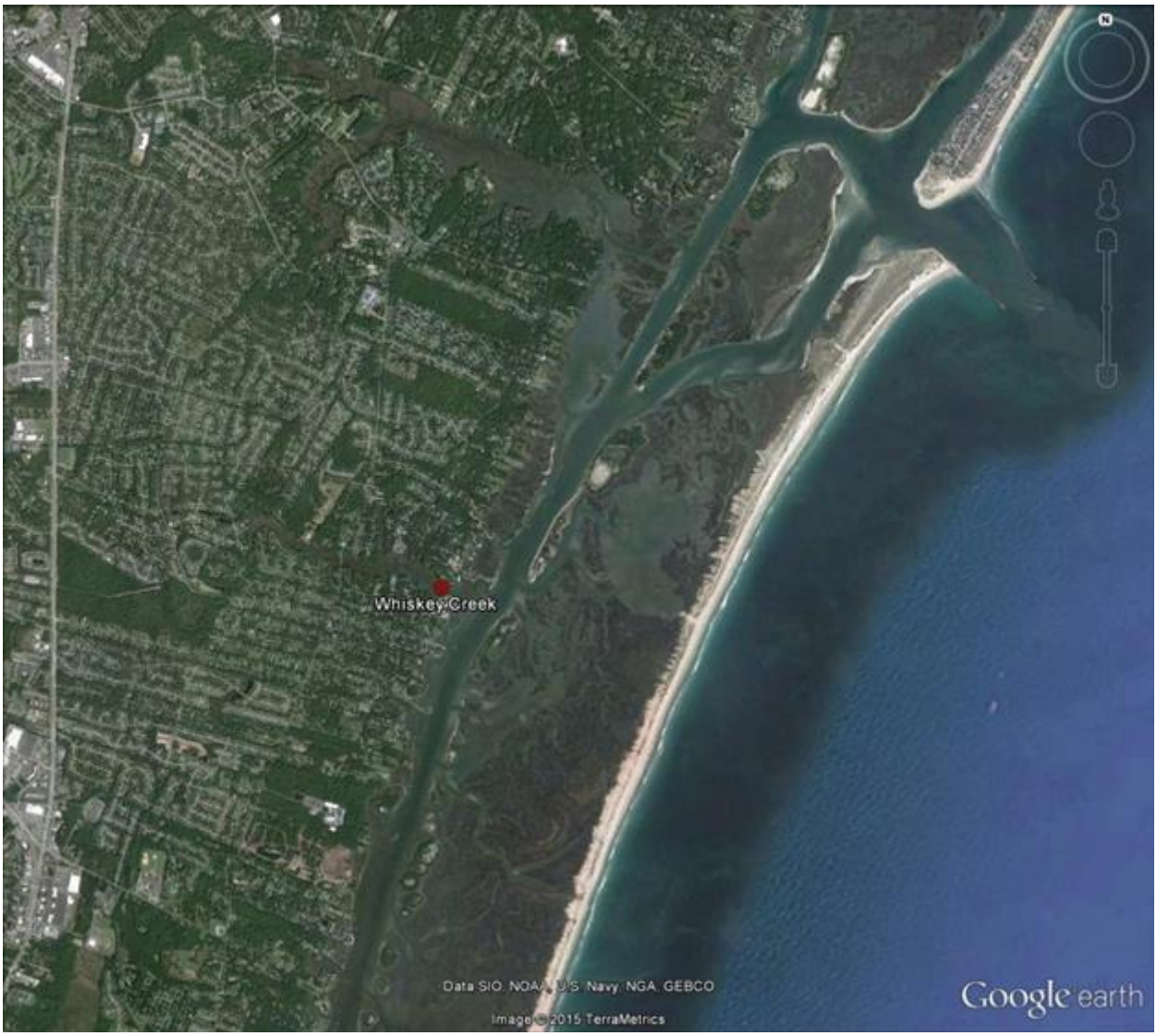


Figure 10. Whiskey Creek harvest site.

Figure 11. Dawson Creek harvest site.

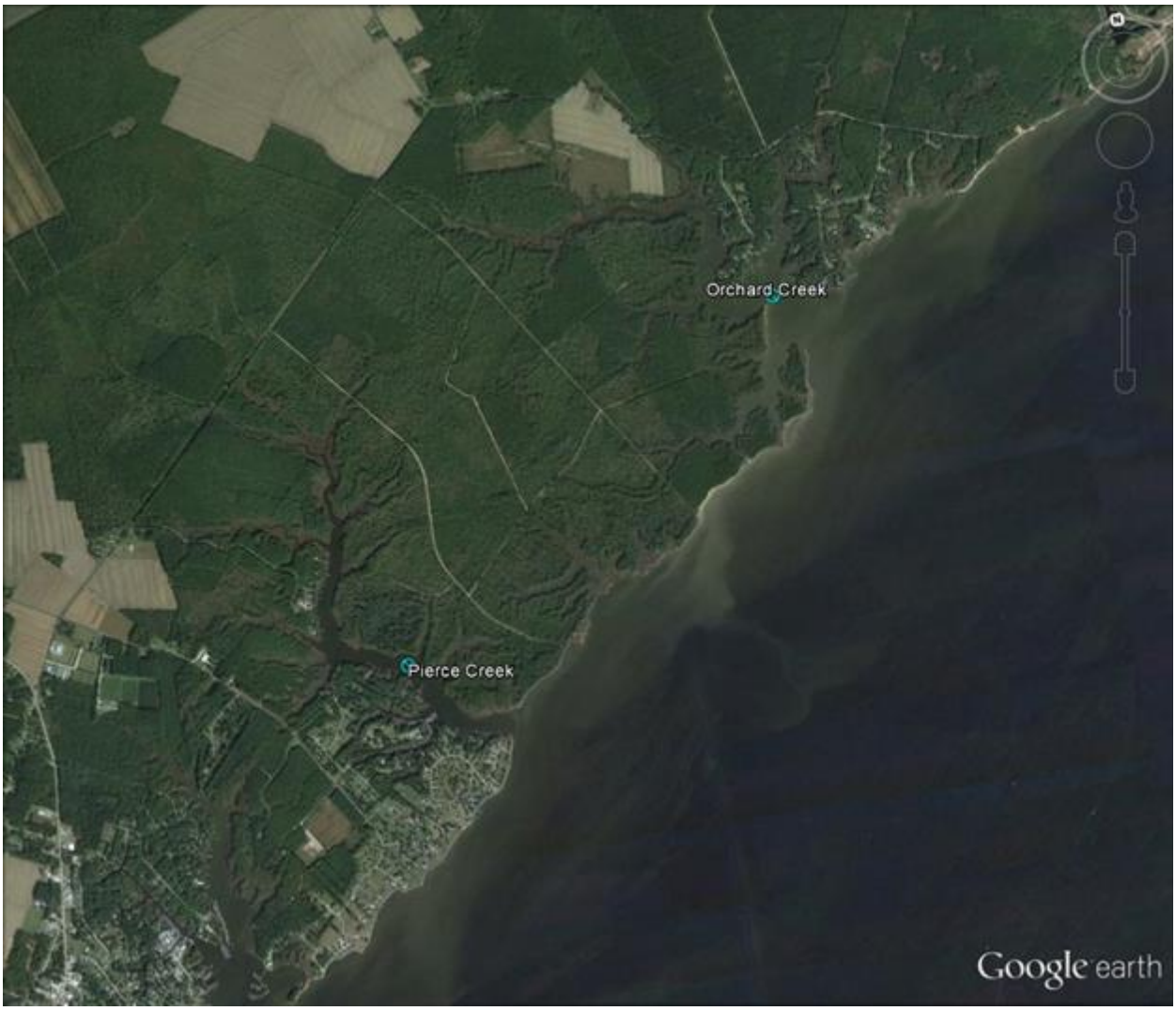


Figure 12. Orchard Creek and Pierce Creek harvest sites.

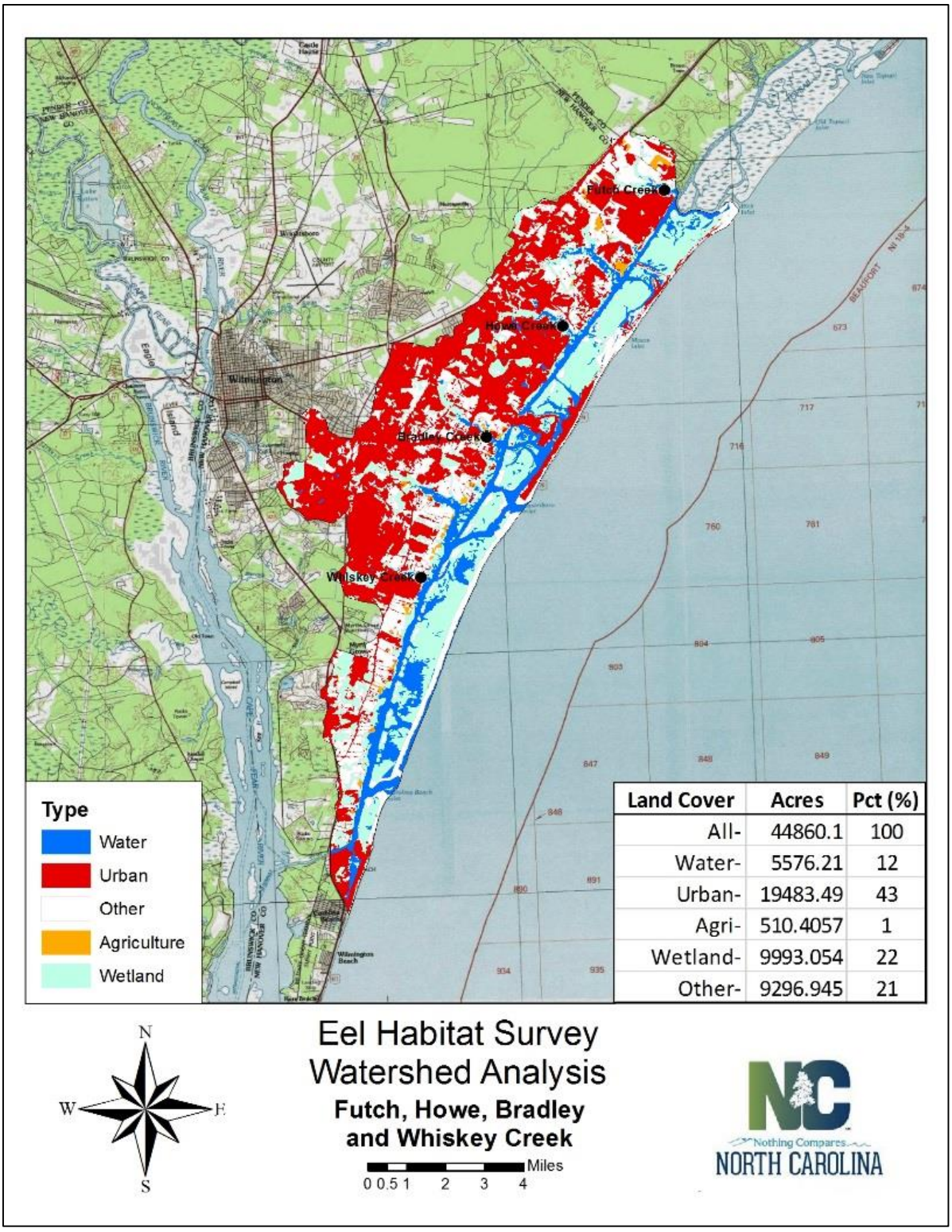


Figure 13. Land use characteristics for the sub-basin containing Bradley, Futch, Howe, and Whiskey creeks.

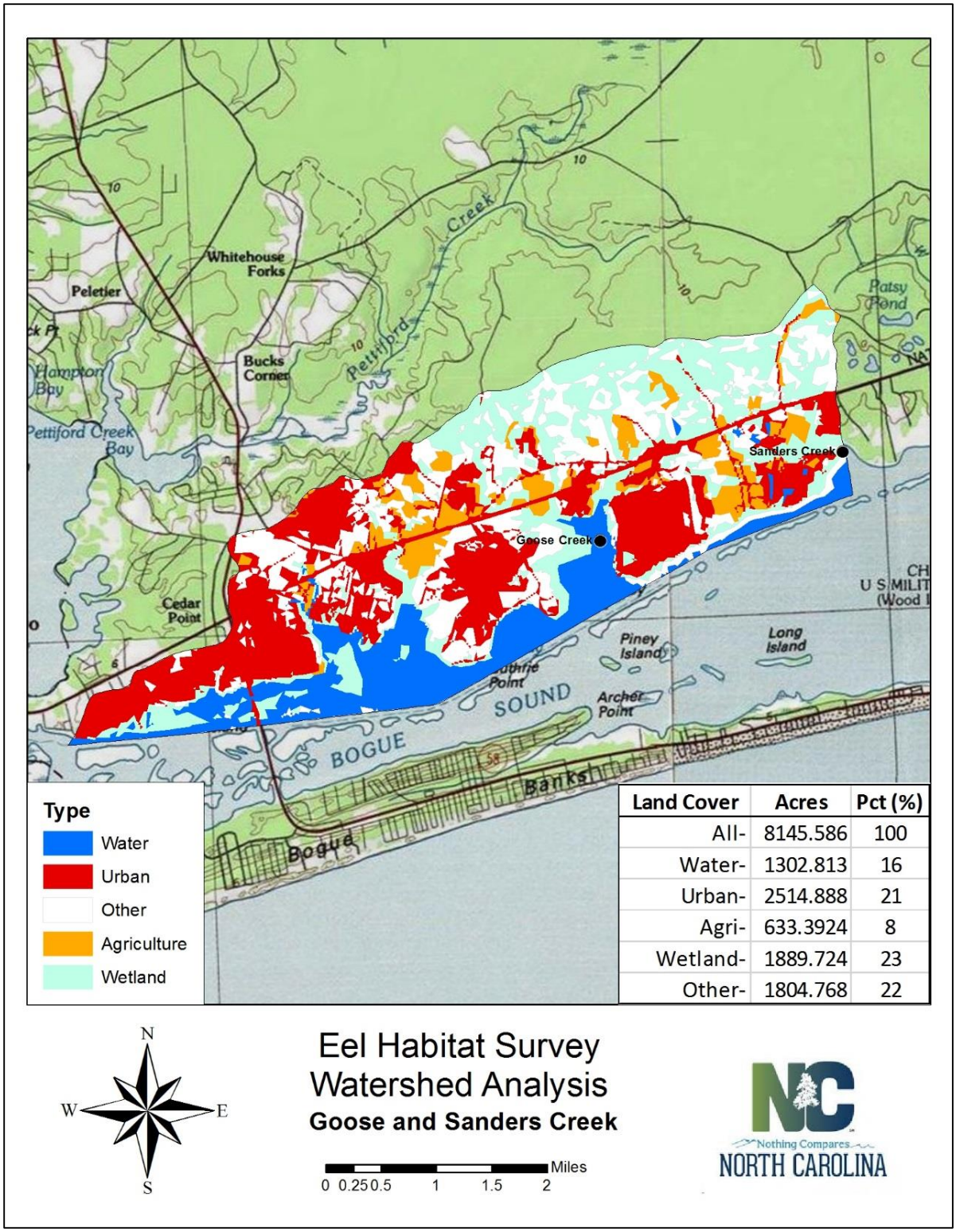


Figure 14. Land use characteristics for the sub-basin containing Goose and Sanders creeks.

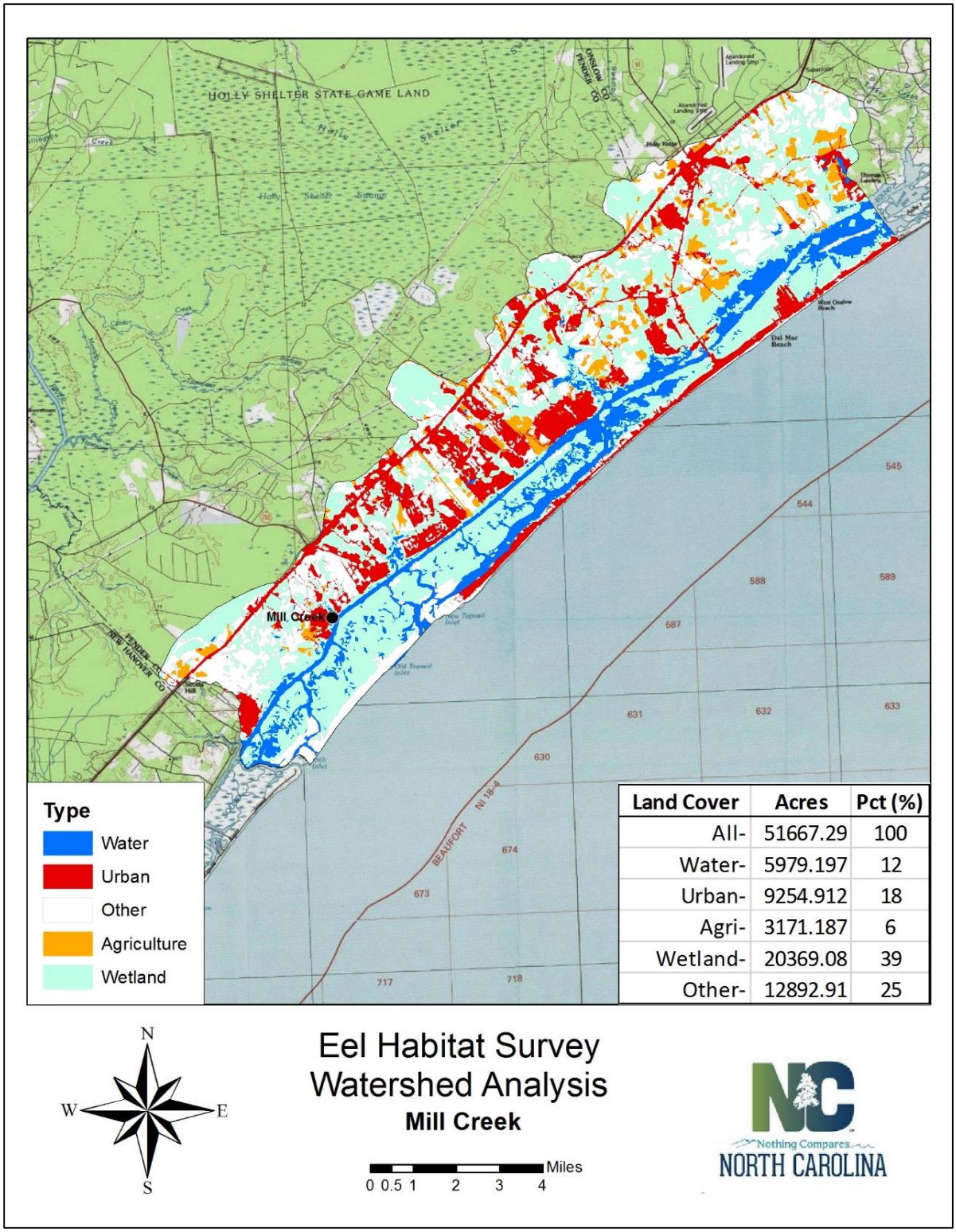


Figure 15. Land use characteristics for the sub-basin containing Mill Creek.

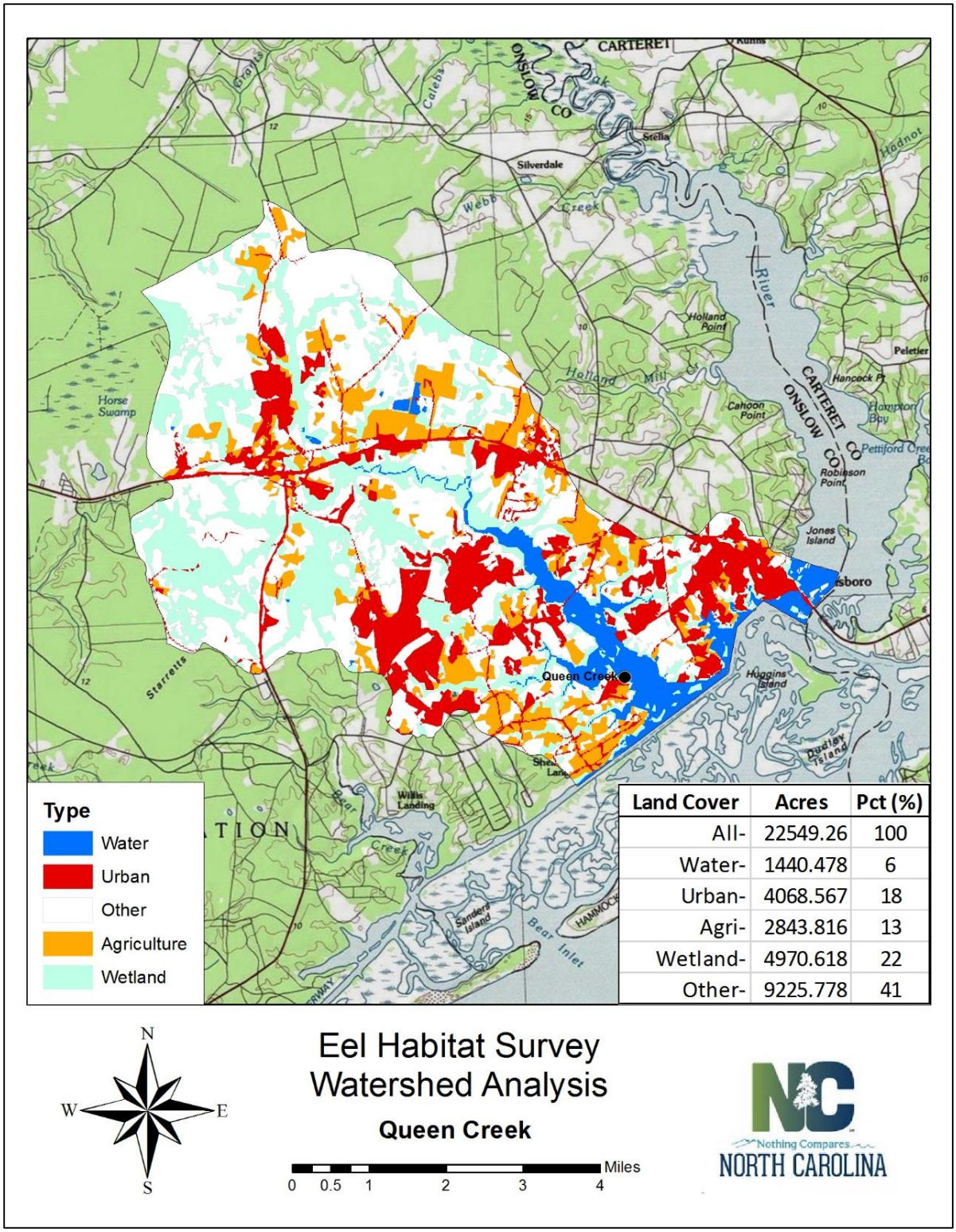


Figure 16. Land use characteristics for the sub-basin containing Queen Creek.

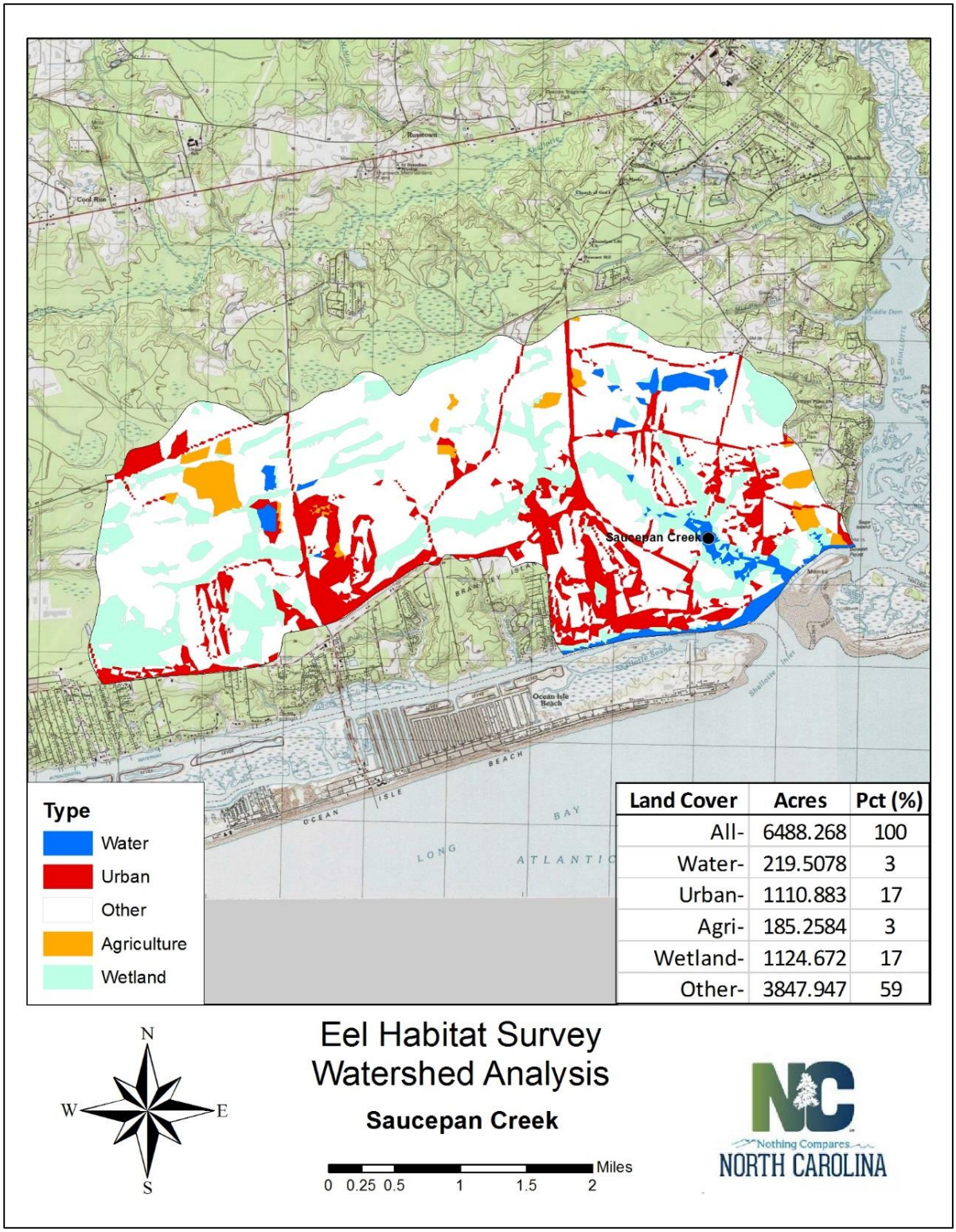


Figure 17. Land use characteristics for the sub-basin containing Saucepan Creek.

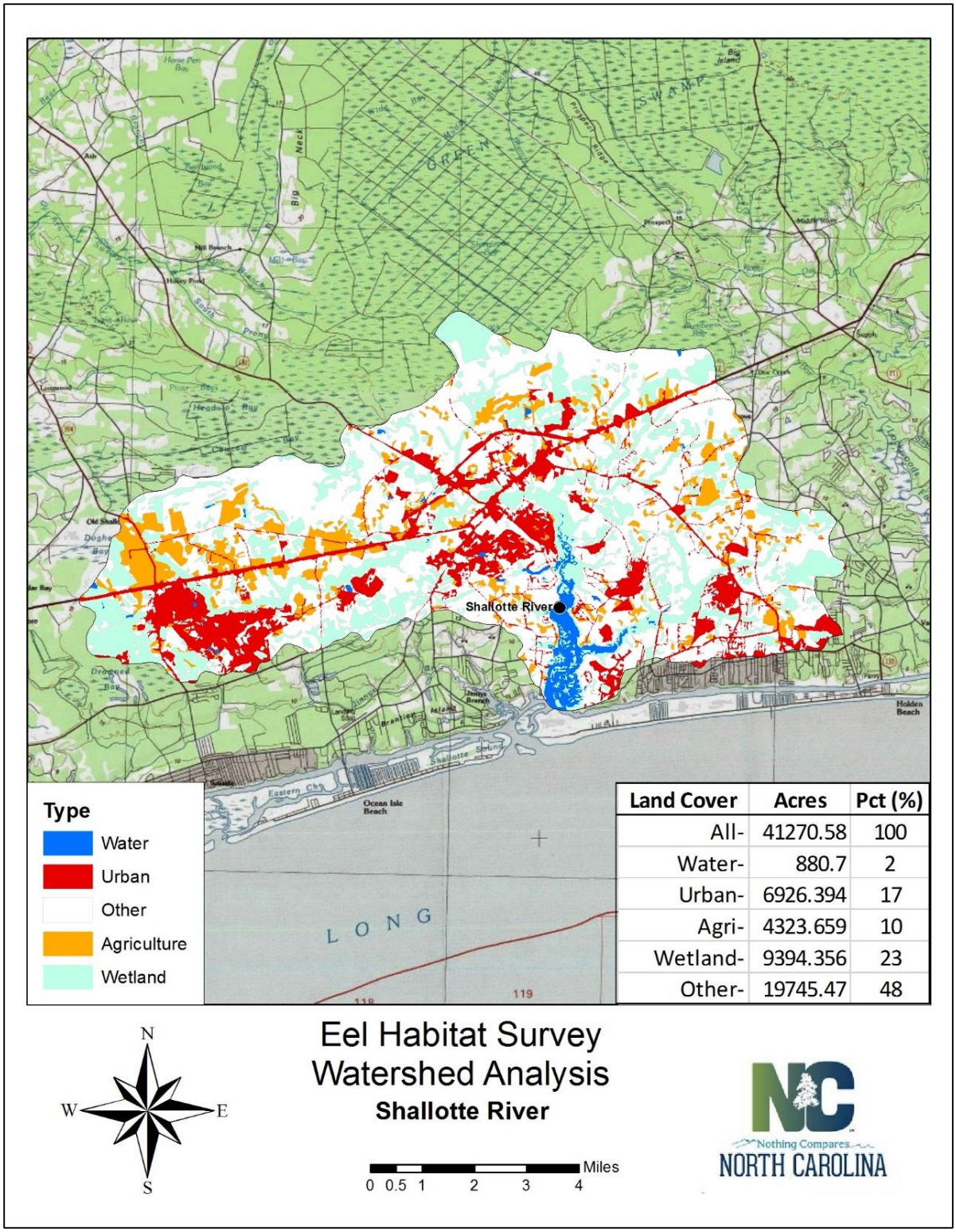


Figure 18. Land use characteristics for the sub-basin containing the Shallotte River.

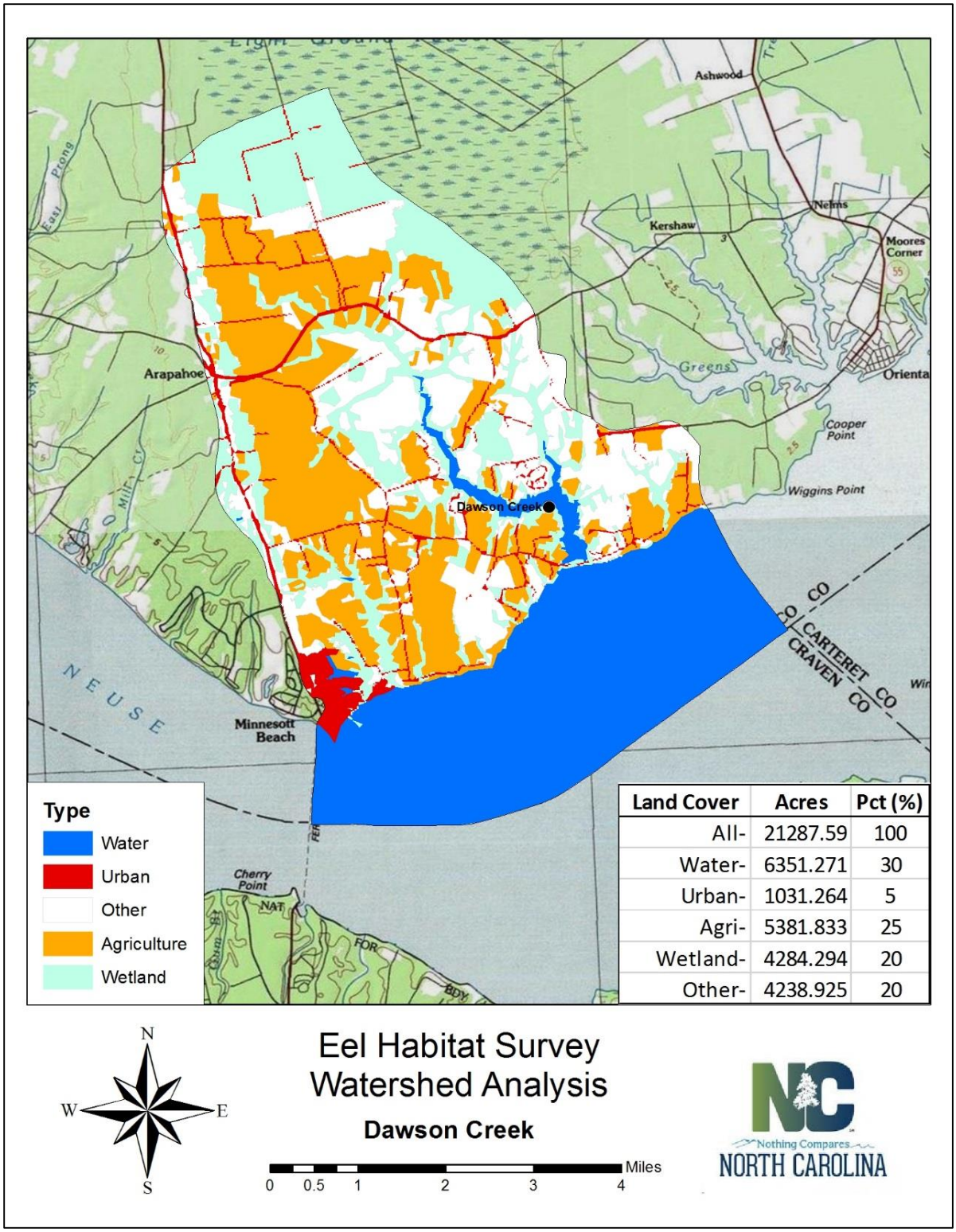


Figure 19. Land use characteristics for the sub-basin containing Dawson Creek.

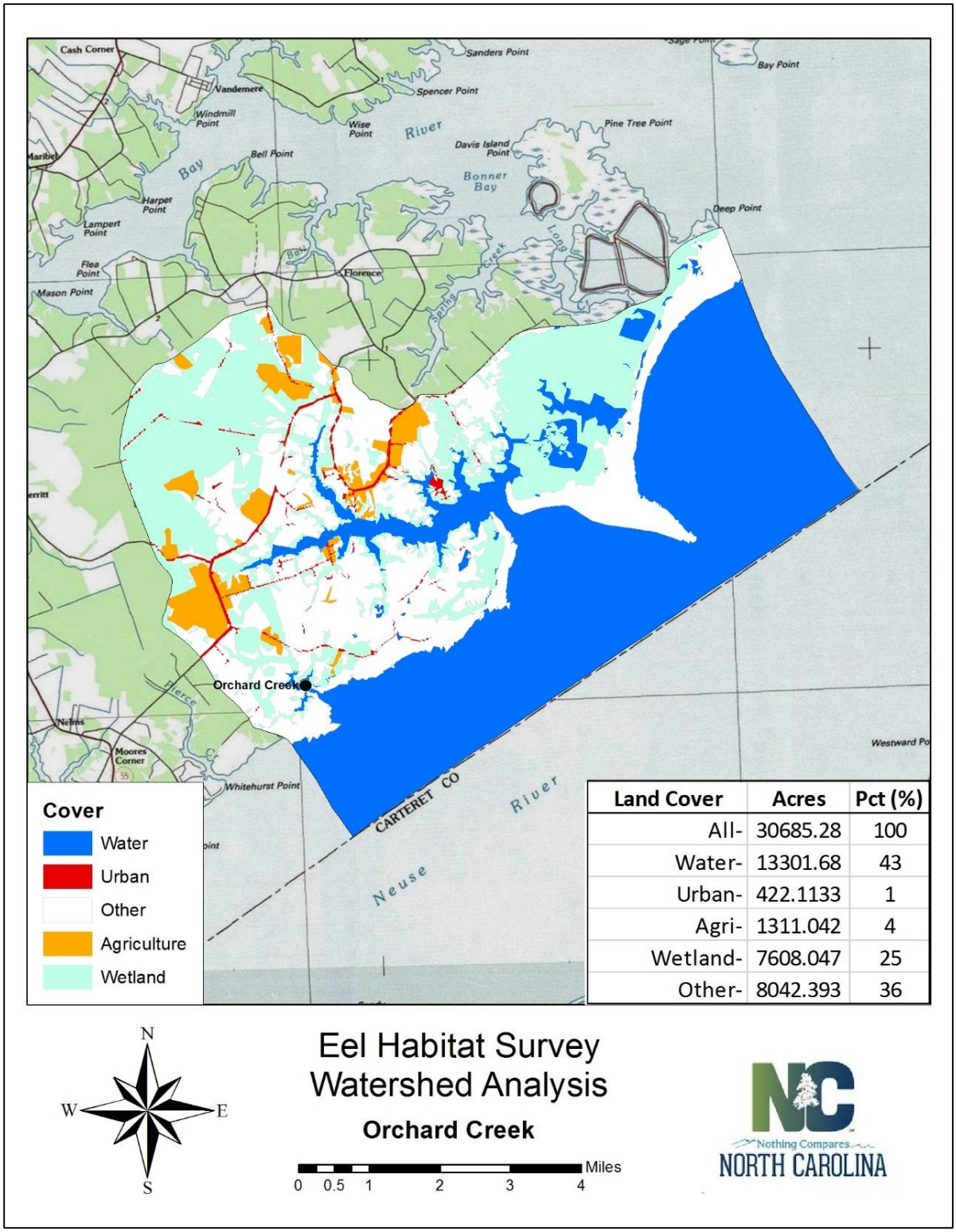


Figure 20. Land use characteristics for the sub-basin containing Orchard Creek

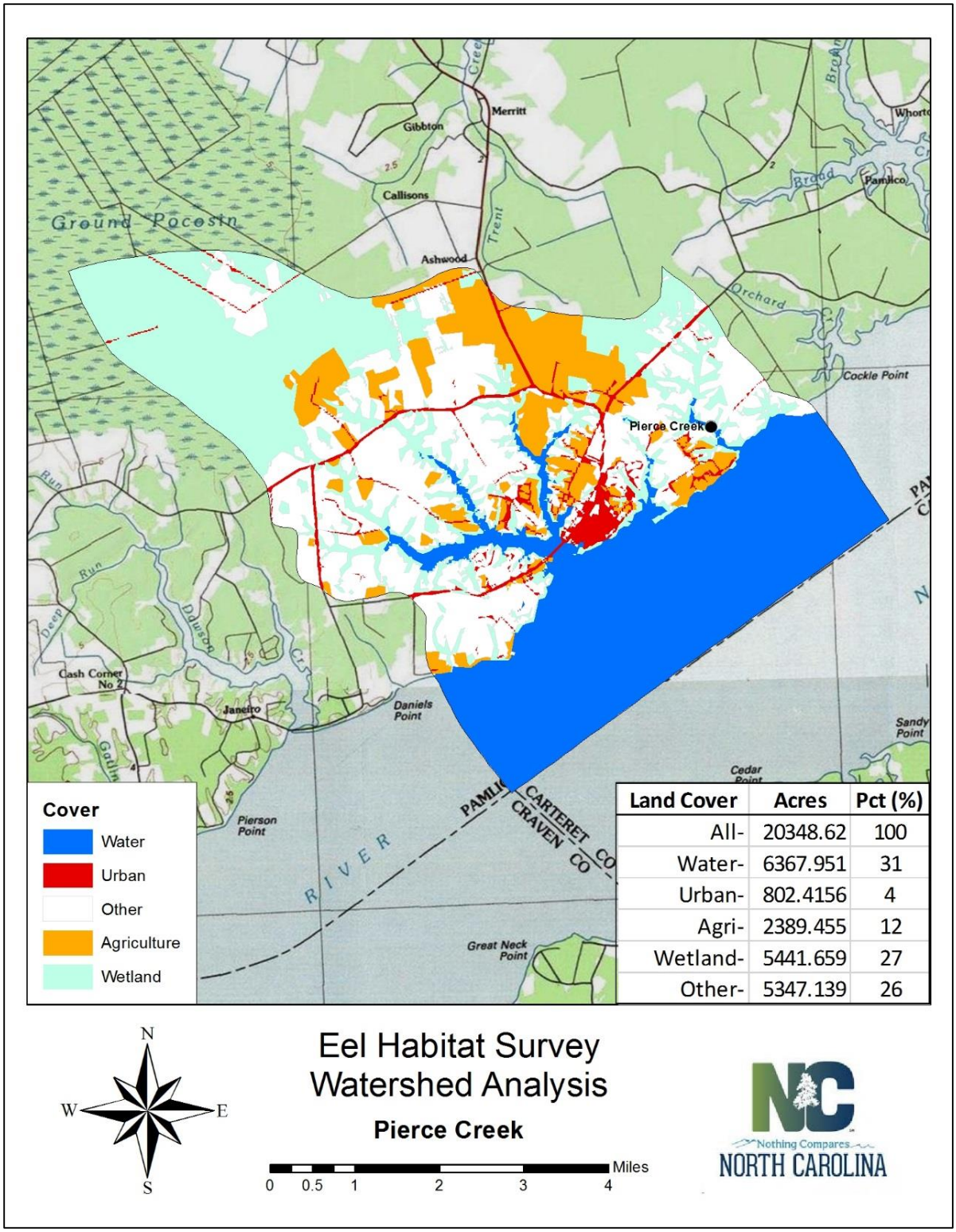


Figure 21. Land use characteristics for the sub-basin containing Pierce Creek.

APPENDIX I

TESTIMONY PRESENTED TO THE COMMITTEE ON MARINE RESOURCES
RE: H.P. 137, AN ACT TO RESTRICT THE TAKING OF EELS LESS THAN 6 INCHES IN LENGTH FROM MAINE COASTAL WATERS (EMERGENCY)

by
James D. McCleave
February 23, 1995

INTRODUCTION

The purpose of my testimony is primarily to educate the members of the committee, other legislators and interested persons about the unique life cycle of a truly fascinating and somewhat mysterious fish, the American eel. The unusual life cycle has some important implications for management and conservation of this species, which are different than for most species of fishes. I will present several of these implications. Finally, I do offer an opinion on the soundness of this particular bill.

I am a Professor of Oceanography and a Cooperating Professor of Zoology at the University of Maine, where I have been since 1968. I have conducted research on the biology of the American eel and the European eel since the early 1970s and have published more than 25 scientific papers on them. I also teach about eels in my classes at the University, and I occasionally have participated in workshops on eels with my European colleagues. A copy of my résumé is appended.

I offer this testimony as a friend of the eel, an awesome fish, and as a friend of eel fishers of all types. It is not my intention to support one group of harvesters over another. My conclusions and opinions are biologically based. The economics of the eel fishing and aquaculture industries and the economic consequences of management decisions are left to the realm of other experts.

LIFE CYCLE OF THE AMERICAN EEL

American eels are highly migratory, with spawning and larval development occurring in the ocean, and feeding and growth occurring in estuaries and fresh waters (rivers, streams, ponds, and lakes) [catadromous life cycle].[1] Spawning occurs near the surface over very deep water in a large area of the Sargasso Sea (Figure 1) and only there, meaning there is a single breeding population for the species. The Sargasso Sea is a large portion of the western North Atlantic Ocean east of the Bahamas and south of Bermuda. Spawning occurs in winter. Eggs hatch in a day or two in the warm water, releasing a long-lived larval stage [leptocephalus], which is flattened from side-to-side and shaped somewhat like a willow leaf. The leptocephali drift and swim in the upper few hundred feet of the

[1]My language is intended to be understood by the nonspecialist. However, the appropriate scientific terms are included in brackets for completeness and to allow direct reference later in the document.

ocean for several months, growing slowly to a length of 2-2.5 inches. The leptocephali dramatically alter their shape [metamorphose] to resemble a miniature, transparent eel, called a glass eel, during the subsequent autumn and winter. This metamorphosis occurs at sea, perhaps near the edge of the continental shelf. The glass eels enter estuaries and ascend rivers during winter and spring, earlier at the southern end of their range, later at the northern end. (My research group at the University of Maine has contributed substantially to this knowledge.) It is during the spring ascent that glass eels, sometimes termed elvers, are harvested commercially in Maine.

The glass eels in estuaries and fresh waters rapidly develop rather drab pigmentation in their skin, dark on the back and often yellowish on the belly, leading to the name yellow eel for this stage. Growth is generally slow, and yellow eels spend several years in estuaries and inland waters. Growth and age at maturity are not well known. Males probably remain as yellow eels for 4-6 years or more, and grow to about 12-18 inches or so. Females remain as yellow eels for many more years, probably 6-20 years in New England and the Maritime Provinces. During this growth period, yellow eels are fished commercially in estuarine and fresh waters, using baited traps or pots.

During late summer and early autumn, maturing yellow eels undergo a second metamorphosis in preparation for a migration to sea to spawn. The pigment on the belly frequently becomes an iridescent silvery, leading to the term silver eel. Silver eels migrate from fresh waters and estuaries to sea in late summer and autumn in the northern part of their range, including Maine, and later in the southern part of the range. During this migration in Maine, silver eels are fished commercially in fixed weirs or nets set across streams and rivers.

Silver eels migrate to the Sargasso Sea, *spawn once and die*. Little is known of this migration or actual spawning, but it seems likely that autumn migrants are the spawners of the subsequent winter. Evidence of the timing and location of spawning comes from the distribution in space and time of small leptocephali. (My research group at the University of Maine has contributed substantially to this knowledge.)

The yellow stage of the American eel ranges from the eastern Gulf of Mexico, all along the east coast of the US, through the states and provinces bordering the Gulf of Maine, to the states and provinces bordering the Gulf of St. Lawrence, to Newfoundland and Labrador. Yet all spawning of the resulting silver eels occurs in the Sargasso Sea.

POINTS OF EMPHASIS FROM THE LIFE CYCLE

- There is a single breeding population for the entire species regardless of where the yellow eels resided [panmixis]. All genetic evidence suggests that a female from Maine is as likely to spawn with a male from Georgia as with a male from Nova Scotia.
  - This means there is no 'homing' of offspring from eels of the Penobscot or Kennebec Rivers to those rivers.

- ◇ Glass eels entering the Maine rivers are just the same genetically as those entering elsewhere within the range.

- There is a single spawning by a female in her lifetime [semelparity]. An adult female may have to grow for 15 years before reaching maturity and spawning *once*.

- Females develop large numbers of eggs [high fecundity], probably 400,000-3,000,000 eggs per female increasing with female size.

- Nearly all the eggs produced by a female and fertilized by a male will die before reaching maturity [high mortality]. This is natural in fecund species; otherwise the earth would be covered with eels.

- Females are much larger at sexual maturity than males [sexual dimorphism].
  - ◇ Most females are larger than 20 inches (50 cm) at maturity.
  - ◇ Most males are less than 18 inches (45 cm) at maturity.

- Determination of whether an eel becomes a male or female is not completely under genetic (chromosomal) control, but the process of sexual determination is not fully understood.

HYPOTHESES RELEVANT TO CONSERVATION

There are two hypotheses, for which there is some scientific evidence, which are important to decisions on conservation of the species. Both hypotheses follow logically from an overriding hypothesis that eels encountering more productive waters have a greater tendency to become males, while those encountering less productive waters have a greater tendency to become females. (There is a body of life history theory that supports this different life history strategy for males and females.)

- There is a gradual increase in the proportion of eels that become females from the estuary toward the headwater streams, i.e. increasing up a given drainage. Within a river drainage, more productive waters are generally found in the lower reaches, especially the estuary.
  - ◇ If correct, this means that Merrymeeting Bay has a lower proportion of females than the higher waters of the Kennebec River.

- There is a gradual increase in the proportion of eels that become females from the southern part of the range to the northern part of the range [a cline]. Along the range of the eel, more productive waters are generally found to the south, less productive waters to the north, including Maine.

- If correct, this means that Maine is likely to have a greater proportion of female eels within its population than, say, Georgia.

MY OPINION ON EEL MANAGEMENT-CONSERVATION

Because of the wide range of the species, and because the species is a single breeding population, one political jurisdiction alone cannot conserve the species. However, Maine can act responsibly from an understanding of the eel's life history.

I will now argue against this bill. The first line of reasoning is on the basis of prudent interpretation of the implications of the life cycle. The second line of reasoning is on the basis of a scenario for interpretation of the high fecundity-high mortality consequences in this species.

From both lines of reasoning, I am led to the conclusion that *there is no biological basis underlying the restriction of harvest proposed by this legislation.* For certain, in my mind, there is *no emergency*. This is not to state that development of sound management and conservation practices are not needed.

IMPLICATIONS FROM THE LIFE CYCLE

In a one-time spawning [semelparous], fecund species with a long lifetime before that one reproduction, prudent conservation strategy would increasingly protect females the closer they get to reproduction. Mortality is high in a fecund species, but the rate of mortality declines exponentially with size. Mortality rate in leptocephali must be enormous; mortality rate in glass eels must be enormous as well. However, mortality rate in females larger than, say, 15 inches is probably very low. (Here I refer to natural mortality, not mortality from people's activities of fishing, damming, polluting, etc.)

Maine, acting in prudent fashion, might choose to protect preferentially maturing females. I stress females because only females produce young. One male may mate with many females, but only females bear eggs.

If the cline in increasing proportion of females from south to north is correct, Maine and the Maritime Provinces might give increased thought to protecting females. A greater proportion of the reproductive potential may be in the northern part of the species' range.

If there is an increasing proportion of females farther up a drainage, it may be prudent to harvest differentially fewer eels farther up drainages.

Weir fisheries, pot fisheries with mesh-size limits, and eel-size limits all shift the harvest toward a greater percentage of females. Because of the sexual dimorphism, the larger the mesh or the larger the size limit, the greater the pressure is transferred to prereproductive females. Further, because females are longer lived than males, greater fishing pressure is transferred to prereproductive females. This is exactly opposite from the desirable effect. It is more logical, if anything, to place a maximum size limit on the harvest of eels. Such a measure

is clearly against conventional wisdom for managing fishes, but this is an unconventional species.

States and provinces that do not allow weir fisheries prudently protect females, whether they know it or not. Only Maine and, to a very limited degree, New York allow weir fisheries for eels.

Likewise, states and provinces that restrict commercial fishing in fresh waters prudently protect females, whether they know it or not. Most states have a substantial or complete restriction on such fishing. Not Maine.

On the other hand, most states and provinces have minimum size limits on commercial eel harvest, generally 4 inches, 6 inches or 8 inches. I do not believe these jurisdictions made those regulations on any basis other than transfer of practices from management of other species, such as trout or bass. In the extreme, Prince Edward Island has a minimum size limit of 18 inches for eels. Other Maritime Provinces are considering similar regulations. This practice would ensure that nearly all harvested eels would be females, a completely counterproductive measure.

Just because other jurisdictions have similar regulation, we should not make the assumption that the regulations have biological basis. Maine should strive gain the information necessary to base regulations in accord with the life cycle of the eel.

IMPLICATIONS FROM MORTALITY RATES

Management of commercial and recreational harvest of fishes (or tolerance of dams and pollution) has always been based on the assumption that there are compensatory mechanisms within the biology of the species, i.e. mechanisms that allow increased survival or increased reproduction of the nonharvested individuals, so the population does not decline. This is the concept of sustainable yield. The key to success of this approach is to understand what the compensatory mechanisms are and when they occur in the life cycle with respect to when harvest occurs.

Again, the eel is unique because of its high-fecundity, high-mortality characteristic. It seems unlikely to me that major compensatory mechanisms are to be found in the oceanic stages of the life cycle. The leptocephali probably have the highest mortality. Food limitation and inability to reach the continental shelf may be the critical factors, neither of which is under control of the leptocephali. Silver eels on migration to the Sargasso Sea to spawn probably have the lowest mortality, and they also have little opportunity for compensating mortality earlier in the life cycle.

In the elver-yellow eel stages, there is high mortality, but there is also the greatest likelihood of compensatory mechanisms for added mortality due to human activities. Because this is the growth phase, competition for food may occur among individual eels, causing starvation or at least slowing the growth. Reduced density of eels *may* result in higher survival, greater growth rate, and perhaps higher fecundity. On the other hand, not all outcomes of reduced density are

predictable. Because the mechanisms of gender determination are not known for eels, reduced density could increase the ratio of females to males (a positive compensatory mechanism) or decrease the ratio of females to males (a negative compensatory effect). However, most density-dependent effects are negative and have positive compensatory mechanisms.

I illustrate the subtle effects of compensatory mechanisms with a *hypothetical* numerical example. For the example, assume an average female has a fecundity of 1,000,000 eggs. Only one female and (less than) one male need to survive from those million eggs and reproduce to maintain a stable population. In the first scenario, I assume there is a compensatory mechanism for harvesting that can occur anytime after harvesting, regardless of when the harvesting occurs. In the second scenario, I assume there is a slightly greater compensatory mechanism in the yellow eel stage (likely, as described above).

- Scenario 1. Minor compensatory mechanism any time.
  - Fecundity 1,000,000 eggs produced by average female.
  - Assume 99.9% die at sea as leptocephali, leaving 1,000 glass eels.
  - Assume 99.2% of those die becoming silver eels, leaving 8 to migrate seaward.
  - Assume a harvest of half the migrating silver eels (4), leaving 4 migrants.
  - Assume 50% of those die, leaving 2 successful spawners.

  - Fecundity 1,000,000 eggs.
  - 99.9% die as leptocephali, leaving 1,000 glass eels.
  - Harvest half the migrating glass eels, leaving 500.
  - 99.2% die before becoming silver eels, leaving 4 to migrate.
  - 50% of those die leaving 2 successful spawners.

  - Conclusion: In this scenario, it does not matter when in the life cycle eels are harvested as long as the allowed harvest is set by actual mortality rates, rather than the hypothetical ones used in the examples here. Alternatively, harvest of a combination of life stages is possible, again as long as actual mortality rates are applied.

- Scenario 2. Greater compensatory mechanism in yellow eel stage.
  - Fecundity 1,000,000 eggs.
  - 99.9% die as leptocephali, leaving 1,000 glass eels.
  - Harvest half the migrating glass eels, leaving 500.
  - Now, if there is compensation such that mortality is reduced in the yellow eels stage by only 1%, 98.2% die before becoming silver eels, leaving 9 to migrate seaward.
  - Harvest half the migrating silver eels (4 or 5), leaving 4 to migrate.

- ◇ 50% of those die leaving 2 successful spawners.

- ◇ Conclusion: In this scenario, harvest of glass eels has no effect on the harvest of silver eels because of a compensatory mechanism in the yellow eel stage. Again harvest size needs to be determined with actual mortality rates.

CONCLUSIONS

I conclude from the two previous sections that there is no biological basis for assuming that harvest of glass eels *per se* is detrimental to the conservation of the American eel. Under certain conditions, the harvest of glass eels could have less detrimental effect on conservation than harvest of silver eels. Under certain conditions, the harvest of glass eels could occur while having little or no detrimental effect on harvest of silver eels.

I also conclude that the current regulatory structure for eels in the States and Provinces in the eel's range is not based upon sound biological principles. However, unregulated or unsoundly regulated commercial fishing in Maine and other jurisdictions is distinctly unwise. By testifying in opposition to this bill, I am not implying that there is not cause for concern and for possible regulations on commercial fishing for eels.

SCIENTIFIC RECOMMENDATIONS FOR CONSERVATION AND MANAGEMENT

In the short term for decision making in Maine, the following steps are important.

- Mortality rates and sources of mortality in the glass eel, yellow eel and early silver eels stages need to be determined to allow estimates of how much harvest could be allowed in what stages of life without deleterious effect on the stock.
  - ◇ Determine sources and rates of natural mortality, and determine whether there is density-dependent mortality, which involves determination of food-webs and predator-prey relations.
  - ◇ Determine sources and rates of anthropogenic mortality at different stages, which includes fishing mortality and nonfishing mortality (fish passage at dams, pollution, hydroelectric turbines, etc.).

- Fishing mortality needs to be determined from the activities of the fishing industry.
  - ◇ A licensing system for fresh waters and tidal waters specific to commercial fishing for eels should be instituted.
  - ◇ A reporting system for commercial catches by life-cycle stage or gear needs to be associated with the licensing system.

- Growth rates of males and females and fecundity of females of various sizes needs to be determined to allow assesment of harvest practices on the reproductive potential of the migrants that do migrate to sea to spawn.

- The distribution of sex ratio throughout selected drainages needs to be determined to allow assessment of harvest practices on abundance of females and males.

In the long term for decision making over the geographic range of the eel, the following steps are important.

- The mechanism of gender determination in eels needs to be understood, so effects of harvest practice on sex ratios can be determined.

- The distribution of sex ratio over the geographic range needs to be determined, so harvest practice could be adjusted over the range as appropriate to the life cycle.

APPENDIX II

NC Marine Fisheries Commission Rule 15A NCAC 03O .0504:

15A NCAC 03O .0504 SUSPENSION/REVOCATION OF PERMITS

(a) For violation of specific permit conditions (as specified on the permit), permits may be suspended or revoked according to the following schedule:

(1) violation of one specific condition in a three year period, permit shall be suspended for 10 days;
(2) violation of two specific conditions in a three year period, permits shall be suspended for 30 days;
(3) violation of three specific conditions in a three year period, permits shall be revoked for a period not less than six months.

If the permit condition violated is the refusal to provide information upon request by Division staff, either by telephone, in writing or in person, the Fisheries Director may suspend the permit. Such permit may be reinstated 10 days after the requested information is provided.

(b) All permits will be suspended or revoked when the permittee's license privilege has been suspended or revoked as set out in G.S. 113-171. The duration of the suspension or revocation shall be the same as the license suspension or revocation. In the event the person makes application for a new permit during any period of license suspension, no new permit will be issued during the suspension period. In case of revocation of license privileges, the minimum waiting period before application for a new permit to be considered will be six months.

(c) Permit designees shall not be permitted to participate in a permit operation during any period they are under license suspension or revocation.

(d) Upon service of a notice of suspension or revocation of a permit, it is unlawful to fail to surrender any permit so suspended or revoked.

Appendix III

NC General Statute 113-170.3:

G.S. 113-170.3. Record-keeping requirements.

(a) The Commission may require all licensees under this Article to keep and to exhibit upon the request of an authorized agent of the Department records and accounts as may be necessary to the equitable and efficient administration and enforcement of this Article. In addition, licensees may be required to keep additional information of a statistical nature or relating to location of catch as may be needed to determine conservation policy. Records and accounts required to be kept must be preserved for inspection for not less than three years.

(b) It is unlawful for any licensee to refuse or to neglect without justifiable excuse to keep records and accounts as may be reasonably required. The Department may distribute forms to licensees to aid in securing compliance with its requirements, or it may inform licensees of requirements in other effective ways such as distributing memoranda and sending agents of the Department to consult with licensees who have been remiss. Detailed forms or descriptions of records, accounts, collection and inspection procedures, and the like that reasonably implement the objectives of this Article need not be embodied in rules of the Commission in order to be validly required.

(c) The following records collected and compiled by the Department shall not be considered public records within the meaning of Chapter 132 of the General Statutes, but shall be confidential and shall be used only for the equitable and efficient administration and enforcement of this Article or for determining conservation policy, and shall not be disclosed except when required by the order of a court of competent jurisdiction: all records, accounts, and reports that licensees are required by the Commission to make, keep, and exhibit pursuant to the provisions of this section, and all records, accounts, and memoranda compiled by the Department from records, accounts, and reports of licensees and from investigations and inspections, containing data and information concerning the business and operations of licensees reflecting their assets, liabilities, inventories, revenues, and profits; the number, capacity, capability, and type of fishing vessels owned and operated; the type and quantity of fishing gear used; the catch of fish or other seafood by species in numbers, size, weight, quality, and value; the areas in which fishing was engaged in; the location of catch; the time of fishing, number of hauls, and the disposition of the fish and other seafood. The Department may compile statistical information in any aggregate or summary form that does not directly or indirectly disclose the identity of any licensee who is a source of the information, and any compilation of statistical information by the Department shall be a public record open to inspection and examination by any person, and may be disseminated to the public by the Department. (1997-400, s.5.1; 2001-213, s. 2.)

NC Marine Fisheries Commission Rule 15A NCAC 03O .0502:

15A NCAC 03O .0502 PERMIT CONDITIONS; GENERAL

The following conditions apply to all permits issued by the Fisheries Director:

(1) it is unlawful to operate under the permit except in areas, at times, and under conditions specified on the permit;

(2) it is unlawful to operate under a permit without having the permit or copy thereof in possession of the permittee or his or her designees at all times of operation and the permit or copy thereof shall be ready at hand for inspection, except for Pound Net Permits;

(3) it is unlawful to operate under a permit without having a current picture identification in possession and ready at hand for inspection;

(4) it is unlawful to refuse to allow inspection and sampling of a permitted activity by an agent of the Division;

(5) it is unlawful to fail to provide complete and accurate information requested by the Division in connection with the permitted activity;

(6) it is unlawful to hold a permit issued by the Fisheries Director when not eligible to hold any license required as a condition for that permit as stated in 15A NCAC 03O .0501;

(7) it is unlawful to fail to provide reports within the timeframe required by the specific permit conditions;

(8) it is unlawful to fail to keep such records and accounts as required by the rules in this Chapter for determination of conservation policy, equitable and efficient administration and enforcement, or promotion of commercial or recreational fisheries;

(9) it is unlawful to assign or transfer permits issued by the Fisheries Director, except for Pound Net Permits as authorized by 15A NCAC 03J .0504;

(10) the Fisheries Director, or his agent, may, by conditions of the permit, specify any or all of the following for the permitted purposes:

(a) species;
(b) quantity or size;
(c) time period;
(e) location;
(d) means and methods;
(f) disposition of resources;
(g) marking requirements; or
(h) harvest conditions.

(11) unless specifically stated as a condition on the permit, all statutes, rules and proclamations shall apply to the permittee and his or her designees; and

(12) as a condition of accepting the permit from the Fisheries Director, the permittee agrees to abide by all conditions of the permit and agrees that if specific conditions of the permit, as identified on the permit, are violated or if false information was provided in the application for initial issuance, renewal or transfer, the permit may be suspended or revoked by the Fisheries Director.

APPENDIX IV

NC Marine Fisheries Commission Rule 15A NCAC 03O .0501:

15A NCAC 03O .0501 PROCEDURES AND REQUIREMENTS TO OBTAIN PERMITS

(a) To obtain any Marine Fisheries permit, the following information is required for proper application from the applicant, a responsible party, or person holding a power of attorney:

(1) Full name, physical address, mailing address, date of birth, and signature of the applicant on the application. If the applicant is not appearing before a license agent or the designated Division contact, the applicant's signature on the application shall be notarized;

(2) Current picture identification of applicant, responsible party, or person holding a power of attorney. Acceptable forms of picture identification are driver's license, North Carolina Identification card issued by the North Carolina Division of Motor Vehicles, military identification card, resident alien card (green card), or passport; or if applying by mail, a copy thereof;

(3) Full names and dates of birth of designees of the applicant who will be acting under the requested permit where that type permit requires listing of designees;

(4) Certification that the applicant and his designees do not have four or more marine or estuarine resource convictions during the previous three years;

(5) For permit applications from business entities:

(A) Business Name;

(B) Type of Business Entity: Corporation, partnership, or sole proprietorship;

(C) Name, address, and phone number of responsible party and other identifying information required by this Subchapter or rules related to a specific permit;

(D) For a corporation, current articles of incorporation and a current list of corporate officers when applying for a permit in a corporate name;

(E) For a partnership, if the partnership is established by a written partnership agreement, a current copy of such agreement shall be provided when applying for a permit; and

(F) For business entities, other than corporations, copies of current assumed name statements if filed and copies of current business privilege tax certificates, if applicable; and

(6) Additional information as required for specific permits.

(b) A permittee shall hold a valid Standard or Retired Standard Commercial Fishing License in order to hold a:

(1) Pound Net Permit;

(2) Permit to Waive the Requirement to Use Turtle Excluder Devices in the Atlantic Ocean; or

(3) Atlantic Ocean Striped Bass Commercial Gear Permit.

(c) A permittee and his designees shall hold a valid Standard or Retired Standard Commercial Fishing License with a Shellfish Endorsement or a Shellfish License in order to hold a:

(1) Permit to Transplant Prohibited (Polluted) Shellfish;

(2) Permit to Transplant Oysters from Seed Oyster Management Areas;

(3) Permit to Use Mechanical Methods for Shellfish on Shellfish Leases or Franchises;

(4) Permit to Harvest Rangia Clams from Prohibited (Polluted) Areas; or

(5) Depuration Permit.

(d) A permittee shall hold a valid:

(1) Fish Dealer License in the proper category in order to hold Dealer Permits for Monitoring Fisheries Under a Quota/Allocation for that category; and

(2) Standard Commercial Fishing License with a Shellfish Endorsement, Retired Standard Commercial Fishing License with a Shellfish Endorsement or a Shellfish License in order to harvest clams or oysters for depuration.

(e) Aquaculture Operations/Collection Permits:

(1) A permittee shall hold a valid Aquaculture Operation Permit issued by the Fisheries Director to hold an Aquaculture Collection Permit.

(2) The permittee or designees shall hold appropriate licenses from the Division of Marine Fisheries for the species harvested and the gear used under the Aquaculture Collection Permit.

(f) Atlantic Ocean Striped Bass Commercial Gear Permit:

(1) Upon application for an Atlantic Ocean Striped Bass Commercial Gear Permit, a person shall declare one of the following gears for an initial permit and at intervals of three consecutive license years thereafter:
(A) gill net;
(B) trawl; or
(C) beach seine.
For the purpose of this Rule, a "beach seine" is defined as a swipe net constructed of multi-filament or multi-fiber webbing fished from the ocean beach that is deployed from a vessel launched from the ocean beach where the fishing operation takes place.
Gear declarations shall be binding on the permittee for three consecutive license years without regard to subsequent annual permit issuance.

(2) A person is not eligible for more than one Atlantic Ocean Striped Bass Commercial Gear Permit regardless of the number of Standard Commercial Fishing Licenses, Retired Standard Commercial Fishing Licenses or assignments held by the person.

(g) Applications submitted without complete and required information shall not be processed until all required information has been submitted. Incomplete applications shall be returned to the applicant with deficiency in the application so noted.

(h) A permit shall be issued only after the application has been deemed complete by the Division of Marine Fisheries and the applicant certifies to abide by the permit general and specific conditions established under 15A NCAC 03J .0501, .0505, 03K .0103, .0104, .0107, .0111, .0401, 03O .0502, and .0503 as applicable to the requested permit.

(i) The Fisheries Director, or his agent may evaluate the following in determining whether to issue, modify, or renew a permit:

(1) Potential threats to public health or marine and estuarine resources regulated by the Marine Fisheries Commission;

(2) Applicant's demonstration of a valid justification for the permit and a showing of responsibility as determined by the Fisheries Director; and

(3) Applicant's history of habitual fisheries violations evidenced by eight or more violations in 10 years.

(j) The Division of Marine Fisheries shall notify the applicant in writing of the denial or modification of any permit request and the reasons therefor. The applicant may submit further information, or reasons why the permit should not be denied or modified.

(k) Permits are valid from the date of issuance through the expiration date printed on the permit. Unless otherwise established by rule, the Fisheries Director may establish the issuance timeframe for specific types and categories of permits based on season, calendar year, or other period based upon the nature of the activity permitted, the duration of the activity, compliance with federal or state fishery management plans or implementing rules, conflicts with other fisheries or gear usage, or seasons for the species involved. The expiration date shall be specified on the permit.

(l) For permit renewals, the permittee's signature on the application shall certify all information as true and accurate. Notarization of signature on renewal applications shall not be required.

(m) For initial or renewal permits, processing time for permits may be up to 30 days unless otherwise specified in this Chapter.

(n) It is unlawful for a permit holder to fail to notify the Division of Marine Fisheries within 30 days of a change of name or address, in accordance with G.S. 113-169.2.

(o) It is unlawful for a permit holder to fail to notify the Division of Marine Fisheries of a change of designee prior to use of the permit by that designee.

(p) Permit applications are available at all Division Offices.

Atlantic States Marine Fisheries Commission

1050 N. Highland Street • Suite 200A-N • Arlington, VA 22201
703.842.0740 • 703.842.0741 (fax) • www.asmfc.org

MEMORANDUM

January 15, 2016

To: American Eel Management Board

From: Law Enforcement Committee

RE: Review of North Carolina's American Eel Aquaculture Proposal

The Law Enforcement Committee (LEC) of the Atlantic States Marine Fisheries Commission (ASMFC) met via conference call on January 7, 2016 to review and provide comments on a proposed aquaculture plan for the collection of American eels from waters of North Carolina. The following members were in attendance:
LEC: Capt. Steve Anthony (NC); Deputy Chief Kurt Blanchard (RI); Deputy Chief Jon Cornish (ME); Deputy Director Chisolm Frampton (SC); Asst. Director Larry Furlong (PA); Special Agent-in- Charge Honora Gordon (USFWS); Capt. Jamie Green (VA); Asst. Chief Wayne Hettenbach (USDOJ); Capt. Rob Kersey (MD); Capt. Bob Lynn (GA); Capt. Doug Messeck (DE); Maj. Pat Moran (MA); Director Kyle Overturf (CT); Lt. Colby Schlaht (USCG); Lt. Jason Snellbaker (NJ); Capt. Rama Shuster (FL)
LEC ALTERNATES: Jeff Ray (NOAA OLE); Tom Gadomski (NY)
OTHER ATTENDEES: Col. Jim Kelley (NC); Maj. Dean Nelson (NC); Chief Dean Hoxsie (RI); Todd Mathes (NCDMF); Jason Rock (NCDMF)
STAFF: Mark Robson; Mike Waine; Megan Ware

LEC comments are based on the proposal dated November 2015, and descriptions provided by staff from the North Carolina Division of Marine Fisheries. The Aquaculture Plan is being considered pursuant to Addendum IV of the ASMFC Interstate Fishery Management Plan for American Eel. Numerous provisions were described to aid enforceability. These include designated collection sites, a maximum number of individuals allowed to harvest under a permit, open inspections, restricted numbers of allowable nets under a permit and reporting requirements.

The Maine representative to the LEC noted that some provisions of the proposal mirror those that have been implemented in Maine and have been supported in court cases.

The LEC supports the plan as presented. They offer the following suggestions or comments:

- The LEC recommends a requirement for immediate reporting of any authorized net that has been altered or modified.
- The LEC supports redundant reporting systems including call-in reporting during harvest and the use of regular trip-ticket reports.
- The LEC expressed some concern that implementation of the proposal indicates increased enforcement responsibility that could result in an "unfunded enforcement mandate". While this may be adequately addressed in North Carolina the LEC wishes to highlight that enforcement resources are continually challenged to keep up with new or innovative fishery management programs as exemplified by this aquaculture proposal.

In support of the above comments, the LEC refers to the ASMFC *Guidelines for Resource Managers on the Enforceability of Fishery Management Measures (2015).*

The LEC appreciates the opportunity to review and provide enforcement advice regarding the North Carolina aquaculture proposal.

South Carolina request to change sampling method for American eel

Annual Young-of-Year Abundance Survey

DNR

South Carolina Department of Natural Resources
DIADROMOUS FISH PROJECT

December 16, 2015

Background

In 1999, Atlantic States Marine Fisheries Commission developed and approved the Interstate Fishery Management Plan (FMP) for American Eel. This plan required all participating states to conduct surveys for young of year (YOY) American eel.

Excerpted text from section 3.1.1 (Annual Young-of-Year Abundance Survey) from the FMP.

Accordingly, states/jurisdictions will conduct annual fishery-independent surveys for young-of year American eel. Each participating jurisdiction shall deploy appropriate gear to capture young of the year at a minimum of two locations over a six-week period. A variety of gear types are available for use, and states should use the gear most suitable to the habitat and geography within their jurisdiction. The cost of most gear ranges from $200 to $400 per unit. The timing and placement of the young-of-year (YOY) sampling gear will coincide with those periods of peak onshore migration of young-of-year. The locations selected will be those previously shown to catch young-of-year American eel and should provide as wide a geographic distribution as possible. Initially, stock assessment biologists may need to alter the timing and placement of the sampling gear in order to determine peak migration period and locations for the annual survey. Thereafter, standard stations and procedures will remain fixed.

At a minimum, the gear will be set so that they are operational during periods of rising or flood tides occurring at nighttime hours. During these conditions, gear will be checked as often as possible and emptied of their catch. The catch will be sorted and all specimens identified to their lowest taxonomic order, measured, weighed and enumerated as appropriate. Species which appear to be predators of young-of-year will be denoted. The entire catch of young-of-year will be weighed and counted, and each individual measured for total length. The number of young-of-year per unit weight (gram) will be determined for each catch examined. Standard statistical techniques (sub-sampling) will be used in instances where the catch of young-of-year is too large (i.e., several hundred individuals or more) to warrant a complete census.

South Carolina YOY sampling

Historically, the Cooper River has been the major producer of elver/glass eel harvest in the state. Since 2000, the South Carolina Department of Natural Resources (SCDNR) has conducted a survey at a single site located in Goose Creek, a tributary of the Cooper River. The site is positioned immediately below the dam and spillway of Goose Creek Reservoir in Berkeley County, South Carolina (Figures 1 and 2) and is 15 river-km from Goose Creek's confluence with the Cooper River; that point being 25 river-km from the Atlantic Ocean.

Sampling consists of using a staked fyke-net for an eight-week period, with samples collected four days per week from mid-February through mid-April. The fyke-net is staked with the trap end upstream and with wings extended from one bank to approximately two-thirds stream width. The gear is staked in a position where the major portion of the elver run is believed to pass and in a manner by which the entire water column is fished (Figure 3).

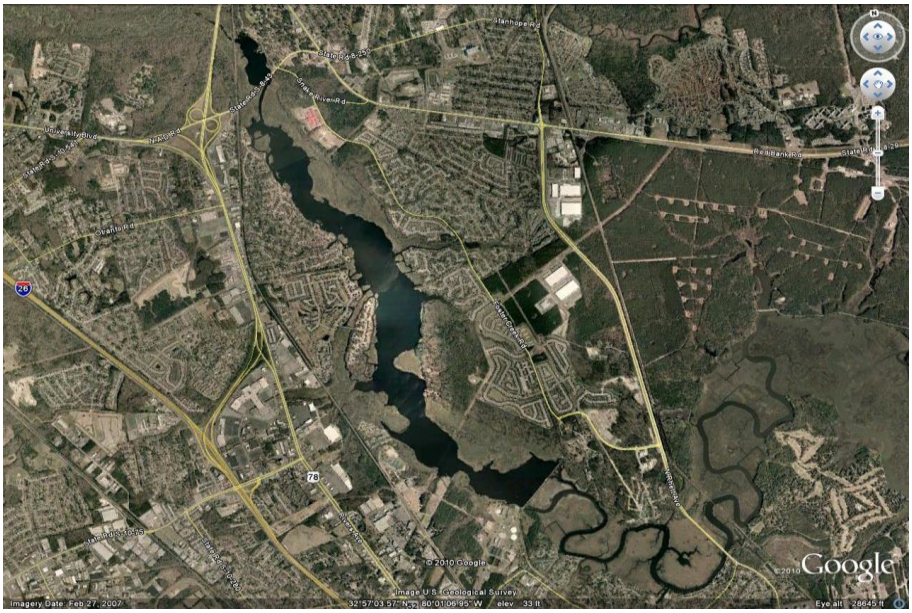


Figure 1. Goose Creek Reservoir, South Carolina

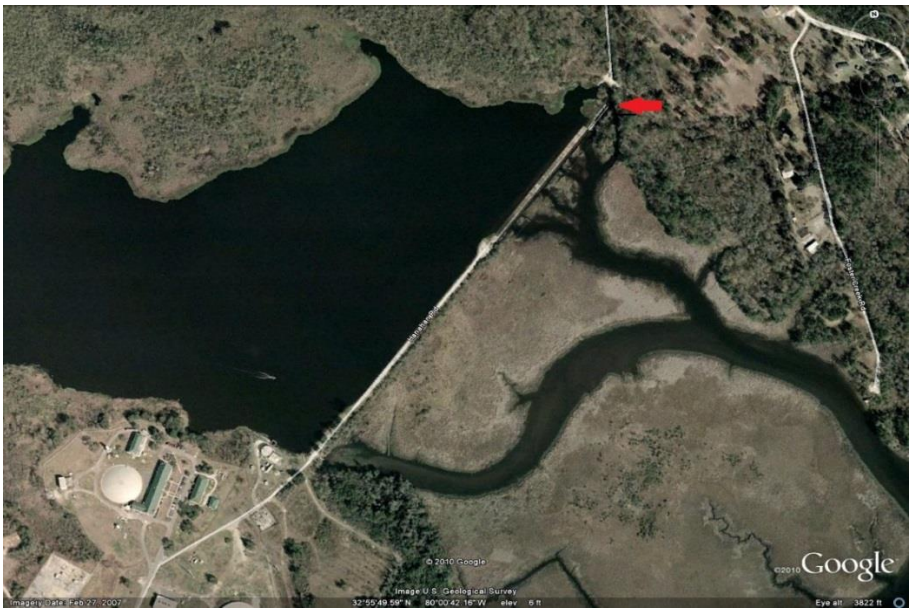


Figure 2. Lower Goose Creek Reservoir, South Carolina and the elver sampling site, indicated by the red arrow.

Figure 3. Fyke net location below the spillway of Goose Creek Reservoir, South Carolina.

Gear limitations

Sampling for YOY using a fyke net has been effective over the years, however the effectiveness is not consistent from year-to-year and lasts for a short duration. The fyke net and sampling location are also susceptible to astronomic tides, high flow events, drought, vandalism, and ongoing bank erosion. All of these external factors are beyond our control and severely impact the success of the gear. During big tidal events, water also rises well above the river bank, allowing elvers to pass the wing walls of the fyke net and thus avoiding capture. Additionally, several high flow events have damaged equipment leading to lost sampling time (Figure 4 and 5). Conversely, during occasional drought conditions, minimal freshwater attraction flows were observed coming from the reservoir resulting in little to no catches (Figure 6). Ongoing river bank erosion continues to be a major issue and makes the sampling site not only more difficult to sample, but it now has also become unsafe because of the imminent threat of trees falling due to the soil being washed away (Figures 7 and 8). All these factors add unaccounted for variability that may lead to data that is not comparable year-to-year.

Figure 4. High flow events at the sampling site leading to ineffective sampling.

Figure 5. Damage to fyke net due to high flows at the sampling site.

Figure 6. Drought events led to low Goose Creek Reservoir levels and minimal freshwater flow into the sample area.

Figure 7. Bank erosion led to trees falling in the sampling area.

Figure 8. Bank erosion has washed away nearly all of the soil from underneath the tree making it susceptible to falling into the sampling area.

Alternative Sampling Gear

In 2011, the SCDNR received funding from the Atlantic Coastal Fish Habitat Partnership to construct two solar powered eel collection and passage ramps at Goose Creek Reservoir Dam (Figure 9). It was important to improve upstream passage at this site because of the access it provides to the Goose Creek watershed, including over 40 stream miles and adjacent freshwater wetlands important to eel maturation. Both the wall ladder and the fyke net sight are located only a few feet apart (Figure 10). The new wall ramp sight was placed in its current location based on nightly reconnaissance observations identifying this spot as a migratory route for YOY eels. During these observations, several elvers were seen climbing the wall at this location, all while the fyke net was in place. This confirmed a hunch that not all elvers were being captured using current gear. The ramps were installed in 2012 and operations began in January 2013. Though not mandated by the ASMFC, the SCDNR operates and maintains the ramps throughout the year. This provides concurrent data that can be compared with fyke net catches, but also provides annual run data that might not be captured by the short sampling season of the fyke net (8weeks). Both ramps operates 7 days a week/365 days a year and the collection bucket is checked a minimum of two times per week. Since operations began, the ramp has collected 16,233 elvers and of those, 13,785 have been YOY. Catches from 2013-

2015 during fyke net sampling season were 2,782 elvers in the fyke net and 6, 177 elvers in the ramp.

Figure 9. Solar power eel ramps (2) located adjacent to the spillway of Goose Creek Reservoir, South Carolina.

Figure 10. Goose Creek Reservoir spillway and red arrows indicating the locations of the fyke net and eel ramp.

Request to change sampling gear

During the last three years of operations, both the ramps and the fyke net were sampled together. Observations during that time showed the ramps are not nearly as susceptible to problems that plagued fyke net operations and the efficiency of the ramps have proven to be a more effective sampling gear (Figure 11).

Because the ramp is located on the dam face in an area secured by fencing, problems with vandalism have been eliminated. The captured eels are also protected by a locked two by two foot catch box that allows for 24/7 operation year round. Additionally, because the ramps are not located in the "pool" area below the dam, the adverse effects of tides and, heavy rainfall events has also been eliminated. The new ramps have demonstrated the ability to withstand the rigors of fluctuating flows and have not required the amount of maintenance of the fyke net. During October 2015, South Carolina experienced one of the most prolific rainfall events in the modern history of the United States. An estimated 20 inches of rainfall fell in the Goose Creek watershed over a 72 hour period and led to what has been termed a 1,000 year flood event. The ramp at the Goose Creek dam survived this event without damage. Additionally, during times of drought, the ramps still have the ability to provide an attraction flow by pumping water out of the reservoir.

Annual catch rates for the YOY elver sampling has been variable through the years as expected but lost sampling times due to environmental factors were particularly evident during the 2012 and 2013 sampling seasons. The 2012 season was affected by both drought and heavy rainfall events which led to lost sampling time. The 2013 season was affected by several periods of heavy rainfall which twice led to damaged or lost gear and lost sampling time.

In 2014 the Technical Committee (TC) and Stock Assessment Subcommittee completed an update of the young of the year (YOY) indices included in the benchmark stock assessment. The TC found no change in the YOY status from the benchmark assessment with the exception of one survey in Goose Creek, SC (Table 1). Variation from year to year and from state to state is to be expected, but recorded variation for SC during this time is likely simply an artifact from environmental conditions reflected in limitations of the gear. Therefore, the SCDNR would like to request changing our sampling gear for the YOY survey from a fyke net to the newly installed and more efficient eel passage ramps. This change would provide a dataset that is less dependent on local environmental factors and more valid and comparable year to year.

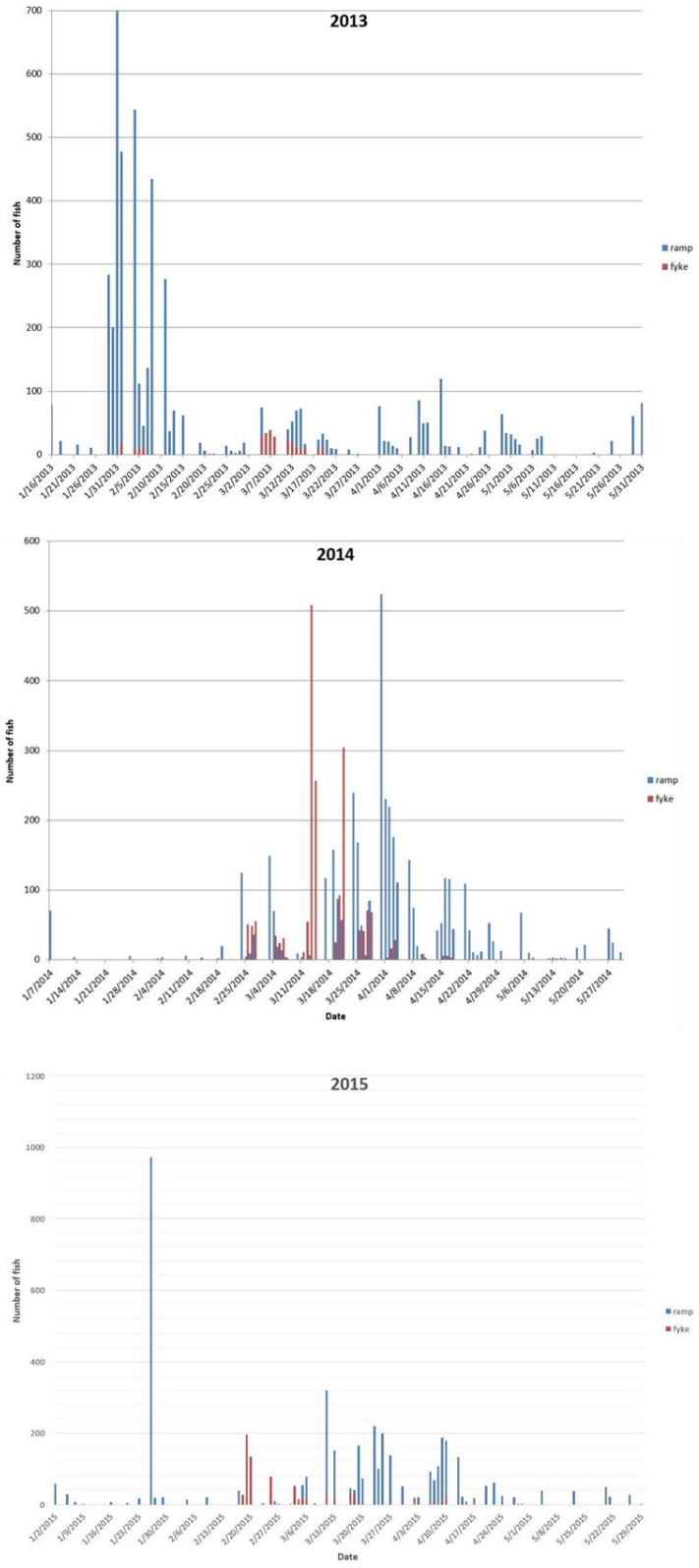


Figure 11. Eel ramp (blue) and fyke net (red) elver catches from January – May in 2013, 2014, and 2015 from the Goose Creek elver sampling site.

Table 1. Update of the young of the year (YOY) indices from Addendum IV.

Region	State	Site	SA Result	Update
Gulf of Maine	ME	West Harbor Pond	NS	NS
	NH	Lamprey River	NS	NS
	MA	Jones River	NS	NS
	MA	Parker River	NS	NS
Southern New England	RI	Gilbert Stuart Dam	NS	NS
	RI	Hamilton Fish Ladder	NS	NS
	NY	Carmans River	NS	NS
Delaware Bay/ Mid-Atlantic Coastal Bays	NJ	Patcong Creek	NS	NS
	DE	Millsboro Dam	NS	NS
	MD	Turville Creek	NS	NS
Chesapeake Bay	PRFC	Clarks Millpond	NS	NS
	PRFC	Gardys Millpond	NS	NS
	VA	Brackens Pond	NS	NS
	VA	Kamps Millpond	NS	NS
	VA	Warehams Pond	NS	NS
	VA	Wormley Creek	NS	NS
South Atlantic	SC	Goose Creek	NS	↓
	GA	Altamaha Canal	NS	NS
	GA	Hudson Creek	NS	NS
	FL	Guana River Dam	NS	NS

Table 1. Results of the Mann-Kendall trend analysis applied to 2012 Benchmark Stock Assessment (SA) and updated YOY indices developed from the ASMFC-mandated recruitment surveys. Trend indicates the direction of the trend if a statistically significant temporal trend was detected (P-value < α; $\alpha = 0.05$). NS = not significant.

Terry Stockwell
Director of External Affairs
Maine Department of Marine Resources
Augusta, ME 04333
1/12/16

Mike Waine
American Eel Fishery Management Plan Coordinator
Atlantic States Marine Fisheries Commission
Arlington, VA 22201

Dear Mike,

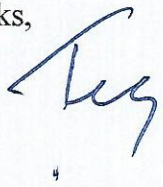
I am writing to submit a proposal from the State of Maine, under Section 4.4 "alternative state management regimes," to eliminate the current requirement for two closed days (Saturday/Sunday) which was part of Maine's original glass eel regulatory package when implementing the ASMFC American Eel Fishery Management Plan (FMP). The rationale and support for this proposal is because Maine has successfully moved away input to output control measures and fully implemented quota based management accounted for by daily swipe card monitoring.

The State of Maine does not foresee any erosion of the FMP's conservation goals or impact to the American eel resource because of the implementation of quota management, a limited season and the continued free passage of eels in the middle section of all water systems.

Please submit this proposal for technical review at the upcoming Technical Committee meeting and add an agenda item to the winter American Eel Board meeting for their consideration and hopeful approval.

As always, please contact me if you have any questions or need more information.

Many thanks,



Atlantic States Marine Fisheries Commission

1050 N. Highland Street • Suite 200A-N • Arlington, VA 22201
703.842.0740 • 703.842.0741 (fax) • www.asmfc.org

MEMORANDUM

January 19, 2016

To: **American Eel Management Board**

From: **American Eel Technical Committee**

RE: **TC Review of South Carolina's Survey Sampling Proposal and Maine's Conservation Equivalent Management Proposal**

South Carolina's Survey Sampling Proposal

The TC reviewed South Carolina's proposal to amend their fyke net sampling gear in 2016. As required in the FMP, all participating states must conduct surveys for the American eel young of the year (YOY). To meet this requirement, SC has used a staked fyke-net since 2000 at their Goose Creek site, a tributary of the Cooper River. However, the gear has not been consistent from year to year due to extreme tides, drought, vandalism, fallen trees, and erosion. These issues have led to inconsistent data in the time series.

After receiving funding to construct eel collection and passage ramps at the same site, it was confirmed that the fyke nets were not properly capturing young-of-year (YOY). For the last three years, both gears have been sampled at the site and the eel ramp has proven to be a more effective sampling gear. SC requests a change in sampling gear to use the eel ramp in their YOY survey. The TC noted that a change in gear type would mean that the data would need to be collected for 10 years before it could be used in the assessment, but that the three years of paired data may provide an opportunity to apply a correction factor to avoid this issue. The TC did not have any biological concerns with this change and supported the proposal.

Maine Conservation Equivalent Management Proposal

The TC also reviewed a proposal from Maine to eliminate the FMP requirement of two closed days (Saturday and Sunday) for the American eel fishery in that state. This was part of Maine's original regulatory package when the state managed based on input controls (e.g., days out) which managed effort. The state has transitioned to a quota management system to control harvest and is requesting to do away with closed days. The TC was concerned about law enforcement on the previously closed days (Saturday and Sunday) and Maine clarified that enforcement officers are active on the weekends. Considering Maine has transitioned to a quota management program that regulates the harvest of glass eels, the TC is not concerned with the removal of days out and supports their proposal.

(1) $2 per pound domestically produced seafood; A Grand Challenge for the 21st Century Bioeconomy in the areas of health, the environment, and agriculture:

When is the last time you bought seafood in the grocery store? Where did it come from? How much did it cost?

Although the health benefits of a diet high in seafood are well known, American consumers continue to eat far less seafood than other forms of meat. This year new dietary guidelines (published by the U.S. Department of Agriculture and U.S. Department of Health and Human Services) call for Americans to double their seafood consumption. However, even at current levels of consumption, the U.S. produces very little of its own seafood supply and other forms of meat are available to consumers at much lower prices. This is not due to any inherent inefficiency in seafood production. Seafood can be produced in low energy culture systems and cultured seafood species normally have more favorable feed conversion ratios than terrestrial species. The lack of affordable domestic product is due to the relatively new and underdeveloped nature of the domestic industry.

Looking forward, finite wild seafood stocks combined with increased domestic and global demand (fueled by both population growth and increased per capita consumption) is likely to result in even higher prices and less availability of quality seafood for the U.S. consumer.

On a global scale, the shortage of wild seafood has been met by explosive growth in the agricultural production of aquatic organisms – herein referred to as aquaculture. Commercial aquaculture production currently makes up greater than half of the global seafood supply. However, the United States has lagged behind other nations in the development of this emerging form of agriculture. U.S. consumers have access to quality, safe, and affordable sources of red meat and poultry, raised in the U.S., under U.S. food safety and environmental regulations, yet only 5% of the seafood consumed in the U.S. is a product of domestic aquaculture. The U.S. represents one of the world's largest seafood markets (second only to Japan), but 86% of that market is supplied by imports, approximately half of which are foreign aquaculture products, contributing to a national seafood trade deficit which recently surpassed $10 billion per year.

Aside from issues of availability and price, U.S. consumers may avoid seafood due to concerns regarding the source, safety, and sustainability of seafood products. Although most of the seafood available to U.S. consumers is safe, there are valid concerns associated with seafood that has been harvested or farmed under less than adequate regulatory oversight. Such concerns would be addressed by the domestic production of seafood, under U.S. environmental and food safety oversight.

Any plan for building a 21st Century Bioeconomy should include the development of a sustainable domestic aquaculture industry that will be large enough to reduce the nation's seafood deficit, add jobs to the U.S. economy, and provide consumers with a quality, safe, and affordable supply of healthful seafood.

In 1980, the passage of the National Aquaculture Act made it this nation's policy to support the development of domestic aquaculture. However, 31 years after the passage of the act, the U.S. has made important contributions to aquaculture innovation, technology, and environmental management; but has failed to take a leading role in production. A modest domestic aquaculture industry has emerged, but not on a scale that can successfully compete with the lower cost of foreign production.

The U.S. demand for seafood is likely to continue to grow, and it is in the best interest of public health and the national economy to produce a greater proportion of that seafood domestically as part of the emerging 21st Century Bioeconomy.

A large scale domestic aquaculture industry will provide the following benefits:

- Benefits to the American consumer – Nutritious and affordable seafood. Clear understanding of the source, security, quality, and safety of U.S. farm-raised seafood.

- Benefits to the U.S. economy – A domestic aquaculture industry on the scale of other meat production industries in the U.S. would provide thousands of jobs in production, support, and scientific discovery. Such development would also be consistent with the objectives of the White House Rural Council to strengthen rural communities and promote economic development [http://www.whitehouse.gov/administration/eop/rural-council]

- Benefits to the environment – One of the world's largest seafood markets would become significantly less dependent on faltering wild fish stocks and on under-regulated foreign aquaculture. Additionally, many forms of aquaculture produce positive ecosystem effects (e.g., Oyster culture can restore degraded habitat and remove excess nutrients from the water column). Furthermore, a successful, competitive U.S. aquaculture industry would set the best practices standards for the rest of the world to follow.

Many of the funding sources that currently support domestic aquaculture development have been, or are likely to be, dramatically reduced in the current budgetary climate. The development of a large scale, competitive aquaculture industry in the U.S. will require commitment and decisive action by the Federal government, companies, academic institutions, non-profit organizations, and others, in the following specific areas:

Seafood species selection and development: The animals used in terrestrial agriculture today have undergone centuries of selective breeding, making them more efficient and productive. Because large-scale aquaculture is a relatively recent form of agriculture, there is still the opportunity to select and develop the most appropriate species for culture. Federal research in the area of selective breeding should be funded at higher levels because genetic improvement of aquaculture species has the potential to dramatically increase productivity, and there are few commercial operations that have the resources to maintain a selective breeding program.

Feed research: Feed comprises a large portion of production cost for any animal species. The same is true for aquatic species. Currently aquatic animal feed relies heavily on fish meal, harvested from wild fish populations, as a key feed ingredient. Since the amount of fish meal available from the wild is a finite and is dependent on fluctuations associated with wild populations, the cost of fish meal is a potential limiting factor for aquaculture production. Additionally, if increased aquaculture is to realize its potential to reduce pressure on faltering wild stocks of fish, alternatives to fish meal need to be developed for use in aquatic animal feeds. Terrestrial plants such as soybeans have shown promise as a partial replacement for fish meal, especially for some species of fish. Perhaps even more promising is the use of aquatic algae – the natural source of fish nutrition, in synergy with biofuel production. Every new feed ingredient needs to be approved by the Food and Drug Administration. The process for this approval requires substantial resources that are often beyond what is practical to spend on an approval for the relatively small U.S. aquaculture feeds market. Federal research should be focused on identifying, testing, and approving fish meal replacements for aquaculture feeds. The National Oceanographic and Atmospheric Administration and U.S. Department of Agriculture recently produced a draft document that outlines potential steps to address this issue. [http://aquaculture.noaa.gov/news/feeds.html]

Aquatic Animal Health: Aside from feed, another major cost associated with intensive animal production is the prevention and cure of infectious disease. Because aquatic animal husbandry is relatively new when compared to traditional agriculture, there is still a lot to learn with regard to aquatic disease agents and host species biology that might impact the productivity of domestic aquaculture. Developing the necessary diagnostic tools, drugs, and vaccines is an expensive proposition that is not justified by the current size of the U.S. industry. Federal effort should focus on developing the tools, knowledge base, and infrastructure needed to monitor, mitigate, treat, and control aquatic animal diseases.

Regulations: Adequate regulation of domestic aquaculture is critically important. A domestic industry would be of little value if consumers can not be certain that the product is of high quality and was produced in a manner that is safe for human consumption and for the environment. In many cases inefficient, confusing, overlapping, and/or undeveloped regulations are a hindrance to the expansion of U.S. aquaculture. The Federal government should make it a priority to critically evaluate its regulations regarding aquaculture, and address regulatory inefficiencies. States should be encouraged to do the same. Such an effort would be consistent with the January 18, 2011, Executive Order regarding Improving Regulation and Regulatory Review [http://www.whitehouse.gov/the-press-office/2011/01/18/improving-regulation-and-regulatory-review-executive-order].

Statistics: It is difficult to understand past, current, and future directions of the domestic aquaculture industry without accurate production and market numbers. The Federal government should track and publish this information through its National Agricultural

Statistics Service. Recent cuts in the census of U.S. aquaculture are inconsistent with the nation's aquaculture policy.

Financing: Due in part to the lack of a clear regulatory climate and the difficulties associated with defining the market, aquaculture startups can have trouble obtaining financing. The Federal government should consider ways to make funding more readily available for properly vetted aquaculture projects.

Information: The U.S. consumer is exposed to many conflicting messages regarding the safety and sustainability of wild, farmed, foreign, and domestic seafood. The result seems to be general confusion and apprehension regarding seafood consumption. The Federal government should provide a source of clear and unbiased information for the consumer. Especially as it pertains to specific consumer concerns (e.g., mercury content, PCBs, and overfishing).

An interagency aquaculture coordinating group, under the Office of Science and Technology Policy, meets on a quarterly basis to better coordinate on aquaculture issues. The group is composed of members of federal agencies with roles in the development and regulation of aquaculture, and is currently proposing a Research and Development Strategic Plan to address these and other issues associated with U.S. aquaculture. Federal support of the Research Plan would be an important initial step toward meeting the proposed challenge.

Meeting this grand challenge - $2 per pound domestically produced seafood - would be a monumental achievement and would dramatically affect the way Americans eat. It would give the U.S. consumer the option to consume seafood in the same way that they now consume chicken breast- or ground beef, and could have important public health benefits. Importantly, it would also be a sign that U.S. aquaculture production is a large and thriving part of the nation's economy, and that the U.S. is a world leader in the industry. It would mean that one of the major seafood markets of the world is no longer dependent on the harvest of imperiled wild seafood stocks or on the low cost production methods of developing countries. As long as high regulatory standards are maintained, it would mean that safe, high quality seafood can be produced in a sustainable manner, without sacrificing the health and function of the environment. This is an attainable challenge. However, the benefits of success would be incremental. If the effort results in the domestic production of $4 per pound, or even $6 per pound seafood, this is still a significant win for the U.S. consumer, the U.S. economy, and the environment.

PART 1

WORLD REVIEW OF FISHERIES AND AQUACULTURE

WORLD REVIEW OF FISHERIES AND AQUACULTURE

Status and trends

OVERVIEW

Capture fisheries and aquaculture supplied the world with about 148 million tonnes of fish in 2010 (with a total value of US$217.5 billion), of which about 128 million tonnes was utilized as food for people, and preliminary data for 2011 indicate increased production of 154 million tonnes, of which 131 million tonnes was destined as food (Table 1 and Figure 1, all data presented are subject to rounding). With sustained growth in fish production and improved distribution channels, world fish food supply has grown dramatically in the last five decades, with an average growth rate of 3.2 percent per year in the period 1961–2009, outpacing the increase of 1.7 percent per year in the world's population. World per capita food fish supply increased from an average of 9.9 kg (live weight equivalent) in the 1960s to 18.4 kg in 2009, and preliminary estimates for 2010 point to a further increase in fish consumption to 18.6 kg[1] (Table 1 and Figure 2). Of the 126 million tonnes available for human consumption in 2009, fish consumption was lowest in Africa (9.1 million tonnes, with 9.1 kg per capita), while Asia accounted for two-thirds of total consumption, with 85.4 million tonnes (20.7 kg per capita), of which 42.8 million tonnes was consumed outside China (15.4 kg per capita). The corresponding per capita fish consumption figures

Table 1
World fisheries and aquaculture production and utilization

	2006	2007	2008	2009	2010	2011
	(Million tonnes)					
PRODUCTION						
Capture						
Inland	9.8	10.0	10.2	10.4	11.2	11.5
Marine	80.2	80.4	79.5	79.2	77.4	78.9
Total capture	**90.0**	**90.3**	**89.7**	**89.6**	**88.6**	**90.4**
Aquaculture						
Inland	31.3	33.4	36.0	38.1	41.7	44.3
Marine	16.0	16.6	16.9	17.6	18.1	19.3
Total aquaculture	**47.3**	**49.9**	**52.9**	**55.7**	**59.9**	**63.6**
TOTAL WORLD FISHERIES	**137.3**	**140.2**	**142.6**	**145.3**	**148.5**	**154.0**
UTILIZATION						
Human consumption	114.3	117.3	119.7	123.6	128.3	130.8
Non-food uses	23.0	23.0	22.9	21.8	20.2	23.2
Population (*billions*)	6.6	6.7	6.7	6.8	6.9	7.0
Per capita food fish supply (*kg*)	17.4	17.6	17.8	18.1	18.6	18.8

Notes: Excluding aquatic plants. Totals may not match due to rounding. Data for 2011 are provisional estimates.

for Oceania, North America, Europe, and Latin America and the Caribbean were 24.6 kg, 24.1 kg, 22.0 kg and 9.9 kg, respectively. Although annual per capita consumption of fishery products has grown steadily in developing regions (from 5.2 kg in 1961 to 17.0 kg in 2009) and in low-income food-deficit countries (LIFDCs, from 4.9 kg in 1961 to 10.1 kg in 2009), it is still considerably lower than in more developed regions, although the gap is narrowing. A sizeable share of fish consumed in developed countries consists of imports, and, owing to steady demand and declining domestic fishery production (down 10 percent in the period 2000–2010), their dependence on imports, in particular from developing countries, is projected to grow in coming years.

China has been responsible for most of the increase in world per capita fish consumption, owing to the substantial increase in its fish production, particularly from aquaculture, despite a downward revision of China's production statistics for recent years (Box 1). China's share in world fish production grew from 7 percent in 1961 to 35 percent in 2010. Driven by growing domestic income and an increase in the diversity of fish available, per capita fish consumption in China has also increased dramatically, reaching about

Figure 1

World capture fisheries and aquaculture production

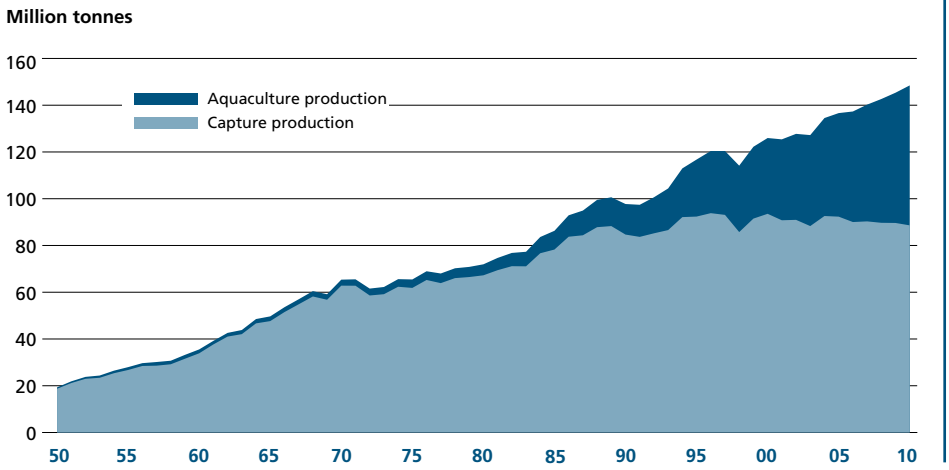
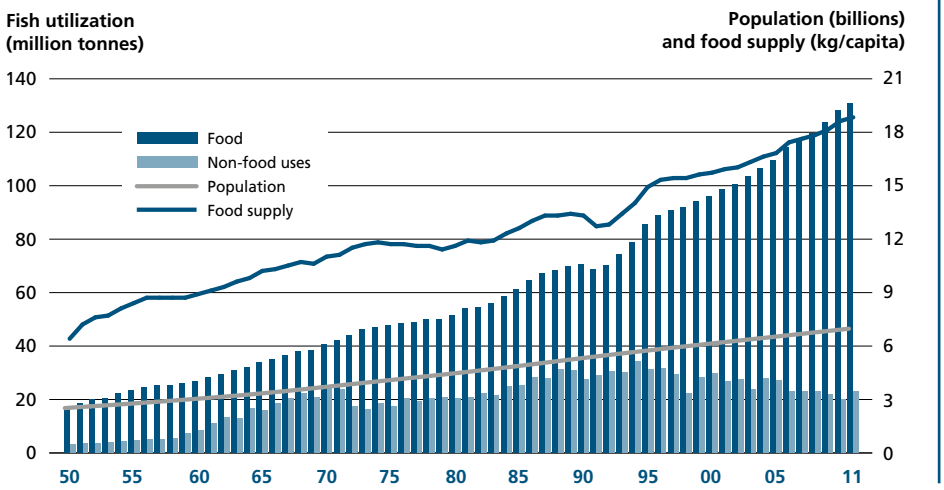


Figure 2

World fish utilization and supply

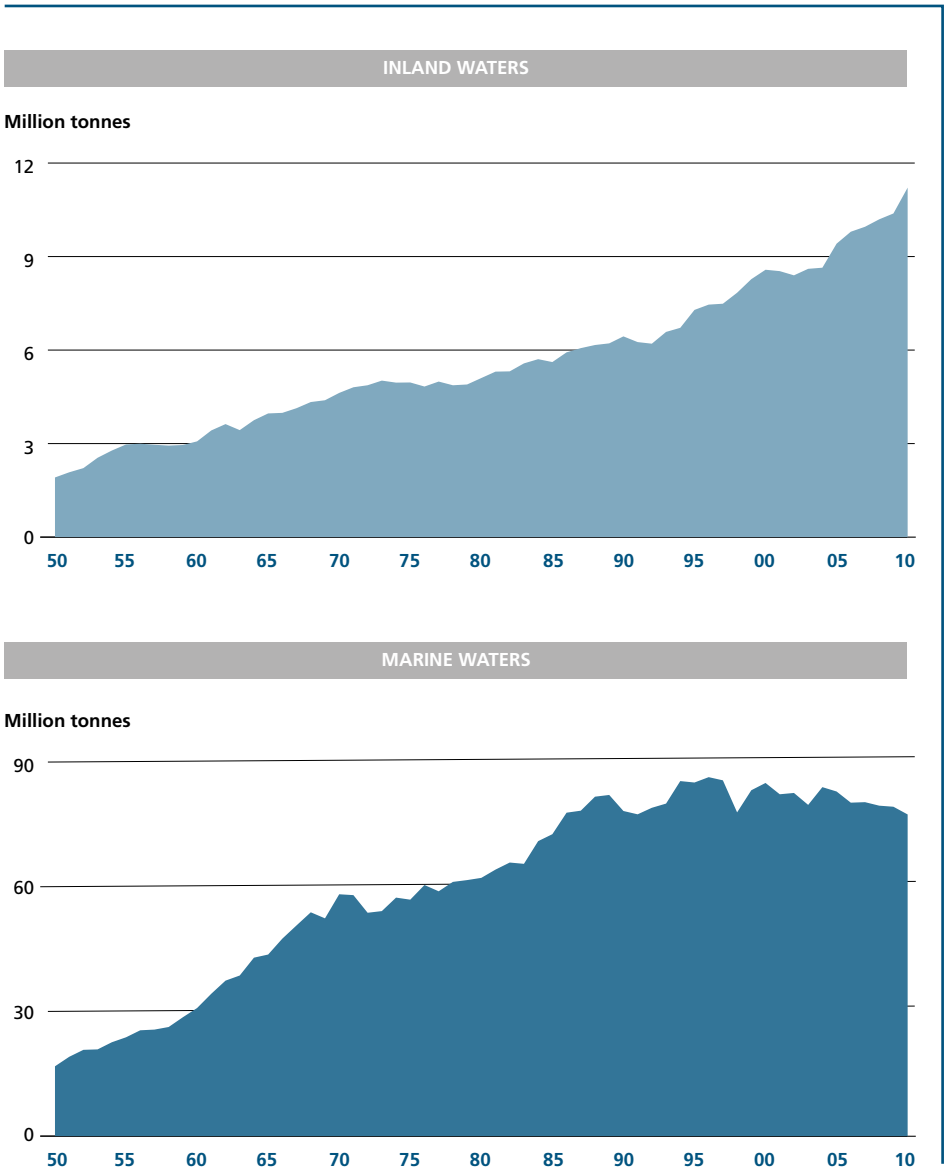


31.9 kg in 2009, with an average annual rate of 6.0 percent in the period 1990–2009. If China is excluded, annual fish supply to the rest of the world in 2009 was about 15.4 kg per person, higher than the average values of the 1960s (11.5 kg), 1970s (13.5 kg), 1980s (14.1 kg) and 1990s (13.5 kg).

Fish and fishery products represent a very valuable source of protein and essential micronutrients for balanced nutrition and good health. In 2009, fish accounted for 16.6 percent of the world population's intake of animal protein and 6.5 percent of all protein consumed. Globally, fish provides about 3.0 billion people with almost 20 percent of their intake of animal protein, and 4.3 billion people with about 15 percent of such protein. Differences among developed and developing countries are apparent in the contribution of fish to animal protein intake. Despite the relatively lower levels of fish consumption in developing countries, the share contributed by fish was significant at about 19.2 percent, and for LIFDCs it was 24.0 percent. However, in both developing and developed countries, this share has declined slightly in recent years as consumption of other animal proteins has grown more rapidly.

Figure 3

World capture fisheries production



Box 1

Improvements in China's fishery and aquaculture statistics

As stated in previous issues of *The State of World Fisheries and Aquaculture*, China revised its production statistics for capture fisheries and aquaculture for 2006 onwards using a revised statistical methodology based on the outcome of China's 2006 National Agricultural Census, which contained questions on fish production for the first time, as well as on results from various pilot sample surveys. FAO subsequently estimated revisions for its historical statistics for China for 1997–2005.

Sample surveys have been increasingly adopted in China as an efficient means of collecting data, with the possibility of tailoring them to collect more detailed information required specifically for the local situation in which they are conducted. Prior to the implementation of more systematic sample surveys, pilot surveys were undertaken to test their utility in a variety of very different situations. In addition to some undertaken independently by Chinese authorities, the following pilot sample surveys were conducted jointly by China and FAO:

- marine capture fisheries in Xiangshan County, Zhejiang Province (2002–03);
- marine capture fisheries in Putuo District, Zhoushan (China's largest fishing port), Zhejiang Province, and in Haimen City, Jiangsu Province (2004–05);
- marine capture fisheries in Laizhou City, Shandong Province (2008–09);
- inland capture fisheries at Lake Liangzi, Hubei Province (2008–09);
- inland capture fisheries at Lake Taihu, Jiangsu Province (2009–2010).

Recognizing the importance of its statistics on fisheries and aquaculture as a basis for its sectoral policy-making and management, as well as their major implications for global statistics, it is notable that China has continued to implement improvements to many aspects of its statistical systems, including the further use of sample-based surveys. Further improvements are in progress, including the disaggregation of primary-sector employment statistics between fisheries and aquaculture. Since 2009, improvement of statistics has been a priority for national fisheries and aquaculture development

Overall global capture fisheries production continues to remain stable at about 90 million tonnes (Table 1) although there have been some marked changes in catch trends by country, fishing area and species. In the last seven years (2004–2010), landings of all marine species except anchoveta only ranged between 72.1 million and 73.3 million tonnes. In contrast, the most dramatic changes, as usual, have been for anchoveta catches in the Southeast Pacific, which decreased from 10.7 million tonnes in 2004 to 4.2 million tonnes in 2010. A marked decrease in anchoveta catches by Peru in 2010 was largely a result of management measures (e.g. fishing closures) applied to protect the high number of juveniles present as a consequence of the La Niña event (cold water). This action paid dividends in 2011

and management, and additional funds have been allocated annually to strengthen the national and local capacity in collecting data and improving data quality through the following activities:

- training of enumerators and statistical officers from county to provincial levels;
- establishment of a qualification system for enumerators and a national database and communication network for enumerators and statistical officers overseen by an advisory expert panel;
- establishment of an Internet-based data reporting and validation system;
- development of field manuals for enumerators.

In addition to annual data collection and reporting, China has established monthly and mid-year data collection and reporting systems for important statistical indicators. Specialized institutes have been commissioned to use geographic information system (GIS) technologies to verify inland fishery and aquaculture areas. Parallel to the national data collection system, networks involving research institutions and fisheries authorities of key producing areas in the country have been established under the Chinese Academy of Fisheries Sciences to monitor aquaculture production of "staple species".

The current data collection system in China covers capture production (by species, fishing area and fishing gear), fishing vessels, aquaculture production (by species, farming system and method), aquaculture areas, aquaculture seed production, fishery products processing, damage and losses in capture and aquaculture, employment and the fishery-dependent population, and fishery household-level economic indicators. China also collects and reports weekly wholesale fish prices for major marketing centres in all the provinces.

In recent years, communication between the Chinese reporting office and FAO has improved, resulting in more information becoming available on fish utilization, more detailed and accurate fishing fleet statistics, and disaggregation of primary-sector employment statistics between fisheries and aquaculture.

when anchoveta catches exceeded their 2009 level. Inland water capture production continued to grow continuously, with an overall increase of 2.6 million tonnes in the period 2004–2010 (Figure 3).

The Northwest Pacific is still by far the most productive fishing area. Catch peaks in the Northwest Atlantic, Northeast Atlantic and Northeast Pacific temperate fishing areas were reached many years ago, and total production had declined continuously from the early and mid-2000s, but in 2010 this trend was reversed in all three areas. As for mainly tropical areas, total catches grew in the Western and Eastern Indian Ocean and in the Western Central Pacific. In contrast, the 2010 production in the Western Central Atlantic decreased, with a reduction in United States catches by about

100 000 tonnes, probably mostly attributable to the oil spill in the Gulf of Mexico. Since 1978, the Eastern Central Pacific has shown a series of fluctuations in capture production with a cycle of about 5–9 years. The latest peak was in 2009, and a declining phase may have started in 2010. Both the Mediterranean–Black Sea and the Southwest Atlantic have seen declining catches, with decreases of 15 and 30 percent, respectively, since 2007. In the Southeast Pacific (excluding anchoveta) and the Southeast Atlantic, both areas where upwelling phenomena occur with strongly varied intensity each year, historical catch trends have been downward in both areas. In the Eastern Central Atlantic, production has increased in the last three years, but there are some reporting inconsistencies for this area.

Chilean jack mackerel catches have declined for this transboundary resource with a very wide distribution in the South Pacific, ranging from the national exclusive economic zones (EEZs) to the high seas. After having peaked at about 5 million tonnes in the mid-1990s, catches were about 2 million tonnes in the mid-2000s but have since declined abruptly, and the 2010 catches were 0.7 million tonnes, the lowest level since 1976. In contrast, Atlantic cod catches have increased by almost 200 000 tonnes in the last two years. In fact, in 2010, the whole group of gadiform species (cods, hakes, haddocks, etc.) reversed the negative trend of the previous three years in which it had declined by 2 million tonnes. Preliminary data for this group also report growing catches for 2011. Capture production of other important commercial species groups such as tunas and shrimps remained stable in 2010. The highly variable catches of cephalopods resumed growth after a decrease in 2009 of about 0.8 million tonnes. In the Antarctic areas, interest in fishing for krill resumed, and a catch increase of more than 70 percent was registered in 2010.

Total global capture production in inland waters has increased dramatically since the mid-2000s with reported and estimated total production at 11.2 million tonnes in 2010, an increase of 30 percent since 2004. Despite this growth, it may be that capture production in inland waters is seriously underestimated in some regions. Nevertheless, inland waters are considered as being overfished in many parts of the world, and human pressure and changes in the environmental conditions have seriously degraded important bodies of freshwater (e.g. the Aral Sea and Lake Chad). Moreover, in several countries that are important in terms of inland waters fishing (e.g. China), a good portion of inland catches comes from waterbodies that are artificially restocked. It is not clear to what extent improvements in the statistical coverage and stock enhancement activities may be contributing to the apparent increase in inland fishery production. Growth in the global inland water catch is wholly attributable to Asian countries. With the remarkable increases reported for 2010 production by India, China and Myanmar, Asia's share is approaching 70 percent of global production. Inland water capture production in the other continents shows different trends. Uganda and the United Republic of Tanzania, fishing mostly in the African Great Lakes, and Nigeria and Egypt, with river fisheries, remain the main producers in Africa. Catches in several South and North American countries have been reported as shrinking. Increased European production between 2004 and 2010 is all attributable to a rise of almost 50 percent in catches of the Russian Federation. Inland fishery production is marginal in countries in Oceania.

In the last three decades (1980–2010), world food fish production of aquaculture has expanded by almost 12 times, at an average annual rate of 8.8 percent. Global aquaculture production has continued to grow, albeit more slowly than in the 1980s and 1990s. World aquaculture production attained another all-time high in 2010, at 60 million tonnes (excluding aquatic plants and non-food products), with an estimated total value of US$119 billion. When farmed aquatic plants and non-food products are included, world aquaculture production in 2010 was 79 million tonnes, worth US$125 billion. About 600 aquatic species are raised in captivity in about 190 countries for production in farming systems of varying input intensities and technological sophistication. These include hatcheries producing seeds for stocking to the wild, particularly in inland waters.

In 2010, global production of farmed food fish was 59.9 million tonnes, up by 7.5 percent from 55.7 million tonnes in 2009 (32.4 million tonnes in 2000). Farmed food fish include finfishes, crustaceans, molluscs, amphibians (frogs), aquatic reptiles (except crocodiles) and other aquatic animals (such as sea cucumbers, sea urchins, sea squirts and jellyfishes), which are indicated as fish throughout this document. The reported grow-out production from aquaculture is almost entirely destined for human consumption. The total farmgate value of food fish production from aquaculture is estimated at US$119.4 billion for 2010.

Aquaculture production is vulnerable to adverse impacts of disease and environmental conditions. Disease outbreaks in recent years have affected farmed Atlantic salmon in Chile, oysters in Europe, and marine shrimp farming in several countries in Asia, South America and Africa, resulting in partial or sometimes total loss of production. In 2010, aquaculture in China suffered production losses of 1.7 million tonnes caused by natural disasters, diseases and pollution. Disease outbreaks virtually wiped out marine shrimp farming production in Mozambique in 2011.

The global distribution of aquaculture production across the regions and countries of different economic development levels remains imbalanced. In 2010, the top ten producing countries accounted for 87.6 percent by quantity and 81.9 percent by value of the world's farmed food fish. Asia accounted for 89 percent of world aquaculture production by volume in 2010, and this was dominated by the contribution of China, which accounted for more than 60 percent of global aquaculture production volume in 2010. Other major producers in Asia are India, Viet Nam, Indonesia, Bangladesh, Thailand, Myanmar, the Philippines and Japan. In Asia, the share of freshwater aquaculture has been gradually increasing, up to 65.6 percent in 2010 from around 60 percent in the 1990s. In terms of volume, Asian aquaculture is dominated by finfishes (64.6 percent), followed by molluscs (24.2 percent), crustaceans (9.7 percent) and miscellaneous species (1.5 percent). The share of non-fed species farmed in Asia was 35 percent (18.6 million tonnes) in 2010 compared with 50 percent in 1980.

In North America, aquaculture has ceased expanding in recent years, but in South America it has shown strong and continuous growth, particularly in Brazil and Peru. In terms of volume, aquaculture in North and South America is dominated by finfishes (57.9 percent), crustaceans (21.7 percent) and molluscs (20.4 percent). In Europe, the share of production from brackish and marine waters increased from 55.6 percent in 1990 to 81.5 percent in 2010, driven by marine cage culture of Atlantic salmon and other species. Several important producers in Europe have recently ceased expanding or have even contracted, particularly in the marine bivalve sector. In 2010, finfishes accounted for three-quarters of all European aquaculture production, and molluscs one-quarter. Africa has increased its contribution to global production from 1.2 percent to 2.2 percent in the past ten years, mainly as a result of rapid development in freshwater fish farming in sub-Saharan Africa. African aquaculture production is overwhelmingly dominated by finfishes, with only a small fraction from marine shrimps and marine molluscs. Oceania accounts for a minor share of global aquaculture production and this consists mainly of marine molluscs and finfishes, with the latter increasing owing mainly to the development of farming of Atlantic salmon in Australia and chinook salmon in New Zealand.

The least-developed countries (LDCs), mostly in sub-Saharan Africa and in Asia, remain minor in terms of their share of world aquaculture production (4.1 percent by quantity and 3.6 percent by value) with the main producers including Bangladesh, Myanmar, Uganda, the Lao People's Democratic Republic and Cambodia. However, some developing countries in Asia and the Pacific (Myanmar and Papua New Guinea), sub-Saharan Africa (Nigeria, Uganda, Kenya, Zambia and Ghana) and South America (Ecuador, Peru and Brazil) have made rapid progress to become significant or major aquaculture producers in their regions. In contrast, in 2010, developed industrialized countries produced collectively 6.9 percent (4.1 million tonnes) by quantity and 14 percent (US$16.6 billion) by value of the world's farmed food fish production, compared with 21.9 percent and 32.4 percent, respectively, in 1990. Aquaculture

production has contracted or stagnated in Japan, the United States of America and several European countries. An exception is Norway, where, thanks to the farming of Atlantic salmon in marine cages, aquaculture production grew from 151 000 tonnes in 1990 to more than one million tonnes in 2010.

Freshwater fishes dominate global aquaculture production (56.4 percent, 33.7 million tonnes), followed by molluscs (23.6 percent, 14.2 million tonnes), crustaceans (9.6 percent, 5.7 million tonnes), diadromous fishes (6.0 percent, 3.6 million tonnes), marine fishes (3.1 percent, 1.8 million tonnes) and other aquatic animals (1.4 percent, 814 300 tonnes). While feed is generally perceived to be a major constraint to aquaculture development, one-third of all farmed food fish production (20 million tonnes) is currently achieved without artificial feeding, as is the case for bivalves and filter-feeding carps. However, the percentage of non-fed species in world production has declined gradually from more than 50 percent in 1980 to the present level of 33.3 percent, reflecting the relatively faster body-growth rates achieved in the culture of fed species and increasing consumer demand for higher trophic-level species of fishes and crustaceans.

Fisheries and aquaculture provided livelihoods and income for an estimated 54.8 million people engaged in the primary sector of fish production in 2010, of whom an estimated 7 million were occasional fishers and fish farmers. Asia accounts for more than 87 percent of the world total with China alone having almost 14 million people (26 percent of the world total) engaged as fishers and fish farmers. Asia is followed by Africa (more than 7 percent), and Latin America and the Caribbean (3.6 percent). About 16.6 million people (about 30 percent of the world total) were engaged in fish farming, and they were even more concentrated in Asia (97 percent), followed by Latin America and the Caribbean (1.5 percent), and Africa (about 1 percent). Employment in the fisheries and aquaculture primary sector has continued to grow faster than employment in agriculture, so that by 2010 it represented 4.2 percent of the 1.3 billion people economically active in the broad agriculture sector worldwide, compared with 2.7 percent in 1990. In the last five years, the number of people engaged in fish farming has increased by 5.5 percent per year compared with only 0.8 percent per year for those in capture fisheries, although capture fisheries still accounted for 70 percent of the combined total in 2010. It is apparent that, in the most important fishing nations, the share of employment in capture fisheries is stagnating or decreasing while aquaculture is providing increased opportunities. Europe experienced the largest decrease in the number of people engaged in capture fishing, with a 2 percent average annual decline between 2000 and 2010, and almost no increase in people employed in fish farming. In contrast, Africa showed the highest annual increase (5.9 percent) in the number of people engaged in fish farming in the same period, followed by Asia (4.8 percent), and Latin America and the Caribbean (2.6 percent). Overall, production per person is lower in capture fisheries than in aquaculture, with global outputs of 2.3 and 3.6 tonnes per person per year respectively, reflecting the huge numbers of fishers engaged in small-scale fisheries.

Apart from the primary production sector, fisheries and aquaculture provide numerous jobs in ancillary activities such as processing, packaging, marketing and distribution, manufacturing of fish-processing equipment, net and gear making, ice production and supply, boat construction and maintenance, research and administration. All of this employment, together with dependants, is estimated to support the livelihoods of 660–820 million people, or about 10–12 percent of the world's population.

The total number of fishing vessels in the world in 2010 is estimated at about 4.36 million, which is similar to previous estimates. Of these, 3.23 million vessels (74 percent) are considered to operate in marine waters, with the remaining 1.13 million vessels operating in inland waters. Overall, Asia has the largest fleet, comprising 3.18 million vessels and accounting for 73 percent of the world total, followed by Africa (11 percent), Latin America and the Caribbean (8 percent), North America (3 percent) and Europe (3 percent). Globally, 60 percent of fishing vessels

were engine-powered in 2010, but although 69 percent of vessels operating in marine waters were motorized, the figure was only 36 percent for inland waters. For the fleet operating in marine waters, there were also large variations among regions, with non-motorized vessels accounting for less than 7 percent of the total in Europe and the Near East, but up to 61 percent in Africa.

Over 85 percent of the motorized fishing vessels in the world are less than 12 m in length overall (LOA). Such vessels dominate in all regions, but markedly so in the Near East, and Latin America and the Caribbean. About 2 percent of all motorized fishing vessels corresponded to industrialized fishing vessels of 24 m and larger (with a gross tonnage [GT] of roughly more than 100 GT) and that fraction was larger in the Pacific and Oceania region, Europe, and North America.

Data from some countries indicate a recent expansion in their fleets. For example, the motorized fishing fleets in Malaysia, Cambodia and Indonesia increased by 26, 19 and 11 percent, respectively, between 2007 and 2009, and Viet Nam reported a 10 percent increase in offshore fishing vessels (those with engines of more than 90 hp) between 2008 and 2010. The case of Sri Lanka illustrates potential overshoot in efforts to re-establish a fishing fleet, of which 44 percent of the motorized vessels were destroyed by the tsunami that swept the region at the end of 2004, with the result that by 2010 there were 11 percent more motorized vessels than before the tsunami.

Many countries have policies to reduce overcapacity in their fishing fleets. China's marine fishing vessel reduction plan for 2003–2010 did achieve a reduction by 2008 close to the target, but since then both the number of vessels and total combined power have started to increase again. Japan implemented various schemes that resulted in a net reduction of 9 percent in the number of vessels, but a net increase of 5 percent in combined power between 2005 and 2009. The evolution in the combined number, tonnage, and power of European Union fishing vessels indicates a downward tendency in the last decade and the combined EU-15 motorized fishing fleet achieved a net reduction of 8 percent in the number of vessels and of 11 percent in power between 2005 and 2010. Other important fishing nations that achieved a net reduction in fleet size in the period 2005–2010 include Iceland, Norway and the Republic of Korea.

The world's marine fisheries increased markedly from 16.8 million tonnes in 1950 to a peak of 86.4 million tonnes in 1996, and then declined before stabilizing at about 80 million tonnes. Global recorded production was 77.4 million tonnes in 2010. The Northwest Pacific had the highest production with 20.9 million tonnes (27 percent of the global marine catch) in 2010, followed by the Western Central Pacific with 11.7 million tonnes (15 percent), the Northeast Atlantic with 8.7 million tonnes (11 percent), and the Southeast Pacific, with a total catch of 7.8 million tonnes (10 percent). The proportion of non-fully exploited stocks has decreased gradually since 1974 when the first FAO assessment was completed. In contrast, the percentage of overexploited stocks has increased, especially in the late 1970s and 1980s, from 10 percent in 1974 to 26 percent in 1989. After 1990, the number of overexploited stocks continued to increase, albeit at a slower rate. Increases in production from these overexploited stocks may be possible if effective rebuilding plans are put in place. The fraction of fully exploited stocks, which produce catches that are very close to their maximum sustainable production and have no room for further expansion and require effective management to avoid decline, has shown the smallest change over time, with its percentage stable at about 50 percent from 1974 to 1985, then falling to 43 percent in 1989 before gradually increasing to 57 percent in 2009. About 29.9 percent of stocks are overexploited, producing lower yields than their biological and ecological potential and in need of strict management plans to restore their full and sustainable productivity in accordance with the Johannesburg Plan of Implementation that resulted from the World Summit on Sustainable Development (Johannesburg, 2002), which demands that all overexploited stocks be restored to the level that can produce maximum sustainable yield by 2015, a target that seems unlikely to be met. The remaining 12.7 percent of stocks were non-fully exploited in 2009, and these are under

relatively low fishing pressure and have some potential to increase their production although they often do not have a high production potential and require proper management plans to ensure that any increase in the exploitation rate does not result in further overfishing.

Most of the stocks of the top ten species, which account in total for about 30 percent of world marine capture fisheries production, are fully exploited and, therefore, have no potential for increases in production, while some stocks are overexploited and increases in their production may be possible if effective rebuilding plans are put in place. The two main stocks of anchoveta in the Southeast Pacific, Alaska pollock in the North Pacific and blue whiting in the Atlantic are fully exploited. Atlantic herring stocks are fully exploited in both the Northeast and Northwest Atlantic. Japanese anchovy in the Northwest Pacific and Chilean jack mackerel in the Southeast Pacific are considered to be overexploited. Chub mackerel stocks are fully exploited in the Eastern Pacific and the Northwest Pacific. The largehead hairtail was estimated in 2009 to be overexploited in the main fishing area in the Northwest Pacific.

Among the seven principal tuna species, one-third were estimated to be overexploited, 37.5 percent were fully exploited, and 29 percent non-fully exploited in 2009. Although skipjack tuna continued its increasing trend up to 2009, further expansion should be closely monitored, as it may negatively affect bigeye and yellowfin tunas (multispecies fisheries). In the long term, the status of tuna stocks (and consequently catches) may further deteriorate unless there are significant improvements in their management. This is because of the substantial demand for tuna and the significant overcapacity of tuna fishing fleets. Concern about the poor status of some bluefin stocks and the inability of some tuna management organizations to manage these stocks effectively led to a proposal in 2010 to ban the international trade in Atlantic bluefin tuna under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and, although the proposal was ultimately rejected, the concern remains.

The overall situation when summarized by FAO statistical areas shows three main patterns in catch trends. Areas that have demonstrated oscillations in total catch are the Eastern Central Atlantic (Area 34), Northeast Pacific (Area 67), Eastern Central Pacific (Area 77), Southwest Atlantic (Area 41), Southeast Pacific (Area 87), and Northwest Pacific (Area 61). These areas have provided about 52 percent of the world's total marine catch on average in the last five years. Several of these areas include upwelling regions that are characterized by high natural variability. The second group consists of areas that have demonstrated a decreasing trend in catch since reaching a peak at some time in the past. This group has contributed 20 percent of global marine catch on average in the last five years, and includes the Northeast Atlantic (Area 27), Northwest Atlantic (Area 21), Western Central Atlantic (Area 31), Mediterranean and Black Sea (Area 37), Southwest Pacific (Area 81), and Southeast Atlantic (Area 47). It should be noted that lower catches in some cases reflect fisheries management measures that are precautionary or aim at rebuilding stocks, and this situation should, therefore, not necessarily be interpreted as negative. The third group comprises the FAO areas that have shown continuously increasing trends in catch since 1950 and includes the Western Central Pacific (Area 71), Eastern (Area 57) and Western (Area 51) Indian Ocean. They have together contributed 28 percent of the total marine catch on average over the last five years. However, in some regions, there is still high uncertainty about the actual catches owing to the poor quality of statistical reporting systems in coastal countries.

The declining global marine catch over the last few years together with the increased percentage of overexploited fish stocks and the decreased proportion of non-fully exploited species around the world convey the strong message that the state of world marine fisheries is worsening and has had a negative impact on fishery production. Overexploitation not only causes negative ecological consequences, but it also reduces fish production, which further leads to negative social and economic consequences. To increase the contribution of marine fisheries to the food security,

economies and well-being of the coastal communities, effective management plans must be put in place to rebuild overexploited stocks. The situation seems more critical for some highly migratory, straddling and other fishery resources that are exploited solely or partially in the high seas. The United Nations Fish Stocks Agreement that entered into force in 2001 should be used as a legal basis for management measures of the high seas fisheries.

In spite of the worrisome global situation of marine capture fisheries, good progress is being made in reducing exploitation rates and restoring overexploited fish stocks and marine ecosystems through effective management actions in some areas. In the United States of America, 67 percent of all stocks are now being sustainably harvested, while only 17 percent are still overexploited. In New Zealand, 69 percent of stocks are above management targets, reflecting mandatory rebuilding plans for all fisheries that are still below target thresholds. Similarly, Australia reports overfishing for only 12 percent of stocks in 2009. Since the 1990s, the Newfoundland–Labrador Shelf, the Northeast United States Shelf, the Southern Australian Shelf, and California Current ecosystems have shown substantial declines in fishing pressure such that they are now at or below the modelled exploitation rate that gives the multispecies maximum sustainable yield of the ecosystem. These and other successes can serve as examples to assist in more effective management of other fisheries.

The information summarizing the state of the major marine fish stocks is impossible to duplicate for the state of most of the world's inland fisheries, for which the exploitation rate is often not the main driver affecting the state of the stocks. Other drivers such as habitat quantity and quality, aquaculture in the form of stocking and competition for freshwater, influence the state of the majority of inland fishery resources much more than exploitation rates do. Water abstraction and diversion, hydroelectric development, draining wetlands, and siltation and erosion from land-use patterns can negatively affect inland fishery resources regardless of the rate of exploitation. Conversely, stock enhancement from aquaculture facilities, which is widely practised in inland waters, can keep catch rates high in the face of increased fishing and in spite of an ecosystem that is not capable of producing that level of catch through natural processes. Overexploitation also affects inland fishery resources, but the result is generally a change in species composition and not necessarily a reduced overall catch. Catches are often higher where smaller and shorter-lived species become the main component of the catch; however, the smaller fish may be much less valuable. Another issue complicating the assessment of inland fishery resources is the definition of a "stock". Very few inland fisheries have stocks that are defined precisely or are defined at the level of species. There are notable exceptions such as the Lake Victoria Nile perch and Tonle Sap dai fisheries, but many inland fishery resources are defined by watershed or river and comprise numerous species. Taking all of these considerations into account, FAO is leading efforts to improve data collection and develop new assessment methodologies for inland fishery resources that are so important but often underestimated in terms of their economic, social and nutritional benefits and contribution to livelihoods and food security. The intention is to utilize the new methodology to provide a more robust and informative summary of the state of the world's inland capture fishery resources in the future.

Concerning utilization of the world's fish production, 40.5 percent (60.2 million tonnes) was marketed in live, fresh or chilled forms, 45.9 percent (68.1 million tonnes) was processed in frozen, cured or otherwise prepared forms for direct human consumption, and 13.6 percent destined for non-food uses in 2010. Since the early 1990s, there has been an increasing trend in the proportion of fisheries production used for direct human consumption rather than for other purposes. Whereas in the 1980s about 68 percent of the fish produced was destined for human consumption, this share increased to more than 86 percent in 2010, equalling 128.3 million tonnes. In 2010, 20.2 million tonnes was destined to non-food purposes, of which 75 percent (15 million tonnes) was reduced to fishmeal and fish oil; the remaining 5.1 million tonnes was largely utilized as fish for ornamental purposes, for culture (fingerlings,

fry, etc.), for bait, for pharmaceutical uses as well as for direct feeding in aquaculture, for livestock and for fur animals. Of the fish destined for direct human consumption, the most important product form was live, fresh or chilled fish, with a share of 46.9 percent in 2010, followed by frozen fish (29.3 percent), prepared or preserved fish (14.0 percent) and cured fish (9.8 percent). Freezing represents the main method of processing fish for human consumption, and it accounted for 55.2 percent of total processed fish for human consumption and 25.3 percent of total fish production in 2010.

The proportion of frozen fish grew from 33.2 percent of total production for human consumption in 1970 to reach a record high of 52.1 percent in 2010. The share of prepared and preserved forms remained rather stable during the same period, and it was 26.9 percent in 2010. Developing countries have experienced a growth in the share of frozen products (24.1 percent of the total fish for human consumption in 2010, up from 18.9 percent in 2000) and of prepared or preserved forms (11.0 percent in 2010, compared with 7.8 percent in 2000). Owing to deficiencies in infrastructure and processing facilities, together with well-established consumer habits, fish in developing countries is commercialized mainly in live or fresh form (representing 56.0 percent of fish destined for human consumption in 2010) soon after landing or harvesting. Cured forms (dried, smoked or fermented) still remain a traditional method to retail and consume fish in developing countries, although their share in total fish for human consumption is declining (10.9 percent in 2000 compared with 8.9 percent in 2010). In developed countries, the bulk of production destined for human consumption is commercialized frozen or in prepared or preserved forms.

Fishmeal is produced from whole fish or fish remains resulting from processing. Small pelagic species, in particular anchoveta, are the main contributors for reduction, and the volume of fishmeal and fish oil produced worldwide fluctuates annually according to the fluctuations in the catches of these species, which are strongly influenced by the El Niño phenomenon. Fishmeal production peaked in 1994 at 30.2 million tonnes (live weight equivalent) and has followed a fluctuating trend since then. In 2010, it dropped to 15.0 million tonnes owing to reduced catches of anchoveta, representing a decrease of 12.9 percent compared with 2009, of 18.2 percent compared with 2008, and of 42.8 percent with respect to 2000. Waste from commercial fish species used for human consumption is increasingly used in feed markets, and a growing percentage of fishmeal is being obtained from trimmings and other residues from the preparation of fish fillets. About 36 percent of world fishmeal production was obtained from offal in 2010.

Technological development in food processing and packaging is progressing rapidly. Processors of traditional products have been losing market share as a result of long-term shifts in consumer preferences as well as in processing and in the general fisheries industry. Processing is becoming more intensive, geographically concentrated, vertically integrated and linked with global supply chains. These changes reflect the increasing globalization of the fisheries value chain, with large retailers controlling the growth of international distribution channels. The increasing practice of outsourcing processing at the regional and world levels is very significant, but further outsourcing of production to developing countries might be restricted by sanitary and hygiene requirements that are difficult to meet as well as by growing labour costs. At the same time, processors are frequently becoming more integrated with producers, especially for groundfish, where large processors in Asia, in part, rely on their own fleet of fishing vessels. In aquaculture, large producers of farmed salmon, catfish and shrimp have established advanced centralized processing plants. Processors that operate without the purchasing or sourcing power of strong brands are also experiencing increasing problems linked to the scarcity of domestic raw material, and they are being forced to import fish for their business.

Fish and fishery products continue to be among the most traded food commodities worldwide, accounting for about 10 percent of total agricultural exports and 1 percent of world merchandise trade in value terms. The share of total fishery production exported in the form of various food and feed items increased from 25 percent in 1976

to about 38 percent (57 million tonnes) in 2010. In the same period, world trade in fish and fishery products grew significantly also in value terms, rising from US$8 billion to US$102 billion. Sustained demand, trade liberalization policies, globalization of food systems and technological innovations have furthered the overall increase in international fish trade. In 2009, reflecting the general economic contraction affecting consumer confidence in major markets, trade dropped by 6 percent compared with 2008 in value terms as a consequence of falling prices and margins, whereas traded volumes, expressed in live weight equivalent, increased by 1 percent to 55.7 million tonnes. In 2010, trade rebounded strongly, reaching about US$109 billion, with an increase of 13 percent in value terms and 2 percent in volume compared with 2009. The difference between the growth in value and volume reflects the higher fish prices experienced in 2010 as well as a decrease in the production of and trade in fishmeal. In 2011, despite the economic instability experienced in many of the world's leading economies, increasing prices and strong demand in developing countries pushed trade volumes and values to the highest level ever reported and, despite some softening in the second half of the year, preliminary estimates indicate that exports exceeded US$125 billion.

Since late 2011 and early 2012, the world economy has entered a difficult phase characterized by significant downside risks and fragility, and key markets for fisheries trade have slowed sharply. Among the factors that might influence the sustainability and growth of fishery trade are the evolution of production and transportation costs and the prices of fishery products and alternative commodities, including meat and feeds. In the last few decades, the growth in aquaculture production has contributed significantly to increased consumption and commercialization of species that were once primarily wild-caught, with a consequent price decrease, particularly in the 1990s and early 2000, with average unit values of aquaculture production and trade declining in real terms. Subsequently, owing to increased costs and continuous high demand, prices have started to rise again. In the next decade, with aquaculture accounting for a much larger share of total fish supply, the price swings of aquaculture products could have a significant impact on price formation in the sector overall, possibly leading to more volatility.

As for trade, fish prices also contracted in 2009 but have since rebounded. The FAO Fish Price Index (base year 2002–04 = 100) indicates that average prices in 2009 declined by 7 percent compared with 2008, then increased by 9 percent in 2010 and by more than 12 percent in 2011. Prices for species from capture fisheries increased by more than those for farmed species because of the larger impact from higher energy prices on fishing vessel operations than on farmed species.

Since 2002, China has been by far the leading fish exporter, contributing almost 12 percent of 2010 world exports of fish and fishery products, or about US$13.3 billion, and increasing further to US$17.1 billion in 2011. A growing share of fishery exports consists of reprocessed imported raw material. Thailand has established itself as a processing centre of excellence largely dependent on imported raw material, while Viet Nam has a growing domestic resource base and imports only limited, albeit growing, volumes of raw material. Viet Nam has experienced significant growth in its exports of fish and fish products, up from US$1.5 billion in 2000 to US$5.1 billion in 2010, when it became the fourth-largest exporter in the world. In 2011, its exports rose further to US$6.2 billion, linked mainly to its flourishing aquaculture industry. In 2010, developing countries confirmed their fundamental importance as suppliers to world markets with more than 50 percent of all fishery exports in value terms and more than 60 percent in quantity (live weight). For many developing nations, fish trade represents a significant source of foreign currency earnings in addition to the sector's important role as a generator of income, source of employment, and provider of food security and nutrition. The fishery industries of developing countries rely heavily on developed countries, not only as outlets for their exports, but also as suppliers of their imports for local consumption or for their processing industries. In 2010, in value terms, 67 percent of the fishery exports of developing countries were directed to developed countries. A

growing share of these exports consisted of processed fishery products prepared from imports of raw fish to be used for further processing and re-export. In 2010, in value terms, 39 percent of the imports of fish and fishery products by developing countries originated from developed countries. For LIFDCs, net export revenues amounted to US$4.7 billion in 2010, compared with US$2.0 billion in 1990.

World imports[2] of fish and fish products set a new record at US$111.8 billion in 2010, up 12 percent on the previous year and up 86 percent with respect to 2000. Preliminary data for 2011 point to further growth, with a 15 percent increase. The United States of America and Japan are the major importers of fish and fishery products and are highly dependent on imports for about 60 percent and 54 percent, respectively, of their fishery consumption. China, the world's largest fish producer and exporter, has significantly increased its fishery imports, partly a result of outsourcing, as Chinese processors import raw material from all major regions, including South and North America and Europe, for re-processing and export. Imports are also being fuelled by robust domestic demand for species not available from local sources, and, in 2011, China became the third-largest importer in the world. The European Union is by far the largest single market for imported fish and fishery products owing to its growing domestic consumption. However, it is extremely heterogeneous, with markedly different conditions from country to country. European Union fishery imports reached US$44.6 billion in 2010, up 10 percent from 2009, and representing 40 percent of total world imports. However, if intraregional trade is excluded, the European Union imported fish and fishery products worth US$23.7 billion from suppliers outside the European Union, an increase of 11 percent from 2009. In addition to the major importing countries, a number of emerging markets have become of growing importance to the world's exporters. Prominent among these there are Brazil, Mexico, the Russian Federation, Egypt, Asia and the Near East in general. In 2010, developed countries were responsible for 76 percent of the total import value of fish and fishery products, a decline compared with the 86 percent of 1990 and 83 percent of 2000. In terms of volume (live weight equivalent), the share of developed countries is significantly less, 58 percent, reflecting the higher unit value of products imported by developed countries.

Owing to the high perishability of fish and fishery products, 90 percent of trade in fish and fishery products in quantity terms (live weight equivalent) consists of processed products. Fish are increasingly traded as frozen food (39 percent of the total quantity in 2010, compared with 25 percent in 1980). In the last four decades, prepared and preserved fish have nearly doubled their share in total quantity, going from 9 percent in 1980 to 16 percent in 2010. However, trade in live, fresh and chilled fish represented 10 percent of world fish trade in 2010, up from 7 percent in 1980, reflecting improved logistics and increased demand for unprocessed fish. Trade in live fish also includes ornamental fish, which is high in value terms but almost negligible in terms of quantity traded. In 2010, 71 percent of the quantity of fish and fishery products exported consisted of products destined for human consumption. The US$109 billion exports of fish and fishery products in 2010 do not include an additional US$1.3 billion for aquatic plants (62 percent), inedible fish waste (31 percent) and sponges and corals (7 percent). In the last two decades, trade in aquatic plants has increased significantly, rising from US$0.2 billion in 1990 to US$0.5 billion in 2000 and to US$0.8 billion in 2010, with China as the major exporter and Japan as the leading importer.

A recent major event related to governance of fisheries and aquaculture has been the UN Conference on Sustainable Development, known as Rio+20, to renew political commitment for sustainable development, assess progress and gaps in the implementation of existing commitments, and address new challenges. The two themes of the conference were the institutional framework for sustainable development and the support of a green economy. As a concept, the green economy aims to ensure that resource exploitation contributes to sustainability, inclusive social development and economic growth, while seeking to counter the notion that sustainability and growth are mutually exclusive.

At Rio+20, FAO promoted the message that there will be no green economy without sustainable growth in agriculture (including fisheries) and that improved management and efficiencies throughout the food value chain can increase food security while using fewer natural resources. The message calls for policies that create incentives to adopt sustainable practices and behaviour and promotes the wide application of ecosystem approaches. FAO also contributed to interagency submissions to Rio+20 concerning the sustainable management of the world's oceans with a focus on the green economy as it relates to marine and coastal resources, sustainable use and poverty eradication, small-scale fisheries and aquaculture operations, and the potential contribution of small island developing States.

The dependence of the fisheries and aquaculture sectors on ecosystem services means that supporting sustainable fishing and fish farming can provide incentives for wider ecosystem stewardship. The greening of fisheries and aquaculture requires recognition of their wider societal roles within a comprehensive governance framework. There are several mechanisms to facilitate this transition, including adopting an ecosystem approach to fisheries and aquaculture with fair and responsible tenure systems to turn resource users into resource stewards.

Small-scale fisheries employ more than 90 percent of the world's capture fishers, and their importance to food security, poverty alleviation and poverty prevention is becoming increasingly appreciated. However, the lack of institutional capacity and the failure to include the sector in national and regional development policies hamper their potential contribution. Since 2003, the FAO Committee on Fisheries (COFI) has promoted efforts to improve the profile of, and understand the challenges and opportunities facing, small-scale fishing communities in inland and marine waters. It has also recommended the development of international voluntary guidelines to complement the Code of Conduct for Responsible Fisheries (the Code) as well as other international instruments with similar purposes. The preparation of the guidelines is expected to contribute to policy development and have considerable impact on securing small-scale fisheries and creating benefits, especially in terms of food security and poverty reduction. The guidelines promote good governance, including transparency and accountability, participation and inclusiveness, social responsibility and solidarity, a human rights approach to development, gender equality, and respect and involvement of all stakeholders.

Regional fishery bodies (RFBs) are the primary organizational mechanism through which States work together to ensure the long-term sustainability of shared fishery resources. The term RFB also embraces regional fisheries management organizations (RFMOs), which have the competence to establish binding conservation and management measures. As intergovernmental organizations, RFBs depend on the political will of their member Governments to implement agreed measures and undertake reform. Most RFBs are experiencing difficulties in fulfilling their mandates (many of which are outdated). However, important progress in extending the global coverage of RFBs is being made through new, strengthened and emerging bodies. In addition, numerous RFBs have been undergoing independent reviews of their performance. The 2010 United Nations Review Conference described the modernizing of RFMOs as a priority and noted that progress had been made in developing best practices for RFMOs and in reviewing their performance against emerging standards. Ten RFBs have so far undergone performance reviews. The Review Conference observed that performance reviews were generally recognized as being useful, particularly when they led to the adoption of new management measures.

Illegal, unreported and unregulated (IUU) fishing and related activities (often encouraged by corrupt practices) threaten efforts to secure long-term sustainable fisheries and promote healthier and more robust ecosystems. The international community continues to express its grave concern at the extent and effects of IUU fishing. Developing countries, often with limited technical capacity, bear the brunt of this IUU fishing, which undermines their limited efforts to manage fisheries, denies them revenue and adversely affects their attempts to promote food security, eradicate

poverty and achieve sustainable livelihoods. However, there are indications that IUU fishing is moderating in some areas (e.g. the Northeast Atlantic Ocean) as policies and measures take effect.

Nonetheless, the international community is deeply frustrated by the failure of many flag States to meet their primary responsibilities under international law, which are to exercise effective control over their fishing vessels and ensure compliance with conservation and management measures. Of particular concern are those vessels flying flags of "non-compliance", which are flags belonging to States that are either unable or unwilling to exercise effective control over their vessels. As a result, the burden of controlling these rogue vessels is gradually falling on coastal States, port States, RFBs and others. This has led FAO Members to request that a Technical Consultation on Flag State Performance be convened. It is anticipated that the outcome will be a set of voluntary criteria for assessing the performance of flag States together with a list of possible actions to be taken against vessels flying the flags of States not meeting such criteria and possibly an agreed procedure for assessing compliance.

Although their achievements in terms of limiting IUU fishing vary widely, most RFBs promote and implement measures to combat IUU fishing. The measures range from more passive activities such as awareness building and dissemination of information (mainly RFBs without fisheries management functions) to aggressive port, air and surface surveillance programmes (RFMOs).

Beyond national boundaries, there is increasing need for international cooperation to improve global fisheries management of shared marine resources and to preserve the associated employment and other economic benefits of sustainable fisheries. Recognizing this, the European Union and the United States of America, as leaders in the global fish trade, undertook (in 2011) to cooperate bilaterally to combat IUU fishing by keeping illegally caught fish out of the world market. Strengthening fisheries management capacity is fundamental in developing countries in order to facilitate sustainable fisheries and to reduce the impacts of IUU fishing. Capacity development is especially important to support the full and effective implementation of existing and new global instruments such as the 2009 Port State Measures Agreement to combat IUU fishing.

Governance of aquaculture has become increasingly important and has made remarkable progress. To improve planning and policy development in aquaculture, many Governments utilize the Code as well as FAO guidelines and manuals on farming techniques promoted by industry organizations and development agencies. Several countries have adequate national aquaculture development policies, strategies, plans and laws, and use "best management practices". The insert: 2011 FAO Technical Guidelines on Aquaculture Certification constitute an additional important tool for good governance of the sector. By setting minimum substantive criteria for developing aquaculture certification standards, these guidelines provide direction for the development, organization and implementation of credible aquaculture certification schemes towards orderly and sustainable development of the sector. Long-term prosperity requires technological soundness, economic viability, environmental integrity and social licence, which, in combination, also ensure that ecological well-being is compatible with human well-being.

An important component of human well-being is employment, which in aquaculture has grown rapidly in the last three decades. More than 100 million people now depend on the sector for a living, either as employees in the producing and support sectors or as their dependants. In many places, these employment opportunities have enabled young people to stay in their communities and have strengthened the economic viability of isolated areas, often enhancing the status of women in developing countries, where more than 80 percent of aquaculture output occurs. Aquaculture has been heavily promoted in several countries with fiscal and monetary incentives and this has improved accessibility to food for many households and increased aquaculture's contribution towards the Millennium Development Goals (MDGs). However, the sector has developed at a time of growing scrutiny from

the public, improved communications and vociferous opposition groups. Although opposition groups can act as environmental and social watchdogs, putting pressure on businesses to increase transparency and improve working conditions, it is also important to consider the benefits accruing from the sector, including those related to employment.

Unfair employment practices in aquaculture, including exploitation of local labour, gender discrimination and child employment, can undermine trust in the sector, threaten the credibility of policy-makers and jeopardize markets for farmed seafood. Most countries have legislation to protect workers but compliance therewith can deter enterprises, with some opting to operate in countries with lower labour and social standards where they can gain a competitive advantage. A possible result is that Governments will be under pressure from companies to reduce labour and social standards.

Employment in aquaculture must be equitable and non-exploitative, with principled values guiding activities to induce beyond-compliance behaviour. With an ethos of corporate social responsibility, aquaculture companies would assist local communities, employ fair labour practices and demonstrate transparency. Increasingly, with rising consumer awareness, it makes good business sense for aquaculture enterprises to demonstrate that they meet the best standards. Legislation should protect labour and reflect concepts of social justice and human rights, but it needs to strike a balance as overly cumbersome regulations can make an otherwise viable business unprofitable.

CAPTURE FISHERIES PRODUCTION

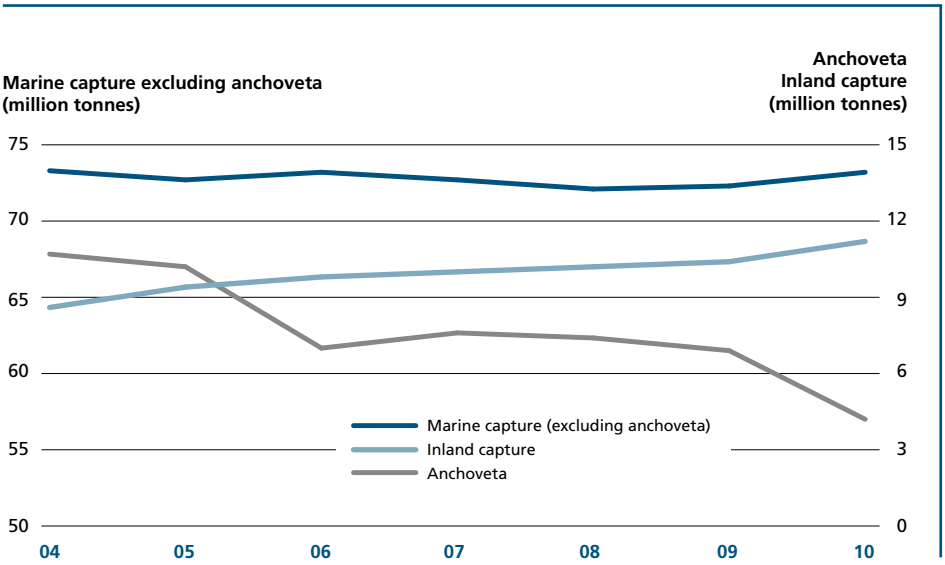
Total capture fisheries production

Overall global capture fisheries production, as derived from the FAO capture database, continues to remain stable (Table 1). This does not mean that there are no changes in catch trends by country, fishing area or species, which indeed do vary significantly throughout the years, but rather that the summation of all the annual fluctuations has been close to zero in recent years.

To analyse trends, global production can be separated into three major components: marine catches excluding anchoveta (*Engraulis ringens*); anchoveta catches; and inland water catches (Figure 4). In the last seven years (2004–2010) for

Figure 4

Recent capture fisheries production by three major components



which detailed catch statistics are available, absolute variations in comparison with the previous year of total marine catches excluding anchoveta never exceeded 1.2 percent, ranging between 72.1 and 73.3 million tonnes. However, anchoveta catches decreased from 10.7 million tonnes in 2004 to 4.2 million tonnes in 2010, and the variation on the previous year exceeded 30 percent in two cases. In the same period, inland water capture production grew continuously, with an overall increase of 2.6 million tonnes (see below).

A marked decrease in anchoveta catches by Peru in 2010 was mostly due to management measures (e.g. fishing closures) that were applied in the final quarter to protect the high number of juveniles present in the anchoveta stock as a consequence of the La Niña event (cold water), which had favoured spawning and generated a good recruitment. Thanks to this precautionary management decision, the 2011 anchoveta catches exceeded their 2009 level. Other preliminary reports from important fishing countries (e.g. the Russian Federation) show that 2011 should have been a year of increased catches. However, Japanese fishery production will probably have dropped significantly as the five prefectures hit by the earthquake and tsunami of 11 March 2011 accounted for about 21 percent of Japan's total marine fisheries and aquaculture production. Overall, preliminary information suggests that the total 2011 global catch should exceed 90 million tonnes, marking a return to 2006–07 levels (Table 1).

Notwithstanding the protracted global economic downturn, which has reduced the funds available to national administrations, the submission rates of 2009 and 2010 catch data to FAO have remained reasonably stable. However, it is well known that the quality of fishery data is very uneven among countries. An evaluation[3] of data quality in capture statistics submitted to FAO found that more than half of the countries reported inadequately. This percentage was greater for developing countries, but also about one-fourth of reports by developed countries were not satisfactory. Countries that should improve their data collection and reporting systems are mainly found in Africa, Asia and among the island States in Oceania and the Caribbean (Table 2).

World marine capture fisheries production

With the great decrease in anchoveta catches, Peru is no longer second after China in the ranking of the major marine producer countries in terms of quantity as it has been surpassed by Indonesia and the United States of America. Some major Asian fishing countries (i.e. China, India, Indonesia, Myanmar and Viet Nam) reported significant increases in 2010, but also other countries (i.e. Norway, the Russian Federation and

Table 2
Countries or territories with no adequate 2009 catch data submission

	Countries	Countries with no adequate submission	Percentage
	(Number)	*(Number)*	*(%)*
Developed	54	13	24.1
Developing	164	100	61.0
Africa	54	33	61.1
North America	37	18	48.6
South America	14	5	35.7
Asia	51	31	60.8
Europe	39	8	20.5
Oceania	23	18	78.3
Total	**218**	**113**	**51.8**

Source: Garibaldi, L. 2012. The FAO global capture production database: a six-decade effort to catch the trend. *Marine Policy*, 36(3): 760–768.

Spain) fishing in other areas and with more robust data collection systems showed growing catches after some years of sluggish production.

In particular, catches reported by the Russian Federation have grown by more than one million tonnes since the low point of 2004. According to the authorities of the Russian Federation, the recent increase is also a consequence of the management decision to remove excessive formalities on documentation of landing operations, as up until early 2010 landings by vessels of the Russian Federation in national ports were treated as imports. Moreover, an official forecast of the Russian Federation indicates further catch increases to a level of 6 million tonnes in 2020, representing an increase of more than 40 percent above present levels.

Besides decreased production by Peru and Chile as a consequence of the drop in anchoveta catches, other major fishing countries with downward trends in total marine catches in 2009 and 2010 were: Japan, the Republic of Korea, and Thailand in Asia; Argentina, Canada and Mexico in the Americas; Iceland in Europe; and to a lesser extent New Zealand. Despite variable trends, Morocco, South Africa and Senegal maintained their positions as the three major marine producers in Africa.

The Northwest Pacific is still by far the most productive fishing area. Catch peaks in the Northwest Atlantic, Northeast Atlantic and Northeast Pacific temperate fishing areas were reached many years ago (in 1968, 1976 and 1987, respectively) and total production had declined continuously from the early and mid-2000s, but in 2010 this trend was reversed in all three areas.

As for mainly tropical areas, total catches grew in the Western and Eastern Indian Ocean and in the Western Central Pacific, and, in the last two, 2010 marked a new maximum. In contrast, the 2010 production in the Western Central Atlantic decreased, driven by the reduction in United States catches by about 100 000 tonnes, probably mostly attributable to the oil spill in the Gulf of Mexico. Since 1978, the Eastern Central Pacific has shown a series of fluctuations in capture production with a cycle of about 5–9 years. The latest peak was in 2009, and a declining phase may have started in 2010.

Both the Mediterranean–Black Sea and the Southwest Atlantic seem to be areas where fisheries are in trouble as, since 2007, total catches have decreased by 15 and 30 percent, respectively. In the two areas along the southwest sides of America and Africa, upwelling phenomena occur, although their intensity varies strongly each year. In 2010, catches in the Southeast Pacific (excluding anchoveta) decreased whereas in the Southeast Atlantic they grew, but examination of historical trends from an earlier period reveals clear downward trajectories in both areas.

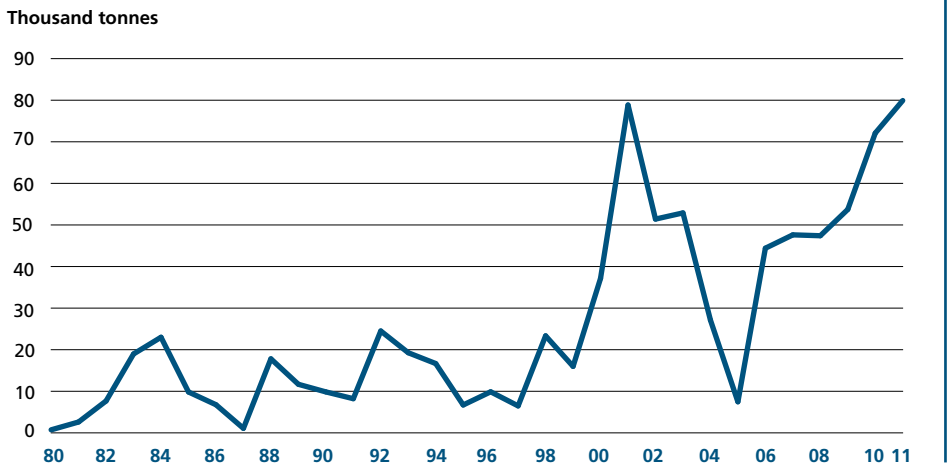
Finally, in the Eastern Central Atlantic, production has increased in the last three years. However, in this area, total capture production is significantly influenced by the activities of distant-water fleets and whether their catches are reported only by the flag States or also complemented with information by some costal countries that register foreign fleet catches in their EEZ but only make these data available to FAO intermittently.

As noted above, annual catches by fishing area, country and in particular by species very often fluctuate considerably, but all these variations combined seem to have a counterbalancing effect on the global total. A demonstration of this is that catches of more than 60 percent of the species varied by more than 10 percent in comparison with 2009 but the global total (excluding anchoveta) changed by only 1.2 percent.

It is well documented[4] that fish populations show large fluctuations in abundance, also in the absence of fishing. Although the causes are well known for some species (e.g. anchoveta – driven by changing environmental regimes), they remain unknown for many others. Besides fishes, such variations also occur in other commercial groups of species. For example, Argentina started industrial-level exploitation of *Pleoticus muelleri*, a high-value shrimp, in the 1980s. However, this species showed a major drop in 2005. Facing much reduced catches, the national authorities implemented management plans to help the species to recover. After six years, catches had rebounded tenfold reaching a new maximum recorded level in 2011 (Figure 5).

Figure 5

Catch trend for Argentine red shrimp

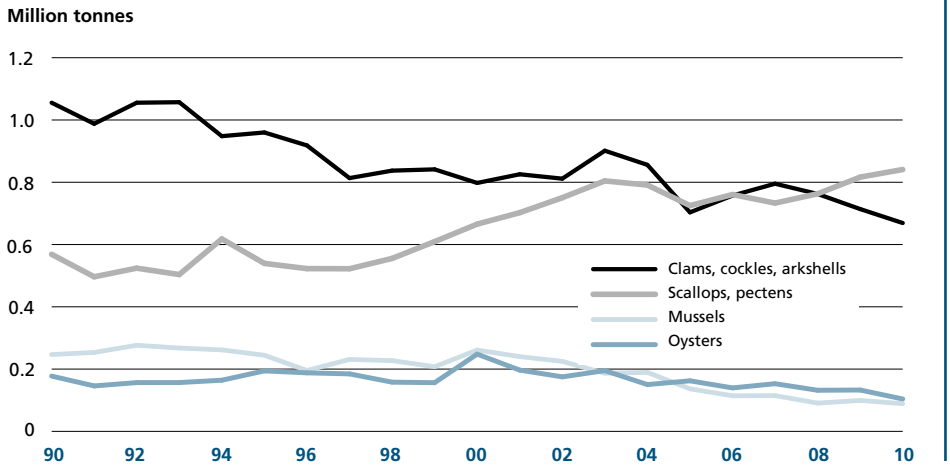


Despite the decreased 2010 catches, anchoveta is again the most-caught species. However, also in the presence of future favourable environmental regimes, yearly catches of this species should not attain the past peaks as the Government of Peru has introduced an annual quota for the whole country, subdivided by vessel, with the purpose of stabilizing the capacity of both the fleet and processing plants.

In the list of top ten species, the most evident change is the disappearance from the list of the Chilean jack mackerel (*Trachurus murphyi*), which had been sixth in 2008. This species is a transboundary resource with a very wide distribution in the South Pacific, ranging from the national EEZs to the high seas. After having peaked at about 5 million tonnes in the mid-1990s, catches were about 2 million tonnes in the mid-2000s but have since declined abruptly, and the 2010 catches were 0.7 million tonnes, the lowest level since 1976. Atlantic cod (*Gadus morhua*) has returned to the list, with a total increase of almost 200 000 tonnes in the last two years to rank tenth in 2010, a position not reached since 1998. In fact, in 2010, the whole group of gadiform species (cods, hakes, haddocks, etc.) reversed the negative trend of the previous three years in

Figure 6

Catch trends for marine bivalve species groups



which it had declined by 2 million tonnes. Preliminary data for this group also report growing catches for 2011.

Capture production of other important commercial species groups such as tunas and shrimps remained stable in 2010. The highly variable catches of cephalopods resumed growth after a decrease in 2009 of about 0.8 million tonnes. In the Antarctic areas, interest in fishing for krill resumed and a catch increase of more than 70 percent was registered in 2010.

Of the four marine bivalve groups (Figure 6), clams and cockles, which in the early 1990s contributed more than half of the overall bivalve catches, have recently accelerated their rate of decline. In 2009–2010, they were largely surpassed by scallops, which in contrast have shown a rising trend since the late 1990s. Capture production of mussels and oysters, for which reporting countries often have difficulty in separating harvest of natural populations from aquaculture production, has not varied much over the years, but an overall downward trend can be noted.

World inland capture fisheries production

Total global capture production in inland waters has increased dramatically since the mid-2000s (Figure 3). Total production, as submitted by countries and as estimated by FAO in cases of non-reporting, amounted to 11.2 million tonnes in 2010, an increase of 30 percent since 2004. Despite this growth, there are still claims that global production is much greater as some studies[5] have pointed out that capture production in inland waters is seriously underestimated in some regions. However, the little well-documented evidence available concerns a limited number of countries. On the other hand, inland waters are considered as being overfished[6] in many parts of the world, and human pressure and changes in the environmental conditions have seriously degraded important bodies of freshwater (e.g. the Aral Sea, and Lake Chad). Moreover, in several countries that are important in terms of inland waters fishing (e.g. China), a good portion of inland catches comes from waterbodies that are artificially restocked and closely monitored and, hence, it is probable that production is recorded quite carefully. Therefore, both improvements in the statistical coverage and stock enhancement activities may be contributing to the apparent increase in inland fishery production.

A closer look at the statistics shows that the growth in the global inland water catch is wholly attributable to Asian countries (Table 3). With the remarkable increases reported for 2010 production by India (up 0.54 million tonnes on 2009) and by China and Myanmar (up 0.1 million tonnes each), Asia's share is approaching 70 percent of global production. Considerable increases by some major Asian countries have seriously influenced the global total in recent years but, in some cases, they seem to be

Table 3
Inland capture fisheries production by continent and major producer

Continent/country	2004	2010	Variation 2004–2010	
	(Tonnes)	(Tonnes)	(Tonnes)	(Percentage)
Asia	5 376 670	7 696 520	2 319 850	43.1
China	2 097 167	2 289 343	192 176	9.2
India	527 290	1 468 757	941 467	178.5
Bangladesh	732 067	1 119 094	387 027	52.9
Myanmar	454 260	1 002 430	548 170	120.7
Africa	2 332 948	2 567 427	234 479	10.1
Americas	600 942	543 428	–57 514	–9.6
Europe	314 034	386 850	72 816	23.2
Oceania	17 668	16 975	–693	–3.9
World total	**8 642 262**	**11 211 200**	**2 568 938**	**29.7**

consequences of a tendency to report continuously increasing catches or of changes in the national data collection system.

For example, until 2009, the calculation of inland catches by Bangladesh was linked to the population increase and, as a consequence, total production grew by 67 percent between 2004 and 2009. Production reported by Myanmar has quadrupled in the last decade, increasing at an average growth rate of almost 18 percent per year, gaining 11 positions in the global ranking of major producer countries, and exceeding one million tonnes in 2010. The gathering of India's catch statistics is complex as the Ministry of Agriculture has to receive and assemble data from 28 states, which often have different systems of collecting and reporting data. It is very difficult to discern whether the dramatic growth (179 percent) in inland catches between 2004 and 2010 is ascribable to a real increase, to overestimation or to improvement in the data collection system of some of these states.

Inland water capture production in the other continents shows different trends. Uganda and the United Republic of Tanzania, fishing mostly in the African Great Lakes, and Nigeria and Egypt, with river fisheries, remain the main producers in Africa. Catches in several South American countries (e.g. Argentina, Colombia, Paraguay and Venezuela [Bolivarian Republic of]) as well as in North American ones have been reported as shrinking. Increased European production between 2004 and 2010 is all attributable to a rise of almost 50 percent in catches of the Russian Federation. Inland fishery production is marginal in countries in Oceania.

More than half of the global inland water capture production is still reported as "catches unidentified by species". However, in recent years, several countries have made efforts to improve the quality of their inland catch statistics and collect data at a finer species breakdown. In the last ten years, the increase in inland water species with statistics in the FAO database has been five times that for marine species (Table 4). Moreover, the percentage of inland water species in total species has improved, reaching 12.3 percent in 2010 – a value very close to the share (12.7 percent) of inland water catches in global catches in that year.

AQUACULTURE

Global aquaculture production has continued to grow in the new millennium, albeit more slowly than in the 1980s and 1990s. In the course of half a century or so, aquaculture has expanded from being almost negligible to fully comparable with capture production in terms of feeding people in the world (see below). Aquaculture has also evolved in terms of technological innovation and adaptation to meet changing requirements.

World aquaculture production attained another all-time high in 2010, at 60 million tonnes (excluding aquatic plants and non-food products), with an estimated

Table 4
Number of species items with statistics in the FAO capture database

	2001	2010	Variation 2001–2010
	(Number)	*(Number)*	*(Percentage)*
Inland water fish, crustaceans and molluscs	113	190	68.1
Marine and diadromous fish, crustaceans and molluscs	1 194	1 356	13.6
Total species items	**1 307**	**1 546**	18.3
Share of inland water species on total species	8.6%	12.3%	

total value of US$119 billion. One-third of the world's farmed food fish harvested in 2010 was achieved without the use of feed, through the production of bivalves and filter-feeding carps. When farmed aquatic plants and non-food products are included, world aquaculture production in 2010 was 79 million tonnes, worth US$125 billion.

About 600 aquatic species are raised in captivity worldwide for production in a variety of farming systems and facilities of varying input intensities and technological sophistication, using freshwater, brackish water and marine water. Aquaculture also contributes substantially, with hatchery-produced seeds for stocking, to culture-based capture fishery production, particularly in inland waters.

However, the stage of development and the distribution of aquaculture production remain imbalanced in all regions. A few developing countries in Asia and the Pacific, sub-Saharan Africa and South America have made considerable progress in aquaculture development in recent years and they are becoming significant or major producers in their respective regions. However, the disparity remains huge across the continents and georegions, as well as among countries of comparable natural conditions in the same region, with aquaculture in many of the LDCs yet to make a significant contribution to national food and nutrition security.

In 2010, FAO recorded 181 countries and territories with aquaculture production, and 9 countries and territories not reporting production in 2010 but with production recorded previously. Of these 190 countries and territories, about 30 percent of them, including a few major producers in Asia and Europe, had failed to report any statistics on national aquaculture production even a year after the 2010 reference year. Less than 30 percent of them were able to report national data covering grow-out production broken down by culture environment and farming method or in terms of seed production and culture areas and facilities. More than 40 percent of them reported national data in varying degrees of completeness, data quality and timeliness of reporting. To compensate for such gaps, FAO made estimates using information available from additional sources where possible.

Global statistics are still lacking on: (i) non-food aquaculture production, including live bait for fishing, live ornamental species (animals and plants) and ornamental products (pearls and shells); (ii) fishes cultured as feed for certain carnivorous farmed species; (iii) culture of biomass of many species (such as plankton, *Artemia* and marine worms) for use as feed in aquaculture hatcheries and grow-out operations; (iv) aquaculture hatchery and nursery outputs for ongrowing in captivity or stocking to the wild; and (v) inputs in terms of captured wild fish ongrown in captivity. These practices are often specialized and segmented standalone operations of local importance in many countries. There is an urgent need to improve and expand national and international aquaculture statistics collection and reporting schemes in order to have a full understanding of aquaculture in accordance with the commitments made by States in 2003 in adopting the FAO Strategy and Outline Plan for Improving Information on Status and Trends of Aquaculture.

Food fish production

In 2010, global production of farmed food fish was 59.9 million tonnes, up by 7.5 percent from 55.7 million tonnes in 2009 (32.4 million tonnes in 2000). Farmed food fish include finfishes, crustaceans, molluscs, amphibians (frogs), aquatic reptiles (except crocodiles) and other aquatic animals (such as sea cucumbers, sea urchins, sea squirts and jellyfishes) that are indicated as fish throughout this document. The reported grow-out production from aquaculture is almost entirely destined for human consumption.

In the last three decades (1980–2010), world food fish production of aquaculture has expanded by almost 12 times, at an average annual rate of 8.8 percent. Aquaculture enjoyed high average annual growth rates of 10.8 percent and 9.5 percent in the 1980s and 1990s, respectively, but has since slowed to an annual average of 6.3 percent.

Since the mid-1990s, aquaculture has been the engine driving growth in total fish production as global capture production has levelled off. Its contribution to world total fish production climbed steadily from 20.9 percent in 1995 to 32.4 percent in 2005 and 40.3 percent in 2010. Its contribution to world food fish production for human consumption was 47 percent in 2010 compared with only 9 percent in 1980.

The growth rate in farmed food fish production from 1980 to 2010 far outpaced that for the world population (1.5 percent), resulting in average annual per capita consumption of farmed fish rising by almost seven times, from 1.1 kg in 1980 to 8.7 kg in 2010, at an average rate of 7.1 percent per year.

The total farmgate value of food fish production from aquaculture is estimated at US$119.4 billion for 2010. This might be overstated considering that some countries reported values other than first-sale prices (e.g. using retail, export or processed product prices).

World aquaculture production is vulnerable to adverse impacts of natural, socio-economic, environmental and technological conditions. For example, marine cage culture of Atlantic salmon in Chile, oyster farming in Europe (notably France), and marine shrimp farming in several countries in Asia, South America and Africa have experienced high mortality caused by disease outbreaks in recent years, resulting in partial or sometimes total loss of production. Countries prone to natural disasters suffer seriously from production damage or losses caused by floods, droughts, tropical storms and, less frequently, earthquakes. Water pollution has increasingly threatened production in some newly industrialized and rapidly urbanizing areas. In 2010, aquaculture in China suffered production losses of 1.7 million tonnes (worth US$3.3 billion) caused by diseases (295 000 tonnes), natural disasters (1.2 million tonnes), pollution (123 000 tonnes), etc. Disease outbreaks virtually wiped out marine shrimp farming production in Mozambique in 2011.

Production among regions

Asia accounted for 89 percent of world aquaculture production by volume in 2010, up from 87.7 percent in 2000 (Table 5). The contribution of freshwater aquaculture has gradually increased, up to 65.6 percent in 2010 from around 60 percent during 1990s. In terms of volume, Asian aquaculture is dominated by finfishes (64.6 percent), followed by molluscs (24.2 percent), crustaceans (9.7 percent) and miscellaneous species (1.5 percent). The share of non-fed species farmed in Asia was 35 percent (18.6 million tonnes) in 2010 (compared with 50 percent in 1980). The contribution of China to world aquaculture production volume in 2010 declined to 61.4 percent from its highest level of about 66 percent in the period 1996–2000. Other major producers in Asia (India, Viet Nam, Indonesia, Bangladesh, Thailand, Myanmar, the Philippines and Japan) are among the world's top producers.

In the Americas, the share of freshwater aquaculture in total production declined from 54.8 percent in 1990 to 37.9 percent in 2010. In North America, aquaculture has ceased expanding in recent years, but in South America it has shown strong and continuous growth, particularly in Brazil and Peru. In terms of volume, aquaculture in North and South America is dominated by finfishes (57.9 percent), crustaceans (21.7 percent) and molluscs (20.4 percent). Bivalve production fluctuated between 14 and 21 percent of total aquaculture production in the 1990s and 2000s, after dropping rapidly in the 1980s from 48.5 percent.

In Europe, the share of production from brackish and marine waters increased from 55.6 percent in 1990 to 81.5 percent in 2010, driven by marine cage culture of Atlantic salmon and other species. Several important producers in Europe have recently ceased expanding or have even contracted, particularly in the marine bivalve sector. In 2010, finfishes accounted for three-quarters of all European aquaculture production, and molluscs one-quarter. The share of bivalves in total production decreased continuously from 61 percent in 1980 to 26.2 percent in 2010.

Africa has increased its contribution to global production from 1.2 percent to 2.2 percent in the past ten years, albeit from a very low base. The share of freshwater

aquaculture in the region fell from 55.2 percent to 21.8 percent in the 1990s, largely reflecting the strong growth in brackish-water culture in Egypt, but it recovered in the 2000s, reaching 39.5 percent in 2010 as a result of rapid development in freshwater fish farming in sub-Saharan Africa, most notably in Nigeria, Uganda, Zambia, Ghana and Kenya. African aquaculture production is overwhelmingly dominated by finfishes (99.3 percent by volume), with only a small fraction from marine shrimps (0.5 percent) and marine molluscs (0.2 percent). In spite of some limited successes, the potential for bivalve production in marine waters remains almost completely unexplored.

Oceania is of relatively marginal importance in global aquaculture production. Production from this region consists mainly of marine molluscs (63.5 percent) and finfishes (31.9 percent), while crustaceans (3.7 percent, mostly marine shrimps) and other species (0.9 percent) constitute less than 5 percent of its total production. Marine bivalves accounted for about 95 percent of the total produced in the first half of 1980s but, reflecting the development of the finfish culture sector (especially Atlantic salmon in Australia and chinook salmon in New Zealand), they currently account for less than 65 percent of the region's total production. Freshwater aquaculture accounts for less than 5 percent of the region's production.

Table 5

Aquaculture production by region: quantity and percentage of world total production

Selected groups and countries		1970	1980	1990	2000	2009	2010
Africa	**(tonnes)**	**10 271**	**26 202**	**81 015**	**399 676**	**991 183**	**1 288 320**
	(percentage)	***0.40***	***0.60***	***0.60***	***1.20***	***1.80***	***2.20***
Sub-Saharan Africa	(tonnes)	4 243	7 048	17 184	55 690	276 906	359 790
	(percentage)	*0.20*	*0.10*	*0.10*	*0.20*	*0.50*	*0.60*
North Africa	(tonnes)	6 028	19 154	63 831	343 986	714 277	928 530
	(percentage)	*0.20*	*0.40*	*0.50*	*1.10*	*1.30*	*1.60*
Americas	**(tonnes)**	**173 491**	**198 850**	**548 479**	**1 423 433**	**2 512 829**	**2 576 428**
	(percentage)	***6.80***	***4.20***	***4.20***	***4.40***	***4.50***	***4.30***
Caribbean	(tonnes)	350	2 329	12 169	39 704	42 514	36 871
	(percentage)	*0.00*	*0.00*	*0.10*	*0.10*	*0.10*	*0.10*
Latin America	(tonnes)	869	24 590	179 367	799 234	1 835 888	1 883 134
	(percentage)	*0.00*	*0.50*	*1.40*	*2.50*	*3.30*	*3.10*
North America	(tonnes)	172 272	171 931	356 943	584 495	634 427	656 423
	(percentage)	*6.70*	*3.70*	*2.70*	*1.80*	*1.10*	*1.10*
Asia	**(tonnes)**	**1 799 101**	**3 552 382**	**10 801 356**	**28 422 189**	**49 538 019**	**53 301 157**
	(percentage)	***70.10***	***75.50***	***82.60***	***87.70***	***88.90***	***89.00***
Asia (excluding China and Near East)	(tonnes)	1 034 703	2 222 670	4 278 355	6 843 429	14 522 862	16 288 881
	(percentage)	*40.30*	*47.20*	*32.70*	*21.10*	*26.10*	*27.20*
China	(tonnes)	764 380	1 316 278	6 482 402	21 522 095	34 779 870	36 734 215
	(percentage)	*29.80*	*28.00*	*49.60*	*66.40*	*62.40*	*61.40*
Near East	(tonnes)	18	13 434	40 599	56 665	235 286	278 061
	(percentage)	*0.00*	*0.30*	*0.30*	*0.20*	*0.40*	*0.50*
Europe	**(tonnes)**	**575 598**	**916 183**	**1 601 524**	**2 050 958**	**2 499 042**	**2 523 179**
	(percentage)	***22.40***	***19.50***	***12.20***	***6.30***	***4.50***	***4.20***
European Union (27)	(tonnes)	471 282	720 215	1 033 982	1 395 669	1 275 833	1 261 592
	(percentage)	*18.40*	*15.30*	*7.90*	*4.30*	*2.30*	*2.10*
Non-European-Union countries	(tonnes)	26 616	38 594	567 667	657 167	1 226 625	1 265 703
	(percentage)	*1.00*	*0.80*	*4.30*	*2.00*	*2.20*	*2.10*
Oceania	**(tonnes)**	**8 421**	**12 224**	**42 005**	**121 482**	**173 283**	**183 516**
	(percentage)	***0.30***	***0.30***	***0.30***	***0.40***	***0.30***	***0.30***
World	**(tonnes)**	**2 566 882**	**4 705 841**	**13 074 379**	**32 417 738**	**55 714 357**	**59 872 600**

Notes: Data exclude aquatic plants and non-food products. Data for 2010 for some countries are provisional and subject to revisions. Production values for 1980 for Europe include the former Soviet Union.

The global distribution of aquaculture production across the regions and countries of different economic development levels remains imbalanced. In 2010, the top ten producing countries accounted for 87.6 percent by quantity and 81.9 percent by value of the world's farmed food fish. At the regional level, production is also concentrated in a few major producers (Table 6).

The LDCs, mostly in sub-Saharan Africa and in Asia, and home to 20 percent of the world's population (1.4 billion people), remain very small in terms of their share of world aquaculture production (4.1 percent by quantity and 3.6 percent by value). The major producers in the LDCs in 2010 include Bangladesh, Myanmar, Uganda, the Lao

Table 6
Top ten regional and world aquaculture producers in 2010

Africa	Tonnes	Percentage	America	Tonnes	Percentage	Asia	Tonnes	Percentage
Egypt	919 585	71.38	Chile	701 062	27.21	China	36 734 215	68.92
Nigeria	200 535	15.57	United States of America	495 499	19.23	India	4 648 851	8.72
Uganda	95 000	7.37	Brazil	479 399	18.61	Viet Nam	2 671 800	5.01
Kenya	12 154	0.94	Ecuador	271 919	10.55	Indonesia	2 304 828	4.32
Zambia	10 290	0.80	Canada	160 924	6.25	Bangladesh	1 308 515	2.45
Ghana	10 200	0.79	Mexico	126 240	4.90	Thailand	1 286 122	2.41
Madagascar	6 886	0.53	Peru	89 021	3.46	Myanmar	850 697	1.60
Tunisia	5 424	0.42	Colombia	80 367	3.12	Philippines	744 695	1.40
Malawi	3 163	0.25	Cuba	31 422	1.22	Japan	718 284	1.35
South Africa	3 133	0.24	Honduras	27 509	1.07	Republic of Korea	475 561	0.89
Other	21 950	1.70	Other	113 067	4.39	Other	1 557 588	2.92
Total	**1 288 320**	**100**	**Total**	**2 576 428**	**100**	**Total**	**53 301 157**	**100**

Europe	Tonnes	Percentage	Oceania	Tonnes	Percentage	World	Tonnes	Percentage
Norway	1 008 010	39.95	New Zealand	110 592	60.26	China	36 734 215	61.35
Spain	252 351	10.00	Australia	69 581	37.92	India	4 648 851	7.76
France	224 400	8.89	Papua New Guinea	1 588	0.87	Viet Nam	2 671 800	4.46
United Kingdom	201 091	7.97	New Caledonia	1 220	0.66	Indonesia	2 304 828	3.85
Italy	153 486	6.08	Fiji	208	0.11	Bangladesh	1 308 515	2.19
Russian Federation	120 384	4.77	Guam	129	0.07	Thailand	1 286 122	2.15
Greece	113 486	4.50	Vanuatu	105	0.06	Norway	1 008 010	1.68
Netherlands	66 945	2.65	French Polynesia	39	0.02	Egypt	919 585	1.54
Faroe Islands	47 575	1.89	Northern Mariana Islands	24	0.01	Myanmar	850 697	1.42
Ireland	46 187	1.83	Palau	12	0.01	Philippines	744 695	1.24
Other	289 264	11.46	Other	19	0.01	Other	7 395 281	12.35
Total	**2 523 179**	**100**	**Total**	**183 516**	**100**	**Total**	**59 872 600**	**100**

Note: Data exclude aquatic plants and non-food products. Data for 2010 for some countries are provisional and subject to revisions.

People's Democratic Republic (82 100 tonnes), Cambodia (60 000 tonnes) and Nepal (28 200 tonnes).

While aquaculture production has shown strong growth in developing countries, particularly in Asia, annual growth rates in developed industrialized countries averaged only 2.1 percent and 1.5 percent in the 1990s and 2000s, respectively. In 2010, they produced collectively 6.9 percent (4.1 million tonnes) by quantity and 14 percent (US$16.6 billion) by value of world farmed food fish production, compared with 21.9 percent and 32.4 percent in 1990. Aquaculture production has contracted or stagnated in Japan, the United States of America, Spain, France, the United Kingdom of Great Britain and Northern Ireland, Canada and Italy. An exception is Norway, where, thanks to the farming of Atlantic salmon in marine cages, aquaculture production grew from 151 000 tonnes in 1990 to more than one million tonnes in 2010, at an average growth rate of 12.6 percent in the 1990s and 7.5 percent in the 2000s.

In the recent past, some developing countries in Asia and the Pacific (Myanmar and Papua New Guinea), sub-Saharan Africa (Nigeria, Uganda, Kenya, Zambia and Ghana) and South America (Ecuador, Peru and Brazil) have made rapid progress to become significant or major aquaculture producers in their regions.

Immediately after their independence more than two decades ago, countries in the former Soviet Union were producing an annual total of almost 350 000 tonnes of food fish from aquaculture. However, production capacity in all these countries deteriorated rapidly in the 1990s to about one-third of its original level. In spite of starting to recover in the 2000s, their combined total production in 2010 amounted to only 59 percent of that in 1988. The lost capacity, especially in hatchery and nursery output, has also had a negative impact on inland culture-based capture fisheries. While Armenia, Belarus, Estonia and Republic of Moldova have exceeded their 1988 production levels, and output in Lithuania and the Russian Federation is at more than 80 percent of its original 1998 level, other countries remain at one-third or less of their 1988 production levels. In 2010, farmed fish production in Kazakhstan and Turkmenistan was less than 5 percent of that before independence.

Production with and without feed

While feed is generally perceived to be a major constraint to aquaculture development, one-third of all farmed food fish production, 20 million tonnes, is currently achieved without artificial feeding (Figure 7). Oysters, mussels, clams, scallops and other bivalve species are grown with food materials that occur naturally in their culture environment in the sea and lagoons. Silver carp and bighead carp feed on planktons proliferated through intentional fertilization and the wastes and leftover feed materials of fed species grown in the same multispecies polyculture systems. Rice–fish farming has long been a common practice, particularly in Asia (Box 2).

However, the percentage of non-fed species in world production has declined gradually from more than 50 percent in 1980 to the present level of 33.3 percent, strongly dominated by changing practices in Asia. This reflects the relatively faster growth in the fed-species culture subsector supported by, among others, the development and improved availability of formulated aquaculture feeds for finfishes and crustaceans.

Some fed species grow on a mixture of natural food proliferated from fertilization and supplementary feeds. If the non-fed portion in their total production were considered, the non-fed portion of world production of all farmed food fish would be higher than the aforesaid 33.3 percent. Owing to the unavailability of information and data needed for the calculation, the said percentage does not include: (i) the non-fed portion of production of some fed species (such as milkfish that grow partially on algal aggregates known as "lab-lab" proliferated through fertilization in culture ponds); and (ii) the non-fed filter feeding carps reported by some producers in aggregation with other species and treated wholly as fed species.

Box 2

Fish culture in rice fields

History and tradition

The capture and culture of aquatic organisms from rice fields has a long history and tradition especially in Asia, where the availability of rice and fish has been associated with prosperity and food security. Designs of rice fields with fish on ancient Chinese pottery from tombs of the Han Dynasty (206 BC–225 AD), inscriptions from a thirteenth century king of Thailand, and traditional sayings, such as one from Viet Nam – "rice and fish are like mother and children", are all testament that the combination of rice and fish has traditionally been regarded as an indicator of wealth and stability.

Status

The cultivation of almost 90 percent of the world's rice crops in irrigated, rainfed and deep-water systems equivalent to about 134 million hectares offers a suitable environment for fish and other aquatic organisms. Rice-based ecosystems provide habitats for a wide range of aquatic organisms extensively used by local people. They also offer opportunities for the enhancement and culture of aquatic organisms. The different integrations of rice and fish farming – either on the same plot, on adjacent plots where by-products of one system are used as inputs on the other, or consecutively – are all variations of production systems that aim to increase the productivity of water, land and associated resources while contributing to increased fish production. The integration can be more or less complete depending on the general layout of the irrigated rice plots and fishponds. There are many options for enhancing food production from fish in managed aquatic systems, which are ingeniously realized by farmers all over the world.[1]

As regards the general scale of rice–fish culture, China is the main producer with an area of about 1.3 million hectares of rice fields with different forms of fish culture, which produced 1.2 million tonnes of fish and other aquatic animals in 2010.[2] Other countries reporting their rice–fish production to FAO include Indonesia (92 000 tonnes in 2010), Egypt (29 000 tonnes in 2010), Thailand (21 000 tonnes in 2008), the Philippines (150 tonnes in 2010) and Nepal (45 tonnes in 2010). Trends observed in China show that fish production from rice fields has increased thirteenfold in the last two decades, and rice–fish culture is now one of the most important aquaculture systems in China, making a significant contribution to rural livelihoods and food security. A broad range of aquatic species including different carps, tilapias, catfish and breams are being farmed in rice fields. Market prices and preferences may provide important opportunities to farmers for a more diversified use of species, especially targeting eels, loaches and various crustaceans, and the sale and marketing of higher-valued organic products.[3] Also in India the practice cuts across different ecosystems from terraced rice fields in the hilly terrain to coastal lands and

deep-water rice fields, and reportedly covered an area of two million hectares in the 1990s. Rice–fish farming is being tried and practised in other countries and continents although to a lesser extent. Apart from Asia, activities have been reported from, among others, Brazil, Egypt, Guyana, Haiti, Hungary, Iran (Islamic Republic of), Italy, Madagascar, Malawi, Nigeria, Panama, Peru, Senegal, Suriname, the United States of America, Zambia, and several countries in the Central Asia and Caucasus region.[1]

Benefits, issues and challenges

Rice–fish farming provides additional food and income by diversifying farm activities and increasing yields of both the rice and fish crops. Evidence shows that although rice yields are similar, the integrated rice–fish system uses 68 percent less pesticide than rice monoculture.[4] Fish feed on rice pests, thus reducing pest pressure. Together with the fact that most broad-spectrum insecticides are a direct threat to aquatic organisms and healthy fish culture, knowledgeable farmers are much less motivated to spray pesticides. Therefore, it has been suggested that fish farming in rice and the integrated management of pests in rice production are complementary activities.[5] Similarly, complementary use of nitrogen between rice and fish resulted in 24 percent less chemical fertilizer application and low nitrogen release into the environment, suggesting positive interactions in the use of resources.[4] Fertilizers and feeds used in the integrated system are more efficiently utilized and converted into food production, and nutrient discharge to the natural environment is minimized. Rice–fish farming reduces the emission of methane by almost 30 percent compared with traditional rice farming.[6]

The challenges related to rice–fish farming are not different from those related to general aquaculture development. They include availability of and access to seed, feed and capital as well as natural risks associated with water control, disease and predation. Freshwater is rapidly becoming one of the scarcest natural resources, and competition for freshwater is among the most critical challenges facing developing countries. Sufficient and good-quality water is a key resource in rice–fish farming, which increases the productivity per unit of water used. Rice–fish farming and other forms of aquaculture in rice-based farming are one component of integrated water management approaches that produce food of high nutritional quality and, often, high economic value. Profits vary depending on production characteristics but income increases of up to 400 percent compared with rice monoculture have been reported and these may be even greater where high-value aquatic species are farmed.[3]

The use of aquatic genetic resources in rice is part of the work of the FAO Fisheries and Aquaculture Department with the Commission on Genetic Resources for Food and Agriculture as part of the preparation for *The State of the World on Aquatic Genetic Resources*. In addition, the rice–fish system has been included as one of the Globally Important Agricultural Heritage Systems under an FAO initiative supported by the Global Environment Facility.

It is the combination of efficient production and use of resources coupled with environmental benefits that has prompted recent international

Box 2 *(cont.)*

gatherings of the International Rice Commission, the Convention of Biological Diversity, and the Ramsar Convention to recommend that rice-producing countries promote the further development of integrated rice and fish systems as a means of enhancing food security and sustainable rural development. In addition, some countries with a long tradition in integrated rice–fish systems are giving renewed attention to the complex rice ecosystem with a focus on its role in biodiversity conservation, as in the Japanese *satoyama* landscape initiative.

The way forward

An increase in integrated farming of rice and fish is possible and would benefit farmers, consumers and the environment worldwide. Several organizations, active in global policies for food production and/or environmental sustainability, have become aware of this, and key policy-makers have formulated and disseminated relevant recommendations to governments, institutions and stakeholders. This is encouraging and, given the benefits of rice–fish farming, it is important to give priority to its continued promotion.

Taking China, the main producer, as an example, with currently 15 percent of the suitable rice area under integrated rice–fish cultivation, there is considerable scope for expansion.[3] The same is true for many rice-producing countries around the globe. Similarly, there is much room for intensification of existing systems. Capacity building with increased knowledge and improved management techniques will be critically important, in particular focusing on all farming household members, both men and women, as well as extension agents. In recent decades, excellent progress has been achieved by applying a "farmer field school" (FFS) approach. This is a discovery-based learning approach where small groups of farmers meet regularly, facilitated by a specially trained technician, to explore new methods, through simple experimentation and group discussion and analysis, over the course of a growing season. This approach allows farmers to modify and adapt newly introduced methods to local contexts and knowledge, ultimately providing a higher likelihood of appropriate adaptation and adoption of improved technologies. It is only relatively recently that aquaculture has been integrated into an FFS-style curriculum in Guyana and Suriname.[7]

In terms of food security, producers in Asia, especially China, Viet Nam, India, Indonesia and Bangladesh, have benefited from the development of culture of low-trophic-level species, such as carps and barbs, tilapias and *Pangasius* catfish, in easing dependence on high-protein feeds, and thus reduced the vulnerability of their sectors to externalities. Grass carp, the world's most-produced finfish species from aquaculture, is grown partially with cultivated and wild-collected "pastures", instead of using formulated feeds only.

The production of 253 000 tonnes of highly carnivorous Mandarin fish (*Siniperca chuatsi*), which feeds on live prey only, was achieved by feeding them with low-trophic-level carp fingerlings grown with low-protein feeds plus pond fertilization.

The approach to validate and disseminate integrated rice–fish farming systems through FFS has been pioneered in Latin America. It is currently being tested in field activities in Mali, with testing also scheduled for Burkina Faso, where considerable potential for the integration of irrigated rice and aquaculture exists.[8] Strong interest has been noted from several other sub-Saharan countries such as the Democratic Republic of the Congo, Senegal, the United Republic of Tanzania, and Zambia.[9]

[1] Halwart, M. and Gupta, M.V., eds. 2004. *Culture of fish in rice fields*. Rome, FAO, and Penang, Malaysia, The WorldFish Center. 83 pp. (also available at www.fao.org/docrep/015/a0823e/a0823e00.htm). (English, French and Spanish language versions)
[2] Bureau of Fisheries. 2011. *2010 China Fishery Statistical Yearbook*. Beijing.
[3] Miao, W.M. 2010. Recent developments in rice–fish culture in China: a holistic approach for livelihood improvement in rural areas. *In* S.S. de Silva and F.B. Davy, eds. *Success stories in Asian aquaculture*, pp. 15–42. London, Springer. (also available at http://web.idrc.ca/en/ev-147117-201-1-DO_TOPIC.html).
[4] Xie, J., Hu, L.L., Tang, J.J., Wu, X., Li, N.N., Yuan, Y.G., Yang, H.S., Zhang, J., Luo, S.M. and Chen, X. 2011. Ecological mechanisms underlying the sustainability of the agricultural heritage rice–fish coculture system. *Proceedings of the National Academy of Sciences of the United States of America*, 108(50): E1381–E1387 [online]. [Cited 19 April 2012]. www.pnas.org/content/108/50/E1381.full
[5] Halwart, M. 1994. *Fish as biocontrol agents in rice: the potential of common carp* Cyprinus carpio *and Nile tilapia* Oreochromis niloticus. Weikersheim, Germany, Margraf Verlag. 169 pp.
[6] Lu, J. and Li, X. 2006. Review of rice–fish-farming systems in China – one of the Globally Important Ingenious Agricultural Heritage Systems (GIAHS). *Aquaculture*, 260(1-4): 106–113.
[7] Halwart, M. and Settle, W., eds. 2008. *Participatory training and curriculum development for Farmer Field Schools in Guyana and Suriname. A field guide on Integrated Pest Management and aquaculture in rice*. Rome, FAO. 122 pp. (also available at www.fao.org/docrep/012/al356e/al356e.pdf).
[8] Peterson, J. and Kalende, M. 2006. The potential for integrated irrigation-aquaculture in Mali. *In* M. Halwart and A.A. van Dam, eds. *Integrated irrigation and aquaculture in West Africa: concepts, practices and potential*, pp. 79–94. Rome, FAO. 181 pp. (also available at www.fao.org/docrep/009/a0444e/a0444e00.htm). (English, French and Spanish language versions)
[9] Yamamoto, K., Halwart, M. and Hishamunda, N. 2011. Supporting African rice farmers in their diversification efforts through aquaculture. *FAO Aquaculture Newsletter*, 48: 42–43.

Comparable in quantity with the total production of farmed rainbow trout in Europe (257 200 tonnes), or the combined world production of gilthead seabream and European seabass (265 100 tonnes), Mandarin fish production has been assumed to be dependent on fishmeal and fish oil for feed, and this now needs reconsideration. As discussed above, part of its production could be treated as the non-fed portion of fed species production.

In sub-Saharan Africa, the carnivorous North African catfish (*Clarias gariepinus*) has replaced tilapia as the most-produced fish in aquaculture since 2004. The progressive dominance of catfish species in aquaculture is particularly pronounced in Nigeria and Uganda. Being the largest producer of catfish in Africa, Nigeria even imports catfish feeds from as far away as Northern Europe.

Figure 7

World aquaculture production of non-fed and fed species

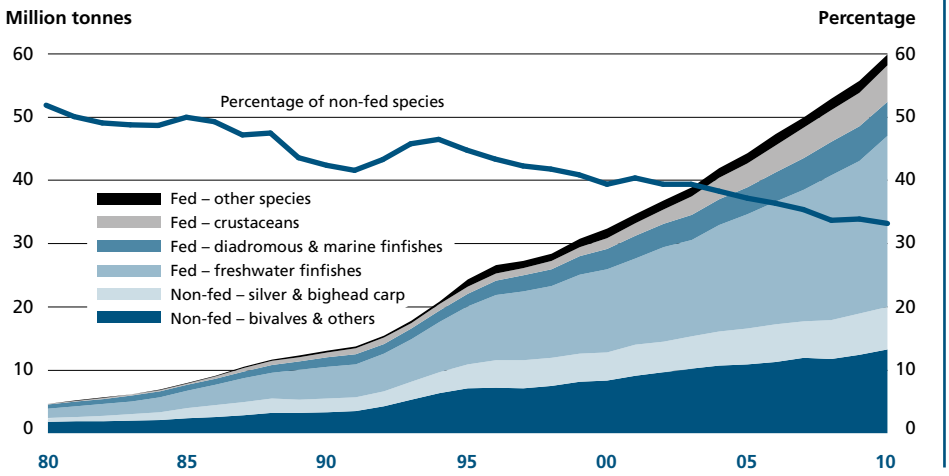
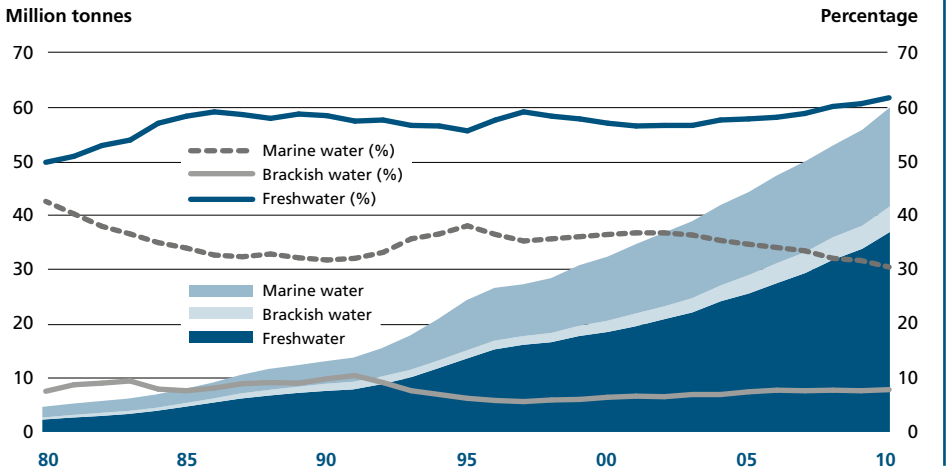


Figure 8

World aquaculture production and relative share by culture environment



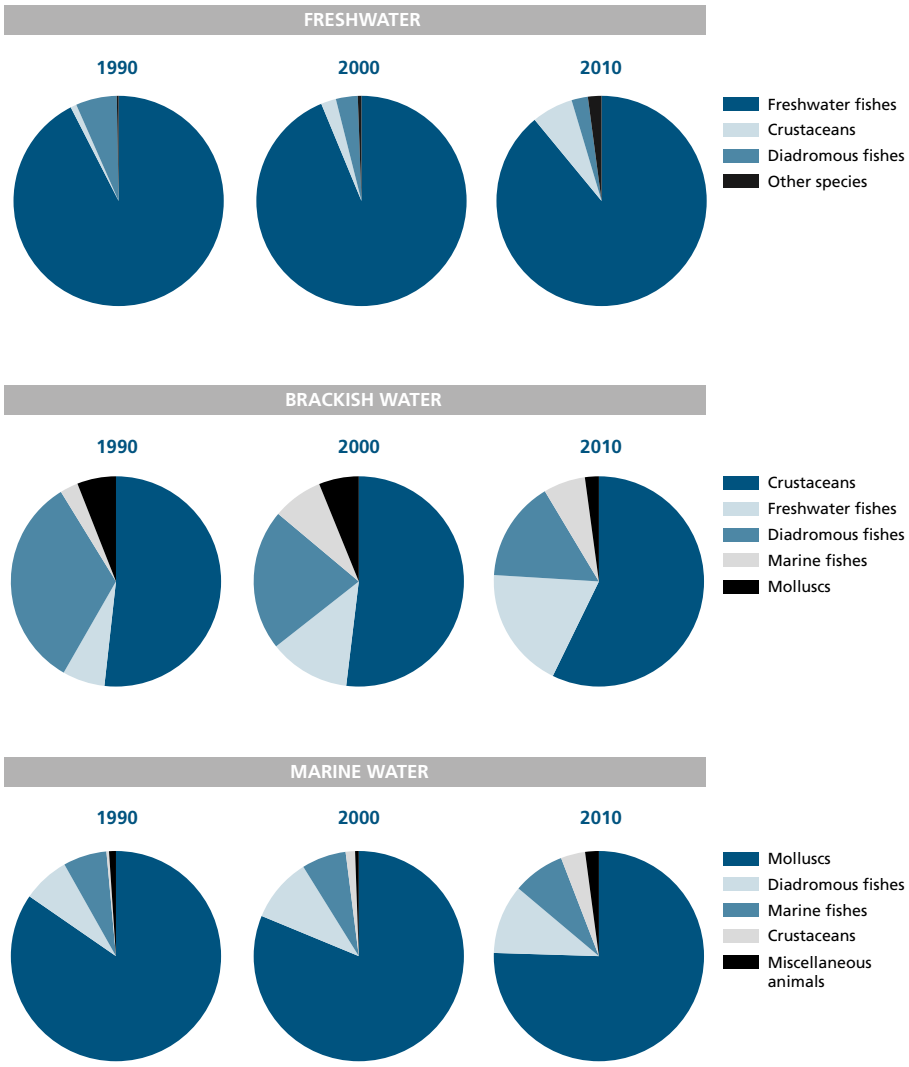
Production by culture environment

Aquaculture production uses freshwater, brackish water and full-strength marine water as culture media. Data available at FAO show that, in terms of quantity, the percentage of production from freshwater rose from less than 50 percent before the 1980s to almost 62 percent in 2010 (Figure 8), with the share of marine aquaculture production declining from more than 40 percent to just above 30 percent. In 2010, freshwater aquaculture was the source of 58.1 percent of global production by value. Brackish-water aquaculture yielded only 7.9 percent of world production in terms of quantity but accounted for 12.8 percent of total value because of the relatively high-valued marine shrimps cultured in brackish-water ponds. Marine water aquaculture accounted for about 29.2 percent of world aquaculture production by value.

The average annual growth rate for freshwater aquaculture production from 2000 to 2010 was 7.2 percent, compared with 4.4 percent for marine aquaculture production. Freshwater fish farming has been a relatively easy entry point for practising aquaculture in developing countries, particularly for small-scale producers.

Figure 9

World aquaculture production composition by culture environment



As such, freshwater aquaculture is expected to contribute further to total aquaculture production in the 2010s.

The share of brackish-water aquaculture production has been stable, ranging between 6 and 8 percent, for most of the time. An exception was in the 1980s and early 1990s when accelerated development of brackish-water culture of marine shrimp species, particularly in coastal regions of Asia and South America, led to brackish-water aquaculture reaching 8–10 percent of total production. However, in the period 1994–2000, world marine shrimp farming was hit by disease outbreaks in Asia and South America, and the share of brackish-water production fell to 6 percent.

At the global level, the composition and types of farmed species differ greatly among the three culture environments, and they have also undergone changes within environments over the years (Figure 9).

Freshwater aquaculture production (36.9 million tonnes) was overwhelmingly dominated by finfishes (91.7 percent, 33.9 million tonnes) in 2010, as in the past. Crustaceans accounted for 6.4 percent, and all other types of species contributed only

1.9 percent. The development of freshwater farming of crustaceans and other species (such as soft-shell turtles and frogs) in the past two decades has slightly eroded the dominance of finfish in production. The share of diadromous fishes, including rainbow trout and other salmonids, eels and sturgeons, shrank from 6.3 percent in 1990 to 2.5 percent in 2010.

Brackish-water aquaculture production (4.7 million tonnes) consisted of crustaceans (57.2 percent, 2.7 million tonnes), freshwater fishes (18.7 percent), diadromous fishes (15.4 percent), marine fishes (6.5 percent) and marine molluscs (2.1 percent) in 2010. More the 99 percent of the crustaceans were marine shrimps. The share of freshwater fishes has increased dramatically in the past two decades, driven largely by rapid development in Nile tilapia and other species in Egypt. Milkfish and barramundi remain important but their combined share has dropped significantly. Salmonids and eels are also cultured in brackish-water in small quantities.

Marine-water aquaculture production (18.3 million tonnes) consists of marine molluscs (75.5 percent, 13.9 million tonnes), finfishes (18.7 percent, 3.4 million tonnes), marine crustaceans (3.8 percent) and other aquatic animals (2.1 percent), e.g. sea cucumbers, and sea urchins. The share of molluscs (mostly bivalves, e.g. oysters, mussels, clams, cockles, arkshells and scallops) declined from 84.6 percent in 1990 to 75.5 percent in 2010, reflecting the rapid growth in finfish culture in marine water, which grew at an average annual rate of 9.3 percent from 1990 to 2010 (seven times faster than the rate for molluscs). Salmonid production, particularly Atlantic salmon, increased dramatically from 299 000 tonnes in 1990 to 1.9 million tonnes in 2010, at an average annual rate exceeding 9.5 percent. Other finfish species also increased rapidly, from 278 000 tonnes in 1990 to 1.5 million tonnes in 2010, at an average annual rate exceeding 8.6 percent. Other finfish species cultured in marine water include amberjacks, seabreams, seabasses, croakers, grouper, drums, mullets, turbot and other flatfishes, snappers, cobia, pompano, cods, puffers and tunas.

Species produced in aquaculture

In 2010, the composition of world aquaculture production was: freshwater fishes (56.4 percent, 33.7 million tonnes), molluscs (23.6 percent, 14.2 million tonnes), crustaceans (9.6 percent, 5.7 million tonnes), diadromous fishes (6.0 percent, 3.6 million tonnes), marine fishes (3.1 percent, 1.8 million tonnes) and other aquatic animals (1.4 percent, 814 300 tonnes). Figure 10 summarizes the production volumes of the major categories. Aquaculture production exceeds capture production for many of the staple species for aquaculture. For example, the wild catch accounts for less than 1 percent of Atlantic salmon production, and farmed marine shrimps contribute 55 percent to the total global production.

Production of freshwater fishes has always been dominated by carps (71.9 percent, 24.2 million tonnes, in 2010). Among carps, 27.7 percent are non-fed filter-feeders and the rest are fed with low-protein feeds. Production of tilapias has a wide distribution, and 72 percent are raised in Asia (particularly in China and Southeast Asia), 19 percent in Africa, and 9 percent in America. Viet Nam dominates production of omnivorous *Pangasius* catfishes although there are other producers, such as Indonesia and Bangladesh. World production of *Pangasius* catfish may be understated because booming production in India has yet to be reflected in statistics. In 2010, Asia accounted for 73.7 percent of the production of other catfish species, America took its share to 13.5 percent (with channel catfish production), leaving 12.3 percent of production in Africa (dominated by North African catfish). Carnivorous species such as perches, basses and snakeheads accounted for only 2.6 percent of all freshwater fish produced in 2010.

Since the beginning of 1990s, more than half of the world production of diadromous fishes has come from salmonids, and the share peaked at 70.4 percent in 2001 before declining slightly in the face of increased milkfish production in Asia. The production of Japanese and European eels, mostly raised in East Asia and to a much lesser extent in Europe, has remained at about 270 000 tonnes in recent years. Limited

by the supply of seeds, the chances of a significant increase in coming years appear remote. Other eel species have been tested with wild-collected seeds with only limited success. Culture of sturgeons, for meat and for caviar, has risen steadily in Asia, Europe and America although production is still small. An increased number of farming systems with sophisticated equipment requiring high investment have been set up to target caviar production in some countries.

World production of marine fishes is more evenly distributed across the cultured species. However, almost half a million tonnes, or one-quarter of global production, are reported without identifying the species, particularly by a few top producers from Asia. There is evidence that production of European seabass and gilthead seabream has been significantly under-reported in some areas in the Mediterranean.

World aquaculture production of crustaceans in 2010 consisted of freshwater species (29.4 percent) and marine species (70.6 percent). The production of marine species is dominated by white leg shrimp (*Penaeus vannamei*), including substantial production in freshwater. In sharp contrast, the giant tiger prawn has lost importance in the last decade. Major freshwater species include red swamp crayfish, Chinese mitten crab, oriental shrimp and giant river prawn.

Regarding molluscs, aquaculture production of clams and cockles has increased much faster than that of other species groups. In 1990, clam and cockle production was half that of oysters, but by 2008 it exceeded oysters and became the most-produced species group of molluscs. Among other aquatic animals, production of sea cucumbers and soft-shell turtles has increased rapidly.

Use of aquatic species in aquaculture production

The number of species recorded in FAO aquaculture production statistics increased to 541 species and species groups in 2010, including 327 finfishes (5 hybrids), 102 molluscs, 62 crustaceans, 6 amphibians and reptiles, 9 aquatic invertebrates and 35 algae. The increase reflects improvements in data collection and reporting at the international and national levels, as well as the farming of new species, including hybrids. In view of the high degree of species aggregation reported by many countries, it is estimated that aquaculture production worldwide uses about 600 aquatic food fish and algae species.

Exotic aquatic species have been widely introduced and used for mass production in aquaculture, and their use is particularly common and important in Asian countries. Successful internationally introduced species for finfishes include tilapias from Africa (especially Nile tilapia), Chinese carps (silver carp, bighead carp and grass carp), Atlantic salmon (*Salmo salar*), *Pangasius* catfishes (*Pangasius* spp.), largemouth black bass (*Micropterus salmoides*), turbot (*Scophthalmus maximus*), piarapatinga (*Piaractus brachypomus*), pacu (*Piaractus mesopotamicus*), and rainbow trout (*Oncorhynchus mykiss*).

Measured by production, white leg shrimp is the most successful internationally introduced marine crustacean species for aquaculture. In 2010, it accounted for 71.8 percent of world production of all farmed marine shrimp species, of which 77.9 percent was produced in Asia (with the rest in its native home in America). Some shrimp-farming countries maintain bans on the farming of this exotic species, and Bangladeshi shrimp growers and seafood exporters have recently requested a lifting of the ban. Red swamp crayfish (*Procambarus clarkii*) from North America and giant river prawn (*Macrobrachium rosenbergii*) from South and Southeast Asia have also become important for freshwater culture in countries foreign to these species.

A significant part of the global production of marine molluscs, particularly in Europe and America, relies on the widely introduced Japanese carpet shell (*Ruditapes philippinarum*, also known as Manila clam) and Pacific cupped oyster (*Crassostrea gigas*). China now produces large quantities of Atlantic bay scallop (*Argopecten irradians*) and Yesso scallop (*Patinopecten yessoensis*).

A considerable number of hybrids, most notably of finfish, are used in aquaculture, especially in countries with a relatively high level of development in aquaculture technologies. Commercially farmed hybrids include: sturgeons (such as beluga *Huso huso* x starlet sturgeon *Acipenser ruthenus* known as “bester”) in Asia and Europe;

Figure 10

Production of major species or species group from aquaculture in 2010

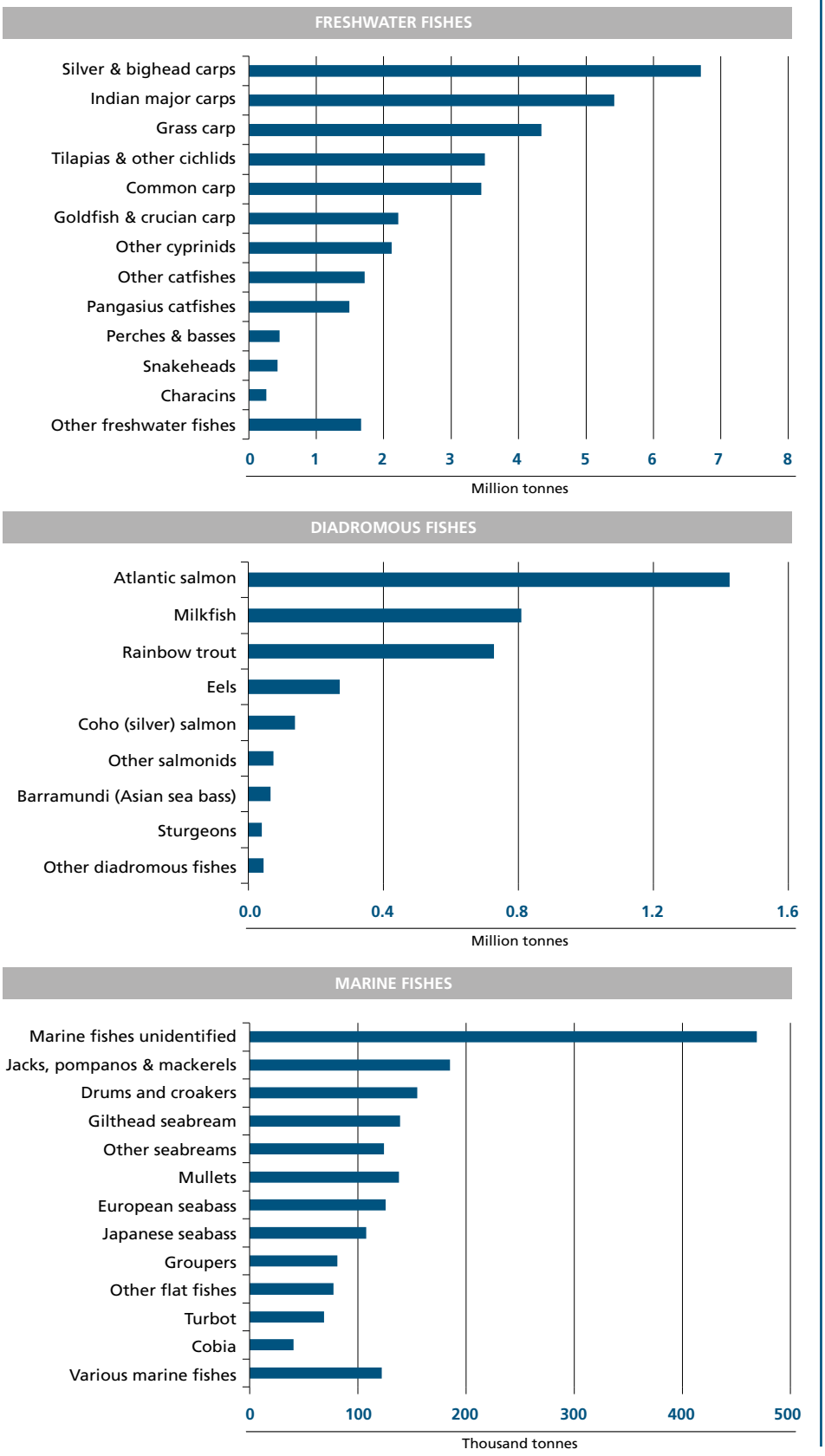
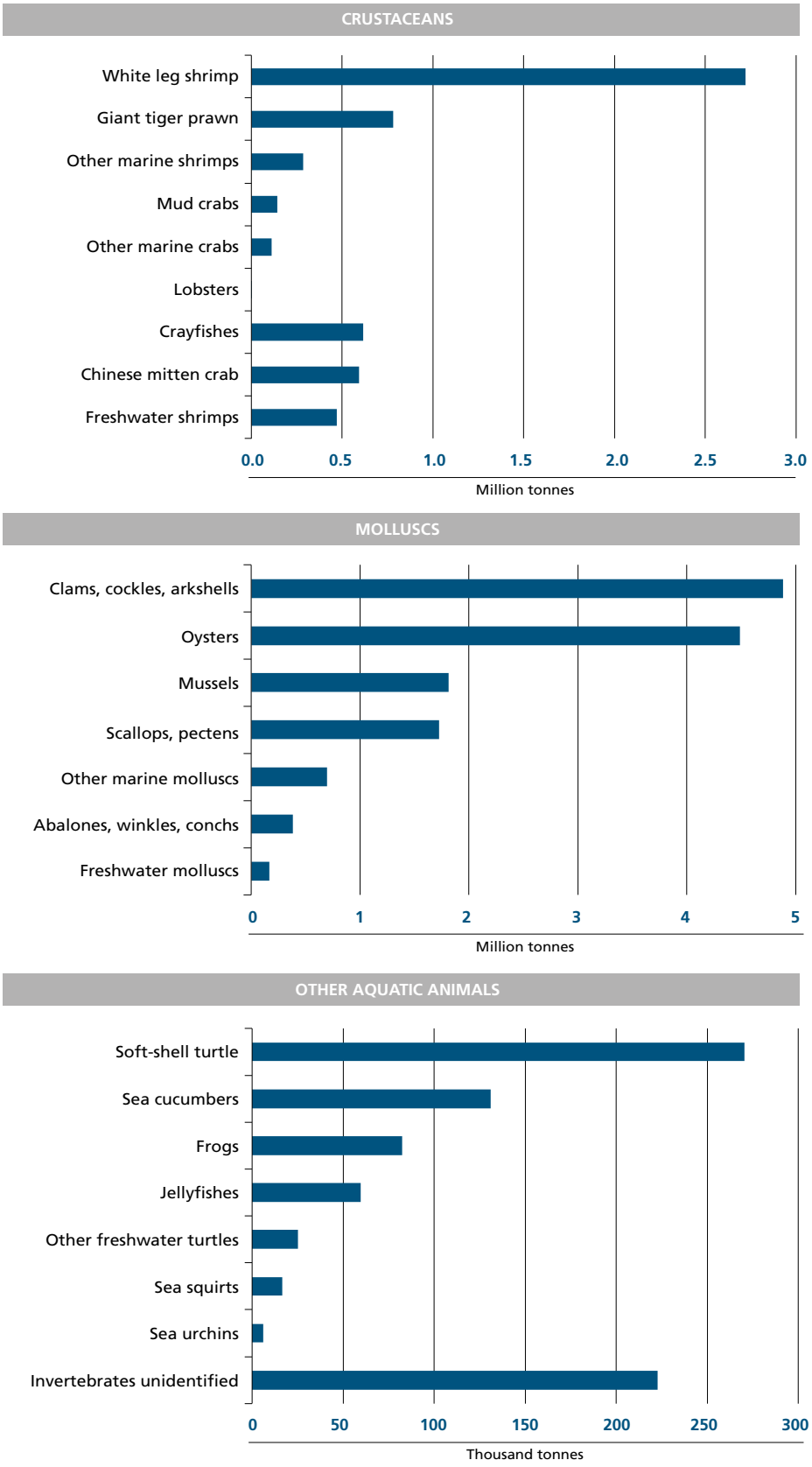


Figure 10 *(cont.)*

Production of major species or species group from aquaculture in 2010



Carassius spp., snakeheads and groupers in China; characins in South America; and freshwater catfishes (*Clarias gariepinus* x *Heterobrachus longifilis*) in Africa and Europe. The culture of hybrid tilapias is particularly common around the world. The hybrid of *Oreochrom aureus* x *O. niloticus* (with a high percentage of male offspring) is farmed in China, and the saline-resistant hybrid of *O. niloticus* x *O. mossambicus* in the Philippines.

Five finfish hybrids have been recorded with national production statistics and FAO estimates, indicating world production levels in 2010 of 333 300 tonnes of blue and Nile tilapia hybrid (*Oreochrom aureus* x *O. niloticus*, in China and in Panama), 116 900 tonnes of *Clarias* catfish hybrid (*Clarias gariepinus* x *C. macrocephalus*, in Thailand), 21 600 tonnes of "tambacu" hybrid (*Piaractus mesopotamicus* x *Colossoma macropomum*, in Brazil), 4 900 tonnes of "tambatinga" hybrid (*Colossoma macropomum* x *Piaractus brachypomus*, in Brazil) and 4 200 tonnes of striped bass hybrid (*Morone chrysops* x *M. saxatilis*, in the United States of America, Italy and Israel).

Aquatic plant (algae) production

To date, only aquatic algae have been recorded globally in farmed aquatic plant production statistics. Global production has been dominated by marine macroalgae, or seaweeds, grown in both marine and brackish waters.

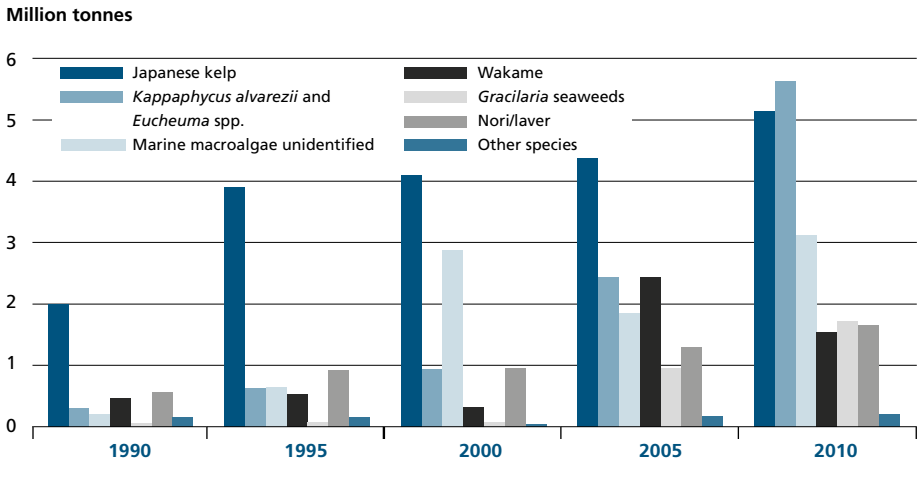
Aquatic algae production by volume increased at average annual rates of 9.5 percent in the 1990s and 7.4 percent in the 2000s – comparable with rates for farmed aquatic animals – with production increasing from 3.8 million tonnes in 1990 to 19 million tonnes in 2010. Cultivation has overshadowed production of algae collected from the wild, which accounted for only 4.5 percent of total algae production in 2010.

Following downward adjustments by FAO of the estimated value of several major species from a few major producers with incomplete reported data, the estimated total value of farmed algae worldwide has been reduced for a number of years in the time series. The total value of farmed aquatic algae in 2010 is estimated at US$5.7 billion, while that for 2008 is now re-estimated at US$4.4 billion.

As shown in Figure 11, a few species dominate algae culture, with 98.9 percent of world production in 2010 coming from Japanese kelp (*Saccharina/Laminaria japonica*) (mainly in the coastal waters of China), *Eucheuma* seaweeds (a mixture of *Kappaphycus alvarezii*, formerly known as *Eucheuma cottonii*, and *Eucheuma* spp.), *Gracilaria* spp., nori/laver (*Porphyra spp.*), wakame (*Undaria pinnatifida*) and unidentified marine macroalgae species (3.1 million tonnes, mostly from China). The remainder consists of

Figure 11

World production of farmed aquatic plant (algae) by major species or species group



marine macroalgae species farmed in small quantities (such as *Fusiform sargassum* and *Caulerpa* spp.) and microalgae cultivated in freshwater (mostly *Spirulina* spp., plus a small fraction of *Haematococcus pluvialis*). The production increase is most obvious in the farming of *Eucheuma* seaweeds. The 2000 production value for unidentified marine macroalgae shown in Figure 11 contains a significant portion of wakame, which was not separately reported by the main producer.

In sharp contrast to fish aquaculture, the cultivation of aquatic algae is practised in far fewer countries. Only 31 countries and territories are recorded with algae farming production in 2010, and 99.6 percent of global cultivated algae production comes from just eight countries: China (58.4 percent, 11.1 million tonnes), Indonesia (20.6 percent, 3.9 million tonnes), the Philippines (9.5 percent, 1.8 million tonnes), the Republic of Korea (4.7 percent, 901 700 tonnes), Democratic People's Republic of Korea (2.3 percent, 444 300 tonnes), Japan (2.3 percent, 432 800 tonnes), Malaysia (1.1 percent, 207 900 tonnes) and the United Republic of Tanzania (0.7 percent, 132 000 tonnes).

FISHERS AND FISH FARMERS

Millions of people around the world find a source of income and livelihood in the fisheries sector. The most recent estimates (Table 7) indicate that in 2010 there were 54.8 million people engaged in the primary sector of capture fisheries and aquaculture. Of these, an estimated 7 million people were occasional fishers and fish farmers (of whom 2.5 million in India, 1.4 million in China, 0.9 million in Myanmar, and 0.4 million each in Bangladesh and Indonesia).

More than 87 percent of all people employed in the fisheries sector in 2010 were in Asia, followed by Africa (more than 7 percent), and Latin America and the Caribbean (3.6 percent). Approximately 16.6 million (about 30 percent of all people employed in the fisheries sector) were engaged in fish farming, and they were even more concentrated in Asia (97 percent), followed by Latin America and the Caribbean (1.5 percent), and Africa (about 1 percent).

In the period 2005–2010, employment in the fisheries sector continued to grow faster (at 2.1 percent per year) than the world's population (at 1.2 percent per year)

Table 7
World fishers and fish farmers by region

	1990	1995	2000	2005	2010
			(Thousands)		
Africa	1 917	2 184	3 899	3 844	3 955
Asia	26 765	31 328	36 752	42 937	47 857
Europe	645	529	752	678	634
Latin America and the Caribbean	1 169	1 201	1 407	1 626	1 974
North America	385	376	343	342	342
Oceania	67	69	74	74	76
World	**30 948**	**35 687**	**43 227**	**49 502**	**54 838**
Of which fish farmers[1]					
Africa	2	61	84	124	150
Asia	3 772	7 050	10 036	12 228	16 078
Europe	32	57	84	83	85
Latin America and the Caribbean	69	90	191	218	248
North America	...	...	...	4	4
Oceania	2	4	5	5	6
World	**3 877**	**7 261**	**10 400**	**12 661**	**16 570**

Note: ... = data not available.
[1] Estimates for 1990 and, partly, for 1995 were based on data available for a smaller number of countries and, therefore, may not be fully comparable with those for later years.

and than employment in the traditional agriculture sector (at 0.5 percent per year). The 54.8 million fishers and fish farmers in 2010 represented 4.2 percent of the 1.3 billion people economically active in the broad agriculture sector worldwide, compared with 2.7 percent in 1990.

However, the relative proportion of those engaged in capture fisheries within the sector actually decreased from 87 percent in 1990 to 70 percent in 2010, while the proportion of those engaged in fish farming increased from 13 to 30 percent (Figure 12). In fact, in the last five years for which data are available, the number of people engaged in fish farming has increased at 5.5 percent per year compared with a mere 0.8 percent per year for those engaged in capture fisheries. It is apparent that, in the most important fishing nations, the share of employment in capture fisheries is stagnating or decreasing while aquaculture is providing increased opportunities. Moreover, as many countries still do not report employment data separately for the capture and farming sectors, the relative importance of employment in aquaculture may be underestimated.

The trends in employment vary according to the regions. Europe experienced the largest decrease in the number of people engaged in capture fishing with a 2 percent average annual decline between 2000 and 2010, and almost no increase in people employed in fish farming in the same period. In contrast, Africa showed the highest annual increase (5.9 percent) in the number of people engaged in fish farming in the last decade, followed by Asia (4.8 percent), and Latin America and the Caribbean (2.6 percent).

Table 8 presents the employment statistics for selected countries, including China, where almost 14 million people (26 percent of the world total) are engaged as fishers and fish farmers. In general, employment in fishing has been decreasing in capital-intensive economies, in particular in most European countries, North America, and Japan. For example, in the period 1990–2010, the number of people employed in marine fishing decreased by 53 percent in the United Kingdom of Great Britain and Northern Ireland, by 45 percent in Japan, by 40 percent in Norway, and by 28 percent in Iceland. Several factors may account for this, including the application of policies to reduce overcapacity and less reliance on human power owing to technological developments.

Table 9 compares per capita annual productivity in the capture fisheries and aquaculture primary sector for each region. Overall, average annual production per person is consistently lower in capture fisheries than in aquaculture, with global outputs of 2.3 and 3.6 tonnes per person per year, respectively.

Figure 12

Employment in the fisheries sector for the period 1990–2010

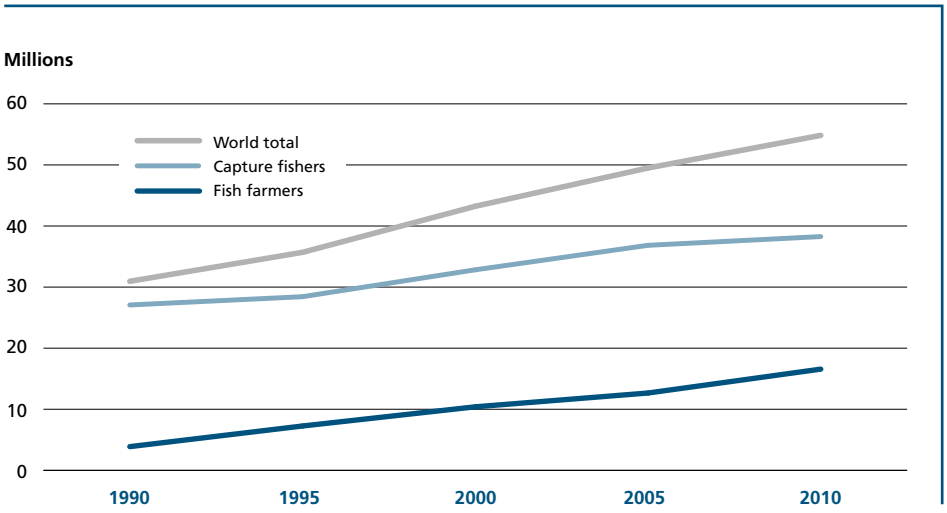


Table 8
Number fishers and fish farmers in selected countries and territories

	Fishery		1990	1995	2000	2005	2010
WORLD	FI + AQ	(number)	**30 948 446**	**35 687 357**	**43 227 132**	**49 502 314**	**54 838 257**
		(index)	***72***	***83***	***100***	***115***	***127***
	FI	(number)	27 071 570	28 426 245	32 826 719	36 841 044	38 268 197
		(index)	*82*	*87*	*100*	*112*	*117*
	AQ	(number)	3 876 876	7 261 112	10 400 413	12 661 270	16 570 060
		(index)	*37*	*70*	*100*	*122*	*159*
China	FI + AQ	(number)	11 173 463	11 428 655	12 935 689	12 902 777	13 992 142
		(index)	*86*	*88*	*100*	*100*	*108*
	FI	(number)	9 432 464	8 759 162	9 213 340	8 389 161	9 013 173
		(index)	*102*	*95*	*100*	*91*	*98*
	AQ	(number)	1 740 999	2 669 493	3 722 349	4 513 616	4 978 969
		(index)	*47*	*72*	*100*	*121*	*134*
Taiwan Province of China	FI + AQ	(number)	325 902	302 161	314 099	351 703	330 181
		(index)	*104*	*96*	*100*	*112*	*105*
	FI	(number)	232 921	204 149	216 501	246 580	246 659
		(index)	*108*	*94*	*100*	*114*	*114*
	AQ	(number)	92 981	98 012	97 598	105 123	83 522
		(index)	*95*	*100*	*100*	*108*	*86*
Iceland	FI	(number)	6 951	7 000	6 100	5 100	5 000
		(index)	*114*	*115*	*100*	*84*	*82*
Indonesia	FI + AQ	(number)	3 617 586	4 568 059	5 247 620	5 096 978	5 971 725
		(index)	*69*	*87*	*100*	*97*	*114*
	FI	(number)	1 995 290	2 463 237	3 104 861	2 590 364	2 620 277
		(index)	*64*	*79*	*100*	*83*	*84*
	AQ	(number)	1 622 296	2 104 822	2 142 759	2 506 614	3 351 448
		(index)	*76*	*98*	*100*	*117*	*156*
Japan	FI	(number)	370 600	301 440	260 200	222 160	202 880
		(index)	*142*	*116*	*100*	*85*	*78*
Mexico	FI + AQ	(number)	242 804	249 541	262 401	279 049	271 608
		(index)	*93*	*95*	*100*	*106*	*104*
	FI	(number)	242 804	249 541	244 131	255 527	240 855
		(index)	*99*	*102*	*100*	*105*	*99*
	AQ	(number)	...	...	18 270	23 522	30 753
		(index)	...	...	*100*	*129*	*168*
Morocco	FI	(number)	56 000	99 885	106 096	105 701	107 296
		(index)	*53*	*94*	*100*	*100*	*101*
Norway	FI + AQ	(number)	24 979	21 776	18 589	18 776	17 667
		(index)	*134*	*117*	*100*	*101*	*95*
	FI	(number)	20 475	17 160	14 262	14 554	12 280
		(index)	*144*	*120*	*100*	*102*	*86*
	AQ	(number)	4 504	4 616	4 327	4 222	5 387
		(index)	*104*	*107*	*100*	*98*	*124*
Peru[1]	FI + AQ	(number)	43 750	62 930	93 789	95 426	99 000
		(index)	*47*	*67*	*100*	*102*	*106*
	FI	(number)	43 750	60 030	87 524	86 755	90 000
		(index)	*50*	*69*	*100*	*99*	*103*
	AQ	(number)	...	2 900	6 265	8 671	9 000
		(index)	...	*46*	*100*	*138*	*144*
United Kingdom	FI	(number)	21 582	19 986	15 649	12 647	10 129
		(index)	*138*	*128*	*100*	*81*	*65*

Note: FI = fishing, AQ = aquaculture; index: 2000 = 100; ... = data not available.
[1] Data for 2010 are FAO estimates.

Box 3

Child labour – an important issue also in fisheries and aquaculture

Child labour is a great concern in many parts of the world. In 2008, some 60 percent of the 215 million boys and girls estimated to be child labourers worldwide were engaged in the agriculture sector, including in fisheries, aquaculture, livestock and forestry.[1] In addition to work interfering with schooling and harming personal development in other ways, many of these children work in hazardous occupations or activities that threaten their health and sometimes their lives. They do work that they should not do according to international conventions and/or national legislation, and this situation endangers not only the children themselves but also efforts at poverty alleviation and sustainable development in a larger sense for their families and communities.

However, tackling child labour is no easy task. The occurrence of child labour is entwined in poverty and social injustices and cannot be addressed in isolation. Moreover, some types of work are not harmful but can even be beneficial for children. While it may be relatively easy to identify and agree to eliminate the "worst forms of child labour", the distinction between "acceptable work" and "harmful labour" is not always clear and assessments can be muddled by local and traditional practices and beliefs. There is a need to exercise due care in analysing existing situations, in applying existing conventions, legislation and guidelines, and in raising the awareness and understanding of child labour issues in order to ensure that they are directly addressed as well as integrated into broader policies and programmes. Improvements have proved possible and the overall number of child labourers in the world has declined since 2000.

Information on child labour in fisheries and aquaculture is limited, and data on agriculture child labour are not generally disaggregated by subsector. Nevertheless, case studies and specific surveys indicate that the numbers are important. Child labour is particularly common in the small-scale informal sector, and children work in a large variety of activities, as part of family enterprises, as unpaid family workers or employed by others. They are found, for example, working on board fishing vessels, preparing nets and baits, feeding and harvesting fish in aquaculture ponds, and sorting, processing and selling fish.

A number of factors influence whether a task should be considered acceptable work, child labour or "worst form of child labour". With the support of initiatives such as the global International Partnership for Cooperation on Child Labour in Agriculture, launched by key international agricultural organizations in 2007,[2] the knowledge base and guidance on how to classify and tackle child labour in agriculture have improved in the last decade. However, there is still an urgent need to learn more about child labour also in fisheries and aquaculture and to address the specific situations.

In April 2010, FAO, in cooperation with the International Labour Organization (ILO), organized a workshop[3] to generate inputs and guidance to the contents and process of developing guidance materials on policy and practice in tackling child labour in fisheries and aquaculture. In order to promote awareness on and effective implementation of the

relevant UN and ILO conventions on child labour and the rights of the child, the workshop participants:

- reviewed the nature, incidence and causes of child labour in fisheries, fish processing and aquaculture;
- examined the different forms and types of child labour in large-scale, small-scale and artisanal fishing operations, shellfish gathering, aquaculture, seafood processing, and work onboard fishing vessels and fishing platforms;
- examined the health and safety hazards of fishing and aquaculture, including the use of hazardous technologies and relevant alternatives;
- shared examples of good practice in the progressive elimination of child labour drawn from various sectors and regions.

The workshop participants agreed on a series of recommendations relating to legal and enforcement measures, policy interventions and practical actions, including risk assessments, to address child labour issues in fisheries and aquaculture. FAO and ILO were called upon for priority actions to assist governments in withdrawing trafficked children and to effectively prohibit slavery and forced labour. The workshop participants also prioritized awareness raising among all stakeholders and the preparation of guidance materials. In addition, they stressed the need to consider gender issues in all actions and to address adequately issues relating to discrimination and exclusion of fishing communities, castes, tribal and indigenous peoples, and ethnic minorities in fisheries and aquaculture.

FAO and ILO are collaborating in helping to assess and address child labour issues in countries such as Cambodia and Malawi. They have also produced a preliminary version of a good practice guide for addressing child labour in fisheries and aquaculture.[4]

[1] International Labour Organization. 2010. *Facts on child labour 2010* [online]. Geneva, Switzerland. [Cited 31 March 2012]. www.ilo.org/wcmsp5/groups/public/@dgreports/@dcomm/documents/publication/wcms_126685.pdf

[2] In addition to FAO, other current members of the International Partnership for Cooperation on Child Labour in Agriculture are the International Labour Organization (ILO), International Fund for Agricultural Development, International Food Policy Research Institute of the Consultative Group on International Agricultural Research, International Federation of Agricultural Producers (representing farmers/employers and their organizations), and International Union of Food, Agricultural, Hotel, Restaurant, Catering, Tobacco and Allied Workers' Associations (representing workers and their organizations). Further information is available on the ILO's Web page on the International Programme on the Elimination of Child Labour (IPEC) at www.ilo.org/ipec/lang--en/index.htm#a1.

[3] FAO. 2010. *FAO workshop on child labour in fisheries and aquaculture in cooperation with ILO* [online]. Rome. [Cited 31 March 2012]. www.fao.org/fileadmin/user_upload/newsroom/docs/Final_recommendationsB.pdf

[4] FAO and International Labour Organization. 2011. *FAO–ILO good practice guide for addressing child labour in fisheries and aquaculture: policy and practice* [online]. [Cited 31 March 2012]. ftp://ftp.fao.org/FI/DOCUMENT/child_labour_FAO-ILO/child_labour_FAO-ILO.pdf

Table 9
Fishery production per fisher or fish farmer by region in 2010

Region	Production[1] per person		
	Capture	Aquaculture	Capture + aquaculture
	(Tonnes/year)		
Africa	2.0	8.6	2.3
Asia	1.5	3.3	2.1
Europe	25.1	29.6	25.7
Latin America and the Caribbean	6.8	7.8	6.9
North America	16.3	183.2	18.0
Oceania	17.0	33.3	18.2
World	**2.3**	**3.6**	**2.7**

[1] Production excludes aquatic plants.

Although 87.3 percent of the world's fishers and fish farmers were in Asia, the region accounted for only 68.7 percent of global production with an average of 2.1 tonnes per person per year in 2010, compared with 25.7 tonnes in Europe, 18.0 tonnes in North America, and 6.9 tonnes in Latin America and the Caribbean. The high productivity of Oceania reflects the contributions mainly of New Zealand and Australia and could be caused by the incomplete statistics provided by many other countries in the region. Production per person is considered to reflect a certain degree of industrialization of fishing activities as well as the relative importance of small-scale operators, especially in Africa and Asia.

The contrast is even more evident for aquaculture production. In 2010, fish farmers in Norway had an average annual production of 187 tonnes per person, while in Chile the corresponding figure was 35 tonnes, in China about 7 tonnes, in India about 4 tonnes, and in Indonesia only about 1 tonne.

As a general global trend, while productivity has dropped slightly from 2.8 to 2.3 tonnes per person in capture production, aquaculture has increased its productivity from 3.1 to 3.6 tonnes per person in the last decade.

Although the information available to FAO does not allow detailed analyses by gender, it is estimated that, overall, women accounted for at least 15 percent of all people directly engaged in the fisheries primary sector in 2010. The proportion of women is considered to be somewhat higher, at least 19 percent, in inland water fishing, and far more important, as high as 90 percent, in secondary activities, such as processing.

As in other sectors, child labour is a cause for concern in the fisheries and aquaculture sector. Therefore, together with other organizations, FAO is working to address this issue (Box 3).

The fisheries and aquaculture sector provides numerous jobs in ancillary activities in addition to fishers and fish farmers, such as processing, packaging, marketing and distribution, manufacturing of fish processing equipment, net and gear making, ice production and supply, boat construction and maintenance. Other people are involved in research, development and administration linked with the fisheries sector. Assuming that for each person directly engaged in fisheries production in 2010 about three to four related jobs were generated in secondary activities, and further assuming that, on average, each jobholder provided for three dependants or family members, then fishers, fish farmers and those supplying services and goods to them would have assured the livelihoods of about 660–820 million people, or about 10–12 percent of the world's population.

THE STATUS OF THE FISHING FLEET

Coverage and quality of data

In 2011, FAO obtained data on national fishing fleets from 138 countries, accounting for 67 percent of the countries involved in capture fisheries. When considering the catch amount together with corresponding fleet size, it is estimated that the reported information accounts for 96 percent of the global fishing fleet. While FAO has estimated the fleet size for another 49 countries for the analysis in this section, no estimation has been made for the remaining 18 countries for which data have never been reported or estimated and whose contribution to the global fishing fleet is considered to be negligible.

Depending on countries, national reports on fleet status may be based on national fishing vessel registers and administrative records that reflect the physical existence of vessels and often include vessels not actually engaged in fishing operations in a certain year. Even for the countries whose statistics correspond to active fishing vessels, there is no information about the extent of their engagement in fishing activities, e.g. full-time, part-time, or occasional. This means that the "fleet size" referred to in this section is only a rough estimate and should not be considered as an indicator for either global fishing capacity or global fishing effort, which in principle should be substantially smaller than those indicated here.

At the same time, data quality varies widely by country from well-maintained, long time series of consistent data to very fragmented records. In general, the data available for marine fishing fleets are of better quality and detail than that available for vessels deployed in inland waters. Moreover, small boats are often not well covered as frequently they are not subject to compulsory registration, especially those used in inland waters.

This year, for the first time, an attempt has been made to separate, to the extent possible, the marine fishing fleet from the fleet operating in inland waters.

Estimate of global fleet and its regional distribution

The total number of fishing vessels in the world was estimated to be about 4.36 million vessels in 2010, a value similar to the previous estimates. The fleet in Asia was the largest, consisting of 3.18 million vessels accounting for 73 percent of the global fleet, followed by Africa (11 percent), Latin America and the Caribbean (8 percent), North America (3 percent) and Europe (3 percent).

Among the global fleet, 3.23 million vessels (74 percent) were considered to operate in marine waters, with the remaining 1.13 million vessels operating in inland waters. The separation between inland and marine fishing fleets was made based on: (i) national reported statistics with sufficient details (e.g. China, Indonesia, and Japan); and (ii) allocation of whole fleets of landlocked countries to inland waters (e.g. Burkina Faso, Burundi, Chad, Kazakhstan, Malawi, Mali, Niger, Uganda, Uzbekistan and Zambia).

This preliminary analysis indicated that the inland fleet represents about 26 percent of the global fleet, but the proportion of vessels operating in inland waters varies substantially depending on the regions (Figure 13), the highest being in Africa (42 percent), followed by Asia (26 percent) and Latin America and the Caribbean (21 percent). Although preliminary, this resolves past confusion as to whether the inland-water operating component was included or excluded in the overall fleet analysis. Further work would be needed to disaggregate components operating specifically in the African Great Lakes.

Globally, 60 percent of fishing vessels were engine-powered in 2010. While 69 percent of vessels operating in marine waters were motorized, the corresponding value for those operating in inland waters was only 36 percent. For the fleet operating in marine waters, there were also large variations among regions, with non-motorized vessels accounting for less than 7 percent of the total in Europe and the Near East, but up to 61 percent in Africa (Figure 14). Although North America has

Figure 13

Proportion of fishing vessels in marine and inland waters by region in 2010

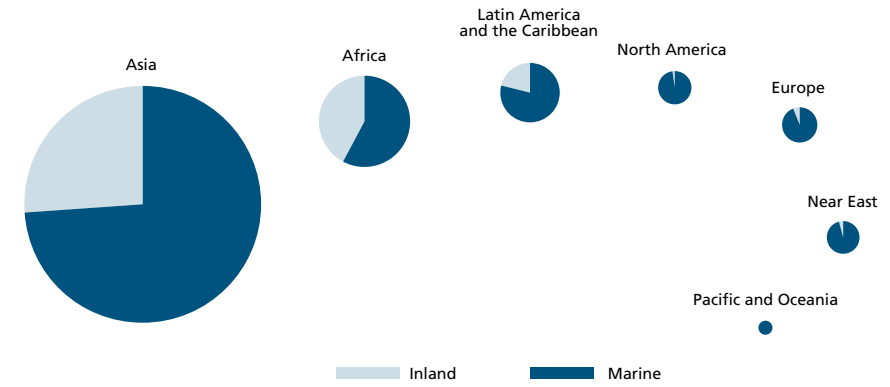


Figure 14

Proportion of marine fishing vessels with and without engine by region in 2010

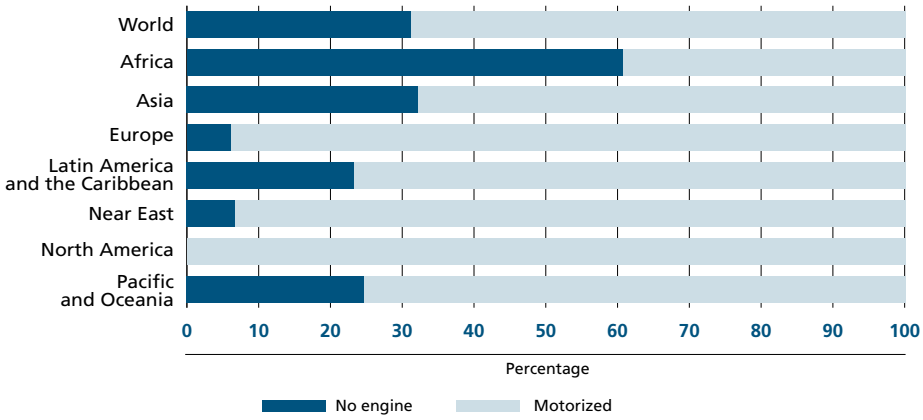
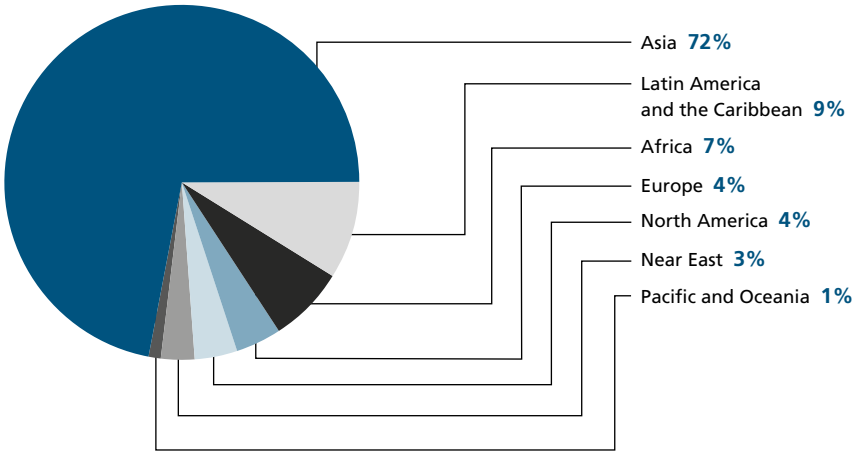


Figure 15

Distribution of motorized fishing vessels by region in 2010



no report of non-motorized vessels, this could be a reflection of the data collection systems in use there.

Globally, the motorized fishing fleet is distributed unevenly among regions. The vast majority of motorized vessels (72 percent) were reported from Asia (Figure 15), with the rest from Latin America and the Caribbean (9 percent), Africa (7 percent), North America (4 percent), and Europe (4 percent).

Size distribution and the importance of small boats

In 2010, more than 85 percent of the motorized fishing vessels in the world were less than 12 m LOA. Such vessels dominated in all regions, particularly the Near East, and Latin America and the Caribbean (Figure 16). About 2 percent of all motorized fishing vessels corresponded to industrialized fishing vessels of 24 m and larger (with a GT of roughly more than 100 GT) and that fraction was larger in the Pacific and Oceania region, Europe, and North America. A segment of the industrialized fishing fleet mentioned above is registered with unique identification numbers provided by the International Maritime Organization (IMO), whose list included more than 22 000 active fishing vessels by the end of 2010.

While the bulk of the global fishing fleet is composed of small-sized vessels (less than 12 m LOA), this is the component for which reliable information is least available. Such is particularly the case in Africa, parts of Asia and the Americas. In many cases, vessels smaller than a certain size are not subject to national registration or are only subject to local registries that might not be reflected in national statistics. In addition, fishing fleets operating in inland waters usually consist mostly of vessels of less than 12 m LOA, which are commonly not subject to either national or local registries and are often omitted from most analyses, particularly in developing countries. Therefore, estimations of the relative importance of the small-scale and industrial components of fisheries for social, economic, and food security purposes are then likely to be skewed owing to inadequate appraisal of the small-scale segment. In Africa, and in Latin America and the Caribbean, small vessels constitute a vast sector of artisanal and subsistence fisheries on which the livelihoods of a great number of fisher households depend.

Table 10 illustrates some examples of the relevance of small motorized vessels for selected countries in different regions. The proportion of vessels of less than 12 m LOA exceeds 90 percent in most cases. In addition, an estimated 98 percent of non-motorized fishing vessels would be less than 12 m LOA.

Figure 16

Size distribution of fishing vessels by region in 2010

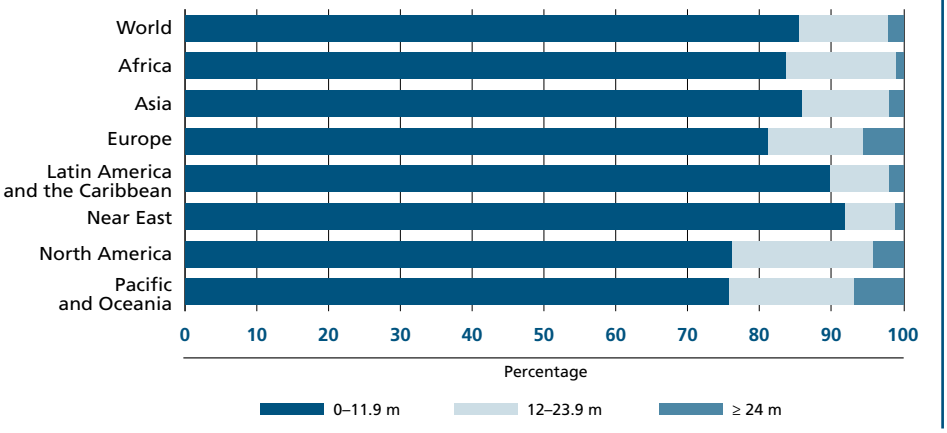


Table 10
Proportion in terms of length of motorized vessels in fishing fleets from selected nations in different regions

Flag	Date of data	Powered vessels	Vessel length category		
			0–11.9 m	12–23.9 m	≥ 24 m
		(Number)		(Percentage)	
Angola[1]	2009	7 767	95.00	4.70	0.30
Cameroon[1]	2009	8 669	82.90	16.50	0.60
Mauritius[1]	2010	1 474	98.20	1.20	0.60
Morocco[1]	2010	19 207	89.70	8.80	1.50
Tunisia[1]	2010	5 705	75.20	20.00	4.80
Subtotal for selected countries in Africa		**42 822**	**87.90**	**9.00**	**3.10**
Bahrain[1]	2010	2 727	90.40	9.60	0.00
Oman[1]	2010	15 349	96.50	3.20	0.30
Syrian Arab Republic[1]	2010	1 663	95.60	4.00	0.40
Subtotal for selected countries in Near East		**19 739**	**95.60**	**4.10**	**0.30**
Bangladesh[1]	2010	21 097	99.20	0.20	0.70
China					
China (marine)[2]	2010	204 456	68.60	20.60	10.80
China (inland)[2]	2010	226 535	88.50	11.10	0.40
Taiwan Province of China[1]	2009	20 654	67.00	24.00	8.90
Myanmar[1]	2010	15 865	88.10	8.40	3.60
Republic of Korea[1]	2010	74 669	90.40	7.60	2.00
Subtotal for selected countries in Asia		**563 276**	**81.10**	**14.10**	**4.80**
EU-27, selected countries in Europe[3]	**2010**	**78 138**	**82.20**	**13.70**	**4.10**
Fiji[1]	2010	2 185	96.90	1.40	1.60
French Polynesia[1]	2010	3 429	98.20	1.70	0.10
New Caledonia[1]	2010	318	93.40	4.70	1.90
New Zealand[1]	2010	1 401	61.20	32.20	6.60
Tonga[1]	2010	951	98.30	1.30	0.40
Subtotal for selected countries in Oceania		**8 284**	**91.50**	**6.80**	**1.70**

[1] Response to FAO questionnaires.
[2] Bureau of Fisheries, Ministry of Agriculture. 2011. *China Fishery Statistical Yearbook 2011*. Beijing.
[3] European Commission. 2012. Fleet Register On the NeT. In: *Europa* [online]. [Cited 13 April 2012]. http://ec.europa.eu/fisheries/fleet/index.cfm?method=Download.menu

Continuous efforts are being made in Africa (in collaboration with regional and subregional fisheries organizations such as the Fishery Committee for the Eastern Central Atlantic [CECAF], Regional Fisheries Committee for the Gulf of Guinea, Fishery Committee for the West Central Gulf of Guinea, and Southwest Indian Ocean Fisheries Commission [SWIOFC]) as well as in Central America (in collaboration with the Organization of Fishing and Aquaculture in Central America) to establish vessel registers as part of fishery resources management plans and policies. Frame surveys and fisheries censuses have already yielded invaluable information, but it may require some time before reflect the results of these efforts are reflected in the official statistics.

Effect of efforts to reduce overcapacity in fishing fleets

In response to the International Plan of Action for the Management of Fishing Capacity, several countries have tried establishing targets for the reduction of national overcapacity of fishing fleets. While the numbers of fishing vessels have been decreasing in some parts of the world in recent years, they have being increasing elsewhere.

Table 11
Motorized fishing fleets in selected countries, 2000–2010[1]

	2000	2005	2007	2008	2009	2010
CHINA						
All fisheries vessels[2]						
number	487 297	513 913	576 996	630 619	672 633	675 170
tonnage GT	6 849 326	7 139 746	7 806 935	8 284 092	8 595 260	8 801 975
power kW[3]	14 257 891	15 861 838	17 648 120	19 507 314	20 567 968	20 742 025
Marine fishing only						
number	–	–	207 353	199 949	206 923	204 456
tonnage GT	–	–	5 527 675	5 776 472	5 838 599	6 010 919
power kW	–	–	12 394 224	12 950 657	13 058 326	13 040 623
Inland fishing only						
number	–	–	172 836	216 571	223 912	226 535
tonnage GT	–	–	835 625	936 774	1 027 500	1 044 890
power kW	–	–	1 940 601	2 908 697	3 382 505	3 473 648
JAPAN						
Marine fishing only						
number	337 600	308 810	296 576	289 456	281 742	–
tonnage GT	1 447 960	1 269 130	1 195 171	1 167 906	1 112 127	–
power kW	11 450 612	12 271 130	12 662 088	12 861 317	12 945 101	–
Inland fishing only						
number	9 542	8 522	8 199	8 422	8 156	–
tonnage GT	9 785	8 623	8 007	8 261	7 978	–
power kW	180 930	209 257	198 098	220 690	219 443	–
EU-15[4]						
number	86 660	77 186	74 597	72 528	72 011	71 295
tonnage GT	2 019 329	1 832 362	1 750 433	1 694 280	1 654 283	1 585 288
power kW	7 632 554	6 812 255	6 557 295	6 343 379	6 243 802	6 093 335
ICELAND						
number	1 993	1 752	1 642	1 529	1 582	1 625
tonnage GT	180 150	181 530	169 279	159 627	158 253	152 401
power kW	522 876	520 242	502 289	471 199	472 052	466 691
NORWAY						
number	13 017	7 722	7 038	6 785	6 510	6 310
tonnage GT	392 316	373 282	354 833	363 169	367 688	366 126
power kW	1 321 624	1 272 965	1 249 173	1 240 450	1 252 813	1 254 129
REPUBLIC OF KOREA						
number	89 294	87 554	82 796	78 280	75 247	74 669
tonnage GT	917 963	697 956	661 519	619 098	592 446	598 367
power kW	10 139 415	9 656 408	10 702 733	9 755 438	9 955 334	9 953 809

[1] Some vessels may not be measured according to the 1969 International Convention on Tonnage Measurement of Ships.
[2] Includes all vessels involved in the fisheries sector, such as capture, aquaculture, support and surveillance, in both inland and marine waters.
[3] All power units standardized to kW.
[4] Combined fleets from Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, Spain, Sweden and United Kingdom.
Sources:
China: Bureau of Fisheries, Ministry of Agriculture. 2011. *China Fishery Statistical Yearbook 2011*. Beijing.
Japan: Fisheries Agency, Government of Japan. 2009. *Statistical Tables of Fishing Vessels*. General Report No. 62.
EU-15: European Commission. 2012. Fleet Register On the NeT. In: Europa [online]. [Cited 13 April 2012]. http://ec.europa.eu/fisheries/fleet/index.cfm?method=Download.menu; and European Commission. 2012. Main tables. In: *Eurostat* [online]. [Cited 13 April 2012]. http://epp.eurostat.ec.europa.eu/portal/page/portal/fisheries/data/main_tables
Iceland: Response to FAO questionnaires; European Commission. 2012. Main tables. In: *Eurostat* [online]. [Cited 13 April 2012]. http://epp.eurostat.ec.europa.eu/portal/page/portal/fisheries/data/main_tables; and Statistics Iceland. 2012. Fishing vessels. In: *Statistics Iceland* [online]. [Cited 13 April 2012]. www.statice.is/Statistics/Fisheries-and-agriculture/Fishing-vessels
Norway: Response to FAO questionnaires; European Commission. 2012. Main tables. In: *Eurostat* [online]. [Cited 13 April 2012]. http://epp.eurostat.ec.europa.eu/portal/page/portal/fisheries/data/main_tables; and Statistics Norway. 2012. Fisheries. In: *Statistics Norway* [online]. [Cited 13 April 2012]. http://statbank.ssb.no/statistikkbanken/Default_FR.asp?PXSid=0&nvl=true&PLanguage=1&tilside=selecttable/hovedtabellHjem.asp&KortnavnWeb=fiskeri
Republic of Korea: Response to FAO questionnaires, national authorities.

When considering measures to limit fleet capacity, decisions will have to evaluate relative contributions and, therefore, the priority in capacity reduction of the industrial component and the small-scale component. When deciding on such policies, many nations are faced with difficult dilemmas, as not only fishery resources but also social and economic issues are at stake.

Data from some countries indicate a continuous expansion of their fleets. For example, the motorized fishing fleet in Cambodia increased by 19 percent from 38 960 vessels in 2007 to 46 427 in 2009. Indonesia's motorized marine fleet increased by 11 percent from 348 425 fishing vessels in 2007 to 390 770 in 2009. Viet Nam reported a 10 percent increase in offshore fishing vessels (those with engines of more than 90 hp) from a total of 22 729 in 2008 to 25 346 in 2010, and Malaysia reported a 26 percent increase from 24 048 licensed motorized fishing vessels in 2007 to 30 389 in 2009. The case of Sri Lanka illustrates the potential overshoot in efforts to re-establish a fishing fleet partly destroyed by the tsunami that swept the region at the end of 2004. The pre-tsunami fishing fleet numbered 15 307 motorized vessels, which according to official reports was reduced to about 6 700 vessels (a 44 percent reduction) by the tsunami. By 2007, the fishing fleet numbered 23 400 and by 2010 had increased even further to 25 973 motorized fishing vessels; a net increase of 11 percent for the whole period.

Table 11 provides summary details of motorized fleets for several major fishing nations. In 2008–2010, the combined total captures of these countries represented about 33 percent of the world total capture.

China's 2003–2010 marine fishing vessel reduction plan was aimed at achieving a marine fishing fleet of 192 390 vessels with a total combined power of 11.4 million kW. The statistics available indicate that, up to 2008, China did achieve a reduction with 199 949 vessels and 12.95 million kW, still short of the target by about 4 percent for the number of vessels and 13 percent for combined power. However, after 2008, both the number of vessels and total combined power started to increase again.

Japan implemented various schemes in order to reduce its fishing fleet, which resulted in a net reduction of 9 percent in the number of vessels, but a net increase of 5 percent in combined power between 2005 and 2009. In fact, while the number of vessels declined, the mean engine power conversely increased, from 40 kW to 46 kW in the same period.

The restructuring of the European fishing fleet to achieve a sustainable balance between the fleet and the available fishery resources has been a major goal of European Union policies. The evolution in the combined number, tonnage, and power of European Union fishing vessels indicates a downward tendency in the last decade. The combined EU-15 motorized fishing fleet achieved a net reduction of 8 percent in number of vessels, and of 11 percent in power between 2005 and 2010. For this same period, mean engine power also decreased slightly from 88 kW to 85 kW.

Other examples of net reduction in fleet for important fishing nations in the period 2005–2010 include Iceland (with a net reduction of 7 percent in the number of vessels and 10 percent in total combined power) and Norway (with a net reduction of 18 percent in the number of vessels but a mere 1.5 percent decrease in total combined power, and increased mean engine power from 165 kW to 199 kW. In a different region, the Republic of Korea achieved a net reduction of 15 percent in the number of vessels but a 3 percent increase in combined power, resulting in the mean engine power increasing from 110 kW to 133 kW for the same period.

THE STATUS OF FISHERY RESOURCES

Marine fisheries

The world's marine fisheries have experienced different stages, increasing from 16.8 million tonnes in 1950 to a peak of 86.4 million tonnes in 1996, and then declining to stabilize at about 80 million tonnes, with interannual fluctuations. Global recorded production was 77.4 million tonnes in 2010. Of the marine areas (Figure 17), the Northwest Pacific had the highest production with 20.9 million tonnes

(27 percent of the global marine catch) in 2010, followed by the Western Central Pacific with 11.7 million tonnes (15 percent), the Northeast Atlantic with 8.7 million tonnes (11 percent), and the Southeast Pacific, with a total catch of 7.8 million tonnes (10 percent).

The proportion of non-fully exploited[7] stocks has decreased gradually since 1974 when the first FAO assessment was completed (Figure 18). In contrast, the percentage of overexploited stocks increased, especially in the late 1970s and 1980s, from 10 percent in 1974 to 26 percent in 1989. After 1990, the number of overexploited stocks continued to increase, albeit at a slower rate. The fraction of fully exploited stocks demonstrates the smallest change over time. Its percentage was stable at about 50 percent from 1974 to 1985, then dropped to 43 percent in 1989 before gradually increasing to 57.4 percent in 2009.

By definition, the fully exploited stocks produce catches that are at or very close to their maximum sustainable production. Therefore, they have no room for further expansion in catch, and may even be at some risk of decline unless properly managed. Among the remaining stocks, 29.9 percent were overexploited, and 12.7 percent non-fully exploited in 2009. Overexploited stocks produce lower yields than their biological and ecological potential. They require strict management plans to rebuild stock abundance and restore full and sustainable productivity. The Johannesburg Plan of Implementation that resulted from the World Summit on Sustainable Development (Johannesburg, 2002) demands that all these stocks be restored to the level that can produce maximum sustainable yield by 2015.[8] The non-fully exploited stocks are under relatively low fishing pressure and have some potential to increase their production. However, these stocks often do not have a high production potential. The potential for increase in catch may be generally limited. Nevertheless, proper management plans should be established before increasing the exploitation rate of these non-fully exploited stocks in order to avoid following the same track of overfishing as many currently overexploited stocks.

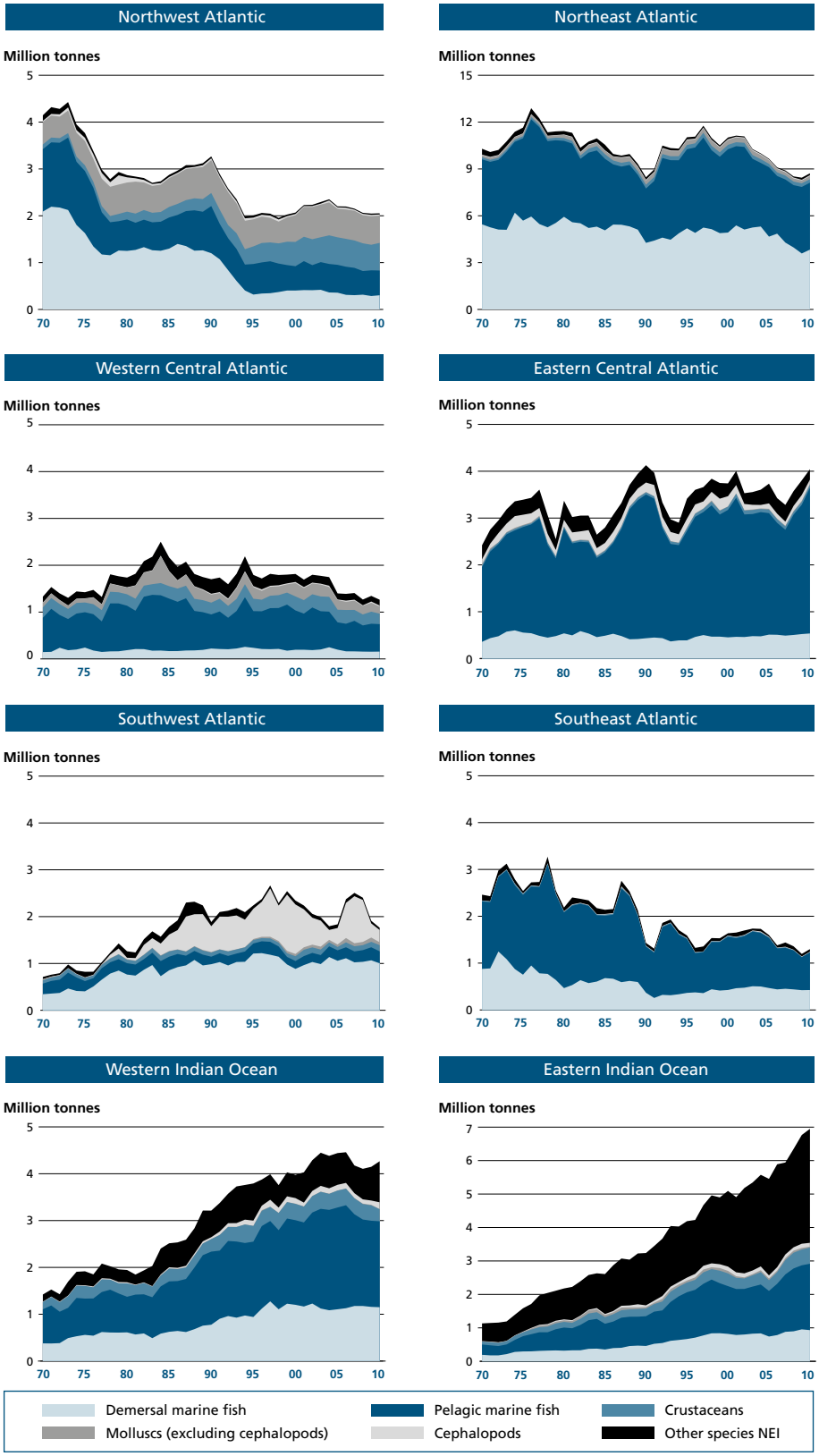
Most of the stocks of the top ten species, which account in total for about 30 percent of the world marine capture fisheries production, are fully exploited and, therefore, have no potential for increases in production, while some stocks are overexploited and increases in their production may be possible if effective rebuilding plans are put in place. The two main stocks of anchoveta in the Southeast Pacific, Alaska pollock (*Theragra chalcogramma*) in the North Pacific and blue whiting (*Micromesistius poutassou*) in the Atlantic are fully exploited. Atlantic herring (*Clupea harengus*) stocks are fully exploited in both the Northeast and Northwest Atlantic. Japanese anchovy (*Engraulis japonicus*) in the Northwest Pacific and Chilean jack mackerel (*Trachurus murphyi*) in the Southeast Pacific are considered to be overexploited. Chub mackerel (*Scomber japonicus*) stocks are fully exploited in the Eastern Pacific and the Northwest Pacific. The largehead hairtail (*Trichiurus lepturus*) was estimated in 2009 to be overexploited in the main fishing area in the Northwest Pacific.

The total catch of tuna and tuna-like species was about 6.6 million tonnes in 2010. The principal market tuna species – albacore, bigeye, bluefin (three species), skipjack and yellowfin – contributed 4.3 million tonnes, maintaining approximately the same level since 2002. About 70 percent of these catches were from the Pacific. The skipjack was the most productive principal market tuna, contributing about 58 percent, and the yellowfin and bigeye were the other two productive species, contributing about 27 and 8 percent, respectively, to the 2010 catch of principal tunas. Bigeye, Atlantic bluefin, Pacific bluefin, southern bluefin and yellowfin tunas have all shown a gradual decline in catch after reaching historical peaks.

Among the seven principal tuna species, one-third were estimated to be overexploited, 37.5 percent were fully exploited, and 29 percent non-fully exploited in 2009. Although skipjack tuna continued its increasing trend up to 2009, further expansion should be closely monitored, as it may negatively affect bigeye and yellowfin tunas (multispecies fisheries). Only for very few stocks of the principal tuna species is their status unknown or very poorly known. In the long term, the status of tuna

Figure 17

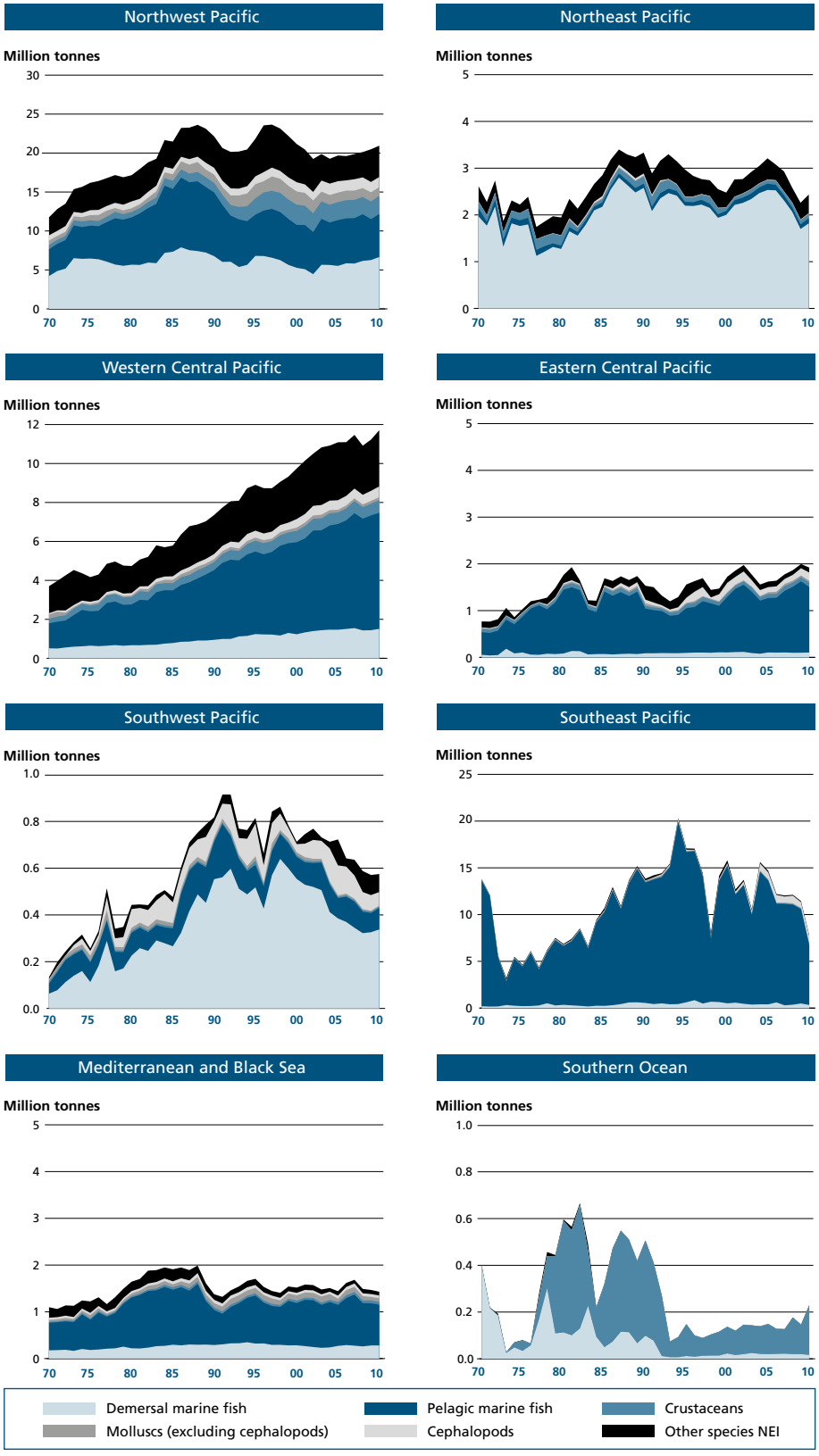
Capture fisheries production in marine areas



(Continued)

Figure 17 *(cont.)*

Capture fisheries production in marine areas



Note: NEI = not elsewhere included.

stocks (and consequently catches) may further deteriorate unless there are significant improvements in their management. This is because of the substantial demand for tuna and the significant overcapacity of tuna fishing fleets.

The concern about the poor status of some bluefin stocks and the inability of some tuna management organizations to manage these stocks effectively led to a proposal by Monaco in 2010 to ban the international trade in Atlantic bluefin tuna under CITES. Although it was hardly disputed that the stock status of this high-value food fish met the biological criteria for listing on CITES Appendix I, the proposal was ultimately rejected. Many parties that opposed the listing stated that in their view the International Commission for the Conservation of Atlantic Tunas (ICCAT) was the appropriate body for management of such an important commercially exploited aquatic species.

World marine fisheries have gone through significant changes since the 1950s. Accordingly, the exploitation level of fish resources and their landings have also varied over time. The temporal pattern of landings differs from area to area depending on the level of urban development and changes that countries surrounding that area have experienced. In general, they can be divided into three groups, i.e. one characterized by oscillations in the catches, another by an overall declining trend following historical peaks, and a third with increasing catch trends.

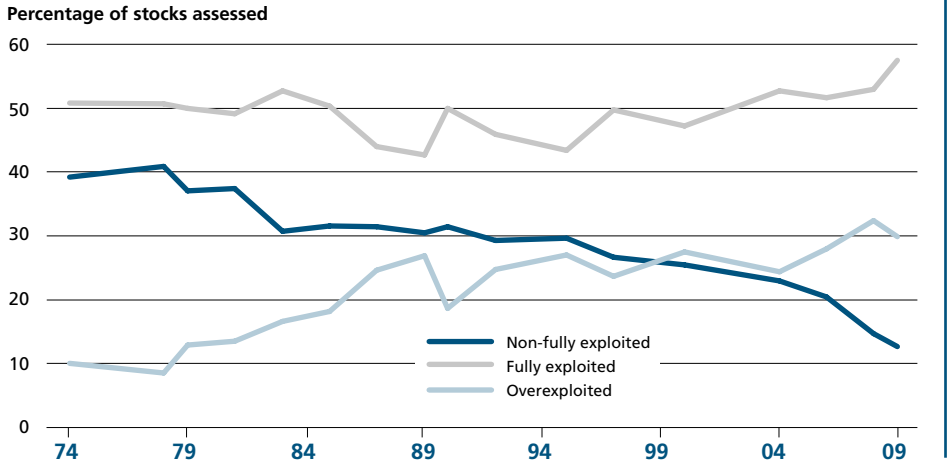
The first group includes those FAO areas that have demonstrated oscillations in total catch (Figure 17), i.e. the Eastern Central Atlantic (Area 34), Northeast Pacific (Area 67), Eastern Central Pacific (Area 77), Southwest Atlantic (Area 41), Southeast Pacific (Area 87), and Northwest Pacific (Area 61). These areas have provided about 52 percent of the world's total marine catch on average in the last five years. Several of these areas include upwelling regions that are characterized by high natural variability.

The second group consists of areas that have demonstrated a decreasing trend in catch since reaching a peak at some time in the past. This group has contributed 20 percent of global marine catch on average in the last five years, and includes the Northeast Atlantic (Area 27), Northwest Atlantic (Area 21), Western Central Atlantic (Area 31), Mediterranean and Black Sea (Area 37), Southwest Pacific (Area 81), and Southeast Atlantic (Area 47). It should be noted that lower catches in some cases reflect fisheries management measures that are precautionary or aim at rebuilding stocks, and this situation should, therefore, not necessarily be interpreted as negative.

The third group comprises the FAO areas that have shown continuously increasing trends in catch since 1950. There are only three areas in this group: Western Central

Figure 18

Global trends in the state of world marine fish stocks since 1974



Pacific (Area 71), Eastern (Area 57) and Western Indian Ocean (Area 51). They have contributed 28 percent of the total marine catch on average over the last five years. However, in some regions, there is still high uncertainty about the actual catches owing to the poor quality of statistical reporting systems in coastal countries.

The Northwest Pacific has the highest production among the FAO statistical areas. Its total catch fluctuated between about 17 and 24 million tonnes in the 1980s and 1990s, and was about 21 million tonnes in 2010. Small pelagics are the most abundant category in this area, with the Japanese anchovy providing 1.9 million tonnes in 2003 but having since declined to about 1.1 million tonnes in 2009 and 2010. Other important contributors to the total catch in the area are the largehead hairtail, considered overexploited, and the Alaska pollock and chub mackerel, both considered fully exploited. Squids, cuttlefish and octopuses are important species, yielding 1.3 million tonnes in 2010.

The Eastern Central Pacific has shown a typical oscillating pattern in its total catch since 1980 and produced about 2 million tonnes in 2010. The Southeast Pacific has had a large interannual variation with a generally declining trend since 1993. There have been no major changes in the state of exploitation of stocks in these two areas, which are characterized by a large proportion of small pelagic species and great fluctuations in catches. The most abundant species in the Southeast Pacific are the anchoveta, the Chilean jack mackerel and the South American pilchard or sardine (*Sardinops sagax*), accounting for more than 80 percent of the current and historical catches, while in the Eastern Central Pacific the most abundant species are California pilchard and Pacific anchoveta. A moderate El Niño developed in 2009 and continued throughout the equatorial Pacific in the first few months of 2010. Deep tropical convection remained enhanced across central and eastern parts of the tropical Pacific with relatively mild impacts reported on the state of stocks and fisheries in the eastern Pacific.

For the Eastern Central Atlantic, total catches, which have fluctuated since the 1970s, were about 4 million tonnes in 2010, about the same as the 2001 peak. The small pelagic species constitute almost 50 percent of the landings, followed by "miscellaneous coastal fishes". The single most important species in terms of landings is sardine (*Sardina pilchardus*) with landings in the range of 600 000–900 000 tonnes in the last ten years. The sardine in Zone C (Cape Bojador and southwards to Senegal) is still considered non-fully exploited; otherwise, most of the pelagic stocks are considered fully exploited or overexploited, such as the sardinella stocks in Northwest Africa and in the Gulf of Guinea. The demersal fish resources are to a large extent fully exploited to overexploited in most of the area, and the white grouper stock (*Epinephelus aenus*) in Senegal and Mauritania remains in a severe condition. The status of some of the deepwater shrimp stocks seems to have improved and they are now considered fully exploited, whereas the other shrimp stocks in the region range between fully exploited and overexploited. The commercially important octopus (*Octopus vulgaris*) and cuttlefish (*Sepia* spp.) stocks remain overexploited. Overall, the Eastern Central Atlantic has 43 percent of its assessed stocks fully exploited, 53 percent overexploited and 4 percent non-fully exploited, a situation warranting attention for improvement in management.

In the Southwest Atlantic, total catches have fluctuated around 2 million tonnes after a period of increasing catches ended in the mid-1980s. Major species such as Argentina hake and Brazilian sardinella are still estimated to be overexploited, although there seem to be some signs of recovery for the latter. The catch of Argentina shortfin squid was only one-fourth of its peak level in 2009 and considered fully exploited to overexploited. In this area, 50 percent of the monitored fish stocks were overexploited, 41 percent fully exploited and the remaining 9 percent considered non-fully exploited.

The Northeast Pacific produced 2.4 million tonnes of fish in 2010, similar to the production level in the early 1970s, although more than 3 million tonnes was seen in the late 1980s. Cods, hakes and haddocks are the largest contributors to its catch.

In this area, only 10 percent of fish stocks were estimated to be overexploited, with 80 percent fully exploited, and another 10 percent non-fully exploited.

In the Northeast Atlantic, total catch appeared to have a decreasing trend after 1975, with a recovery in the 1990s, and was 8.7 million tonnes in 2010. The blue whiting stock decreased rapidly from the peak of 2.4 million tonnes in 2004 to only 0.6 million tonnes in 2009. Fishing mortality has been reduced in cod, sole and plaice, with recovery plans in place for the major stocks of these species. The Arctic cod spawning stock was particularly large in 2008, having recovered from the low levels observed in the 1960s–1980s. Similarly, the Arctic saithe and haddock stocks have increased to high levels, although stocks elsewhere remain fully exploited or overexploited. The largest sand eel and capelin stocks remain overexploited. Concern remains for redfishes and deep-water species for which data are limited and which are likely to be vulnerable to overfishing. Northern shrimp and Norway lobster are generally in good condition, but there are indications that some stocks are being overexploited. Recently, maximum sustainable yield has been adopted as the standard basis for reference points. Overall, 62 percent of assessed stocks are fully exploited, 31 percent overexploited, and 7 percent non-fully exploited.

Although fishery resources in the Northwest Atlantic continue to be under stress from previous and/or current exploitation, some stocks have recently shown signs of renewal in response to an improved management regime in the last decade (e.g. Greenland halibut, yellowtail flounder, Atlantic halibut, haddock, spiny dogfish). However, some historical fisheries such as cod, witch flounder and redfish still evidence lack of recovery, or limited recovery, which may be the result of unfavourable oceanographic conditions and the high natural morality caused by increasing numbers of seals, mackerel and herring. These factors appear to have affected fish growth, reproduction and survival. Conversely, invertebrates remain at near record levels of abundance. The Northwest Atlantic has 77 percent of stocks fully exploited, 17 percent overexploited and 6 percent non-fully exploited.

The Southeast Atlantic is a typical example of the group of areas that has demonstrated a generally decreasing trend in catches since the early 1970s. This area produced 3.3 million tonnes in the late 1970, but only 1.2 million tonnes were recorded in 2009. The important hake resources remain fully exploited to overexploited although there are signs of some recovery in the deepwater hake stock (*Merluccius paradoxus*) off South Africa and of the shallow-water Cape hake (*Merluccius capensis)* off Namibia, as a consequence of good recruitment years and of the strict management measures introduced since 2006. A significant change concerns the Southern African pilchard, which was at a very high biomass and estimated to be fully exploited in 2004, but which now, under unfavourable environmental conditions, has declined considerably in abundance and is now fully exploited or overexploited. In contrast, Southern African anchovy has continued to improve and its status was estimated to be fully exploited in 2009. Whitehead's round herring has not been fully exploited. The condition of Cunene horse mackerel has deteriorated, particularly off Namibia and Angola, and it was overexploited in 2009. The condition of the perlemoen abalone stock continues to be worrying, exploited heavily by illegal fishing, and it is currently overexploited and probably depleted.

The Mediterranean has maintained an overall stable catch in a difficult situation in recent years. All hake (*Merluccius merluccius*) and red mullet (*Mullus barbatus*) stocks are considered overexploited, as are probably also the main stocks of sole and most seabreams. The main stocks of small pelagic fish (sardine and anchovy) are assessed as either fully exploited or overexploited. A newly identified threat is the increasing penetration of exotic Red Sea species, which in some cases seem to be replacing native species, especially in the Eastern Mediterranean. In the Black Sea, the situation of small pelagic fish (mainly sprat and anchovy) has recovered somewhat from the drastic decline suffered in the 1990s, probably as a consequence of unfavourable oceanographic conditions, but they are still considered fully exploited to overexploited, an assessment shared with turbot, while most other stocks are probably fully exploited

to overexploited. In general, the Mediterranean and Black Sea had 33 percent of assessed stocks fully exploited, 50 percent overexploited, and the remaining 17 percent non-fully exploited in 2009.

Total production in the Western Central Pacific grew continuously to a maximum of 11.7 million tonnes in 2010. This area contributes about 14 percent of the global marine production. Despite this catch trend, there are reasons for concern as regards the state of the resources, with most stocks being either fully exploited or overexploited, particularly in the western part of the South China Sea. The high catches have probably been maintained through expansion of the fisheries to new areas and possible double counting in the transshipment of catches between fishing areas, which leads to bias in estimates of production, potentially masking negative trends in stock status.

The Eastern Indian Ocean (Fishing Area 57) is still experiencing a high growth rate in catches, with a 17 percent increase from 2007 to 2010, and now totalling 7 million tonnes. The Bay of Bengal and Andaman Sea regions have seen total catches increase steadily and there are no signs of the catch levelling off. However, a very high percentage (about 42 percent) of the catches in this area are attributed to the category "marine fishes not identified", which is a cause of concern as regards the need for monitoring stock status and trends. Increased catches may in fact be due to the expansion of fishing to new areas or species. Declining catches in the fisheries within Australia's EEZ can be partly explained by a reduction in effort and in catches following a structural adjustment and a ministerial direction in 2005 aimed at ceasing overfishing and allowing overfished stocks to rebuild. The economics of fishing in this area are expected to improve in the medium and long term, but higher profits can also be expected for individual fishers in the short term because fewer vessels are operating.

In the Western Indian Ocean, total landings reached a peak of 4.5 million tonnes in 2006, but have declined slightly since, and 4.3 million tonnes were reported in 2010. A recent assessment has shown that narrow-barred Spanish mackerel (*Scomberomerus commerson*), a migratory species found in the Red Sea, Arabian Sea, Gulf of Oman, Persian Gulf, and off the coast along Pakistan and India, is overexploited. Catch data in this area are often not detailed enough for stock assessment purposes. However, the Southwest Indian Ocean Fisheries Commission conducted stock assessments for 140 species in its mandatory area in 2010 based on best-available data and information. Overall, 65 percent of fish stocks were estimated to be fully exploited, 29 percent overexploited, and 6 percent non-fully exploited in 2009.

The declining global catch over the last few years together with the increased percentage of overexploited fish stocks and the decreased proportion of non-fully exploited species around the world convey a strong message – the state of world marine fisheries is worsening and has had a negative impact on fishery production. Overexploitation not only causes negative ecological consequences, but it also reduces fish production, which further leads to negative social and economic consequences. To increase the contribution of marine fisheries to the food security, economies and well-being of the coastal communities, effective management plans must be put in place to rebuild overexploited stocks. The situation seems more critical for some highly migratory, straddling and other fishery resources that are exploited solely or partially in the high seas. The United Nations Fish Stocks Agreement that entered into force in 2001 should be used as a legal basis for management measures of the high seas fisheries.

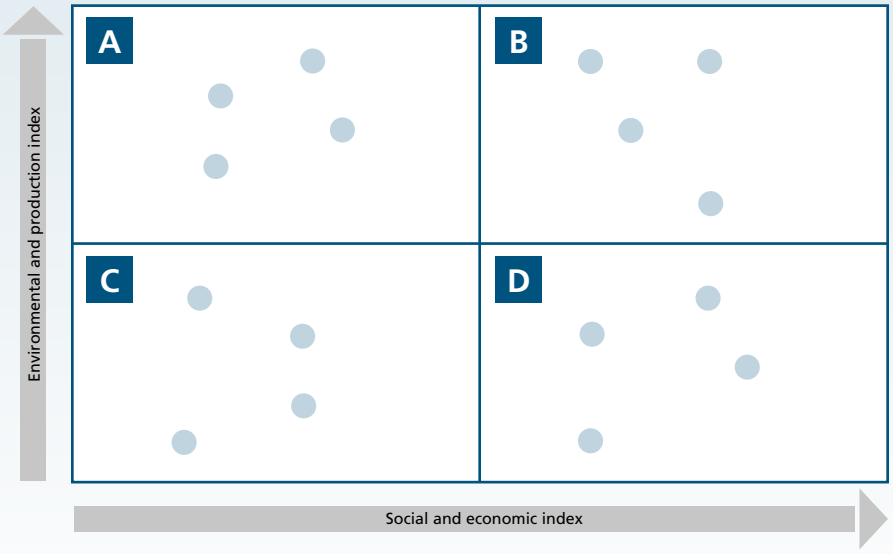
In spite of the worrisome global situation of marine capture fisheries, good progress is being made in reducing exploitation rates and restoring overexploited fish stocks and marine ecosystems through effective management actions in some areas. In the United States of America, the Magnuson–Stevens Act and subsequent amendments have created a mandate to put overfished stocks into restoration; 67 percent of all stocks are now being sustainably harvested, while only 17 percent are still being overexploited. In New Zealand, 69 percent of stocks are above management targets, reflecting mandatory rebuilding plans for all fisheries that are still below target thresholds. Similarly, Australia reports overfishing for only 12 percent of stocks in 2009.[9] Since the 1990s, the Newfoundland–Labrador Shelf, the Northeast United

Box 4

Developing an assessment strategy for inland fishery resources

An accurate assessment of inland fishery resources must take into account the numerous aspects and drivers that influence the health of inland aquatic ecosystems and the status of inland fishery resources. Given the multiple uses of freshwater, it is recognized that an assessment of inland fishery resources should be based on more than just the amount of catch and the effort applied. The assessment should determine whether or not the management goals for the fishery or waterbody are being met. In general, the goals of responsible inland fisheries include an environmental component, e.g. production and protection of biodiversity, and a social and economic component, e.g. poverty reduction, income generation, and cultural heritage. Thus, rather than a single dimensional plot of status of exploitation rate, inland fisheries could be plotted on multidimensional axes that examine environmental and production parameters in the light of social and economic parameters. In the accompanying figure, specific inland capture fisheries (●) are assigned to a given quadrant (A, B, C or D) depending on how they perform according to environmental and production parameters (y-axis) and social and economic parameters (x-axis). Fisheries in quadrant B would be performing well on both environmental/production and social/economic criteria, whereas fisheries in quadrant C would be performing poorly. Individual fisheries could be tracked over time to determine how the state of the fishery was changing and whether changes to management are indicated. For example, a highly productive fishery that provided very little economic value would be placed in quadrant A; a very lucrative recreational fishery that focused on a few high-value species that were stocked from aquaculture facilities would be placed in D.

Conceptual diagram of assessment of the status of inland capture fisheries



For such an assessment, it will be necessary to develop appropriate indicators (i.e. data requirements) in order to create indices that can be expressed in a simple and effective graph. The objective would be to examine the services provided by inland fisheries over time to assess whether or not the fishery was performing as desired. The services provided by inland fisheries are similar to the ecosystem services provided by inland water ecosystems (see accompanying table). Specific services provided by inland capture fisheries could also be seen as management objectives. It is not expected that indices would be developed to encompass the complete range of services provided by inland capture fisheries. Additional work will be needed to prioritize data requirements and develop indicators that are informative, practical and cost-effective.

Ecosystem services provided by inland capture fisheries

Ecosystem service type	Specific service provided by inland capture fisheries
Provisioning	Food provision – extraction of aquatic organisms for human consumption and nutrition Livelihood provision – contribution to employment and income, including recreational and ornamental fisheries Aquaculture seed provision – inputs to aquaculture for grow-out
Cultural and scientific	Cultural heritage and identity – value associated with freshwater fisheries themselves Recreational fisheries – the non-commercial perspective Cognitive values – education and research resulting from the fisheries Catch composition and species as bio-indicators of health of ecosystem
Regulation	Regulation of food web dynamics Nutrient transport and cycling Control of pest organisms
Support	Maintenance of genetic, species and ecosystem biodiversity Resilience and resistance – life support by the freshwater environment and its response to pressures, including maintenance of ecosystem balance

The specific data requirements, indicators and indices for this assessment have not yet been established. However, together with partners and resource managers, FAO will work on refining the model and test its applicability in selected inland fisheries around the world.

States Shelf, the Southern Australian Shelf, and California Current ecosystems have shown substantial declines in fishing pressure such that they are now at or below the modelled exploitation rate that gives the multispecies maximum sustainable yield of the ecosystem.[10] It is critically important to understand the key elements of these and other successes and apply them well to other fisheries.

Inland fisheries

The difficulty in assessing the state of inland capture fisheries has been noted in past editions of The State of World Fisheries and Aquaculture as well as by those working on the active management and development of inland fishery resources.[11] Reasons for the lack of adequate assessments include:

- the diffuse nature of the sector, with numerous landing sites and methods of fishing;
- the large number of people involved and the seasonality of fishing effort;
- the subsistence nature of many small-scale inland fisheries;
- the fact that catch is often consumed or traded locally without entering the formal market chain;
- a lack of capacity and resources to collect adequate data;
- activities not associated with inland fishing can greatly influence the abundance of inland fishery resources, e.g. stocking from aquaculture, water diversion for agriculture and hydroelectric development.

The informative and widely cited data summarizing the state of the major marine fish stocks are virtually impossible to duplicate for the state of the world's inland fisheries. The primary reason for this is that whereas exploitation rate is the main driver affecting the state of the major marine stocks that comprise the figure, other drivers affect the status of inland fishery resources to a much greater extent.[12] Drivers associated with habitat quantity and quality, including aquaculture in the form of stocking and competition for freshwater, influence the state of the majority of inland fishery resources much more than exploitation rates do. Water abstraction and diversion, hydroelectric development, draining wetlands, and siltation and erosion from land-use patterns can negatively affect inland fishery resources regardless of the rate of exploitation. Conversely, stock enhancement from aquaculture facilities, which is widely practised in inland waters, can keep catch rates high in the face of increased fishing and in spite of an ecosystem that is not capable of producing that level of catch through natural processes. Overexploitation can also affect inland fishery resources, but the result is generally a change in species composition and not necessarily a reduced overall catch. Catches are often higher where smaller and shorter-lived species become the main component of the catch; however, the smaller fish may be much less valuable.

Another issue complicating the assessment of inland fishery resources is the definition of a "stock". The major marine fish stocks are well defined biologically and geographically, and comprise management units. Very few inland fisheries have stocks that are defined as precisely or are defined at the level of species. There are notable exceptions, e.g. Lake Victoria Nile perch and Tonle Sap dai fisheries, but many inland fishery stocks are defined by watershed or river and comprise numerous species.

Nonetheless, it is vitally important that an accurate assessment be made of those inland fishery resources that are of major importance. The Twenty-eighth Session of COFI observed that data and statistics on small-scale fisheries, especially in inland waters, were not always comprehensive, resulting in underestimating their economic, social and nutritional benefits and contribution to livelihoods and food security.[13] FAO convened a workshop in late 2011 to develop a strategy to undertake such an assessment[14] (Box 4). The intention is to utilize the new methodology to provide a more robust and informative summary of the state of the world's inland capture fishery resources for future editions of *The State of World Fisheries and Aquaculture*.

FISH UTILIZATION AND PROCESSING

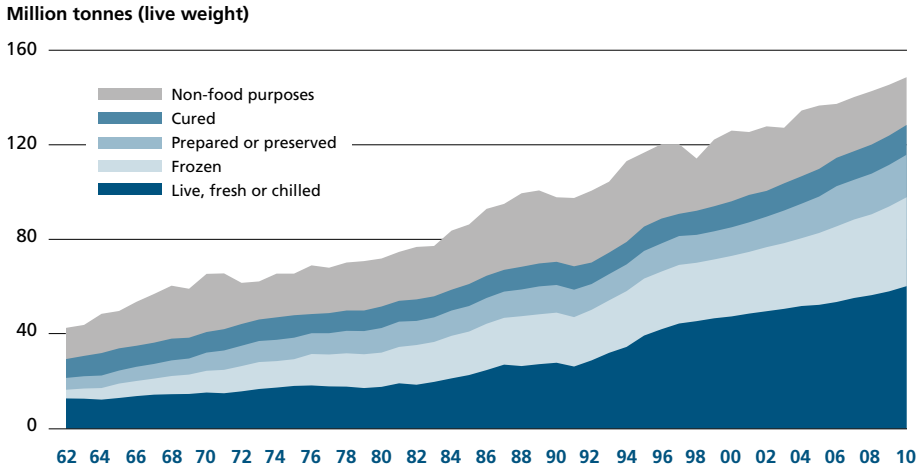
Fishery production is very heterogeneous in terms of its range of species and product forms. Being highly perishable, fish needs timely harvesting and procurement, efficient transportation, and advanced storage, processing and packaging facilities for its marketing. In particular, specific requirements and preservation techniques (Box 5) are needed in order to preserve its nutritional quality, extend its shelf-life, minimize the activity of spoilage bacteria and avoid losses caused by poor handling. Fish is also very versatile as it can be processed into a wide array of products to increase its economic value. It is generally distributed as live, fresh, chilled, frozen, heat-treated, fermented, dried, smoked, salted, pickled, boiled, fried, freeze-dried, minced, powdered or canned, or as a combination of two or more of these forms. Fish can also be preserved by many other methods destined for food or non-edible uses.

In 2010, 40.5 percent (60.2 million tonnes) of world fish production was marketed in live, fresh or chilled forms, 45.9 percent (68.1 million tonnes) was processed in frozen, cured or otherwise prepared forms for direct human consumption, and 13.6 percent destined to non-food uses (Figure 19). Since the early 1990s, there has been an increasing trend in the proportion of fisheries production used for direct human consumption rather than for other purposes. In the 1980s, about 68 percent of the fish produced was destined for human consumption, this share increased to 73 percent in the 1990s, and in 2010 it was more than 86 percent, equalling 128.3 million tonnes. In 2010, 20.2 million tonnes was destined to non-food purposes, of which 75 percent (15 million tonnes) was reduced to fishmeal and fish oil; the remaining 5.1 million tonnes was largely utilized as fish for ornamental purposes, for culture (fingerlings, fry, etc.), for bait, for pharmaceutical uses as well as raw material for direct feeding in aquaculture, for livestock and for fur animals.

In 2010, of the fish destined for direct human consumption, the most important product form was live, fresh or chilled fish, with a share of 46.9 percent, followed by frozen fish (29.3 percent), prepared or preserved fish (14.0 percent) and cured fish (9.8 percent). Freezing represents the main method of processing fish for human consumption, and it accounted for 55.2 percent of total processed fish for human consumption and 25.3 percent of total fish production in 2010. These general data mask significant differences. The utilization of fish and, more significantly, the processing methods vary according to the continent, region, country and even within countries. The highest percentage of fishmeal is produced by Latin American countries (44 percent of the total in 2010). In Europe and North America, fish in frozen and

Figure 19

Utilization of world fisheries production (breakdown by quantity), 1962–2010



Box 5

The work of the Codex Alimentarius Commission

The Codex Alimentarius Commission (CAC) develops Standards, Codes of Practice, and Guidelines in the area of food safety and fair practices in trade. The Standards specify the characteristics of food products, while the Codes of Practice identify the procedures that national competent authorities and operators in the food chain need to follow in order to reach those Standards. The Guidelines identify steps that need to be taken to protect consumers' health from certain specific food hazards. Standards, Codes of Practice and Guidelines are continuously updated, and new sections are added as required.

Recent work by the CAC has led to: (i) adoption of Standards for live and raw bivalve molluscs and fish sauce; (ii) updating of the Code of Practice for Fish and Fishery Products with sections on live and raw bivalve molluscs and smoked fish; and (iii) adoption of Guidelines on the Application of General Principles of Food Hygiene to the Control of Pathogenic *Vibrio* Species in Seafood.

canned forms represents more than two-thirds of fish used for human consumption. Africa has a higher proportion of cured fish (14 percent of total production) than the world average. In Africa, but also significantly in Asia, a large amount of production is commercialized in live or fresh forms. Live fish is particularly appreciated in Asia (especially by the Chinese population) and in niche markets in other countries, mainly among immigrant Asian communities. Commercialization of live fish has grown in recent years as a result of technological developments, improved logistics and increased demand. An elaborate network of handling, transport, distribution, display and holding facilities has been developed to support the marketing of live fish. New technological systems include specially designed or modified tanks and containers, as well as trucks and other transport vehicles equipped with aeration or oxygenation facilities to keep fish alive during transportation or holding and display. Nevertheless, marketing and transportation of live fish can be challenging as they are often subject to stringent health regulations and quality standards. In some parts of Southeast Asia, their commercialization and trade are not formally regulated but based on tradition. However, in markets such as the European Union, live fish have to comply with requirements, *inter alia*, concerning animal welfare during transportation.

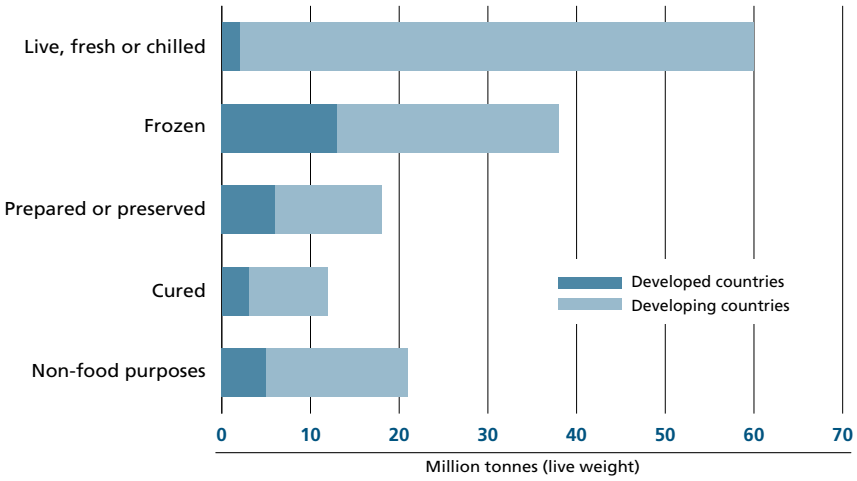
Not only live fish, but, as mentioned above, fish and fishery products must be handled and transported by highly efficient distribution channels that can ensure that the integrity of the produce is maintained. Improvements in packaging help in preserving the quality of products. In the last few decades, major innovations in refrigeration, ice-making and transportation have also allowed the distribution of fish in fresh and other forms. As a result, developing countries have experienced a growth in the share of frozen products (24.1 percent of the total fish for human consumption in 2010, up from 18.9 percent in 2000) and of prepared or preserved forms (11.0 percent in 2010, compared with 7.8 percent in 2000). However, notwithstanding the technical advances and innovations, many countries, especially less-developed economies, still lack adequate infrastructure and services including hygienic landing centres, electric power supply, potable water, roads, ice, ice plants, cold rooms and refrigerated transport. These factors, associated with tropical temperatures, result in a high proportion of post-harvest losses and quality deterioration, with subsequent

risk to the health of consumers. In addition, marketing of fish is also more difficult owing to often limited and congested market infrastructure and facilities. Owing to these deficiencies, together with well-established consumer habits, fish in developing countries is commercialized mainly in live or fresh form (representing 56.0 percent of fish destined for human consumption in 2010) soon after landing or harvesting. Cured forms (dried, smoked or fermented) still remain a traditional method to retail and consume fish in developing countries, even if their share in total fish for human consumption is declining (10.9 percent in 2000 compared with 8.9 percent in 2010). In developed countries, the bulk of production destined to human consumption is commercialized frozen or in prepared or preserved forms. The proportion of frozen fish has been growing in the last four decades: it represented 33.2 percent of total production for human consumption in 1970, increased to 44.8 percent in 1990, to 49.8 percent in 2000, and reached a record high at 52.1 percent in 2010. The share of prepared and preserved forms remained rather stable during the same period and it was 26.9 percent in 2010 (Figure 20).

Fishmeal is the crude flour obtained after milling and drying fish or fish parts, and it is produced from whole fish, fish remains or other fish by-products resulting from processing. Many different species are used for fishmeal and fish-oil production. However, small pelagics, in particular anchoveta, are the main groups of species used for reduction, and the volume of fishmeal and fish oil produced worldwide annually fluctuates according to the fluctuations in the catches of these species. The El Niño phenomenon has considerable effects on catches of anchoveta, which has experienced a series of peaks and drastic drops in the last few decades, going from 12.5 million tonnes in 1994 to 4.2 million tonnes in 2010. Fishmeal production peaked in 1994 at 30.2 million tonnes (live weight equivalent) and has followed a fluctuating trend since then. In 2010, it dropped to 15.0 million tonnes owing to reduced catches of anchoveta, representing a 12.9 percent decrease compared with 2009, of 18.2 percent compared with 2008 and of 42.8 percent with respect to 2000. Another important source of raw material for the production of fishmeal is the processing waste from commercial fish species used for human consumption. Growing value addition in fishery products for human consumption leads to more residues, which in the past very often were simply discarded. Nowadays, more and more waste is used in feed markets, and a growing percentage of fishmeal is being obtained from trimmings and other residues from the preparation of fish fillets. According to recent estimates, about 36 percent of world fishmeal production was obtained from offal in 2010.

Figure 20

Utilization of world fisheries production (breakdown by quantity), 2010



In the past, fishery by-products, including waste, were considered to be of low value, or as a problem to be disposed of in the most convenient way or discarded. In the last two decades, there has been a global trend of growing awareness about the economic, social and environmental aspects of optimal use of fishery by-products, and of the importance of reducing discards and losses in post-harvesting phases (storage, processing and distribution). The utilization of fish by-products has become an important industry in various countries, with a growing focus on handling by-products in a controlled, safe and hygienic way. Improved processing technologies have also helped in their utilization. In addition to the fishmeal industry, fisheries by-products are also utilized for a wide range of other purposes, including the production of cosmetics and pharmaceuticals, other industrial processes, as direct feeding for aquaculture and livestock, incorporation into pet feed or feed for animals kept for fur production, ensiling, fertilizer and landfill. Technologies such as microencapsulation and nanoencapsulation are facilitating incorporation of important nutrients such as fish oils into various other foods. These technologies enable the extension of shelf-life, and provide a taste profile barrier eliminating fish-oil taste and odour while improving the nutritional availability. Chitin and chitosan obtained from shrimp and crab shells have a variety of uses, such as in water treatments, cosmetics and toiletries, food and beverages, agrochemicals and pharmaceuticals. From crustacean wastes, also the pigments carotenoids and astaxanthins can be extracted for use in the pharmaceutical industry, and collagen can be extracted from fish skin, fins and other processing discards. Fish silage and fish protein hydrolysates obtained from fish viscera are finding applications in the pet-feed and fish-feed industries. Calcium carbonate for industrial use can be obtained from mussel shells. In some countries, oyster shells are used as a raw material in the construction of buildings and for the production of quicklime (calcium oxide). Small fish bones, with a minimum amount of meat, are also consumed as snacks in some Asian countries. A number of anticancer agents have been discovered following research on marine sponges, bryozoans and cnidarians. However, following their discovery, for reasons of conservation, these agents are not extracted from marine organisms directly but are chemically synthesized. Another approach being researched is aquaculture of some sponge species. Fish skin, in particular of larger fish, is exploited to obtain gelatin as well as leather to be used in clothing, shoes, handbags, wallets, belts and other items. Species commonly used for leather include shark, salmon, ling, cod, hagfish, tilapia, Nile perch, carp and seabass. Shark cartilage is utilized in many pharmaceutical preparations and reduced in powder, creams and capsules, as are other parts of sharks, e.g. ovaries, brain, skin and stomach. In addition, shark teeth are used in handicrafts; similarly, the shells of scallops and mussels can be used in handicrafts and jewellery, and for making buttons. Procedures for the industrial preparation of biofuel from fish waste as well as from seaweeds are being developed.

Great technological development in food processing and packaging is in progress, with increases in efficient, effective and lucrative utilization of raw materials, and innovation in product differentiation for human consumption as well as for the production of fishmeal and fish oil. Processors of traditional products have been losing market share as a result of long-term shifts in consumer preferences as well as in processing and in the general fisheries industry. The fish industry is dynamic by nature and, in the last two decades, the utilization and processing of fish production have diversified significantly, fuelled by changing consumer tastes and advances in technology, packaging, logistics and transport. In developed countries, innovation in value addition is converging on convenience foods and a wider range of high-value-added products, mainly in fresh, frozen, breaded, smoked or canned forms to be marketed as ready and/or portion-controlled, uniform-quality meals. These require sophisticated production equipment and methods and, hence, access to capital. Supported by cheaper labour, in developing countries, processing is still done through less sophisticated methods of transformation, such as filleting, salting, canning, drying

and fermentation. These traditional labour-intensive, fish-processing methods provide livelihood support to large numbers of people in coastal areas in many developing countries, and they will probably remain important components in rural economies structured to promote rural development and poverty alleviation. However, in the last decade, fish processing has been evolving also in many developing countries, with increased fish processing. This may range from simple gutting, heading or slicing to more advanced value addition, such as breading, cooking and individual quick-freezing, depending on the commodity and market value. Some of these developments are driven by demand in the domestic retail industry, by a shift in cultured species, by outsourcing of processing and by the fact that producers in developing countries are increasingly being linked with, and coordinated by, firms located abroad. Supermarket chains and large retailers are also emerging as important players in setting requirements for the products they buy. Processing is becoming more intensive, geographically concentrated, vertically integrated and linked with global supply chains. These changes reflect the increasing globalization of the fisheries value chain, with large retailers controlling the growth of international distribution channels. The increasing practice of outsourcing processing at the regional and world levels is very significant, its extent depending on the species, product form, and cost of labour and transportation. For example, in Europe, smoked and marinated products, for which shelf-life and transportation time are important, are being processed in Central and Eastern Europe, in particular in Poland and in the Baltic States. Whole frozen fish from European and North American markets are sent to Asia (China in particular, but also India and Viet Nam) for filleting and packaging, and then re-imported. The further outsourcing of production to developing countries might be restricted by sanitary and hygiene requirements that are difficult to meet as well as by growing labour costs.

At the same time, processors are frequently becoming more integrated with producers, especially for groundfish, where large processors in Asia, in part, rely on their own fleet of fishing vessels. In aquaculture, large producers of farmed salmon, catfish and shrimp have established advanced centralized processing plants to enhance the product mix, obtain better yields and respond to evolving quality and safety requirements in importing countries. Processors that operate without the purchasing or sourcing power of strong brands are also experiencing increasing problems linked to the scarcity of domestic raw material, and they are being forced to import fish for their business.

FISH TRADE AND COMMODITIES

Fish and fishery products are among the most traded food commodities worldwide. Trade plays a major role in the fishery industry as a creator of employment, food supplier, income generator, and contributor to economic growth and development. For many countries and for numerous coastal, riverine, insular and inland regions, fishery exports are essential to the economy. For example, in 2010 they accounted for more than half of the total value of traded commodities in Greenland, Seychelles, Faeroe Islands and Vanuatu. In the same year, fishery trade represented about 10 percent of total agricultural exports (excluding forest products) and 1 percent of world merchandise trade in value terms.

A significant share of total fishery production is exported in the form of various food and feed items. This share increased from 25 percent in 1976 to about 38 percent (57 million tonnes in 2010 (Figure 21), reflecting the sector's growing degree of openness to, and integration in, international trade. Sustained demand, trade liberalization policies, globalization of food systems and technological innovations have furthered the overall increase in international fish trade. Improvements in processing, packaging and transportation as well as changes in distribution and marketing have significantly changed the way fishery products are prepared, marketed and delivered to consumers. All these factors have facilitated and increased the movement of production in relative terms from local consumption to international markets. The fishery supply chain is complex as goods might cross national boundaries several times before final consumption, also owing to increasing outsourcing of processing to

countries where comparatively low wages and production costs provide a competitive advantage, as indicated above in the Fish Utilization and Processing section.

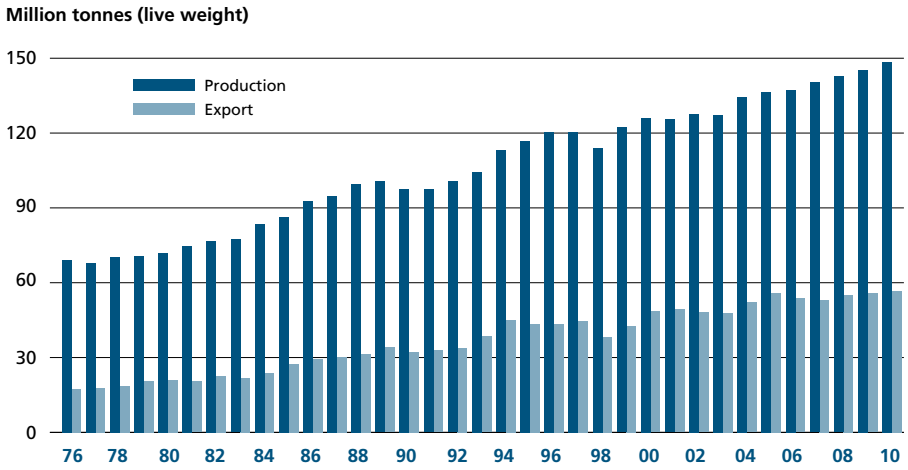
In the period 1976–2008, world trade in fish and fishery products grew significantly also in value terms, rising from US$8 billion to US$102 billion, with annual growth rates of 8.3 percent in nominal terms and of 3.9 percent in real terms. In 2009, as a consequence of the general economic contraction affecting consumer confidence in major markets, trade dropped by 6 percent compared with 2008. The decline was only in value terms as a consequence of falling prices and margins, whereas traded volumes, expressed in live weight equivalent, increased by 1 percent to 55.7 million tonnes. The decrease was not uniform and, in particular, many developing countries experienced rising demand and imports even during a difficult 2009. In 2010, trade rebounded strongly, reaching about US$109 billion, with an increase of 13 percent in value terms and 2 percent in volume compared with 2009. The difference between the growth in value and volume reflects the higher fish prices experienced during 2010 as well as a decrease in the production of and trade in fishmeal.

In 2011, despite the economic instability experienced in many of the world's leading economies, increasing prices and strong demand in developing countries pushed trade volumes and values to the highest level ever reported and, despite some softening in the second half of the year, preliminary estimates indicate that exports exceeded US$125 billion. It is worth noting that currency fluctuations influence not only sales and markets, but also trade statistics; for statistics stated in US dollars, a weakening dollar will inflate both import and export figures.

Fishery trade is closely tied to the overall economic situation. In the last few years, world trade has been hit by a series of economic, financial and food crises. After the 12 percent drop experienced in 2009, world trade recovered strongly in 2010 and, according to the World Trade Organization (WTO), merchandise exports increased by 14.5 percent, sustained by a 3.6 percent growth in global output as measured by gross domestic product.[15] In 2010, economic conditions rebounded in both developed and developing economies, but the resurgence of both trade and output was slower in developed countries. The World Bank estimates that the volume of global trade (merchandise and services) increased by a further 6.6 percent in 2011.[16] However, performance across the year was not uniform. Since late 2011 and early 2012, the world economy has entered a difficult phase characterized by significant downside risks and fragility, with great uncertainty on how markets will evolve in the medium

Figure 21

World fisheries production and quantities destined for export



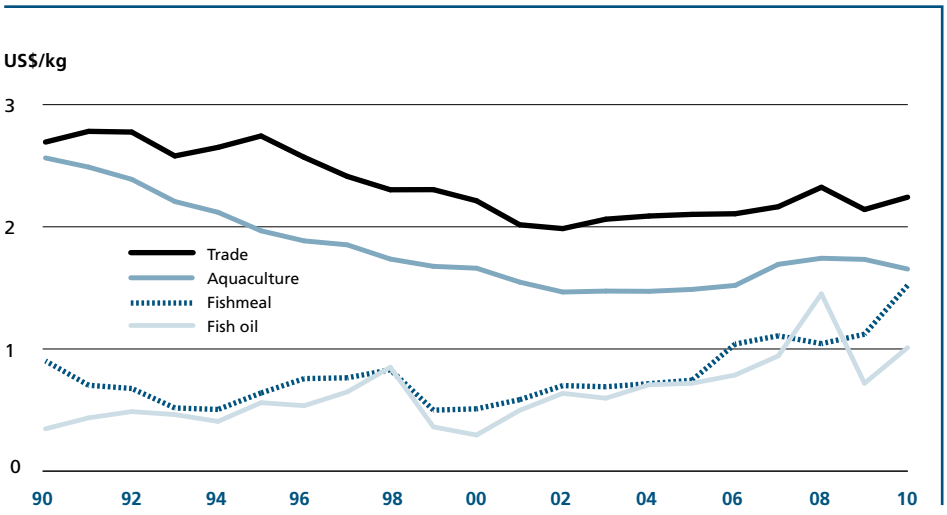
term. The financial turmoil generated by the intensification of the fiscal crisis in Europe has expanded to both developing and high-income countries. As a result, and despite relatively strong activity in the United States of America and Japan, key markets for fisheries trade, global growth and world trade have slowed sharply. In addition, among other risks, there is the possibility that geopolitical and domestic political tensions could disrupt oil supplies, which could have an impact on increasing costs of capture fisheries as well. Therefore, according to the World Bank, the global economy is now expected to expand by 2.5 percent in 2012 and by 3.1 percent in 2013. The growth rate for high-income countries should be 1.4 percent in 2012 and 2.0 percent in 2013, while growth for developing countries is projected at 5.4 percent and 6.0 percent in 2012 and 2013, respectively. Reflecting this slowdown, world trade is expected to expand by 4.7 percent in 2012, before strengthening to 6.8 percent in 2013. Despite the renewed economic instability, fish trade has expanded in key markets in the first few months of 2012, and the long-term trend for fish trade remains positive, with a growing share of fish production entering international markets.

Among the factors that might influence the sustainability and growth of fishery trade are the evolution of production and transportation costs and the prices of fishery products and alternative commodities, including meat and feeds. As is the case for other products, fish prices are influenced by demand and supply factors. At the same time, the very heterogeneous nature of the sector, with hundreds of species and thousands of products entering international trade, makes it challenging to estimate price developments for the sector as a whole. In the last few decades, the growth in aquaculture production has contributed significantly to increased consumption and commercialization of species that were once primarily wild-caught, with a consequent price decrease. This was particularly evident in the 1990s and early 2000 (Figure 22), with average unit values of aquaculture production and trade in real terms regularly declining. Subsequently, owing to increased costs and continuous high demand, prices have started to rise again. In the next decade, with aquaculture accounting for a much larger share of total fish supply, the price swings of aquaculture products could have a significant impact on price formation in the sector overall, possibly leading to more volatility.

Similar to trade, also fish prices contracted in 2009 but have since rebounded. Fish prices rose strongly in the first part of 2011, declining slightly towards the end of the year and into early 2012, but remaining higher than levels of earlier years. Rising energy and feed costs will probably keep fish prices high in 2012, especially

Figure 22

Average fish prices in real terms (2005)



as alternative protein sources such as meat are influenced by the same factors. Since 2009, FAO has been working on the construction and enhancement of a fish price index to illustrate both relative and absolute price movements. The index is being developed in cooperation with the University of Stavanger and with data support from the Norwegian Seafood Council. The FAO Fish Price Index (base year 2002–04 = 100) indicates that average prices in 2009 declined by 7 percent compared with 2008, then increased by 9 percent in 2010 and by more than 12 percent in 2011. The absolute peak in the index was reached in August 2011 at 158.3 (14 percent more than in August 2010). Prices for species from capture fisheries increased by more than those for farmed species because of the larger impact from higher energy prices on fishing vessel operations than on farmed species.

Trade in fish and fishery products is characterized by a wide range of product types and participants. In 2010, 197 countries reported exports of fish and fishery products. The role of fishery trade varies among countries and is important for many economies, in particular for developing nations. Table 12 shows the top ten exporters and importers of fish and fishery products in 2000 and 2010. Since 2002, China has been by far the leading fish exporter, contributing almost 12 percent of 2010 world exports of fish and fishery products, or about US$13.3 billion, and increasing further to US$17.1 billion in 2011. China's fishery exports have grown considerably since the 1990s, although at present they represent only 1 percent of its total merchandise exports. A growing share of fishery exports consists of reprocessed imported raw material. Thailand has established itself as a processing centre of excellence largely dependent on imported raw material, while Viet Nam has a growing domestic resource base and imports only limited, albeit growing, volumes of raw material. Viet Nam has experienced significant growth in its exports of fish and fish products, up from US$1.5 billion in 2000 to US$5.1 billion in 2010, when it became the fourth-largest exporter in the world. In 2011, its exports rose further to US$6.2 billion. Its rising exports are linked to its flourishing aquaculture industry, in particular to the production of *Pangasius* and of both marine and freshwater shrimps and prawns.

In addition to China, Thailand and Viet Nam, many other developing countries play a major role in global fisheries. In 2010, developing countries confirmed their fundamental importance as suppliers to world markets with more than 50 percent of all fishery exports in value terms and of more than 60 percent in quantity (live weight). For many developing nations, fish trade represents a significant source of foreign currency earnings in addition to the sector's important role as a generator of income, source of employment, and provider of food security and nutrition. The fishery industries of developing countries rely heavily on developed countries, not only as outlets for their exports, but also as suppliers of their imports for local consumption (mainly low-priced small pelagics as well as high-value fishery species for emerging economies) or for their processing industries. In 2010, in value terms, 67 percent of the fishery exports of developing countries were directed to developed countries. A growing share of these exports consisted of processed fishery products prepared from imports of raw fish to be used for further processing and re-export. In 2010, in value terms, 39 percent of the imports of fish and fishery products by developing countries originated from developed countries. Developing countries cover an important segment of world exports of non-food fish exports (74 percent in 2010 in terms of quantity). Fishmeal represents a significant share of their exports (35 percent by quantity, but only 5 percent by value in 2010). However, developing countries have also considerably increased their share of the quantity of world fish exports destined for human consumption, from 32 percent in 1980 to 47 percent in 2000 and to 56 percent in 2010. Net exports of fish and fish products (i.e. the total value of fish exports less the total value of fish imports) are particularly important for developing countries, being higher than those of several other agricultural commodities such as rice, meat, sugar, coffee and tobacco (Figure 23). They have grown significantly in recent decades, rising from US$3.7 billion in 1980 to US$10.2 billion in 1990, to US$18.3 billion in 2000, and reaching US$27.7 billion in 2010. For LIFDCs, net export revenues amounted to US$4.7 billion in 2010, compared with

US$2.0 billion in 1990.[17] In 2010, their fishery exports (US$8.2 billion) accounted for 8 percent of world exports in value terms.

World imports[18] of fish and fish products set a new record at US$111.8 billion in 2010, up 12 percent on the previous year and up 86 percent with respect to 2000. Preliminary data for 2011 point to further growth, with a 15 percent increase. The United States of America and Japan are the major importers of fish and fishery products and are highly dependent on imports for about 60 percent and 54 percent, respectively, of their fishery consumption. With a growing population and a positive long-term trend in seafood consumption, United States imports reached US$15.5 billion in 2010, 12 percent more than in 2009, and further increased in 2011 to US$17.5 billion. After the decline of 11 percent experienced in 2009 as compared with 2008, Japanese imports of fish and fishery products increased by 13 percent in 2010. In 2011, they grew by a further 16 percent, reaching US$17.4 billion, also as a consequence of the tsunami that struck Japan in early 2011, which had an impact on the country's production capacity in the affected area, with damage to the fleet, aquaculture facilities, processing plants and port infrastructure. China, the world's largest fish producer and exporter, has significantly increased its fishery imports, partly a result of outsourcing, as Chinese processors import raw material from all major regions, including South and

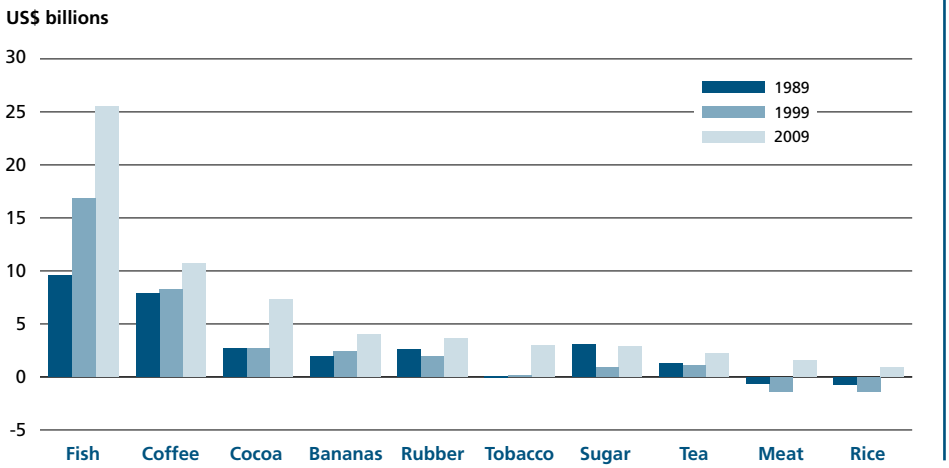
Table 12
Top ten exporters and importers of fish and fishery products

	2000	2010	APR
	(US$ millions)		*(Percentage)*
EXPORTERS			
China	3 603	13 268	13.9
Norway	3 533	8 817	9.6
Thailand	4 367	7 128	5.0
Viet Nam	1 481	5 109	13.2
United States of America	3 055	4 661	4.3
Denmark	2 756	4 147	4.2
Canada	2 818	3 843	3.1
Netherlands	1 344	3 558	10.2
Spain	1 597	3 396	7.8
Chile	1 794	3 394	6.6
TOP TEN SUBTOTAL	26 349	57 321	8.1
REST OF WORLD TOTAL	29 401	51 242	5.7
WORLD TOTAL	**55 750**	**108 562**	**6.9**
IMPORTERS			
United States of America	10 451	15 496	4.0
Japan	15 513	14 973	–0.4
Spain	3 352	6 637	7.1
China	1 796	6 162	13.1
France	2 984	5 983	7.2
Italy	2 535	5 449	8.0
Germany	2 262	5 037	8.3
United Kingdom	2 184	3 702	5.4
Sweden	709	3 316	16.7
Republic of Korea	1 385	3 193	8.7
TOP TEN SUBTOTAL	26 349	69 949	10.3
REST OF WORLD TOTAL	33 740	41 837	2.2
WORLD TOTAL	**60 089**	**111 786**	**6.4**

Note: APR refers to the average annual percentage growth rate for 2000–2010.

Figure 23

Net exports of selected agricultural commodities by developing countries



North America and Europe for re-processing and export. Imports are also being fuelled by robust domestic demand for species not available from local sources, in particular marine species, as a consequence of economic growth and rising disposable incomes. Its imports increased from US$1.8 billion in 2000 to US$6.2 billion in 2010. Imports further grew by 23 percent in 2011 to US$7.6 billion, when China became the third-largest importer in the world. This increase in imports also reflects the lowered import duties following China's accession to the WTO in late 2001.

The European Union is by far the largest single market for imported fish and fishery products owing to its growing domestic consumption. However, it is extremely heterogeneous, with markedly different conditions from country to country. European Union fishery imports reached US$44.6 billion in 2010, up 10 percent from 2009, and representing 40 percent of total world imports. However, if intraregional trade is excluded, the European Union imported fish and fishery products worth US$23.7 billion from suppliers outside the European Union, an increase of 11 percent from 2009. This makes the European Union the largest market in the world, with about 26 percent of world imports (excluding intra-European Union trade). In 2011, imports rose further to US$50.0 billion including intra-European Union trade (US$26.5 billion if excluded). The dependence of the European Union on imports for its fish consumption is growing. This is a result of the positive underlying trend in consumption, but also evidences the constraints within the European Union on further expansion of supply. In this respect, the current reform of its Common Fisheries Policy aims to rebuild its fish stocks, as well as boosting its aquaculture production. The results of the reform and the effects on supply and trade will only be felt in the medium-to-long term.

In addition to the major importing countries, a number of emerging markets have become of growing importance to the world's exporters. Prominent among these there are Brazil, Mexico, the Russian Federation, Egypt, Asia and the Near East in general. In Asia, Africa and South and Central America, regional trade continues to be of importance even though it is not always adequately reflected in official statistics. Improved domestic distribution systems for fish and fishery products have played a role in increased regional trade, as has growing aquaculture production. Domestic markets, in particular in Asia, but also in Central and South America, remained strong in 2010–11, providing welcome outlets for domestic and regional producers. Africa has also become a growing market for farmed freshwater species from Asia.

In 2010, developed countries were responsible for 76 percent of the total import value of fish and fishery products, a decline compared with the 86 percent of 1990 and 83 percent of 2000. In volume (live weight equivalent), the share of developed countries is significantly less, 58 percent, reflecting the higher unit value of products imported by developed countries. Owing to stagnating domestic fishery production, developed countries have to rely on imports and/or on domestic aquaculture to cover their increasing domestic consumption of fish and fishery products. This may be one reason for low import tariffs on fish in developed countries, albeit with a few exceptions, i.e. for some value-added products. As a consequence, in the last few decades, developing countries have increasingly been able to supply fishery products to markets of developed countries without facing prohibitive custom duties. In 2010, 48 percent of the import value of developed countries originated from developing countries.

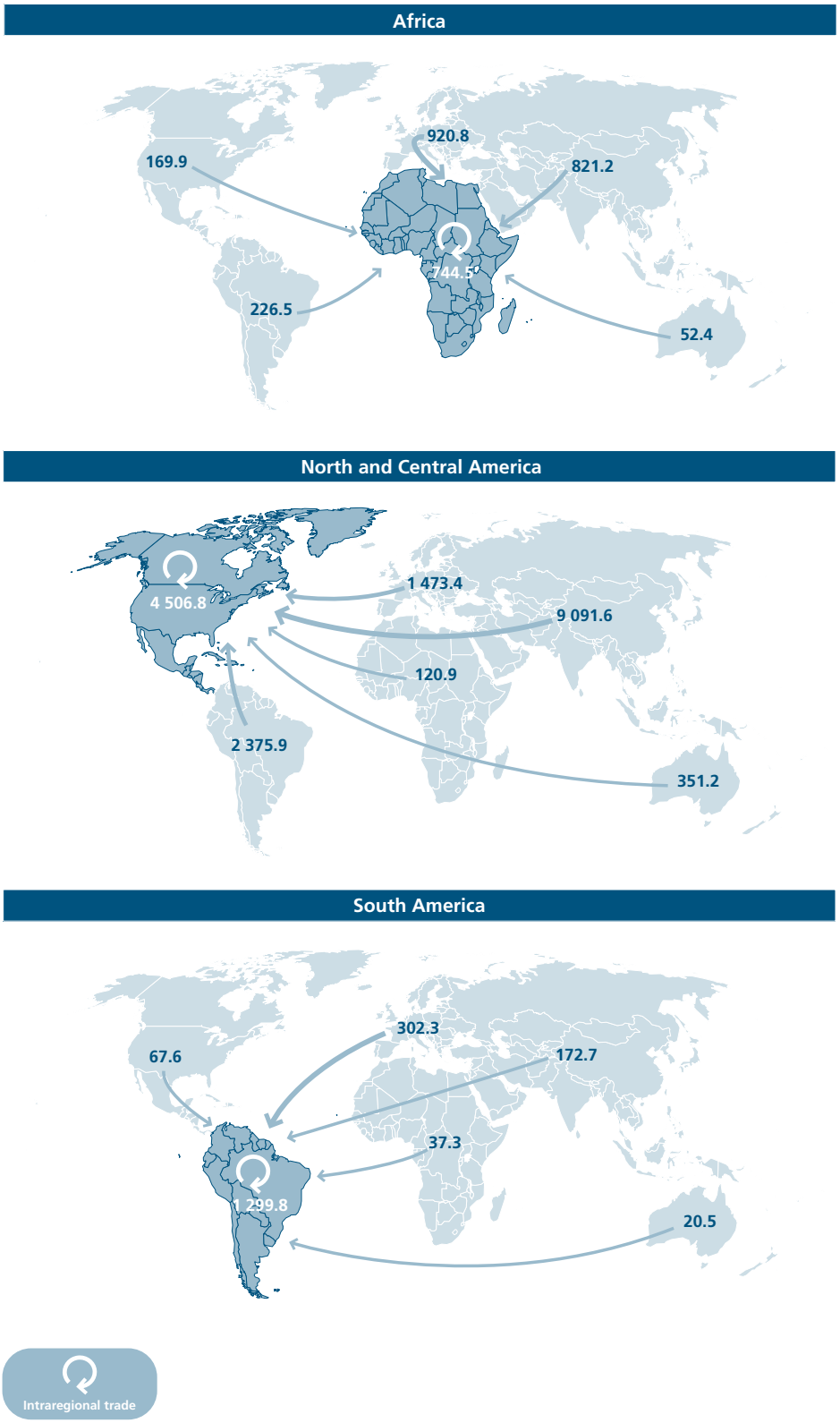
In recent decades, there has been a tendency towards increased fishery trade within regions. Most developed countries trade more with other developed countries. In 2010, in value terms, 79 percent of fishery exports from developed countries were destined to other developed countries, and about 52 percent of fishery imports of developed countries originated from other developed countries. In the same year, fishery trade between developing countries represented only 33 percent of the value of their exports of fish and fishery products. Over time, fishery trade between developing countries will probably increase in the wake of rising disposable incomes in emerging economies, gradual trade liberalization and a reduction in the high import tariffs following the expanding membership of the WTO, and the entry into force of a number of bilateral trade agreements with strong relevance to the trade in fish. The maps in Figure 24 summarize the average trade flows of fish and fishery products by continent for the period 2008–2010. The overall picture presented by these maps is not exhaustive as trade data are not fully available for all countries, in particular for several African countries. However, the quantity of data at hand is sufficient to establish general trends, with no major changes taking in place compared with the past few years. The Latin America and the Caribbean region continues to maintain a solid positive net fishery exporter role, as is the case for the Oceania region and the developing countries of Asia. By value, Africa has been a net exporter since 1985, but it is a net importer in quantity terms, reflecting the lower unit value of imports (mainly for small pelagics). Europe and North America are characterized by a fishery trade deficit (Figure 25).

Some of the major issues in the past biennium that continue to affect fishery international trade are:

- the volatility of commodity prices in general and their influence on producers as well as on consumers;
- the impact on the domestic fisheries sector of the rising imports of farmed products;
- the role of the small-scale sector in future fish production and trade;
- the relationship between fisheries management design, allocation of rights and the economic sustainability of the sector;
- the introduction of private standards, including for environmental and social purposes, and their endorsement by major retailers;
- the multilateral trade negotiations within the WTO, including the focus on fisheries subsidies;
- climate change, carbon emissions and their impacts on the fisheries sector;
- the growing concern of the general public and the retail sector about overexploitation of certain fish stocks;
- the need to ensure that internationally traded fishery products from capture fisheries have been produced legally;
- the need for competitiveness versus other food products;
- the perceived and real risks and benefits of fish consumption.

Figure 24

Trade flows by continent (total imports in US$ millions, c.i.f.; averages for 2008–2010)

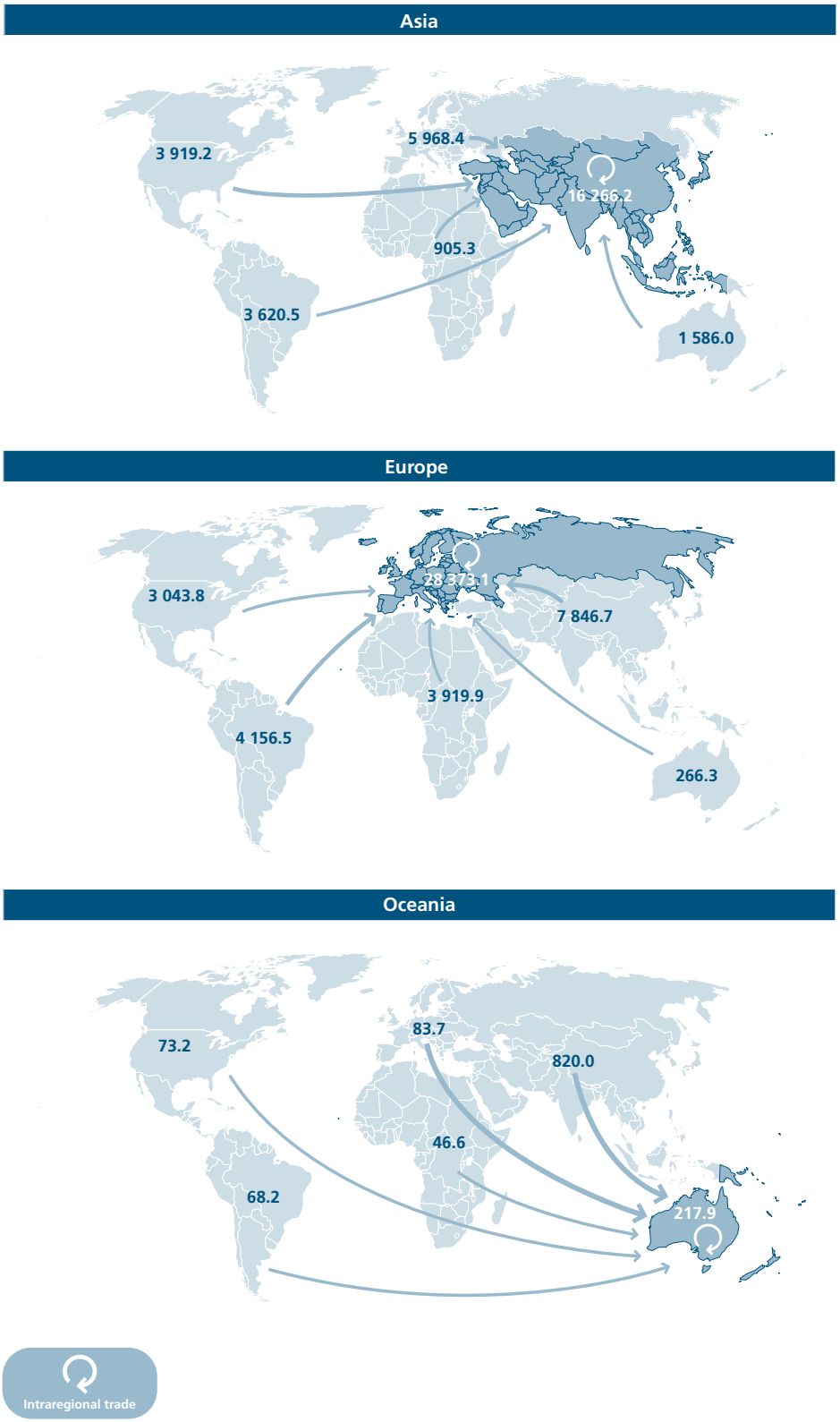


Note: The maps indicate the borders of the Republic of the Sudan for the period specified. The final boundary between the Republic of the Sudan and the Republic of South Sudan has not yet been determined.

(Continued)

Figure 24 *(cont.)*

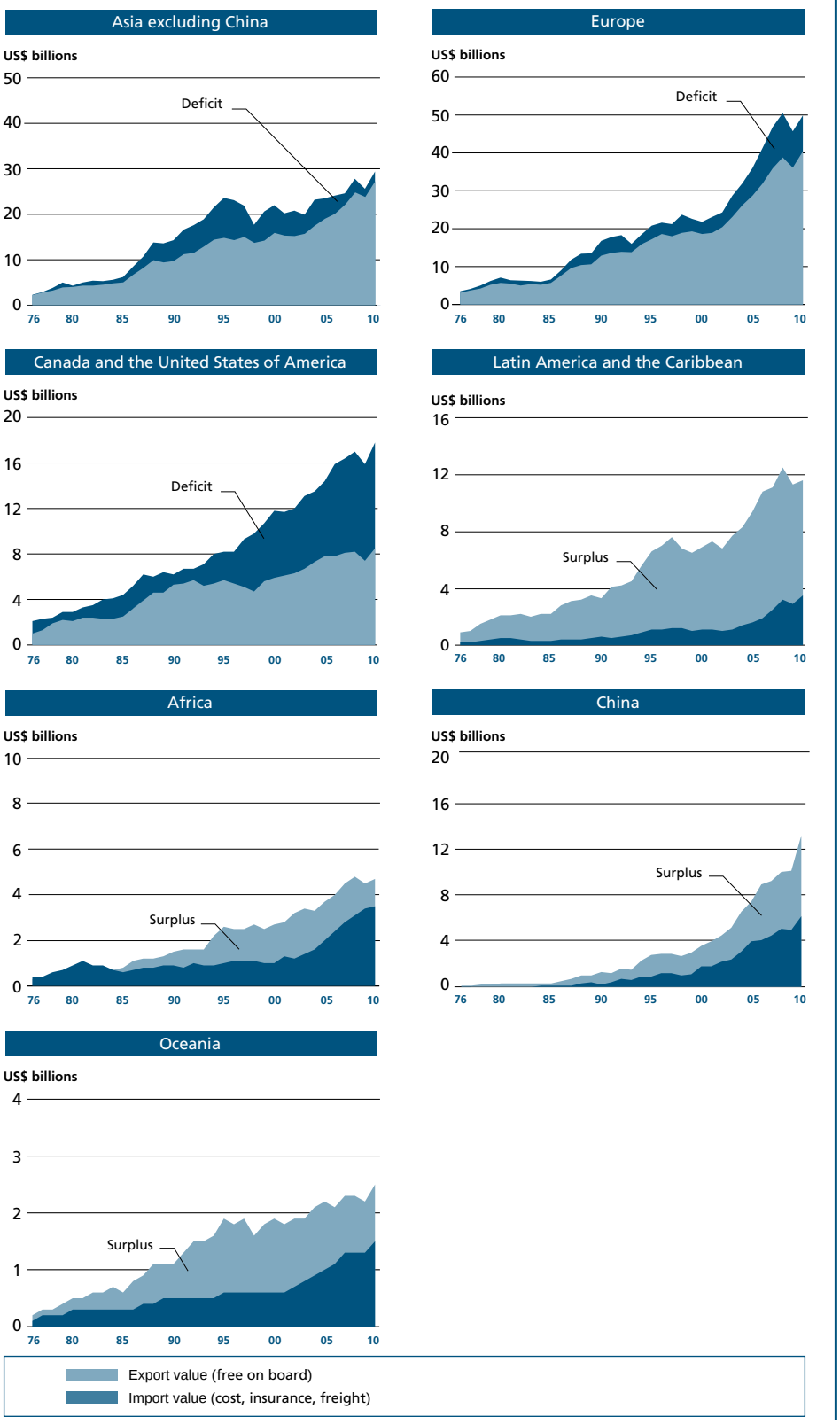
Trade flows by continent (total imports in US$ millions, c.i.f.; averages for 2008–2010)



Note: The maps indicate the borders of the Republic of the Sudan for the period specified. The final boundary between the Republic of the Sudan and the Republic of South Sudan has not yet been determined.

Figure 25

Imports and exports of fish and fishery products for different regions, indicating net deficit or surplus



Commodities

The fishery market is very dynamic and it is changing rapidly. It is becoming much more complex and stratified, with greater diversification among species and product forms. High-value species such as shrimp, prawns, salmon, tuna, groundfish, flatfish, seabass and seabream are highly traded, in particular towards more prosperous markets. Low-value species such as small pelagics are also traded in large quantities, mainly being exported to feed low-income consumers in developing countries. In the last two decades, aquaculture has contributed to a growing share of the international trade in fishery commodities, with species such as shrimp, prawns, salmon, molluscs, tilapia, catfish (including *Pangasius*), seabass and seabream. Aquaculture is expanding in all continents in terms of new areas and species, as well as intensifying and diversifying the product range in species and product forms to respond to consumer needs. Many of the species that have registered the highest export growth rates in the last few years are produced by aquaculture. However, it is difficult to determine the extent of this trade because the classification used internationally to record trade statistics for fish does not distinguish between products of wild and farmed origin. Hence, the exact breakdown between products of capture fisheries and aquaculture in international trade is open to interpretation.

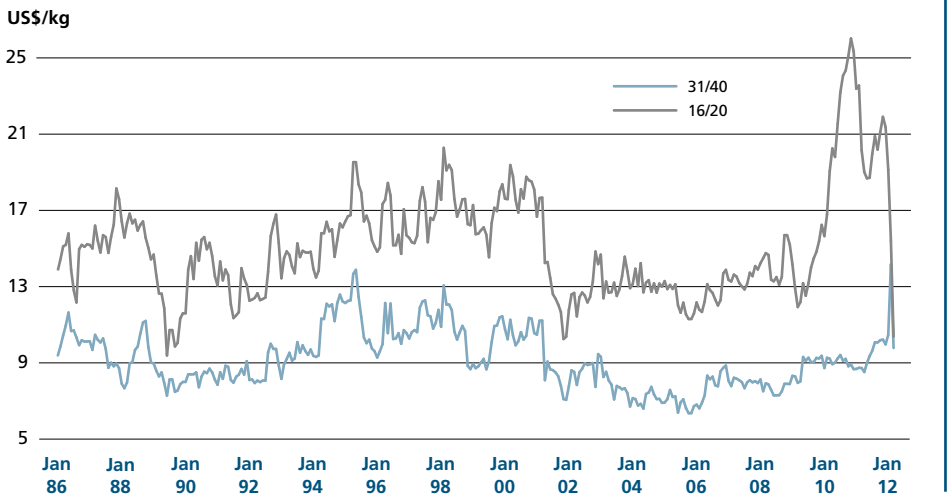
Owing to the high perishability of fish and fishery products, 90 percent of trade in fish and fishery products in quantity terms (live weight equivalent) consists of processed products (i.e. excluding live and fresh whole fish). Fish are increasingly traded as frozen food (39 percent of the total quantity in 2010, compared with 25 percent in 1980). In the last four decades, prepared and preserved fish have nearly doubled their share in total quantity, going from 9 percent in 1980 to 16 percent in 2010. Notwithstanding their perishability, trade in live, fresh and chilled fish represented 10 percent of world fish trade in 2010, up from 7 percent in 1980, reflecting improved logistics and increased demand for unprocessed fish. Trade in live fish also includes ornamental fish, which is high in value terms but almost negligible in terms of quantity traded. In 2010, 71 percent of the quantity of fish and fishery products exported consisted of products destined for human consumption. The US$109 billion exports of fish and fishery products in 2010 do not include an additional US$1.3 billion for aquatic plants (62 percent), inedible fish waste (31 percent) and sponges and corals (7 percent). In the last two decades, trade in aquatic plants has increased significantly, going from US$0.2 billion in 1990 to US$0.5 billion in 2000 and to US$0.8 billion in 2010, with China as the major exporter and Japan as the leading importer. Trade in inedible fish waste has also grown remarkably in this period, owing to the increasing production of fishmeal and other products deriving from fishery residues from processing (see the Fish Utilization and Processing section above). From just US$61 million in 1990, exports of inedible fish rose to US$0.2 billion in 2000 and reached US$0.4 billion in 2010.

Shrimp

Shrimp continues to be the largest single commodity in value terms, accounting for about 15 percent of the total value of internationally traded fishery products in 2010. In 2010, the shrimp market recovered, after the decline of 2009, characterized by stable volumes, but by substantially decreases of prices. In 2011, notwithstanding a contraction in world production of farmed shrimp, the market performed well. Despite the scepticism and concern over the economic situation, both the United States of America and the European Union imported more shrimp than the year before. The Japanese market moved away from basic raw shrimp to value-added and processed shrimp, thus paying more for imports. Many domestic and regional markets in Asia and Latin America consumed more shrimp, which also kept their prices relatively high and stable throughout 2011 (Figure 26). In 2012, the shrimp market began with positive notes in demand and price trends in various markets. In value terms, the major exporting countries are Thailand, China and Viet Nam. The United States of America continues to be the main shrimp importer, followed by Japan.

Figure 26

Shrimp prices in Japan



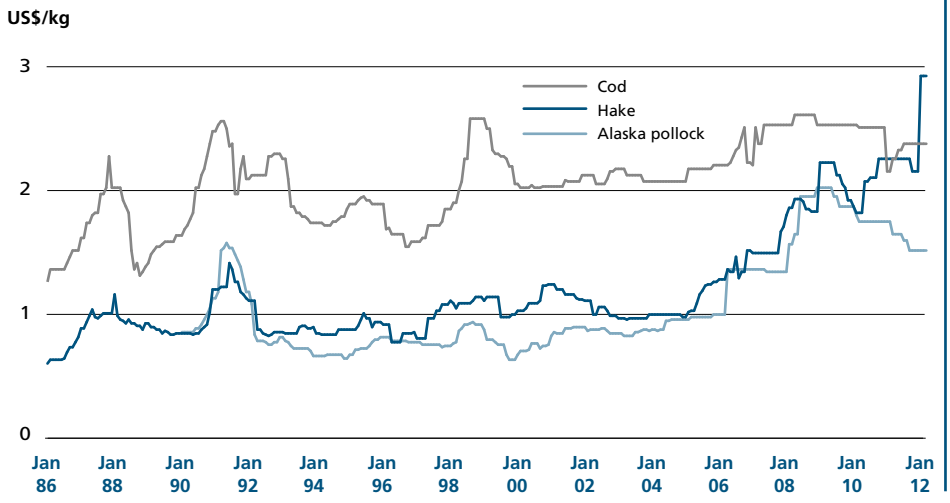
Note: 16/20 = 16–20 pieces per pound; 31/40 = 31–40 pieces per pound.
Data refer to wholesale prices for black tiger, headless, shell-on shrimps. Origin: Indonesia.

Salmon

The share of salmon and trouts in world trade has increased considerably in recent decades, and in 2010 it was more than 14 percent. Overall, demand for farmed salmon has been growing steadily from year to year. However, supply has been more variable, mostly as a result of disease-related problems in the producing countries. In a situation with a positive long-term trend in demand, a temporary shortfall in supply is bound to lead to large price reactions, and this is what happened in 2010 and early 2011, with exceptionally high prices, in particular for farmed Atlantic salmon. Prices started to weaken in the following months also as a result of large additional volumes of farmed salmon reaching world markets. At the beginning of 2012, prices recovered from the low levels reached in late 2011. Demand growth continues to be consistent

Figure 27

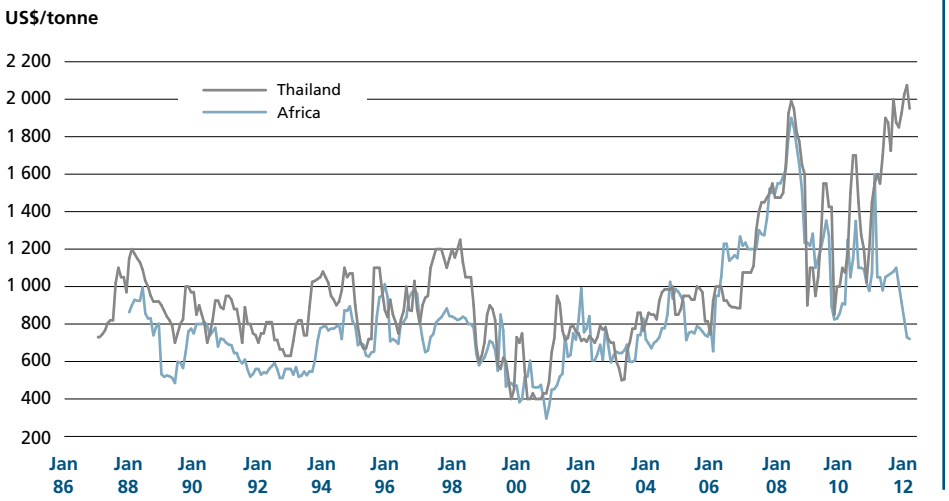
Groundfish prices in the United States of America



Note: Data refer to c&f (cost and freight) prices for fillets.

Figure 28

Skipjack tuna prices in Africa and Thailand



Note: Data refer to c&f (cost and freight) prices for 4.5–7.0 pounds of fish.
For Africa: ex-vessel Abidjan, Côte d'Ivoire.

in most markets and it is expanding geographically, in particular for farmed Atlantic salmon, also through new varieties of processed products. Norway remains the dominant producer and exporter of Atlantic salmon, but Chile is rapidly ramping up its production towards levels prior to the crisis experienced in 2010. Wild Pacific salmon also plays an important part in world salmon markets with wild salmon representing about 30 percent of the total market for salmonids.

Groundfish

Groundfish species represented about 10 percent of total fish exports by value in 2010. Their prices went down in 2010 and 2011 as a result of good supply from capture fisheries and strong competition from farmed species such as *Pangasius* and tilapia on the market (Figure 27). General demand for groundfish species is increasing, and increased supply will come from good management practices of the wild stocks. Emerging countries will provide new opportunities. For example, Brazil has become a growing destination for Norwegian cod, helping to ease somewhat the concerns of Norwegian exporters that their sales in southern Europe were being affected by the economic crisis, particularly in Portugal, which is the largest single importer of Norwegian cod.

Tuna

The share of tuna in total fish exports in 2010 was about 8 percent. In the last three years, tuna markets have been unstable owing to large fluctuations in catch levels. The major issues affecting the global tuna sector in 2011 were lower catches in major fishing areas, growing restrictions on longline and purse-seine fishing in the pursuit of more sustainable resource management, other moves towards sustainability and the introduction of ecolabels. These factors have had an impact on the tuna market for sashimi and as raw material for canning, with consequent increases in tuna prices (Figure 28). Japan continues to be the main market for sashimi-grade tuna, while the European Union and the United States of America represent the major importers and Thailand the main exporter of canned tuna.

Cephalopods

The share of cephalopods (squid, cuttlefish and octopus) in world fish trade was 4 percent in 2010. Spain, Italy and Japan are the largest consumers and importers of these species. Thailand is the largest exporter of squid and cuttlefish, followed by Spain, China and Argentina, while Morocco and Mauritania are the principal octopus exporters. Recently, Mexico has also emerged as an important supplier to Europe. Supplies of octopus have been a problem, and throughout 2011 this characterized the trade. Import volumes in the main markets, however, were relatively stable, with growing price levels (Figure 29). The diminishing catches of octopus have revived interest in octopus farming. Whether the new technologies being experimented will be able to produce significant amounts of octopus of the right market size in the future remains to be seen, although progress so far is encouraging. Squid supplies were also quite tight throughout 2011. This is reflected in the trade figures. Imports into all major markets, with the exception of Japan, declined. The cuttlefish market has been flat for the last few years. The main importers have seen little variation in imported volumes over the years, although there have been some changes among the suppliers to the various markets.

Pangasius

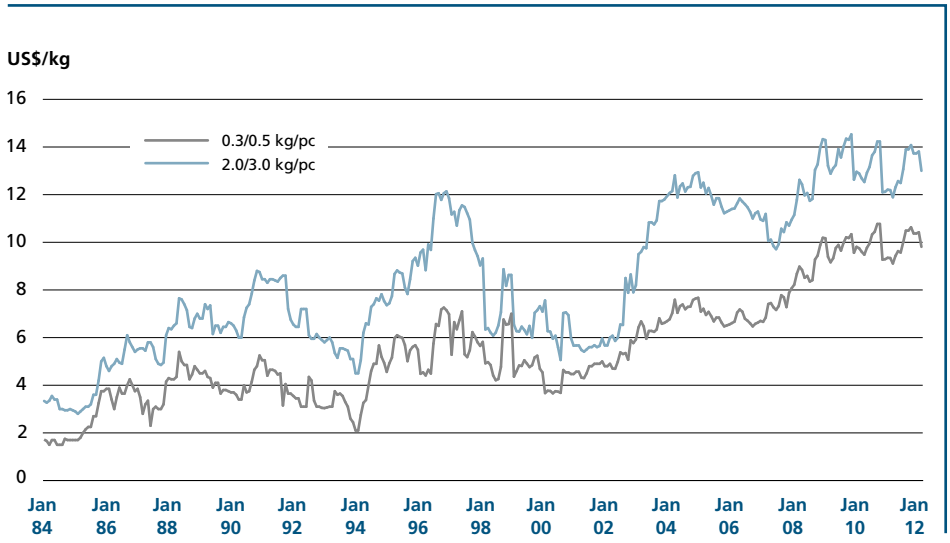
Pangasius is a freshwater fish, and it is a relatively recent arrival in terms of international trade. However, with production of about 1.3 million tonnes, mainly in Viet Nam and all going to the international markets, this species is an important source of low-priced fish. The European Union and the United States of America are the main importers of *Pangasius*. In 2011, imports declined in the European Union, while they increased in the United States market. Supply issues affected the *Pangasius* sector in Viet Nam, and overall output declined in 2011. Although Viet Nam is the largest supplier to the European Union markets, the product is also sourced from China and Thailand. Asian demand remains strong with new markets emerging, including those of India and the Near East, in particular for fillets. Local production facilitated by aggressive promotional activities is also increasing in many countries for domestic consumption.

Fishmeal

Fishmeal production and trade decreased significantly in 2010 owing to reduced catches of anchoveta, while production for 2011 increased by about 40 percent in the

Figure 29

Octopus prices in Japan



Note: kg/pc = kilograms per piece. Data refer to wholesale prices. Whole, 8 kg/block.

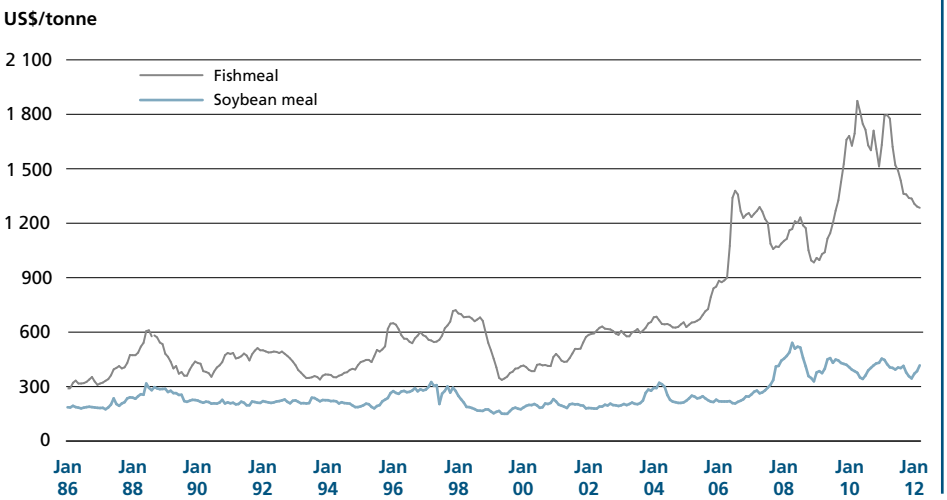
major producing countries. Demand for fishmeal was strong in 2010 and 2011, leading to sharply higher fishmeal prices (Figure 30). Despite some recent softening in late 2011 and early 2012, prices remain at fairly high levels. China remains the main market for fishmeal, importing more than 30 percent of the fishmeal quantity, while Peru and Chile are the major exporters.

Fish oil

Improved landings and access to raw material contributed to a rise in fish-oil production in 2011, after the decline in 2010. Notwithstanding some fluctuations, fish-

Figure 30

Fishmeal and soybean meal prices in Germany and the Netherlands

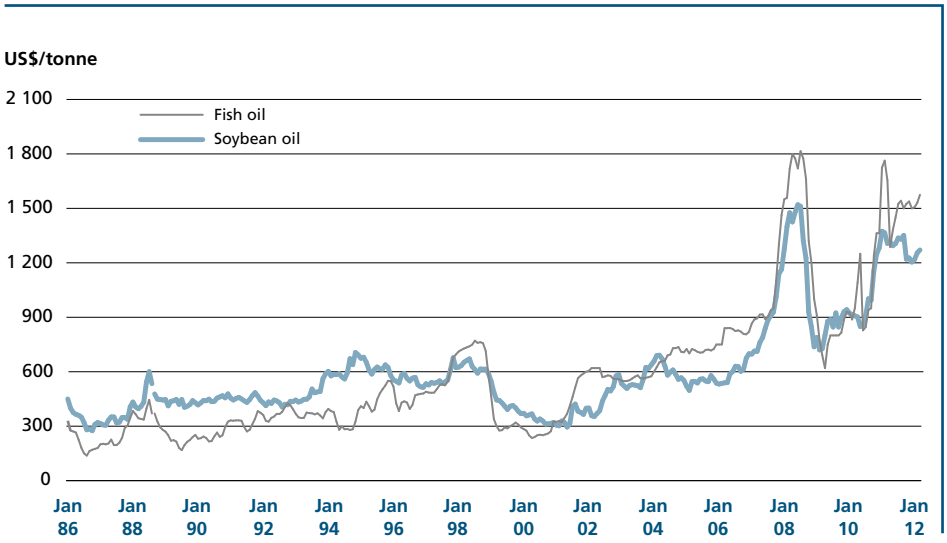


Note: Data refer to c.i.f. prices.
Fishmeal: all origins, 64–65 percent, Hamburg, Germany.
Soybean meal: 44 percent, Rotterdam, Netherlands.

Source: Oil World; FAO GLOBEFISH.

Figure 31

Fish oil and soybean oil prices in the Netherlands



Note: Data refer to c.i.f. prices.
Origin: South America; Rotterdam, Netherlands.

Source: Oil World; FAO GLOBEFISH.

oil prices continued to be at high levels in 2011 and early 2012 (Figure 31). Demand from the aquaculture and health supplement sectors will continue to take most of the volumes offered. The share going to aquaculture is used as an ingredient in fish and shrimp feeds. In 2011, a large increase in salmonoid production in Chile boosted oil demand from Chile and Peru while producers in Europe were able to increase supply, despite high prices of mackerel and herring for direct human consumption.

FISH CONSUMPTION[19]

Fish and fishery products represent a valuable source of nutrients of fundamental importance for diversified and healthy diets. With a few exceptions for selected species, fish is usually low in saturated fats, carbohydrates and cholesterol. Fish provides not only high-value protein, but also a wide range of essential micronutrients, including various vitamins (D, A and B), minerals (including calcium, iodine, zinc, iron and selenium) and polyunsaturated omega-3 fatty acids (docosahexaenoic acid and eicosapentaenoic acid). While average per capita fish consumption may be low, even small quantities of fish can have a significant positive nutritional impact by providing essential amino acids, fats and micronutrients that are scarce in vegetable-based diets. There is evidence of beneficial effects of fish consumption[20] in relation to coronary heart disease,[21] stroke, age-related macular degeneration and mental health.[22] There is also convincing evidence of benefits in terms of growth and development, in particular for women and children during gestation and infancy for optimal brain development of children.[23]

On average, fish provides only about 33 calories per capita per day. However, it can exceed 150 calories per capita per day in countries where there is a lack of alternative protein food and where a preference for fish has been developed and maintained (e.g. Iceland, Japan and several small island States). The dietary contribution of fish is more significant in terms of animal proteins, as a portion of 150 g of fish provides about 50–60 percent of the daily protein requirements for an adult. Fish proteins can represent a crucial component in some densely populated countries where total protein intake levels may be low. In fact, many populations, more those in developing countries than developed ones, depend on fish as part of their daily diet. For them, fish and fishery products often represent an affordable source of animal protein that may not only be cheaper than other animal protein sources, but preferred and part of local and traditional recipes. For example, fish contributes to, or exceeds, 50 percent of total animal protein intake in some small island developing States, as well as in Bangladesh,

Figure 32

Total protein supply by continent and major food group (average 2007–2009)

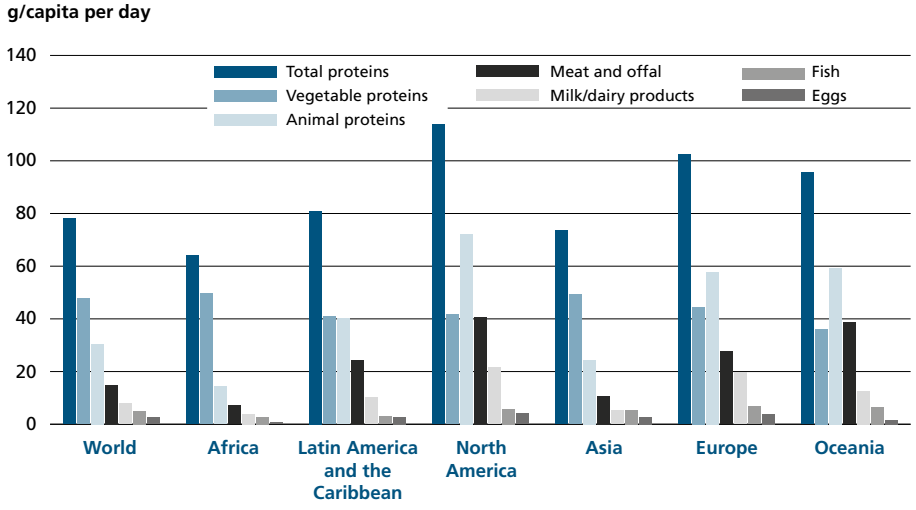
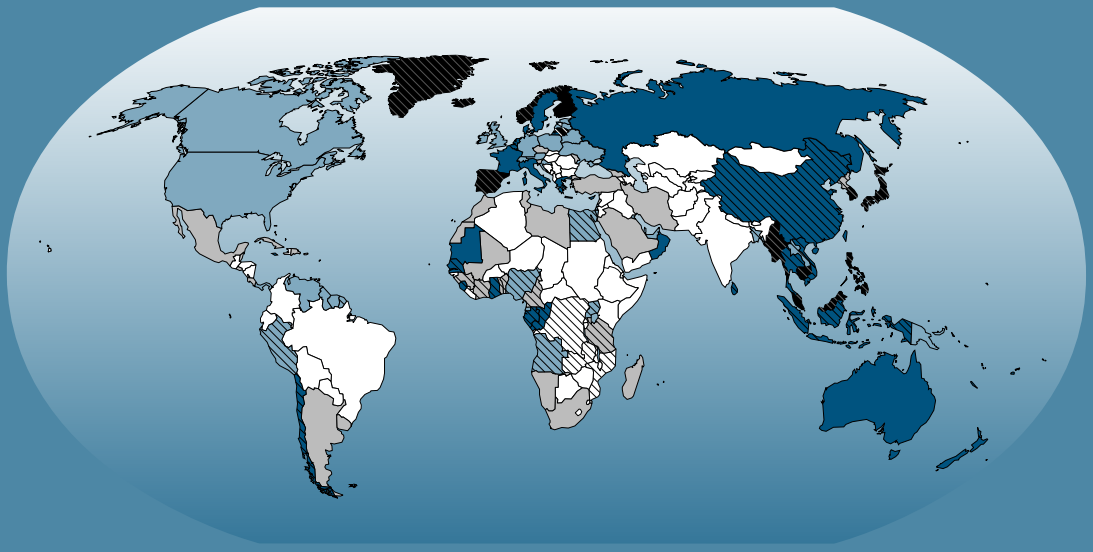


Figure 33

Contribution of fish to animal protein supply (average 2007–2009)



Fish proteins (per capita per day)

< 2 g
2–4 g
4–6 g
6–10 g
> 10 g

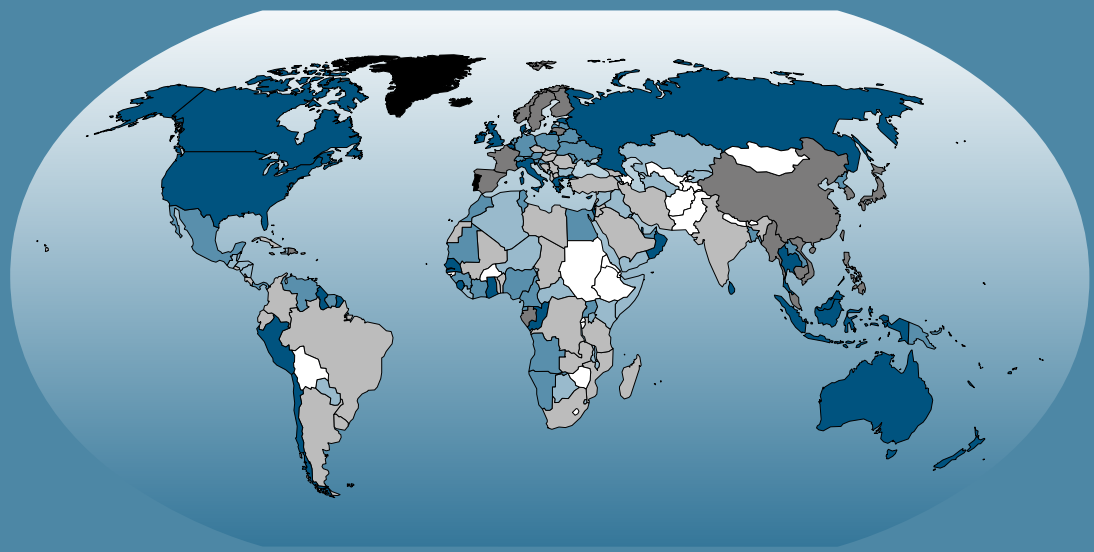
Contribution of fish to animal protein supply

> 20%

Note: The map indicates the borders of the Republic of the Sudan for the period specified. The final boundary between the Republic of the Sudan and the Republic of South Sudan has not yet been determined.

Figure 34

Fish as food: per capita supply (average 2007–2009)



Average per capita fish supply (in live weight equivalent)

0–2 kg/year
2–5 kg/year
5–10 kg/year
10–20 kg/year
20–30 kg/year
30–60 kg/year
> 60 kg/year

Note: The map indicates the borders of the Republic of the Sudan for the period specified. The final boundary between the Republic of the Sudan and the Republic of South Sudan has not yet been determined.

Cambodia, Ghana, the Gambia, Indonesia, Sierra Leone and Sri Lanka. In 2009, fish[24] accounted for 16.6 percent of the global population's intake of animal protein and 6.5 percent of all protein consumed (Figure 32). Globally, fish provides about 3.0 billion people with almost 20 percent of their average per capita intake of animal protein, and 4.3 billion people with about 15 percent of such protein (Figure 33).

Linked to the strong expansion of fish production and of modern distribution channels, world fish food supply grew at an average rate of 3.2 percent per year in the period 1961–2009, outpacing the increase of 1.7 percent per year in the world's population; hence, average per capita availability has risen. World per capita fish consumption increased from an average of 9.9 kg in the 1960s to 11.5 kg in the 1970s, 12.6 kg in the 1980s, 14.4 kg in the 1990s, 17.0 kg in the 2000s and reached 18.4 kg in 2009. Preliminary estimates for 2010 point towards a further increase in per capita fish consumption to 18.6 kg. It should be noted that figures for 2000 are higher than those reported in previous editions of *The State of World Fisheries and Aquaculture*, as FAO has revised downwards the non-food estimates for China's apparent consumption, starting from 2000 data, to reflect improved national information on the sector. As a consequence, per capita fish consumption figures for China as well as for the world have increased in comparison with previous assessments.

Notwithstanding the strong increase in the availability of fish to most consumers, the growth in fish consumption differs considerably among countries and within countries and regions in terms of quantity and variety consumed per head. For example, per capita fish consumption has remained static or decreased in some countries in sub-Saharan Africa (e.g. the Congo, South Africa, Gabon, Malawi and Liberia) and in Japan in the last two decades, while the most substantial increases in annual per capita fish consumption have occurred in East Asia (from 10.6 kg in 1961 to 34.5 kg in 2009), Southeast Asia (from 12.8 kg in 1961 to 32.0 kg in 2009) and North Africa (from 2.8 kg in 1961 to 10.6 kg in 2009). China has been responsible for most of the increase in world per capita fish consumption, owing to the substantial increase in its fish production, in particular from aquaculture. China's share in world fish production grew from 7 percent in 1961 to 34 percent in 2009. Per capita fish consumption in China has also increased dramatically, reaching about 31.9 kg in 2009, with an average annual growth rate of 4.3 percent in the period 1961–2009 and of 6.0 percent in the period 1990–2009. In the last few years, fuelled by growing domestic income and wealth, consumers in China have experienced a diversification of the types

Table 13
Total and per capita food fish supply by continent and economic grouping in 2009[1]

	Total food supply	Per capita food supply
	(million tonnes live weight equivalent)	*(kg/year)*
World	**125.6**	**18.4**
World (excluding China)	83.0	15.1
Africa	9.1	9.1
North America	8.2	24.1
Latin America and the Caribbean	5.7	9.9
Asia	85.4	20.7
Europe	16.2	22.0
Oceania	0.9	24.6
Industrialized countries	27.6	28.7
Other developed countries	5.5	13.5
Least-developed countries	9.0	11.1
Other developing countries	83.5	18.0
LIFDCs[2]	28.3	10.1

[1] Preliminary data.
[2] Low-income food-deficit countries.

of fish available owing to a diversion of some fishery exports towards the domestic market as well as an increase in fishery imports. If China is excluded, annual per capita fish supply to the rest of the world was about 15.4 kg in 2009, higher than the average values of the 1960s (11.5 kg), 1970s (13.5 kg), 1980s (14.1 kg) and 1990s (13.5 kg). It should be noted that during the 1990s, world per capita fish supply, excluding China, was relatively stable at 13.1–13.5 kg and lower than in the 1980s as population grew more rapidly than food fish supply (at annual rates of 1.6 and 0.9 percent, respectively). Since the early 2000s, there has been an inversion of this trend, with food fish supply growth outpacing population growth (at annual rates of 2.6 percent and 1.6 percent, respectively).

Table 13 summarizes per capita fish consumption by continent and major economic group. The total amount of fish consumed and the species composition of the food fish supply vary according to regions and countries, reflecting the different levels of availability of fish and other foods, including the accessibility of fishery resources in adjacent waters as well as the interaction of several socio-economic and cultural factors. These factors include food traditions, tastes, demand, income levels, seasons, prices, health infrastructure and communication facilities. Annual per capita apparent fish consumption can vary from less than 1 kg in one country to more than 100 kg in another (Figure 34). Differences may also be significant within countries, with consumption usually higher in coastal, riverine and inland water areas. Of the 126 million tonnes available for human consumption in 2009, fish consumption was lowest in Africa (9.1 million tonnes, with 9.1 kg per capita), while Asia accounted for two-thirds of total consumption, with 85.4 million tonnes (20.7 kg per capita), of which 42.8 million tonnes was consumed outside China (15.4 kg per capita). The corresponding per capita fish consumption figures for Oceania, North America, Europe, and Latin America and the Caribbean were 24.6 kg, 24.1 kg, 22.0 kg and 9.9 kg, respectively.

Differences in fish consumption exist between the more-developed and the less-developed countries. Although annual per capita consumption of fishery products has grown steadily in developing regions (from 5.2 kg in 1961 to 17.0 kg in 2009) and in LIFDCs (from 4.9 kg in 1961 to 10.1 kg in 2009), it is still considerably lower than that of more developed regions, even though the gap is narrowing. The actual values may be higher than indicated by official statistics in view of the under-recorded contribution of subsistence fisheries and some small-scale fisheries. In 2009, apparent per capita fish consumption in industrialized countries was 28.7 kg, while for all developed countries it was estimated at 24.2 kg. A sizeable share of fish consumed in developed countries consists of imports, and owing to steady demand and declining domestic fishery production (down 10 percent in the period 2000–2010), their dependence on imports, in particular from developing countries, is projected to grow. In developing countries, fish consumption tends to be based on locally and seasonally available products, and the fish chain is driven by supply rather than demand. However, in emerging economies, imports of fishery products not available locally have recently been growing.

Disparities among developed and developing countries exist also with reference to the contribution of fish to animal protein intake. Despite their relatively low levels of fish consumption, this share was significant at about 19.2 percent for developing countries and 24.0 percent for LIFDCs. However, this share has declined slightly in recent years owing to the growing consumption of other animal proteins. In developed countries, the share of fish in animal protein intake, after consistent growth up to 1989, declined from 13.9 percent in 1984 to 12.4 percent in 2009, while consumption of other animal proteins continued to increase.

The seafood sector remains very fragmented, in particular for markets of fresh seafood, but it is in a phase of consolidation and globalization. Fish is very heterogeneous and differences may be based on species, production area, method of fishing or farming, handling practice and hygiene. Raw fish can be processed into

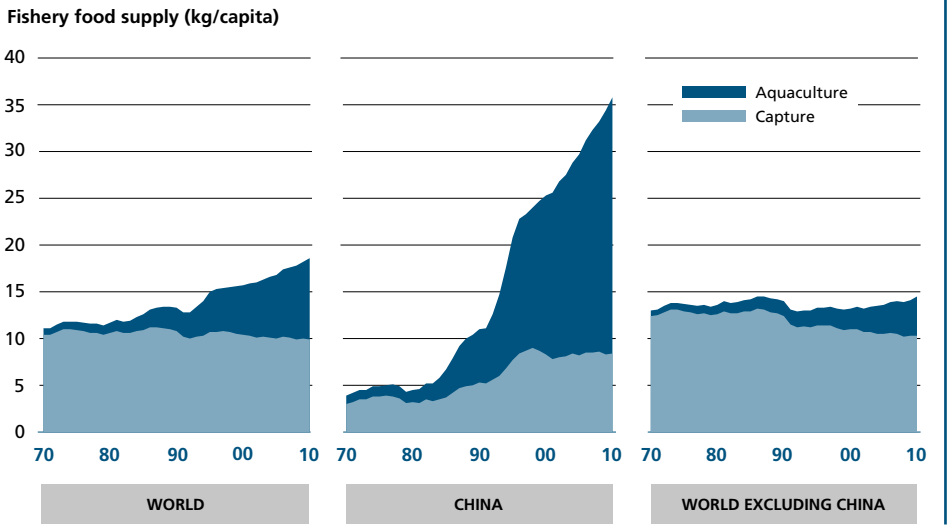
an even wider range of products to meet consumer demands that differ according to markets, flexibility in supply volumes, physical proximity, suppliers' trustworthiness, ability to adapt to different portion-size specifications, etc. In the last two decades, the consumption of fish and fishery products has also been influenced considerably by globalization in food systems and by innovations and improvements in processing, transportation, distribution, marketing and food science and technology. These factors have led to significant enhancements in efficiency, lower costs, wider choice and safer and improved products. Owing to the perishability of fish, developments in long-distance refrigerated transport and large-scale and faster shipments have facilitated the trade and consumption of an expanded variety of species and product forms, including live and fresh fish. Consumers can benefit from increased choice, with imports boosting the availability of fish and fishery products in the domestic markets.

Growing interest from local consumers has also underpinned aquaculture development in many regions in Asia and, increasingly, in Africa and in Latin America. Since the mid-1980s, and in particular in the last decade, the contribution of aquaculture to fish consumption has shown dramatic growth, as capture fisheries production has stagnated or even declined in some countries. In 2010, aquaculture contributed about 47 percent of the fishery output for human consumption – impressive growth compared with its 5 percent in 1960, 9 percent in 1980 and 34 percent in 2000 (Figure 35), with an average annual growth rate of 4.7 percent in the period 1990–2010. However, if China is excluded, the average contribution of aquaculture is significantly lower at 17 percent in 2000 and 29 percent in 2010, corresponding to an average annual growth rate of 5.4 percent. Aquaculture has pushed the demand for, and consumption of, species that have shifted from being primarily wild-caught to being primarily aquaculture-produced, with a decrease in their prices and a strong increase in their commercialization, such as for shrimps, salmon, bivalves, tilapia, catfish and *Pangasius*. Aquaculture also plays a role in food security through the significant production of some low-value freshwater species, which are mainly destined for domestic production, also through integrated farming.

The surging contribution of aquaculture can also be noted by observing fish consumption by major groups. Owing to the increasing production of shrimps, prawns and molluscs from aquaculture and the relative decline in their price, annual per capita availability of crustaceans grew substantially from 0.4 kg in 1961 to 1.7 kg in 2009, and that of molluscs (including cephalopods) rose from 0.8 kg to 2.8 kg in the

Figure 35

Relative contribution of aquaculture and capture fisheries to food fish consumption



same period. The increasing production of salmon, trouts and selected freshwater species has led to a significant growth in annual per capita consumption of freshwater and diadromous species, up from 1.5 kg in 1961 to 6.0 kg in 2009. In the last few years, no major changes have been experienced by the other broader groups. Annual consumption of demersal and pelagic fish species has stabilized at about 3.0 kg and 3.4 kg per capita, respectively. Demersal fish continue to be among the main species favoured by consumers in Northern Europe and in North America (8.6 kg and 7.0 kg per capita per year, respectively, in 2009), whereas cephalopods are mainly preferred by Mediterranean and East Asian countries. Of the 18.4 kg of fish per capita available for consumption in 2009, about 74 percent came from finfish. Shellfish supplied 26 percent (or about 4.5 kg per capita, subdivided into 1.7 kg of crustaceans, 0.5 kg of cephalopods and 2.3 kg of other molluscs).

The global growth in fish consumption mirrors trends in food consumption in general. Per capita food consumption has also been growing in the last few decades. With the exception of the periods of the food and economic crises, the global food market, including the fish market, has experienced unprecedented expansion and a change in global dietary patterns, becoming more homogeneous and globalized. This change has been the result of several factors, including rising living standards, population growth, rapid urbanization and opportunities for trade and transformations in food distribution. A combination of these factors has led to growing demand for proteic food products, in particular meat, fish, milk, eggs as well as vegetables in the diet, with a reduction in the share of staples such as roots and tubers. Protein availability has increased in both the developed and developing world, but this growth has not been equally distributed. There has been a remarkable increase in the consumption of animal products in countries such as Brazil and China and in other less-developed countries. According to FAOSTAT, annual global per capita meat consumption grew from 26.3 kg in 1967 to 32.4 kg in 1987 to reach 40.1 kg in 2007. The growth was particularly marked in the most rapidly emerging economies of developing countries, and annual per capita meat consumption in developing countries more than doubled from 11.2 kg in 1967 to 29.1 kg in 2007. The supply of animal protein continues to remain significantly higher in industrialized and other developed countries than in developing countries. However, having attained a high level of consumption of animal protein, more developed economies have been increasingly reaching saturation levels and are less reactive than low-income countries to income growth and other changes. In developed countries, per capita meat consumption increased from 61.4 kg in 1967 to 80.7 kg in 1987, but then declined to 75.1 kg in 1997 before reaching 82.9 kg in 2007.

Notwithstanding the improvement in per capita availability of food and the positive long-term trends in nutritional standards, undernutrition (including inadequate levels of consumption of protein-rich food of animal origin) remains a huge and persistent problem. Malnutrition is a major problem worldwide, with one person in seven undernourished and more than one-third of infant mortality attributable to undernutrition. This is especially the case in many developing countries, with the bulk of undernourished people living in rural areas. According to the FAO report *The State of Food Insecurity in the World 2011*,[25] the number of undernourished people was 850 million in 2006–08, of whom 223.6 million were in Africa, 567.8 million in Asia and 47 million in Latin America and the Caribbean. About two-thirds of the undernourished originate in seven countries (Bangladesh, China, the Democratic Republic of the Congo, Ethiopia, India, Indonesia and Pakistan) and more than 40 percent of them live in China and India alone. According to preliminary estimates, the number of undernourished people could have reached about 925 million people in 2010–11. At the same time, many people in countries around the world, including developing countries, suffer from obesity and diet-related diseases. This problem is caused by excessive consumption of high-fat and processed products, as well as by inappropriate dietary and lifestyle choices.

The food sector in general is encountering a period of structural adjustment as a result of growing incomes, modifications in the population structure, new lifestyles, globalization, liberalization of trade and the emergence of new markets. A greater

focus is also being given to marketing, with producers and retailers becoming more attentive to consumer preferences and attempting to anticipate market expectations in terms of quality, safety standards, variety, value addition, etc. Consumer habits have changed significantly in the past few decades, and food issues such as indulgence, convenience, health, ethics, variety, value for money, and safety are becoming increasingly important, especially in more affluent economies. In these markets, consumers are requesting higher standards in terms of food freshness, diversity, convenience and safety, including quality assurances such as traceability, packing requirements and processing controls. Consumers now demand guarantees that their food has been produced, handled and sold in ways that safeguard their health, respect the environment and address various ethical and social concerns. Health and well-being are increasingly influencing consumption decisions, and fish has a particular prominence in this respect, following mounting evidence confirming the health benefits of eating fish (see above). This is partly related to an ageing society, but food safety issues as well as obesity and allergic reactions have also raised awareness about the relationship between food and health. In more-developed economies, rapid reductions in fertility combined with improvements in survival are leading to an ageing population, wherein an increasing proportion of the population is concentrated among older age groups. In many countries of the more developed regions, more than 20 percent of the population are aged 60 or over. This affects the demand for different types of food.

These ongoing changes in consumer preferences are having an increasing impact on technological innovations and on new procedures for organizing the supply chain. The majority of product innovations deal with incremental modifications, such as variations in taste and packages designed for different forms of consumption. World food markets have become more flexible, with new products entering the markets, including value-added products that are easier for consumers to prepare. Retail chains, transnational companies and supermarkets are also emerging as a major force, particularly in developing countries, offering consumers a wider choice, reduced seasonal fluctuation in availability and, often, safer food. Several developing countries, especially in Asia and Latin America, have experienced a rapid expansion in the number of supermarkets, which are increasingly targeting lower- and middle-income consumers as well as the higher-income groups.

Growing urbanization is one of the factors modifying food consumption patterns, with an impact also on the demand for fishery products. People living in urban areas tend to devote a higher proportion of their income to food purchased and, in addition, to eat out of the home more frequently, and to purchase larger quantities of fast and convenience foods. Moreover, increasing urbanization compounds the pressure on adjacent areas to meet the demand of large, concentrated populations. According to the United Nations Population Division,[26] in 2011 52.1 percent (3.6 billion people) of the world's population were living in urban areas. Disparities in the levels of urbanization persist among countries and regions of the world, with more-developed countries having an urban share of up to 78 percent, while others remain mostly rural, in particular, LDCs (with an urban share of about 29 percent) and Africa (40 percent) and Asia (45 percent). However, also in these latter areas, a vast movement of the population towards the cities is taking place. An additional 294 million and 657 million people are expected to become urbanized by 2015 and 2020, respectively, with the bulk of the increase in urban areas expected in Asia and Africa. By 2050, the shares of urban population will be 58 percent in Africa and 64 percent in Asia, although this will still be significantly less than most other continents. The rural population is expected to decline in every major area except in Africa.

The outlook for the global food sector remains uncertain. It is facing various challenges related to the economic turndowns in selected countries and demographic issues, including growing urbanization. The long-term forecast for food demand remains positive, also driven by population growth and urbanization. In particular,

demand for fish products is expected to continue to rise in the coming decades. However, future increases in per capita fish consumption will depend on the availability of fishery products. With capture fisheries production stagnating, major increases in fish food production are forecast to come from aquaculture (see p. 188). However, future demand will be determined by a complex interaction of several factors and elements. The global food sectors, including the fishery sector, will have to face several challenges stemming from demographic, dietary, climate and economic changes, including reduced reliance on fossil energy and increasing constraints on other natural resources. In particular, the future supply and demand of food commodities, including fisheries, will be affected by population dynamics and the location and rate of economic growth. World population growth is expected to slow in the next decade, in all regions and continents, with developing countries continuing to experience the most rapid population increases. The global population is set to increase from about 7 billion in 2011 to 7.3 billion in 2015 and to 7.7 billion in 2020 and 9.3 billion in 2050, with the bulk of the increase occurring in developing countries, according to the medium-variant projections prepared by the United Nations.[27] Much of this increase is projected to come from the high-fertility countries and it is expected to occur in urban areas (see above).

GOVERNANCE AND POLICY

Rio+20

The United Nations Conference on Sustainable Development was held in June 2012 to mark the twentieth anniversary of the 1992 United Nations Conference on Environment and Development, in Rio de Janeiro, and the tenth anniversary of the 2002 World Summit on Sustainable Development in Johannesburg. Known as Rio+20, the objective of the conference – envisioned as a gathering at the highest level possible – aimed to "secure renewed political commitment for sustainable development, assess the progress to date and the remaining gaps in the implementation of the outcomes of the major summits on sustainable development, and address new and emerging challenges".[28] The two themes of the conference were the institutional framework for sustainable development and the support of a green economy in the context of sustainable development and poverty eradication.

While the green economy has no precise definition, it is viewed as a holistic, equitable and far-sighted approach to sustainability that seeks to eliminate the notion that sustainability and growth are mutually exclusive. The hope is that a transition to a green economy will result in resource exploitation that contributes to sustainability, inclusive social development and economic growth.

The conference prioritized seven thematic areas including green jobs and social inclusion, energy, sustainable cities, food security and sustainable agriculture, water, sustainable use of oceans and coasts, and disaster risk reduction and building resilience.

There are several ongoing international initiatives that seek to integrate fisheries and aquaculture into the Rio+20 agenda and framework and continue the processes established by Agenda 21 and the Rio Declaration.

FAO's corporate message to Rio+20 – and beyond – is that hunger eradication is essential for sustainable development, and sustainable consumption and production systems are essential to eradicate hunger and protect ecosystems. Underpinning this message it the need to increase food security – in terms of availability, access, stability and utilization – while using fewer natural resources, through improved management and efficiencies throughout the food value chain. This requires policies that create incentives for producers and consumers to adopt sustainable practices and behaviour. It is also necessary to promote the wide application of ecosystem approaches that encourage producers to participate in managing land, water, fisheries and water resources and help in internalizing environmental costs and benefits and rewarding environmental service provision.

FAO also contributed to specific interagency submissions that address the sustainable management of the world's oceans. The FAO Fisheries and Aquaculture Department co-authored, with the Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organization, the IMO and the United Nations Development Programme, a submission to Rio+20 titled "A Blueprint for Ocean and Coastal Sustainability",[29] which seeks to engage and focus leaders on oceans while attempting to define the green economy as it relates to marine and coastal resources. It also contributed to the "Monaco Message",[30] i.e. the outcome of a workshop convened by the Principality of Monaco on the sustainable use of oceans in the context of the green economy and poverty eradication. Key components include, *inter alia*: the protection and restoration of ocean biodiversity; a change in fisheries and aquaculture management regimes with an emphasis on non-subsidized and sustainable practices; climate change adaptation (CCA) and disaster risk management (DRM); integrated coastal management; and other cross-sectoral and comanagement approaches.

In addition, the FAO Fisheries and Aquaculture Department contributed to a paper co-ordinated by the United Nations Environment Programme on the "Green Economy in a Blue World",[31] and it prepared with WorldFish Center and others a paper titled "Blending Green and Blue Economics: Sustainability Transitions in the Fisheries and Aquaculture Sector of Small Island Developing States".[32]

The critical role of fisheries and aquaculture in food and nutrition security has been well-recognized at Rio+20. There is urgency to stem overfishing in marine and inland fisheries and curb the degradation of habitats caused by pollution and other forms of unsustainable use of aquatic ecosystems. Fisheries and aquaculture have considerable potential as vectors for the green economy. Their dependence on ecosystem services means that supporting sustainable fishing and fish farming can provide incentives for wider ecosystem stewardship. Therefore, in the context of the green economy, the greening of fisheries and aquaculture requires the overall recognition of their wider societal roles – in particular of small-scale operations for local economic growth, poverty reduction and food security – within a comprehensive governance framework, aiming *inter alia*: to manage externalities from or on the sector; to create alternative livelihood opportunities; and to improve access to social and financial services and education. The greening of marine fisheries and aquaculture also implicitly recognizes the urgency of reducing the carbon footprint of human activities to the goals of sustainable development and management and equitable benefit sharing of marine resources.

The main mechanisms for behavioural change and transition to green growth in fisheries and aquaculture include: (i) adopting an ecosystem approach to fisheries and aquaculture with fair and responsible tenure systems to turn resource users into resource stewards; (ii) integrating fisheries and aquaculture into watershed and coastal area management; (iii) supporting the development of and investment in "green" technology (e.g. low impact and fuel-efficient fishing methods; innovative aquaculture production systems, including greater use of environmentally friendly feeds, reduced energy use, greener refrigeration technologies and improved waste management in fish handling, processing and transportation); and (iv) building industry and consumer awareness to give preference to products from sustainable fisheries and aquaculture.

Furthermore, there is broad recognition of the need to improve ocean governance at all scales, i.e. local, national, regional and global. At the global level, there is the need for stronger coordination across the various UN agencies with mandates in ocean affairs and greater stakeholder participation, including by industry and civil-society organizations. There is also the need to strengthen the management framework for fisheries and other marine resources in areas beyond national jurisdictions. At the regional level, RFMOs need to coordinate more closely with other regional bodies and programmes including the regional seas and large marine ecosystem programmes. Capacity development and strengthening of legal and institutional arrangements are critical at the national and local levels where fisheries and aquaculture stakeholders

are often poorly represented and equipped to contribute to intersectoral planning and policy-making.[33]

Small-scale fisheries

The importance of small-scale fisheries to food security, poverty alleviation and poverty prevention in the developing world is becoming increasingly understood and appreciated. However, a lack of institutional capacity and a failure to include the sector into national and regional development policies continue to hamper the potential contributions of small-scale fisheries to economic growth, poverty alleviation and rural development. According to the latest figures, the livelihoods of about 357 million people are directly affected by small-scale fisheries, and they employ more than 90 percent of the world's capture fishers.

Since 2003, COFI has promoted efforts to improve the profile of, and understand the challenges and opportunities facing, small-scale fishing communities in inland and marine waters. Prompted by COFI, in 2008, the FAO Fisheries and Aquaculture Department embarked on a broad-based consultative process that included a global conference[34] and a series of regional workshops for Asia and the Pacific, Africa, and Latin America and Caribbean[35] to examine the need and various options for an international instrument on small-scale fisheries and a global assistance programme for the sector.

Throughout this process, strong support was expressed for the creation of an international instrument as well as for the delivery of an assistance programme. Subsequently, COFI agreed to these suggestions and recommended that this instrument should take the form of international voluntary guidelines and complement the Code as well as other international instruments with similar purposes, in particular those related to human rights, sustainable development and responsible fisheries.

The preparation of the guidelines is expected to contribute to policy development at the national and regional levels. In addition, both the process and the final product are expected to have considerable impact on securing small-scale fisheries and creating benefits, especially in terms of food security and poverty reduction. The process itself has been designed to be highly participatory and collaborative, with the inclusion of cross-sectoral, national and international consultative workshops.[36] The guidelines should be a document that is agreed by governments, regional organizations and civil-society organizations. In addition, the document should be one that small-scale fishers, fishworkers and their communities across the world feel ownership of and can relate to, thus contributing to the process of turning resource users into resource stewards.

A set of basic principles underlie the development process of the guidelines. They promote good governance, including transparency and accountability as well as participation and inclusiveness. Social responsibility and solidarity are supported, as the guidelines take a human rights approach to development (which recognizes that everyone has legally mandated rights and that these rights carry with them responsibilities). These principles include equitable development based on gender equality, non-discrimination, and respect and involvement of all stakeholders, including indigenous people.

The consultative process also aims at identifying good practices, in particular with regard to governance and resource management through the implementation of an ecosystem approach to fisheries (EAF), and by reducing vulnerability and improving livelihoods' resilience through DRM and CCA.

The guidelines promote holistic and integrated approaches that combine natural-resource and ecosystem management with social and economic development. Equal consideration should be given to the environment, social and economic development needs, and community rights.[37] Sustainability is a key concept that is valid for both bioecological aspects and human dimensions. Actions should be guided by the precautionary approach and risk management to guard against undesirable outcomes, including not only overexploitation of fishery resources and negative environmental impacts but also unacceptable social and economic consequences.

The development of the guidelines serves as both process and objective, and intends to:

- provide a comprehensive framework that enhances the understanding of the actions needed to support the governance and sustainable development of small-scale fisheries;
- establish principles and criteria for the elaboration and implementation of national policies and strategies for the enhancement of small-scale fisheries governance and development, and provide practical guidance for implementation of these policies and strategies;
- serve as a reference tool for governments, their development partners and other stakeholders in the area of small-scale fisheries governance and development with a view to assisting in the formulation and implementation of relevant actions and the establishment or improvement of required institutional structures and processes;
- facilitate cooperation in support of small-scale fisheries governance and development;
- promote further research and the advancement of the knowledge on small-scale fisheries governance and development.

Ultimately, it is expected that policies and practices will be developed and adopted, and capacities strengthened for securing sustainable small-scale fisheries at the national and regional levels.

Regional fishery bodies

The RFBs are the primary organizational mechanism through which States work together to ensure the long-term sustainability of shared fishery resources. Throughout the twentieth and twenty-first centuries, the number and diversity of RFBs have expanded so that today the term "RFBs" can apply to fishery bodies with a mandate in a particular region, for a particular species, for marine or inland fisheries and/or for aquaculture bodies. The term RFB also embraces RFMOs, which are those RFBs that have the competence to establish binding conservation and management measures.

The 2010 United Nations Review Conference (the Review Conference) encouraged all States to become parties to RFBs, as these bodies rely upon State cooperation.[38] However, despite this significant endorsement of regional bodies, it is apparent that most RFBs are experiencing difficulties in fulfilling their mandates, and that many of these mandates are outdated as they do not provide appropriate frameworks within which RFBs can address current critical fisheries management issues. The situation is reflected in "alarming statistics" on global fish stocks "highlighting the need to strengthen the regulatory regime for regional fisheries management organizations and arrangements with a view to making them more accountable, transparent and open."[39] The RFBs are intergovernmental organizations and as such they depend on the political will of their member Governments to implement agreed measures or to undertake much needed reform.[40]

New regional fishery bodies

Since publication of *The State of World Fisheries and Aquaculture 2010*, new RFBs have been established, existing RFBs have been modernized, and other RFBs are in the planning or development stage. These new, strengthened and emerging bodies represent an important step forwards in extending the global coverage of RFBs.

The Central Asian and Caucasus Regional Fisheries and Aquaculture Commission (CACFish) was approved by the Hundred and Thirty-seventh Session of the FAO Council in October 2009.[41] It deals with fisheries management and aquaculture in inland waters within the territorial boundaries of the States of Central Asia (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan) and of the Caucasus (Armenia, Azerbaijan, Georgia and Turkey). The agreement to establish CACFish came into effect on 3 December 2010.

The Southern Indian Ocean Fisheries Agreement (SIOFA)[42] aims to ensure the long-term conservation and sustainable use of Southern Indian Ocean fishery resources

(other than tuna) outside national jurisdictions in the area (which is defined in Article 3 of the agreement).

In 2008, the Inter-American Tropical Tuna Commission (IATTC) comprehensively updated and replaced its 1950 convention with the new Antigua Convention.[43] The Antigua Convention deals with tuna and tuna-like species within the convention area, which is a broad zone of the Eastern Pacific Ocean delimited by boundaries prescribed in Article 3 of the convention. The Antigua Convention came into force on 27 August 2010. The current members are: Belize, Canada, China, Costa Rica, El Salvador, European Union, France, Guatemala, Japan, Kiribati, Republic of Korea, Mexico, Nicaragua and Panama. In accordance with the terms of the convention, Taiwan Province of China has lodged a written communication of commitment to abide by the terms of the Antigua Convention.

The South Pacific Regional Fisheries Management Organisation (SPRFMO) concluded its convention on 14 November 2009.[44] The convention aims to close the high seas gap that exists in the South Pacific for the conservation and management of non-highly migratory fish stocks, as well as the protection of marine biodiversity. The convention will enter into force 30 days after the date of receipt of the eighth instrument of ratification, accession, acceptance or approval, including three coastal States (one from each side of the Pacific) and three distant-water fishing States that have been or are fishing in the Convention Area. In 2011, there was a burst of activity by signatory States and the number of ratifications increased to five (Belize, Cook Islands, Cuba, Denmark and New Zealand). The SPRFMO anticipates that the convention will come into effect in the course of 2012.

Finally, preparatory discussions aiming to create an RFB for the Red Sea have been initiated with the Regional Organization for the Conservation of the Environment of the Red Sea and Gulf of Aden. Countries from this region have been calling for the establishment of such an RFB for many years.

Regional Fishery Body Secretariats Network

The third meeting of the Regional Fishery Body Secretariats Network was held on 7–8 February 2011 in Rome, Italy. Twenty-eight RFB secretariats, with varied responsibilities for inland, coastal and marine capture fisheries and aquaculture, were represented at the meeting. The meeting discussed a range of subjects of particular relevance or importance to RFBs. These subjects included, but were not limited to: combating IUU fishing; managing fishing capacity; ecolabelling and aquaculture certification; supporting small-scale fisheries; adopting an ecosystem approach to capture fisheries and aquaculture; identification of vulnerable marine ecosystems; rebuilding of stocks; low levels of financial and human resources; pollution control; climate change; bycatch; and, where a performance review had taken place, the ongoing need to address its recommendations. The meeting concluded that, to address these issues, RFBs need financial, administrative and scientific support, plus a strong regional (as distinct from a national) focus for achieving sustainable fish stocks.

Performance review of regional fishery bodies

The need for RFBs to modernize their mandates and ensure better compliance with fishery instruments has led to numerous RFBs undergoing independent reviews of their performance. The Review Conference noted that progress had been made in developing best practices for RFMOs and in reviewing their performance against emerging standards. In addition, the Review Conference described the modernizing of RFMOs as a priority. The criteria used to assess RFMO performance have been refined through the Kobe Process (itself developed through meetings by the five joint tuna RFMOs that commenced in Kobe, Japan, in 2007).

Seven RFMOs had undergone performance reviews by the end of 2009. They included: the North Atlantic Salmon Conservation Organization (NASCO, in 2004–05 (where performance was evaluated by stakeholders and non-governmental organizations [NGOs]);[45] the North East Atlantic Fisheries Commission (NEAFC,

in 2006);[46] the Commission for the Conservation of Southern Bluefin Tuna (CCSBT, in 2006); the Indian Ocean Tuna Commission (IOTC, in 2007);[47] the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR, in 2008);[48] the International Commission for the Conservation of Atlantic Tunas (ICCAT, in 2009); and the South East Atlantic Fisheries Organisation (SEAFO, in 2009).[49]

Since 2009, another three RFBs have completed a performance review: the North Pacific Anadromous Fish Commission (NPAFC, in 2010); the General Fisheries Commission for the Mediterranean (GFCM)[50] and the Northwest Atlantic Fisheries Organization (NAFO).[51] Reports for these last two reviews were presented in 2011. The Western and Central Pacific Fisheries Commission (WCPFC) is currently undergoing a performance review.

To update its earlier stakeholder review, NASCO is planning a second performance review for 2012 using the Kobe Process. This is a significant initiative as the performance review exercise should not be seen as a singular event, and the United Nations General Assembly (UNGA) has noted the need for reviews to be regular.[52]

When a performance review is conducted, the primary subject of evaluation is the management process. This is relevant to all RFMOs because they have a prescribed management mandate. However, the performance review process is also relevant for other RFBs, including those that mainly serve as advisory bodies. The critical issue for each body, whether an advisory RFB or an RFMO, is the nature of its mandate and how effectively it is addressing its mandate. The Review Conference has encouraged all RFMOs that have not yet done so to undertake a performance review.[53] It observed that performance reviews were generally recognized as being useful, particularly when they led to the adoption of new management measures.[54] In 2011, two FAO Article VI advisory RFBs (without a prescribed regulatory mandate) also underwent the process of independent review: the Fishery Committee for the Eastern Central Atlantic (CECAF) and the Southwest Indian Ocean Fisheries Commission (SWIOFC). The Committee for Inland Fisheries and Aquaculture of Africa (CIFAA), another FAO Article VI body, is also investigating the possibility of conducting an independent review.

Regional fishery bodies can provide an example of strength through unity, with developed and developing States working cooperatively to produce sustainable fish stocks. This is more than a vision; it is a necessity for global food security.

Illegal, unreported and unregulated fishing

Illegal, unreported and unregulated (IUU) fishing and related activities threaten national, regional and international efforts to secure long-term sustainable fisheries and promote healthier and more robust ecosystems. Consequently, the international community continues to express its grave concern at the extent and effects of IUU fishing, referring to it as a "global scourge",[55] and calling for it to be addressed at all levels and on all fronts. Often, IUU fishing is encouraged through corrupt practices.

Some 90 percent of the world's fish harvest is estimated to be taken within the EEZs of coastal States. Given the limited technical capacity of developing coastal States to detect and eradicate IUU fishing and related activities, a very significant proportion of IUU fishing also occurs within their EEZs. Developing countries bear the brunt of this IUU fishing, which undermines their efforts to manage fisheries. It denies them revenue from the fish that is poached and stolen, and adversely affects their attempts to promote food security, eradicate poverty and achieve sustainable livelihoods.

There are indications that IUU fishing is moderating in some areas of the world (e.g. the northeast Atlantic Ocean) as successful policies and measures take hold. However, IUU fishing remains widespread both in the EEZs of coastal States and on the high seas, in contravention of conservation and management measures put in place by RFMOs that have mandates to take fisheries management decisions that are binding on their members. In many areas of the world, IUU fishing is of such magnitude and importance that it is considered routinely not only at RFB sessions but also at global meetings (e.g. at FAO and by the UNGA).

The issue of IUU fishing was covered in the 2010 Secretary General's report to the UNGA.[56] In UNGA Resolution 65/38,[57] IUU fishing was dealt with at length in Section IV. The emphasis given to IUU fishing in the resolution underscored the threat that this practice poses to fisheries and their ecosystem, and the need to intensify fisheries monitoring, control and surveillance, and to implement international instruments and catch documentation schemes (CDSs) and traceability schemes. In addition, the resolution encouraged international cooperation on IUU fishing among States, including through RFBs.

Shortly after the UNGA, the Twenty-ninth Session of the FAO Committee on Fisheries (COFI) addressed IUU fishing.[58] Discussion focused principally on FAO's work and activities to promote and enhance international action against IUU fishing. Subsequently, the 2011 meeting of the UN Open-ended Informal Consultative Process on Oceans and the Law of the Sea[59] also drew attention to IUU fishing, largely in the context of discussions relating to the implementation of global instruments and problems associated with unregulated fishing activities in EEZs.

The international community is deeply frustrated by the failure of many flag States to meet their primary responsibilities under international law, which are to exercise effective control over their fishing vessels and, at the same time, ensure compliance with conservation and management measures. Of particular concern are those vessels that fly flags of "non-compliance". These are flags belonging to States that sell them to raise revenue. Such States are either unable or unwilling to exercise effective control over their vessels. Many of the vessels carrying these flags engage in IUU fishing in areas beyond the national jurisdiction of the flag State (i.e. on the high seas or in areas under the sovereignty or jurisdiction of other States). As a result, the burden of controlling these rogue vessels is gradually falling on coastal States, port States, RFBs and others. Thus, these States and RFBs need to train staff, and to obtain and develop compliance tools and mechanisms required to combat IUU fishing. This shift in burden, which is costly, has important ramifications for developing countries.

The international community's irritation with IUU fishing by vessels carrying flags of "non-compliance" led FAO Members to request that a Technical Consultation on Flag State Performance be convened. Following extensive preparatory work, the first session of the Technical Consultation was held in May 2011 and a resumed session in March 2012. It is anticipated that the outcome of the Technical Consultation will be a set of voluntary criteria for assessing the performance of flag States. In addition, a list of possible actions to be taken against vessels flying the flags of States not meeting such criteria is likely to be developed.[60] An agreed procedure for assessing compliance would be an important part of the criteria.

The RFBs are grappling with IUU fishing and its effects on the resources they are attempting to manage. Many of them have difficulty in estimating the volume and value of IUU catches. Their achievements in terms of limiting IUU fishing vary widely, depending on factors that are either internal or external to their respective organizations and fisheries. Nonetheless, in one way or another, RFBs promote and implement measures to combat IUU fishing. Depending on the particular circumstances, the measures range from more passive activities such as awareness building and dissemination of information (mainly RFBs without fisheries management functions) to aggressive port, air and surface programmes (RFMOs).

Some recent examples of RFBs' activities in relation to their work on IUU fishing are:

- In 2010, the SEAFO underscored the importance of regional training. Measures to develop capacity were noted as critical tools to speed up the implementation of measures to combat IUU fishing.[61]
- In 2010, the CCAMLR expressed concern as estimates of IUU catches in the convention area had risen since 2009 and concluded that, despite progress in the control of nationals and the implementation of CDSs, IUU fishing did not appear to be declining significantly. Importantly, several Members expressed the view that the CCAMLR appeared to be unable to improve its control of IUU fishing and was,

therefore, neither fulfilling the objectives of Article II of its convention nor, as a consequence, the Antarctic Treaty.[62]

- In 2010, the NEAFC informed the Conference of the Parties of the Convention on Biological Diversity of the importance of its two main tools in addressing IUU fishing: blacklisting of vessels flying the flags of non-contracting parties, and a port State control system that controls all landings of frozen fish into the ports of NEAFC contracting parties.[63] These tools have reduced considerably the level of IUU-caught product entering the European market.

The European Commission (EC) is moving forwards with the implementation of its CDS that took effect on 1 January 2010.[64] Its purpose is to stem the flow of IUU-caught fish into the European market. Cooperation between the EC and relevant RFBs has been established to assist them to develop schemes to ensure conformity with the European Union regulation. On the whole, CDSs should provide an effective tool to strengthen existing efforts to combat IUU fishing while also providing a mechanism for improved economic returns and social development for developing countries that trade fish internationally.

Beyond national boundaries, there is increasing need for international cooperation among fishing and seafood-importing countries to improve global fisheries

Box 6

An update on the 2009 Port State Measures Agreement

On 22 November 2009, the FAO Conference approved the FAO Agreement on Port State Measures to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing (the Agreement). It remained open for one year for signature. During that period, 23 FAO Members signed the Agreement. In addition, at the 2011 session of the FAO Committee on Fisheries (COFI), 13 Members indicated that they had domestic processes in train to ratify, accept or approve the Agreement. It will enter into force 30 days after the date of deposit with the Director-General of FAO of the twenty-fifth instrument of ratification, acceptance, approval or accession. As at 30 September 2011, four FAO Members (including the European Union) had become Parties to the Agreement.

In 2011, COFI reiterated that port State measures are a potent and cost-effective tool to combat illegal, unreported and unregulated (IUU) fishing.[1] It recognized the need to assist developing countries to combat IUU fishing by building their capacity to undertake port State measures.[2] Consequently, in April 2012, a global series of capacity-development workshops to support the implementation of the Agreement was launched. The initial workshop was convened in Thailand to cater for countries from Southeast Asia. To date, Australia, Canada, Norway, the Republic of Korea and the Indian Ocean Tuna Commission have contributed to the programme, which is planned to last three years.

[1] FAO. 2011. *Report of the twenty-ninth session of the Committee on Fisheries. Rome, 31 January – 4 February 2011*. Fisheries and Aquaculture Report No. 973. Rome. 59 pp.
[2] In this respect, Article 21 of the Agreement, which addresses the special requirement of developing States, is central.

management of shared marine resources and to preserve the associated employment and other economic benefits of sustainable fisheries. In September 2011, recognizing this and in line with their commitment to the fight against IUU fishing, the European Union and the United States of America undertook to cooperate bilaterally to combat IUU fishing effectively. As leaders in global fish trade, the United States of America and European Union Members recognize their obligation to keep illegal fish out of the world market. The agreement commits the two signatories to work together to adopt effective tools to combat IUU fishing.[65]

Strengthening fisheries management capacity is fundamental in developing countries in order to facilitate sustainable fisheries and to reduce and mitigate the impacts of IUU fishing. Capacity development is especially important to support the full and effective implementation of existing and new global instruments (e.g. the 2009 Port State Measures Agreement [Box 6]) and other fisheries initiatives as tools to combat IUU fishing.

Aquaculture governance

With the recent dramatic growth in aquaculture, governance of this sector has become increasingly important and has made remarkable progress. Many governments worldwide utilize the the Code, in particular its Article 9. They also use FAO published guidelines for reducing administrative burdens and for improving planning and policy development in aquaculture. In addition, several countries have adequate national aquaculture development policies, strategies, plans and laws, and use "best management practices" and manuals on farming techniques that have been promoted by industry organizations and development agencies. The FAO Technical Guidelines on Aquaculture Certification, which were approved by the Twenty-ninth Session of COFI held in Rome from 31 January to 4 February 2011, constitute an additional important tool for good governance of the sector. By setting minimum substantive criteria for developing aquaculture certification standards, including animal health and welfare, food safety, environmental integrity and socio-economic aspects, these guidelines provide direction for the development, organization and implementation of credible aquaculture certification schemes. The ultimate aim is to ensure orderly and sustainable development of the sector.

Many governments have now recognized sustainability as the principal goal of aquaculture governance because it enables aquaculture to prosper for a long period. Long-term prosperity is predicated on fulfilling the four prerequisites for sustainable aquaculture development: technological soundness, economic viability, environmental integrity and social licence. Meeting these prerequisites also ensures that ecological well-being is compatible with human well-being.

An important component of human well-being is employment. In the last three decades, employment in the primary fisheries and aquaculture sector has grown faster than the world's population and employment in traditional agriculture (see Employment section in Part 1, p. 41). Including employment in the primary aquaculture producing sector and in the secondary services and support sector together with household dependants, more than 100 million people depend on the aquaculture sector for a living; the industry has provided, and continues to create, a good number of jobs, particularly non-seasonal jobs.

In many places, these employment opportunities have enabled young people to stay in their communities and have strengthened the economic viability of isolated areas. By generating incomes for female workers, especially in fish processing and marketing, employment in aquaculture has enhanced the economic and social status of women in many places in developing countries, where more than 80 percent of aquaculture output occurs. Through incomes from these jobs and various multipliers, employment in aquaculture has also improved the accessibility to food for many households and has increased aquaculture's contribution to the Millennium Development Goals. For these reasons, aquaculture has been heavily promoted in several countries with fiscal and monetary incentives.

However, these benefits induced by employment in aquaculture are often overlooked. The sector has developed at a time of growing scrutiny from the public, improved communications and vociferous opposition groups. Although opposition groups can act as environmental and social watchdogs and as lobby groups, putting pressure on aquaculture businesses to increase transparency and improve working conditions, it is also important to consider the benefits accruing from the sector, including employment.[66]

However, there are well-documented cases of unfair employment practices in aquaculture. For example, there are some research findings according to which aquaculture enterprises, especially large corporations, exploit local labour. One study argue that local labour is employed in lower-paid jobs, paid low salaries, and subjected to discriminatory practices such as willingly creating gender imbalances or paying female workers less than male workers doing the same jobs.[67] Child labour employment, for example, in factories, processing units, peeling sheds, and in the collection of shrimp seeds, is also sometimes highlighted.[68]

Such claims can undermine trust in the sector, threaten the credibility of policy-makers and jeopardize markets for farmed seafood. Hence, there is a need for more research into this issue, as there are sufficient indications to suggest that these practices might occur on a large scale, especially in developing countries for economic reasons.

Most countries have labour legislation to protect workers. However, compliance with such legislation can result in high indirect costs and deter firms, especially when goods are intended for export. Where these costs are high for firms and differ amply across borders, they can give enterprises operating in countries with lower labour and social standards a competitive advantage compared with those in jurisdictions with higher standards.

A possible result is that governments will be under pressure from companies to reduce labour and social standards in order to ease the burden of high indirect labour costs, thereby enhancing their competitive edge. Otherwise, the companies, especially large transnationals, may threaten to make new investments, or even to relocate existing establishments, in jurisdictions where lower labour standards exist with more amenable regulations. The threat can be exacerbated when there are negative shocks, such as fish disease outbreaks, or price or currency fluctuations, that expose companies to the risk of further erosion of their competitive position.

This pattern of behaviour becomes possible because large companies farming some species (such as shrimp, salmon, tilapia, abalone and others that become global commodities) are generally located in isolated rural communities, which gives them power over the labour force as the sole or dominant employer. To remain attractive to these companies and safeguard employment in rural communities, governments may be prepared to sacrifice good working conditions or even accept the employment of minors. Workers in these communities may also accept reduced wages and salaries, work longer hours without compensation or forgo some benefits.

A thorough understanding of these and other aspects of governance of employment in aquaculture is necessary. It will assist policy-makers in implementing corrective measures where these claims are proved well founded or in taking preventive action otherwise.

For the purpose of improving human well-being, employment in aquaculture, as in any other sector of the economy, must be equitable and non-exploitative. Principled values should guide aquaculture activities so that farmers with strong corporate social responsibility induce beyond-compliance behaviour. This would obviate the need for restrictive regulations; the best regulation is self-regulation. With an ethos of corporate social responsibility, aquaculture companies would assist local communities, employ fair labour practices and demonstrate transparency. Increasingly, with rising consumer awareness of employment practices in general, it makes good business sense for aquaculture enterprises to demonstrate (through certification, or otherwise) that they conform to the best standards. For these reasons, legislation should protect labour, particularly in developing countries, reflecting concepts of social justice and human

rights. In reality, however, labour legislation will strike a balance between concern for social justice and control measures that discourage investment. Overly cumbersome regulations can make an otherwise viable business economically unprofitable.

At a minimum, research on the governance of aquaculture employment should lead to information on:

- existing labour legislation (monitoring, enforcement and compliance);
- types of labour contracts; employment characteristics such as the nature of employment (full time or part time);
- workers' educational background, age and gender;
- remuneration schemes including possible wage discrimination, salary levels and competitiveness and minimum wages;
- working conditions such as hours of work, occupational safety and job security;
- miscellaneous benefits including bonuses, training opportunities, maternity leave, health benefits (employer-provided insurance) and education grants.

Improved governance of aquaculture based on such improved knowledge will benefit the development of aquaculture in the long term.

NOTES

1 Figures for 2000 are higher than those reported in previous editions of *The State of World Fisheries and Aquaculture* as FAO has revised downwards the non-food use estimates for China from 2000 onwards to reflect improved national information on the sector. As a consequence, per capita fish consumption for China, as well as for the world, has increased in comparison with previous assessments.

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18 See note 2.
19 Statistics reported in this section are based on data from the Food Balance Sheets published in *FAO yearbook. Fishery and Aquaculture Statistics. 2010* (FAO, 2012). Consumption data for 2009 should be considered as preliminary. Some discrepancies may occur with other sections that quote data made available to FAO more recently. Food Balance Sheet data calculated by FAO refer to "average food available for consumption", which, for a number of reasons (for example, waste at the household level), is not equal to average food intake or average food consumption. It should be noted that the production from subsistence fisheries as well as border trade between some developing countries could be incompletely recorded and might therefore lead to an underestimation of consumption.
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PART 2

SELECTED ISSUES IN FISHERIES AND AQUACULTURE

SELECTED ISSUES IN FISHERIES AND AQUACULTURE

Mainstreaming gender in fisheries and aquaculture: from recognition to reality

THE ISSUE

> "Gender mainstreaming is not only a question of social justice but is necessary for ensuring equitable and sustainable human development. The long-term outcome of gender mainstreaming will be the achievement of greater and more sustainable human development for all."[1]

In 1997, the United Nations Economic and Social Council (ECOSOC) adopted gender mainstreaming as the methodology by which the entire UN system would work towards the advancement of women and gender equality goals, noting that: "Mainstreaming a gender perspective is the process of assessing the implications for women and men of any planned action, including legislation, policies or programmes, in all areas and at all levels. It is a strategy for making women's as well as men's concerns and experiences an integral dimension of the design, implementation, monitoring and evaluation of policies and programmes in all political, economic and societal spheres so that women and men benefit equally and inequality is not perpetuated. The ultimate goal of mainstreaming is to achieve gender equality".[2]

In 2000, all 193 UN Member States and more than 23 international organizations agreed to the Millennium Development Goals (MDGs), and the issue of promoting gender equality and empowering women (MDG 3) was again highlighted on the international agenda. The objective was one of ensuring that, in whatever sector they may be working, men and women should have equal rights to participate in the development process, and their interests and needs should be protected.

Despite this, women tend to be marginalized in a variety of ways – and this is very much true for women in the fisheries and aquaculture sector. Thus, more than 30 years after the 1979 Convention on the Elimination of All Forms of Discrimination Against Women, some 15 years after the ECOSOC decision and more than a decade after the Millennium Declaration, and with only 3 years to go before the goal of achieving the MDGs by 2015, the issue at hand is how to ensure genuine and active mainstreaming of gender and the many facets of gender considerations in the fisheries and aquaculture sector.

Indeed, until recently, gender analysis in fishing communities focused mainly on the different occupational roles of men and women, i.e. that men usually do the actual fishing and women are to a large extent involved in post-harvest and marketing activities. While the role of women in the management and utilization of natural resources is generally acknowledged, their role does not carry the same weight as that of men. Given that production goals have tended to be the focus of research and policy, the predominantly male catching sector has remained the centre of attention.[3]

However, with the shift to a multidimensional and more holistic definition of poverty and the increased focus on reducing vulnerability, gender has become more central to fisheries policy and development practice. Fisheries resource management

is increasingly being linked to all levels of the so-called "deck to dish" fish value chain in which both men and women have important roles to play. With almost 45 million people worldwide directly engaged, full time or part time, in the fishery primary sector in 2008[4] and an additional estimated 135 million people employed in the secondary sector, including post-harvest activities, this is no simple task. Many involved in these sectors are recognizing that it is vital to look beyond the simplified picture of men as fishers and women as processors and to examine the more complex picture of multifaceted relationships between men and women as boat owners, processors, sellers, family members, community members and co-workers (Box 7).

Information provided to FAO from 86 countries indicates that, in 2008, 5.4 million women worked as fishers and fish farmers in the primary sector and represented 12 percent of the total. In two major producing countries, China and India, women represented 21 percent and 24 percent, respectively, of all fishers and fish farmers. Women make up at least 50 percent of the workforce in inland fisheries, while as much as 60 percent of seafood is marketed by women in Asia and West Africa. Moreover, although comprehensive data are not available on a sex-disaggregated basis, case studies suggest that women may comprise up to 30 percent of all those employed in fisheries, including primary and secondary activities.

Revealing hidden contributions

While reliable estimates are not available, a recent expert panel review paper[5] reported that women are probably more involved in aquaculture (Box 8) than in fisheries[6] but that studies of women and gender issues are more numerous for the fisheries sector than for the aquaculture sector. As the review paper points out, this relative lack of attention to gender in aquaculture may reflect the more recent history of aquaculture

Box 7

A gender baseline in the fisheries and aquaculture sector

Men and women engage in distinct and often complementary activities that are strongly influenced by the social, cultural and economic contexts in which they live. Male–female relations in the fisheries sector vary greatly and are based on economic status, power relations and access to resources.

In most regions, women have rarely participated in commercial offshore and long-distance capture fishing. Ocean-going boats for offshore deep-sea fishing have male crews – not only because of the vigorous work involved, but also because of women's domestic responsibilities and/or social norms.

More commonly, in coastal artisanal fishing communities, women manage the smaller boats and canoes that go out fishing. Women are also involved in gathering shells, sea cucumbers and aquatic plants in the intertidal zone. They also contribute as entrepreneurs and provide labour before, during and after the catch in both artisanal and commercial fisheries. In addition, they are often responsible for skilled and time-consuming onshore tasks, such as net making and mending, processing and marketing catches, and providing auxiliary services to the boats.

However, gender issues in the fisheries and aquaculture sector have seldom been examined, and the important role women that play has often been overlooked and, thus, not taken into account in decision-making processes and outcomes, thereby hindering development.

and academic interest in the complex sociology and anthropology of fishing communities and practices.

However, it is known that there are vital differences in the power positions of men and women (Box 9); as a result, women generally have less control over the value chain, their activities are less profitable, and they have access to fish of poorer quality. Women

Box 8

The contribution of women in the aquaculture sector

FAO's National Aquaculture Sector Overview[1] provides insights into the roles and contributions of women in the aquaculture sector in countries around the globe:

- In Bangladesh, women's non-governmental organizations and other entrepreneurs have encouraged women to participate in aquaculture activities.
- In Belize, most workers involved in processing are women from rural communities where unemployment levels are high and poverty is greatest.
- In Cuba, female workers constitute 27 percent of the aquaculture workforce (19 percent are intermediate and higher education technicians; 11 percent have attended higher education institutions).
- In Estonia, the gender ratio of the aquaculture workforce is 1:1.
- In Israel, the workforce is a skilled one because of the highly technical nature of aquaculture in the country. In a sector where women make up about 95 percent of the workforce, most workers have a high school diploma while a high percentage have a degree (Bachelor of Science or Master of Science).
- In Jamaica, about 8–11 percent of fish farmers are women who own and operate fish farms; and in processing plants, women dominate the workforce.
- In Malaysia, women account for about 10 percent of the total aquaculture workforce, and they are mostly involved in freshwater aquaculture and hatchery operations for marine fish, shrimp and freshwater fish.
- In Panama, 80 percent of the workforce in processing plants are women, but in the production sector only 7 percent of workers are women.
- In Sri Lanka, women constitute 5 percent of the workforce in shrimp aquaculture and 30 percent of those engaged in the production and breeding of ornamental fish.

Information such as this provides a starting point for learning about the differences between men and women in these situations and about whether there are similar opportunities, wages and benefits – or whether there are policy, governance and operational gaps that need to be addressed in order to really mainstream gender in the sector.

[1] FAO. 2012. National Aquaculture Sector Overview. NASO Fact Sheets. In: *FAO Fisheries and Aquaculture Department* [online]. Rome. [Cited 20 March 2012]. www.fao.org/fishery/naso/search/en

Box 9

Differences in power lead to different opportunities

Artisanal fisherwomen's relatively insecure access to fish resources and, hence, to fish leads to different opportunities for women and men. When fish business activities are being upscaled in response to increasing globalization, local women risk being forced out of the business and, therefore, not benefiting from development and market opportunities in the sector in which they were previously extensively involved. Examples are:

- In India in the early 1980s, shrimp marketing was initially largely in the hands of women. However, when shrimp became a higher-priced commodity, male traders arrived on bicycles and later in motorized transport, eventually forcing the fisherwomen out of this trade (Bay of Bengal Programme).
- In Cotonou, Benin, urban-based male and female traders entered the fish trade, forcing women from the fishing villages out of business and making their access to fish more difficult (Programme for the Integrated Development of Artisanal Fisheries in West Africa).
- In Senegal, as fishermen change gear and the focus of their effort in response to changing profit opportunities in their fishery (e.g. shifting from harvesting pelagic fish to cephalopods) and switch from selling into local to export markets, the local post-harvest sector can suffer (Network on Fishery Policies in West Africa).

tend to be excluded from the most profitable markets and enterprises, and from highly paid posts in fish-processing factories even though they make up the majority of workers in the post-harvest sector. Compared with men, they are often greater losers from increasing market globalization, and they are more vulnerable to poor services and catch declines.

The most significant role played by women in both artisanal and industrial fisheries is at the processing and marketing stages. Active in all regions of the world, in some countries, women have become significant entrepreneurs in fish processing. In fact, most fish processing is performed by women, either in their own household-level industries or as wage labourers in the large-scale processing industry. For example, in West Africa, women play a major role – they usually own capital and are directly and vigorously involved in the coordination of the fisheries chain, from production to the sale of fish.

Some of the factors that weaken women's capabilities in terms of participation in decision-making are:

- lower literacy and education levels;
- time burdens and constraints;
- mobility burdens and constraints;
- participation in less-formal organizations that are, as a result, weaker organizations;
- fewer or reduced organizational skills in the sense that women frequently associate in less-formal organizations and, where part of formal organizations, frequently do not hold leadership roles such as president and secretary because of poor literacy skills.

Very importantly, the absence of women from most post-harvest statistics means that it is extremely difficult to quantify the number of women and the extent of the value addition and contribution their work makes to economies. Nonetheless, inequalities are beginning to be quantified and publicized.

POSSIBLE SOLUTIONS

Women's participation as equal and productive partners in the fisheries and aquaculture sector has significant impacts on households' nutrition and living standards. If fisheries and aquaculture projects generate the data for and, potentially, include analyses of, all gender aspects (livelihood factors, relationships, actions and results), they can contribute to gender equality and promote women's participation as active agents for change in the sector (Box 10).

Data solutions

Comprehensive and accurate sex-disaggregated statistics are lacking, and this gap must be filled as one of the first steps in gender mainstreaming at the policy level. Quantitative and qualitative gender-sensitive indicators can be formulated with fishing communities to see how well policies and associated development projects satisfy the practical and strategic needs of men and women, and to help reduce existing gender gaps.

At the more macro level, statistical censuses should focus more attention on areas in which women are relatively more active. They should collect sex-disaggregated data on ownership of, access to and control over productive resources such as land, water, equipment, inputs, information and credit.

Macro-level policy solutions

As in other sectors, women's empowerment in fisheries requires examination of the means of production, gender relationships, and how to create equalities. New institutional arrangements are being created in response to climate change, resource depletion, aquaculture development and global trade. All these factors are increasingly affecting the sector, and it is vital that gender considerations are built into the new

Box 10

Quantifying inequalities

A study conducted for the United States Agency for International Development on the Bangladesh shrimp value chain[1] revealed differences in earnings between women and men (see table), a finding that created a starting point for addressing gender-related discrepancies.

Relative earnings of women compared with those of male counterparts

Activity	Percentage
Catching, sorting fry	64
Repairing ponds, undertaking casual agricultural labour	82
Processing plants – packing section	72
Processing plants – cooking/breading section	60

[1] Development & Training Services, Inc. 2006. *A pro-poor analysis of the shrimp sector in Bangladesh* [online]. USAID. [Cited 21 May 2012]. www.usaid.gov/our_work/cross-cutting_programs/wid/pubs/Bangladesh_Shrimp_Value_Chain_Feb_2006.pdf

arrangements. Increasingly, practical manuals for gender mainstreaming and gender analysis are being produced to facilitate just such changes.[7]

Responsible governance of tenure and tenure security, especially of access to natural resources, are issues where mainstreaming gender can have a marked effect. Providing policies that create the opportunities for ensuring equitable resource access rights, access to markets, benefits from aquaculture and codes of conduct for the industry – especially for the most marginalized and poorest categories of men and women – can empower people to become more equal stakeholders. However, where governance and policies are developed without a strategic assessment of the relative roles of the men and women involved, the effect can be to disempower stakeholders.

Resource control and access

In addition to the responsible governance of tenure, the broader issue of women's access to and control over resources is an important gender consideration. For women to have a real impact on their economic situation and their position in society, it is essential that they have access to and control over aquatic resources as well as appropriate information that enables them to use such resources wisely.[8]

Development arena solutions

Gendered value-chain approaches can be used to recognize and value women's roles and contributions to agriculture and fisheries. To mainstream gender equality in development cooperation programmes and related activities, a number of steps are essential:[9]

- Require that programmes and related activities generate or obtain sex-disaggregated statistics (not only at the level of project and/or programme beneficiary, but also at both middle and macro levels of policy and governance) and qualitative information on the situation of women and men for the population in question. This information is required.
- Conduct a gender analysis with regard to: the gendered division of labour; access to and control over material and non-material resources; the legal basis for gender equality/inequality; political commitments with respect to gender equality; and the culture, attitudes and stereotypes that affect all preceding issues. Gender analyses should be conducted at the micro, meso and macro levels.
- Conduct a gender analysis of a programme or project concept to reveal whether gender equality objectives are articulated in the initial idea, whether or not the planned activity will contribute to or challenge existing inequalities, and whether there are any gender issues that have not been addressed.
- During the identification and formulation phases, ensure that the gender analysis contributes to the identification of entry points for actions that will be needed in order to meet gender equality objectives.
- Strengthen the participatory and organizational capacity of stakeholders at various levels so that they are better able to translate gender concerns into actions. This includes strengthening female umbrella organizations that can participate in debates and in project and programme processes.
- Put in place a gender-sensitive monitoring and evaluation system from the design phase onwards, including the establishment of indicators to measure the extent to which gender equality objectives are met and changes in gender relations are achieved.

On the ground – closing the gap in social capital

Building women's social capital can be an effective way to improve information exchange and resource distribution, to pool risks and to ensure that women's voices are heard in decision-making at all levels. This includes strengthening women's organizational abilities and roles and developing the capacity of women to take on leadership positions and engage with decision-makers and other stakeholders.

Functioning as production cooperatives, savings associations and marketing groups, women's groups can promote production and help women maintain control over the additional income they earn, as has been demonstrated by a project based around polyculture fish production in Bangladesh. As the project proved successful in providing additional incomes, the position of women within the household and community was also strengthened.[10] Indeed, in communities with a high level of gender segregation, single-sex groups may lead to more desirable outcomes for women.[11]

However, excluding men can sometimes generate unnecessary obstacles. A project to introducing the new livelihood strategy of mud-crab production to supply hotels on Unguja Island, United Republic of Tanzania, excluded men. The resultant anger among the men added transaction and input costs as women had to rely on a small number of male fishers for seedstock and feedstuffs.[12]

The clear message here is that interventions within the local sociocultural dynamics should base their interventions on the specific context – including the gender segregation within a community – and the underlying problem.

RECENT ACTIONS

The issues of women, gender and fisheries have been highlighted in a series of international and now global symposiums and other related initiatives:[13]

- The Global Conference on Aquaculture 2010 delivered the Phuket Consensus and responded to the recommendations of Expert Panel VI.3 (Sustainable Aquaculture by Developing Human Capacity and Enhancing Opportunities for Women Development) by including a recommended action to: "Support gender sensitive policies and implement programmes in line with globally accepted principles of gender equality and women's empowerment."
- The 2011 Special Workshop on Future Directions for Gender in Aquaculture and Fisheries Action, Research and Development (Shanghai, China)[14] prepared a working draft of a working vision statement for mainstreaming gender in the aquaculture and fisheries sectors: "To promote and achieve gender equity in the aquaculture and fisheries sector in support of responsible and sustainable use of resources and services for food and nutrition security, quality of life of all stakeholders, primarily women, children, vulnerable and marginalized groups/communities."

Other ongoing initiatives that have contributed to increasing attention on gender issues in fisheries and aquaculture include:

- the triennial symposia on women and gender in fisheries and aquaculture organized by the Asian Fisheries Society;
- the Women in Fisheries publications of the Secretariat of the Pacific Community, and *Yemaya* (published by the International Collective in Support of Fishworkers);
- the Asia–Europe Meeting Aquaculture Platform (AqASEM09) project work on Empowering Vulnerable Stakeholder Groups.

OUTLOOK

No single blueprint exists for closing the gender gap as yet, but some basic principles are universal,[15] and its seems plausible that governments, the international community and civil society will work together to:

- eliminate discrimination under the law, improving women's endowments, opportunities and agency to help shape more positive outcomes for the next generation;
- promote equal access to resources and opportunities, reducing barriers to more efficient allocation of women's skills and talents and helping to generate large (and growing) productivity gains;
- ensure that policies and programmes are gender-aware, increasing women's individual and collective agency to produce better outcomes, institutions and policy choices;
- make women's voices heard as equal partners for sustainable development.[16]

In addition to helping to achieve the MDG of promoting gender equality and empowering women, mainstreaming gender is an essential component of alleviating poverty, achieving greater food and nutrition security, and enabling sustainable development of fisheries and aquaculture resources.

Gender considerations should be firmly placed on all fisheries and aquaculture policy agendas at all geographical and institutional scales. Attention to gender is needed in order to help improve women's productivity and enhance human justice. Increasing awareness on gender and being gender-sensitive are no longer sufficient. A coalition of gender champions, informed researchers, expert networks and policy advocates will be necessary.[17]

An opportunity to alleviate poverty and ensure greater food and nutrition security

Women who are offered and provided with the best circumstances to enhance their socio-economic empowerment will also be able to contribute meaningfully to food security, poverty alleviation and improved well-being for themselves, their families and their communities. In short, they will help to create a world in which responsible and sustainable use of fisheries and aquaculture resources can make an appreciable contribution to human well-being, food security and poverty alleviation.

An opportunity for economic empowerment

Economic empowerment should be the end goal of a road map on gender in fisheries and aquaculture. Economic empowerment is not narrowly focused on the financial component but rather on having the ability to recognize and exploit opportunities to make wealth and to make the right decisions, which means having the capacity for analytical thinking – and this boils down to having a good education (formal or informal) and appropriate human capacity development.

An opportunity to contribute fully

By mainstreaming gender in the fisheries and aquaculture sector, women will be given a chance to recognize and appropriately exploit opportunities to generate wealth and to make the right decisions in terms of more responsible fisheries and aquaculture practices and sustainable development.

Improved preparedness for and effective response to disasters in fisheries and aquaculture

THE ISSUE

Fishers, fish farmers and their communities around the world tend to be particularly vulnerable to disasters. This is because of their location, the characteristics of their livelihood activities, and their overall high levels of exposure to natural hazards, livelihood shocks and climate change impacts. Exposure and vulnerability to these hazards is increasing. For example, in the past century, there has been an increasing trend in the number of natural disasters reported around the world (Figure 36).

The social, economic and environmental impact of these disasters is significant, with disproportionate effects in developing countries and on vulnerable groups. Between 2000 and 2004, of the 262 million people affected annually by disasters related to weather and climate, more than 98 percent lived in developing countries and the vast majority were dependent mainly on agriculture and fisheries for their livelihoods.[18] Loss of life from such events is more prevalent in developing countries – from 1970 to 2008, more than 95 percent of deaths from natural disasters were in developing countries.[19] In 2010 alone, a total of 385 natural disasters killed more than 297 000 people worldwide, affected more than 217 million others and caused almost US$124 billion of economic damages.[20] It is acknowledged that the poor will be most affected by such hazards in the future and that this is likely to undermine progress

toward poverty reduction.[21] While total economic damage from disasters tends to be higher in developed countries, as a percentage of gross domestic product it is higher in developing countries.[22]

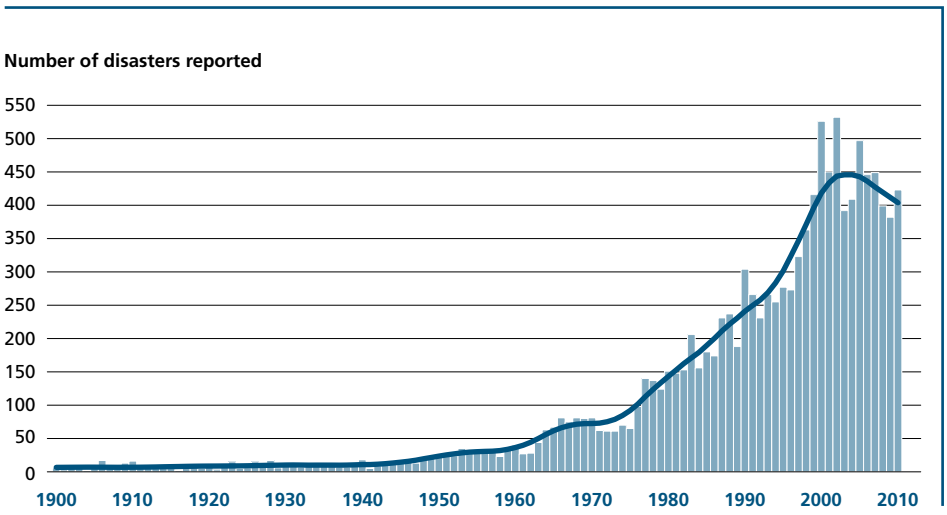
The types of disasters that affect the fisheries and aquaculture sector include natural disasters such as storms, cyclones/hurricanes with associated flooding and tidal surges, tsunamis, earthquakes, droughts, floods and landslides. Disasters of human origin affecting the sector have included oil and chemical spills and nuclear/radiological material. Food and nutrition security, post-conflict and protracted crises, HIV/AIDS and sector-specific hazards (e.g. transboundary aquatic animal diseases and pest outbreaks) can also have significant impacts on aquaculture production and fisheries. In addition to the tragic loss of life, the effects of disasters on the sector can include the loss of livelihood assets such as boats, gear, cages, aquaculture ponds and broodstock, post-harvest and processing facilities, and landing sites. In the longer term, the impact of the effects of disasters can be considerably mitigated by the effectiveness of response activities. However, damage caused by disasters can have social and economic impacts throughout and well beyond the sector (such as in terms of reduced employment and food availability). Other longer-term disasters such as fish disease outbreaks can build up over time and significantly affect production.

The vulnerability of countries and communities to these hazards is determined, on the one hand, by their exposure to such hazards and, on the other, by their ability to withstand (sensitivity), respond to and recover from (adaptive capacity) the effects of such hazards. Thus, susceptibility is directly affected by underlying issues such as food and nutrition insecurity, weak institutions, conflict and poor access to markets. However, the way each of these issues affects people varies considerably. Men and women, the old and the young, the rich and the poor, and small-scale and large-scale undertakings are all affected differently and have different ways of responding to hazards that affect them. Different people can also have quite distinctly different needs in the face of an emergency, face different threats and have different skills and aspirations.[23]

For coastal fishers, fish farmers and their communities, the relationship between them and the ecosystems that they depend on is complex.[24] This complexity is changing as the interface between fishers and fish farmers and the ecosystem is being affected by both slow- and rapid-onset hazards. The exposed nature of the livelihoods of fishers

Figure 36

Natural disasters reported worldwide, 1900–2010



Source: EM-DAT. 2012. *EM-DAT: The OFDA/CRED International Disaster Database* [online]. Université Catholique de Louvain, Brussels. [Cited 22 March 2012]. www.emdat.be

and fish farmers, and the location of their communities, means that hazards often become disasters.

The extent of the impact of such disasters is also affected by people's social and economic conditions, which often include poverty and marginalization, especially in developing countries. Given the important role of the fisheries and aquaculture sector in food and nutrition security at both the local and national levels, disasters that affect these communities will also have multiplier effects on the wider economy. Fishers, fish farmers and their communities have been particularly affected by recent major events such as the Asian tsunami of 2004, Cyclone Nargis (which affected Myanmar in 2008), the recent floods in Bangladesh, Pakistan and Viet Nam, and the 2011 tsunami in Japan.

The effect of these hazards on fishing communities is increasing for a number of reasons. Extreme weather events are becoming more frequent, often associated with increasing climate variability and change. The impacts of disasters on coastal communities are particularly pronounced in the case of subsea events resulting in tsunamis (geological), storm surges and coastal flooding (hydrological), and coastal and lakeshore storms (meteorological). Droughts and floods can also affect river flows, wetland areas, and lacustrine and riparian communities. More indirectly, droughts and other catastrophic events can cause mass migration of people into areas normally occupied by fishing and fish-farming communities, so increasing competition for resources such as water.

Fishers, fish farmers and their communities are also often exposed to more prolonged hazards such as the spread of fish disease, the increase in invasive undesirable alien species, pollution from land and aquatic sources, and aquatic ecosystem degradation from farming, mining, industry and urbanization. Moreover, fishers, fish farmers and their communities often live in locations where tenure over land and other resources is contested, leading to disputes and more complex emergencies.

The land–water interface is being particularly affected by inward migration and the unsustainable use of resources. The result can be a depletion of the ecosystem services that these resources provide, particularly protection from coastal hazards such as storms and cyclones, and a reduction in support for productive livelihoods. Deforestation is leading to increased sedimentation and land erosion in coastal, lakeshore and delta regions, and this can adversely affect marine habitats (especially reefs). In addition, the effects of population increases in fishing and fish-farming communities are compounded by the lack of alternative livelihood options and weak market linkages.

The susceptibility of fishers, fish farmers and their communities to rapid-onset disasters is also being affected by climate change.[25] Seasonal weather patterns are likely to change, with some areas experiencing greater periods of drought and others more floods. Extreme weather events, such as storms, are likely to increase in frequency and affect fishing operations, and coastal and wetland flooding is likely to become more frequent. Increased precipitation in some areas will lead to the erosion of riparian lands and to greater sedimentation in coastal areas, affecting seagrass and reef production. Sea-level rise is likely to increase coastal flooding, and the incursion of saltwater into coastal areas will affect agricultural production and fish farming. Species distributions are also being changed, and increased temperatures are likely to affect coral reefs adversely, with higher incidences of coral bleaching occurring. Temperature changes will also affect fish physiology, with implications for both capture fisheries and fish farming. Increased ambient air temperatures could have very significant effects on the types of fish that can be cultured.

Changes in weather patterns will affect traditional fish processing methods, especially where fish is sun-dried. In some locations, this may be of benefit for processors. However, in other locations, poor weather in glut fish landing seasons will affect drying rates, with the potential for substantial losses. There are also likely to be changes in terms of road access to markets where unusual flooding or heavy rains occur.

Badly managed fisheries and aquaculture farms may cause increased stress in fish, reduce water quality, and make fisheries and aquaculture more exposed to climate change threats such as changes in water temperature and salinity.

Changing weather patterns will also affect non-fisheries livelihood strategies and will increase pressure on people to join a fishery where other opportunities have decreased. Efforts to redirect fishing to alternative livelihoods are also being affected by climate change effects on livelihood options and opportunities in the wider economy.

POSSIBLE SOLUTIONS

Reducing the effects of disasters on the fisheries and aquaculture sectors can be achieved through measures for prevention, mitigation,[26] and preparedness (disaster risk reduction [DRR]; Box 11). In the fisheries and aquaculture sector, this includes preparedness to respond rapidly and effectively if disasters occur, and early warning to provide information before potentially disastrous events occur. Managing the effects of hazards and disasters (disaster risk management [DRM]) goes beyond DRR to incorporate emergency response, recovery and rehabilitation within a management framework. Thus, as shown in Figure 37, DRM involves three distinct phases: (i) reducing vulnerability; (ii) responding to emergencies when they arise; and (iii) rehabilitating communities after the emergency has passed.

Box 11

Disaster management and climate change adaptation: key definitions

Disaster risk reduction (DRR) is the concept and practice of reducing disaster risks through systematic efforts to analyse and manage the causal factors of disasters, including through reduced exposure to hazards, lessened vulnerability of people and property, wise management of land and the environment, and improved preparedness for adverse events.[1]

Disaster risk management (DRM) goes beyond preparedness, prevention and mitigation, which form the core of DRR, to incorporate emergency response, recovery and rehabilitation within a management framework.[2]

Climate change adaptation (CCA) refers to adjustments in ecological, social or economic systems in response to actual or expected climate stimuli and their effects or impacts. This term refers to changes in processes, practices and structures to moderate or offset potential damages or to take advantage of opportunities associated with changes in climate. It involves adjustments to reduce the vulnerability of communities, regions and activities to climate change and variability. Adaptation is important in the climate change issue in two ways: one relating to the assessment of impacts and vulnerabilities; and the other to the development and evaluation of response options.[3]

[1] United Nations International Strategy for Disaster Reduction. 2009. Terminology. In: *UNISDR* [online]. [Cited 20 April 2012].

[2] Baas, S., Ramasamy, S., Dey DePryck, J. and Battista, F. 2008. *Disaster risk management systems analysis: a guide book* [online]. Rome, FAO. [Cited 19 March 2012]. ftp://ftp.fao.org/docrep/fao/010/ai504e/ai504e00.pdf

[3] Intergovernmental Panel on Climate Change. 2001. *Climate Change 2001: Impacts, Adaptation, and Vulnerability*. Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, UK, Cambridge University Press. 1042 pp.

Key actions in the DRM cycle may include:

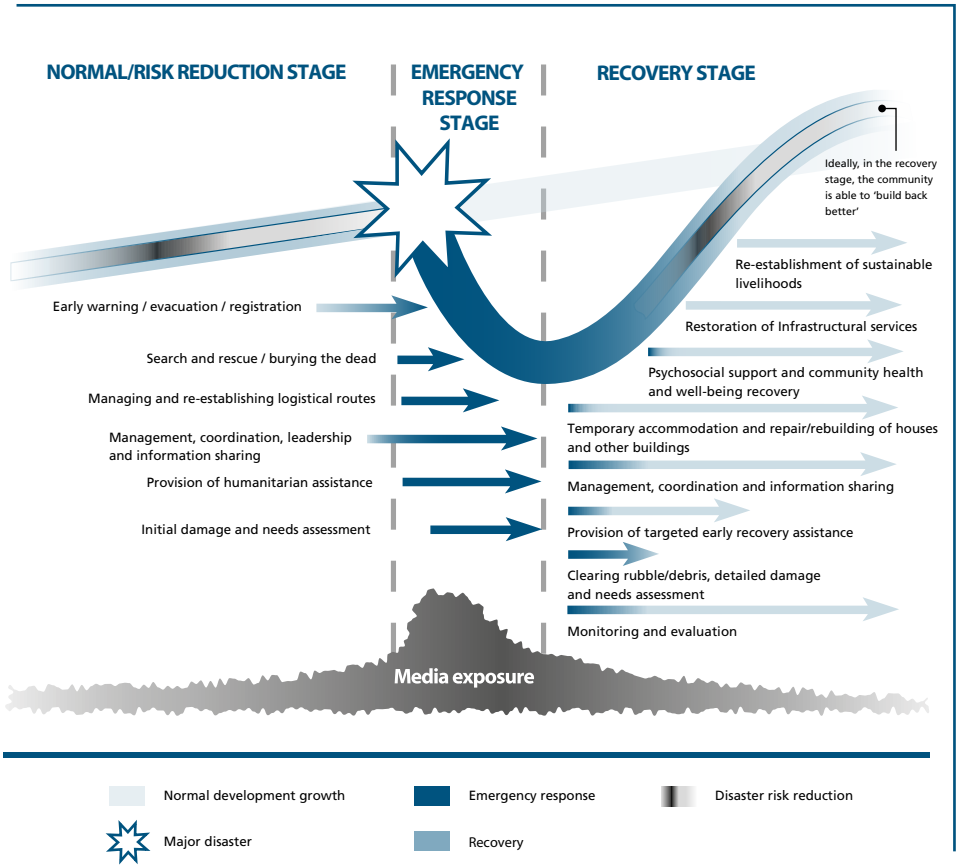
- assessment of damage and need (with respect to fisheries and aquaculture);
- rehabilitation of livelihoods (to reduce dependence on food aid);
- longer-term development and planning and preparedness;
- relief or emergency response to address immediate humanitarian needs and to protect livelihoods following a disaster;
- rehabilitation to initialize the restoration and rebuilding of livelihoods;
- reconstruction for replacing destroyed infrastructure;
- sustainable recovery for longer-term re-establishment and enhancement of livelihoods and livelihood support structures.

During emergency response, advocacy is required in order to ensure that recovery efforts comply with international instruments (including the Code of Conduct for Responsible Fisheries [the Code] and the MDGs) and are guided by international best practice, national policies and agreed recovery plans. This can include the promotion of:

- sustainable rehabilitation of fishing and fish farming;
- fish preservation and processing practices compatible with the state of fishery resources;
- rehabilitation and conservation of the environment and fisheries resources;
- strengthened governance and community-based planning;
- strengthening and diversification of sustainable livelihoods of traditional fishing and fish-farming communities.

Figure 37

The disaster risk management cycle[1]



[1] This mainly applies to a relatively quick-onset disaster (e.g. cyclone, flood, earthquake, tsunami, bushfire), rather than a slow-onset one such as famine (due to drought/war).

Source: Adapted from: Piper, C./TorqAid. 2011. *DRMC version XVI* [online]. [Cited 22 March 2012]. www.torqaid.com/images/stories/latestDRMC.pdf

Resilience to the effects of disasters can be achieved by working with communities and multilevel stakeholders to reduce their sensitivity to disasters (through preventive actions or by reducing levels of dependence) and/or by strengthening coping and adaptive strategies that respond to those hazards. In so doing, the differences between different stakeholder groups within a given community need to be carefully considered.

As the effects of climate change will be to alter the magnitude and frequency of extreme events, it is important to recognize that existing coping and response mechanisms to disasters – based on past vulnerabilities – may no longer be appropriate for what is to come. Indeed, in many countries, existing mechanisms are already insufficient for the current level of vulnerability.[27]

Climate change and more rapid-onset hazards such as cyclones, floods and earthquakes are related in a number of ways:

- They both directly affect the livelihoods of fishers and fish farmers and invariably reduce the quality of those livelihoods.
- They interact to compound the adverse effects of both – most noticeable will be the increased frequency and impact of extreme events as a result of climate change.
- Climate change will interact with extreme events to change their location and, thus, the communities affected.
- Adaptation to both forms of hazard at the community level tends to have many aspects in common.

Effective DRM needs to consider changing climate risk patterns, and, given that an increase in extreme climate events is one of the major threats posed by climate change, DRM is a natural entry point for adaptation.[28] When considering adaptation to climate change risks, it should be recognized that adaptive capacity has developed as a response to existing vulnerability to extreme events. Improving the adaptive capacity of communities, civil society and governments to deal with current hazards is also likely to improve their capacity to adapt to climate change.[29]

The extent of climate change effects on fishing and fish-farming communities has been extensively investigated.[30] The exposure and vulnerability of fishing communities to hazards is increasingly being seen as a convergence of climate change and more acute hazards. This compounds situations where natural resources are already overexploited or under other forms of pressure from human activities. The Intergovernmental Panel on Climate Change has recently drawn attention to the need to integrate expertise in climate science, DRM and adaptation in order to reduce and manage more effectively the risks of extreme events and disasters in a changing climate.[31] However, climate change adaptation (CCA) is not simply an extension of DRM. Adaptation to climate change not only means addressing changes in the intensity and frequency of extreme events, but also more subtle changes in climate conditions as well as emerging risks that have not been experienced in a region before.[32] Some effects of climate change, such as global changes in sea levels, are new within recent human history, and little experience is available to tackle such impacts.[33]

This growing interconnectedness of climate change and more acute events suggests a need for a convergence of DRM and CCA preparedness and response approaches, particularly at the land–water interface where the effects are felt most strongly and particularly by fishers, fish farmers and their communities. This would suggest that DRM and CCA need to be fully incorporated into fisheries and fish-farming policies and plans, and that fisheries and fish farming should be fully considered in CCA and DRM approaches. In addition, the increasing vulnerability of the poor to both climate change and hazards would suggest that CCA and DRM need to link to livelihoods (taking account of the different assets and production, coping and adaptive strategies of different groups, such as the old and the young, men and women, and people from different cultures and religions) in a holistic and integrated way. Moreover, the implications of both extreme events and climate change for wider national and regional food security suggest that these elements also need to be integrated with each other.

RECENT ACTIONS

A World Conference on Disaster Reduction was convened by the United Nations General Assembly (UNGA) in Hyogo, Japan, in 2005 just a few weeks after the Indian Ocean tsunami. The conference, which was attended by representatives of 168 States, agreed on a strategic and systematic approach to reducing vulnerabilities and risks to hazards. The need for building resilience of nations and communities was stressed, and the conference adopted five priorities for action:

- Ensure that DRR is a national and a local priority with a strong institutional basis for implementation.
- Identify, assess and monitor disaster risks and enhance early warning.
- Use knowledge, innovation and education to build a culture of safety and resilience at all levels.
- Reduce the underlying risk factors.
- Strengthen disaster preparedness for effective response at all levels.

The Hyogo Framework for Action (HFA) 2005–2015: Building the Resilience of Nations and Communities to Disasters was endorsed by the UNGA in Resolution 60/195. The ten-year plan of the HFA reflects the intention to take a holistic approach in identifying and putting into action complex multidisciplinary DRR measures. The HFA supports a stronger recognition of climate change concerns in DRR strategies and seeks to establish a multidisciplinary, forward-looking approach. It also calls on the United Nations International Strategy for Disaster Reduction to facilitate the coordination of effective and integrated action among the organizations of the UN System and among other relevant international and regional entities, in accordance with their respective mandates, to support the implementation of the HFA.

In line with the HFA, FAO has developed a Framework Programme on Disaster Risk Reduction/Management. The Framework Programme strives to assist Members in implementing the HFA five priorities for action in the agriculture sector. The direction and content of the Framework Programme respond to recent recommendations by FAO governing bodies, including priority areas as identified by FAO Regional Conferences. These "pillars" are: (i) institutional strengthening and good governance for DRR in the agriculture sector; (ii) information and early warning systems on food and nutrition security and transboundary threats; (iii) preparedness for effective response and recovery in agriculture, livestock, fisheries and forestry; and (iv) good practices, processes and technologies for mitigation and prevention in farming, fisheries and forestry. Interventions under the Framework Programme are tailored to the specific strengths and needs of a country or region and delivered in a demand- and modular-responsive manner.

The fisheries and aquaculture sector must be considered in a different way to other sectors (such as agriculture) in emergencies in view of the many unique challenges related to management and the complex range of activities undertaken by fishers and fish farmers. Specifically, within the fisheries and fish-farming sector, FAO has initiated a programme of consultation with partners at the global level, where the synergies between managing climate change and DRR were explored.[34] At the regional level, in Bangkok, Maputo and San José, consultations with partners addressed regional issues,[35] where the integration of fisheries and aquaculture with DRM–CCA was discussed in detail and options for taking this integration forward were outlined. The need for this integration was further endorsed at the 29th Session of the FAO Committee on Fisheries (COFI) in 2011. The different initiatives at the regional and international level constitute important opportunities for ensuring that concerted efforts are made to tackle the issues relevant to DRM and CCA. However, challenges remain with regard to integrating CCA and DRM sufficiently in fisheries and aquaculture governance and development planning and implementation and, vice versa, integrating fisheries and aquaculture into CCA and DRM, and taking the characteristics and special needs of fishers, fish farmers and their communities into account in DRM and CCA policies and actions. To this extent, FAO is actively involved in identifying climate-related vulnerabilities and adaptation strategies, including DRR/DRM, specific to fisheries and

aquaculture in order to inform more fully fisheries and climate-change decision-makers. The work of the FAO Fisheries and Aquaculture Department is aligned to priorities expressed in international, regional and national policies and agreements, such as national adaptation programmes of action for least-developed countries and regional strategies/agreements for disaster reduction and related programme of action. It is also aligned with the FAO Framework Programme on Climate Change Adaptation (known as FAO-Adapt).

Furthermore, the FAO Fisheries and Aquaculture Department continues to provide support to FAO Members and partners in responding to emergencies affecting the fisheries and aquaculture sector. Since 2005, it has supported emergency responses through 135 projects in 25 countries. The overall objective of this support has been to strengthen food and nutrition security through the sustainable rehabilitation and long-term recovery of the fisheries and aquaculture sector and the livelihoods that depend on it. In particular, efforts have focused on targeting women and other marginalized groups. The technical advice provided aims to ensure that these efforts are aligned to national policies, regional strategies and international best practice and guidance for the sector, in particular the Code.

OUTLOOK

In view of the in-depth and ongoing consultation with partners and stakeholders from the DRM, CCA and fisheries and fish-farming sectors, it seems likely that that the key areas for action in the coming years will include:

- strengthening policy coherence and institutional structures to ensure explicit and adequate consideration of fisheries and aquaculture activities in disaster preparedness and CCA strategies;
- integrating an understanding of the increasing vulnerability of fishers, fish farmers and their communities both to extreme events and to climate change, and developing and incorporating comprehensive preparedness and response strategies into fisheries and fish-farming sector plans and wider development frameworks;
- building an increased understanding of the vulnerability of fishers, fish farmers and their communities into wider social, economic and environmental development plans;
- working with communities, governments and civil society to help build their productive, coping and adaptive capacity and to ensure that the adaptive, coping and livelihood strategies of fishers, fish farmers and their communities are incorporated into wider disaster preparedness and response strategies;
- developing shared tools, guidance and approaches that combine DRM and CCA at a practical level and that link into fisheries and fish-farming development strategies to increase the resilience of communities and that of aquatic systems on which they depend;
- building partnerships at the global, regional, national and subnational levels among international agencies, national agencies, local government, civil society and communities to learn lessons about, prepare for and respond to slow- and rapid-onset hazards in an integrated and informed way.

Managing recreational fisheries and their development

THE ISSUE

Recreational fishing is well established in most developed countries and expanding fast elsewhere. It involves a large number of individuals, and there is growing awareness that recreational fishing is a considerable industry in terms of numbers of practitioners, catch and social and economic relevance. However, in many recreational fisheries, this awareness has not been accompanied by enhanced management practices, and

concerns are spreading about the influence of recreational fishing on the livelihood opportunities of full-time fishers, on the environment and on aquatic biodiversity.

Recreational fishing is fishing of aquatic animals that do not constitute the individual's primary resource to meet nutritional needs and are not generally sold or otherwise traded on export, domestic or black markets.[36] While angling is how most people perceive recreational fishing, the activity also includes gathering, trapping, spearing, bow fishing and netting aquatic organisms. Recreational fishing currently constitutes the dominant use of wild fish stocks in freshwater environments of industrialized countries. The increased affordability of high-efficiency fishing equipment (including navigational devices, fish finders and improved boats) and ongoing urbanization in coastal zones have resulted in a continuing expansion of recreational fisheries in coastal and marine environments.

Although estimates are difficult, the total annual catch by recreational fishers was estimated at 47 billion fish in 2004, or at about 12 percent of the total world catch.[37] Tentative estimates indicate that about 10 percent of the population in developed countries practise recreational fishing, and recreational fishers probably number more than 140 million worldwide.[38] One study,[39] summarizing ecosystem-based marine recreation valuation results, estimated the total number of marine recreational fishers for 2003 at 58 million. Several million jobs depend on recreational fisheries as associated spending may add up to billions of dollars annually. In the United States of America and in Europe, where angling is the best-documented form of recreational fishing, it has been estimated in recent years that there are at least 60 million and 25 million recreational anglers, respectively;[40] and it has been estimated that there are 8–10 million recreational saltwater fishers in Europe.[41] Similarly, it was estimated in 2009 that some 10 percent of the population in Central Asia were involved in recreational fisheries in inland waters of that region.[42]

The contribution that recreational fishing can make to local economies is considerable, including in less-developed countries. In some areas, the income and employment generated by the spending of recreational fishers is higher than that generated by commercial fisheries or aquaculture. Improved valuation of natural habitats and clean waters have been additional benefits of recreational fishing.[43]

Recreational fishing has shown itself able to provide value as an educational activity, promoting the concept of responsibility for fish stocks and the environment they inhabit and upon which all people depend. Recreational fishers often have a strong sense of responsibility for the environment in which they fish, as is, for example, recognized by the Bern Convention of the Council for Europe in the European Charter on Recreational Fishing and Biodiversity (2010).[44]

In some cases, aquaculture escapees have come under the control of sports fishers. In southern Chile, recreational fisheries that used to be based only on rainbow trout and brown trout now include escaped Atlantic salmon (*Salmo salar*) and chinook salmon (*Oncorhynchus tshawytscha*). In Chile and Argentina, where chinook salmon have migrated successfully in the ocean, self-sustained populations of chinook salmon have generated much enthusiasm among recreational fishers and concerns among conservationists.[45]

However, at times, recreational fishers also interact negatively with professional small-scale and artisanal fishers in open-access areas and at common fishing grounds. There are records of controversial and anecdotal observations of the detrimental effects of recreational fisheries, such as spear fishing on individual species of groupers along the coasts of the Mediterranean and Australia[46] and in the eastern Red Sea.[47] Moreover, recreational diving for species such as Caribbean spiny lobster[48] in combination with commercial fisheries and other pressures (e.g. pollution) has caused significant declines in certain stocks.

Nevertheless, recreational fishers have the potential to enhance fish conservation and maintain or rehabilitate important habitat.[49] As stakeholders, they can be instrumental in successful fisheries conservation through participation in management and conservation endeavours.

Increasingly, recreational fishers are capable of reaching offshore fishing grounds and use technologies – including fish-locating devices – that can make them equivalent to commercial fishers in term of fishing capacity and capability. Recreational fisheries have developed for species historically only exploited by the commercial fishery, in some cases causing conflict between the sectors.[50] Fishing similar locations and using the same types of fishing gear and facilities, such as moorings, can also put recreational fishers in competition with coastal small-scale commercial fishers. Other specialized recreational fisheries target highly iconic species such as salmon, marlins, sailfish and swordfish, often in particular areas and seasons, contributing significantly to the total catch. However, it should be noted that most game fishing associations actively promote catch-and-release practices and that the fish caught in game fishing tournaments are generally released unless the fish caught is a record fish.

Many recreational fisheries tend to be highly selective. Often, recreational fisheries target larger individuals in the population. However, removal of larger individuals of long-lived species may have important effects on the reproductive potential of the population.[51] Larger females are more fecund, spawn over prolonged periods (thus providing more resilience to changing environmental conditions), and can produce larvae with higher survival rates. Sequential hermaphroditic species may have large individuals of the same sex and their sustained removal can affect spawning success. Age- or size-truncated populations may suffer from changes in density or from behaviourally mediated indirect interactions, and cause significant effects in food webs, also altering the ecosystem structure and productivity.[52] All this would assume even more relevance in the case of those stocks concurrently exploited by both commercial and recreational fisheries.

POSSIBLE SOLUTIONS

Development

Sustainable development of the recreational fisheries sector will depend on the acceptance of its multidisciplinary nature and whether recreational fishery stakeholders will be allowed to facilitate successful conservation and management. There is an urgent need to integrate biological and social sciences in order to provide insights into the dynamics of the entire social and ecological system of the recreational fishing industry.[53]

The sustainability of recreational fisheries – including the conservation of aquatic animal biodiversity in areas fished – in combination with commercial fisheries requires recognition by those responsible for this sector. Policy-makers and managers responsible for recreational fisheries need to obtain information about the sector, as well as knowledge of possible factors that affect the sector negatively (including coastal development, fish habitat modification, pollution and extreme climate events). In addition, recreational fishing has a significant social component, and the benefits of the activity need to be weighed against investment in resource protection.[54]

Appraisal of the performance of recreational fisheries and of their potentialities needs to be a multidimensional and multidisciplinary exercise in order to capture the societal, economic, environmental and educational components of the sector, and importantly, to ensure effective participation of stakeholders.[55] One recent study[56] has made an effort in this respect by recommending "methodologies assessing socio-economic benefits of European inland recreational fisheries", which may be of use not only in Europe but also elsewhere.

Management

Management of recreational fisheries needs to reconcile conflicting demands for access to the wild fish while ensuring both sustained exploitation of the marine fauna and conservation of the marine ecosystem of which the fauna are a part.

To do this, management of recreational fisheries needs to follow a process that is similar to that used by most fisheries managers; it involves: (i) defining the resource to be managed, the state of the system and constraints; (ii) setting goals and objectives; (iii) evaluating management options; (iv) choosing appropriate

actions to achieve management objectives; (v) implementing such actions and monitoring outcomes; and (vi) evaluating the success of management, and adjusting management in the light of learning.[57] The choice of tools is wide in freshwater recreational fisheries. Management tools include: stocking, biomanipulation, prey enhancement, suppression of detrimental fishes, selective removal, renovation, and management of aquatic plants.

However, at the same time, fisheries managers need to recognize that freshwater recreational fisheries differ from commercial fisheries and aquaculture and that, therefore, they need to be dealt with in a way that reflects this difference. The main differences relate to species introduction, stocking of waterbodies, catch-and-release practices, the potential for selective overexploitation, and the role of recreational fishers in habitat and biodiversity conservation.

Managers also need to be aware that for many fisheries there exists a perception that the catch of the individual recreational fisher will have only a minimal and localized impact on resources, and that recreational fishing has had little influence on reported stock declines worldwide. However, this perspective often changes dramatically when the size and activity of the recreational fisher population is considered.

There is an open-access scenario characterizing many recreational fisheries, particularly marine ones, that has consequences for the sustainability of the resources and the fisheries. In contrast, many inland and coastal recreational fishing areas, especially in Europe, North America and Oceania, do not apply open-access regimes and sometimes have extremely restrictive access requirements instead.

However, traditional management objectives such as maximizing yield may not be the most appropriate goal for a recreational fishery – enjoyment of the fishing experience is the primary objective of recreational fishing, and this requires different management strategies and tools.[58]

An integrated monitoring system in support of the management of recreational fisheries should entail all the relevant components of the recreational fishery. It could include, *inter alia*, representatives of: recreational fishers and their associations, equipment suppliers, commercial fishers and their organizations, public authorities, civil society, universities, research institutes, and the tourism industry.

The limited reliable data and scientific information available call for precautionary management. As in any other fishery, management of recreational fisheries requires clear identification of goals and measurable operational objectives. Simple and easy-to-obtain multidisciplinary indicators, and their reference points, should be used to measure the state of recreational fishery systems in terms of pressure exerted on the resources and generation of added value. Such indicators can be used to compare recreational fisheries with commercial fisheries.[59] Adequate funding and support should be available to manage recreational fishing within the wider context of fisheries and environmental management strategies. The recreational fishers may be requested to contribute to the cost of managing recreational fishing; "user-pay, user-benefit" systems could be used in some cases. The need to estimate total harvest, effort and impact has to be addressed in order to be able to manage a resource responsibly. Recreational fisheries registration and licensing can play a major role in this respect; registration being a means to quantify and identify participation, and licensing being a means to do the same and generate income. Issues to consider when establishing licensing schemes are the costs of their establishment and operation, and how to ensure that the licence revenues collected flow back into the sector.

Management that focuses on preserving larger specimens of a population may involve the creation of appropriate conservation areas (refugia, marine protected areas or areas closed to fishing) or guidance and/or regulations on catch and release.

Some recreational fisheries target individuals belonging to stocks of transboundary or migratory fish species that are exploited by recreational and commercial fisheries of more than one country. Moreover, some target species of marine recreational fisheries (e.g. tuna and marlin) migrate between high seas areas and areas under national

jurisdiction. This confers an additional international facet to the national management system. Regional fisheries management organizations (RFMOs) and regional fisheries advisory bodies can provide the regional frameworks required to include recreational fisheries into the regional dialogue and mechanisms for the conservation and management of recreational fisheries of common interest.

RECENT ACTIONS

The Code of Practice (COP) for Recreational Fisheries developed (2007–08) under the auspices of the then European Inland Fishery Advisory Commission (EIFAC, now the European Inland Fisheries and Aquaculture Advisory Commission [EIFAAC]) constituted a major step towards elaborating a suite of tools for the management and conservation of recreational inland fisheries.[60] The COP includes standards for responsible, environmentally friendly recreational fishing in consideration of changing societal values and conservation concerns. Its aim is to foster best practices in recreational fisheries that would promote their long-term viability in the face of expanding threats, such as habitat manipulation and destruction, resource overexploitation, and loss of biodiversity.

The relevance of the development and management of recreational fisheries beyond national jurisdictions is becoming evident in the agenda of regional fishery bodies (RFBs), particularly where recreational fishing occurs in international waterbodies or semi-closed seas.[61] Regional bodies could develop long-term common monitoring frameworks and promote regional cooperation in order to: establish standard guidelines to describe the fishery and determine the impact upon the resources; and characterize the social and economical dimension of recreational fisheries that occur in the region of their competence.

At the global scale, the World Recreational Fishing Conference series is a major scientific forum for discussing progress and issues in the development and management of recreational fisheries. The conferences aim to increase dialogue and knowledge about the diversity, dynamics and future prospects of recreational fisheries.

FAO is developing technical guidelines on responsible recreational fisheries. In August 2011, an Expert Consultation met to develop the FAO Technical Guidelines for Responsible Fisheries: Recreational Fisheries. The technical guidelines cover all types of recreational fisheries (harvest-oriented angling, catch-and-release fishing, trapping, spearfishing, etc.) in all environments (marine, coastal and inland). They are global in scope, and will be congruent with the the Code.

OUTLOOK

Recreational fishing is developing and expanding in many countries, as are its impacts on fish stocks through exploitation or related practices such as stocking and introduction of non-native fishes. The social and economic importance to local and regional economies is also being recognized.[62] The dimension of global fisheries is greater than previously assumed when recreational fisheries are considered, and local economies are a major beneficiary of good recreational fisheries management. The economic, educational, health and other social benefits of recreational fishing should be recognized and promoted. Ideally, both commercial and recreational fishing industries should share a common interest in ensuring the maintenance of fish stocks and their habitats.

It seems plausible that, over time, the development and management of recreational fisheries will build increasingly on the application of the precautionary and ecosystem approaches. This will include using a holistic approach to recreational fisheries management based on the concomitant consideration of fish biology, fishing activity, catches, and the economic and social values of recreational fishing.

Given the growing importance of recreational fisheries, national fisheries management will probably recognize and incorporate them in the overall fisheries management discourse, including in fisheries sector reviews, management plans and conservation strategies. Future fisheries management will probably aim for balanced

development of recreational and commercial fishing, including allocation of resource shares in order to optimize local community benefits and ecosystem health.

The potential role of recreational fisheries for livelihoods of rural communities will be assessed and promoted, given that, in many parts of the world, recreational fisheries and associated tourism activities could provide alternative livelihoods for small-scale fishers.

Barriers to achieving low-impact fuel-efficient fishing

THE ISSUE

Most fishing techniques in use today have their origin in an era when fisheries resources were abundant, energy costs were much lower than current levels, and less attention was paid to the negative impacts of fishing on aquatic and atmospheric ecosystems. Current high energy prices and greater awareness of ecosystem impacts are

Box 12

Fishing vessels and fuel consumption

With regard to consumption of fuel, recent overall estimates have shown that about 620 litres of fuel (530 kg) is used per tonne of landed fish.[1] The global fishing fleet is estimated to consume approximately 41 million tonnes of fuel per annum.[2] This amount of fuel generates about 130 million tonnes of CO_2. However, fuel consumption varies widely according to gear type, fishing practice, operational technique and the distance between the fishing ground and port. Moreover, there are substantial differences in fuel consumption between fisheries targeting groundfish or shellfish and those targeting pelagic fish or industrial fisheries.

Notwithstanding the above, studies of fuel consumption patterns by gear type indicate that passive fishing gear (e.g. pots, traps, longlines and gillnets) generally require lower amounts of fuel than active fishing gear (e.g. bottom trawls). Encircling gear types that are dragged a limited distance at slow speed, including gear such as bottom seines, rank between passive and towed gears in fuel consumption.

Active pelagic gear types like midwater trawls and purse seines target fish that form dense schools, and the catch can be hundreds of tonnes of fish in one short tow or haul; therefore, the fuel consumption is generally low in relation to the quantity of catch. In particular, purse seining is one of the most fuel-efficient techniques for catching fish although vessels using this gear often spend significantly more time and fuel searching for schools than actually catching fish. Fishing with the help of powerful artificial lights is common in purse seining, squid jigging and stick-held dip netting, particularly in Asia. While these fishing operations in themselves are fuel efficient, the use of the lights adds to the energy requirement.

[1] Tyedmers, P.H., Watson, R. and Pauly, D. 2005. Fueling global fishing fleets. *Ambio*, 34(8): 635–638.
[2] World Bank and FAO. 2009. *The sunken billions. The economic justification for fisheries reform*. Washington, DC, Agriculture and Rural Development Department, The World Bank. 100 pp.

now realities and present major challenges to the viability of fisheries, particularly in developing countries where access to and promotion of energy-efficient technologies have been limited. However, as illustrated in this article, which is largely based on a paper by Suuronen *et al.*,[63] each type of fishing gear and practice has advantages and disadvantages, and the suitability of each gear type depends considerably on the operational conditions and on the species to be targeted.

The impacts of fishing gear on ecosystems vary widely. Overall, these impacts largely depend on: the physical characteristics of the gear; the mechanics of its operation; where, when and how the gear is used; and the extent of its use. Moreover, gear types that rank high for one kind of impact may rank low for another. Physical damage to the environment may also result from the inappropriate use of an otherwise acceptable gear. Only a small number of fishing methods are recognized as inherently destructive no matter how they are used, prime examples being explosives and toxins. It should also be kept in mind that in spite of the fact that many fisheries are highly selective, fishers are often not capable of catching only the desired target species. When poorly selective fishing occurs, it leads to the incidental catch of fish and invertebrates, part of which may consist of juveniles of ecologically important and/or economically valuable species. In addition, fishing can also result in the incidental mortality of non-target species of seabirds, sea turtles and marine mammals, as well as causing damage to vulnerable ecosystems, such as coldwater corals, which can take many decades to recover.

With regard to greenhouse gas (GHG) emissions, insufficient attention has been paid to the fisheries sector as a whole and to fishing operations in particular. Consequently, it is difficult to rank fishing gear and practices in terms of GHG emissions. However, using the consumption of fuel as a proxy for total GHG emissions can provide a good estimate (Box 12). It is also a fact that, notwithstanding the provisions of existing international conventions, the quality of available fuel is not constant worldwide with regard to sulphur content.

It is noteworthy that life cycle assessments show that significant energy consumption and GHG emissions occur after the catch is taken on board and more so after landing, owing to fish processing, cooling, packaging and transport. Thus, minimizing the impacts and energy consumption throughout the whole product chain would be important to reducing the overall environmental costs of fishing.

POSSIBLE SOLUTIONS

The fishing sector should strive to further lower its fuel consumption and decrease ecosystem impacts. Despite a growing number of initiatives and experimentation with energy-reducing technologies, there is currently no viable alternative to fossil fuels for mechanically powered fishing vessels. However, it is well demonstrated that, through technological improvements, gear modifications and behavioural change, the fishing sector can substantially decrease the damage to aquatic ecosystems, reduce GHG emissions (which is a legal obligation for governments under existing international conventions) and lower operational costs for fuel without excessive negative impacts on fishing efficiency.

Solutions by fishing operation

Demersal trawling

Trawls are flexible gear and can be used on many types of areas and grounds, in shallow and deep waters, and by small and large vessels for a wide range of target species. These characteristics have made trawling the preferred method for many fishers, and it may be the only short-term economic solution for capturing, for example, certain shrimp species. However, bottom trawling has been identified as one of the most difficult to manage in terms of bycatch and habitat impacts.

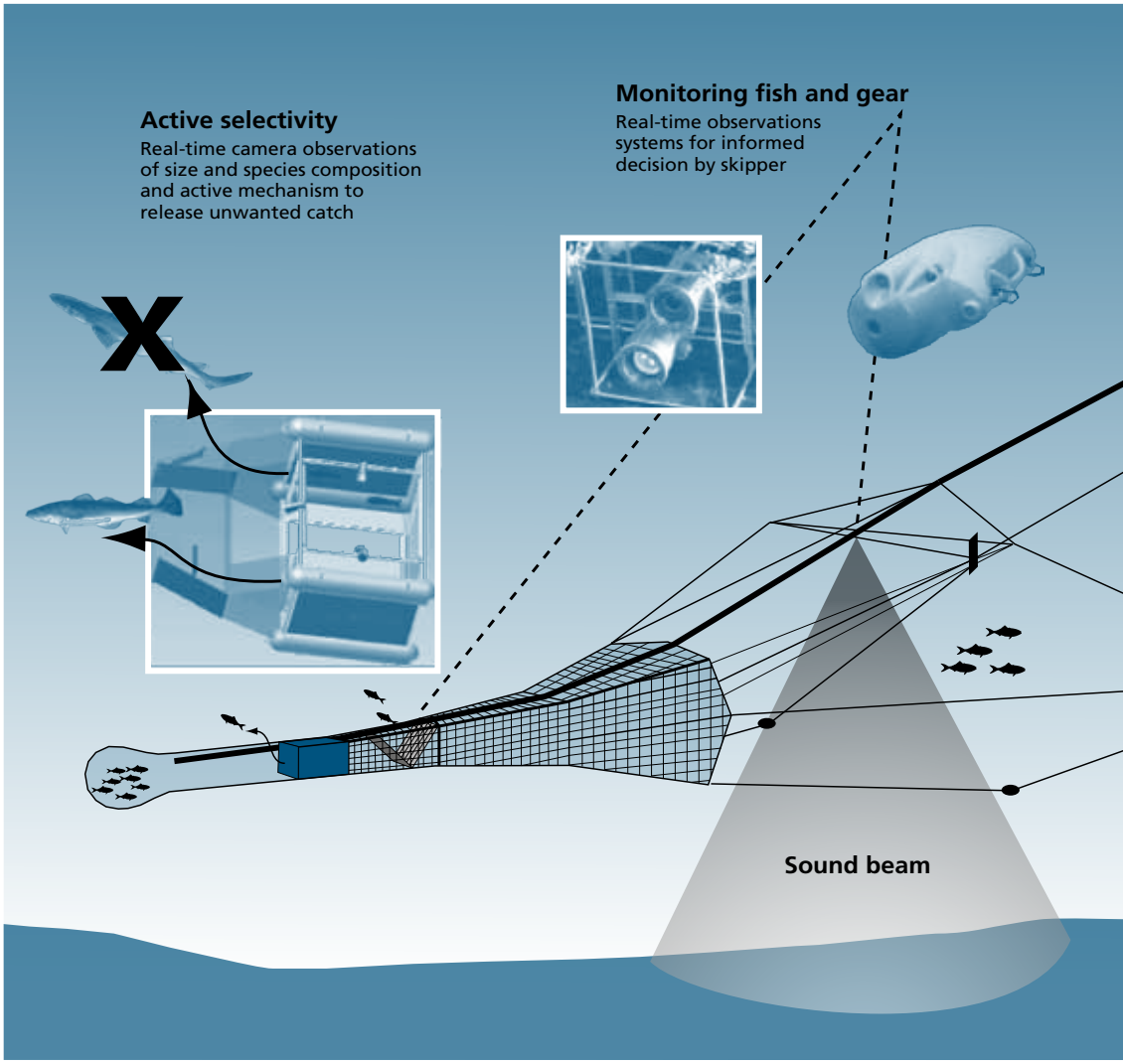
There are many techniques and operational adaptations available to reduce the drag and weight of the bottom trawl gear and, thereby, to reduce significantly fuel consumption and sea-bed impacts without marked decrease in the catch of the target

species.[64] Fuel savings of 25–45 percent and gear-drag reductions of 20–35 percent have been reported.

However, in general, further work is needed to improve the construction of different components of trawl gear in order to minimize friction on the bottom and to reduce overall gear drag. In this regard, there is further potential to develop technologies in which the force of trawl doors and ground gear on the sea bed is automatically measured and adjusted by instrumentation (Figures 38 and 39). In the case of beam trawls, progress has been made in recent years by developing alternative

Figure 38

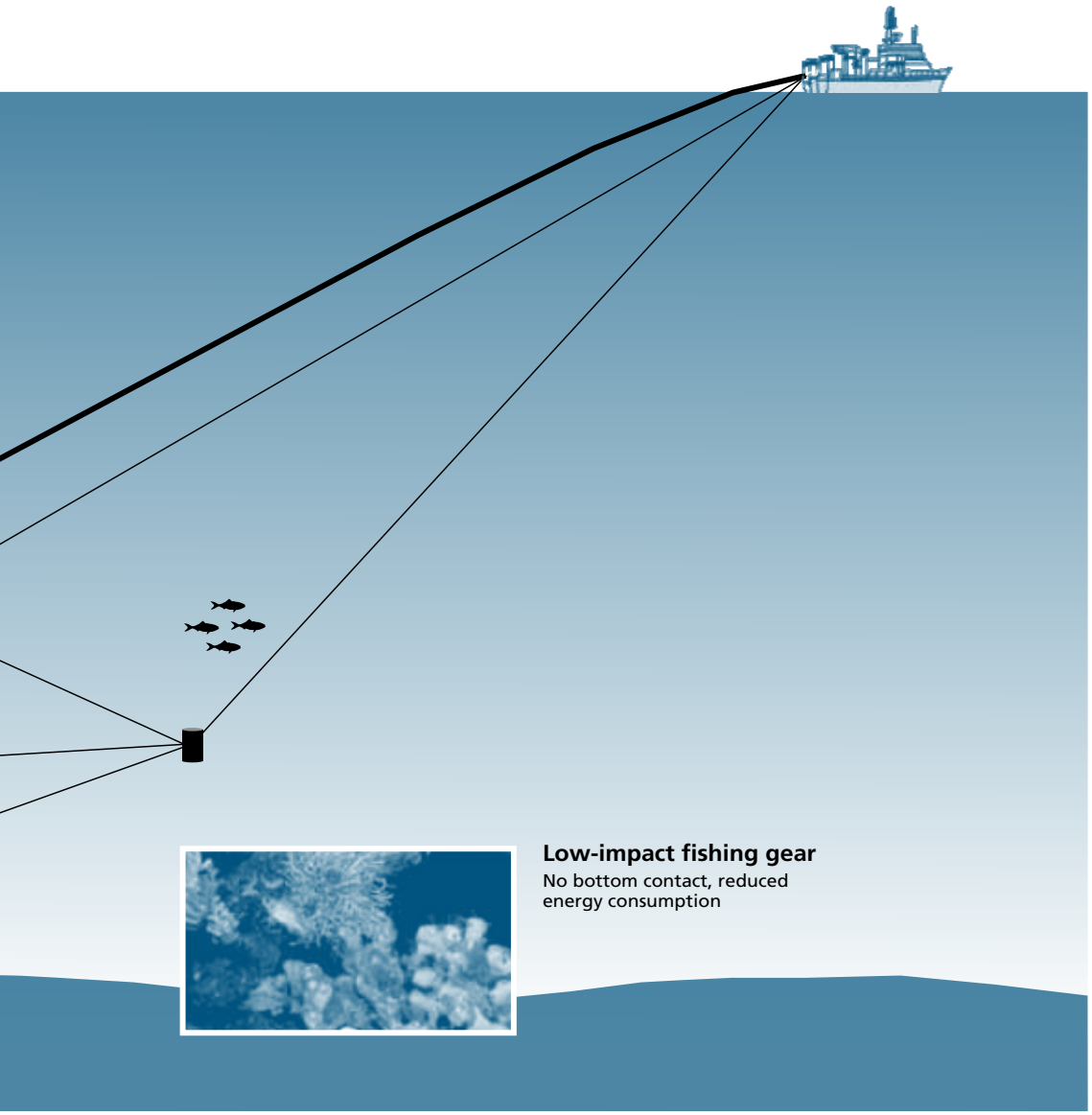
A new semi-pelagic low-impact and selective trawl gear (CRIPS-trawl) that is under development in Norway



Notes: The new trawl design (CRIPS-trawl) has a reduced bottom contact and less drag compared with a conventional bottom trawl. The trawl doors and the footrope of the trawl are lifted off the bottom. The front panels of the trawl are replaced by herding ropes, and the aft parts are made of square-mesh netting. This will reduce the drag of the trawl while still maintaining the stimulation for herding the fish into the codend. The extension piece and the codend are made of four panels and include a net camera and various selection devices to release unwanted fish from the trawl. The four-panel design improves the stability of the trawl and the selection devices. The net camera gives real-time information of the fish species and sizes entering the codend, and allows the skipper to make informed decisions regarding how to continue the fishing process. The trawl may also be fitted with an active mechanism to release unwanted catch (based on image analysis). The trawl concept also includes a cable connection from the vessel to the trawl headline. The cable will carry the video signal from the net camera and acoustic sensors, and it will also increase the vertical opening of the trawl. The concept will later also include an independent system to adjust the distance of the doors from the sea bed.

gear designs. In essence, the objectives are to reduce the amount of tickler chains, avoid excess weight in the beams, and use other stimuli (e.g. electric pulses) as an alternative to chains to scare the target fish off the bottom and into the net. The use of acoustics, light or any other additional stimuli to enhance encounters by target species within the catching zone of trawl nets is worth exploring.

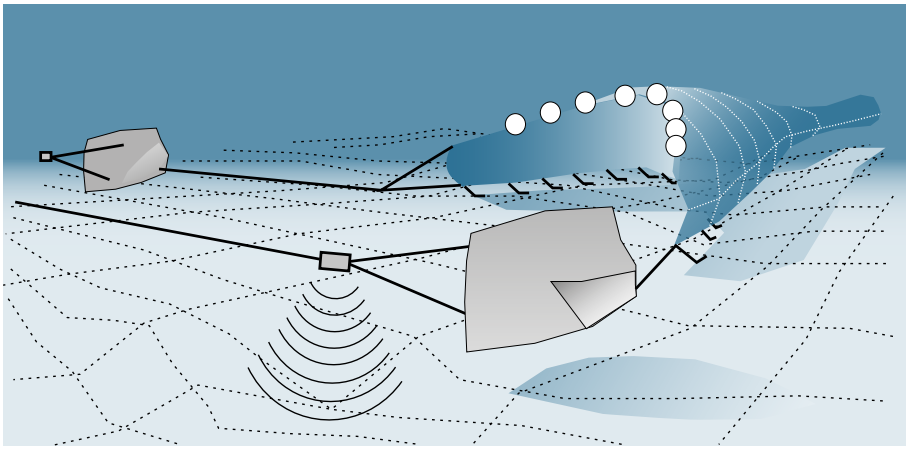
The use of improved location and targeting of fish with the help of electronic sea-bed mapping tools and integrated global navigation satellite systems has resulted in avoidance of sensitive bottom habitats and helped to minimize fishing effort and fuel



Source: Valdemarsen, J.W., Øvredal, J.T. and Åsen, A., 2011. *Ny semipelagisk trålkonstruksjon (CRIPS-trålen). Innledende forsøk i august-september 2011 om bord i M/S "Fangst"*. Rapport fra Havforskningen nr. 18. Bergen, Norway, Institute of Marine Research. 17 pp.

Figure 39

Smart trawling: reduced seabed damage of bottom trawling



Note: In "smart trawling technology", the distance of trawl doors and ground gear from the sea bed is constantly and automatically measured and adjusted by special instrumentation. The use of ballast elements or dropper chains suspended from the footrope to hold the trawl near to, but not in contact with, the bottom offers potential in some fisheries to reduce sea bed contact while maintaining catching efficiency.

Source: Modified from Valdermarsen, J.W. and Suuronen, P. 2003. Modifying fishing gear to achieve ecosystem objectives. *In* M. Sinclair and G. Valdimarsson, eds. *Responsible fisheries in the marine ecosystem,* pp. 321–341. Rome, Italy, and Wallingford, UK, FAO and CABI International Publishing.

consumption. Multibeam acoustic technology, widely used in sea-bed exploration, has been successfully applied, for example, to mapping scallop beds off the east coast of Canada, thereby substantially reducing the time required to locate the grounds and the actual fishing time.

Bottom seining

Bottom seining (Danish, Scottish and pair seining) is generally considered to be a more environmentally friendly and fuel-efficient fishing method than bottom otter trawling. The gear is lighter in construction and the area swept is smaller than in bottom trawling. Moreover, because there are no trawl doors or heavy ground gear, there is less force on the sea bed. The light gear and low hauling speed mean that fuel usage can be significantly lower than for a comparable trawling operation. Bottom seine nets are generally also regarded as having low impact on benthic invertebrates. However, the high bycatch of both undersized individuals of the target species and individuals of non-target species can be a problem in some seine fisheries.

Trap-net

Trap-nets are passive fishing gear that are usually set on traditional sites in the path of migrating fish in relatively shallow coastal waters. Leader-netting herds and guides fish into a holding chamber or pound where they are entrapped. The pontoon trap is a more recent innovation and offers various advantages compared with traditional trap-nets such as being easy to transport, handle and haul, adjustable in terms of size, target species and capture depth, as well as being predator-safe. Future developments may include large-scale, ocean-based fish traps together with the technology to attract fish. Modern trap-net fisheries can be energy efficient, flexible, selective and habitat-friendly, providing catches of high quality as the catch is usually alive when brought aboard the vessel. Live capture provides the operator with a greater number of options to add value to the catch. However, designs and practices need to be developed to prevent the entangling of non-fish species in netting and mooring ropes of the trap.

Pots

A pot is a small transportable cage or basket with one or more entrances designed to allow the entry of fish, crustaceans or cephalopods, and prevent or retard their escape. Pots are usually set on the bottom, with or without bait. While pot fishing vessels in general have low fuel use, some pot fisheries have high fuel use owing to the need to tend fleets of many pots and lifting them more than once a day, necessitating travelling at high speed over long distances.

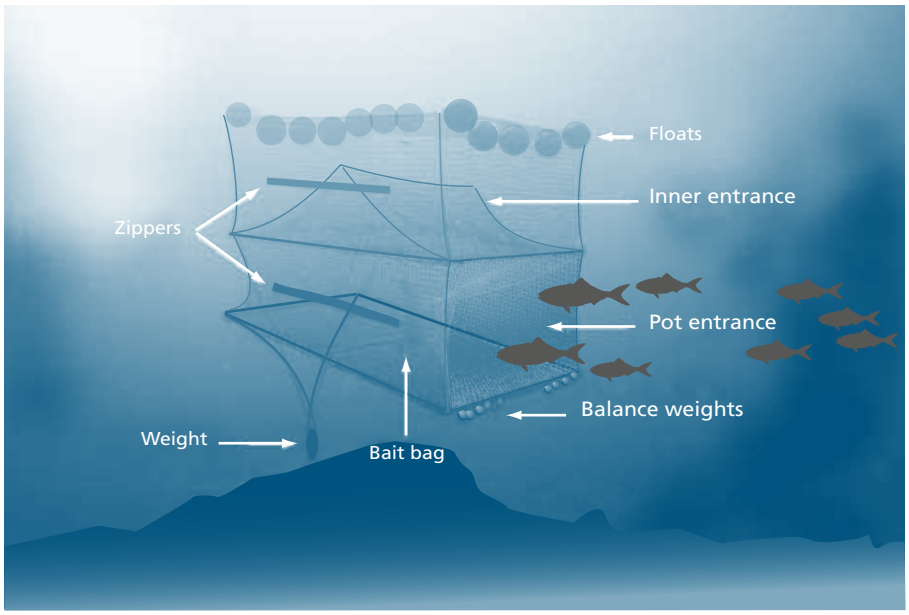
Pots are extensively used in the capture of crustaceans such as lobster and crab. Although the use of pots for capturing finfish has a long tradition in many parts of the world, it has progressively declined. Nevertheless, pots are still an efficient and economically viable fishing method for finfish. They are also successfully used in fisheries targeting coral-reef species inhabiting areas where the use of active gear is banned or not practical.

Recent tests with collapsible pots have shown promising results for Atlantic cod in Canada and for pink cusk-eel (*Genypterus blacodes*) in Argentina. A floating pot developed in Scandinavia provides another example of an innovative pot design that has shown significant potential (Figure 40).[65] Floating the pot off the bottom allows the pot to turn with the current so the entrance always faces down current, resulting in a higher catch rate of cod. It also avoids non-target catch of crabs and may also reduce the seabed impacts compared with a pot sitting on the bottom. The same type of floating pot has successfully been tested in the Baltic Sea as an alternative to the gillnet fishery for cod, where there are serious problems with depredation by seals.

Compared with many other types of fishing gear, pots, like trap-nets, possess several appealing characteristics such as low energy use, minimal habitat impact, high quality and live delivery. On the negative side, lost or abandoned pots may continue catching target and non-target species (ghost fishing) and contribute to marine debris with associated effects. Design features such as biodegradable materials may reduce ghost fishing, while delayed surface marker buoys and location aids may promote the recovery of lost gear. Understanding fish behaviour in relation to pots is essential in

Figure 40

A floating pot



Source: Adapted from Königson, S. 2011. *Seals and fisheries: a study of the conflict and some possible solutions.* Department of Marine Ecology, University of Gothenburg. (PhD thesis)

order to increase efficiency for those species that are currently not captured by pots in commercially viable quantities.[66]

Hook and line

Hook and line refers to gear to which fish, squid or other species are attracted by natural or artificial bait or lures placed on a hook, on which they are caught. Wide variations in hook and line configuration and their mode of operation have made them an effective gear type for a wide variety of species. It is a versatile fishing method, employed by a wide range of vessels from artisanal boats to large mechanized longliners. Hook and line fishing is generally considered an environmentally friendly but labour-intensive fishing method that catches fish of high quality. Fuel consumption in these fisheries is comparatively low although it can increase significantly depending on the distances vessels have to travel to and from the fishing ground (e.g. coastal hook and line fisheries versus high seas tuna longlining). Longline fishing may cause the incidental mortality of seabirds, sea turtles and sharks, many of which are either protected or endangered. The lines can be set with a streamer[67] in order to deter seabirds from seizing the baited hooks – this system is reported to have led not only to a reduced mortality level of sea birds but also to higher catch rates of the target species. There are several other mitigation measures capable of reducing the likelihood of incidental bycatch of seabirds[68] and sea turtles,[69] such as the new "circle hook" and "weak hook". While bottom-set longlines may snag and damage benthic epifauna and irregular objects on the bottom, longline fisheries do offer the potential to conduct fishing without severe habitat damage and to do so in a relatively energy-conscious manner.

Gillnetting

Bottom-set gillnets, entangling nets and trammelnets are widely used, and improved materials and techniques have allowed the expansion of such gear to rougher grounds (including wrecks and reefs) and deeper waters. Gillnetting is a very versatile and flexible fishing method but can also be labour-intensive. Except with trammelnets, the size selectivity for finfish is generally good, but species selectivity can be poor. In addition, fish are often injured and die during capture; accordingly, catch quality is typically not as good as with pots, traps and longlines, although gillnets may also give catch of good quality when the time the net is left in the water to fish is short.

Gillnet fishing operations in general can damage benthic epifauna during retrieval of the gear, at which time the nets and leadlines are more likely to snag bottom structures. Although the capture of seabirds, sea turtles and marine mammals by gillnets has received increased attention in recent years, more development work is required to develop mitigation measures further.

The impacts of ghost fishing by abandoned, lost or otherwise discarded gillnets are of concern as such nets may continue to fish for long periods depending on their construction, the depth, and prevailing environmental conditions. This problem can be addressed by increasing efforts to avoid losing gillnets and by facilitating the quick recovery of lost nets. Abandoned gillnets have been identified as a particular problem in deeper waters and where long lengths of gear are deployed.[70]

Barriers to change

There are many barriers to the transition to low-impact and less fuel-intensive practices and gear.[71] In summary, the most important seem to be:

- lack of familiarity with cost-effective and practical alternatives;
- limited availability of suitable technologies, especially in developing countries;
- incompatibility of vessels with alternative gear;
- risk of losing marketable catch;
- additional work at sea;
- concerns with safety at sea related to using unfamiliar gear or strategies;
- high investment costs;

- lack of capital or restricted access to capital;
- ineffective technology infrastructure support;
- inflexible fisheries management systems that include too rigid regulatory regimes.

With regard to inflexible management systems, regulatory regimes that are too rigid can create a new set of problems to be solved and deny fishers the flexibility required to innovate and adopt new technologies. In this regard, stakeholders should be an integral part of the management process, particularly as and when amendments to legislation are under consideration. Changes from high-energy high-impact fishing methods or practices to ones with lower energy consumption and lower ecosystem impacts offer opportunities for conserving fuel, preserving ecosystems and improving food security. However, the transition from one gear type to another is seldom easy or practical. First, the size and design of existing fishing vessels and their machinery and equipment often limit the possibilities of changing the fishing method. Second, fishing gear, fishing vessels, operations and practices have evolved around specific fishing grounds and the behaviour of target fish species over a considerable period. Accordingly, the evolved fishing gear and practices are "tailor-made" to catch specific target species or species groups in a manner that is often perceived to be optimized to the best technical and economic scenarios that will be encountered during fishing. Moreover, where fishing practices are rooted in tradition there is a strong resistance to change.

Nevertheless, fuel consumption and ecosystem impacts can often be reduced through simple modifications in operational techniques and gear design without drastic changes in the gear and operational practices. This approach has shown promising results in many cases and is often preferred by the fishing industry over transitioning to a completely new gear type and fishing practice, which is an alternative that has many more uncertainties and higher economic risks.

RECENT ACTIONS

Environment

International conventions include timetables for compliance regarding emissions of nitrogen oxides from diesel engines of over 130 kW and new fishing vessels are required to comply. Morevoer, as a consequence of research and development (R&D) on energy-saving technologies carried out by designers of machinery and fishing vessels and gear, there are signs that the fishing industry has begun to improve its fuel efficiency. Nevertheless, fuel continues to be the major cost of operation in capture fisheries and further refinements to fuel quality, such as lowering the content of sulphur oxides and particulate matter, could well lead to even higher fuel and lubricating-oil costs. This may have an even greater impact on the fishing industry in developing countries where mechanization continues to increase, although it will also strengthen the drive for fuel efficiency.

Bycatch and discards

The seriousness of the impacts related to bycatch and discards has been recognized by the international community and in particular through the endorsement of the International Guidelines on Bycatch Management and Reduction of Discards at the Twenty-ninth Session of the FAO Committee on Fisheries in 2011. There is a range of tools to manage bycatch and reduce discards, including technological measures to improve the selectivity of fishing gear. The declines in the bycatches and discards in many fisheries have mainly been the result of introducing effective gear modifications and bycatch reduction devices.[72] However, there remains concern about the impacts of unaccounted fishing mortalities such as ghost fishing by abandoned, lost or otherwise discarded fishing gear and the fact that such gear may also cause environmental damage.

Furthermore, at the sixty-second session of the Marine Environment Protection Committee of the International Maritime Organization (IMO) in July 2011, Annex V

of the International Convention for the Prevention of Pollution from Ships 1973/78 (MARPOL) was amended to provide a regulation for the loss of fishing gear that may be a substantial threat to the environment or the safety of navigation to be reported to the flag State, and, where the loss occurs in waters under the jurisdiction of another coastal State, to that State. This regulation is supported within guidelines for the application of Annex V currently under revision.

OUTLOOK

With continued exposure to rising fuel prices and little or no significant price increases at the point of first sale for catches, capture fisheries will probably continue to suffer declining profitability. Moreover, if resource abundance remains static, some bottom trawl and dredge fisheries may become uneconomic (although passive gear and seine net fisheries may be less affected). As demersal trawl fishing accounts for a significant part of the total catch destined for direct human use, there could be an adverse affect on global fish supply and food security, at least in the short term.

With medium-term forecasts indicating a high likelihood of further and steady increases in fuel prices, as indicated by the International Energy Agency, the future of the fishing industry is challenging. An increase in sulphur-oxide-emission control areas (the most recent being adopted by the IMO in 2011) would add to the cost of fuel for vessels operating in such zones.

The fishing sector will no doubt strive to lower its fuel consumption, reduce its carbon footprint, and decrease ecosystem impacts. Although the continuation or expansion of fuel subsidies would reduce immediate costs, this is less acceptable. To help the fisheries sector achieve significant and permanent reductions, governments will most probably strengthen their fisheries sector energy policy and create an enabling environment in which fishing industries can rapidly and comprehensively adopt low-impact fuel-efficient (LIFE) fishing technologies and practices. The development and adoption of such fishing techniques offer scope for maintaining the long-term profitability and sustainability of capture fisheries worldwide.

With fossil fuels remaining the dominant energy source, pursuing energy efficiency in capture fisheries may generate benefits by reducing operating costs, controlling GHG emissions and minimizing environmental impacts within the aquatic environment. However, the success of this transition will depend heavily on the response of governments to the implementation of international conventions together with a positive reaction from the engine manufacturing sector, fuel-oil and lubricating-oil producers and the fishing industry (including the manufacturers of fishing gear). This could lead to the development and application of suitable and acceptable measures to conventional fisheries and create an appropriate catalyst for change in the behaviour of fishers. Of equal importance are initiatives such as pursuing the modification of existing gear types and the development of low-resistance towed fishing gear with minimal impact within the aquatic environment. In some cases, it may be necessary to switch to completely new gear types or practices in order to enable LIFE fishing.

However, to be effective, this would require global R&D priorities to be established and work undertaken in support of the development and uptake of LIFE fishing.[73] These include:

- promoting and funding studies of cost-effective gear designs and fishing operations, including the establishment of technology incubators and other public–private sector initiatives to commercialize economically viable, practical and safe alternatives to conventional fishing methods;
- analysis and review of best practice operations across fisheries;
- improvement of technical ability among fishers;
- establishment of appropriate incentives;
- industry compliance with international conventions;
- execution of robust but flexible fishery policies that support the transition to alternative technologies.

Finally, close cooperation between the fishing industry, scientists, fisheries managers and other stakeholders will be fundamental to the development, introduction and acceptance of LIFE fishing technologies.

Putting into practice the ecosystem approach to fisheries and aquaculture

THE ISSUE

The ecosystem approach to fisheries (EAF) represents a move away from management systems that focus only on the sustainable harvest of target species to a system that also considers the major components in an ecosystem, and the social and economic benefits that can be derived from their utilization.

An ecosystem approach to aquaculture (EAA) follows similar considerations and it has been defined as: "a strategy for the integration of the activity within the wider ecosystem such that it promotes sustainable development, equity and resilience of interlinked social-ecological systems."[74]

While the term "ecosystem approach" often evokes the idea that the approach is mainly a natural-science undertaking, the approach adopted by FAO[75] explicitly states the importance of taking into account all the essential components of sustainability (ecological, social and economic), i.e. taking a genuinely systemic approach by considering fisheries and aquaculture as systems whose sustainability depends on all their parts.

In addition to sector-based approaches, the need for developing adequate institutional frameworks to address multisectoral management is also recognized (e.g. ecosystem-based management), and EAF/EAA will then be nested within these broader frameworks.

Despite general acceptance of the principles of EAF and EAA, a widespread perception has existed of their being too complex and impossible to implement in practice because they require human and financial resources that are usually not available, particularly in developing countries.

POSSIBLE SOLUTIONS

Despite the perceived complexity of implementing an ecosystem approach, there is good evidence that progress is being made at various levels, from formally adoption of the framework by regional and national institutions, to actually starting with implementation.

There are examples of concrete steps being taken towards an ecosystem approach, both in sectoral fisheries management (e.g. EAF and EAA) and at the multisectoral level (such as ecosystem-based management), the latter being necessary where more than one sector affects a given area or region. Management approaches that integrate across sectors become particularly relevant in inland waters (Box 13), where major impacts on fishery resources and ecosystems are often not caused by fishing activities but by water use and habitat modification. Moreover, as the once-separate sectors of "fisheries" and "aquaculture" increasingly overlap and integrate an ecosystem approach may well facilitate sustainable resource management (Box 14).

Practical implementation of EAF/EAA entails examining existing or developing fisheries or aquaculture activities so as to identify key priority issues to be dealt with by management in order to achieve sustainable outcomes within a risk-based management framework. An example of a framework for planning and implementation is presented in Figure 41. The framework facilitates the developing of the EAF/EAA management/development plans, which are the backbone of any ecosystem approach strategy.

The key features of the strategy proposed for implementing an ecosystem approach to fisheries and to aquaculture can be summarized as:

Box 13

The need for an ecosystem approach in inland waters

Inland waters are characterized by strong competition for freshwater resources from sectors outside the fisheries and aquaculture sector. Demands on freshwater are expected to double by 2050 as the world population reaches 9 billion people. Of the available 3 800 km^3 of freshwater in the world, agriculture currently uses 70 percent, industry extracts another 20 percent, and 10 percent is for domestic use.[1] These sectors are extremely important in national economies, but they rarely consider fishery resources, although freshwater fisheries are a non-consumptive user of water. Implementing an ecosystem approach to managing freshwater resources for fisheries and aquaculture will necessitate involving these competing sectors and appreciating the value of multiple uses of freshwater resources.

In 2008, capture fishery production from inland waters was 10.2 million tonnes and was worth about US$5.5 billion, while the corresponding figures for inland aquaculture were 33.8 million tonnes and US$61.1 billion, respectively. However, these figures are much lower than the value derived from other uses of freshwater. On a global scale, the value of industrial and agricultural products produced with freshwater as a necessary factor of production is several magnitudes larger. However, at the regional or local level, there may be little industrial use for freshwater, and fish can be an essential contributor of animal protein and micronutrients in local diets. In such locations, using an ecosystem approach to the development and management of natural resource should ensure a place also for freshwater fisheries.

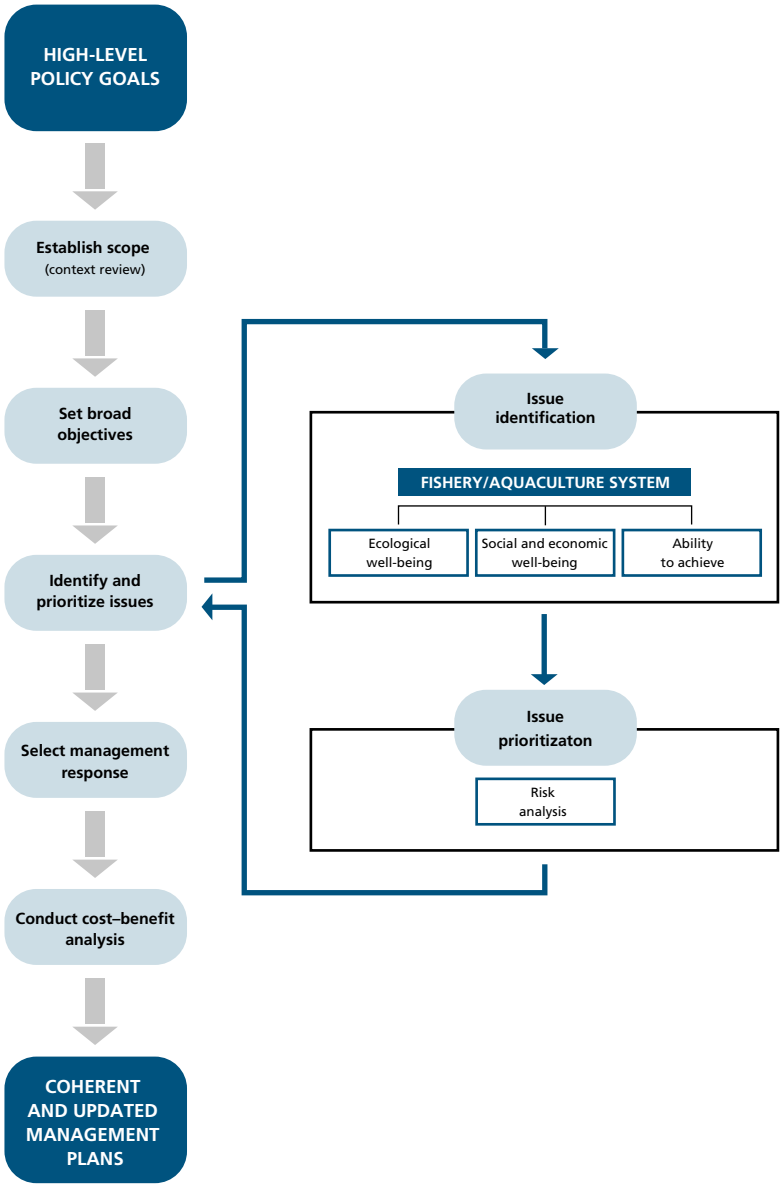
The continued use of freshwater as a locale for fish production, as industries and agriculture grow, can be promoted through technological change. There are encouraging signs of this, such as the development of improved fish passes that allow riverine fish to migrate past hydroelectric facilities and improvements in irrigation systems that increase their efficiency.[2] However, many countries still lack the institutional capacity to deal effectively with multisectoral issues.

[1] Comprehensive Assessment of Water Management in Agriculture. 2007. *Water for food, water for life: a comprehensive assessment of water management in agriculture*. Summary. London, Earthscan, and Colombo, International Water Management Institute. 40 pp.
[2] FAO. 2003. *Unlocking the water potential of agriculture*. Rome. 70 pp. (also available at www.fao.org/DOCREP/006/Y4525E/Y4525E00.HTM).

- adopting participatory approaches at all levels of the planning and implementation steps;
- ensuring that all the key components of the fishery/aquaculture system are considered, including those related to the ecological, social, economic and governance dimensions, while also taking into account external drivers (e.g. changes in the supply of and demand for inputs and outputs; climate change; and environmental disturbances);
- encouraging the use of the "best available knowledge" in decision-making, including both scientific and traditional knowledge, while promoting risk assessment and management and the notion that decision-making should take place also in cases where detailed scientific knowledge is lacking;

Figure 41

The EAF/EAA planning framework



Source: Modified from: FAO. 2003. *Fisheries management 2. The ecosystem approach to fisheries.* FAO Technical Guidelines for Responsible Fisheries No. 4, Suppl. 2. Rome. 112 pp.; and FAO. 2005. *Putting into practice the ecosystem approach to fisheries.* Rome. 76 pp.

- promoting the adoption of adaptive management systems, including monitoring performance and creating feedback mechanisms linked to performance, at different time scales, to permit the adjusting of the tactical and strategic aspects of the management/development plans;
- building on existing institutions and practices.

The methodology proposed has aspects that are common to any other sector utilizing renewable natural resources. The methodology is recommended by the ISO 14000 that deals specifically with the management of renewable resources.[76]

The methodology builds on the accumulated experience of the management of fisheries and aquaculture but also embraces recent insights about what makes socio-ecological systems sustainable. These insights lead to an approach that:

Box 14

Interactions between fisheries and aquaculture

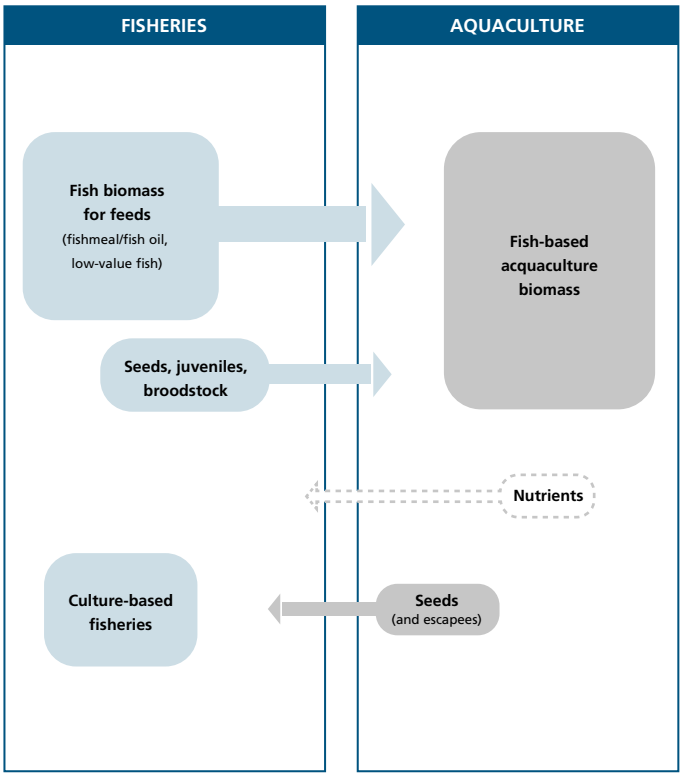
Increasingly – by design or by accident – fisheries and aquaculture occur in the same ecosystem. Aquaculture-based fisheries (stock enhancement programmes) and capture-based aquaculture are becoming more common and resulting in a growing interdependence of fisheries and aquaculture. Fish that escape from fish farms may affect not only local fisheries but have a wider interaction in the marine environment. Fisheries and aquaculture interact with increasing intensity as fishers shift from fishing to aquaculture and by competing in the same markets with similar products. The need to integrate planning and management of the two sectors seems vital to their future development and sustainability.

The implementation of the ecosystem approach to aquaculture and the ecosystem approach to fisheries should help to overcome the sectoral and intergovernmental fragmentation of resource management efforts and to develop institutional mechanisms and private-sector arrangements for effective coordination among the various sectors and subsectors active in ecosystems in which aquaculture and fisheries operate and between the various levels of government. Ecosystem-based management involves a transition from traditional sectoral planning and decision-making to the application of a more holistic approach to integrated natural resource management in an adaptive manner.

In the long run, all significant commercial seafood supplies and non-food fish will come from one of three sources: (i) fish farms/aquaculture; (ii) aquaculture-enhanced fisheries; and (iii) fisheries that adopt efficient management systems. The first two pose a challenge to aquaculture and require an emphasizing of the synergies and complementarities between fisheries and aquaculture including institutional, social, economic, environmental and biotechnological aspects. Acknowledgement of these interactions offers opportunities for sectoral development, for increasing food security, reducing poverty and improving rural livelihoods. The two subsectors need to form partnerships as both are strongly linked (see accompanying figure), both depend on healthy aquatic environments, and both are affected by other development activities. For example, in the coming decades, culture-based fisheries will probably play a much greater role in sustaining and increasing capture fisheries yields for an ultimate public good including conservation objectives. Therefore, it is important to analyse the present status of culture-based fisheries culture-based fisheries and stock enhancement, to assess comprehensively the impacts of the activities, and to identify constraints and ways to improve the ecological, economic and socio-economic benefits by implementing an ecosystem approach to overall fish production. It is also necessary to improve understanding on the potential and actual environmental impacts of stocking and escapees worldwide.

- is context-specific – it describes a process whose result depends on cultural context and needs;
- emphasizes stakeholder participation – the approach advocates participation of stakeholders in the planning and implementation processes, and encourages various forms of comanagement that will in turn be shaped by context and type of fisheries;
- is systemic – by taking a "systemic" approach, it tries to ensure that all "system" components move towards the same and agreed direction;

Biophysical linkages between capture fisheries and aquaculture



Source: Soto, D., White, P., Dempster, T., De Silva, S., Flores, A., Karakassis, Y., Knapp, G., Martinez, J., Miao, W., Sadovy, Y., Thorstad, E. and Wiefels, R. 2012. Addressing aquaculture-fisheries interactions through the implementation of the ecosystem approach to aquaculture (EAA). *In* R.P. Subasinghe, J.R. Arthur, D.M. Bartley, S.S. De Silva, M. Halwart, N. Hishamunda, C.V. Mohan and P. Sorgeloos, eds. *Farming the Waters for People and Food. Proceedings of the Global Conference on Aquaculture 2010, Phuket, Thailand, 22–25 September 2010*, pp. 385–436. Rome, FAO, and, Bangkok, NACA. 896 pp.

- is risk-based – being risk-based, it allows a more proactive approach to addressing information-poor situations, considered one of the main obstacles to the ecosystem approach in fisheries and aquaculture.

In summary, success in implementing the ecosystem approach to fisheries and aquaculture requires that management and development of the sectors are well-functioning components in a public-sector, multisectoral coordination effort supported by adequate governance. Consistent with the commitments reflected in the United Nations Convention on Biological Diversity (CBD), each economic sector (including,

mining, tourism, coastal development, fisheries and aquaculture) relying on the use of natural resources within a given region/ecosystem should adopt an ecosystem approach.

RECENT ACTIONS

The ecosystem approach was first defined by the CBD in 1993 as a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way.

Since 1993, countries have taken several steps to promote the use of the ecosystem approach, including specifically in fisheries. The Code of Conduct for Responsible Fisheries (the Code) was adopted in 1995 by FAO Members. The Reykjavik Declaration on Responsible Fisheries in the Marine Ecosystem (adopted in 2001) encouraged countries and fishing entities to achieve sustainable fisheries in the marine ecosystem. Guidelines for an EAF were produced by FAO in 2003. Aquaculture has also developed a framework for the adoption of the ecosystem approach.[77] At present, FAO is developing voluntary guidelines on securing small-scale fisheries. These guidelines will recognize the ecosystem approach as an important guiding principle.

Approaches are being developed to coordinate multiple uses of natural resources, such as marine spatial planning[78] and integrated watershed management. These are methodologies that complement the sectoral-based approaches to management that remain the basic pillars of sustainable development and its governance.

In some ways, the ecosystem approach has been practised in traditional management regimes for a long time. An example is the tenure system in marine fisheries as practised in Pacific island States.

More recently, many countries have made important strides towards the application of several of the principles contained in the EAF/EAA. Some are partly implementing the approach without necessarily recognizing this.[79] In some cases, progress has also been made in the development of multisectoral management.

In Australia, following the outcomes of the 1992 United Nations Convention on Environment and Development, a national strategy for ecologically sustainable development was endorsed in the same year.[80] Since then, significant progress has been made in implementing an ecosystem approach within the management of most individual fisheries and, and there has also been more recent progress in adopting more coordinated regional level management for this sector.[81]

In the European Union, substantial efforts are being made to integrate the objectives of its Marine Strategy Framework Directive within the new European Union Common Fisheries Policy, as part of an ecosystem-based management approach. As a result of the project Making the European Fisheries Ecosystem Plan Operational (funded by the European Union), fisheries ecosystem plans have been developed for three major European marine regions (North Sea, North Western Waters and South Western Waters).[82] Efforts are also being made at the national level. For example, in Norway, an integrated management plan for the Barents Sea–Lofoten area has been developed to resolve conflicts between petroleum activities, fisheries activities and to address conservation concerns.[83] Implementation of the plan is ensured through multisectoral coordinating groups headed by a steering group that is in turn coordinated by the Ministry of Environment. Representatives from the Norwegian Petroleum Directorate and the Directorate of Fisheries have worked together to revise laws and regulations covering seismic activities in order to reduce conflicts. A central concept of the plan is that it is based on science and takes a precautionary approach. A similar plan has also been developed for the Norwegian Sea, and the idea is to cover all the Norwegian Exclusive Economic Zone (EEZ).[84]

Ongoing efforts in the adoption of ecosystem-based approaches at both the sectoral and multisectoral level are being pursued in various large marine ecosystems including in the Caribbean,[85] the Canary Current,[86] the Benguela Current[87] and the Bay of Bengal.[88] However, in most of these large marine ecosystems, efforts are concentrated

on planning for an ecosystem-based approach – its full-scale implementation remains to be realized.

In addition, FAO has specifically addressed EAF by developing guidance[89] for its implementation and by providing extrabudgetary funding for regional and/or national case studies, dedicated workshops and training courses.

Collaborations with universities in Africa, i.e. University of Ghana (Ghana), Rhodes University (South Africa) and Ibn Zohr University (Morocco), have allowed a large number of fisheries professionals to be trained in the ecosystem approach, and it is hoped that the approach will be absorbed by universities in developing countries as part of existing curricula in fisheries science and management. These efforts have resulted in increased understanding of the approach and its "demystification".

OUTLOOK

A dramatic shift in attitudes as regards the relevance and applicability of the ecosystem approach has taken place, including an increasing appreciation of how this approach can help in addressing the challenges linked to sustaining socio-ecological systems such as fisheries, both within the sector and across sectors affecting a given ecosystem. Pragmatic ways are being adopted to improve conventional fisheries and aquaculture management by incorporating ecosystem considerations and by dealing with the social dimension more properly.

However, important challenges still exist beyond the technical aspects of practical day-to-day implementation. The challenges are not only those related to controlling the direct drivers of marine ecosystem change such as fisheries and aquaculture. Probably the greatest challenges come from indirect drivers such as changes in human population coupled with a widespread aspiration for improved standards of living. At the national level, economic policies and social and economic conditions are often in conflict with sustainability objectives. Climate change will most probably emerge as a major driver of change in aquatic ecosystems and will in turn affect coastal communities. In this situation, modifying governance towards more holistic approaches (such as the ecosystem approach), both horizontally (across sectors and institutions) and vertically (from local to global), may take on increased urgency.

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More generally, toolkits such as the FAO Agri-Gender Statistics Toolkit (www.fao.org/gender/agrigender/en/) and Web sites such as FAO's Sharing our resources – participation (www.fao.org/Participation/) are also becoming available.

8 The work of Chen with low-income women in Bangladesh and India enabled the identification of four pathways by which women experience change; and having access to and control of aquatic resources can also facilitate changes in the above pathways. The pathways include: (i) material change in access to and control over material resources, in level of income and in satisfaction of basic needs; (ii) cognitive change, change in level of knowledge, skills and awareness of wider environment; (iii) perceptual change, change in individual perceptions of own individuality, interested and value; and (iv) relational change, change in contractual agreements, in bargaining power and in ability to resist exploitation. *Source:* Chen, M.A. 1997. *A guide for assessing the impact of microenterprise services at the individual level*. AIMS Project Report, USAID/G/EG/MD. Washington, DC, Management Systems International.

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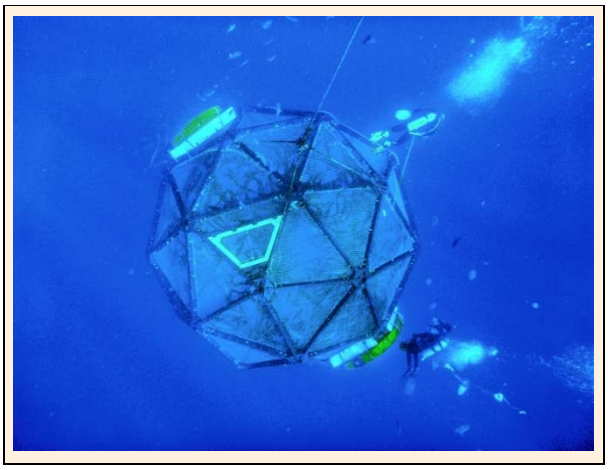
83 This plan is detailed in a press release from the Office of the Prime Minister, available at www.regjeringen.no/mobil/en/dep/smk/press-center/Press-releases/2011/updated-version-of-the-integrated-manage.html?id=635620
84 A description of the integrated management plans are available on a Web page of Norway's official site for information about seafood safety, fisheries and aquaculture management at www.fisheries.no/resource_management/Area_management/Integrated_management_plans/
85 The Web page for the Caribbean Large Marine Ecosystem Project is hosted at www.cavehill.uwi.edu/cermes/clme.html
86 The Web site for the Canary Current Large Marine Ecosystem is at www.canarycurrent.org/
87 The Web site for the Benguela Current Commission is at www.benguelacc.org/
88 The Web site for the Bay of Bengal Large Marine Ecosystem Project is at www.boblme.org/
89 Op. cit., see note 75.
Carocci, F., Bianchi, G., Eastwood, P. and Meaden, G. *Geographic information systems to support the ecosystem approach to fisheries: status opportunities and challenges.* FAO Fisheries and AquacultureTechnical Paper No. 532. Rome, FAO. 101 pp.
FAO. 2005. *Putting into practice the ecosystem approach to fisheries.* Rome. 76 pp.
FAO. 2008. *Fisheries management. 2. The ecosystem approach to fisheries. 2.1 Best practices in ecosystem modelling for informing an ecosystem approach to fisheries.* FAO Technical Guidelines for Responsible Fisheries No. 4, Suppl. 2, Add. 1. Rome. 78 pp.

NOAA FISHERIES
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Aquaculture Policy & Regulation



NOAA's Role

NOAA Fisheries plays a central role in developing and implementing policies that enable marine aquaculture and works to ensure that aquaculture complies with existing federal laws and regulations that NOAA enforces under its marine stewardship mission.

In the United States, marine aquaculture operates within one of the most comprehensive regulatory environments in the world. Projects that are sited in U.S. waters must meet a suite of federal, state, and local regulations that ensure environmental protection, water quality, food safety, and protection of public health.

Science and adaptive management inform NOAA policy, regulatory, and management decisions regarding aquaculture in marine waters.

Aquaculture Policies

Regulating Aquaculture

Current Policy and Regulatory Initiatives

NOAA is working with its federal, state, and tribal partners on a variety of initiatives stemming from the 2011 Aquaculture Policies, the recent National Ocean Policy Implementation Plan, and its mandates under the Magnuson Stevens Act and the National Aquaculture Act.

Interagency Working Group on Aquaculture

NOAA chairs the Aquacuture Regulatory Task Force under the Interagency Working Group on Aquaculture (formerly, Joint Subcommittee on Aquaculture), through which federal agencies collaborate with the **National Ocean Council** to streamline and

better coordinate federal permitting for aquaculture. The goal is to produce a more coordinated and consistent federal regulatory process that will provide protection for the ocean environment and increase efficiency, transparency, and predictability in making permit decisions.

National Shellfish Initiative

The goal of the **National Shellfish Initiative** is to increase populations of bivalve shellfish (oysters, clams, and mussels) in our nation's coastal waters through commercial production and conservation activities. Efforts focus on encouraging shellfish aquaculture, advancing science and research, and streamlining permitting at federal, state, and local levels.

Inspired by the national initiative is the **Washington State Shellfish Initiative**, in which federal and state agencies, tribes, the shellfish industry, and the restoration community are working together to restore and expand shellfish resources to promote shellfish aquaculture and create family-wage jobs.

Technology Transfer Initiative

The **Aquaculture Technology Tranfer Initiative** was announced in concert with the 2011 aquaculture policies. The purpose is to foster the development of innovative technology for commercial aquaculture in the United States.

Rulemaking for the Gulf of Mexico Aquaculture Fishery Management Plan

NOAA is developing rules to implement a **Fishery Management Plan for Regulating Offshore Marine Aquaculture in the Gulf of Mexico** - the first comprehensive regional approach to authorizing aquaculture in federal waters. The public will have an opportunity to comment on the draft rule before it is finalized.

Mayflower International Ltd.

5 Yeamans Road
Charleston, SC 29407

Tel: +1 857 222 6664
Email: mayflower@mindspring.com

ATN: Mike Waine, Senior FMP Coordinator

9 November 2015

Re: American Eel – ASMFC November Annual Meeting

Dear Mike,

For the second year I took time to attend the ASMFC eel discussion. We knew years ago a. rostrata would eventually be declared NOT endangered and there would need to be some changes. Most States however continue to ignore the opportunity to develop this fishery and allow for aquaculture – like Europe and Asia have done.

There has not been much of an opportunity for interested fishermen to be involved in management decisions. ASMFC commissioners follow TC recommendations. Historic catch reports are inadequate. Too many other things take priority and eels are on the back burner.

Together with several multi – national organizations, I followed the process for over 5 years. Today commercial eel fishing continues to be basically blocked and underutilized. Even Maine has much greater potential. The 12 tons of baby eel being harvested in the Caribbean do not effect us. It is said that 90 pct of baby eels die from predators and natural mortality.

Given that you are the ASMFC plan coordinator for American Eel, I appreciate the ability to discuss next steps. I am concerned that Amendment 4 will unnecessarily delay things further. At a minimum, states should have a research allocation for glass eel. A percentage of harvest can be returned to the rivers to better know what was there during their short migration. A system that preserves the resource and makes available a quota that makes sense is needed. Let the normal laws of supply and demand and nature work here. There are many tools we can use to learn about this resource. Daily reporting requirements and permit conditions give enough protection.

Where do we go now? What can be done?

Thank you for your attention and reply.

Best Regards, Bill Quinby

BQ

Mayflower International Ltd.

5 Yeamans Road **Tel: 1-857 222 6664**
Charleston, SC 29407 **Email: mayflower@mindspring.com**

14 December 15

Re: ASMFC American Eel Technical Committee meeting today

ATN: Interested Parties

The lack of overwhelming support today for N. Carolina to utilize a facility specifically built to grow eel was disturbing. The project offered by NCDNR and The American Eel Farm is a gift. It gives an opportunity to learn more about eel – utilize a sustainable public resource - help our domestic economy – improve science – better understand ecosystems etc.

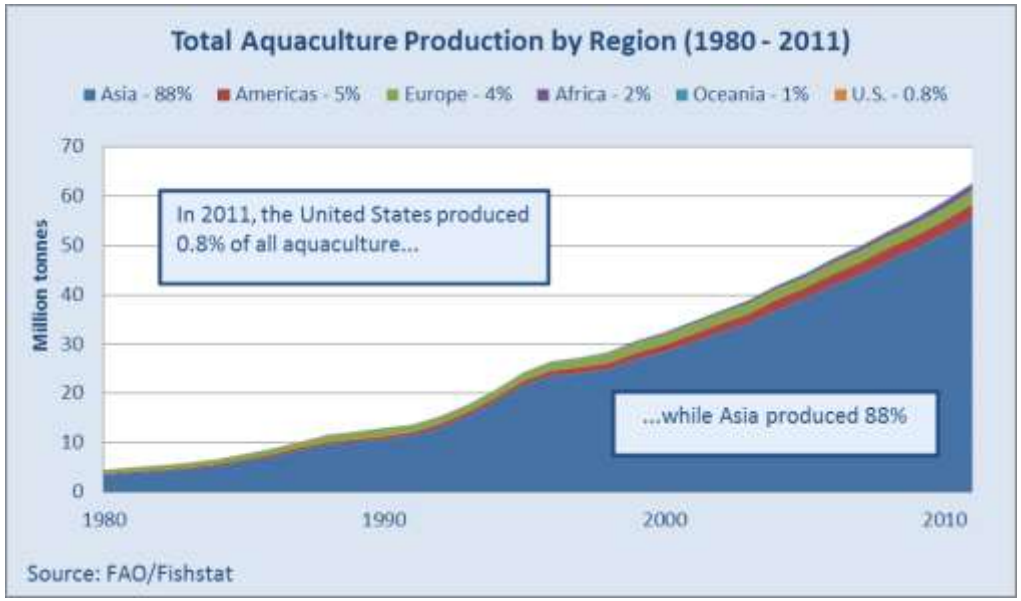
States are afraid to authorize any significant research or commercial activity without USFWS and ASMFC blessing. There must be more eels fished to better understand the resource.

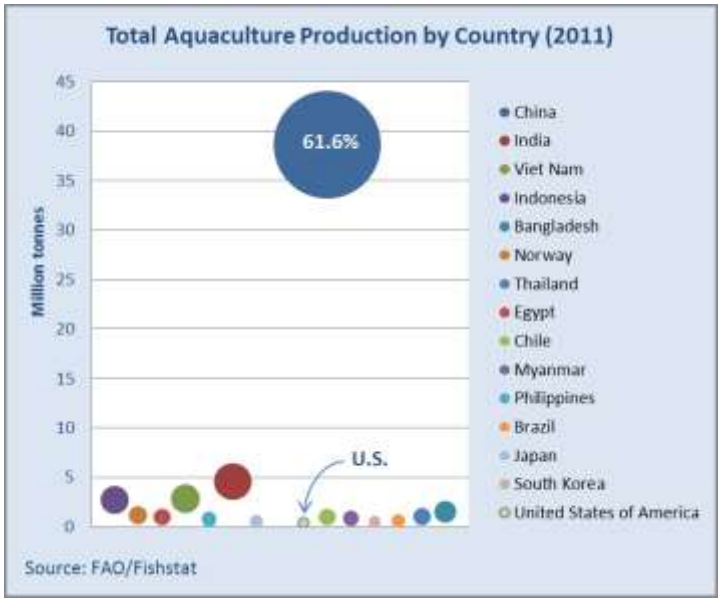
Lets not allow more years to pass.

Amendment 4 is outdated.

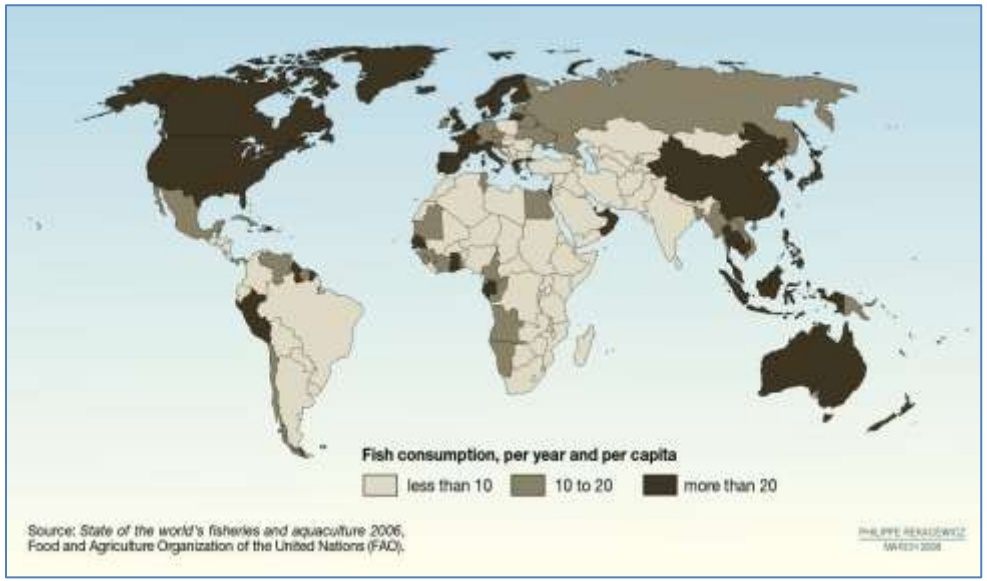
Where are the proposals for 2017 and beyond?

World Production of Aquaculture



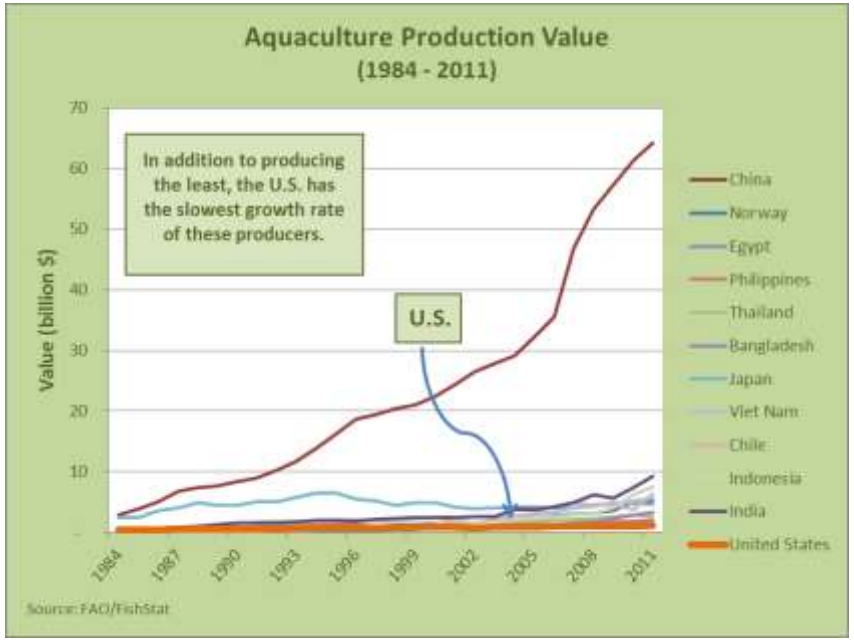


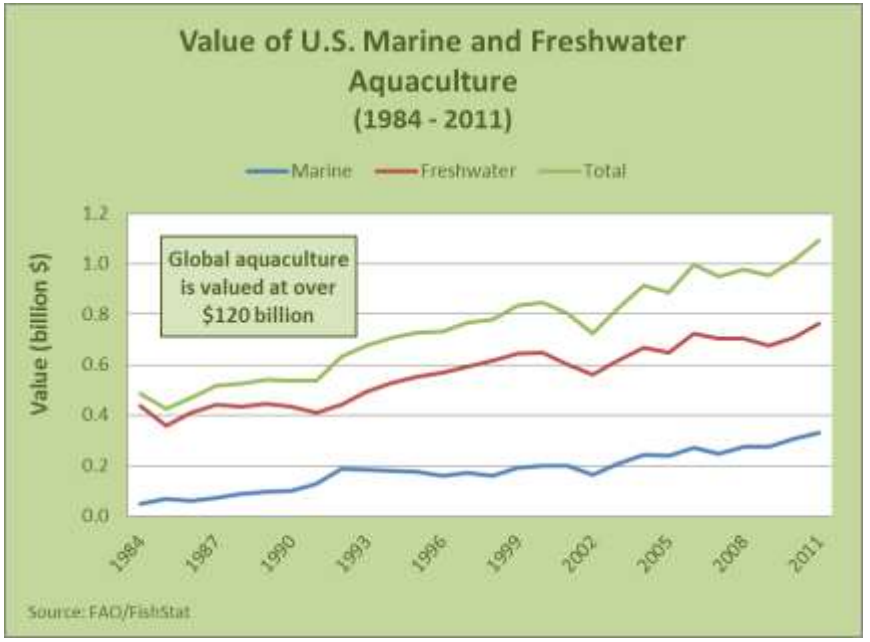
World Consumption of Seafood



Total Seafood Consumed, 2009 by Country (tonnes)	
China	42,365,316
United States	7,424,152
Japan	7,163,895
India	6,646,244
Indonesia	6,040,631
Republic of Korea	2,691,931
Thailand	1,690,540
Source: FAO FishStat	

U.S and World Aquaculture Projections and Values





June 2011

National Oceanic and Atmospheric Administration
MARINE AQUACULTURE POLICY[1]

Purpose

The purpose of this policy is to enable the development of sustainable marine aquaculture within the context of the National Oceanic and Atmospheric Administration's (NOAA) multiple stewardship missions and broader social and economic goals. Meeting this objective will require NOAA to integrate environmental, social, and economic considerations in management decisions concerning aquaculture. This policy reaffirms that aquaculture is an important component of NOAA's efforts to maintain healthy and productive marine and coastal ecosystems, protect special marine areas, rebuild overfished wild stocks, restore populations of endangered species, restore and conserve marine and coastal habitat, balance competing uses of the marine environment, create employment and business opportunities in coastal communities, and enable the production of safe and sustainable seafood.

Statement of Policy

For purposes of this policy, aquaculture is defined as the propagation and rearing of aquatic organisms for any commercial, recreational, or public purpose. This definition covers all production of finfish, shellfish, plants, algae, and other marine organisms[2] for 1) food and other commercial products; 2) wild stock replenishment for commercial and recreational fisheries; 3) rebuilding populations of threatened or endangered species under species recovery and conservation plans; and 4) restoration and conservation of marine and Great Lakes habitat.

It is the policy of NOAA, within the context of its marine stewardship missions and its strategic goals with respect to healthy oceans and resilient coastal communities and economies, to:

1. Encourage and foster sustainable aquaculture development that provides domestic jobs, products, and services and that is in harmony with healthy, productive, and resilient marine ecosystems, compatible with other uses of the marine environment, and consistent

[1] The term "marine aquaculture" is used because the majority of NOAA's aquaculture authorities and activities relate to marine species. However, this policy applies to all of NOAA's aquaculture authorities and activities, including those related to marine, freshwater, and anadromous species and includes the Great Lakes.
[2] This definition does not include marine mammals or birds.

with the National Policy for the Stewardship of the Ocean, our Coasts, and the Great Lakes (National Ocean Policy).[3]

2. Ensure agency aquaculture decisions protect wild species and healthy, productive, and resilient coastal and ocean ecosystems, including the protecting of sensitive marine areas.

3. Advance scientific knowledge concerning sustainable aquaculture in cooperation with academic and federal partners.

4. Make timely and unbiased aquaculture management decisions based upon the best scientific information available.

5. Support aquaculture innovation and investments that benefit the Nation's coastal ecosystems, communities, seafood consumers, industry, and economy.

6. Advance public understanding of sustainable aquaculture practices; the associated environmental, social, and economic challenges and benefits; and the services NOAA has to offer in support of sustainable aquaculture.

7. Work with our federal partners, through the Joint Subcommittee on Aquaculture[4] and other avenues, to provide the depth of resources and expertise needed to address the challenges facing expansion of aquaculture in the United States.

8. Work internationally to learn from aquaculture best practices around the world and encourage the adoption of science-based sustainable practices and systems.

9. Integrate federal, regional, state, local, and tribal priorities along with commercial priorities into marine aquaculture siting and management and ensure aquaculture development is considered within other existing and potential marine uses to reduce potential conflicts.

Basis for the Policy

NOAA has a long history of conducting regulatory, research, outreach, and international activities on marine aquaculture issues within the context of its missions of service, science, and environmental stewardship. The National Aquaculture Act of 1980, which applies to all federal agencies, states that it is "in the national interest, and it is the national policy, to encourage the development of aquaculture in the United States." The statutory basis for NOAA's aquaculture activities includes the Magnuson-Stevens Fishery Conservation and Management Act, the Marine Mammal Protection Act, the Endangered Species Act, the Coastal Zone Management

[3] EO 13547, which adopts the final recommendations of the Interagency Ocean Policy Task Force (July 19, 2010) is available online at http://www.whitehouse.gov/oceans.

[4] The Joint Subcommittee on Aquaculture of the Federal Coordinating Council on Science, Engineering, and Technology was created in the National Aquaculture Act of 1980. The purpose of the coordinating group is to increase the overall effectiveness and productivity of federal aquaculture research, transfer, and assistance programs.

Act, the National Marine Sanctuaries Act, and the Fish and Wildlife Coordination Act. Under these laws, in addition to the National Environmental Policy Act, NOAA is responsible for considering and preventing and/or mitigating the potential adverse environmental impacts of planned and existing marine aquaculture facilities through the development of fishery management plans, sanctuary management plans, permit actions, proper siting, and consultations with other regulatory agencies at the federal, state, and local levels. Other statutes, including the National Sea Grant College Program Act, the Saltonstall-Kennedy Act, the Anadromous Fish Conservation Act, the Interjurisdictional Fisheries Act, the Merchant Marine Act, and the Agricultural Marketing Act, authorize NOAA to enable and provide assistance for both public and private sector aquaculture. In addition, the Oceans and Human Health Act calls for research related to aquaculture.

NOAA may engage in regulatory actions in the Exclusive Economic Zone under the authority of the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) through Fishery Management Plans for species in need of conservation and management. NOAA may also engage in regulatory action under National Marine Sanctuaries Act (NMSA) authority with respect to aquaculture activities within or potentially affecting Sanctuaries. NOAA has a direct regulatory role for aquaculture within the sanctuaries, in both state and federal waters, except in state waters when limited by formal written agreement with the Governor of that state. NOAA also engages in consultations with other federal permitting agencies under the authority of the Endangered Species Act, Marine Mammal Protection Act, the Essential Fish Habitat provisions of the Magnuson-Stevens Fishery Conservation and Management Act, the National Environmental Policy Act, and other statutes. Through the Coastal Zone Management Act, NOAA also reviews and approves state coastal management programs, which identify permissible uses in the coastal zone, and oversees federal consistency with these programs.[5]

In developing this policy, NOAA evaluated the application of past NOAA and Department of Commerce aquaculture policies and planning documents and considered the specific challenges and opportunities of today and tomorrow, drawing on the agency's institutional knowledge of the state of science on aquaculture and its potential impacts. In addition, NOAA considered public input provided via an initial public comment period and a series of seven public listening sessions during April and May 2010, and a 60-day public comment period on a public draft of this policy released in February 2011.[6] The policy also aligns with several objectives in NOAA's Next Generation Strategic Plan and is a primary component of NOAA's strategic objective for safe and sustainable seafood.[7]

This policy was also informed by the National Ocean Policy and the framework for effective coastal and marine spatial planning (CMSP).[8] Many of the themes found in the National Ocean Policy – such as protecting, maintaining, and restoring healthy and diverse ecosystems;

[5] Some federal permit actions are subject to state review under the consistency certification provisions of the Coastal Zone Management Act.
[6] Summaries of the listening sessions and all comments submitted as public input to the development of the NOAA aquaculture policy are posted online at http://aquaculture.noaa.gov
[7] Available at http://www.ppi.noaa.gov/strategic_planning.html
[8] Final Recommendations of the Interagency Ocean Policy Task Force. Available online at http://www.whitehouse.gov/administration/eop/ceq/oceans

supporting sustainable uses of the ocean; and increasing scientific understanding and applying that knowledge to make better decisions – are echoed in this document. This policy also mirrors the National Goals for CMSP, setting the stage for aquaculture to be properly considered within the CMSP process. NOAA, as the primary bureau within the Department of Commerce with programmatic aquaculture responsibilities, developed this policy as a complement to the broader Department of Commerce aquaculture policy.

Background

Approximately 84 percent of the seafood consumed in the United States is imported,[9] about half of which is sourced from aquaculture. In 2009, aquaculture crossed the threshold of providing more than half of all seafood consumed worldwide.[10] However, domestic aquaculture provides only about 5 percent of the seafood consumed in the United States.[11] Growing U.S. and worldwide demand for seafood is likely to continue as a result of increases in population and consumer awareness of seafood's health benefits. The most recent federal *Dietary Guidelines for Americans* (2010) recommend Americans more than double their current seafood consumption.[12] Because wild stocks are not projected to meet increased demand even with rebuilding efforts, future increases in supply are likely to come either from foreign aquaculture or increased domestic aquaculture production, or some combination of both.

The existing domestic marine aquaculture community is mainly comprised of shellfish growing, but also includes finfish and algae production in coastal waters and hatchery production of fish and shellfish to replenish stocks of important commercial, recreational, and endangered species and to restore marine habitat (e.g., oyster reefs). Emerging technologies for marine aquaculture include land-based closed-recirculating systems, marine algae production technologies for biofuels and non-food products, systems that integrate different types of aquaculture or combine aquaculture with other uses, and systems in exposed open-ocean waters.

Federal support, engagement, and authorities related to aquaculture development span a number of agencies, in particular the Food and Drug Administration, Environmental Protection Agency, Army Corps of Engineers, Fish and Wildlife Service, and the U.S. Department of Agriculture. These agencies collaborate with each other, industry, states, and academia to address issues related to aquaculture facilities[13] and to promote the development of new technologies that

[9] Source: U.S Department of Commerce, *Fisheries of the United States 2009*.
[10] United Nations Food and Agriculture Organization. (2009). FISHSTAT Plus: Universal Software for Fishery Statistical Time Series (Food and Agriculture Organization, Rome). Version 2.32. This figure includes both freshwater and marine production.
[11] This figure includes both freshwater and marine production. Not included in this figure is the amount of salmon produced in Alaska by regional aquaculture associations and others in Alaska's salmon stock enhancement program. In 2009, Alaska's salmon aquaculture stock enhancement programs produced over 45 million salmon, mostly pink and chum salmon.
[12] See www.mypyramid.gov
[13] A recent example is the National Aquatic Animal Health Plan, which was developed in response to the growing need for a coordinated government effort to ensure aquatic animal health. See http://aquaculture.noaa.gov/news/naahp.html

improve the sustainability of the industry. This policy sets the stage for NOAA's continued involvement in these coordinated efforts.

Benefits and Challenges

As interest in commercial aquaculture production and wild species restoration in the marine environment has increased, so too has debate about the potential economic, environmental, and social effects of aquaculture – and the need for better public understanding with respect to these issues. Benefits of sustainable aquaculture may include species and habitat restoration and conservation; nutrient removal; provision of safe, local seafood that contributes to food security and human health and nutrition; increased production of low trophic-level seafood; and synergies with fishing (e.g., using fish processing trimmings in aquaculture feeds). Sustainable aquaculture can also contribute economic and social benefits by creating jobs in local communities and helping to maintain the cultural identity of working waterfronts. Environmental challenges posed by aquaculture, depending upon the type, scope, and location of aquaculture activity, may include nutrient and chemical wastes, water use demands, aquatic animal diseases and invasive species, potential competitive and genetic effects on wild species, effects on endangered or protected species, effects on protected and sensitive marine areas, effects on habitat for other species, and the use of forage fish for aquaculture feeds. Economic and social challenges may include market competition affecting the viability of domestic aquaculture and/or the prices U.S. fishermen receive for their wild seafood products; competition with other uses of the marine environment; degraded habitats and ecosystem services; and impacts to diverse cultural traditions and values.

Growing consumer demand for safe, local, and sustainably produced seafood, increasing energy costs, increasing seafood demand in countries that currently export seafood to the United States, and growing interest in maintaining working waterfronts are emerging drivers that support sustainable domestic aquaculture production. U.S. aquaculture production – both small-scale and large-scale – has evolved and improved over time through regulations at the federal and state levels, scientific advancements, consumer demand, technological innovation, industry best management practices, and protocols for responsible stock replenishment and hatchery practices. This policy will allow NOAA to further advance these developments through the actions described below.

NOAA Aquaculture Priorities

To implement the Statement of Policy, NOAA has identified the following priorities:

Science and Research

- Expand NOAA's research portfolio to (1) provide the necessary ecological, technological, economic, and social data and analysis to effectively and sustainably develop, support, manage, and regulate private and public sector marine aquaculture and species restoration, including technologies deemed necessary under recovery and

conservation plans for depleted, threatened, and endangered species and habitat; (2) monitor, assess, and address the environmental and socioeconomic effects of marine aquaculture, including cumulative impacts; and (3) complement the scientific work of our federal, state, and academic partners.

- Evaluate alternative protein and lipid sources to be used in lieu of wild fish and fish oil in aquaculture feeds and develop cost-effective alternative feeds that maintain the human health benefits of seafood and reduce reliance on the use of wild forage fish in the diets of farmed fish.

- Develop and evaluate the cost-effectiveness of methodologies to prevent, minimize, and mitigate potential adverse ecosystem and socioeconomic impacts of aquaculture.

- Monitor and assess the effects of ocean acidification and climate change on marine aquaculture and develop adaptation strategies.

Regulation

- Actively engage federal agencies, Fishery Management Councils, federal advisory councils or committees, coastal states, tribes, other stakeholders, and Congress to clarify NOAA's regulatory authority related to aquaculture in federal waters in the context of other federal, state, and tribal authorities and to establish a coordinated, comprehensive, science-based, transparent, and efficient regulatory program, taking into account relevant international standards, as appropriate, for aquaculture in federal waters consistent with the President's Executive Order on Improving Regulation and Regulatory Review.

- Work with federal, state, local, tribal, and regional agencies and organizations to clarify regulatory requirements and to establish coordinated, comprehensive, science-based, transparent, and efficient processes for permit reviews, permit consultations, and other regulatory and management actions for marine aquaculture in state waters – taking into account existing authorities, international standards, and regional, state, and local goals, policies, and objectives.

- Engage in coastal and marine spatial planning with other agencies and jurisdictions, including the Regional Planning Bodies being created under the National Ocean Council, to ensure siting of marine aquaculture that reduces conflicts among competing uses, minimize adverse impacts on the environment, and identify activities for potential co-location with aquaculture operations.

Innovation, Partnerships, and Outreach

- Collaborate with federal partners, coastal communities, states, tribes, the aquaculture industry, non-governmental organizations, and other stakeholders to transition innovative aquaculture technologies from laboratory studies to commercial and restoration projects and document and assess their environmental, ecosystem, and socioeconomic impacts. Focus on projects that will create jobs in coastal communities, produce healthful local

seafood, revitalize working waterfronts, support traditional fishing communities, avoid impacts to protected areas, and restore depleted species and habitat.

- Work with extension and outreach services to interpret technical and scientific data and provide informational products to transfer that knowledge to other stakeholders and the public.

- Support restoration and commercial shellfish aquaculture initiatives to restore shellfish populations that provide locally produced food and jobs, help improve water quality, and restore and conserve coastal habitat.

- Develop synergies among NOAA's fisheries management, enforcement, financial assistance, aquaculture, seafood inspection, Coastal Zone Management, National Marine Sanctuaries, and National Sea Grant programs to rebuild wild fish stocks and support alternative or supplemental economic options for fishermen.

- Engage within the Joint Subcommittee on Aquaculture and National Ocean Council to promote coordination among federal agencies on marine aquaculture regulatory and science issues and pursue opportunities for collaboration, such as integrating aquaculture with other ocean uses and using aquaculture facilities as a platform for more comprehensive environmental monitoring.

International Cooperation

- Work with other federal agencies to establish a coordinated, consistent, and comprehensive international strategy on sustainable marine aquaculture that supports and is consistent with U.S. policies and priorities regarding food security, international trade, healthy oceans, and economic well-being.

- Work with other nations, as appropriate, to adopt sustainable aquaculture and seafood safety approaches using the best practices.

- Exchange scientific insights with other nations and promote joint participation in cooperative research that is of potential multinational value, including addressing impacts of aquaculture that breach international boundaries.

Implementation and Periodic Review

NOAA will begin to implement this policy immediately upon release. This policy will henceforth guide all NOAA activities with respect to marine aquaculture, until such time as it is amended or rescinded by the NOAA Administrator.

Appendices

NOAA will take a tiered approach with respect to this policy and may publish more detailed policies related to specific authority to regulate aquaculture activities. These tiered documents will be included as appendices to the overarching policy.

Appendix 1. NOAA Guidance for Aquaculture in Federal Waters

Appendix 1 establishes goals for NOAA's regulatory actions with respect to aquaculture production in federal waters of the U.S. Exclusive Economic Zone, and provides a list of principles and approaches that NOAA will take to achieve each goal. In the future, NOAA will be identifying specific actions to be taken to implement each goal.

APPENDIX 1

NOAA GUIDANCE FOR AQUACULTURE IN FEDERAL WATERS

The purpose of this appendix is to establish a set of goals to guide NOAA's regulatory and programmatic actions with respect to aquaculture production in federal waters of the U.S. Exclusive Economic Zone and to provide a list of implementing actions that NOAA will take to achieve each goal. NOAA will take these actions to the extent of the agency's discretion and funding availability under relevant authorities and in coordination with our federal partners.

These goals and implementing actions are an extension of the NOAA Aquaculture Policy, which applies broadly to all marine aquaculture-related activities at NOAA.

Goal 1. Ecosystem compatibility – Aquaculture development in federal waters is compatible with the functioning of healthy, productive, and resilient marine ecosystems.

NOAA will achieve this goal by:

- developing, implementing, and enforcing ecosystem-based conservation and management measures for aquaculture that fulfill the agency's marine stewardship responsibilities to protect and restore healthy coastal and ocean ecosystems and to conserve living marine resources, their habitats, and other protected areas
- developing, implementing, and enforcing conservation and management measures for aquaculture designed to maintain the health, genetics, habitats, and populations of wild species; maintain water quality; prevent escapes and accidental discharges into the environment; and avoid harmful interactions with wild fish stock, marine mammals, birds, and protected species
- pursuing efforts to restore wild stocks
- supporting the use of only native or naturalized species in federal waters unless best available science demonstrates use of non-native or other species in federal waters would not cause undue harm to wild species, habitats, or ecosystems in the event of an escape
- employing science-based adaptive management
- taking into account the cumulative impacts of aquaculture throughout all trophic levels of the marine environment and in combination with the impacts of other activities
- encouraging the use of aquaculture feeds that either use fish from sustainably managed fisheries or alternative protein and lipid sources
- considering interactions with marine resources managed by other agencies and jurisdictions
- conducting programmatic or site-specific reviews of impacts related to proposed facilities in federal waters in compliance with National Environmental Policy Act requirements

Goal 2. Compatibility with other uses – Aquaculture facilities in federal waters are sited and operated in a manner that is compatible with other authorized uses of the marine environment.

NOAA will achieve this goal by:

- coordinating with other agencies to develop tools to properly site aquaculture in federal waters, including tools to reduce conflicts among competing uses and identify activities for potential co-location with aquaculture operations, in the context of regional and national coastal and marine spatial planning (CMSP) activities and ecosystem compatibility goals
- incorporating the preferences of states in decisions about aquaculture development in federal waters
- facilitating discussions among interested aquaculture developers, concerned state agencies, Fishery Management Councils, tribes, other federal agencies, federal advisory committees, and the public as early as possible in project planning and development
- promoting the safety of human life at sea and providing situational awareness for those working on offshore aquaculture operations, including coastal and marine forecasts and marine navigation weather

Goal 3. Best available science and information – Management decisions for aquaculture in Federal waters are based upon the best available science and information.

NOAA will achieve this goal by:

- basing management decisions on best available scientific information – including biological, technological, ecological, economic, and social data – in management decisions
- synthesizing and delivering information on the current state of scientific understanding about the observed and potential impacts and benefits of open ocean aquaculture
- identifying gaps and uncertainties associated with the current body of knowledge and taking these uncertainties into account in agency decisions
- conducting and supporting scientific studies to inform agency decision-makers on open ocean aquaculture technologies, practices, benefits, costs, and risks and to develop new and improve existing sustainable practices and products
- monitoring, evaluating, and maintaining databases on the impacts of aquaculture, including cumulative impacts, on biodiversity, predator-prey relationships, and other important characteristics of healthy and productive ecosystems
- working with state and federal agencies, academia, tribes, and other entities to improve scientific understanding of the effects of open ocean aquaculture and to develop cost-effective open ocean aquaculture technologies and practices that prevent, minimize, or mitigate negative environmental or societal effects
- updating and adapting conservation and management measures to reflect the best available scientific information
- incorporating the insights gained by other countries that actively participate in open ocean aquaculture activities

Goal 4. Social and economic benefits – Investments in sustainable aquaculture in federal waters provide a net benefit to the Nation's economy, coastal communities, and seafood consumers while considering regional and state goals and objectives.

NOAA will achieve this goal by:

- creating opportunities for new aquaculture jobs and economic growth for U.S. communities that complement commercial and recreational fishing, maintain and revitalize working waterfronts, provide upstream and downstream economic opportunities throughout the U.S. economy and provide additional domestic seafood choices for U.S. consumers
- assessing the food safety and human health effects of consumption of aquaculture products (foreign and domestic) in coordination with other federal agencies
- making the agency's fee-for-service seafood inspection services available to aquaculture producers operating in federal waters
- assessing the likely positive and negative social, economic, and cultural impacts of management decisions, individually and cumulatively, over both the short and long term, on permit applicants, individual communities, the group of all affected communities identified, and the U.S. economy, including impacts on employment and the economic viability of working waterfronts
- identifying, developing, and supporting mitigation measures to address social, economic, and cultural impacts

Goal 5. Industry Accountability – To secure long-term access to operate aquaculture facilities in federal waters, operators are held accountable for protecting the environment, wild species, and human safety and for conducting and reporting ongoing monitoring.

NOAA will achieve this goal by working with federal agencies and other partners to develop an appropriate framework through which operators of aquaculture facilities will:

- conduct a baseline environmental analysis of the proposed site prior to permit review
- prepare and implement a broodstock management plan, an aquatic animal health plan, and a contingency plan for responding to emergencies
- prepare, obtain federal approval for, and comply with an operating plan that uses recognized best management practices to ensure good husbandry, biosecurity, predator control, and maintenance practices that minimize the number and frequency of escapes, disease outbreaks, noise impacts, and entanglements
- prepare, obtain federal approval for, and comply with a monitoring plan to meet all monitoring and reporting requirements, including reports of escapes, disease outbreaks, drug or chemical applications, nutrient discharges, and other environmental monitoring as required by NOAA or other federal agencies
- incorporate environmentally efficient and responsible management practices that limit inputs and waste discharges into the environment from drugs, chemicals, feeds, etc.
- allow regular inspection of facilities by authorized officers
- provide, upon request, evidence of compliance with applicable laws, including those governing use of drugs and feeds and other operational details that are under the jurisdiction of other agencies
- provide evidence of an assurance bond to address facility removal and site remediation
- safely remove facilities and organisms once operations end and, to the extent necessary and practicable, restore environmental conditions of the site
- ensure the safety of human life at sea

Goal 6. Approval process – Management decisions for aquaculture operations in federal waters are made in an efficient and transparent manner that produces timely, unbiased, and scientifically based decisions.

NOAA will achieve this goal by:

- implementing efficient, coordinated, transparent, and timely processes for science-based permit review and issuance and making easily understood information about the permitting process and requirements available on the agency's website
- reducing regulatory uncertainty and minimizing unnecessary regulatory burden on individuals, private or public organizations, or federal, state, tribal, or local governments
- coordinating permit review, approval, and enforcement, both internally and with other federal agencies, to ensure compliance with existing regulatory requirements and to foster an efficient and timely regulatory process
- providing public notice and opportunities for Fishery Management Council, state, tribal, local government and stakeholder input on agency management decisions
- providing leadership in conducting periodic reviews of federal statutory and regulatory requirements to identify gaps or overlaps in federal authority, clarify federal agency roles and responsibilities, and develop streamlined processes for authorizing aquaculture and enforcing regulatory requirements in federal waters, in consultation with Congress, other federal agencies, Fishery Management Councils, and states

Goal 7. Public information – The public has an accurate understanding of sustainable aquaculture development in federal waters and the associated environmental, social, and economic challenges and benefits; monitoring information is readily available to the public.

NOAA will achieve this goal by:

- developing, widely disseminating, and effectively communicating regional and national informational materials on the merits, trade-offs, technologies, species, and practices used to conduct aquaculture in federal waters
- making publicly available – in a timely manner and in accordance with applicable standards for transparency and confidentiality – monitoring data, results, and information submitted by aquaculture facilities operating in federal waters, analyses of the data reported by aquaculture operators in federal waters, and the results of research conducted by NOAA and others
- communicating to the public, through extension or other outreach services, new research findings, particularly those from local research and demonstration projects

Mike Waine

From: liveeels@gmail.com
Sent: Wednesday, November 18, 2015 7:24 PM
To: William Quinby
Cc: Ann Parmely; Asm. Bob Andrzejczak; Bill R. Orndorf; BRADFORD C.CHASE; Brandon Muffley; Brian Langley; Bryan King; CATHERINE W.DAVENPORT; Chris Zeman; Craig D Pugh; Dan Mckiernan@state.ma.us; Daniel Ryan; DAVE GOSHORN; DAVID BORDEN; David Chanda; David Saveikis; David Simpson; Del. Dana Stein; Dennis Abbott; Derek Orner; Doug Brady; Douglas Grout; Dr Lance Stewart; DR. MALCOLM RHODES; Emerson Hasbrouck; Eric Reid; G. RITCHIE WHITE; J. Thomas Moore; James Gilmore; JESSICA MCCAWLEY; Jocelyn Cary; John A. Arway; John Bull; JOHN CLARK; Kyle Schick; LEROY YOUNG; LOREN W.LUSTIG; Louis Daniel; Major Jon Cornish; Mark Alexander; Mark Gibson; Martin Gary; Michelle Duval; Nancy Addison; Nancy Bernier; Patrick Geer; Patrick Keliher; Rep. Craig A. Miner; Rep. Jon Burns; REP. MIKE VEREB; SEN. RICHARD STUART; ROB OREILLY; Robert Ballou; Robert H. Boyles JR; ROSS SELF; Roy Miller; Russ Allen; SEN. DAVID H.WATTERS; Sen. Philip Boyle; Sen. Susan Sosnowski; Sen.Thad Altman; Senator Ronnie W. Cromer; SHEILA EYLER; Spud Woodward; Stephen Train; Steve Heins; Terry Stockwell; TOM FOTE; William A. Adler; William Goldsborough; Mike Waine; Toni Kerns; Robert Beal
Subject: Re: november ASMFC eel comments

Att Mike Waine ,re letter from mr Quinby,
Upon reading this letter I can only think of the last meetings we have had and the time we took listening to all the ideas that came forward out of aquaculture part of the meetings with very little result or info to the members other then wanting permits for the right to fish glass eels all in the name of aquaculture ,
Up to now I have really not seen anyone trying to actually aquaculture eels ,which in the U S is a very expensive but profitable business if done in a serious way I myself do have the feeling that most of the permits ,if issued are very hard to control ,
The members must understand that aquaculture for eels is an easy proposal in Europe and Asia because your market is at your doorstep ,for all different sizes ,in the US the only profitable market is the susi market.
Looking at the last proposal for the deadline for the eel aquaculture set for the first of December to submit a plan ,I hope you will really check that out because there are the fishermen, that really are not having a say in this deal and it's their future livelihood you are touching ,I would suggest a public hearing in the state where the permit is going to be issued for their input .and a stipulation that only licensed eelers are allowed to catch the elvers needed for the permit,
Also remember that the real endangered specie here is the eel fishermen ,there are less and less of them ,and for this year the catches have been very good by only a few of them ,market price is very low and sales are poor .
Let me know if you need any more info,

Martie Bouw. A P chair

Sent from my iPad

On Nov 9, 2015, at 4:52 PM, William Quinby <mayflower@mindspring.com> wrote:

> Thank you for your attention to attached.
> Bill Quinby
> Mayflower International Ltd.

Mike Waine

From: William Quinby <mayflower@mindspring.com>
Sent: Tuesday, November 17, 2015 1:34 PM
To: Mike Waine
Subject: FW: 2016 elver fishing
Attachments: scdnr elver lottery.pdf; scdnr-elver proposal-4nov.docx; scdnr-2016 bq applic.docx

Hi mike - thanks for your offer to help move SC along with modifying their current obsolete elver regs.
One year I set a net across the river from a maine fishermen. They said it was too close (no warning) – I got a 400 usd fine and lost my licence for the following year. This is not the first time SC fishermen lose their eel license for not receiving a notice and personally showing up in time!
Brgds, Bill Q.

From: William Quinby [mailto:mayflower@mindspring.com]
Sent: Tuesday, November 17, 2015 1:22 PM
To: 'Mel Bell' <BellM@dnr.sc.gov>
Cc: 'Robert H. Boyles, Jr.' <BoylesR@dnr.sc.gov>; 'Ross Self' <SelfR@dnr.sc.gov>; 'Bill Post' <PostB@dnr.sc.gov>; 'Angel Curry Brown' <BrownAC@dnr.sc.gov>
Subject: RE: 2016 elver fishing

Thank you for your attention to attached Mel.
Mike Waine - ASMFC eel FMP – may send a letter to SCDNR about the process they like to follow for SC to amend their domestic eel fishery and remain in compliance.
I believe it was 2009 when we met in your offices with gentlemen from china and japan to discuss aquaculture of eel in SC.
The business opportunity is even more valid today. I hope we can discuss it again Tuesday December 1.
Kind regards,
Bill Q.

From: Mel Bell [mailto:BellM@dnr.sc.gov]
Sent: Tuesday, November 17, 2015 11:47 AM
To: William Quinby <mayflower@mindspring.com>
Cc: Robert H. Boyles, Jr. <BoylesR@dnr.sc.gov>; Ross Self <SelfR@dnr.sc.gov>; Bill Post <PostB@dnr.sc.gov>; Angel Curry Brown <BrownAC@dnr.sc.gov>
Subject: RE: 2016 elver fishing
Importance: High

Good morning Bill,

I have received your request to apply for a SC 2016 elver fishery license without following the standard protocol described in our letter of November 2, 2015 (attached). The protocol described, and the timing of our notification letter was the same this year as it has been for each year you have been associated with our fishery (since 2011). The elver fyke net fishery is one of two limited entry fisheries managed by our department, and both fisheries rely upon a similar protocol for annual application and participation. Since making and acceptation to following these application protocols for participating in these fisheries would be inconsistent with our standard operating procedures and unfair to all of those who are following the protocols properly I am unable to exempt you from these requirements. My recommendation would be to fill out the attached application for participating in the elver fyke net lottery and get it back to us today. I know you have done this at least twice in the past and have still been selected to participate in the fishery.

Be sure to apply today if you wish to participate in the lottery as you have done before.

Thanks

mb

From: William Quinby [mailto:mayflower@mindspring.com]
Sent: Monday, November 16, 2015 2:13 PM
To: Mel Bell <BellM@dnr.sc.gov>; Bill Post <PostB@dnr.sc.gov>; Angel Curry Brown <BrownAC@dnr.sc.gov>
Cc: Robert H. Boyles, Jr. <BoylesR@dnr.sc.gov>; Ross Self <SelfR@dnr.sc.gov>; RonnieCromer@scsenate.gov
Subject: 2016 elver fishing

Dear Mel,
Thank you for your attention to attached.
Pleased if I can visit with you on/about December 1.
Bill Q.
857 222 6664

Jones Po

Thursday, July 27, 2006 Vol. 31 No. 31 Trenton, North Carolina

Some eels find their home in the

Charles Buchanan / Freedom ENC

Aquaculturist Alexis Blanchard says eels are not spawned in captivity. Her company purchases them as elvers and brings them into their high-density enclosed recirculatory system that mimics nature.

Eel farm located on N.C. 41 between Trenton and Comfort

By KATIE MARSHALL
Freedom ENC

TRENTON — Alexis Blanchard and George Koonce got an early start in a market that is not fully developed yet — raising eels.

The North Carolina Eel Farm located in Jones County off N.C. 41 heading toward Comfort, is the only one of its kind in the nation. The farm raises American or "glass" eels, which have been considered a prize for sport fishing.

"Everything eats eels," Blanchard said.

Fishermen use eels to catch catfish, bass, cobia, sailfish and marlin.

"Several state records were caught using our eels," Koonce said.

Eels begin their lives in the Sargasso Sea which is part of the North Atlantic Ocean lying between the West Indies and the Azores.

It's the pull of fresh water that compels millions of clear blobs to swim from the Sargasso Sea to congregate with millions of similar blobs that one day will become glass eels like Blanchard's.

> ***"Several state records were caught using our eels."***
> — George Koonce
> North Carolina Eel Farm owner

Blanchard said scientists don't really know why they are pulled to fresh water, but once they get there, you can see them in countless numbers.

Blanchard's eels come from the only two certified sources available to commercial growers: Maine and Canada. They are brought in as elvers, minute versions of what they will soon become.

The eel farm is 24/7 opera-

Attention: Mike Waine

To: Chairman John Clark
Members of the American Eel Board

RE: Maine's Elver Quota

We are providing the following letter as an outline of what has happened to Maine's Elver Fishery and to ask for our fishery to be restored. First we would like to point out the reductions that the State of Maine has done to enhance the glass eels and the overall population of American Eel.

1999

License Reduction

Maine enacts a moratorium on elver licenses. If you did not have a license in 1996, 1997, or 1998. You couldn't get your license in 1999. Approximately a 70% reduction. (See table below)

1998 there were:	2,314 licensed elver fishermen
1999 (after moratorium on licenses)	- 744 licensed elver fishermen
This reduced the number of elver licenses by:	1583 licensed elver fishermen

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Gear Reduction

Maine also reduced the amount of gear people were allowed to fish, five nets to two nets. (See table below)

In 1998 there were:	3,806 Fyke nets	2,011 dip nets
In 1999 after the gear reductions there were:	- 804 Fyke nets	428 dip nets
This reduced the amount of fishing gear by:	3002 Fyke nets	1583 dip nets

For a total of 4585 pieces of gear removed which is approximately a 75% reduction.

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Season reduction

Maine reduced the elver fishing season by 50%.

2012

- Maine's elver fishery was well regulated.
- We had a very mild winter and an early spring. This warm weather enabled us to fish the entire 10 weeks of our allocated season.
- The fishermen landed 16,000 + lbs. (Maine landing report records)
- Maine's four Native American Tribes requested licenses. They caught 14% of the above reported landings.
- Maine held a lottery and gave out 29 non-tribal licenses

Summary of 2012: Maine had beautiful weather, an abundance of elvers, and more people participating in the fishery. Maine was still able to fish without a quota system in place.

2013

Maine fished the 2013 season without a quota system in place.

In the fall of 2013 at the Atlantic States Marine Fishery Commission Meeting Maine implements the following for the 2014 fishing season:

- 35% reduction from the 2012 landings (18,000+ lbs.) reduced to 11,700 lbs. of which the four tribes receive 21.9% of total allocated quota.
- Non-tribal elver fishermen were allocated personal quota based on catch history in the following manner: Maine reviewed 3 years of catch history (2011, 2012, and 2013) for each individual fisherman. They dropped the lowest catch year. They added the remaining two years together and divided by two. When the final number was reached that total was then reduced by 41.8%. Maine also decided no fisherman would be allocated less than 4 lbs. (Even if the individual fisherman had not caught 4 lbs.)
- Because of the individual fishermen who had not caught enough in the past 3 years to receive 4 lbs. combined with the allocation to the four Maine Native
- American tribes the non-tribal fishermen were in fact forced to take an even further reduction.
- In addition Maine holds back 5% of the total quota as a buffer to ensure Maine remains in compliance with the allocated quota.
- Maine implemented the swipe card system
- The vast majority of fishermen fill their quotas.

2014

At the fall 2014 Atlantic States Marine Fishery Commission Meeting Maine implements the following quota for 2015 fishing season.

- Maine Elver Fishermen forced to take another cut (13.8%) in the overall quota. This reduced us to 9,688 lbs.
- Four Maine Tribes receive 21.9 % of the total allocated quota leaving us with 7,567 lbs. to divide among the non-tribal fishermen.
- Maine closes the silver, yellow and pigmented eel fishery. *Exception: Recreational fishing for yellow eels: (25 per day) and a person who holds a dealer's license may take 50 per day.*

2015

Maine experiences a horrendous winter and very late spring. This gave us a very short season to fish. Majority of fishermen did not catch their quota

Summary and statement of facts

Maine Elver Fisherman have taken enormous reductions (41.8% and then 13.8% for a total of 55.6% of our fishery) because of the threat of American Eel being listed as endangered, threatened or a species of concern by the U.S. Fish and Wildlife. This past fall the U.S. Fish and Wildlife determined **American Eel are not endanger, threatened or a species or concern**. In fact the report states the **stocks are stable** and in some cases **improving**.

Maine Elver Fishermen have made great financial sacrifices, with concern for the fishery. We respectfully ask that the reductions that have been placed against us be removed and you restore our fishery to what it was before the implemented quota reductions. We request 16,000 lbs. be allocated back to Maine Elver fishermen as it is now crystal clear there is no reason not to do so based on the science provided by U.S. Fish and Wildlife.

The current laws and regulations (including the swipe card system) are very stringent. We feel these laws and regulations will ensure a healthy fishery. They also guard against poaching or over fishing. Maine Elver Fishermen greatly value our fishery and we have done everything possible to comply with all the unnecessary reductions we have been forced to endure. We feel we have been unduly punished by a groundless lawsuit which was filed against the U.S. Fish and Wildlife.

We would like to point out South Carolina has a three month season, Canada has a four month season while Maine has only a 10 week season. In addition we would also like to remind you of the conservation Maine has completed by removing dams and restoring 2.5 million acres of habitat of which 1.5 million acres is pristine spawning habitat. The habitat restoration entitles us to 25% of the elvers that our returning to our rivers. This allocation should be returned to the fishermen but this should not be used as quota restoration, as it is a completely separate issue. Maine is also gearing up to do lifecycle studies to contribute to the overall knowledge of American Eel.
Maine has millions of yellow, silver, and pigmented eels in our brooks, rivers, streams, and tidal waters. The reductions, conservation efforts, and stringent laws the State of Maine has put in place since 1999 has had an enormous impact on the health of the American Eel populations. We are finally seeing an abundance of eels. The stocks are stable. All the sacrifices are working, the fishery is healthy. We are doing everything possible and respectfully ask that you please consider restoring our fishery to a 16,000 lb. quota. All of the laws and reductions that have been enacted by the State Maine have made it impossible to over fish them.

Thank you for your attention to this matter. We are available to answer any questions or concerns you may have.

Sincerely,
Darrell Young
Founder and Co-Director of MEFA
All Members of Maine Elver Fisherman's Association
PO Box 35
Ellsworth, ME 04606

1-207-460-3677
ayoung@1972.40@gmail.com

Mayflower International Ltd.

5 Yeamans Road **Tel: +1 857 222 6664**
Charleston, SC 29407 **Email: mayflower@mindspring.com**

19 January 2016

Atlantic States Marine Fisheries Commission
ATN: Robert Beal, Director
Mike Waite, Plan Director

Re: American Eel - Comments for February 2016 Annual Meeting

Dear Bob,

While the formal management responsibility for American Eel officially lies with USFWS – we need to ask if it is correct and in the best interest of the species to be assigned to ASMFC.

The current situation has resulted in one group having a monopoly within the fishery and delays with its development. Your commission relys on 2 annual meetings to adopt policies / regulations for its member states – who can be concerned about being "out of compliance" if managing something differently. This doesn't help.

In Europe and Asia, Eel is an Aquaculture species. Today only Maine has been able to take advantage of the U.S. situation by exporting baby glass eel to help with demand to farmers in Asia. European countries and Morocco are adding value to their elvers and question why we do not. The glass eel harvest in EU this year will be over 100 metric tons. France 57 MT, Spain 20-30 MT, UK 5-10 MT), plus unsanctioned exports etc.

Development of our American Eel was hung up for years by a bogus "endangered" claim – only a few were able to operate for several years. We must continue to ask ASMFC to give its member States the ability to utilize their eel resource - they need to be able to provide benefits to constituents and nutrition to a global population.

While considering changes to Amendments 4, please pass a motion next month that gives flexibility to States to operate in this fishery. Thank you.

Sincerely,

W. C. Quinby