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

TO: American Lobster Management Board

FROM: American Lobster Technical Committee

DATE: October 14, 2016

SUBJECT: Season Closures and Trip Limits in the SNE Lobster Fishery

During their September 27th -28th meeting in Gloucester, MA, the American Lobster Technical Committee (TC) discussed ways to analyze the effects of season closures and trip limits on egg production in Southern New England (SNE). This discussion was prompted by a request from the Plan Development Team (PDT), who was interested in learning more about the potential impacts of these management tools on the stock.

Model simulations show a season closure during the summer results in the largest increase in egg production (21.6%), followed by spring (15%), fall (8.1%), and winter (3%). Importantly, this analysis is predicated on the assumption that fishermen do not adapt to the implementation of the season closure by increasing their fishing effort during the rest of the year. Thus, the results shown here likely represent an optimistic impact of closures, and realized effects on egg production would likely be lower.

In their discussion on trip limits, the TC identified several concerns with this management tool, including the ability for impacted fishermen to increase their number of trips to maintain harvest levels, the disproportionate impact on the offshore fleet, and the incentive for fishermen currently harvesting under the trip limit to increase their effort. Given these concerns, the TC noted that trip limits must be combined with a quota in order to effectively manage fishing mortality in SNE.

1. Simulated Season Closures on the SNE Lobster Fishery

The TC was asked to conduct an analysis on how short-term closures in the fishery would affect egg production. Such analysis is problematic as short-term (i.e. monthly) fishing mortality is not known and it is difficult to predict and model how fishermen might adapt to short-term closures by changing fishing effort before and after a closure. It is also difficult to predict any changes in the spatial distribution of lobsters and fishing effort as a result of the closure. In a best effort to analyze the effect of short-term closures, the TC chose to examine the effects of simulated quarterly closures as quarterly fishing mortality rates are estimated in the assessment model (quarter 1=January-March; quarter 2=April-June; quarter 3=July-September; quarter 4=October-December). These simulations make the following important assumptions:

1. Fishing effort or the fleet's capacity to fish lobsters will not change significantly in the near future.

2. Fishermen do not adapt to the implementation of seasonal closures by intensifying effort during the rest of the year.
3. Changing lobster length compositions as a result of the closure do not affect the ability of the fleet to fish the population.
4. Spatial distribution of lobsters does not change during the closure or in any way affect availability following the closure.

The TC also highlights that increases in egg production will benefit the stock only if environmental conditions are favorable for larval development and settlement. As mentioned in the April 2016 TC memo to the Lobster Board, recruitment appears to be decoupled from SSB. This could potentially be the result of reduced mating success, environmentally-mediated changes in survivorship, and/or increased predation. As a result, prospective increases in egg production will only benefit the stock if recruitment rates remain constant or improve.

A. Methods

The same lobster population simulation software previously used by the TC to analyze other scenarios, including trap reductions and changes in legal size, was used in this analysis. Current quarterly fishing mortality was estimated by averaging the model-estimated quarterly fishing mortality across 2011 – 2013. Seasonal closures in projection model runs were simulated by setting F=0 for the appropriate quarter (winter, spring, summer, fall) and comparing results to model runs with no seasonal closures. All simulation runs were conducted with no initial population so populations built monotonically to a stable value. Natural mortality was assumed to be 0.28 as in the original assessment model. For convenience, recruitment was always assumed to be one million individuals per year as only a comparison between scenarios is required for this analysis. As a result, the values presented in the figures should only be interpreted relative to other scenarios and <u>not as projections of the SNE stock</u>.

The case of closing the fishery for quarter 3 (summer) is special as most reproductive activities take place during this time. Female lobsters spawn (extrude eggs) in the fall. Thus, protecting pre-spawn females in the summer (when they are not egg-bearing and thus normally susceptible to harvest) would allow more to survive into the fall when they will have eggs and be protected from fishing until the next summer. As a result, the TC hypothesized if lobsters were protected during the summer, there may be enhanced reproductive activities and egg production. To attempt to specifically account for this seasonal impact, a separate adjusted Summer scenario was run in which it was assumed that at least 50% of females in the fall bear eggs (based on the 2 year reproductive cycle), and incorporated empirical data based on biosamples of egg-bearing females at-length to model resulting size compositions and egg production. For all population metrics, the regular and adjusted Summer scenarios were very similar indicating that the summer closure simulation run inherently accounts for these effects by increasing the total number of females available to spawn in the fall. Thus only the results for the regular Summer scenario are presented.

All simulations were allowed to run for 25 model years for populations to stabilize. Length composition and biomass (spawning stock biomass (SSB) and reproductive biomass (males and sexes combined; RB)) of the population in quarter 3 (summer hatching season), length composition of the total annual catch, total catch weight, and exploitation rates were then calculated and compared with an “Open” scenario with no closed seasons. Egg production was calculated by applying the fecundity-at-size relationship from Estrella and Cadrin (1995) to the female numbers at size during the summer, then summing across lengths within a scenario.

B. Results

Quarterly fishing mortality rates from the assessment model, used in the simulations, vary by sex and across seasons (Table 1). Male mortality rates are highest in the spring, then decline through the winter. Female mortality rates are comparable in the spring and summer, then decrease through the fall and winter. Mortality rates are consistently higher for males than females due to lower availability of females as a result of their egg-bearing status.

Reproductive Biomass increased between 2.7% and 19% for different seasonal closures, and differed by sex (Table 2). SSB increased most in the summer scenario, followed by spring, fall, and winter, but total increases in RB (both sexes included) were similar in spring (16.0%) and summer (15.5%). This order mirrors the fishing mortality otherwise applied to these seasons except that, as expected, protection through the summer for females had a higher effect than spring despite comparable quarterly fishing mortalities.

Similar to SSB, egg production was highest with a summer closure, increasing by 21.6%, compared to 15% for spring, 8.1% for fall, and 3% for winter (Table 2). Seasonal closures primarily benefitted populations by increased numbers of individuals and egg production for lobsters between 90 and 110mm (Figures 1 and 2).

Seasonal closures decreased total landings for all scenarios (Table 2). Decreases in total landings varied from 12.3% for summer closures to 0.7% for winter closures. Decreases in landings were always larger for females than males. The only case of increased landings was for male lobsters with spring closures, returning an increase of 0.3%. The simulations suggest that seasonal closures will generally decrease catches of lobsters below 100mm but may increase the catch of larger lobsters (Figure 3). Thus, the one case of increased (approximately equal) landings for males with spring closures occurs because lobsters are protected until the annual molt, resulting in a higher net harvest of larger lobsters.

Seasonal closures also had the effect of decreasing exploitation rates (Table 2). Both sexes saw the greatest benefit from summer closures, with decreased exploitation of 33.2% and 21% for females and males, respectively. Thus, overall exploitation decreased most in the summer (26%), followed by fall (13.6%), spring (10.8%), and winter (2.1%).

C. Discussion

Depending on the management goals for SNE, closing the fishery for a full quarter would have a measurable effect in the summer or spring, whereas a fall or winter closure would result in a <10% increase in egg production. We note that these estimates of increased egg production should be viewed as optimistic due to the assumptions listed in the introduction, particularly that fishermen will not change their fishing effort in other seasons if a quarterly closure is implemented.

Extending a closure from July through September would protect the lobster stock during the period of high water temperature. This would prevent handling stress and mortality when water temperatures are above 20°C, the threshold temperature causing immune, respiratory and cardiac trauma (Dove et al. 2005). Eliminating harvest during the molt and times of high water temperature may substantially reduce total mortality and aid in rebuilding the spawning stock by minimizing gear, and handling-induced, immediate and delayed mortality as well as sub-lethal stress. In inshore areas of SNE, late summer and fall (July-October) bottom water temperatures often exceed 20°C, with increasing duration since the early 2000s. Warm hypoxic waters are known to herd lobsters into 'islands' of marginally sustainable habitat. During this time of year, repeated catch and throwback into warm low-oxygen water can be stressful if not fatal, especially if major predators are actively feeding in the same area.

A summer closure may enhance reproductive capacity, not only by leaving more females in the water to spawn, but by:

- Allowing females who hatched eggs in early summer to molt (and mate), thus attaining larger sizes for harvest after the fishery re-opens, and increasing fecundity for those that escape harvest.
- For the unknown percentage of females who may be on 1 year reproductive cycle, allowing them to molt after hatching and spawn in the fall.
- Allowing large males who would otherwise be harvested during summer fishing the opportunity to mate with molting females.

Economic implications of seasonal closures in Maine were evaluated by Cheng and Townsend (1993); they found that gross revenues would increase from extended seasonal closures (e.g. August to November) due to a redistribution of landings across seasons which evened out prices and strengthened markets. This analysis also showed that short (1-2 month) regional closures in peak months (August and/or September) increased the value of landings, but only by a small amount because landings increased immediately after the closures, seriously depressing prices in the late fall (October-December). Closures of at least 3-4 months were required to stabilize the fishery from an economic standpoint. SNE markets are more tenuous than in Maine but may be strengthened by consolidation.

As mentioned above, this analysis is largely predicated on the assumption that creating a seasonal closure will not incentivize fishermen to increase effort in other seasons to make up lost catch, which seems implausible. Thus, the TC is concerned that a seasonal closure during the warmer months, when a closure is most likely to benefit the stock, will result in increased fishing activity in the colder, stormier months when conditions are more dangerous for fishermen.

2. Trip Limits in the SNE Lobster Fishery

The TC was also asked to analyze the impacts of various trip limits in the SNE fishery. During their discussion, the TC identified multiple concerns with the effectiveness of this management tool, primarily that trip limits are usually implemented to distribute catch through a designated time period (Pikitch et al., 1988), such as a year, rather than to limit harvest. Other concerns included the fact that fishermen landing above the proposed trip limit would be expected to increase the number of trips taken per year in order to maintain their current level of harvest. In contrast, fishermen who typically harvest less than the proposed trip limit may be incentivized to increase their catch up to the limit, further reducing the effectiveness of this management tool. Additionally, trip limits increase discards and promote high-grading of catch, which adds stress on lobsters as they are hauled and handled. There are also economic impacts of trip limits as fishermen will have reduced flexibility to respond to variations in catch and may have reduced profitability on each trip.

Given these concerns, the TC strongly recommends that, if the Board is interested in pursuing a trip limit, this management tool be combined with a quota for the SNE stock. A quota, if properly enforced, would cap landings in the fishery and allow managers to increase or decrease the total catch for the year in order to respond to the current stock status. Moreover, it is possible to control the exploitation rate by directly controlling the amount of lobsters taken through a quota.

Implementing a quota in the lobster fishery presents many challenges and raises many questions. The establishment of quotas also requires tough discussions on how the total allowable catch will be allocated among jurisdictions, LCMAs, and/or seasons. Implementation of a quota also requires the ability to model future abundance and recruitment, a challenge in the SNE fishery given the decreasing rate of recruitment per SSB. An effective quota also requires good monitoring and enforcement, both of which need to be carefully considered prior to implementation. Particular challenges in the lobster fishery include how states with fishermen harvesting from both the SNE stock and Gulf of Maine/Georges Bank stock should monitor landings, and how reporting will need to be altered to provide the temporal resolution needed to track the quota. Given these complexities, the TC recommends that further discussion, consideration, and guidance be given on trip limits and quotas. Should the Board be interested in pursuing trip limits and quotas, either in Addendum XXV, or a subsequent document, specific quotas and trip limits should be provided for analysis.

References

Cheng, H. and R. Townsend, 1993. Potential impact of seasonal closures in the US lobster fishery. Marine Resource Economics, 8:101-117.

Dove, A., A. Bassem, J. Powers, and M. Sokolowaki, 2005. A prolonged thermal stress experiment on the American lobster, Homarus americanus. J. Shellfish Research, 24(3):761-766.

Estrella B.T., S.X. Cadrin. 1995. Fecundity of the American lobster (Homarus americanus) in Massachusetts coastal waters. ICES J. Mar. Sci. Symp. 199:61-72.

Pikitch, E. K., Erickson, D. L., and Wallace, J. R. 1988. An Evaluation of the Effectiveness of Trip Limits as a Management Tool. Northwest and Alaska Fisheries Center Processed Report 88-27.

Table 1. Quarterly Fishing Mortalities as estimated in the 2015 SNE Basecase Lobster Assessment Model

Quarter	Months	Females	Males
1	Jan - March	0.07	0.09
2	May - June	0.37	0.59
3	July - Sept.	0.37	0.42
4	Oct. - Dec.	0.26	0.36

Table 2. Changes in Reproductive Biomass (SSB and RB), Egg Production, Catch Weight, and Exploitation for different seasonal closure scenarios.

		Seasonal Closure			
Metric	Sex	Winter	Spring	Summer	Fall
Increases in Reproductive Biomass	Females (SSB)	2.7%	13.4%	19.0%	7.3%
	Males (RB)	1.9%	18.9%	11.9%	9.7%
	Combined (RB)	2.3%	16.0%	15.5%	8.4%
Increases in Egg Production	Females	3.0%	15.0%	21.6%	8.1%
Changes in Catch Weight	Females	-1.4%	-4.8%	-19.0%	-5.3%
	Males	-0.2%	0.3%	-8.0%	-3.5%
	Total	-0.7%	-1.7%	-12.3%	-4.2%
Decreases in Exploitation	Females	-3.1%	-12.5%	-33.2%	-12.4%
	Males	-1.4%	-9.6%	-21.0%	-14.9%
	Combined	-2.1%	-10.8%	-26.0%	-13.6%

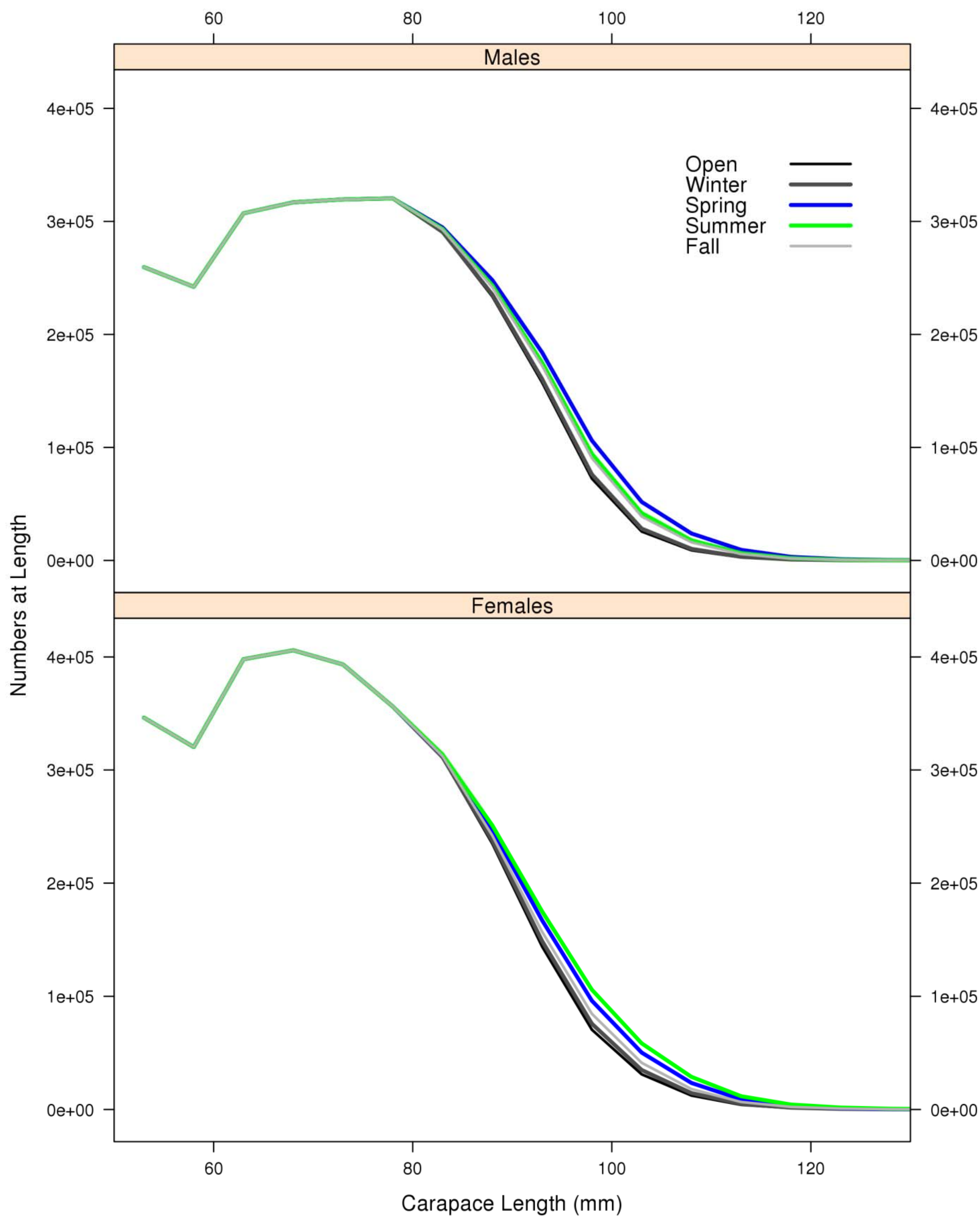

Figure 1. Numbers of lobsters at length by sex at the summer hatch under different seasonal closure scenarios; “Open” is the default scenario with no seasonal closures.

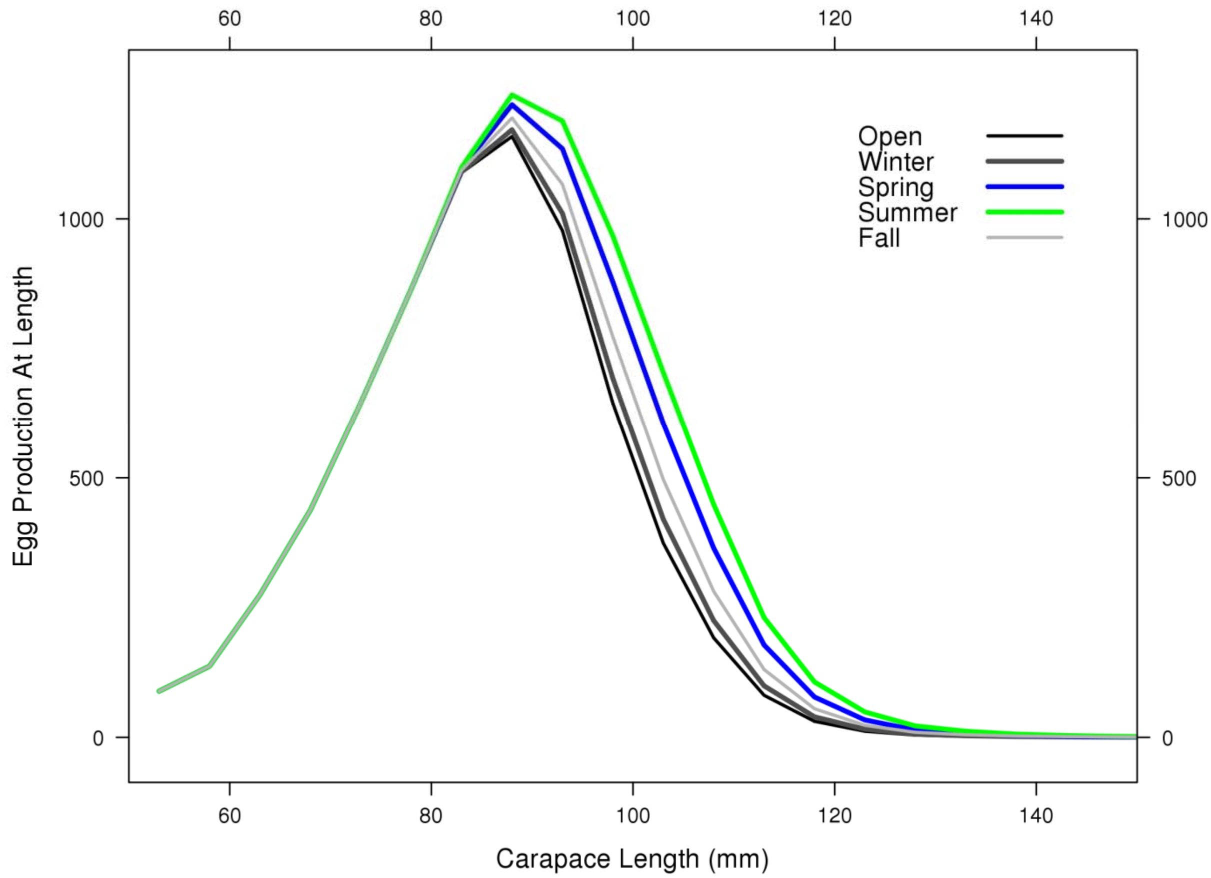

Figure 2. Egg production by size for different seasonal closure scenarios; “Open” is the default with no seasonal closures.

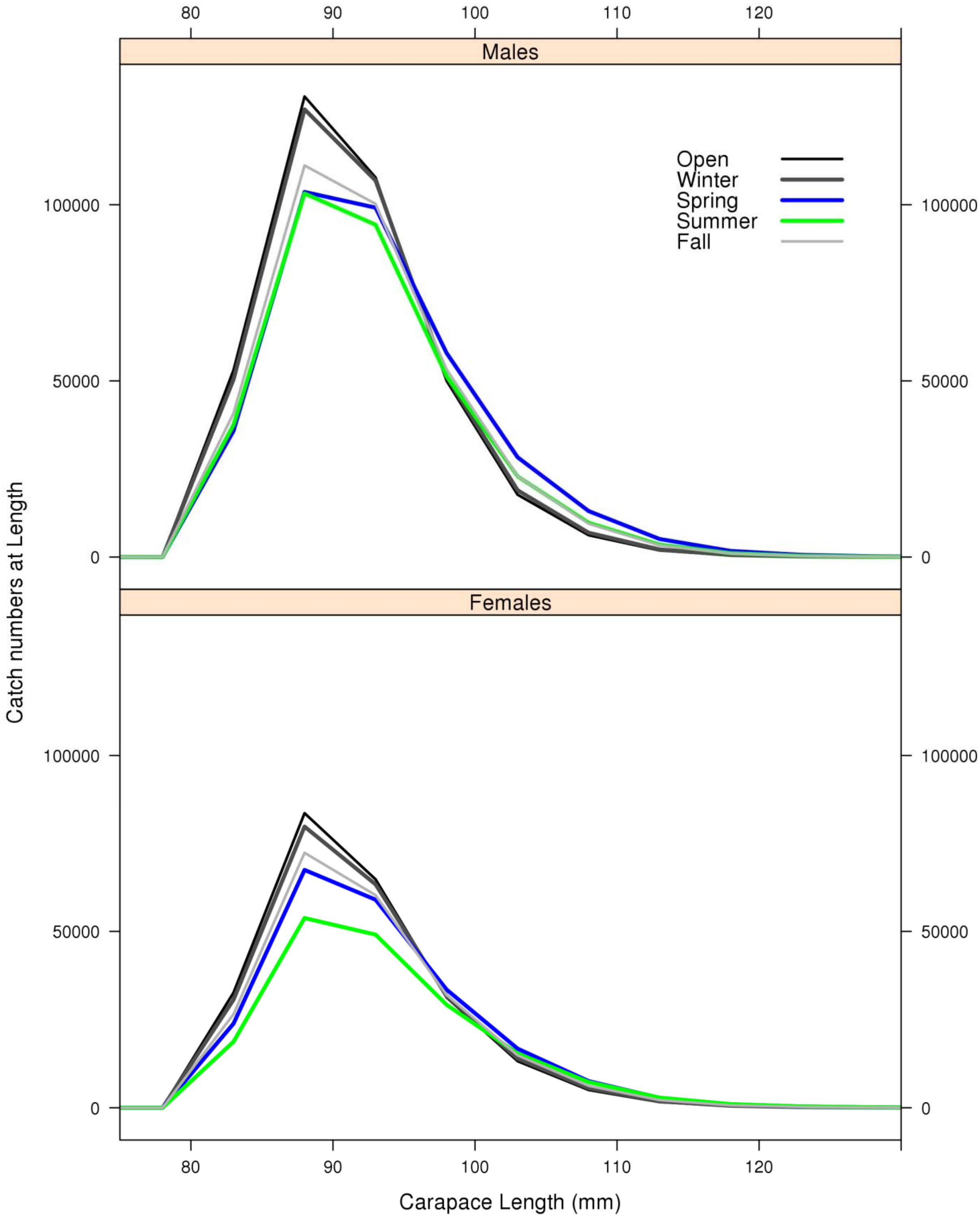

Figure 3. Catch numbers at length by sex under different seasonal closure scenarios; "Open" is the default with no seasonal closures.