Atlantic States Marine Fisheries Commission

ADDENDUM XXIX TO AMENDMENT 3 TO THE AMERICAN LOBSTER FISHERY MANAGEMENT PLAN; ADDENDUM IV TO THE JONAH CRAB FISHERY MANAGEMENT PLAN

Electronic Vessel Tracking for Federal Permit Holders

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Sustainable and Cooperative Management of Atlantic Coastal Fisheries

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1.0 INTRODUCTION

The Atlantic States Marine Fisheries Commission (Commission) has coordinated the interstate management of American lobster (*Homarus americanus)* and Jonah crab (*Cancer borealis*) from 0-3 miles offshore since 1996 and 2015, respectively. American lobster is currently managed under Amendment 3 and Addenda I-XXVI to the Fishery Management Plan (FMP). Jonah crab is managed under the Interstate Fishery Management Plan and Addenda I-III. Management authority in the Exclusive Economic Zone (EEZ) from 3-200 miles from shore lies with NOAA Fisheries. The management unit for both species includes all coastal migratory stocks between Maine and Virginia. The management unit encompasses seven Lobster Conservation Management Areas (LCMAs) and two lobster stocks: the Gulf of Maine/Georges Bank (GOM/GBK) stock and the Southern New England (SNE) stock (Figure 1).

The American Lobster Management Board (Board) initiated Addendum XXIX to the American lobster FMP and Addendum IV to the Jonah crab FMP (here forth, the Addenda) to consider implementing electronic vessel tracking requirements for federally-permitted vessels in the lobster and Jonah crab fisheries to collect location and spatial effort data. For several years, the Board has recognized the critical need for high-resolution spatial and temporal data to characterize effort in the federal American lobster and Jonah crab fisheries. In February 2018, the Board approved Addendum XXVI to improve the spatial resolution of lobster and Jonah crab harvester data to address ongoing marine spatial planning activities and assessment challenges. At the same time, the Board approved a one-year pilot program to test electronic tracking devices in the lobster and Jonah crab fishery. The intent of this pilot program was to identify appropriate tracking devices for use in the fishery and inform a Board decision on whether electronic tracking should be pursued in part, or all, of the lobster and Jonah crab fishery. Simultaneously, the Board supported additional work focusing on data integration and hardware testing. These projects lay the groundwork for implementing electronic tracking in the fishing fleet.

Based on recommendations from a work group comprising representatives from NOAA Fisheries, state and federal law enforcement, and members of the Board, the Addenda were initiated to consider requirements for electronic vessel tracking for federally-permitted vessels in the lobster and Jonah crab fishery under the authority of the Atlantic Coastal Fishery Cooperative Management Act (ACFCMA). The goal of the addendum is to collect high-resolution spatial and temporal data to characterize effort in the federal American lobster and Jonah crab fisheries for management and enforcement needs. These data will improve stock assessment, inform discussions and management decisions related to protected species and marine spatial planning, and enhance offshore enforcement.

2.0 OVERVIEW

2.1 Statement of the Problem

To date, the majority of spatial analyses of lobster and Jonah crab fishery data have been constrained to NOAA statistical areas and state management areas, hindering the ability to quantify effort in specific regions or identify important transit routes and fishing grounds. The

application of electronic vessel tracking to this fishery could significantly improve the information available to fishery managers and stock assessment scientists. In particular, a number of challenges the fishery is currently facing pose a critical need for electronic tracking data in the offshore fishery:

1) The stock assessment is currently limited by the coarse spatial scale of available harvest data for American lobster. NOAA Fisheries statistical areas and latitude/longitude coordinates are collected on the NOAA Fisheries Greater Atlantic Regional Fisheries Office (GARFO) Vessel Trip Report (VTR), however the collected spatial data represent the location of where the majority of the fishing effort occurred. The nature of the coarse spatial data is insufficient for management and scientific purposes. Though harvester reporting at the 10-minute square level was adopted for federally-permitted lobster vessels reporting to the states and the federal VTR continued to collect latitude and longitude for each trip, the precision of spatial information is not consistent across federal permit holders. This finer scale data does not provide the precision to accurately apportion effort within the stock units.

2) Due to interactions between protected marine resources and the lobster and Jonah crab fisheries, the fisheries will be required to implement significant risk reduction efforts under the Atlantic Large Whale Take Reduction Plan. These risk reduction efforts are based on models that estimate the location of vertical buoy lines using effort data of a similarly coarse resolution.

3) Recent executive orders have prioritized the development of offshore renewable energy and the conservation of US waters. The development of emerging ocean uses such as wind energy, aquaculture, and marine protected areas may all create marine spatial planning challenges for the lobster and Jonah crab fisheries.

4) The large geographic footprint and low density of lobster gear in the offshore federal management area makes it difficult to locate gear for compliance checks, reducing the efficiency and efficacy of offshore enforcement efforts.

Each of these issues pose an acute need for high-resolution data on where and when fishery effort in the federal fleet occurs. Electronic tracking requirements in the federal fishery would fill this information gap and support fishery managers in addressing the aforementioned challenges.

2.2 Background

2.2.1 Electronic Tracking Pilot Program

When Addendum XXVI/III to the Lobster and Jonah Crab FMPs, respectively, were approved in February 2018, a one year pilot program was established to test electronic tracking devices on lobster and/or Jonah crab fishing vessels. Given the variety of vessels and the spatial distribution of the fishery (both in distance from shore and breadth along the coast), the pilot

program tested multiple tracking devices in various conditions to identify technologies for use the lobster and Jonah crab fisheries.

The project assessed tracking devices from several different vendors by placing them on volunteer vessels from Maine and Massachusetts with lobster permits from June 2019 to May 2020. The project evaluated the technologies by looking at ease of compliance (or non-compliance), ability to determine trap hauls from steaming activity, industry feedback, cost-per fisherman, and law enforcement feedback. The results of the pilot showed that though the devices differed somewhat in features and performance, they all were able to deliver vessel positions and detect individual trap hauls. It also found that cellular based systems were both lower in cost and permitted faster ping rates than satellite systems. For example, the costs associated with cellular tracking devices tested during the pilot program range from $150 to $650 for the initial purchase of the tracking unit, and annual data service plans that would meet the proposed tracking requirements range from $191 to $420 per year. These costs are provided as examples only and may change dependent on which devices are approved for use in the fishery.

In addition to the pilot program testing tracking devices, the Board supported work on data integration and additional hardware testing. Specifically, this project focused on linking spatial data collected on vessel tracking devices to harvester reports submitted on eTrips Mobile. Recognizing the critical need for data to characterize spatial and temporal effort of the lobster fishery and the potential of available technology to address this need at low costs, the Board initiated Addendum XXIX in August 2021 to consider the adoption of electronic tracking devices in the federal fleet of the lobster and Jonah crab fisheries.

2.2.2 Stock Assessment

A complicating factor in the management of lobster is that the boundaries of the LCMAs do not align with the biological boundaries of the stocks (GOM/GBK vs. SNE). This is particularly problematic in LCMAs 2 and 3 which span both stocks. The intricacy of the stock boundaries is further complicated by the fact that many vessels fishing out of Rhode Island and Massachusetts that harvest lobsters on Georges Bank, must travel through the SNE stock area to reach their port of landing. In addition, these vessels may be permitted to fish in multiple management areas, including areas that span both lobster stocks.

To date, the stock assessment has only been able to analyze stock composition data at the spatial resolution of the NOAA statistical area. This is because not all lobster permit holders report at a finer scale than the NOAA statistical area; for each trip some provide a single latitude and longitude point meant to represent where the majority of fishing occurred, some provide 10 minute square(s) fished, and some provide only the statistical area fished. This creates challenges for the assessment because some parameters in the stock assessment model vary at a finer spatial scale than statistical area. For example, size composition data for lobster catch are currently generated by matching statistical area-specific total harvest data and biosampling data, but preliminary work has indicated size composition varies at a finer spatial scale. Improved spatial resolution of total harvest data from vessel tracking will improve size

composition data used in the stock assessment models to improve the accuracy of exploitation and reference abundance estimates.

2.2.3 Fishery Interactions with Right Whales and Protected Resources

To meet the goals of the Marine Mammal Protection Act and the Endangered Species Act, NOAA Fisheries recently published a final rule to amend the regulations implementing the Atlantic Large Whale Take Reduction Plan (ALWTRP) to reduce the incidental mortality and serious injury to North Atlantic right whales (*Eubalaena glacialis*), fin whales (*Balaenoptera physalus*), and humpback whales (*Megaptera novaeangliae*) in commercial lobster and Jonah crab trap/pot fisheries in the Northeast Atlantic (86 FR 51970). This action is being taken to reduce the risks to endangered North Atlantic right whales and other large whales associated with the presence of fishing gear in waters where these animals occur. The ALWTRP includes a significant reduction in the number of vertical buoy lines in the fishery in order to reduce right whale encounters with buoy lines. Weak rope requirements are included to reduce mortalities and serious injuries when entanglements do occur by increasing the chance of right whales freeing themselves from gear. The ALWTRP also includes changes to seasonal restricted areas closed to pot/trap gear that uses stationary vertical buoy lines. Current and future requirements for gear modifications are expected to have a substantial economic impact on the fishing industry.

The required risk reductions included in the ALWTRP are informed by the co-occurrence model, which pairs information regarding the distribution of whales and commercial fishing gear to predict areas where whales may be prone to entanglement. Electronic vessel tracking data would significantly improve the models used to assess the location of vertical lines in the fishery and their associated risk to right whales in the ALWTRP. The Biological Opinion[1] released in May 2021 outlines a Conservation Framework that intends to reduce mortality and serious injury to North Atlantic Right Whales by 95% over ten years. Within this Framework, additional risk reductions could be required in the US lobster fishery starting in 2025. Therefore, it is critical to gather and provide updated and enhanced spatial effort data to improve the associated risk reduction models ahead of this timeline.

2.2.4 Marine Spatial Planning

It is critically important to record the footprint of the US lobster fishery as spatial allocation discussions occur as a result of emerging ocean uses such as aquaculture, marine protected areas, and offshore energy development. For example, in 2016, the New England Fishery Management Council (NEFMC) took action on an Omnibus Deep-Sea Coral Amendment, which looked to provide protection to corals in the northwest Atlantic Ocean through the creation of discrete regions and/or broad depth zones. Given the harvest of lobster and Jonah crab occurs offshore, the Commission was asked to provide information on the magnitude of lobster and Jonah crab catch in specific regions in order to understand potential economic impacts. At the

[1] The Biological Opinion issued on May 27, 2021 can be found here: https://www.greateratlantic.fisheries.noaa.gov/public/nema/PRD/Final%20Fisheries%20BiOp_05_28_21.pdf?fbclid=IwAR3ombXyORsm5o0aFYuoU84W-oUUIEMQUIK5_bqv2FnmVRuEBV3p_pFOenA

time, the lobster and Jonah crab fishery management plans required harvesters to report landings via NOAA statistical areas, regions much larger than those being considered for coral protection. As a result, the spatial resolution of catch and effort data for the lobster and Jonah crab fishery proved too coarse; without fine scale spatial information, impacts to the lobster and Jonah crab fishery had to be estimated by piecing together information from harvester reports, industry surveys, and fishermen interviews. Similar challenges occurred when the Northeast Canyons and Seamounts Marine National Monument was established in 2016, and it is expected that these challenges will continue given increased activity surrounding offshore wind, aquaculture, and oil and gas exploration. Additionally, in January 2021 President Biden issued an Executive Order on Tackling the Climate Crisis at Home and Abroad. Included in this Executive Order is a goal of protecting 30% of US waters by 2030. Given this goal, documentation of the US lobster fishery footprint is essential for consideration in future discussions and decisions regarding marine protected areas.

2.2.5 Offshore Enforcement

A potential benefit of collecting electronic vessel tracking data is the ability to improve enforcement in the offshore area. It has long been recognized that enforcement efforts in the offshore federal lobster fishery need to be improved, a particular concern given the rapid increase in landings and value during the last decade. As a result, there are ongoing efforts to enhance enforcement capabilities, including discussions around an offshore enforcement vessel capable of hauling and re-setting long trawls.

Enforcement personnel have consistently noted that having the ability to differentiate when a boat is steaming versus hauling is critical to efforts to inspect gear and identify when fishermen are using illegal gear. Even if location data are not reported in real-time, once a fishing location can be identified from vessel tracking data, enforcement personnel would be able to go to that location to inspect gear for appropriate markings, buoys, escape vents, and ghost panels. Given finite enforcement resources, information on distinct fishing locations would improve the efficiency and capability of offshore enforcement efforts.

3.0 MANAGEMENT PROGRAM

This section adds to Section 3.1 of Addendum XXVI to American Lobster Amendment 3 and Section 3.4.1 of the FMP for Jonah Crab under the adaptive management procedures established in section 3.6 of the FMP for American Lobster and 4.4 of the FMP for Jonah Crab. The intent of the selected management program is to enhance harvester effort data collection.

Addendum XXIX (American lobster) and IV (Jonah crab) implement electronic tracking requirements for federally-permitted lobster and Jonah crab vessels with commercial trap gear area permits.

Federal lobster and Jonah crab vessels issued commercial trap gear area permits are required to install an approved electronic tracking device to collect and transmit spatial data in order to participate in the trap gear fishery. This means any federally-permitted vessel without an approved electronic tracking device is prohibited from landing lobster or Jonah crab taken with

trap gear. Federal permit holders are required to install and activate an approved device prior to beginning a lobster or Jonah crab fishing trip with trap gear. The device must remain on board the vessel and powered at all times when the vessel is in the water, unless the device is authorized to power down by the principal port state. Possible reasons for authorization to power down include but are not limited to vessel haul out/repairs and device failure reported to the principal port state. Tampering with an approved tracking device or signal is prohibited; tampering includes any activity that may affect the unit's ability to operate or signal properly, or to accurately compute or report the vessel's position. These requirements apply to all federal permit categories included in Table 1.

Table 1. Applicable Federal Permit Categories*

Federal Permit Category Name	Federal Permit Category Abbr.	Description
Commercial Trap Gear Area 1	A1	May harvest lobster in Federal Lobster Management Area 1 using trap gear
Commercial Trap Gear Area 2	A2	May harvest lobster in Federal Lobster Management Area 2 using trap gear
Commercial Trap Gear Area 3	A3	May harvest lobster in Federal Lobster Management Area 3 using trap gear
Commercial Trap Gear Area 4	A4	May harvest lobster in Federal Lobster Management Area 4 using trap gear
Commercial Trap Gear Area 5	A5	May harvest lobster in Federal Lobster Management Area 5 using trap gear
Commercial Trap Gear Outer Cape Area	AOC	May harvest lobster in Federal Lobster Management Outer Cape Area using trap gear

Commercial Trap Gear Area 6 is excluded, as the area occurs in state waters and requires a valid CT or NY state lobster license to fish in this area. If a vessel is permitted for Commercial Trap Gear Area 6 only, these requirements do not apply. Additionally, these requirements do not apply to vessels that hold an Area 5 Waiver Permit[2] and no other lobster trap gear area permits.

For additional clarity on situations for which the electronic tracking requirements do not apply, several examples are provided below:

- A person with a state-only lobster permit and no federal commercial trap gear area permit
- A permit holder with federal commercial trap gear permit that has been placed in confirmation of permit history (CPH), a permit status for when a vessel with limited

[2] The Area 5 Waiver is a permit category that may be selected by federal lobster permit holders with an Area 5 trap allocation who also hold a federal black sea bass permit. By opting into the Area 5 Waiver, permit holders are exempted from the more restrictive lobster trap gear specifications and trap tagging requirements to target black sea bass with unbaited traps. While in the Area 5 Waiver category, the vessel may retain the non-trap possession limit of 100 lobsters per day or up to 500 lobsters for a trip of 5 or more days.

access permits has sunk, been destroyed, or has been sold to another person without its permit history

- A vessel with a federal lobster commercial trap gear permit listed in Table 1 that does not fish trap gear at any point in the fishing year (i.e., only fishes other gear under a federal lobster commercial/non-trap permit, charter/party non-trap permit, and/or does not fish any trap gear at any point in the fishing year)

Specifications required of tracking devices to be approved for use in the fishery are described in Section 3.1. Administrative processes for the tracking program are described in Section 3.2. A separate document will be developed that will include additional details and standard operating procedures to guide the management agencies in implementing the vessel tracking requirements.

3.1 Tracker Specifications and Approval

3.1.1 Required Components and Minimum Technological Standards

The minimum criteria that must be met by tracking devices and product vendors for approval for use in the fishery are summarized in Table 2. Additional details on these requirements is included in the subsequent sections.

Table 2. Required criteria for approval of vessel tracking devices and vendors

Requirements of Tracking Devices and Vendors
• Collection of location data at a minimum rate of one ping per minute for at least 90% of the fishing trip • Data events must contain device's current datetime, latitude, longitude, device and vessel identifier • Minimum accuracy of 100 m (328.1 ft) accuracy and position fix precision to the decimal minute hundredths • Ruggedness specifications allowing function in the marine environment • Ability to PUSH location data to the ACCSP trip locations API • Vendor customer service requirements • Vendor must maintain the confidentiality of personally identifying information and other protected data in accordance with federal law

Data Collection Rates

A tracking device must collect location data at a minimum rate of one ping per minute for at least 90% of the fishing trip. A "ping" refers to a data event created by a tracking device containing the device's current datetime, latitude, longitude, device/vessel identifier and other optional data fields. The above rate is necessary to distinguish lobster fishing activity from transiting activity and can allow estimation of the number of traps per trawl (See Appendix A). Data transmission from the tracking device to the vendor should be initiated as soon as possible but no more than 60 minutes from the time the fishing trip is completed.

If the tracking device can determine when the vessel is in its berth, the device may automatically decrease the tracker ping rate. If the device is unable to automatically detect a berth location, the device must remain connected and pinging at one ping per minute at all times. This recommendation is designed to permit vendors' efforts to minimize cellular data and power consumption while the vessel is in port. For example, if pinging at a slower rate in the port, the tracking device could run on an internal battery and sleep between pings to save power versus being hard-wired to the vessel's power system. Additionally, this feature would improve data quality and allow for validation of track data against self-reported VTR trip start and end times.

Precision and Accuracy Requirements

A tracking device must meet minimum precision and accuracy requirements, specifically a minimum of 100 m (328.1 ft) accuracy and position fix precision to the decimal minute hundredths. It is expected that most modern tracking devices will be capable of significantly higher accuracies than 100 m.

Tracking Hardware Considerations

A tracking device must have ruggedness specifications that allow it to function in the marine environment, which may depend on where the device is installed on the vessel.

No specific requirement is specified for how a device shall be powered, provided that the tracking device can satisfy the technical requirements set forth in this section. Devices will likely be powered by some combination of vessel power, internal battery, and/or solar. The Commission level work group will be responsible for determining whether a device satisfies hardware requirements.

Data Submission Requirements

Tracking vendors must be able to PUSH location data to the Atlantic Coastal Cooperative Statistics Program (ACCSP) trip locations API and meet all specifications of this interface (https://accsp-software.github.io/spec-unified-api-prod/#tag/eTrips/paths/~1trip_locations/post). In addition to the device identifier, datetime, latitude, and longitude, vendors must also include a vessel identifier (Coast Guard number or state registration number) in the API submission. This data element is necessary to identify the vessel the device is tracking at the time of the ping. Data transmission from the vendor to the ACCSP trip locations API should occur in near real time upon receipt.

Tracking vendors must send test data to the ACCSP trip locations API as proof of the ability to satisfy the data submission requirements. The vendor is expected to have a mechanism for setting the vessel identifier in the administrative web interface to their tracking system.

Customer Service Requirements

Device vendors serve as the primary contact for the vessel tracking devices distributed by their company. This includes technical support related to hardware and any device-specific software. Vendors should provide diagnostic and troubleshooting support to permit holders, state agencies, and ACCSP, which is available seven days per week and year-round. Response times for customer service shall not exceed 24 hours. Detailed installation instructions must be provided to permit holders or their designated agents by vendors. Procedures must be established that assist permit holders to properly maintain their device. In the event of tracker malfunction, vendors must be available to troubleshoot, repair, or replace the device. Vendors must have the capability to diagnose and resolve communication anomalies with permit holders or state agencies. Upon request of ACCSP, state partners, or NOAA Fisheries, vendors must be available to assist with vessel tracking system operation, resolving technical issues, and related data analyses.

3.1.2 Device Approval Process

The approval of vendors and devices is undertaken by a Commission-level work group process. The work group is comprised of state, federal, and Commission staff. Changes to the requirements of tracking devices can be made by this working group with approval of the Lobster Board. The work group reviews device specifications to determine if a device meets the required components and minimum technological standards. Vendors are required to provide the ASMFC work group with the information in Table 3.

Table 3. Information that must be submitted by vendors to device approval work group

Information to be provided by vendors for work group review and device approval

• Company information (name, contact, etc.)
• Customer service policy/capabilities (what assistance can be provided for troubleshooting)
• Complete cost information for devices and data
• Devices capable of a one ping per minute rate
• Whether devices can detect when the vessel is berthed/in port
• Precision (fixed) of 5 decimal places and accuracy capability (100 m max)
  o Does device evaluate quality of positional fix prior to pinging or does it just ping every minute?
  o Is the device capable of reporting horizontal accuracy and/or any other ping metadata?
• Which cellular providers and bands the device utilizes
• Whether vendor can PUSH the vessel ID (Coast Guard number or state registration number) as part of the location data to the ACCSP trip locations API, as well as meet all additional provisions of this interface: (https://accsp-software.github.io/spec-unified-api-prod/#tag/eTrips/paths/~1trip_locations/post)
• Power supply specifications
• Installation instructions/requirements
• Ruggedness specifications
• Ability to maintain the confidentiality of personally identifying information and other protected data in accordance with federal law

3.2 Administrative Processes

This section describes the required administrative processes that must be implemented at the state and federal level to facilitate the collection and management of data under the electronic vessel tracking requirements for federal permit-holders in the lobster and Jonah crab pot/trap fisheries. Additionally, it describes the recommended roles and responsibilities of the states, federal agencies, and ACCSP in the processes involved in data reporting, validation, and management.

3.2.1 State-Level Administrative Processes

Certification of Device Installation

States must certify the installation and activation of approved vessel tracking devices for permit holders whose principal port listed on the federal fishery permit is within their state. Principal port is contained in the GARFO permit data which will be made accessible to states. An affidavit with uniform language is distributed by the states to permit holders (see Appendix B for affidavit language). This affidavit certifies an approved tracking device is installed on each vessel and is activated for transmitting spatial data. These requirements apply to all fishing trips regardless of the landing state, trip type, location fished, or target species. Each affidavit must be signed and returned to states prior to departing on the first fishing trip after the program implementation date. For initial implementation of this project, states will collaborate to define a deadline by which permit holders will need to have a certified tracker installed. A state may require additional information to certify installation such as photographs, notarized affidavits, or inspections, but this is not required.

GARFO provides states with American lobster-trap gear area permit ownership information, enabling states to contact permit holders and complete the process of certification of installation. In the event a vessel tracker is transferred between permit holders, states will instruct harvesters to contact tracking device vendors to complete the transfer of a vessel tracker.

Permit Holder Support

State agencies will communicate with permit holders to assist them in properly complying with the vessel tracking requirements. States are expected to respond to general inquiries from permit holders that land in their state, troubleshoot where feasible, and transfer inquires to the appropriate body for answers as needed (e.g., device issues to the vendors, electronic reporting app issues to the appropriate electronic vessel trip report provider help desk, etc.). Staff should be available to confirm with harvesters that vessel tracks are being received by ACCSP. States are not required to aid with the installation or troubleshooting of vessel trackers. If there is an issue with hardware or software related to tracker, states may assist the permit holder in contacting device vendors. It is the permit holder's responsibility to work with the vendor when they discover or are notified by the state of an issue.

Data validation and compliance monitoring is the responsibility of the states. States contact permit holders to resolve data issues for trips landing in their state. Specifically, state agencies are tasked with resolving mismatches between vessel trip reports and associated vessel tracking information, or when tracking data are missing or incomplete. Additionally, states must validate that the data collected from a tracker meets the specifications defined by ASMFC. The administrative processes for permit holder support will be further developed and refined prior to implementation of the management program. A final data validation system and protocol will be developed by ACCSP and state and federal partners. This will include developing and testing data QA/QC for each jurisdiction prior to implementation of the program.

3.2.2 Federal-Level Administrative Processes

The following processes are the responsibility of GARFO to facilitate the implementation of the tracking program:

Federal Permit Data

To successfully administer a vessel tracking program, states will need access to up-to-date Federal American lobster permit data. GARFO will provide states with American lobster-trap gear area permit ownership information. The following information will be available:

- Vessel permit number
- Vessel name
- Hull ID (state registration or US Coast Guard Documentation Number)
- Permit endorsement
- Permit issuance date
- Permit expiration date
- Permit-holder name
- Permit-holder contact information
- Principal port and state

Electronic Vessel Trip Report Data Processing

Upon completion of rulemaking to implement federal harvester electronic vessel trip report (eVTR) requirements for federal lobster permits, GARFO will incorporate federal lobster eVTR data into its quality assurance program. Electronic reporting applications ensure the submission of complete and valid vessel trip reports, but do not ensure quality. Upon submission, eVTRs will be further validated to ensure a high level of data quality. Errors identified through the quality assurance program will be resolved through GARFO outreach efforts resulting in corrections and resubmissions of eVTR. Federal eVTR data will be available to ACCSP in near real-time, which can be used by ACCSP and state partners in identifying fishing activity in the vessel tracking data.

3.2.3 Data Reporting, Validation and Management Processes

This section outlines the expected processes for data reporting, validation and management for electronic vessel tracking. It also identifies the recommended roles and responsibilities of state and federal agencies and partner organizations in administrating these data processes.

Data Dissemination and Confidentiality

ACCSP maintains the confidentiality of trip and location data that have been submitted to ACCSP via API in addition to the trip data already maintained under its authority. Data is accessible to the appropriate state or federal entities with confidential data access. A map interface will be available in the SAFIS Management System (SMS) for authorized federal and state administrators to query and visualize trip locations.

Data Flow

ACCSP supports data flows for integrated and non-integrated trip report and location data from American lobster and Jonah crab federal permit holders required to collect location data via an approved tracking device. Figure 1 shows the flow of trip data and location data (vessel tracks) from the vessel to the ACCSP SAFIS database. Each step is broken down and described below.

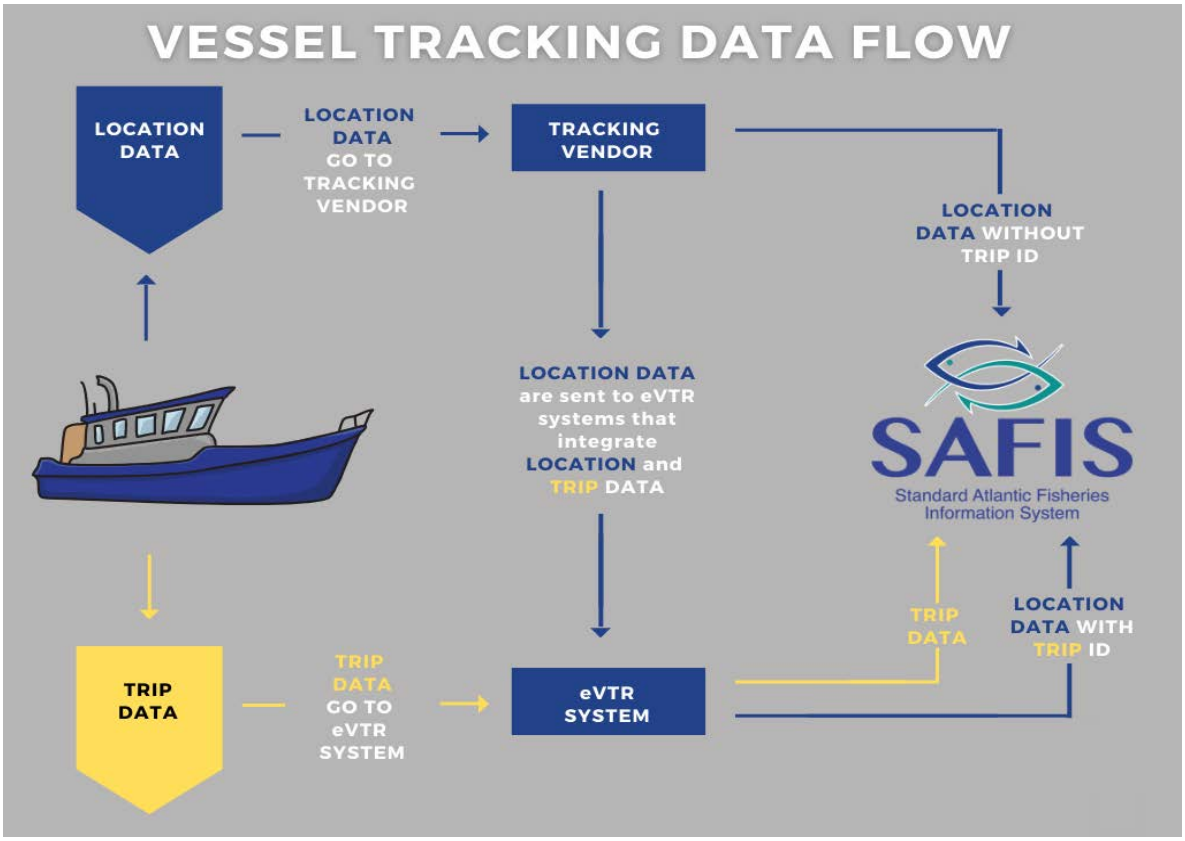

Figure 1. Vessel Tracking Data Flow

Trip Data

EVTR data must be submitted using a NOAA Fisheries GARFO approved eVTR application. All eVTR submissions are available in SAFIS at or near real-time.

Location Data (Vessel Tracks)

Tracking vendors must submit location data to the SAFIS database via the ACCSP trip locations API. Vendors will need to obtain the necessary API key, and devices must be capable of providing data in accordance with the API specifications.

SAFIS API

All parties, including ACCSP partners and vendors, submitting trip data and/or location data to the SAFIS Unified API (https://accsp-software.github.io/spec-unified-api-prod/) will need to obtain the necessary API keys and must be able to provide data in accordance with the API specifications.

Data Management

ACCSP maintains the database structures and processing required to store trip and location data. ACCSP will develop a process to match non-integrated trip and location data after they have been submitted to ACCSP. The trip ID will be assigned to the appropriate trip location data. The system will require the following by each partner:

- NOAA Fisheries is responsible for providing vessel registration (hull ID) and vessel permit number data contained in eVTR data to ACCSP. All eVTR data submitted to GARFO will be sent to ACCSP via API at or near real-time.
- State management agencies are responsible for working with tracking vendors to ensure data are being sent to ACCSP in accordance with the requirements outlined for certification. Two levels of coordination will be in place.
    - In Level 1, the device approval work group will coordinate with the vendor to address overall device issues that have arisen post certification.
    - In Level 2, individual state management agencies will work with the permit holder(s) to resolve issues specific to a single or small number of isolated devices.
    - Details on the roles and responsibilities for specific issues are outlined in the standard operating procedures document.
- Vendors will submit accurate vessel registration information and other required data elements to the ACCSP Trip Location API.

ACCSP is responsible for running trip matching programs at specified intervals. Criteria for matching reported trip data with location data will be developed with federal and state input. Data auditing reports, as specified in the standard operating procedures document, will be made available to the appropriate state and/or federal entities with confidential data access.

Data Quality

GARFO and the state management agencies are responsible for data reporting compliance; GARFO is responsible for validation of eVTR data, and state management agencies are responsible for validation of trip location data. The matching of trip and location data by ACCSP is subject to the accuracy of the trip report data.

4.0 COMPLIANCE

This Addendum is effective on December 15, 2023.

5.0 RECOMMENDATIONS FOR ACTIONS IN FEDERAL WATERS

The management of American lobster in the EEZ is the responsibility of the Secretary of Commerce through the National Marine Fisheries Service. The Atlantic States Marine Fisheries Commission recommends that the federal government promulgate all necessary regulations in Section 3.0 to implement complementary measures to those approved in this addendum. The Commission requests that NOAA Fisheries publish the final rule on vessel tracking by May 1, 2023, with implementation no later than December 15, 2023.

6.0 REFERENCES

Atlantic States Marine Fisheries Commission (ASMFC). 1997. Amendment 3 to the Interstate Fishery Management Plan for American Lobster.

ASMFC. 2015. American Lobster Benchmark Stock Assessment and Peer Review Report.

ASMFC. 2020. American Lobster Benchmark Stock Assessment and Peer Review Report.

Appendix A. Ping Rate Analysis

Introduction

Goals of High-Resolution Tracking Data

Extracting Effort from Tracking Data

Ping Rate Analysis

Case Studies from Other Trips

Data Size Considerations

Conclusions

References

Lobster Vessel Tracking Ping Rate Analysis

Bill DeVoe, Maine Department of Marine Resources,
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Introduction

Conversations regarding requirements for cellular-based vessel tracking in the federal lobster fishery have repeatedly recommended a one-minute ping interval as being necessary to distinguish fishing from non-fishing activity. This analysis utilizes data collected from tracking devices deployed on federal lobster vessels off the coast of Maine to illustrate the ability to discern and quantify effort at varying ping rates.

Goals of High-Resolution Tracking Data

The primary goal considered in this analysis is to utilize high-resolution tracking data to extract the locations and size of trawls. These locations can be used to quantify vertical line concentrations spatiotemporally. Although a harvester report may be available with additional information on gear configuration, such as the number of sets or total number of traps, tracking data of sufficient resolution should be capable of predicting gear configuration and gear quantities. Collecting this information from tracking data would likely provided higher accuracy and could ease reporting burdens on harvesters.

Five trap trawls are currently the smallest permissible trawl that can be fished in federal waters of the Gulf of Maine. While there may be future utility in detecting smaller gear events, this analysis will consider the necessary minimum detectable gear size to be a five trap trawl.

Extracting Effort from Tracking Data

The following overview of current methods for automated extraction of trawl locations from lobster fishing tracking data is provided before analyzing the impact of ping rate on the ability to discern effort.

Machine learning models generally fall into the categories of supervised and unsupervised. Supervised models are built using groundtruthed training data containing classified events to train a model to predict the probability of those events in unclassifed data. For example, lobster tracking data where each ping was labeled as hauling/non-hauling based on a hauler sensor or observer data could be used to build a supervised model. Unfortunately, at present there are few instances of high-resolution classified lobster fishing tracking data. As such, the following details current efforts to produce an unsupervised effort detection model based on several prevalent unsupervised machine learning techniques.

Estimation of fishing effort based on velocity alone has been shown to overestimate fishing effort in some fisheries (Arasteh et al. 2020). Different vessels transit at varying speeds, and even for a single vessel within a single trip, transiting speeds may vary based on sea conditions. However, within the lobster fishery the density distribution of velocity as calculated between sequential points in a trip typically exhibits a bimodal or multimodal pattern corresponding with vessel activity (steaming, hauling, and setting.) Gaussian Mixture Modeling (GMM) has been utilized successfully to classify vessel activity in Scottish small-scale fisheries, including those fishing 10-50 trap trawls for European lobster. Establishing velocity thresholds using a GMM calculated on a per trip basis was shown to be effective at correctly labeling vessel activity, and also had rapid processing times compared with other models (Mendo, Smout, Photopoulou, et al. 2019). This study also found that multivariate models incorporating turning angle between pings resulted in minimal increases in activity detection accuracy, likely because hauling of trawls often presented as straight trajectories similar to transiting. Since tracking data for lobster vessels demonstrates similar patterns, velocity is therefore used as the primary variable to classify vessel activity within this analysis.

The following example uses tracking data obtained from a Succorfish SC2 pinging at a one-minute interval. The vessel was fishing ten trap trawls and was carrying a DMR observer who recorded a GPS point at the beginning of each trawl.

All processing in this analysis was completed in R 4.0.1 on a 64-bit Windows machine (R Core Team 2020), relying heavily on the tidyverse (Wickham 2019), sf (Pebesma 2018) and Rcpp (Eddelbuettel 2013) packages.

Preprocessing

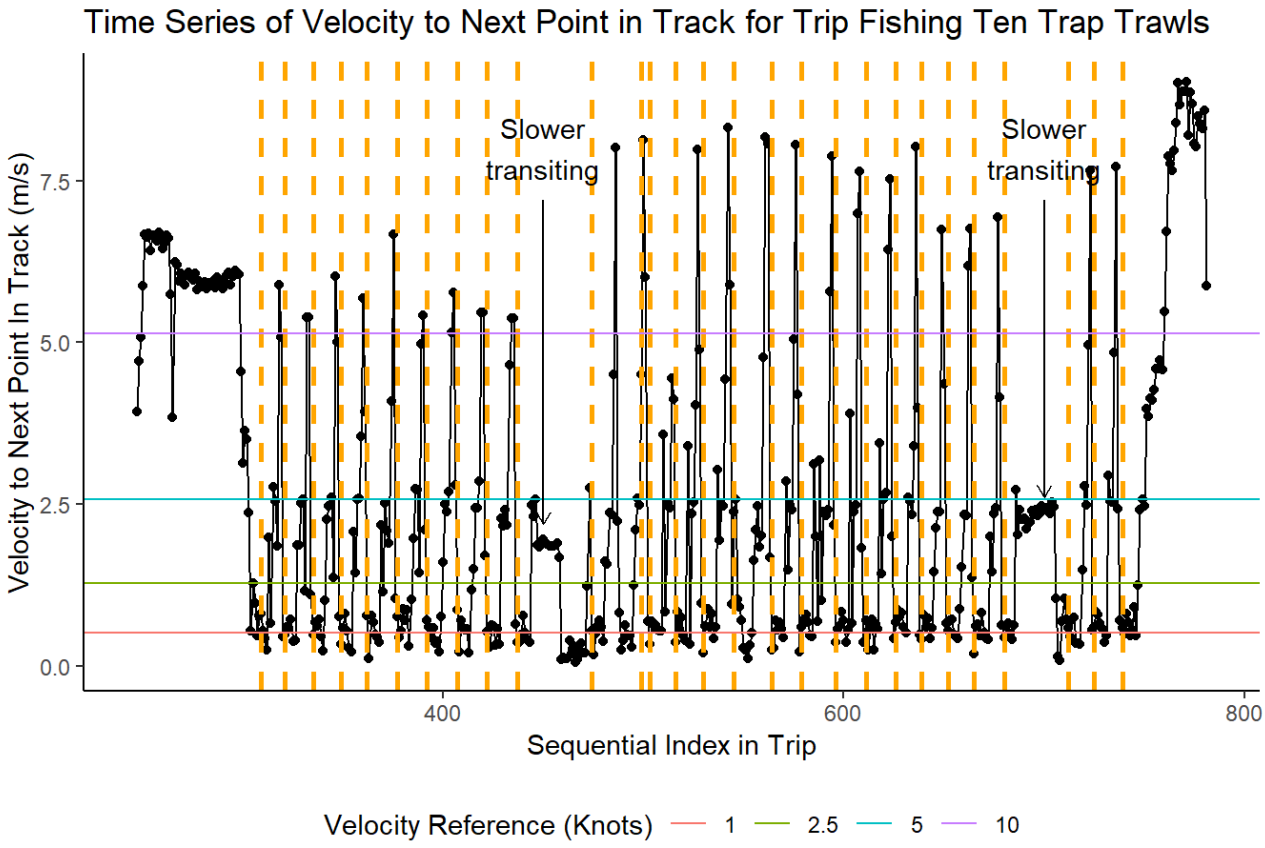
Raw tracking data was pre-processed to split the data into daily tracks and calculate metadata for each ping. This metadata most notably included the spatial and temporal difference between successive pings. Once tracking data had been divided into tracks, polyline features for each track were also created in pre-processing. Pre-processing was handled by a R/C++ package created by the author, and details of this processing are beyond the scope of this analysis.

Removal of Pings-in-Port

The removal of pings in port is necessary prior to analysis of vessel tracking data. This was accomplished programmatically by taking the first and last point in the trip and calculating the distance between them. If the distance was below a reasonable threshold for indicating the vessel returned to port, points within a given radius of the centroid of the first and last point in the track were removed. Spatial filtering of pings within known port areas can also be utilized to remove pings in port from tracking data (Mendo, Smout, Photopoulou, et al. 2019).

After removal of pings in port, the minimum and maximum datetimes of the remaining points were used to calculate the trip start and end times, as well as the total trip temporal and spatial length.

The following plot shows the velocity for each point in the example trip, along with the timestamps of known trawl locations from the onboard observer.

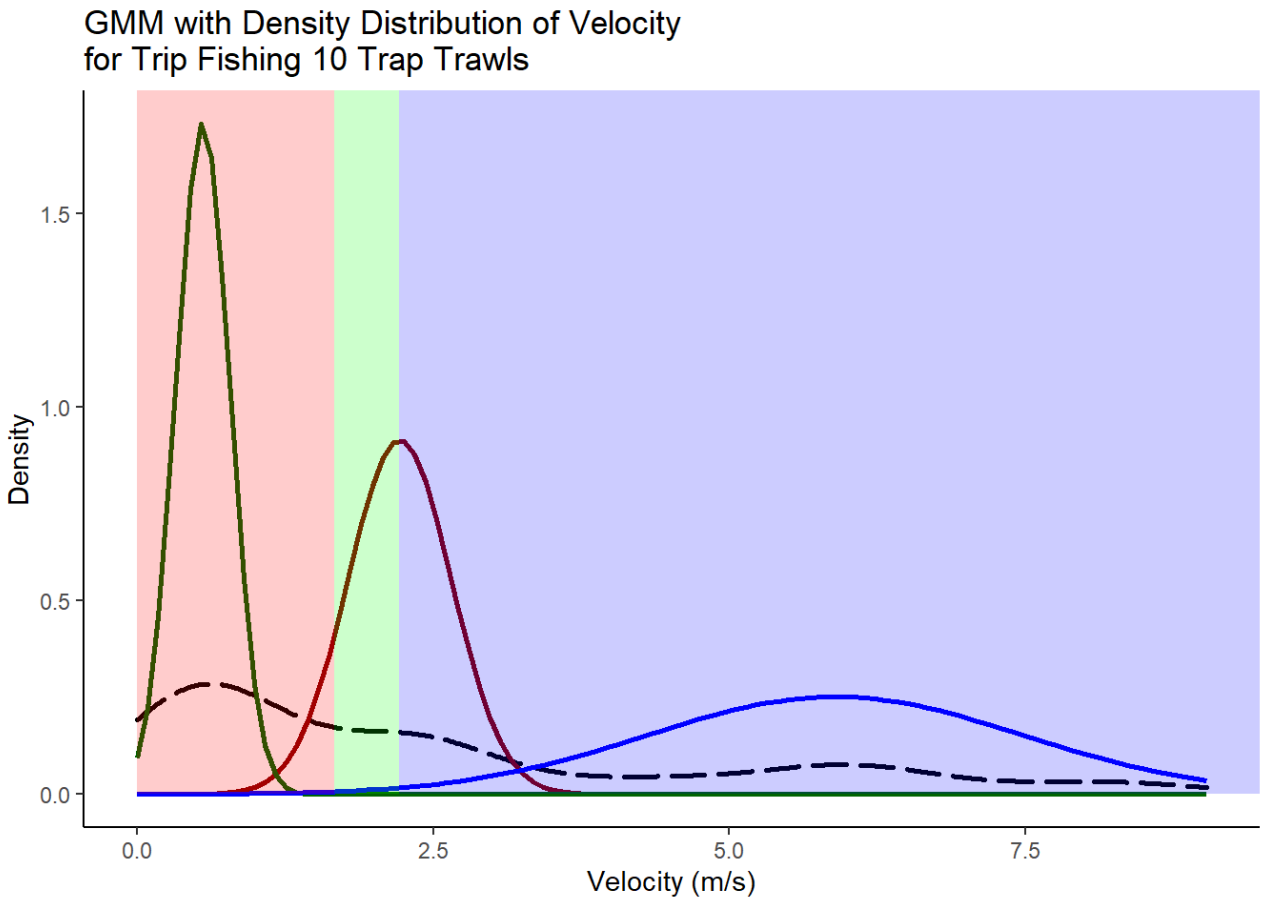


Orange vertical lines are haul begin times collected by an onboard observer.

Gaussian Mixture Model

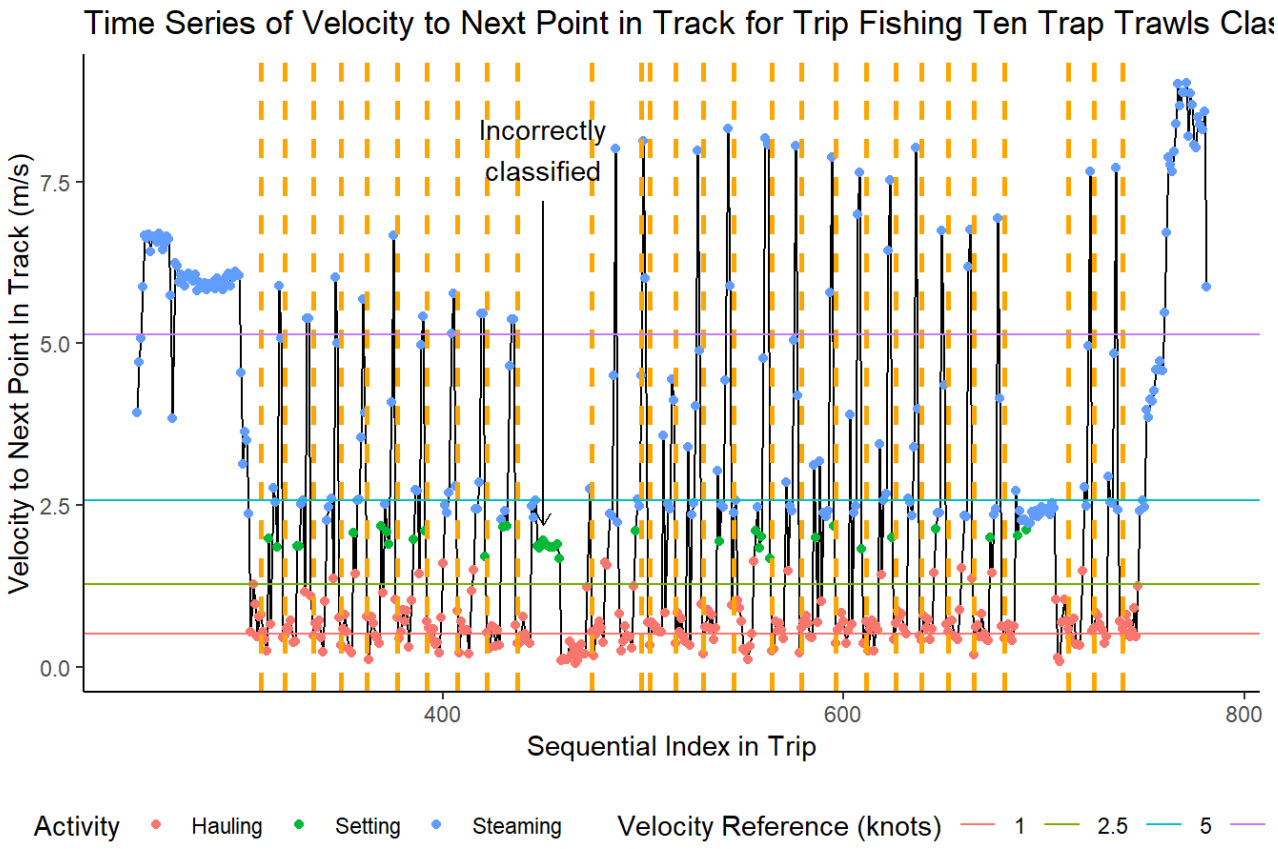
The vector of velocities between sequential points in the trip was used to fit a Gaussian Mixture Model using the mixtools (Young et al. 2020) R package as per the method described in Mendo, Smout, Photopoulou, et al. (2019). An expectation-maximization (EM) algorithm was utilized to fit the model to three components corresponding to steaming, hauling, and setting activity. The upper threshold for hauling velocity was defined as 2 SD from the mean of the first distribution (Ibid). Since setting of gear can be difficult to detect and may overlap speeds used when hauling and steaming, a more conservative estimate from the upper hauling limit to the mean of the second distribution was utilized to classify gear setting. Steaming was classified using velocities above the second mean.

The velocity density distribution (dashed) and the normal distributions resulting from the EM fitted GMM for the example trip are shown below. Velocities corresponding to hauling (red), setting (green) and steaming (blue) are also highlighted.



Initial Activity Classification

Points in the trip track were than classified using the velocity thresholds established by the GMM.



Orange vertical lines are haul begin times collected by an onboard observer.

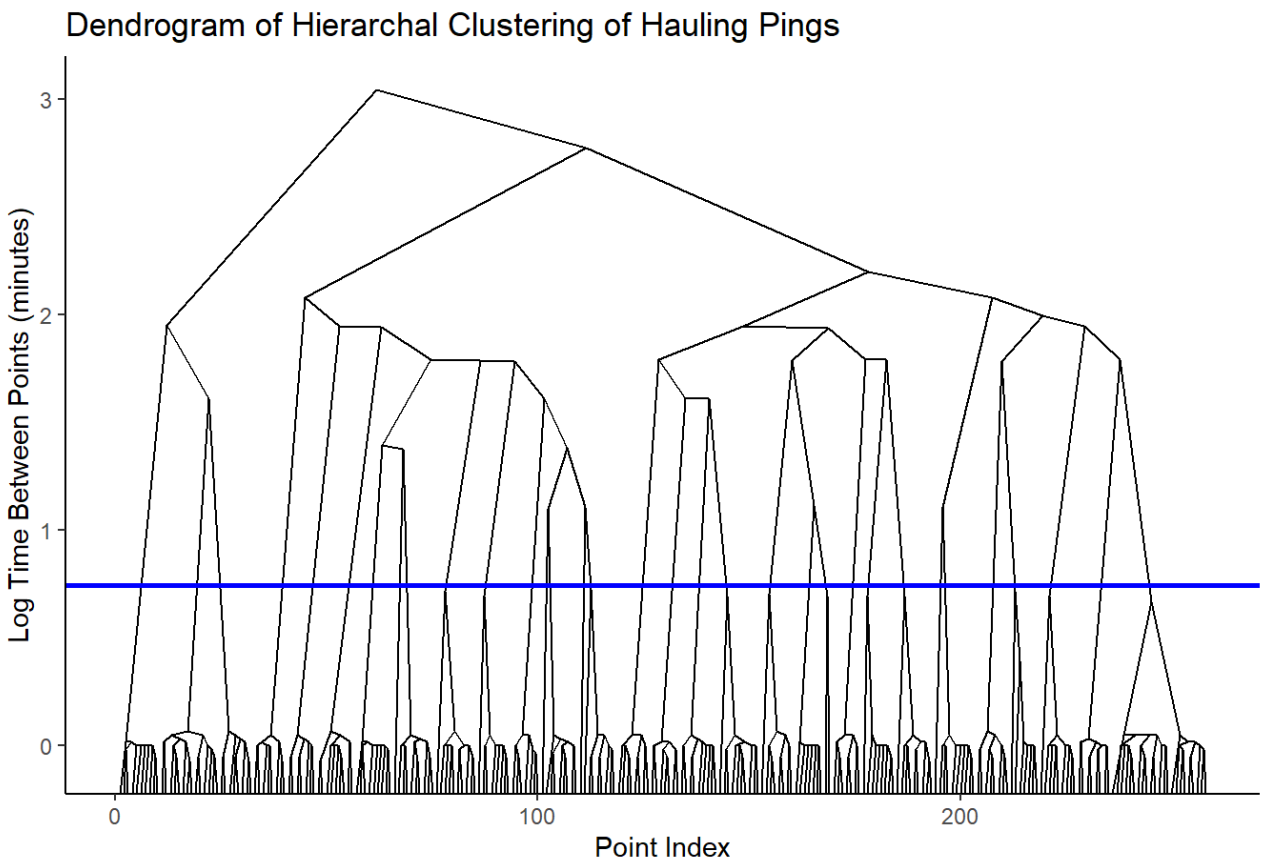
Delineation of Hauls and Sets

Since above plot shows only individual pings classified as activities, clustering of classified points was necessary to identify discreet hauling and setting events. This also allowed for the removal of misclassified pings based on filtering criteria, for example a single ping classified as setting between two clusters of hauling pings.

Trip data was filtered into pings representing hauling and setting, and a matrix of the time difference in minutes between all pings in each data set was calculated. Hierarchical clustering was performed on the resulting matrices, using the single linkage method. The single linkage method clusters points based on the minimum distance between clusters; in this case, “distance” was the minimum time difference in minutes between distinct hauls and sets.

For this analysis, a common sense value of 2.1 minutes between hauls was utilized, such that at minimum one ping would occur between successive haul events. The same value was utilized for clustering sets. Deriving the value to cut the hauling clustering tree using the above GMM method applied to the sequential distance between hauling pings could be another approach, but was not explored in this analysis.

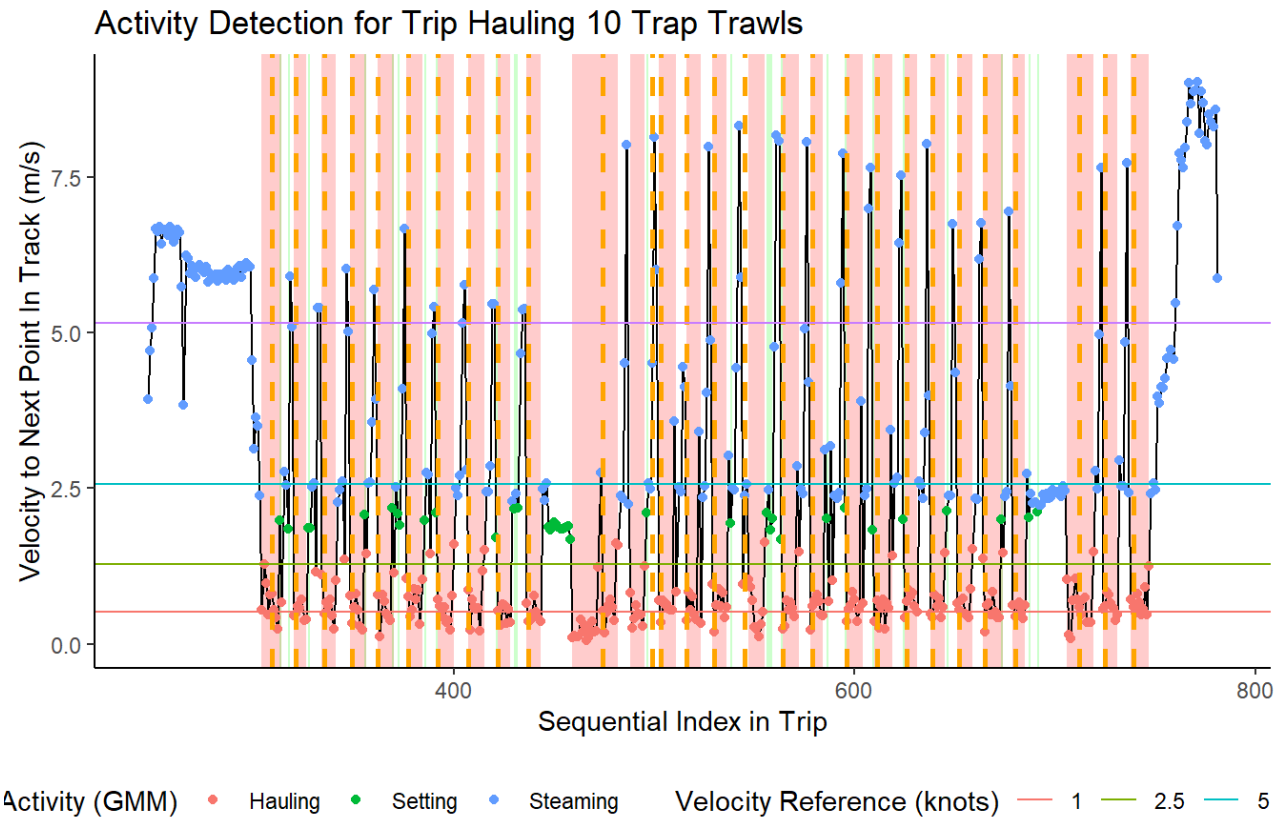
The dendrogram of hierarchal clustering of pings classified as hauling in the example trip is shown below, produced using the R package ggdendro (de Vries and Ripley 2020).



Blue line is 2.1 minute threshold. Since log(1) = 0, 1 minute between pings is y=0

Constrictions on the minimum haul temporal length and maximum set temporal length were also applied to all trips, such that hauls less than 2 minutes and sets greater than 6 minutes were excluded. In production, these values could be adjusted based on the spatial area fished or on gear configuration details from a harvester report.

In the following plot, the duration of the parsed hauling and setting events from the example trip are highlighted. Observer-derived points were within the extracted haul spans, with the exception of one point that appeared to have been taken after the haul was complete. Detection of setting was much more difficult.

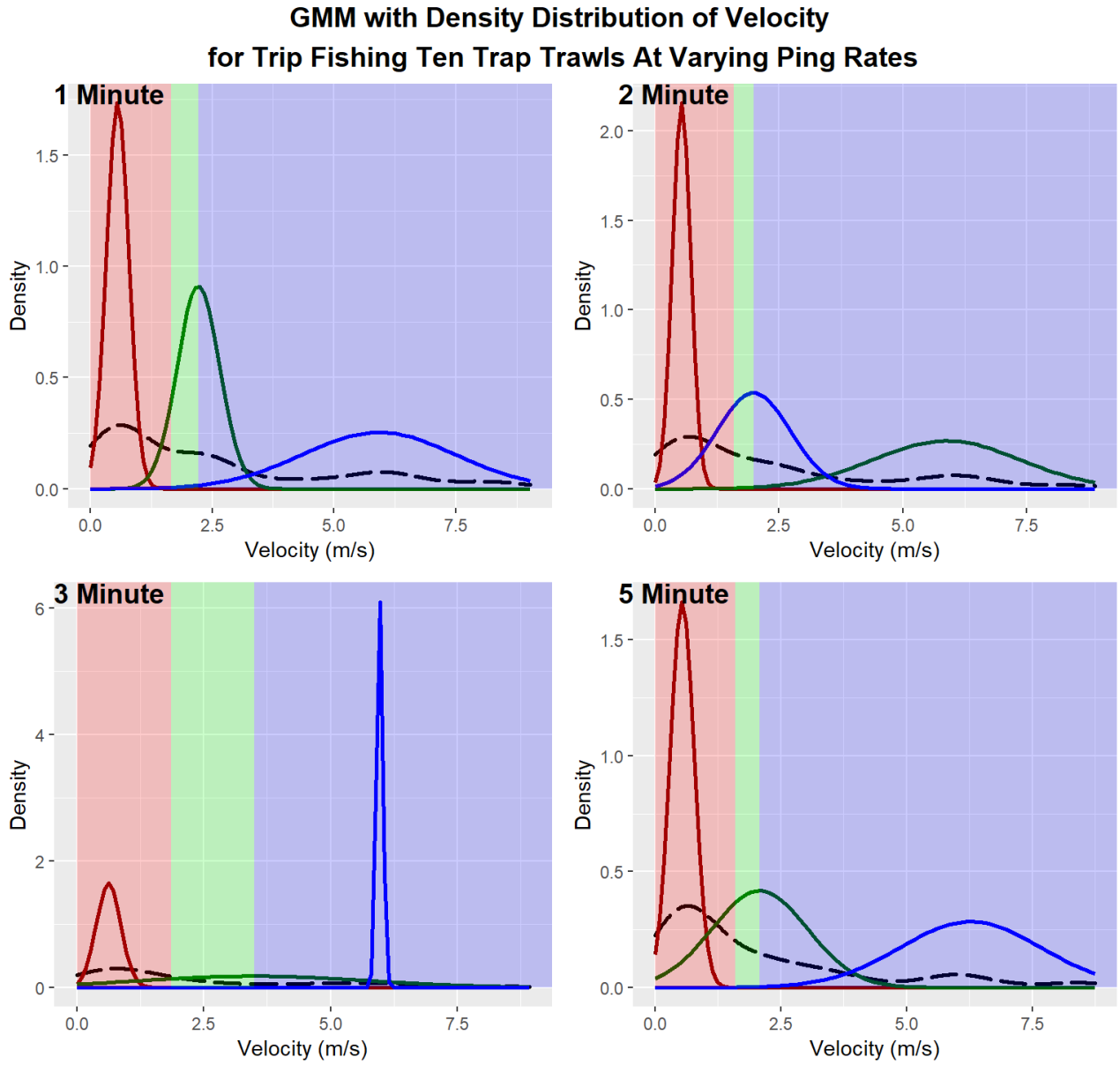


Light red bars are filtered haul durations. Light green bars are filtered set durations.
Orange dashed vertical lines are haul begin times collected by an onboard observer.

Ping Rate Analysis

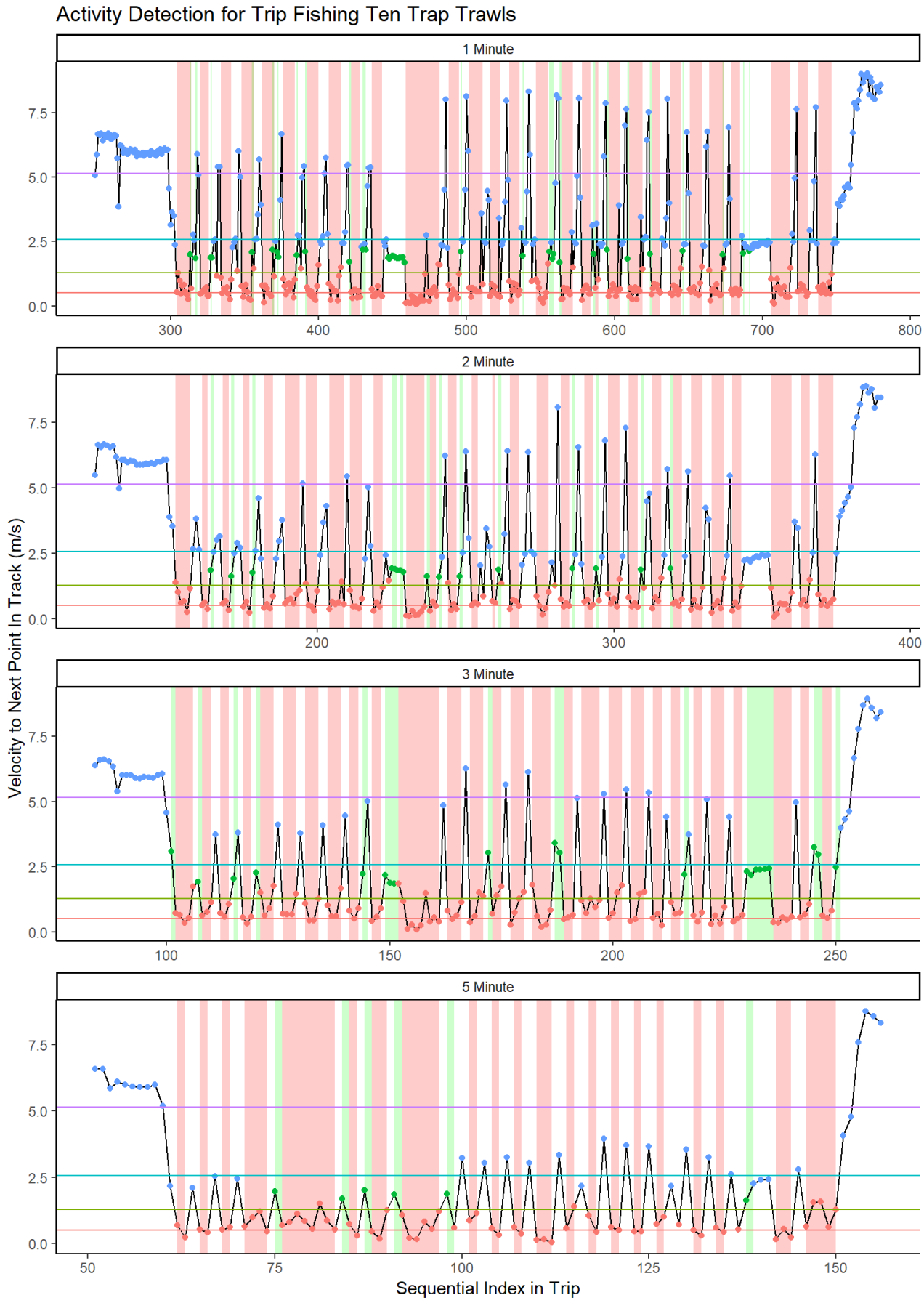
In the following scenarios, tracking data from trips fishing a variety of gear configurations were subsampled to lower ping rates. The above method of detecting effort was utilized, with notable differences in the ability to detect vessel activity occurring as ping rate decreased.

The first example used the same trip fishing ten trap trawls as above. GMM results were similar at different ping rates, with the exception of three minutes.



Dashed lines are velocity density distribution. Colored lines GMM normal distributions.
Velocities classified as hauling, setting, and steaming are colored red, green, and blue respectively.

Trawls were detected at the one, two and three minute ping rates.



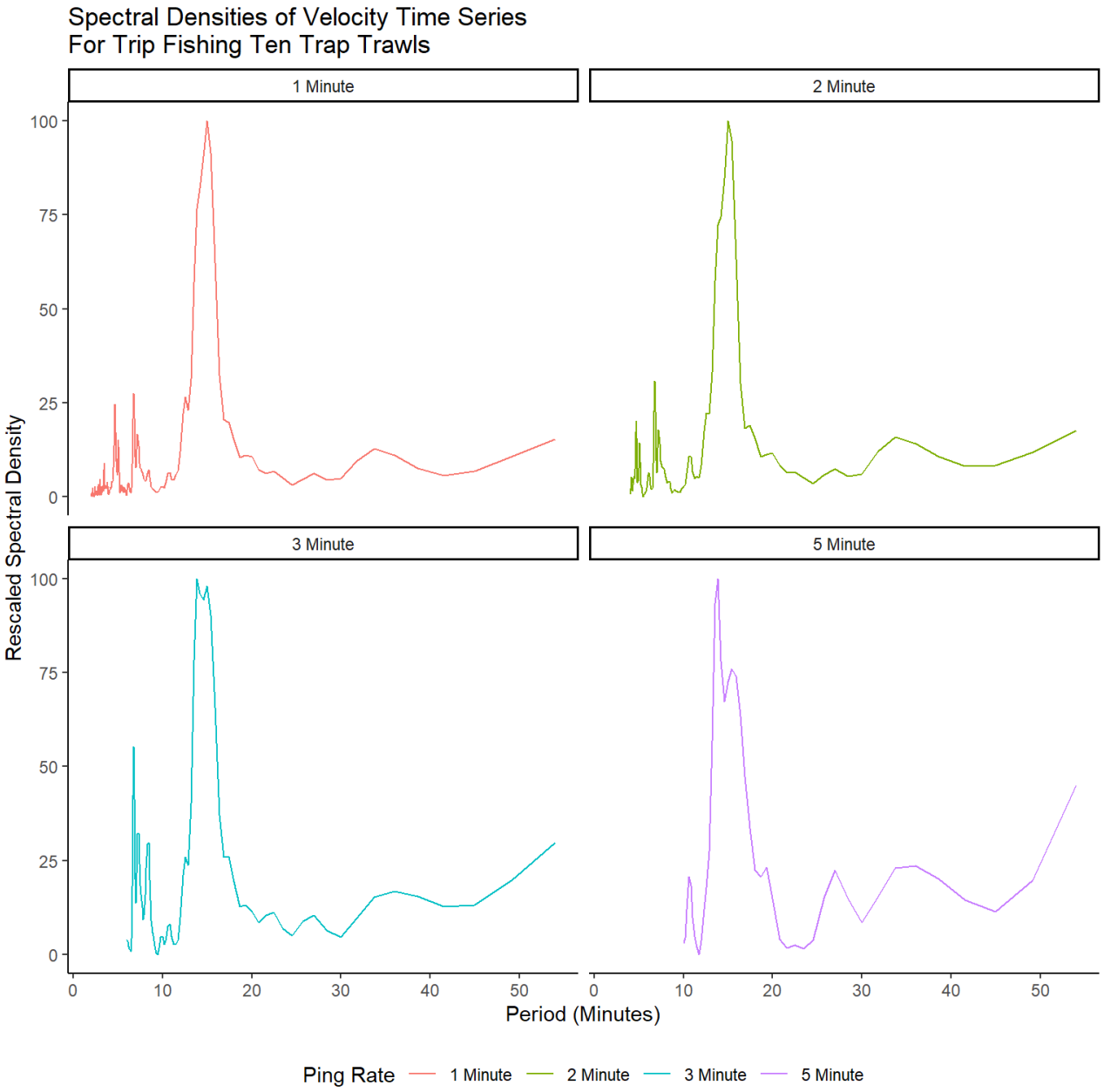
Light red bars are filtered haul durations. Light green bars are filtered set durations.

Trawl Location vs Trawl Size

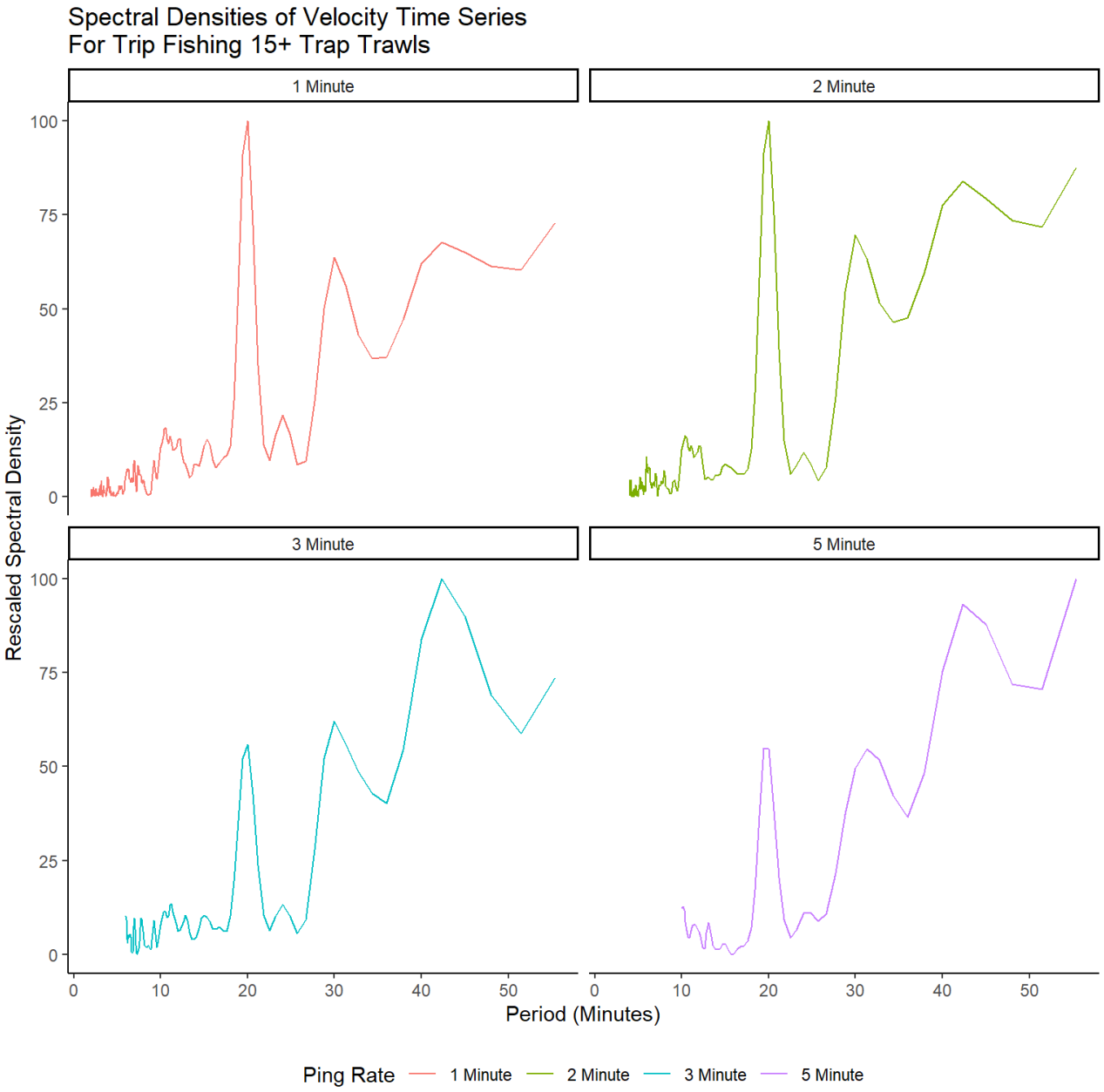
In the plot above, clusters of pings around known trawl locations remain visible at ping rates slower than one minute. The one-minute and two-minute time series demonstrate flat-bottomed valleys corresponding to trawls. As the ping rate decreases, fewer pings occur during the haul and the pattern becomes more saw-toothed; there is still an indication of fishing activity, but the temporal resolution of the haul length decreases as the amount of time each ping represents increases. If the ten trap trawls fished in this example trip took 15 minutes to haul, at a one minute ping rate the temporal length of the haul could be estimated within 12% of the actual haul length (15 minutes +/- 1 minute). At a 5 minute ping rate, if the detected haul consisted of only one ping, this could represent anywhere from 5-15 minutes of fishing effort. Faster ping rates are therefore essential to estimating trawl size; measured temporal/spatial lengths of trawls combined with the minimum and maximum trawl sizes permitted in the area fished could provide probabilities of trawl size.

The Rhythm of Work

The plot above also shows a consistent rhythm of hauling familiar to anyone who has worked in fixed gear fisheries. In many cases hauling is so consistent that a frequency corresponding to the haul time can be detected in tracking data. This may also be another possible future method for detecting trawl configurations. In the plot below, the Fast Fourier Transform has been taken of the velocity time series at different frequencies. The resulting spectral densities demonstrate the occurrence of repeating frequencies within the time series (likely the length of the trawl including setting). Note how the 1 minute and 2 minute time series have sharply defined peaks at 15 minutes, while the peaks widen to either side of 15 minutes as the ping rate decreases.



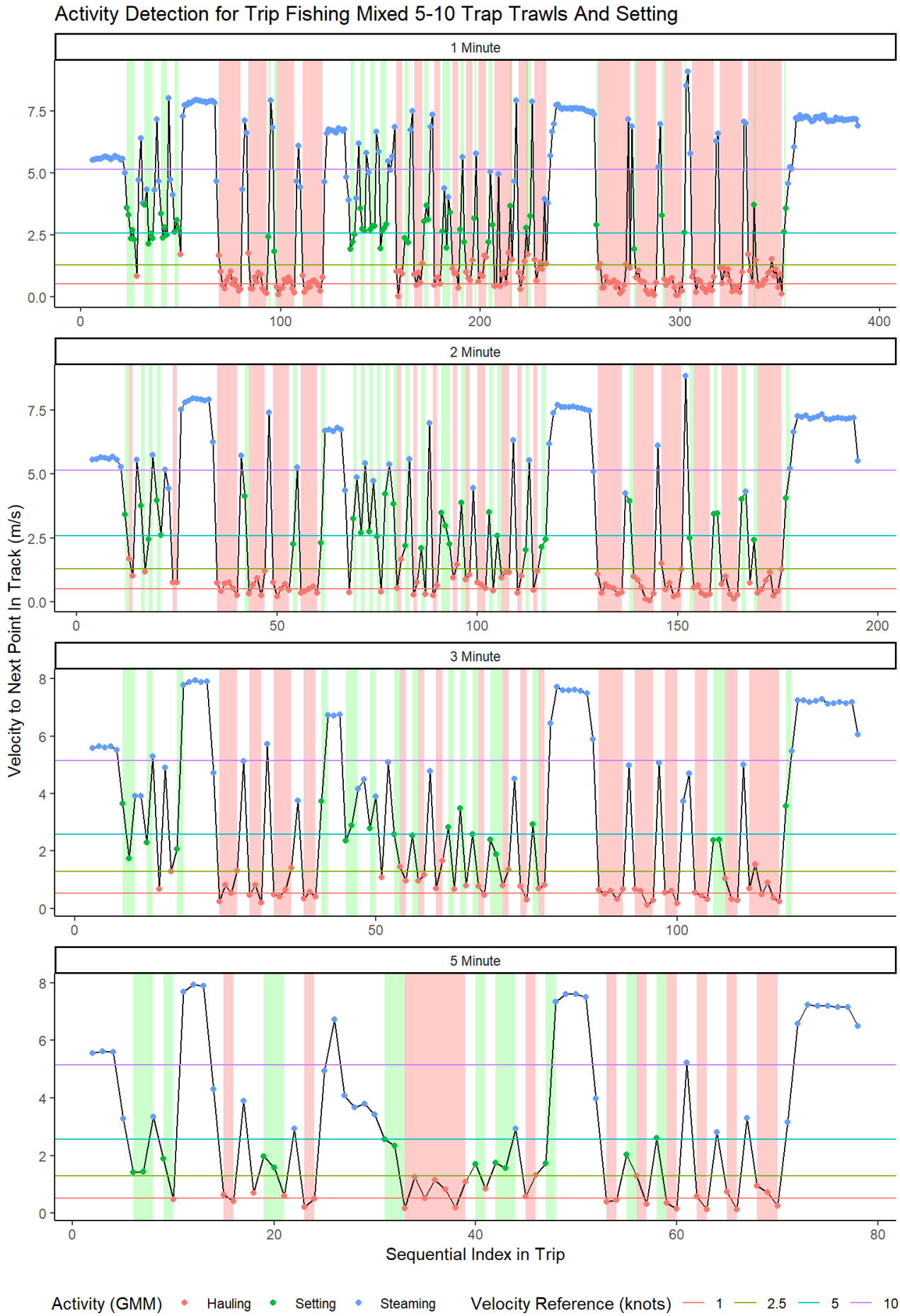
Another spectral analysis from a vessel fishing 15+ trap trawls is shown below, indicating a haul/set period of about 20 minutes. Other frequencies become more prevalent than the 20 minute signal at slower ping rates. It is likely that cleaner spectral densities would be acquired by applying the Fast Fourier Transform to vectors of pings classified as hauling/non-hauling versus raw velocity. However, the utility of this method in analyzing vessel tracking data has yet to be determined, and is presented more as a curiosity and comment on the consistency of hauling in the lobster fishery.



Case Studies from Other Trips

Mix of 5-10 Trap Trawls

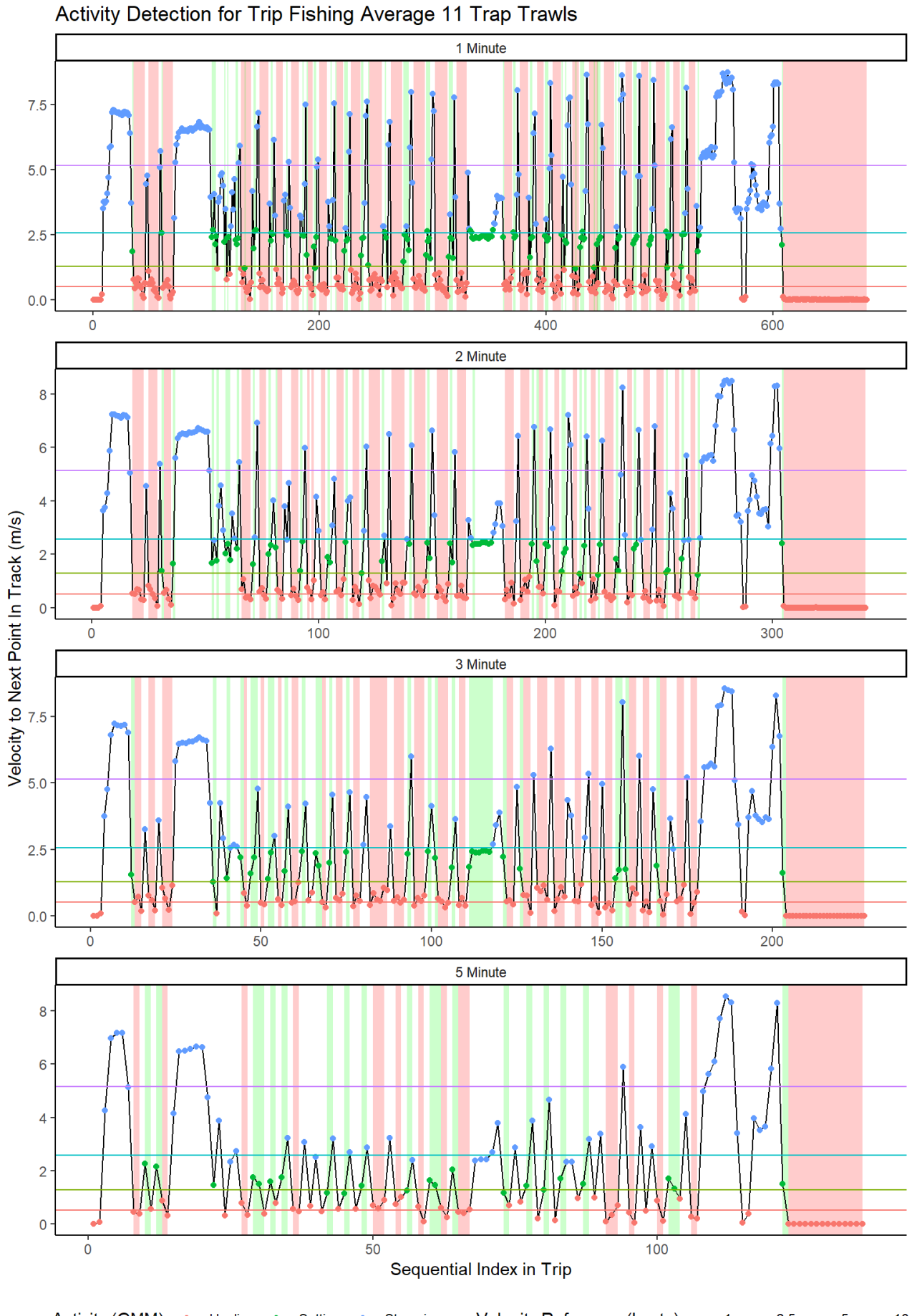
The following trip consisted of a mix of trawl sizes between 5 and 10 traps per trawls. Larger trawls were fished at the beginning and end of the trip, with shorter trawls in the middle. Several gear events that appeared in the spatial data to be sets (no hauling) were correctly classified. Detection of all trawls decreased at slower ping rates; most notably, the smaller trawls became harder to detect even at a 2 minute rate, with some trawls only being represented by a single ping.


Activity Detection for Trip Fishing Mixed 5-10 Trap Trawls And Setting
1 Minute
2 Minute
3 Minute
5 Minute
Velocity to Next Point In Track (m/s)
Sequential Index in Trip
Activity (GMM)
Hauling
Setting
Steaming
Velocity Reference (knots)
1
2.5
5
10
Light red bars are filtered haul durations. Light green bars are filtered set durations.

Spectral analysis of this trip showed no strong signals corresponding to haul periods for the different gear configurations; it is possible that applying the Fast Fourier Transform using windowed approach (iterating over the trip subsetting 1-hour window for example) may allow for detecting of haul period signals for mixed gear configurations.

Mix of 10 and 15 Trap Trawls (Average 11)

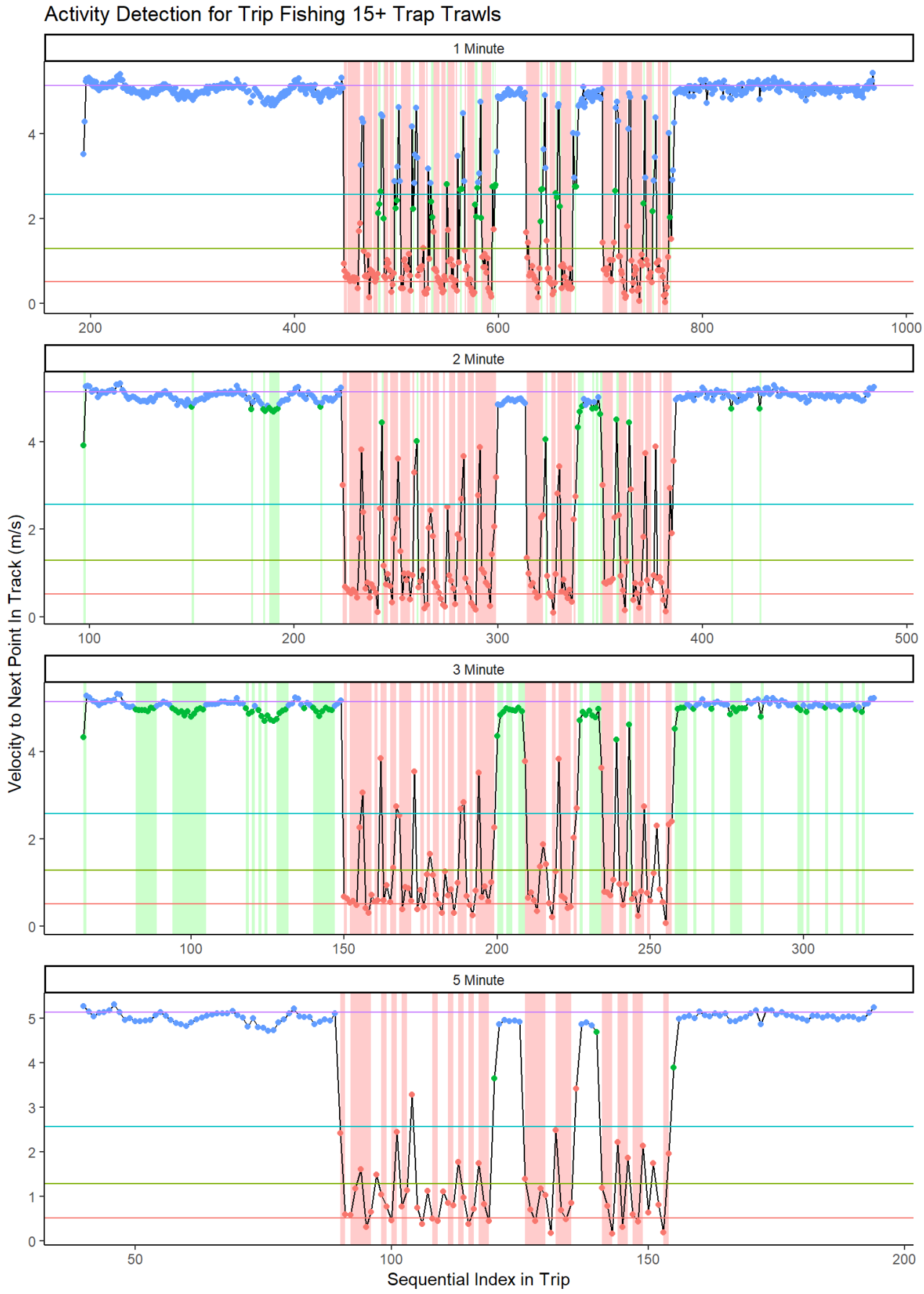
This trip had 25 reported hauls, which were detectable at the one and two minute ping rates. A cluster of points toward the end of the trip that was likely setting activity was misclassified as steaming. A notable issue occurred removing pings in port where the vessel moved to a new location at the end of the day.



Light red bars are filtered haul durations. Light green bars are filtered set durations.

15+ Trap Trawls

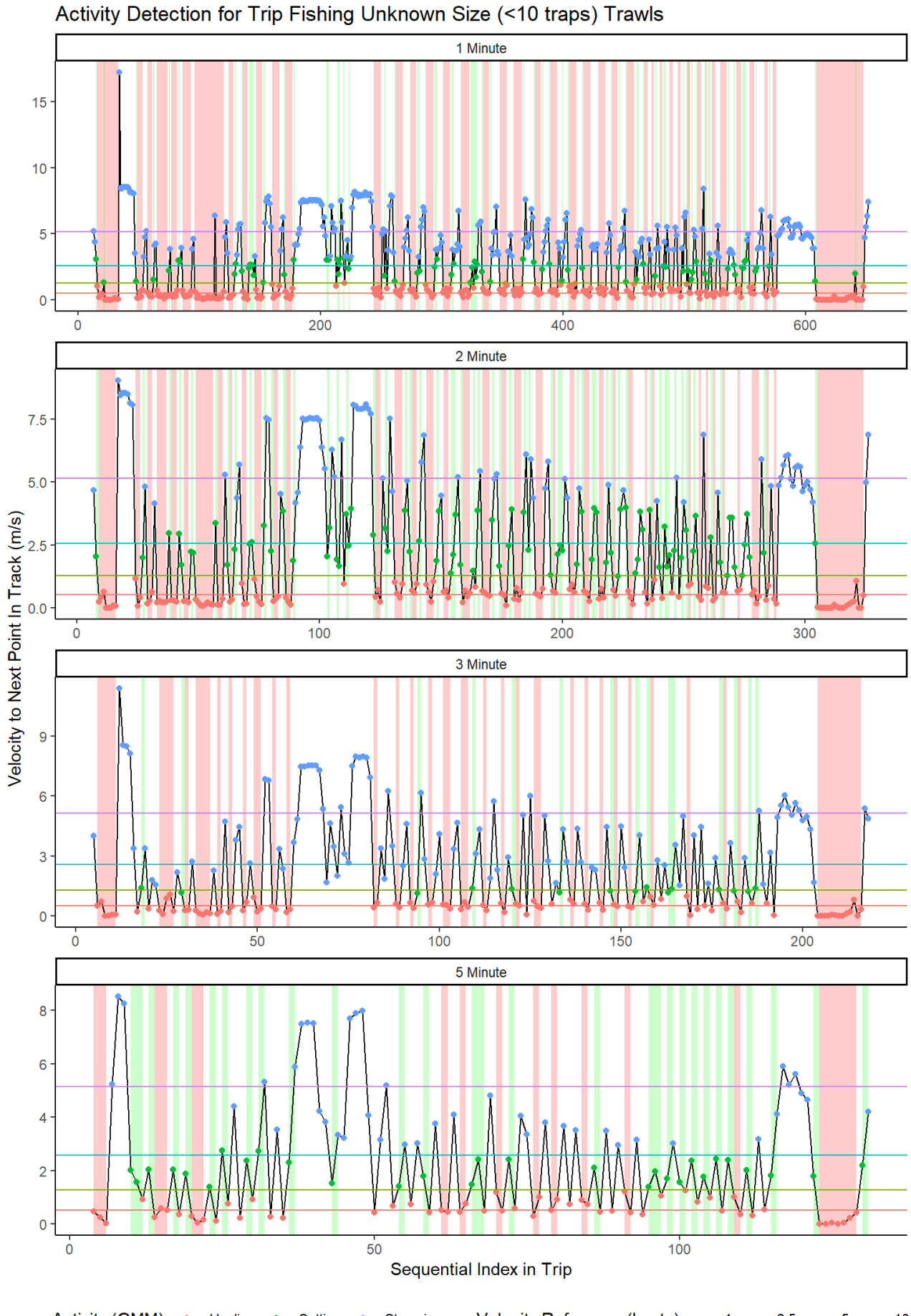
Trawls within this example trip were mostly detected; however, a notable issue is visible where several of the hauls were split into two hauls even though adjacent pings were correctly classified as hauling. This was likely due to dropped pings; the device lost GNSS reception causing the time difference between adjacent pings to be 2 or 3 minutes. When the resulting hauling classified data was clustered, the clustering threshold fell below this time difference causing two separate hauls to emerge. It will likely be necessary to interpolate dropped pings to avoid this issue. This example also highlights the necessity of a consistent ping rate during fishing.



Light red bars are filtered haul durations. Light green bars are filtered set durations.

Unknown Trawls - Vessel 1

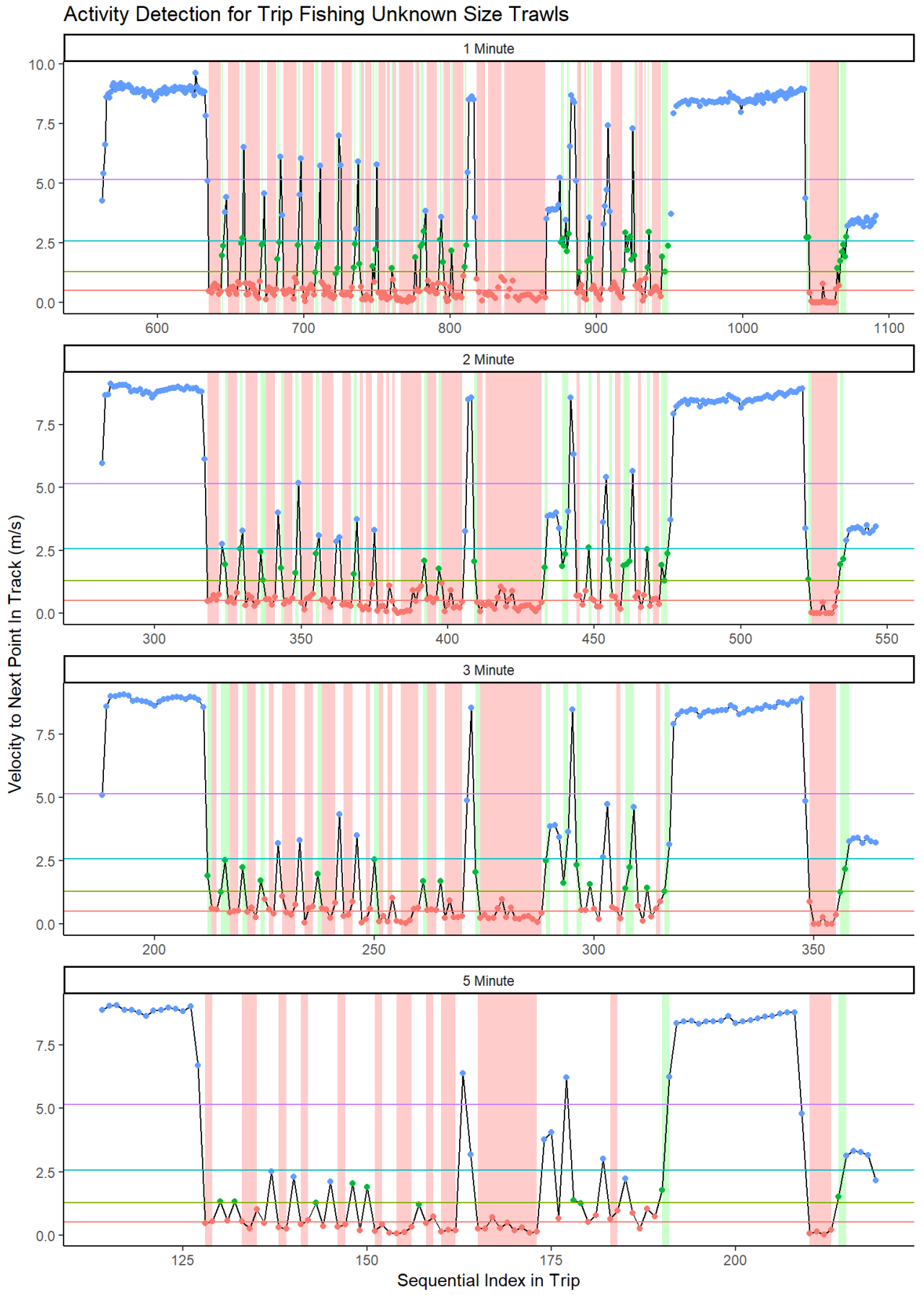
Unknown size trawls (likely < 10 traps) from a vessel not used in previous examples. Some pings in port were not removed, indicating the need for larger buffer size from the beginning of the track.



Light red bars are filtered haul durations. Light green bars are filtered set durations.

Unknown Trawls - Vessel 2

Unknown size trawls from a vessel not used in previous examples.



Light red bars are filtered haul durations. Light green bars are filtered set durations.

Data Size Considerations

Ping Data Structure

The following is the minimal datatype sizes necessary to represent a ping attributes in a relational database. Actual implementations would likely utilize structure requiring more space; these numbers are intended to represent the absolute minimum space to store ping data in an uncompressed state.

Attribute	Optimal Data Type	Attribute Size Bytes	Comments
Device ID	16-bit unsigned integer	2	Able to represent 65,536 unique devices/vessels. Actual device ID per manufacturer likely much longer than this, but can use lookup table in DB.
Time	64-bit unsigned integer	8	Most devices transmit ping time as the UNIX epoch or an ISO datetime string, store as UNIX epoch.
Latitude	single-precision float	4	Precise to 7 decimal places.
Longitude	single-precision float	4	Precise to 7 decimal places.
Horizontal Accuracy	16-bit unsigned integer	2	Store accuracy to one decimal * 10 - ie, accuracy of 2.45 meters stored as 25

Database Size

A single vessel pinging at a one minute rate 24 hours a day would produce 525,960 pings annually. Thus, the full federal lobster fleet of ~1600 vessels would produce 841,536,000 pings. Given the above minimum size of 20 bytes per ping, this would result in 16.83GB of data annually. Minimizing pinging while in port and/or removing pings in port prior to long-term storage would further reduce this figure by likely more than 50%.

Ping rates slower than one minute would decrease data storage sizes accordingly. However, given the relatively small amount of data that would be produced by the entire fleet at even a one minute rate, reductions in ping rate would likely realize minimal cost savings if any relative to the loss of data resolution.

Conclusions

- For trawls <10 traps in length, a one minute ping rate is necessary to distinguish the location of individual trawls. The size of the trawl relative to other small trawl sizes may not be discernible even at a one minute rate due to differences in hauling speed between vessels, locations and conditions. These results are consistent with findings in the Scottish European lobster creel fishery that a one minute ping rate was necessary to delimit hauling of 10-50 trap creels (Mendo, Smout, Russo, et al. 2019).

- A one minute ping rate can allow for the detection of setting of gear when no hauling occurred.
- The location of trawls of 10 traps and greater can be distinguished at up to a 3 minute ping rate. However, as with smaller trawls, the precision with with the size of the trawl can be estimated will decrease at slower ping rates.
- The lack of groundtruthed classified ping data makes calculating metrics on the performance of effort detection algorithms difficult. With validated training data, such as haul times from an onboard observer or a hauler sensor connected to the tracker, it may be possible to build better models and calculate metrics of their accuracies.

References

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Appendix B. Standard Affidavit Language for Tracking Device Certification

NOTICE TO FEDERAL AMERICAN LOBSTER COMMERCIAL TRAP GEAR AREA PERMIT HOLDERS

Under the authority of the Atlantic Coastal Fisheries Cooperative Management Act, Addendum XXIX to Amendment 3 to the Interstate Fishery Management Plan for American Lobster and Addendum IV to the Fishery Management Plan for Jonah crab requires all vessels with a federal American Lobster Trap Gear Area permit to have an approved vessel tracker installed as of *Month DD, YYYY*. Tracking devices must be installed prior to the permit holder's first fishing trip. This vessel tracker must remain powered and transmitting when the vessel is in the water regardless of landing state, trip type, location fished, or target species. All devices must follow the specifications outlined in Section 3.1 of Addendum XXIX. A list of approved devices along with vendor contact information is attached to this document.

The principal port on your Federal Fishery Permit lies within the [*Principal Port State*], thus the [*Principal Port State Agency*] will be tasked with certifying the installation of your vessel tracking device. In the event you believe your tracker is not functioning correctly and must be serviced, please contact [*Principal Port State Agency*], and inform them of your situation.

Please complete, sign and return this form once an approved device has been installed on your vessel.

Federal Fishery Permit Number:

Documentation or Vessel Registration Number:

Vessel Name:

Vessel Tracking Device Vendor:

Vessel Tracking Device Identifier:

I certify that the above vessel tracking device is installed and properly functioning to the best of my knowledge.

Permit Holder Signature:

Permit Holder Printed Name:

Date: