IPHC Scientific Review Board (SRB013) – A Collection of Published Meeting Documents

25 – 27 September 2018, Seattle, WA

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INTERNATIONAL PACIFIC HALIBUT COMMISSION

IPHC-2018-SRB013-01

Late updated: 26 August 2018

DRAFT: AGENDA & SCHEDULE FOR THE 13th SESSION OF THE IPHC SCIENTIFIC REVIEW BOARD (SRB013)

Date: 25–27 September 2018
Location: Seattle, Washington, U.S.A.
Venue: IPHC Board Room, Salmon Bay
Time: 12:00-17:00 (25th), 09:00-17:00 (26th), 09:00-14:00 (the 27th)
Chairperson: Dr Sean Cox (Simon Fraser University)
Vice-Chairperson: Nil

1. OPENING OF THE SESSION

2. ADOPTION OF THE AGENDA AND ARRANGEMENTS FOR THE SESSION

3. IPHC PROCESS
- 3.1. Update on the actions arising from the 12th Session of the SRB (SRB012) (D. Wilson)
- 3.2. Outcomes of the 2018 IPHC Work Meeting (WM2018) (D. Wilson)
- 3.3. SRB annual workflow (D. Wilson)

4. IPHC FISHERY-INDEPENDENT SETLINE SURVEY (FISS)
- 4.1. Methods for spatial setline survey modelling – results to date for 2018 (R. Webster)

5. PACIFIC HALIBUT STOCK ASSESSMENT: 2018
- 5.1. Data source development (I. Stewart)
- 5.2. Modelling updates (I. Stewart)

6. MANAGEMENT STRATEGY EVALUATION: UPDATE
- 6.1. Updates to MSE framework and closed-loop simulations (A. Hicks)
- 6.2. MSE Simulation results (A. Hicks)
- 6.3. Distribution procedures (A. Hicks)

7. BIOLOGICAL AND ECOSYSTEM SCIENCE RESEARCH UPDATES
- 7.1. Biological research updates (J. Planas)
- 7.2. Review of discussions on long-term research plans incorporating new research topics (J. Planas).

8. REVIEW OF THE DRAFT AND ADOPTION OF THE REPORT OF THE 13TH SESSION OF THE IPHC SCIENTIFIC REVIEW BOARD (SRB013)

INTERNATIONAL PACIFIC HALIBUT COMMISSION

IPHC-2018-SRB013-01

Late updated: 26 August 2018

DRAFT: SCHEDULE FOR THE 13th SESSION OF THE IPHC SCIENTIFIC REVIEW BOARD (SRB013)

Tuesday, 25 September 2018		
Time	**Agenda item**	**Lead**
12:00-12:30	Arrival (light lunch provided)	
12:30-12:45	1. OPENING OF THE SESSION 2. ADOPTION OF THE AGENDA AND ARRANGEMENTS FOR THE SESSION	S. Cox & D. Wilson
12:45-13:15	3. IPHC PROCESS 3.1 Update on the actions arising from the 12th Session of the SRB (SRB012) 3.2 Outcomes of the 2018 IPHC Work Meeting (WM2018) 3.3 SRB annual workflow (D. Wilson)	D. Wilson
13:15-15:00	4. IPHC FISHERY-INDEPENDENT SETLINE SURVEY (FISS) 4.1 Methods for spatial setline survey modelling – Results to date for 2018	R. Webster
15:00-15:30	5. PACIFIC HALIBUT STOCK ASSESSMENT: 2018 5.1 Data source development 5.2 Modelling updates	I. Stewart
15:30-15:45	Break	
15:45-17:00	5. PACIFIC HALIBUT STOCK ASSESSMENT: 2018 (continued)	I. Stewart
Wednesday, 26 September 2018		
Time	**Agenda item**	**Lead**
09:00-10:00	Review of Day 1 and discussion of SRB Recommendations	Chairperson
10:00-10:30	6. MANAGEMENT STRATEGY EVALUATION: UPDATE 6.1 Updates to the MSE framework and closed-loop simulations	A. Hicks
10:30-10:45	Break	
10:45-12:30	6. MANAGEMENT STRATEGY EVALUATION: UPDATE 6.2 MSE Simulation results (A. Hicks) 6.3 Distribution procedures (A. Hicks)	A. Hicks
12:30-13:30	Lunch	

13:30-15:30	7. BIOLOGICAL AND ECOSYSTEM SCIENCE PROGRAM RESEARCH UPDATES 7.1 Biological research updates (J. Planas) 7.2 Review of discussions on long-term research plans incorporating new research topics (J. Planas).	J. Planas
15:30-15:45	Break	
15:45-16:30	7. BIOLOGICAL AND ECOSYSTEM SCIENCE PROGRAM RESEARCH UPDATES (continued)	J. Planas
16:30-17:00	SRB drafting session	SRB members
Thursday, 27 September 2018		
Time	**Agenda item**	**Lead**
09:00-10:30	Review of Day 2 and discussion of SRB Recommendations	S. Cox
10:30-10:45	Break	
10:45-12:30	SRB drafting session	SRB members
12:30-13:30	Lunch	
13:30-14:00	8. REVIEW OF THE DRAFT AND ADOPTION OF THE REPORT OF THE 12th SESSION OF THE IPHC SCIENTIFIC REVIEW BOARD (SRB012)	S. Cox

INTERNATIONAL PACIFIC HALIBUT COMMISSION

IPHC-2018-SRB013-02

Last updated: 26 August 2018

PROVISIONAL: LIST OF DOCUMENTS FOR THE 13th SESSION OF THE IPHC SCIENTIFIC REVIEW BOARD (SRB013)

Document	Title	Availability
IPHC-2018-SRB013-01	DRAFT: Agenda & Schedule for the 13th Session of the Scientific Review Board (SRB013)	✓ 27 June 2018 ✓ 26 August 2018
IPHC-2018-SRB013-02	DRAFT: List of Documents for the 13th Session of the Scientific Review Board (SRB013)	✓ 27 June 2018 ✓ 26 August 2018
IPHC-2018-SRB013-03	Update on the actions arising from the 12th Session of the SRB (SRB012) (IPHC Secretariat)	✓ 26 August 2018
IPHC-2018-SRB013-04	Update on inputs to space-time modelling of survey data for 2018 (R. Webster)	✓ 24 August 2018
IPHC-2018-SRB013-05	Data sources and modelling update for the 2018 stock assessment (I. Stewart)	✓ 24 August 2018
IPHC-2018-SRB013-06	Management Strategy Evaluation: Update for 2018 (A. Hicks, I. Stewart)	✓ 27 August 2018
IPHC-2018-SRB013-07	Report on current biological research activities and progress on discussions regarding new research topics (J. Planas)	✓ 25 August 2018
Information papers		
IPHC-2018-SRB013-INF01	Research project summary	✓ 25 August 2018
IPHC-2018-SRB013-INF02	Research project location summary	✓ 25 August 2018

UPDATE ON ACTIONS ARISING FROM THE 12TH SESSION OF THE IPHC SCIENTIFIC REVIEW BOARD (SRB012)

PREPARED BY: IPHC SECRETARIAT (26 AUGUST 2018)

PURPOSE

To provide the Scientific Advisory Board (SRB) with an opportunity to consider the progress made during the intersessional period, on the recommendations/requests arising from the SRB012.

BACKGROUND

At the SRB012, the members recommended/requested a series of actions to be taken by the IPHC Secretariat staff, as detailed in the SRB012 meeting report (IPHC-2018-SRB012-R) available from the IPHC website, and as provided in Appendix A.

DISCUSSION

During the 13th Session of the SRB (SRB013), efforts will be made to ensure that any recommendations/requests for action are carefully constructed so that each contains the following elements:

1) a specific action to be undertaken (deliverable);
2) clear responsibility for the action to be undertaken (such as the IPHC Staff or SRB officers);
3) a desired time frame for delivery of the action (such as by the next session of the SRB or by some other specified date).

RECOMMENDATION/S

That the SRB:

1) **NOTE** paper IPHC-2018-SRB013-03, which provided the SRB with an opportunity to consider the progress made during the inter-sessional period, in relation to the consolidated list of recommendations/requests arising from the previous SRB meeting (SRB012).
2) **AGREE** to consider and revise the actions as necessary, and to combine them with any new actions arising from SRB013.

APPENDICES

Appendix A: Update on actions arising from the 12th Session of the IPHC Scientific Review Board (SRB012)

APPENDIX A
Update on actions arising from the 11th Session of the IPHC Scientific Review Board (SRB011)

RECOMMENDATIONS

(para. 8) **NOTING** that the core purpose of the SRB012 is to review progress on the IPHC scientific program, and to provide guidance for the delivery of products to the SRB013 in September 2018, the SRB **AGREED** that formal recommendations to the Commission would not be developed at the present meeting, but rather, these would be developed at the SRB013.

REQUESTS

Action No.	Description	Update
SRB012–Req.01 (para. 18)	***Pacific halibut stock assessment: 2018 - Data source development*** **NOTING** the "map" presentation showing Recent Trend and Current Status, the SRB **REQUESTED** the IPHC Secretariat to further code the symbols to indicate relative stock sizes. An example approach for time series was provided via email and code can be made available.	**Completed.** The ideas discussed at SRB012 are being incorporated into the presentation of the assessment and will be discussed at SRB013.
SRB012–Req.02 (para. 24)	***Modelling updates: Graphical and tabulation tools for presentation of currently implemented reference points, potentially including a phase plot*** The SRB **NOTED** that the phase plot presentation showing historical stock status and fishing intensity is a common and informative way to present fishery status. However, the perception of fishery status depends on the choices for reference points (i.e. vertical and horizontal lines in the spawning biomass and fishing intensity dimensions, respectively) and corresponding zones. Therefore, the SRB **REQUESTED** that the plot not be coloured with discrete "stoplight" colours. It is important that the IPHC Secretariat make it clear to viewers that (1) that F46% is the implied fishing intensity given relatively recent catch history, and (2) that the implied biomass target associated with F46% is not at the crosshairs given in the plot.	**Completed.** The ideas discussed at SRB012 are being incorporated into the presentation of the assessment and will be discussed at SRB013.

Action No.	Description	Update
SRB012–Req.03 (para. 28)	***Outcomes of MSAB011*** With respect to the above two excerpts from IPHC-2017-SRB011-R, the SRB **AGREED** to the following clarifications: a) *IPHC-2017-SRB011-R, paragraph 24* simply recognizes that perfect knowledge simulation will under-represent short- and medium-term risks to both the stock and fisheries that result from persistent stock assessment errors. The SRB also **NOTED** that *IPHC-2017-SRB011-R paragraph 24* does not imply concatenating short-term projections from the ensemble assessment model with long-term projections from the MSE. b) The SRB **NOTED** that the original intent of *IPHC-2017-SRB011-R, paragraph 28* was to exclude OM states and parameters that resulted in quasi-extinction of the stock before 2017 and **REQUESTED** that, by SRB013, the IPHC Secretariat confirm that this problem no longer exists so that the full OM distribution can be used.	**Completed.** Estimation error has been introduced into the simulation framework, including error in parameter estimation, catch determination, and autocorrelation. Trajectories are also being tested for quasi-extinction and results will be discussed at SRB013.
SRB012–Req.04 (para. 33)	***Updates to MSE framework and closed-loop simulations*** The SRB **AGREED** that with respect to all of the topics listed above in paragraph 32, it cannot make an objective assessment of the appropriateness of choices and methods used in the MSE OM conditioning and projections in the absence of simulation results. The SRB **REQUESTED** a presentation of MSE simulation results by SRB013.	**Completed.** Results are presented in IPHC-2018-SRB013-06 and additional results will be presented at SRB013.
SRB012–Req.05 (para. 36)	***Five-year research plan and management implications*** The SRB **NOTED** and was very pleased with the progress made integrating the biological, assessment, and MSE aspects of IPHC research, as well as the approach used to present this integration. The SRB further **REQUESTED** that the presentation approach be further developed and used to communicate IPHC research at future annual meetings.	**Completed**: Will be presented again at SRB013 and future meetings.

Action No.	Description	Update
SRB012–Req.06 (para. 37)	The SRB **REQUESTED** that readers of this report to refer to paragraphs 46-72 from IPHC-2017-SRB010-R for in-depth background comments previously made on the biological research program components.	**Completed:** No action required
SRB012–Req.07 (para. 39)	The SRB **REQUESTED** that IPHC establish dedicated academic funding programs through which IPHC-funded university students participate in research activities.	**Pending**. This was included in the 2018 AM094 meeting documents but was not approved by the Commission, rather it was deferred for consideration again at AM095.

Update on inputs to space-time modelling of survey data for 2018

PREPARED BY: IPHC SECRETARIAT (R. WEBSTER; 24 AUGUST 2018)

PURPOSE

To update SRB members on space-time modelling data inputs for 2018.

BACKGROUND/INTRODUCTION

Since 2016, IPHC Secretariat staff has used a space-time modelling approach to estimate indices of density and biomass for use in stock assessment modelling and estimation of stock distribution. Among other advantages over the previous empirical method, the modelling allows easy integration of data from expansions of the IPHC fishery-independent setline survey (FISS), removing the need for computing ad-hoc adjustment scalars each time new regions are covered by the FISS. In 2018, planned IPHC FISS expansions took place in IPHC Regulatory Areas 2B and 2C. In addition to the planned expansions, FISS stations were added off the north Washington coast in a repeat of the 2017 ad-hoc expansion that doubled the station density in that region. At the time of writing, the FISS is currently nearing completion, and results (including modelling output) are still to be determined.

OTHER CHANGES OR UPDATES

- As per SRB recommendations in June (SRB012), environmental covariate data will not be used in space-time modelling for IPHC Regulatory Area 2A for the purpose of estimating density indices.
- The FISS timing adjustment will be updated using 2017 data (recall that following SRB advice, this adjustment has a one-year lag).
- Data from an ad-hoc northern expansion of the NMFS Bering Sea trawl survey (covering an area from the entrance to Norton Sound to the EEZ boundary with Russia) is expected to be available along with the annual trawl survey data, and will be included in the space-time modelling in 2018.
- A fixed versus snap gear comparison study is being designed for IPHC Regulatory Area 2C in 2019, with the intention being to estimate differences in catch rates using space-time modelling.
- We are exploring space-time modelling of trawl survey-caught two-year old Pacific halibut to complement the recent modelling of juvenile Pacific halibut reported at SRB012.

Data sources and modelling update for the 2018 stock assessment

PREPARED BY: IPHC SECRETARIAT (I. STEWART; 24 AUGUST 2018)

PURPOSE

To provide the Scientific Review Board (SRB) a summary of updates to data sources and modelling for the 2018 stock assessment and harvest policy analyses.

INTRODUCTION

Updates and improvements to the data sources supporting the annual stock assessment and harvest strategy policy analyses are made each year as new information and new processing of older information becomes available. Ongoing avenues of data development, specific changes anticipated for inclusion into 2018 models, and changes planned for 2019 were discussed during SRB012 (IPHC 2018), in June 2018. This document provides updates specifically relevant to the 2018 stock assessment, and will be supplemented with additional presentation material as/if 2018 data become available.

ONGOING DEVELOPMENT

There have been no new developments with regard to the use of measured individual fish weights, historical bycatch estimates and biological data, or effective skate (hook-spacing) calculations since SRB012. Similarly, there is no new progress to report with regard to model weighting, Bayesian integration. The IPHC Secretariat's manuscript on ensemble stability is in revision at this time. Status of each of these projects was documented in more detail in the documents and presentations by the Secretariat during that meeting (IPHC Secretariat 2018a, b).

DEVELOPMENT FOR 2018

Space-Time modelling improvements

Based on the results of SRB012, there are no anticipated changes to the basic approach for space-time modelling to be used in 2018.

Enhanced reporting of commercial fishery Catch-Per-Unit-Effort (CPUE) indices

In addition to the delineation of fixed hook and snap gear in the commercial CPUE time-series' presented during SRB012, the SRB "URGED the IPHC Secretariat to further provide a correlation plot between relative CPUEs for each gear type by region". This is provided in **Appendix A**. The comparison generally shows a linear (but not 1:1) relationship between the gear types, but does highlight the relative lack of correlation in Regulatory Area 4B, an Area with relatively low sample sizes.

Data status and trend summary tools

The IPHC Secretariat is moving forward with the development of presentation tools for use during meetings, as well as through the new website. As the complexity of supporting analyses and the number of diverse data sets considered during the annual management process has increased, it has become more challenging to provide the information in easily accessible and efficient formats. Inspired by approaches first encountered through the North Pacific Fishery Management Council's (NPFMC; https://www.npfmc.org/) Ecosystem report and other National Marine Fisheries Service presentations, one potential tool to condense both trend and status information is to 'map' data sources into simple quadrants. A preliminary qualitative approach was discussed during SRB012, and "the SRB REQUESTED the IPHC Secretariat to further code the symbols to indicate relative stock sizes". This approach has been refined to make it easier to combine time-series with the same interpretation of the axes, and to reflect the relative importance of each point. An example using the IPHC's FISS O32 WPUE is provided in **Appendix B**.

Software updates

As discussed during SRB012, the current version of stock synthesis (3.30.11) has at least two features used in the four Pacific halibut models that are incompletely implemented. These features have been included in subsequent development, but that version (3.30.12) remains a beta version in testing (as of August 2018). When a full release is made, the testing and conversion of the four Pacific halibut models will continue. No change in the software version used by the IPHC will be made for 2018 unless all features and results can be mapped identically.

Phase plots and status indicators

During SRB012, a 'phase' plot reflecting stock status and fishing intensity relative to the IPHC's reference points was discussed. Because the IPHC's reference points for stock status and fishing intensity are not logically (or analytically) related, "the SRB REQUESTED that the plot not be coloured with discrete "stoplight" colours", and that the description of the figure make this clear. The revised figure is presented in **Appendix C**.

Routine data updates

Although there may be some preliminary data available for SRB013, it is unlikely that these data will be complete enough for testing in stock assessment models. FISS results will be summarized during the meeting and evaluated for consistency with stock projections, depending on availability.

DEVELOPMENT PROPOSED FOR 2019

A full assessment analysis and review is planned for 2019 (see discussion in IPHC-2018-SRB12-07), which will allow more in-depth investigation and model-based evaluation of the new and/or revised data. Progress continues on the reevaluation of whale depredation accounting in the Fishery Independent Setline Survey time-series, as well as the sex-ratio of the commercial catch in 2017; both products are anticipated in February 2019. That analysis will also allow for an in-depth exploration of data weighting, parameterization of time-varying processes and other modelling approaches implemented in the four Pacific halibut models comprising the stock assessment ensemble.

SUMMARY

As has been the standard practice since 2015, any changes to existing data sources, and all updated information subsequent to SRB013 will be reported directly in the 2018 stock assessment. Any questions and/or clarifications will be provided for the SRB during the annual conference call held in December (after the IPHC's Interim Meeting IM094, and before the IPHC's Annual Meeting AM095).

RECOMMENDATION/S

The IPHC secretariat requests that the SRB:

a) **NOTE** paper IPHC-2018-SRB013-05 which summarizes ongoing, pending and future data source and modelling development efforts by the IPHC Secretariat.

b) **NOTE** any preliminary data and/or results from 2018 that may be available in presentations made by the IPHC Secretariat (but were unavailable at the time this document was created).

c) **NOTE** any discussion occurring during SRB013, and **RECOMMEND** any improvements to and/or new tools for summarizing and presenting data sources or formulating the 2018 stock assessment.

REFERENCES

IPHC. 2018. Report of the 12th Session of the IPHC Scientific Review Board (SRB012). Seattle, Washington, U.S.A., 19-21 June 2018. IPHC-2018-SRB012-R. 17 p.

IPHC Secretariat. 2018a. Data source development. IPHC-2018-SRB012-06. 10 p.

IPHC Secretariat. 2018b. Modelling updates. IPHC-2018-SRB012-07. 11 p.

APPENDICES

Appendix A: Expanded reporting of commercial fishery catch-rates.

Appendix B: Example of data 'mapping'.

Appendix C: Updated 'phase' plot.

APPENDIX A

Expanded reporting of commercial fishery catch-rates.

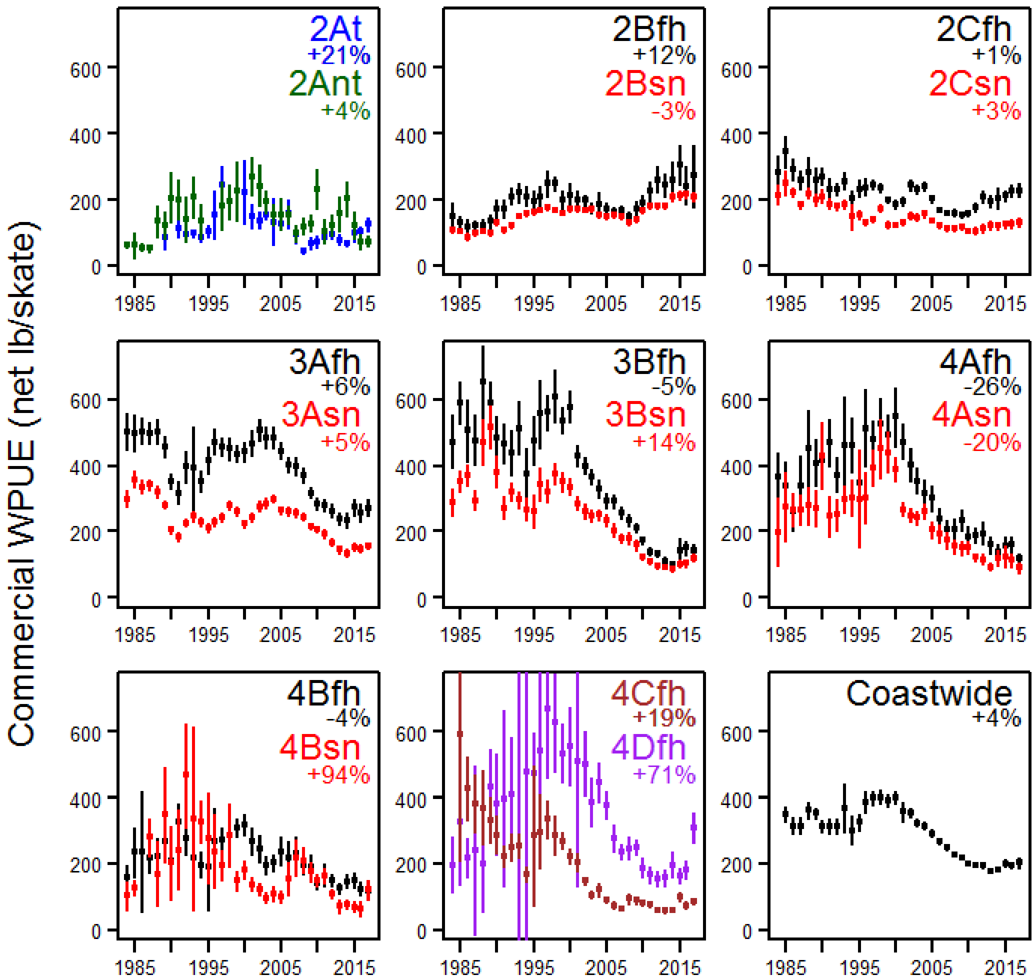


Figure A1 (duplicated from IPHC-2018-SRB012-06). Commercial WPUE: Area 2A delineated by fishery (t = tribal, nt = non-tribal), Areas 2B-4B delineated by gear type (fh = fixed-hook, sn = snap gear) and Area 4CDE delineated by Area (4C, 4D; too few snap gear data to summarize). Percentages indicate the change from 2016-2017; vertical bars an approximate 95% confidence interval based only on between-set variability.

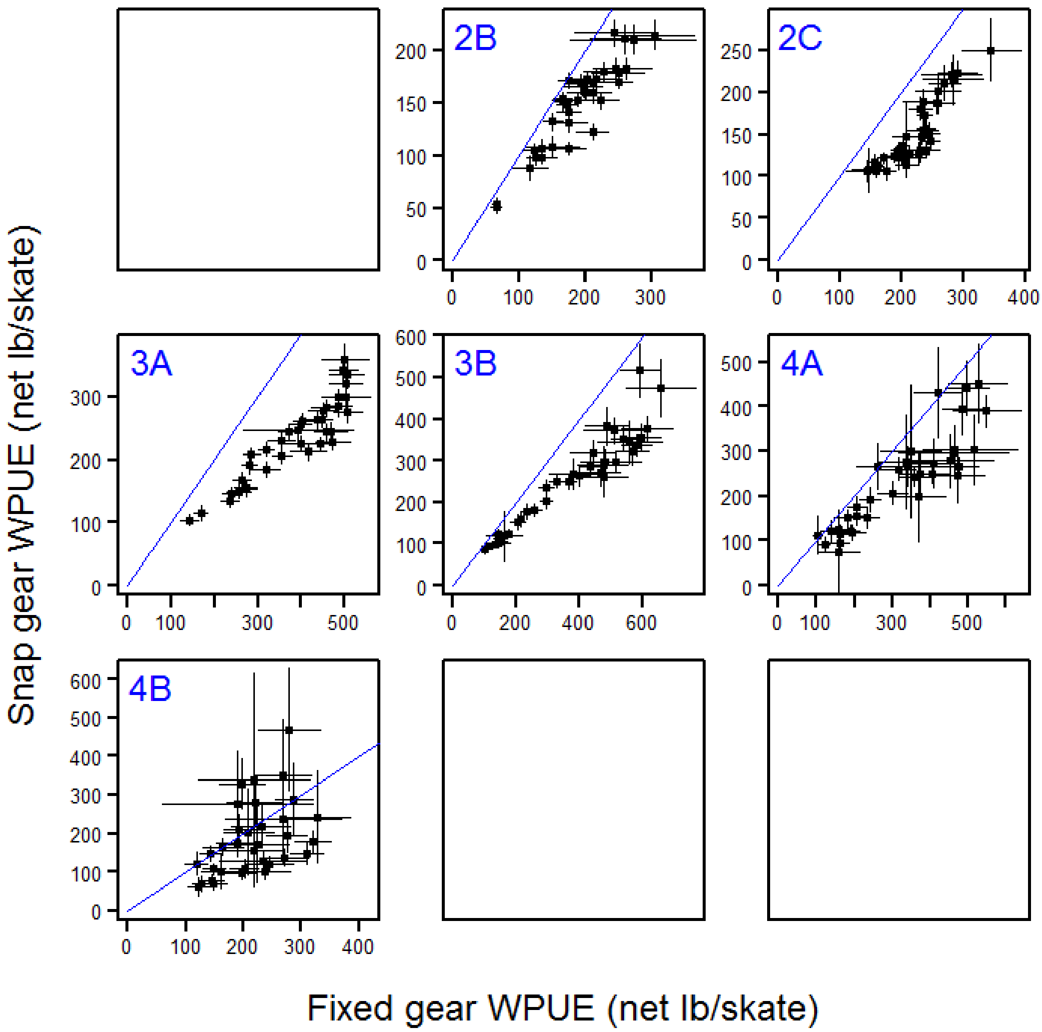


Figure A2. Relationship between commercial annual WPUE by gear type and Regulatory Area. Points indicate individual years; vertical and bars an approximate 95% confidence interval based only on between-set variability. The diagonal line represents a 1:1 relationship for comparison. Format follows Figure A1, with comparisons shown only for those Regulatory Areas where snap and fixed-hook gear have been delineated.

APPENDIX B

Example of qualitative data mapping where "status" is determined relative to the time-series mean, and recent trend is relative to the most recent five years. It may be desirable to provide a small set of panels, or perhaps colored series (by data type) on a single panel reporting trends across a variety of data sources for simultaneous evaluation. Provided below is a single example, where the FISS catch rate estimates from the S-T model (Figure B1) are 'mapped' and labelled (Figure B2).

In order to provide a basis for Figure B2 that can be applied to any time-series with a consistent interpretation, the a simple analytical approach was used. The status (*s*) in the terminal year (*y*) is defined on a scale from -1.0 to 1.0, with 0.0 in the center of the plot. If the current value (x_y) is above the mean of the time series ($\bar{x}$), it's status is calculated relative to the highest value in the time series, given by:

$$s = \frac{x_y - \bar{x}}{\max\left(\mathrm{x}_{1,\ldots,y}\right) - \bar{x}}$$

If the current value is below the mean, it's status is calculated relative to the lowest value in the time series:

$$s = \frac{\bar{x} - x_y}{\min(\mathrm{x}_{1,\ldots,y})}$$

Similarly, the trend of the terminal three years is also reported on a scale of -1.0 to 1.0, and centered on 0.0. The trend (*t*) is defined as the slope (b_y) of a linear regression (without a fixed intercept), and calculated relative to the maximum and minimum slope over any three year period in the observed time series

$$t = \begin{cases} \dfrac{b_y}{\max\left(\mathrm{b}_{3,\ldots,y}\right)} \; where\ b_y \ \geq 0.0 \\ \dfrac{-b_y}{\min\left(\mathrm{b}_{3,\ldots,y}\right)} \; where\ b_y \ < 0.0 \end{cases}$$

This formulation leads to a simple interpretation on each axis: 1) is the value currently above or below the mean, and its value is relative to the previously observed range, and 2) is the recent trend positive or negative, and how rapidly is it changing relative to the observed time series. Thus, series with different absolute values or units (survey NPUE vs. fishery WPUE) can be overlain on the same figure with the same interpretation. Alternative approaches utilizing axes on absolute scales (rather than relative to each time-series), would require a subjective choice of which ranges to consider high vs. low.

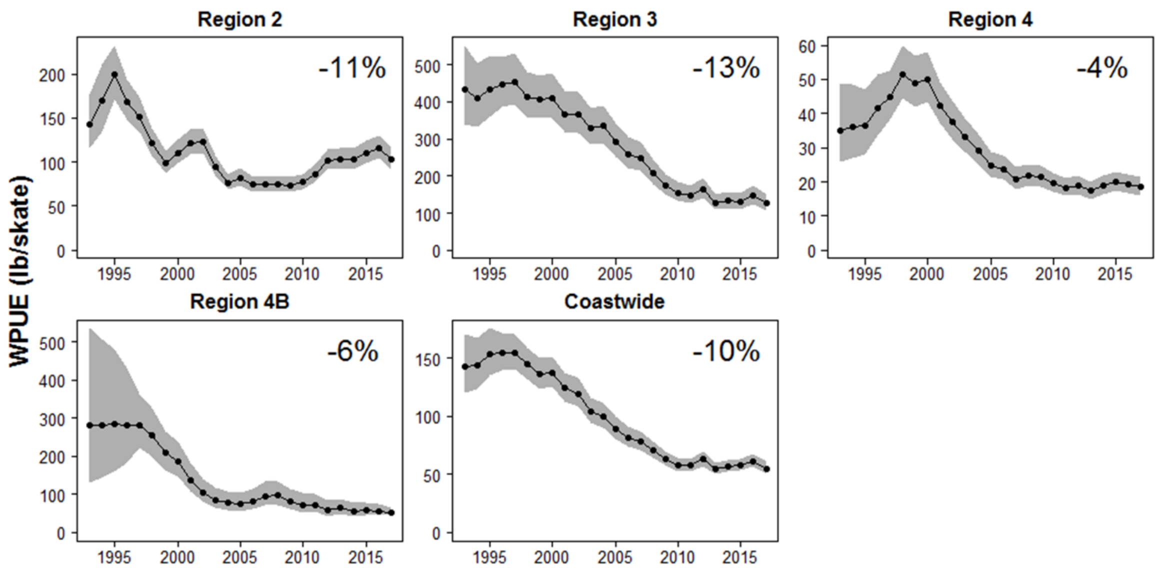


Figure B1. Survey O32 WPUE by Region. Percentages indicate the change from 2016-2017; shaded area indicates an approximate 95% credible interval.

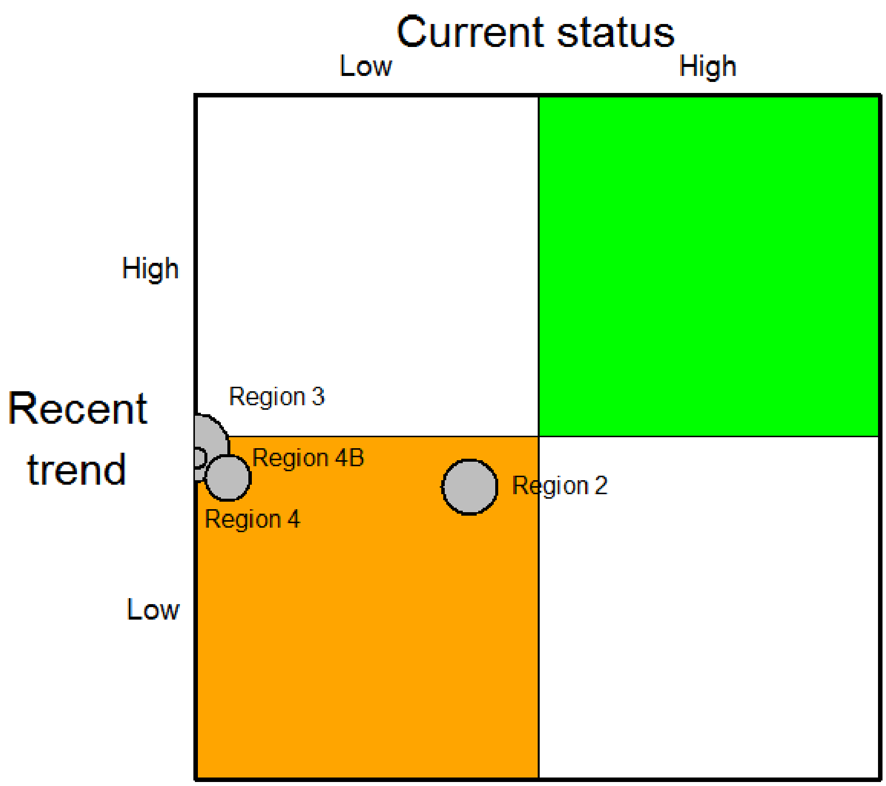


Figure B2. Survey WPUE by Region (identical data from Figure B1) 'mapped' to show current (2017) status (relative to the time-series mean) and three-year trend (relative to the trends observed over the time series). Circles indicate individual Regions, with the area of the circles proportional to the contribution to the aggregate coastwide WPUE (i.e., the 2017 WPUE distribution). See text for quantitative description of the axes.

APPENDIX C

Updated 'phase plot' reflecting the stock and fishing intensity relative to IPHC reference points ($SB_{20\%}$, $SB_{30\%}$) and the fishing intensity 'handrail' (SPR=46%).

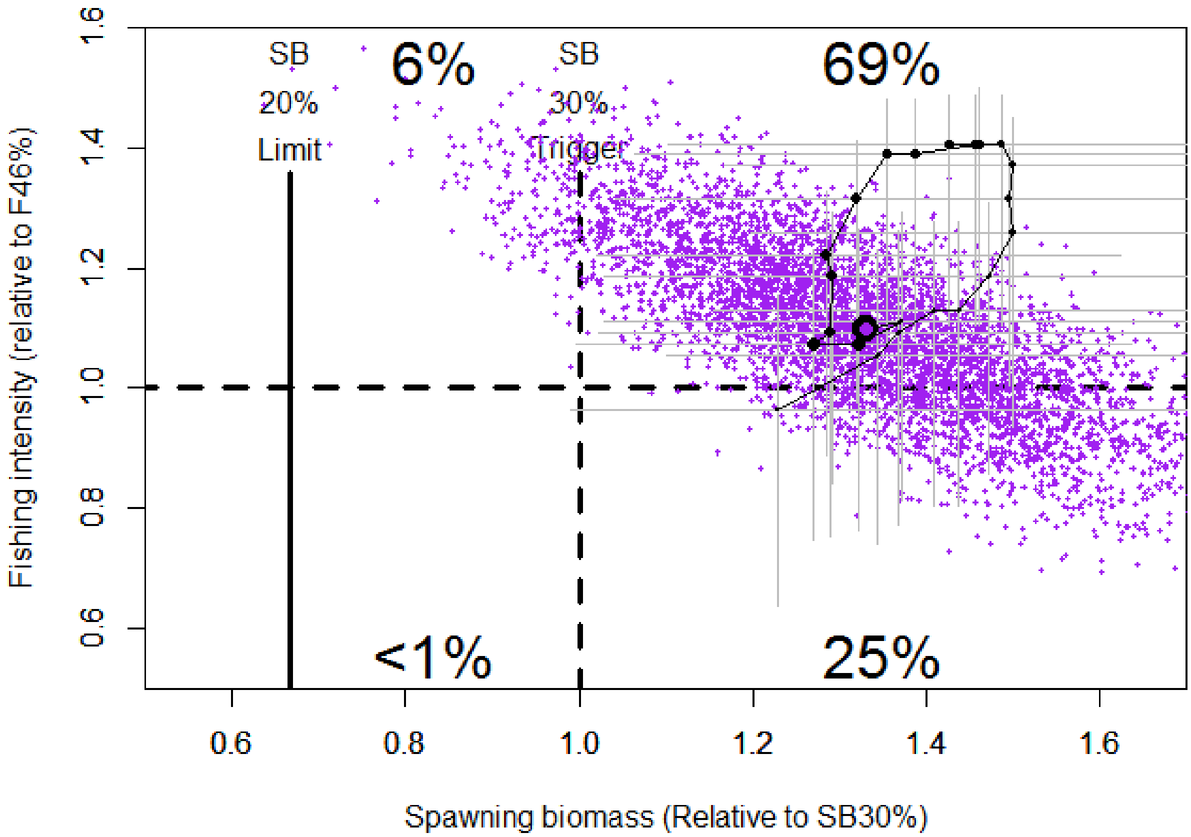


Figure C1. Recent stock (female spawning biomass) status relative to the IPHC's $SB_{30\%}$ and $SB_{20\%}$ reference points (x axis), and fishing intensity status relative to the 'handrail' reference level of SPR=46% (y axis). Connected points indicate years since 1996, with point size increasing to 2017 (purple filled point). Vertical and horizontal lines indicate approximate 95% credibility intervals for each year; small points (purple) represent an approximation of the bivariate uncertainty in the terminal year, with percentages printed on the figure describing the relative probability of the terminal estimate being in each of the quadrants. Note that the two axes are not logically related in that fishing at the reference level does not correspond to the $SB_{30\%}$ biomass level at equilibrium.

Management Strategy Evaluation: Update for 2018

PREPARED BY: IPHC SECRETARIAT (A. HICKS; 26 AUGUST 2018)

1 PURPOSE

To provide the SRB with an update on the MSE-related activities of the IPHC Secretariat in 2018 (as of 26 August 2018).

2 INTRODUCTION

At the 2017 Annual Meeting (AM093) Commissioners supported a revised harvest policy that separates the scale and distribution of fishing mortality (Figure 1). Furthermore, the Commission identified an interim "hand-rail" or reference for harvest advice based on a status-quo SPR, which uses the average estimated coastwide SPR for the years 2014–2016 from the 2016 stock assessment, resulting in an SPR of 46%. The justification for using an average SPR from recent years is that this corresponds to fishing intensities that have resulted in a stable or slightly increasing stock, indicating that, in the short-term, this may provide an appropriate fishing intensity that will result in a stable or increasing female spawning biomass.

The 2017 stock assessment updated the population estimates and determined that the SPR resulting from actual total mortality from all sources in 2017 was 40%, instead of the 45% adopted by Commissioners at AM093. This was an example of estimation error and something that is inherent in the process due to uncertainty in the data. The SPR of 40% was well within the confidence bounds for SPR reported in the 2017 stock assessment (30-59%), and was most likely less than the adopted SPR because of the updated estimation of recent below average recruitment. The estimation may easily go either way (above or below the adopted value).

This document (IPHC-2018-SRB013-06 focuses on five topics:

1. goals and objectives,
2. simulation framework
3. simulation results,
4. a brief description of topics related to distributing the TCEY, and
5. a review of the five-year work plan.

Appropriate background or reference to documents is provided, when needed. Useful documents to reference are IPHC-2018-MSAB011-07 for a description of objectives (with an update in Appendix Va in IPHC-2018-MSAB011-R, and reproduced here in Appendix I), IPHC-2018-MSAB011-08 for a description of the simulation framework, and IPHC-2018-MSAB011-09 for a discussion of the TCEY distribution framework. The 5-year program of work is described in document IPHC-2018-MSAB011-10, with a detailed description of deliverables up to and including the Annual Meeting in 2021 (AM097). The MSAB011 report (IPHC-2018-MSAB011-R) provides a summary of the outcomes of that meeting. Additionally, documents IPHC-2018-SRB012-08 and IPHC-2018-SRB012-R provide background to SRB discussions in June 2018.

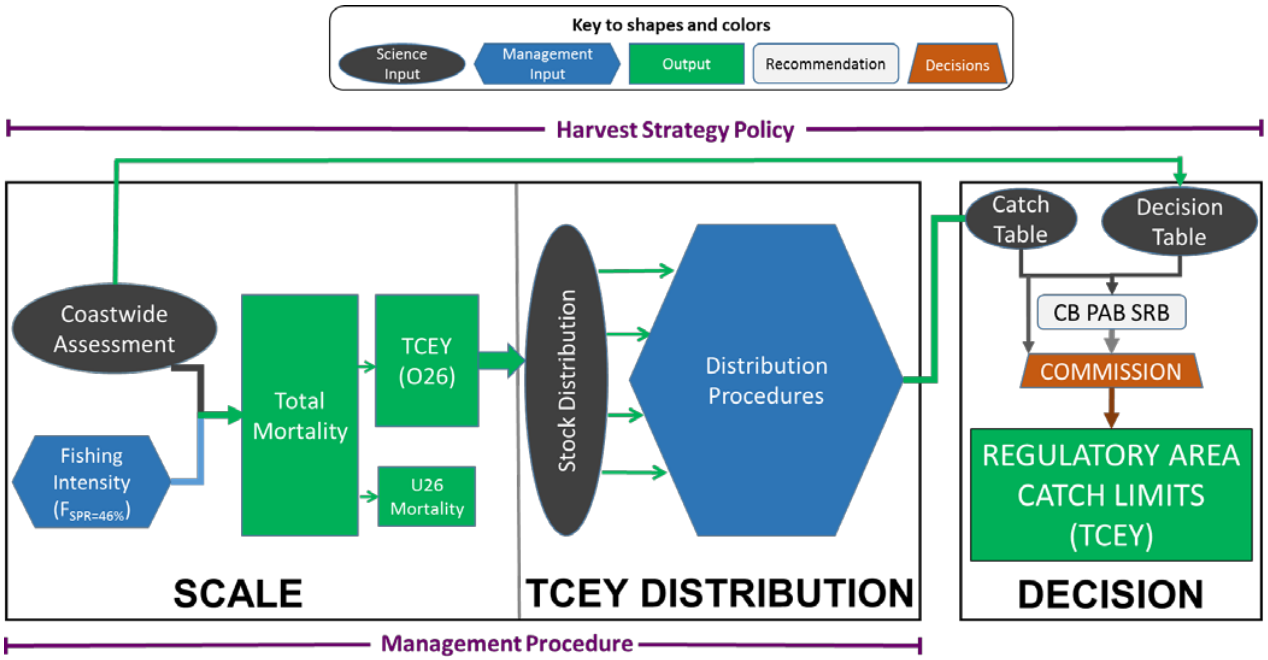


Figure 1: A pictorial description of the interim IPHC harvest strategy policy showing the separation of scale and distribution of fishing mortality. The "decision step" is when policy and decision making (not a procedure) influences the final mortality limits.

3 Goals and Objectives

Defining goals and objectives is a necessary part of a management strategy evaluation (MSE) which should be revisited often to make sure that they are inclusive and relevant. The MSAB originally developed five goals with multiple objectives for each (Tables A1–A5 in Appendix A). Performance metrics have also been developed from the goals and objectives by defining a measurable outcome, a probability (i.e. level of risk), and time-frame over which it is desired to achieve that outcome. Management procedures will be evaluated by determining which ones meet the objective (via the performance metric).

At MSAB011, the goals and objectives in Appendix A were discussed. It was determined that the goal "serve consumer needs" was not necessary at this time as it would be captured under the goal of "fishery sustainability and stability," and MSAB members appointed an *ad hoc* working group to refine the objectives presented in Appendix A (IPHC-2018-MSAB011-R, paragraph 20). This *ad hoc* working group is currently refining the objectives to reflect the current objectives of the MSAB and Commission, reduce redundant objectives, and clarify and simply the objectives for evaluation. There is also an ongoing discussion of objectives related to distributing the stock, and these will be reflected in the refined objectives. Further refinements will occur after discussion at MSAB012, and as results are evaluated. Final objectives used to evaluate the harvest control rule will be presented to the Commission at AM095.

The concept of biological regions (Figure 2) was also discussed at MSAB011 and followed up at SRB012. The SRB agreed that the "defined bioregions (i.e., 2, 3, 4, and 4b described in paper IPHC-2018-SRB012-08) are presently the best option for implementing a precautionary approach given uncertainty about spatial population structure and dynamic of Pacific halibut" (IPHC-2018-SRB012-R, paragraph 31). Additional data collected and analyzed in the future may provide guidance on redefining biological regions that best represent spatial diversity and meet management needs.

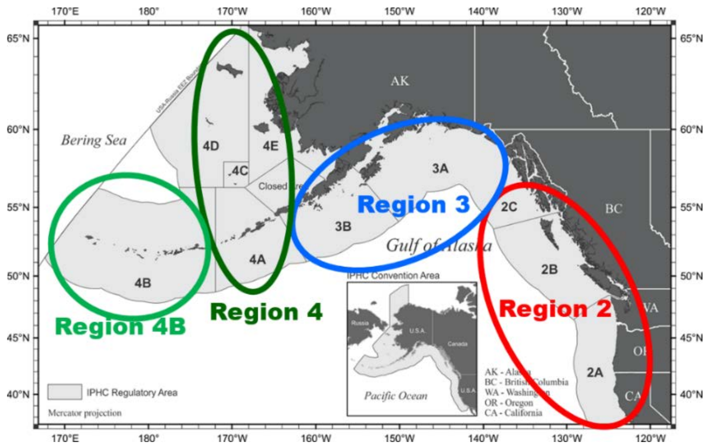


Figure 2:. Four biological Regions. They are overlayed on IPHC Regulatory Areas with Region 2 comprised of 2A, 2B, and 2C, Region 3 comprised of 3A and 3B, Region 4 comprised of 4A and 4CDE, and Region 4B comprised solely of 4B.

From this discussion on biological regions, the goal of preserving biocomplexity was considered. The SRB noted that biocomplexity is "poorly defined and not understood for Pacific halibut" (IPHC-2018-SRB012-R, paragraph 30). Additionally, "preserve" is not the appropriate term, because conservation is typically the goal of fisheries management. It was determined that conserving Pacific halibut stock structure across the entire range would be easily incorporated as objectives within the Biological Sustainability goal.

The MSAB agreed that the Commission should review and provide guidance on the revised goals to be presented at AM095 (IPHC-2018-MSAB011-R, paragraph 34).

4 SIMULATIONS

The framework of the closed-loop simulations is a map to how the simulations will be performed (Figure 3). There are four main modules to the framework:

1. The **Operating Model (OM)** is a representation of the population and the fishery. It produces the numbers-at-age, accounting for mortality and any other important processes. It also incorporates uncertainty in the processes and may be composed of multiple models to account for structural uncertainty.

2. **Management Procedure**

    a. **Monitoring (data generation)** is the code that simulates the data from the operating model that is used by the estimation model. It can introduce variability, bias, and any other properties that are desired.

    b. The **Estimation Model (EM)** is analogous to the stock assessment and simulates estimation error in the process. Using the data generated, it produces an annual estimate of stock size and status and provides the advice for setting the catch levels for the next time step. However, simplifications may be necessary to keep simulation times within a reasonable time.

    c. **Harvest Rule** is the application of the estimation model output along with the scale and distribution management procedures (Figure 1) to produce the catch limit for that year.

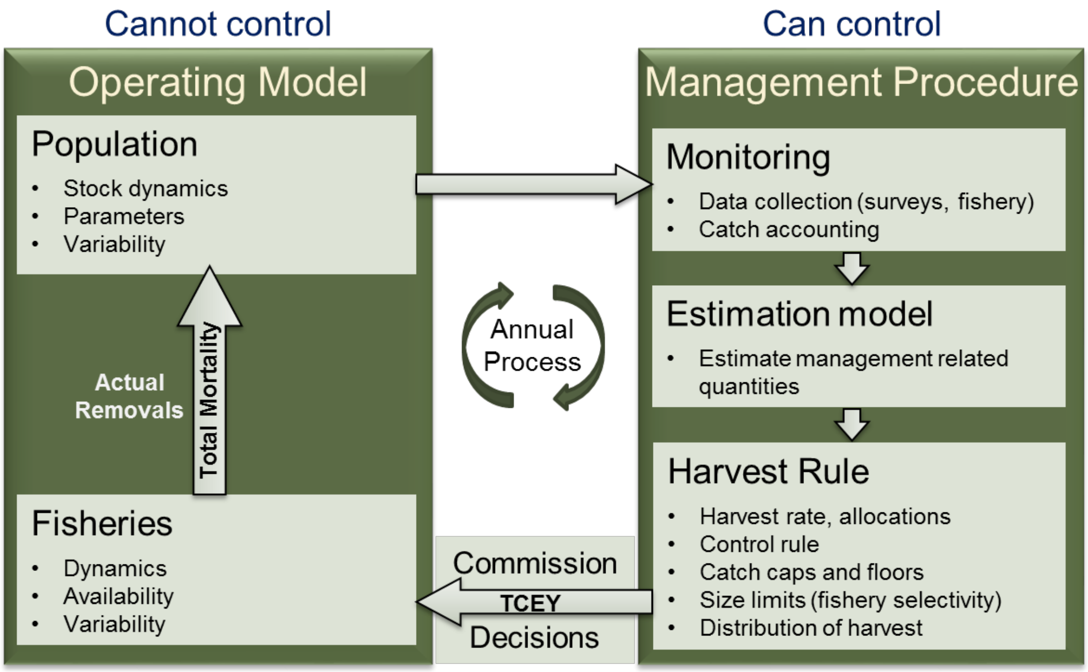


Figure 3: Diagram of the relationship between the four modules in the framework. The simulations run each module on an annual time-step, producing output that is used in the next time-step. See text for a description of operating model, monitoring, estimation model, and harvest rule.

4.1 Operating Model

For the simulations to investigate a coastwide fishing intensity, the stock synthesis (Methot and Wetzel 2013) assessment software was used as an operating model. This platform is currently used for the stock assessment, and the operating model was comprised of the two coastwide assessment models (short and long time-series) currently used in the ensemble. For future MSE evaluations (in particular, investigating the Distribution component of the harvest policy) a more complex operating model will be developed that can provide outputs by defined areas or regions and can account for migration between these areas. This model has been referred to as a multi-area model.

The current stock assessment ensemble, composed of four different assessment models, includes a cross between coastwide or fleets-as-areas structuring of the data, and the length of the time series. Using an areas-as-fleets model would require generating data and distributing catch to four areas of the coast, which would involve many assumptions. In addition, without a multi-area model, there would not be feedback from migration and productivity of harvesting in different areas. Therefore, only the two coastwide models were used, but with additional variability. These models are structured to use five general sources of removals (these are aggregated for modelling purposes and do not necessarily correspond to specific fisheries or sectors): the directed commercial halibut fishery (including research landings), commercial discard mortality (previously known as wastage), bycatch (from non-halibut-target fisheries), recreational, and subsistence. The TCEY was distributed to each source in an ad hoc manner using current available information (see below).

4.1.1 Conditioning the Operating Model

The operating model (OM) should be a reasonable depiction of reality with an appropriate level of uncertainty, which is accomplished through a process called conditioning. The operating model (OM) consists of two Stock Synthesis, or SS (Methot and Wetzel 2013), models parameterized similarly to the short and long coastwide assessment models for Pacific halibut (Stewart 2015 appendix of RARA). Each SS model is conditioned by fitting to the same data used in the 2017 stock assessment (Stewart & Hicks 2018, documents 08-10). In order to evaluate and choose management procedures that are robust to uncertainty in the population, many assumptions in the assessment model were freed up to characterize a wider range of possibilities in the future. Table 1 shows the parameters that were different from the assessment models. Estimating natural mortality in both models and estimating steepness were the only processes changed from the assessment model when conditioning.

Table 1: Parameter estimation in the assessment and operating model.

Parameter	Assessment	OM
Natural Mortality (*M*)	Some estimated	All estimated without priors
Recruitment (lognormal devs)	Variability 0.6 (long) and 0.9 (short)	Same as assessment
Steepness (*h*)	Fixed at 0.75 (long) 0.9 (short)	Estimated variability introduced around assessment value

4.1.1.1 Characterizing Variability in Stock and Fishery Dynamics

Variability was characterized by the estimated variance-covariance matrix estimated automatically by inverting the Hessian within ADMB (http://www.admb-project.org/), which is the optimization software that SS uses. This provides the uncertainty for each estimated parameter, and its correlation with other parameters, given the data and assumptions. Using this variance-covariance matrix, sets of parameters were randomly generated from a truncated multivariate normal distribution. The truncation of parameter bounds was determined from the bounds entered in the SS model files. Some bounds (e.g., dev parameters) were infinite.

An alternative approach for characterizing variability is to design a grid over which different parameter values and assumptions are used. For example, different values of steepness could be chosen and simulations use those fixed values of steepness. Then, the simulations are combined across grid points. We are using the Hessian approach to integrate over a range of parameter values and account for correlation between parameters.

To ensure that parametrically sampling from using a multivariate normal distribution and the inverted Hessian produced similar results as the assessment SS models (the current best information for the historical trajectory), 1000 samples of the parameters estimated in the assessment models were generated from a multivariate normal distribution. Estimated recruitment deviations were bias-corrected by their corresponding estimated variances before sampling from the multivariate normal distribution. The mean spawning biomass trajectory and 95% confidence interval around that trajectory were compared to the assessment results and the long coastwide model showed an increased density of low spawning biomass compared to the assessment model (Figure 4). Trajectories with a maximum F greater than 0.4 were not within the 95% confidence interval determined from the inverted Hessian in assessment model, thus the sampling from the multivariate normal was limited to trajectories that had a maximum fishing mortality rate less than 0.4.

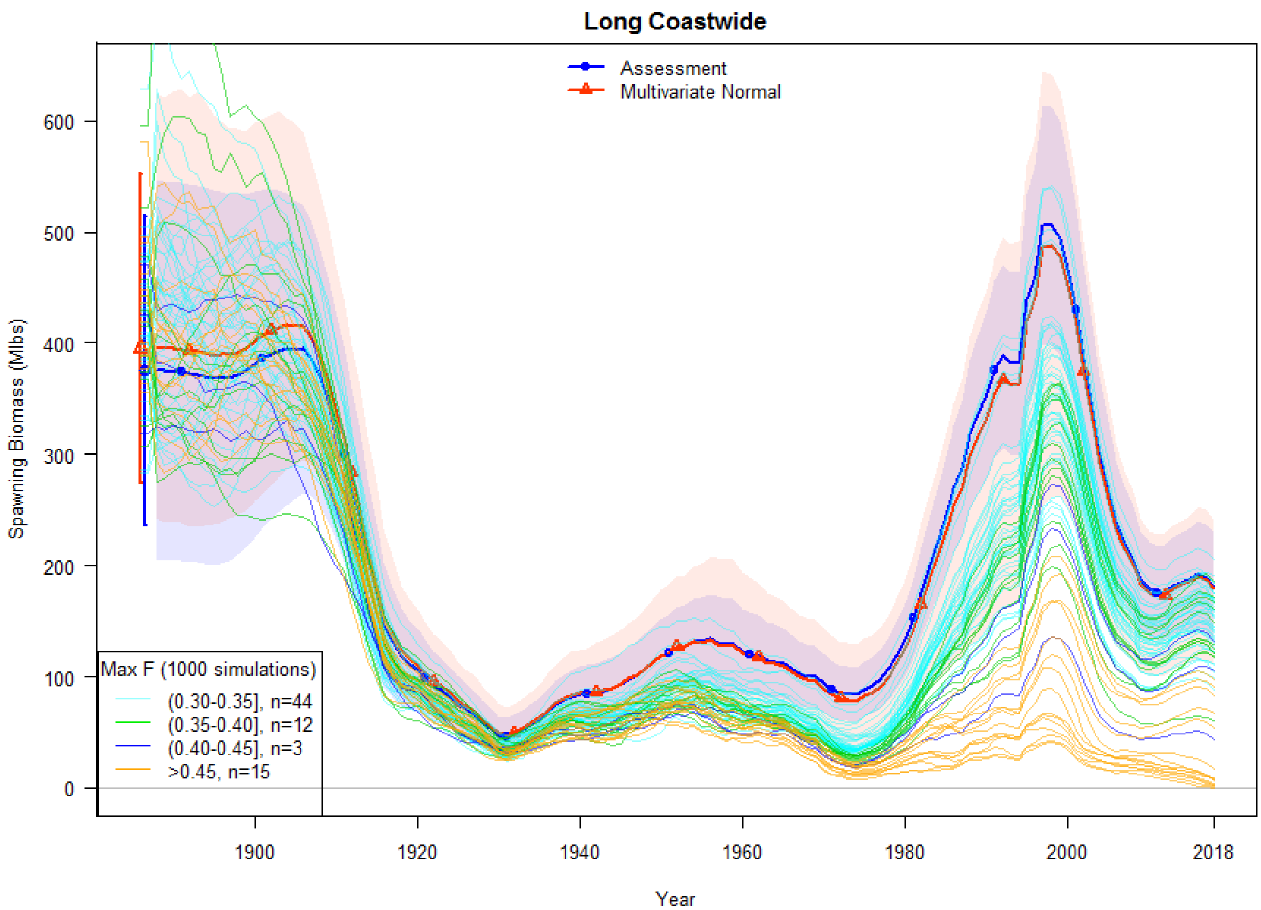


Figure 4: Mean spawning biomass trajectories from the long coastwide assessment model with 95% confidence range (blue) and the mean and 95% confidence range of 1000 samples from a multivariate normal using the parameter estimates and inverted Hessian from the long coastwide assessment model (red). Individual trajectories from specific samples that produced large maximum F values are also plotted with the number of trajectories for various ranges of F listed in the legend.

Implementing a maximum F of 0.4 when sampling from the multivariate normal distribution (only the long coastwide was limited as short coastwide showed fishing mortality rates lower than 0.2), the assessment was mimicked reasonably well by the sampled trajectories for the long and short coastwide models (Figure 2).

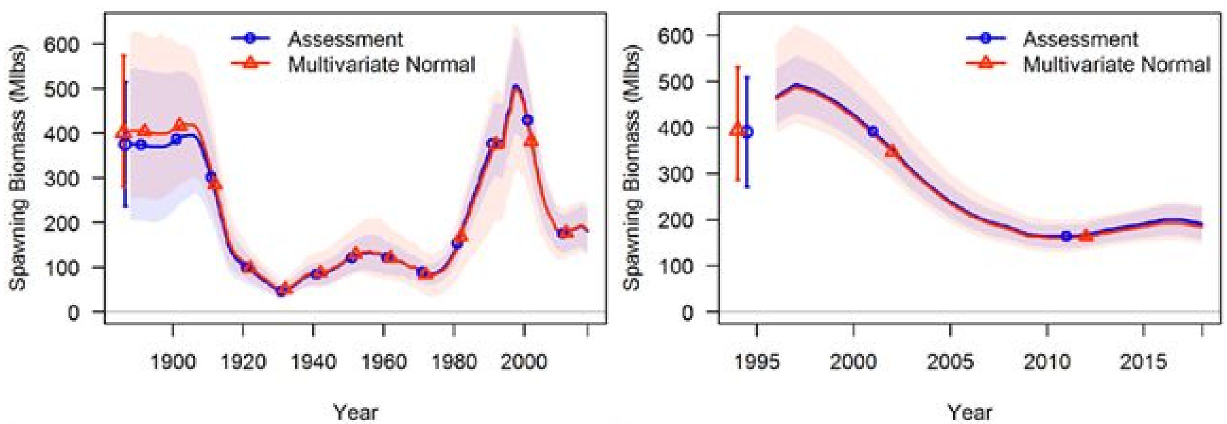


Figure 5: Median spawning biomass trajectories from the long coastwide (left) and short coastwide (right) assessment models with a 95% confidence range (blue) and the median and 95% confidence range of 1000 samples from a multivariate normal using the parameter estimates and inverted Hessian from each assessment model (red).

Estimating parameters that were fixed in the assessment may produce stock dynamics that are not consistent with the assessment. To condition the OM to match the assessment, but introduce additional variability, the following steps were performed.

1. Allow for the estimation of the additional parameters in the assessment models. For the long coastwide model, steepness was estimated without a prior. For the short coastwide model, female M was estimated without a prior (and the upper bounds on female and male M's were increased to 0.45) and steepness was estimated with a prior created from the results of the long coastwide model and assuming a normal distribution. A prior on steepness was used to keep steepness within a reasonable range and force the estimated standard deviation for the short coastwide OM to be similar to the standard deviation in the long coastwide OM (i.e., both operating models are sampling from the same steepness distribution). Without a prior, the estimated variability in steepness resulted in a nearly uniform distribution between 0.2 and 1.0. The prior is centered around 0.75 with a standard deviation of 0.084 (2.5th and 97.5th percentiles equal to 0.59 and 0.91, respectively). See Figure 6 and the following steps.
2. Use the estimated covariance from the models with the extra parameters estimated (full model), the variances from the assessment model, and the variance of the additional estimated parameters from the full model to build a covariance matrix. Use the point estimates from the assessment model with that covariance matrix to sample from a multivariate normal distribution. This keeps the full model's predictions near the assessment model, but introduces extra variability accounting for correlation between estimated parameters.
3. Run the SS model using the sampled parameters, but without estimation to predict the historical population dynamics.
4. Eliminate the simulation if the maximum exploitation rate is greater than 0.4 in any year, or if the spawning biomass drops below 100 pounds in any year.
5. Repeat 2 through 4 as many times as necessary to create 1000 simulated trajectories.

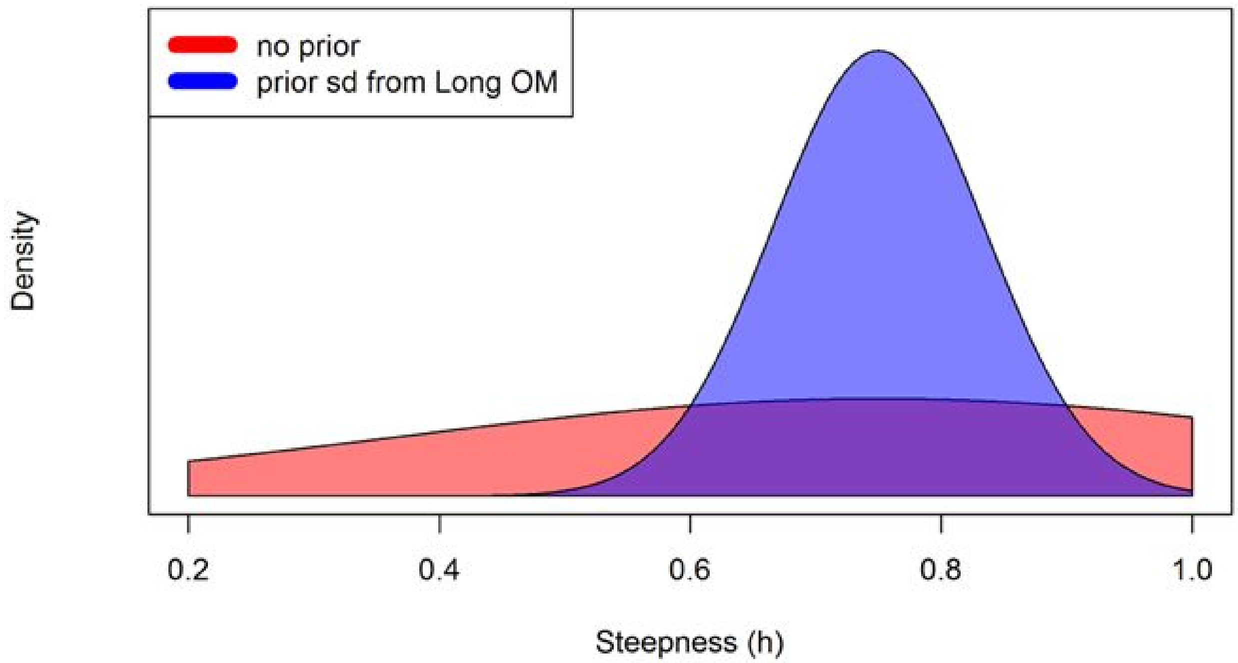


Figure 6: Steepness Normal distributions centered around 0.75 using the standard deviations estimated without a prior in the short coastwide model (red) and with a prior determined from the long coastwide operating model (blue).

4.1.1.2 Long coastwide operating model

Steepness was the only additional parameter in the long coastwide operating model, compared to the assessment, that had variability. Steepness was centered on 0.75, as in the assessment, even though the estimated value of steepness was 0.9463, but the estimated variance (standard deviation = 0.08376) and covariances were used. The normal distribution of steepness, from which values were sampled, can be seen as the blue curve in Figure 6, and the estimated value (0.9463) is the 88th percentile in this distribution.

The parameters, including steepness centered around 0.75, were sampled from a multivariate normal distribution to create 1000 parameter vectors, each used to create a population trajectory. Trajectories that showed a maximum exploitation rate greater than 0.4 at any point in the time series were eliminated and parameters were re-sampled until 1000 acceptable parameter vectors were found. In total, 399 parameter draws were eliminated in the process. The final 1000 trajectories of historical spawning biomass from the operating model are compared to the assessment in Figure 7.

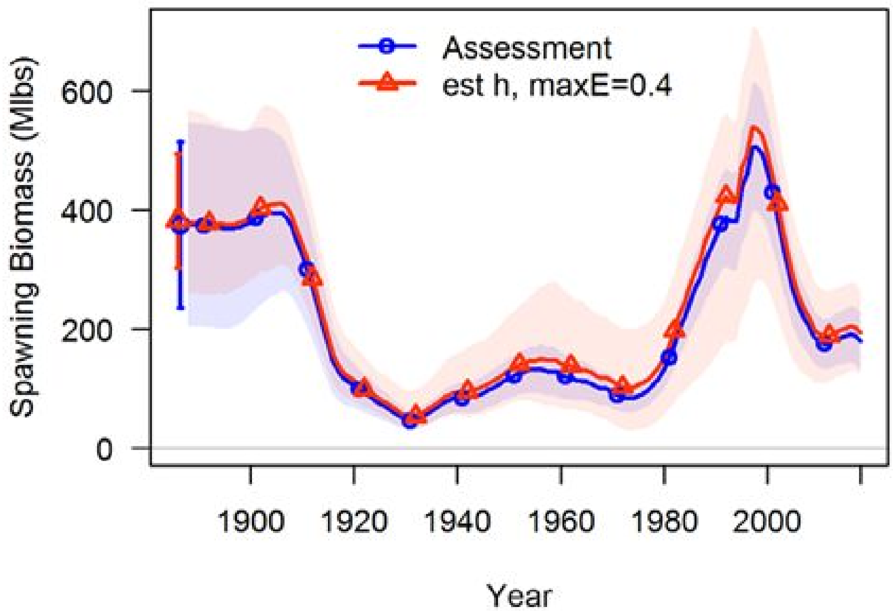


Figure 7: Predicted median biomass trajectories with 95% confidence intervals for the long coastwide assessment model (blue) and the long coastwide operating model (red).

The median spawning biomass in the operating model is slightly greater than the assessment model. This is an effect of using a parametric bootstrap and adding the variability on steepness, even though the distribution of steepness was centered on the assessment value of 0.75. There are a number of reasons that the median of the operating model is slightly greater than the assessment model.

1. The distribution of spawning biomass from the operating model is broader and not necessarily symmetric, whereas the assessment model uses a point estimate (maximum likelihood) and an assumption that the variability in spawning biomass is characterized by a normal distribution.
2. The threshold maximum exploitation rate of 0.4 eliminates some low trajectories.
3. The covariances in the variance-covariance matrix used to characterize the normal distribution are from the full model (with steepness estimated) and are different than the covariances estimated in the assessment model. The variances of the parameters estimated in the assessment model are from the assessment model in the variance-covariance matrix used for sampling. Even setting the variance and covariances of the steepness parameter to zero in the variance-covariance matrix for sampling resulted in a median spawning biomass trajectory slightly above the assessment for most of the time-series, although it was similar to the assessment in recent years.

The 2018 point-estimate of spawning biomass from the assessment is the 36th percentile of the distribution of 2018 spawning biomass in the operating model (see Figure 8).

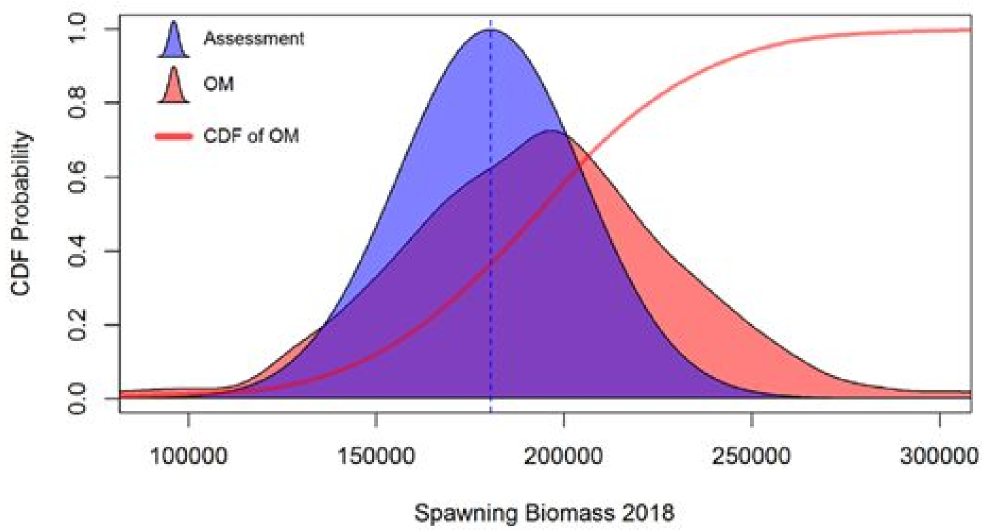


Figure 8: Predicted distributions of 2018 spawning biomass for the long coastwide assessment model (blue) and the long coastwide operating model (OM, red). The cumulative distribution function (CDF) of the OM distribution and the median of the assessment 2018 spawning biomass (dashed blue line) are also shown.

4.1.1.3 Short coastwide operating model

Steepness and female natural mortality were the additional parameters in the full short coastwide model, compared to the assessment, that had variability. Steepness was centered on 0.75, as in the assessment, even though the estimated value of steepness (without a prior distribution) was 0.43. A prior was put on the steepness parameter (normal with a mean of 0.75 and a standard deviation of 0.08376, from the long coastwide model estimate of steepness), as discussed above, to make it have a similar distribution as the long coastwide model (see Figure 6). Female natural mortality was estimated without a prior, but the upper bound was extended to 0.45 because the estimate was 0.35. The upper bound on male natural mortality was also extended to 0.45 and its estimate was 0.26.

The estimated variances and covariances of steepness and female natural mortality were used, along with estimated variances and covariances from the assessment model for other parameters, to characterize the variance-covariance matrix used in the multivariate normal distribution from which parameters were sampled. The estimated standard deviations for steepness and female natural mortality were 0.08399 and 0.00864, respectively. The means for the multivariate normal distribution were the estimated or fixed values from the assessment (i.e., h = 0.75 and female M = 0.15).

The parameters, including steepness, were sampled from a multivariate normal distribution to create 1000 parameter vectors, each used to create a population trajectory. Trajectories that showed a maximum exploitation rate greater than 0.4 at any point in the time series were eliminated until 1000 parameter vectors were obtained. In total, 68 parameter draws were eliminated. The final 1000 trajectories of historical spawning biomass from the operating model are compared to the assessment in Figure 9.

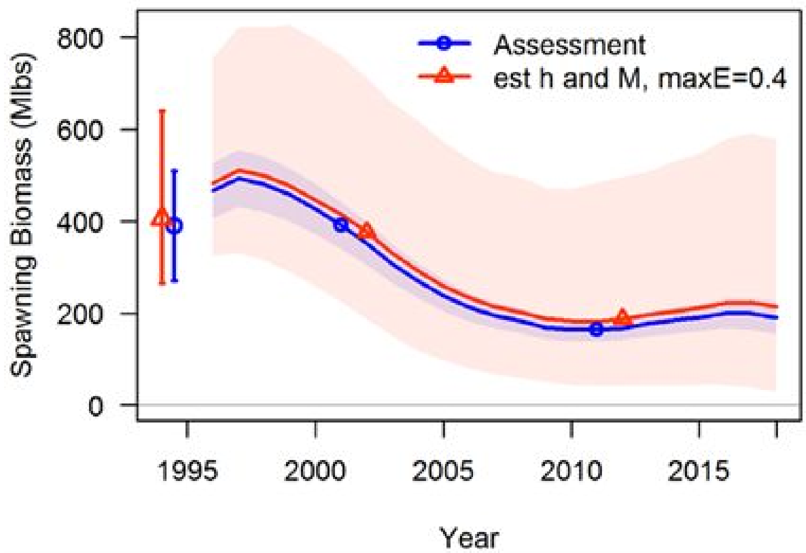


Figure 9: Predicted median biomass trajectories with 95% confidence intervals for the short coastwide assessment model (blue) and the short coastwide operating model (red).

The median spawning biomass in the operating model is slightly greater than the assessment model. This is an effect of using a parametric bootstrap and adding the variability on steepness and female natural mortality, even though the distributions of these parameters were centered on the assessment values. This occurs for a number of reasons, as outlined above when discussing the long coastwide model.

The 2018 point estimate of spawning biomass from the assessment is the 44th percentile of the distribution of 2018 spawning biomass in the operating model (see Figure 10).

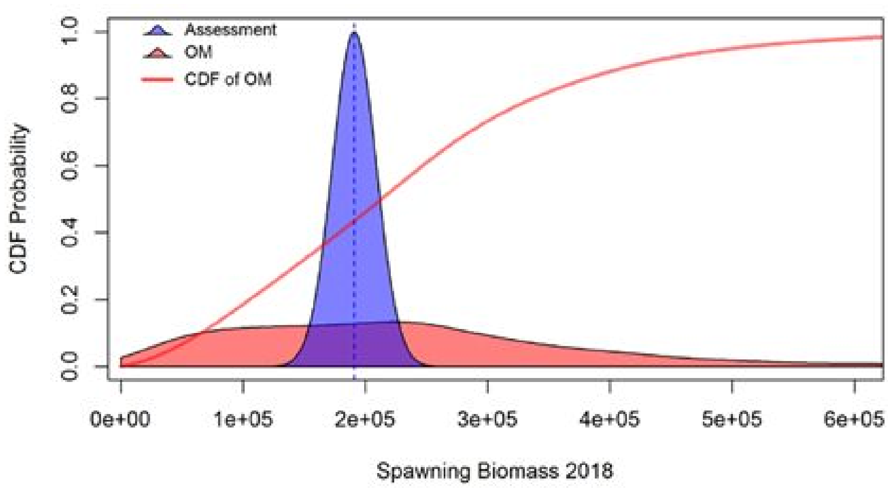


Figure 10: Predicted distributions of 2018 spawning biomass for the short coastwide assessment (blue) and the short coastwide operating model (OM, red). The cumulative distribution function (CDF) of the OM distribution and the median of the assessment 2018 spawning biomass are also shown.

4.1.1.4 Summary of conditioned operating models

Overall, the individual operating models mimic the assessment well, but with additional uncertainty. The presence of a slightly higher median spawning biomass in the individual operating models is not a concern because the MSE is focused on ranking procedures and is not meant to predict the exact quantities. The most important aspect is to characterize variability and the dynamics of the stock. The variability in the short coastwide model is much greater than in the long coastwide model, and is a large contributor to the overall variability, in recent years, of the operating model consisting of the combination of the two individual models (Figure 11). When comparing the combined operating model to the ensemble assessment, the median spawning biomass trajectories are similar, but the variability in the operating model is much greater than the ensemble assessment (Figure 11).

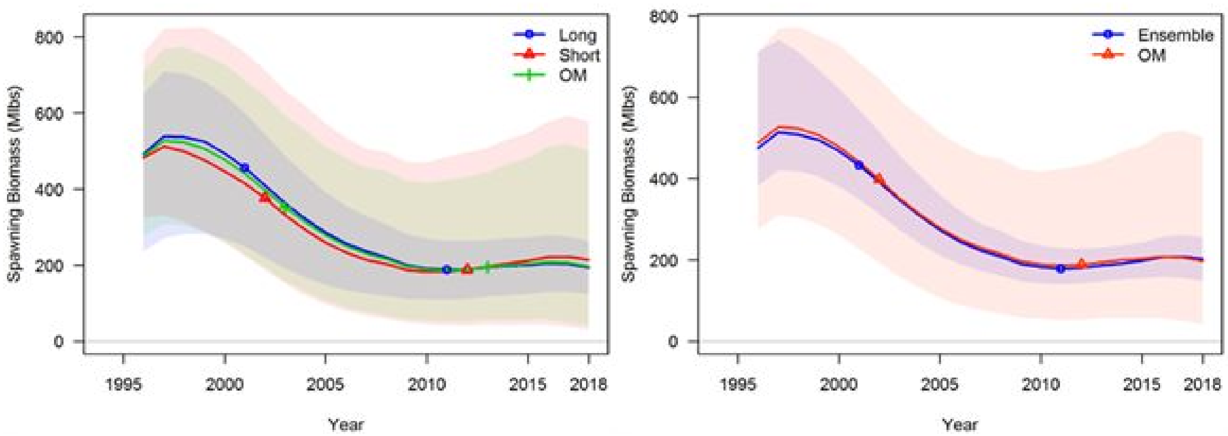


Figure 11: The conditioned operating model (red) compared to the stock assessment ensemble (blue) with 95% confidence intervals on each.

The historical simulated trajectories were examined for evidence of “quasi-extinction”, which can be defined as a trajectory that reaches a value low enough that it would unlikely recover (in reality). That low value is not defined, so we compared simulated trajectories of spawning biomass to observed total mortality from all fisheries (Figure 12). The spawning biomass was generally low from around 1920 to 1980, and again in recent years. Especially low spawning biomass occurred near 1930 and 1975, and in recent years in the short coastwide model. The observed total mortality from fishing overlaps the lower trajectories around these low points, even with a maximum exploitation rate of 0.4. This can occur because the fishing mortality is partially composed of immature, young fish. Overall, some spawning biomass trajectories are surprisingly low, but it does not appear that quasi-extinction is apparent.

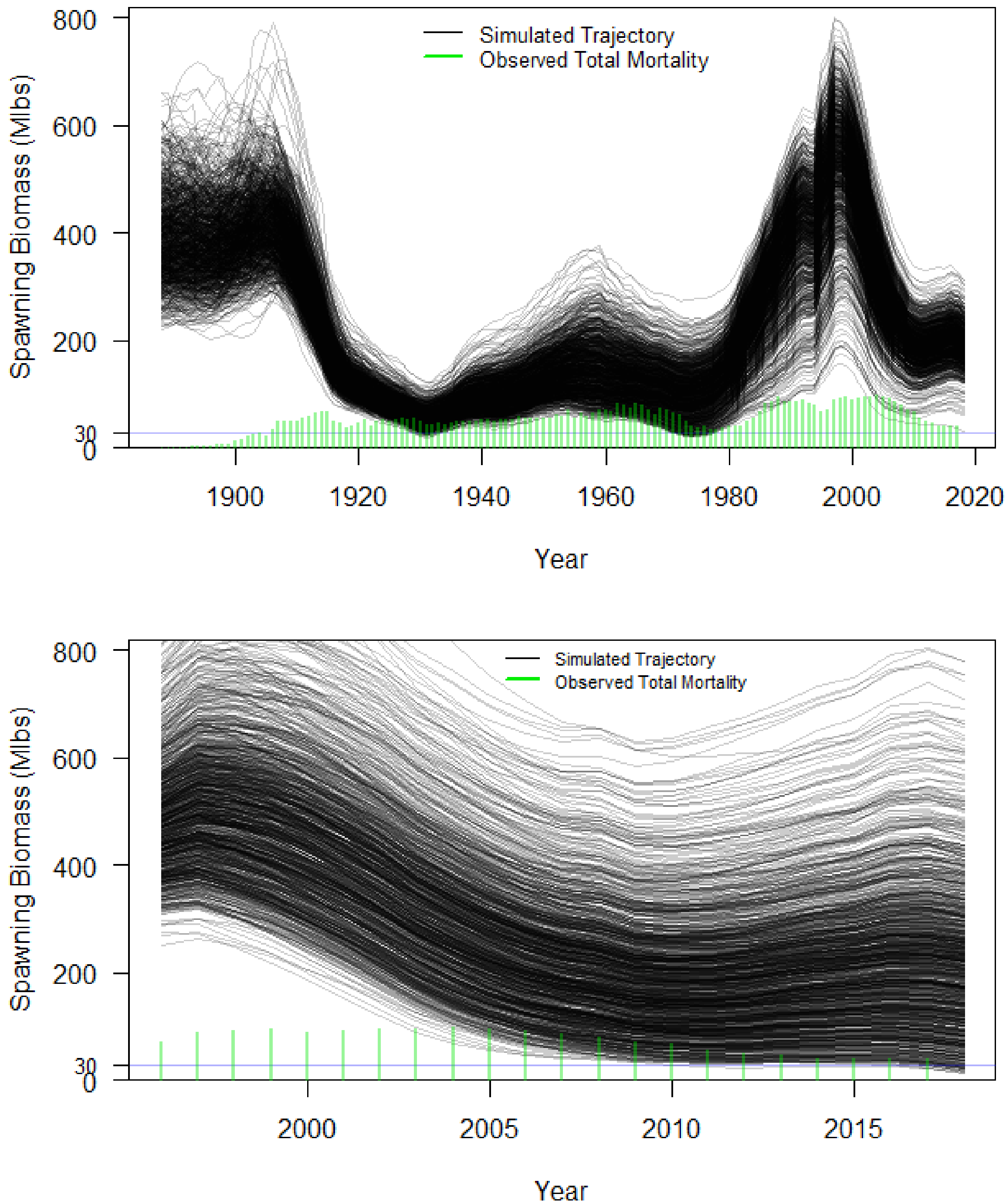


Figure 12: Historical simulated trajectories of spawning biomass (M lbs) from the long coastwide operating model (top) and the short coastwide operating model (bottom). Observed total mortality (M lbs) from all fisheries is shown by the green histogram bars. A horizontal line at 30 million pounds is drawn for reference.

4.1.2 Simulating Forward with the Operating Model

The short and long coastwide models make up the operating model and incorporate variability associated with estimated parameters describing stock and fishery dynamics. Variability from other sources (e.g., weight-at-age, recruitment regimes, and allocation to fishery sectors) was introduced when projecting into the future. Descriptions of these procedures are provided in IPHC-2017-MSAB010-09 Rev1, and updates to the procedures are described here.

4.1.2.1 Allocating the Total Mortality to Fishery Sectors

There are five fishing sectors in simulations, as is defined in the coastwide assessment models. These are a commercial fishery, a discard mortality from the commercial fishery, a recreational fishery, bycatch mortality, and a subsistence fishery. The changes to the methods used to allocate total mortality to these five sectors are described below.

Bycatch Mortality

Bycatch mortality across all IPHC Regulatory Areas (Figure 13) has been declining since a peak in 1992 of 20 million pounds (~9,000 t). In 2017, bycatch mortality was estimated to be 6.0 million pounds (~2,700 t), which is due to industry measures to reduce bycatch as well as reductions in the Pacific halibut stock.

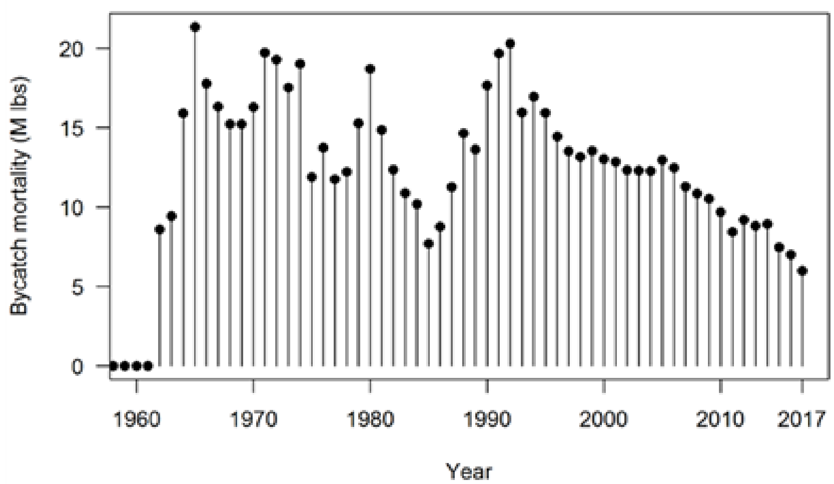


Figure 13: Observed bycatch mortality.

A look at the historical relationship between bycatch mortality and total biomass was done to predict how bycatch may change with changes in Pacific halibut biomass. Before 1997 bycatch increased greatly with little change to total biomass (Figure 14) and after 2014 the bycatch dropped substantially with little change in total biomass (likely due to the industry specified protocols to reduce bycatch, such as deck sorting in the Amendment 80 trawl fleet). Therefore, using bycatch mortality from 1997 to 2014 and estimating the relationship with total biomass, the predicted slope of the line is 0.004. This is interpreted as each pound increase in total biomass results in a 0.4% increase in bycatch mortality. However, in the past three years, the bycatch mortality has declined from approximately 9 million pounds (4,000 t) to 6 million pounds (2,700 t) with little change in total biomass, thus the prediction line should reflect the efforts to reduce bycatch mortality, and the intercept was shifted to match the 2017 observations of bycatch mortality and total biomass (Figure 14). The predicted total biomass in 2017 was 848 million pounds (385 thousand t) which shifts the line downward by 3.4 million pounds to current bycatch levels but retains the relationship (change in bycatch) with total biomass.

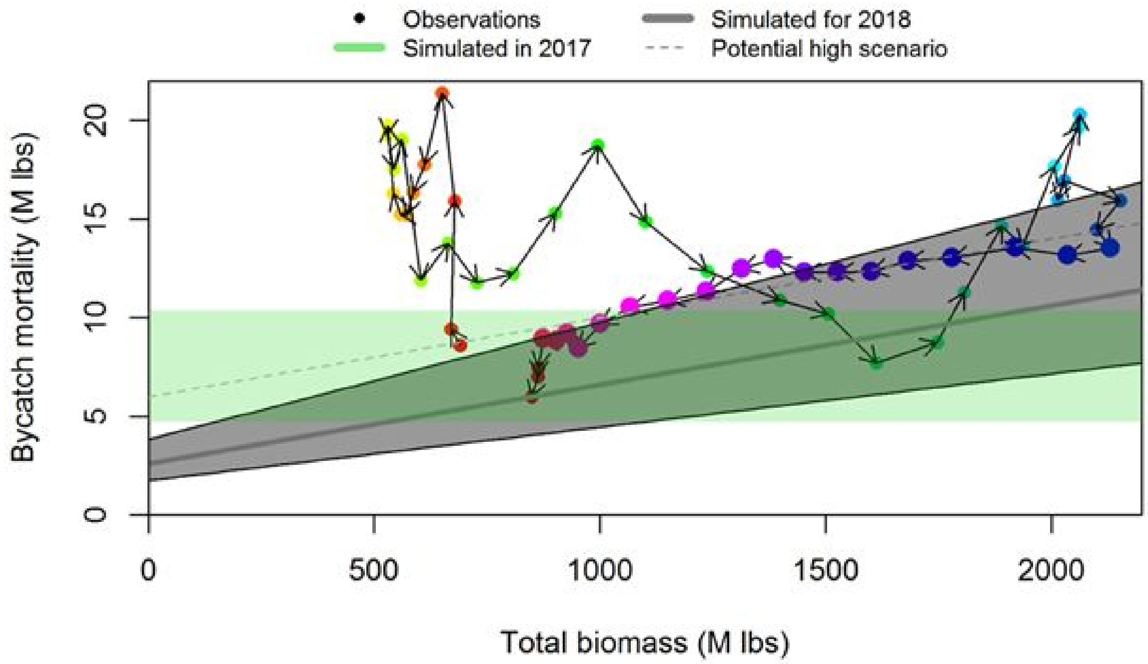


Figure 14: Bycatch mortality (colored dots) plotted against estimated total biomass from the 2017 stock assessment. Arrows and colors show the sequence of time. The years 1997 to 2014 are shown by larger dots. The light green area shows the range of bycatch that was simulated from a lognormal distribution for 2017 MSE results, and did not change with total biomass. The grey areas shows the updated lognormal distribution for simulated bycatch that is a function of total biomass. The dashed line shows the mean of a potential high scenario for simulating bycatch.

A potential high bycatch scenario would be to use the original intercept of 6, which creates a line passing through the 1997-2014 observations (Figure 2, dashed line).

The previous CV on bycatch was 0.2 with a constant mean bycatch regardless of total biomass. This CV was kept to maintain the unpredictability of bycatch in the future.

Recreational mortality

A recommendation from MSAB012 was to modify the recreational allocation so that it kept increasing as the biomass (or TCEY) increased (REF to paragraph). Therefore, recreational mortality was investigated, and a constant proportion of the total mortality was used for allocation. To determine the proportion, the last five years (2013-2017) were used to determine the mean proportion, which was 0.18. The error on the proportion was set to capture the range of proportions observed over the past five years, resulting in a CV of 0.01. Figure 15 shows the recreational mortality and the proportion of recreational mortality plotted against the total mortality, as well as the simulated mean and range.

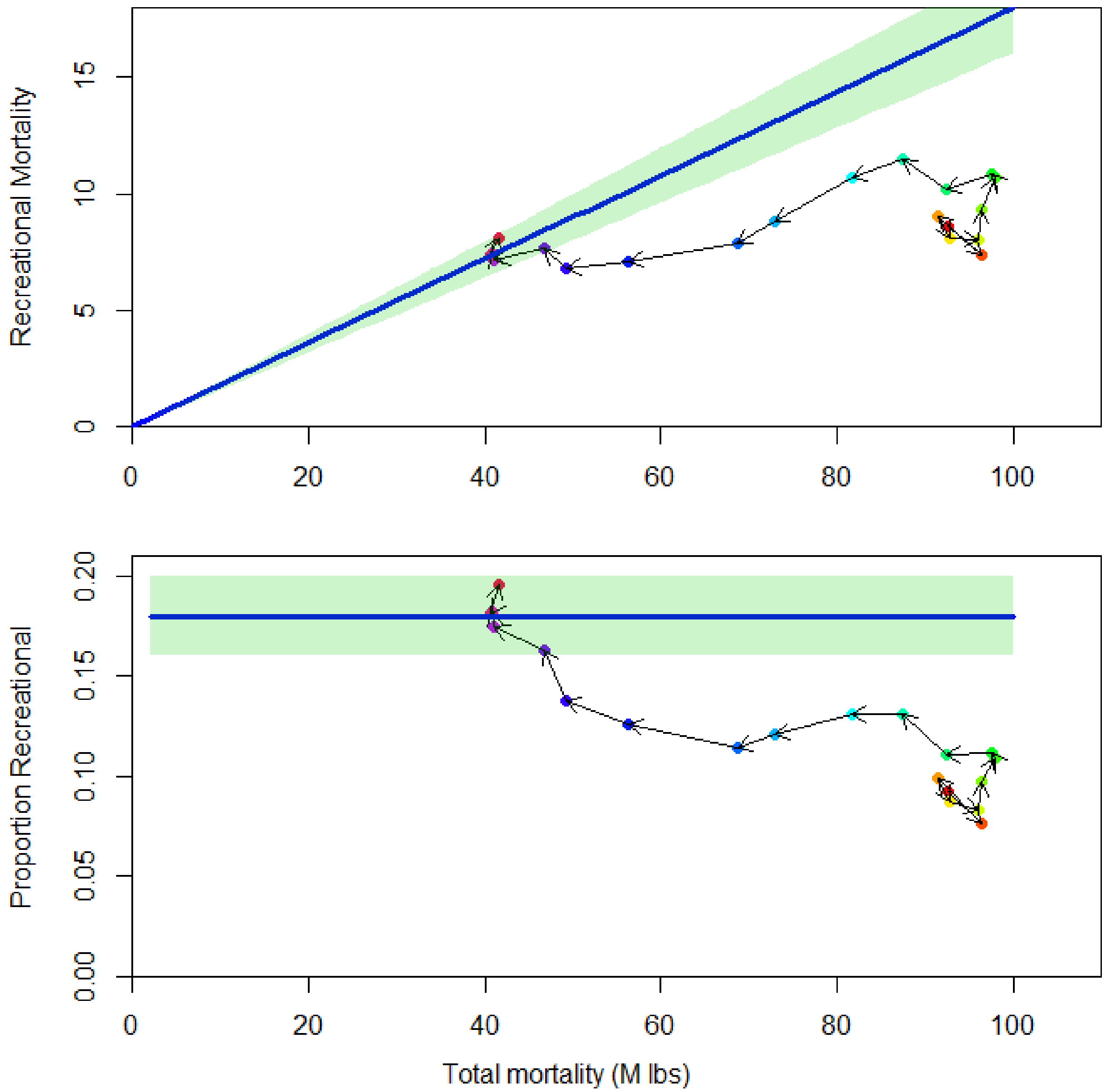


Figure 15: Recreational mortality (top) and the proportion of recreational mortality (bottom) plotted against the total mortality, as well as the simulated mean (blue line) and range (green area). Arrows show the sequence of time.

The resulting average allocations are shown in Figure 16.

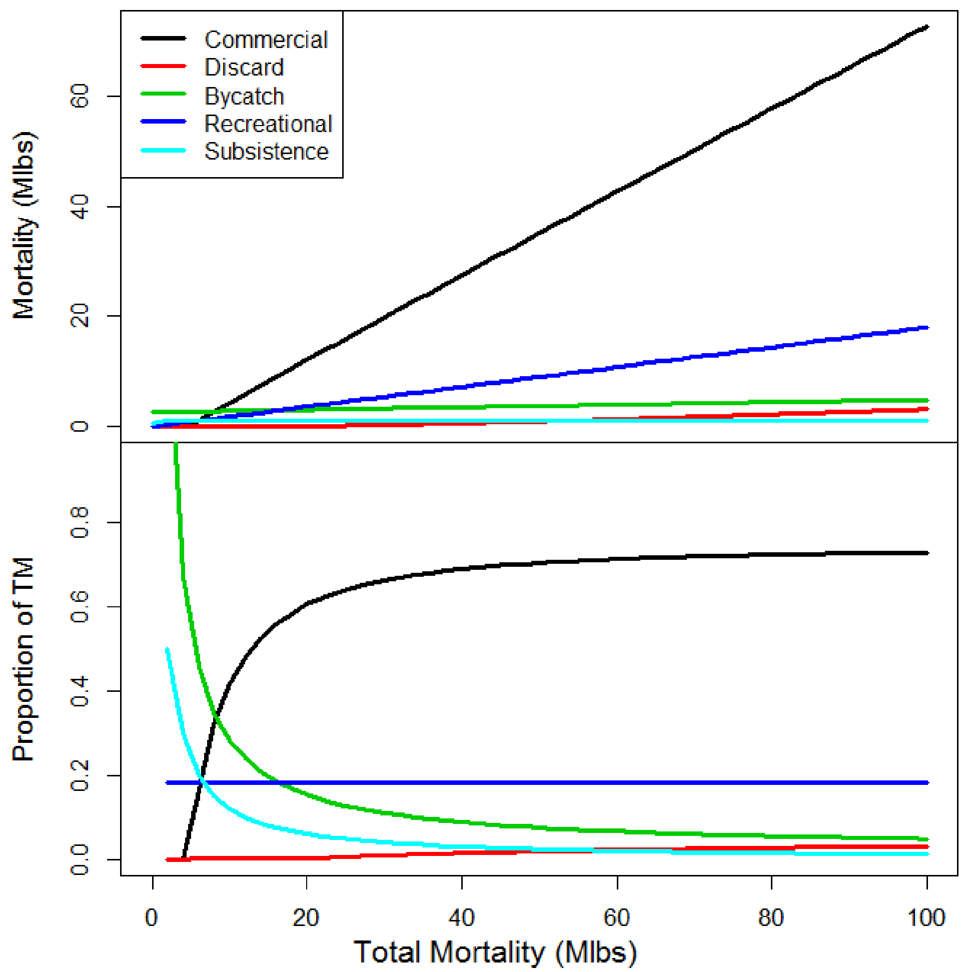
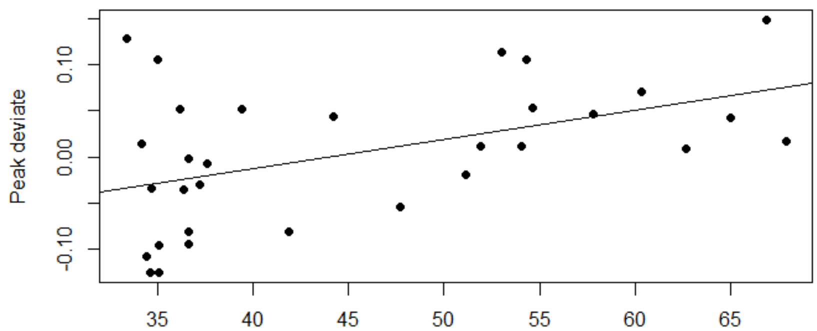


Figure 16: Average allocations in terms of mortality (top) and proportion (bottom) for the five fishing sectors. Bycatch allocation is a function of total biomass, and it was assumed that total mortality is 17.5% of total biomass (based on estimates from 1998–2017).

4.1.2.2 Variability in Commercial Selectivity

Commercial selectivity varies annually in the stock assessment model through estimated deviations on the ascending width and peak parameters of the double normal paramterization. This time-varying concept is retained in the operating model and it is easy to simply generate random deviates for the selectivity parameters. However, it is likely that selectivity varies because of the behavior of another process, such as weight-at-age. It is proposed to make selectivity vary with changes to weight-at-age.

Random walk deviates are estimated for the ascending width and peak parameters of the double normal parameterization for female selectivity. Male selectivity is tied parametrically to the female selectivity, thus it also varies in time without any additional estimated deviates. Therefore, the relationship between the deviates and the weight for a specific age was investigated. Using female weight at age 17 showed a positive relationship with the deviates (Figure 17) and some of the highest R^2 values for the relationship using different ages (22.6% for the peak deviations and 44.5% for the ascending limb deviations)



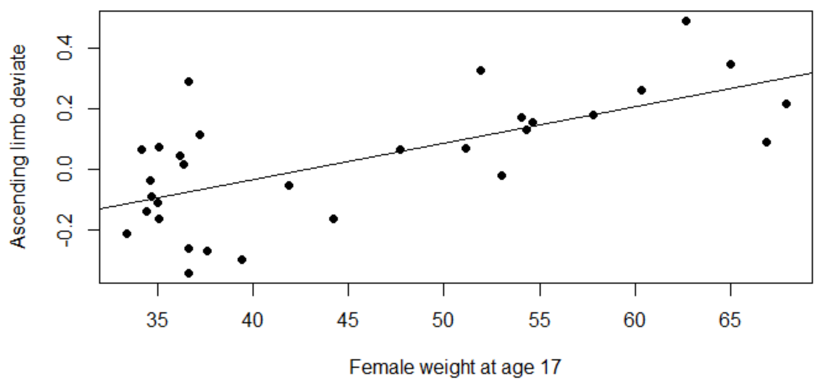


Figure 17: Selectivity deviates plotted against female weight at age 17.

It is proposed to randomly draw the selectivity deviates from a normal distribution with a mean that is a function of the female weight at age 17.

4.2 MANAGEMENT PROCEDURE

The elements of the management procedure are described in reverse order because it is easier to understand the decisions made for modelling them since they are dependent on each other. Therefore, the harvest rule is presented first, followed by the estimation model, and finishing with monitoring.

4.2.1 Harvest Rule

The generalized management procedure to evaluate is shown in Figure 1, but the focus will be on the Scale portion to produce results for the MSAB to evaluate before AM095 in 2019. Specifically, the portion of the management procedure being evaluated is a harvest control rule (Figure 18) that is responsive to stock status and consists of a procedural SPR determining fishing intensity, a fishery trigger based on stock status that determines when the fishing intensity begins to be linearly reduced (note that this may differ from the biological threshold), and a fishery limit that determines when there is theoretically no fishing intensity (this may differ from the biological limit). For these simulations, the two coastwide models were used, thus mortality only needed to be distributed to the five coastwide sources of mortality (directed commercial, discard mortality, bycatch mortality, recreational, and subsistence).

Simulations have been used in the past to evaluate a range of SPR values from 25% to 60% and trigger values of 30% and 40% (IPHC-2017-MSAB10-09 Rev 1). Those simulations provided insight into how those different levels of SPR would meet the objectives defined by the MSAB, but few values of SPR below 40% were tested. Future simulations will use a finer resolution of SPR values ranging from 30% to 56% and fishery trigger points of 30% and 40% (with the addition of 45% if time allows).

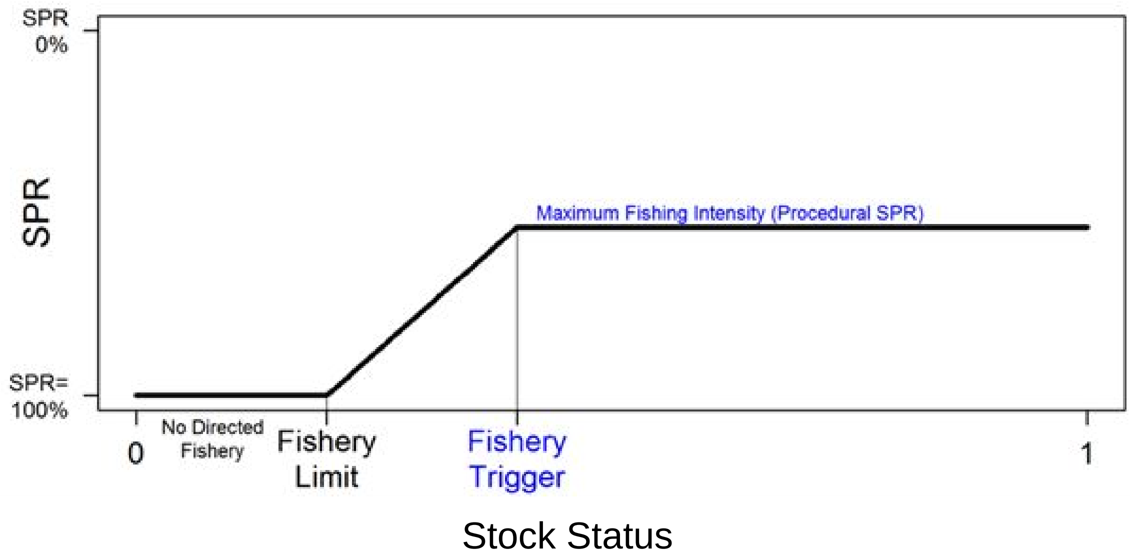


Figure 18: A harvest control rule responsive to stock status that is based on Spawning Potential Ratio (SPR) to determine fishing intensity, a fishery trigger level of stock status that determines when the fishing intensity begins to be linearly reduced, and a fishery limit based on stock status that determines when there is theoretically no fishing intensity (SPR=100%). In reality, it is likely that only the directed fishery would cease. The Procedural SPR and the Fishery Trigger (in blue) are the two values to be evaluated.

4.2.2 Estimation Model

Two options to simulate an estimation model will be used: the No Estimation Model (previously called Perfect Information) option, as was used in past simulations, and the Simulate Error option. The No Estimation Model method assumes that the population values needed to apply the management procedure are exactly known (e.g., spawning biomass). This option is useful as a reference to better understand the performance with and without uncertainty in an estimation model. Due to time constraints, the only other option to be considered for simulations in 2018 is the Simulate Error option, which will be suitable to understand the effects of estimation error. This method is described below.

The harvest control rule contains two components that have estimation error. The first component is the estimated total mortality determined from the specified SPR. The second component is the estimated stock status that is used to reduce the fishing intensity when stock status is low (fishery trigger and fishery limit). These components are dependent on the estimated biomass, but it is more straightforward and computationally efficient to introduce error into these two components, rather than introducing error on the estimated biomass and then determining the resulting estimates of total mortality and stock status.

The 2017 stock assessment (Hicks & Stewart 2018) was used to determine a reasonable amount of variability in these two components and the correlation between them. Autocorrelation is currently being investigated and will also be implemented in the MSE simulation framework through a procedure that will introduce persistent time periods of negative or positive errors. At this time, bias will not be introduced, unless time allows for some sensitivities.

Overall, there are many assumptions in this incorporation of estimation error, but we are only trying to determine a reasonable amount of error for the simulations. Other levels of error will likely be simulated to determine how sensitive the results are to the estimation error.

4.2.3 Monitoring (Data Generation)

The simplified incorporation of estimation error will be used due to time constraints; thus no data are required to be generated. However, if a stock assessment were simulated, there would be many sources of data to generate.

4.3 SUMMARY OF THE FRAMEWORK

A summary of the major specifications for each component is provided below, with the components listed in a specific order where the next component is dependent on the decisions for the previous components.

1) Operating Model
    a) Stock synthesis, based on coastwide assessment models (short and long models).
    b) Five fleets, as in the assessment models (commercial, discards, bycatch, sport, personal use).
    c) Uncertainty incorporated through parameter uncertainty and model uncertainty. See Scenarios.
2) Management Procedure
    a) Estimation Models
        i) Perfect Information (as a reference if we knew population values exactly when applying the harvest rule).
        ii) Simulate error in total mortality and spawning biomass, with autocorrelation, from the simulated time-series to mimic an unbiased stock assessment.
    b) Data Generation
        i) Not needed at this time.
    c) Harvest Rule
        i) Coastwide fishing intensity (F_{SPR}) using a procedural SPR.
        ii) A fishing trigger to reduce the fishing intensity (increase SPR) when stock status is below a specified level.
        iii) A fishing limit to cease directed fishing when the stock status is less than a specified value (20%).
        iv) Catch assigned to sectors based on historical information (with variability).

5 Simulation Results

Using the simulation framework described above and in previous documents, test cases were first investigated to better understand the dynamics of the simulations. The simulations were done with no directed fishing, but with bycatch and subsistence fishing (approximately ranging from 4.5 million pounds to 12 million pounds), to investigate the nature of the projections and the presence, if any, of quasi-extinction. Additionally, projections with constant levels of weight-at-age and recruitment (low/high combinations) were done.

Figure 19 shows forward simulation results for the no fishing case with simulated variability in weight-at-age and simulated recruitment regimes. Only one-hundred trajectories were simulated, but it is clear that the entire range of variability is not captured until at least after 60 years. As also shown in the conditioning results, the short coastwide model had a wider range of variability. No simulated trajectory for the long coastwide model produced a spawning biomass less than 30 million pounds, and the minimum spawning biomass from all long coastwide model trajectories was near 60 million pounds, which occurred at time step 2. The short coastwide model produced four (out of 100) trajectories that had a spawning biomass less than 30 million pounds. Of these four, three of them started at a spawning biomass less than 30 million pounds, and all three recovered to levels above that. One trajectory started above 30 million pounds, but eventually crashed to zero.

Specific states of weight-at-age and the recruitment regime were simulated to investigate how these factors, and the combination of them, affect the simulated population trajectories. Low and high recruitment regimes were simulated by fixing the regime in the model at its low or high value since it is modeled as discrete low or high. Changes in weight-at-age are continuous, thus specific states had to be determined. Low, medium, and high states are determined by calculating the 15^{th}, 50^{th}, and 85^{th} percentiles of the historical weight-at-age (1935-2017) for each age, running a loess smoother through the specific quantile-at-ages, and then making sure it increases monotonically over age by predicting weight (from the loess model) for any ages that had a weight less than the weight at a younger age (Figure 20).

Using the low and high states of weight-at-age, crossed with the low and high recruitment regimes, and keeping them static for the entire simulation allowed for the investigation of these different factors as well as testing to make sure that they produced reasonable results. Figure 19 shows the simulated trajectories using the long coastwide model and the short coastwide model for the four different combinations. The long coastwide model was most influenced by weight-at-age, and each combination produced a well-defined band of trajectories. The short coastwide model showed more influence from recruitment with the high weight low recruitment scenario showing similar trajectories as the low weight high recruitment scenario. Some trajectories in the low weight low recruitment scenario showed quasi-extinction. In both models, the high recruitment regime resulted in more variability.

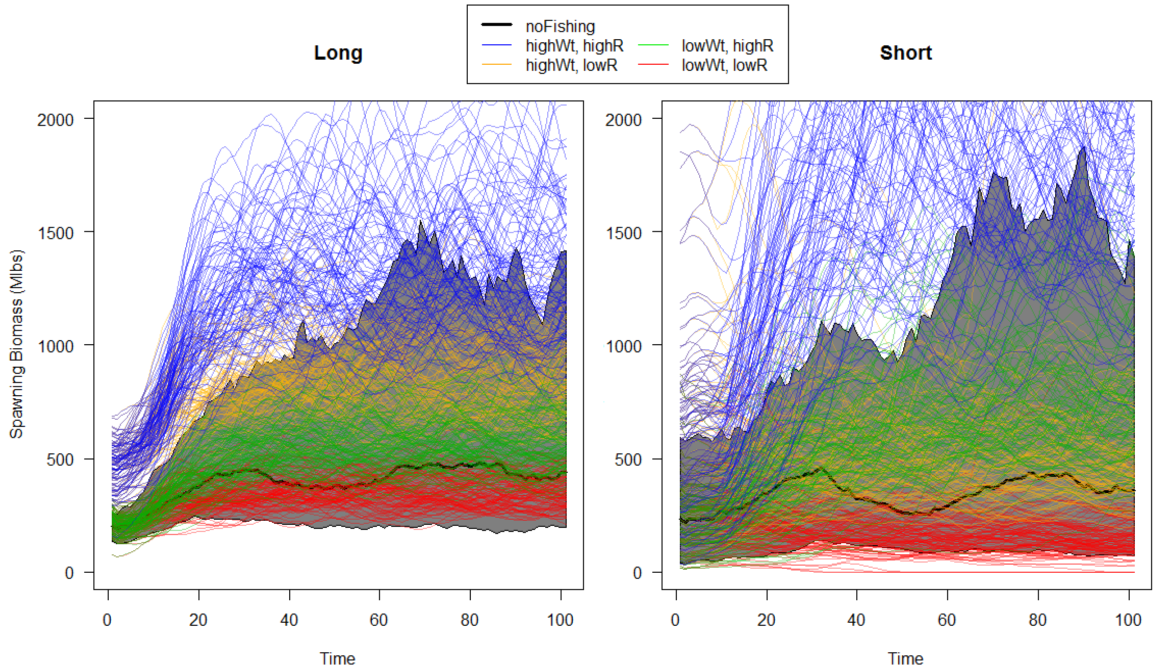


Figure 19: One-hundred forward simulated trajectories of spawning biomass without directed fishing. Bycatch mortality and subsistence mortality occurred (note, bycatch is simulated as a constant level with error for these trajectories). The gray area shows the range of simulations between the 2.5th and 97.5th percentiles with no fishing, but with simulated weight-at-age and simulated recruitment regimes. The individual lines of different colors show individual simulated trajectories with specific constant levels of weight-at-age and recruitment.

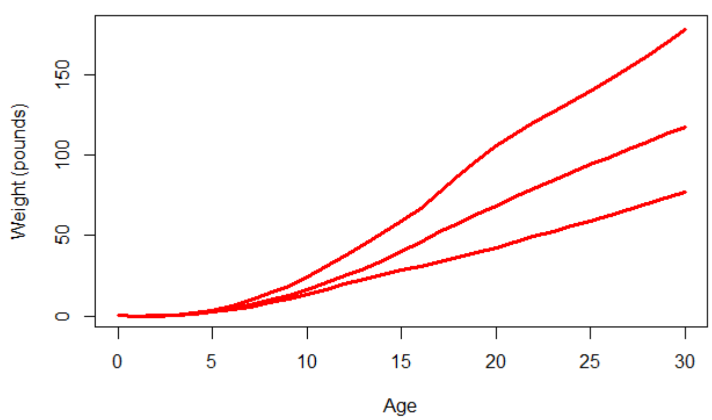


Figure 20: Plot of the low, medium, and high states of weight-at-age for testing.

Additional results will be presented at SRB013.

6 DISTRIBUTING THE TCEY

A considerable amount of discussion related to a description of the harvest strategy policy occurred at previous MSAB meetings. Figure 1 shows an updated depiction of the harvest strategy policy with terms describing the various components. These terms are defined in the IPHC glossary[1], but of note for this paper are TCEY distribution, stock distribution, and distribution procedures. The management procedure is the sequence of elements including the assessment, fishing intensity, stock distribution, and distribution procedures. The goal of the MSAB is to define a management procedure that will be used to output O26 mortality limits (TCEY) for each Regulatory Area that meet the long-term objectives of managers and stakeholders. The "decision" step on the right of Figure 1 is where a deviation from the management procedure may occur due to input from other sources and decisions of the Commissioners that may reflect current biological, environmental, social, and economic conditions.

In 2017, the Commission agreed to move to an SPR-based management procedure to account for the mortality of all sizes and from all fisheries. The procedure uses a coastwide fishing intensity based on spawning potential ratio (SPR), which defines the "scale" of the coastwide catch. This eliminates the use of EBio and area-specific absolute harvest rates. Therefore, there are currently two inputs to the current management procedure for distributing the TCEY among IPHC Regulatory Areas: 1) the current estimated stock distribution and 2) relative target harvest rates.

6.1 STOCK DISTRIBUTION

The IPHC uses a space-time model to estimate annual Weight-Per-Unit-Effort (WPUE) for use in estimating the annual stock distribution of Pacific halibut (Webster 2018). Briefly, observed WPUE is fitted with a model that accounts for correlation between setline survey stations over time (years) and space (within Regulatory Areas). Competition for hooks by Pacific halibut and other species, the timing of the setline survey relative to annual fishery mortality, and observations from other fishery-independent surveys are also accounted for in the approach. This fitted model is then used to predict WPUE (relative density) of Pacific halibut for every setline survey station in the design (including all setline survey expansion stations), regardless of whether it was fished in a particular year. These predictions are then averaged within each IPHC Regulatory Area, and combined among IPHC Regulatory Areas, weighting by the "geographic extent" (calculated area within the survey design depth range) of each IPHC Regulatory Area. It is important to note that this produces relative indices of abundance and biomass, but does not produce an absolute measure of abundance or biomass because it is weight-per-unit-effort scaled by the geographic extent of each IPHC Regulatory Area. These indices are useful for determining trends in stock numbers and biomass, and are also useful to estimate the geographic distribution of the stock.

6.2 USING RELATIVE HARVEST RATES

The distribution of the TCEY for 2018 was shifted from the estimated stock distribution to account for additional factors related to productivity and paucity of data in each IPHC Regulatory Area. Previously, this was accomplished by applying different harvest rates in western areas (16.125% in IPHC Regulatory Areas 3B, 4A, 4B, and 4CDE)) and eastern areas (21.5% in IPHC Regulatory Areas 2A, 2B, 2C, and 3A). However, with the elimination of EBio and the use of SPR-based fishing intensity to determine the coastwide scale, the TCEY, rather than the esoteric concept of exploitable biomass, was distributed. Therefore, an absolute measure of harvest rate is not necessary, but it may still be desired to shift the distribution of the TCEY away from the estimated stock distribution to account for other factors. Consistent with the previous approach, relative harvest rates were used with a ratio of 1.00:0.75, being equal to the ratio between 21.5% and 16.125%. This application shifted the target TCEY distribution away from the stock distribution by moving TCEY into IPHC Regulatory Areas 2A, 2B, 2C, and 3A and removing TCEY from IPHC Regulatory Areas 3B, 4A, 4B, and 4CDE (Table 1), thus harvesting at a higher rate in eastern IPHC Regulatory Areas.

[1] https://iphc.int/the-commission/glossary-of-terms-and-abbreviations

Table 1: IPHC Regulatory Area stock distribution estimated from the 2017 space-time model O32 WPUE, IPHC Regulatory Area-specific relative target harvest rates, and resulting 2018 target TCEY distribution based on the IPHC's 2018 interim management procedure (reproduced from Table 1 in IPHC-2018-AM094-11 Rev_1).

	2A	2B	2C	3A	3B	4A	4B	4CDE	Total
O32 stock distribution	1.7%	11.3%	16.6%	35.6%	10.0%	6.6%	4.8%	13.3%	100.0%
Relative harvest rates	1.00	1.00	1.00	1.00	0.75	0.75	0.75	0.75	--
Target TCEY Distribution	1.9%	12.4%	18.2%	38.9%	8.2%	5.4%	3.9%	10.9%	100.0%

6.3 REDEFINING THE DISTRIBUTION OF THE TCEY

TCEY distribution is the part of the management procedure for distributing the TCEY among Regulatory Areas and is composed of a purely scientific component to distribute the TCEY in proportion to its estimated biomass in each area (stock distribution) and steps to further modify the distribution of the TCEY based on additional considerations (distribution procedures). Those two components are described below.

6.3.1 Stock Distribution

Emerging understanding of Pacific halibut diversity across the geographic range of the Pacific halibut stock indicates that IPHC Regulatory Areas should only be considered as management units and do not represent relevant sub-populations (Seitz et al. 2017). Balancing the removals against the current stock distribution is likely to protect against localized depletion of spatial and demographic components of the stock that may produce differential recruitment success under changing environmental and ecological conditions. Biological Regions, defined earlier and shown in Figure 2, are considered by the IPHC Secretariat, and supported by the SRB, to be the best current option for biologically-based areas to meet management needs.

The overarching conservation goal for Pacific halibut is to maintain a healthy coastwide stock. However, given the wide geographic range of the Pacific halibut stock, there likely is stock structure that we do not fully understand, and this stock structure may be important to coastwide stock health. Therefore, conservation objectives relate to where harvesting occurs, with an objective to retain viable spawning activity in all portions of the stock. One method for addressing this objective is to distribute the fishing mortality relative to the distribution of observed stock biomass. This requires defining appropriate areas for which the distribution is to be conserved. Splitting the coast into many small areas for conservation objectives can result in complications including being cumbersome to determine if conservation objectives are met, being difficult to accurately determine the proportion of the stock in that area, being subject to inter-annual variability in estimates of the proportion, forcing arbitrary delineation among areas with evidence of strong stock mixing, and not being representative of biological importance. Therefore, Biological Regions represent the most logical scale over which to consider conservation objectives related to distribution of the fishing mortality. Adjusting the distribution of the TCEY among Biological Regions to account for additional considerations, and further distributing the TCEY to IPHC Regulatory Areas would be done through steps defined in the Distribution Procedures component (Figure 1).

In addition to using Biological Regions for stock distribution, the "all sizes" WPUE from the space-time model (Figure 21), which is largely composed of O26 Pacific halibut (due to selectivity of the setline gear), is more congruent with the TCEY (O26 catch levels) than O32 WPUE. Therefore, when distributing the TCEY to Biological Regions, the estimated proportion of "all sizes" WPUE from the space-time model should be used for consistency.

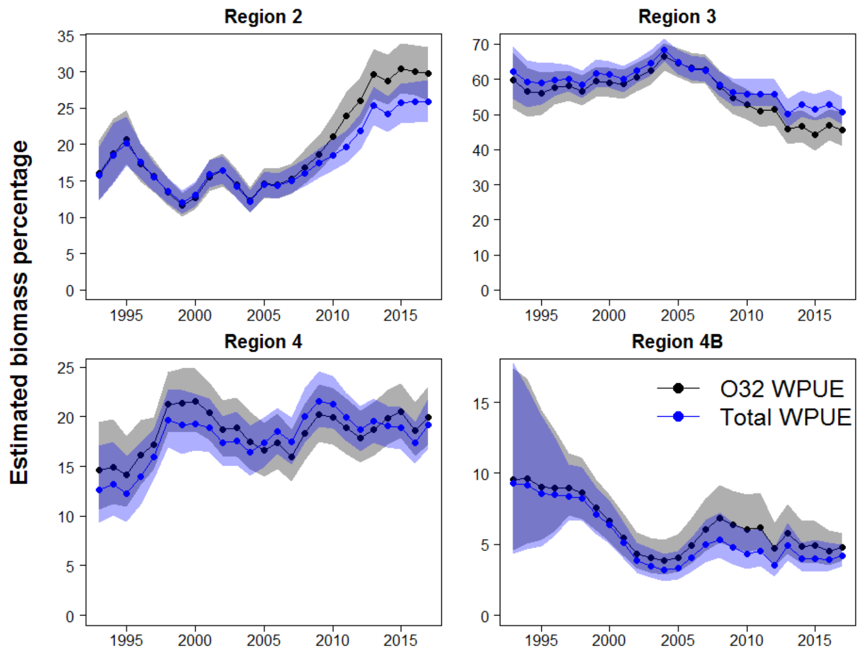


Figure 21: Estimated stock distribution (1993-2017) based on estimate WPUE from the space-time model of O32 (black series) and all sizes (blue series) of Pacific halibut. Shaded zones indicate 95% credible intervals.

6.3.2 Distribution Procedures

Distribution Procedures contains the steps of further modifying the distribution of the TCEY among Biological Regions and then distributing the TCEY among IPHC Regulatory Areas within Biological Regions (Figure 22). Modifications at the Biological Region or IPHC Regulatory Area level may be based on differences in production between areas, observations in each area relative to other areas (e.g., WPUE), uncertainty of data or mortality in each area, defined allocations, or national shares. Data may be used as indicators of stock trends in each Region or IPHC Regulatory Area and are included in the Distribution Procedures component because they may be subject to certain biases and include factors that may be unrelated to biomass in that Biological Region or IPHC Regulatory Area. For example, commercial WPUE is a popular source of data used to indicate trends in a population, but may not always be proportional to biomass. Types of data to be used may include fishery WPUE, survey observations (not necessarily the IPHC fishery-independent setline survey), age-compositions, size-at-age, and environmental observations.

The steps in the Distribution Procedures may consider conservation objectives, but they will mainly be developed with respect to fishery objectives. Yield and stability in catch levels are two important fishery objectives that often contradict each other (i.e. higher yield often results in less stability). Additionally, area-specific fishery objectives may be in conflict across IPHC Regulatory Areas. Pacific halibut catch levels are defined for each IPHC Regulatory Area and quota is accounted for by those Regulatory Areas. Therefore, IPHC Regulatory Areas are the appropriate scale to consider fishery objectives.

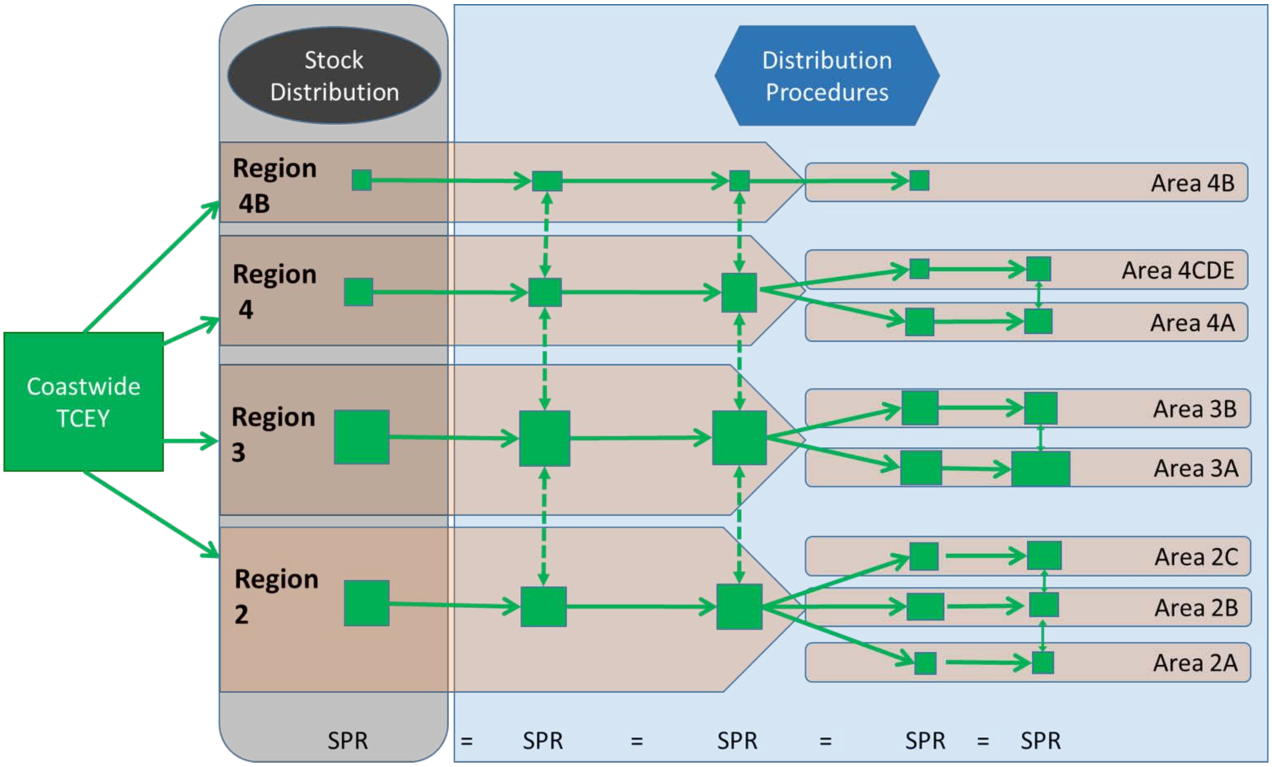


Figure 22: The process of distributing the TCEY to Regulatory Areas from the coastwide TCEY. The first step is to distribute the TCEY to Biological Regions based on the estimate of stock distribution. Following this, a series of adjustments may be made based on observations or social, economic, and other considerations. Finally, the adjusted regional TCEY's are allocated to IPHC Regulatory Areas. The allocation to IPHC Regulatory Areas may occur at any point after regional stock distribution. The dashed arrows represent balancing that is required to maintain a constant coastwide SPR.

6.4 A Summary of the Management Procedure for Distributing TCEY Across the Coast

The harvest strategy policy begins with the coastwide TCEY determined from the stock assessment and fishing intensity determined from a target SPR (Figure 1). When distributing the TCEY among regions, stock distribution occurs first to distribute the harvest in proportion to biomass and satisfy conservation objectives, and then is followed by adjustments across Regions and Regulatory Area based on distribution procedures to further encompass conservation objectives and consider fishery objectives. The key to these adjustments is that they are relative adjustments such that the overall fishing intensity (target SPR) is maintained (i.e., a zero sum game relative to fishing intensity). Otherwise, the procedure is broken, and it is uncertain if the defined objectives will be met.

A framework for a management procedure that ends with the TCEY distributed among IPHC Regulatory Areas and would encompass conservation and fishery objectives is described below.

1. **Coastwide Target Fishing Intensity:** Determine the coastwide total mortality using a target SPR that is most consistent with IPHC objectives defined by the Commission. Separate the total mortality in ≥26 inches (O26) and under 26 inches (U26) components. The O26 component is the coastwide TCEY.
    1.1. Target SPR is scheduled for evaluation at the 2019 Annual Meeting. The current interim target SPR is 46%.
2. **Regional Stock Distribution:** Distribute the coastwide TCEY to four (4) biologically-based Regions using the proportion of the stock estimated in each Biological Region for all sizes of Pacific halibut using information from the IPHC setline survey and the IPHC space-time model.
    2.1. Four Regions (2, 3, 4, and 4B) are defined above (Figure 2).
3. **Regional Allocation Adjustment:** Adjust the distribution of the TCEY among Biological Regions to account for other factors.
    3.1. For example, relative target harvest rates are part of a management/policy decision that may be informed by data and observations. This may include evaluation of recent trends in estimated quantities (such as fishery-independent WPUE), inspection of historical trends in fishing intensity, recent or historical fishery performance, and biological characteristics of the Pacific halibut observed in each Biological Region. The IPHC Secretariat may be able to provide Yield-Per-Recruit (YPR) and/or surplus production calculations as further supplementary information for this discussion. The regional relative harvest rates may also be determined through negotiation, which is simply an allocation agreement for further Regional adjustment of the TCEY.
4. **Regulatory Area Allocation:** Apply IPHC Regulatory Area allocation percentages within each Biological Region to distribute the Region-specific TCEY's to Regulatory Areas.
    4.1. This part represents a management/policy decision, and may be informed by data, based on past or current observations, or defined by an allocation agreement. For example, recent trends in estimated all sizes WPUE from the setline survey or fishery, age composition, or size composition may be used to distribute the TCEY to IPHC Regulatory Areas. Inspection of historical trends in fishing intensity or catches by IPHC Regulatory Area may also be used. Finally, agreed upon percentages are also an option. This allocation to IPHC Regulatory Areas may be a procedure with multiple adjustments using different data, observations, or agreements

The four steps described above would be contained within the IPHC Harvest Strategy Policy as part of the Management Procedure and are pre-determined steps that have a predictable outcome. The decision-making process would then occur (Figure 1).

5. **Seasonal Regulatory Area Adjustment**: Adjust individual Regulatory Area TCEY limits to account for other factors as needed. This is the policy part of the harvest strategy policy and occurs as a final step where other objectives are considered (e.g. economic, social, etc.).
    5.1. Departing from the target SPR may be a desired outcome for a particular year (short-term, tactical decision making based on current trends estimated in the stock assessment) but would deviate from the management procedure and the long-term management objectives. Departures from the management procedure may result in unpredictable outcomes but could also take advantage of current situations.

7 WORK PLAN

This Program of Work (IPHC-2018-MSAB011-10) is a description of activities related to the MSE and the Management Strategy Advisory Board (MSAB) that the IPHC Secretariat will engage in for the next five years. It describes each of the priority tasks, lists some of the resources needed for each task, and provides a timeline for each task. However, this work plan is flexible and may be changed throughout this period with the guidance of the MSAB, Science Review Board (SRB) members, and Commission. The order of the tasks in this work plan represents the sequential development of each task, and many subsequent tasks are dependent on the previous tasks.

7.1 MANAGEMENT STRATEGY EVALUATION (MSE)

Management Strategy Evaluation (MSE) is a process to evaluate alternative management strategies. This process involves the following

1. defining fishery goals and objectives with the involvement of stakeholders and managers,
2. identifying management procedures to evaluate,
3. simulating a halibut population with those management procedures,
4. evaluating and presenting the results in a way that examines trade-offs,
5. applying a chosen management procedure, and
6. repeating this process in the future in case of changes in objectives, assumptions, or expectations.

Figure 23 shows these different components and that the process is not necessarily a sequential process, but there may be movement back and forth between components as learning progresses. The involvement of stakeholders and managers in every component of the process is extremely important to guide the MSE and evaluate the outcomes.

7.2 BACKGROUND

Many important tasks have been completed or started and much of the work proposed will use past accomplishments to further the Management Strategy Evaluation (MSE) process. The past accomplishments include:

1. Familiarization with the MSE process.
2. Defining goals for the halibut fishery and management.
3. Developing objectives and performance metrics from those goals.
4. Development of an interactive tool (the Shiny application).
5. Discussions about coast-wide (single-area) and spatial (multiple-area) models.
6. Presentation of preliminary results investigating fishing intensity.
7. Discussions of ideas for distributing the TCEY to Regulatory Areas.

Management Strategy Evaluation is a process that can develop over many years with many iterations. It is also a process that needs monitoring and adjustments to make sure that management procedures are performing adequately. Therefore, the MSE work for Pacific halibut fisheries will be ongoing as new objectives are addressed, more complex models are built, and results are updated. This time will include continued consultation with stakeholders and managers via the MSAB meetings, defining and refining goals and objectives, developing and coding models, running simulations, reporting results, and making decisions. Along the way, there will be useful outcomes that may be used to improve existing management and will influence recommendations for future work.

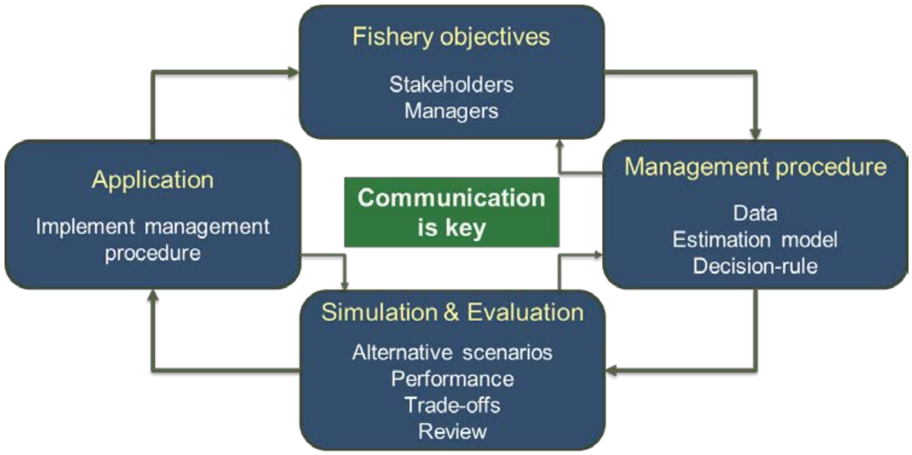


Figure 23: A depiction of the Management Strategy Evaluation (MSE) process showing the iterative nature of the process with the possibility of moving either direction between most components.

A detailed program of work has been developed for the next two years, with results for decision-making being presented to the Commission at the Annual Meetings in 2019 and 2021 (Table 2). More specifically, an evaluation of "Scale" (coastwide fishing intensity and the harvest control rule) will be presented at AM095 in January 2019. An evaluation of the entire harvest strategy depicted in Figure 1 (Scale and Distribution) will be completed in late 2020 and presented to the Commission for decision-making at AM097 in January 2021.

The evaluations delivered at AM097 will shape the IPHC harvest policy, but other aspects will become of interest and MSE work will continue afterwards.

Table 2: Timeline for MSE work in 2018–21.

May 2018 MSAB Meeting
Review Goals
Look at results of SPR
Review Performance Metrics
Identify Scale MP's
Review Framework
Identify Preliminary Distribution MP's
October 2018 MSAB Meeting
Review Goals
Complete results of SPR
Review Performance Metrics
Identify Scale MP'S
Verify Framework
Identify Distribution MP's
Annual Meeting 2019
Recommendation on Scale Present possible distribution MP’s
May 2019 MSAB Meeting
Review Goals
Spatial Model Complexity
Identify MP's (Distn Scale)
Review Framework
October 2019 MSAB Meeting
Review Goals
Spatial Model Complexity
Identify MP's (Distn Scale)
Review Framework
Review multi-area model development
Annual Meeting 2020
Update on progress
May 2020 MSAB Meeting
Review Goals
Review multi-area model
Review preliminary results
October 2020 MSAB Meeting
Review Goals
Review preliminary results
Annual Meeting 2021
Presentation of first complete MSE product to the Commission Recommendations on Scale and Distribution MP

MSE TASKS FOR THE NEXT 5 YEARS

Task 1. Verify that goals are still relevant and further define objectives.

Task 2. Develop performance metrics to evaluate objectives.

Task 3. Identify realistic management procedures of interest to evaluate with a closed-loop simulation framework. This includes management procedures related to coastwide scale (e.g., SPR) and to distributing the TCEY.

Task 4. Design a closed-loop simulation framework and code a computer program to extend the current simulation framework.

Task 5. Develop educational and visualization tools that will engage stakeholders and Commissioners, as well as facilitate communication and evaluation.

Task 6. Further the development of operating models to include multiple areas and structural uncertainty.

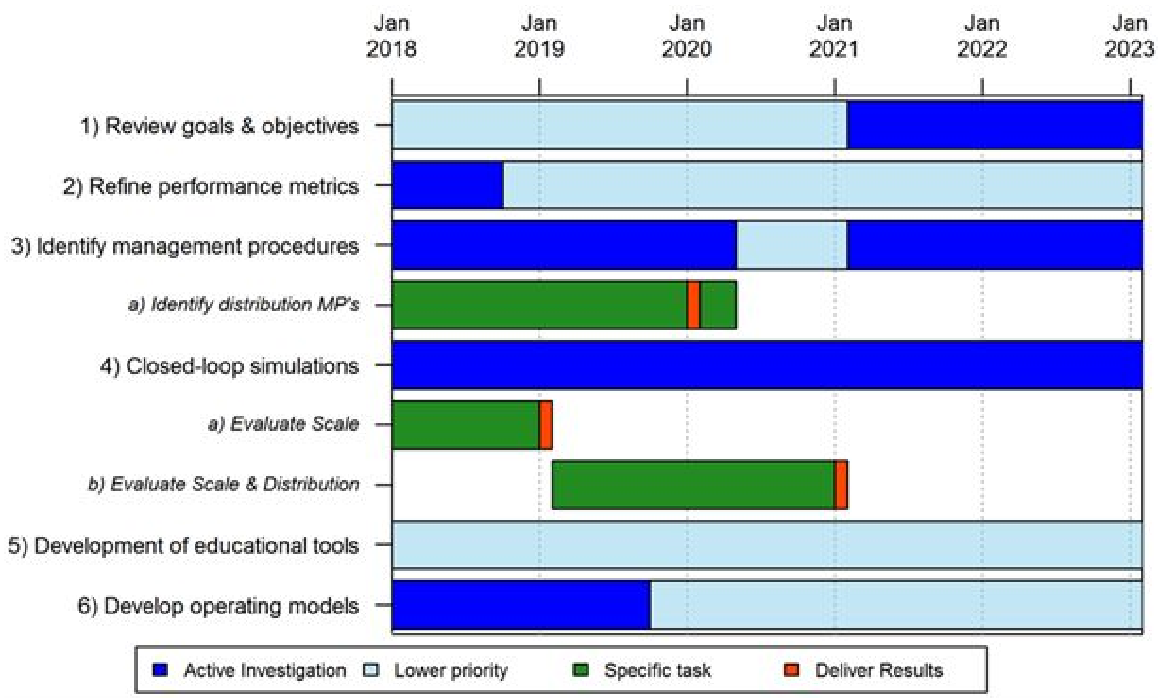


Figure 24: Gantt chart for the five-year work plan. Tasks are listed as rows. Dark blue indicates when the major portion of the main tasks work will be done. Light blue indicates when preliminary or continuing work on the main tasks will be done. Dark green indicates when the work on specific sub-topics will be done. The orange color shows when results will be presented at an Annual Meeting.

8 Recommendation

That the SRB:

1) **NOTE** paper IPHC-2018-SRB013-06 which provides the SRB with a preliminary update on MSE-related activities of the IPHC Secretariat in 2018.
2) **NOTE** the goal and objectives currently being refined by the MSAB.
3) **NOTE** the simulation framework and improvements to the simulation framework
4) **RECOMMEND** any additional improvements to the simulation framework. Improvements explained in this document included the following.
    a. A prior on steepness developed from the long coastwide model, that was used when conditioning the short coastwide model.
    b. Rejecting simulations with a maximum exploitation rate greater than 0.4 to avoid cases of quasi-extinction.
    c. Modifying the allocation of total mortality procedure to make bycatch mortality increase with increasing total biomass.
    d. Modifying the allocation of total mortality procedure to make recreational mortality a constant proportion with variability on the proportion.
    e. Future improvements that will be described at SRB013, including autocorrelation in estimation error and commercial selectivity a function of weight-at-age.
5) **NOTE** the results of simulating forward in time with no fishing and the influence of weight-at-age and recruitment regimes.
6) **NOTE** the distribution frame-work and the separation of scientific and management elements of distribution procedures.
7) **RECOMMEND** modifications that may improve the TCEY distribution framework and which components the MSAB should consider when developing management procedures to evaluate.
8) **NOTE** the five-year workplan and the timeline for deliverables in 2019 and 2021.

9 Appendices

I. Goals, measurable objectives, and intent (From IPHC-2018-MSAB011-07)

APPENDIX I: GOALS, MEASURABLE OBJECTIVES, AND INTENT (FROM IPHC-2018-MSAB011-07)

Table A1: Objectives for the biological sustainability goal along with intent and performance metric quantities (measurable outcome, probability, and time-frame). Acknowledgements to Michele Culver (WDFW) for originally putting this table together.

Goal	Objective	Measurable Outcome	Probability	Time-frame	Intent
Biological Sustainability	1.1. Keep biomass above a **limit** below which no fishing can occur	a) Maintain a minimum number ***[spawning potential ratio]*** of mature female Pacific halibut coast-wide	0.99	Each year	• Ensure that conservation needs of the stock are met for long-term sustainability with a high degree of certainty
		b) 2) Maintain a minimum spawning stock biomass of 20% of the unfished biomass	0.95	Each year	• Regularly monitor stock biomass (i.e. continuation and improvement of survey and stock assessment efforts) to detect changes in status and abundance
	1.2. Account for all sizes in the population?	*c)*			
	1.3. Reduce harvest rate when abundance is below a threshold	d) Maintain a minimum spawning stock biomass of 30% of the unfished biomass	0.75	Each year	• **Define reference points and harvest targets (e.g. MSY)**
	1.4. Risk tolerance and assessment uncertainty	e) When Limit < estimate biomass < Threshold, limit the probability of declines	0.05 – 0.5, depending on est. stock status	10 years	• Take a risk-averse approach when the stock is below the threshold

Table A2: Objectives for the fishery sustainability goal along with intent and performance metric quantities (measurable outcome, probability, and time-frame). Acknowledgements to Michele Culver (WDFW) for originally putting this table together.

Goal	Objective	Measurable Outcome	Probability	Time-frame	Intent
Fishery Sustainability and Stability and Assurance of Access – Minimize Probability of Fishery Closures	2.1. Maintain an economically sufficient level of catch (i.e., target) across regulatory areas	a) Maintain directed fishing opportunity	0.95	Each year	• Ensure that the directed fishery has viable fishing opportunities every year • Provide directed fisheries that are economically beneficial to individual participants, local businesses, and broader communities • Support efforts to allow continued access to the halibut resource within acceptable conservation limits
		b) Maximize [Optimize?] yield in each regulatory area	0.5	Each year	
		c) Maintain median catch within ±10% of 1993-2012 average	?	Within 5 yrs	
		d) Maintain average catch at > 70% of historical 1993-2012 average	0.9	Each year	
	2.2. Limit catch variability	e) Limit annual changes in TAC, coast-wide and/or by Regulatory Area, to < 15%		Each year	

Table A3: Objectives for the minimize wastage goal along with intent and performance metric quantities (measurable outcome, probability, and time-frame). Acknowledgements to Michele Culver (WDFW) for originally putting this table together.

Goal	Objective	Measurable Outcome	Probability	Time-frame	Intent
Minimize Discard Mortality	3.1. Harvest efficiency	a) Discard mortality in the longline fishery < 10% of annual catch limit	0.75	Over 5 years	• Support fishing practices that reduce discard mortality • Regulatory revisions that promote efficiency

Table A4: Objectives for the minimize bycatch goal along with intent and performance metric quantities (measurable outcome, probability, and time-frame). Acknowledgements to Michele Culver (WDFW) for originally putting this table together.

Goal	Objective	Measurable Outcome	Probability	Time-frame	Intent
Minimize Bycatch and Bycatch Mortality	4.1.	a)		Over 5 years	• Support fishing practices that reduce bycatch and bycatch mortality

Report on Current Biological Research Activities and Progress on Discussions Regarding New Research Topics at IPHC

PREPARED BY: IPHC SECRETARIAT (J. PLANAS, 25 AUGUST 2018)

PURPOSE

To provide the Scientific Review Board with an update of current progress on research projects conducted by the Biological and Ecosystem Science Research Program and on discussions regarding new research topics at IPHC.

BACKGROUND

The primary biological research activities at IPHC that follow Commission objectives are identified and described in the proposed Five-Year Research Plan for the period 2017-2021, as summarized in a previous document IPHC-2017-SRB010-INF02. These activities are summarized in five broad categories, as follows:

1) Reproduction. Studies are aimed at providing information on the sex ratio of the commercial catch and to improve current estimates of maturity.
2) Growth and Physiological Condition. Studies are aimed at describing the role of some of the factors responsible for the observed changes in size-at-age and to provide tools for measuring growth and physiological condition in Pacific halibut.
3) Discard Mortality Rates (DMRs) and Survival. Studies are aimed at providing updated estimates of DMRs in both the longline and the trawl fisheries.
4) Migration. Studies are aimed at further understanding reproductive migration and identification of spawning times and locations as well as larval and juvenile dispersal.
5) Genetics and Genomics. Studies are aimed at describing the genetic structure of the Pacific halibut population and at providing the means to investigate rapid adaptive changes in response to fishery-dependent and fishery-independent influences.

UPDATE ON PROGRESS ON THE MAIN RESEARCH ACTIVITIES

1. Reproduction. Efforts at IPHC are currently underway to address two critical issues in stock assessment based on estimates of female spawning biomass: the sex ratio of the commercial catch and maturity estimations.

   1.1. Sex ratio of the commercial catch. In 2017, the sex-marking project requested voluntary participation from the commercial longline fleet coastwide. During the course of the commercial season, a total of 929 samples were obtained from 84 sex-marked offloads coastwide. Sex (SNP) assays on these samples have been finalized at the new biological laboratory at IPHC and the results are being currently analyzed and expressed as a function of age. The results of this study will be written up for publication in the Fall of 2018.

   1.2. Maturity estimations. In order to characterize the gonadal maturation schedule, the IPHC is conducting a full characterization of the annual reproductive cycle in female and male Pacific halibut. Biological samples (gonads, blood, pituitary, otolith, fat content) have been collected at monthly intervals from female (N=30) and male (N=30) Pacific halibut captured from the Portlock region in the central Gulf of Alaska throughout an entire calendar year. Sample processing will begin in late Summer and early Fall of 2018. Analysis of a portion of this study will be conducted by a MSc student from Alaska Pacific University and will constitute the basis of her MSc thesis.

2. Growth. Investigations on the effects of **temperature** variation on growth potential are being continued by describing changes in the skeletal muscle proteome (in collaboration with the Environmental Proteomics laboratory at the Department of Genome Sciences, University of Washington). At the present time, we are in the process of evaluating methods for the preparation of Pacific halibut skeletal muscle samples for mass spectrometry. Proteomic analyses are planned for the fall of 2018. In addition, we are also currently conducting RNAseq analyses to identify differentially expressed genes in liver, another important tissue in relation to growth, in response to temperature-induced growth manipulations. We have also conducted experiments on the effects of **density** on growth. Growth data is currently being analyzed and, based on the results, skeletal muscle tissue samples will be processed for RNA extraction and the expression of selected growth markers previously identified by RNAseq will be assessed by quantitative real-time PCR.

3. Discard Mortality Rates (DMRs) and Survival. Within framework of a 2-yr project partially funded by the Saltonstall-Kennedy Grant Program that is led by IPHC in partnership with the Alaska Pacific University, we are conducting investigations to understand the relationship between fish handling practices and fish physical and physiological condition and survival post-capture as assessed by tagging in order to better estimate post-release survival in Pacific halibut caught incidentally in the directed and bycatch longline fisheries.

    3.1. Evaluation of the effects of **hook release techniques** on injury levels and association with the physiological condition of captured Pacific halibut. The work involved evaluating the effects of different release techniques on injury levels and associated physiological condition levels from the large (16/0) circle hooks used in the Pacific halibut longline fishery. Physiological condition measures as well as physiological disturbance indicators in the blood of captured fish are being currently analyzed.

    3.2. Investigations on the effects of fish handling methods and associated injury level and physiological condition on **post-release survival**. In order to evaluate the survival of discarded fish, two types of tagging approaches were used. 1) Classical mark-and-recapture of released fish with wire tags: 1,027 fish (under 33 inches in length) were tagged. 2) Biotelemetric monitoring of released fish with the use of satellite-transmitting electronic archival tags equipped with accelerometers: resuts from a total of 79 Pacific halibut ranging from 53-81 cm FL allowed us to estimate that the DMR of U32 Pacific halibut under excellent-condition is approximately 4%.

    3.3. Application of **electronic monitoring** (EM). Evaluation of EM data whereby reviewers recorded the release method and condition of released fish evidenced a high degree

(95%-100%) of agreement between the actual release method used and that captured by EM was observed. Assessment of injury profiles by release method evidenced that careful shake and gangion cutting are the release methods resulting in the highest proportion of fish in excellent condition (> 70%) for both small and large Pacific halibut).

4. Migration

Knowledge of Pacific halibut migration throughout all life stages is necessary in order to gain a complete understanding of stock distribution and the factors that influence it.

4.1. Larval distribution and connectivity between the Gulf of Alaska and Bering Sea. Work has continued on the application of the IPHC-developed spatial model on assessing possible changes in larval density and distribution between warm (2001-2005) and cold (2007-2013) stanzas and differences between the ocean basins. The advection modeling portion of this project is still scheduled for Fall 2018.

4.2. Wire tagging of U32 Pacific halibut. Wire tagging of Pacific halibut caught in the NMFS trawl surveys and during 2018 IPHC fisheries-independent setline survey is still being conducted.

4.3. Electronic archival tagging. Electronic archival tags that allow for daily light-based geo-positioning and depth recording are being deployed in Pacific halibut caught in the 2018 IPHC fishery-independent setline survey.

PROGRESS ON DISCUSSIONS REGARDING NEW RESEARCH TOPICS AT IPHC

- In order to begin discussions regarding the three topics that the IPHC Secretariat solicited guidance from the SRB, as indicated in document IPHC-2018-SRB12-09, the SRB has shared with the IPHC Secretariat relevant scientific literature. A discussion on approaches to determine the level of genetic variation in the sampled Pacific halibut population and, therefore, infer possible contributions of genetically distinct spawning groups was recently initiated.

- Furthermore, in response to comments by the SRB, the IPHC Secretariat (L. Sadorus) has produced a summary of research projects and activities conducted by IPHC since 1995 in which biological samples were collected in addition to maps indicating the geographic location of the sampling sites in the IPHC fisheries-independent setline and NMFS trawl surveys during the period 1995-2017. The research project summary will be useful for identifying sources of biological samples that could potentially be used in genetic studies and is found in document IPHC-2018-SRB013-INF01. The maps showing the sampling locations are found in document IPHC-2018-SRB013-INF02.

Year	Name of research	Description	Collection platform	Regulatory Area(s)	Vessel(s)	Gear used: longline	trawl	pot	other	Data/sampling: oto	frklen	sex	mat	PHI	condition	chalky	fin clip	tissue	live	bycatch	sexmark	morpho	stomach	gonads	tagging	images	depth	temp	DO	pH	salt	chloro	Map #	Data	Notes
1995-present	IPHC Fishery-Independent Setline Survey (FISS)	The FISS provides catch information and biological data that are independent of the commercial fishery. These data, collected with standard methods and gear during the summer of each year, provide an important comparison with data provided by the commercial fishery. Biological data collected on the surveys are used to monitor changes in biomass, growth, and mortality of adult and subadult components of the population. In addition, records of other species caught during survey operations provide insight into bait competition, rate of bait attacks, as well as an index of abundance over time for some of these bycatch species. Maps for each year reflect annual variations in design and scope.	FISS	2A, 2B, 2C, 3A, 3B, 4A, 4B, 4C, 4D, 4E	All FISS vessels	X				X	X	X	X	X						X															
1995	Forum Star Trawl bycatch and survival	Study designed to evaluate long-term mortality of trawl-caught Pacific halibut subjected to different tow durations, time on deck, and handling methods. Halibut of all sizes Data collected included tow duration, location, depth, time on deck, fork length, release condition, and tag number. In addition, notes were collected on estimated tow size.	Independent charter	3A	Forum Star		X				X				X										X									tagreleaserecovery, trlheader, trlhalibut	
1996	National Marine Fisheries Service trawl survey	The National Marine Fisheries Service (NMFS) conducts bottom trawl surveys in the Gulf of Alaska (triennially until 1999, bienially after), Bering Sea (annually), and Aleutian Islands (triennially until 2000, biennially after). These surveys operate in the summer months and generally include 2-3 vessels fishing simultaneously. All halibut on the surveys are measured, and the IPHC placed one sampler on board one vessel in this survey to collect additional basic halibut information and samples. Biological data collected is used to monitor juvenile year class strength and distribution, provide information on areas not surveyed during the FISS, and as a comparison to FISS results.	Trawl survey	GOA - 2C, 3A, 3B, 4A	Vesteraalen		X			X	X	X	X	X														X						trlNMFSHaul, trlHeader, trlHalibut	
1997	National Marine Fisheries Service trawl survey	The National Marine Fisheries Service (NMFS) conducts bottom trawl surveys in the Gulf of Alaska (triennially until 1999, bienially after), Bering Sea (annually), and Aleutian Islands (triennially until 2000, biennially after). These surveys operate in the summer months and generally include 2-3 vessels fishing simultaneously. All halibut on the surveys are measured, and the IPHC placed one sampler on board one vessel in this survey to collect additional basic halibut information and samples. Biological data collected is used to monitor juvenile year class strength and distribution, provide information on areas not surveyed during the FISS, and as a comparison to FISS results.	Trawl survey	AI - 4A, 4B	Vesteraalen		X			X	X	X	X	X														X						trlNMFSHaul, trlNMFSHalibut	
1998	Bait Size Experiments	The purpose of this project was to compare two, three, six, seven, and eight ounce pieces of chum salmon bait to the survey standard four ounce bait	Independent charter	2B, 2C, 3A	Ocean Viking, Western Sunrise, Tradition	X					X																							stlHeader, stlHalibut	Tech Rep. 58
1998	Bait Quality Experiments	This project involved comparing either dark chum salmon to semi-bright chum, two different batches of semi-bright chum salmon, or two different batches of silver-bright chum salmon.	Independent charter	2C, 3A, 3B, 4B	Angela Lynn, Sand Island, Ocean Viking	X					X																							stlHeader, stlHalibut	Tech Rep. 58
1998	Hook Size Experiments	The purpose of this project was to compare 13/0 circle hooks against the survey standard 16/0 circle hook.	Independent charter	2B, 2C, 3B	Bold Pursuit, Tyanna, Western Sunrise, Zenith	X					X																							stlHeader, stlHalibut	Tech Rep. 58
1998	Bait Type and Day/Night Experiments	This project involved comparing either Pacific cod or octopus to semi-bright chum salmon, or pollock to squid, and an additional component during one trip comparing differences in catch at night versus during the day.	Independent charter	2B, 3A, 3B, 4B	Angela Lynn, Sand Island, Venturous	X					X																							stlHeader, stlHalibut	Tech Rep. 58
1998	Gear Type Experiments	The purpose of this experiment was to compare sablefish gear commonly found in the commercial fishery to the survey standard halibut gear. These sets were made with the same or differently sized chum baits, or with chum salmon on halibut gear and herring on the sablefish gear.	Independent charter	3A	Lualda	X					X																							stlHeader, stlHalibut	Tech Rep. 58
1998	Bait Type Experiments	The purpose of these projects was to determine the relative effectiveness of herring and squid as possible bait substitutes for the chum salmon normally used during the annual FISS. This included determining what differences in catch or size composition might be associated with different baits, and whether there was a bait which could be directly substituted with no associated corrections.	Independent charter	2B, 2C, 3A	Bold Pursuit, Heritage, Royal Pursuit	X					X																							stlHeader, stlHalibut	Tech Rep. 58
1998	National Marine Fisheries Service trawl survey	The National Marine Fisheries Service (NMFS) conducts bottom trawl surveys in the Gulf of Alaska (triennially until 1999, bienially after), Bering Sea (annually), and Aleutian Islands (triennially until 2000, biennially after). These surveys operate in the summer months and generally include 2-3 vessels fishing simultaneously. All halibut on the surveys are measured, and the IPHC placed one sampler on board one vessel in this survey to collect additional basic halibut information and samples. Biological data collected is used to monitor juvenile year class strength and distribution, provide information on areas not surveyed during the FISS, and as a comparison to FISS results.	Trawl survey	BS - 4A(BS), 4C, 4D, 4E, Closed area	Arcturus, Aldebaran		X			X	X	X	X	X														X						trlNMFSHaul, trlNMFSHalibut	
1998	National Marine Fisheries Service trawl survey	The National Marine Fisheries Service (NMFS) conducts bottom trawl surveys in the Gulf of Alaska (triennially until 1999, bienially after), Bering Sea (annually), and Aleutian Islands (triennially until 2000, biennially after). These surveys operate in the summer months and generally include 2-3 vessels fishing simultaneously. All halibut on the surveys are measured, and the IPHC placed one sampler on board one vessel in this survey to collect additional basic halibut information and samples. Biological data collected is used to monitor juvenile year class strength and distribution, provide information on areas not surveyed during the FISS, and as a comparison to FISS results.	Trawl survey	WC - 2A	Dominator		X			X	X	X	X	X														X						trlNMFSHaul, trlNMFSHalibut	
1999	SE AK survey design layout experiment	The annual IPHC standardized grid survey was completely redesigned prior to the 1998 survey season. Results from the 1998 survey indicated a notable drop in catch per unit effort (CPUE) in Areas 2B, 2C, and 3A from the previous year. An experiment was completed by survey vessels in Area 2C during the 1999 grid survey to ensure that this CPUE shift was not a result of the design change. The experiment entailed fishing stations from the old survey design, alongside the new survey stations.	FISS	2C	Bold Pursuit, Ocean Viking, Tyanaa	X				X	X	X	X	X														X						stlHeader, stlHalibut	

1999	Comparison of between-reader precision for two aging techniques (surface and break-and-burn)	Otoliths from several trips of the F/V Angela Lynn in Area 3B, 1999 were surface-aged twice by two different readers, then broken and burnt and the burnt sections were aged twice by the same two readers. The purpose of the paired readings was to compare between-reader precision for the two aging techniques (surface and break-and-burn). There is no RARA report.	FISS	3B	Angela Lynn	X		X											
1999	Bait Type Experiments	The purpose of these surveys was to determine the relative effectiveness of herring and squid as possible bait substitutes for the chum salmon normally used during the annual FISS. This included determining what differences in catch or size composition might be associated with different baits, and whether there was a bait which could be directly substituted with no associated corrections.	Independent charter	2B, 3A	Angela Lynn, Bold Pursuit, Heritage, Masonic, Royal Pursuit, Ocean Viking, Tyanna	X			X									stlHeader, stlHalibut	Tech Rep. 58
1999	Chalky Fish Survey	Purpose of these surveys was to investigate the effects of stunning and bleeding on the development of the chalky condition.	Independent charter	2B, 3A	Angela Lynn, Star Wars II	X							X						Tech Rep. 58
1999	National Marine Fisheries Service trawl survey	The National Marine Fisheries Service (NMFS) conducts bottom trawl surveys in the Gulf of Alaska (triennially until 1999, bienially after), Bering Sea (annually), and Aleutian Islands (triennially until 2000, biennially after). These surveys operate in the summer months and generally include 2-3 vessels fishing simultaneously. All halibut on the surveys are measured, and the IPHC placed one sampler on board one vessel in this survey to collect additional basic halibut information and samples. Biological data collected is used to monitor juvenile year class strength and distribution, provide information on areas not surveyed during the FISS, and as a comparison to FISS results.	Trawl survey	BS - 4A(BS), 4C, 4D, 4E, Closed area	Arcturus		X	X	X	X	X	X			X			trlNMFSHaul, trlNMFSHalibut	
1999	National Marine Fisheries Service trawl survey	The National Marine Fisheries Service (NMFS) conducts bottom trawl surveys in the Gulf of Alaska (triennially until 1999, bienially after), Bering Sea (annually), and Aleutian Islands (triennially until 2000, biennially after). These surveys operate in the summer months and generally include 2-3 vessels fishing simultaneously. All halibut on the surveys are measured, and the IPHC placed one sampler on board one vessel in this survey to collect additional basic halibut information and samples. Biological data collected is used to monitor juvenile year class strength and distribution, provide information on areas not surveyed during the FISS, and as a comparison to FISS results.	Trawl survey	GOA - 2C, 3A, 3B, 4A	Vesteraalen		X	X	X	X	X	X			X			trlNMFSHaul, trlNMFSHalibut	
2000	Comparison of ages derived from paired right and left side otoliths through surface and break and burn aging technique	Early investigations into aging of Pacific halibut indicated that the otoliths from the blind or "left" side of the fish were easier to read and gave more reliable ages than right-side otoliths. IPHC samplers routinely collect left-side sagittal otoliths from halibut, but right-side otoliths are occasionally collected, either by mistake or because the left-side otolith was lost, badly broken or crystallized. Since surface ages from right otoliths are considered inaccurate, right otolith ages are not entered into the database. We aged paired sagittal otoliths by both surface and break-and-burn technique, and evaluated whether ages obtained by breaking-and-burning right otoliths were more accurate (i.e., closer to left-side ages).	FISS	4B	Trident	X		X											RARA report Forsberg et al. Comparison of surface and break-and-burn ages for paired left and right otoliths. Report of Assessment and Research Activities 2002. p 245-258
2000	Water column profiler environmental data collection	In 2000, one water column profiler was purchased to test the efficacy of deployment from a survey fishing vessels with minimal disruption to the core survey operations. Deployments continued over the next several years on a variety of vessels and areas.	FISS	2C, 3A	Bold Pursuit	X								X	X	X	n/a	Spreadsheet and individual cast files, not yet in database	See Tech Rep 60
2000-2002	Incidence of crystallized otoliths	A variable but small proportion of Pacific halibut otoliths are "crystallized" (i.e., they contain calcium carbonate in the form of vaterite instead of the usual aragonite in part or all of the otolith). Growth patterns are obscured in crystallized portion of the otolith so fully crystallized otoliths are usually discarded at sea. In order to look at rates of full and partial crystallization between sexes and among areas, samplers retained crystallized left-side otoliths on the setline surveys between 2000 and 2002. The right-side otolith was also collected from fish with crystallized left-side otoliths. Collection occurred in all regions surveyed during the sampled years. Because right otoliths were only collected for fish that had a noticeably crystallized left otolith, rates of right-side crystallization could not be determined from this data set. To compare occurrence rates of crystallized right and left otoliths, paired otoliths were collected from all trawl survey-caught halibut in 2000 as well as from a small portion of the 2000 setline survey halibut. In 2000, otolith pairs were collected on a subset of setline survey stations that had high rates of crystallized otoliths in previous years. This paired collection supplied otoliths for two studies: relative rates of left- and right-side crystallization and a right/left otolith age comparison.	FISS	2B, 2C, 3A, 3B, 4B, 4D (2000-2002); 2A (2001-2002)	Angela Lynn, Bold Pursuit, Free to Wander, Heritage, Kristiana, Lualda, Ocean Marauder, Pacific Sun, Pender Isle, Star Wars II, Taasinge, Trident, Tyanna, Vansee, Viking Spirit, Black Hawk, Norska, Viking Joy, Waterfall, Barren Islands	X		X											See RARA reports Tobin, R.S., and Forsberg, J.E. 2003. Incidence of crystallized otoliths from the 2000 and 2001 setline surveys. Int. Pac. Halibut Comm. Report of Assessment and Research Activities 2002: 239-244. and Tobin, R.S., Blood, C.L., and Forsberg, J.E. 2005.Incidence of crystallized otoliths from the 2000 to 2002 IPHC setline and NMFS trawl surveys. Int. Pac. Halibut Comm. Report of Assessment and Research Activities 2004: 327-338.
2000	SSA Grid and Bait Comparison Study	Survey vessels working on grid survey charter regions within Area 2B, and the border between 3A and 3B, and in the Cape Cleare region in Area 3A participated in a bait comparison experiment along with the standardized grid survey. The purpose of this experiment was to compare the relative effectiveness of using only salmon bait, which had been the standard on the annual surveys since 1993, with mixed salmon and herring which was the standard used between 1976 and 1986. The standardized grid survey entailed fishing a number of predetermined stations evenly distributed on a 10 nmi by 10 nmi grid and using standardized gear and techniques. The bait comparison experiment required vessels to set a second set of gear berthed approximately 1 nmi away and parallel to the grid survey station. - Tech Rep. 58.	Independent charter	2B, 3A, 3B	Angela Lynn, Free to Wander, Kristiana, Lualda, Pacific Sun, Pender Isle, Star Wars II, Taasinge, Vanisle	X		X	X	X	X	X						stlHeader, stlHalibut	
2000	Hook Orientation and Gangion Length Survey	Purpose of these surveys was to investigate the effect of gangion threading (through the front or back side of the hook eye) and gangion length on catch rates.	Independent charter	3A	Free to Wander	X			X									stlHeader, stlHalibut	Tech Rep. 58
2000	Bait-size and Hook-size/ Run origin effect survey	Purpose of these surveys was to compare two sizes of salmon bait with two sizes of hooks. Run concurrently with the bait-run origin experiment where the goas was to compare the effect of different runs of chum salmon on catch rates.	Independent charter	3A	Ocean Bay	X			X									stlHeader, stlHalibut	Tech Rep. 58

2000	National Marine Fisheries Service trawl survey	The National Marine Fisheries Service (NMFS) conducts bottom trawl surveys in the Gulf of Alaska (triennially until 1999, bienially after), Bering Sea (annually), and Aleutian Islands (triennially until 2000, biennially after). These surveys operate in the summer months and generally include 2-3 vessels fishing simultaneously. All halibut on the surveys are measured, and the IPHC placed one sampler on board one vessel in this survey to collect additional basic halibut information and samples. Biological data collected is used to monitor juvenile year class strength and distribution, provide information on areas not surveyed during the FISS, and as a comparison to FISS results.	Trawl survey	AI - Regulatory Areas 4A and 4B	Vesteraalen		X	X	X	X	X	X				X			trlNMFSHaul, trlNMFSHalibut	
2000	National Marine Fisheries Service trawl survey	The National Marine Fisheries Service (NMFS) conducts bottom trawl surveys in the Gulf of Alaska (triennially until 1999, bienially after), Bering Sea (annually), and Aleutian Islands (triennially until 2000, biennially after). These surveys operate in the summer months and generally include 2-3 vessels fishing simultaneously. All halibut on the surveys are measured, and the IPHC placed one sampler on board one vessel in this survey to collect additional basic halibut information and samples. Biological data collected is used to monitor juvenile year class strength and distribution, provide information on areas not surveyed during the FISS, and as a comparison to FISS results.	Trawl survey	BS - 4A(BS), 4C, 4D, 4E, Closed area	Arcturus		X	X	X	X	X	X				X			trlNMFSHaul, trlNMFSHalibut	
2000-2001	Incidence of crystallized otoliths	The IPHC routinely collects and reads only left- or blind-side otoliths. Normally, crystallized otoliths encountered in sampled survey halibut are discarded, and a "C" (for crystallized) is recorded in the Comments column on the data form. Samplers on NMFS trawl surveys collected both otoliths for all halibut in 2000, and in 2001, they collected both the left and right otolith from halibut with crystallized left otoliths. Information such as capture location and sex was obtained from the survey data. Collection occurred in all regions surveyed during the sampled years. NMFS trawl surveys took place in the Bering Sea (BS) region in 2000 and 2001, in the Aleutian Islands (AI) region in 2000, and in the Gulf of Alaska (GOA) region in 2001.	Trawl survey	2C, 3A, 3B, 4A, 4B, 4C, 4D, 4E	Arcturus, Vesteraalen		X	X												[illegible] Forsberg, J.E. 2003. Incidence of crystallized otoliths from the 2000 and 2001 setline surveys. Int. Pac. Halibut Comm. Report of Assessment and Research Activities 2002: 239-244. and Tobin, R.S., Blood, C.L., and Forsberg, J.E. 2005.Incidence of crystallized otoliths from the 2000 to 2002 IPHC setline and NMFS trawl surveys. Int. Pac.
2000	Comparison of ages derived from paired right and left side otoliths through surface and break and burn aging technique	Early investigations into aging of Pacific halibut indicated that the otoliths from the blind or "left" side of the fish were easier to read and gave more reliable ages than right-side otoliths. IPHC samplers routinely collect left-side sagittal otoliths from halibut, but right-side otoliths are occasionally collected, either by mistake or because the left-side otolith was lost, badly broken or crystallized. Since surface ages from right otoliths are considered inaccurate, right otolith ages are not entered into the database. We aged paired sagittal otoliths by both surface and break-and-burn technique, and evaluated whether ages obtained by breaking-and-burning right otoliths were more accurate (i.e., closer to left-side ages).	Trawl survey	4A, 4C, 4D, 4E, Closed area	Arcturus		X	X												RARA report Forsberg et al. Comparison of surface and break-and-burn ages for paired left and right otoliths. Report of Assessment and Research Activities 2002. p 245-258
2001	Water column profiler environmental data collection	In 2000, one water column profiler was purchased to test the efficacy of deployment from a survey fishing vessels with minimal disruption to the core survey operations. Deployments continued over the next several years on a variety of vessels and areas.	FISS	3A, 3B	Kristiana	X									X	X	X	n/a	Spreadsheet and individual cast files, not yet in database	See Tech Rep 60
2001	PIT - Pilot tagging location and shedding experiments	Purpose of this pilot studies was to capture halibut for studies to determine the optimal PIT tagging location.	Independent charter	2B, 2C, 3A	Free to Wander, Hotspur, Resurrection, Star Wars II	X							X						stlHeader, stlHalibut, tagreleaserecovery, tagsummary	Tech Rep. 58
2001	National Marine Fisheries Service trawl survey	The National Marine Fisheries Service (NMFS) conducts bottom trawl surveys in the Gulf of Alaska (triennially until 1999, bienially after), Bering Sea (annually), and Aleutian Islands (triennially until 2000, biennially after). These surveys operate in the summer months and generally include 2-3 vessels fishing simultaneously. All halibut on the surveys are measured, and the IPHC placed one sampler on board one vessel in this survey to collect additional basic halibut information and samples. Biological data collected is used to monitor juvenile year class strength and distribution, provide information on areas not surveyed during the FISS, and as a comparison to FISS results.	Trawl survey	BS - 4A(BS), 4C, 4D, 4E, Closed area	Arcturus		X	X	X	X	X	X				X			trlNMFSHaul, trlNMFSHalibut	
2001	National Marine Fisheries Service trawl survey	The National Marine Fisheries Service (NMFS) conducts bottom trawl surveys in the Gulf of Alaska (triennially until 1999, bienially after), Bering Sea (annually), and Aleutian Islands (triennially until 2000, biennially after). These surveys operate in the summer months and generally include 2-3 vessels fishing simultaneously. All halibut on the surveys are measured, and the IPHC placed one sampler on board one vessel in this survey to collect additional basic halibut information and samples. Biological data collected is used to monitor juvenile year class strength and distribution, provide information on areas not surveyed during the FISS, and as a comparison to FISS results.	Trawl survey	GOA (partial) - 3A, 3B, 4A	Vesteraalen		X	X	X	X	X	X				X			trlNMFSHaul, trlNMFSHalibut	
2002	Genetics: summer sampling	Purpose of this study was to collect tissue samples from commercially-landed fish for investigation of spatial population structure. Samples collected in 2002 primarily intended for microsatellite development. Otoliths and associated data collected as per port sampling protocols; ages subsequently retrieved from database. Genetic data generated by UW-SAFS.	Commercial trips	2A, 2C, 4B, 4C		X		X	X	X	X	X								See Scientific Report 81
2002	Juvenile OEF: component not collected or controlled by IPHC	See description above: this row denotes samples that were provided to the IPHC by outside investigators without an IPHC control over the sampling and with limited information regarding those collections.	Commercial trips		Unknown		X	X	X	X								n/a	Spreadsheet - Not yet incorporated into database	
2002-2004	Pribilof Temperature-CPUE correlation	Study designed to investigate the hypothesis that interannual trends in Area 4C were the result of changes in water temperature as correlated with the arrival of migratory halibut in shallow water. Temperature loggers were voluntarily deployed by commercial fishermen on their longline gear, for subsequent correlation with logbook data.	Commercial trips	4C	multiple	X										X			location data not available due to confidentiality concerns with commercial data	See publication in Deep Sea Res II 2008, 55:1801.
2002	Gulf spawning PAT tag deployment	Tim has details	FISS	2B, 2C, 3A, 3B	Angela Lynn, Bold Pursuit, Free to Wander, Norska, Pender Isle, Star Wars II, Waterfall	X								X					Stlhalibut, stlheader, tagreleaserecovery	

2002	Water column profiler environmental data collection	In 2000, one water column profiler was purchased to test the efficacy of deployment from a survey fishing vessels with minimal disruption to the core survey operations. Deployments continued over the next several years on a variety of vessels and areas.	FISS	3A	Angela Lynn	X											X	X	X	n/a	Spreadsheet and individual cast files, not yet in database	See Tech Rep 60
2002-present	Pacific halibut contaminant monitoring	Cooperative project with Alaska Department of Environmental Conservation, collecting muscle tissue from Pacific halibut for contaminant analysis (heavy metal, POP's)	FISS	2C, 3A, 3B, 4A, 4B, 4C, 4E	multiple	X							X							n/a		Data not yet incorporated into database
2002	PIT - Demonstration Project	Purpose of this project was to field test the PIT tagging procedures, workload, electronic equipment, deck setup, and workflow. The intent of this charter was to mimic typical IPHC setline stock assessment survey fishing so that problems and process bottlenecks could be tested and problems resolved prior to main PIT tagging experiment in 2003. - Tech Rep. 58.	Independent charter	2B	Pender Isle	X										X					stlHeader, stlHalibut, tagreleaserecovery, tagsummary	
2002	PIT - Live capture and holding	Capture of fish for live holding experiments investigating tagging location and tag retention.	Independent charter, holding tanks	3A	Free to Wander, Hotspur	X								X							stlHeader, stlHalibut, tagreleaserecovery, tagsummary	Tech Rep. 56
2002	Juvenile Otolith Elemental Fingerprinting (OEF)	Purpose was to evaluate the potential to identify regionally-distinct otolith microchemistry in order to assign individuals back to their settlement sources. Sampling in southeast Alaska (IPHC charter) specifically designed to examine temporal and small-scale spatial variability in signatures; Alaskan Peninsula samples (IPHC staff deployed to Alaska Environmental Monitoring and Assessment Program (EMAP) platform and NMFS-AFSC-Newport vessel) intended for spatial analysis. Trawl set forms (IPHC charters) detail trawl start-end times and lat-lon coordinates, water depth, water temperature, tow speed, warp length; full speciation and accounting of animal bycatch. Post-capture processing includes fish (halibut) length, sex, weight, and otolith weight, and tissue samples for archiving. For selected individuals, additional data generated characterizing isotopic concentrations within otoliths.	Independent charter, other agency charters	3A, 3B	Heron, Ocean Cape, Miss O		X	X	X	X			X		X					n/a	Spreadsheet - Not yet incorporated into database	
2002	National Marine Fisheries Service trawl survey	The National Marine Fisheries Service (NMFS) conducts bottom trawl surveys in the Gulf of Alaska (triennially until 1999, bienially after), Bering Sea (annually), and Aleutian Islands (triennially until 2000, biennially after). These surveys operate in the summer months and generally include 2-3 vessels fishing simultaneously. All halibut on the surveys are measured, and the IPHC placed one sampler on board one vessel in this survey to collect additional basic halibut information and samples. Biological data collected is used to monitor juvenile year class strength and distribution, provide information on areas not surveyed during the FISS, and as a comparison to FISS results.	Trawl survey	BS - 4A(BS), 4C, 4D, 4E, Closed area	Aldebaran		X	X	X	X	X	X						X			trlNMFSHaul, trlNMFSHalibut	
2002	Juvenile Otolith Elemental Fingerprinting (OEF)	Purpose was to evaluate the potential to identify regionally-distinct otolith microchemistry in order to assign individuals back to their settlement sources. Collection data retrieved from trawl survey database. Post-capture processing includes fish (halibut) length, sex, weight, and otolith weight; and tissue samples for archiving. For selected individuals, additional data generated characterizing isotopic concentrations within otoliths.	Trawl survey	4A, 4B, 4C, 4D, 4E	Vesteraalen, Aldebaran		X	X	X	X	X	X								n/a		Data collected during trawl survey. Specific locations not yet available.
2003	Genetics: summer sampling	See 2002 description. 2003 samples collected to generate a coastwide archive and begin a sampling program capable of investigating temporal changes. Note that a combination of port and survey collections was employed (also see FISS component).	Commercial trips	2A, 2B, 2C, 3A	multiple	X		X	X	X	X	X								n/a	Locations for commercial trips not available due to confidentiality issues.	
2003	Coastwide PIT tag release	Primary purpose was to develop estimates of exploitation rates independent of the stock assessment, secondary goal was information on migration rates. An additional 3 skates of gear was set at each FISS station to provide fish for tagging. Pacific halibut caught on the first three skates were tagged.	FISS	2A, 2B, 2C, 3A, 3B, 4A, 4B, 4C, 4D, 4E	Black hawk, Bold Pursuit, Free to Wander, Heritage, Kristiana, Norska, Pacific Sun, Predator, Star Wars II, Viking Joy, Viking Spirit, Waterfall	X										X					stlheader, stlhalibut, tagreleaserecovery, scansamples	
2003	Water column profiler environmental data collection	In 2000, one water column profiler was purchased to test the efficacy of deployment from a survey fishing vessels with minimal disruption to the core survey operations. Deployments continued over the next several years on a variety of vessels and areas.	FISS	4A, 4D	Heritage	X											X	X	X		Spreadsheet and individual cast files, not yet in database	See Tech Rep 60
2003	Genetics: summer sampling	Purpose of this study was to collect tissue samples for investigation of spatial population structure and temporal variabilty. Otoliths and associated data collected as per survey protocols; sex and ages subsequently retrieved from database. Note that 2003 collections included a combination of survey and port. Genetic data generated by UW-SAFS.	FISS and Ports	Coastwide	Bold Pursuit, Waterfall, Kristiana, Norska	X		X	X	X	X	X	X									
2003	PIT - Demonstration Project	Purpose of this project was to field test the PIT tagging procedures, workload, electronic equipment, deck setup, and workflow. The intent of this charter was to mimic typical IPHC setline stock assessment survey fishing so that problems and process bottlenecks could be tested and problems resolved prior to main PIT tagging experiment in 2003.	Independent charter	3A	Heritage	X			X			X				X					stlHeader, stlHalibut, tagreleaserecovery, tagsummary	See Tech Rep. 58
2003	PIT - Double tag shedding experiment	Purpose of this project was to determine an estimated rate at which halibut in situ shed PIT tags. This entailed a double-tagging experiment (both PIT and spaghetti tags) on popular fishing grounds in northern British Columbia.	Independent charter	2B	Pender Isle	X			X			X				X					stlHeader, stlHalibut, tagreleaserecovery, tagsummary	See Tech Rep. 58

2003	Juvenile OEF	Continued from 2002. Purpose was to evaluate the potential to identify regionally-distinct otolith microchemistry in order to assign individuals back to their settlement sources. Sampling in southeast Alaska (IPHC charter) specifically designed to examine temporal and small-scale spatial variability in signatures; Alaskan Peninsula samples (IPHC staff deployed to Alaska Environmental Monitoring and Assessment Program (EMAP) platform and NMFS-AFSC-Newport vessel) intended for spatial analysis. Trawl set forms (IPHC charters) detail trawl start-end times and lat-lon coordinates, water depth, water temperature, tow speed, warp length; full speciation and accounting of animal bycatch. Post-capture processing includes fish (halibut) length, sex, weight, and otolith weight, and tissue samples for archiving. For selected individuals, additional data generated characterizing isotopic concentrations within otoliths.	Independent charter, other agency charters	2B, 2C	Heron, Andy C, other		X	X	X	X			X	X							n/a	Spreadsheet - Not yet incorporated into database	
2003	National Marine Fisheries Service trawl survey	The National Marine Fisheries Service (NMFS) conducts bottom trawl surveys in the Gulf of Alaska (triennially until 1999, bienially after), Bering Sea (annually), and Aleutian Islands (triennially until 2000, biennially after). These surveys operate in the summer months and generally include 2-3 vessels fishing simultaneously. All halibut on the surveys are measured, and the IPHC placed one sampler on board one vessel in this survey to collect additional basic halibut information and samples. Biological data collected is used to monitor juvenile year class strength and distribution, provide information on areas not surveyed during the FISS, and as a comparison to FISS results.	Trawl survey	BS - 4A(BS), 4C, 4D, 4E, Closed area	Arcturus		X	X	X	X	X	X							X			trlNMFSHaul, trlNMFSHalibut	
2003	National Marine Fisheries Service trawl survey	The National Marine Fisheries Service (NMFS) conducts bottom trawl surveys in the Gulf of Alaska (triennially until 1999, bienially after), Bering Sea (annually), and Aleutian Islands (triennially until 2000, biennially after). These surveys operate in the summer months and generally include 2-3 vessels fishing simultaneously. All halibut on the surveys are measured, and the IPHC placed one sampler on board one vessel in this survey to collect additional basic halibut information and samples. Biological data collected is used to monitor juvenile year class strength and distribution, provide information on areas not surveyed during the FISS, and as a comparison to FISS results.	Trawl survey	GOA - 2C, 3A, 3B, 4A	Northwest Explorer, Sea Storm, Gladiator		X	X	X	X	X	X							X			trlNMFSHaul, trlNMFSHalibut	
2003	Juvenile Otolith Elemental Fingerprinting (OEF)	Purpose was to evaluate the potential to identify regionally-distinct otolith microchemistry in order to assign individuals back to their settlement sources. Collection data retrieved from trawl survey database. Post-capture processing includes fish (halibut) length, sex, weight, and otolith weight; and tissue samples for archiving. For selected individuals, additional data generated characterizing isotopic concentrations within otoliths.	Trawl survey	2C, 3A, 3B, 4A, 4B, 4C, 4E	Aldebaran, Arcturus, Sea Storm, Gladiator		X	X	X	X	X	X									n/a		Data collected during trawl survey. Specific locations not yet available.
2003	Comparison of stomach contents between PHI and non-PHI halibut	The sampler aboard the NMFS trawl survey in the Gulf of Alaska examined the stomach contents of a sub-sample of Pacific halibut - 86 with no PHI and 84 with PHI. The stomachs were weighed and dissected with prey items identified, enumerated, and weighed. The results were compared to examine feeding differences between the two groups. See 2003 RARA for report.	Trawl survey	2C, 3A, 3B, 4A	Sea Storm		X					X			X							trlNMFSHaul, trlNMFSCatch	trawl header information in database. Stomach content data in spreadsheet outside database.
2004	Bering spawning PAT tag deployment	Tim has details	FISS	4B	Heritage, Pacific Sun												X					Stlhalibut, stlheader, tagreleaserecovery	
2004	2B and 3A PIT tag release	Pacific halibut were PIT tagged in Areas 2B and 3A only. Vessels participating in the FISS in these Areas fished an extra 3 skates of gear to supply fish for tagging. Pacific halibut caught on the first 3 skates hauled were tagged.Purpose of this PIT tag experiment was to measure annual survival.	FISS	2B, 3A	Bold Pursuit, Kristiana, Pender Isle, Predator, Prosperity, Proud Venture, Star Wars II, Waterfall	X			X			X					X					stlheader, stlhalibut, tagreleaserecovery, scansamples	
2004	Water column profiler environmental data collection	In 2000, one water column profiler was purchased to test the efficacy of deployment from a survey fishing vessels with minimal disruption to the core survey operations. Deployments continued over the next several years on a variety of vessels and areas.	FISS	3A	Predator	X												X	X	X	n/a	Spreadsheet and individual cast files, not yet in database	See Tech Rep 60
2004	Juvenile OEF	Started in 2002. Purpose was to evaluate the potential to identify regionally-distinct otolith microchemistry in order to assign individuals back to their settlement sources. Sampling in southeast Alaska (IPHC charter) specifically designed to examine temporal and small-scale spatial variability in signatures; Alaskan Peninsula samples (IPHC staff deployed to Alaska Environmental Monitoring and Assessment Program (EMAP) platform and NMFS-AFSC-Newport vessel) intended for spatial analysis. Trawl set forms (IPHC charters) detail trawl start-end times and lat-lon coordinates, water depth, water temperature, tow speed, warp length; full speciation and accounting of animal bycatch. Post-capture processing includes fish (halibut) length, sex, weight, and otolith weight, and tissue samples for archiving. For selected individuals, additional data generated characterizing isotopic concentrations within otoliths.	Independent charter, other agency charters	2C	Heron		X	X	X	X			X	X							n/a	Spreadsheet - Not yet incorporated into database	
2004	Genetics: Winter Charters	Purpose of this study was to collect tissue samples from mature fish collected on winter spawning grounds for use in studies of population structure. In addition, otoliths were collected in order to age the fish and for use in a chemical analysis of spawning site fidelity, and ovaries were collected from a subsample of the females to examine maturity schedules and egg development during spawning season. Genetic data generated by UW-SAFS.	Independent charters	2B, 3A, 4D	Free to Wander, Kema Sue, Nopsa	X		X	X	X	X		X			X						stlHeader, stlHalibut, and likely other (spreadsheets etc.). See Loher/Hauser	See reporting in 2004 RARA and subsequent peer-reviewed publications.

2004	National Marine Fisheries Service trawl survey	The National Marine Fisheries Service (NMFS) conducts bottom trawl surveys in the Gulf of Alaska (triennially until 1999, bienially after), Bering Sea (annually), and Aleutian Islands (triennially until 2000, biennially after). These surveys operate in the summer months and generally include 2-3 vessels fishing simultaneously. All halibut on the surveys are measured, and the IPHC placed one sampler on board one vessel in this survey to collect additional basic halibut information and samples. Biological data collected is used to monitor juvenile year class strength and distribution, provide information on areas not surveyed during the FISS, and as a comparison to FISS results.	Trawl survey	BS - 4A(BS), 4C, 4D, 4E, Closed area	Arcturus, Aldebaran		X	X	X	X	X	X					X				trlNMFSHaul, trlNMFSHalibut	
2004	Juvenile OEF	Purpose was to evaluate the potential to identify regionally-distinct otolith microchemistry in order to assign individuals back to their settlement sources. Collection data retrieved from trawl survey database. Post-capture processing includes fish (halibut) length, sex, weight, and otolith weight; and tissue samples for archiving. For selected individuals, additional data generated characterizing isotopic concentrations within otoliths.	Trawl survey	4A, 4C, 4D, 4E	Arcturus, Aldebaran		X	X	X	X	X	X									trlNMFSHaul, trlNMFSCatch	Header information available in NMFS trawl database. Specific project information not yet available.
2005	Genetics: summer sampling	Purpose of this study was to collect tissue samples for investigation of spatial population structure and temporal variabilty. Otoliths and associated data collected as per survey protocols; sex and ages subsequently retrieved from database. Genetic data generated by UW-SAFS.	FISS	Coastwide	Black hawk, Pender Isle, Star Wars II, Viking Joy, Bold Pursuit, Predator, Waterfall, Clyde, Kema Sue, Pacific Sun	X		X	X	X	X	X			X					n/a	Spreadsheet, not yet incorporated into IPHC database	
2005	Gulf migration timing PAT tag deployment	Tim has details	FISS	2B, 2C, 3A, 3B	Bold Pursuit, Clyde, Free to Wander, Pender Isle, Predator, Star Wars II, Viking Joy, Waterfall										X						Stlhalibut, stlheader, tagreleaserecovery	
2005	Water column profiler environmental data collection	In 2000, one water column profiler was purchased to test the efficacy of deployment from a survey fishing vessels with minimal disruption to the core survey operations. Deployments continued over the next several years on a variety of vessels and areas. In 2005, a dissolved oxygen sensor was added for testing and southern British Columbia was designated the priority area for profiler deployment.	FISS	2B, 2C	Pender Isle	X										X	X	X	X	n/a	Spreadsheet and individual cast files, not yet in database	See Tech Rep 61
2005	Hook Size and Spacing Experiment	Purpose of the experiment was to estimate the relative fishing power of gear with different hook sizes and spacings compared with the standard IPHC survey gear skates of 100 #3 circle hooks, with 18-foot spacing.	Independent charter	3A	Free to Wander	X		X	X	X	X	X									stlHeader, stlHalibut	See 2005 RARA
2005	Juvenile OEF	Started in 2002. Purpose was to evaluate the potential to identify regionally-distinct otolith microchemistry in order to assign individuals back to their settlement sources. Sampling in southeast Alaska (IPHC charter) specifically designed to examine temporal and small-scale spatial variability in signatures; Alaskan Peninsula samples (IPHC staff deployed to Alaska Environmental Monitoring and Assessment Program (EMAP) platform and NMFS-AFSC-Newport vessel) intended for spatial analysis. Trawl set forms (IPHC charters) detail trawl start-end times and lat-lon coordinates, water depth, water temperature, tow speed, warp length; full speciation and accounting of animal bycatch. Post-capture processing includes fish (halibut) length, sex, weight, and otolith weight, and tissue samples for archiving. For selected individuals, additional data generated characterizing isotopic concentrations within otoliths.	Independent charter, other agency charters	2C	Heron		X	X	X	X			X	X						n/a	Spreadsheet - Not yet incorporated into database	
2005	National Marine Fisheries Service trawl survey	The National Marine Fisheries Service (NMFS) conducts bottom trawl surveys in the Gulf of Alaska (triennially until 1999, bienially after), Bering Sea (annually), and Aleutian Islands (triennially until 2000, biennially after). These surveys operate in the summer months and generally include 2-3 vessels fishing simultaneously. All halibut on the surveys are measured, and the IPHC placed one sampler on board one vessel in this survey to collect additional basic halibut information and samples. Biological data collected is used to monitor juvenile year class strength and distribution, provide information on areas not surveyed during the FISS, and as a comparison to FISS results.	Trawl survey	BS - 4A(BS), 4C, 4D, 4E, Closed area	Aldebaran		X	X	X	X	X	X					X				trlNMFSHaul, trlNMFSHalibut	
2005	National Marine Fisheries Service trawl survey	The National Marine Fisheries Service (NMFS) conducts bottom trawl surveys in the Gulf of Alaska (triennially until 1999, bienially after), Bering Sea (annually), and Aleutian Islands (triennially until 2000, biennially after). These surveys operate in the summer months and generally include 2-3 vessels fishing simultaneously. All halibut on the surveys are measured, and the IPHC placed one sampler on board one vessel in this survey to collect additional basic halibut information and samples. Biological data collected is used to monitor juvenile year class strength and distribution, provide information on areas not surveyed during the FISS, and as a comparison to FISS results.	Trawl survey	GOA - 2C, 3A, 3B, 4A	Sea Storm		X	X	X	X	X	X					X				trlNMFSHaul, trlNMFSHalibut	
2005	Juvenile OEF	Purpose was to evaluate the potential to identify regionally-distinct otolith microchemistry in order to assign individuals back to their settlement sources. Collection data retrieved from trawl survey database. Post-capture processing includes fish (halibut) length, sex, weight, and otolith weight; and tissue samples for archiving. For selected individuals, additional data generated characterizing isotopic concentrations within otoliths.	Trawl survey	2C, 3A, 3B, 4A	Sea Storm, Gladiator		X	X	X	X	X	X									trlNMFSHaul, trlNMFSCatch	Header information available in NMFS trawl database. Specific project information not yet available.
2006	Halibut aggregation by sex and size	Work conducted to investigate the hypothesis that Pacific halibut are captured on longlines in spatial aggregation that is non-random with respect to their length and sex. Data were survey-standard but conducted at the hook-by-hook level. See J. Hobden internship and publication in Fishery Bulletin 2011, 110:46.	FISS	4B	Kema Sue	X		X	X	X	X	X								n/a	Spreadsheet - not yet incorporated into IPHC database.	
2006	2A dispersal PAT tag deployment	Tim has details	FISS	2A, 2B	Proud Venture, Star Wars II, Black Hawk, Pender Isle										X						Stlhalibut, stlheader, tagreleaserecovery	

2006	Bering spawning PAT tag deployment	Tim has details	FISS	4A, 4D	Heritage, Pacific Sun													X									Stlhalibut, stlheader, tagreleaserecovery	
2006	Water column profiler environmental data collection	In 2000, one water column profiler was purchased to test the efficacy of deployment from a survey fishing vessels with minimal disruption to the core survey operations. Deployments continued over the next several years on a variety of vessels and areas. In 2005, a dissolved oxygen sensor was added for testing and southern British Columbia was designated the priority area for profiler deployment.	FISS	2B, 2C	Pender Isle	X														X	X	X		X		n/a	Spreadsheet and individual cast files, not yet in database	See Tech Rep 62
2006	DIDSON Pot Study of Halibut and Rockfish Behavior	The purpose of the experiment was to try different pot modifications and determine their effect on the catch of these species using a high frequency acoustic camera (DIDSON). This study was designed to investigate halibut and rockfish behaviors, which might be exploited to catch halibut without catching rockfish.	Independent charter	2B	Ocean Pearl			X											X								stlHeader, stlHalibut, and likely other (spreadsheets, DIDSON imagery etc.).	See 2006 RARA
2006	National Marine Fisheries Service trawl survey	The National Marine Fisheries Service (NMFS) conducts bottom trawl surveys in the Gulf of Alaska (triennially until 1999, bienially after), Bering Sea (annually), and Aleutian Islands (triennially until 2000, biennially after). These surveys operate in the summer months and generally include 2-3 vessels fishing simultaneously. All halibut on the surveys are measured, and the IPHC placed one sampler on board one vessel in this survey to collect additional basic halibut information and samples. Biological data collected is used to monitor juvenile year class strength and distribution, provide information on areas not surveyed during the FISS, and as a comparison to FISS results.	Trawl survey	BS - 4A(BS), 4C, 4D, 4E, Closed area	Arcturus		X			X	X	X	X	X							X						trlNMFSHaul, trlNMFSHalibut	
2007	Water column profiler environmental data collection	This is a continuation of the profiler program started in 2000. In 2007, the IPHC received a grant from Oregon department of Fish and Wildlife for the purchase of an additional profiler for deployment off of the coast of Oregon. This profiler measured pH and chlorophyll concentration in addition to the other measurements.	FISS	2A, 2B, 2C	Pender Isle, Bernice	X														X	X	X	X	X	X	n/a	Spreadsheet and individual cast files, not yet in database	See Tech Rep 63
2007	DIDSON - Halibut Hooking Success	The purpose of the experiment was to investigate halibut hooking behaviors to better describe the hooking success curve for halibut on #3 circle hooks.	Independent charter	3A	Free to Wander				X																		and likely other (spreadsheets, DIDSON imagery etc.).	See 2007 RARA
2007	Genetics: Winter Charters	Purpose of this study was to collect tissue samples from mature fish collected on winter spawning grounds for use in studies of population structure. In addition, otoliths were collected in order to age the fish and for use in a chemical analysis of spawning site fidelity, and ovaries were collected from a subsample of the females to examine maturity schedules and egg development during spawning season. Genetic data generated by UW-SAFS.	Independent charter	2B, 3A, 4B, 4D	Banker II, Predator, Kema Sue	X				X	X	X	X		X		X										stlHeader, stlHalibut, and likely other (spreadsheets etc.). See Loher/Hauser	See reporting in 2004 RARA and subsequent peer-reviewed publications.
2007	Dogfish Shark Avoidance - Mischmetal	The purpose of the experiment was to assess whether the magnetic fields of rare earth metals could be used to keep dogfish off of longline gear.	Independent charter	3A	Predator	X										X											and likely other (spreadsheets etc.). See Kaimmer.	See 2007 RARA
2007	Hook Size and Spacing Experiment	Purpose of the experiment was to estimate the relative fishing power of gear with different hook sizes and spacings compared with the standard IPHC survey gear skates of 100 #3 circle hooks, with 18-foot spacing, and was a follow up to the 2005 experiment.	Independent charter	2C	Proud Venture	X				X	X	X	X			X											stlHeader, stlHalibut	See 2007 RARA
2007	Juvenile OEF	See previous year's descriptions, noting: a) 2007 sampling was simply intended to begin the mapping of nurseries for subsequent coastwide sampling; b) no chemical analyses were conducted on these fish and disposition of dissection data and otoliths is currently undetermined.	Independent charter	2B	Royal Pride		X			X	X	X			X	X											??	
2007	National Marine Fisheries Service trawl survey	The National Marine Fisheries Service (NMFS) conducts bottom trawl surveys in the Gulf of Alaska (triennially until 1999, bienially after), Bering Sea (annually), and Aleutian Islands (triennially until 2000, biennially after). These surveys operate in the summer months and generally include 2-3 vessels fishing simultaneously. All halibut on the surveys are measured, and the IPHC placed one sampler on board one vessel in this survey to collect additional basic halibut information and samples. Biological data collected is used to monitor juvenile year class strength and distribution, provide information on areas not surveyed during the FISS, and as a comparison to FISS results.	Trawl survey	BS - 4A(BS), 4C, 4D, 4E, Closed area	Arcturus, Aldebaran		X			X	X	X	X	X							X						trlNMFSHaul, trlNMFSHalibut	
2007	National Marine Fisheries Service trawl survey	The National Marine Fisheries Service (NMFS) conducts bottom trawl surveys in the Gulf of Alaska (triennially until 1999, bienially after), Bering Sea (annually), and Aleutian Islands (triennially until 2000, biennially after). These surveys operate in the summer months and generally include 2-3 vessels fishing simultaneously. All halibut on the surveys are measured, and the IPHC placed one sampler on board one vessel in this survey to collect additional basic halibut information and samples. Biological data collected is used to monitor juvenile year class strength and distribution, provide information on areas not surveyed during the FISS, and as a comparison to FISS results.	Trawl survey	GOA - 2C, 3A, 3B, 4A	Gladiator		X			X	X	X	X	X							X						trlNMFSHaul, trlNMFSHalibut	
2008	Bering dispersal PAT tag deployment	Tim has details	FISS	4A, 4B, 4C, 4D	Free to Wander, Kema Sue													X									Stlhalibut, stlheader, tagreleaserecovery	
2008	Water column profiler environmental data collection	This is a continuation of the profiler program started in 2000. In 2007, the IPHC received a grant from Oregon department of Fish and Wildlife for the purchase of an additional profiler for deployment off of the coast of Oregon. This profiler measured pH and chlorophyll concentration in addition to the other measurements.	FISS	2A, 2B	Star Wars II, Bernice	X														X	X	X	X	X	X	n/a	Spreadsheet and individual cast files, not yet in database	See Tech Rep 64
2008	Depletion/Removal Fishing	Removal fishing to estimate catch probability.	Independent charter	3A	Bold Pursuit	X				X	X	X	X			X											stlHeader, stlHalibut	See 2008 RARA
2008	DIDSON - Halibut Hooking Success	The purpose of the experiment was to continue to investigate halibut hooking behaviors to better describe the hooking success curve for halibut on #3 16/0 circle hooks similar to the work of 2007, as well as 14/0 hooks. - 2008 RARA.	Independent charter	3A	Free to Wander				X																		stlHeader, stlHalibut, and likely other (spreadsheets, DIDSON imagery etc.).	See 2008 RARA

2008	Effects of Swivel Gear on Halibut Catch Rates	Purpose of this study was to compare swivel and non-swivel gear in Regulatory Area 2B. Perlon gear with swivels on the hook eyes was tested against a non-swiveled, nylon gangion gear.	Independent charter	2B	Vanisle	X		X	X	X	X				X												stlHeader, stlHalibut	See 2008 RARA
2008	Archival Tagging Deployment - Migration and Behavior	Electronic tagging program to study multi-year behavior of individual halibut, and behavior of sublegal fish that have traditionally been considered too small to carry Pop-up Archival Transmitting tags. Fish were deployed during the Gear Swivel study noted above.	Independent charter	2B	Vanisle	X												X									stlHeader, stlHalibut, tagreleaserecovery, tagsummary, and likely other (along with spreadsheets, see Loher).	See 2008 RARA
2008	Ultrasonic sex determination	Work conducted to establish protocols for non-invasive determination of sex - and potenitally maturity status - of Pacific halibut using veterinary ultrasound. 2008 was initial phase conducted using captive fish and during the swivel gear study. Data include fish sex and gonad morphometrics and ultrasound images.	Independent charter, fish holding facility	2A	Vanisle, Heidi Sue	X				X	X					X	X		X							n/a	??	See S. Stephens internship and publication in North American Journal of Fisheries Management 2011, 31:1034.
2008	National Marine Fisheries Service trawl survey	The National Marine Fisheries Service (NMFS) conducts bottom trawl surveys in the Gulf of Alaska (triennially until 1999, bienially after), Bering Sea (annually), and Aleutian Islands (triennially until 2000, biennially after). These surveys operate in the summer months and generally include 2-3 vessels fishing simultaneously. All halibut on the surveys are measured, and the IPHC placed one sampler on board one vessel in this survey to collect additional basic halibut information and samples. Biological data collected is used to monitor juvenile year class strength and distribution, provide information on areas not surveyed during the FISS, and as a comparison to FISS results.	Trawl survey	BS - 4A(BS), 4C, 4D, 4E, Closed area	Aldebaran		X	X	X	X	X	X									X						trlNMFSHaul, trlNMFSHalibut	
2009-present	Water column profiler environmental data collection	Following a successful multi-year feasibility study started in 2000, a grant was received by IPHC from the National Oceanic and Atmospheric Administration to purchase enough profiling units to outfit every survey vessel. Beginning in 2009, water column profiles have been collected at each standard survey station coastwide just prior to hauling the gear. One exception is when fishing deep expansion stations where maximum depth exceedes the standard maximum depth of ~550 m. In those cases the profiler is not deployed. The IPHC has a contract with NOAA/JISAO for processing of the full profiles through 2016. For 2017 forward, the IPHC will be processing the data either in-house or via contractor yet to be named.	FISS	2A, 2B, 2C, 3A, 3B, 4A, 4B, 4C, 4D, 4E	All FISS vessels	X														X	X	X	X	X	X		stlWaterColumnBottom, stlWaterColumn, individual cast files	See Tech Rep. 60
2009	Ultrasonic sex determination	Work conducted to establish protocols for non-invasive determination of sex - and potenitally maturity status - of Pacific halibut using veterinary ultrasound. 2009 was fiel;d work conducted as student internship. Data include fish sex and gonad morphometrics and ultrasound images. See S. Stephens internship and publication in North American Journal of Fisheries Management 2011, 31:1034.	FISS		Waterfall	X		X	X	X	X	X				X	X		X								stlHeader, stlHalibut	Header information available in setline survey database. Images and morphometrics not in database.
2009	Bering dispersal PAT tag deployment	Tim has details	FISS	4C, 4D	Kema Sue													X									Stlhalibut, stlheader, tagreleaserecovery	
2009	Live Fish Collection for Archival Tagging Study	Twenty four (24) halibut ranging from 66-89cm (26-35 in) fork length were collected during June, 2009, and placed in captivity at the Oregon Coast Aquarium for tag attachment and retention studies.	Independent charter	2A	Heidi Sue									X												n/a	??	See 2009 RARA
2009	Dummy Archival Tag Release	Pacific halibut were captured south of Kodiak Island during September 2009, and tagged with either an internal or external dummy archival tag, in addition to a wire opercular tag. These fish were released at their collection locations. Fishery recoveries will provide a long-term comparison of relative recovery probabilities associated with internal versus external tagging, integrating differences in fish mortality, tag shedding, and differential detection rates between tag treatments.	Independent charter	3B	Vanisle													X									tagreleaserecovery, tagsummary (not in stlheader or stlhalibut--setforms were lost, data imported into tag tables from excel sheet)	See 2009 RARA
2009	Ultrasonic sex determination	Work conducted to establish protocols for non-invasive determination of sex - and potenitally maturity status - of Pacific halibut using veterinary ultrasound. 2009 was the continuation of the study started in 2008 and saw additional work during the Oregon live-fish collection charter and on survey. Data include fish sex and gonad morphometrics and ultrasound images.	Independent charter, FISS	2A	Vanisle, Heidi Sue	X				X	X					X	X		X							n/a	??	See S. Stephens internship and publication in North American Journal of Fisheries Management 2011, 31:1034.
2009	National Marine Fisheries Service trawl survey	The National Marine Fisheries Service (NMFS) conducts bottom trawl surveys in the Gulf of Alaska (triennially until 1999, bienially after), Bering Sea (annually), and Aleutian Islands (triennially until 2000, biennially after). These surveys operate in the summer months and generally include 2-3 vessels fishing simultaneously. All halibut on the surveys are measured, and the IPHC placed one sampler on board one vessel in this survey to collect additional basic halibut information and samples. Biological data collected is used to monitor juvenile year class strength and distribution, provide information on areas not surveyed during the FISS, and as a comparison to FISS results.	Trawl survey	BS - 4A(BS), 4C, 4D, 4E, Closed area	Arcturus		X	X	X	X	X	X									X						trlNMFSHaul, trlNMFSHalibut	
2009	National Marine Fisheries Service trawl survey	The National Marine Fisheries Service (NMFS) conducts bottom trawl surveys in the Gulf of Alaska (triennially until 1999, bienially after), Bering Sea (annually), and Aleutian Islands (triennially until 2000, biennially after). These surveys operate in the summer months and generally include 2-3 vessels fishing simultaneously. All halibut on the surveys are measured, and the IPHC placed one sampler on board one vessel in this survey to collect additional basic halibut information and samples. Biological data collected is used to monitor juvenile year class strength and distribution, provide information on areas not surveyed during the FISS, and as a comparison to FISS results.	Trawl survey	GOA - 2C, 3A, 3B, 4A	Pacific Explorer		X	X	X	X	X	X									X						trlNMFSHaul, trlNMFSHalibut	
2010	Sex ratio analysis	Purpose of this study was to collect sex and age data on commercial vessels along with tissue samples for subsequent sex assay, in order to investigate the hypothesis that commercial sex-at-length-and-age distributions differs between survey and commercial harvests. Genetic assays conducted generated by UW-SAFS.	Commercial trips	2B, 3A, 4C	Ashley Erin, Kruzof, various St. Paul Island vessels	X		X	X	X	X		X													n/a	location data not available due to confidentiality concerns with commercial data	See M. Woods internship; 2010 and 2011 RARAs; and subsequent peer-reviewed publications.
2010	Conventional Tag Releases on Commercial Grounds in 4B	Purpose of this study was to investigate the possibility of enhancing tag recovery rates by focusing releases on active commercial fishing grounds instead of at IPHC survey stations.	Independent charter	4B	Pacific Sun	X												X									stlHeader, stlHalibut, tagreleaserecovery, spreadsheets not yet in database	See 2010 RARA

2009-2011	Deepwater acoustic range test	Study designed to invesigate efficacy of acoustic tagging for studies of movement in demersal fishes - sablefish and halibut in particular - with respect to detection range in water depths of 200-600m, and correlated with various noise-generating and attenuating oceanographic features. Data primarily in the form of the timing of individual tag detections and partial code-bursts as received at acoustic receivers. Collaborative project: all field work and data acquisition conducted under the auspices of D. Carlile, ADF&G Juneau, retired.	Other agency charters	2C	Medeia, Seaview			X								X			n/a		See publication in Animal Biotelemetry 2017, 5:27.
2010	National Marine Fisheries Service trawl survey	The National Marine Fisheries Service (NMFS) conducts bottom trawl surveys in the Gulf of Alaska (triennially until 1999, bienially after), Bering Sea (annually), and Aleutian Islands (triennially until 2000, biennially after). These surveys operate in the summer months and generally include 2-3 vessels fishing simultaneously. All halibut on the surveys are measured, and the IPHC placed one sampler on board one vessel in this survey to collect additional basic halibut information and samples. Biological data collected is used to monitor juvenile year class strength and distribution, provide information on areas not surveyed during the FISS, and as a comparison to FISS results.	Trawl survey	BS - 4A(BS), 4C, 4D, 4E, Closed area	Aldebaran, Vesteraalen		X		X	X	X	X	X					X		trlNMFSHaul, trlNMFSHalibut	
2011	Sex ratio analysis	Continued from 2010. Purpose of this study was to collect sex and age data on commercial vessels along with tissue samples for subsequent sex assay, in order to investigate the hypothesis that commercial sex-at-length-and-age distributions differs between survey and commercial harvests. Genetic assays conducted generated by UW-SAFS.	Commercial trips	2B, 3B, 4A, 4D	Waterfall, Kema Sue, Aleutian Sable	X			X	X	X	X		X					n/a	location data not available due to confidentiality concerns with commercial data	See M. Woods internship; 2010 and 2011 RARAs; and subsequent peer-reviewed publications.
2011	Geomagnetic Tag Releases	Deployment of geomagnet archival tags during the 2011 Bait Comparison Pilot's as described above (FTW), and from setline survey operations (STW).	FISS, Independent charter	3A	Free to Wander, Star Wars II	X										X				stlHeader, stlHalibut, tagreleaserecovery and spreadsheets not yet in database	See 2011 RARA
2011	Bait Comparison Pilot	Pilot study comparing the IPHC standard survey bait of chum salmon with three alternative bait species conducted in regions in Area 3A. A major goal of this pilot study was to provide information on variability of catch rates for use in designing a large scale experiment to be carried out in 2012. Secondly, the results would aid in the selection of one of two competing designs.	Independent charter	3A	Free to Wander, Vanisle	X			X	X	X	X			X					stlHeader, stlHalibut	See 2011 RARA
2011	National Marine Fisheries Service trawl survey	The National Marine Fisheries Service (NMFS) conducts bottom trawl surveys in the Gulf of Alaska (triennially until 1999, bienially after), Bering Sea (annually), and Aleutian Islands (triennially until 2000, biennially after). These surveys operate in the summer months and generally include 2-3 vessels fishing simultaneously. All halibut on the surveys are measured, and the IPHC placed one sampler on board one vessel in this survey to collect additional basic halibut information and samples. Biological data collected is used to monitor juvenile year class strength and distribution, provide information on areas not surveyed during the FISS, and as a comparison to FISS results.	Trawl survey	BS - 4A(BS), 4C, 4D, 4E, Closed area	Alaska Knight		X		X	X	X	X	X					X		trlNMFSHaul, trlNMFSHalibut	
2011	National Marine Fisheries Service trawl survey	The National Marine Fisheries Service (NMFS) conducts bottom trawl surveys in the Gulf of Alaska (triennially until 1999, bienially after), Bering Sea (annually), and Aleutian Islands (triennially until 2000, biennially after). These surveys operate in the summer months and generally include 2-3 vessels fishing simultaneously. All halibut on the surveys are measured, and the IPHC placed one sampler on board one vessel in this survey to collect additional basic halibut information and samples. Biological data collected is used to monitor juvenile year class strength and distribution, provide information on areas not surveyed during the FISS, and as a comparison to FISS results.	Trawl survey	GOA - 2C, 3A, 3B, 4A	Ocean Explorer		X		X	X	X	X	X					X		trlNMFSHaul, trlNMFSHalibut	
2012	Modified Circle Hook (whisker hook study) to reduce rockfish bycatch.	Purpose of this study was to see if circle hooks could be modified to reduce rockfish bycatch. Spring wires of various thicknesses, were attached across the gap of the hook, hypothesizing that fish with less aggressive hook attacks might not hook as readily due to the wires.	Independent charter		Towego	X											X			stlHeader, possibly stlHalibut, and likely in spreadsheets and video files (Kaimmer)	See 2012 RARA
2012	National Marine Fisheries Service trawl survey	The National Marine Fisheries Service (NMFS) conducts bottom trawl surveys in the Gulf of Alaska (triennially until 1999, bienially after), Bering Sea (annually), and Aleutian Islands (triennially until 2000, biennially after). These surveys operate in the summer months and generally include 2-3 vessels fishing simultaneously. All halibut on the surveys are measured, and the IPHC placed one sampler on board one vessel in this survey to collect additional basic halibut information and samples. Biological data collected is used to monitor juvenile year class strength and distribution, provide information on areas not surveyed during the FISS, and as a comparison to FISS results.	Trawl survey	AI - 4A, 4B	Ocean Explorer		X		X	X	X	X	X					X		trlNMFSHaul, trlNMFSHalibut	
2012	National Marine Fisheries Service trawl survey	The National Marine Fisheries Service (NMFS) conducts bottom trawl surveys in the Gulf of Alaska (triennially until 1999, bienially after), Bering Sea (annually), and Aleutian Islands (triennially until 2000, biennially after). These surveys operate in the summer months and generally include 2-3 vessels fishing simultaneously. All halibut on the surveys are measured, and the IPHC placed one sampler on board one vessel in this survey to collect additional basic halibut information and samples. Biological data collected is used to monitor juvenile year class strength and distribution, provide information on areas not surveyed during the FISS, and as a comparison to FISS results.	Trawl survey	BS - 4A(BS), 4C, 4D, 4E, Closed area	Alaska Knight		X		X	X	X	X	X					X		trlNMFSHaul, trlNMFSHalibut	
2013	National Marine Fisheries Service trawl survey	The National Marine Fisheries Service (NMFS) conducts bottom trawl surveys in the Gulf of Alaska (triennially until 1999, bienially after), Bering Sea (annually), and Aleutian Islands (triennially until 2000, biennially after). These surveys operate in the summer months and generally include 2-3 vessels fishing simultaneously. All halibut on the surveys are measured, and the IPHC placed one sampler on board one vessel in this survey to collect additional basic halibut information and samples. Biological data collected is used to monitor juvenile year class strength and distribution, provide information on areas not surveyed during the FISS, and as a comparison to FISS results.	Trawl survey	BS - 4A(BS), 4C, 4D, 4E, Closed area	Alaska Knight		X		X	X	X	X	X					X		trlNMFSHaul, trlNMFSHalibut	

2013	National Marine Fisheries Service trawl survey	The National Marine Fisheries Service (NMFS) conducts bottom trawl surveys in the Gulf of Alaska (triennially until 1999, bienially after), Bering Sea (annually), and Aleutian Islands (triennially until 2000, biennially after). These surveys operate in the summer months and generally include 2-3 vessels fishing simultaneously. All halibut on the surveys are measured, and the IPHC placed one sampler on board one vessel in this survey to collect additional basic halibut information and samples. Biological data collected is used to monitor juvenile year class strength and distribution, provide information on areas not surveyed during the FISS, and as a comparison to FISS results.	Trawl survey	GOA - 2C, 3A, 3B, 4A	Alaska Provider		X		X	X	X	X	X						X		trlNMFSHaul, trlNMFSHalibut	
2014	Salish Sea PAT tag deployment	Tim has details	FISS	2A, 2B	Pacific Surveyor												X				Stlhalibut, stlheader, tagreleaserecovery	
2014	PAT Deployment in Salish Sea	Purpose was to deploy PAT tags investigating seasonal dispersal of Pacific halibut in the southern Salish Sea. - 2014 RARA.	FISS	2A	Pacific Surveyor	X				X							X				stlHeader, stlHalibut, tagreleaserecovery and spreadsheets.	
2014	Estimating Hooking Success of Large Halibut	Purpose of this study was to investigate hooking success of large halibut (>110cm) on single baited hooks via observations from an underwater GoPro camera.	Independent charter	3A	Venturess			X										X			stlHeader, possibly stlHalibut, and likely in spreadsheets and video files (Kaimmer)	See 2014 RARA
2014	National Marine Fisheries Service trawl survey	The National Marine Fisheries Service (NMFS) conducts bottom trawl surveys in the Gulf of Alaska (triennially until 1999, bienially after), Bering Sea (annually), and Aleutian Islands (triennially until 2000, biennially after). These surveys operate in the summer months and generally include 2-3 vessels fishing simultaneously. All halibut on the surveys are measured, and the IPHC placed one sampler on board one vessel in this survey to collect additional basic halibut information and samples. Biological data collected is used to monitor juvenile year class strength and distribution, provide information on areas not surveyed during the FISS, and as a comparison to FISS results.	Trawl survey	AI - 4A, 4B	Alaska Provider		X		X	X	X	X	X						X		trlNMFSHaul, trlNMFSHalibut	
2014	National Marine Fisheries Service trawl survey	The National Marine Fisheries Service (NMFS) conducts bottom trawl surveys in the Gulf of Alaska (triennially until 1999, bienially after), Bering Sea (annually), and Aleutian Islands (triennially until 2000, biennially after). These surveys operate in the summer months and generally include 2-3 vessels fishing simultaneously. All halibut on the surveys are measured, and the IPHC placed one sampler on board one vessel in this survey to collect additional basic halibut information and samples. Biological data collected is used to monitor juvenile year class strength and distribution, provide information on areas not surveyed during the FISS, and as a comparison to FISS results.	Trawl survey	BS - 4A(BS), 4C, 4D, 4E, Closed area	Alaska Knight, Vesteraalen		X		X	X	X	X	X						X		trlNMFSHaul, trlNMFSHalibut	
2015	Sex marking: port samples	Purpose of this study was to collect length, age, and physical sex-mark data from commercial offloads, along with tissue samples for subsequent sex assay, in order to investigate the accuracy/efficacy of developing a commercial sex-marking program. 2015 was a 2-vessel pilot conducted in Seward with the assistance of J. Marx. Genetic assays conducted generated by UW-SAFS.	Commercial trips	3A	Predator, Sheik	X			X	X					X	X				n/a	location data not available due to confidentiality concerns with commercial data	See O. McCarthy internship; and 2015 RARA
2015	National Marine Fisheries Service trawl survey	The National Marine Fisheries Service (NMFS) conducts bottom trawl surveys in the Gulf of Alaska (triennially until 1999, bienially after), Bering Sea (annually), and Aleutian Islands (triennially until 2000, biennially after). These surveys operate in the summer months and generally include 2-3 vessels fishing simultaneously. All halibut on the surveys are measured, and the IPHC placed one sampler on board one vessel in this survey to collect additional basic halibut information and samples. Biological data collected is used to monitor juvenile year class strength and distribution, provide information on areas not surveyed during the FISS, and as a comparison to FISS results.	Trawl survey	BS - 4A(BS), 4C, 4D, 4E, Closed area	Alaska Knight		X		X	X	X	X	X						X		trlNMFSHaul, trlNMFSHalibut	
2015	National Marine Fisheries Service trawl survey	The National Marine Fisheries Service (NMFS) conducts bottom trawl surveys in the Gulf of Alaska (triennially until 1999, bienially after), Bering Sea (annually), and Aleutian Islands (triennially until 2000, biennially after). These surveys operate in the summer months and generally include 2-3 vessels fishing simultaneously. All halibut on the surveys are measured, and the IPHC placed one sampler on board one vessel in this survey to collect additional basic halibut information and samples. Biological data collected is used to monitor juvenile year class strength and distribution, provide information on areas not surveyed during the FISS, and as a comparison to FISS results.	Trawl survey	GOA - 2C, 3A, 3B, 4A	Sea Storm		X		X	X	X	X	X						X		trlNMFSHaul, trlNMFSHalibut	
2015	Wire tagging pilot on NMFS trawl surveys	Purpose was to evaluate feasibility of wire tagging a portion of Pacific halibut caught on the NMFS trawl survey on vessels staffed by an IPHC sampler. Fifty percent of captured Pacific halibut were randomly chosen for tagging, the other 50% were sampled for otoliths and other biological data.	Trawl survey	2C, 3A, 3B, 4A, 4C, 4D, 4E, Closed area	Alaska Knight, Sea Storm		X							X			X					
2016	Sex marking: port samples	Begun in 2015, this study's purpose was to collect length, age, and physical sex-mark data from commercial offloads, along with tissue samples for subsequent sex assay, in order to investigate the accuracy/efficacy of developing a commercial sex-marking program.2016 was a scale-up to Area 2B.	Commercial trips	2B	multiple	X			X	X					X	X				n/a	location data not available due to confidentiality concerns with commercial data	See 2016 RARA
2016	Wire tagging U32 Pacific halibut on FISS: pilot study	Purpose was to evaluate feasibility of wire tagging a portion of U32 Pacific halibut caught on the FISS. An area with relatively low catch rates of U32 halibut was chosen to minimize impact on other survey activities. 75% of fish were sampled for otoliths, and U32 fish from the remaining 25% were tagged and released.	FISS	4D	Sunward, St. Peter	X								X			X				stlHeader, stlHalibut	
2016	4D PAT tag deployment	Tim has details	FISS	4D	St. Peter	X											X				Stlhalibut, stlheader, tagreleaserecovery	

	2016	National Marine Fisheries Service trawl survey	The National Marine Fisheries Service (NMFS) conducts bottom trawl surveys in the Gulf of Alaska (triennially until 1999, bienially after), Bering Sea (annually), and Aleutian Islands (triennially until 2000, biennially after). These surveys operate in the summer months and generally include 2-3 vessels fishing simultaneously. All halibut on the surveys are measured, and the IPHC placed one sampler on board one vessel in this survey to collect additional basic halibut information and samples. Biological data collected is used to monitor juvenile year class strength and distribution, provide information on areas not surveyed during the FISS, and as a comparison to FISS results.	Trawl survey	AI - 4A, 4B	Sea Storm		X	X	X	X	X	X							X		trlNMFSHaul, trlNMFSHalibut	
	2016	National Marine Fisheries Service trawl survey	The National Marine Fisheries Service (NMFS) conducts bottom trawl surveys in the Gulf of Alaska (triennially until 1999, bienially after), Bering Sea (annually), and Aleutian Islands (triennially until 2000, biennially after). These surveys operate in the summer months and generally include 2-3 vessels fishing simultaneously. All halibut on the surveys are measured, and the IPHC placed one sampler on board one vessel in this survey to collect additional basic halibut information and samples. Biological data collected is used to monitor juvenile year class strength and distribution, provide information on areas not surveyed during the FISS, and as a comparison to FISS results.	Trawl survey	BS - 4A(BS), 4C, 4D, 4E, Closed area	Vesteraalen		X	X	X	X	X	X							X		trlNMFSHaul, trlNMFSHalibut	
	2016	Wire tagging U32 Pacific halibut on NMFS trawl surveys	Goal is to obtain information on movement of young Pacific halibut through tag recoveries. Tagging took place on NMFS trawl vessels staffed with an IPHC sampler. Fifty percent of captured Pacific halibut were randomly selected for otolith sampling, the other 50% became potential tagging candidates, however only U32 halibut were tagged, O32 halibut were measured and released.	Trawl survey	4A, 4B, 4C, 4D, 4E	Sea Storm, Vesteraalen		X						X					X			stlHeader, stlHalibut	
	2017	Sex marking: port samples	See 2015 description. 2017 was scale-up to coastwide with all samples collected through the port sampling program. In theory, all of the collection and mark data should reside in the commercial database; "age" lab generating and curating all sex assay information.	Commercial trips	Coastwide	multiple	X		X	X						X	X					??	See 2017 RARA
	2017	Wire tagging U32 Pacific halibut on FISS	U32 wire tagging took place on all FISS areas where otolith sampling was less than 100%. A portion of U32 Pacific halibut not sampled for otoliths were wire tagged and released. Each year, a tagging rate was calculated for each regulatory area with the goal of tagging 500 U32 fish per regulatory area (similar to the otolith sampling rate).	FISS	2B, 2C, 3A, 3B, 4A, 4B	Allstar, Bold Pursuit, Clyde, Free to Wander, Kema Sue, Norcoaster, Pender Isle, Predator, Saint Nicholas, Star Wars II, Vanisle	X							X	X				X			stlHeader, stlHalibut	
	2017	4B PAT tag deployment	Tim has details	FISS	4B	Kema Sue	X												X			Stlhalibut, stlheader, tagreleaserecovery	
	2017	Discard Mortality Rate (DMR) study on DMRs in the directed longline fishery	Purpose of this study was to investigate the relationship between Pacific halibut release practices, physiological condition, injury levels, and post-release survival in an effort to improve discard mortality rate estimates in the directed Pacific halibut longline fishery.	Independent charter		Kema Sue	X							X					X			stlHeader, stlHalibut, tagreleaserecovery, and spreadsheets for PAT data	
2017-2018		Reproductive Assessment Project	Purpose of this study is to collect Pacific halibut of both sexes on a monthly basis during an entire annual reproductive cycle from the central Gulf of Alaska region, to collect samples and data on the annual reproductive cycle	Independent charter	3A		X		X	X	X	X	X			X		X			n/a	Not yet available	
	2017	National Marine Fisheries Service trawl survey	The National Marine Fisheries Service (NMFS) conducts bottom trawl surveys in the Gulf of Alaska (triennially until 1999, bienially after), Bering Sea (annually), and Aleutian Islands (triennially until 2000, biennially after). These surveys operate in the summer months and generally include 2-3 vessels fishing simultaneously. All halibut on the surveys are measured, and the IPHC placed one sampler on board one vessel in this survey to collect additional basic halibut information and samples. Biological data collected is used to monitor juvenile year class strength and distribution, provide information on areas not surveyed during the FISS, and as a comparison to FISS results.	Trawl survey	BS - 4A(BS), 4C, 4D, 4E, Closed area	Vesteraalen		X	X	X	X	X	X		X					X		trlNMFSHaul, trlNMFSHalibut	
	2017	National Marine Fisheries Service trawl survey	The National Marine Fisheries Service (NMFS) conducts bottom trawl surveys in the Gulf of Alaska (triennially until 1999, bienially after), Bering Sea (annually), and Aleutian Islands (triennially until 2000, biennially after). These surveys operate in the summer months and generally include 2-3 vessels fishing simultaneously. All halibut on the surveys are measured, and the IPHC placed one sampler on board one vessel in this survey to collect additional basic halibut information and samples. Biological data collected is used to monitor juvenile year class strength and distribution, provide information on areas not surveyed during the FISS, and as a comparison to FISS results.	Trawl survey	GOA - 2C, 3A, 3B, 4A	Ocean Explorer		X	X	X	X	X	X		X					X		trlNMFSHaul, trlNMFSHalibut	
	2017	Wire tagging U32 Pacific halibut on NMFS trawl surveys	Goal is to obtain information on movement of young Pacific halibut through tag recoveries. Tagging took place on NMFS trawl vessels staffed with an IPHC sampler in both survey regions and on the non-IPHC Bering Sea vessel. On IPHC-staffed vessels, 50% of captured Pacific halibut were randomly selected for otolith sampling; the other 50% became potential tagging candidates, however only U32 halibut were tagged, O32 halibut were measured and released. On the non-IPHC vessel in the Bering Sea, Pacific halibut were also randomly assigned to a tagging and non-tagging group (50% in each group) but otoliths were not collected from the non-tagging group.	Trawl survey	2C, 3A, 3B, 4A, 4C, 4D, 4E	Vesteraalen, Sea Storm, Alaska Knight		X						X	X				X			trlNMFSHaul, trlNMFSHalibut	

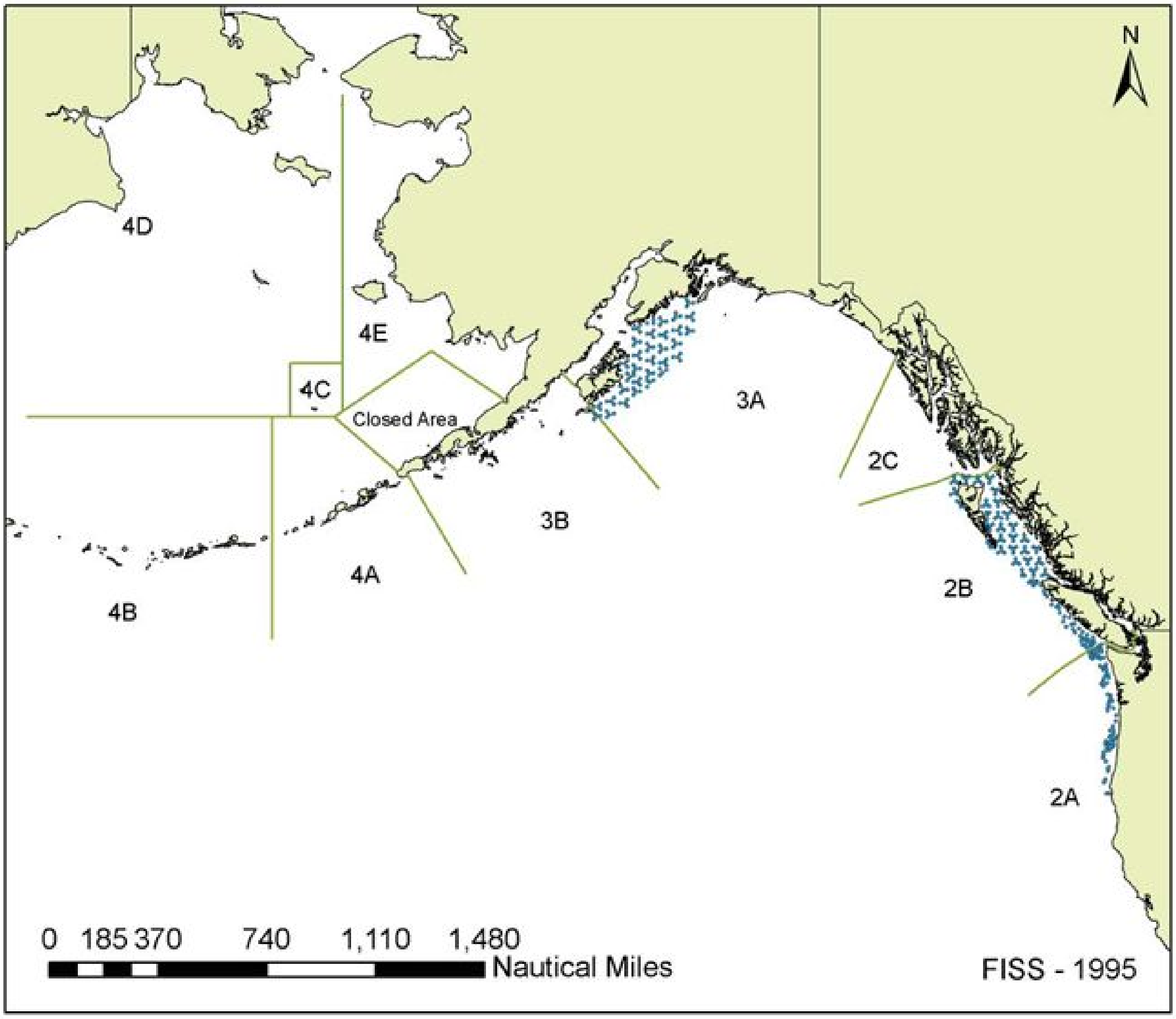

N
4D
4E
4C
Closed Area
3A
2C
3B
4A
4B
2B
2A
0 185 370 740 1,110 1,480
Nautical Miles
FISS - 1995

Figure 1

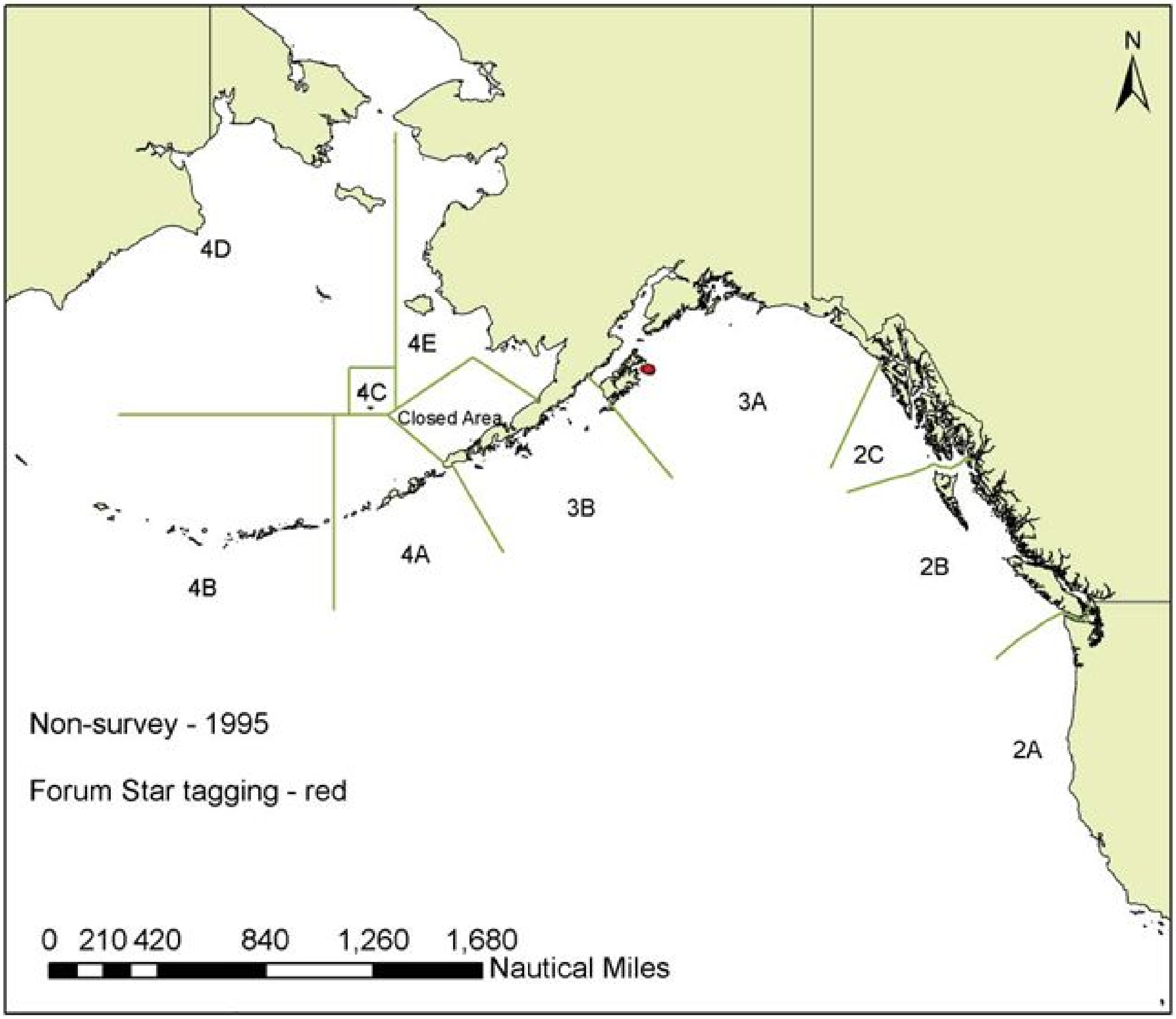

N
4D
4E
4C
Closed Area
3A
2C
3B
4A
4B
2B
2A
Non-survey - 1995
Forum Star tagging - red
0 210 420 840 1,260 1,680
Nautical Miles

Figure 2

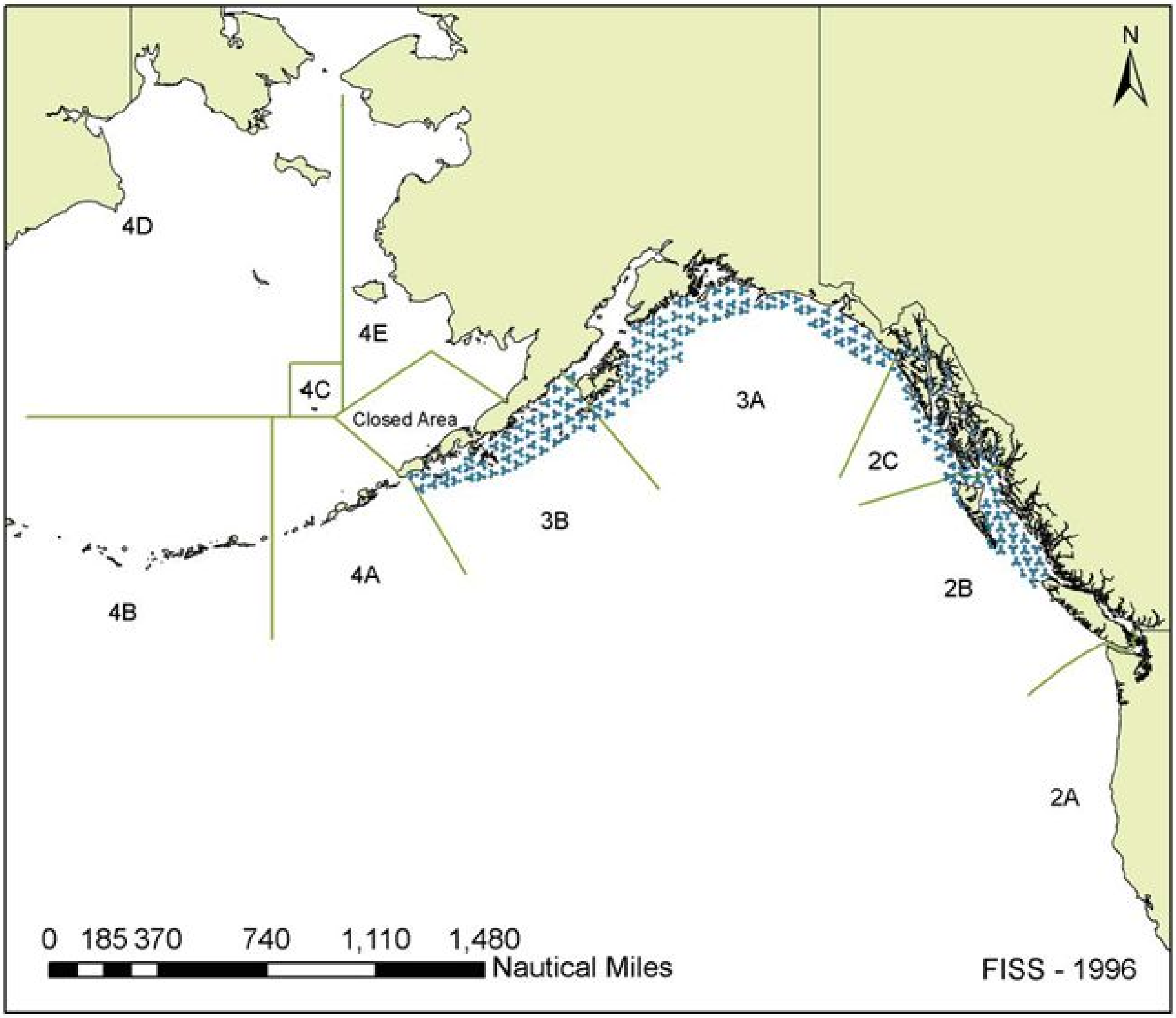

N
4D
4E
4C
Closed Area
3A
2C
3B
4A
4B
2B
2A
0 185 370 740 1,110 1,480
Nautical Miles
FISS - 1996

Figure 3

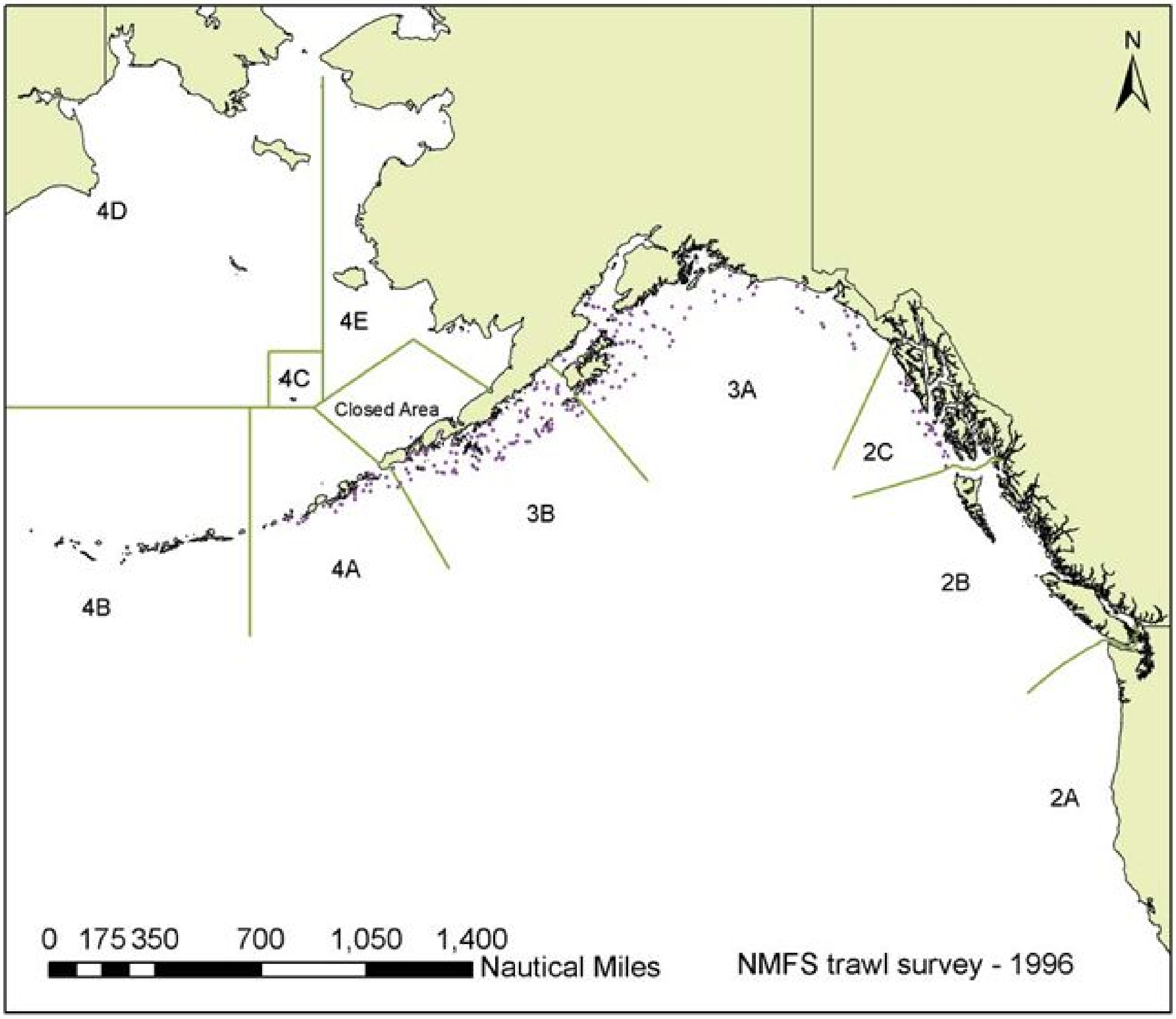

N
4D
4E
4C
Closed Area
3A
3B
2C
4A
4B
2B
2A
0 175 350 700 1,050 1,400
Nautical Miles
NMFS trawl survey - 1996

Figure 4

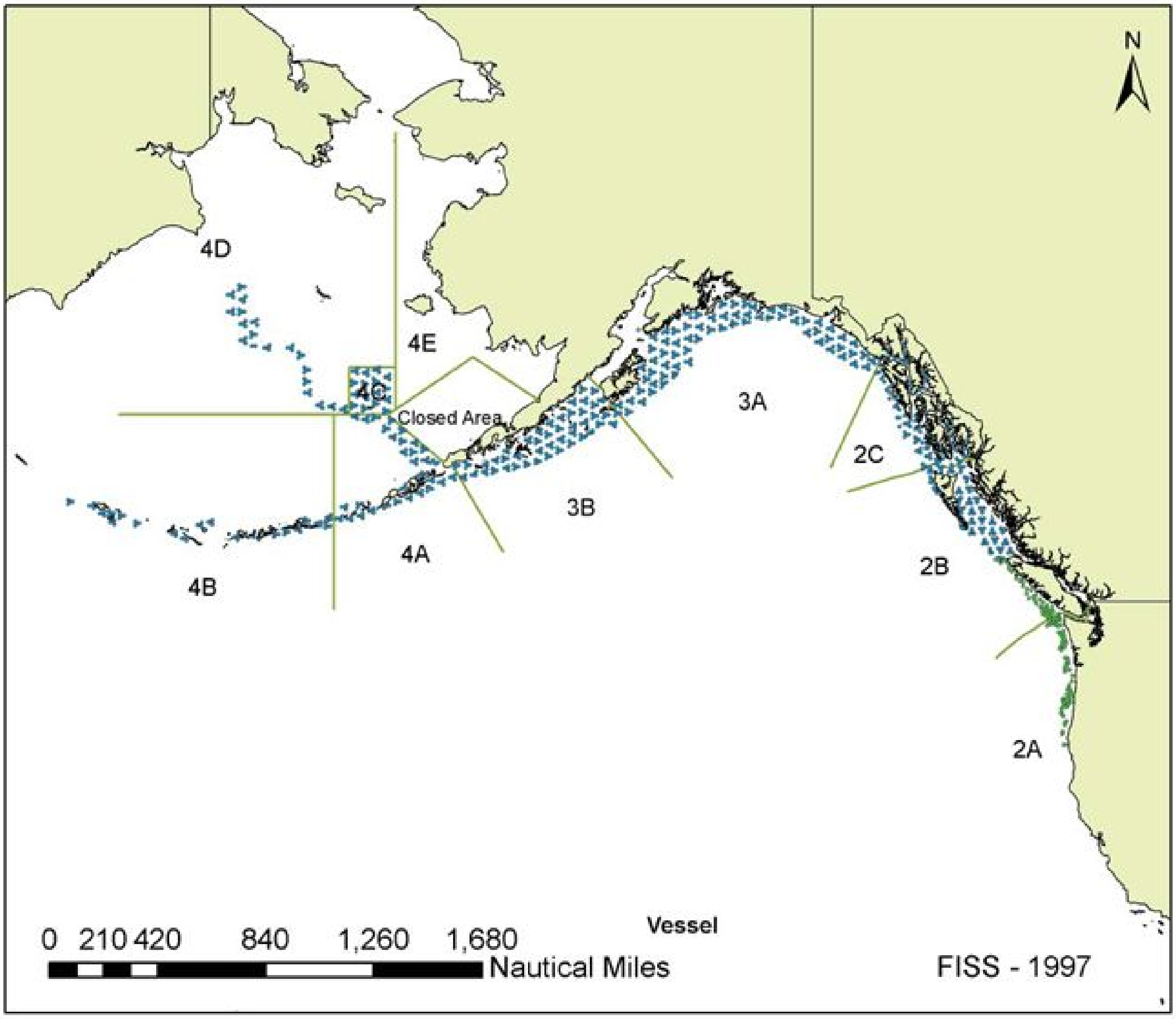
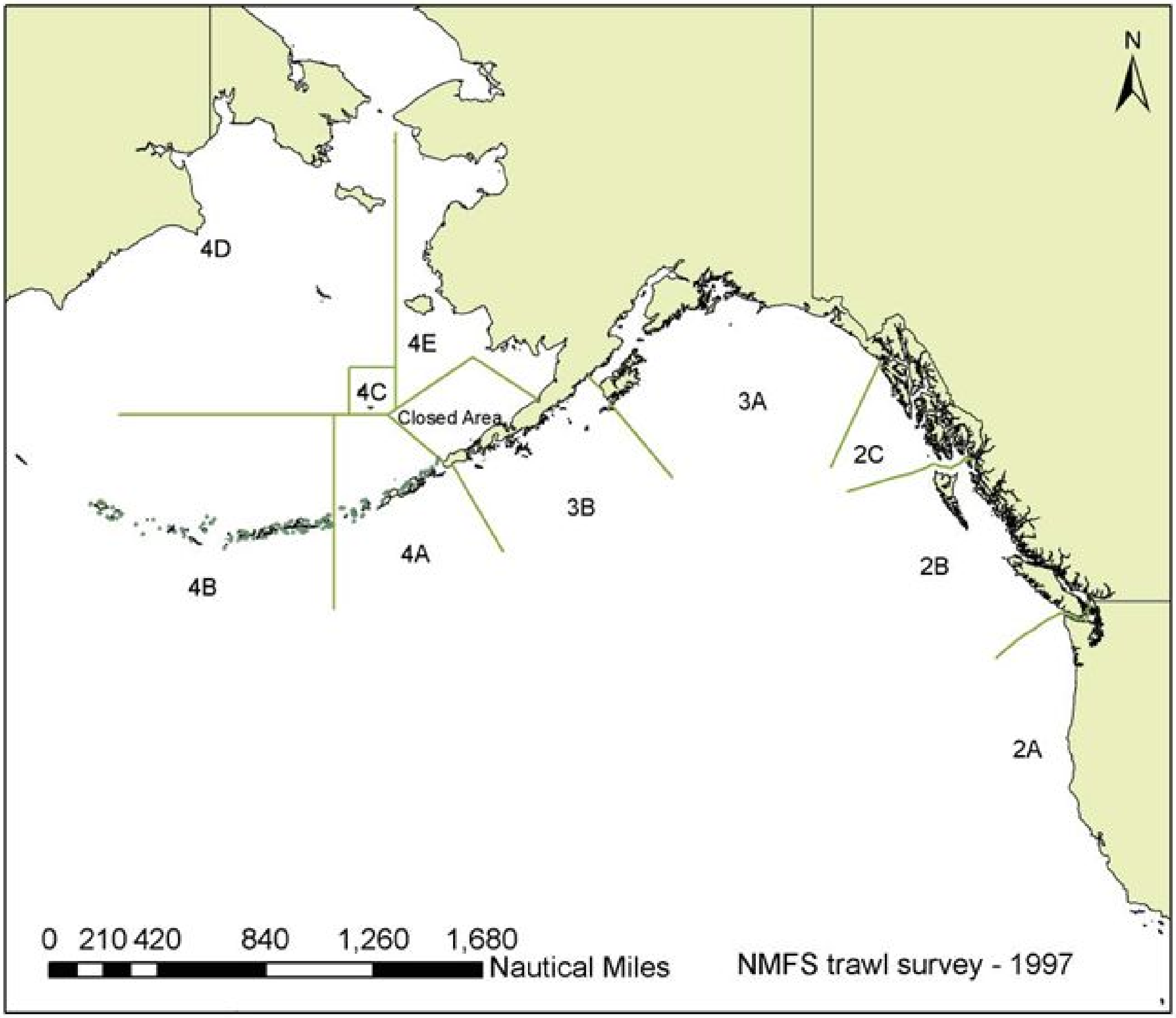

N
4D
4E
4C
Closed Area
3A
2C
3B
4A
4B
2B
2A
Vessel
0 210 420 840 1,260 1,680
Nautical Miles
FISS - 1997

Figure 5



N
4D
4E
4C
Closed Area
3A
2C
3B
4A
4B
2B
2A
0 210 420 840 1,260 1,680
Nautical Miles
NMFS trawl survey - 1997

Figure 6

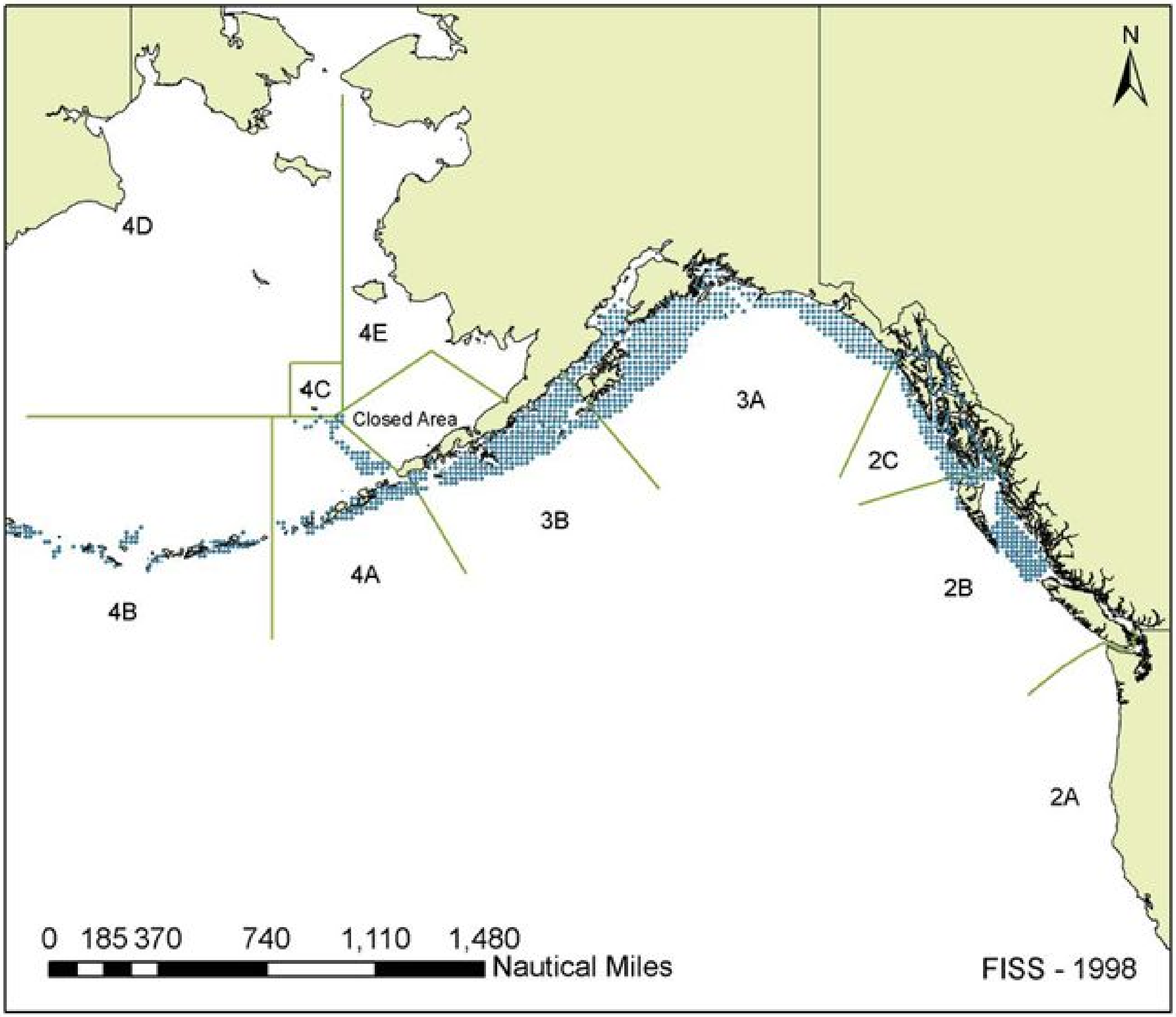

N
4D
4E
4C
Closed Area
3A
2C
3B
4A
4B
2B
2A
0 185 370 740 1,110 1,480
Nautical Miles
FISS - 1998

Figure 7

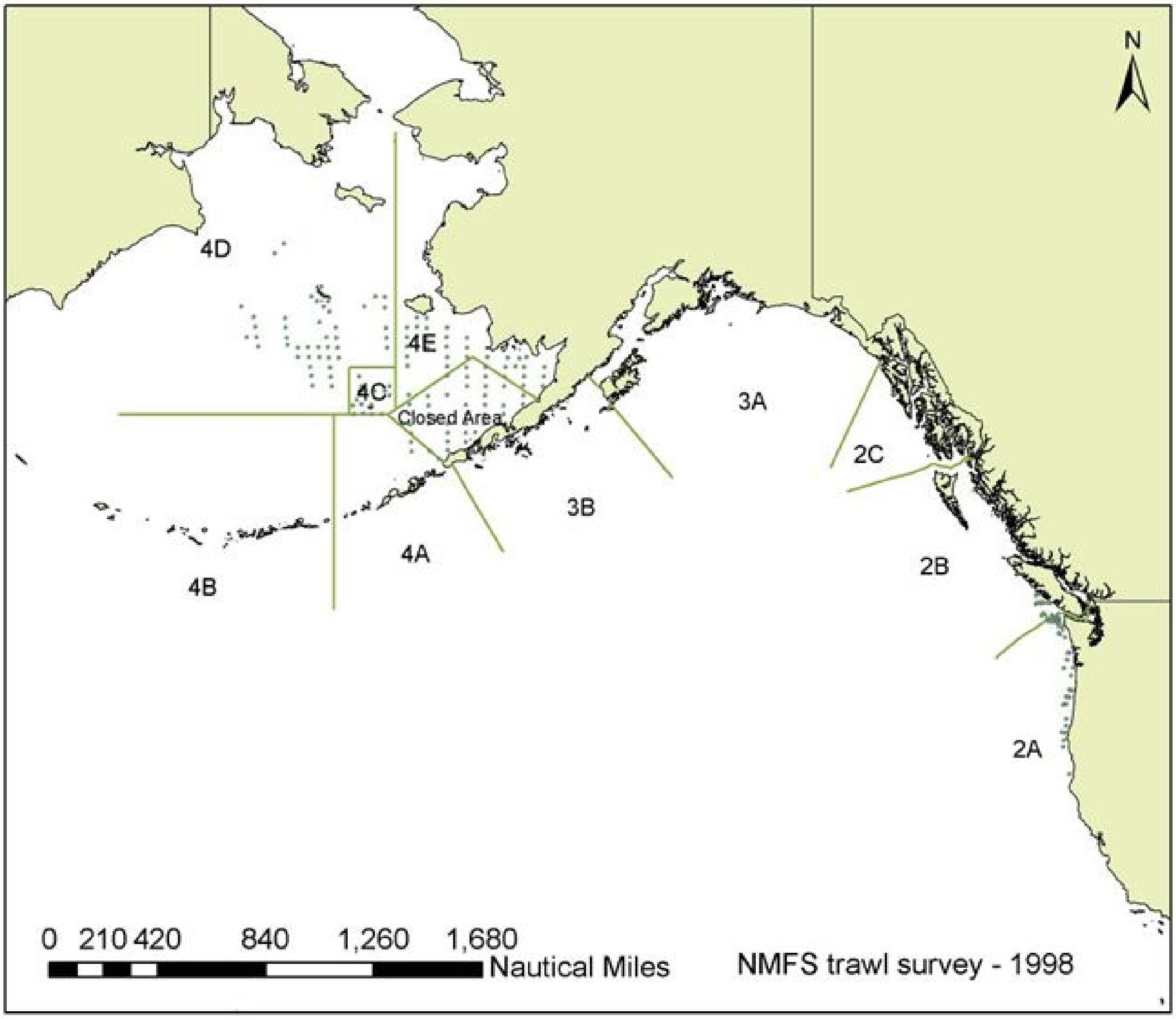

N
4D
4E
4C
Closed Area
3A
2C
3B
4A
2B
4B
2A
0 210 420 840 1,260 1,680
Nautical Miles
NMFS trawl survey - 1998

Figure 8

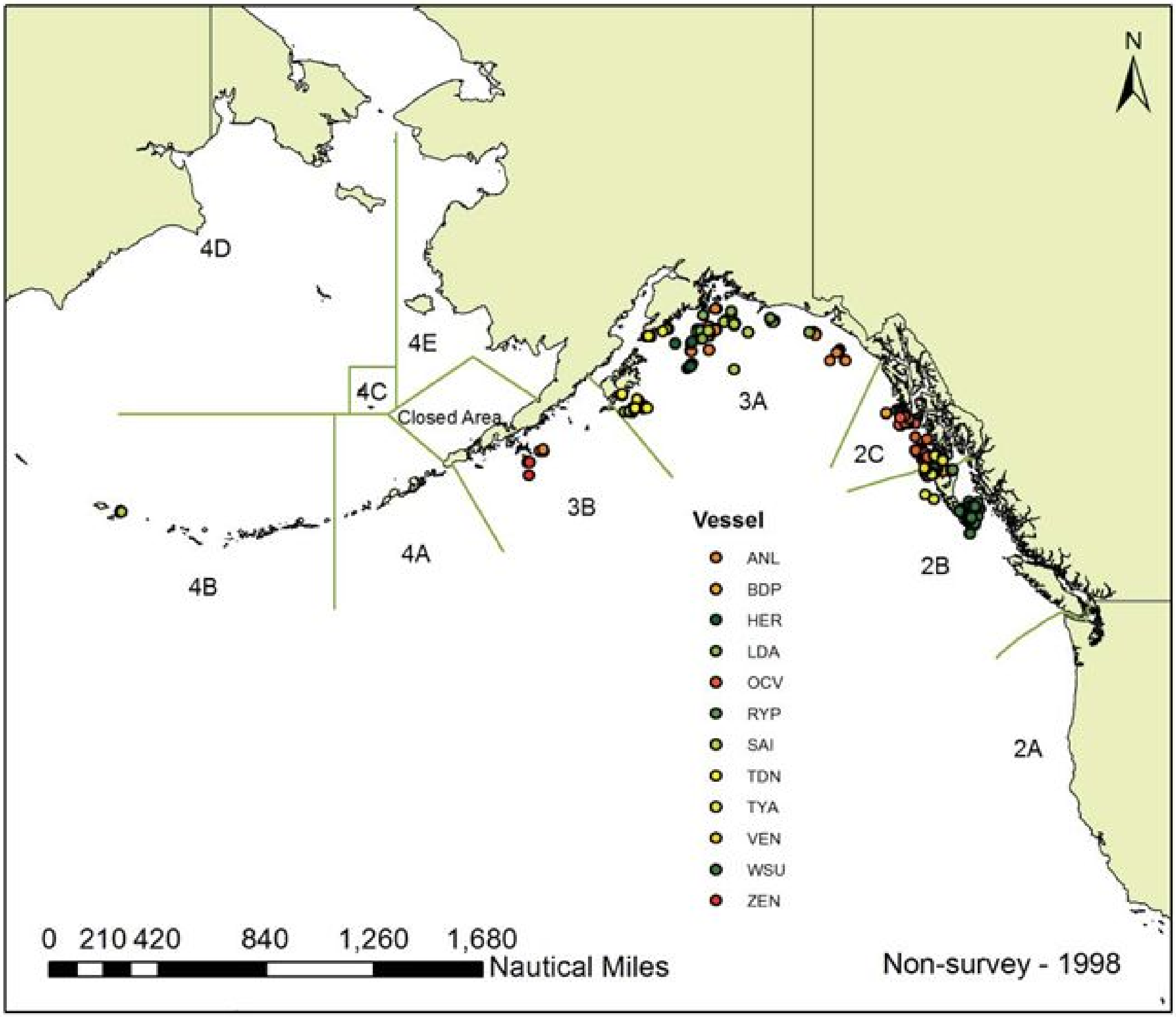

N
4D
4E
4C
Closed Area
3A
2C
3B
4A
4B
2B
2A
Vessel
ANL
BDP
HER
LDA
OCV
RYP
SAI
TDN
TYA
VEN
WSU
ZEN
0 210 420 840 1,260 1,680
Nautical Miles
Non-survey - 1998

Figure 9

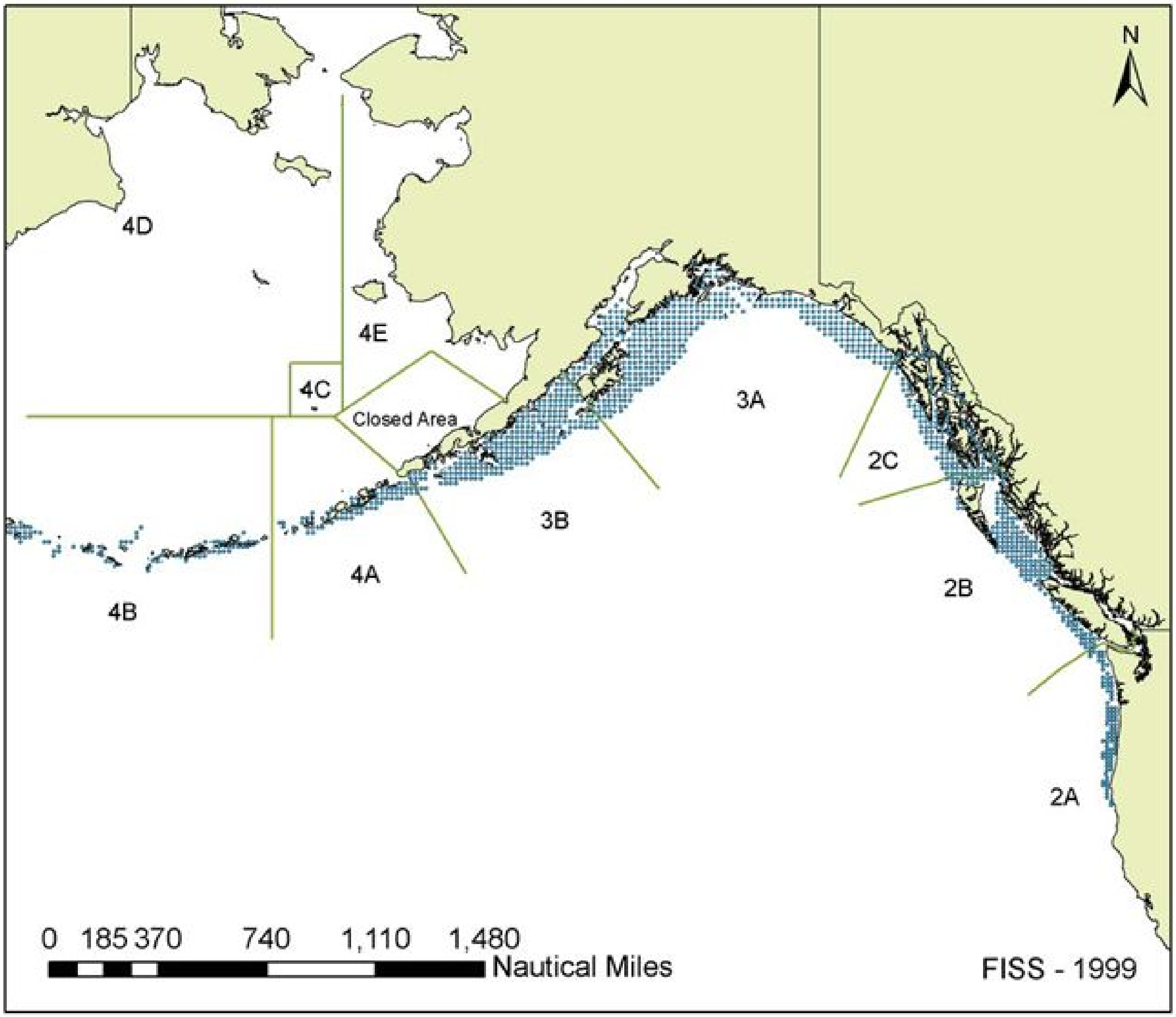

N
4D
4E
4C
Closed Area
3A
2C
3B
4A
4B
2B
2A
0 185 370 740 1,110 1,480
Nautical Miles
FISS - 1999

Figure 10

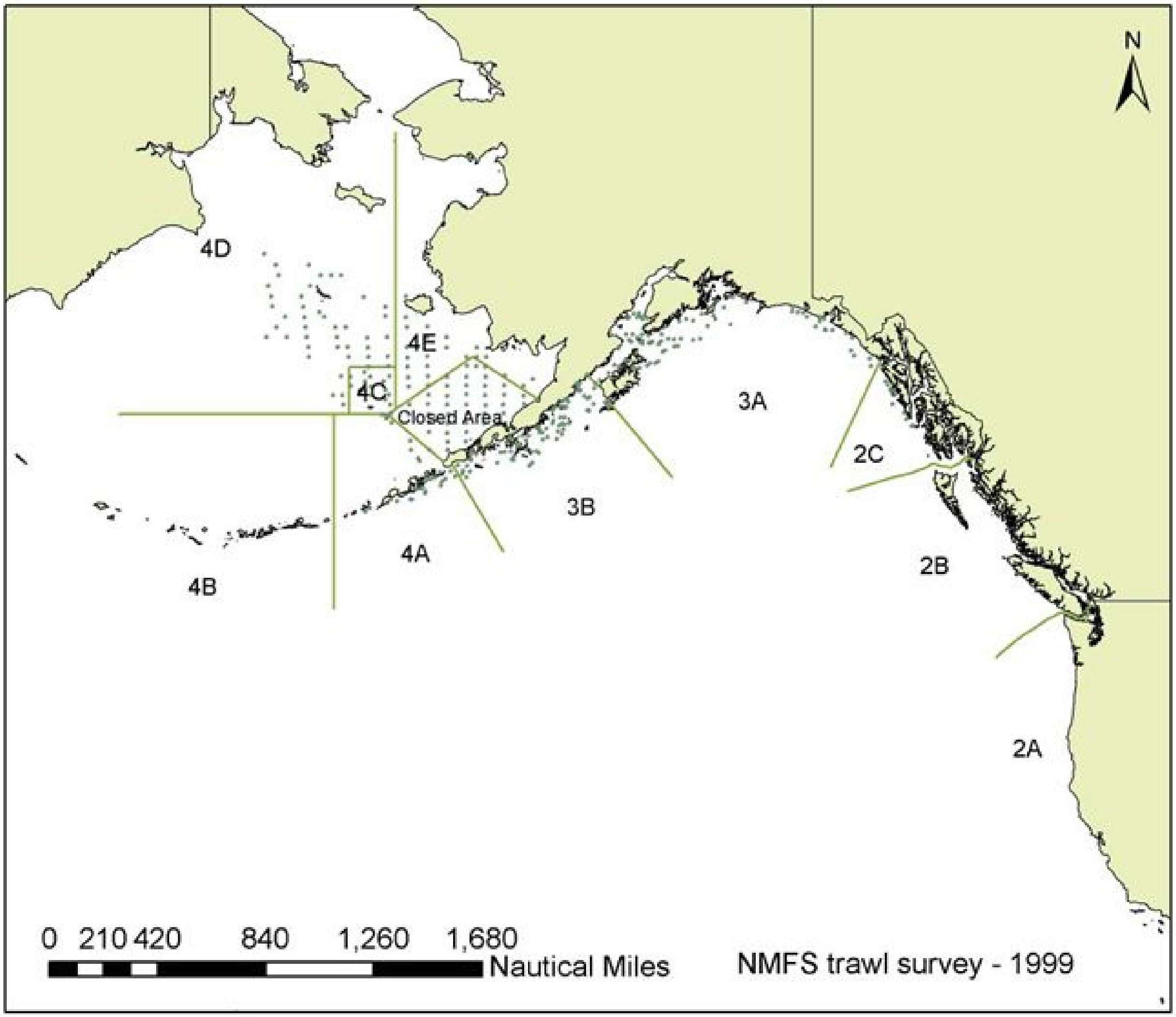

N
4D
4E
4C
Closed Area
3A
2C
3B
4A
4B
2B
2A
0 210 420 840 1,260 1,680
Nautical Miles
NMFS trawl survey - 1999

Figure 11

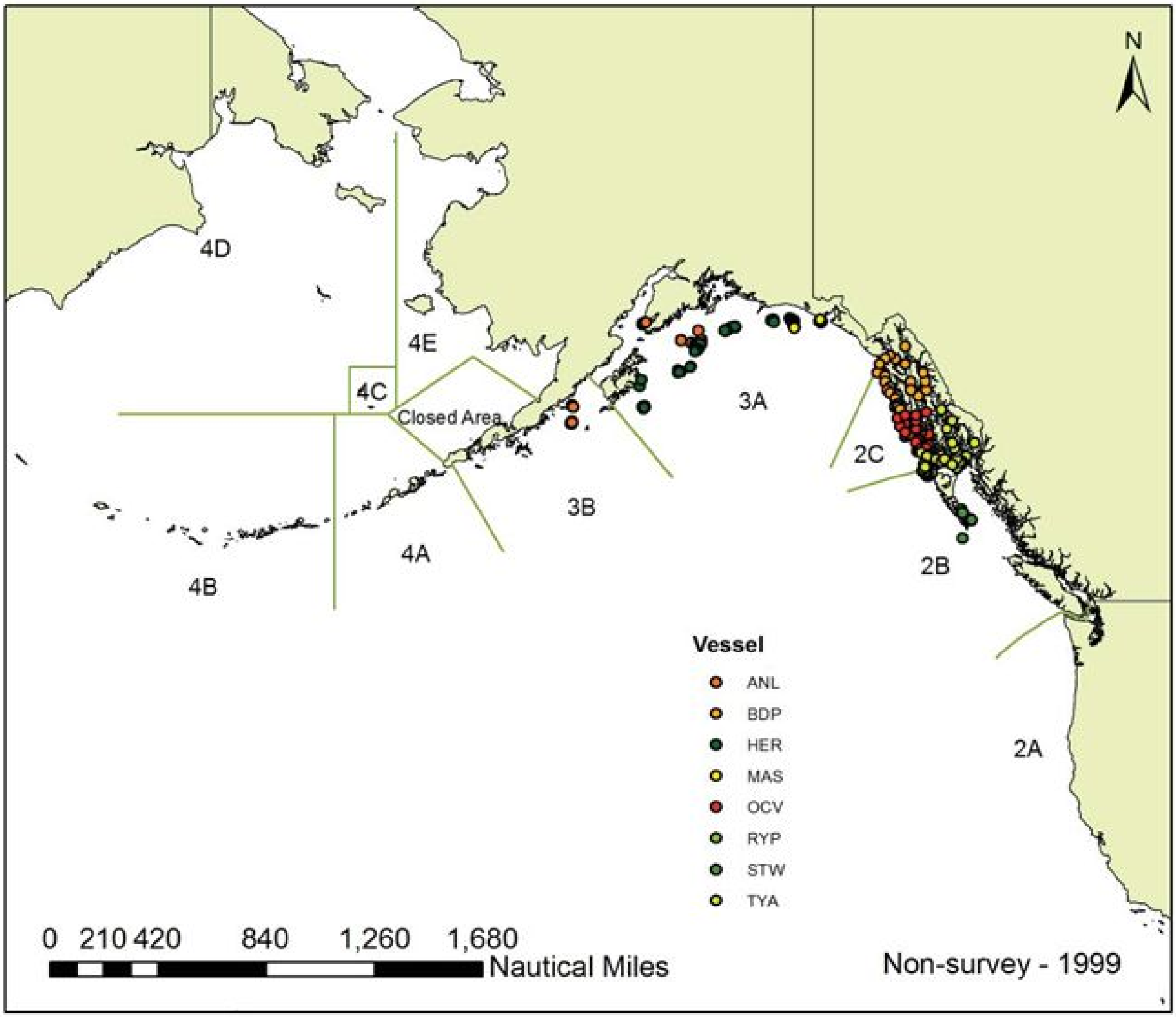

N
4D
4E
4C
Closed Area
3A
2C
3B
4A
4B
2B
2A
Vessel
ANL
BDP
HER
MAS
OCV
RYP
STW
TYA
0 210 420 840 1,260 1,680
Nautical Miles
Non-survey - 1999

Figure 12

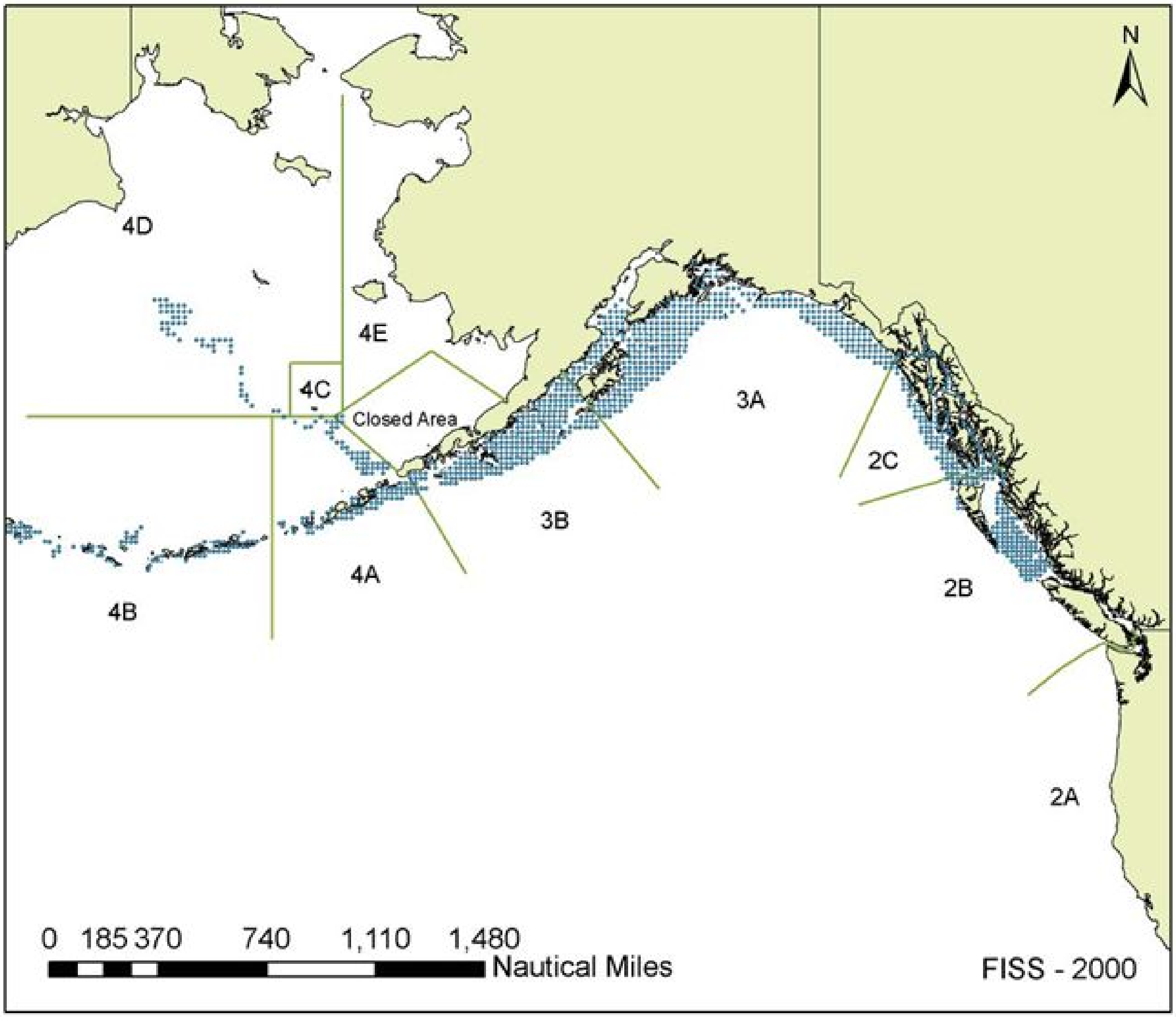

N
4D
4E
4C
Closed Area
3A
2C
3B
4A
2B
4B
2A
0 185 370 740 1,110 1,480
Nautical Miles
FISS - 2000

Figure 13

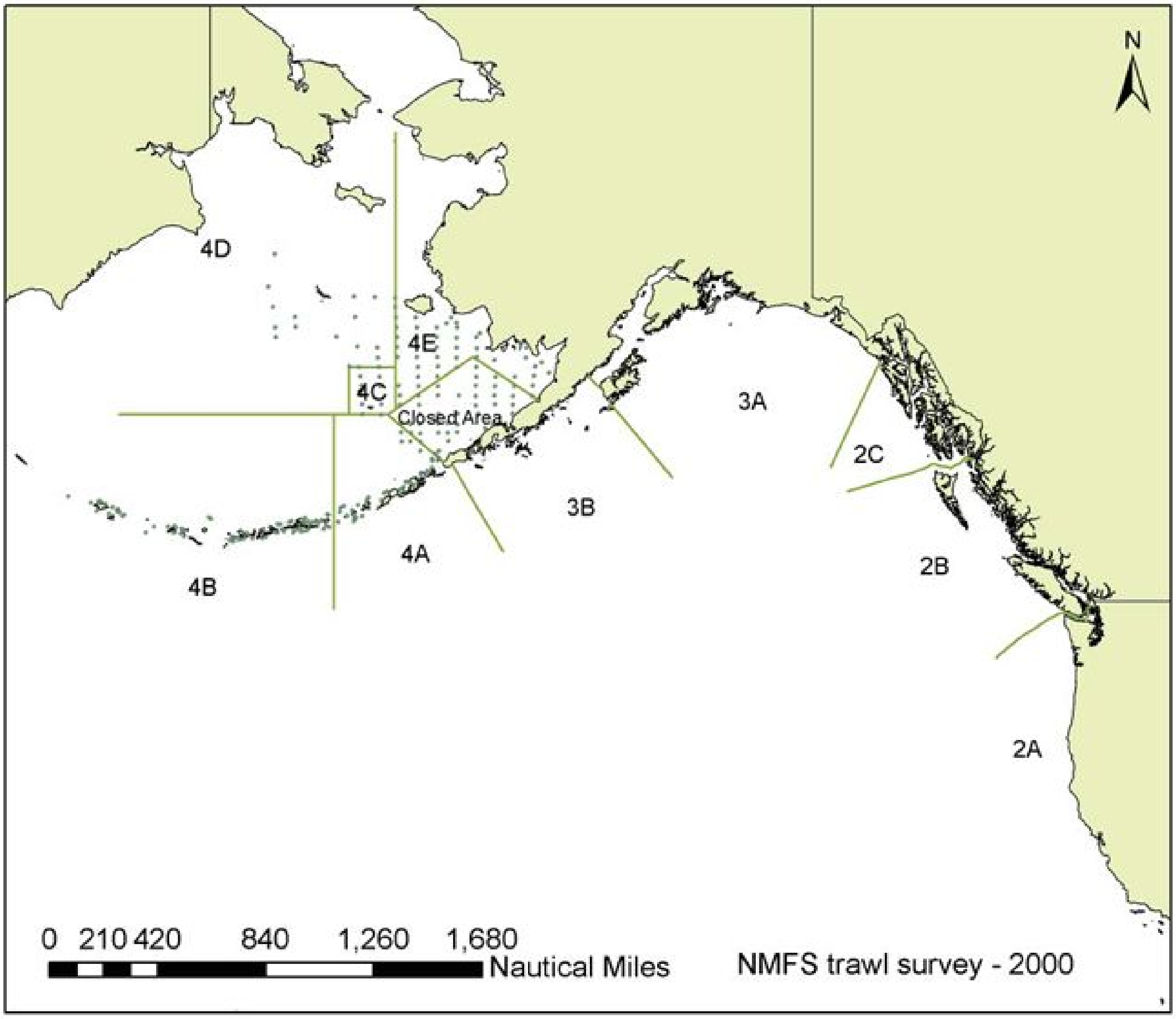

N
4D
4E
4C
Closed Area
3A
2C
3B
4A
4B
2B
2A
0 210 420 840 1,260 1,680
Nautical Miles
NMFS trawl survey - 2000

Figure 14

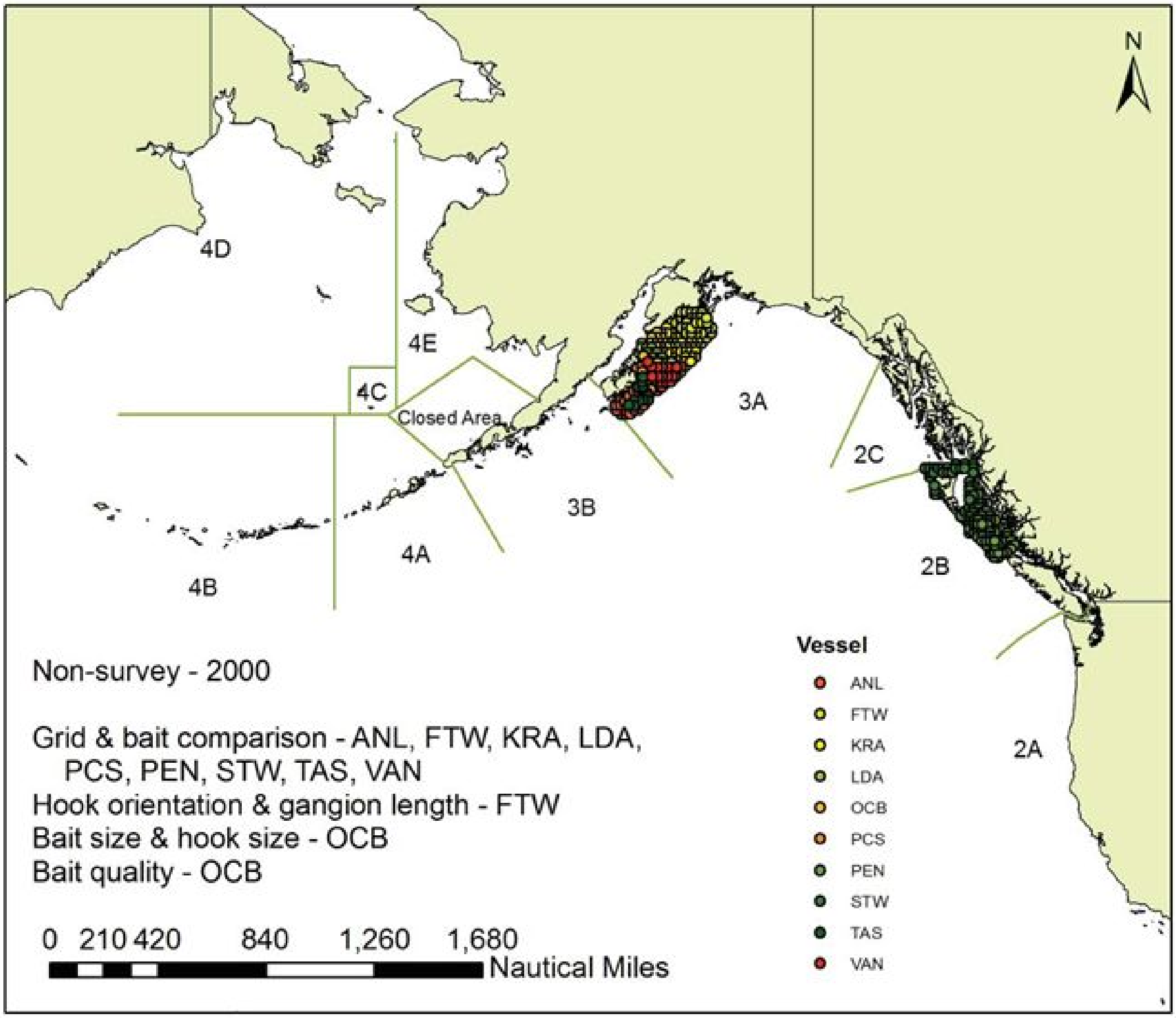

N
4D
4E
4C
Closed Area
3A
2C
3B
4A
4B
2B
2A
Non-survey - 2000
Grid & bait comparison - ANL, FTW, KRA, LDA,
PCS, PEN, STW, TAS, VAN
Hook orientation & gangion length - FTW
Bait size & hook size - OCB
Bait quality - OCB
0 210 420 840 1,260 1,680
Nautical Miles
Vessel
ANL
FTW
KRA
LDA
OCB
PCS
PEN
STW
TAS
VAN

Figure 15

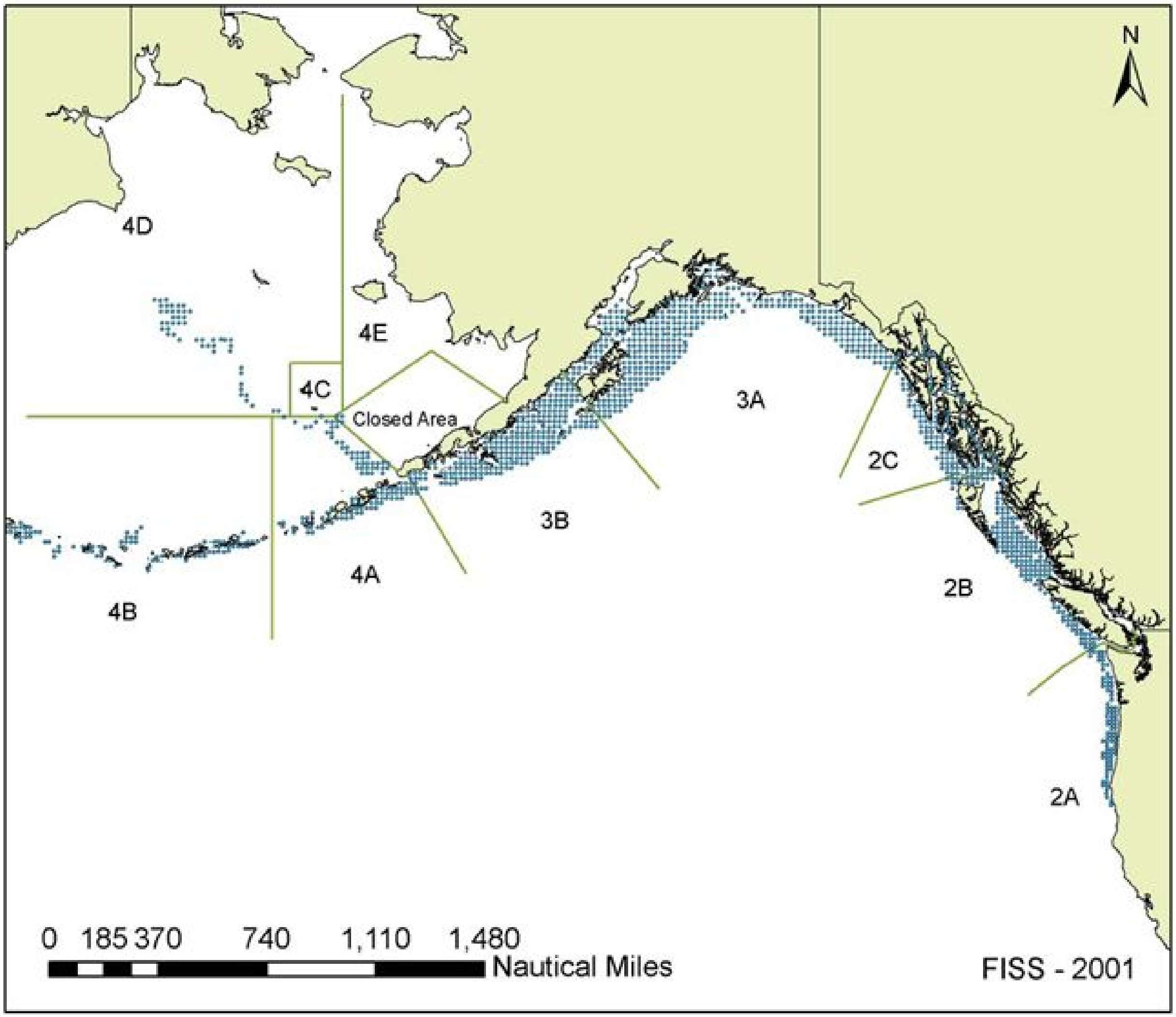

N
4D
4E
4C
Closed Area
3A
2C
3B
4A
4B
2B
2A
0 185 370 740 1,110 1,480
Nautical Miles
FISS - 2001

Figure 16

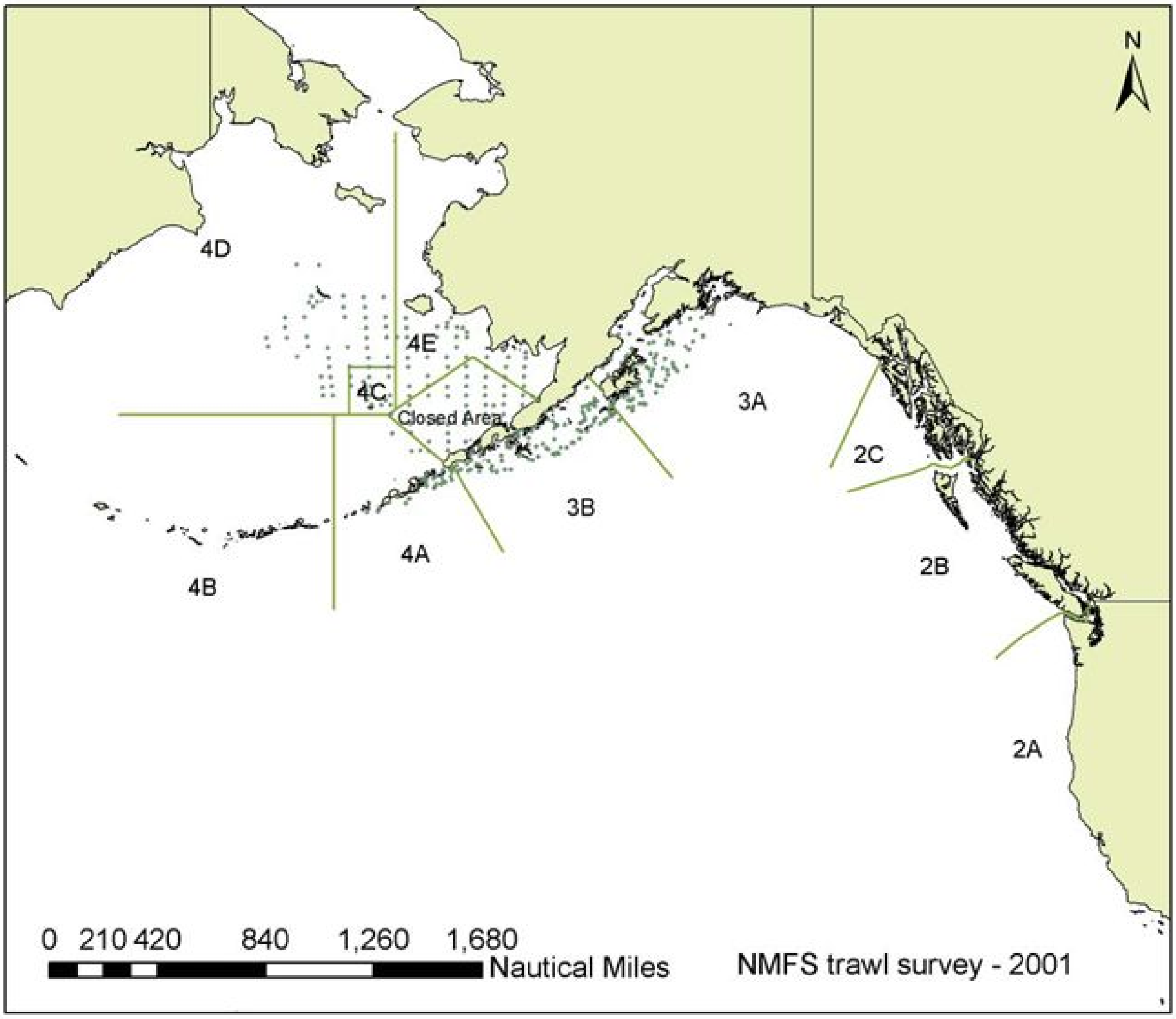

N
4D
4E
4C
Closed Area
3A
2C
3B
4A
4B
2B
2A
0 210 420 840 1,260 1,680
Nautical Miles
NMFS trawl survey - 2001

Figure 17

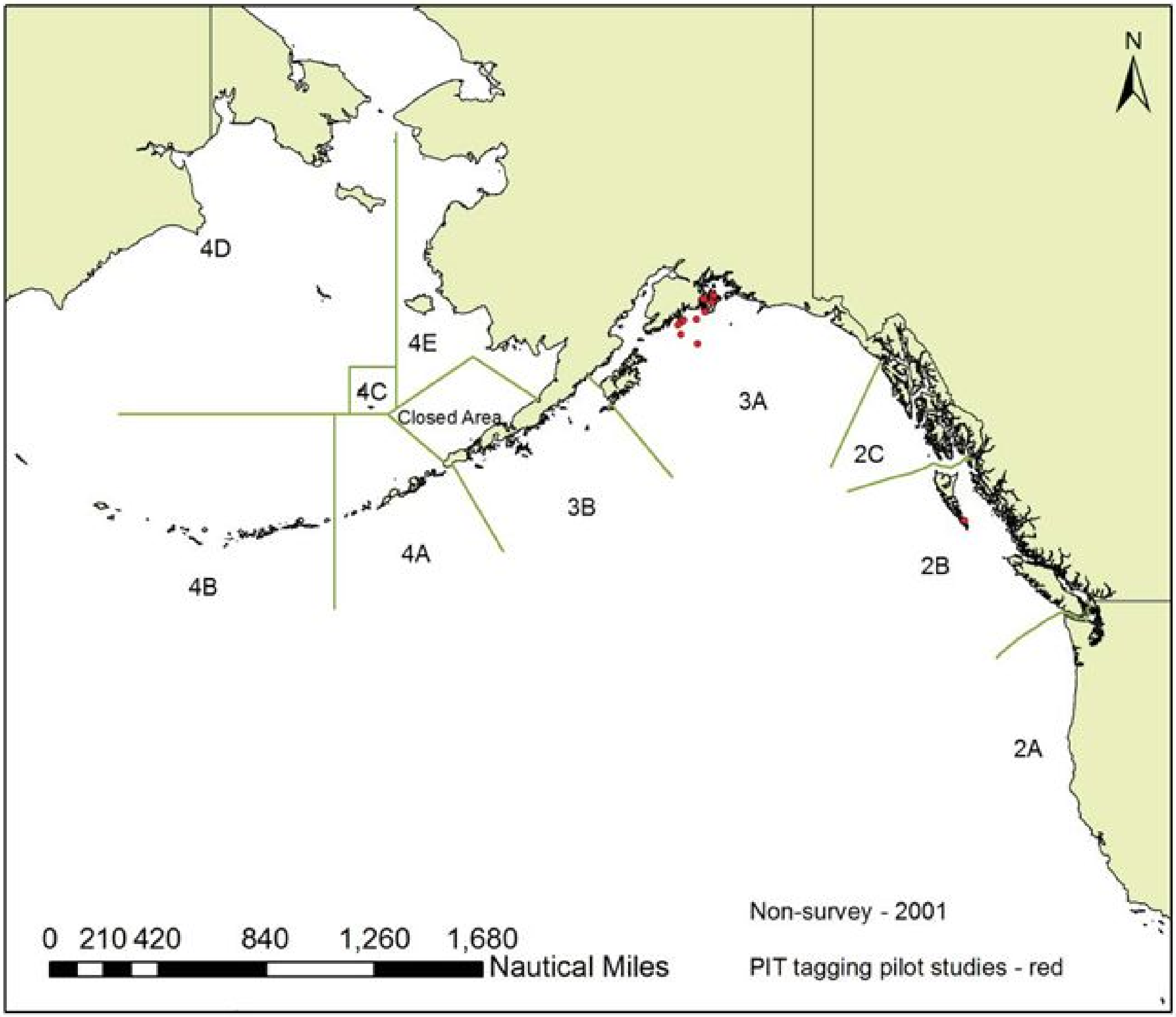

N
4D
4E
4C
Closed Area
3A
2C
3B
4A
4B
2B
2A
Non-survey - 2001
PIT tagging pilot studies - red
0 210 420 840 1,260 1,680
Nautical Miles

Figure 18

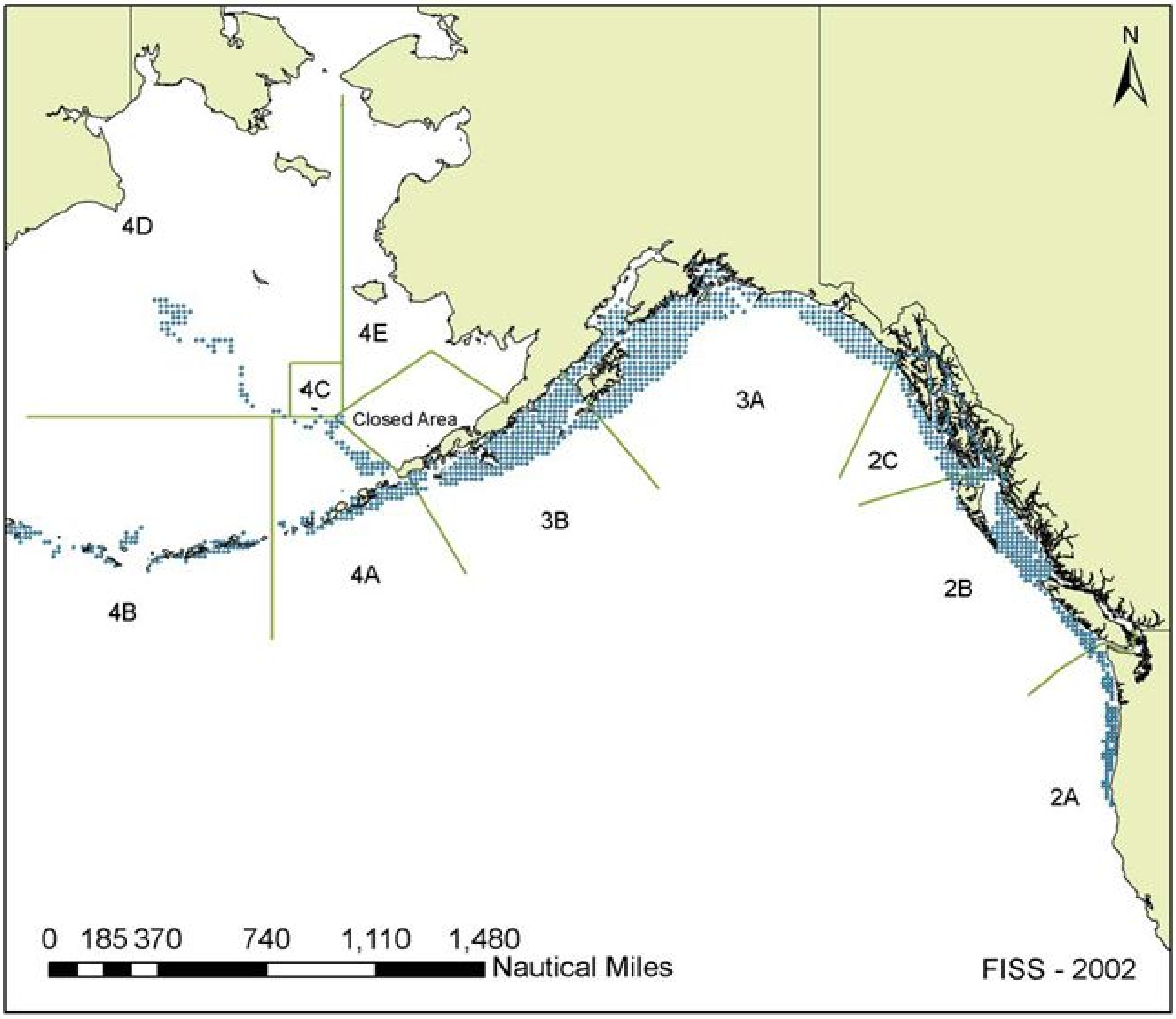

N
4D
4E
4C
Closed Area
3A
2C
3B
4A
4B
2B
2A
0 185 370 740 1,110 1,480
Nautical Miles
FISS - 2002

Figure 19

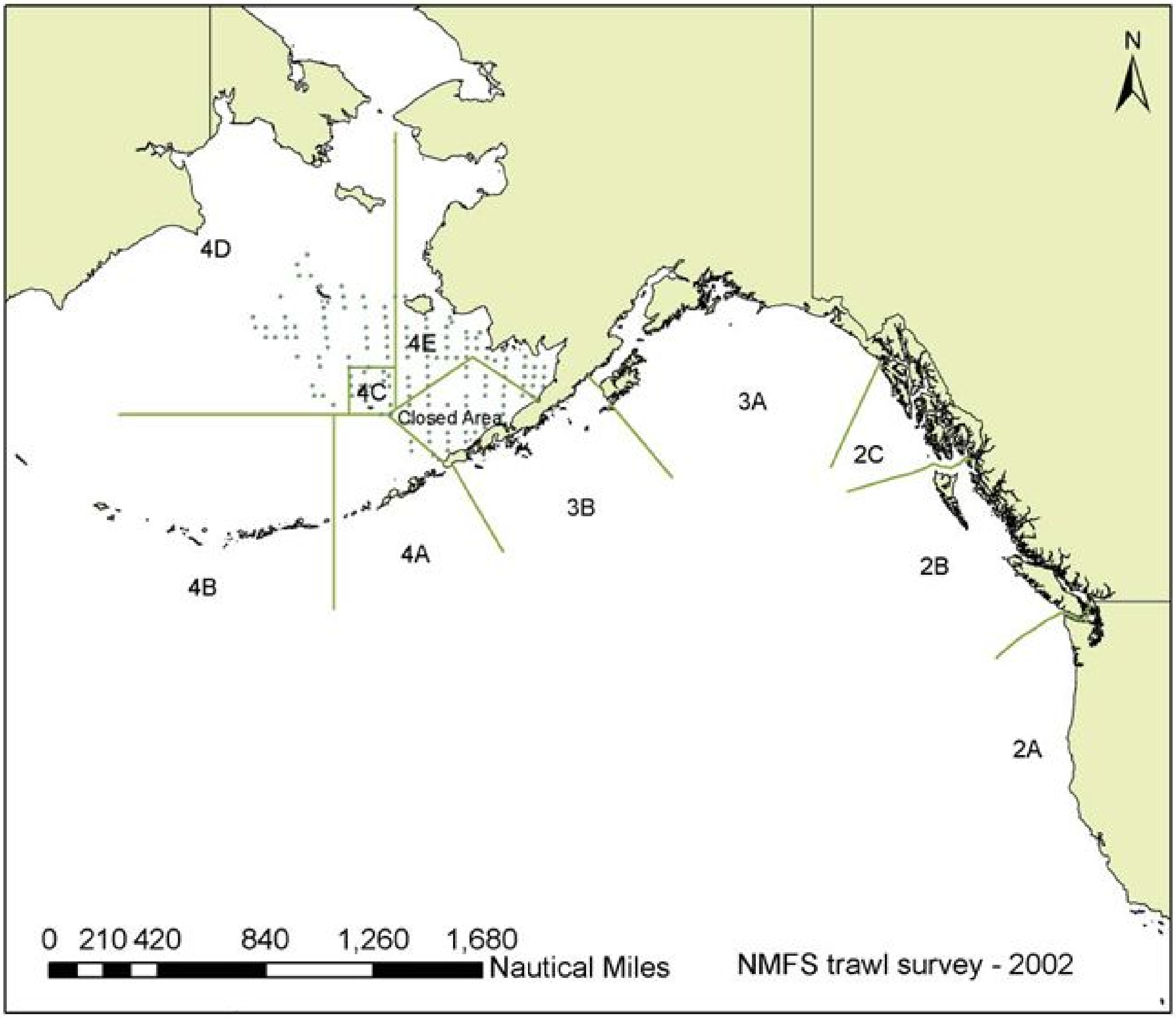
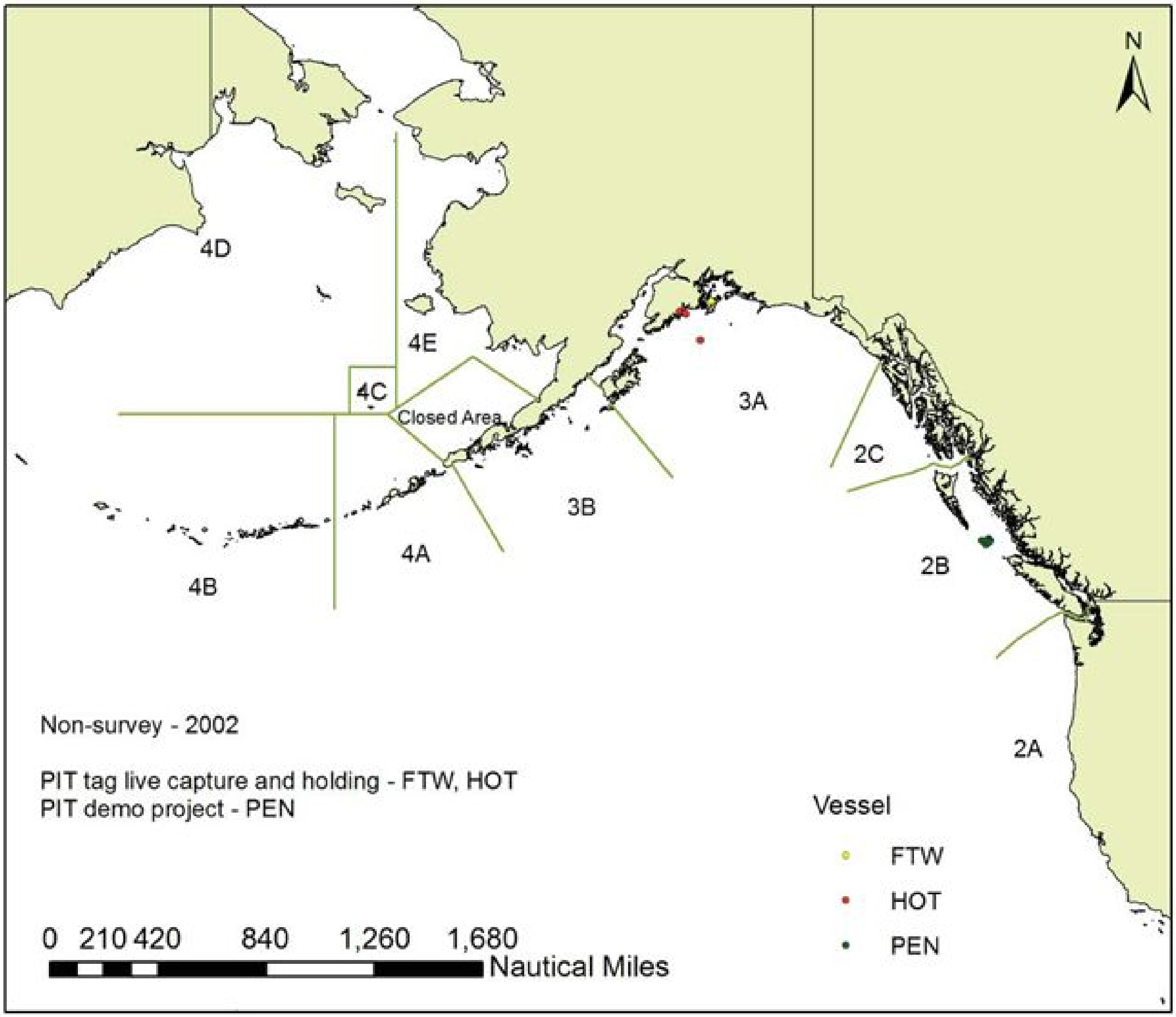
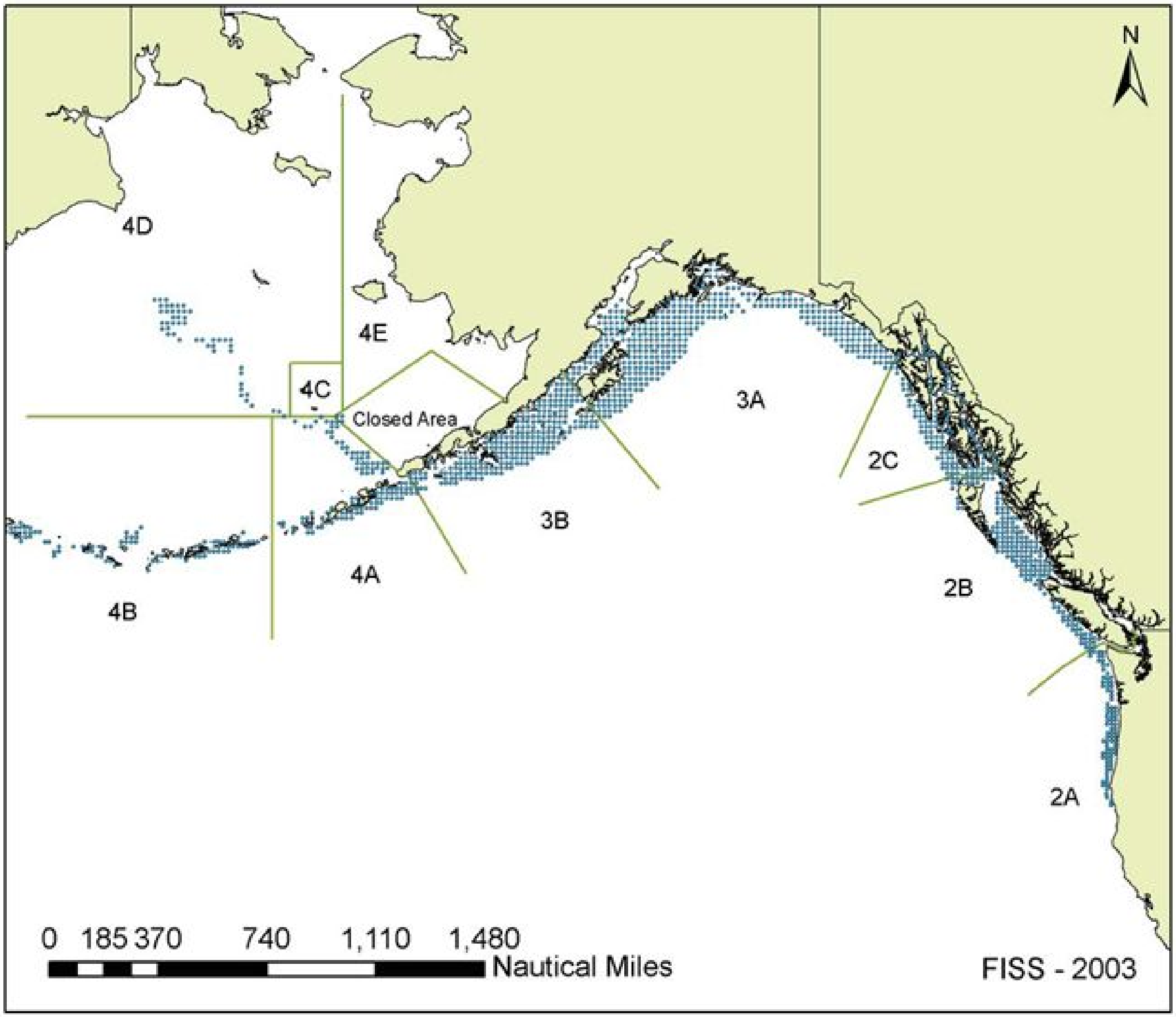

N
4D
4E
4C
Closed Area
3A
2C
3B
4A
4B
2B
2A
0 210 420 840 1,260 1,680
Nautical Miles
NMFS trawl survey - 2002

Figure 20



N
4D
4E
4C
Closed Area
3A
2C
3B
4A
4B
2B
2A
Non-survey - 2002
PIT tag live capture and holding - FTW, HOT
PIT demo project - PEN
Vessel
FTW
HOT
PEN
0 210 420 840 1,260 1,680
Nautical Miles

Figure 21



N
4D
4E
4C
Closed Area
3A
2C
3B
4A
4B
2B
2A
0 185 370 740 1,110 1,480
Nautical Miles
FISS - 2003

Figure 22

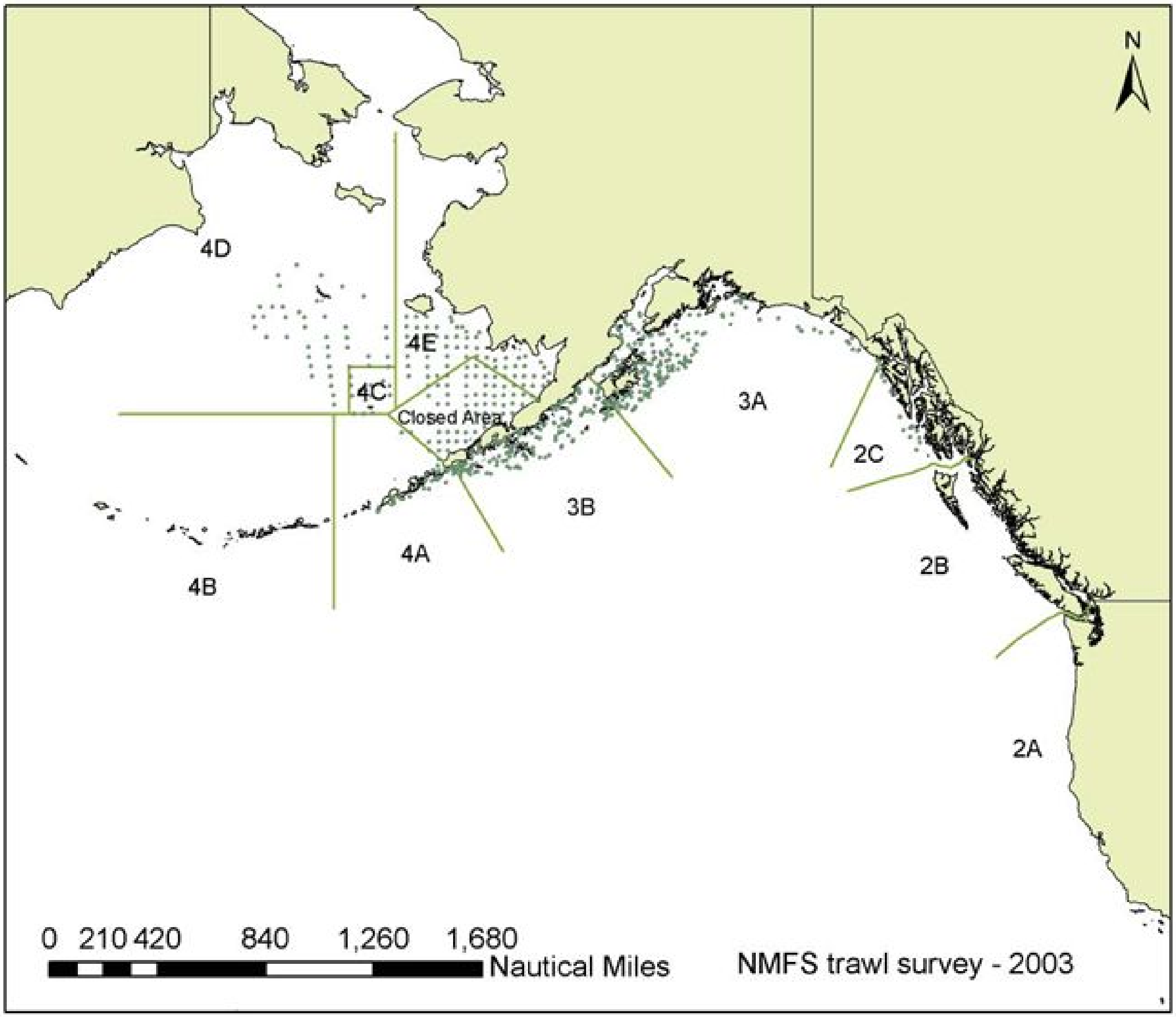

N
4D
4E
4C
Closed Area
3A
2C
3B
4A
4B
2B
2A
0 210 420 840 1,260 1,680
Nautical Miles
NMFS trawl survey - 2003

Figure 23

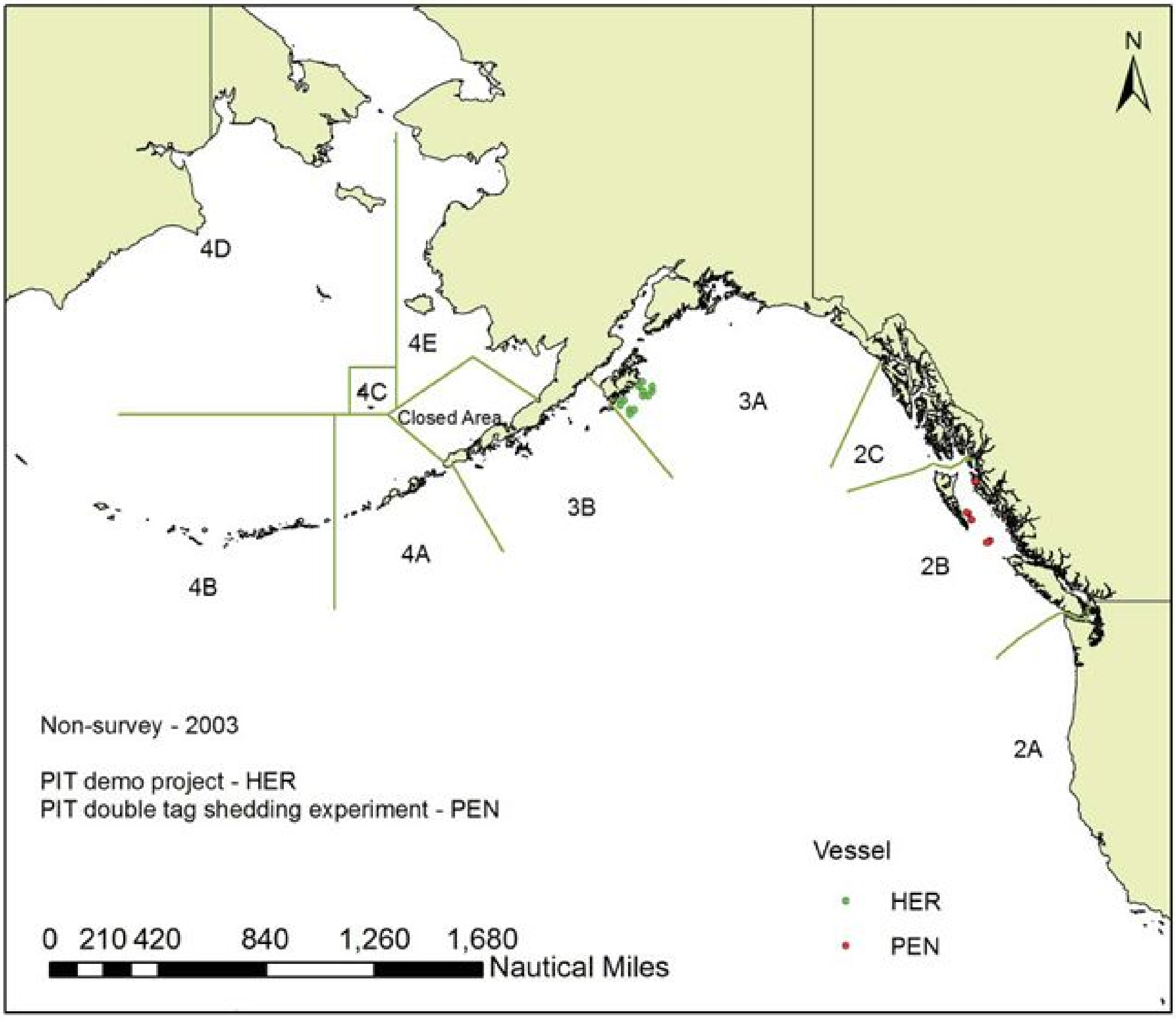

N
4D
4E
4C
Closed Area
3A
2C
3B
4A
4B
2B
2A
Non-survey - 2003
PIT demo project - HER
PIT double tag shedding experiment - PEN
Vessel
HER
PEN
0 210 420 840 1,260 1,680
Nautical Miles

Figure 24

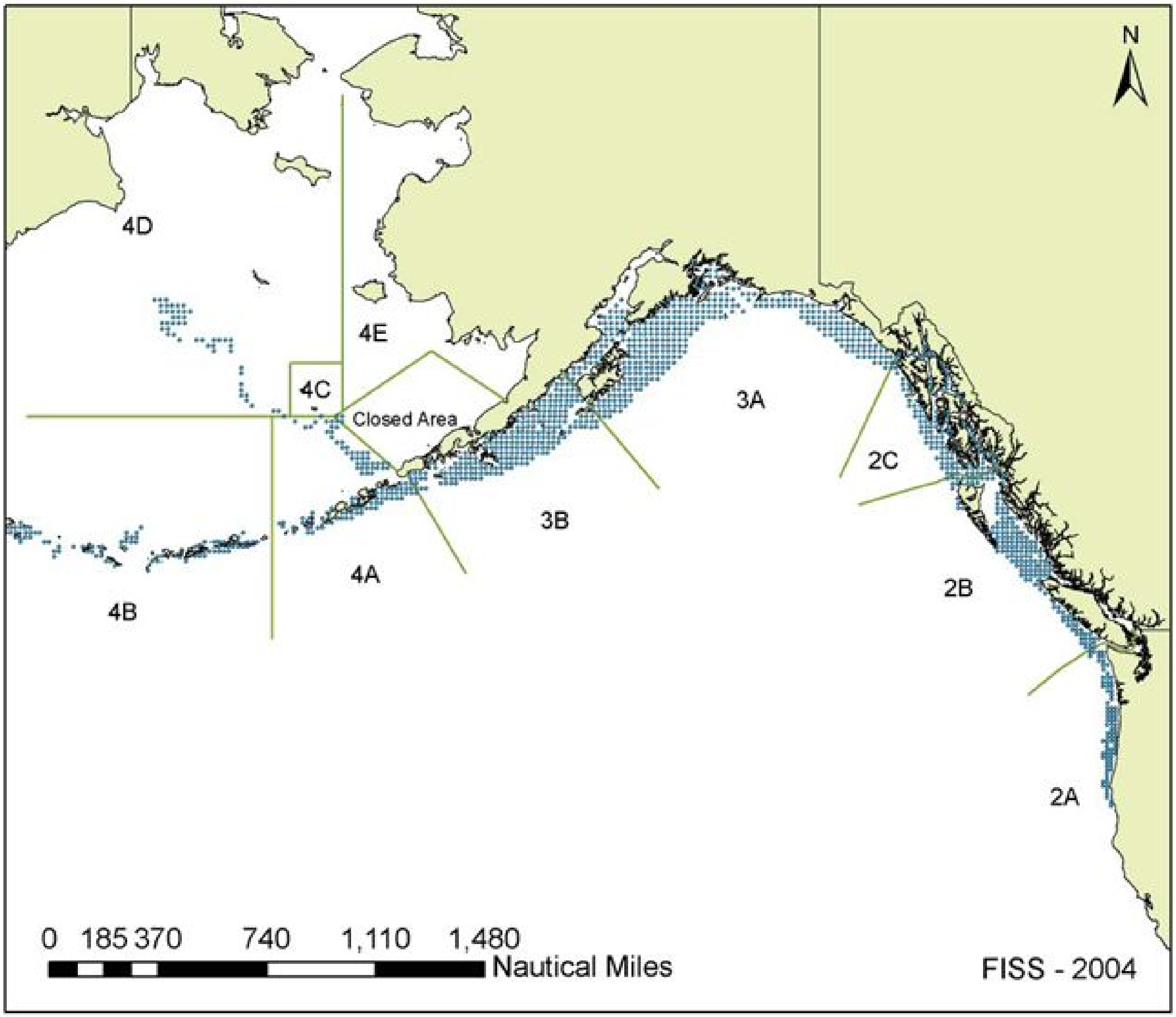

N
4D
4E
4C
Closed Area
3A
2C
3B
4A
2B
4B
2A
0 185 370 740 1,110 1,480
Nautical Miles
FISS - 2004

Figure 25

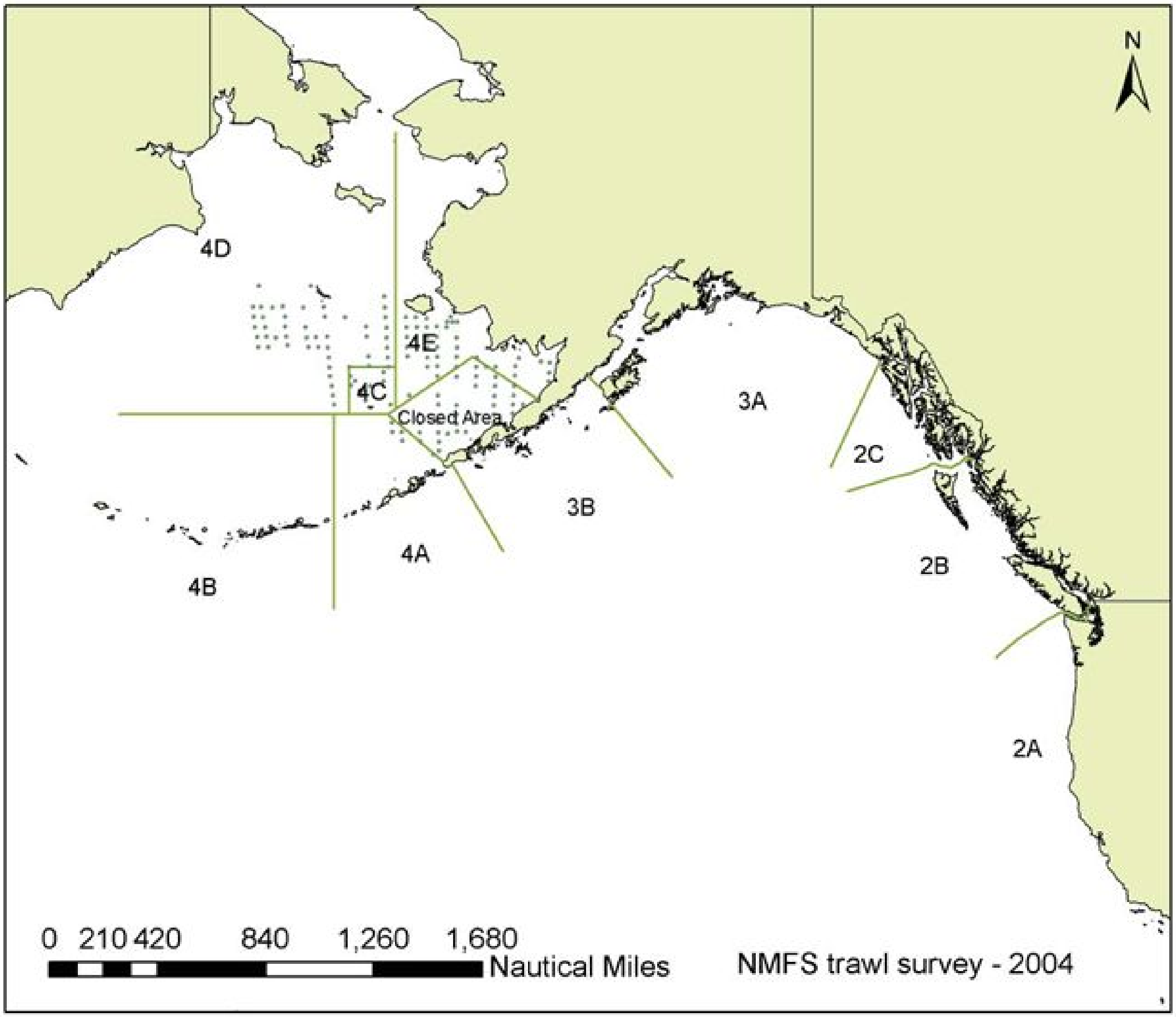

N
4D
4E
4C
Closed Area
3A
2C
3B
4A
4B
2B
2A
0 210 420 840 1,260 1,680
Nautical Miles
NMFS trawl survey - 2004

Figure 26

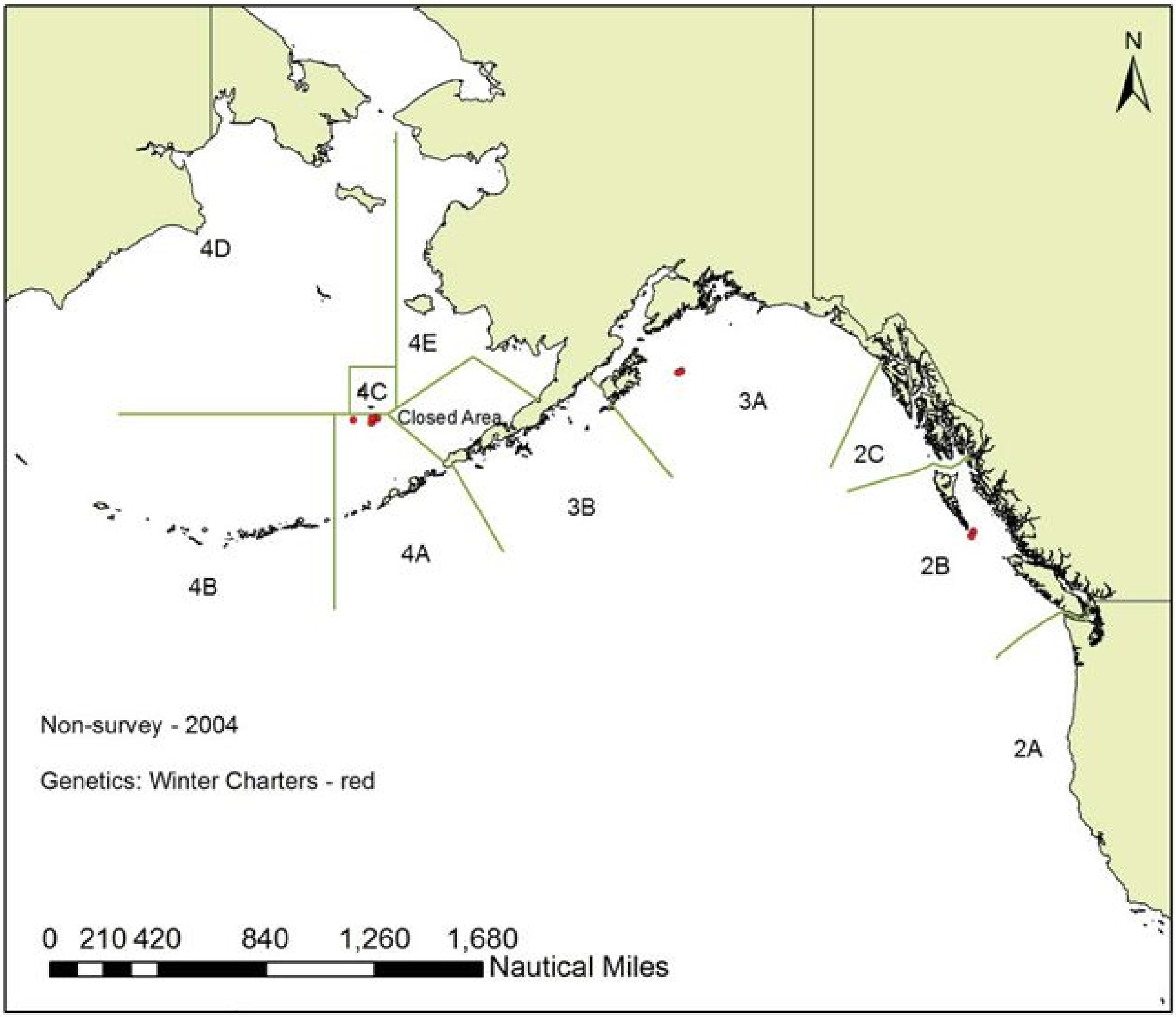

N
4D
4E
4C
Closed Area
3A
2C
3B
4A
4B
2B
2A
Non-survey - 2004
Genetics: Winter Charters - red
0 210 420 840 1,260 1,680
Nautical Miles

Figure 27

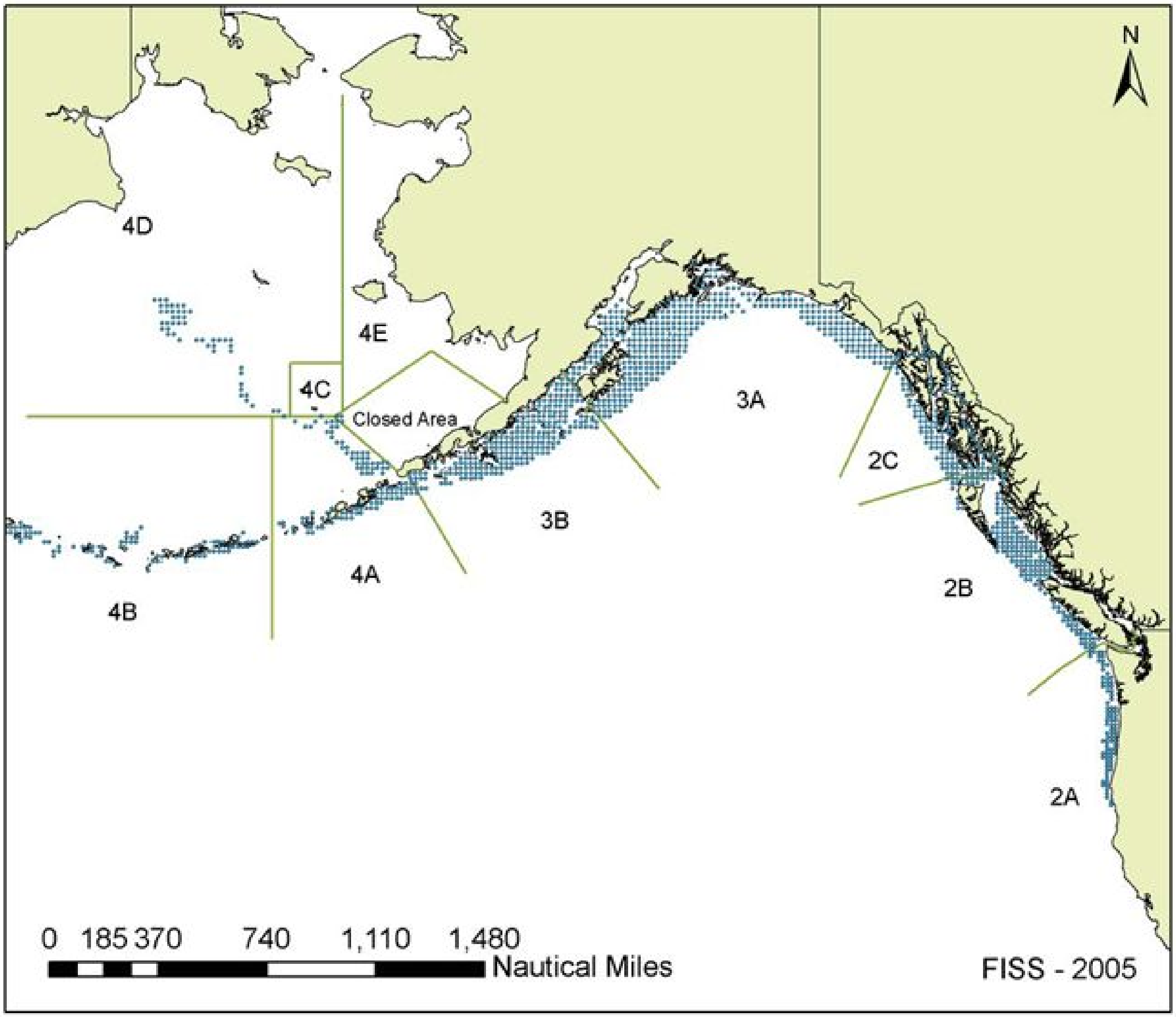

N
4D
4E
4C
Closed Area
3A
3B
2C
2B
4A
4B
2A
0 185 370 740 1,110 1,480
Nautical Miles
FISS - 2005

Figure 28

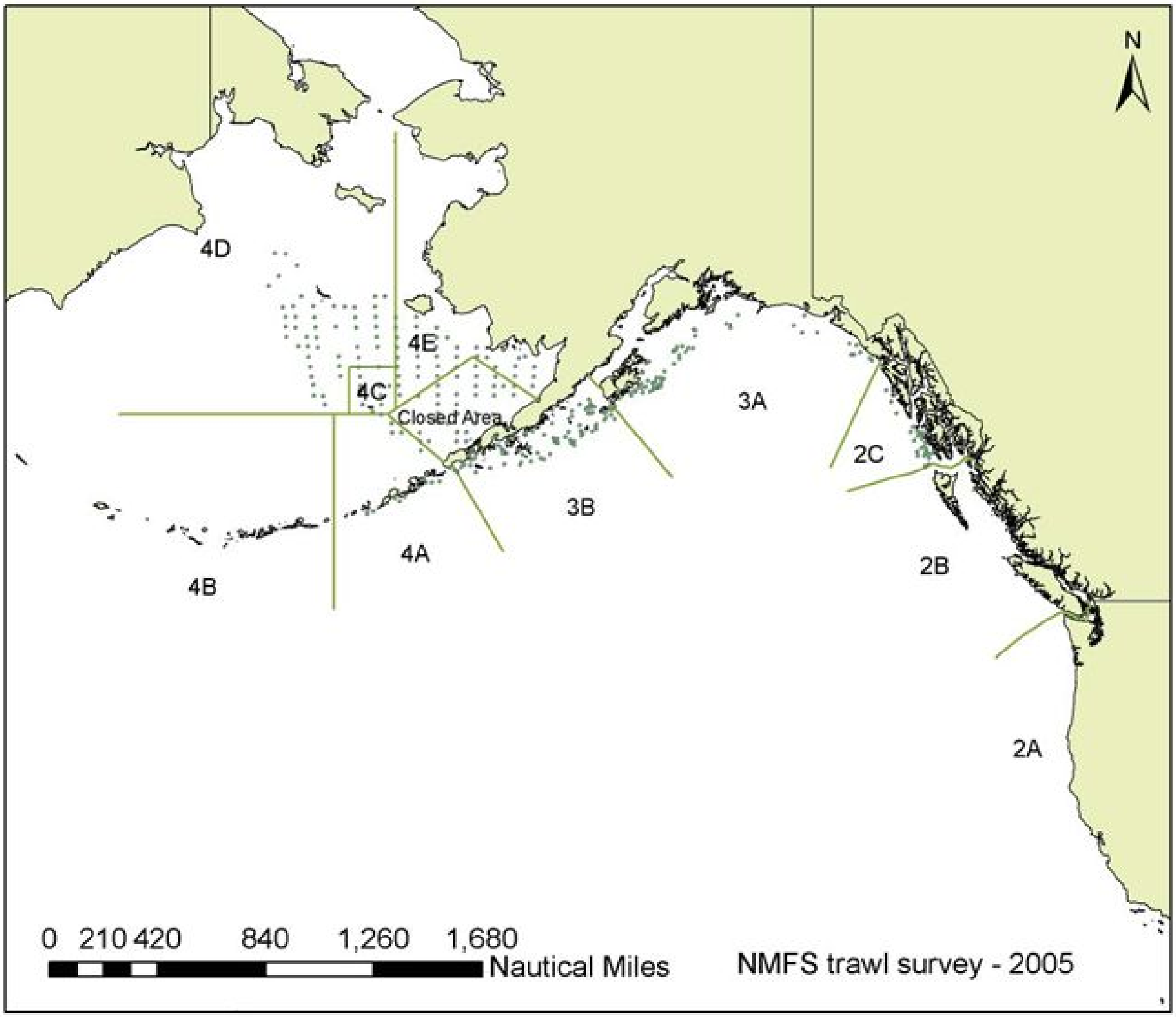

N
4D
4E
4C
Closed Area
3A
2C
3B
4A
4B
2B
2A
0 210 420 840 1,260 1,680
Nautical Miles
NMFS trawl survey - 2005

Figure 29

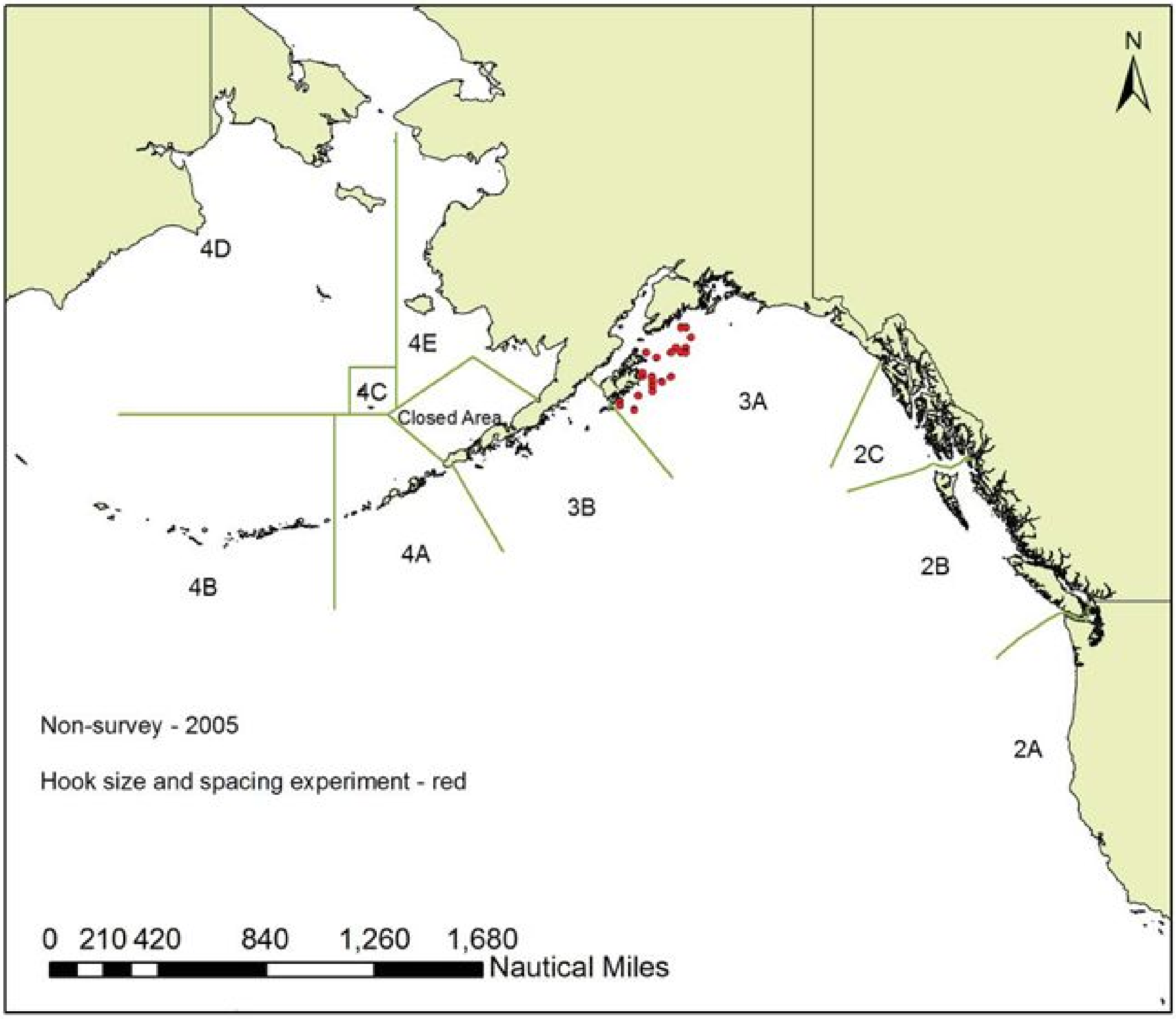

N
4D
4E
4C
Closed Area
3A
2C
3B
4A
4B
2B
2A
Non-survey - 2005
Hook size and spacing experiment - red
0 210 420 840 1,260 1,680
Nautical Miles

Figure 30

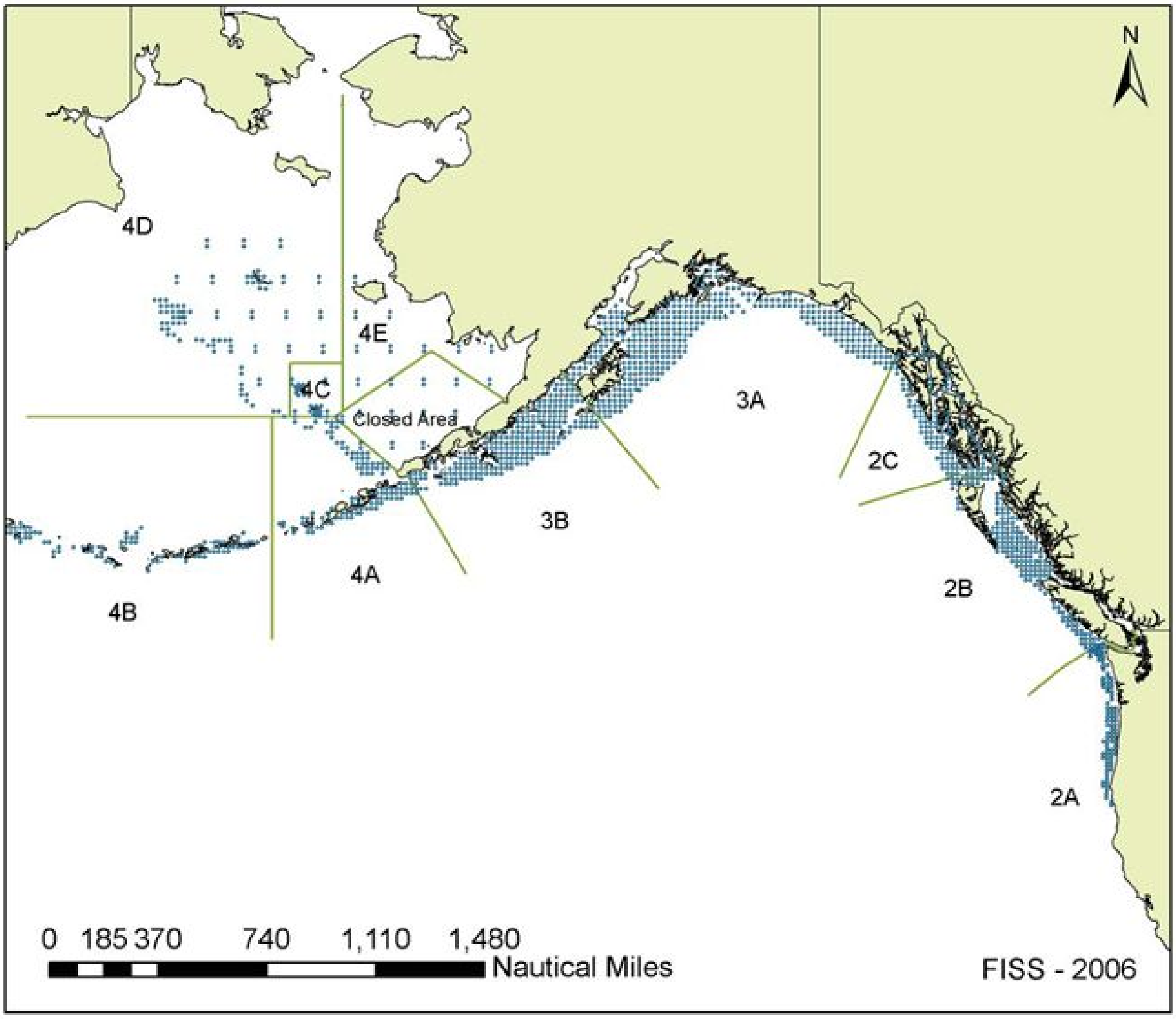

N
4D
4E
4C
Closed Area
3A
3B
2C
2B
2A
4A
4B
0 185 370 740 1,110 1,480
Nautical Miles
FISS - 2006

Figure 31

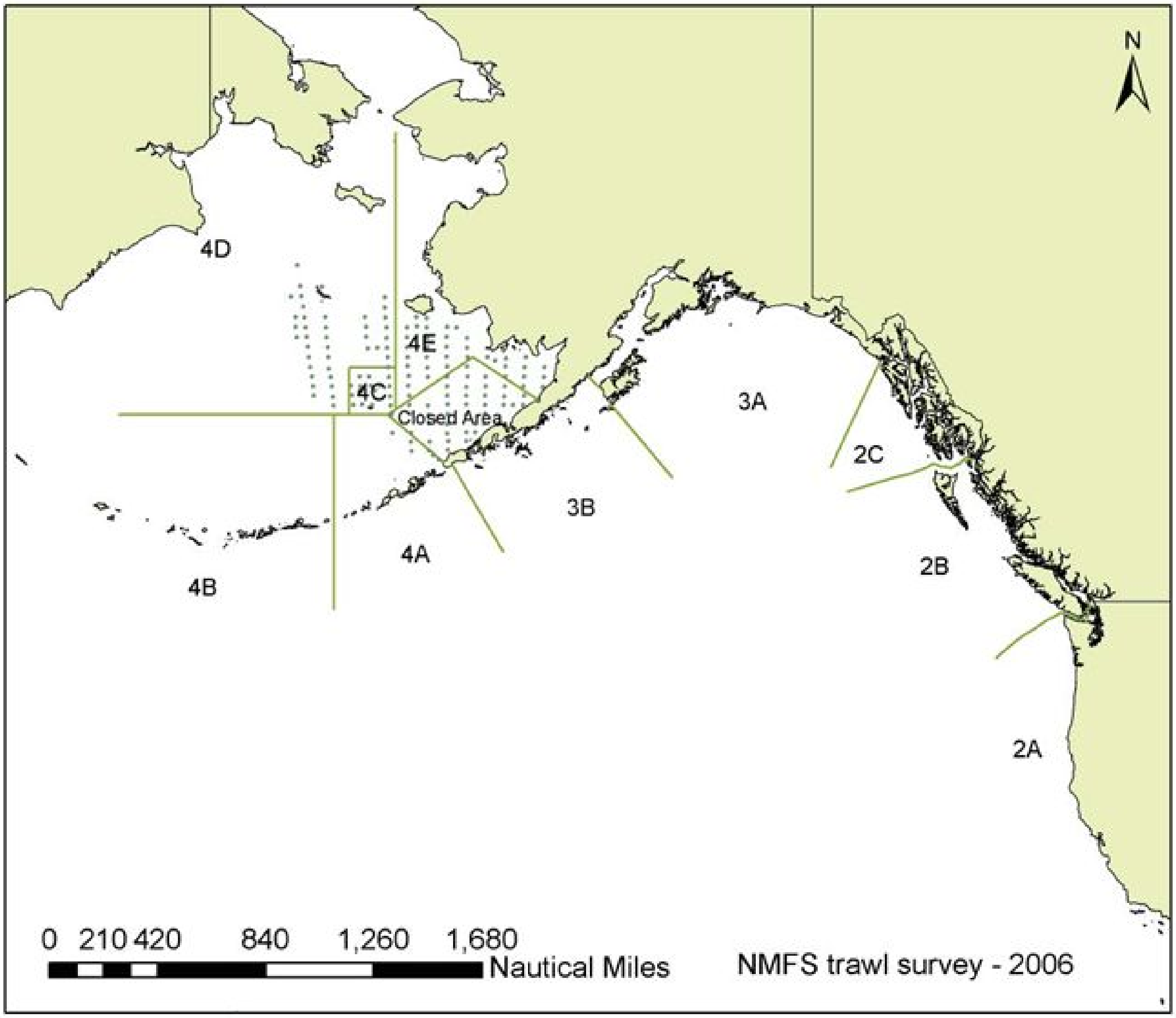

N
4D
4E
4C
Closed Area
3A
2C
3B
4A
4B
2B
2A
0 210 420 840 1,260 1,680
Nautical Miles
NMFS trawl survey - 2006

Figure 32

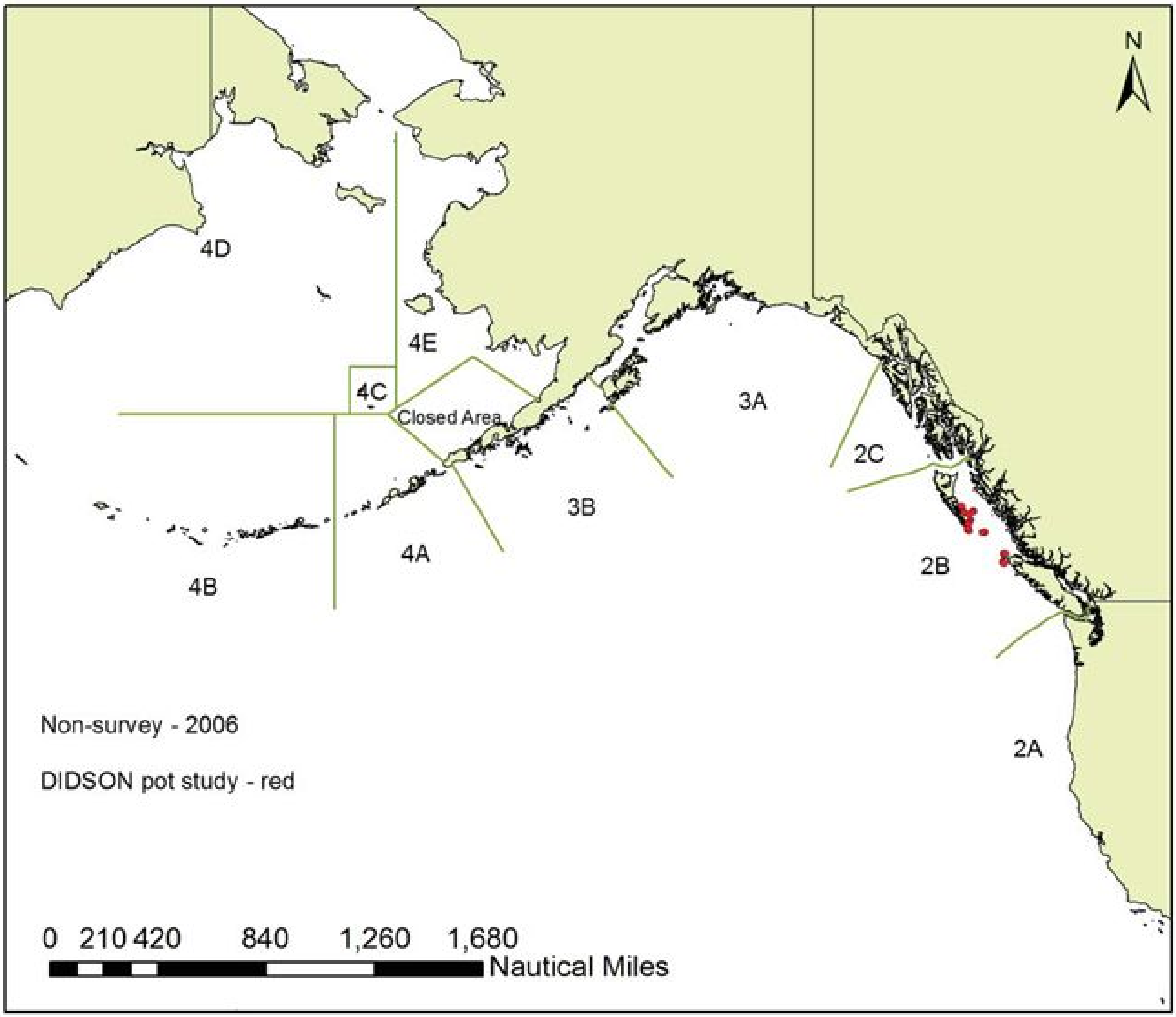
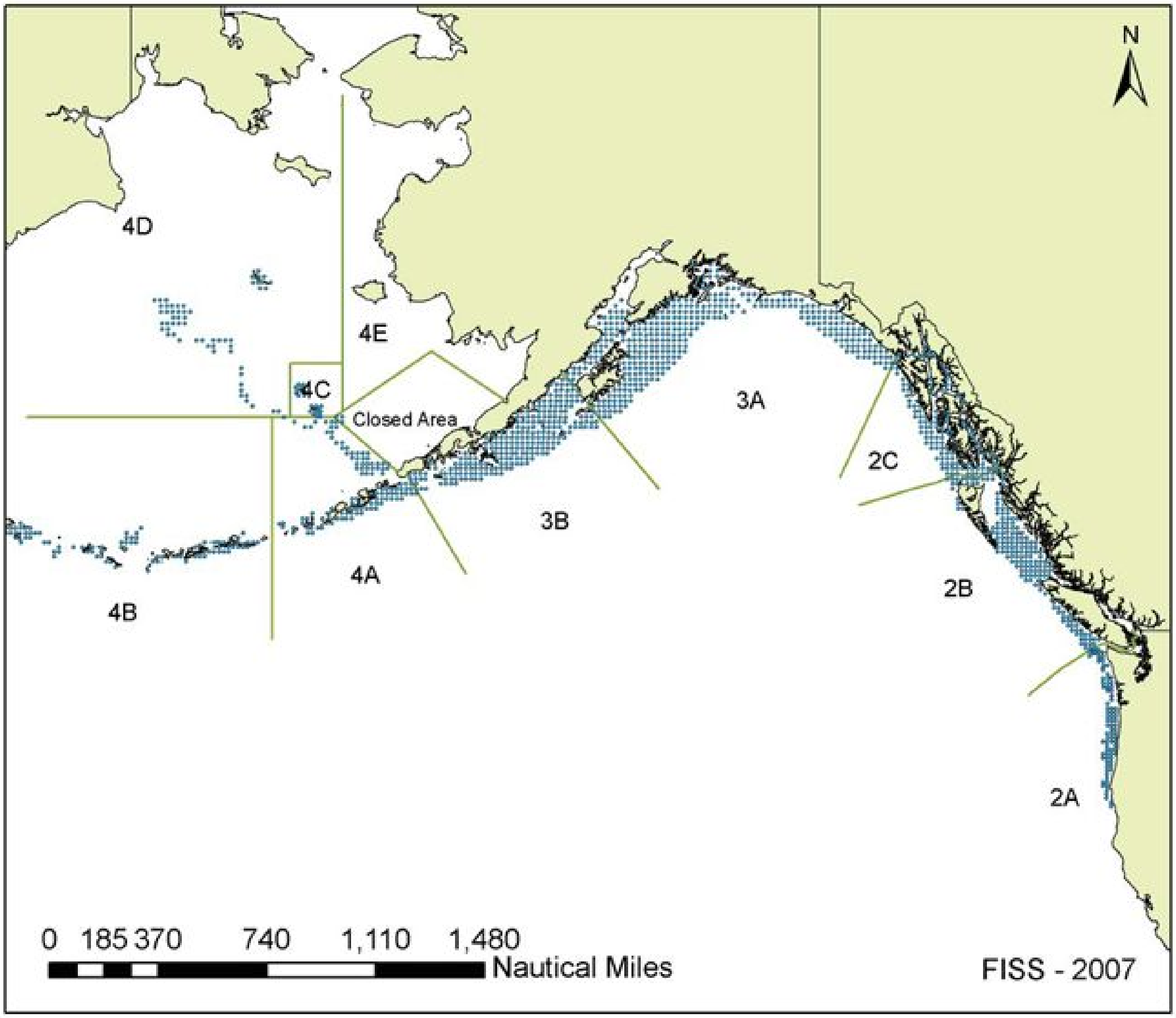

N
4D
4E
4C
Closed Area
3A
2C
3B
4A
4B
2B
2A
Non-survey - 2006
DIDSON pot study - red
0 210 420 840 1,260 1,680
Nautical Miles

Figure 33



N
4D
4E
4C
Closed Area
3A
2C
3B
4A
4B
2B
2A
0 185 370 740 1,110 1,480
Nautical Miles
FISS - 2007

Figure 34

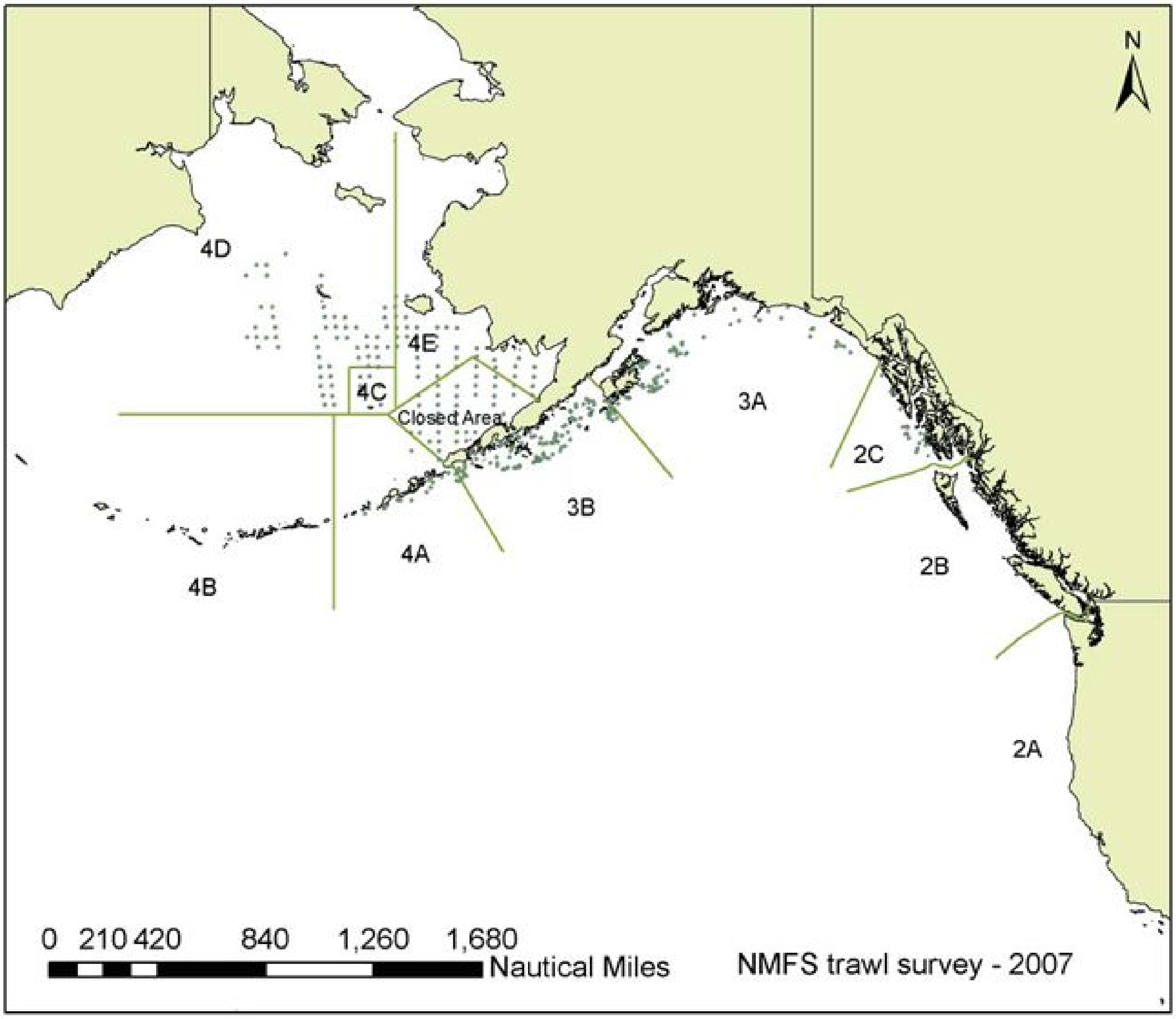

N
4D
4E
4C
Closed Area
3A
2C
3B
4A
4B
2B
2A
0 210 420 840 1,260 1,680
Nautical Miles
NMFS trawl survey - 2007

Figure 35

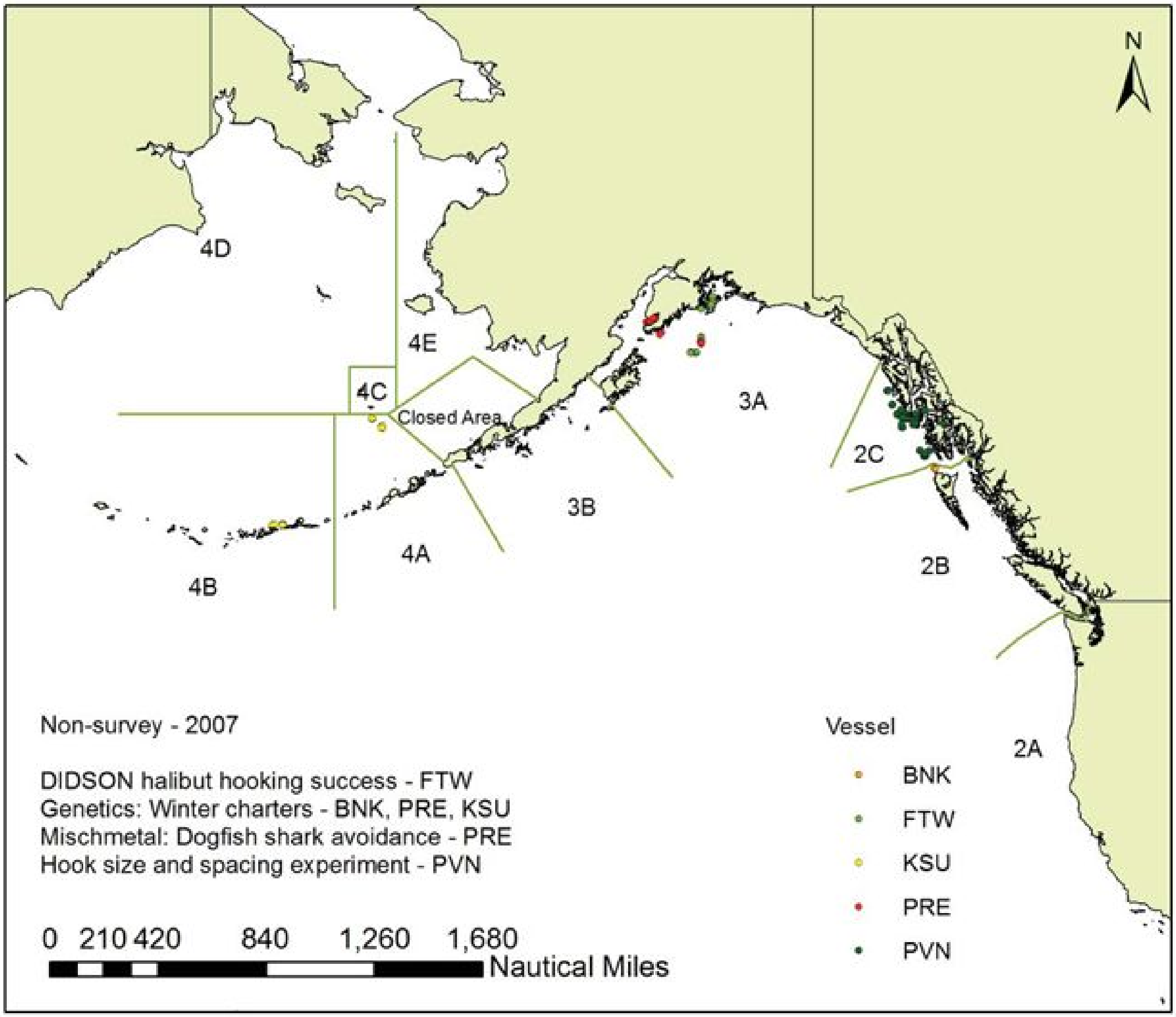

N
4D
4E
4C
Closed Area
3A
2C
3B
4A
2B
4B
2A
Non-survey - 2007
DIDSON halibut hooking success - FTW
Genetics: Winter charters - BNK, PRE, KSU
Mischmetal: Dogfish shark avoidance - PRE
Hook size and spacing experiment - PVN
0 210 420 840 1,260 1,680
Nautical Miles
Vessel
BNK
FTW
KSU
PRE
PVN

Figure 36

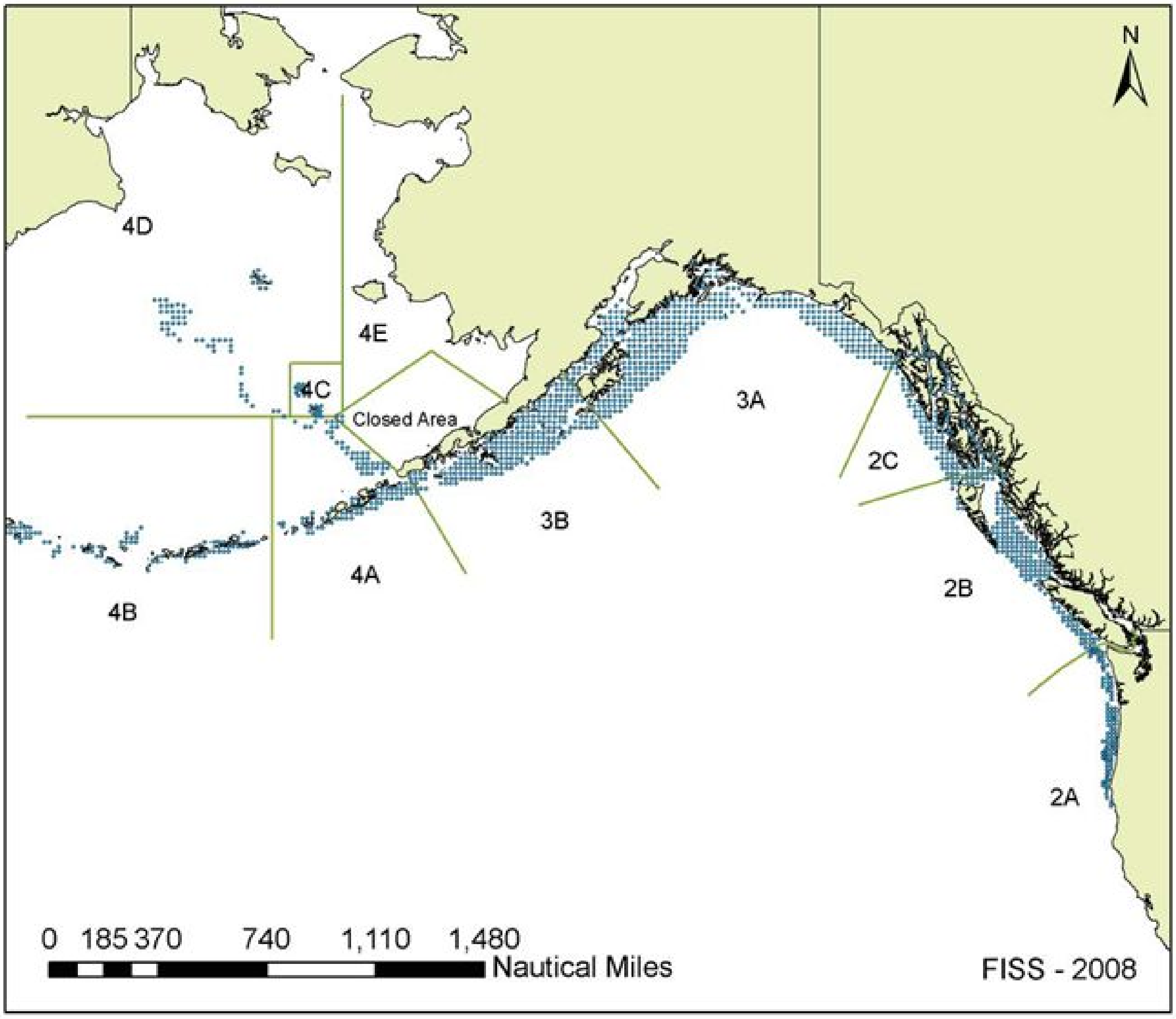

N
4D
4E
4C
Closed Area
3A
2C
3B
4A
2B
4B
2A
0 185 370 740 1,110 1,480
Nautical Miles
FISS - 2008

Figure 37

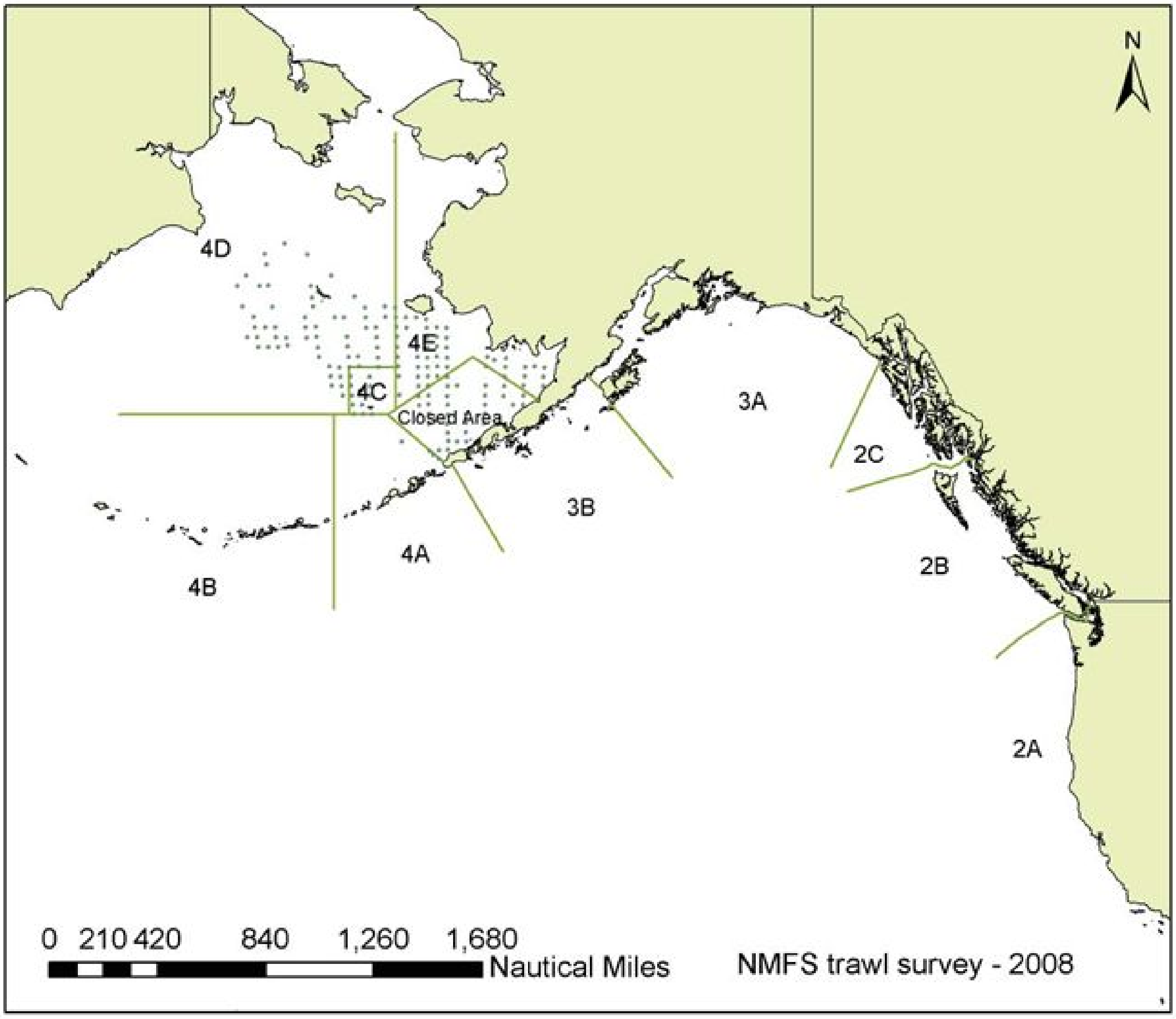

N
4D
4E
4C
Closed Area
3A
2C
3B
4A
4B
2B
2A
0 210 420 840 1,260 1,680
Nautical Miles
NMFS trawl survey - 2008

Figure 38

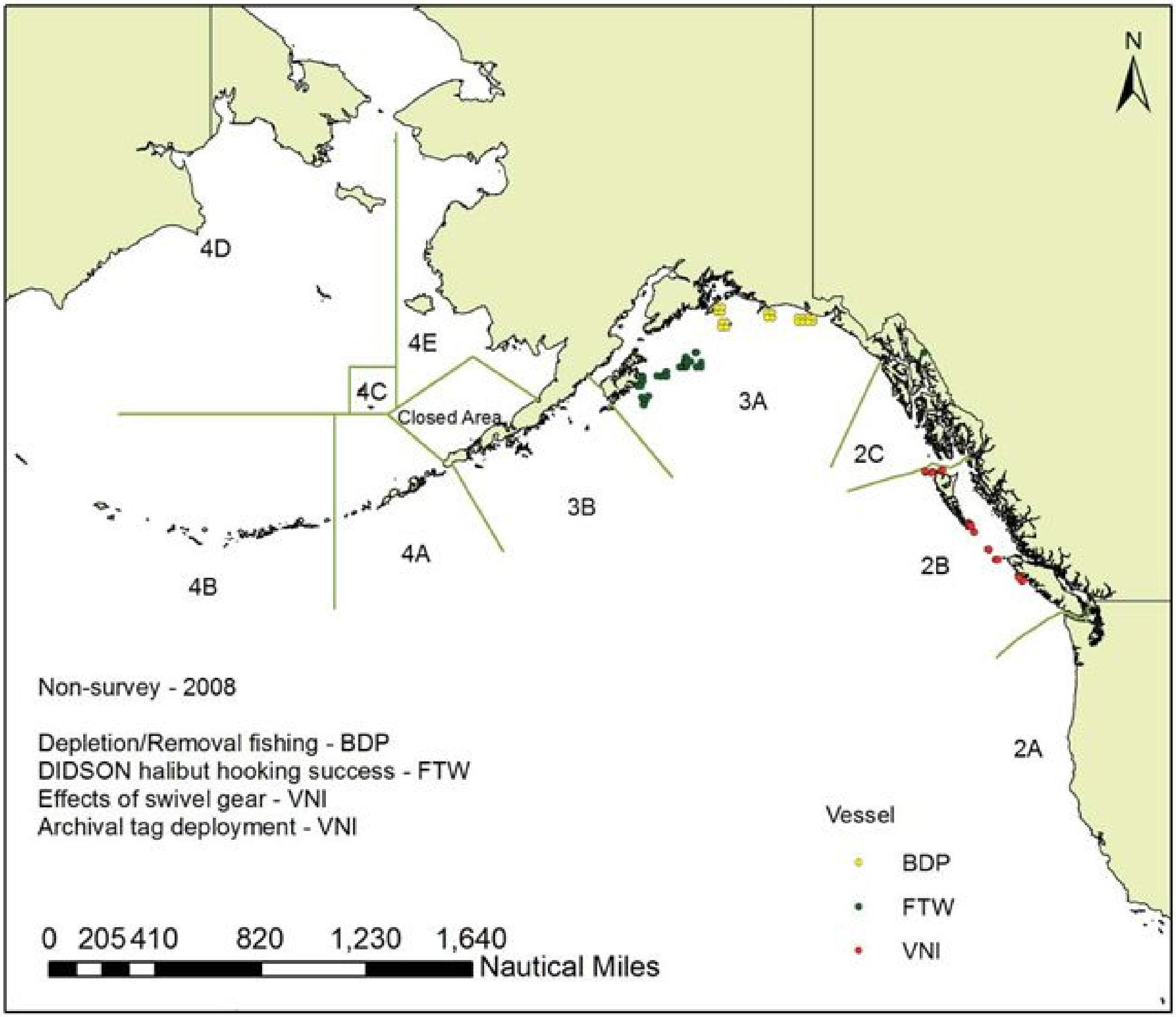

N
4D
4E
4C
Closed Area
3A
2C
3B
4A
4B
2B
2A
Non-survey - 2008
Depletion/Removal fishing - BDP
DIDSON halibut hooking success - FTW
Effects of swivel gear - VNI
Archival tag deployment - VNI
Vessel
BDP
FTW
VNI
0 205 410 820 1,230 1,640
Nautical Miles

Figure 39

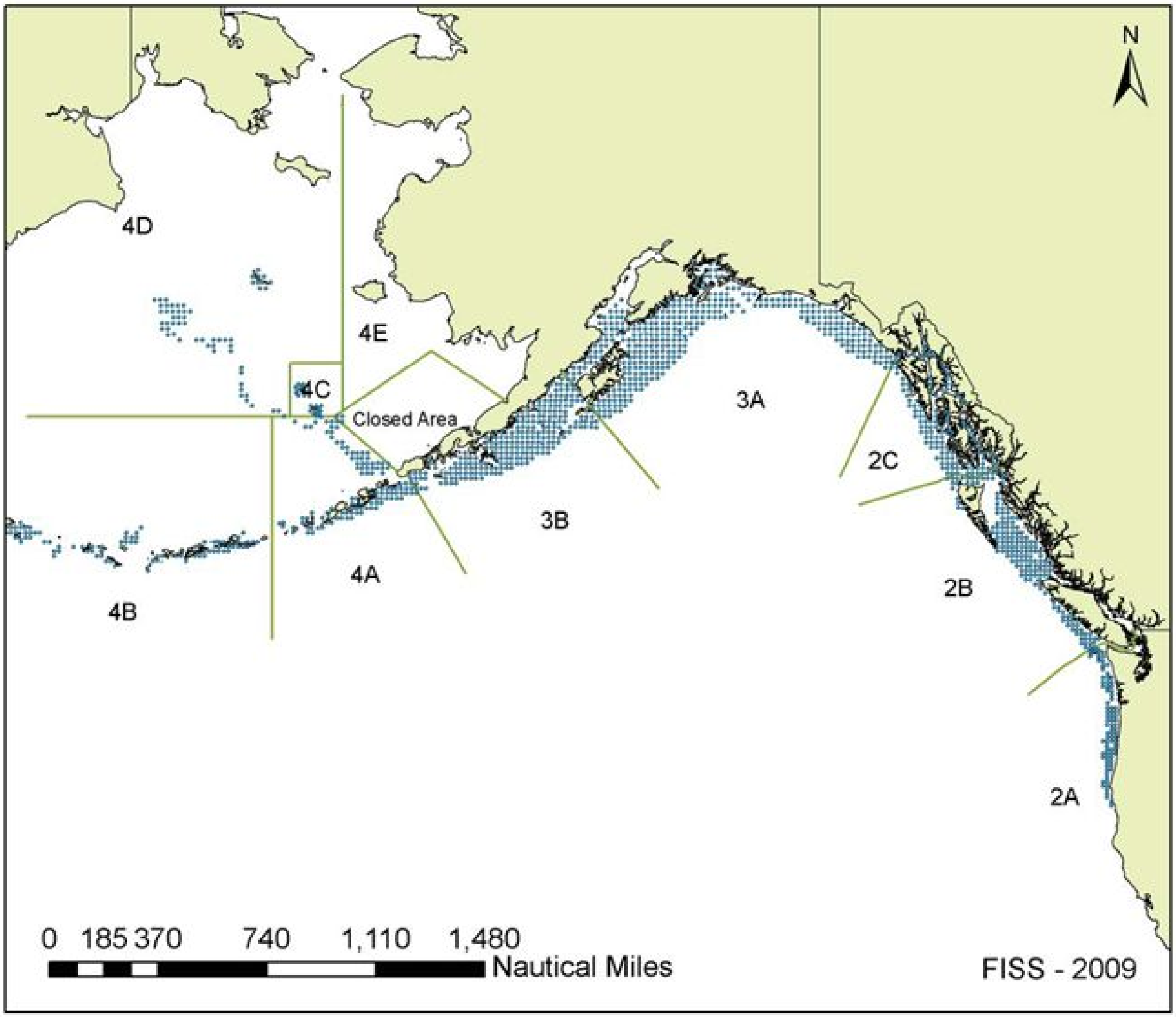

N
4D
4E
4C
Closed Area
3A
2C
3B
4A
2B
4B
2A
0 185 370 740 1,110 1,480
Nautical Miles
FISS - 2009

Figure 40

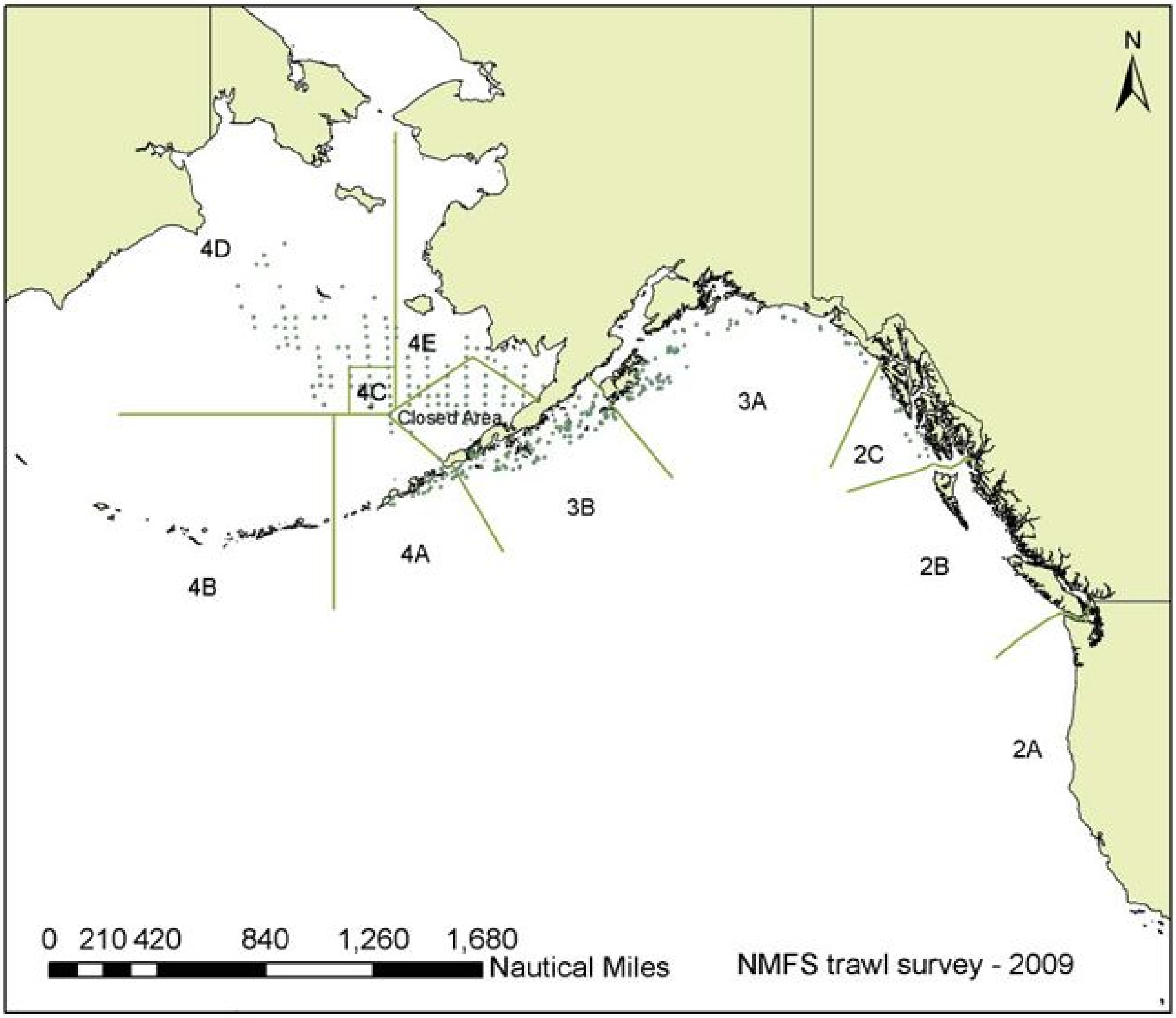

N
4D
4E
4C
Closed Area
3A
2C
3B
4A
4B
2B
2A
0 210 420 840 1,260 1,680
Nautical Miles
NMFS trawl survey - 2009

Figure 41

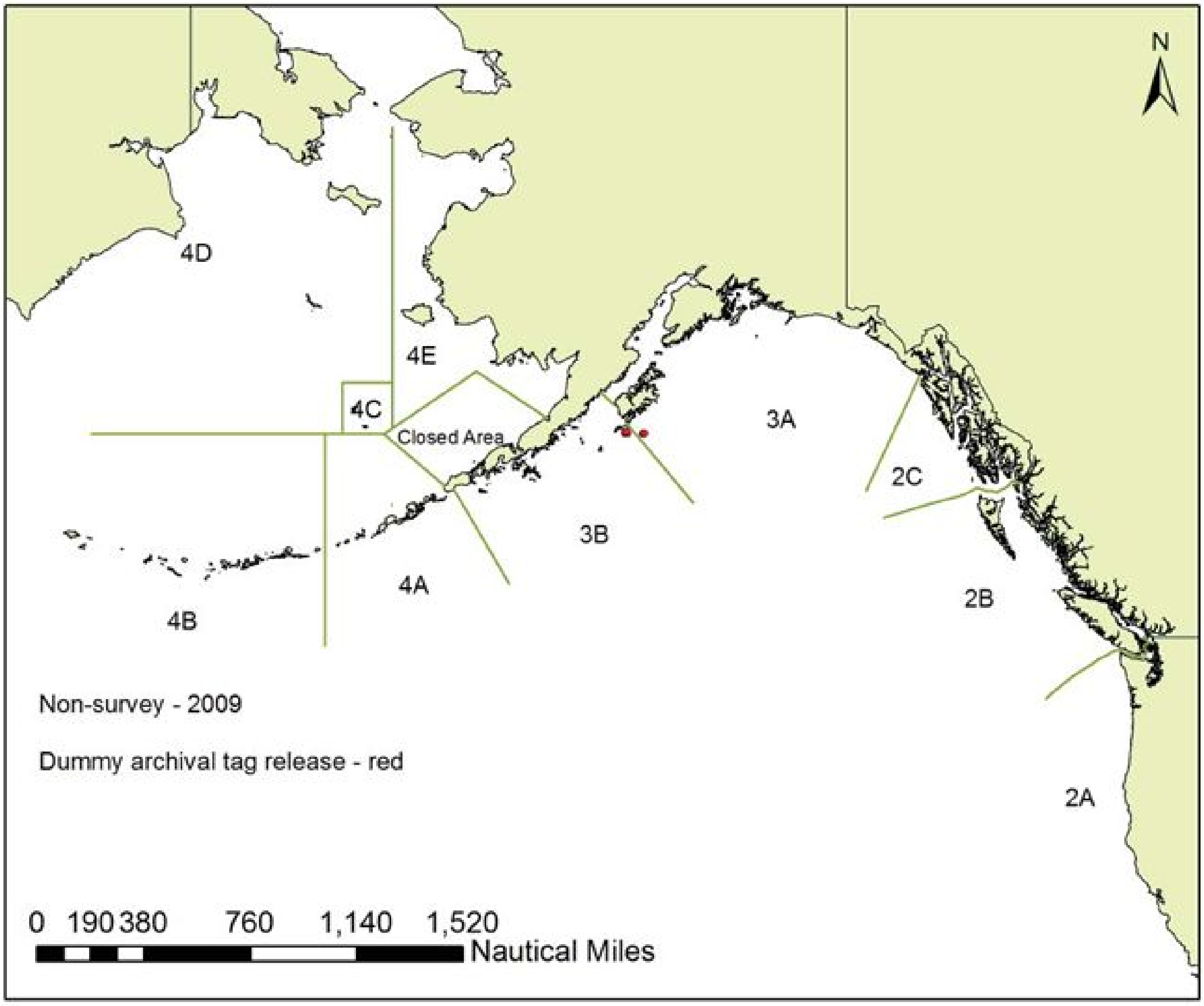

N
4D
4E
4C
Closed Area
3A
2C
3B
4A
4B
2B
2A
Non-survey - 2009
Dummy archival tag release - red
0 190 380 760 1,140 1,520
Nautical Miles

Figure 42

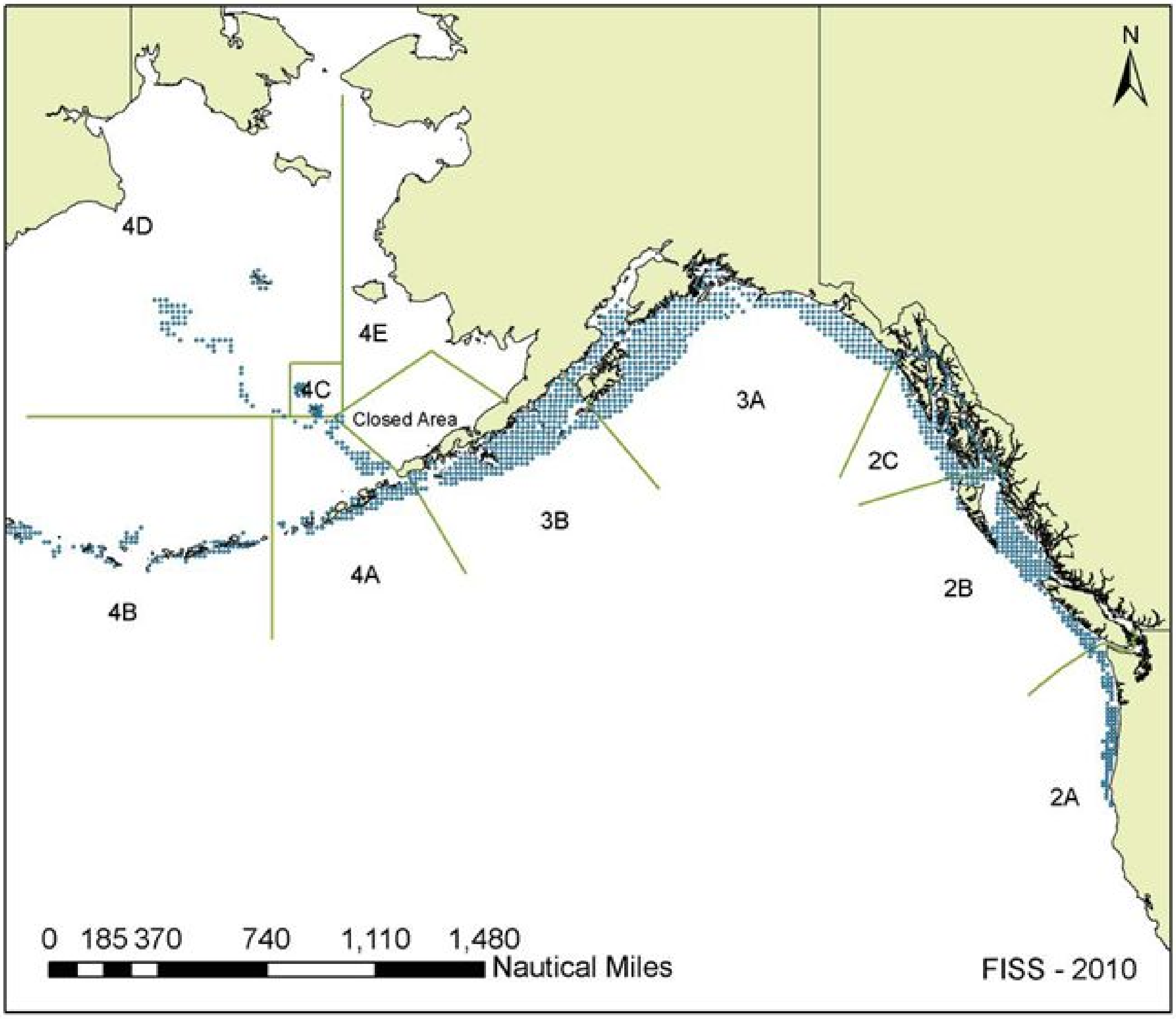

N
4D
4E
4C
Closed Area
3A
2C
3B
4A
4B
2B
2A
0 185 370 740 1,110 1,480
Nautical Miles
FISS - 2010

Figure 43

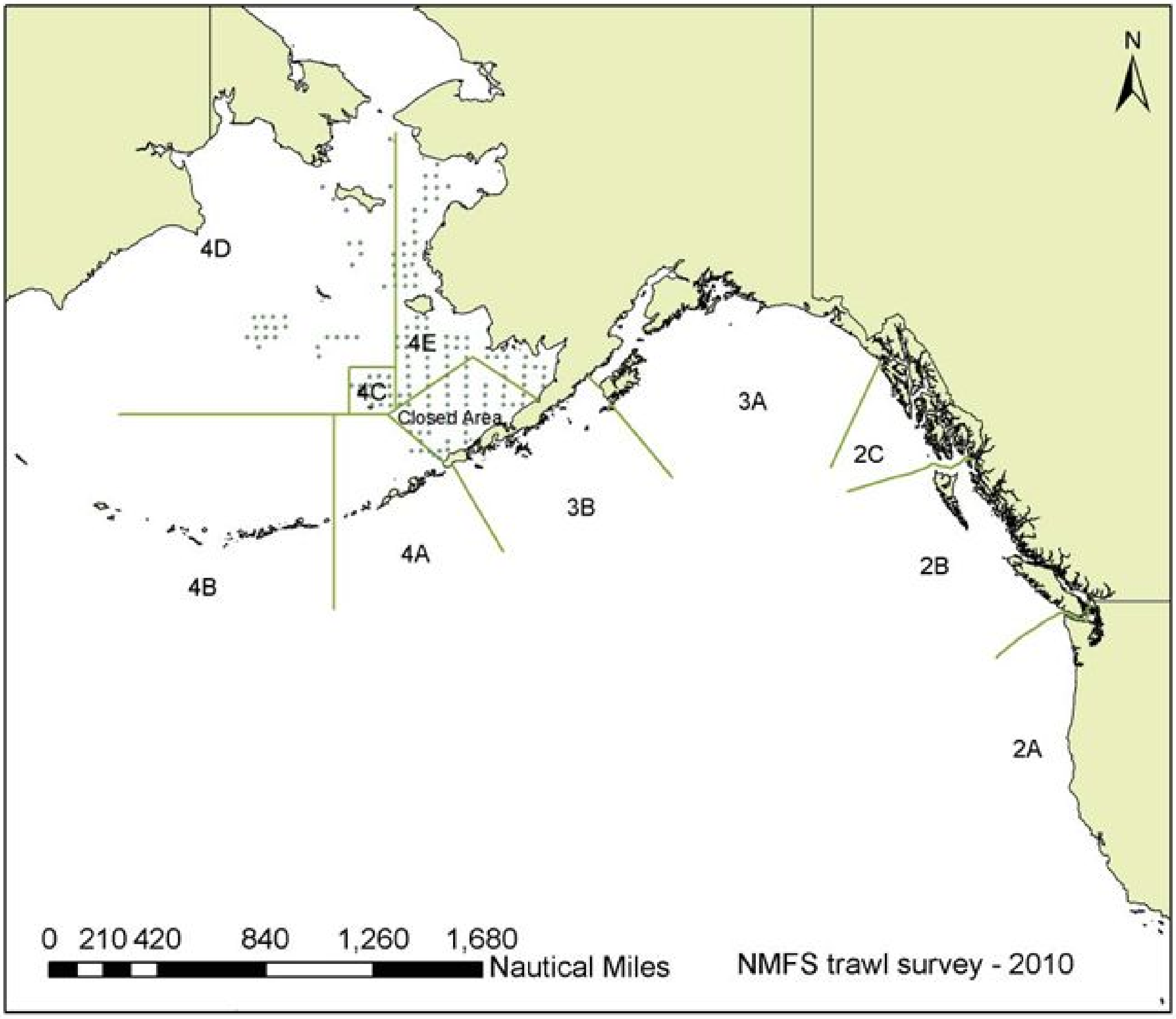

N
4D
4E
4C
Closed Area
3A
2C
3B
4A
2B
4B
2A
0 210 420 840 1,260 1,680
Nautical Miles
NMFS trawl survey - 2010

Figure 44

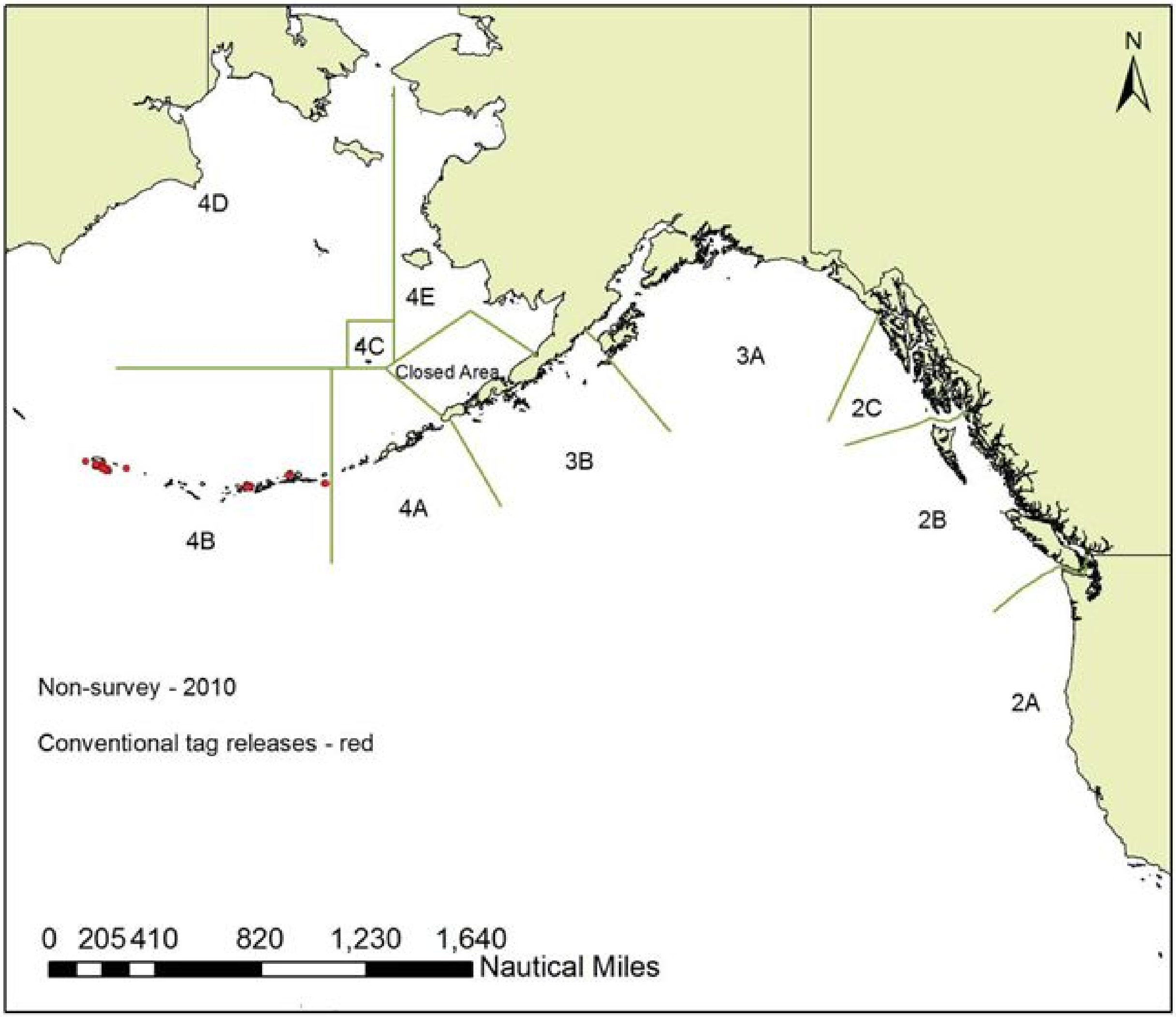

N
4D
4E
4C
Closed Area
3A
2C
3B
4A
4B
2B
2A
Non-survey - 2010
Conventional tag releases - red
0 205 410 820 1,230 1,640
Nautical Miles

Figure 45

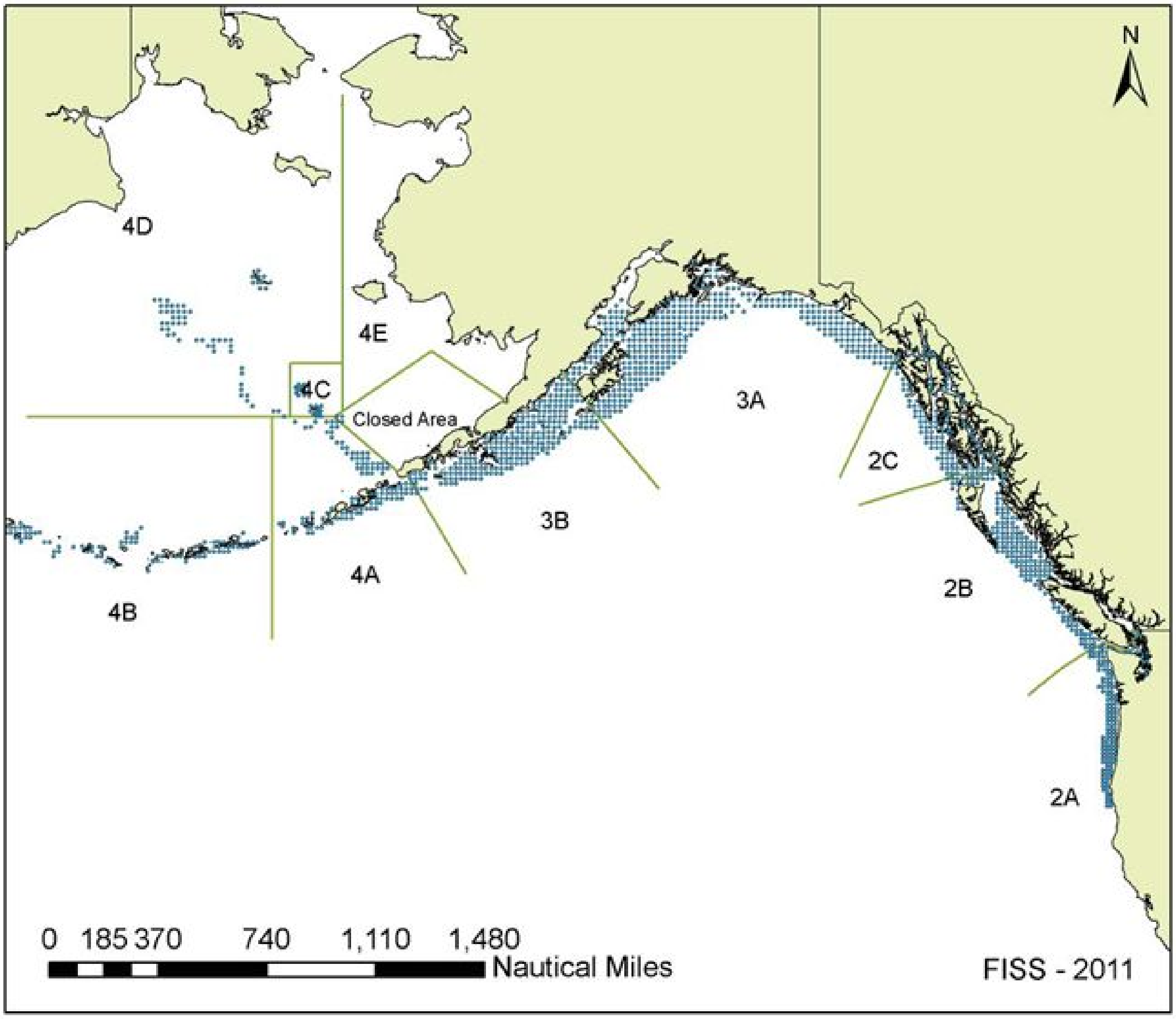
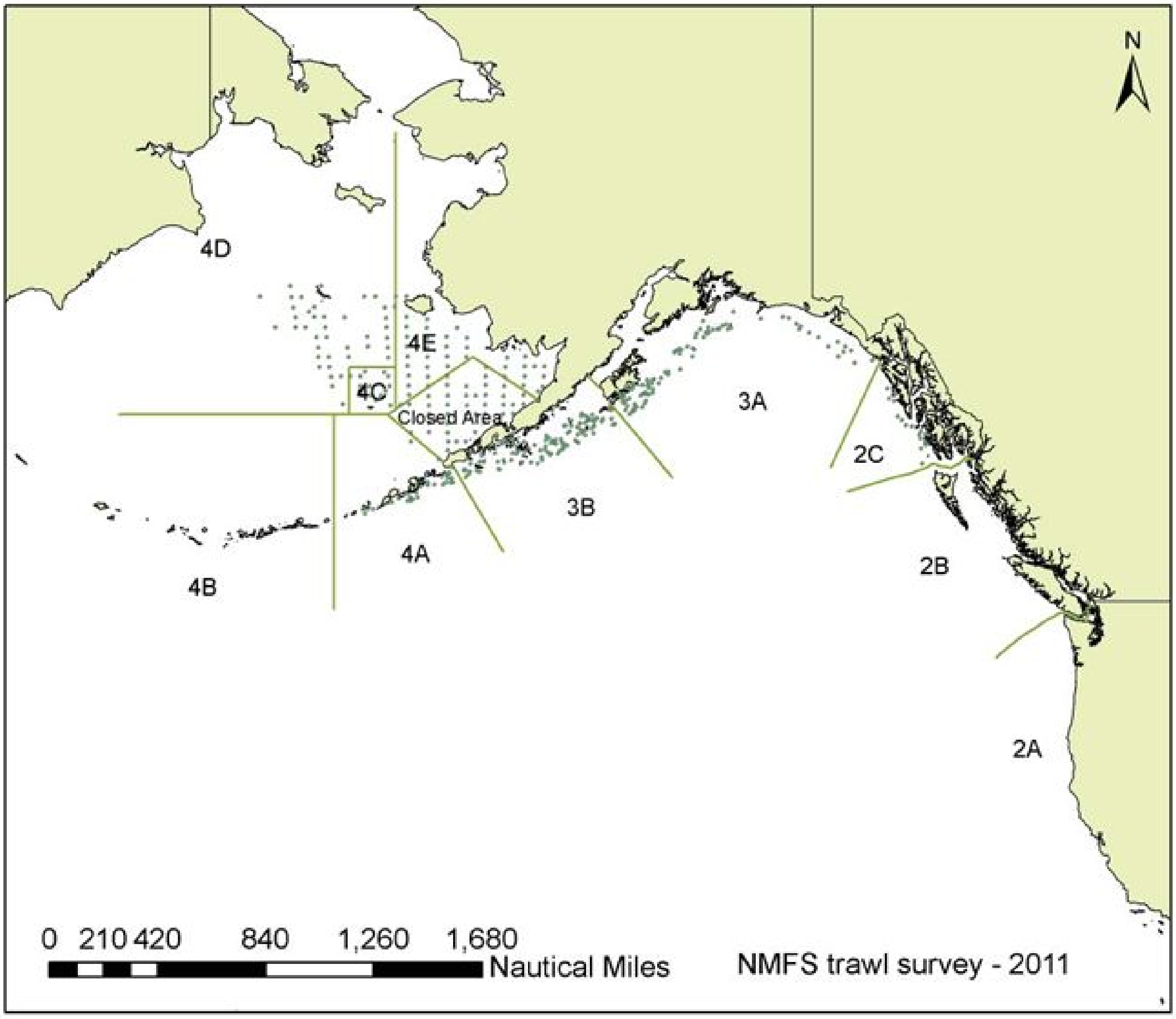

N
4D
4E
4C
Closed Area
3A
3B
2C
4A
2B
4B
2A
0 185 370 740 1,110 1,480
Nautical Miles
FISS - 2011

Figure 46



N
4D
4E
4C
Closed Area
3A
2C
3B
4A
4B
2B
2A
0 210 420 840 1,260 1,680
Nautical Miles
NMFS trawl survey - 2011

Figure 47

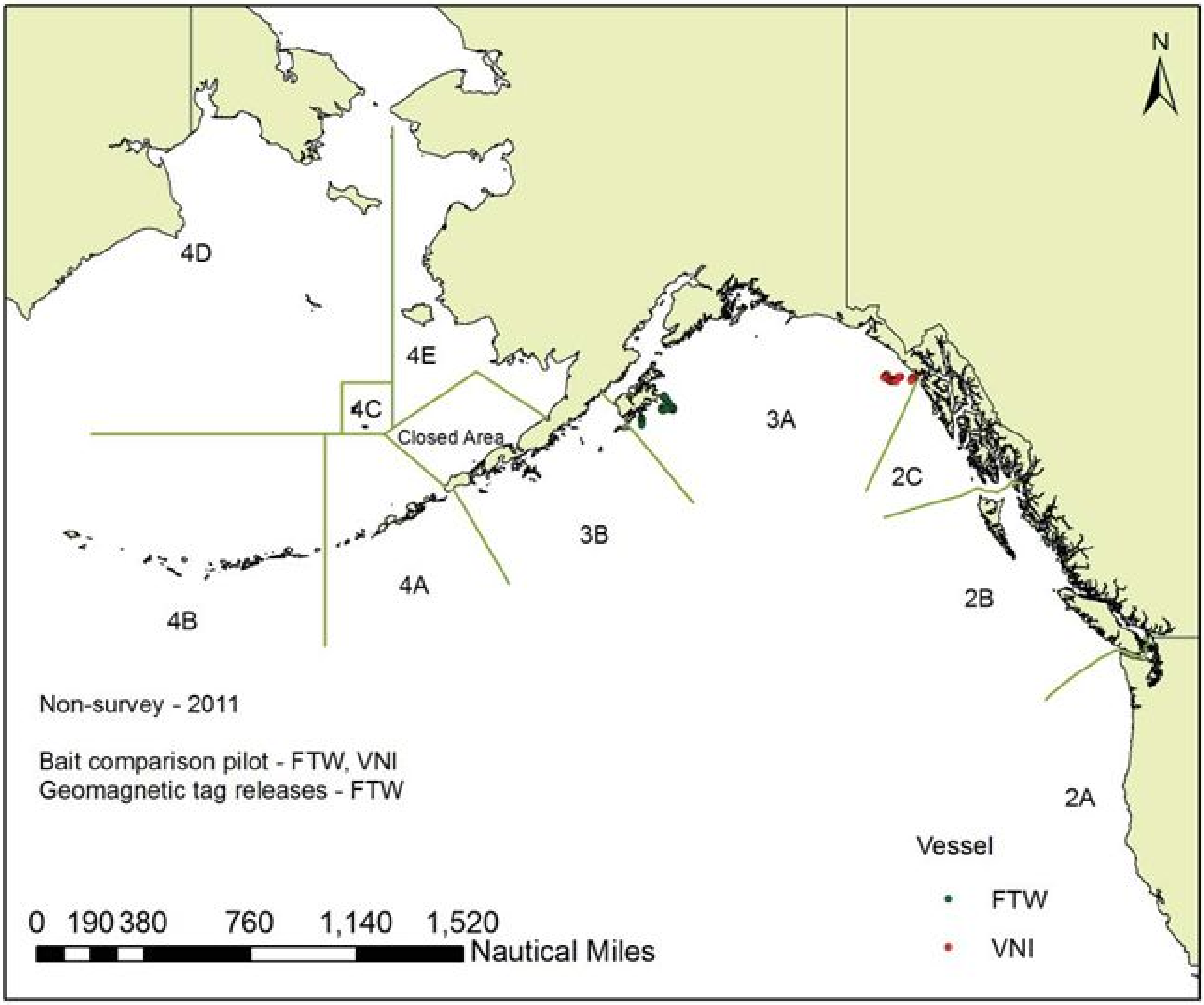

N
4D
4E
4C
Closed Area
3A
2C
3B
4A
4B
2B
2A
Non-survey - 2011
Bait comparison pilot - FTW, VNI
Geomagnetic tag releases - FTW
Vessel
FTW
VNI
0 190 380 760 1,140 1,520
Nautical Miles

Figure 48

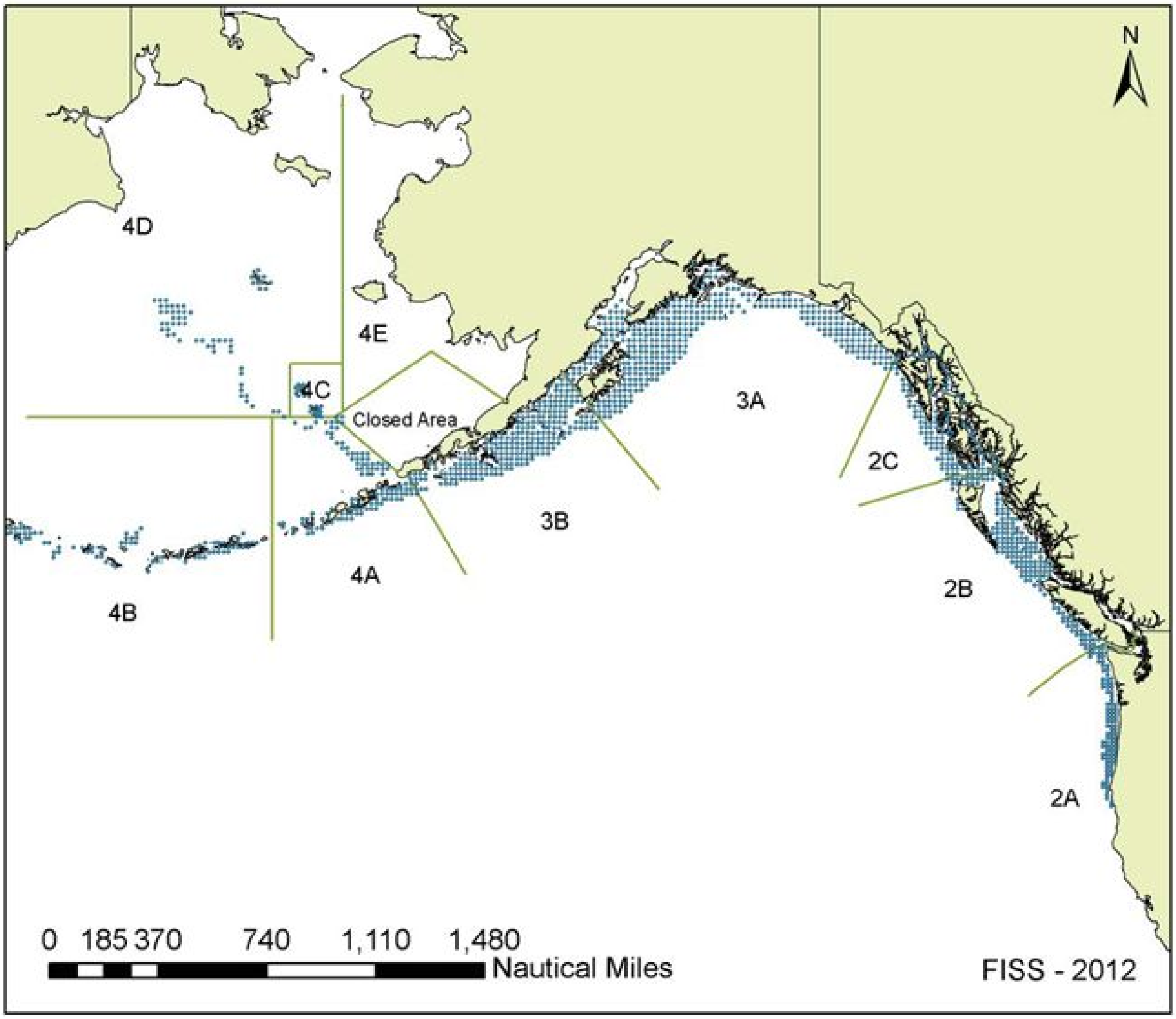

N
4D
4E
4C
Closed Area
3A
3B
4A
4B
2C
2B
2A
0 185 370 740 1,110 1,480
Nautical Miles
FISS - 2012

Figure 49

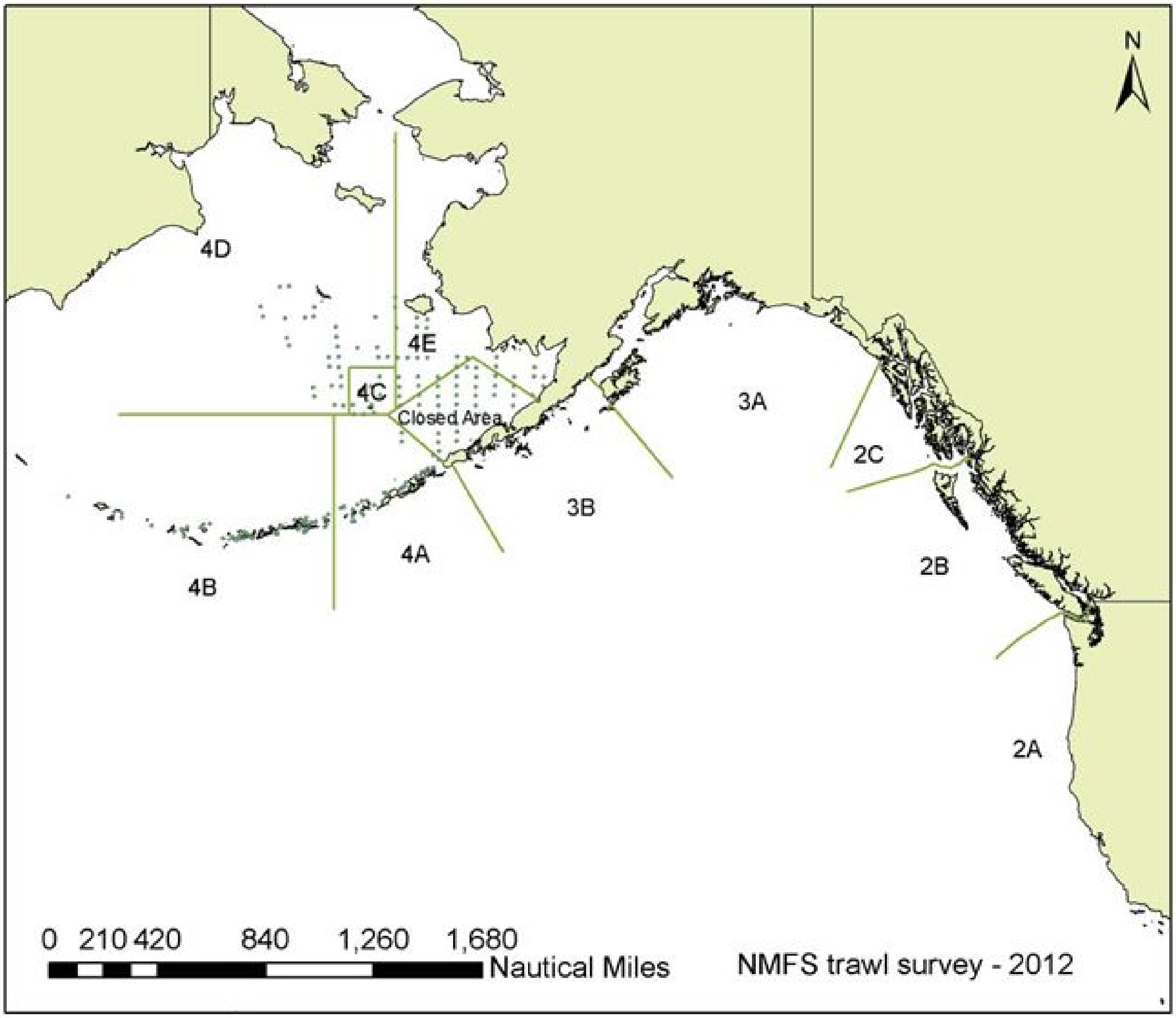

N
4D
4E
4C
Closed Area
3A
2C
3B
4A
4B
2B
2A
0 210 420 840 1,260 1,680
Nautical Miles
NMFS trawl survey - 2012

Figure 50

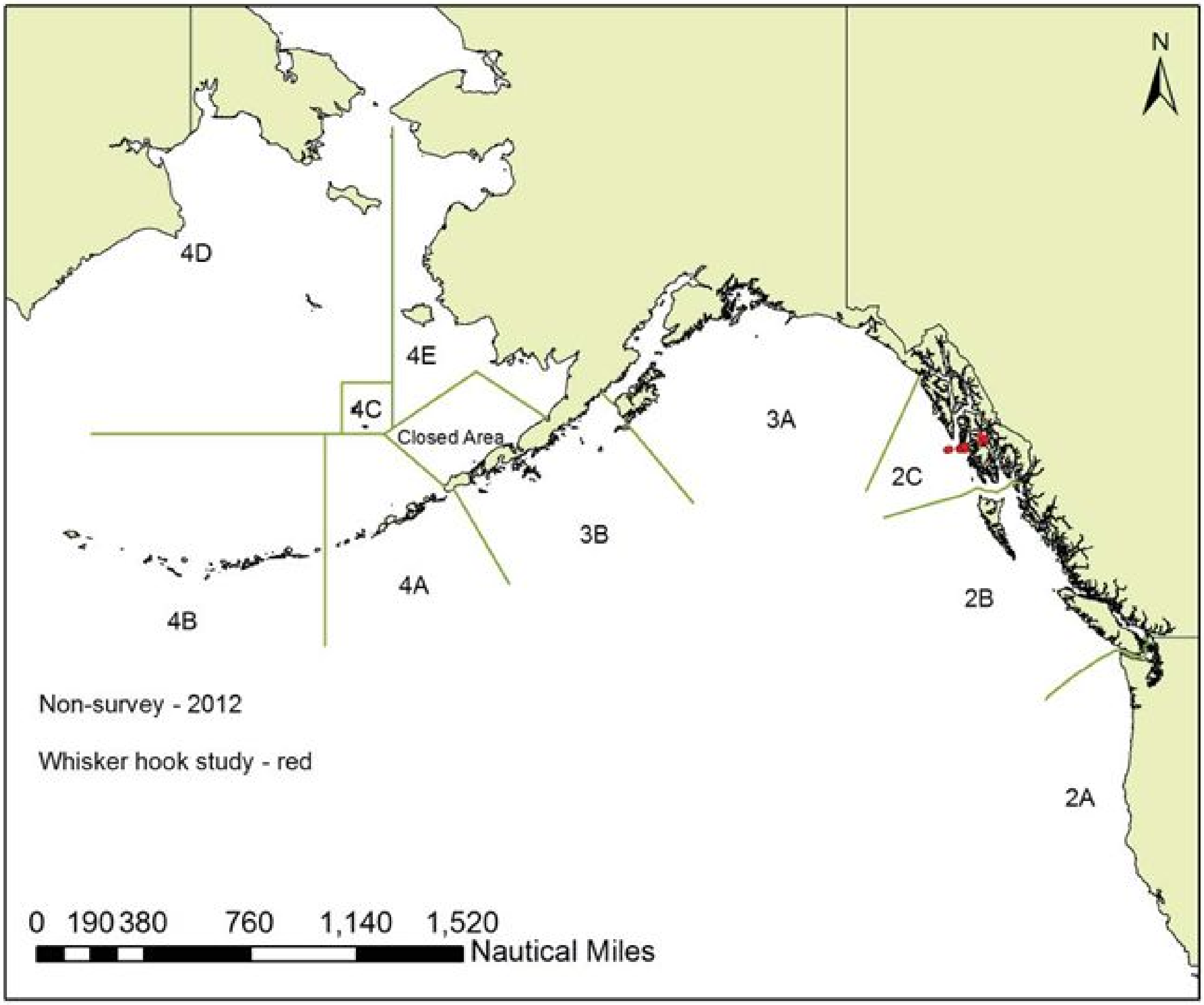

N
4D
4E
4C
Closed Area
3A
2C
3B
4A
4B
2B
2A
Non-survey - 2012
Whisker hook study - red
0 190 380 760 1,140 1,520
Nautical Miles

Figure 51

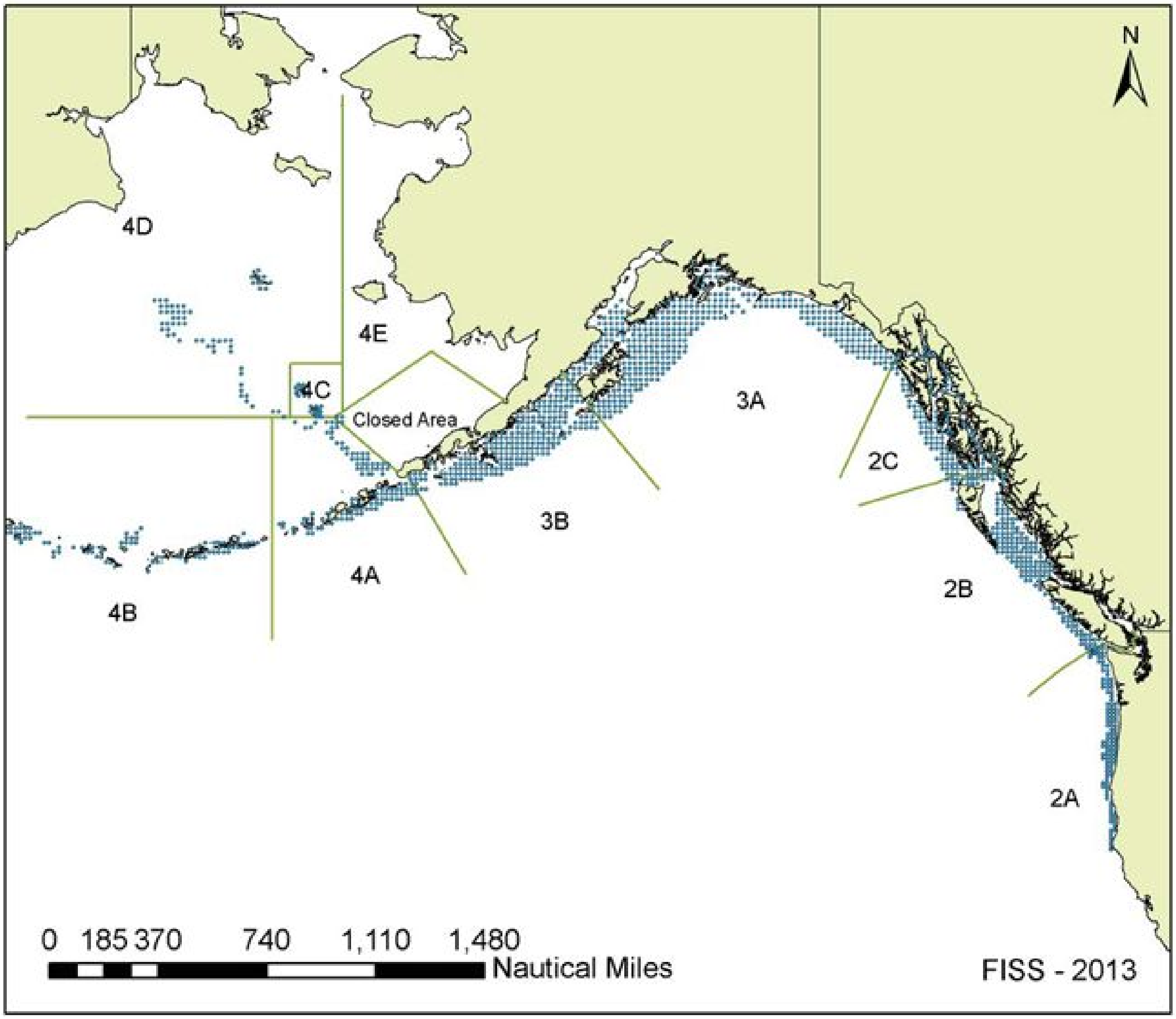

N
4D
4E
4C
Closed Area
3A
2C
3B
4A
4B
2B
2A
0 185 370 740 1,110 1,480
Nautical Miles
FISS - 2013

Figure 52

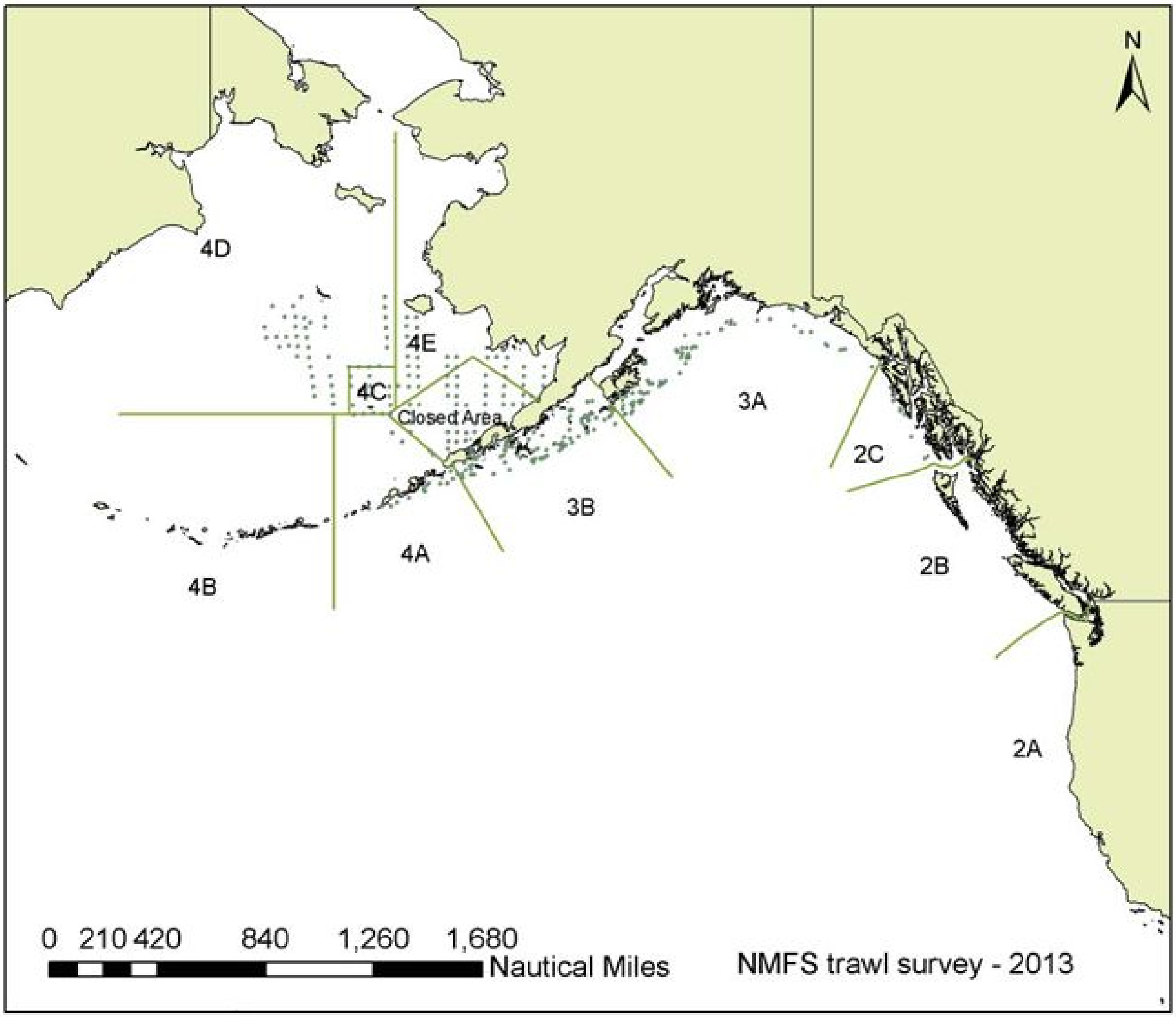

N
4D
4E
4C
Closed Area
3A
2C
3B
4A
4B
2B
2A
0 210 420 840 1,260 1,680
Nautical Miles
NMFS trawl survey - 2013

Figure 53

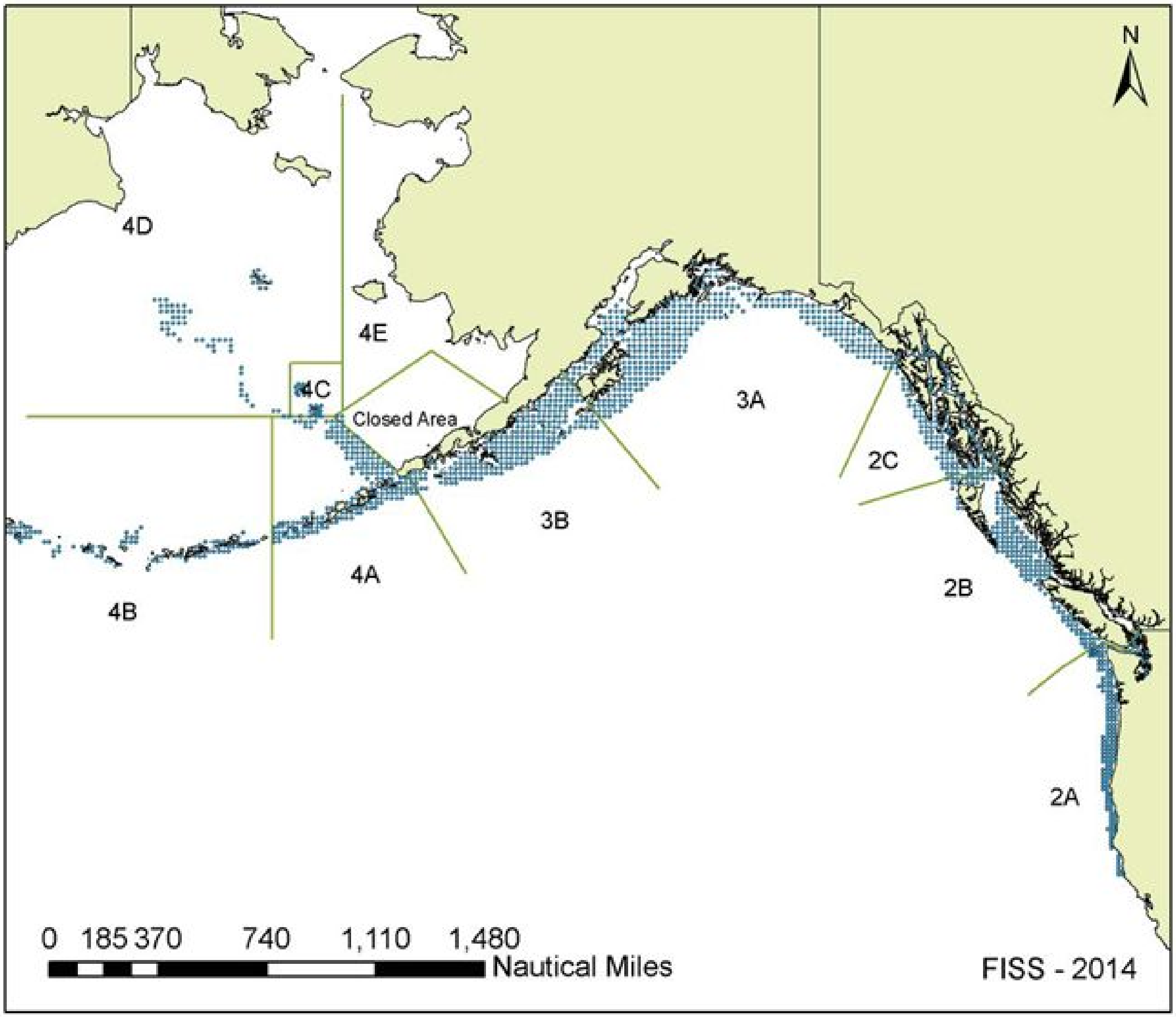

N
4D
4E
4C
Closed Area
3A
2C
3B
4A
2B
4B
2A
0 185 370 740 1,110 1,480
Nautical Miles
FISS - 2014

Figure 54

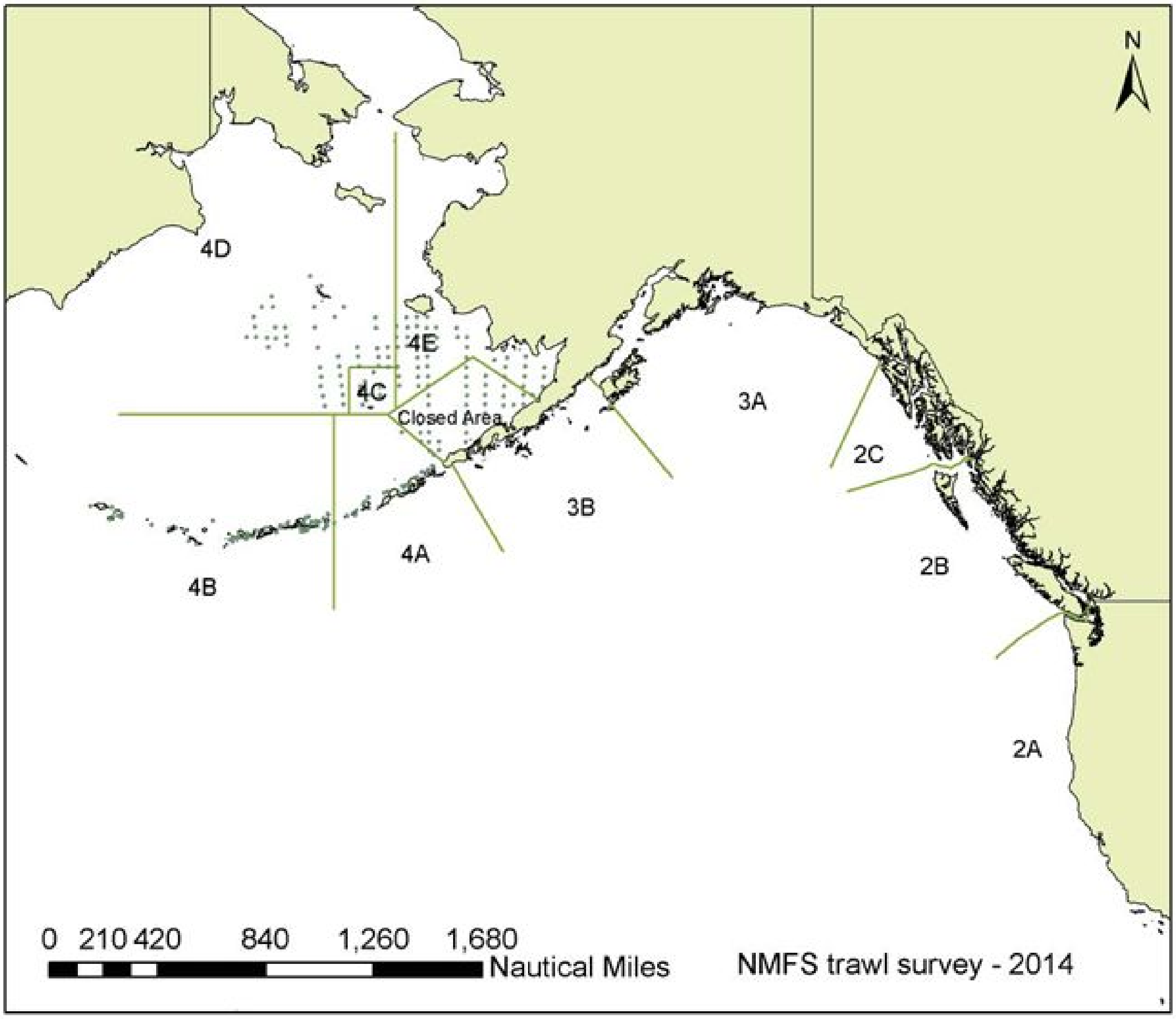

N
4D
4E
4C
Closed Area
3A
2C
3B
4A
4B
2B
2A
0 210 420 840 1,260 1,680
Nautical Miles
NMFS trawl survey - 2014

Figure 55

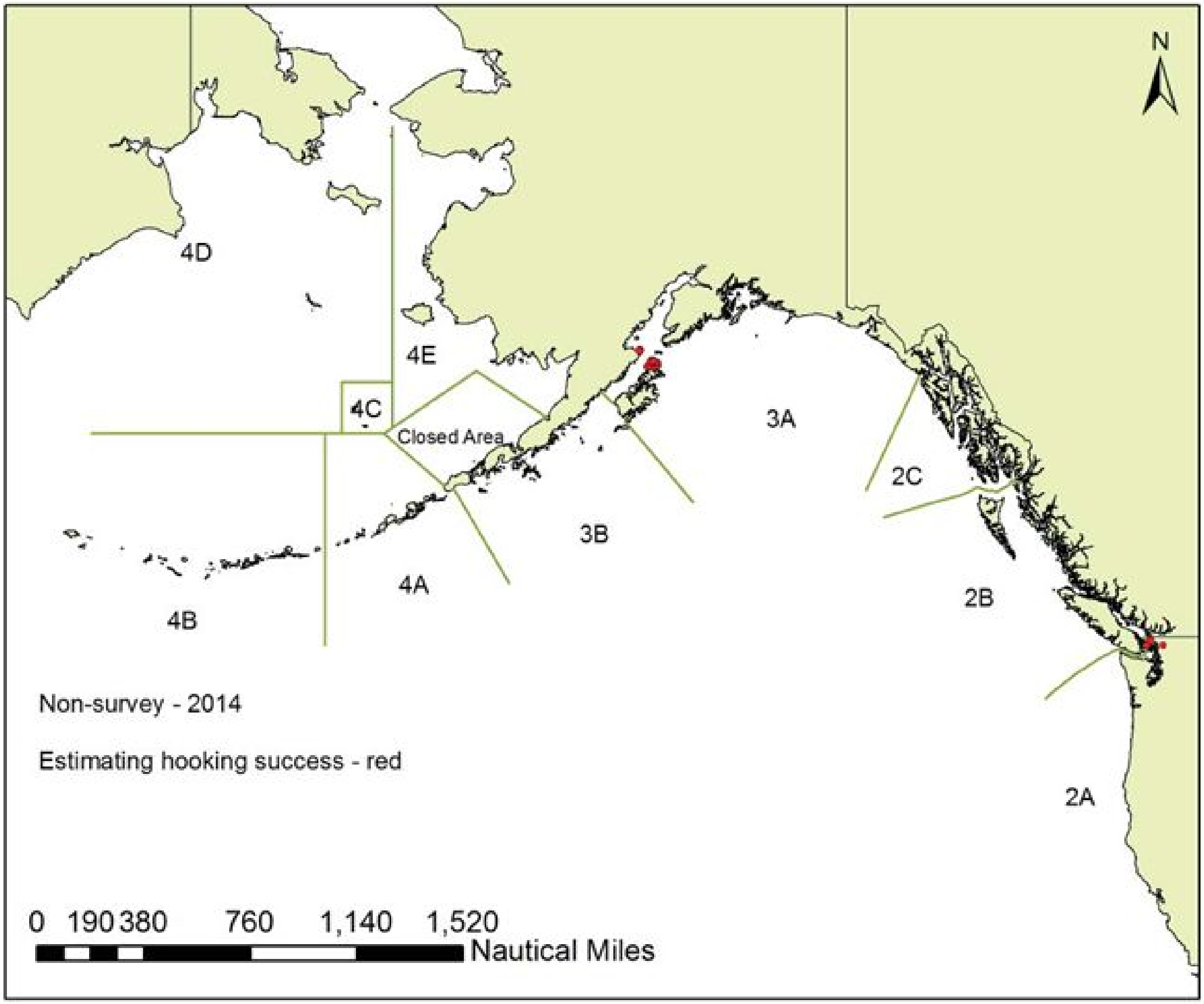
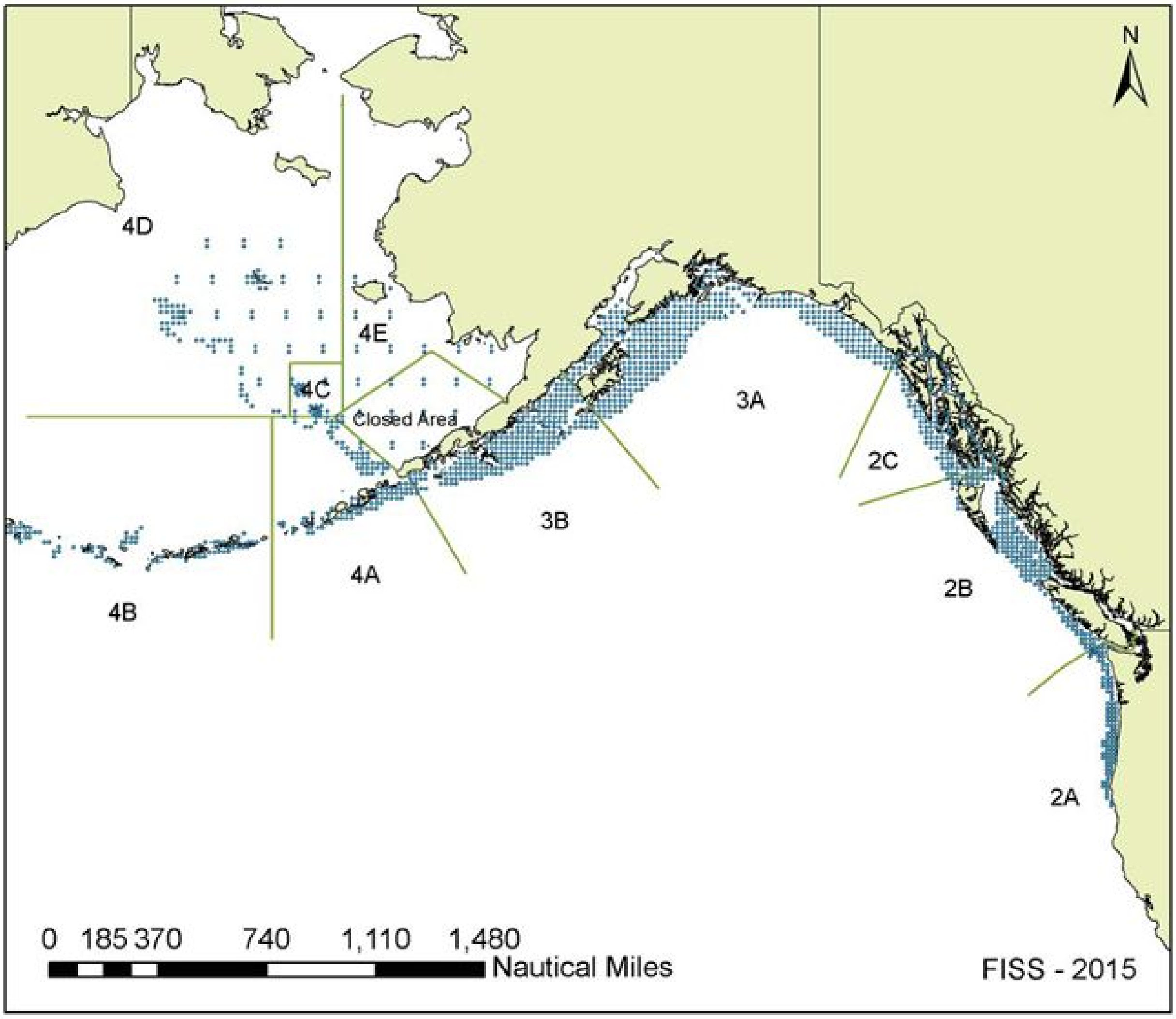

N
4D
4E
4C
Closed Area
3A
2C
3B
4A
4B
2B
2A
Non-survey - 2014
Estimating hooking success - red
0 190 380 760 1,140 1,520
Nautical Miles

Figure 56



N
4D
4E
4C
Closed Area
3A
3B
2C
2B
4A
4B
2A
0 185 370 740 1,110 1,480
Nautical Miles
FISS - 2015

Figure 57

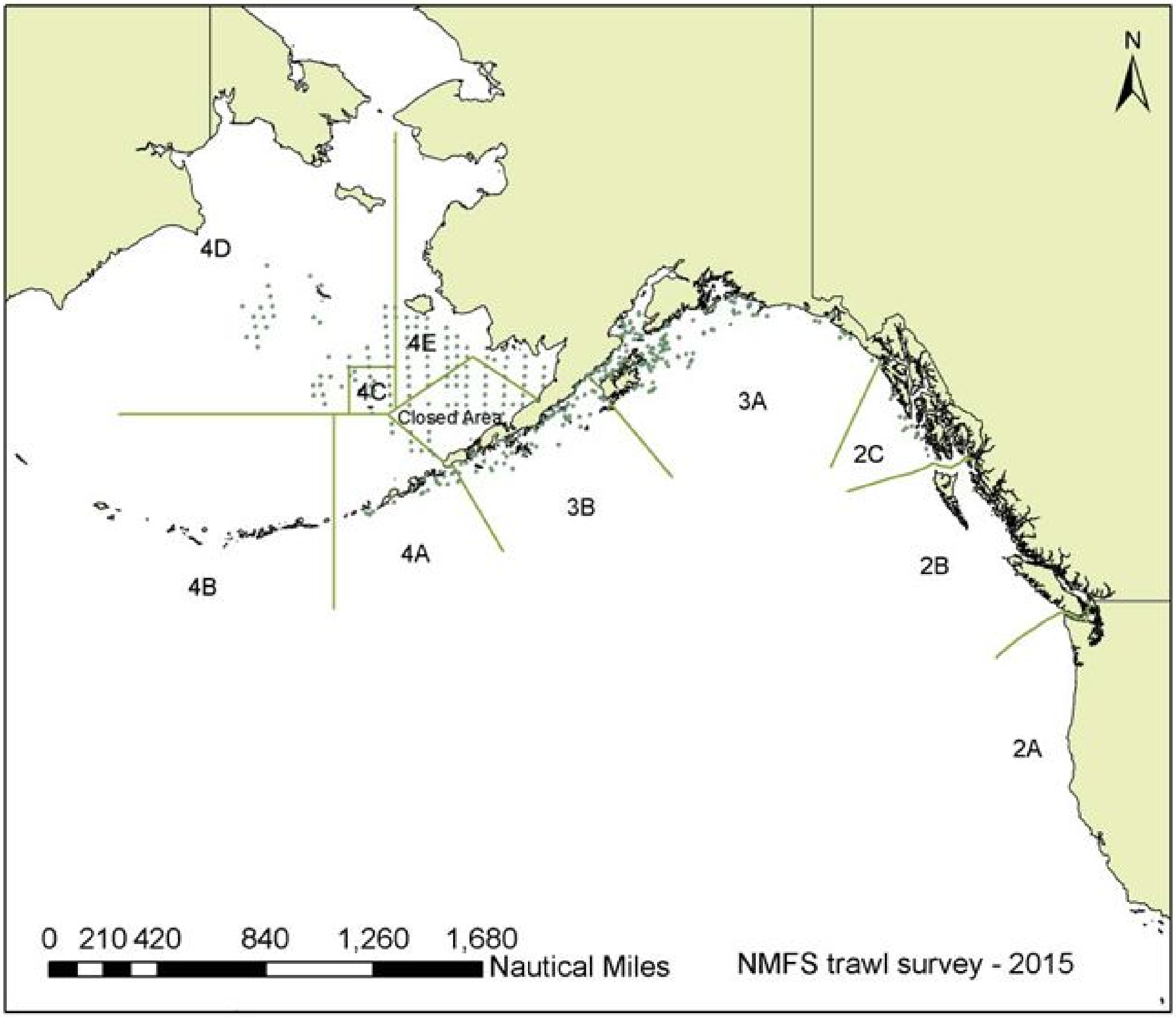
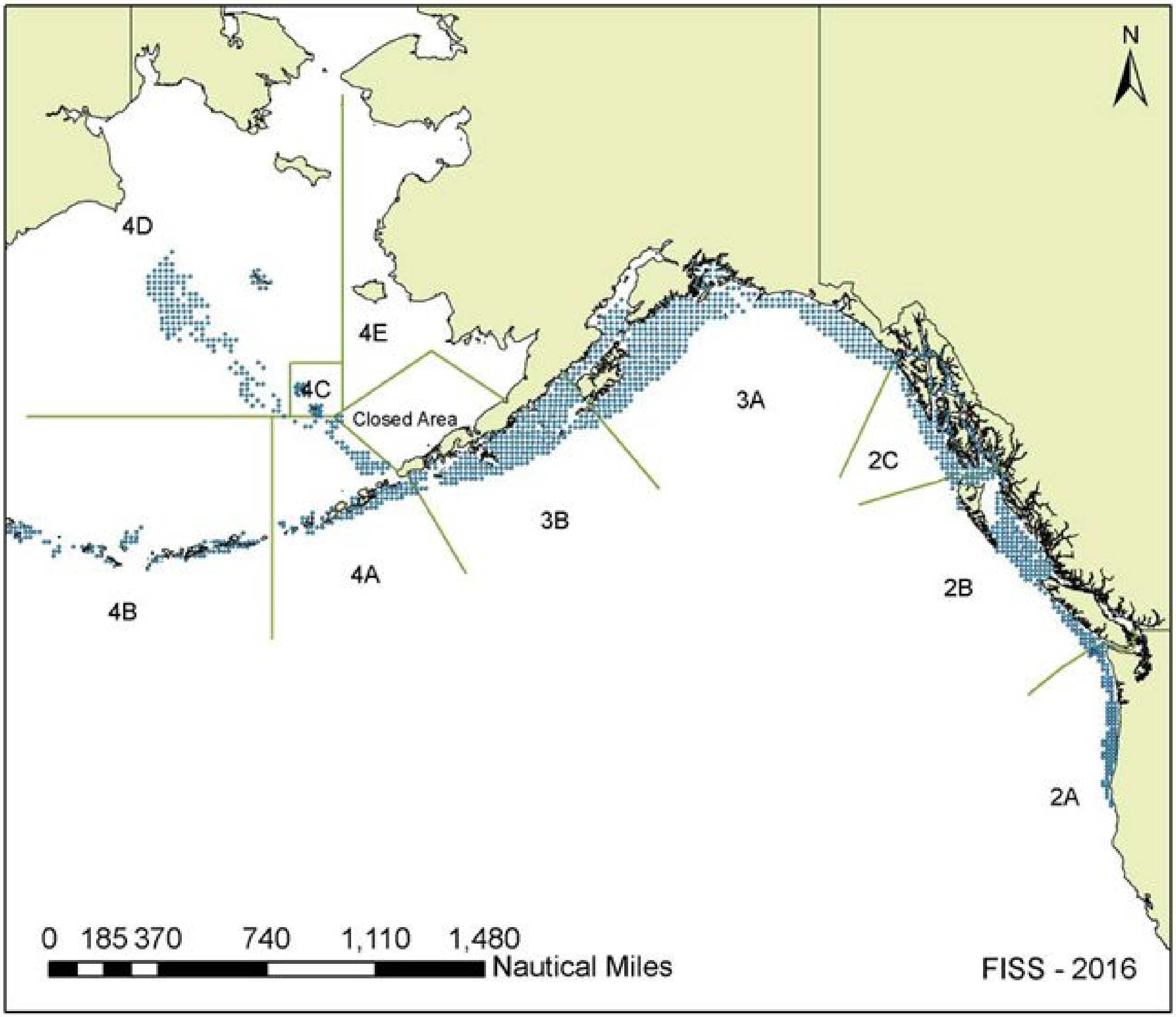

N
4D
4E
4C
Closed Area
3A
2C
3B
4A
4B
2B
2A
0 210 420 840 1,260 1,680
Nautical Miles
NMFS trawl survey - 2015

Figure 58



N
4D
4E
4C
Closed Area
3A
3B
4A
4B
2C
2B
2A
0 185 370 740 1,110 1,480
Nautical Miles
FISS - 2016

Figure 59

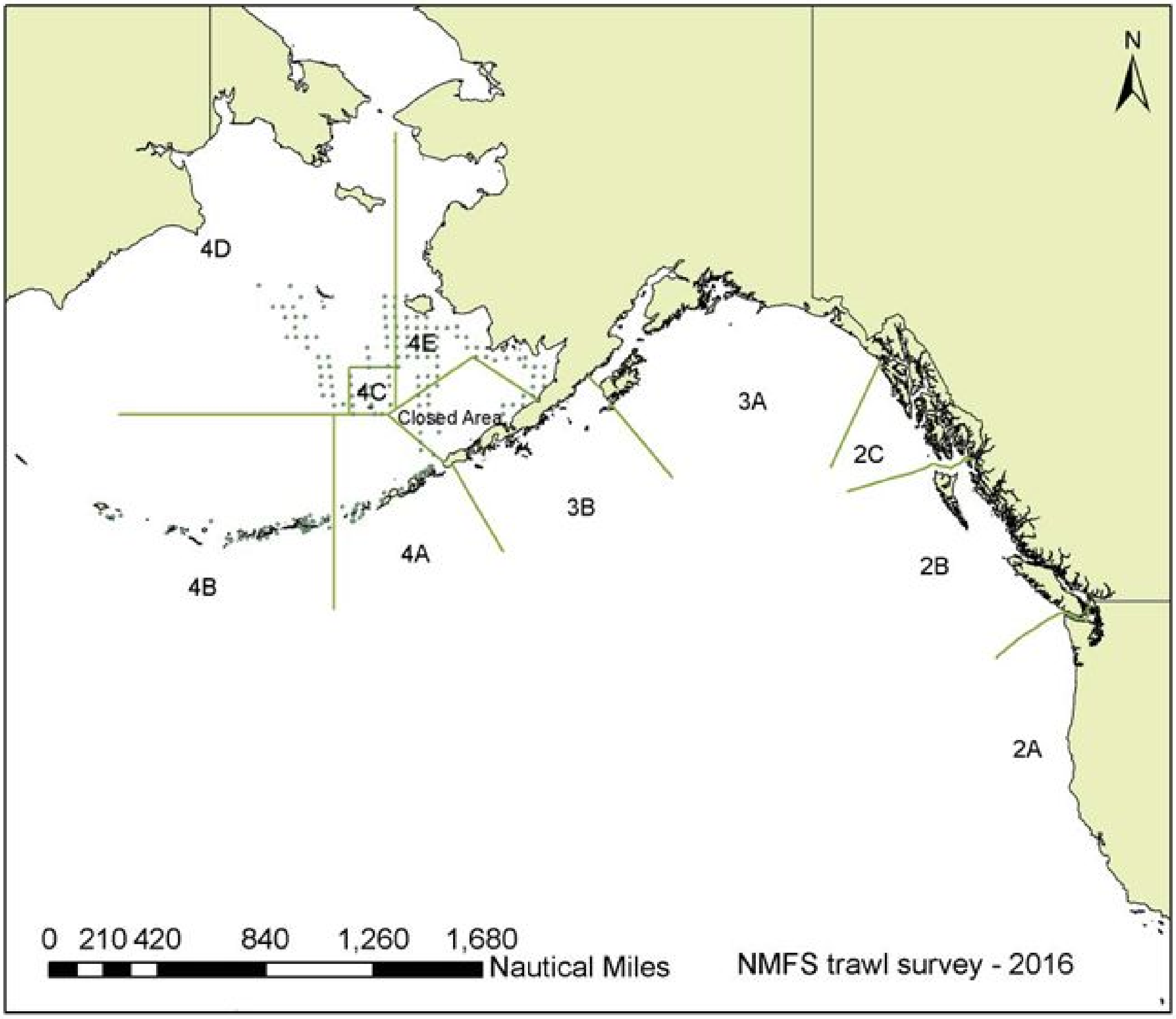
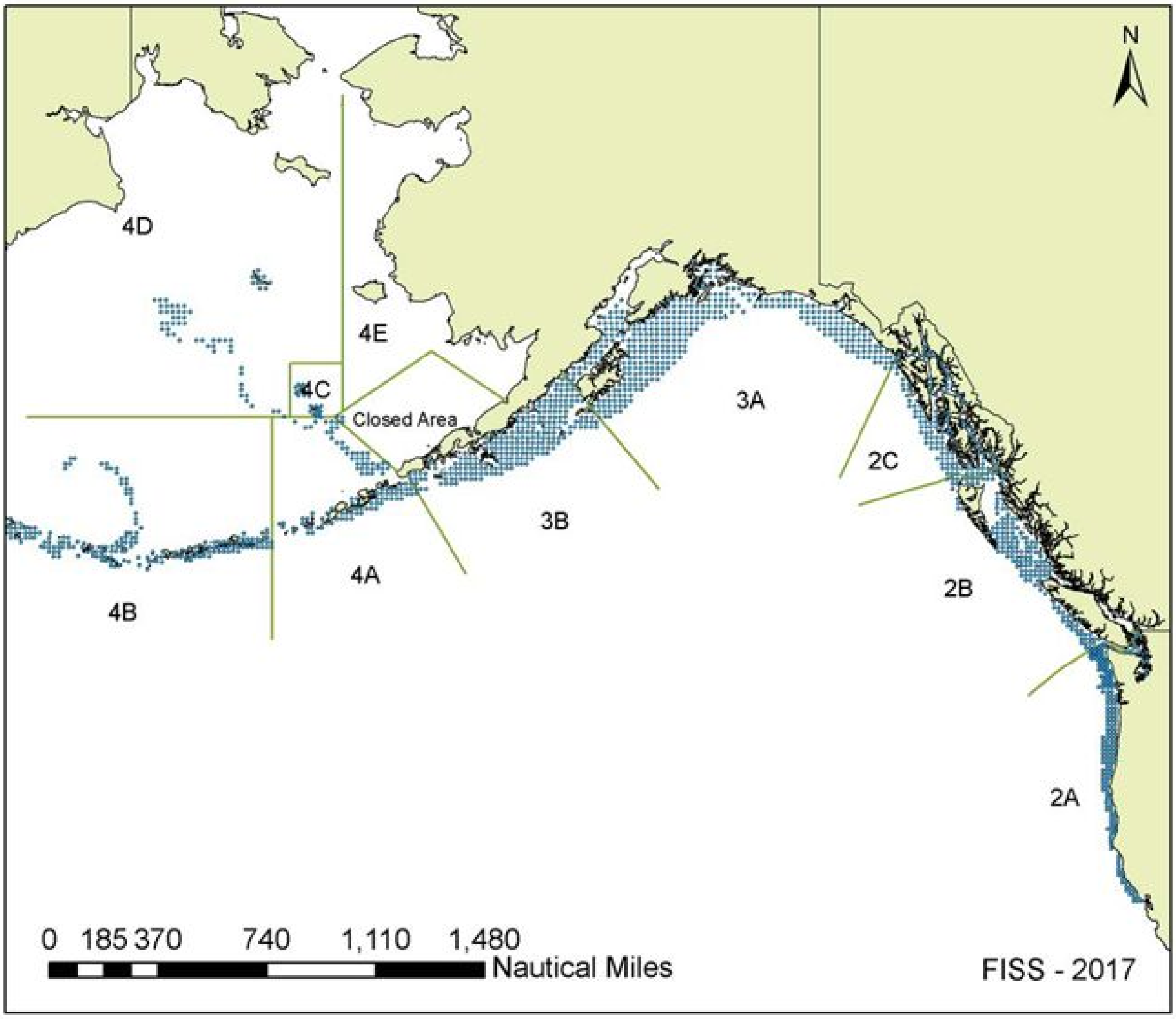

N
4D
4E
4C
Closed Area
3A
2C
3B
4A
4B
2B
2A
0 210 420 840 1,260 1,680
Nautical Miles
NMFS trawl survey - 2016

Figure 60



N
4D
4E
4C
Closed Area
3A
2C
3B
4A
4B
2B
2A
0 185 370 740 1,110 1,480
Nautical Miles
FISS - 2017

Figure 61

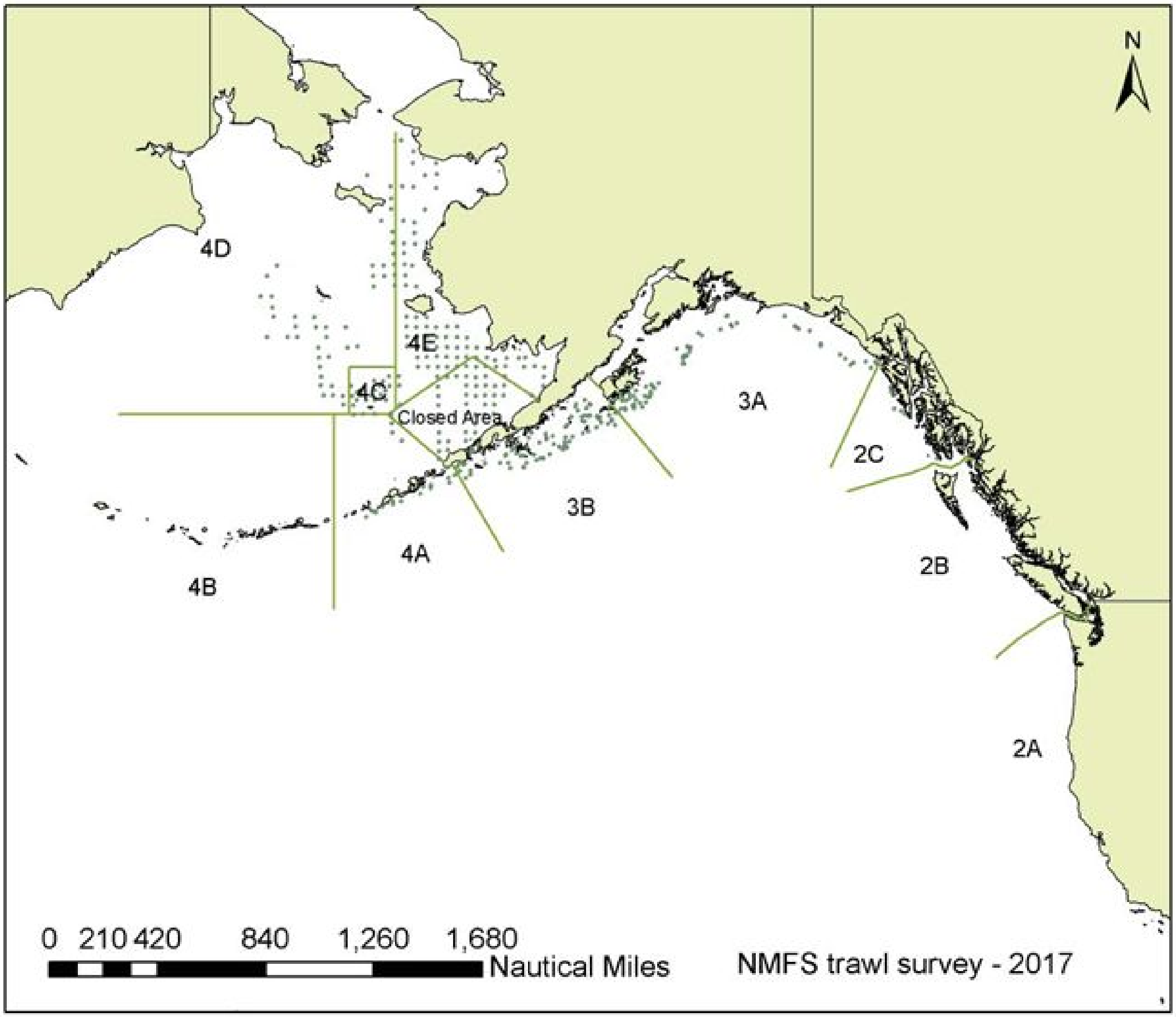

N
4D
4E
4C
Closed Area
3A
2C
3B
4A
4B
2B
2A
0 210 420 840 1,260 1,680
Nautical Miles
NMFS trawl survey - 2017

Figure 62

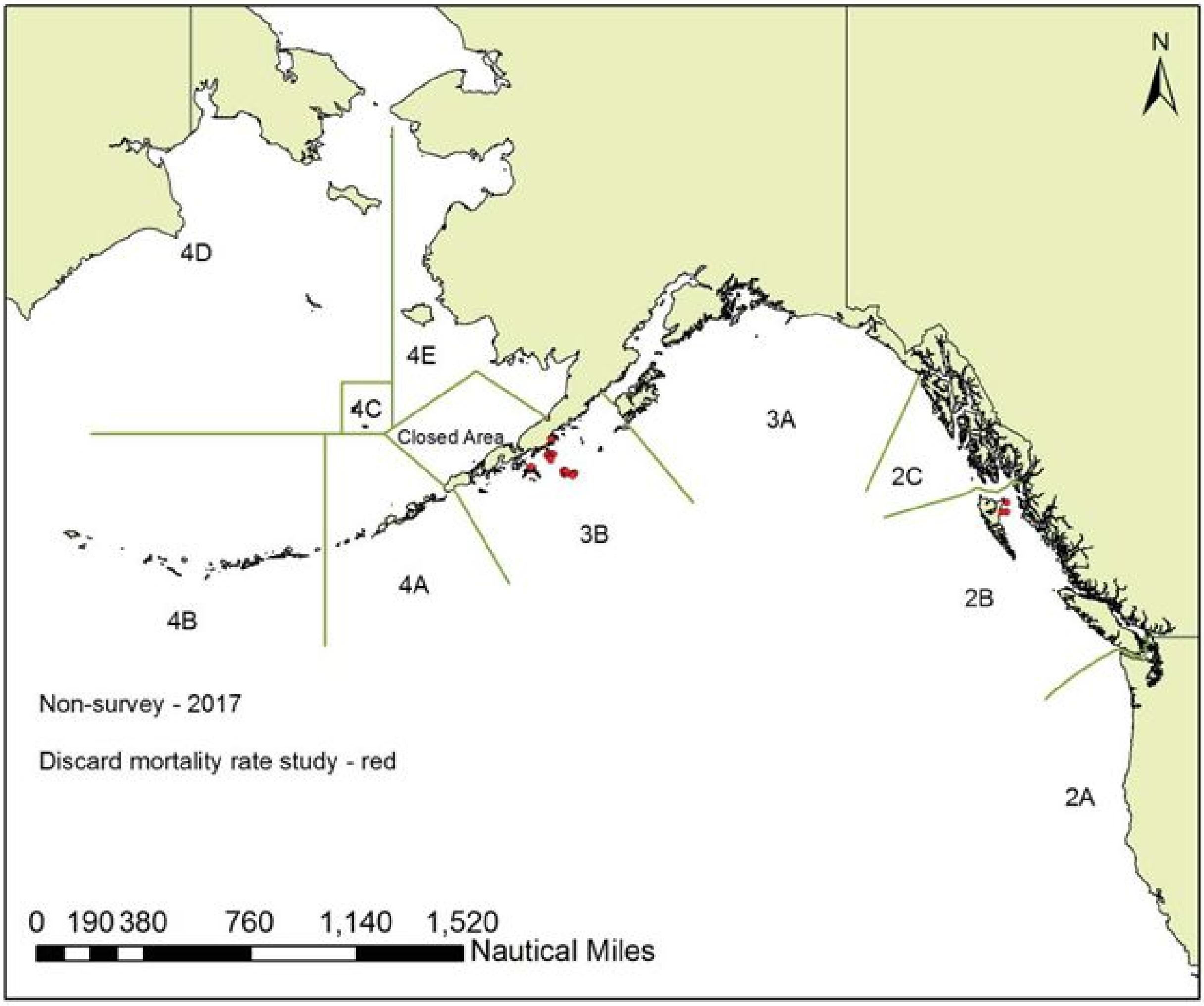

N
4D
4E
4C
Closed Area
3A
2C
3B
4A
4B
2B
2A
Non-survey - 2017
Discard mortality rate study - red
0 190 380 760 1,140 1,520
Nautical Miles

Figure 63