NOAA FISHERIES

Alaska Region

EFH 5-year Review
Model descriptions

EFH Species Descriptions

EFH Levels within EFH Regulation (50 CFR Part 600)

Level 1 - *Distribution data are available* for some or all portions of the geographic range of the species.

Level 2 - *Habitat-related densities* of the species are available

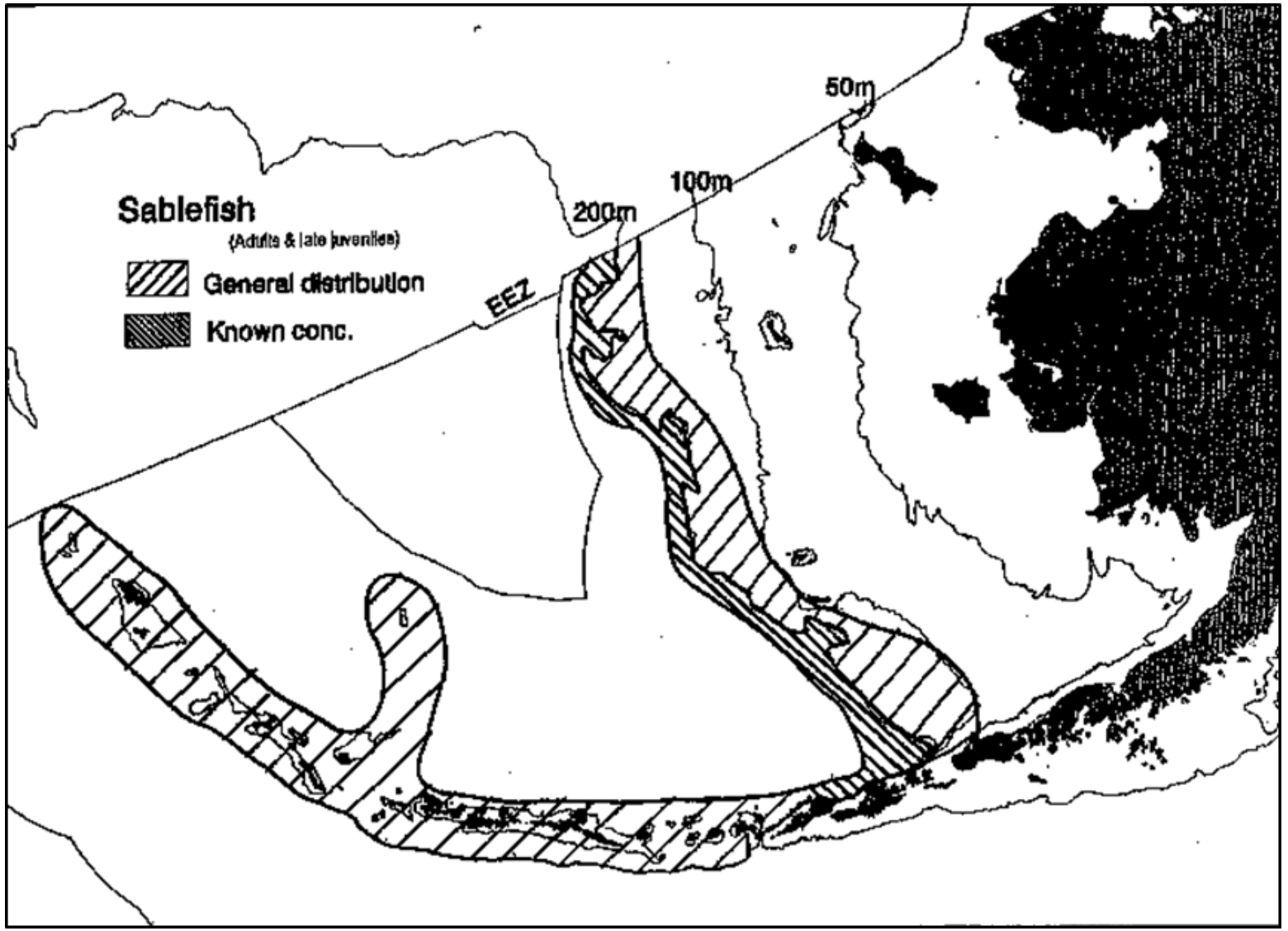
Level 3 - *Growth, reproduction, or survival rates* within habitats are available.

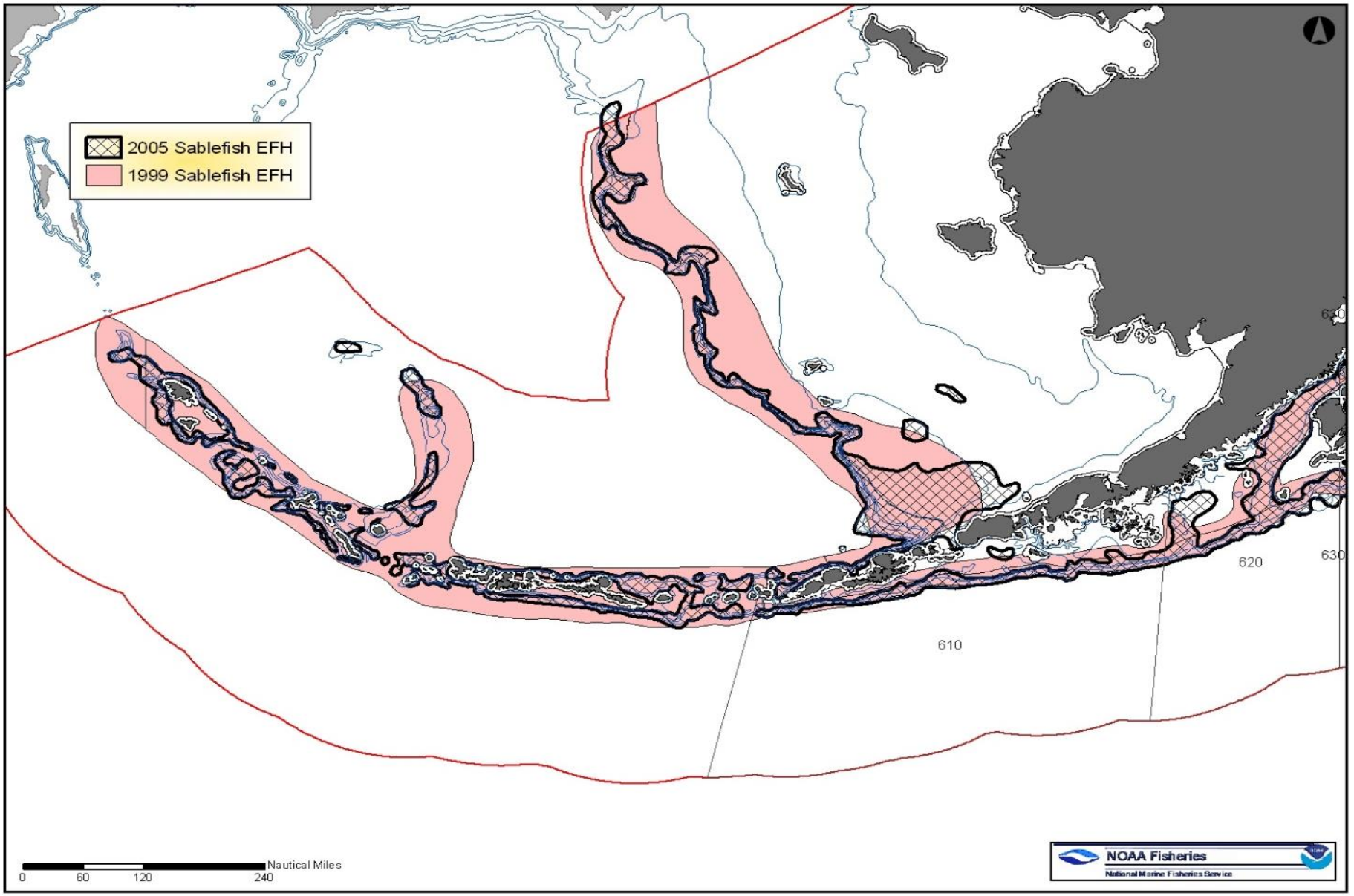
Level 4 - *Production rates* by habitat are available.

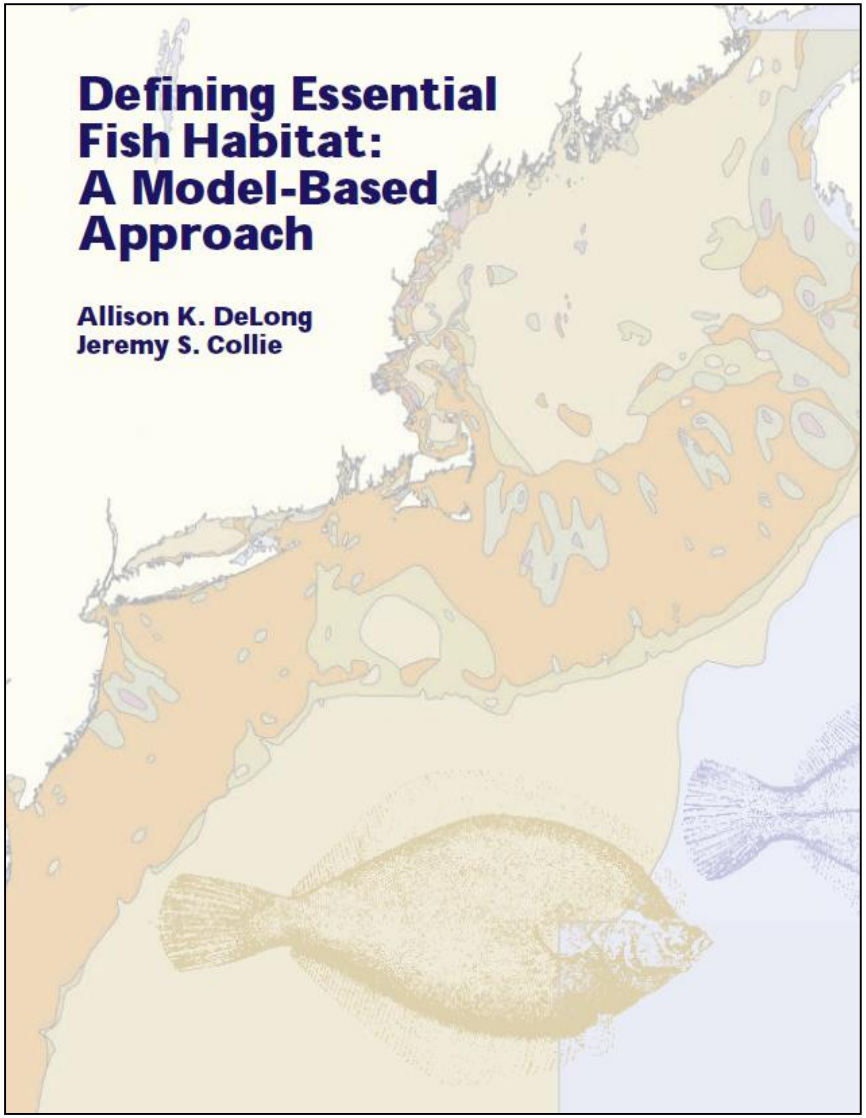
- 600.815 (a)(1)(**ii**)(B). FMPs must demonstrate that the **best scientific information available was used in the description and identification of EFH**, consistent with National Standard 2.

- 600.815 (a)(1)(**iii**)(B). Councils should **strive to describe habitat based on the highest level of detail (i.e., Level 4**). If there is no information on a given species or life stage, and habitat usage cannot be inferred from other means, such as information on a similar species or another life stage, EFH should not be designated.

Sablefish EFH, 1999




2005 Sablefish EFH
1999 Sablefish EFH
620
630
610
Nautical Miles
0
60
120
240
NOAA Fisheries
National Marine Fisheries Service



NOAA Technical Memorandum NMFS-AFSC-236

A Refined Description of Essential Fish Habitat for Pacific Salmon Within the U.S. Exclusive Economic Zone in Alaska

by
K. Echave, M. Eagleton, E. Farley, and J. Orsi

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Alaska Fisheries Science Center

June 2012

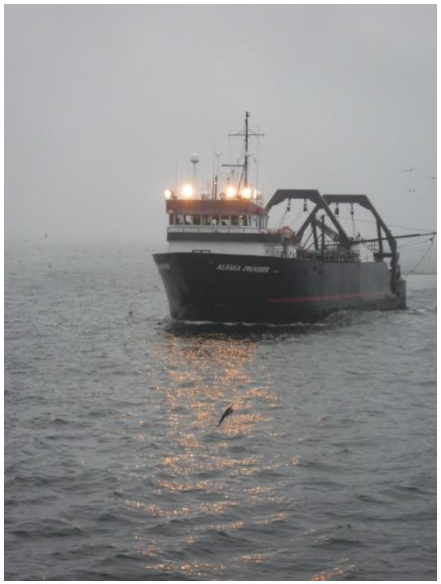
NOAA Technical Memorandum NMFS-AFSC-

Model-based Essential Fish Habitat Definitions for Aleutian Islands Groundfish Species

by
Turner, K, Rooper, CN, Rooney, S, Laman, E, Cooper, D, Zimmermann, M

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration National Marine Fisheries Service Alaska Fisheries Science Center
October 2015

Data Sources



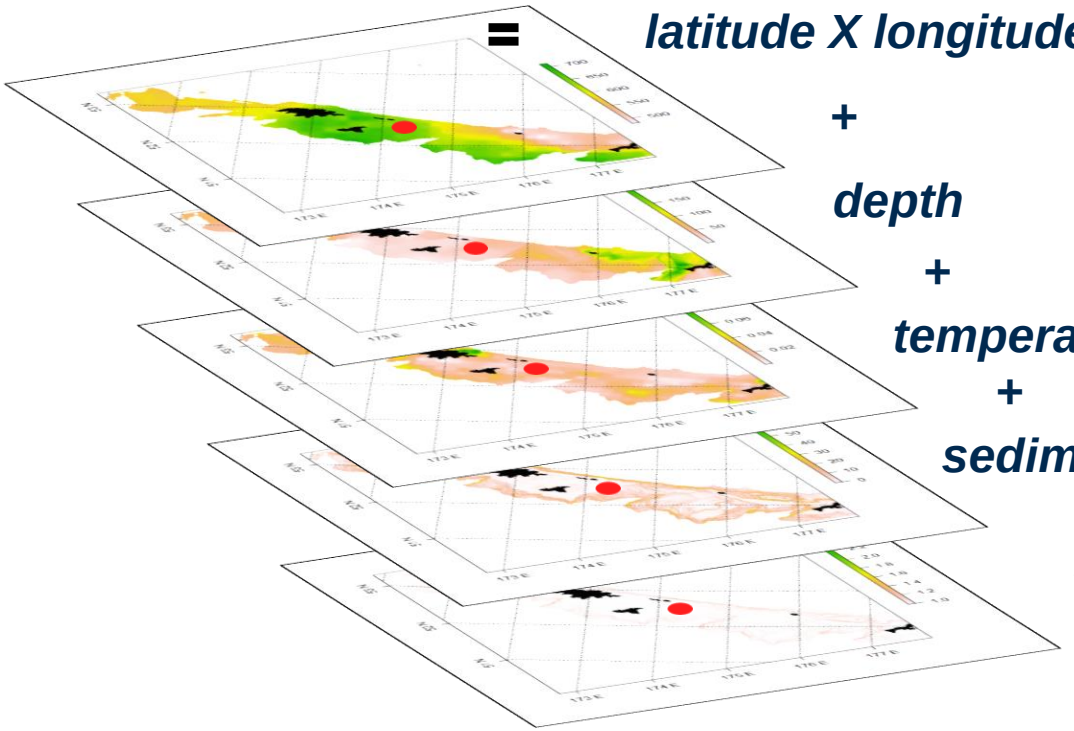
- Bottom trawl surveys (1982-2014)
  - CPUE (GAM, hurdle GAM, Maxent)
  - Adults
  - Settled juveniles
  - Summer only
- EcoFOCI data (1994-2015)
  - Presence only (MaxEnt)
  - Eggs
  - Larvae
  - Pelagic juveniles
  - All seasons
- Catch in areas database (2005-2013)
  - Presence only (MaxEnt)
  - Fall, winter, spring
  - Adults only

Variable	Unit	Definition	Interpolation method	Source	
Position	eastings, northings	Latitude and longitude of bottom trawl hauls in Alaska Albers projection corrected for the position of the trawl net relative to the vessel	--	DGPS collected at bottom trawl hauls	
Depth	m	Bathymetry of the seafloor based on digitized and position corrected NOS charts	Linear interpolation	Mean depth of bottom trawl hauls (modeling), Zimmermann et al. 2014	
Slope	percent	Maximum difference between a depth measurement and its adjoining cells	--	Zimmermann et al. 2014	
Bottom temperature	°C	Mean summer bottom temperature for the region measured during bottom trawl surveys from 1996-2010	Ordinary kriging	Temperature data collected at bottom trawl hauls	
Surface temperature	°C	Ocean current speed predicted from the ROMS model during the years 1970-2004 and averaged on a 10 km by 10 km grid	Inverse distance weighting	Danielson et al. 2011	1
Ocean color	Carbon*m^{-2}*day^{-1}	Net primary production in surface waters in May to September averaged by 1080 by 2160 grid cells then averaged across years (2002-2011)	Inverse distance weighting	Behrenfeld and Falkowski 1997	
Mean bottom ocean current	m*sec^{-1}	Seafloor ocean current speed predicted from the ROMS model during the years 1970-2004 and averaged on a 10 km by 10 km grid	Inverse distance weighting	Danielson et al. 2011	
Maximum tidal current	cm*sec^{-1}	Maximum of the predicted tidal current at each bottom trawl location over a 1-year cycle	Ordinary kriging	Egbert and Erofeeva 2000	
Mean surface ocean current speed	m*sec^{-1}	Surface ocean current speed predicted from the ROMS model during the years 1970-2004 and averaged on a 10 km by 10 km grid	Inverse distance weighting	Danielson et al. 2011	1
Mean surface ocean current direction	angle	Surface ocean current direction predicted from the ROMS model during the years 1970-2004 and averaged on a 10 km by 10 km grid	Inverse distance weighting	Danielson et al. 2011	1
Surface ocean current direction variability	--	Variability in surface ocean current direction predicted from the ROMS model during the years 1970-2004 and averaged on a 10 km by 10 km grid	Inverse distance weighting	Danielson et al. 2011	1
Coral presence or absence	--	Coral presence or absence in bottom trawl catch and raster of predicted presence or absence of coral	--	Catch data from bottom trawl hauls (modeling), Rooper et al. (2014) (prediction)	2
Sponge presence or absence	--	Sponge presence or absence in bottom trawl catch and raster of predicted presence or absence of Sponge	--	Catch data from bottom trawl hauls (modeling), Rooper et al. (2014) (prediction)	2
Pennatulacean presence or absence	--	Pennatulacean presence or absence in bottom trawl catch and raster of predicted presence or absence of Pennatulacean	--	Catch data from bottom trawl hauls (modeling), Rooper et al. (unpublished data) (prediction)	2

[1] Used to model egg, larval and early juvenile stages only

[2] Used to model bottom trawl survey data only

Term Selection & Model Fitting



= *latitude X longitude*

\+

depth

\+

temperature

\+

sediment size

\+

slope

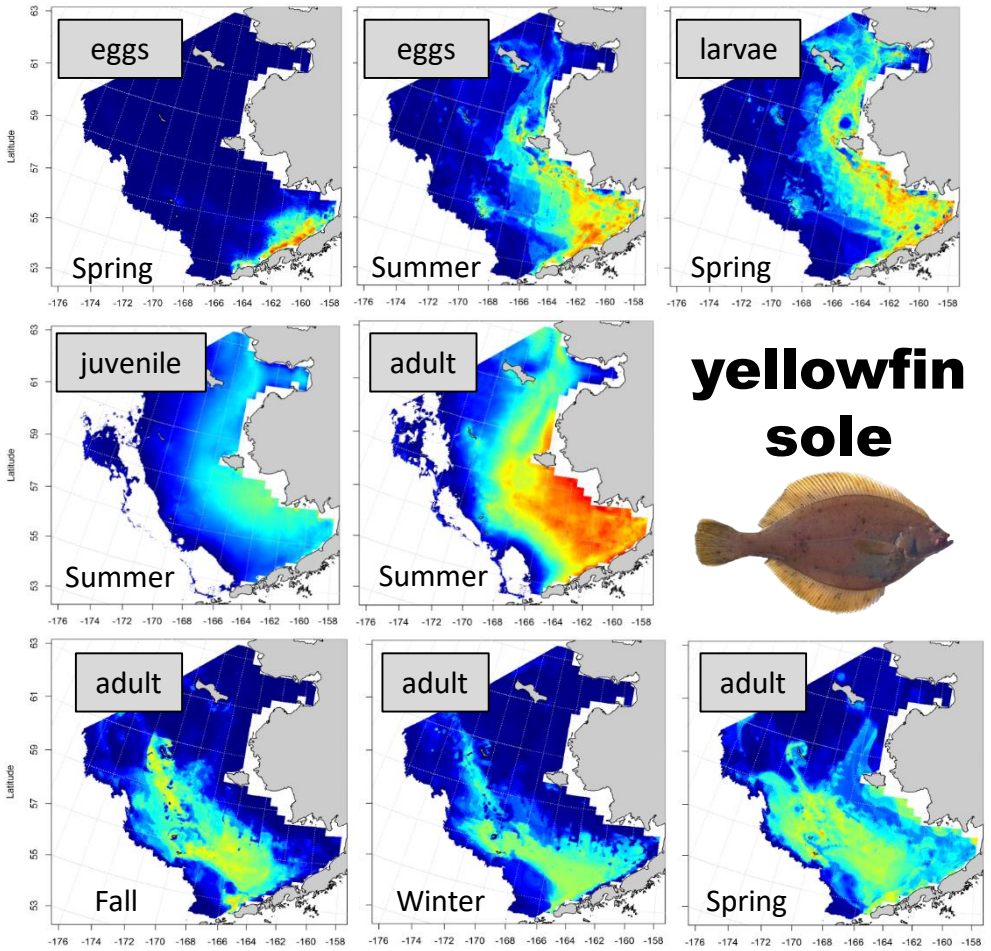
Species	Eggs	Larvae	Early juveniles	Late juveniles	Adults
Pollock					
Pacific cod					
Sablefish					
Yellowfin sole					
Greenland turbot					
Arrowtooth flounder	Atheresthes sp. as group				
Kamchatka flounder					
Southern rock sole					
Northern rock sole					
Alaska plaice					
Rex sole					
Dover sole					
Flathead sole					
Pacific ocean perch	Sebastes sp. as group				
Northern rockfish					
Shortraker rockfish					
Blackspotted/rougheye rockfish					
Dusky rockfish					
Thornyhead rockfish					
Atka mackerel					
Great sculpin					
Yellow Irish lord					
Bigmouth sculpin					
Alaska skate					
Bering skate					
Aleutian skate					
Mud skate					
Pacific giant octopus					
Red king crab					
Blue king crab					
Tanner crab					
Snow crab					

	no data available or NA
	Presence or presence absence models
	Density (CPUE) models

ichthyoplankton survey
MaxEnt – presence only

bottom trawl survey
GAM – presence/ absence

observer catch
MaxEnt – presence only



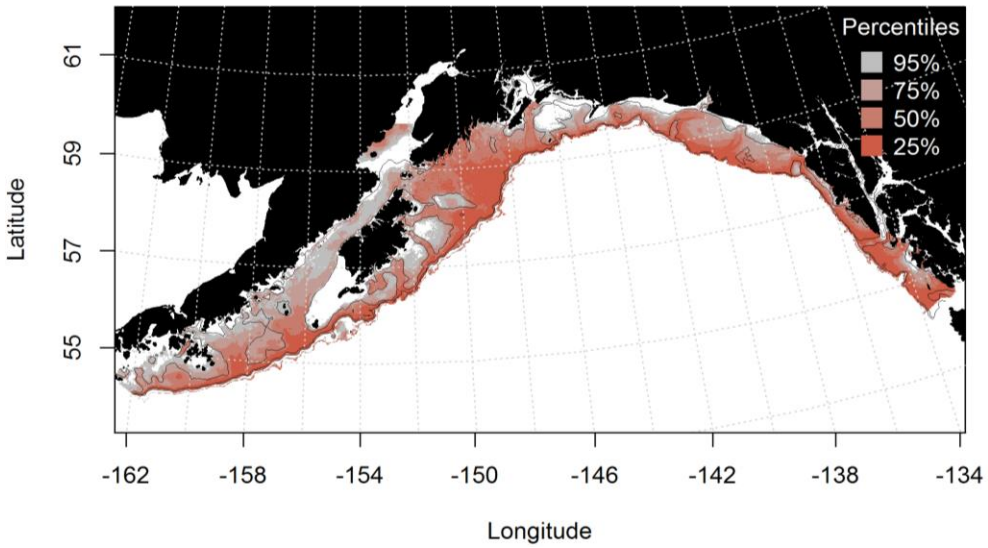


Figure 1. -- Predicted summer essential fish habitat for *S. alutus* adults (top and bottom panel, respectively) from summer bottom trawl surveys.

All the data was divided into four seasons for analyses: fall (October-November), winter (December-February), spring (March-May), and summer (June-September).

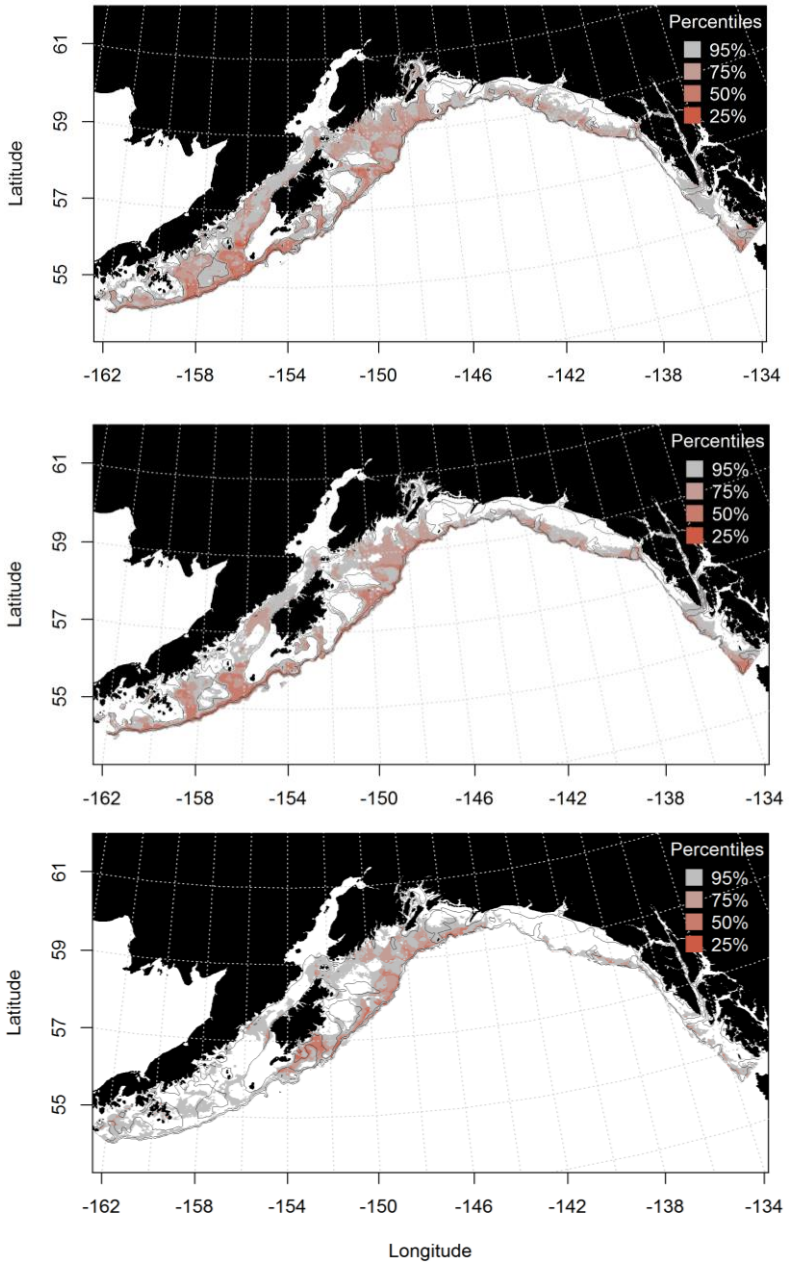
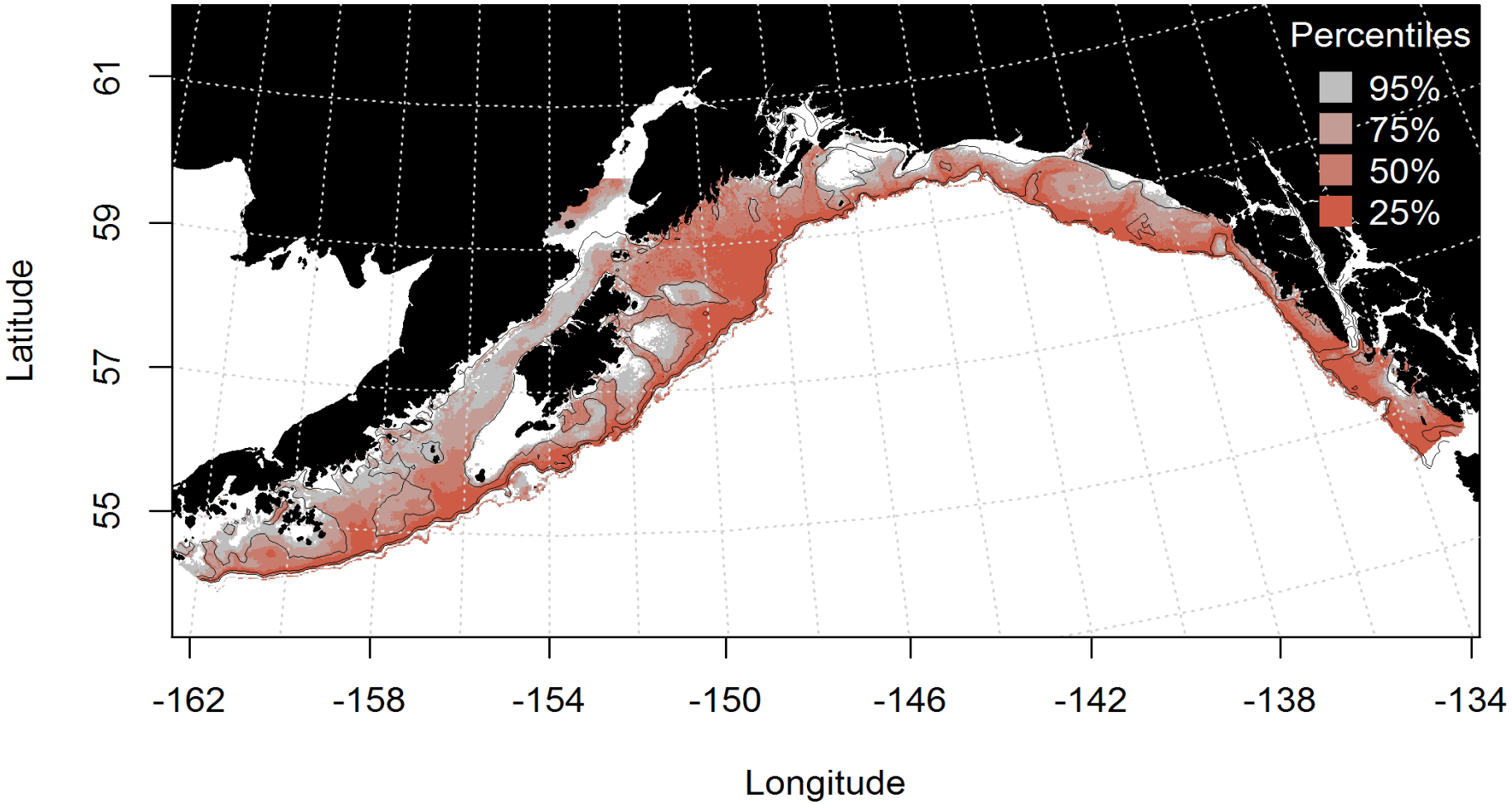


Figure 1. -- Essential fish habitat predicted for *S. alutus* during fall (top panel), winter (middle panel), and spring (bottom panel) from commercial catches.



The SSC recommends that annual EFH be defined, and that seasonal EFH maps be provided to support stock-author review of EFH designations, as well as assessment of fishing effects.

Examination of the Fujioka fishing effects model: model formulation, implementation, and interpretation

The Fisheries, Aquatic Science, & Technology (FAST) Laboratory

at

Alaska Pacific University

Director - *Brad Harris, Ph.D.*

Quantitative Ecologist - *Suresh Sethi, Ph.D.*

Coastal Geographer - *Chris Maio, Ph.D.*

Fishery Scientist and Conservation Engineer - *Craig Rose, Ph.D.*

Geostatistical Analyst - *Scott Smeltz, M.Sc.*

Laboratory Manager - *Sarah Webster*

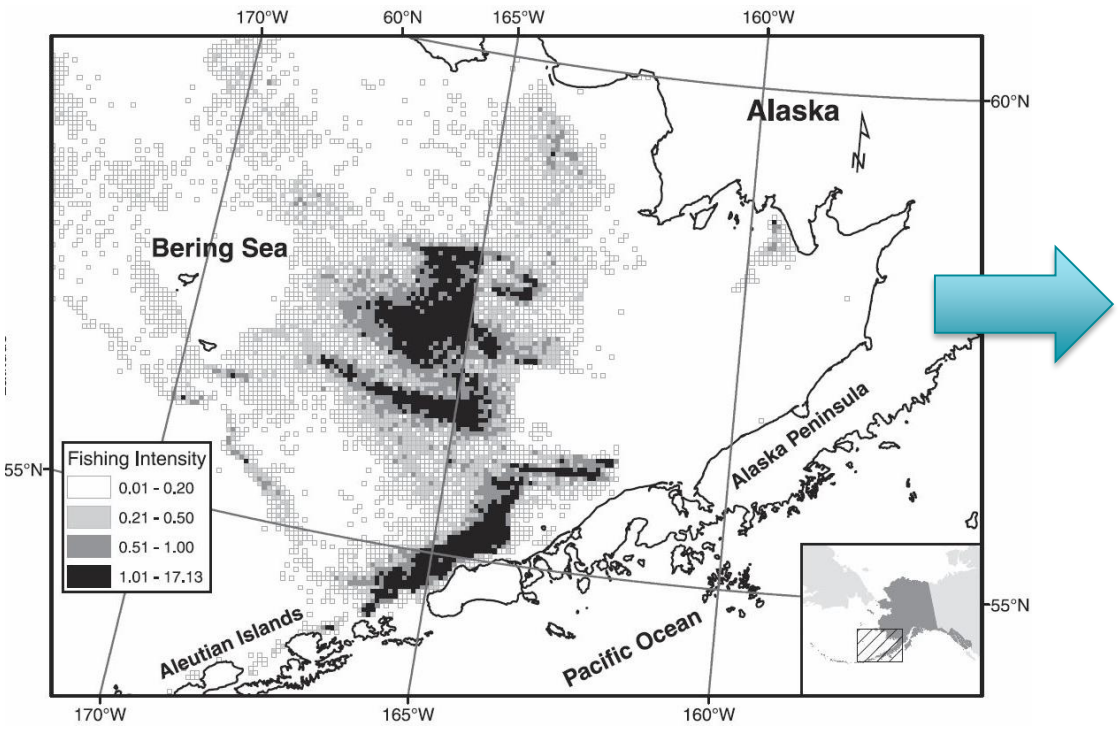
Draft Recommendations from White Paper

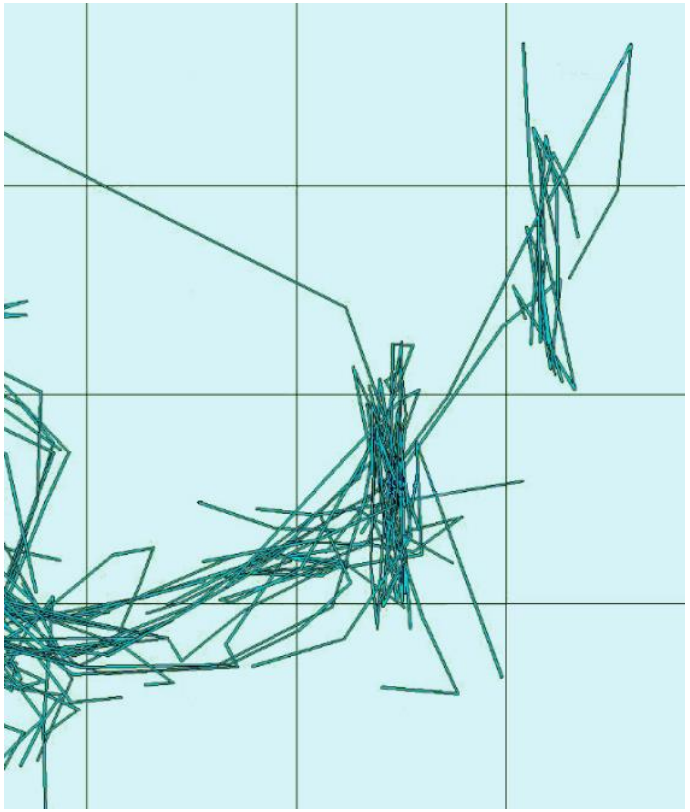
1. Use updated substrate distribution data
2. Use updated commercial fishing effort, including Catch-in-Areas database and VMS
3. Develop R code to implement the time-varying fishing effort version of the Fujioka fishing impacts model
4. Reflect uncertainty in habitat feature sensitivity and recovery parameters

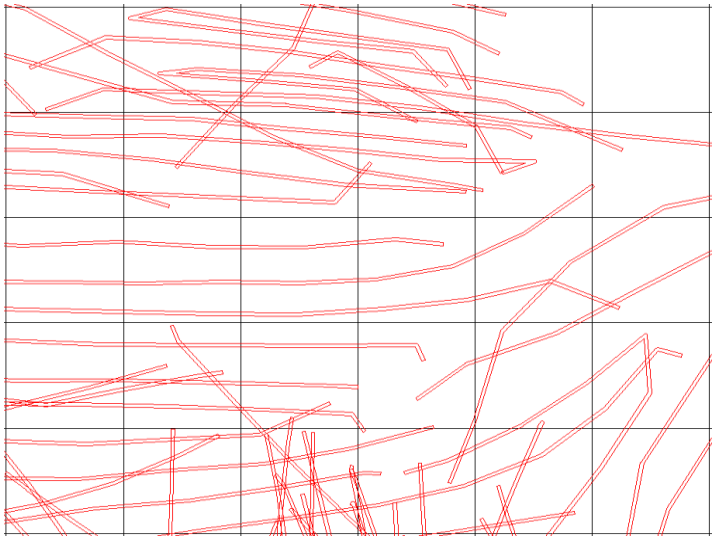
SSC request for model modifications:

- Discrete time (like SASI)
- Incorporate literature review from SASI
- Track fishing effects over time with monthly time step

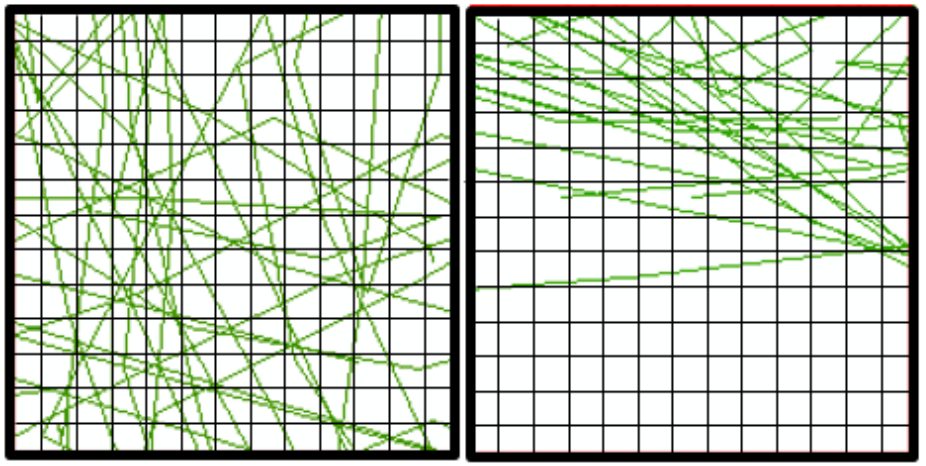
Increasing spatial resolution & accounting for overlapping fishing impacts

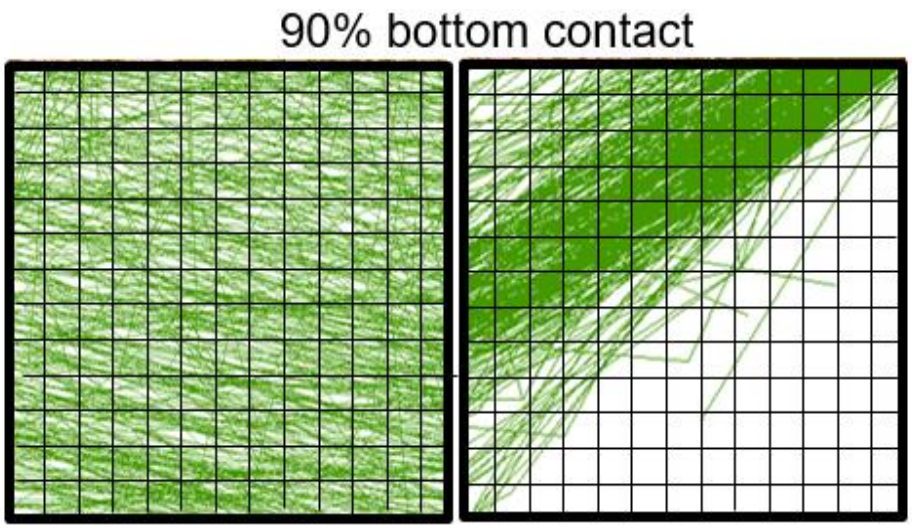






Catch-in-area database (CIA)





LITERATURE REVIEW DATABASE V 3.0

Final review?

STUDY DESCRIPTION

Number: 408

Cite: Mirarchi and CR Environmental 2003

Related studies: 409

Study Characteristics

Study design: 2

Study relevance: 4

Study appropriateness: 2

Methods/general comments:

Evaluated imm effects of 6 replicate tows in 2 lanes at 2 locations, one heavily and one lightly trawled (HT/LT) locations), with controls, using SS sonar, grab samples, benthic dredge, and video cameras.

Location

Multisite? ☐

Gulf of Maine, MA coast

Substrate

- ☐ Clay-silt
- ☐ Granule-pebble
- ☑ Muddy sand
- ☐ Cobble
- ☑ Sand
- ☐ Boulder
- ☐ Rock outcrop

Substrate notes:

HT - muddy sand; LT - sand

Look up by study #:

Reviewer: Bachman/Stevenson

Depth (m): 0-50m

Minimum: 36

Maximum: 48

Energy: 4

Energy notes:

inferred based on shallow depth

Gear Types

Multigear? ☐

- ☑ Generic otter trawl
- ☐ Shrimp trawl
- ☐ Squid trawl
- ☐ Raised footrope trawl
- ☐ New Bedford scallop dredge
- ☐ S. clam/O. quahog dredge
- ☐ Lobster trap
- ☐ Deep-sea red crab trap
- ☐ Longline
- ☐ Gillnet

Gear notes:

Smooth bottom (flatfish) trawl: 350 kg doors, 2.5 in rubber cookies on ground cables/bridles, sweep 0.5 in chain with continuous string of 6 in cookies

FEATURES EVALUATED AND IMPACTS

☑ Geological ☑ Biological ☑ Prey ☐ Recovery? ☐ Deep-sea corals?

Geological features

- ☑ Featureless
- ☑ Bedforms
- ☑ Biogenic depressions
- ☑ Biogenic burrows
- ☐ Special case biogenic burrows
- ☐ Gravel
- ☐ Gravel pavement
- ☐ Gravel piles
- ☐ Shell deposits
- ☐ Geochemical

Impacts:

Doors created furrows/ridges in seabed (6" in mud, 2-3" in sand), smoothed seafloor, exposed worm tubes, reduced grain size in trawl and control lanes (resuspension by trawl); physical impacts of trawling less visible at shallower/sandy site

Biological features

- ☑ Emergent sponges
- ☑ Hydroids
- ☑ Emergent anemones
- ☐ Burrowing anemones
- ☐ Soft corals
- ☐ Sea pens
- ☐ Hard corals
- ☐ Colonial tube worms
- ☑ Epifaunal bivalves
- ☐ Emergent bryozoans
- ☐ Tunicates
- ☐ Leafy macroalgae
- ☐ *Sea grass*
- ☐ *Brachiopods*

Species:

Sea stars and sand dollars most abundant epifauna, Cancer crabs at HT site, scallops at LT site

Impacts:

Fish and inverts (eg Cancer crabs) less numerous imm after trawling, differences not obvious 4-18 hrs later

Prey features

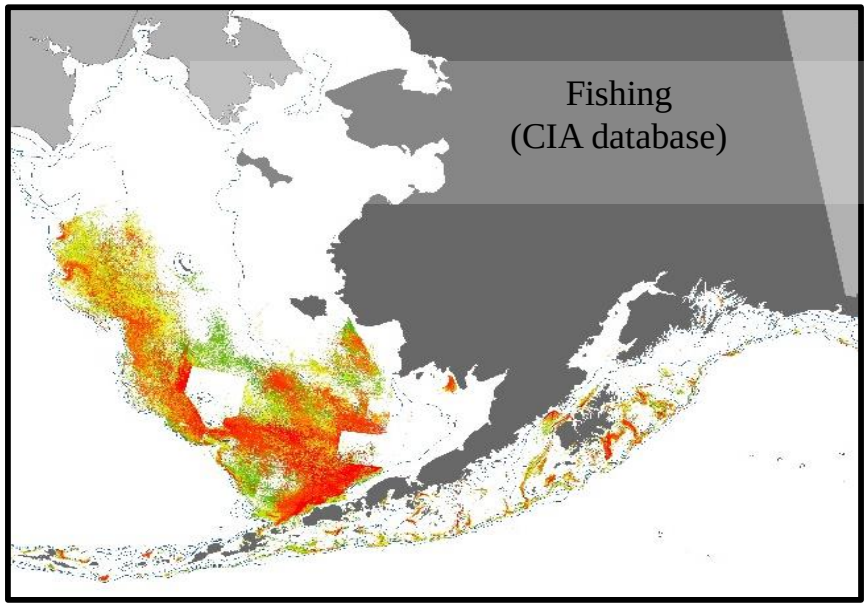
- ☑ Amphipods
- ☐ Isopods
- ☐ Decapod shrimp
- ☐ Mysids
- ☑ Decapod crabs
- ☑ Polychaetes
- ☑ Infaunal bivalves
- ☐ Brittle stars
- ☐ Sea urchins
- ☑ Sand dollars
- ☑ Sea stars

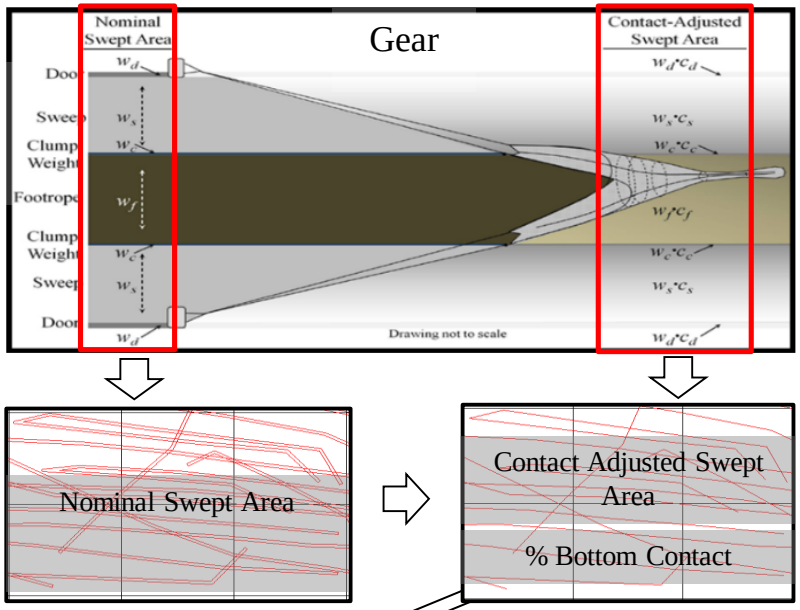
Species:

Polychaete Prionospio steenstrupi common in mud, amphipod Unicola inermis in sand -

Impacts:

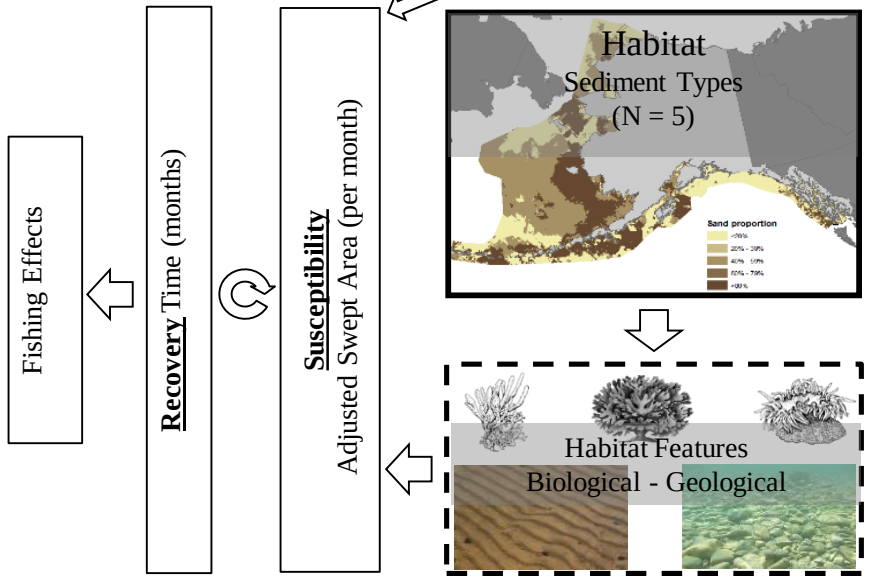
No difference in infaunal density, richness, or species composition between treatment and control lanes after exp tows at either location

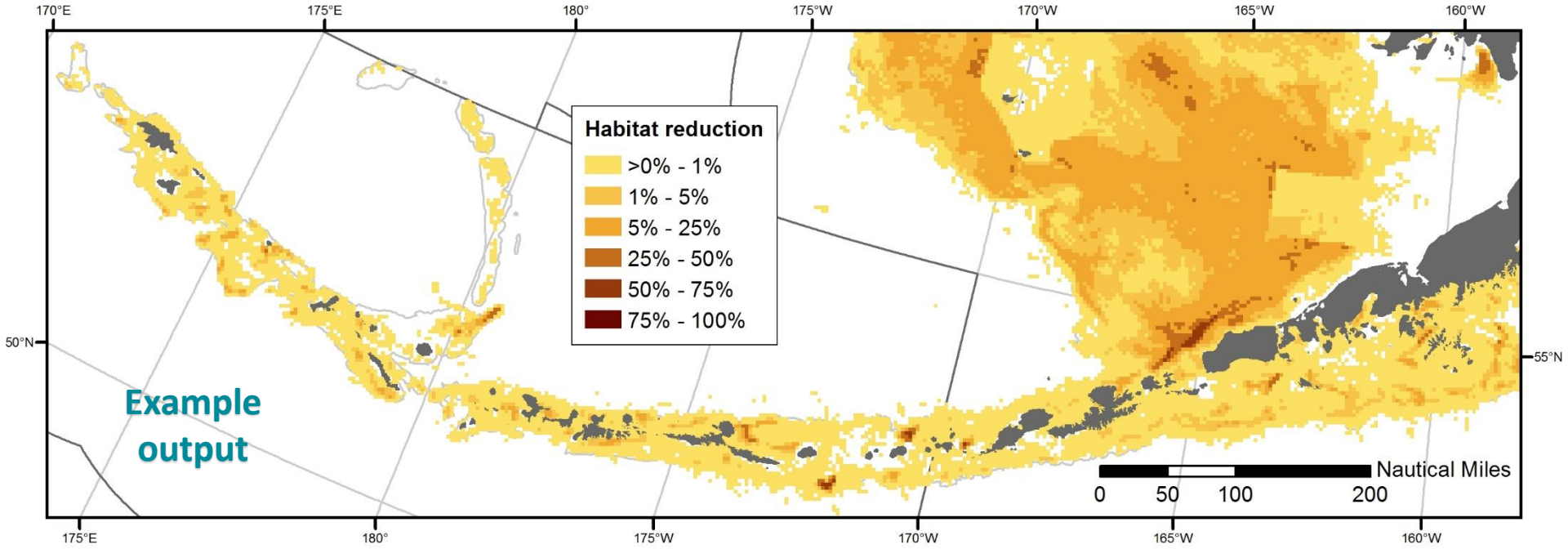


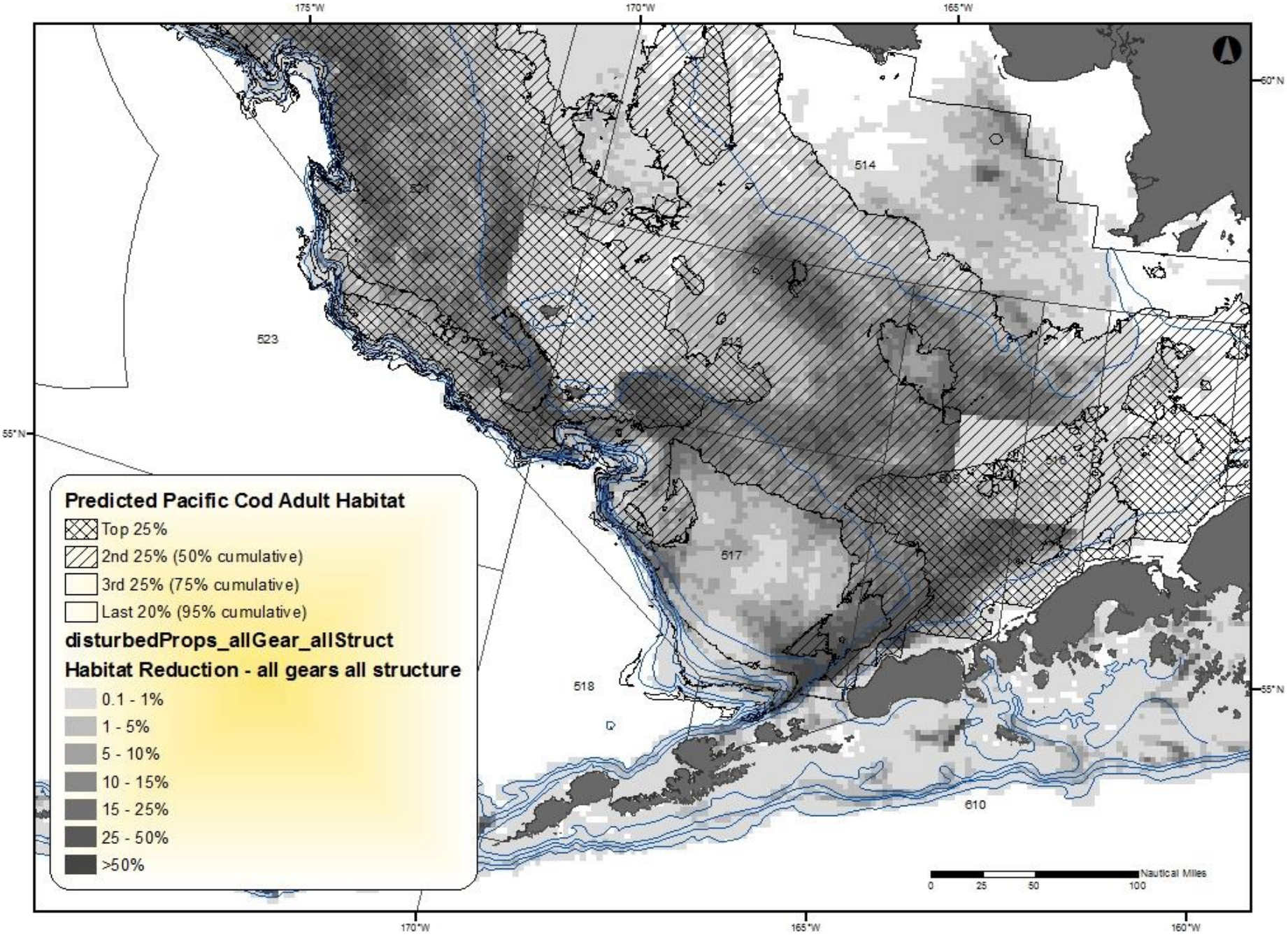


$$H_{t+1} = H_t(1 - I'_t) + h_t\rho'_t$$

H: habitat undisturbed from fishing
h: habitat disturbed from fishing
I': monthly impact rate
ρ': monthly recovery rate




170°E
175°E
180°
175°W
170°W
165°W
160°W
50°N
55°N
Habitat reduction
>0% - 1%
1% - 5%
5% - 25%
25% - 50%
50% - 75%
75% - 100%
Example output
Nautical Miles
0
50
100
200


175°W
170°W
165°W
160°W
60°N
55°N
514
523
513
517
518
610
Predicted Pacific Cod Adult Habitat
Top 25%
2nd 25% (50% cumulative)
3rd 25% (75% cumulative)
Last 20% (95% cumulative)
disturbedProps_allGear_allStruct
Habitat Reduction - all gears all structure
0.1 - 1%
1 - 5%
5 - 10%
10 - 15%
15 - 25%
25 - 50%
>50%
Nautical Miles
0
25
50
100

Dusky rockfish

	AI	BS	GOA
Adult - Summer	1.7		
Adult - Fall	3.4		1.8
Adult - Spring	2.3		1.7
Adult - Winter	2.4		1.7
Juvenile	2.5		1.7

	GOA	REP610	REP620	REP630	REP640	REP649	REP650	REP659
Jan-03	1.43%	2.14%	1.43%	2.36%	0.06%	0.01%	0.00%	0.00%
Feb-03	1.45%	2.17%	1.41%	2.43%	0.06%	0.01%	0.00%	0.00%
Mar-03	1.48%	2.19%	1.46%	2.45%	0.06%	0.01%	0.00%	0.00%
Apr-03	1.60%	2.40%	1.64%	2.59%	0.06%	0.01%	0.00%	0.00%
May-03	1.68%	2.57%	1.88%	2.59%	0.06%	0.01%	0.00%	0.00%
Jun-03	1.64%	2.49%	1.83%	2.52%	0.05%	0.01%	0.00%	0.00%
Jul-03	1.70%	2.43%	1.83%	2.70%	0.08%	0.01%	0.00%	0.00%
Aug-03	1.71%	2.68%	1.85%	2.66%	0.08%	0.01%	0.00%	0.00%
Sep-03	1.70%	2.61%	1.83%	2.64%	0.08%	0.01%	0.00%	0.00%
Oct-03	1.75%	2.58%	1.96%	2.70%	0.08%	0.01%	0.00%	0.00%
Nov-03	1.70%	2.51%	1.91%	2.62%	0.07%	0.01%	0.00%	0.00%
Dec-03	1.65%	2.43%	1.85%	2.55%	0.07%	0.01%	0.00%	0.00%
Jan-04	1.62%	2.43%	1.80%	2.51%	0.07%	0.01%	0.00%	0.00%
Feb-04	1.60%	2.39%	1.79%	2.47%	0.07%	0.01%	0.00%	0.00%
Mar-04	1.58%	2.35%	1.77%	2.44%	0.07%	0.01%	0.00%	0.00%
Apr-04	1.64%	2.54%	1.75%	2.57%	0.06%	0.01%	0.00%	0.00%
May-04	1.61%	2.48%	1.71%	2.53%	0.06%	0.01%	0.00%	0.00%
Jun-04	1.56%	2.40%	1.65%	2.47%	0.06%	0.01%	0.00%	0.00%
Jul-04	1.61%	2.50%	1.63%	2.61%	0.07%	0.01%	0.00%	0.00%
Aug-04	1.59%	2.49%	1.60%	2.57%	0.07%	0.01%	0.00%	0.00%
Sep-04	1.59%	2.45%	1.60%	2.57%	0.06%	0.01%	0.00%	0.00%

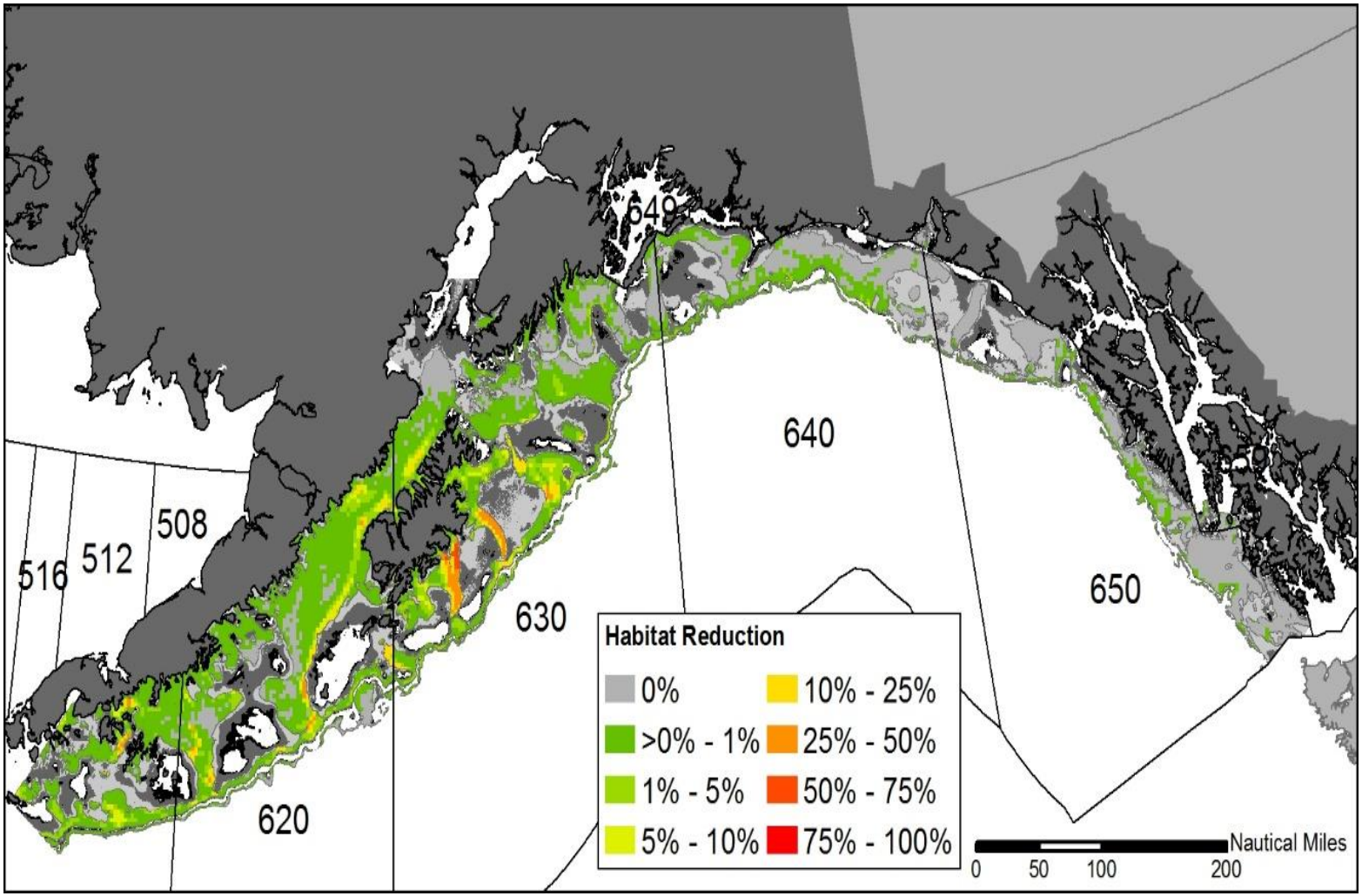
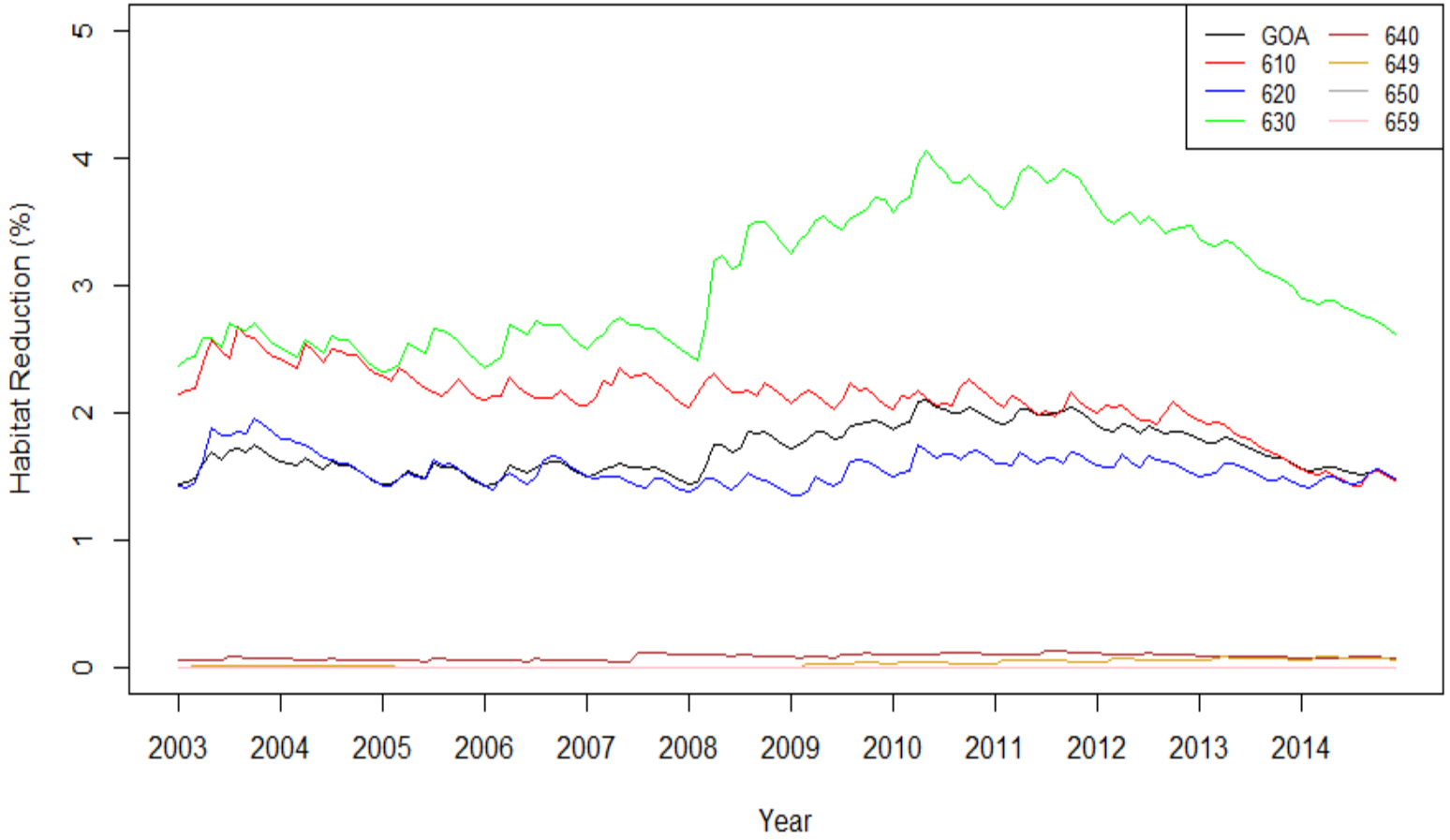


Figure 4. Habitat reduction for December 2014 in GOA pollock summer core EFH area.


GOA
610
620
630
640
649
650
659
Habitat Reduction (%)
0
1
2
3
4
5
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
Year