



UNITED STATES DEPARTMENT OF COMMERCE  
National Oceanic and Atmospheric Administration  
National Marine Fisheries Service  
Southwest Fisheries Science Center  
Fisheries Ecology Division  
110 McAllister Way  
Santa Cruz, California 95060

## Project Report

**Date Submitted:** November 14, 2023  
**Platform:** NOAA Ship *Reuben Lasker*  
**Project Number:** RL-23-03 (OMAO)  
**Project Title:** Rockfish Recruitment and Ecosystem Assessment  
**Project Dates:** May 16 – June 25, 2023

Prepared by: Keith M. Sakuma  
Keith Sakuma  
Chief Scientist  
NOAA NMFS SWFSC FED

Dated: November 14, 2023

Approved by: Steve Lindley  
Steve Lindley  
Laboratory Director  
NOAA NMFS SWFSC FED

Dated: 11/14/2023

**A. Project period:** May 16 – June 25, 2023

**Leg 1:** May 16 – June 1 (scientists initially were required to board on May 14 in Seattle, WA and transit two days to the project operating area off CA).

**Leg 2:** June 4– June 25

**B. Operating area and days at sea (DAS)**

**Operating area:** San Diego, CA to Flint Rock Head, CA (see Appendix I and II for station sample dates and locations).

**DAS:** Scheduled for 39 DAS.

DAS lost due to inclement weather=0.

DAS with compromised operations due to inclement weather=4 (10%).

DAS lost or compromised due to ship issues=24 (62%).

**C. Summary of objectives**

1. Sample for pelagic YOY rockfish (*Sebastes* spp.) and other epipelagic micronekton off California.
2. Characterize prevailing ocean conditions and examine prominent hydrographic features.
3. Map the distribution and abundance of krill (Euphausiacea).
4. Observe seabird and marine mammal distribution and abundance.
5. Collect samples for stable isotope analysis.
6. Collect samples for thiamine deficiency complex (TDC) study.
7. Collect samples for eDNA.
8. Adaptive sampling near Piedras Blancas and Trinidad Head trawl lines.

**D. Participating organizations**

NOAA National Marine Fisheries Service (NMFS) Southwest Fisheries Science Center (SWFSC) Fisheries Ecology Division (FED)

NOAA NMFS SWFSC La Jolla (NOAA NMFS SWFSC LJ)

NOAA Atlantic Oceanographic and Meteorological Laboratory (NOAA AOML)

NOAA Ocean and Atmospheric Research (NOAA OAR)

NOAA NMFS Northwest Fisheries Science Center (NWFSC)

University of California Santa Cruz (UCSC)

UCSC Fisheries Collaborative Program (FCP)

Farallon Institute for Advanced Ecosystem Research (FIAER)

University of California (UC) Davis

Monterey Bay Aquarium Research Institute (MBARI)

Scripps Institution of Oceanography (SIO)

State University of New York (SUNY) Brockport

Idaho State University (ISU)

## **E. Personnel**

### ***Leg 1-A (May 14-23 Seattle, WA to San Francisco, CA)***

Canceled due to problems with ship's winch systems.

### ***Leg 1-B (May 23 San Francisco, CA, winch system gear trials)***

Keith Sakuma, Fish Biologist, NMFS SWFSC FED (Chief Scientist)

Tanya Rogers, Fish Biologist, NMFS SWFSC FED

Jarrold Santora, Fish Biologist, NMFS SWFSC FED

Michael Force, Ornithologist, FIAER

### ***Leg 1-B cont. (May 24-June 1 Santa Cruz, CA to San Francisco, CA)***

#### ***Night Shift***

Keith Sakuma, Fish Biologist, NMFS SWFSC FED (Chief Scientist)

Tanya Rogers, Fish Biologist, NMFS SWFSC FED

Rebecca Miller, GIS Specialist, NMFS SWFSC FED/UCSC

Jack Conroy, Postdoctoral Researcher, NMFS SWFSC FED

Steve Munch, Program Lead Fish Biologist, NMFS SWFSC FED

Liane Bauer, Associate Scientist, UCSC FCP

Francheska Torres, Graduate Student, UC Davis

#### ***Day Shift***

Jarrold Santora, Fish Biologist, NMFS SWFSC FED

Michael Force, Ornithologist, FIAER

### ***Leg 2-A (June 4-15 San Francisco, CA to Santa Cruz, CA)***

Canceled due to ship's crew staffing issue. Personnel from FIAER and MBARI along with NOAA OAR, AOML, and NMFS SWFSC LJ withdrawn from all of Leg 2 due to project uncertainty.

### ***Leg 2-B cont. (June 15-20 San Francisco, CA to San Francisco, CA)***

#### ***Night Shift***

Keith Sakuma, Fish Biologist, NMFS SWFSC FED (Chief Scientist)

Tanya Rogers, Fish Biologist, NMFS SWFSC FED

Jaime Hendrix, NOAA Corp., NMFS SWFSC FED

Dan Palance, PhD Student, UCSC

Buddy Pendergast, Undergraduate Student, UCSC

Sophia Simon, Postdoctoral Researcher, UC Davis

#### ***Day Shift***

Jarrold Santora, Fish Biologist, NMFS SWFSC FED

**Leg 2-B cont. (June 20-25 San Francisco, CA to San Diego, CA)**

Canceled due to ship's crew staffing issue.

**Scientist duty hours**

Nighttime Shift        1800-0600 (4-7 scientists on duty)  
Daytime Shift         0600-1800 (2 scientists on duty)

**F. Licenses and permits**

This project was conducted under NOAA NMFS scientific research permit SRP-33-2023 as well as NOAA NMFS SWFSC's MMPA LOA for the California Current and ESA section 7 biological opinion and associated incidental take statement WCR ESA consultation 2020-01302. Operations in CA state waters were under California Department of Fish and Wildlife (CDFW) permit S-203450001-21022-003. Operations within the Channel Islands National Marine Sanctuary (CINMS) were under permit CINMS-2021-008 with permitted activities including the use of midwater sampling gear as well as CTDs and all other activities subject to CINMS regulations. Principal Investigator John Field and Chief Scientist Keith Sakuma.

**G. Operations and Results**

**1. Sample for pelagic YOY rockfish and other epipelagic micronekton off California**

Sampling was initially planned at 23 transect lines off California using a modified-Cobb midwater trawl with a 26 m (86') headrope (effective mouth opening of 8 m x 12 m based on net mensuration data) and a 9.5 mm (3/8") codend liner. Replicate sampling at trawl stations was planned to examine temporal variability. Trawl operations were at night at a target headrope depth of 30 m unless bottom depths were shallow (e.g., less than 55 m) in which case the target headrope depth was 10 m to avoid contact with the bottom. Tow speed was ~3.7 km/hr (~2 knots) with a target trawl duration of 15 minutes at target headrope depth. Wire out was determined based on depth recordings collected from the ship's SIMRAD real-time acoustic net sensing system and also from TDRs post-trawl. Fish and select invertebrates from each trawl were sorted, identified and enumerated. Size information was recorded on select species. All YOY rockfish were frozen for later laboratory analyses.

Due to issues with the ship's winch systems the project was unable to start on schedule on May 14 in Seattle, WA. While trying to address the issues with the winch systems, the ship transited from Seattle, WA to San Francisco, CA to be in the actual project operating area once the winch issues were resolved. On May 23 select project scientists boarded the ship to conduct gear trials to determine the status of the winch systems. Unfortunately, during the gear trials the primary midwater trawl was severely damaged requiring extensive repair back on land. The backup trawl net was then the only usable trawl net. To prevent damaging the sole remaining trawl net with overly large gelatinous catches (e.g., pyrosomes, jellyfish such as *Chrysaora fuscescens*, etc.), "test" bongo tows were sometimes implemented prior to trawl deployment and target trawl duration was reduced to 5 minutes. The rest of the scientific party was boarded via small boat operations out of Santa Cruz, CA on May 24 to start project operations for Leg 1. The start of Leg 2 on June 4 was delayed due to ship's crew staffing issues. Temporary ship's crew staffing was obtained for the period of June 15-20 allowing for some operations to be completed on Leg 2. From June 20-25 project operations were canceled due to ship's crew staffing issues. The loss of sea days severely impacted the project with only 12 of the 23 planned station lines sampled and only one station line resampled for temporal variability. In addition, the most northern and southern station lines were not sampled, negatively impacting the spatial coverage of the project. A total of 50 midwater trawls were completed, which is less than half the number normally completed in a normal year. Number of standard

station trawls completed and station spatial coverage by year are shown in Appendix III.

Time series of the annual means of the log-transformed catches of select species/taxa in the various survey regions off California are shown in Appendix IV. 10819 YOY rockfish were caught north of Point Conception and 3994 were caught south. In contrast to prior years there was no difference in the most dominant species north and south of Point Conception with shortbelly rockfish (*Sebastes jordani*), widow rockfish (*S. entomelas*), and chilipepper (*S. goodei*) being the most abundant species in both areas. However, the two most southern station lines were not sampled this year due to the loss of DAS, which may have had an effect on the species composition. YOY Pacific hake (*Merluccius productus*) catches were higher than in 2022 with the highest catches ever observed in the north central region. However, other groundfish, such as YOY sanddabs (*Citharichthys* spp.), remained at moderately low abundances and no YOY lingcod (*Ophiodon elongatus*) were caught this year.

Pacific sardine (*Sardinops sagax*) catches were higher this year in all regions except for the north central region with the highest catches ever observed in the south. Catches of YOY Pacific sardine were low with only a few observed in the south and south central regions. Adult northern anchovy (*Engraulis mordax*) were quite abundant with increased catches in all regions and the highest catches ever observed in the north central and south central regions. Catches of YOY northern anchovy remained quite high in the south, but were low or absent in other regions.

Myctophids and krill both decreased in abundance in all regions compared to last year with the exception of the north region (which was not sampled last year due to loss of DAS due to ship's crew staffing issues). Market squid (*Doryteuthis opalescens*) catches in the south central and south region were high with the south having the highest catches ever observed for that region, but catches dropped significantly to the north. Catches of octopus remained moderate in the south and low in other regions.

*Thetys* salps were abundant in all regions except the north, while other salps had their highest abundances ever in the north and north central regions with large numbers in the other regions as well. Pyrosomes were also very abundant with the largest catches ever observed in the south central region and the second largest catches in the south region, though catches did seem to decrease at higher latitudes. Catches of *Aurelia* spp. and *Chrysaora fuscescens* were relatively low. Jellyfish are generally most abundant at shallower nearshore stations and several of those shallow nearshore stations were not sampled this year due to loss of DAS.

## **2. Characterize prevailing ocean conditions and examine prominent hydrographic features**

Due to ship's crew staffing issues daytime CTD stations were not sampled as deck operations were prioritized for the nighttime trawl operations (see map in Appendix II). CTD casts were done at the first and last trawl stations of the night and if time allowed at one of the middle trawl stations at night. Because of this constraint only 35 CTD casts were done and all of them at trawl stations. With daytime sampling the project normally is able to complete well over 200 CTD casts. A Seabird Electronics CTD and water sampling system with conductivity, temperature, depth, fluorometer, transmissometer, photosynthetically active radiation (PAR), and dissolved oxygen sensors was used. The CTD was lowered to a maximum depth of 500 m, as bottom depth allowed. Water samples were taken during the upcast for chlorophyll samples. Unfortunately, due to Seabird Electronics not returning the ship's CTD sensors back from calibration in time, a substitute fluorometer was used on Leg 1 that only recorded chromophoric dissolved organic matter (CDOM) and not chlorophyll. Therefore, chlorophyll data was only collected on Leg 2 as the Leg 1 data was only for CDOM and not consistent with prior years' collections. Oceanographic data was also collected while underway by the ship's Turner Designs SCUFA fluorometer and SeaBird thermosalinometer. Because of the lack of daytime CTD sampling and the project uncertainty due to the ship's crew staffing issues, the eDNA sampling collections were canceled (see objective 7 below).

### **3. Map the distribution and abundance of krill**

Throughout the project, the EK80 echosounder was operated at 18, 38, 70, 120, 200 and 333 kHz to estimate the biomass of krill and other micronekton between 10 and 700 m depth. Targeted transect lines were run during daylight hours. Seabird and marine mammal observations were recorded concurrently along the transect lines (see objective 4 below for specifics). Preliminary krill abundances were based on expanding counts from a 10-20 ml subsample from each nighttime midwater trawl. To confirm the at sea krill numbers and to determine species composition a 100 ml subsample from each trawl was preserved in formalin and returned to the laboratory for future work up.

### **4. Observe seabird and marine mammal distribution and abundance**

An ornithologist/marine mammal biologist from the FIAER visually surveyed and estimated abundance and distribution of seabirds and marine mammals from the ship's flying bridge during daylight hours while underway on Leg 1 May 24-June 1. The observer recorded all birds seen within a 300 m strip transect to one side of the vessel while the ship was underway at greater than 5 knots. Marine mammals were surveyed out to the horizon. Each observation included the species, the number of individuals observed, and their behavior (mostly flying or sitting for birds). Observation data were post-processed using standardized species codes, validation of positioning data, and binning of observations into along-track sections 3 km in length. Due to the ship's crew staffing issues and the uncertainty of Leg 2, FIAER personnel did not participate in that leg. For Leg 2 June 15-20, an experienced NMFS SWFSC FED staff member completed the daytime seabird/marine mammal observations.

A map of the FIAER Leg 1 survey effort is shown in Appendix V, a summary of survey effort in Appendix VI, and the top five most numerous seabirds and marine mammals in Appendix VII. For Leg 1 there were very high numbers of sooty shearwater (*Ardenna grisea*) with high densities observed for the third consecutive year and continuing an increasing trend since 2019. Pink-footed shearwater (*Puffinus creatopus*) were observed at average density levels, while density levels of common murre (*Uria aalge*) were below average. Additionally, brown pelican (*Pelecanus occidentali*), a warmer-water species, had relatively high densities with the second highest observed in the time series. Marine mammal abundances were low this year with the third consecutive year of low Pacific white-sided dolphin (*Lagenorhynchus obliquidens*) observations, although humpback whales (*Megaptera novaeangliae*) were present at average abundances. For Leg 2 the area between Point Reyes and Trinidad Head was surveyed with 5632 seabirds comprised of 16 different species and 73 marine mammals with two species observed. Sooty shearwaters dominated the sightings with 5289 observed and common murre were second with 238 observed. There were 30 Pacific white-sided dolphins observed and 43 humpback whales.

### **5. Collect samples for stable isotope analysis**

Samples of krill and other micronekton were collected to provide baseline samples at multiple trophic levels to explore the potential for developing an "isoscape" analysis of the California Current, as well as to support ongoing investigations related to thiamine studies for central California salmon (objective 6 below). The overall idealized objective was to collect samples from each trawl station with up to five individuals or tissue samples of each species at each station. This included tissue samples from krill, market squid, adult northern anchovy, YOY Pacific hake, and also northern lampfish (*Stenobranchius leucopsarus*), blue lanternfish (*Tarletonbeania crenularis*), and California headlightfish (*Diaphus theta*). YOY rockfish were also archived for these studies after being processed back at the laboratory).

### **6. Collect samples for thiamine deficiency complex (TDC) study**

Tissue samples from a suite of salmon prey items were collected to support ongoing research into the potential drivers of TDC in California Current salmon populations. TDC is a nutritional deficiency of thiamine (vitamin B1) recently linked with high mortalities of early life stage Chinook salmon (*Oncorhynchus tshawytscha*) in several Central Valley, CA salmon populations (for more information, see <https://www.fisheries.noaa.gov/west-coast/science-data/monitoring-thiamine-deficiency-california->

[salmon](#)). Some evidence suggests that TDC may result from a narrowing of diversity in the food habits of Chinook salmon, particularly when the major contributor to that diet is northern anchovy, which are generally higher in thiaminase (an enzyme that destroys or inactivates thiamine) than other forage species. Samples of northern anchovy, market squid, YOY rockfish, Pacific sardine, krill and other salmon forage species were collected in support of these ongoing studies. Several samples of pyrosomes, which are not typically preyed upon by salmon but which showed surprisingly high levels of thiaminase during some initial investigations in earlier years, were also collected. The results will support investigations into possible trophic mechanisms driving the increased occurrence of TDC in California salmon populations.

### **7. Collect samples for eDNA**

Water sample collections by Niskin bottles mounted on the CTD rosette were planned for eDNA and nutrient analysis with a focus on fish metabarcoding (12S amplicon sequencing) and prokaryotic functional profiles (metagenomic shotgun sequencing). Sample collection was planned for 10 lines, four stations per line, for a total of 40 stations from: San Nicolas, San Miguel, Point Sal, Piedras Blancas, Monterey Inside, Monterey Outside, Davenport, Pescadero, Gulf of the Farallones, and Point Reyes. Water sample collections for eDNA were canceled due to ship's crew staffing issues leading to project uncertainty as well as lack of experienced deck personnel to conduct daytime winch operations resulting in no daytime CTD operations.

### **8. Adaptive sampling near Piedras Blancas and Trinidad Head trawl lines**

Adaptive sampling was planned to support a combination of survey mitigation needs, baseline data improvement, and future impacts analysis of the Bureau of Ocean Energy Management (BOEM) wind energy areas (WEA) in California waters specifically south (downwind) of the existing Piedras Blancas and Trinidad Head trawl station lines. For Piedras Blancas nighttime midwater trawls were planned at the new Morro Bay station line, while for Trinidad Head nighttime midwater trawls were planned at the existing CTD stations to the south (stations 6001-6004). In addition to the nighttime trawls, CTDs, acoustic transects, and seabird and marine mammal observations were planned along the trawl station lines and within the vicinity during the day. Data from these survey collections would have been used to develop a baseline to facilitate future changes to the survey grid, as well as provide information to evaluate potential changes in the epipelagic micronekton community and associated predators (seabirds and marine mammals) with the implementation of WEAs. All these operations were canceled due to the loss of DAS due to the ship's winch issues and crew staffing issues.

## **H. Disposition of data**

Requests and questions regarding the seabird and marine mammal data should be sent to:

Leg 1 – FIAER, William Sydeman 707-981-8033 [wsydeman@comcast.net](mailto:wsydeman@comcast.net).

Leg 2 – NOAA NMFS SWFSC FED, Jarrod Santora 831-420-3991 [jarrod.santora@noaa.gov](mailto:jarrod.santora@noaa.gov)

Requests and questions regarding the stable isotope data should be sent to:

MBARI, Steven Litvin 831-775-1939 [litvin@mbari.org](mailto:litvin@mbari.org) and

SIO, Anela Choy 858-822-3020 [anela@ucsd.edu](mailto:anela@ucsd.edu).

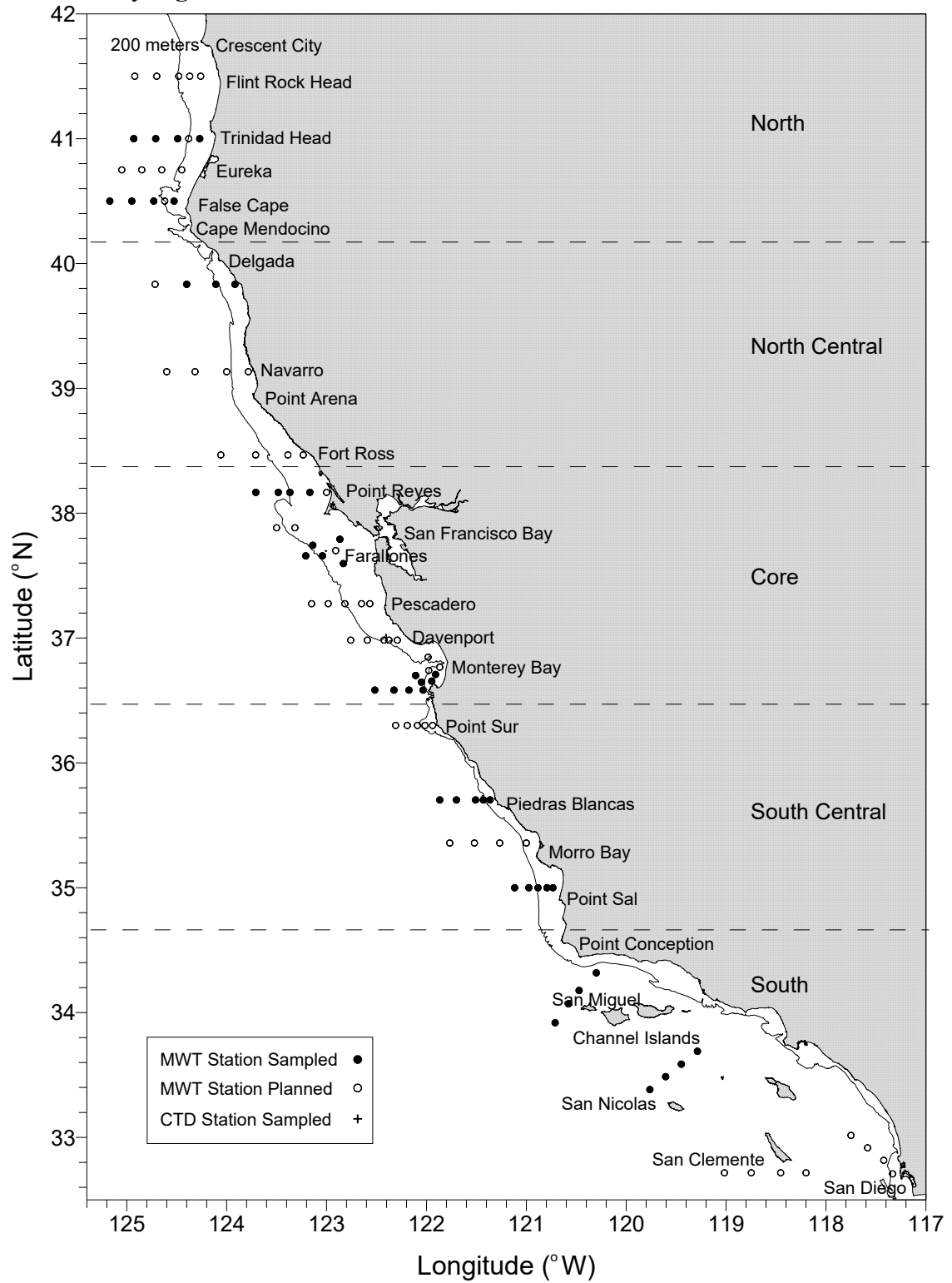
All other data requests should be sent to NOAA NMFS SWFSC FED, Keith Sakuma 831-420-3945 [keith.sakuma@noaa.gov](mailto:keith.sakuma@noaa.gov).

## Appendix I: Daily transect schedule

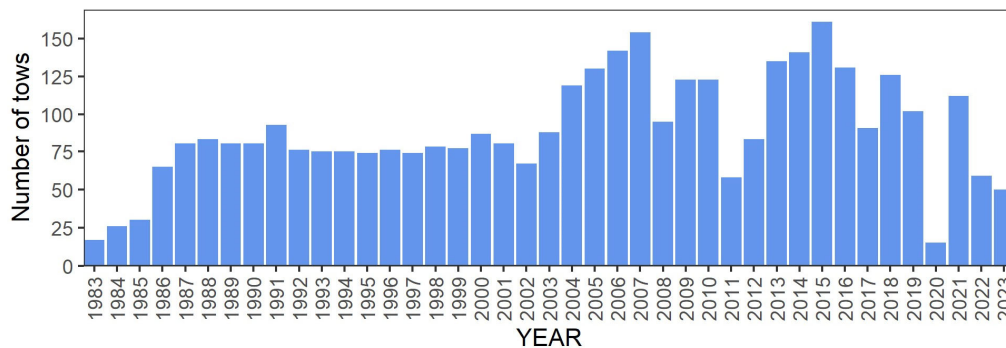
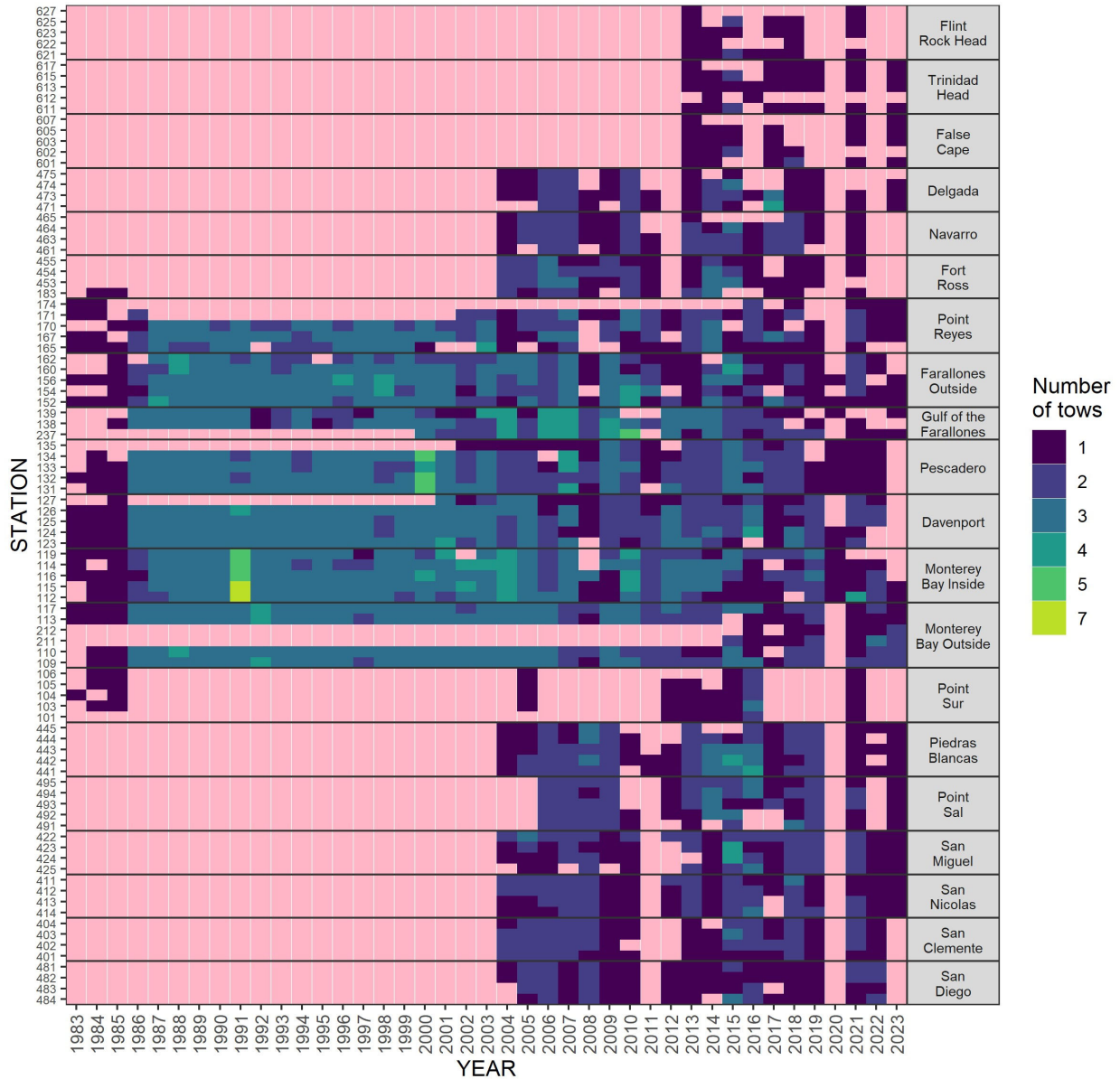
Date	Location	# Sampled	Notes
14-May	<b>Seattle Anchored</b>		Sunday-Delay due to winch issues, Seattle, WA
15-May	<b>Transit</b>		Transit to S.F., CA
16-May	<b>Transit</b>		
17-May	<b>Transit</b>		
18-May	<b>Transit</b>		Arrive S.F., CA
19-May	<b>S.F. Port</b>		Troubleshoot winch issues
20-May	<b>S.F. Port</b>		Saturday
21-May	<b>S.F. Port</b>		Sunday
22-May	<b>S.F. Port</b>		
23-May	<b>Transit</b>		Depart S.F., CA-Begin Leg 1-Test winches
24-May	Monterey Inside	0.3	Skiff transfer-board rest of science party, Santa Cruz, CA
25-May	Monterey Outside	1	
26-May	Piedras Blancas	1	
27-May	San Miguel	1	Saturday
28-May	San Nicolas	1	Sunday
29-May	Point Sal	1	Memorial Day
30-May	Monterey Outside	2	
31-May	Gulf of Farallones	0.7	
1-Jun	<b>S.F. Port</b>		End Leg 1-Begin in port S.F., CA
2-Jun	<b>S.F. Port</b>		In port
3-Jun	<b>S.F. Port</b>		Saturday-In port
4-Jun	<b>S.F. Port</b>		Leg 2 start delay due to lack of 1st engineer
5-Jun	<b>S.F. Port</b>		
6-Jun	<b>S.F. Port</b>		
7-Jun	<b>S.F. Port</b>		
8-Jun	<b>S.F. Port</b>		
9-Jun	<b>S.F. Port</b>		
10-Jun	<b>S.F. Port</b>		Saturday
11-Jun	<b>S.F. Port</b>		Sunday
12-Jun	<b>S.F. Port</b>		
13-Jun	<b>S.F. Port</b>		
14-Jun	<b>S.F. Port</b>		
15-Jun	Point Reyes	0.8	Depart S.F., CA, Begin Leg 2
16-Jun	Delgada	0.8	
17-Jun	Trinidad Head	1	Saturday
18-Jun	False Cape Outside	1	Sunday
19-Jun	Farallones	0.6	Juneteenth
20-Jun	<b>S.F.</b>		Skiff transfer-Disembark 1st engineer and all scientists
21-Jun	<b>Transit</b>		Transit to San Diego, CA
22-Jun	<b>Transit</b>		
23-Jun	<b>San Diego Port</b>		
24-Jun	<b>San Diego Port</b>		Saturday
25-Jun	<b>San Diego Port</b>		Sunday-Project ends



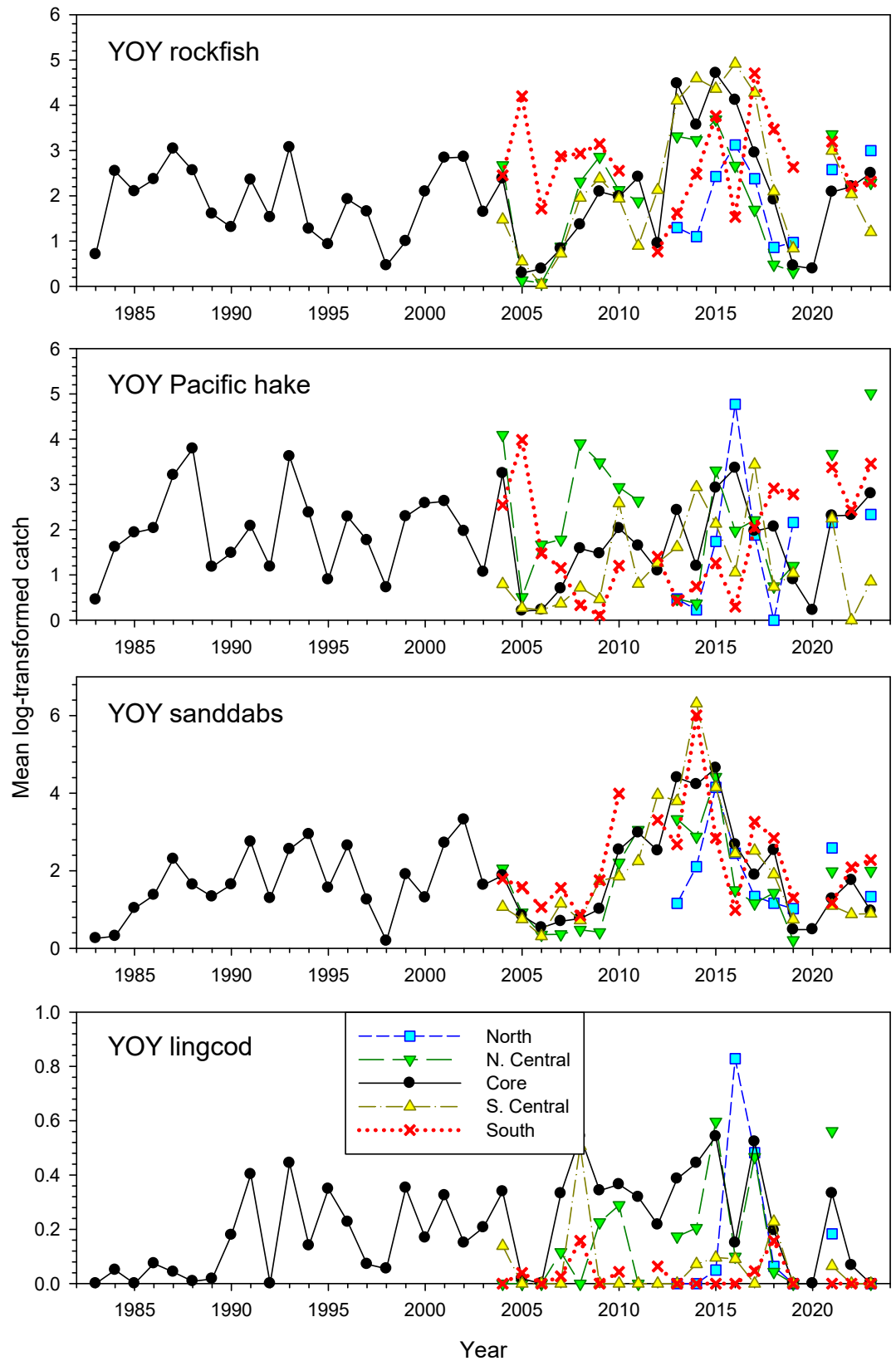
## Appendix II: Survey regions and midwater trawl and CTD station locations

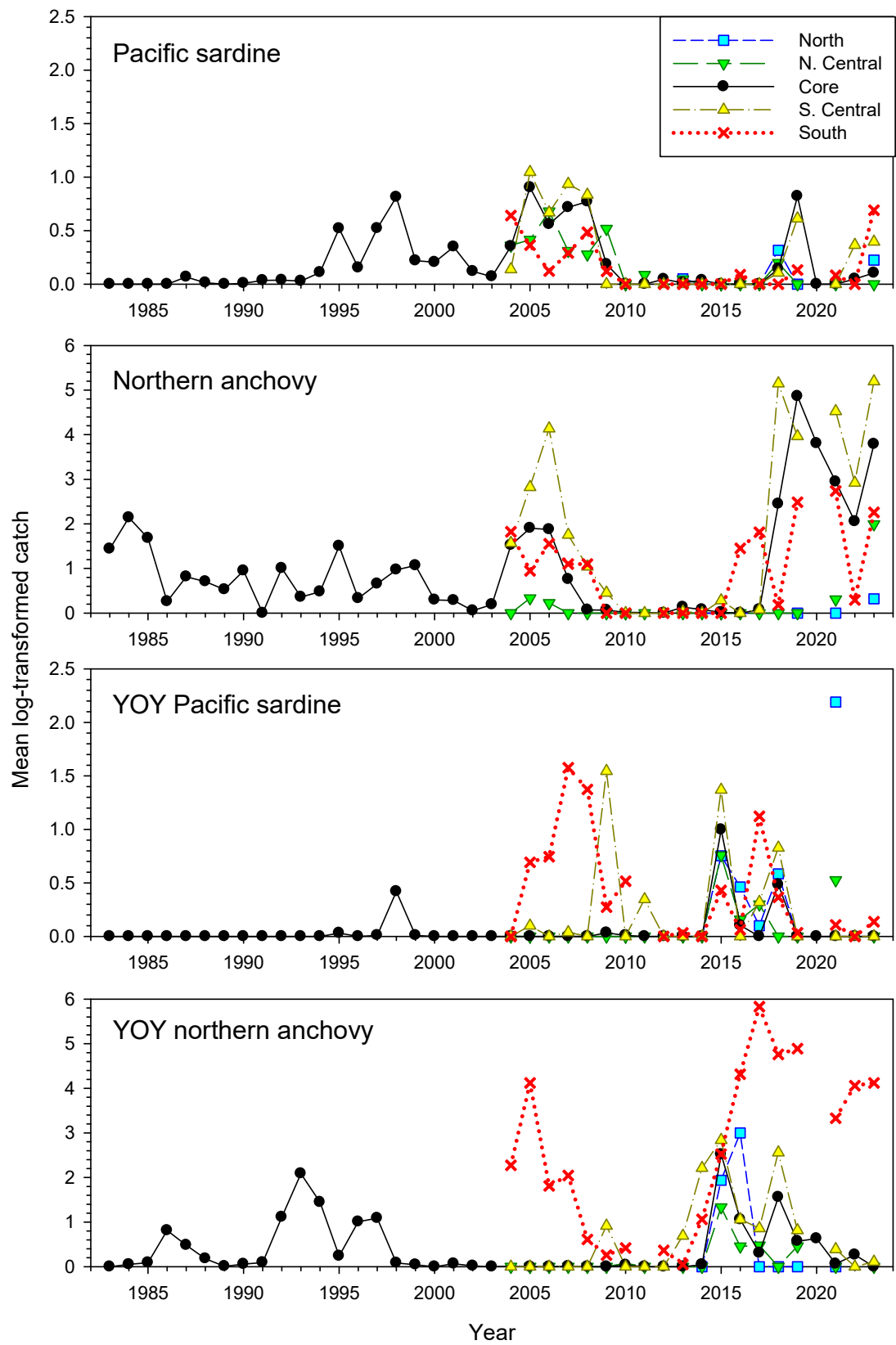


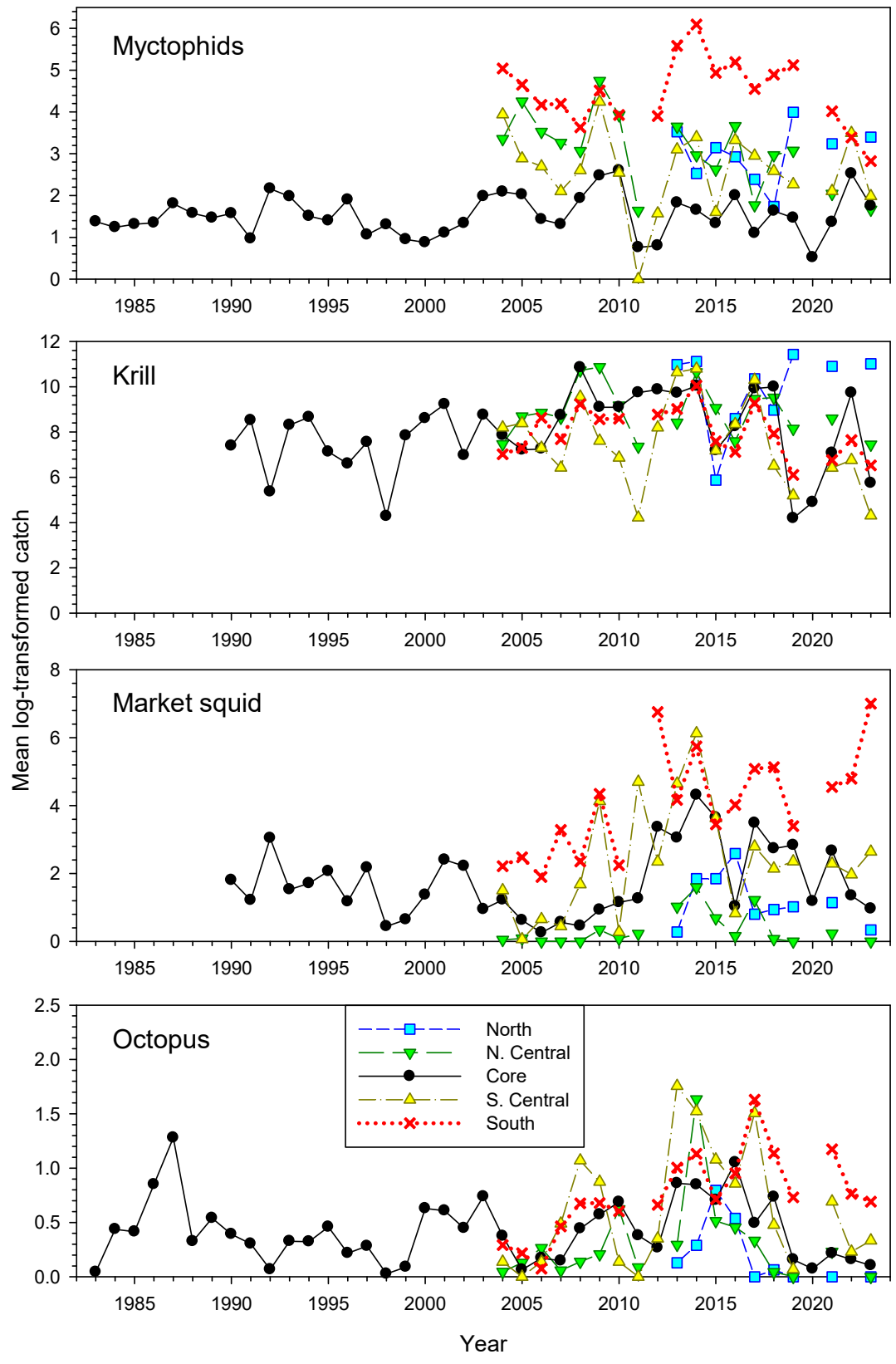
**Appendix III: Number of standard trawls completed by year and station/area. 1983-85 DAS allocation was ~14 days, 1986-2003 was ~30 days, and 2004-present was ~40+ days with some exceptions (e.g., 2011 and 2020 were on chartered fishing vessels due to loss of NOAA ship time).**

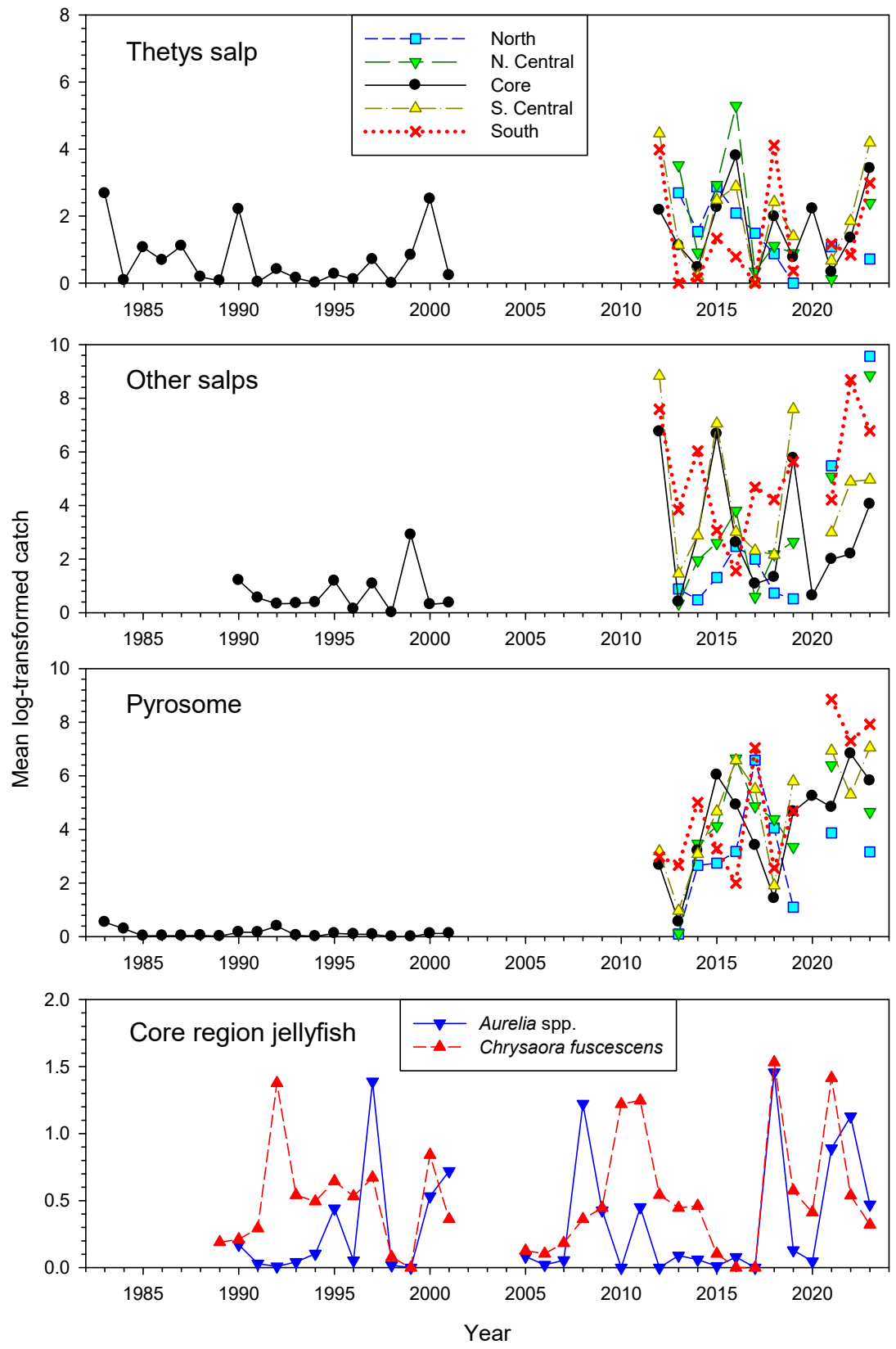


### Appendix IV: Annual catch summaries for select species/taxa off California

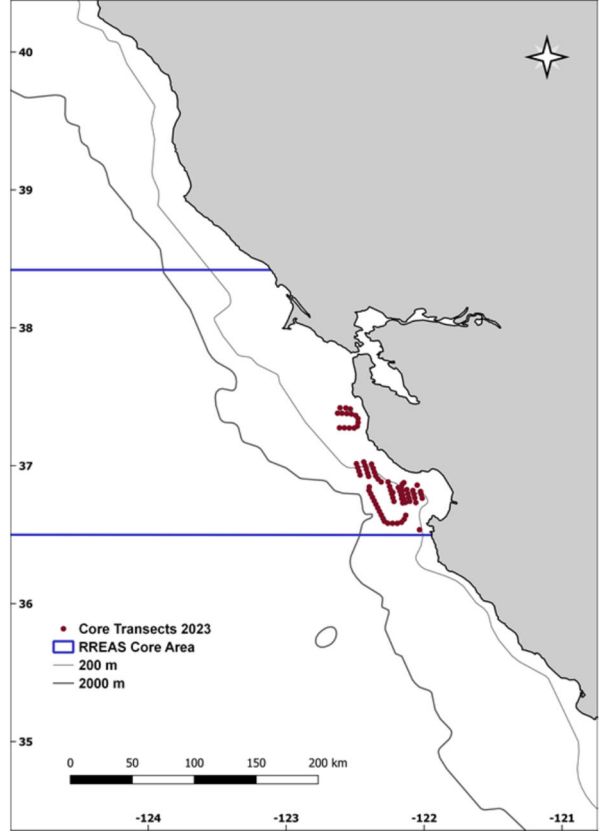
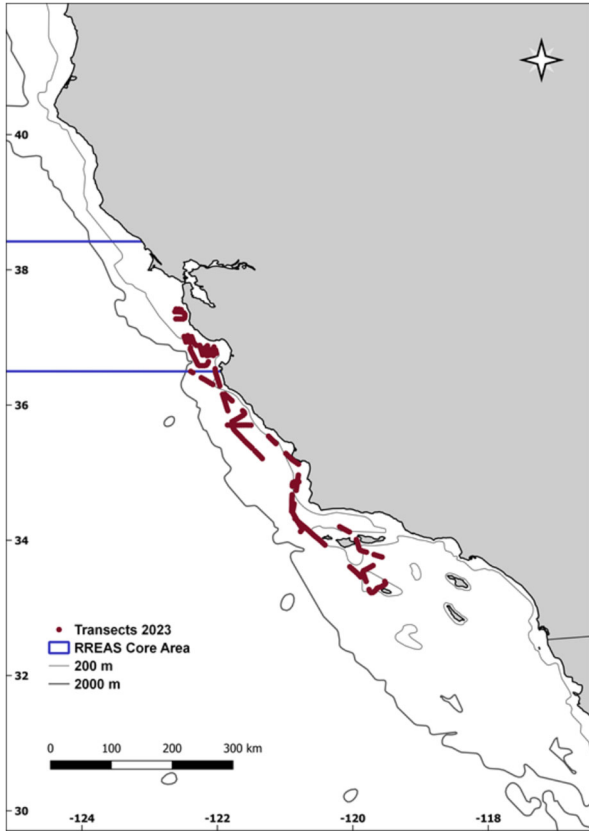








**Appendix V: Leg 1 FIAER seabird and marine mammal transects for the full (left) and core (right) regions. Gaps usually reflect nighttime.**



**Appendix VI: Summary of Leg 1 FIAER survey effort and seabird and marine mammal community statistics**

2023	Core Area	Full Area
Survey vessel		<i>R/V Reuben Lasker</i>
Start date		5/24/2023
End date		5/31/2023
Number of survey days	4	8
Distance surveyed (km)	237	865
Area surveyed (km <sup>2</sup> )	71	260
Number of bird species	19	24
Overall bird density (per km <sup>2</sup> )	168.94	80.041
Total birds observed	12,029	20,780
Number of mammal species	6	17
Overall mammal encounter rate (per 100 km)	13.9	289.8
Total mammals observed	33	2,508



**Appendix VII: Leg 1 FIAER top five most numerous seabirds and marine mammals observed. For seabirds, cell values = total number of individuals seen / number of species sightings / average density (birds per km<sup>2</sup>) while for marine mammals cell values = total number of individuals seen / number of species sightings / average density (individuals per 100 km).**

<b>Common Name</b>	<b>Scientific Name</b>	<b>Core Region Standardized</b>	<b>Full Region</b>
Sooty Shearwater	<i>Ardenna grisea</i>	11537/310/162.03	18296/688/70.47
Pink-Footed Shearwater	<i>Puffinus creatopus</i>	28/19/0.39	1471/227/5.67
Common Murre	<i>Uria aalge</i>	268/71/3.76	466/102/1.79
Western Gull	<i>Larus occidentalis</i>	76/69/1.07	222/169/0.860.72
Brown Pelican	<i>Pelecanus occidentalis</i>	11/7/0.15	71/41/0.27

<b>Common Name</b>	<b>Scientific Name</b>	<b>Core Region Standardized</b>	<b>Full Region</b>
Northern Right Whale Dolphin	<i>Lissodelphis borealis</i>		1560/2/180.3
California Sea Lion	<i>Zalophus californianus</i>	3/3/1.3	542/40/62.6
Humpback Whale	<i>Megaptera novaeangliae</i>	16/14/6.7	173/69/20
Pacific White-Sided Dolphin	<i>Lagenorhynchus obliquidens</i>		63/11/7.3
Short-Beaked Common Dolphin	<i>Delphinus delphis</i>		60/1/6.9