

West Coast Groundfish Bottom Trawl Survey

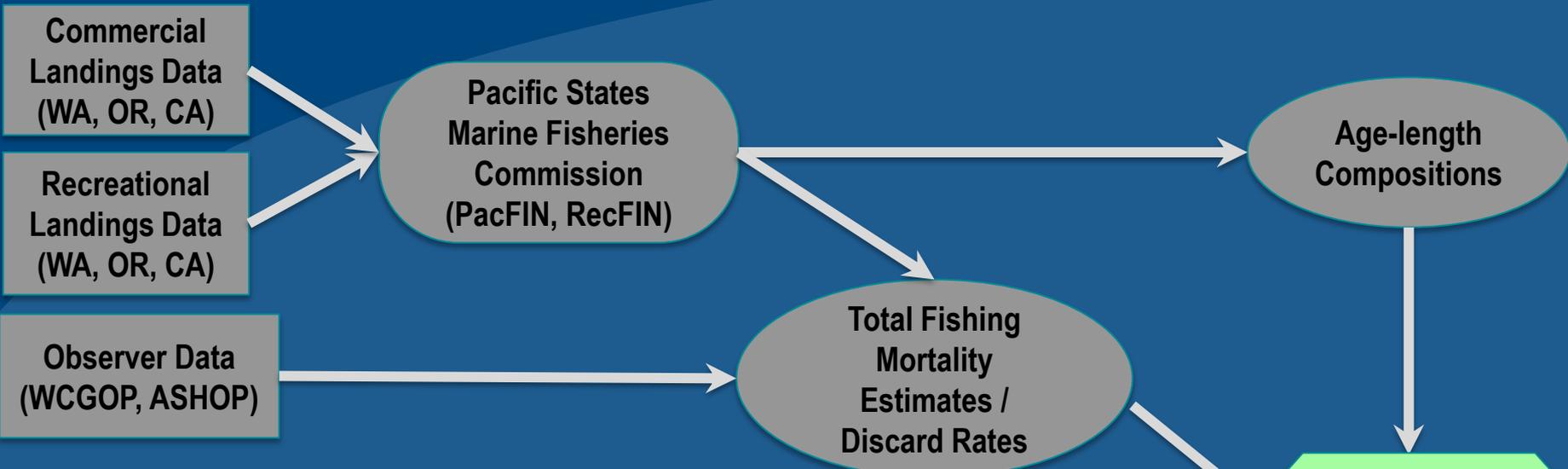
Introduction

- Survey description
- Data collection efforts
- QA/QC procedures – at-sea, on-shore, national protocols
- Data management
- Strengths and challenges



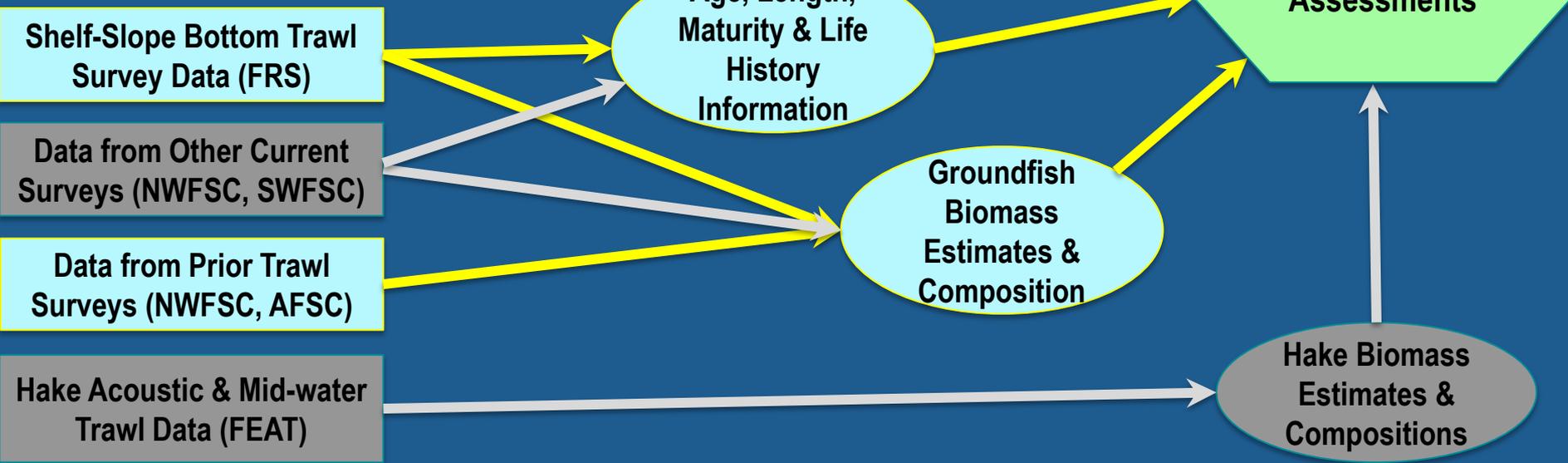
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Fishery Dependent Data



Fishery Data Flows

Fishery Independent Data



Trawl Survey Mission



- primary source of fisheries-independent data for west coast stock assessments
- provide biomass indices used in assessments for 27 species; sufficient data for additional 11 species; and limited data for 26 species
- time series for species composition, catch, weight, abundance, size, age, and maturity by area and depth
- associated environmental and habitat data



ROCKFISH

- Aurora rockfish
- Bank rockfish
- Black rockfish
- Black/yellow rockfish
- Blackgill rockfish
- Blue rockfish
- Bocaccio
- Bronzespotted rockfish
- Brown rockfish
- Calico rockfish
- California scorpionfish

ROCKFISH

- Canary rockfish
- Chameleon rockfish
- Chilipepper
- China rockfish
- Copper rockfish
- Cowcod
- Darkblotched rockfish
- Dusky rockfish
- Dwarf-red rockfish
- Flag rockfish
- Freckled rockfish
- Gopher rockfish
- Grass rockfish
- Greenblotched rockfish
- Greenspotted rockfish
- Greenstriped rockfish
- Halfbanded rockfish
- Harlequin rockfish
- Honeycomb rockfish
- Kelp rockfish

ROCKFISH

- Squarespot rockfish
- Starry rockfish
- Stripetail rockfish
- Swordspine rockfish
- Tiger rockfish
- Treefish
- Vermilion rockfish
- Widow rockfish
- Yelloweye rockfish
- Yellowmouth rockfish
- Yellowtail rockfish
- Puget Sound rockfish

90+ FMP Species

GRENADIERS

Pacific grenadier

MORIDS

Finescale codling

FLATFISH

- Arrowtooth flounder
- Butter sole
- Curlfin sole
- Dover sole
- English sole
- Flathead sole
- Pacific sanddab
- Petrale sole
- Rex sole
- Rock sole
- Sand sole
- Starry flounder

SHARKS

- Big skate
- California skate
- Leopard shark
- Longnose skate
- Soupin shark
- Spiny dogfish

RATFISH

- Spotted ratfish

ROCKFISH

- Rosethorn rockfish
- Rosy rockfish
- Rougeye rockfish
- Sharpchin rockfish
- Shortbelly rockfish
- Shortraker rockfish
- Shortspine thornyhead
- Silvergray rockfish
- Sunset rockfish
- Speckled rockfish
- Splitnose rockfish



ROCKFISH

- Longspine thornyhead
- Mexican rockfish
- Olive rockfish
- Pink rockfish
- Pinkrose rockfish
- Pygmy rockfish
- Pacific ocean perch
- Quillback rockfish
- Redbanded rockfish



Survey History: 1977 - 1998

AFSC Triennial Shelf Survey (1977 – 2001)

- variable dates: Jun/Jul to late Sept
- shelf region: 55 – 366 m or 55 – 500 m
- transect based design
- U.S. – Canada to Pt. Conception
- chartered AK commercial trawlers (20 – 45 m)



AFSC West Coast Slope Survey (1984 – 2001)

- annual after 1988
- dates variable: May to Sept.
- slope region: 183 – 1280 m
- transect based design
- U.S. – Canada to Pt. Conception
- RV Miller Freeman (65.5 m)

Survey History NWFSC: 1998 to present

1998 – 2001

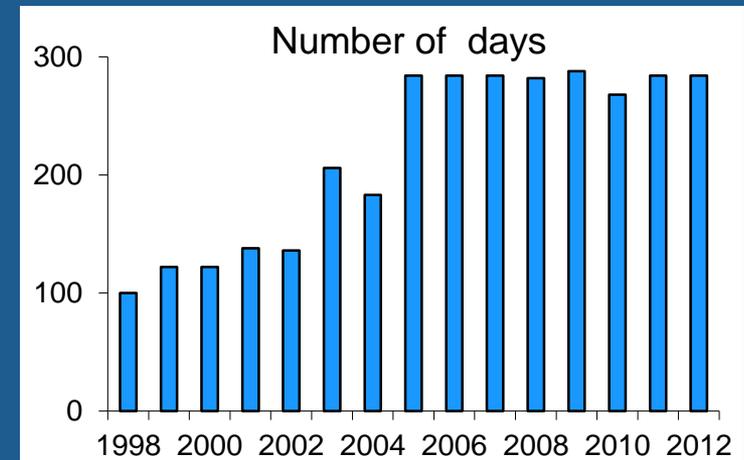
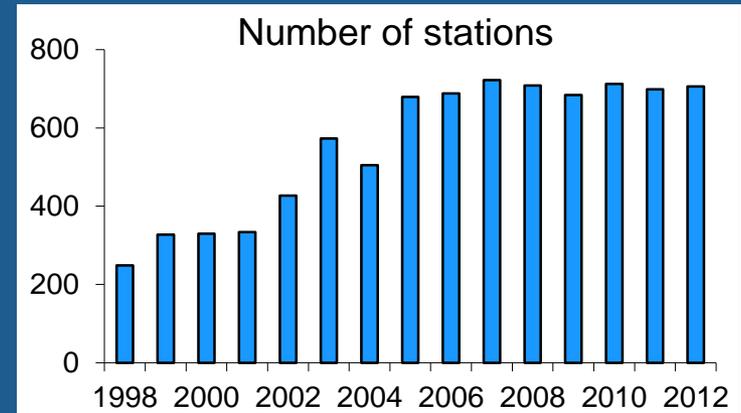
- annually June – Sept.
- slope region (183 – 1280 m)
- transect based design
- US – Canada to Pt. Conception

2002

- expanded to U.S. – Mexico border

2003 – present

- annually May – Oct.
- shelf and slope regions (55 – 1280 m)
- US – Canada to US – Mexico border
- stratified – random sampling design
- national protocols



Trawl Survey Description

- 4 chartered West Coast fishing vessels (~20 to 30 m)*
- 2 passes (N to S) down coast (May – Jul; Aug – Oct.)
- average 4 – 5 tows per day
- fish during daylight hours
- 3 scientists; 3 crew
- 188 fishing days-at-sea
- 72 days per pass
- avg catch 335 kg tow⁻¹ (range <1 to 18,300 kg tow⁻¹)



* 2013 “The Reduced Survey” – three vessels due to budget cuts

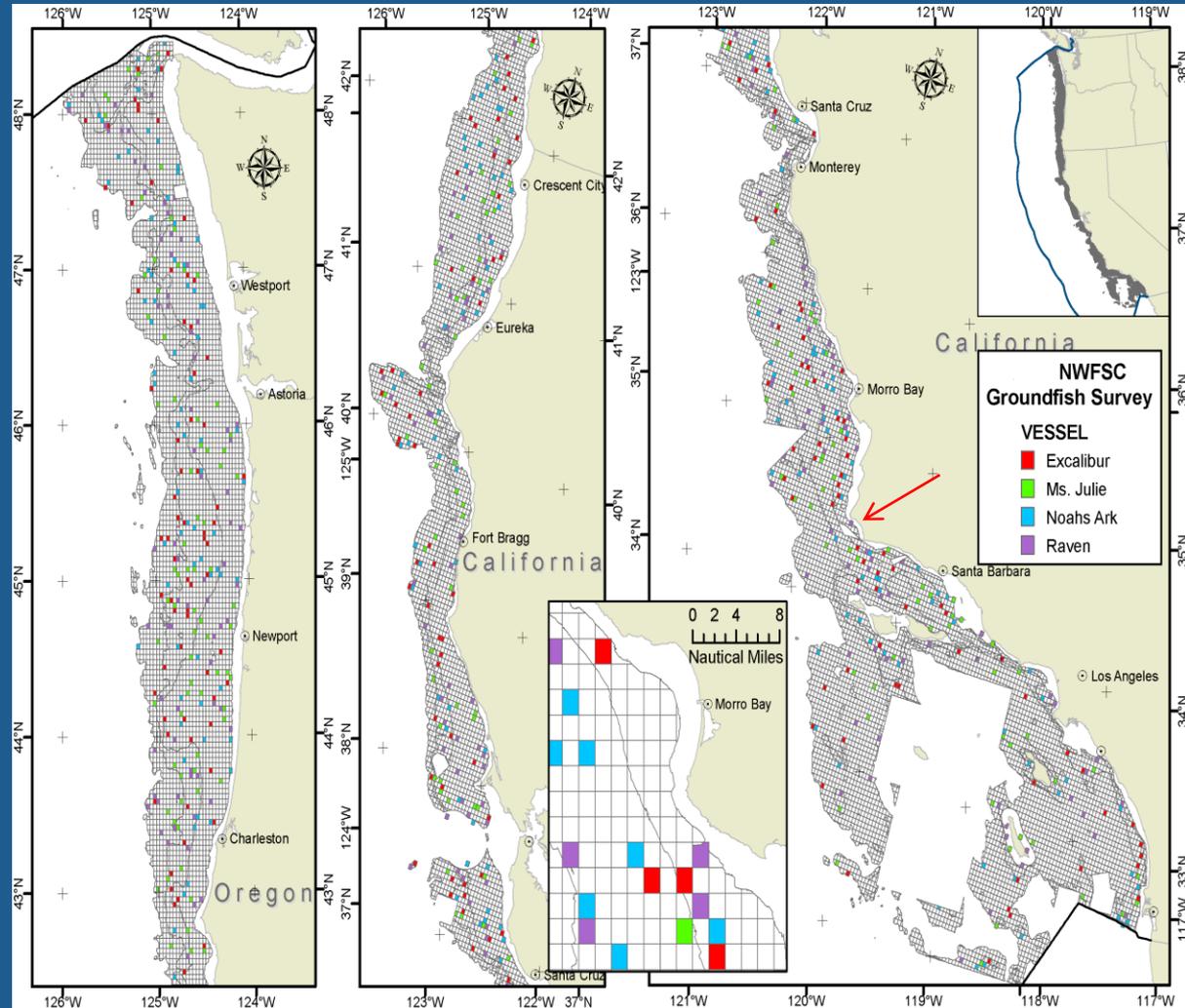
Trawl Survey Methods

- standardized fishing gear: Aberdeen trawl and warps
- wireless back deck: scales, fish meter boards, bar code scanner
- depth 55 -1280 m
- target tow speed 2.2 kt
- target tow duration 15 min
- all catch sorted to species and weighed
- selected species individually sexed, measured
- age structures, DNA, stomachs and maturities collected

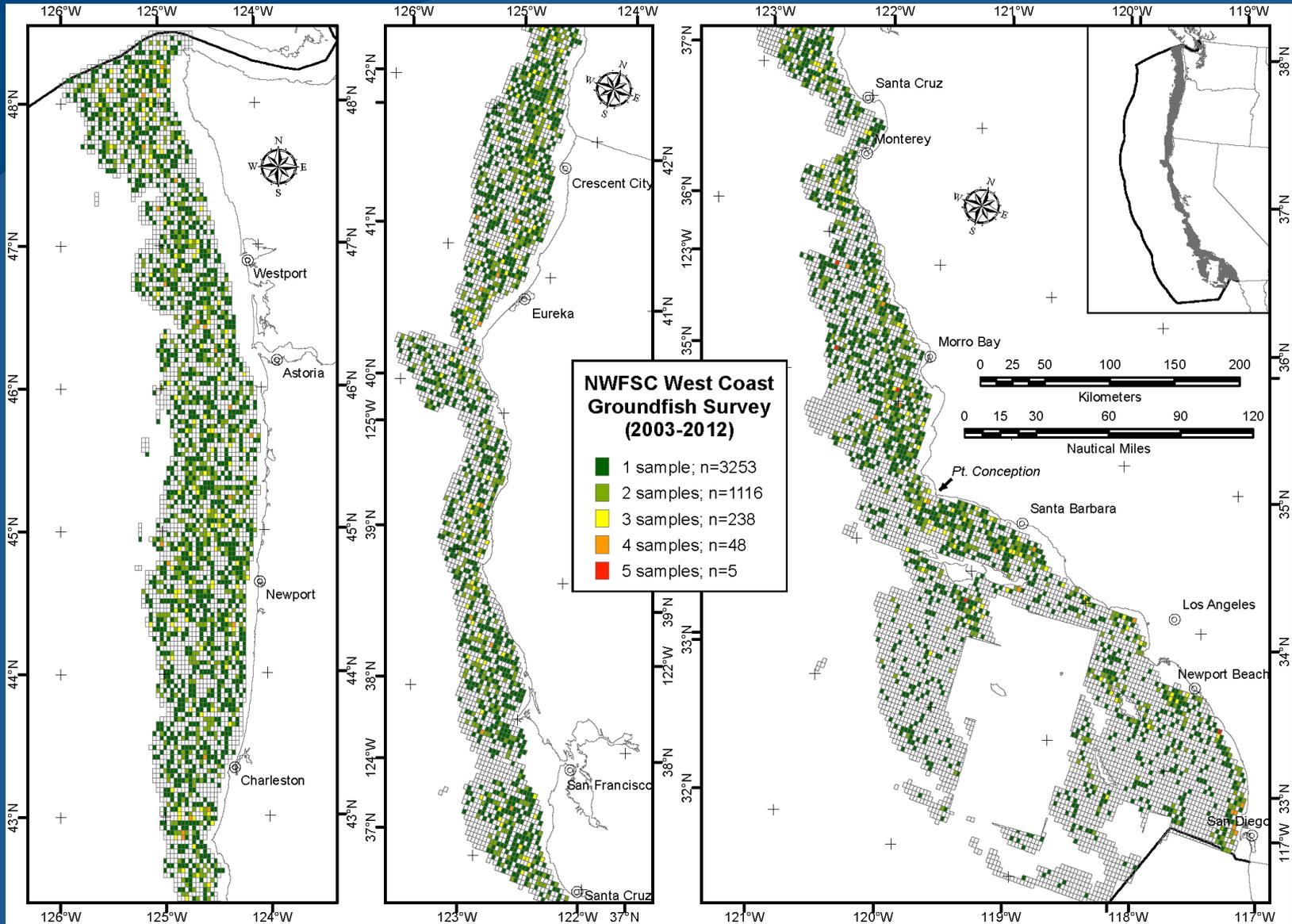


Survey Design: Stratified-Random Sampling

- US Canada border to US Mexico border
- Survey area sub-divided into ~13,000 equally sized cells (1.5 X 2.0 nm)
- Each of 4 charter vessels randomly assigned a set of 188 cells, secondary and tertiary cells also assigned (not shown)
- 2 geographic strata: 80% N of Pt. Conception, 20% S
- 3 depth strata (55-183 m, 183-549 m; 550-1,280 m)
- Minimum 30 tows/strata (with four vessels)

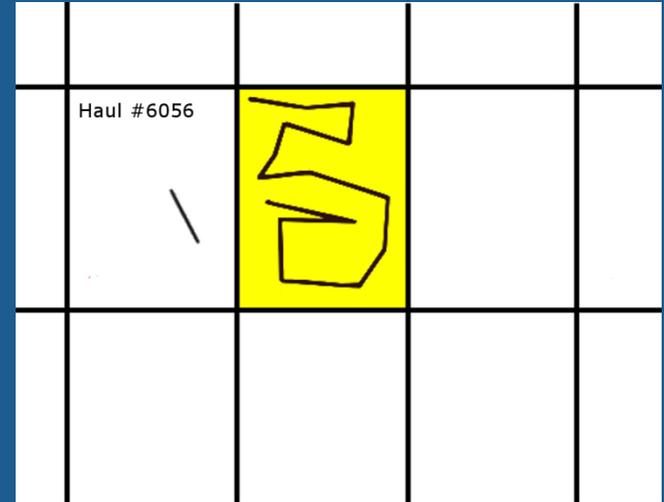


Cumulative Survey Coverage 2003 - 2012



Excluded Areas:

- Cow cod area – 985 cells
- Protected areas: state – 109 cells
federal – 46 cells
- Safety: shipping lanes, pipelines, cables, chemical waste – 238 cells
- Military test range – 43 cells
- Radioactive dumpsites – 47 cells
- Mooring /subsurface instruments – 16 cells



initial number of cells 12,996
current number of cells 11,512
89% of possible cells included

Survey Gear: Warps and Aberdeen trawl

NMFS supplied gears = consistency

Aberdeen net:

- height 4.5 m; width 15 m
- headrope length 85 feet
- footrope length: 104 feet
- mesh 5.5 in (1.5 inch in cod end)
- mud gear cookies 8-10 in diameter

Trawl Warps:

- 16-mm, galvanized, steel core
- 2286 m of contiguous wire, no splices
- each strand drawn galvanized steel
- breaking force ≥ 1570 Newtons mm^{-1}

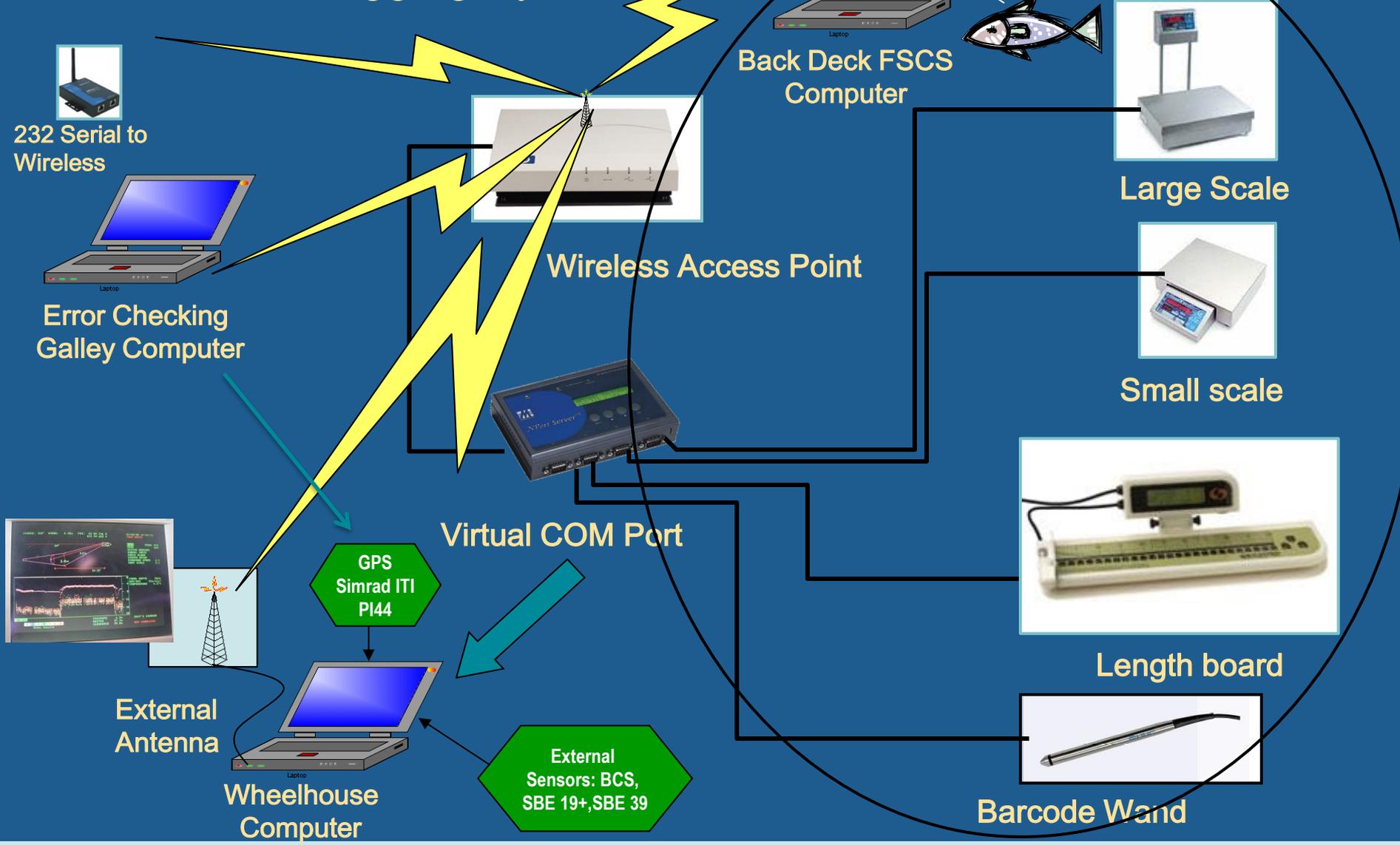


Trawl Survey: Data Collection Efforts

- quantify biomass and distribution of groundfish by species
- obtain biological data
- collect environmental and habitat data
- record net mensuration data for trawl performance – QA/QC



Data Collection Techniques: Software and Data Logging System



Data Collection: Biological sampling

Tow Level:

- sort by species
- all catch weighed by species
- subsample FMP species for biological sampling
- count non-FMP species

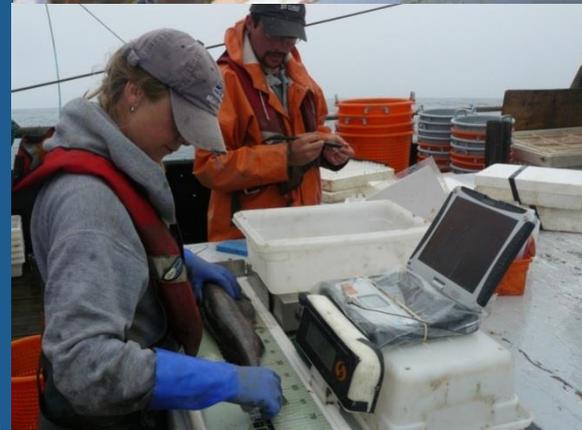
Species level (individual):

- gender
- individual lengths
- individual weights
- extract otoliths
- remove stomachs
- DNA samples (fin clips)
- ovary samples for maturity
- tissue samples – diet studies
- collect specimens for special projects



Sampling Protocols: length, weight, age per tow

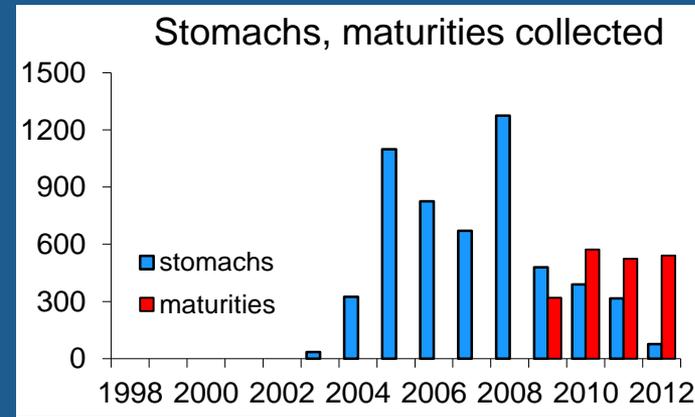
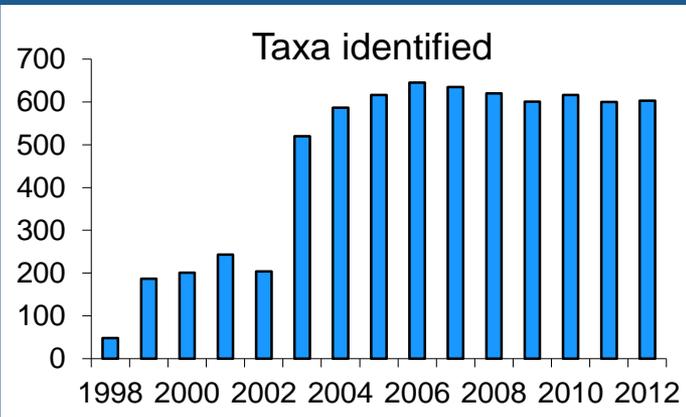
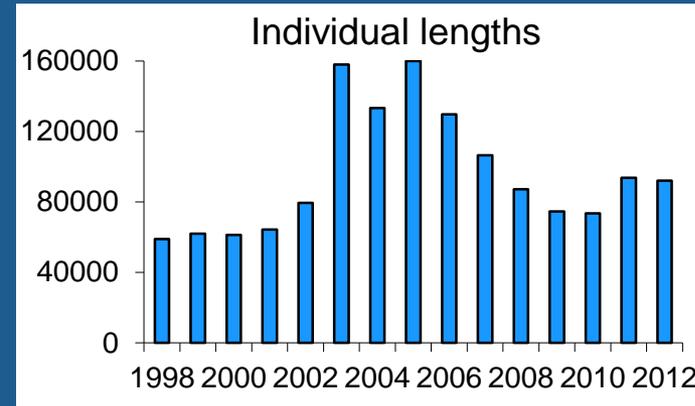
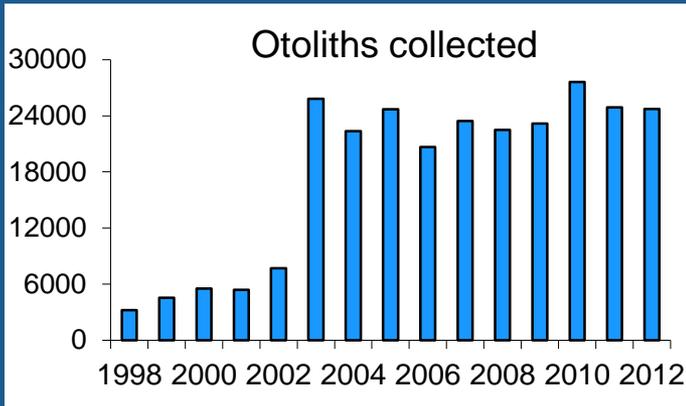
Species	Lengths per Tow	Age Structures per Tow
arrowtooth flounder	20	5
aurora rockfish	100	15
Baird's Tanner Crab	50	-
bank rockfish	100	25
big skate	100	-
black and yellow rockfish	100	15
black rockfish	100	15
blackgill rockfish	100	50
blackspotted rockfish	100	15
blue rockfish	100	15
bocaccio	100	50
bronzespotted rockfish	100	15
brown rockfish	100	15
butter sole	100	25
cabezon	100	15
calico rockfish	100	15
California scorpionfish	100	15
California skate	100	-
canary rockfish	100	50
chameleon rockfish	100	15
chilipepper	25	15
China rockfish	100	15



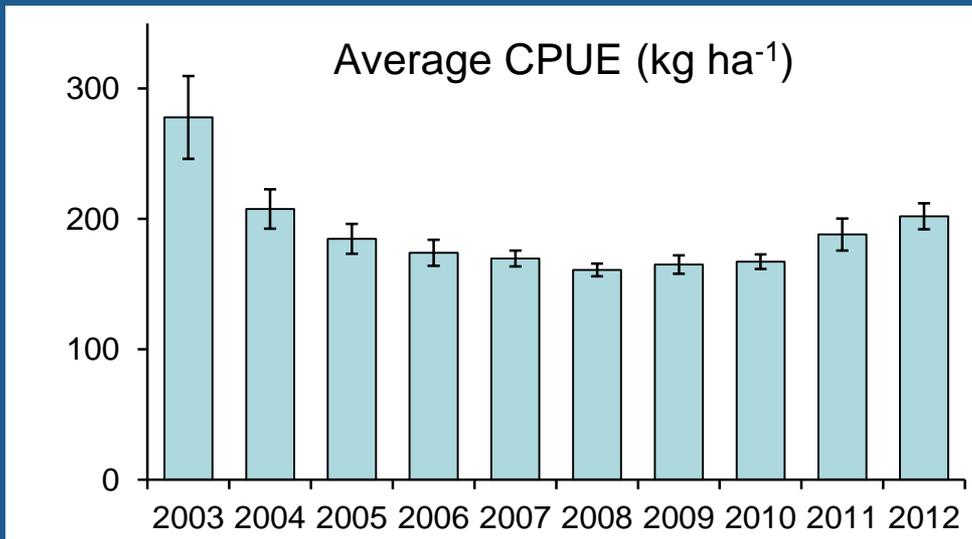
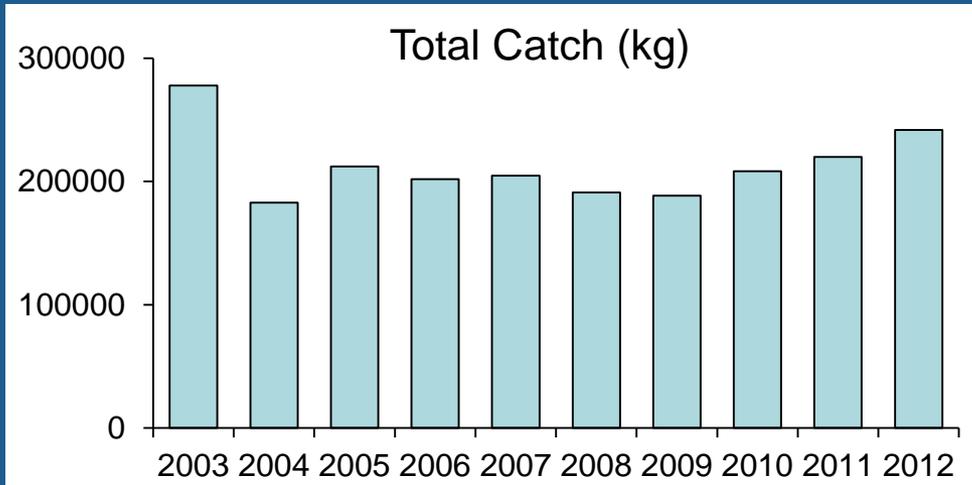
Similar protocols established for an additional 68+ species – not shown

Sampling Summary: 1998 - 2012

number

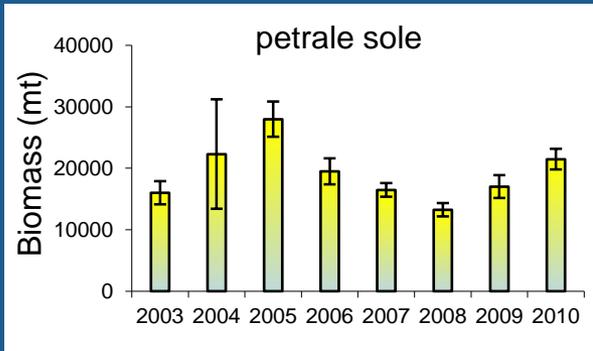


Trawl Survey Data: CPUE = Catch/area swept

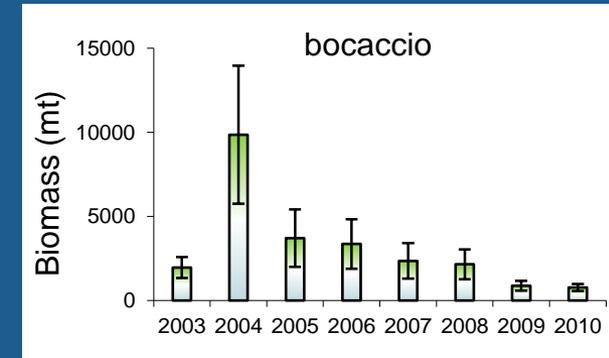


Survey data products: Biomass Indices - \hat{b}

Species-specific biomass estimates (metric tons) are calculated by multiplying the mean CPUE for given depth or geographic strata (or overall) by the appropriate area of the strata:

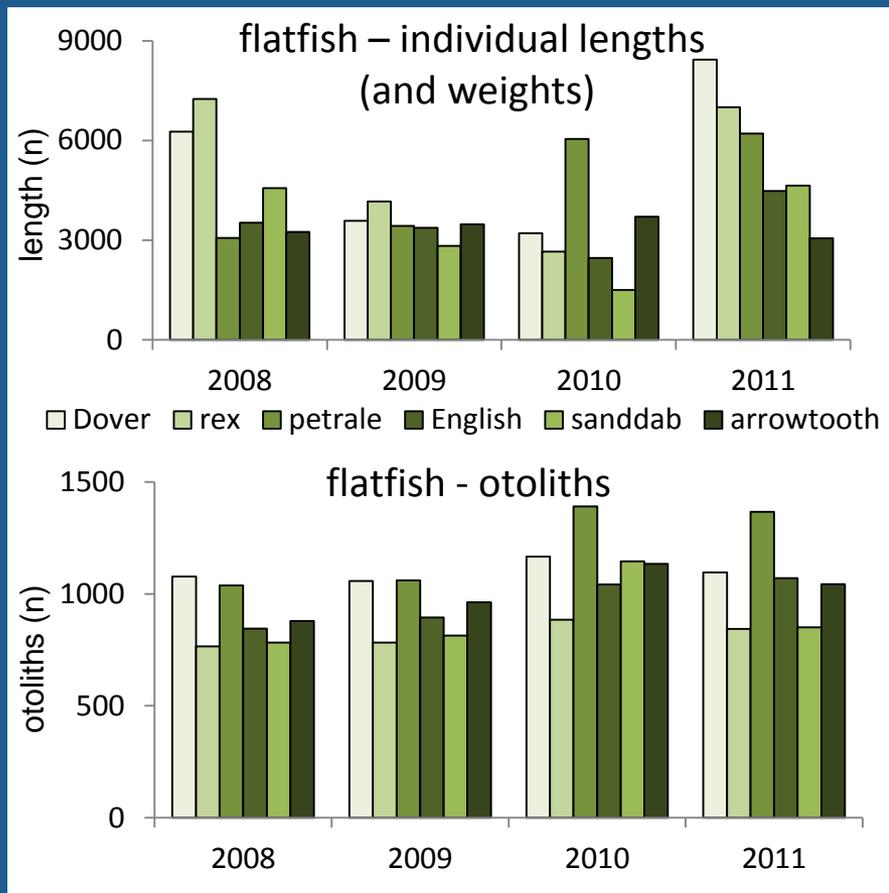


$$\hat{b} = \sum_{i=1}^n (\overline{CPUE}_i \times A_i)$$



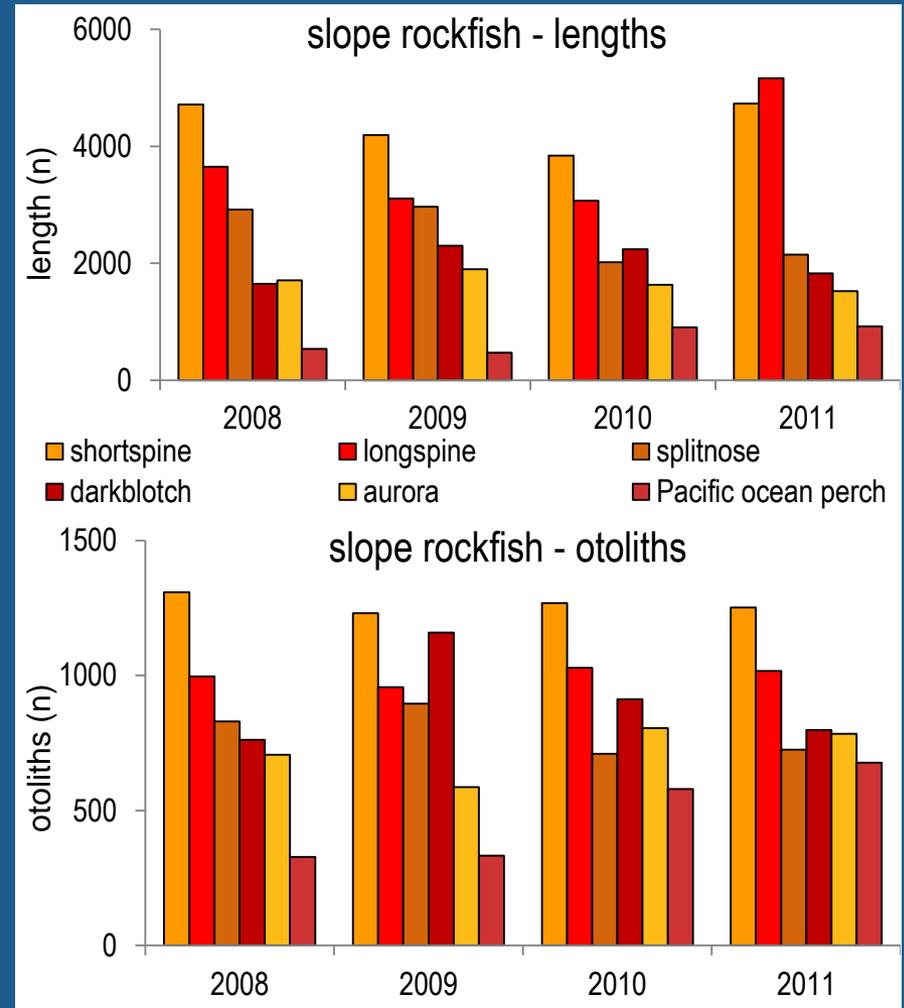
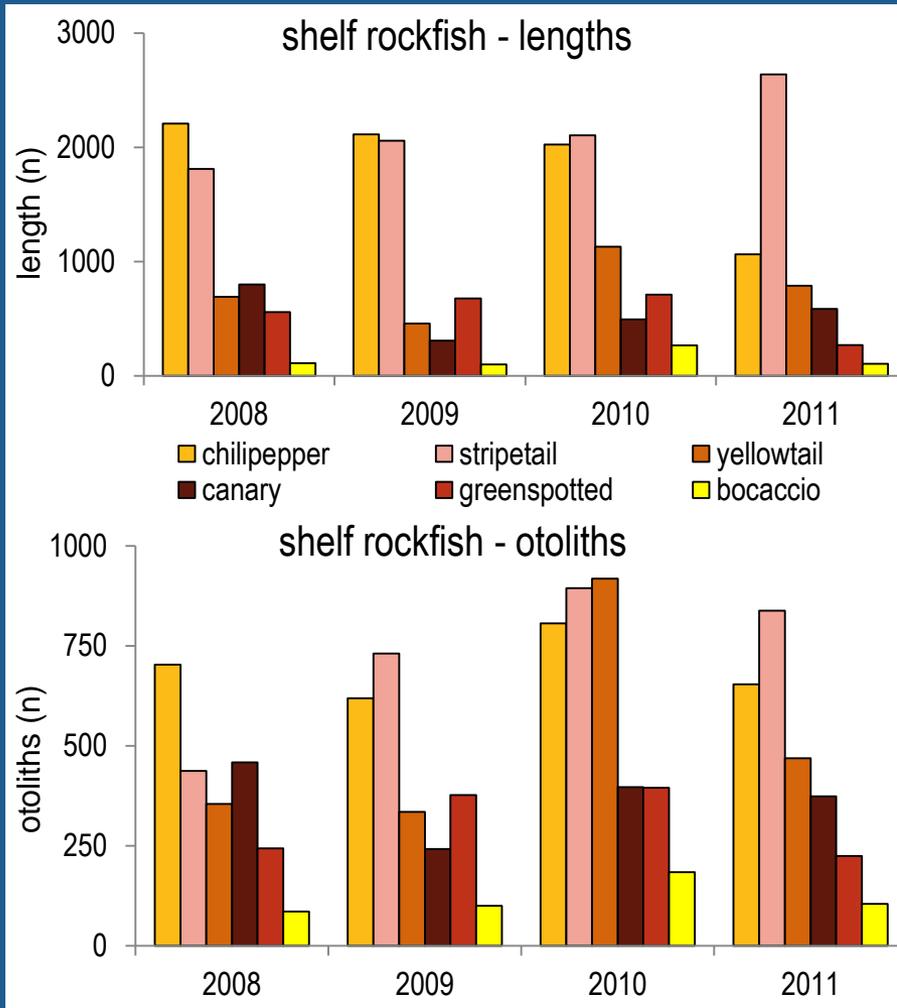
where mean CPUE is the average of all tows within the selected area, even those with zero catch.

Trawl Survey Data: Biological Samples - flatfish



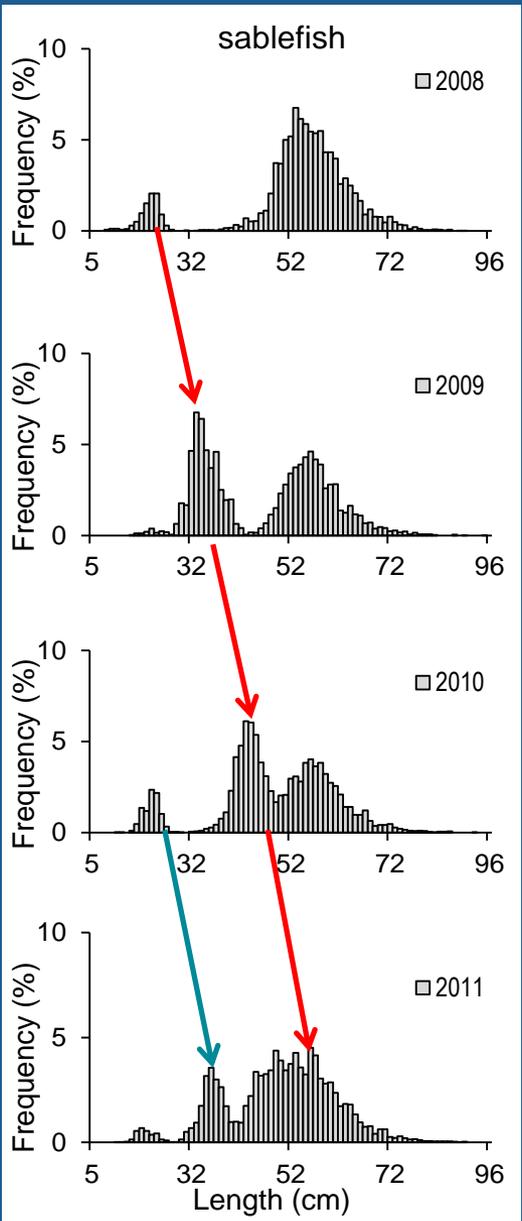
number of individual lengths, weights, and otoliths collected for some flatfish species 2008 - 2011

Trawl Survey Data: Biological Samples - rockfish



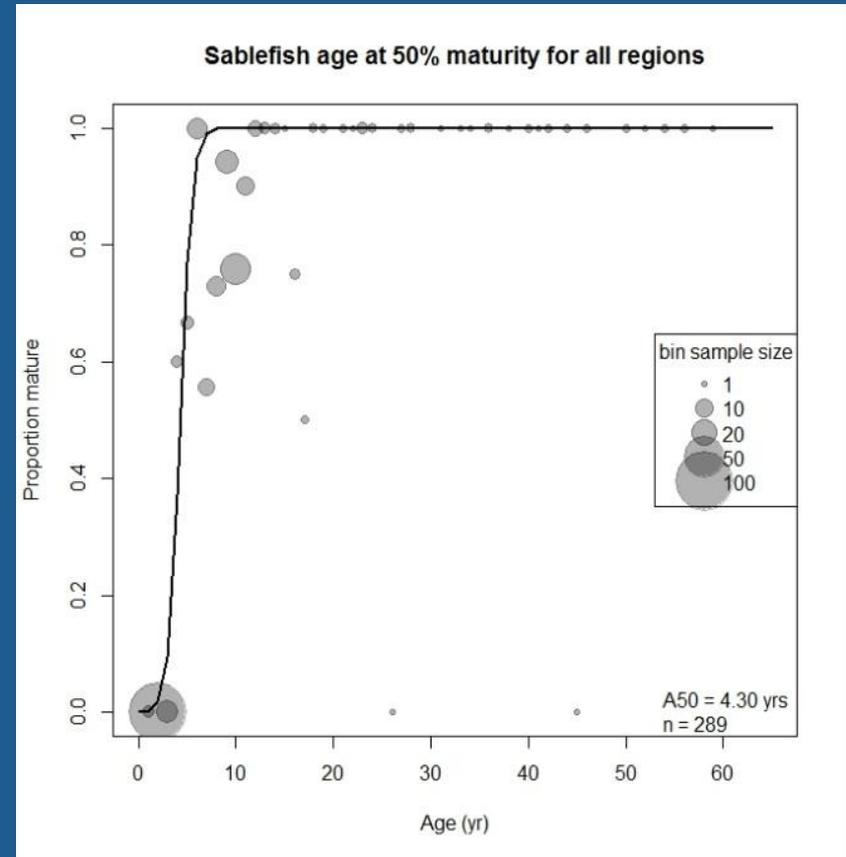
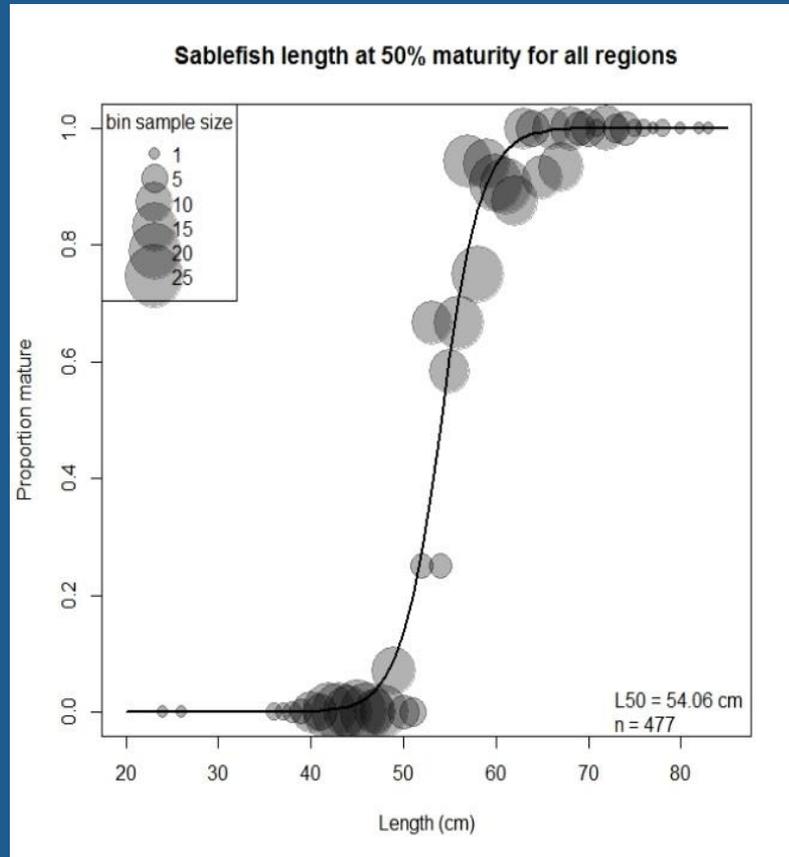
number of individual lengths, weights, and otoliths collected for some rockfish species 2008 - 2011

Example: Sablefish Length Frequency Distribution: 2008 to 2011

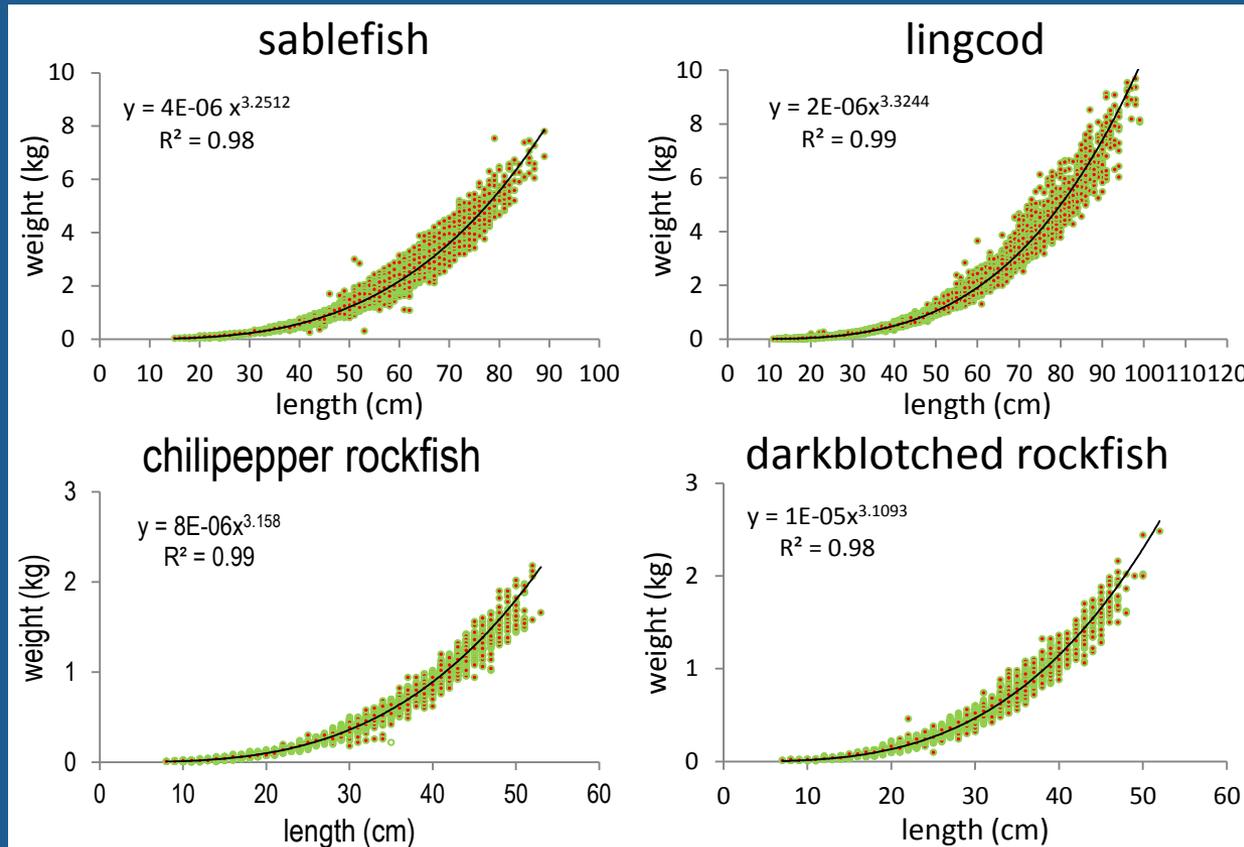


Data Products:
Length /Age
Composition
Distributions

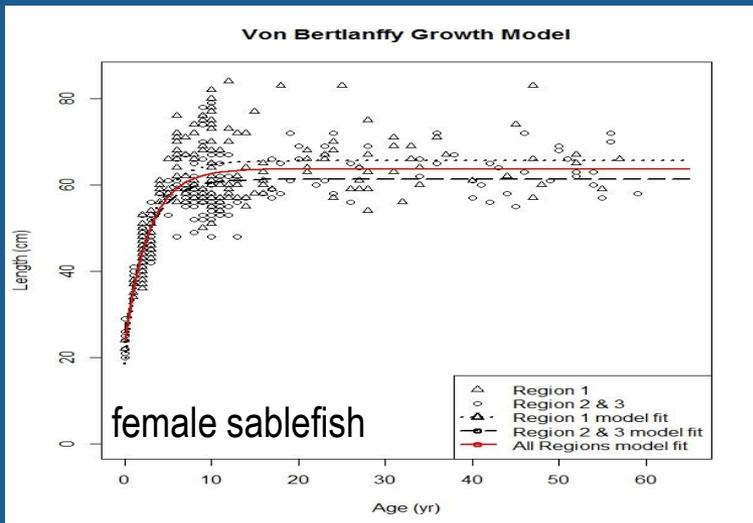
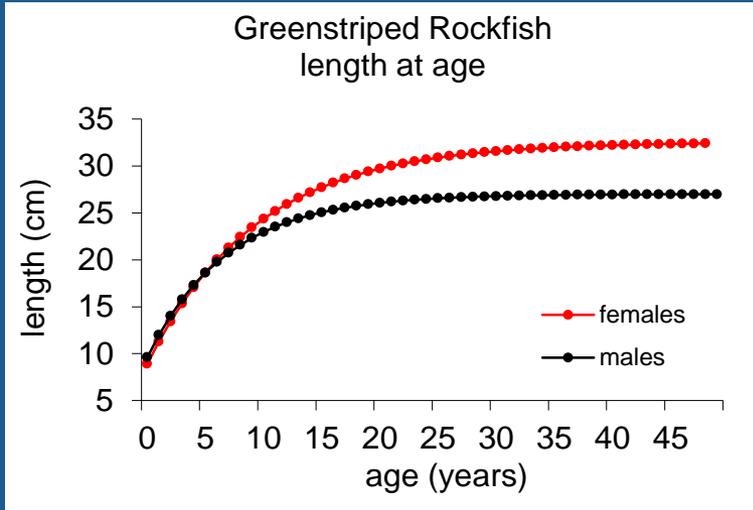
Trawl Survey Data: Estimated size and age at 50% maturity



Trawl Survey Data: Weight versus Length



Survey data products: length at age



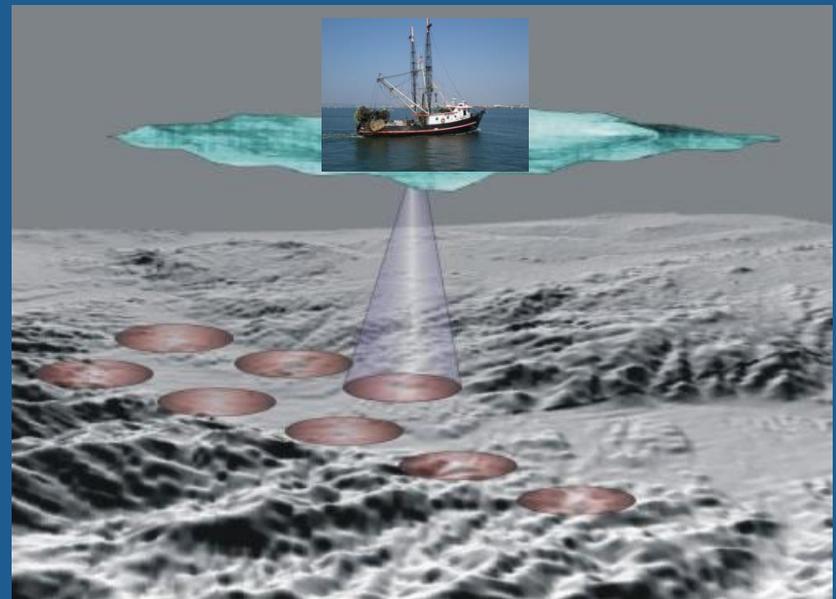
Data Collection: Sampling Efficiency

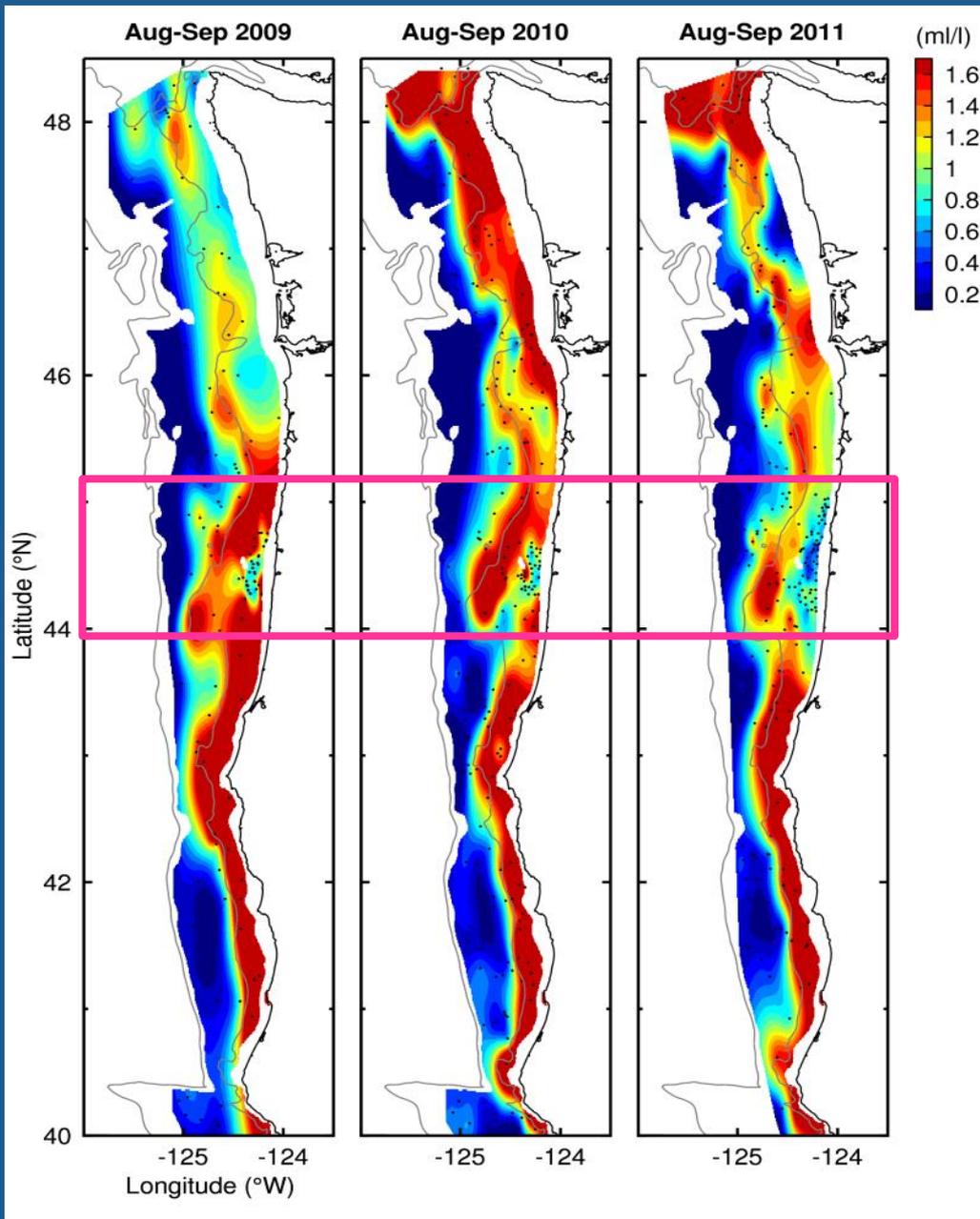
During tow via sensors on trawl:

- depth
- temperature
- salinity
- dissolved oxygen
- chlorophyll fluorescence
- pressure
- irradiance - at depth
- turbidity
- BCS: seabed slope, roughness

Continuous via sensors on vessel:

- wind speed
- irradiance - surface
- EK 60 – bottom type





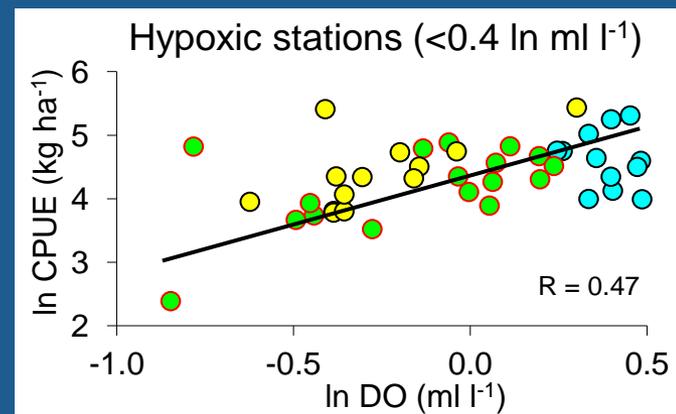
Near Bottom DO

2009

2010

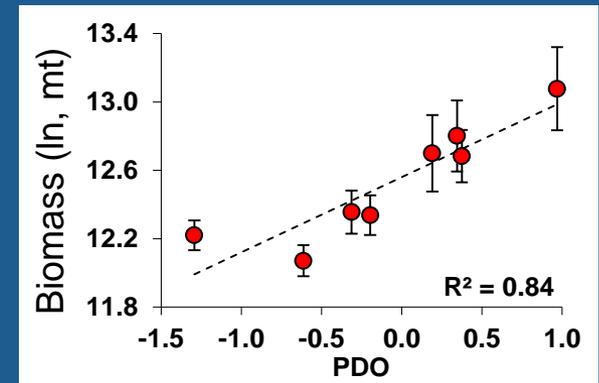
2011

North of Cape Mendocino



Research Projects: In support of assessments or supported by assessment data

- Herding and flatfish catch
- Classifying habitat
- Climate change and groundfishes
- Variance and number of charter vessels
- Relations between climate cycles and recruitment
- Rockfish Conservation Area: size distribution and biomass of fish
- Decreasing size at maturity over time
- Influence of sub-surface light levels on fish catch



National Protocols Summary – Trawl QA/QC

- Warp measurements
- Net geometry, trawl monitoring
- Net construction, repair, certification
- Scope ratio, speed
- Duration (or distance) of tow
- Direction of tow
- Location of sampling sites
- Search procedures
- Criteria for success of tow

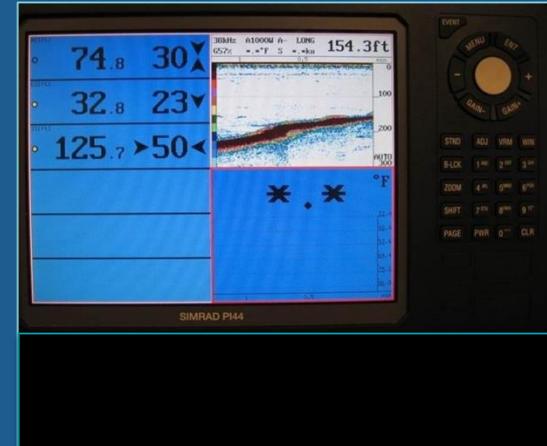


Survey QA/QC: Warps and Aberdeen trawl

- wires marked side-by-side prior to each pass, after significant hangs and measured and removed at end of charter
- marks provide real time verification of release of equal warp length from both winches while setting a tow
- nets and all components (netting, head rope, bolsh line, fishing line, breast line and ribline) built to exact standards using detailed net, rigging, gear diagrams and individually identified
- all nets examined, repaired and certified prior to each use by scientists working with net shed personnel



QA/QC Trawl Performance: real-time information on trawl geometry via acoustic data streams

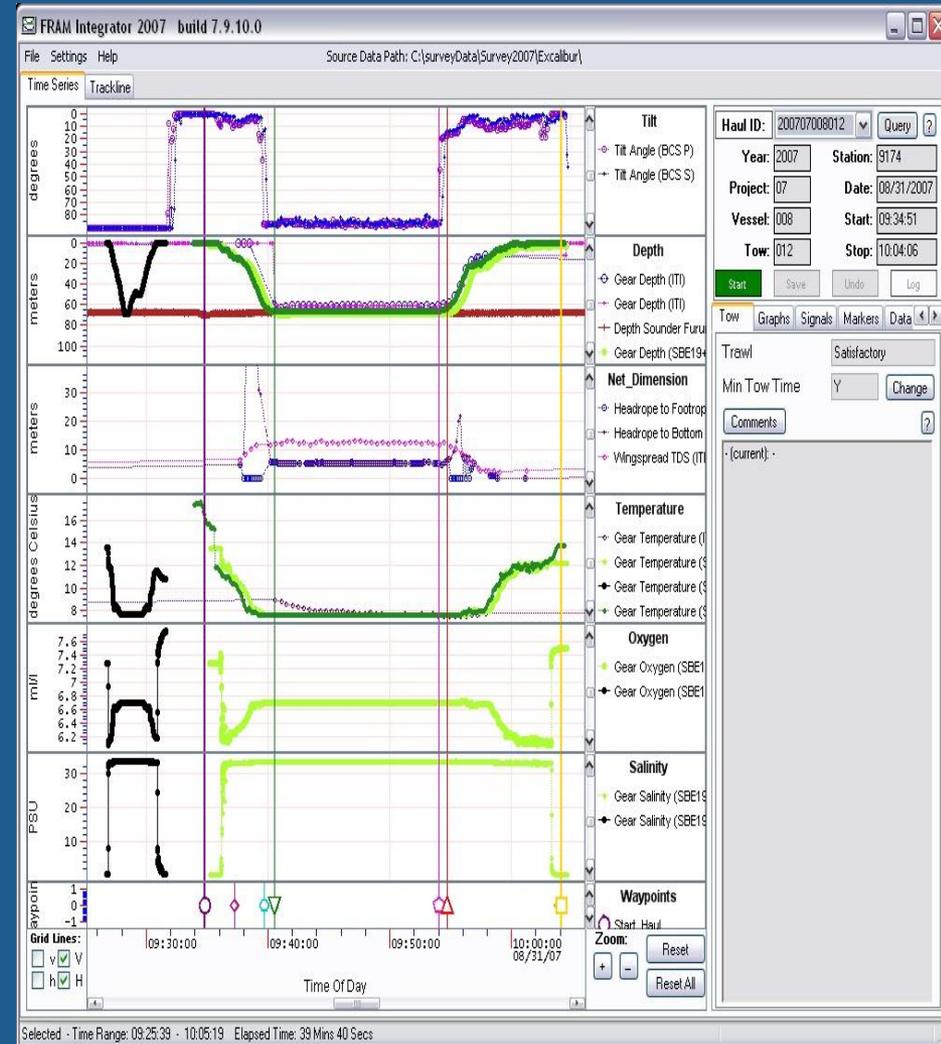


Simrad systems data:

- door spread
- wing spread
- net height
- trawl position
- footrope clearance
- depth of head rope
- distance to sea floor
- distance fished
- net configuration
- net depth

Trawl Survey QA/QC: Criteria for Successful Tow

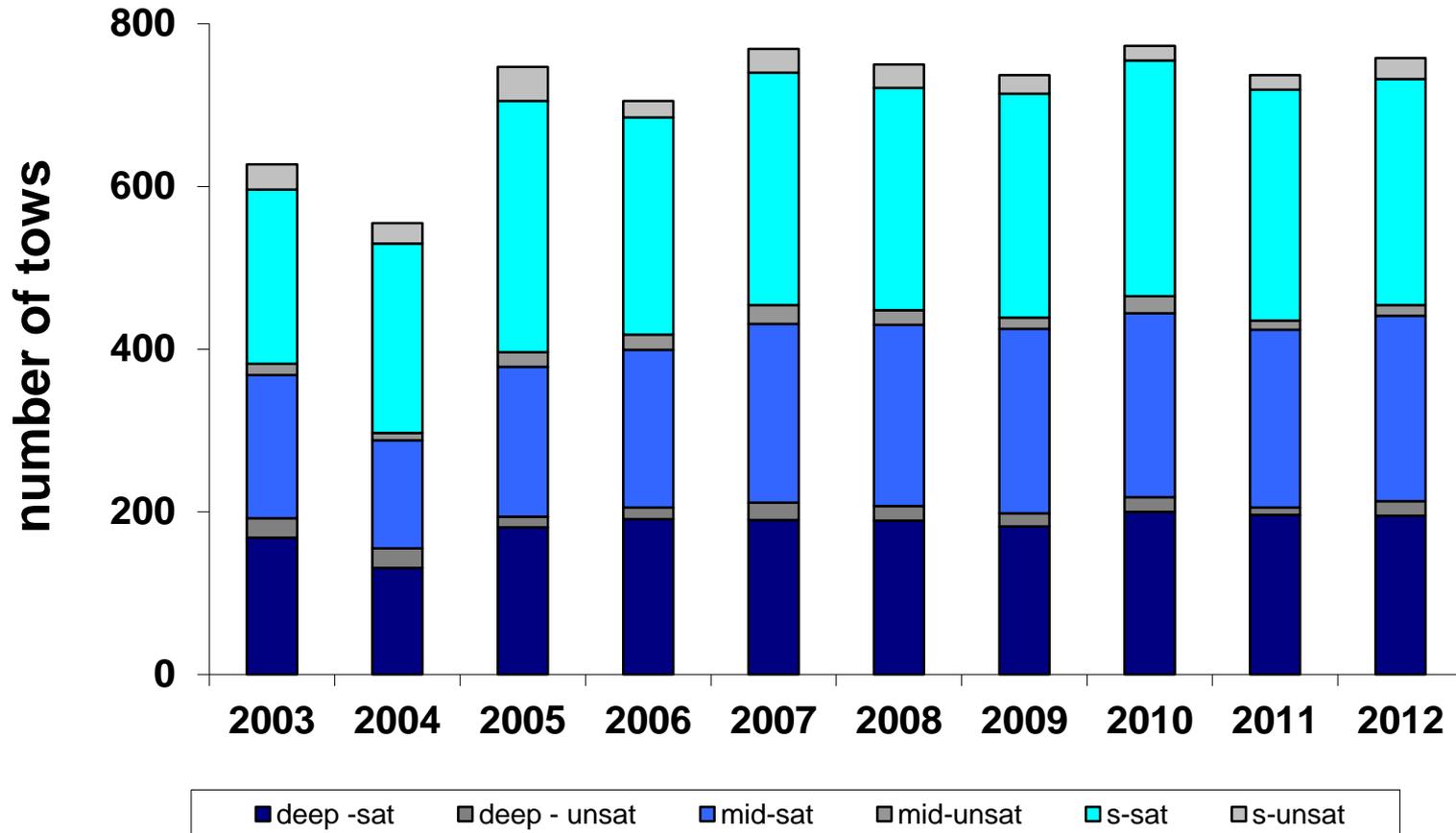
- tow speed 1.7 to 2.7 knots
- 12 min minimum duration
- net height 3.0 to 6.8 m during tow
- wingspread 11 to 17 m
- door spread 25 to 55 m



Successful versus Unsuccessful Tows

2003 to 2012

Satisfactory versus unsatisfactory tows - by depth
2003 - 2012



At Sea Data QA/QC: SurveyEdit

Tow Detail		Personnel		Trawl Notes		Weather Condition		Waypoints		Equipment		Observations		Performance	
Summary		Split Catch		Species		Baskets		Fish		OverRides		Validation Status			
	Sp Code	Species Name	Mix ID	Bskts	Sub Bskts	Tot Wt (KG)	Sub Wt (KG)	Ave Wt (
+	110	Black hagfish - SP PROJ	0	1	0	0.80	0								
+	210	Brown cat shark - SP PROJ	0	1	0	0.55	0								
+	460	Bathyraja trachura - SP PRO	0	1	0	0.75	0								
+	10190	Deepsea sole	0	1	0	3.75	0								
+	20038	Blackfin poacher - SP PROJ	0	1	0	0.01	0								
▶	20510	Sablefish - PRIORITY 1 - SP	0	1	0	14.25	0	1.7							
		View Baskets													
		View Individual Fish													
		View Special Samples													
+	20614	Bathylagidae unident.	0	1	0	0.06	0								
+	21010	Pacific viperfish	0	1	0	0.04	0								
+	21220	Pacific grenadier - PRIORIT	0	1	0	1.80	0	0.1							

Species page – species summary information: basket, individual fish, and special sample data all accessed from this page by clicking on the plus sign next to the species code

Individual page – displays individual fish; includes multiple validation steps for error checking and correction

Shoreside QA/QC: Examine At-sea Database

FSCS data

- Ensure all hand entered data uploaded to database

Field data

- Address issues indicated by field crew
- All validation tags reviewed – i.e. data validated at-sea using SurveyEdit

CTD Electronic data

- Processed using proprietary software
- Examined graphically
- Outliers eliminated

Simrad Sensor data

- Simrad data filtered for corrupt data
- Recovery logic in place for known error patterns



Shoreside QA/QC: Trawl Operations and Data

Trawl Operations data

- Tow quality reviewed
- Net touchdown lift-off reviewed
- Tow duration and location reviewed
- Software used to calculate depth, temp, net dimensions etc.

Individual Catch data

- Weight versus length data reviewed for outliers
- Subsample basket weight validated based on fitted W-L regressions

Specimen data

- Bar codes examined for duplicates
- Bar codes compared to physical specimens

Basket Weight data

- FMP species – sum of individual weights compared to subsample weight
- Non-FMP – any weight exceeding average by 3 STD examined
- Weight of mixes examined for difference > 10% between total and components



Data Management



Process

- Survey data stored in Oracle database
- Data available from data manager through data requests
- Data retrieved by manager using SQL queries
- Data output as excel workbooks
- Limited survey data available at FINSS (Fisheries Independent Survey System – Survey Inventory) website
<https://www.st.nmfs.noaa.gov/finss/si/siMain.jsp>
- Limited survey data available at PaCOOS (Pacific Coast Ocean Observing System) website
<http://pacoos.coas.oregonstate.edu/>

Standard Fishery Assessment Data Package

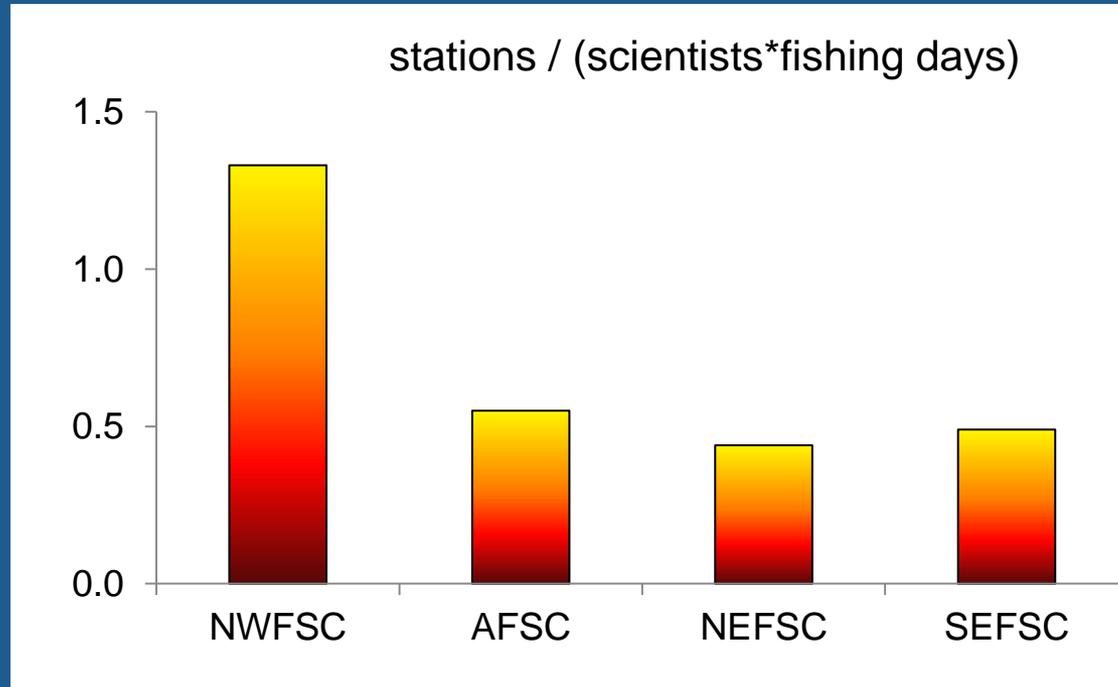
Contents:

- design-based estimates of biomass
- length composition
- age composition
- detailed haul and catch data
- detailed individual data
(length, weight, age by gender)
- maturity data

(provided to NWFSC, SWFSC, WDFW)



Comparison among groundfish surveys: number of stations sampled / scientist-days



NWFSC: West Coast Bottom
Trawl Survey - charter vessels

AFSC: Bering Sea and Aleutian Is.
Bottom Trawl Surveys - charter vessels

NEFSC: Spring and Fall Bottom
Trawl Surveys - FRV *Bigelow*

SEFSC: Spring and Fall Bottom Trawl
Survey Surveys - FRV *Oregon II*

Benefits of using chartered fishing vessels



F/V Last Straw

- Efficient operations minimize costs
- Opportunities for mutual education among scientists and fishermen
- Scientists learn from industry's insights and experience on the water
- Improved understanding of research and management processes by industry

Collaborating Agencies, Organizations, Universities

Universities

Oregon State University, University of Oregon, University of Washington, Portland State University, Washington State University, San Diego State University, Scripps Inst. of Oceanography, Tulane University, Harvard University, U.C. Santa Cruz, U.C. Santa Barbara, San Jose State University, Centenarian Species and Rockfish Project (14 diff. Universities and Weis Center for Research, Penn.), Instituto de Investigaciones Marinas CSIC (Vigo, Spain), Queens University (Belfast, N. Ireland), Dresden University of Technology (Germany)

Government Agencies and Research Institutes

Oregon Dept. of Fish and Wildlife, Alaska Fisheries Science Center, Southwest Fisheries Science Center, Moss Landing Marine Laboratories, Pacific Shark Research Center, Bamfield Marine Science Center (Canada), Hatfield Marine Science Center, Monterey Bay Aquarium Research Institute, Oregon Institute of Marine Biology, California Sea Grant, Washington Sea Grant

Museums

Natural History Museum of Los Angeles County
American Museum of Natural History (N.Y.)
Smithsonian Museum of Natural History (Wash., D.C.)

Divisions within NWFSC

FE, EC, CB, REUT



Challenge: Non-trawlable habitat

Scoring:

Trawlable:

- At least one 15 min tow completed with no hangs
- At least two tows completed with only minor hangs

Mixed:

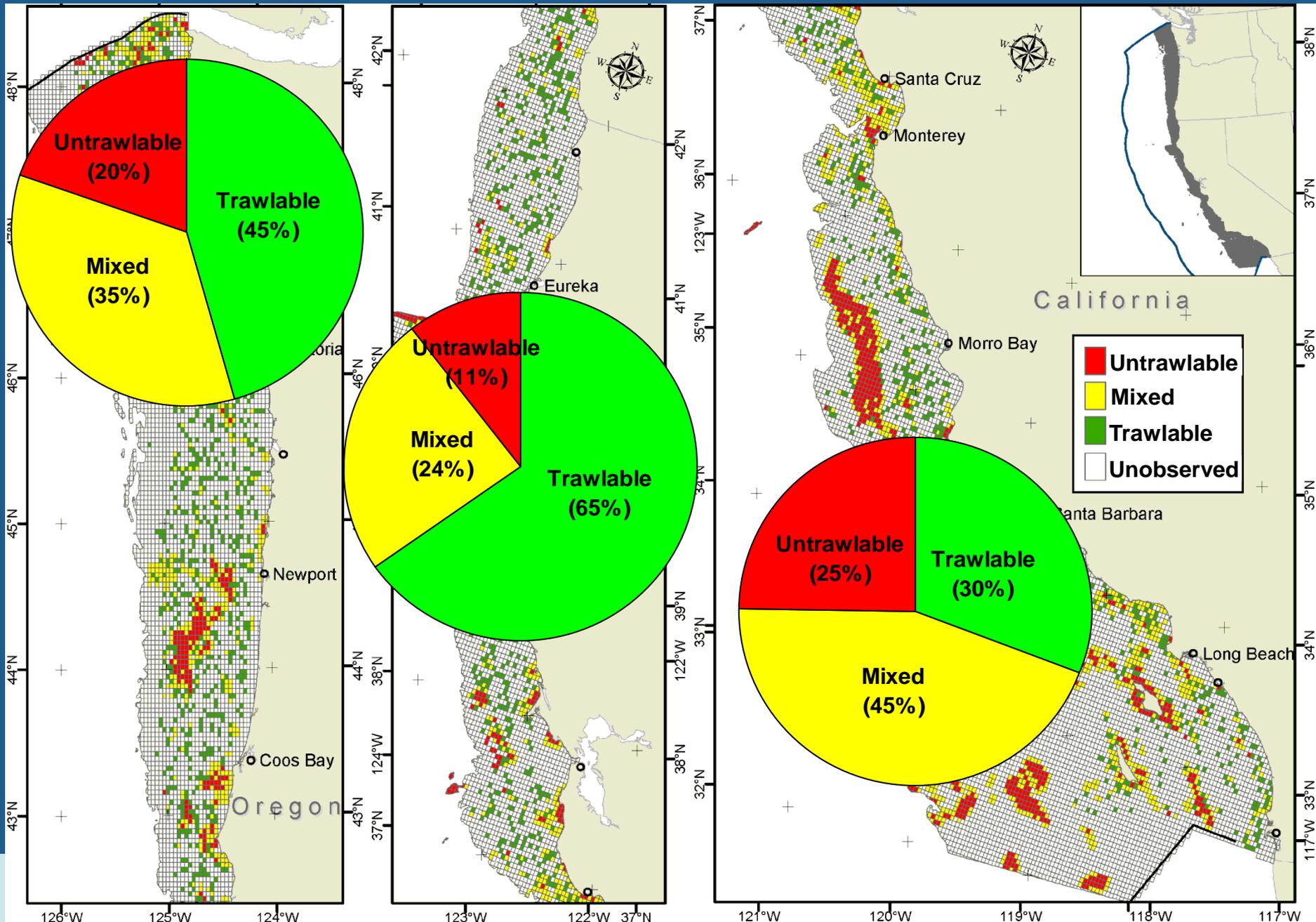
- One tow completed with minor hangs
- Mixed substrate mapped

Non-trawlable:

- Cell searched (60 min) with no sets made
- At least two tows 'hung' on bottom
- 100% hard substrate mapped



2003 – 2007: 4377 stations



Trawl Survey: Strengths

Spatial coverage

→ tow density similar to earlier surveys but coast-wide

Biological data

→ data used in 27 assessments; sufficient for 11 others

→ established time-series

Ecosystem data

→ important for future ecosystem based management

Consistency

→ follows national protocols

Sampling

→ collaboration with assessors used to focus sampling efforts

→ special sampling needs addressed (example maturities)

→ efficient sampling methods

Trawl Survey: Challenges

Spatial Coverage

- non-trawlable habitat
- loss of sampling sites

Data Management

- limited staffing
- timeliness of data availability
- aging database structure

Groundfish Survey

- securing annual funding for 4 charter vessels
- limited number of permanent FTEs
- small platform limits sample collection opportunities



Possible Solutions

- Define location and extent of non-trawlable habitat
- Add coast-wide, non-trawlable habitat survey
- Stop slow loss of sampling sites to protected areas
- Continue moving forward on data management overhaul
- Maintain annual funding for 4 charter vessels
- Retain trained chief scientists
- Continue to improve sampling efficiency



