The U.S. West Coast Groundfish Bottom Trawl Survey

Northwest Fisheries Science Center
Fisheries Resource Analysis and Monitoring Division
NOAA, 2725 Montlake Blvd. E, Seattle, WA, 98112, U.S.A.

Survey Team: Keith Bosley, Mark Bradburn, John Buchanan, John Harms, Dan Kamikawa, Aimee Keller, Victor Simon, Vanessa Tuttle

Northwest Fisheries Science Center
NOAA Fisheries Service

Fisheries Resource Analysis and Monitoring Division, NWFSC

Mission: provide the scientific basis for the management of U.S. West Coast groundfish stocks and their ecosystems

Tools: fishery-independent resource survey, fishery monitoring, biological investigations, and population models

Survey goal: provide data for assessment purposes on the distribution and abundance of commercially important West Coast groundfish, including changes in species composition, size and age with geographic area, depth and time

Background

The NWFSC assumed responsibility for the West Coast Groundfish Bottom Trawl Survey in 1998; earlier west coast surveys conducted by the Alaska Fisheries Science Center (AFSC)

History

1977 – 2001: AFSC's triennial shelf survey (55 - 500 m) using chartered commercial AK fishing trawlers (>110 ft)

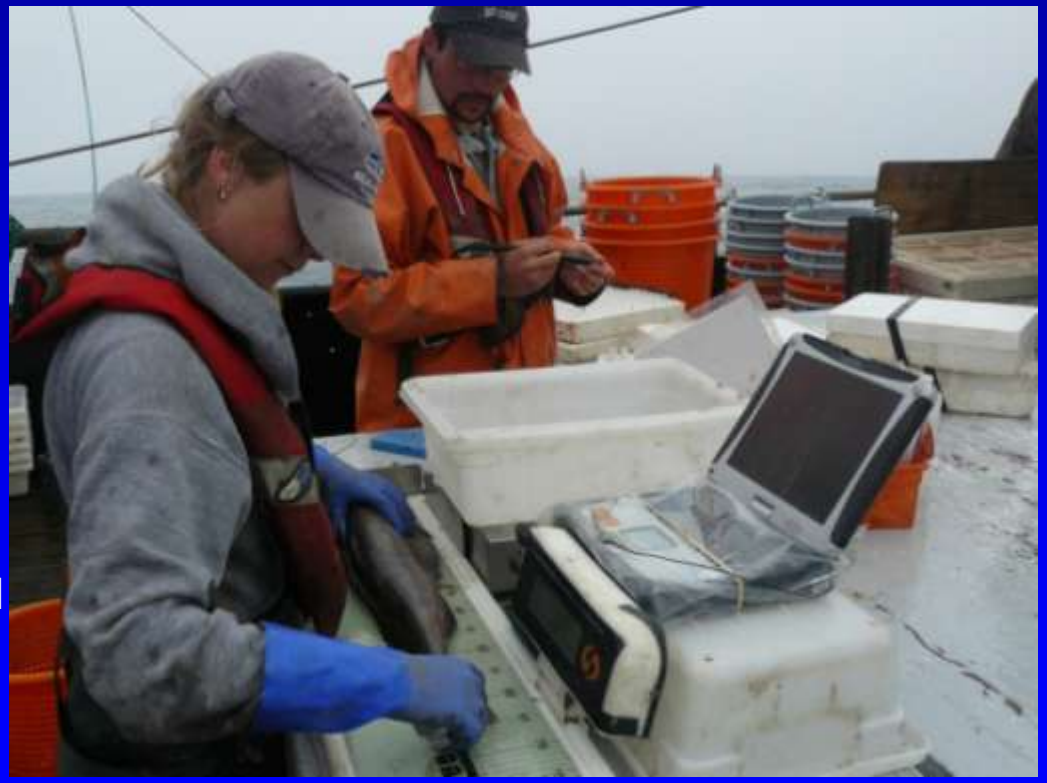
1984 – 2001: AFSC's West Coast semi-annual slope (183 -1,280 m) trawl survey using FRV Miller Freeman (>200 ft)

1998 – 2002: NWFSC annual slope (183 -1,280 m) trawl survey using smaller (< 93 ft) chartered West Coast (CA, OR, WA) commercial fishing vessels

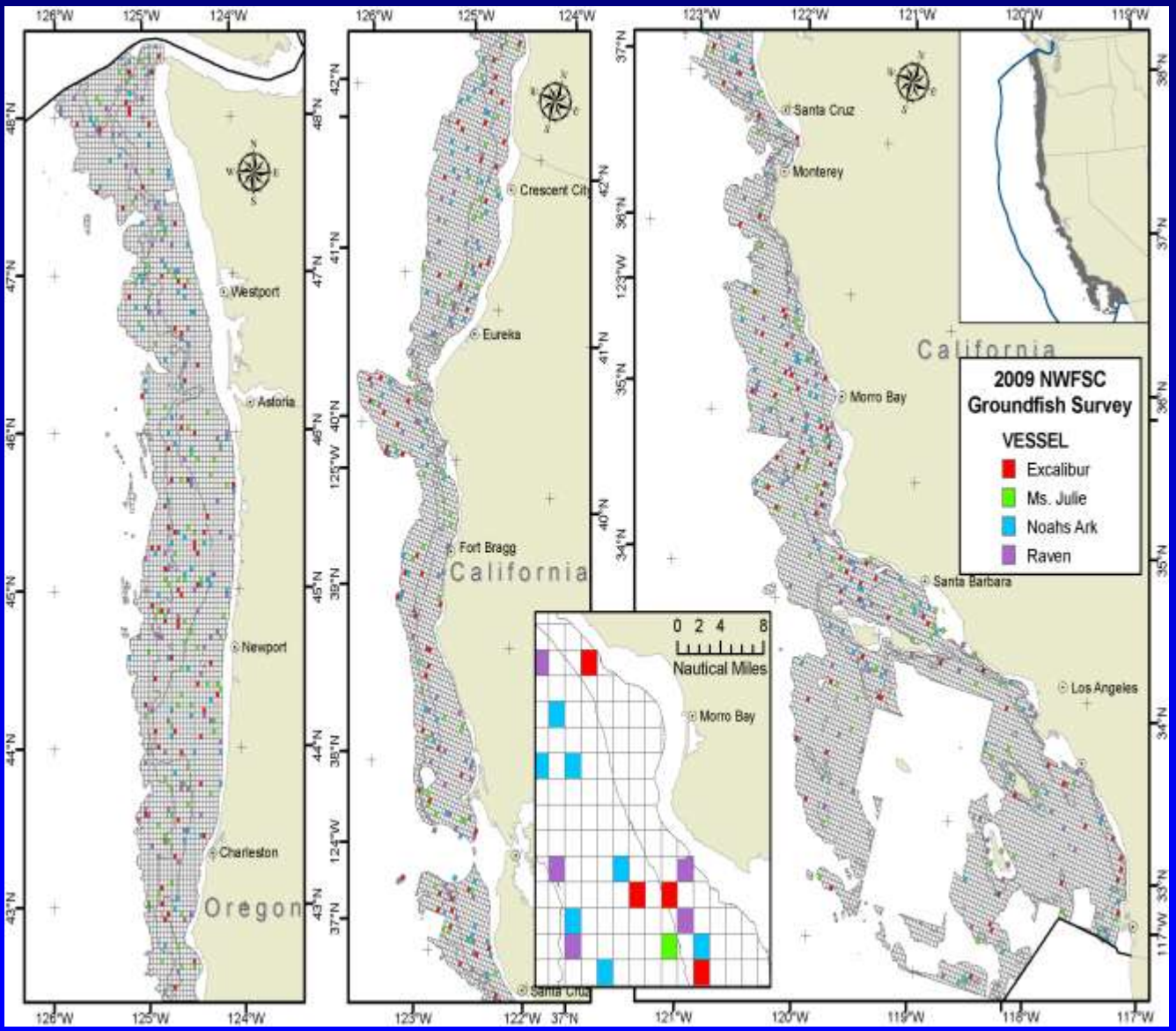
2003 – present: NWFSC survey expanded to cover shelf and slope waters (55 – 1,280 m) from US-Can to US-Mexico borders

West Coast Survey

- Annually chartered 4 west coast fishing vessels, 65-96' (19.8 – 29.3 m)
- 2 passes down the entire coast (mid-May – July; mid-Aug – Oct)
- Fish at depths 55 – 1,280 m
- Target tow speed 2.2 kt
- Target tow duration 15 minutes
- Fish during daylight hours
- Average 4 - 5 tows per day
- 160 days at sea; ~760 tows yr^{-1}
- 3 scientists, 3 crew

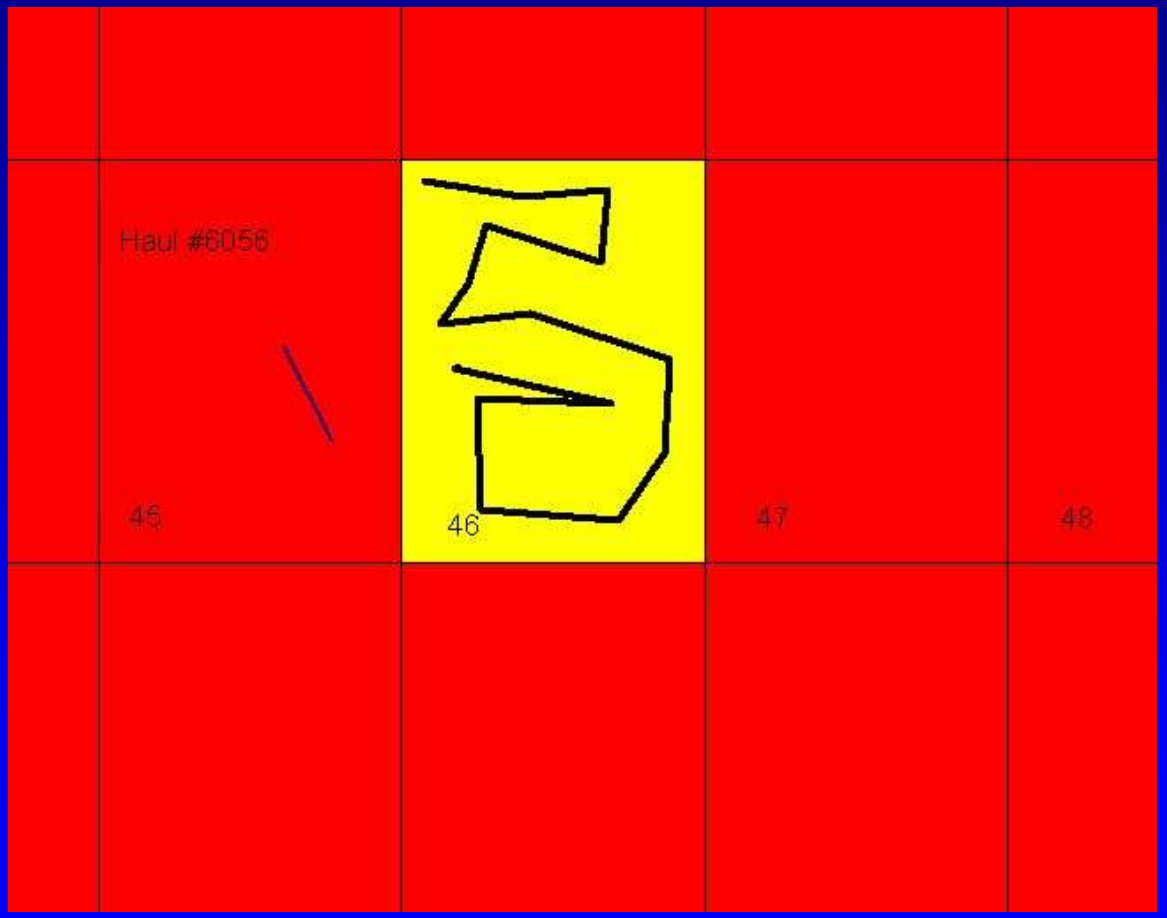


Stratified-Random Sampling Design



- US Canada border to US Mexico border
- Survey area sub-divided into ~11,500 equally sized cells (1.5 X 2.0 nm)
- Each of 4 vessels randomly assigned a set of 188 cells, secondary and tertiary cells also assigned (not shown)
- 2 geographic strata: 80% N of Pt. Conception (34° 30'N), 20% S
- 3 depth strata (55-183 m, 184-549 m; 550-1,280 m)
- Minimum 30 tows/stratum

Trawl Search and Selection Procedure



- Search within a randomly selected, previously specified cell
- Search within a specified depth range
- Limit search for trawlable ground 1-hr per cell
- If no trawlable site found within 1-hr, move to secondary cell and repeat 1-hr search
- Repeat at tertiary site if needed

Methods

- All catch sorted, identified to species and weighed
- Selected species individually sexed and measured
- Stomachs, ovaries, age structures, DNA, tissue samples collected
- Wireless back deck with electronic scales, fish meter boards, bar code scanner
- Trawl performance monitored via sensors (net width, height, speed, door spread, distance fished, position of trawl transect, bottom contact, temperature, depth, salinity, DO, etc.)
- Trawl and catch data input via customized software
- Average catch 300 kg/tow (range <1 to 18,000 kg/tow)
- Special projects undertaken

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

ROUNDFISH
Cabezon
Kelp greenling
Lingcod
Pacific cod
Pacific hake
Sablefish

SHARKS
Big skate
California skate
Leopard shark
Longnose skate
Soupfin shark
Spiny dogfish

RATFISH
Ratfish

ROCKFISH
Rosethorn rockfish
Rosy rockfish
Rougheye rockfish
Sharpchin rockfish
Shortbelly rockfish
Shortraker rockfish
Shortspine thornyhead
Silvergray rockfish
Sunset rockfish
Speckled rockfish
Splitnose rockfish

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

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

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

GRENADIERS
Pacific rattail

MORIDS
Finescale codling

Environmental Variables Measured

On Vessel

- wind speed: anemometer

On Trawl

- Dissolved oxygen
- Salinity
- Temperature
- In vivo fluorescence
- Optical backscatter

On Trawl and Vessel

- Irradiance

Standardized Protocols

Aberdeen Trawl

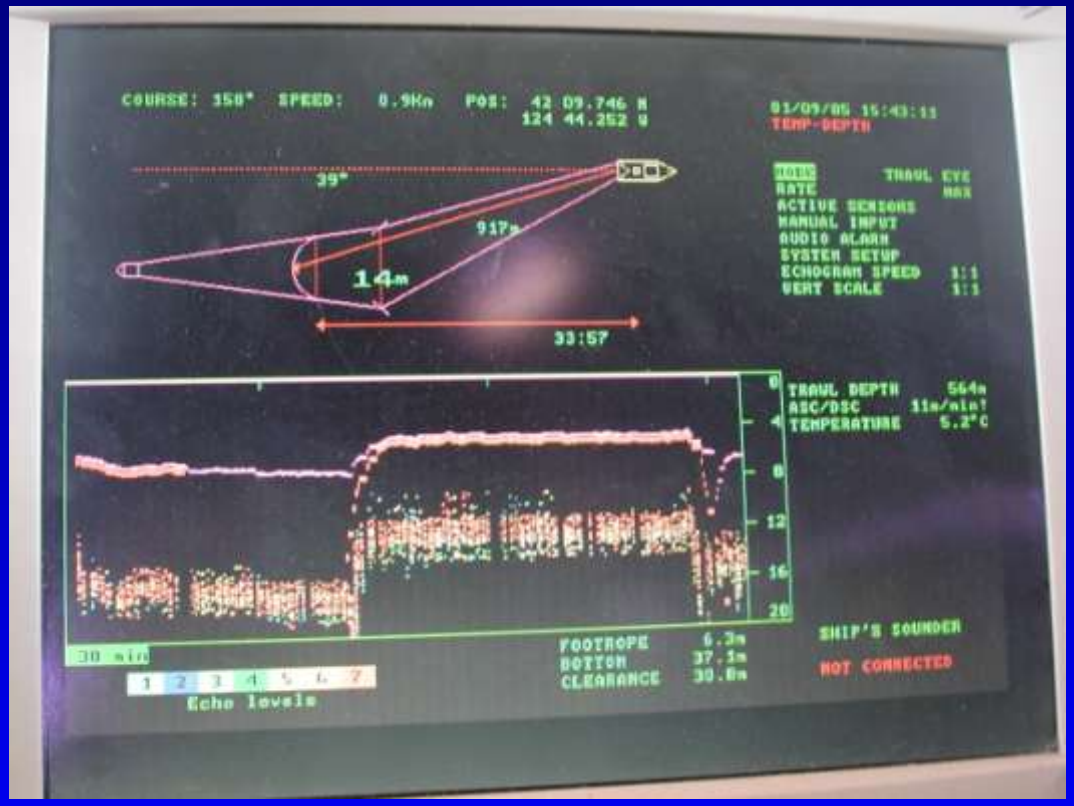
- Height 4.5 m; width 15 m
- Mesh 5.5 inches (1.5 inches in cod end)
- Headrope length 85 feet
- Footrope length: 104 feet
- Cookies 8-10 inch diameter
- Average area swept per tow 1.85 hectare

Trawl Performance Monitoring: Acoustic and Bottom Contact Sensors

- Dual/triple beam transducers mounted on vessel hull (through hull design)
- GPS and gyroscope measure vessel location and heading, respectively
- Simrad trawl eye and wing sensors mounted on net, doors
- Bottom contact sensors mounted on footrope (port and starboard) to monitor bottom contact, net touch down and lift off
- SeaBird 39 and 19+ mounted on net

Sensors supplied by NWFSC

Simrad ITI and PI44 Systems Used to Monitor Trawl Performance

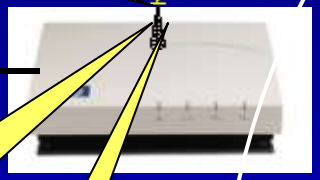


Simrad ITI and PI44 systems integrate data streams of net width, net height, trawl position, depth of head rope, distance to sea floor, temperature, door spread, distance fished, net configuration

Software and Data Logging System

232 Serial to Wireless

Error Checking Galley Computer



Wireless Access Point

Back Deck FSCS Computer

Large Scale

Small scale

Virtual COM Port

Length board

Barcode Wand

External Antenna

GPS Simrad ITI

Wheelhouse Computer

External Sensors: BCS, SBE 19+,SBE 39

Customized Software

TowLogger – log operation and environmental data during tow

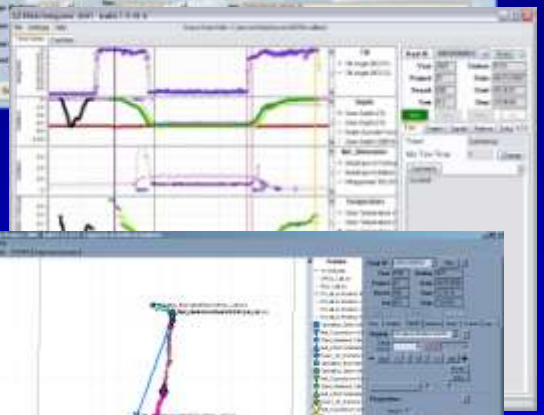
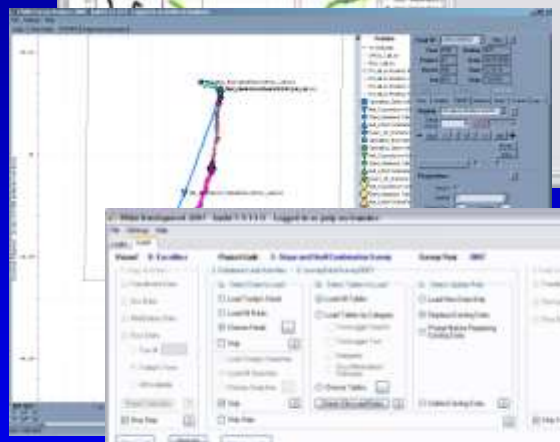
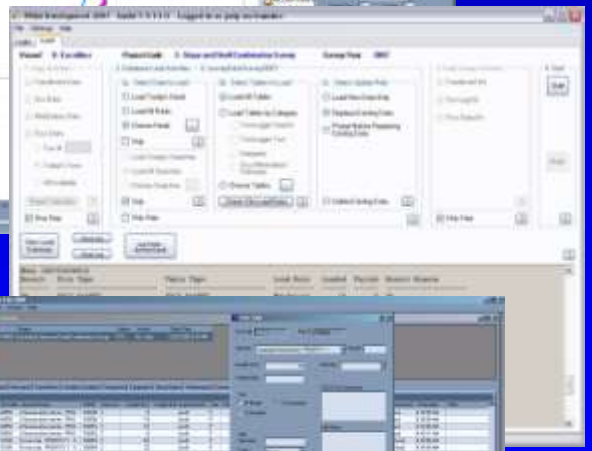
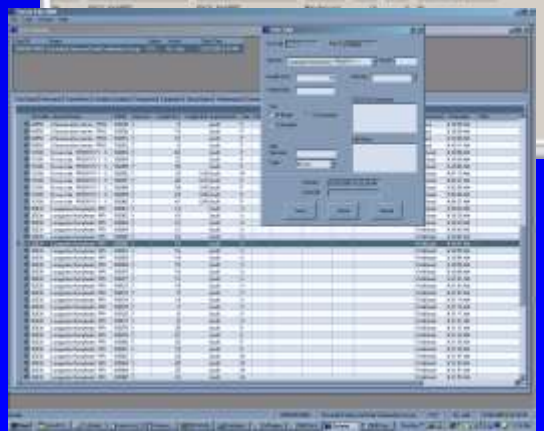
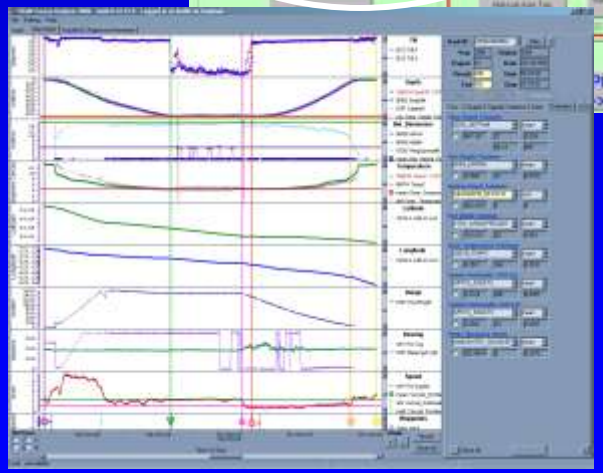
FSCS – input sampling data

Integrator – visualize sensor data and assess tow quality

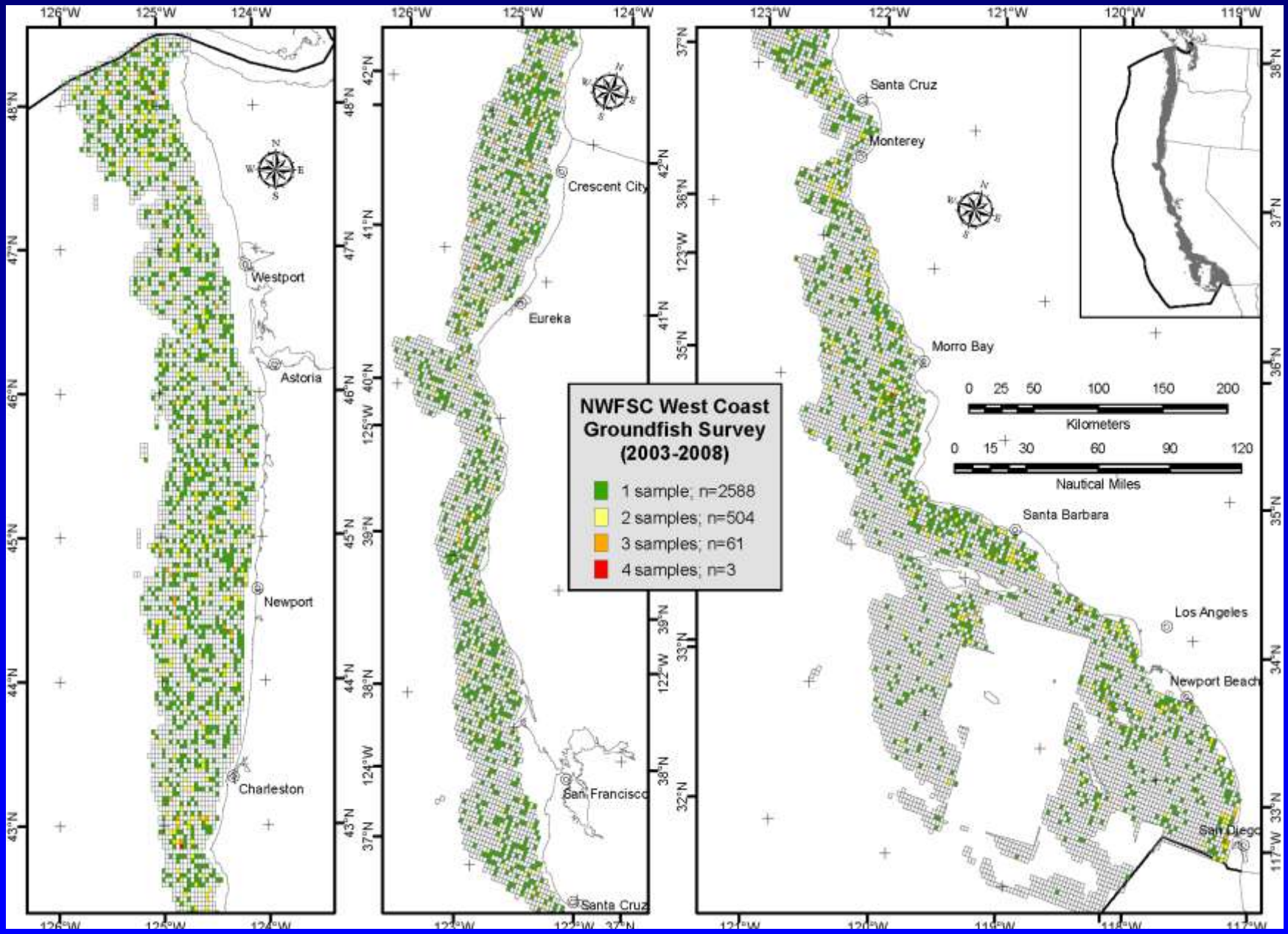
DataSquirrel – compile and upload operational and fish data into database

SurveyEdit – review and edit data at sea

DataAnalyzer – post survey data processing

Spatial Coverage 2003 - 2008










CELEBRATING
200
YEARS





2007 – 2010 Bottom Oxygen Studies during the NWFSC Groundfish Survey

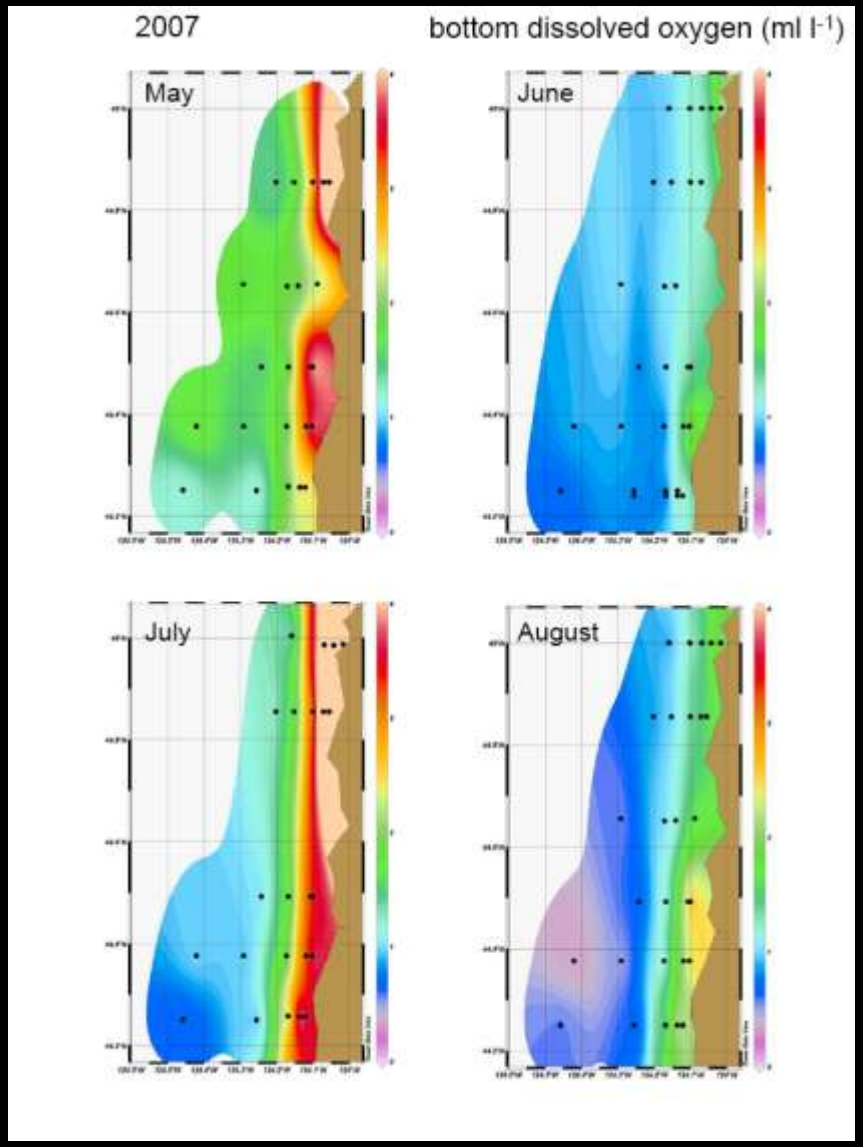
1. Hypoxia Studies offshore Oregon (annually since 2007) with some coverage back to 2003

2. Southern California basin study (2008)

3. Coast wide near-bottom oxygen measurements from US Canada to US Mexico (two vessels May – Oct. 2009; four vessels May – Oct. 2010) as part of groundfish survey

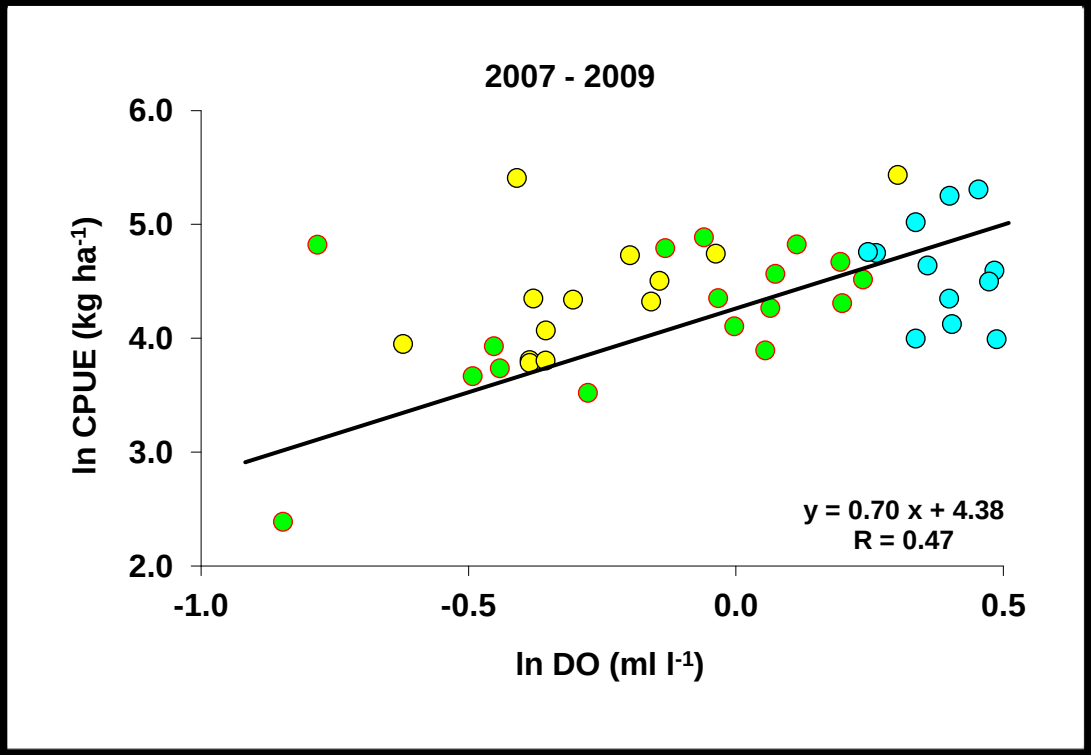
Hypoxia Study 2007 – 2010 - Oregon

- FV Excalibur
- 4 scientists; 3 crew
- 2-3 days (late Aug – early Sept)
- sample along 2 depth contours (50 to 80 m) in vicinity of low oxygen region off Newport
- catch sorted to species, weighed
- selected species sexed, measured
- stomachs, tissue and otoliths collected for selected species
- condition, length, weight measured for Dungeness crab
- dissolved oxygen, depth, temperature, salinity, measured during each tow via net mounted gear (seabird 19+)



Hypoxia Studies (2007 – 2009)

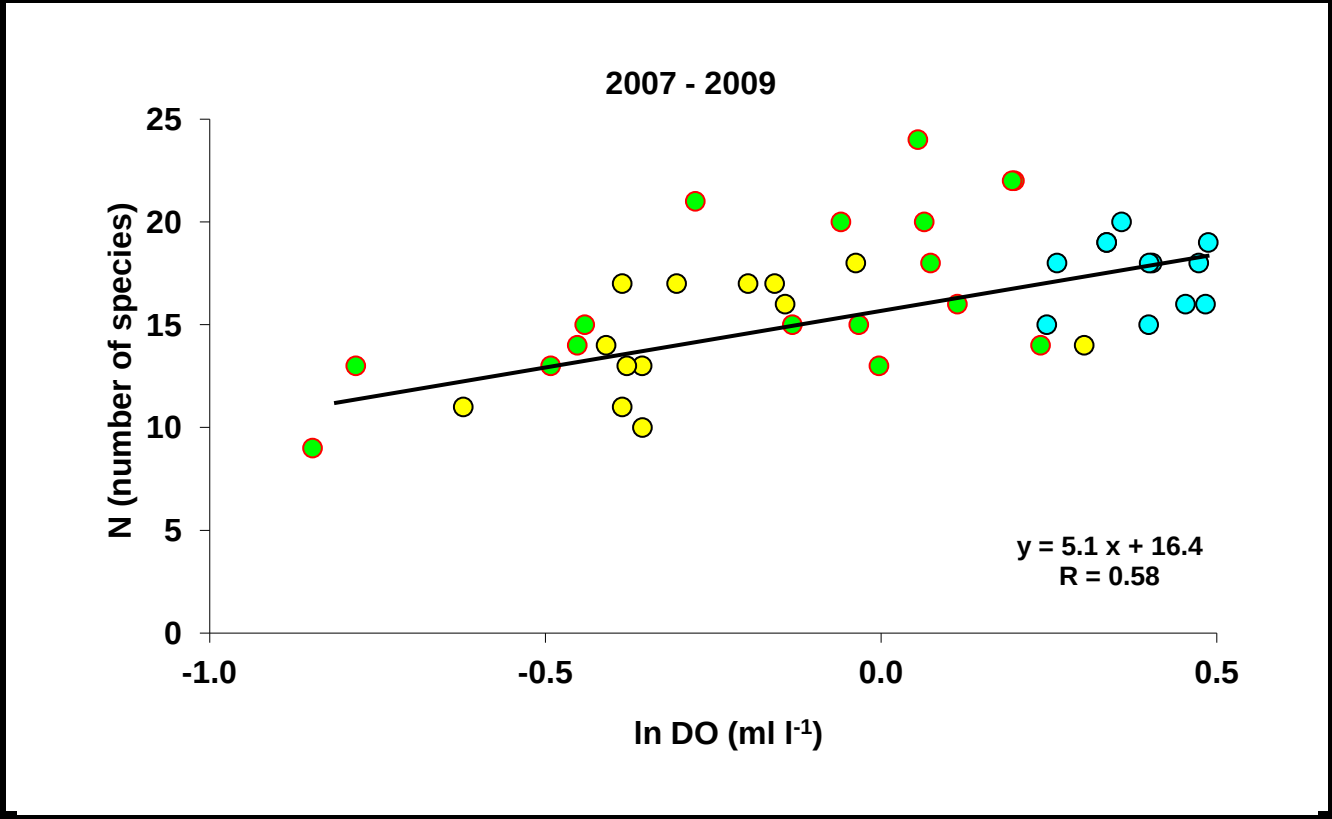
Total CPUE versus average bottom DO



CPUE (kg ha^{-1}) = Catch (kg) /Area Swept (ha)

Hypoxia Studies (2007 – 2009)

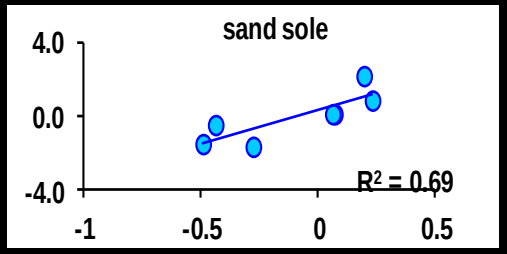
Number of species per tow versus Average bottom DO along the tow tract

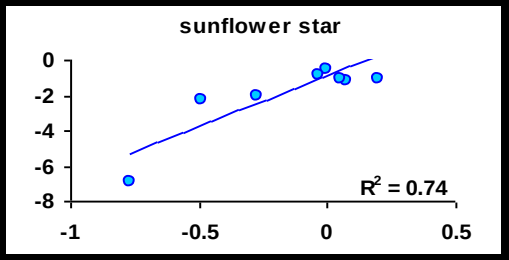


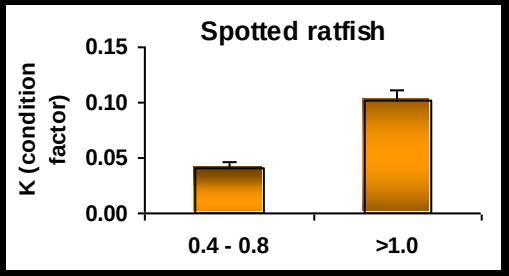
Includes: demersal fish and benthic invertebrates

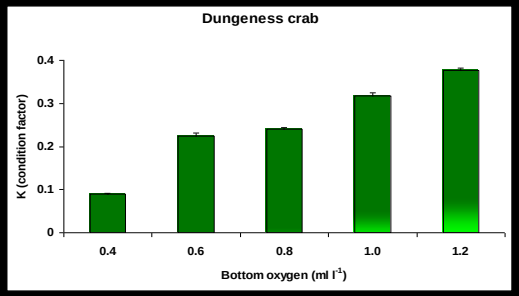
Summary of other results in hypoxic bottom water off Oregon

- CPUE (ln, kg ha^{-1}) for 11 of 17 groundfish species significantly related to near bottom DO (ln, mg l^{-1}) concentration
- CPUE ((ln, kg ha^{-1}) for 5 of 8 benthic invertebrate species significantly related to near bottom DO (ln, mg l^{-1}) concentration
- condition factors for 5 of 6 groundfish species increased significantly at higher oxygen levels (mg l^{-1}) within the hypoxic region (except Dover sole)
- condition factors for Dungeness crab increased significantly with increased oxygen levels (mg l^{-1}) within the hypoxic zone









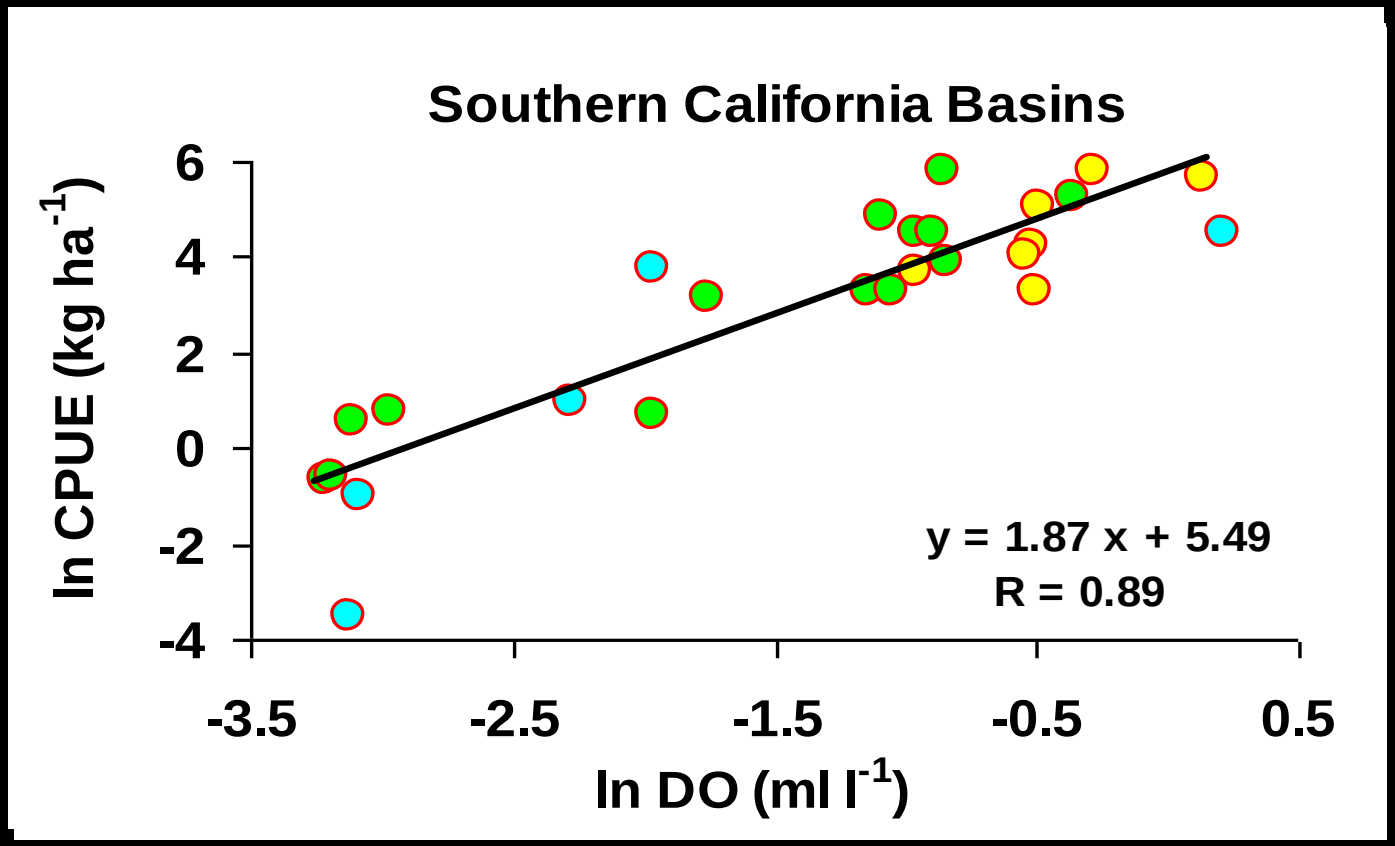
2008 Southern California Basin Study

- 39 stations sampled
  - 19 in Santa Barbara Basin
  - 9 in Santa Monica Basin
  - 11 in adjacent areas
- Depth range: 59 – 1,100 m
- Near Bottom DO range: 0.04 – 4.22 ml l^{-1} or 1.8 – 188.2 µmol kg^{-1}
- Hypoxic: 26 of 39 stations
  - 14 of 19 in Santa Barbara Basin
  - 6 of 9 in Santa Monica Basin
  - 7 of 11 in adjacent areas

California Basin Study - 2008

Total CPUE versus average bottom DO

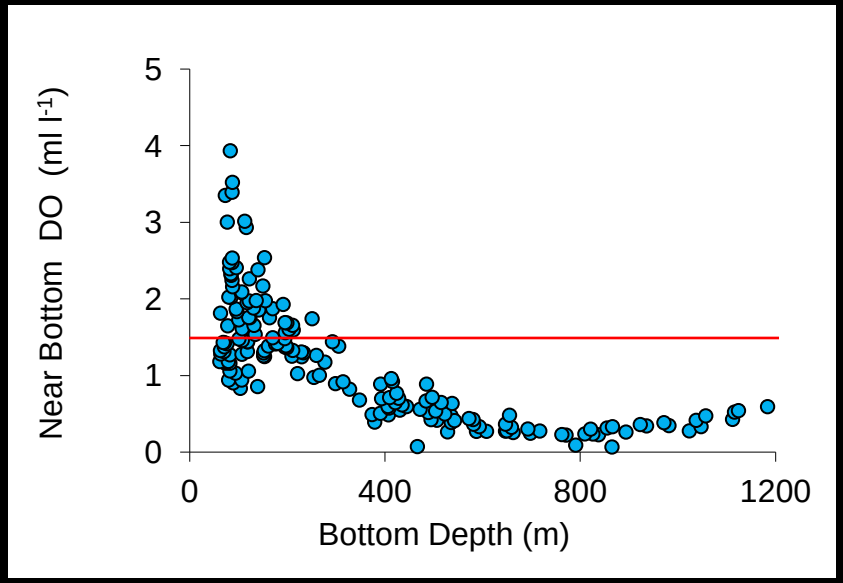
Hypoxic Stations



CPUE (kg ha^{-1}) = Catch (kg) /Area Swept (ha)

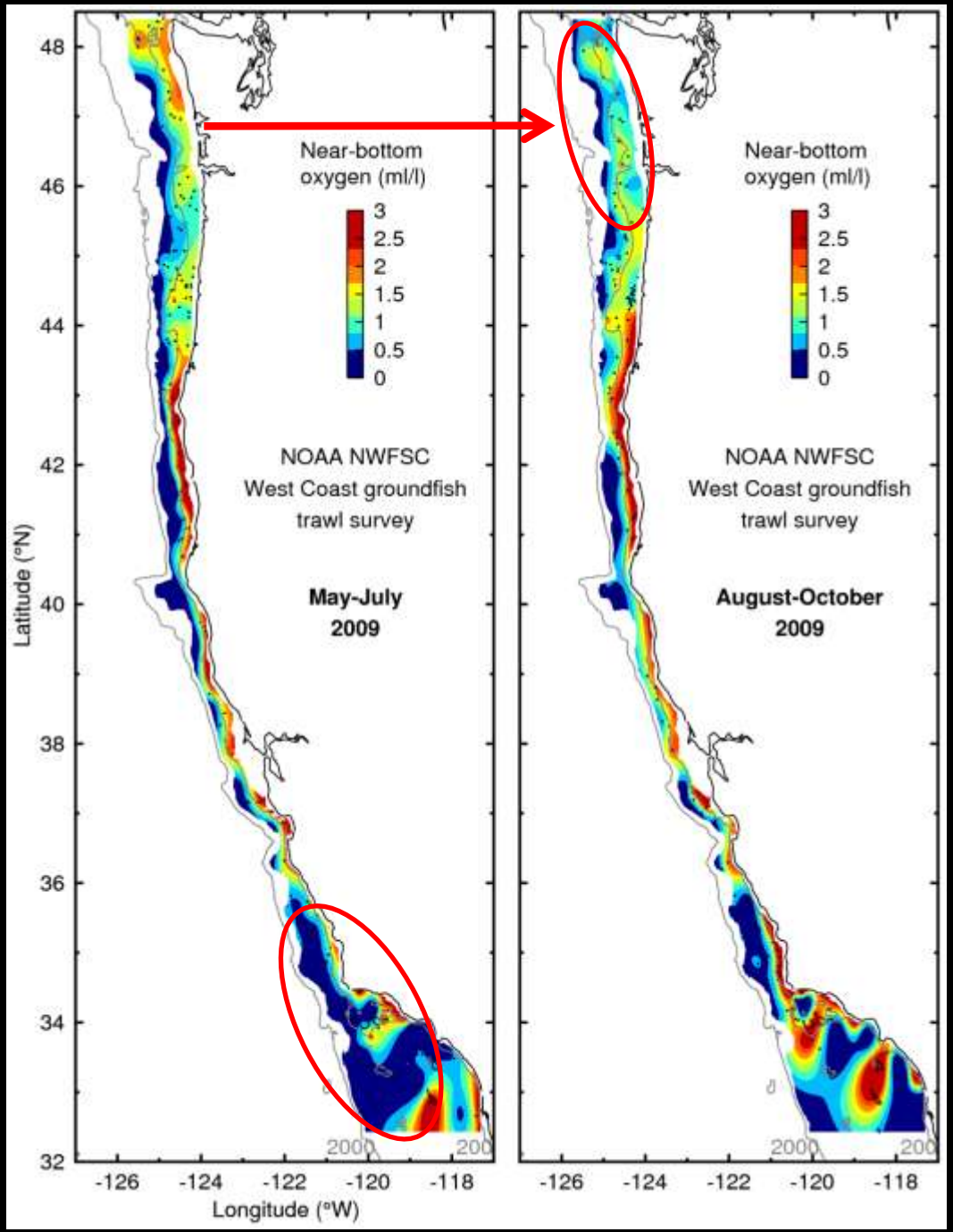
Coast Wide Study – 2009

- 360 stations sampled
- Depth range: 59 – 1,204 m
- Near Bottom DO: 0.08 – 4.25 ml l^{-1}
- Hypoxic stations (DO < 1.43 ml l^{-1})
  - Pass 1: 117 of 176 stations
  - Pass 2: 123 of 184 stations



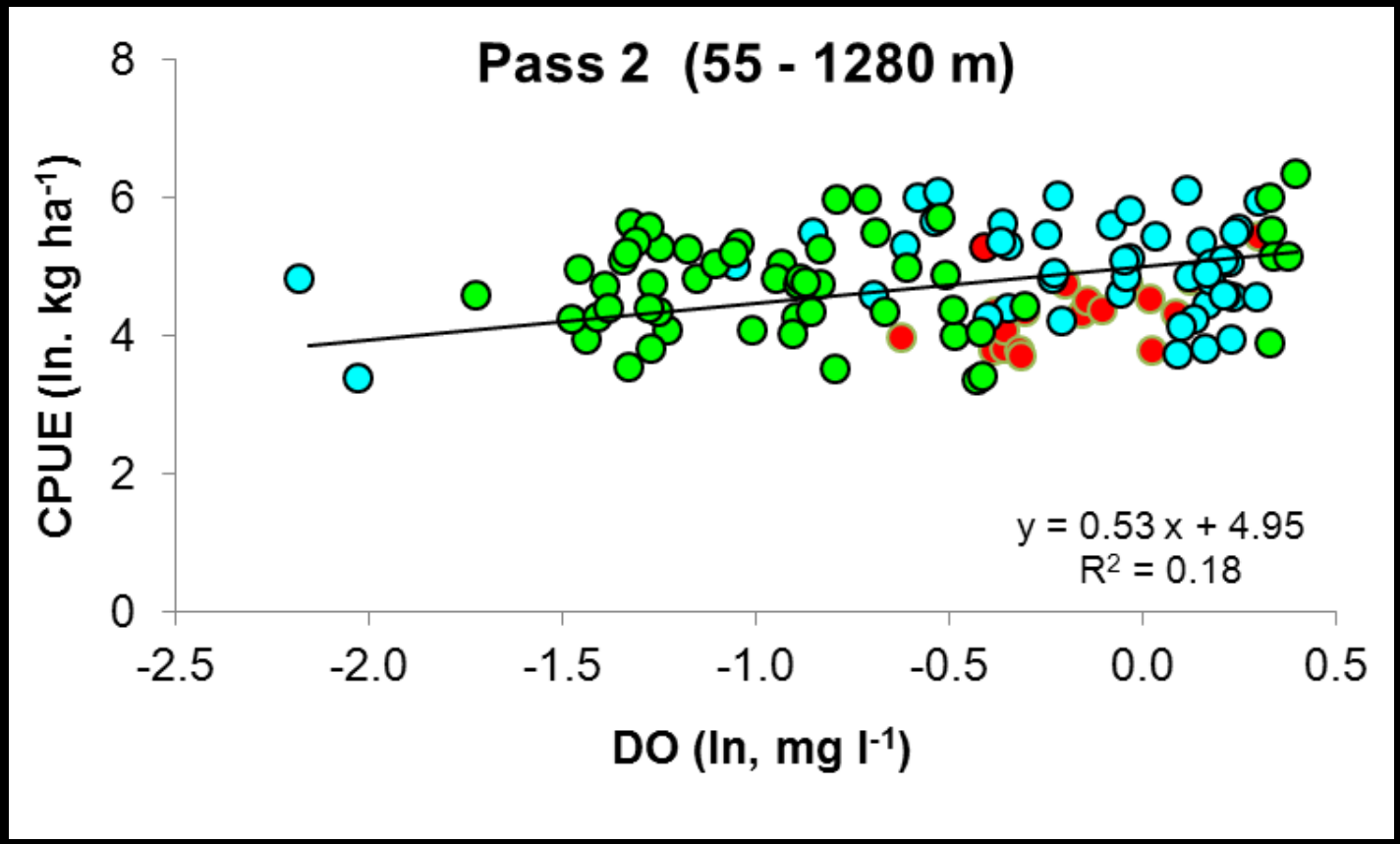
funding: NOAA's Office of Ocean Exploration & Research through West Coast & Polar Regions Undersea Research Center

Coast Wide Study 2009



Thanks to S. Pierce

2009 Coast Wide Study – Pass 2



Total CPUE versus average bottom DO by depth

Ongoing and Future Hypoxia Research

- continue collection of near bottom DO during annual trawl survey (~750 station per year)
- continue 2-3 day hypoxia study off Newport, OR
- conduct species-specific analyses coast wide
- define species-environmental relationships (light, oxygen, temperature, salinity, fluorescence, backscatter, seafloor roughness and geographic variables) using a modified version of Generalized Additive Models
- stomach content and tissue studies on selected species