Update on Untrawlable Survey Research in RACE

Research Goals – long term

1) Map untrawlable regions within the survey area
2) Estimate rockfish abundance in untrawlable areas

Objective for FY19

Design a GOA-wide index survey for rockfish species in untrawlable habitat that can be run in parallel to the current trawl and longline surveys and provide data on trends and size structure for stock assessors.

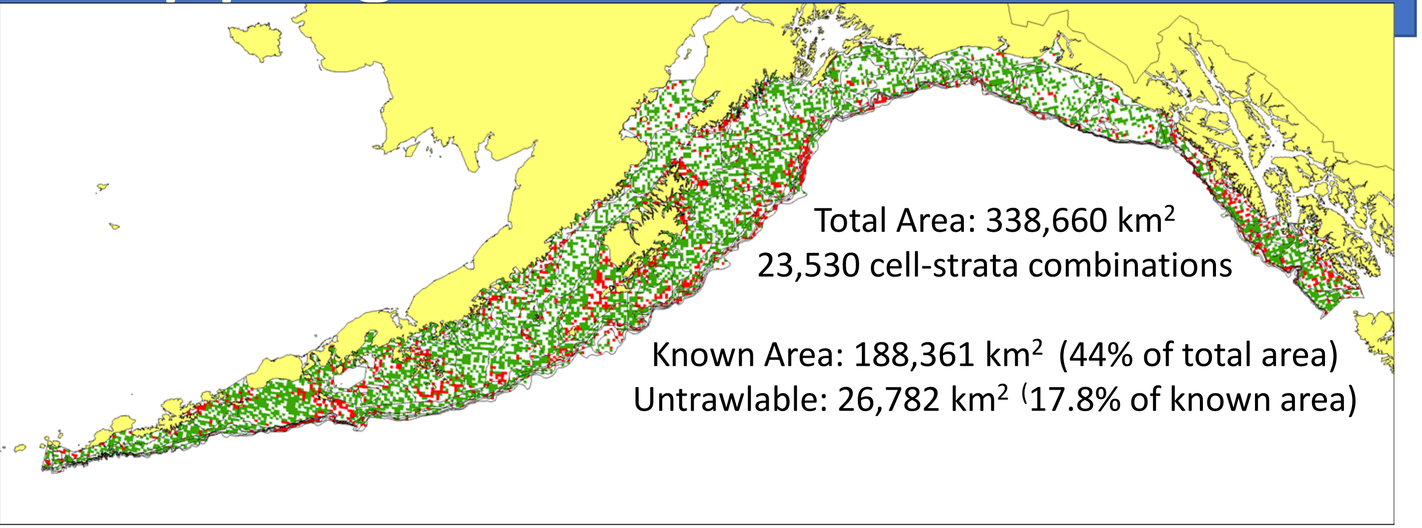
How big is the problem (how much untrawlable area is there)?

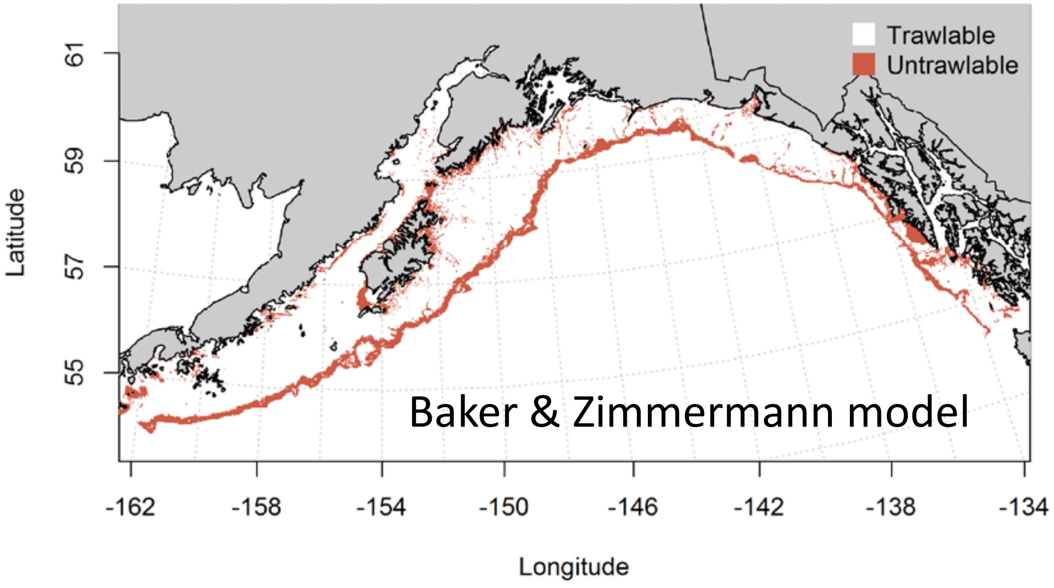
What have we done so far?

Untrawlable Habitat Strategic Initiative results

What works/doesn't work?

How Big Is The Problem? Mapping Untrawlable Areas





<u>Ongoing Projects</u>

Trawlability grid (Palsson, Von Szalay)

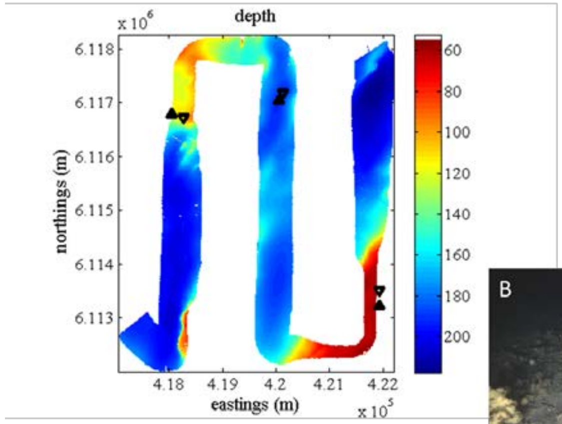
Modeling – Smooth Sheets (Baker, Zimmermann)

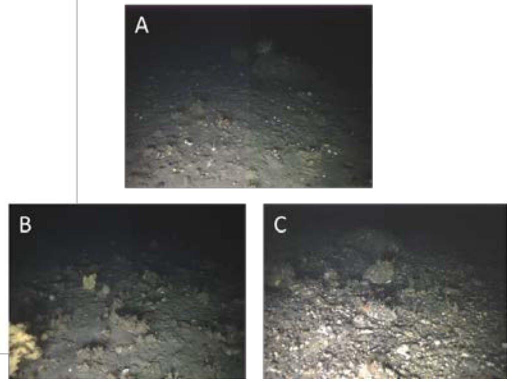
Modeling – ES60 (Von Szalay, Jorgensen)

Modeling – ME70 (Stienessen, Pirtle)

Mapping – Multibeam (McConnaughey)

Stienessen & Pirtle

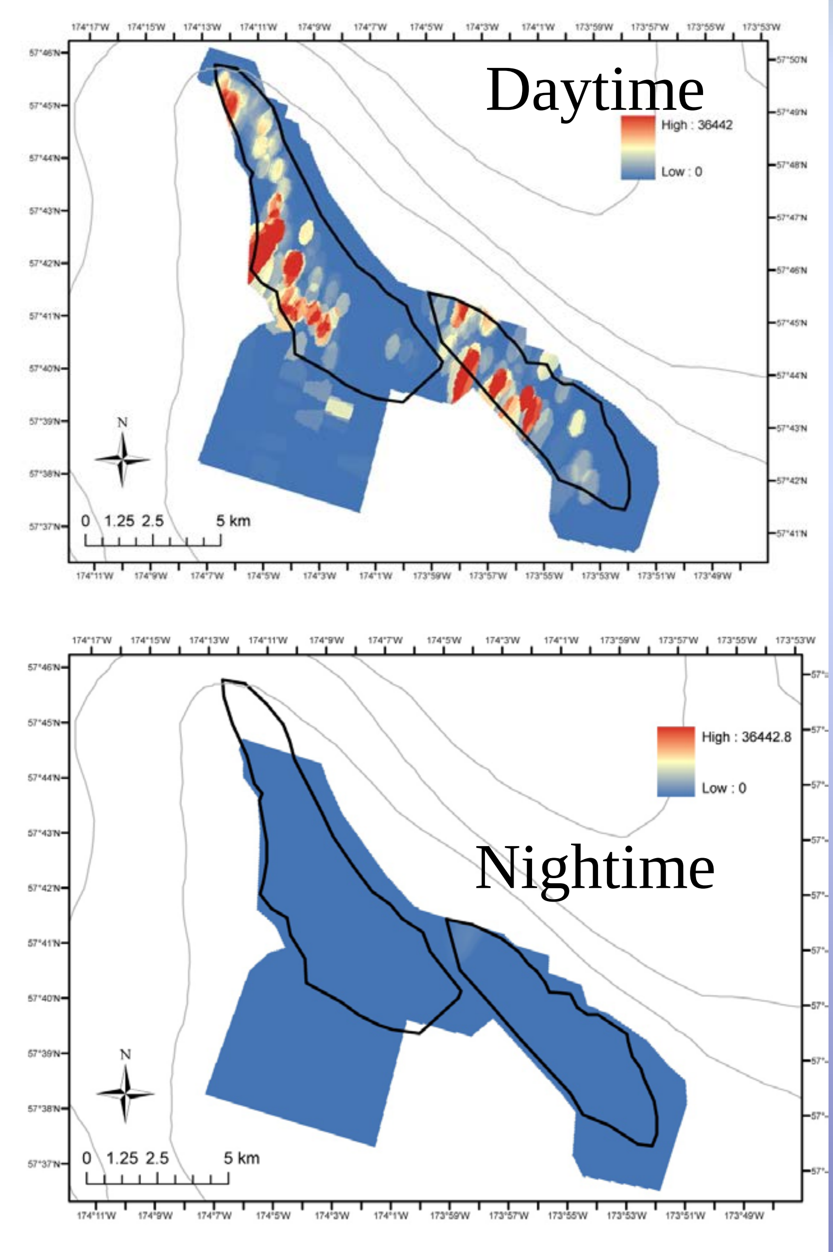


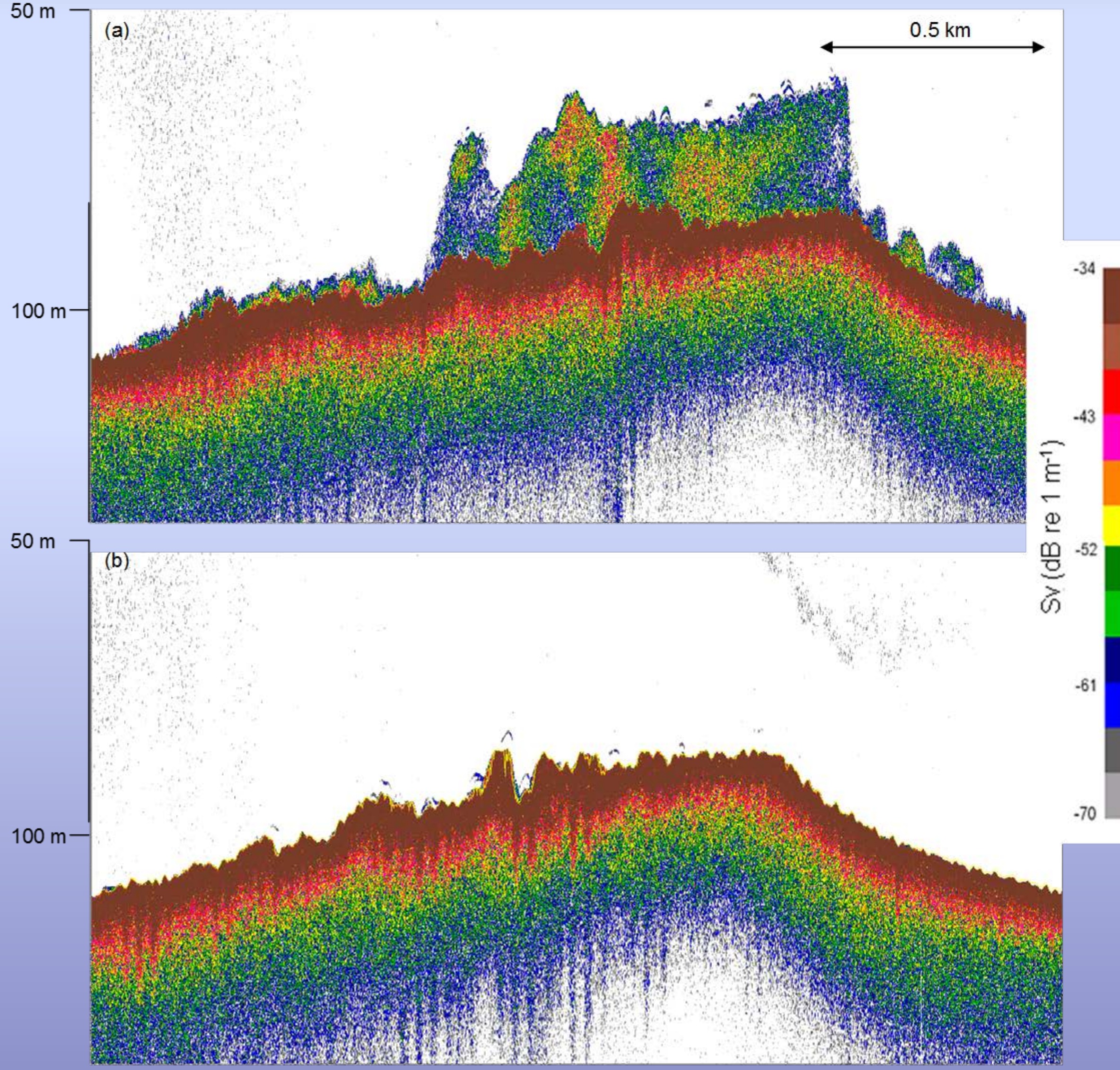


Study #1 – Zhemchug Ridges

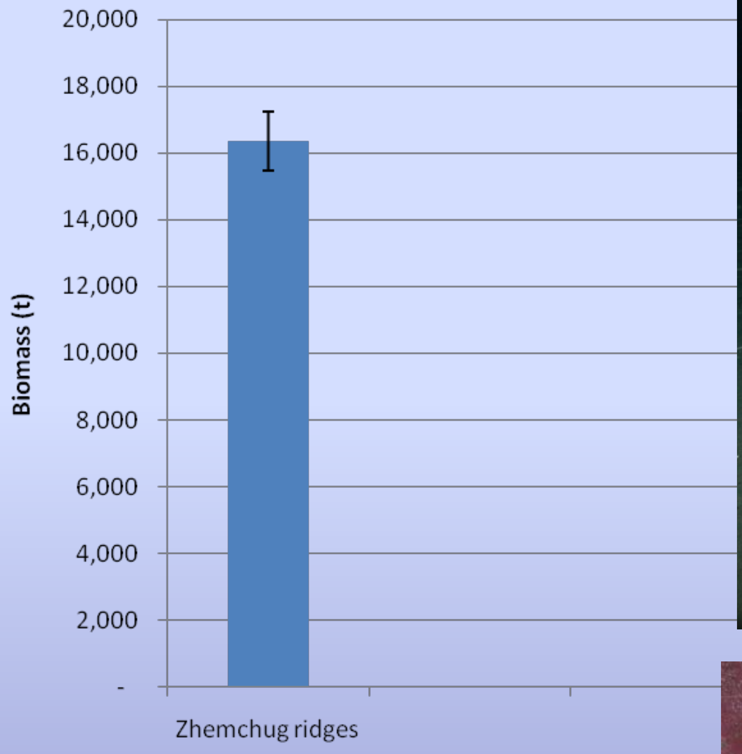
Study #2 – The Snakehead

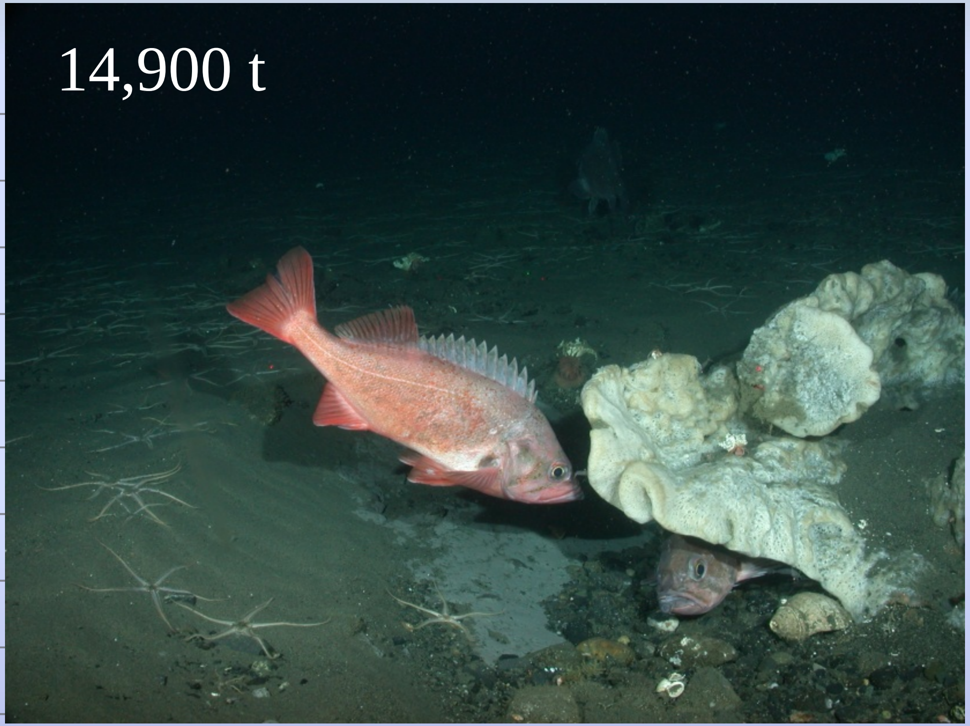
1. Calibrated acoustic data
2. Determine distribution by substrate type (trawlable or untrawlable)





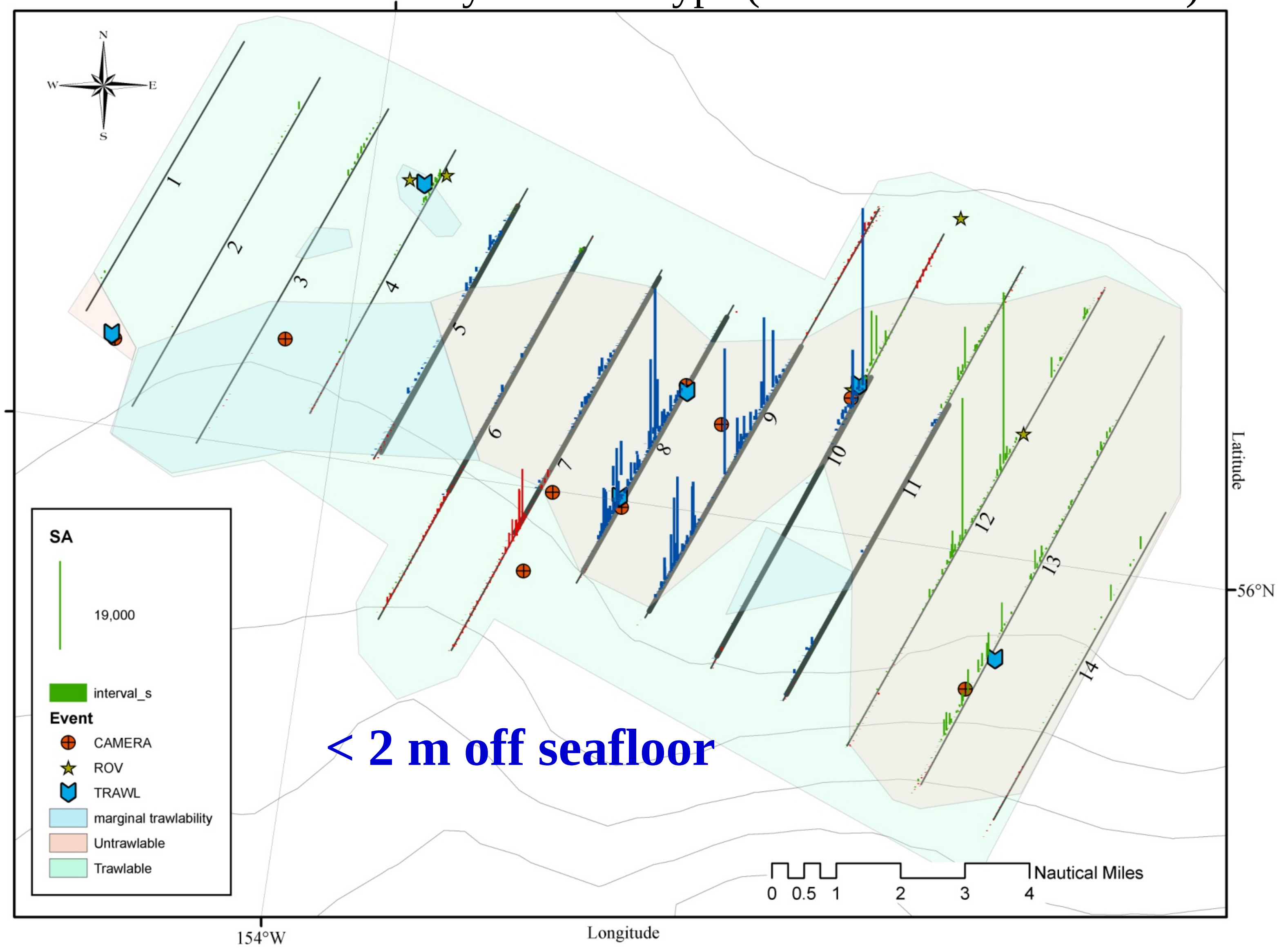
Biomass Estimate for Zhemchug ridges (~60 km^2)





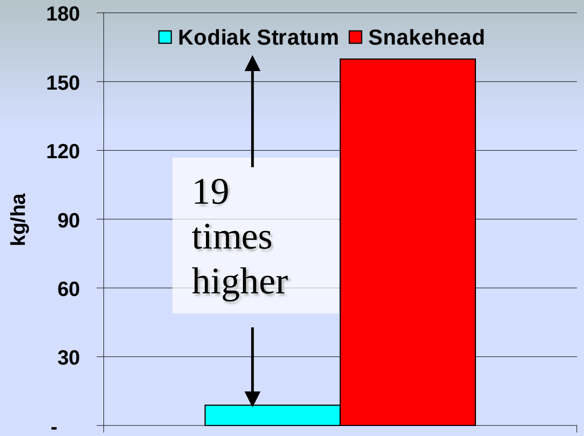
1. Collect calibrated acoustic data along survey path

2. Determine distribution by substrate type (trawlable or untrawlable)



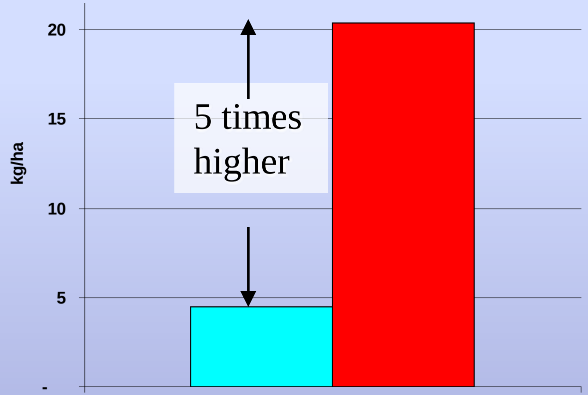
Snakehead/Kodiak Area Stratum (kg/ha)

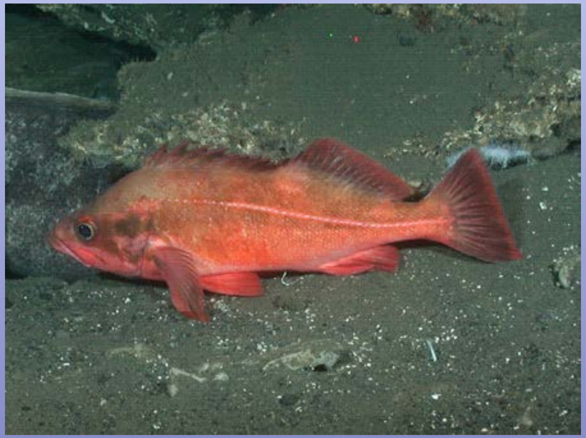
0.33% of Kodiak Area depth stratum

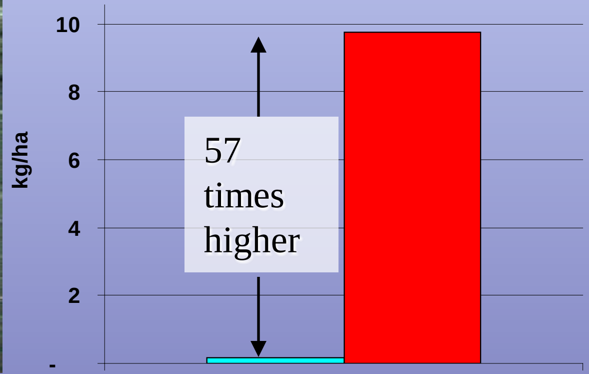


Dusky Rockfish

Northern Rockfish



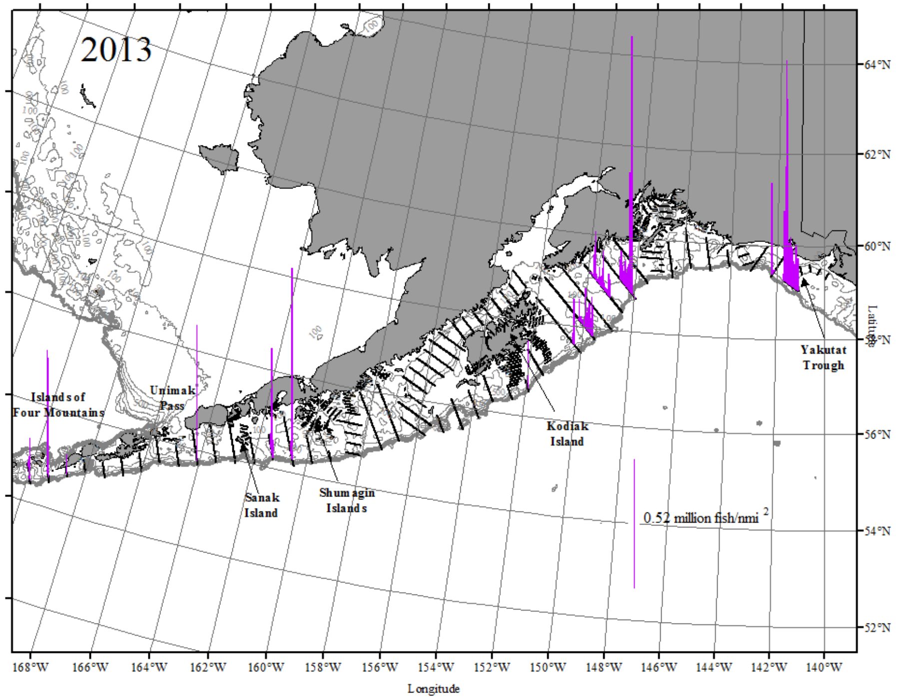


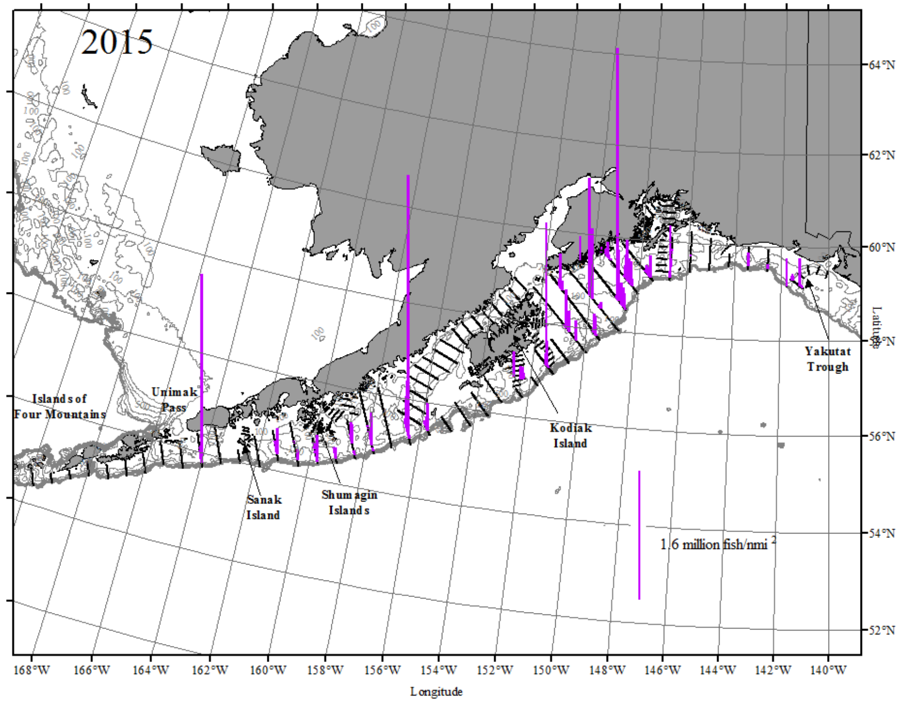


Harlequin Rockfish

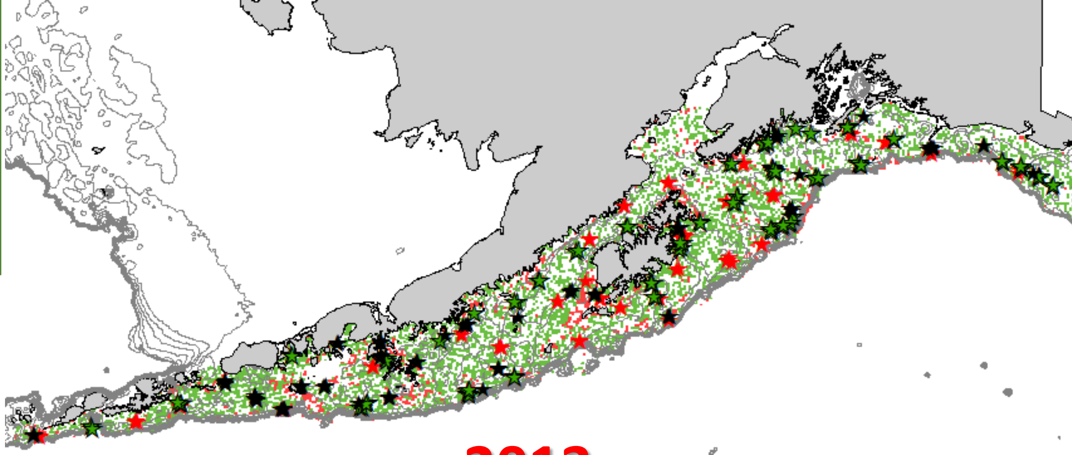
What have we done so far? Acoustic-Trawl Surveys (2011-2017)

- Opportunistically assessing rockfish spp. abundance (primarily POP) during summer GOA walleye pollock acoustic-trawl surveys (2011 partial coverage, 2013, 2015, 2017).
- Survey designed for pollock detection
- Trawl confirmation of species ID and size distribution
- Currently using generalized physoclist TS to obtain biomass





What have we done so far?
Acoustic-Optic Surveys (2009-2017)



- Pilot project on Snakehead bank in 2009 to determine feasibility
- Opportunistic surveys of BT "Trawlable" and "Untrawlable" grids using acoustics (splitbeam and multibeam) and lowered stereo cameras
- Assess substrate type/trawlability and rockfish ID/abundance
- Conducted during summer GOA walleye pollock AT survey
- Primarily nighttime operations

2013

36 grids surveyed

- **18 trawlable,11 untrawlable**

63 Lowered Stereo Camera deployments

2015

45 grids surveyed

- **18 trawlable, 19 untrawlable**

89 Lowered Stereo camera deployments

2017

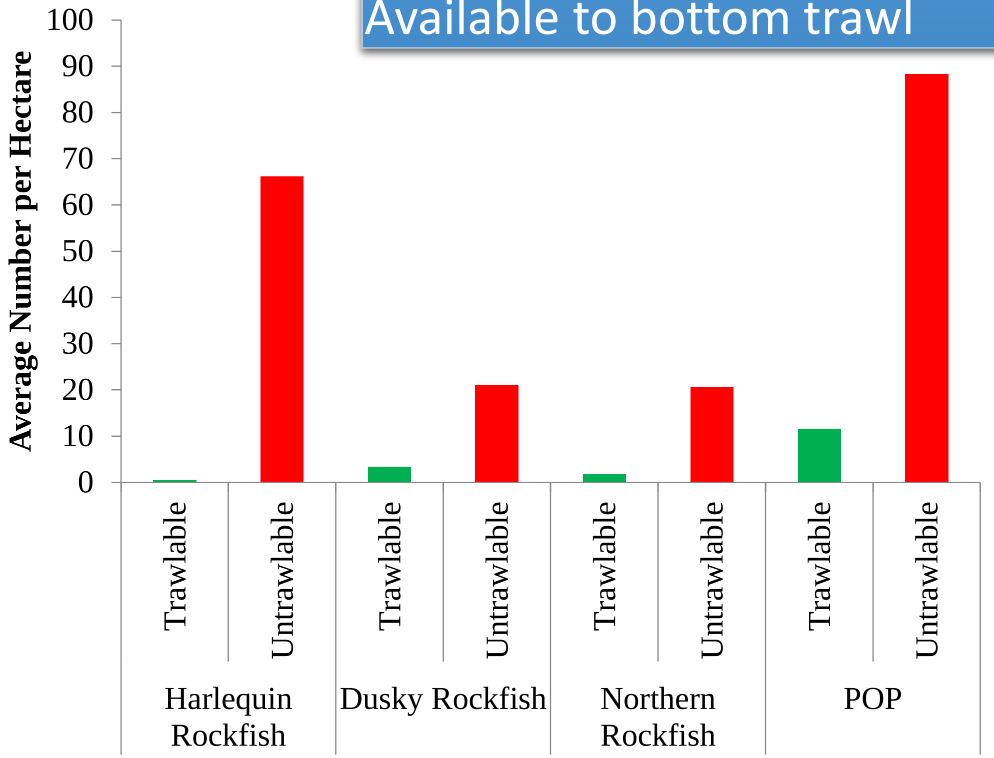
29 grids surveyed

- **16 trawlable, 13 untrawlable**

88 Lowered Stereo camera deployments

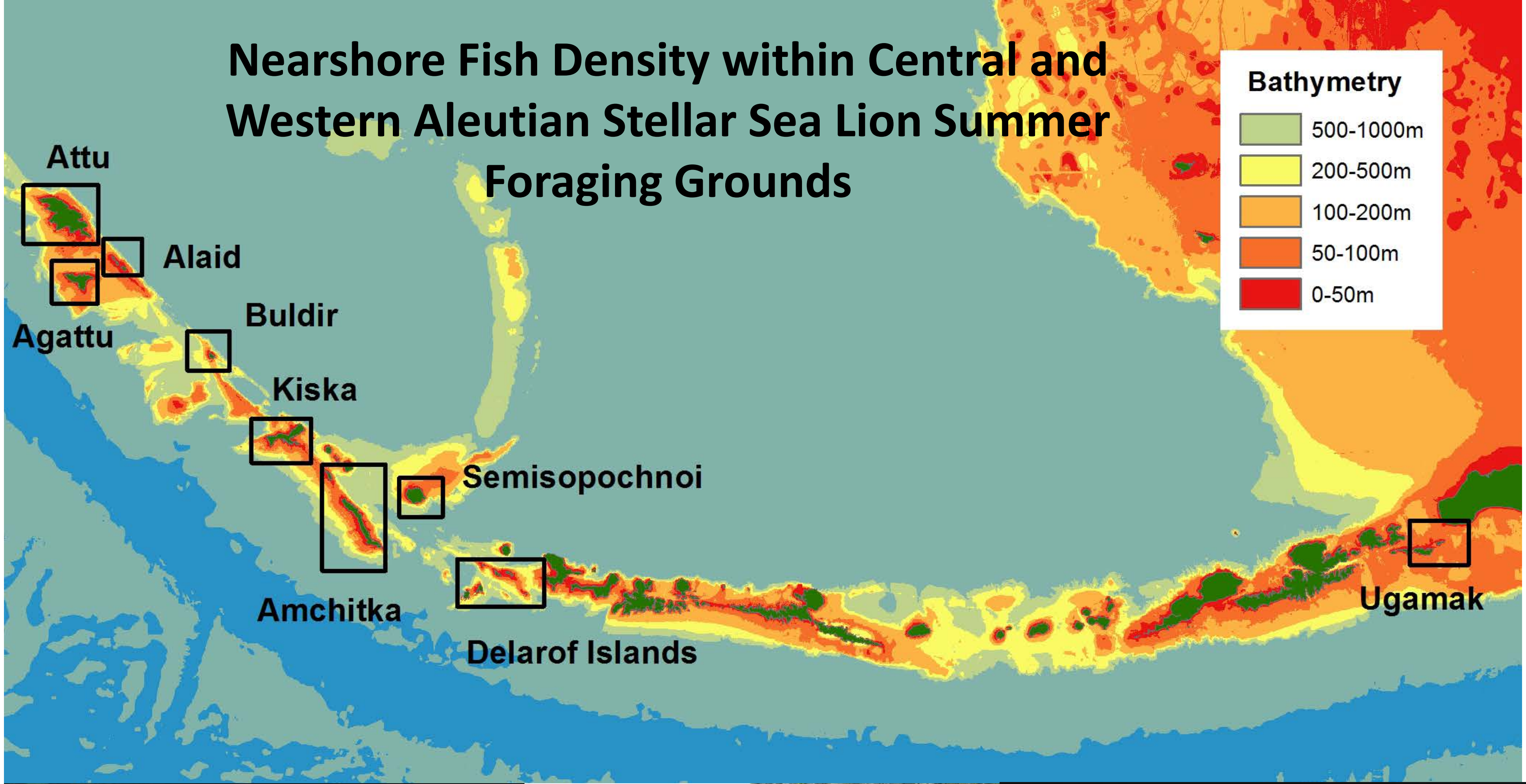
What have we done so far?
Q Estimation (HAIP Project – 2013 & 2015)

Species	Harlequin RF	Dusky RF	Northern RF	POP
Trawlable Density (#/ha)	0.45	3.46	1.74	11.57
Untrawlable Density (#/ha)	66.15	21.05	20.63	88.36
Available to bottom trawl	6.0%	40.7%	37.3%	52.0%

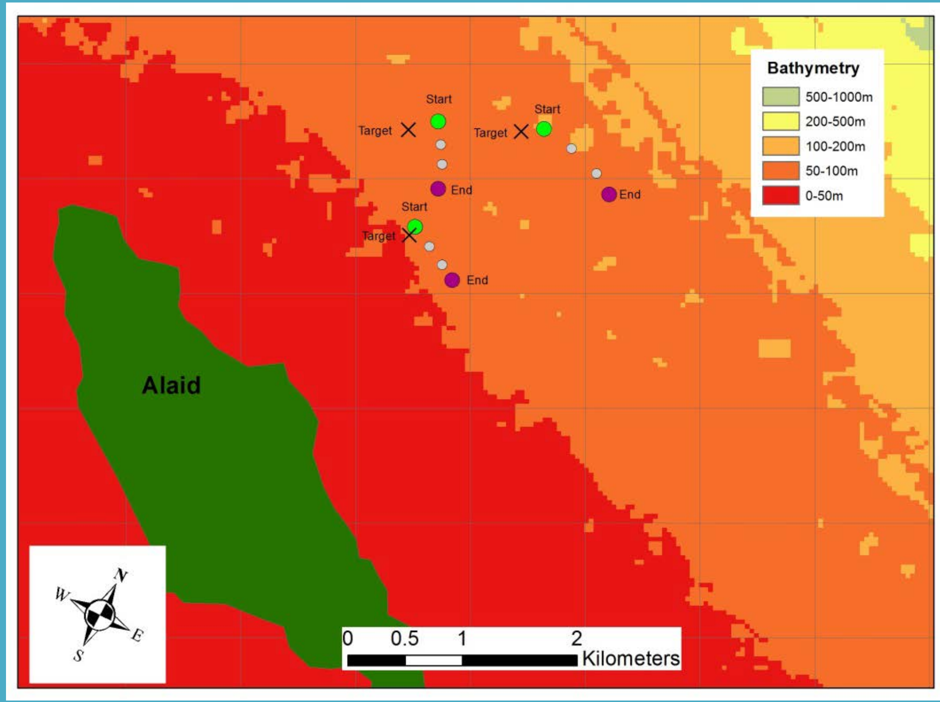


- Based on trawlability as determined from camera images
- Indication of the availability of select species to the bottom trawl

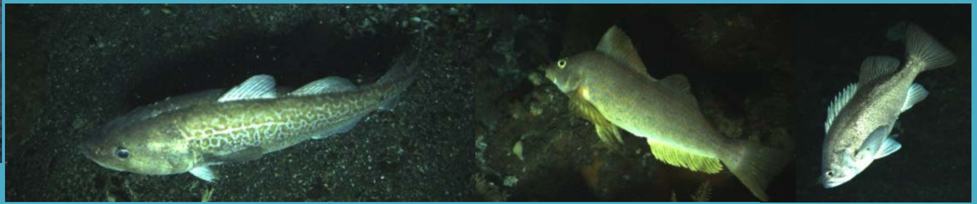
Nearshore Fish Density within Central and Western Aleutian Stellar Sea Lion Summer Foraging Grounds



- **Stereo Machine Vision Camera System**
- US Fish and Wildlife R/V Tiglax
- Randomly selected sites from 1km x 1km grid (25-200m depth)
- 15 min tows, 1-1.5 knots
- 1-2 m off bottom controlled with winch and live feed of 8 frames per second
- SEBASTES software for data acquisition (numbers and size of fish, habitat classification)

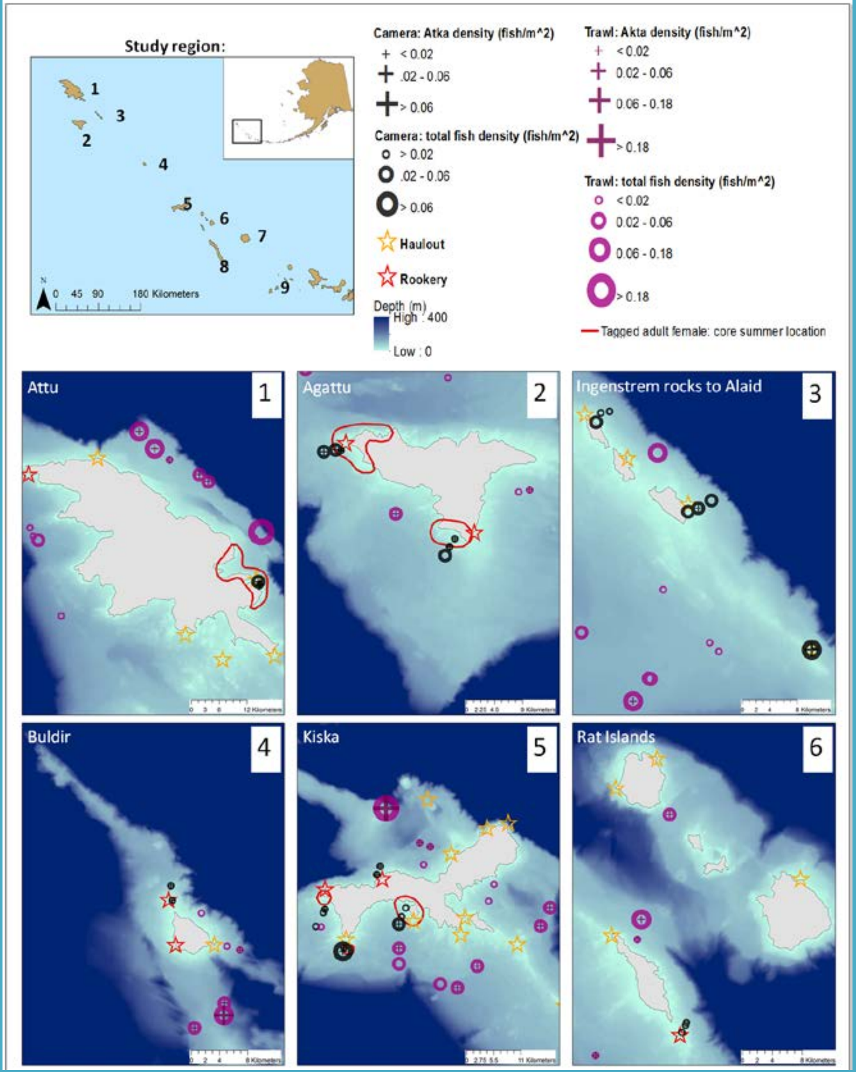


2016 – 47 transects
2017 – 17 transects

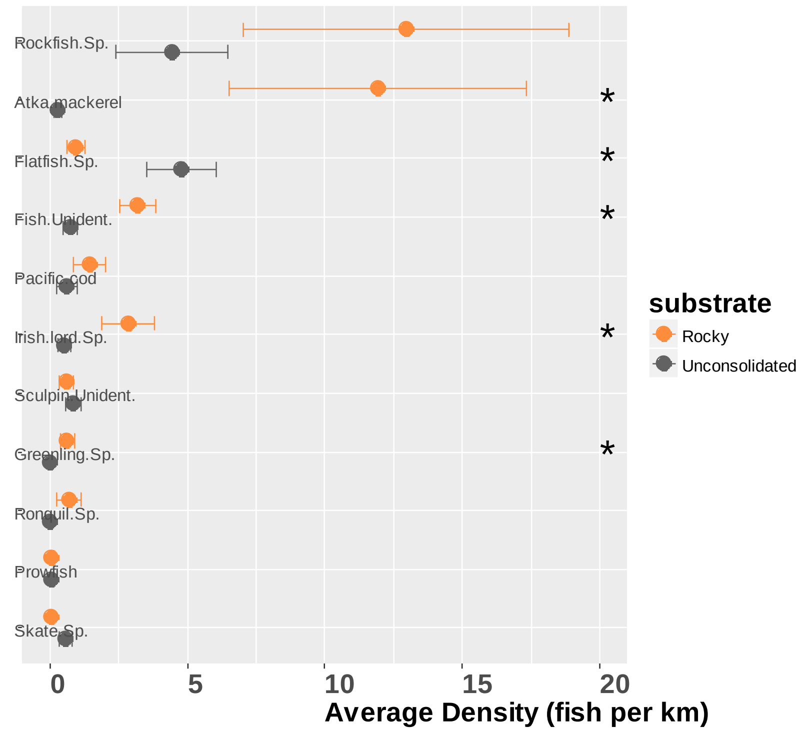


Preliminary Analysis

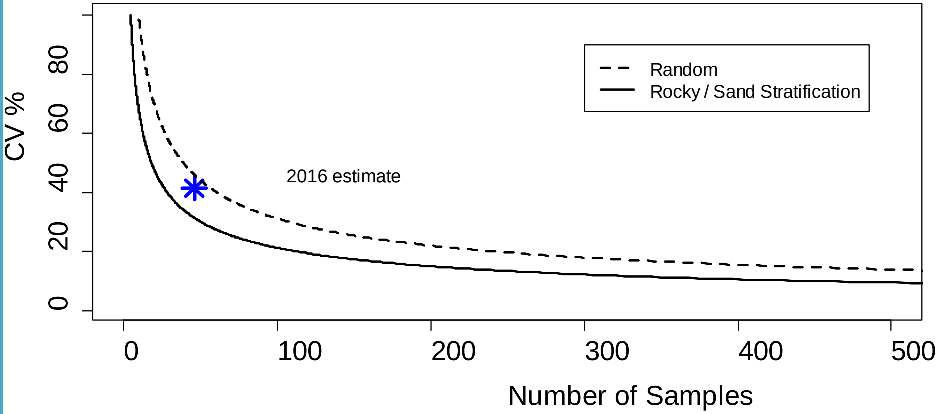
Comparison of Density Estimates: Camera System and Trawl Survey



Density Estimates by Habitat Type



Sample size Estimates for Atka Mackerel



Untrawlable habitat surveying methods

- Stationary cameras
- Volumetric density estimation
- Automated image processing

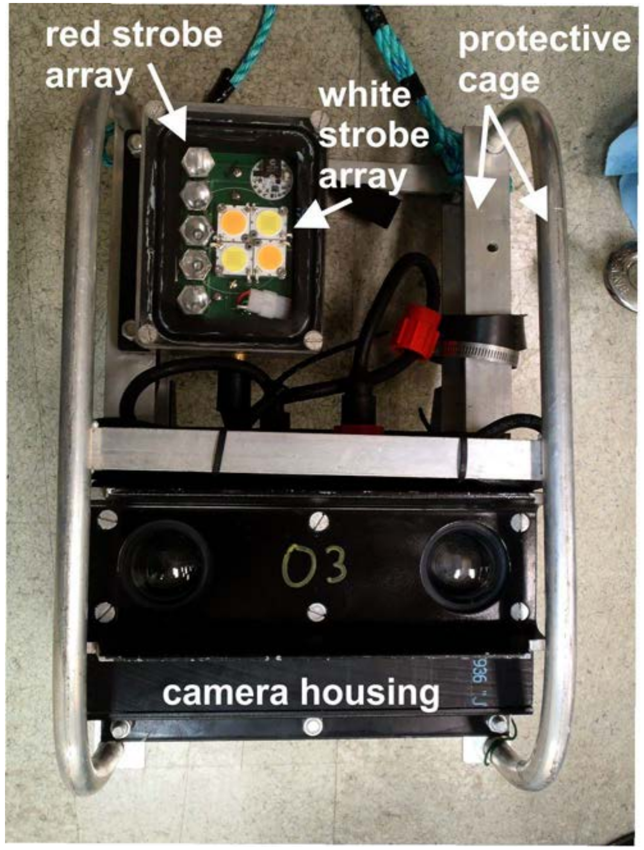
Moored, motion triggered or time lapse stereo camera systems ("TrigCams")

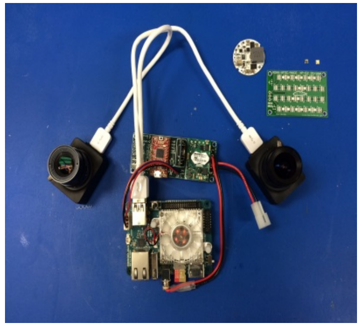
Deployed similar to small pot fishing gear

Long duration collections (24 + h)

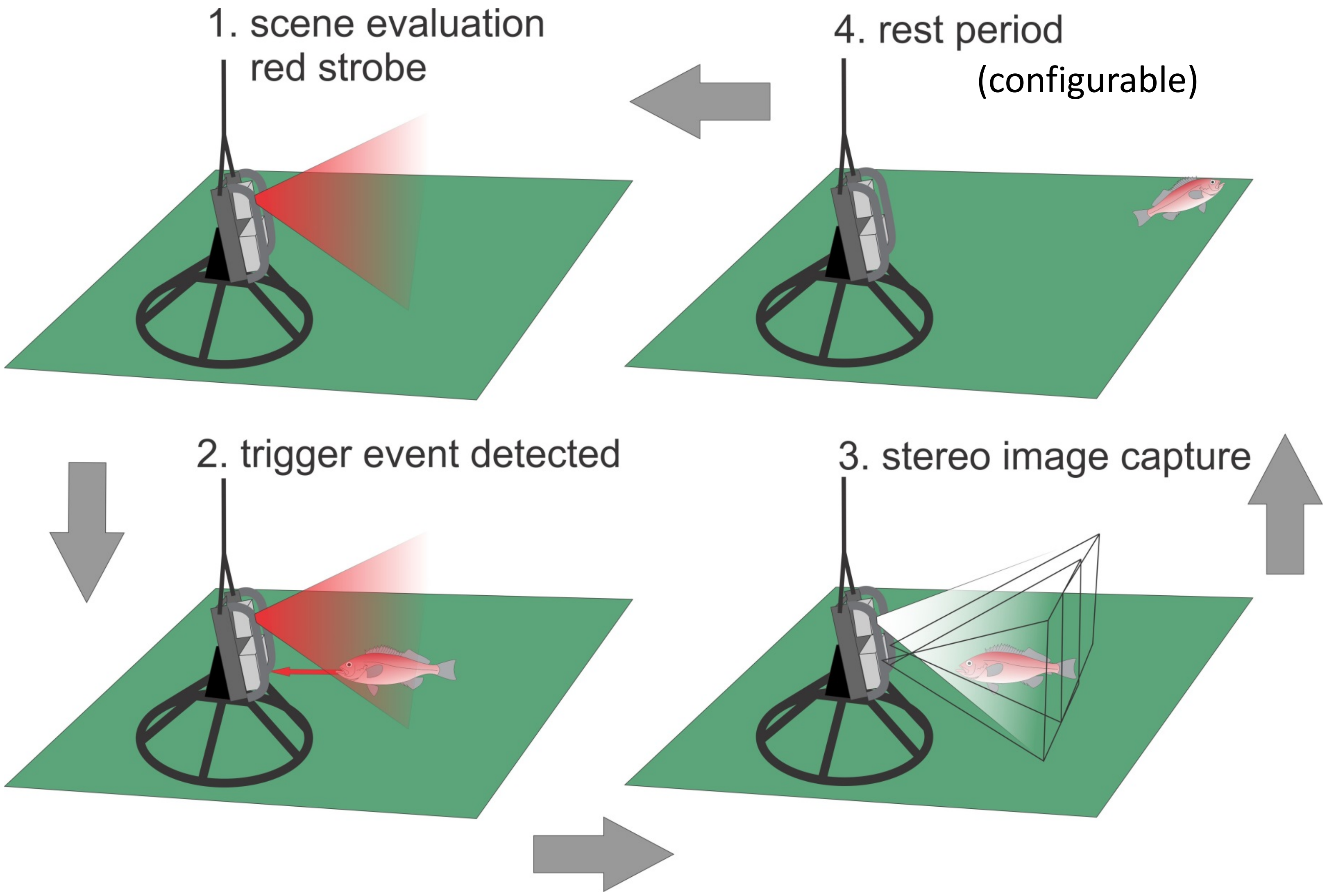
Minimally obtrusive

Low cost

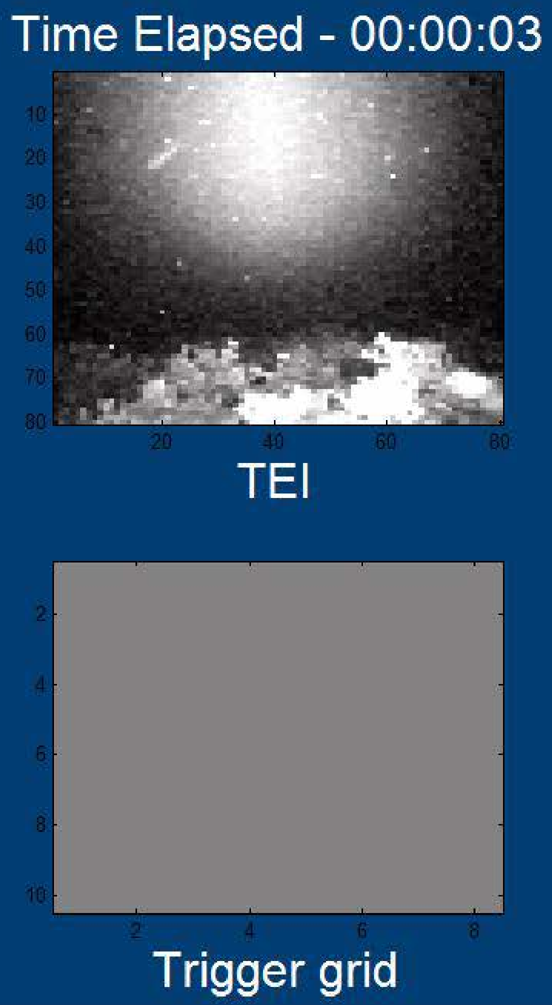




Triggering operation – the basic idea…

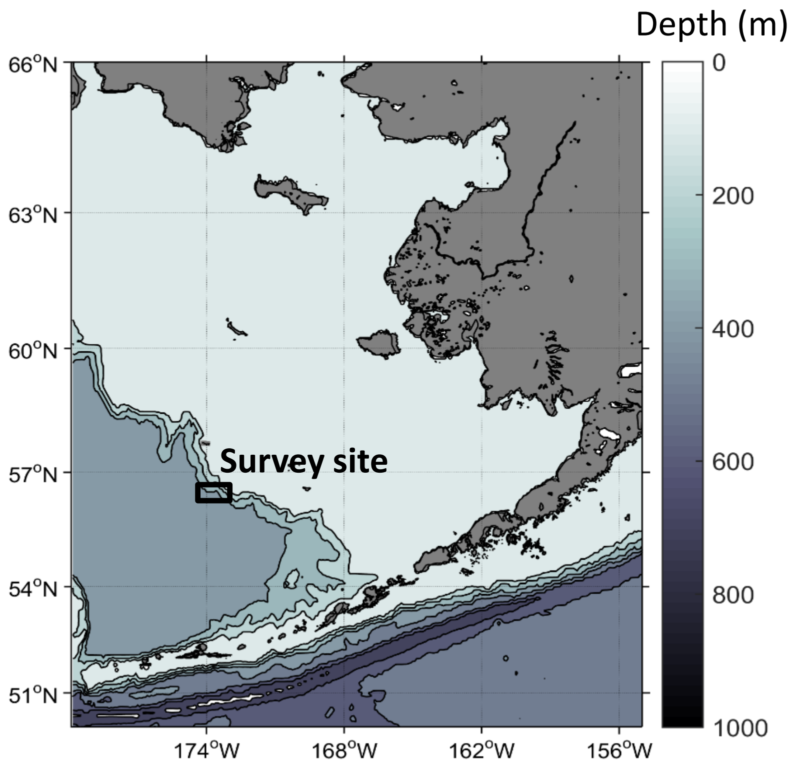


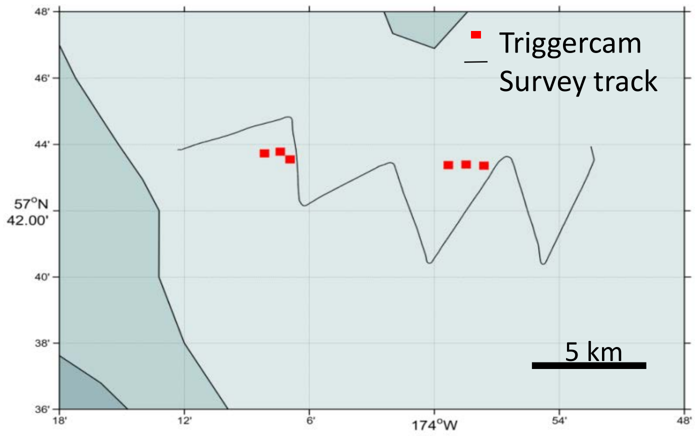
Triggercam operation example - detected 6 targets in 45 min



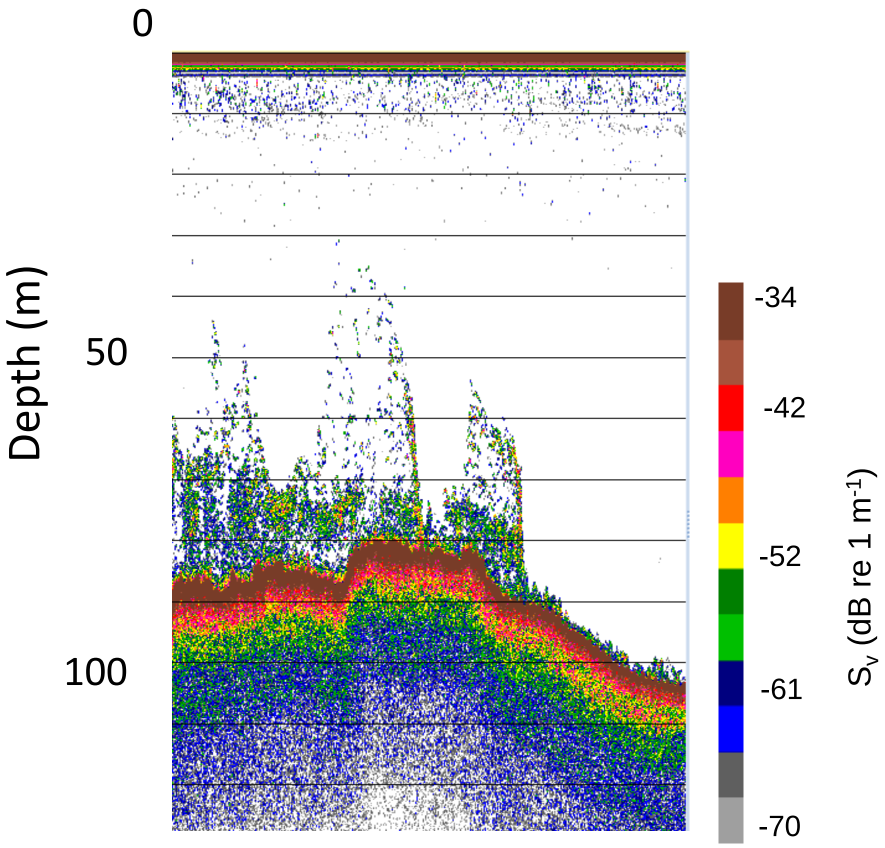
Test deployment – Zemchug Canyon, July 2014

Six units deployed for 12 hours



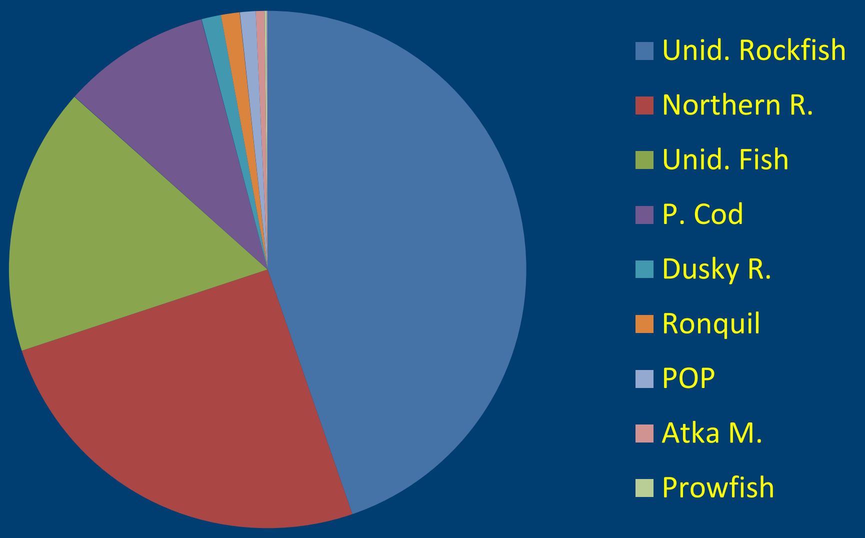


38 kHz Echogram

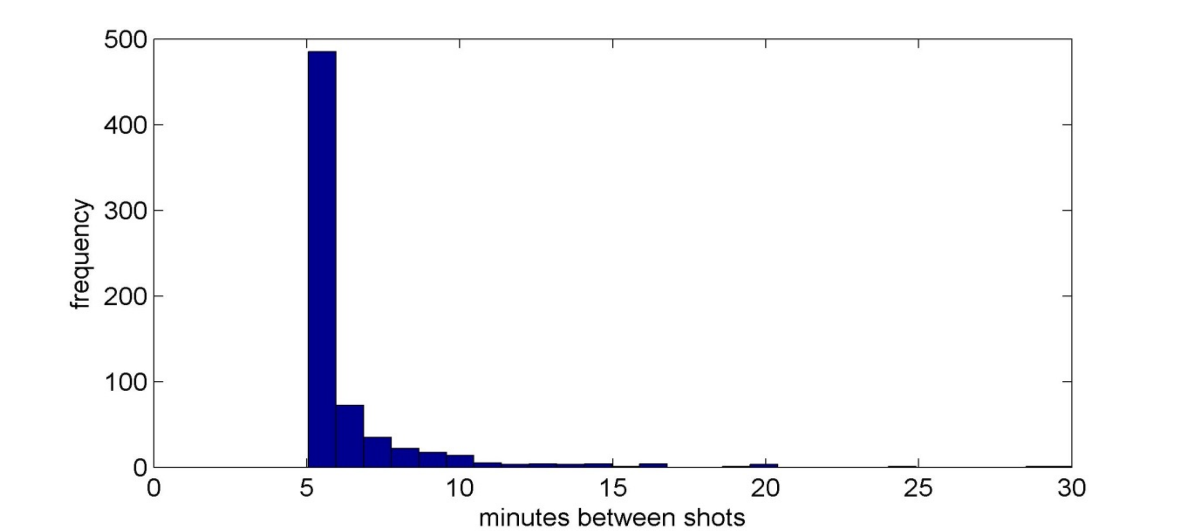


Test deployment results – triggering performance

Units deployed	6 (5 analyzed)
Trigger events	498 (790 possible)
False triggers	111 (70 % due to platform movement)
Fish targets	1629

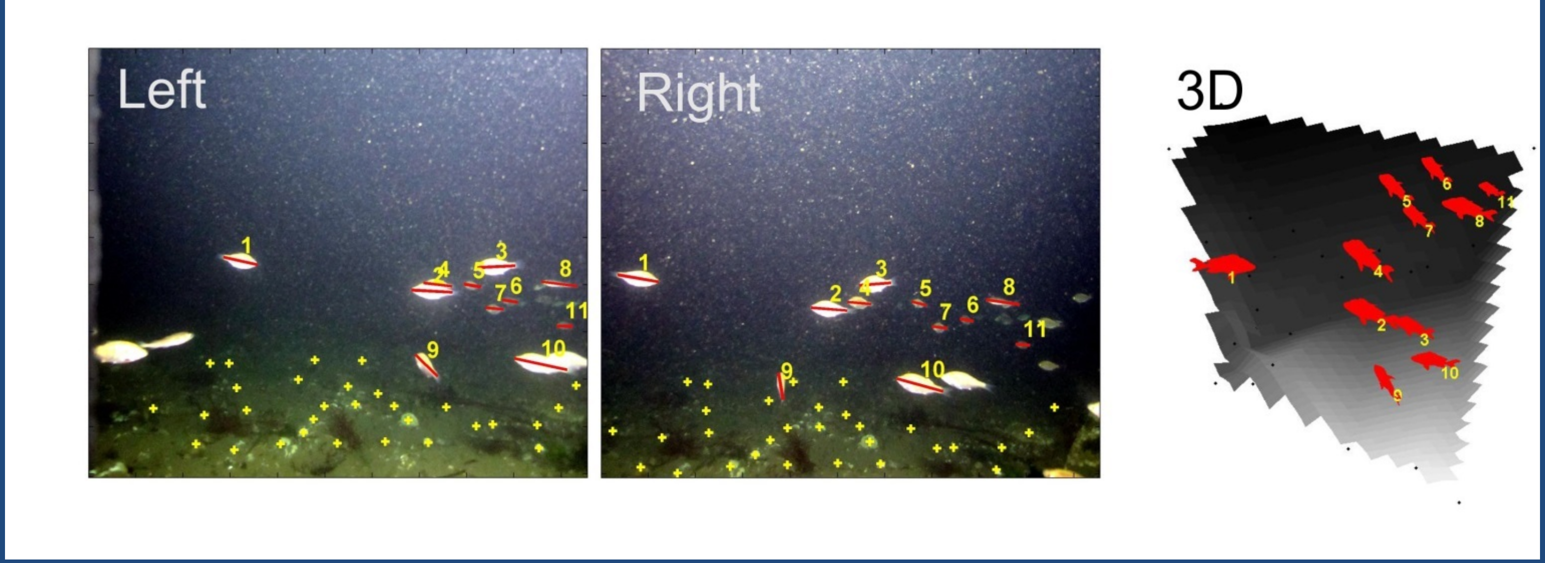


Most triggers occurring immediately after 5 min "rest" period



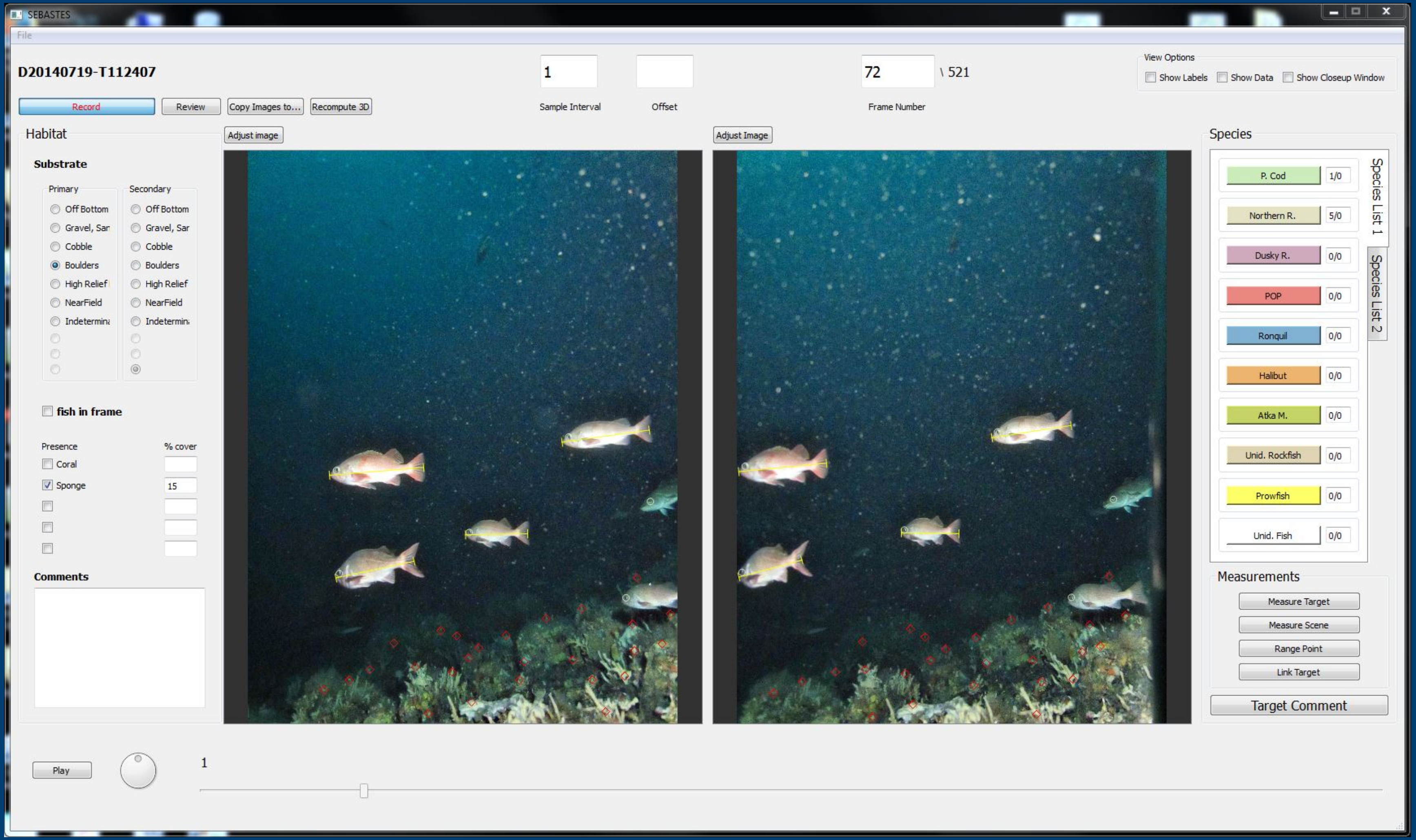
Volumetric density estimation from stereo cameras

- Reconstruct 3D positions of fish and seafloor from stereo image analysis
- Estimate joint-camera imaging volume that is “above ground”
- Estimate fish range-detection loss function



Stereo data analysis – SEBASTES software

- Fish counts by species
- Habitat assessment
- Accurate length measurements
- Fish position/orientation



Volumetric density estimation from stereo cameras

- Fit plane to bottom points (magenta points)

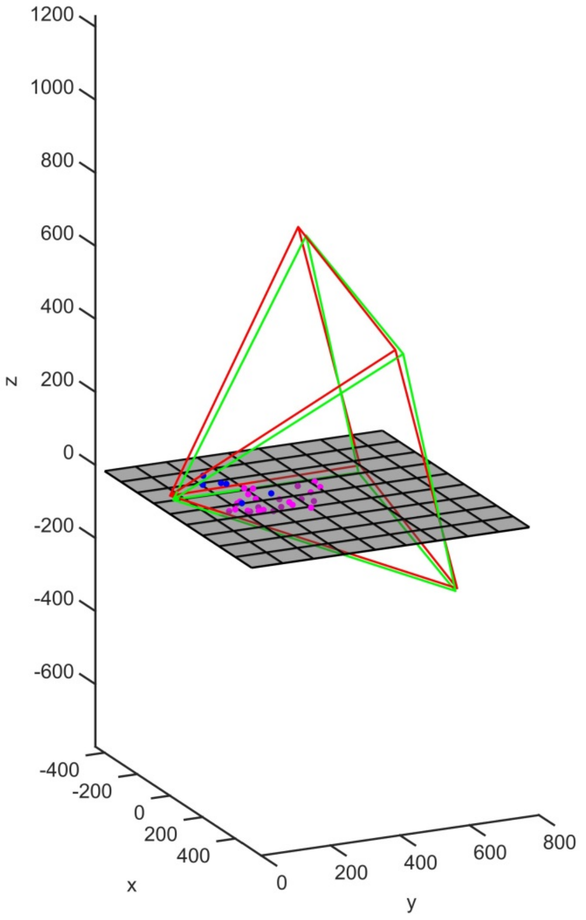
- Estimate camera positions and view fields
  from stereo calibration data (red = left, green = right)

- Normalize 3 d data to bottom plane

- Estimate “positive” joint camera volume

- Divide fish count (blue dots) by “available” volume
  to yield #fish/m^3

Problem….
Where to cut off volume estimate?



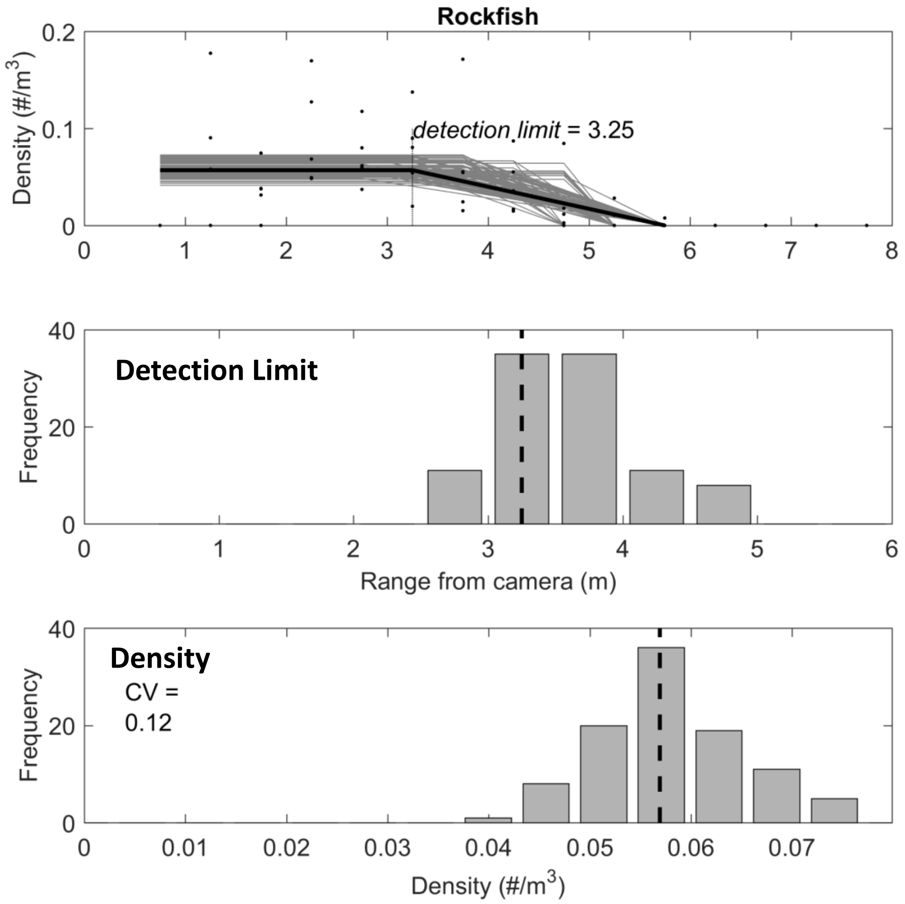
Volumetric density estimation from stereo cameras

- Compute density by range using previous approach

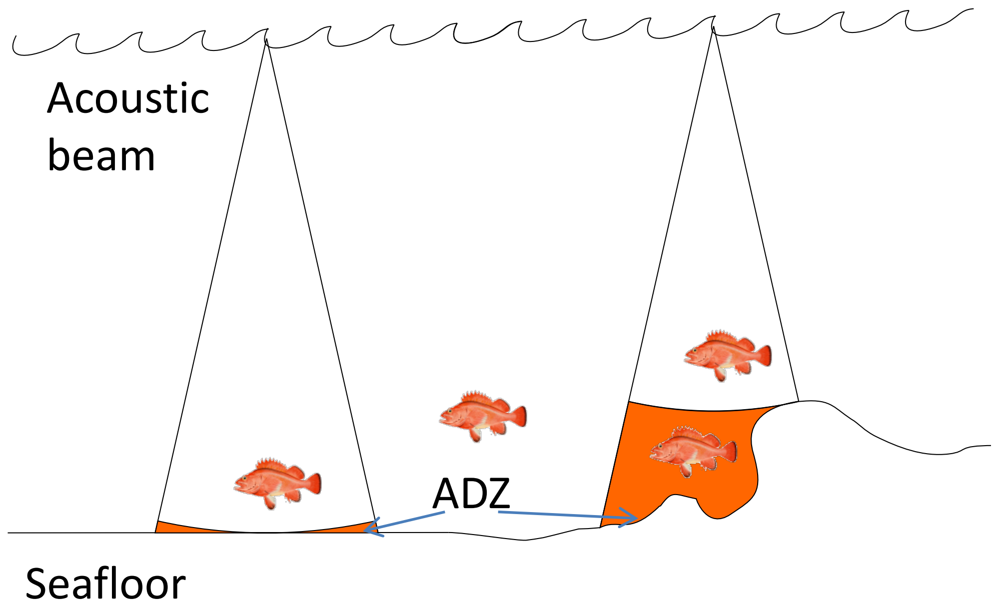
- Estimating the “detection limit” where density starts to drop off

- Intercept is “true” density

- Variance estimate by bootsrap



Assessing fish distribution in the Acoustic Dead Zone (ADZ)



Problem is much greater in high relief and sloping seafloor conditions

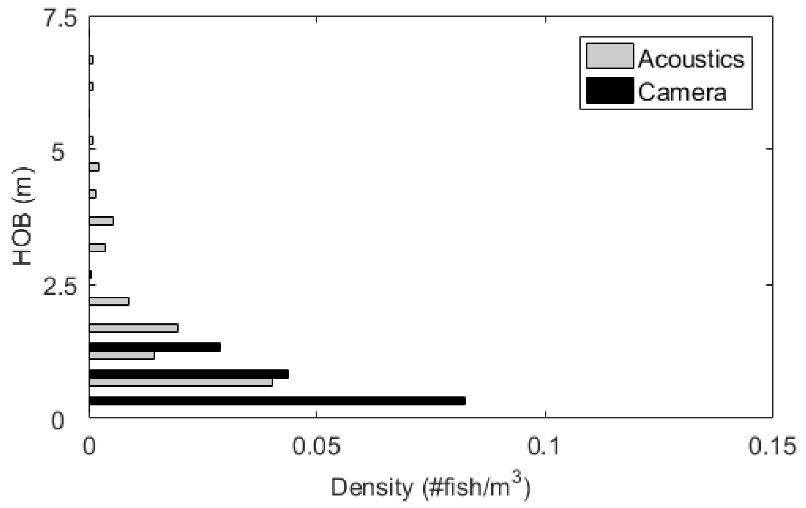
Size of the ADZ currently cannot be estimated from the acoustics

Fish distribution within the ADZ is unknown

Theoretical ADZ can be estimated for a flat smooth seafloor

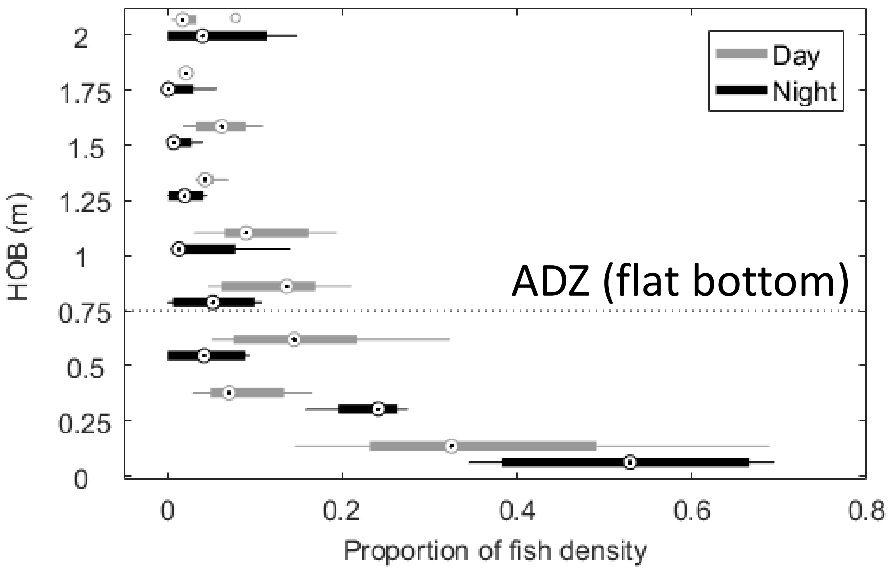
Assessing fish distribution in the Acoustic Dead Zone (ADZ)

Height off bottom: Comparison of acoustics and TrigCam derived density – Trigcam max vertical extent is 2 m



Diel pattern with TrigCam observations

Highest densities are within ADZ, during day and nighttime



Automated image processing

- Collaborative effort with UW

- CamTrawl imagery (inside midwater trawls) already highly automated: Fish detection, tracking, size estimation, and species classification

- Detecting and classifying fish in uncontrolled complex backgrounds is challenging – pattern based detection vs. threshold based (face recognition for fish)

- Primary focus of NOAA ASTWG Automated image analysis strategic initiative (AIASI) ending in 2018

Automated stereo-based length measurement

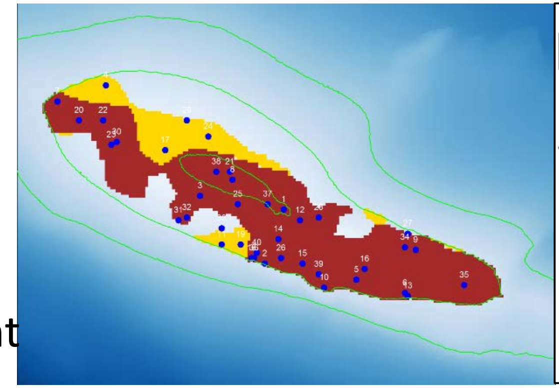
DPM fish detection for video with tracking (SWFSC)

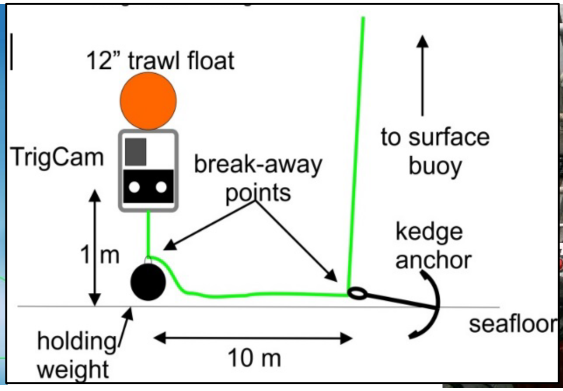
Automated image processing

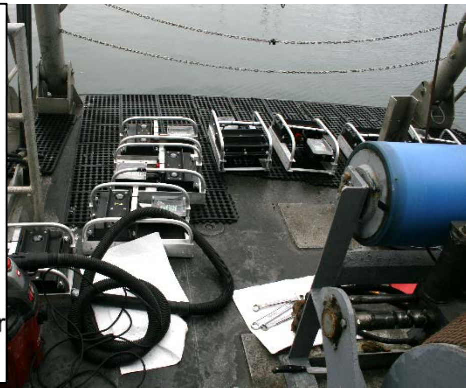
- Great potential for solving analysis “bottleneck”
- Trade-offs in accuracy and efficiency
- Accuracy is a moving target with continual improvements
- Will always require humans in the loop

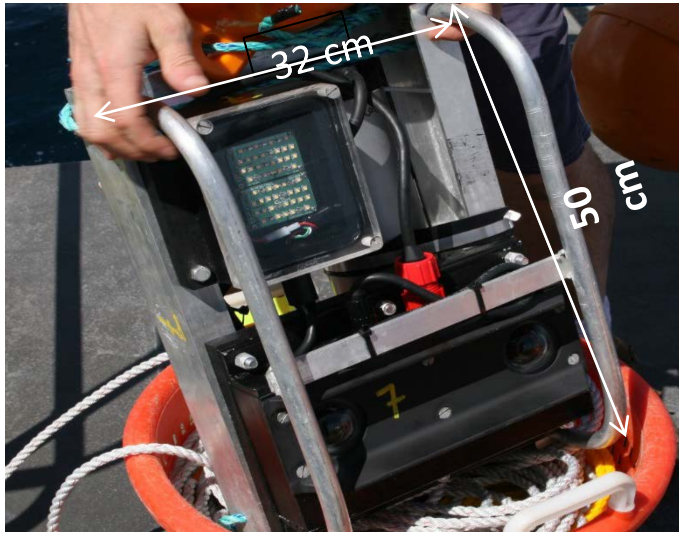
Footprint bank density estimation – Williams/Rooper

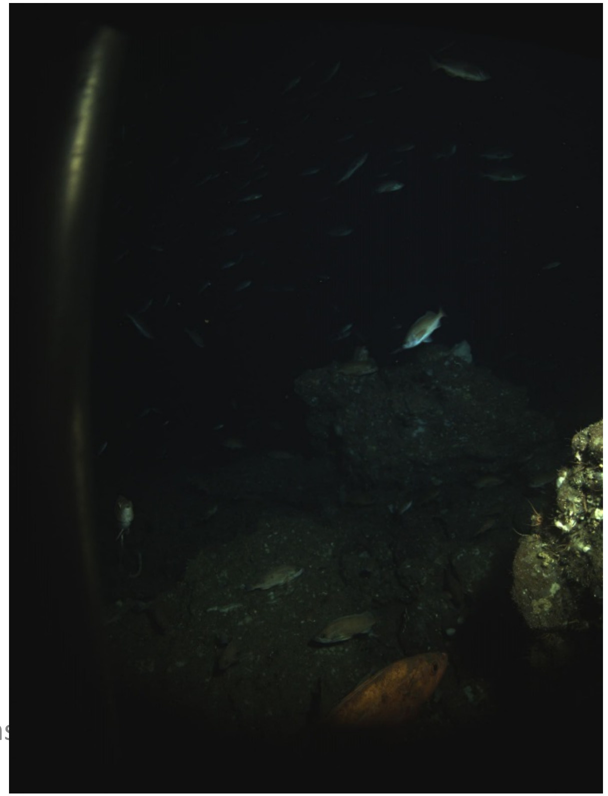
Nine cameras were built
Deployments at 26 of 40 randomly selected sites
Depths from 96-150 m
3.5 days of at sea time
Habitats from Cobble to High Relief Bedrock
Soak times from 3 to 17 hours including overnight
Many rockfish were observed



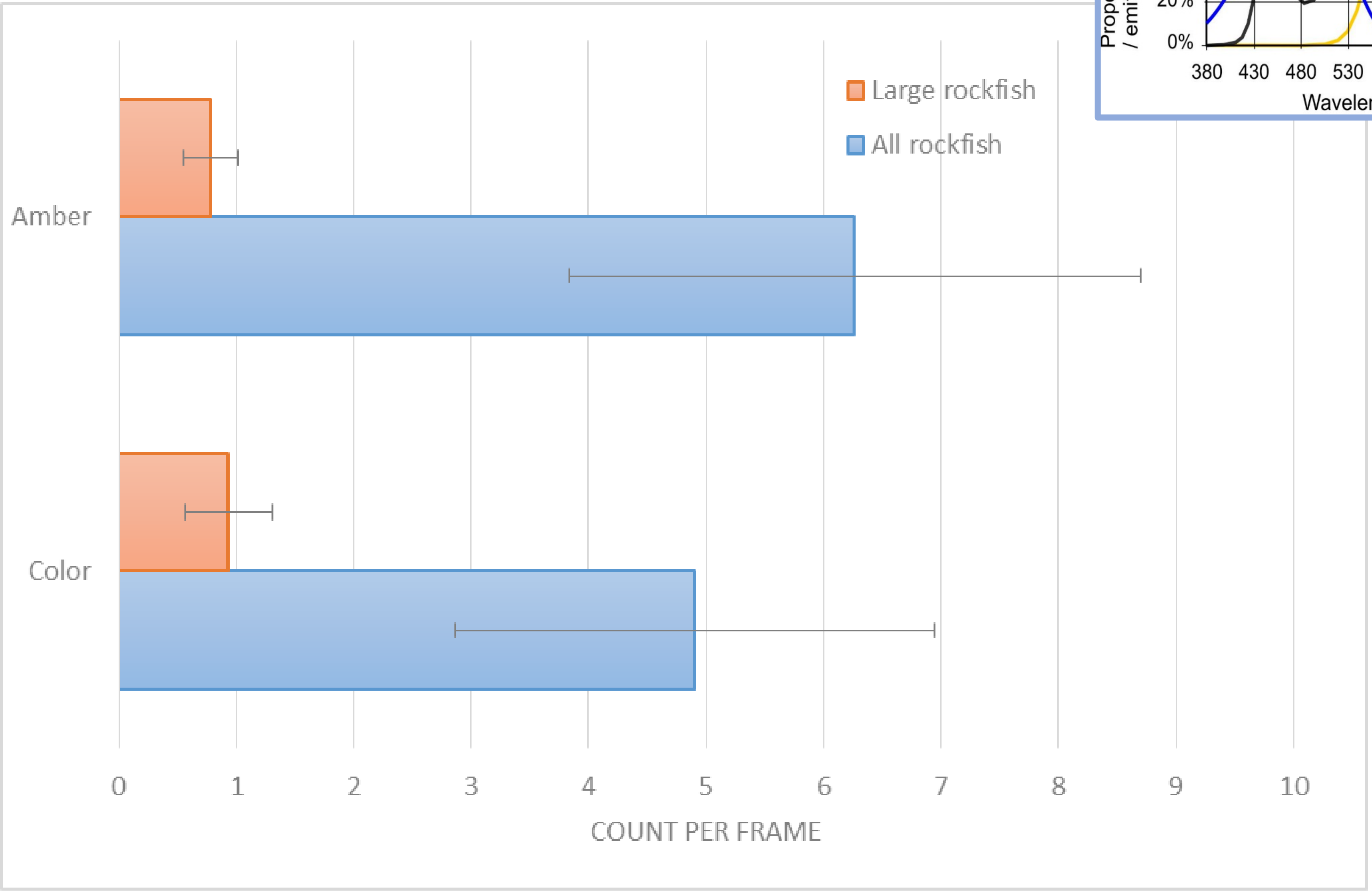


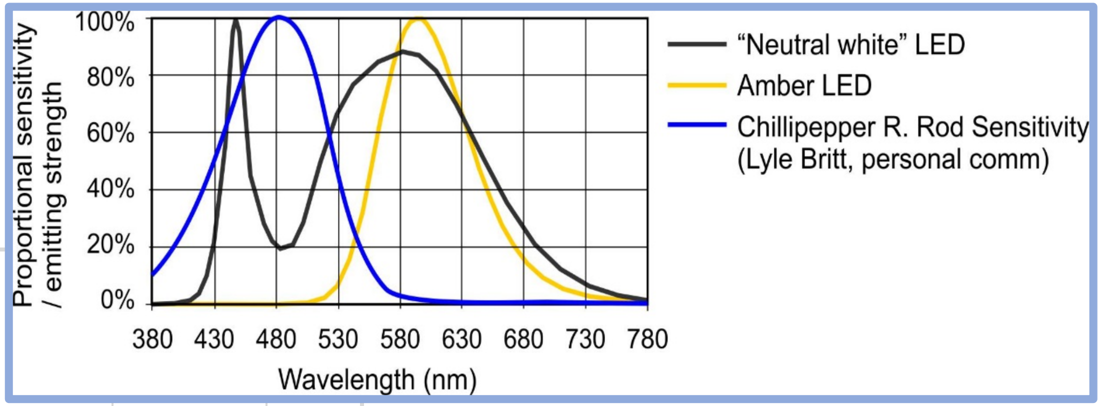






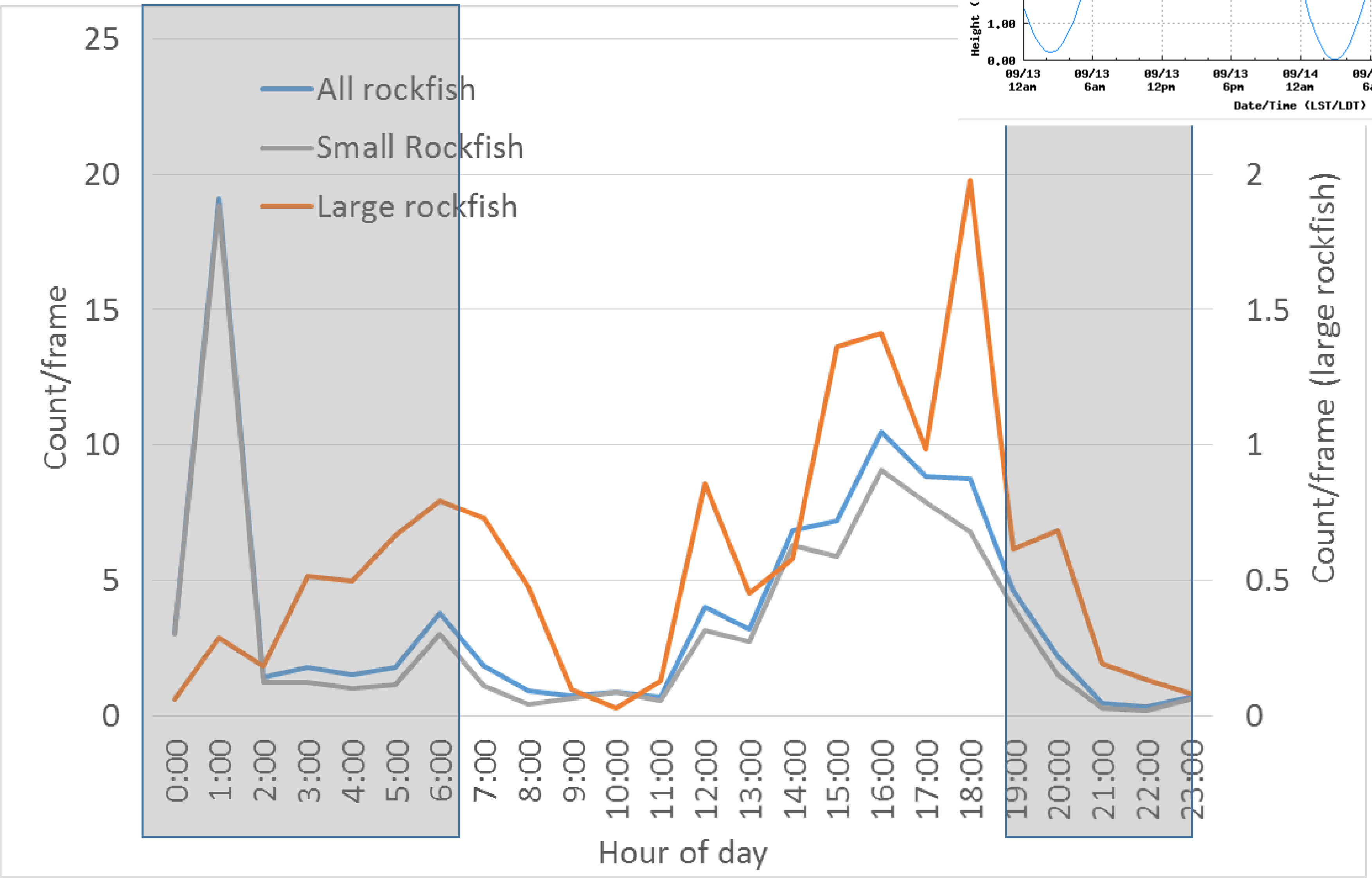
Lighting comparisons

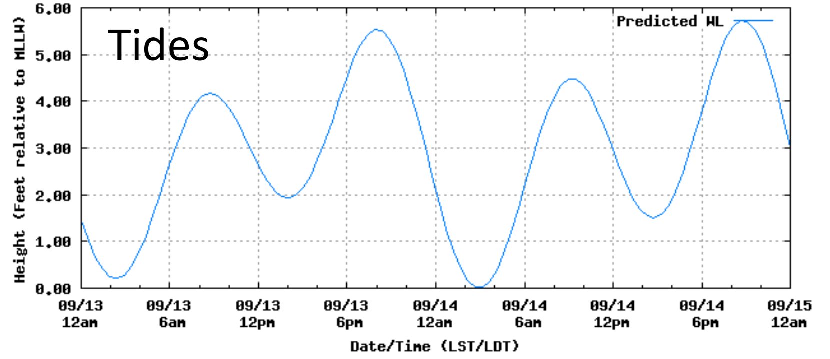




- Differences not significant
- Probably a bit larger FOV with mono cameras/amber lights
- Need to correct for habitat type and possibly time of day
- Tending towards white

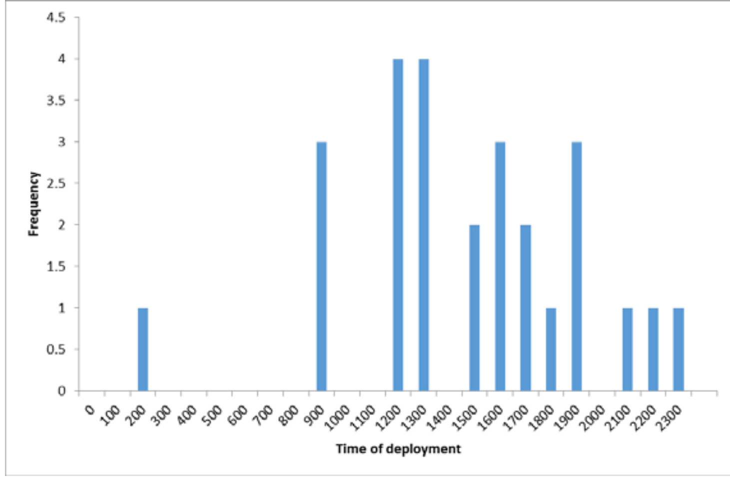
Time of day comparisons

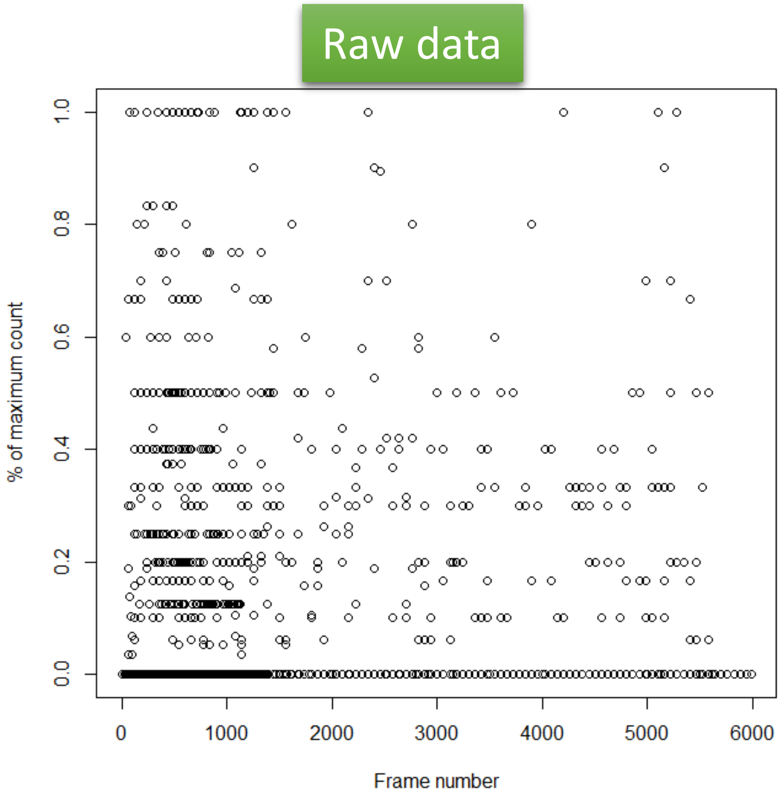


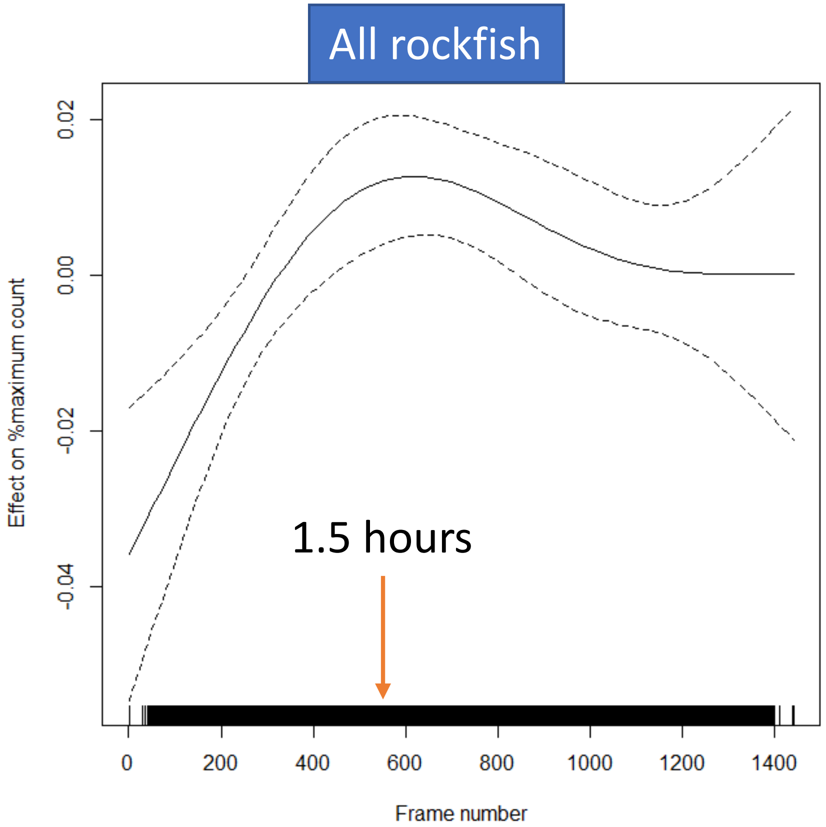


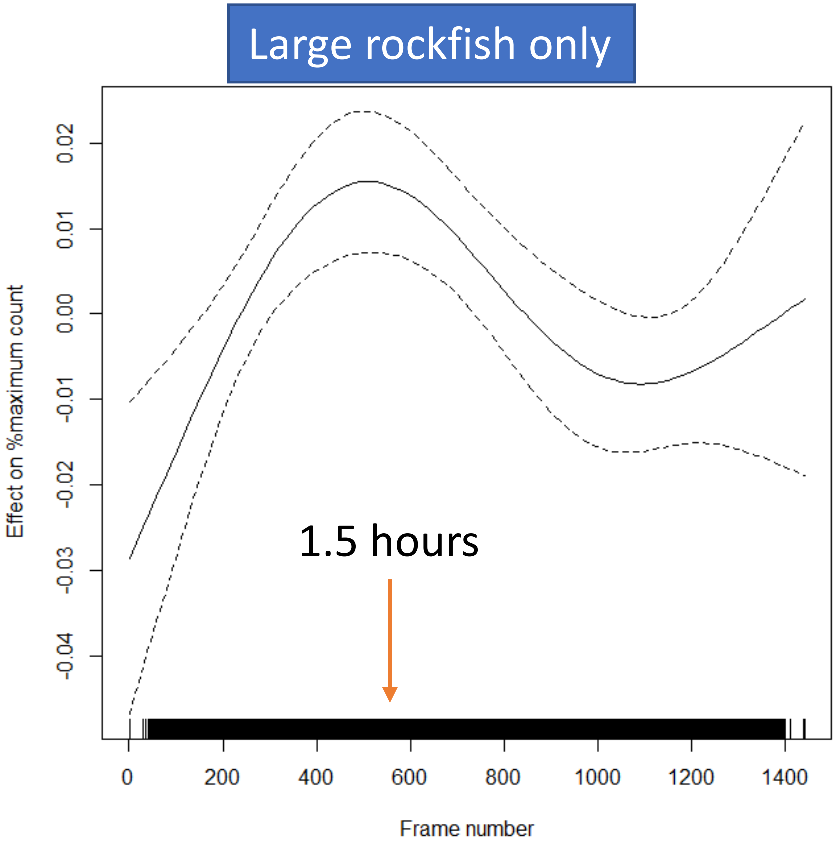
Time since deployment

- Peak counts occur ~ 1.5 hours after deployment
- Consistent across size classes
- Haven't accounted for factors (time of deployment)



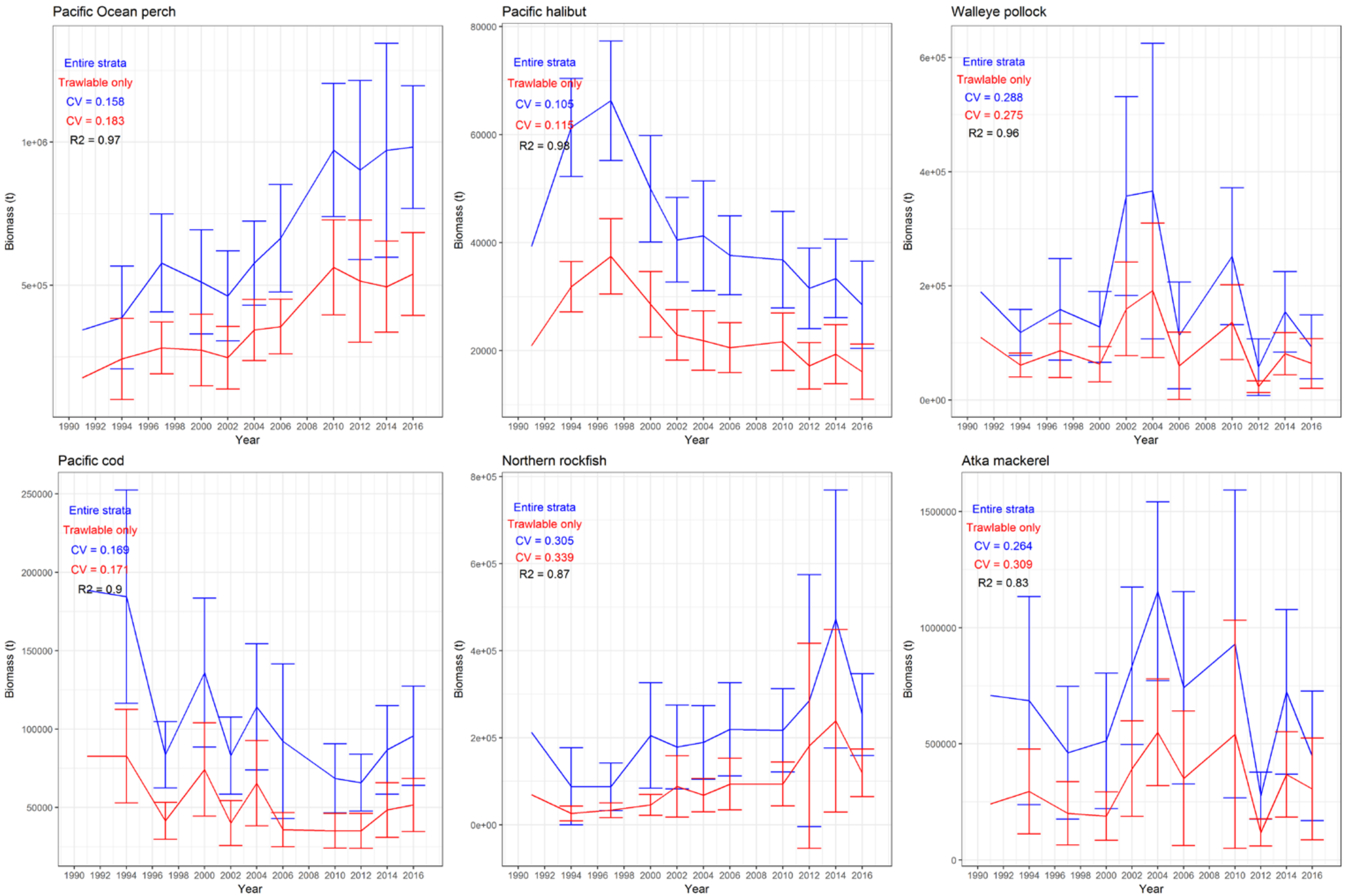






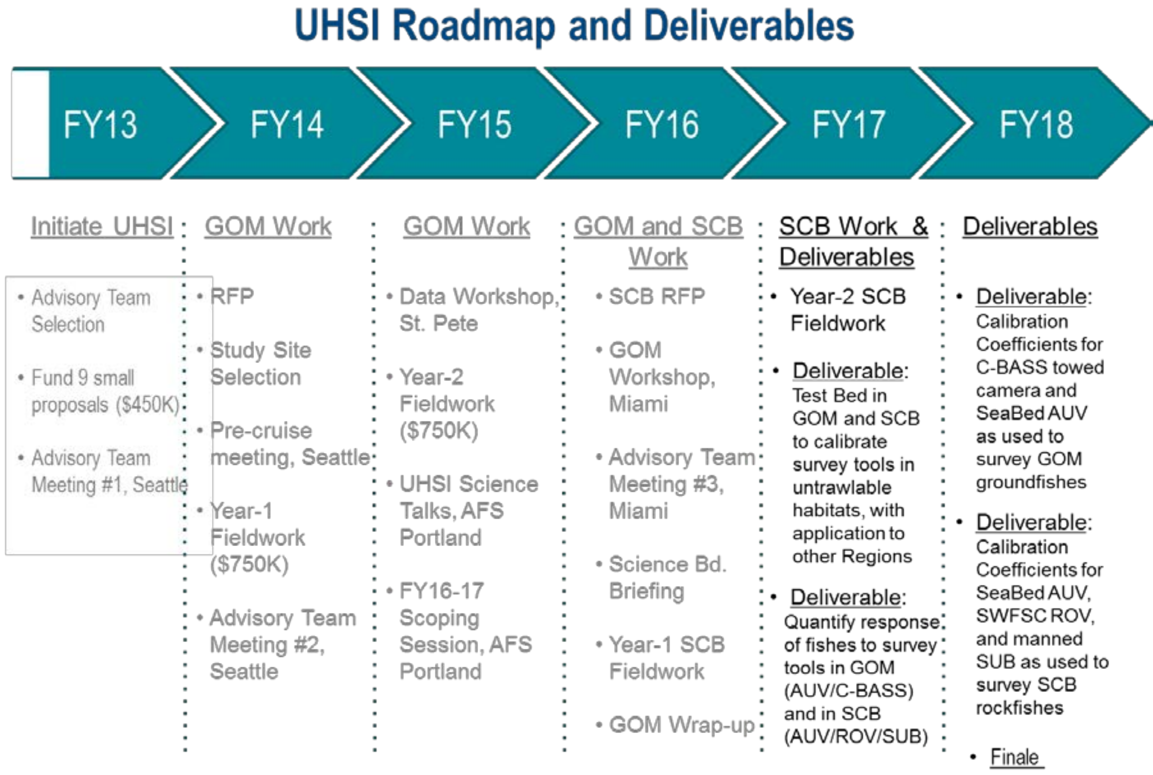
Accounting for UT areas in the AI survey

- Not much change in trend (estimates highly correlated)
- CV's slightly larger for trawlable only
- Estimates for most species about ½ of current (~53% Untrawlable)



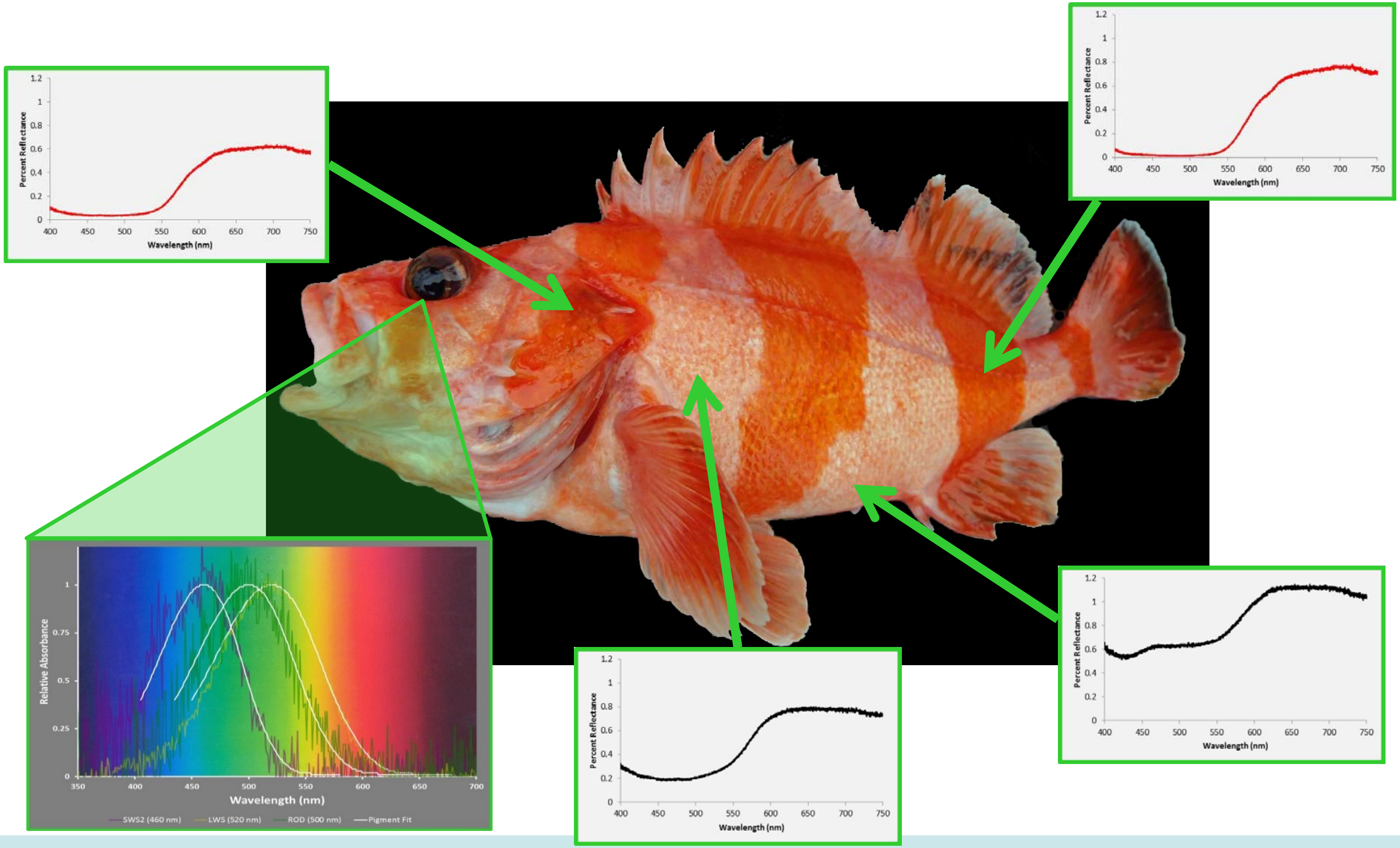
Untrawlable Habitat Strategic Initiative

1. Assess the behavior of fish to the introduction of novel gears in the environment.
2. Estimate the change in local density attributed to a transiting vehicle.
3. Estimate the sampling efficiency and survey capabilities of each vehicle.
4. Calculate platform and species specific sighting functions.
5. Evaluate the effectiveness of the test-bed method of experimentation.
6. Vehicle and sampling recommendations

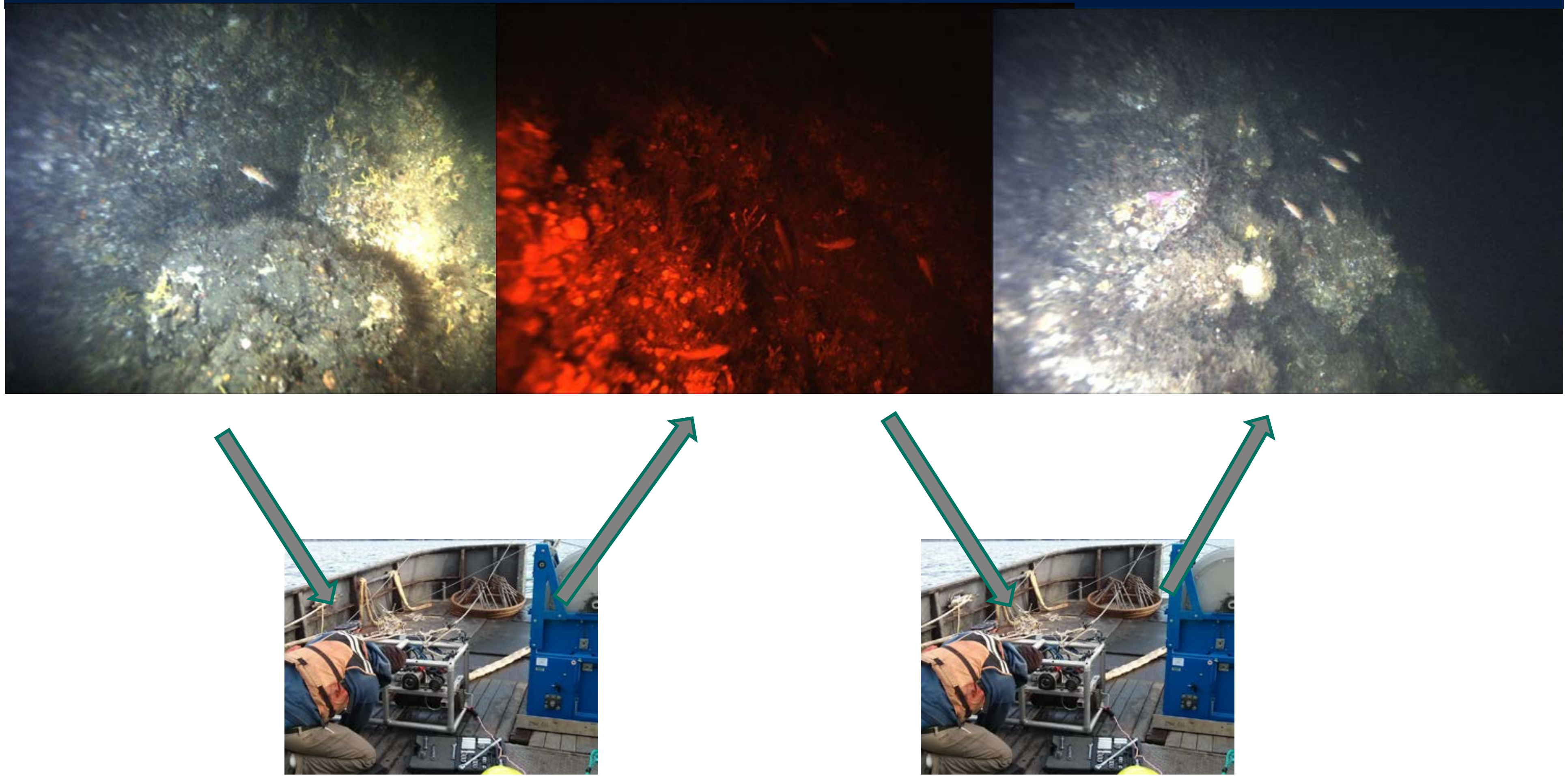


https://www.youtube.com/watch?v=RjzC1Dgh17A

Britt, L, and E. Loew. Rough draft. Determining the spectral sensitivity and reflectance of California Rockfishes (Sebastes).



Methods: Stereo Drop Camera

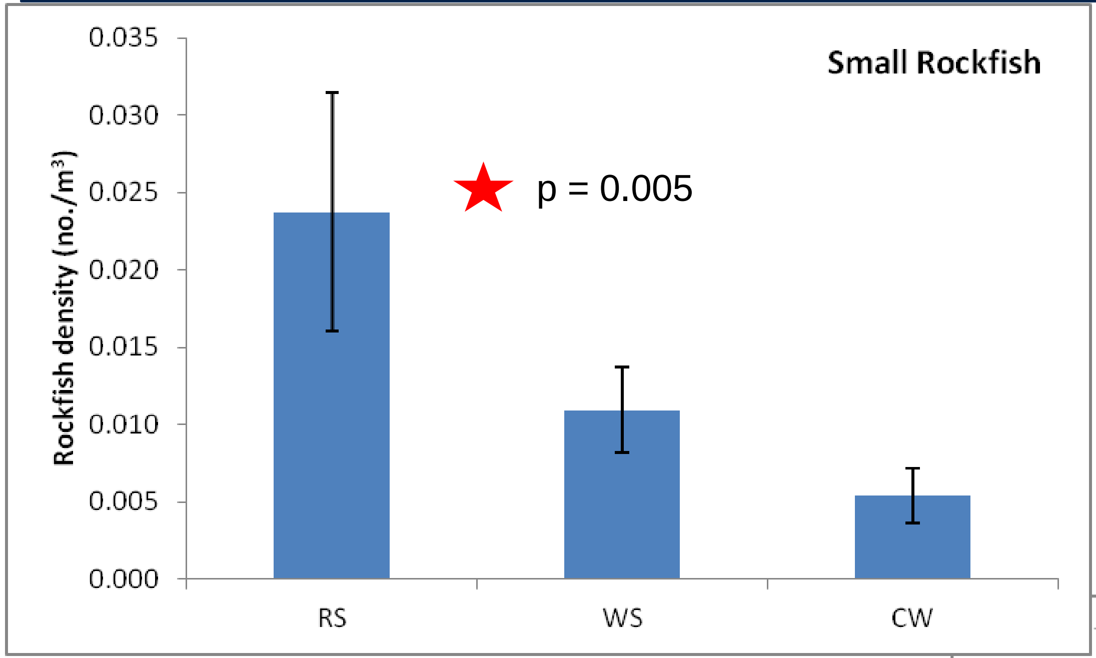


Data

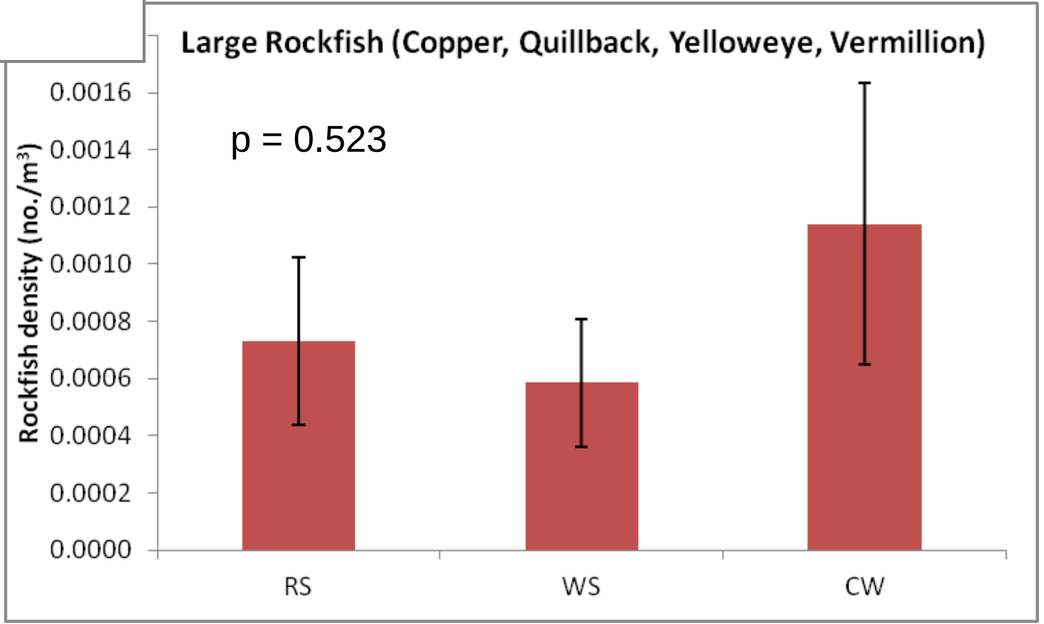
- Soft (sand, pebble, mud) or Hard (cobble, boulder, bedrock)
- Species ID
- Count

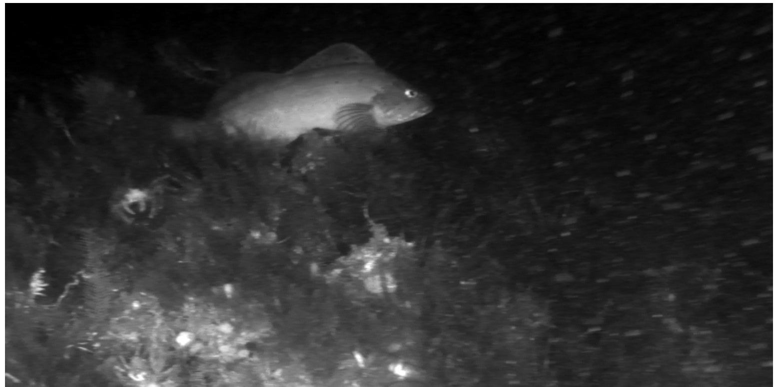
Results: Rockfish Density

Treatments = Red strobe (RS), white strobe (WS), constant white (CW)



Post-hoc
RS & WS > CW





UHSI Year-1 Southern California Bight Test Bed Experiment

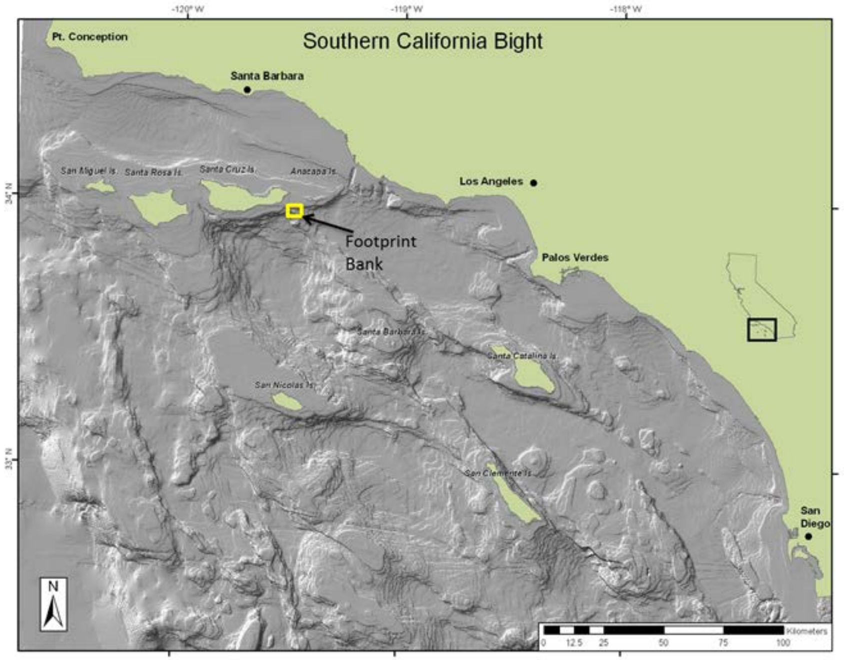
Coordinators: Clarke, Wakefield, Yoklavich

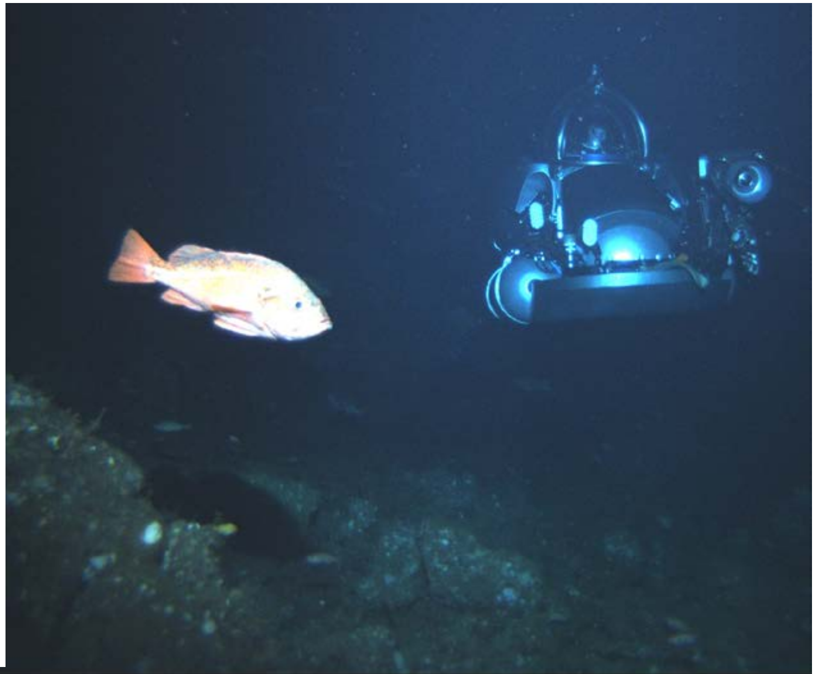
Objective:

To understand the effects of optical and acoustic survey vehicles on the behavior of rockfish species living on or near untrawlable (rocky) deep habitats

Challenges to Rockfish Surveys in Untrawlable Habitats

- Offshore deep water (100-150 m)
- Dark (requires artificial lighting)
- Diverse rocky habitats with patchy spatial distributions
- Diverse assemblage of species, many resembling one another



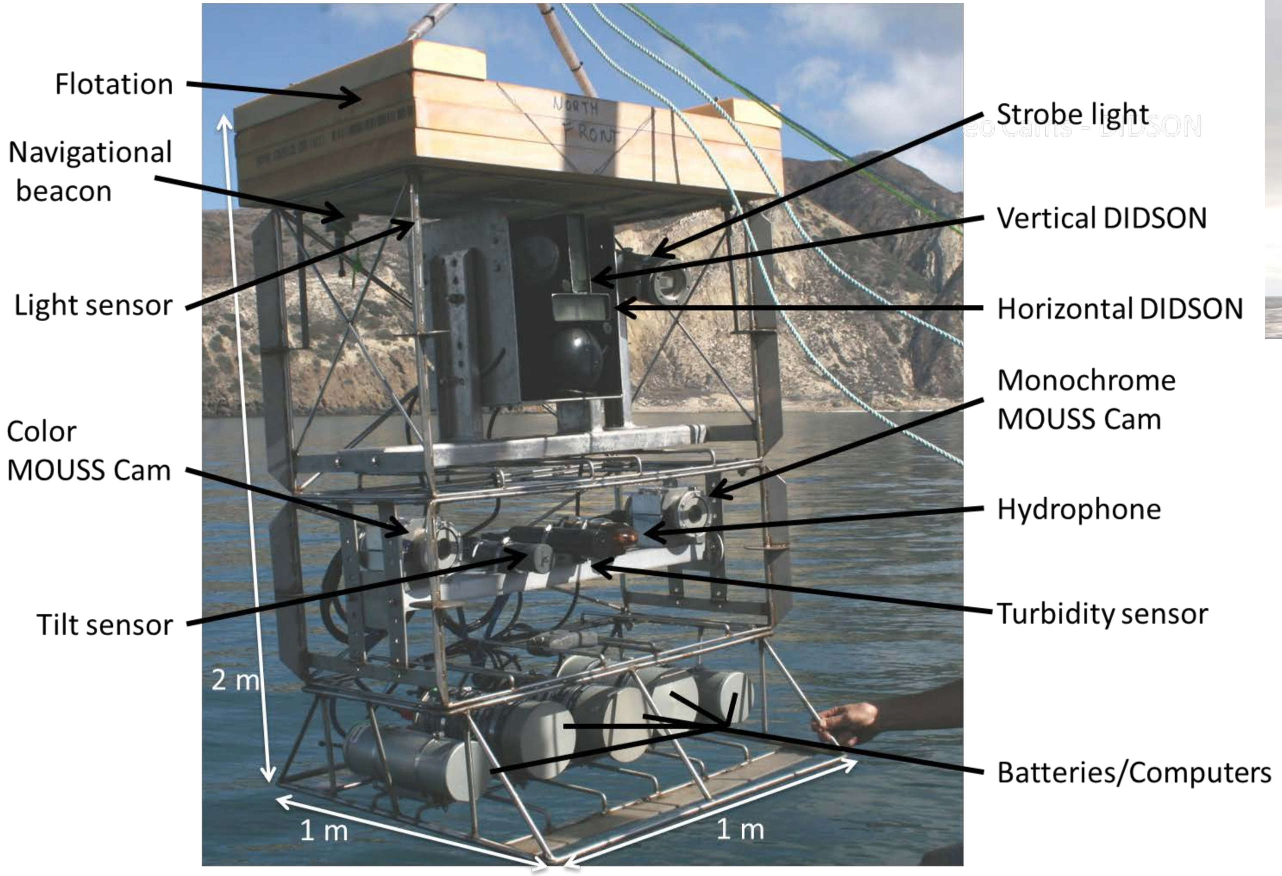


Approach to Quantify Rockfish Reactions to Mobile Survey Gear

October 19-30, 2016: Deploy visual and acoustic cameras on fixed surveillance platforms on top of Bank

- Researchers from SWFSC, NWFSC, SEFSC, AFSC, UCSB
- Use of NOAA R/V *Lasker* and contracted R/V *Velero IV*
- Monitor fish reactions to movement/noise/light associated with mobile survey tools
    - Metric is change in fish behavior and abundance before, during, after passage by mobile tool

Surveillance Systems: MOUSS-DIDSON Platforms

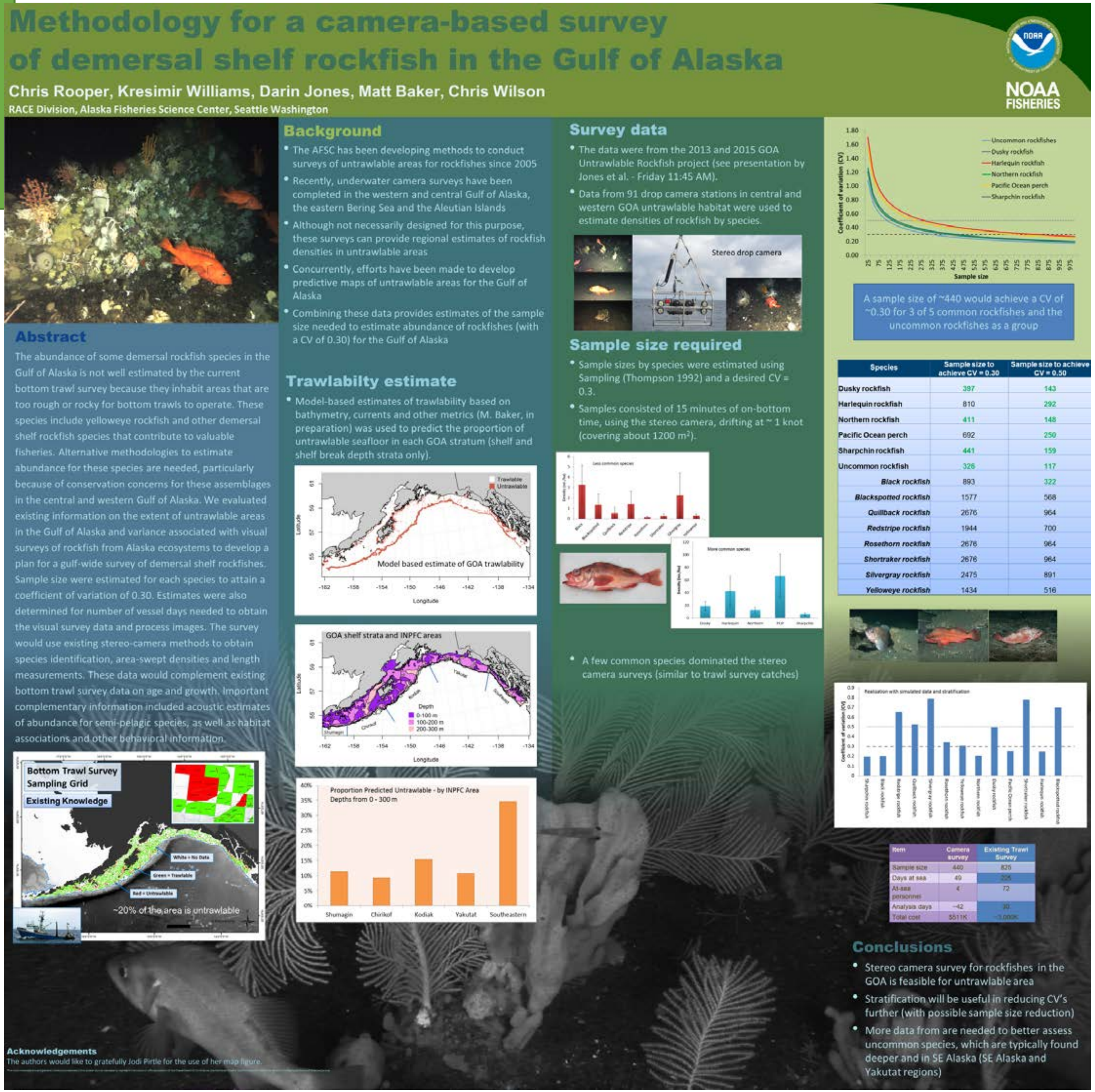



NWFSC PIFSC SeaBED AUV


DeepWorker Manned Submersible

What have we done so far? Sample Size Estimation for DropCam Survey

- ~ 440 to 2500 transects depending on the target species/area



Summary Research in Trawl Survey(?) Parlance

Acoustic-optic assessment

- Zhemchug
- Snakehead
- GOA AT Surveys (2013-2017)
- Footprint Bank study - UHSI

Availability to trawl survey

- Snakehead
- Q estimation project
- Aleutians SSL project
- Diel behavior studies

Gear efficiency/Behavior

- Puget sound RF lighting project
- Vision project
- UHSI vehicle response
- Dead zone projects
- Footprint study

Survey Design/Analysis

- Image processing automation
- Sample size estimates
- Q estimation project
- Volumetric density estimation
- Aleutian untrawlable area effect study

Conclusion

We know something about a lot of these things

What works/Doesn't work/Needs more work
Topics for Friday Discussion

Things that work

- Acoustic-optic methods (for some species)
- TrigCam (for all species)
- Towed camera (for some species)

Things that don't work/need more work

- Demersal and semi-pelagic species – No one method will work for all?
  - Partitioning the dead-zone
- Daytime surveys needed - Diel vertical and horizontal(?) migration
- Rockfish target strength – unknown
- Camera avoidance and attraction – Species specific
- Sample sizes (especially for TrigCams)
- ROV/AUV/SUB probably not an option (cost, large area)

What are we proposing for survey
Topics for Friday Discussion

- Acoustic-optic methods
- Towed camera transects
- Complemented by TrigCam experiments to get at some of the remaining questions

What we need to decide

- Ideally random placement of stations/transects/acoustics into untrawlable areas – is this feasible
- Sample design (stratified random only untrawlable or both)
- Others?

Further Topics for Friday Discussion

- What is the best platform? (Lasker in FY19?)
- How are we paying for this?
- Can we deliver results in parallel with survey (i.e. in the same year)?