

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.

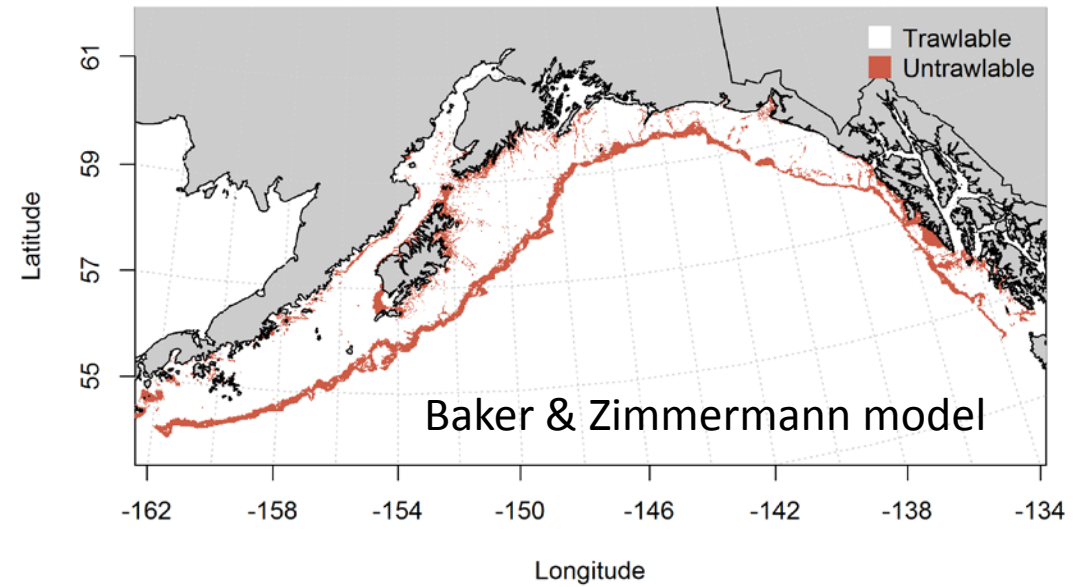
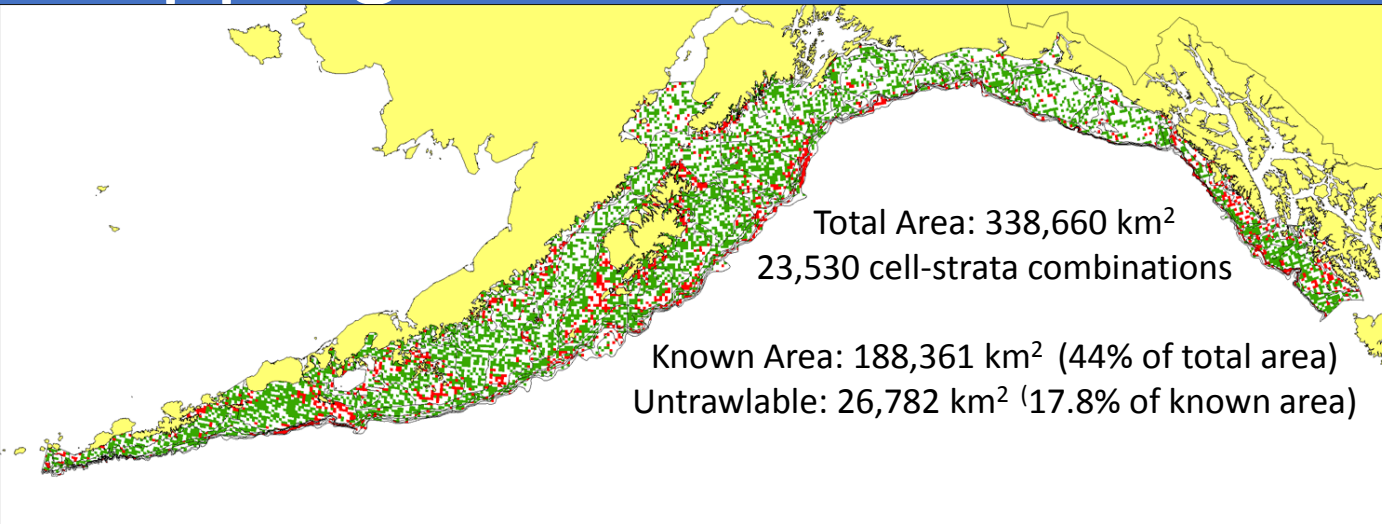
How big is the problem (how much untrawlable area is there)?

What have we done so far?

Untrawlable Habitat Strategic Initiative results

What works/doesn't work?

How Big Is The Problem? Mapping Untrawlable Areas



Ongoing Projects

Trawlability grid (Palsson, Von Szalay)

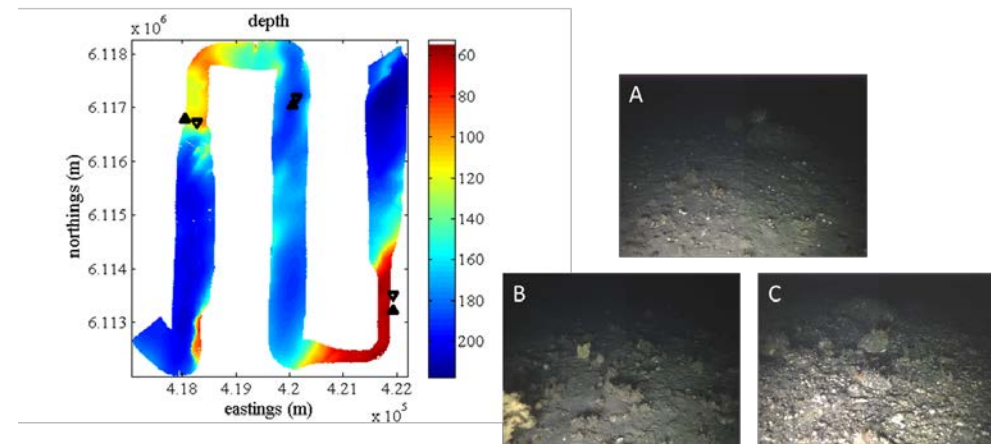
Modeling – Smooth Sheets (Baker, Zimmermann)

Modeling – ES60 (Von Szalay, Jorgensen)

Modeling – ME70 (Stienessen, Pirtle)

Mapping – Multibeam (McConnaughey)

Stienessen & Pirtle



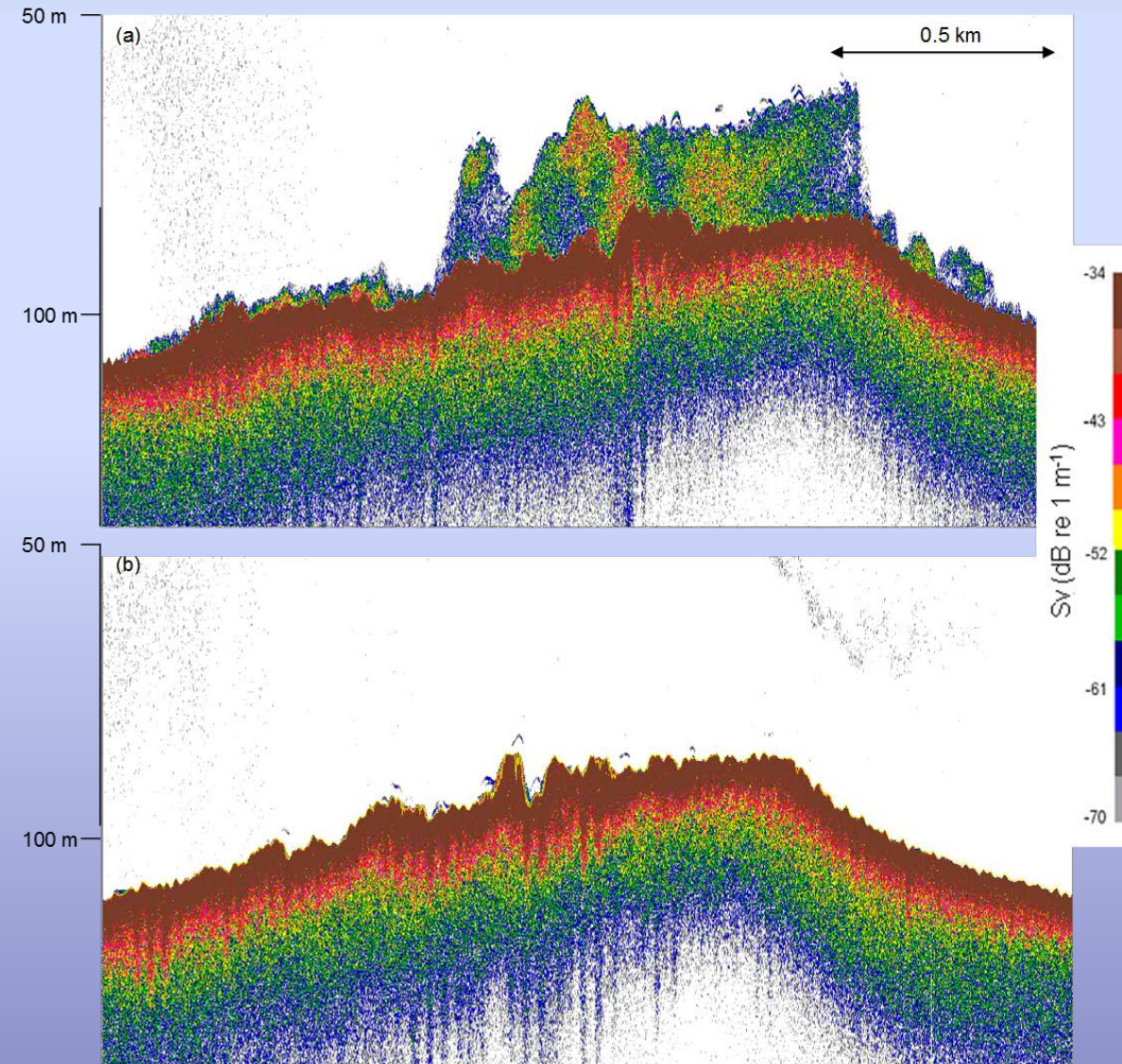
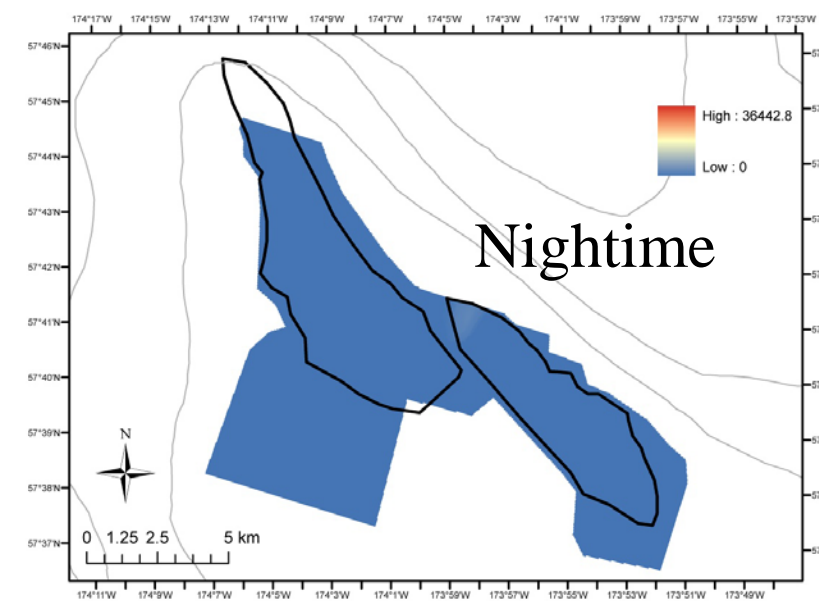
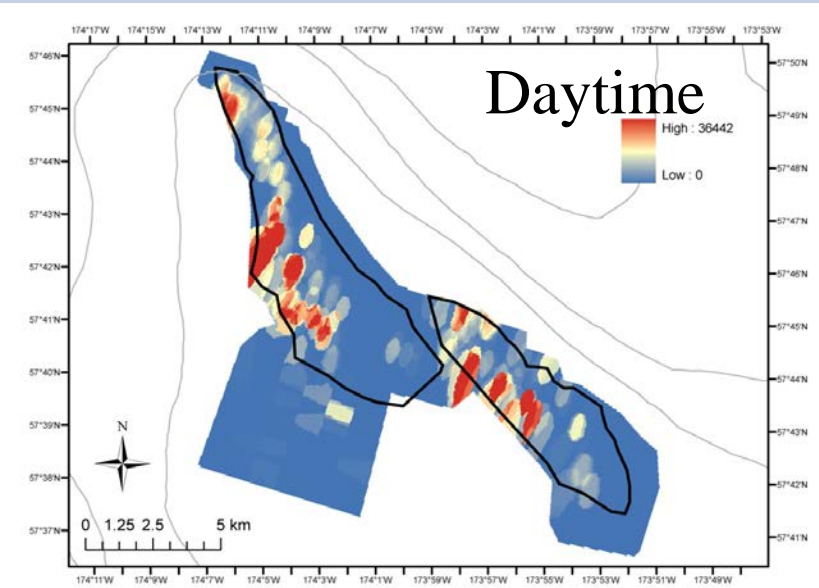
Study #1 – Zhemchug Ridges



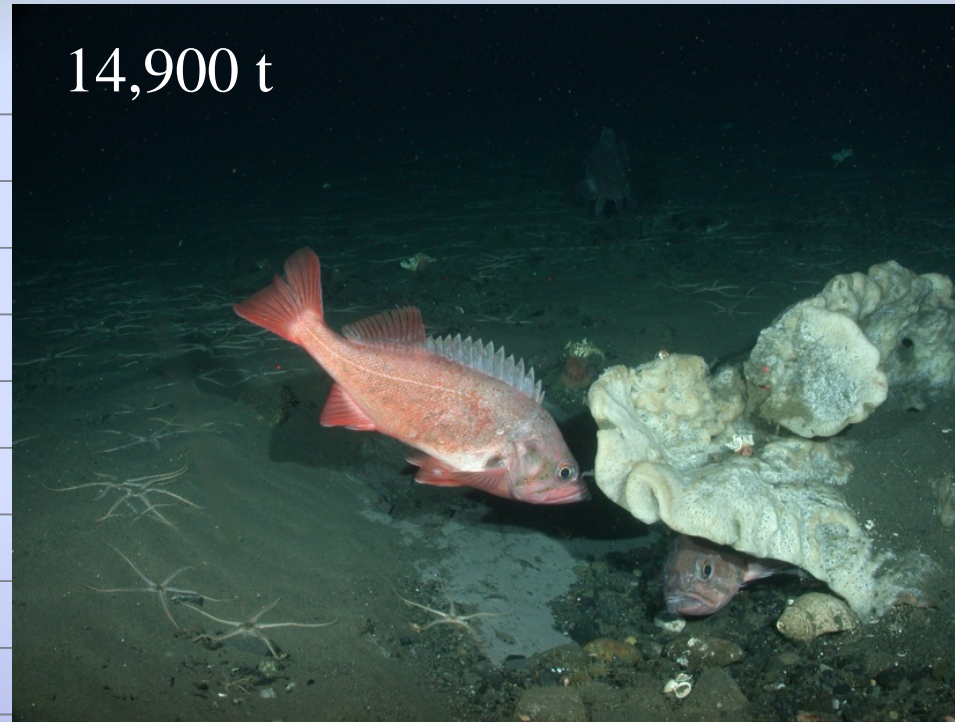
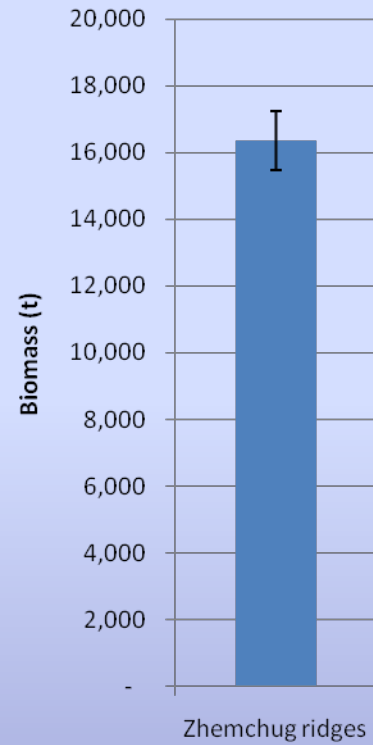
Study #2 – The Snakehead



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

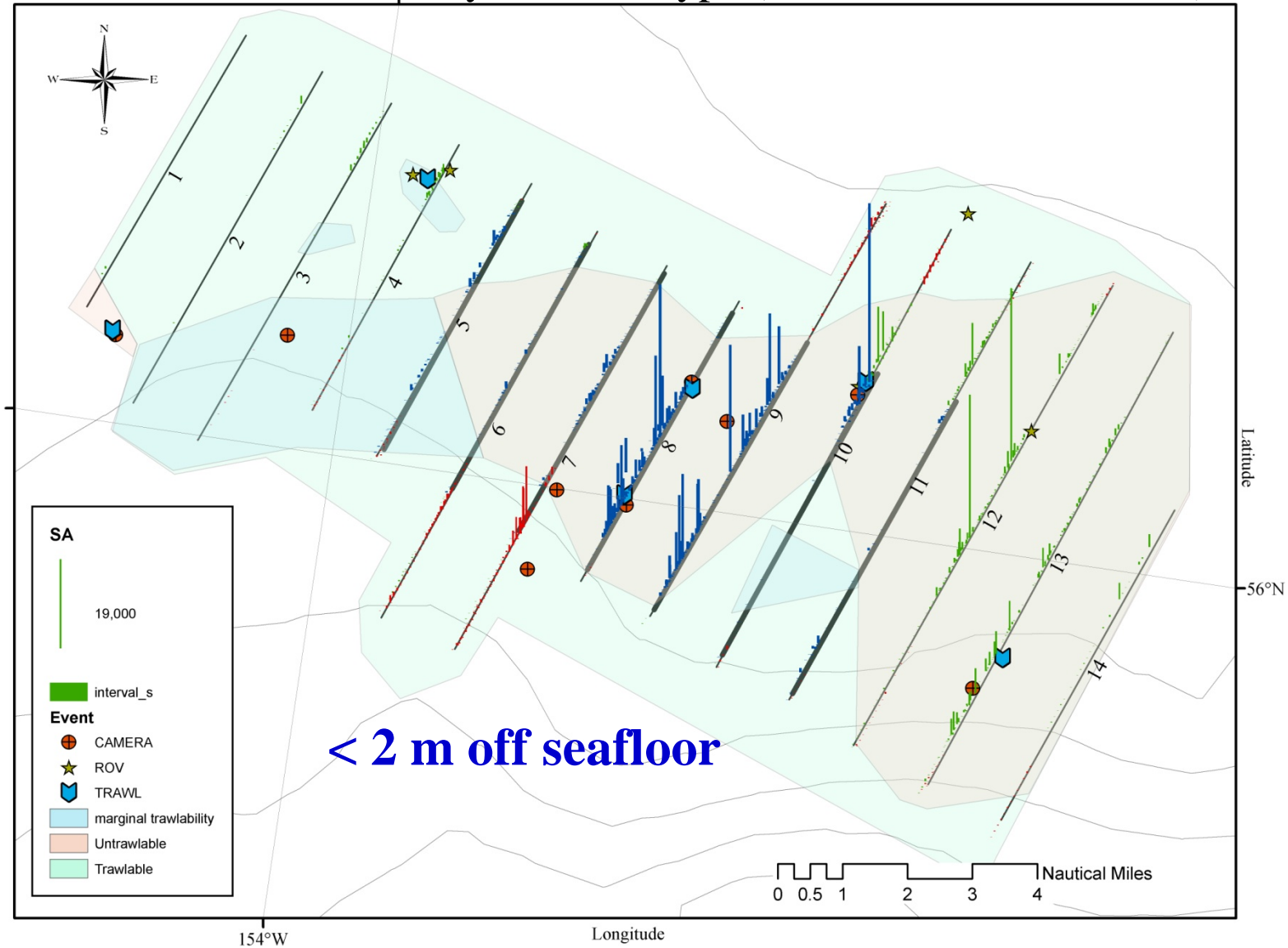


Biomass Estimate for Zhemchug ridges (~60 km²)



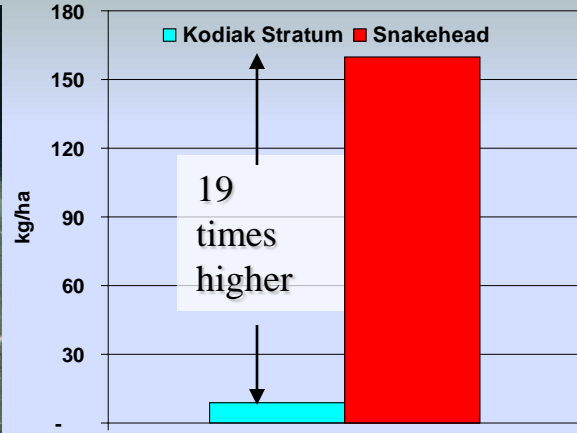
1. Collect calibrated acoustic data along survey path

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



Snakehead/Kodiak Area Stratum (kg/ha)

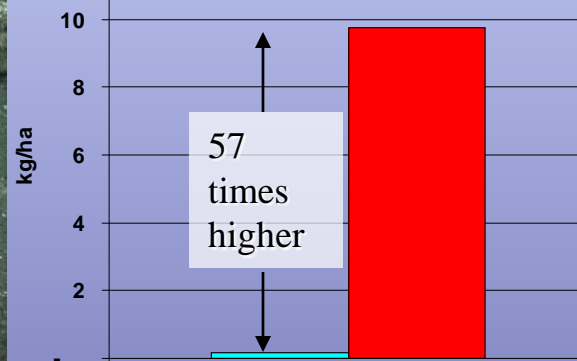
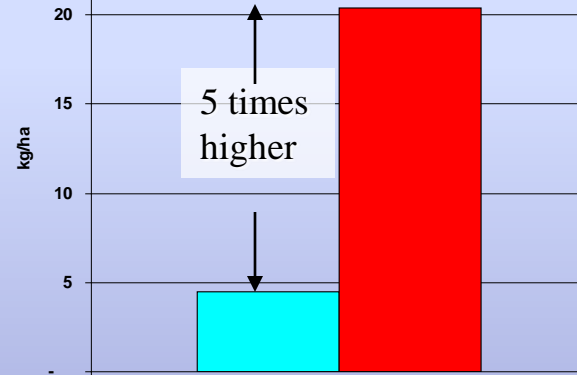
0.33% of Kodiak Area depth stratum



Dusky
Rockfish



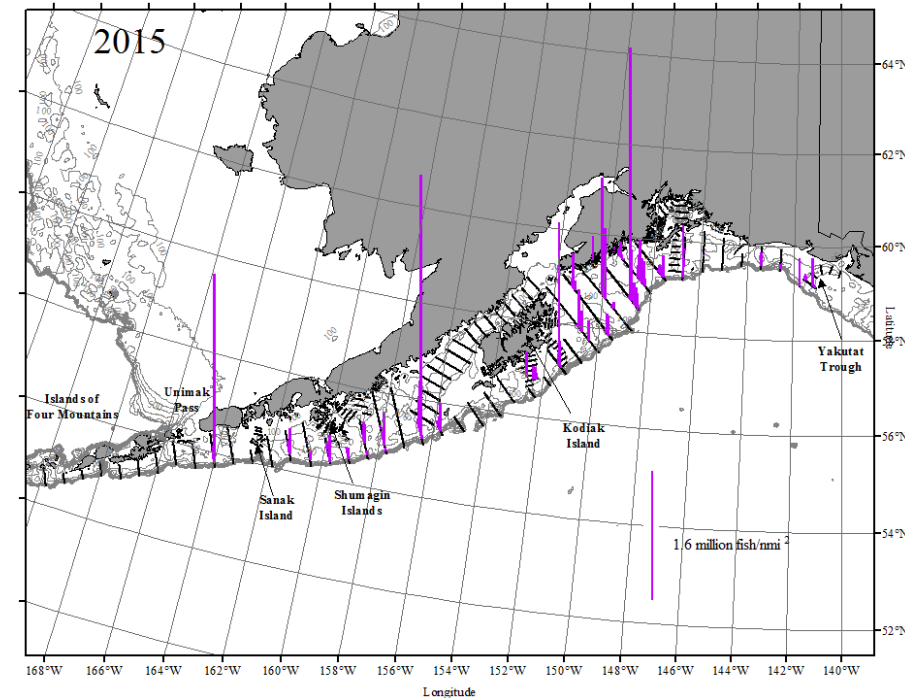
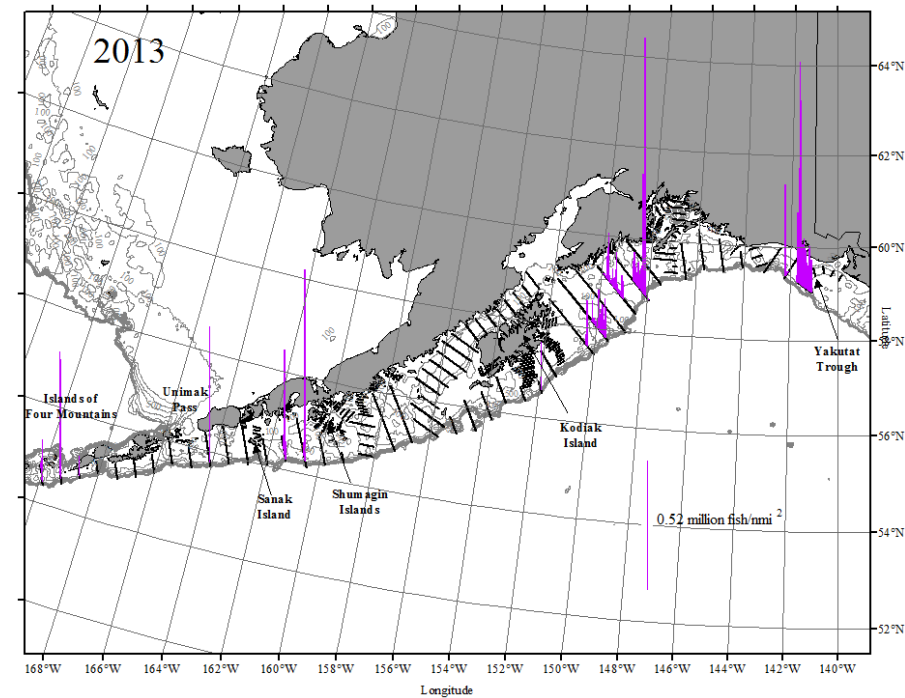
Northern
Rockfish



Harlequin
Rockfish

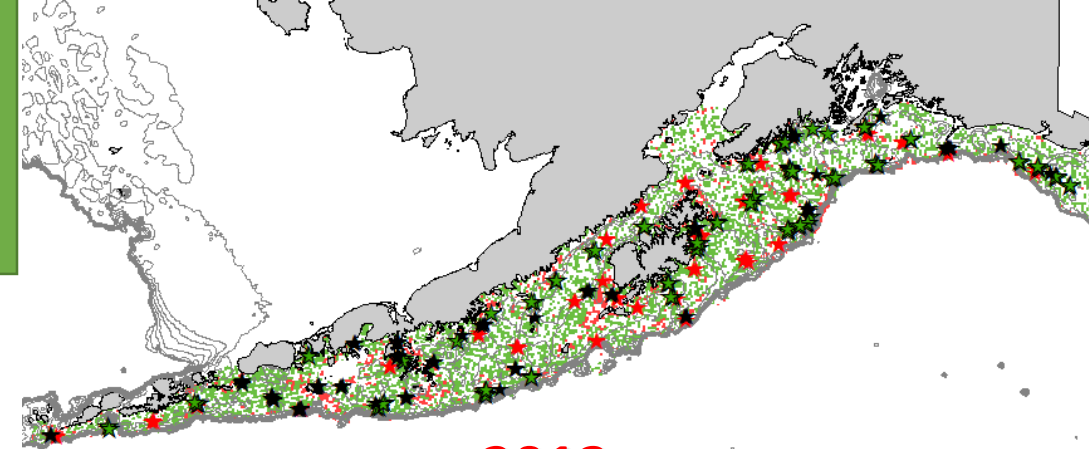
What have we done so far? Acoustic-Trawl Surveys (2011-2017)

- 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

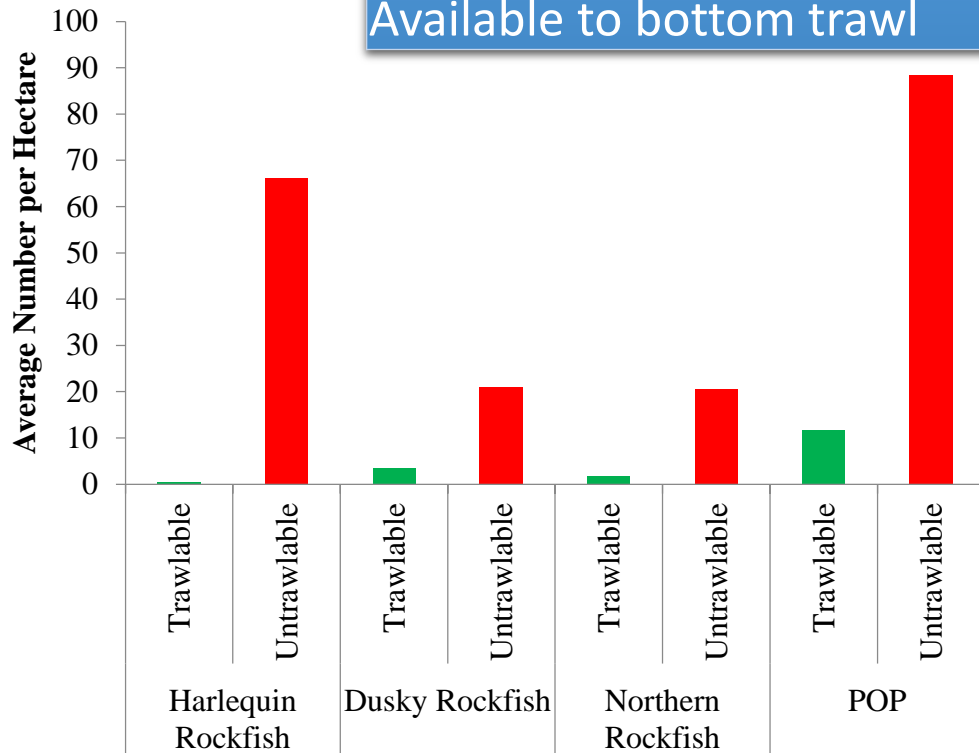
- **16 trawlable, 13 untrawlable**

88 Lowered Stereo camera deployments

What have we done so far?

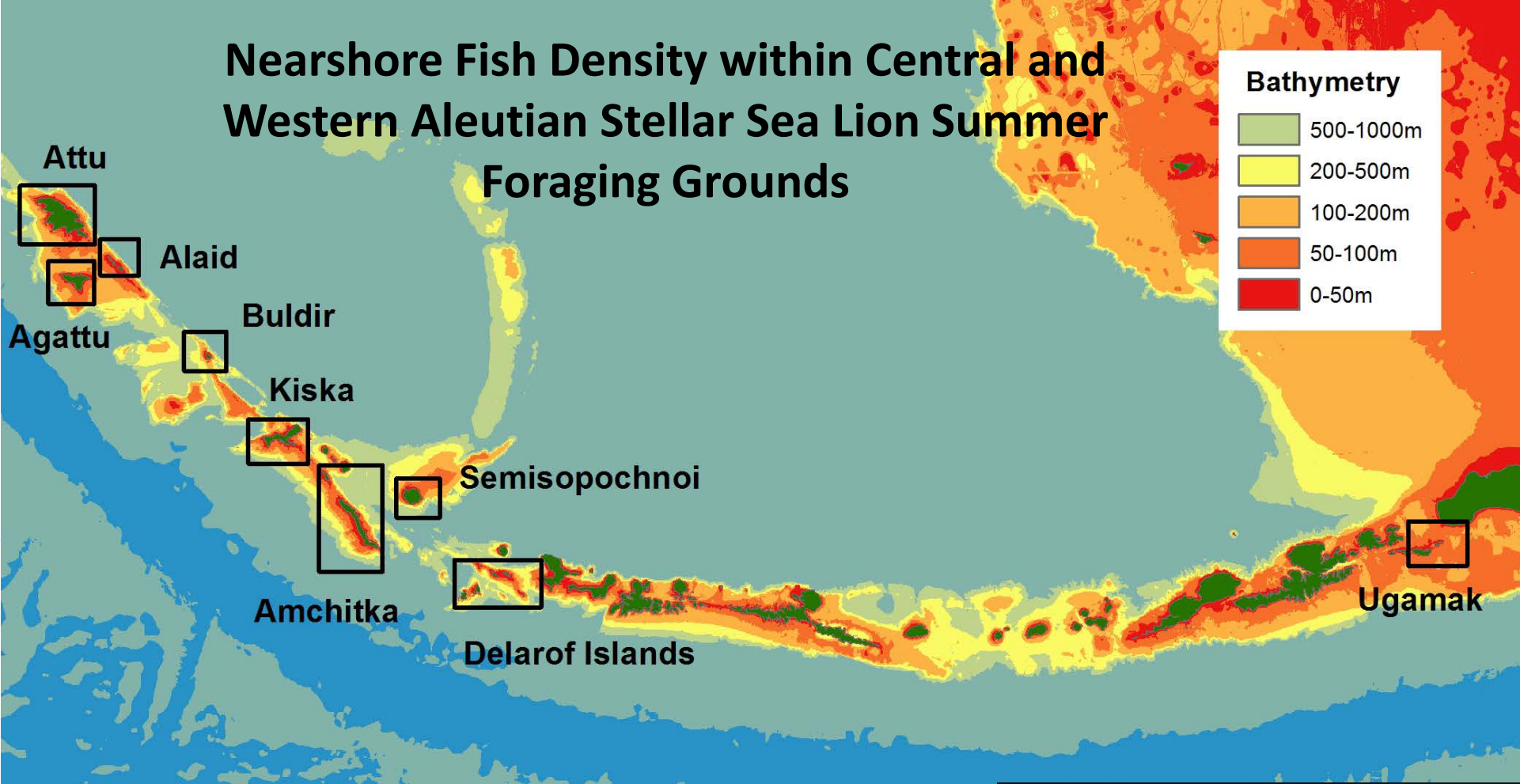
Q Estimation (HAIP Project – 2013 & 2015)

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%

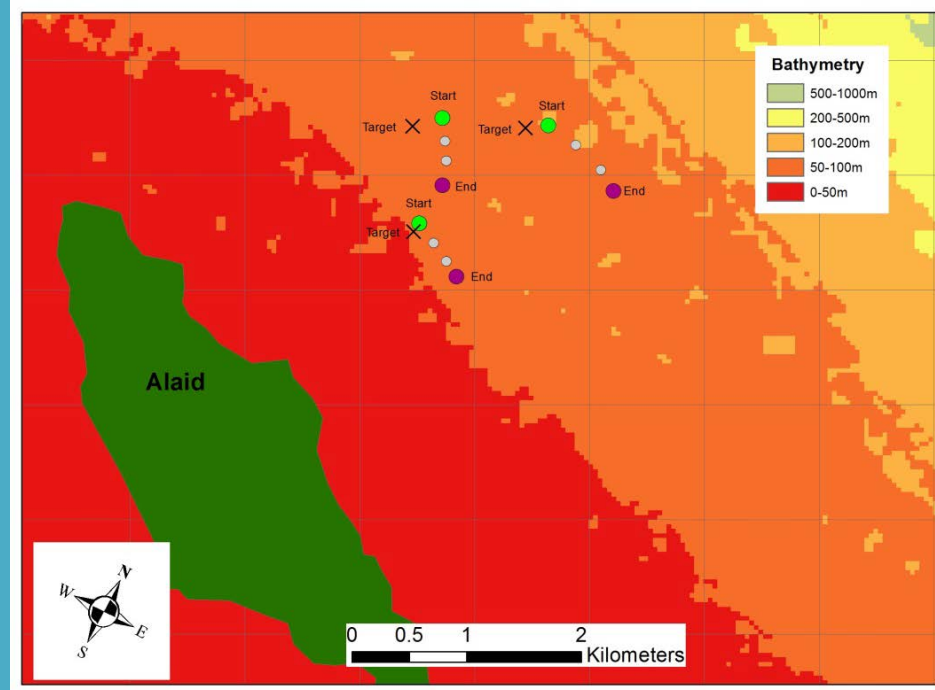


- Based on trawlability as determined from camera images
- Indication of the availability of select species to the bottom trawl

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)

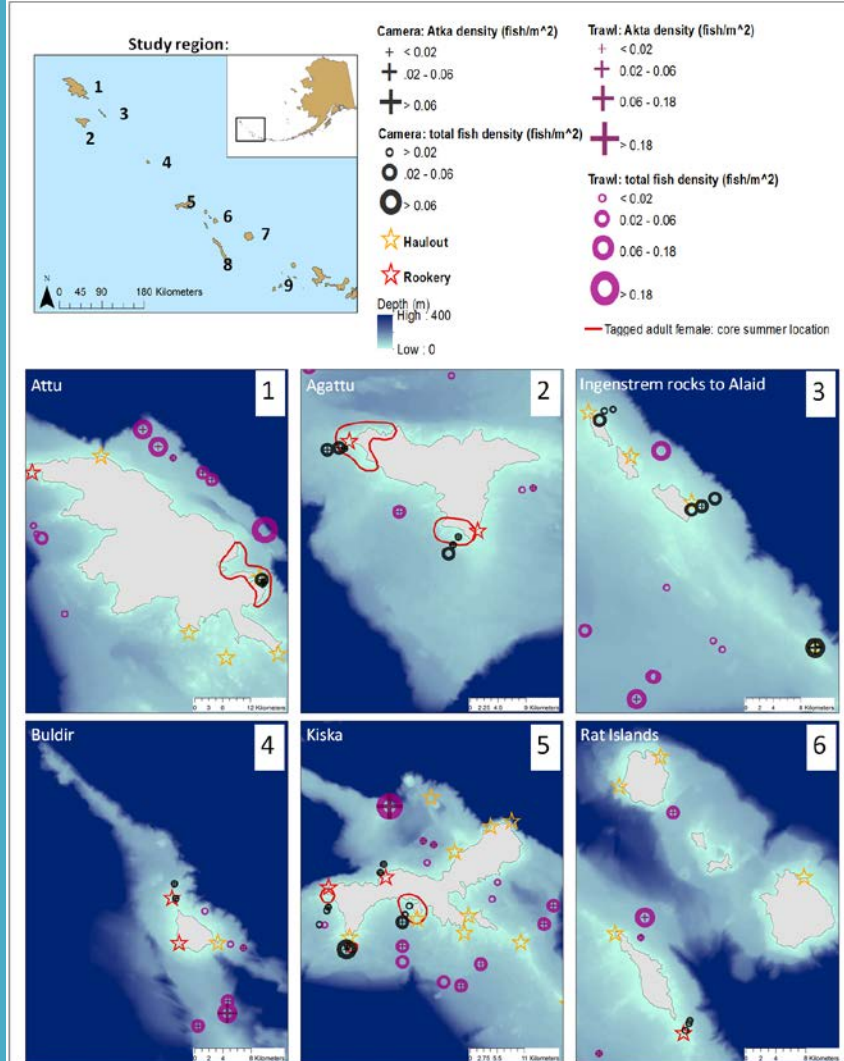


2016 – 47 transects
2017 – 17 transects



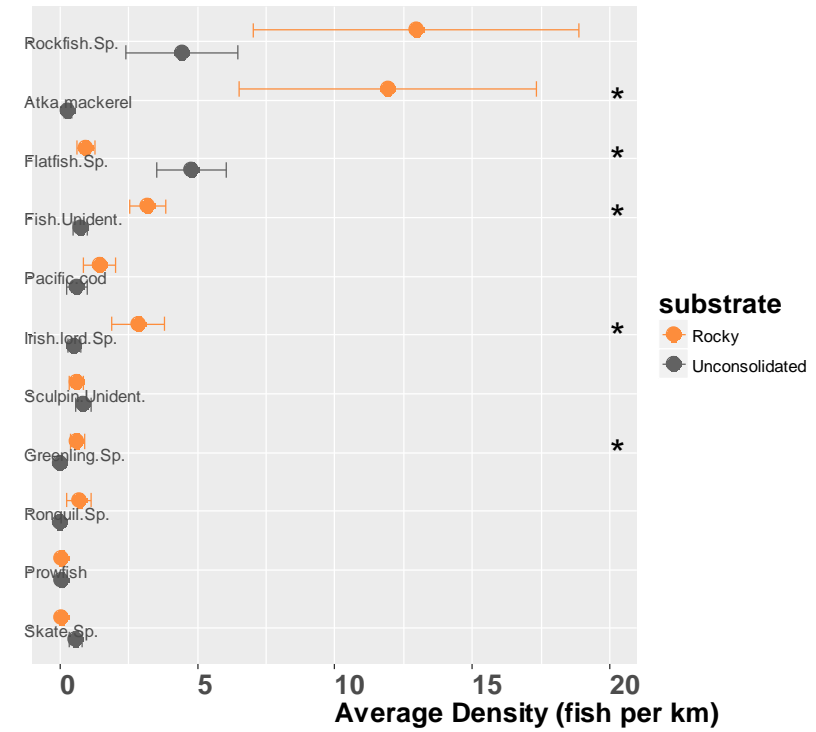
Preliminary Analysis

Comparison of Density Estimates: Camera System and Trawl Survey

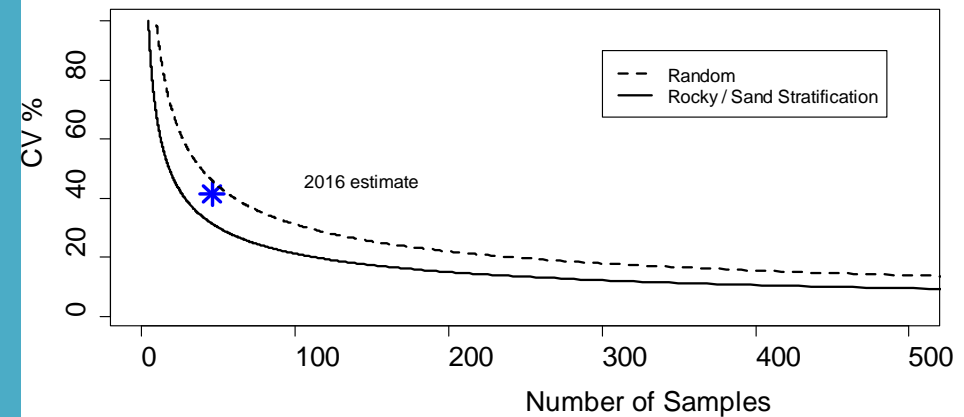


Density Estimates by Habitat Type

Average Fish Density (□ SE) per km

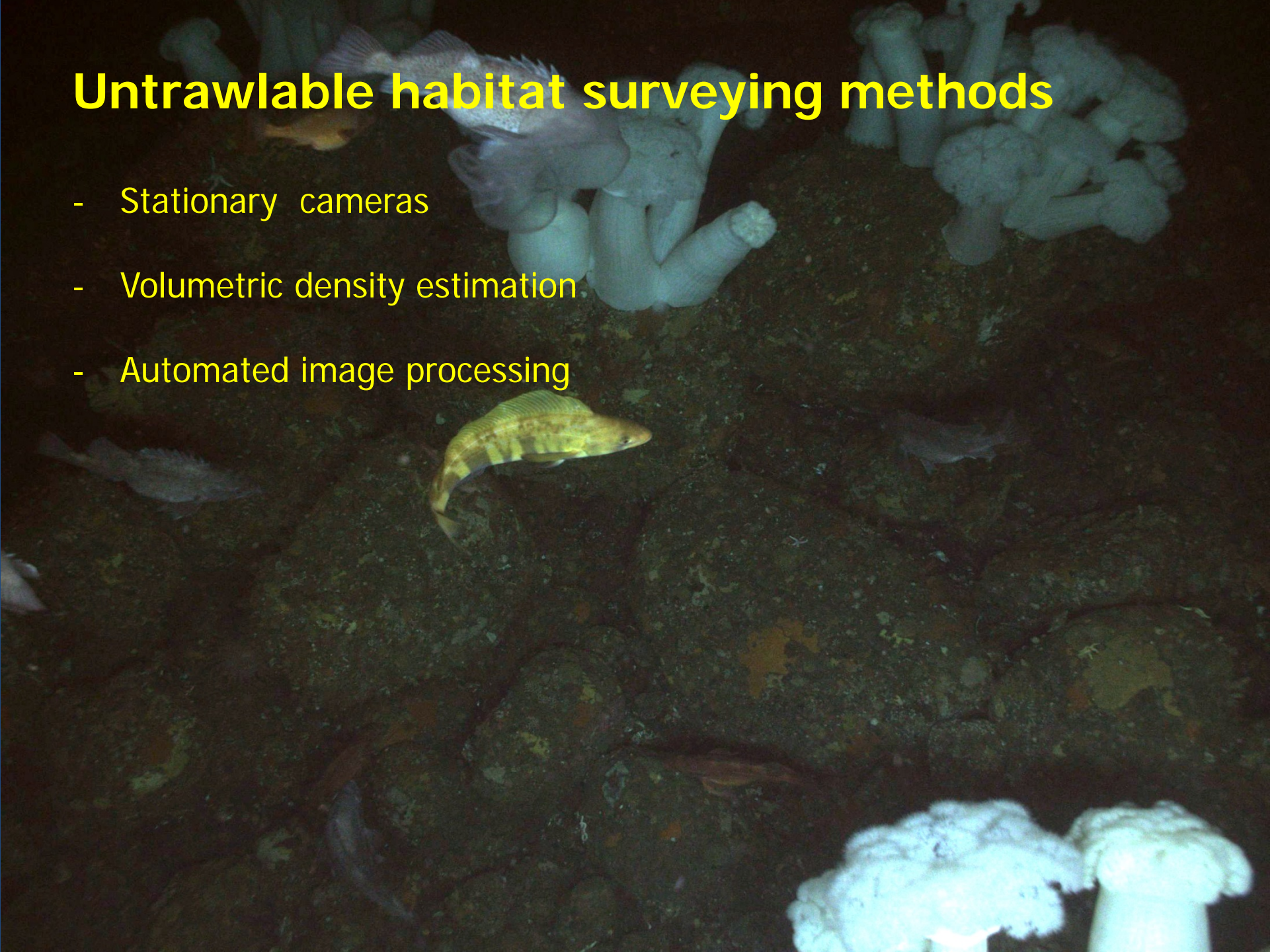


Sample size Estimates for Atka Mackerel



Untrawlable habitat surveying methods

- Stationary cameras
- Volumetric density estimation
- Automated image processing



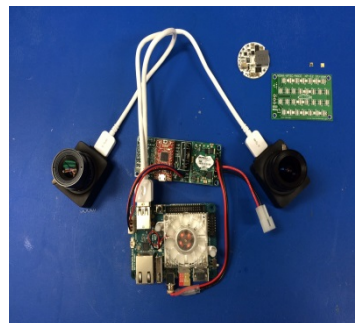
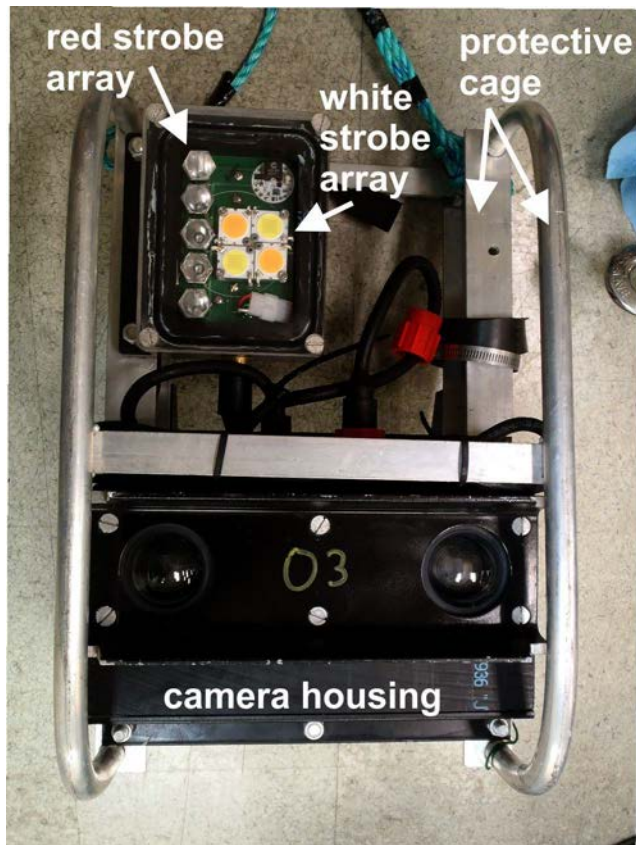
Moored, motion triggered or time lapse stereo camera systems (“TrigCams”)

Deployed similar to small pot fishing gear

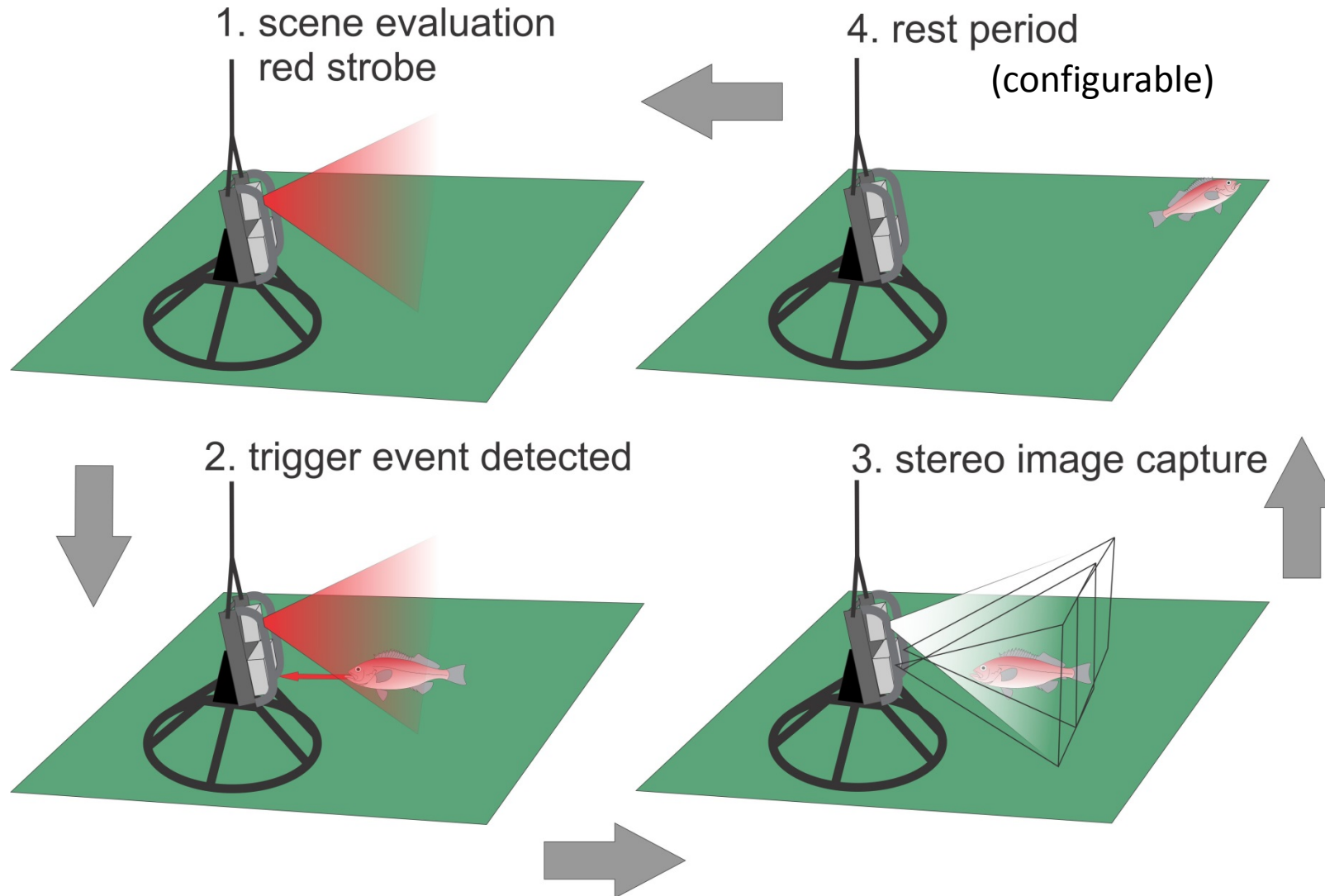
Long duration collections (24 + h)

Minimally obtrusive

Low cost

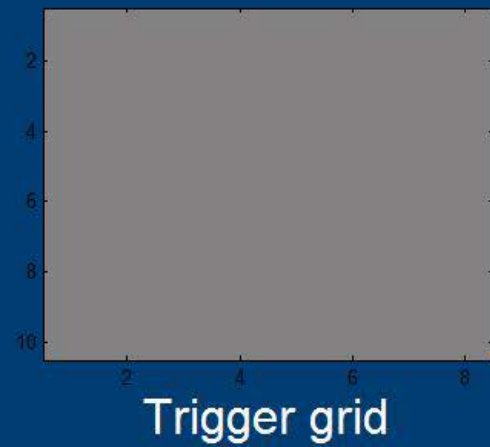
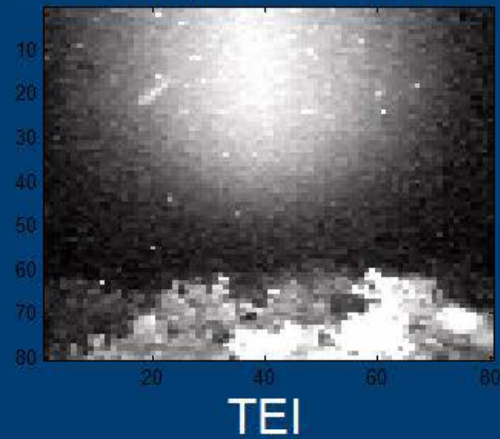


Triggering operation – the basic idea...



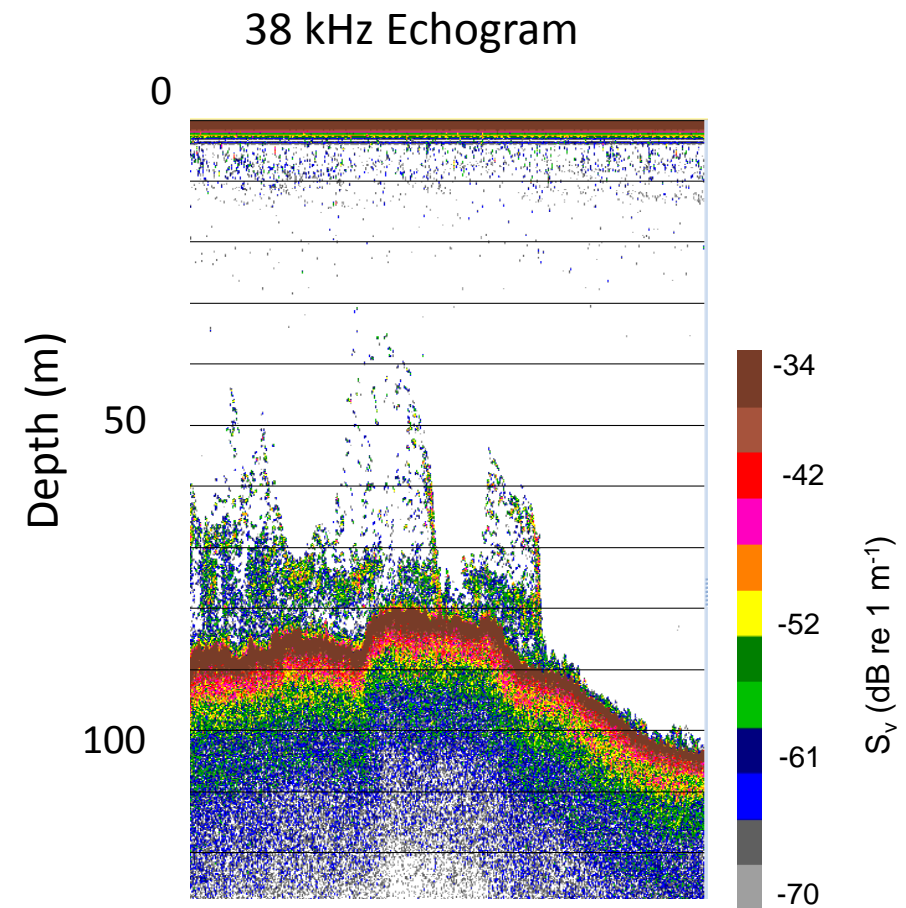
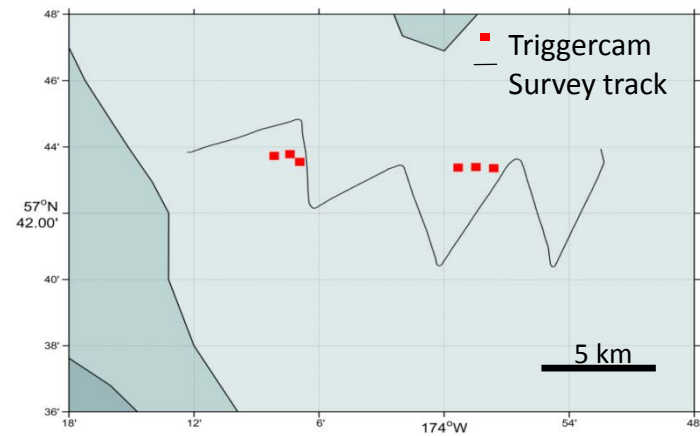
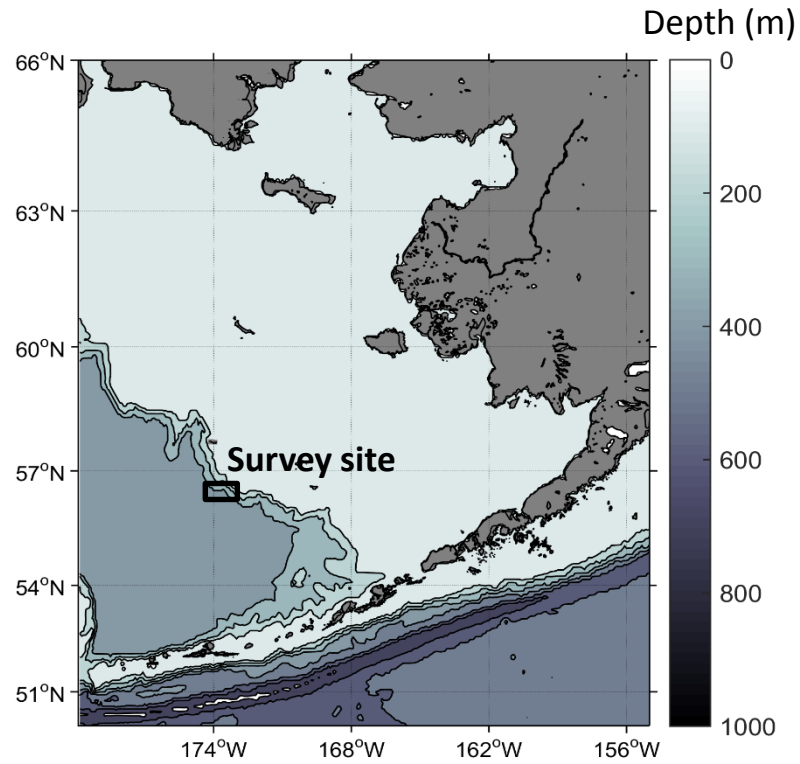
Triggercam operation example - detected 6 targets in 45 min

Time Elapsed - 00:00:03



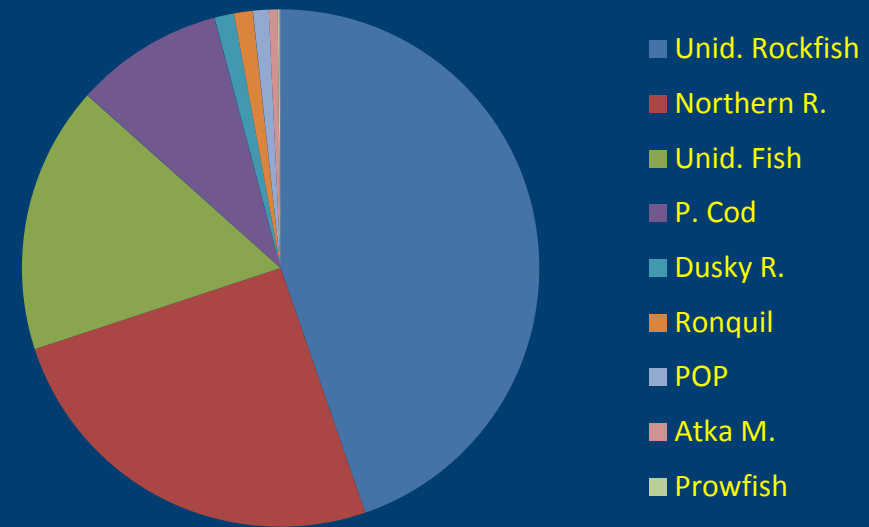
Test deployment – Zemchug Canyon, July 2014

Six units deployed for 12 hours

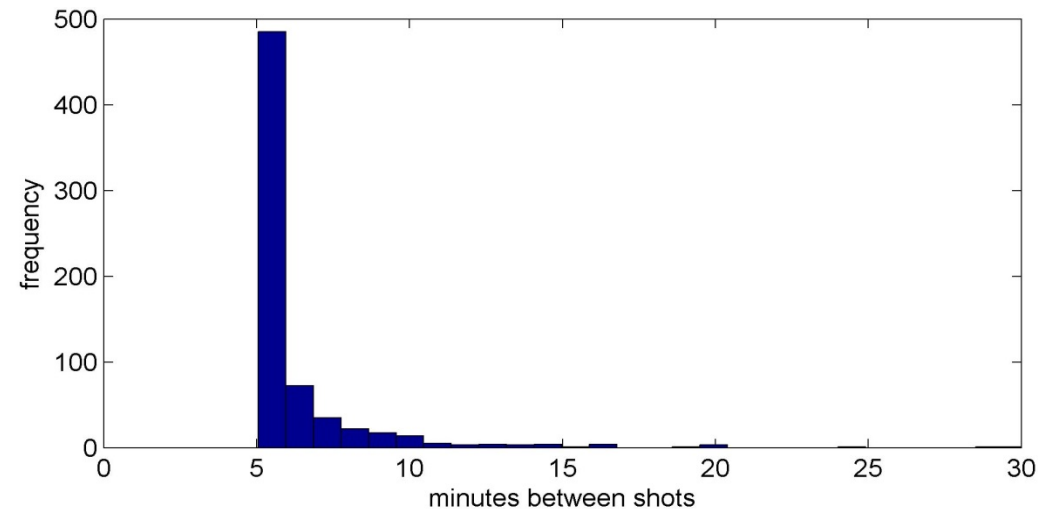


Test deployment results – triggering performance

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

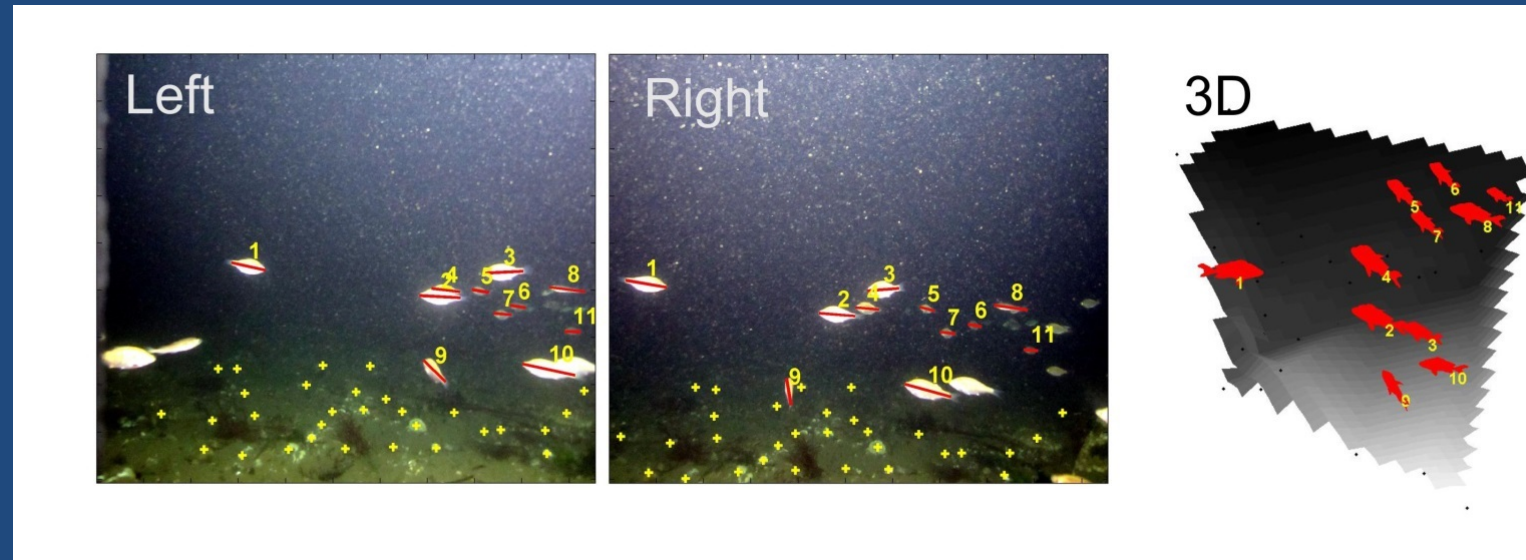


Most triggers occurring immediately after 5 min “rest” period



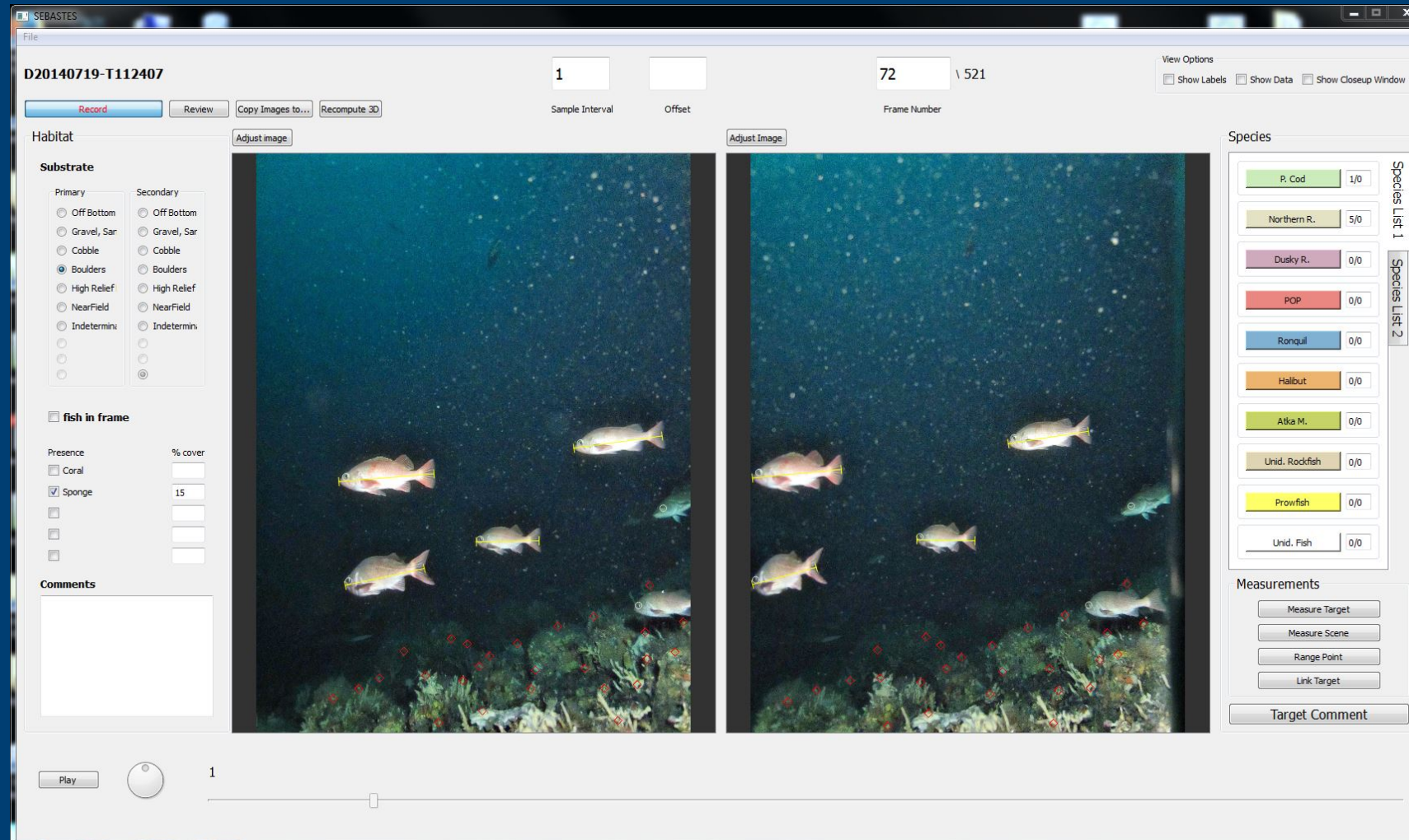
Volumetric density estimation from stereo cameras

- 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

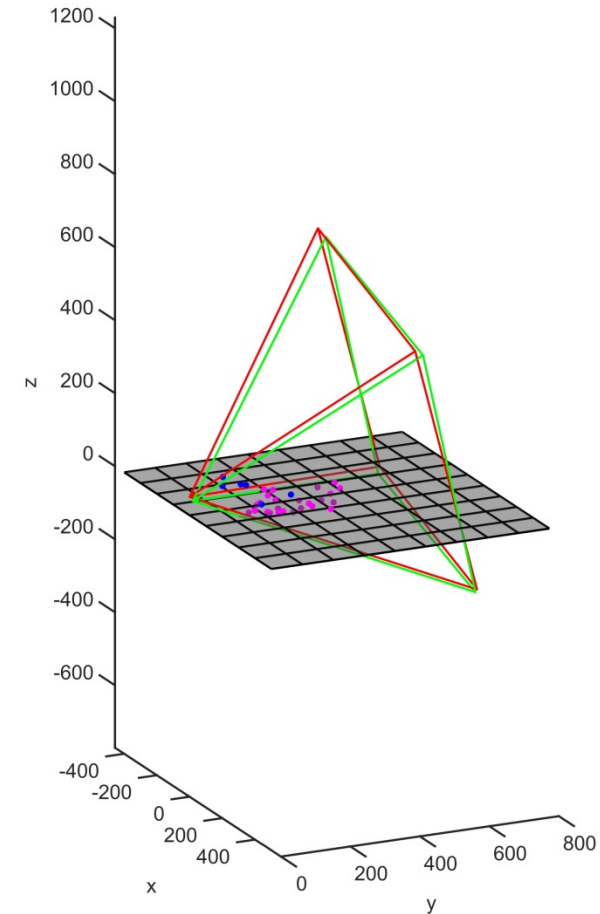


Volumetric density estimation from stereo cameras

- 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/m³

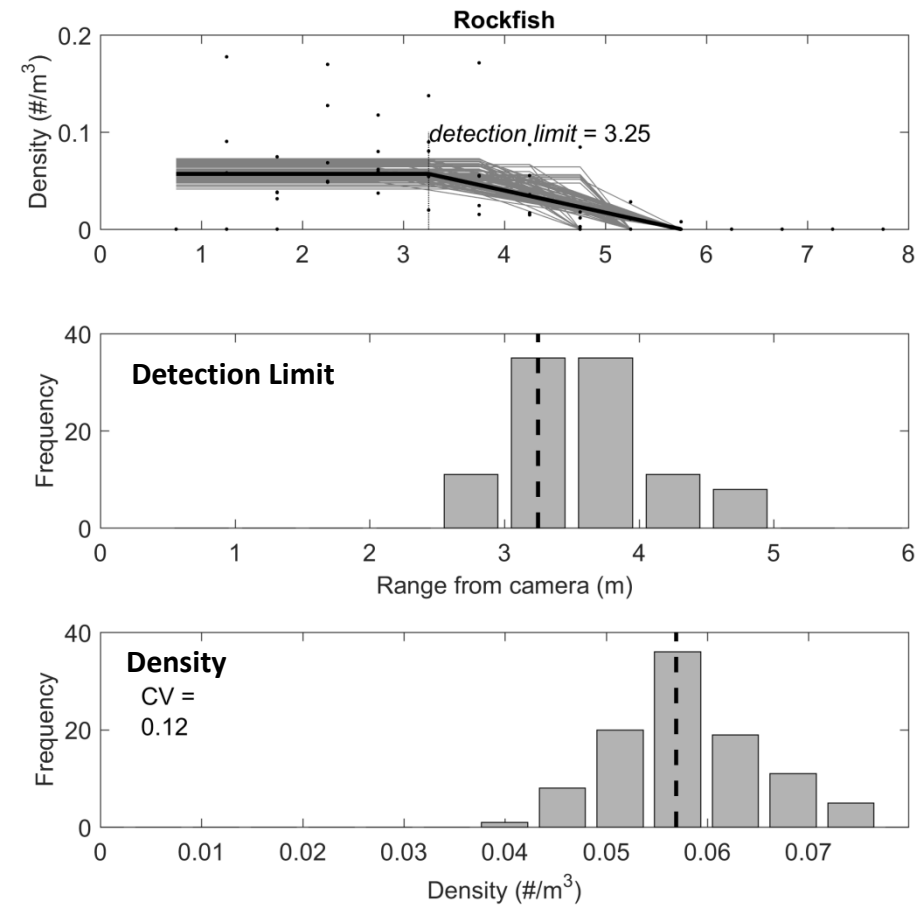
Problem....

Where to cut off volume estimate?

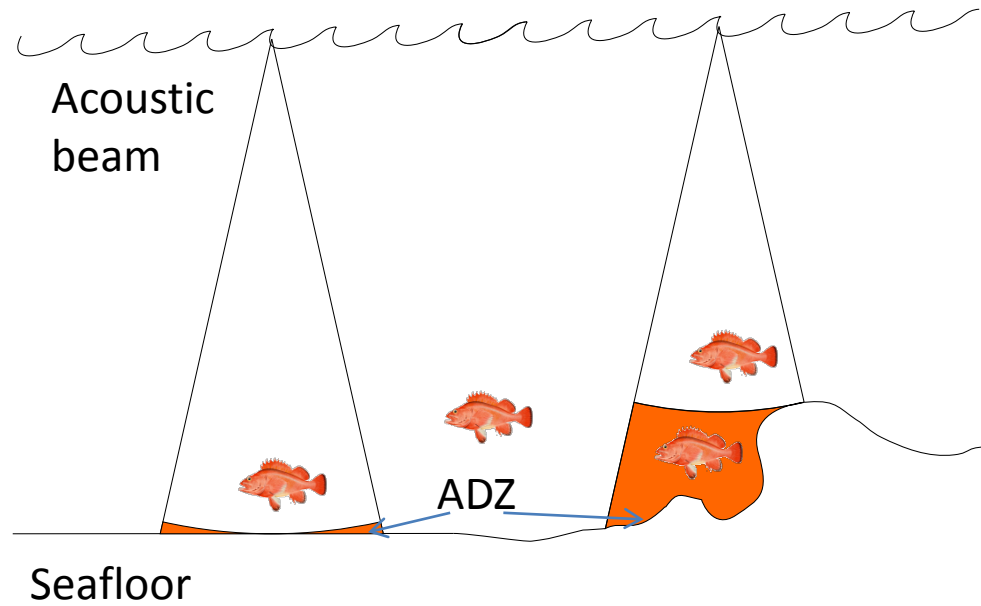


Volumetric density estimation from stereo cameras

- Compute density by range using previous approach
- Estimating the “detection limit” where density starts to drop off
- Intercept is “true” density
- Variance estimate by bootstrap



Assessing fish distribution in the Acoustic Dead Zone (ADZ)



Problem is much greater in high relief and sloping seafloor conditions

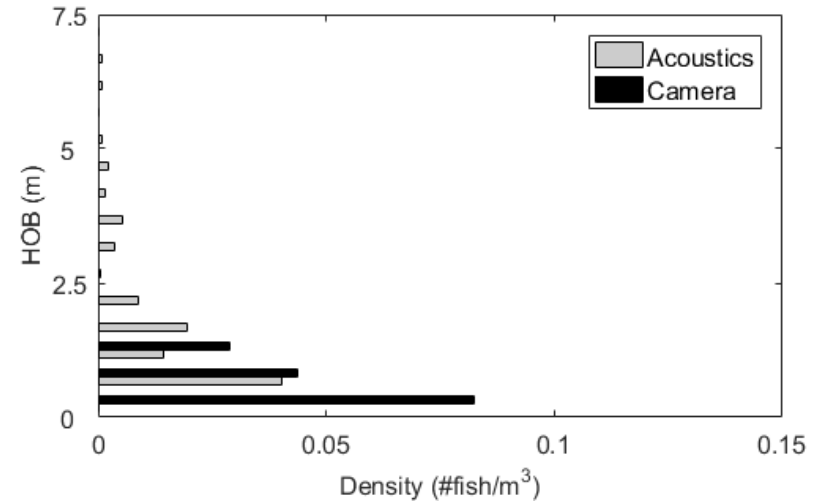
Size of the ADZ currently cannot be estimated from the acoustics

Fish distribution within the ADZ is unknown

Theoretical ADZ can be estimated for a flat smooth seafloor

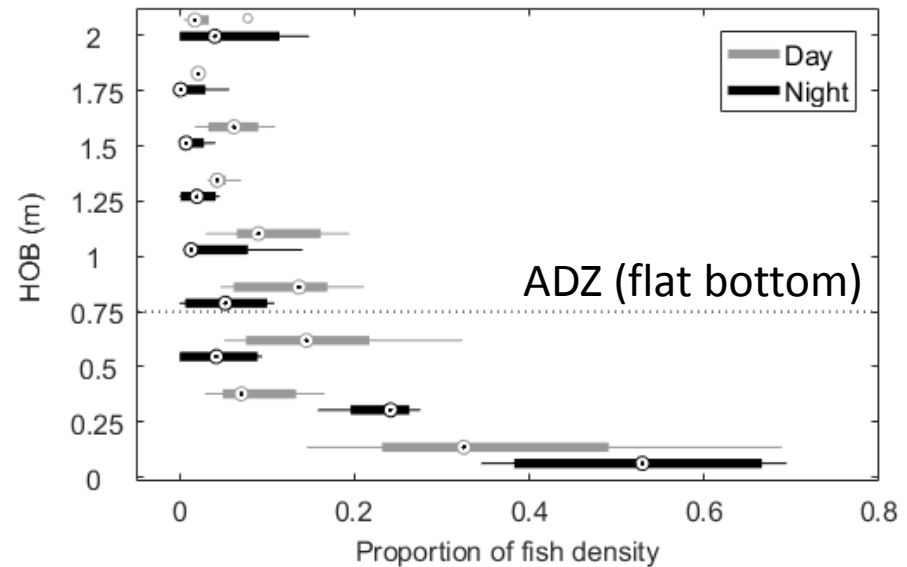
Assessing fish distribution in the Acoustic Dead Zone (ADZ)

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

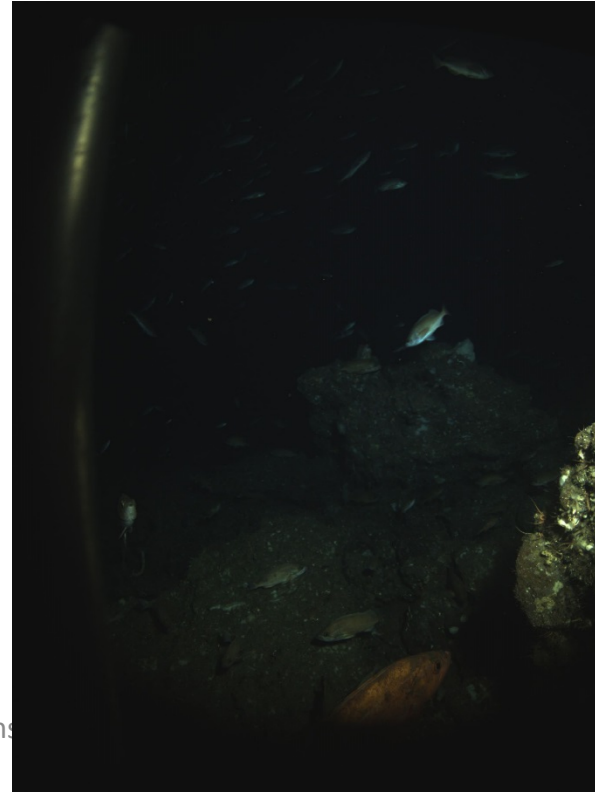
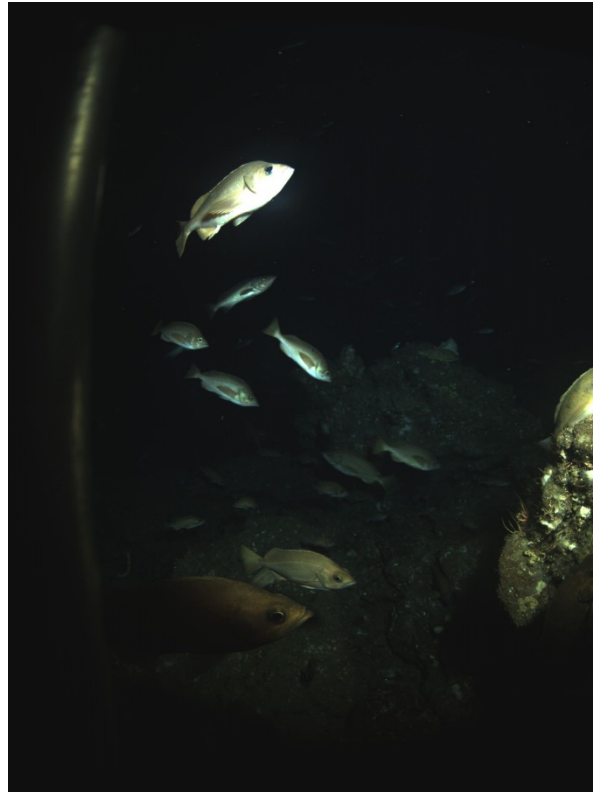
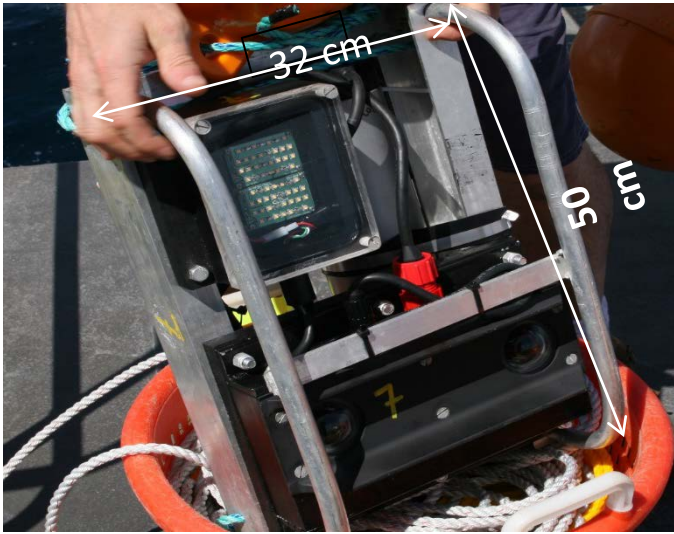
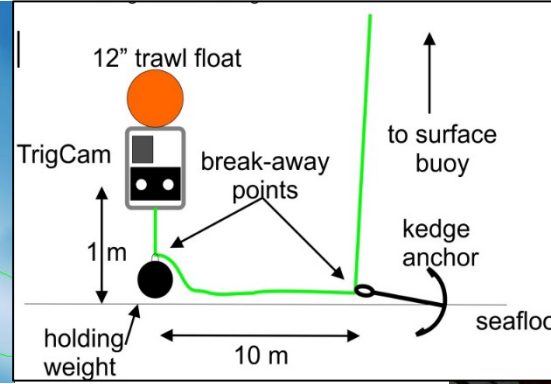
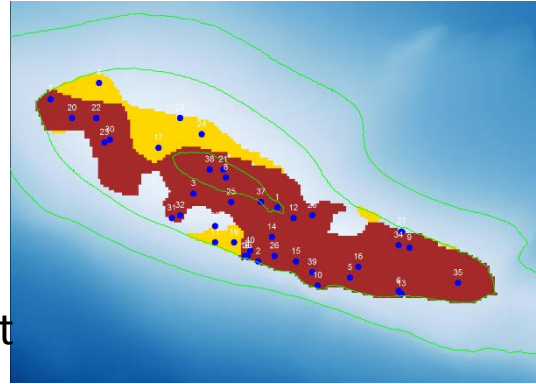
Depths from 96-150 m

3.5 days of at sea time

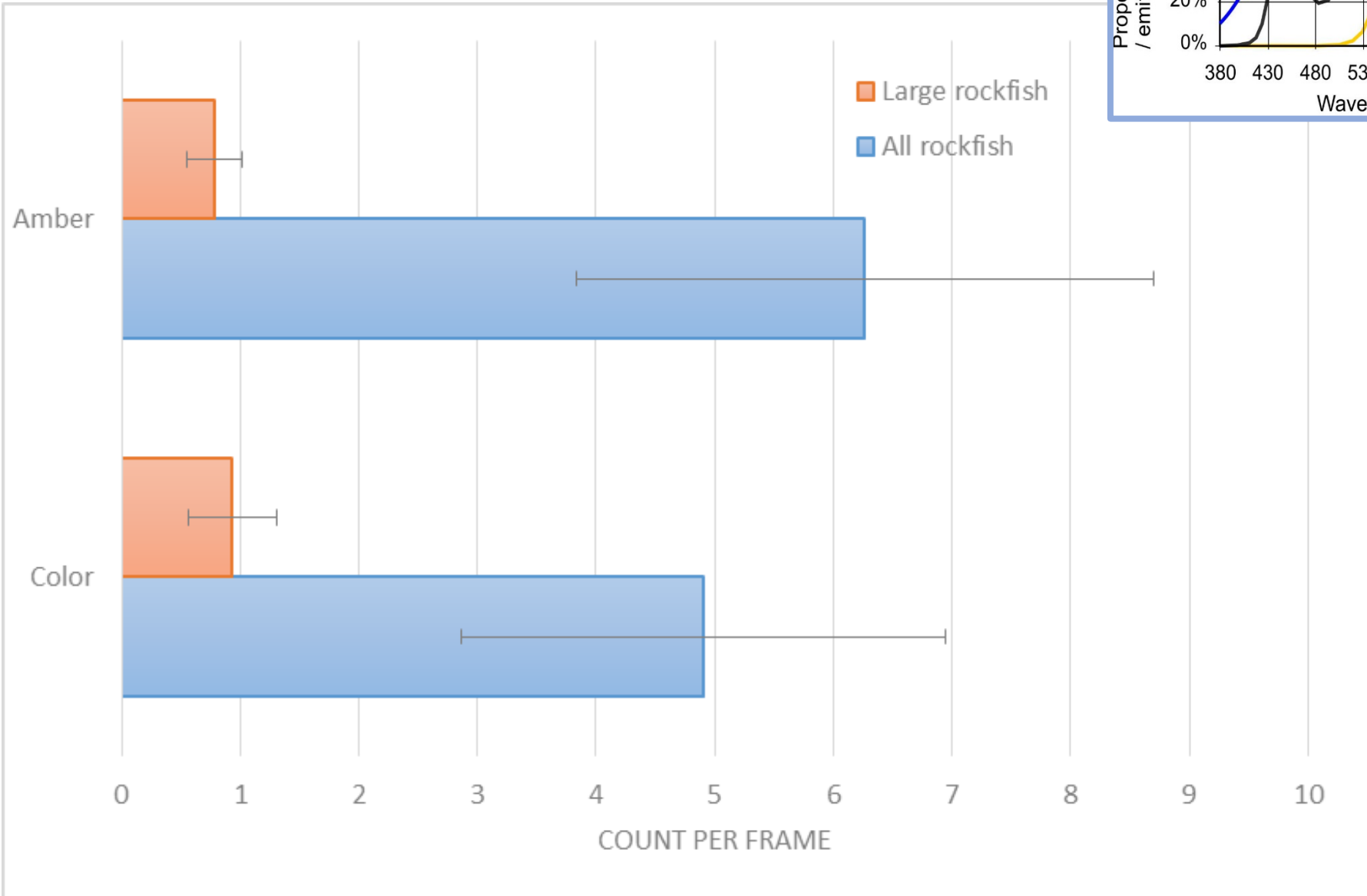
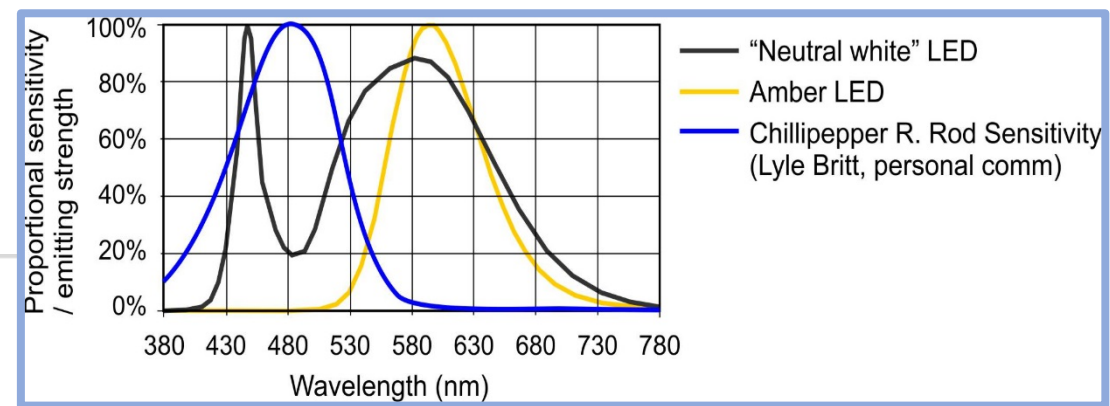
Habitats from Cobble to High Relief Bedrock

Soak times from 3 to 17 hours including overnight

Many rockfish were observed

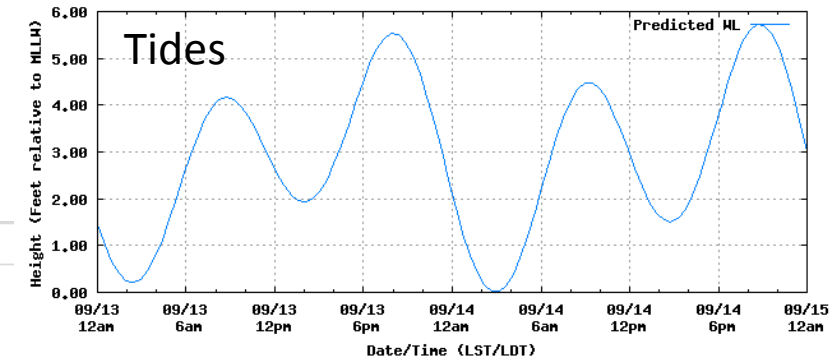
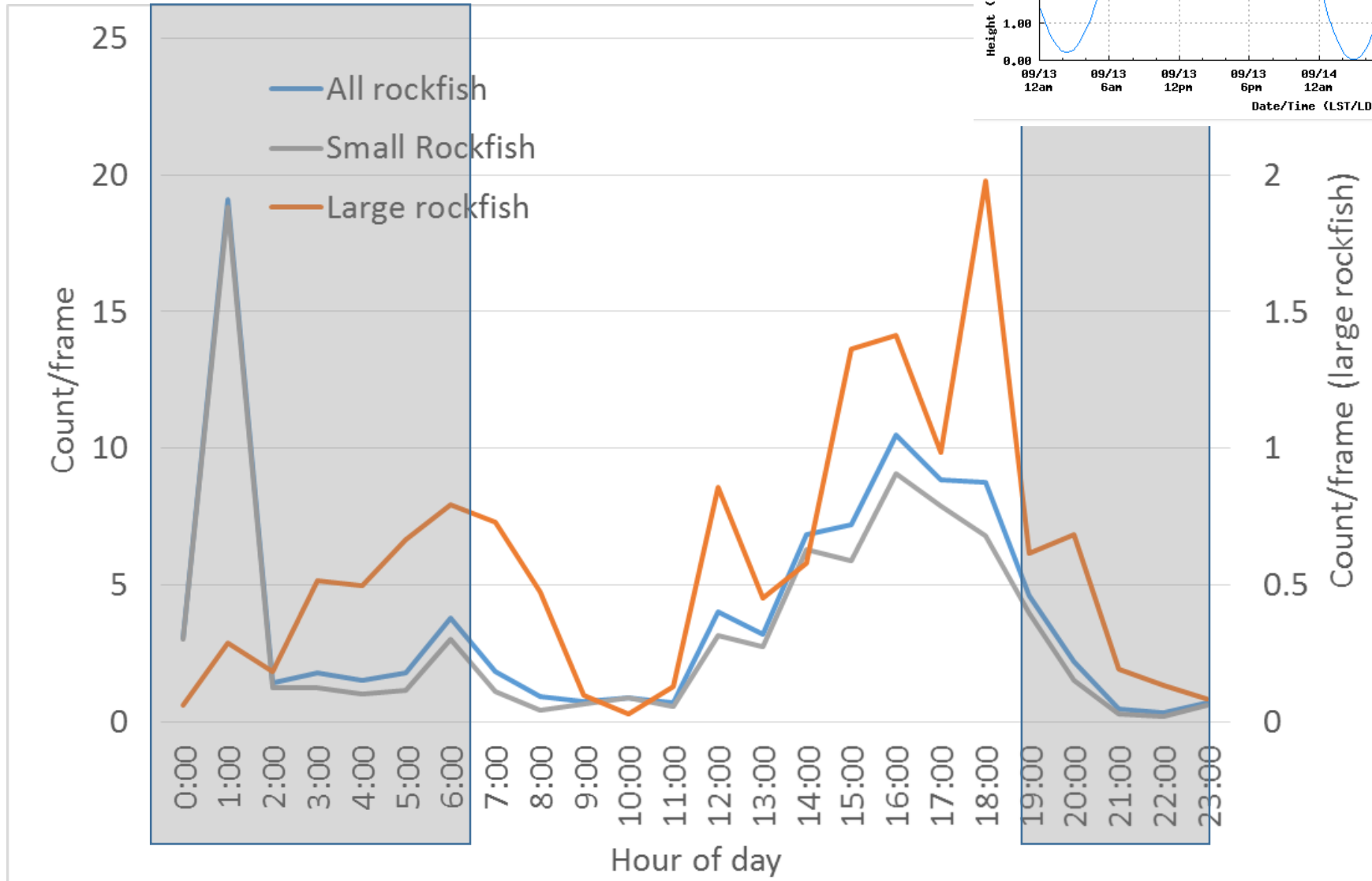


Lighting comparisons



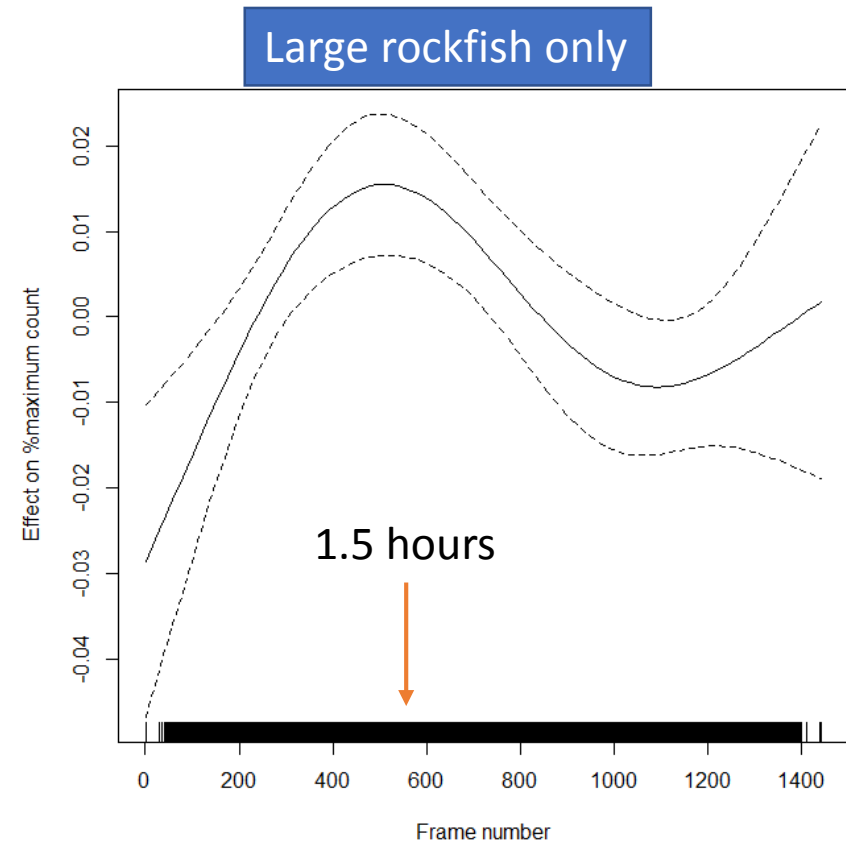
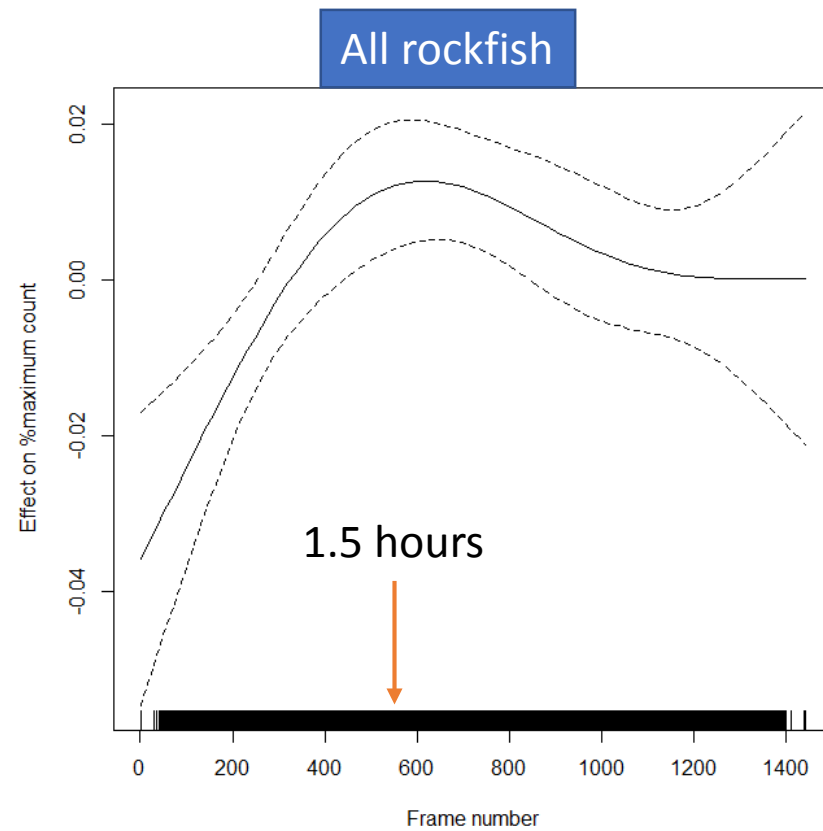
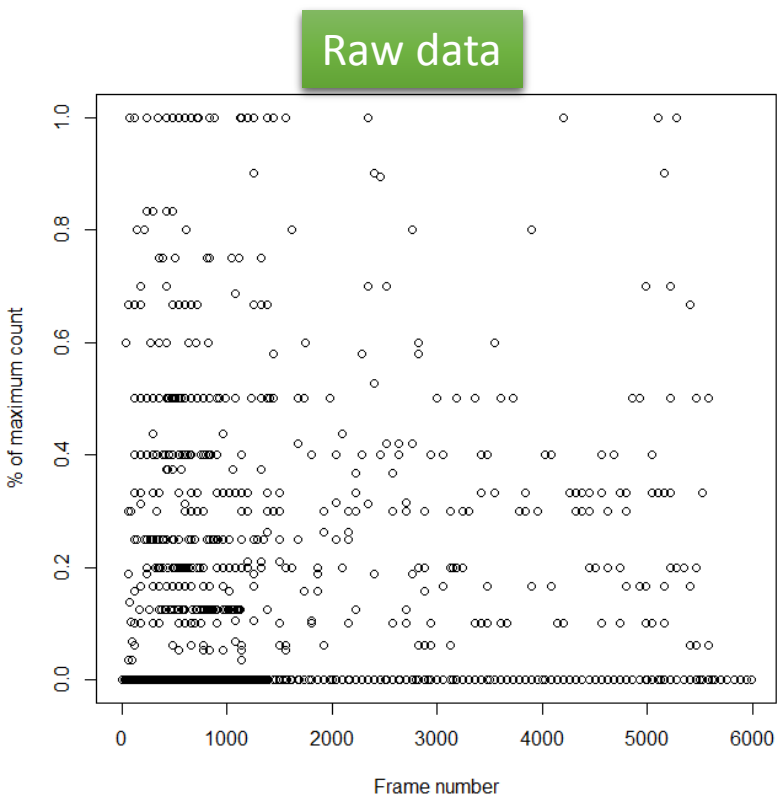
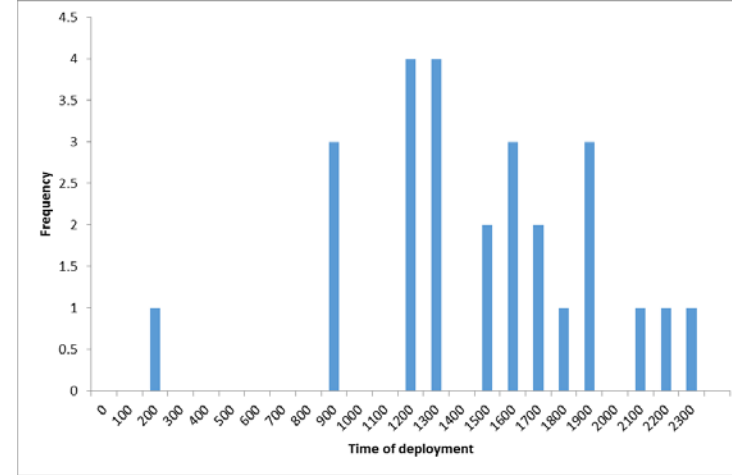
- Differences not significant
- Probably a bit larger FOV with mono cameras/amber lights
- Need to correct for habitat type and possibly time of day
- Tending towards white

Time of day comparisons



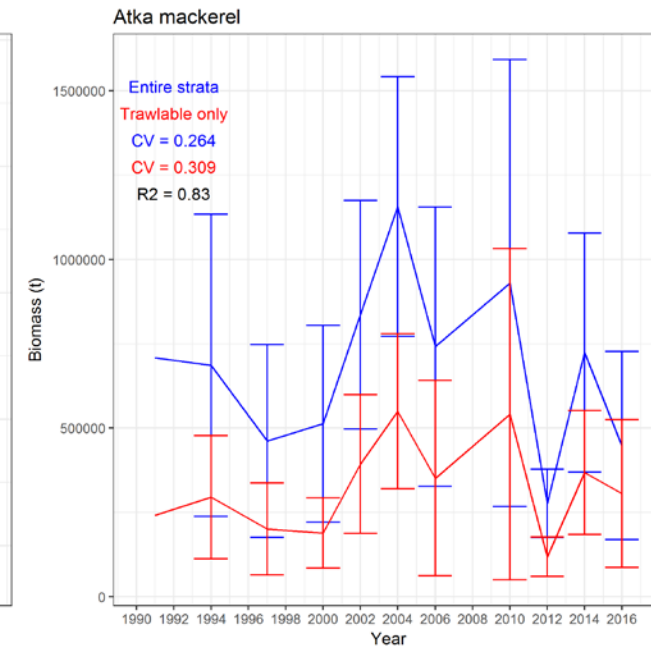
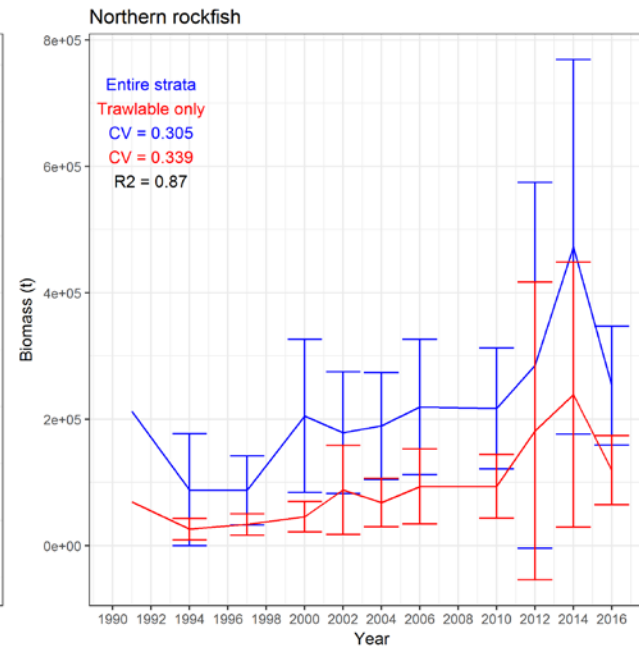
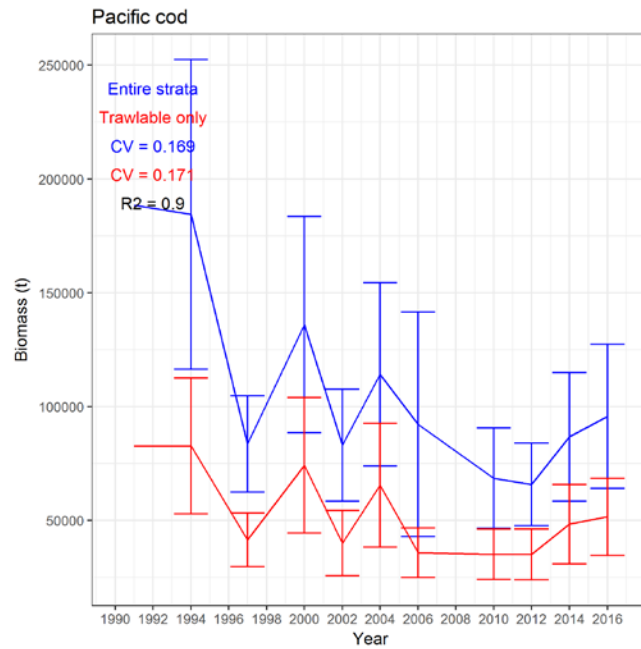
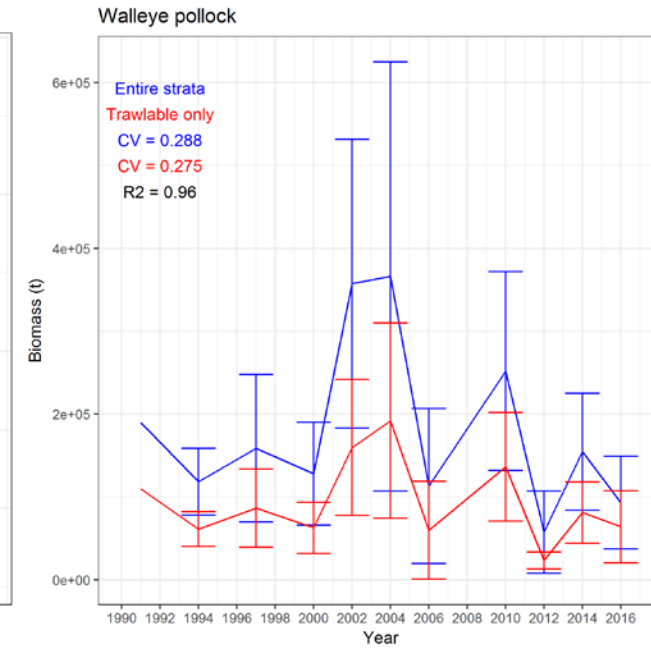
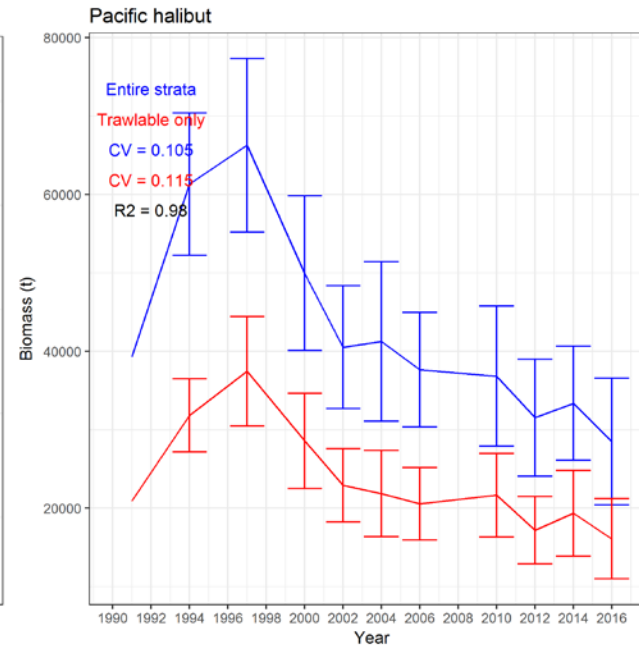
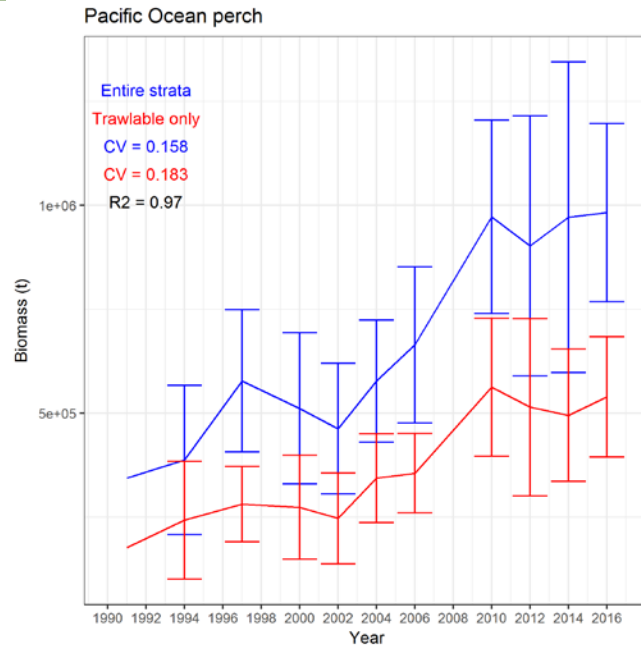
Time since deployment

- 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

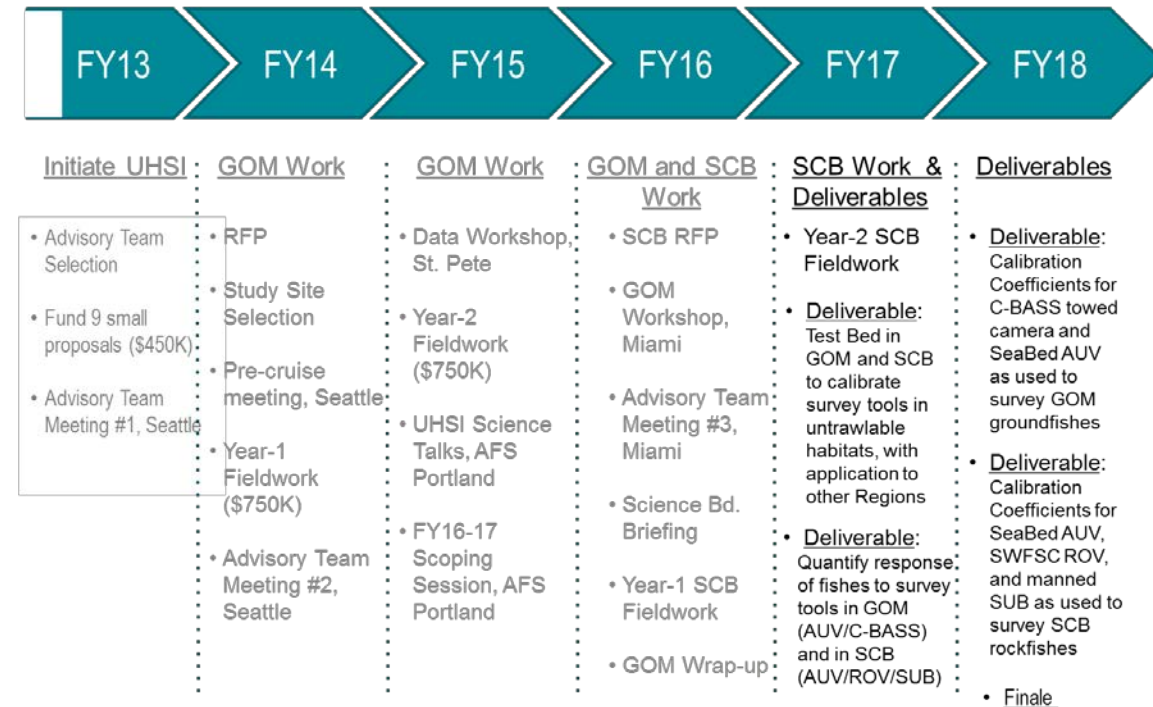
- Not much change in trend (estimates highly correlated)
- CV's slightly larger for trawlable only
- Estimates for most species about ½ of current (~53% Untrawlable)



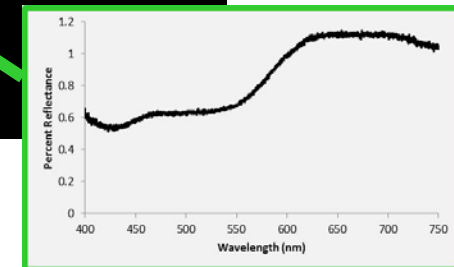
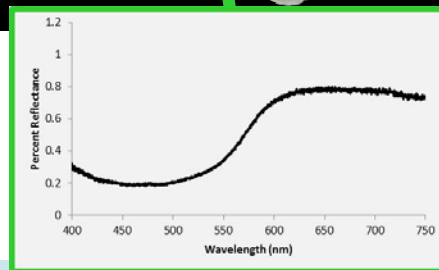
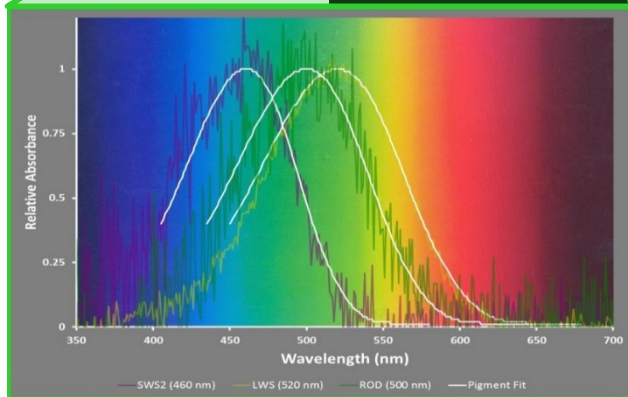
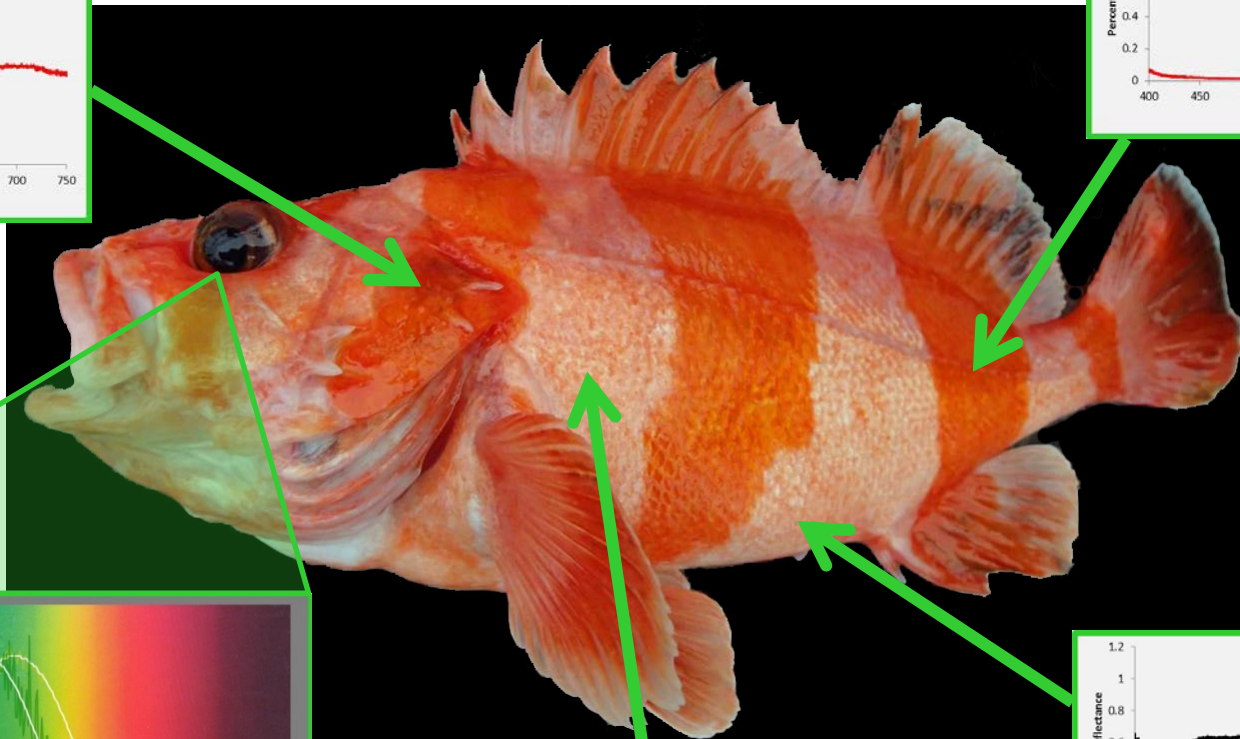
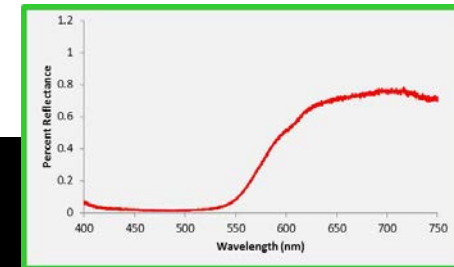
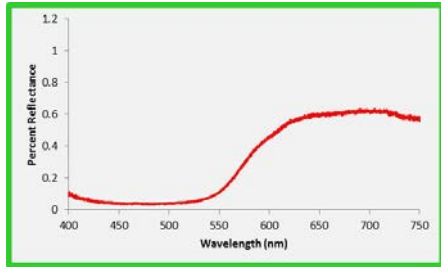
Untrawlable Habitat Strategic Initiative

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

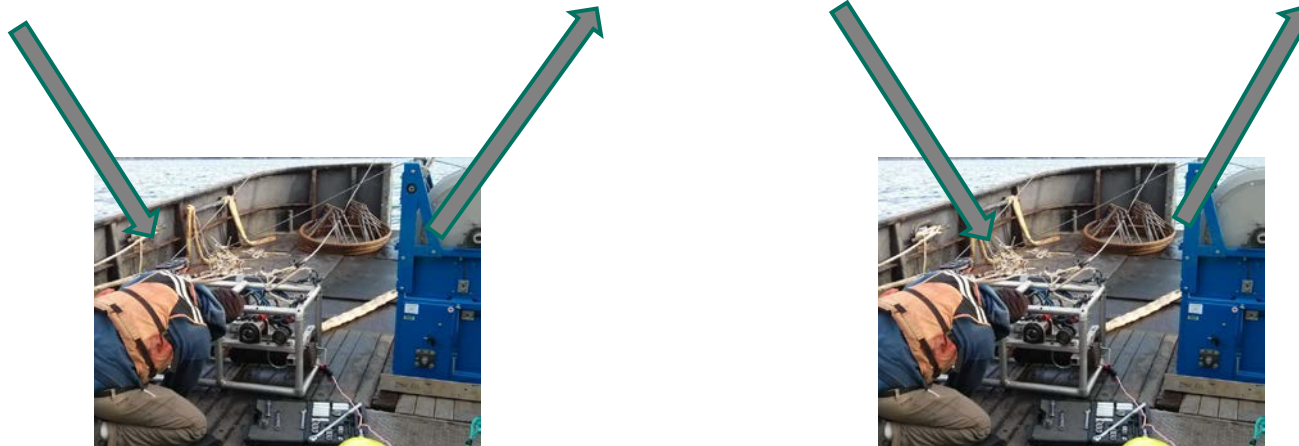
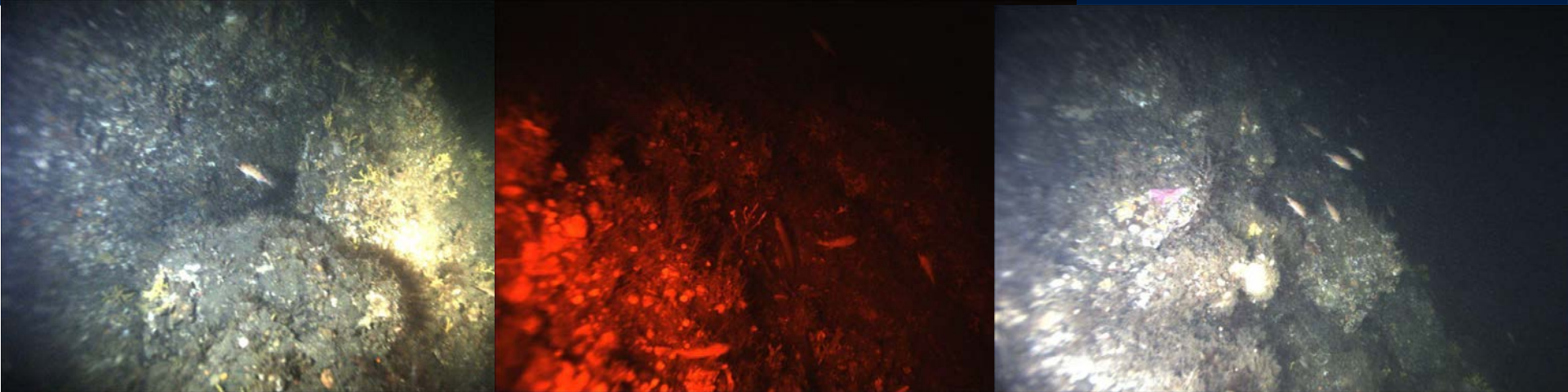
UHSI Roadmap and Deliverables



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



Methods: Stereo Drop Camera

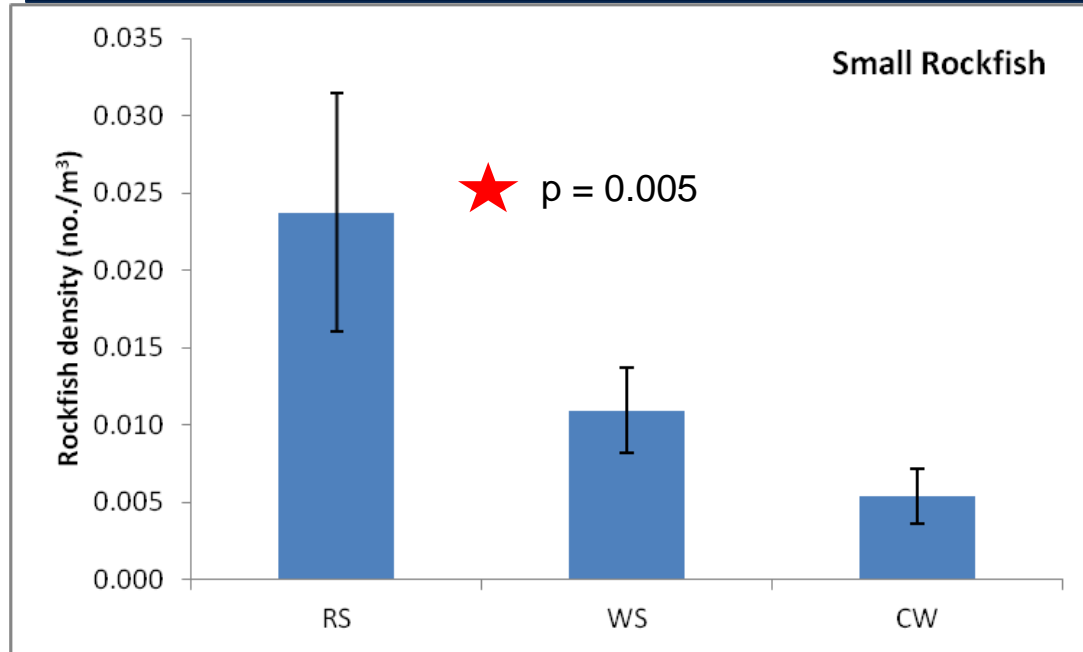


Data

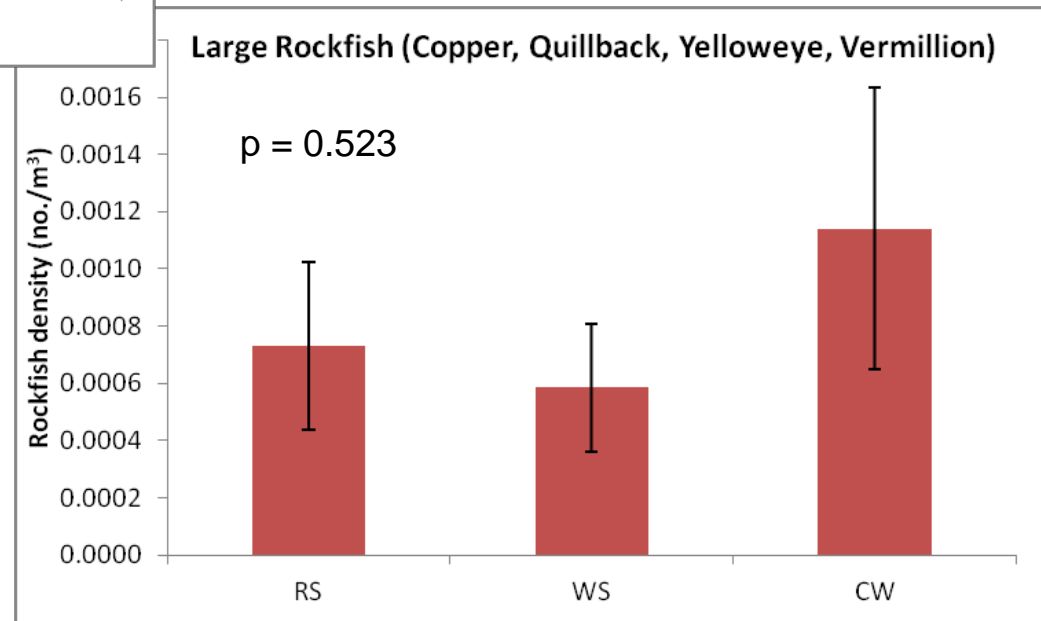
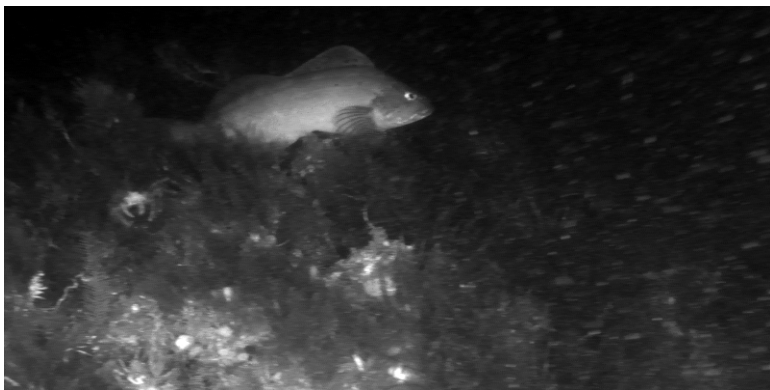
- Soft (sand, pebble, mud) or Hard (cobble, boulder, bedrock)
- Species ID
- Count

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

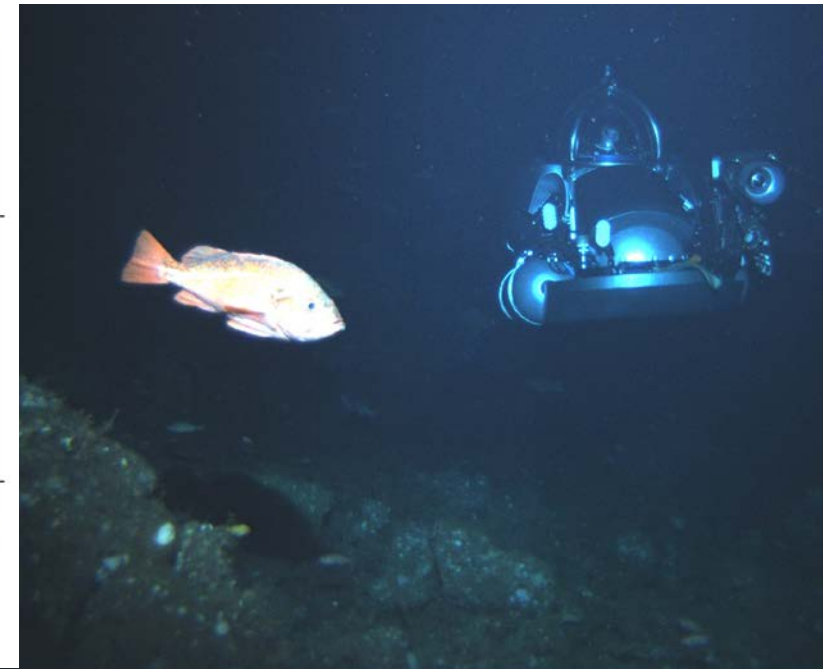
Coordinators: Clarke, Wakefield, Yoklavich

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

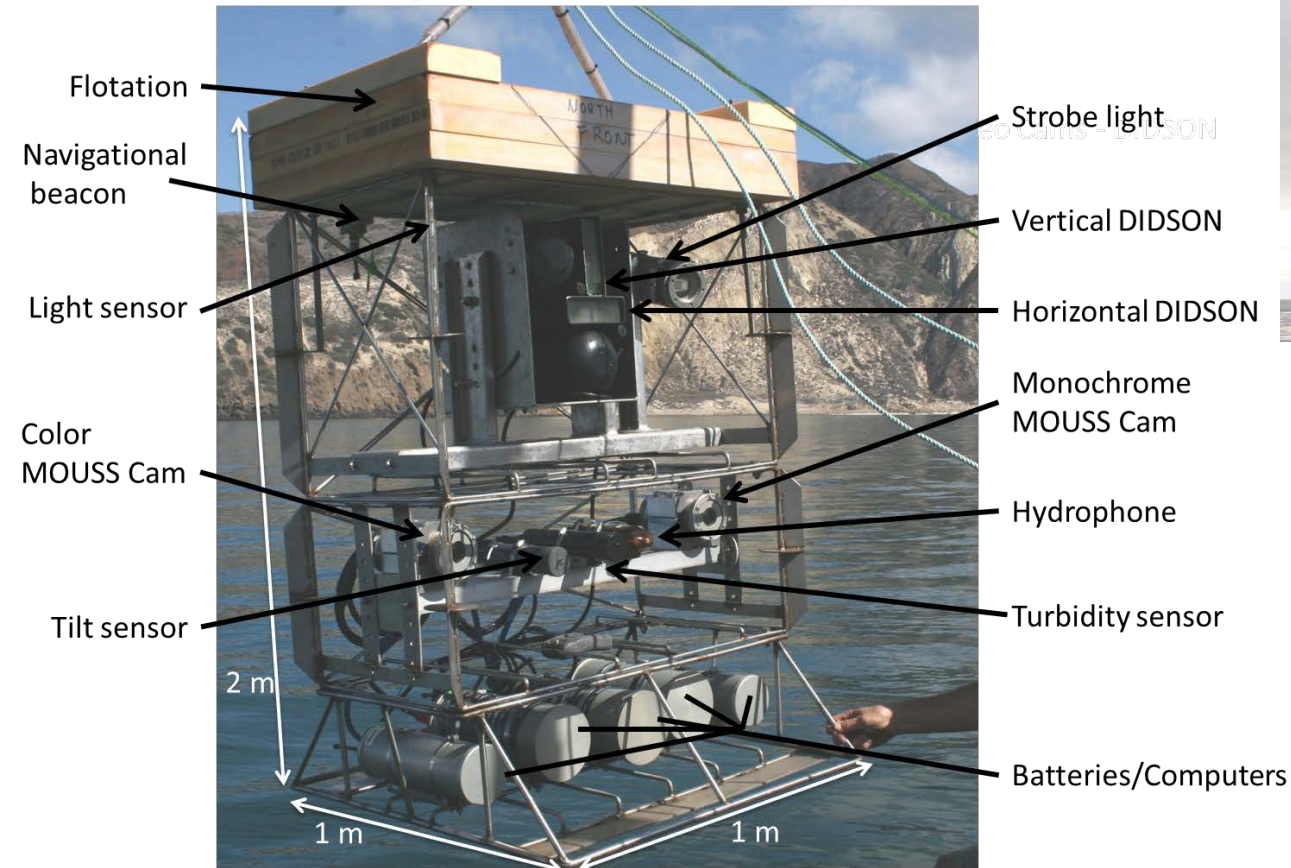


Approach to Quantify Rockfish Reactions to Mobile Survey Gear

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



NWFS 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

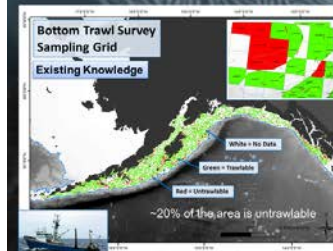
Methodology for a camera-based survey of demersal shelf rockfish in the Gulf of Alaska

Chris Rooper, Kresimir Williams, Darin Jones, Matt Baker, Chris Wilson
RACE Division, Alaska Fisheries Science Center, Seattle Washington



Abstract

The abundance of some demersal rockfish species in the Gulf of Alaska is not well estimated by the current bottom trawl survey because they inhabit areas that are too rough or rocky for bottom trawls to operate. These species include yelloweye rockfish and other demersal shelf rockfish species that contribute to valuable fisheries. Alternative methodologies to estimate abundance for these species are needed, particularly because of conservation concerns for these assemblages in the central and western Gulf of Alaska. We evaluated existing information on the extent of untrawlable areas in the Gulf of Alaska and variance associated with visual surveys of rockfish from Alaska ecosystems to develop a plan for a gulf-wide survey of demersal shelf rockfishes. Sample size were estimated for each species to attain a coefficient of variation of 0.30. Estimates were also determined for number of vessel days needed to obtain the visual survey data and process images. The survey would use existing stereo-camera methods to obtain species identification, area-swept densities and length measurements. These data would complement existing bottom trawl survey data on age and growth. Important complementary information included acoustic estimates of abundance for semi-pelagic species, as well as habitat associations and other behavioral information.



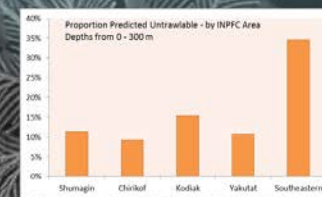
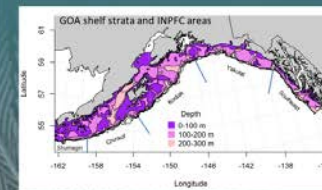
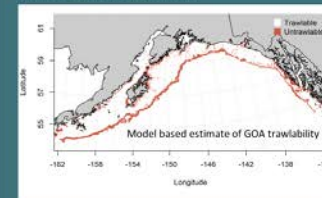
Acknowledgements
The authors would like to gratefully Jodi Pirtle for the use of her map figure.

Background

- The AFSC has been developing methods to conduct surveys of untrawlable areas for rockfishes since 2005
- Recently, underwater camera surveys have been completed in the western and central Gulf of Alaska, the eastern Bering Sea and the Aleutian Islands
- Although not necessarily designed for this purpose, these surveys can provide regional estimates of rockfish densities in untrawlable areas
- Concurrently, efforts have been made to develop predictive maps of untrawlable areas for the Gulf of Alaska
- Combining these data provides estimates of the sample size needed to estimate abundance of rockfishes (with a CV of 0.30) for the Gulf of Alaska

Trawlability estimate

- Model-based estimates of trawlability based on bathymetry, currents and other metrics (M. Baker, in preparation) was used to predict the proportion of untrawlable seafloor in each GOA stratum (shelf and shelf break depth strata only).



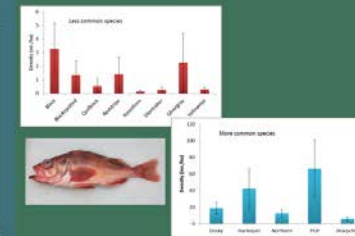
Survey data

- The data were from the 2013 and 2015 GOA Untrawlable Rockfish project (see presentation by Jones et al. - Friday 11:45 AM).
- Data from 91 drop camera stations in central and western GOA untrawlable habitat were used to estimate densities of rockfish by species.

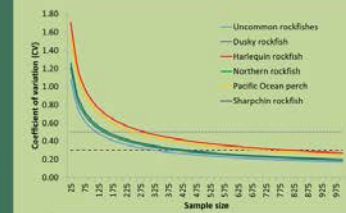


Sample size required

- Sample sizes by species were estimated using Sampling (Thompson 1992) and a desired CV = 0.3.
- Samples consisted of 15 minutes of on-bottom time, using the stereo camera, drifting at ~ 1 knot (covering about 1200 m²).



- A few common species dominated the stereo camera surveys (similar to trawl survey catches)



A sample size of ~440 would achieve a CV of ~0.30 for 3 of 5 common rockfishes and the uncommon rockfishes as a group

Species	Sample size to achieve CV = 0.30	Sample size to achieve CV = 0.50
Dusky rockfish	397	143
Harlequin rockfish	810	292
Northern rockfish	411	148
Pacific Ocean perch	692	250
Sharpchin rockfish	441	159
Uncommon rockfish	326	117
Black rockfish	893	322
Blackspotted rockfish	1577	568
Quillback rockfish	2676	964
Redstripe rockfish	1944	700
Rosehorn rockfish	2676	964
Shortraker rockfish	2676	964
Silvergray rockfish	2475	891
Yelloweye rockfish	1434	516



Item	Camera survey	Existing Trawl Survey
Sample size	460	825
Days at sea	40	205
At-sea personnel	4	72
Analysis days	-42	30
Total cost	\$511K	~1,000K

Conclusions

- Stereo camera survey for rockfishes in the GOA is feasible for untrawlable area
- Stratification will be useful in reducing CV's further (with possible sample size reduction)
- More data from are needed to better assess uncommon species, which are typically found deeper and in SE Alaska (SE Alaska and Yakutat regions)

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)?