Surveying commercial fish species and habitat in wind farm areas using a suite of non-lethal survey methods

(Award DE-EE0009799)

Coonamessett Farm Foundation –
Dr. Liese Siemann, Tasha O'Hara, Farrell Davis, and Luisa Garcia

National Academies Standing Committee on Offshore Wind Energy and Fisheries:
Winter Meeting November 18, 2024

Coonamessett Farm Foundation

Collaborators

Video trawl survey

UMASS School of Marine Science and Technology – Dr. Kevin Stokesbury and Nicholas Calabrese

Technology development

Kitware. Inc. – Matthew Dawkins and Dr. Anthony Hoogs

Sexton Corporation – Jeremy Childress and Charley Weller

Commercial fishing companies – research vessels and advisory panel

Arnie’s Fisheries

Atlantic Capes Fisheries

Atlantic Shellfish

Eastern Fisheries

Empire Fisheries

Fox Harbor Fisheries

Nordic Inc.

Owen James Fisheries

Quinn Fisheries

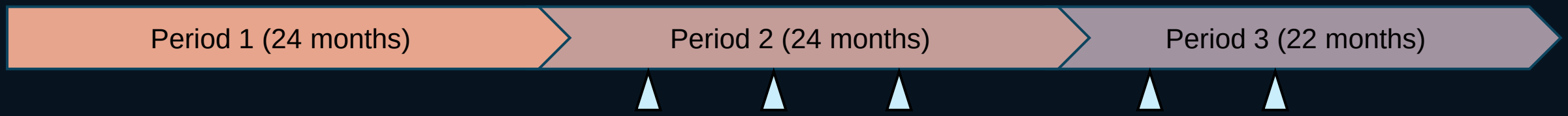
Shamrock Fisheries

Viking Village

Project Objectives

1. **Develop a methodological framework for monitoring commercial fish and invertebrate species in wind farms using optical surveys**
   - Preferred survey designs
   - Freely available automated detectors and image sets for training new machine learning algorithms
   - Design schematics/technical drawings for any new gear designs (ropeless stationary camera systems and video trawl)
2. **Evaluate the impacts of offshore wind development on commercial fish and invertebrate species and benthic habitats by conducting spring and fall surveys during pre-construction, construction, and post-construction periods (spring 2025 – fall 2027)**

Project Timeline



- Establish relationships with project partners
- Complete peer-reviewed survey designs
- Design and test modified video trawl
- Design and test ropeless camera system
- Test front-facing sonar on HabCam v3
- Continue developing automated detector models

- Conduct three sets of optical surveys (HabCam, video trawl, and stationary cameras) in spring 2025, fall 2025, and spring 2026
- Develop project database
- Upgrade data storage capacity
- Continue developing automated detector models

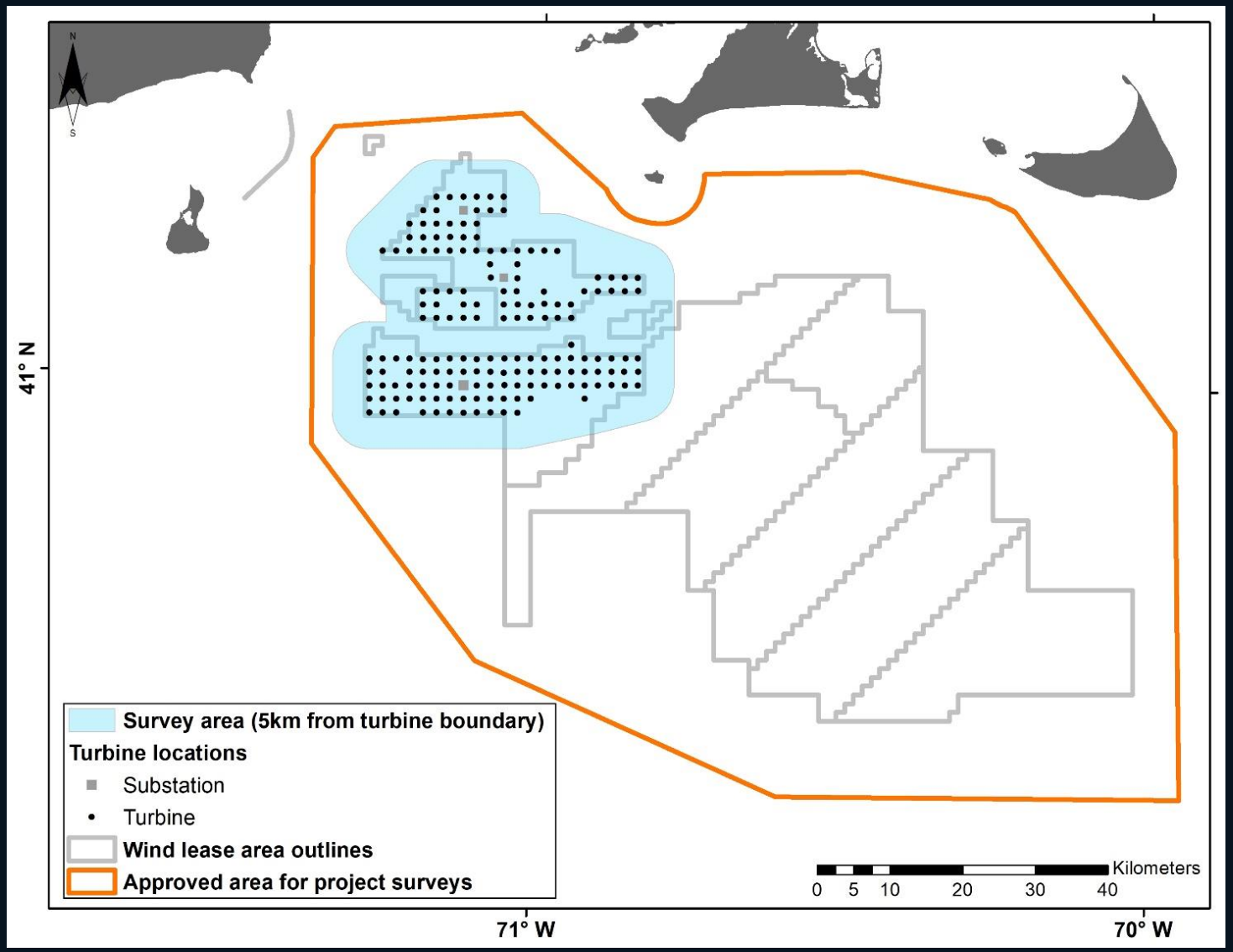
- Conduct two sets of optical surveys in spring 2027 and fall 2027
- Complete statistical analysis of project data
- Finalize automated detector models and upload to open-source repository

Project deliverables:

- Stakeholder meetings and public webinars
- Project reports
- Peer-reviewed publications
- Drawings and specifications for new technologies
- Open-source automated detectors for marine species and habitats

Project Location

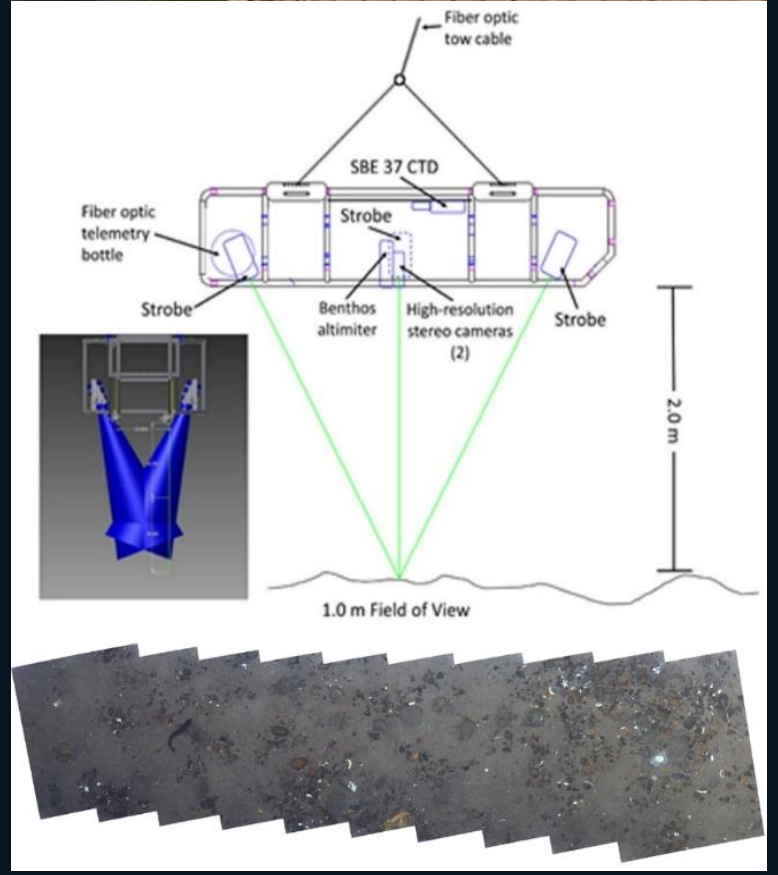
Project surveys will take place in three lease areas held by Ørsted – South Fork Wind (operating), Revolution Wind (under construction), and Sunrise Wind (under construction in 2025)



Focal Species and Fisheries

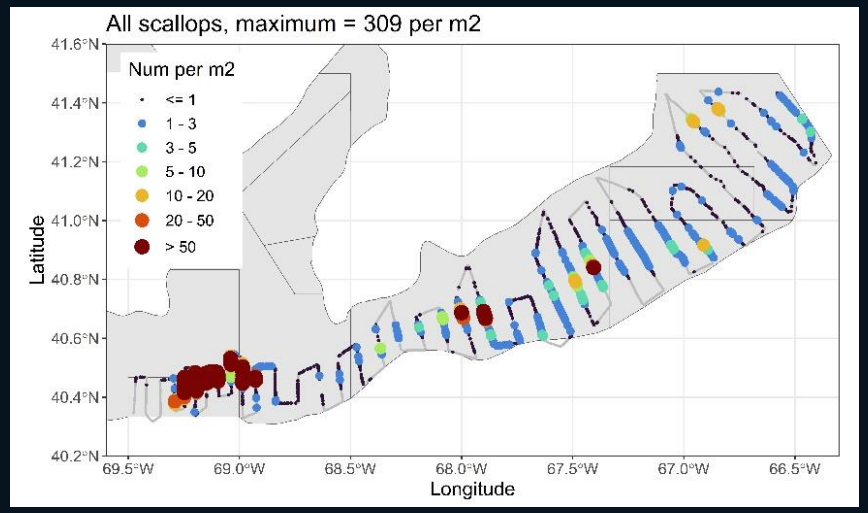
SPECIES	HABCAM SURVEY	VIDEO TRAWL SURVEY	STATIONARY CAMERA SURVEYS	FISHERY MANAGEMENT PLAN (FMP)
LONGFIN SQUID	X	X	X	Mackerel, Squid, and Butterfish FMP
WINTER AND LITTLE SKATE	X	X	X	Skate Complex FMP
SUMMER FLOUNDER	X	X	X	Summer Flounder, Scup, and Black Sea Bass FMP
SCUP		X	X	Summer Flounder, Scup, and Black Sea Bass FMP
BLACK SEA BASS	X	X	X	Summer Flounder, Scup, and Black Sea Bass FMP
SILVER AND OFFSHORE HAKE	X	X	X	Small-Mesh Multispecies FMP
RED HAKE	X	X	X	Small-Mesh Multispecies FMP
MONKFISH	X	X	X	Monkfish FMP
JONAH AND ROCK CRAB	X		X	Interstate FMP for Jonah Crab
AMERICAN LOBSTER	X		X	Interstate FMP for American Lobster
ATLANTIC COD	X	X	X	Northeast Multispecies FMP
SEA SCALLOP	X			Sea Scallop FMP

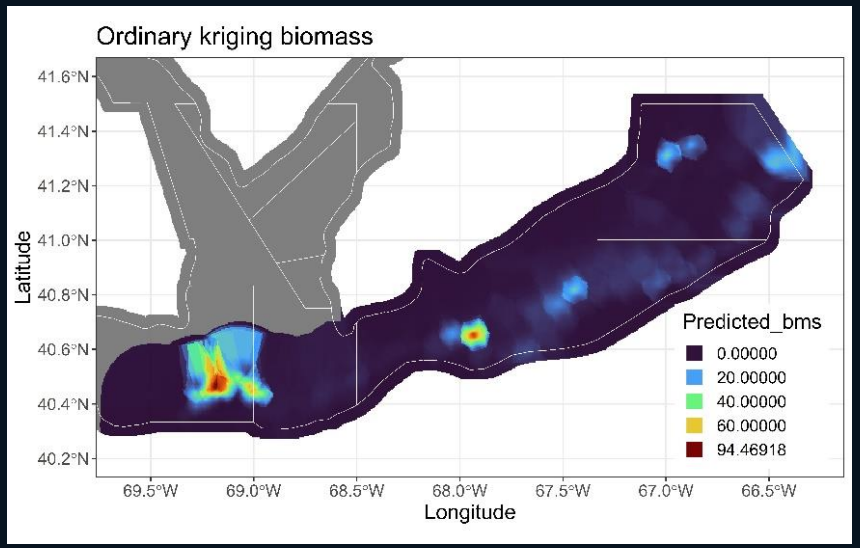
Optical Survey Tools – HabCam v3



Towed off-bottom stereo camera system

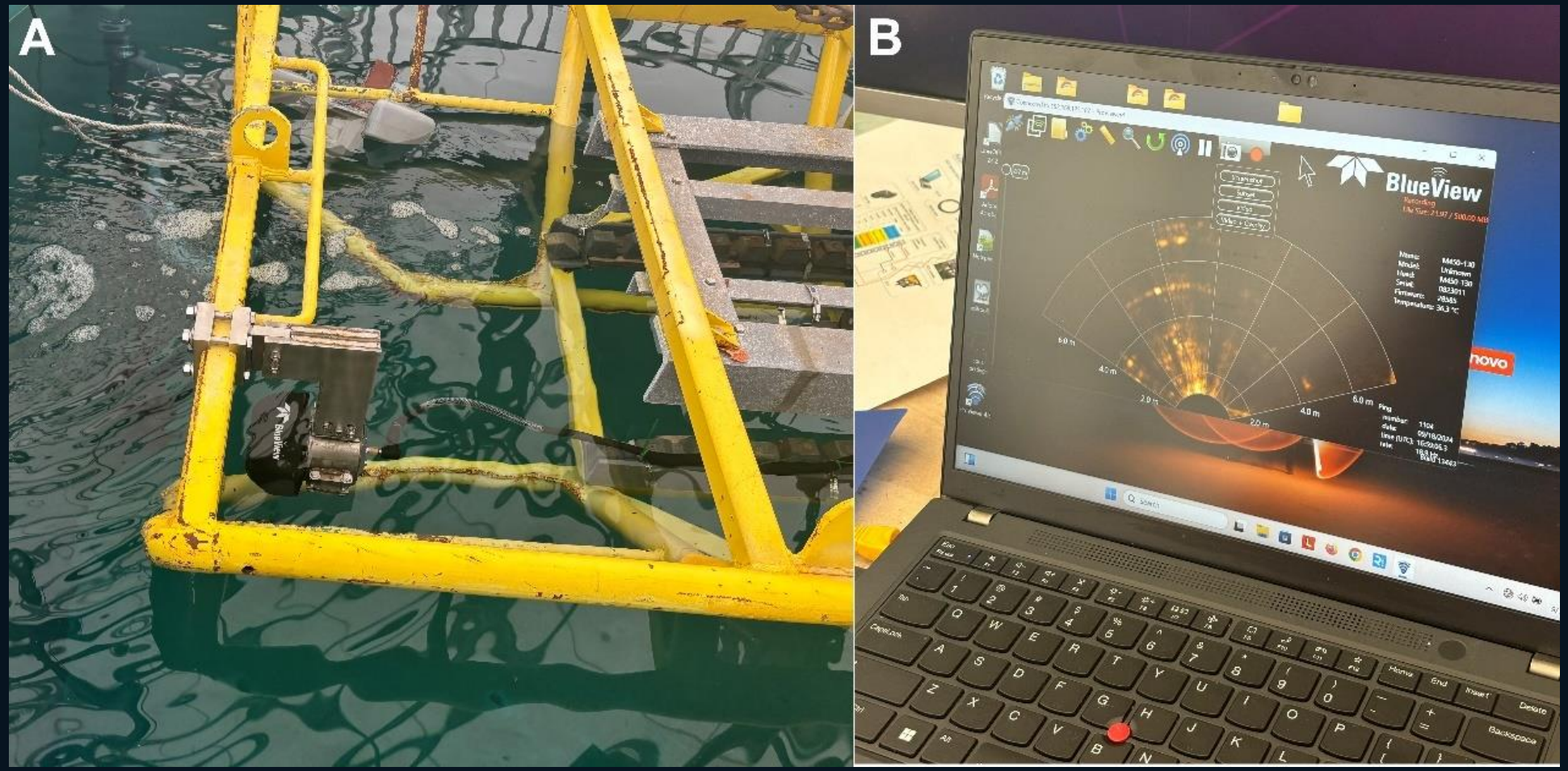
- 24-hr continuous survey tracks
- Overlapping still images
- Typical annotation rate of 1:100 provides data at 40-m intervals along the track





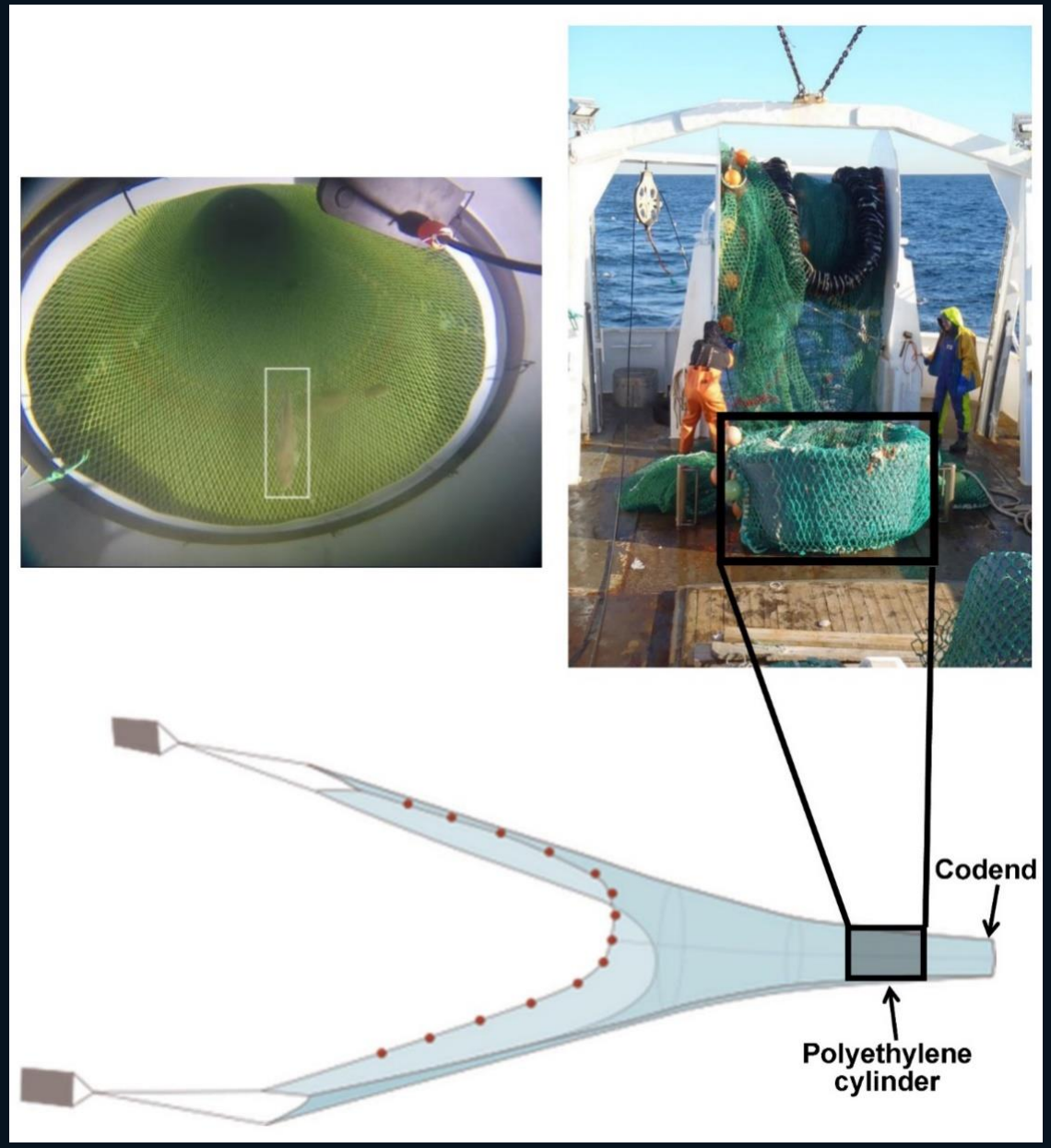
Abundance and biomass maps

Adding Sonar to HabCam v3



(A) Sonar attached to the HabCam v3 using a custom stainless-steel bracket. (B) Sonar output displayed in the BlueView software.

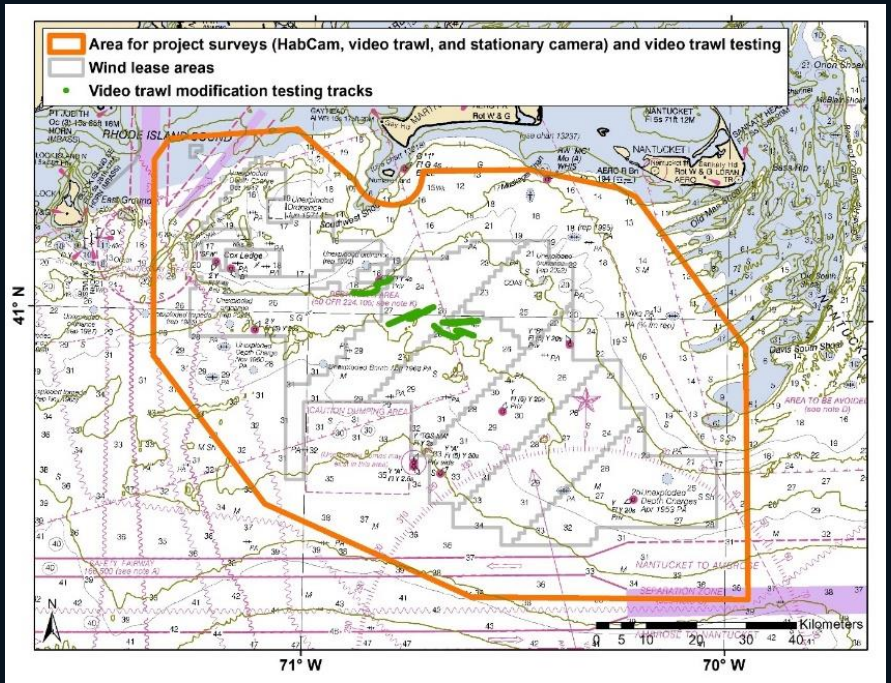
Optical Survey Tools – Video Trawl (SMAST)



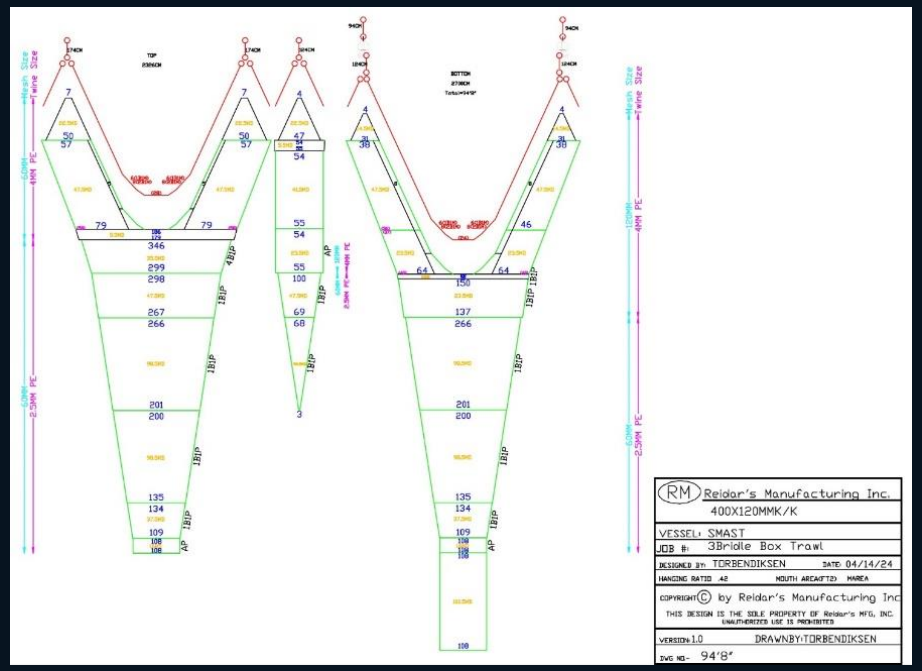
SMAST video trawl

- Cylinder with cameras and lights, and sensors at the leading edge of the cod end in a standard bottom trawl net
- Fish/other are filmed as they pass into the cod end
- Effective tool for fish surveys over hard bottom when mud clouds do not obscure the video

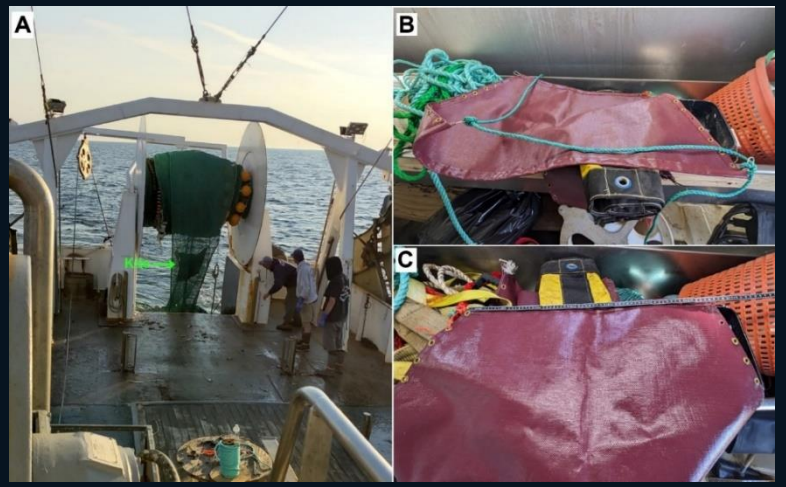
Video Trawl Modifications



Test tows completed in areas with soft silty bottom aboard the F/V Justice.



Longer net

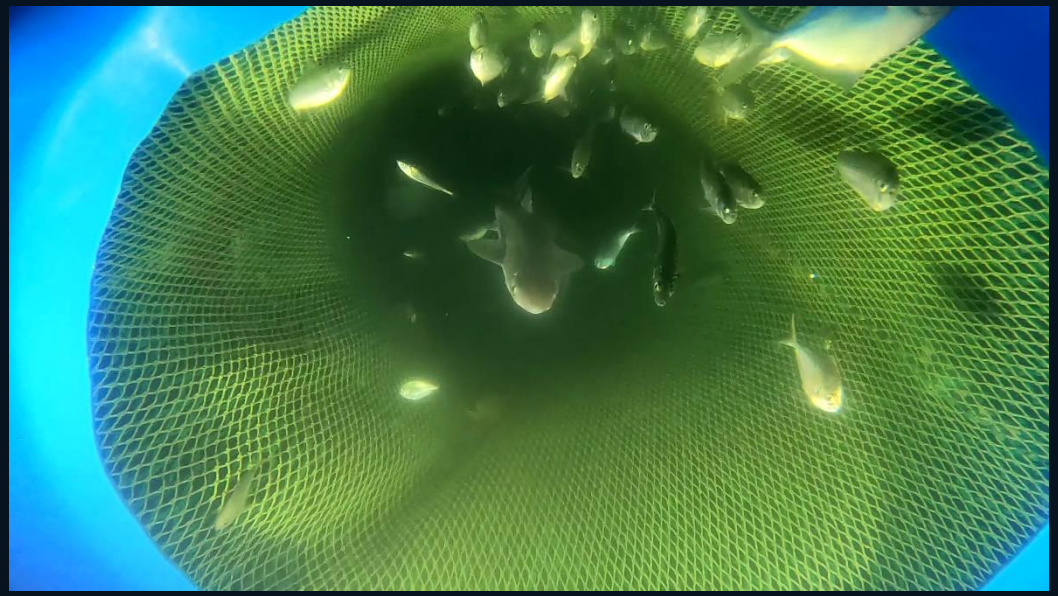


Kite located in front of the codend

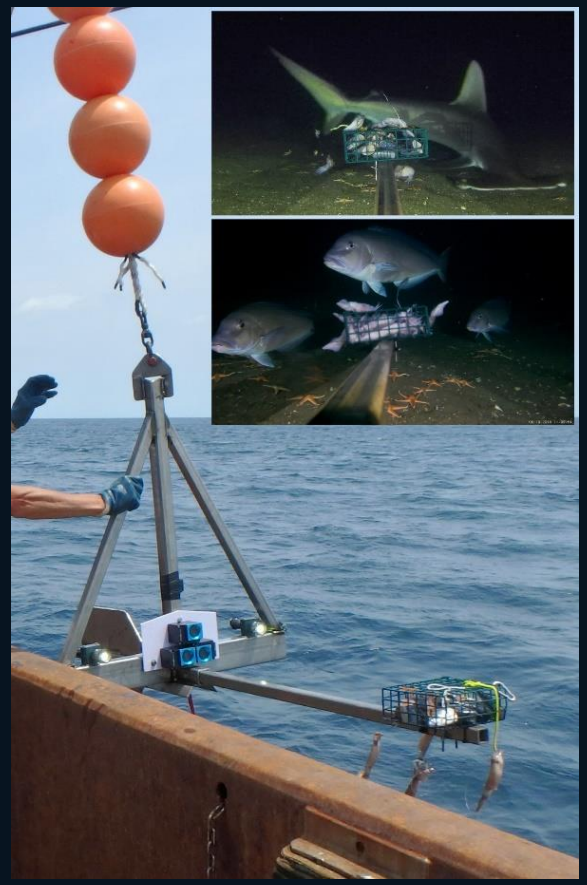
Video Footage Before and After

Old net soft bottom

New net soft bottom



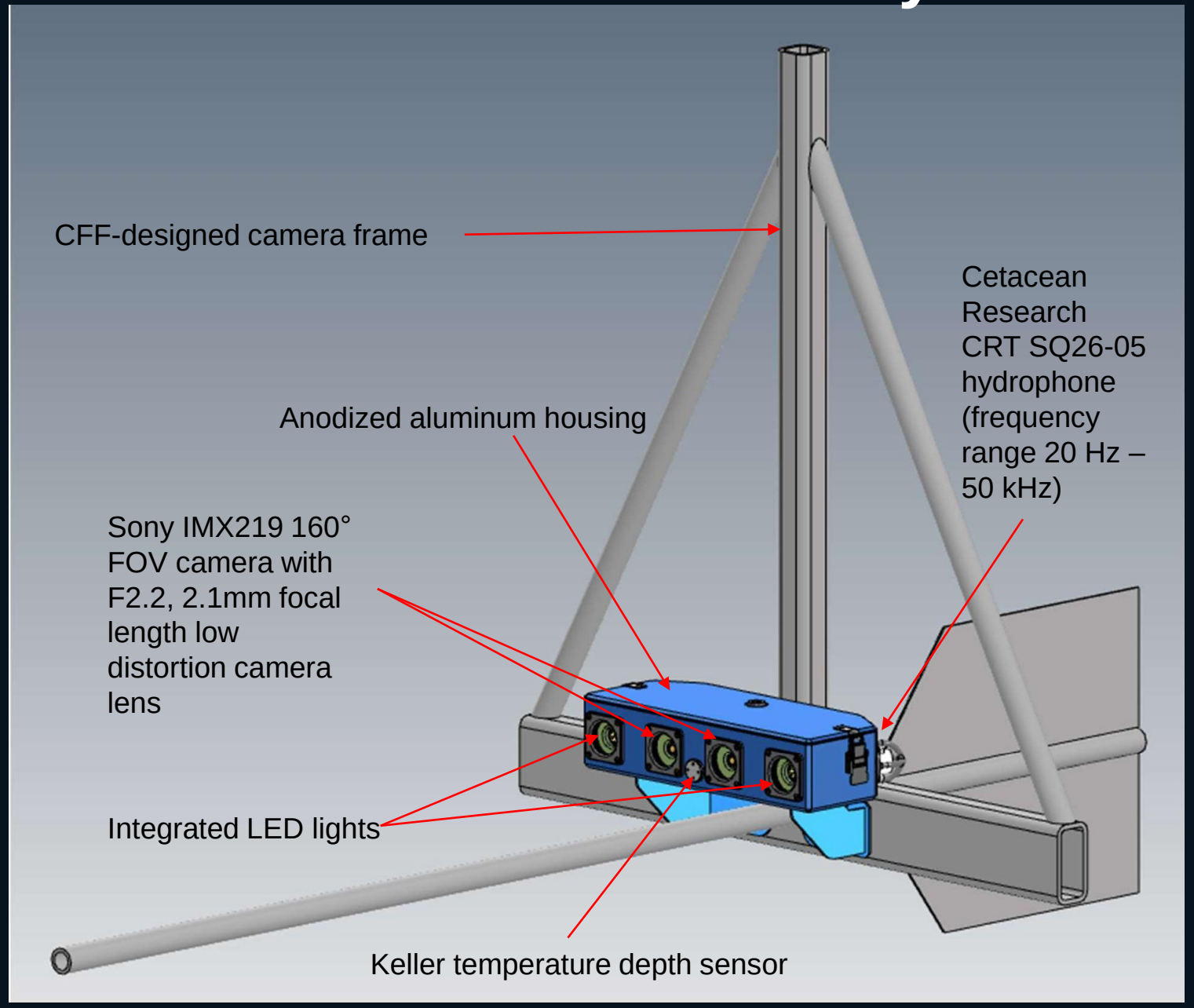
Optical Survey Tools – Stationary Cameras



Anchored systems
- Short deployments
- Mixed of baited and unbaited
- Impacts of lighting
- Custom cameras with hydrophones (Sexton)

Ropeless systems
- Multi-day deployments over full diurnal and tidal cycles
- Edgetech ropeless lobster traps as base
- Custom cameras with hydrophones and long-term batteries (Sexton)

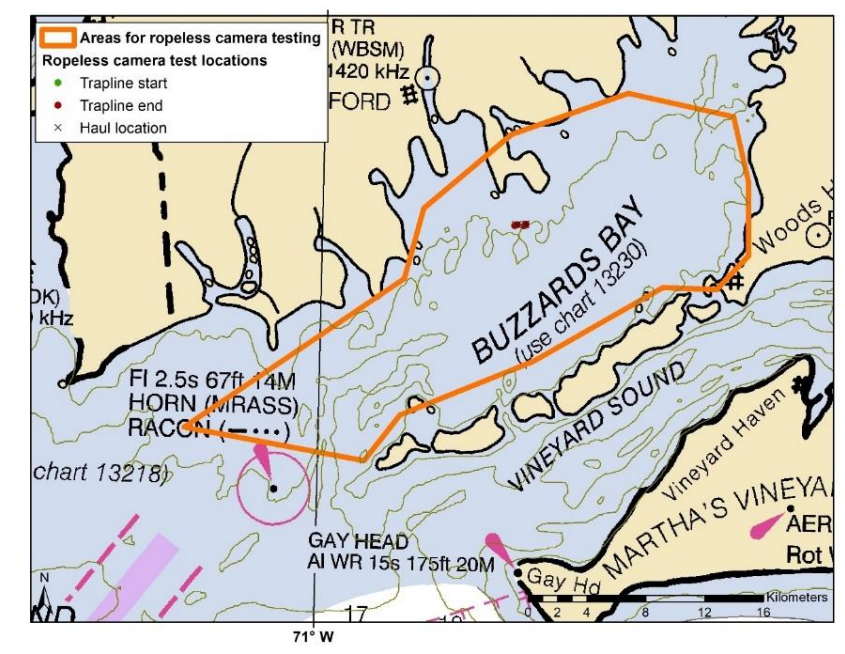
Anchored Stationary Camera System

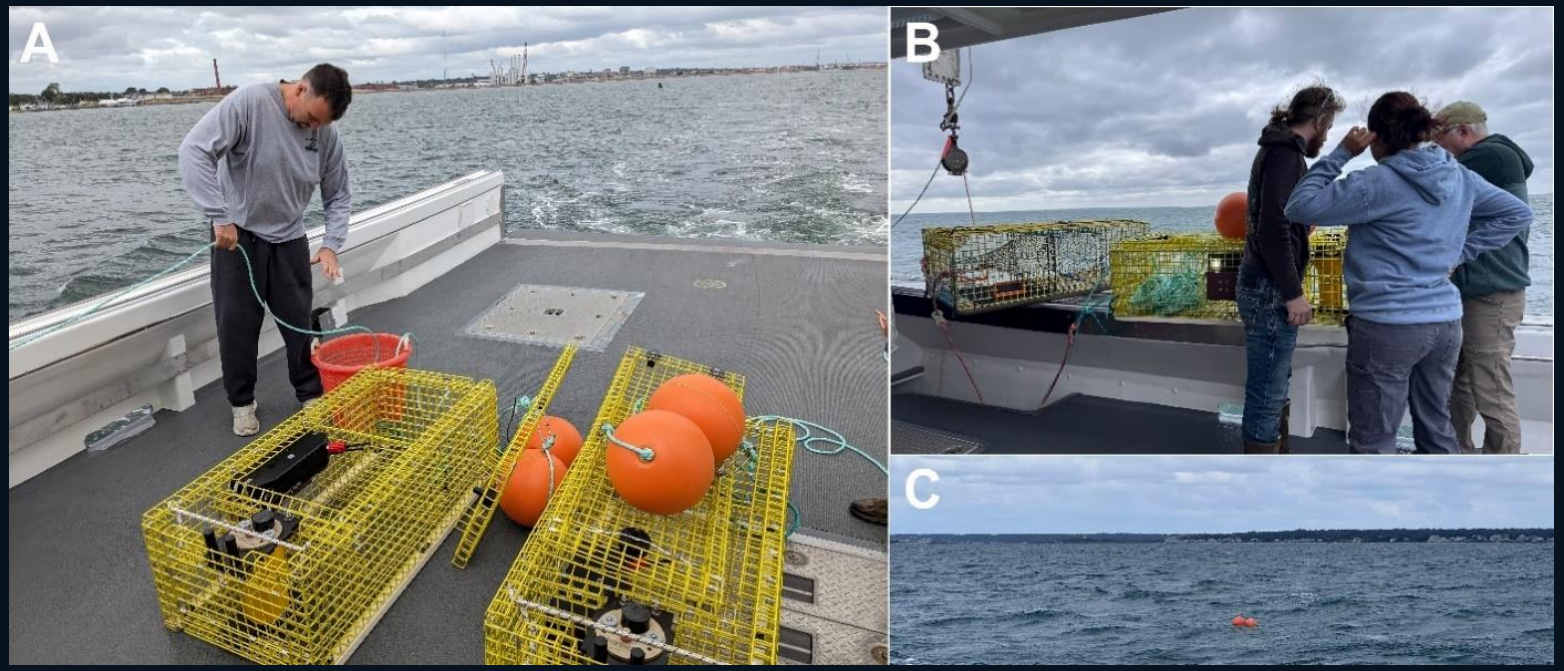


Images from pond testing

Ropeless Camera System

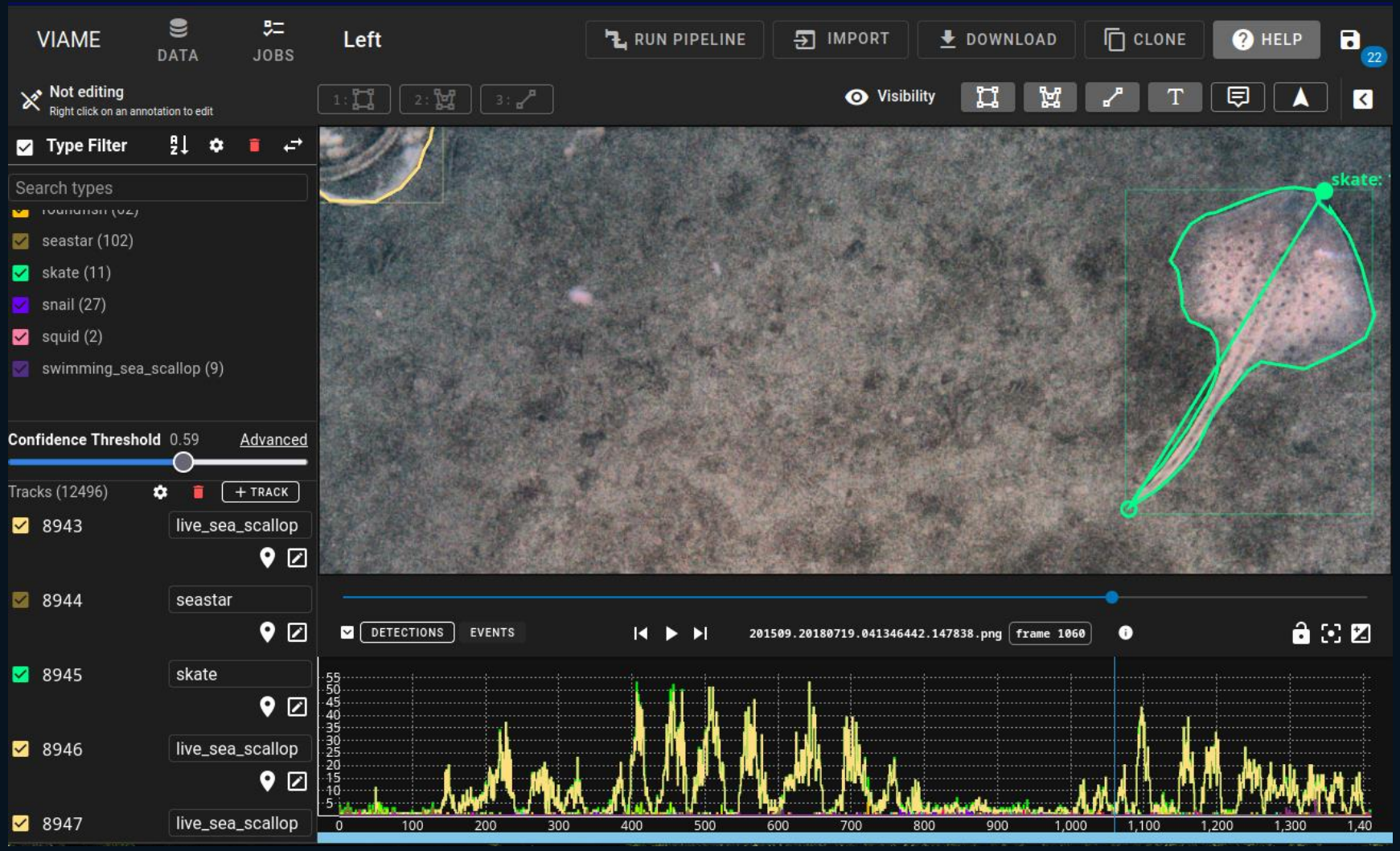
Testing Edgetech ropeless traps with camera systems in Buzzards Bay aboard the F/V Never Enough.





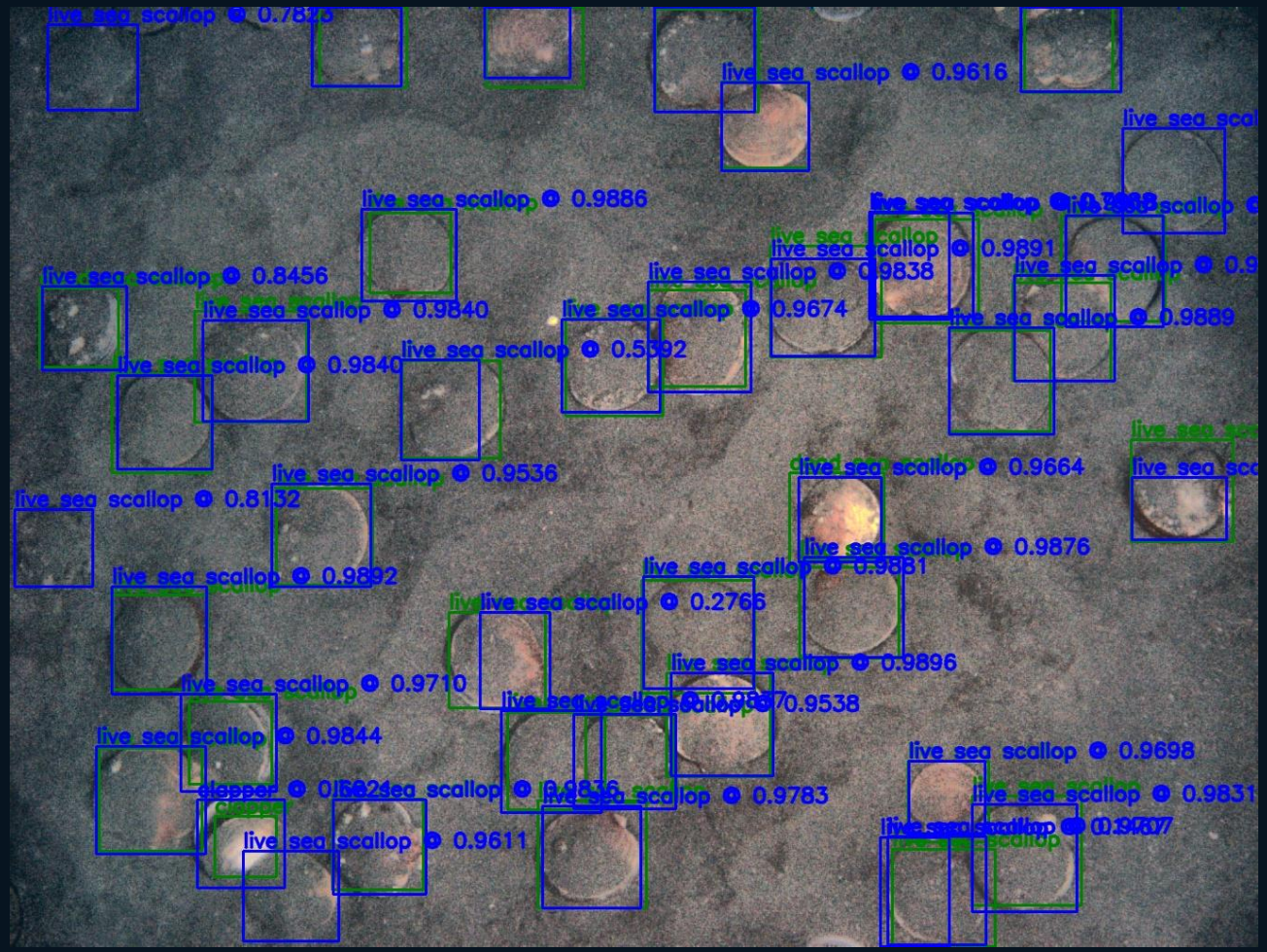
Video and Image Analytics for Marine Environments (VIAME)

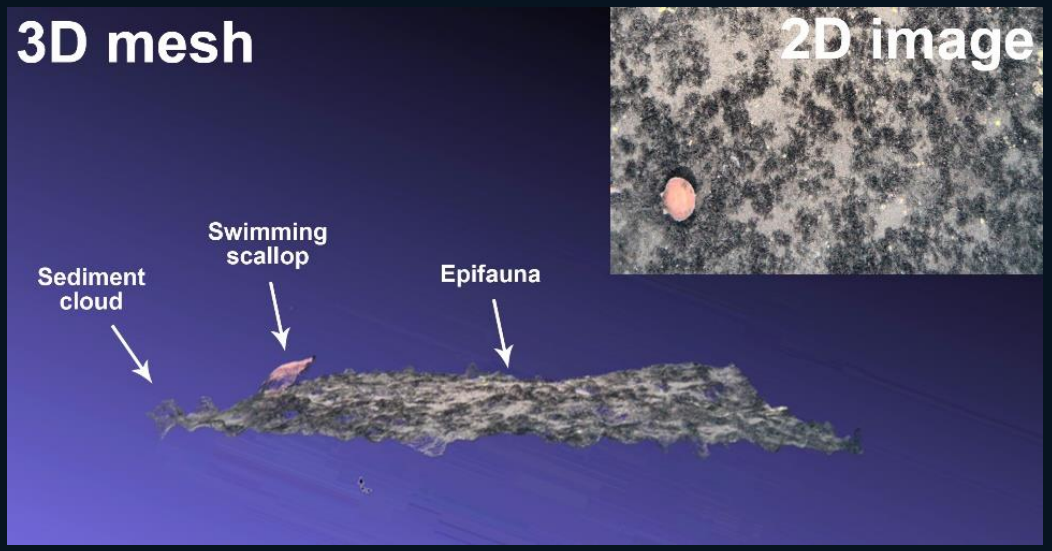
Open-source computer vision software platform designed for do-it-yourself artificial intelligence



Automated Detector Models

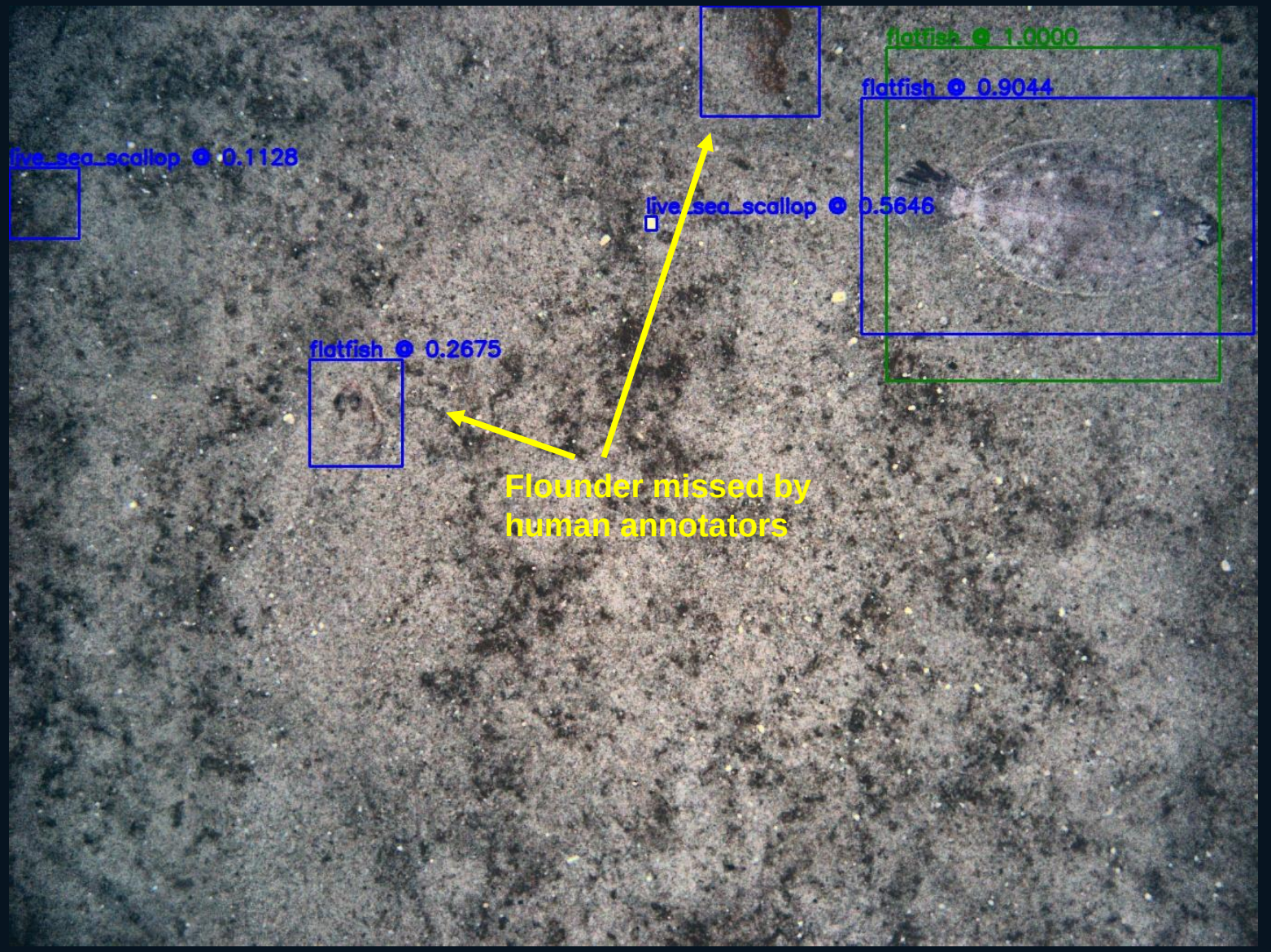
Improving scallop models developed using other funding (2019 Sea Scallop Research Set-Aside grant)





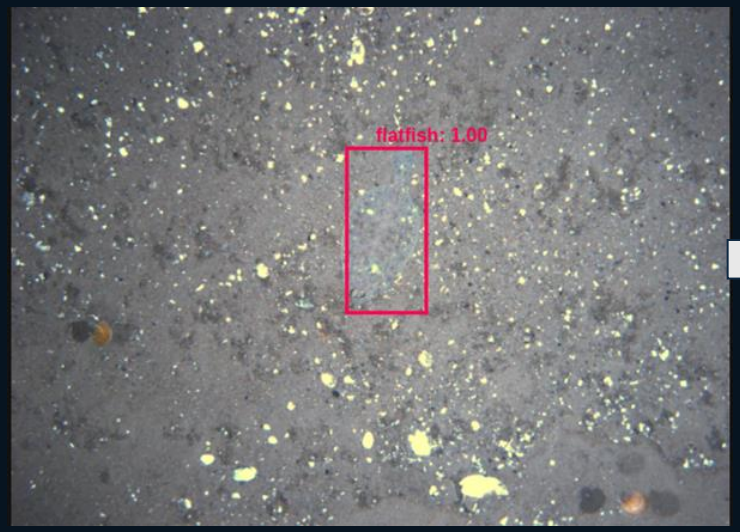
Automated Detector Models

Improving flatfish models developed using other funding (2019 Sea Scallop Research Set-Aside grant)



Automated Detector Models

Stereo Measurement - Automatic Segmentation and Head/Tail ID



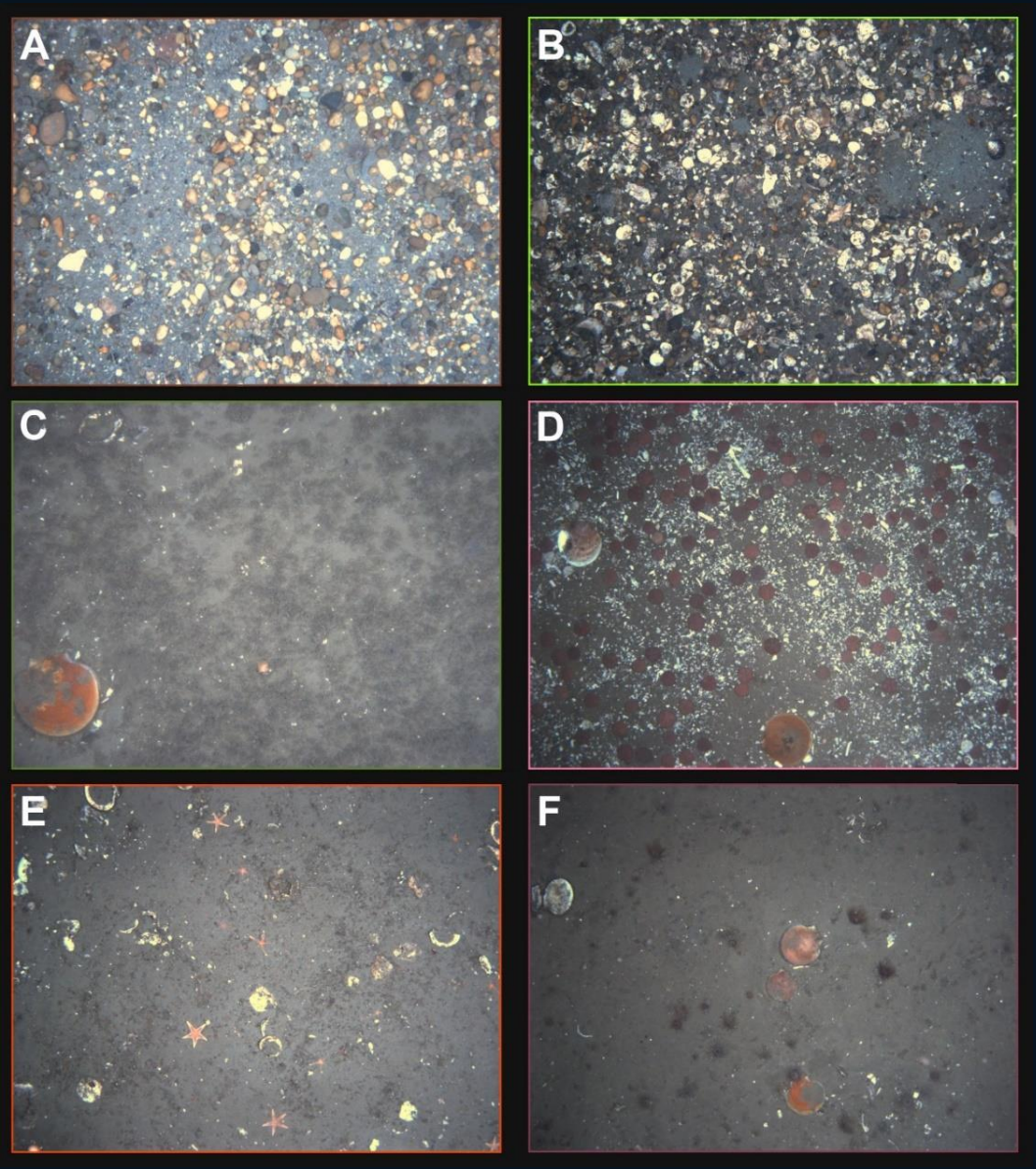
Detection

Mask / Polygon

Mask / Tail

Automated Detector Models

Improving substrate/habitat models developed using other funding (2021 Sea Scallop Research Set-Aside grant)



Examples of output from substrate component detectors.

(A) Gravel.

(B) Shell hash.

(C) Bryozoans.

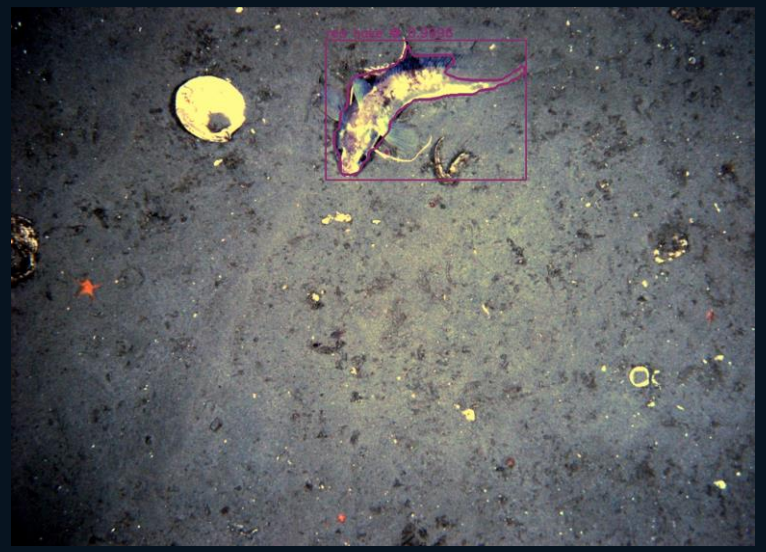
(D) Shell hash plus sand dollar bed.

(E) Sea star bed.

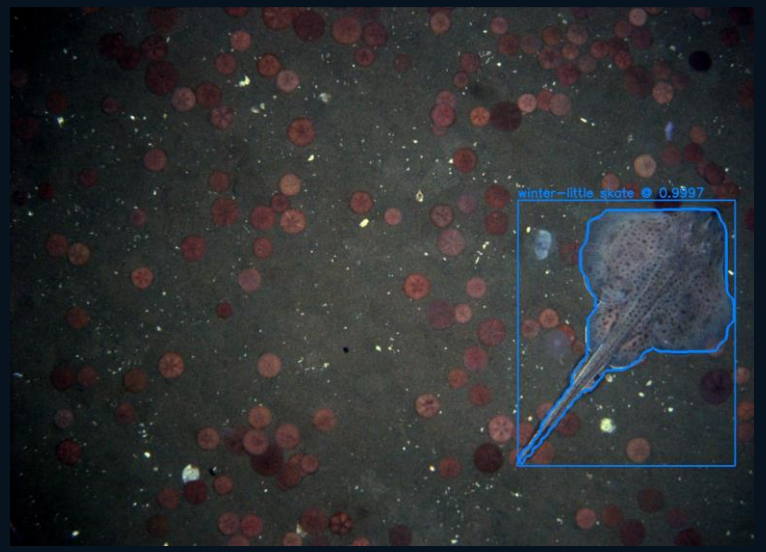
(F) Burrowing anemone bed.

Automated Detector Models

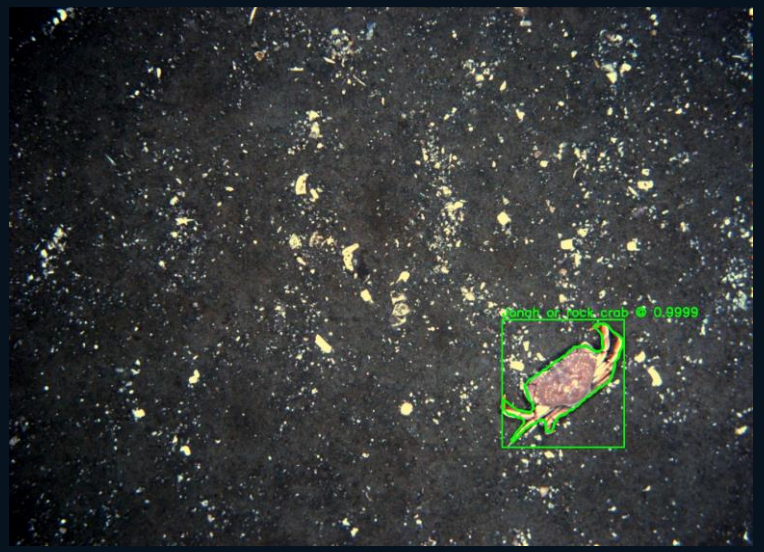
Mid-shot object detection - Trained three detectors for target fish species of interest containing only a low number of annotations (100-500 samples)



Red hake

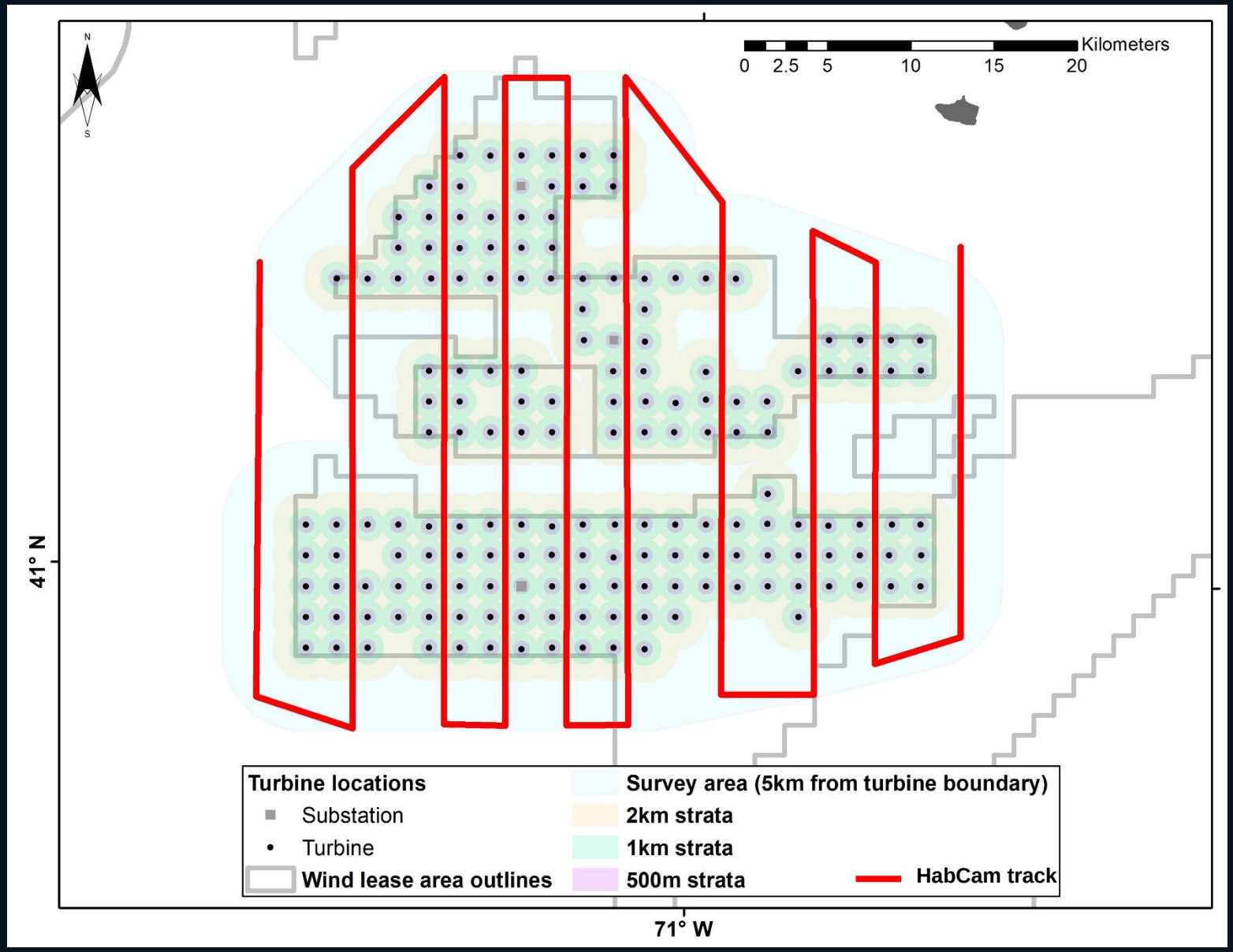


Little/winter skate



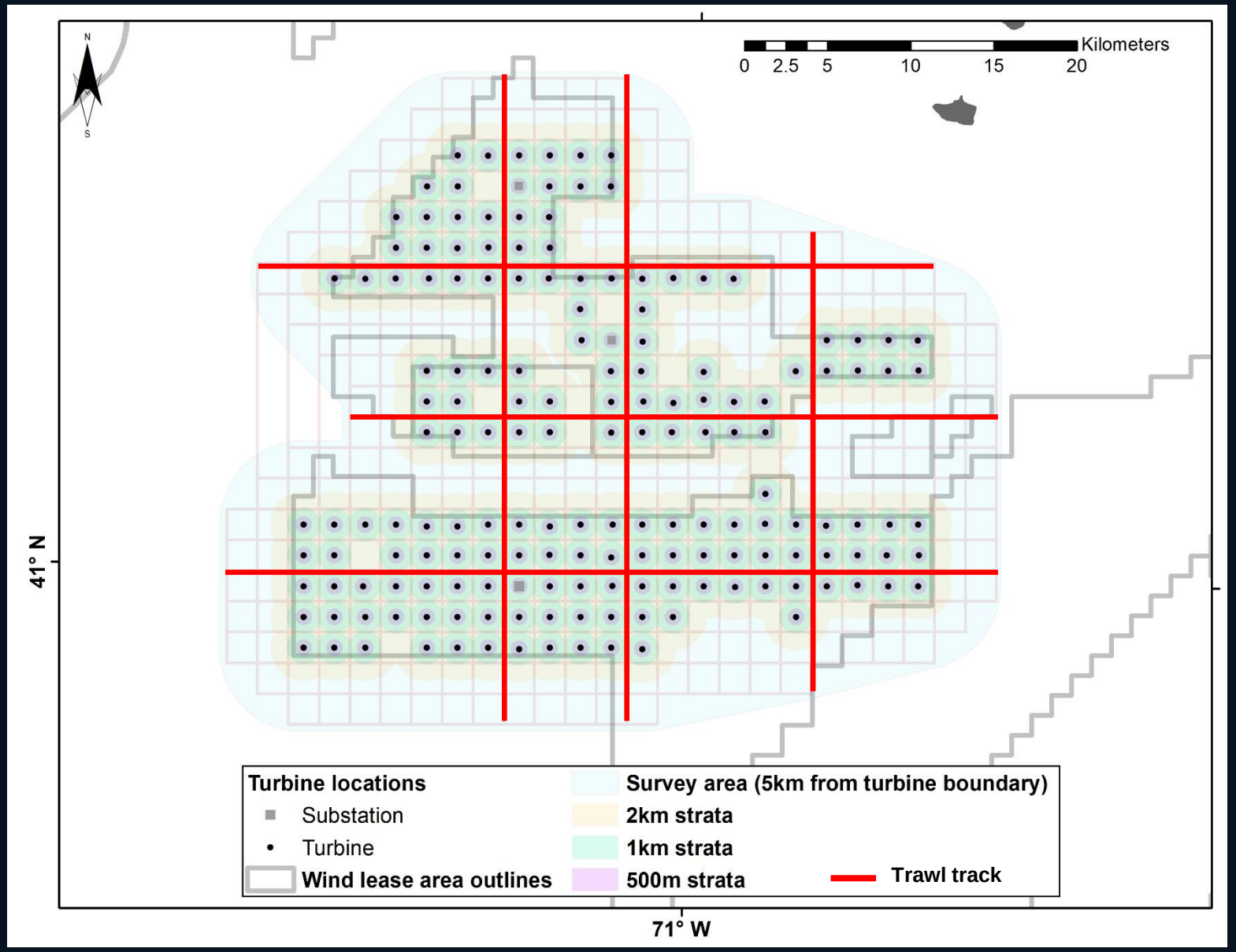
Jonah/rock crabs

Survey Design - HabCam



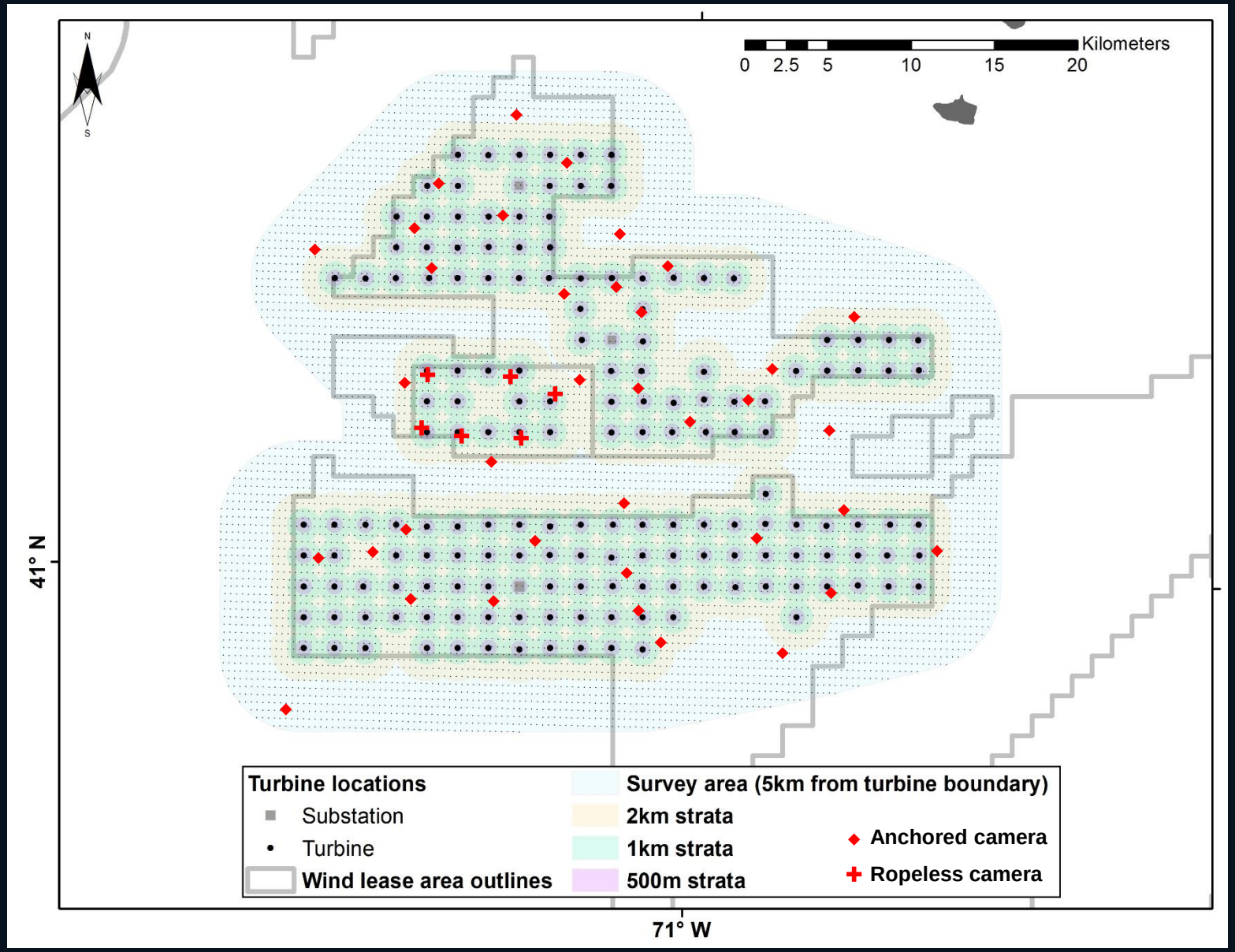
- Set track for each survey
- May be modified based on presence of obstructions
- Relative abundance = density

Survey Design – Video Trawl



- Random selection of N-S and E-W tracks
- May be modified based on presence of obstructions
- Total number of tracks limited by survey trip length
- Relative abundance = density

Survey Design – Stationary Cameras



- Random selection anchored and ropeless stationary camera locations (GEBCO grid)
- Six ropeless camera systems deployed per trip near turbine bases only – 7-day deployments
- Total number of anchored stationary cameras limited by survey trip length – 60 to 90-min deployments
- Relative abundance = MaxN

Modeling Wind Farm Impacts

Expect to use generalized additive mixed models to model species relative abundance as a function of the factors shown below.

By survey

Relative Abundance ~

Distance from turbine base +

Proximity to other wind farms +

Bottom depth +

Bottom temperature +

Sound level (under 200 kHz)+

Habitat type +

Season

Distance from turbine base =
Pre-defined distance strata
and
Post-hoc stratification

Aggregated

Relative Abundance ~

Distance from turbine base +

Proximity to other wind farms +

Bottom depth +

Bottom temperature +

Sound level (under 200 kHz)+

Habitat type +

Season +

Survey type

Distance from turbine base =
Pre-defined distance strata

Next Steps

1. **Finalize custom stationary cameras**
   - Improved operation – mechanical on/off switch and easy image back-up
   - Improved housing geometry
   - Improved internal wiring and component placement
   - Option to swap out lenses
2. **Complete first set of surveys in spring 2025**