First direct assessment of the size-selectivity of hook and line gear, chevron traps, and underwater cameras for Red Snapper and other reef fishes in the U.S South Atlantic

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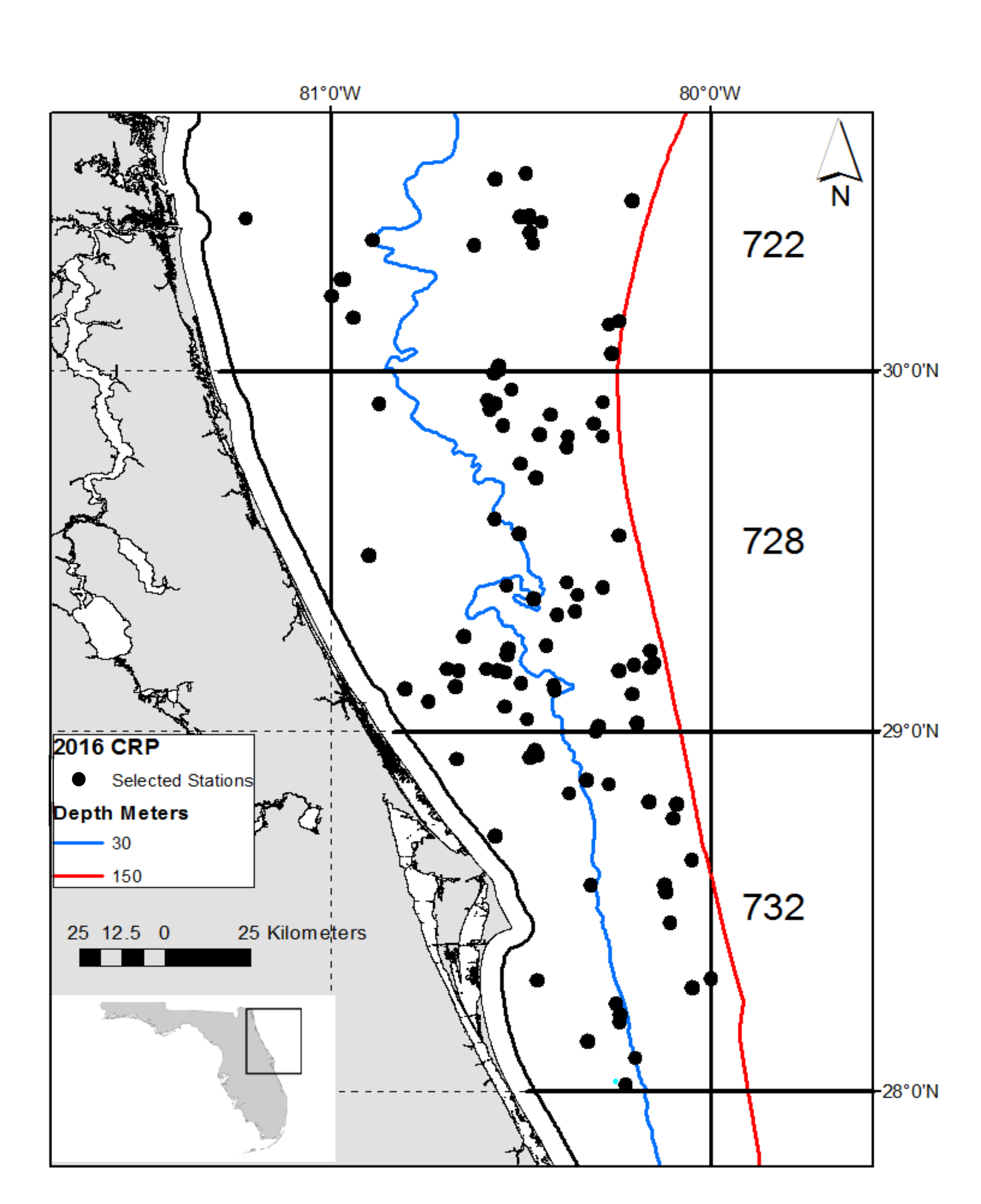
Objectives

- Recent questions as to appropriate selectivity function for SERFS Chevron trap survey – especially Red Snapper
- Evaluate size-selectivity of Chevron traps and fishery-independent hooked-gears by comparing the size structure of the catches with those determined by stereo baited remote underwater video camera arrays (stereo-BRUV) for Red Snapper
- Selectivity study was part of a larger study that also provided demographic data (i.e., age, sex, reproductive condition)

Sampling methods

- 100 stations randomly selected
- U.S. South Atlantic coast of Florida
  - NMFS zones 722, 728, 732
- Two depth strata
  - ≤30 m and >30 m
- Each station sampled using
  - Chevron traps
  - Two hooked-gears: standardized and unstandardized
  - All capture gears paired with stereo-BRUV

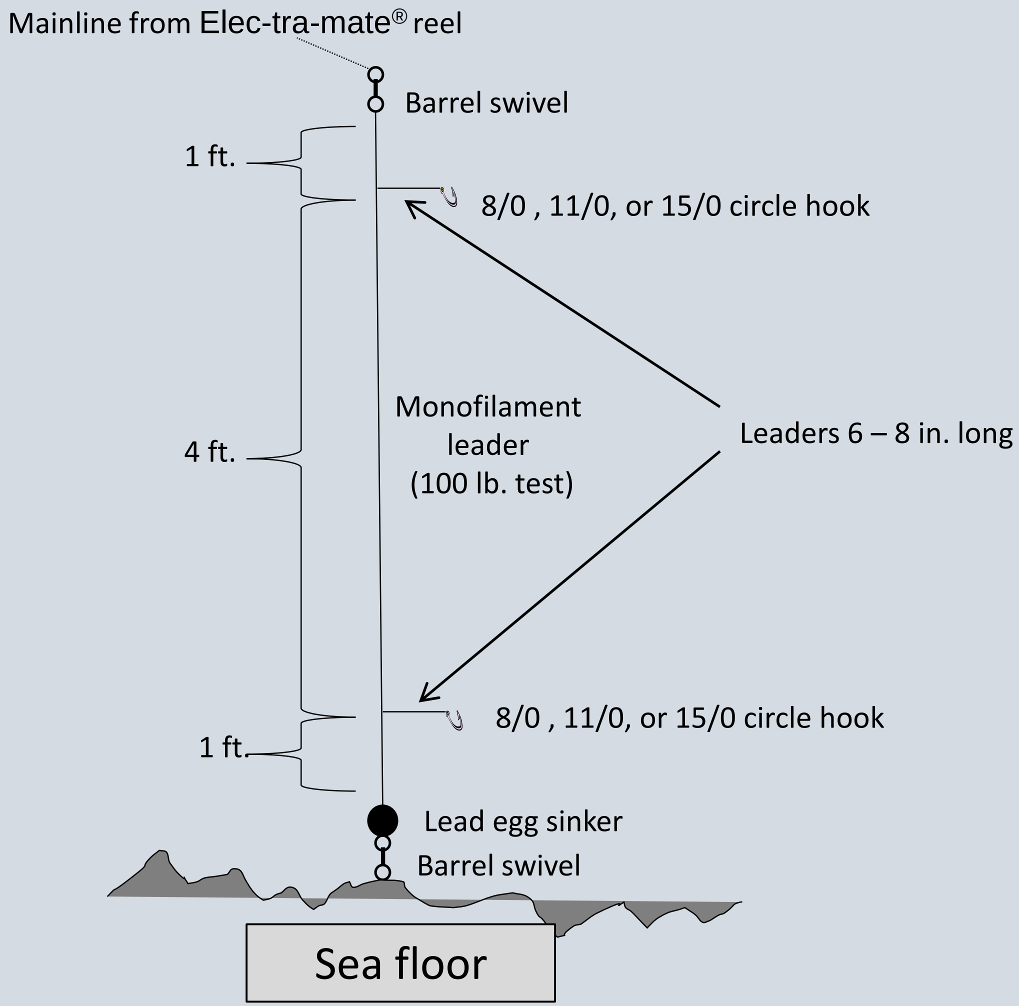


Chevron Trap

- Gear specs and deployment procedures followed SERFS protocols, including bait
- 35 x 35 mm square mesh plastic-coated wire
- 90-minute soak
- Stereo-BRUV attached to trap and was deployed concurrently (recorded 35 mins)

Repetitive Timed-Drop (RTD)

- Standardized hook gear
- 3 anglers per vessel
- Two hooks each
  - 8/0, 11/0, or 15/0
- Baited with Atlantic Mackerel
- Simultaneously fish for 2 minutes or until fish hooked
- 10 repetitive drops at each station
- Stereo-BRUV deployed prior to sampling



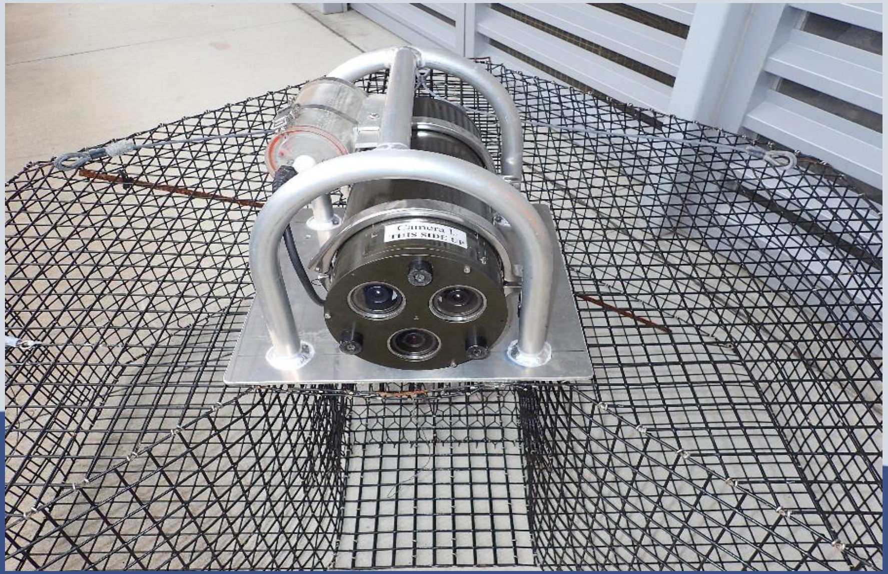
Captain's Choice (CC)

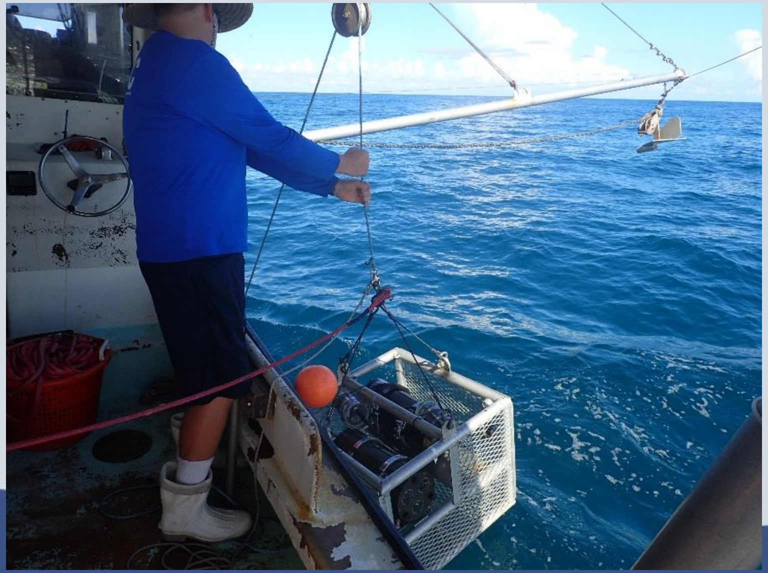
- Captain directed to use unstandardized hooked-gear methods to target Red Snapper
- Based on knowledge and experience of industry partners
  - Mostly commercial or charter captains
- Specific gear, tackle, and bait dictated by Captain
- Three anglers 30 minutes
  - Recorded deployment details
- Stereo-BRUV deployed prior to sampling

Stereo Baited Underwater Remote Video (Stereo-BRUV)

- Chevron traps had one stereo-BRUV mounted above the throat and recorded for 35 mins

- 2 stereo-BRUVs facing 180° with 2 orthogonal GoPro© cameras were deployed prior to hooked gear sampling and recorded for 30 mins





Stereo-BRUV: processing

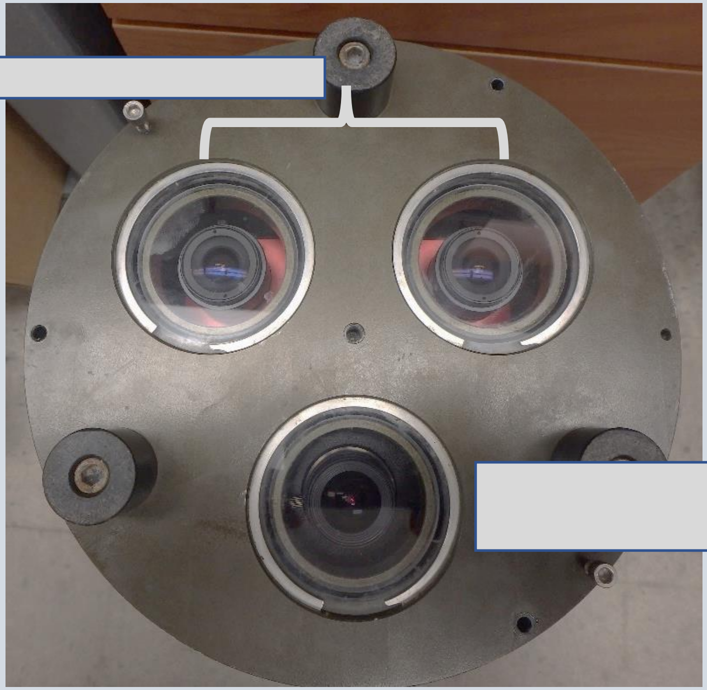
- Videos were read for 20 min
- One video was read for abundance estimates
- Relative abundance = MaxN, maximum number of individuals of single species in any one frame
- Fork length measured in SeaGIS

Stereo-BRUV

Videre STH-MDCS3-9cm Still Cameras

- 1280 x 960 resolution
- ½” CMOS sensor
- monochrome
- ~1 frame/second simultaneous image capture
- Used for measures

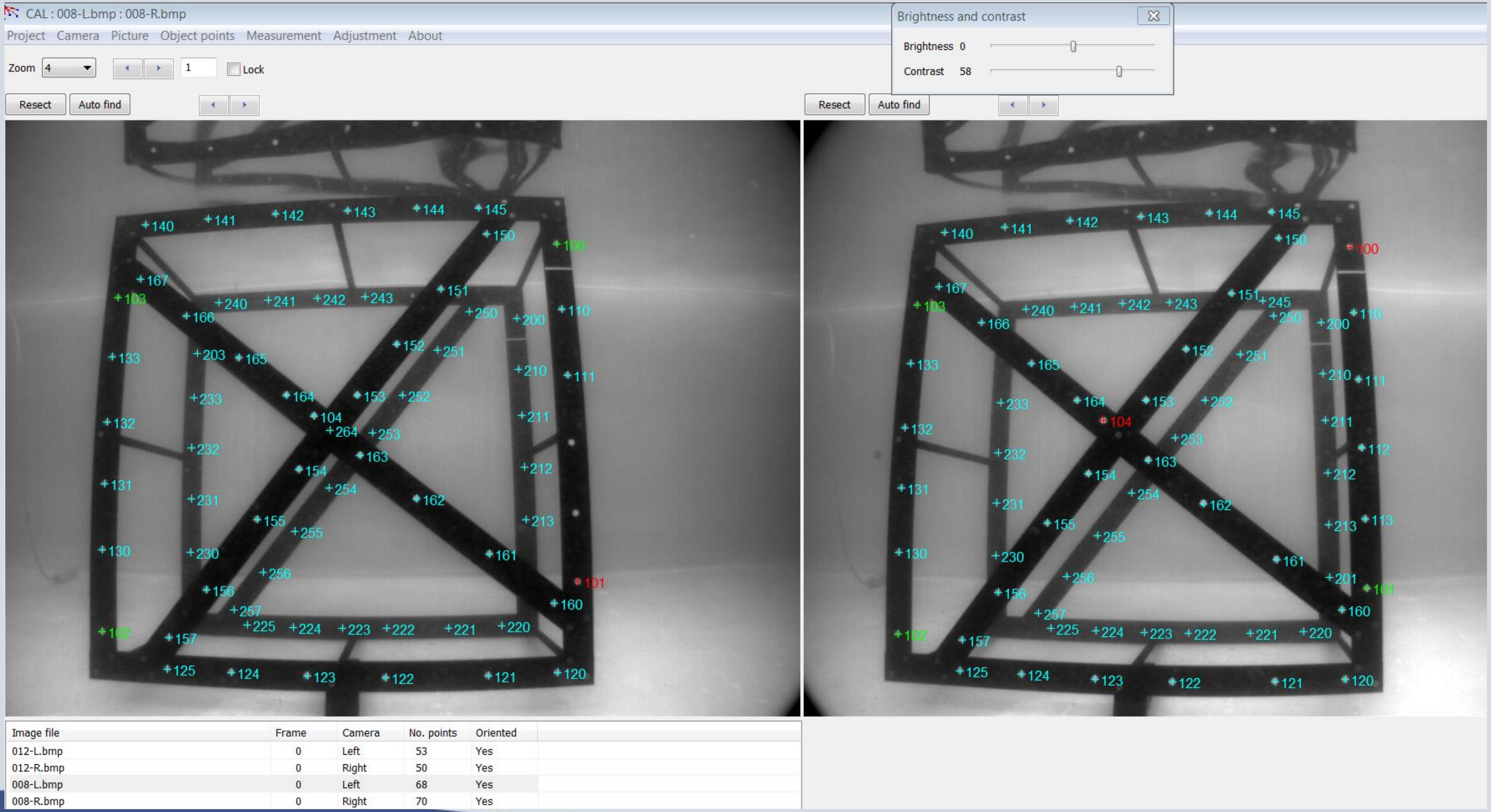
90 mm baseline



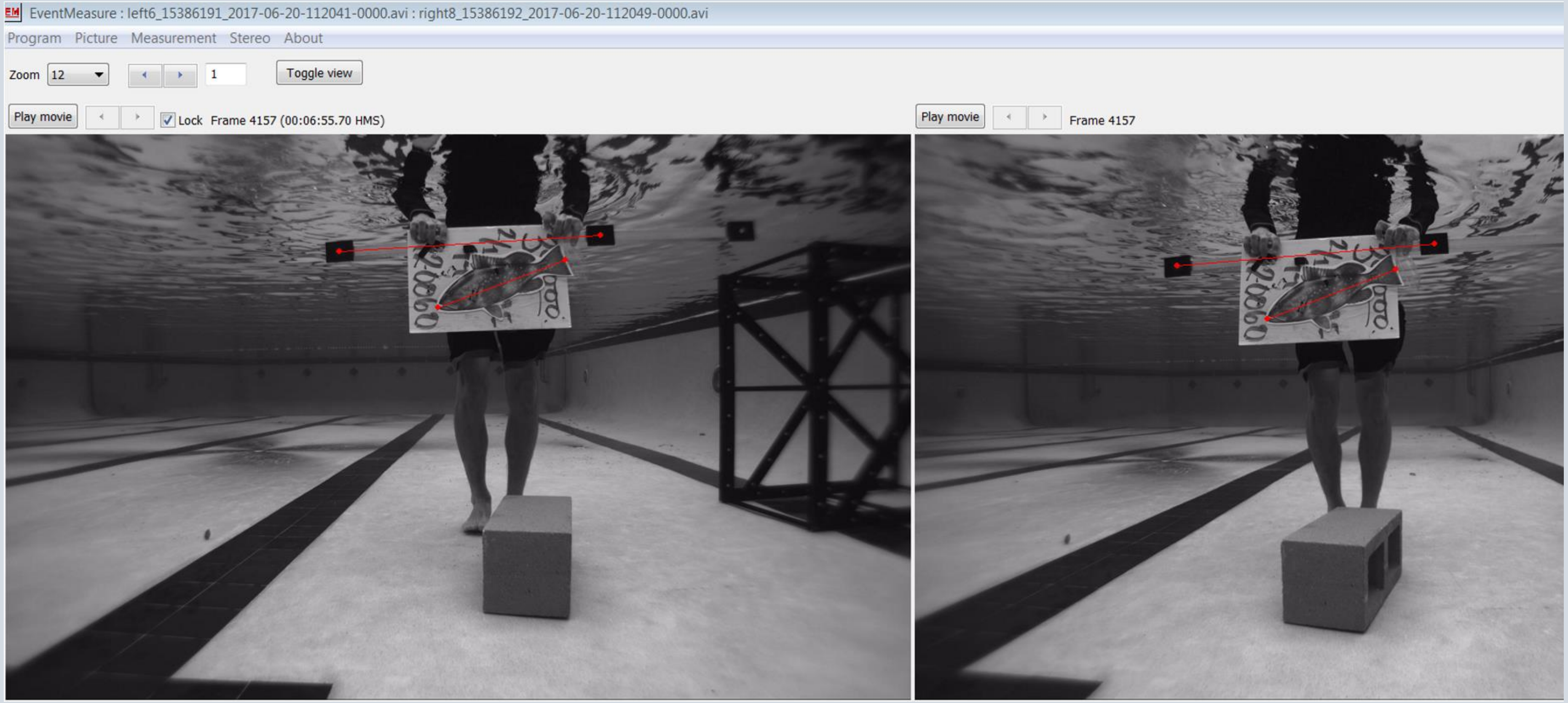
Arecont AV2105DN Video Camera

- 1280 x 1024 resolution
- 2mp CMOS sensor
- Color
- Used for abundance

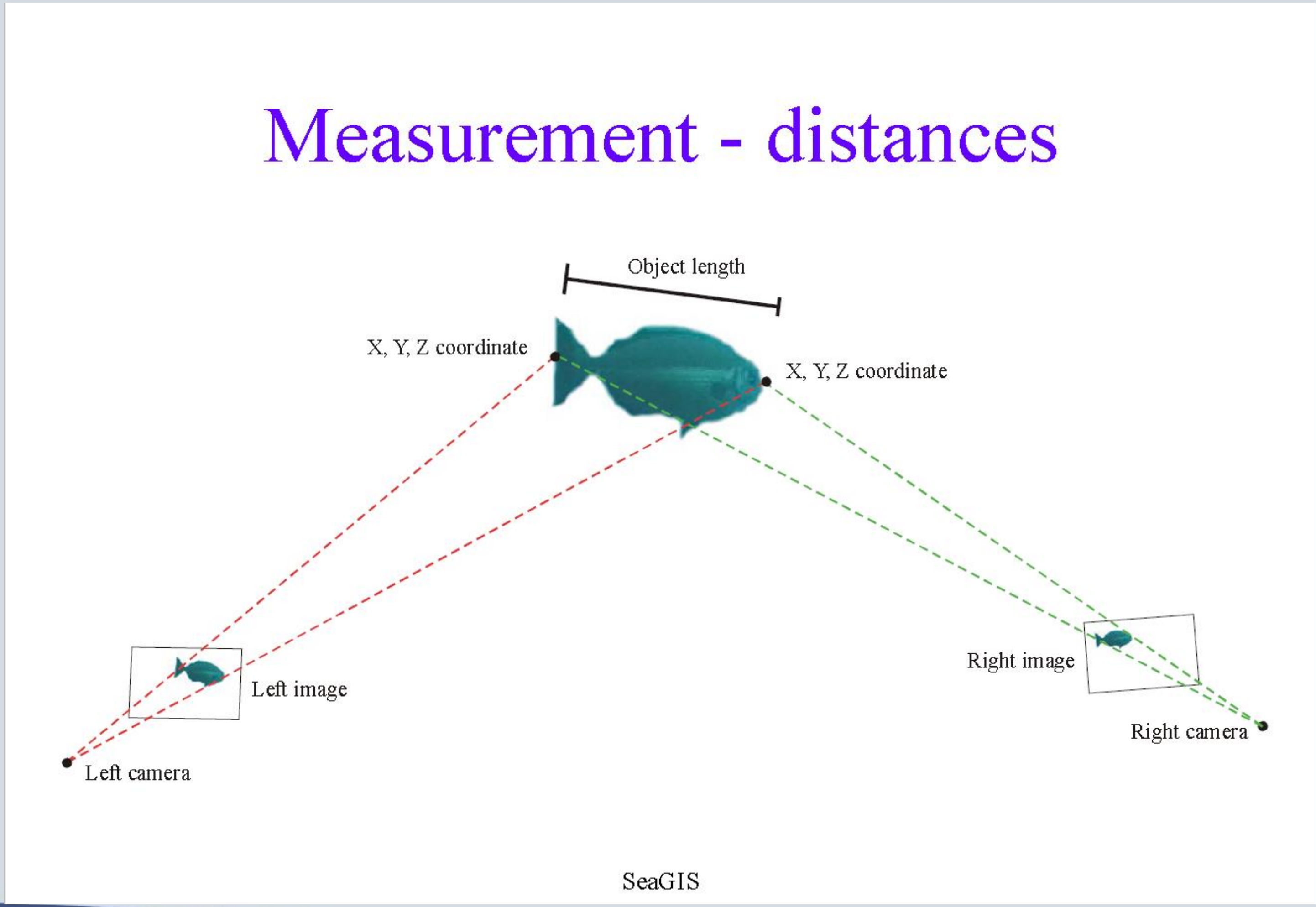
Stereo-BRUV: calibration



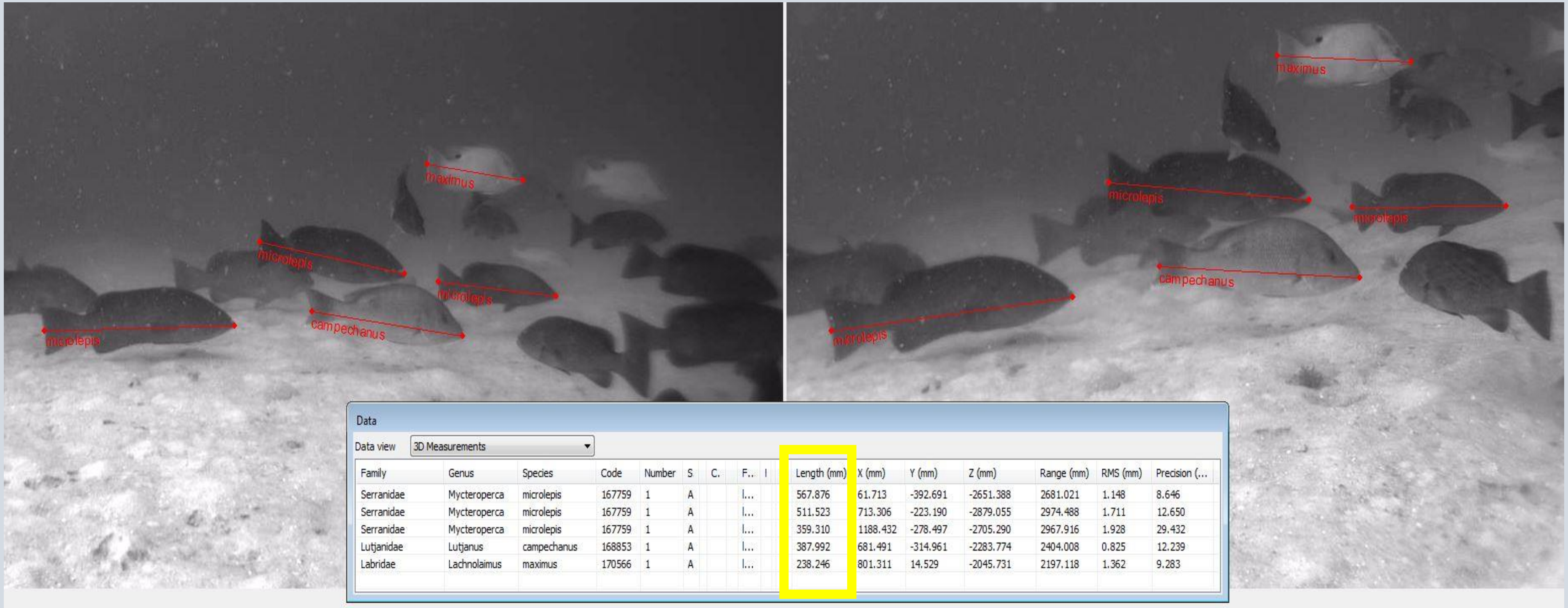
Stereo-BRUV: calibration



Stereo-BRUV: measurements



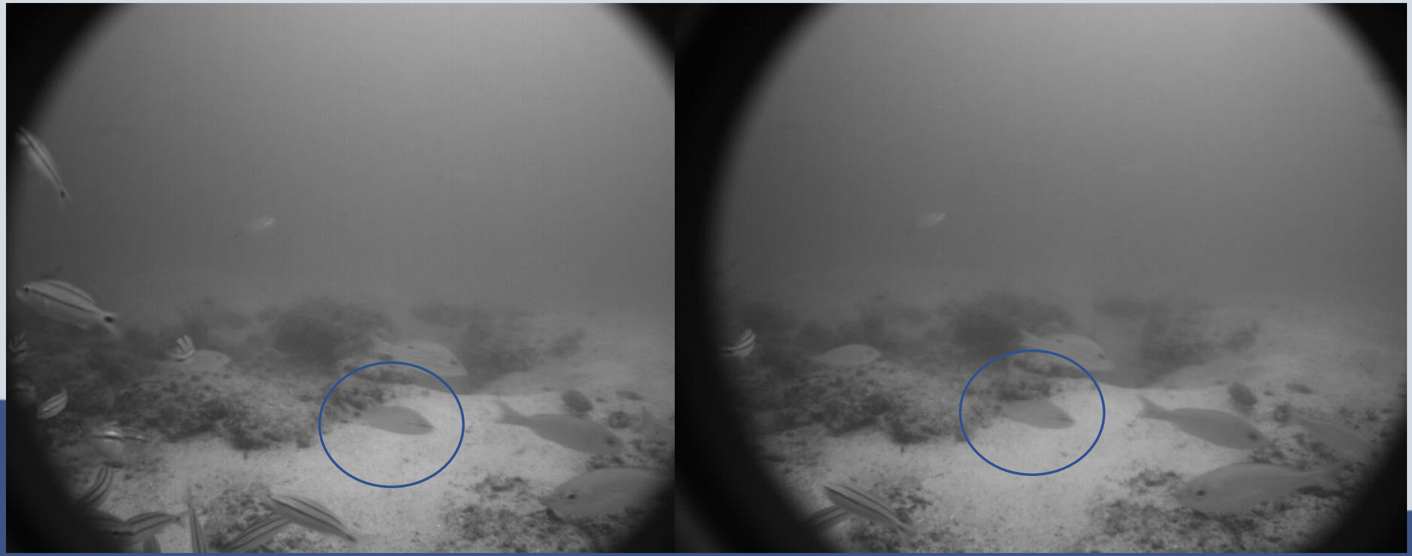
Stereo-BRUV: measurements



Family	Genus	Species	Code	Number	S	C.	F..	I	Length (mm)	X (mm)	Y (mm)	Z (mm)	Range (mm)	RMS (mm)	Precision (...
Serranidae	Mycteroperca	microlepis	167759	1	A		I...		567.876	61.713	-392.691	-2651.388	2681.021	1.148	8.646
Serranidae	Mycteroperca	microlepis	167759	1	A		I...		511.523	713.306	-223.190	-2879.055	2974.488	1.711	12.650
Serranidae	Mycteroperca	microlepis	167759	1	A		I...		359.310	1188.432	-278.497	-2705.290	2967.916	1.928	29.432
Lutjanidae	Lutjanus	campechanus	168853	1	A		I...		387.992	681.491	-314.961	-2283.774	2404.008	0.825	12.239
Labridae	Lachnolaimus	maximus	170566	1	A		I...		238.246	801.311	14.529	-2045.731	2197.118	1.362	9.283

Stereo-BRUV: measurement considerations

- Tail and snout must be visible in both L and R stills
- Contrast is important, sometimes can be teased out with adjustment of brightness and contrast
- Fast moving, blurry fish are harder to get accurate measure
- Angle and distance: two most important factors to determine feasible measures
- Provides precision measures
- Usable measurements not available for all observed individuals



Statistical analysis

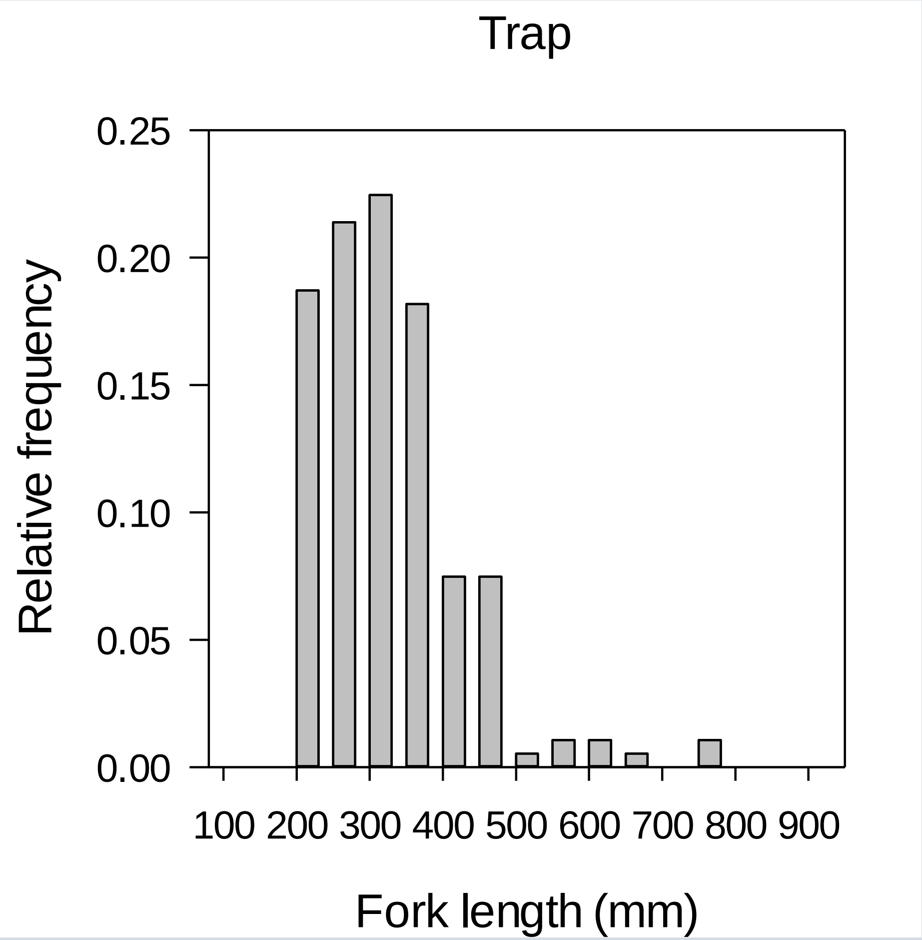
- Length frequency distributions
  - Kernel Density Estimates- sensitive to differences both in shape and location of length-frequency distributions
- Catch proportion of individual gear to Stereo-BRUV
- Indirect selectivity (SELECT method Millar 1999)- RTD only
  - Normal (fixed spread), Normal (proportional spread), Gamma, Lognormal
  - Modeled with equal fishing intensity or proportional fishing intensity

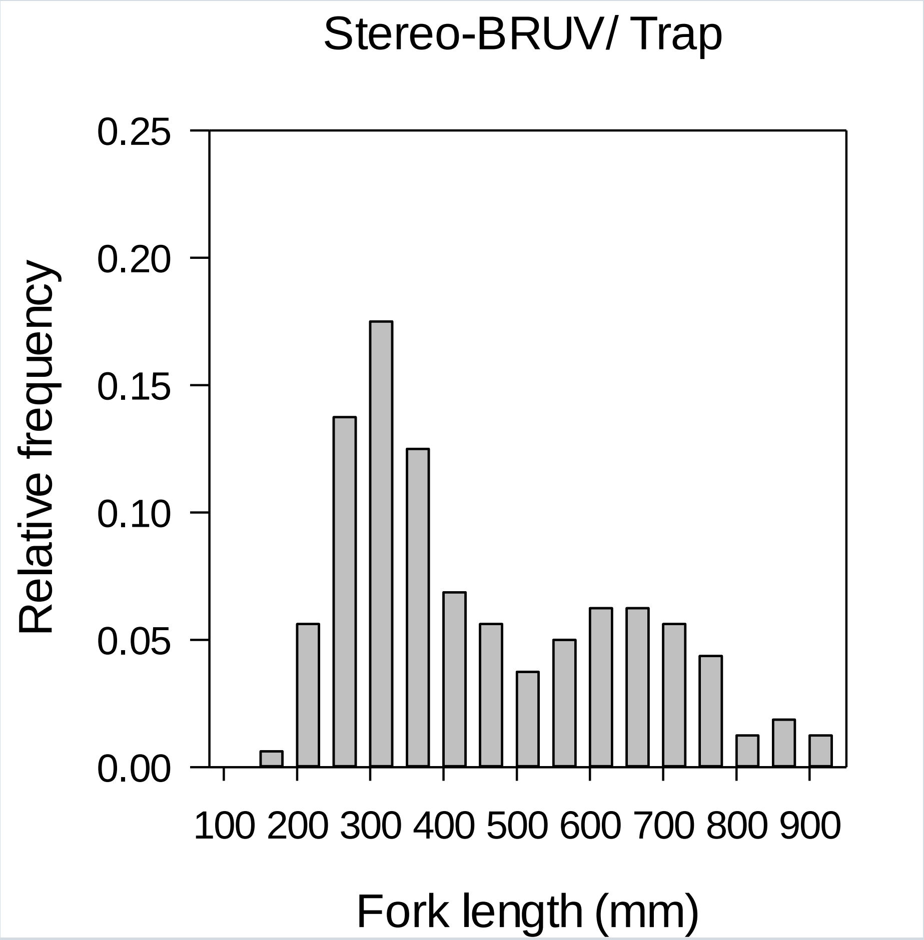
Results

- 93/100 stations completed
- 1151 Red Snapper captured/observed

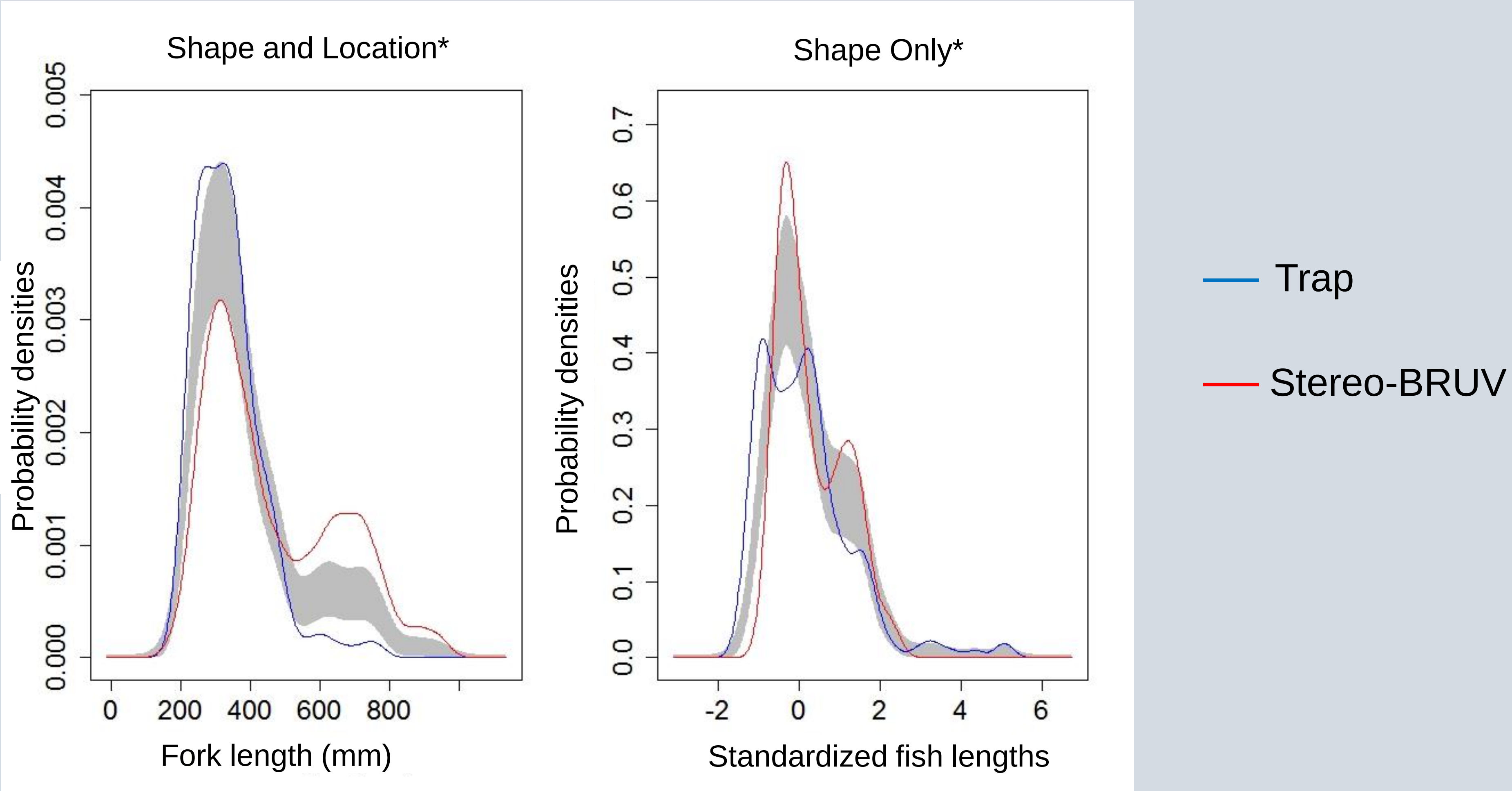
Gear Combination	N
Trap	266
Stereo-BRUV/Trap	162
RTD	240
Stereo-BRUV/RTD	138
Captain's Choice	188
Stereo-BRUV/Captain's Choice	157

Trap/Stereo-BRUV: length frequency

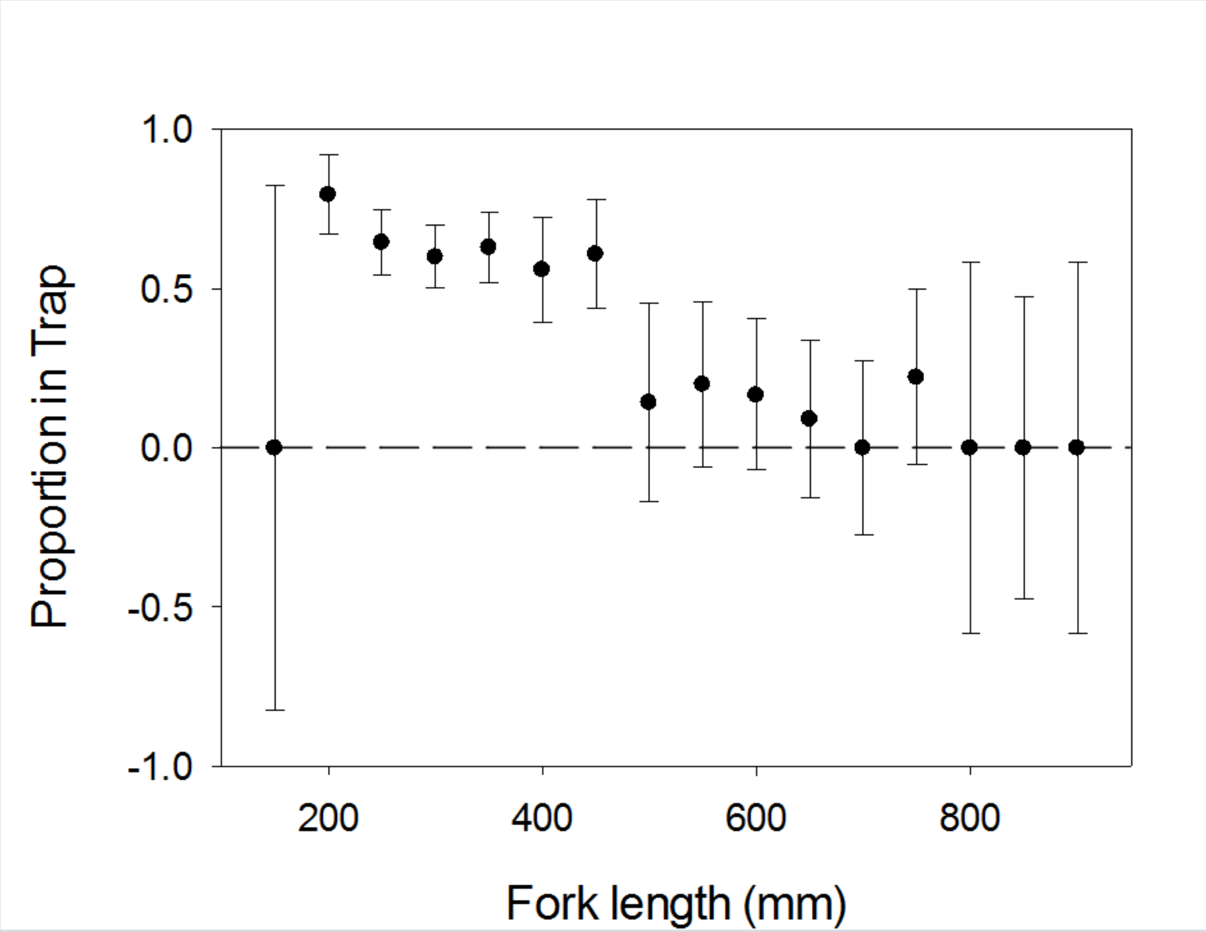




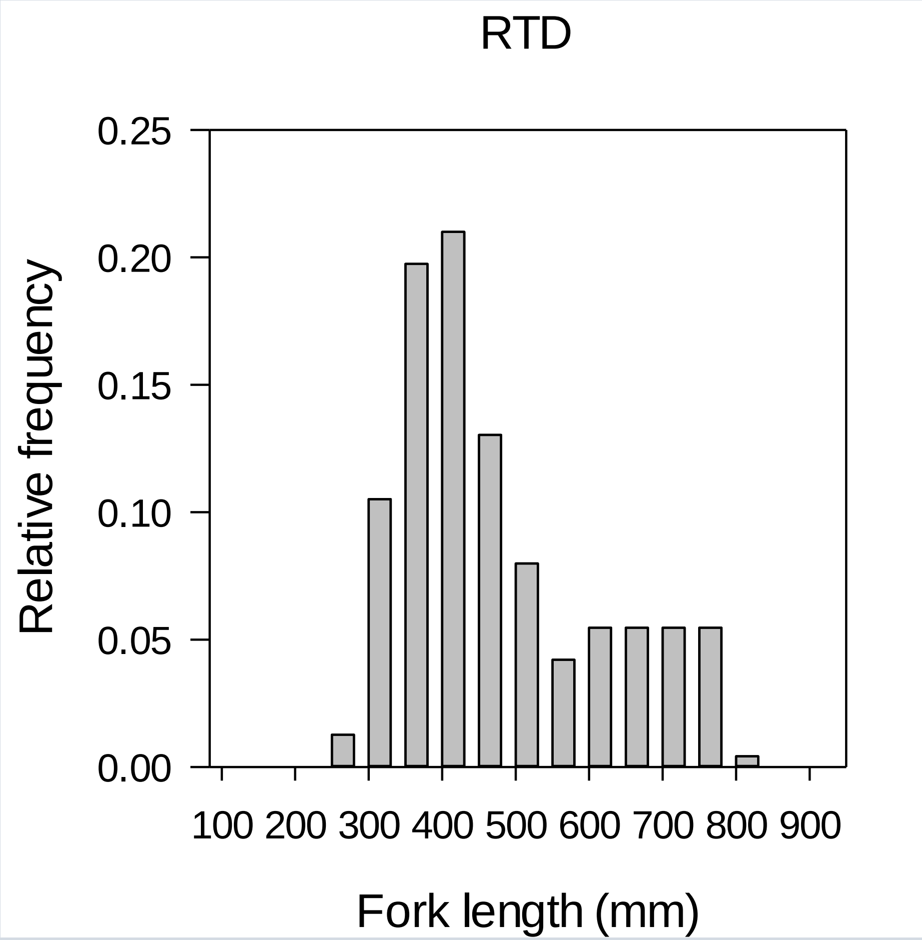
Trap/Stereo-BRUV: KDE analysis

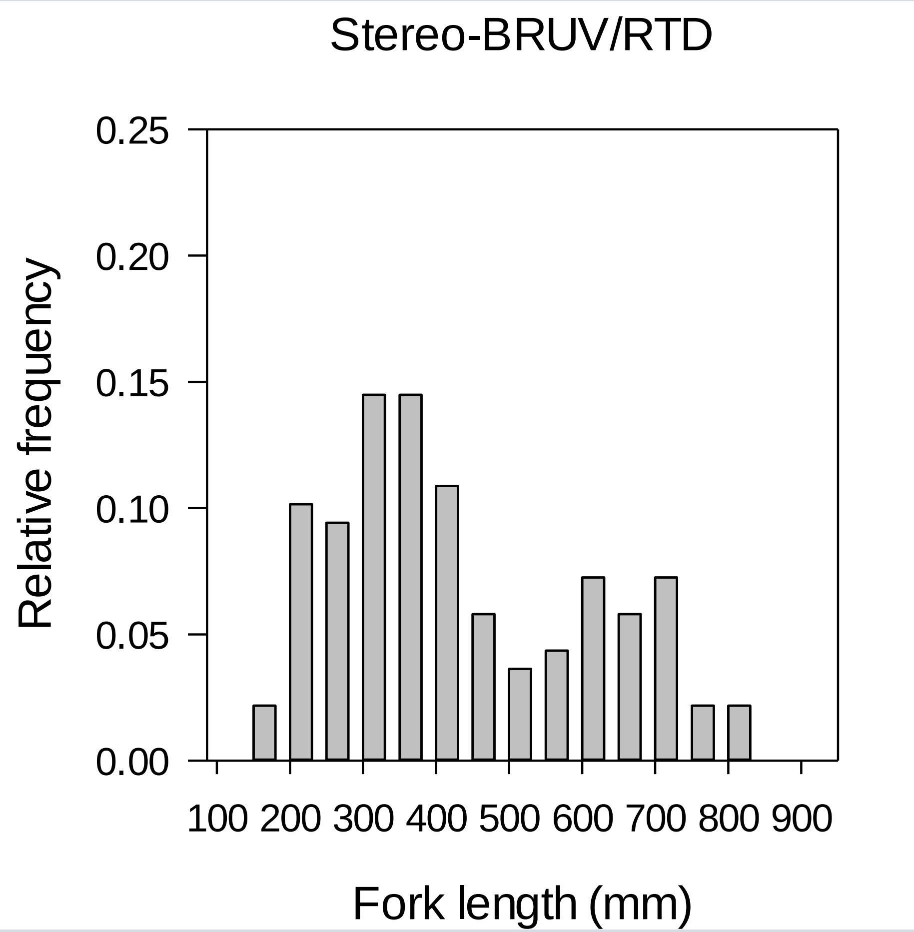


Trap/Stereo-BRUV: catch proportions

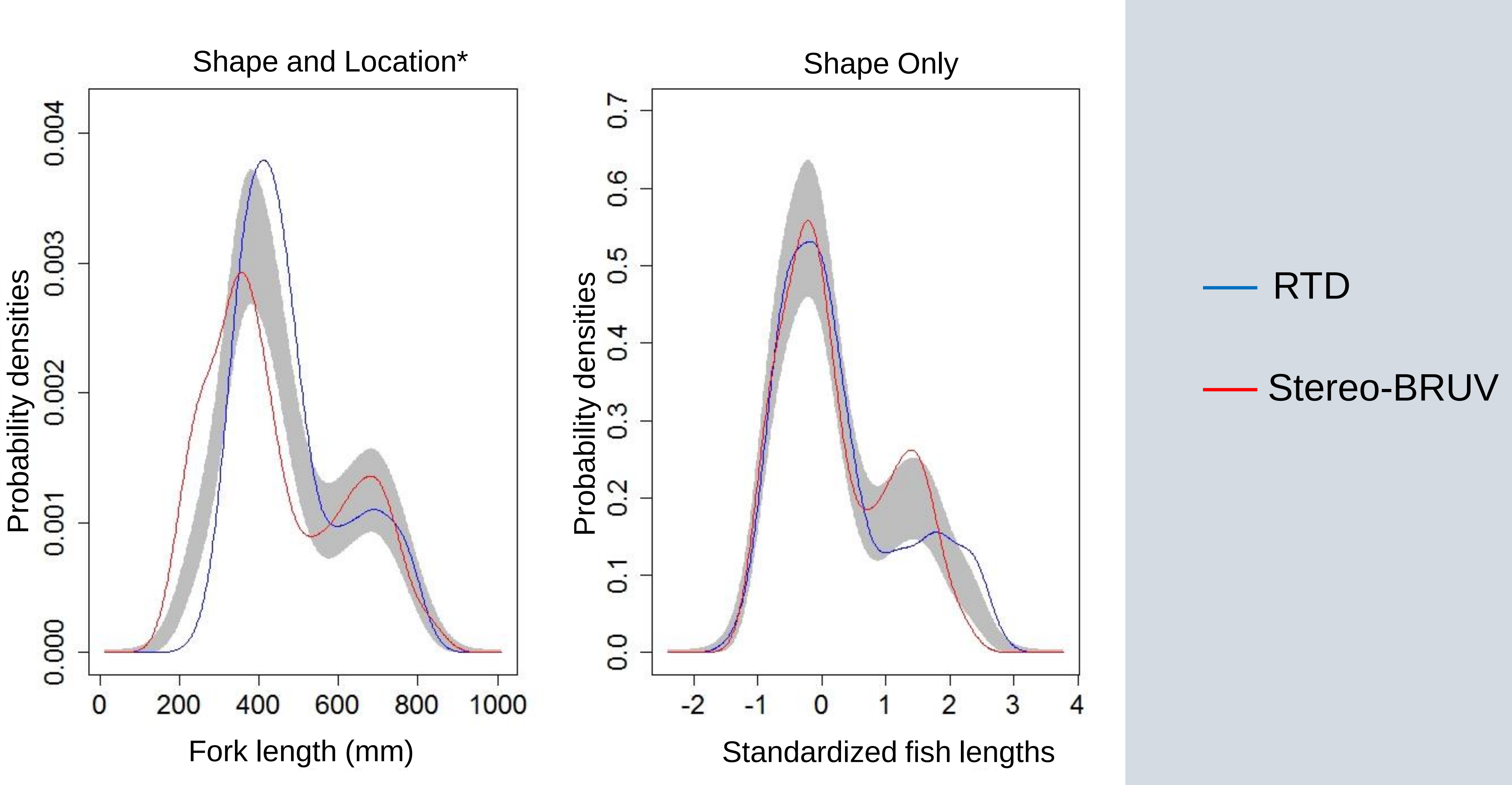


RTD/Stereo-BRUV: length frequency

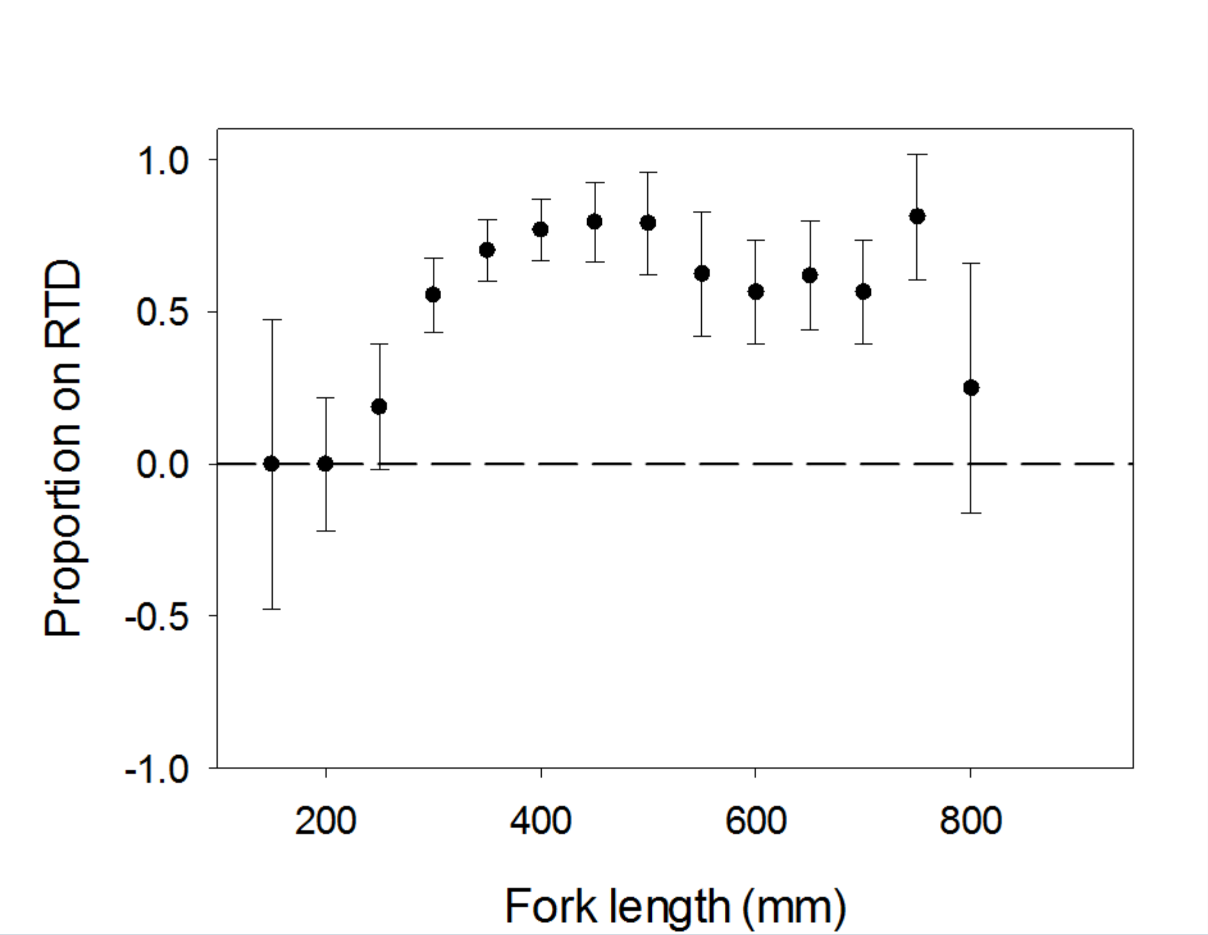




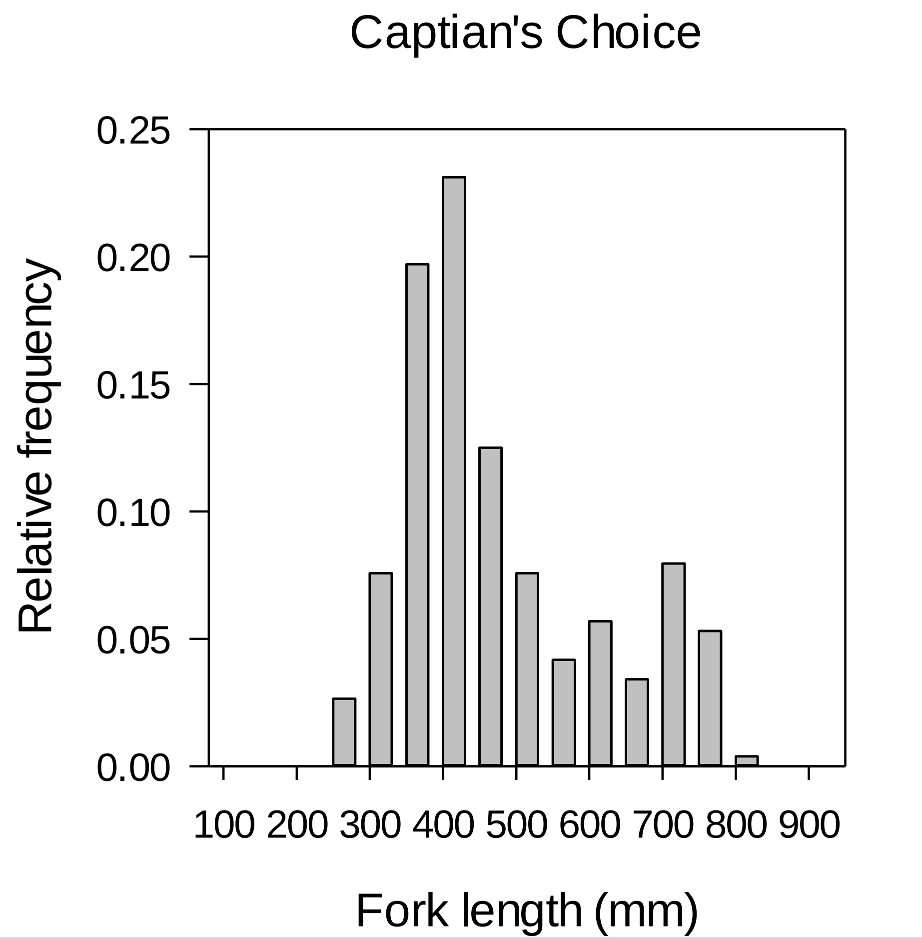
RTD/Stereo-BRUV: KDE analysis

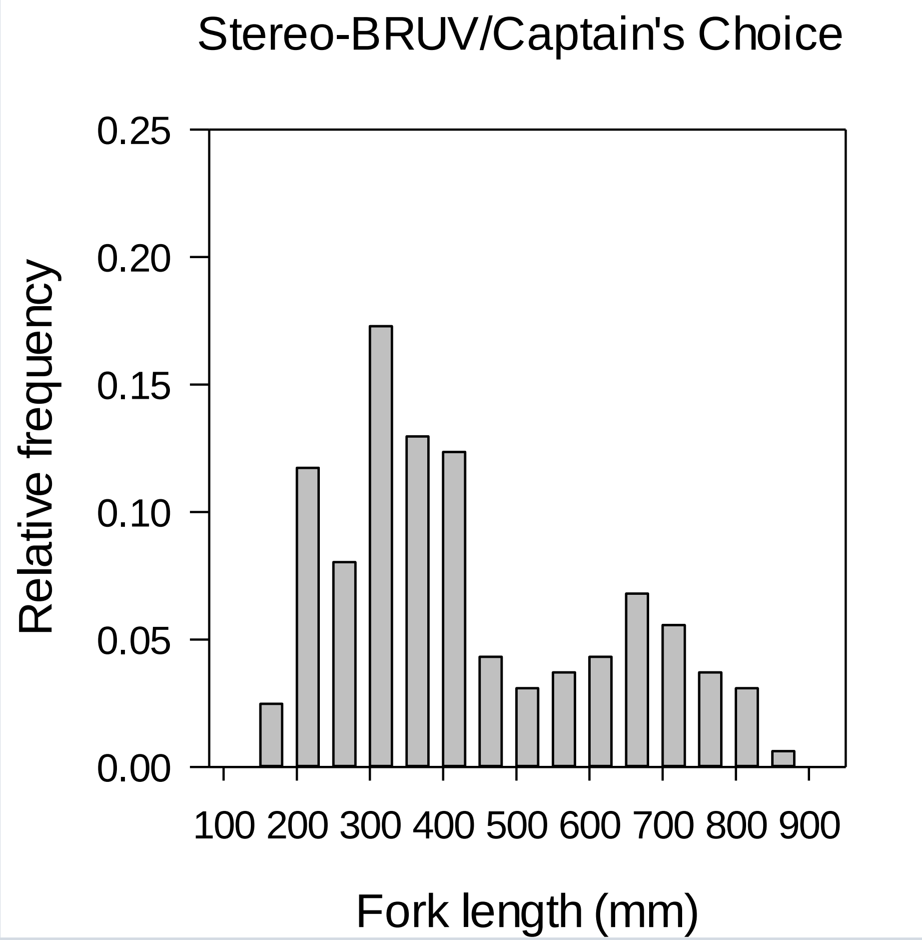


RTD/Stereo-BRUV: catch proportions

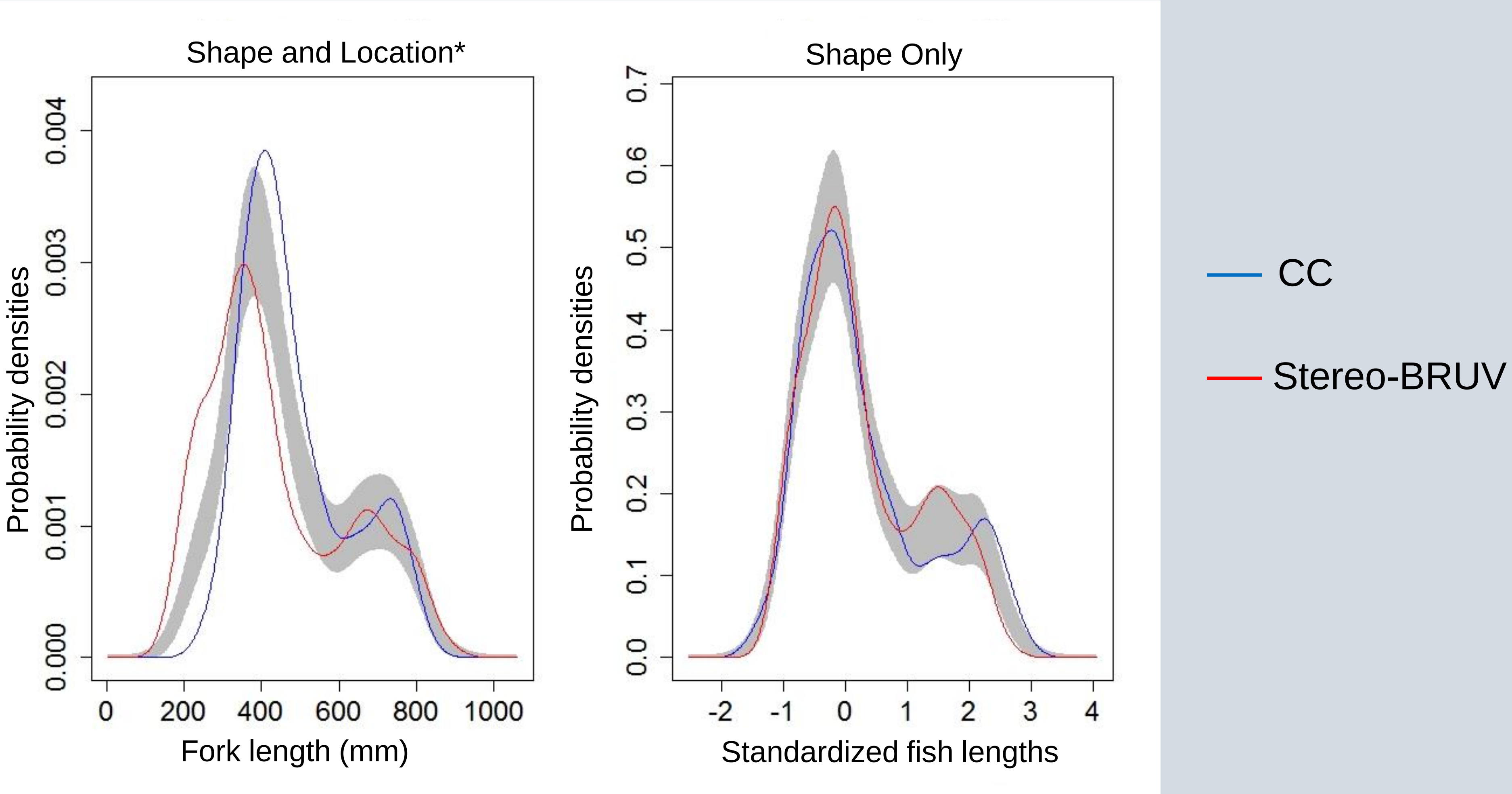


CC/Stereo-BRUV: length frequency

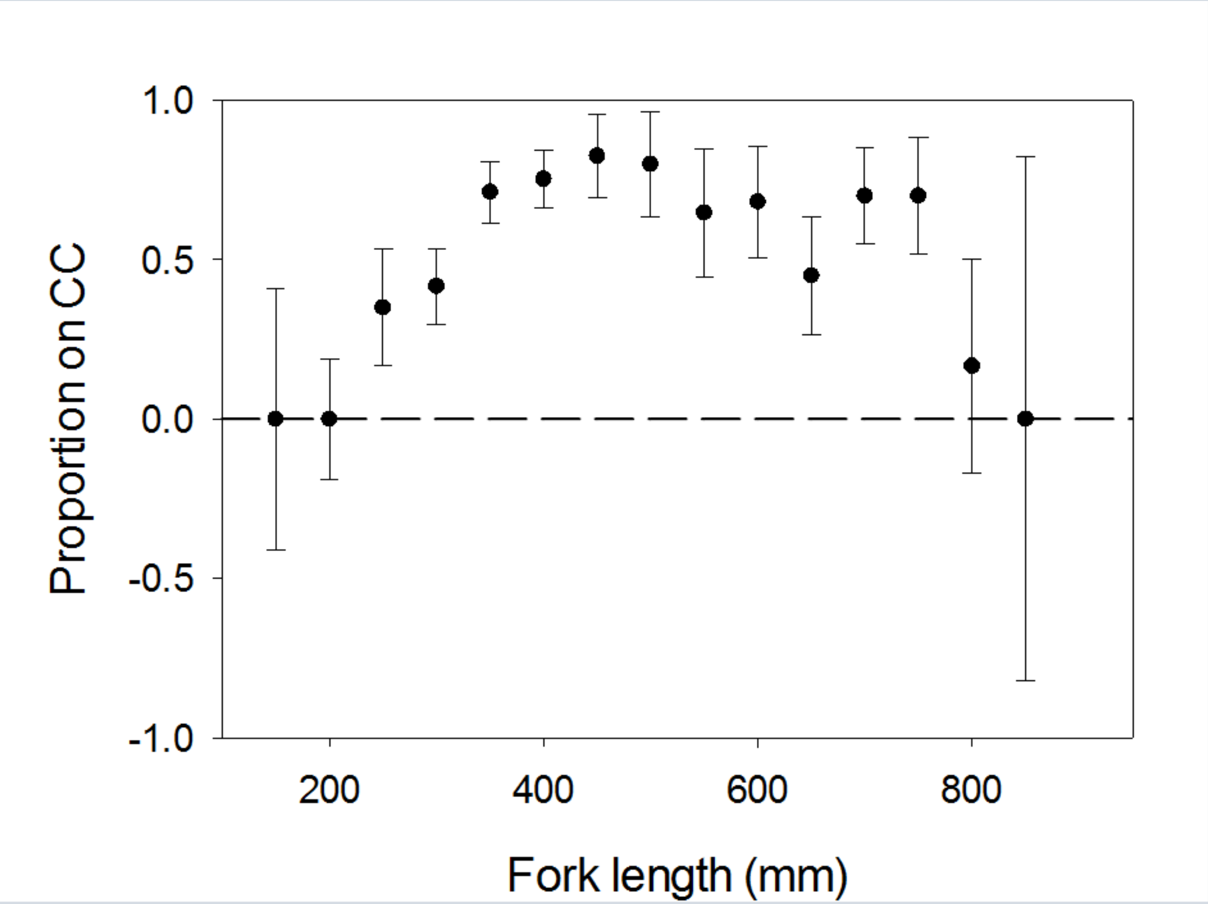




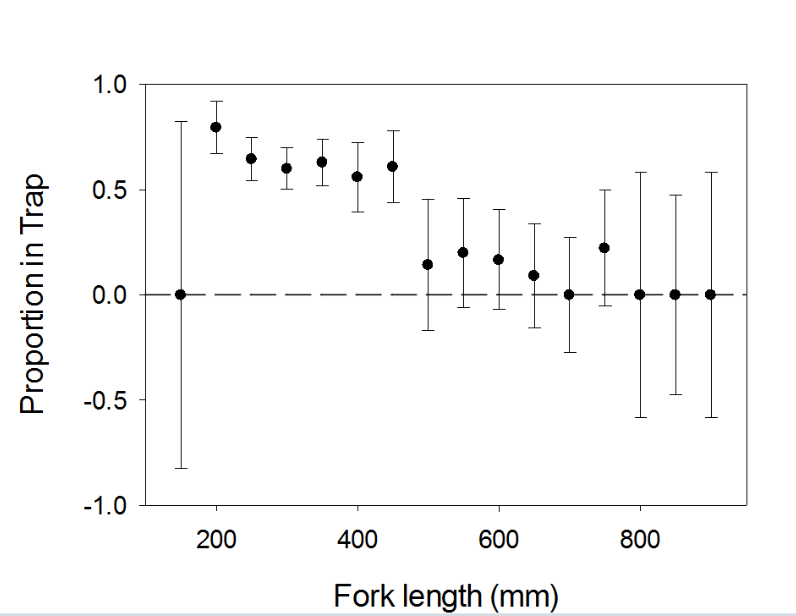
CC/Stereo-BRUV: KDE analysis

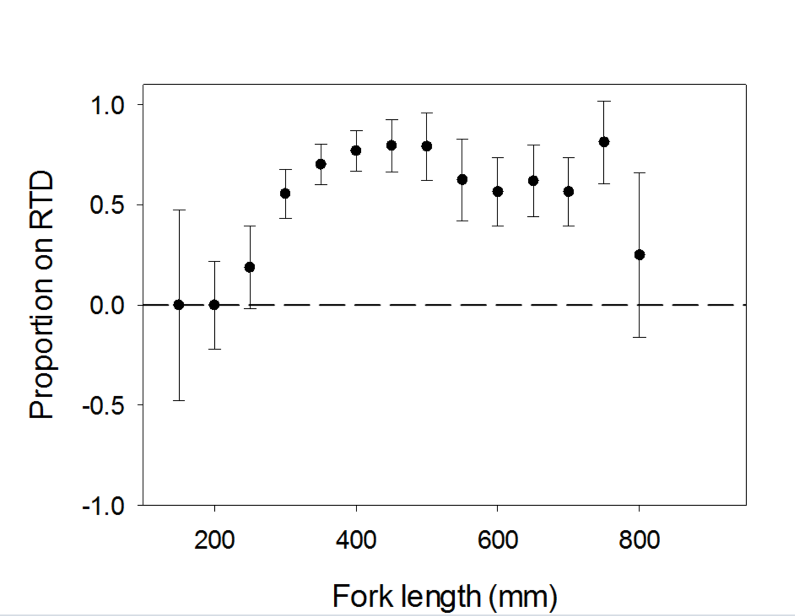


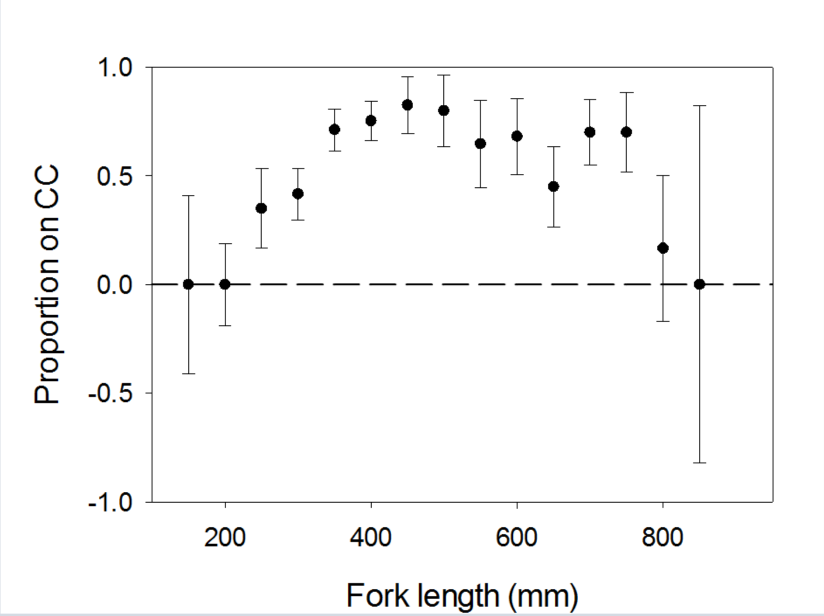
CC/Stereo-BRUV: catch proportions



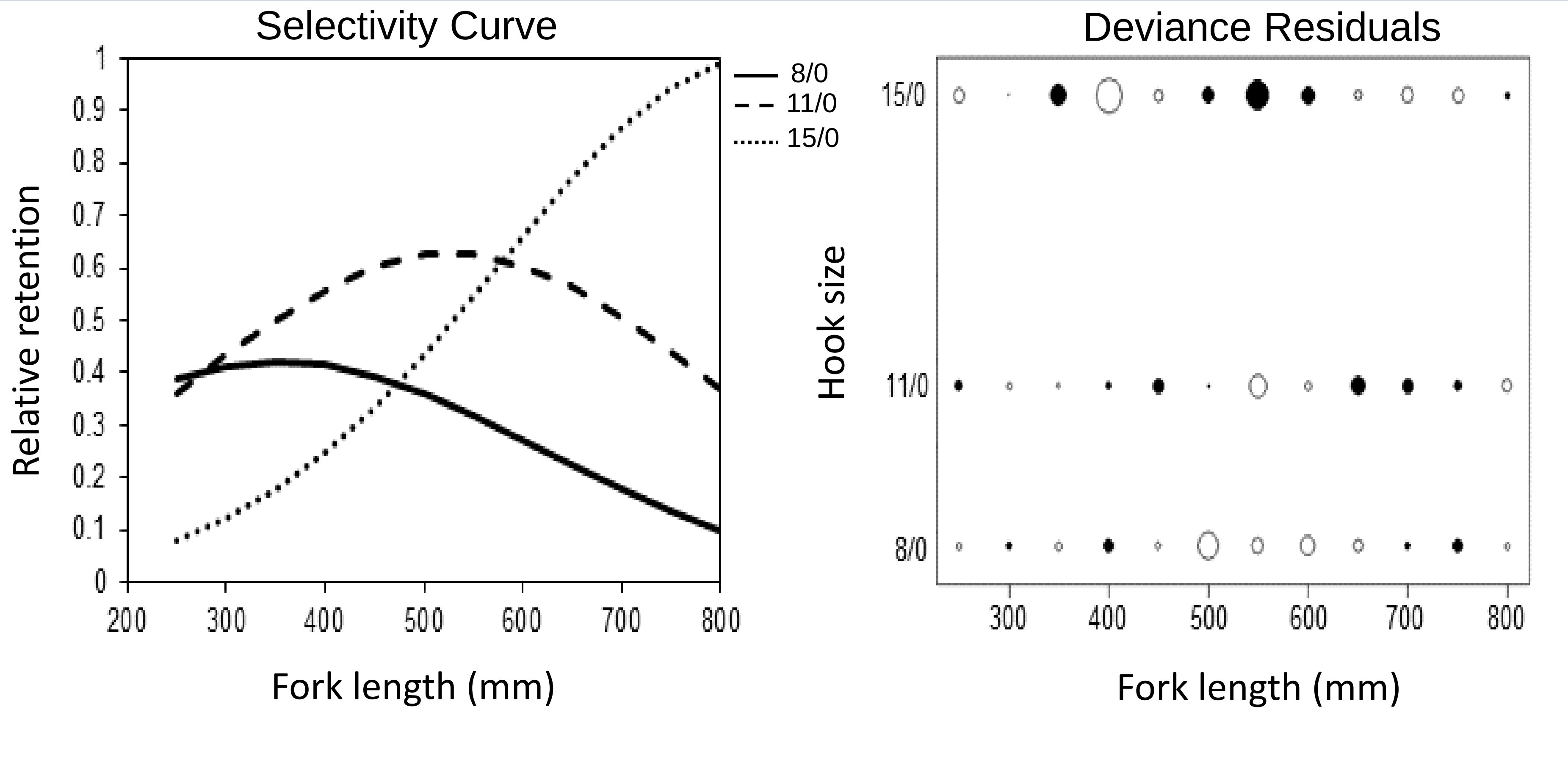
Catch proportions







Indirect RTD hook selectivity

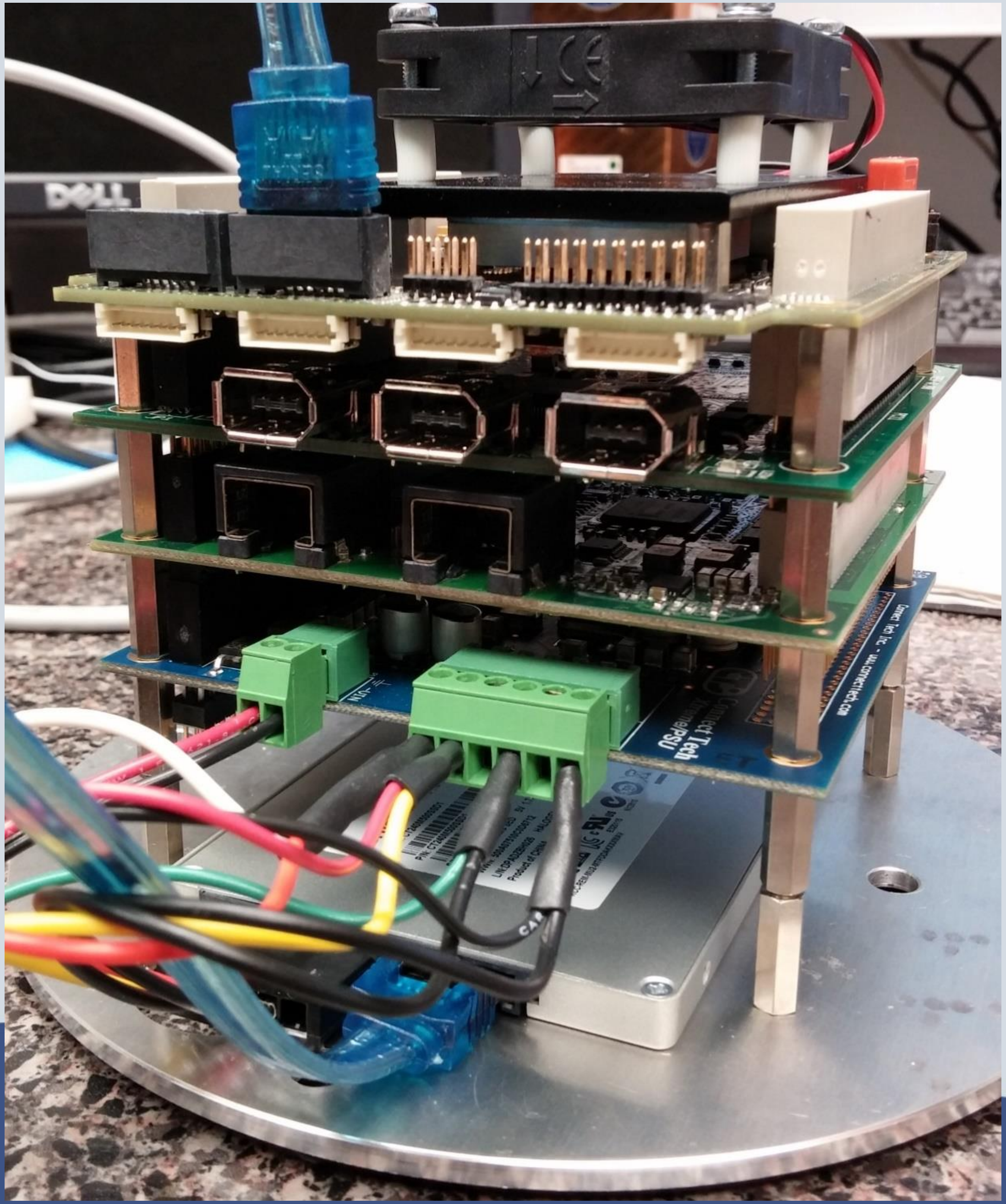


Summary

- Largest fish were observed by Stereo-BRUV (for all gear comparisons)
- Hooked gears caught larger fish than traps
- Catch proportions suggest dome-shaped selectivity is appropriate for traps
- Some evidence that hooked-gear selectivity may be dome-shaped (at extreme upper end of size distribution); however low sample sizes for the largest size classes must be considered

The following slides are considered backup material and are not anticipated to be part of the actual presentation

Camera Computer Stack

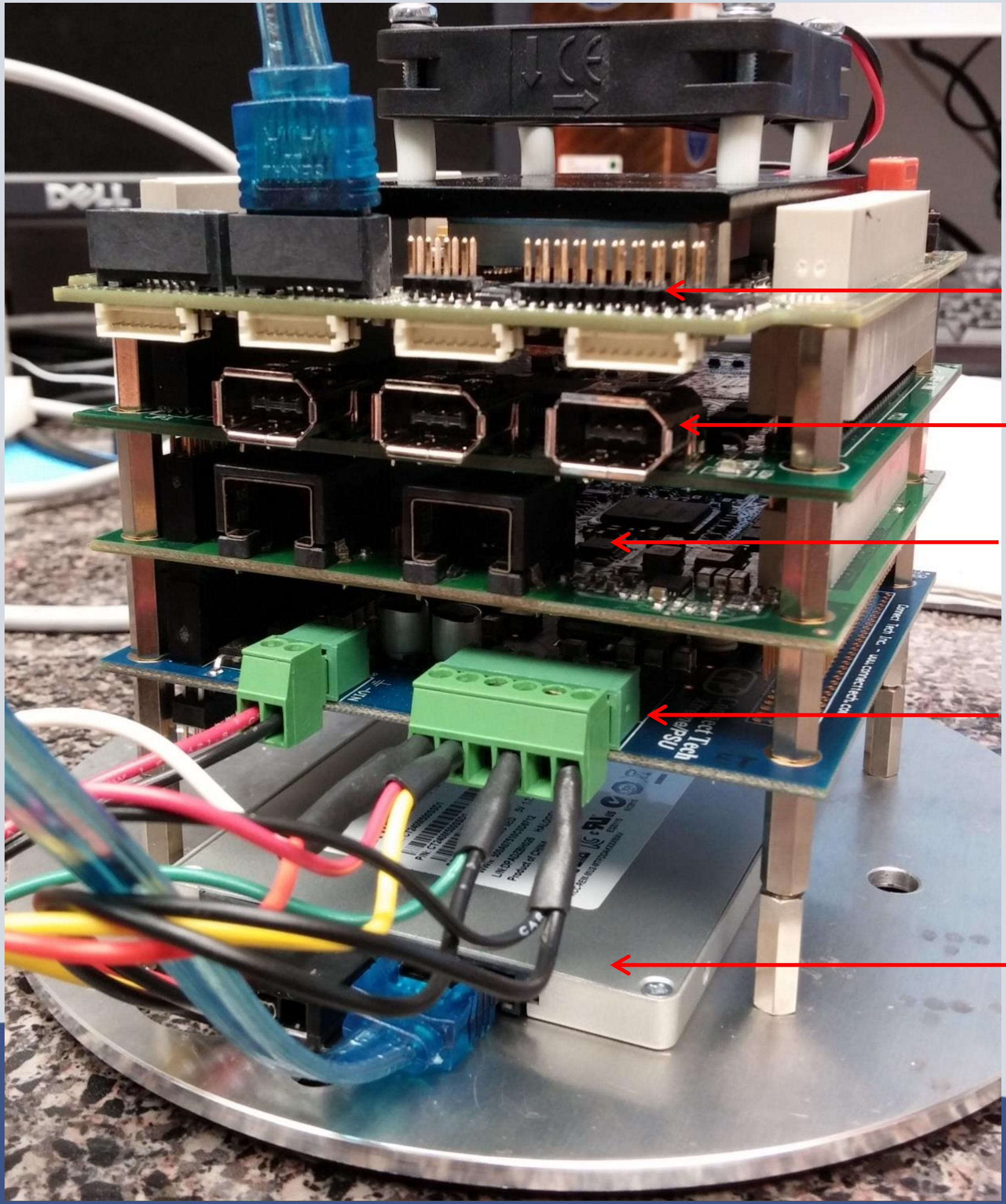


- Computer stacks are built in-house. A team of FWC-FIM employees wire, solder and connect all facets of the internal computer.

- The video camera and two stereo cameras are connected to the computer stack. Specific timing sequences are programmed by FWC scientists to synchronize still images for measurement software, while also allowing adjustments to video duration if desired.

- A series of bulkheads on the outside of the camera computer housing are used to connect external battery power, as well as providing video data transfer from the 500 GB solid state drive to laptops/external hard drives for processing.

Camera Computer Stack



Processor board forms a complete PC in small spaces

Firewire card – high speed data transfer b/w stereo video cameras and internal computer

Dual Gigabyte Ethernet board allows quick transfer of video files to laptop/external drives; connects to 8-pin data transfer bulkhead

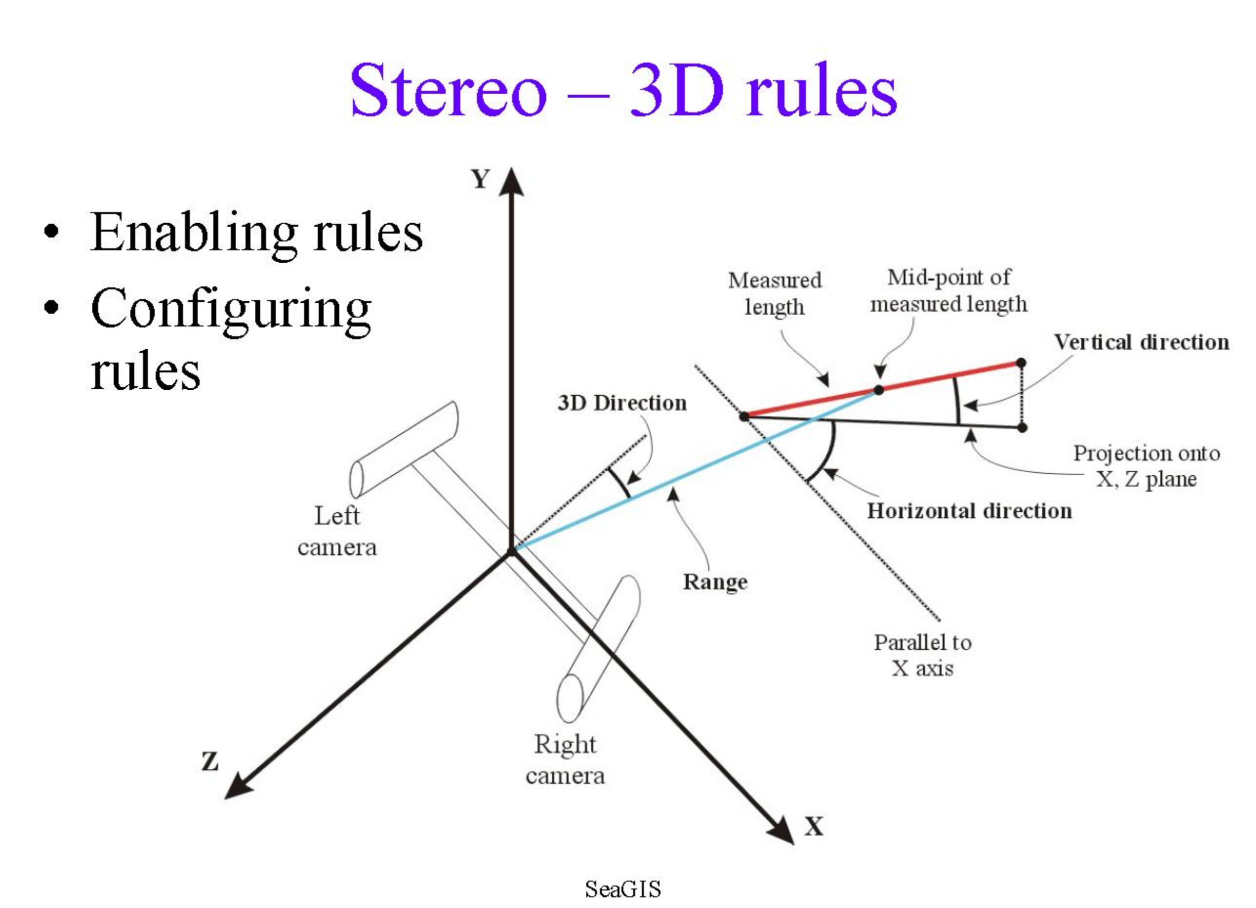
Power supply board – external battery and underwater housing connected to 4-pin bulkhead supplies power to cameras and internal computer

500 GB Solid State Drive to store multiple videos; greater stability than spinning storage

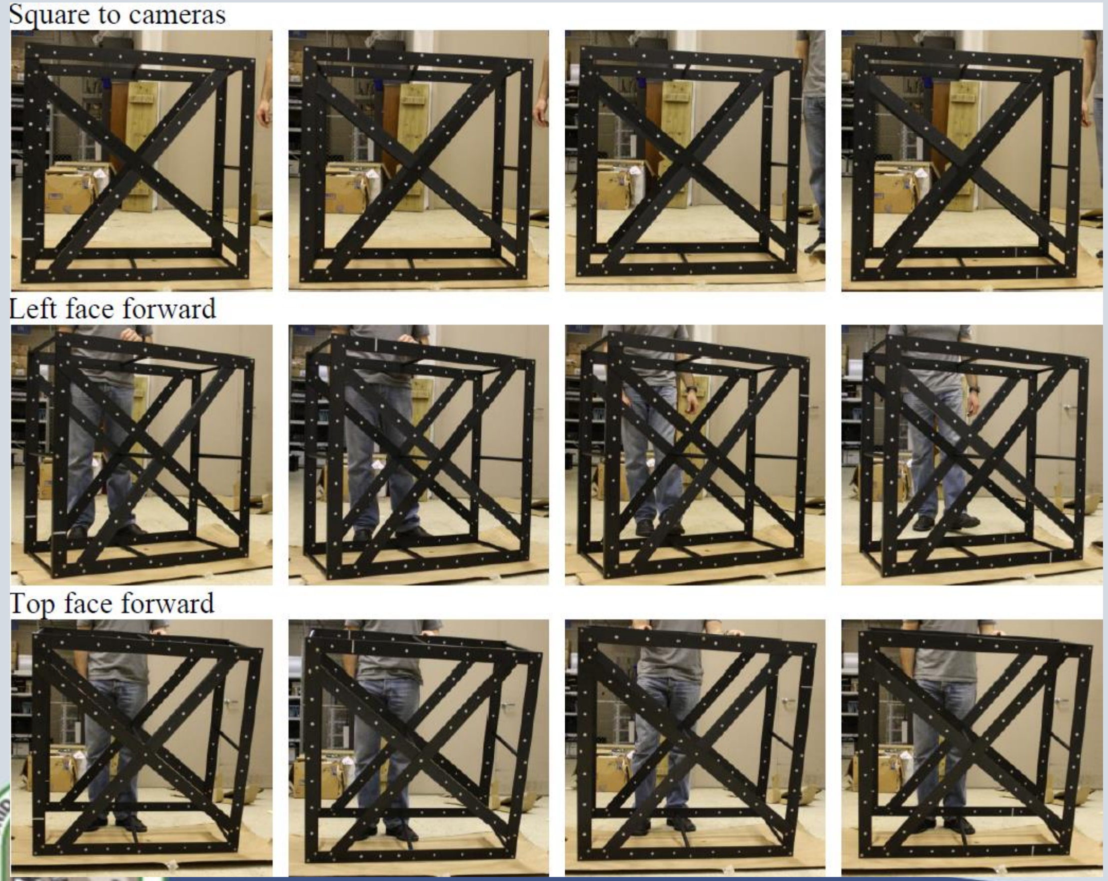
Internal View
of Stereo-BRUV

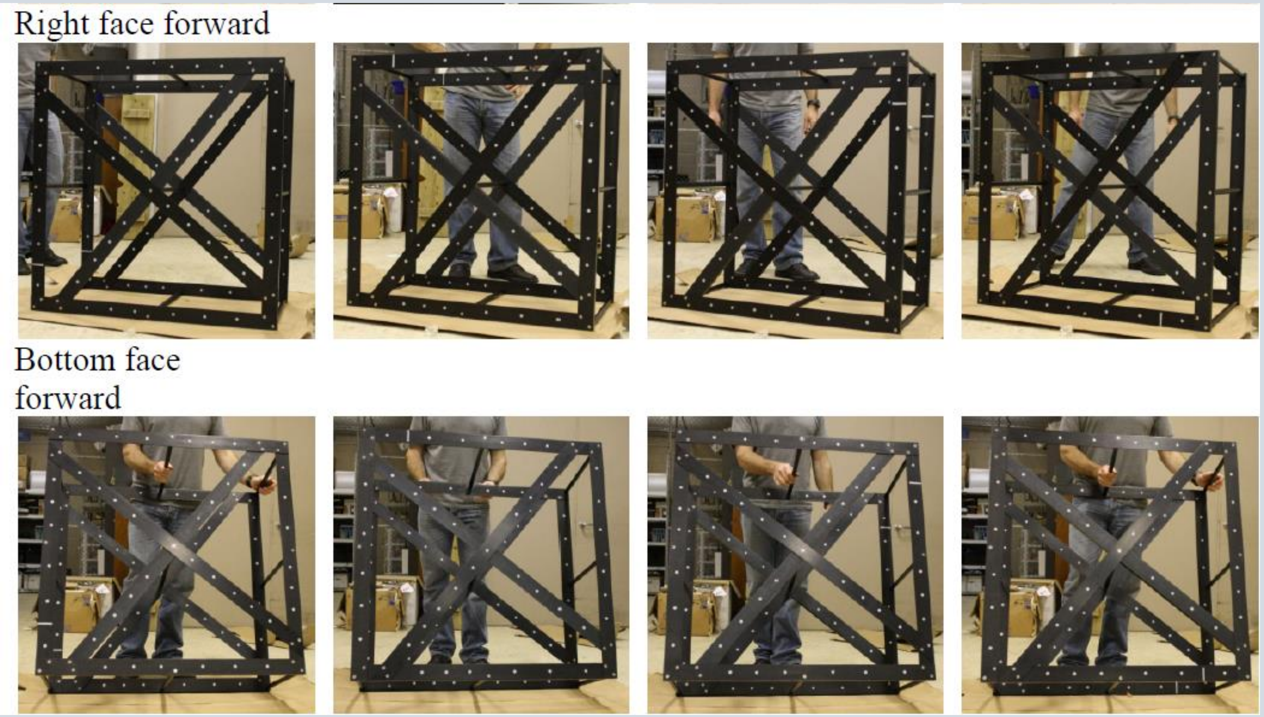
SIS unit

BRUV-measurements



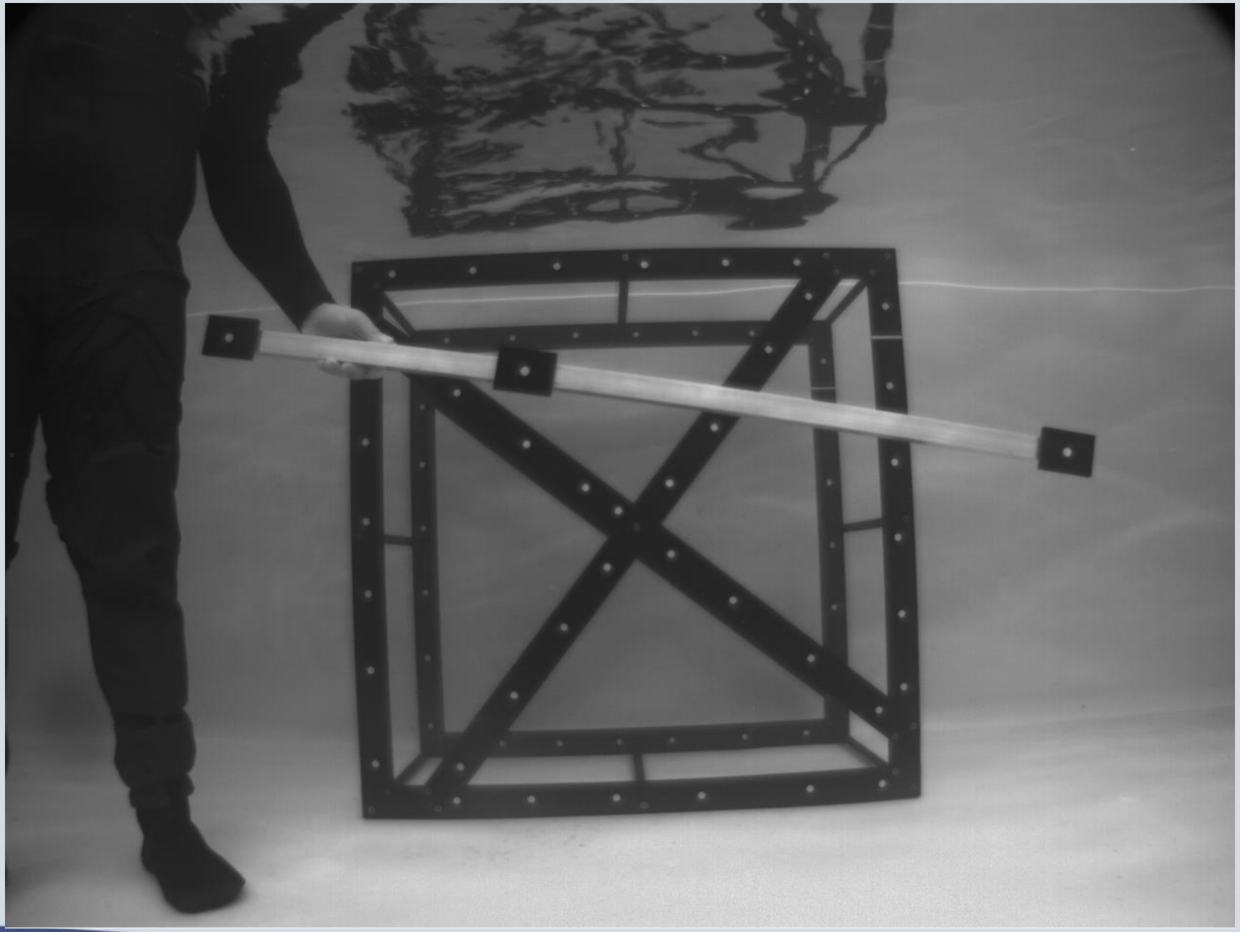
Stereo-BRUV: calibration





20 cube positions are recorded underwater

Stereo-BRUV: calibration



Stereo-BRUV: calibration

- 3D intersection of 2 rays in space
- Precision (of 3D coordinates or a length)
  - Image measurement quality
  - Camera resolution
  - Camera orientation/separation
  - Intersection geometry
- RMS
  - Shortest distance between intersecting rays
  - Function of measurement/image quality and calibration

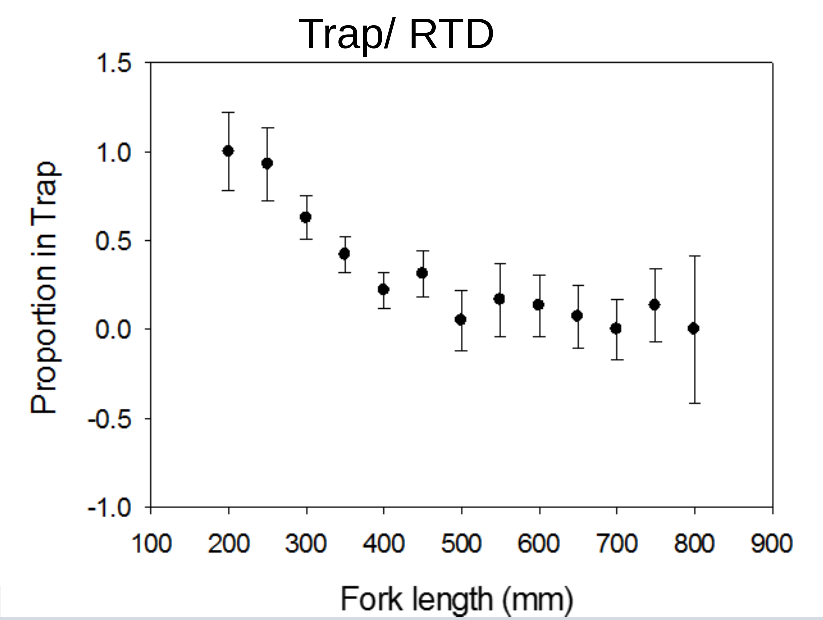
Stereo-BRUV: calibration

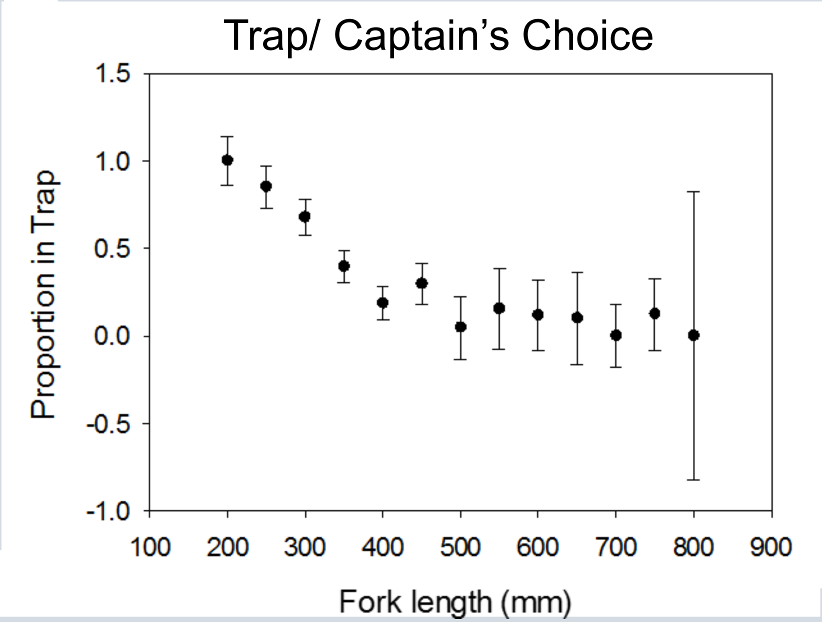
- Angles up to ~45 acceptable
- Snout and Tail must be visible in both stills
- 1-3 meters ideal

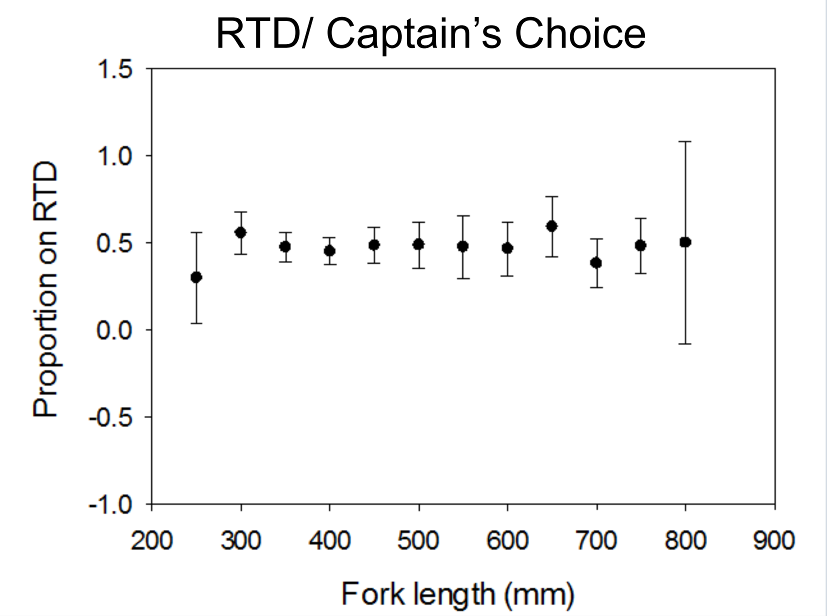
Kolmogorov-Smirnov test

	d	p
Trap_Stereo-BRUV	**0.33608**	**8.47e-09**
RTD_Stereo-BRUV	**0.27555**	**3.47e-06**
Captain's Choice_Stereo-BRUV	**0.29658**	**4.28e-08**
Trap_RTD	**0.54889**	**<2.2e-16**
Trap_Captain's Choice	**0.53498**	**<2.2e-16**
RTD_Captain's choice	0.041285	0.9833
Stereo-BRUV/Trap Stereo-BRUV/RTD	0.074033	0.8156
Stereo-BRUV/Trap Stereo-BRUV/CC	0.091216	0.5208
Stereo-BRUV/RTD Stereo-BRUV/CC	0.05985	0.9523

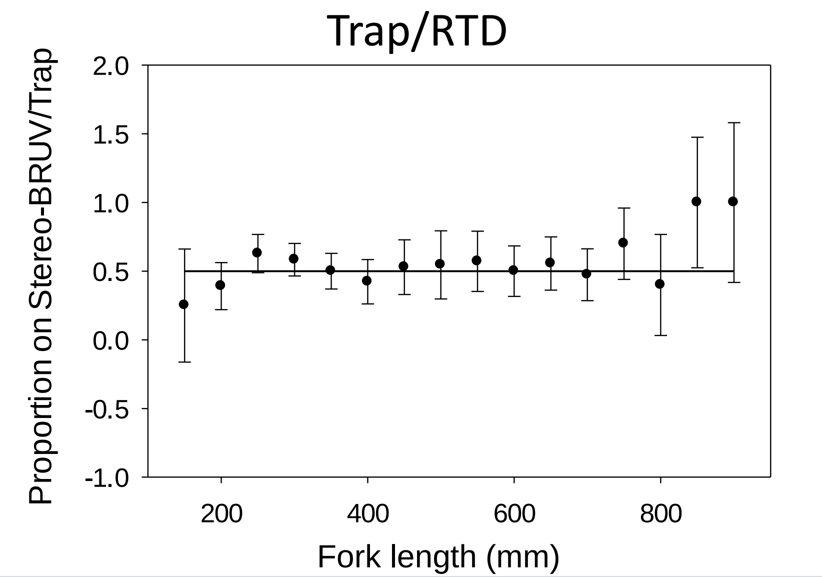
Catch proportions among gear types

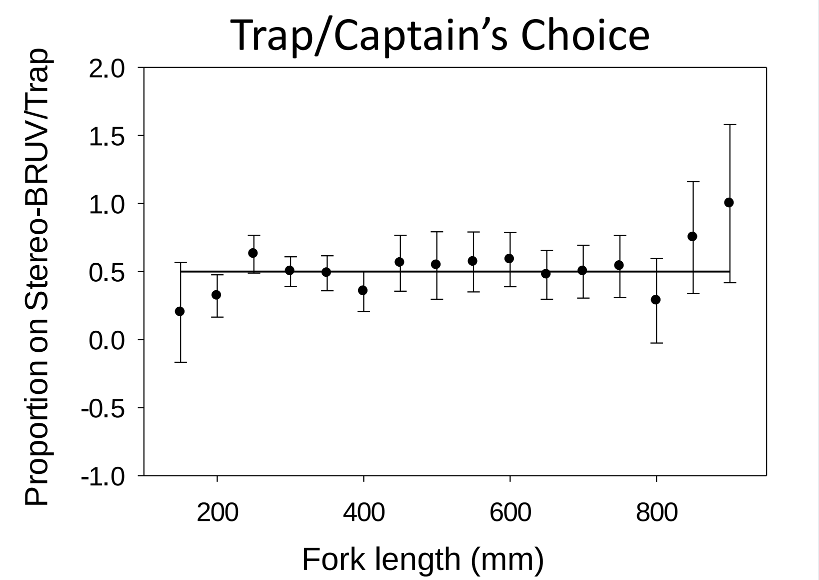


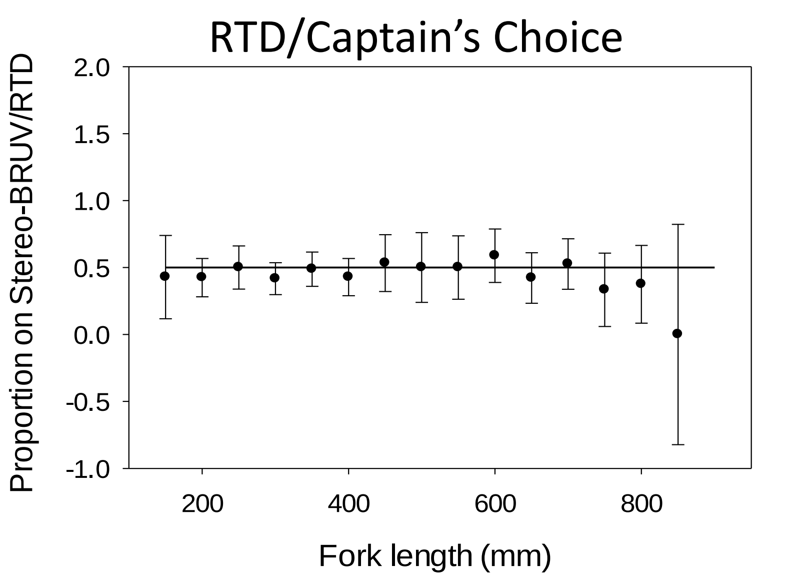




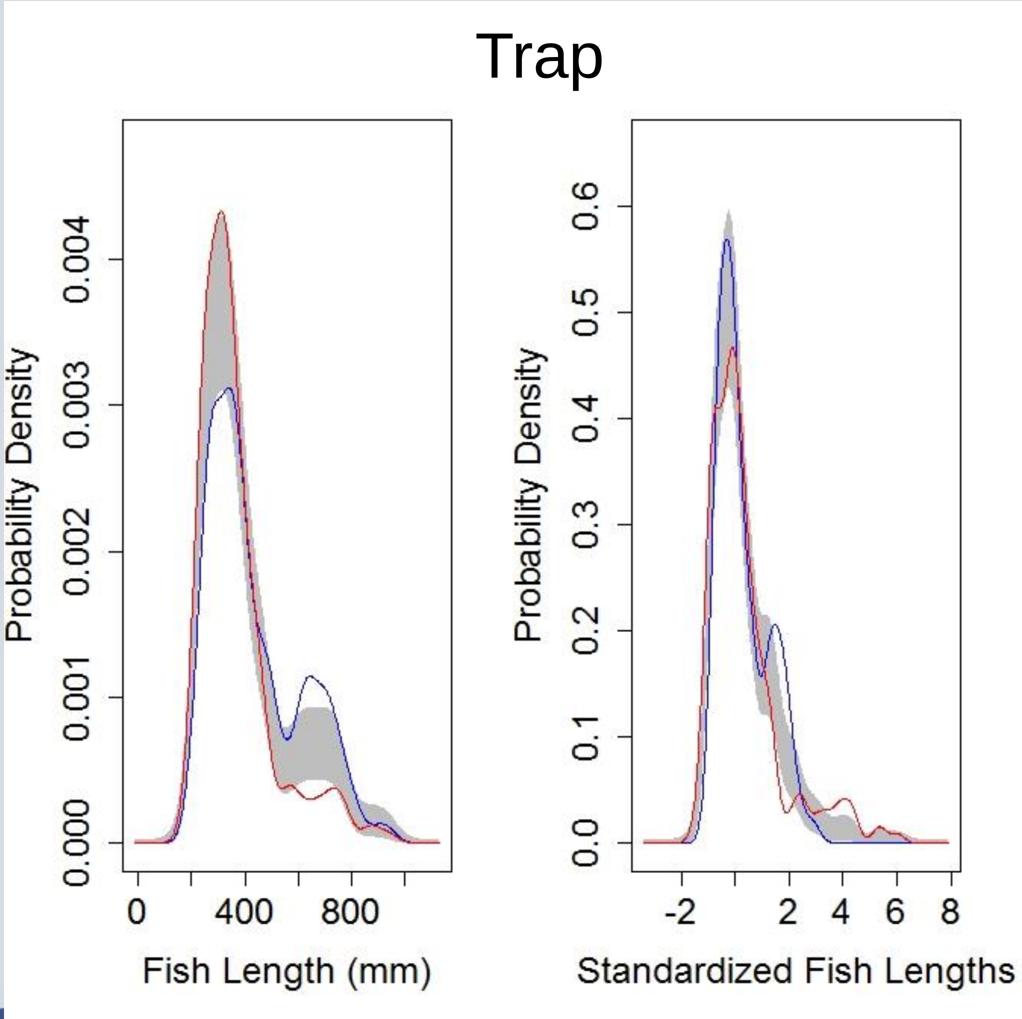
Catch proportions among stereo-BRUVs

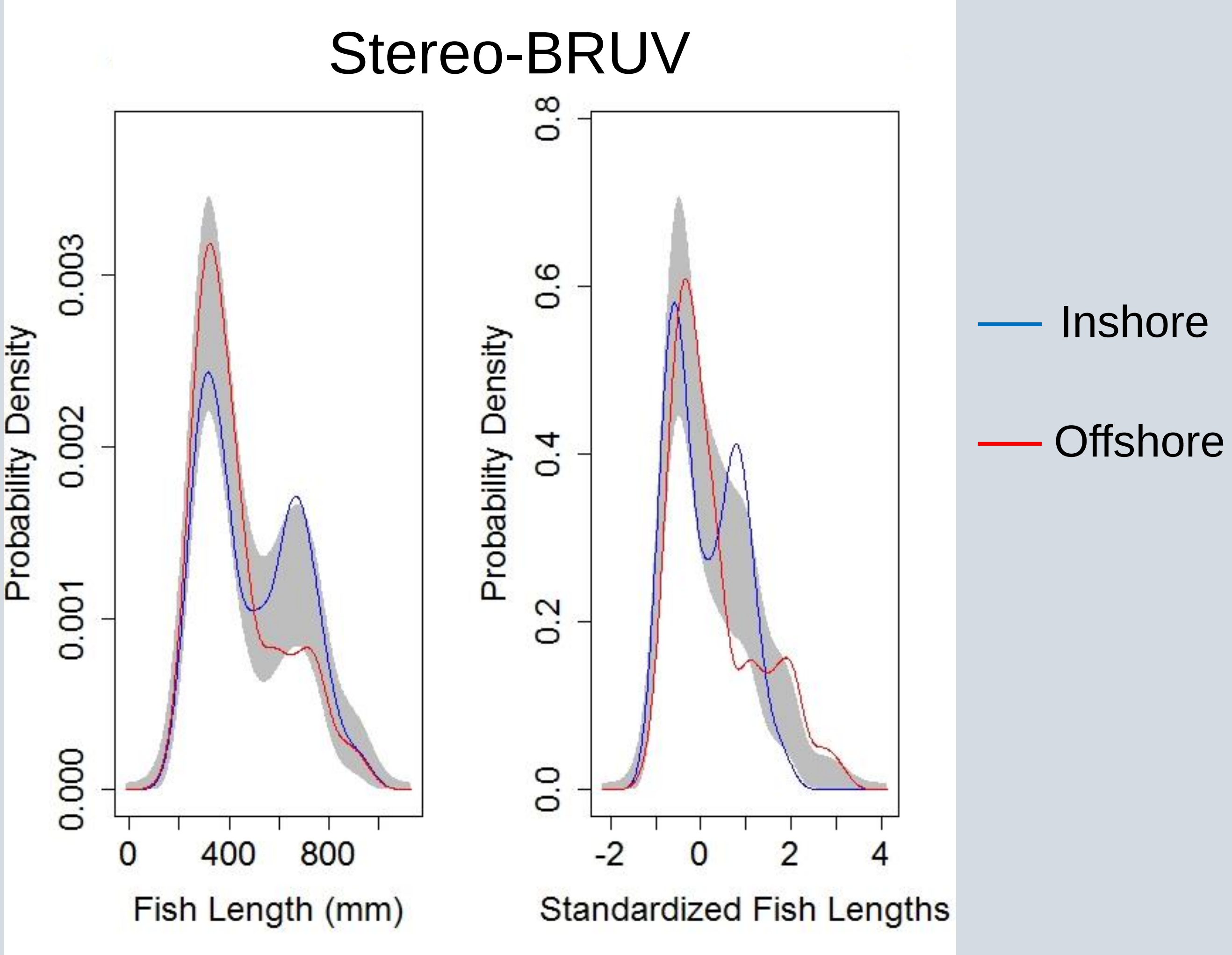






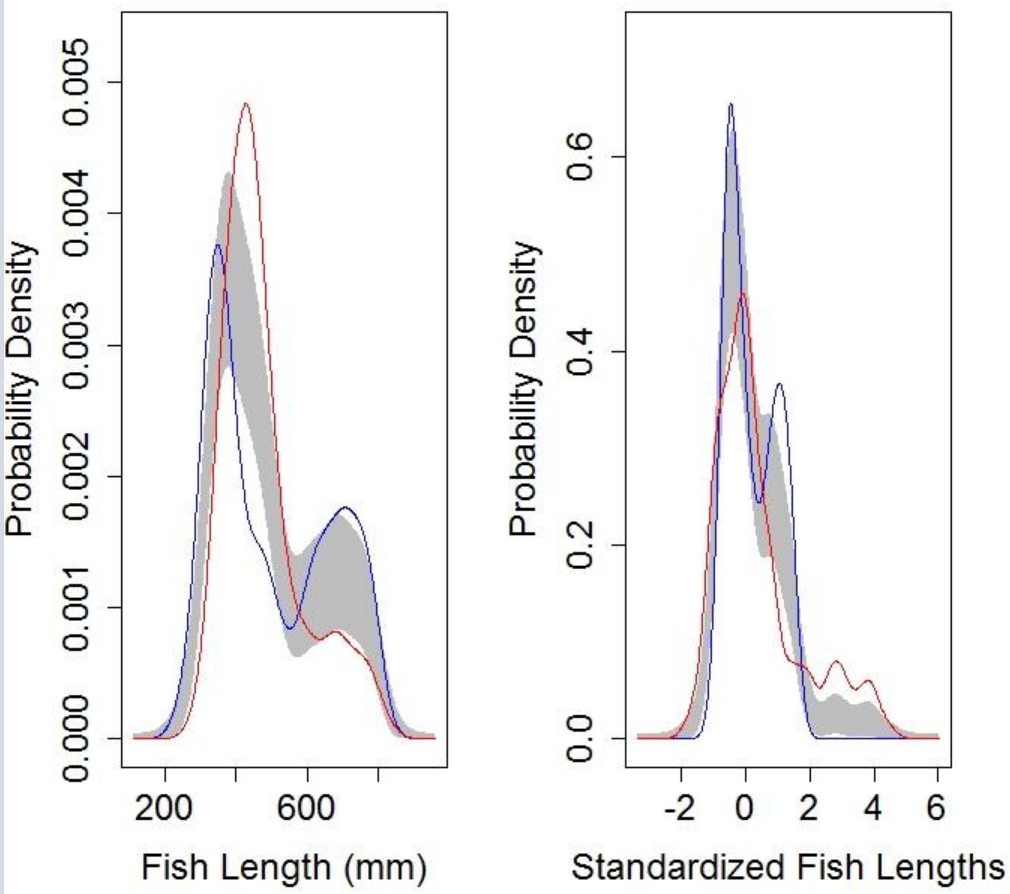
KDE by depth strata



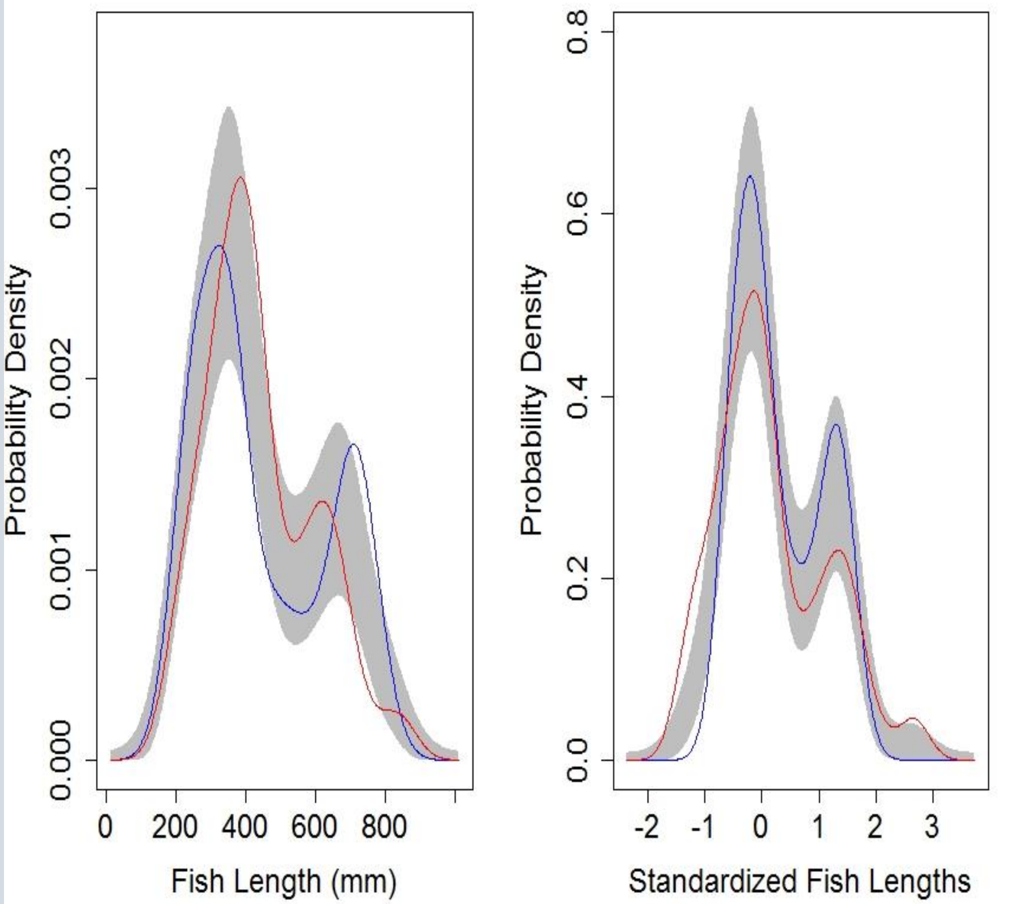


KDE by depth strata

RTD



Stereo-BRUV



Inshore

Offshore

KDE by depth strata