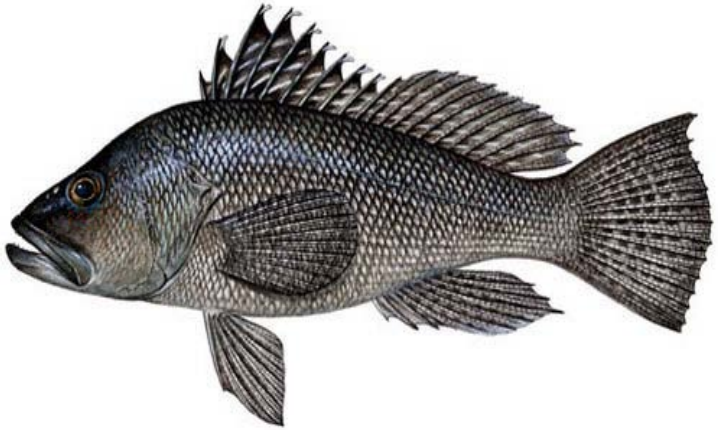
Using underwater video for assessing abundance and behavior of black sea bass and seafloor habitats

Bradley Stevens
Dan Cullen
Courtney McGeachy
Emily Tewes



Outline

- BSB Biology & Fishery
- Methods & Location
- Fish Assessment
- Fish Behavior
- Habitat mapping
- Future plans
- Conclusions

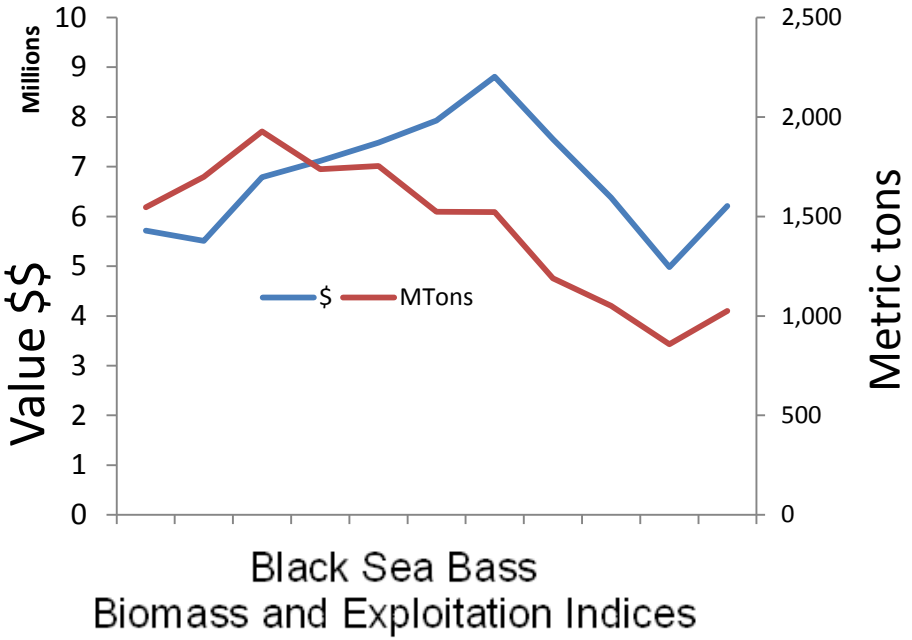
Black Sea Bass

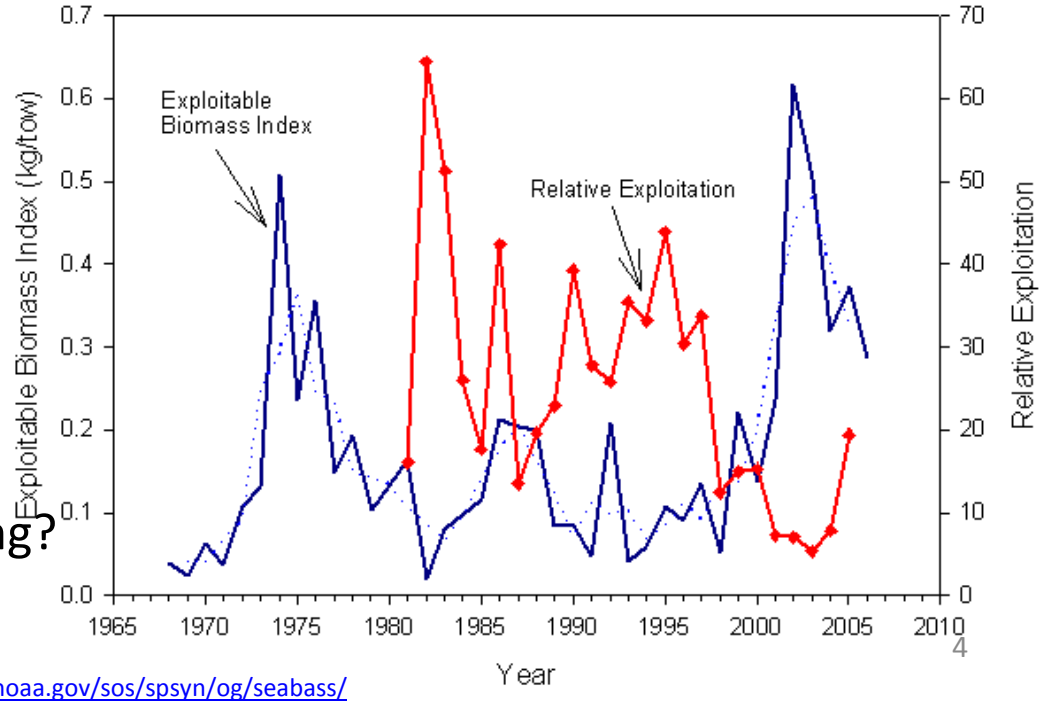
Centropristis striata

- Support valuable commercial and recreational fisheries
- Protogynous hermaphrodites
  - Adult males acquire typical “blue head”
- Inhabit heterogeneous inshore habitats from spring-fall, deeper offshore habitats in the winter.
  - Cannot be assessed with NOAA spring/fall trawl surveys
  - There is no adequate abundance index for adult BSB.
- NOAA has requested fixed-gear surveys of abundance
  - but gear effectiveness is unknown.

Landings and Biomass

- Landings avg at 1,500 mt/y
  - Worth about $6 M/yr
- Trawl-Biomass estimates unstable
  - And Exploitation varies inversely
- A classic "Data-Poor" Stock
- 2006 Assessment Workshop:
  - Overfished, not overfishing
- 2009 Datapoor Stocks WG:
  - Not overfished, overfishing
- NO VALID INFORMATION about
  - baseline biomass
  - fishing mortality (F)
  - Max sustainable yield (MSY)
- In other words – WTF is happening?





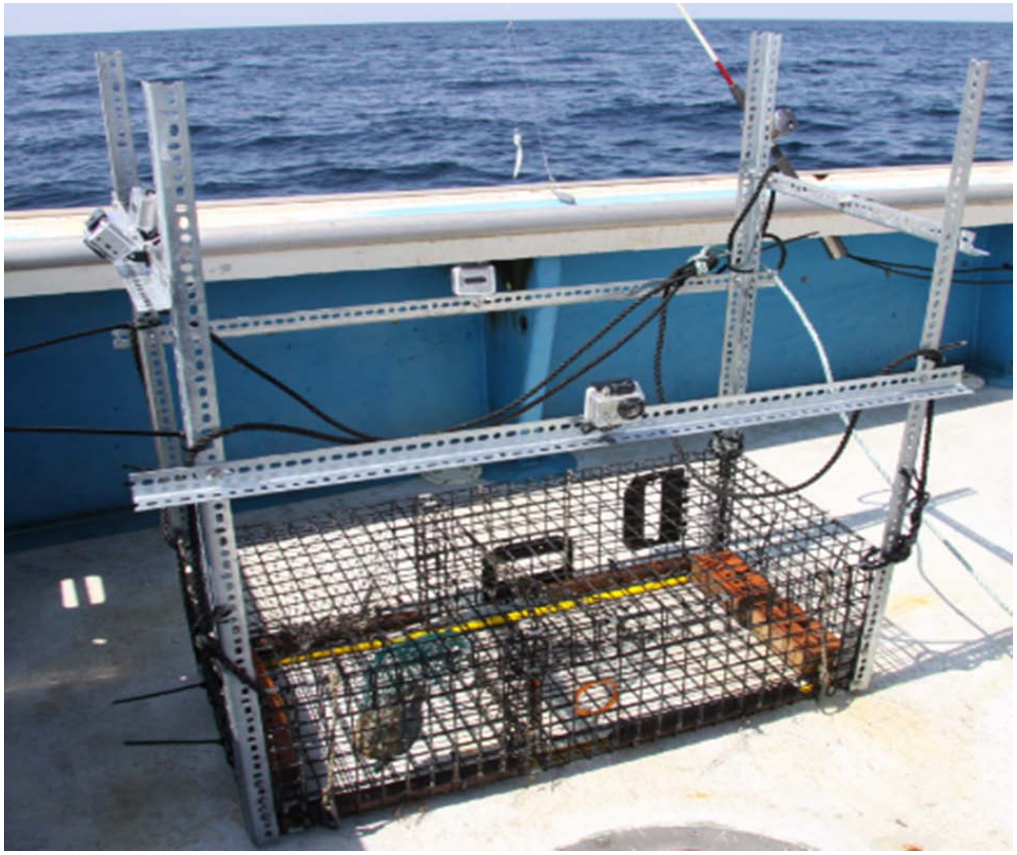
http://www.nefsc.noaa.gov/sos/spsyn/og/seabass/

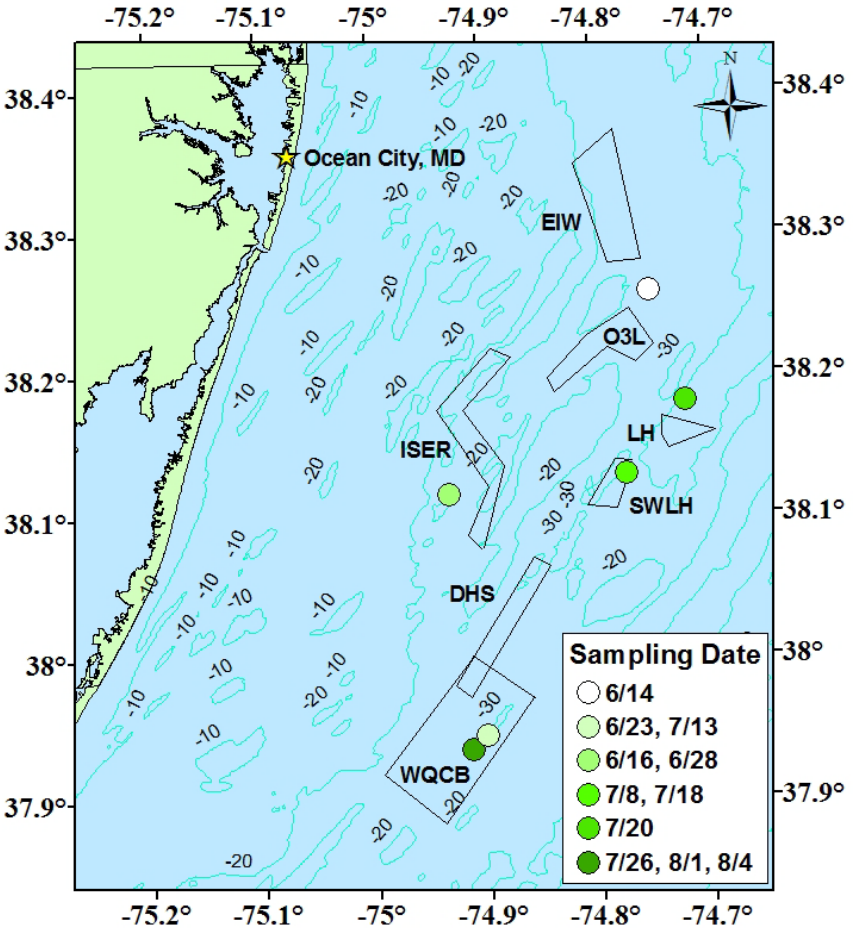
Research Objectives

- Test alternative In-Situ Methods
  - Using video camera systems
  - Economical stand-alone system
- Deployment methods
  - 2011: Baited vs unbaited
  - 2012: Video vs rod&reel
  - 2013: Video vs commercial traps
- Behavior of fish in/near traps
  - Proportion entering/caught
  - Field vs Laboratory Mesocosm (JJ Howard Lab)
- Distribution of critical habitats in nearshore retion
- Long-term
  - Develop a plan to estimate relative abundance of BSB

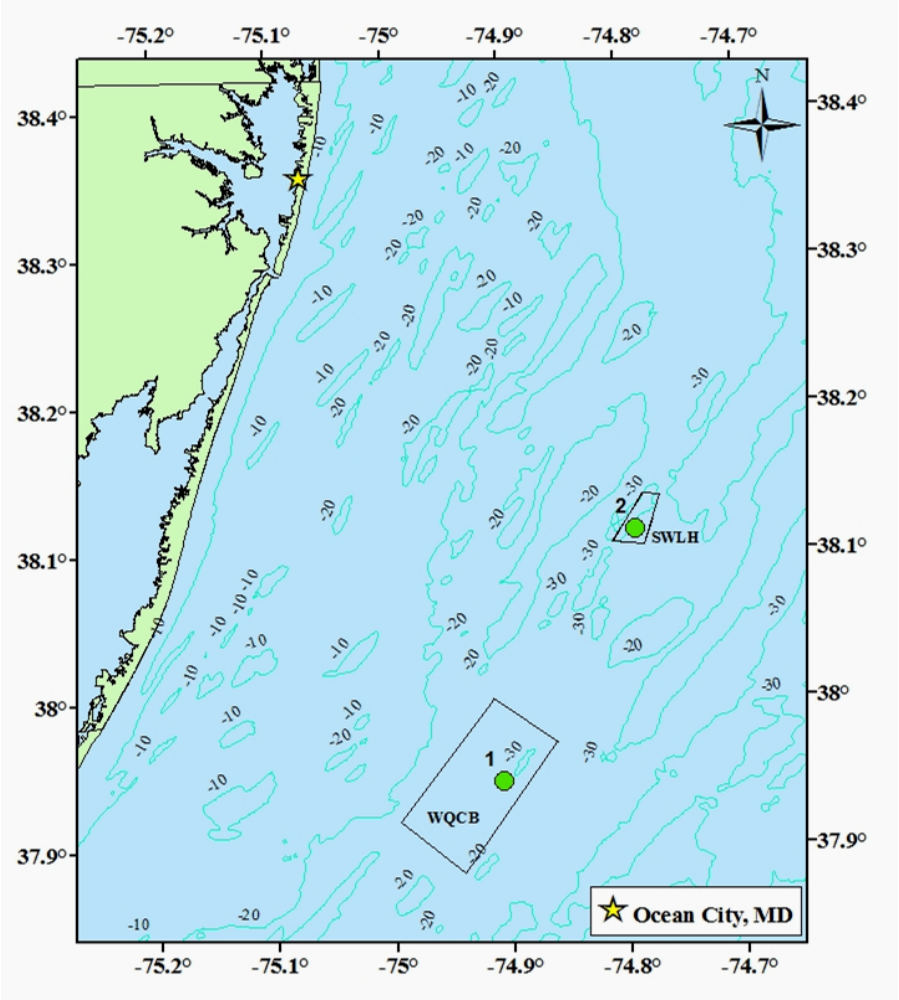
BSB Trap-cam

- Two standard fish traps
- Each with 5 video cameras
- Trap 1 (Assessment):
  - 4 cameras face out, 1 in
- Trap 2 (Behavior):
  - 4 cameras face in, 1 out
- Deployment
  - 2 hours w/ bait
  - 2 hours w/o bait
  - Each “sample” separated by “bouncing”
- Over 90 hrs of Video in 2011
  - *10 cameras!!!





2011 Sampling Sites with outlined reef areas.



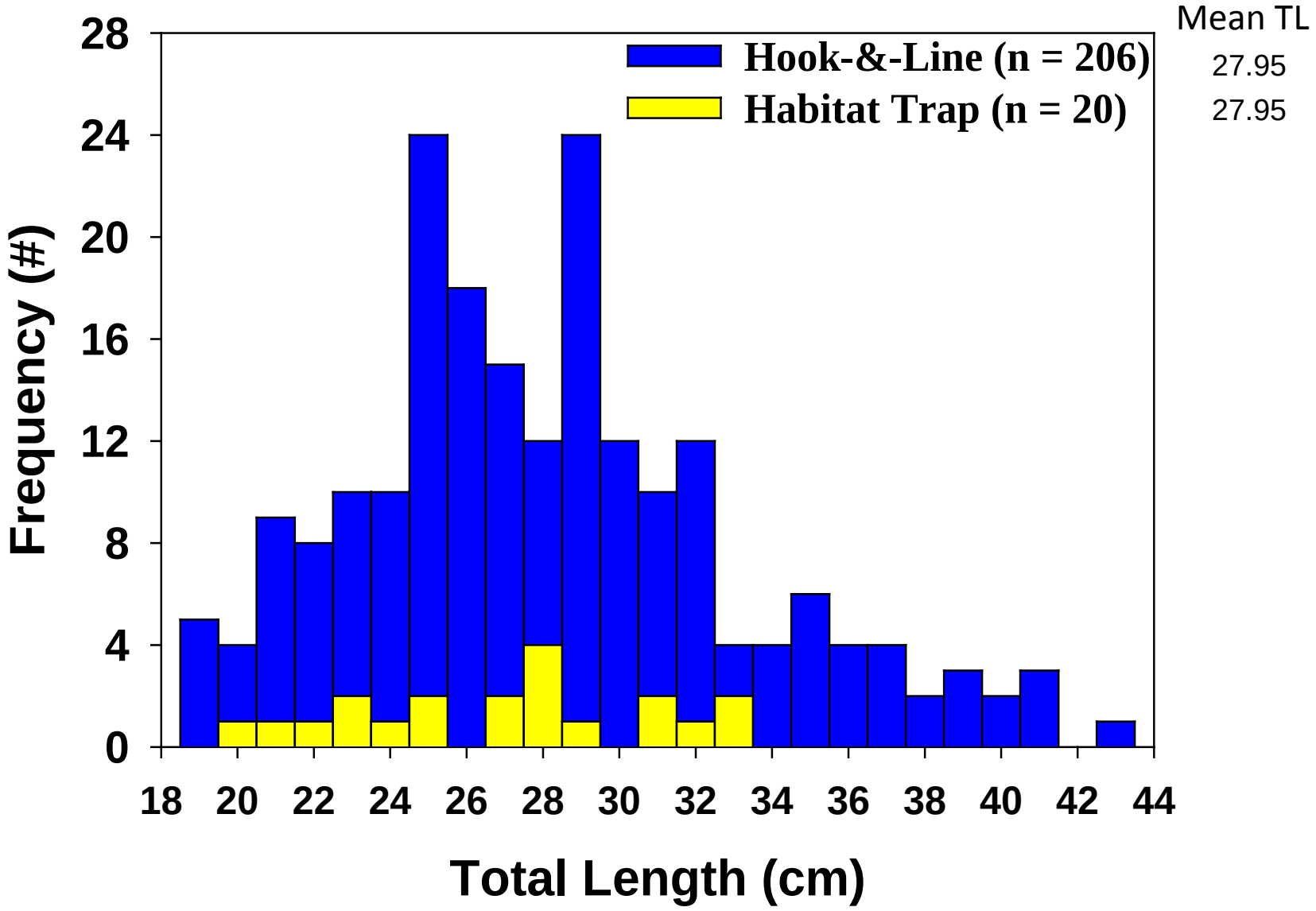
2012 Sampling Sites with outlined reef areas.

Part 1: Assessment

(Dan Cullen – PhD Student)

- Estimated fish abundance using the “Mean-Count” method
- Single frames sampled systematically at 30 s intervals for the first 30 min of video
- The number of fish observed in each frame is recorded (max-n)
- Counts from sampled frames used to calculate the MeanCount $(\bar{y})$ and SD.

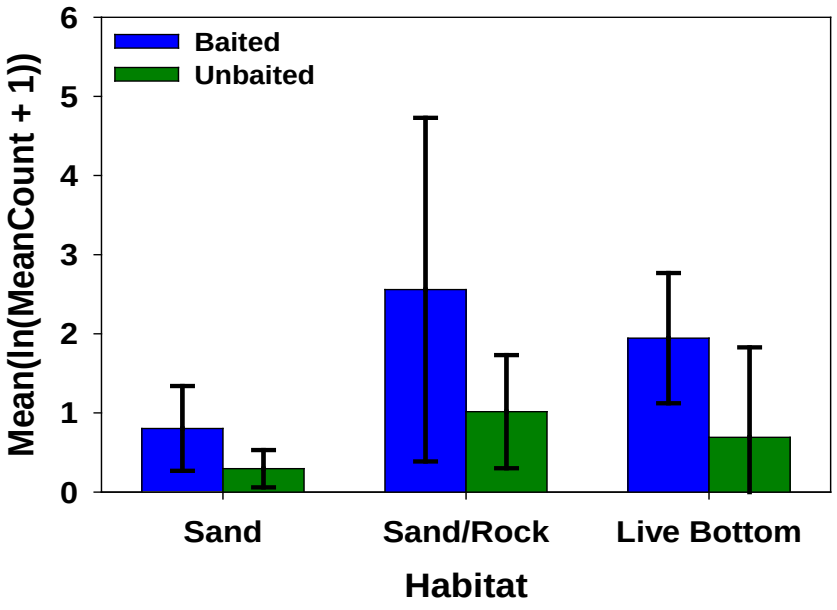
- During camera deployments, angling was conducted near traps to capture fish for size comparison.
- All fish measured to nearest cm (TL)

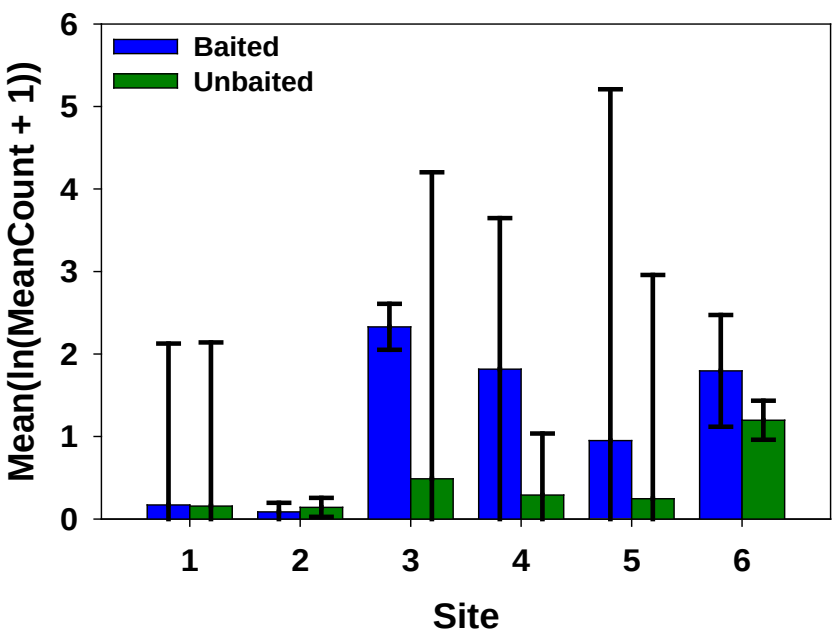

Mean TL
27.95
27.95
Hook-&-Line (n = 206)
Habitat Trap (n = 20)
Frequency (#)
0
4
8
12
16
20
24
28
18
20
22
24
26
28
30
32
34
36
38
40
42
44
Total Length (cm)


Habitat

2011: Baited vs. Unbaited

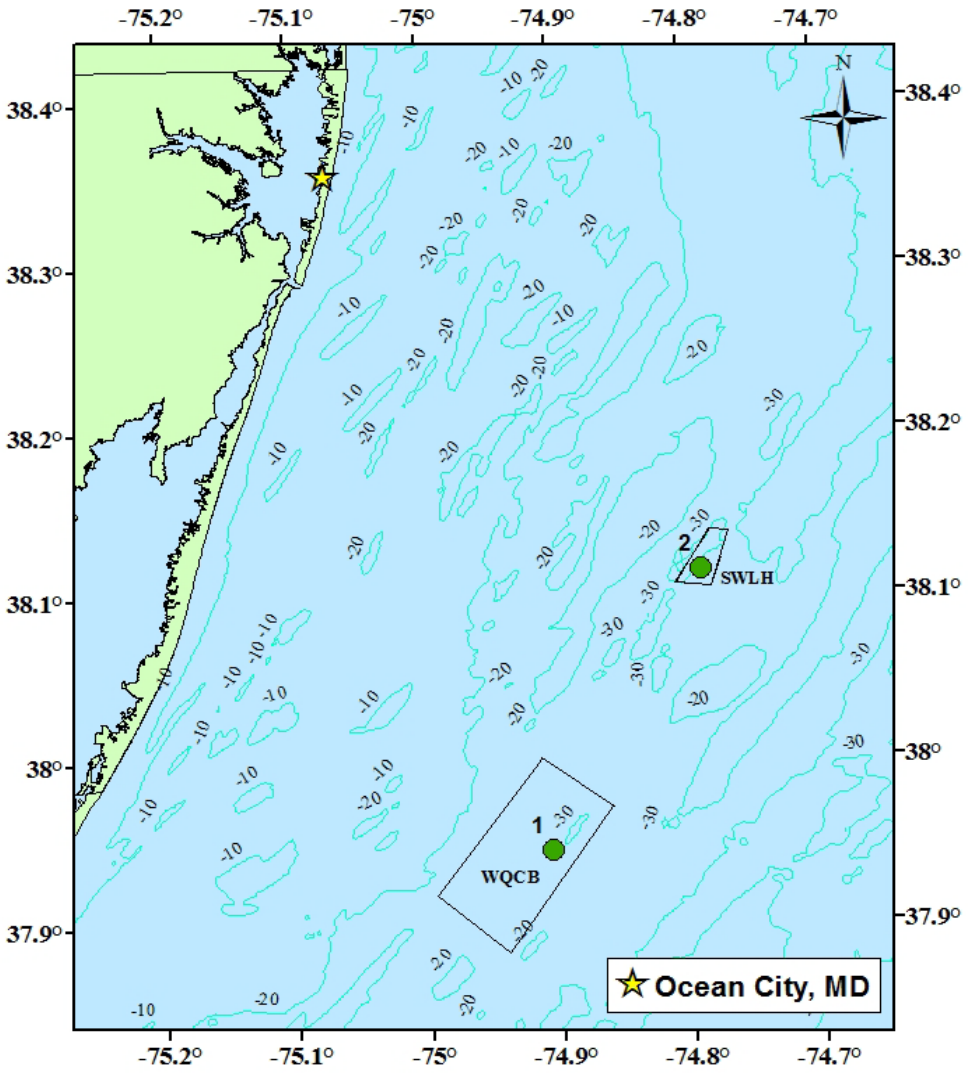
- Mixed-effects ANOVA on log transformed data
- Habitat: Sand < Rock = Live Bottom (p=0.002)
- Baited > Unbaited (p=0.055)
- Interaction (p=0.021): bait effect changed w/ site





2012 studies

- Site 1: Sand with little structure and few fish
- Site 2: Live bottom with rock & coral
- 5 days each
  - but only 3 analyzed



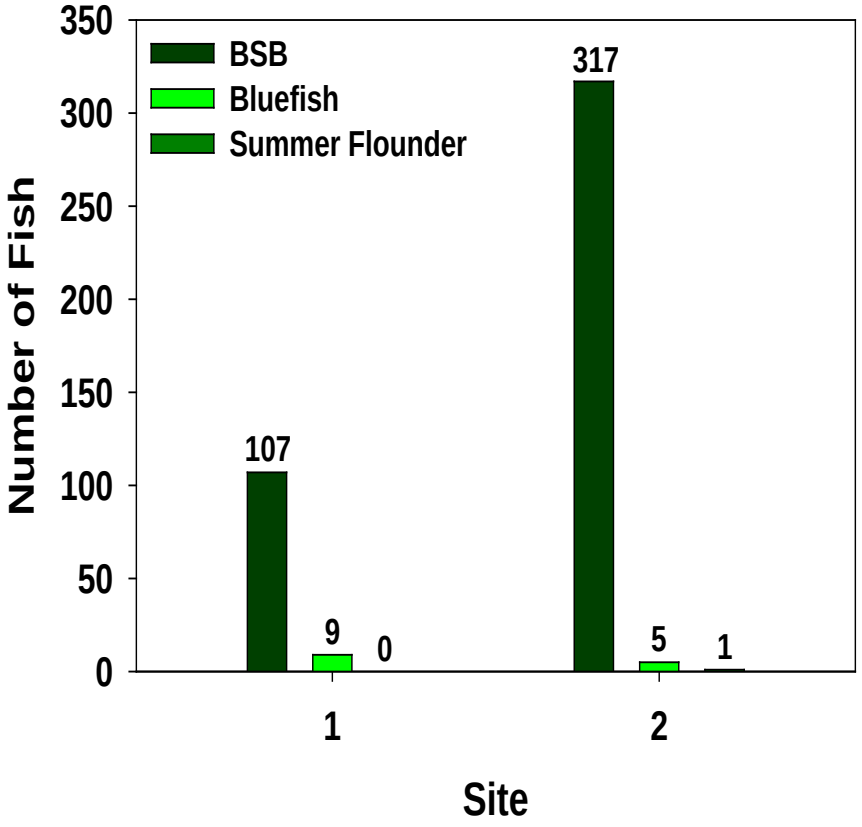
RUFAS – Remote Underwater Fish Assessment System

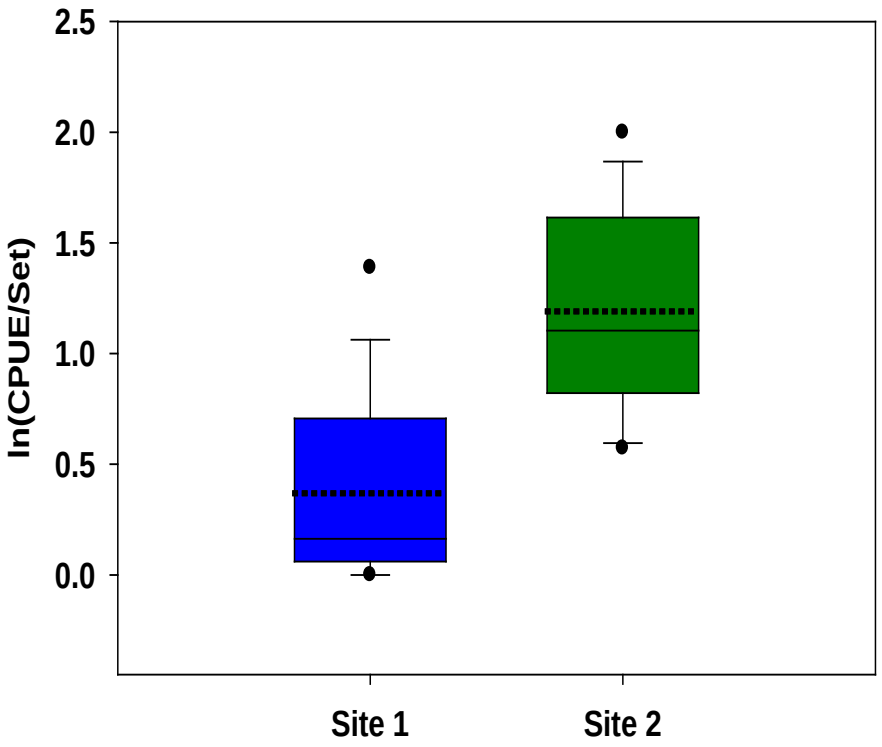
- Canon videocam in dive housing
- Four Go-Pros
  - on all sides
- External Lights
  - Don't help much
  - backscatter
- No bait
  - Hard to standardize

Timed Fishing

- With rod&reel/hook-and-line
- Eight 30-min camera sets/day
- Four 3-min drifts past camera
- Three fishers/rods with 3 hooks
- Recorded time to: drop, bottom, bite, retrieve, surface
- All fish measured to nearest cm
- CPUE = $Catch_{BSB}$/Effort(3 min)
- 8*4*3 = 96 data points/day

Preliminary results
using only 3 of 5 days at each site





Number caught by species
Total counts listed above bars

Mann-Whitney U = 135,
$X^2 = 9.964$, $p = 0.002$

Spearman Correlations

Variable	r
Sampling Date	-0.433
Bottom Temp. (°c)	-0.175
Depth (m)	0.642
Drift Speed (m/s)	-0.292
Wind Speed (m/s)	0.052
Air Pressure (mbar)	-0.346
Wind Direction (°)	0.377
Drift Direction (°)	0.373

CPUE was not correlated with any other variables, but there was ←almost a significant correlation with wind speed

Rotating pool of anglers (and skill) may have had some effect but not quantified

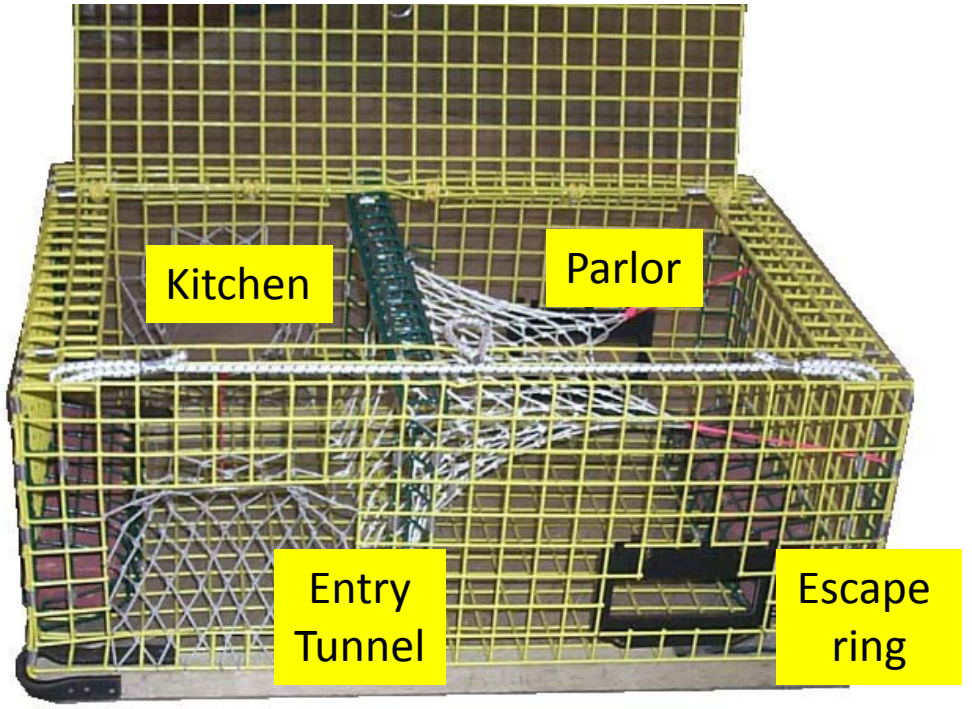
2012 Plans

- Compare 2012 video counts to R&R CPUE
- Assess abundance relative to habitat, weather, depth, date, etc
  - Build mixed effects model
- 2013
  - Compare video to commercial trap catch
  - 20 days funded
- Applied for RSA quota for 2013
  - 100,000 lbs mixed sp
  - Strat-Syst vs Adaptive sampling

Part 2: Behavior of BSB in and around traps

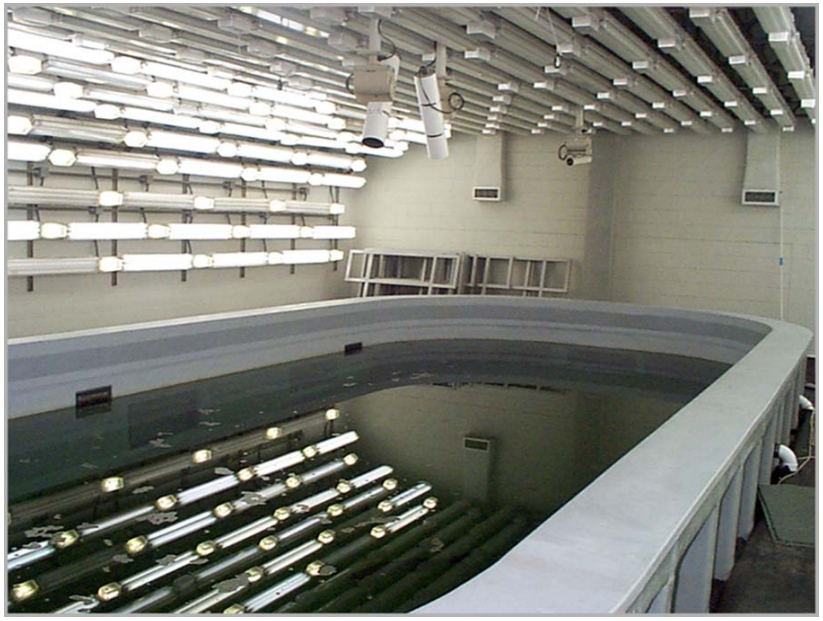
(Courtney McGeachy, M.S. Student)

- Traps account for 78% of the commercial harvest
- BSB interaction and behavior in/around traps is an important component in managing this fishery
- Knowledge of fish behavior can allow improved interpretation of CPUE and landing data
- Is trap catch an accurate indicator of abundance?
- Does behavior influence trap catch?



- Phase 1: Field sampling:
  - Open ocean
  - Random sites;
  - Abundance unknown;
  - Uncontrolled conditions.

- Phase 2: Mesocosm
  - J. J. Howard Lab, Sandy Hook, NJ
  - Known abundance (32)
  - Trap deployed 4-5 hr/d
  - 5 sequential days
  - Mid-day light setting

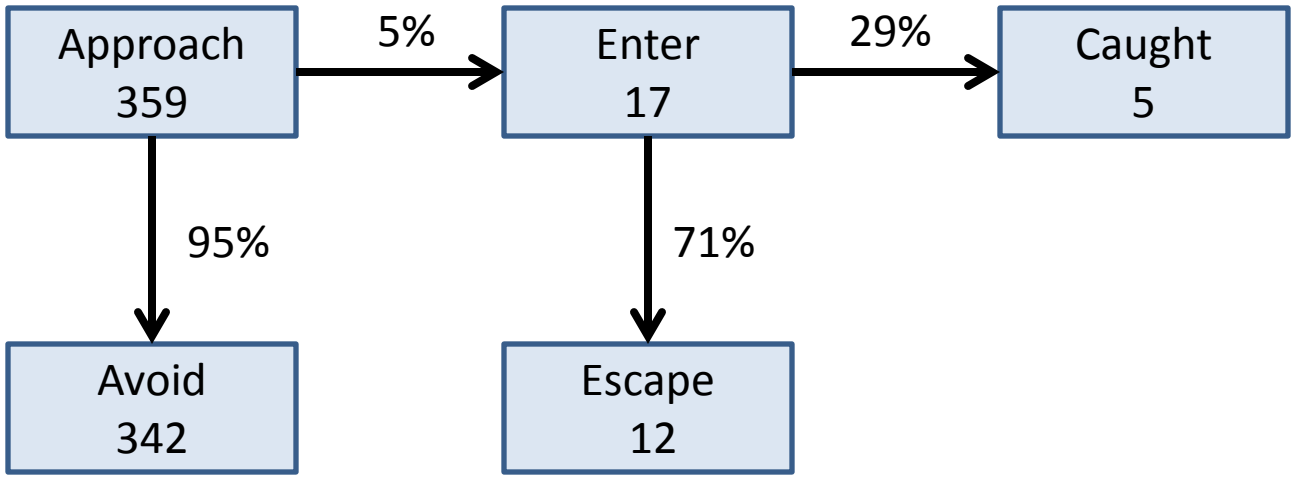


Behavioral categories

- **Towards Traps**
  - Approach, entering the field of view of the camera
    - Assuming many fish were counted multiple times, due to inability to identify individual fish
  - Half-entry, entered more than half a body length
  - Entry – Into kitchen or parlor
  - Exit or escape
  - Catch, number in trap
- **Towards cohorts**
  - Agonistic: Attack, Chase
  - Non-agonistic: Hover, Sit, Feeding

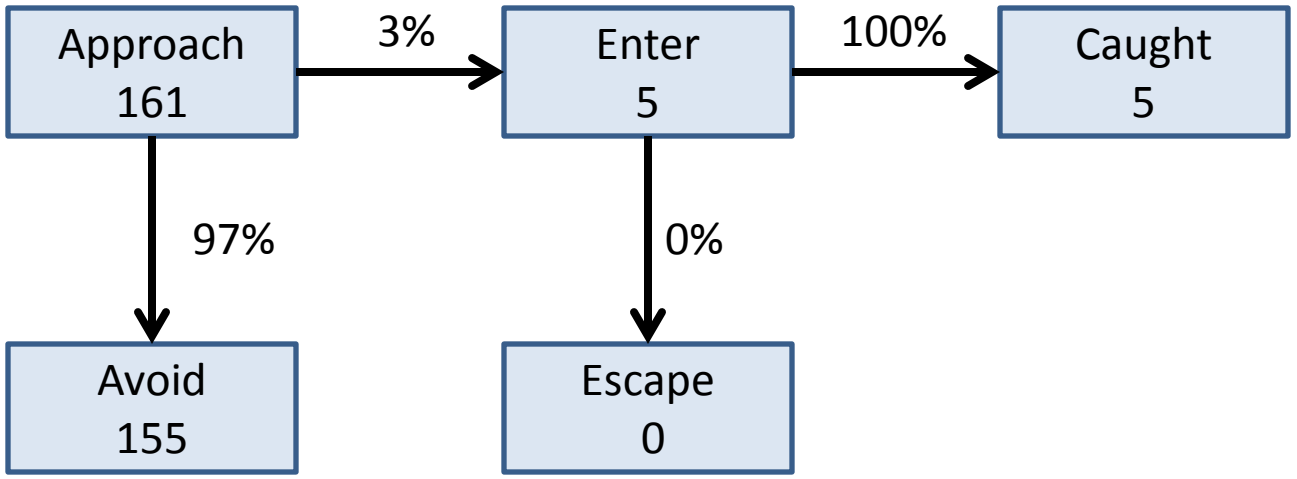
Trap Dynamics: Phase 1 (Field)

- 37 hr * 5 cameras
- 359 BSB approaches → 5 fish caught (1.4% ± 1.2%)
- Null hypothesis (Approach = catch) REJECTED

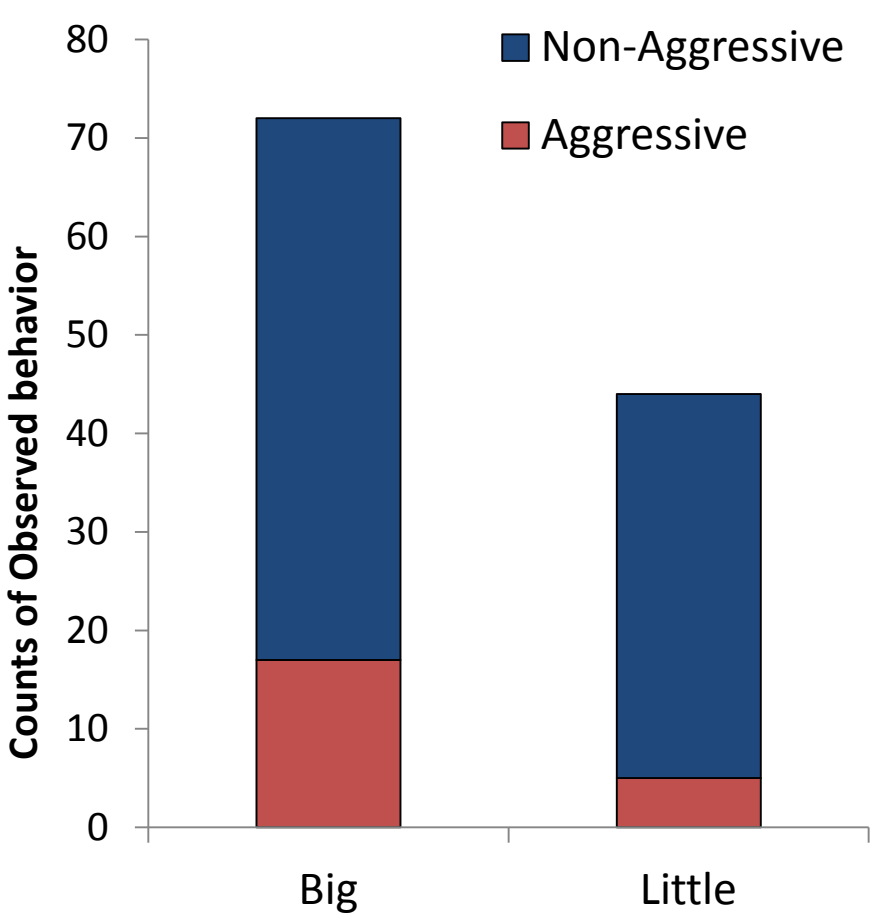


Trap Dynamics: Phase 2 (Mesocosm)

- 24 hr * 5 cameras
- 161 BSB approaches → 5 fish caught (3.1% ± 2.7%)
- Null hypothesis (Approach = catch) REJECTED

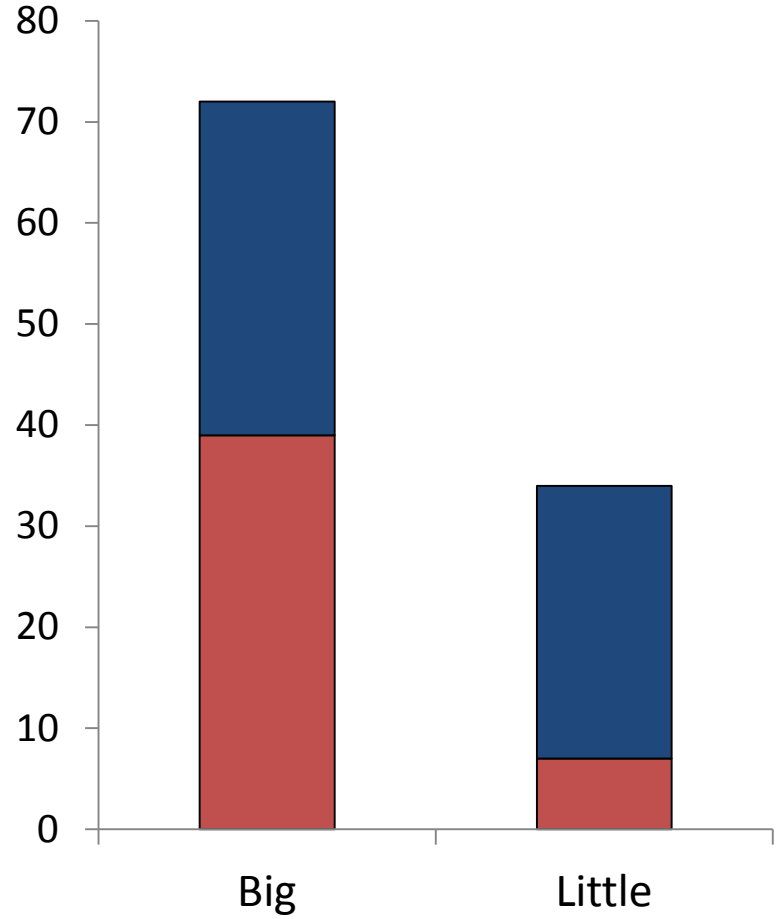


Aggressive Behaviors



Field

$X^2 = 4.90$ $p > 0.05$ ns



Mesocosm

$X^2 = 4.90$ $p < 0.05$ *

Results Summary

H_{01}: Number of fish approaching = number caught.

- Field: REJECTED, Approaches >>> catch
- Mesocosm: REJECTED, Approaches >>> catch

H_{02}: Frequency of agonistic behaviors: large = small fish.

- Field: ACCEPTED null hypothesis, no difference
- Mesocosm: REJECTED null hypothesis, big fish > small fish

Field vs Mesocosm

- Two sample T-test (unequal variances) arc-sine transformed
- n.s.d. between proportion entering (df= 11, $p \leq 0.359$)
- n.s.d. between proportion caught (df=7, $p \leq 0.217$).

Observations

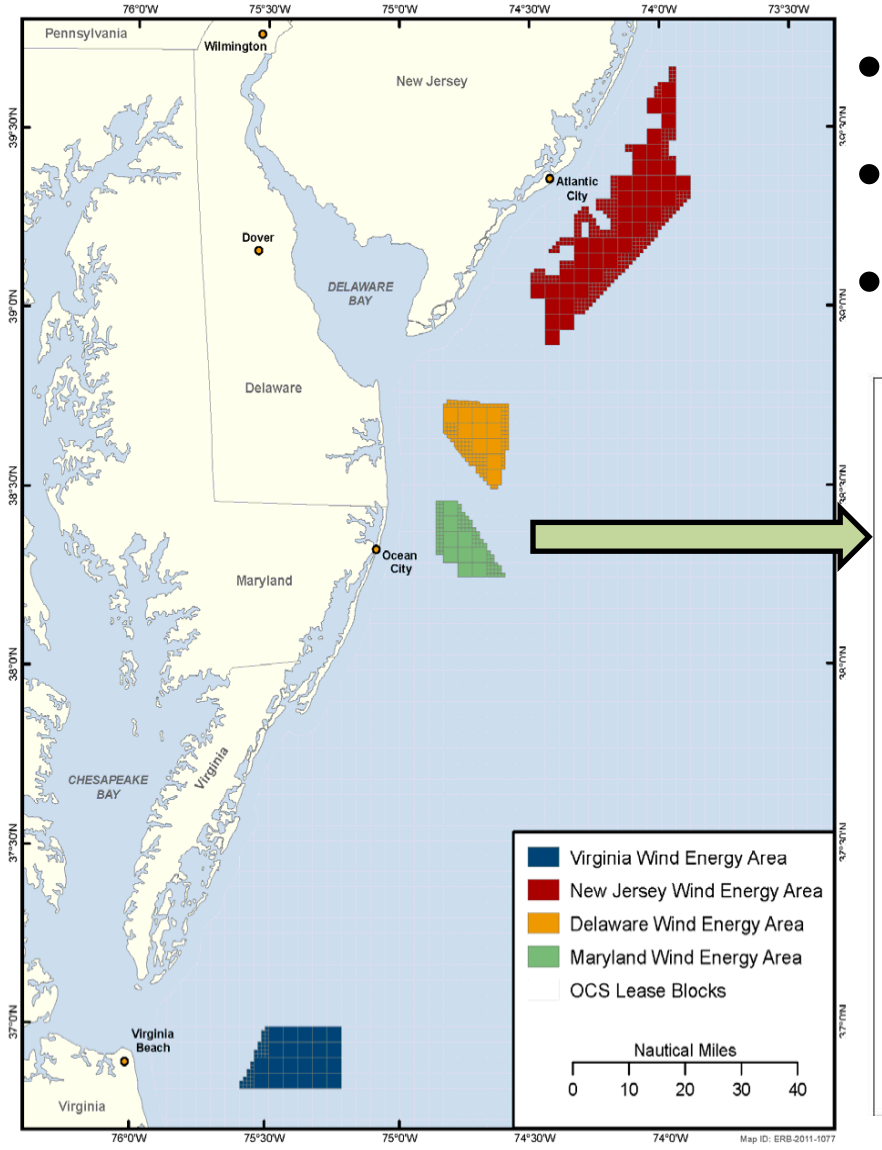
- Large/adult males often approached the trap, but only the smaller fish entered during first 2 hrs
- Few fish entered during first hour, but fish entered more frequently during second hour
- Trapped BSB swam frantically, and charged at the walls in an attempt to escape
  - BSB on the outside of the trap swam, sat, and hovered calmly.
- Territorial behavior was exhibited in the trap when multiple large fish were trapped. Ex: grouper
- Tagged fish in the mesocosm tank “rubbed” their sides and backs against the sand, as if trying to remove the tag.
  - Should be considered in tagging studies

Marine Habitat Mapping for Windpower Installation Siting

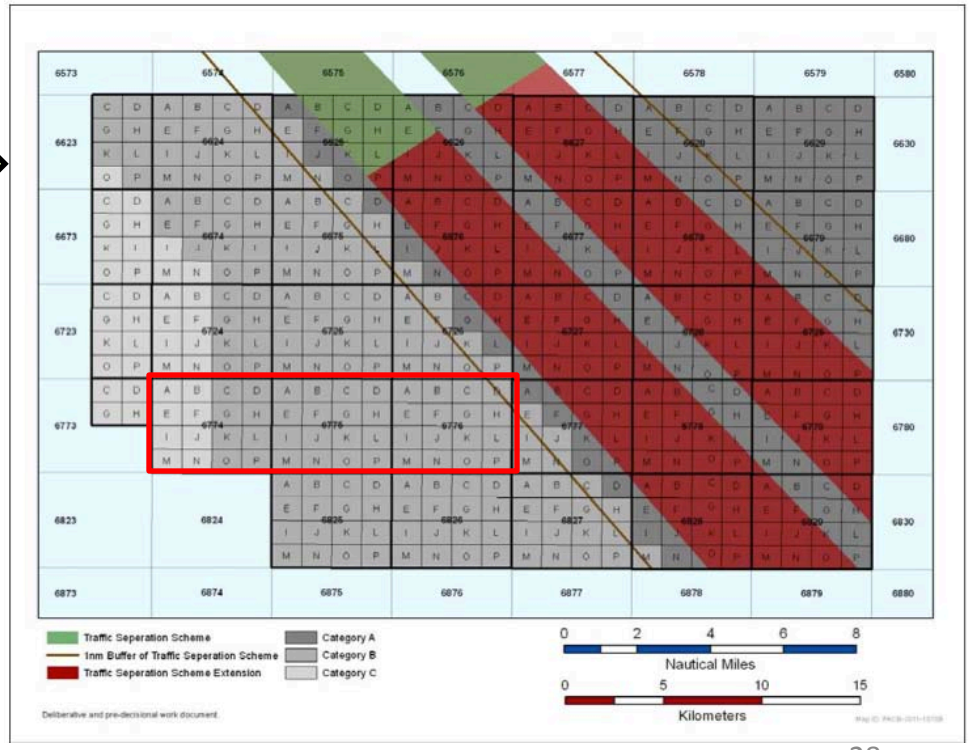
Emily Tewes (MS Student)

- First Identified high priority Wind Energy Areas (WEA's) in Mid-Atlantic: New Jersey, Delaware, **Maryland** and Virginia.
- Maryland DNR has documented cold-water corals, minor commercial and recreational fishing conflicts, and tournament and boating corridors.
- Need to understand distribution of benthic habitat types and community structure in Maryland's proposed WEA
- Funding from DOE-BOEM via MD DNR

OCS sites in Mid-Atlantic



- Potential Windpower sites
- OCS Blocks 6774, 6775, 6776
- 10-20 nm E of Ocean City, MD



Objectives

- Classify habitat types using NOAA's Coastal and Marine Ecological Classification Standard (CMECS)
- Determine biotic communities associated with habitats
- Sediments: Average grain size distributions
- Add data to the Maryland Coastal Atlas and MARCO planning resource which can be used to assist in Marine Spatial Planning.
- Use information to assist with BSB assessment
  - Proportional area and location of critical habitats

Video Camera Sled

Lo-light DSPL Wide-i SeaCam

3 GoPro HD video cameras

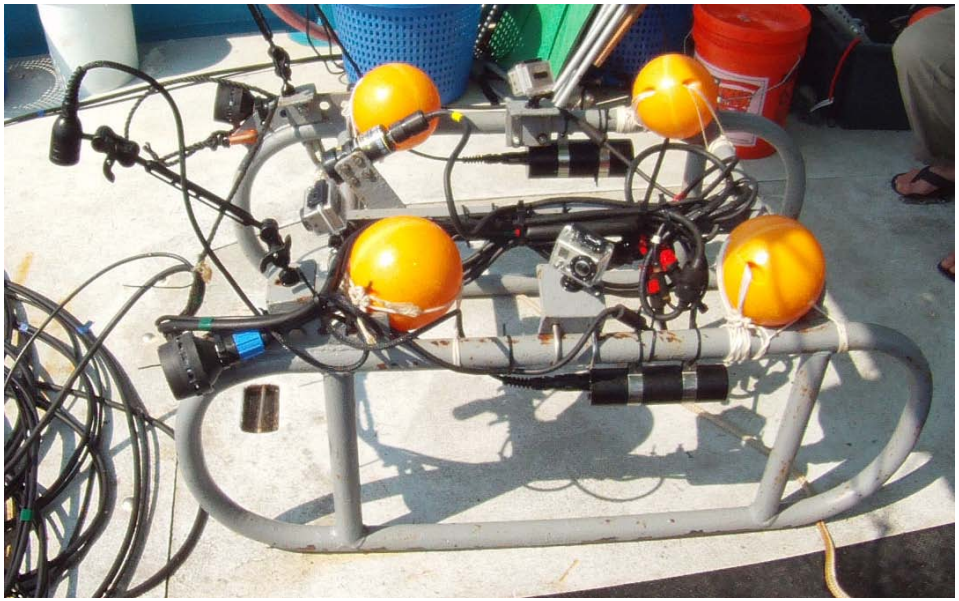
Lights w/ batteries

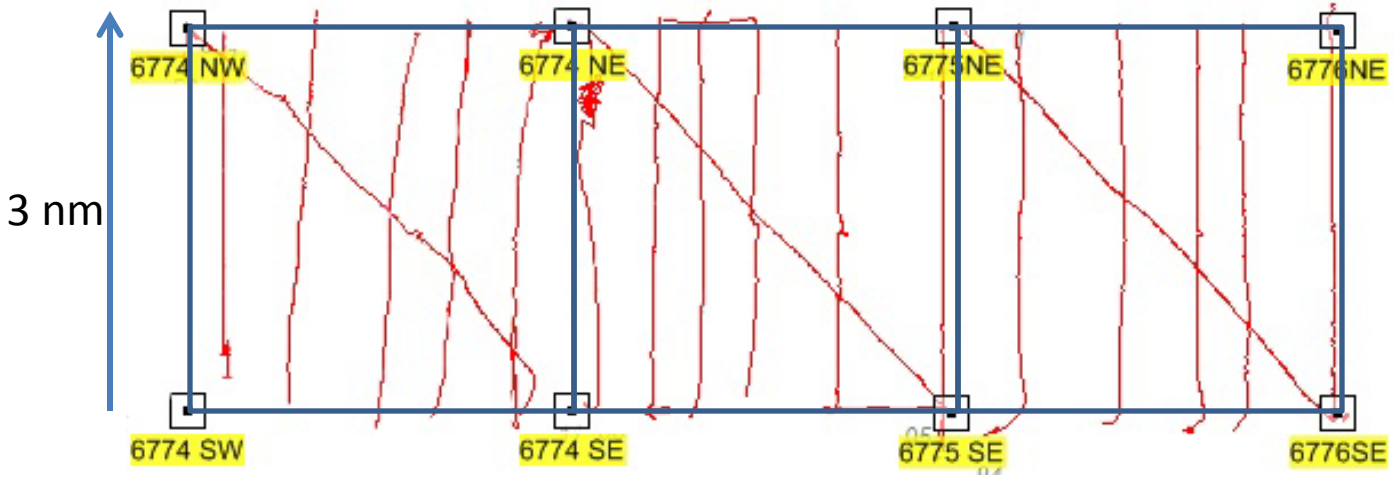
HOBO Pro temp logger

500 feet power/data cable

Video monitor and recorder

Nobeltec GPS software



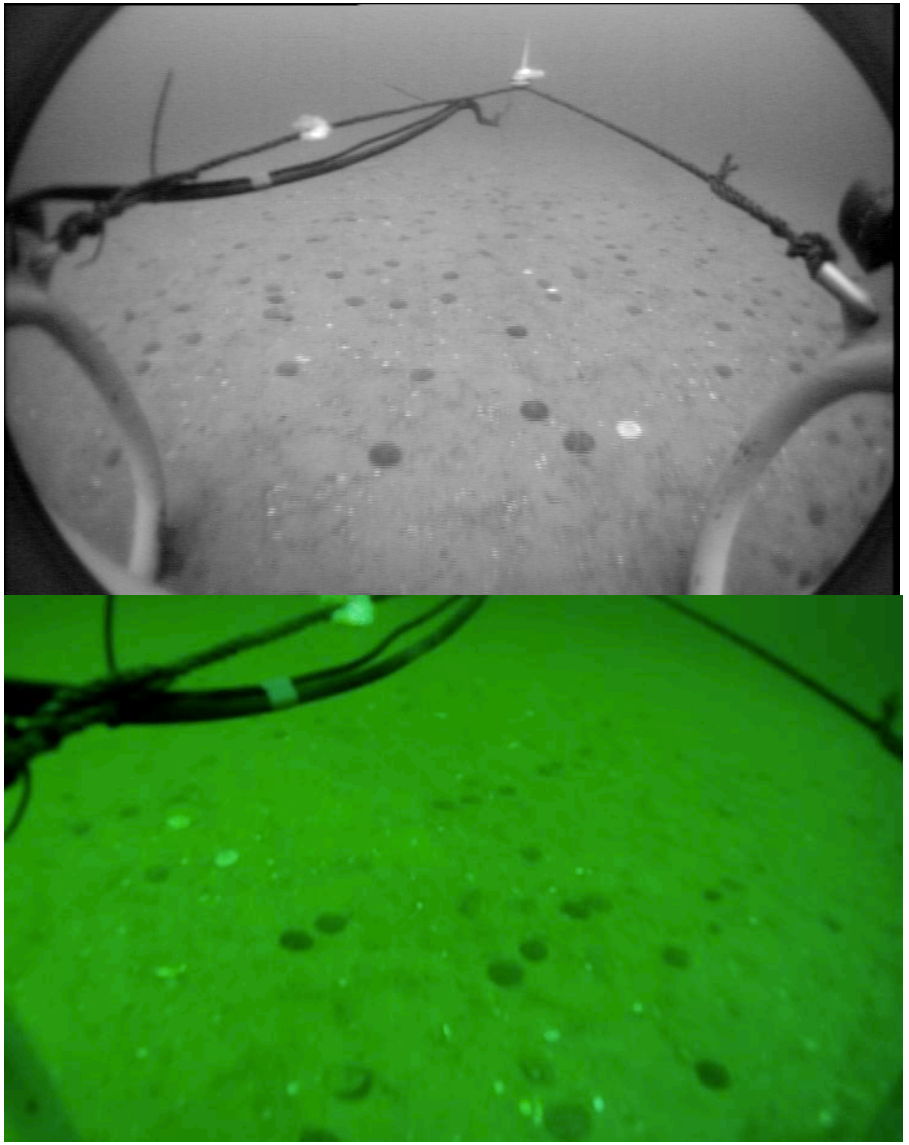


Sampling

- Systematic Sampling design:
  - Continuous video over 3-5 nm transects
- Habitat Classification:
  - Average over 15 sec of video, at 5 min intervals
- Identify species to lowest possible taxon.
  - Diversity, species richness, and abundance
- Ponar grabs
  - At start, middle, end of transects
- Plot results with ArcGIS.

Preliminary Results

- Habitat types
  - Morphology: Sand bars, sand waves and depressions
  - Sediments: Anoxic mud, Sand, Sand w/shell, Pebbles
- Observed fauna includes sand dollars, sea robins, skates, lobsters, and ctenophores.
- Still to do – count, analyze critters
- Next year – continued funding
  - Improve sled w/digital still cam?
  - Geo-referenced frames?
  - High-res mapping with mosaics?



Conclusions

- Underwater video
  - Samples habitats that trawls cannot
  - Includes habitat information
  - Allows behavioral observations without disturbance
  - Permanent record can be subsampled, re-viewed
  - May be more cost effective
- R&R sampling
  - Provides size frequency (within limits)
  - Provides quantitative estimate of relative abundance
  - Comparable to video estimates?
- Habitat distribution
  - Heterogeneous habitat is a small fraction of seafloor
  - Accounts for largest proportion of BSB biomass

Acknowledgements:

NOAA Office of Education,
Educational Partnership Program
NOAA J.J. Howard Laboratory
F/V Andrew G, Capts. Chet and Wes Townsend
Students: Yannick Nkeng, Nikkia King, BJ Peemoeller

Serendipity Strikes!

- During sampling in the J.J. Howard Lab on August 23, 2011 ….

Earthquake !!!

- at approximately 2:45 pm (m =5.8)
- Unique opportunity to observe BSB response to earthquake.
  - BSB appeared to school together at one end of the tank <u>prior</u> to detectable (by humans) vibrations
  - Typical stress behavior

BSB Earthquake Behavior Timeline