Artificial Reef Monitoring in Nantucket Sound Using Baited Remote Underwater Video (BRUV)

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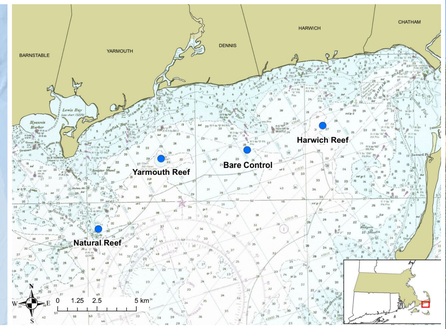
Background

Artificial reefs are used as a tool in fisheries management in Massachusetts. When artificial reefs are properly placed and sized, They can provide structured habitats that benefit recreational and commercial fisheries. Artificial reefs placed off of Cape Cod have been successful at enhancing fish habitats and supporting fishermen. Developing an artificial reef site involves site selection, expert collaboration, and guideline adherence. We used a baited remote underwater video (BRUV) monitoring approach to help evaluate reef performance of new materials deployed in 2019 and 2020. Successful reefs may inform future deployments, bolster marine habitat and improve sustainable fisheries.

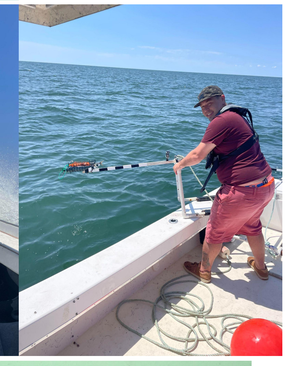
Artificial Reef Sites in Massachusetts

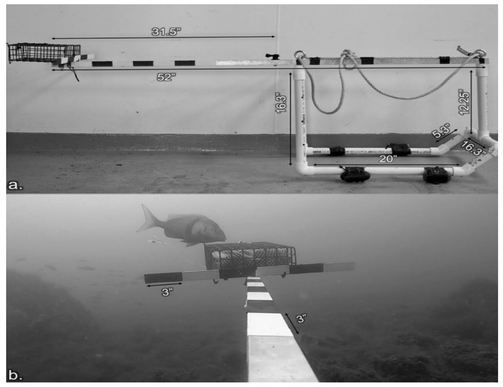
- Yarmouth
  - Tires (1978)
  - ILF (2019/2020)
- Harwich (2016)
- Dartmouth(1997)
- Boston Harbor, Brewster Island(Hubline)(2006)
- Boston Harbor, Sculpin Ledge(1999)

Reef locations thought Massachusetts:



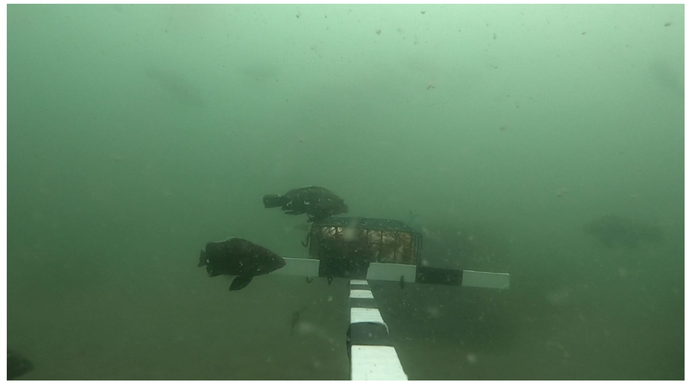
Natural and artificial reef locations in Nantucket Sound, Massachusetts:





A:Mono - Baited Remote Underwater Video (Mono BRUV):
B: Gopro Video frame with Scup:

Construction materials used to make artificial reefs:

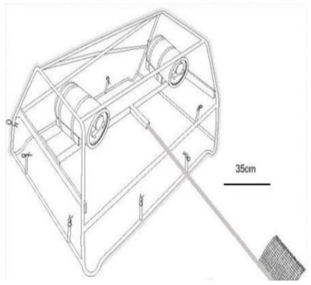


Frame taken from data analysis: Black Sea Bass in BIN size 3"-6" up to 6"-12":

Methods

Deployment and Usage of Mono-Horizontal Baited Remote Underwater Video (Mono BRUV) Units:

1. **Site Preparation and Equipment Deployment:**
   a. A boat was used to reach each predetermined site.
   b. The bait box of the BRUV was loaded with three to four pounds of Atlantic mackerel.
   c. A time stamp card initiated the video recording. The BRUV was then systematically lowered into the water, ensuring proximity to the predetermined GPS marker.
   d. The deployment procedure was consistently executed across all sites.
   e. At every site, a standardized mono BRUV unit was deployed.
   f. Recording began once the final BRUV was deployed at a particular site and lasted for 1 hour. The setup time of the last BRUV influenced the start of data collection, leading to differing video durations for preceding sites. After the hour, the most recently deployed BRUV was retrieved first, followed by the others in the reverse order of their deployment.
   g. Upon collection, the bait was removed from the BRUV's bait box.
2. **Redeployment (subject to conditions):**
   a. If weather conditions and time permitted, the deployment was repeated.
3. **Data Analysis:**
   a. Videos captured by the BRUV underwent off-site evaluation.
   b. The BRUV video was divided into 30 minute footage
   c. The 30-minute footage was further divided into a series of 10-second clips. Out of every 30-second duration, only 10 seconds were analyzed, this procedure was consistently applied at all sites, ensuring synchronous recording across all BRUVs.
   d. Each fish identified by species. Then each fish was counted and measured in the frame and binned for analysis into categories based on size (ex. 3-6 inches, 6-12 inches, 12-18 inches, etc.)

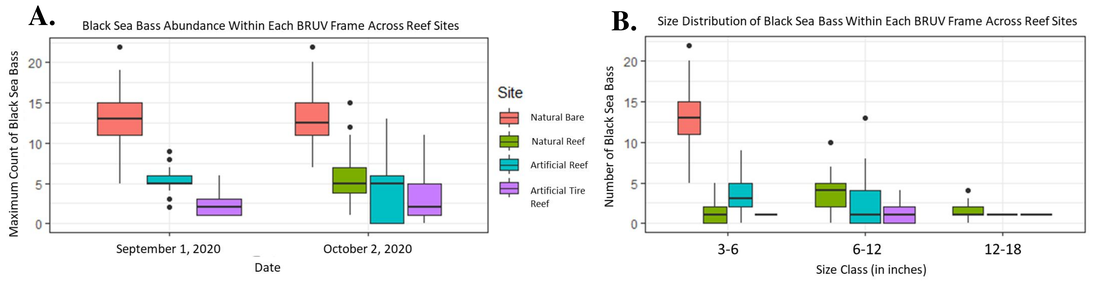


Stereo BRUV prototype by Guardian Geomatics

Species Observed

- *Centropristis striata*
  - Black Sea Bass
- *Stenotomus chrysops*
  - Scup
- *Carcharias taurus*
  - Sand Tiger Shark
- *Squalidae sp.*
  - Dogfish Species

4 fishing boats located at Yarmouth Artifical ILF site: Photo taken during BRUV deployment showing the accessibility and usage of the site:



Boxplot visualizations of fish abundance data (A) and fish size data (B) post video analysis. Boxplots were created to visualize the distribution of the maximum number of black sea bass counted within each frame (A) and the size distribution of black sea bass (B) across sites. BRUV deployments occurred across sites during September and October 2020. The solid line displays the median value, the box displays the interquartile range which highlights 50% of the values, and the lower and upper quartiles display the minimum and maximum range, respectively. Graph A suggests that there are more black sea bass within the Natural Bare site (median of 13 fish per frame) than the artificial reef sites. However, graph B suggests that the black sea bass present at the Natural Bare site (all within 3"-6") are smaller in size than those at the artificial reef sites. Graph B also suggests that the larger black sea bass, which are more appreciated by recreational fishers, are present at the artificial reef sites throughout Nantucket Sound in September and October.

Results

Boxplot visualizations highlight the varied behaviors of black sea bass across sites. The Natural Bare site mainly hosts juvenile bass, sized between 3"-6", even with a higher median count. Reef sites in Nantucket Sound accommodate larger bass; additional data are needed to discern seasonal trends and distinguish between artificial and natural reefs for larger fish. Reefs draw in recreational fishers. The Natural Bare site could function as crucial nursery habitat for juveniles with larger numbers of smaller fish, whereas artificial reefs cater to adults. By understanding the succession of the reef, we can assess its benefits of artificial reefs for fishermen

Discussion

- **Management Challenges and Research Needs:**
  - Funding remains a challenge. Financial support can help sustained research and effective management.
  - Understanding the potential impacts of offshore wind farm projects in New England.
- **Knowledge Gaps and Limitations:**
  - BRUV systems are a new and useful non invasive tool, but data can be time consuming to analyze.
  - The use of 3D stereo systems could enhance the usage of BRUVs. 3D stereo systems allow for accurate fish size measurements, fish identification, and tracking fish within frames with the help of AI.
- **Strategies for Monitoring, Usage, and Management:**
  - Monitoring efforts could extend beyond the typical 5-year post-deployment phase. Extended monitoring could provide insights into longer-term reef dynamics and associated marine life interactions, and assess climate related impacts.
  - Domestic research and development endeavors that center on BRUVs and underwater stereo camera systems could lead to more efficient data collection and processing.

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