Massachusetts Department of Fish and Game

In-Lieu Fee Program

Marine Habitat Enhancement, Yarmouth MA Artificial Reef (IL05) 2021 Annual Report

Implemented by the Division of Marine Fisheries

DFG ILF Project Number: ILF4-CSTL-IL05
Army Corp Permit #: NAE - 2012 - 00311
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Submitted to:

The Massachusetts In Lieu Fee Program

Administered by the Department of Fish and Game

Dan McKiernan, Director

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Project Overview

In 2019, the Massachusetts Department of Fish and Game (DFG) In-Lieu Fee Program (ILFP) funded the Division of Marine Fisheries (DMF) to implement a marine subtidal habitat enhancement project in Nantucket Sound. The project is located within a 125-acre permitted artificial reef site located 2.2 miles off the coast of Yarmouth (Figure 1). The site was permitted in 2014 under the Corps General Permit number NAE-2012-00311. Project construction consisted of deploying two-thousand cubic yards of granite and secondary use concrete to create dispersed patches of structured habitats extending two to six feet off the bottom. Construction was completed on January 14, 2020, and a side scan survey of the site was completed on January 23, 2020. Deployment and side scan survey results were reported to the ILFP in *Marine Habitat Enhancement, Yarmouth MA Artificial Reef Annual Report* - *Revised August 6, 2020.* The report also included a request by DMF for an adjustment of available credits to reflect the actual (vs. the proposed) amount of habitat enhanced by the project.

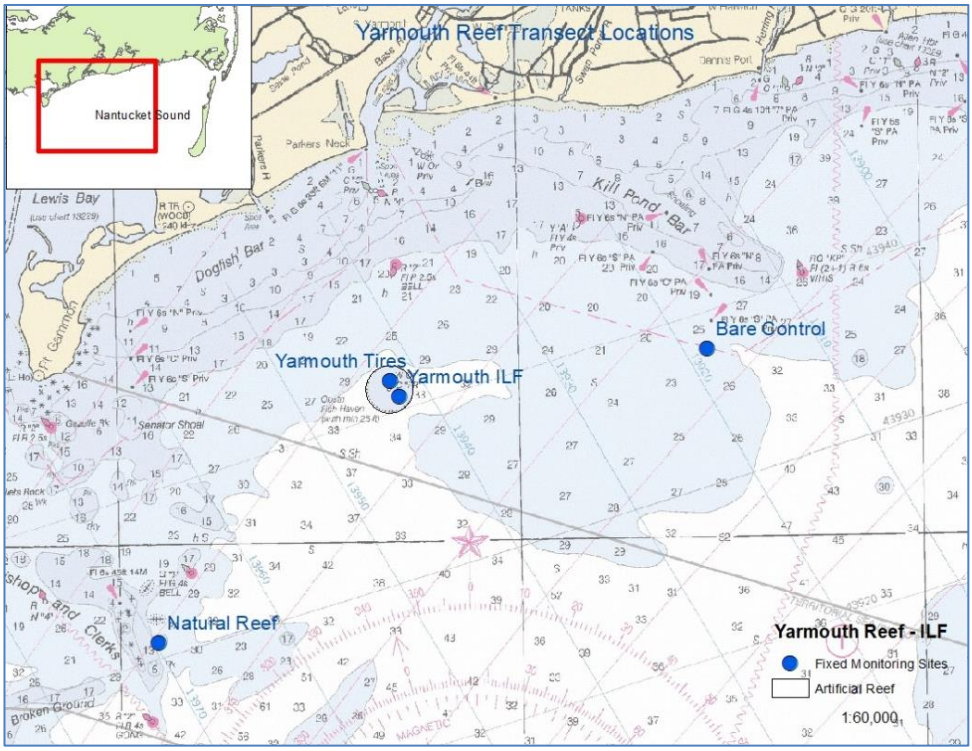

Figure 1. Location of Artificial Reef and Monitoring Stations.

The initial credit generation estimate for this project was 0.366 tidal wetlands credits based on proposed structured habitat enhancement within a 1.1-acre footprint at a ratio of 1:3 (reef structure 0.35 acres, undisturbed sandy bottom 0.66 acres). However, DMF deployed additional materials within a larger area and the ILFP requested a larger credit release to reflect the increased habitat enhancement achieved. On November 24, 2020, a larger credit release was approved by the Corps to account for the actual project enhancement area based on the findings of the side scan survey. Total project credits were increased to 0.7 tidal wetland credits to reflect 0.699 acres of structured habitat enhancement within a 2.1-acre footprint. The Corps also confirmed the release of 0.2796 credits for successfully meeting the project's design and construction performance standards (40% of total credits). The release of the remaining 0.0699 construction and design credits (10% of total credits) is contingent upon the completion of a follow-up side scan survey in 2025.

Ecological performance monitoring accounts for fifty percent (0.3495 credits) of available project credits. Monitoring methods herein describe the data collection methods employed to assess diversity and size class

similarity of species inhabiting the new artificial reef as well as a nearby natural rocky reef and bare sand control site over time. This report includes a summary of data collected during the first two years of monitoring. A full evaluation of ecological performance monitoring will require several additional years of data collection.

Monitoring

Monitoring data is collected by DMF staff in accordance with the schedule included in (Table 1). Transect surveys and video surveys using Baited Remote Underwater Video (BRUV) are conducted annually between May and October when migratory species are present in Nantucket Sound. An additional set of transect surveys are collected once per year during the off-season between November and April.

In 2021, there were five SCUBA monitoring field days: winter/spring sampling on January 14 and March 22, and summer/fall sampling on May 18, July 1, and August 26. HOBO remote temperature loggers and VEMCO acoustic receivers were swapped out in May, with new equipment deployed to the site expected to remain on station until mid-2022. SCUBA transect data collection occurred at the artificial reef (1/14. 3/22, 7/1) the natural rocky reef (3/22, 5/18, 8/26) and bare sandy (5/18, 8/26) sites.

Additionally, there were three BRUV sampling events on April 14, May 26, and August 10. BRUV survey data collected in 2021 has not been processed for quantitative length analysis or relative abundance estimates (MaxN); however, video imagery has been reviewed to identify new or unique species. Status of all data collection and processing is summarized in Table 2.

Table1. Monitoring Schedule

		Pre-Deploy (2019)	Year 0 (2020)		Year 1 and 2 (2021-2022)		Year 3 and 4 (2023-2024)	2025
			May-Oct	Nov-Apr	May-Oct	Nov-Apr	Annual	Annual
Permanent transect survey Quadrats (sessile species) and Swath (mobile species) along 50m fixed transects								
	natural reef	x	x	x	x	x	x	x
	artificial reef	x	x	x	x	x	x	x
Camera/ Video survey	natural reef	x	3		3		3	3
	artificial reef	x	3		3		3	3
Side scan survey		x	x					x
Temp / acoustics			x	x	x	x	x	x
completed								
2021								

Table 2. Status of Data Collection

	Ecological Performance: Diversity (species presence / richness)			Ecological Performance: Production (Size / age class / % cover similarity)		Status of Data 12/2021
	Mobile	Sessile		Mobile	Sessile	
Diver Survey	X[1]	X[1]		X	X[1]	Collected, processed
BRUV	X			X[1]		Collected, in processing
Remote Acoustic	X					Collection ongoing –, 1 data dump per year. 2020 – 2021 data is in processing
[1] primary data source for analysis						

Methods

Ecological performance monitoring parameters for this project were established to assess species diversity and species size class distributions (production) at the newly deployed reef structures when compared with a nearby natural rock reef site.

Species diversity is assessed using diver-based underwater visual census (UVC) surveys along 50m transects. Finfish and mobile macroinvertebrates are counted within two-meter width swaths along both sides of a transect. Sessile invertebrate and macroalgae percent cover estimates are collected from 20 $1m^2$ quadrats along each transect. Quadrat locations are determined by randomly selecting two quadrats every ten meters from each side of the transect (20 quadrats/50m).

Mobile species detectability using UVC surveys can be significantly underestimated due to poor visibility and diver effect (reaction of fish to divers). To help address this, remote acoustic sensors are deployed year-round to a fixed location within the new reef habitat to record presence of any fish that has been implanted with an acoustic tag. Fish presence is recorded when a fish travels within +/- four hundred feet of the receiver. The receiver records date/time, and tag ID, which can then be traced back to species, tagged location, etc., from a database. Divers recover the acoustic receiver data from the field once per year for processing. Unique mobile species (species not recorded in UVC's) counts from acoustic receivers also inform mobile species diversity metrics. In addition to remote acoustic sensors, BRUV footage is also analyzed for mobile species presence.

Size class distribution (production) is assessed using BRUV data collected from fixed stations at the rock reef, tire reef, ILF reef, and bare sand sites. Visibility is estimated directly from BRUV videos using a bait box (0.8 m from camera) as a guide. Still frames for analysis are captured from each 30-minute recording in 30-second increments for a total of 60 analyzed frames per recording (sampling event). The identity of each species of fish, an index of its relative abundance (MaxN), and quantitative length estimates of two species of economic significance, *Centropristis striata (*black sea bass (BSB)), and *Stenotomus chrysops* (scup) are documented within each frame. Unique mobile species (species not recorded in UVC's) counts from BRUV's also inform mobile species diversity metrics.

Specific field sampling methods are further described in Appendix A - *Yarmouth Artificial Reef Monitoring SOP's for the ILF-funded deployment in 2020.*

Preliminary Results

2021 monitoring was successfully completed in accordance with the monitoring schedule (Table 1) and will continue through 2024. An insufficient amount of data has been collected to assess project ecological diversity or performance standards at this time; however, there were some notable preliminary observations.

Species diversity –The total number of unique species identified at each site is summarized in Table 3. In 2021, UVC surveys observed 20 unique species on the reef site compared to 21 species at the rocky reef site and 5 species at the bare sand site. The total number of unique species increased from 2020 to 2021; however, the number of finfish species observed in 2021 decreased. Unique sessile species (macroinvertebrate and macroalgae) increased at both artificial and rocky reef sites between 2020 and 2021. BRUV footage analyses identified at least four unique finfish species (butterfish, dogfish sp. (smooth or spiney), sand tiger shark, and northern puffer) not found in UVC surveys. The most notable change is the increase in unique sessile species at the ILF reef site from 2020 (5) to 2021 (13). Mobile species data is summarized in Table 6 and sessile species data is summarized in Table 7.

Size class distribution – BRUV survey data collected in 2020 and 2021 has not been processed for analysis; however, video imagery has been reviewed to identify new or unique species (Figure 2). Video processing includes still frame extraction and analysis for abundance and fish lengths. Status of all data collection and processing is summarized in Table 3. Preliminary BRUV species presence results are summarized in Table 8.

Table 3. 2021 Species Summary Table

Species Summary		2020 Transects			2020 BRUV (preliminary)			2021 Transects			2021 BRUV (Preliminary)		
		Rocky Reef Site	ILF Reef Site	Bare Sand Site	Rocky Reef Site	ILF Reef Site	Bare Sand Site	Rocky Reef Site	ILF Reef Site	Bare Sand Site	Rocky Reef Site	ILF Reef Site	Bare Sand Site
Total # of Species		16	15	5	6	5	5	21	20	5	5	8	8
Mobile Species		10	10	6	6	5	5	6	7	5	5	8	8
	Finfish	7	6	2	6	5	4	4	4	2	4	6	7
	Macro Invertebrates	0	4	3	0	0	1	2	3	3	1	2	1
Sessile Species		9	5					15	13				
	Macroalgae	7	3					9	5				
	Macro Invertebrates	2	2					6	8				

Figure 2. Still images taken from 2021 BRUV footage. Top Left: rough tail stingray at Bare Sand Control Site. Top Right: scup, triggerfish, and black sea bass at Natural Rock Reef. Bottom Left: summer flounder at Natural Rock Reef. Bottom Right: sand tiger sharks at the ILF reef.

CY2021 Budget Update

In calendar year 2021, the ILF Yarmouth reef project (IL05) expended $1,188 in dive pay (including indirect and payroll) for monitoring. A breakdown of the expenses is summarized in Table 4. The remaining balance for the project is $20,312.

There were no expenses charged for field supplies, travel, or gear maintenance, in 2021. To improve project equipment and supplies expense tracking, two budget summary table line items with no expenses reported since project initiation have been consolidated in the budget summary. Boat and Fuel Maintenance combined with the Gear Maintenance, and Monitoring Supplies combined with Field Supplies. This consolidation does not alter the project budget and better aligns reporting of equipment and supplies expenses for this project with the Commonwealth's Massachusetts Management Accounting and Reporting System (MMARS) for tracking non-payroll expenditures.

Table 4. Budget summary table.

Line Item	Approved 5-Year Budget	CY2019 Expenses	CY 2020 Expenses	CY 2021 Expenses	Total Expenditures	Remaining Balance
SCUBA air tank fills	$2,160	$800	$0	$0	$800	$1,360
Boat fuel and maintenance[1]	$15,500	$1,174	$82	$0	$1,256	$14,244
Monitoring supplies [2]	$14,500	$4,611	$0	$0	$4,611	$9,889
Vehicle travel and lodging	$2,750	$0	$0	$0	$0	$2,750
Material Deployment Contract	$230,000	$0	$246,277	$0	$246,277	($16,277)
Dive pay	$10,187	$0	$652.57	$1,187.82	$1,840	$6,507
Total	**$275,097**	**$6,586**	**$247,012**	**$1,188**	**$254,785**	**$20,312**

[1] Boat fuel and maintenance and Gear maintenance budget categories consolidated into one line item.
[2] Monitoring supplies and Field supplies budget categories consolidated into one line item

Credit Release/Performance Standards

Newly deployed structures were expected to undergo early successional changes, and fifty percent of project credits are linked to ecological performance standards assessing similarity to nearby natural structured habitat. Five years of monitoring are required for the project, and we expect several years of data will be necessary before any similarity assessments can occur. Accordingly, no additional credits are being requested for release at this time.

Project credit tables herein reflect the 2020 Corps approved credit adjustment to 0.7 tidal wetland credits, based on 0.699 acres of structured habitat enhancement within a 2.1-acre footprint, replacing the initially proposed credits of 0.366 for 0.35 acres of structured habitat enhancement within a 1.1-acre footprint (Table 5). Fifty percent of project credits are linked to construction and design, of which 40% have been released (0.2796). The release of the final 0.07 construction and design credits is contingent upon the completion of a follow-up side scan survey in 2025. A copy of the Corps' credit release letter is included in Appendix B.

Summary and Conclusions

MA DMF has completed the second year of the ILF Yarmouth Artificial Reef Habitat Enhancement Project, and the first three seasons of post-deployment ecological performance monitoring. A few interesting observations are noteworthy, notwithstanding data limitations. Scup and BSB were observed at all sampling sites, indicating a wide/uniform species distribution throughout Nantucket Sound. Tautog and cunner were only observed on sites with structure. More than twice as many species of macroalgae were identified at the rocky reef compared to the newly deployed structures. This is expected for macroalgae and for several sessile invertebrate species, as new structures undergo several stages of colonization and die off during early the successional stages. Divers observed adult sized finfish species while monitoring the reef site and angling was observed at the reef during all monitoring visits indicating larger sized fish were consistently present on the reef throughout the season.

A total of $1188 was expended in 2021, well below the proposed 2021 project budget of $6744.

The timeline for release of the remaining 0.42 potential project credits will require meeting specific monitoring performance benchmarks outlined in Table 5 and is expected to take several years.

Short videos created using a GoPro footage collected during monitoring are routinely posted to the Artificial Reef Playlist on the MA Marine Fisheries YouTube Channel.

Acknowledgements

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Appendices

Yarmouth Artificial Reef Monitoring SOPs for the ILF-funded deployment in 2020

Table 5. Goals, Performance Standards, Metrics and Mitigation Credit Release Schedule (updated 01/2022)

Type of mitigation	**Project Area**		**Proposed Habitat Area**		**Proposed Credits**
Artificial Reef Habitat	2.1 acres		Reef structure – 0.699 acres Undisturbed sandy bottom – 1.4 acres Total enhanced area = 2.1 acres		.70 wetland credits (*multiplier 1:3 for 2.1 acres of enhanced marine subtidal habitat*)
Performance Standards & metrics	**% Total Credit**	**Credit amount**		**Timeline -credit release**	**Comments**
Design & Construction Parameters:	**50%**	**0.35** (0.1830)			Designed to maximize its potential to function effectively as sub-tidal structured habitat
Materials deployed to site as specified in design	40%	0.2796 (0.1464)	2019 / 2020	Post-construction	Completed. 40% credit based on adjusted credit release (reference ACOE 11/24/20 letter)
Material remains within proposed site and remains stable in accordance with permit conditions	10%	0.0699 (0.0366)	2025	Post 5-year monitoring report	Upon completion of 5-year (2025) side scan sonar survey
Monitoring: Conducted as per monitoring plan					**Submitted annually** **Year 1 and Year 2, season 1 monitoring data are included with this report. Ecological performance is assessed across two or more years of monitoring data.**
Ecological Performance: Diversity	**25%**	0.175 (0.0915)			Monitoring results show evidence of similarity of species diversity
Species diversity – mobile species	12.5%	0.08735 (0.04575)	2020-2024	Percent similarity exceeds 60% in two monitoring periods	The resident mobile species assemblage on the reef shall have species richness similar to natural reefs within the region.
Species diversity – sessile species	12.5%	0.08735 (0.04575)	2020-2024	Percent similarity exceeds 60% in two monitoring periods	The resident sessile species assemblage on the reef shall have species richness similar to natural reefs within the region
Ecological Performance: Production	**25%**	0.175 (0.0915)			Monitoring results show evidence of multiple size classes of predator and prey species
Size/age class similarity of mobile species – upper-level consumers	12.5%	0.0875 (0.04575)	2020-2024	Percent similarity exceeds 60% in two monitoring periods	Mobile species size class distribution on the artificial reef shall be similar to natural reefs within the region
Size/age class similarity of sessile species – benthic community/ lower-level producers	12.5%	0.0875 (0.04575)	2020-2024	Percent similarity exceeds 60% in two monitoring periods	The relative abundance of the top 10 sessile species on the artificial reef shall be similar to the top 10 sessile species on natural reefs within the region
Total Credit Potential	**100%**	**0.70** **(0.366)**		**2020-2024**	**Wetlands Mitigation Credits**

Table 6. Mobile Species Monitoring

	Season / Year	Summer/Fall 2020										
	Location	Natural Rock Reef (RR)		Artificial Reef (AR)				Bare Control (BC)		RR	AR	BC
	Transect (bearing)	1 (0)	2 (260)	1 (80)	2 (135)	3 (230)	4 (300)	1 (90)	2 (180)	Avg Ct / transect		
Arthropods	American lobster (*Homarus americanus*)	0	0	0	0	0	1	0	0	0	0.25	0
	Spider/decorator crab Family Majidae (*Libina/Hyas*)	0	0	0	0	0	0	1	1	0	0	1
	Large hermit crabs (*Pagarus sp.*)	0	0	0	0	0	1	5	0	0	0.25	2.5
	Lady Crab (*Ovalipes ocellatus*)	0	0	0	0	1	0	0	0	0	0.25	0
Cnidarian/Tunicates	Frilled anemone (*Metridium senile*)	0	0	1	0	0	0	0	0	0	0.25	0
Gastropods	Northern moon snail (Euspira *heros*)	0	0	0	0	0	0	1	0	0	0	0.5
Sponges	Yellow Sponge (*Cliona celata*)	0	0	4	0	2	5	0	0	0	2.75	0
Fish	Scup (*Stenotomus chrysops*)	10	4	23	4	11	23	0	0	7	15.25	0
	Juvenile Scup (*Stenotomus chrysops*)	18	30	0	0	0	0	23.1	43.3	24	0	33.2
	Cunner (*Tautogolabrus adspersus*) **Estimate**	68.1	230.5	6	11	17	14	0	0	149.3	12	0
	Shorthorn, grubby & longhorn (*Myoxocephalus sp.*)	0	2	0	0	0	0	0	0	1	0	0
	Summer flounder (*Paralichthys dentatus*)	0	1	0	1	2	0	0	0	0.5	0.75	0
	Black sea bass (*Centropristis striata*)	97.2	79	11	14	14	19	0	3	88.1	14.5	1.5
	Juvenile Black Sea bass	75	137	0	0	0	0	20.1	123.4	106	0	71.75
	Tautog (*Tautoga onitis*)	0	7	9	10	7	13	0	0	3.5	9.75	0
	Juvenile Tautog (*Tautoga onitis*)	5	0	0	0	0	0	0	0	2.5	0	0
	Northern Sea Robin (*Prionotus carolinus*)	0	1	0	0	0	1	0	0	0.5	0.25	0

	Season/Year	Winter/Spring 2021										
	Location	Natural Rock Reef (RR)		Artificial Reef (AR)				Bare Control (BC)		RR	AR	BC
	Transect (Bearing)	1 (0)	2 (260)	1 (80)	2 (135)	3 (230)	4 (300)	1 (90)	2 (180)	Avg Ct / transect		
Arthropods	Large hermit crabs (*Pagarus sp.*)	0	5	6	2	1	1			2.5	2.5	
Gastropods	Northern moon snail (*Euspira heros*)	0	0	0	0	1	3			0	1	
Fish	Cunner (*Tautogolabrus adspersus*) **Estimate**	0	0	1	0	0	0			0	0.25	
Sponges	Yellow Sponge (*Cliona celata*)	0	0	12	4	0	0			0	4	
Other	Blood Ark/Cockle	0	0	0	0	1	0			0	0.25	
	Nudibranch	0	14	0	0	0	0			7	0	

	Season/Year	**Summer/Fall 2021**										
	Location	Natural Rock Reef (RR)		Artificial Reef (AR)				Bare Control (BC)		RR	AR	BC
	Transect (Bearing)	1 (0)	2 (100)	1 (80)	2 (135)	3 (230)	4 (300)	1 (90)	2 (180)	Avg Ct / transect		
Arthropods	Spider/decorator crab Family Majidae (*Libina/Hyas*)	0	0	0	0	0	0	0	2	0	0	1
Gastropods	waved whelk (*Buccinum undatum*)	0	0	1	0	1	0	0	1	0	0.5	0.5
	Channeled whelk (*Busycon canaliculatum*)	0	0	0	0	0	0	0	1	0	0	0.5
Fish	Scup (*Stenotomus chrysops*)	8	5	0	0	0	1	2	7	6.5	0.25	4.5
	Juvenile Scup (*Stenotomus chrysops*)	27	266	0	0	0	120	0	0	146.5	30	0
	Cunner (*Tautogolabrus adspersus*) **Estimate**	5	19	10	5	5	22	0	0	12	10.5	0
	Black sea bass (*Centropristis striata*)	2	7	16	6	10	5	0	0	4.5	9.25	0
	Juvenile Black Sea bass (*Centropristis striata*)	35	171	0	5	5	253	772	793	103	65.75	782.5
	Tautog (*Tautoga onitis*)	0	0	7	4	15	6	0	0	0	8	0
	Juvenile Tautog (*Tautoga onitis*)	1	0	0	2	0	0	0	0	0.5	0.5	0
Sponges	Yellow Sponge (*Cliona celata*)	8	15	0	0	0	2	0	0	11.5	0.5	0

Table 7. Sessile Species Monitoring

Season / Year	**Summer/Fall 2020**										
Location	Natural Rock Reef (RR)		Artificial Reef (AR)				Bare Control (BC)		RR	AR	BC
Transect (bearing)	1 (0)	2 (260)	1 (80)	2 (135)	3 (230)	4 (300)	1 (90)	2 (180)	Avg % cover / transect		
Brown Algae											
Knotted wrack (*Ascophyllum nodosum*)	0.3	0	0	0	0	0			0.15	0	
Unid filamentous browns	0.18	0.27	0.29	0.09	0.09	0.59			0.225	0.265	
Red Algae											
Red Filamentous/Foliose	2.79	3.57	0.7	1.2	0.09	0			3.18	0.4975	
Red Blade (*Palmaria or Membranoptera)*	0.77	1.18	0	0	0	0.5			0.975	0.125	
Unid filamentous reds	0.18	2.3	0	0	0	0			1.24	0	
Green Algae											
Branching green (*Codium sp.)* drift	0.99	3.19	0	0	0	0			2.09	0	
Unid filamentous greens	0	0.09	0	0	0	0			0.045	0	
Invertebrates											
Tufted or bushy bryozoan (*Bugula / Crisularia turrita*)	24.1	32.09	0	0	0	0			28.095	0	
Northern Rock Barnacle (*Balanus balanoides*)	0	0	16	10	0	0			0	6.5	
Yellow Sponge (*Cliona celata*)	0	0.8	1.2	0	0.5	1.6			0.4	0.825	

Season / Year	**Winter/Spring 2021**										
Location	Natural Rock Reef (RR)		Artificial Reef (AR)				Bare Control (BC)		RR	AR	BC
Transect (bearing)	1 (0)	2 (260)	1 (80)	2 (135)	3 (230)	4 (300)	1 (90)	2 (180)	Avg Ct / transect		
Brown Algae											
Knotted wrack (*Ascophyllum nodosum*)	0	0.2	0	0	0	0			0.2	0	
Unid filamentous browns	0.09	0.27	0	0	0	0			0.18	0	
Red Algae											
Red Filamentous/Foliose	0.6	7.8	6.2	9.7	1.28	0.2			4.2	4.345	
Red Blade (*Palmaria or Membranoptera*)	0.28	0.58	1.2	0.6	0	0			0.43	0.45	
Red Coralline Crust	0.2	0.5	0	0	0	0			0.35	0	
Irish moss *(Chondrus crispus)*	2	11.09	0	0	0	0			6.545	0	
Unid filamentous reds	8	47.59	0	0	1.6	1.07			27.795	0.6675	
Green Algae											
Branching green (*Codium sp.)* drift	0.1	0.1	0	0	0	0.1			0.1	0.025	
Unid filamentous greens	0.09	0	0	0	0	0			0.045	0	
Invertebrates											
Tufted or bushy bryozoan (*Bugula / Crisularia turrita*)	0.1	7.98	0	0.5	3.18	0.39			4.04	1.0175	
Palmate sponge (*Isodictya sp*.)	0	0	0	1	0	0			0	0.25	
Sheath tunicate (*Botrylloides violaceus*)	0	0	0.18	3.9	0.5	0.3			0	1.22	
Northern Rock Barnacle (*Balanus balanoides*)	0	0	0	0.1	0	0.1			0	0.05	
Yellow Sponge (*Cliona celata*)	0.3	0.5	0	1	0	0.28			0.4	0.32	

Season / Year	**Summer/Fall 2021**										
Location	Natural Rock Reef (RR)		Artificial Reef (AR)				Bare Control (BC)		RR	AR	BC
Transect (bearing)	1 (0)	2 (100)	1 (80)	2 (135)	3 (230)	4 (300)	1 (90)	2 (180)	Avg Ct / transect		
Brown Algae											
Knotted wrack (*Ascophyllum nodosum*)	0	0.1	0	0	0	0			0.05	0	
Unid filamentous browns	0.18	0.19	4.79	9.3	0.79	0			0.185	3.72	
Red Algae											
Red Filamentous/Foliose	0.18	2.89	0	1.1	0	4.09			1.535	1.2975	
Red Blade (*Palmaria* or *Membranoptera*)	0	0	0	0.18	0	0.1			0	0.07	
Irish moss *(Chondrus crispus)*	0.1	0.1	0	0	0	0			0.1	0	
Unid filamentous reds	1.1	6.69	20.89	11.88	7.37	0			3.895	10.035	
Green Algae											
Branching green (*Codium sp.)* drift	0.09	0.47	0	0	0	0			0.28	0	
Invertebrates											
Tufted or bushy bryozoan (*Bugula / Crisularia turrita*)	3.8	14.89	0	0	0.1	5.09			9.345	1.2975	
Crumb Bread Sponge (*Halichondria sp.*)	0	0.1	0	0	0	0			0.05	0	
Sheath tunicate (*Botrylloides violaceus*)	0	0.1	2.29	1.77	2.59	0.48			0.05	1.7825	
Northern Rock Barnacle (*Balanus balanoides*)	0	0.18	0	0	0	0			0.09	0	
Pink-hearted hydroid *(Tubularia crocea)*	0	0	0	0.2	0	0			0	0.05	
Snotty gray tunicate (*Didemnum sp.*)	0	4.2	0	0	0	0.1			2.1	0.025	
Yellow Sponge (*Cliona celata*)	4	2.1	0	0.1	0	0.4			3.05	0.125	
Sea vase sea squirt (*Ciona intestinalis*)	0	0	0	0	0.1	0			0	0.025	

Table 8. BRUV Species Presence (preliminary)

	September 2020 BRUV Monitoring				October 2020 BRUV Monitoring 1				October 2020 BRUV Monitoring 2			
	Natural Rock Reef	Bare Sand Control	ILF Reef	Tire Reef	Natural Rock Reef	Bare Sand Control	ILF Reef	Tire Reef	Natural Rock Reef	Bare Sand Control	ILF Reef	Tire Reef
Black Sea Bass (*Centropristis striata)*	X		X	X	X		X	X	X		X	X
Juvenile Black Sea Bass (*Centropristis striata)*	X	X	X	X	X	X		X	X	X	X	
Scup (*Stenotomus chrysops*)	X	X	X	X	X	X	X	X	X	X	X	X
Juvenile Scup (*Stenotomus chrysops*)	X	X								X		
Northern Sea Robin *(Prionotus carolinus)*	X											
Summer Flounder (*Paralichthys dentatus*)	X											
Dogfish (spiny and/or smooth)		X				X						
Sand Tiger Shark *(Carcharias Taurus)*			X	X			X				X	X
Cunner (*Tautogolabrus adspersus)*					X				X			
Tautog (*Tautoga onitis*)					X		X	X	X		X	
Butterfish (*Peprilus triacanthus*)										X		
Northern Puffer *(Phoeroides maculatus)*											X	
Spider Crab (*Libinia emarginata)*						X						
Unconfirmed ID (possibly Blue Runner, Bluefish or Weakfish)						X	X			X	X	X

	Winter/Spring 2021							
	April 14 2021 Deployment 1				**April 14 2021 Deployment 2**			
	Natural Rock Reef	Bare Sand Control	ILF Reef	Tire Reef	Natural Rock Reef	Bare Sand Control	ILF Reef	Tire Reef
Cunner (*Tautogolabrus adspersus)*								X
Spider Crab (*Libinia emarginata)*	X						X	X
American Lobster (*Homarus americanus*)							X	
Notes		Dense algae limited visibility				Video did not record		

	Summer/Fall 2021							
	May 26 2021 Deployment 1				May 26 2021 Deployment 2			
	Natural Rock Reef	Bare Sand Control	ILF Reef	Tire Reef	Natural Rock Reef	Bare Sand Control	ILF Reef	Tire Reef
Black Sea Bass (*Centropristis striata)*		X	X		X	X	X	X
Scup (*Stenotomus chrysops*)		X	X	X	X	X	X	X
Spider Crab (*Libinia emarginata)*						X		
Sea Robin (*Prionotus carolinus*)								X
Notes	Video did not record							

	Summer/Fall 2021							
	August 10 2021 Deployment 1				August 10 2021 Deployment 2			
	Natural Rock Reef	Bare Sand Control	ILF Reef	Tire Reef	Natural Rock Reef	Bare Sand Control	ILF Reef	Tire Reef
Black Sea Bass (*Centropristis striata)*	X	X	X	X	X	X	X	X
Juvenile Black Sea Bass (*Centropristis striata)*			X		X	X	X	X
Scup (*Stenotomus chrysops*)	X	X	X	X	X	X	X	X
Tautog (*Tautoga onitis*)			X					
Summer Flounder (*Paralichthys dentatus*)					X	X	X	
Dogfish (spiny and/or smooth)		X		X		X		
Sand Tiger Shark *(Carcharias Taurus)*			X				X	X
Cunner (*Tautogolabrus adspersus)*								X
Spider Crab (*Libinia emarginata)*		X				X		
Grey Trigger Fish (*Balistes capriscus*)	X							
Butterfish (*Peprilus triacanthus*)							X	
Rough tail Stingray (*Dasyatis centroura*)						X		
Bluefish (*Pomatomus saltatrix*)						X		
Banded Rudderfish (*Seriola zonata*)		X						
Notes					BRUV unit flipped onto side			