Massachusetts Department of Fish and Game

In-Lieu Fee Program

Marine Habitat Enhancement, Yarmouth MA Artificial Reef (IL05) 2022 Annual Report

Implemented by the Division of Marine Fisheries

DFG ILF Project Number: ILF4-CSTL-IL05
Army Corp Permit #: NAE - 2012 - 00311
issued May 8, 2014

Prepared by:

M. Rousseau and K. Frew

Submitted to:

The Massachusetts In Lieu Fee Program

Administered by the Department of Fish and Game

Dan McKiernan, Director

Submitted February 2, 2023

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.

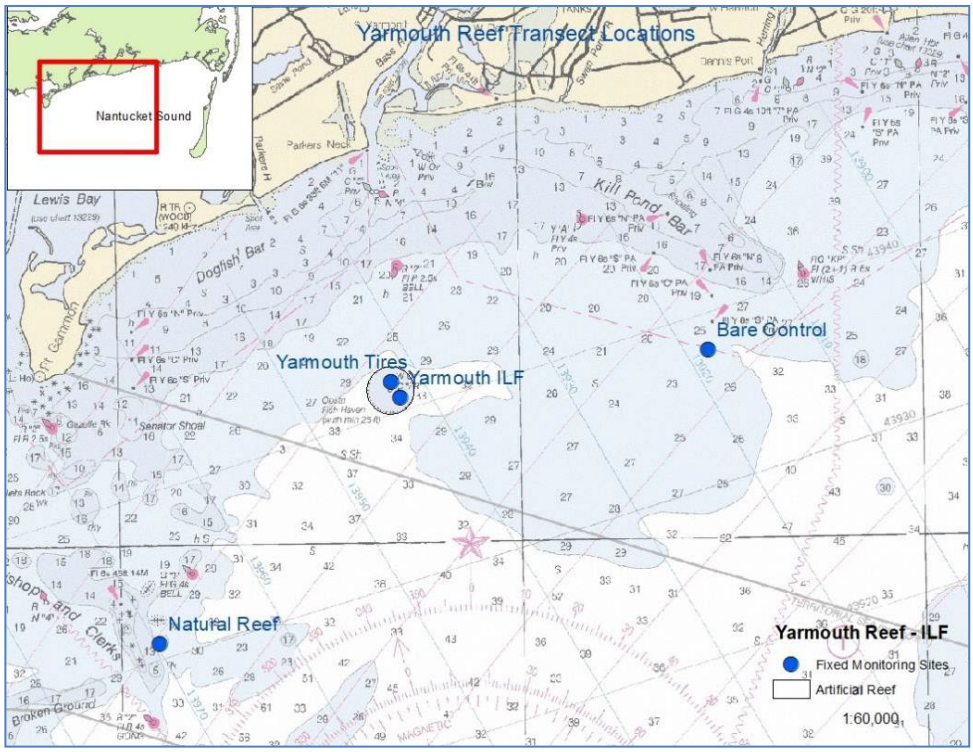

Figure 1. Location of Artificial Reef and Monitoring Stations.

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.

Table1. Monitoring Schedule

		Pre-Deploy	Year 0 (2020)		Year 1 (2021)		Year 2 (2022)		Year 3 (2023)		Year 4 (2024)	Year 5 (2025)
			May-Oct	Nov-Apr	May-Oct	Nov-Apr	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	**10/6/2009**	**9/24/2020**	**3/22/2021**	**8/26/2021**	**x**	**8/3/2022 10/11/2022**	**x**	**x**	**x**	**x**	**x**
	natural bare		**9/24/2020**		**8/26/2021**		**8/3/2022**		x		x	x
	artificial reef	**10/6/2009**	**7/1/2020**	**1/14/2021 3/22/2021**	**5/18/2021 8/26/2021 (to complete May Sampling)**	**x**	**5/20/2022 10/112022**	**x**	**x**	**x**	**x**	**x**
Camera/ Video survey (BRUV)		**y**	**9/1/2020 10/2/2020**		**4/14/2021 5/27/2021 8/10/2021**		**6/2/2022 7/29/2022**		**x**		**x**	**x**
Side scan survey		**11/5/2019**	**1/23/2020**									**x**
Temp / acoustics			**6/3/2020**		**5/18/2021**		**5/20/2022**		**x**		**x**	**x**
x - Proposed												
Completed												
Additional												
y- see Harrison, Simonetta & Rousseau, Mark. (2020). Comparison of Artificial and Natural Reef Productivity in Nantucket Sound, MA, USA. Estuaries and Coasts. 43. 10.1007/s12237-020-0749-6.												

Table 2. Status of Data Collection

	Ecological Performance: Diversity (species presence / richness)			Ecological Performance: Production (Size / age class / % cover similarity)		Status of Collected Data 12/2022
	Mobile	Sessile		Mobile	Sessile	
Diver Survey	X[1]	X[1]		X	X[1]	processed
BRUV	X			X[1]		in processing
Remote Acoustic	X					Ongoing –, 1 data dump per year. 2020 – 2022 data is in processing
[1] primary data source for analysis						

Monitoring

Monitoring data is collected by DMF staff in accordance with a monitoring schedule (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 during the off-season between November and April for three of the five years of monitoring. The monitoring schedule covers a five-year period post deployment, from 2020-2025. Monitoring data summarized in this report includes all data collected through 2022, year two of a five-year monitoring plan.

In 2022, there were three SCUBA monitoring field days: May 20, August 3, and October 11, accounting for the Year 2 (2022) May-Oct sampling period. 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-2023. SCUBA transect data collection occurred at the artificial reef (5/20, 10/11) the natural rocky reef (8/3, 10/11) and bare sandy (8/3) sites.

Additionally, three BRUV deployments occurred in 2022 over two sampling events on June 2 and July 29. BRUV survey data collected in 2022 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.

We were unable to conduct sampling during the Year 1 (2021) Nov-Apr period. Weather was a significant factor, coupled with agency-wide staffing and equipment shortages. Sampling in the Nov-Apr period was proposed for the first three (year 0-2) of five seasons of monitoring. To address this data gap, we intend on continuing sampling the Nov-Apr period until we have three complete years of Nov-Apr data. Ideally, we will complete the Nov-Apr data collection in 2023 (Year 3). Table 1 has been updated to reflect this change. This adjustment is not expected to impact the duration of the sampling schedule or the approved project budget.

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 SOPs for the ILF-funded deployment in 2020.*

Preliminary Results

2022 monitoring was partially completed in accordance with the monitoring schedule (Table 1) and will continue through 2025. 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 2022, UVC surveys observed 28 unique species on the reef site compared to 26 species at the rocky reef site and 6 species at the bare sand site. The total number of unique species increased from 2020 and 2021; however, the number of finfish species observed exhibits some variability across years. We believe some of this may be explained by temporal differences in species presence within the May- Oct sampling period. UVC transect surveys have required multiple trips to Nantucket Sound to complete. In 2021, May-Oct transect sampling was initiated on May 18 and completed on August 26 (100 days between start and finish dates). In 2022, transect sampling was initiated on May 20 and completed on October 11 (146 days between start and finish dates. Natural sites sampled in August). To address this, we have modified our approach to transect sampling for 2023 and beyond by targeting smaller windows (2-3 weeks) to complete all transect sampling across all sites and by utilizing multiple teams of divers per trip.

Overall, unique sessile species (macroalgae and macroinvertebrate) increased in 2022, with the number of macroalgae species doubling at the artificial reef site from 2021 to 2022. This was an expected outcome as the reef continues to undergo a period of successional colonization through the third growing season. BRUV footage analyses identified at least three unique finfish species (northern kingfish, dogfish sp. (smooth or spiney) and sand tiger shark) and one unique macroinvertebrate (lady crab not identified in UVC surveys). Mobile species data is summarized in Table 6 and 6a. Sessile species data is summarized in Table 7and 7a.

Size class distribution – BRUV survey data collected since 2020 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. 2022 UVC & BRUV Species Summary Tables

UVC Species Summary		2020 Transects			2021 Transects			2022 Transects		
		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	21	20	5	26	28	6
Mobile Species		10	10	6	6	7	5	8	11	6
	Finfish	7	6	2	4	4	2	6	5	3
	Macro Invertebrates	0	4	3	2	3	3	2	6	3
Sessile Species		9	4		15	13		18	17	
	Macroalgae	7	2		9	5		11	10	
	Macro Invertebrates	2	2		6	8		7	7	

BRUV Species Summary		2020 BRUV (Preliminary)			2021 BRUV (Preliminary)			2022 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
Total # of Species		6	5	5	5	8	8	4	5	8
	Finfish	6	5	4	4	6	7	4	5	6
	Macro Invertebrates	0	0	1	1	2	1	0	0	2

Figure 2. Still images taken from 2022 BRUV footage. Top Left: dogfish at Bare Sand Control Site. Top Right: black sea bass and scup at Natural Rock Reef. Bottom Left: scup and black sea bass at Yarmouth ILF site. Bottom Right: black sea bass at ILF site. (Note poor visibility in some photos).

CY2021 Budget Update

In calendar year 2022, the ILF Yarmouth reef project (IL05) expended $598.10 in dive pay (including indirect and payroll) for monitoring. A breakdown of the expenses to date is summarized in Table 4. There were no expenses charged for field supplies, travel, or gear maintenance in 2022. The remaining project balance is $19,714.

Table 4. Budget summary table.

Line Item	Approved 5-Year Budget	CY2019 Expenses	CY 2020 Expenses	CY 2021 Expenses	CY 2022 Expenses	Total Expenditures	Remaining Balance
SCUBA air tank fills	$2,160	$800	$0	$0	$0	$800	$1,360
Boat fuel and maintenance[1]	$15,500	$1,174	$82	$0	$0	$1,256	$14,244
Monitoring supplies [2]	$14,500	$4,611	$0	$0	$0	$4,611	$9,889
Vehicle travel and lodging	$2,750	$0	$0	$0	$0	$0	$2,750
Material Deployment Contract	$230,000	$0	$246,277	$0	$0	$246,277	($16,277)
Dive pay	$10,187	$0	$652.57	$1,187.82	$598.10	$2,438	$7,749
Total	**$275,097**	**$6,586**	**$247,012**	**$1,188**	**$598**	**$255,383**	**$19,714**

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

This is the third year of the ILF Yarmouth Artificial Reef Habitat Enhancement Project, including three seasons of the five-year post-deployment ecological performance monitoring assessing species diversity and production. Three distinct methods, acoustics, BRUV, and UVC transect surveys are utilized to collect data for assessing performance for credit release. Acoustic data using remotely deployed receivers continues to be collected, although data has not been processed. BRUV image and video data has been used to document species presence. To date, seven field days have been utilized to collect BRUV data post deployment. Assessment of BRUV data for age / size class similarities will require several more sampling events before a full analysis can be conducted. UVC survey is the primary data collection method for assessing species diversity and % similarity (production) of sessile species. To date, nine field days have been utilized for post deployment UVC surveys. A total of eight transects (2 at natural bare, 2 at natural reef, 4 at artificial reef) are sampled May-Oct, and six transects (natural and artificial reefs) are sampled

Nov-Apr. Completing all transects within a sampling period requires 2-3 field days using one team of divers. A preliminary assessment of 2021 and 2022 UVC data identified potentially significant temporal gaps between initiation and completion of data collection within the May-Oct season (100 days in 2021 and 146 days in 2022). To address this, we will target smaller intervals between sampling events (2-3 weeks) and, where practicable, utilize multiple teams of divers per trip.

Due to difficulties with weather and equipment availability, DMF was unable to complete UVC transect survey sampling for Year 1 (2021) Nov-Apr monitoring period in CY 2022. To account for this, we will extend our winter sampling effort into 2023.

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 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 $598 was expended in 2022, well below the proposed 2022 project budget of $4122.

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

We appreciate all those who assisted in the field and reviewed this draft, especially Steven Voss, Vin Malkoski, Forest Schenck, Dave Chosid, Kevin Creighton, Iris Seto, Ross Kessler and Alex Boeri from DMF. Thanks to Aisling O'Shea and Elisabeth Cianciola for draft edits and budget assistance. Thanks also to the Town of Yarmouth Department of Natural Resources and the Cape Cod Salties for their continued project support.

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 (Summer / Fall)

	Date	5/20/2022				8/3/2022		8/3/2022		10/11/2022				10/11/2022				
	Location	Artificial Reef (AR)				Natural Rock Reef (RR)		Bare Control (BC)		Artificial Reef (AR)				Natural Rock Reef (RR)		AR	RR	BC
	Transect (Bearing)	1 (80)	2 (135)	3 (230)	4 (300)	1 (0)	2 (260)	1 (0)	2 (180)	1 (80)	2 (135)	3 (230)	4 (300)	1 (0)	2 (260)	Average Ct / transect		
Arthropods	Spider/dec. crab Family Majidae (*Libina/Hyas*)	0	0	0	0	0	0	7	4	0	0	0	0	0	0	0	0	5.5
	Large hermit crabs (*Pagarus sp.*)	1	0	0	0	0	0	0	3	0	0	0	0	0	0	0.125	0	1.5
	Mud crab Family Panopeidae	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0.25	0
	Horseshoe Crab (Limulus polyphemus)	1	2	2	0	0	0	0	0	5	1	1	2	0	0	1.75	0	0
Cnidarian/ Tunicates	Frilled anemone (*Metridium senile*)	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0.125	0	0
	Northern cerianthid (*Cerianthus borealis*)	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0.125	0	0
Gastropods	Northern moon snail (Euspira *heros*)	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0.125	0	0
	Channeled whelk (*Busycotypus canaliculatus*)	0	0	0	0	0	0	2	3	0	0	0	0	0	0	0	0	2.5
Sponges	Yellow Sponge (*Cliona celata*)	0	0	0	0	12	26	0	0	0	1	3	3	0	2	0.875	10	0
Fish	Scup (*Stenotomus chrysops*)	0	0	0	0	0	0	0	0	7	6	37	4	3	2	6.75	1.25	0
	Juvenile Scup	0	0	0	0	185	60	200	0	0	0	0	0	0	0	0	61.25	100
	Cunner (*Tautogolabrus adspersus*) Estimate	8	92	28	9	3	13	0	0	50	76	2	38	2	53	37.875	17.75	0
	Summer flounder (*Paralichthys dentatus*)	0	0	0	0	0	3	1	0	0	0	0	0	0	0	0	0.75	0.5
	Black sea bass (*Centropristis striata*)	12	25	10	18	8	6	0	0	24	39	71	48	0	6	30.875	5	0
	Juvenile Black sea bass	0	0	4	0	223	453	312	642	185	197	118	158	21	123	82.75	205	477
	Tautog (*Tautoga onitis*)	11	4	4	3	4	0	0	0	0	21	17	28	0	3	11	1.75	0
	Juvenile Tautog	0	0	0	0	2	1	0	0	16	66	28	13	0	1	15.375	1	0
	Northern Sea Robin (*Prionotus carolinus*)	1	0	0	0	1	0	0	0	1	0	0	0	0	0	0.25	0.25	0
Notes										HS crabs may just be molts				Did not finish monitoring transect 0; transect tape moved due to current				

Table 6a. Mobile Species Monitoring (Winter/Spring)

	Season/Year	**Winter/Spring 2021**							
	Location	Natural Rock Reef (RR)		Artificial Reef (AR)				RR	AR
	Transect (Bearing)	1 (0)	2 (260)	1 (80)	2 (135)	3 (230)	4 (300)	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
	Nudibranch	0	14	0	0	0	0	7	0

Table 7. Sessile Species Monitoring (Summer / Fall)

Date	5/20/2022				8/3/2022		10/11/2022						Average all	
Location	Artificial Reef (AR)				Natural Rock Reef (RR)		Artificial Reef (AR)				Natural Rock Reef (RR)		AR	RR
Transect (bearing)	1 (80)	2 (135)	3 (230)	4 (300)	1 (0)	2 (260)	1 (80)	2 (135)	3 (230)	4 (300)	1 (0)	2 (260)		
Brown Algae														
Knotted wrack *(Ascophyllum nodosum)*	0	0	0	0	0.1	3.1	0	0	0	0	0	0	0	0.821
Brown seaweed/kelp (Sargassum filipendula)	0	0	0	0	0	0	0	0.5	0.5	0	0	2.99	0.125	0.69
Unid filamentous browns	0.5	1	6.1	0	0.5	0	0.09	0.09	0.18	0.18	0	0.1	1.018	0.151
Red Algae														
Red Filamentous/ Foliose	3.3	4.1	0	3.3	6.69	28.5	0	0	0	0	3	20	1.338	14.408
Red Blade (*Palmaria or Membranoptera)*	0	0	0	0	2.6	1.6	0.1	0.09	0	0.79	1	0.78	0.123	1.513
Red Coralline Crust (*Lithothamnion sp.*)	0.5	0.7	2.2	1.1	0	1	0	0	0	0	0	0	0.563	0.256
Irish moss *(Chondrus crispus)*	0.5	0	0	0	0	0	0	0	0	0	8	0	0.063	2.051
Red seaweed (*Porphyra sp.)*	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0.026
Sea moss (*Gracilaria sp.*)	0	0	0	0	0	1	0	0	0	0	0	0.56	0	0.385
Unid filamentous reds	0	0	0.5	0	0	0	0	0.09	0.37	0.36	0.09	0.1	0.165	0.046
Green Algae														
Sea Lettuce *(Ulva lactuca)*	0.5	0.7	0.1	0	0	0	0.1	0.09	0.28	0.09	0	0	0.233	0
Branching green *(Codium sp.)* drift	0.2	0.2	0	0.1	2	1.8	2.38	1.37	1.17	0.99	0.8	1.31	0.801	1.482
Unid filamentous greens	0	0	0	0	0	0	2.78	0	0	0	0	0	0.316	0
Invertebrates														
Tufted or bushy bryozoan *(Bugula or C. turrita)*	1.6	0.5	14	6.8	15.6	27.2	0.2	1.49	0.47	5.1	11	11	3.77	16.333
Palmate sponge *(Isodictya sp.)*	0	0	0	0	0	0	0	0	0	0	0	0.56	0	0.128
Sheath tunicate (*Botrylloides violaceus*)	0	0	0	0	0.3	3.1	0.09	0.6	0.09	0.66	0.19	0.21	0.18	0.969
Star tunicate *(Botryllus schlosseri)*	0	0	0	0	0	0	0	0	0	0.1	0	0	0.013	0
Northern Rock Barnacle (*Balanus balanoides*)	0.1	0	0	0.1	0	0	0	0	0	0	0	0	0.025	0
Pink-hearted hydroid *(Tubularia crocea)*	0	0	1.5	0	0	0	0	0	0	0	0	0	0.188	0
Snotty gray tunicate *(Didemnum sp.)*	0	0	0	0	0	0	0	0	0	0	0.18	0	0	0.046
Yellow sponge *(Cliona celata)*	0	0	0.5	0.2	1.5	0	0	0	0	0.5	0	0.67	0.15	0.538
Blue mussel (*Mytilus edulis*)	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0.026
Northern cup coral (*Astrangia poculata*)	0	0	0	0	0.5	3.5	0	0	0	0.2	0.5	0.89	0.025	1.359
Notes											Heading off due to current	Did not do Q1 left		

Table 7a. Sessile Species Monitoring (Winter / Spring)

	Season / Year	**Winter/Spring 2021**							
	Location	Natural Rock Reef (RR)		Artificial Reef (AR)				RR	AR
	Transect (bearing)	1 (0)	2 (260)	1 (80)	2 (135)	3 (230)	4 (300)	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

Table 8. BRUV species presence table

	June 2, 2022 Deployment 1			June 2, 2022 Deployment 2			July 29, 2022 Deployment 1			Totals		
	Rocky Reef Site	ILF Reef Site	Bare Sand Site	Rocky Reef Site	ILF Reef Site	Bare Sand Site	Rocky Reef Site	ILF Reef Site 2022**	Bare Sand Site	Rocky Reef Site	ILF Reef Site	Bare Sand Site
Black Sea Bass (*Centropristis striata)*	X	X	X	X	X	X	X	X	X	X	X	X
Juvenile Black Sea Bass (*Centropristis striata)*							X	X	X	X	X	X
Scup (*Stenotomus chrysops*)	X	X	X	X	X	X	X	X	X	X	X	X
Juvenile Scup							X			X		
Tautog (*Tautoga onitis*)												
Summer Flounder (*Paralichthys dentatus*)								X			X	
Dogfish (spiny and/or smooth)									X			X
Sand Tiger Shark *(Carcharias Taurus)*				X		X				X		X
Cunner (*Tautogolabrus adspersus)*		X			X						X	
Spider Crab (*Libinia emarginata)*			X			X			X			X
Sea Robin (*Prionotus carolinus*)	X		X			X				X		X
Northern Kingfish (*Menticirrhus saxatilis*)					X	X					X	X
Lady Crab (*Ovalipes ocellatus*)						X						X

Table 9. Mobile Species Annual Summary Table (by calendar year)

Year	2020 Average All			2021 Average All			2022 Average All		
Site	AR	RR	BC	AR	RR	BC	AR	RR	BC
American lobster (*Homarus americanus*)	0.25	0	0	0	0	0	0	0	0
Spider/dec. crab Family Majidae (*Libina/Hyas*)	0	0	1	0	0	1	0	0	5.5
Large hermit crabs (*Pagarus sp.*)	0.25	0	2.5	1.25	1.25	0	0.125	0	1.5
Lady Crab (*Ovalipes ocellatus*)	0.25	0	0	0	0	0	0	0	0
Frilled anemone (*Metridium senile*)	0.25	0	0	0	0	0	0.125	0	0
Northern cerianthid (*Cerianthus borealis*)	0	0	0	0	0	0	0.125	0	0
Northern moon snail (Euspira *heros*)	0	0	0	0.5	0	0	0.125	0	0
Common/waved whelk (*Buccinum undatum*)	0	0	0	0.25	0	0.5	0	0	0
Channeled whelk (*Busycotypus canaliculatus*)	0	0	0	0	0	0.5	0	0	2.5
Scup (*Stenotomus chrysops*)	15.25	7	0	0.125	18.5	4.5	6.75	1.25	0
Juvenile Scup	0	24	100	15	91.25	0	0	61.25	100
Cunner (*Tautogolabrus adspersus*) **Estimate**	12	149	0	5.375	6	0	37.875	17.75	0
Shorthorn, grubby & longhorn (*Myoxocephalus sp.*)	0	1	0	0	0	0	0	0	0
Summer flounder (*Paralichthys dentatus*)	0.75	0.5	0	0	0	0	0	0.75	0.5
Black sea bass (*Centropristis striata*)	14.5	88	1.5	4.625	2.25	0	30.875	5	0
Juvenile Black sea bass	0	106	100	32.875	67.75	782.5	82.75	205	477
Tautog (*Tautoga onitis*)	9.75	4.5	0	4	0	0	11	1.75	0
Juvenile Tautog (*Tautoga onitis*)	0	2.5	0	0.25	0.25	0	15.375	1	0
Northern Sea Robin (*Prionotus carolinus*)	0.5	0.5	0	0	0	0	0.25	0.25	0
Yellow Sponge (*Cliona celata*)	2.75	0	0	2.25	6.5	0	0.875	10	0
Horseshoe Crab (*Limulus polyphemus*)	0	0	0	0	0	0	1.75	0	0
Mud crab (Family Panopeidae)	0	0	0	0	0	0	0	0.25	0
Blood cockle (*Tegillarca granosa*)	0	0	0	0.125	0	0	0	0	0
Nudibranch sp.	0	0	0	0	3.5	0	0	0	0

Table 10. Sessile Species Annual Summary Table (by calendar year)

Year	2020 Average		2021 Average		2022 Average	
Site	AR	RR	AR	RR	AR	RR
Brown Algae						
Knotted wrack (*Ascophyllum nodosum*)	0	0.15	0.063	0.075	0	0.821
Brown seaweed/kelp (*Sargassum filipendula*)	0	0	0	0	0.125	0.690
Unid filamentous browns	0.245	0.225	1.923	0.263	1.018	0.151
Red Algae						
Red filamentous/foliose	0.623	3.18	2.32	2.868	1.338	14.408
Red blade (*Palmaria or Membranoptera)*	0	0.975	0.26	0.215	0.123	1.513
Red coralline crust (*Lithothamnion sp.*)	0	0	0.125	0.175	0.563	0.256
Irish moss (*Chondrus crispus)*	0	0	0	3.323	0.063	2.051
Red seaweed (*Porphyra sp.*)	0	0	0	0	0	0.026
Sea moss (*Gracilaria sp.*)	0	0	0	0	0	0.385
Unid filamentous reds	0	1.24	5.526	16.345	0.165	0.046
Green Algae						
Sea lettuce (*Ulva lactuca*)	0	0	0	0	0.233	0
Branching green (*Codium sp.*) drift	0	1.19	0.013	0.19	0.801	1.482
Unid filamentous greens	0	0.045	0.063	0.023	0.316	0
Invertebrates						
Tufted or bushy bryozoan (*Bugula or C. turrita*)	0	28.095	1.283	6.693	3.77	16.333
Palmate sponge *(Isodictya sp.)*	0	0	0	0	0	0.128
Crumb bread sponge (*Halichondria sp.*)	0	0	0	0.025	0	0
Sheath tunicate (*Botrylloides violaceus*)	0	0	1.513	0.025	0.18	0.969
Star tunicate *(Botryllus schlosseri*)	0	0	0	0	0.013	0
Northern Rock Barnacle (*Balanus balanoides*)	3.9	0	0	0.045	0.025	0
Pink-hearted hydroid *(Tubularia crocea*)	0	0	0.025	0	0.188	0
Snotty gray tunicate (*Didemnum sp.*)	0	0	0.013	1.05	0	0.046
Yellow sponge (*Cliona celata*)	0.825	0.4	0.223	1.725	0.15	0.538
Yellow sea squirt (*Ciona Intestinalis)*	0	0	0.013	0	0	0
Blue mussel (*Mytilus edulis*)	0	0	0	0	0	0.026
Northern cup coral (*Astrangia poculata*)	0	0	0	0	0.025	1.359
*Highlighted cells note species that had a new or increased presence in 2022.						