Marine Underwater Benthic Habitat Survey

Auld's Cove, Nova Scotia

151248.00 ● Final Report ● January 2016

ISO 9001
Registered Company

Prepared for:
Nova Scotia Power Incorporated

Prepared by:
CBCL LIMITED
Consulting Engineers

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January 6, 2016

Mr. Glenn Goudey
Senior Environmental Scientist
Nova Scotia Power
1223 Lower Water Street
Halifax NS B3J 3S8

Dear Mr. Goudey:

RE: Final Underwater Benthic Habitat Survey

CBCL limited is pleased to provide Nova Scotia Power with the Final Underwater Benthic Habitat Survey that was undertaken near Auld's Cove, Nova Scotia. The survey has been conducted to characterize the fisheries habitat located at the proposed transmission tower location in Auld's Cove, NS.

The survey was completed on November 10th, 2015. The information was used to classify habitat types, habitat quality and habitat functionality in relation to CRA fisheries for the DAS.

Yours very truly,

CBCL Limited

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CHAPTER 1 INTRODUCTION

1.1 Project Background

Nova Scotia Power Incorporated (NSPI) is planning to construct a steel lattice transmission tower adjacent to an existing transmission tower situated on the barrier beach at Auld's Cove, Guysborough County, Nova Scotia (Figure 1). CBCL Limited was engaged by NSPI to conduct an underwater benthic habitat survey of the nearshore area immediately south of the existing transmission tower on both the exposed shoreline adjacent to the Strait of Canso and the sheltered shoreline adjacent to Archie Pond. These study areas represent the maximum estimated infill area for the new transmission tower, should it be necessary. The underwater survey of benthic habitat consisted of 20 spot checks and one transect line filmed using an underwater drop camera.

1.2 Scope of Report

This report presents the results of 20 drop camera spot checks and one video transect survey. The underwater benthic habitat survey was conducted to characterize benthic substrates, macroflora and macrofauna. A review of commercial, recreational and Aboriginal (CRA) fisheries that could occur within the project study area, or within proximity of the study area, was also conducted. Additionally, a comprehensive functional assessment of the observed benthic habitats that could support the identified CRA fisheries was performed.

1.3 Project Location

The spot checks and survey transect were completed within two 50 x 50 m study areas provided by Nova Scotia Power Inc. (Figure 1). These study areas are located adjacent to the existing transmission tower on both the sheltered and exposed sides of the barrier beach. One area was located on the inside of Archie Pond and was accessed using a small boat launched at The Cove Motel. The second area was located in the Strait of Canso (outer study area) and was accessed via a shallow channel that ran out of Archie Pond and connected to the Strait of Canso (see Figure 1).

Spot Check Locations with Depth in Meters

UBHS Transect Line

50m Buffer

Habitat Types

Fines Dominant Habitat

Mixed Substrate Habitat

Rocky Intertidal Habitat

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Auld's Cove Transmission Tower

Figure 1:
Underwater Benthic Habitat Survey

Drawn: MD	Date: 09/12/2015
Checked: IB	-
Approved: IB	Scale @ 11"x17" 1:1,000

Notes:

0 10 20 40 m

Coordinate System: NAD 1983 CSRS UTM Zone 20N
Units: Meter

CHAPTER 2 METHODOLOGY

The survey methodology implemented for this project was developed to characterize the benthic habitat and its functionality in relation to CRA fisheries within the Auld's Cove survey locations. The following section details the survey methodology utilized.

2.1 Fisheries Habitat Survey Plan

The survey was conducted on November 10th, 2015 by CBCL Limited personnel and a sub-contracted boat operator (CDMS Atlantic – formerly Scuba Tech Limited). The CBCL Limited observer on site used a handheld GPS unit (Garmin 76CSx) to ensure that the correct survey locations were videoed and recorded any deviations from the proposed survey design (Tables 2.1 & 2.2). The location of the drop camera spot checks and the linear transect are depicted in Figure 1.

2.2 Underwater Video Spot Checks

Video spot checks were completed in 20 predetermined locations (Table 2.1). Twelve of these locations were within Archie Pond along the sheltered shoreline of the barrier beach, and the remaining eight were located along the exposed shoreline in the Strait of Canso (Figure 1). A video of the sea floor was taken at the select location by completing a 360° video pan of the surrounding area.

Table 2.1: Geographical coordinates for the surveyed spot check locations (Datum: WGS 1984)

Spot Checks	*Surveyed Spot Check Locations*	
	LAT	*LONG*
SC1	45.653285	-61.437805
SC2	45.653197	-61.437790
SC3	45.653132	-61.437633
SC4	45.653022	-61.437472
SC5	45.653050	-61.437271
SC6	45.653184	-61.437431
SC7	45.653261	-61.437521
SC8	45.653337	-61.437634
SC9	45.653389	-61.437401
SC10	45.653337	-61.437313

Spot Checks	*Surveyed Spot Check Locations*	
	LAT	*LONG*
SC11	45.653236	-61.437162
SC12	45.653104	-61.437082
SC13	45.653784	-61.436250
SC14	45.653669	-61.436138
SC15	45.653607	-61.436061
SC16	45.653505	-61.435987
SC17	45.653418	-61.436221
SC18	45.653538	-61.436269
SC19	45.653641	-61.436316
SC20	45.653778	-61.436399

2.3 Underwater Video Transect

Initially, there were four spot check locations proposed near the shoreline in the Strait of Canso (i.e., spot check locations 21 through 24). However, these spot check locations were too shallow for the survey boat to safely navigate. It was determined in the field that CBCL personnel would record a linear transect video on foot through these spot check locations using the drop camera (Figure 1). In total, a 50 m long linear transect was delineated in the exposed Strait of Canso study area (Table 2.2).

Table 2.2: Geographical coordinates for the surveyed transect start and end points (Datum: WGS 1984)

Transect	*Surveyed Start Point*		*Surveyed End Point*	
	LAT	***LONG***	***LAT***	***LONG***
T1	45.653700	-61.436675	45.653350	-61.436380

2.4 Habitat Classification and Function

During the review of the underwater video, habitats were identified and categorized based on substrate type, flora and fauna. Substrate types were approximated visually using the following Wentworth scale (Wentworth, 1922):

- Boulder: > 256 mm;
- Cobble: 64-256 mm;
- Gravel: 2-64 mm; and
- Fines: < 2 mm.

Marine macroflora and macrofauna species abundance was assessed based on a semi-quantitative scale and on the professional judgement of CBCL biologists. The classifications included:

- Abundant (A) : Numerous (not quantifiable) observations;
- Common (C): Frequent (not quantifiable) observations;
- Occasional (O): Intermittent (quantifiable) observations; and
- Uncommon (U): Infrequent (quantifiable) observations.

Habitat suitability and functionality for each habitat type identified was determined for the following lifecycles of identified or potential CRA fisheries: spawning, rearing, overwintering, adult foraging, cover and migration. Using professional judgement and information gleaned from a thorough literature review of the habitat requirements of each species, an evaluation of poor, poor-moderate, moderate, moderate-good or good was provided for each lifecycle.

CHAPTER 3 CRA FISHERIES ASSESSMENT

3.1 CRA Fisheries Assessment Approach

The proximity of the study area to St George's Bay required an investigation into the potential CRA fisheries species that may be temporally and spatially present in the study area at various stages of their lifecycles. As such, a summary of CRA fisheries and prey species that have the potential to find habitat within, or in proximity to, the Auld's Cove site was derived from the following sources:

- Personal communications with the Fisheries and Oceans (DFO) (Dwyer, Alan. pers. comm. 2015);
- A comprehensive desktop review, including a literature search; and
- Positive identification of species in the underwater benthic habitat videos.

A list of all species selected for the CRA fisheries assessment and the fish habitat functional assessment (see Chapter 5) is provided in Table 3.1.

Table 3.1: List of Selected CRA Fisheries Species

Common Name	Species Name	Inclusion Criteria
Atlantic cod	*Gadus morhua*	Recreational
White hake	*Urophycis tenuis*	Recreational
Cunner	*Tautogolabrus adspersus*	Prey species to CRA
Yellowtail flounder	*Limanda ferruginea*	Potentially observed in Study Area Commercial, Recreational
Winter flounder	*Pseudopleuronectes americanus*	Potentially observed in Study Area Commercial, Recreational
Windowpane flounder	*Scophthalmus aquosus*	Potentially observed in Study Area Commercial, Recreational
Sand shrimp	*Crangon sp.*	Observed in Study Area Prey species to CRA
Atlantic rock crab	*Cancer irroratus*	Observed in Study Area Commercial
Hermit crab	*Pagarus sp.*	Observed in Study Area Prey species to CRA
American lobster	*Homarus americanus*	Commercial, Aboriginal
Sea scallop	*Placopecten magellanicus*	Commercial, Recreational

Common Name	Species Name	Inclusion Criteria
Snow crab	*Chionoecetes opilio*	Commercial, Aboriginal
Bluefin tuna	*Thunnus thynnus*	Commercial, Recreational, Aboriginal
Mackerel	*Scomber scombrus*	Commercial, Recreational
American oyster	*Crassostrea virginica*	Observed in Study Area Commercial, Recreational
Bar clam	*Spisula solidissima*	Commercial, Recreational
Northern quahog	*Mercenaria mercenaria*	Commercial, Recreational
American eel	*Anguilla rostrata*	Commercial, Recreational, Aboriginal
Alewife	*Alosa pseudoharengus*	Commercial, Recreational
Green crab	*Carcinus maenas*	Observed in Study Area Commercial
Blue mussel	*Mytilus edulis*	Observed in Study Area Commercial, Recreational
Razor clam	*Ensis directus*	Commercial, Recreational
Atlantic salmon	*Salmo salar*	Recreational, Aboriginal
Atlantic silverside	*Menidia menidia*	Commercial
Soft shell clam	*Mya arenaria*	Commercial, Recreational
Striped bass	*Morone saxatilis*	Recreational, Aboriginal

3.2 Commercial Fisheries

Over 15 species of finfish and shellfish have the potential to be commercially harvested in the St. Georges Bay region (Dwyer, Alan, pers. comm., 2015). The commercial species that were observed in the underwater video include:

- Rock crab;
- Green crab;
- Yellowtail flounder (potential);
- Winter flounder (potential);
- Windowpane flounder (potential);
- Blue mussel; and
- American oyster.

A functional assessment of the habitat requirements of these species is provided in Chapter 5.

3.3 Recreational Fisheries

Over 15 species of finfish and shellfish have the potential to be recreationally harvested in the St. Georges Bay region (Dwyer, Alan, pers. comm., 2015). Recreationally fished species that were observed in the underwater video include:

- Yellowtail flounder (potential);
- Winter flounder (potential);
- Windowpane flounder (potential);
- Blue mussel; and

- American oyster.

A functional assessment for the habitat requirements of these species is provided in Chapter 5.

3.4 Aboriginal Fisheries

Aboriginal fisheries for American lobster, snow crab and bluefin tuna are presently ongoing in the St. Georges Bay region (Dwyer, Alan, pers. comm., 2015). Other potential species harvested by the Aboriginal fishery in the region include: Atlantic salmon, American eel and striped bass. A functional assessment of the habitat requirements of these species is provided in Chapter 5.

3.5 Fish that Support CRA Fisheries

Three species have been identified through desktop research and observations of the underwater benthic habitat videos as prey species of the above noted CRA fisheries. Shrimp (*Crangon* sp.*)* and hermit crabs *(Paguroidea* family*)* were identified in the survey. Cunner (*Tautogolabrus adspersus*), common in near-shore intertidal and subtidal areas, were identified as by-catch during commercial fishing (Canada-Nova Scotia Strait of Canso Environment Committee, 1975) and during trawl surveys of the St. Georges Bay area conducted by Fisheries and Oceans Canada (Kenchington, 1980).

CHAPTER 4 VIDEO TRANSECT INTERPRETATION

4.1 Spot Checks

The survey consisted of 12 spot checks conducted on the inside of the barrier beach surrounding Archie Pond, as well as eight spot checks and one transect conducted in the Strait of Canso on the outside of the barrier beach. The spot checks conducted inside of Archie Pond were dominated by fine substrates, comprised of sand, silt, clay and mud. This fine sediment revealed an anoxic layer just below the surface when disturbed. The substrate remained fine along the barrier beach, but an abundance of empty mollusc shells and occasional live bivalves provided a moderate measure of hard substrate. Along the Strait of Canso, the barrier beach was comprised of hard substrates. Boulders, cobbles and gravel made up the majority of the substrate in the surveyed area. Boulders and cobbles were most abundant at depths less than 3 m. At greater depths, the substrate was comprised of cobbles and gravel with lesser amounts of boulder and fine substrates (see spot check interpretations in Appendix A).

Macrofloral species identified during the interpretation of the spot check videos consisted of *Ascophyllum nodosum, Fucus sp., Chondrus crispus, Polysiphonia sp., Lithothamnium sp., Furcellaria lumbricalis and Spongomorpha sp.* Photographs of these observed species are provided in Appendix B.

Macrofauna positively identified during the interpretation of the spot checks included rock crab (*Cancer irroratus*), green crab (*Carcinus maenas*), hermit crab (*Pagurus sp.*), rock barnacle (*Balanus sp.*), periwinkle (*Littorina sp*.), northern sea star (*Asterias sp*.), sand shrimp (*Crangon sp.*), blue mussel (*Mytilus edulis*), American oyster (*Crassostrea virginica*) and slipper snail (*Crepidula sp.*). Other macrofauna that was observed, but could not be identified, is included in the summary of each spot check and in Appendix A. Photographs of some of the species observed are provided in Appendix B.

A summary of the findings of each spot check can be found in Sections 4.1.1 to 4.1.2. A breakdown of depth, substrate composition, macrofauna and macroflora for each spot check is provided in Appendix A.

4.1.1 Archie Pond

The spot checks conducted inside of Archie Pond were located along the inside of the barrier beach that separates the cove from the larger Strait of Canso (Figure 1). The outer rows of spot checks were performed in the shallow subtidal zone. The row of spot checks located nearest the beach was performed in the intertidal zone. Video analysis of these spot checks concluded that the benthic substrate inside of Archie Pond was comprised entirely of fine materials, including sand, silt, clay and mud, except along the upper intertidal zone where shell debris was also abundant. Spot checks 1 through 8 ranged between 3 - 4 m in depth and were comprised of a fine substrate devoid of any features, aside from the occasional piece of shell debris or anthropogenic input such as rubber tires and wooden debris. Spot checks 9 through 11 were near the margin of the barrier beach. At these sites, the depth ranged from 1 - 3 m and the fine substrate was heavily littered with empty blue mussel, American oyster and littorine shells. These shells were in such abundance that they provided substrate for small amounts of algae and encrusting invertebrates. At spot check 12, the substrate appeared to be comprised of a mix of gravel and fines, in addition to an abundance of shell debris.

Spongomorpha sp. was the only species of macroflora identified during the video interpretation inside Archie Pond. It was mainly found growing on rubber tires scattered throughout the study area and at one spot check (SC9) with abundant shell debris (see Appendix A).

Macrofauna identified during these twelve spot checks included green crab (*Carcinus maenas*), hermit crab (*Pagurus sp.*), northern sea star (*Asterias sp*.), sand shrimp (*Crangon sp.*), blue mussel (*Mytilus edulis*), American oyster (*Crassostrea virginica*) and slipper snail (*Crepidula sp.*). Other fish and annelid species were observed throughout the spot checks but could not be identified to species. These include two sightings of juvenile flounders that were too small to identify and one unidentified marine oligochaete (see Spot Check Interpretation Results in Appendix A for further details). Photographs of some of the species observed are provided in Appendix B.

Encrusting invertebrates observed grew both epilithically and epiphytically throughout the study area and included colonial bryozoans (*Membranipora sp.* and *Electra sp.*), colonial hydrozoans and spiral tube worms (*Spirorbis sp.*).

4.1.2 Outer Study Area (Strait of Canso)

The spot checks conducted outside of Archie Pond were located along the outer barrier beach buttressing the Strait of Canso. The two outer spot check rows were conducted in the shallow subtidal zone between 1-5 m; Transect 1, located nearest to the barrier beach, was conducted in the intertidal zone in less than 1 m of water (see Figure 1). It was determined that in the outer study area, the substrate was predominately a rocky type comprised of large and small boulders, cobbles and gravels in varying percentages. Spot check 13, the deepest site surveyed at 5 m, was the only outer site to show a predominately fine substrate type.

Species of macroflora were present throughout the outer study area and included *Ascophyllum nodosum*, *Fucus sp., Lithothamnium sp., Chondrus crispus, Furcellaria lumbricalis, Polysiphonia sp. and Spongomorpha sp*. Where boulders were found at water depths between 1-3 m, *Fucus sp*. and

Lithothamnium sp. were the most abundant macroalgae. *Ascophyllum nodosum* was the predominate algae in depths less than 1 m in the upper to mid-ranges of the intertidal zone, corresponding with the transect line. *Chondrus crispus* was most abundant in the deeper spot check locations (SC 13 through 16) compared to the other areas surveyed. Other algae noted above were observed on occasion throughout the spot checks and Transect 1 (see Appendix A). Photographs of some of the species observed are provided in Appendix B.

Macrofauna observations in the outer study area were limited to a single rock crab, northern sea star, *Balanus sp.* and *Littorina sp* (see Spot Check Interpretation Results in Appendix A for further details). *Balanus sp.* and *Littorina sp.* were found in increasingly abundant numbers as the depth and distance to shore decreased. The highest concentrations of both were recorded during Transect 1. Photographs of some of the species observed are provided in Appendix B.

Encrusting invertebrates observed grew both epilithically and epiphytically throughout the study area and included colonial bryozoans (*Membranipora sp.* and *Electra sp.*), colonial hydrozoans and spiral tube worms (*Spirorbis sp.*).

CHAPTER 5 FISH HABITAT FUNCTIONAL ASSESSMENT

5.1 Habitat Types

The following three generalized habitat types were observed within the project study area during the underwater benthic habitat video interpretation:

- Rocky intertidal habitat;
- Mixed substrate habitat; and
- Fines dominant habitat.

A description of each habitat type is provided in the sections below.

5.1.1 Rocky Intertidal Habitat

The rocky intertidal habitat type was observed along the outer study area where the barrier beach is influenced by tidal action in the Strait of Canso and larger St. George's Bay area (see Photographs 5.1 and 5.2). This habitat was mainly comprised of large and small boulders, large and small cobbles, and gravels with intermittent small patches of sandy fines. This habitat was the predominant habitat of the outer study area, extending from the cobble beach and exposed intertidal area to the lower limit of the intertidal zone and shallow subtidal zone. Spot checks 17 through 20, and parts of the transect line, were located in this habitat type. *Ascophyllum nodosum* was the most abundant algae observed during the transect line, coinciding with depths less than 1 m. At slightly deeper depths, up to 3 m, *Fucus sp.* and *Lithothamnium sp*. were the predominant algae observed. *Ascophyllum nodosum*, *Polysiphonia sp*. and *Furcellaria lumbricalis* were noted intermittently at these spot check locations (SC 17 through 20). Macrofaunal observations consisted mainly of *Littorina sp*. and *Balanus sp*. Each of these were noted in abundance. *Asterias sp.* was also observed in this area. At high tide, the rocky intertidal habitat provides an abundance of feeding opportunities for motile species including fish and crab. It is likely that a larger number of motile individuals were present in this habitat type but were not observed due to the cryptic nature of these species and the abundance of shelter provided by dense stands of *Ascophyllum nodosum*, *Fucus sp.* and other less abundant macroflora.

Photograph 5.1: Rocky intertidal habitat type.

Photograph 5.2: Rocky intertidal habitat. Note the presence of *Balanus sp., Littorina sp*. and *Ascophyllum nodosum*.

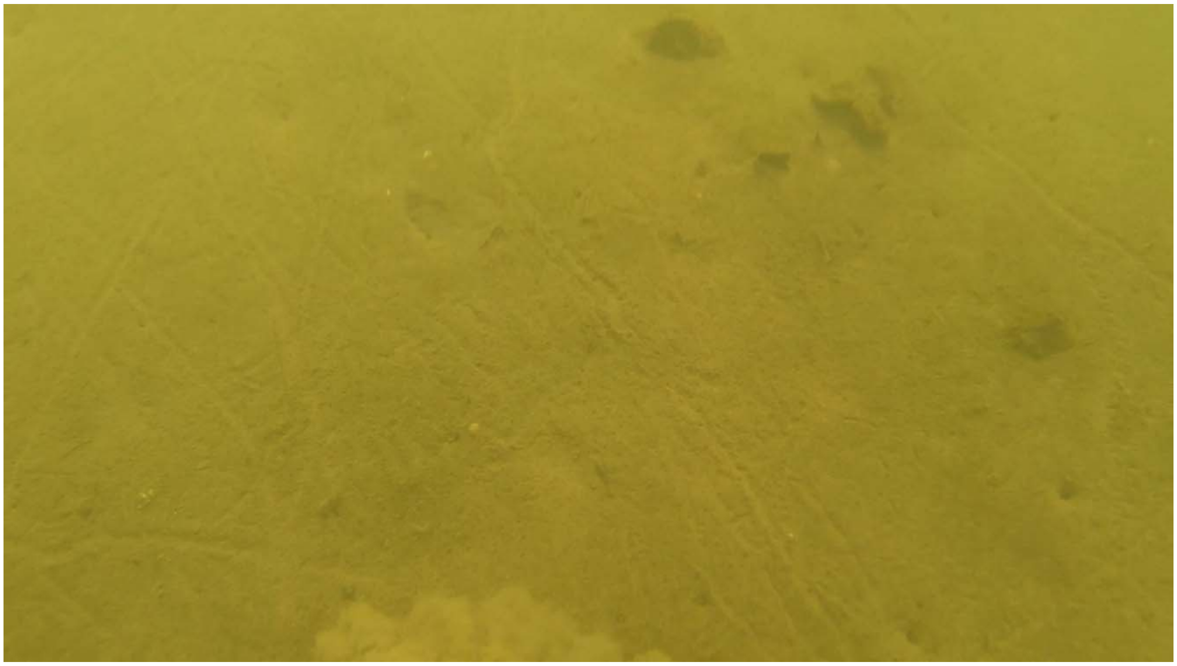
5.1.2 Mixed Substrate Habitat

The mixed substrate habitat was observed in three spot checks located in the outer study area; spot checks 14, 15 and 16 were of this habitat type and were conducted along the outermost edge of the study area approximately 50 m from the shoreline (see Appendix A). This substrate type was observed in the shallow subtidal zone and was comprised mainly of cobbles and gravels, with some protruding boulders and small patches of sandy fines (see Photograph 5.3). *Chondrus crispus* was the most abundant macroflora observed at this substrate type, but it was not always observed in abundance. Other algae observed in these areas included *Fucus sp. Lithothamnium sp.* and *Polysiphonia sp.* on exposed cobbles and small boulders. Macrofaunal observations consisted of intermittent and occasional observations of *Balanus sp.* and *Littorina sp.*, as well as a single observation of rock crab (see Appendix A). It is likely that the macrofauna observed represents a small percentage of the total macrofauna present in this habitat type. The practical restrictions of spot checks (e.g., duration and area surveyed) and the cover provided by macroalgae likely limited the number of faunal observations.

Photograph 5.3: Mixed substrate habitat type. Note the small patch of *Chondrus crispus* at centre and occasional *Littorina sp.* throughout.

5.1.3 Fines Dominant Habitat

The fines dominant habitat type was the most dominant habitat type within Archie Pond. It was observed in 11 of the 12 spot check locations within Archie Pond. A single location, spot check 12, was comprised of a mixed fine and gravel substrate. The remaining 11 spot check locations (SC 1 through SC 11) were composed entirely of fines, which appeared to be a mix of sand, silt, clay and mud (see Photograph 5.4). When this sediment was disturbed, it revealed a very shallow anoxic layer immediately beneath the oxygenated surface layer. Macrofloral observations were uncommon to occasional. *Spongomorpha sp.*, a filamentous green algae, was observed growing intermittently on shell debris in spot check 9. It was also observed growing on occasional rubber tires strewn throughout the study area. Macrofauna was observed throughout the study area but diversity was low. Hermit crab (*Pagurus sp.*) and sand shrimp (*Crangon sp.*) were the most commonly observed species at spot checks 1 through 8. Slipper snails (*Crepidula sp*.) were observed on rubber tires in the area, and an unidentified juvenile flounder was seen sheltering under the rim of one of these tires. In spot checks closest to the barrier beach (SC 9 through 12), the macrofaunal observations consisted mainly of shellfish, such as American oysters (*Crassostrea virginica*) and blue mussels (*Mytilus edulis*), as well as green crab (*Carcinus maena*), *Asterias sp.* and another unidentified juvenile flounder.



Photograph 5.4: Fines dominant habitat type. Note the Hermit crab trails throughout and the leaf litter in the upper right corner.

5.2 Habitat Functions

An assessment of the habitat function of CRA fish and fish that support a CRA fishery is detailed in Tables 5.1 (fines dominant habitat), 5.2 (mixed substrate habitat) and 5.3 (rocky intertidal habitat). The rationale for choosing the fish listed in Tables 5.1-5.3 is provided in Chapter 3. Habitat descriptions of species which received an evaluation of “good” or “moderate to good” for three or more life history events is provided in Section 5.2.2. It should be noted that spot checks were conducted at depths between 0 - 5 m, which influences the results of the habitat evaluations (Tables 5.1-5.3).

5.2.1 Habitat Utilization

The three observed habitat types serve a variety of functions for the macroflora and macrofauna observed. Below is a brief discussion of the habitat utilization by the macrofauna on record.

5.2.1.1 Fines Dominant Habitat

Fine substrate was present at each of the 12 spot checks conducted inside of Archie Pond and at one location outside of Archie Pond (SC 13). When this substrate was exposed by the impact of the drop camera, cryptic macrofauna such as sand shrimp (*Crangon* sp.) and marine oligochaete worms were disturbed and became active. Hermit crabs and juvenile flounders were also present on the fine

Table 5.1: Fines Dominant Habitat

Habitat Types	Species	Commercial, Recreational, Aboriginal	Habitat Function - Auld's Cove						References
			Spawning	Rearing	Overwintering	Adult Foraging	Cover	Migration	
Fines Dominant Habitat	American Oyster	Commercial, Recreational	Moderate-Good	Moderate-Good	n/a	Moderate-Good	n/a	n/a	Cake 1983, DFO 2003a
	American Eel	Commercial, Recreational, Aboriginal	Poor	Poor	Poor-Moderate	Poor-Moderate	Poor-Moderate	Poor-Moderate	COSEWIC 2012, Facey and Van Den Avyle 1987
	Bar Clam	Commercial, Recreational	Poor	Poor	n/a	Moderate-Good	n/a	n/a	Cargnelli et al. 1999, DFO 1996a
	Soft Shell Clam	Commercial, Recreational	Poor	Poor	n/a	Moderate-Good	n/a	n/a	Christian et al. 2010
	Atlantic Cod	Recreational	Poor-Moderate	Poor-Moderate	Poor	Moderate	Poor	Poor	COSEWIC 2010a, Fahay et al. 1999
	Hermit Crab	Prey Species to CRA	Good	Good	Good	Good	Poor	n/a	Christian et al. 2010
	Lobster	Commercial, Aboriginal	Poor	Poor	Poor	Poor	Poor	n/a	DFO 2009a, Lawton et al. 2009, Mercaldo-Allen and Kuropat 1994, MacKenzie and Moring 1985
	Mackerel	Commercial, Recreational	Poor	Poor-Moderate	Poor	Moderate-Good	n/a	Poor	Studholme et al. 1999
	Blue Mussel	Commercial, Recreational	Poor-Moderate	Poor-Moderate	n/a	Poor-Moderate	n/a	n/a	Christian et al. 2010, Newell 1989
	Rock Crab	Commercial	Good	Poor-Moderate	Good	Good	Moderate-Good	Poor-Moderate	DFO 2013a, Christian et al. 2010, DOFA 1999
	Green Crab	Commercial	Poor-Moderate	Poor-Moderate	Poor	Moderate-Good	Poor	Poor-Moderate	DFO 2011a, Klassen and Locke, 2007
	Snow Crab	Commercial, Aboriginal	Poor	Poor	Poor-Moderate	Moderate	Poor-Moderate	Poor	DFO 2013b, Lovrich et al. 1995
	Bluefin Tuna	Commercial, Recreational, Aboriginal	Poor	Poor	Poor	Poor	Poor	Poor	Rooker et al. 2007, DFO 2011b
	White Hake	Recreational	Poor	Moderate	Poor	Poor-Moderate	Poor-Moderate	Moderate	Chang et al. 1999a, Simon and Cook 2013, Simpson et al. 2012
	Atlantic Salmon	Recreational, Aboriginal	Poor	Poor	Poor	Poor	Poor	Poor-Moderate	COSEWIC 2010b
	Sea Scallop	Commercial, Recreational	Poor	Poor	Poor	Poor-Moderate	n/a	n/a	Christian et al. 2010, Moriyasu et al. 2001
	Sand Shrimp	Prey Species to CRA	Moderate-Good	Good	Poor	Good	Moderate-Good	Moderate	Locke et al. 2005, Christian et al. 2010
	Cunner	Prey Species to CRA	Poor	Poor	Poor	Poor	Poor	Poor	Auster 1989
	Striped Bass	Recreational, Aboriginal	Poor	Poor	Poor-Moderate	Moderate-Good	Poor	Poor	DFO 2010a, Bradford et al. 2015
	Atlantic Sturgeon	Aboriginal	Poor	Poor	Poor	Moderate-Good	Poor	Poor	DFO 2013c
	Winter Flounder	Commericial, Recreational	Poor-Moderate	Moderate	Poor-Moderate	Good	Good	Good	USFWS 2001
	Yellowtail Flounder	Commericial, Recreational	Poor-Moderate	Poor-Moderate	Poor	Moderate-Good	Moderate	Poor	Kenchington 1980, DFO 2009b
	Windowpane Flounder	Commericial, Recreational	Moderate-Good	Moderate-Good	Poor	Moderate-Good	Moderate	Poor	Kenchington 1980, Fishbase 2015, Chang et al. 1999b
	Northern Quahog	Commericial, Recreational	Poor-Moderate	Poor-Moderate	n/a	Good	n/a	n/a	Bricelj 1993, DFO 1997, MacKenzie et al. 2002, Marshall 1997
	Alewife/Blueback Herring	Commericial, Recreational	Poor-Moderate	Poor-Moderate	Poor-Moderate	Poor-Moderate	Poor	Poor	Kenchington 1980, DFO 2015
	Razor Clam	Commericial, Recreational	Poor	Poor	n/a	Moderate	n/a	n/a	Gollasch et al. 2015, Kenchington et al. 1998, Leavitt 2010
	Atlantic Silverside	Commercial	Poor	Poor	Poor-Moderate	Good	Poor	Moderate-Good	Kenchington 1980, DFO 2010b

Table 5.2 Mixed Substrate Habitat

Habitat Types	Species	Commercial, Recreational, Aboriginal	Habitat Function - Auld's Cove						References
			Spawning	Rearing	Overwintering	Adult Foraging	Cover	Migration	
Mixed Substrate Habitat	American Oyster	Commercial, Recreational	Poor	Poor	n/a	Poor	n/a	n/a	Cake 1983
	American Eel	Commercial, Recreational, Aboriginal	Poor	Poor	Poor	Moderate	Moderate	Moderate	COSEWIC 2012, Facey and Avyle 1987
	Bar Clam	Commercial, Recreational	Poor	Poor	n/a	Moderate-Good	n/a	n/a	Cargnelli et al. 1999, DFO 1996a
	Soft Shell Clam	Commercial, Recreational	Poor-Moderate	Poor-Moderate	n/a	Moderate-Good	n/a	n/a	Christian et al. 2010
	Atlantic Cod	Recreational	Moderate	Moderate	Poor	Moderate	Moderate	Moderate	COSEWIC 2010a, Fahay et al. 1999
	Hermit Crab	Prey Species to CRA	Moderate-Good	Moderate-Good	Moderate-Good	Moderate-Good	Moderate-Good	n/a	Christian et al. 2010
	Lobster	Commercial, Aboriginal	Good	Good	Moderate-Good	Good	Moderate-Good	n/a	DFO 2009a, Lawton et al. 2009, Mercaldo-Allen and Kuropat 1994, MacKenzie and Moring 1985
	Mackerel	Commercial, Recreational	Poor	Moderate-Good	Poor	Moderate-Good	n/a	Moderate-Good	Studholme et al. 1999
	Blue Mussel	Commercial, Recreational	Moderate-Good	Moderate-Good	n/a	Good	n/a	n/a	Newell 1989
	Rock Crab	Commercial	Moderate	Good	Moderate-Good	Good	Moderate-Good	Moderate-Good	DFO 2013a, DOFA 1999
	Green Crab	Commercial	Poor-Moderate	Poor-Moderate	Poor	Moderate	Moderate	Moderate-Good	DFO 2011a, Klassen and Locke, 2007
	Snow Crab	Commercial, Aboriginal	Poor	Poor	Poor-Moderate	Moderate	Poor	Poor-Moderate	DFO 2013b, Lovrich et al. 1995
	Bluefin Tuna	Commercial, Recreational, Aboriginal	Poor	Poor	Poor	Poor	Poor	Poor	Rooker et al. 2007, DFO 2011b
	White Hake	Recreational	Poor	Poor-Moderate	Poor	Poor-Moderate	Poor-Moderate	Moderate	Chang et al. 1999a, Simon and Cook 2013, Simpson et al. 2012
	Atlantic Salmon	Recreational, Aboriginal	Poor	Poor	Poor	Poor	Poor	Poor-Moderate	COSEWIC 2010b
	Sea Scallop	Commercial, Recreational	Moderate-Good	Moderate-Good	Moderate-Good	Moderate-Good	Moderate-Good	n/a	Christian et al. 2010, Moriyasu et al. 2001
	Sand Shrimp	Prey Species to CRA	Poor-Moderate	Poor-Moderate	Moderate	Moderate	Moderate	Moderate	Locke et al. 2005, Christian et al. 2010
	Cunner	Prey Species to CRA	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Auster 1989
	Striped Bass	Recreational, Aboriginal	Poor	Poor	Poor	Poor-Moderate	Poor-Moderate	Moderate	DFO 2010a, Bradford et al. 2015
	Atlantic Sturgeon	Aboriginal	Poor	Poor	Poor	Poor-Moderate	Poor	Poor-Moderate	DFO 2013c
	Winter Flounder	Commericial, Recreational	Poor-Moderate	Poor-Moderate	Poor	Poor-Moderate	Poor-Moderate	Poor-Moderate	USFWS 2001
	Yellowtail Flounder	Commericial, Recreational	Poor	Poor	Poor	Poor-Moderate	Poor-Moderate	Moderate	Kenchington 1980, DFO 2009b
	Windowpane Flounder	Commericial, Recreational	Poor-Moderate	Poor-Moderate	Poor	Poor-Moderate	Poor-Moderate	Moderate	Kenchington 1980, Fishbase 2015
	Northern Quahog	Commericial, Recreational	Poor	Poor	n/a	Good	n/a	n/a	Bricelj 1993, DFO 1997, MacKenzie et al. 2002, Marshall 1997
	Alewife/Blueback Herring	Commericial, Recreational	Poor	Moderate	Moderate	Moderate	Poor	Moderate	Kenchington 1980, DFO 2015
	Razor Clam	Commericial, Recreational	Poor	Poor	n/a	Poor	n/a	n/a	Gollasch et al. 2015, Kenchington et al. 1998, Leavitt 2010
	Atlantic Silverside	Commercial	Moderate	Moderate-Good	Poor-Moderate	Moderate-Good	Poor-Moderate	Moderate-Good	Kenchington 1980, DFO 2010b

Table 5.3 Rocky Intertidal Habitat

			Habitat Function - Auld's Cove						
Habitat Types	**Species**	**Commercial, Recreational, Aboriginal**	**Spawning**	**Rearing**	**Overwintering**	**Adult Foraging**	**Cover**	**Migration**	**References**
Rocky Intertidal Habitat	American Oyster	Commercial, Recreational	Poor	Poor	n/a	Poor	n/a	n/a	Cake 1983
	American Eel	Commercial, Recreational, Aboriginal	Poor	Poor	Poor	Moderate	Moderate-Good	Moderate	COSEWIC 2012, Facey and Avyle 1987
	Bar Clam	Commercial, Recreational	Poor	Poor	n/a	Moderate-Good	n/a	n/a	Cargnelli et al. 1999, DFO 1996a
	Soft Shell Clam	Commercial, Recreational	Poor	Poor	n/a	Moderate-Good	n/a	n/a	Christian et al. 2010
	Atlantic Cod	Recreational	Moderate	Moderate-Good	Poor	Moderate	Moderate	Moderate	COSEWIC 2010a, Fahay et al. 1999
	Hermit Crab	Prey Species to CRA	Moderate-Good	Moderate-Good	Moderate-Good	Moderate-Good	Good	n/a	Christian et al. 2010
	Lobster	Commercial, Aboriginal	Good	Good	Poor-Moderate	Good	Good	n/a	DFO 2009a, Lawton et al. 2009, Mercaldo-Allen and Kuropat 1994, MacKenzie and Moring 1985
	Mackerel	Commercial, Recreational	Poor	Poor-Moderate	Poor	Poor-Moderate	n/a	Poor-Moderate	Studholme et al. 1999
	Blue Mussel	Commercial, Recreational	Good	Moderate-Good	n/a	Good	n/a	n/a	Newell 1989
	Rock Crab	Commercial	Moderate	Moderate	Moderate-Good	Good	Moderate-Good	Moderate-Good	DFO 2013a, DOFA 1999
	Green Crab	Commercial	Poor-Moderate	Poor-Moderate	Poor	Moderate-Good	Moderate-Good	Moderate-Good	DFO 2011a, Klassen and Locke, 2007
	Snow Crab	Commercial, Aboriginal	Poor	Poor	Poor	Poor	Poor	Poor	DFO 2013b, Lovrich et al. 1995
	Bluefin Tuna	Commercial, Recreational, Aboriginal	Poor	Poor	Poor	Poor	Poor	Poor	Rooker et al. 2007, DFO 2011b
	White Hake	Recreational	Poor	Poor	Poor	Poor-Moderate	Poor	Poor-Moderate	Chang et al. 1999a, Simon and Cook 2013, Simpson et al. 2012
	Atlantic Salmon	Recreational, Aboriginal	Poor	Poor	Poor	Poor	Poor	Poor	COSEWIC 2010b
	Sea Scallop	Commercial, Recreational	Poor-Moderate	Poor-Moderate	Poor-Moderate	Moderate-Good	Moderate-Good	n/a	Christian et al. 2010, Moriyasu et al. 2001
	Sand Shrimp	Prey Species to CRA	Poor-Moderate	Poor-Moderate	Moderate	Moderate	Moderate	Moderate	Locke et al. 2005, Christian et al. 2010
	Cunner	Prey Species to CRA	Good	Good	Good	Good	Good	Good	Auster 1989
	Striped Bass	Recreational, Aboriginal	Poor	Poor	Poor	Poor	Poor-Moderate	Poor-Moderate	DFO 2010a, Bradford et al. 2015
	Atlantic Sturgeon	Aboriginal	Poor	Poor	Poor	Poor	Poor-Moderate	Poor-Moderate	DFO 2013c
	Winter Flounder	Commericial, Recreational	Poor-Moderate	Poor-Moderate	Poor	Poor-Moderate	Poor	Poor-Moderate	USFWS 2001
	Yellowtail Flounder	Commericial, Recreational	Poor	Poor	Poor	Poor-Moderate	Poor-Moderate	Poor-Moderate	Kenchington 1980, DFO 2009b
	Windowpane Flounder	Commericial, Recreational	Poor-Moderate	Poor-Moderate	Poor	Poor-Moderate	Poor-Moderate	Moderate	Kenchington 1980, Fishbase 2015
	Northern Quahog	Commericial, Recreational	Poor	Poor	n/a	Good	n/a	n/a	Bricelj 1993, DFO 1997, MacKenzie et al. 2002, Marshall 1997
	Alewife/Blueback Herring	Commericial, Recreational	Poor	Moderate	Moderate	Poor-Moderate	Poor	Poor-Moderate	Kenchington 1980, DFO 2015
	Razor Clam	Commericial, Recreational	Poor	Poor	n/a	Poor	n/a	n/a	Gollasch et al. 2015, Kenchington et al. 1998, Leavitt 2010
	Atlantic Silverside	Commercial	Moderate-Good	Moderate-Good	Poor	Moderate-Good	Moderate-Good	Moderate-Good	Kenchington 1980, DFO 2010b

substrates. It is possible that macrofauna in the study area was not observed due to their ability to hide in their preferred habitats. For example, rock crab and winter flounder will often burrow themselves into the soft substrate to rest between foraging activities. Skates and shrimp have adapted to use camouflage; having similar colouration to the sea floor makes them difficult for predators to detect (Tyrell, 2005).

Shell debris was very sparse in deeper sections and sharply transitioned to abundant closer to shore. It is likely that these shells were deposited largely by feeding shore birds. Live shellfish, such as American oysters (*Crassostrea virginica*) and blue mussels (*Mytilus edulis*), were observed growing on this shell debris where the fine sediment would have otherwise choked these filter-feeding species. It is likely that the valves of shellfish have concentrated enough along the beach that additional habitat is being created for the settlement of shellfish requiring hard substrates for attachment.

The fines dominant habitat provides good or moderate to good habitat for some CRA fisheries, including (see Table 5.1):

- American oyster;
- Hermit crab;
- Rock crab;
- Sand shrimp;
- Winter flounder; and
- Windowpane flounder.

5.2.1.2 Mixed Substrate Habitat

The mixed substrate habitat was observed in spot checks 14, 15 and 16. It is likely more extensive beyond the 50 x 50 m study area, as the bottom was transitioning from boulder dominated to a more cobble and gravel dominated substrate. These spot check locations were thus likely on the margin of the larger transitional area. As such, faunal species may have been present in larger numbers in the mixed habitat than was observed during the video interpretation. Cover and the durational limitations of the spot checks may have also limited the number of faunal observations. For example, species such as lobster and crab are sedentary for extended periods of time and may have taken cover under macroflora or within crevices, thereby impeding their observation on video. It is possible that, in addition to the single rock crab observed in SC 14, there were additional macrofaunal organisms hidden within interstitial spaces and amongst macroflora (such as *Chondrus crispus* and *Fucus sp*.) that were not observed.

Many marine fauna species require complex environments, such as variable substrates, larger cobbles and boulders, as well as dense vegetation to meet the needs of one or more stages of their lifecycle (see Table 5.1). Marine habitats with increased structural complexity are typically inhabited by more species than less complex areas due to an increase in niche (functional) diversity (Dustan *et al.*, 2013). Habitat complexity can be measured by rugosity of the substratum, diversity of the substratum, variety of refuge hole sizes, height of substratum, percentage of live cover (i.e., seagrasses and corals) and percentage of hard substrate. A more complex and variable habitat shows greater species diversity and abundance (Gratwicke and Speight, 2004). The rugosity and percentage of hard substrate are mediums on which microscopic algae, macroalgae, corals, sponges and mussels can fasten and thrive. They generally will not grow on soft substrates due to instability (shifting sands). These organisms can be a food source, provide cover from predators or provide spawning grounds for many other species (Gratwicke and Speight, 2004). Having structures with varying forms and heights (i.e., rocks, algae, corals) will provide different functionalities for many species (microhabitats). Thus, the assortment of physical and biotic characteristics produces a more suitable habitat and therefore increased biodiversity (Friedman et al., 2012).

The mixed substrate habitat would provide good or moderate to good habitat for some CRA fisheries, including species that were not observed, such as (see Table 5.2):

- Hermit crab;
- American lobster;
- Mackerel;
- Blue mussel;
- Rock crab;
- Sea scallops; and
- Atlantic silverside.

5.2.1.3 Rocky Intertidal Habitat

The rocky intertidal habitat was observed in four spot checks (SC 17 through SC 20) and the linear transect conducted in the very shallow upper intertidal zone. The coastal rocky intertidal zone in the study area is subject to repeated and repetitive submersion and flushing of sea water over roughly a 12 hour cycle. As such, the area is periodically submerged and periodically exposed to the sun. Macroflora and macrofauna species have developed the ability to withstand the intense and prolonged period in which desiccation is possible as well as the ability to remain attached to a substrate when exposed to high energy wave action. A few common species observed in the local area included *Ascophyllum nodosum*, *Fucus sp*., *Balanus sp*., *Mytilus edulis* and *Littorina sp*. *M. edulis* was not observed during the video interpretation of the outer study area but is a common intertidal species found in the St. George's Bay area (Dwyer, Alan, pers. comm., 2015). Motile species were not observed in large numbers in the outer intertidal study area. Spot checks and the linear transect were conducted on a mid-falling tide; it is, therefore, likely that the majority of the motile macrofauna had retreated to deeper waters. At low tide these non-motile species are protected from motile predatory species, but as the tide rises, motile species can move in and feed on the inhabitants of the intertidal zone. It is thus likely that although the intertidal zone is not suitable for long stretches of inhabitation by CRA or CRA-supporting species, it does provide important foraging opportunities. It is also possible for motile juveniles to shelter in the tide pools and sea water retained by exposed intertidal macroflora at low tide, providing both shelter and feeding opportunities for juvenile CRA and CRA-supporting species. It should also be noted that species of fauna may have been present in the algal cover of the intertidal zone but were not visible due to the abundance of cover provided by the presence of dense stretches of macroalgae.

The rocky intertidal habitat identified provides good or moderate to good habitat for some CRA fisheries including (see Table 5.3):

- Hermit crab;

- American lobster;
- Blue mussel;
- Rock crab;
- Green crab;
- Cunner; and
- Atlantic silverside.

5.2.2 Species Descriptions

The following subsections provide descriptions for those species observed, or for which habitat exists, at spot check locations and/or along the survey transect.

5.2.2.1 Rock Crab (Cancer irroratus)

Rock crab was observed in the mixed substrate habitat. Rock crab is a common species along the shores of Atlantic Canada, distributed between southern Labrador to South Carolina (DFO, 2013a). On the eastern coasts of Canada, the rock crab frequents shallow waters with sandy bottoms that range between 5 to 20 m in depth. Although a sandy substrate is preferred, rock crabs can be found on all substrate types. Spawning and egg laying occur in autumn and can continue into the following year. The egg mass is attached to the stomach of the female until they are ready to hatch, which occurs the following year during the late spring or early summer months. The larvae remain in the upper reaches of the water column until they complete six moulting stages, after which they settle on the ocean floor. The juvenile crab prefers to remain inshore inhabiting areas with rocky substrates (i.e., gravels and cobbles) (DOFA, 1999). Rock crab was observed in the outer study area.

5.2.2.2 Winter Flounder (Pleuronectes americanus)

Winter flounder was observed in habitat dominated by fines. This species can be found in shallow waters (near the tideline) to depths greater than 140 m. Their movements are correlated to seasonal warming, moving to warmer offshore depths during the winter months and returning to warmer inshore, shallow waters during the summer. Coastal populations tend to spawn near the mouths of estuaries (peak times are March and April) over sandy or muddy bottoms. Juveniles will remain in the shallow, sandy estuaries for a period of two to three years. Adults prefer sandy or muddy bottoms but can also be found in areas with pebbly and gravelly substrate (USFWS, 2001). Two juvenile flounders were observed in Archie Pond but could not be identified to species. It is most likely that these flounders were either winter flounder or windowpane flounder (see below). This was determined via the physical characteristics of the habitat in which they were observed and the habits of juvenile flounders found in the local area.

5.2.2.3 Hermit Crabs (*Pagurus* sp.)

Hermit crabs were observed in habitats dominated by fines. There are three species (*P. acadianus, P. arcuatus, and P. pubescens*) of hermit crab that are present in the northwest Atlantic and are generally found in the shallow subtidal zone. Spawning occurs in the summer months. Studies have found that hermit crabs, particularly *P. pubescens*, prefer a sandy environment, but also inhabit sand/gravel/shell substrates in waters ranging between 5 and 15 m depth with a wide variation of temperatures and wave energy exposures (Christian et al., 2010).

5.2.2.4 American Lobster (*Homarus americanus*)

Although not observed in the underwater video survey, American lobster are commercially fished in the George's Bay area. American lobster is found throughout Atlantic Canada with major fisheries occurring in the Gulf of St. Lawrence and the Gulf of Maine. The highest concentration of lobster occurs near coastal waters, with lower concentrations in deeper, warm waters (e.g., Gulf of Maine). All the important life history events such as molting, mating, egg extrusion and hatching typically occur between mid-July to mid-September (DFO, 2009a). Mature females mate in late summer and carry their eggs under their tails for 10 to 12 months. Eggs hatch between May and September depending on water temperatures (DFO, 2009a), and the larvae will live near the surface of the water for 30 to 60 days (Pezzack et al., 2009). After completing one pre-larval and four free-swimming larval stages, the larvae will descend to the bottom where they will molt into juveniles (MacKenzie and Moring, 1985). Juveniles and adults either inhabit natural crevices for shelter found in cobble/boulder environments or excavate space in the absence of natural shelters (i.e., sand-boulder habitats). Young lobster will rarely leave the safety of their shelters. Juveniles (with a carapace length greater than 45 mm) and adults usually travel no more than 300 m from their shelters when foraging. Lobsters will migrate to shallow water in the summer and deeper water in the winter (Pezzack et al., 2009) with adults travelling distances of up to 20 km. Although a rocky substrate is preferable, lobster may be present in the fines dominant habitat during seasonal movements or when foraging for food.

5.2.2.5 Blue Mussel (*Mytilus edulis*)

Blue mussels are semi-sessile, epibenthic mollusks that are commonly harvested in the aquaculture industry (Newell, 1989). Blue mussels have a wide geographic range, inhabiting temperate and polar waters worldwide. Blue mussel habitat ranges from rocky coastal shores, slightly brackish waters to saline deep offshore environments (DFO, 2003b). However, they are most commonly found in the intertidal and shallow subtidal zones less than 20 m (Christian et al., 2010) of nutrient-rich bays and estuaries with an abundance of phytoplankton, their main food source (DFO, 2003b). They are highly efficient suspension feeders and feed actively by filtering particles from the water (DFO, 2003b). Predators of blue mussels, include sea ducks, starfish, crustaceans and humans (Christian et al., 2010).

Blue mussels can tolerate a wide range of salinity, from 0-31 ppt (optimum salinity being around 26 ppt), and temperature, from below 0 to 25°C; spawning occurs between May and August, usually in response to environmental triggers such as sufficient phytoplankton abundance, fluctuations in water temperature and physical disturbance (DFO, 2003b). Ideal water temperature for spawning ranges from 10-12°C (Christian et al., 2010) Eggs and sperm are released concurrently into the water column where fertilization occurs (Newell, 1989). Fertilization tends to be successful in waters that are at least 15 ppt salinity (Bayne, 1976 in Christian et al., 2010). The embryos quickly differentiate into free-swimming larvae, a life stage that lasts at least three to four weeks, before their final metamorphosis when they settle on the bottom as juveniles (DFO, 2003b). To secure themselves to submerged substrates, blue mussels secrete byssal threads that adhere to hard surfaces, where they continue to grow until reaching 1-2 mm in length, at which point they detach from their substrates and migrate via currents to an existing mussel bed (Bayne, 1964). Upon reaching adult mussels, juveniles are stimulated to produce new byssal threads that they use to attach to substrates or adult mussels in a process referred to as secondary settlement (Newell, 1989). Juvenile mussels will continue to grow and within two years will have reached maturity (Bayne, 1964).

Blue mussels were observed growing amongst the shell debris along the upper intertidal zone of Archie Pond.

5.2.2.6 Sea scallop (Placopecten magellanicus)

Scallops are bivalve molluscs that inhabit coastal waters (Moriyasu et al., 2001). They are particularly abundant within gravel bottom waters that are well mixed by the ebb and flow of tides (Schaefer et al., 2004). Sexual differentiation occurs after one year of age, and sexual maturity typically takes place once shell height has reached 70 mm (Moriyasu et al., 2001). Sea scallop spawning occurs between August and October (Schaefer *et al*., 2004). Spat is free floating within the water column for four to six weeks before attaching to substrates on rocky, sandy, sand-gravel and occasionally muddy bottoms. Scallops tend to aggregate in scallop beds at depths of 20 to 40 m but can inhabit waters as shallow as 2 m in depth (Moriyasu et al., 2001).

Although not observed in either study area, the mixed substrate of the outer study area could provide good habitat for sea scallops.

5.2.2.7 Sand Shrimp (Crangon septemspinosa)

Sand shrimp were identified within the fines dominant habitat. The sand shrimp is a small decapod crustacean that typically occupies sandy habitats (Reebs et al., 2011) in coastal and estuarine waters ranging from the lower intertidal zone to depths of 450 m along the Atlantic coast from Newfoundland to Florida (Corey, 1980). Sand shrimp prefer depths ranging from 0 to 90 m (Squires, 1990 in Christian et al., 2010). They overwinter offshore and migrate inshore to spawn. Sand shrimp exhibit both continuous and distinct spawning seasons. In Passamaquoddy Bay, New Brunswick, sand shrimp exhibit two distinct spawning periods: spring spawning (March to early June) occurs typically by large females and summer spawning (mid-July to August) by smaller females (Corey, 1987 in Christian et al., 2010). Whereas, larger females in Kouchibouguac River, New Brunswick, spawn in May and June while smaller females spawn in summer and fall; reproduction is continuous throughout the spring and summer (Locke et al., 2005). Hatching of planktonic larvae varies geographically, ranging from early spring to late fall (Christian et al., 2010). Sand shrimp feed on small crustaceans, other invertebrates and detritus and are an important food source for both commercial and non-commercial fish (Modlin, 1980).

5.2.2.8 Mackerel (Scomber scombus)

Although not observed during the underwater video survey, Atlantic Mackerel are commercially fished within the George's Bay area. The Atlantic mackerel is a migratory, schooling fish species that lives its entire life in a pelagic environment (i.e., never settling on the substrate) (Studholme et al., 1999). Atlantic mackerel are widely distributed on both sides of the north Atlantic. Within the northwest Atlantic, they range from Newfoundland to North Carolina, inhabiting nearshore, coastal waters during the spring-summer (DFO, 2007; DFO, 2012) at depths of 10 to 180 m, with the majority between 50 to 70 m (Studholme et al., 1999). In late fall-winter, they inhabit deeper, warmer waters (DFO, 2007; DFO, 2012) at depths between 10 to 270 m, with the majority between

20 to 30 m (Studholme et al., 1999). Atlantic mackerel overwinter in deep water along the continental shelf from Sable Island Bank off of Nova Scotia to the Chesapeake Bay region (Studholme et al., 1999). Within Canada, Atlantic mackerel spawn primarily in the southern Gulf of St. Lawrence from June-July at water temperatures ranging from 9-12°C (DFO, 2007) and an ideal salinity of greater than 30 ppt (Studholme et al., 1999). Females spawn multiple times within this period and do so at or near the surface of the water column; pelagic larvae feed constantly to promote rapid growth (Studholme et al., 1999) and develop into juveniles after roughly two months (DFO, 2007). Once juveniles, Atlantic mackerel resemble adults and form highly mobile, obligate swimming schools characteristic of this species due to absence of a swim bladder (Studholme et al., 1999; DFO, 2000). Larvae feed primarily on zooplankton and juveniles feed primarily on small crustaceans and small pelagic mussels; adults feed on zooplankton, crustaceans and fish larvae of yellowtail flounder, silver hake, redfish and conspecifics (Studholme et al., 1999). Growth rate and age at maturity are variable in Atlantic mackerel, possibly due to differences in year-class size and adult stock size. Sexual maturity typically ranges from two to four years of age, and Atlantic mackerel lifespan can exceed 15 years (DFO, 2000). Main causes of mortality include fishing activities and predation (DFO, 2007). Predators include, but are not limited to, cetaceans and grey seals (DFO, 2007), harbor seals, porpoises, squid, other fish (e.g., hake, mackerel, polluck, Atlantic cod, etc.) and seabirds (Studholme et al., 1999).

5.2.2.9 CUNNER (TAUTOGOLABRUS ADSPERSUS)

Cunner were not observed during the video interpretation, however they are common in the Strait of Canso and St. George's Bay. Cunner inhabit shallow waters from Newfoundland to Chesapeake Bay. Juvenile and adult cunner are active in the day and lethargic at night and thus prefer habitats with suitable cover for protection. Such habitats can include rocky areas, eelgrass, kelp and gravel. Cunner are omnivores and feed primarily on blue mussels, barnacles, soft shell clams, amphipods, shrimp and small lobster. During the summer, cunner disperse to seasonal habitats comprised of eelgrass, macro algae or mussels. They return to the same sites during the fall where they overwinter in a state of torpor under rocks, in crevices and other areas providing adequate protection when water temperatures reach between 5-8 degrees Celsius (Auster, 1989).

5.2.2.10 GREEN CRAB (CARCINUS MAENA)

Green crab was observed in habitat dominated by fines and comprised of an abundance of shell debris. Originating in Europe and Northern Africa, green crabs have dispersed to and invaded marine habitats in North and South America, Australia, and Asia as a result of shipping transport (e.g., dry hulls, ballast water, etc.). In North America, the green crab is distributed along both the Atlantic (from Newfoundland to Virginia) and Pacific (from British Columbia to California) coasts, inhabiting coastal areas comprised of hard substrates and estuarine areas comprised of hard and soft substrates. Specifically, habitats range from rocky to vegetated intertidal, mud and sand subtidal and salt marshes to eel grass beds, the latter being particularly important habitat for juvenile green crabs (Klassen and Locke, 2007). While green crabs have been found to inhabit waters as deep as 60 m, they are commonly found at water depths ranging from high tide to 6 m (Klassen and Locke, 2007) and trapped at depths from 2 to 5 m in the southern Gulf of St. Lawrence (Williams *et al*., 2006). The green crab has a life span of four to seven years, surviving in waters ranging from 0-35 degrees Celcius and reproducing at temperatures ranging from 18-26 degrees Celsius. The timing of reproduction varies according to geographical area, but females typically spawn in spring-summer in Northeastern North America (Klassen and Locke, 2007; DFO, 2011a). Planktonic larvae will remain in the water column and transverse four larval stages for upwards of two months before settling on the benthos, utilizing vertical migration and tidal activities to disperse from estuaries to coastal waters. Although the green crab can survive in water salinities ranging from 4-55 ppt, larvae appear to require salinities around 25 or above for normal development (Klassen and Locke, 2007). Offshore migration from estuaries to deeper and warmer coastal waters has been observed in European populations of green crab. Although not directly observed in Canadian waters, evidence suggesting offshore migration was observed in a population of green crab in Basin Head Lagoon, PEI (Sharp et al., 2003).

Green crabs are omnivores that prey on various marine organisms including algae, nematodes, polychaetes, small crustaceans (e.g., juvenile lobster, hermit crabs) fish (e.g., juvenile winter flounder, plaice) and gastropods (e.g., *Littorina spp*.); however, their preferred food source are bivalve mollusks, including, but not limited to, blue mussels, surf clams, soft-shelled clams and American oysters (Klassen and Locke, 2007). Green crab predation has been found to adversely impact mollusk and crustacean aquaculture as well as eel bed abundance and coverage, an ecologically important habitat for many marine species (DFO, 2011a).

5.2.2.11 American oyster (Crassostrea virginica)

American oysters were observed in habitats where fines were mixed with shell debris and where fines were mixed with gravel. The American oyster is a benthic bivalve that is native to coastal estuaries and sheltered bays within Atlantic Canada, predominantly in the southwest Gulf of St. Lawrence (DFO, 1996b) and the Gulf of Mexico (Cake, 1983). American oysters inhabit water depths ranging from 0 to 11 m in Canadian waters, however optimal habitat ranges from 0.6 to 2 m in depth (Jenkins et al., 1997 in NOAA, 2007). The American oyster prefers habitats with a firm bottom and is found attached to hard substrates, such as rocks or shells in brackish waters, bays, coves and estuaries (DFO, 2003a). Water quality, temperature, salinity and food availability influence life history events. Within the mid to North Atlantic distribution of the American oyster, spawning is seasonal (NOAA, 2007), occurring in the summer where water temperatures are warmer, preferably around 20 degrees Celsius (DFO, 1996b). Whereas, spawning occurs throughout the year, except during the coldest months (December-February), in the Gulf of Mexico (Cake, 1983). While adult American oysters can survive in waters with salinities ranging from 5-40 ppt (NOAA, 2007), they prefer to spawn in waters where salinity ranges from 10-30 ppt (DFO, 1996b); larvae require salinities ranging from 10-27.5 ppt for survival (NOAA, 2007). Larvae are pelagic for roughly 21 days before becoming sessile on the bottom. Larvae prefer to settle on substratum that is free of sediment and encrusting invertebrates (Cake, 1983). Areas with eel grass are favorable rearing sites as they provide larvae with suitable substrate for attachment and proximity to nutrient rich water needed for growth (DFO, 1996b). American oysters mature into adults after 4 to 12 weeks of settlement and growth (Cake, 1983). Harvesting occurs when adults have reached 76mm, occurring between 2 to 4 years of growth (Lavoie, 1989 in DFO, 1996b). Only 1% of oysters reach this size due to loss of suitable substratum such as eel grass (DFO, 1996b), changes in water condition (e.g., salinity, temperature, food availability), predation, disease and human activities, such as dredging, pollution and infilling (Cake, 1983). American oysters are filter feeding planktivores and omnivores that ingest flagellates, diatoms, detritus, bacterial particles and silt (Cake, 1983).

5.2.2.12 Atlantic silverside (*Menidia menidia*)

The Atlantic silverside was not observed during the video interpretation of the study areas but are potentially in the area. They are small-bodied fish less than 12 cm in length and are distributed from the Gulf of St. Lawrence to Florida. Atlantic silverside are short-lived, typically surviving to one year of age and rarely (<1%) two years of age (Conover et al., 2005). They inhabit both salt and brackish nearshore waters, such as shallow bays and estuaries (DFO, 2010b). Atlantic silverside migrates offshore to continental shelf waters in winter, returning near shore in spring (Conover et al., 2005). Within the Gulf of St. Lawrence, some remain near shore and overwinter under ice in bays and estuaries (DFO, 2010b). Atlantic silverside reproduces in spring and can spawn several times during the season and within the intertidal zone (DFO, 2010b), including salt marsh environments (Conover et al., 2005), estuaries and tributaries (Fay et al., 1983). Spawning only occurs during the day at high tide and is dependent on the lunar phase, the first spawning typically occurring during a full or new moon. The extruded eggs attach to substrates such as submerged vegetation, including algae and eel grass. Larvae appear to be most abundant at depths less than 3 m and can survive in waters ranging in salinity from 1-14 ppt and water temperatures between 15-30°C (Fay et al., 1983). Incubation time is shorter in warmer waters (Fay et al., 1983), and larvae hatch when they reach 5 mm in length, soon after displaying schooling behavior characteristic of adults (Conover et al., 2005). Juvenile Atlantic silverside can tolerate a broader temperature range from 3-32 °C. Smaller juvenile Atlantic silverside tend to prefer habitats with vegetated substrates more often than larger juveniles and adults, which seem to prefer habitats comprised of sand and gravel substrates. Atlantic silverside forage on small planktonic and benthic organisms, including copepods, amphipods, fish eggs, mysids, squid, worms, mollusk larvae, algae, diatoms and detritus (Fay et al., 1983). Common predators of Atlantic silverside include birds, marine mammals and fish (DFO, 2010b).

5.2.2.13 Windowpane flounder (*Scophthalmus aquosus*)

Windowpane flounder is a fast-growing, thin fish that is euryhaline and thus able to survive salinities ranging from 5.5-36 ppt. It is distributed from the Gulf of St. Lawrence to North Carolina but is most abundant from George's Bank to Chesapeake Bay. Windowpane flounder inhabit near shore waters of estuaries and bays (< 110 m depth) from spring to autumn, but are most abundant between 1 to 56 m depth. In late autumn, juveniles and adults migrate to deeper waters along the continental shelf in the northwest Atlantic. Overwintering in deeper waters lasts until late spring. Windowpane flounder prefer habitats comprised of sand, sand/silt or mud substrates (Chang et al., 1999b).

Sexual maturity in windowpane flounder typically occurs between three to four years of age. Spawning occurs throughout most of the year, from February to September, depending on the location. Several populations have a split spawning season that peak in spring and autumn. Spawning in spring occurs both in estuaries and on the shelf, while spawning in autumn occurs primarily on the shelf. All spawning events occur at night on or near the benthos. Water temperatures during spawning range from 6-21°C, however most spawning occurs between 8.5-13.5°C. Larvae settle on the bottom when reaching 10-20 mm in length. Juveniles that have settled in near shore waters move to deeper waters as they grow (Chang et al., 1999b). Juvenile and adult windowpane feed on small crustaceans (e.g., mysid and decapod shrimp) and fish larvae of various species, including hake, tomcod and their own species. Windowpane flounder are predated upon by various fish, including spiny dogfish, Atlantic cod, black sea bass, summer flounder, thorny skate and weakfish (Chang et al., 1999b).

Two juvenile flounders were observed in Archie Pond but could not be identified to species. It is most likely that these flounders were either winter flounder or windowpane flounder (see above). This was determined via the physical characteristics of the habitat in which they were observed and the habits of juvenile flounders found in the local area.

CHAPTER 6 CONCLUSIONS

6.1 Fisheries Habitat Summary

There were three distinct habitat types identified during the analysis of the spot checks and the linear transect survey of the study area:

- Rocky intertidal habitat;
- Mixed substrate habitat; and
- Fines dominant habitat.

The physical complexity of the rocky intertidal habitat and mixed substrate habitat exhibited more macrofloral species diversity and abundance than the fines dominant environments. The fines dominant habitat exhibited sparse algal coverage, except where rubber tires had sunk to the benthic floor and where shell debris had concentrated to sufficient levels to allow for algal attachment and growth (see Appendix A).

Sessile and slow moving macrofauna were found to be most abundant throughout the study area, whereas highly motile macrofauna diversity and abundance was found to be relatively low (see Appendix A). Abundant species such as *Balanus sp*. and *Littorina sp.* were found exclusively in the rocky intertidal habitat. A rock crab and a northern sea star were also observed in the mixed and rocky intertidal substrates, respectively. The fines dominant habitat exhibited less diversity and abundance. *Crangon sp*. and hermit crab were observed in the deeper subtidal spot check locations, whereas shellfish (American oysters and blue mussels) were found along the shallow barrier beach margin. Two juvenile flounders were also observed in the fines dominant habitat in Archie Pond. No other species of fish were observed. It is possible that the relatively low abundance and diversity of macrofauna within the study areas was due to the individual habitat preferences of species within the local area and/or to the temporal and spatial limitations of benthic video interpretation, such as duration of observation and total area covered. In addition, habitats with complex structural attributes and dense algal and macrophyte coverage, such as those that were observed in the rocky intertidal habitat, can limit macrofaunal observation.

Marine habitats with increased structural complexity are typically inhabited by more species than areas that are devoid of this due to the increase in niche (functional) diversity (Dustan et al., 2013). Habitat complexity can be measured by rugosity (measure of complexity/degree of roughness) of the substratum, diversity of the substratum, variety of refuge hole sizes, height of substratum, percentage of live cover (i.e., seagrasses, corals) and percentage of hard substrate. A more complex and variable habitat shows greater species diversity and abundance (Gratwicke and Speight, 2004). The rugosity and percentage of hard substrate are mediums in which microscopic algae, macroalgae, corals, sponges and mussels can fasten upon and thrive. They generally will not grow on soft substrates due to instability (shifting sands). These organisms can be a food source, provide cover from predators, or provide spawning grounds for many species (Gratwicke and Speight, 2004). Having structures with varying forms and heights (i.e., rocks, algae, and corals) will provide different functionalities for many species (microhabitats). It is therefore possible that a greater array of macrofauna may have been present in the rocky intertidal and mixed substrate habitats, but were not observed due to the cryptic complexity of the surveyed environments.

Fines dominated habitats can be dynamic and influenced by tidal currents and waves. The nature of this environment influences species abundance and diversity. Although this environment has less diversity when compared to more structurally complex areas, some species have adapted to utilize the functions that fine substrates provide. Species such as the sand lance and rock crab will bury themselves in the soft substrate as they rest between foraging activities. These species can be difficult to observe during video interpretation if they have buried themselves in the soft sediment. Fine substrates can also provide shelter and cover from predators. Species such as flounders, skates and shrimp have adapted to use camouflage, specifically colouration similar to the sea floor, making them difficult for predators to spot (Tyrell, 2005).

6.2 Potential Impacts to CRA Fish

An assessment of the habitat function of CRA fish and fish that support a CRA fishery was conducted for each habitat type observed during the survey. The species listed below could potentially be negatively impacted by the proposed transmission tower installation since good or moderate to good habitat exists for these species. The fines dominant habitat was found to provide good or moderate to good habitat for some CRA fisheries, including (see Table 5.1):

- American oyster;
- Hermit crab;
- Rock crab;
- Sand shrimp;
- Winter flounder; and
- Windowpane flounder.

The mixed substrate habitat was found to provide good or moderate to good habitat for some CRA fisheries, including species that were not observed, such as (see Table 5.2):

- Hermit crab;
- American lobster;
- Mackerel;
- Blue mussel;
- Rock crab;
- Sea scallops; and

- Atlantic silverside.

The rocky intertidal habitat was found to provide good or moderate to good habitat for some CRA fisheries including (see Table 5.3):
- Hermit crab;
- American lobster;
- Blue mussel;
- Rock crab;
- Green crab;
- Cunner; and
- Atlantic silverside.

DFO has indicated that the study area is within the bounds of active lobster fishing grounds. The outer study area in the Strait of Canso contains suitable habitat for the entire lifecycle of American lobster (see Tables 5.2-5.3). Their presence was not confirmed during the video interpretation of the linear transect and spot checks undertaken; however, the observed mixed substrate and lower rocky intertidal habitat was deemed suitable habitat for both juvenile and adult lobster. The deposition of materials for the purpose of constructing a transmission tower on habitat that supports CRA fisheries, notably lobster, could cause harm to CRA fisheries and require authorization pursuant to Section 35 of the *Fisheries Act*. The underwater benthic survey of the study areas revealed that the nearshore habitat should be considered appropriate habitat for CRA fisheries species, including lobster, and those species that support CRA fisheries.

American oysters and blue mussels can be found along the barrier beach of Archie Pond, but abundance is low in this area. The fines dominant habitat and steep sloped beach is not suitable for American oyster spat or blue mussel veliger settlement; however, the buildup of shell debris along the shallow shoreline margin over time has allowed for the settlement of some intermittent individuals (Appendix A). The majority of the shellfish in Auld’s Cove are located east of the Archie Pond study area where a shallow channel runs out into the Strait of Canso (pers. obs.).

6.3 Sensitive Habitat Features

The underwater video interpretation of the study area did not identify any sensitive or rare habitat types within the study area. The habitats identified are characteristic of the coastal habitat of the margins of the Strait of Canso and St. Georges Bay areas. The physical characteristics of the study areas do not appear to be suitable for the establishment of sensitive habitats such as eel grass beds and coral reefs.

Habitats occurring outside of the 20 spot check locations and one linear transect reviewed have not been characterized and may contain alternative habitat types and functions.

CHAPTER 7 REFERENCES

Auster, P.J. 1989. Species Profiles: Life histories and Environmental Requirements of Coastal Fishes and Invertebrates (North Atlantic and Mid-Atlantic)--Tautog and Cunner. U.S. Fish Wildl. Serv. Biol. Rep. 82 (11.105). U.S. Army Corps of Engineers, TR EL-82-4. 13pp.

Bayne, B.L. 1964. Primary and Secondary Settlement in *Mytilus edulis L*. (Mollusca). Journal of Animal Ecology. 33 (3). 513-523 pp.

Bayne, B.L. 1976. The Biology of Mussel Larvae. p. 81-120. *In* Bayne, B.L. (Ed.). Marine Mussels, their Ecology and Physiology. International Biological Programme: 10. Cambridge University Press, New York, NY.

Bradford, R.G., Halfyard, E.A., Hayman, T., and LeBlanc, P. 2015. Overview of 2013 Bay of Fundy Striped Bass Biology and General Status. DFO Can. Sci. Advis. Sec. Res. Doc. 2015/024. iv + 36 p.

Bricelj, V.M. 1993. Aspects of the Biology of the Northern Quahog, *Mercenaria mercenaria*, with Emphasis on Growth and Survival During Early Life History. In: M.A. Rice and D. Grossman-Garber (Eds.), Proceedings of the Second Rhode Island Shellfish Industry Conference, Rhode Island Sea Grant, University of Rhode Island, Kingston, pp. 29-46.

Cake, E.W., JR. 1983. Habitat Suitability Index Models: Gulf of Mexico American Oyster. U.S. Dept. Int. Fish. Wildl. Serv. FWS/OBS-82/10.57. 37pp.

Canada-Nova Scotia Strait of Canso Environment Committee. 1975. Fish and Wildlife Resources *in* Strait of Canso Natural Environment Inventory. Institute for Resource and Environmental Studies, Dalhousie University, Halifax. Pp. [i]-ix,(1),1-18,(2).

Cargnelli, L.M., Griesbach, S.J., and Packer, D.B. 1999. Essential Fish Habitat Source Document: Atlantic Surfclam, *Spisula solidissima*, Life History and Habitat Characteristics. NOAA Technical Memorandum NMFS-NE-142. 22pp. Available Online: http://www.nefsc.noaa.gov/publications/tm/tm142/tm142.pdf

Chang, S., Morse, W.W., and Berrien, P.L. 1999a. Essential Fish Habitat Source Document: White Hake, *Urophycis tenuis*, Life history and Habitat Characteristics. NOAA Tech Memo NMFS NE 136. 23pp.

Chang, S., Berrien, P.L., Johnson, D.L., and Morse, W.W. 1999b. Essential Fish Habitat Source Document: Windowpane, *Scophthalmus aquosus*, Life History and Habitat Characteristics. NOAA Technical Memorandum NMFS-NE-137. 40pp.

Christian, J.R., Grant, C.G.J., Meade, J.D. and Noble, L.D. 2010. Habitat Requirements and Life History Characteristics of Selected Marine Invertebrate Species Occurring in the Newfoundland and Labrador Regions. Can. Manuscr. Rep. Fish. Aquat. Sci. 2925: vi +207 p.

Conover, D.O., Arnott, S.A., Walsh, M.R., and Much, S.B. 2005. Darwinian Fishery Science: Lessons from the Atlantic Silverside (*Menidia menidia*). Can. J. Fish. Aquat. Sci. 62: 7pp.

Corey, S. 1980. The Life History of *Crangon septemspinosa* Say (*Decapoda, Caridea*) in the Shallow Sublittoral Area of Passamaquoddy Bay, New Brunswick, Canada. Crustaceana 41(1): 21-28.

Corey, S. 1987. Reproductive Strategies and Comparative Fecundity of *Crangon septemspinosa* Say (*Decapoda, Caridea*). Crustaceana 52(1): 25-28.

COSEWIC. 2010a. COSEWIC Assessment and Status Report on the Atlantic Cod *Gadus morhua* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xiii. + 105pp.

COSEWIC. 2010b. COSEWIC Assessment and Status Report on the Atlantic Salmon *Salmo salar* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xlvii + 136pp.

COSEWIC. 2012. COSEWIC Assessment and Status Report on the American Eel *Anguilla rostrata* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. Xiii. + 121pp.

Department of Fisheries and Aquaculture (DOFA). 1999. Emerging Species Profile Sheets: Rock Crab (*Cancer irroratus*). Available Online: http://www.fishaq.gov.nl.ca/research_development/fdp/rock_crab.pdf

Dustan, P., Doherty, O., and Pardede, S. 2013. Digital Reef Rugosity Estimates Coral Reef Habitat Complexity. PLoS ONE 8(2): e57386. doi: 10. 1371/journal.pone.0057386.

Dwyer, A. Pers. Comm. November 2015. DFO Fisheries Officer.

Facey, D.E., and Van Den Avyle, M.J. 1987. Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (North Atlantic) – American Eel. U.S. Fish Wildl. Serv. Biol. Rep. 82(11.74) U.S. Army Corps of Engineers, TR EL-82-4. 28pp.

Fahay, M.P., Berrien, P.L., and Johnson, D.L. 1999. Atlantic Cod, *Gadus morhua*, Life History and Habitat Characteristics. Available Online: http://www.nefsc.noaa.gov/publications/tm/tm124/tm124.pdf

Fay, C.W., Neves, R.J., and Pardue, G.B. 1983. Species Profiles: Life Histories and Environmental

Requirements of Coastal Fishes and Invertebrates (Mid-Atlantic)- Atlantic Silverside. U.S. Fish and Wildlife Service, Division of Biological Services, FWS/OBS-82/11.10. U.S. Army Corps of Engineers. TR EL-82-4. 15pp.

Fishbase. 2015. Windowpane Flounder. Available Online: http://www.fishbase.ca/summary/530

Fisheries and Oceans Canada (DFO). 1996a. Atlantic Fisheries Stock Status Reports. Maritimes Region. Southern Bar Clam. Available Online: http://www.dfo-mpo.gc.ca/csas/Csas/status/1996/SSR_1996_100_e.pdf

Fisheries and Oceans Canada (DFO). 1996b. Atlantic Fisheries Stock Status Reports. Cape Breton American Oyster. Available Online: http://www.dfo-mpo.gc.ca/csas/Csas/status/1996/SSR_1996_124_e.pdf

Fisheries and Oceans Canada (DFO). 1997. Scotian Shelf Northern Quahaug. Maritimes Region. DFO Atlantic Fisheries Stock Status Report 96/121E. Available Online: http://www.dfo-mpo.gc.ca/csas/Csas/status/1996/SSR_1996_121_e.pdf

Fisheries and Oceans Canada (DFO). 2000. Atlantic Mackerel of the Northwest Atlantic. DFO – Science. Stock Status Report B4-04. 10 pp. Available Online: http://www.dfo-mpo.gc.ca/csas/Csas/status/2000/B4-04e.pdf

Fisheries and Oceans Canada (DFO). 2003a. Profile of the American Oyster (*Crossostrea virginica*), Gulf Region. Available Online: http://www.dfo-mpo.gc.ca/Library/271085-e.pdf

Fisheries and Oceans Canada (DFO). 2003b. Profile of the Blue Mussel (*Mytilus edulis*). Gulf Region. Available online: http://www.dfo-mpo.gc.ca/Library/270029-e.pdf

Fisheries and Oceans Canada (DFO). 2007. Integrated Fisheries Management Plan: Atlantic Mackerel. Available Online: http://www.dfo-mpo.gc.ca/fm-gp/peches-fisheries/ifmp-gmp/mackerel-atl-maquereau/mac-atl-maq-2007-eng.pdf

Fisheries and Oceans Canada (DFO). 2009a. Assessment of American Lobster in Newfoundland. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2009/026.

Fisheries and Oceans Canada (DFO). 2009b. Yellowtail Flounder. Available Online: http://www.dfo-mpo.gc.ca/Science/publications/uww-msm/articles/yellowtailflounder-limandeaqueuejaune-eng.html

Fisheries and Oceans Canada (DFO). 2010a. Assessment of Habitat Quality and Habitat Use by the Striped Bass (*Morone saxatilis*) Population of the St. Lawrence Estuary, Quebec. Can. Sci. Advis. Sec. Sci. Advis. Rep. 2010/069. Available Online: http://www.dfo-mpo.gc.ca/Library/343101.pdf

Fisheries and Oceans Canada (DFO). 2010b. Opportunity for Atlantic Silverside and Atlantic Saury Fisheries in the Nova Scotia Portion of the Southern Gulf of St. Lawrence. Gulf Region. Available Online: http://www.dfo-mpo.gc.ca/Library/340387.pdf

Fisheries and Oceans Canada (DFO). 2011a. Ecological Assessment of the Invasive European Green Crab (*Carcinus maenas*) in Newfoundland 2007-2009. Newfoundland and Labrador Region. Available Online: http://www.dfo-mpo.gc.ca/CSAS/Csas/publications/sar-as/2010/2010_033_e.pdf

Fisheries and Oceans Canada (DFO). 2011b. Recovery Potential Assessment for Western Atlantic Bluefin Tuna (*Thunnus Thynnus*) in Canadian Waters. Can. Sci. Advis. Sec. Sci. Advis. Rep. 2011/056. Available Online: http://www.dfo-mpo.gc.ca/Library/344451.pdf

Fisheries and Oceans Canada (DFO). 2012. Assessment of the Atlantic Mackerel Stock for the Northwest Atlantic (Subareas 3 and 4) in 2011. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2012/031.

Fisheries and Oceans Canada (DFO). 2013a. Assessment of the Rock Crab (*Cancer irroratus*) Fishery in the Southern Gulf of St. Lawrence for 2006 to 2011. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2013/030.

Fisheries and Oceans Canada (DFO). 2013b. Snow Crab. Available at: http://www.dfo-mpo.gc.ca/Science/publications/uww-msm/articles/snowcrab-crabedesneiges-eng.html

Fisheries and Oceans Canada (DFO). 2013c. Recovery Potential Assessment for the Atlantic Sturgeon, St. Lawrence Population. Quebec Region. Can. Sci. Advis. Sec. Sci. Advis. Rep. 2013/22. Available Online: http://www.dfo-mpo.gc.ca/csas-sccs/Publications/SAR-AS/2013/2013_022-eng.pdf

Fisheries and Oceans Canada (DFO). 2015. Alewife/Blueback Herring. Available Online: http://www.dfo-mpo.gc.ca/science/publications/uww-msm/articles/alewife-gaspareau-eng.htm

Friedman, A., Pizarro, O., Williams, S.B., and Johnson-Roberson, M. 2012. Multi-Scale Measures of Rugosity, Slope and Aspect from Benthic Stereo Image Reconstructions. PLoS ONE 7(12), e50440.

Gollasch, S., Kerckhof, F., Craeymeersch, J., Goulletquer, P., Jensen, K., Jelmert, A., and Minchin, D. 2015. Alien Species Alert*: Ensis directus*. Current Status of Invasions by the Marine Bivalve *Ensis directus.* ICES Cooperative Research Report No. 323. 32pp.

Gratwicke, B., and Speight, M.R. 2004. The Relationship Between Fish Species Richness, Abundance and Habitat Complexity in a Range of Shallow Tropical Marine Habitats. The Fisheries Society of the British Isles, J. Fish Biol. 66(3): 650-667.

Jenkins, J.B., A. Morrison, and C.L. MacKenzie, Jr. 1997. The Molluscan Fisheries of the Canadian Maritimes. *In* The History, Present Condition, and Future of the Molluscan Fisheries of North and Central America and Europe, Vol. 1. Atlantic and Gulf Coasts. (Ed.) MacKenzie et al. U.S. Department of Commerce, NOAA Technical Report NMFS. pp 15-44.

Kenchington, T. J. 1980. The Fishes of St. Georges Bay, Nova Scotia. Can. Tech. Rep. Fish. Aquat. Sci. 955: 154p.

Kenchington, E., Duggan, R., Riddel, T. 1998. Early Life History Characteristics of the Razor Clam (*Ensis directus*) and the Moonsnails (*Euspiru spp*.) with Applications to Fisheries and Aquaculture. Can. Tech. Rep. Fish. Aquat. Sci. 2223: vii + 32 p.

Klassen, G., and Locke, A. 2007. A Biological Synopsis of the European Green Crab, *Carcinus maenas*. Can. Manuscr. Rep. Fish. Aquat. Sci. No. 2818: vii+75pp.

Lavoie, R.E. 1989. Culture of the American Oyster, *Crassostrea virginica*. In: Cold-Water Aquaculture in Atlantic Canada. A. D. Boghen, editor. Canadian Institute for Research on Regional Development, Moncton, N.B. p.125.

Lawton, P., Singh, R.S., and Strong, M.B. 2009. Coastal Habitat Occupancy by Lobsters, *Homarus americanus*, in Relation to Dredge Spoil Disposal in the Approaches to Saint John Harbour, New Brunswick, Canada. Can. Tech. Rep. Fish. Aquat. Sci. 2844: v +60pp.

Leavitt, D.F. 2010. Biology of the Atlantic Jacknife (Razer) Clam (*Ensis directus* Conrad, 1843). NRAC Publ. No. 217. 5pp. Available Online: http://www2.ca.uky.edu/wkrec/BiologyRazorClam_NRAC.pdf

Locke, A., Klassen, G.J. Bernier, R., and Joseph, V. 2005. Life History of the Sand Shrimp, *Crangon Septemspinosa* Say, in a Southern Gulf of St. Lawrence Estuary. J. Shellfish Res. 24(2): 10pp.

Lovrich, G.A., Sainte-Marie, B., and Smith, B.D. 1995. Depth Distribution and Seasonal Movements of *Chionoecetes opilio* (Brachyura: Majidae) in Baie Sainte-Marguerite, Gulf of Saint Lawrence. Can. J. Zool. 73: 1712-1726.

MacKenzie, C., and Moring, J.R. 1985. Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (North Atlantic) – American Lobster. U.S. Fish and Wildlife Service. Biol. Rep. 82 (11.33). U.S. Army Corps of Engineers, TR EL-82-4. 19pp

MacKenzie, C.L.-Jr., Morrison, A., Taylor, D.L, Burrell, V.G.-Jr., Arnold, W.S., and Wakida-Kusunoki, A.T. 2002. Quahogs in Eastern North America: Part 1, Biology, Ecology, and Historical Uses. Mar. Fish. Rev. 64(2): 1-55.

Marshall, R.D. 1997. The Suitability of the Northumberland Coast of Nova Scotia for the Culture of the Northern Quahog, *Mercenaria mercenaria*. Master's Thesis. Simon Frasier University. 120pp.

Mercaldo-Allen, R., and Kuropat, C.A. 1994. Review of American Lobster (*Homarus americanus*) Habitat Requirements and Responses to Contaminant Exposures. Available Online: http://www.st.nmfs.noaa.gov/tm/ne_image/ne105image.pdf

Modlin, R.F. 1980. The Life Cycle and Recruitment of the Sand Shrimp, *Crangon septemspinosa*, in the Mystic River Estuary, Connecticut. Estuaries. 3(1): 10pp.

Moriyasu, M., Davidson, L.A., Lanteigne, M., Biron, M., Comeau, M., Hebert, M., Savoie, L., Surette, T., Wade, E., and Sabean, C. 2001. Current Knowledge on the Commercially Important Invertebrates (Lobster, Snow Crab, and Sea Scallop) in the Proposed Oil and Gas Exploration Sites in the Southern Gulf of St. Lawrence, Sidney Bight and Adjacent Areas. Can. Sci. Adv. Sec. Res. Doc. 2001/111.

Newell, R.I.E. 1989. Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (North and Mid-Atlantic) – Blue Mussel. U.S. Fish.Wildl. Serv. Biol. Rep. 82(11. 102). U.S. Army Corps of Engineers, TR EI-82-4. 25pp.

NOAA Fisheries Eastern Oyster Biological Review Team. 2007. Status Review of the Eastern Oyster (*Crassostrea virginica*). Report to the National Marine Fisheries Service, Northeast Regional Office. February 16, 2007. NOAA Tech. Memo. NMFS F/SPO-88, 105 p.

Pezzack, D.S., Frail, C.M., Reeves, A., and Tremblay, M.J. 2009. Offshore Lobster LFA 41 (4X and 5Zc). DFO Can. Sci. Advis. Sec. Res. Doc. 2009/023. vi+118pp.

Reebs, S.G., Jackman, P.M., Locke, A., and Fairchild, W.L. 2011. Avoidance by Sand Shrimp, *Crangon septemspinosa*, of Sandy Patches Covered by Hydrated Lime (Calcium Hydroxide) Deposits. Can. Tech. Rep. Fish. Aquat. Sci. 2938: iv + 7 p.

Rooker, J.R., Alvarado Bremer, J.R., Block, B.A., Dewar, H., De Metrio, G., Corriero, A., Kraus, R.T., Prince, E.D., Rodriguez-Marin, E., and Secor, D.H. 2007. Life History and Stock Structure of Atlantic Bluefin Tuna (*Thunnus Thynnus*). Rev. Fish. Sci. 15:265–310.

Schaefer, H.L., McCullough, D.M., Johnston, S.K., and Duggan, D.R. 2004. Significant Habitats: Atlantic Coast Initiative (SHACI). Sydney Bight - Unit 11. Can. Manuscr. Rep. Fish. Aquat. Sci. 2650: x + 213 pp.

Sharp, G., Semple, R., Connolly, K., Blok, R., Audet, D., Cairns, D., and Courtenay, S. 2003 Ecological Assessment of the Basin Head Lagoon: A Proposed Marine Protected Area. Can. Manuscr. Rep. Fish. Aquat. Sci. 2641.

Simon, J., and Cook, A. 2013. Pre-COSEWIC Review of White Hake (*Urophysis tenuis*) for the Maritimes Region. DFO Can. Sci. Advis. Sec. Res. Doc. 2013/024. iv + 82 p.

Simpson, M.R., Miri, C.M., and Mello, L.G.S. 2012. A Pre-COSEWIC Assessment of White Hake (*Urophycis tenuis*) in Newfoundland and Labrador Waters. DFO Can. Sci. Advis. Sec. Res. Doc. 2012/038. ii + 59p.

Squires, H.J. 1990. Decapod Crustacea of the Atlantic Coast of Canada. Can. Bull. Fish. Aquat. Sci. 221: 532 p.

Studholme, A., Packerand, D.B., and Berrien, P.L. 1999. Atlantic Mackerel, *Scomber scombrus*, Life

History and Habitat Characteristics. U.S. Dept. of Commerce. NOAA Technical Memorandum NMFS-NE- 141. 44pp.

Tyrrell, M.C. 2005. Gulf of Maine Marine Habitat Primer. Gulf of Maine Council on the Marine Environment, www.gulfofmaine.org. vi+54 pp.

U.S. Fish and Wildlife Service (USFWS). 2001. Winter Flounder Habitat Model: Gulf of Maine Watershed Habitat Analysis. Available Online: http://www.fws.gov/r5gomp/gom/habitatstudy/metadata/winter_flounder_model.htm

Wentworth, C.K. 1992. A Scale of Grade and Class Terms for Classic Sediments. J. Geol. 30(5): 377-392.

Williams, P.J., Floyd, T.A., and Rossong, M.A. 2006. Agonistic Interactions Between Invasive Green Crabs, *Carcinus maenas* (Linnaeus) and Sub-Adult American Lobsters, *Homarus americanus* (Milne Edwards). J. Exp. Mar. Biol. Ecol. 329: 66-74.

CHAPTER 8 CLOSURE

This report has been prepared for the sole benefit of Nova Scotia Power Inc. The report may not be relied upon by any other person or entity without the express written consent of CBCL Limited and Nova Scotia Power Inc.

Any use which a third party makes of this report and any reliance on decisions made based on it, are the responsibility of such third parties. CBCL Limited accepts no responsibility for damages, if any, suffered by any third party as a result of decisions or actions made based on this report.

The conclusions and recommendations presented represent the best judgement of the assessor based on current environmental standards and on the observed site conditions. Due to the nature of the investigation and the limited data available, the assessor cannot warrant against undiscovered environmental liabilities.

The conclusions are based on results from specific drop camera locations, and can only be extrapolated to an undefined limited area around these locations.

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APPENDIX A

Underwater Video Table

Appendix A: Spot Check Interpretation Results - Archie Pond

Spot Check Number	*Depth (ft)*	*Substrate Composition*	*Observed Flora*	*Observed Fauna*	*Comments*
SC1	8.2	Fines (100%)	N/A	Hermit crab - U (0:43), Sand shrimp - U (0:43, 0:47, 0:55), Slipper snail - U	Video SC1B. Shell debris - U (oyster), Leaf litter - U. Slipper snail on shell debris. Hermit crab tracks.
SC2	9.4	Fines (100%)	N/A	N/A	Video SC2B. Shell debris - U (oyster), Leaf litter - U. Hermit crab tracks.
SC3	10.8	Fines (100%)	N/A	Hermit crab - U (0:51), Sand shrimp - U (0:57x4)	Video SC3B. Shell debris - U (oyster), Leaf litter - U. Hermit crab tracks.
SC4	10	Fines (100%)	N/A	Hermit crab - U (1:10, 1:25, 1:32, 1:41), Sand shrimp - U (1:41)	Shell debris - U (oyster), Wood debris - U. Hermit crab and crab tracks. Boat drifts toward shore and shell debris becomes C.
SC5	9.6	Fines (100%)	N/A	N/A	Shell debris - O (oyster), Wood debris - U. Hermit crab and crab tracks.
SC6	9.8	Fines (100%)	*Spongomorpha sp* . - U	Juvenile flounder - U (4:58), Sand shrimp - U (5:17)	Via TR video. Shell debris - U (oyster). Rubber tire (upright) - U. Algae on tire. Hermit crab tracks. Metal pipe - U .
SC7	8.6	Fines (100%)	*Spongomorpha sp* . - U	Slipper snail - U	Shell debris - U (oyster). Rubber tire - U. *Crepidula* and algae on tire. Boat drifts toward shore and shell debris becomes A.
SC8	8.3	Fines (100%)	*Spongomorpha sp* . - U	Slipper snail - U; Unidentified oligochaete worm - U (1:10), Sand shrimp - U (1:12x8), Hermit crab - U (1:32)	Shell debris - U (oyster/littorine). Rubber tire - U. Hermit crab and crab tracks. *Crepidula* and algae on tire.
SC9	4.3	Fines (100%)	*Spongomorpha sp* . - O	Green crab - U (2:27), American oyster - C	Shell debris - A (blue mussel/oyster/littorine). Algae on shell debris.
SC10	4	Fines (100%)	N/A	Green crab - U (1:12x2), Blue mussel - U, American oyster - O, Juvenile flounder - U (1:23), Slipper snail - O	Shell debris - A (blue mussel/oyster/littorine). Rubber tire - U.
SC11	8	Fines (100%)	N/A	Blue mussel - U, American oyster - O, Slipper snail - C	Shell debris - A (blue mussel/oyster/littorine).
SC12	6.8	Gravel (50%), Fines (50%)	N/A	American oyster - O, Slipper snail - U, Northern sea star - U	Shell debris - A (blue mussel/oyster/littorine).

Appendix A: Spot Check Interpretation Results - Strait of Canso

Spot Check Number	*Approximate Location*	*Depth (ft)*	*Substrate Composition*	*Observed Flora*	*Observed Fauna*	*Comments*
SC13	N/A	13.3	Boulder (20%), Gravel (10%), Fines (70%)	*Chondrus crispus* - O, *Lithothamnium sp*. - U, *Spongomorpha sp*. - U	N/A	Shell debris - U
SC14	N/A	10.7	Cobble (60%), Gravel (35%), Fines (5%)	*Fucus sp*. - U, *Lithothamnium sp*. - U	*Balanus sp*. - U, Littorines - O, Rock crab - U (2:10)	*Zostera* debris - U, Shell debris - U. Bryozoans and spiral tube worms encrusting *Fucus sp*.
SC15	N/A	9.9	Boulder (5%), Cobble (45%), Gravel (45%), Fines (5%)	*Fucus sp*. - U, *Lithothamnium sp*. - U, *Chondrus crispus* - O, *Polysiphonia sp*. - U	*Balanus sp*. - U, Littorines - O	Shell debris - U. Bryozoans and spiral tube worms encrusting *Fucus sp.*
SC16	N/A	10.5	Cobble (60%), Gravel (35%), Fines (5%)	*Chondrus crispus* - O, *Lithothamnium sp*. - O, *Polysiphonia sp*. - U	*Balanus sp*. - U, Littorines - O	Shell debris - U
SC17	N/A	3	Boulder (80%), Cobble (10%), Gravel (10%)	*Fucus sp*. - O, *Ascophyllum nodosum* - U, *Lithothamnium sp*. - O, *Furcellaria lumbricalis* - U, *Polysiphonia sp*. - U	*Balanus sp*. - U, Littorines - O	Bryozoans and spiral tube worms encrusting *Fucus sp*.
SC18	N/A	4.7	Boulder (70)%, Cobble (20%), Gravel (10%)	*Fucus sp*. - O, *Ascophyllum nodosum* - U, *Lithothamnium sp*. - C, *Furcellaria lumbricalis* - U, *Polysiphonia sp*. - U	Littorines - C	Bryozoans and spiral tube worms encrusting *Fucus sp*.
SC19	N/A	5.5	Boulder (70)%, Cobble (20%), Gravel (10%)	*Fucus sp*. - C, *Ascophyllum nodosum* - U, *Lithothamnium sp*. - C, *Furcellaria lumbricalis* - U, *Polysiphonia sp*. - U	*Balanus sp*. - O, Littorines - C, Northern sea star - U (1:07)	Bryozoans and spiral tube worms encrusting *Fucus sp*.
SC20	N/A	6.4	Boulder (70%), Cobble (15%), Gravel (10%), Fines (5%)	*Fucus sp*. - C, *Ascophyllum nodosum* - U, *Lithothamnium s* p. - C, *Furcellaria lumbricalis* - U, *Polysiphonia s* p. - U	*Balanus sp*. - U, Littorines - O	Bryozoans and spiral tube worms encrusting *Fucus sp*.
Transect 1	SC21	<3	Boulder (50%), Cobble (35%), Gravel (10%), Fines (5%)	*Ascophyllum nodosum* - C	*Balanus sp*. - A, Littorines - A	
	SC22	<3	Boulder (50%), Cobble (35%), Gravel (10%), Fines (5%)	*Ascophyllum nodosum* - C	*Balanus sp*. - A, Littorines - A	
	SC23	<3	Boulder (50%), Cobble (35%), Gravel (10%), Fines (5%)	Ascophyllum nodosum - C	*Balanus sp*. - A, Littorines - A	
	SC24	<3	Boulder (50%), Cobble (35%), Gravel (10%), Fines (5%)	Ascophyllum nodosum - C, Fucus sp. - U	Balanus sp. - A, Littorines - A	

APPENDIX B

Photographs

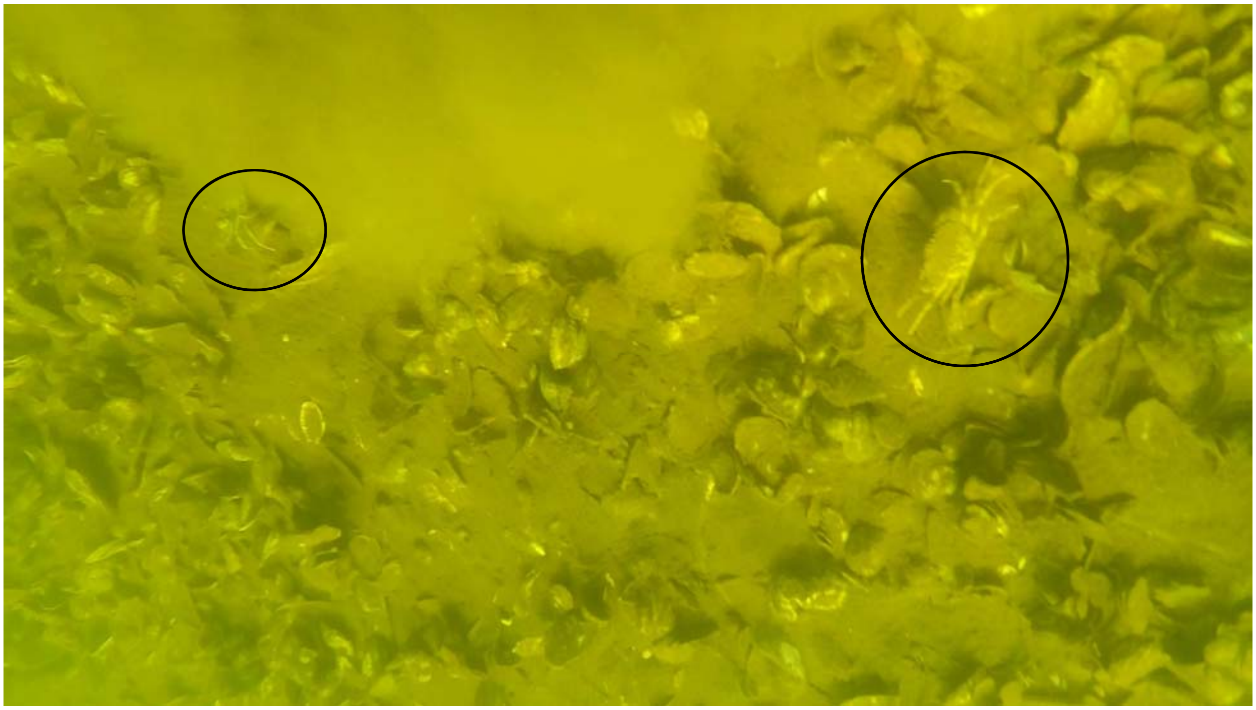
Figure 1. Green crabs (*Carcinus maenas*)

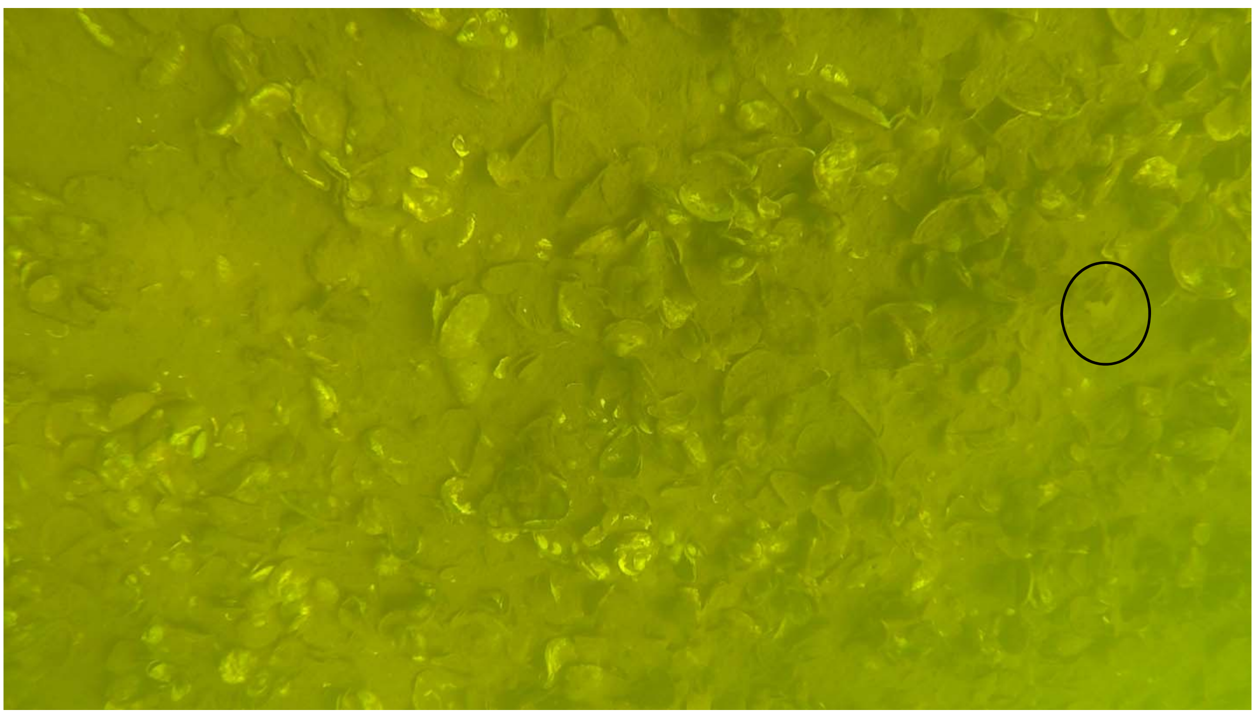
Figure 2. Unidentified Juvenile Flounder

Figure 3. Northern Sea Star (*Asterias sp*.)

Figure 4. Rock Crab (*Cancer irroratus*)

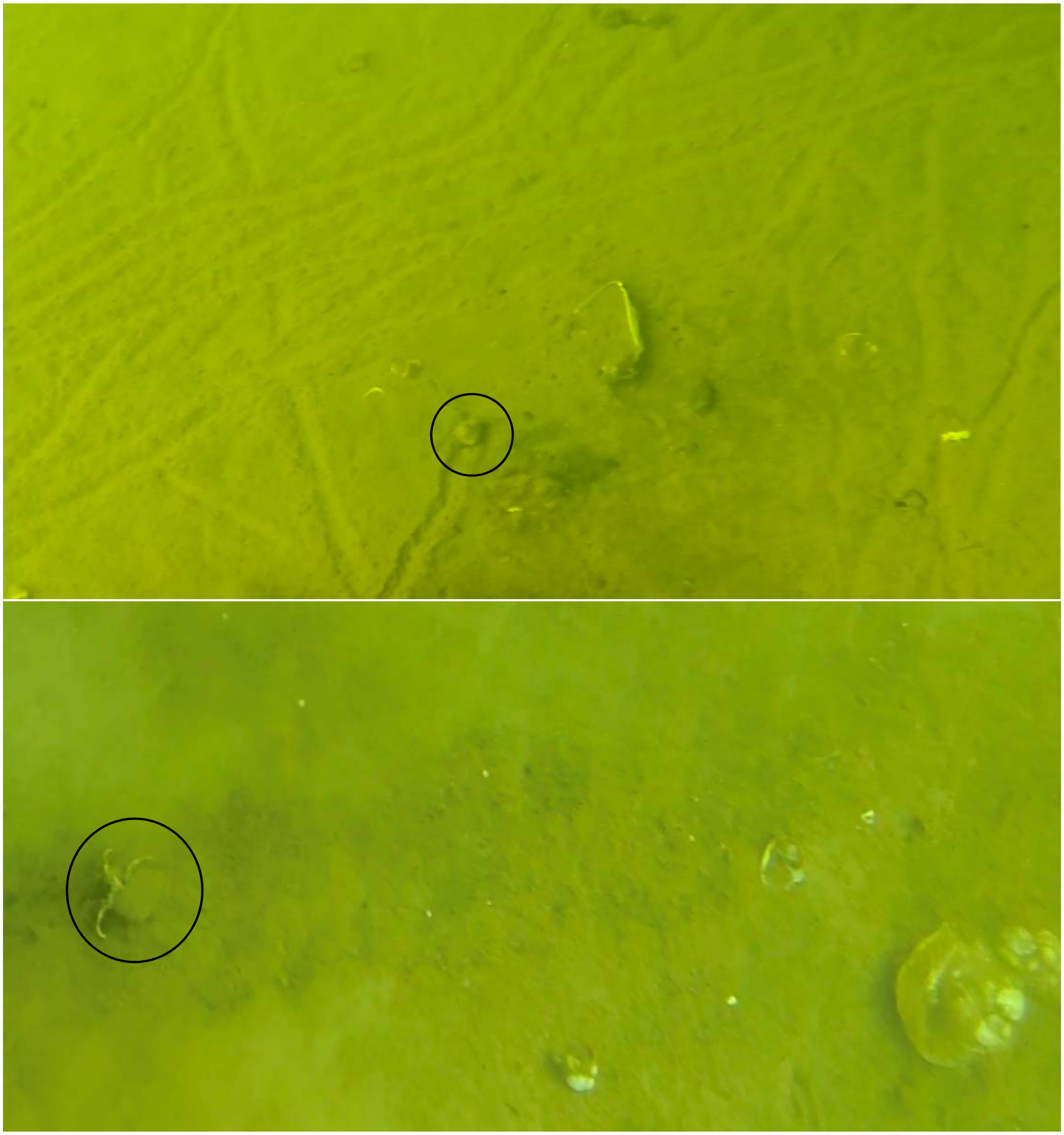

Figure 5. Hermit Crabs (*Pagarus sp*.)

Figure 6. American Oysters (*Crassostrea virginica*)

Figure 7. Blue Mussels (*Mytilus edulis*)

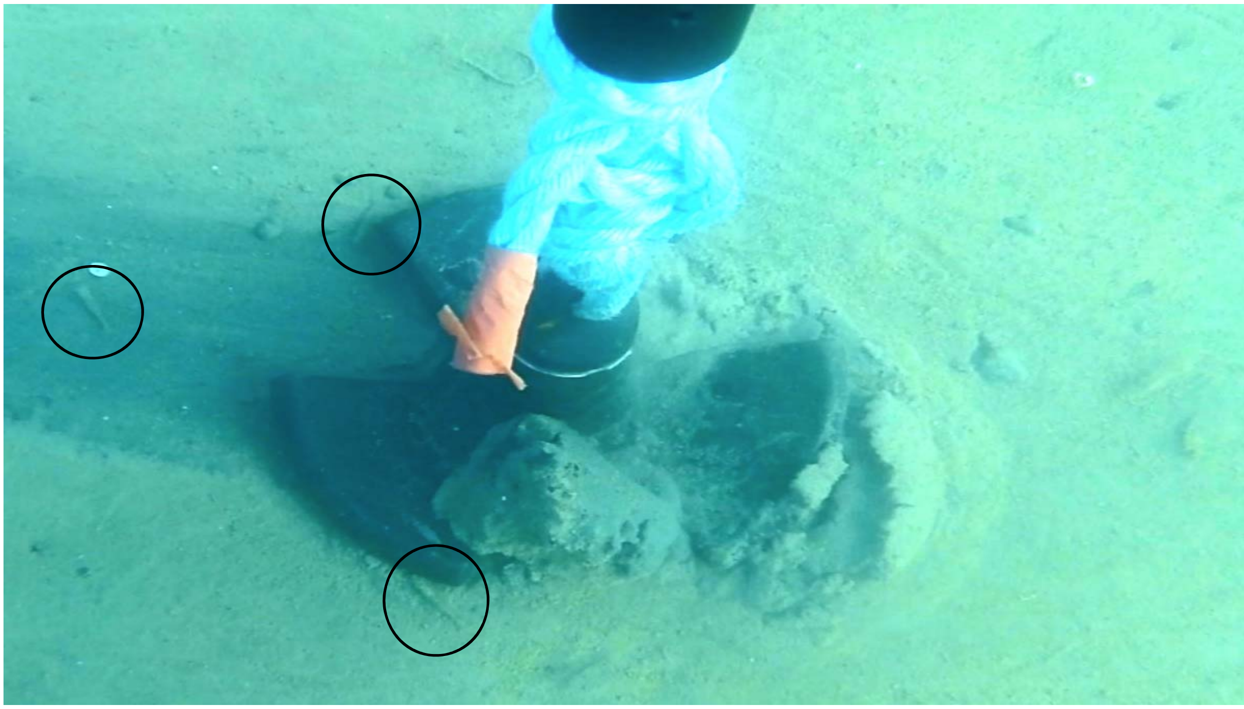

Figure 8. Sand Shrimp (*Crangon Septemspinosa*)

Figure 9. Unidentified Oligeochaete Worm

Figure 10. Slipper Snails (*Crepidula fornicata*)

Figure 11. *Balanus sp.*

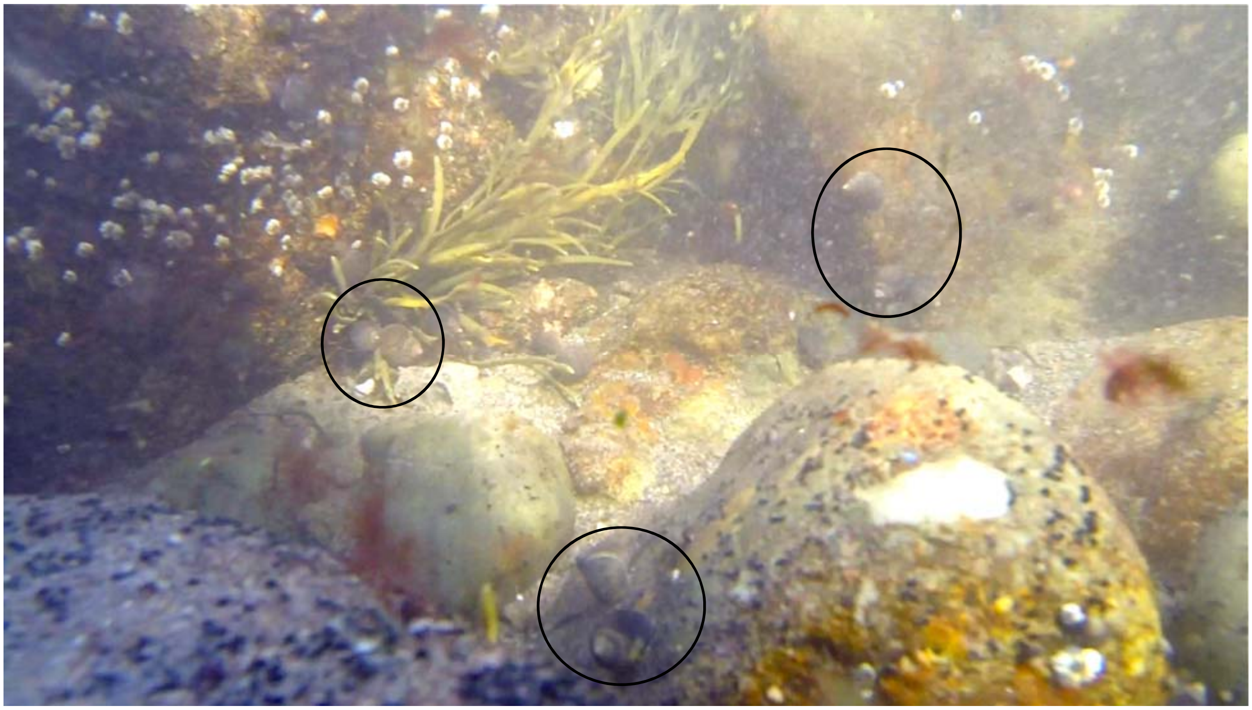
Figure 12. Littorines.


Figure 13. *Fucus sp*.

Figure 14. *Ascophyllum nodosum* below and above the water column.

Figure 15. *Spongomorpha sp.* growing on submerged tire.

Figure 16. *Furcellaria lumbricalis.*

Figure 17. *Lithothamnium sp*. forms a pink tinged plaque on boulder.

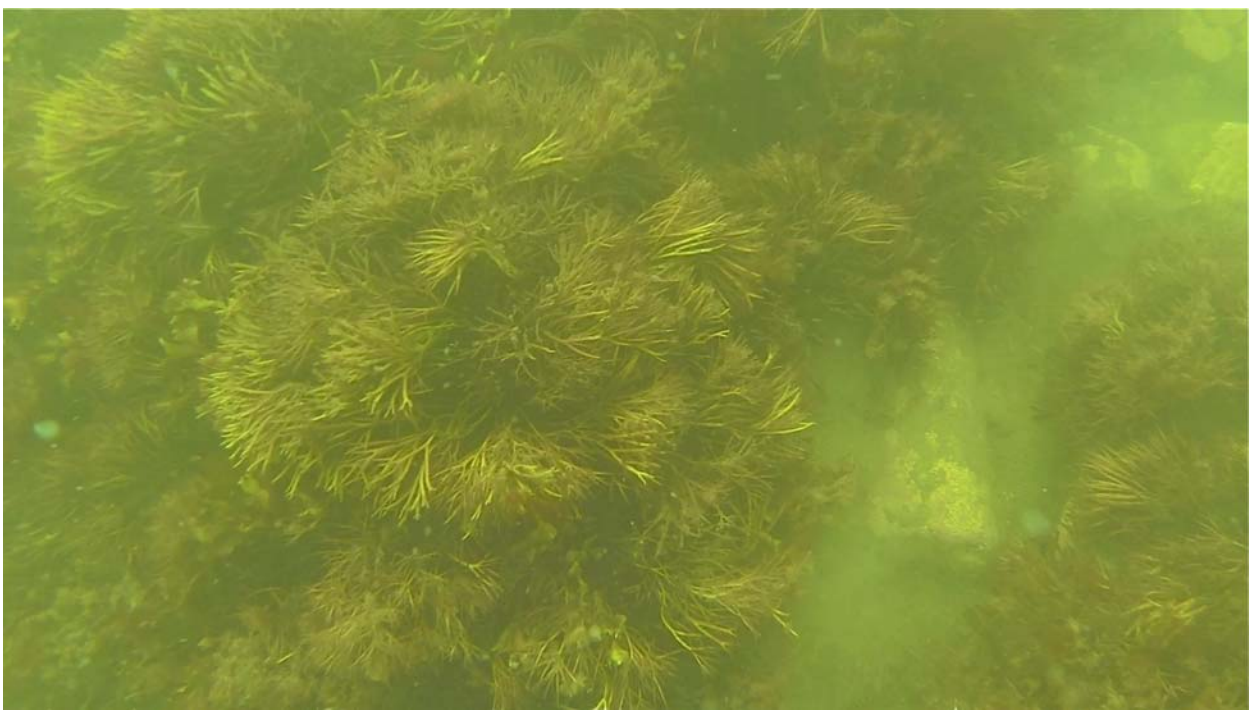

Figure 18. *Chondus crispus.*

Figure 19. *Polysiphonia sp*. growing epiphytically on *Chondus crispus*.