Results of a Survey of the Intertidal Marine Habitats and Communities at a Proposed Quarry Site Located in the Vicinity of Whites Cove, Digby Neck, Nova Scotia

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1. Introduction

As part of a study of the biological resources contained within a property proposed as a site for a rock quarry, a survey of the intertidal area bordering the shoreline of the property was conducted during 13-14 June 2002. The primary objective of the survey was to describe and document the general nature of the marine habitats and plant community types present within the intertidal zone. In addition, observations were also made of two freshwater brooks that flow across the property and into the Bay of Fundy.

2. Approach

An initial brief survey of the coastline of the property was carried out to determine the degree of heterogeneity of the intertidal communities along its length. This revealed that the entire shoreline varied little in terms of the marine habitats and communities present. There was, however, some variation in the extent and patterns of zonation within the area of Whites Cove, as well as within the areas north and south of Whites Cove. Accordingly three transects, each running from the high tide to low tide mark, were established for a more detailed survey. One transect was located within Whites Cove, the most probable area for the location of a marine terminal serving the quarry if it were to be constructed. The remaining two transects were located to the north and south of Whites Cove (Figure 1).

3. General Shoreline Morphology

The length of the shoreline bordering the property is approximately 3.1 km and consists of a predominantly rocky shoreline dominated by basaltic bedrock. Fine sediments are scarce resulting in the absence of sandy beaches and mudflats. The most extensive beach development is within Whites Cove where a small till deposit has been eroded to produce a cove containing a beach. The eroded material has been prograded forming a beach composed of small boulders (generally less than 1 meter in diameter) at the low tide mark to cobble along the high tide mark. The area to the north of Whites Cove is largely a mixture of exposed bedrock and large boulders. The area to the south of Whites Cove is largely exposed bedrock, somewhat steeper in relief and containing more extensive areas of vertical cliffs than the area to the north. The lack of sediment and the presence of a hard stable substrate along most of the coastline provides ideal conditions for the establishment of macroalgal communities and these are very well developed along the entire shoreline of the property.

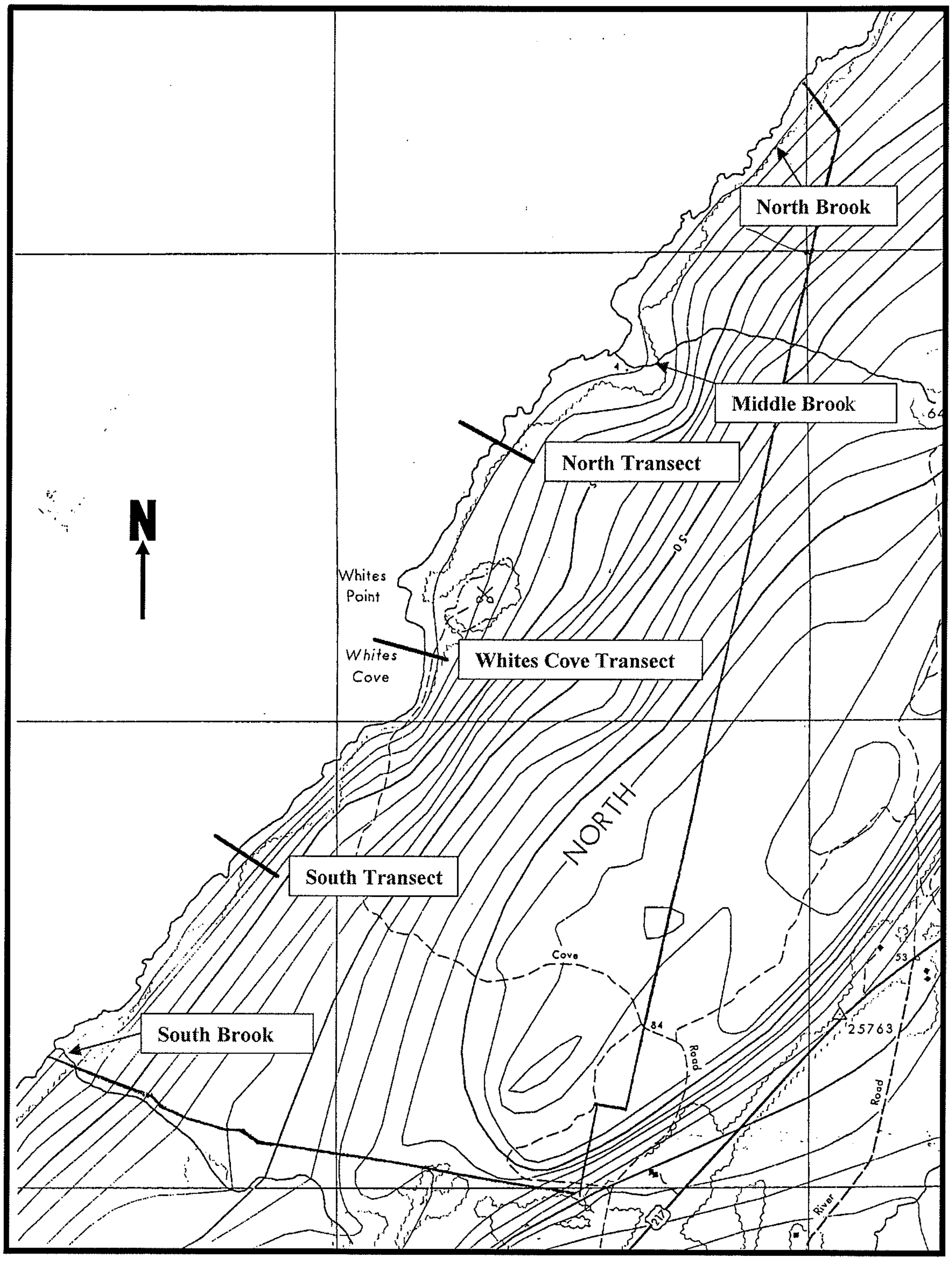

Figure 1. Site map showing boundary line and location of survey transects and brooks.

4. Intertidal Habitats and Communities

Intertidal, or littoral areas as they are often referred to, commonly exhibit a distinct pattern of zonation. Zonation patterns on rocky shorelines vary, largely in response to variations in tidal range, exposure time and wave and ice action. Figure 4.1 illustrates one of the simpler schemes used to describe the zonation pattern typically found in northern rocky intertidal areas.

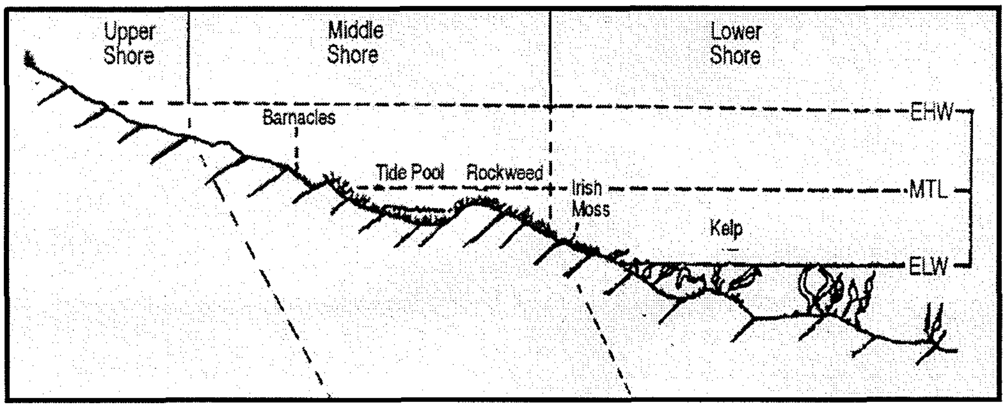

Figure 4.1. Zonation pattern typical of rocky marine intertidal communities (EHW – Extreme High Water; MTL- Mid-Tide Level; ELW – Extreme Low Water).

The upper shore consists largely of bare rocks but may have growths of microscopic algae and lichens. Few animals are present in this area other than sparse populations of periwinkles. The upper area of the middle shore typically contains a barnacle zone which, as one moves towards the low tide mark, gives way to dense growths of rockweeds which are often interspersed with various species of macroscopic green and red algae. In addition to barnacles, periwinkles, blue mussels and dog welks are common to this zone. The lower shore is often dominated by red algae and various species of calcareous algae. This area, because of less exposure time, contains a greater diversity of marine animals and typically contains limpets, numerous crustaceans, horse mussels and starfish. Sponges, hydroids and tunicates are also often present in this zone. Below the lower shore and within the sub-tidal, or sub-littoral area, which is always submersed except at extreme low tides, the macroalgal community changes from rockweeds to kelps.

All of these zones, and their general characteristics, are evident along the entire shoreline of the property and surveyed transects. The pattern of zonation described above is most notable at Whites Cove, which has the gentlest relief. North and south of Whites Cove the zonation pattern is less distinct as a result of the more severe gradient which causes the zones to merge into each other.

The following presents a more detailed account of the community types and intertidal zonation found at each of the survey transects.

4.2. The Whites Cove Transect

As mentioned previously, the Whites Cove transect, because of its more gradual relief, exhibited the most distinct intertidal zonation pattern. The very uppermost part of the shoreline contained small isolated rafts of seaweed wrack, composed mainly of rockweeds and smaller amount of kelps in the process of decomposition. These wracks were heavily colonized by *Hyale nilloni*, a small amphipod commonly found associated with seaweed wrack.

The upper shore contained a number of small tide pools. These pools, because of their small size and long exposure time, are subjected to wide ranges in temperature and salinity and support only the hardiest of species and are dominated almost entirely by *Enteromorpha intestinalis*, green macroscopic algae known for its hardiness.

The macroalgae of the upper shore consists largely of sparsely scattered mats of rockweeds (*Fucus vesiculosus*, and *Ascophyllum nodosum*) and patches of barnacles (*Balanus balanoides*). The intertidal community is poorly developed in this area as a result of the cobble substrate, which is typically too mobile to allow colonization by most marine organisms (Figure 4.2.1). This area also lacked a distinct barnacle zone, barnacles being present only on some of the larger, more immobile boulders.

Figure 4.2.1. View of Whites Cove intertidal looking seaward.

The substrate of the mid and lower shore is more stable being composed mainly of bedrock (Figure 4.2.2). It is overlain with a thick mat of rockweeds. Periwinkles (*Littorina* spp.) are abundant in this area, especially in the tide pools and rock crevices. Barnacles are confined mainly to areas exposed to strong wave action where rockweeds have difficulty establishing themselves. The lower shoreline has a distinct band of red algae, mostly *Polysiphonia lanosa,* which grows as an epiphyte attached to *Ascophyllum*. Other algae observed scattered among the rockweeds in the mid and lower zone included sea lettuce (*Ulva lactuca*), dulse (*Palmaria palmata*), irish moss (*Chondrus crispus*) and dead man's fingers (*Codium fragile)*.

Figure 4.2.2. View of lower intertidal at Whites Cove.

There was an abundance of periwinkles (*Littorina sp.*) in the mid and lower shore zones, especially in tide pools and rock crevices. Other marine animals observed included small patches of blue mussels (*Mytilus edulis*), mainly in the mid shore zone, and horse mussels (*Modiolus modiolus*), hermit crabs (*Pagurus sp.*), dog whelk (*Nucella lapillus*) and green crabs (*Carcinus maenas*) in the low shore zone.

The sublittoral zone was not examined thoroughly but obviously contained a dense macroalgal community (Figure 4.2.3) consisting largely of sugar kelp (*Laminaria saccharina*).

4.3. The North and South Transects

The north and south transects differed mainly in the more pronounced relief and the lack of a cobble-boulder beach. The result of this difference in morphology is a better developed upper shore zone, the presence of larger and more abundant tide pools and a more compressed, less well defined mid and lower shoreline.

The more stable bedrock substrate of the upper zone contains growths of lichens in the uppermost shore. These organisms (probably *Xanthoria sp.*) are present as small, scattered yellow patches. The exposed bedrock of the upper shore zone is also colonized by bluegreen algae, which impart the dark green color to rock surfaces.

Tide pools are scattered throughout the mid and lower shore zones. Because these seldom become dry, they contain a diversity of marine organisms. Periwinkles are especially abundant along with amphipods (*Gammarus sp.*), encrusting red coralline algae (*Lithothamnion sp.* and *Phytolithon* sp.) and limpets (*Acmaea testudinalis*). Some of these pools also contained a fleshy encrusting brown alga (probably *Ralfsia fungiformis*).

The middle and lower shore zones were very similar to that described for the Whites Cove transect except that, because of the steeper relief, the zonation was somewhat compressed and less distinct (Figures 4.3.1 and 4.3.2). Most of the plant and animal algal species present at Whites Cove were also present along the North and South transects. *Fucus* and *Ascophyllum* were the dominant macroalgae.

Figure 4.3.1. View of intertidal along North transect looking landward.

Figure 4.3.2. View of South transect looking seaward.

Table 1 lists the plant and animal species observed along each transect.

Table 1 Species observed along each transect.

Species	Whites Cove	North Transect	South Transect
PLANTS			
Xanthoria sp. (Yellow lichen)		X	X
Ulva lactuca (Sea lettuce)	X		
Enteromorpha intestinalis (Hollow green weed)	X	X	X
Codium fragile (Dead man's fingers)	X		
Fucus sp. (Bladderwrack)	X	X	
Ascophyllum nodosum (Knotted wrack)	X	X	
Laminaria saccharina (Sugar kelp)	x	X	
Alaria esculenta (Edible kelp)	X		
Chondrus crispus (Irish moss)	X		X
Palmaria palmata (Dulse)	X		
Polysiphonia lanosa (Tubed red weed)	X	X	
Lithothamnion sp (Coralline algae)		X	X
Phymatolithion sp. (Coralline algae)		X	X
ANIMALS			
Mytilus edulis (Blue mussel)			
Modiolus modiolus (Horse mussel)			
Spirorbis sp. (Tube worm)			
Nucella lapillus (Dog welk)			
Littorina spp. (Periwinkle)			
Acamaea testudinalis (Tortiseshell limpet)			
Balanus balanoides (barnacle)	X	X	X
Pagurus sp. (Hermit crab)			
Carcinus maenas (Green crab)			
Cancer irroratus (Rock crab)			
Gammarus sp. (Scud)		X	X
Hyale nilssoni (Beach flea)	X		

Other species of plants and animals that are common to intertidal rockweed communities in the lower Bay of Fundy, but not observed during this survey include: *Lunatica heros* (moon snail); *Lacuna vincta* (chink snail); *Crepidula fornicata* (slipper limpet); *Aeolidia papillosa* (a nudibranch); *Astreias sp.* (starfish); *Ceramium rubum* (a red alga); and *Gigartina stellata* (a red alga).

4.4. Brooks

The lower portion of two small brooks, one located near the north property line (727577E; 4927983N) and one near the south property line (727870E; 4928434N), were surveyed. A third brook, shown as 'Middle Brook' on Figure 1, flows through a bog located just above the shoreline. Before flowing into the intertidal zone, this book forms a small (< 3 meter diameter), shallow (< 0.2 meter) pool. At the time of the survey, the surface of the pool was covered with a green filamentous alga, and most of the bottom was covered with a bacterial mat (probably a sulfur bacteria) and the pool had a strong odor indicative of anaerobic conditions. Because this stream is not suitable as fish habitat, it was not examined in detail.

The lower portion of the north brook (Figure 4.4.1) is about 0.7-1.0 meter in width and, at the time of the survey, had a moderate flow of water. Water depths averaged about 0.2 meters, but in some places there were small pools, generally less than one meter in diameter and 0.5 m in depth. The bottom of the stream was mainly bedrock with a few small areas that contained cobbles. There was little evidence of any sandy or gravelly areas that would serve as suitable spawning habitat for salmonids. Two surber samples, taken in an area containing a cobble substrate, contained only a few caddis fly larvae, and visual examination of the undersides of submersed rocks failed to reveal the presence of any other types of aquatic invertebrates. It is unlikely that this stream serves as a significant habitat for salmonids.

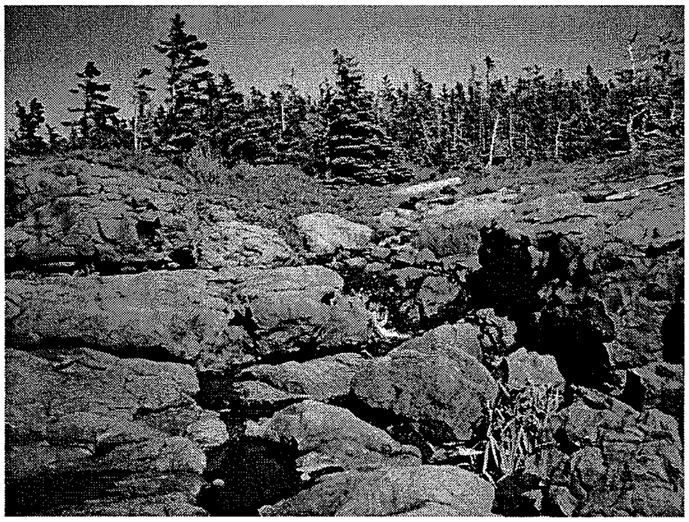

Figure 4.4.1. Landward view of lower portion of North brook.

The south brook is only about 0.2-0.5 meters in width at its lower end and flows over a very steep gradient containing a number of small waterfalls. Water depths were only 5-10 centimeters at the time of the survey. Its steepness and small size make it unlikely to be a significant habitat for salmonids

4.5 Ecological Significance of Rocky Intertidal Macroalgal Communities

Rocky intertidal macroalgal communities play a number of important ecological roles. They are major primary producers and, although macroalgae are grazed on directly by some animals, especially sea urchins, much of this material is eventually exported to the open waters of the Bay where it becomes part of the detrital food web (Bradford 1989; Mann 1992). Rafts of floating macroalgae are also thought to play an important role as a feeding area for seabirds, marine mammals and fish (Rangley 1994).

Macroalgae are not only important as an energy source but, because of their large size and structural characteristics, are also important in providing foraging and refuge habitat for various

Figure 4.4.2. Landward view of lower portion of South brook.

species of marine organisms (Mann 1992; Percy, 1996). Rangley (1998) estimates that as many as 31 species of fish use rockweed habitat during summer, and about 17 species are present as juveniles suggesting it is an important nursery habitat. Black and eider ducks are known to forage for amphipods and periwinkles living in the rockweed community. It is also generally well known that lobsters and other commercially important marine organisms rely on macroalgal habitat during various stages of their life cycle.

Rockweed is also a valuable commercial commodity that is harvested and processed for use in food and agricultural products, livestock feeds and as an emulsifier in numerous products such as paints, cosmetics and foods. Species currently being harvested in the Bay of Fundy include dulse (*Palmeria* palmata), irish moss (*Chondrus crispus*), kelps (*Laminaria* spp.) and rockweeds (*Fucus* spp. and *Ascophyllum nodosum*).

4.6 Summary

The results of this survey indicate that the intertidal marine communities and habitats present along the shoreline of the property are typical of the rocky shoreline areas of the lower Bay of Fundy. The predominant habitat and community type is a rockweed community dominated by *Fucus* and *Ascophyllum*. This community is very well developed along the entire shoreline and appears to be in a healthy, prolific condition. Most species of marine organisms associated with this type of community were observed to be present. There does not appear to be any particularly unique or extraordinary characteristics associated with this shoreline.

The two small brooks examined do not appear to be particularly good salmonid habitat due to their small size, steep gradient and lack of substrate suitable for spawning.

4.7 References

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