Dynamics of Macroalgal Blooms along the Cape Cod National Seashore

Patrick Lyons\textsuperscript{1,2,*}, Carol Thornber\textsuperscript{1}, John Portnoy\textsuperscript{3}, and Evan Gwilliam\textsuperscript{3}

\textbf{Abstract} - Accumulations of nuisance drift macroalgae along the open coast Atlantic beaches of the Cape Cod National Seashore have been observed on an anecdotal basis for over 50 years. This entire stretch of coastline is sandy, with no solid substrata for algal attachment. During the summer of 2006, we collected data on drift macroalgal accumulations repeatedly throughout this National Seashore. Peak biomass (consisting of several filamentous red species and green algae, primarily \textit{Ulva lactuca}) was found in early August, mainly at the northernmost site. Our data, together with ocean current patterns and anecdotal evidence, suggest that macroalgae may originate in rocky shorelines of northern New England and are transported south by Gulf of Maine currents. Algae are most likely caught along the Cape Cod National Seashore shoreline by sand bars, particularly in the northern part of the shoreline.

\textbf{Introduction}

Macroalgal blooms have received increasing attention in the scientific community throughout the last few decades. Although less well studied than toxic phytoplankton (Townsend et al. 2001), macroalgal blooms also have important ecosystem functions such as providing habitat for invertebrates (Hull 1987, Norkko et al. 2000) or fish (Kingsford 1995), and food for herbivorous grazers (Salovius and Bonsdorf 2004). In addition, blooms may cause hypoxic (indirectly) or anoxic conditions upon decomposition, altering ecosystem function (Raffaelli et al. 1998). Blooms have also been associated with the decline of corals (Bell 1992) and seagrasses (Peckol et al. 1994) due to competition for nutrients and/or shading. Bloom-forming species are typically characterized by thalli with large surface-area-to-volume ratios (either thin and blade-like or filamentous and repeatedly branched), allowing for fast uptake of nutrients (Littler and Littler 1980, Lotze and Schramm 2000, Wallentinus 1984). Blooms most commonly consist of green algae (Raffaelli et al. 1998, Valiela et al. 1997), but both red and brown species of macroalgae can be bloom forming as well (Gross 1994). Common explanations for the occurrence of macroalgal blooms include increased availability of nitrogen and/or phosphorus, as well as changes in water circulation (Raffaelli et al. 1998). Wind-driven upwelling events, which replenish nutrients, have also been linked to occurrences of blooms (Kiiirikki and Blomster 1996). In the northeastern United States,
several estuaries with frequent macroalgal blooms exist. Wilce et al. (1982) and Gross (1994) both described seasonal blooms of *Pilayella littoralis* (Linnaeus) Kjellan. in Nahant Bay, MA, which have occurred for at least fifty years. Seasonal blooms of green algae such as *Ulva* and *Cladophora* have been described in the Waquoit Bay Natural Research Reserve on the south shore of Cape Cod, MA (Valiela et al. 1997). Vadas and Beal (1987) and Vadas et al. (2004) described blooms of *Ulva* and *Cladophora* species in Cobscook Bay, ME. In Narragansett Bay, RI, green and red macroalgal blooms have been observed, particularly in Greenwich Bay (Granger et al. 2000; C. Thornber, unpubl. data).

The Cape Cod National Seashore (CCNS) is known for its extensive and continuous Atlantic beaches, attracting swimmers, surfers, fisherman, and sunbathers by the thousands. These sandy beaches are frequently fouled by filamentous drift macroalgae during the summer. While Collins (1914) noted only scattered remnants of drift algae on these shores, casual observations over recent decades (Graham Giese, Provincetown Center for Coastal Research, Provincetown, MA, pers. comm.) imply that although drift algae amounts vary from year to year, they are becoming more abundant. In the late 1980s, macroalgal accumulation caused repeated beach closures during late August at Head of the Meadow Beach (Gross 1994). A few years later, in June of 1993, *P. littoralis* was positively identified throughout the CCNS, particularly at Head of the Meadow Beach (Gross 1994).

This occurrence is particularly interesting in that macroalgal blooms are typically found in eutrophic estuaries, in which water residence times are long enough for macroalgae to absorb large pulses of nutrients and form blooms (Valiela et al. 1997). By contrast, the blooms at the CCNS occur along well-flushed, open coastline. Furthermore, the entire stretch of shore is sandy, with no hard substrate for algal attachment. Thus, it is likely that these algae originate elsewhere and are transported to beaches at the CCNS via physical processes, e.g., by coastal currents and/or by upwelling (Kiirikki and Blomster 1996). Gulf of Maine coastal currents are largely counter clockwise, running southward along the coast of Maine, New Hampshire, and northern Massachusetts (see fig. 3 of Pettigrew et al. 2005). Thus, algae are likely to be transported from northern New England. Where, when, and at what rate algae are transported to the shore will have a large effect on their spatial and temporal abundance. Local proliferation and deterioration rates also are likely to be important and may be determined by algal density, nutrient availability (Lotze and Schramm 2000), and herbivory (Salovius and Bonsdorff 2004).

With this background, we identified three main objectives for our study: 1) establish a quantitative baseline of seasonal and spatial variation in the density and species composition of drift macroalgae throughout the summer; 2) assess the relationship between algal density and water-column nutrient concentrations, and 3) examine the hypothesis that drift macroalgae are transported shoreward by upwelling events.
Field-site Description

The entire outer shore of Cape Cod is characterized by shifting sand bars. The southern stretch of the shore (sites 1–22, Fig. 1) contains sand bars extending perpendicularly from shore forming a hook (referred to as “J bars” hereafter, which accurately describes their appearance as viewed aerially from offshore). Extending northwards (sites 22–26), a sandbar runs parallel to the shoreline, almost acting as a barrier island. At the northern end of Cape Cod (sites 27–40), J bars once again dominate (Fig. 2). In the three months in which this study was conducted (June through August, 2006), considerable sandbar movement was observed, particularly of J bars, throughout this region.

Figure 1. Field sampling sites along the Cape Cod National Seashore (CCNS). The three sites where quantitative surveys were conducted are marked with black dots. The sites (spaced equally at 1 km apart) where qualitative surveys were conducted are marked with white dots; however, for clarity, only three of the forty qualitative survey sites are shown. Bars represent site summer means (six survey dates) based on the daily sum of qualitative subtidal and intertidal score (0–10) for algal abundance, ± 1 standard error.
Methods

Qualitative visual surveys

Shore-wide surveys were conducted biweekly, from 14 June to 23 August 2006 from Coast Guard Beach, Eastham, MA (Site 1) to Race Point Beach, Provincetown, MA (Site 40), at 1-km intervals (Fig. 1), to assess macroalgal abundance throughout the entire CCNS region. To allow for monitoring of the entire shoreline, surveys were conducted visually from shore, using a scale from 0 to 5 (See Tables 1 and 2 for scoring guide). No actual measurements or collections were made to allow for rapid monitoring; thus the data provide only relative abundances. Surveys were conducted at low tide so that the macroalgal abundance could be assessed both on shore (intertidal) and in the water out to 10 m from shore (subtidal); typically, algae would occur on the beach most often at low tide, having been cast during the ebb tide (P. Lyons, pers. observ.). At each site, the two levels (intertidal and subtidal) were assessed separately and then summed together. We summed the data so that estimate of overall abundance at each site could be determined, as often large amounts of algae were present in the intertidal and absent in the subtidal or vice versa. We used a Kruskal-Wallis test to determine differences in relative algal abundance among sites.

Figure 2. Cape Cod National Seashore’s northern stretch of shoreline with J bars. Taken by J. Portnoy on 8 May 2004.
Quantitative surveys

Biweekly quantitative surveys of macroalgal abundance were conducted from 14 June to 23 August 2006 at three beaches on the Atlantic shoreline of CCNS (Head of the Meadow Beach, Truro; Cahoon Hollow Beach, Wellfleet; and Coast Guard Beach, Eastham; Fig. 1); each are spaced approximately 12 km apart. All three beaches contained J Bars. At each beach, three random locations were selected within a 1-km stretch using GIS software, and for each location, algal biomass was measured during low tide in both 1.5 m water depth (subtidal) and in the lower intertidal zone. Three subtidal samples for each location were collected directly offshore; thus, nine collections were made per sampling day per beach. We used a 40-cm long by 15-cm diameter cylinder to collect approximately 10.5 L of ocean water for each sample, from a depth of 0–40 cm. The seawater and drift algae were brought to shore and filtered through a 1-mm sieve to remove all drift macroalgae.

### Table 1. Intertidal survey scale assessed for area between mean tide level and mean low-tide level.

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0. Absent</td>
<td>No macroalgae present on the beach.</td>
</tr>
<tr>
<td>1. Sparse</td>
<td>Some cover by macroalgae (0–10% of any given area). Sulfur dioxide odor unlikely. Thin accumulations present (&lt;1 cm thick), mostly individuals occurring separately.</td>
</tr>
<tr>
<td>2. Mediocre</td>
<td>Cover by macroalgae roughly 10–40%. Thin accumulations present but thicker areas (0–2 cm thick) may occur. Odor possible in proximity to macroalgae.</td>
</tr>
<tr>
<td>3. Masses</td>
<td>Much cover by macroalgae (40–75% of any given area). Thickness from 0–4 cm, with extremes up to 6 cm. Odor likely in proximity and even several meters from macroalgae.</td>
</tr>
<tr>
<td>4. Complete coverage</td>
<td>Generally, the whole area is covered with very few areas of exposed sand. Depth ranges to 20 cm. Odor present throughout most of beach, dependent on wind.</td>
</tr>
<tr>
<td>5. Severe</td>
<td>Complete coverage. Depth of 20 cm or more. Odor powerful and present well away from algae, dependent on wind.</td>
</tr>
</tbody>
</table>

### Table 2. Subtidal surveys assessed for water extended from shore out 10 m.

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0. Absent</td>
<td>No macroalgae present throughout the water column.</td>
</tr>
<tr>
<td>1. Sparse</td>
<td>Some individual macroalgae scattered in water column on surface or bottom. No large clumps.</td>
</tr>
<tr>
<td>2. Mediocre</td>
<td>Some clumps present on bottom, in water column, or on surface. Macroalgae mostly scattered.</td>
</tr>
<tr>
<td>3. Masses</td>
<td>Large clumps present. Macroalgae may blanket the bottom or surface. Difficulty in distinguishing clumps. Roughly half of the entire water column contains macroalgae.</td>
</tr>
<tr>
<td>4. Saturated</td>
<td>Large clumps present. Very little algal-free water. Some difficulty in swimming would result.</td>
</tr>
<tr>
<td>5. Severe</td>
<td>Large scale clumping. Entire water column full of macroalgae. Clumps can’t be distinguished from water or other clumps. Wind induced ripples absent, and wave dynamics appear altered. Much difficulty swimming or just moving through the water.</td>
</tr>
</tbody>
</table>
The collected algae were later identified to species or genus (using Villalard-
Bohnsack 2003), and voucher specimens were preserved on herbarium paper
and on permanent slides. The total wet biomass of all algal material of each
sample was determined by first spinning all algae 20 times in a salad spinner
to remove excess water and then weighing the algae to the nearest 0.1 g.

For intertidal surveys, on each sampling date, a 10-m transect running
parallel to the shore in the lower intertidal was used for each location (thus
three transects per beach). The transect was placed approximately 0.5 m
above mean low water. We used a 0.25-m² quadrat (subdivided into 100
squares), placed at 1-m intervals, to determine algal percent cover in each
quadrat for each of three groups: 1) Ulva spp. which consisted mostly of U.
lactuca Linnaeus but also included Ulva intestinalis Linnaeus; 2) filamen-
tous red/brown, which consisted mostly of the genus Polysiphonia; and,
3) other, which included all other species including green, red, and brown
algae. Group 3 species had larger thalli, but were typically rare (less than 2%
cover in individual quadrats); Appendix 1 contains a complete list of all mac-
roalgal species encountered. Algae in quadrats 1, 5, and 9 along each 10-m
transect were collected and brought to the lab to determine wet mass using
methods described above. Two-way repeated measure ANOVAs were used
(locations within the three beaches were kept the same from week to week)
to assess the effects of site and sampling date on both intertidal and subtidal
algal densities. It was found that data did not conform to the assumption of
sphericity, and thus the degrees of freedom were adjusted using Greenhouse
and Geisser’s Epsilon correction. All statistics here and below were run us-
ing JMP 5.1 (SAS Institute, Cary, NC).

Nutrient assays

We collected water samples to determine dissolved inorganic nitrogen
(DIN) concentrations in the form of nitrate (NO₃⁻) and ammonium (NH₄⁺),
from the middle of dense macroalgal accumulations as well as areas free, or
relatively free, of macroalgae. Water samples were collected at both Head of
the Meadow Beach and Cahoon Hollow Beach, as both often had areas of dense
accumulation (Coast Guard Beach was usually completely free of algae). At
each beach, one sample was taken in a dense patch and another in an algal-free
patch during low tide on each sampling date. Macroalgal densities were mea-
sured as above (see Quantitative surveys, subtidal sampling). All water samples
were analyzed by flow-injection analysis using a Lachat Quik-Chem™ system.
Correlations among nutrients (NO₃⁻ and NH₄⁺, and total DIN) and subtidal mac-
roalgal densities were analyzed with logistic regression analysis.

Upwelling events

Temperature was recorded using HOBO® data loggers (Onset Com-
puter Corporation, Pocasset, MA) attached to buoys anchored by cinder
blocks in approximately 1.5 m of water (at low tide) at Head of the Meadow
Beach, Cahoon Hollow Beach, and Coast Guard Beach (Fig. 1). Data
were recorded at half-hour intervals from 31 May 2006 to 28 August 2006,
and daily temperatures were averaged for each site. Wind data and daily air temperature averages were collected for Chatham, MA from www.wunderground.com. The occurrence of an upwelling event was based on the satisfaction of three criteria: 1) the wind was consistently from the southwest for at least 16 hours during the given day, 2) daily water temperature was at least 1.5 °C lower than the previous day, and 3) daily air temperature was at most 2.0 °C lower than the previous day. With the orientation of the shore, a southwest wind would be needed to generate an upwelling event, which would be marked by a decrease in water temperature due to influx of cold bottom water. The third criterion was put in place to avoid anomalous identification of upwelling events. Changes in subtidal and intertidal macroalgal densities—wet mass per area (intertidal) or volume (subtidal)—since the last sampling date as well as the time since the last upwelling event were taken from the quantitative survey data. A one-way ANOVA was used to assess the effects of the presence of an upwelling event on the changes in intertidal and subtidal algal densities.

Results

Qualitative visual surveys

Significant differences in relative algal abundance (sum of both intertidal and subtidal score) were found among the 40 sites (P < 0.001). Sites 29 through 34 had the highest mean abundances (1.4–2.3 relative summer mean; Fig. 1). The week of 9 August had the highest overall algal densities throughout the CCNS, matching our quantitative survey data (see below).

Quantitative surveys

Drift macroalgal densities were the highest during August, for both the intertidal and subtidal zones, and varied significantly among sampling dates (P = 0.005 and P = 0.0126, respectively; Tables 3 and 4, Figs. 3 and 4). Intertidal densities were typically 1–2 orders of magnitude greater in August than in June or July. Head of the Meadow and Cahoon Hollow beaches had higher densities of macroalgae (2911.5 gm² and 243.9 gm² in the intertidal during the week of 9 August) than Coast Guard Beach; this among-site variation was significant for intertidal sites (P = 0.028) but not subtidal sites (P = 0.153) (Tables 3 and 4). The week of 9 August was the only sampling date with measurable amounts of algae at Coast Guard Beach (37.0 gm² intertidal and 0.08252 gL⁻¹ subtidal). The most abundant species were Ulva lactuca and Polysiphonia/Neosiphonia spp.

Nutrient assays and upwelling events

Water-column DIN (both NO₃⁻ and NH₄⁺) varied inversely with subtidal macroalgal density (r² = 0.543, P = 0.037; Fig. 5). NO₃⁻ was significantly negatively correlated (r² = 0.472, P = 0.013) with algal density, while NH₄⁺ was not (r² = 0.055, P = 0.575). Although several upwelling events were recorded, their occurrence had no significant effect on either intertidal (F = 2.6202, P = 0.1664) or subtidal (F = 2.2466, P = 0.1942) algal density.
A peak of algal density occurred during the second week of August in the subtidal and intertidal sites for two of three beaches and in the last week of August for the third beach. This closely matched our prediction based on

![Figure 3](image3.png)

Figure 3. Intertidal algal densities (wet mass, gm⁻²) for the three quantitative survey sites in summer 2006; the Y-axis is in log scale. Data are means ± 1 standard error.

![Figure 4](image4.png)

Figure 4. Subtidal algal densities (wet mass, gL⁻¹) at the three quantitative survey sites in summer 2006. Data are means ± 1 standard error.
previous findings (Gross 1994). However, unlike previous studies (Wilce et al. 1982), we found very little *P. littoralis* in either the ball form described by (Wilce et al. 1982) or in the linear form; our blooms were mainly composed of *Ulva* spp. and *Polysiphonia* spp. We found the highest densities of macroalgae at Head of the Meadow Beach, in both the intertidal and subtidal. These results were substantiated by our shore-wide qualitative surveys, which revealed a peak just north of Head of the Meadow Beach (Fig. 1).

Table 3. Results of a repeated-measures two-way ANOVA on intertidal macroalgal density (g*m²) among sites and sampling dates. Degrees of freedom were adjusted with G-G Epsilon correction (see text), resulting in non-integer values. *P* values with asterisk are significant (*P* < 0.05).

<table>
<thead>
<tr>
<th>Source</th>
<th>df (num, den)</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site</td>
<td>2.00, 22.00</td>
<td>4.232</td>
<td>0.028*</td>
</tr>
<tr>
<td>Sample week</td>
<td>1.74, 38.14</td>
<td>6.572</td>
<td>0.005*</td>
</tr>
<tr>
<td>Site*week</td>
<td>3.47, 38.14</td>
<td>7.198</td>
<td>0.004*</td>
</tr>
</tbody>
</table>

Table 4. Results of a repeated measures two-way ANOVA on subtidal density (g*L⁻¹) among sites and sampling dates. Degrees of freedom were adjusted with G-G Epsilon correction (see text), resulting in non-integer values. *P* values with asterisk are significant (*P* < 0.05).

<table>
<thead>
<tr>
<th>Source</th>
<th>df (num, den)</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site</td>
<td>2.00, 23.00</td>
<td>2.039</td>
<td>0.153</td>
</tr>
<tr>
<td>Sample week</td>
<td>1.22, 27.98</td>
<td>6.471</td>
<td>0.013*</td>
</tr>
<tr>
<td>Site*week</td>
<td>2.43, 27.98</td>
<td>2.142</td>
<td>0.128</td>
</tr>
</tbody>
</table>

Figure 5. Correlation between DIN and subtidal algal density from both sites (Head of the Meadow Beach and Cahoon Hollow Beach). Solid circles denote NH₄⁺ (*r² = 0.055, P = 0.575*), and open circles denote NO₃⁻ (*r² = 0.472, P = 0.013*).
Temporal abundance patterns

Drift macroalgal blooms have typically been described in the literature as following broadly consistent temporal trends in abundance. Blooms typically peak in late summer (e.g., Berglund et al. 2003) due to light levels, nutrient levels, water temperature, and other factors associated with seasonality. We found that algal abundance along the CCNS did peak in August. However, on smaller temporal and spatial scales, drift macroalgal biomass was quite patchy. We found a significant negative relationship between algal density and NO$_3^-$ concentration (Fig. 5), implying that algae are likely using nutrients to proliferate while drifting, and their growth may be nutrient-limited in dense aggregations (Escartin and Aubrey 1995). However, dense aggregations (those characteristic of a 4 or 5 score on subtidal survey scale; table 2) were only found at low tide and occasionally at most. Along the CCNS, waves break closer to shore at high tide, acting to disperse aggregations every 12 hours. Thus, algae may be rarely nutrient limited. We found no significant relationship between algal abundance and upwelling events, which are typically nutrient-rich (Kiirikki and Blomster 1996); however, we did not investigate a potential relationship between upwelling events and nutrient levels.

Sources of macroalgae

The large abundance of drifting macroalgae and lack of hard substrate found along the CCNS imply that macroalgae are most likely transported from other locations. While some macroalgae may originate from local areas, this portion is likely a minor fraction of the total. Much of the offshore bottom has been mapped and consists of sandy sediment, with little habitat suitable for macroalgal attachment (Poppe et al. 2005). Upwelling events could provide a means of transportation from offshore locations to beaches, but no correlation between upwelling events and algal abundance was found. Instead, we suggest that macroalgae drift from more distant locations; the most likely mechanism is that drift algae originate within the Gulf of Maine and are transported by the Western Maine Coastal Current (WMCC) toward Cape Cod (Churchill et al. 2005; see Fig. 3 of Pettigrew et al. 2005). Surface velocity of the WMCC ranges from 6 to 20 cm/sec during the summer months (May to September; Pettigrew et al. 2005); thus, dislodged algae could be transported from southern Maine to Cape Cod rather quickly. For example, algae originating in Portland, ME could be transported to Cape Cod (approximately 175 km) in ten days to one month’s time. Gulf of Maine circulation and mixing of the WMCC and the Eastern Maine Coastal Current (EMCC) have been linked to the spread of the toxic red tide dinoflagellate, *Alexandrium fundyense* Balech, throughout the Gulf of Maine (Townsend et al. 2001). The EMCC typically contains higher levels of nutrients and *A. fundyense* cells (Townsend et al. 1987). It is possible that some of the same mechanisms affecting *A. fundyense* spread may contribute to drift macroalgal accumulations along the Atlantic shore of Cape Cod.
Spatial patterns

Significant spatial variability occurred throughout the summer in macroalgae density. Both quantitative and qualitative surveys indicate that the shoreline just north of Head of the Meadow beach has the greatest algal biomass. This pattern is consistent with our hypothesis that algae drift from northern New England. This northern stretch of shoreline would be the first to receive drift macroalgae via the southward flowing WMCC. In addition, drogue studies (J. Manning, National Marine Fisheries Service, Wood’s Hole, MA., pers. comm.) indicate that the extensive bar and shoal system just east of the tip of Cape Cod acts to increase water residence times and thus capture southward-drifting debris.

Drift macroalgae were not limited to the northern part of the shore. Accumulations in the southern part of the shoreline occurred near J bars, which could retain algae drifting southward, while macroalgae along the more northern shoreline accumulated even in areas without J bars. It is probable the stretch of beach between sites 22 and 26 (Fig. 1) had relatively little algae due to a lack of J bars to concentrate southward drifting macroalgae (Paalme et al. 2004).

The most southern part of the shore received very little algae throughout the summer, except for the first week in August, even though this stretch of shore does contain J bars that could locally retain algae. During early August, large amounts of macroalgae did occur at the southern stretch of shoreline, following a period of strong northwest winds. Thus, the general occurrence of drift macroalgae, as well as site-to-site differences in accumulations along CCNS’s Atlantic shoreline, appear to result from seasonal production in waters north of Cape Cod, southward transport via Gulf of Maine coastal currents, and capture of drift algae by the outer Cape shoal and bar system. This study provides a repeatable protocol and quantitative database for future assessments of trends in the timing, spatial distribution, species composition, and abundance of drift macroalgae along the Atlantic shore of Cape Cod.

Acknowledgments

Funding for this study was provided by a grant from the National Park Service to C. Thornber. The Cape Cod National Seashore National Resource Department provided trucks, lab space, housing, and equipment. Field assistance was provided by Tracy Fayollat, Mary Hake, and Kathleen Kughen. Nutrient tests were run by Judith Oset, Krista Lee, and Justin Rivera. Arthur Mathieson, Charles Roman, Robert Wilec, and two anonymous reviewers provided helpful insights for the manuscript. Graham Giese and Jim Manning provided considerable help with understanding local coastal currents. Mark Adams provided help with GPS and GIS.

Literature Cited


Appendix 1. Macroalgae species present during surveys conducted at Cape Cod, MA. Superscripts refer to algal taxonomy: R = Rhodophyta (red), C = Chlorophyta (green), P = Phaeophyceae (brown).

Commonly found during quantitative surveys, qualitative surveys, and observation.

- *Neosiphonia harveyi* (J. Bailey) M.-S. Kim, H.-G. Choi, Guiry & G.W. Saunders
- *Polysiphonia flexicaulis* (Harvey) F.S. Collins
- *Polysiphonia fucoides* (Hudson) Greville
- *Polysiphonia nigra* (Hudson) Batters
- *Polysiphonia stricta* (Dillwyn) Greville
- *Ulva lactuca* Linnaeus

Rarely found during quantitative surveys, qualitative surveys, and observation.

- *Callithamnion corymbosum* (J.E. Smith) Lyngbye
- *Ceramium virgatum* Roth
- *Chondrus crispus* Stackhouse
- *Cladophora albida* (Nees) Kützing
- *Codium fragile* subsp. *tomentosoides* (Van Goor) P. C. Silva
- *Ectocarpus siliculosus* (Dillwyn) Lyngbye
- *Palmaria palmata* (Linnaeus) Kuntze
- *Pilayella littoralis* (Linnaeus) Kjellman
- *Rhodomela confervoides* (Hudson) P.C.Silva
- *Ulva intestinalis* Linnaeus
- *Vertebrata lanosa* (Linnaeus) T.A. Christensen
- Several *Fucus* and *Laminaria* species