“The seaweed is always greener in somebody else’s lake.”

–Sebastian, Disney’s *The Little Mermaid*

The diversity and taxonomy of *Ulva* species (Ulvales, Chlorophyta) in the Bay of Fundy (New Brunswick, Canada)

by

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ABSTRACT

Species in the green algal genus *Ulva* have simple morphologies with few diagnostic features for species identification, and characters used for identification are often subject to high intraspecific variability and plasticity in response to environmental conditions. Routine *Ulva* species identification using morphological characteristics is therefore challenging even for seasoned phycologists. Molecular techniques (namely, DNA barcoding) are useful for species recognition when morphological investigation alone is inadequate, but molecular work must be accompanied by taxonomic study for accurate morphospecies name application. In this thesis I employed molecular techniques along with observations on biogeography, ecology, and morphology in order to assign meaningful morphospecies names to species of *Ulva* present in the Bay of Fundy (New Brunswick, Canada). Ten unique genetic groups were identified from the Bay of Fundy: eight genetic groups were assigned existing morphospecies names and the remaining two were assigned provisional species names pending publication.

DEDICATION

To my partner in science, fun, and life.

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Introduction

A recent estimate of the biodiversity on Earth suggested that the total number of eukaryotic species is around 8.7 million, ~2.2 million of which are marine (Mora *et al*. 2011). These estimates suggest that 86% of total species and 91% of marine species have yet to be described (Mora *et al*. 2011). Despite the majority of the surface area of the Earth being occupied by ocean and hundreds of years of taxonomic endeavour, we have barely scratched the surface in our discovery of marine biodiversity.

Understanding marine macroalgae, because of the services they provide to other species in their community (e.g. habitat, nutrition, and oxygenation of coastal waters), will be a key factor in the development of conservation and management plans for coastal communities in a changing climate (Harley *et al*. 2012). Yet, despite their importance, our knowledge of seaweed is still limited and new species discoveries are a regular occurrence (e.g. Phillips *et al*. 2016, Evans & Saunders 2017, Griffith *et al*. 2017, McDevit & Saunders 2017). Our generally limited understanding of marine ecosystems is particularly tragic when considering Earth's rapidly changing climate. Marine systems are likely to see changes in distribution and abundance of species (Harley *et al*. 2006), which could lead to localized or complete extinction of species (e.g. Harley 2011), including many of which we have little to no understanding. Environmental change can cause shifts in coastal communities directly owing to abiotic factors (e.g. shifting water temperature and chemistry), but also indirectly through changes in interspecific interactions (Harley *et al*. 2006, 2012). Climate-driven alterations to the distribution, zonation, and abundance of some primary producers could have pronounced effects on coastal herbivore communities, in turn causing bottom-up changes for the entire system (Harley *et al*. 2006, 2012).

Marine macroalgae form a polyphyletic group, the members of which stem from three main lineages: the Chlorophyta (green algae), the Phaeophyceae (brown algae), and the Rhodophyta (red algae). Algae in the monophyletic division Chlorophyta are a morphologically diverse group including both freshwater and marine, and micro- and macro-algal species. The appearances of green macroalgae range from calcified structures, filaments with cells visible to the naked eye, to inflated sacs, and foliose blades (Fig. 1). One of the most diverse families of green algae is the Ulvaceae, which boasts over 1700 species (Guiry & Guiry 2017). Of these species, 125 are in the genus *Ulva* Linnaeus (Guiry & Guiry 2017), a ubiquitous and cosmopolitan genus of foliose and/or tubular algae commonly referred to as "sea lettuce" (Lee 2008). *Ulva* has a diplohaplontic life history with an isomorphic alternation of generations (Womersley 1984, Brodie *et al*. 2007) (Fig. 2).

Species assigned to the genus *Ulva* were previously divided between two genera: *Ulva* and *Enteromorpha* Link. The former included all species which at maturity formed distromatic (two cell layers thick) foliose blades, while the latter encompassed forms which were monostromatic (one cell layer thick) and tubular, at least in part (Bliding 1963, Bliding 1968, Bonneau 1977). While most species were readily assignable to one genus or the other, prior to the merging of the two genera some confusion existed regarding the classification of certain species. For instance, on which side of the tube/blade division should a distromatic blade with a monostromatic tubular base and tubular margins (e.g. *Ulva linza* Linnaeus; Fig. 3) lie (Silva 1952, Papenfuss 1960)? And how should a distromatic plant be classified if it can give rise to tubular progeny? Culturing *Ulva* in a laboratory demonstrated unmistakeable phenotypic plasticity in the previous morphological trait in response to environmental factors and the bacteria colonising the algal surfaces (Bonneau 1977, Provasoli & Pintner 1980). These dilemmas threw doubt on the wisdom of maintaining separate genera based on gross morphology alone (Silva 1952, Bonneau 1977, Provasoli & Pintner 1980, Tan *et al.* 1999). Hayden *et al*. (2003) merged the two genera, using genetic data as justification to finally end the more-than 180-year division and restore the original monogeneric classification (Linnaeus 1753, Link 1820, Hayden *et al.* 2003).

Taxonomy (the classification of organisms) has long been a discipline reliant on morphological and anatomical features to differentiate species, but it has become increasingly evident that the complicated nature of algal taxonomy warrants a different approach. Members of the genus *Ulva*, as it is currently recognised, have simple morphologies with few characters that can be used to distinguish between species, and many of these diagnostic features are often considered unreliable or uninformative (Blomster *et al*. 1998, Brodie *et al*. 2007, Kraft *et al*. 2010). Species-level identification in *Ulva* is further complicated by the striking intraspecific morphological variation exhibited by members of this group, rendering even the most basic of diagnostic features largely unreliable (Papenfuss 1960, Bonneau 1977, Blomster *et al.* 1998, Brodie *et al.* 2007). Molecular tools provide a powerful and modern solution to address longstanding taxonomic issues. In particular, DNA barcoding – the amplification and sequencing of a short (<800 base pairs), standardized region of the genome that is variable enough to distinguish members of different species from one another but conserved enough to be constant (or nearly so) among specimens of a single species (Hebert *et al*. 2003) – has proven time and again to be useful and accurate for species discrimination in marine macroalgae including the genus *Ulva* (e.g. Saunders 2005, Saunders 2008, Hollingsworth *et al*. 2009, Saunders & Kucera 2010, Le Gall & Saunders 2010, Kirkendale *et al*. 2013). Full functionality of DNA barcoding as a tool for rapid species identification relies on the accumulation of a database of taxonomically verified DNA barcodes (i.e. barcode sequences accurately linked with a species name), a task that is still in progress for many groups including algae (Puillandre *et al*. 2012, Kress *et al*. 2014). Creating a database of DNA barcodes therefore requires extensive taxonomic work in order to unite recognised morphospecies (species that were described based on morphology alone) with identifiable genetic groups (Hajibabaei 2007), and in the process identify those genetic groups which have no current morphospecies identity (and therefore require description). This is no small task in a group with the morphological simplicity yet variability that *Ulva* exhibits.

The methodology employed in this thesis to unite morphospecies concepts with genetic groups consisted of a combination of molecular analyses with morphological, biogeographical, and ecological investigations in an approach termed "molecular-assisted alpha taxonomy" (MAAT; e.g. Saunders 2005, Saunders 2008, Cianciola *et al*. 2010, Clarkston & Saunders 2013, Hind *et al*. 2014). Specimens are considered as a unique genetic group if, for a given barcode marker, the specimens form a closely related group for which the genetic variation within the group is less than the variation between groups. In other words, there is a barcode gap (Čandek & Kuntner 2015). A detailed examination of the morphologies of these specimens can identify potential morphospecies identities. Included in the description of each morphospecies is the designation of a type specimen (the entity on which the morphological description was based) and a specific type locality (the location from which the type specimen was collected). While some older morphospecies had less-than-helpful notes in this regard [e.g. *Ulva lactuca* Linnaeus: the type specimen was lost for many years and the type locality is, quite literally, "in the ocean" (Linnaeus 1753, Papenfuss 1960)], this information can be used in conjunction with morphological data to confirm a morphospecies name for each unique genetic group. If a genetic group is morphologically similar to a morphospecies type specimen and its presence can be confirmed in the type locality of that same morphospecies – using the Barcode of Life Data System [BOLD; Ratnasingham & Hebert (2007)] and GenBank (National Institutes of Health) databases to find genetic matches uploaded by researchers worldwide – then the identity of the genetic group is supported.

While a DNA barcoding marker near the 5' end of the mitochondrial gene cytochrome *c* oxidase subunit I (commonly called COI-5P) has been successfully used for species delimitation and identification in animals and red algae (Hebert *et al*. 2003, Saunders 2005), it has not been successful in green algae (Saunders & Kucera 2010). Rather, two plastid-encoded markers – the 3' end of the RuBisCO large subunit (*rbc*L-3P) and the elongation factor TU (*tufA*) – have been proposed and successfully used as barcode markers for many Chlorophyta (Saunders & Kucera 2010, Wolf *et al*. 2012, Kirkendale *et al*. 2013). The use of these markers in the MAAT method has allowed me to identify genetic groups and apply morphospecies names to the species of *Ulva* present in the Bay of Fundy.

The purpose of this thesis was to re-evaluate the taxonomy of *Ulva* species present in the Bay of Fundy. The last checklist of seaweed species in the Bay of Fundy reported one species of *Ulva* and 10 species of *Enteromorpha* (Macfarlane & Milligan 1965). Using DNA barcoding I have identified 10 unique genetic groups of *Ulva* in the Bay of Fundy. Comparison of within- and between-species divergences in the markers *tufA* and *rbc*L-3P has shown that *tufA* is more variable and is therefore better able to differentiate between species. I was able to provide meaningful morphospecies names for eight of the *Ulva* genetic groups present in the Bay of Fundy. The other two genetic groups have been assigned provisional names pending publication. By using the robust MAAT methodology I was able to resolve the taxonomy of *Ulva* in the Bay of Fundy with confidence. Furthermore, providing the barcode data collected here to BOLD (Ratnasingham & Hebert 2007) and GenBank will help clarify the taxonomy and biogeographical ranges of these species in future studies.

Methods

Collection and processing

Green blades and tubes for morphological observation were collected from various substrata with emphasis on Bay of Fundy shores according to the protocols outlined by Saunders & McDevit (2012). For some specimens additional vouchers were pressed on herbarium paper. *Ulva* specimens collected worldwide were included in the molecular analyses for comparison.

Molecular data generation

The extraction of DNA from silica-dried samples followed either the protocol in Saunders & McDevit (2012) (95-well high-throughput plate) or Saunders (1993) with modification (Saunders 2008) (single specimen extraction). Amplification of an 807 base-pair region of the plastid elongation factor TU (*tufA*) and a 747 base-pair region at the 3' end of the RuBisCO gene (*rbc*L-3P) was carried out according to the protocols in Saunders & Kucera (2010). Amplified PCR products (one forward and one reverse read per specimen) were sequenced by Génome Québec (Montréal, Québec) and sequence data were aligned and edited using Geneious R6.1.8 (www.geneious.com, Kearse *et al*. 2012).

Molecular analysis

The barcode gap analysis option available through the BOLD website [www.boldsystems.org; Ratnasingham & Hebert (2007)] was used to identify genetic species. The sequence alignment tool MUSCLE (Edgar 2004) and a pairwise distance model were used for the barcode gap analyses.

A single representative *tufA* sequence for each genetic group was aligned with MUSCLE and the resulting 29-species alignment was used to construct a maximum likelihood (ML) tree using the RAxML (Stamatakis 2006) plugin for Geneious R8.1.9 (www.geneious.com, Kearse *et al*. 2012). The general time reversible model with incorporation of invariable sites and gamma distribution (GTR+I+G) was used with partitioning by codon and 500 bootstrap replicates were completed to determine robustness (Felsenstein 1985). An alignment and ML tree were similarly constructed with the available *rbc*L sequence data: 27 genetic groups had data for the *rbc*L-3P gene region and for 14 of these *rbc*L-5P data were included as well (see Appendix 2). Because no major discrepancies in relationships were detected between the nodes of these trees, the data were concatenated and a single ML analysis was completed using the GTR+I+G model with partitioning by both gene and codon using the three gene regions combined with 1000 bootstrap replicates completed to assess robustness. Species of the genera *Ulvaria* and *Umbraulva* were included as outgroups (Kirkendale *et al.* 2013).

Morphological analysis

Microscopic observations were made of fresh material and images taken with a Leica DFC480 digital camera mounted on a Leica DM5000B light microscope. Quantitative (cell diameter, pyrenoid count, blade thickness in cross section) and qualitative (cell shape and distribution pattern in wholemount; chloroplast shape, approximate size, and arrangement) assessments of a marginal piece of the mid-upper thallus were recorded prior to sample desiccation as in Blomster *et al*. (1998). Cross sections were completed either by hand or with a Leica CM1850 freezing microtome. Dried material was rehydrated prior to examination in either seawater or a 4% formalin in seawater solution depending on the delicacy of the sample. Permanent slides of notable features were prepared using a 4% formalin, 50% karo solution. If available, the base of each thallus was examined for the presence of rhizoidal cells.

Results

Barcode assessment of Ulva *specimens from the Bay of Fundy in the context of other species for which comparative data were available*

Barcode gap analyses revealed 10 distinct genetic groups of *Ulva* in the Bay of Fundy: *U. clathratioides* L.G.Kraft, Kraft & R.F.Waller, *U. compressa* Linnaeus, *U. gigantea* (Kützing) Bliding, *U. intestinalis* Linnaeus, *U. lactuca*, *U. laetevirens* Areschoug, *U. linza*, *U. taylorii* nom. prov., *U. viatoria* nom. prov., and *U. prolifera* O.F.Müller (Table 1).

For the *rbc*L-3P, intraspecific divergences typically ranged from 0.00-0.14%, with one species (*U. lactuca*) showing unusually high divergence at 0.27% (Table 1). The *tufA* barcoding marker had higher intraspecific divergence than the *rbc*L-3P with typical divergences ranging from 0.00-0.40% and two exceptions, *U.* sp._1GH and *U. compressa*, showing divergences as high as 0.52 and 0.91%, respectively.

Interspecific divergences typically ranged from 0.40-2.83% in the *rbc*L-3P and from 0.65-5.78% in the *tufA*, however values as low as 0.13% in the *rbc*L-3P and 0.52-0.65% in the *tufA* were found for certain groups (Table 1). In all cases, the *tufA* region exhibited equal or greater intra- and interspecific divergence than the *rbc*L-3P region. The former also proved a superior barcode marker displaying better within versus between group separation.

Phylogeny

In phylogenetic analyses of the concatenated alignment of *tufA*, *rbc*L-3P, and *rbc*L-5P, the 10 genetic groups in the genus *Ulva* from the Bay of Fundy did not form a monophyletic group, nor did specimens of similar gross morphology or shared biogeography (Fig. 4).

Taxonomy

Ulva clathratioides L.G.Kraft, Kraft & R.F.Waller (Fig. 5)

A total of 31 specimens were molecularly assigned to this group; only one of these was collected from Bay of Fundy waters (Appendix 1). Morphological observations were made on eight thalli molecularly assigned to this group, including the lone Bay of Fundy record.

Morphology: Specimens of *U. clathratioides* were found attached to rocks or invertebrates, but were most often retrieved in drift or as tangled mats (Fig. 5A) among grass or other algae. Thalli were typically yellow-green (sometimes darker green), extremely thin (thallus width ranged from 0.07-0.21mm), and highly branched tubes (Fig. 5B). Cells in surface view were square to rectangular with dimensions typically ranging from 5-30µm, though rare observations of cells as large as 45µm were recorded (Fig. 5C). Cells were consistently arranged in meandering rows along the length of the thallus with no obvious organization along the width of the thallus (Fig. 5C).

Chloroplasts varied greatly in arrangement: parietal bands around the entire cell or along the apical and lateral cell walls; while central, stellate-appearing masses were observed in some specimens. Pyrenoids were miniscule and numerous (Fig. 5C). In cross section, thalli were monostromatic tubes with round cells (Fig. 5D). Cell layer thickness was 16-37.5µm. Holdfast regions were not available for observation.

Type locality: Point Lonsdale, Victoria, attached to rocks on inner-reef flat submerged 20–30cm at low tide.

Representative specimens: See Appendix 1.

Representative DNA barcode: GWS004454 [GenBank accession numbers HQ603672 (*rbc*L-3P) and HQ610436 (*tufA*); Appendix 1].

Distribution: Genetically verified records of this species have been collected from British Columbia, New Brunswick, and Newfoundland and Labrador in Canada, as well as Tasmania and Victoria in Australia (Appendix 1, Kraft *et al*. 2010).

Ulva compressa Linnaeus (Fig. 6)

There were 57 specimens molecularly assigned to this group, of which 13 were collected from Bay of Fundy waters (Appendix 1). Morphological observations for this study were made on eight of these collections with four having been collected from Bay of Fundy coasts.

Morphology: Thalli were found growing epiphytically, on rocks and mussels, or unattached in mudflats and estuaries. Specimens of *U. compressa* were light to medium-green and in overall form were: tubes, both branched (either at the base of the thallus or sparsely along main axis) and unbranched; branched, narrow blades (0.5-5mm width) with tubular margins (Fig. 6A); or broad blades lacking tubular margins (Fig. 6B). In surface view cells were typically irregular polygons with rounded corners measuring 5-18.5µm in diameter, often with no particular arrangement but occasionally in meandering rows (Fig. 6C). Chloroplasts were parietal or occupied the entire cell, with 1-2 (rarely 3) pyrenoids visible (Fig. 6C). In cross section, individuals with a blade and tubular edges were 47.7-55.1μm thick in the distromatic central portion of the blade and the monostromatic blade margins were 20-26μm thick (Fig. 6D). The thickness of the distromatic bladed specimens ranged from 36.5-47.5μm (Fig. 6E). Thickness of the tubular specimen was 21.1-23.7μm (Fig. 6F). For all morphologies, cells in cross section were palisade (Figs. 6D-F). Basally, rhizoidal cells were present and three pyrenoids per cell were observed more commonly than elsewhere in the thalli.

Type locality: Bognor, Sussex, England (Hayden *et al.* 2003).

Representative specimens: See Appendix 1.

Representative DNA barcode: GWS005862 [GenBank accession numbers HQ603522 (*rbc*L-3P) and HQ610286 (*tufA*); Appendix 1].

Distribution: Genetically verified specimens were collected from British Columbia, New Brunswick, Nova Scotia, and Prince Edward Island in Canada; New South Wales and Tasmania in Australia; Clare and Kerry in Ireland; and from California in the United States of America (See Appendix 1).

Ulva gigantea (Kützing) Bliding (Fig. 7)

Only eight collections have been molecularly assigned to this group, all from the Bay of Fundy (Appendix 1). Two of these collections were assessed morphologically for this study. Of the two, only one was not reproductive and therefore had clearly discernible vegetative features.

Description: Specimens collected were growing on rocks or epiphytically. Thalli were small medium-green blades, with or without undulating margins (e.g. Fig. 7A). In surface view, specimens exhibited cell diameters ranging from 7.5-20μm and cells were irregular to angular in shape (Fig. 7B). Chloroplasts usually occupied from one half to the entire cell in surface view (Fig. 7C), but in some specimens were occasionally parietal. A single pyrenoid per cell was typical, though occasionally 2-3 pyrenoids were present in a cell (Fig. 7B). In cross section, cells were ovoid and wider than tall. Thalli were distromatic with blade thickness from 30-40µm (Fig. 7C). Rhizoidal cells were present at the base of the thallus.

Type locality: Granville, Normandy, France (Bliding 1968).

Representative specimens: See Appendix 1.

Representative DNA barcode: GWS005870 [GenBank accession numbers HQ603535 (*rbc*L-3P) and HQ610299 (*tufA*); Appendix 1].

Distribution: Genetically verified specimens were collected from New Brunswick in Canada (See Appendix 1), from Clare in Ireland (Loughnane *et al.* 2008), and Cornwall in the United Kingdom (Loughnane *et al.* 2008).

Ulva intestinalis Linnaeus (Fig. 8)

A total of 107 specimens were molecularly assigned to this group, 33 of which were collected in the Bay of Fundy (Appendix 1). Of the 16 thalli assessed morphologically, 13 were collected from the Bay of Fundy.

Morphology: Thalli were found growing on rocks, wood, other algae, or embedded in mud, often with nearby or direct freshwater influence. Thalli were light to medium-green in colour, and the morphology of these plants was consistently tubular and unbranched, though other morphological aspects varied greatly between specimens including corkscrew-like twisting of the thallus with marginal undulations (Fig. 8A), constrictions along the thallus at irregular intervals (Fig. 8B), and numerous thalli of long, thin tubes growing together as clumps (Fig. 8C). Thallus width (0.2-25.7mm) and length (up to 63cm) were also variable. In surface view, cells were angular and polygonal, sometimes with rounded corners (Fig. 8D). Cell diameters ranged from 3.5-19.5µm. Chloroplasts were inconsistently arranged between specimens with some forming apical caps, others parietal bands, and still others appearing as rounded masses occupying about one half of each cell with no consistent arrangement (Fig. 8D). Typically 1-2 pyrenoids were present in each cell (Fig. 8D). In cross section, the monostromatic cell layer was 17.5-31µm thick and cells appeared palisade (Fig. 8E). Cells were rhizoidal at the base of the plant.

Type locality: Woolwich, London, England (Hayden *et al*. 2003)

Representative specimens: See Appendix 1.

Representative DNA barcode: GWS003699 [GenBank accession numbers HQ603560 (*rbc*L-3P) and HQ610324 (*tufA*); Appendix 1].

Distribution: Genetically verified specimens were collected from British Columbia, New Brunswick, Newfoundland and Labrador, Nova Scotia, Prince Edward Island, and Québec in Canada; Tasmania in Australia; Saint Pierre et Miquelon, a French archipelago near Newfoundland; Hordaland in Norway; and from California, Maine, Massachusetts, and Rhode Island in the United States of America (See Appendix 1).

Ulva lactuca Linnaeus (Fig. 9)

Of 170 specimens molecularly assigned to this group, 63 were collected from the Bay of Fundy (Appendix 1). A total of 35 thalli were assessed morphologically, 32 of which were collected from Bay of Fundy coasts.

Morphology: Specimens of *U. lactuca* were found growing on rocks, wood, invertebrates, other algae, and in sand. Thallus morphologies varied greatly: large, broad blades with or without lattice-like perforations and undulating margins (Fig. 9A, B); delicate, pyriform blades with undulating margins (Fig. 9C); and irregularly clustered blades (Fig. 9D). Blades most often appeared dark green, sometimes medium-green, and frequently had a metallic blue sheen underwater. In surface view, cell diameter ranged commonly from 5-27.5μm though cells as large as 60μm were observed. Cells appeared rounded or angular with rounded corners, usually paired with the chloroplast appressed against the cell wall furthest from the sister cell (Fig. 9E). In unpaired cells, chloroplasts formed parietal bands or irregular, rounded masses occupying from one quarter to the entire cell in surface view (Fig. 9F). Commonly 1-3 pyrenoids were visible (Fig. 9E, F) with up to four visible in cells toward the base of the plant. In cross section, the blades were distromatic and ranged from 35-105μm thick with palisade cells (Fig. 9G). Rhizoidal cells were present at the bases of the plants.

Type locality: The west coast of Sweden (Womersley 1984).

Representative specimens: See Appendix 1.

Representative DNA barcode: GWS003687 [GenBank accession numbers HQ603572 (*rbc*L-3P) and HQ610336 (*tufA*); Appendix 1].

Distribution: Genetically verified specimens were collected from British Columbia, Manitoba, New Brunswick, Newfoundland and Labrador, Nova Scotia, and Prince

Edward Island in Canada; California, Connecticut, Maine, Massachusetts, and Rhode Island in the United States of America; Waterford in Ireland; and from Hordaland and Ormhilleren in Norway (See Appendix 1).

Ulva laetevirens Areschoug (Fig. 10)

A total of 24 specimens were molecularly assigned to this group, three of which were recovered from Bay of Fundy waters (Appendix 1). Of the 10 thalli used for morphological observations, one was collected in the Bay of Fundy.

Morphology: Members of this group were found growing on rocks, seagrass, invertebrates, or often unattached in sheltered pools. Thalli were irregularly shaped, often tattered light green or yellow-green blades ranging from as small as 2.5cm to larger than 50cm wide (e.g. Fig. 10A). Where intact blade margins were observed, small but regular dentations were sometimes visible (Fig. 10B). In surface view cell diameters were 5-30µm (Fig. 10C, D). Cells had irregular polygonal shapes with no discernable distribution pattern other than occasional cell pairing in some specimens (Fig. 10D). Chloroplasts most often appeared as parietal bands, rarely occupying the entirety of a cell in surface view (Fig. 10D). Chloroplasts of partnered cells rested against the cell wall furthest from the respective sister cell. Commonly 1-3 pyrenoids per cell were visible, though some specimens exhibited 1-5 pyrenoids per cell with countless pyrenoids in other cells (Fig. 10C, D). In cross section the distromatic blades ranged from 45-57.5µm in thickness and cells appeared round or ovoid and wider than tall (Fig. 10E). In specimens with the holdfast region intact, cells near the thallus base appeared rounded with 1-4 (rarely 5) pyrenoids and rhizoidal cells were present.

Type locality: Port Phillip, Victoria, Australia (Areschoug 1854).

Representative specimens: See Appendix 1.

Representative DNA barcode: GWS006232 [GenBank accession numbers HQ603664 (*rbc*L-3P) and HQ610428 (*tufA*); Appendix 1].

Distribution: Genetically verified specimens were collected from New Brunswick and Nova Scotia in Canada; Tasmania and Western Australia in Australia; and from Kerry in Ireland (See Appendix 1).

Ulva linza Linnaeus (Fig. 11)

A total of 21 specimens molecularly assigned to this group were collected, six of which were collected from the Bay of Fundy (Appendix 1). Microscopic observations were made on only one specimen of this genetic group.

Morphology: Specimens of *U. linza* were found growing on rocks and other algae. Thalli appeared tubular or as either broad or elongated blades with undulating margins (e.g. Fig. 11A). Cells in surface view were often square or rectangular, sometimes angular polygons, and 5-12.5µm in diameter (Fig. 11B). Chloroplasts appeared to occupy the entirety of cells in surface view, typically with one pyrenoid per cell observable (occasionally 2-3) (Fig. 11B). The upper bladed region was distromatic in cross section and 35-50µm thick with palisade cells (Fig. 11C). Near the holdfast the thallus narrowed to a monostromatic tube with a cell layer thickness of 54µm (Fig. 11D). Rhizoidal cells were present near the base of the thallus.

Type locality: Sheerness, Kent, England (Hayden *et al.* 2003).

Representative specimens: See Appendix 1.

Representative DNA barcode: GWS003752 [GenBank accession numbers HQ603624 (*rbc*L-3P) and HQ610388 (*tufA*); Appendix 1].

Distribution: Genetically verified specimens were collected from British Columbia, New Brunswick, Newfoundland and Labrador, and Nova Scotia in Canada, and from Maine and Rhode Island in the United States of America (See Appendix 1).

Ulva taylorii K.Morrill & G.W.Saunders, nom. prov. (Fig. 12)

A total of 33 specimens molecularly assigned to this group were collected, five of which were collected from the Bay of Fundy (Appendix 1). Microscopic observations were made on only one specimen of this genetic group.

Description: Specimens were found growing on rocks, invertebrates, and other algae. Specimens from the Bay of Fundy that were molecularly assigned to this group were narrow blades with tubular margins (Fig. 12A), though members of the group from the northeastern Pacific Ocean ranged in appearance from bunches of small tubes to large, broad blades. In the specimen suitable for morphological analysis, cell diameters in surface view ranged from 7.5-22.5µm with cells appearing angular and irregularly distributed (Fig. 12B). Chloroplasts were parietal bands in distal cells, but less distally they formed a band through the middle of the cells, around the single, central pyrenoid (rarely two pyrenoids are observable) (Fig. 12B). In cross section tubular blade margins were revealed and cells appeared palisade (Fig. 12C). The thickness range of the distromatic bladed centre was 28.7-30.9µm and the thickness of the monostromatic margin ranged from 21.7-35.7µm. Cells were rhizoidal at the base.

Holotype: UNB, voucher: GWS036988 collected 3 October 2015 by K. Morrill and T. Bringloe (Fig. 12A-C).

Type locality: Lepreau, New Brunswick, Canada, growing on *Ascophyllum nodosum.* Lat. 45.1270, Long. -66.4576.

Holotype DNA Barcode: GenBank number pending.

Etymology: Named in honour of the botanist Dr. A.R.A. Taylor of the University of New Brunswick, without whose intervention the Connell Memorial Herbarium might never have become what it is today.

Distribution: Genetically verified specimens were collected from British Columbia and New Brunswick in Canada, and from California in the United States of America (See Appendix 1).

Representative specimens: See Appendix 1.

Ulva viatoria K.Morrill & G.W.Saunders, nom. prov. (Fig. 13)

A total of 10 specimens were molecularly assigned to this group, three of which were recovered from Bay of Fundy waters (Appendix 1). Four thalli were used for morphological observations with three collected from the Bay of Fundy.

Description: Specimens were collected growing on rocks, shells, other hard substrata, and on other algae. Thalli molecularly assigned to this group appeared most often as branched tubes ranging from as small as 2cm total length to as long as 13cm, growing both alone or in clumps (e.g. Fig. 13A, B). Both broad (thallus width 1.5-10.4mm; Fig. 13A) and narrow (thallus width 0.1-0.4mm; Fig. 13B) morphologies were present in this group and one specimen was only tubular at its blade margins. Cells in wholemount are irregular, angular polygons 5-22.5µm in diameter (Fig. 13C) and are often arranged in meandering rows, especially in the lower thallus. In the tubular specimens, the monostromatic cell layer was 20-35µm thick. In the bladed specimen, the monostromatic tubular margins were 15-25µm thick and the distromatic central portion was 25-42.5µm thick (Fig. 13D). Typically 1-2 pyrenoids were present in each cell with as many as four pyrenoids per cell rarely observed (Fig. 13C). In the only thallus collected with the base of the plant intact, rhizoidal cells were present at the thallus base.

Holotype: UNB, voucher: GWS037951 collected 30 March 2016 by K. Morrill and G.W. Saunders (Fig. 13A, C).

Type locality: Oak Bay, New Brunswick, Canada, growing on concrete in fresh water drainage. Lat. 45.2287, Long. -67.1871.

Holotype DNA Barcode: GenBank number pending.

Etymology: Named in observance of the widespread distribution of this species relative to the other species in the *U. linza* species complex.

Distribution: Genetically verified specimens were collected from British Columbia, New Brunswick, Newfoundland and Labrador, and Nova Scotia in Canada, and from Tasmania in Australia (See Appendix 1).

Representative specimens: See Appendix 1.

Ulva prolifera O.F.Müller (Fig. 14)

A total of 26 specimens molecularly assigned to this group were collected, ten of which were collected from the Bay of Fundy (Appendix 1). Microscopic observations were made on only one specimen of this genetic group.

Morphology: Specimens of *U. prolifera* were found growing on rocks, concrete, man-made debris, and other algae. Thalli molecularly assigned to this group were highly branched, tubular, narrow (0.2-4.2mm thallus width), and were frequently found growing in clumps (Fig. 14A). Cells most often appeared square or rectangular in surface view, however various irregular polygonal shapes were not uncommon (Fig. 14B). Cells were arranged in irregular, meandering rows and cell diameters ranged from 7.5-15µm, sometimes even as large as 17.5µm (Fig. 14B). Chloroplasts occupied from one half to the entirety of the cell in surface view with no discernible pattern to their arrangement with 1-2 pyrenoids in each cell (Fig. 14B). In cross section the tube's single cell layer was 15-60µm thick (Fig. 14C). The holdfast region was not available for observation.

Type locality: Lolland, Denmark (Womersley 1984).

Representative specimens: See Appendix 1.

Representative DNA barcode: GWS003715 [GenBank accession numbers HQ603634 (*rbc*L-3P) and HQ610398 (*tufA*); Appendix 1].

Distribution: Genetically verified specimens were collected from Manitoba, New Brunswick, Newfoundland and Labrador, Nova Scotia, and Québec in Canada, and from Alaska and Maine in the United States of America (See Appendix 1).

Discussion

Of the 10 species of *Ulva* assessed in this report for being present in the Bay of Fundy, eight were confidently assigned morphospecies names based on morphological and biogeographical data, which are discussed in more detail below. For the two remaining taxa, new morphospecies identities are proposed.

The worldwide distribution of many of these species is typical of the group (Schaffelke *et al.* 2006, Heesch *et al*. 2009), particularly considering the propensity of *Ulva* species to foul ships (Blomster *et al.* 1998, Schaffelke *et al.* 2006) and travel in ballast water (Schaffelke *et al.* 2006, Flagella *et al*. 2007), and New Brunswick's history of introduction events via shipping (e.g. Carlton & Cohen 2003, Einfeldt & Addison 2015).

Barcode assessment of Ulva *specimens from the Bay of Fundy in the context of other species for which comparative data were available*

More interspecific genetic variation was observed in the *tufA* marker than was observed in the *rbc*L-3P, indicating that *tufA* is a superior barcode marker to *rbc*L-3P for species discrimination in *Ulva* (Saunders & Kucera 2010). However, because of the paucity of *tufA* data available in GenBank, *rbc*L (either the 3' region or the full gene) is still useful in taxonomic studies for establishing biogeography using sources from around the world, as numerous records are available in GenBank.

A clear barcoding gap is discernable in all groups, although the gap is small in the *U. linza* and *U. prolifera* clades (Fig. 4, Table 1). The decision to separate the *U. linza* clade into three distinct species entities was made despite the relatively low level of interspecific variation observed in the *rbc*L-3P because these low variation levels are also observable between *U. laetevirens* and *U. ohnoi*, both of which are confirmed molecular species of distinct morphospecies entities (Hiraoka *et al*. 2003, Kraft *et al*. 2010, Kazi *et al*. 2016). The low interspecific variation in the *tufA* gene region of genetic groups within the *U. linza* clade relative to other groups is indicative of very close relatedness and is considered as indicative of relatively recent speciation events. Nevertheless there is a clear barcode gap, albeit not as large as between other *Ulva* species (Table 1). Likewise, despite *U. prolifera* exhibiting a relatively high level of intraspecific variation, a clear barcode gap exists between *U. prolifera* and its yet to be named nearest neighbour, *U.* sp._2prolifera (Fig. 4).

Rationale for morphospecies name application

Ulva clathratioides

Molecular data

Ulva clathratioides was described by Kraft *et al.* (2010) as a species cryptic with *Ulva clathrata* (Roth) C.Agardh but genetically distinct from molecular data available in GenBank from specimens collected in the general type locality of *U. clathrata*. Despite having been unable to find a specimen of *U. clathrata* for comparison, the authors found that without more molecular data from the type locality of *U. clathrata* and/or more clear anatomical descriptions to accompany GenBank records, there was enough evidence to describe a new, distinct species with Australia as the type locality (Kraft *et al*. 2010). Genetic data from Bay of Fundy specimens were 100% matched *U. clathratioides* (EU933940) over 1291 base pairs of the *rbc*L.

Taxonomy

Members of *U. clathratioides* recovered from New Brunswick resembled the morphospecies concept of *U. clathrata* as reported in this area [as *Enteromorpha clathrata* (Roth) J.Agardh] by Taylor (1957). Specifically, specimens collected in this study were similar to the morphology of *Enteromorpha crinita* (Roth) J.Agardh nom. illeg., a name that Taylor (1957) mentioned as being generally applied to the "more delicate forms" of what he considered to be *U. clathrata*, but he was unable to distinguish multiple forms in northeastern North America. Bliding (1963) grouped four similar species into his informal, "Clathrata Group" within *Enteromorpha*, a section which had been proposed before and since under the name Clathratae (Blomster *et al.* 1999), including the species *E. aragoënsis* Bliding, *E. multiramosa* Bliding, *E. ramulosa* (Smith) Carmichael, and *E. clathrata* (Blomster *et al*. 1999). The first two, in addition to being invalid names that were later revised (Kraft 2007, Alongi *et al*. 2014), have never been reported in the northwestern Atlantic. The last two species, *E. clathrata* and *E. ramulosa*, were both reported in the northwestern Atlantic [the latter under the synonym *E. muscoides* (Clemente) Cremades (Guiry & Guiry 2017)], though genetic data do not support a species-level distinction between these two species (Blomster *et al*. 1999). That so many synonyms have existed for a single genetic group is testament to the diverse morphologies present in the group. Specimens of *U. clathratioides* collected for this study had more diverse chloroplast arrangement and slightly more varied cell sizes (both larger and smaller) than reported for *U. clathrata* (Taylor 1957, Bliding 1963) and thalli were much more slender [the largest thallus width observed for this study was less than half of the smallest reported by Taylor (1957)].

New Brunswick *U. clathratioides* specimens were morphologically similar to the *U. clathratioides* type, differing from the species' type description of Kraft *et al.* (2010) only in pyrenoid number per cell, more slender thalli, and smaller cells (Fig. 5). Blomster *et al*. (1999) noted that *U. clathrata* (as *E. clathrata* and *E. muscoides*, the latter now having been synonymised with the former) is difficult to confuse with other *Enteromorpha*-type algae because of its unique morphological features, most notably the arrangement of chloroplasts contributing to a net-like appearance in wholemount. While this distinctiveness might be true of European *Enteromorpha*-type *Ulva* species, the *U. clathratioides* collected in this study and by Kraft *et al.* (2010) appear morphologically cryptic with *U. clathrata* but genetically distinct from European *U. clathrata* based on sequence data available in GenBank. This is supportive of the maintenance of *U. clathratioides* as a distinct species from *U. clathrata* with an Australian type locality.

Kirkendale *et al*. (2013) identified specimens genetically identical to *U. clathratioides* as *Ulva torta* (Mertens) Trevisan, likely due to the cell organization, habitat, and the appearance of matted specimens. *Ulva torta* are unbranched tubes 30-50µm wide with a very narrow central lumen, growing in brackish sheltered harbours, mudflats, or saltmarshes (Brodie *et al.* 2007). They have also been reported growing in lagoons in Maine, U.S.A. (Taylor 1957). While the *U. clathratioides* identified in the current study were frequently found in similar conditions, the thalli were much larger with a wider central lumen and more ramification than descriptions of *U. torta*. Additionally, although *U. torta* shares the longitudinal organization of quadrangular cells with *U. clathratioides*, *U. clathratioides* lacks the longitudinal spiralling of these cell rows up the thallus sometimes present in *U. torta* (Brodie *et al.* 2007). There are currently no genetic data available for taxonomically confirmed records of *U. torta*, and the species has often been regarded as a form of *U. prolifera* rather than a unique entity (see Brodie *et al.* 2007). The *U. clathratioides* identification is a better fit for New Brunswick specimens.

Ulva compressa

Molecular data

Specimens from New Brunswick identified as *Ulva compressa* are a genetic match over 1290/1291 base pairs of the *rbc*L to an *U. compressa* record from Ireland (AY255859), near the type locality of England. The only base pair mismatch was with an ambiguity in the uploaded GenBank sequence. The GenBank match was originally collected for an in-depth taxonomic study of *U. compressa* and *U. intestinalis* in Europe, and a thorough morphological description is available to corroborate the morphospecies identification (Blomster *et al.* 1998).

Taxonomy

While *U. compressa* was originally described as a tubular alga (Linnaeus 1753), phylogenetic work has revealed its ability to present as a blade as well (Tan *et al.* 1999). Both morphologies are present in New Brunswick: the tube morphology has been recovered from multiple sites in the Bay of Fundy, and the blade morphology was collected from the Northumberland Strait (Appendix 1). Although specimens collected in this study included the blade form, which was not included by Bliding (1963) in his description of the gross morphology of *Enteromorpha compressa* (Linnaeus) Nees [which is now recognised as *Ulva compressa* (Hayden *et al.* 2003)], cell features and cross section characteristics were nearly identical between Bliding's observations of *E. compressa* var. *compressa* and New Brunswick *U. compressa* specimens. Bliding (1963) also made observations on *E. compressa* var. *usneoides* (Bonnemaison ex J.Agardh) Bliding, but this variety exhibited larger cells and more ordered cell distribution than were observed in New Brunswick *U. compressa* specimens.

Ulva gigantea

Molecular data

Collections of *U. gigantea* were genetically distinct from other species in the region, with no doubt that these specimens represent a separate species. Interestingly, our records of this species are only from the Bay of Fundy, despite extensive worldwide sampling of *Ulva* (e.g. Saunders & Kucera 2010, Kirkendale *et al.* 2013). Although there were no *tufA* matches available in GenBank, a 100% match over 702 base pairs of the 3' end of the *rbc*L was available (EU484403). This genetic match was a specimen collected from Ireland identified as *U. gigantea* based on morphological analyses (Loughnane et al. 2008).

Taxonomy

First described as *Phycoseris gigantea* Kützing and subsequently synonymized with *U. lactuca*, *U. gigantea* was published as a new combination following examination of Kützing's herbarium (Bliding 1968). Bliding (1968) identified the type locality as Granville, Normandy, France, and provided descriptions of both the lectotype specimen and fresh material collected from Roscoff, Normandy, France.

The name *Ulva gigantea* was applied to a genetic group collected in the U.K. by Loughnane *et al*. (2008) based on morphological evidence. Of two potential morphospecies identities for the group (*U. gigantea* and *U. pseudocurvata* Koeman & van den Hoek), the authors determined that the correct epithet was *U. gigantea*, citing cell shape and arrangement in surface view: polygonal cells with rounded corners arranged in long rows or short curved rows are ascribed to *U. gigantea*, whereas polygonal cells with unrounded corners and an unordered or indistinctly grouped cell distribution in surface view are ascribed to *U. pseudocurvata* (Loughnane *et al.* 2008). Descriptions of the *U. gigantea* lectotype and the *U. pseudocurvata* holotype confound these perceived differences. Bliding (1968) described *U. gigantea* cells in the centre of the thallus as ranging from quadrangular with rounded corners to round in shape in wholemount, with their organization alternating between regions of distinctly ordered rows and regions of disorder. Koeman and van den Hoek (1981) described *U. pseudocurvata* cells in the middle of the thallus as polygonal with angular corners to slightly rounded corners "partly arranged in indistinct groups whose cells form often short mostly curved rows." With the notably overlapping descriptions and the subjective nature of these features, distinguishing between these two species based on these morphological descriptions is extremely difficult. However, *rbc*L data from a specimen identified as *U. pseudocurvata* from Scotland (Tan *et al.* 1999, Hayden *et al.* 2003) that is distinct from *U. gigantea* genetic data (Loughnane *et al.* 2008), as well as the absence of curvature in the thalli collected for this study are supportive of the continued use of the morphospecies name *U. gigantea* for this genetic group.

Ulva intestinalis

Molecular data

Specimens from New Brunswick identified as *U. intestinalis* are a genetic match over 1289/1291 base pairs of the *rbc*L to an *U. intestinalis* from England (AY255860), which is the type locality of *U. intestinalis* (Hayden *et al*. 2003). The GenBank match was part of a thorough taxonomic study in Europe including morphological descriptions to corroborate morphospecies identification (Blomster *et al*. 1998).

Taxonomy

The gross morphology of *U. intestinalis* varied greatly between New Brunswick specimens, but was consistently unbranched and tubular. Smaller cells were observed in New Brunswick specimens compared to Bliding's (1963) diagnosis of *E. intestinalis* (Linnaeus) Link var. *intestinalis*, however all other observed features fell within the ranges of observations reported by Bliding. With a plethora of genetic matches available in GenBank from near the European type locality, including some accompanied by thorough morphological investigations (e.g. Blomster *et al*. 1998), the application of this morphospecies name is appropriate.

Ulva lactuca

Molecular data

Ulva lactuca is clearly genetically distinct from other species of *Ulva*, but has higher within-species divergence (Table 1). These intraspecific divergences separate the species into several distinct groups that don't appear to represent individual species. In *tuf*A analyses these slightly divergent groups might represent unique DNA signatures for the Atlantic and Pacific oceans, however *rbc*L-3P data do not corroborate this observation. Evaluation of the species from different oceans using more marker regions would be an interesting avenue of further study.

Members of this genetic group are a match over 1286/1287 base pairs of the full *rbc*L gene to a record in GenBank (EU484400) from the general European type locality. The GenBank match was part of a European investigation including morphological data to corroborate morphospecies identifications (Loughnane *et al.* 2008).

Taxonomy

The identity of *U. lactuca* has long been questioned (e.g. Papenfuss 1960), and molecular data have again brought the true identity of this simple species into question. O'Kelly *et al*. (2010) consider the morphospecies concept *U. lactuca* as applicable to what has lately been identified as *Ulva fasciata* Delile, according to sequence data reportedly obtained from the *U. lactuca* type specimen (Butler 2007, O'Kelly *et al.* 2010). However, the sequence data from the type specimen have not been made publically available. Without these data for firsthand examination, we opt here to continue to use the name and genetic concept of *U. lactuca* as it is more commonly applied (e.g. Hayden & Waaland 2002, Hayden *et al*. 2003, Hayden & Waaland 2004, Loughnane *et al.* 2008, Kirkendale *et al.* 2013), acknowledging that should the sequence data from the *U. lactuca* type be released the genetic group examined here might be assigned a different name.

Keeping the demonstrably variable morphology of *U. lactuca* in mind (Taylor 1957, Loughnane *et al.* 2008), specimens collected for this study fall well within the morphological range ascribed to the morphospecies in Taylor (1957) and Bliding (1968), though New Brunswick specimens displayed a greater range of cell diameters and thallus thicknesses in cross section.

Ulva laetevirens

Molecular data

Specimens from New Brunswick identified as *U. laetevirens* are a match to an Australian record (EU933961) in GenBank over 1289/1291 base pairs of the full *rbc*L gene. This matching GenBank record was part of a detailed taxonomic study with morphological data corroborating the morphospecies identification and the type locality for *U. laetevirens* is Australia. This is also not the first time *U. laetevirens* has been reported in the northwest Atlantic (Kirkendale *et al.* 2013, Mao *et al.* 2014).

Taxonomy

Specimens collected from New Brunswick fell well within the morphological range of *U. laetevirens* as described by Kraft *et al*. (2010), with some minor variations: New Brunswick specimens displayed a greater variety of gross morphologies, a greater range of cell sizes, some thinner thallus thickness in cross section, and more pyrenoids in some cells.

The Ulva linza *species complex taxonomy*

The following three genetic groups vary little in *rbc*L-3P but are clearly distinct in *tufA* (Table 1). They share a geographical range including the western and eastern coasts of North America, however thus far appear to vary in their respective Australian and European distributions (Fig. 4). Morphologically they are virtually indistinguishable in the field due to their wildly varying gross morphologies, while low sample sizes and overlapping features make it difficult to assert that the microscopically-observed differences between these genetic groups will facilitate reliable identification. This species complex can be assigned the morphospecies *U. linza* because it agrees well with the European concept of the morphospecies including the recognised variability of the species (Brodie *et al.* 2007), and some specimens share the morphotype of the *U. linza* lectotype (Dillenius 1742).

Of the three genetic groups in this complex, the presence of only one could be confirmed in Europe, the general type locality of *U. linza,* due to the paucity of *tufA* data in GenBank and ambiguities in available European *rbc*L sequence data. The morphospecies name *U. linza* has therefore been assigned to that group, and alternative morphospecies names were explored for the other two genetic groups. *Ulva procera* (K.Ahlner) Hayden, Blomster, Maggs, P.C.Silva, M.J.Stanhope & J.R.Waaland is a morphospecies name that was previously applied to members of the *U. linza* species complex (Saunders & Kucera 2010, Kirkendale *et al.* 2013), however it was synonymised with *U. linza* following ITS data analysis (Brodie *et al.* 2007). Now *U. procera* is considered to be one of the various morphologies displayed by *U. linza* specimens and therefore is not an applicable morphospecies name. Therefore, new names are proposed for the two unidentified genetic groups in this complex.

Ulva linza

Molecular data

Specimens identified as *U. linza* were collected extensively off the coasts of Atlantic Canada and were confirmed to also occur in the general European type locality of the morphospecies (Appendix 1). As such this genetic group is assigned to the species *U. linza* (Fig. 4). The remaining two genetic groups are described here as the new species *U. taylorii* nom. prov. and *U. viatoria* nom. prov.

Ulva taylorii nom. prov.

Molecular data

This species is closely related to *U. linza* and *U. viatoria* nom. prov. There seem to be no available morphospecies names applicable to this group and no reliable evidence of this species' existence in the *U. linza* type locality. Genetic distinction from the other species in the *U. linza* species complex necessitates the description of the new morphospecies *U. taylorii* nom. prov. (see Results).

Ulva viatoria nom. prov.

Molecular data

This species is closely related to *U. linza* and *U. taylorii* nom. prov. (Fig. 4.) There seem to be no available morphospecies names applicable to this group and no reliable evidence of this species' existence in the *U. linza* type locality. This species is morphologically quite variable and is genetically distinct from *U. linza* and *U. taylorii* nom. prov. We describe it here as *U. viatoria* nom. prov. (see Results).

Ulva prolifera

Molecular data

Molecular data from New Brunswick specimens identified as *U. prolifera* are a perfect match over 1291 base pairs of the *rbc*L gene to a European record in GenBank also identified as *U. prolifera* from Scotland (AY255864), confirming the presence of this genetic group in the general European type locality.

Taxonomy

Morphological observations made in this study agree well with Bliding's (1963) description of *Enteromorpha prolifera* (O.F.Müller) J.Agardh subsp. *prolifera* with the exception of cell organization (New Brunswick specimens exhibited rows, but not specifically organized longitudinally as described by Bliding (1963)).

Conclusion

In 2004, the renowned scientist E.O. Wilson poetically wrote that "given the extreme particularity of species and how little we know about them as a whole, taxonomy can justly be called the pioneering exploration of life on a little known planet." Taxonomy is perhaps one of the most basic and necessary studies in biology: it is the describing, naming, and classifying of organisms. Taxonomy is part of the foundation on which other biological disciplines are built. The father of modern taxonomy, Carl Linnaeus (1707-1778), with his publication *Systema Naturae* (1735) popularized a nomenclatural system by which described species could be communicated between researchers: a system we now know as binomial nomenclature. In this system each unique species is represented by two-part Latin name, consisting of its genus (shared by other species) followed by a unique specific name. Linnaeus approached his work with the intention of describing all unique organisms on Earth, with the implication that his task was finite and species were unequivocally real (Paterlini 2007). Systematics at its core relies upon the assumption that species are objectively real and yet today the definition of this most basic unit of study for a taxonomist is the subject of exhaustive discussion and debate (e.g. Wheeler & Meier 2000, De Quiroz 2007, Richards 2010).

Perhaps the most well-known species concept is the biological species concept, which posits that species are groups in which members may interbreed, but are reproductively isolated from other such groups (Mayr 1942). This concept, while appealingly intuitive, reflects the zoological background of its author and begins to falter when applied to asexual organisms or the complicated sexual systems of many plant species (Wheeler & Meier 2000). While many species concepts exist and the advantages and disadvantages of each are debateable, what they have in common is the more general concept that species are “separately evolving metapopulation lineages” (De Quiroz 2007). The conflict between species concepts stems from the selection of secondary features to define species: by doing so, some separately evolving metapopulations are excluded from species status in some concepts (De Quiroz 2007). By recognising this operational definition of species, taxonomists have the freedom to use the various characteristics of lineages as multiple lines of evidence of the separate evolution of lineages (De Quiroz 2007). This encourages an integrative approach to species delimitation.

The use of biogeographical, morphological, ecological, and molecular data together is a robust method for species delimitation and identification. Using this multifaceted approach allows us to better grasp the biodiversity in groups such as algae, where in many cases species boundaries are not clear from a morphological perspective (Saunders 2008, Díaz-Martínez *et al*. 2016). The use of MAAT has been key for the re-evaluation of marine floras in a variety of taxa (e.g. Saunders 2005, Saunders 2008, Ciancola *et al*. 2010, Clarkston & Saunders 2013, Hamsher & Saunders 2014, Hind *et al*. 2014, Schneider *et al*. 2015, Filloramo & Saunders 2016, Urbánková *et al*. 2016), with *Ulva* species being no exception (e.g. Blomster *et al*. 1998, Blomster *et al*. 1999, Woolcott & King 1999, Hofmann *et al*. 2010, Kraft *et al*. 2010, Phillips *et al*. 2016). In this thesis, I employed the MAAT methodology to explore the genus *Ulva* in the Bay of Fundy.

Ulva has a long history of taxonomic confusion. It was first described by Linnaeus in his book *Species Plantarum* (1753), and the genus originally included not only green algal members of the genus *Ulva* as it is currently accepted, but also some red algae and kelp. Members of *Ulva* as we currently accept it have few diagnostic features and many of those features are subject to high variability and overlap between species (Hayden & Waaland 2004). Species of *Ulva* therefore cannot be easily or reliably identified using morphology alone, and serve as an illustration of the necessity and utility of DNA barcoding. Using DNA for species identification circumvents the uncertainty of reliance on plastic or ephemeral features for identification, as well as adding a level of objectivity that cannot be achieved with anatomical observations alone (Saunders 2005, Saunders 2008, Saunders & Kucera 2010). DNA barcoding is a simple yet powerful tool for rapid species differentiation, even between morphologically similar or identical species (Hebert *et al*. 2003, Saunders 2005, Saunders 2008, Saunders & Kucera 2010). Furthermore, by uncovering cryptic species (which have been referred to as "the biodiversity wildcard;" Bickford *et al*. 2007) we can better understand regional and global biodiversity and as a consequence make more informed conservational decisions (e.g. Witt *et al*. 2006).

In this thesis I used MAAT to unite traditional morphospecies concepts in *Ulva* with unique genetic groups based on *rbc*L and *tufA* data. This integrated approach bridges the gap between traditional taxonomy and modern molecular techniques, thereby contributing to DNA barcoding reaching its full potential as a tool for rapid and accurate identification. Using anatomical and morphological observations, I was able to assign meaningful, previously-described morphospecies identities to eight of the genetic groups in the genus *Ulva* in the Bay of Fundy. The two remaining genetic groups closely resembled and were cryptic with *U. linza*. These previously unidentified taxa were assigned provisional names for the purpose of this thesis and will be formally described in upcoming publications: *Ulva taylorii* nom. prov., and *Ulva viatoria* nom. prov.

The data I obtained for this thesis indicate that for the genus *Ulva, tufA* is a superior barcoding marker to *rbc*L-3P, as it has greater species-level resolution. The *tufA* data presented here also provide another perspective on the variability of the local barcode gap for this relatively new barcode marker. The molecular data obtained here are now paired with meaningful morphospecies names, painting a clearer picture of the biodiversity present in the Bay of Fundy and allowing for more rapid identification in the future.

Future work

My work for this thesis has solved another part of the green algal taxonomic puzzle, but Chlorophyta remains a taxonomically confused and complicated group. Given the economic importance of *Ulva* in both desirable (as food, as a filter in aquaculture operations, and in bioremediation; Arasaki & Arasaki 1983, Nisizawa *et al.* 1987, Neori *et al.* 2003, Neori *et al.* 2004, El-Sikaily *et al.* 2006, El-Sikaily *et al.* 2007) and undesirable (as biofouling organisms and harmful algal blooms; Callow *et al.* 1997, Nelson *et al.* 2003, Flagella *et al.* 2007, Wang *et al.* 2010, Guoying *et al.* 2014) capacities, an accurate understanding of the group is important for maximizing our ability to control their growth. There are several avenues of potential future research that could be used to broaden this work, and here I will discuss three: geographic, taxonomic, and methodological.

The genus *Ulva* has in the past been largely investigated from a Eurocentric viewpoint, when in retrospect the worldwide application of European morphospecies names is not always justifiable (Kraft *et al*. 2010, O'Kelly *et al*. 2010). Therefore, many areas with morphologically assessed floras are likely less well-understood than previously believed. The MAAT methodology could be used to reassess *Ulva* species in other floras. An excellent candidate for reassessment is the Pacific coast of North America: an *Ulva* species (that currently bears the provisional epithet *U.* sp._1Pacificlinza) collected in British Columbia and California was previously identified as *U. linza* (Saunders & Kucera 2010, Saunders 2014) but is genetically distinct from European and other North American records identified as *U. linza* (Fig. 4). Its closest relative is another as-yet unidentified, exclusively Pacific species of *Ulva* (Fig. 4). Reassessment of the Pacific North American coastline would yield some interesting insights into *Ulva* diversity and biogeography.

Taxonomic questions still remain to be answered within the Bay of Fundy flora as well. Other than the genus *Ulva* there are several taxa within Chlorophyta that remain taxonomically unresolved in this area. A pursuant avenue of research would be the genus *Monostroma*, of which there are historically three species reported in the Bay of Fundy: *M. grevillei* (Thuret) Wittrock, *M. oxyspermum* (Kützing) Doty, and *M. pulchrum* Farlow (MacFarlane & Milligan 1965). Two of the species have since been moved to different genera (Guiry & Guiry 2017), however two species of *Monostroma* from the Bay of Fundy have been identified genetically (unpublished data). The methodology used in this thesis could be applied to *Monostroma* and other groups of Chlorophyta in the Bay of Fundy and complete our understanding of the small but unique flora in our area.

In this thesis the *U. linza* species complex was very closely related, with species found in similar habitats, and yet they exhibited interestingly diverse biogeographic ranges. A potential research question based on these Bay of Fundy *Ulva* species is: which if any of the species in the *U. linza* complex are native to the Bay of Fundy? In other words, are all three species in the *U. linza* complex relatively recent additions to our flora, or were any of them a part of the Bay of Fundy flora prior to any anthropogenic influence on *Ulva* distribution? Also, are the members of the *U.* linza complex interbreeding in the Bay of Fundy? Similar population genetics questions in other taxa have been answered with coalescent analyses (Provan *et al*. 2005, Einfeldt & Addison 2015). Pursuing this line of research would provide interesting insights into the origin of the algal flora in the Bay of Fundy.

On a planet covered mostly with salt water, seaweeds will likely become an increasingly precious food resource to feed the growing human population (Duarte *et al.* 2009, Rebours *et al.* 2014). Despite their importance, the discovery and description of new algal species is an ongoing pursuit with no signs of slowing down (De Clerck *et al.* 2012). My taxonomic work on *Ulva* in the Bay of Fundy provides further insight into the distribution of these cosmopolitan algae in temperate coastal waters and clarifies some long-standing misconceptions about the constituents of our flora. By uniting meaningful morphospecies names with molecular barcodes I have simplified the identification of *Ulva* species for future research and provided a baseline of the current biodiversity in a cold, northern marine basin in a changing climate. DNA barcoding and MAAT are powerful tools for the identification and description of algal species, and with the information sharing made possible through portals like Algaebase, BOLD, and

GenBank, biodiversity research has become more dynamic than ever before. This dynamism is essential in the documentation and comparison of shifting biomes as the global climate changes.

Bibliography

Alongi G., Cormaci M., and Furnani G. 2014. A nomenclatural reassessment of some of Bliding's Ulvaceae. *Webbia*. 69(1): 89-96.

Bickford D., Lohman D.J., Sodhi N.S., Ng P.K.L., Meier R., Winker K., Ingram K.K., and Das I. 2007. Cryptic species as a window on diversity and conservation. *Trends Ecol. Evol*. 22(3): 148-155.

Bliding C. 1963. A critical survey of European taxa in Ulvales. Part I. *Capsosiphon*, *Percursaria*, *Blidingia*, and *Enteromorpha*. *Opera Bot*. 8(3): 1-160.

Bliding C. 1968. A critical survey of European taxa in Ulvales. Part II. *Ulva*, *Ulvaria*, *Monostroma*, *Kornmannia*. *Bot. Not*. 121: 535-629.

Blomster J., Maggs C.A., and Stanhope M.J. 1998. Molecular and morphological analysis of *Enteromorpha intestinalis* and *E. compressa* (Chlorophyta) in the British Isles. *J. Phycol*. 34: 319-340.

Blomster J., Maggs C.A., and Stanhope M.J. 1999. Extensive intraspecific morphological variation in *Enteromorpha muscoides* (Chlorophyta) revealed by molecular analysis. *J. Phycol*. 35: 575-586.

Bonneau E.R. 1977. Polymorphic behaviour of *Ulva lactuca* (Chlorophyta) in axenic culture. I. Occurrence of *Enteromorpha*-like plants in haploid clones. *J. Phycol*. 13: 133-140.

Brodie J., Maggs C.A., John D.M., and Blomster J. 2007. *Green seaweeds of Britain and Ireland*. 242 pgs. British Phycological Society.

Butler D. 2007. Ancient algal mixup sorted. *Nature News*. doi:10.1038/news.2007.396.

Callow M.E., Callow J.A., Pickett-Heaps J.D., and Wetherbee R. 1997. Primary adhesion of *Enteromorpha* (Chlorophyta, Ulvales) propagules: quantitative settlement studies and video microscopy. *J. Phycol*. 33: 938-947.

Čandek K. and Kuntner M. 2015. DNA barcoding gap: reliable species identification over morphological and geographical scales. *Mol. Ecol. Resour*. 15: 268-277.

Carlton J.T. and Cohen A.N. 2003. Episodic global dispersal in shallow water marine organisms: the case history of the European shore crabs *Carcinus maenas* and *C. aestuarii*. *J. Biogeogr*. 30: 1809-1820.

Ciancola E.N., Popolizio T.R., Schneider C.W., and Lane C.E. 2010. Using molecular-assisted alpha taxonomy to better understand red algal biodiversity in Bermuda. *Diversity*. 2(6): 946-958.

Clarkston B.E. and Saunders G.W. 2013. Resolving species diversity in the red algal genus *Callophyllis* (Kallymeniaceae, Gigartinales) in Canada using molecular assisted alpha taxonomy. *Eur. J. Phycol*. 28(1): 27-46.

De Clerck O., Guiry M.D., Leliaert F., Samyn Y., and Verbruggen H. 2012. Algal taxonomy: a road to nowhere? *J. Phycol.* 49: 215-225.

De Queiroz K. 2007. Species concepts and species delimitation. *Syst. Biol*. 56(6): 879-886.

Díaz-Martínez S., Zuccarello G.C., Chávez G.A.S., Pedroche F.F., and Avila-Ortiz A.G. 2016. Species of *Padina* (Dictyotales, Phaeophyceae) in tropical Mexican waters based on molecular-assisted taxonomy. *Phycologia*. 55(6): 673-687.

Dillenius J.J. 1742. *Historia muscorum*. Sheldon, Oxford.

Duarte C.M., Holmer M., Olsen Y., Soto D., Marbà N., Guiu J., Black K., and Karakassis I. 2009. Will the oceans help feed humanity? *BioScience*. 59(11): 967-976.

Edgar R.C. 2004. MUSCLE: a multiple sequence alignment method with reduced time and space complexity. *BMC Bioinformatics*. 5(1): 113.

Einfeldt A.L. and Addison J.A. 2015. Anthropocene invasion of an ecosystem engineer: resolving the history of *Corophium volutator* (Amphipoda: Corophiidae) in the North Atlantic. *Biol. J. Linn. Soc*. 115: 288-304.

El Sikaily A., Khaled A., El Nemr A., and Abdelwahab O. 2006. Removal of Methylene Blue from aqueous solution by marine green alga *Ulva lactuca*. *Chem. Ecol*. 22(2): 149-157.

El Sikaily A., El Nemr A., Khaled A., and Abdelwahab O. 2007. Removal of toxic chromium from wastewater using green alga *Ulva lactuca* and its activated carbon. *J. Hazard. Mater*. 148: 216-228.

Evans J.R. and Saunders G.W. 2017. PCR fishing for red endophytes in British Columbia Kallymeniaceae (Gigartinales, Florideophyceae) uncovers the species-rich *Kallymenicola* gen. nov. (Palmariales, Nemaliophycidae). *J. Phycol*. 53(3): 577-588.

Felsenstein J. 1985. Confidence limits on phylogenies: An approach using the bootstrap. *Evolution*. 39(4): 783-791.

Filloramo G.V. and Saunders G.W. 2016. Molecular-assisted alpha taxonomy of the genus *Rhodymenia* (Rhodymeniaceae, Rhodymeniales) from Australia reveals overlooked species diversity. *Eur. J. Phycol*. 51(3): 354-367.

Flagella M.M., Verlaque M., Soria A., and Buia M.C. 2007. Macroalgal survival in ballast water tanks. *Mar. Pollut. Bull*. 54: 1395-1401.

Griffith M.K., Schneider C.W., Wolf D.I., Saunders G.W., and Lane C.E. 2017. Genetic barcoding resolves the historically known red alga *Champia parvula* from southern New England, USA, as *C. farlowii* sp. nov. (Champiaceae, Rhodymeniales). *Phytotaxa*. 302(1): 77-89.

Guiry M.D. and Guiry G.M. 2017. AlgaeBase. World-wide electronic publication, National University of Ireland, Galway. http://www.algaebase.org; searched on 26 October 2017.

Guoying D.U., Feifei W.U., Yunxiang M.A.O., Shenghua G.U.O., Hongfan X.U.E., and Guiqi B.I. 2014. DNA barcoding assessment of green macroalgae in coastal zone Around Qingdao, China. *J. Ocean Univ. China*. 13(1): 97-103.

Hajibabaei M., Singer G.A.C., Hebert P.D.N., and Hickey D.A. 2007. DNA barcoding: how it complements taxonomy, molecular phylogenetics and population genetics. *Trends Genet*. 23(4): 167-172.

Hamsher S.E. and Saunders G.W. 2014. A floristic survey of marine tube-forming diatoms reveals unexpected diversity and extensive co-habitation among genetic lines of the *Berkeleya rutilans* complex (Bacillariophyceae). *Eur. J. Phycol*. 49(1): 47-59.

Harley C.D.G. 2011. Climate change, keystone predation, and biodiversity loss. *Science*. 334: 1124-1127.

Harley C.D.G., Hughes A.R., Hultgren K.M., Miner B.G., Sorte C.J.B., Thornber C.S., Rodriguez L.F., Tomanek L., and Williams S.L. 2006. The impacts of climate change in coastal marine systems. *Ecol. Lett.* 9(2): 228-241.

Harley C.D.G., Anderson K.M., Demes K.W., Jorve J.P., Kordas R.L., and Coyle T.A. 2012. Effects of climate change on global seaweed communities. *J. Phycol*. 48: 1064-1078.

Hayden H.S. and Waaland J.R. 2002. Phylogenetic systematics of the Ulvaceae (Ulvales, Ulvophyceae) using chloroplast and nuclear DNA sequences. *J. Phycol*. 38: 1200-1212.

Hayden H.S. and Waaland J.R. 2004. A molecular systematic study of *UIva* (Ulvaceae, Ulvales) from the northeast Pacific. *Phycologia*. 43(4): 364-382.

Hayden H.S., Blomster J., Maggs C.A., Silva P.C., Stanhope M.J., and Waaland J.R. 2003. Linnaeus was right all along: *Ulva* and *Enteromorpha* are not distinct genera. *Eur. J. Phycol*. 38: 277-294.

Hebert P.D.N., Cywinska A., and Ball S.L. 2003. Biological identifications through DNA barcodes. *Proc. R. Soc. Lond. B.* 270: 313-321.

Heesch S., Broom J.E.S., Neill K.F., Farr T.J., Dalen J.L., and Nelson W.A. 2009. *Ulva*, *Umbraulva* and *Gemina*: genetic survey of New Zealand taxa reveals diversity and introduced species. *Eur. J. Phycol*. 44(2): 143-154.

Hind K.R., Gabrielson P.W., Lindstrom S.C., and Martone P.T. 2014. Misleading morphologies and the importance of sequencing type specimens for resolving coralline taxonomy (Corallinales, Rhodophyta): *Pachyarthron retaceum* is *Corallina officinalis*. *J. Phycol*. 50: 760-764.

Hiraoka M., Shimada S., Uenosono M., and Masuda M. 2003. A new green-tide-forming alga, *Ulva ohnoi* Hiraoka et Shimada sp. nov. (Ulvales, Ulvophyceae) from Japan. *Phycol. Res.* 51: 17-29.

Hofmann L.C., Nettleton J.C., Neefus C.D., and Mathieson A.C. 2010. Cryptic diversity of *Ulva* (Ulvales, Chlorophyta) in the Great Bay Estuarine System (Atlantic USA): introduced and indigenous distromatic species. *Eur. J. Phycol*. 45(3): 230-239.

Hollingsworth P.M., Forrest L.L., Spouge J.L., Hajibabaei M., Ratnasingham S., Van Der Bank M., Chase M.W., Cowan R.S., Erickson D.L., Fazekas A.J., Graham S.W., James K.E., Kim K.J., Kress W.J., Schneider H., Van Alphenstahl J., Barrett S. C.H., Van Den Berg C., Bogarin D., Burgess K.S., Cameron K.M., Carine M., Chacon J., Clark A., Clarkson J.J., Conrad F., Devey D.S., Ford C.S., Hedderson T.A.J., Hollingsworth M.L., Husband B.C., Kelly L.J., Kesanakurti P.R., Kim J.S., Kim Y.D., Lahaye R., Lee H.L., Long D.G., Madrinan S., Maurin O., Meusnier I., Newmaster S.G., Park C.W., Percy D.M., Petersen G., Richardson J.E., Salazar G.A., Savolainen V., Seberg O., Wilkinson M.J., Yi D.K., and Little D.P. 2009. DNA barcode for land plants. *P. Natl. Acad. Sci. USA*. 106: 12794-12797.

Provasoli L. and Pintner I.J. 1980. Bacteria induced polymorphism in an axenic laboratory strain of *Ulva lactuca* (Chlorophyceae). *J. Phycol*. 16: 196-201.

Kazi M.A., Kavale M.G., and Singh V.V. 2016. Morphological and molecular characterization of *Ulva chaugulii* sp. nov., *U. lactuca* and *U. ohnoi* (Ulvophyceae, Chlorophyta) from India. *Phycologia*. 55(1): 45-54.

Kearse M., Moir R., Wilson A., Stones-Havas S., Cheung M., Sturrock S., Buxton S., Cooper A., Markowitz S., Duran C., Thierer T., Ashton B., Meintjes P., and Drummond A. 2012. Geneious Basic: an integrated and extendable desktop software platform for the organization and analysis of sequence data. *Bioinformatics*. 28(12): 1647-1649.

Kirkendale L., Saunders G.W., and Winberg P. 2013. A molecular survey of *Ulva* (Chlorophyta) in temperate Australia reveals enhanced levels of cosmopolitanism. *J. Phycol*. 49: 69-81.

Koeman R.P.T., and van den Hoek C. 1981. The taxonomy of *Ulva* (Chlorophyceae) in the Netherlands. *Br. Phycol. J.* 16: 9-53.

Kraft G.T. 2007. *Marine Benthic Algae of Lord Howe Island and the Southern Great Barrier Reef, 1. Green Algae*. 347 pgs. Australian Biological Resources Study ⁄ CSIRO Publishing, Melbourne, Australia.

Kraft L.G.K., Kraft G.T., and Waller R.F. 2010. Investigations into Southern Australian *Ulva* (Ulvophyceae, Chlorophyta) taxonomy and molecular phylogeny indicate both cosmopolitanism and endemic cryptic species. *J. Phycol*. 46: 1257-1277.

Kress W.J., García-Robledo C., Uriarte M., and Erickson D.L. 2014. DNA barcodes for ecology, evolution, and conversation. *Trends Ecol. Evol*. 30(1): 25-35.

Le Gall L. and Saunders G.W. 2010. DNA barcoding is a powerful tool to uncover algal diversity: a case study of the Phyllophoraceae (Gigartinales, Rhodophyta) in the Canadian flora. *J. Phycol*. 46(2): 374-389.

Lee R. E. 2008. *Phycology*. 547 pgs. Cambridge University Press, Cambridge, United Kingdom.

Link H.F. 1820. *De algis aquaticis in genera disponendis*. In: Horae physicae berolinenses. (Nees von Esenbeck, C.G.D. Eds) 8 pgs. Bonnae [Bonn]: Sumtibus Adolphi Marcus.

Linnaeus C. 1753. *Species plantarum, exhibentes plantas rite cognitas, ad genera relatas, cum differentiis specificis, nominibus trivialibus, synonymis selectis, locis natalibus, secundum systema sexuale digestas*. 1200 pgs. Holmiae (Stockholm): Impensis Laurentii Salvii.

Loughnane C.J., McIvor L.M., Rindi F., Stengel D.B., and Guiry M.D. 2008. Morphology, *rbcL* phylogeny and distribution of distromatic *Ulva* (Ulvophyceae, Chlorophyta) in Ireland and southern Britain. *Phycologia*. 47(4): 416-429.

Macfarlane C.I. and Milligan G.M. 1965. *Marine algae of the maritime provinces of Canada. A preliminary checklist*. 24 pgs. Nova Scotia Research Foundation - Seaweeds Division, Halifax, Nova Scotia, Canada.

Mayr E. 1942. *Systematics and the origin of species*. 334 pgs. Columbia University Press, New York.

McDevit D.C. and Saunders G.W. 2010. A DNA barcode examination of the Laminariaceae (Phaeophyceae) in Canada reveals novel biogeographical and evolutionary insights. *Phycologia*. 49(3): 235-248.

Mora C., Tittensor D.P., Adl S., Simpson A.G.B., and Worm B. 2011. How many species are there on Earth and in the ocean? *PLoS Biol*. 9(8): e1001127.

Nelson T.A., Lee D.J., and Smith B.C. 2003. Are "green tides" harmful algal blooms? Toxic properties of water-soluble extracts from two bloom-forming macroalgae, *Ulva fenestrata* and *Ulvaria obscura* (Ulvophyceae). *J. Phycol*. 39: 874-879.

Neori A., Msuya F.E., Shauli L., Schuenhoff A., Kopel F., and Shpigel M. 2003. A novel three-stage seaweed (*Ulva lactuca*) biofilter design for integrated mariculture. *J. Appl. Phycol*. 15: 543-553.

Neori A., Chopin T., Troell M., Buschmann A.H., Kraemer G.P., Halling C., Shpigel M., and Yarish C. 2004. Integrated aquaculture: rationale, evolution and state of the art emphasizing seaweed biofiltration in modern mariculture. *Aquaculture*. 231: 361-391.

Nisizawa K., Noda H., Kikuchi R., and Watanabe T. 1987. The main seaweed foods in Japan. *Hydrobiologia*. 151/152: 5-29.

O'Kelly C.J., Kurihara A., Shipley T.C., and Sherwood A.R. 2010. Molecular assessment of *Ulva* spp. (Ulvophyceae, Chlorophyta) in the Hawaiian Islands. *J. Phycol*. 46: 728-735.

Papenfuss G.F. 1960. On the genera of the Ulvales and the status of the order. *J. Linn. Soc. (Bot.)*. 56(367): 303-318.

Paterlini M. 2007. There shall be order - the legacy of Linnaeus in the age of molecular biology. *EMBO Rep*. 8 (9): 814-816.

Phillips J.A., Lawton R.J., Denys R., Paul N.A., and Carl C. 2016. *Ulva sapora* sp. nov., an abundant tubular species of *Ulva* (Ulvales) from the tropical Pacific Ocean. *Phycologia*. 55(1): 55-64.

Provasoli L. and Pintner I.J. 1980. Bacteria induced polymorphism in an axenic laboratory strain of *Ulva lactuca* (Chlorophyceae*). J. Phycol*. 16: 196-201.

Provan J., Wattier R.A., and Maggs C.A. 2005. Phylogeographic analysis of the red seaweed *Palmaria palmata* reveals a Pleistocene marine glacial refugium in the English Channel. *Mol. Ecol*. 14: 793-803.

Puillandre N., Lambert A., Brouillet S., and Achaz G. 2012. ABGD. Automatic Barcode Gap Discovery for primary species delimitation. *Mol. Ecol*. 21: 1864-1877.

Ratnasingham S. and Hebert P. D. N. 2007. BOLD: The Barcode of Life Data System (www.barcodinglife.org). *Mol. Ecol. Notes*. 7: 355-364.

Rebours C., Marinho-Soriano E., Zertuche-González J.A., Hayashi L., Vásquez J.A., Kradolfer P., Soriano G., Ugarte R., Abreu M.H., Bay-Larsen I., Hovelsrud G., Rødven R., and Robledo D. 2014. Seaweeds: an opportunity for wealth and sustainable livelihood for coastal communities. *J. Appl. Phycol*. 26: 1939-1951.

Richards R. A. 2010. *The species problem – a philosophical analysis*. 236 pgs. Cambridge University Press, Cambridge, United Kingdom.

Saunders G.W. and Kucera H. 2010. An evaluation of *rbc*L, *tufA*, UPA, LSU and ITS as DNA barcode markers for the marine green macroalgae. *Cryptogamie Algol*. 31(4): 487-528.

Saunders G.W. and McDevit D.C. 2012. Methods for DNA barcoding photosynthetic protists emphasizing the macroalgae and diatoms. *Methods Mol. Biol*. 858: 207-222.

Saunders G.W. 1993. Gel purification of red algal genomic DNA: an inexpensive and rapid method for the isolation of polymerase chain reaction-friendly DNA. *J. Phycol*. 29: 251-254.

Saunders G.W. 2005. Applying DNA barcoding to red macroalgae: a preliminary appraisal holds promise for future applications. *Phil. Trans. R. Soc. B*. 360(1462): 1879-1888.

Saunders G.W. 2008. A DNA barcode examination of the red algal family Dumontiaceae in Canadian waters reveals substantial cryptic species diversity. 1. The foliose *Dilsea-Neodilsea* complex and *Weeksia*. *Botany*. 86: 773-789.

Saunders G.W. 2014. Long distance kelp rafting impacts seaweed biogeography in the Northeast Pacific: the kelp conveyor hypothesis. *J. Phycol*. 50: 968-974.

Schaffelke B., Smith J.E., and Hewitt C.L. 2006. Introduced macroalgae - a growing concern. *J. Appl. Phycol*. 18: 529-541.

Schneider C.W., Cianciola E.N., Popolizio T.R., Spagnuolo D.S., and Lane C.E. 2015. A molecular-assisted alpha taxonomic study of the genus *Centroceras* (Ceramiaceae, Rhodophyta) in Bermuda reveals two novel species. *Algae*. 30(1): 15-33.

Silva P. C. 1952. A review of nomenclatural conservation in the algae from the point of view of the type method. *Univ. Calif. Publ. Bot.* 25: 241-324.

Stamatakis A. 2006. RAxML-VI-HPC: maximum likelihood-based phylogenetic analyses with thousands of taxa and mixed models. *Bioinformatics*. 22(21): 2688-2690.

Tan I.H., Blomster J., Hansen G., Leskinen E., Maggs C.A., Mann D.G., Sluiman H.J., and Stanhope M.J. 1999. Molecular phylogenetic evidence for a reversible morphogenetic switch controlling the gross morphology of two common genera of green seaweeds, *Ulva* and *Enteromorpha*. *Mol. Biol. Evol*. 16(8): 1011-1018.

Taylor W. R. 1957. *Marine algae of the northeastern coast of North America*. Revised edition. 509 pgs. Ann Arbor, University of Michigan Press.

Urbánková P., Scharfen V., and Kulichová J. 2016. Molecular and automated identification of the diatom genus *Frustulia* in northern Europe. *Diatom Res*. 31(3): 217-229.

Wang J., Jiang P., Cui Y., Li N., Wang M., Lin H., He P., and Qin S. 2010. Molecular analysis of green-tide-forming macroalgae in the Yellow Sea. *Aquat. Bot.* 93: 25-31.

Wheeler Q. and Meier R. (Eds.). 2000. *Species concepts and phylogenetic theory: a debate*. 230 pgs. Columbia University Press.

Wilson E.O. 2004. Taxonomy as a fundamental discipline. *Phil. Trans. R. Soc. Lond. B*. 359: 739.

Witt J.D.S., Threloff D.L., and Hebert P.D.N. 2006. DNA barcoding reveals extraordinary cryptic diversity in an amphipod genus: implications for desert spring conservation. *Mol. Ecol*. 15: 3073-3082.

Wolf M.A., Sciuto K., Andreoli C., and Moro I. 2012. *Ulva* (Chlorophyta, Ulvales) biodiversity in the North Adriatic Sea (Mediterranean, Italy): cryptic species and new introductions. *J. Phycol*. 48: 1510-1521.

Womersley H.B.S. 1984. *The marine benthic flora of Southern Australia. Part I*. 329 pgs. Government Printer, Adelaide, South Australia.

Woolcott G.W. and King R.J. 1999. *Ulva* and *Enteromorpha* (Ulvales, Ulvophyceae, Chlorophyta) in eastern Australia: comparison of morphological features and analyses of nuclear rDNA sequence data. *Aust. Syst. Bot*. 12: 709-725.

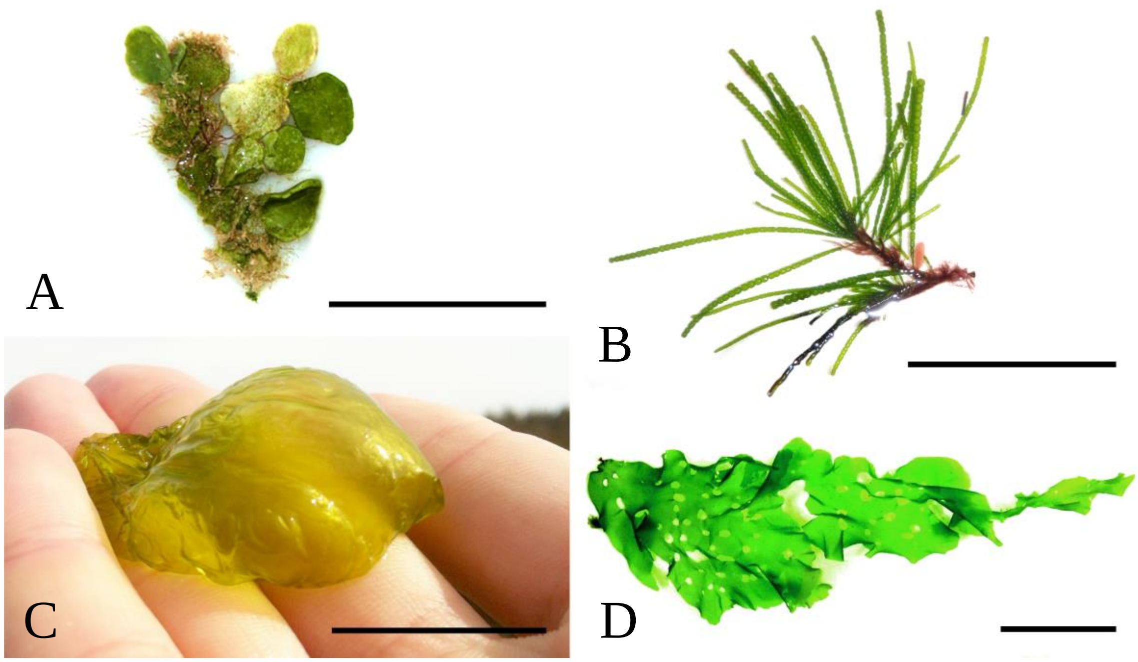


Figure 1. Diversity in morphology exhibited by green algae (Chlorophyta). (A) Calcified alga: *Halimeda discoidea* from Bermuda (BDA0079). (B) Filamentous alga with large cells visible to the naked eye: *Chaetomorpha coliformis* from Tasmania, Australia (GWS015218). (C) Alga growing as an inflated sac: *Monostroma* sp. from New Brunswick, Canada. (D) Bladed alga: *Ulva lactuca* from New Brunswick, Canada (GWS036935). Scale bars = 5cm (A, B, D) and 2cm (C).

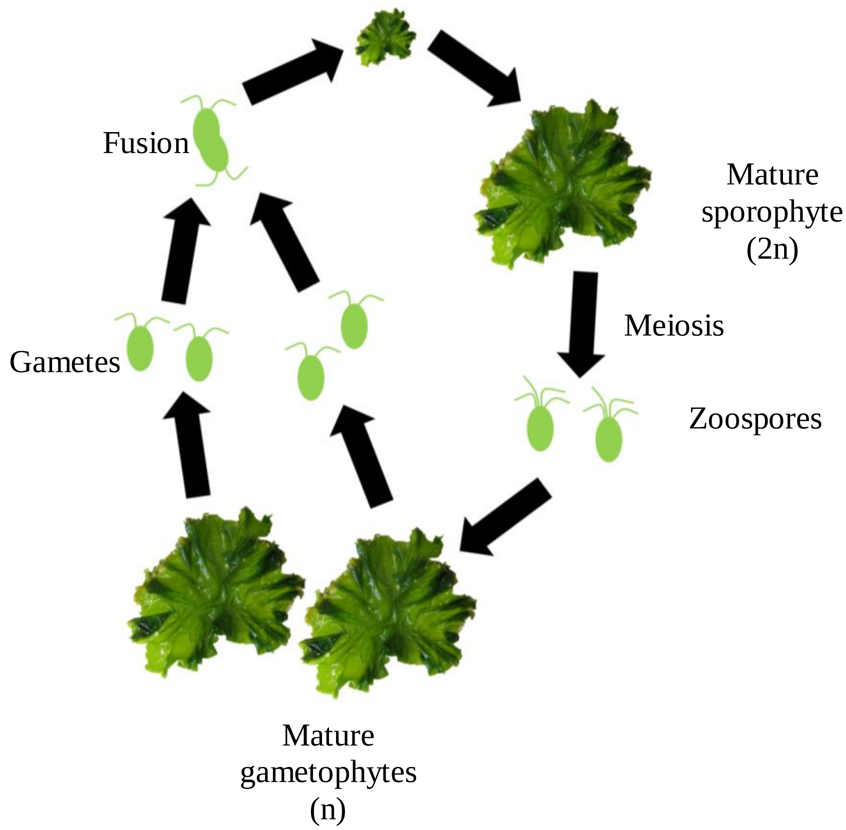


Figure 2. A simplified *Ulva* life cycle: diplohaplontic alternation of isomorphic generations.

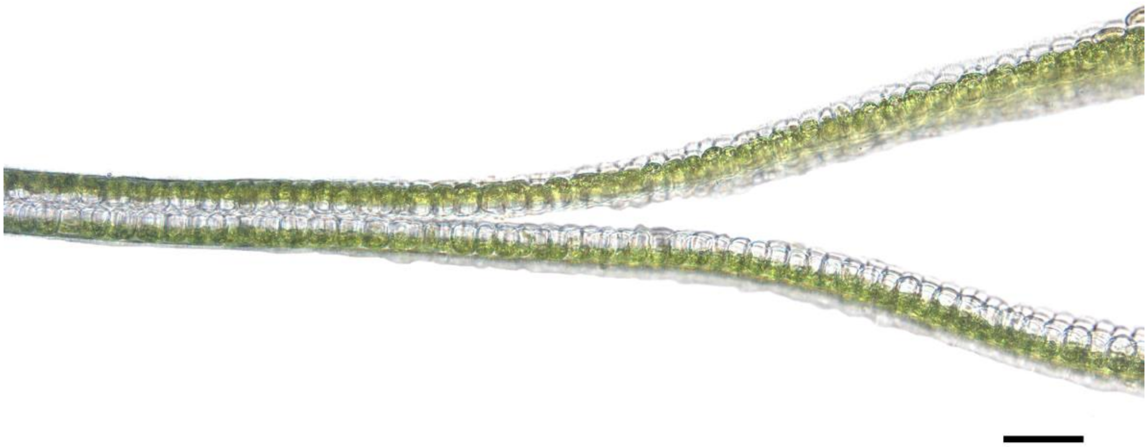
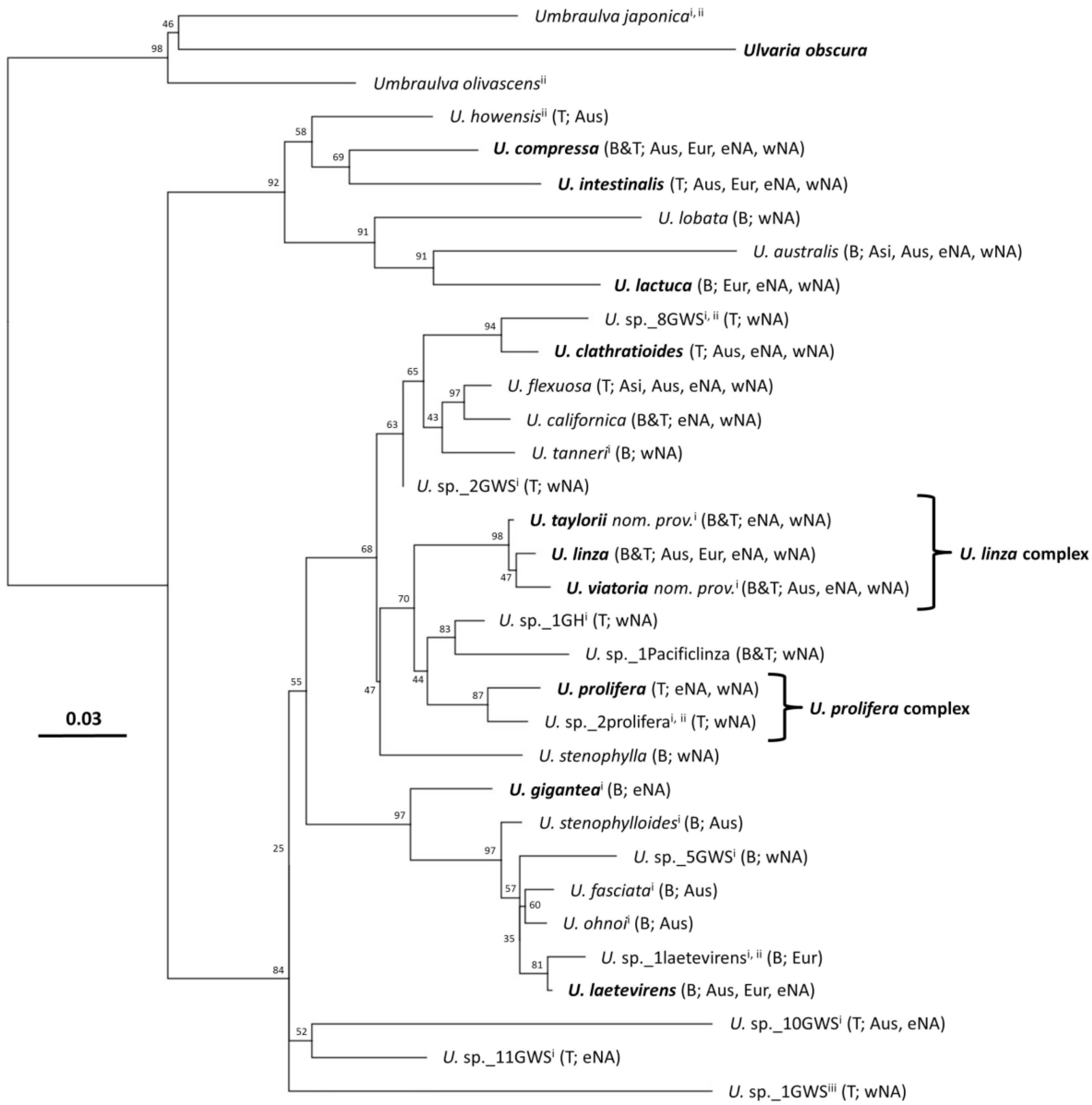


Figure 3. Close view of the transition from distromatic to monostromatic at the margin of an *Ulva linza* specimen. Scale bar = 50µm.



Umbraulva japonica i, ii
Ulvaria obscura
Umbraulva olivascens ii
U. howensis ii (T; Aus)
U. compressa (B&T; Aus, Eur, eNA, wNA)
U. intestinalis (T; Aus, Eur, eNA, wNA)
U. lobata (B; wNA)
U. australis (B; Asi, Aus, eNA, wNA)
U. lactuca (B; Eur, eNA, wNA)
U. sp._8GWS i, ii (T; wNA)
U. clathratioides (T; Aus, eNA, wNA)
U. flexuosa (T; Asi, Aus, eNA, wNA)
U. californica (B&T; eNA, wNA)
U. tanneri i (B; wNA)
U. sp._2GWS i (T; wNA)
U. taylorii nom. prov. i (B&T; eNA, wNA)
U. linza (B&T; Aus, Eur, eNA, wNA)
U. viatoria nom. prov. i (B&T; Aus, eNA, wNA)
U. linza complex
U. sp._1GH i (T; wNA)
U. sp._1Pacificlinza (B&T; wNA)
U. prolifera (T; eNA, wNA)
U. sp._2prolifera i, ii (T; wNA)
U. prolifera complex
U. stenophylla (B; wNA)
U. gigantea i (B; eNA)
U. stenophylloides i (B; Aus)
U. sp._5GWS i (B; wNA)
U. fasciata i (B; Aus)
U. ohnoi i (B; Aus)
U. sp._1laetevirens i, ii (B; Eur)
U. laetevirens (B; Aus, Eur, eNA)
U. sp._10GWS i (T; Aus, eNA)
U. sp._11GWS i (T; eNA)
U. sp._1GWS iii (T; wNA)
0.03

Figure 4. Maximum-likelihood tree built from an alignment of three concatenated gene regions: *rbc*L-5P, *rbc*L-3P, and *tufA*. Bootstrap values are indicated at each node and missing data are denoted with superscript i, ii, and iii for the respective markers. Species occurring in Bay of Fundy waters are indicated in bold type. Gross morphology is indicated with the letters B (blade) and/or T (tube) in parentheses after the species name. Also included in parentheses are geographic data with the following abbreviations: Asi (Asia), Aus (Australia), Eur (Europe), wNA (western North America), eNA (eastern North America). Scale bar refers to substitutions per site.

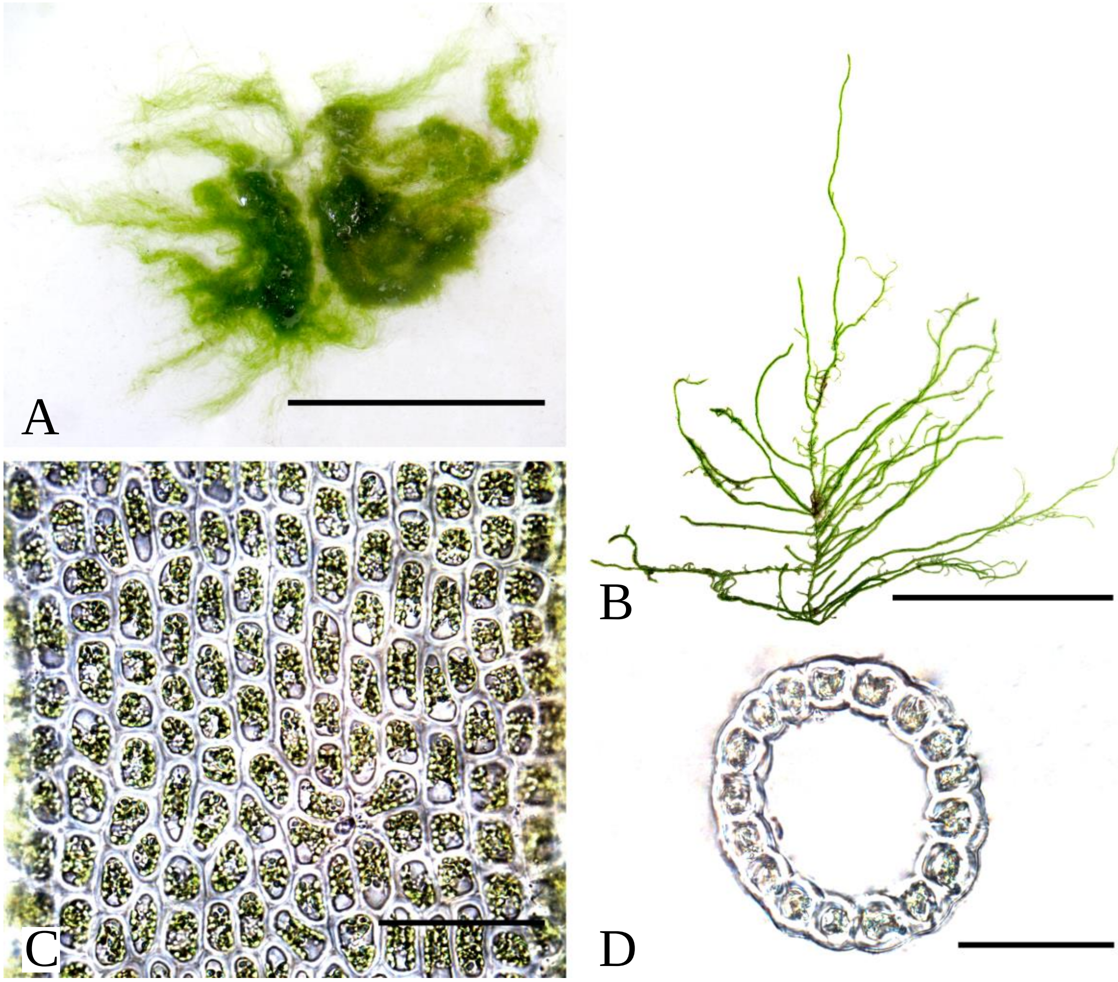


Figure 5. Morphological features of *U. clathratioides*. (A) Thalli are typically found in a tangled mat (GWS036970). (B) A single thallus separated from the morass, demonstrating dense branching on both main axis and laterals (GWS036977). (C) Wholemount of main axis (GWS036920). (D) Cross section of rehydrated thallus (GWS036947). Scale bars = 5cm (A, B) and 50μm (C, D).

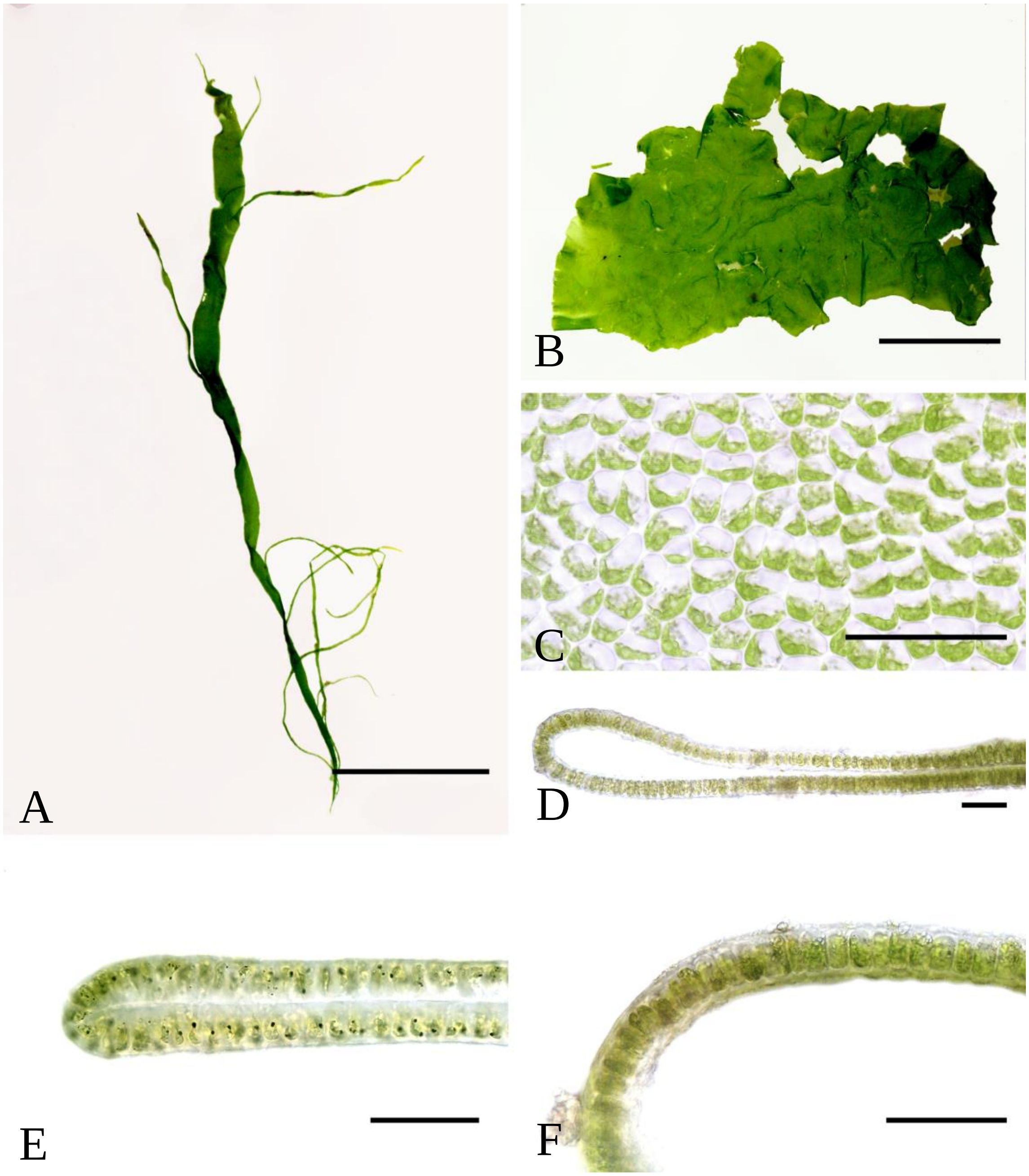

A
B
C
D
E
F

Figure 6. Morphological features of *U. compressa*. (A) Gross morphology of an enteromorphoid specimen with strap-shaped main axis and multiple proliferations (GWS036907). (B) Gross morphology of a bladed specimen (GWS036973). (C) Mid-thallus wholemount of main axis (GWS030291). (D) Mid-thallus cross section from main axis of a bladed specimen with tubular margins (GWS036907). (E) Marginal cross section of a distromatic bladed specimen (GWS036973). (F) Cross section of a tubular specimen (GWS030291). Scale bars = 2cm (A), 5cm (B), and 50µm (C, D, E, F).

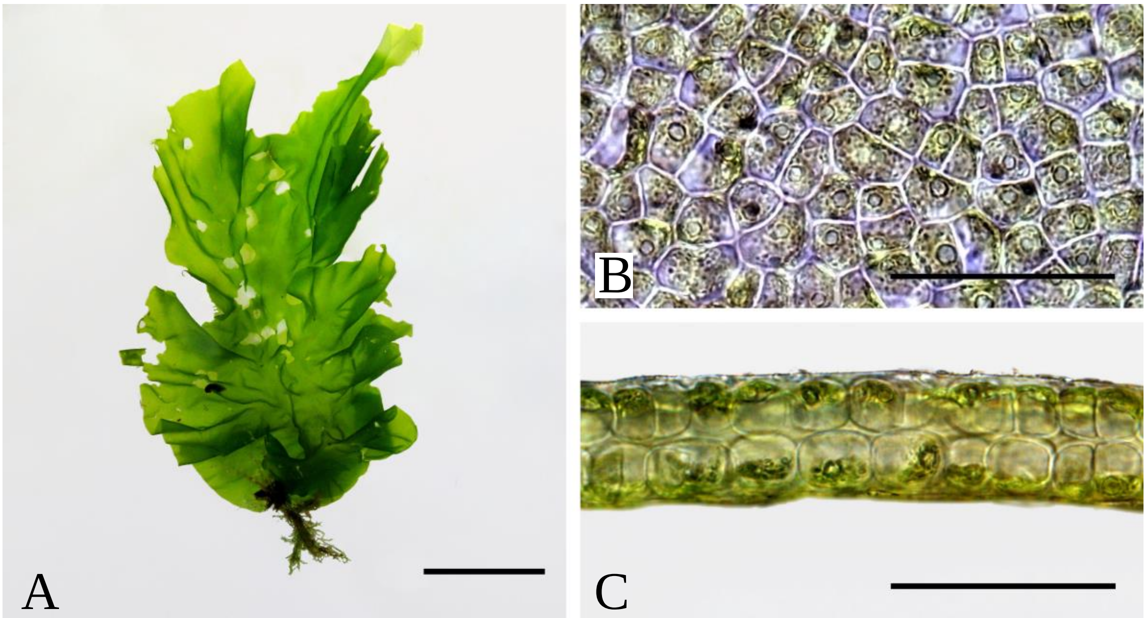


Figure 7. Morphological features of *U. gigantea.* (A) Thallus typically an expanded blade with gently undulating margins (GWS036933). (B) Cells in wholemount irregularly polygonal typically with a single pyrenoid (GWS036931). (C) Mid-thallus cross section (GWS036931). Scale bars = 2cm (A) and 50µm (B, C).

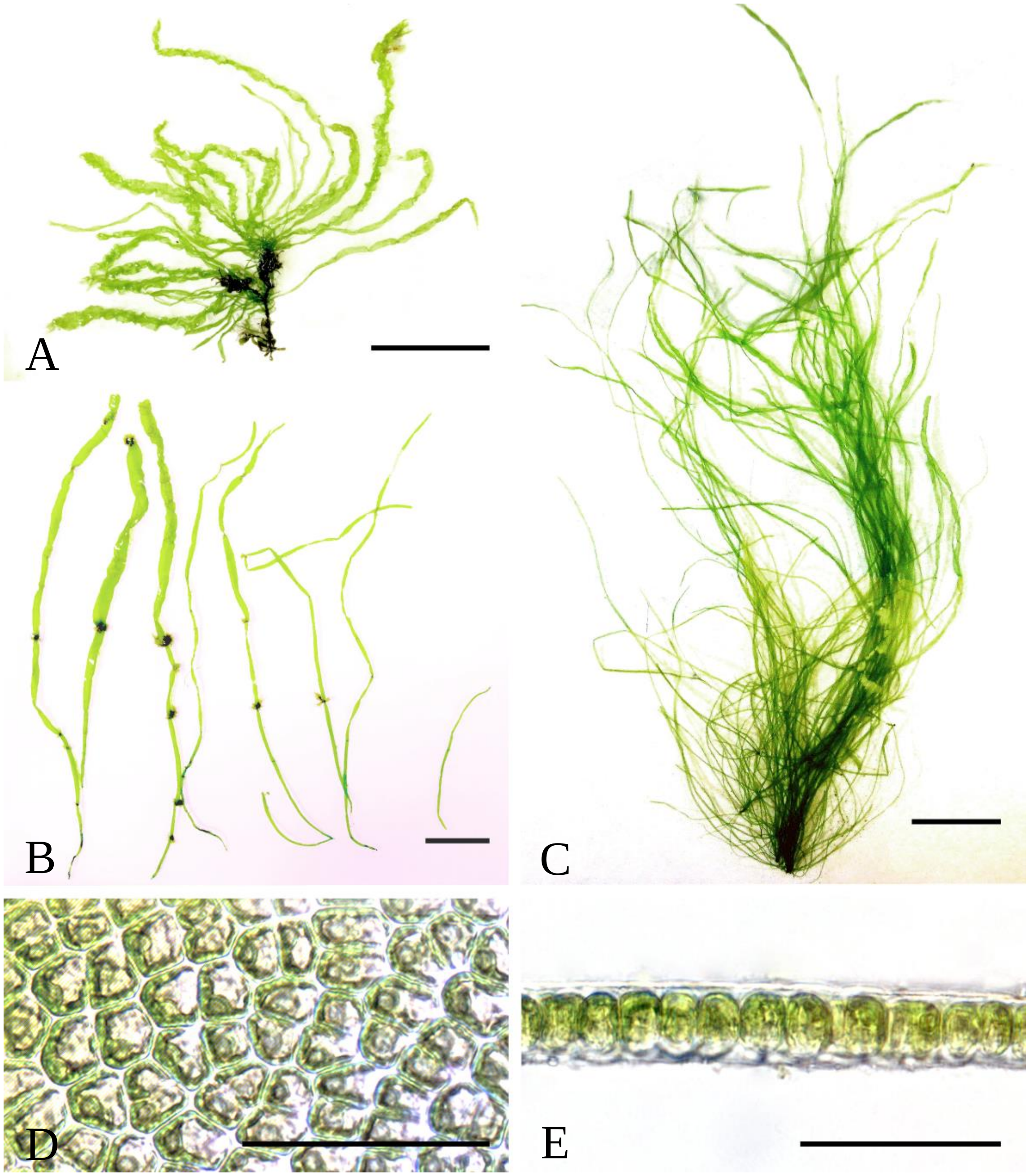

A
B
C
D
E

Figure 8. Morphological features of *U. intestinalis*. Broad range of gross morphologies included: twisted, corkscrew-like tubes with undulating margins (A)(GWS036982); long, irregularly compressed, inflated tubes, occasionally with multiple tubes arising from a common point of attachment (B)(GWS036967); and clumps of long, thin tubes stemming from a common point of attachment (C)(GWS036963). (D) Mid-thallus wholemount (GWS036937). (E) Mid-thallus cross section (GWS036937). Scale bars = 10cm (A), 2cm (B, C), and 50μm (D, E).

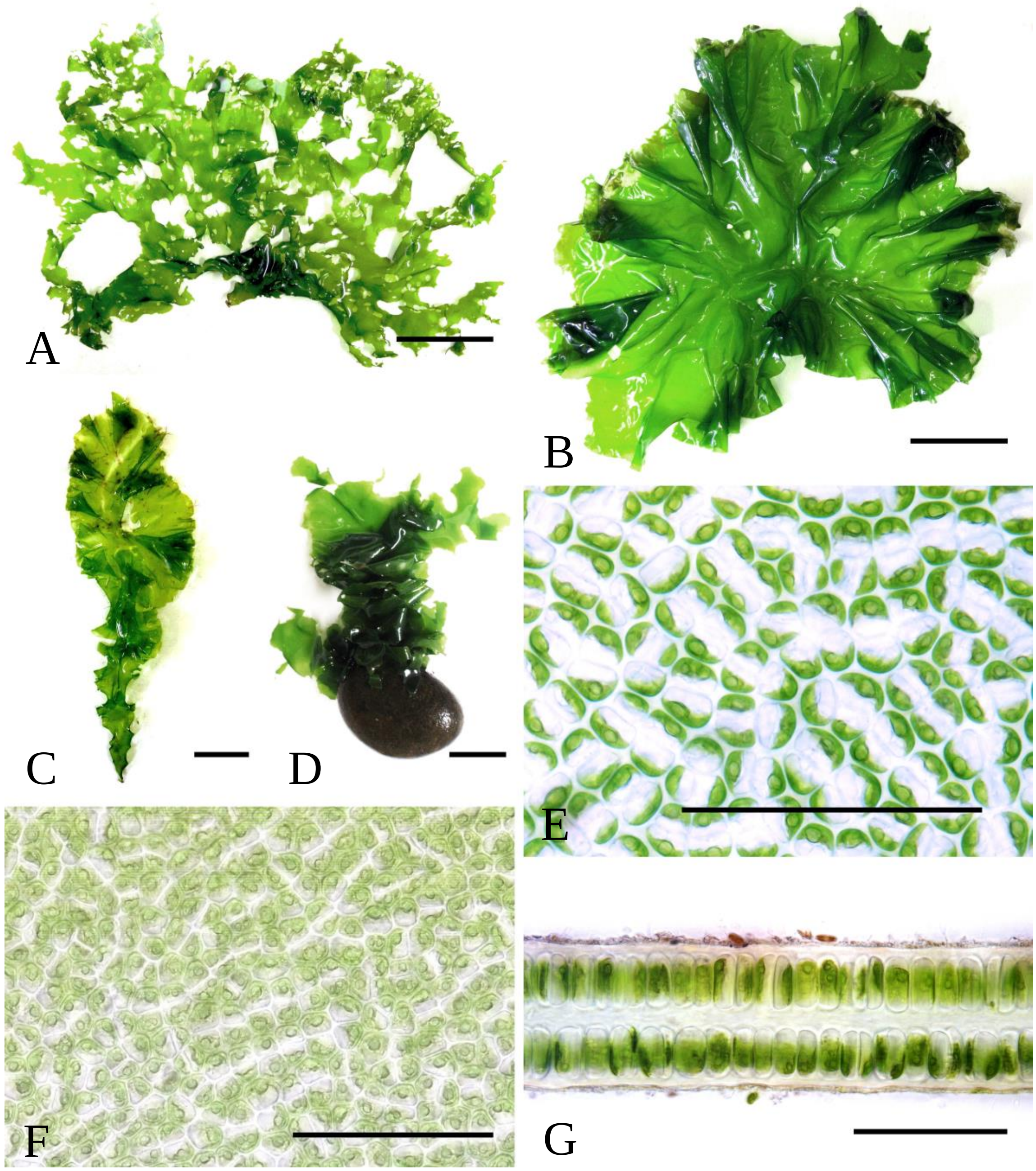

A
B
C
D
E
F
G

Figure 9. Morphological features of *U. lactuca*. Gross morphology was extremely variable: examples included: fenestrate blades (A)(GWS036930); broad blades with undulating margins (B)(GWS036934); pyriform blades with undulating margins (C)(GWS036952); and irregularly clustered blades (D)(GWS036904). (E) Mid-thallus wholemount with consistently paired cells (GWS036904). (F) Mid-thallus wholemount with unpaired cells (GWS036935). (G) Cross section displaying palisade cells (GWS036904). Scale bars = 5cm (A, B), 2cm (C, D), and 100µm (E, F, G).

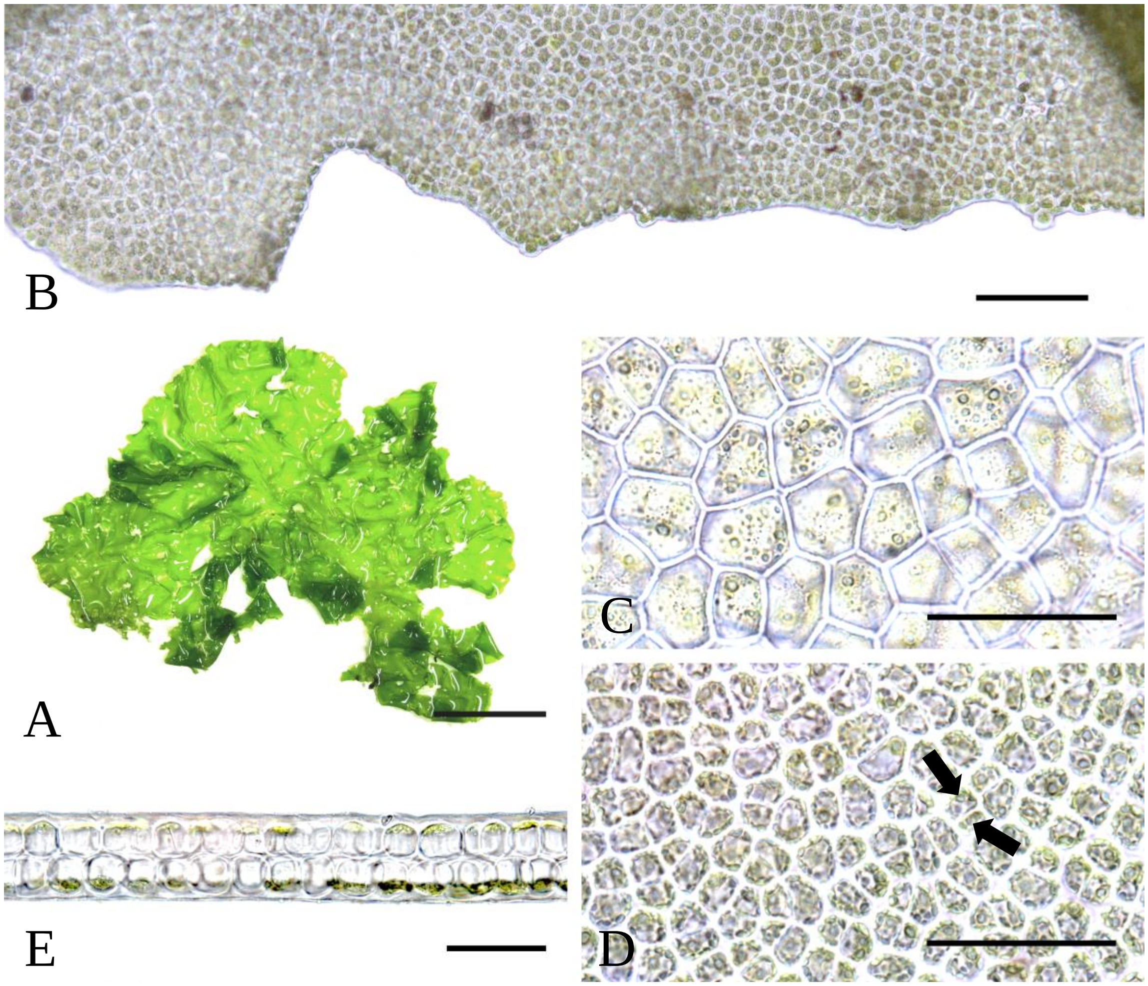


Figure 10. Morphological features of *U. laetevirens*. (A) Typical gross morphology (GWS036993). (B) Dentations visible on blade margin (GWS036923). (C) Wholemount at blade margin exhibiting angular cells with numerous pyrenoids in each cell (GWS036950). (D) Wholemount at blade margin with a cell pairing indicated with arrows (GWS036994). (E) Cross section near blade margin (GWS036950). Scale bars = 5cm (A), 100µm (B) and 50µm (C, D, E).

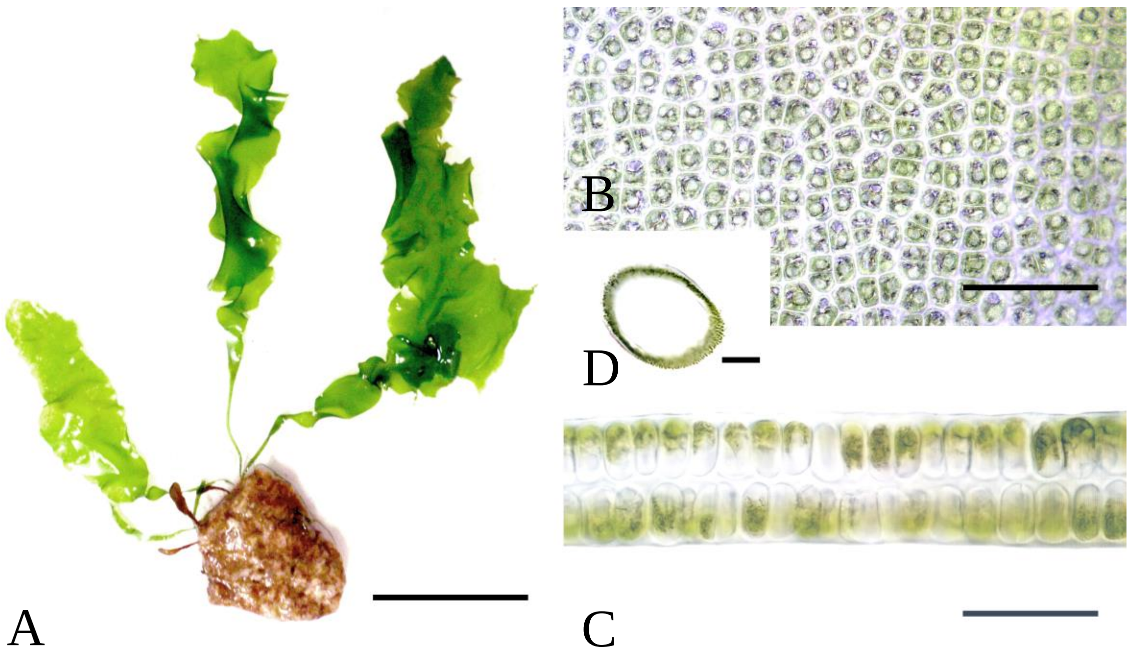


Figure 11. Morphological features of *U. linza* (GWS036906). (A) Thallus narrow and tubular at the base, broadening into oblong blades. (B) Mid-thallus wholemount near blade margin. (C) Cross section from upper thallus. (D) Cross section near base of thallus. Scale bars = 2cm (A), 50µm (B, C), and 200µm (D).

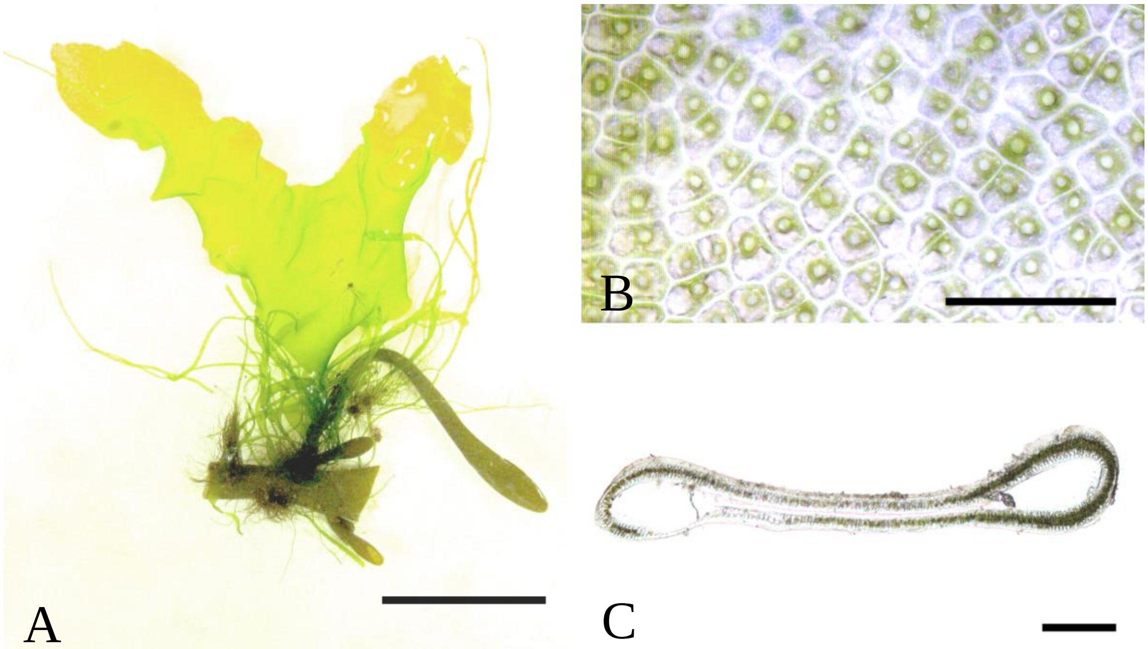


Figure 12. Morphological features of *U. taylorii* nom. prov. (Holotype: GWS036988). (A) Bifurcate bladed specimen growing on and amidst other algae. (B) Low-mid thallus wholemount. (C) Cross section from upper thallus. Scale bars = 2cm (A) 50µm, (B), and 200µm (C).

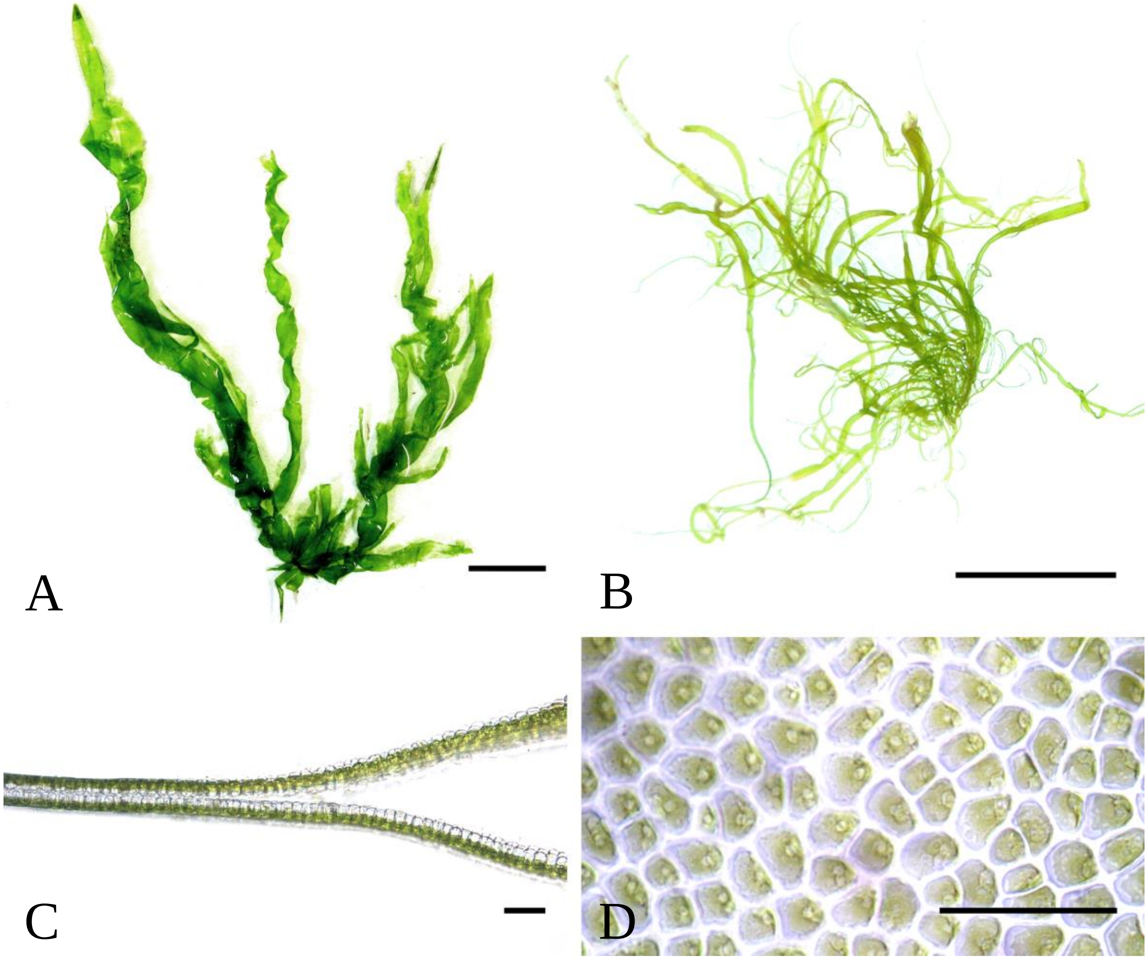


Figure 13. Morphological features of *U. viatoria* nom. prov. (A) Wide thallus morph (Holotype: GWS036951). (B) Narrow thallus morph (GWS034067). (C) Mid-thallus wholemount (Holotype: GWS036951). (D) Mid-thallus cross section (GWS037993). Scale bars = 2cm (A, B) and 50μm (C, D).

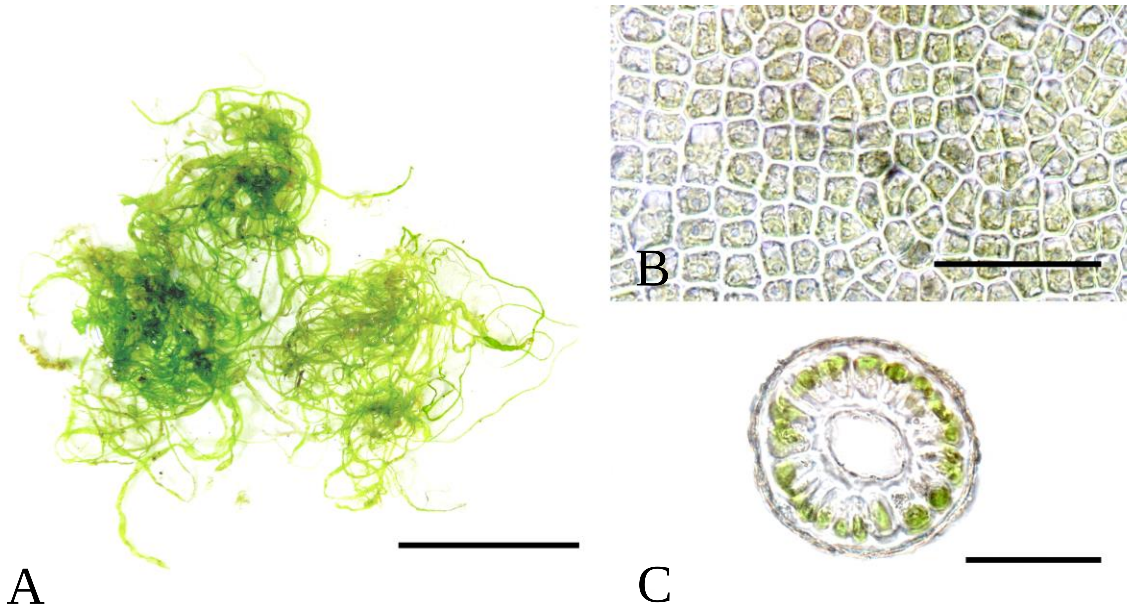


Figure 14. Morphological features of *U. prolifera* specimen (GWS036916). (A) Thalli typically grow in clumps. (B) Mid-thallus wholemount. (C) Mid-thallus cross section. Scale bars = 2cm (A) and 50μm (B, C).

Table 1. Summary of intra- and interspecific genetic distances (including the name of the nearest neighbour) for 29 species of *Ulva* represented as percent divergence for the barcoding markers *rbc*L-3P and *tufA*. A lack of data is indicated with N/A.

Species name	n=		Maximum variation within group (%)		Divergence from nearest neighbour (nearest neighbour)	
	*rbc*L-3P	*tufA*	*rbc*L-3P	*tufA*	*rbc*L-3P	*tufA*
U. australis	12	47	0.14	0.26	2.02 (*U. howensis*)	5.56 (*U. lactuca*)
U. californica	11	15	0.13	0.39	0.54 (*U.* sp._2GWS)	0.78 (*U. flexuosa*)
U. clathratioides[1]	4	27	0.14	0.26	0.40 (*U.* sp._2GWS)	1.29 (*U.* sp._8GWS)
U. compressa[1]	14	47	0.00	0.91	1.48 (*U. howensis*)	3.23 (*U. howensis*)
U. fasciata	1	10	N/A	0.00	0.40 (*U. ohnoi*)	0.65 (*U. ohnoi*)
U. flexuosa	2	7	0.13	0.13	0.67 (*U. californica*)	0.78 (*U. californica*)
U. gigantea[1]	5	6	0.00	0.00	1.20 (*U. laetevirens*)	2.41 (*U. laetevirens*)
U. howensis	4	13	0.00	0.00	1.48 (*U. compressa*)	3.23 (*U. compressa*)
U. intestinalis[1]	33	82	0.13	0.13	1.64 (*U. lactuca*)	3.34 (*U. howensis*)
U. lactuca[1]	53	131	0.27	0.52	1.64 (*U. intestinalis*)	4.94 (*U. intestinalis*)
U. laetevirens[1]	2	21	0.00	0.13	0.13 (*U. ohnoi*)	0.78 (*U.* sp._1laetevirens)
U. sp._1laetevirens	0	2	N/A	0.00	N/A	0.78 (*U. laetevirens*)
U. linza[1]	8	18	0.00	0.00	0.13 (*U. taylorii* nom. prov.)	0.52 (*U. taylorii* nom. prov.)
U. taylorii nom. prov.[1]	11	25	0.00	0.26	0.13 (*U. linza, U. viatoria* nom. prov.)	0.52 (*U. linza*)
U. viatoria nom. prov.[1]	1	8	N/A	0.13	0.13 (*U. taylorii* nom. prov.)	0.65 (*U. taylorii* nom. prov.)

U. sp._1Pacificlinza	6	11	0.00	0.00	1.62 (*U. taylorii* nom. prov.)	1.29 (*U.* sp._1GH)
U. lobata	16	42	0.00	0.26	2.43 (*U. australis*)	4.91 (*U. howensis*)
U. ohnoi	1	9	N/A	0.13	0.13 (*U. laetevirens*)	0.65 (*U. fasciata*)
U. prolifera[1]	14	20	0.14	0.39	1.35 (U. *linza*)	0.65 (*U.* sp._2prolifera)
U. sp._2prolifera	0	1	N/A	N/A	N/A	0.65 (*U. prolifera*)
U. sp._10GWS	1	3	N/A	0.00	2.83 (*U.* sp._11GWS)	4.40 (*U.* sp._8GWS)
U. sp._11GWS	1	2	N/A	0.00	1.75 (*U. clathratioides*)	2.45 (*U.* sp._2GWS)
U. sp._1GH	1	5	N/A	0.52	1.48 (*U. taylorii* nom. prov.)	0.78 (*U.* sp._2GWS)
U. sp._1GWS	1	0	N/A	N/A	2.72 (*U. stenophylla*)	N/A
U. sp._2GWS	1	1	N/A	N/A	0.40 (*U. clathratioides*)	0.78 (*U.* sp._1GH)
U. sp._5GWS	3	4	0.00	0.00	0.94 (*U. ohnoi*)	1.42 (*U. fasciata*)
U. sp._8GWS	0	1	N/A	N/A	N/A	1.29 (*U. clathratioides*)
U. stenophylla	4	19	0.00	0.00	1.35 (*U. clathratioides*)	2.07 (*U.* sp._1GH)
U. stenophylloides	0	1	N/A	N/A	N/A	0.78 (*U. fasciata*)
U. tanneri	1	1	N/A	N/A	0.81 (*U.* sp._2GWS)	1.16 (*U. flexuosa*)

[1]Species occurs in the Bay of Fundy.

Appendix 1

Collection information for *Ulva* specimens used in genetic analyses.

Species	Herbarium voucher #	Habitat	Location, province/state	Cou-ntry	Latitude, longitude	Date	Collected by
Ulva australis Areschoug	LAK59	No data	Bamfield, Scotts Bay, New South Wales	AUS	48.8346, -125.1463	No data	No data
	LAK61	No data	Comox Marina Breakwater, New South Wales	AUS	49.6692, -124.9289	No data	No data
	LAK62	No data	Richebucto Cape Breakwater, New South Wales	AUS	46.6754, -64.7109	No data	No data
	LAK70	No data	Beach W of Marco Island, Gwaii Haanas, New South Wales	AUS	52.5117, -131.5022	No data	No data
	LAK75	No data	Pachena Beach, Bamfield, New South Wales	AUS	48.7862, -125.1191	No data	No data
	LAK45	No data	Snug Park, South Australia	AUS	-43.0662, 147.2645	No data	No data
	LAK46	No data	Bamfield, Aguilar Point, South Australia	AUS	48.8371, -125.1436	No data	No data
	LAK7	No data	Raspberry Cove, Gwaii Haanas, Tasmania	AUS	52.1666, -131.0837	No data	No data

	LAK72	No data	East Copper Island (easterly point), Gwaii Haanas, Victoria	AUS	52.3576, -131.1736	No data	No data
	GWS031377	Low intertidal on rock	Sea Lion Point North (frontside), Point Lobos State Reserve, BC	CAN	36.5192, -121.953	4.6.2012	G.W.S. & K.D.
	GWS005800	Low intertidal on rock	Koga Islet, Gwaii Haanas, BC	CAN	52.4283, -131.3786	28.12.2006	H.K. & D.R.
	GWS006489	Low intertidal on rock	Saw Reef, Gwaii Haanas, BC	CAN	52.4501, -131.2915	27.5.2007	D.M., B.C., K.R. & S.H.
	GWS005834	Low mid-intertidal on *Mastocarpus* sp.	Tahsis, Island #40 on Esperenza Inlet Chart, BC	CAN	49.8125, -126.9873	29.12.2006	H.K. & D.R.
	GWS005836	Low mid-intertidal on *Neorhodomela* sp.	Snug Park, BC	CAN	-43.0662, 147.2645	29.12.2006	H.K. & D.R.
	GWS006807	Mid-intertidal on rock	Bamfield, Dixon I., BC	CAN	48.8524, -125.1224	31.5.2007	D.M., B.C., K.R. & H.K.
	GWS035855	Mid-intertidal on rock	Bamfield, Dixon I., BC	CAN	48.8524, -125.1224	19.8.2013	G.W.S. & K.D.
	GWS005802	Mid-intertidal on rock	Rocky Reef at Lighthouse ‘Point’ Piyangdo Island, BC	CAN	33.4198, 126.2244	28.12.2006	H.K. & D.R.

GWS005803	Mid-intertidal on rock	Kul Rocks, Gwaii Haanas, BC	CAN	52.7358, -131.5986	28.12.2006	H.K. & D.R.
GWS005804	Mid-intertidal on rock	Tahsis, Islands at ocean end of McKay Passage, BC	CAN	49.6087, -126.6146	28.12.2006	H.K. & D.R.
GWS003288	Mid-intertidal pool on rock	Mazarredo Islands, NW of Masset, Haida Gwaii, BC	CAN	54.0905, -132.5509	19.9.2005	G.W.S.
GWS008443	Subtidal (2 m) on rock	Otter Point, near Sooke, Vancouver Island, BC	CAN	48.3625, -123.8048	12.6.2007	G.W.S. & D.M.
GWS006459	High intertidal pool on rock	Martin Rd., Beaver I., near Sechelt, Sunshine Coast, BC	CAN	49.6222, -124.0611	27.5.2007	H.K., D.M., B.C., K.R. & S.H.
GWS006460	High intertidal pool on rock	Bamfield, Trail Head, inner most reach of inlet, BC	CAN	48.8124, -125.1571	27.5.2007	H.K., D.M., B.C., K.R. & S.H.
GWS006462	High intertidal pool on rock	Tswassen Ferry Terminal, BC	CAN	49.0111, -123.1178	27.5.2007	H.K., D.M., B.C., K.R. & S.H.
GWS022348	Subtidal (16 m) on worm tube	Gerringong, CA	USA	-34.7439, 150.8352	23.5.2010	B.C., K.H. & S.T.
GWS018618	Drift	Stephenson Pt., Nanaimo, Jeju	KOR	49.2133, -123.9402	18.5.2010	G.W.S. & H.G.C.

	GWS018395	Mid-intertidal pool on rock	Stephenson Pt., Nanaimo, Jeju	KOR	49.2133, -123.9402	21.5.2010	G.W.S.
	GWS018271	Subtidal (10 m) on rhodolith	Stephenson Pt., Nanaimo, Jeju	KOR	49.2133, -123.9402	20.5.2010	G.W.S. & H.G.C.
	GWS017341	Drift on *Acropora* sp. tine	Hells Gates (beach to north), New South Wales	AUS	-42.2172, 145.2229	9.10.2009	G.T.K.
	GWS023392	Subtidal (1 m) on rock	Spanish Point, New South Wales	AUS	No data	23.11.2010	G.T.K.
	GWS023393	Subtidal (1 m) on rock	Sea Lion Point North (backside), Point Lobos State Reserve, New South Wales	AUS	36.5192, -121.953	23.11.2010	G.T.K.
	GWS018060	Subtidal (3 m) on rock	Green Island, RI	USA	-35.2723, 150.5172	16.4.2010	B.C., D.M., M.B., A.S. & C.L.
	GWS015625	Subtidal (8 m)	Arch Rock, Huon Estuary, Tasmania	AUS	-43.2874, 147.1795	17.5.2010	F.S.
	GWS015975	Drift	Tasmania	AUS	No data	24.1.2010	G.W.S. & K.D.
	GWS015993	Drift	Tasmania	AUS	No data	24.1.2010	G.W.S. & K.D.
	GWS014874	Low intertidal on basalt	Hells Gates (beach to north), Tasmania	AUS	-42.2172, 145.2229	18.1.2010	G.T.K.
	GWS015129	Low intertidal pool on rock	Hells Gates (beach to north), Tasmania	AUS	-42.2172, 145.2229	20.1.2010	G.W.S., L.K. & K.D.

	GWS015139	Low intertidal pool on rock	Smerwick Harbour, Tasmania	AUS	No data	20.1.2010	G.W.S., L.K. & K.D.
	GWS015136	Mid-intertidal pool on rock	Lord Howe Island, Neds Beach, south end of beach, Tasmania	AUS	-31.517, 159.069	20.1.2010	G.W.S., L.K. & K.D.
	GWS015573	Subtidal (1-2 m) on rock	Tasmania	AUS	No data	22.1.2010	G.T.K. & L.K.
	GWS015576	Subtidal (1-2 m) on rock	Tasmania	AUS	No data	22.1.2010	G.T.K. & L.K.
	GWS015875	Subtidal (2 m) on rock	Tasmania	AUS	No data	23.1.2010	G.W.S. & K.D.
	GWS015932	Subtidal (4 m) on rock	Far Rocks, Signal Point, Lord Howe, Tasmania	AUS	-31.5248, 159.0601	23.1.2010	G.T.K. & L.K.
	GWS015933	Subtidal (4 m) on rock	Far Rocks, Signal Point, Lord Howe, Tasmania	AUS	-31.5248, 159.0601	23.1.2010	G.T.K. & L.K.
	GWS014913	Subtidal (8 m) on rock	English Harbour East on intertidal, Tasmania	AUS	47.6339, -54.8848	18.1.2010	G.W.S. & K.D.
	GWS014914	Subtidal (8 m) on rock	Lord Howe I., Neds Beach, Tasmania	AUS	-31.5167, 159.0667	18.1.2010	G.W.S. & K.D.

	GWS016684	Subtidal (4 m) on rock	Whiffen Spit, Sooke Harbour, Vancouver Island, Victoria	AUS	48.3521, -123.7281	2.2.2010	G.W.S., L.K. & K.D.
	GWS024561	Mid-intertidal on rock	Indian Head, Skidegate, Haida Gwaii, Western Australia	AUS	53.2481, -131.9837	8.11.2010	G.W.S. & K.D.
	GWS025531	Subtidal (2 m) on algae	Western Australia	AUS	No data	14.11.2010	G.W.S. & K.D.
	GWS025363	Subtidal (2.5 m) on articulated coralline	Western Australia	AUS	No data	13.11.2010	G.W.S. & K.D.
	GWS025378	Subtidal (2.5 m) on rock	Western Australia	AUS	No data	13.11.2010	G.W.S. & K.D.
	GWS024273	Subtidal (5 m) on rock	Far Rocks, Signal Point, Lord Howe, Western Australia	AUS	-31.5248, 159.0601	6.11.2010	G.W.S. & K.D.
Ulva californica Wille	LAK49	No data	Tahsis, Friendly Cove, Victoria	AUS	49.5933, -126.6165	No data	No data
	GWS006389	High intertidal on rock	Bamfield, ‘Sparlingia Pt.’, Brady's Beach, BC	CAN	48.8242, -125.1593	25.5.2007	H.K.

	GWS004797	Low intertidal on rock	Sea Lion Point North (frontside), Point Lobos State Reserve, BC	CAN	36.5192, -121.953	6.7.2006	G.W.S., B.C. & D.M.
	GWS008616	High mid-intertidal on rock	Bamfield, Aguilar Point, BC	CAN	48.8371, -125.1436	15.6.2007	G.W.S., B.C., D.M. & K.R.
	GWS030439	Mid-intertidal on barnacle	Soberanes Point, BC	CAN	36.4479, -121.9288	6.6.2012	G.W.S. & K.D.
	GWS020135	Mid-intertidal on barnacle, exposed	Bamfield, Trail Head, inner most reach of inlet, BC	CAN	48.8124, -125.1571	13.6.2010	G.W.S. & K.D.
	GWS020345	Mid-intertidal on barnacle, exposed	Bamfield, Dixon I., BC	CAN	48.8524, -125.1224	14.6.2010	G.W.S. & K.D.
	GWS004051	Mid-intertidal on rock	Bamfield, Seppings I., BC	CAN	48.8391, -125.2075	15.6.2006	G.W.S., B.C. & D.M.
	GWS005072	Mid-intertidal on rock	Bamfield, Ross Islets, BC	CAN	48.8737, -125.16	11.7.2006	G.W.S., B.C. & D.M.
	GWS008619	Mid-intertidal on rock	Gross Île au Marteau, BC	CAN	50.2267, -63.5425	15.6.2007	G.W.S., B.C., D.M. & K.R.
	GWS005068	Mid-intertidal pool on rock	Nine Pin Point, BC	CAN	-43.2865, 147.1643	11.7.2006	G.W.S., B.C. & D.M.

	GWS004842	Drift on Fucus sp.	English Harbour East Government Dock, BC	CAN	47.6319, -54.8863	8.7.2006	G.W.S., B.C. & D.M.
	GWS006407	Subtidal (0.5 m) on rock	Bird Rock, Pacific Grove, BC	CAN	36.5917, -121.9642	25.5.2007	D.M., B.C., K.R. & S.H.
	GWS004221	Subtidal (2 m) on cobble	Otter Point, near Sooke, Vancouver Island, BC	CAN	48.3625, -123.8048	21.6.2006	G.W.S., B.C. & D.M.
	GWS006302	High intertidal on Fucus sp.	Windmill Point, George Town, BC	CAN	-41.1097, 146.817	24.5.2007	H.K.
	GWS006384	High intertidal on rock	Tahsis Nuchatliz Island, (#37 on Esperenza Inlet Chart), BC	CAN	49.8101, -126.9823	25.5.2007	H.K.
	GWS006501	High mid-intertidal on rock	Sea Lion Point South, Point Lobos State Reserve, BC	CAN	36.5187, -121.9533	28.5.2007	H.K., D.M., B.C., K.R. & S.H.
	GWS021404	High intertidal on rock	North Brighton, CA	USA	-37.9088, 144.9849	15.5.10	B.C. & K.H.
	GWS021868	High intertidal on rock	Bendalong, CA	USA	-35.2431, 150.5415	18.5.2010	B.C. & K.H.
	GWS021592	High intertidal on rock in crevice	Bendalong, CA	USA	-35.2431, 150.5415	17.5.2010	B.C., K.H. & S.T.

	GWS007436	Intertidal on rock	Ridley Island (south of coal terminal), Prince Rupert, NL	CAN	54.2212, -130.3293	19.7.2006	L.L.G., H.K. & D.M.
Ulva clathratioides L.G.Kraft, Kraft & R.F.Waller	LAK29	No data	Koga Islet, Gwaii Haanas, New South Wales	AUS	52.4283, -131.3786	No data	No data
	LAK36	No data	Pigeon Point Lighthouse, New South Wales	AUS	37.1832, -122.3887	No data	No data
	LAK43	No data	Bamfield, Wizard I., South Australia	AUS	48.8583, -125.1588	No data	No data
	GWS002856	High intertidal pool on rock	Bamfield, Wizard I., BC	CAN	48.8583, -125.1588	7.6.2005	G.W.S.
	GWS004454	High intertidal pool on rock	Botany Beach, near Port Renfrew, Vancouver Island, BC	CAN	48.5304, -124.4535	26.6.2006	G.W.S., B.C. & D.M.
	GWS004459	High intertidal pool on rock	Botany Beach, near Port Renfrew, Vancouver Island, BC	CAN	48.5304, -124.4535	26.6.2006	G.W.S., B.C. & D.M.
	GWS004617	High intertidal on rock	Kye Bay, Vancouver Island, BC	CAN	49.7060, -124.8720	30.6.2006	B.C. & D.M.
	GWS006531	Subtidal (4 m) on rock	Tahsis Narrows, BC	CAN	49.4453, -126.8275	29.5.2007	B.C., D.M. & S.H.

GWS006808	High mid-intertidal pool on rock	Tahsis, Friendly Cove, BC	CAN	49.5933, -126.6165	31.5.2007	D.M., B.C., K.R. & H.K.
GWS007428	High intertidal in tangled mats	Alexander Bay Causeway near Terra Nova Park, NL	CAN	48.6524, -53.9064	19.7.2006	L.L.G., H.K. & D.M.
GWS007443	High intertidal in tangled mats	Alexander Bay Causeway near Terra Nova Park, NL	CAN	48.6524, -53.9064	19.7.2006	L.L.G., H.K. & D.M.
GWS007981	Intertidal on rock	Cap des Caissie, north of Shediac, NB	CAN	46.3266, -64.5157	17.8.2006	L.L.G., H.K. & J.U.
GWS008544	High intertidal on rock	Backeddy Resort, BC	CAN	49.7585, -123.9381	14.6.2007	G.W.S., B.C., D.M. & K.R.
GWS008768	Drift on seagrass	Summerside (bike trail), PE	CAN	46.3948, -63.7991	18.8.2007	B.C., K.D. & K.R.
GWS012523	Low intertidal on rock	Park at end of Honna Road, Queen Charlotte City, Haida Gwaii, BC	CAN	53.2496, -132.1167	15.6.2009	G.W.S. & D.M.
GWS012524	Drift	Park at end of Honna Road, Queen Charlotte City, Haida Gwaii, BC	CAN	53.2496, -132.1167	15.6.2009	G.W.S. & D.M.

GWS012525	Drift	Park at end of Honna Road, Queen Charlotte City, Haida Gwaii, BC	CAN	53.2496, -132.1167	15.6.2009	G.W.S. & D.M.
GWS013257	Drift	Murchison Island Lagoon, Gwaii Haanas, BC	CAN	52.6042, -131.4499	22.6.2009	G.W.S. & D.M.
GWS015137	Mid-intertidal pool on rock	Snug Park, Tasmania	AUS	-43.0662, 147.2645	20.1.2010	G.W.S., L.K. & K.D.
GWS019910	Low intertidal on invertebrate, semi-exposed	Koga Islet, Gwaii Haanas, BC	CAN	52.4283, -131.3786	12.6.2010	G.W.S. & K.D.
GWS020591	Low intertidal on cobble, sheltered	Tanuu Island (Watchmen Station), Haida Gwaii, BC	CAN	52.7625, -131.6121	16.6.2010	G.W.S. & K.D.
GWS031320	Drift	Queen Charlotte City Information Centre, Haida Gwaii, BC	CAN	53.2531, -132.0692	2.6.2012	G.W.S. & K.D.
GWS031400	Low intertidal on rock	Gordon Islands (Lagoon), Gwaii Haanas, BC	CAN	52.0974, -131.1502	4.6.2012	G.W.S. & K.D.
GWS036920	On marsh grasses at edge of saltmarsh in dense mat	Cape Jourimain National Wildlife Area, NB	CAN	46.1578, -63.8207	18.5.2015	K.L.M.

	GWS036922	On saltmarsh grass	Cape Jourimain National Wildlife Area, NB	CAN	46.1578, -63.8207	18.5.2015	K.L.M.
	GWS036932	On mud by saltmarsh pool in dense mat	Cape Jourimain National Wildlife Area, NB	CAN	46.1578, -63.8207	2.6.2015	K.L.M.
	GWS036947	Mid-intertidal on mud, sheltered	South Cove, Shediac, NB	CAN	46.2321, -64.5163	11.6.2015	K.L.M. & L.K.
	GWS036970	Subtidal (1 m) on rock	Pointe du Chêne, Northumberland Strait, NB	CAN	46.2418, -64.5300	26.8.2015	K.L.M., G.W.S. & A.S.
	GWS036977	Subtidal (1 m) drift	Pointe du Chêne, Northumberland Strait, NB	CAN	46.2418, -64.5300	26.8.2015	K.L.M., G.W.S. & A.S.
	GWS036978	Subtidal (1 m) drift	Pointe du Chêne, Northumberland Strait, NB	CAN	46.2418, -64.5300	26.8.2015	K.L.M., G.W.S. & A.S.
	GWS036984	Lower pond on rock	Sam Orr's Pond, NB	CAN	45.1620, -67.0446	3.9.2015	K.L.M., A.S. & G.W.S.
Ulva compressa Linnaeus	LAK35	No data	Backeddy Resort, New South Wales	AUS	49.7585, -123.9381	No data	No data

LAK51	No data	Koga Islet, Gwaii Haanas, New South Wales	AUS	52.4283, -131.3786	No data	No data
LAK57	No data	Bamfield, Scotts Bay, New South Wales	AUS	48.8346, -125.1463	No data	No data
LAK60	No data	Stream at head of Shuttle Island waterhole, Gwaii Haanas, New South Wales	AUS	52.6656, -131.7309	No data	No data
LAK63	No data	Bamfield, Blowhole at Brady's Beach, New South Wales	AUS	48.824, -125.1621	No data	No data
LAK74	No data	Santa Cruz (Four Mile), New South Wales	AUS	36.9661, -122.1234	No data	No data
LAK76	No data	Bamfield, Scotts Bay, New South Wales	AUS	48.8346, -125.1463	No data	No data
LAK40	No data	Sea Lion Point North (frontside), Point Lobos State Reserve, South Australia	AUS	36.5192, -121.953	No data	No data
LAK41	No data	Backeddy Resort, South Australia	AUS	49.7585, -123.9381	No data	No data

LAK42	No data	Sea Lion Point North (frontside), Point Lobos State Reserve, South Australia	AUS	36.5192, -121.953	No data	No data
LAK50	No data	Bamfield, Scotts Bay, Victoria	AUS	48.8346, -125.1463	No data	No data
ENT15	Mid-intertidal on rock	St. Andrews (Blockhouse), Bay of Fundy, NB	CAN	45.0757, -67.0638	11.9.2013	T.T.
ENT20	High intertidal in sand	Maces Bay, Lepreau, Bay of Fundy, NB	CAN	45.1093, -66.4817	11.9.2013	G.M.
GWS003101	High mid-intertidal pools on red algae, semi-exposed	Pachena Beach, Bamfield, BC	CAN	48.7862, -125.1191	12.9.2005	G.W.S.
GWS003155	High mid-intertidal pool on rock, semi-exposed	Pachena Beach, Bamfield, BC	CAN	48.7862, -125.1191	14.9.2005	G.W.S. & R.W.
GWS003574	Mid-intertidal pool on rock	Lepreau exposed biodiversity site, Bay of Fundy, NB	CAN	45.0722, -66.4690	3.3.2006	G.W.S.
GWS003928	High intertidal on rock	Bamfield, Dixon I., BC	CAN	48.8524, -125.1224	13.6.2006	G.W.S., B.C. & D.M.

GWS003929	High intertidal on rock	Bamfield, Dixon I., BC	CAN	48.8524, -125.1224	13.6.2006	G.W.S., B.C. & D.M.
GWS004052	Mid-intertidal on rock	Bamfield, "Sparlingia Pt.", Brady's Beach, BC	CAN	48.82402, -125.1593	15.6.2006	G.W.S., B.C. & D.M.
GWS004084	Low intertidal on rock, semi-exposed	Bamfield, Wizard I., BC	CAN	48.8583, -125.1588	16.6.2006	G.W.S., B.C. & D.M.
GWS004085	High intertidal pool on rock	Bamfield, Wizard I., BC	CAN	48.8583, -125.1588	16.6.2006	G.W.S., B.C. & D.M.
GWS004087	High intertidal pool on rock	Bamfield, Wizard I., BC	CAN	48.8583, -125.1588	16.6.2006	G.W.S., B.C. & D.M.
GWS004796	Mid-intertidal on rock	Seal Cove, Prince Rupert, BC	CAN	54.3325, -130.2834	6.7.2006	G.W.S., B.C. & D.M.
GWS005694	Mid-intertidal on rock	Lepreau exposed biodiversity site, Bay of Fundy, NB	CAN	45.0722, -66.46900	11.1.2007	H.K.
GWS005862	Mid-intertidal on rock	Lepreau exposed biodiversity site, Bay of Fundy, NB	CAN	45.0722, -66.46900	11.1.2007	H.K.
GWS006813	Mid-intertidal on *Fucus* sp.	Tahsis, Friendly Cove, BC	CAN	49.5933, -126.6165	31.5.2007	D.M., B.C., K.R. & H.K.
GWS008197	Mid-intertidal on rock	Bamfield, Scotts Bay, BC	CAN	48.8346, -125.1463	3.6.2007	H.K.

GWS008198	High mid-intertidal on rock	Bamfield, Scotts Bay, BC	CAN	48.8346, -125.1463	3.6.2007	H.K.
GWS008260	Mid-intertidal on rock	Bamfield, Blowhole at Brady's Beach, BC	CAN	48.8240, -125.16201	4.6.2007	D.M., B.C., K.R. & H.K.
GWS008262	High Mid-intertidal on *Fucus* sp.	Bamfield, Blowhole at Brady's Beach, BC	CAN	48.8240, -125.16201	4.6.2007	D.M., B.C., K.R. & H.K.
GWS008267	High intertidal pool on rock	Bamfield, Blowhole at Brady's Beach, BC	CAN	48.8240, -125.16201	4.6.2007	D.M., B.C., K.R. & H.K.
GWS008297	Mid-intertidal pool on rock	Pachena Beach, Bamfield, BC	CAN	48.7862, -125.1191	5.6.2007	D.M., B.C., K.R. & H.K.
GWS008298	High mid-intertidal on rock	Pachena Beach, Bamfield, BC	CAN	48.7862, -125.1191	5.6.2007	D.M., B.C., K.R. & H.K.
GWS008764	Drift	Summerside (bike trail), PE	CAN	46.3948, -63.7991	18.8.2007	B.C., K.D. & K.R.
GWS008765	Drift	Summerside (bike trail), PE	CAN	46.3948, -63.7991	18.8.2007	B.C., K.D. & K.R.
GWS014506	No data	Spanish Point, Clare	IRE	No data	27.8.2010	M.D.G.
GWS014628	No data	Cuan, Ventry, Kerry	IRE	No data	11.8.2010	M.D.G.
GWS015146	Mid-intertidal on rock	Snug Park, Tasmania	AUS	-43.0662, 147.2645	20.1.2010	G.W.S., L.K. & K.D.
GWS015974	Drift	Hells Gates (beach to north), Tasmania	AUS	-42.2172, 145.2229	24.1.2010	G.W.S. & K.D.

GWS017336	Subtidal (0.45m) on rock on sides of a deep pool	Lord Howe Island, Neds Beach, shoreward end of south reef, New South Wales	AUS	-31.5170, 159.0690	11.10.2009	
GWS021577	High intertidal pool on rock	Sea Lion Point North (frontside), Point Lobos State Reserve, CA	USA	36.5192, -121.9530	16.5.10	B.C. & K.H.
GWS023095	Intertidal pool on rock	Old Gulch, Lord Howe I., New South Wales	AUS	-31.5132, 159.0423	22.11.2010	G.W.S., K.D. & R.W.
GWS023629	Subtidal (0.5 m) on rock	Lord Howe Island, Lovers Bay, New South Wales	AUS	-31.5489, 159.0749	24.11.2010	G.T.K.
GWS030291	High intertidal on rock sheltered	Wallace Cove Lighthouse, NB	CAN	45.0386, -66.8077	7.10.2013	G.W.S., C.J. & A.S.
GWS030292	Mid-intertidal on *Ascophyllum* sp. & *Vertebrata* sp., exposed	Wallace Cove Lighthouse, NB	CAN	45.0386, -66.8077	7.10.2013	G.W.S., C.J. & A.S.

GWS032182	Subtidal (0.25 m) on mussel	Pomquet (far on Monks Head Road), NS	CAN	45.6589, -61.8218	16.8.2012	G.W.S., A.S., C.L., K.D. & M.B.
GWS036901	High intertidal pool on rock	Lepreau exposed biodiversity site, Bay of Fundy, NB	CAN	45.0722, -66.4690	16.6.2014	K.L.M. & A.S.
GWS036907	High intertidal on rock, sheltered	Wallace Cove Lighthouse, NB	CAN	45.0386, -66.8077	6.11.2014	K.L.M. & A.S.
GWS036968	Subtidal (3 m) drift	Pointe du Chêne, Northumberland Strait, NB	CAN	46.2418, -64.5300	26.8.2015	K.L.M., G.W.S. & A.S.
GWS036972	Subtidal (3 m) drift	Pointe du Chêne, Northumberland Strait, NB	CAN	46.2418, -64.5300	26.8.2015	K.L.M., G.W.S. & A.S.
GWS036973	Subtidal (3 m) drift	Pointe du Chêne, Northumberland Strait, NB	CAN	46.2418, -64.5300	26.8.2015	K.L.M., G.W.S. & A.S.
GWS036974	Subtidal (3 m) drift	Pointe du Chêne, Northumberland Strait, NB	CAN	46.2418, -64.5300	26.8.2015	K.L.M., G.W.S. & A.S.

	PHYC2014-26	Mid-intertidal pool on *Ascophyllum* sp., semi-exposed	Wallace Cove Lighthouse, NB	CAN	45.0386, -66.8077	8.10.2014	L.M.B., A.H., H.M., K.L. & M.M.
	PHYC2014-30	Mid-intertidal pool on rock, sheltered	Wallace Cove Lighthouse, NB	CAN	45.0386, -66.8077	8.10.2014	L.M.B., A.H., H.M., K.L. & M.M.
	PHYC2014-34	Drift in freshwater runoff, sheltered	Wallace Cove Lighthouse, NB	CAN	45.0386, -66.8077	8.10.2014	L.M.B., A.H., H.M., K.L. & M.M.
	PHYC2014-44	Low intertidal on rock, sheltered	St. Andrews (Blockhouse), Bay of Fundy, NB	CAN	45.0757, -67.0638	9.10.2014	L.M.B., A.H., H.M., K.L. & M.M.
	PHYC2014-45	Low intertidal on rock, sheltered	St. Andrews (Blockhouse), Bay of Fundy, NB	CAN	45.0757, -67.0638	9.10.2014	L.M.B., A.H., H.M., K.L. & M.M.
Ulva fasciata Delile	GWS017335	Subtidal (0.15-0.2 m) on vertical basalt	Lord Howe Island, Old Gulch, head of Gulf, New South Wales	AUS	-31.5132, 159.0423	11.10.2009	G.T.K., R.K., M.D.G. & W.G.
	GWS017342	Drift on stones	Hells Gates (beach to north), New South Wales	AUS	-42.2172, 145.2229	8.10.2009	G.T.K., M.D.G. & W.G.

	GWS022744	Intertidal pool on rock	Stillwater Cove, Pebble Beach, New South Wales	AUS	36.5667, -121.9429	20.11.2010	G.W.S. & K.D.
	GWS023094	Intertidal pool on rock	Stillwater Cove, Pebble Beach, New South Wales	AUS	36.5667, -121.9429	22.11.2010	G.W.S., K.D. & R.W.
	GWS023543	Subtidal (15 m) on invertebrate	New South Wales	AUS	No data	24.11.2010	G.W.S., K.D. & R.W.
	GWS023030	Subtidal (5 m) on rock	Alexander Bay Causeway near Terra Nova Park, New South Wales	AUS	48.6524, -53.9064	22.11.2010	G.W.S., K.D. & R.W.
	LAK32	No data	Gordon Islands (Lagoon), Gwaii Haanas, New South Wales	AUS	52.0974, -131.1502	No data	No data
	LAK55	No data	Bamfield, Scotts Bay, New South Wales	AUS	48.8346, -125.1463	No data	No data
	LAK56	No data	Bamfield, Scotts Bay, New South Wales	AUS	48.8346, -125.1463	No data	No data
	LAK8	No data	Tahsis, Friendly Cove, New South Wales	AUS	49.5933, -126.6165	No data	No data

Ulva flexuosa Wulfen	LAK10	No data	Old Gulch, Lord Howe I., New South Wales	AUS	-31.5132, 159.0423	No data	No data
	GWS008618	Drift	Emu Beach Holiday Park, BC	CAN	-35.0012, 117.9405	15.6.2007	G.W.S., B.C., D.M. & K.R.
	GWS036040	Mid-intertidal forming mat	Bamfield, Aguilar Point, BC	CAN	48.8371, -125.1436	22.8.2013	G.W.S. & K.D.
	GWS008545	Mid-intertidal on rock	Gross Île au Marteau, BC	CAN	50.2267, -63.5425	14.6.2007	G.W.S., B.C., D.M. & K.R.
	GWS028694	Subtidal (1.5 m)	Bird Rock, Pacific Grove, BC	CAN	36.5917, -121.9642	11.7.2011	G.W.S. & K.D.
	GWS018661	High mid-intertidal pool on rock	Alder Island, Gwaii Haanas, Jeju	KOR	52.4421, -131.3189	18.5.2010	G.W.S. & H.G.C.
	GWS006274	Mid-intertidal on rock	Soberanes Point, NB	CAN	36.4479, -121.9288	28.8.2007	K.R.
	GWS007577	Intertidal on rock	Comox Marina Breakwater, NL	CAN	49.6692, -124.9289	21.7.2006	H.K.
	GWS025530	Subtidal (2 m) on mussel	Western Australia	AUS	No data	14.11.2010	G.B.
Ulva gigantea (Kützing) Bliding	GWS005692	Mid-intertidal pool on *Devaleraea* sp.	Lepreau exposed biodiversity site, Bay of Fundy, NB	CAN	45.0722, -66.4690	11.1.2007	H.K.

	GWS005693	Mid-intertidal on rock	Lepreau exposed biodiversity site, Bay of Fundy, NB	CAN	45.0722, -66.4690	11.1.2007	H.K.
	GWS005699	Mid-intertidal on rock	Lepreau exposed biodiversity site, Bay of Fundy, NB	CAN	45.0722, -66.4690	11.1.2007	H.K.
	GWS005861	Mid-intertidal on rock	Lepreau exposed biodiversity site, Bay of Fundy, NB	CAN	45.0722, -66.4690	11.1.2007	H.K.
	GWS005870	Mid-intertidal on rock	Letete exposed biodiversity site, Bay of Fundy, NB	CAN	45.0382, -66.8912	31.1.2007	H.K.
	GWS030294	Low intertidal on rock, exposed	Wallace Cove Lighthouse, NB	CAN	45.0386, -66.8077	7.10.2013	G.W.S., C.J. & A.S.
	GWS036931	Low intertidal on drift *Fucus* sp.	Lepreau - seagrass flats near bridge along highway, NB	CAN	45.1270, -66.4576	21.5.2015	K.L.M., G.W.S., J.E. & C.B.
	GWS036933	Low intertidal pool on *Fucus* sp., sheltered	Lepreau - seagrass flats near bridge along highway, NB	CAN	45.1270, -66.4576	4.6.2015	K.L.M., G.W.S. & T.B.
Ulva howensis (A.H.S.Lucas) Kraft	GWS017338	Subtidal (0.05 m) pool on calcarenite wall	Lord Howe Island, Neds Beach, New South Wales	AUS	-31.517, 159.069	8.10.2009	G.T.K., M.D.G. & W.G.

	GWS017334	Subtidal (0.45 m) pool on rock	Lord Howe Island, Neds Beach, shoreward end of south reef, New South Wales	AUS	-31.517, 159.069	12.10.2009	R.K.
	GWS017337	Low intertidal on vertical calcarenite	Lord Howe Island, Neds Beach, shoreward end of south reef flat, New South Wales	AUS	-31.517, 159.069	8.10.2009	G.T.K., M.D.G. & W.G.
	GWS023390	High intertidal on rock	Seongsan, New South Wales	AUS	33.4625, 126.9384	23.11.2010	G.T.K.
	GWS023391	High intertidal on rock	Comox Marina Breakwater, New South Wales	AUS	49.6692, -124.9289	23.11.2010	G.T.K.
	GWS023394	High intertidal on rock	Stillwater Cove, Pebble Beach, New South Wales	AUS	36.5667, -121.9429	23.11.2010	G.T.K.
	GWS017340	High mid-intertidal on calcarenite reef flat	Sea Lion Point North (backside), Point Lobos State Reserve, New South Wales	AUS	36.5192, -121.953	10.10.2009	R.K. & G.T.K.
	LAK12	No data	Santa Cruz (Four Mile), New South Wales	AUS	36.9661, -122.1234	No data	No data

	LAK26	No data	Sea Lion Point North (frontside), Point Lobos State Reserve, New South Wales	AUS	36.5192, -121.953	No data	No data
	LAK31	No data	Gordon Islands (Lagoon), Gwaii Haanas, New South Wales	AUS	52.0974, -131.1502	No data	No data
	LAK58	No data	Bamfield, Scotts Bay, New South Wales	AUS	48.8346, -125.1463	No data	No data
	LAK44	No data	Snug Park, South Australia	AUS	-43.0662, 147.2645	No data	No data
	GWS024579	Mid-intertidal on rock	Lord Howe Island, Lovers Bay, Western Australia	AUS	-31.549, 159.075	8.11.2010	G.W.S. & K.D.
Ulva intestinalis Linnaeus	LAK13	No data	Raspberry Cove, Gwaii Haanas, New South Wales	AUS	52.1666, -131.0837	No data	No data
	2016_BIO309A_40	Intertidal	Espegrend, Hordaland	NOR	60.2697, 5.2208	17.4.2016	K.S.
	ENT01	Drift	Sam Orr's Pond, NB	CAN	45.1620, -67.0446	9.9.2013	Kr.M. & C.H.
	ENT05	Drift	Wallace Cove Lighthouse, NB	CAN	45.0386, -66.8077	10.9.2013	T.T.

ENT11	Drift	Sam Orr's Pond, NB	CAN	45.1620, -67.0446	9.9.2013	Kr.M.
ENT13	Mid-intertidal on mussel shell	St. Andrews (Blockhouse), Bay of Fundy, NB	CAN	45.0757, -67.0638	11.9.2013	Kr.M.
ENT14	Drift	Maces Bay, Lepreau, Bay of Fundy, NB	CAN	45.1093, -66.4817	11.9.2013	G.M.
GWS002673	High intertidal pool on rock	Cape Elizabeth, near Portland, ME	USA	43.5652, -70.1970	14.4.2005	G.W.S.
GWS002815	High intertidal pool on rock	Bamfield, Dixon I., BC	CAN	48.8524, -125.1224	6.6.2005	G.W.S. & S.C.
GWS002857	High intertidal pool on rock	Bamfield, Wizard I., BC	CAN	48.8583, -125.1588	7.6.2005	G.W.S.
GWS003095	High mid-intertidal pool on rock	New River Beach, Bay of Fundy, NB	CAN	45.1292, -66.5280	8.8.2005	G.W.S.
GWS003584	High mid-intertidal pool on rock	Cape Neddick, southern ME	USA	43.1658, -70.5924	24.4.2006	S.C.
GWS003585	High mid-intertidal pool on rock	Cape Neddick, southern ME	USA	43.1658, -70.5924	24.4.2006	S.C.
GWS003592	High mid-intertidal pool on rock	Cape Neddick, southern ME	USA	43.1658, -70.5924	24.4.2006	G.W.S.

GWS003622	High intertidal pool on rock	End of public road, Starboard, ME	USA	44.6091, -67.3966	25.4.2006	G.W.S., L.L.G., D.M., S.C. & C.L.
GWS003623	High intertidal pool on rock	End of public road, Starboard, ME	USA	44.6091, -67.3966	25.4.2006	G.W.S., L.L.G., D.M., S.C. & C.L.
GWS003699	High intertidal pool on rock	Letete exposed biodiversity site, Bay of Fundy, NB	CAN	45.0382, -66.8912	26.5.2006	H.K.
GWS003798	High intertidal pool on rock	Meadow Cove exposed biodiversity site, Bay of Fundy, NB	CAN	45.0381, -66.8913	28.5.2006	H.K.
GWS003820	High intertidal pool on rock	SE of Beaver Harbour on rocky cliffs, Bay of Fundy, NB	CAN	45.0563, -66.7358	28.5.2006	H.K.
GWS003857	High intertidal pool on rock	Lepreau exposed biodiversity site, Bay of Fundy, NB	CAN	45.0722, -66.4690	29.5.2006	H.K.
GWS004455	High intertidal pool on rock	Botany Beach, near Port Renfrew, Vancouver Island, BC	CAN	48.5304, -124.4535	26.6.2006	G.W.S., B.C. & D.M.
GWS004618	High intertidal on rock	Kye Bay, Vancouver Island, BC	CAN	49.7060, -124.8720	30.6.2006	B.C. & D.M.

GWS004829	High intertidal pool on rock	Ridley Island (south of coal terminal), Prince Rupert, BC	CAN	54.2212, -130.3293	8.7.2006	G.W.S., B.C. & D.M.
GWS005074	High intertidal pool on rock	Ridley Island (south of coal terminal), Prince Rupert, BC	CAN	54.2212, -130.3293	11.7.2006	G.W.S., B.C. & D.M.
GWS005857	High intertidal pool	Bamfield, Brady's Beach, BC	CAN	48.8240, -125.1620	29.12.2006	H.K. & D.R.
GWS005858	High intertidal pool	Bamfield, Brady's Beach, BC	CAN	48.8240, -125.1620	29.12.2006	H.K. & D.R.
GWS006027	High intertidal pool on rock	Hazard Ave., Narragansett, RI	USA	41.4145, -71.4526	23.4.2007	G.W.S., B.C. & D.M.
GWS006125	High intertidal pool on rock	Escoumins (cross point in town), QC	CAN	48.350006, -69.3972	13.5.2007	G.W.S., D.M. & H.K.
GWS006453	High intertidal pool on *Scytosiphon* sp.	Spring Bay, BC	CAN	48.4558, -123.2690	26.5.2007	H.K.
GWS006454	High intertidal pool on rock	Spring Bay, BC	CAN	48.4558, -123.2690	26.5.2007	H.K.
GWS006458	High intertidal on rock	Stephenson Pt., Nanaimo, BC	CAN	49.2133, -123.9402	27.5.2007	H.K., D.M., B.C., K.R. & S.H.
GWS006812	High intertidal pool on rock	Tahsis, Friendly Cove, BC	CAN	49.5933, -126.6165	31.5.2007	D.M., B.C., K.R. & H.K.

GWS006923	High intertidal on rock	Cape St. Marys, NS	CAN	44.0871, -66.2034	27.6.2006	T.M., S.C., N.C. & A.B.
GWS006927	High intertidal on rock	Cape St. Marys, NS	CAN	44.0871, -66.2034	27.6.2006	T.M., S.C., N.C. & A.B.
GWS006936	High intertidal on rock	Beach Meadows, NS	CAN	44.0600, -64.6300	28.6.2006	T.M., S.C., N.C. & A.B.
GWS006939	High intertidal on rock	Beach Meadows, NS	CAN	44.0600, -64.6300	28.6.2006	T.M., S.C., N.C. & A.B.
GWS006952	High intertidal on rock	Peggys Cove, NS	CAN	44.4905, -63.9166	29.6.2006	T.M., S.C., N.C. & A.B.
GWS006955	High intertidal on rock	Peggys Cove, NS	CAN	44.4905, -63.9166	29.6.2006	T.M., S.C., N.C. & A.B.
GWS006962	On rock	Whycocomagh Picnic Area Site #1, bras d'Or Lake, Cape Breton, NS	CAN	45.9633, -61.1064	9.7.2006	L.L.G., H.K. & J.U.
GWS007134	Intertidal on rock	Deer Arm, Bonne Bay, NL	CAN	49.5200, -57.8700	12.7.2006	B.H.
GWS007135	Intertidal on rock	Deer Arm, Bonne Bay, NL	CAN	49.5200, -57.8700	12.7.2006	B.H.
GWS007175	High intertidal on rock in freshwater runoff	Rocky Harbour, Bonne Bay, NL	CAN	49.6072, 57.9499	13.7.2006	L.L.G., H.K. & J.U.

GWS007187	High intertidal on rock	Rocky Harbour, Bonne Bay, NL	CAN	49.6072, 57.9499	13.7.2006	L.L.G., H.K. & J.U.
GWS007205	High intertidal on rock in freshwater runoff	Rocky Harbour, Bonne Bay, NL	CAN	49.6072, 57.9499	13.7.2006	L.L.G., H.K. & J.U.
GWS007251	High intertidal on rock in freshwater runoff	Green Point, Bonne Bay, NL	CAN	49.682, -57.9628	15.7.2006	L.L.G. & H.K.
GWS007463	No data	Alexander Bay Causeway near Terra Nova Park, NL	CAN	48.6524, -53.9064	19.7.2006	L.L.G., H.K. & D.M.
GWS007578	Intertidal on rock	English Harbour East on intertidal, NL	CAN	47.6339, -54.8848	21.7.2006	H.K.
GWS007595	High intertidal pool on rock	exposed coast west of Grand Barrachois, Miquelon, St. Pierre et Miquelon	FRA	47.0065, -56.3599	23.7.2006	L.L.G., H.K., D.M. & J.U.
GWS007614	Mid-intertidal on rock	exposed coast west of Grand Barrachois, St. Pierre et Miquelon	FRA	47.0065, -56.3599	23.7.2006	L.L.G., H.K., D.M. & J.U.
GWS007619	Mid-intertidal on rock	exposed coast west of Grand Barrachois, St. Pierre et Miquelon	FRA	47.0065, -56.3599	23.7.2006	L.L.G., H.K., D.M. & J.U.

GWS007648	Intertidal on rock	Grand Barrachois, northern bank, St. Pierre et Miquelon	FRA	46.9982, -56.3234	23.7.2006	L.L.G., H.K., D.M. & J.U.
GWS007649	Intertidal on rock	Grand Barrachois, northern bank, St. Pierre et Miquelon	FRA	46.9982, -56.3234	23.7.2006	L.L.G., H.K., D.M. & J.U.
GWS007650	Intertidal on rock	Grand Barrachois, northern bank, St. Pierre et Miquelon	FRA	46.9982, -56.3234	23.7.2006	L.L.G., H.K., D.M. & J.U.
GWS007661	High intertidal on rock in freshwater runoff	Lighthouse at Fortune Head Reserve, NL	CAN	47.0744, -55.8597	24.7.2006	L.L.G., H.K., D.M. & J.U.
GWS007722	High intertidal on rock in freshwater runoff	Point Lance (exposed point west of beach), NL	CAN	46.7992, -54.0982	26.7.2006	L.L.G., H.K., D.M. & J.U.
GWS007856	High intertidal pool on rock	Cap St. MIr, Digby, NS	CAN	44.6919, -65.7853	12.8.2006	L.L.G. & J.U.
GWS007864	High intertidal pool on rock	Cap St. MIr, Digby, NS	CAN	44.6919, -65.7853	12.8.2006	L.L.G. & J.U.
GWS007867	High intertidal on rock	Cap St. MIr, Digby, NS	CAN	44.6919, -65.7853	12.8.2006	L.L.G. & J.U.
GWS007877	High intertidal on rock	Cape St. Marys, NS	CAN	44.0871, -66.2034	12.8.2006	L.L.G. & J.U.

GWS007878	High intertidal pool on rock	Cape St. Marys, NS	CAN	44.0871, -66.2034	12.8.2006	L.L.G. & J.U.
GWS007880	High intertidal pool on rock	Cape St. Marys, NS	CAN	44.0871, -66.2034	12.8.2006	L.L.G. & J.U.
GWS007921	High intertidal pool on rock	Meteghan (front of 'Auberge du Capitaire), NS	CAN	44.2208, -66.1411	12.8.2006	L.L.G. & J.U.
GWS007959	Intertidal on sandstone	L'Anse Bleue Breakwater, Northumberland Strait, NB	CAN	47.8313, -66.0828	15.8.2006	L.L.G., H.K. & J.U.
GWS007995	Intertidal on sandstone	St. Thomas, Northumberland Strait, NB	CAN	46.4480, -64.6418	17.8.2006	L.L.G., H.K. & J.U.
GWS008032	Mid-intertidal on rock	Riviere du Loup, QC	CAN	47.8494, -69.5489	26.8.2006	H.K.
GWS008036	Mid-intertidal on rock	Riviere du Loup, QC	CAN	47.8494, -69.5489	26.8.2006	H.K.
GWS008058	High intertidal pool on rock	Les Escoumins, Off Discovery Centre, QC	CAN	48.3500, -69.4167	27.8.2006	H.K.
GWS008081	High intertidal pool on rock	Le Chalet Jaune, QC	CAN	47.7560, -69.9532	13.5.2007	G.W.S., D.M. & H.K.

GWS008130	Mid-intertidal on rock in freshwater runoff	Lands End up the left side of Pachena Bay where it opens to the ocean, Bamfield, BC	CAN	48.7715, -125.1578	2.6.2007	B.C., D.M., K.R. & H.K.
GWS008141	High intertidal pool on rock	Lands End up the left side of Pachena Bay where it opens to the ocean, Bamfield, BC	CAN	48.7715, -125.1578	2.6.2007	B.C., D.M., K.R. & H.K.
GWS008270	High intertidal pool floating	Bamfield, Blowhole at Brady's Beach, BC	CAN	48.8240, -125.16201	4.6.2007	D.M., B.C., K.R. & H.K.
GWS008321	High intertidal on rock	Ridley Island (south of coal terminal), Prince Rupert, BC	CAN	54.2212, -130.3293	8.6.2007	G.W.S., B.C., D.M. & K.R.
GWS008549	High intertidal on mud in estuarine region	Courtenay Estuary at the dyke, BC	CAN	49.6783, -124.9650	15.6.2007	G.W.S.
GWS009995	High intertidal on rock in freshwater runoff, exposed	Tahsis, Island #40 on Esperenza Inlet Chart, BC	CAN	49.8125, -126.9873	21.5.2008	G.W.S. & B.C.
GWS011659	Mid-intertidal on cobble	Pownal, East of Charlottetown, PE	CAN	46.1917, -62.9561	29.7.2008	G.W.S.

GWS012846	High intertidal on rock in freshwater runoff	Burnaby Island near Saw Reef, Gwaii Haanas, BC	CAN	52.4494, -131.2831	19.6.2009	G.W.S. & D.M.
GWS013255	High mid-intertidal pool on rock	Murchison Island Lagoon, Gwaii Haanas, BC	CAN	52.6042, -131.4499	22.6.2009	G.W.S. & D.M.
GWS013266	High mid-intertidal pool on rock	Murchison Island Lagoon, Gwaii Haanas, BC	CAN	52.6042, -131.4499	22.6.2009	G.W.S. & D.M.
GWS014875	Mid-intertidal on basalt	Pardoe Beach, Devonport, Tasmania	AUS	-41.1704, 146.3756	18.1.2010	G.T.K.
GWS017830	High intertidal on wood	Plymouth Rock Cage, Plymouth, MA	USA	41.9581, -70.6621	14.4.2010	B.C.
GWS019837	High intertidal pool on rock, sheltered	Alder Island, Gwaii Haanas, BC	CAN	52.4421, -131.3189	11.6.2010	G.W.S. & K.D.
GWS020362	High intertidal pool on rock, exposed	East Copper Island (easterly point), Gwaii Haanas, BC	CAN	52.3576, -131.1736	14.6.2010	G.W.S. & K.D.
GWS021098	Mid-intertidal on rock	West of Juskatla Narrows, Masset Inlet, Haida Gwaii, BC	CAN	53.6743, -132.3771	9.6.2010	G.W.S. & K.D.

GWS021401	High intertidal on rock	Pigeon Point Lighthouse, CA	USA	37.1832, -122.3887	15.5.10	B.C. & K.H.
GWS028279	High intertidal on rock in freshwater runoff	Haswell Bay (stream at southeast), Gwaii Haanas, BC	CAN	52.5226, -131.5891	8.7.2011	G.W.S. & K.D.
GWS030299	High intertidal on rock in freshwater runoff	St. Andrews (Blockhouse), Bay of Fundy, NB	CAN	45.0757, -67.0638	7.10.2013	G.W.S., C.J. & A.S.
GWS031305	High intertidal on cobble	Park at end of Honna Road, Queen Charlotte City, Haida Gwaii, BC	CAN	53.2496, -132.1167	1.6.2012	G.W.S. & K.D.
GWS036937	High intertidal on rock in freshwater runoff, sheltered	Lepreau - seagrass flats near bridge along highway, NB	CAN	45.1270, -66.4576	4.6.2015	K.L.M., G.W.S. & T.B.
GWS036943	Low intertidal on rock	Pointe du Chêne, Northumberland Strait, NB	CAN	46.2418, -64.5300	11.6.2015	K.L.M. & L.K.
GWS036963	High intertidal pool on rock, exposed	Lepreau exposed biodiversity site, Bay of Fundy, NB	CAN	45.0722, -66.4690	4.8.2015	K.L.M.

GWS036966	High intertidal on rock, exposed	Lepreau exposed biodiversity site, Bay of Fundy, NB	CAN	45.0722, -66.4690	4.8.2015	K.L.M.
GWS036967	High intertidal on rock, exposed	Lepreau exposed biodiversity site, Bay of Fundy, NB	CAN	45.0722, -66.4690	4.8.2015	K.L.M.
GWS036975	High intertidal in mud, sheltered	South Cove, Shediac, NB	CAN	46.2321, -64.5163	26.8.2015	K.L.M., G.W.S. & A.S.
GWS036976	High intertidal in mud, sheltered	South Cove, Shediac, NB	CAN	46.2321, -64.5163	26.8.2015	K.L.M., G.W.S. & A.S.
GWS036981	High intertidal on rock	Sam Orr's Pond, NB	CAN	45.1620, -67.0446	3.9.2015	K.L.M., A.S. & G.W.S.
GWS036982	High intertidal on brown	Sam Orr's Pond, NB	CAN	45.1620, -67.0446	3.9.2015	K.L.M., A.S. & G.W.S.
GWS036983	High intertidal on brown	Sam Orr's Pond, NB	CAN	45.1620, -67.0446	3.9.2015	K.L.M., A.S. & G.W.S.
GWS037944	High intertidal on rock in fresh water runoff	Mascarene Road estuary, Letete, NB	CAN	45.0999, -66.8913	8.3.2016	K.L.M. & G.W.S.
GWS037954	High intertidal on rock in freshwater runoff	St. Croix River mouth estuary, NB	CAN	45.1921, -67.2871	30.3.2016	K.L.M. & G.W.S.

GWS037963	High intertidal on rock in freshwater runoff	Sam Orr's Pond, NB	CAN	45.1620, -67.0446	30.3.2016	K.L.M. & G.W.S.
GWS037967	On rock in freshwater flow out to the cove	Pagans Cove estuary off Oak Bay, NB	CAN	45.1875, -67.201	30.3.2016	K.L.M. & G.W.S.
GWS037985	High intertidal pool on rock, semi-exposed	Lepreau exposed biodiversity site, Bay of Fundy, NB	CAN	45.0722, -66.4690	29.4.2016	K.L.M. & A.C.
GWS037993	Mudflat drift	Saints Rest Marsh, NB	CAN	45.0034, -66.1408	22.9.2016	A. Beck
GWS037994	Mudflat drift	Saints Rest Marsh, NB	CAN	45.0034, -66.1408	22.9.2016	A. Beck
PHYC2014-29	Mid-intertidal pool on *Chaetomorpha* sp., sheltered	Wallace Cove Lighthouse, NB	CAN	45.0386, -66.8077	8.10.2014	L.M.B., A.H., H.M., K.L. & M.M.
PHYC2014-40	High intertidal pool on rock, sheltered	Wallace Cove Lighthouse, NB	CAN	45.0386, -66.8077	8.10.2014	L.M.B., A.H., H.M., K.L. & M.M.
PHYC2014-43	Low intertidal on rock, sheltered	St. Andrews (Blockhouse), Bay of Fundy, NB	CAN	45.0757, -67.0638	9.10.2014	L.M.B., A.H., H.M., K.L. & M.M.

Ulva lactuca Linnaeus	2016_BIO309A_39	Intertidal	Espegrend, Hordaland	NOR	60.2697, 5.2208	17.4.2016	K.S.
	GWS003444	Mid-intertidal pool on rock	Pachena Beach, Bamfield, BC	CAN	48.7862, -125.1191	12.6.2006	G.W.S., B.C. & D.M.
	GWS003489	High intertidal on rock	Bamfield, Dixon I., BC	CAN	48.8524, -125.1224	13.6.2006	G.W.S., B.C. & D.M.
	GWS003586	High mid-intertidal pool on rock	Cape Neddick, southern ME	USA	43.1658, -70.5924	24.4.2006	S.C.
	GWS003589	Low mid-intertidal pool on rock	Cape Neddick, southern ME	USA	43.1658, -70.5924	24.4.2006	G.W.S.
	GWS003651	High intertidal pool on rock	End of public road, Starboard, ME	USA	44.6091, -67.3966	25.4.2006	G.W.S., L.L.G., D.M., S.C. & C.L.
	GWS003686	Low intertidal pool on rock	Letete exposed biodiversity site, Bay of Fundy, NB	CAN	45.0382, -66.8912	26.5.2006	H.K.
	GWS003687	Low intertidal pool on rock	Letete exposed biodiversity site, Bay of Fundy, NB	CAN	45.0382, -66.8912	26.5.2006	H.K.
	GWS003760	Low intertidal on rock	Harrington Cove exposed biodiversity site, Grand Manan, NB	CAN	44.6249, -66.8604	27.5.2006	H.K.

GWS003794	Mid-intertidal pool on *Chaetomorpha* sp.	Meadow Cove exposed biodiversity site, Bay of Fundy, NB	CAN	45.0381, -66.8913	28.5.2006	H.K.
GWS003817	High mid-intertidal pool	SE of Beaver Harbour on rocky cliffs, Bay of Fundy, NB	CAN	45.0563, -66.7358	28.5.2006	H.K.
GWS003848	Mid-intertidal on rock	Lepreau exposed biodiversity site, Bay of Fundy, NB	CAN	45.0722, -66.4690	29.5.2006	H.K.
GWS004229	Subtidal (2 m) on rock	Whiffen Spit, Sooke Harbour, Vancouver Island, BC	CAN	48.3521, -123.7281	21.6.2006	G.W.S., B.C. & D.M.
GWS004456	High intertidal on rock	Botany Beach, near Port Renfrew, Vancouver Island, BC	CAN	48.5304, -124.4535	26.6.2006	G.W.S., B.C. & D.M.
GWS004717	Low mid-intertidal on rock	Palmerston Recreation Reserve near Raft Cove, Vancouver Island, BC	CAN	50.5933, -128.2583	3.7.2006	B.C. & D.M.
GWS005100	Mid-intertidal on rock	Ridley Island (north of grain terminal), Prince Rupert, BC	CAN	54.2212, -130.3293	11.7.2006	G.W.S., B.C. & D.M.
GWS005176	Low intertidal on rock	Butze Rapids, Prince Rupert, BC	CAN	54.3007, -130.2507	12.7.2006	G.W.S., B.C. & D.M.

GWS005244	Subtidal (5 m) on rock	Out the river & right, Churchill, MB	CAN	58.7787, -94.1582	19.8.2006	G.W.S., B.C. & D.M.
GWS005338	Subtidal (2 m) on rock	Button Bay, Churchill, MB	CAN	58.7806, -94.2767	22.8.2006	G.W.S., B.C. & D.M.
GWS005340	Subtidal (6 m) on rock	Button Bay, Churchill, MB	CAN	58.7806, -94.2767	22.8.2006	G.W.S., B.C. & D.M.
GWS005557	Drift	Wreck of the Ithaca, east of Churchill, MB	CAN	58.7678, -93.8897	11.7.2007	G.W.S., B.C., D.M. & K.R.
GWS005613	Mid-intertidal pool on algae & rock	Cape Neddick, southern ME	USA	43.1658, -70.5924	3.11.2006	G.W.S., B.C. & D.M.
GWS005695	Low mid-intertidal pool on coralline alga	Lepreau exposed biodiversity site, Bay of Fundy, NB	CAN	45.0722, -66.4690	11.1.2007	H.K.
GWS005696	Edge of mid-intertidal pool on rock	Lepreau exposed biodiversity site, Bay of Fundy, NB	CAN	45.0722, -66.4690	11.1.2007	H.K.
GWS005698	Mid-intertidal on rock	Lepreau exposed biodiversity site, Bay of Fundy, NB	CAN	45.0722, -66.4690	11.1.2007	H.K.
GWS005750	Subtidal (4 m) on kelp holdfast	Fort Wetherill, RI	USA	41.4791, -71.3607	10.8.2007	D.M. & S.H.
GWS005785	High intertidal pool on rock	Seal point (to right of marina), PE	CAN	46.7399, -64.3779	17.8.2007	B.C., K.D. & K.R.

GWS005791	Drift on pebble	Sea Cow Pond, PE	CAN	46.9988, -63.9923	17.8.2007	B.C., K.D. & K.R.
GWS005792	Drift	Sea Cow Pond, PE	CAN	46.9988, -63.9923	17.8.2007	B.C., K.D. & K.R.
GWS005801	Low intertidal on rock	Bamfield, Aguilar Point, BC	CAN	48.8371, -125.1436	28.12.2006	H.K. & D.R.
GWS005837	Low mid-intertidal on rock	Bamfield, Scotts Bay, BC	CAN	48.8346, -125.1463	29.12.2006	H.K. & D.R.
GWS005841	Low mid-intertidal on rock	Bamfield, Scotts Bay, BC	CAN	48.8346, -125.1463	29.12.2006	H.K. & D.R.
GWS005842	Low mid-intertidal on rock	Bamfield, Scotts Bay, BC	CAN	48.8346, -125.1463	29.12.2006	H.K. & D.R.
GWS005859	Mid-intertidal on Fucus	Lepreau exposed biodiversity site, Bay of Fundy, NB	CAN	45.0722, -66.4690	11.1.2007	H.K.
GWS005871	Mid-intertidal on rock	Letete exposed biodiversity site, Bay of Fundy, NB	CAN	45.0382, -66.8912	31.1.2007	H.K.
GWS005872	Mid-intertidal on rock	Letete exposed biodiversity site, Bay of Fundy, NB	CAN	45.0382, -66.8912	31.1.2007	H.K.

GWS005875	Mid-intertidal on rock	Letete exposed biodiversity site, Bay of Fundy, NB	CAN	45.0382, -66.8912	31.1.2007	H.K.
GWS005876	Mid-intertidal on rock	Letete exposed biodiversity site, Bay of Fundy, NB	CAN	45.0382, -66.8912	31.1.2007	H.K.
GWS005877	Mid-intertidal on rock	Letete exposed biodiversity site, Bay of Fundy, NB	CAN	45.0382, -66.8912	31.1.2007	H.K.
GWS005907	Low mid-intertidal pool on rock	SE of Beaver Harbour on rocky cliffs, Bay of Fundy, NB	CAN	45.0563, -66.7358	19.3.2007	G.W.S.
GWS005933	Low intertidal on rock	Letete exposed biodiversity site, Bay of Fundy, NB	CAN	45.0382, -66.8912	22.3.2007	G.W.S.
GWS005997	Subtidal (4 m) on rock	Pier #5, Narragansett, RI	USA	41.4226, -71.4546	23.4.2007	G.W.S., B.C. & D.M.
GWS005998	Subtidal (4 m) on rock	Pier #5, Narragansett, RI	USA	41.4226, -71.4546	23.4.2007	G.W.S., B.C. & D.M.
GWS006041	High mid-intertidal on *Fucus* sp. in estuary	Governor Sprague Bridge 17, Narragansett, RI	USA	41.4487, -71.4491	23.4.2007	G.W.S., B.C., D.M., S.C. & S.H.

GWS006094	Subtidal (6 m) on *Cystoclonium* sp.	Fort Wetherill, RI	USA	41.4791, -71.3607	24.4.2007	G.W.S., B.C. & D.M.
GWS006258	Subtidal drift	Richebucto Cape Breakwater, NB	CAN	46.6754, -64.7109	28.8.2007	G.W.S.
GWS006405	Subtidal (1.5 m) on rock	Whiffen Spit, Sooke Harbour, Vancouver Island, BC	CAN	48.3521, -123.7281	25.5.2007	D.M., B.C., K.R. & S.H.
GWS006452	High mid-intertidal pool on rock	Spring Bay, BC	CAN	48.4558, -123.2690	26.5.2007	H.K.
GWS006574	Subtidal (8 m) on rock	Tahsis Nuchatliz Island, (#37 on Esperenza Inlet Chart), BC	CAN	49.8101, -126.9823	30.5.2007	B.C., D.M., K.R. & S.H.
GWS006666	Mid-intertidal on rock	Tahsis, Island #40 on Esperenza Inlet Chart, BC	CAN	49.8125, -126.9873	30.5.2007	B.C., D.M., K.R. & S.H.
GWS006685	Mid-intertidal on rock	Tahsis, Island #40 on Esperenza Inlet Chart, BC	CAN	49.8125, -126.9873	30.5.2007	B.C., D.M., K.R. & S.H.
GWS006694	Subtidal (8 m) on coralline alga	Tahsis, Islands at ocean end of McKay Passage, BC	CAN	49.6087, -126.6146	31.5.2007	B.C. & D.M.

GWS006803	Low intertidal on rock, exposed	Tahsis, Friendly Cove, BC	CAN	49.5933, -126.6165	31.5.2007	D.M., B.C., K.R. & H.K.
GWS006956	Mid-intertidal on rock	Peggys Cove, NS	CAN	44.4905, -63.9166	29.6.2006	T.M., S.C., N.C. & A.B.
GWS007420	Mid-intertidal on *Fucus* sp.	Eastport, NL	CAN	48.6552, -53.7519	18.7.2006	L.L.G., H.K., D.M. & J.U.
GWS007425	Mid-intertidal on rock	Eastport, NL	CAN	48.6552, -53.7519	18.7.2006	L.L.G., H.K., D.M. & J.U.
GWS007476	Subtidal (12 m) on jetty piling	English Harbour East Government Dock, NL	CAN	47.6319, -54.8863	20.7.2006	L.L.G., D.M. & J.U.
GWS007518	Subtidal (12 m) on kelp stipe	English Harbour East Government Dock, NL	CAN	47.6319, -54.8863	20.7.2006	L.L.G., D.M. & J.U.
GWS007550	Subtidal (7 m) on rock	English Harbour Eastern Cove, NL	CAN	47.6331, -54.87	20.7.2006	L.L.G., D.M. & J.U.
GWS007660	Low intertidal pool on rock	Lighthouse at Fortune Head Reserve, NL	CAN	47.0744, -55.8597	24.7.2006	L.L.G., H.K., D.M. & J.U.
GWS007700	Low intertidal on rock	St. Brides, NL	CAN	46.9207, -54.1738	25.7.2006	L.L.G., H.K., D.M. & J.U.
GWS007775	High intertidal on rock	White Pt., NS	CAN	46.8823, -60.3508	28.7.2006	H.K.
GWS007776	High intertidal on rock	White Pt., NS	CAN	46.8823, -60.3508	28.7.2006	H.K.

GWS007795	Subtidal (2.5 m) on rock	White Pt., NS	CAN	46.8823, -60.3508	28.7.2006	L.L.G. & D.M.
GWS007825	Subtidal (2.5 m) on rock	White Pt., NS	CAN	46.8823, -60.3508	28.7.2006	L.L.G. & D.M.
GWS007828	Mid-intertidal pool on rock	Cap St. MIr, Digby, NS	CAN	44.6919, -65.7853	12.8.2006	L.L.G. & J.U.
GWS007841	Low mid-intertidal pool on rock	Cap St. MIr, Digby, NS	CAN	44.6919, -65.7853	12.8.2006	L.L.G. & J.U.
GWS007908	Intertidal on rock	Cape St. Marys, NS	CAN	44.0871, -66.2034	12.8.2006	L.L.G. & J.U.
GWS007930	Intertidal on wharf	L'Anse Bleue Breakwater, Northumberland Strait, NB	CAN	47.8313, -66.0828	15.8.2006	L.L.G., H.K. & J.U.
GWS007931	Intertidal on wharf	L'Anse Bleue Breakwater, Northumberland Strait, NB	CAN	47.8313, -66.0828	15.8.2006	L.L.G., H.K. & J.U.
GWS007962	Intertidal on rock	Cap des Caissie, North of Shediac, NB	CAN	46.3266, -64.5157	17.8.2006	L.L.G., H.K. & J.U.
GWS007999	Intertidal on sandstone	St. Thomas, Northumberland Strait, NB	CAN	46.4480, -64.6418	17.8.2006	L.L.G., H.K. & J.U.

GWS008006	Intertidal on *Ceramium* sp.	Pointe Sapin, Northumberland Strait, NB	CAN	46.9600, -64.8300	17.8.2006	L.L.G., H.K. & J.U.
GWS008016	Intertidal on rock	Pointe Sapin, Northumberland Strait, NB	CAN	46.9600, -64.8300	17.8.2006	L.L.G., H.K. & J.U.
GWS008067	Mid-intertidal on rock	Pointe Verde, NB	CAN	No data	28.8.2006	H.K.
GWS008132	Mid-intertidal on rock	Lands End up the left side of Pachena Bay where it opens to the ocean, Bamfield, BC	CAN	48.7715, -125.1578	2.6.2007	B.C., D.M., K.R. & H.K.
GWS008133	Mid-intertidal pool on rock	Lands End up the left side of Pachena Bay where it opens to the ocean, Bamfield, BC	CAN	48.7715, -125.1578	2.6.2007	B.C., D.M., K.R. & H.K.
GWS008143	Mid-intertidal, exposed, on rock	Lands End up the left side of Pachena Bay where it opens to the ocean, Bamfield, BC	CAN	48.7715, -125.1578	2.6.2007	B.C., D.M., K.R. & H.K.
GWS008144	Mid-intertidal, exposed, on rock	Lands End up the left side of Pachena Bay where it opens to the ocean, Bamfield, BC	CAN	48.7715, -125.1578	2.6.2007	B.C., D.M., K.R. & H.K.

GWS008295	High mid-intertidal on rock	Pachena Beach, Bamfield, BC	CAN	48.7862, -125.1191	5.6.2007	D.M., B.C., K.R. & H.K.
GWS008296	High intertidal on rock	Pachena Beach, Bamfield, BC	CAN	48.7862, -125.1191	5.6.2007	D.M., B.C., K.R. & H.K.
GWS008313	High intertidal pool on rock	Ridley Island (south of coal terminal), Prince Rupert, BC	CAN	54.2212, -130.3293	8.6.2007	G.W.S., B.C., D.M. & K.R.
GWS008324	Low intertidal on rock	Ridley Island (south of coal terminal), Prince Rupert, BC	CAN	54.2212, -130.3293	8.6.2007	G.W.S., B.C., D.M. & K.R.
GWS008392	Shallow subtidal on barnacle	Ridley Island (south of coal terminal), Prince Rupert, BC	CAN	54.2212, -130.3293	10.6.2007	D.M., B.C. & G.W.S.
GWS009987	Mid-intertidal on rock, exposed	Tahsis, Island #40 on Esperenza Inlet Chart, BC	CAN	49.8125, -126.9873	21.5.2008	G.W.S. & B.C.
GWS012845	Low intertidal on rock	Burnaby Island near Saw Reef, Gwaii Haanas, BC	CAN	52.4494, -131.2831	19.6.2009	G.W.S. & D.M.
GWS012906	Mid-intertidal on rock	Scudder Point, Burnaby Island, Gwaii Haanas, BC	CAN	52.4460, -131.2325	20.6.2009	G.W.S. & D.M.

GWS012907	High intertidal on rock	Scudder Point, Burnaby Island, Gwaii Haanas, BC	CAN	52.4460, -131.2325	20.6.2009	G.W.S. & D.M.
GWS013153	Low intertidal on rock	Ramsey Island (point adjacent Kloo Rock), Gwaii Haanas, BC	CAN	52.5864, -131.3716	21.6.2009	G.W.S. & D.M.
GWS013219	Mid-intertidal on rock	Ramsey Island (beach on NW coast), Gwaii Haanas, BC	CAN	52.5692, -131.4030	21.6.2009	G.W.S. & D.M.
GWS013487	Low intertidal in channel on rock	Burnaby (Dolomite) Narrows, Gwaii Haanas, BC	CAN	52.3599, -131.3520	23.6.2009	G.W.S. & D.M.
GWS014687	No data	The Curragh, Ardmore, Waterford	IRE	No data	27.8.2010	M.D.G.
GWS014726	Subtidal (5 m) on rock	White Horse Beach, Plymouth, MA	USA	41.9336, -70.5605	12.4.2010	B.C., D.M., M.B., A.S., C.L.
GWS014727	Subtidal (5 m) on rock	White Horse Beach, Plymouth, MA	USA	41.9336, -70.5605	12.4.2010	B.C., D.M., M.B., A.S., C.L.
GWS014779	Subtidal (10 m) on rock	Folly Cove, Gloucester left side, MA	USA	42.6850, -70.6415	13.4.2010	D.M., M.B.

GWS017805	Subtidal (6 m) on rock	Folly Cove, Gloucester, right side, MA	USA	42.6850, -70.6415	13.4.2010	B.C., A.S.
GWS017943	Subtidal (1 m) on rock	East Point Beach, Groton, CT	USA	41.32, -72.0748	15.4.2010	B.C., D.M., M.B., A.S., C.L.
GWS017962	Subtidal (3 m) on red	East Point Beach, Groton, CT	USA	41.32, -72.0748	15.4.2010	B.C., D.M., M.B., A.S., C.L.
GWS018091	Subtidal (5 m) on rock	Two Lights, Cape Elizabeth, ME	USA	43.5648, -70.1987	19.4.2010	B.C., D.M., M.B., A.S., C.L.
GWS019701	Low intertidal on rock, sheltered	Alder Island, Gwaii Haanas, BC	CAN	52.4421, -131.3189	11.6.2010	G.W.S. & K.D.
GWS019719	Mid-intertidal on rock, sheltered	Alder Island, Gwaii Haanas, BC	CAN	52.4421, -131.3189	11.6.2010	G.W.S. & K.D.
GWS019780	Mid-intertidal on rock, exposed	Alder Island, Gwaii Haanas, BC	CAN	52.4421, -131.3189	11.6.2010	G.W.S. & K.D.
GWS019797	Low intertidal on rock wall, semi-exposed	Alder Island, Gwaii Haanas, BC	CAN	52.4421, -131.3189	11.6.2010	G.W.S. & K.D.

GWS020123	Low intertidal on rock, sheltered	Saw Reef, Gwaii Haanas, BC	CAN	52.4501, -131.2915	13.6.2010	G.W.S. & K.D.
GWS020143	Low mid-intertidal pool on rock, sheltered	Saw Reef, Gwaii Haanas, BC	CAN	52.4501, -131.2915	13.6.2010	G.W.S. & K.D.
GWS020308	High mid-intertidal on rock, exposed	East Copper Island (easterly point), Gwaii Haanas, BC	CAN	52.3576, -131.1736	14.6.2010	G.W.S. & K.D.
GWS020377	Mid-intertidal on cobble, sheltered	Hot Spring Island (east 'back' side), Gwaii Haanas, BC	CAN	52.5779, -131.4377	15.6.2010	G.W.S. & K.D.
GWS020629	Low intertidal on rock, semi-exposed	North Beach (near Naval Station), Haida Gwaii, BC	CAN	54.0327, -132.0530	17.6.2010	G.W.S. & K.D.
GWS020930	Subtidal (2.5 m) on rock	Indian Head, Skidegate, Haida Gwaii, BC	CAN	53.2481, -131.9837	7.6.2010	G.W.S. & K.D.
GWS021097	Mid-intertidal on rock	West of Juskatla Narrows, Masset Inlet, Haida Gwaii, BC	CAN	53.6743, -132.3771	9.6.2010	G.W.S. & K.D.

GWS021171	Low intertidal on rock, sheltered	Alder Island, Gwaii Haanas, BC	CAN	52.4421, -131.3189	11.6.2010	G.W.S. & K.D.
GWS021334	Low intertidal on rock	Pigeon Point Lighthouse, CA	USA	37.1832, -122.3887	15.5.10	B.C. & K.H.
GWS028591	Subtidal (16 m) on rock.	Kul Rocks, Gwaii Haanas, BC	CAN	52.7358, -131.5986	11.7.2011	G.W.S. & K.D.
GWS030147	Subtidal (3 m) on rock	Folly Cove, Gloucester, right side, MA	USA	42.6850, -70.6415	19.4.2012	G.W.S.
GWS030246	Subtidal (3.5 m) on rock	Carrying Cove, New River Beach, NB	CAN	45.1299, -66.5262	15.5.2012	G.W.S., A.S., M.B. & K.D.
GWS030248	Subtidal (3.5 m) on rock	Carrying Cove, New River Beach, NB	CAN	45.1299, -66.5262	15.5.2012	G.W.S., A.S., M.B. & K.D.
GWS030293	Mid-intertidal on *Ascophyllum* sp., exposed	Wallace Cove Lighthouse, NB	CAN	45.0386, -66.8077	7.10.2013	G.W.S., C.J. & A.S.
GWS030296	Low intertidal pool on kelp	Wallace Cove Lighthouse, NB	CAN	45.0386, -66.8077	7.10.2013	G.W.S., C.J. & A.S.
GWS030484	Low intertidal on rock in sand	Raspberry Cove, Gwaii Haanas, BC	CAN	52.1666, -131.0837	6.6.2012	G.W.S. & K.D.
GWS030563	Mid-intertidal on rock wall	Solitude Point Tide Pool (Rose Harbour), Gwaii Haanas, BC	CAN	52.1533, -131.0748	8.6.2012	G.W.S. & K.D.

GWS030908	Subtidal on *Nereocystis* sp. stipe	Knoll between Bokus Islands & Pelican Pt., Gwaii Haanas, BC	CAN	52.3312, -131.2559	12.6.2012	G.W.S. & K.D.
GWS031537	Mid-intertidal pool on rock, semi-exposed	Wallace Cove Lighthouse, NB	CAN	45.0386, -66.8077	4.7.2012	G.W.S., A.S. & G.F.
GWS034077	Drift	St. Andrews (Blockhouse), Bay of Fundy, NB	CAN	45.0757, -67.0638	7.10.2013	G.W.S., C.J. & A.S.
GWS034987	Low intertidal pool on rock	Ormhilleren	NOR	60.4936, 4.919	4.6.2016	G.W.S. & T.B.
GWS035900	Low intertidal on rock	Woodruff Bay (NE beach), Gwaii Haanas, BC	CAN	51.9741, -131.0322	20.8.2013	G.W.S. & K.D.
GWS036904	High intertidal pool on rock, sheltered	Wallace Cove Lighthouse, NB	CAN	45.0386, -66.8077	6.11.2014	K.L.M. & A.S.
GWS036905	High intertidal pool on rock, sheltered	Wallace Cove Lighthouse, NB	CAN	45.0386, -66.8077	6.11.2014	K.L.M. & A.S.
GWS036915	Low intertidal on rock, exposed	Lepreau exposed biodiversity site, Bay of Fundy, NB	CAN	47.0722, -66.4690	7.5.2015	K.L.M. & G.W.S.

GWS036917	Low intertidal on rock, exposed	Lepreau exposed biodiversity site, Bay of Fundy, NB	CAN	47.0722, -66.4690	7.5.2015	K.L.M. & G.W.S.
GWS036924	Low intertidal on rock, exposed	Lepreau exposed biodiversity site, Bay of Fundy, NB	CAN	45.0722, -66.4690	21.5.2015	K.L.M., G.W.S. & T.B.
GWS036927	Low intertidal drift	Lepreau - seagrass flats near bridge along highway, NB	CAN	45.1270, -66.4576	21.5.2015	K.L.M., G.W.S., J.E. & C.B.
GWS036930	Low intertidal on rock, exposed	Lepreau exposed biodiversity site, Bay of Fundy, NB	CAN	45.0722, -66.4690	21.5.2015	K.L.M., G.W.S., J.E. & C.B.
GWS036934	Low intertidal pool on rock, sheltered	Lepreau - seagrass flats near bridge along highway, NB	CAN	45.1270, -66.4576	4.6.2015	K.L.M., G.W.S. & T.B.
GWS036935	Low intertidal pool on rock, sheltered	Lepreau - seagrass flats near bridge along highway, NB	CAN	45.1270, -66.4576	4.6.2015	K.L.M., G.W.S. & T.B.
GWS036944	Low intertidal on rock	Pointe du Chêne, Northumberland Strait, NB	CAN	46.2418, -64.5300	11.6.2015	K.L.M. & L.K.
GWS036952	Subtidal (2 m) on rock	Pointe du Chêne, Northumberland Strait, NB	CAN	46.2418, -64.5300	25.6.2015	K.L.M. & G.W.S.

GWS036958	High intertidal pool on *Fucus* sp., exposed	Wallace Cove Lighthouse, NB	CAN	45.0386, -66.8077	17.7.2015	K.L.M. & A.S.
GWS036962	Low intertidal on rock, exposed	Lepreau exposed biodiversity site, Bay of Fundy, NB	CAN	45.0722, -66.4690	4.8.2015	K.L.M.
GWS036964	Low intertidal on *Chondrus* sp., exposed	Lepreau exposed biodiversity site, Bay of Fundy, NB	CAN	45.0722, -66.4690	4.8.2015	K.L.M.
GWS036971	Low intertidal on *Chondrus* sp., sheltered	Pointe du Chêne, Northumberland Strait, NB	CAN	46.2418, -64.5300	26.8.2015	K.L.M., G.W.S. & A.S.
GWS036985	Low intertidal on rock, semi-exposed	Lepreau - seagrass flats near bridge along highway, NB	CAN	45.1270, -66.4576	3.10.2015	K.L.M. & T.B.
GWS036986	Drift, sheltered	Lepreau - seagrass flats near bridge along highway, NB	CAN	45.1270, -66.4576	3.10.2015	K.L.M. & T.B.
GWS036987	Drift, sheltered	Lepreau - seagrass flats near bridge along highway, NB	CAN	45.1270, -66.4576	3.10.2015	K.L.M. & T.B.
GWS036989	Low mid-intertidal on rock, exposed	Lepreau - seagrass flats near bridge along highway, NB	CAN	45.1270, -66.4576	3.10.2015	K.L.M. & T.B.

GWS036990	High intertidal pool on rock	Maces Bay, Lepreau, Bay of Fundy, NB	CAN	45.1093, -66.4817	3.10.2015	K.L.M. & T.B.
GWS036992	Low intertidal pool drift	Maces Bay, Lepreau, Bay of Fundy, NB	CAN	45.1093, -66.4817	3.10.2015	K.L.M. & T.B.
GWS036999	Subtidal (3 m) on kelp	Wallace Cove Dive Site, NB	CAN	45.0433, -66.8087	14.10.2015	K.L.M. & A.S.
GWS037921	Subtidal (3 m)	Wallace Cove Dive Site, NB	CAN	45.0433, -66.8087	14.10.2015	K.L.M. & A.S.
GWS037930	Low intertidal on *Fucus* sp., sheltered	Lepreau - seagrass flats near bridge along highway, NB	CAN	45.1270, -66.4576	1.3.2016	K.L.M. & G.W.S.
GWS037934	High intertidal pool on rock, exposed	Lepreau exposed biodiversity site, Bay of Fundy, NB	CAN	45.0722, -66.4690	1.3.2016	K.L.M. & G.W.S.
GWS037937	High mid-intertidal pool on rock, exposed	Lepreau exposed biodiversity site, Bay of Fundy, NB	CAN	45.0722, -66.4690	1.3.2016	K.L.M. & G.W.S.
GWS037945	High intertidal on rock in fresh water runoff	Mascarene Road estuary, Letete, NB	CAN	45.0999, -66.8913	8.3.2016	K.L.M. & G.W.S.
GWS037947	Mid-intertidal pool on rock, exposed	Letete exposed biodiversity site, Bay of Fundy, NB	CAN	45.0382, -66.8912	8.3.2016	K.L.M. & G.W.S.

GWS037984	High intertidal pool on rock, semi-exposed	Lepreau exposed biodiversity site, Bay of Fundy, NB	CAN	45.0722, -66.4690	29.4.2016	K.L.M. & A.C.
GWS037988	Low intertidal on brown alga, sheltered	Lepreau - seagrass flats near bridge along highway, NB	CAN	45.1270, -66.4576	29.4.2016	K.L.M. & A.C.
GWS039189	High intertidal pool on rock, sheltered	Nanny's Hole in Sleepy Cove, North Twillingate Island, NL	CAN	49.6848, -54.8068	23.7.2016	K.L.M.
PHYC2014-28	Mid-intertidal pool on *Ascophyllum* sp., semi-exposed	Wallace Cove Lighthouse, NB	CAN	45.0386, -66.8077	8.10.2014	L.M.B., A.H., H.M., K.L. & M.M.
PHYC2014-31	Low intertidal pool on rock, exposed	Wallace Cove Lighthouse, NB	CAN	45.0386, -66.8077	8.10.2014	L.M.B., A.H., H.M., K.L. & M.M.
PHYC2014-32	Low intertidal pool on *Ascophyllum* sp., exposed	Wallace Cove Lighthouse, NB	CAN	45.0386, -66.8077	8.10.2014	L.M.B., A.H., H.M., K.L. & M.M.

PHYC2014-35	Low intertidal pool on *Chondrus* sp., exposed	Wallace Cove Lighthouse, NB	CAN	45.0386, -66.8077	8.10.2014	L.M.B., A.H., H.M., K.L. & M.M.
PHYC2014-37	High intertidal on rock, sheltered	Wallace Cove Lighthouse, NB	CAN	45.0386, -66.8077	8.10.2014	L.M.B., A.H., H.M., K.L. & M.M.
PHYC2014-41	Low intertidal on rock, sheltered	St. Andrews (Blockhouse), Bay of Fundy, NB	CAN	45.0757, -67.0638	9.10.2014	L.M.B., A.H., H.M., K.L. & M.M.
PHYC2014-42	Low intertidal on rock, sheltered	St. Andrews (Blockhouse), Bay of Fundy, NB	CAN	45.0757, -67.0638	9.10.2014	L.M.B., A.H., H.M., K.L. & M.M.
ULV06	Mid-intertidal pool on rock, exposed	Wallace Cove Lighthouse, NB	CAN	45.0386, -66.8077	10.9.2013	J.E.
ULV07	Mid-intertidal pool on *Ahnfeltia* sp., exposed	Wallace Cove Lighthouse, NB	CAN	45.0386, -66.8077	10.9.2013	C.B.
ULV10	Drift	St. Andrews (Blockhouse), Bay of Fundy, NB	CAN	45.0757, -67.0638	11.9.2013	J.E.
ULV11	Mid-intertidal on rock	Maces Bay, Lepreau, Bay of Fundy, NB	CAN	45.1093, -66.4817	11.9.2013	S.S.

	ULV13	Mid-intertidal pool on rock	Maces Bay, Lepreau, Bay of Fundy, NB	CAN	45.1093, -66.4817	11.9.2013	K.T.
	ULV14	Drift	Maces Bay, Lepreau, Bay of Fundy, NB	CAN	45.1093, -66.4817	11.9.2013	J.E.
	ULV18	Low intertidal on rock under *Fucus* sp.	Maces Bay, Lepreau, Bay of Fundy, NB	CAN	45.1093, -66.4817	11.9.2013	J.E.
Ulva laetevirens Areschoug	LAK34	No data	Bamfield, Dixon I., New South Wales	AUS	48.8524, -125.1224	No data	No data
	LAK14	No data	Alder Island, Gwaii Haanas, Tasmania	AUS	52.4421, -131.3189	No data	No data
	LAK71	No data	Saw Reef, Gwaii Haanas, Victoria	AUS	52.4501, -131.2915	No data	No data
	GWS006232	Subtidal (1 m) on seagrass	Kouchibouguac lagoon seagrass beds, NB	CAN	46.8348, -64.9299	27.8.2007	G.W.S.
	GWS010964	Subtidal in tidal marsh pond on rock	Sam Orr's Pond, NB	CAN	45.1620, -67.0446	23.7.2008	G.W.S., S.H., M.L. & R.C.
	GWS014614	No data	Cuan, Ventry, Kerry	IRE	No data	11.8.2010	M.D.G.
	GWS016544	Subtidal (5 m) on rock	Stanley Breakwater, Tasmania	AUS	-40.7673, 145.3058	29.1.2010	G.W.S., L.K. & K.D.

GWS024562	Low intertidal pool on rock	Emu Beach Holiday Park, Western Australia	AUS	-35.0012, 117.9405	8.11.2010	G.W.S. & K.D.
GWS024686	Intertidal on GWS024685	Windy Harbour, Western Australia	AUS	-34.8375, 116.0143	8.11.2010	G.W.S. & K.D.
GWS025623	Subtidal (2.5 m) on rock	Ricey Beach, Rottnest I., Western Australia	AUS	-32.0002, 115.49	17.11.2010	G.W.S. & K.D.
GWS032167	Subtidal (0.25 m) on mussel	Pomquet (far on Monks Head Road), NS	CAN	45.6589, -61.8218	16.8.2012	G.W.S., A.S., C.L., K.D. & M.B.
GWS032168	Subtidal (0.25 m) on mussel	Pomquet (far on Monks Head Road), NS	CAN	45.6589, -61.8218	16.8.2012	G.W.S., A.S., C.L., K.D. & M.B.
GWS032181	Subtidal (0.25 m) on mussel	Pomquet (far on Monks Head Road), NS	CAN	45.6589, -61.8218	16.8.2012	G.W.S., A.S., C.L., K.D. & M.B.
GWS034070	Drift	St. Andrews (Blockhouse), Bay of Fundy, NB	CAN	45.0757, -67.0638	7.10.2013	G.W.S., C.J. & A.S.
GWS036919	Saltmarsh pool drift	Cape Jourimain National Wildlife Area, NB	CAN	46.1578, -63.8207	18.5.2015	K.L.M.
GWS036923	Saltmarsh pool drift	Cape Jourimain National Wildlife Area, NB	CAN	46.1578, -63.8207	18.5.2015	K.L.M.

	GWS036948	Mid-intertidal drift, sheltered	South Cove, Shediac, NB	CAN	46.2321, -64.5163	11.6.2015	K.L.M. & L.K.
	GWS036950	Subtidal (3 m) drift	Pointe du Chêne, Northumberland Strait, NB	CAN	46.2418, -64.5300	25.6.2015	K.L.M. & G.W.S.
	GWS036993		Beach NE Burnt Chuch dock, NB	CAN	47.1939, -65.1362	7.10.2015	G.W.S. & T.B.
	GWS036994		Beach NE Burnt Chuch dock, NB	CAN	47.1939, -65.1362	7.10.2015	G.W.S. & T.B.
	GWS036995		Beach NE Burnt Chuch dock, NB	CAN	47.1939, -65.1362	7.10.2015	G.W.S. & T.B.
	GWS036996	On rock	Beach NE Burnt Chuch dock, NB	CAN	47.1939, -65.1362	7.10.2015	G.W.S. & T.B.
	GWS037992	Low saltmarsh pool drift	Cape Jourimain National Wildlife Area, NB	CAN	46.1578, -63.8207	7.6.2016	K.L.M.
	ULV09	Drift	St. Andrews (Blockhouse), Bay of Fundy, NB	CAN	45.0757, -67.0638	11.9.2013	C.B.
Ulva linza Linnaeus	LAK48	No data	Stephenson Pt., Nanaimo, Victoria	AUS	49.2133, -123.9402	No data	No data
	ENT02	High intertidal on *Enteromorpha* sp.	Wallace Cove Lighthouse, NB	CAN	45.0386, -66.8077	10.9.2013	G.M.

GWS003625	High intertidal pool on rock	End of public road, Starboard, ME	USA	44.6091, -67.3966	25.4.2006	G.W.S., L.L.G., D.M., S.C. & C.L.
GWS003752	Low intertidal on rock	Harrington Cove exposed biodiversity site, Grand Manan, NB	CAN	44.6249, -66.8604	27.5.2006	H.K.
GWS005864	Mid-intertidal on rock	Lepreau exposed biodiversity site, Bay of Fundy, NB	CAN	45.0722, -66.4690	11.1.2007	H.K.
GWS006271	High mid-intertidal on rock	Richebucto Cape Breakwater, NB	CAN	46.6754, -64.7109	28.8.2007	K.R.
GWS007252	High mid-intertidal pool on rock	Green Point, Bonne Bay, NL	CAN	49.682, -57.9628	15.7.2006	L.L.G. & H.K.
GWS007253	High mid-intertidal pool on *Enteromorpha* sp.	Green Point, Bonne Bay, NL	CAN	49.682, -57.9628	15.7.2006	L.L.G. & H.K.
GWS007677	Mid-intertidal on rock wall	St. Brides, NL	CAN	46.9207, -54.1738	25.7.2006	L.L.G., H.K., D.M. & J.U.

GWS007925	High intertidal pool on rock	Meteghan (front of 'Auberge du Capitaire), NS	CAN	44.2208, -66.1411	12.8.2006	L.L.G. & J.U.
GWS007963	Intertidal on rock	Cap des Caissie, North of Shediac, NB	CAN	46.3266, -64.5157	17.8.2006	L.L.G., H.K. & J.U.
GWS008005	Intertidal on alga	Pointe Sapin, Northumberland Strait, NB	CAN	46.9600, -64.8300	17.8.2006	L.L.G., H.K. & J.U.
GWS008018	Intertidal on *Chordaria* sp.	Pointe Sapin, Northumberland Strait, NB	CAN	46.9600, -64.8300	17.8.2006	L.L.G., H.K. & J.U.
GWS008022	Intertidal on *Nemalion* sp.	Escuminac wharf, Northumberland Strait, NB	CAN	47.0826, -64.8872	17.8.2006	L.L.G., H.K. & J.U.
GWS018027	Subtidal (17ft) on red alga	Fort Wetherill, RI	USA	41.4791, -71.3607	16.4.2010	B.C., D.M., M.B., A.S., C.L.
GWS018061	Subtidal (2.5 m) on rock	Fort Wetherill, RI	USA	41.4791, -71.3607	16.4.2010	B.C., D.M., M.B., A.S., C.L.
GWS030396	Low intertidal on rock	Raspberry Cove, Gwaii Haanas, BC	CAN	52.1666, -131.0837	6.6.2012	G.W.S. & K.D.
GWS030407	Low intertidal on *Alaria* sp. stipe	Raspberry Cove, Gwaii Haanas, BC	CAN	52.1666, -131.0837	6.6.2012	G.W.S. & K.D.

	GWS036906	High intertidal on rock, sheltered	Wallace Cove Lighthouse, NB	CAN	45.0386, -66.8077	6.11.2014	K.L.M. & A.S.
	PHYC2014-27	Mid-intertidal pool on *Ascophyllum* sp., semi-exposed	Wallace Cove Lighthouse, NB	CAN	45.0386, -66.8077	8.10.2014	L.M.B., A.H., H.M., K.L. & M.M.
	ULV08	Mid-intertidal pool on rock, exposed	Wallace Cove Lighthouse, NB	CAN	45.0386, -66.8077	10.9.2013	S.S.
Ulva lobata (Kützing) Harvey	GWS019909	Low intertidal on invertebrate, semi-exposed	Bamfield, Brady's Beach, BC	CAN	48.8241, -125.1593	12.6.2010	G.W.S. & K.D.
	GWS002779	Low intertidal on rock	Jade Cove, BC	CAN	35.9134, -121.4698	6.6.2005	G.W.S. & S.C.
	GWS008542	Low intertidal on rock	Lands End up the left side of Pachena Bay where it opens to the ocean, Bamfield, BC	CAN	48.7715, -125.1578	14.6.2007	G.W.S., B.C., D.M. & K.R.
	GWS004083	Low intertidal on rock, semi-exposed	Saw Reef, Gwaii Haanas, BC	CAN	52.4501, -131.2915	16.6.2006	G.W.S., B.C. & D.M.

GWS006798	Low intertidal on *Egregia sp.*, exposed	Bamfield, Scotts Bay, BC	CAN	48.8346, -125.1463	31.5.2007	D.M., B.C., K.R. & H.K.
GWS008200	Low mid-intertidal on rock	Hamdeok Beach, BC	CAN	33.5462, 126.6627	3.6.2007	H.K.
GWS019918	Low mid-intertidal on rock, semi-exposed	Ridley Island (south of coal terminal), Prince Rupert, BC	CAN	54.2212, -130.3293	12.6.2010	G.W.S. & K.D.
GWS005839	Low mid-intertidal on rock	Bamfield, Blowhole at Brady's Beach, BC	CAN	48.824, -125.1621	29.12.2006	H.K. & D.R.
GWS035989	Mid-intertidal on barnacle	Lord Howe Island, Signal Point, near supply-boat dock, BC	CAN	-31.5275, 159.0569	21.8.2013	G.W.S. & K.D.
GWS008196	Mid-intertidal on *Fucus* sp.	Bamfield, Seppings I., BC	CAN	48.8391, -125.2075	3.6.2007	H.K.
GWS003250	Mid-intertidal on rock	Petite Île au Marteau, BC	CAN	50.2019, -63.5578	17.9.2005	G.W.S.
GWS006672	Mid-intertidal on rock	Petite Île au Marteau, BC	CAN	50.2019, -63.5578	30.5.2007	B.C., D.M., K.R. & S.H.
GWS020136	Mid-intertidal on rock, exposed	Petite Île au Marteau, BC	CAN	50.2019, -63.5578	13.6.2010	G.W.S. & K.D.

GWS019925	Mid-intertidal on rock, semi-exposed	Whiffen Spit, Sooke Harbour, Vancouver Island, BC	CAN	48.3521, -123.7281	12.6.2010	G.W.S. & K.D.
GWS020151	Mid-intertidal on rock, semi-exposed	Far Rocks, Signal Point, Lord Howe, BC	CAN	-31.5248, 159.0601	13.6.2010	G.W.S. & K.D.
GWS008194	Mid-intertidal on *Prionitis* sp.	Far Rocks, Signal Point, Lord Howe, BC	CAN	-31.5248, 159.0601	3.6.2007	H.K.
GWS002820	Low intertidal pool on *Corallina* sp.	Algae Hole North, Lord Howe, BC	CAN	-31.5619, 159.0658	6.6.2005	G.W.S. & S.C.
GWS003926	Upper low intertidal on rock	North Head Gutters, Lord Howe, BC	CAN	-31.5244, 159.042	13.6.2006	G.W.S., B.C. & D.M.
GWS004094	Mid-intertidal on rock	Blackwall Reach, Swan River, BC	CAN	-32.021, 115.7832	16.6.2006	G.W.S., B.C. & D.M.
GWS028608	Subtidal (10 m) on rock	Pt. Peron, BC	CAN	-32.271, 115.6817	11.7.2011	G.W.S. & K.D.
GWS006695	Subtidal (11 m) on rock	Fort Wetherill, BC	CAN	41.4791, -71.3607	31.5.2007	B.C. & D.M.
GWS012670	Subtidal (13 m) on rock	Cozy Corner (Knobby Pt.), BC	CAN	-34.256, 115.0278	17.6.2009	G.W.S. & D.M.
GWS009007	Subtidal (2 m) on *Mastocarpus* sp.	Otter Point, near Sooke, Vancouver Island, BC	CAN	48.3625, -123.8048	22.9.2007	G.W.S. & B.C.

	GWS009013	Subtidal (6 m) on red alga	Mutton Bird I., BC	CAN	-35.0475, 117.6939	22.9.2007	G.W.S. & B.C.
	GWS008430	Subtidal (6 m) on rock	Roach Wall, Lord Howe, BC	CAN	-31.4982, 159.0656	12.6.2007	G.W.S., B.C. & K.R.
	GWS006573	Subtidal (8 m) on rock	Martin Rd., Beaver I., near Sechelt, Sunshine Coast, BC	CAN	49.6222, -124.0611	30.5.2007	B.C., D.M., K.R. & S.H.
	GWS006575	Subtidal (8 m) on rock	English Harbour Eastern Cove, BC	CAN	47.6331, -54.87	30.5.2007	B.C., D.M., K.R. & S.H.
	GWS008398	Subtidal (8 m) on rock	English Harbour Eastern Cove, BC	CAN	47.6331, -54.87	12.6.2007	D.M. & S.H.
	GWS003445	High intertidal pool on rock	Pigeon Point Lighthouse, BC	CAN	37.1832, -122.3887	12.6.2006	G.W.S., B.C. & D.M.
	GWS006806	High mid-intertidal on shell	Jade Cove, BC	CAN	35.9134, -121.4698	31.5.2007	D.M., B.C., K.R. & H.K.
	GWS022121	Drift	Cuan, Ventry, CA	USA	No data	20.5.2010	B.C., K.H. & S.T.
	GWS022158	Drift	Manyana, CA	USA	-35.2654, 150.5139	20.5.2010	B.C., K.H. & S.T.
	GWS022182	Drift	Narrawallee, CA	USA	-35.3152, 150.4718	20.5.2010	B.C., K.H. & S.T.

	GWS021456	Mid-intertidal on *Neogastro-clonium subarticulatum*	Narrawallee, CA	USA	-35.3152, 150.4718	16.5.10	B.C. & K.H.
	GWS021458	Mid-intertidal pool on red alga	Coledale, CA	USA	-34.2899, 150.9492	16.5.10	B.C. & K.H.
	GWS021975	Low intertidal on boulder in sand	Port Lincoln, CA	USA	-34.72, 135.86	19.5.2010	B.C., K.H. & S.T.
	GWS021491	Low intertidal on *Egregia* sp.	Port Lincoln, CA	USA	-34.72, 135.86	16.5.10	B.C. & K.H.
	GWS021308	Low intertidal on rock	Port Lincoln, CA	USA	-34.72, 135.86	15.5.10	B.C. & K.H.
	GWS021490	Low intertidal on rock	St. Kilda, CA	USA	-37.8646, 144.9695	16.5.10	B.C. & K.H.
	GWS021471	Low intertidal on rock wall	St. Kilda, CA	USA	-37.8646, 144.9695	16.5.10	B.C. & K.H.
	GWS021555	Mid-intertidal on rock	Narooma, CA	USA	-36.2114, 150.134	16.5.10	B.C. & K.H.
	GWS021457	Mid-intertidal pool on rock	Dolphin Point, CA	USA	-35.3965, 150.449	16.5.10	B.C. & K.H.
	GWS021629	Low mid-intertidal pool on *Laminaria* stipe	Manyana, CA	USA	-35.2654, 150.5139	17.5.2010	B.C., K.H. & S.T.

	GWS021631	Low mid-intertidal pool on *Laminaria* stipe	Manyana, CA	USA	-35.2654, 150.5139	17.5.2010	B.C., K.H. & S.T.
	GWS021651	Low mid-intertidal on rock	Manyana, CA	USA	-35.2654, 150.5139	17.5.2010	B.C., K.H. & S.T.
	GWS039582	In aquaculture tanks	Pachena Beach, Bamfield, WA	USA	48.7862, -125.1191	02.06.2014	J.C.
	GWS040565	In aquaculture tanks	Clarence Point, WA	USA	-41.1162, 146.8091	01.08.2013	J.C.
	GWS040569	In aquaculture tanks	Lake Conjola, WA	USA	-35.2696, 150.5009	01.10.2013	J.C.
	GWS040577	In aquaculture tanks	Narrawallee, WA	USA	-35.3152, 150.4718	15.07.2015	J.C.
	GWS040578	In aquaculture tanks	Narrawallee, WA	USA	-35.3152, 150.4718	15.07.2015	J.C.
Ulva ohnoi M.Hiraoka & S.Shimada	GWS017343	Subtidal (0.3-0.4 m) on reef flat	Lord Howe Island, Neds Beach, southern reef flat, New South Wales	AUS	-31.517, 159.069	12.10.2009	R.K. & G.T.K.
	GWS023201	Subtidal (11 m) on rock	New South Wales	AUS	No data	23.11.2010	G.W.S., K.D. & R.W.
	GWS023576	Subtidal (11 m) on rock	New South Wales	AUS	No data	24.11.2010	G.W.S., K.D. & R.W.

	GWS023193	Subtidal (15 m) on rock	New South Wales	AUS	No data	23.11.2010	G.W.S., K.D. & R.W.
	LAK11	No data	Pardoe Beach, Devonport, New South Wales	AUS	-41.1704, 146.3756	No data	No data
	LAK33	No data	Seal Cove, Prince Rupert, New South Wales	AUS	54.3325, -130.2834	No data	No data
	LAK52	No data	Bamfield, Scotts Bay, New South Wales	AUS	48.8346, -125.1463	No data	No data
	GWS024861	Subtidal (3 m) on rock	Western Australia	AUS	No data	9.11.2010	G.W.S. & K.D.
	GWS025010	Subtidal (3 m) on rock	Western Australia	AUS	No data	10.11.2010	G.W.S. & K.D.
Ulva prolifera O.F. Müller	ENT17	Low intertidal on mussel shell	St. Andrews (Blockhouse), Bay of Fundy, NB	CAN	45.0757, -67.0638	11.9.2013	C.H.
	GWS003591	High mid-intertidal pool on rock	Cape Neddick, southern ME	USA	43.1658, -70.5924	24.4.2006	G.W.S.
	GWS003715	High intertidal on cobble (?) forming mats	"Cottonii" Creek, near Letete, NB	CAN	45.0544, -66.8919	26.5.2006	H.K.

GWS003716	High intertidal on cobble (?) forming mats	"Cottonii" Creek, near Letete, NB	CAN	45.0544, -66.8919	26.5.2006	H.K.
GWS003764	Mid-intertidal pool on rock	Harrington Cove exposed biodiversity site, Grand Manan, NB	CAN	44.6249, -66.8604	27.5.2006	H.K.
GWS003841	Mid-intertidal on rock	Lepreau exposed biodiversity site, Bay of Fundy, NB	CAN	45.0722, -66.4690	29.5.2006	H.K.
GWS003858	High intertidal on rock	Lepreau exposed biodiversity site, Bay of Fundy, NB	CAN	45.0722, -66.4690	29.5.2006	H.K.
GWS005321	Low High intertidal on rock	Gordon Point, Churchill Northern Studies Centre, MB	CAN	58.7958, -93.7542	21.8.2006	G.W.S., B.C. & D.M.
GWS005322	High intertidal fringe carpet in brackish basin	Gordon Point, Churchill Northern Studies Centre, MB	CAN	58.7958, -93.7542	21.8.2006	G.W.S., B.C. & D.M.
GWS005446	Mid-intertidal pool on pebble	East shore Churchill River, S of SeaNorth, MB	CAN	58.7683, -94.1819	9.7.2007	G.W.S., D.M. & J.D.W
GWS005447	High intertidal pool on pebble	East shore Churchill River, S of SeaNorth, MB	CAN	58.7683, -94.1819	9.7.2007	G.W.S., D.M. & J.D.W

GWS005572	High intertidal on cobble	Gravel Pit E of Churchill, MB	CAN	58.7679, -94.0721	12.7.2007	G.W.S., B.C., D.M. & K.R.
GWS006124	High intertidal pool on rock	Escoumins (cross point in town), QC	CAN	48.350006, -69.3972	13.5.2007	G.W.S., D.M. & H.K.
GWS006135	High intertidal pool on rock	Escoumins (old ferry terminal), QC	CAN	48.3454, -69.3902	14.5.2007	G.W.S., D.M. & H.K.
GWS007057	Intertidal	St. Paul, Bonne Bay, NL	CAN	49.8656, 59.2911	11.7.2006	L.L.G., H.K. & J.U.
GWS007256	High intertidal pool on rock in bird waste	Green Point, Bonne Bay, NL	CAN	49.6820, -57.9628	15.7.2006	L.L.G. & H.K.
GWS007879	High intertidal pool on rock	Cape St. Marys, NS	CAN	44.0871, -66.2034	12.8.2006	L.L.G. & J.U.
GWS014107	High intertidal on mud	Castalia salt marsh (outer coast), Grand Manan, NB	CAN	44.7228, -66.7485	15.9.2010	G.W.S., K.D. & K.H.
GWS034068	High intertidal on rock	St. Andrews (Blockhouse), Bay of Fundy, NB	CAN	45.0757, -67.0638	7.10.2013	G.W.S., C.J. & A.S.
GWS036916	High intertidal pool, exposed	Lepreau exposed biodiversity site, Bay of Fundy, NB	CAN	47.0722, -66.46900	7.5.2015	K.L.M. & G.W.S.
GWS038851	Low intertidal on concrete	Endicott island, AK	USA	70.3562, -147.9604	26.7.2015	T.B.

	GWS039308	High intertidal pool on rock	Duck Islands, Torngat, Labrador, NL	CAN	60.2339, -64.3414	7.9.2014	T.B.
	GWS039309	Mid-intertidal pool on rock	Duck Islands, Torngat, Labrador, NL	CAN	60.2339, -64.3414	7.9.2014	T.B.
	GWS039503	Subtidal (0.5 m) on sandbag	Endicott Boat Launch, Prudhoe Bay, AK	USA	70.3563, -147.9604	21.8.2014	M.B.
	GWS040547	Subtidal	Petite Île au Marteau, QC	CAN	50.2019, -63.5578	18.10.2014	Ka.M.
	PHYC2014-36	Drift, sheltered	Wallace Cove Lighthouse, NB	CAN	45.0386, -66.8077	8.10.2014	L.M.B., A.H., H.M., K.L. & M.M.
Ulva sp._1GH	GWS020945	Drift caught on anchor	Gordon Islands (across from access beach), Gwaii Haanas, BC	CAN	52.0963, -131.1462	7.6.2010	G.W.S. & K.D.
	GWS021190	Low intertidal on cobble, sheltered	Emu Beach Holiday Park, BC	CAN	-35.0012, 117.9405	11.6.2010	G.W.S. & K.D.
	GWS021540	Mid-intertidal on rock	Narooma, CA	USA	-36.2114, 150.134	16.5.10	B.C. & K.H.
	GWS021821	Mid-intertidal on rock	Mystery Bay, CA	USA	-36.3021, 150.1341	18.5.2010	B.C., K.H.

	GWS021570	High intertidal pool on rock	Dolphin Point, CA	USA	-35.3965, 150.449	16.5.10	B.C. & K.H.
Ulva sp._1GWS	GWS004319	On cobble in freshwater runoff	North Head Gutters, Lord Howe, BC	CAN	-31.5244, 159.042	24.6.2006	G.W.S., B.C. & D.M.
Ulva sp._1laetevirens	GWS014646	Drift	Lands End up the left side of Pachena Bay where it opens to the ocean, Bamfield, Kerry	IRE	48.7715, -125.1578	12.8.2010	M.D.G.
	GWS014619	No data	Sea Lion Point North (frontside), Point Lobos State Reserve, Kerry	IRE	36.5192, -121.953	11.8.2010	M.D.G.
Ulva sp._1Pacificlinza	GWS030475	Low intertidal on cobble in sand	Backeddy Resort, BC	CAN	49.7585, -123.9381	6.6.2012	G.W.S. & K.D.
	GWS031393	Low intertidal on pebble	Tahsis, Island #40 on Esperenza Inlet Chart, BC	CAN	49.8125, -126.9873	4.6.2012	G.W.S. & K.D.
	GWS008128	Mid-intertidal on rock	Petite Île au Marteau, BC	CAN	50.2019, -63.5578	2.6.2007	B.C., D.M., K.R. & H.K.
	GWS003447	Mid-intertidal pool on rock	East side of Powrivco Bay, Gwaii Haanas, BC	CAN	52.6876, -131.5523	12.6.2006	G.W.S., B.C. & D.M.

GWS031001	Subtidal (10 m) on cobble	Pt. Peron, BC	CAN	-32.271, 115.6817	14.6.2012	G.W.S. & K.D.
GWS004181	Subtidal (3 m) on rock	Otter Point, near Sooke, Vancouver Island, BC	CAN	48.3625, -123.8048	20.6.2006	G.W.S., B.C. & D.M.
GWS006376	Subtidal (3 m) on rock	The Springs, Point Lonsdale, BC	CAN	-38.276, 144.6203	25.5.2007	D.M., B.C., K.R. & S.H.
GWS006377	Subtidal (3 m) on rock	Bamfield, Scotts Bay, BC	CAN	48.8346, -125.1463	25.5.2007	D.M., B.C., K.R. & S.H.
GWS006378	Subtidal (3 m) on rock	Newbury Cove, Gwaii Haanas, BC	CAN	52.4653, -131.4386	25.5.2007	D.M., B.C., K.R. & S.H.
GWS030918	Subtidal (4 m) on cobble	Tinderbox (Fiona's Point), BC	CAN	-43.0585, 147.3332	13.6.2012	G.W.S. & K.D.
GWS008140	High intertidal on rock	Tahsis Nuchatliz Island, (#37 on Esperenza Inlet Chart), BC	CAN	49.8101, -126.9823	2.6.2007	B.C., D.M., K.R. & H.K.
GWS022308	Subtidal (2 m) on articulated coralline in sand, semi-exposed	Gerringong, CA	USA	-34.7439, 150.8352	22.5.2010	B.C., K.H. & S.T.
GWS022315	Subtidal (2 m) on rock in sand, semi-exposed	Gerringong, CA	USA	-34.7439, 150.8352	22.5.2010	B.C., K.H. & S.T.

	GWS022317	Subtidal (2 m) on rock in sand, semi-exposed	Clarence Point, CA	USA	-41.1162, 146.8091	22.5.2010	B.C., K.H. & S.T.
	GWS022161	Subtidal (5 m) on rock	North Brighton, CA	USA	-37.9088, 144.9849	20.5.2010	B.C., K.H. & S.T.
Ulva sp._2GWS	GWS021216	Mid-intertidal on rock	Dolphin Point, CA	USA	-35.3965, 150.449	14.5.10	B.C. & K.H.
Ulva sp._2prolifera	GWS019864	High intertidal pool on rock, exposed	Otter Point, near Sooke, Vancouver Island, BC	CAN	48.3625, -123.8048	11.6.2010	G.W.S. & K.D.
Ulva sp._5GWS	GWS005835	Low mid-intertidal on *Neorhodomela* sp.	Pachena Beach, Bamfield, BC	CAN	48.7862, -125.1191	29.12.2006	H.K. & D.R.
	GWS005840	Low mid-intertidal on red alga	Sea Lion Point North (backside), Point Lobos State Reserve, BC	CAN	36.5192, -121.953	29.12.2006	H.K. & D.R.
	GWS005838	Low mid-intertidal on rock	Bamfield, Aguilar Point, BC	CAN	48.8371, -125.1436	29.12.2006	H.K. & D.R.
	GWS021994	Mid-intertidal on boulder in sand	St. Kilda, CA	USA	-37.8646, 144.9695	19.5.2010	B.C., K.H. & S.T.

Ulva sp._8GWS	GWS004320	Forming tangled mat on mud	Windmill Point, George Town, BC	CAN	-41.1097, 146.817	24.6.2006	G.W.S., B.C. & D.M.
Ulva sp._10GWS	GWS007502	Subtidal (12 m) on rock	Cape Leeuwin Lighthouse, NL	CAN	-34.3717, 115.1363	20.7.2006	L.L.G., D.M. & J.U.
	GWS015963	Drift	Tasmania	AUS	No data	24.1.2010	G.W.S. & K.D.
	GWS015984	Drift	Tasmania	AUS	No data	24.1.2010	G.W.S. & K.D.
Ulva sp._11GWS	GWS007551	Subtidal (7 m) on rock	Stillwater Cove, Pebble Beach, NL	CAN	36.5667, -121.9429	20.7.2006	L.L.G., D.M. & J.U.
	GWS007571	Subtidal (7 m) on rock	Gilbert Island, Broken Group, NL	CAN	48.8785, -125.3271	20.7.2006	L.L.G., D.M. & J.U.
Ulva stenophylla Setchell & N.L.Gardner	GWS008543	Low intertidal on rock	Montara, BC	CAN	37.5461, -122.5146	14.6.2007	G.W.S., B.C., D.M. & K.R.
	GWS008264	Mid-intertidal in sand	Soberanes Point, BC	CAN	36.4479, -121.9288	4.6.2007	D.M., B.C., K.R. & H.K.
	GWS004599	Mid-intertidal on cobble in freshwater runoff	Btw Butze Rapids & Grassy Bay, Prince Rupert, BC	CAN	54.2981, -130.2497	28.6.2006	G.W.S., B.C. & D.M.
	GWS006668	Mid-intertidal pool on rock	Nine Pin Point, BC	CAN	-43.2865, 147.1643	30.5.2007	B.C., D.M., K.R. & S.H.
	GWS008261	Mid-intertidal pool on rock	Tanu, Tanu Island, Gwaii Haanas, BC	CAN	52.7646, -131.6107	4.6.2007	D.M., B.C., K.R. & H.K.

GWS003927	Mid-intertidal pool on rock	Algae Hole North, Lord Howe, BC	CAN	-31.5619, 159.0658	13.6.2006	G.W.S., B.C. & D.M.
GWS003290	Mid-intertidal on seagrass, sheltered	Monterey Bay (Shale Bed), BC	CAN	36.6094, -121.8786	19.9.2005	G.W.S.
GWS008165	Subtidal (4 m) on rock	Tinderbox (Fiona's Point), BC	CAN	-43.0585, 147.3332	3.6.2007	D.M., B.C., K.R. & S.H.
GWS039579	In aquaculture tanks	Tahsis, Friendly Cove, WA	USA	49.5933, -126.6165	30.08.2013	J.C.
GWS039580	In aquaculture tanks	Seongsan, WA	USA	33.4625, 126.9384	02.12.2013	J.C.
GWS039581	In aquaculture tanks	Willow Pt., Campbell River, WA	USA	49.9662, -125.2081	28.02.2014	J.C.
GWS040566	In aquaculture tanks	Bombo, WA	USA	-34.6518, 150.8627	01.08.2013	J.C.
GWS040568	In aquaculture tanks	Thirroul, WA	USA	-34.3298, 150.9288	01.30.2013	J.C.
GWS040570	In aquaculture tanks	Lake Conjola, WA	USA	-35.2696, 150.5009	01.10.2013	J.C.
GWS040571	In aquaculture tanks	Lake Conjola, WA	USA	-35.2696, 150.5009	01.11.2013	J.C.
GWS040572	In aquaculture tanks	Lake Conjola, WA	USA	-35.2696, 150.5009	01.11.2013	J.C.
GWS040573	In aquaculture tanks	Port Lincoln, WA	USA	-34.72, 135.86	31.01.2014	J.C.

	GWS040574	In aquaculture tanks	Port Lincoln, WA	USA	-34.72, 135.86	31.01.2014	J.C.
	GWS040575	In aquaculture tanks	Port Lincoln, WA	USA	-34.72, 135.86	30.04.2014	J.C.
	GWS040576	In aquaculture tanks	Port Lincoln, WA	USA	-34.72, 135.86	30.04.2014	J.C.
	GWS017361	Low intertidal on reef flat	Kangaroo Island, Pennington Bay, South Australia	AUS	-35.8525, 137.747	20.10.2009	G.T.K., R.K., M.D.G. & W.G.
Ulva tanneri H.S.Hayden & J.R.Waaland	GWS021582	High intertidal on rock	Bendalong, CA	USA	-35.2431, 150.5415	16.5.10	B.C. & K.H.
Ulva taylorii nom. prov.	GWS003289	Mid-intertidal pool on rock	Bamfield, Seppings I., BC	CAN	48.8391, -125.2075	19.9.2005	G.W.S.
	GWS003694	Low intertidal on rock	Letete exposed biodiversity site, Bay of Fundy, NB	CAN	45.0382, -66.8912	26.5.2006	H.K.
	GWS003765	Mid-intertidal pool on rock	Harrington Cove exposed biodiversity site, Grand Manan, NB	CAN	44.6249, -66.8604	27.5.2006	H.K.
	GWS005066	Low intertidal on *Nereocystis* sp.	Ridley Island (south of coal terminal), Prince Rupert, BC	CAN	54.2212, -130.3293	11.7.2006	G.W.S., B.C. & D.M.

GWS005177	Low intertidal on *Odonthalia* sp.	Butze Rapids, Prince Rupert, BC	CAN	54.3007, -130.2507	12.7.2006	G.W.S., B.C. & D.M.
GWS005878	Mid-intertidal on barnacle	Letete exposed biodiversity site, Bay of Fundy, NB	CAN	45.0382, -66.8912	31.1.2007	H.K.
GWS006301	High intertidal on *Fucus* sp.	Tswassen Ferry Terminal, BC	CAN	49.0111, -123.1178	24.5.2007	H.K.
GWS006388	High intertidal on rock	Whiffen Spit, Sooke Harbour, Vancouver Island, BC	CAN	48.350021, -123.7281	25.5.2007	H.K.
GWS006450	High mid-intertidal pool on red alga	Spring Bay, BC	CAN	48.4558, -123.2690	26.5.2007	H.K.
GWS006451	High intertidal pool on limpet	Spring Bay, BC	CAN	48.4558, -123.2690	26.5.2007	H.K.
GWS006532	Subtidal (3 m) on shell	Tahsis Narrows, BC	CAN	49.4453, -126.8275	29.5.2007	B.C., D.M. & S.H.
GWS006719	Subtidal (8 m) on rock	Tahsis, Islands at ocean end of McKay Passage, BC	CAN	49.6087, -126.6146	31.5.2007	B.C. & D.M.
GWS006800	High intertidal pool on rock	Tahsis, Friendly Cove, BC	CAN	49.5933, -126.6165	31.5.2007	D.M., B.C., K.R. & H.K.

GWS008129	Mid-intertidal on limpet	Lands End up the left side of Pachena Bay where it opens to the ocean, Bamfield, BC	CAN	48.7715, -125.1578	2.6.2007	B.C., D.M., K.R. & H.K.
GWS008131	Mid-intertidal on rock	Lands End up the left side of Pachena Bay where it opens to the ocean, Bamfield, BC	CAN	48.7715, -125.1578	2.6.2007	B.C., D.M., K.R. & H.K.
GWS008139	High intertidal pool on rock	Lands End up the left side of Pachena Bay where it opens to the ocean, Bamfield, BC	CAN	48.7715, -125.1578	2.6.2007	B.C., D.M., K.R. & H.K.
GWS008142	Mid-intertidal on rock	Lands End up the left side of Pachena Bay where it opens to the ocean, Bamfield, BC	CAN	48.7715, -125.1578	2.6.2007	B.C., D.M., K.R. & H.K.
GWS008199	High mid-intertidal on rock	Bamfield, Scotts Bay, BC	CAN	48.8346, -125.1463	3.6.2007	H.K.
GWS013053	Low intertidal on cobble	Warden Station Huxley Island, Gwaii Haanas, BC	CAN	52.4332, -131.3704	21.6.2009	G.W.S. & D.M.
GWS013220	Mid-intertidal on cobble	Ramsey Island (beach on NW coast), Gwaii Haanas, BC	CAN	52.5692, -131.4030	21.6.2009	G.W.S. & D.M.

GWS013486	Mid-intertidal on *Fucus* sp.	Burnaby (Dolomite) Narrows, Gwaii Haanas, BC	CAN	52.3599, -131.3520	23.6.2009	G.W.S. & D.M.
GWS013512	Low intertidal on rock	Newberry Cove (east side of western inlet), Gwaii Haanas, BC	CAN	52.4618, -131.4471	24.6.2009	G.W.S. & D.M.
GWS013838	High intertidal on *Fucus* sp.	Lower Duck Pond, Campobello Island, NB	CAN	44.8403, -66.9353	19.8.2009	G.W.S., B.C. & D.M.
GWS013850	Subtidal (1.5 m) on *Fucus* sp. (EGWS000042)	Liberty Point, Campobello Island, NB	CAN	44.8309, -66.9277	19.8.2009	G.W.S., B.C. & D.M.
GWS019946	Mid-intertidal on rock, semi-exposed	Koga Islet, Gwaii Haanas, BC	CAN	52.4283, -131.3786	12.6.2010	G.W.S. & K.D.
GWS020140	Mid-intertidal on rock, exposed	Saw Reef, Gwaii Haanas, BC	CAN	52.4501, -131.2915	13.6.2010	G.W.S. & K.D.
GWS020595	Low intertidal on cobble, sheltered	Tanuu Island (Watchmen Station), Haida Gwaii, BC	CAN	52.7625, -131.6121	16.6.2010	G.W.S. & K.D.
GWS020633	Low intertidal on rock, semi-exposed	North Beach (near Naval Station), Haida Gwaii, BC	CAN	54.0327, -132.0530	17.6.2010	G.W.S. & K.D.

	GWS021924	High intertidal on boulder below mussels	Santa Cruz (Four Mile), CA	USA	36.9661, -122.1234	19.5.2010	B.C., K.H. & S.T.
	GWS022078	High mid-intertidal on rock	Santa Cruz (Four Mile), CA	USA	36.9661, -122.1234	19.5.2010	B.C., K.H. & S.T.
	GWS031399	Low intertidal on coralline alga	Gordon Islands (Lagoon), Gwaii Haanas, BC	CAN	52.0974, -131.1502	4.6.2012	G.W.S. & K.D.
	GWS035341	Low intertidal on GWS035340	Gudal Beach, Haida Gwaii, BC	CAN	53.2313, -132.5732	23.8.2013	G.W.S. & K.D.
	GWS036988	Low intertidal on *Ascophyllum* sp., sheltered	Lepreau - seagrass flats near bridge along highway, NB	CAN	45.1270, -66.4576	3.10.2015	K.L.M. & T.B.
Ulva viatoria nom. prov.	GWS006970	On large cobble	Whycocomagh Picnic Area Site #4, bras d'Or Lake, Cape Breton, NS	CAN	45.9815, -60.8113	9.7.2006	L.L.G., H.K. & J.U.
	GWS007049	Intertidal on *Fucus vesiculosus*	St. Paul, Bonne Bay, NL	CAN	49.8656, 59.2911	11.7.2006	L.L.G., H.K. & J.U.
	GWS007137	Intertidal tangled with GWS007136	Deer Arm, Bonne Bay, NL	CAN	49.5200, -57.8700	12.7.2006	B.H.

GWS007929	Intertidal on wharf	L'Anse Bleue Breakwater, Northumberland Strait, NB	CAN	47.8313, -66.0828	15.8.2006	L.L.G., H.K. & J.U.
GWS007998	Tangled in other algae	St. Thomas, Northumberland Strait, NB	CAN	46.4480, -64.6418	17.8.2006	L.L.G., H.K. & J.U.
GWS008444	Subtidal (2 m) on *Sargassum* sp.	Pier at Davis Bay Sunshine Coast, BC	CAN	49.4453, -123.7297	12.6.2007	G.W.S. & D.M.
GWS016002	Drift on shell	Hells Gates (beach to north), Tasmania	AUS	-42.2172, 145.2229	25.1.2010	G.T.K. & R.K.
GWS034067	High intertidal on rock in freshwater runoff	St. Andrews (Blockhouse), Bay of Fundy, NB	CAN	45.0757, -67.0638	7.10.2013	G.W.S., C.J. & A.S.
GWS036951	Subtidal (2 m) drift	Pointe du Chêne, Northumberland Strait, NB	CAN	46.2418, -64.5300	25.6.2015	K.L.M. & G.W.S.
GWS037971	High intertidal on culvert in freshwater run off	Culvert at head of Oak Bay, NB	CAN	45.2287, -67.1871	30.3.2016	K.L.M. & G.W.S.

[1] Collector information is abbreviated: A.C.= Alvin Chan; A.S.= Amanda Savoie; Al.B.= Allen Beck; A.B.= Andrew Blakney; A.H.= Austin Hetherington; B.C.= Bridgette Clarkston; B.H.= B. Hooper; C.L.= Caroline Longtin; C.J.= Chris Jackson; C.L.= Chris Lane; C.B.= Cody Brooks; C.H.= Courtney Hawkins; D.M.= Daniel McDevit; D.R.= D. Riddell; F.S.= F. Scott; G.M.= Gage Monteith; G.W.S.= Gary W. Saunders; G.T.K.= Gerald T. Kraft; G.F.= Gina Filloramo; G.B.= G. Belton; H.K.= Hana Kucera; H.M.= Hilary MacLean; H.G.C.= H-G. Choi; J.U.= Jose Utge; J.E.= Josh Evans; J.D.W.= J. De Waard; J.C.= J. Colt; K.H.= Katharine Hind; K.R.= Katherine Roy; Ka.M.= Katie MacGregor; K.T.= Kelsey Trottier; K.L.M.= Kirby L. Morrill; K.L.= Krista Latimer; Kr.M.= Kristin MacKenzie; K.D.= Kyatt Dixon; K.S.= K. Sjøtun; L.K.= Lesleigh Kraft; L.L.= Louise Levesque; L.L.G.= Line Le Gall; L.M.B.= L.M. Britt; M.B.= Meghann Bruce; M.M.= Melody McLean; M.D.G.= Michael D. Guiry; M.L.= M. Lang; N.C.= N. Chisti; R.C.= R. Campbell; R.K.= R. Kraft; R.W.= R. Withall; S.H.= Sarah Hamsher; S.C.= Susan Clayden; S.S.= Sydney Slipp; S.T.= S. Toews; T.M.= Tanya Moore; T.B.= Trevor Bringloe; T.T.= Tyler Trask; W.G.= W. Guiry.

[2] North American provinces and states are abbreviated: AK= Alaska; BC= British Columbia; CA= California; CT= Connecticut; MB= Manitoba; ME= Maine; MA= Massachusetts; NB= New Brunswick; NL= Newfoundland and Labrador; NS= Nova Scotia; PE= Prince Edward Island; QC= Québec; RI= Rhode Island.

[3] Countries are abbreviated: AUS= Australia; CAN= Canada; FRA= France; IRE= Ireland; NOR= Norway; USA= United States of America.

Appendix 2

Single-gene trees

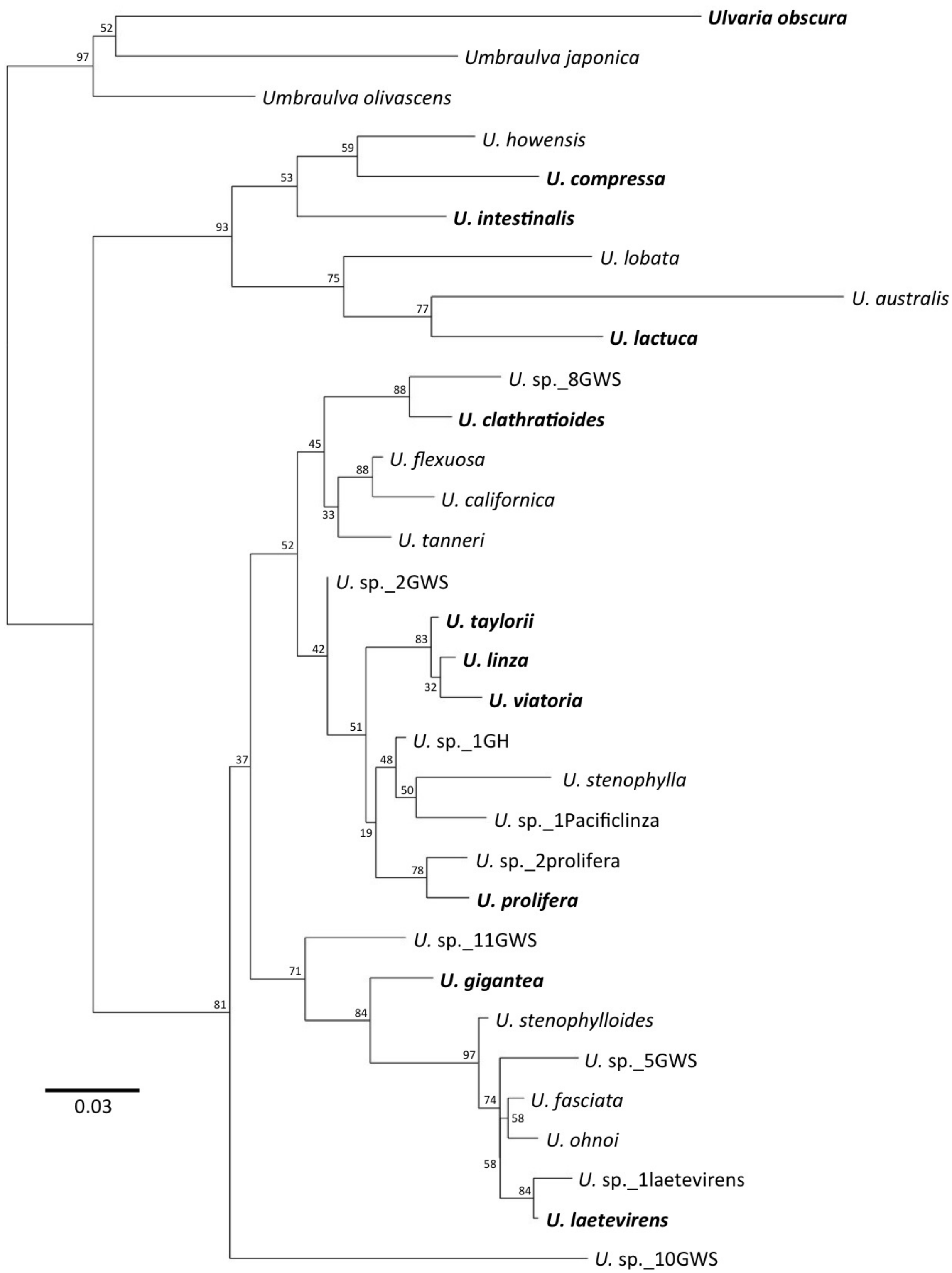


Figure A1. Maximum-likelihood tree built from a 29-*Ulva* species *tufA* alignment. Bootstrap values are indicated at each node. Species occurring in Bay of Fundy waters are indicated in bold type. Scale bar refers to substitutions per site.

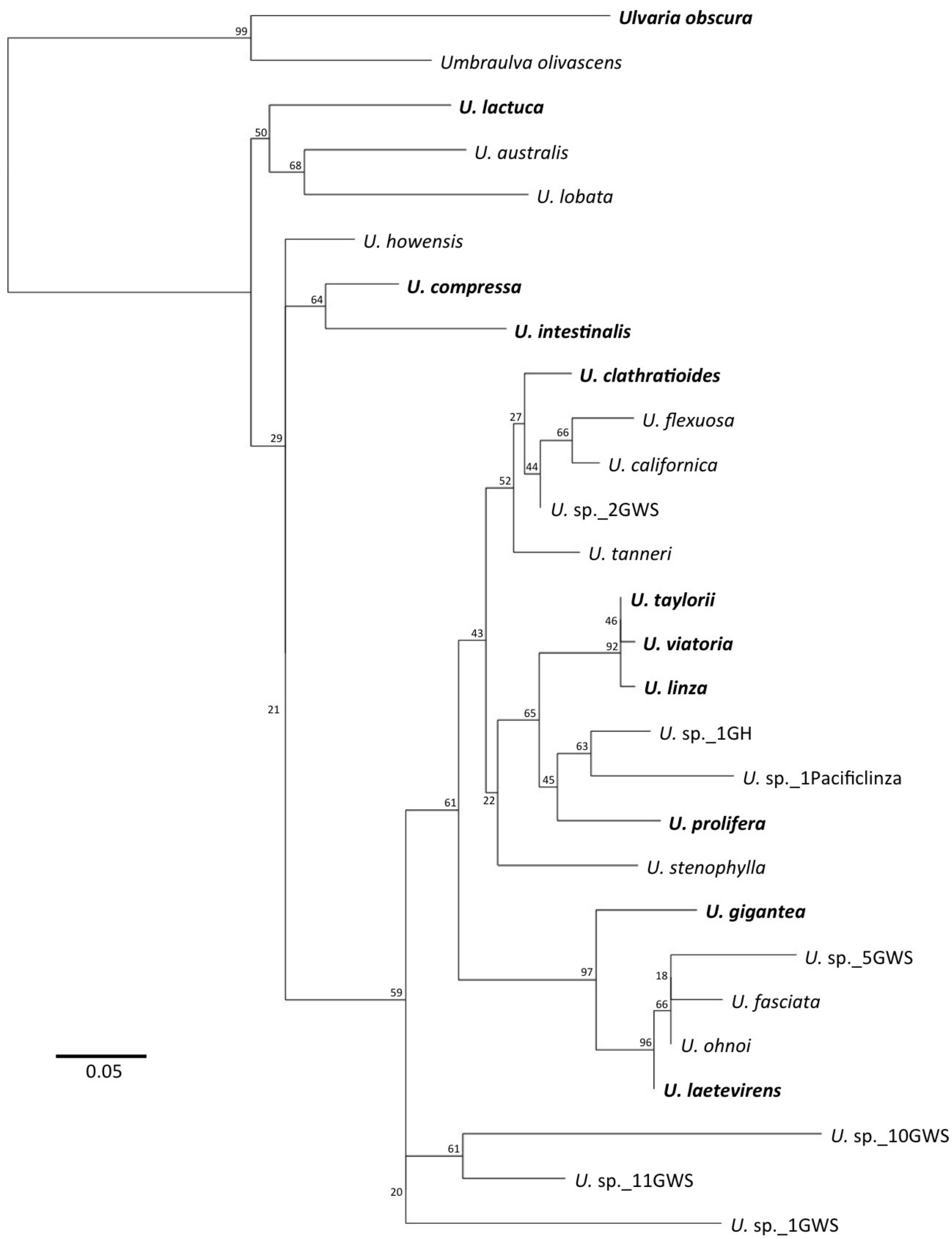

Ulvaria obscura
Umbraulva olivascens
U. lactuca
U. australis
U. lobata
U. howensis
U. compressa
U. intestinalis
U. clathratioides
U. flexuosa
U. californica
U. sp._2GWS
U. tanneri
U. taylorii
U. viatoria
U. linza
U. sp._1GH
U. sp._1Pacificlinza
U. prolifera
U. stenophylla
U. gigantea
U. sp._5GWS
U. fasciata
U. ohnoi
U. laetevirens
U. sp._10GWS
U. sp._11GWS
U. sp._1GWS
0.05
99
50
68
64
29
21
27
66
44
52
43
46
92
65
63
45
22
61
97
18
66
96
59
61
20

Figure A2. Maximum-likelihood tree built from a 27-*Ulva* species *rbc*L-3P alignment. Bootstrap values are indicated at each node. Species occurring in Bay of Fundy waters are indicated in bold type. Scale bar refers to substitutions per site.

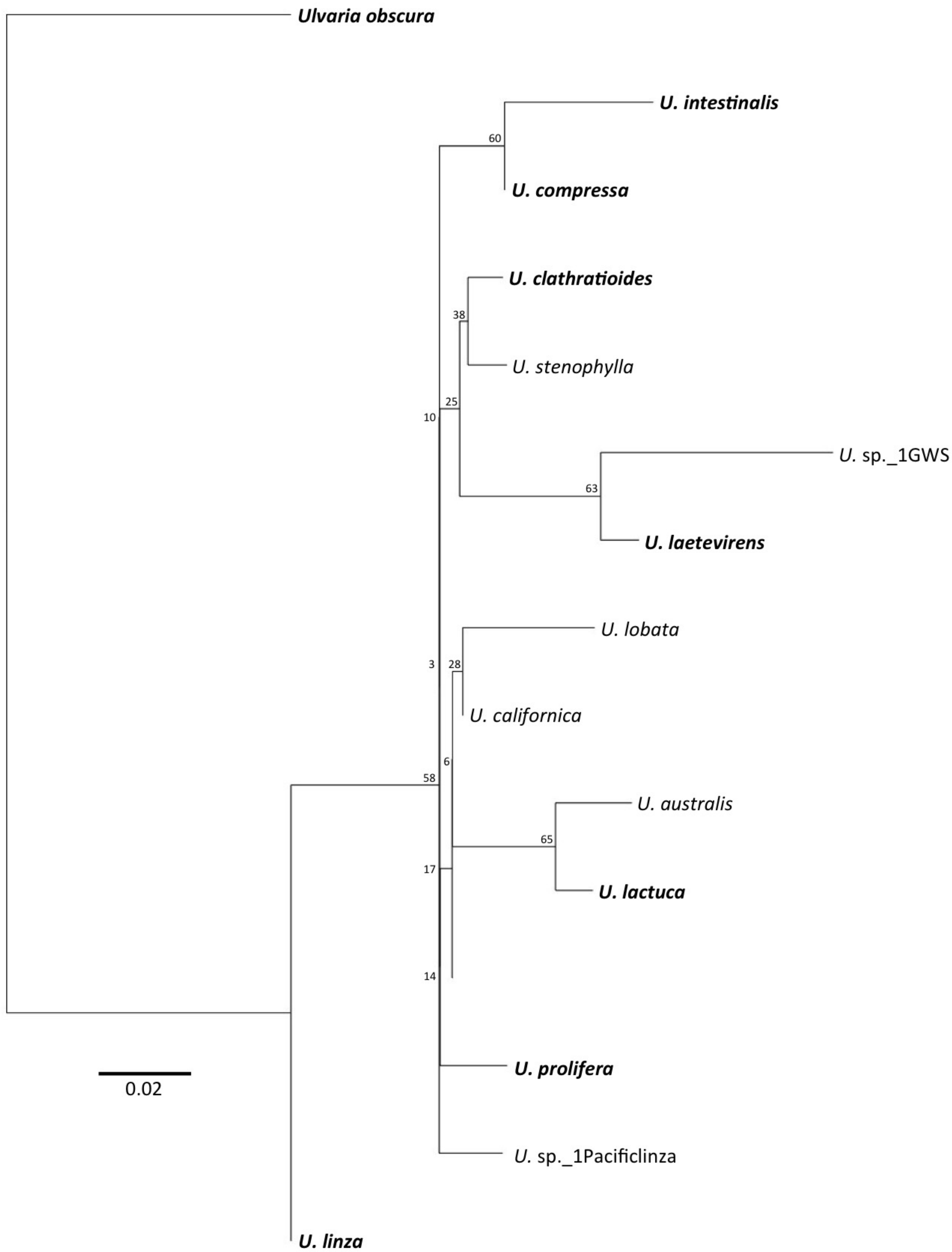

Ulvaria obscura
U. intestinalis
60
U. compressa
U. clathratioides
38
U. stenophylla
25
10
U. sp._1GWS
63
U. laetevirens
U. lobata
3
28
U. californica
6
58
U. australis
65
17
U. lactuca
14
U. prolifera
0.02
U. sp._1Pacificlinza
U. linza

Figure A3. Maximum-likelihood tree built from a 14-*Ulva* species *rbc*L-5P alignment. Bootstrap values are indicated at each node. Species occurring in Bay of Fundy waters are indicated in bold type. Scale bar refers to substitutions per site.

Curriculum Vitae

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Conference Presentations:

Morrill K. and Saunders G.W. 2017. Molecular-assisted alpha taxonomy reveals less diversity among tubular *Ulva* spp. in the Bay of Fundy (N.B., Canada) than previously reported. Northeast Algal Symposium, Mount Washington Hotel and Resort, Bretton Woods, New Hampshire. (*International*, Oral presentation.)

Morrill K. and Saunders G.W. 2016. Re-evaluating green algal biodiversity in the Bay of Fundy: a molecular and morphological assessment of broadly bladed *Ulva* spp. (Chlorophyta). Bay of Fundy Ecosystem Partnership Bay of Fundy Science Workshop, Saint Thomas University, Fredericton, New Brunswick. (*Regional*, Oral presentation.) *Best Student Oral Presentation*

Morrill K. and Saunders G.W. 2016. An evaluation of broadly bladed *Ulva* spp. (Chlorophyta) in the outer Bay of Fundy (New Brunswick, Canada). Northeast Algal Symposium, Westfield State University, Westfield, Massachusetts. (*International*, Oral presentation.)

Morrill K. and Saunders G.W. 2015. A morphological and molecular survey of Ulvales (Chlorophyta) species in the Bay of Fundy region (New Brunswick, Canada). Annual meeting of the Phycological Society of America, Drexel University, Philadelphia, Pennsylvania. (*International*, Poster presentation.)

Morrill K. and Saunders G.W. 2015. Molecular-assisted alpha taxonomy reveals less diversity among tubular *Ulva* spp. in the Bay of Fundy (N.B., Canada) than previously reported. Northeast Algal Symposium, Genesee Grande Hotel, Syracuse, New York. (*International*, Poster presentation.)