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Distribution and abundance of marine plants in the nearshore of Cape Breton in potential oil and gas exploration areas

La distribution et l'abondance de macro algue près des côtes dans région avec la possibilité de l'exploration d'huile et du gaz

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Abstract

This document integrates all readily available data on the distribution and abundance of macro-algae from potential oil and gas explorations areas on the Gulf of St Lawrence and Atlantic coasts of Cape Breton. Early phycological collections identified 126 species in a series of collections. Due to the lack of data in the western Cape Breton license area additonal ground truthing was required of air photo data that had identified a minimum of 1285 hectares of algal cover. Three depth zones were defined with distinctive dominant species were 0-4 m *Chondrus crispus* and *Cystoclonium purpureum,* 4-8 m *Fucus serratus*, over 8 m *Fucellaria lumbricalis*. The eastern coast of Cape Breton algal communities were documented in environmental studies and indirectly during sea urchin surveys. The shallow zone was dominated by *Fucus serratus* and the deeper zone by Laminarians with an understory of tufted reds.

Résumé

Ce document unifie les données facilement disponibles sur la distribution et l'abondance de macro algues dans les régions ou il y a un potential pour l'exploration d'huile et du gaz dans la région du Golfe St. Laurent et la côte Atlantique du Cap-Breton. Des collections (phycologies) avaient déjà identifiées douze espèces dans des séries de ramassage. Parce ce qu'il n'y avait pas de données dans la région licencié de l'Ouest du Cap-Breton il a fallu chercher de l'information additionnelle en examinant des photos aériennes et faire une vérification sur place qui avaient identifies au moins 1285 hectares de couches d'algues. Trois zones de profondeur furent délimitées avec les espèces qui les dominent : 0-4 m Chondrus crispus et *Cystoclonium purpureum*, 4-8 m *Fucus serratus*, plus que 8 m *Furcellaria lumbricalis* et *Phylophora spp*. Les communautés d'algues sur la côte de l'est du Cap-Breton furent traitées pendant des études environnementales et indirectement pendant des études sur les oursins de mer. La zone peu profonde était dominée par le *Fucus serratus* et la zone plus profonde était dominée par sous étage des rouge algues touffetées.

Introduction

Marine plants provide a resource base, a component of benthic habitat architecture and are significant contributors to nearshore primary production (Mann, 1972).

Several algal species in the Maritimes have been the basis for a harvesting industry since the Second World War. Harvesting was concentrated in Prince Edward Island and the southwestern shores of Nova Scotia. The closest area of exploitation to the subject area was George's Bay with some reports of periodic harvests from the Judique area. In coastal regions such as western Prince Edward Island where commercial harvesting was active the data base on distribution, diversity and abundance has been updated throughout the years (Pringle and Mathieson, 1986)

The degree of complexity of benthic habitat is greatly enhanced by algal cover. They provide a wide variety of micro and macro niches within a plant and within an algal bed, (Johnson and Scheibling, 1987) The shape, degree of branching, biomass, surface area, and degree of epiphyte cover are some the factors affecting the number, size and density of associated invertebrates, vertebrates and algal flora. Algal beds, as a whole alter ambient levels of some environmental factors including light, water movement and erosion of the substrate.

Macrophytes contribute only a small component (1 to 2 %) of primary productivity in the context of open water bodies (Prouse et al 1984). However in the nearshore environment and semi-enclosed bays or basins the portion of the total production and detrital pool of algae can be significant.

The western coast of Cape Breton as a part of the Gulf of St. Lawrence system has the unique hydrography of an inland sea distinct to the more open Atlantic coast near the Sydney Bight. However both areas are subject to ice scour and ice cover during most winters. Frequent perturbation of intertidal and shallow subtidal areas (< 0.5 m) reduces the algal population here to fast growing ephemerals rather than the substantial cover of brown algae on the Atlantic coast. The tidal amplitude of the west coast of Cape Breton is 0.8 m (mean tide) and in the Sydney area 0.9 m resulting in a narrow intertidal zone.

The work assembled here is the readily available existing knowledge on the distribution of algal species in the license areas and to a limited extent, fills in some knowledge gaps. We have used traditional knowledge, existing remote sensing information, surveys, and relevant literature including environmental monitoring projects. This information was placed as layers in a Map Info format and in tabular form. The western coast of Cape Breton had the least amount of information on algal populations and ground truthing was focused on this area.

Methods

New data was acquired from analysis of existing air photos and ground truthing of selected intertidal and subtidal stations. All relevant literature from earlier research and surveys was reviewed and key data were integrated into the analysis.

i) Analysis of airphotos

One hundred and thirty 1:10000 colour air photos from 1999 Nova Scotia Lands and Forest series were examined for their value as data on subtidal algal coverage scenes with good water penetration, low tide and lack of glitter were chosen to digitize and imported to Map Info software.

The portions of the image with indications of algal cover (dark edges with contrasting colour were considered as algal covered. When the contrast was lost (usually due to the limit of water penetration) a line was drawn to complete the area to the last boundary of contrast) the images were placed in a mosaic on a 1:35000 coastal outline. The area of each bed was calculated and compiled into 12 units in the Sydney Bight and 10 units in western Cape Breton.

ii) Ground truthing

During September and October 2001 qualitative observations of cover and species diversity were made at 56 stations in the area covered by air photo analysis by using surface viewers. Depth, bottom type, algal diveristy and cover were noted at each station. At 6 stations on the western coast of Cape Breton divers made observations of algal cover, bottom type and collected all algal biomass from 3, 0.25 m^2 quadrats. Dominant species were identified and weighed, biomass was measured in wet weight to 10 gm. Spreadsheet data tables were assigned as a layer on the MapInfo files.

iii) Existing data bases

Overlaid on this recent data were the results of environmental studies related to Point Aconi thermal power plant aquatic monitoring program and the Lingan Phalen coal waste project environmental monitoring program (N.S. Power Corporation, 1996, Drinnan and Knight, 1985). Both of these studies included data on the abundance and/or the diversity of algal species and biomass near the point of potential impact. The relevant stations from each study were plotted in Map Info and the associated data was keyed to these locations.

The monitoring program at Point Aconi was conducted from 1989 to 1995. Species diversity and total macrophyte biomass was measured along eight, 500 m transects at eight stations near the thermal effluent outfall of the power station. The stations were sampled one to two times per year.

To monitor any potential impact on lobster habitat near the site of proposed coal waste dumping at Lingan Phalen and Donkin/Morien, permanent stations were established at 27 sites at lobster burrows. Near these burrows, one quadrat was sampled completely by scraping all biota and at a second the biota was left intact as a control. The quadrats were photographed at each sampling after complete descriptions were made of the algal community. In addition, three randomly placed 0.25 m^2 quadrats scraped to sample all algae.

An extensive survey of subtidal habitat in relationship to sea urchin abundance and seaweed was conducted in the area of interest from the Sydney Bight to St. Lawrence Bay (Moore et al, 1986). This qualitative survey was initiated to determine the area of habitat occupied by sea urchins and seaweeds in 1984 and 1985. The survey was limited to a maximum depth of 15 m and observations were made by glass bottom bucket in shallow waters. In deeper water, divers made observations every 10 m on transects starting at +0.5 m. This survey included observations of substrate type, percent plant cover, principal algal types including *Fucus spp., Chondrus crispus, Laminaria longicruris, Laminaria digitata, Sacchoriza dermatodea, Alaria esculenta* and *Agarum cribosum*. Sea urchin density was also estimated within 4 ranges from 1 to 1000 per square meter.

iv) Traditional knowledge

The Coastal Resources Mapping project (1996) included traditional knowledge of algal beds in the Sydney Bight area. Lobster fishers observe seaweeds caught in lines or around traps and most cases this would be *Laminaria* spp. In shallow water, other species can be distinguished but are unlikely to be identified. This information was transferred to the Map Info database and the total area of "kelp" was calculated for each shoreline section. Kelp is traditionally used to refer to bladed Laminaria species, however in this context it must be considered as all seaweed found below the low tide mark. This may include Laminaria, but can be predominately other species. The term "Rockweed" refers to fucoid species that were very widespread and abundant in direct observations.

The 10 m line was designated as the most important depth contour in relation to seaweed distribution. Given solid substrate within this depth limit we expect macroalgal cover (Moore et al, 1986). The exception would be in areas of abundant sea urchin populations, which results in over-grazing of macrophytes. The area of bottom in the 0 – 10 m depth contours was calculated for each Map Info sector.

v) Historical database:

Algal collections from the Gulf of St. Lawrence date back to the earliest biological surveys of the area and the Atlantic Coast of Nova Scotia the 1800's. Since 1960 there have been several extensive collection efforts in areas near the area of interest. The general descriptions were compared to more recent observations from the target areas from: Caddy et al, 1977, Edelstein and McLachlan, 1977, Bird et al, 1983 Novaczek and McLachlan, 1989).

Results

Sydney Bight:

i) Air photo analysis & traditional knowledge

This coastline (Figure A-1, A-2) was divided into 12 units (Figures A3 to A 14). Of the 20000 hectares of shallow (<10 m) bottom in the study area, 9.2 % of the area was identified as algal covered from the analysis of 1999 air photos (Table1). In some sectors this proportion rose to 24% of the bottom. Traditional knowledge identified most of the shallow water zone as algal covered (72 %).

Table 1: Area of algal beds in the Sydney Bight area

Sector (Appendix figure)	Air Photo analysis Algal cover, hectares	Area of bottom less than 10 m, hectares
A-3	241	1020
A-4	175	1633
A-5	436	3862
A-6	47	2763
A-7	141	2076
A-8	309	3329
Total hectares	**1349**	**14683**

ii) Ground truthing 2001

Five sites (57 to 61) in the New Waterford area were within the area identified as algal cover by air photo analysis (Figure A-11). The dominant species were *Fucus serratus, Chondrus crispus,* and *Chorda filum*. All of these stations were in depths less than 3m. This site was sampled for macrophytes during the Lingan Phalen habitat study. Their description for Site 16 included *C. crispsus, Furcellaria lumbricalis* and *Phyllophora spp. as dominants. Fucus serratus* and *Palmaria palmata* were noted as abundant in the area. Similarly at the stations in less than 5 m in the area north of Sydney Harbour (45-56) *Fucus serratus* dominated followed by *C. filum* and *Desmarestia spp.* (Figure A-10). *Laminaria longicruris* was present but only as widely dispersed small fronds (<1m).

iii) Monitoring studies and surveys (1985-1995)

Point Aconi

In a typical year, *Fucus serratus* and *Chondrus crispus* were the dominant algae in dense beds on the outfall transects (Figure A-9). Deeper water transects completed at the intake pipe described a sparse Laminaria population. The effects of ice scour on shallow water and grazing by sea urchins in deeper water introduced annual variability.

Over the five years of the benthic monitoring program it was noted that the total biomass of macrophytes was highly variable between years and between replicates (Figure A-9).

The biomass diversity index increased over the five years of the study with 20 to 29 species being identified. The transects did have very significant difference in total algal biomass particularly at the more distant and deeper stations (Figure 1).

Lingan Phalen

These stations represented mostly "deep" water for marine plants starting at 6 m and ending at 15 m. It is the only survey that includes a comprehensive species list defined by station (Table A-I) as well as biomass data (Figure A-11toA-14). Biomass averaged 436 +/- 432 g m^{-2} in May to 224 +/- g m^{-2} in October. The examination of permanent quadrats over a 1 year period identified the important effect sea urchin grazing had on any deeper algal flora. When sites 37,41,44,55,63,66 were initiated October 1984 they were identified as shallow water urchin "barren" sites and by October 1985 they were heavily covered by tufted red species such as *Polysiphonia spp* and *Ceramium spp.* Shallow sites (6m) (16,23,38) were dominated by *Fucus serratus, Chondrus crispus* and *Furcellaria lumbricalis* were stable in comparison to the grazed deep site over the same period.

Survey of Shallow Benthic Habitat Eastern Shore and Cape Breton (Moore et al 1986)

Four transects in the approaches to Sydney Harbour (48-51) had a mean algal cover of 10% to 90% and the eight transects from St. Ann's Bay to St. Lawrence Bay were 30% to 70% covered with algae (Figure A-2). Sea urchin populations at the time were mainly in the 10 – 100 m^{-2}.

This area was noted as having greater amounts of sub tidal Fucus spp. 47% occurring in 47% of all observations and *Chondrus crispus* appearing in 39% of all observation both had significantly greater in occurrence than in other regions of the Atlantic coast of Nova Scotia. *Laminaria* species were less abundant in the Cape Breton area than in the remaining surveyed, coastline.

Laminaria digitata was in only 9% of the observations in the Cape Breton area compared to over 40% on the rest of the coast. *Saccorhiza dermatodea* appeared in only 10% of the stations. Tufted reds (filamentous) occurred in 84% of the stations in Cape Breton versus 59% on the Eastern Shore. The kelp, *Alaria esculenta* was missing in observations from this region while other *Laminarians* were four times less frequent than the rest of the coastline.

Transects from the Sydney Bight such as Table Head #49 (Figure A-7) feature *Fucus* spp. and *Chondrus crispus* as dominants of the flora to 2 m *Laminarians* take over below 3 m with an understory of tufted reds (Figure 2). In the presence of moderate sea urchin densities, tufted reds can be the only macrophytes below 6 m Low Point # 50 (Figure A-2). In the same area, *Fucus* spp can occur in abundance down to 6 m mixed with a low density of *Laminaria* spp. # 51 (Fig. A-5).

Four transects were completed in a study of the vertical distribution in the algae on Maritime rocky shores within our eastern Cape Breton study area conducted between 1975 and 1987(Novaczek and McLachlan). Diversity, percentage cover was recorded to a resolution of 1 m horizontal and vertically. These stations were reported as a group with those of eastern Nova Scotia in a detailed species list. However, the eastern Cape Breton stations were isolated in a description of the vertical limits of the Fucoid belt. Fucoids and *C. crispus* were below the low low water spring tides similar to the ice scoured Gulf shores (opp. cit.). Detailed limits of predominant species were reported by transect for Sydney Bight and this description corresponded with observations in the Lingan Phalen subtidal species list.

Western Cape Breton.

i)Air photo analysis

This coastline (Fig. A-15) was divided into 5 main units (Fig. A-17 to A-21) and 4 sub units (A-22 to A-25). There was a total of 9692 hectares of shallow (<10 m) bottom in the study area of which 13.2 % was identified as algal covered from the analysis of 1999 air photos (Table2). In some sectors on this coast the proportion identified as alga covered rose to 25% of the bottom.

Table 2. Algal beds in Western Cape Breton

Sector (Appendix figure)	Air Photo analysis Algal cover, hectares	Area of bottom less than 10 m, hectares
A-17	236	2875
A-18	265	1045
A-19	181	1607
A-20	313	1842
A-21	290	2313
Total	**1285**	**9692**

ii) Ground truthing:

Rocky substrate in waters less than 4 m were dominated by a mixture of three species nearly equally represented in the biomass: *F. serratus , C. crispus, and Cystoclonium purpureum* at about 20% each (Fig. 3). In mid depths *Fucus serratus* was clearly dominant over 60% of the biomass (Fig. 3). Beyond 8 m F. serratus declined while tufted reds *Furcellaria lumbricalis* and

Phyllophora were dominant. *Laminaria longicuris and digitata* were present but only in small fronds (<1m) (Fig. 3). (Table A-II) The total biomass of macrophytes was approximately 2 kg m^{-2} (Fig. A-22 and A-24).

At depths of less than 8m the algal community was very homogenous throughout the sites sampled on the western Cape Breton coast. The dominance of *F. serratus* was consistent between 2 and 8 m in all but 2 of the 38 stations with algal cover (Fig. A-22, A-23, A-24).

iii) Historical data bases

Dredge samples from 48 stations in the Northumberland Strait captured algal material in 31 of 48 stations. Stations 1-48 were distributed from the west end of P.E.I. to the middle of the Straits: (Cape Tormintine) (Caddy et al, 1977). A total of 74 species were recorded 27 browns, 43 red, 2 green and 2 blue-green. The most common species were *Laminaria, Phyllophora and Polysiphonia*. This method was noted as being very poor for collecting seaweeds and quantification was not very reliable since both drift and attached seaweeds were captured and some substrates were poorly sampled.

An intensive diving survey of 60 km of shore line on the northeastern part of Prince Edward Island is relevant due to its proximity to the western Cape Breton Shore (Bird et al 1983). A total of 52 red , 50 brown, 19 green and 5 blue-green species were identified. In their survey area *Fucus vesiculousus* dominated the 0 to 2.5 m zone but became mixed with *Fucus serratus* in deeper water. *Chondrus crispus* dominated from 2.5 to 5m but became mixed with *Furcellaria* to 7.5 m. Below 10 m Phyllophora spp. composed most of the biomass with occasional plants of *Laminaria* spp. Below 15 m, *Agarum cribosum* and coraline algae were the only macrophytes present in quantity. Associated annuals such as the epiphytes *Ceramium rubrum* and *Cystoclonium purpureum* (tufted reds) reached high seasonal biomasses. An important observation made on this data set was the high degree of homogeneity in the distribution and diversity of algal species in this 60 km section of coastline.

Discussion

Stock aerial photos available from the Department of Lands and Forests are flown for terrestrial targets. The problems of sun angle, tide level and wave state are not taken into account. Therefore it is by chance that a good low tide image with deep-water penetration is part of the inventory. The area of algal cover in shallow waters is likely under estimated by this technique. Areas of stable substrate surrounded by highly reflective sand substrate will return a high resolution of boundaries. There was better resolution of algal cover on the air photo series from western Cape Breton than the series from eastern Cape Breton. This was compensated on the eastern coast by a larger historical database from the Sydney Bight area.

In general, stable substrate from cobbles to bedrock within 10 m of depth is highly likely to be algal covered in the absence of high sea urchin populations. The community observed on the western coast of Cape Breton appeared to be mature due to the abundance of red and brown perennials down to depths of 15 m. The definition of the traditional knowledge base “kelp” zone as primarily within the 10 m contour also confirms this as hard bottom. Without a complete bottom type survey from these areas we can only assume that the total algal covered bottom is less than the “kelp” zone and the area within the 10 m contour. The Cape Breton shoreline from Sydney Bight to Inverness have more simularities to the Gulf algal assemblage than the Atlantic coast of Nova Scotia (Novaczek and McLachlan, 1989).

Time and resources were limited for ground truthing dedicated to this study, studies 6 to 20 years old were relied upon particularly in the Sydney Bight area. However, in the shallow waters there appears to have been a stable assemblage over this time. The reoccurrence of *F. serratus* as the dominant species of the shallow water in each of the studies of this area supports this observation. Less reliable are the observations in deeper (>8m) water due to the dynamics of sea urchin populations preferentially grazing macrophytes such as Laminarians. Species diversity is still stable but biomass can change quickly. The recent major die off of sea urchins along the Atlantic coast of Nova Scotia has allowed a rapid increase of algal biomass (R. Miller, pers. comm.). There are normal seasonal changes in biomass particularly due to the recruitment and growth of red turf ephemerals such as *Ceramium spp*. in the summer months declining in the fall and winter. A spot or single evaluation of the biomass, in the fall must be considered as a minimal estimate.

Although it is possible to expand the biomass values obtained in several studies to the whole area, the data in general is inadequate to provide a total standing stock within reasonable error limits. A comprehensive biomass survey is required before biomass estimates can be made for the entire area.

The perennial species observed in the historic databases and more recent studies and surveys have life habits and life cycles that are not very vulnerable to periodic perturbation, whether natural or anthroprogenic. An example of this group is *Chondrus crispus* that has a triphasic life cycle with two isomorphic visible life stages both producing spores for distribution. It also has a very strong holdfast that is capable of expanding over and into the micro crevices of the substrate (Pringle and Mathieson 1986).

Fucus serratus reproduces in the summer releasing zygotes over the summer settling successfully in a wide range of habitats. It is considered competitively inferior to *Ascophyllum nodosum* intertidally but *Ascophyllum* does not occur in the subtidal(Jenkins et al, 1999). Among *Fucus spp., F. serr*atus is the highest in competitive ranking when they occur together (Karez, R. and A. Chapman, 1998). Grazing pressure is one of the most critical factors in the dominance of this species (opp cit).

Red turf species such as *Cystoclonium purpureum* are widely distributed species in the North Atlantic. It is a perennial species but the erect fronds are usually lost over the winter (Bird and McLachlin, 1992). These dominant species among others are noted in all studies in the general area over a span of 40 years.

Conclusion

The shallow subtidal zone of western Cape Breton and the Sydney Bight are covered by a diverse algal flora that is dominated in biomass by less than 10 species. This part of the zone (<8m) is stable in a 20 year time frame or more. The canopy is low (less than .5m) lacking distinct dense beds of large (>1m) Laminarians. The deeper part of the zone (>8m) in the Sydney Bight area has been unstable over the last 20 years.

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Appendix A- Tables and Figures

Table A I. Species diversity in collections made near Lobster Habitat Monitoring Stations Lingan-Phalen/Donkin Morein Marine Monitoring Program 1985 (Dobrocky Seatech Ltd.

Species

<u>Brown Algae</u>
Laminaria longicruris
Laminaria digitata
Agarum cribosum
Desmarestia aculeata
Saccorihiza dermatodea
Fucus serratus
Chorda filum
Ectocarpus siliculosus
Pylaiella littoralis
Giffordia granulosa
Sphacelaria plumosa
Haplospora globosa
Dictyosiphon foeniculaceus
Scytosiphon lomentaria
Chordaria flagelliformis

<u>Red Algae</u>
Chondrus crispus
Palmaria palmata
Phycodrus rubens
Phylllophora truncata
Polysiphonia urceolata
Polysiphonia nigrescens
Polysiphonia flexicaulis
Rhodomela confervoides
Polyides rotundus
Furcellaria lumbricalis
Devaleraea ramentacea
Callophyllis cristata
Ceramium rubrum
Cystoclonium purpureum
Scagelia corallina
Corallina officinalis
Odonthalia dentata
Membranoptera alata
Ptilota serrata
Neodilsea integra
Ahnfeltia plicata
Audouinella sp.
Bonnemaisonia hamifera
Lithothamnion glaciale

Green Algae
Chaetomorpha melogonium
Chaetomorpha capillaris
Spongomorpha sp.
Enteromorpha linza
Clathromorphum
circumscriptum
Phymatolithon laevigatum
Phymatolithon rugulosum

Table A II Principal algal species
Western Cape Breton 2001 Survey

Brown Algae
Fucus serratus
Laminaria longicruris
Laminaria digitatus
Chorda filum
Chordaria flagelliformes
Desmarestia viridus

Red Algae (Red algal turf)
Cystoclonium purpureum
Chondrus crispus
Furcellaria fastigiata
Ceramium sp.
Polysiphonia sp.
Phyllophora membranifolia
Phyllophora brodiaei
Palmata palmata
Polyides caprinus
Ahnfeltia plicata
Corallina officinalis
Rhodamela confervoides

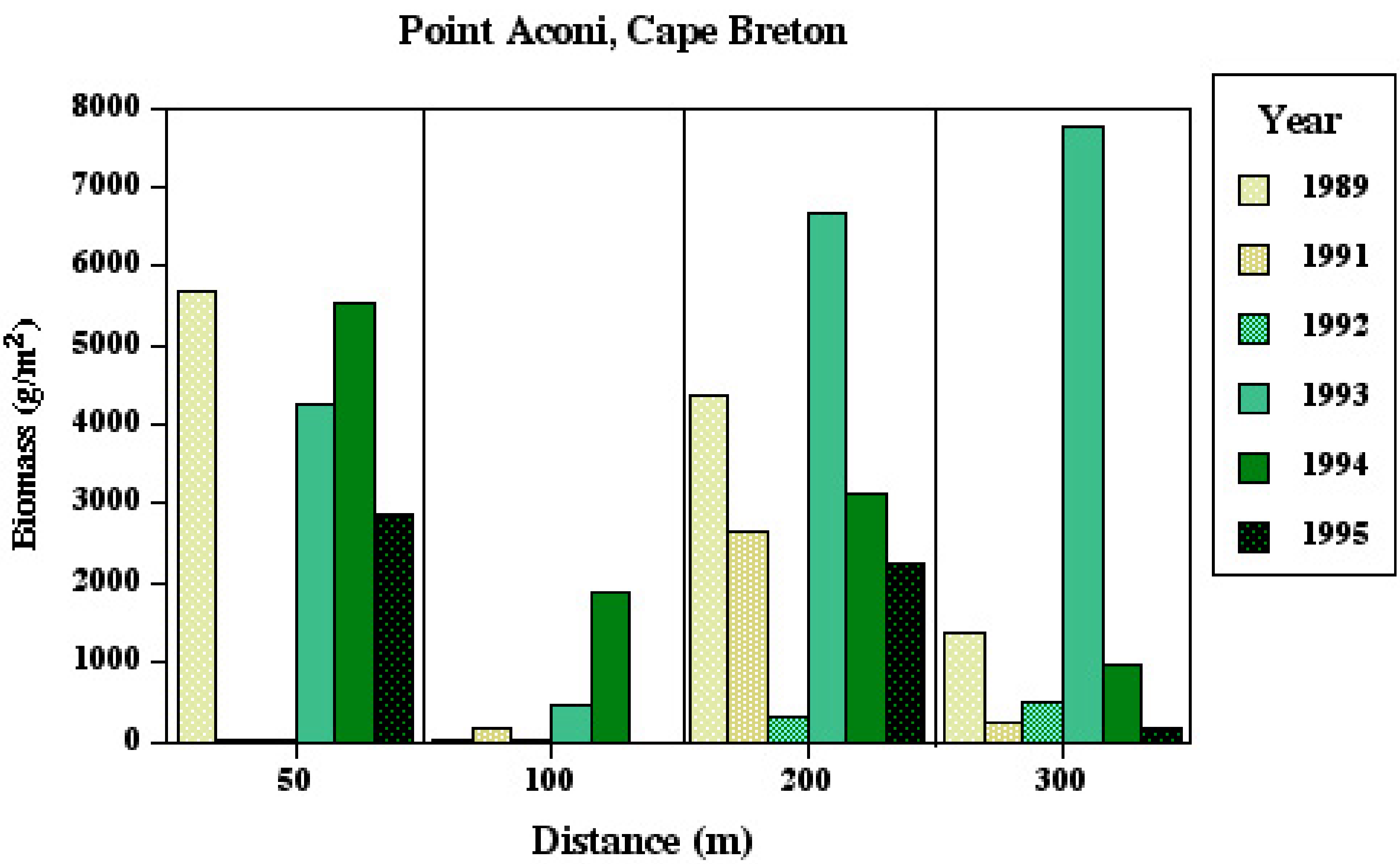


Figure 1. Biomass of transects at various distances from shore at Point Aconi, Cape Breton.

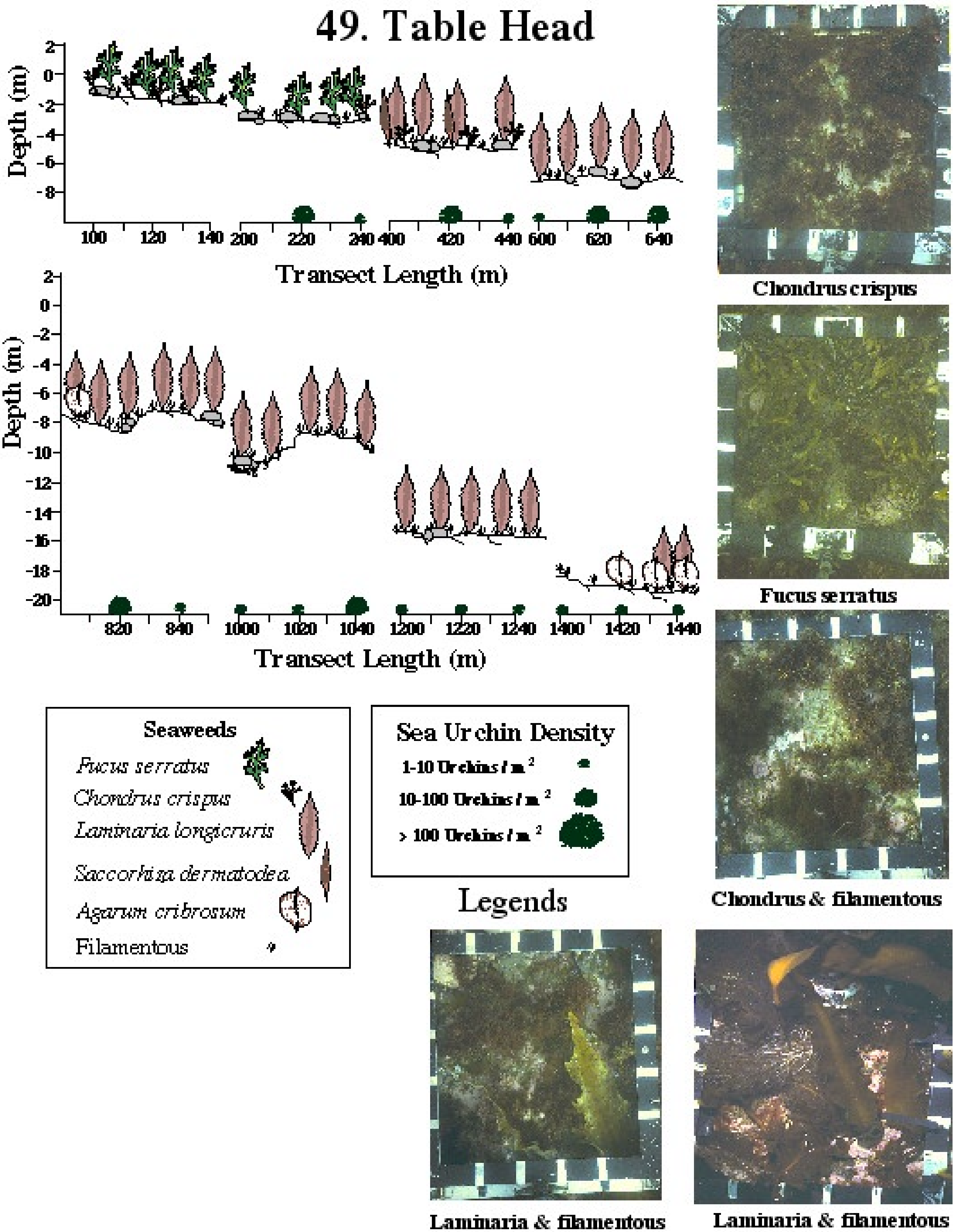


Figure 2. Transect and photos from eastern Cape Breton showing algae type and sea urchin cover.

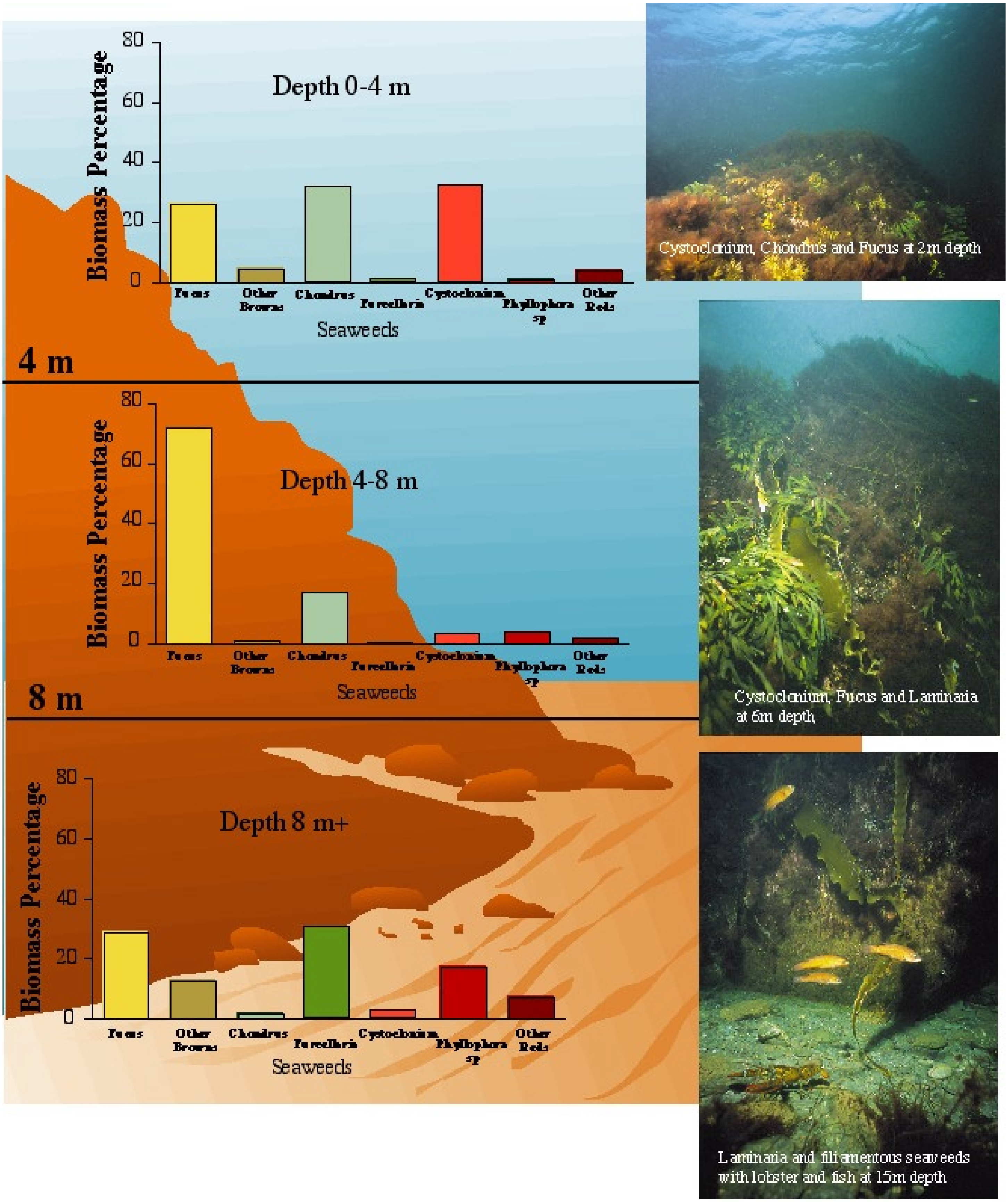


Figure 3. Diagram of percentage of biomass of the major seaweed species at various depth ranges from western Cape Breton and photos representative of the area.

Figure A-1: CAPE BRETON(EAST COAST)

Figure Index

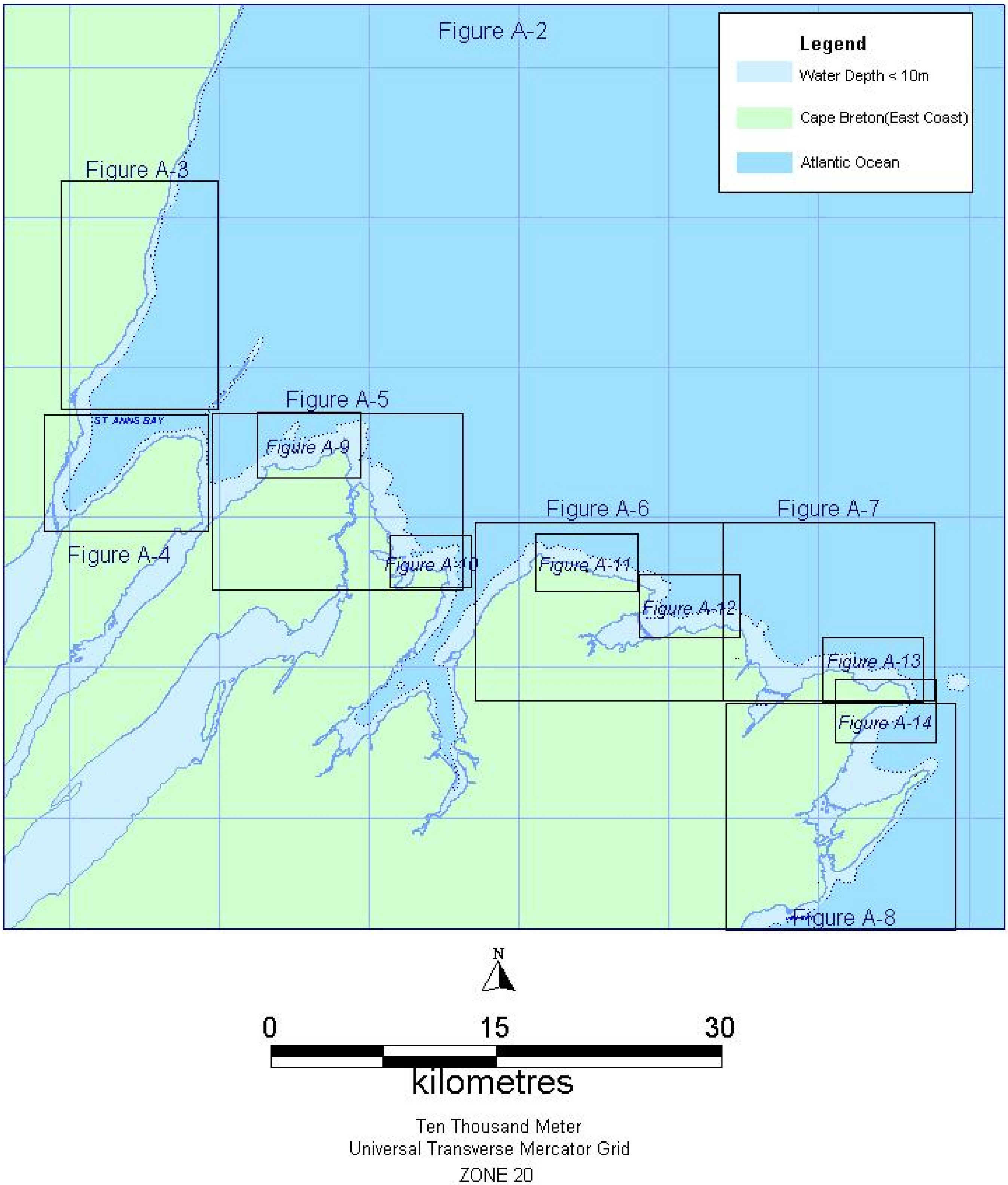


Figure A-2: Algal Cover for the East Coast of Cape Breton

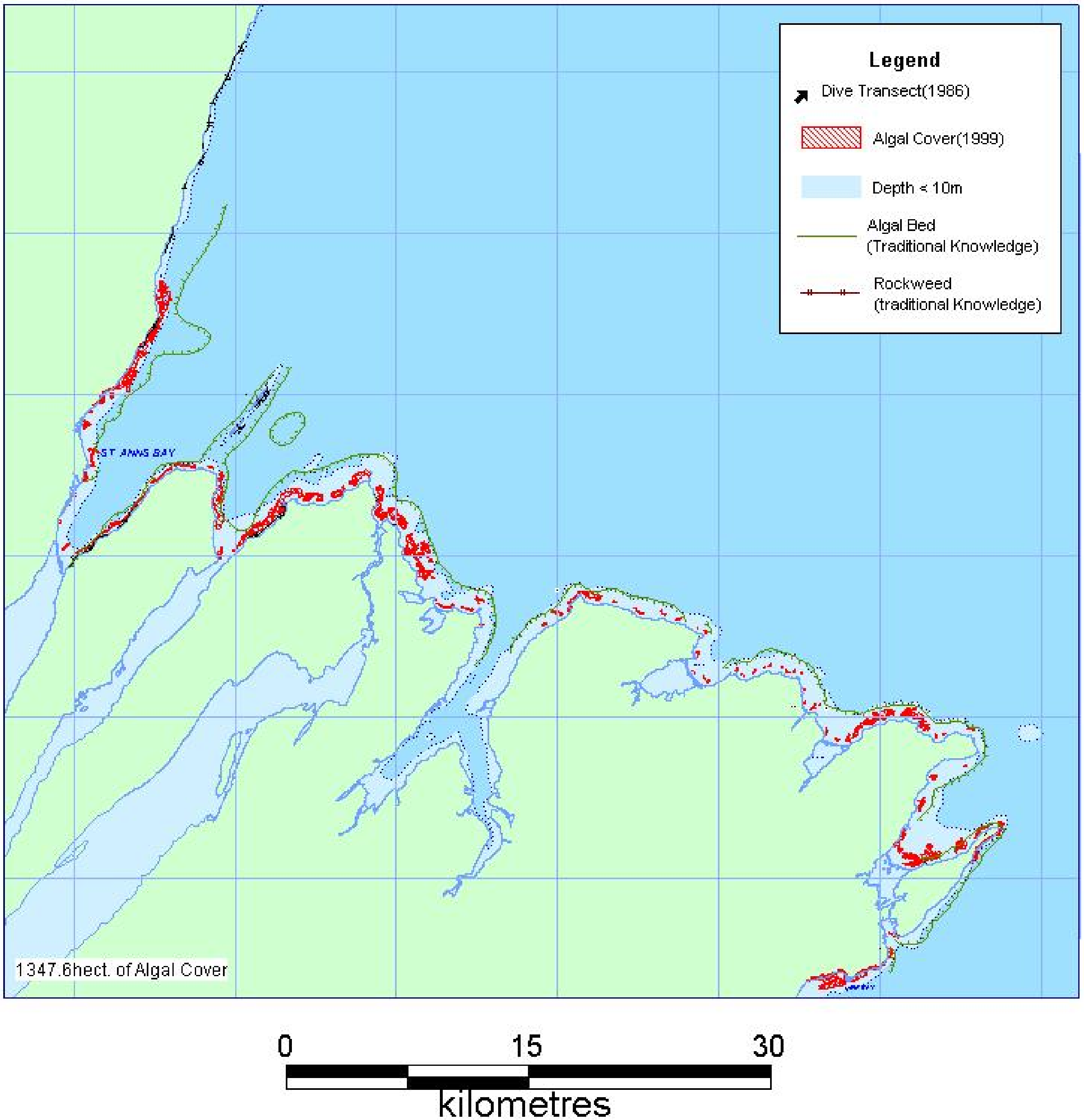


Figure A-3: Algal Cover from Wreck Point to St. Anns Bay

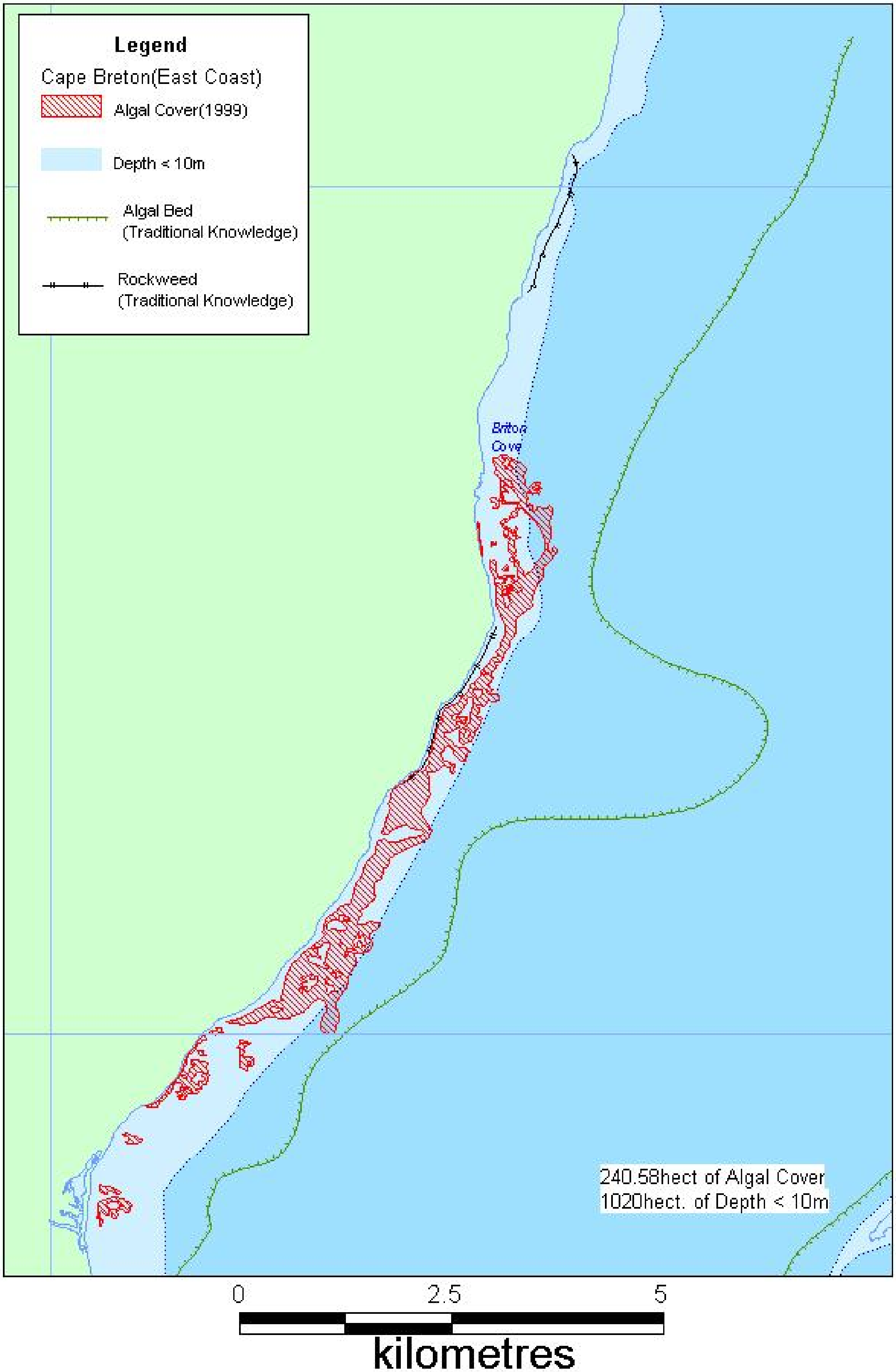


Figure A-4: Algal Cover from St. Anns Bay to Cape Dauphin

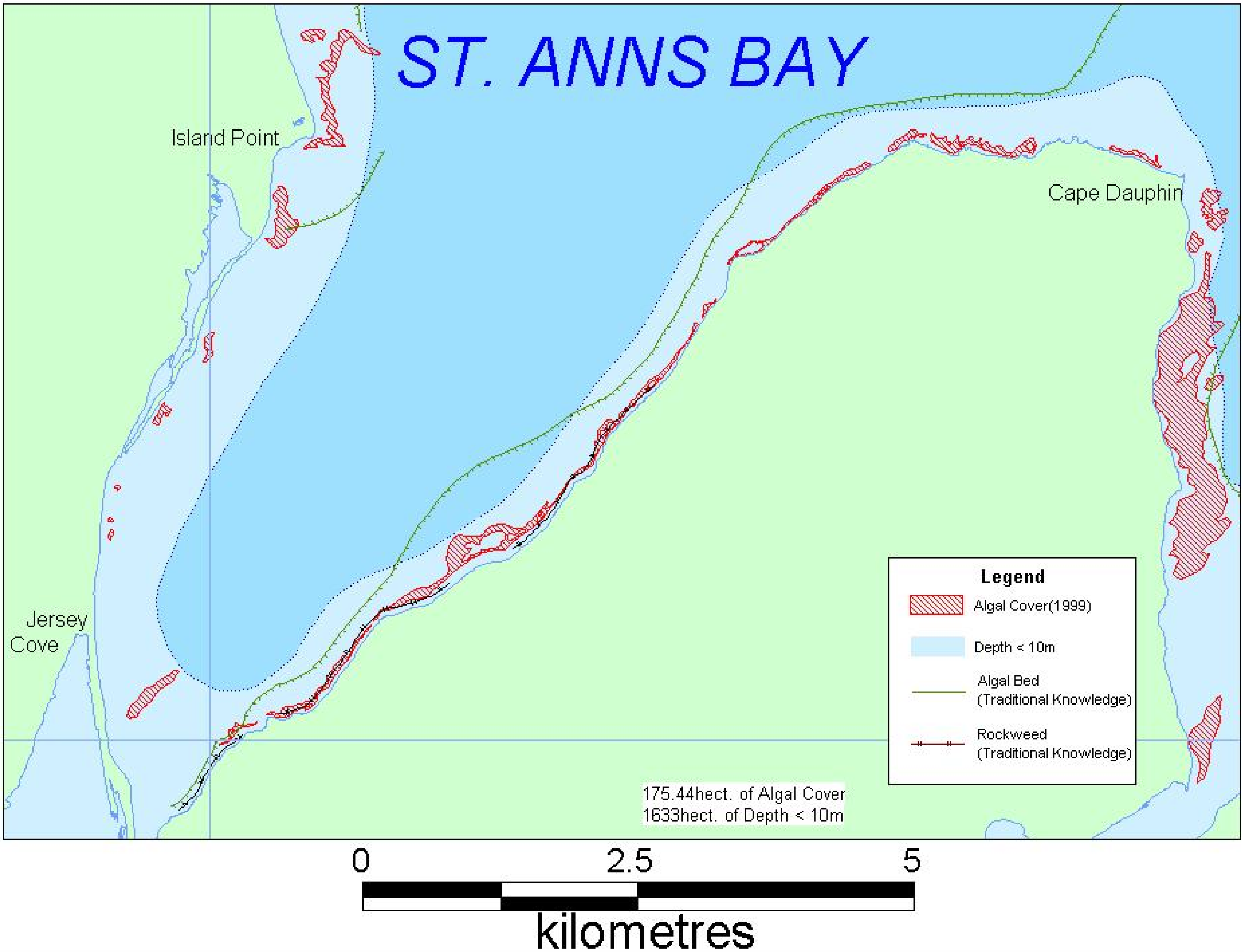


Figure A-5: Algal Cover from South West of Table Head to Cranberry Point

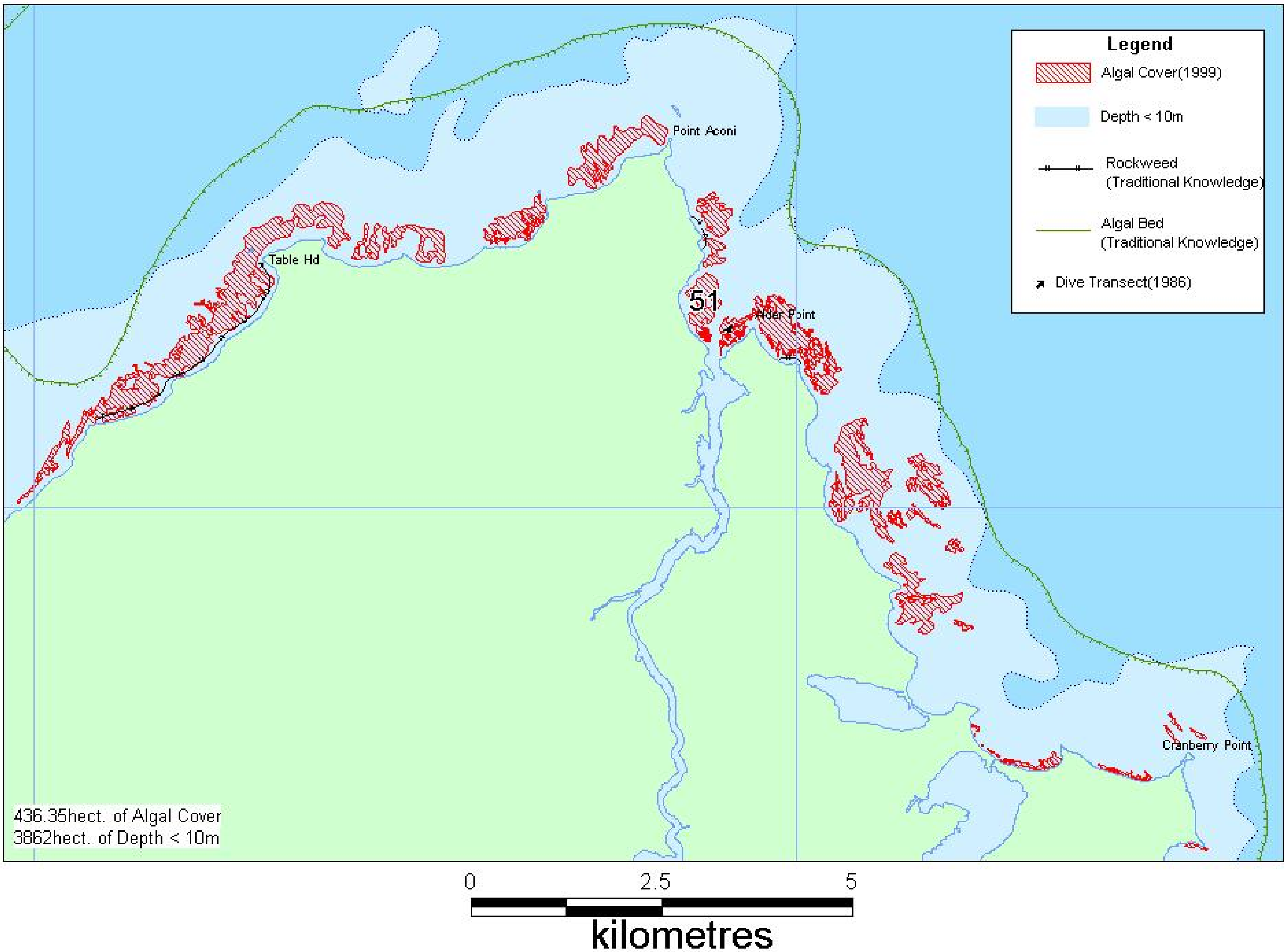


Figure A-6: Algal Cover from Sydney Harbour to Indian Bay

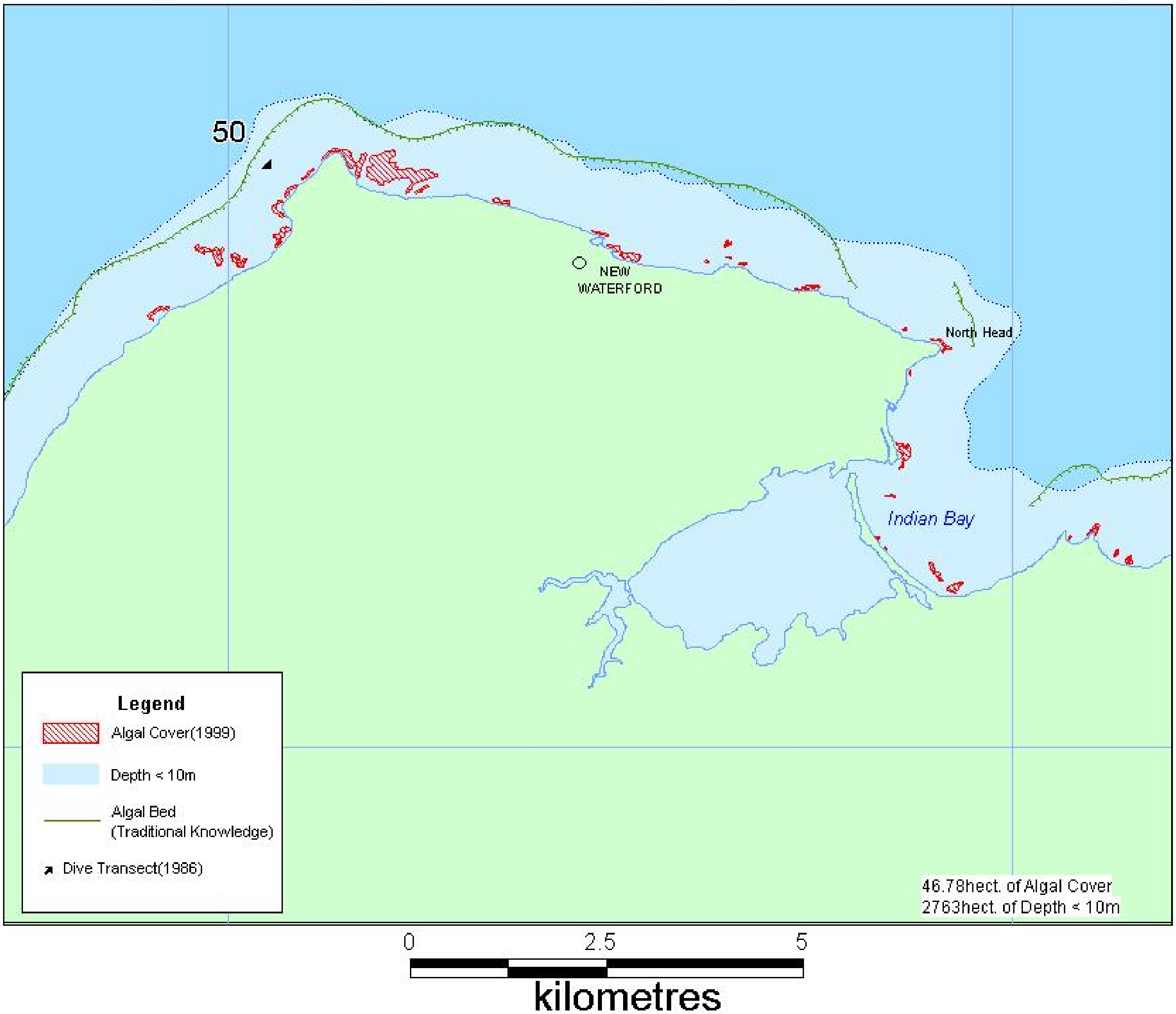


Figure A-7: Algal Cover from Table Head to Cape Perce

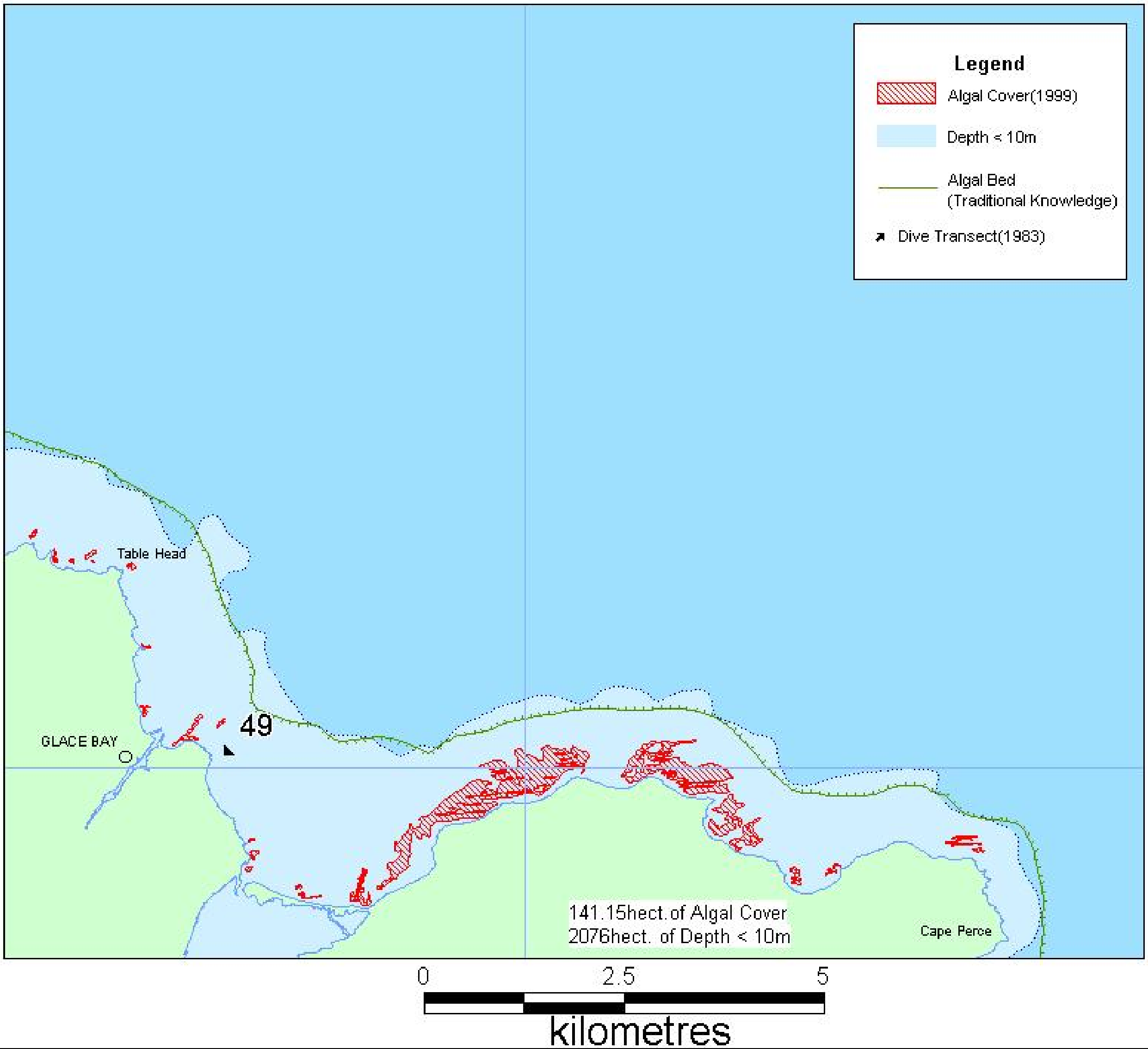


Figure A-8: Algal Cover from Cape Perce to Mira Bay

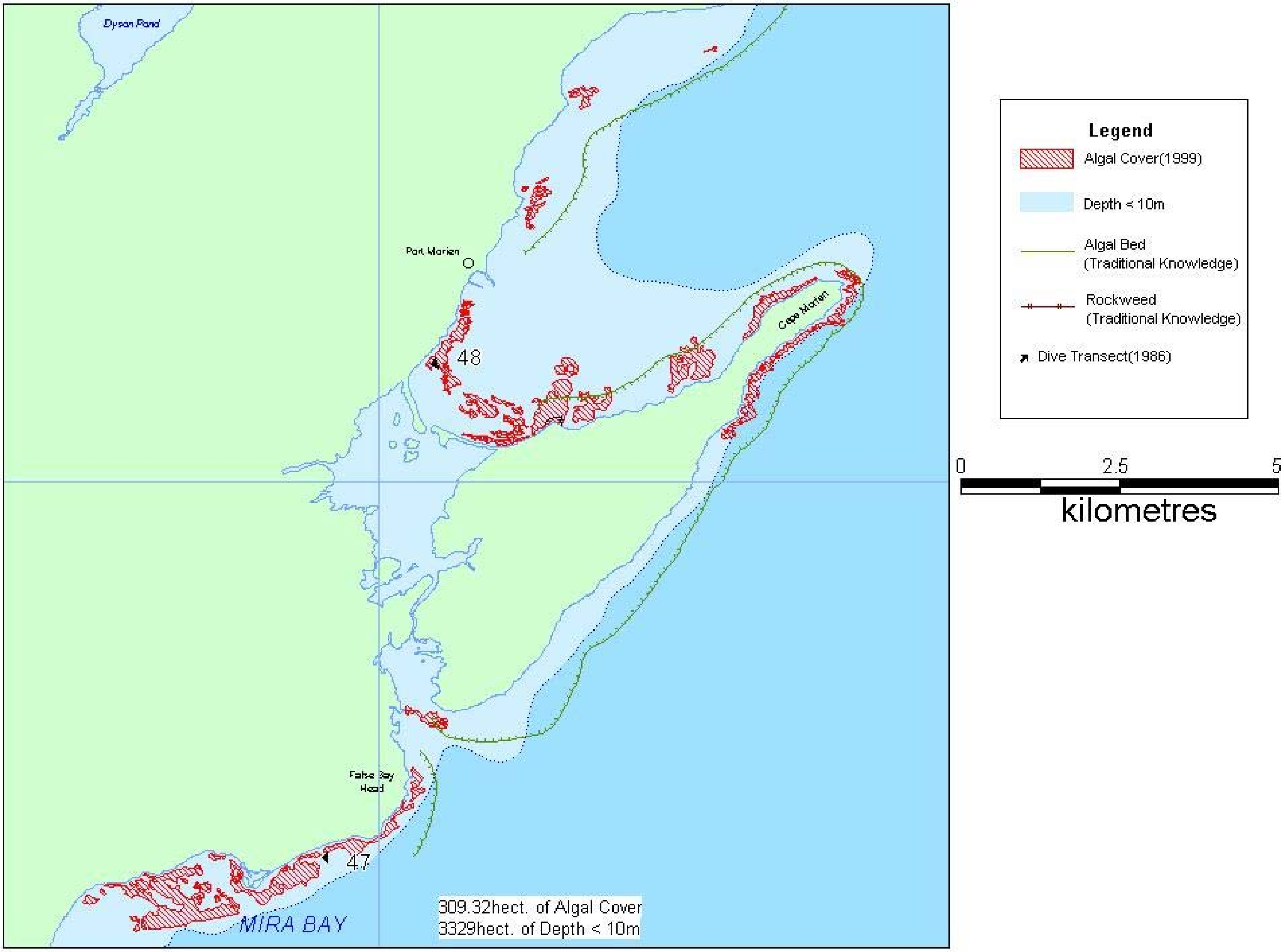
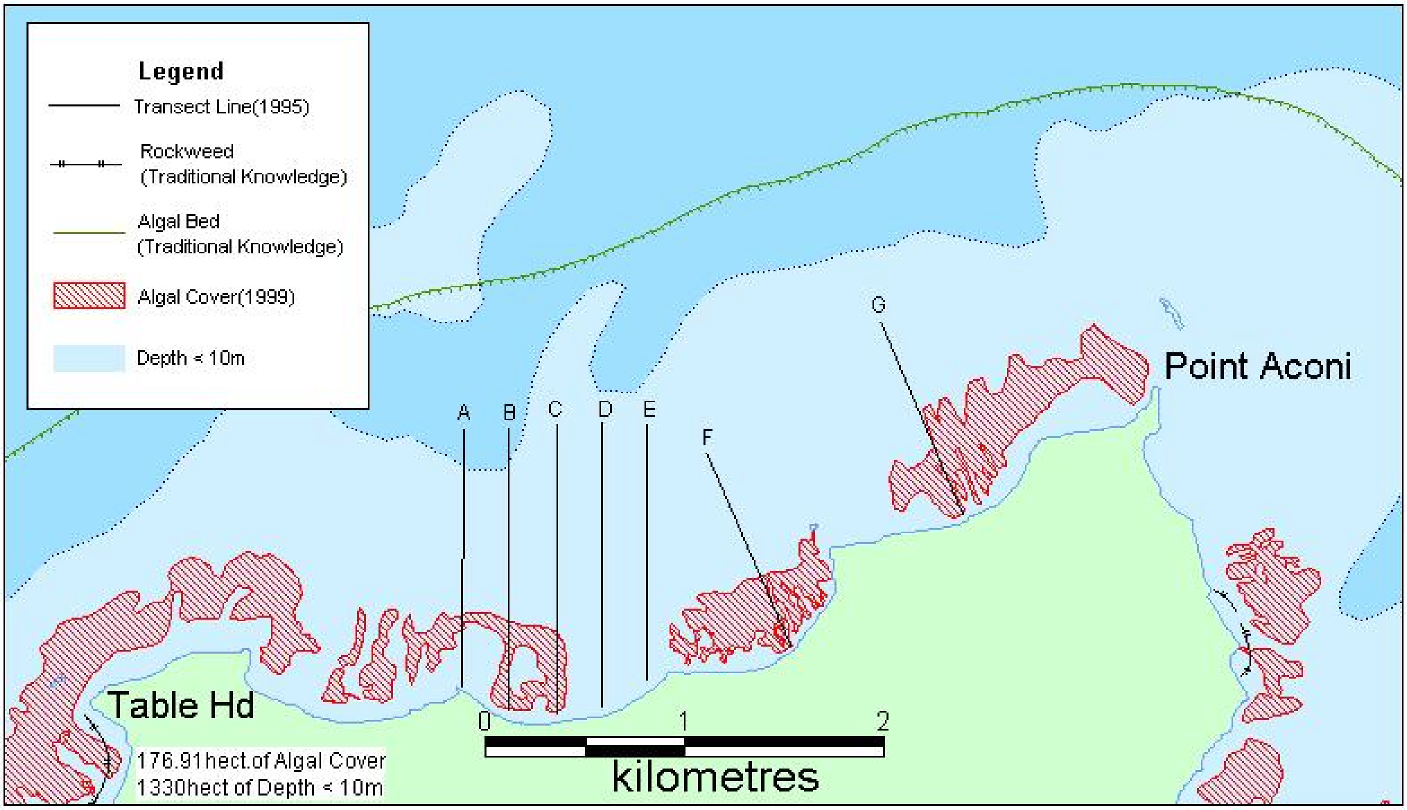


Figure A-9: Location of Transect Lines(1985)



Transect Line Summary

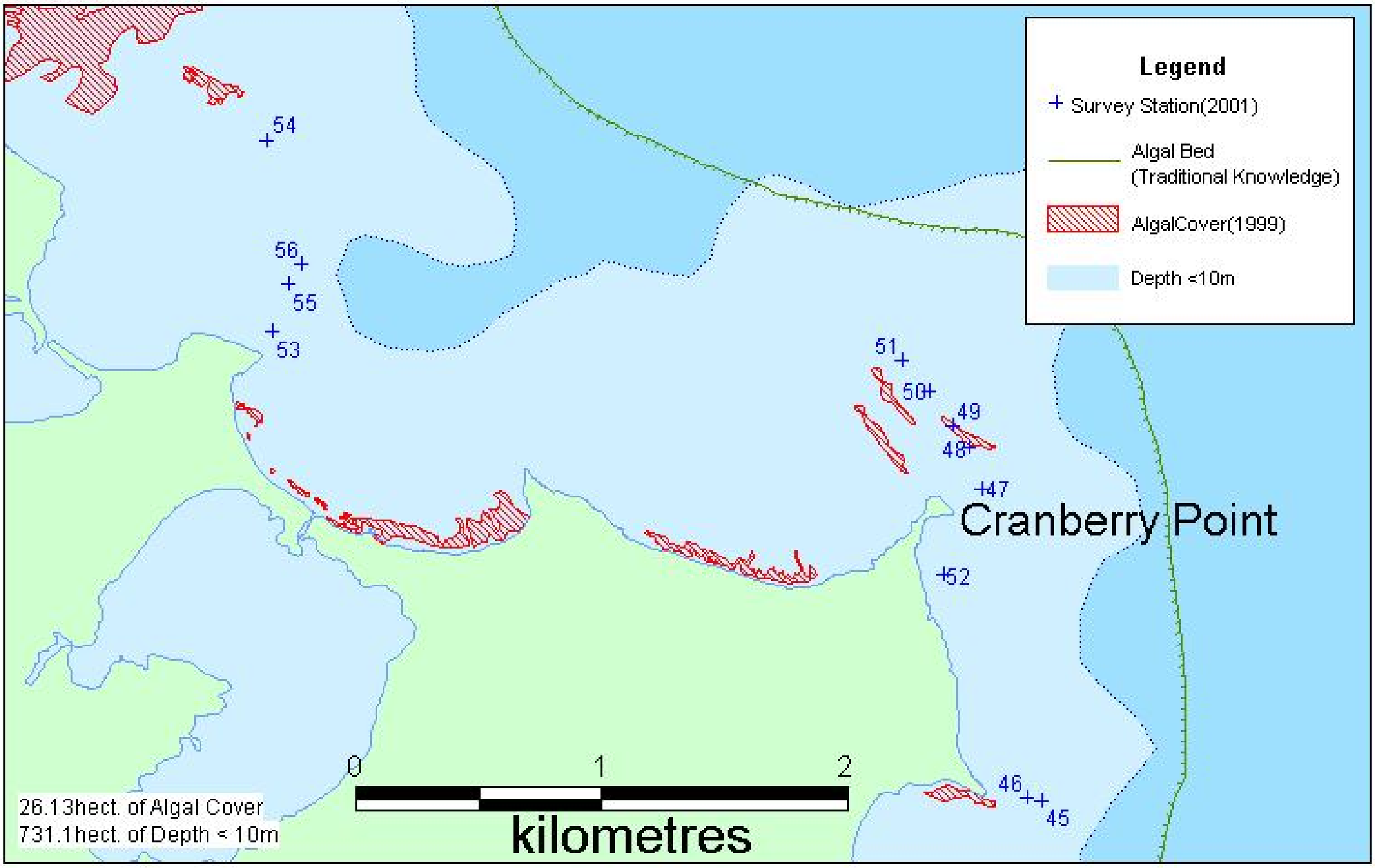
Number of Algal Species Along Transects

ID	Num_Species_Sept92	Num_Species_May93	Num_Species_Aug93	Num_Species_May94	Num_Species_July94	Num_Species_Aug95
A	10	10	3	6	15	1
B	9	10	11	14	14	9
C	8	9	9	13	6	10
D	5	0	0	0	5	0
E	6	14	7	13	14	1
F	13	7	15	13	10	14
G	15	16	21	0	17	8

Biomass in g/m^2(M and SD = Means and Standard Deviations)

ID	M_Sept92	SD_Sept92	M_May93	SD_May93	M_Aug93	SD_Aug93	M_May94	SD_May94	M_July94	SD_July94	M_Aug95	SD_Aug95
A	662	554	2575	3136	18	38	11	31	2106	1490	337	178
B	1522	1580	1006	595	2490	1461	1360	1127	2721	1350	177	268
C	1188	881	2891	915	3069	1320	549	326	1654	825	955	640
D	24	24	0	0	0	0	0	0	225	518	0	0
E	239	181	120	166	68	121	220	129	1400	666	301	186
F	397	450	610	424	1650	1342	395	640	3142	2315	1009	234
G	1672	845	1046	1050	2510	1246	0	0	867	414	336	250

Figure A-10: Survey Stations



Survey Station(2001) Summary

Station	Algal_Species	Depth_feet	Bottom_Type
45	Chorda, Fucus serratus, Chondrus crispus	6	cobble/boulder
46	Fucus serratus	8 - 10.1	ledge
47	Chorda, Fucus serratus	6 - 7.7	ledge/cobble
48	Chorda, Fucus serratus, Chondrus crispus, Desmarestia	8.1	ledge
49	Chorda(20%), Fucus serratus(20%), Chondrus crispus(10%)	10	ledge/cobble
50	Fucus serratus(40%), Chorda, Desmarestria	14.6 - 16	ledge
51	Fucus serratus	18	ledge
52	Fucus serratus(90%), Chorda, Laminaria longichuris(<1%), Desmarestria	N / A	N / A
53	Fucus serratus(70%), Desmarestia	6	ledge
54	Desmarestia(30%), Fucus serratus(20%), Chorda(10%), Chondrus crispus(<1%)	8	cobble
55	Fucus serratus(30%), Desmarestia(20%), Chorda(20%)	10	cobble
56	Fucus serratus(80%), Chorda(10%), Laminaria longichuris	15	ledge