

# Introduced Marine Species in the Haida Gwaii (Queen Charlotte Islands) Region, British Columbia

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This historical review of a marine area's introduced species was facilitated by geo-referenced marine species inventories of the Haida Gwaii (Queen Charlotte Islands) region. One plant, 14 invertebrate, and two fish introduced species have been recorded since the early 20<sup>th</sup> century from the marine waters around Haida Gwaii. Records of species occurrences are listed and mapped, and modes of introduction are discussed. It will be important to continue documenting areas' introduced species locations to track the progress of invasions that could affect local marine ecosystem well-being.

Key Words: introduced species, marine, Haida Gwaii, Queen Charlotte Islands, British Columbia.

"... the control of alien marine species is in its infancy." (Bax et al. 2001)

Introduced (non-indigenous) marine species are of global concern (Bax et al. 2001). The dynamism and connectivity of marine ecosystems, mariculture and shipping facilitate species' introductions. The introduction of some species may be followed by rapid local dispersal of propagules and appreciable ecological consequences (Grosholz 2002). Introduced species knowledge is more developed for land and freshwater than for marine ecosystems (Ruiz et al. 2000; Simberloff 2000; Bax et al. 2001).

Carl and Guiguet (1958) were the first to broadly document species introductions in Pacific Canada. Current awareness of the problem is growing in the region, and Levings et al. (2002) have reviewed introduced marine species found in the Strait of Georgia, southern British Columbia.

Using the 30 introduced mollusks along the Pacific coast of North America as an example, Carlton (1992) reported the main modes of introduction as: (1) associated with introduced Japanese and Atlantic oysters imported for mariculture (approximately 27 species), (2) via vessel hull fouling and organisms living in wood, and (3) from overseas ships' ballast water releases. More recently, Chapman et al. (2003) reported that along the U.S. Pacific coast, 24 of the 37 marine and estuarine bivalve species commercially available as seafood are alien species.

We report on the documented presence of introduced marine plants, invertebrates and fishes in the Haida Gwaii (Queen Charlotte Islands) region of northern British Columbia. No introduced marine birds or mammals have been recorded. The plant and invertebrate records, gleaned from the literature and museum collections, are archived in the geographic information system (GIS) databases of Gwaii Haanas National Park Reserve and Haida Heritage Site (Sloan and Bartier

2000; Sloan et al. 2001). We excluded introduced species whose total geographic range encompasses the Haida Gwaii region, although, of course, their presence could be inferred. An example is the amphipod *Corophium acherusicum* from Asia and now known from the northern mainland British Columbia coast (Bousfield and Hoover 1997). The American Shad (*Alosa sapidissima*) have long been known from the whole northeast Pacific (Welander 1940), but only recently from Haida Gwaii waters (Workman et al. 1996). Atlantic salmon (*Salmo salar*) observations were from the Atlantic salmon Watch Program web site: [http://www.pac.dfo-mpo.gc.ca/sci/aqua/ASWP\\_e.htm](http://www.pac.dfo-mpo.gc.ca/sci/aqua/ASWP_e.htm). The fish records are not yet in our database.

## Results and Discussion

For Haida Gwaii, accidental (or active) introductions of one plant, 14 invertebrate, and two fish species associated with fishery or mariculture development are summarized in Table 1 and illustrated in Figures 1 and 2. Likely some of these species have spread northward to Haida Gwaii from the more developed southern mainland British Columbia and U.S. coasts where they first became established. There have been introductions of species to British Columbia targeted for mariculture, such as Pacific Oyster (*Crassostrea gigas*) from Japan, plus their attached associates (Quayle 1988) or parasites (Bower et al. 1994). For example, the seaweed *Sargassum muticum* is now ubiquitous coast-wide, including Haida Gwaii (Figure 1). It was accidentally introduced into southern British Columbia in the early 20<sup>th</sup> century attached to Pacific oysters. Another example of collateral introduction in British Columbia is the parasitic copepod *Mytilicola orientalis*, likely introduced via Pacific Oyster stock and now widely infesting Native Littleneck Clams (*Protothaca staminea*) and Butter Clams (*Saxidomus giganteus*) in southern British Columbia (Bower et al. 1994).

TABLE 1. Marine plant, invertebrate and fish species recorded from the Haida Gwaii region whose introduction has been accidental or attempted for fisheries development or mariculture. Other bibliographic citations and specimen records for the plant and invertebrate records are cited in Sloan and Bartier (2000) and Sloan *et al.* (2001), archived in Gwaii Haanas' GIS and available from [www.marinebioiversity.ca](http://www.marinebioiversity.ca).

Species	Native Range / Non-native Range	Introduction Pathway	History of Expansion in the Northeast Pacific	First Record(s) and Current Distribution around Haida Gwaii	Sources
<b>Plant</b>					
<i>Sargassum</i> Seaweed <i>Sargassum muticum</i>	Japan / SE Alaska to S California, Scandinavia, Netherlands, UK, France, Spain	Mariculture	Introduced on Japanese oyster shells in the Strait of Georgia and Puget Sound in the 1900s to 1930s; now known from Mexico to Alaska	1981 – Skidegate Inlet; now widespread	Carlton 1979 Druehl 2000 Sloan and Bartier 2000
<b>Invertebrates</b>					
Hydrozoan <i>Tubularia crocea</i>	NW Atlantic / Possibly <i>cosmopolitan</i>	Shipping <sup>1</sup>	San Francisco Bay, 1859; San Juan Island and Vancouver Island, 1932; N British Columbia, 1911; now known from S California to Alaska	1935 – Houston-Stewart Channel; current distribution unknown	Carlton 1979 Fraser 1936
Oligochaete <i>Limnodrilus monothecus</i>	NW Atlantic / NE Pacific, Mediterranean	Shipping <sup>1</sup> or Mariculture	San Francisco Bay, 1960; now known from Mexico to British Columbia	1980 – Masset inlet, Parry Passage; current distribution unknown	Cohen and Carlton 1995 Erséus 1982 Sloan <i>et al.</i> 2001
Soft-shell Clam <i>Mya arenaria</i>	NW Atlantic / NE Pacific, North Sea, Black Sea	Mariculture	San Francisco Bay, 1874; Coos Bay, 1880; Puget Sound by 1889; S British Columbia in the early 1900s; now known from central California to Alaska	1939 – Masset Inlet; 1955 – Naden Harbour; Prior to 1964 – Rennell Sound; now widespread	Carlton 1979 Quayle 1964
Pacific Oyster <i>Crassostrea gigas</i>	Japan, Korea, China, SE Asia / Pacific, North America, Europe, Australia	Mariculture	Puget Sound, 1875; Alaska, 1910; S British Columbia, 1912/13; wild breeding populations established from S British Columbia to Oregon	1957 – Mouth of Kumdis Bay; 1990s – Juveniles <sup>2</sup> taken to raft culture sites in Skidegate Inlet and Rennell Sound	Carlton 1979 Coan <i>et al.</i> 2000
Weathervane × Japanese Scallop Hybrid ( <i>Patinopecten caurinus</i> × <i>Mizuhopecten</i> <i>yessoensis</i> )	NW Pacific ( <i>M. yessoensis</i> 35°–61°N)	Mariculture	<i>M. yessoensis</i> first outplanted in British Columbia in 1988; no breeding populations have established in the wild	1997–2001 hybrid juveniles <sup>2</sup> monitored at pilot raft culture sites in Masset Inlet, off Masset, Skidegate Inlet and Rennell Sound	Harbo 1997
Manila Clam <i>Venerupis philippinarum</i>	NW Pacific / Central British Columbia to N California, Hawaii, Mediterranean	Mariculture	S British Columbia, 1936; Washington State, 1930s; northern extent is Laredo Sound, British Columbia	1962 – Fisheries and Oceans Canada (DFO) introduced 15,000 each into Masset Inlet and Naden Harbour – none were located in a 1997 survey	Coan <i>et al.</i> 2000 Gillespie and Bourne 1998 Harbo 1997
Snail <i>Subia conica</i>	NW Pacific / British Columbia	Shipping <sup>1</sup>	Queen Charlotte Sound, 1940	1963 – Tasu Sound; current distribution unknown	Cowan 1973 Carlton 1979

TABLE 1. (continued)

Species	Native Range / <i>Non-native Range</i>	Introduction Pathway	History of Expansion in the Northeast Pacific	First Record(s) and Current Distribution around Haida Gwaii	Sources
Amphipod <i>Ampithoe vallida</i>	NW Atlantic / <i>NE Pacific</i>	Shipping <sup>1</sup> or Mariculture	San Francisco and Tomales Bays, 1941; Coos Bay, 1950; Strait of Georgia, 1973; current distribution unknown, likely common from Oregon northwards	1957 - Masset, Yakoun Bay; Peril Bay and Hotspring Island; 1993 - Burnaby Narrows; current distribution unknown	Carlton 1979 Sloan et al. 2001
Carabid Intertidal Beetle <i>Trechus obtusus</i>	Europe / <i>Europe, Pacific North America</i>	Nursery Stock	Puget Sound by 1925; currently ranges from Haida Gwaii to California	1980s - Delkatka Inlet; current distribution unknown	Kavanaugh 1992 Kavanaugh and Erwin 1985
Bryozoan <i>Bowerbankia gracilis</i>	Atlantic / <i>Cosmopolitan</i>	Shipping <sup>1</sup> or Mariculture	Los Angeles Harbour and Tomales Bay, 1940s; Puget Sound prior to 1953; now known from Baja California to Alaska	1976 - Tasu Sound; current distribution unknown	Cohen and Carlton 1995 Sloan et al. 2001
Bryozoan <i>Cryptosula pallasiana</i>	N Atlantic / <i>Cosmopolitan</i>	Shipping <sup>1</sup> or Mariculture	S California, 1943; San Francisco Bay, 1947; SE Alaska, 1944-1946; Vancouver Island, 1970	1968 - 3 nearshore sites, NW Graham Island; current distribution unknown	Cohen and Carlton 1995 Hines and Ruiz 2000 Sloan et al. 2001
Bryozoan <i>Schizoporella unicornis</i>	NW Pacific / <i>NE Pacific</i>	Shipping <sup>1</sup> or Mariculture	Washington State, 1927; California, 1938; British Columbia, 1966; now known from Mexico to Alaska	1992 - Anthony Island (S Gaang Gwaii); current distribution unknown	Cohen and Carlton 1995 Hines and Ruiz 2000 Sloan et al. 2001
Tunicate <i>Ciona intestinalis</i>	N Atlantic / <i>Cosmopolitan</i>	Unknown	Unknown, but reported from 15 estuaries in California in 2002	1976 - Tasu Sound; current distribution unknown	California Department of Fish and Game 2002 Ruiz et al. 2000
Tunicate <i>Pelonata corrugata</i>	NW Pacific, Atlantic Arctic / <i>British Columbia</i>	Unknown	The only known record is from Haida Gwaii, 1906	1906 - off Rose Spit; current distribution unknown	Austin 1985 Huntsman 1912
<i>Fishes</i> Atlantic Salmon <i>Salmo salar</i>	N Atlantic / <i>N Pacific</i>	Mariculture	Salmon farming began in Washington in the 1970s and British Columbia, 1985; caught in British Columbia waters 1987; natural reproduction in British Columbia, 2000; now known from Washington to Alaska	Records are listed annually by Fisheries and Oceans Canada <sup>3</sup>	McKinnell et al. 1997 Mecklenburg et al. 2002
American Shad <i>Alosa sapidissima</i>	NW Atlantic / <i>E Bering Sea to Baja California</i>	Mariculture	Sacramento River, 1871; Puget Sound, 1882; Fraser and Stikine Rivers, 1891; Cook Inlet, 1904	Haida Gwaii records are not yet available, likely widespread	Mecklenburg et al. 2002 Welander 1940 Workman et al. 1996

1 introduction through shipping could be from ballast water exchange or hull fouling

2 juveniles are certified disease-free by the commercial supplier

3 [http://www.pac.do-mpo.gc.ca/sci/aqua/ASWP\\_e.htm](http://www.pac.do-mpo.gc.ca/sci/aqua/ASWP_e.htm)

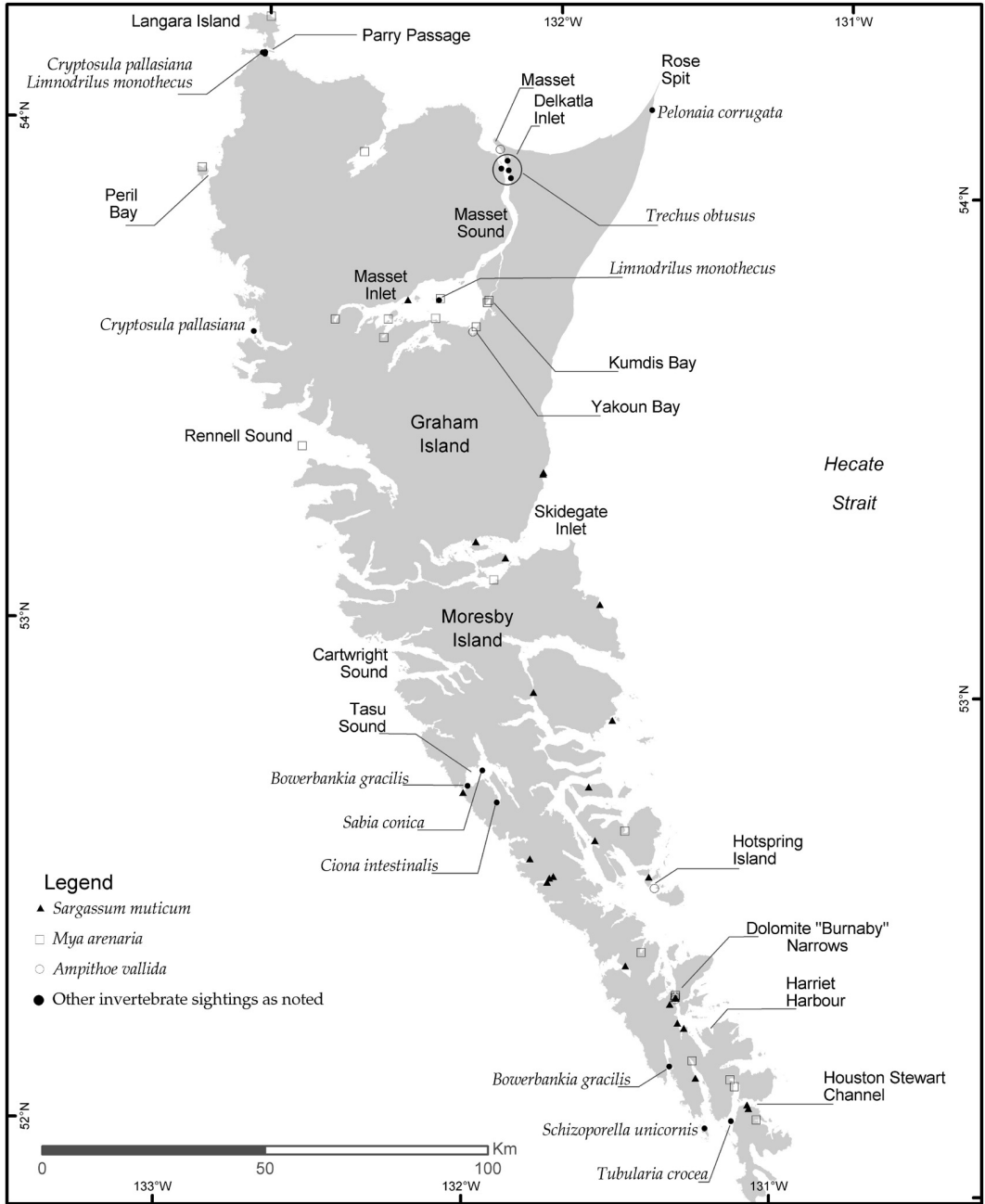


FIGURE 1. Map of Haida Gwaii showing locations mentioned in the text and collection sites of introduced marine plant and invertebrate species, based on data from Sloan and Bartier (2000) and Sloan et al. (2001).

*Mariculture-associated Introductions*

In 1977, concern over introduced aquatic species issues stimulated establishment of the federal-provincial Fish Transplant Committee (recently renamed Introductions and Transfers Committee – ITC) under

mandates from the federal *Fisheries Act* and the *British Columbia Fisheries Act* and *British Columbia Wildlife Act* (BC 1990). The ITC evaluates potential risks to the environment associated with introductions or transfers of either finfish or invertebrates (“shellfish”)

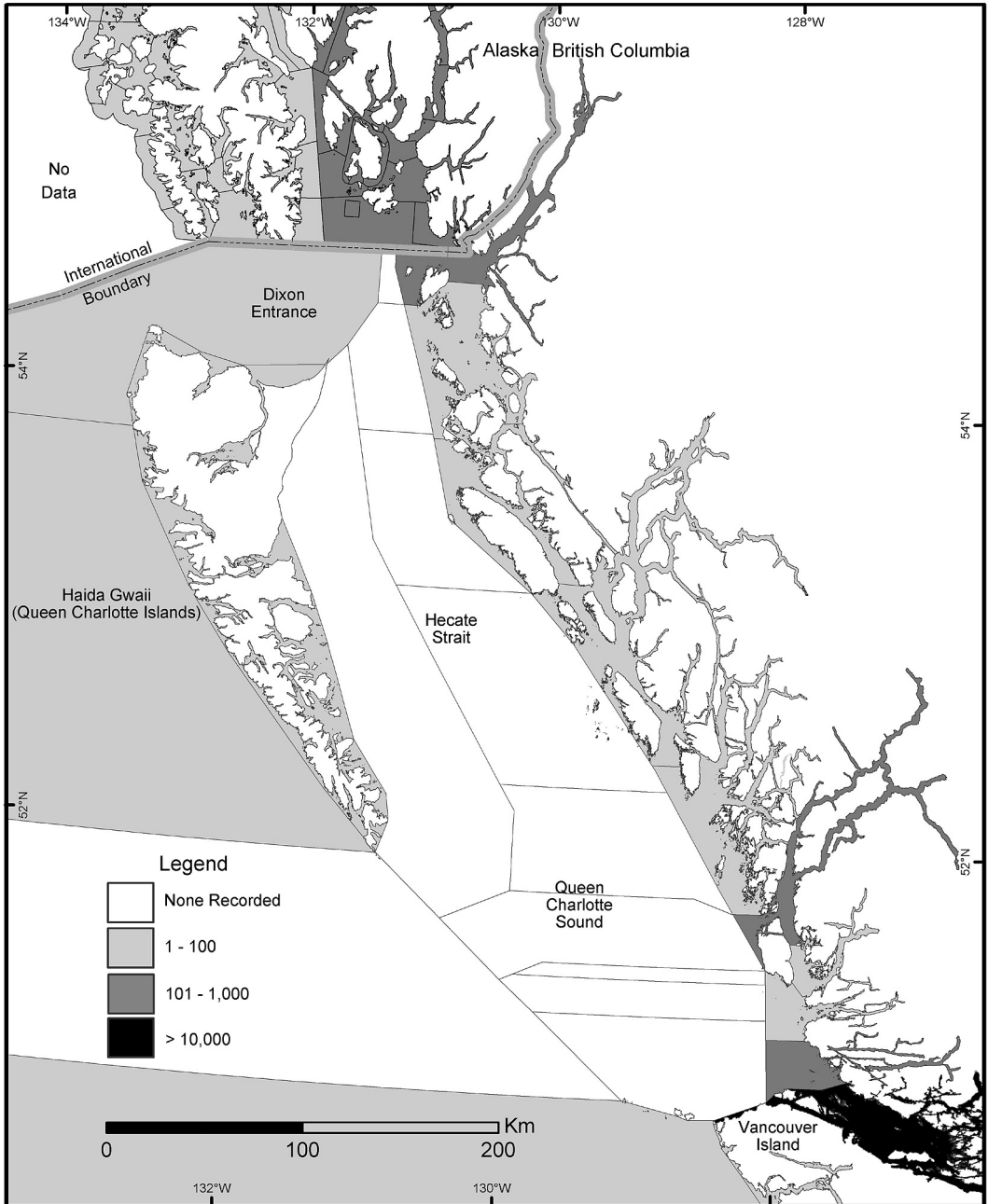


FIGURE 2. Map of the northern British Columbia and southeast Alaska regions showing the density of Atlantic salmon observations. All data are from Fisheries and Oceans Canada's Atlantic Salmon Watch Program: [http://www.pac.dfo-mpo.gc.ca/sci/aqua/ASWP\\_e.htm](http://www.pac.dfo-mpo.gc.ca/sci/aqua/ASWP_e.htm). [accessed May, 2004]. British Columbia data are from 1987 to 2002 and partitioned according to Pacific Fishery Management Areas, and the Alaska data are from 1990 to 2002 and partitioned according to the Alaska Department of Fish and Game Area Polygons.

into British Columbia marine or freshwaters. Besides the species themselves and their attached associates, there is the risk of introducing diseases, parasites or

genetic material into native species. Further, there are concerns over potential ecological displacement of native species. The ITC issues licences to introduce

aquatic species into British Columbia or to transfer species between domestic water bodies.

Shellfish mariculture remains a potential avenue of species introduction to Haida Gwaii. A Masset-based group has investigated the potential for local shellfish mariculture for coastal community economic development. Leased culture operations in Skidegate Inlet and Rennell Sound remain active for Pacific Oyster culture. These operations are unlikely a threat of introducing oysters as local waters are too cold for oyster breeding although they are suitable for growth of certified disease-free juveniles (spat) from culture in southern British Columbia. However, local waters may not be too cold for oysters' parasites or other associated species. From 1997 to 2001, pilot raft culture sites were tested to grow certified disease-free Weathervane Scallop (*Patinopecten* sp.) hybrid (native × Japanese) spat (B. Mark, Masset, personal communication). Only the Rennell Sound site remains active for scallop culture (R. Lozon, Queen Charlotte City, personal communication). The potential for species introduction is likely low, because no successful settlement of hybrid Weathervane Scallops has occurred in British Columbia in the last decade (Island Scallops Ltd., Qualicum Beach, personal communication).

#### *Ships' Ballast Water*

Gauthier and Steel (1998) reported that Canada was receiving approximately 52 million tonnes of ballast water from foreign shipping annually with little protective policy or regulation. Indeed, the major vector of introductions to Pacific North America has been from shipping (Ruiz et al. 2000). Concerning Pacific Canada, Levings (1999) mentioned the Canadian Ballast Water Management Guidelines issued by Transport Canada in 2000 with an Annex (II) for the Pacific coast aimed at preventing introduction of non-indigenous aquatic organisms (<http://www.tc.gc.ca/MarineSafety/>). These Guidelines will become Regulations under the *Canada Shipping Act*.

The Vancouver Port Authority has had a mandatory ballast water program since 1997. It is based on the assumption that mid-ocean ballast water exchange, with water containing pelagic species not likely adapted to coastal conditions, decreases likelihood of introducing viable species into port waters (Levings et al. 2004). Port authorities are now finding, however, that such exchange criteria are only partially effective (C. Levings, Fisheries and Oceans Canada (DFO), personal communication). Other British Columbia ports invoking ballast water management are Nanaimo and New Westminster. The north coast of British Columbia, with an active deep-water international port in Prince Rupert, however, has no ballast water program. Further, Levings et al. (2004) express concern about "intracoastal" transport. For example, from Haida Gwaii there is on-going barge and self-dumping log barge traffic with

southern British Columbia and there has been relatively recent international vessel traffic for mine ore concentrates from Tasu Sound (mine closed 1973) and Harriet Harbour (mine closed 1968).

The ecological effects of introduced species such as invertebrates on the Pacific coast are poorly studied (Carlton 1992). It is sobering to reflect that, once introduced, marine species may be difficult to control and their ecosystem consequences may be damaging (Simberloff 2000; Grosholz 2002). An example is the European Green Crab, *Carcinus maenas*, introduced to the San Francisco Bay area in 1989. The Green Crab has since been recorded from Esperanza Inlet on the northwest coast of Vancouver Island (Jamieson et al. 2002). As active predators, Green Crabs could affect British Columbia intertidal fauna, as they have in California (Grosholz 2000).

Times and attitudes have changed about introductions of marine species. In the 1980s, DFO discussed introduction of the large, predatory Atlantic lobster (*Homarus americanus*) around Haida Gwaii. Barber (1983) concluded that up to 7700 km<sup>2</sup> of Hecate Strait area south of Skidegate Inlet, as well as Masset Inlet, were suitable for lobster introduction. Now, such initiatives are contrary to agency mandates for sustainable, ecosystem-based management.

Among introduced marine species, Atlantic Salmon (*Salmo salar*) currently has the highest ecosystem and socio-political profile in British Columbia (Gross 1998; Volpe et al. 2001). Important issues include escapement and persistence in river systems facilitating competition for spawning habitat with native salmonids. Further, the threat of continuing introductions helps animate the vigorous debate over expansion of salmon farming in British Columbia. Although Atlantic Salmon have been reported from Haida Gwaii coastal waters, there are no salmon farms in Haida Gwaii, and there are no records at this time of Atlantic salmon from within Haida Gwaii rivers and streams (V. Fradette, DFO, personal communication).

This overview of a marine region's introduced species was facilitated through marine species inventories from the historical literature of the Haida Gwaii region. We do not claim that it is complete, but it is a start. It will be important to continue documenting introduced species reports to track the progress of introductions that could affect local marine ecosystem well-being.

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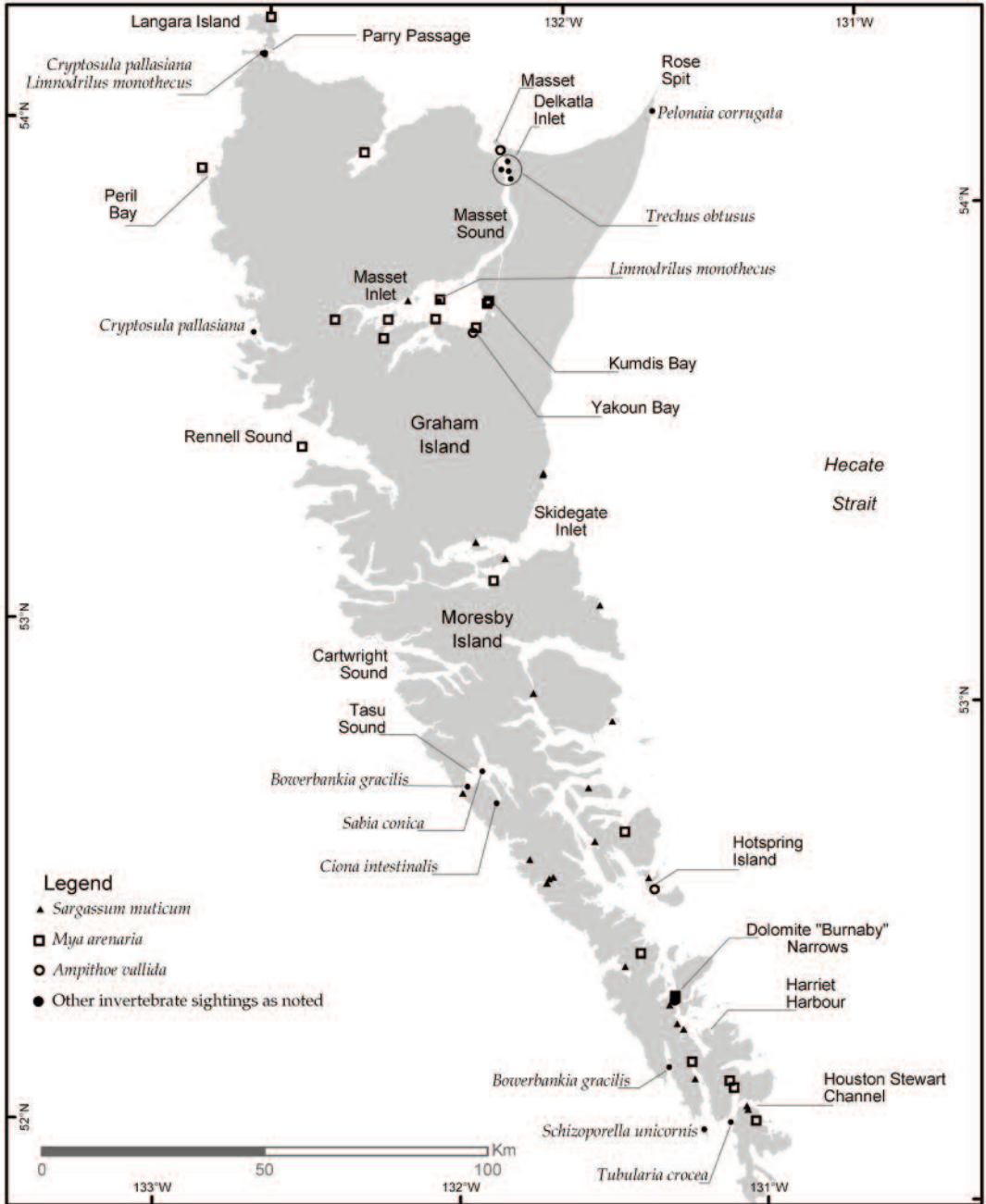


FIGURE 1. Map of Haida Gwaii showing locations mentioned in the text and collection sites of introduced marine plant and invertebrate species, based on data from Sloan and Bartier (2000) and Sloan et al. (2001).