Chapter 9A. Overview of NIS Surveys

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9A1. Purpose

A central goal of this project was to determine whether NIS have been, or are becoming, established within Prince William Sound. Because of the diversity of potential vectors and changing patterns of transport mechanisms, our purpose was to provide as broad and comprehensive a search for NIS as possible with our resources. Since previous ecological and systematic work in Alaska has not focused on NIS, we also wished to provide a baseline for the status of NIS in Alaskan waters, against which future introductions could be measured. Recent and on-going work on NIS along the temperate west coast of North America indicates that many invasive species appear to be spreading northward from a peak of NIS diversity in San Francisco Bay, as well as other highly invaded source ports for ballast water arriving to Prince William Sound. Some of these NIS (e.g., *Carcinus maenas*) have moved rapidly from central California to Washington and British Columbia, and may be expected to reach Alaskan waters in coming years. We focused on Prince William Sound for our field surveys and analysis of existing samples; but because NIS often spread coast-wise, we also sampled ports on the adjacent Kenai Peninsula, and we considered scientific reports broadly from Alaskan waters.

9A2. Approach

To detect recent or well-established NIS in Port Valdez / Prince William Sound and adjoining areas of risk for invasion, we used several methods, including:

- Rapid assessment field surveys of estuarine and marine invertebrates and plants for Port Valdez, Prince William Sound, Seward and Homer. The objective was for experienced general ecologists to survey major habitats and communities, especially for large NIS plants and animals detectable in the field by experienced naturalists.
- Focal taxonomic field collections in Prince William Sound, Seward and Homer. The objective was for taxonomic experts to sample and analyze key taxonomic groups that have known NIS but which are difficult for generalists to identify, providing definitive identification and careful, authoritative assessments of the native, invasive and cryptogenic status. Whenever possible, we also wished the taxonomic experts to have the opportunity to sample the sites using their specialized methods and knowledge for collecting the focal taxon.
- Fouling plate surveys in Prince William Sound, Seward and Homer. The objective was to provide a replicated standard sampling method of assay for NIS in a community that is prone to invasions, but which has received little prior ecological analysis in Alaska.
- Re-examination of museum and reference collections for Prince William Sound. The objective was to re-examine extensive collections already available in the University of Alaska Museum and vouchers samples from Exxon Valdez Oil Spill (EVOS) and other ecological studies, developing a screening method of screening for potential NIS.

Our approach of utilizing this array of methods served to maximize spatial, temporal, taxonomic, and habitat coverage, while still focusing our limited resources upon elements known to be of highest risk of invasion. The field surveys provided broad coverage of Prince William Sound, as

will as Anchorage, Homer and Seward as important ports in neighboring Cook Inlet and the Kenai Peninsula (Fig. 9.A.1).

Figure 9A.1. Map of Sampling Sites for NIS Surveys (1997-1999).

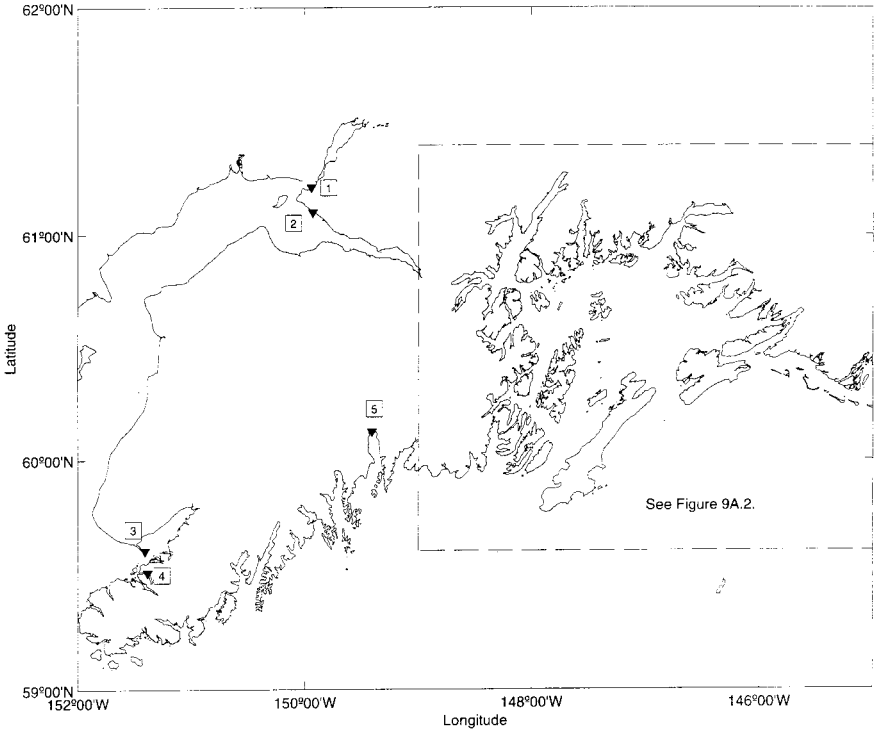
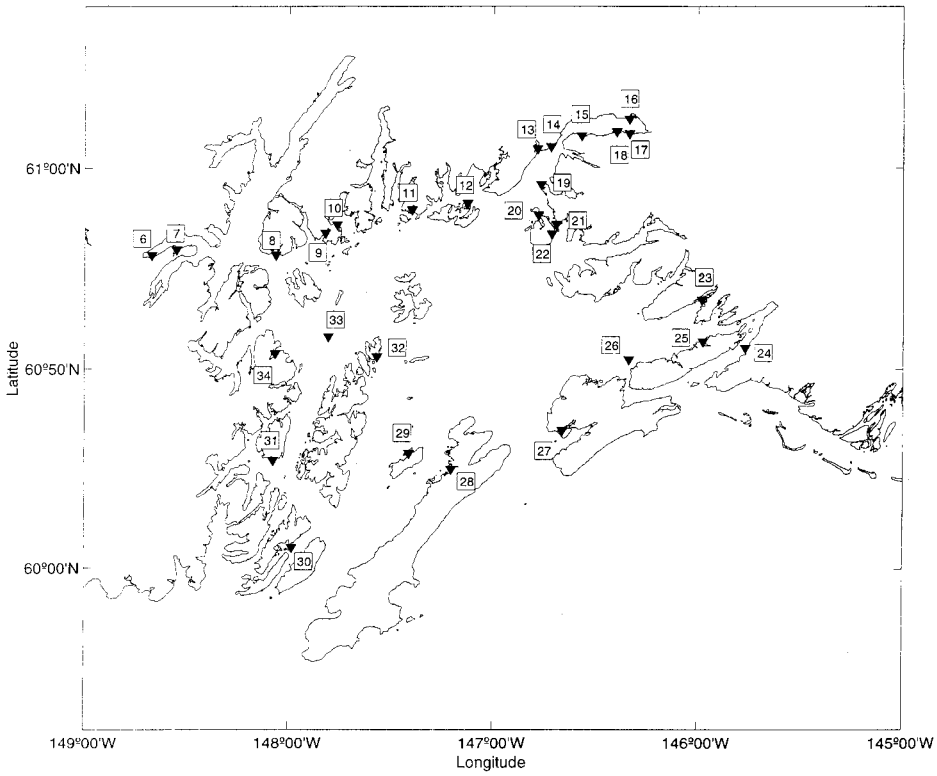


Figure 9A.2. Map of Sampling Sites for NIS Surveys (1997-1999).



In any ecosystem, the ability to detect established NIS varies in space and time, because most aspects of species distribution and abundance are probabilistic. Like any population, NIS populations are typically patchily distributed across the full range of habitats, and may undergo marked seasonal and annual fluctuations. In high latitude ecosystems like Prince William Sound, this variation is extremely pronounced, due to rapid changes in photoperiod and fluctuations in surface salinities resulting from warm season runoff. By using an array of sampling at several times throughout the growing season, we increased the probability of detecting NIS.

In addition to the stochastic aspect of detecting NIS, detection of NIS in Prince William Sound is difficult because the biota is not well described by taxonomists and biogeographers. Despite the extensive sampling in Prince William Sound for EVOS and other ecological programs, there are no comprehensive keys or field guides to the biota of the region (a notable exception is the guide to Alaskan molluscs; Foster 1991). In our Pilot Study (Ruiz & Hines 1997) of Port Valdez alone, we found a surprisingly high percentage of new species records, and our literature analysis showed that 20-50% of the species are cryptogenic in origin.

It was necessary to sample several habitats of Prince William Sound that have received little scientific study. For example, there are almost no publications on the fouling community of floats and pilings, yet NIS are very common in this habitat in west coast source ports, where some of these NIS have been very destructive. Soft-bottom habitats of Prince William Sound have received less study than rocky substrates.

Also, in much of the previous work associated with the Exxon Valdez Oil Spill, taxonomic identifications were not carried out to species but were reported at relatively high taxonomic levels (e.g., Family, Order). Without careful identification to species by expert taxonomists, NIS are often confused with similar native species. Therefore, we brought systematic experts for several focal taxonomic groups to Alaska for field collections or contracted them to identify selected subsets of samples.

9A3. Site selection and sampling design

In addition to a survey of Port Valdez and Sawmill Bay during our Pilot Study in June 1997, we conducted two broad expeditions to survey Prince William Sound for NIS during low tide series of 20-28 June 1998 and 8-16 August 1999. Fouling Plate Surveys were conducted during 7-17 September 1998 and in 8-16 August 1999.

The surveys in September 1998 and August 1999 included sampling stations at Homer and Cordova on the Kenai Peninsula adjacent to Prince William Sound. The survey sampling design focused on invertebrates and plants in a variety of habitats of shallow water, the intertidal zone, and accessible man-made surfaces (e.g., floats, pilings, buoys). We selected sampling sites that were judged to be most susceptible to invasion by NIS:

- areas most likely to be in the path of ballast water discharged from tankers (as estimated by circulation models and the path of the Exxon Valdez Oil Spill);
- ports and sites of sustained disturbance by human activities (especially Port Valdez, Cordova, and Whittier, as well as Homer and Seward);
- habitats associated with previously reported NIS and cryptogenic species;

- warmer water areas;
- marinas, floats, buoys, and pilings with accessible fouling communities; and
- sites of active aquaculture for the Japanese Oyster *Crassostrea gigas*.

Together, these habitats comprise a broad area of the shallow, nearshore margins and islands of Prince William Sound. The survey attempted to gain broad coverage of these habitats, including 46 sites in June 1998, 9 sites for fouling plates in September 1998, and 33 sites including a subset of 7sites for fouling plates in August 1999, which were spread throughout the major regions of the Sound and the port sites of the Kenai Peninsula (see map Fig. 9A.1, Table 9A.1). The survey sampled three major habitats: intertidal and shallow rocky substrates; intertidal and shallow soft sediments; and fouling communities on floats, buoys, pilings and oyster culture structures. The salinity of the array of sites ranged from fresh to fully marine areas of the Sound.

The rapid assessment survey methods were similar to those employed in NIS surveys of San Francisco Bay (Cohen & Carlton 1995) and Puget Sound (Cohen et al. 1998). The approach utilizes a team of experienced naturalists and general ecologists to sample as great a diversity of organisms at as broad an array of sites as possible within the region of concern. The team for the surveys consisted of:

- John Chapman (OSU), general NIS of northeast Pacific and peracaridan crustacea;
- Nora Foster (UAF), marine invertebrates of Alaska, especially mollusca;
- Anson Hines (SERC), barnacles and decapod crustaceans; and
- Todd Miller (Hatfield Marine Science Center), technical assistance and peracaridan crustaceans.

The survey teams utilized a variety of transportation modes to travel among sites throughout Prince William Sound, including vans, ferries, float planes, small boats, vessels of Stan Stephens Tours, and the Fishing Vessel Kristina. Following collecting, samples were processed in temporary laboratories provided by USF&WS Refuge in Homer, the Seward Marine Science Center, University of Alaska in Seward, Prince William Science Center in Cordova, the SERC Invasions Biology Laboratory in Valdez, the Prince William Sound Community College in Valdez, and several hotels. The F/V Kristina also served as laboratory platform for processing of samples while in transit among some of the sites. For each sampling site, the diversity and relative abundance of species were recorded. Field notes included GPS readings, sketches of the sites, salinity and temperature readings, and notes on common or abundant species identified in the field. Samples were collected by hand, by scraper to remove fouling organisms, and by trowel to collect soft sediment. Samples of sediment, algal-invertebrate turf, and scrapings of fouling communities were washed and sieved on 5mm, 1mm and 0.5 mm mesh. Each sample was “rough sorted” immediately after collection to aid in identification of large or delicate specimens and to preserve voucher specimens for subsequent work-up in the laboratory. Voucher samples were preserved in either 70% EtOH or 10% formalin (as appropriate to the type of organism). Voucher samples from the survey have been distributed to appropriate taxonomic experts for definitive identification in the laboratory using microscopes.

TABLE 9A.1. Collecting Sites for NIS Surveys (1997,1998,1999).

Map No.	Site	Station	98 Cruise Station No.	Latitude	Longitude	Rapid Community Assessments			Fouling Plate Surveys	
						1997 Pilot Study	1998 Surveys	1999 Survey	1998	1999
1	Anchorage	Port Anchorage		61º14'N	149º45'W		X			
		Westchester Lagoon		61º13'N	149º50'W		X			
2	Potter	Potter flats		61º05'N	149º40'W		X			
3	Katchemak Bay	Homer small boat harbor						X	X	X
		Homer spit						X	X	X
		Homer spit mudflat						X	X	X
4		Sadie Cove								X
5	Seward	Seward small boat harbor						X	X	X
		Lowell Point								X
6	Whittier	Whittier small boat harbor		60º46'37"N	148º41'24"W		X	X	X	
		Whittier ferry dock		60º46'25"N	148º40'55"W		X		X	
7	Shotgun Cove	Shotgun Cove		60º47'26"N	148º32'30"W		X			
8	Esther Island	Lake Bay buoy	28	60º47'37"N	148º05'01"W		X			
		Lake Bay oysters	30	60º48'00"N	148º05'24"W		X			
9	Squaw Bay	Squaw Bay oysters	36	60º50'00"N	147º49'20"W		X			
10	Eaglek Bay	Eaglek Bay oysters	37	60º51'00"N	147º45'36"W		X			
11	Fairmont Bay	Fairmont Bay oysters					X			X
12	Growler Island	Growler mudflat	38	60º54'15"N	147º07'48"W		X		X	
		Growler dock	39	60º54'13"N	147º07'48"W		X		X	
13	Valdez Arm, Sawmill Bay	Sawmill Bay shore	9	61º03'15"N	146º47'24"W	X	X			
		Sawmill Bay mudflat	10	61º03'23"N	146º47'24"W	X	X			
		Navigation buoy	40	61º03'16"N	146º41'39"W		X			
14	Valdez Arm	Potato Point								X
15	Port Valdez	Anderson Bay				X				
16	Valdez	Duck Flats low intertidal	44	61º07'28"N	146º18'00"W	X		X		
		Duck Flats high intertidal	45	61º08"24"N	146º19'30"W		X	X		
		Floating cargo dock	43	61º07'25"N	14618'36 "W				X	X
		SERVS dock		61º07'25"N	146º21'15"W	X			X	X
		Small boat harbor	46	61º07'25"N	146º21'15"W	X	X	X	X	X
		USCG dock		"	"				X	X
		Ferry dock		"	"					X
17	Port Valdez, Dayville flats	Dayville flats	4	61º04'54"N	146º19'00"W	X	X			
18	Valdez Marine Terminal	Alyeska small boat ramp	1	61º05'12N	146º23'30"W	X	X			
		Alyeska small boat harbor	2	61º05'10"N	146º22'28"W				X	X
		Alyeska entrance	3	61º05'10"N	146º21'55"W					
		Terminal floats	42	61º05'20"N	146º24'09"W				X	X

TABLE 9A.1. (continued) Collecting Sites for NIS Surveys (1997,1998,1999).

Map No.	Site	Station	98 Cruise Station No.	Latitude	Longitude	Rapid Community Assessments			Fouling Plate Surveys	
						1997 Pilot Study	1998 Surveys	1999 Survey	1998	1999
19	Valdez Arm, Rockey Point	Rockey Point	11	60º57'36"N	146º45'36"W		X			
20	Busby Island	South reef	5	60º52'55"N	146º46'29"W		X			
		Busby Island	6	60º52'54"N	146º46'24"W		X			
21	Tatitlek	Tatitlek Narrows oysters	8,12	60º52'06"N	146º43'30"W		X	X		X
		Village dock		60º52'06"N	146º43'30"W		X	X		X
		Ferry dock		60º52'06"N	146º43'28"W			X		X
22	Bligh Island	Cloudman Bay	7	60º50'11"N	146º43'15"W		X			
23	Sheep Bay	Upper Sheep Bay	13	60º52'12"N	146º43'48"W		X			
		Middle Sheep Bay	14	60º40'21"N	145º57'06"W		X			
24	Cordova	Small boat harbor	15,19	60º32'30"N	145º46'28"W		X	X		X
		Mudflat S of Small Boat Harbor	18	60º32'28"N	145º46'28"W		X	X		X
		Marine Science Center	17	60º32'48"N	145º46'27"W		X			X
		Fish Dock & Flats	16	60º32'27"N	145º46'26"W		X			
		Ferry dock		60º32'27"N	145º46'24"W					X
25	Hawkins Island	Windy Bay	20	60º33'54"N	145º58'38"W		X			
26	Orca Bay	Channel Buoy	21	60º32'22"N	146º55'55"W		X			
27	Hinchinbrook Island	Constantine Harbor						X		
28	Montague Island	Port Chalmers							X	X
29	Green Island	Green Island	22	60º18'19"N	145º58'38"W		X			
30	Evans Island	Sawmill Bay	23	60º03'31"N	147º59'47"W		X			
		Port San Juan	24	60º04'2"N	148º03'36"W		X			
31	Chenega Island	Chenega dock					X		X	
32	Eleanor Island	Northwest Bay middle arm	25	60º32'57"N	147º34'48"W		X			
33	Knight Island Passage	Knight Island Passage buoy	26	60º33'52"N	147º49'11W		X			
34	Main Bay	Main Bay	27	60º31'58"N	148º04'41"W		X			
		Main Bay fish hatchery	28	60º31'16"N	148º05'35"W		X			

The experts for the Focal Taxonomic Collections included:

- Gayle Hansen (Hatfield Marine Science Center, Oregon State University), phycologist with special expertise in Alaskan macroalgae;
- John Chapman (Hatfield Marine Science Center, Oregon State University), peracarid crustacea;
- Jeff Cordell (School of Fisheries, University of Washington), copepod crustaceans;
- Nora Foster (University of Alaska Museum), molluscs and other marine invertebrates of Alaska;
- Jeffery Goddard (University of California, Santa Barbara), opisthobranch molluscs
- Jerry Kudenov (University of Alaska, Anchorage), polychaete worms;
- Gretchen Lambert (Friday Harbor Laboratories, University of Washington), ascidians;
- Charles Lambert (Friday Harbor Laboratories, University of Washington), ascidians;
- Claudia Mills (Friday Harbor Laboratories, University of Washington), cnidarian medusae and ctenophora;
- Lise Schickel (University of California, Santa Barbara), decapod crustaceans and parasitic crustaceans;
- Anson Hines (SERC), barnacles and decapod crustaceans;
- Judith Winston (Virginia Natural History Musem), bryozoans; and
- Lea Ann Henry (University of Toronto), hydrozoan cnidarians.

At numerous locations in Port Valdez / Prince William Sound, sediment samples were collected for identifications of foraminiferans, particularly the Asian NIS *Trochammina hadai*, which is extensively introduced in San Francisco Bay and other west coast source ports. This NIS was reported from deep-water samples taken for the Exxon Valdez Oil Spill study. Samples were processed and sent to Mary McGann of US Geological Survey, Menlo Park, CA, for identification.

Other details of the methods are provided below within the individual chapters for each Focal Taxonomic Collection, the Fouling Community Analysis and the Re-examination of the Museum, Reference and Voucher Collections.

9A4. References

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