Alaska Natural Heritage Program
Environment and Natural Resources Institute
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The Distribution of the Freshwater Mussels *Anodonta* spp. and *Margaritifera falcata* in Alaska

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Final Report

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EXECUTIVE SUMMARY

In June 2004 the Alaska Natural Heritage Program (AKNHP), University of Alaska Anchorage, entered into a grant agreement with the U. S. Fish and Wildlife Service's (USFWS) Coastal Program to gather baseline distribution data on three freshwater mussel species: *Anodonta beringiana, Anodonta kennerlyi,* and *Margaritifera falcata.* In addition to this work, a modification to the original grant enabled the project to concurrently investigate the presence of two invasive mollusks, the Zebra Mussel (*Dreissena polymorpha*) and the New Zealand Mudsnail (*Potamopyrgus antipodarum*). This report summarizes the methods and results of the study and makes recommendations for future research and management of freshwater mussels in Alaska.

The distribution, abundance, and ecological roles of the three dominant freshwater mussel species in Alaska have been poorly documented. The objective of this study was to conduct a survey of freshwater mussel populations in lakes and streams of Southeast Alaska, Prince William Sound, Kodiak Island, the Aleutian Islands and the Alaska Peninsula to enhance current knowledge of their distribution, composition, and habitat preferences. Additionally, the project strove to promote public education about mussel ecology and conservation. A third goal was to determine whether two non-native mollusk species had already invaded Alaska and to investigate the potential for certain vectors of introduction.

This project relied largely on volunteer support from researchers within state and federal agencies as well as the general public. Agency personnel, particularly those with projects in aquatic environments, were contacted and petitioned to volunteer. Collected shell specimens were returned to the project coordinator for identification. Participants were also given information concerning the two aforementioned invasive species and asked to sample for their presence and freshwater mussel presence simultaneously. To investigate the potential for invasive species entering Alaska via personal watercraft and boats, surveys were conducted in campgrounds and RV parks in and around Anchorage and on the Kenai Peninsula. From these surveys, information was obtained about the ratio of boats to vehicles registered at campgrounds. Whenever possible, watercraft were visually inspected for the presence of potentially invasive mollusks.

A total of 195 native mussel specimens were collected by 36 individuals at 77 different locations during the 2004 surveys. These results greatly expand the record of freshwater mussel distribution in Alaska and increase the probability that only the three species collected are indigenous to Alaska. No invasive species were detected by any project participants and campground surveys indicated less than one percent of visitors who drive to Alaska bring boats or watercraft with them.

Freshwater mussels are an important part of the ecosystems they inhabit and should no longer be ignored in resource management planning. The information garnered in this study should be used to continue researching mussel populations and their use as bio-indicators of the aquatic environment. The establishment of non-native mollusks should be monitored, and educational programs continued to involve the public in the prevention of invasive species establishing in Alaska.

Introduction

Freshwater mussels inhabit watersheds throughout Alaska, yet they are often overlooked. Available literature and specimen data indicate that as many as three species of freshwater mussels may inhabit Alaskan rivers and lakes, but little is known about species distribution south of 61° N latitude. Freshwater mussels are good indicators of environmental conditions because they are long lived, they bio-concentrate contaminants, and they are sensitive to changes in environmental conditions (Havlik and Marking 1987; Williams and Neves 2003). Freshwater mussel larvae are obligate parasites of specific host fish, so their existence is closely tied to certain fish populations.

In some river drainages, mussel populations have declined due to competition from introduced species (Dillon 2000). Thirty-five freshwater species have gone extinct as a result of human-caused habitat loss and 64 species are currently listed as endangered (Master and Flack 1997). To raise public awareness about declining populations and to provide resource managers with up-to-date information, agencies such as the U. S. Fish and Wildlife Service, U. S. Geological Survey, Natural Heritage programs, and non-game wildlife programs in several states have compiled information on distribution, life history and conservation status of freshwater mussels in the Midwest U.S. (www.midwest.fws.gov/mussel).

Alaskan waters contain three known species of freshwater mussels: *Anodonta beringiana*, *Anodonta kennerlyi*, and *Margaritifera falcata*. *Anodonta beringiana*, the Yukon floater, is a Beringian endemic that occurs in lakes in the Yukon River drainage, Alaska, and in Chukotka and Kamchatka, Russia. *Anodonta kennerlyi* has a more southerly distribution, although it may overlap with *A. beringiana* in northern reaches. *Margaritifera falcata* is a river dweller, with limited distribution records from Prince of Wales Island, Revillagigedo Island, and the Stikine River in Southeast Alaska (Clarke, 1981; UAF Museum records; Reger, unpublished data). Other species such as *Anodonta oregonensis, Anodonta nuttalliana*, and *Gonidea angulata*, which occur in adjacent watersheds in British Columbia and Washington, may also be endemic to Southeast Alaska (NatureServe 2003). Although current collections made throughout the state indicate that mussel populations are healthy, there has been a lack of systematic collecting that would help to answer questions about species distribution and composition, dispersal, life cycle, and response to environmental changes.

The distribution, abundance, and ecological roles of Alaska's freshwater mussel species have been poorly documented. The objective of this study was to conduct a survey of freshwater mussel populations in lakes and streams of Southeast Alaska, Prince William Sound, Kodiak Island, the Aleutian Islands and the Alaska Peninsula to enhance current knowledge of their distribution, composition, and habitat preferences. Additionally, the project strove to promote public involvement and education about mussel ecology and conservation. A third goal was to determine whether two non-indigenous mollusk species, the Zebra Mussel (*Dreissena polymorpha*) and the New Zealand Mudsnail (*Potamopyrgus antipodarum*) had already invaded Alaska and to investigate the potential for certain vectors of introduction. Both non-native species are cold water tolerant and have infested large areas of the contiguous U.S., displacing native mollusks The Zebra Mussel is a freshwater species that was introduced into the Great Lakes in 1986 and has quickly spread from the 100th meridian east. Because these species tolerate cold water, their introduction to Alaska could be ecologically disastrous to the state .

Study Area

The study area included freshwater lakes and rivers anywhere in the state south of 61°N latitude (Figure 1). Particular emphasis was made to obtain collections from Southeast Alaska, Prince William Sound, Kodiak Island, the Aleutian Islands and areas along the Alaska Peninsula. Collections to the north of 61°N latitude were also included when unsolicited samples were obtained or when, as occurred in a few cases, special requests to join the project were received.

Figure 1. Map of Alaska - area highlighted in yellow indicates study area focus.

Methods

Volunteer Recruitment and Project Advertisement

The project relied largely on volunteer support from researchers within state and federal agencies as well as the general public. Agency personnel, particularly those with projects in aquatic environments, were contacted and petitioned to volunteer. It was assumed that many participants would gather samples as an adjunct to their own field work. To help advertise the mussel survey project, we developed a web page that was hosted by the Alaska Natural Heritage Program (AKNHP) at http://aknhp.uaa.alaska.edu/mussels/Mussels_Home.htm, and was linked to the Alaska Freshwater Mussel Workgroup website at http://www.stikine.org/sri_akmussels_listinfo.htm. The website provided interested parties with an overview of mussel ecology, detailed information concerning mussel collection techniques, instructions on how to participate in surveys, and coordinator contact information. Survey participants were able to download data sheets directly from the web-site.

Public presentations were advertised through posters and email announcements. A PowerPoint presentation was developed as a visual aid for use during presentations. Displays of freshwater mussel shells were available for viewing during each presentation.

Specimen Collection

While shell characteristics are not always the most reliable method of identification for mussel species, shells are easy to collect and transport. Since we anticipated a high volume of collections would come from remote areas, we chose shell collection as the sampling method. Interested participants were supplied with mussel collection kits. Each kit consisted of a self-addressed pre-paid mailing tube, plastic bags for shell specimens, and data sheets. Also included was information about common habitats where mussels could be found, collection instructions, and information describing the ecology of invasive species, the Zebra Mussel and the New Zealand Mudsnail.

Specimens were frozen until ready to process. Shells were cleaned and preserved by coating with petroleum jelly to prevent cracking, then identified to species by Steven Smith and Nora Foster using shell characteristics. *Margaritifera falcata* shells were easily identified by the hinge teeth they possess as well as by the more streamlined shape and thicker shell material. The *Anodonta* species, which are often very similar in shape, were ultimately identified by the coloration of the periostracum and nacre. Identification of some *Anodonta* specimens collected in Southeast Alaska proved problematic, and these were referred to Dr. Terry Frest at Deixes Consultants for species confirmation. Specimen data including collector, collection location, date and species were entered into a database that was developed specifically for this project.

Kenai Peninsula Survey

A survey of road accessible lakes and streams on the Kenai Peninsula was conducted June 12–14 and July 18–20, 2004 by project member Steven Smith. The first leg began at Homer, on the southern terminus of the Sterling Highway, and progressed northward until reaching the intersection of the Sterling and Seward Highways. The second leg began at the Sterling and Seward Highway intersection and continued east on the Seward Highway, ending at the town of Seward. The last leg explored areas west of the Sterling-Seward Highway intersection

on the Seward Highway, continuing north from there to Anchorage (Figure 2). Habitat accessible by primary roads was explored as time permitted. Roads that required four-wheel drive vehicles were not explored.

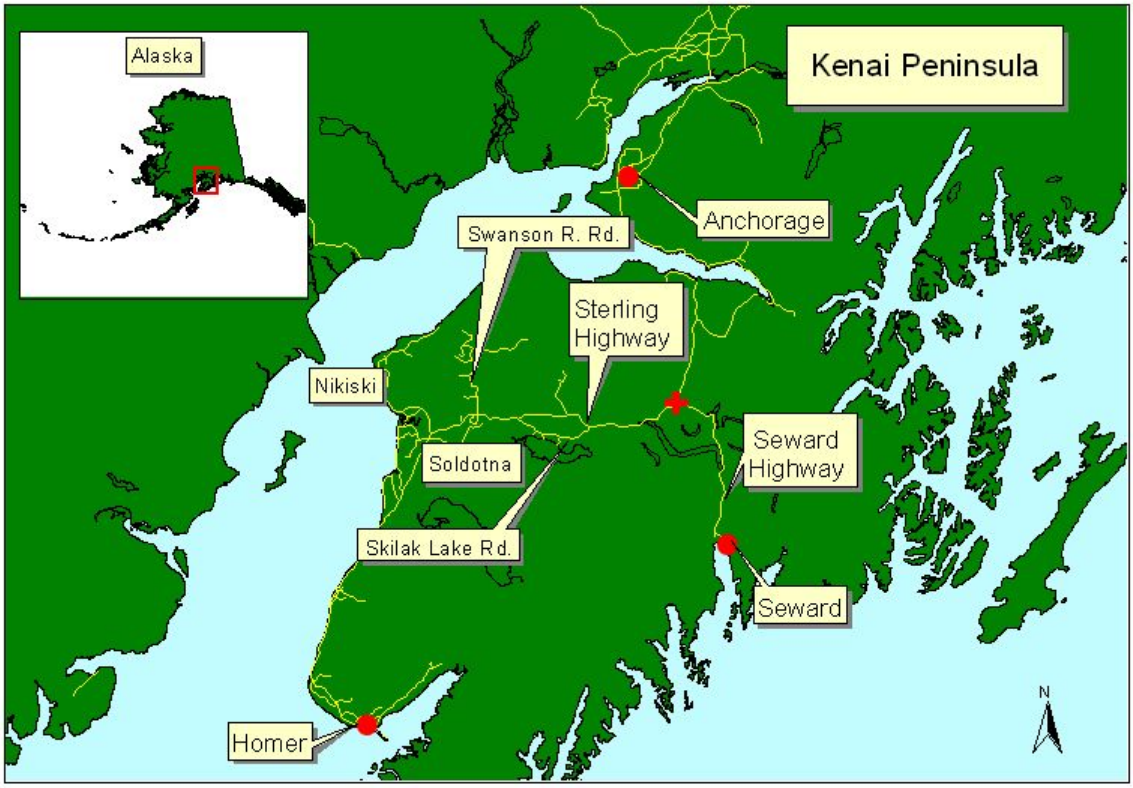

Figure 2. Map depicting the road system and area surveyed on the Kenai Peninsula, June and July 2004.

Lakes and streams were inspected visually from the shore for live mussels or shells of dead specimens. A clear bottom bucket was employed when surface visibility was low or to gain a view of the bottom to a greater depth. When mussels were discovered, a small mesh net was used to extract the specimen from the substrate. Specimens were stored in ice until they could be processed and placed in a freezer to await preservation and identification. If several specimens of the same species were found in an individual stream or lake, only one specimen was collected.

Thorne Bay Area Survey

On July 11-17, 2004, Nora Foster, with the assistance of Forest Service personnel led by Brandy Prefontaine, conducted a road accessible survey of lakes and streams in the Thorne

Bay area of Southeast Alaska (Figure 3). Collection methods were similar to those described for the Kenai Peninsula survey.

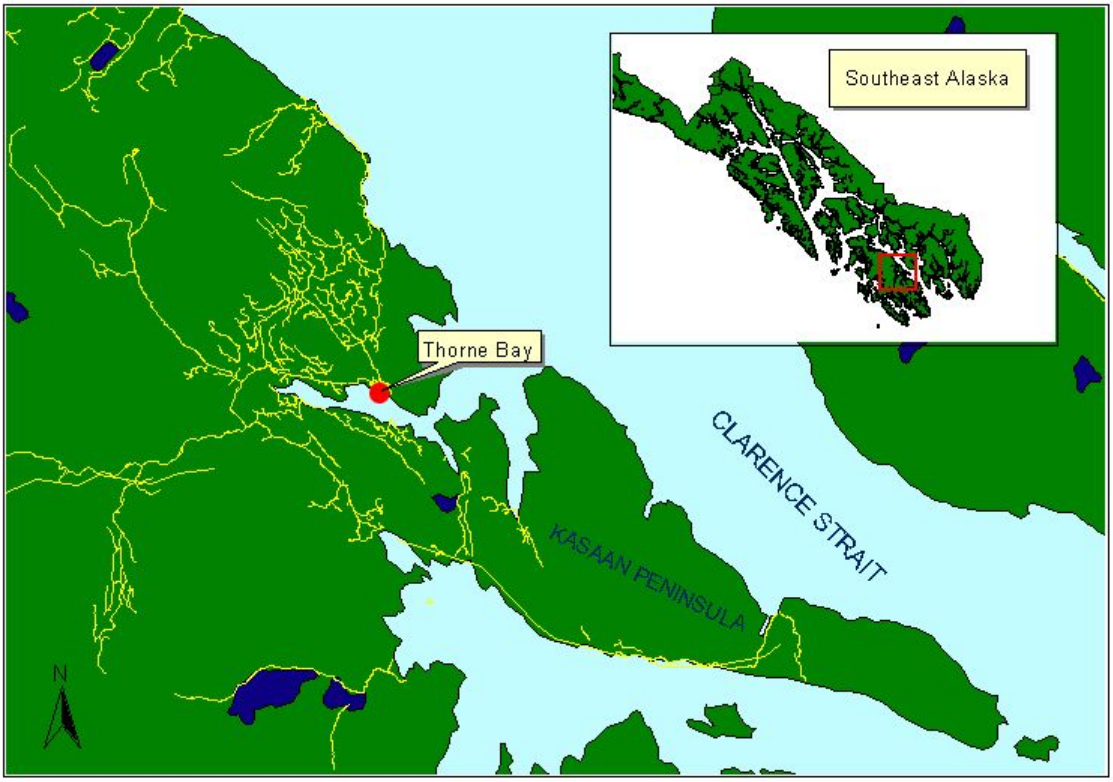

Figure 3. Map of the road system where surveys were conducted in and around the Thorne Bay area, Southeast Alaska, July 2004.

Invasive Pathways Surveys

A secondary component of this project was to provide educational materials to project participants and the general public about the potential danger of invasive species introductions to Alaska. A page was added to the AKNHP freshwater mussel website that provided information on two potential invasive species: the Zebra Mussel and the New Zealand Mudsnail. Included on this web page was a physical description of these species as well as conservation information describing the need to prevent such species from entering and gaining a foothold in Alaska. If a potential invasive species was encountered, observers were advised to contact the Alaska Department of Fish and Game or the U.S. Fish and Wildlife Service and the Freshwater Mussel Project coordinator. Similar information was distributed in the collection kits sent to project participants in hopes that areas surveyed for indigenous mussel species would also be inspected for the presence of invasives.

During June and July, 2004, a non-systematic survey around the Anchorage Bowl and Kenai Peninsula was undertaken to count the number of boats and personal watercraft being brought into the state by summer visitors. This information was collected to assess the potential for invasive aquatic species introductions through this mechanism. Campgrounds and RV parks in Anchorage and on the Kenai Peninsula were surveyed. Each park was visited once during summer 2004 and the number of vehicles registered was compared to the number of boats or watercraft accompanying those vehicles. When an out-of-state boat was encountered, every effort was made to gain permission to inspect the boat for the presence of invasive species. Whenever possible, the management of each park was questioned regarding the number of watercraft brought into the park prior to the survey in 2004 and annually in other years.

U.S. Customs officials, now under the Department of Homeland Security, were contacted and questioned regarding the number of boats moving across the Canada-Alaska border each year.

Results

Public Awareness and Recruitment

Most potential participants learned of the mussel survey through the project web-site, e-mail announcements sent to agency personnel or through co-workers. A total of 95 collection kits were distributed to 34 participants during the 2004 field season (Appendix A). The majority of participants were agency personnel from the U.S. Fish and Wildlife Service, Alaska Department of Fish and Game, U.S. Forest Service, and the National Park Service.

Specimen Collections, Composition and Distribution

Prior to collections made during this study, a total of 35 specimen records existed for freshwater mussels in Alaska (31 for *Anodonta beringiana*, 3 for *A. kennerlyi*, and 1 for *Margaritifera falcata*) (R. Reger, unpub. data, S. Smith, unpub. data). An additional 195 mussel specimens were collected by 36 individuals at 77 different locations during surveys in 2004 (this includes specimens collected during the Kenai Peninsula and Thorne Bay surveys) (Table 1; Figures 4 & 5).

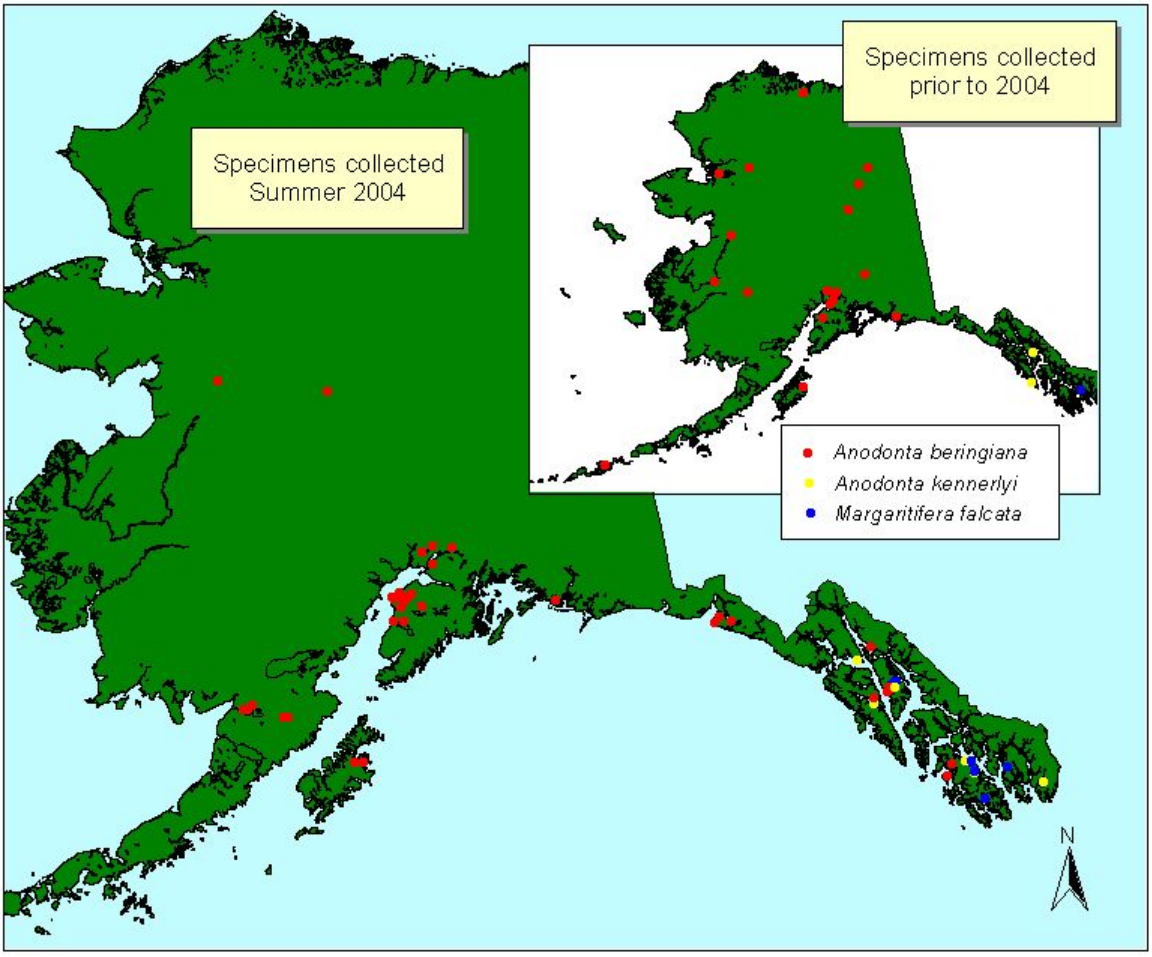

Figure 4. Map showing locations of freshwater mussels collected during summer 2004 and prior to 2004.

Table 1. Freshwater mussel specimens collected by species and region, summer 2004.				
	Number of locations within area			**Total**
Area	***A. beringiana***	***A. kennerlyi***	***M. falcata***	**Collections**
Alaska Peninsula	5			10
Copper River Drainage	2			9
Interior	4			7
Kodiak Island	3			10
Kenai Peninsula	25			37
Southcentral Alaska	4			17
Southeast Alaska	11	11	12	105
Total	**54**	**11**	**12**	**195**

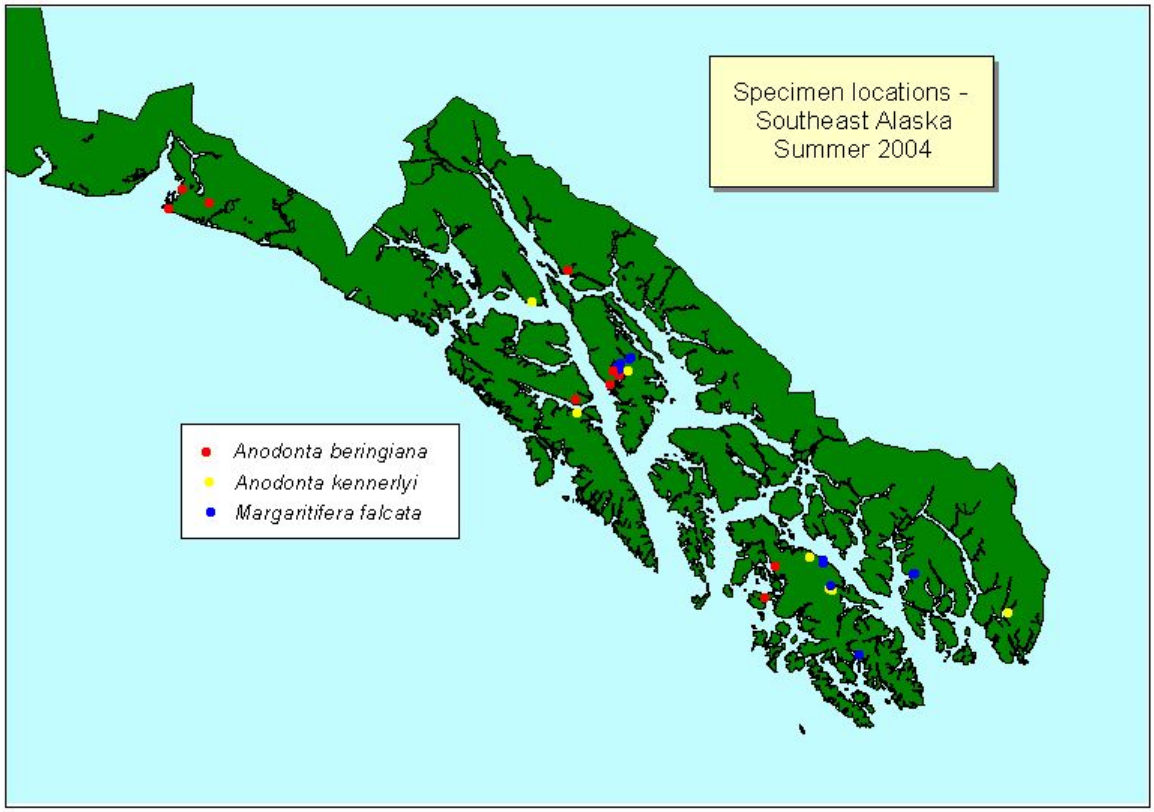

Figure 5. Close-up map showing locations of freshwater mussels collected in Southeast Alaska during summer 2004.

The 195-specimen sample was comprised of three species: *Margaritifera falcata*, *Anodonta beringiana*, and *Anodonta kennerlyi*. *A. beringiana* (Figure 6), a lake and pond dweller, was the most abundant freshwater mussel detected during surveys, with 105 specimens gathered from 54 unique locations (Table 1). *A. beringiana* was located in every region where samples were taken, including the Alaska Peninsula, Copper River Drainage, Interior, Kodiak Island, Kenai Peninsula, Southcentral, and Southeast (Table 1). The greatest number of specimens for this species, 59 and 37, were collected in the Southeast and the Kenai Peninsula regions of the state, respectively.

Figure 6. *Anodonta beringiana* specimen collected at JoJo Lake, Katmai National Park, Alaska.

M. falcata (Figure 7), a river-dwelling species, was found only in Southeast Alaska where 33 specimens were collected at 12 different locations (Table 1).

Figure 7. *Margaritifera falcata* specimen collected at the Naha River in Southeast Alaska.

Similar to the distribution of *M. falcata, A. kennerlyi* (Figure 8) was found only in Southeast Alaska, where 44 specimens were collected from 11 unique locations.

Figure 8. A specimen of *Anodonta kennerlyi* taken from Luck Lake, Southeast Alaska.

Participants also collected seven freshwater and thirteen marine clams from various locations in Southeast Alaska.

The directed surveys on the Kenai Peninsula resulted in the documentation of 21 new records for *A. beringiana*. The similar surveys conducted in the Thorne Bay area documented two new records for *A. kennerlyi* at Boyd and Angel Lakes and one new record for *M. falcata* at Thorne River.

Invasive Species Component

A survey of the four largest RV-camper parks in Anchorage (listed in Appendix C) was conducted July 6-9, 2004. A total of 516 vehicles were registered during that period for the four parks combined. Only two water-craft were observed in the RV-parks during the survey (Appendix C). Both were small lake-boats that had been towed up the AlCan Highway to Alaska from the contiguous United States. One boat was inspected with permission of the owner; no indication of the presence of invasive species was detected. The other boat was inspected to a lesser degree without encroaching on the owner's privacy, as they were not available; no sign of invasive species was noted. Managers for the four parks estimated that nine boats had been through their combined campgrounds during summer 2004 (this estimate

includes those noted during surveys) (Appendix C). Based on limited observation, the percentage of visitors traveling with watercraft to these four campgrounds was very low, or 0.39% (2 out of 516) during survey dates, which subsequently corresponded to the summer peak in tourism.

On the Kenai Peninsula, seven RV-camper parks were surveyed over two three-day periods in July and August of 2004. A total of 245 vehicles were counted; of these, two vehicles were towing watercraft. Thorough inspections of the watercraft were not possible as the boat owners could not be located; however, a cursory inspection yielded no evidence of invasive species. The percentage of visitors to these parks who had traveled with watercraft (2 of 246) was 0.82% during the survey period (Appendix C).

Personnel from the Dept. of Homeland Security who guard the U.S.-Canadian border had no specific information about the annual number of watercraft entering Alaska from Canada. Two former border guards were interviewed and each estimated between 75 to 100 watercraft passing into Alaska from Canada during an average year, although this type of information is not officially recorded.

Discussion

A New Distributional Picture

Data gathered during the course of this study, in combination with previously recorded specimen locations, helped to achieve the goal of better defining the distribution and known range of freshwater mussel species occurring in Alaska. The collections made during this study greatly increased the number of location records for the three known freshwater mussels species in the state. Specifically, new records for *Margaritifera falcata* and *Anodonta kennerlyi*, for which few records existed prior to the study, expanded our knowledge of their ranges considerably. Prior to this study, the occurrence of *M. falcata* in Alaska was based on one specimen collected in Naha Bay, near Ketchikan on Revillagigedo Island. As a result of this study, this species was found in twelve new locations in the southeast, extending its known range north to Admiralty Island and west to Heta Lake on Prince of Wales Island. Similarly, only two historical records were available for *A. kennerlyi* prior to this study; one from Alexander Lake on Admiralty Island and the other from farther southwest in Bear Bay

on Baranof Island. The 11 new occurrences for this species documented during surveys expanded their known range in the north to Neva Lake, southeast of Gustavus, and southward to Hugh Smith Lake in Misty Fiords National Monument. No new freshwater mussel species were discovered during the course of this study.

New Host Fish Discovered

Four potentially new host fishes for *Anodonta beringiana* were discovered during this study by Joe Miller, fisheries biologist at Katmai National Park. Miller, with help from other Park Service personnel, described four previously unreported fish species infested with mussel glochidia during research at JoJo Lake. These potential host fishes were identified as the nine-spined stickleback (*Pungitius pungitius*), the slimy sculpin (*Cottus cognathus*), the Alaska blackfish (*Dallia pectoralis*), and the Kokanee salmon (landlocked *Oncorhynchus nerka*). These are the first new records of potential host fish for *A. beringiana* since a study by Cope (1959) indicated the Chinook salmon (*Oncorhynchus tshawytscha),* the Sockeye salmon (anadromous *Oncorhynchus nerka),* and the Three-spined stickleback (*Gasterosteus aculeatus)* were probable host fish. The viability of free-living juveniles resulting from the parasitization of the newly discovered fish by glochidia has not yet been confirmed, however.

Species Identification

Identification of *Anodonta* species using only shell characteristics is often problematic because different species that inhabit the same range may appear similar morphometrically. This is true of the two *Anodonta* species that occur in Alaska. Some juvenile *A. beringiana* exhibit a light brown and/or greenish periostracum that is markedly different from the dark brown color of other juveniles and of nearly all mature animals of this species. Furthermore, this light brown coloration is similar to mature specimens of *A. kennerlyi.* Shell shape of the two species can also be similar for some pairs of individuals. *A. beringiana* often have umbos that are more inflated than those of *A. kennerlyi*, whose umbos never extend far above the hinge line (Clarke 1981). The extent to which the umbos are inflated, however, may be identical for younger *A. beringiana* and mature *A. kennerlyi*. In this study, when shell shape proved to be inconclusive as an identification tool, nacre and periostracum coloration were used to make the final species determination.

Based on extensive handling of *A. beringiana* specimens from many parts of the state, *A. beringiana* nearly always has a gun-metal blue (pearlescent) nacre in extremely young as well as in mature animals. The nacre of *A. kennerlyi* is more white than blue, but it should be noted that *A. beringiana* shells that have weathered for a month or more will exhibit a washed out color that is very close to the whitish blue of the *A. kennerlyi* nacre. Therefore, it is important that shell age be considered, especially if the shell is found as a remnant or as part of a midden pile. In this study, specimens classified as *A. kennerlyi* all possessed a much lighter brown periostracum as well as a whiter nacre than those considered to be *A. beringiana*.

The overall taxonomic classification of *Anodonta* species throughout the Pacific Northwest is still a matter of question and debate. Classification of *A. kennerlyi* used in this project is potentially problematic when compared to specimens from the Pacific Northwest, whose valves are generally more inflated and beak sculpture more ornate (Clarke 1981; Dr. Terry Frest, pers. comm.). New studies are currently underway and others are being planned (Pacific Northwest Freshwater Mussel Workgroup, July 2005 annual meeting) that will utilize DNA analysis to help clarify the identification of these species. Based upon the results of DNA studies, it is possible that the species referred to as *Anodonta kennerlyi* in this study may be re-classified. What is certain, however, is that two distinct *Anodonta* species are inhabitants of Alaskan waters. Identification of the *Margaritifera falcata* specimens were never in question because of the unique characteristics of these animals compared to *Anodonta* spp.. It can now be said with greater certainty that only three freshwater mussel species inhabit Alaska waters, although the precise taxonomic classification of one species, *Anodonta kennerlyi*, may need genetic clarification..

The Threat of Invasive Molluscan Species

The invasive species component of this project sought to gather information on potential vectors for introduction into the state, and to evaluate the magnitude of potential introduction by gathering information on the number of watercraft being transported to Alaska each year from the Lower 48, Canada, and elsewhere. Although surveys did not cover the entire state, they did cover a large area that included many important water systems that receive high boat traffic from both tourists and residents during summer months. Surveys conducted at

campgrounds were designed to obtain a rough estimate of the percentage of summer visitors that bring personal watercraft to Alaska. Survey size was small and surveys were not systematic, so results obtained through this method should not be considered conclusive. With consideration to these caveats, our results indicate that a very low percentage of visitors to Alaska during summer months bring boats with them and the potential for invasive species introductions from boat hulls and ballast is also probably low. In light of the growing concern about and expanding range of the Zebra Mussel and New Zealand Mudsnail, this subject warrants further investigation.

Recommendations

The results of this study should be viewed as a starting point for future research on Alaska's freshwater mussels. Studies addressing specific questions about freshwater mussel populations as well as studies of ecological impact and water contamination using mussels as bio-indicators are needed in the future. Also, the close relationship between freshwater mussels and host fishes should be considered when studies of fish populations are conducted. With many questions still unanswered about Alaska freshwater mussel ecology, it is hoped that this study will provide some direction and impetus for those wishing to conduct future research. For this reason, the major portion of shell specimens collected during the study will be housed at the University of Alaska Fairbanks Museum, as part of its permanent Aquatics Collection.

It is recommended that state and federal agencies whose task it is to preserve and manage fish and wildlife resources will consider freshwater mussels when planning and implementing management strategies. Populations of *Margaritifera falcata,* in particular, may deserve special protection. This species is apparently widespread on Prince of Wales and Admiralty Islands, where extreme heat and dryness during recent summers may have caused high mortalities in the Thorne River drainage.

It is further recommended that future studies of freshwater mussel taxonomy utilize the distributional information gained in this study. In particular, the relationships between *Anodonta kennerlyi, A. oregonensis* and *A. beringiana* have not been established, and may best be resolved by continued sampling and DNA analysis.

Several recommendations can be made regarding the possible future introduction of invasive aquatic species to Alaska. Primarily, the effort should continue on the part of USFWS and other agencies to educate the public about the dangers of invasive introductions and the steps that can be taken to prevent them. Additionally, since this study obtained only rudimentary knowledge of the number of watercraft entering the state from elsewhere, a more thorough survey is recommended to assess that introduction pathway using the enlistment of border crossing personnel, if possible. Finally, a state of continued vigilance must be maintained by all fisheries and resource workers for the presence of the Zebra Mussel, the New Zealand Mudsnail and for others.

ACKNOWLEDGEMENTS

This project was supported by the U.S. Fish and Wildlife Service, Coastal Conservation Grants program, Anchorage, Alaska, and the Alaska Natural Heritage Program, University of Alaska Anchorage. We would like to thank, Dr. Terry Frest of Deixes Consultants, who volunteered his time to provide analysis of problematic specimen identification. Both Al Smith and Jen Stone of the Pacific Northwest Freshwater Mussel Workgroup graciously answered a myriad of questions concerning their experiences in researching freshwater mussels in their area. A special acknowledgement goes out to Phil Brna of the USFWS for his ideas on project methods and management that led to the successful recruitment of the participants necessary to bring the project to fruition. We wish to thank Jodi McClory for editorial comments that helped improve this manuscript. Lastly and above all, we would like to thank all those who participated in the collection of samples, either directly or indirectly, without whom this project would not have been a success.

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APPENDIX A. Table of mussel collection locations including latitude, longitude, and water body name, collector name, and fish species associated with individual water bodies.

Specimen	Collector Name	Waterbody	Latlong (dms or NAD27)	Type	Species & Number	Fish species	Env. Factors
AP 1	Richard Russel	Eskimo Creek	N58 42 00 W156 30 00	NSd	A. beringiana (2)	AB	none
AP 2	Joe MIller	JoJo Lake	N58 35 00 W155 14 00	NL	A. beringiana (1)	KS, TSSt, NSSt	none
AP 3	Joe Miller	Grosvenor Lake	N58 36 00 W155 04 00	NL	A. beringiana (1)	NP, SS	none
AP 4	Richard Russel	Hidden Lake	N58.70240 W156.64511	NL	A. beringiana (1) **SR**	AB	none
AP 5	Richard Russel	King Salmon Creek	N58.79116 W156.35493	NS	A. beringiana (5)	AB	none
CRD 1	Ken Hodges	Alaganik Slough	N60 25 46 W145 17 71	NS	A. beringiana (4) **P**	TSSt, CoS	Dam, beaver
CRD 2	Ken Hodges	Alaganik Slough	N60 25 50 W145 17 44	NS	A. beringiana (5) **P**	TSSt, CoS	Dam, beaver
INT 1	Melanie Hans	Nowitna River	N64 28 00 W153 37 00	NS	A. beringiana (1)	not listed	none
INT 2	Melanie Hans	unnamed pond	N64 34 54 W158 16 21	NL	A. beringiana (4)	not listed	none
INT 3	Melanie Hans	Koyokuk River	N65 48 00 W155 08 00	NS	A. beringiana **DNS(1)**	not listed	**LocAppx**
INT 4	Melanie Hans	Dulbi River	N65 17 00 W155 06 00	NS	A. beringiana **DNS(1)**	not listed	**LocAppx**
KO 1	Susanne Schmidt	Lake Catherine	N57 46 310 W152 46 585	NL	A. beringiana (3)	not listed	none
KO 2	Susanne Schmidt	Lake Catherine	N57 45 988 W152 29 894	NL	A. beringiana (3)	SS	none
KO 3	Susanne Schmidt	Lake Louise	N57 45 857 W152 29 988	NL	A. beringiana (4)	SS	none
KP 1	Mari Reeves	unnamed pond	N60.28361 W150.91994	NL	A. beringiana (3)	not listed	none
KP 2	Mari Reeves	Mouse Lake	N60.77113 W150.55821	NL	A. beringiana (4)	not listed	none
KP 3	Larry Marsh	Island Lake	N60 43 00 W151 18 00	NL	A. beringiana (5)	RT	none
KP 4	Pam Russell	East Mackey Lake	N60 31 54 W150 59 31	NL	A. beringiana (4)	NP	none
KP 6	Steve Smith	Jenn Lake	N60 32 62 W150 10 62	NL	A. beringiana (1)	not listed	none
KP 7	Steve Smith	unnamed pond	N60 17 12 W151 17 04	NL	A. beringiana (1)	not listed	none
KP 8	Steve Smith	Swanson River	N60 48 00 W151 01 00	NS	A. beringiana (1)	not listed	none
KP 9	Steve Smith	Stormy Lake	N60 47 00 W151 02 00	NL	A. beringiana (1)	not listed	none
KP 10	Steve Smith	S. E. Twinlake	N60 43 00 W151 10 00	NL	A. beringiana (1)	not listed	none
KP 11	Steve Smith	Barbara Lake	N60 43 00 W151 09 00	NL	A. beringiana (1)	not listed	none
KP 12	Steve Smith	unammed lake	N60 43 00 W151 10 00	NL	A. beringiana (1)**JUV**	not listed	none

APPENDIX A. Continued.

Specimen	Collector Name	Waterbody	Latlong (dms or NAD27)	Type	Species & Number	Fish species	Env. Factors
KP 13	Steve Smith	unammed lake	N60 43 00 W151 11 00	NL	A. beringiana (1)	not listed	none
KP 14	Steve Smith	unammed pond	N60 43 05 W151 12 00	NL	A. beringiana (1)	not listed	none
KP 15	Steve Smith	unammed lake	N60 44 05 W151 06 00	NL	A. beringiana (1)	not listed	none
KP 16	Steve Smith	unammed lake	N60 44 00 W151 05 00	NL	A. beringiana (1)**JUV**	not listed	none
KP 17	Steve Smith	unammed lake	N60 38 00 W150 51 00	NL	A. beringiana (1)**JUV**	not listed	none
KP 18	Steve Smith	Wick Lake	N60 42 00 W151 13 00	NL	A. beringiana (1)	not listed	none
KP 19	Steve Smith	unnamed pond	N60 38 05 W150 52 00	NL	A. beringiana (1)	not listed	none
KP 20	Steve Smith	unnamed pond	N60 40 00 W150 53 00	NL	A. beringiana (1)	not listed	none
KP 21	Steve Smith	unnamed lake	N60 42 05 W150 45 05	NL	A. beringiana (1)	not listed	none
KP 22	Steve Smith	unnamed lake	N60 43 00 W150 47 00	NL	A. beringiana (1)**JUV**	not listed	none
KP 23	Steve Smith	Camp Island Lake	N60 38 00 W150 50 00	NL	A. beringiana (1)	not listed	none
KP 24	Steve Smith	unnamed pond	N60 43 00 W150 40 00	NL	A. beringiana (1)	not listed	none
KP 25	Steve Smith	Rainbow Lake	N60 43 00 W150 47 05	NL	A. beringiana (1)	not listed	none
KP 26	Steve Smith	Lili Lake	N60 40 00 W150 49 00	NL	A. beringiana (1)	not listed	none
SC 1	Lynn Fuller	Seymour Lake	N61 36 497 W149 40 295	NL	A. beringiana (12)	TSSt, RT	none
SC 2	Lynn Fuller	Jim Lake	N61 33 00 W148 55 00	NL	A. beringiana (2)	CS, TSSt	none
SC 3	John DeLapp	Kingfisher Lake	N61 31 03 W150 04 00	NL	A. beringiana (1)	not listed	none
SC 4	Chris Garner	Otter Creek	N61 17 40 W149 43 45	NS	A. beringiana (2)	TSSt, RT	Fswr
SE 1	Lance Lerum	Freshwater Lake	N57.57216 W134.40093	NL	A. beringiana (2) **P**	CT, DVT, PS, TSSt, Sc	none
SE 2	Ed Grossman	Auke Lake	N58 22 91 W134 37 95	NL	A. beringiana (8) **JUV**	Sc, SS, CT	none
SE 3	Scott Walker	Hetta Lake	N55.1714 W132.5680	NL	M. falcata (1)	SS	none
SE 4	Scott Walker	Naha River	N55.5930 W131.5894	NS	M .falcata (2)	CoS,PS,SS,ChS,TSSt,CT	none
SE 5	Scott Walker	Lake Eva	N57.4059 W135.0874	NL	A. kennerlyi (1) **P**	not listed	none
SE 6	L. Lerum (Dan Shultz)	Hasselburg Cr./Lk.	N57.588826 W134.27909	NL/NS	M. falcata **DNS(1)**	CT, SH	
SE 7	L. Lerum (Dan Shultz)	Guerin Lk / Cr.	N57.64954 W134.3398	NL/NS	M. falcata(1)proxy for 6, 8-11	CT	none
SE 8	L. Lerum (Dan Shultz)	Beaver Lake	N57.66878 W134.21288	NL	M. falcata **DNS(1)**	CT	none
SE 9	L. Lerum (Dan Shultz)	Lake Alexander	N57.67053 W134.18353	NL	M. falcata **DNS(1)**	CT	none
SE 10	L. Lerum (Dan Shultz)	Davidson Lake	N57 37 00 W134 23 00	NL	M. falcata **DNS(1)**	not listed	none

APPENDIX A. Continued.

Specimen	Collector Name	Waterbody	Latlong (dms or NAD27)	Type	Species & Number	Fish species	Env. Factors
SE 11	L. Lerum (Dan Shultz)	Distin Lake	N57 38 00 W134 24 00	NL	M. falcata **DNS(1)**	not listed	none
SE 12	Molly Kemp	Hugh Smith Lake	N55 06 00 W130 39 00	NL	A kennerlyi (4)	CoS,SS,PS,ChS,RT,SH.Sc	none
SE 13	L. Lerum (Jan Waatti)	Dredge Lakes	N58.40861 W134.56569	MML	marine(3)pea clams(3)	CT,CS,DVT	Chan
SE 14	Ben VanAlen	Neva Lake	N58.24219 W135.24258	NL	A. kennerlyi (1)	SS,PS,CoS,ChS,CT,DVT	none
SE 15	Kim Hastings	Ratz Creek	N55 52 039 W132 36 934	NSA	M. falcata (2)	not listed	none
SE 16	Becki Saari	Sweetwater Lake	N/A	delta	marine clams (10)		
SE 17	Nora Foster	Angel Lake	N55 40 00 W132 37 00	NL	A. kennerlyi (6)	SH,CoS,CT,TSSt	none
SE 18	Adam Moles	Auke Lake	N58 22 91 W134 37 95	NL	A. beringiana (2) **JUV P**	not listed	Pol
SE 19	Neil Stichert	Naha River	N55 35 31 W131 34 56	NS	A. kennerlyi (1) M. falcata(1)	CT,DVT,RT,CoS,SS	none
SE 20	Dave Gregovich	Luck Lake	N55 56 00 W132 46 00	NL	A. kennerlyi (3)	RT,DVT,CuT,CS	none
SE 21	Steve McCurdy	Chuck Creek	N55 45.735 W133 28.203	NS	A kennerlyi (2) **P**	PS,CoS,SS,DVT,CT,SH	none
SE 22	Lance Watkins	Big Ratz Creek	N55 53 00 W132 37 00	NS	M. falcata (2)	CoS,PS,ChS,CT,DVT	Fswr
SE 23	Steve McCurdy	Clam Creek	N55 57 00 W133 13 00	NS	A. beriingiana (4) **P**	SS,CoS,DVT	none
SE 24	L. Lerum (R.Piehl)	Angoon Resevoir	N57.53036 W134.56259	MML	A. beringiana (2)	TSSt,NSSt	none
SE 25	Lance Lerum	Thayer Lake	N57.62058 W134.46272	NL	A. beringiana (3)	CT,DVT,NSSt,TSSt	none
SE 26	Bob Piordowski	Situk River	N56 30 00 W139 30 00	NS	A. kennerlyi (2)	SS,CS,CS,CoS,ChS,RT	**LocAppx**
SE 27	Lerum (Jan Waatti)	Jim's Lake	N57.58219 W134.27140	NL	A. kennerlyi (2)	CT,DVT,KS,TSSt,NSSt	none
SE 28	Ed Grossman	Auke Lake	N58 22 91 W134 37 95	NL	A. beringiana (33) **JUV**	SS,CT,DVT	none
SE 29	Nate Catterson	Redfield Lake	N59 37 33 W139 31 27	NL	A. beringiana (1) **JUV**	CoS,SS,PS,ChS,RT	none
SE 30	Nate Catterson	Situk River	N56 31 00 W139 30 00	NS	A. kennerlyi (1) **P**	CoS,SS,PS,ChS,RT,DVT	**LocAppx**
SE 31	Nate Catterson	Pike Lake	N59 29 41 W139 11 31	NL	A. beringiana (1)	NP,SS	none
SE 32	Nate Catterson	Aka Lake	N59 31 01 W139 46 50	NL	A. beringiana (1) **JUV**	CoS,SS,CT	none
SE 33	Troy Tydingco	Sitkoh Lake	N57 30 05 W135 03 00	NL	A. beringiana (2)	CT, SH, DVT, Sc, all Salmon	none
SE 34	Ben VanAlen	Hoktaheen Lake	N58 03 00 W136 30 30	NL	pea clams(4)	SS, CoS, PS, ChS, DVT, CT	none
SE 35	Nora Foster	Boyd Lake	N55 41 00 W132 39 00	NL	A. kennerlyi (8)	not listed	none
SE 36	Nora Foster	Thorne River	N55 42 00 W132 37 00	NR	M. falcata (1)	not listed	none

Totals = 80 Locations (77 for freshwater mussels), 195 freshwater mussels (including 7 proxy), 7 pea clams, and 13 marine clams.

APPENDIX A. Continued. Key to Appendix A abbreviations.

FISH SPECIES	DESCRIPTION	LOCATION	ENVIRONMENTAL FACTORS
SH=Steelhead	NL=Natural Lake or Pond	INT = Interior	Dam=Dammed
Sc=Sculpin	NS=Natural Stream, River, Slough	KO = Kodiak Island	Silt=Siltation
CT=Cuthtroat Trout	MML=Manmake Lake/Pond	KP = Kenai Peninsula	Chan=Channelization
CS=Chinook Salmon	SR=Sample Returned to Collector	SC = Southcentral Alaska	Pol=Pollution Evident
SS=Sockeye Salmon	DNS=Described by Proxy - Not Sent	SE = Southeast Alaska	
ChS=Chum Salmon	LocAppx=Lat/Long Approximated	Fswr=Fish Wier	
CoS=Coho Salmon	JUV=Juvenile Specimen		
NP=Northern Pike	P=Identification initially problematic.		
AB=Alaska Blackfish			
RT=Rainbow Trout			
KS=Kokane Salmon			
TSSt=Three-spined Stickleback			
NSSt=Nine-spined Stickleback			
DVT=Dolly Varden Trout			
PS=Pink Salmon			

APPENDIX B. Historical freshwater mussel collection records.

Collector Name	Date/Year	Waterbody	Latlong (dms or NAD27)	Species	Reference
INHS	2002	Cottonwood Cr.	N61 36 00 W149 15 00	A. beringiana	INHS website
INHS	2002	Nancy Lake	N61 42 00 W150 00 00	A. beringiana	INHS website
Tuthill, S. J. et al.	1969	Martin-Bering River	N60 23 00 W144 21 00	A. beringiana	Nautilus Vol 83 (2) 1969
Barry Stratton,ADFG	2003	Lake Louise	N62 17 00 W146 34 00	A. beringiana	personal comm
Steve Smith	2003	Wasilla Lake	N61 34 00 W149 27 00	A. beringiana	Smith, S.(UAA) Unpub. Data
Steve Smith	2003	Lucille Lake	N61 34 00 W149 28 00	A. beringiana	Smith, S.(UAA) Unpub. Data
Steve Smith	2003	Goose Lake	N61 09 00 W149 49 00	A. beringiana	Smith, S.(UAA) Unpub. Data
Steve Smith	2003	Jewel Lake	N61 09 00 W149 49 00	A. beringiana	Smith, S.(UAA) Unpub. Data
Steve Smith	2003	Waldron Lake	N61 09 00 W149 49 00	A. beringiana	Smith, S.(UAA) Unpub. Data
Steve Smith	2003	Cheney Lake	N61 09 00 W149 49 00	A. beringiana	Smith, S.(UAA) Unpub. Data
Steve Smith	2003	Upper Fire Lake	N61 20 00 W149 32 00	A. beringiana	Smith, S.(UAA) Unpub. Data
Steve Smith	2003	Lower Fire Lake	N61 20 00 W149 32 01	A. beringiana	Smith, S.(UAA) Unpub. Data
Steve Smith	2004	Taku Lake	N61 09 00 W149 49 02	A. beringiana	Smith, S.(UAA) Unpub. Data
Steve Smith	2004	Chester Creek	N61 09 00 W149 49 00	A. beringiana	Smith, S.(UAA) Unpub. Data
Rae Baxter	1963	Big Martin Lake	N50 20 00 W144 32 00	A. beringiana	Reger, R. (UAF) Unpub. Data
W.J. Eyerdam	1933	Woody Island	N57 47 00 W152 19 00	A. beringiana	Reger, R. (UAF) Unpub. Data
Dall, W. H.	1905	Kuskokwim River	N61 41 00 W157 00 00	A. beringiana	Reger, R. (UAF) Unpub. Data
Dall, W. H.	1905	Yukon River	N62 00 00 W160 00 00	A. beringiana	Reger, R. (UAF) Unpub. Data
McFarlane	1965	Colville River Delta	N70 00 00 W151 30 00	A. beringiana	Reger, R. (UAF) Unpub. Data
Hopkins, D. M.	1965	Black River	N66 50 00 W157 30 00	A. beringiana	Reger, R. (UAF) Unpub. Data
Maddren, A. C.	1965	unamed lake	N66 40 00 W145 00 00	A. beringiana	Reger, R. (UAF) Unpub. Data
Benninghoff, W.S.	1948	Fish Creek Slough	N66 00 00 W146 10 00	A. beringiana	Reger, R. (UAF) Unpub. Data
Benninghoff, W.S.	1948	Beaver Creek	N66 00 00 W146 10 00	A. beringiana	Reger, R. (UAF) Unpub. Data
Benninghoff, W.S.	1948	Beaver Creek	N65 36 00 W147 30 00	A. beringiana	Reger, R. (UAF) Unpub. Data
Olson, V E.	1948	un-named lake	N65 36 00 W147 30 01	A. beringiana	Reger, R. (UAF) Unpub. Data
Gilmore, G W.	1965	Yukon River	N64 00 00 W158 50 00	A. beringiana	Reger, R. (UAF) Unpub. Data
Middendorff	1851	Unalaska Island	N53 50 00 W166 30 00	A. beringiana	Reger, R. (UAF) Unpub. Data
Hanna, G.D.	1966	Spenard Lake	N61 09 00 W149 49 02	A. beringiana	Reger, R. (UAF) Unpub. Data
Reger, R.	1968	E. Fork Moose River	N60 35 00 W150 35 00	A. beringiana	Reger, R. (UAF) Unpub. Data
Hanna, G.D.	1965	Woody Island	N57 47 00 W152 19 00	A. beringiana	Reger, R. (UAF) Unpub. Data
Foster, N	1993	Selawik Lake	N66 30 00 W160 30 00	A. beringiana	UAF Museum
Stephans, K.	1966	Bear Bay, Baronof Island	N56 30 00 W135 00 00	A. kennerlyi	Reger, R. (UAF) Unpub. Data
Hannibal H. B.	1966	Alexander Lake area	N57 39 50 W134 10 00	A. kennerlyi	Reger, R. (UAF) Unpub. Data

APPENDIX B Continued. Historical freshwater mussel collection records.

Collector Name	Date/Year	Waterbody	Latlong (dms or NAD27)	Species	Reference
Foster, N.	1985	Kegan Lake, Pr of Wales Island	N55 02 00 W132 12 00	A. kennerlyi	Reger, R. (UAF) Unpub. Data
Dall, W.H.	1905	Naha Bay	N55 34 00 W131 36 00	M. falcata	Reger, R. (UAF) Unpub. Data

Appendix C. Campground watercraft survey of Anchorage and Kenai Peninsula, summer 2004.

Anchorage Area RV and Camper Park Data

Facility Name	Anchorage RV Park
Address	1200 N. Muldoon Rd.- Anch 99506
Date Surveyed	7/6/04
Total Vehicles Registered	165
Number of Watercraft on Survey Day	1
*Number of Watercraft all season to date	1
Facility Name	Ship Creek Landing
Address	150 N. Ingra St.- Anch 99502
Date Surveyed	7/6/04
Total Vehicles Registered	150
Number of Watercraft on Survey Day	0
*Number of Watercraft all season to date	2
Facility Name	Golden Nugget Camper Park
Address	4100 DeBarr Road - Anch 99508
Date Surveyed	7/7/04
Total Vehicles Registered	161
Number of Watercraft on Survey Day	0
*Number of Watercraft all season to date	4
Total Vehicles on Survey Dates	516
Total Watercraft on Survey Dates	2
Percentage of Watercraft per Vehicle	0.39%
Total Boats Inspected	1

Facility Name	Creekwood Inn
Address	
Date Surveyed	7/7/04
Total Vehicles Registered	40
Number of Watercraft on Survey Day	1
*Number of Watercraft all season to date	2

*based on facility manager information

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