Beringia: Intercontinental exchange and diversification of high latitude mammals and their parasites during the Pliocene and Quaternary

Joseph A. Cook^{1,*}, Eric P. Hoberg², Anson Koehler¹, Heikki Henttonen³, Lotta Wickström³, Voitto Haukisalmi³, Kurt Galbreath⁴, Felix Chernyavski⁵, Nikolai Dokuchaev⁵, Anatoli Lahzuhtkin⁵, Stephen O. MacDonald¹, Andrew Hope¹, Eric Waltari⁶, Amy Runck⁶, Alasdair Veitch⁷, Richard Popko⁷, Emily Jenkins⁸, Susan Kutz⁹ and Ralph Eckerlin¹⁰

¹ Museum of Southwestern Biology, University of New Mexico, Albuquerque, NM, USA

² US National Parasite Collection & Animal Parasitic Disease Laboratory, USDA, Agricultural Research Service, Beltsville, Marvland, USA

³ Vantaa Research Centre Finnish Forest Research Institute, Vantaa, Finland

⁴ Ecology and Evolutionary Biology, Cornell University, Ithaca, NY, USA

⁵ Institute of Biological Problems of the North, Magadan, Russia

⁶ Biology Department, Idaho State University, Pocatello, ID, USA

⁷ Environment and Natural Resources, Government of the NWT, Norman Wells, NWT, Canada

⁸ Canadian Wildlife Service, Saskatoon, Saskatchewan, Canada

⁹ Faculty of Veterinary Medicine, University of Calgary, Calgary, AB, Canada

¹⁰ Northern Virginia Community College, Annandale, VA, USA

Abstract. Beringia is the region spanning eastern Asia and northwestern North America that remained ice-free during the full glacial events of the Pleistocene. Numerous questions persist regarding the importance of this region in the evolution of northern faunas. Beringia has been implicated as both a high latitude refugium and as the crossroads (Bering Land Bridge) of the northern continents for boreal mammals. The Beringian Coevolution Project (BCP) is an international collaboration that has provided material to assess the pattern and timing of faunal exchange across the crossroads of the northern continents and the potential impact of past climatic events on differentiation. Mammals and associated parasite specimens have been collected and preserved from more than 200 field sites in eastern Russia, Alaska and northwestern Canada since 1999. Previously, fossils and taxonomic comparisons between Asia and North America mammals have shed light on these events. Molecular phylogenetics based on BCP specimens is now being used to trace the history of faunal exchange and diversification. We have found substantial phylogeographic structure in the Arctic and in Beringia in mustelid carnivores, arvicoline rodents, arctic hares and soricine shrews, including spatially concordant clades and contact zones across taxa that correspond to the edges of Beringia. Among the tapeworms of these mammalian hosts, new perspectives on diversity have also been developed. Arostrilepis horrida (Hymenolepididae) was considered to represent a single widespread and morphologically variable species occurring in a diversity of voles and lemmings in eastern and western Beringia and more broadly across the Holarctic region. The BCP has demonstrated a complex of at least 10 species that are poorly differentiated morphologically. The diversity of Paranoplocephala spp. and Anolocephaloides spp. (Anoplocephalidae) in Beringia included relatively few widespread and morphologically variable species in arvicolines. BCP collections have changed this perspective, allowing the recognition of a series of highly endemic species of Paranoplocephala that demonstrate very narrow host specificity, and additional species complexes among arvicolines. Thus, extensive, previously unrecognized, diversity for tapeworms of 2 major families characterizes the Beringian fauna. By elucidating evolutionary relationships and phylogeographic variation among populations, species and assemblages, refined views of the sequence and timing of biotic expansion, geographic colonization and impact of episodic climate change have been developed for Beringia. Ultimately, Beringia was a determining factor in the structure and biogeography of terrestrial faunas across the Nearctic and Neotropical regions during the Pliocene and Quaternary.

Key words: Alaska, biogeography, cestode, climate change, coevolution, Siberia

^{*}To whom correspondence should be addressed. E-mail: cookjose@unm.edu

Beringia is the region spanning eastern Asia and northwestern North America that remained ice-free during the full glacial events of the Pleistocene (Hultén 1937; Hopkins 1959; Yurtsev 1974). Beringia affords a unique opportunity for resolution of the drivers for isolation and speciation across a complex fauna in the context of a regional history over an extended time frame. The wellrefined geochronology for marine transgression and exposure of the Bering Land Bridge is critical to understanding the timing and patterns of biotic expansion, faunal exchange and isolating events for the Holarctic across two continents. We are developing a neontological approach to deciphering the complex history of this crossroads of the northern continents by examining exemplar systems representing assemblages of mammalian hosts and their parasites. Explicit hypotheses relate to climate change and environmental perturbation as a determinant of genetic structure and phylogeography of members of these host-parasite assemblages.

The Beringian Coevolution Project (BCP) is a multinational cooperative effort aimed at providing outstanding comparative material from Beringia (Fig. 1). The major objectives of the BCP are to: 1) provide a spatiallyextensive and site intensive resource of museum specimens from numerous key high latitude areas that have not yet been inventoried. An extended array of specimens is crucial for testing the drivers of isolation and diversification in this geologically dynamic system; 2) develop a comparative framework for the Arctic to examine the history of host-parasite systems that are phylogenetically and ecologically disparate providing the basis for detailed studies of associated hosts and parasites; 3) explore forces that have structured high latitude biomes, including biotic expansion and exchange across the northern continents using comparative phylogeographic analyses; 4) build a spatial and temporal foundation for biotic investigations in the Arctic by identifying and further characterizing regions of endemism and contact zones between divergent lineages; and 5) to accelerate the exploration of coevolution, cospeciation, episodic host switching and rates of diversification in associated hosts and parasites. This foundation is crucial for conservation efforts in the face of changing climate and increasing anthropogenic impacts in the Arctic (Kutz et al. 2004, 2005).

Field Expeditions and Results

Field inventories were conducted during July, August,



Fig. 1. A relational model for the Beringian Coevolution Project emphasizes integrated biotic survey and inventory for parasites (protozoans, arthropods and helminths) and mammals. Field based collections are focused on development of biodiversity baselines and associated specimens and data that are maintained in interconnected archives and informatics resources of museums. Multifaceted data for hosts and parasites are available for analyses and synthesis focusing on historical reconstruction and the determinants of faunal structure in evolutionary and ecological time. Beringian systems serve as an historical analogue for understanding processes ranging from ecological perturbation linked to global climate change, emerging infectious diseases, invasive species and conservation.

and September (1999 to 2005) and were focused on sampling mammals and associated parasites in Beringia across remote sites in Siberia, Canada, and Alaska (Fig. 2).

Mammals

Across all field seasons, more than 15,000 mammal specimens (>80 species, 39 genera) were acquired or captured, based on more than 150,000 trap nights of sampling effort at over 200 sites (Fig. 2); materials represent geographically extensive and site intensive collections of unprecedented depth and scope. Significant new series of specimens resulted from collaboration with trappers and state and federal agencies in Russia, Alaska and Canada. Each mammal was assigned a unique field identifier, and all tissues, parasites, and other subsamples were linked to the original voucher specimen. Thus materials on divergent pathways could be associated with a specific animal, GPS locality, and date for collection. All mammals sampled were preserved as scientific specimens (skeletal preparations, as whole bodied alcoholics or as dried study skins); survey crews preserved tissues (heart, liver, kidney, spleen, and lung), and embryos in liquid nitrogen. Specimens were deposited in the University of Alaska Museum of the North (UAM)



Fig. 2. Sites of intensive collections for hosts and parasites in the Beringian Coevolution Project, 1999–2005.

and Museum of Southwestern Biology. Searchable databases at UAM (http://www.uaf.edu/museum/) and MSB (nix.msb.unm.edu) document these collections.

Parasites

Helminth, arthropod and protozoan parasites were a primary focus and many thousands of lots were processed, preserved and archived (a lot represents 1 to several hundreds of specimens including fleas, ticks, mites, coccidia and other protozoan parasites, cestodes, nematodes, and digeneans) from each host. Subsamples of parasites were preserved in appropriate reagents, and frozen in LN2. Protozoans, helminths and arthropods were dispersed to colleagues and collections. Specimens are archived, and information is available for components of the BCP collections through the database of the US National Parasite Collection (http://anri.barc. usda.gov).

Discussion

Regional endemism, intercontinental exchange and the history of Beringia

Major geologic and historical features have influenced the structure of morphological and genetic diversity in high latitude parasites and mammals. In particular, the close historical connection between eastern Asian and northwestern North American species (i.e., Beringian species) has been demonstrated by the close genetic relationships of conspecific populations on opposite sides of the Bering Land Bridge including arvicoline cestodes (Anoplocephalinae, Wickström et al. 2003), tundra voles (Microtus oeconomus, Galbreath and Cook 2004), northern red-backed vole (Clethrionomys rutilus, Cook et al. 2004), and arctic ground squirrel (Spermophilus parryii, Eddingsaas et al. 2004). A number of outstanding questions regarding sister group relationships across the Bering Strait exist, however. Classically, Beringia has been thought of as a region of intercontinental exchange. In addition, elements of the Beringian fauna and flora are highly endemic, and appear much older and diverse than previously assumed (Hoberg et al. 2003). In these instances, parasites are indicators of "cryptic events" because they have responded to either host isolation through vicariance or dispersal and peripheral isolation that were insufficient to drive divergence in host populations (Hoberg 1995, 2005a).

Beringian studies also afford an elegant system to explore the role of taxon pulses, alternating or episodic periods of biotic expansion and isolation, as determinants for patterns of diversification and distribution across a number of host and parasite clades (Halas et al. 2005). We are beginning to explore Beringia's impact on generating diversity as well as the sequence, direction, and number of colonization events between the Old World and New World for particular taxa. Questions related to micro- and macroevolution may be placed in the following framework.

Biogeography

A) Beringia as the high latitude crossroads

The Bering Land Bridge was repeatedly exposed prior to and during the Pleistocene. This 1800 km wide connection filtered the movement of fauna and flora between Asia and North America (Hopkins 1959, 1967; Hopkins et al. 1982; Hoffmann 1985; Elias et al. 1996). BCP collections are providing opportunities to explore fundamental questions such as: What were the characteristics of invasive species (both hosts and parasites) that used this nexus and what do their ecological requirements tell us about historic environmental conditions? How have varying modes and tempos of population expansion and geographic colonization (e.g., phalanx and pioneer dispersal, sensu Hewitt 2000) served to influence host and parasite biodiversity (Hoberg 2005b)? What characteristics are associated with episodes of biotic expansion and the ability of behaviorally and phylogenetically disparate mammalian hosts and their associated parasites to invade (disperse) and establish and how does this serve as an analogue for contemporary systems that are experiencing rapid climatic shifts?

High latitude exchange across the Bering Land Bridge has been characterized as asymmetric with most taxa originating in Northeastern Asia and moving to North America. During the glacial maxima, eastern Beringia (Alaska and northwestern Canada) was effectively isolated from the rest of North America by the Laurentide Ice Sheet (Pielou 1991), while western Beringia (Siberia) had a "leaky" border with the remainder of Asia. Was the movement of colonizing species primarily east to west (Rausch 1994)? Waltari et al. (unpublished observations; ms) reviewed 34 phylogeographic studies focused on high latitude species and found a preponderance of eastward colonization (from Asia to North America); a minimum number of studies, however, have documented westward colonization (Steppan et al. 1999; Waltari et al. 2004).

Additional questions that are being addressed by high latitude phylogeographers include: What was the sequence of geographic colonization and how many events are represented for particular taxa (Runck and Cook 2005)? What are the downstream effects for multiple events of expansion and establishment for host and parasite populations? How has episodic geographic colonization influenced parasite biodiversity? Over what timeframe has the Bering Land Bridge influenced the evolution of this biota?

B) Beringia as a refugium in the diversification of high latitude fauna

Can we define a Beringian parasite and host fauna? If so, was this a primary center of endemism and diversification for the Arctic as proposed by Sher (1999)? Or did most diversification take place at southern latitudes during full glacial advances with subsequent recolonization northward, as advanced by many (e.g., Hewitt 2000). Evidence from multiple arvicoline-tapeworm systems suggests high in-situ diversification for anoplocephalines and hymenolepidids in Microtus, Clethrionomys, Lemmus, Synaptomys and Dicrostonyx (e.g., Haukisalmi and Henttonen 2000; Hoberg et al. 2003; Wickström et al. 2003; Haukisalmi et al. 2004). We also found substantial phylogeographic structure in the Arctic and in Beringia among mustelid carnivores (Fleming and Cook 2002), arvicoline rodents (Brunhoff et al. 2003; Galbreath and Cook 2004), arctic hares (Waltari et al. 2004), and soricine shrews (Demboski and Cook 2003). This geographic structure includes spatially concordant clades and contact zones across taxa that likely correspond to major vicariant events at the eastern (roughly Yukon/Alaska border) and western (Omolon/ Kolyma) borders of Beringia (Fleming and Cook 2002; Galbreath and Cook 2004; Waltari and Cook 2005).

Separation of Asia and North America by the Bering Strait generally is not reflected in phylogeographic analyses (Eddingsaas et al. 2004; Galbreath and Cook 2004), suggesting that this recurring vicariant barrier (most recently formed 10,000 years before present) has had a minor influence on geographic structure or divergence among many mammalian and perhaps parasite taxa. In a few instances, however, this barrier delineates significant breaks (Fedorov and Stenseth 2002; Wickström et al. 2003). Future investigations will focus on population level processes and integrate host and parasite studies to explore co-evolutionary processes.

Coevolutionary history

Testing hypotheses for host/parasite coevolution — Parasites and hosts may be associated via coevolutionary processes involving macroevolutionary components such as cospeciation (association of host and parasite lineages by descent), or microevolutionary components such as coadaptation (e.g., Brooks and McLennan 2002; Hoberg 2005a). In contrast, ecologically-based mechanisms, particularly colonization (host switching), may represent the basis for an association, and depending on the timing of such events complex systems may be further modified by coevolutionary processes (e.g., see review in Hoberg 2005a).

Diverse parasite assemblages in Beringia, encompassing faunas associated with a range of small (insectivores and arvicoline rodents), medium (leporids and ochotonids), and large (artiodactyls, ursids) mammals constitute unique systems for exploring coevolutionary processes. Through an examination of multiple parasite clades (e.g., different parasite clades inhabiting the same hosts (or areas)) relative to host phylogenies we can develop and evaluate hypotheses for coevolutionary processes in diversification. Collectively this approach is designed to reveal fundamental insights about the Beringian fauna and contributes to a broader understanding of faunal structure and history in the Nearctic (e.g., Hoberg 2005b).

The tapeworm faunas established among arvicoline rodents provide a primary example of the potential for coevolutionary studies in Beringia. Arvicolines are hosts for 2 major groups of tapeworms, the anoplocephalines (Anoplocephaloides spp. and Paranoplocephala spp.) and hymenolepidids (Arostrilepis spp.) that differ considerably in their apparent specificity, effective populations and species diversity across the Holarctic. Radiation of arvicoline and cestode faunas appears to have occurred over a short time frame, but respective families of cestodes appear to have relatively long histories with species of Microtus, Clethrionomys, Lemmus, and Dicrostonyx (Wickström et al. 2005). Both faunas appear to harbor considerable levels of cryptic diversity that has only recently been revealed through site intensive and geographically extensive sampling in conjunc-



Fig. 3. Coevolution and historical biogeography among arvicoline rodents, anoplocephalid and hymenolepidid cestodes across Beringia and the Holarctic. Relationships for arvicolines, tapeworms, and biogeography summarized in the tanglegram are consistent with a complex mosaic of geographic colonization, host switching and cospeciation. Multiple events of vicariance for the northern fauna across Beringia and independent events of biotic expansion from the Palearctic to Nearctic are postulated. Associations for Anoplocephaloides spp. and Paranoplocephala spp. are shown by linkages between phylogenetic trees for arvicoline hosts and anoplocephalid parasites (patterned lines specific to different host genera). The most consistently supported segments of the anoplocpehaline tree are as follows: (1) Paranoplocephala s. str. (P. omphalodes s.l. + P. kalelai + P. macrocephala; (2) Anoplocephaloides s. str. (A. dentata s. sl. + A. lemmi + A. kontrimavichusi); and (3) A. cf. variabilis + P. krebsi. Regional biogeography for anoplocephalines is designated as follows: H = Holarctic, P = Palearctic, N = Nearctic. Host associations for putative lineages within the Arostrilepis horrida- complex are mapped directly onto the phylogeny for the arvicolines (Aros- 1-10). Arvicoline phylogeny is modified from Conroy and Cook (1999); anoplocephaline phylogeny is modified from Wickström et al. (2005). Data for host associations and biogeography for anoplocephaliines are summarized from Haukisalmi et al. (2001, 2002) and Wickström et al. (2005); data for Arostrilepis are from K. Galbreath and E. P. Hoberg (unpublished observations).

tion with new assessments of morphological and genetic variation (e.g., Haukisalmi et al. 2001, 2002, 2004; Hoberg et al. 2003).

Specificity among anoplocephalines (a minimum of

35 species of Paranoplocephala; 10 species of Anoplocephaloides) is often manifested as a species to species relationship, whereas patterns of host association for Arostrilepis (likely in excess of 10 species with 3 nominal taxa and 9 recognized lineages in Beringia) are demonstrated among genera of arvicolines (Fig. 3). Comparisons of host and parasite phylogenies reveal a complex history for geographic colonization, host switching and varying degrees of cospeciation (Fig. 3). Biotic expansion across Beringia, refugial effects and isolation north and south of the Laurentide and Cordilleran glaciers is further evident in these associations but, alone cannot account for the major disparity (nearly 3 fold) in diversity which may be attributable to different patterns of life history, patchy versus homogenous distributions, differential responses to local or regional habitat fragmentation and isolation, and variation in effective population sizes for respective parasites (Haukisalmi et al. 2001; Hoberg et al. 2003; Wickström et al. 2003).

Complex biogeographic and coevolutionary patterns also emerge from studies of nematodes in such mammals as ochotonids, leporids and artiodactyls (Hoberg et al. 1999; Hoberg 2005b). For example, distributions for other faunal assemblages including the nematode muscleworms in Dall's sheep and mountain goats, are compatible with rapid post-Pleistocene range expansion from the south through ice free corridors separating the Cordilleran and Laurentide ice (Jenkins 2005; Jenkins et al. 2005; E. P. Hoberg, B. Rosenthal, E. Jenkins, et al. unpublished observations).

Protostrongylid nematodes such as Parelaphostrongylus odocoilei (in Odocoileus hemionus, Oreamnos americanus and Ovis dalli) and Protostrongylus stilesi (in O. dalli, O. canadensis, and O. americanus) afford the opportunity to explore contrasting histories for complex host-parasite systems in ungulates associated with Beringia. Genetic homogeneity in nuclear ITS-2 and patterns of variation for mitochondrial COX-II for P. odocoilei across a broad geographic range occupied in the northwestern Nearctic are consistent with rapid expansion and geographic colonization for parasite populations (Jenkins 2005; Jenkins et al. 2005; E. P. Hoberg et al. unpublished observation). Host associations in conjunction with geographic distributions are further compatible with host-switching from cervids to caprines and an expansion from south to north tracking deglaciation and retraction of Cordilleran and Laurentide ice in the post-Pleistocene. A history of recent expansion and colonization contrasts with the deeper temporal associations between *P. stilesi* and *Ovis* spp. that are attributed to biotic expansion for a lungworm fauna from Eurasia into the Nearctic during the middle Pleistocene (Jenkins 2005). Thus, we would predict that phylogeography for *P. stilesi* and *P. odocoilei* will be discordant, and that populations of the former will show patterns largely congruent with a history of refugial isolation and secondary biotic expansion that has been postulated for *Ovis* spp. in Beringia (Loehr et al. 2005). The array of phylogenetically disparate nematode parasites among caprines, including potential complexes of cryptic species, further promote a powerful comparative foundation to explore determinants of biogeography, geographic colonization and faunal structure in evolutionary and ecological time (Hoberg et al. 1999; Hoberg 2005b).

Phylogeographic models

Recently colonized areas should show reduced variation relative to areas where populations remained relatively stable. However, changes in overall genetic variation may also reflect differences in local population size and levels of genetic exchange between populations. Assessments of these alternatives lead to different predictions. Populations that have remained stable for long periods of time should have reached equilibrium between mutation and drift. In contrast, recently expanded populations should not be in equilibrium. Lessa et al. (2003) used these contrasting predictions to demonstrate that several clades of high latitude boreal mammals are not in equilibrium; rather they show the distinctive footprints of demographic expansion. Because these patterns were concordant across diverse mammalian taxa, ranging from shrews to bears, they likely reflect demographic change.

Interpretation of paleoclimatic events and prediction of future events often relies on knowledge of the identity and relationships of past and extant biotas. Examining the histories of mammals and parasites of Beringia, a region that was profoundly and repeatedly impacted by climate change, is helping to establish chronologies (e.g. Riddle 1996) and a framework for predicting future change. Hypotheses for historical biogeography and community dynamics of these parasite host assemblages are being addressed through integration of molecular, morphological, and phylogenetic approaches. Phylogeographic patterns, coupled with changes in levels of genetic variation across geography, can suggest possible areas of persistence of populations and possible directions of colonization of deglaciated areas. This is an exceptional model system for examining the influence of cyclic, episodic, and identifiable isolation events on the patterns and processes of differentiation among evolutionarily diverse groups of parasites and mammalian hosts.

The Beringian Coevolution Project also establishes significant baselines that are necessary for tracking and predicting the impacts of environmental change in ecological time. Global climate warming and concomitant perturbation in high latitude ecosystems can only be understood when examined in an historical context provided by specimens-based collections and information on geographic distribution and host association provided by museum resources. Survey and inventory feed into larger programs established for monitoring change in these dynamic systems (Hoberg et al. 2003); and survey and inventory continue to result in the discovery of considerable hidden diversity in northern systems (e.g., Hoberg et al. 1999; Haukisalmi and Henttonen 2001; Kutz et al. 2001a; Kutz et al. 2001b; Haukisalmi et al. 2002). Thus we are in a position to use insights from deep history in Beringian systems as an analogue for how complex biotic associations are structured and influenced by climate change (e.g., Kutz et al. 2004, 2005; Hoberg 2005b). Indeed potential changes in transmission dynamics in complex host-parasite systems, and altered patterns of host association and geographic colonization and emergence of disease have been documented in the context of Beringian-related field research (e.g., Hoberg et al. 2002; Kutz et al. 2005).

Acknowledgments: Many individuals have participated and enhanced the Beringian Coevolution Project. We appreciate the state and federal agency biologists that have assisted in numerous ways over the past six years. We particularly acknowledge the intellectual influence of early Beringian pioneers Robert Rausch, Vitus Kontrimavichus and David Hopkins. Personnel of the University of Alaska Museum, Museum of Southwestern Biology, and US National Parasite Laboratory archived the specimens. Funding was provided by the US National Park Service and National Science Foundation (DEB 0196095 and 0415668).

References

- Brooks, D. R. and McLennan, D. A. 2002. The Nature of Diversity: An Evolutionary Voyage of Discovery. University of Chicago Press.
- Brunhoff, C., Galbreath, K. E., Federov, V. B., Cook, J. A. and

Jaarola, M. 2003. Holarctic phylogeography of the root vole (*Microtus oeconomus*): implications for late Quaternary biogeography of high latitudes. Molecular Ecology 12: 957–968.

- Conroy, C. J. and Cook, J. A. 1999. MtDNA evidence for repeated pulses of speciation within arvicoline and murid rodents. Journal of Mammalian Evolution 6: 221–245.
- Cook, J. A., Runck, A. M. and Conroy, C. J. 2004. Historical biogeography at the crossroads of the northern continents: Molecular phylogenetics of red-backed voles (Rodentia: Arvicolinae). Molecular Phylogenetics and Evolution 30: 767–777.
- Demboski, J. R. and Cook, J. A. 2003. Phylogenetic diversification within the *Sorex cinereus* complex (Insectivora: Soricidae). Journal of Mammalogy 84: 144–158.
- Eddingsaas, A., Jacobsen, B., Lessa, E. and Cook, J. 2004. Evolutionary history of the arctic ground squirrel (*Spermophilus parryii*) in Nearctic Beringia. Journal of Mammalogy 85: 591–600.
- Elias, S. A., Short, S. K., Hans Nelson, C. and Birks, H. A. 1996. Life and times of the Bering land bridge. Nature 382: 60–63.
- Fedorov, V. and Stenseth, N. 2002. Multiple glacial refugia in the North American Arctic: inference from Phylogeography of the collared lemming (*Dicrostonyx groenlandicus*). Proceedings of the Royal Society of London Series B 269: 2071–2077.
- Fleming, M. A. and Cook, J. A. 2002. Phylogeography of endemic ermine (*Mustela erminea*) in southeast Alaska. Molecular Ecology 11: 795–808.
- Galbreath, K. and Cook, J. 2004. Genetic consequences of Pleistocene glaciations for the tundra vole (*Microtus oeconomus*) in Beringia. Molecular Ecology 13: 135–148.
- Halas, D., Zamparo, D. and Brooks, D. R. 2005. A historical biogeographic protocol for studying diversification by taxon pulses. Journal of Biogeography 32: 249–260.
- Haukisalmi, V. and Henttonen, H. 2000. Paranoplocephala serrata sp. n. (Cestoda, Anoplocephalidae) in collared lemmings (*Dicrostonyx* spp., Arvicolinae) from Arctic Siberia and North America. Systematic Parasitology 45: 219–231.
- Haukisalmi, V., Wickström, L. M., Hantula, J. and Henttonen, H. 2001. Taxonomy, genetic differentiation and Holarctic biogeography of *Paranoplocephala* spp. (Cestoda: Anoplocephalidae) in collared lemmings (*Dicrostonyx*; Arvicolinae). Biological Journal of Linnean Society 74: 171–196.
- Haukisalmi, V., Henttonen, H., Niemimaa, J. and Rausch, R. L. 2002. Paranoplocephala etholeni n.sp. (Cestoda: Anoplocephalidae) in Microtus pennsylvanicus from Alaska, with a synopsis of Paranoplocephala-species in Holarctic rodents. Parasite 9: 305–314.
- Haukisalmi, V., Wickström, L. M., Henttonen, H., Hantula, J. and Gubányi, A. 2004. Molecular and morphological evidence for multiple species within *Paranoplocephala omphalodes* (Cestoda: Anoplocephalidae) in *Microtus* voles (Arvicolinae). Zoologica Scripta 33: 277–290.
- Hewitt, G. M. 2000. The genetic legacy of the Quaternary ice ages. Nature 405: 907–913.
- Hoberg, E. P. 1995. Historical biogeography and modes of speciation across high latitude seas of the Holarctic: concepts for host-parasite coevolution among the Phocini (Phocidae) and Tetrabothriidae (Eucestoda). Canadian Journal of Zoology 73: 45–57.
- Hoberg, E. P. 2005a. Coevolution in marine systems. Chapter 8.1. In (K. Rofde, ed.) Marine Parasitology (Chapter 8, Evolution). Pp. 329–339. CSIRO, Sydney, Australia.
- Hoberg, E. P. 2005b. Coevolution and biogeography among Nematodirinae (Nematoda: Trichostrongylina), Lagomorpha and Artiodactyla (Mammalia): exploring determinants of history and structure for the northern fauna across the Holarctic. Journal of

Parasitology 91: 358-369.

- Hoberg, E. P., Monsen, K., Kutz, S. and Blouin, M. 1999. Structure, biodiversity, and historical biogeography of nematode faunas in Holarctic ruminants: Morphological and molecular diagnoses for *Teladorsagia boreoarcticus* sp.n. (Nematoda: Ostertagiinae) a dimorphic cryptic species in muskoxen (*Ovibos moschatus*). Journal of Parasitology 85: 910–934.
- Hoberg, E. P., Kutz, S. J., Galbreath, K. E. and Cook, J. 2003. Arctic biodiversity: From discovery to faunal baselines — revealing the history of a dynamic ecosystem. Journal of Parasitology 89: S84– S95.
- Hoberg, E. P., Kutz, S., Nagy, J., Jenkins, E., Elkin, B., Branigan, M. and Cooley, D. 2002. *Protostrongylus stilesi*, ecological isolation and host switching between muskoxen and Dall's sheep in a contact zone. Comparative Parasitology 69: 1–9.
- Hoffmann, R. S. 1985. An ecological and zoogeographical analysis of animal migration across the Bering Land Bridge during the Quaternary Period. In (V. L. Kontrimavichus, ed.) Beringia in the Cenozoic. Pp. 464–481. Akademiia Nauk, SSSR, Vladivostok, Russia (English Translation, Gidison Printing Works, New Delhi, India).
- Hopkins, D. M. 1959. Cenozoic history of the Bering Land Bridge. Science 129: 1519–1528.
- Hopkins, D. M. 1967. The Bering Land Bridge. Stanford University Press, Stanford, California.
- Hopkins, D. M., Matthews, Jr., J. V., Schweger, C. E. and Young, S. B. (eds). 1982. Paleoecology of Beringia. Academic Press, New York, New York.
- Hultén, E. 1937. Outline of the History of Arctic and Boreal Biota during Quaternary Period. Bokforlags Aktiebolgaet. Thule, Stockholm.
- Jenkins, E. J. 2005. Ecological investigation of a new host-parasite relationship: *Parelaphostrongylus odocoilei* in thinhorn sheep (*Ovis dalli*). Unpublished PhD dissertation, University of Saskatchewan, Saskatoon, Canada.
- Jenkins, E. J., Appleyard, G. D., Hoberg, E. P., Rosenthal, B. M., Kutz, S. J., Veitch, A., Schwantje, H. and Polley, L. 2005. Geographic distribution of the muscle dwelling nematode *Parelaphostrongylus odocoilei* (Protostrongylidae: Elaphostrongylinae) in North America using molecular identification of first stage larvae. Journal of Parasitology 91: 574–584.
- Kutz, S., Hoberg, E. P., Nagy, J., Polley, L. and Elkin, B. 2004. Emerging parasitic infections in Arctic ungulates. Integrative and Comparative Biology 44: 109–118.
- Kutz, S., Hoberg, E. P. and Polley, L. 2001a. A new lungworm in muskoxen: an exploration in Arctic Parasitology. Trends in Parasitology 17: 276–280.
- Kutz, S., Hoberg, E. P., Polley, L. and Jenkins, E. 2005. Global warming is changing the dynamics of Arctic host-parasite systems.

Proceedings of Royal Society, B (in press).

- Kutz, S. J., Veitch, A. M., Hoberg, E. P., Elkin, B. T., Jenkins, E. J. and Polley, L. 2001b. New host and geographic records for two protostrongylids in Dall's sheep. Journal of Wildlife Diseases 37: 761–774.
- Lessa, E. P., Cook, J. A., and Patton, J. L. 2003. Genetic footprints of demographic expansion in North America, but not Amazonia, following the Late Pleistocene. Proceedings of the National Academy of Sciences of USA 100: 10331–10334.
- Loehr, J., Worley, K., Grapputo, A., Carey, J., Veitch, A. and Coltman, D. W. 2005. Evidence for cryptic glacial refugia from North American mountain sheep mitochondrial DNA. Journal of Evolutionary Biology (in press).
- Pielou, E. C. 1991. After the Ice Age: The Return of Life to Glaciated North America. University of Chicago Press, Chicago, Illinois.
- Rausch, R. L. 1994. Transberingian dispersal of cestodes in mammals. International Journal of Parasitology 24: 1203–1212.
- Riddle, B. R. 1996. The molecular phylogeographic bridge between deep and shallow history in continental biotas. Trends in Ecology and Evolution 11: 207–212.
- Runck, A. and Cook, J. 2005. Post-glacial expansion of the southern red-backed vole (*Clethrionomys gapperi*) in North America. Molecular Ecology 14: 1445–1456.
- Sher, A. V. 1999. Traffic lights at the Beringian crossroads. Nature 397: 103–104.
- Steppan, S. J., Akhverdyan, M. R., Lyapunova, E. A., Fraser, D. G., Vorontsov, N. N., Hoffmann, R. S. and Braun, M. J. 1999. Molecular phylogeny of the marmots (Rodentia: Sciuridae): tests of evolutionary and biogeographic hypotheses. Systematic Biology 48: 715–734.
- Waltari, E., Demboski, J. R., Klein, D. and Cook, J. A. 2004. A molecular perspective on the historical biogeography of the northern high latitudes. Journal of Mammalogy 85: 601–610.
- Waltari, E. and Cook, J. 2005. Historical demographics and phylogeography of arctic hares (*Lepus*): genetic signatures test glacial refugia hypotheses. Molecular Ecology 14: 3005–3016.
- Wickström, L. M., Haukisalmi, V., Varis, S., Hantula, J., Fedorov, V. B. and Henttonen, H. 2003. Phylogeography of the circumpolar *Paranoplocephala arctica* species complex (Cestoda: Anoplocephalidae) parasitizing collared lemmings (*Dicrostonyx* spp.). Molecular Ecology 12: 3359–3371.
- Wickström, L. M., Haukisalmi, V., Varis, S., Hantula, J. and Henttonen, H. 2005. Molecular phylogeny and systematics of anoplocephaline cestodes in rodents and lagomorphs. Systematic Parasitology 62: 83–99.
- Yurtsev, B. A. 1974. Problems of the Botanical Geography of Northeast Asia. Nauka, Leningrad.

Received 5 December 2005. Accepted 11 January 2006.

Appendix 1.

Localities sampled by the BCP from 1999–2005.

Locale	Latitude	Longitude	Year	Country	Region	Locality
1	75.49	143.24	1994	Russia	Yakutia	Ostrov Faddeyevskiy
2	72.3	140.83	1994	Russia	Yakutia	Yana R. Delta
3	72.18	148.44	1994	Russia	Yakutia	Lopatka Peninsula
4	69.5	157	1991	Russia	Yakutia	Bolshaya Chukochya R.
5	69.35	163.58	1994	Russia	Yakutia	Kolyma R. Delta
6	68.78	170.5	1992	Russia	Chukotka	Chaun
7	70.96	179.56	1994	Russia	Chukotka	Ostrov Vrangelya
8	64.467	141.89	2004	Russia	Yakutia	El'gi R.
9	64.545	143	2004	Russia	Yakutia	20 km NW Ust Mera
10	63.123	144.518	2004	Russia	Yakutia	Taryn-Yuryakn R.
11	63.218	145.266	2004	Russia	Yakutia	Upper Tymtey R.
12	63.873	145.492	2004	Russia	Yakutia	Delyankir R.
13	62.83	148.25	2000	Russia	Magadanskaya	15 km E. Susuman
14	61.83	147.17	1992	Russia	Khabarovskiy	Pervy Ozero
15	61.847	147.662	2004	Russia	Magadanskaya	Stokovo Station
16	60.28	147.62	1991	Russia	Magadanskaya	Chelomdzha
17	59.98	148.08	1992	Russia	Magadanskaya	Chelomdzha R. Area
18	59.79	148.27	1994	Russia	Magadanskaya	Chelomdzha R.
19	59.76	149.81	1994	Russia	Magadanskaya	Oira R.
20	59.69	150.34	2000	Russia	Magadanskaya	40 km W. Magadan
21	59.5	150.67	2002	Russia	Magadanskaya	Chirikova Cape
22	59.57	150.83	1999	Russia	Magadanskaya	Magadan
23	59.72	150.85	2002	Russia	Magadanskaya	28 km N. Gertnera Bay
24	59.75	150.88	1994	Russia	Magadanskaya	Snow Valley
25	59.73	150.87	1994	Russia	Magadanskaya	Snezhnaya Valley
26	60.88	149.91	2000	Russia	Magadanskaya	35 km Se Ust-Omchug
27	60.83	151.7	2000	Russia	Magadanskaya	2 km S. Atka
28	60.79	151.73	2000	Russia	Magadanskaya	7 km S. Atka
29	60.757	151.784	2004	Russia	Magadanskaya	Elikchan Lakes
30	62.52	152.28	2000	Russia	Magadanskaya	Kolyma R.
31	62.95	152.37	1998	Russia	Magadanskaya	Seimchan Area
32	62.86	152.41	2000	Russia	Magadanskaya	Elegan R.
33	62.333	153.35	1998	Russia	Magadanskaya	Buynda R.
34	63.33	158.58	2002	Russia	Magadanskaya	Omolon R.
35	63.42	158.91	2000	Russia	Magadanskaya	Omolon R.
36	63.63	159.45	2000	Russia	Magadanskaya	Omolon R.
37	63.82	160.5	2000	Russia	Magadanskaya	Omolon R.
38	64.38	161.03	2000	Russia	Magadanskaya	Omolon R.
39	64.45	161.13	2000	Russia	Magadanskaya	Omolon R.
40	65.31	160.34	2000	Russia	Magadanskaya	Omolon R.
41	65.46	160.18	2000	Russia	Magadanskaya	Omolon R.
42	65.59	159.68	2000	Russia	Magadanskaya	Omolon R.
43	65.65	159.38	2000	Russia	Magadanskaya	Omolon R
44	65	168.67	1992	Russia	Chukotka	Upper Anadyr R.
45	64.68	170.4	2002	Russia	Chukotka	Markovka R.
46	62.7	170.42	2002	Russia	Chukotka	Kamenka R.
47	65.22	172.33	2002	Russia	Chukotka	Getlyangen Lagoon
48	64.87	172.67	2002	Russia	Chukotka	10 km Sw Yanrakynnot Village
49	64.65	172.53	2002	Russia	Chukotka	Ne Side Ostrov Yttygran
50	64.52	172.75	2002	Russia	Chukotka	3 km Nne Tkachen Bay
51	64.42	172.53	2002	Russia	Chukotka	Ulhum R.
52	64.57	177.32	2002	Russia	Chukotka	Mount Dionysus
53	64.81	177.55	2002	Russia	Chukotka	volchya K.
54	64.533	-1/2./5	1998	Russia	Chukotka	6 km NE Chapline

Locale	Latitude	Longitude	Year	Country	Region	Locality
55	64.867	-172.667	2002	Russia	Chukotka	10 km SW of Yanrakynnot
56	64.65	-172.533	1998	Russia	Chukotka	NE end of Yttygran Island
57	64.417	-172.533	1998	Russia	Chukotka	12 km W of Old Chapline
58	65.217	-172.333	1998	Russia	Chukotka	Gerlyangen Lagoon
59	53.08	158.83	1997	Russia	Kamchatka	Petropaulousk Kamchatskiy
60	54.97	158.95	1997	Russia	Kamchatka	Elizovo
61	64.87	-166.21	2000	USA	Alaska	Woolley Lagoon
62	64.9	-166.18	2000	USA	Alaska	Wesley Creek
63	64.9	-165.11	2000	USA	Alaska	Grand Central R
64	65.1	-164.92	2000	USA	Alaska	Pilgrim Hotsprings
65	65.05	-164.83	2000	USA	Alaska	Pilorim Hotsprings Road
66	64 48	-164.63	2000	USA	Alaska	Safety Sound
67	64 71	-164.01	2000	USA	Alaska	Skookum R
68	64 78	-163 79	2000	USA	Alaska	Foy/Lil Creek
69	65.41	-164.65	2000	USA	Alaska	Kougarok Landing Strin
70	65.38	163.27	2000		Alaska	Kuzitrin Lake
70	65.85	-103.27	2001	USA	Alaska	Sorpontino Hot Springs
71	66.29	-104.7	2001	USA	Alaska	Devil Mountain Lakes
72	00.38	-104.48	2001	USA	Alaska	Devil Mountain Lakes
73	00.93	-102.0	2000	USA	Alaska	8 km S. Kolzebue
/4	67.07	-103.32	2000	USA	Alaska	Tukrok R.
75	67.13	-162.88	2003	USA	Alaska	
/6	67.2	-163.17	2001	USA	Alaska	Situkuyok R.
77	67.27	-163.67	2003	USA	Alaska	Kakagrak Hills
78	67.52	-163.58	2001	USA	Alaska	Rabbit Creek
79	67.62	-163.85	2001	USA	Alaska	Red Dog Road
80	67.47	-162.22	2001	USA	Alaska	Asik Mountain
81	67.92	-162.28	2000	USA	Alaska	Kelly R.
82	68.47	-161.47	2001	USA	Alaska	Copter Peak
83	68.2	-159.82	2001	USA	Alaska	Aniralik Lake
84	68.33	-158.73	2001	USA	Alaska	Desperation Lake
85	68.13	-158.98	2001	USA	Alaska	Sidik Lake
86	67.6	-159.78	2003	USA	Alaska	Baird Mountains
87	67.08	-159.78	2001	USA	Alaska	Kallarichuk R.
88	67.12	-159.03	2000	USA	Alaska	Kavet Creek
89	67	-158.48	2003	USA	Alaska	Waring Mountains
90	67.1	-158.27	2001	USA	Alaska	Onion Portage
91	67.48	-158.23	2003	USA	Alaska	Headwaters Akillik R.
92	67.65	-158.18	2001	USA	Alaska	Kaluich Creek
93	67.72	-156.13	2002	USA	Alaska	Lake Isiak
94	68.12	-154.12	2002	USA	Alaska	Lake Tulilik
95	68.57	-152.95	2002	USA	Alaska	Fortress Mountain
96	68.27	-150.65	2002	USA	Alaska	Nunushuk R.
97	68.455	-149.478	2005	USA	Alaska	Lake Galbreath
98	67.5	-154.5		USA	Alaska	Baird and Brooks M.
99	67.1	-154.27	2002	USA	Alaska	Walker Lake
100	67.33	-153.67	2002	USA	Alaska	Lake Takahula
101	67.07	-152.93	2002	USA	Alaska	Agiak Lake
102	67.45	-150.85	2002	USA	Alaska	North Fork Koyukuk R.
103	66.539	-150.796	2005	USA	Alaska	Fish Creek on Dalton Hwv
104	66.358	-150.461	2005	USA	Alaska	Finger Mtn
105	66.303	-150.432	2005	USA	Alaska	2 mi S Finger Mtn
106	65.668	-149.107	2005	USA	Alaska	Hess Creek on Dalton Hwv
107	65.288	-149.291	2005	USA	Alaska	10 mi N., 1 mi E Minto
108	65.149	-147.387	2005	USA	Alaska	Steese Highway
109	63.933	-147.467		USA	Alaska	Central Alaska Range
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110 63.077 -146.221 2005 USA Alaska 29.5 mi W Paxon 111 63.189 147.597 2005 USA Alaska 85.6 mi W Paxon, 113 63.75 -148.372 2002 USA Alaska Stamped Creek 114 63.75 -150.82 2002 USA Alaska Stamped Creek 115 63.92 151.5 2002 USA Alaska Creek 116 62.356 150.82 2005 USA Alaska 0.5 mi F Pereville 118 62.38 -150.72 2002 USA Alaska Perev Streek 119 62.27 -150.24 2002 USA Alaska Tupper Verma R. 121 61.1 -153.85 2003 USA Alaska Tupper Verma R. 122 60.38 153.83 2003 USA Alaska Mirry Lake 123 60.38 153.83 2003 USA Alaska Mirry Lake	Locale	Latitude	Longitude	Year	Country	Region	Locality
111 63.189 -147.377 2005 USA Alaska 85.5 mi W Passon 112 63.75 -150.32 2002 USA Alaska 120 mi W. Passon 114 63.7 -150.32 2002 USA Alaska Kantshan Hills 115 63.79 -150.58 2002 USA Alaska Peters Creek 116 62.536 150.82 2005 USA Alaska Peters Creek 118 62.38 150.72 2002 USA Alaska Uper Versita R. 121 61.1 153.85 2003 USA Alaska Targore Creek 122 60.78 153.85 2003 USA Alaska Head of Lake Clark 123 60.18 -153.85 2003 USA Alaska Head of Lake Clark 124 59.98 -122.67 2003 USA Alaska Head of Lake Clark 125 60.17 -154.57 2003 USA Alaska Head of	110	63.077	-146.221	2005	USA	Alaska	29.5 mi W Paxson
112 63.375 148.378 2065 USA Alaska 120 mit W rason, 113 63.75 -150.28 2002 USA Alaska Stampede Creek 114 63.7 -150.58 2002 USA Alaska Chichubane Lake 115 63.92 -151.5 2005 USA Alaska 0.5 mit Ferrs/Hers/Hers/Hers/Hers/Hers/Hers/Hers/	111	63.189	-147.597	2005	USA	Alaska	85.5 mi W Paxson
113 67.7 -150.58 2002 USA Alaska Sumption 114 65.7 -150.58 2002 USA Alaska Chichtukabena Lake 115 63.92 -151.5 2002 USA Alaska Peters Creck 116 62.38 -150.76 2005 USA Alaska Peters Creck 118 62.38 -150.72 2002 USA Alaska Peters Creck 120 62.28 -153.85 2003 USA Alaska Upper Creck 121 61.1 153.85 2003 USA Alaska Two Lakes 122 60.78 -152.67 2003 USA Alaska Head of Lake Clark 124 59.98 -152.67 2003 USA Alaska Churke Clark 125 60.17 -154.57 2003 USA Alaska Churke Clark 128 58.67 -155.622 2004 USA Alaska Cohin	112	63.375	-148.378	2005	USA	Alaska	120 mi W. Paxson,
114 63.7 -150.8 2002 USA Alaska Kamilla 115 63.92 -151.5 2003 USA Alaska Chilchalabena Lake 117 62.49 150.768 2005 USA Alaska 0.5 mic Peters/Ule 118 62.33 -150.24 2002 USA Alaska Troper Creek 119 62.27 -150.24 2002 USA Alaska Troper Creek 120 62.28 -152.05 2003 USA Alaska Tropoise Lake 121 61.1 -153.85 2003 USA Alaska Tropoise Lake 123 60.38 -153.83 2003 USA Alaska Mead of Lake Clark 124 59.98 -152.67 2003 USA Alaska Mead of Lake Clark 125 60.77 -155.028 2004 USA Alaska Mark 126 58.77 -155.891 2004 USA Alaska Drerk <td>113</td> <td>63.75</td> <td>-150.32</td> <td>2002</td> <td>USA</td> <td>Alaska</td> <td>Stampede Creek</td>	113	63.75	-150.32	2002	USA	Alaska	Stampede Creek
115 63.92 -151.5 2002 USA Alaska Chichaben Lake 116 62.536 -150.76 2005 USA Alaska O 5 ml E Peters/lile 117 62.49 -150.76 2002 USA Alaska Peters Creek 118 62.38 -150.72 2002 USA Alaska Upper Creek 120 62.23 -153.85 2003 USA Alaska Upper Creek 122 60.78 -153.85 2003 USA Alaska Fuero Lake 123 60.38 -153.85 2003 USA Alaska Fuero Lake 124 59.98 -152.67 2003 USA Alaska Fuero Creek 125 60.17 -154.57 2003 USA Alaska Fuero Creek 128 58.67 -155.429 2004 USA Alaska Chairs 129 58.21 -150.67 2003 USA Alaska Cobinin	114	63.7	-150.58	2002	USA	Alaska	Kantishna Hills
116 62.336 150.82 2005 USA Alaska Peters Creek 117 62.49 -150.768 2002 USA Alaska 0.5 m. Creek 119 62.27 -150.72 2002 USA Alaska Trapper Creek 120 62.28 152.05 2002 USA Alaska Trapper Creek 121 61.1 -153.85 2003 USA Alaska Two calosis 123 60.38 -153.85 2003 USA Alaska Head of Lake Clark 124 59.98 -152.67 2003 USA Alaska Biver Salmon 125 60.17 -154.57 2003 USA Alaska Chaitma Bay 126 58.773 -155.429 2004 USA Alaska Gortat Creek 130 58.105 -154.527 2004 USA Alaska Contat Creek 131 59.62 -150.63 2003 USA Alaska	115	63.92	-151.5	2002	USA	Alaska	Chilchukabena Lake
117 62.49 -150.768 2002 USA Alaska 0.5 mi E Petersville 118 62.27 -150.24 2002 USA Alaska Upper Yentus R. 120 62.28 -152.05 2002 USA Alaska Upper Yentus R. 121 61.1 -153.85 2003 USA Alaska Turopiose Lake 123 60.38 -153.85 2003 USA Alaska Turopiose Lake 124 59.98 -152.67 2003 USA Alaska Chiker Station 125 60.17 -154.57 2003 USA Alaska Murmy Lake 127 58.67 -155.028 2004 USA Alaska Murmy Lake 128 58.755 -154.527 2004 USA Alaska Contact Creek 130 59.02 -150.67 2003 USA Alaska Upper Nuka R. 131 59.25 -150.35 2003 USA Alaska UpitMuka R.	116	62.536	-150.82	2005	USA	Alaska	Peters Creek
118 62.28 -150.72 2002 USA Alaska Peters Creek 119 62.27 -150.24 2002 USA Alaska Tupper Ventua R. 120 61.28 -152.05 2002 USA Alaska Two aloss 121 61.1 -153.85 2003 USA Alaska Two aloss 123 60.38 -153.85 2003 USA Alaska Silvergance 124 59.98 -152.67 2003 USA Alaska Chuitma Bay 125 60.17 -154.57 2004 USA Alaska Harry Lake 127 58.67 -155.429 2004 USA Alaska Idavia Lake 128 58.765 -155.891 2004 USA Alaska Idavia Lake 130 58.105 -154.527 2004 USA Alaska Markika 131 59.62 150.63 2003 USA Alaska North Arm, Nuka Bay	117	62.49	-150.768	2005	USA	Alaska	0.5 mi E Petersville
119 62.27 -150.24 2002 USA Alaska Trapper Creek 120 62.28 -152.05 2002 USA Alaska Two Lakes 121 61.1 -153.85 2003 USA Alaska Two Lakes 122 60.78 -153.83 2003 USA Alaska Fundor Flact Clark 124 59.08 -152.67 2003 USA Alaska Silver Salmon 125 60.17 154.57 2003 USA Alaska Marray Lake 127 58.67 -155.921 2004 USA Alaska Fure's Cabin 128 58.755 -155.891 2004 USA Alaska Chaina Bay 130 58.105 -154.527 2004 USA Alaska Cabin 131 59.62 -150.67 2003 USA Alaska Matk Bay 133 59.53 -150.35 2003 USA Alaska Delight Lake <	118	62.38	-150.72	2002	USA	Alaska	Peters Creek
120 62.28 -152.05 2002 USA Alaska Upper Yentna R. 121 61.1 -153.85 2003 USA Alaska Turquoise Lake 123 60.78 -153.85 2003 USA Alaska Turquoise Lake 124 59.98 -152.47 2003 USA Alaska Silver Salmon 125 60.17 -154.57 2003 USA Alaska Fure's Cabin 128 58.757 -155.429 2004 USA Alaska Fure's Cabin 128 58.75 -155.821 2004 USA Alaska Contact Creek 130 58.105 -154.527 2004 USA Alaska Contact Creek 133 59.55 -150.63 2003 USA Alaska Shelter Creek 134 59.65 -150.33 2003 USA Alaska Delight Shit 135 59.53 -150.33 2003 USA Alaska Northwesteren Lagoon </td <td>119</td> <td>62.27</td> <td>-150.24</td> <td>2002</td> <td>USA</td> <td>Alaska</td> <td>Trapper Creek</td>	119	62.27	-150.24	2002	USA	Alaska	Trapper Creek
121 61.1 -153.85 2003 USA Alaska Two Lakes 122 60.78 -153.83 2003 USA Alaska Irruptoise Lake 124 59.98 -152.67 2003 USA Alaska Chaitae Clark 125 60.17 -154.57 2003 USA Alaska Chaitae Bay 126 58.773 -155.028 2004 USA Alaska Chaitae 128 58.765 -155.891 2004 USA Alaska Idvaria Iake 129 58.221 -155.892 2004 USA Alaska Uper Nuka R. 130 59.62 -150.67 2003 USA Alaska Uper Nuka R. 131 59.62 -150.63 2003 USA Alaska North Arm. 133 59.55 -150.35 2003 USA Alaska North Arm. 134 59.53 -150.35 2003 USA Alaska Pagma Bay	120	62.28	-152.05	2002	USA	Alaska	Upper Yentna R.
122 60.78 -153.85 2003 USA Alaska Turquoise Lake 123 60.38 -153.85 2003 USA Alaska Silver Salmon 124 59.98 -152.67 2003 USA Alaska Silver Salmon 125 60.17 -154.57 2003 USA Alaska Muray Lake 126 58.707 -155.429 2004 USA Alaska Muray Lake 128 58.765 -155.982 2004 USA Alaska Contact Creek 130 58.105 -154.527 2004 USA Alaska Contact Creek 131 59.62 -150.63 2003 USA Alaska Dielpht Dake 132 59.53 -150.33 2003 USA Alaska Dielpht Pait 134 59.53 -150.33 2003 USA Alaska Paguna Bay 135 59.53 -150.3 2003 USA Alaska Paguna Bay <t< td=""><td>121</td><td>61.1</td><td>-153.85</td><td>2003</td><td>USA</td><td>Alaska</td><td>Two Lakes</td></t<>	121	61.1	-153.85	2003	USA	Alaska	Two Lakes
123 60.38 -153.83 2003 USA Alaska Head of Lake Clark 124 59.98 -152.67 2003 USA Alaska Chuima Bay 125 60.17 -154.57 2003 USA Alaska Chuima Bay 126 58.73 -155.429 2004 USA Alaska Hurs' Lake 128 58.765 -155.891 2004 USA Alaska Idavain Lake 129 58.105 -154.527 2004 USA Alaska Contact Creek 130 58.105 -154.527 2004 USA Alaska Contact Creek 131 59.62 -150.67 2003 USA Alaska Delight Spit 133 59.55 -150.33 2003 USA Alaska Delight Spit 134 59.53 -150.13 2003 USA Alaska Delight Spit 135 59.72 -149.72 2003 USA Alaska Crater Bay 139 59.82 -149.63 2003 USA Alaska Lop	122	60.78	-153.85	2003	USA	Alaska	Turquoise Lake
124 59.98 -152.67 2003 USA Alaska Silver Salmon 125 60.17 -154.57 2003 USA Alaska Murray Lake 126 58.773 -155.289 2004 USA Alaska Murray Lake 127 58.67 -155.891 2004 USA Alaska Fure's Cabin 128 58.765 -155.982 2004 USA Alaska Contact Creek 130 58.105 -154.527 2004 USA Alaska Marka 131 59.62 -150.67 2003 USA Alaska Shelter Cove, Benuty Bay 133 59.55 -150.66 2003 USA Alaska Delight Spit 134 59.53 -150.3 2003 USA Alaska Delight Spit 135 59.53 -150.3 2003 USA Alaska Northwestern Lagoon 138 59.77 -149.77 2003 USA Alaska Vation 140 60.28 -149.77 2003 USA Alaska <td< td=""><td>123</td><td>60.38</td><td>-153.83</td><td>2003</td><td>USA</td><td>Alaska</td><td>Head of Lake Clark</td></td<>	123	60.38	-153.83	2003	USA	Alaska	Head of Lake Clark
125 60.17 -154.57 2003 USA Alaska Chulima Bay 126 58.773 -155.028 2004 USA Alaska Fure's Cabin 127 58.67 -155.429 2004 USA Alaska Fure's Cabin 128 58.765 -155.982 2004 USA Alaska Contact Creek 130 58.105 -154.527 2004 USA Alaska Amaik Bay 131 99.62 -150.67 2003 USA Alaska Scheet Cove, Bauty Bay 133 59.55 -150.56 2003 USA Alaska Delight Pit 134 59.53 -150.33 2003 USA Alaska Delight Eale 135 59.53 -150.13 2003 USA Alaska Crater Bay 137 59.77 -149.77 2003 USA Alaska Crater Bay 139 59.82 -149.63 2003 USA Alaska Crater Bay	124	59.98	-152.67	2003	USA	Alaska	Silver Salmon
126 58.773 -155.028 2004 USA Alaska Murray Lake 127 58.67 -155.82 2004 USA Alaska Idavian Lake 128 58.765 -155.892 2004 USA Alaska Contact Creek 130 58.105 -154.527 2004 USA Alaska Contact Creek 131 59.62 -150.63 2003 USA Alaska Shelter Creek, Baury Bay 133 59.55 -150.63 2003 USA Alaska Delight Apit 134 59.53 -150.33 2003 USA Alaska Delight Apit 135 59.53 -150.3 2003 USA Alaska Delight Lake 136 59.68 -150.13 2003 USA Alaska Northwestern Lagoon 138 59.77 -149.92 2003 USA Alaska Crater Bay 139 59.82 -149.77 2003 USA Alaska Crater Bay 140 60.28 -149.71 2003 USA Alaska	125	60.17	-154.57	2003	USA	Alaska	Chulitna Bay
127 58.67 -155.429 2004 USA Alaska Fure's Cabin 128 58.21 -155.982 2004 USA Alaska Idavain Lake 130 58.105 -154.527 2004 USA Alaska Amalik Bay 131 59.62 -150.67 2003 USA Alaska Shelter Cove, Benuty Bay 133 59.55 -150.56 2003 USA Alaska North Arm, Nuka Bay 134 59.53 -150.33 2003 USA Alaska Delight Spit 135 59.53 -150.13 2003 USA Alaska Paguna Bay 135 59.53 -160.3 2003 USA Alaska Northwestern Lagoon 136 59.68 -150.13 2003 USA Alaska Crater Bay 137 59.77 -149.92 2003 USA Alaska Crater Bay 139 59.82 -149.63 2003 USA Alaska Upper Jean Lake 141 60.53 -150.46 2003 USA Alaska </td <td>126</td> <td>58.773</td> <td>-155.028</td> <td>2004</td> <td>USA</td> <td>Alaska</td> <td>Murray Lake</td>	126	58.773	-155.028	2004	USA	Alaska	Murray Lake
128 58.765 -155.891 2004 USA Alaska Idavain Lake 129 58.221 -155.982 2004 USA Alaska Contact Creck 130 58.105 -154.527 2004 USA Alaska Contact Creck 131 59.62 -150.67 2003 USA Alaska Upper Nuka R. 132 59.56 -150.63 2003 USA Alaska North Arm, Nuka Bay 133 59.53 -150.33 2003 USA Alaska Delight Spit 135 59.53 -150.13 2003 USA Alaska Delight Lake 136 59.77 -149.92 2003 USA Alaska Routhwestern Lagoon 138 59.72 -149.77 2003 USA Alaska Reutrection R. 140 60.28 -149.7 2003 USA Alaska Longmere Lake 142 60.54 -150.41 2003 USA Alaska Portage Clac	127	58.67	-155.429	2004	USA	Alaska	Fure's Cabin
129 58.221 -155.982 2004 USA Alaska Contact Creek 130 58.105 -154.527 2004 USA Alaska Amalik Bay 131 59.62 -150.67 2003 USA Alaska Mpper Nuka R. 132 59.56 -150.63 2003 USA Alaska North Arm, Nuka Bay 133 59.55 -150.56 2003 USA Alaska Delight Spit 134 59.53 -150.33 2003 USA Alaska Delight Jake 135 59.53 -150.3 2003 USA Alaska Delight Jake 136 59.72 -149.77 2003 USA Alaska Cater Bay 140 60.28 -149.63 2003 USA Alaska Upper Jan Lake 141 60.53 -150.4 2003 USA Alaska Upper Jan Lake 142 60.49 -150.91 2003 USA Alaska Portage Creek Rd <	128	58,765	-155.891	2004	USA	Alaska	Idayain Lake
130 58,105 -154,527 2004 USA Alaska Amalik Bay 131 59,62 -150,67 2003 USA Alaska Upper Nuka R. 132 59,56 -150,63 2003 USA Alaska North Arn, Nuka Bay 133 59,55 -150,53 2003 USA Alaska Delight Spit 134 59,53 -150,33 2003 USA Alaska Delight Lake 135 59,53 -150,13 2003 USA Alaska Paguna Bay 137 59,77 -149,92 2003 USA Alaska Crater Bay 138 59,72 -149,77 2003 USA Alaska Varier Bay 140 60,28 -149,7 2003 USA Alaska Upper Jean Lake 141 60,53 -150,4 2003 USA Alaska Upper Jean Lake 142 60,54 -149,73 2003 USA Alaska Palarer Creek Rd	129	58.221	-155.982	2004	USA	Alaska	Contact Creek
131 59,62 -150,67 2003 USA Alaska Upper Nuka R. 132 59,56 -150,63 2003 USA Alaska Shelter Cove, Beauty Bay 133 59,55 -150,56 2003 USA Alaska North Arm, Nuka Bay 134 59,53 -150,3 2003 USA Alaska Delight Spit 135 59,53 -150,3 2003 USA Alaska Delight Lake 136 59,68 -150,13 2003 USA Alaska Northwestern Lagoon 138 59,72 -149,77 2003 USA Alaska Resurcetion R. 141 60,23 -149,63 2003 USA Alaska Upper Jauke 142 60,54 -150,46 2003 USA Alaska Upper Jauke 143 60,49 -150,91 2003 USA Alaska Upper Jauke 144 60,831 -148,901 2005 USA Alaska Portage Gla	130	58,105	-154.527	2004	USA	Alaska	Amalik Bay
132 59.56 -150.63 2003 USA Alaska Shelter Cove, Beauty Bay 133 59.55 -150.36 2003 USA Alaska North Arm, Nuka Bay 134 59.53 -150.33 2003 USA Alaska Delight Spit 135 59.53 -150.3 2003 USA Alaska Delight Spit 136 59.68 -150.13 2003 USA Alaska Paguna Bay 137 59.77 -149.92 2003 USA Alaska Crater Bay 139 59.82 -149.63 2003 USA Alaska Resurrection R. 141 60.54 -150.46 2003 USA Alaska Upper Jean Lake 142 60.54 -150.46 2003 USA Alaska Longmere Lake 144 60.81 -149.506 2005 USA Alaska Portage Creek Rd 144 60.81 -148.94 2003 USA Alaska Portage Creek Rd 145 60.793 -148.94 2001 USA A	131	59.62	-150.67	2003	USA	Alaska	Upper Nuka R.
133 59.55 -150.56 2003 USA Alaska North Arm, Nuka Bay 134 59.53 -150.33 2003 USA Alaska Delight Spit 135 59.53 -150.3 2003 USA Alaska Delight Spit 136 59.68 -150.13 2003 USA Alaska Paguna Bay 137 59.77 -149.92 2003 USA Alaska Northwestern Lagoon 138 59.72 -149.63 2003 USA Alaska Cater Bay 139 59.82 -149.63 2003 USA Alaska Resurrection R. 141 60.53 -150.4 2003 USA Alaska Upper Jean Lake 142 60.49 -150.91 2003 USA Alaska Portage Clacier Rd 144 60.831 -149.536 2005 USA Alaska Portage Clacier Rd 145 60.793 -148.901 2005 USA Alaska Summit L	132	59.56	-150.63	2003	USA	Alaska	Shelter Cove, Beauty Bay
134 59.53 -150.33 2003 USA Alaska Delight Spit 135 59.53 -150.13 2003 USA Alaska Delight Lake 136 59.68 -150.13 2003 USA Alaska Paguna Bay 137 59.77 -149.77 2003 USA Alaska Northwestern Lagoon 138 59.72 -149.77 2003 USA Alaska Aiaska Northwestern Lagoon 140 60.28 -149.7 2003 USA Alaska Upper Jean Lake 142 60.54 -150.46 2003 USA Alaska Upper Jean Lake 143 60.49 -150.91 2003 USA Alaska Portage Creek Rd 144 60.831 -148.901 2005 USA Alaska Portage Creek 144 60.81 -148.94 2003 USA Alaska Portage Creek 147 61.31 -144.23 2001 USA Alaska	133	59.55	-150.56	2003	USA	Alaska	North Arm. Nuka Bay
135 59.53 -150.3 2003 USA Alaska Deight Lake 136 59.68 -150.13 2003 USA Alaska Paguna Bay 137 59.77 -149.92 2003 USA Alaska Northwestern Lagoon 138 59.22 -149.77 2003 USA Alaska Crater Bay 140 60.28 -149.7 2003 USA Alaska Wainet Bay 141 60.53 -150.4 2003 USA Alaska Wainet Creek Rd 142 60.54 -150.46 2003 USA Alaska Wainet Lake 143 60.49 -150.91 2003 USA Alaska Portage Glacier Rd 144 60.811 -148.901 2005 USA Alaska Portage Glacier Rd 145 60.793 -148.94 2003 USA Alaska Portage Creek 147 61.31 -143.78 2001 USA Alaska Chokona Lake	134	59.53	-150.33	2003	USA	Alaska	Delight Spit
136 59.68 -150.13 2003 USA Alaska Pagun Bay 137 59.77 -149.92 2003 USA Alaska Northwestern Lagoon 138 59.72 -149.77 2003 USA Alaska Crater Bay 139 59.82 -149.63 2003 USA Alaska Resurrection R. 140 60.28 -149.7 2003 USA Alaska Resurrection R. 141 60.53 -150.4 2003 USA Alaska Watson Lake 142 60.54 -150.91 2003 USA Alaska Pagune Bay 144 60.81 -149.536 2005 USA Alaska Patmer Creek Rd 145 60.793 -148.901 2005 USA Alaska Portage Glacier Rd 146 60.81 -148.94 2001 USA Alaska Harry's Guich 147 61.37 -143.44 2002 USA Alaska Ruby Lake </td <td>135</td> <td>59.53</td> <td>-150.3</td> <td>2003</td> <td>USA</td> <td>Alaska</td> <td>Delight Lake</td>	135	59.53	-150.3	2003	USA	Alaska	Delight Lake
137 59.77 -149.92 2003 USA Alaska Northwestern Lagoon 138 59.72 -149.77 2003 USA Alaska Crater Bay 139 59.82 -149.63 2003 USA Alaska Crater Bay 140 60.28 -149.7 2003 USA Alaska Resurrection R. 141 60.53 -150.4 2003 USA Alaska Upper Jean Lake 142 60.54 -150.46 2003 USA Alaska Palmer Creck Rd 144 60.81 -148.901 2005 USA Alaska Portage Glacier Rd 145 60.793 -148.901 2005 USA Alaska Portage Glacier Rd 146 60.81 -148.94 2003 USA Alaska Burny's Gulch 147 61.31 -144.23 2001 USA Alaska Burny's Gulch 148 61.06 -143.9 2001 USA Alaska Ruby Lake </td <td>136</td> <td>59.68</td> <td>-150.13</td> <td>2003</td> <td>USA</td> <td>Alaska</td> <td>Paguna Bay</td>	136	59.68	-150.13	2003	USA	Alaska	Paguna Bay
138 59,72 -149,77 2003 USA Alaska Crater Bay 139 59,82 -149,63 2003 USA Alaska Aialik Bay 140 60,28 -149,7 2003 USA Alaska Resurrection R. 141 60,53 -150,4 2003 USA Alaska Upper Jean Lake 142 60,54 -150,46 2003 USA Alaska Watson Lake 143 60,49 -150,91 2003 USA Alaska Portage Glacier Rd 144 60,831 -149,536 2005 USA Alaska Portage Creek Rd 145 60,793 -148,901 2005 USA Alaska Portage Creek Rd 146 60,81 -148,54 2003 USA Alaska Nortage Glacier Rd 147 61.31 -144.23 2001 USA Alaska Summit Lake 148 61.06 -143.36 2001 USA Alaska Ruby Lake	137	59.77	-149.92	2003	USA	Alaska	Northwestern Lagoon
139 59.82 -149.63 2003 USAAlaskaAlaskaAialik Bay140 60.28 -149.7 2003 USAAlaskaResurrection R.141 60.53 -150.4 2003 USAAlaskaUpper Jean Lake142 60.54 -150.46 2003 USAAlaskaWatson Lake143 60.49 -150.91 2003 USAAlaskaPalmer Creek Rd144 60.831 -149.536 2005 USAAlaskaPortage Glacier Rd145 60.793 -148.901 2005 USAAlaskaPortage Glacier Rd146 60.81 -143.92 2001 USAAlaskaSummit Lake148 61.06 -143.78 2002 USAAlaskaSummit Lake148 61.06 -143.78 2002 USAAlaskaRuby Lake150 61.37 -143.78 2002 USAAlaskaRuby Lake151 61.06 -143.36 2001 USAAlaskaRock Creek152 61 -142.75 2001 USAAlaskaRock Creek153 61.39 -142.03 2001 USAAlaskaGoat Creek154 60.98 -142.03 2001 USAAlaskaGoat Creek155 60.75 -139.5 CanadaYukon TerritoryKluane National Park156 61.83 -141.2 2001 USAAlaskaBraye Lakes155 </td <td>138</td> <td>59.72</td> <td>-149.77</td> <td>2003</td> <td>USA</td> <td>Alaska</td> <td>Crater Bay</td>	138	59.72	-149.77	2003	USA	Alaska	Crater Bay
140 60.28 -149.7 2003 USA Alaska Resurrection R. 141 60.53 -150.4 2003 USA Alaska Upper Jean Lake 142 60.54 -150.46 2003 USA Alaska Watson Lake 143 60.49 -150.91 2003 USA Alaska Longmere Lake 144 60.81 -149.536 2005 USA Alaska Palmer Creek Rd 145 60.793 -148.901 2005 USA Alaska Portage Glacier Rd 146 60.81 -143.78 2001 USA Alaska Summit Lake 148 61.06 -143.78 2002 USA Alaska Chokona Lake 150 61.37 -143.44 2002 USA Alaska Ruby Lake 151 61.06 -143.78 2001 USA Alaska Chokona Lake 152 61 -142.75 2001 USA Alaska Goat Creek	139	59.82	-149.63	2003	USA	Alaska	Aialik Bay
141 60.53 -150.4 2003 USAAlaskaUpper Jean Lake142 60.54 -150.46 2003 USAAlaskaWatson Lake143 60.49 -150.91 2003 USAAlaskaLongmere Lake144 60.831 -149.536 2005 USAAlaskaPalmer Creek Rd145 60.793 -148.901 2005 USAAlaskaPortage Glacier Rd146 60.81 -148.94 2005 USAAlaskaPortage Glacier Rd147 61.31 -144.23 2001 USAAlaskaSummit Lake148 61.06 -143.9 2001 USAAlaskaHarry's Gulch149 61.45 -143.78 2002 USAAlaskaRuby Lake150 61.37 -143.44 2002 USAAlaskaRuby Lake151 61.06 -142.75 2001 USAAlaskaRock Creek152 61 -142.75 2001 USAAlaskaTana Lake153 61.3 -142.03 2001 USAAlaskaRock Creek154 60.98 -142.03 2001 USAAlaskaRock Creek155 60.75 -139.5 CanadaYukon TerritoryKluane National Park156 61.83 -141.83 2001 USAAlaskaRock Lake158 62.05 -142.03 2001 USAAlaskaRock Lake159 62.02	140	60.28	-149.7	2003	USA	Alaska	Resurrection R.
142 60.54 -150.46 2003 USA Alaska Watson Lake 143 60.49 -150.91 2003 USA Alaska Longmere Lake 144 60.831 -149.536 2005 USA Alaska Palmer Creek Rd 145 60.793 -148.901 2005 USA Alaska Portage Glacier Rd 146 60.81 -148.901 2003 USA Alaska Portage Creek Rd 147 61.31 -144.23 2001 USA Alaska Summit Lake 148 61.06 -143.9 2001 USA Alaska Harry's Gulch 149 61.45 -143.78 2002 USA Alaska Ruby Lake 150 61.37 -143.44 2002 USA Alaska Ruby Lake 151 61.06 -143.36 2001 USA Alaska Tana Lake 153 61.3 -142.75 2001 USA Alaska Rex Creek 153 61.3 -142.03 2001 USA Alaska Goat Cr	141	60.53	-150.4	2003	USA	Alaska	Upper Jean Lake
14360.49-150.912003USAAlaskaLongmere Lake144 60.831 -149.5362005USAAlaskaPalmer Creek Rd145 60.793 -148.9012005USAAlaskaPortage Glacier Rd146 60.81 -148.942003USAAlaskaPortage Creek147 61.31 -144.232001USAAlaskaSummit Lake148 61.06 -143.92001USAAlaskaHarry's Gulch149 61.45 -143.782002USAAlaskaRuby Lake150 61.37 -143.442002USAAlaskaRuby Lake151 61.06 -143.362001USAAlaskaRuby Lake152 61 -142.752001USAAlaskaRoket Creek153 61.3 -142.032001USAAlaskaGoat Creek154 60.98 -142.032001USAAlaskaGoat Creek155 60.75 -139.5CanadaYukon TerritoryKluane National Park156 61.83 -141.832001USAAlaskaRok Lake158 62.05 -142.032001USAAlaskaBraye Lakes159 62.02 -141.122001USAAlaskaBraye Lakes159 62.02 -141.122001USAAlaskaBraye Lakes160 62.23 -140.682001CanadaYukon TerritorySn	142	60.54	-150.46	2003	USA	Alaska	Watson Lake
144 60.831 -149.536 2005 USA Alaska Palmer Creek Rd 145 60.793 -148.901 2005 USA Alaska Portage Glacier Rd 146 60.81 -148.94 2003 USA Alaska Portage Creek 147 61.31 -144.23 2001 USA Alaska Summit Lake 148 61.06 -143.9 2001 USA Alaska Harry's Gulch 149 61.45 -143.78 2002 USA Alaska Ruby Lake 150 61.37 -143.44 2002 USA Alaska Ruby Lake 151 61.06 -143.36 2001 USA Alaska Rock Creek 152 61 -142.75 2001 USA Alaska Goat Creek 152 61.3 -142.03 2001 USA Alaska Goat Creek 155 60.75 -139.5 Canada Yukon Territory Kluane National Park 156 61.83 -141.83 2001 USA Alaska Braye Lakes <td>143</td> <td>60.49</td> <td>-150.91</td> <td>2003</td> <td>USA</td> <td>Alaska</td> <td>Longmere Lake</td>	143	60.49	-150.91	2003	USA	Alaska	Longmere Lake
145 60.793 -148.901 2005 USA Alaska Portage Glacier Rd 146 60.81 -148.94 2003 USA Alaska Portage Creck 147 61.31 -144.23 2001 USA Alaska Summit Lake 148 61.06 -143.9 2001 USA Alaska Harry's Gulch 149 61.45 -143.78 2002 USA Alaska Chokosna Lake 150 61.37 -143.44 2002 USA Alaska Ruby Lake 151 61.06 -143.36 2001 USA Alaska Rock Creek 152 61 -142.75 2001 USA Alaska Rex Creek 153 61.3 -142.52 2001 USA Alaska Goat Creek 154 60.98 -142.03 2001 USA Alaska Goat Creek 155 60.75 -139.5 Canada Yukon Territory Kluane National Park 155 60.75 -141.2 2001 USA Alaska Rock Lake	144	60.831	-149.536	2005	USA	Alaska	Palmer Creek Rd
14660.81-148.942003USAAlaskaPortage Creek147 61.31 -144.232001USAAlaskaSummit Lake148 61.06 -143.92001USAAlaskaHarry's Gulch149 61.45 -143.782002USAAlaskaRuby Lake150 61.37 -143.442002USAAlaskaRuby Lake151 61.06 -143.362001USAAlaskaPocket Creek152 61 -142.752001USAAlaskaTana Lake153 61.3 -142.522001USAAlaskaGoat Creek154 60.98 -142.032001USAAlaskaGoat Creek155 60.75 -139.5CanadaYukon TerritoryKluane National Park156 61.83 -141.832001USAAlaskaRock Lake158 62.05 -142.032001USAAlaskaRock Lake158 62.05 -142.032001USAAlaskaRock Lake158 62.02 -141.122001USAAlaskaBraye Lakes160 62.23 -140.682001CanadaYukon TerritorySnag Junction161 62.34 -141.062001USAAlaskaScottic Creek162 62.3 -141.172001USAAlaskaCarden Hills163 62.53 -143.252002USAAlaskaCarden Hills	145	60.793	-148,901	2005	USA	Alaska	Portage Glacier Rd
14761.31-144.232001USAAlaskaSummit Lake14861.06-143.92001USAAlaskaHarry's Gulch14961.45-143.782002USAAlaskaChokosna Lake15061.37-143.442002USAAlaskaRuby Lake15161.06-143.362001USAAlaskaPocket Creek15261-142.752001USAAlaskaTana Lake15361.3-142.522001USAAlaskaGoat Creek15460.98-142.032001USAAlaskaGoat Creek15560.75-139.5CanadaYukon TerritoryKluane National Park15661.83-141.832001USAAlaskaSolo Mountain15761.78-142.032001USAAlaskaRock Lake15862.05-142.032001USAAlaskaRock Lake15862.02-141.122001USAAlaskaBraye Lakes16062.23-140.682001CanadaYukon TerritorySnag Junction16162.34-141.062001USAAlaskaCarden Hills16362.53-143.252002USAAlaskaCarden Hills16463.678-144.1562005USAAlaska2 mi W Dot Lake	146	60.81	-148.94	2003	USA	Alaska	Portage Creek
14861.06 -143.9 2001USAAlaskaHarry's Gulch14961.45 -143.78 2002USAAlaskaChokosna Lake15061.37 -143.44 2002USAAlaskaRuby Lake15161.06 -143.36 2001USAAlaskaPocket Creek15261 -142.75 2001USAAlaskaTana Lake15361.3 -142.52 2001USAAlaskaGoat Creek15460.98 -142.03 2001USAAlaskaGoat Creek15560.75 -139.5 CanadaYukon TerritoryKluane National Park15661.83 -141.83 2001USAAlaskaRock Lake15761.78 -141.2 2001USAAlaskaRock Lake15862.05 -142.03 2001USAAlaskaRock Lake15862.02 -141.12 2001USAAlaskaBraye Lakes16062.23 -140.68 2001CanadaYukon TerritorySnag Junction16162.34 -141.06 2001USAAlaskaCarden Hills16362.53 -143.25 2002USAAlaskaCarden Hills16463.678 -144.156 2005USAAlaska2 mi W Dot Lake	147	61.31	-144.23	2001	USA	Alaska	Summit Lake
149 61.45 -143.78 2002 USA Alaska Chokosna Lake 150 61.37 -143.44 2002 USA Alaska Ruby Lake 151 61.06 -143.36 2001 USA Alaska Pocket Creek 152 61 -142.75 2001 USA Alaska Tana Lake 153 61.3 -142.75 2001 USA Alaska Goat Creek 154 60.98 -142.03 2001 USA Alaska Goat Creek 155 60.75 -139.5 Canada Yukon Territory Kluane National Park 156 61.83 -141.2 2001 USA Alaska Solo Mountain 157 61.78 -141.2 2001 USA Alaska Rock Lake 158 62.05 -142.03 2001 USA Alaska Braye Lakes 158 62.02 -141.12 2001 USA Alaska Braye Lakes 160 62.23 -140.68 2001 Canada Yukon Territory Snag Junction	148	61.06	-143.9	2001	USA	Alaska	Harry's Gulch
150 61.37 -143.44 2002 USA Alaska Ruby Lake 151 61.06 -143.36 2001 USA Alaska Pocket Creek 152 61 -142.75 2001 USA Alaska Tana Lake 153 61.3 -142.52 2001 USA Alaska Rex Creek 154 60.98 -142.03 2001 USA Alaska Goat Creek 155 60.75 -139.5 Canada Yukon Territory Kluane National Park 156 61.83 -141.2 2001 USA Alaska Boot Creek 156 61.78 -141.2 2001 USA Alaska Solo Mountain 157 61.78 -141.2 2001 USA Alaska Rock Lake 158 62.05 -142.03 2001 USA Alaska Braye Lakes 159 62.02 -141.12 2001 USA Alaska Braye Lakes 160 62.23 -140.68 2001 Canada Yukon Territory Snag Junction	149	61.45	-143.78	2002	USA	Alaska	Chokosna Lake
151 61.06 -143.36 2001 USA Alaska Pocket Creek 152 61 -142.75 2001 USA Alaska Tana Lake 153 61.3 -142.52 2001 USA Alaska Rex Creek 154 60.98 -142.03 2001 USA Alaska Goat Creek 155 60.75 -139.5 Canada Yukon Territory Kluane National Park 156 61.83 -141.83 2001 USA Alaska Book Lake 156 61.83 -141.2 2001 USA Alaska Solo Mountain 157 61.78 -141.2 2001 USA Alaska Rock Lake 158 62.05 -142.03 2001 USA Alaska Braye Lakes 159 62.02 -141.12 2001 USA Alaska Braye Lakes 160 62.23 -140.68 2001 Canada Yukon Territory Snag Junction 161 62.34 -141.06 2001 USA Alaska Carden Hills	150	61.37	-143.44	2002	USA	Alaska	Ruby Lake
15261 -142.75 2001USAAlaskaTana Lake15361.3 -142.52 2001USAAlaskaRex Creek15460.98 -142.03 2001USAAlaskaGoat Creek15560.75 -139.5 CanadaYukon TerritoryKluane National Park15661.83 -141.83 2001USAAlaskaSolo Mountain15761.78 -141.2 2001USAAlaskaRock Lake15862.05 -142.03 2001USAAlaskaBraye Lakes15962.02 -141.12 2001USAAlaskaBraye Lakes16062.23 -140.68 2001CanadaYukon TerritorySnag Junction16162.34 -141.06 2001USAAlaskaCorteek16262.3 -141.17 2001USAAlaskaCarden Hills16362.53 -143.25 2002USAAlaskaCarden Hills16463.678 -144.156 2005USAAlaska2 mi W Dot Lake	151	61.06	-143.36	2001	USA	Alaska	Pocket Creek
151111101101101101101101153 61.3 -142.52 2001 USAAlaskaRex Creek154 60.98 -142.03 2001 USAAlaskaGoat Creek155 60.75 -139.5 CanadaYukon TerritoryKluane National Park156 61.83 -141.83 2001 USAAlaskaSolo Mountain157 61.78 -141.2 2001 USAAlaskaRock Lake158 62.05 -142.03 2001 USAAlaskaRock Lake159 62.02 -141.12 2001 USAAlaskaBraye Lakes160 62.23 -140.68 2001 CanadaYukon TerritorySnag Junction161 62.34 -141.06 2001 USAAlaskaCarden Hills162 62.3 -141.17 2001 USAAlaskaCarden Hills163 62.53 -143.25 2002 USAAlaskaTwin Lakes164 63.678 -144.156 2005 USAAlaska 2 mi W Dot Lake	152	61	-142.75	2001	USA	Alaska	Tana Lake
152 60.75 -142.03 2001 USA Alaska Goat Creek 155 60.75 -139.5 Canada Yukon Territory Kluane National Park 156 61.83 -141.83 2001 USA Alaska Solo Mountain 157 61.78 -141.2 2001 USA Alaska Rock Lake 158 62.05 -142.03 2001 USA Alaska Rock Lake 159 62.02 -141.12 2001 USA Alaska Braye Lakes 160 62.23 -140.68 2001 Canada Yukon Territory Snag Junction 161 62.34 -141.06 2001 USA Alaska Scottie Creek 162 62.3 -141.17 2001 USA Alaska Carden Hills 163 62.53 -141.17 2001 USA Alaska Carden Hills 163 62.53 -141.166 2002 USA Alaska Carden Hills 164 63.678 -144.156 2005 USA Alaska 2 mi	153	61.3	-142.52	2001	USA	Alaska	Rex Creek
151 6075 -139.5 Canada Yukon Territory Kluane National Park 156 61.83 -141.83 2001 USA Alaska Solo Mountain 157 61.78 -141.2 2001 USA Alaska Rock Lake 158 62.05 -142.03 2001 USA Alaska Braye Lakes 159 62.02 -141.12 2001 USA Alaska Braye Lakes 160 62.23 -140.68 2001 Canada Yukon Territory Snag Junction 161 62.34 -141.06 2001 USA Alaska Scottie Creek 162 62.3 -141.17 2001 USA Alaska Carden Hills 163 62.53 -141.17 2001 USA Alaska Carden Hills 163 62.53 -143.25 2002 USA Alaska Twin Lakes 164 63.678 -144.156 2005 USA Alaska 2 mi W Dot Lake	154	60.98	-142.03	2001	USA	Alaska	Goat Creek
156 61.83 -141.83 2001 USA Alaska Solo Mountain 157 61.78 -141.2 2001 USA Alaska Rock Lake 158 62.05 -142.03 2001 USA Alaska Rock Lake 159 62.02 -141.12 2001 USA Alaska Braye Lakes 160 62.23 -140.68 2001 Canada Yukon Territory Snag Junction 161 62.34 -141.06 2001 USA Alaska Scottie Creek 162 62.3 -141.17 2001 USA Alaska Carden Hills 163 62.53 -143.25 2002 USA Alaska Twin Lakes 164 63.678 -144.156 2005 USA Alaska 2 mi W Dot Lake	155	60.75	-139.5	2001	Canada	Yukon Territory	Kluane National Park
157 61.78 -141.2 2001 USA Alaska Rock Lake 158 62.05 -142.03 2001 USA Alaska Chisana 159 62.02 -141.12 2001 USA Alaska Braye Lakes 160 62.23 -140.68 2001 Canada Yukon Territory Snag Junction 161 62.34 -141.06 2001 USA Alaska Carden Hills 162 62.3 -141.17 2001 USA Alaska Carden Hills 163 62.53 -143.25 2002 USA Alaska Twin Lakes 164 63.678 -144.156 2005 USA Alaska 2 mi W Dot Lake	156	61.83	-141.83	2001	USA	Alaska	Solo Mountain
158 62.05 -142.03 2001 USA Alaska Chisana 159 62.02 -141.12 2001 USA Alaska Braye Lakes 160 62.23 -140.68 2001 Canada Yukon Territory Snag Junction 161 62.34 -141.06 2001 USA Alaska Scottie Creek 162 62.3 -141.17 2001 USA Alaska Carden Hills 163 62.53 -143.25 2002 USA Alaska Twin Lakes 164 63.678 -144.156 2005 USA Alaska 2 mi W Dot Lake	157	61.78	-141.2	2001	USA	Alaska	Rock Lake
159 62.02 -141.12 2001 USA Alaska Braye Lakes 160 62.23 -140.68 2001 Canada Yukon Territory Snag Junction 161 62.34 -141.06 2001 USA Alaska Scottie Creek 162 62.3 -141.17 2001 USA Alaska Carden Hills 163 62.53 -143.25 2002 USA Alaska Twin Lakes 164 63.678 -144.156 2005 USA Alaska 2 mi W Dot Lake	158	62.05	-142.03	2001	USA	Alaska	Chisana
160 62.23 -140.68 2001 Canada Yukon Territory Snag Junction 161 62.34 -141.06 2001 USA Alaska Scottie Creek 162 62.3 -141.17 2001 USA Alaska Carden Hills 163 62.53 -143.25 2002 USA Alaska Twin Lakes 164 63.678 -144.156 2005 USA Alaska 2 mi W Dot Lake	159	62.02	-141.12	2001	USA	Alaska	Brave Lakes
161 62.34 -141.06 2001 USA Alaska Scottie Creek 162 62.3 -141.17 2001 USA Alaska Carden Hills 163 62.53 -143.25 2002 USA Alaska Twin Lakes 164 63.678 -144.156 2005 USA Alaska 2 mi W Dot Lake	160	62.23	-140.68	2001	Canada	Yukon Territory	Snag Junction
162 62.3 -141.17 2001 USA Alaska Carden Hills 163 62.53 -143.25 2002 USA Alaska Twin Lakes 164 63.678 -144.156 2005 USA Alaska 2 mi W Dot Lake	161	62.34	-141.06	2001	USA	Alaska	Scottie Creek
163 62.53 -143.25 2002 USA Alaska Carden Inits 164 63.678 -144.156 2005 USA Alaska 2 mi W Dot Lake	162	62.3	-141 17	2001	USA	Alaska	Carden Hills
164 63.678 -144.156 2005 USA Alaska 2 mi W Dot Lake	163	62.5	-143 25	2002	USA	Alaska	Twin Lakes
	164	63.678	-144.156	2005	USA	Alaska	2 mi W Dot Lake

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Locale	Latitude	Longitude	Year	Country	Region	Locality
165	63.7	-142.25	2002	USA	Alaska	Mount Fairplay
166	63.886	-142.242	2005	USA	Alaska	Taylor Highway
167	64.61	-143.1	2001	USA	Alaska	Copper Mountain
168	64.81	-143.77	2001	USA	Alaska	Upper Crescent Creek
169	64.97	-143.05	2001	USA	Alaska	Mount Sorenson
170	65.17	-143.55	2001	USA	Alaska	Mount Kathryn
171	65.35	-143.12	2001	USA	Alaska	Yukon R.: Slaven Cabin
172	65.37	-142.51	2001	USA	Alaska	Mouth of Kandik R.
173	65.3	-142.08	2001	USA	Alaska	Yukon R.: Glenn Creek
174	65.37	-142.02	2001	USA	Alaska	Kathul Mountain
175	65.44	-142.01	2001	USA	Alaska	Upper Kandik R.
176	65.06	-141	2001	USA	Alaska	Squaw Mountain
177	64.753	-141.23	2005	USA	Alaska	3 mi SW Eagle
178	69.2	-140.25		Canada	NWT	Ivvavik National Park
179	67.917	-136		Canada	NWT	Richardson Mountains
180	66.886	-136.338	2005	Canada	Yukon Territory	2 mi S Rock R.
181	64.084	-139.442	2005	Canada	Yukon Territory	Dawson City
182	64.026	-138.579	2005	Canada	Yukon Territory	North Fork of Klondike R
183	63 555	-137 412	2005	Canada	Yukon Territory	McQuesten R
184	63 543	-137 195	2005	Canada	Yukon Territory	15 mi W Stewart Crossing
185	63 696	-136 137	2005	Canada	Yukon Territory	Minto Lake
186	63 841	135.461	2005	Canada	Yukon Territory	7 mi S Keno
187	62 200	126 555	2005	Canada	Yukon Territory	27.5 mi S Pally Crossing
107	61.1	-130.333	2005	Canada	Yukon Territory	Eav Creak
100	50.582	-133.293	2003	Canada	Pritich Columbia	Atlin Laka
100	59.585	-133.785	2000	Canada	British Columbia	Aun Lake
190	62.25	-133.25		Canada	Yukon Territory	Anvii Mountains
191	62.3	-128.967		Canada	NW I	Ramnead
192	64.467	-129.4		Canada	NW1	Palmer Lake
193	65.017	-127.583		Canada	NWT	Katherine Creek
194	64.867	-127.1		Canada	NWT	Sheep Mountain
195	64.317	-126.8		Canada	NW1	Keele R.
196	62.633	-124.483		Canada	NWT	Trench Lake
197	61.467	-123.333		Canada	NWT	Nahanni Range
198	61.117	-124.533		Canada	NWT	Tlogotscho Plateau
199	61.028	-117.328	2005	Canada	NWT	Kakisa R.
200	60.897	-116.792	2005	Canada	NWT	
201	60.75	-116.633		Canada	NWT	Hay R.
202	60.56	-116.122	2005	Canada	NWT	Hay R.
203	58.75	-125.167		Canada	British Columbia	Muskwa–Kechika Mountains
204	56.5	-123.917		Canada	British Columbia	Ospika R.
205	56.083	-122.5		Canada	British Columbia	Williston Reservoir
206	55.1	-122.95	2000	Canada	British Columbia	Misinchinka R.
207	58.885	-130.029	2001	Canada	British Columbia	Cassiar Highway
208	57.683	-129.883		Canada	British Columbia	Spatsizi Plateau
209	56.358	-129.342	2001	Canada	British Columbia	Bowser and Bell-Irving R.
210	56.115	-129.283	2001	Canada	British Columbia	Meziadin Junction
211	55.69	-128.765	2001	Canada	British Columbia	Cassiar Highway
212	56.668	-134.265	2005	USA	Alaska	Kuiu Island, Rowan Bay
213	56.644	-133.721	2005	USA	Alaska	Kuiu Island, Rocky Pass
214	56.643	-133.698	2005	USA	Alaska	Kupreanof Island
215	55.104	-131.365	2005	USA	Alaska	Annette Island, Crab Bay
216	53.783	-126.617	2000	Canada	British Columbia	Andrew's Bay
217	53.85	-126.433	2000	Canada	British Columbia	Shelford Creek
218	53.783	-126.25	2000	Canada	British Columbia	Ootsa Lake
219	53.917	-125.617	2000	Canada	British Columbia	Uncha Lake