University of Alaska

Coastal Marine Institute

The Alaska Frozen Tissue Collection: A Resource for Marine Biotechnology, Phase II

Principal Investigators:
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Final Report

November 2002

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Final Report

The Alaska Frozen Tissue Collection: A Resource for Marine Biotechnology

by

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Abstract

The Alaska Frozen Tissue Collection (AFTC) has grown into one of the world's major archives of marine mammal tissue samples. There are now frozen tissues from at least 2,400 marine mammals in the collection. Agreements with two Alaska Native management commissions were established whereby future samples from subsistence hunters will continue to be archived in the AFTC. Samples from the AFTC's marine mammal holdings have been used in at least eleven refereed publications since the beginning of this task. Data for the AFTC have been combined into a museum-wide effort to develop an online database that is geo-referenced, and includes full information on the usage of individual specimens, including citation of refereed publications. Data from all of the University of Alaska Museum's mammals, including frozen samples, are now online in a normalized Oracle database, as is much of the structure for project descriptions. Web clients can see most of the data on mammal specimens directly from the working database (http://arctos.museum.uaf.edu:8080/uam_db). Other taxa, including marine birds and fish, will be moved into Oracle over the next two years. The two state-funded student positions leveraged from Coastal Marine Institute support were combined with National Science Foundation support and leveraged to a state-funded, full-time staff coordinator of the AFTC. In its creation of the Museum's new Arctic Archival Observatory, the National Science Foundation has endorsed the paradigm that we have demonstrated with the AFTC.

Introduction

By supporting the Alaska Frozen Tissue Collection (AFTC) for the past three years (and for three years before that), CMI has sustained the development of a unique addition to the scientific infrastructure in Alaska. The AFTC provides a mechanism with established protocols for sharing and preserving data from faunal investigations of the marine environment. Essentially, the AFTC serves as an archive, storing and providing access to zoological samples that would otherwise be difficult, expensive, and often impossible to reacquire. We hope to show here that CMI, in supporting the AFTC, has catalyzed an exemplary development. We will explain what the Collection is and why we believe that it is important. We will describe the objectives of CMI support, and how we have succeeded in meeting those objectives. In addition, we will describe how these activities have catalyzed the development of a new, encompassing entity—the Arctic Archival Observatory (AAO).

What is the AFTC?

The Alaska Frozen Tissue Collection is an archive for biological samples housed at the University of Alaska Museum (UAM) in Fairbanks. Physically, the Collection is comprised of three ultra-cold chest freezers operated at –70° C. Each freezer is equipped with racks and slotted boxes to hold approximately 60,000 samples, most of which are in 2-mL cryo-tubes. The freezers connect to an alarm system monitored by the University's Safety Services Department at all times. They also connect to a compressed carbon dioxide back-up system that vents into the freezers in case of a continuing temperature rise.

Samples are in the public domain and available for scientific use under the terms of the Museum's specimen-use policy (www.uaf.edu/museum/af/using.html). In general, samples are used by sub-sampling such that part of each sample is retained in perpetuity. Rarer, large animals (especially marine mammals) are represented by as many as ten tubes of tissue. Except where unusual additional tissues were collected for specific immediate usage, no samples in the AFTC have ever been entirely consumed in analysis. In the event that total consumption of a sample becomes an issue, the AFTC would (1) scrutinize the merits of the specific project, and (2) require the user to return any extraction products remaining after analysis.

An online database makes the Collection's resources known to potential users worldwide.

Why archive?

Long-term monitoring of biological change dictates long-term accumulation of data and this is difficult because:

- The short-term payoff for long-term projects is small. It is difficult to find sponsorship for projects that do not offer a predictable, reasonably short-term result.
- We can only guess at what data will be important to future investigations or even what analytical methods may be available.

The AFTC is predicated on the following assumptions:

- Samples archived now contain data about present conditions and these data can be rendered in the future.
- New tools for rendering ecological, genetic, and pathological data from small amounts of biological material are developing rapidly. (Stable isotope ecology and DNA sequencing are prominent examples.)
- Freezing biological materials preserves the broadest possible suite of biochemical characteristics and thereby gives the greatest flexibility to future investigators.
- Samples collected for short-term goals should be sub-sampled and archived for the long-term goal of monitoring change, and many such samples from recent projects are invaluable when retrievable now.
- High trophic level organisms are particularly sensitive bio-indicators and are worth sampling now for potential use later.

For three years CMI has provided a coordinator for the AFTC in the form of a graduate student assistantship dedicated to recruiting and processing marine animals from subsistence hunting. CMI has also provided auxiliary support for supplies and travel, and the Museum has matched these monies with a state-funded student assistantship created initially from earlier (1995–98) CMI support.

Methods

Objective 1

Expand the scope of the collection by continuing to recruit contributions of marine mammal, bird, fish, and invertebrate specimens from Cook Inlet, Shelikov Strait, and the Beaufort and Chukchi seas, especially those taken by subsistence hunters of marine mammals.

Over the past six years, the Alaska Frozen Tissue Collection has grown to become one of the world's largest collections of frozen tissues from wild mammals. Data in the last survey of North American collections [Hafner et al. 1997] suggest that only the Museum of Southwestern Biology at the University of New Mexico has more mammal tissues than the AFTC. Collections containing comparable numbers of general vertebrates are at the University of California (UC) Berkeley's Museum of Vertebrate Zoology (MVZ), Texas Tech University Museum, and the Museum of Natural Science at Louisiana State University.

The UAM Mammal Collection is now about the fourteenth largest systematic mammal collection in the western hemisphere, and it has long been one of the major collections of marine mammals. At this point, the AFTC holdings from northern marine mammals are world class. The counts in Table 1 do not include several substantial accessions awaiting data entry and several accessions intended for UAM that are still in the hands of management agencies.

Formal agreements for specimen deposition were reached with two Alaska Native marine mammal co-management commissions: the Alaska Native Harbor Seal Commission (ANHSC), and the Alaska Sea Otter and Steller Sea Lion Commission. Both organizations were established under the Native co-management mandate of the Marine Mammal Protection Act (MMPA), and give Native subsistence hunters substantial control over scientific sampling and the disposition of scientific samples. Both commissions have agreed to deposit samples collected by their members in the AFTC. No formal agreement exists with the Alaska Eskimo Whaling Commission, but the Department of Wildlife Management at the North Slope Borough regularly contributes samples from harvested bowhead whales and many other marine mammals. Such long-term arrangements will steadily build chronological samples relevant to environmental change and to parameters that may vary naturally over time. The AFTC is eager to accommodate samples from resource management agencies, either on a case-by-case basis for individual projects, or in broader, more formal, cooperative agreements.

Under the Marine Mammal Protection Act, acquisition and transfer of marine mammal tissues are tightly regulated activities. Native Americans can take marine mammals for food and for use in handicrafts. Members of the National Marine Fisheries Service's (NMFS) region stranding networks can salvage parts of marine mammals found dead. All other activities involving parts of marine mammals require explicit permits from the relevant management agency (NMFS or USFWS [U.S. Fish and Wildlife Service]) or are forbidden. UAM is member of the Alaska Regional Marine Mammal Stranding Network and holds limited permits from both agencies for importation and exportation of legally acquired marine mammal samples. Generally, samples from subsistence hunting are acquired from an Alaska Native co-management commission, or from NMFS or USFWS. Some samples are acquired from researchers holding their own permits. Copies of such permits must accompany accessions of marine mammal material deposited at UAM. Samples held by UAM are available to qualified investigators under the general terms applying to other specimens (www.uaf.edu/museum/af/using.html).

Table 1. Major marine mammal tissue holdings.

Species	Frozen Sample	All Specimens
Bowhead	128	188
Belukha	112	282
Harbor seal	528	958
Spotted seal	64	639
Ringed seal	160	2807
Ribbon seal	33	308
Bearded seal	20	1392
Walrus	611	1199
Northern fur seal	13	31
Steller sea lion	79	142
Polar bear	178	481
Sea otter	503	1334
Total	**2429**	**9761**

Half of the species in Table 1 are clearly dependent on polar pack ice and are likely already affected by climate change. Two other species, Steller sea lions and harbor seals, are thought to have declined precipitously in recent decades.

Collection use

The following are selected anecdotes reflecting the variety of uses the collection has seen during the past three years.

- The AFTC sent samples from 105 harbor seals provided by the Alaska Native Harbor Seal Commission to Michael Castellini (Institute of Marine Science [IMS], UAF) and to Sara Iverson (Dalhousie University, Halifax) for metabolic analyses. Teeth from the same seals were sent to Laurie Jemsion (Alaska Department of Fish and Game [ADF&G], Juneau) for age analysis. Samples of these were also sent to Greg O'Corry-Crowe (NMFS, LaJolla) for Robin Westlake's doctoral work.

- The Mammal Collection contributed the full skeleton of a Cuvier's beaked whale to the new Near Island Research Laboratory associated with the Fishery Industrial Technology Center at Kodiak. Statewide newspapers noted the loan because the skeleton will be articulated for a permanent exhibit at the new building.

- Joshua Snodgrass, working with Diane Gifford-Gonzalez at UC Santa Cruz, spent a week gathering materials for a guide to the post-cranial osteology of northern Pacific pinnipeds. Their main objective is to provide a useful and widely available guide for archaeologists and paleontologists, who often must try to identify isolated and/or fragmentary elements to taxon. The impetus for this project is based on Paul Koch and Robert Burton's work on historic and prehistoric carbon stable isotope signatures. Burton visited the Collection from Santa Cruz to sample seals in 1997. Their research is revealing dramatic changes in the stable isotope signatures in Pacific coast pinnipeds over the past 3000 years. It has also ascertained that a large proportion of the pinniped bones recovered from Paleo-Indian middens have been misidentified by archeologists.

- Sylvia Brunner, working with Peter Shaughnessy and Michael Bryden at the University of Sydney, spent one month in August and September 1998 measuring all otariid seal skulls in the collection for a taxonomic revision of sea lions and fur seals. Dr. Brunner's project involved an 18-month tour to many of the world's major collections of marine mammals.

- Tyson Sacco, a doctoral student from UCLA, visited the collection for two weeks to measure 303 bear skulls, including 73 polar bears, for his dissertation project, "Ecomorphology and Evolutionary Biology of the Ursidae".

- Some of the earliest specimens to be catalogued into the AFTC are blood samples from Antarctic Weddell seals collected in 1991. Donald Siniff of the University of Minnesota requested four of these in May 1999 for paternity analyses (at Curtis Strobeck's lab, University of Alberta) in order to complete a pedigree of the White Island population and test

genetic distances and population subdivision in the McMurdo Sound region. These investigators have indicated that they will now archive samples from two decades of work on Weddell seals.

- Donald Schell's laboratory (IMS/UAF) used frozen tissues from twelve western arctic bowhead whales in a study to determine the importance of the eastern part of the Alaskan Beaufort Sea as a spring feeding area.

- Peter Boveng of the National Marine Mammal Lab received teeth from 45 harbor seals for age analysis. The anayses are being used in an age class and capture study that is necessary for effective harbor seal management.

- Michael Castellini and Heather Harmon of the Alaska SeaLife Center received pituitary and pineal glands from six Steller sea lions and one fur seal. These glands will be used in reproductive hormone analysis. Little is known about their reproductive endocrinology, and evidence suggests that their reproductive rates may have decreased over the past several decades.

- Six seal skeletons were loaned to National Park Service archeologist Becky Saleeby (National Park Service, Anchorage) for use in a course on faunal analysis of archeological middens.

- Tissue samples from 28 sea otters were sent to Klaus Koepfli in Robert Wayne's laboratory at UCLA for a study of geographic population structure of the entire species.

- Tissue samples from a walrus and a harbor porpoise were also sent to Klaus Koepfli. The samples will be used to characterize the molecular evolution of a gene in the pathway that synthesizes cellular cholesterol.

- Educational donations of a belukha skull were made to Kate Wynne of the UAF Marine Advisory Program at Kodiak and of a sea otter skull to Kay Furman of the Staatliches Museum für Naturkunde, Oldenburg, Germany. A polar bear skull was loaned to Brendan Kelly (University of Alaska Southeast) for a student project on bear craniology.

- Samples of two abnormal harbor seals, submitted by subsistence hunters, were sent to Kathy Burek, a veterinary pathologist in Eagle River, Alaska. One was diagnosed as having complications resulting from lung worm infestation. The other appeared to have a liver parasite, but the organism could not be identified.

- Edward Miller from the Memorial University of Newfoundland spent ten days at the Museum working with bacula from sea otters and seals. He took measurements of 287 specimens.

Recent publications resulting from marine specimens in the AFTC:

Amano, M., Y. Koyam, E.A. Petrov, A. Hayano and N. Miyazaki. 2000. Morphometric comparison of skulls of seals of the subgenus *Pusa*, p. 315–323. *In* K. Minoura [ed.], Lake Baikal: A Mirror in Time and Space for Understanding Global Climate Change Processes. Elsevier Press.

Burton, R.K., and P.L. Koch. 1999. Isotopic tracking of foraging and long-distance migration in northeastern Pacific pinnipeds. Oecologia 119:578–585.

Burton, R.K., J.J. Snodgrass, D. Gifford-Gonzalez, T. Guilderson, T. Brown and P.L. Koch. 2001. Holocene changes in the ecology of northern fur seals: Insights from stable isotopes and archaeofauna. Oecologia 128:107–115.

Fadely, B.S., J.M. Castellini and M.A. Castellini. 1998. Recovery of harbor seals from EVOS: Condition and health status. *Exxon Valdez* Oil Spill Restoration Project Final Report (Restoration Project 97-001). Alaska Department of Fish and Game, Habitat and Restoration Division, Anchorage.

Hirons, A.C., D.M. Schell and D.J. St. Aubin. 2001. Growth rates of vibrissae of harbor seals (*Phoca vitulina*) and Steller sea lions (*Eumetopias jubatus*). Can. J. Zool. 79:1053–1061.

O'Corry-Crowe, G.M., and L.F. Lowry. 1997. Genetic ecology and management concerns for the beluga whale (*Delphinapterus leucas*), p. 249–274. *In* A.E. Dizon, S.J. Chivers and W.F. Perrin [eds.], Molecular Genetics of Marine Mammals. Special Publication 3 by the Society for Marine Mammalogy.

O'Corry-Crowe, G.M., and R.L. Westlake. 1997. Molecular investigations of spotted seals (*Phoca largha*) and harbor seals (*P. vitulina*), and their relationship in areas of sympatry, p. 291–304. *In* A.E. Dizon, S.J. Chivers and W.F. Perrin [eds.], Molecular Genetics of Marine Mammals. Special Publication 3 by the Society for Marine Mammalogy.

Schell, D.M. 2000. Declining carrying capacity in the Bering Sea: Isotopic evidence from whale baleen. Limnol. Oceanogr. 45:459–462.

Schell, D.M. 2001. Carbon isotope ratio variations in Bering Sea biota: The role of anthropogenic carbon dioxide. Limnol. Oceanogr. 46:999–1000.

Schell, D.M., V.J. Rowntree and C.J. Pfeiffer. 2000. Stable-isotope and electron-microscopic evidence that cyamids (Crustacea: Amphipoda) feed on whale skin. Can. J. Zool. 78:721–727.

Shields, G.F., D. Adams, G. Garner, M. Laelle, J. Pietsch, M. Ramsay, C. Schwartz, K. Titus and S. Williamson. 2000. Phylogeography of mitochondrial DNA variation in brown bears and polar bears. Mol. Phylogenet. Evol. 15:319–326.

Objective 2

a.) Free existing staff to concentrate on the increasingly demanding aspects of collection management, permit management, and security.

CMI funding supported a half-time subsistence coordinator for the AFTC and this was critical to growth of the collection. Mammal specimens are being processed and archived at approximately three times the rate at which they were previous to the creation of the AFTC coordinator's position. Since UAM's searchable online database has been in place, the number of loan requests has tripled (Figure 1).

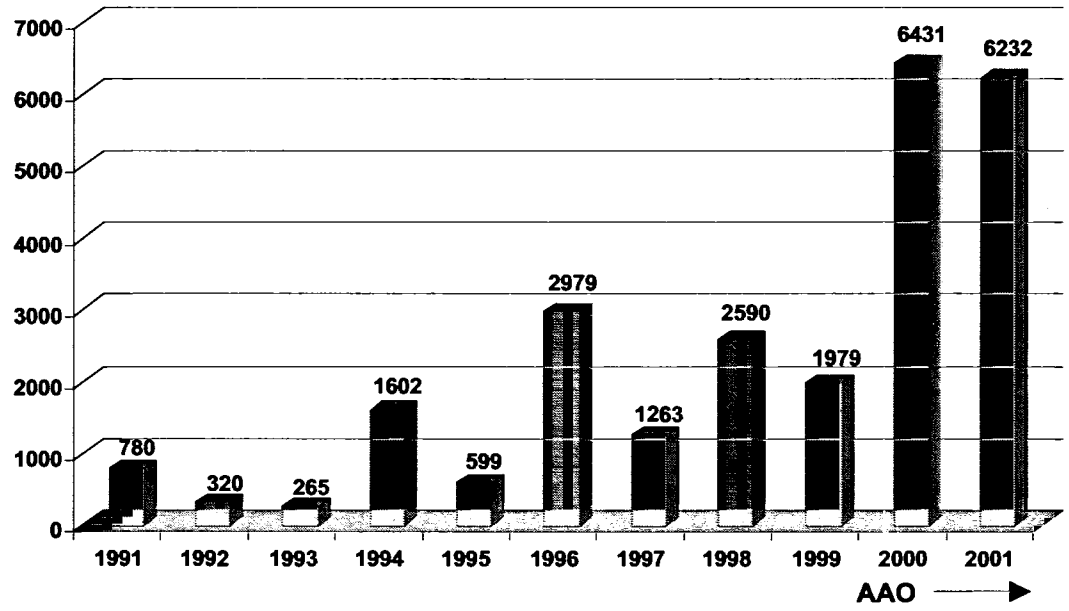

Figure 1. Total number of mammal specimens loaned to researchers by UAM.

b.) Develop additional backup systems for the freezers and an automated object-tracking system.

The AFTC freezers have alarms set to go off in the event of a 10° rise in cabinet temperature. They are hooked into a common system that sounds locally and is also connected to the University's Silent Night® remote system. Thus, alarms are monitored by the university Safety Services Department dispatcher's desk at all times. In addition to the alarms, the freezers are manifolded to three 50-pound tanks of compressed carbon dioxide. Regulators on the freezer cabinets are set to vent the compressed gas in the event of a 15° temperature rise.

Object tracking, through a system of barcoded specimens and containers, has been implemented in the data model, but only barcoding of containers is in full practice. There

is ongoing development on two fronts: We are extending the object-tracking system to treat specimen loans as virtual containers, and we are working with Allez Software in Lexington, Massachusetts to incorporate parts of their GenTrack® software into our overall system.

c.) *Develop project-level tracking in the AFTC database to group accessions and specimen loans, increase accountability of collection users, and develop the world wide web interface to collection usage.*

Since 1996, there has been a summary database of AFTC holdings on the world wide web, but in the past year we have upgraded the database for the AFTC dramatically. The 110-table database is running in Oracle software on a dedicated Sun server named Arctos. This is a modern, three-tiered (Figure 2) enterprise system. The database architecture and the development environment for user and client interfaces are identical to those at UC Berkeley's Museum of Vertebrate Zoology. MVZ's programmer, John Wieczorek, has moved mammal records into the system, and our National Science Foundation (NSF)–funded full-time programmer, Dusty McDonald, is now working on expanding the model and developing interfaces for our other biological collections. Insect data and a web interface have recently been added to the system; plants and birds will be included within the next 12 months.

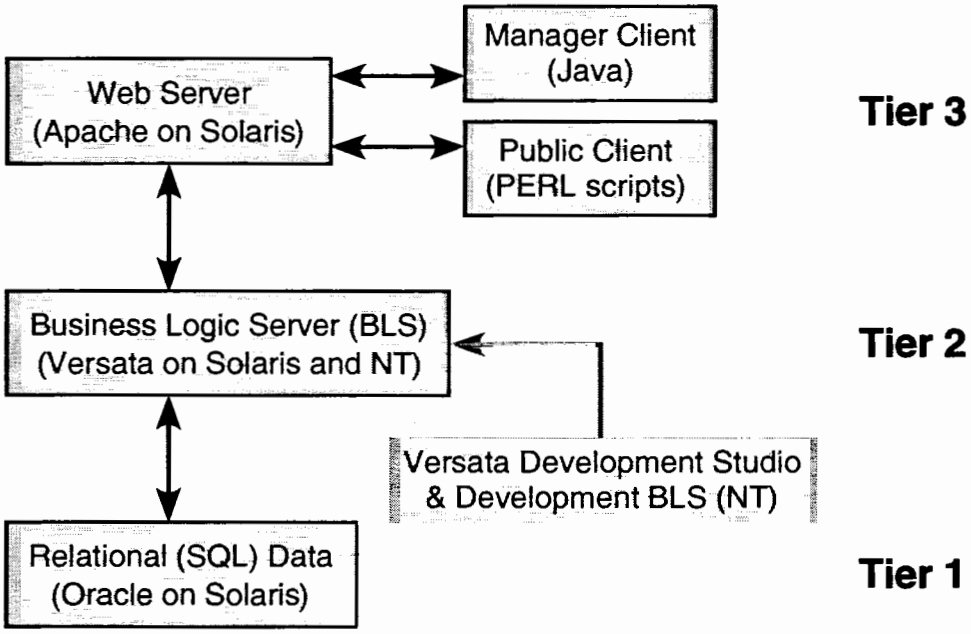

Figure 2. Three-tiered architecture.

The significance of the three-tiered system is its platform independence and modularity. For example, although (for reasons of institutional licensing) Berkeley's MVZ is using Sybase,

rather than Oracle, for the database engine (Tier 1), most of the difficult programming is developed in Tier 2, and can thus be shared. Differences in the appearance of the interface, or differences in the amount of data displayed to the public are accommodated in Tier 3, again allowing us to share the critical business logic in Tier 2. The non–public-user interfaces (for data entry and editing) are Java applications served over the web and can thus be operated by anyone able to log into the business logic server, irrespective of physical location.

The Arctos database contains substantial data that are not incorporated into the website. These include information about individual animals, such as age and measurements. Age data, for example, are recorded in several fields when they are available. "Age class" includes general descriptions such as adult, juvenile, neonate, etc. Chronological age is recorded in two fields: one for a numeric value, and another for age units (weeks, months, years). Another field records "Age method," such as "premolar cementum layers." Collectors or users of the specimens have not regularly contributed these data. Also, data such as "Age class" are somewhat subjective and are often better determined by examination of the specimens. Nevertheless, where such data are available, or when they become available, they are included in the database and can be made available to investigators upon request.

Database development for the AFTC is now subsumed within the larger initiative of bringing all of the Museum's biological collections into a single, comprehensive database of the new Arctic Archival Observatory (AAO), an NSF-funded initiative. Support from CMI and ideas gleaned from interaction with other CMI investigators, were crucial to the conceptual development of the AAO.

An essential part of the AAO is to include a variety of ecological samples in the geo-referenced database, thereby extending the data model beyond conventional museum specimens. An environmental sample might be almost anything removed from the environment and archived for further study—for example, a frozen benthic core, the preserved result of an oceanographic trawl, a sample of invertebrates sorted or identified only as far a higher taxonomic category, etc. Like museum specimens, environmental samples have the attributes of our data model such as a "Collecting event", involvement in transactions, and physical storage locations. They differ from conventional museum specimens in that they lack precise taxonomic attributes, or they lack all taxonomic attributes. Therefore, ignoring taxonomy and increasing the allowable vocabulary in other descriptive fields can allow their inclusion in a museum data model.

We believe that this will be a major extension of the system's utility for environmental researchers. For example, a benthic ecologist looking for specimens or records of a particular polychaete worm could first search the Museum's collection of marine invertebrates by taxonomy and learn what is known based on the collection. Dissatisfied with this information and believing the species may occur in, say, Shelikof Strait, he or she could then go to the data interface for environmental samples and search for benthic-grab samples taken at appropriate depths in Shelikof Strait. Having located appropriate samples, the ecologist can request and analyze them, rather than chartering a ship or speculating vaguely in the literature.

We are beginning to realize benefits from our substantial investment in Arctos:

- Web clients can now do far more specific queries for specimen information, drilling down to individual specimen records that display almost everything we know about the specimen. (Attributes that are specific to particular taxa are not included in the web interface, e.g., no measurements.)
- The displayed data are current because the queries are directed to the working database.
- The data are cleaner for a host of reasons associated with the migration and with the demands of the relational model.
- Queries that return 50 or fewer records with geographic coordinates can be mapped on the java-based GIS map server, a powerful tool for visualizing data, administered by MVZ Digital Library Project.
- Literature citations of individual specimens are being added.
- GenBank accession numbers are being added where there are DNA sequence data for specimens. These link directly from a specimen detail page to the designated sequence in GenBank. We are discussing with GenBank how to implement the converse linkage, i.e., GenBank sequence to UAM specimen record. UAM is the first specimen repository to thusly engage GenBank.
- Identifying numbers from other collections (such as the Arctic Marine Mammal Tissue Archival Program) are being added. These collections, or data repositories, can be engaged by mechanisms similar to our connection to GenBank when they put adequately standardized data into online databases.

An important feature of the database structure is the incorporation of "PROJECTS" (Figure 3). Projects that contribute specimens (such as the Alaska Native Harbor Seal Commission), projects that use specimens, and projects that do both can be related to each other through data on specimen sources ("ACCESSIONS") and specimen usage ("LOANS", which includes subsampling for destructive analysis). We have now implemented most of this structure but we have not yet incorporated data on loans, nor have we systematically associated accessions with projects. This will be straightforward once we have developed our internal interface for managing loans. Nevertheless, there is now a web interface that displays the available project data, including the ANHSC.

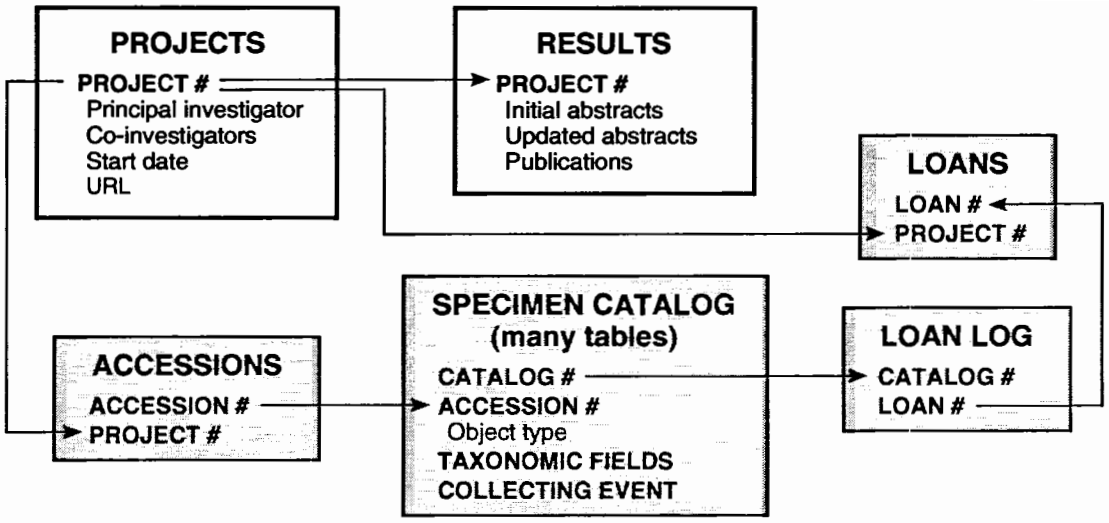

Figure 3. Schematic of projects layer. Projects are defined as programs that contribute samples, use samples, or both. An accession is an acquisition of samples. With project numbers in loans and accessions, queries can link projects producing samples to those using them.

AFTC specimens generally have geographic-coordinate data that describe their collecting localities. The current web interface (through the Berkeley Digital Library Project's GIS viewer) will return detailed maps, on a variety of scales. This Java-powered GIS system runs across the web. It supports a multitude of GIS data layers, including the U.S. Geological Survey topographic maps for Alaska and aerial photographs, where these are available.

Given such high-resolution mapping capacity, the precision of geographic coordinates will become an obvious issue. The Arctos database accommodates an estimate of maximum error and multiple determinations of latitude and longitude for a single locality. We are currently retroactively determining maximum error (precision), and providing additional determinations where more precision or corrections are justified. NSF is funding our geo-referencing effort under a grant through MVZ to 17 North American mammal collections. All 17 collections will then share a common interface. Web clients will be able to search the AFTC's holdings in conjunction with essentially all of the computerized North American holdings of mammal tissues.

With the MVZ, we are attempting the most comprehensive, powerful system ever implemented within the arena of scientific museum collections. The University of Alaska Museum, in large part because of CMI support for the AFTC, has been able to demonstrate the utility of such a system to the National Science Foundation. We have been fortunate: a smaller museum could not attract the resources; the largest museums have too much inertia to innovate. Also, we have attracted a committed group of students and information technology (IT) professionals, happy to be developing global scientific infrastructure, not merely expanding the Internet's role as worldwide Yellow Pages.

Some relevant URLs:

General UAM database interface: http://arctos.museum.uaf.edu:8080/uam_db

Projects: http://arctos.museum.uaf.edu:8080/cgi-bin/uam_db/projects.cgi
(Figures 4, 5, 6)

Specimens: http://arctos.museum.uaf.edu:8080/cgi-bin/uam_db/specimensearch.cgi
(Figures 7, 8, 9)

Museum of Vertebrate Zoology: http://dlp.cs.berkeley.edu/mvz

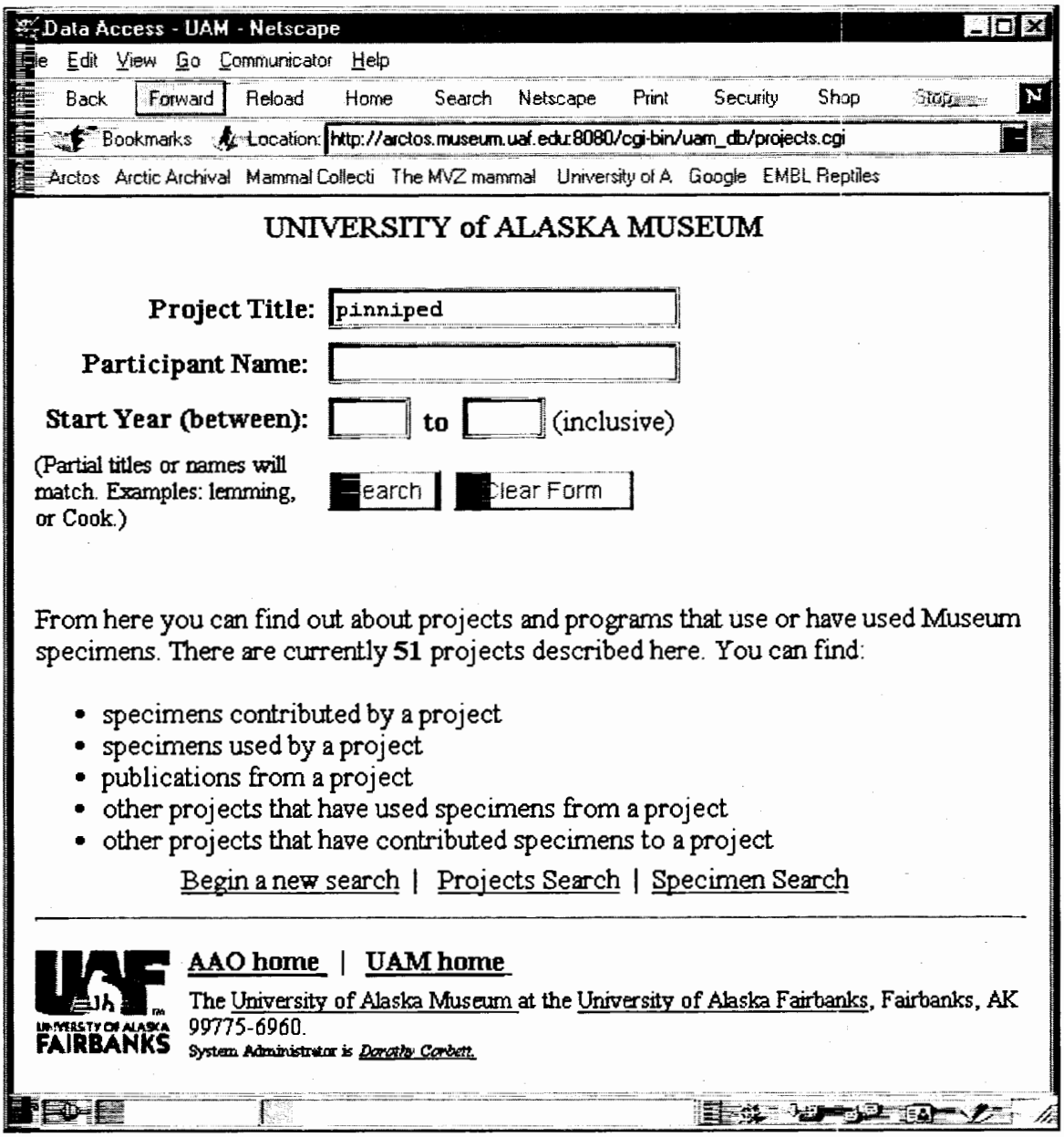

Figure 4. Initial project query screen. From here, web users can search on projects which have used Museum specimens, including tissue samples.

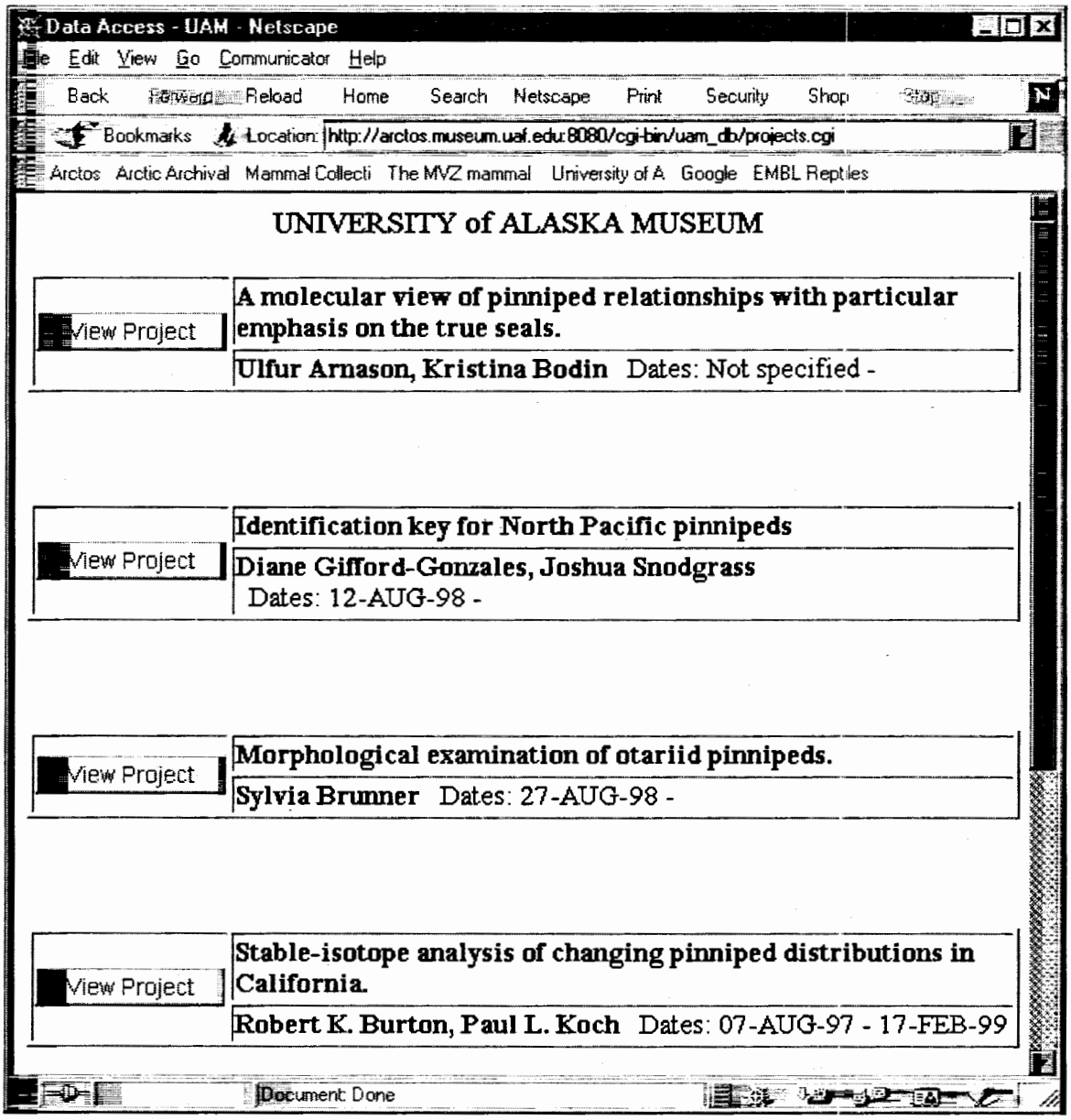

Figure 5. Project list. A list of projects meeting the parameters specified in the project query screen, in this case all projects containing the character string "pinniped" in the title. Clicking on "View Project" takes the user to a description of the project.

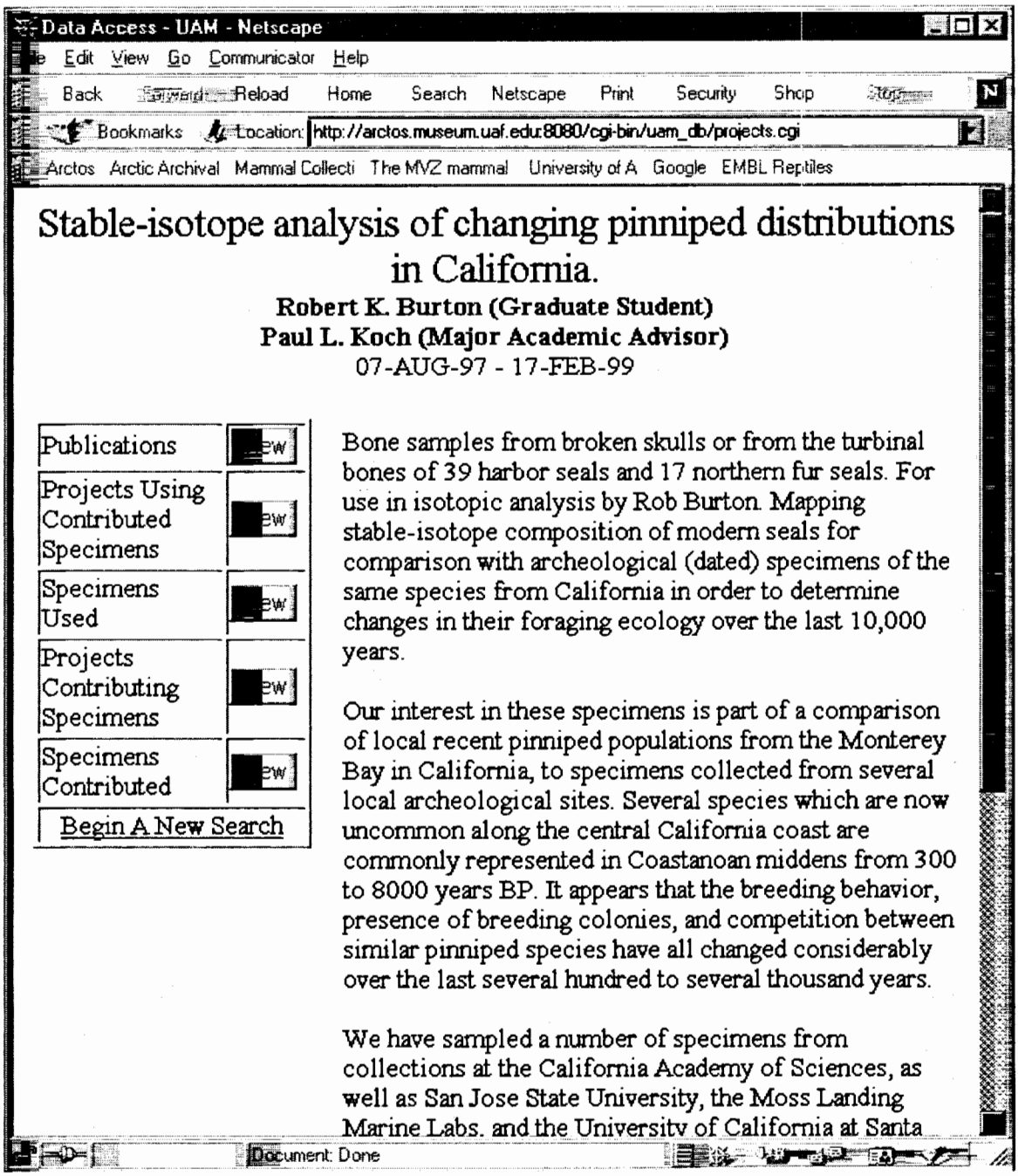

Figure 6. Project description. Individual projects are described in an abstract and the user has the option of viewing specimen lists related to the project, or of viewing projects that contributed specimens, or used specimens contributed by the present project (if any). This screen executes the circuit diagramed in Figure 2.

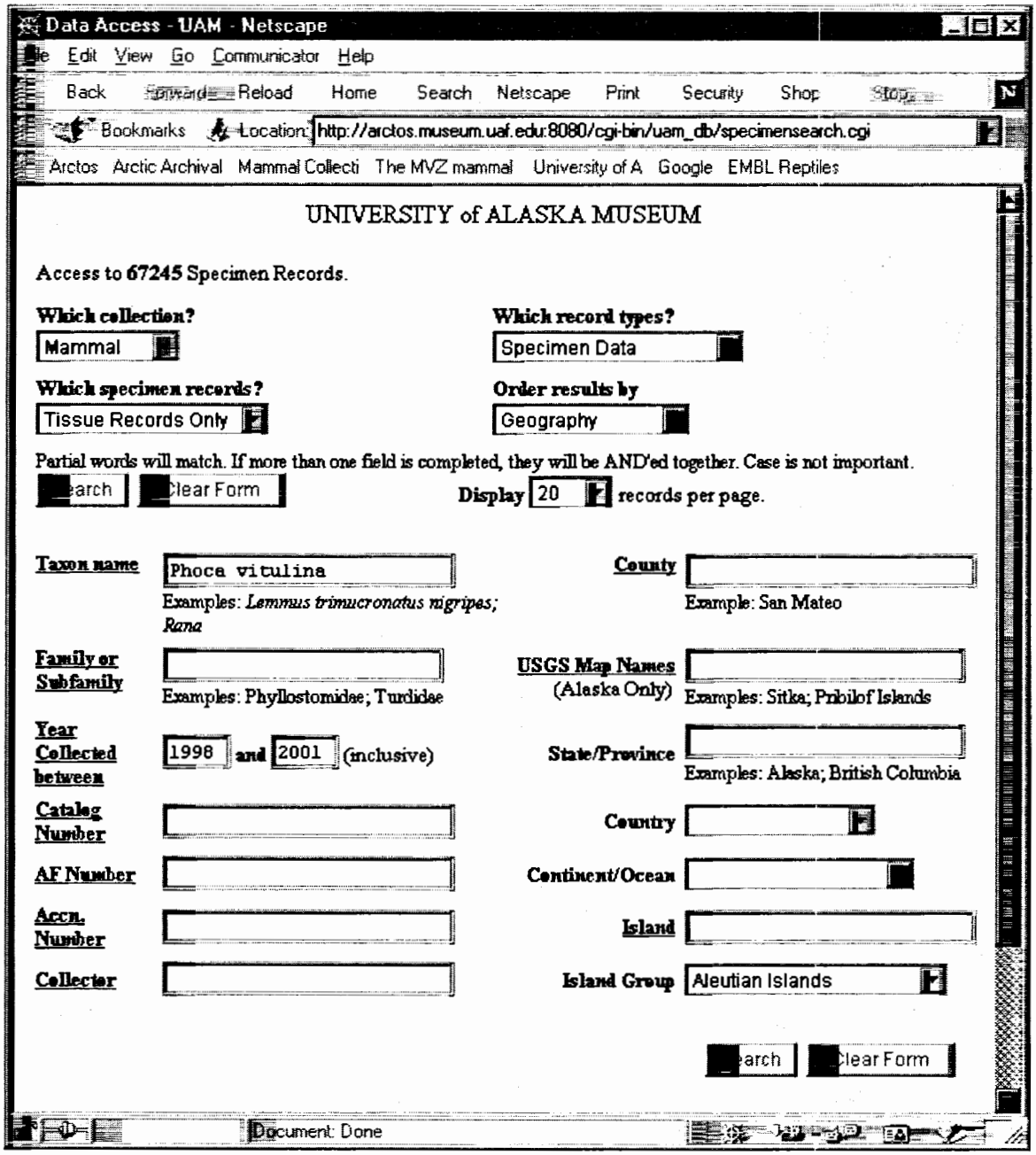

Figure 7. Specimen query screen. From this screen, the user can generate a list of specimens meeting a variety of taxonomic and geographic parameters.

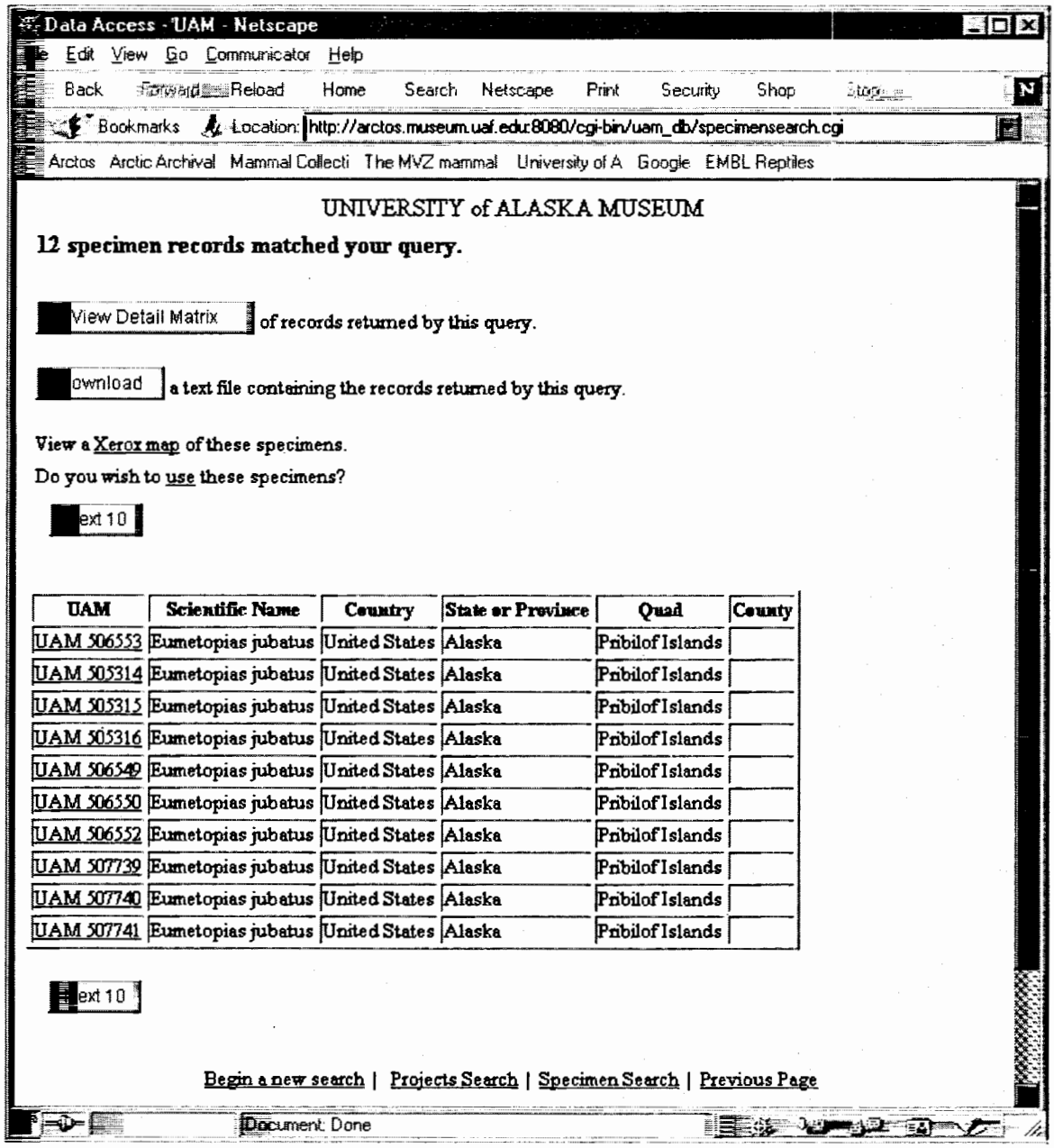

Figure 8. Initial query result. The user sees a list of specimens retrieved by the specified search parameters. From here the user can choose a) a more detailed specimen matrix, b) to download the result as a text file to import into the user's system, c) to view the resulting localities on the Xerox Corporation's map server (if there are fifty or less specimen records), d) to view the Museum's specimen usage protocols, or e) to view an individual specimen record.

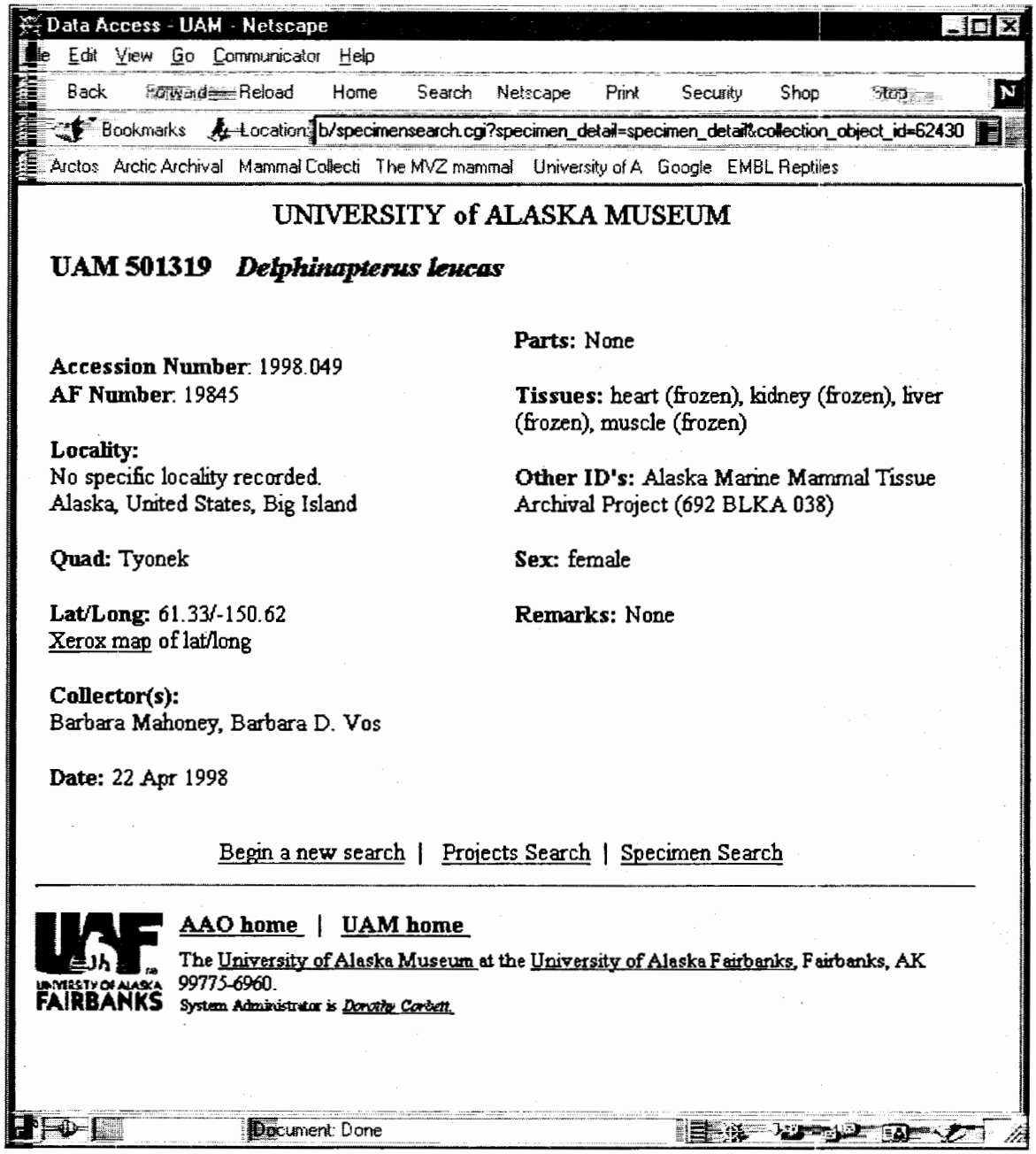

Figure 9. Individual specimen record. At this level, virtually all of the Museum's information about a specimen is displayed. This belukha whale from Cook Inlet has an identifying number with the Alaska Marine Mammal Tissue Archival Project.

Objective 3

Secure the AFTC subsistence coordinator as a second permanent, state-funded position, thus ensuring a broad, long-term, systematic record of marine populations in Alaska.

As with earlier support for the AFTC from CMI, an objective of this project has been to leverage permanent state support for the Collection. In 1998, we proposed that CMI support a subsistence coordinator as a half-time graduate research assistantship in the Collection, and that this position would be extended beyond the period of CMI funding.

In order to meet the promise made in 1995, the present (1998–01) CMI funding was matched by the Museum with support for the AFTC coordinator. Further support for that position was received from NSF and the AFTC coordinator became a full-time staff position last year. The AFTC coordinator position is now in the Museum's budget as a full-time position.

Amy Runck filled the position for the past three years, initially as a graduate assistant, completing her M.S. in 2001, and then as full-time staff for the past year. Ms. Runck is now attending Idaho State University as a doctoral student. Gordon Jarrell has relinquished the position of Mammal Collection manager and become the AFTC coordinator and acting curator of mammals. The Museum hired a new Mammal Collection manager, Sylvia Brunner; this position continues to be full-time and state-funded. John Chythlook, a Yupik Eskimo who served as the AFTC subsistence coordinator on this project, completed his M.S. on the molecular genetics of stickleback fishes. He is now working with the Bristol Bay Native Corporation and ADF&G on fisheries management issues.

By combining the state funds leveraged from two rounds of CMI funding, the AFTC has evolved from a specialized annex of the Mammal Collection, with no personnel beyond that department, into a permanent, separately staffed collection within the Museum.

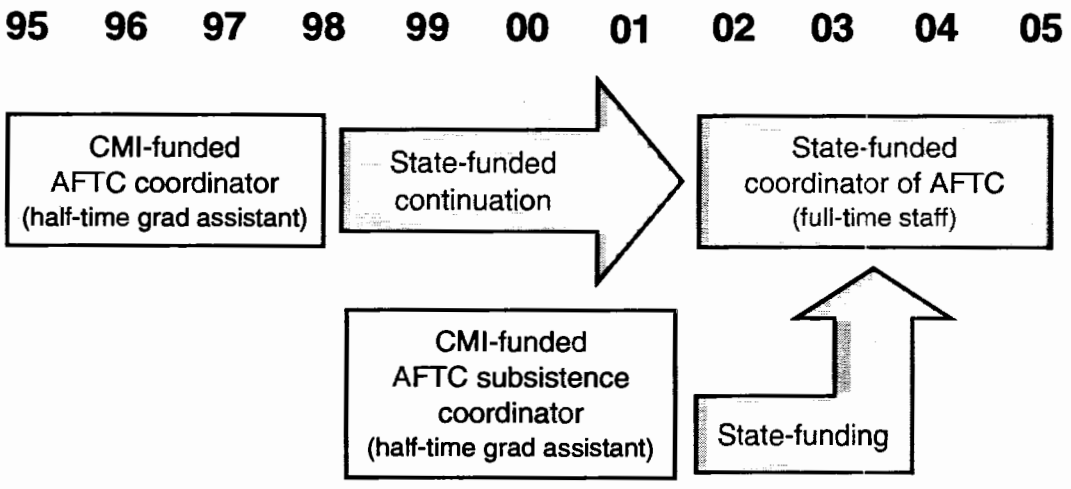

Figure 10. Funding and the development of AFTC.

Conclusions

We are now supporting projects that investigators conceived only after realizing the scope of available material. On several occasions investigators have significantly refined working hypotheses upon learning that available samples were far more diverse and numerous than anticipated. We cannot predict all potential uses of the collections through the system we are developing; however, we can make collection information more accessible to a creative audience of potential users.

The AFTC is a logical extension of a scientific museum. Increasingly, science is done less with the "rare and wonderful" in museums than with statistically significant samples of the typical. Only recently have a few museums begun to think in terms of high-volume sampling for consumptive analyses. The idea of the University of Alaska Museum as a regional clearinghouse—archiving, and providing thorough public documentation of extensive series of environmental samples—is new, and results from the success of the AFTC.

The National Science Foundation embraced this vision in 2000 by creating the Arctic Archival Observatory at UAM. This million-dollar initiative is 1) unifying and expanding the Museum's collection databases, 2) broadening its biological coverage by starting an insect collection, and 3) supporting extended sampling related to climate change in all of the Museum's scientific collections.

The Museum has hired a curator of fishes, Gordon Haas. There will now be an active program in fish systematics; we will incorporate samples from fishes into the AFTC and into the Arctos database. We will incorporate the UAM Bird Collection into Arctos under present funding for the AAO. The AFTC has served as a paradigm upon which we are building a more comprehensive, general resource.

The product of this project is thus a firmly institutionalized resource for the preservation and distribution of environmental samples. The AFTC has grown from a single freezer in the Museum's Mammal Collection, into a separate Museum department with its own full-time, state-funded coordinator. It is now one of the largest collections of its type in the world. The supporting information technology has evolved from a few data tables operated on locally networked personal computers into a state-of-the-art, enterprise system operated on the world wide web. The AFTC has become the primary regional archive for frozen biological samples as a direct result of CMI's interest in promoting "projects which design or establish mechanisms or protocols for the sharing of data..." (Technical Framework Issue 4).

Study Products

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Jarrell, G.H. 1999. Scientific use of the Alaska Frozen Tissue Collection, p. 37 (abstract). *In* Proceedings Seventh MMS Information Transfer Meeting. Alaska OCS Region, Minerals Management Service, January 1999, Anchorage.

(The 5 April 1999 edition of the Fairbanks News-Miner featured Gordon Jarrell on the front page with an extensive description of management and use of scientific collections including the AFTC. The article was subsequently carried in the Ketchikan Daily News.)

Jarrell, G.H. 1999. Contributing to the Alaska Frozen Tissue Collection. Alaska Sea Otter and Steller Sea Lion Commission, November 1999, Anchorage.

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Jarrell, G.H. 2000. The Alaska Department of Fish and Game's contributions to the Alaska Frozen Tissue Collection. ADF&G Seminar, April, Juneau.

Jarrell, G.H. 2000. The Arctic Archival Observatory and its relationship to the Alaska Frozen Tissue Collection. Minerals Management Service Seminar, May, Anchorage.

Reference

Hafner, M.S., W.L. Gannon, J. Salazar-Bravo and S.T. Alvarez-Castañeda. 1997. Mammal Collections in the Western Hemisphere: A Survey and Directory of Existing Collections. American Society of Mammalogists.

The Department of the Interior Mission

As the Nation s principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

The Minerals Management Service Mission

As a bureau of the Department of the Interior, the Minerals Management Service s (MMS) primary responsibilities are to manage the mineral resources located on the Nation s Outer Continental Shelf (OCS), collect revenue from the Federal OCS and onshore Federal and Indian lands, and distribute those revenues.

Moreover, in working to meet its responsibilities, the **Offshore Minerals Management Program** administers the OCS competitive leasing program and oversees the safe and environmentally sound exploration and production of our Nation s offshore natural gas, oil and other mineral resources. The MMS **Royalty Management Program** meets its responsibilities by ensuring the efficient, timely and accurate collection and disbursement of revenue from mineral leasing and production due to Indian tribes and allottees, States and the U.S. Treasury.

The MMS strives to fulfill its responsibilities through the general guiding principals of: (1) being responsive to the public s concerns and interests by maintaining a dialogue with all potentially affected parties and (2) carrying out its programs with an emphasis on working to enhance the quality of life for all Americans by lending MMS assistance and expertise to economic development and environmental protection.