

## I. TITLE OF APPLICATION

Application for a Permit for Scientific Research under the Marine Mammal Protection Act and the Fur Seal Act.

## II. DATE OF APPLICATION

January 15, 2007

## III. APPLICANT AND PERSONNEL

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## **B. Qualifications and Experience**

**Andrew Trites, Ph.D.** directs the research of the North Pacific Universities Marine Mammal Research Consortium. He is a Professor and Director of the Marine Mammal Research Unit at the University of British Columbia, and has extensive experience studying northern fur seals and Steller sea lions.

Curriculum Vitae for the Applicant and Co-investigators listed in this application are on file with the office of Protected Resources.

All research, and contracts awarded for research under this permit, will be supervised by the Principal Investigator and Co-Investigators.

## **IV. PROPOSAL**

### **A. Summary**

The North Pacific Universities Marine Mammal Research Consortium is conducting a long term research program into the decline of pinnipeds that has occurred throughout most of Alaska. A permit is requested for five years from the date of issuance to test various hypotheses that might explain the decline of **northern fur seals**, (*Callorhinus ursinus*) and offer solutions for recovery. The proposed research includes studies of diets, distributions, life history traits, physiology and the timing of weaning. The range of research activities involves different kinds of takes including disturbance of animals on rookeries and haulouts during scat collection and resighting surveys, and the capture and tagging of pups and adults for long-term demographic and distribution studies, instrument attachment, physiological research and sample collection. These activities address the most pressing research needs as identified by the Northern Fur Seal Conservation Plan (NMFS 2006). Field work will take place during all seasons of the year and throughout the range of northern fur seals in Alaska. All field operations will be supervised directly by the Principal Investigator or Co-Investigators listed above. This permit does not involve intentional lethal take.

**Activity 1. Behavioral foraging ecology of northern fur seals.** Three types of electronic tags: dead-reckoners, satellite platform terminal transmitters (PTTs) and VHF radio transmitters will be deployed on each of up to 30 adult female northern fur seals per year from St. Paul Island, Alaska, to gather fine scale foraging data needed to 1) identify critical habitat, 2) assess the extent of spatial overlap with commercial fisheries, and 3) determine whether attendance cycles of lactating fur seals changed appreciably over time as the population declined. Determining where and how pinnipeds feed is one of the most important research activities needed to assess the decline and recovery of northern fur seals.

We successfully used the new dead-reckoning technology in pilot studies conducted in 2005 and 2006 (Lestenkof and Trites, in prep) under permits 782-1708 (NMML) and 1045-1713 (Insley). The study was designed to extend the simple position studies that have been conducted to date on northern fur seals (Bengston *et al.* 1985; Goebel 1985; Loughlin *et al.* 1987; Goebel *et al.* 1991; Robson *et al.* 2004), and determine the various at-sea behaviors that fur seals exhibit (i.e., sleeping, traveling, feeding, etc.) and how these behaviors relate to localities and fishing activities surrounding the Pribilof Islands. Lactating northern fur seals from St. Paul Island will be equipped with dead-reckoning tags, satellite PTT tags, and VHF tags throughout the breeding season from July 2007 to December 2011. They will be recaptured as late as October of each year to recover the electronic devices and download the archived data.

***Activity 2. Demographic and behavioral studies of northern fur seals.***

Data obtained from known aged animals are needed as part of a comprehensive assessment of reasons for the decline of northern fur seals. Such data have not been collected since the 1960s and early 1970s when the age and reproductive condition of fur seals was determined by shooting animals during research cruises in Canada and the United States (Lander 1980b). Up to 200 fur seal pups will be marked each year at a rookery on St. Paul Island using flipper tags, and will be resighted in following years to estimate vital rates needed to determine whether the population decline is related to reproductive failure or age specific mortality. Adult females will also be captured, aged and tagged in the first three years (100 per year). Small coded tags may also be implanted to estimate tag loss and facilitate re-tagging animals with the correct ID-tag. Establishing a marked population of known aged animals will allow questions to be answered about growth rates, nutritional status, duration of feeding trips and annual ocean conditions, and the effect of age on these factors. Results will have bearing on management actions that might be imposed to mitigate possible impacts of fisheries on northern fur seals.

***Activity 3. Assessing changes in body size and annual growth increments of teeth of northern fur seals.***

Changes in body size are believed to reflect changes in the availability of prey (Calkins *et al.* 1998). In theory, animals of a given age that have difficulty capturing prey should be shorter and lighter than those feeding upon more abundant food. Body sizes of subadult males will be measured during the annual subsistence harvest on St. Paul and St. George Islands using a metal caliper placed over the dead animals as they lie belly up on the grass. Lengths will be recorded from the tip of the nose to the tip of the tail, to the nearest centimeter. Teeth will later be removed for subsequent aging of the animal following the method of Scheffer (1950), and growth rings on teeth will be measured to assess annual growth over the first three years of life. Vibrissae may also be taken to assess changes in diet using stable isotope analysis. These data from subsistence killed animals will provide

insights into the conditions currently experienced by northern fur seals and should provide new insights into the factors that caused their population decline and are preventing their recovery.

## **B. Introduction**

### **1. Species**

Northern fur seals (*Callorhinus ursinus*) from the Pribilof Islands and Bogoslof Island, Alaska are the target species.

The northern fur seal population on the Pribilof Islands (St. Paul and St. George Island; 57° N, 170°W), in the central Bering Sea, is the largest U.S. population and accounts for about 56% of the world's population. A smaller, but increasing breeding population occurs further south on Bogoslof Island (Lloyd *et al.* 1981; Testa 2005). However, the Pribilof Island rookeries are the principal breeding areas for this species (Gentry 1998; York *et al.* 2000; Testa 2005). In 1988 it was determined that northern fur seals were below their optimum sustainable population level and were listed as “depleted” under the Marine Mammal Protection Act.

The 2004 estimate of numbers of pups born on St. Paul Island was 122,825 (SE=1,290), which was 15.7% less than the estimate in 2002, and 22.6% less than the estimate in 2000 (NMFS 2006). The 2004 pup estimate for St. George Island was 16,876 (SE=239), which was 4.1% less than the estimate in 2002, and 16.4% less than the estimate in 2000. Total numbers of pups born on the Pribilof Islands reflects a total population estimate of approximately 629,000 animals of all ages. Estimated numbers of pups born declined at 6.2% per year (SE = 0.78%, P = 0.01) on St. Paul Island, and at 4.5% per year (SE = 0.45%, P = 0.01) on St. George Island, from the estimated numbers in 1998. Estimated numbers of pups on the two islands, as a whole, has declined at 6.0% per year (SE = 0.59%, P = 0.01) since 1998 (NMFS 2006). The 2004 pup production estimate on St. Paul Island is comparable with the level observed in 1918, while the St. George pup production estimate is below the level observed in 1916 (Angliss and Lodge 2004; NMFS 2006).

Authority is requested for inadvertent disturbance Steller sea lions (*Eumetopias jubatus*) during capture and observation of northern fur seals at Bogoslof Island (both species inhabit this island). No other species will be taken disturbed during the course of our activities. Steller sea lions were listed as “endangered” under the ESA on 4 May 1997 (62 FR 24345), and are listed as “depleted” under the MMPA. Neither Steller sea lions nor northern fur seals are listed under CITES.

## 2. Background/Literature Review

There are several environmental and anthropogenic factors that may affect population trends of northern fur seals. These include, but are not limited to large-scale oceanographic climate change, fishing vessel disturbance, shift in prey species distribution and abundance, competition with fisheries, interactions with commercial fisheries, and subsistence harvesting (Angliss and Lodge 2004). Anthropogenic impacts may affect the population both directly (e.g. physical damage, disturbance) and indirectly (e.g. association with fishing activity); however there is little direct evidence to support this (Trites 1992a; Gentry 1998; Gisner and 1998).

**Activity 1. Behavioral foraging ecology of northern fur seals.** Fur seals and fisheries are known to target similar prey (Bengston *et al.* 1985). In the Bering Sea juvenile pollock ranging from 4 to 40 cm appear to be the most important prey for northern fur seals around the Pribilof Islands (Perez and Bigg 1986; Sinclair *et al.* 1994; Sinclair *et al.* 1996). Eastern Bering Sea walleye pollock stock assessments indicate that the fishery primarily targets adult pollock (> 40 cm), but juvenile pollock are also taken as bycatch (lanelli *et al.* 2002).

Given the dietary overlap between fur seals and fisheries, there is a potential for the Bering Sea fishery to be linked with the decline of northern fur seals. However, evaluating the role that commercial fisheries might be playing in the decline of northern fur seals at the Pribilof Islands requires fine scale, high resolution data on fur seal habitat use.

Previous studies have revealed the movement patterns and at-sea locations of female fur seals, their diving behavior in relation to oceanographic and bathymetric features, and indicated that females express foraging site fidelity (Bengston *et al.* 1985; Goebel 1985; Loughlin *et al.* 1987; Goebel *et al.* 1991; Robson *et al.* 2004). Satellite telemetry and TDRs have been successfully deployed to determine at-sea locations of fur seals, but do not accurately identify critical foraging habitat since their findings only indicate diving activity and not foraging behavior per se. To accurately determine critical habitat, we cannot assume that diving locations correspond to successful foraging areas. It is essential that the relationships between fur seals and fisheries be investigated on a finer spatial scale, and that areas and depths be identified where considerable foraging effort occurs (Thompson *et al.* 2003). This can be accomplished by simultaneously using PTTs and the new Dead-Reckoning technology.

The extent of interactions between fur seals and fisheries continues to remain unclear. Fisheries may adversely affect the declining Pribilof Island population if competition for prey exists. This potential interaction requires that the how, when and where of fur seal foraging be determined (Harcourt and Davis 1997). Critical feeding habitat needs to be identified

since survival of northern fur seal offspring depends on the foraging success of lactating females (Antonelis *et al.* 1997).

Assessing the overlap with fisheries is important for determining the effects of fisheries on fur seal foraging behavior. Summer feeding areas may be more localized in contrast to winter feeding areas in the North Pacific Ocean and Gulf of Alaska. Therefore, fur seals may be affected by commercial fisheries in the eastern Bering Sea, if fisheries are also geographically localized (Boyd *et al.* 2002).

In 2005, we deployed 5 Dead-Reckoning tags on lactating females at Reef rookery under permit 782-1708. Animals were captured during the first week of July, and were recaptured at the end of July (1 animal) and September (3 animals). One animal migrated southward before the recapture team returned to the Pribilofs, and one animal was missing her tag when recaptured. Thus, we recovered 3 tags.

In 2006, we modified our capture protocols, and deployed and recovered 15 tags on lactating females under permits 782-1708 (NMML) and 1045-1713 (Insley). Data from these instruments are being analyzed and written to describe fine scale foraging behavior and identify foraging habitat (Lestenkof in prep).

Over the coming 5 years, we propose to deploy another 30 sets of tags per year following the protocols we developed in 2006 (each set of tags consists of 3 electronic devices as described below). This will double our sample sizes and significantly improve the accuracy of our habitat maps. We will also employ a second approach to identify critical habitat using the knowledge-based methodology we previously developed for central place foragers and applied to Steller sea lions (Gregs and Trites, in prep). These knowledge-based models explicitly include process-based assumptions about how the animals use their habitat and can be tested against observations of animals at sea. Spatial descriptions of trawl fisheries will then be compared with fur seal habitat to assess the extent of overlap and potential competition between the two.

**Activity 2. Demographic and behavioral studies of northern fur seals.**

Limited information is available to help resolve the causes for the continued decline and lack of recovery of northern fur seals (*Callorhinus ursinus*) on the Pribilof Islands (Trites 1992a; Angliss and Lodge 2002). Two of the most important missing pieces of needed information are age-specific birth and survival rates (Trites and Larkin 1989). Unfortunately such data have not been collected since the 1960s and early 1970s when the age and reproductive condition of fur seals was determined during research cruises in Canada and the United States (Lander 1980c; Lander 1980a; Trites and York 1993).

Destructive sampling is one means to calculate vital rates of northern fur seals. Another means (and one that requires more years to achieve the same goal) is to mark and follow known aged individuals over time. The

most effective means yet developed to mark northern fur seals has been to attach a small numbered metal tag to each of the pectoral flippers. The rate of tag loss can be calculated by double tagging individuals, which in turn ensures that estimated rates of survival are not biased by tag loss. Coded wire tags can also be implanted to provide a permanent means of identifying animals that were previously tagged. By resighting marked individuals each year when they return to rookeries and haulouts on the Pribilof Islands, it is possible to determine who is alive and who has died. Recording who has pups and who does not allows birth rates to be determined. The key is to put the effort into looking for the marked animals each year.

Marked populations allow a number of questions to be answered that may have bearing on why the Pribilof populations declined and what can be done to help them recover. For example, behavioral observations of marked animals can provide information about the timing of birth and the duration of feeding trips. Weighing, measuring, and sampling known individuals from one year to the next can provide information about growth rates, physiological condition, and an assessment of annual ocean conditions encountered during the annual migration. Other questions that can be addressed include the relationship between weaning size and future survival, whether female condition (from year to year) is related to the size of pups they produce, and whether there are in fact 'silver spooned' individuals that hold the key to population viability (Beauplet *et al.* 2006; Beauplet and Guinet 2007).

We propose to initiate a long-term (10-15 year) marking and resighting research program on St. Paul Island to estimate vital rates (birth and death rates) and set the foundation for answering a suite of questions pertaining to the decline of northern fur seals on the Pribilof Islands. We propose to expand this program to St. George Island and Bogoslof Island in years 3-5 following assessment of the success of the program initiated on St. Paul Island.

**Activity 3. Assessing changes in body size and annual growth increments of teeth of northern fur seals.** Calkins *et al.* (1998) concluded that Steller sea lions were physically smaller in the mid 1980s compared to sea lions sampled in the mid 1970s. Their conclusion was further supported by morphometric measurements of sea lions caught in the trawl fisheries (Perez and Loughlin 1991). These studies suggest that sea lions may not have obtained adequate nutrition during the 1980s, and gave credence to the hypothesis that Steller sea lions were nutritionally stressed.

Northern fur seals and harbor seals have also undergone declines that may be related to the decline of Steller sea lions (Pitcher 1990; Trites 1992a). Most growth occurs outside of the Bering Sea (Trites and Bigg 1992; Trites and Bigg 1996). If food is the common factor that links all of these declines, the physical size of all three species should be reduced.

A collaborative study undertaken by Trites from 1995-1997 with the Tribal Government of St. Paul Island measured the lengths of Pribilof fur seals taken in the subsistence harvest. The goal was to compare the size of animals today to those of the past to gain insight into the general health of the fur seals' and Steller sea lions' ecosystems. This was premised on size of an animal (length and weight) reflecting its general health relative to the ability of the environment to sustain it. Thus animals of a given age that have difficulty capturing prey should be shorter and lighter than those feeding upon more abundant food.

Lengths of fur seals measured in the 1990s showed signs of stunted growth (Trites, unpubl. data). They were as short as when the population was thought to be at carrying capacity in the early 1950s. This was in sharp contrast to the large body sizes recorded in 1911 and in the late 1960s and early 1970s when the fur seal population was thought to be well below carrying capacity. The measurements recorded in the 1990s suggest that the fur seal population was at carrying capacity at that time, which was about half of what it once was.

An examination of the teeth of the fur seals taken in the harvest from 1995-1997 showed distinct differences in tooth growth during the first, second, third and fourth years of life. Each tooth taken in 1995, 1996 and 1997 contained a time series of information about conditions experienced in past years, making it possible to track the growth of an individual or to reconstruct the growth of an entire year class. Using the teeth from 2, 3 and 4 year olds, it was possible to get three independent measures of first year growth for any given year. Preliminary results showed year class differences, but strong consistency between the independent measures of year class growth. For example, 1 year old growth in 1993 as measured from the teeth of 2 year olds killed in 1995 and 3 year olds in 1996 were not significantly different, whereas there was a significant difference between the growth of 1 year olds in 1993 and 1 year olds in 1994.

The results from measuring body size and tooth growth increments of northern fur seals are encouraging. Such measurements may be a powerful means of assessing the nutritional status of fur seals, and may provide significant insights into conditions experienced by fur seals.

Measurements of growth rings of teeth archived at NMML (1950 – 1994) have been completed (Trites in prep.). Body size changes of subsistence-killed 3 year old males indicated a severe stunting of growth in 2005 and improved (but still stunted) growth in 2006. We propose to continue measuring fur seals and their teeth growth rings from subsistence-killed animals on St. Paul and St. George Islands.



### **3. Hypothesis/Objectives and Justification**

The proposed research addresses the major hypotheses that the decline and lack of recovery of northern fur seals on the Pribilof Islands is related to changes birth and death rates caused by predation, competition with fisheries, and natural changes in the quality and quantity of available prey (Trites 1992a; Angliss and Lodge 2004; NMFS 2004). There is no other alternative to using northern fur seals.

**Activity 1. Behavioral foraging ecology of northern fur seals.** The primary goal is to determine what pelagic habitat is used by lactating northern fur seals in the eastern Bering Sea and how they use it. Data gathered from tracking animals at sea will be used to determine how much spatial overlap exists between fur seal foraging habitat and commercial fishing activity in the eastern Bering Sea. The data will also be used to determine whether attendance cycles (the combined duration of a feeding trip and time on shore nursing) of lactating fur seals increased appreciably over time as the Pribilof population declined, and whether there are changes within a season that might be related to fishing. Scats will further be used to determine what the average animal consumes during summer. Longer feeding trips are generally believed to reflect a shortage of prey (Milette and Trites 2003; Soto *et al.* 2006), and will be measured to test the hypotheses that fur seals are experiencing food shortages in the Bering Sea. We expect to obtain detailed records of diving patterns from the Dead-Reckoning tags and be able to describe how diving patterns vary with prey type, season, and local conditions and topography. This will allow us to test the hypothesis that fisheries are competing with fur seals for prey, and will lead to a more detailed understanding of northern fur seal foraging patterns, how they utilize prey stocks, and will ultimately provide an improved assessment of critical habitat features and the degree of overlap with fisheries.

**Activity 2. Demographic and behavioral studies of northern fur seals.** This study will establish a marked population of known aged northern fur seals that will be resighted in future years to estimate vital rates and provide information about the feeding and behavioral ecology of northern fur seals. We will establish whether the population decline is caused by a high mortality of young animals or mature individuals, or whether it is related to reproductive failure. This will be done by estimating the birth and death rate of marked animals, and running demographic models with these data to fit the patterns of observed decline of fur seal pups. Health of individual animals will be assessed from blood samples; dietary history will be assessed from feces, vibrissae and blubber samples; toxicology screening will be done from blubber samples; disease screening will be done from blood samples and by swabbing eyes, lesions, rectums and genitalia; and genetic analyses will be done using skin samples. Ages of adults will be determined from teeth. This information is needed to fully assess and diagnose the status and cause of the northern fur seal decline.

We will establish whether there is a relationship between the size of pups and future survival, and will attempt to identify which animals are contributing to population growth and which are not. Larger pups are generally assumed to be better prepared to survive, but this hypothesis has not been tested. Knowing what conditions result in enhanced survival and reproduction of fur seals will help to identify which animals and factors need the greatest protection, and may provide a means for predicting and anticipating future population trends. Data collected from known individuals will also contribute significantly to determining what has caused the decline of northern fur seals, and what is preventing it from recovering.

A database will be established containing all information collected for each marked individual. The data will be managed by the North Pacific Universities Marine Mammal Research Consortium and will be made available to other researchers and groups concerned with conservation and management of northern fur seals. These data from known aged animals are needed as part of a comprehensive assessment of the reasons why northern fur seals have declined. It is particularly needed to help determine whether the problems fur seals are encountering are related to mortality or reproductive failure, and whether it is occurring in the Bering Sea, the Gulf of Alaska or elsewhere in the North Pacific. Results will have bearing on fishery management actions that might be imposed to mitigate possible impacts on northern fur seals. For example temporal and spatial restrictions could be placed on fisheries if they are found to negatively affect northern fur seals.

***Activity 3. Assessing changes in body size and annual growth increments of teeth of northern fur seals.*** Body size of male northern fur seals taken in subsistence harvests on St. Paul and St. George will be compared with historical measurements taken since 1911 to assess the current condition of fur seals relative to carrying capacity. A minimum of 100 animals will be measured and aged each year. Growth increments on the canine teeth collected during the harvest of young fur seals on St. Paul and St. George will also be measured to determine whether any of the age groups have experienced nutritional stress. Reduced growth is commonly accepted as a measure of nutritional stress, while enhanced growth is generally accepted to reflect an abundance of food. The taking of samples from subsistence hunts will be coordinated each year with the Tribal Governments of St. Paul and St. George Islands. This study will help to resolve whether changes in fur seal growth occurred, and whether such changes correlate with the regime shifts reported in the North Pacific. Measurements of growth will also provide an assessment of population size relative to carrying capacity, and may provide new insights into the factors that caused the decline of fur seals and are preventing population recovery.

## **C. Methods**

### **1. Duration of the Project and Locations of Taking:**

A five-year permit is requested from the date of issuance. Research will occur in all months and seasons, but will be concentrated in the months of July – September while fur seals are on land. Northern fur seal research will be conducted on the Pribilof Islands (St. Paul and St. George islands) and Bogoslof Island. Activity 3 will be conducted on both Pribilof Islands. Activity 2 will be initiated on St. Paul Island, and will be expanded to St. George Island and Bogoslof Island in years 3-5 subject to available funding and review of protocols established in years 1-2. Activity 1 will be conducted on St. Paul Island and will be expanded to St. George Island and Bogoslof Islands in years 3-5 subject to available funding.

We anticipate continuing to capture lactating fur seals at Reef rookery (St. Paul Island) in 2007 (Activity 1), but propose to establish the foraging habitat of fur seals using Northeast Point in subsequent years. Other candidate rookeries on St. Paul Island include Lukanon, Zapadni and Polovina, which are also possible sites for conducting long term behavioral observations of marked individuals (due to the relative ease of observing from elevated positions without disturbing the animals). Final decisions about study sites will be made in consultation with NMFS biologists and the Tribal Government. Announcements will be sent to NMFS prior to this work noting the precise location of the proposed captures and disturbances.

### **2. Types of Activities, Methods, and Numbers of Animals or Specimens to be Taken or Imported/Exported**

This permit application includes different kinds of takes within a variety of inter-dependent research programs and activities. All requested takes occur in the wild and include the following:

- a. disturbance while conducting behavioral observations and mark-resight efforts;
- b. disturbance during scat collections and captures;
- c. capture of fur seal pups and adults on rookeries for marking, tagging, measuring, and sampling;
- d. collection of blood, feces, skin, teeth, vibrissae, and blubber samples;
- e. swabbing lesions, eyes, genitalia, or rectum of animals exhibiting symptoms of disease.

Research takes are summarized in Table 1 according to number, type and age. The greatest portion of the estimated number of takes consists of incidental disturbance, or unintended harassment. Estimates of both direct

takes and incidental disturbance represent the maximum levels; actual numbers incidentally disturbed are likely to be much lower.

### **Narrative account of research methods**

***Activity 1. Behavioral foraging ecology of northern fur seals.*** We propose to capture 30 females beginning August 1 and ending October 15. Captures will be done following the protocol developed by NMFS. Three people will crawl towards a group of fur seals using rocks and other structures to hide themselves. When within arms reach of the fur seals, two people will each put a hoop net (long pole with a soft fine meshed net on a bendable plastic rim) over the head of a lactating female. The third person will have a pole to be used only if a bull or other individual should charge. The captured fur seals will be carried by hand to the tagging station a short distance away where they are measured and weighed. A female that is deemed to not be representative of the lactating population (if poorly lactating or infected from bite wounds) will be released as there is a low likelihood of this animal returning to the rookery for recapture. The female will be placed by hand on a retraining board with its head in a padded V-notch to prevent it from biting. A neoprene Velcro attached belt will hold the side flippers against the body thereby immobilizing the animal. No drugs will be used. Time between capture and release is about 1 hour or less. All animals are released at the tagging site and will return by themselves to their pups (as per other years). This method of capture ensures the safety of the researchers and fur seal.

Three instruments (a dead-reckoning tag, a VHF tag, and a PTT) will be glued to the fur using a 5 minute epoxy, after cleaning the fur. This is the standard procedure used by researchers to attach electronic tracking devices to pinnipeds. Animals will molt their fur in the fall. The tags will be placed between the shoulder blades of each animal.

The Dead-Reckoning tags (140 g, 90 x 65 x 28 mm) record high resolution (16 bit) data, and have large memory capacity (48 MB flash-ram). The unit is potted in resin, which incorporates a titanium turned battery housing containing 2 x 3.6 V Saft Lithium cells (SAFT, Bagnolet, France) as well as an infra-red interface for communication with a computer. They can record for 56 to 141 days at sampling frequencies of 2 to 5 seconds, respectively. Dedicated software for the D&K devices is commercially available (Multitrace, Jensen Software Systems, Laboe, Germany). It can calculate the position for every sampling interval using vectors, and distinguishes different dive phases (descent, bottom and ascent), and can calculate dive duration, min/max depth, vertical velocities, and the changes of heading and tilt during these phases. In addition, it can calculate an Area-Interest-Index to determine directionality of movement.

Table 1. Annual Takes:

Species	Age Class	Sex	Number of individuals taken per year	Number of takes per individual per year	Activity / Take Action	Transport	Location	Dates / Time Period
<b>Activity 1</b>								
Northern fur seal ( <i>Callorhinus ursinus</i> )	Lactating	Females	30	2	Capture via hoop-net, restraint via neck-squeeze type restraining board and "H" harness  Processing: external exam; measure (girth, length, weight); attach instruments (dead reckoning tag, satellite tag, and radio tag)		Pribilof Islands, Bogoslof Island	Jul.2007 – Oct.2012
			5	1	Captured as above but incompletely processed and released without instrumentation (not recaptured) because they are not lactating well (may not have a pup) or may be compromised by infections and are therefore not representative of the population and are unlikely to return to the rookery			
			2	1	Accidental mortality			
Northern fur	Pups	both	1800	30	Disturbance to peripheral seals		Pribilof	Jul.2007 –

seal ( <i>Callorhinus ursinus</i> )	Mature	females	1200	30	during capture, recapture, and monitoring of site		Islands, Bogoslof Island	Oct.2012
	Mature	males	150	30				
	Immature	males	150	30				
<b>Activity 2</b>								
Northern fur seal ( <i>Callorhinus ursinus</i> )	pups	both	200	1	Capture by hand, restrain, sample (weight, length, girth, swab, blood, tissue), administer tetracycline, flipper tag, insert coded wire tag, draw blood, take vibrissae, skin and blubber sample		Pribilof Islands, Bogoslof Island	Jul.2007 – Oct.2012
	mature subadult	females males	100 100	1 1	Capture by hoop net or noose pole, restraint via neck-squeeze type restraining board and “H” harness, sedate with isoflorine, sample (weight, length, girth, swab, blood, tissue), remove single post-canine tooth 1 for aging, flipper tag, insert coded wire tag, draw blood, take vibrissae, skin and blubber sample			
Northern fur seal ( <i>Callorhinus ursinus</i> )	subadults	males	2	1	Accidental mortality		Pribilof Islands, Bogoslof Island	Jul.2007 – Oct.2012
	pups	both	2	1	Accidental mortality			
	mature	females	2	1	Accidental mortality			
	mature	males	2	1	Accidental mortality			

Northern fur seal ( <i>Callorhinus ursinus</i> )	pups	both	250	30	Disturbance to peripheral animals during monitoring of site and capture and release of study animals, or collecting of scats		Pribilof Islands, Bogoslof Island	Jul.2007 – Oct.2012
	mature	females	250	30				
	mature	males	25	30				
	immature	males	250	30				
Steller sea lions ( <i>Eumetopias jubatus</i> )	all	both	100	5	Disturbance to peripheral animals during monitoring of fur seals and capture and release of study animals (fur seals), or collecting of fur seal scats		Bogoslof Island	Jul.2007 – Oct.2012

Ten PTTs (Wildlife Computers SPOT 2: 90 g, 150 x 30 x 20 mm; powered by a 3 V M3 Lithium battery) and 10 Dead-Reckoning tags will be deployed on 10 adult female fur seals for 2-4 weeks before they are recovered (covering 2-4 feeding cycles). Each female will also have a small VHF-tag to locate the animal when it returns to the rookery. Thus each female will carry 3 tags for 2-4 weeks.

Tagged animals will be recaptured using the same method described for capturing them. The glued devices will be removed by cutting the epoxy. Thus all devices will be removed and the remaining glue on the fur will fall off as the animal molts.

Data will be downloaded and the devices will be re-deployed on other groups of 10 lactating females for additional 2-4 week periods until the end of the breeding season. The second set of deployments will depend on the ease of capture and the availability of a recapture team. A third set of deployments may be subsequently attempted, with an overall goal of collecting data from 30 lactating females.

Scats that are collected from the captured animals (should they defecate while being handled) will be placed in plastic bags and frozen. They will be shipped frozen to the University of British Columbia, and cleaned using an elutriator or washing machine. Soft parts may be sampled for DNA analysis, while hard parts would be sent to Pacific Identifications to determine the prey types. Approximately 70 scats may also be collected from the rookery to determine diet of the overall population (Trites and Joy 2005).

NMFS personnel assisted in capturing and recapturing fur seals in 2005 and 2006, and additional assistance was provided by the Tribal Government of St. Paul's Ecosystem Conservation Office with training by Dr. Stephen Insley. The research was conducted under permits 782-1708 (NMML) and 1045-1713 (Insley). We propose to work again with this local capture team.

A measure of feeding activity (Area-Interest-Index) will be calculated from the dead-reckoning data to identify areas used by lactating fur seals. These maps will use a color coded system to identify a gradient of relative use (from low to high). Habitat will also be mapped using a knowledge-based approach developed by Gregr and Trites (in prep). It will incorporate accessibility assumptions based on published age and sex specific constraints, as well as suitability assumptions that use a variety of physical variables to differentiate between regions of equal accessibility. The waters surrounding the Pribilof Islands will be divided into grids to show the relative foraging importance of each area, thereby identifying critical summer feeding habitat on a finer spatial scale than is currently available. The fine scale movements of fur seals will also be analyzed in context with dietary information collected by NMFS, and with available fisheries, bathymetric and oceanographic data (which we currently have)



to assess the overlap in spatial distribution of fisheries and northern fur seal feeding areas in the eastern Bering Sea.

**Activity 2. Demographic and behavioral studies of northern fur seals.**

In 2007 and 2008, we propose to initiate a pilot study at one of three rookeries on St. Paul Island (Lukanon, Zapadni, or Polovina Rookeries) to develop protocols for handling, marking and aging fur seals. Each of these sites is bordered by a hill or higher ground from where observations can be made without disturbing the animals. They also have a number of boulders to hide capture teams, and are reasonably small self-contained rookeries that facilitate the likelihood of resighting and potentially capturing known individuals. Resightings will be made from blinds using binoculars and spotting scopes located 30-100 meters from the rookeries and are not expected to disturb the animals. Final selection will be made following consultation with the Tribal Government, NMFS fur seal researchers and independent biologists, and will consider the tradeoffs between the likelihood of disturbance by non-biologists and the ease with which animals can be captured and re-sighted.

We propose to mark three groups of animals — pups, juvenile males, and adult females — using flipper tags that are commonly used with northern fur seals. Pups are readily distinguished from adult females, and juvenile males haul out separately from the rookery population with bachelor males. Small pods of pups (10-20 at a time) will be rounded up in September for weighing measuring and tagging (Trites 1991). They will be rounded up by walking towards them and having them move towards a staging area. We propose to tag 200 pups following protocols that have been used in earlier years on the Pribilof Islands. Individual animals will be removed from the small pods and placed in a small hoop net, and carried by hand to the tagging station a short distance away where they will be weighed and measured. The sex of the pups will be determined by visual examination of the genital area. The pup will then be placed on the ground and physically restrained while tags are applied to the posterior edge of each front flipper (one on each side). The pups will be released after tagging. We expect to tag the pups over a two to three day period late in the breeding season so that it has no effect on the breeding structure of the rookery.

We are considering three approaches to capturing adult females. One is to use the wooden box during the month of August to capture, anesthetize and sample 50 females (Boltnev *et al.* 1998; Boltnev and York 2001). The box is currently used by NMFS and is approximately 3X6 feet — large enough to allow three people to work within it. The experiences of Russian researchers suggest that about 10 animals can be handled per day using this system (S. Boltnev, pers. comm.). A second approach is to sneak up on resting animals and capture them using hoop nets as described in Activity 1. The third approach is to round up small groups (10-30 individuals) of females in September, similar to the way in which subadult males are rounded up for the subsistence harvest (Trites and Scordino 1994). Moving between the

animals and the water will cause the fur seals to move in land where they can rest together in a grassy field.

The box and hoop net methods have been developed for northern fur seals, while the herding method used for male northern fur seals has not been attempted with adult females. However, the herding method may ultimately be easier and more efficient to employ. Decision on which method is used will be made in consultation with other fur seal biologists. Handling time (from time of restraint to release) is expected to be less than 30 minutes per individual.

All capture methods will likely require the use of a noose pole (a long wooden pole with a loop of rope on the end that can be put over the head of an animal and twisted to hold an animal). Animals will be placed on a restraint board (as described in Activity 1). An alternative approach might be to use a squeeze cage for animals that are herded as used with captive Steller sea lions and with cage captured Steller sea lions in the wild. Permission is therefore requested to develop this third methodology to capture and restrain northern fur seals.

Consultations will be undertaken with fur seal biologists employed by NMFS, Universities and the Tribal Governments of the Pribilof Islands on these three alternative approaches to capturing and tagging animals.

Three to four people will be required to capture fur seals from the box or with hoop nets (a vet, capturer, tagger), and 6-8 people will be needed for a roundup team (three to corral and three to handle animals).

All animals captured and tagged will be weighed and measured using a measuring tape for length, and weighing the restraint board with the animal on it. Health of individual animals will be assessed from blood samples obtained via the caudal gluteal vein. Approximately 6 mL of whole blood will be obtained to supply the required plasma, serum, and RBC samples. This represents a physiologically insignificant proportion of the animals' total blood volume. Blood samples will be analyzed for 34 common parameters of blood biochemistry and hematology. A vibrissa will be plucked or cut from the sampled animal to assess diet from stable isotope analysis.

A blubber sample may be taken for fatty acid or toxicology analysis from anesthetized individuals (while under isoflurane gas). A 4 cm square around the biopsy site (sited 10 cm above the pelvic girdle and 5 cm from the spine of the animal) will be closely shaved using a number 40 electric razor and then thoroughly cleaned in a three step process using habitane and alcohol wipes, followed by an iodine wash. Using sterile techniques, a 2 cm incision will be made using a size 11 scalpel to allow for the application of a 8 mm biopsy punch. Gentle pressure and a twisting motion is used to collect a blubber sample as far as the fascia/muscle interface. Tweezers and hooked scissors are used for removal. The sample is stored temporarily in aluminium foil and within 10 minutes stored in chloroform

(plus 0.01% BHT – an anti-oxidant) prior to being frozen at –20 C for later analysis. The biopsy site would receive two sutures. The process should take about 15 minutes

Other protocols that may be instigated include collecting of skin samples for genetic analyses (using a punch to remove a small piece of the hind flipper); and swabbing lesions, eyes, genitalia, or rectums of animals exhibiting symptoms of disease. The swabbing of potentially infected individuals will provide information needed to fully assess and diagnose the health of individual fur seals.

Approximately 70 scats from the rookery under study will be collected at this time to determine diet (Trites and Joy 2005). This would likely be done during the disturbances caused to capture pups and adult females. Scats would be picked up using spoons to place samples into individual plastic zip-lock bags for freezing. They would be sent to the University of British Columbia where soft parts would be archived and hard parts would be removed using a washing machine or elutriator. Hard parts would be identified by Pacific Identifications to determine the species that were consumed by northern fur seals.

We propose to inject (intramuscular) each of the 200 pups captured in 2007 and 2008 with a small dose of tetracycline (10 mg) to leave a mark on teeth and bone. The injection site on the rump of the animal will be cleaned with alcohol. Tetracycline will not have any adverse affect on the animals (Brodie 1990). The individuals that are injected with tetracycline would be recaptured in 2009 – 2012 to assess body condition and remove a post-canine tooth (see below). We propose to re-capture each of these marked animals only once. Teeth of the injected animals will have a yellowish mark on them that is visible under ultraviolet light, from which aging can be calibrated and verified for all teeth collected from northern fur seals. This validation study will ensure that the teeth of unmarked individuals are accurately aged. The mark left on vibrissa can also be used to validate stable isotope timelines.

Given that it will take 4 to 6 years before the marked pups recruit into the breeding population, we propose to also tag and age subadult males (from the bachelor haulout) and adult females (non-pups from the rookery). The tags will applied to the posterior edge of each front flipper (one on each side) and have been used by NMFS for many years on northern fur seals. The fur seals will be released after tagging.

Aging a random sample of subadult males from an adjoining haulout as well as adult females from the rookery population will establish the age structure (and yield age-specific survival rates), and will establish a marked population of known aged individuals to jump start other studies of feeding and behavioral ecology.

Procedures have been developed for removing and sectioning a single tooth from southern species of fur seals (Arnbom *et al.* 1992). Adults will be aged by sectioning and counting the rings on extracted post canine teeth.

Animals will be anesthetized using isoflurane gas, and then the mouth will be kept open and immobilized using a surgical spanning device. Isoflurane gas appears to be a safer anesthesia for pinnipeds than injectable drugs, and results in animals recovering faster. Teeth and gums situated around the tooth to be extracted will be cleaned with an antiseptic solution. The lower left post-canine 1 will then be removed using a dental elevator as described in Arnbom et al. (1992). The empty alveolus will be cleaned with an antiseptic solution before placing an adhesive antiseptic diffuser into the root cavity to prevent hemorrhaging and infection. Each removed tooth will be cleaned, labeled, and frozen (-20 C). This procedure for aging has been successfully used with Antarctic fur seals (Dabin *et al.* 2004), but has not yet been applied to northern fur seals.

A small blind large enough to house 3 researchers sitting side by side will be constructed from wood and placed on a hillside overlooking the rookery (about 30-100 meters from the rookery). Observations will be made from June to November through an opened window with the aid of binoculars and spotting scopes. Observers will note the tag number of individuals and monitor movements and attendance behaviors of known individuals. This will provide information about birth and survival rates.

**Activity 3. Assessing changes in body size and annual growth increments of teeth of northern fur seals.** This study will be coordinated with the Tribal Governments of the Pribilof Islands and with the National Marine Fisheries Service. Measurements will be made of animals taken by Aleuts for subsistence purposes on the Pribilof Islands. It is a legal harvest. Body sizes of subadult males will be measured during the annual subsistence harvest using a metal caliper placed over the dead animals as they lie belly up on the grass. Lengths will be recorded from the tip of the nose to the tip of the tail, to the nearest centimeter. Girth is not measured. Care will be taken not to reposition the animal to avoid stretching it and biasing the results. For each animal, length will be recorded on a numbered zip-lock bag that is inserted into the animal's mouth. Jaws will later be removed and inserted into each bag for subsequent aging of the animal following the method of Scheffer (1950). Measuring body lengths during the harvest requires three people. We have successfully used this technique in the past.

Jaws will be boiled on the Pribilof Islands. Teeth will be removed, cleaned, dried and packaged in zip-lock bags for subsequent aging and measuring. Each set of teeth is individually labeled to identify the animal measured. Teeth will be shipped to the University of British Columbia for archiving and measurement.

Measurements of teeth will be done using a dissecting scope configured with a digital camera. Each tooth will be aged and growth rings will be marked using a pencil. The tooth will then be placed under the dissecting scope, and a calibrated picture will be taken, from which lengths can be

measured using imaging software. The data will be entered automatically into the computer database.

The teeth will not be sectioned. Only distance along the outside of the tooth will be measured. The teeth will not be damaged, although a light pencil mark will be put on each tooth to mark the year separations. The separations are easily distinguished by the naked eye, but are very difficult to discern when illuminated under the power of a dissecting scope. It is therefore necessary to lightly mark the separations before measuring.

### **3. Additional Information for Removing Animals from the Wild into Captivity and Research or Enhancement on Captive or Rehabilitating Animals**

No animals will be removed from the wild.

### **4. Lethal Take**

No intentional lethal take is involved as part of the behavioral and foraging ecology studies of northern fur seals. However, unintentional mortality while restraining and anesthetizing fur seals is always a possibility (but is highly unlikely based on past experience). The numbers of unintentional mortalities we are requesting are listed in Table 1. Animals that might die as a result of research activities would be sampled following protocols established for dead stranded marine mammals. Research activities would be stopped should these limits be reached.

### **5. Exports of Marine Mammals from the U.S.**

No living marine mammals will be exported. However, permission is requested to transport fecal matter, and tissues and hard parts of northern fur seals to the Marine Mammal Research Unit at the University of British Columbia, Vancouver BC. Scats are shipped frozen, teeth are dry or frozen, tissue samples might be in alcohol or formaldehyde, while blood is usually shipped frozen. All samples are labeled by species, dates of samples and animal ID; and usually shipped by courier or transported by researchers.

## **D. Research Effects and Mitigation Measures**

### **1. Effects**

There are no anticipated effects of the proposed research (Activities 1, 2 and 3) on the survival and reproduction of northern fur seals.

**Activity 1. Behavioral foraging ecology of northern fur seals.** This research is proposed late in the breeding season (Trites 1992b) when copulations are finished, and territorial males are less aggressive, and pups are better able to fend for themselves. Capturing females late in the season means that females can readily reunite with their pups and are free to move through the rookery. Collecting scats will cause most animals to move away from the researchers, with adults moving towards the water, and some entering the water. Field observations suggest that most fur seals return their resting places within 24 hours following such disturbances (pers. obs.). Temporarily holding northern fur seals for less than one hour to attach tags will not decrease their reproductive or survival rates. Pups normally remain on land and frequently spend 5-8 days fasting while their mothers are at sea feeding during summer (Gentry 1998). Adult females captured and instrumented in past studies have also been shown to reunite with their pups within hours after release.

**Activity 2. Demographic and behavioral studies of northern fur seals.** This research is proposed to occur late in the breeding season when copulations are finished, and territorial males are less aggressive, and pups are better able to fend for themselves. Capturing females late in the season means that females can readily reunite with their pups and are free to move through the rookery. Collecting scats will cause most animals to move away from the researchers, with adults moving towards the water, and some entering the water. Field observations suggest that most fur seals return their resting places within 24 hours following such disturbances (pers. obs.). Temporarily holding northern fur seals for less than one hour to attach tags will not decrease their reproductive or survival rates. Pups normally remain on land and frequently spend 5-8 days fasting while their mothers are at sea feeding during summer (Gentry 1998). Adult females captured and instrumented in past studies have also been shown to reunite with their pups within hours after release. Behavioral observations are designed to collect data on undisturbed animals. There is potential for some animals to be aware of the observation blind being constructed, and they may move to another part of the rookery. However, animals are unlikely to enter the water given the distance with which such observation posts are placed.

**Activity 3. Assessing changes in body size and annual growth increments of teeth of northern fur seals.** This proposed research will have no affect on living northern fur seals.

## **2. Measures to minimize effects**

Research on northern fur seals has occurred for almost 100 years on the Pribilof Islands and for about 20 years on Bogoslof Island. There is considerable experience on how to approach, capture, handle, observe and study northern fur seals on land. Our research has been designed to

not disrupt breeding and to reduce any chance of mothers and pups to not reunite. Our techniques in animal handling are also designed to ensure that animals are not harmed and researchers are not hurt. All proposed research will be coordinated with other permitted research on northern fur seals to ensure minimal disturbance of animals.

**Activity 1. Behavioral foraging ecology of northern fur seals.** The protocols for studying diet and the fine-scale foraging ecology of lactating fur seals are well worked out. We have developed our foraging study protocols over the past three years and have a system that is efficient and minimizes population effects. All animals are handled humanely with minimal disturbance or harm. The nets, retraining board, and neoprene belt are state of the art.

**Activity 2. Demographic and behavioral studies of northern fur seals.** The protocols described above to achieve a marked population of known aged individuals are well worked out for southern species of fur seals, but have not been fully developed for northern fur seals. As such, we are proposing a pilot study in 2007 to safely and effectively develop protocols for handling, marking and aging fur seals on the Pribilof Islands. In other words, we will begin by capturing a few individuals (<10) and evaluate and modify if necessary our methods of capture, tagging, and sampling. We will pay close attention to how other animals respond to the disturbance caused by our research and will implement protocols if necessary to reduce pain and distress that we might cause. Sample sizes will be increased in subsequent years as the protocols become more firmly established.

Researchers working on the Pribilof Islands and Bogoslof Islands have developed expertise in how to approach haulouts and rookeries to ensure that minimum numbers of animals are disturbed. The methods outlined above describe how research is conducted to minimize effects on animals. All research will be coordinated with NMFS, ADF&G, Alaska SeaLife Center and other groups and individuals conducting northern fur seal research in Alaska to minimize effects.

**Activity 3. Assessing changes in body size and annual growth increments of teeth of northern fur seals.** Protocols described above for measuring and sampling subsistence killed fur seals have been developed in collaboration with the subsistence hunters and NMFS researchers. Measurements are made after the animal has been killed by the hunters. The animals are not killed for research, and the researchers are taking advantage of an opportunity to learn more about the animals that breed on the Pribilof Islands.

### **3. Monitoring effects of activities**

Two possible effects of capturing and handling fur seals is that they die, or mothers and pups fail to reunite. Lactating fur seals that are instrumented (Activity 1) will therefore be looked for each day of the study (either through satellite relayed information while at sea, or from VHF tags and direct observations while on land). They will be observed with binoculars when found on shore to ascertain whether they are with their pups. In addition, we will look at changes in behavior, time spent on the rookery, and time spent at sea as measures of the effects of our activities.

Marked fur seals (Activity 2) will be monitored through behavioral observations (made from blinds) to assess any potential effects of the research on them. Measuring and sampling fur seals killed in the subsistence harvest will have no effect on living individuals (Activity 3).

### **4. Alternatives**

Our studies do not propose to intentionally cause mortality or injury to northern fur seals. Captures and handling will cause some level of stress, and potential discomfort, but is not believed to cause undue pain or suffering. The research we are proposing to undertake under this permit is specific to northern fur seals, and must also be permitted by the Animal Care Committee of the University of British Columbia. There is no alternative species that can be substituted to yield relevant data.

### **E. Resources Needed to Accomplish Objectives**

Funding to undertake the proposed research is anticipated from NOAA to the North Pacific Marine Science Foundation, which funds the North Pacific Universities Marine Mammal Research Consortium. The Consortium has been conducting research on Steller sea lions since 1992. Some of the research may be conducted in collaboration with research cruises run by other research organizations such as NMFS and ADF&G.

### **F. Publication of Results**

Researchers associated with the North Pacific Universities Marine Mammal Research Consortium have published over 100 papers related to the pinniped declines in Alaska. They have a strong record of publishing their findings in peer reviewed journals (see [www.marinemammal.org](http://www.marinemammal.org)), and will share their information through conferences and meetings.



## V. NATIONAL ENVIRONMENTAL POLICY ACT CONSIDERATIONS (NEPA)

- a) *The research involves new, innovative, controversial or experimental equipment or techniques;*

No. All techniques have been previously carried out on northern fur seals or other related mammal species.

- b) *Does your activity involve the collection, handling or transport of potentially infectious agents or pathogens?*

There is always a risk of a transfer of disease agents from wildlife to humans. We will take all necessary precautions (e.g., use gloves, disinfectants, appropriate clothing, etc.) to minimize this risk. We will also ensure that appropriate techniques are employed when collecting, handling and transporting potentially infectious agents from diseased animals that may be sampled.

- c) *Do any of the proposed activities occur in or near unique geographic areas?*

No.

- d) *Would proposed work affect entities listed in or eligible for listing in the National Register of Historic Places, or cause loss or destruction of scientific, cultural or historic resources?*

No.

- e) *Would any of the proposed activities include actions that might involve the transportation of any material, biological or otherwise, from one area to another?*

Yes, we expect to transport blood, scats, vibrissa, teeth, and blubber. Samples will be sent frozen or dried, and will be transported in sealed containers following internationally accepted guidelines.

## VI. PREVIOUS AND OTHER PERMITS

**A. Previous Permits:** Permit 715-1792 was previously held to conduct Steller sea lion research.

**B. Other Permits:** All research carried out under this permit application must also be covered by permits issued by the UBC Animal Care Committee. No other permits are required.

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## VI. CERTIFICATION AND SIGNATURE

I hereby certify that the foregoing information is complete, true, and correct to the best of my knowledge and belief. I understand that this information is submitted for the purpose of obtaining a permit under one or more of the following statutes and the regulations promulgated there under, as indicated in Section I. of this application:

The Endangered Species Act of 1973 (16 U.S.C. 1531-1543) and regulations (50 CFR 222.23(b)); and/or

The Marine Mammal Protection Act of 1972 (16 U.S.C. 1361-1407) and regulations (50 CFR Part 216); and/or

The Fur Seal Act of 1966 (16 U.S.C. 1151-1175).

I also understand that any false statement may subject me to the criminal penalties of 18 U.S.C. 1001, or to penalties provided under the Endangered Species Act of 1973, the Marine Mammal Protection Act of 1972, or the Fur Seal Act of 1966, whichever are applicable."

Signature of Applicant:

Date of Signature:



January 15, 2007

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Andrew W. Trites, Ph.D.

Research Director  
North Pacific Universities Marine Mammal Research Consortium