INVESTIGATING VITAL RATES AND INDICES OF HEALTH IN THE DECLINING POPULATION OF HARBOR SEALS IN GLACIER BAY

ANNUAL REPORT 2006

Alaska Dept. of Fish and Game, Harbor Seal Research Program
Principal Investigator: Gail Blundell
gail_blundell@fishgame.state.ak.us
(907) 465-4345

Harbor seals in Glacier Bay (GLBA) are declining at a rapid rate (Mathews and Pendleton 2006). A 9.6%/year (1992-2001) decline has been documented in non-pups using ice habitat in John Hopkins Inlet (JHI) during August trend surveys and a 14.5%/yr (1992-01) decline has occurred in seals at terrestrial sites throughout the park (Mathews and Pendleton 2006). Data from the 2004 and 2005 trend survey of terrestrial sites in Glacier Bay indicate that the decline continues at a rate of 14.7%/yr (ADF&G unpublished). Due to inclement weather, insufficient data were obtained to update trend estimates for 2006.

In stark contrast to the sharp declines observed in GLBA, populations of harbor seals in other parts of Southeast Alaska are stable or increasing (Small et al. 2003), thus it is possible that factors contributing to this decline may be specific to the park, or to glacial areas in general. Seasonal variation in the number of seals counted in GLBA has been reported (Mathews and Kelly 1996, Mathews and Pendleton 2006), with several thousand fewer seals located in the park in the fall and winter compared with the spring, summer, and early fall. Some of the largest concentrations of harbor seals in Alaska occur on glacial ice, representing approximately 15% of the total seal population in Alaska (NMFS National Marine Mammal Laboratory unpublished); therefore it is important to understand the ecology of seals occupying this habitat.

The most direct manner in which to understand fluctuations in population abundance is by estimating survival and reproduction, and quantifying the effect that proximate factors (e.g., nutritional stress, contaminants) have on these vital rates. Whether the decline of seals in GLBA is due to emigration, decreased survival or reproduction or a combination of these vital population parameters is unknown. Since 2004 we have subcutaneously implanted VHF transmitters into 155 seals captured in Glacier Bay. The transmitters are duty cycled to transmit a signal for 5 years, allowing us to radio track those seals through time, assessing survival, age of first reproduction, and reproductive success for nearly ¼ of the maximum lifespan of the seal.

At the time of capture we obtain a complete suite of biological samples from each individual to assess age, genetics, body condition and health, diet, immunocompetency, reproductive condition, disease status and contaminant load. The long-term vital rates data provided by these multi-year VHF implants, paired with data on diet and health status of the individuals at the time of capture, permits an assessment of what factors differentiate between seals that survive and reproduce and those that do not, potentially elucidating key factors contributing to the decline of seals in Glacier Bay.

Summary of 2006 Research Activities and Results for ADF&G Vital Rates Study

In 2006 we conducted two capture trips in Glacier Bay (April and September) in which a total of 105 seals were captured; 82 in ice habitat (JHI) and 23 at terrestrial sites in the Beardslee Islands. Only external transmitters were deployed on seals in the April capture trip as part of the ongoing foraging ecology study (see 2006 report). VHF implants were deployed only during the September trip and only in seals captured in the ice. A total of 38 seals captured in JHI received 5-yr VHF implants including 19 young-of-the-year (17 females, 2 males), 5 yearling females, 9 subadult females, and 5 adult females. Five seals captured in September were equipped with satellite dive recorders provided by NMFS/National Marine Mammal Laboratory to track winter movements and dive behavior of female seals captured in Johns Hopkins Inlet.

In three years of capture and radio-tagging work in Glacier Bay for the vital rates study, we have now deployed a total of 155 5-yr VHF implants (109 females, 46 males). Because female reproduction, age of first reproduction, and the survival and recruitment of young into the population (i.e., remaining in the population to reproduce) have the most profound effect on population dynamics, our samples are purposefully biased toward females and young animals. The 155 seals tagged with long-term transmitters include: 59 young of the year: 12 from 2004 (9F, 3M), 28 from 2005 (10 F, 9 M), and 19 from 2006 (17F, 2M). A total of 36 yearlings (26 F, 10 M), 34 subadults (25F, 9 M), and 26 adults (13 F, 13M) also received VHF implants, resulting in a total of 70.3% females, 23.2% yearlings, and 38.1% young of the year. Of those 155 seals, 106 were captured in JHI (glacial habitat) and 49 were captured at terrestrial sites. Some males in each age category were also tagged with long-term transmitters to aid in our understanding of factors that may affect population numbers. For example, there has been a documented decline in the number of non-pups in Glacier Bay, but could that be a result of fewer males returning to their birth place, but females continue to return to the Park to pup as do their female offspring?

Radio Tracking of VHF Implants

The land-based datalogger (Advanced Telemetry System [ATS] R4500S) deployed in JHI in May 2005 and powered by two 85W solar panels maintained adequate power to remain functional throughout the year. The equipment continuously scans for all radio-telemetry frequencies deployed in the area and transmits those data via a NOAA operated Geostationary Operational Environmental Satellite (GOES). That monitoring equipment allows for collection of presence/absence and survival data without requiring the presence of a researcher in the field. Due to unusually bad weather in summer 2006 (e.g., heavy overcast and high levels of precipitation) we were unable to keep the two data logger sites established in the Beardslees in 2004 functional for the entire summer because the single solar panel at each site did not receive enough sunlight to adequately power the data logging equipment. Therefore we request authorization to keep two solar panels at each of the Beardslee Island locations in the future.

Analysis of data obtained from data loggers in Glacier Bay was done in conjunction with similar data collected from a comparable vital rates study in Prince William Sound (PWS), where 6 GOES stations are collecting telemetry data. All remotely collected data from 2004 through 2006 were analyzed to determine resight rates in both locations. Code was written in Auto-It scripting language and run via Windows scheduled task manager to automatically download GOES-transmitted data from 7 sites

(one site in JHI and 6 in PWS) every 2 days, merge files weekly, and translate encrypted data with ATS software. SAS code was written to sort and filter data, eliminating false positives. Data are retained if pulse rate is correct, transmit time matches duty cycling, and noise level $\leq$1. The SAS code was revised to sort and filter data collected at the two monitoring sites in the Beardslee Islands, as those data are logged in a different format.

The earliest data collected in 2005 from the GOES sites had 75% false positives but we had fewer problems with false positives in GLBA than in PWS, perhaps due to less vessel traffic in the Park. ATS revised the R4500S units to accommodate the narrow (25ppm**)** pulse width of our transmitters and made other revisions to filter additional ambient interference resulting in ~25% of data rejected as false positives. In 2006, following the ATS revisions, we ground-truthed the data and noted that remotely logged data were comparable to data collected by ADF&G personnel during aerial and skiff-based telemetry (i.e., actual signals present were recorded as present, noise/interference was not logged). Further methods of determining function of the telemetry monitoring station and accuracy of data logged include scanning for a reference transmitter deployed at each site (if stations are functioning properly the reference transmitter should be logged during each scan of the frequencies) and scanning for two "dummy" frequencies (frequencies that are not deployed in the area and thus should never be recorded as present). Recording a small amount of false positive data is unavoidable given the variety of sources of electronic interference. Nonetheless, due to our thorough screening of data to assure data accuracy, we are now satisfied that data accepted as "good data", recording seal presence at these sites is accurate.

In the analysis conducted this winter we included telemetry data that logged presence of external transmitters (TDRs and VHF headmounts) deployed each year in Glacier Bay on seals for the foraging ecology study. The code written to sort and filter data was an iterative process to improve our ability to extract only "good data". Much of the resight data provided last year were tallied by hand thus, to assure that all data were sorted and filtered using identical methods, we re-analyzed all telemetry data for all years of the GLBA study. Because external tags are shed each year, we often re-used the same frequencies on different seals in subsequent years. In an analysis of all years of data, seal ID was occasionally confused and seals were misidentified and data may have been sorted as either good or bad data based on proper pulse rate for a seal that was misidentified. In the initial analysis most of these errors were believed to have been corrected by hand, but given the importance of these data we have revised the SAS code to assure that seals will be correctly identified and the analysis of all data will be completed again. Therefore we will not report on resight rates in this annual report.

Preliminary results indicated that resight rates were higher for GLBA compared with PWS, despite twice as many data-logging stations in PWS and intermittent functionality of our sites in GLBA. Similar to results tallied by hand last year there appeared to be equal resight probability for males and females and resight rates were highest in the year of tagging (>87%) and declined in subsequent years. Again, these results are only from the remote monitoring sites (i.e., does not include aerial and vessel-based telemetry resights) and results reported here are preliminary, prior to revising the SAS code and re-analyzing the data. We will re-analyze the remote telemetry data along with resight data from vessel and aerial telemetry and we anticipate submitting a manuscript with these results in the near future. Additionally we will conduct the first

round of multivariate analysis examining these survival data in relation to the health and condition data we have for seals tagged in the first year of the vital rates studies GLBA and PWS.

Our remotely obtained telemetry data show a relatively high resight rate for seals despite the intermittent functionality of some monitoring stations and the limited spatial coverage by our three land-based data sites that can only detect radio signals from VHF implants of seals on that particular haul out. Results from the collaborative foraging ecology studies noted considerable movement of seals tagged in ice. Invariably when we have ventured into Adams Inlet we have located radio tagged seals. Thus, in 2007, we propose to increase the frequency of radio tracking of VHF implants through a combination of incidental tracking of VHF implants while tracking seals with external tags, closer monitoring of land-based data loggers to assure that they are functioning, and additional radio tracking specifically for VHF implants via vessel-based surveys conducted by ADF&G and possibly by tribal members selected by the Hoonah Indian Association (HIA), pending funding of a USFWS Tribal Wildlife Grant. ADF&G proposes to track seals with VHF implants for a period of 3-5 consecutive days up to two times monthly using kayaks for tracking in the Beardslees and other restricted waters, and the ADF&G whaler to track in non-restricted waters. If problems with the JHI data logger are detected via GOES transmission we may need to request authorization to enter those restricted waters to correct the problem.

We are also attempting to forge a more in-depth collaboration with HIA. We (ADF&G) have jointly applied for a USFWS Tribal Wildlife Grant, which would augment the telemetry data collected for the vital rates study. A tribal member would be trained in radio tracking and a small vessel owned and operated by another tribal member would be chartered for the purpose of tracking seals with VHF implants in GLBA and surrounding areas. As with ADF&G personnel, the HIA tracking vessel would not enter non-motorized vessel waters. If the grant is awarded, once training is complete HIA personnel will take over responsibility for radio tracking seals with VHF implants and ADF&G personnel would use the ADF&G skiff and kayaks to intermittently (and often blind to HIA) verify accuracy of HIA-collected data.

Assessing Reproductive Status

In our efforts to investigate factors that may contribute to the decline of harbor seals we continued our assessment of reproductive status of females using several techniques. Pregnancy is visually diagnosed when females are captured in April and, in collaboration with the Alaska SeaLife Center (ASLC), progesterone assays are run on blood samples from females captured in September. Depending upon what phase of delayed implantation reproductive females are in, progesterone assays may or may not provide information on reproductive status. In September 2006 we initiated collaboration with Dr. Gregg Adams of University of Saskatchewan to determine whether we could more effectively diagnose pregnancy in the field during the early stages of delayed implantation. Dr. Adams is an internationally recognized theriogenologist that has developed the technique for conducting transrectal ultrasonography on many wildlife species, most recently in fur seals Adams et al., 2007), to diagnose pregnancy in the field. During the September field trip transrectal ultrasonography was conducted on female harbor seals using a Sonosite 180 scanner equipped with a 5-7 MHz linear-array, side-fire transducer attached to a rigid probe

extension (Adams et al., 2007). Seals were tranquilized with Diazepam or gas-anesthetized with isoflurane prior to transrectal examination. Seals were maintained in sternal recumbency, the probe with probe extension was lubricated with vegetable oil and introduced into the rectum with the lens of the probe facing ventrally to examine the uterine body, uterine horns and the ovaries.

Only 10 females (Table 1) were of sufficient size to permit transrectal ultrasonography (mean±SD: 52.0 ± 16.6 kg; range: 31.6-86.1 kg). The time required to complete ultrasonographic examination was 12.0±4.1 minutes; range: 7-20 minutes). The entire reproductive tract (uterus and both ovaries) was visualized in 7 of 10 females. Of the 3 remaining, portions of the reproductive tract were seen in 2 and none of the reproductive organs were identified in 1 seal. The best images were obtained from females ≥ 55 kg. Difficulty in obtaining images from smaller animals was attributed to insufficient mobility of rectum of small animals and the small size of reproductive organs in immature animals.

The ovaries were ovoid and approximately 1.0 x 2.0 cm in size, and follicles (Figure 1) ranging from 1 to 6 mm in diameter were detected around the periphery (i.e., outer cortex). The inner medulla of the ovary was relatively bright (echogenic) compared to the outer cortex. Of the 7 females in which both ovaries were seen, the total number of follicles ≥2 mm in both ovaries per individual was 14.7±11.1; the number of follicles ≥ 3 mm was 4.3±3.4. A single corpus luteum (CL) was detected in 6 of the 7 females – 3 in the left ovary and 3 in the right ovary. In addition to a CL, a corpus albicans (CA) was detected in 1 female. Corpora lutea ranged in diameter from 10 to 19 mm (13.2±3.2 mm). A CL was detected in 5 of 5 females ≥ 55 kg body weight, and in only 1 of 5 that were smaller (Figure 1).

Table 1. Description of views obtained from transrectal ultrasound performed on subadult and adult female harbor seals captured in Glacier Bay in September 2006.

Seal ID	Date	Description
06GB39	9/5/06	Good view of uterus and kidney
06GB48	9/6/06	Good view of uterus, ovary, and kidney
06GB50	9/6/06	Good view of ovary with CL and small follicles
06GB62	9/9/06	Good view of uterus and ovary with CL
06GB64	9/10/06	Good view of uterus and ovary with CL, pregnant - embryonic vesicle 7 mm
06GB74	9/11/06	Good view of uterus and both ovaries with follicles & CL
06GB76	9/11/06	Good view of uterus and both ovaries with follicles & CL
06GB81	9/11/06	Excellent view of ovary with many small follicles
06GB86	9/12/06	Excellent view of ovary – no significant structures

Pregnancy was diagnosed in 1 of 9 females in which the uterus was visualized. The embryonic vesicle (inner cell mass and expanding trophoblastic vesicle) was spherical, 7 mm in diameter, in the proximal (to ovary) third of the right uterine horn, and ipsilateral to the side of the CL (CL -15 mm in diameter). The embryo proper was not detected.

We anticipated that pregnancy in the harbor seals may still be in the diapause phase, but that resumption of embryo development may begin in some animals sometime in September. The lone embryonic vesicle detected in the study period appeared morphologically identical to those described in northern fur seals examined on the Pribilof

Islands in mid-November (Adams et al., 2007). Structures <1-2 mm in size are beyond the limit of resolution of current diagnostic ultrasound equipment; hence, embryos less than 2 mm in diameter will have escaped detection. It is possible, indeed likely, that most of the seals with a CL (i.e., mature enough to ovulate) were pregnant. Re-examination by transrectal ultrasonography in the following weeks would provide an effective means of determining pregnancy rate, characterizing embryonic diapause and early development, and of quantifying embryonic/fetal loss by comparison with pupping rates.

In conclusion, transrectal ultrasonography provides a simple, rapid, non-disruptive method of assessing reproductive status in harbor seals in a field setting. No untoward effects of the examination procedure were noted, and the procedure represented a minor part of data collection in terms of time and invasiveness. With experience, the procedure will become routine, will require only 5 to 10 min. to complete, and will not require sedation or anesthesia.

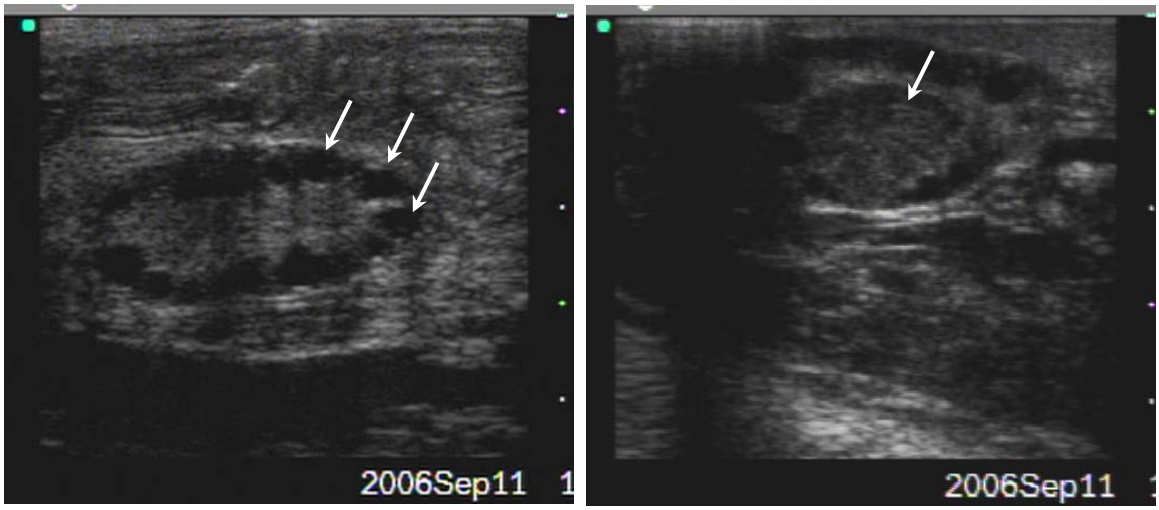

Figure 1. Ultrasound images of harbor seal follicles and Corpus Luteum obtained via transrectral ultrasound performed in the field on harbor seals captured in Glacier Bay National Park.

Sample and Data Analysis

Given the long-term nature of this vital rates study in our efforts to identify causes of the decline in harbor seals, the bulk of ADF&G staff time and funds have been committed to the capture, radio tagging and tracking enough seals to accurately assess their survival, as well as financing the majority of the radio transmitters and all of the dive recorders used in the foraging ecology study. Analyses of samples collected from the 155 seals with VHF implants, and for seals that were radio tracked for the foraging ecology study, are in progress by ADF&G and our collaborators. Stable isotope analysis of diets has been completed for those seals from hair, red blood cells and serum to provide different seasons/time frames of their diet. Early results from this study were presented at The Wildlife Society meeting in Anchorage in Sept. 2006. Further interpretation of these results will begin in March. Also completed are analyses of body condition (% fat), and hematology and serum chemistry profiles of the health of these animals (and other seals

captured in Glacier Bay that did not receive radio tags). Preliminary results from serum chemistry profiles of GLBA seals was presented at the Society of Marine Mammalogy in December 2005. Fatty acids analysis of diet for these GLBA seals with radio tags is partially complete; all samples are at the laboratory waiting for processing and funds have been encumbered to pay for those analyses. Results for additional Brucella titers for 50 animals are pending and other disease screens have been completed by ASLC.

In our genetics study conducted by an MSc student at University of Wyoming, a total of 456 seals have been genotyped (comparing PWS – a population without seasonal migration— with GLBA where seasonal migration is prevalent) using 6 microsatellite primers. All but a few individuals had distinct genotypes (i.e., individual DNA "fingerprints"). A 7th hypervariable microsatellite primer is being sequenced in hopes of distinguishing between the remaining, likely highly-related individuals that have similar genotypes. Analyses of gene flow and kin relationships will begin in March 2007 and all aspects of the genetics study are expected to be complete by early fall 2007. As part of that same study, the technique for extracting DNA from seal feces has been optimized and DNA has been extracted from a total of 222 scat samples, primarily collected in GLBA. At least half of those are expected to yield DNA of sufficient quality for genotyping to establish the sex of the seal, and individual DNA identification (i.e., DNA "fingerprint"). Prey remains from 73 of those scat samples from which DNA was extracted were sent to the laboratory for identification, as part of the study on sex-specific diet of harbor seals. Stable isotope data will also be used to address that question. Quality control has already been completed on samples from >50 seals, confirming that the DNA sequences obtained from the blood of an individual matches the DNA amplified from the feces of the same seal.

Analyses for a subset of samples for contaminants have been conducted by the Alaska SeaLife Center (ASLC). Because of the high cost of analyzing contaminants, it is possible that only a subset of the samples collected in Glacier Bay will be analyzed by ASLC. For all other samples collected from seals in GLBA involved in the vital rates and foraging ecology studies, all sample analyses will be completed before the batteries of the 5-yr VHF implants expire so that we can evaluate whether particular parameters are associated with increased survival or reproductive success.

ADF&G is in the initial stages of interpreting the results from the laboratory data that we have in hand and thus have no results to present in this report. Below are excerpts of reports on preliminary results from ASLC investigations using samples obtained from harbor seals captured in Glacier Bay:

Disease screening of harbor seals in Prince William Sound and Glacier Bay in 2003-2004

A. Hoover-Miller, G. Blundell, P. Tuomi, M. Grey, and S. Conlon

Harbor seal populations in the Gulf of Alaska declined from 60-90% since the mid-1970s (Pitcher 1990; Frost et al. 1999). Sera obtained from harbor seals between 1976-1999, including periods of rapid population decline, were tested for evidence of exposure to Brucella, phocid herpesvirus-1, phocid herpesvirus-2, and phocine distemper virus in four regions of Alaska (Zarnke et al. 2006 and Zarnke 2001). Based on the results of those surveys, none of those agents were determined to be a significant mortality factor.

Sera from 140 seals captured in Prince William Sound (n=77) and Glacier Bay (n=63) during 2003 and 2004 were used for analysis. Virus neutralization tests, carried out at the Oklahoma Disease Diagnostic Lab, included phocid herpesvirus-1 (PhHV-1), Toxoplasmosis latex (Toxo), canine distemper virus (CDV), phocine distemper virus (PDV), porpoise morbillivirus (PMV), dolphin morbillivirus (DMV) and Leptospirosis (L. canicola, L. grippotyphosa, L. hardjo, L. Ictero, L. Pomona, and L. Bratislava). Brucella abortus was assayed using the Brucella card test. Positive titers to Toxoplasmosis were identified in 2 of 140 samples, both located in Glacier Bay. One positive titer response was found for Leptospirosis hardjo. Positive titers to Brucella were detected for about 28% of the subadult and yearling seals. Seventeen percent of adult seals that were not classified as pregnant showed positive titers to Brucella, however none of the pregnant females, nor any of the pups in this study showed positive titers. Phocid Herpesvirus-1 was widespread and actively infects harbor seals in Alaska. Overall 96% of the seals tested showed a positive response, however 82% of pregnant seals exhibited high titers while only 42% of other age groups exhibited high response levels. Negative titers were only detected in young-of-year and yearling categories. Many of the serum samples that were tested for the morbiliviruses PDV, CDV, DMV, and PMV using serum neutralization assays were compromised by toxicity. Any serum samples observed to be contaminated by bacteria or to be non-specifically toxic to Vero cells were regarded as negative; therefore, reported prevalence values are minimums.

Of the 140 samples, all but four of the samples testing for DMV were toxic as were all but 8 tested for PMV. The 8 samples that were non-toxic were negative. CDV testing resulted in 116 toxic samples and 17 samples were negative; 7 (41%) of the non-toxic samples were positive at low titers of 1:8-1:32. Tests for PDV showed the least toxicity and highest prevalence of positive titers. Of the 140 samples, 43 were toxic, 9 were negative and the remaining 82 (90%) were positive at low levels of 1:8-1:32. Results from this screening suggest that Brucella may have an adverse effect on sustaining successful pregnancies and that positive titers to PDV are more numerous than reported by Zarnke et al. (2006). Studies comparing pregnancy rates versus partuition rates over time may reflect the impact of Brucella on the PWS and BG harbor seal populations. The consistently low titers shown in the PDV tests suggest that cross-reactivity may be occurring and do not reflect recent exposure to or outbreaks of PDV.

Differences in harbor seal serum chemistries between Prince William Sound and Glacier Bay, Alaska

S. Conlon, A. Hoover-Miller, G. Blundell, and S. Atkinson

Abstract
We initiated long-term monitoring studies to assess diet, health status and reproductive success in two declining populations of harbor seals (Phoca vitulina). Study areas included Prince William Sound (PWS) and Glacier Bay National Park (GB), where seal numbers have decreased by >65%. Current rates of decline differ, -3.1%/yr in PWS [1990-2004] and -15.5%/yr in GB [1992-2004]. We measured serum chemistry variables in free-ranging harbor seals in PWS (n=39) and GB (n=32) from 2003-2005 to compare population-specific values and differences among cohorts (adult, subadult, yearling/young of the year (YOY)). Within each age category, differences in serum chemistries were not apparent between locations. Samples combining both GB and PWS showed significant differences between yearling/YOY (n=25) and the other age

classes (subadult n=29, adult n=17) in the following variables: Alkaline phosphatase (ALKP), calcium (Ca) and total protein (TP). The higher levels of ALKP and Ca in yearling/YOY were expected as they reflect skeletal growth. TP was lower in yearling/YOY, suggesting lower dietary protein or lower protein assimilation. Higher levels of cholesterol (CHOL) in yearling/YOY than adults may reflect higher lipid intake from nursing and prey than consumed by other seals. Blood urea nitrogen (BUN) and creatinine (CREA) levels were significantly higher in the adults indicating differences in diet and hydration state. Seasonal and developmental differences within the yearling/YOY category were indicated for albumin (ALB), globulin (GLOB), chloride (Cl), sodium (Na), total bilirubin (TBIL), inorganic phosphate (PHOS), creatine kinase (CK), alanine aminotransferase (ALT), aspartate aminotransferase (AST), and amylase (AMYL). Ongoing research and sampling effort may help to establish critical serum chemistry reference ranges for different age classes; however, blood chemistries seem to reflect consistent homeostasis across regions.

PCBs and DDT contaminants burdens of harbor seals in Alaska using high-performance liquid chromatography/photodiode array (HPLC/PDA) method

S. Atkinson, P. Krahn, G. Ylitalo, M. Myers, and A. Hoover-Miller

Abstract
The importance of seals in the diet of Alaska Natives and the tendency of contaminants to accumulate in the fatty tissues and organs of seals make it essential to monitor contaminant loads in harbor seals throughout Alaska. Contaminant analysis provides data important for evaluating the health and condition of seals as well as monitoring the exposure levels to humans that consume seals. This report summarizes the analysis of polychlorinated biphenyls (PCBs) and Dichloro-diphenyl-trichloroethane (DDTs) from 66 blubber and blood samples collected between 2003 and 2005 that were analyzed at the NOAA Fisheries Environmental Assessment Program for PCB and DDT contaminant analysis. These samples represent 50 individual seals collected through the ANHSC Biosampling Program from Prince William Sound (n=16), Southeast Alaska (n=14), Kodiak (n=13) area and Bristol Bay/Alaska Peninsula (n=7). Sample analysis supported the following objectives: (1) Regional Variation: All samples were used to identify regional influence of contaminants on seals to examine the role of contaminants, samples from 10 wild seals captured in Central Prince William Sound and Glacier Bay were used to contrast contaminant burdens of young female seals prior to their first pregnancy as a preliminary assessment of factors that may be contributing to population declines seen in Glacier Bay. The selected seals were monitored for a 3-5 year period using subcutaneously implanted VHF transmitters. The results of the contaminant analysis will be used to provide a more complete profile of the health and condition of monitored seals. (2) Seasonal mobilization of contaminants: Contaminants build up in the blubber layer of marine mammals; however, it is the contaminants circulating in the blood that influence the health of tissues throughout the body. We contrasted contaminant burdens in the blood with levels in the blubber to better understand seasonal changes in circulating contaminant levels as seals store fats in blubber and use blubber for energy and reproduction. All samples were analyzed for PCBs and congeners, plus DDT, DDE and DDD. All samples were analyzed at the NMFS Northwest Fisheries Science Center in Seattle, WA. Blood and blubber samples of harbor seals were analyzed for dioxin-like PCBs and other selected OCs by a high-performance liquid chromatography/photodiode array (HPLC/PDA) method.

Additional blubber samples obtained from 46 seals (15 subadult females and 31 males) were analyzed. Twenty-four samples were obtained through the BioSampling program and 22 samples were obtained from live captures of harbor seals in Prince William Sound and Glacier Bay. Regional samples included Prince William Sound (n=19), Kodiak Island (n=19), the Alaska Peninsula (n=4), Bristol Bay (n=1), and Southeast Alaska (n= 14). SPCBs averaged 535 ng/g (range 150-3,400 ng/g). SPCBs concentrations in male seals were significantly higher than in females. Sum Toxic Equivalents (STEQs) (a standardized measure of PCB toxicity) averaged 1.75 ng/g (range 0-9.53 ng/g) and did not significantly differ by age, sex, or region. SDDTs were significantly higher in southeast Alaska (mean=690 ng/g; range 1-1,326 ng/g) than other regions (regional mean values: PWS =339 ng/g, range = 110-1,042 ng/g; Kodiak = 196 ng/g range 0-782 ng/g; AK Peninsula = 267 ng/g; Bristol Bay =125 ng/g, range=125-463 ng/g). SPCBs of pups were similar to those of adult females and tended to be lowest, juvenile males and juvenile females showed intermediate values while adult males tended to show higher concentrations. Nevertheless, adult females and pups did not show lower STEQs levels relative to other age groups, indicating that adult females and pups were influenced by toxicity at similar levels to other age classes, despite the transfer of PCBs via lactation. DDT concentrations appeared higher in southeast Alaska relative to other sampled locations. With the exception of a few individual animals, PCB contaminant levels were low and below threshold levels for adverse effects on the seal's immune and reproductive function. Additional samples and analyses are needed to provide a more complete representation of contaminant levels in seals throughout coastal Alaska, particularly in areas influence by human activities.

We (ADF&G) and our collaborators will continue to analyze samples and will evaluate these laboratory results in conjunction with other data, including our data on survival and reproductive success obtained from 5-yr VHF implants, to determine whether particular health or diet parameters may have biological significance, influencing those vital rates in a manner that pinniped researchers had not previously identified.

LITERATURE CITED

Adams, G.P., J.W. Testa, C.E.C. Goertz, R.R. Ream, and J.T. Sterling. 2007. Ultrasonographic characterization of reproductive anatomy and early embryonic detection in the Northern Fur Seal (*Callorhinus ursinus*) in the field. Marine Mammal Science *in press*.

Mathews, E.A. and B.P. Kelly. 1996. Extreme temporal variation in harbor seal (Phoca vitulina richardsi) numbers in Glacier Bay, a glacial fjord in Southeast Alaska. Marine Mammal Science 12:483-488.

Mathews, E.A, and Pendleton G.W. 2006. Declines in Harbor Seal (Phoca vitulina richardsi) Numbers in Glacier Bay National Park, Alaska, 1992-2002. Marine Mammal Science 22(1): 167-189

Pitcher, K. W., 1990. Major decline in number of harbor seals, *Phoca vitulina richardsi*, on Tugidak Island, Gulf of Alaska. Mar. Mamm. Sci. 6:121-134.

Small, R.J., Pendleton G.W., and Pitcher K.W. 2003. Trends in abundance of Alaska harbor seals, 1983-2001. Marine Mammal Science 19: 96-114

Zarnke, R.L. 2001. Serological survey of harbor seal populations for evidence of exposure to selected disease agents. Pp. 345-350 in Harbor seal investigations in Alaska annual report NOAA Grant NA87FX0300. Annual report for NOAA Grant NA87FX0300. Alaska Department of Fish and Game, Division of Wildlife Conservation, Anchorage, Alaska, 356 pages.

Zarnke, R.L., Saliki, J. T., Macmillan, A. P., Brew, S. D., Dawson, C. E., Ver Hoef, J. M., Frost, K. J. and Small, R. J. 2006. Serological survey for Brucella spp., phocid herpesvirus-1, phocid herpesvirus-2, and phocine distemper virus in harbor seals from Alaska, 1976-1999. Journal of Wildlife Diseases 42(2): 290-300.