

Observations of Harbor Seals in Southern Puget Sound during 2009

**Dyanna M. Lambourn, Steven J. Jeffries
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**Washington Department of Fish and Wildlife
Wildlife Program
Wildlife Science Division**

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Dyanna M. Lambourn¹, Steven J. Jeffries¹
and Harriet R. Huber²

¹Washington Department of Fish and Wildlife
Marine Mammal Investigations
7801 Phillips Rd. SW
Lakewood WA 98498

² National Marine Mammal Laboratory
Alaska Fisheries Science Center, NMFS
7600 Sand Point Way NE
Seattle WA 98115

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Introduction

Harbor seals are the most abundant pinniped in Washington State. Based on population assessments conducted by Washington Department of Fish and Wildlife (WDFW) and National Marine Mammal Laboratory (NMML) from 1978-1999, the harbor seal population was estimated to be over 32,000 animals in Washington waters. An estimated 13,000 of those animals compose the “Washington Inland” harbor seal stock with about 1,000 animals in Puget Sound not including San Juan Islands and Hood Canal (Jeffries et al. 2003). In recent years, the annual rate of increase in the number of harbor seals in Washington has slowed indicating that the population is nearing carrying capacity (Jeffries et al. 2003). Life history theory predicts that parameters such as survival, recruitment, and female reproductive success will differ between an increasing population and a stable population (Huber et al. 2004). Changes in life history parameters affect the long-term management of pinnipeds, an essential goal of the Marine Mammal Protection Act.

In southern Puget Sound, harbor seals haulout on a variety of substrate materials including intertidal beaches, reefs, sandbars, log booms and floats. There are five main harbor seal haulout areas including: mouth of the Nisqually River, Cutts Island, Gertrude Island, Eagle Island, and Woodard Bay. Based on periodic aerial and boat surveys, each of these sites regularly supports a population of over 100 seals. In 1993, three of the main haulout sites (Gertrude Island, Woodard Bay and Eagle Island) were chosen for long term monitoring. The haulout site on log booms in Commencement Bay was added as another monitoring site in 1998 (Figure 1).

Historically, small numbers of harbor seals used other haulout areas on Steamboat, Heron and Squaxin Islands in southern Puget Sound. These islands have been developed and are no longer being regularly used by harbor seals. Haulout sites on Cutts Island, Eagle Island and McMicken Island are historic sites as well and are currently used regularly by harbor seals, but experience high levels of disturbance because of access for human use and recreational boat traffic. Haulout sites at the mouth of the Nisqually River were not chosen for this observational study largely due to the fact that neither land nor boat based observations could easily be conducted. Presently, harbor seals are reported to haulout and pup at other locations in south Puget Sound such as log storage sites in Budd Inlet and Hammersly Inlet as well as commercial shellfish floats and many small recreational floats and rafts in Totten Inlet and Eld Inlet. These haulout sites were not considered for this study because haulout numbers are low and all are regularly subject to varying levels of disturbance.

In 1993, WDFW and NMML began the first branding study of west coast harbor seals to determine life history parameters. Observational studies of branded animals were standardized and concentrated during the breeding season to provide estimates of age of first reproduction, age-specific natality, individual reproductive success, age specific survival, and longevity. Observations during the rest of the year provide additional data on age-specific survival and longevity. Other studies of west coast harbor seal life history parameters were based on collection of specimens in Canada and southeast Alaska (Bigg

1969; Pitcher and Calkins 1979). WDFW, NMML and Puget Sound Ambient Monitoring Program (PSAMP) provided funding for field efforts between 1993-1998. Funding for work in 1999-2009 was provided by WDFW and NMML.

Gertrude Island

Gertrude Island is a small; approximately 10-acre island located on the north side of McNeil Island and is managed by WDFW and Washington Department of Corrections. It is located inside Still Harbor and is connected to McNeil Island by a land bridge during low tides. Still Harbor is closed to the public and has a 100-yard security limit because it is a Department of Corrections prison facility.

Harbor seals were first reported on Gertrude Island with a count of 12 in 1948 made by Cecil Brousseau (former Director of Point Defiance Aquarium). Currently, Gertrude Island is the largest harbor seal haulout and rookery area in southern Puget Sound and is used year round by harbor seals of all ages, with peak counts recorded during July to December for pupping, breeding and molting periods (Jeffries et al. 2003). The number of seals increases during summer months related to annual reproductive cycle and also due to increased disturbance at other haulout sites in southern Puget Sound (Jones and Stokes 1989).

Harbor seals at Gertrude Island have been studied as part of numerous ongoing research projects since the 1960's (Arnold 1968; Newby 1971; Johnson and Jeffries 1983). Gertrude Island was chosen as the primary haulout for this study because it is readily accessible; seals are easy to observe; it is the largest haulout in south Puget Sound; and public access is restricted due to being part of McNeil Island Correction Center. Seals haulout at this site during all tidal heights, but highest numbers of seals are seen during moderate low afternoon tides when disturbance is lower at Gertrude Island (fewer deer, coyotes and eagles) and disturbance increases at other more public accessible locations nearby (Eagle Island and Cutts Island).

Historically, the first newborn live harbor seal pup births were reported the first week in August (Newby 1971; Johnson and Jeffries 1983) at Gertrude Island and pups were reported weaned by mid-October. Historic pupping at other sites in south Puget Sound was reported to start around the first week in July. In recent years, peak pupping has shifted almost a month earlier with the first live healthy harbor seal pups at Gertrude Island reported born around the first week of July, with pupping continuing until the last births in mid-August. This phenology is consistent with the other haulouts in south Puget Sound. The number of documented pups born on Gertrude Island has increased from 27 in 1976 (Johnson and Jeffries 1983) to over 100 pups since 1991 (Lambourn and Jeffries 2000). Harbor seal pups generally nurse for four to six weeks with the majority of pups at Gertrude Island weaned by mid September. Following pupping season, their annual molt cycle begins and continues into December.

Capture and tagging studies have been conducted since 1985 on harbor seals at Gertrude Island (Lambourn and Jeffries 2000; Huber, Lambourn and Jeffries 2004). Because of

unequal resight effort, tag loss, and difficulty of reading worn tags, it was not possible to determine life history parameters from a tagging study alone. For this reason, a branding study was begun at Gertrude Island in 1993 and has continued each year to present.

Woodard Bay

Washington Department of Natural Resources (DNR) purchased what is now the Woodard Bay Natural Resources Conservation Area located in Henderson Inlet in south Puget Sound from the Weyerhaeuser Corporation in 1988. Harbor seals have used log booms at this site to haulout since the 1930s when it was an active log dump site (Calambokidis et al. 1991). Research began in 1970 when Newby (1971) reported 10 seals on the log booms. Woodard Bay is the other major haulout in south Puget Sound where pupping occurs.

Haulout areas in Woodard Bay are on log booms and are therefore not influenced by tide. The log booms are ideal for harbor seal pupping due to easy access to water escape routes and low platform for pups to get in and out of the water. The proportion of females with pups is higher at this site when compared to other haulouts such as Gertrude Island (Calambokidis et al. 1991). In the summer of 1990, log booms at Woodard Bay had a reported haulout area of 9,900 m² and haulout space was not considered a limiting factor for the number of seals using the area. In recent years, the log boom haulout area has decreased significantly because logs have decayed, sunk and floated away. A minimum haulout area needed for approximately 500 seals was reported to be 1,250 m² (Calambokidis et al. 1991).

Attempts by DNR (south side) and a local resident (north side) have been made to reestablish some lost haulout area. During 2007 observations, there were two partial log booms, a 50 ft x 50 ft float and a log boom approximately 100 ft long that DNR added in 2005. On the north side of Woodard Bay, two more log floats and a private boat dock are used as haulout sites by seals depending on the time of day. Prior to the 2008 pupping season DNR added more logs to the south side closest to the trestle and this location is where the majority of the seals haulout. In the past 10 years, loss of haulout space availability has become an issue with numerous sightings of females hauled out while pups nursed from the water.

Eagle Island

Eagle Island is a state marine park located between McNeil Island and Anderson Island. The primary harbor seal haul out sites are on the east and north sides of this rocky island. At lower tides, Eagle Shoal is exposed on the west side of the island and is used by seals to haulout as well. Harbor seals have used Eagle Island as a haulout area for some time (Newby 1971). Because Eagle Island is a state marine park and the channel between Eagle Island and McNeil Island is one of the primary marine traffic passages to access south Puget Sound, this site has high disturbance, especially on weekends and during summer midday low tides. Highest counts for this site are generally during early morning

low tides and observations conducted after Labor Day when recreational boat traffic decreases.

Commencement Bay

The Commencement Bay haulout area is located on log booms at the log storage area on the north side of Commencement Bay off the entrance to Hylebos Waterway. Harbor seals were first reported hauled out at this site during aerial surveys conducted in the 1980's. Weekly summer ground observations started 1998. This site is an active working location for log booming and sorting, and seal observations are better either in the early morning, late afternoon or evening when work in this area is done. Weekends are also a good time for observation because this site is not easily accessible to public and typically tugboats are not working on the weekends. This site, like Woodard Bay, is not influenced by tides, but disturbance plays an important role in its use by harbor seals. Commencement Bay is not a major pupping and nursing site, although in recent years there has been increasing numbers of females seen nursing pups. This site is currently being phased out as a log dumpsite and DNR and Port of Tacoma have purchased the shoreline. Private residents have reported that this area is undergoing shoreline restoration and it is unclear the plans for use of the remaining log dump site area.

Methods

Field Observations

Observations were made using a 20x60 zoom spotting scope and/or binoculars. Counts of harbor seals hauled out, number of pups present and seals in the water were recorded at all sites. If observations lasted longer than 1 hour, total counts were repeated at least once during the observation period. Observations were scheduled close to the lowest daytime low tide for Gertrude Island and Eagle Island. Haulout sites at Woodard Bay and Commencement Bay are not tidally dependant so observations at those locations were scheduled during times when disturbance was expected to be lowest. Woodard Bay disturbance is typically lowest during early morning to mid-afternoon during the week. Commencement Bay disturbance is lowest late afternoon and evening during the week and during the weekend.

Gertrude Island observations occurred 2 to 4 days per week during the breeding season (18 June to 1 October) and opportunistically prior to 18 June and 1 day per week until 30 October. Observations at Gertrude Island were made from four locations: 1) west side of Still Harbor; 2) gravel pit on the south side of Still Harbor; 3) blind on the southeast side Still Harbor on McNeil Island; and 4) blind on south side of Gertrude Island. Observations were conducted at least once a week at Eagle Island, Woodard Bay and Commencement Bay. Brand resights at locations other than Gertrude Island were made opportunistically.

Field data were recorded onto a data sheet and subsequently entered into an Excel spreadsheet. Data included date, time, number of seals hauled out, number of seals in the water, number of pups, and weather conditions. Counts are typically repeated every hour during the observation period. Notes are made on causes of disturbance, number of seals disturbed, and observations of interest. Resight observations of marked seals were recorded on a data form and typically entered into a separate Excel file on a Dell Axim Personal Data Assistant (PDA) in the field. The resight spreadsheet contains resight information for each marked individual from previous years. Additional information was collected on marked females including whether the female was pregnant, not pregnant, post partum, with or without a pup, or of unknown reproductive status.

Females were considered reproductive if they were seen pregnant or were seen nursing a pup at any time during the breeding season. Their reproductive status was listed as unknown if they were seen near a pup, but not nursing and their pregnancy status could not be determined. A female was considered to not be pregnant if it was too thin to be pregnant at the beginning of the breeding season and it was never observed nursing a pup. Data was also recorded on disturbance, including the number of seals observed and cause of disturbance. All original capture, branding, and resight data from 1993-2008 were entered into an Access database.

Dead Pup Counts and Collections

Dead pup counts were conducted at least once per week between 9 June to 30 September at Gertrude Island and opportunistly at all harbor seal haulouts. Dead pups were collected and given a unique identification number, weighed, length and girth measured, age estimated, gender identified (if possible), and state of decomposition quantified. All fresh dead carcasses Code 2 (fresh dead) and 3 (moderately decomposed) received either complete or partial necropsies depending upon the extent of scavenging. Necropsies were performed by WDFW (Dyanna Lambourn), with Cascadia Research Collective (CRC) staff or volunteers assisting. Samples were sent to Dr. Stephen Raverty, British Columbia Animal Health Centre in Abbotsford for histopathology and ancillary diagnostics including microbiology, virology, PCR for *Brucella* spp., morbillivirus, *Toxoplasma gondii*, *Sarcocystis neurona*, *Leptospira* spp., trace minerals Vitamin A levels and serum chemistries. Final results are still pending for some animals. All pups were removed or marked to avoid being recounted. Dead pup data were entered into WDFW marine mammal stranding database. Dead non-pups were also collected when found and protocol for those animals were the same as listed above. Mortality rate was calculated for Gertrude Island only. Mortality rate was calculated by taking the number of dead pups counted for both the end of pupping (the date the last pregnant female was observed) and pre-weaning (30 September) dividing by the corrected total peak pup count (total dead pups from start of observations to end of pupping and peak live pup count).

Capture and Handling Techniques

Harbor seals were captured in September at Gertrude Island and Eagle Island. Harbor seals were captured using a beach seine technique described in Jeffries et al. (1993).

Once captured, seals were placed in individual hoop nets. Data collected on each animal includes: weight, length, estimated age, and sex, and animals were tagged and permanently marked with hot brands. Seals of all age classes were captured and marked, however, weaned pups under 25 kg were tagged but not branded. All seals marked as pups or yearlings were considered known age. In addition, seals tagged as pups and yearlings before 1993 and branded at recapture were also considered known age. Blood for serologic disease screening was drawn from the extradural intravertebral vein using a vacutainer adapter and an 18-gauge 1½ to 3½ inch needle depending on animal size. For blood collection, serum separator vacutainer tubes were used. Serum was separated as soon as possible after collection and aliquoted into 1-2 ml samples and frozen (-20° C) pending disease screening. Blubber biopsies were also taken from for contaminant analysis at Department and Fisheries and Oceans Canada.

Results

Gertrude Island Observation Effort

A total of 176 hours of observation were conducted at Gertrude Island on 59 days in 2009. This estimate does not include time spent in dead pup collection or necropsies. For days where two observers were present, hours of observation were counted for only one observer (Table 3).

South Puget Sound Peak Counts

Annual land and boat based counts were initiated in 1993 by WDFW and NMML as part of the Puget Sound Ambient Monitoring Program (PSAMP) to monitoring and research harbor seal life history parameters. The two major haulout sites where pupping occurs in south Puget Sound are located at Gertrude Island and Woodard Bay. Peak counts from 1993 to 2008 at Gertrude and Woodard Bay occurred in August or September except the 1993 count at Gertrude Island, which occurred 1 November. For 2009 the peak count for Gertrude Island occurred on 28 June with a total of 395 seals and outside the peak pupping window (Figure 2, Table 1).

For 2009, peak harbor seal counts at south Puget Sound haulouts (Appendices 1-4) during the pupping season were: Gertrude Island, 369 seals on 11 August (this count includes seals hauled out from east of Still Harbor to Hyde Point); Woodard Bay, 250 seals on 1 August; Eagle Island, 141 seals on 14 August; and Commencement Bay, 219 seals on 25 September (Table 1). The maximum total counts for all four major south Puget Sound haulout areas combined occurred on Week 33 (9-15 August) with a total count of 780 seals. The maximum high counts for Eagle Island was 228 seals on 15 October during the molt (Figure 3).

Maximum Pup Counts 1993-2009

The number of pups counted at primary pupping areas (Gertrude Island and Woodard Bay) has increased since the 1970s (Figure 4.). In 2009, peak pup count for all sites

combined was 229 pups and occurred during week of 9-15 August (Figure 5). In 2004, the peak pup count at Gertrude Island was 90 pups and represents the lowest peak count on record since annual land based observation began in 1993. This year 2009 represents the lowest peak count at Woodard Bay record since a low count in 1995 when observations started late in August that year (Table 4). The space available for seals to haulout has decreased since last year. Post-weaning counts at Woodard Bay have decreased significantly; this may be the result of decreased haulout space on log booms forcing pups to other haulout area such as Gertrude Island for weaning.

Pupping Summary

In 2009, the first live pups were recorded on 23 June at Gertrude Island. The last newborn pup was observed on 17 August at Gertrude Island. The last observation of nursing and/or calling pups was on 23 September with no additional pups recorded as calling or nursing after that date (Table 3).

A review of observation records since 1999 indicates first observations of live pups have occurred from 18 June to 5 July; with last pups born or females observed still pregnant between 11-22 August; and last pups observed nursing between 13-27 September. Data collected in 2009 are consistent with these time periods (Table 3).

In 2009, at Woodard Bay, first full term pups were observed on 26 June, and were observed suckling from water with female hauled out on the logs. At Eagle Island the first pup was observed on 29 June. At Commencement Bay the first pup was observed on 7 July (Figure 5). In 2004-2009 females were seen nursing pups at Commencement Bay during the peak pupping window for south Puget Sound. Females observed at Commencement Bay with young pups were not with the larger groups of seals. They were typically on the periphery and tended to blend in with the log boom substrate making them easily missed. Pup counts at Commencement Bay have increased in recent years (Figure 4).

Movement of branded animals was observed between Woodard Bay, Eagle Island and Gertrude Island in 2008. Although unlike previous years no branded females at Woodard Bay were observed with pup. One seal marked as a yearling male at Gertrude Island in 2006 was also recorded moving to and from a log boom haulout site near Poulsbo.

Pupping Success

A minimum of 174 pups were born at Gertrude Island during 2009 based on a count of 118 live pups on 11 August plus 56 dead pups through 17 August when the last newborn pup/pregnant female was observed. Peak pup counts for 2003, 2004, 2005, 2006, 2007, 2008 and 2009 are listed in Table 4.

Dead Pup Surveys

In 2003, WDFW and NMML initiated a study intended to systematically tally and examine dead pups on Gertrude Island to determine pre-weaning pup mortality. Dead pups surveys were conducted throughout the observation period (5 June – 30 September). In 2009, the first dead pup was collected on 9 June, total dead pups counted was 80, the highest dead pup count since the study initiated (Figure 6). To account for possible movement between haulout sites and increase certainty that dead pups encountered were born at Gertrude Island, three dead pups found after 30 September were excluded from the pupping mortality rate analysis. Therefore the calculated pupping mortality rate for 2009 is 32.18% (56/174) with a pre-weaning mortality rate of 44.25% (77/174), these are the highest rates since 2003 (Table 5).

A total of 88 harbor seals were collected dead on or near Gertrude Island in 2009 (80 pups or near term fetuses; 2 yearlings, 1 sub-adult as a capture mortality, and 5 adults). Three dead harbor seal were collected from Eagle Island. One harbor seal was reported dead from Woodard Bay and one dead pup was reported from Cutt's Island.

Non-Pup Mortalities

During 2009 five adult males (GI09-12, GI09-45, GI09-74, GI09-80), one skeleton of a yearling unknown (GI09-44), one yearling male (GI09-07). One adult female (EI09-01) was found directly across from Eagle on McNeil Island.

Other mortalities of note include: 1) WDFW2009-010 (Br 661), a male found dead on 28 February 2009 on Vashon Island.; 2) WDFW2009-033 (Br 142), a 16+ years male found dead on the North of Southworth ferry Port Orchard on 2 June 2009; 3) WDFW2009-022 (Brand >9), a yearling male was found dead 22 April 2009 in Longbranch; 4) WDFW2008-111 (BL1829), a weaned male pup was found dead on 05 October 2009 on Maury Island; 5) EI09-04 (Brand 643), a adult male was found dead on 20 December 2009 on Eagle Island.

Final necropsy results are pending for harbor seal samples submitted to Animal Health Center for histopathology and other ancillary diagnostics.

Pup Scavenging

Since 2004 bald eagles scavenging on dead pups and placentas on Gertrude Island were noted during observations in June and continuing through the end of the pupping season. Newby (1971), reported on observations scavenging during the 1960's, and concluded most scavenging was by turkey vultures and coyotes.

In the 1990's there were occasional notes of eagles scavenging on dead pups but it appears most scavenging between 1993-1999 was coyotes. Five coyotes were noted on Gertrude Island at one time in 1999. Between 2000 and 2003, eagles scavenging on pups

and placentas were increasing and are the most common scavenging event today. Coyote sightings on the island have dropped to one to two individuals per observation year. In 2009 no coyotes or tracks were observed on Gertrude Island either through direct observation or observation done with the use of the seal cam.

The Gertrude Island Great Blue Heron colony had been inactive since 1990s when a windstorm destroyed nests and nest trees. In 2004 and 2005, the Great Blue Heron colony attempted to reestablish itself on Gertrude Island. During that time eagles were seen harassing the herons and remains of chick were found around the island. During 2006-2009 there was no herons observed nesting on Gertrude Island.

From 2004-2009 eagles were noted during most observations from the start of observation to the end of pupping (11-22 August). Notably, on multiple observations in 2009 there were as multiple observations of as 12 bald eagles were seen scavenging harbor seal pup carcasses or placenta in the Still Harbor area. In 2008, prior to 22 July only adult bald eagles were seen taking placentas and scavenging. After that date there were juveniles, hatchlings and adults. This fledgling of eaglets appears to be later than in previous years. In 2009, fledglings were observed with adult eagle as early as 3 July.

All observations of scavenging by eagles in occurred on dead pups with multiple observations of eagle scavenging on a dead pup with lone live pups lying nearby. There were also observations this year of lone pups approaching bald eagle on to have the bald eagle back away. The exception was on 18 June 2008, two adult bald eagles were observed eating a live newborn lanugo pup on Eagle Island. This pup (EI08-01) was alive, calling, moving and both eyes were gone and nose was broken. It also appears that eagles tend to target placentas and newborn or stillborn pups. If the seal alive and responsive, not associated with a placenta or a newborn with a day of birth or carcass is either emaciated or died of a systemic infection such as peritonitis, eagles appear to be less likely to scavenge this type of carcass or will do so minimally either eating around the face or just the blubber.

Resight Summary

In 2009, a total of 1,698 resight observations were made 288 individuals (Table 5). The most resights (n=33) were of a sub-adult female (originally branded “605” on 20 September 2006). The oldest seal resighted was brand “165”, an adult female with an actual age of 22 years. There were five adult females with an estimated age over 20+ years. One (Brand 380) was seen pregnant and once with a pup. Four (Brands 15, 39, 295 and 352) were not seen pregnant or with a pup. The next oldest known age seals that were resighted were all 16 years old (Brand 123 original Brand 2, Brand 5 Brand 28, Brand 79).

Capture Summary

In 2009, the total number of seals captured and marked at all locations was 101 (Table 6). Pup captures occurred in the Padilla Bay (n=9) for genetic sampling to investigate harbor

seal stock (inland and outer). Seals were captured on various islands in the Protection Island (n=12), Hood Canal (n=8) Skagit Bay (n=6), British Columbia (n=7), Blakely/Orchard Rocks (n=3) and at Gertrude and Cutt's Islands (n=65). Blood was taken for disease screening and archiving on 99 seals. Blood samples were also taken immunology studies on selected individuals. Blubber biopsies were taken from 31 seals for contaminant analysis by DFO. A total of 44 seals were branded. Two previously marked seal was recaptured; they were released immediately and not rehandled. There was one capture related mortality that occurred.

SealCam

The Pan, Tilt, and Zoom (PTZ) camera which was setup in 2008 was reconnected for the 2009 field season. The PTZ transmits via cellular air card to the internet was set up on McNeil Island, directly across from the main haulout area on the south tip of Gertrude Island. There were also two other set cameras similarly transmitting, one focused on Gertrude Island and the other directed at the flat near where the camera is on McNeil Island – this one is equipped with a microphone that allows sound to be transmitted as well. This affords researchers the ability to monitor harbor seals remotely in addition to in-person observations. This is the first time in over a decade that video camera monitoring of seal activities on Gertrude Island via the internet has been available for longer than a two week period. The PTZ camera works well for remote viewing and monitoring for presence/absence and disturbances, though it is not ideal for accurate counting, resights or observation of individuals. In the future, grant funding through sources such as the Aquatic Lands Enhancement Account (ALEA), administered by WDFW, may offer opportunities to acquire and install a camera on Gertrude Island that will allow observers to accurately count resight and observe individual harbor seals and other wildlife on Gertrude Island and in the vicinity of Still Harbor. The seal cam is available on WDFW website with images beginning in August at <http://wdfw.wa.gov/wildwatch/sealcam/index.html>. These cameras are multi purpose, allowing scientists to conduct research and provide the public with an opportunity to view a harbor seal haulout over the internet through Watchable Wildlife, and eventually be brought into schools as part of an academic curriculum.

Video footage will be edited into smaller clips along with selected pictures taken during observation over the last couple years to post on the seal cam website. Portions of the video footage taken by the seal cam will also be stored on an external hard drive.

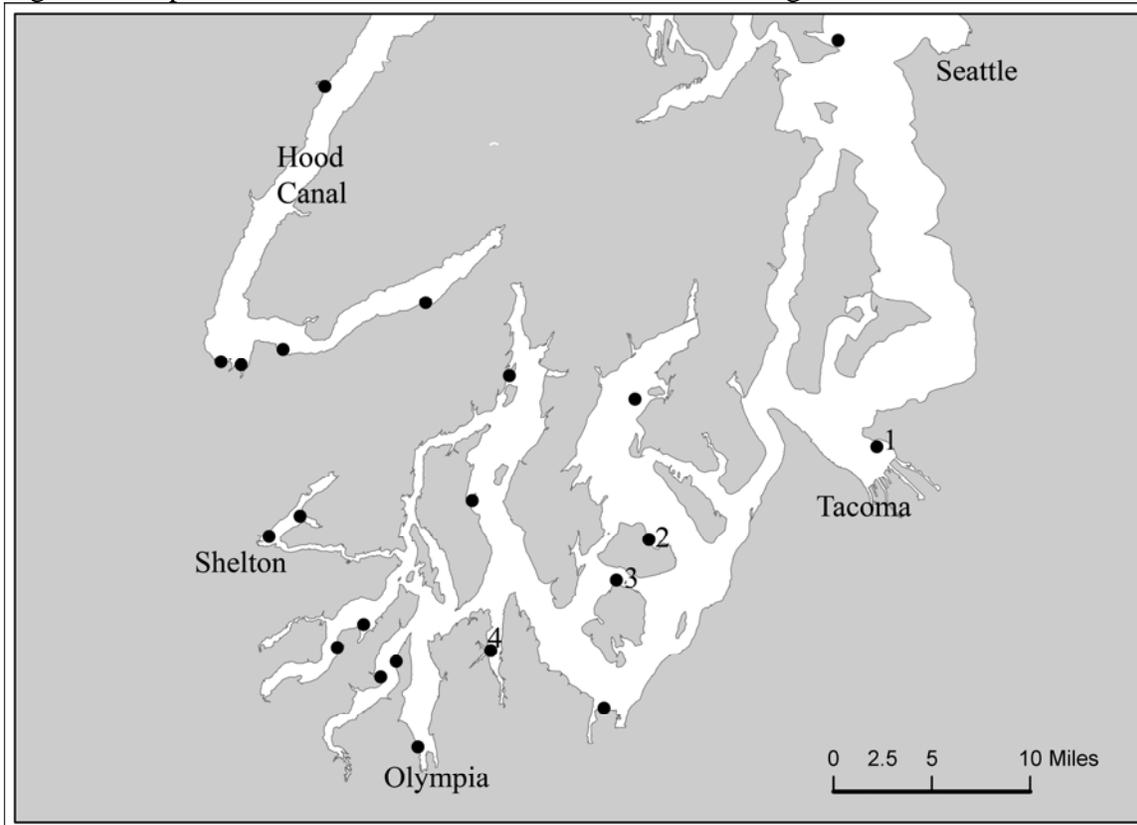
Acknowledgments

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Figure 1. Map of harbor seal haulout locations in southern Puget Sound.



Dots indicate known harbor seal haulout areas.

1 = Commencement Bay 2 = Gertrude Island 3 = Eagle Island 4 = Woodard Bay

Figure 2. Peak Harbor Seal Counts at South Puget Sound Haulout Sites, 1993-2009

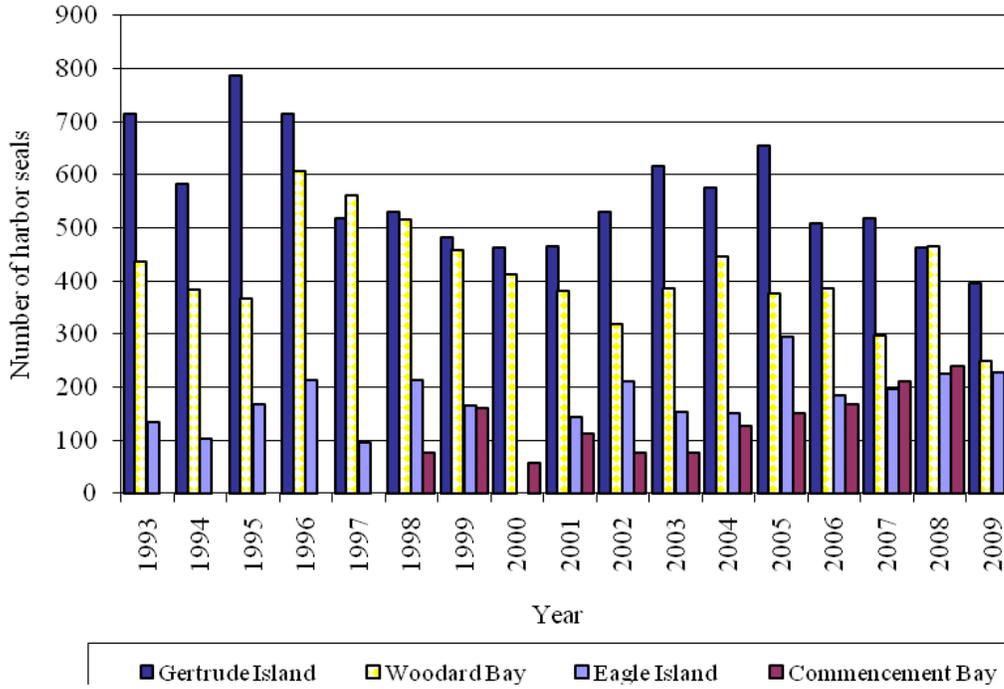


Figure 3. Peak harbor seal counts by week for 2009

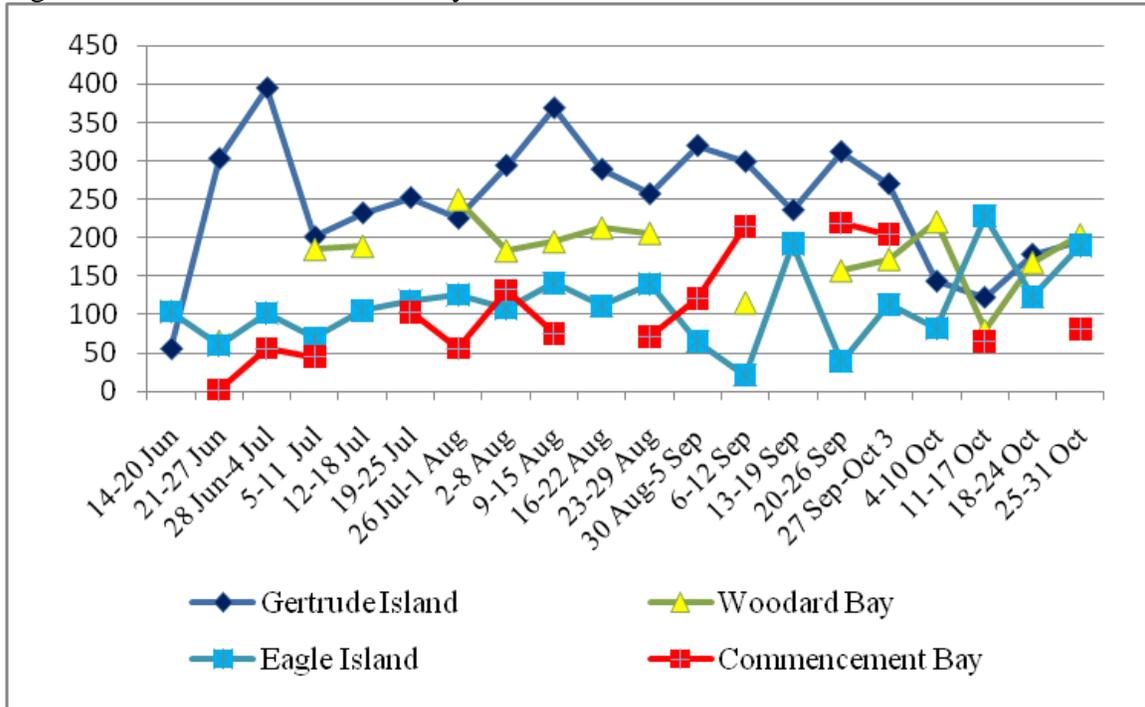
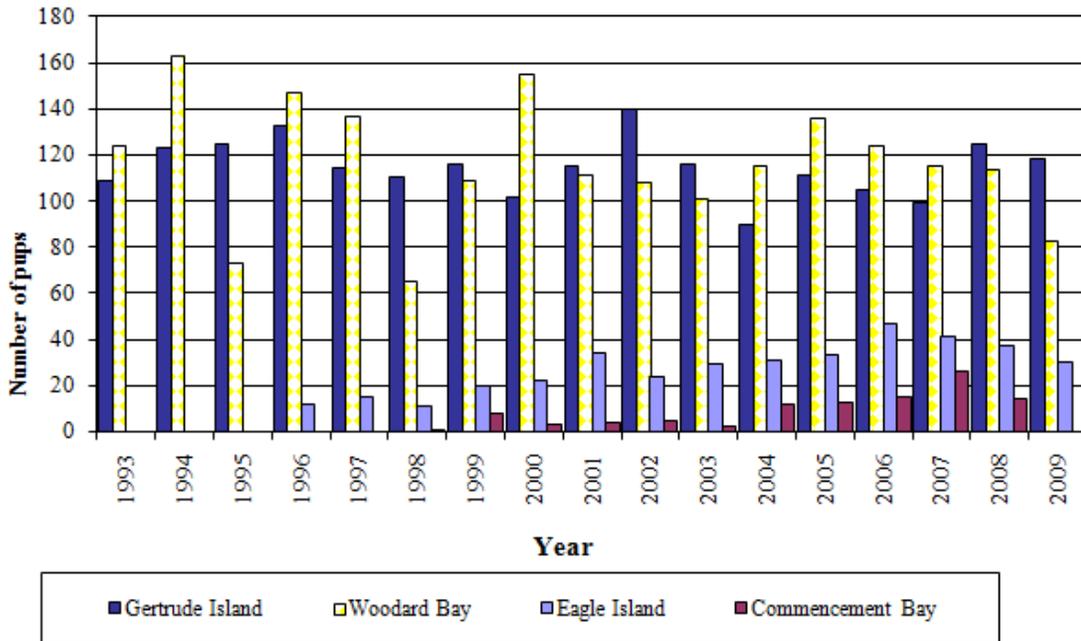


Figure 4. Peak pup counts in South Puget Sound, 1993-2009



Note: Observations did not start during 1995 and 1998 until after the peak pupping period for Woodard Bay.

Figure 5. High pup counts by week for 2009

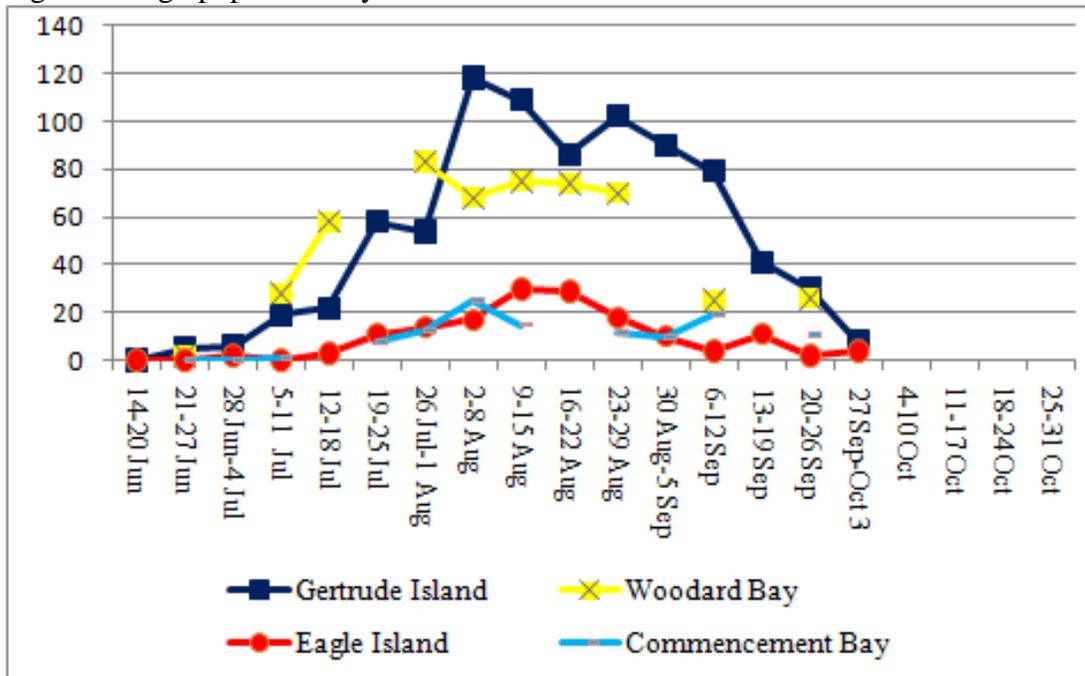


Table 1. Peak total counts from 1948-2009.

Year	Gertrude Island		Woodard Bay		Eagle Island		Commencement	
	Date	Count	Date	Count	Date	Count	Date	Count
1948		12	n/a	n/a	n/a	n/a	n/a	n/a
1965	10-Oct	150	n/a	n/a	n/a	n/a	n/a	n/a
1966	4-Jun	100-125	n/a	n/a	n/a	n/a	n/a	n/a
1969	6-Dec	55	n/a	n/a	n/a	n/a	n/a	n/a
1970	25-Jul	210	n/a	n/a	n/a	n/a	n/a	n/a
1971	29-Jan	88	n/a	n/a	n/a	n/a	n/a	n/a
1975	14-Aug	167	n/a	n/a	n/a	n/a	n/a	n/a
1976	12-Oct	157	n/a	n/a	n/a	n/a	n/a	n/a
1977	1-Sep	146	13-Aug	40	n/a	n/a	n/a	n/a
1979	11-Sep	220	n/a	n/a	n/a	n/a	n/a	n/a
1981	n/a	n/a	22-Aug	56	n/a	n/a	n/a	n/a
1982	n/a	n/a	20-Nov	92	n/a	n/a	n/a	n/a
1983	n/a	n/a	19-Jun	134	n/a	n/a	n/a	n/a
1984	n/a	n/a	16-Sep	228	n/a	n/a	n/a	n/a
1985	n/a	n/a	28-Oct	303	n/a	n/a	n/a	n/a
1986	n/a	n/a	12-Aug	255	n/a	n/a	n/a	n/a
1987	n/a	n/a	8-Aug	197	n/a	n/a	n/a	n/a
1988	n/a	n/a	5-Oct	282	n/a	n/a	n/a	n/a
1989	n/a	n/a	17-Jan	329	n/a	n/a	n/a	n/a
1990	n/a	n/a	23-Jul	391	n/a	n/a	n/a	n/a
1991	n/a	n/a	25-Aug	334	n/a	n/a	n/a	n/a
1992	n/a	n/a	20-Apr	316	n/a	n/a	n/a	n/a
1993	1-Nov	716	7-Aug	436	1-Dec	133	n/a	n/a
1994	1-Sep	584	18-Aug	383	1-Jul	104	n/a	n/a
1995	1-Aug	786	22-Aug	367	N/a	167	n/a	n/a
1996	1-Sep	714	19-Aug	608	1-Nov	214	n/a	n/a
1997	2-Sep	519	11-Aug	562	16-Sep	96	n/a	n/a
1998	25-Aug	530	24-Sep	515	15-Oct	214	24-Sep	76
1999	16-Aug	481	9-Aug	458	13-Jul	165	27-Sep	160
2000	22-Aug	462	8-Aug	413	n/a	na	26-Sep	58
2001	7-Sep	466	31-Jul	382	12-Oct	143	31-Aug	113
2002	9-Aug	530	30-Jul	320	22-Oct	211	24-Oct	77
2003	2-Aug	616	9-Aug	387	10-Sep	153	27-Sep	76
2004	8-Aug	575	7-Aug	447	27-Aug	152	3-Aug	128
2005	15-Sep	654	15-Aug	376	16-Oct	295	29-Aug	150
2006	22-Aug	509	14-Aug	387	21-Aug	185	3-Oct	168
2007	16-Aug	517	25-Jul	298	5-Oct	196	12-Oct	212
2008	17-Aug	464	10-Aug	435	25-Oct	225	22-Sep	241
2009	28-Jun	395	1-Aug	250	15-Oct	228	25-Sep	219

Data prior to 1993 were taken from Arnold 1968; Newby 1971; Skidmore and Babson 1981; Johnson and Jeffries 1983; Calambodokidis et al. 1991 and Calambodokidis unpublished data.

Table 2. Peak pup counts from 1965 to 2008.

Year	Gertrude Island		Woodard Bay		Eagle Island		Commencement	
	Date	Count	Date	Count	Date	Count	Date	Count
1965	1-10 Sep	36	n/a	n/a	n/a	n/a	n/a	n/a
1970	21-31Aug	30	n/a	n/a	n/a	n/a	n/a	n/a
1975	8-Sep	25	n/a	n/a	n/a	n/a	n/a	n/a
1976	12-Oct	33	n/a	n/a	n/a	n/a	n/a	n/a
1977	12-Sep	29	n/a	5	n/a	n/a	n/a	n/a
1981	n/a	n/a	22-Aug	3	n/a	n/a	n/a	n/a
1982	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1983	n/a	n/a	24-Jul	8	n/a	n/a	n/a	n/a
1984	n/a	n/a	7-Aug	52	n/a	n/a	n/a	n/a
1985	n/a	n/a	8-Aug	45	n/a	n/a	n/a	n/a
1986	n/a	n/a	12-Aug	46	n/a	n/a	n/a	n/a
1987	n/a	n/a	24-Jul	71	n/a	n/a	n/a	n/a
1988	n/a	n/a	2-Aug	58	n/a	n/a	n/a	n/a
1989	n/a	n/a	3-Jul	5	n/a	n/a	n/a	n/a
1990	n/a	n/a	7-Aug	95	n/a	n/a	n/a	n/a
1991	22-Sep	110	n/a	n/a	n/a	n/a	n/a	n/a
1993	30-Sep	109	12-Aug	124	n/a	n/a	n/a	n/a
1994	22-Sep	123	29-Jul	163	n/a	n/a	n/a	n/a
1995	13-Sep	125	22-Aug	73	n/a	n/a	n/a	n/a
1996	3-Sep	133	1-Aug	147	24-Sep	12	n/a	n/a
1997	2-Sep	114	11-Aug	137	28-Aug	15	n/a	n/a
1998	26-Aug	110	26-Aug	65	17-Sep	11	28-Aug	1
1999	9-Sep	116	19-Aug	109	20-Aug	20	27-Sep	8
2000	22-Sep	102	8-Aug	155	9-Aug	22	21-Aug	3
2001	3-Sep	115	31-Jul	111	18-Aug	34	24-Sep	4
2002	9-Aug	140	8-Aug	108	6-Aug	24	12-Aug	5
2003	27-Aug	116	9-Aug	101	7-Sep	29	29-Jul	2
2004	8-Aug	90	7-Aug	115	27-Aug	31	3-Aug	12
2005	30-Aug	111	1-Aug	136	30-Aug	33	29-Aug	13
2006	15-Aug	105	14-Aug	124	21-Aug	47	8-Aug	15
2007	16-Aug	99	10-Aug	115	24-Aug	41	8-Aug	26
2008	8-Aug	125	10-Aug	115	27-Aug	37	14-Aug	12
2009	11-Aug	118	1-Aug	83	14-Aug	30	4-Aug	25

Data prior to 1993 were taken from Arnold 1968; Newby 1971; Skidmore and Babson 1981; Johnson and Jeffries 1983; Calambodokidis et al. 1991 and Calambodokidis unpublished data.

Table 3. Dates for start of observations, first live pup, last pup born, last pup nursing, last observation, and effort 1998-2009.

Year	Start observation	First live pup	Last pup born	Last pup nursing	Last observation	# of days 1st obs. to 15 Sept	# of days after 15 Sept	Total hours of observation	Dates of captures
1998	17-Aug	n/d	21-Aug	n/d	4-Nov	10	12	n/d	21, 22,23 Sep and 5,6,7 Oct
1999	4-Jan	28-Jun	n/d	n/d	28-Dec	107	15	n/d	28 Apr, 13,14, 22, 23 Sep
2000**									24 Mar, 19 Apr, 14,15, 18 Sep
2001	18-Jul	n/d	17-Aug	27-Sep	19-Oct	28	7	n/d	18, 19 Sep
2002	25-Jun	2-Jul	22-Aug	23-Sep	22-Oct	39	8	n/d	18,19, 20, Sep
2003	5-May	5-Jul	19-Aug	13-Sep	27-Oct	45	11	n/d	25,26,28,29 Sep, 5 Nov
2004	9-May	5-Jul	11-Aug	17-Sep	26-Oct	39	9	147	13, 14, 15, 27,28 Sep
2005	27-Jun	27-Jun	15-Aug	18-Sep	31-Oct	41	12	143.6	15, 16, 19, 20 Sep
2006	16-Jun	28-Jun	15-Aug	26-Sep	23-Oct	42	7	153	11, 12, 19, 20 Sep
2007*	30-May	7-Jul	17-Aug	14-Sep	26-Oct	46	10	138	12, 13, 26, 27 Sep and 8 Oct
2008	18-Jun	18-Jun	21-Aug	26-Sep	28-Oct	44	9	165	17,18,21,23 Apr, 5,7 May, 12, 15,16, 29,30 Sep
2009	18-Jun	23-Jun	17-Aug	23-Sep	30-Oct	48	11	176	17, 18, 29, 30 Sep
	* Observational data from 27-jan-07								
	**Lost electronic file only have written notes								

Table 4. Peak pup counts for Gertrude Island from 2003-2009

2003		2004		2005		2006		2007		2008		2009	
Date	Count												
2-Aug	105	8-Aug	90	6-Aug	98	15-Aug	105	16-Aug	99	6-Aug	94	4-Aug	94
17-Aug	111	26-Aug	71	21-Aug	97	21-Aug	102	17-Aug	93	8-Aug	125	7-Aug	118
26-Aug	116	11-Sep	66	30-Aug	111	25-Aug	92	29-Aug	96	16-Aug	105	11-Aug	109
30-Aug	102	17-Sep	63	2-Sep	101	30-Aug	104	31-Aug	89	18-Aug	124	26-Aug	102

Table 5. Pup mortality rates for Gertrude Island, 2003-2009.

	2003	2004	2005	2006	2007	2008	2009
Pupping Mortality Rate	17.14	20.35	26.97	28.57	22.05	29.55	32.18
Pre-weaning Mortality Rate	17.86	28.32	30.92	34.01	27.56	42.61	44.25
Total Mortality Rate for the season	22.14	30.1	31.6	36.7	31.5	44.9	45.98

Figure 6. Number of dead pups for Gertrude Island, 2003-2009

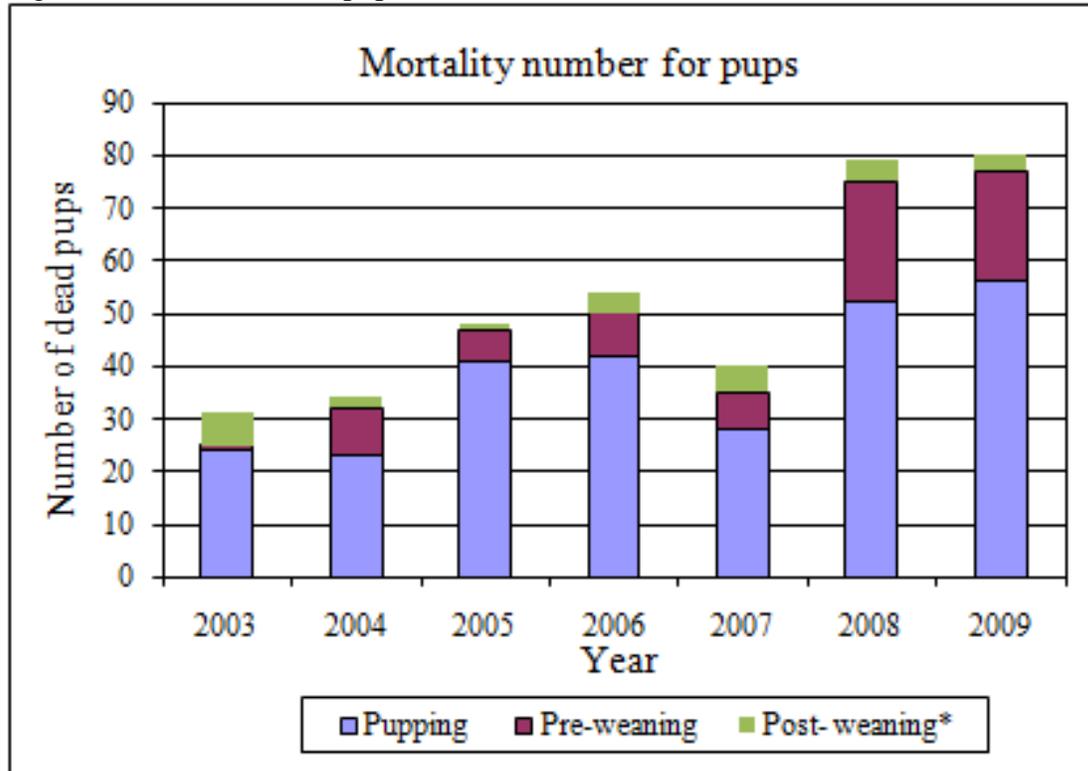


Table 5. Number of resights by brand for 2009.

Brand	Number resights										
0.06	1	279	9	442	2	536	4	607	2	665	3
5	3	281	1	443	10	537	4	608	15	666	25
14	12	282	1	450	1	539	2	609	1	668	17
15	11	286	4	455	1	540	12	610	1	669	11
16	9	293	1	461	5	542	7	611	4	670	11
17	6	295	5	462	18	543	3	612	4	671	16
18	2	301	1	463	2	544	8	614	16	672	9
25	9	308	11	465	13	545	4	616	20	673	27
28	3	309	18	467	10	547	12	617	11	674	17
39	24	310	15	468	3	548	6	618	5	675	10
44	1	312	9	469	9	549	1	619	8	676	1
67	4	313	1	470	2	553	14	620	8	677	3
79	13	315	15	471	5	554	1	621	1	678	2
89	1	323	5	474	3	555	4	622	6	679	6
94	12	324	1	475	9	557	1	623	1	680	16
95	11	326	4	476	6	559	1	624	17	681	4
102	1	337	2	478	2	561	3	625	1	682	12
105	4	346	1	479	1	562	9	626	6	683	9
110	1	352	3	480	1	563	1	627	5	684	4
118	6	370	5	481	13	564	8	631	6	685	11
121	2	372	1	482	7	565	3	632	27	688	5
123	29	373	17	483	6	567	5	634	3	689	8
133	1	374	1	488	22	569	1	635	3	690	1
135	7	379	2	492	4	570	1	636	2	691	4
165	1	380	5	493	4	571	2	637	4	692	3
172	1	382	4	494	8	572	2	638	7	694	4
185	3	383	1	495	11	573	1	639	14	695	2
190	3	385	6	496	1	575	6	641	3	696	3
192	2	388	10	497	8	576	2	642	3	697	2
200	2	390	1	498	12	579	4	643	2	699	6
213	3	393	1	500	15	580	2	644	2	700	6
225	4	394	11	501	1	581	21	645	1	701	3
234	1	394.1	1	503	12	582	15	647	17	702	1
236	6	395	7	505	3	583	3	648	6	703	2
238	1	396	8	506	1	584	2	649	29	704	4
239	2	397	2	507	6	586	1	650	1	705	3
241	3	401	3	509	1	587	11	651	2	706	1
253	3	407	1	512	2	590	1	653	2	707	3
259	2	410	1	514	3	593	1	654	4	710	5
263	9	411	7	515	3	595	1	655	2	711	3
264	12	412	1	517	15	597	2	656	1	712	1
265	1	416	2	518	14	598	2	657	1	714	6
266	2	417	7	520	1	600	12	658	7	715	3
267	9	421	13	521	2	601	6	659	15	716	4
269	2	428	2	529	2	602	11	660	7	721	1
270	2	430	4	532	1	603	14	661	2	722	3
271	6	437	3	533	1	605	33	663	8	723	1
276	8	439	10	535	3	606	9	664	11		

Table 6. 2009 harbor seal captures at all locations.

Locations	Female				Male				Total
	Pup	Yearling	Sub-adult	Adult	Pup	Yearling	Sub-adult	Adult	
Protection Island	0	3	0	4	0	0	0	5	12
Quilcene Bay	4	0	0	0	1	0	0	0	5
Dosewallips River	3	0	0	0	0	0	0	0	3
Seal Rock (Skagit Bay)	3	0	0	0	1	0	0	0	4
North Skagit Bay	0	0	0	0	1	0	0	0	1
Skagit Bay/N of Point Brown	0	0	0	0	1	0	0	0	1
Orchard Rocks	2	0	0	0	0	0	0	0	2
Blakely Rocks	0	0	0	0	1	0	0	0	1
Cutt's Island	0	1	1	8	0	0	0	0	10
Gertrude Island	9	11	5	3	11	2	8	6	55
Canada, B.C.	0	0	0	2	0	0	0	5	7
Total	21	15	6	17	16	2	8	16	101

Location	Tags	Blood	Genetics	Biopsy	Brand	Transmitter
Protection Island	12	11	0	0	0	9
Quilcene Bay	5	5	5	5	0	0
Dosewallips River mouth	3	3	3	3	0	0
Seal Rock (Skagit Bay)	4	4	4	4	0	0
North Skagit Bay	1	1	1	1	0	0
Skagit Bay/N of Point Brown	1	1	1	1	0	0
Orchard Rocks	2	2	2	2	0	0
Blakley Rocks	1	1	1	1	0	0
Cutt's Island	10	10	0	0	10	0
Gertrude Island	55	54	0	7	34	0
B.C., Canada	7	7	0	7	0	0
Total	101	99	17	31	44	9

Appendix 1.
Daily harbor seal counts at Gertrude Island.

Week number	Date	# Hauled out	# In water	Total Count	Pup Count	Observer	Observation time
20	10-May-09	110		110	0	DML, DMLH	2
23	5-Jun-09	100		100	0	DML, JSO, SJJ	1
24	9-Jun-09	100		100		SJJ, JSO	
25	18-Jun-09	51	4	55	0	DML, JO	5
26	23-Jun-09	80	12	92	2	DML, AA	3
26	24-Jun-09	70	4	74	2	DML, JSO	
26	25-Jun-09	303		303	2	hrh	4
26	26-Jun-09	120	6	126	5	DML, JSO	2
27	28-Jun-09	395		395	6	hrh	2.75
27	1-Jul-09	25		25	2	hrh	2.3
27	2-Jul-09	1	25	26	3	AA and DML	2.25
27	3-Jul-09	1	15	16	1	DML	3.25
28	7-Jul-09	164	7	171	8	DML, LT and EH	3
28	8-Jul-09	90	12	102	10	DML, LT	2
28	10-Jul-09	189	12	201	19	DML, LT, NOAA Entf	3
28	11-Jul-09	152		152	7	KW, EH, NOAA enf	
29	14-Jul-09	227	5	232	22	DML, AA, LT	
29	15-Jul-09	131	7	138	14	DML, JSO, LT	
29	17-Jul-09	9	12	21	8	DML, JO, LT	5
30	21-Jul-09	128	14	142	31	DML, EH, AA	3
30	22-Jul-09	216	14	230	39	DML, JO	4.5
30	24-Jul-09	226	6	232	38	DML, JO	5
30	25-Jul-09	252		252	58	hrh	3.15
31	28-Jul-09	225		225	54	DML	4
31	29-Jul-09	186		186	48	DML	3
31	30-Jul-09	154	18	172	43	DML and JSO	4
31	31-Jul-09	132		132	40	DML and JSO	3.5
32	2-Aug-09	277		277	52	hrh	4.4
32	3-Aug-09	185		185	38	hrh	4.4
32	4-Aug-09	279	12	291	92	DML	3.1
32	5-Aug-09	198	5	203	67	DML and JSO	3.1
32	7-Aug-09	289	5	294	118	DML and JSO	5
32	8-Aug-09	293		293	69	hrh	4.15
33	11-Aug-09	351	18	369	109	DML and AA	3
33	12-Aug-09	251	18	269	83	DML and JSO	3
33	13-Aug-09	326		326	72	DML and AA	1.5
33	14-Aug-09	227	35	262	84	DML	1.25
34	17-Aug-09	203		203	49	hrh	3.4
34	18-Aug-09	259	30	289	84	DML and AA	2.75
34	19-Aug-09	232	28	260	86	DML and AA	2.75
35	26-Aug-09	236	21	257	102	DML	2
35	28-Aug-09	191	0	191	72	DML and EH	3.25
36	3-Sep-09	320		320	90	DML	4
36	4-Sep-09	221		221	36	DML and AA	2.5
36	5-Sep-09	209		209	47	DML and AA	3
37	6-Sep-09	182		182	24	hrh	3.15
37	8-Sep-09	268	15	283	63	DML	3.25
37	9-Sep-09	238		238	78	DML and RL	3.5
37	10-Sep-09	291	8	299	79	DML	4.5
38	14-Sep-09	197		197	17	hrh	4.4
38	15-Sep-09	169		169	41	DML, EH and AA	
38	16-Sep-09	154		154	17	hrh	4.4
38	17-Sep-09						
38	18-Sep-09						
38	19-Sep-09	236		236	36	DML, EH and AA	2
39	21-Sep-09	312		312	14	hrh	3.15
39	22-Sep-09	175		175	25	DML and EH	2.25
39	23-Sep-09	189		189	30	DML	3
40	28-Sep-09	270		270	8	hrh	4.4
40	29-Sep-09						
40	30-Sep-09						
40	2-Oct-09	168	10	178		DML and AA	
41	6-Oct-09	138	5	143		DML	2.75
42	15-Oct-09	112	10	122		DML	3
43	20-Oct-09	178		178		DML and AA	2
44	30-Oct-09	182	12	194		DML and AA	3

Daily counts harbor seal counts at Eagle Island

Week number	Date	Time	# Hauled out	# In water	Total Count	Pup Count	Observer
20	10-May-09	12:15	90	10	100	0	DML et al
25	18-Jun-09	8:04	100	4	104	0	DML and JSO
26	23-Jun-09	14:20	53	7	60	0	DML and AA
26	25-Jun-09	10:30	23	0	23	0	HRH
27	28-Jun-09	13:30	0	0	0	0	HRH
27	1-Jul-09	7:55	92	0	92	2	HRH
27	2-Jul-09	10:00	102		102	0	DML and AA
27	3-Jul-09	9:10	101		101		DML
28	7-Jul-09	11:40	65	4	69	0	DML, LT, EH
28	8-Jul-09	12:12	32	4	36	0	DML, LT
28	10-Jul-09	13:40	46	8	54	0	DML, LT
29	14-Jul-09	13:32	0	6	6	0	DML, LT
29	17-Jul-09	8:10	90	15	105	3	DML, LT
30	21-Jul-09	10:41	84	5	89	1	DML, EH
30	22-Jul-09	11:40	115	3	118	11	DML
30	24-Jul-09	13:03	96		96	6	DML, EH
30	25-Jul-09	11:30	0	0	0	0	HRH
31	28-Jul-09	14:25	0	6	6		DML
31	31-Jul-09	8:00	126		126	14	DML
32	2-Aug-09	7:55	45	0	45	14	HRH
32	3-Aug-09						HRH
32	4-Aug-09	10:30	100	8	108	17	DML
32	5-Aug-09	11:40	56	12	68	4	DML
32	8-Aug-09						HRH
33	11-Aug-09	14:25	10	36	46	7	DML, AA
33	12-Aug-09	15:09	29	12	41	8	DML
33	13-Aug-09	16:05	43	4	47	7	DML
33	14-Aug-09	8:20	123	18	141	30	DML
34	17-Aug-09	7:55	111		111	29	HRH
34	18-Aug-09	9:20	63		63	15	DML
34	19-Aug-09	9:20	84	5	89		DML and AA
35	25-Aug-09	15:25	0	8	8		DML
35	27-Aug-09	8:05	134	6	140	18	DML
36	3-Sep-09	11:20	40	3	43	8	DML
36	4-Sep-09	11:30	53	12	65	10	DML
37	6-Sep-09	10:30	0		0	0	HRH
37	8-Sep-09	14:25	0	12	12	3	DML
37	9-Sep-09	13:05	12	9	21	4	DML
38	14-Sep-09	7:55	169		169	11	HRH
38	15-Sep-09	9:05	189	3	192	9	DML
38	16-Sep-09	7:55	116		116	11	HRH
38	18-Sep-09	13:00					
39	21-Sep-09	11:30	40		40	2	HRH
39	22-Sep-09	12:50	24	7	31	2	DML
40	28-Sep-09	7:55	61		61	4	HRH
40	2-Oct-09	10:45	108	5	113		DML
41	6-Oct-09	12:30	70	12	82		DML
42	15-Oct-09	8:05	218	10	228		DML
43	20-Oct-09	12:45	118	5	123		DML and JSO
44	30-Oct-09	8:00	190		190		DML and AA

Daily counts harbor seal counts at Woodard Bay

Week number	Date	Time	# Hauled out	# In water	Total Count	Pup Count	Observer
26	26-Jun-09	13:20	61	4	65	2	DML and JO
28	8-Jul-09	15:40	173	12	185	28	DML, AA, JO
29	17-Jul-09	15:07	175	14	189	58	DML, JO, TAS
31	29-Jul-09	11:58	166	10	176	68	JSO
31	1-Aug-09	10:42	246	4	250	83	JSO
32	8-Aug-09	17:00	180	3	183	68	DML
33	15-Aug-09	15:35	187	8	195	75	JSO
34	20-Aug-09	14:54	209	4	213	74	DML and AA
35	27-Aug-09	15:30	204	2	206	70	DML
37	10-Sep-09	19:22	113	2	115	25	JSO and AA
39	24-Sep-09	13:50	151	6	157	26	DML
40	2-Oct-09	15:30	164	8	172		DML
41	10-Oct-09	14:30	219	2	221		AA and EH
42	13-Oct-09	11:15	76	3	79		AA and EH
43	20-Oct-09	15:00	160	8	168		DML
44	28-Oct-09	16:30	202	2	204		JSO

Daily counts harbor seal counts at Commencement Bay

Week number	Date	Time	# Hauled out	# In water	Total Count	Pup Count	Observer
14	4-Apr-09	12:37	52		52		EH
17	25-Apr-09	11:34	26	2	28		EH
19	9-May-09	17:22	23	2	25		EH
22	30-May-09	9:12	0	0	0		EH
26	27-Jun-09	12:30	1	1	2	0	AA
27	30-Jun-09	14:00	2	15	17	0	AA and CK
27	2-Jul-09	16:21	56		56	0	EH
28	5-Jul-09	14:00	37	8	45	1	DML et al
28	7-Jul-09	16:32	32	0	32	0	EH
30	22-Jul-09	7:46	100	3	103	8	JSO
31	30-Jul-09	11:06	42	14	56	13	JSO
32	2-Aug-09	11:57	112	20	132	20	
32	4-Aug-09	12:30	74	24	98	25	DML
33	14-Aug-09	12:00	70	5		15	JSO
35	23-Aug-09	12:00	68	3	71	12	DML et al
36	1-Sep-09	13:20	113	8	121	10	EH
37	12-Sep-09	15:00	207	8	215	19	
39	25-Sep-09	1:35	214	5	219	11	AA
40	2-Oct-09	1:49	201	3	204		AA
42	16-Oct-09	11:58	60	5	65		AA and KA
44	27-Oct-09	12:06	78	3	81		
47	20-Nov-09	16:00	109		109		AA and EH