

Marine mammal monitoring of the replacement and repair of fur seal research observation towers and walkways on St. Paul Island, Alaska

90 day report

Prepared by:

Michael Williams and Juan Leon Guerrero, Alaska Region, NOAA Fisheries, and Devin Johnson, National Marine Mammal Laboratory, Alaska Fisheries Science Center

with assistance from:

Michael Ulroan and Chelsea Malstrom, Alaska Native Science and Engineering Program, University of Alaska Anchorage, and Rory Godinez, Wade Perrow Construction, Gig Harbor, Washington

ABSTRACT

The National Marine Fisheries Service, Alaska Region (AKR) has prepared a 90 day report in accordance with the provisions of the Incidental Harassment Authorization (IHA) issued on 16 April 2010 and valid from 20 April through 7 June and 1 through 31 December 2010 by the National Marine Fisheries Service, Office of Protected Resources in Silver Spring, MD. The IHA covered northern fur seal harassment that might have occurred during the replacement and repair of fur seal research observation towers and walkways on St. Paul Island, Alaska. All construction was completed on 19 May 2010 prior to the temporary expiration of the IHA on 7 June 2010. Marine mammal monitoring continued through 6 June 2010. No construction activities occurred at Reef Rookery after 19 May 2010, though modifications to the walkways and towers may be necessary in subsequent years. Fifty-two male northern fur seals (*Callorhinus ursinus*) were harassed on land and departed to the water due to the presence of construction and monitoring staff at three different sites on St. Paul Island. Statistical analysis suggests the on shore arrival of the first adult males at the affected rookery sections might have been delayed 4-19 days versus control rookery sections. This delay may have affected an additional 22 adult males within sections 1-7 at Reef. It is possible that some other factor in 2010 at Reef rookery or sections within the rookery may have contributed or caused adult males to arrive later at those sections versus other rookeries. The following text describes in detail the IHA reporting requirements (*in italics*).

(i) Dates, times, locations, weather conditions, and associated activities during construction operations and marine mammal sightings.

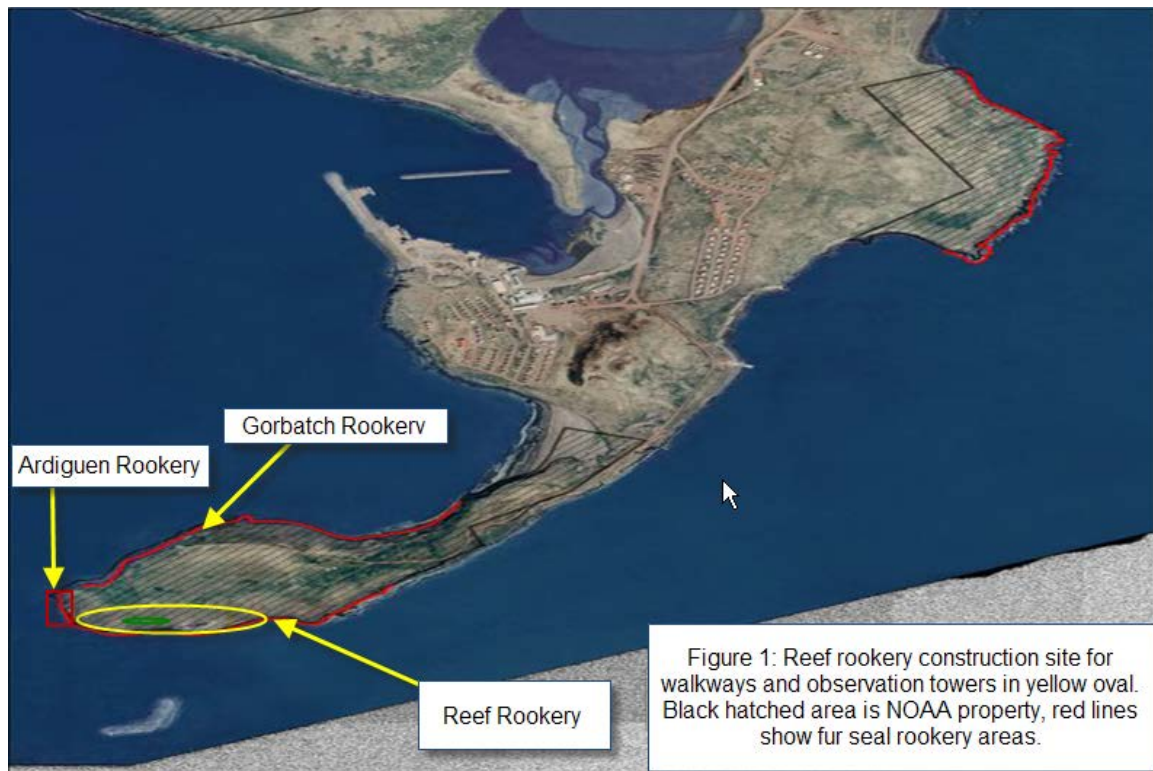
Construction operations occurred in three phases at each rookery site on St. Paul Island: (1) walkway and tower construction, (2) tripod repair and upgrade, and (3) final inspection, modification, and monitoring. Construction crews began work on 9 January 2010 and all work at all sites was complete on 19 May 2010. Wade Perrow Construction or their subcontractors (WPC) completed all construction field work and incidental



marine mammal observations. AKR completed systematic marine mammal monitoring at Reef, Gorbach, Ardiguen, and Tolstoi rookeries from 22 April through 6 June 2010.

Walkway and Tower Construction

Walkway and tower construction occurred within Reef rookery sections one through seven only (Figure 1). Tripods in Reef sections 8-10 were repaired, and there is no tripod in section 11. Crews began walkway and tower construction on 5 January 2010 and completed their work on 19 May 2010. Construction operations began with equipment and material mobilization on the periphery of the inland hauling grounds at Reef Rookery. Old catwalks and tripods were demolished and demolition waste was removed. Crews cleared access trails as needed by moving large boulders with a backhoe to allow access to the sites with an all-terrain fork lift. Materials and equipment were moved to sites within the rookery as towers and walkways were completed. Work was completed using hand or cordless tools with use of a small generator to power corded tools



or recharge batteries. Crews first poured a small grout slab for the foundation anchors. Once the slab cured the tower legs were set into place and a plastic culvert was placed around the foundation slab and leg. The culvert was then filled with rocks brought from the quarry. Once the foundations and legs were set the remaining components were installed and secured (Figure 2).

Once construction work was completed boulders were replaced, as practical, to their original locations, ruts were back-filled with sand, seeded and fertilized, and erosion prevention matting was used to retain seed and fertilizer at the restoration sites. Crews used on-site burn barrels for heat and for disposal of non-treated waste lumber from

construction or demolition. All burn barrel sites were cleaned and old nails were removed and disposed in accordance with municipal ordinance. Treated demolition lumber was provided to the community for reuse as practical with remaining treated and non-treated lumber scraps disposed in accordance with municipal ordinance.

All construction work was completed in sections 1-4 of Reef by 10 March 2010. No marine mammals were observed in sections 1-4 at Reef during the construction work through 10 March 2010. The remaining construction work in sections 5-7 of Reef were completed by 13 May 2010. No marine mammals were observed in sections 5-7 of Reef during the construction work.



Tripod Repair and Upgrade

Crews worked at Vostochni, Morjovi, Polovina Cliffs, Polovina, Kitovi, Gorbach, Tolstoi, Zapadni Reef, Little Zapadni and Big Zapadni rookeries to repair and upgrade tripods and tripods with ramps from 23 April to 15 May 2010. Crews repaired and upgraded the tripods in sections 8-11 at Reef on 8-10 February 2010. Crews were present at each rookery for 1-4 days and at each tripod site for 1-3 hours. While at each rookery they either hand-carried or drove a standard pick-up truck to deliver lumber, used hand carpentry and cordless tools to make repairs, and removed all construction and demolition debris created during their work. Treated demolition lumber was provided to the community for reuse as practical. The remaining treated and non-treated lumber scraps and construction waste were disposed in accordance with municipal ordinance.

Final Inspection, Modification, and Monitoring

On 17 May 2010 four staff went to each rookery to inspect all towers, walkways, tripods and ramps. Inspections took from 5-15 minutes per tower. Final minor modifications to

the walkways and handrails were completed at Reef rookery on 16-18 May 2010, and no modifications were made to any other structures at other locations.

Marine mammal monitoring began on 22 April 2010 and continued daily at Reef, Gorbatch, Ardiguén, and Tolstoi until construction activities were completed. Marine mammal monitoring from 25 May to 6 June 2010 continued at the same sites, but the frequency of sampling was reduced to minimize potential harassment of recently arriving juvenile males adjacent to many of our adult male counting sites.

Temperatures remained below freezing for nearly the entire work and monitoring period, but increased to the mid-30s in early May, with mixed snow and rain on 16 May 2010. The sea ice was present around the island for much of the construction period. Near shore floating sea ice was present around the Reef peninsula (including Gorbatch, Ardiguén, and Reef rookeries) and at Tolstoi rookery until 3 June 2010. Sea ice was present in significant accumulations on shore at these four rookeries until 13 May 2010 and may have prevented northern fur seals from hauling out on land at rookery sites around the island. Near shore ice was absent from the monitored sections at Reef and Gorbatch on 14 May, 13 May at Ardiguén, and 12 May at Tolstoi.

(ii) Species, number, location, distance, and behavior of any marine mammals, as well as the associated activity observed throughout all monitoring activities.

No northern fur seals were observed on St. Paul Island until 13 May 2010. Northern fur seals were regularly observed at Sea Lion Rock (a small offshore islet) beginning on 22 April 2010. Observations are presented by rookery (i.e., breeding site), but data were collected by sections within each rookery as each rookery section was the smallest sampling area where there was differential exposure to construction activities. For example, construction activities at Reef rookery occurred nearly every day of the construction period at sections 4-7, only in February and March at sections 1-3 and for only a few days in February at sections 8-10, and never in section 11. Thus we may conclude incorrectly no “construction effect” by categorizing Reef as being “impacted” equally by construction activities from January through May. We have no reason to believe construction actions (human presence, airborne noise and smell) within one rookery section would have affects beyond a few 10s of meters (or past the adjacent section) from the source under most conditions.

One lone adult male northern fur seal was first observed on Ardiguén Rookery (control site) on 13 May 2010. Three adult male northern fur seals were first observed on Gorbatch Rookery (control site) on 14 May 2010. Two adult male northern fur seals were first observed on Reef Rookery (impact site) on 14 May 2010, but they did not remain hauled out the subsequent day. No construction work occurred at Reef Rookery on 14-15 May 2010. One adult male was observed on Reef Rookery on 18 May 2010, and adult males were present on each subsequent day of monitoring. One adult male northern fur seal was first observed on Tolstoi Rookery (control site) on 17 May 2010. No construction or repair activity occurred at Ardiguén Rookery or the sections of Tolstoi Rookery monitored for fur seal presence. Minor repair work occurred at Gorbatch



Rookery (sections 2-4) in April. All adult males observed exhibited their normal behaviors of resting, vocalizing, and fighting with neighboring bulls. All arrival and fur seal presence data are provided in Appendix 1.

The inspection crew encountered about 30 subadult male northern fur seals at Little Zapadni Rookery on 17 May 2010 (Table 1, Figure 3). All 30 subadult males departed land and entered the water within a minute of noticing the crew. The inspection crew encountered about 20 subadult male northern fur seals at Big Zapadni Rookery on 18 May 2010 (Table 1, Figure 3). All 20 subadult males departed land and entered the water within a minute of detecting the crew. Marine mammal monitoring crews encountered and displaced two adult male northern fur seals at Reef rookery on 24 May 2010 (Table 1), after construction was complete.

Table 1. Dates, locations, and numbers of male northern fur seals responding to construction and monitoring activities on St. Paul Island, Alaska.

Species	Date	Number	Location	Closest Approach	Behavior
N. fur seal	17 May	~30	Little Zapadni	<100m	Depart to water
N. fur seal	18 May	~20	Big Zapadni	<100m	Depart to water
N. fur seal	24 May	2	Reef	>100m	Depart to water



(iii) An estimate of the number (by species) of marine mammals that are known to have been taken by Level B harassment, with a discussion of any specific behaviors those individuals exhibited.

Approximately 52 male northern fur seals (Table 2) are known to have departed their resting location on land entering the water in response to the presence of WPC or AKR staff. Two adult males and approximately 50 subadult males responded in this fashion.

Adult male fur seals vocalize regularly as new males arrive on shore. Adult male fur seals appear alert while lying down or sitting upright, and we could not reliably distinguish “alert” adult male seals. In addition, their behavioral “status” (i.e., alert or not alert) would change numerous times within our counting/observation period. While there was likely some slight response by adult male fur seals to our presence on the walkways and towers to make counts at Reef rookery, we felt the response was not outside the normal range of behaviors exhibited by adult male northern fur seals and did not result in additional departures to the water. Our presence on the towers would have been significantly extended in order to further distinguish differences in minor behavioral responses, thus contributing to the potential effects of the project.

Table 2. Estimated number of male northern fur seals harassed by construction and monitoring activities associated with the replacement and repair of research observation towers and walkways on St. Paul Island, Alaska.

Species	Number	Location	Behavior	Harassed
N. fur seal	30	Little Zapadni	Depart to water	30
N. fur seal	20	Big Zapadni	Depart to water	20
N. fur seal	22	Reef	Delayed arrival	0-191*
N. fur seal	2	Reef	Depart to water	2
TOTAL	74*	St. Paul Island	Depart to water	52*

* Number harassed does not include those delayed because the estimate includes zero.

(iv) A description of the implementation and effectiveness of the monitoring and mitigation measures of the IHA, as well as any conservation recommendations for minimizing potential adverse effects of the action on marine mammals.

The monitoring and mitigation measures were implemented as practical at all construction and repair sites on St. Paul Island. Marine mammal sightings and responses were collected by WPC and reported when AKR could not be present due to the primary monitoring of the construction at Reef rookery. AKR systematically monitored for marine mammal presence at Reef, Gorbach, Ardiguen, and Tolstoi rookeries from 22 April through 6 June 2010. AKR monitored all eleven sections at Reef, sections 2 through 6 at Gorbach, the only section at Ardiguen and sections 1-3 of eight at Tolstoi. Sections 4-7 at Reef rookery were exposed to the highest level of project activities and new structure presence in May as northern fur seals became increasingly present in the near shore waters of St. Paul Island. Sections 1-3 at Reef rookery were not exposed to significant levels of construction activity (i.e., inspection and railing modifications), but the new structures were present.

Required mitigation included the following 4 items (*in italics*) followed by our implementation of the measures:

- (a) Avoid visits to sites used by northern fur seals during periods of molting, pupping, breeding, and rearing. Construction operations shall not be conducted at construction sites (as described in the application for this IHA) when dependent breeding animals are present.*



No northern fur seal sites were entered by WPC construction crews during the periods of molting, pupping, breeding and rearing. WPC and AKR were present from 22 April – 6 June 2010, well in advance of the arrival of females in late June.

(b) Plan to minimize the potential for disturbance (to the lowest level practical) near known pinniped haul-outs and rookeries by field personnel approach during construction operations. NMFS AKR is expected to conduct the activities during the planned dates stated in the application and above.

All WPC construction crews completed their work on 19 May 2010, and marine mammal monitoring was completed on 7 June 2010. All construction crews approached known haul-out sites from inland and minimized their presence on the offshore side of walkways and towers to reduce the potential for newly arriving fur seals from detecting crew's presence.

(c) Be judicious in the route of approach to construction sites, avoiding close proximity with pinnipeds hauled-out on shore. In no case will marine mammals be directly or deliberately approached by field crew personnel, and in all cases every possible measure will be taken to select a pathway of approach to sites that minimizes the number of marine mammals harassed.

All WPC construction crews completed their work on 19 May 2010, and marine mammal monitoring was completed on 7 June 2010. All construction crews approached known haul-out sites from inland and minimized their presence on the offshore side of walkways, towers, and tripods to reduce the potential for newly arriving fur seals from detecting crew's presence. The subadult male fur seals were encountered accidentally by the inspection crew and had not been present in the same location the few days prior to the inspection while repair crews worked.

(d) Conduct the replacement and repair of fur seal research observation towers and walkways on St. Paul Island by field crew personnel as quickly as possible. After each visit to a haul-out site and/or rookery, the site will be vacated as soon as possible so that it can be re-occupied by any hauled-out pinnipeds that may have been disturbed.

All WPC construction crews completed their work on 19 May 2010 ahead of schedule. No construction crews encountered hauled out northern fur seals at any sites. The final inspection crew encountered ~50 northern fur seals. The inspection crew's presence at each tower, walkway or tripod was reduced to the shortest duration practical by using a checklist of technical specifications at each structure. Marine mammal monitoring crews implemented their monitoring in a similar fashion by not spending time detecting and recording subtle behavioral responses to the monitoring crew's required presence after the departure of construction crews. Mitigation measures included entering the rookeries from a consistent location, removing waste generated by construction, completing as much construction as possible prior to the arrival of northern fur seals. Most harassment occurred on the final days of repair and inspection (17 May and 18 May 2010), thus the mitigation measure of working on the rookeries in the absence of fur seals was useful.

It is possible that the presence of the new towers and walkways or presence of the construction crew at Reef rookery may have delayed the arrival of adult male northern fur seals, and this was our primary consideration to continue monitoring through 6 June 2010, but at a reduced sampling frequency. The presence of sea ice both near shore and



on shore may have influenced the timing of male fur seal arrival in ways that we could not detect, though we collected data regarding the presence of sea ice onshore and offshore. Fur seals were observed on shore where we estimated complete near shore sea ice coverage. Thus subtle changes in the near shore sea ice that we could not detect allowed fur seals to land on shore. A statistical analysis of the data collected suggested a delay in the earliest arrival of adult male northern fur seals, though additional data are needed to resolve the inconsistency of the relationship between the various “impacted sections” and the control sections.

Our hypothesis was that there was no difference in the timing of arrival of adult male fur seals at any of the rookery sections monitored. If there was an effect from the presence of crews or the new towers and walkways it would be most evident at sections 4-7, and then at section 1-3 at Reef rookery. That is, the combination of the construction, inspection, monitoring of new structures occurred later into May at section 4-7 (greater potential effect; i.e., “most disturbed”), than sections 1-3 at Reef (lesser potential effect). The remaining rookery sections at Reef, Ardiguén, Gorbach, and Tolstoi had no new structures or construction crew presence during the monitoring period as seals arrived.

Statistical Methods

Initial analysis utilized parametric methods to test the hypothesis regarding the timing of arrival of adult male fur seals. These methods were unsatisfactory given the data assumptions. NMML researchers count the number of adult males during the second week of July each year. These counts represent the maximum number of breeding age males on shore, and are further refined into three categories, territorial with females, territorial without females, and idle (Antonelis 1992). We were not able to distinguish among the three groups when we made our counts in April and May because no females have arrived. Upon further consideration we (DJ) completed a Bayesian analysis of the data, and those methods, results and discussion are provided here.

1. Data model

Counts of adult males were made from April 22, 2010 (day 0) until June 6, 2010 (day 46). Reef rookeries sections 4-7 were classified as group 1 and were hypothesized as being the “most disturbed.” Reef sections 1-3 were classified as group 2 and were thought to be disturbed at an intermediate level. Finally, all other sections of Reef (8-11), Ardiguén, Gorbach, and Tolstoi rookeries were placed into group 3 (control). Bull counts were conducted in July and were used to represent the maximum capacity of the rookery sections in 2010. Every section count, $y_{ij}(t)$, of section j on rookery i at time t was modeled as a proportion of the maximum capacity with a binomial distribution
$$y_{ij}(t) \sim \text{Binomial}(N_{ij}, P_{ij}(t))$$
, where N_{ij} is the July bull count and $P_{ij}(t)$ is the cumulative proportion of the maximum capacity of adult males that have arrived to set up breeding territories.



2. Process model

The cumulative proportion $P_{ij}(t)$ of adult male fur seals in section j of rookery i at time t was modeled with a Weibull distribution function

where α_{ij} and β_{ij} are separate parameters for each section within each rookery. The curve parameters were subsequently modeled as

$$\alpha_{ij} = \alpha_i + \epsilon_{ij}$$
 and
$$\beta_{ij} = \beta_i + \delta_{ij}$$
,
where ϵ_{ij} and δ_{ij} are random effect error terms for each section within each rookery. The error terms are designed to capture the natural random differences between different section and rookeries on the island. The group parameters are designed to capture any systematic differences in the arrival curves due to construction and inspection disturbance.

3. Derived parameters

The main object of interest is the date of initial arrival of the males to set up breeding territories in addition to the explicit parameters in the arrival models (α and β). I defined this date to be the day on which 1% of the males in a given section had arrived. This can be calculated from the arrival model parameters as

The overall group arrival day, D_{group} , can be estimated using the expected value $E[D_{ij}]$ over the section random effect. This gives an estimate of the date of arrival for any random section in any possible year. This assumes, that variation across sections in 2010 is representative of variation across years at any given section. Another estimate of the group arrival date is simply the average of the D_{ij} for sections in each group, say \bar{D}_{ij} . This later quantity gives an estimate for the arrival dates specific to 2010.

In addition, if there is a significant delay in arrival between control sections and disturbed sections, then the number of animals displaced (at least temporarily) is also of interest. The displacement can be calculated as

where $F_{ij}(t)$ is the cumulative curve with parameters α_{ij} and β_{ij} . This gives the expected cumulative proportion if a specified disturbed section fell within the group of control sections. The total number of displaced males in all of the disturbed sections is $\sum_{i \in \text{disturbed}} N_i (F_{ij}(t) - F_{ij}(t_0))$.

4. Bayesian inference



I used a Bayesian approach and Markov Chain Monte Carlo (MCMC) to sample the posterior distribution to estimate the explicit and derived parameters. Prior distributions for the parameters are given in Table 3. Flat priors were used to allow little prior influence over the results. The MCMC sampler was allowed to run for 20,000 iterations as a burn-in followed by 100,000 iterations which were used for inference. For all parameters, derived and explicit, the mode of the posterior distribution was used as a point estimate. This reflects the fact that these distributions can be heavily skewed and the mode is a better measure of central tendency.

Table 3.
Prior distributions for parameters used in the MCMC sampler

Parameter	Prior Distribution
β_{group}	Uniform(0, 100)
γ_{group}	Uniform(0, 100)
σ_{η}	Uniform(0, 10)
σ_{ε}	Uniform(0, 10)

In order to determine if the added complexity of the section random effects was necessary, I also fitted the “fixed effects” only model (setting the random effects to zero). The models were compared with the Deviance Information Criterion (DIC). Differences in DIC values over 10 are considered strong evidence that the lower DIC model is better.

5. Results and Discussion

After comparison of the DIC values for the random effects model and the fixed effects model it appears that there is significant variation in the distribution of arrival at each of the sections. The difference in DIC was 185. Therefore, we can conclude that the added complexity of the random effects is warranted, and the fixed effects model was not appropriate.

The estimates of the derived parameters of interest are given in Table 4. The mode of the difference between β_{group} and γ_{group} was 6.19 days (range: 3.73 to 8.74). This indicates the timing of the arrival of the first 1% of the adult males in the most impacted sections at Reef rookery () was 6.19 days later than the control rookery sections (). Looking at the σ_{η} values, there is no overlap in intervals for group 1 and group 3 (see bars on Figure 4), leading to the conclusion that on average, there was a significant delay in arrival between Reef 4-7 and the control sections. The mode of the difference between σ_{η} and σ_{ε} was 9.69 days (range: 4.61 to 18.51). We hypothesized Reef 1-3 () to be less disturbed than Reef 4-7 () because construction in those sections was completed



prior to the detection of any fur seals offshore in spring 2010. Thus the longer delay in arrival between group 2 and the control is contrary to our prediction.

Table 4.

Estimates for derived parameters. The credible interval given is the 90% highest probability density interval. The estimate for Arrival dates in any year (D_{group}) and 2010 () is days from April, 22, while T is in units of animals displaced.

Parameter	Estimate	90% Credible Interval
D_1	31.2	(13.2, 51.2)
D_2	34.1	(16.6, 56.2)
D_3	25.4	(11.4, 40.7)
	31.87	(29.9, 33.7)
	35.34	(30.5, 43.8)
	25.51	(24.3, 27.2)
T	22.4	(0.00, 190.8)

Inspection of the arrival date for a random section/year (D_1, D_2, D_3) within each group indicated there is substantial overlap in the 90% “credible intervals” (i.e., no difference between the upper and lower bounds for each interval). This suggests section to section variation may account for the detected disturbance effect in 2010 if we had additional arrival data from other years.

The 9.69 day delay between group 2 (intermediate predicted effect) and control was greater than the 6.19 day delay between group 1 and the control group. This discrepancy between the two “impact” groups from the 2010 analysis suggests caution in a definitive conclusion of construction effects over effects of section to section variation in arrival date. Figure 4 provides an illustration of the model fit and estimated date of arrival. The estimated number of animals delayed at the disturbed sections had they followed the arrival distribution of the control sections is 22.4 adult male northern fur seals; however, there is large uncertainty in this estimate ranging from 0 males to 191.

In conclusion, there was a detected delayed arrival compared to other rookeries in 2010 on the construction sections of Reef rookery (i.e., 4-7 and 1-3). Confounding a definitive conclusion in the “delay in arrival” is the estimated of range of adult males delayed includes zero. It is our assessment that a definitive “construction” effect cannot be separated conclusively from section-to-section and year-to-year variations in arrival date. Sea ice presence on-shore at Reef rookery up to 2 days longer than at some control rookeries might also have influenced arrival. This may have lead to a yearly random delay that was not construction related, but related to natural phenomenon. This is reflected in the large credible intervals of the expected arrival dates.



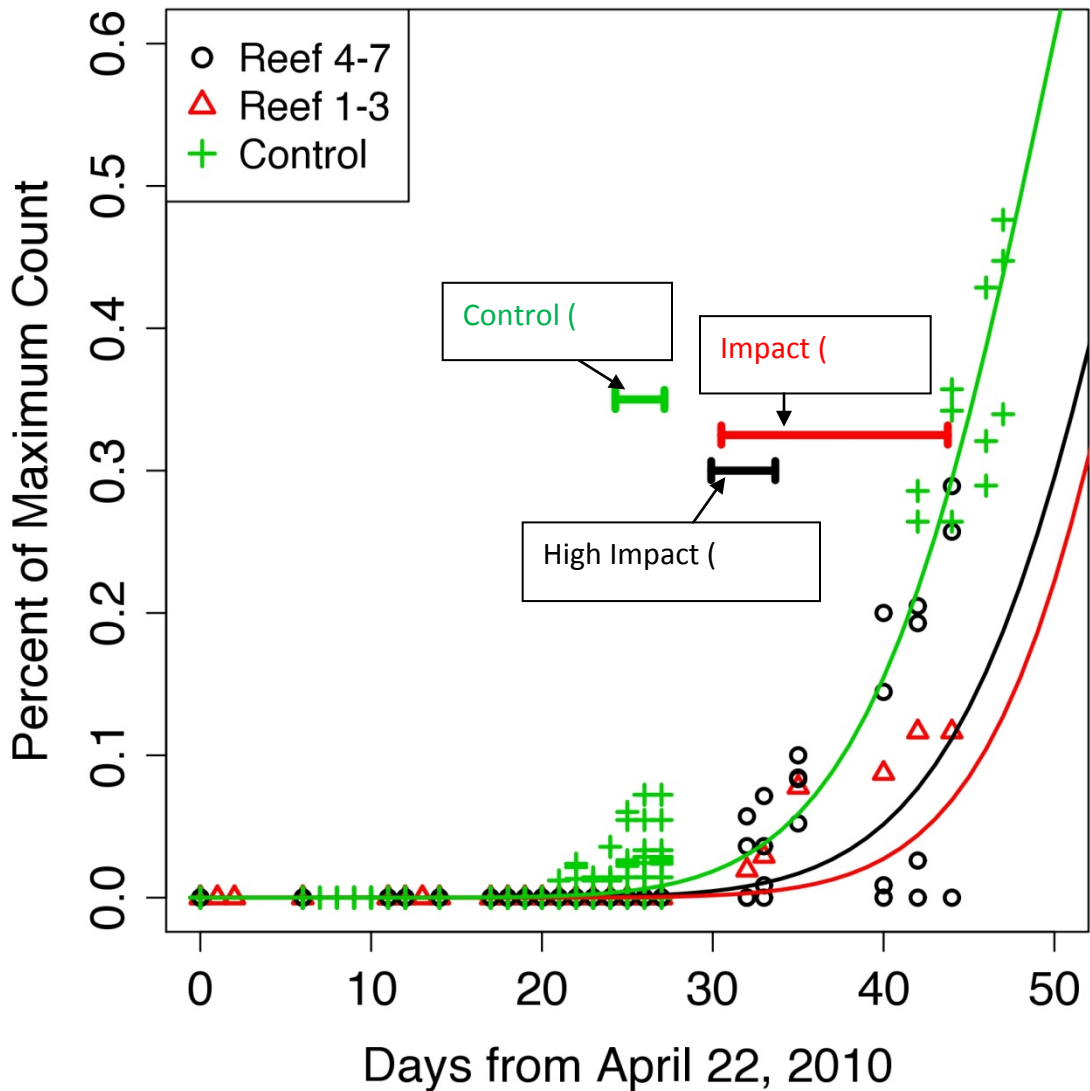


Figure 4. Counts of adult male northern fur seals within each rookery section at two sets of potentially affected sections (Reef 1-3 and Reef 4-7) and control sections not affected by construction crew or new tower and walkway presence. Lines through data points represent the average cumulative arrival curve for each group. Horizontal bars represent 90% credible intervals for the average arrival date in each group in 2010. Maximum count data (not shown here) provided by the National Marine Mammal Laboratory.

Literature Cited

Antonelis, G. A. 1992. Northern fur seal research techniques manual. United States Department of Commerce, NOAA Technical Memorandum NMFS F/NWC-214, 47 p.



Appendix 1. Northern fur seal counts, presence of sea ice and presence of Wade Perrow Construction(WPC) crew on select rookery sections on St. Paul Island Alaska in from April through July 2010.

Rookery Code: Reef = 1, Gorbach = 2, Ardiguen = 3, Tolstoi = 4;

Ice Offs: 0 = Sea ice is NOT present offshore, 1 = Sea ice is present offshore;

Ice Ons: 0 = Sea ice is NOT present onshore, 1 = Sea ice is present onshore;

WPC present: 0 = Wade Perrow Construction is NOT present, 1= WPC is present

Date	Rookery	Section	# Adult Male	# subadult	#SSL	Ice Offs	Ice Ons	WPC present
22-Apr-10	1	1	0	0	0	0	1	0
23-Apr-10	1	1	0	0	0	0	1	0
24-Apr-10	1	1	0	0	0	0	1	0
28-Apr-10	1	1	0	0	0	1	1	0
3-May-10	1	1	0	0	0	1	1	0
4-May-10	1	1	0	0	0	1	1	0
5-May-10	1	1	0	0	0	1	1	0
6-May-10	1	1	0	0	0	1	1	0
9-May-10	1	1	0	0	0	1	1	0
10-May-10	1	1	0	0	0	1	1	0
11-May-10	1	1	0	0	0	1	1	0
12-May-10	1	1	0	0	0	1	1	0
13-May-10	1	1	0	0	0	1	1	1
14-May-10	1	1	0	0	0	1	0	0
15-May-10	1	1	0	0	0	1	0	0
16-May-10	1	1	0	0	0	1	0	0
16-May-10	1	1	0	0	0	1	0	0
17-May-10	1	1	0	0	0	1	0	1
18-May-10	1	1	0	0	0	1	0	0
19-May-10	1	1	0	0	0	1	0	0
15-Jul-10	1	1	74	?	0	0	0	0
22-Apr-10	1	2	0	0	0	0	1	0
23-Apr-10	1	2	0	0	0	0	1	0
24-Apr-10	1	2	0	0	0	0	1	0
28-Apr-10	1	2	0	0	0	1	1	0
3-May-10	1	2	0	0	0	1	1	0
4-May-10	1	2	0	0	0	1	1	0
5-May-10	1	2	0	0	0	1	1	0
6-May-10	1	2	0	0	0	1	1	0
9-May-10	1	2	0	0	0	1	1	0
10-May-10	1	2	0	0	0	1	1	0
11-May-10	1	2	0	0	0	1	1	0
12-May-10	1	2	0	0	0	1	1	0
13-May-10	1	2	0	0	0	1	1	1
14-May-10	1	2	0	0	0	1	0	0
15-May-10	1	2	0	0	0	1	0	0
16-May-10	1	2	0	0	0	1	0	0
16-May-10	1	2	0	0	0	1	0	0
17-May-10	1	2	0	0	0	1	0	1



Appendix 1. Northern fur seal counts, etc

Date	Rookery	Section	# Adult Male	# subadult	#SSL	Ice Offs	Ice Ons	WPC present
18-May-10	1	2	0	0	0	1	0	0
19-May-10	1	2	0	0	0	1	0	0
15-Jul-10	1	2	95	?	0	0	0	0
22-Apr-10	1	3	0	0	0	0	1	0
28-Apr-10	1	3	0	0	0	1	1	0
3-May-10	1	3	0	0	0	1	1	0
4-May-10	1	3	0	0	0	1	1	0
6-May-10	1	3	0	0	0	1	1	0
9-May-10	1	3	0	0	0	1	1	0
10-May-10	1	3	0	0	0	1	1	0
11-May-10	1	3	0	0	0	1	1	0
12-May-10	1	3	0	0	0	1	1	0
13-May-10	1	3	0	0	0	1	1	1
14-May-10	1	3	0	0	0	1	0	0
15-May-10	1	3	0	0	0	1	0	0
16-May-10	1	3	0	0	0	1	0	1
16-May-10	1	3	0	0	0	1	0	0
17-May-10	1	3	0	0	0	1	0	1
18-May-10	1	3	0	0	0	1	0	0
19-May-10	1	3	0	0	0	1	0	0
24-May-10	1	3	2	0	0	1	0	0
25-May-10	1	3	3	0	0	1	0	0
27-May-10	1	3	8	0	0	1	1	0
1-Jun-10	1	3	9	0	0	1	0	0
3-Jun-10	1	3	12	0	0	1	0	0
5-Jun-10	1	3	12	0	0	1	0	0
15-Jul-10	1	3	103	?	0	0	0	0
22-Apr-10	1	4	0	0	0	0	1	0
28-Apr-10	1	4	0	0	0	1	1	0
3-May-10	1	4	0	0	0	1	1	1
4-May-10	1	4	0	0	0	1	1	1
6-May-10	1	4	0	0	0	1	1	0
9-May-10	1	4	0	0	0	1	1	0
10-May-10	1	4	0	0	0	1	1	1
11-May-10	1	4	0	0	0	1	1	1
12-May-10	1	4	0	0	0	1	1	0
13-May-10	1	4	0	0	0	1	1	1
14-May-10	1	4	0	0	0	1	0	0
15-May-10	1	4	0	0	0	1	0	0
16-May-10	1	4	0	0	0	1	0	0
16-May-10	1	4	0	0	0	1	0	0
17-May-10	1	4	0	0	0	1	0	1
18-May-10	1	4	0	0	0	1	0	1
19-May-10	1	4	0	0	0	1	0	0
24-May-10	1	4	3	0	0	1	0	0
25-May-10	1	4	3	0	0	1	0	0
27-May-10	1	4	7	2	0	1	1	0
1-Jun-10	1	4	12	0	0	1	0	0



Appendix 1. Northern fur seal counts, etc

Date	Rookery	Section	# Adult Male	# subadult	#SSL	Ice Offs	Ice Ons	WPC present
3-Jun-10	1	4	17	2	0	1	0	0
5-Jun-10	1	4	24	38	0	1	0	0
15-Jul-10	1	4	83	?	0	0	0	0
22-Apr-10	1	5	0	0	0	0	1	0
28-Apr-10	1	5	0	0	0	1	1	0
3-May-10	1	5	0	0	0	1	1	1
4-May-10	1	5	0	0	0	1	1	1
6-May-10	1	5	0	0	0	1	1	0
9-May-10	1	5	0	0	0	1	1	0
10-May-10	1	5	0	0	0	1	1	1
11-May-10	1	5	0	0	0	1	1	1
12-May-10	1	5	0	0	0	1	1	0
13-May-10	1	5	0	0	0	1	1	1
14-May-10	1	5	0	0	0	1	0	0
15-May-10	1	5	0	0	0	1	0	0
16-May-10	1	5	0	0	0	1	0	0
16-May-10	1	5	0	0	0	1	0	0
17-May-10	1	5	0	0	0	1	0	1
18-May-10	1	5	0	0	0	1	0	1
19-May-10	1	5	0	0	0	1	0	0
24-May-10	1	5	0	0	0	1	0	0
25-May-10	1	5	1	0	0	1	0	0
27-May-10	1	5	6	0	0	1	1	0
1-Jun-10	1	5	1	30	0	1	0	0
3-Jun-10	1	5	3	20	0	1	0	0
15-Jul-10	1	5	115	?	0	0	0	0
22-Apr-10	1	6	0	0	0	0	1	0
28-Apr-10	1	6	0	0	0	1	1	0
3-May-10	1	6	0	0	0	1	1	1
4-May-10	1	6	0	0	0	1	1	1
6-May-10	1	6	0	0	0	1	1	0
9-May-10	1	6	0	0	0	1	1	0
10-May-10	1	6	0	0	0	1	1	1
11-May-10	1	6	0	0	0	1	1	1
12-May-10	1	6	0	0	0	1	1	1
13-May-10	1	6	0	0	0	1	1	1
14-May-10	1	6	0	0	0	1	0	0
15-May-10	1	6	0	0	0	1	0	0
16-May-10	1	6	0	0	0	1	0	0
16-May-10	1	6	0	0	0	1	0	0
17-May-10	1	6	0	0	0	1	0	1
18-May-10	1	6	0	0	0	1	0	1
19-May-10	1	6	0	0	0	1	0	0
24-May-10	1	6	8	0	0	1	0	0
25-May-10	1	6	10	0	0	1	0	0
27-May-10	1	6	14	0	0	1	1	0
1-Jun-10	1	6	28	0	0	1	0	0
3-Jun-10	1	6	27	0	0	1	0	0



Appendix 1. Northern fur seal counts, etc

Date	Rookery	Section	# Adult Male	# subadult	#SSL	Ice Offs	Ice Ons	WPC present
5-Jun-10	1	6	36	0	0	1	0	0
15-Jul-10	1	6	140	?	0	0	0	0
22-Apr-10	1	7	0	0	0	0	1	0
28-Apr-10	1	7	0	0	0	1	1	0
3-May-10	1	7	0	0	0	1	1	1
4-May-10	1	7	0	0	0	1	1	1
6-May-10	1	7	0	0	0	1	1	0
9-May-10	1	7	0	0	0	1	1	0
10-May-10	1	7	0	0	0	1	1	1
11-May-10	1	7	0	0	0	1	1	1
12-May-10	1	7	0	0	0	1	1	1
13-May-10	1	7	0	0	0	1	1	1
14-May-10	1	7	0	0	0	1	0	0
15-May-10	1	7	0	0	0	1	0	0
16-May-10	1	7	0	0	0	1	0	0
16-May-10	1	7	0	0	0	1	0	0
17-May-10	1	7	0	0	0	1	0	1
18-May-10	1	7	0	0	0	1	0	1
19-May-10	1	7	0	0	0	1	0	0
24-May-10	1	7	0	0	0	1	0	0
25-May-10	1	7	0	0	0	1	0	0
27-May-10	1	7	1	0	0	1	1	0
1-Jun-10	1	7	0	0	0	1	0	0
3-Jun-10	1	7	0	0	0	1	0	0
5-Jun-10	1	7	0	0	0	1	0	0
15-Jul-10	1	7	12	?	0	0	0	0
22-Apr-10	1	8	0	0	0	0	1	0
28-Apr-10	1	8	0	0	0	1	1	0
3-May-10	1	8	0	0	0	1	1	0
4-May-10	1	8	0	0	0	1	1	0
6-May-10	1	8	0	0	0	1	1	0
9-May-10	1	8	0	0	0	1	1	0
10-May-10	1	8	0	0	0	1	1	0
11-May-10	1	8	0	0	0	1	1	0
12-May-10	1	8	0	0	0	1	1	0
13-May-10	1	8	0	0	0	1	1	0
14-May-10	1	8	0	0	0	1	0	0
15-May-10	1	8	0	0	0	1	0	0
16-May-10	1	8	0	0	0	1	0	0
16-May-10	1	8	0	0	0	1	0	0
17-May-10	1	8	0	0	0	1	0	0
18-May-10	1	8	0	0	0	1	0	0
19-May-10	1	8	0	0	0	1	0	0
15-Jul-10	1	8	140	?	0	0	0	0
22-Apr-10	1	9	0	0	0	0	1	0
28-Apr-10	1	9	0	0	0	1	1	0
3-May-10	1	9	0	0	0	1	1	0
4-May-10	1	9	0	0	0	1	1	0



Appendix 1. Northern fur seal counts, etc

Date	Rookery	Section	# Adult Male	# subadult	#SSL	Ice Offs	Ice Ons	WPC present
6-May-10	1	9	0	0	0	1	1	0
9-May-10	1	9	0	0	0	1	1	0
10-May-10	1	9	0	0	0	1	1	0
11-May-10	1	9	0	0	0	1	1	0
12-May-10	1	9	0	0	0	1	1	0
13-May-10	1	9	0	0	0	1	1	0
14-May-10	1	9	0	0	0	1	0	0
15-May-10	1	9	0	0	0	1	0	0
16-May-10	1	9	0	0	0	1	0	0
16-May-10	1	9	0	0	0	1	0	0
17-May-10	1	9	0	0	0	1	0	0
18-May-10	1	9	1	0	0	1	0	0
19-May-10	1	9	2	0	0	1	0	0
15-Jul-10	1	9	70	?	0	0	0	0
22-Apr-10	1	10	0	0	0	0	1	0
28-Apr-10	1	10	0	0	0	1	1	0
3-May-10	1	10	0	0	0	1	1	0
4-May-10	1	10	0	0	0	1	1	0
6-May-10	1	10	0	0	0	1	1	0
9-May-10	1	10	0	0	0	1	1	0
10-May-10	1	10	0	0	0	1	1	0
11-May-10	1	10	0	0	0	1	1	0
12-May-10	1	10	0	0	0	1	1	0
13-May-10	1	10	0	0	0	1	1	0
14-May-10	1	10	0	0	0	1	0	0
15-May-10	1	10	0	0	0	1	0	0
16-May-10	1	10	0	0	0	1	0	0
16-May-10	1	10	0	0	0	1	0	0
17-May-10	1	10	0	0	0	1	0	0
18-May-10	1	10	0	0	0	1	0	0
19-May-10	1	10	0	0	0	1	0	0
15-Jul-10	1	10	83	?	0	0	0	0
22-Apr-10	1	11	0	0	0	0	1	0
28-Apr-10	1	11	0	0	0	1	1	0
3-May-10	1	11	0	0	0	1	1	0
4-May-10	1	11	0	0	0	1	1	0
6-May-10	1	11	0	0	0	1	1	0
9-May-10	1	11	0	0	0	1	1	0
10-May-10	1	11	0	0	0	1	1	0
11-May-10	1	11	0	0	0	1	1	0
12-May-10	1	11	0	0	0	1	1	0
13-May-10	1	11	0	0	0	1	1	0
14-May-10	1	11	0	0	0	1	0	0
15-May-10	1	11	0	0	0	1	0	0
16-May-10	1	11	0	0	0	1	0	0
16-May-10	1	11	0	0	0	1	0	0
17-May-10	1	11	0	0	0	1	0	0
18-May-10	1	11	0	0	0	1	0	0



Appendix 1. Northern fur seal counts, etc

Date	Rookery	Section	# Adult Male	# subadult	#SSL	Ice Offs	Ice Ons	WPC present
19-May-10	1	11	0	0	0	1	0	0
15-Jul-10	1	11	23	?	0	0	0	0
15-Jul-10	2	1	124	?	0	0	0	0
28-Apr-10	2	2	0	0	0	1	1	0
1-May-10	2	2	0	0	0	1	1	0
2-May-10	2	2	0	0	0	1	1	0
3-May-10	2	2	0	0	0	1	1	0
4-May-10	2	2	0	0	0	1	1	0
6-May-10	2	2	0	0	0	1	1	0
9-May-10	2	2	0	0	0	1	1	0
10-May-10	2	2	0	0	0	1	1	0
11-May-10	2	2	0	0	0	1	1	0
12-May-10	2	2	0	0	0	1	1	0
13-May-10	2	2	0	0	0	1	1	0
14-May-10	2	2	0	0	0	1	0	0
15-May-10	2	2	0	0	0	1	0	0
16-May-10	2	2	0	0	0	1	0	0
16-May-10	2	2	0	0	0	1	0	0
17-May-10	2	2	0	0	0	1	0	0
18-May-10	2	2	2	0	0	1	0	0
19-May-10	2	2	2	0	0	1	0	0
15-Jul-10	2	2	70	?	0	0	0	0
28-Apr-10	2	3	0	0	0	1	1	0
1-May-10	2	3	0	0	0	1	1	0
2-May-10	2	3	0	0	0	1	1	0
3-May-10	2	3	0	0	0	1	1	0
4-May-10	2	3	0	0	0	1	1	0
6-May-10	2	3	0	0	0	1	1	0
9-May-10	2	3	0	0	0	1	1	0
10-May-10	2	3	0	0	0	1	1	0
11-May-10	2	3	0	0	0	1	1	0
12-May-10	2	3	0	0	0	1	1	0
13-May-10	2	3	0	0	0	1	1	0
14-May-10	2	3	3	0	0	1	0	0
15-May-10	2	3	2	0	0	1	0	0
16-May-10	2	3	2	0	0	1	0	0
16-May-10	2	3	5	0	0	1	0	0
17-May-10	2	3	2	0	0	1	0	0
18-May-10	2	3	2	0	0	1	0	0
19-May-10	2	3	2	0	0	1	0	0
15-Jul-10	2	3	140	?	0	0	0	0
28-Apr-10	2	4	0	0	0	1	1	0
1-May-10	2	4	0	0	0	1	1	0
2-May-10	2	4	0	0	0	1	1	0
3-May-10	2	4	0	0	0	1	1	0
4-May-10	2	4	0	0	0	1	1	0
6-May-10	2	4	0	0	0	1	1	0
9-May-10	2	4	0	0	0	1	1	0



Appendix 1. Northern fur seal counts, etc

Date	Rookery	Section	# Adult Male	# subadult	#SSL	Ice Offs	Ice Ons	WPC present
10-May-10	2	4	0	0	0	1	1	0
11-May-10	2	4	0	0	0	1	1	0
12-May-10	2	4	0	0	0	1	1	0
13-May-10	2	4	0	0	0	1	1	0
14-May-10	2	4	0	0	0	1	0	0
15-May-10	2	4	0	0	0	1	0	0
16-May-10	2	4	0	0	0	1	0	0
16-May-10	2	4	0	0	0	1	0	0
17-May-10	2	4	3	0	0	1	0	0
18-May-10	2	4	3	0	0	1	0	0
19-May-10	2	4	3	0	0	1	0	0
15-Jul-10	2	4	55	?	0	0	0	0
28-Apr-10	2	5	0	0	0	1	1	0
1-May-10	2	5	0	0	0	1	1	0
2-May-10	2	5	0	0	0	1	1	0
3-May-10	2	5	0	0	0	1	1	0
4-May-10	2	5	0	0	0	1	1	0
6-May-10	2	5	0	0	0	1	1	0
9-May-10	2	5	0	0	0	1	1	0
10-May-10	2	5	0	0	0	1	1	0
11-May-10	2	5	0	0	0	1	1	0
12-May-10	2	5	0	0	0	1	1	0
13-May-10	2	5	0	0	0	1	1	0
14-May-10	2	5	0	0	0	1	0	0
15-May-10	2	5	0	0	0	1	0	0
16-May-10	2	5	0	0	0	1	0	0
16-May-10	2	5	0	0	0	1	0	0
17-May-10	2	5	2	0	0	1	0	0
18-May-10	2	5	3	0	0	1	0	0
19-May-10	2	5	3	0	0	1	0	0
15-Jul-10	2	5	90	?	0	0	0	0
28-Apr-10	2	6	0	0	0	1	1	0
1-May-10	2	6	0	0	0	1	1	0
2-May-10	2	6	0	0	0	1	1	0
3-May-10	2	6	0	0	0	1	1	0
4-May-10	2	6	0	0	0	1	1	0
6-May-10	2	6	0	0	0	0	1	0
9-May-10	2	6	0	0	0	1	1	0
10-May-10	2	6	0	0	0	1	1	0
11-May-10	2	6	0	0	0	1	1	0
12-May-10	2	6	0	0	0	1	1	0
13-May-10	2	6	0	0	0	1	1	0
14-May-10	2	6	0	0	0	1	0	0
15-May-10	2	6	0	0	0	1	0	0
16-May-10	2	6	0	0	0	1	0	0
16-May-10	2	6	0	0	0	1	0	0
17-May-10	2	6	2	0	0	1	0	0
18-May-10	2	6	2	0	0	1	0	0



Appendix 1. Northern fur seal counts, etc

Date	Rookery	Section	# Adult Male	# subadult	#SSL	Ice Offs	Ice Ons	WPC present
19-May-10	2	6	2	0	0	1	0	0
15-Jul-10	2	6	82	?	0	0	0	0
28-Apr-10	3	1	0	0	0	1	1	0
1-May-10	3	1	0	0	0	1	1	0
2-May-10	3	1	0	0	0	1	1	0
3-May-10	3	1	0	0	0	1	1	0
4-May-10	3	1	0	0	0	1	1	0
6-May-10	3	1	0	0	0	0	1	0
9-May-10	3	1	0	0	0	1	1	0
10-May-10	3	1	0	0	0	1	1	0
11-May-10	3	1	0	0	0	1	1	0
12-May-10	3	1	0	0	0	1	1	0
13-May-10	3	1	1	0	0	1	0	0
14-May-10	3	1	0	0	0	1	0	0
15-May-10	3	1	1	0	0	1	0	0
16-May-10	3	1	1	0	0	1	0	0
16-May-10	3	1	1	0	0	1	0	0
17-May-10	3	1	5	0	0	1	0	0
18-May-10	3	1	6	0	0	1	0	0
19-May-10	3	1	6	0	0	1	0	0
15-Jul-10	3	1	83	?	0	0	0	0
28-Apr-10	4	1	0	0	0	1	1	0
29-Apr-10	4	1	0	0	0	1	1	0
30-Apr-10	4	1	0	0	0	1	1	0
1-May-10	4	1	0	0	0	1	1	0
2-May-10	4	1	0	0	0	1	1	0
3-May-10	4	1	0	0	0	1	1	0
4-May-10	4	1	0	0	0	1	1	0
9-May-10	4	1	0	0	0	1	1	0
10-May-10	4	1	0	0	0	1	1	0
11-May-10	4	1	0	0	0	1	1	0
12-May-10	4	1	0	0	0	1	0	0
14-May-10	4	1	0	0	0	1	0	0
15-May-10	4	1	0	0	0	1	0	0
16-May-10	4	1	0	0	0	1	0	0
16-May-10	4	1	0	0	0	1	0	0
17-May-10	4	1	1	0	0	1	0	0
19-May-10	4	1	1	0	0	1	0	0
3-Jun-10	4	1	14	0	0	1	0	0
5-Jun-10	4	1	13	0	0	1	0	0
7-Jun-10	4	1	11	0	0	1	0	0
8-Jun-10	4	1	17	0	0	1	0	0
6-Jul-10	4	1	29	0	0	0	0	0
10-Jul-10	4	1	38	?	0	0	0	0
28-Apr-10	4	2	0	0	0	1	1	0
29-Apr-10	4	2	0	0	0	1	1	0
30-Apr-10	4	2	0	0	0	1	1	0
1-May-10	4	2	0	0	0	1	1	0



Appendix 1. Northern fur seal counts, etc

Date	Rookery	Section	# Adult Male	# subadult	#SSL	Ice Offs	Ice Ons	WPC present
2-May-10	4	2	0	0	0	1	1	0
3-May-10	4	2	0	0	0	1	1	0
4-May-10	4	2	0	0	0	1	1	0
9-May-10	4	2	0	0	0	1	1	0
10-May-10	4	2	0	0	0	1	1	0
11-May-10	4	2	0	0	0	1	1	0
12-May-10	4	2	0	0	0	1	0	0
14-May-10	4	2	0	0	0	1	0	0
14-May-10	4	2	1	0	0	1	0	0
15-May-10	4	2	0	0	0	1	0	0
16-May-10	4	2	0	0	0	1	0	0
16-May-10	4	2	0	0	0	1	0	0
17-May-10	4	2	0	0	0	1	0	0
19-May-10	4	2	1	0	0	1	0	0
3-Jun-10	4	2	12	0	0	1	0	0
5-Jun-10	4	2	15	0	0	1	0	0
7-Jun-10	4	2	18	0	0	1	0	0
8-Jun-10	4	2	20	0	0	1	0	0
6-Jul-10	4	2	39	0	0	0	0	0
10-Jul-10	4	2	42	?	0	0	0	0
28-Apr-10	4	3	0	0	0	1	1	0
29-Apr-10	4	3	0	0	0	1	1	0
30-Apr-10	4	3	0	0	0	1	1	0
1-May-10	4	3	0	0	0	1	1	0
2-May-10	4	3	0	0	0	1	1	0
3-May-10	4	3	0	0	0	1	1	0
4-May-10	4	3	0	0	0	1	1	0
9-May-10	4	3	0	0	0	1	1	0
10-May-10	4	3	0	0	0	1	1	0
11-May-10	4	3	0	0	0	1	1	0
12-May-10	4	3	0	0	0	1	0	0
14-May-10	4	3	0	0	0	1	0	0
15-May-10	4	3	0	0	0	1	0	0
16-May-10	4	3	0	0	0	1	0	0
16-May-10	4	3	0	0	0	1	0	0
17-May-10	4	3	0	0	0	1	0	0
19-May-10	4	3	0	0	0	1	0	0
3-Jun-10	4	3	14	0	0	1	0	0
5-Jun-10	4	3	14	0	0	1	0	0
7-Jun-10	4	3	17	0	0	1	0	0
8-Jun-10	4	3	18	0	0	1	0	0
6-Jul-10	4	3	37	0	0	0	0	0
10-Jul-10	4	3	53	?	0	0	0	0

