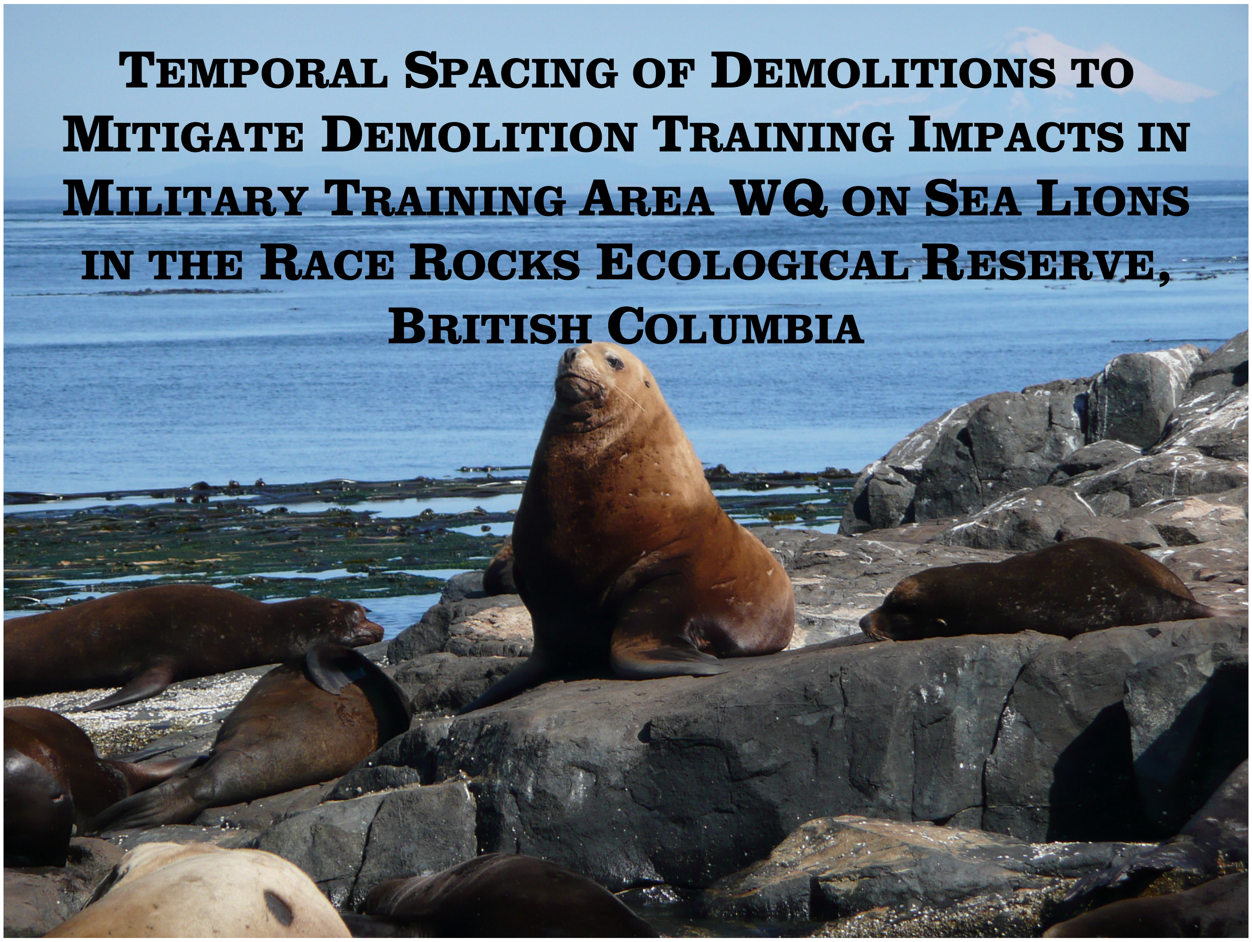
EA3099

Temporal Spacing of Demolitions to Mitigate Demolition Training Impacts in Military Training Area WQ on Sea Lions in the Race Rocks Ecological Reserve, British Columbia



Prepared for

Department of National Defence
Formation Environment
Canadian Forces Base Esquimalt
Victoria, BC

&

Public Works & Government Services Canada
Pacific Region
Victoria, BC

Prepared by

Mike W. Demarchi (M.Sc. R.P.Bio.)
LGL Limited
environmental research associates
9768 Second Street Sidney, BC V8L 3Y8

LGL LIMITED
environmental research associates

23 March 2009

ABSTRACT

Noise from explosions at the Bentinck Island Demolition Range at Canadian Forces Ammunition Depot (CFAD) Rocky Point has the potential to disturb pinnipeds (seals and sea lions) hauled out in the Race Rocks Ecological Reserve (ER). The disturbance of marine mammals is prohibited by the Marine Mammal Regulations under the Fisheries Act, requiring authorization to do so.

Previous research (Demarchi et al. 2008) suggested that by extending the interval between projects (blasts) in a run by up to ~5 min, the probability of disturbing sea lions to the point of vacating a haulout was diminished. Accordingly, the objective of this research was to determine whether spacing projects (demolitions) within a run by at least 5 min amounted to an effective means of mitigating the adverse effects of disturbance on sea lions within the ER. Using observational methods consistent with previous DND-sponsored research by LGL Limited at Race Rocks, pinniped behaviour in the ER was monitored in response to demolitions on Bentinck Island during three training courses during September to November 2008.

As in previous years, harbour seal abundance was affected primarily by tide height, with fewer animals occurring on haulouts with increasing tide level. Northern sea lions were very sensitive to detonations, with many animals moving to the water after the first project of a run. Too few California sea lions and northern elephant seals were present to permit analysis.

In conclusion, behavioural trials involving a 5-min inter-project interval were not an effective means of mitigating the adverse effects of blasting disturbance on northern sea lions under the conditions examined in October and November 2008. Although blast-noise levels were not measured, it was likely that environmental conditions (i.e., atmospheric wind profiles) served to enhance noise transmission from Bentinck Island to the ER, thereby resulting in higher received levels at the haulouts and greater sea lion displacement simply due to louder noise levels.

Further attempts to mitigate adverse effects include approaches to habituate northern sea lions to blast noise and conducting training at alternate locations at certain times of the year (e.g., late summer through early winter when sea lion abundance is greatest). However, before examining alternate means of mitigation, additional monitoring of the 5-min inter-project interval should be conducted during August–December to confirm the mitigation value of this action (which was deemed capable of mitigating the effects of disturbance during monitoring conducted in 2007 [Demarchi et al. 2008]).

ACKNOWLEDGEMENTS

The following individuals provided important assistance in coordinating and conducting this study: Graham Smith, Duane Freeman, Mike Waters, Arianne Ransome-Hodges (Public Works and Government Services Canada); Lt(N) Don Mitchell, Vivian Skinner and Ernest Hooker (Coast Guard) kindly provided access to the light tower on Great Race Rock. Kathryn Ryan-Wilson (B.C. Ministry of Environment) assisted with permitting in the Race Rocks Ecological Reserve. Chris Blondeau and Mike and Slater (Pearson College) assisted with logistics on Great Race Rock. Jamie Fenneman, Lucia Ferreira, Meike Holst, Steve Johnson, Krysia Tuttle (LGL Limited) assisted Mike Demarchi with data collection. Mike Waters, Arianne Ransome-Hodges, and Tim Edgell (LGL) provided valuable comments on a draft of this report.

Suggested Citation:

Demarchi, M.W. 2009. Temporal spacing of demolitions to mitigate demolition training impacts in Military Training Area WQ on sea lions in the Race Rocks Ecological Reserve, British Columbia. Report EA3099 prepared by LGL Limited. Prepared for Department of National Defence, Canadian Forces Base Esquimalt and Public Works and Government Services Canada.

Cover photo: northern sea lion (upright) and California sea lions (prone) hauled out in Race Rocks Ecological Reserve, September 2008. Mike Demarchi.

TABLE OF CONTENTS

Page

ABSTRACT i
ACKNOWLEDGEMENTS ii
TABLE OF CONTENTS iii
LIST OF FIGURES iv
LIST OF APPENDICES iv
ABBREVIATIONS v
1. INTRODUCTION 1
2. STUDY GOAL & OBJECTIVES 2
3. STUDY AREA 2
4. METHODOLOGY 5
4.1 Data Collection 5
4.2 Analytical Limitations 7
5. RESULTS & DISCUSSION 8
5.1 CENSUS TOTALS & ACTIVITY LEVELS 8
5.2 DAILY OBSERVATIONS 12
5.2.1 *September Session* *12*
5.2.2 *October Session* *15*
5.2.3 *November Session* *18*
6. SUMMARY & CONCLUSIONS 19
7. LITERATURE CITED 23

LIST OF FIGURES

Page

Figure 1. Map of southern Vancouver Island and vicinity, showing Rocky Point, Race Rocks Ecological Reserve (bounded by the 20-fathom contour), and Military Training Area WQ (circle). 4

Figure 2. Aerial photo (taken in 2005) of Bentinck Island. 4

Figure 3. Total number of harbour seals (HASE) in the Race Rocks census area during the morning (am) and afternoon (pm) counts. 9

Figure 4. Total number of California sea lions (CASL) in the Race Rocks census area during the morning (am) and afternoon (pm) counts.. 10

Figure 5. Total number of northern sea lions (NOSL) in the Race Rocks census area during the morning (am) and afternoon (pm) counts. 11

Figure 6. Mean (○), median (■) and standard deviation (bars) of proportion of northern sea lions active grouped by samples prior to when the Bentinck demolition range was active ("Pre"; n = 6), samples after the first blast on a day when the range was active ("During"; n = 5), and samples taken the day following a day when the range had been active and prior to any blasting that might have occurred on such days ("Post"; n = 5). 12

Figure 7. Cause-and-effect (Ishikawa) diagram showing linkages between known or suspected factors that increase the probability that sea lions will be displaced from haulouts in the Race Rocks Ecological Reserve. 21

LIST OF APPENDICES

Page

Date, time and number of slabs of C4 explosive detonated in each project of demolitions training runs on Bentinck Island during the monitoring sessions in October and November 2008. 24

Data collected during pinniped monitoring sessions at Race Rocks. 25

Weather conditions observed from atop the light tower on Great Race Rock during the study. 27

Total numbers of pinnipeds (shaded) and birds in Race Rocks Ecological Reserve as counted from atop the light tower during each of the two daily censuses (Cen.) for the monitoring sessions in September through October 2008. 28

ABBREVIATIONS

~	Approximately
asl	Above Sea Level
C4	C4 plastique is a white, plastic, high-explosive made of RDX (Royal Demolition Explosive; a.k.a. cyclonite or hexogen; chemical name, trinitrotriazine) and an inert plastic binder.
CASK	California sea lion
CFAD	Canadian Forces Ammunition Depot
CFB	Canadian Forces Base
cm	Centimetre
dB	Decibel (F – flat-weighted; A – A weighted; Leq – equivalent continuous noise level)
DFO	Department of Fisheries and Oceans [Canada]
DND	Department of National Defence [Canada]
ER	[Race Rocks] Ecological Reserve
GPS	Global Positioning System
ha	Hectare
HASE	Harbour Seal
kg	Kilogram
km	Kilometre
m	Metre
min	Minute
mm	Millimetre
N	North
NE	Northeast
NNE	North by Northeast
NNW	North by Northwest
NOSL	Northern Sea Lion
PST	Pacific Standard Time
s	Second
SD	Standard Deviation
sec	Second
SSE	South by Southeast
WQ	[Military Training Area] Whiskey Quebec

1. INTRODUCTION

Race Rocks, a small island group at the southernmost point of Vancouver Island, is a provincial ecological reserve (ER) and proposed federal marine protected area. The area supports a diversity of marine algae, invertebrates, fish, birds, and pinnipeds (seals and sea lions). Marine birds use Race Rocks throughout the year for breeding, foraging, and roosting. Pinnipeds are the largest and perhaps most charismatic inhabitants of Race Rocks, and the focus of this study which explores a putative relationship between DND training activities and disturbances to the local pinniped population.

Harbour seals are present year-round, using exposed rocks to breed and haul out, and the adjacent kelp beds to forage for fish and invertebrates. Northern elephant seals, California sea lions, and northern sea lions also use Race Rocks to haul out and forage, although unlike harbour seals, these larger pinnipeds breed elsewhere[1]. Killer whales transit the area intermittently, sometimes hunting pinnipeds.

A major portion of Race Rocks ER is contained within the Department of National Defence (DND) Military Training Area WQ (Whiskey Quebec); however, no training activities actually occur within the ER boundary. The effects of the demolition training and ordnance disposal activities in WQ were studied by LGL Limited in 1997 and 1998 (Demarchi et al. 1998), 2002 and 2003 (Demarchi and Bentley 2004), and 2007 (Demarchi et al. 2008). We found DND training exercises that involved detonation of high explosives (on Bentinck Island) elicited variable, yet predictable responses from local, hauled-out seals and sea lions. Reactions to blasting included no response, short-term increases in animal activity, or stampedes towards water while abandoning the haulout. Northern sea lions were particularly prone to disturbance, insomuch that individuals were frequently displaced from their haulouts by such events. However, the fact that these animals return to the haulout suggests they are resilient to disturbance, and provides strong evidence that DND blasting activity is not excluding them from the study area. Although other non-military factors were found to elicit similar flight responses, only the effects of military actions were considered.

One or more local members of the Whale Watch Operators Association Northwest[2] filed complaints with Canadian Forces Base (CFB) Esquimalt about detonations at Bentinck Island. Complaints focused on potential revenue loss should pinnipeds – a major tourist attraction – be displaced from Race Rocks because of persistent noise disturbances. In the operators' view, noise disturbance by DND blasting could cause pinnipeds to avoid Race Rocks ER, thus limiting marine mammal viewing opportunities for clients and negatively affecting revenue potential. At the same time, the Department of Fisheries and Oceans (DFO) has expressed concerns about military actions that disturb seals and sea lions where such disturbance is prohibited by the Fisheries Act and its associated Marine Mammal Regulations[3].

---

[1] Note that the first two records of northern elephant seal pupping in the Race Rocks ER were recorded in early 2009 (http://www.racerocks.com/racerock/eco/taxalab/miroungaa/newborn/jan3009.htm)

[2] http://www.nwwhalewatchers.org/victoria.html

[3] Note that the Marine Mammal Regulations were undergoing review while this report was being prepared (http://www-comm.pac.dfo-mpo.gc.ca/pages/consultations/marinemammals/mmr-update_e.htm).

Military training exercises in WQ continue in compliance with CFB Esquimalt Range Standing Orders (summarized in Appendix I of Demarchi and Holst 2008). Nonetheless, DND commissioned a study to investigate ways to lessen the (real and perceived) impacts of military demolition training exercises on marine mammals at Race Rocks ER and the local ecotourism industry (Demarchi and Holst 2008). This report presents the results of a 2008 pinniped monitoring project that ran concurrently with DND demolition trials, as per selected recommendations in Demarchi et al. (2008) pertaining to the time interval between projects (blasts) in a run.

2. STUDY GOAL & OBJECTIVES

The overall goal of this research program, described by Demarchi and Holst (2008), is to identify means of mitigating the impacts of military demolitions training on pinnipeds (namely northern sea lions) hauled out in the Race Rocks Ecological Reserve. Demarchi et al. (2008) demonstrated that spacing demolitions by intervals of 5 min or more instead of 30 sec reduced the probability of sea lions moving from a haulout into the water. They also showed that demolitions at an alternate location on Bentinck Island resulted in reduced noise propagation toward the Reserve, again reducing the magnitude of pinniped disturbance.

The objective of the present study was to conduct further tests of the 5-min blasting interval at the main demolition site on Bentinck Island. If successful, such mitigation would allow training activities to continue on that portion of Bentinck Island. Having to move to an alternate site would entail costs associated with range development, including construction of an additional bunker.

3. STUDY AREA

CFB Esquimalt conducts military explosives training in Marine Training and Exercise Area WQ (Figure 1). WQ is near Rocky Point on southern Vancouver Island, British Columbia, and is owned by the Federal Government (DND). WQ encompasses 1075 ha of terrestrial and marine environment, including a portion of the Race Rocks ER. No military training occurs within the ER boundary.

Two ranges within WQ are used for ordnance-based demolitions: the Whirl Bay Underwater Demolition Range, and the Bentinck Island Demolition Range (Figure 1). Moreover, surplus and outdated ordnance is disposed (detonated) at WQ by Canadian Forces Ammunition Depot (CFAD) Rocky Point, at the Christopher Point Ordnance Disposal Range. Training activities at WQ are controlled by Base Operations, CFB, Esquimalt, and must be approved as per the CFB Esquimalt Range Standing Orders. Ordnance disposal activities are overseen by CFAD Rocky Point.

Bentinck Island (31 ha) comprises three forested lobes connected in the middle by a sandy isthmus. The forests consist of mature stands of Douglas fir, arbutus, and shore pine. The central isthmus region, which is also the main demolition site, consists of three low-lying and connected banks of sand and pebble (Figure 2). Bentinck Island is separated from Rocky Point by Eemdyk Passage – a shallow channel that supports an abundance of macroalgae, including ecologically important species like bull kelp and eelgrass. Harbour seals seem to be the only pinniped to use Eemdyk Passage (pers. obs.).

The Bentinck Island Demolition Range is used primarily by Canadian Forces Fleet School (Seamanship Division) for above-water beach-clearing and obstacle-creation exercises, usually involving metal cutting and the displacement and demolition of rocks and logs. The range is used for about 12 training courses per year, each spanning 1–4 days. During the 4-day courses, the range is active from 08:00 to 15:00 on days one and three, and 08:00 to 12:00 on days two and four.

The range is licensed for a maximum individual charge size of 4 slabs[4] (2.3 kg) of C4 (Appendix I of Demarchi and Holst 2008). A typical demolition (a.k.a. project) – used to cut timber, steel, or clear obstacles from beaches – consists of 1–4 slabs of C4. Two to three projects are usually set up (but not detonated) simultaneously by one or more training groups; such a project queue is called a Run. A typical range day involves 2–4 runs of 1–3 projects (i.e., 4–12 blasts in total). Prior to 1998, there was no minimum time interval between projects of a run. From 1998 to 2004, projects in the same run were detonated at a minimum interval of 2 min in an attempt to mitigate disturbance to pinnipeds on Race Rocks. Range Standing Orders have since been revised, requiring a minimum interval of 30 sec between projects.

Projects are detonated by non-electric (fuse) and electric (wire) means. The first project in a run is typically "non-electric", with the length of the fuse (of a known burn rate – usually specified as seconds per foot) calculated to allow for adequate time for all personnel to retreat to the bunker. Subsequent charges are usually "electric" and have none of the time limitations on the spacing (time) between detonations as is the case for non-electric detonations. Thus, there is considerable flexibility in the timing between projects. Tamping (sand-filled polypropylene sacks) is sometimes used to help confine the explosion and possibly reduce blast noise (PO1 McEvoy pers. comm. 2007). Demolition training is conducted on the central beaches of Bentinck Island, with a direct line-of-sight to most of the Race Rocks ER. The nearest haulout used by seals and sea lions in the ER is ~1.2 km from the blasting site (see Appendix I of Demarchi et al. 2009). We observed pinnipeds from the light tower on Great Race Rock.

[4] one slab of C4 weighs 0.56 kg

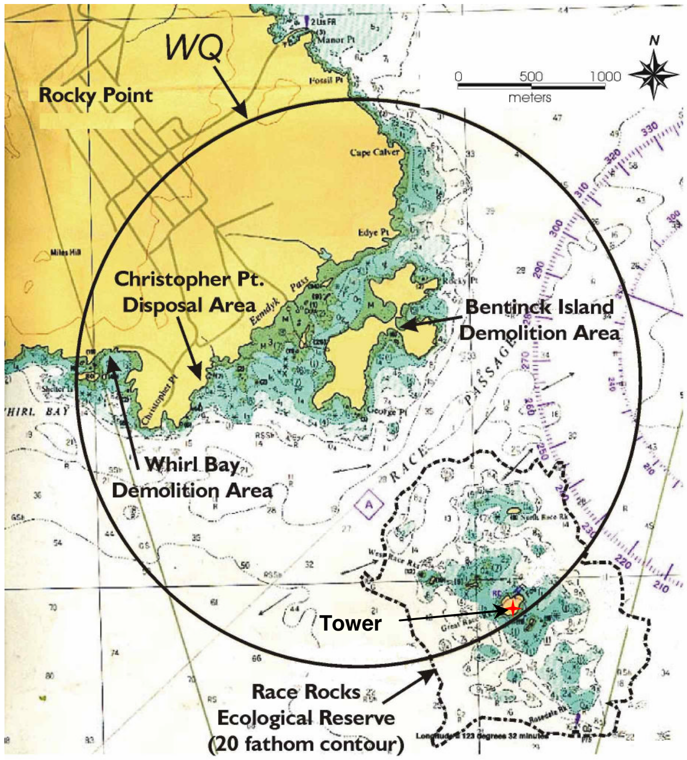


Figure 1. Map of southern Vancouver Island and vicinity, showing Rocky Point, Race Rocks Ecological Reserve (bounded by the 20-fathom contour), and Military Training Area WQ (circle). General locations of standard demolition training and ordnance disposal sites are indicated.

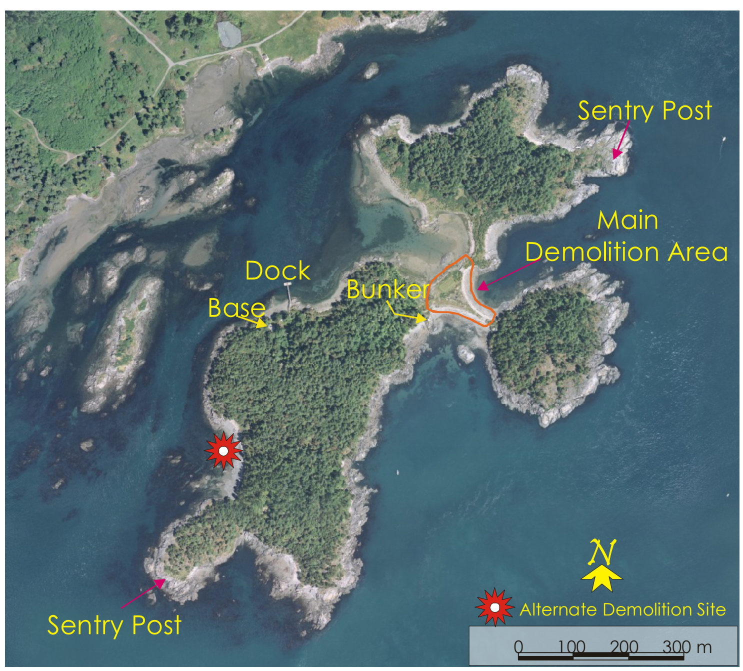


Figure 2. Aerial photo (taken in 2005) of Bentinck Island. Locations of key features relevant to demolition training exercises are shown. Source of photo: Capital Regional District Natural Areas Atlas (http://www.crd.bc.ca/es/natatlas/atlas.htm). Only the main demolition area was used during monitoring in 2008. The alternate site was tested in 2007 (Demarchi et al. 2008).

4. METHODOLOGY

4.1 Data Collection

Methodology was similar to that used in related studies: 1997 and 1998 (Demarchi et al. 1998), 2002 and 2003 (Demarchi and Bentley 2004), and in 2007 (Demarchi et al. 2008). For a detailed description of the biophysical resources and environmental factors affecting the Race Rocks ER, refer to Wright and Pringle (2001) and Demarchi and Bentley (2004).

Three monitoring sessions were conducted in 2008: (1) 11–13 September (to monitor a night shoot with one project on 12 September), (2) 21–24 October (to monitor blasting on 22 and 23 October), and (3) 3–7 November (to monitor blasting on 3–6 November). A detailed summary of all detonations is provided in (Appendix I). Note that the CFAD Demolition Area was used 8 October and 13 November 2008. Whirl Bay was not used between 11 September and 7 November 2008.

Observations were made from atop the Great Race Rock light tower (except on 2 occasions), and only pinnipeds within the Race Rocks ER boundary were documented. Travel between Rocky Point and Race Rocks was by inflatable boat. Because the September training course was a night shoot, we used images from the LBPC remote-controlled webcam[5] to document and gauge pinniped responses to blasting; pinnipeds were monitored by LGL observers throughout the day prior to the explosion. On 6 November 2008, the third day of the QL3 course, gale-force winds prevented travel to Race Rocks, therefore pinniped observations were made from the bunker on Bentinck Island with binoculars (8x) and a tripod-mounted spotting scope (15–45x). Two biologists recorded data for four different Microsoft Access 2002 databases using paper dataforms and a hand-held Compaq iPAQ computer running Visual CE v6.1. Digital photographs were taken regularly throughout the monitoring sessions. Additional information about data collection is presented in Appendix II.

Database 1: Weather observations. Weather conditions (wind speed in knots and direction in degrees off true north) were measured using on-site meteorological equipment operated by the Coast Guard. Because animal responses to disturbance may vary with time of day, cloud cover, wind speed, wind direction, wave height, swell condition, and tide height, weather parameters were measured in the morning and at the end of the day, and whenever notable changes in conditions occurred throughout the day. Tidal data were obtained for William Head (123° 32.0' W, 48° 20.0' N) using the computer program WXtide32 v2.7 (Hopper 2002). William Head is < 5 km north of Race Rocks.

Database 2: Counts of bird and pinniped species in the study area. These data provided information about daily changes in the number of animals using the study area. A census of birds and pinnipeds was conducted twice daily (morning and afternoon). Only animals that were supported by terrestrial features (i.e., islands, islets, rocks, man-made structures, etc.) within one of the sub-areas (see Demarchi and Bentley 2004) were counted because of the difficulties in seeing animals in the water or counting birds in the air. Further, only animals visible from the tower were counted except where otherwise noted. In the past, some animals were hidden from view, but in our opinion, the vast majority (>90%) of individuals were visible from the tower.

---

[5] www.racerocks.com

For the first time since monitoring began in 1997, notable numbers of pinnipeds were observed using the north side of Area 13, out of view from the tower. The number of sea lions using that area was therefore estimated during morning and afternoon boat trips to and from the ER, respectively. Crowding may have also biased our density estimates because some animals obscured our view of others – especially when they were resting in the prone position. Increased activity (e.g., heads up) sometimes resulted in a higher and more reliable sea lion count per given area. Considering these visibility biases, sea lion counts were probably conservative.

Database 3: Sweep counts of animal density and behaviour in selected areas. These data allowed us to evaluate differences (in behaviour and haulout density) pre- and post-disturbance. Counts were made at ~30 min intervals during the observation period, plus additional counts were made immediately before and in the minutes following a blast or the closest approach by people or boats. Two visible measures of disturbance are: 1) the change in body position (i.e., activity level; head-down or head-up of pinnipeds[6]), and 2) the change in numbers of pinnipeds hauled out. Potential disturbance stimuli were noted during sampling of activity levels (e.g., if an ecotour boat was situated such that the passengers were focusing on the animals in the selected sub-area; or if a blast had recently occurred). Descriptions of visible effects (or lack thereof) of a given stimulus were also noted for each record. For each species, the proportion of active animals was calculated by dividing the number of individuals with heads up by the total number in a given sub-area. Because increased activity could lead to modest increases in total counts whereby animals previously hidden from view become visible as they raised their heads, observers also attempted to count the number of animals that moved to the water after a disturbance event in addition to making total counts in an area pre- and post-disturbance to calculate displacement. That way, if the sequential sampling records did not show a change in numbers (e.g., via increased counts due to heads up) but animals were observed moving to the water, displacement was noted.

Database 4: Tracking potential disturbance events. A 250 x 250-m grid was superimposed on a map of the study area to track disturbances in the vicinity of the pinnipeds. The position and timing of each disturbance stimulus was entered into the survey grid. Disturbances were recorded only once per individual grid cell, even if the disturbance temporarily left then re-entered that same cell. The time at which each detonation was detectable by observers at Race Rocks (by sound) was also recorded.

Field sampling occurred during one 3-day session, one 4-day session, and one 5-day session spanning September to November 2008. Prior to the September session, Bentinck Island was last used for live fire exercises from 28 July to 1 August; the CFAD disposal area was last used for ordnance disposal on 22 July; and Whirl Bay was last used for live fire from 16–20 June. The first day in each session provided baseline conditions prior to demolition exercises, which occurred on the second and third days of each session (except for the night shoot in September which involved a single blast on one day). The fourth (third in September) and final day of monitoring in each session provided a measure of animal abundance and behaviour one day after the demolitions. All observations were opportunistic. Although the observers on Great Race Rock were in radio contact with DND personnel on Bentinck Island, the observers did not dictate

[6] It is acknowledged that sea lions sometimes rest in a head-up position, but in LGL's extensive experience at Race Rocks, the proportion of such animals is in the vast minority.

charge size or interval. All detonations were within the range maximum and consecutive detonations were never within 5 min of each other.

4.2 Analytical Limitations

Interpretation of the study's results is complicated or compromised by several factors which were beyond the investigator's control:

1. The study was conducted at a single (unreplicated) site. Consequently, data from one or more control sites (i.e., sites with biophysical properties similar to those of Race Rocks, but without any disturbances) are not available for comparison. Furthermore, military activities, ecotourism, and other human activities have been occurring near or at Race Rocks for many years and no baseline (pre-disturbance) data from Race Rocks are available for comparison.
2. Because human-induced disturbance events and weather conditions – two factors that affect pinniped behaviour – were not under the investigators' control, observations of pinniped responses to disturbances were made opportunistically.
3. Residual effects of disturbance can persist for hours or more, and individual animals are likely to retain knowledge of past disturbances. Therefore, multiple observations of the same animals are not independent of each other, especially when consecutive samples are recorded over short periods of time (e.g., multiple measures in a single day). For example, if a disturbance occurs at time = t and animals move to the water, a sample of animal numbers and activity taken at time = t + 1 is likely to differ from another hypothetical sample taken without a previous disturbance. Sample values averaged during the course of a day are more appropriate for use in statistical testing than individual values obtained from repeated observations of the same animals on the same day.
4. Dependent response variables (i.e., activity and number of individuals visible in the study area) are not exclusively affected by human-caused disturbance events. Animal activity and departure from a haulout occur naturally and are potentially affected by many variables such as: time of year, time of day, weather, sea state, tide height, local prey availability, time since feeding, interspecific interactions, intraspecific interactions, behavioural differences among individuals, animal body condition, animal migration, and interactions between these variables. In other words, human-induced effects on sea lion behaviour are confounded by natural effects, making it difficult to discriminate cause. An even greater challenge is to determine how much of a change in animal behaviour or population density constitutes a biologically significant effect (see Demarchi 2002; Demarchi and Bentley 2004).
5. Total counts allow for the estimation of changes in the total numbers of animals populating the study area, but without individual identification or a sample of radio-tagged animals one cannot reasonably determine what proportion of the population is either temporarily or permanently abandoning Race Rocks ER following each disturbance.
6. For the most part, the number of animals moving to and from a haulout can be estimated by the difference in numbers before and after a disturbance. Error in this estimate is

associated with animals moving in and out of view while remaining on the haulout (e.g., when some animals obscure our view of others).

5. RESULTS & DISCUSSION

A maximum of three northern elephant seals were observed on a given day during the three monitoring sessions. As per previous observations (e.g., Demarchi and Bentley 2004), elephant seals did not appear reactive to blasting noises. Consequently, only harbour seals, California sea lions, and northern sea lions are examined below.

Environmental conditions during the study were mixed, with air temperatures ranging from 6–17 °C, and a range of wind directions, wind speeds, and ocean swell heights (Appendix III). Visibility was unlimited throughout most of the monitored area during the entire study.

5.1 Census Totals & Activity Levels

Total numbers of pinnipeds and birds on each of the two daily surveys for each of the three monitoring sessions are summarized in Appendix IV. As documented by Demarchi et al. (1998), Demarchi and Bentley (2004), and Demarchi et al. (2008), daily numbers of harbour seals hauled out at Race Rocks were not greatly affected by blasting on Bentinck Island (Figure 3). Rather, harbour seal numbers are more strongly correlated to tide height (Demarchi and Bentley 2004; Demarchi et al. 2008). Demarchi and Bentley (2004) showed that even in the absence of any potential human-caused disturbance, numbers of harbour seals hauled out in the Race Rocks ER will diminish to zero during rising tides and/or moderate to high ocean swell.

Again in 2008, harbour seal abundance (on haulouts) was negatively proportionate to tide height ($r = -0.73$, $P < 0.001$, $df = 21$), such that higher tides were associated with significantly fewer hauled out seals. Relatively low numbers of seals in November (compared to September and October) was likely the result of the high tides that persisted throughout the days of that session, together with the disruptive effects of a storm that spanned the 4–6 November. Stormy seas and high tides result in waves and swells that wash over much of the intertidal haulout areas used by this species, resulting in fewer seals maintaining their positions on the rocks. Incidentally, sea lions are more agile than seals on land, and thus the former haul out much higher on shore where they are less affected by moderately high tides and swells.

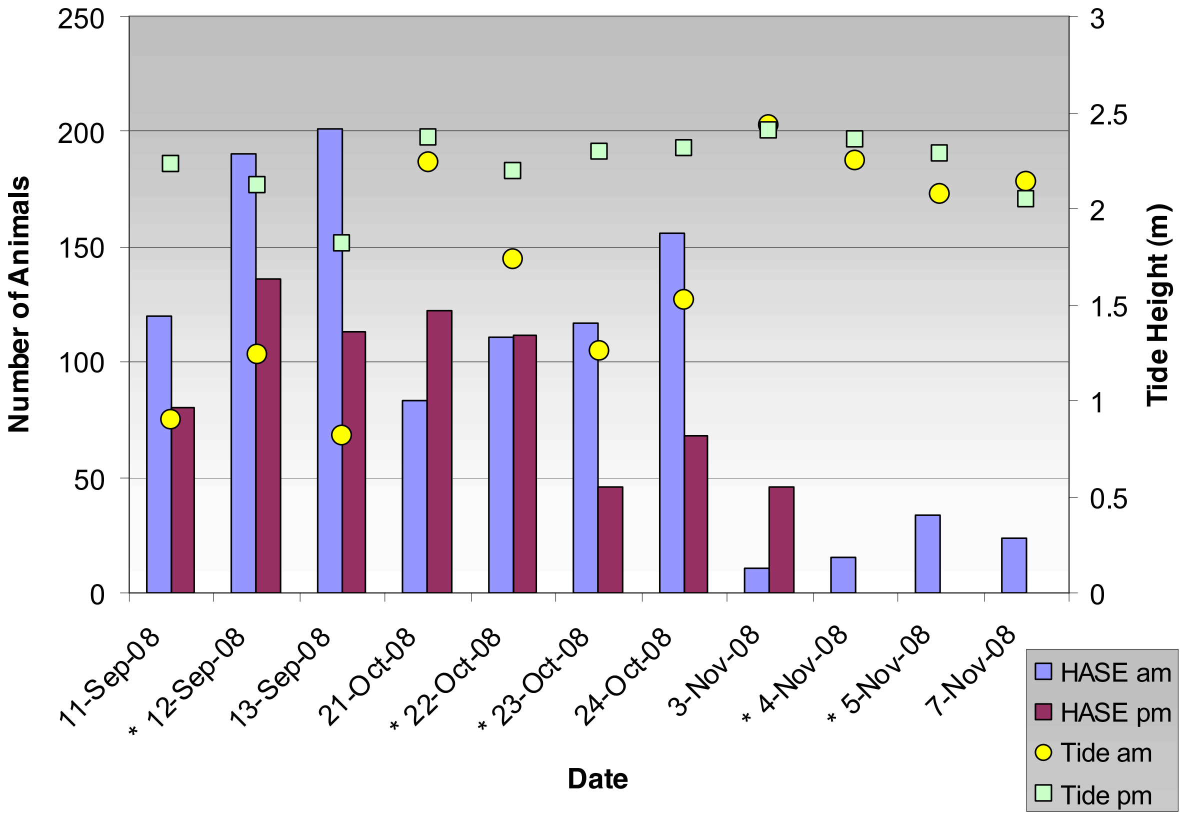


Figure 3. Total number of harbour seals (HASE) in the Race Rocks census area during the morning (am) and afternoon (pm) counts. Predicted tide heights at William Head are also shown for each census. Dates on which blasting occurred are identified with asterisk (*). Blasting on 12 September occurred after the second count that day.

The number of California sea lions in the ER was highest during the September session, but diminished to no more than a few animals thereafter (Figure 4). Changes in their numbers over time were primarily the result of natural movements on and off of their haulouts, but a few animals were displaced by blasting on Bentinck Island.

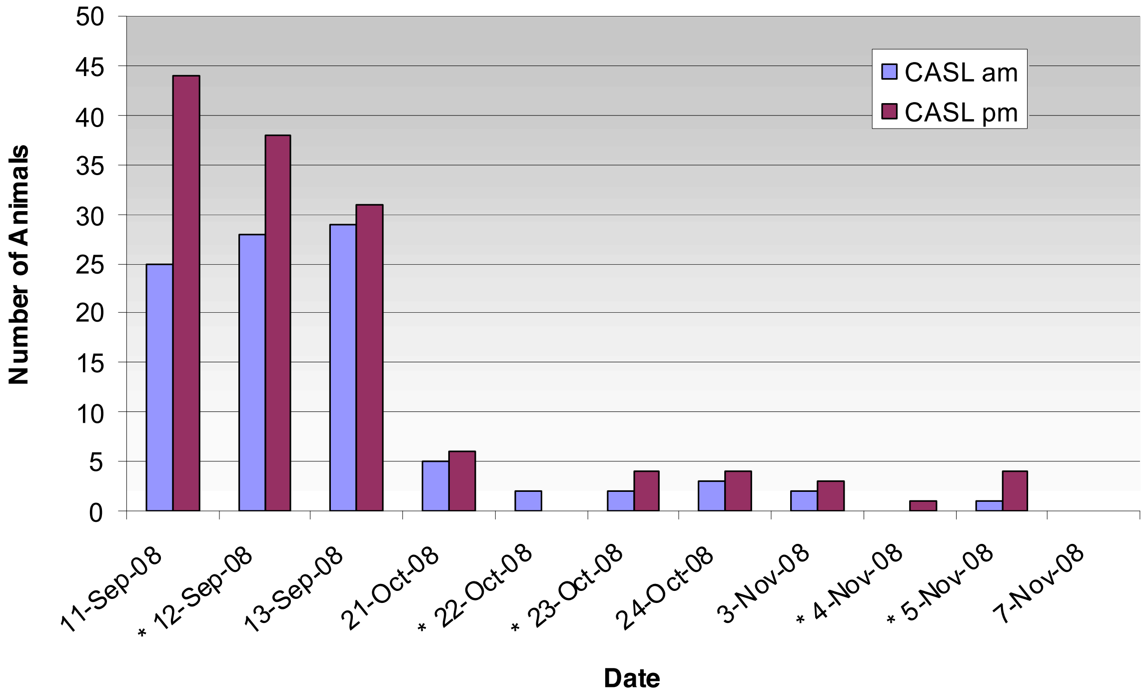


Figure 4. Total number of California sea lions (CASL) in the Race Rocks census area during the morning (am) and afternoon (pm) counts. Dates on which blasting occurred are identified with asterisk (*). Blasting on 12 September occurred after the second count that day.

The number of northern sea lions in the census area varied as a function of the time of year, weather conditions, and demolition activity on Bentinck Island (Figure 5). Sea lions were least active before blasting and on days after blasting (including samples taken on the second or third day of blasting, but only prior to any blasting on those days), and were most active after blasting on a given day (Figure 6). Small sample sizes (where n is based on the aggregate daily mean rather than repeated measurements [pseudoreplicates] of the same individuals each day) precluded statistical analysis, but the similarity between pre- and post-blasting conditions suggests that northern sea lions returned to near pre-blast activity levels within one day after blasting. Median activity level was lower than the corresponding mean for the pre-blasting observations only (Figure 6). The higher median activity value associated with post-blasting compared with pre-blasting observations suggests that some lingering effects of blasting might have occurred – possibly manifesting as increased sensitivity to non-DND disturbances (see § 5.2.2 and 5.2.3).

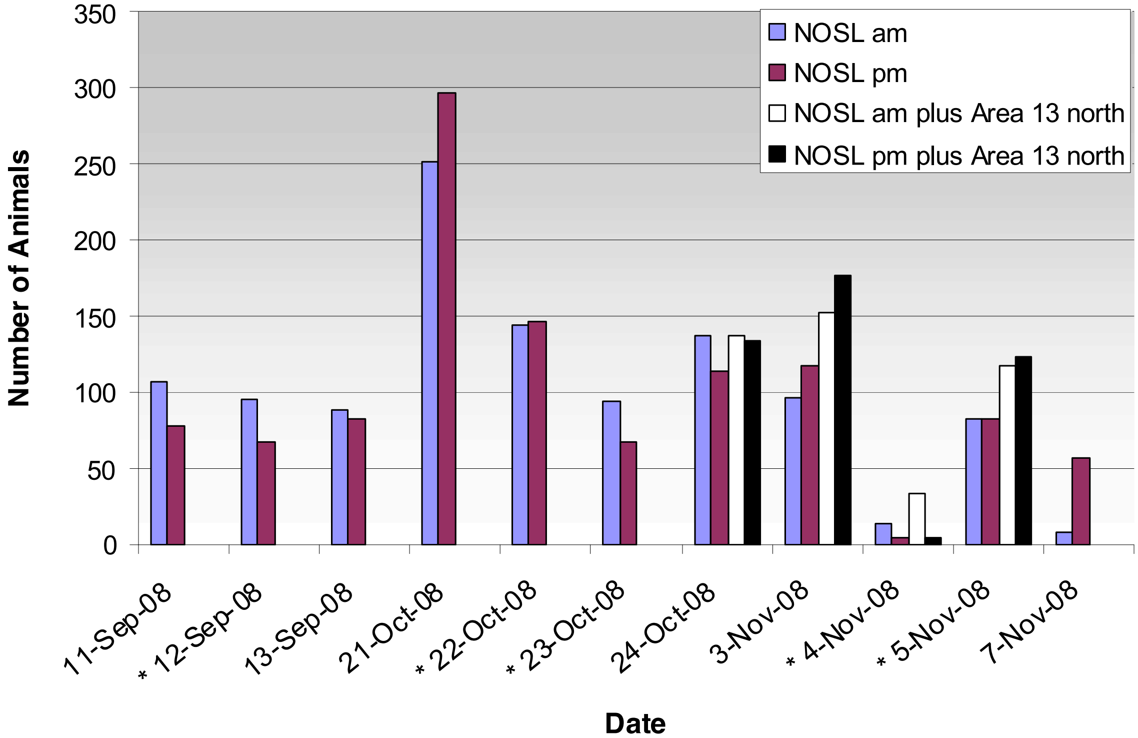


Figure 5. Total number of northern sea lions (NOSL) in the Race Rocks census area during the morning (am) and afternoon (pm) counts. On days when animals were present on the north side of Area 13 and not visible from atop the light tower, numbers were estimated during morning and afternoon boat trips to and from Great Race Rock (24 October and 3–5 November). The white and black bars depict the total numbers in the census area plus those Area 13 north estimates. Dates on which blasting occurred are identified with asterisk (*). Blasting on 12 September occurred after the second count that day.

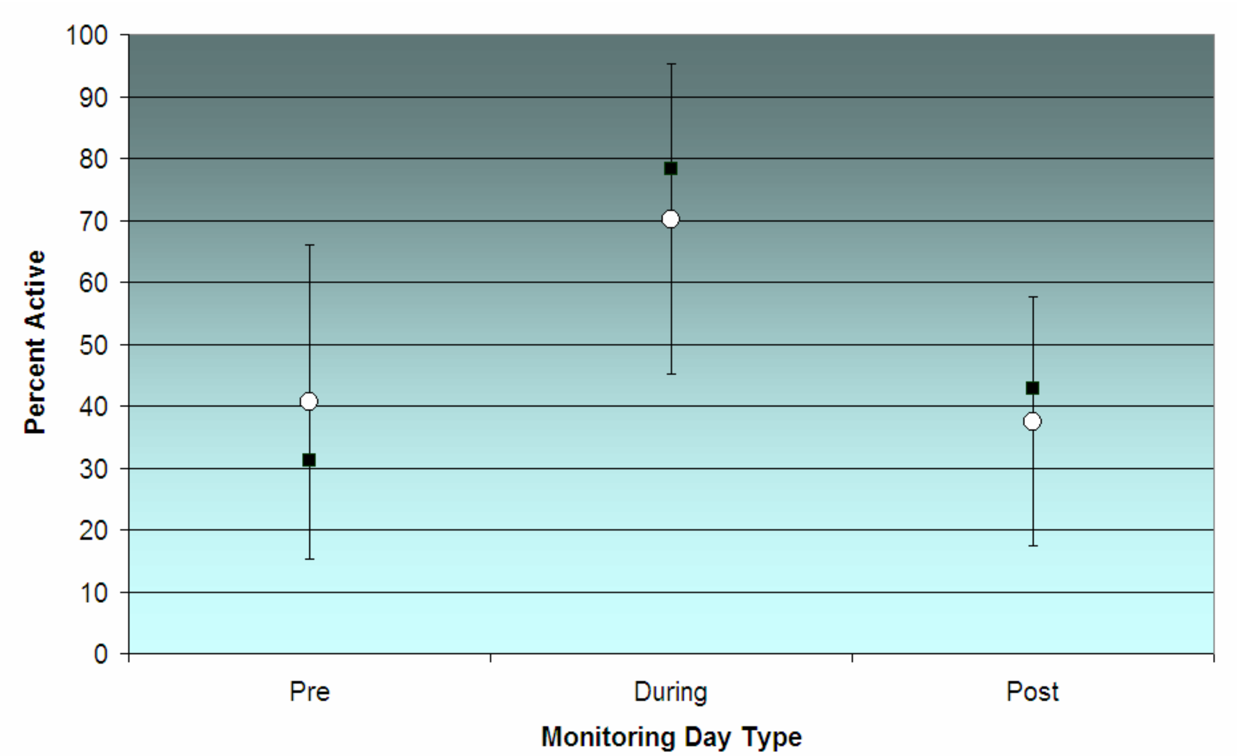


Figure 6. Mean (○), median (■) and standard deviation (bars) of proportion of northern sea lions active grouped by samples prior to when the Bentinck demolition range was active ("Pre"; n = 6), samples after the first blast on a day when the range was active ("During"; n = 5), and samples taken the day following a day when the range had been active and prior to any blasting that might have occurred on such days ("Post"; n = 5). Only samples involving 10 or more animals are included. Data from 2008.

5.2 Daily Observations

Discussion of results is limited mainly to northern sea lions – the pinniped species that is consistently sensitive to blasting disturbances (Demarchi et al. 1998; Demarchi and Bentley 2004; Demarchi et al. 2008). There were too few northern elephant seals (maximum of 3) to warrant analyses. Moreover, past observations of elephant seals suggest they are not disturbed by blasting noises (Demarchi and Bentley 2004). Harbour seals have exhibited little response to blasting noise in the past (Demarchi and Bentley 2004), and their haulout behaviour at Race Rocks seems primarily related to tidal height (Figure 3). California sea lions were present in appreciable numbers during the September monitoring session only, however, because only one blast occurred in that session (and after monitoring had ended for the day), it was not possible to provide quantitative data on this species' response to projects spaced by 5 min.

5.2.1 *September Session*

The September session spanned three days of monitoring at Race Rocks (11-13 September). Weather was mostly calm and clear, with some patch fog on 12 September. Demolition activities during this session consisted of a single charge at ~20:50 on 12 September.

There was no indication that the single blast caused any animals to leave the ER. Although harbour seal responses to the single detonation were not monitored, Figure 3 suggests the number of hauled out individuals were not likely influenced by the blast. Again, tide height seemed to dictate the presence of harbour seals on haulouts; highest counts were in the morning during lower tides.

The number of California sea lions peaked (n = 44) on 11 September, gradually increasing in morning and decreasing in afternoon (Figure 4). Daily population peaks of California sea lions continued to decline on 13 September.

Numbers of northern sea lions fluctuated across the three days, exhibiting a slight downward trend among morning counts. However, counts were higher on 13 September (the day after the blast) than they were on the second count of 12 September (pre-blast) (Figure 5).

The single blast on 12 September occurred after observers had departed from the ER for the day; the main portion of the sea lion haulout in Area 2–5 was monitored remotely via the LBPC Race Rocks web cam. Light conditions at the time of the blast were poor, but sea lion silhouettes were conspicuous enough to permit counting. Prior to the blast, animals were mainly in a head-down resting position (Photo 1). After the blast, most, if not all northern sea lions on Area 2–5 raised their heads, but no movement to the water was evident – at least not in the foreground (Photo 2). A web-camera photo taken early on 13 September indicated that animal abundance and behaviour on Area 2–5 had returned to pre-blast levels (Photo 3).

Photo 1. Photo captured from the Race Rocks web cam, showing northern sea lions in a portion of Area 2–5 mainly in resting positions ~1 hour prior to a single blast on Bentinck Island at 20:05 on 12 September 2008.

Photo 2. Photo captured from the Race Rocks web cam, showing northern sea lions in "heads-up" position immediately after a single blast on Bentinck Island at 20:05 on 12 September 2008.

Photo 3. Photo captured from the Race Rocks web cam, showing northern sea lions in resting position the morning (07:16) of 13 September after a single blast on Bentinck Island at 20:05 on 12 September 2008.

5.2.2 *October Session*

Blasting in conjunction with a QL3 course occurred on 22 and 23 October only, with pre- and post-blast monitoring on 21 and 24 October, respectively. All blasts (projects) in a run were spaced at least 5 min apart. From the tower on Great Race Rock, the blasts seemed loud relative to past observations (pers. obs., MWD). This was most likely a result of meteorological conditions that favoured noise transmission from Bentinck to the ER. The last blast of the monitoring session (13:53:12 on 23 Oct) was particularly loud.

There were no notable disturbance events during pre-blast monitoring on 21 October. The number of all hauled-out pinnipeds – particularly northern sea lions – increased throughout the day (Figure 3 – Figure 5).

The number of northern sea lions hauled out on the morning of 22 October (pre-blasting) was considerably lower than that at the end of the previous monitoring day. The reduction was believed to have been caused by factor(s) other than DND activities, weather, or sea conditions. Numbers of northern sea lions on the main haulout (Area 2–5) increased steadily during the morning, from 135 individuals in the first count to 203 just prior to the first blast at 12:16:51 (Photo 4). Following that blast, all northern sea lions in Area 2–5 immediately began moving to the water. By the time the second blast occurred ~5 min later, only 1 animal was hauled out (Photo 5).

Blasting during the remainder of the day (October 22) caused varying degrees of disturbance, but animals continued to haul out nonetheless (and then were often disturbed to the point of re-entering the water). By the end of the monitoring day the total number of sea lions hauled out was similar to that in the morning (146 cf. 144 in the AM; Figure 5), but animal distribution within the ER and within individual haulouts differed, and activity levels were higher. Notably, many animals shifted to the lower (eastern) portions of Area 2–5 (as in Photo 6) and to Area 13.

Photo 4. Northern sea lions on Area 2–5 (~203 animals at ~11:47 on 22 October 2008; pre-blasting).

Photo 5. Northern sea lions on Area 2–5 (1 animal at ~12:20 on 22 October 2008; between first and second projects detonated on Bentinck Island).

The number of northern sea lions hauled out on the morning of 23 October was lower than at the end of the previous monitoring day (Figure 5). The first blast (on 23 October) occurred at 09:22:22. All 88 northern sea lions on Area 2–5 (Photo 6) went to the water (Photo 7) and northern sea lions in other parts of the ER increased their activity level. As seen in the photos, hundreds of Thayer's Gulls were also disturbed by the blast. Whether the sea lions were disturbed by the blast or the mass exodus of birds is not known; and vice-versa for the birds. In 2003, increased gull activity in response to a raptor overflight caused increased sea lion activity, but not mass displacement from a haulout (Demarchi and Bentley 2004). Although it is possible that gull activity amplified the sea lions' tendency to flee, the stampede would have probably occurred even in the absence of birds. By the time of the fourth blast (10:15:20), there were no northern sea lions hauled out in the ER. Sea lions continued to haul out during the remainder of the day, but the number at the end of the day did not return to the pre-blasting level (Figure 5).

Photo 6. Northern sea lions on Area 2-5 (~72 animals at ~08:29 on 23 October 2008; pre blasting. Note altered position on haulout as compared with Photo 4.)

Photo 7. Northern sea lions moving off Area 2–5 in response to the first blast of the day (~09:22 on 23 October 2008.)

On 24 October, the total number of northern sea lions in the ER was similar to that during the morning of 22 October (pre blasting; Figure 5), but animal distribution was different – presumably as a result of disturbances over the previous two days. For the first time since monitoring began in 1997, a notable number of northern sea lions were hauled out on the north side of Area 13 (Figure 5). Although no blasting occurred this day, an ecotour boat flushed ~70 sea lions to the water from Area 2–5 (Photo 8–Photo 10). It is possible that the animals were already sensitized from the blasting disturbances of the previous two days as evidenced by reactions to an unidentified disturbance stimuli at ~09:20, which caused all (~135 animals) to briefly raise their heads. Sea lion numbers recovered to near morning levels throughout the rest of the day (134 cf. 137 in the AM; Figure 5). Periodic checks of Areas 2–5 and 13 via the LBPC web camera through 31 October 2008 suggested that the numbers of northern sea lions in the ER did not show a notable increase or return to pre-disturbance distribution.

Photo 8. Northern sea lions on Area 2–5 prior to disturbance by an ecotour boat (~10:40 on 24 October 2008). Note most animals have heads down.

Photo 9. Northern sea lions on Area 2–5 during onset of disturbance by an ecotour boat (~11:21 on 24 October 2008). Note most animals are in a heads-up position.

Photo 10. Approximately 70 northern sea lions left Area 2–5 in response to the approach of an ecotour boat (~11:22 on 24 October 2008).

5.2.3 *November Session*

There were fewer animals present during the November session than during the October session. Pinniped distribution on the ER's haulouts in November likely reflected the disturbance caused during the QL3 course in October. This conclusion was based on the observation that pinniped distribution during November more closely resembled that which occurred after the October training course than that which occurred before it. For example, Area 2–5, which is usually covered with northern sea lions this time of year, was vacant, whereas Area 13, which is typically not used very much by northern sea lions, was most populated. Rough seas that washed over many of the haulouts also affected the distribution and abundance of pinnipeds in the ER.

Blasting occurred during a QL7 course on 4–6 November. As heard at the tower, blasts seemed about average in comparison with others during past monitoring sessions. Runs consisted of two projects detonated 5-min apart. From Race Rocks, the first blasts were not as loud as the second blasts, probably because the former, unlike the latter, were buried and not in a direct line-of-sight to Race Rocks.

No notable disturbance events were observed during the day of pre-blast monitoring (3 November), and the numbers of harbour seals and northern sea lions at haulouts increased throughout the day (Figure 3and Figure 5).

On the morning of 4 November, prior to any blasting, the number of northern sea lions in the ER was considerably lower (n = 34) than the previous evening (n = 177) (Figure 5). The reduction was probably caused by natural factors – namely the gale-force winds and large waves that had been washing over many of the haulout areas since early morning on 4 November. Numbers of northern sea lions on the main haulout (Area 2–5) were negligible all day. Numbers rose on Area 6–7 to a maximum of 40, but ended the day at 2 because of blasting-related disturbances (0 on Area 13).

On 5 November, numbers of northern sea lions were much higher in the morning than during the previous afternoon, most likely because of calmer sea conditions following the early morning storm on 4 November. By the end of the day, the number of northern sea lions in the ER was almost the same as that morning (Figure 5). Blasting caused a few animals to abandon their haulout, but most blasts just caused animals to raise their heads and maintain their position. Weather conditions this day were the gentlest of the three days of blasting (low swell, low seas, moderate winds; Appendix III).

Gale-force winds on 6 November prevented travel to Race Rocks, and the big winds and waves likely reduced the pre-blast numbers of northern sea lions hauled out on Area 6–7 and Area 13 (relative to numbers on the afternoon of 5 November). Therefore, observations were made during that day's demolition training from the Bentinck Island bunker. Although it was not possible to complete the two daily censuses this day, as viewed through a spotting scope on Bentinck Island, it was evident that the number of animals on Areas 6-7 and 13 were very low immediately prior to blasting (~15 total; note that we counted 6 northern sea lions on Area 6-7 and none on Area 13 during the first count of the morning). Blasting caused all animals to evacuate their haulout and enter the water. No sea lions were visibly hauled out by the time the final run of the day was conducted.

No blasting occurred on 7 November. Sea lion numbers increased slowly during the day but did not reach pre-blasting levels (i.e., as on 3 November). However, as we were departing after the afternoon census, an ecotour boat flushed ~30–40 sea lions from Area 13 to the water. It was possible that these animals were already sensitized to disturbance by the storms and blasting of the previous three days, suggested by their increased activity levels on post-blasting days (Figure 6).

6. SUMMARY & CONCLUSIONS

Group-living confers certain benefits to sea lions in that vigilance duties can be shared. In the event that a threat is present, not all animals need to detect it before responding. Rather, it only takes one or two animals to react strongly; their actions are sufficient to initiate a stampede that rapidly spreads through the group, especially if they physically contact or displace others when moving to the water (see “Inherent Sensitivity” in Figure 7). And while all animals undoubtedly hear the blasts on Bentinck Island and raise their heads independently, I hypothesize that the net displacement response of all animals is likely indicative of the disturbance thresholds of the more sensitive members of the group. In other words, if one individual rushes towards the water, others will likely follow.

Figure 7 presents a summary of cause-and-effect relationships between factors known or suspected to influence the response of sea lions (namely northern sea lions) to demolitions on Bentinck Island. The diagram shows single-factor relationships, but interactions between factors undoubtedly occur (i.e., the effect of one factor can be enhanced or ameliorated by the simultaneous occurrence of one or more other factors). The “fickle” factor refers to that aspect of animal behaviour resulting in animal responses that are inconsistent with our expectations based on our understanding of the effects of given stimuli. For example, as per Figure 7, it could account for the outcome of disturbance in situations where no such disturbance would otherwise be expected. Several researchers have documented haulout abandonment by northern sea lions for unknown reasons (e.g., Porter 1997; Demarchi and Bentley 2004; Kucey 2005).

During the three monitoring sessions in 2008, stormy seas, blasting, and ecotour boats independently caused the number of animals on the haulouts to be lower than expected in the absence of such influences. In general, 5-min intervals between blasts did not satisfactorily reduce disturbances of northern sea lions in the ER during monitoring sessions in 2008. During the October and November sessions, the first blasts of each day caused most animals (all in some areas) to abandon their haulout. Subsequent blasts often forced remaining animals to the water.

It is possible that certain atmospheric conditions propagated noise from Bentinck Island to the ER. For example, wind speed and direction, and air temperature profiles up to at least 1000 m asl have a considerable effect on noise levels reaching Race Rocks (Demarchi et al. 2008). Unfortunately, aside from some seasonal trends, these profiles can change hourly and are difficult, if not impossible, to accurately forecast. Furthermore, there is no available dataset that would lend itself to a detailed examination of the effects of wind speed and direction, and air temperature profiles (to 1000 m asl) on pinniped response. Although possible to calculate a relationship between wind direction at the lighthouse and the following wind[7] (i.e., the extent to which winds would attenuate or enhance sound propagation from Bentinck to Race Rocks), the shape of the wind profiles in figures 9 to 11 of Demarchi et al. (2008) suggest such a relationship would be weak and of little practical use as a planning tool for mitigating training impacts by selecting only those days with favourable wind conditions. Demarchi and Bentley (2004) found no relationship between wind direction at the tower and northern sea lion response to blast noise; although a relationship did exist in the case involving California sea lions (Table 5 in Demarchi et al. 2008).

[7] As described by Demarchi et al. (2008) a “following wind” is one in which the propagation of in-air noise from Bentinck Island to Race Rocks Ecological Reserve is enhanced. The opposite of a following wind is a countering wind. That wind attenuates noise propagation between Bentinck Island and Race Rocks.

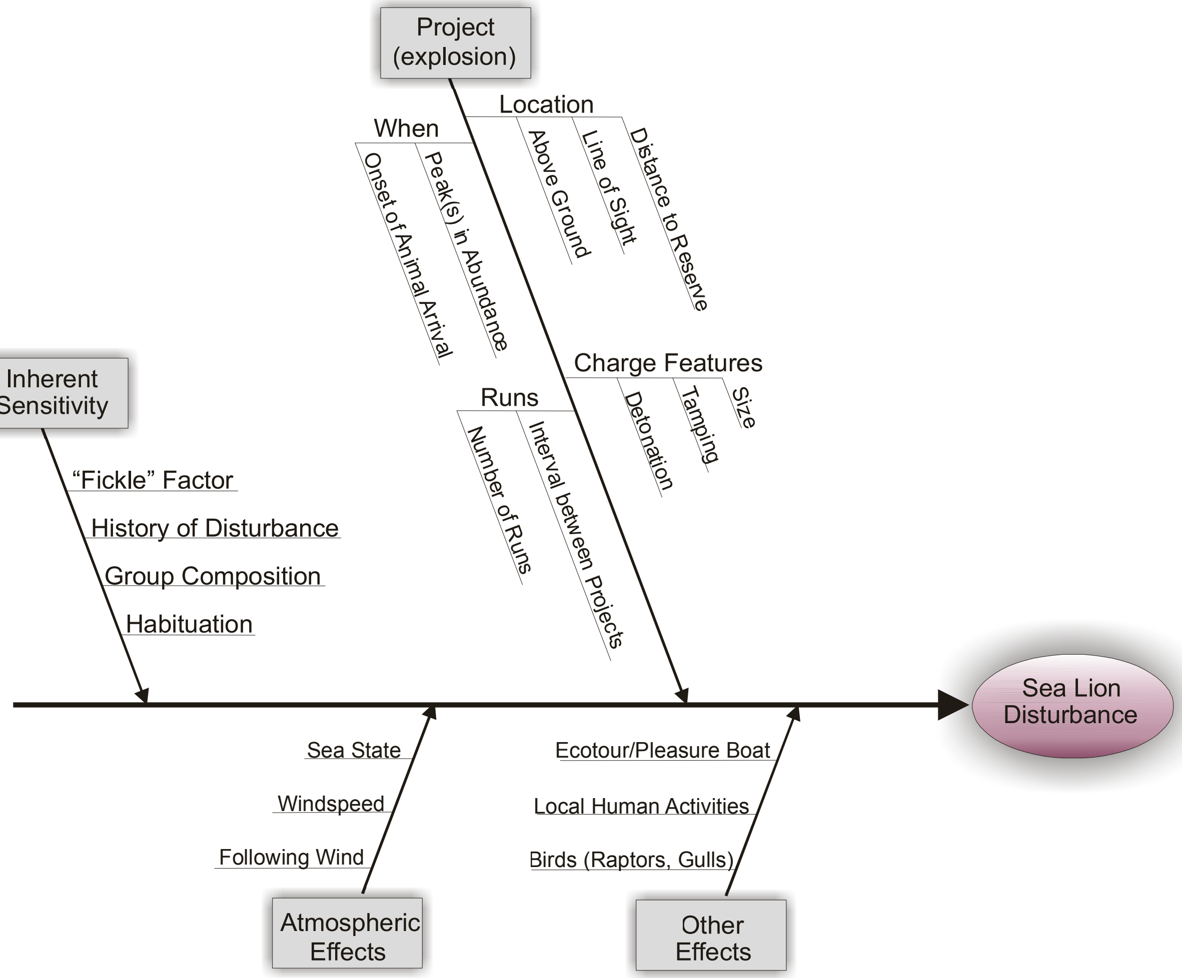


Figure 7. Cause-and-effect (Ishikawa) diagram showing linkages between known or suspected factors that increase the probability that sea lions will be displaced from haulouts in the Race Rocks Ecological Reserve. Interactions between factors are not shown, but are expected to occur.

By understanding the possible roles of the factors in Figure 7, further potential mitigation measures can be developed and tested. As discussed above, atmospheric conditions are crucial, but it is impractical to factor weather into training schedules as a means of mitigation. Options to modify charge features or runs (as per Figure 7) are either limited by training requirements or do not sufficiently influence animal responses to constitute an effective mitigation.

Based on work to date (Demarchi et al. 1998; Demarchi and Bentley 2004; Demarchi et al. 2008; this study), the remaining options to mitigate impacts on sea lions include:

Habituation – experimental trials to test the ability of sea lions to habituate to blast noise by subjecting them to impulsive noises of lower levels (e.g., gas cannon or rifle shot on Bentinck) prior to demolitions.

Alternate training location(s) – at specific times of year (e.g., late summer through early winter when sea lion abundance is greatest) conducting demolitions at an alternate site, either on Bentinck Island (as per Demarchi et al. 2008) or elsewhere in WQ, could reduce noise propagation towards the ER and thus reduce the probability of disturbing sea lions. As noted in conversation with Range personnel, the shoreline of Whirl Bay might be a suitable alternative, partly because it already has a safety bunker on site. Moreover, moving operations to Whirl Bay would have the added benefit of reducing disturbances to harbour seals around Bentinck Island (as documented by Demarchi et al. 1998). It is worth noting that Demarchi et al. (1998) observed underwater blasts in Whirl Bay to disturb sea lions at Race Rocks under certain atmospheric conditions. As the in-air noise levels of above-water demolitions would be even louder than in-air levels of underwater charges, some disturbance could still be expected to occur under certain atmospheric conditions.

While the results of the two monitoring sessions in October and November 2008 were unequivocal, they are inconsistent with observations reported by Demarchi et al. (2008) which suggested that spacing projects ~5 min apart could reduce the magnitude of sea lion disturbance. Furthermore, the small sample sizes (i.e., number of monitoring sessions) conducted to-date serve to reduce the confidence of the conclusion that blast-spacing is an ineffective mitigation. Therefore, prior to exploring further mitigation options, it is advisable to conduct additional monitoring of the blast-spacing mitigation in order to better gauge the extent to which this approach can function as a viable mitigation. Collecting additional observational data during demolition training exercises between August and December should provide greater certainty on the effectiveness of spacing projects by at least 5 min as a means of mitigating disturbance of pinnipeds in the Race Rocks ER. Should it be necessary to explore alternate means of mitigating the adverse effects of training activities on sea lions, an expanded monitoring dataset would inform and substantiate management actions.

7. LITERATURE CITED

Demarchi, M.W. 2002. Grizzly bears, impact significance, and the Greenville to Kincolith Road Project in western central British Columbia. Pages 491-498 in: 2001 Proceedings of the International Conference on Ecology and Transportation, Keystone Colorado. Center for Transportation and the Environment, Raleigh, NC.

Demarchi, M.W. and M. Holst. 2008. Options to mitigate impacts of DND's demolition training exercises in WQ on marine mammals and ecotourism in the Race Rocks Ecological Reserve British Columbia. Draft version 2. LGL Report EA1931. Prepared for Department of National Defence, Canadian Forces Base Esquimalt and Public Works and Government Services Canada.

Demarchi, M.W. and M.D. Bentley. 2004. Effects of natural and human-caused disturbances on marine birds and pinnipeds at race rocks, British Columbia. Report Prepared by LGL Ltd., Sidney, BC, for Department of National Defence and Public Works & Government Services Canada, Victoria, BC.

Demarchi, M.W., W.B. Griffiths, D. Hannay, R. Racca, and S. Carr. 1998. Effects of military demolitions and ordnance disposal on selected marine life near Rocky Point, southern Vancouver Island. LGL Report EA1172. Prepared for Department of National Defence, Canadian Forces Base Esquimalt.

Demarchi, M.W, A. MacGillivray, R. Racca and M. Austin. 2008. Mitigation of demolition training impacts in Military Training Area WQ on seals and sea lions in the Race Rocks Ecological Reserve, British Columbia: Phase II Final Report. LGL Report EA1931.1. Prepared for Department of National Defence, Canadian Forces Base Esquimalt and Public Works and Government Services Canada.

Hopper, M. 2002. WXTide32 Version 2.7. Program downloaded from the INTERNET in 2002: http://wxtide32.com/.

Kucey, L. 2005. Human disturbance and the hauling out behavior of Steller sea lions (*Eumetopias jubatus*). MSc. Thesis, Univ. British Columbia. 67 p.

Porter B. 1997. Winter ecology of Steller sea lions (*Eumetopias jubatus*) in Alaska. MSc Thesis. University of British Columbia. Vancouver, BC. 84 p.

Wright, C.A. and J.P. Pringle. 2001. Race Rocks Marine Protected Area: an ecological overview. Canadian Technical Report of Fisheries and Aquatic Sciences 2353: 1-93.

Appendix I. Date, time and number of slabs of C4 explosive detonated in each project of demolitions training runs on Bentinck Island during the monitoring sessions in October and November 2008. One slab of C4 weighs 0.56 kg.

Date	Time	Slabs
12-Sept-08	~20:50	≤4
22-Oct-08	12:16	2
	12:22	1
	12:27	1
	14:14	3
	14:19	1
	14:24	1
	15:09	3
	15:14	1
	15:20	1
23-Oct-08	9:22	3
	9:28	1
	9:34	1
	10:09	3
	10:15	1
	10:20	1
	11:03	3
	11:08	1
	11:13	1
	13:42	2
	13:47	3
	13:53	3

Date	Time	Slabs
04-Nov-08	10:38	4
	10:44	4
	11:50	4
	11:55	4
	14:08	4
	14:13	4
	15:07	4
	15:13	4
05-Nov-08	10:15	4
	10:21	4
	11:30	4
	11:37	4
	12:42	4
	12:47	4
	14:52	4
	14:57	4
06-Nov-08	9:57	4
	10:02	4
	11:00	4
	11:06	4

Appendix II. Data collected during pinniped monitoring sessions at Race Rocks.

Weather Data

Date: day, month, year of observation
Time: hh:mm:ss of observation
Air: air temperature
Wind: windspeed (knots) from the tower instrument
Wind direction: bearing off true north from the tower instrument
Sea State: Beaufort Scale 0-12
Swell Height: The extent to which swells washed over the haulouts. N=Nil; L=Low; M=Moderate; H=High
Cloud: cloud class 1=clear; 2=broken <50% cloud cover; 3=broken >50%; 4=unbroken cloud
Rain: rain class N=nil; F=fog; M=misty; D=drizzle; LR=light rain; HR=hard rain; H=hail; S=snow
Vis: horizontal visibility class; U=unlimited; M=moderate (near Vancouver Island still visible); L=low (Vancouver Island not visible; Race Rocks visible); P=poor (not all of Race Rocks complex visible)

Census Data

A census of all marine birds and mammals on land and visible in the study area was conducted twice daily – once in the morning and once at the end of the monitoring day.
Time: hh:mm:ss of start of census for each area
Sub-Area: zone of Great Race Rock (A-H) or islet number (see Figure 2 of Demarchi and Bentley 2004)
Species: 4-letter species code
Number of individuals: count

Activity Data

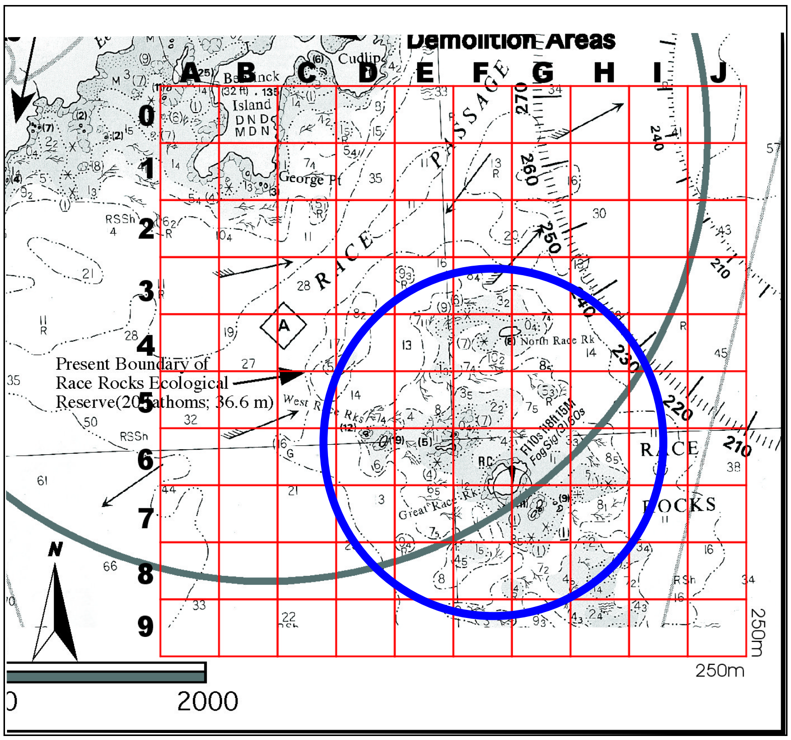
Observations of animal activity during periods of no disturbance and disturbance.

Time: hh:mm:ss of start of sample
Sub-Area: Zone of Great Race Rock or islet number sampled
Disturbance: indicate if a disturbance event is associated with this sample – Y=yes; N=no
Disturbance Type: (see below)
Species: birds and pinnipeds
Count: total number of each pinniped species hauled out in the Sub-Area
Heads Up: number of pinnipeds with raised heads (including ones resting in this position)

Disturbance Data

Observations of potential disturbance factors.

Disturbance type: Aircraft; Bald Eagle; Blast location; Foghorn; Helicopter; Human; Kayak; Pleasure Boat <6m; Pleasure Boat >6m; Lester B. Pearson College boat; Race Rocks boat; Whale-watching (ecotour) boat (inflatable, fiberglass or aluminum); Other
Time Begin: hh:mm:ss when disturbance (or potential disturbance) factor entered the monitored area or departed from the helipad or dock on Great Race Rock
Time End: hh:mm:ss when disturbance factor landed/docked in the monitored area, or when it left the monitored area
Zones Entered: List all the alpha-numeric zones that the disturbance factor is present in during the observation period (see figure below).



Grid over the monitored area to track water- and land-based disturbances within blue-line perimeter.

Appendix III. Weather conditions observed from atop the light tower on Great Race Rock during the study. Swell conditions of N=nil; L=low; M=moderate; H=high indicate the degree to which water washes over the main haulouts (e.g., Area 2-5). Sea state is per the Beaufort Scale. Could cover: 1=clear; 2=>1 and <50% cloud cover; 3=>50 and <100% cloud cover; 4=100% cloud cover. Data on 6 Nov 08 were estimated from Bentinck Island.

Date & Time	Air (°C)	Wind (Knots)	Wind_Dir. (bearing)	Sea State	Swell	Cloud Cover	Rain	Vis
11/09/2008 8:48	13	6	80	1	N	1	Nil	Unlimited
11/09/2008 12:09	15	11	115	2	N	1	Nil	Unlimited
11/09/2008 15:38	17	5	137	0	N	1	Nil	Unlimited
12/09/2008 10:56	13	13	254	2	N	1	Nil	Moderate
12/09/2008 12:28	13	18	262	2	N	1	Nil	Unlimited
12/09/2008 15:03	14	20	243	2	N	1	Fog	Poor
12/09/2008 16:22	14	19	252	3	N	1	Nil	Unlimited
12/09/2008 18:09	14	15	233	3	N	1	Nil	Unlimited
13/09/2008 9:13	14	3	245	1	N	1	Nil	Unlimited
13/09/2008 11:17	14	10	150	1	L	1	Nil	Unlimited
13/09/2008 12:06	14	10	130	1	N	1	Nil	Unlimited
13/09/2008 12:55	16	9	135	1	N	1	Nil	Unlimited
21/10/2008 10:52	12	3	131	2	N	2	Nil	Unlimited
21/10/2008 12:21	10	7	37	2	L	3	Nil	Unlimited
21/10/2008 15:46	10	10	20	2	L	4	Nil	Unlimited
22/10/2008 8:41	8	15	44	2	N	1	Nil	Unlimited
22/10/2008 8:41	8	15	44	2	N	1	Nil	Unlimited
22/10/2008 10:57	9	11	44	2	L	1	Nil	Unlimited
22/10/2008 12:25	10	10	77	2	N	1	Nil	Unlimited
22/10/2008 12:52	10	10	103	1	N	1	Nil	Unlimited
22/10/2008 14:33	11	9	131	2	N	1	Nil	Unlimited
23/10/2008 8:21	8	14	288	2	L	2	Nil	Unlimited
23/10/2008 12:08	12	7	263	2	L	2	Nil	Unlimited
23/10/2008 13:30	11	5	260	1	L	1	Nil	Unlimited
23/10/2008 13:57	11	4	247	1	L	1	Nil	Unlimited
24/10/2008 9:04	9	10	260	1	L	3	Nil	Unlimited
24/10/2008 11:29	10	14	277	2	L	3	Nil	Unlimited
24/10/2008 13:08	10	19	270	2	L	3	Nil	Unlimited
03/11/2008 10:26	10	6	44	1	M	3	Nil	Unlimited
03/11/2008 12:38	10	6	44	1	L	4	Nil	Unlimited
03/11/2008 15:19	10	6	105	1	L	4	Light Rain	Unlimited
04/11/2008 8:56	10	30	250	6	L	3	Nil	Unlimited
04/11/2008 10:16	10	25	245	6	L	3	Nil	Unlimited
04/11/2008 11:50	10	23	260	6	L	3	Nil	Unlimited
04/11/2008 13:09	10	28	265	6	M	3	Nil	Unlimited
04/11/2008 14:34	10	28	270	6	M	2	Nil	Unlimited
05/11/2008 8:35	6	10	67	2	N	3	Nil	Unlimited
05/11/2008 10:14	6	13	60	2	N	3	Nil	Unlimited
05/11/2008 11:35	7	14	56	2	L	3	Nil	Unlimited
05/11/2008 14:34	9	20	70	4	L	4	Nil	Unlimited
06/11/2008 8:21	12	20	-	6	H	4	Light Rain	Low
06/11/2008 9:33	10	12	-	4	H	4	Light Rain	Moderate
07/11/2008 10:07	12	18	29	2	N	4	Light Rain	Moderate
07/11/2008 13:39	12	13	36	0	N	4	Nil	Moderate

Appendix IV. Total numbers of pinnipeds (shaded) and birds in Race Rocks Ecological Reserve as counted from atop the light tower during each of the two daily censuses (Cen.) for the monitoring sessions in September through October 2008. Swimming or flying individuals are not included.

Date	Cen.	ELSE	HASE	CASL	NOSL	Gulls	Cormorants	Shorebirds	Bald Eagle
11-Sep-08	1	0	120	25	107	1685	2	5	0
	2	3	80	44	78	1088	5	8	0
12-Sep-08	1	2	190	28	95	633	2	17	0
	2	1	136	38	67	849	1	57	0
13-Sep-08	1	2	201	29	88	1096	0	5	0
	2	3	113	31	83	638	4	11	0
21-Oct-08	1	1	83	5	251	3549	111	2	1
	2	1	122	6	297	4185	71	11	0
22-Oct-08	1	1	111	2	144	8491	4	0	0
	2	1	112	0	146	2317	74	0	0
23-Oct-08	1	1	117	2	94	7515	1	1	0
	2	1	46	4	68	1738	67	0	0
24-Oct-08	1	1	156	3	137	7082	5	0	0
	2	1	68	4	134*	2135	51	4	1
03-Nov-08	1	0	11	2	152*	3479	143	1	0
	2	0	46	3	177*	4027	111	20	0
04-Nov-08	1	0	15	0	34*	3592	165	2	0
	2	0	27	1	5	4401	80	1	0
05-Nov-08	1	0	34	1	118*	3971	141	0	0
	2	0	23	4	123*	2721	162	4	0
07-Nov-08	1	0	24	0	8	2691	83	10	0
	2	0	119	0	57	2838	60	1	0

ELSE = Northern Elephant Seal
HASE = Harbour Seal
CASL = California Sea Lion
NOSL = Northern (Steller) Sea Lion

* includes animals on the north side of Area 13 which were counted from the water on daily trips to and from Race Rocks, respectively.