Marine-living Northern River Otter Health and Their Feasibility as a Sentinel Species Along the Coast of Southern Vancouver Island



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EXECUTIVE SUMMARY

The goal of this project was to investigate the feasibility of using the Northern River Otter (*Lontra canadensis*) as a sentinel species[1] (in particular for products associated with oil spills) and to assess the general health of the coastal population from Port Renfrew to Victoria, on southern Vancouver Island.

Objectives:

1. To characterize marking activities and use along the coastline of the study area.
2. To assess Northern River Otter health by examining for evidence of exposure to environmental contaminants.
3. To assess the prevalence of *Cryptosporidium*, *Giardia*, *Toxoplasmosis*, *Brucella*, marine caliciviruses, influenza A virus, canine distemper virus, and *Sarcocystis* in marine-living Northern River Otters.

Sampling of the spraint (otter scat) was integrated with a similar project underway in Puget Sound, so that the two projects complement each other and provide a good picture of Northern River Otter in the region.

The results of the laboratory testing of six otters for environmental contaminant had not been received at reporting time, but, based on experience in Europe and Alaska, it appears that otters are a good indicator of environmental contamination.

A total of 36 spraint samples were tested for zoonotic protozoa and other parasites. *Cryptosporidium* was found in three samples, and a *Sarcocystis* oocyst and Strongyle eggs were found in two different samples.

In the west end of the study area Northern River Otters seem to mark less often at very exposed sites. In and around Victoria they prefer to locate marking sites on islands. We found fewer marking sites on gravel beaches than on rocky shores.

[1] A sentinel species is a species that is sensitive to pollutants and therefore useful for measuring or indexing levels of environmental contamination in an environment (Bowyer *et al.* 2003).

TABLE OF CONTENTS

Acknowledgements iii
Executive Summary iv
Introduction 1
Goal and Objectives 2
Study Area 3
Methods 5
Characterization of Northern River Otter Use 5
Northern River Otter Health Assessment Sampling 6
Results 8
Northern River Otter Transects 8
Northern River Otter Health 10
Discussion 11
References 13
Appendices 17
Appendix 1: Description of Diseases. 17
Appendix 2: Dr. J. Gaydos' Northern River Otter Necropsy and Disease-testing Protocol. 19
Appendix 3: Attributes of Northern River Otter Spraint Sampling Sites. 22
Appendix 4: Data from Surveyed Northern River Otter Transects along Juan de Fuca Strait, Vancouver Island, 2004. 25

LIST OF TABLES

Table 1. Categories of Northern River Otter site use. 6
Table 2. Northern River Otter signs along surveyed transects along the coast of Juan de Fuca Strait, 2004. 9
Table 3. Results of laboratory tests on Northern River Otter spraints. 11
Table 4. Selected nematodes, viruses, and protozoa hosted by marine animals.[1] 13

LIST OF FIGURES

Figure 1. Study area. 4
Figure 2. Examples of spraint age categories used. 5
Figure 3. Northern River Otter spraint sampling sites (Map 1). 7
Figure 4. Northern River Otter spraint sampling sites (Map 2). 7
Figure 5. Elevation above sea level of Northern River Otter marking sites. 8
Figure 6. Location of searched Northern River Otter transects along the coast of Juan de Fuca Strait, southern Vancouver Island, 2004. 9
Figure 7. Results of analysis of Northern River Otter spraints from along the coast of Juan de Fuca Strait, southern Vancouver Island, 2004. 10

INTRODUCTION

The Northern River Otter (*Lontra canadensis*) is found throughout North America in both freshwater and marine environments. In British Columbia, the Northern River Otter is listed as a species not at risk of extinction (B.C. CDC 2003). It is, however, listed in Appendix II of the Convention on International Trade of Endangered Species (CITES Identification Manual, Reference Number A-112.004.023.001), which indicates it may be threatened if trade, trapping, and other factors are not tightly controlled. These other factors could include both environmental contamination and parasitic disease.

In marine ecosystems, Northern River Otters inhabit the intertidal and near-shore environment, where they play an important ecological role (Melquist and Dronkert 1987). The diet of coastal Northern River Otters consists mainly of mid-sized, slow-moving fish, but they will opportunistically feed on birds and occasionally crustaceans (Stenson *et al.* 1983). Because, like pinnipeds and cetaceans, the Northern River Otter feeds mainly on fish, it is considered a good indicator (i.e., a sentinel species) of environmental contaminants such as the PCBs and heavy metals that accumulate in many fish species (Harding *et al.* 1998; Ross *et al.* 2001; Bowyer *et al.* 2003). A good indicator of environmental contaminants must mirror the contaminant levels in the environment and must be relatively cost efficient to sample. Because Northern River Otters are relatively abundant in the study area, they may fulfil both these criteria.

Catastrophic oil spills are now well documented as having a major impact on local marine wildlife populations (Wiens 1996; Bodkin *et al.* 2002; Esler *et al.* 2002; Golet *et al.* 2002), with environmental contamination causing both short- and long-term effects (Bowyer *et al.* 2003). For example, Northern River Otters and Sea Otters (*Enhydra lutris*) exposed to crude oil from the 1989 Exxon Valdez spill showed acute mortality and a much higher death toll than was first expected. They also suffered from chronic blood and enzyme chemistry changes that affected their health two years after the spill (Duffy *et al.* 1994). Otters that survived in oiled areas had lower body weight than in non-oiled areas. Over time their weight increased and, after about eight years, was back to normal (Bowyer *et al.* 2003).

Oils spills do not have to be large to significantly affect concentrated local populations of sea birds (Burger, pers. comm. 2004). Other localized populations, such as Northern River Otters, are likely similarly vulnerable. Hundreds of sports fishing vessels congregate near Rocky Point during salmon runs (C. Engelstoft, unpublished data) and could be a source of almost constant small oil spills that could have a negative impact on local marine wildlife.

Environmental contamination is not limited to oil spills. In the waters around Vancouver Island, where there has not been a major oil spill, the resident Killer Whales (*Orcinus orca*) are known to carry high levels of environmental toxins such as PCBs and other organic and non-organic pollutants (Ross *et al.* 2000). The high level of toxins in Killer Whales is suspected to be reflected in poor reproductive performance and other health parameters (Krahn *et al.* 2002; Wiles 2003). Other marine species, such as the southern population of Sea Otter, are increasingly affected by environmental contaminants and mortality associated with zoonotic parasites (Lambourn *et al.* 2001b). The impact of these pollutants is significant; PCBs are regarded as one of several factors

that have contributed to the decline of the European River Otter (*Lutra lutra*; Ross *et al.* 2001; Miller *et al.* 2002).

Wildlife health issues (Addison *et al.* 1988), whether caused by environmental contaminants or related to infectious disease, are becoming an important aspect of conservation (Deem *et al.* 1999). An ongoing study in Puget Sound, Washington, is assessing the exposure of Northern River Otters to several viruses seen in marine mammals (Gaydos, pers. comm.) and is complemented by the current study investigating Northern River Otters in the adjoining Canadian waters. Several parasites are currently being investigated as significant causes of mortality in Sea Otter populations in California. The studies are also evaluating the role of environmental contaminants, particularly those from oil spills, and their effect on the immune systems and health of Sea Otters (Schwantje, pers. comm. 2004).

Like the California study, we broadened the scope of our investigation to include both parasitic disease and environmental contamination.

We propose to determine the prevalence of disease in Northern River Otter populations (and in other mammal species) along the coast of Juan de Fuca Strait. We hypothesize that the short- and long-term effects of oil spills in the southwest coastal ecosystem of Vancouver Island include the deposition of many contaminants into the environments used by Northern River Otters. We propose that by evaluating the health and environmental contaminant burdens of Northern River Otters, we can evaluate the degree of environmental contamination by oil spills in the study area.

GOAL AND OBJECTIVES

The goal of this project is to investigate the feasibility of using Northern River Otters as a sentinel species (in particular for products associated with oil spills) and to assess the general health of the coastal population on Vancouver Island from Port Renfrew to Victoria.

The proposed otter health assessment is similar to a study presently underway in Puget Sound, Washington, headed by Joe Gaydos of the Wildlife Health Center, U.C. Davis, Orcas Island, and we anticipate that the two projects will complement each other and provide good comparisons and a regional picture of otter health.

Objectives:

1. To characterize marking activities and otter use along the coastline of the study area.
2. To assess Northern River Otter health by examining for evidence of exposure to environmental contaminants.
3. To assess the prevalence of *Cryptosporidium*, *Giardia*, *Toxoplasmosis*, *Brucella*, marine caliciviruses, influenza A virus, canine distemper virus, and *Sarcocystis* in marine-living Northern River Otters.

STUDY AREA

The study area is located on the southern tip of Vancouver Island, B.C., and stretches along a 100-km coastline from Port Renfrew (UTM 10U 396352mE 5378319nN) in the west to Victoria (UTM 10U 482123mE 5363726mN) in the east (Figure 1). Three major rivers and approximately 18 creeks enter the ocean in the study area. The Jordan River is located by the settlement of the same name, and the San Juan and Gordon rivers run into Harris Cove by Port Renfrew, at the west end of the study area.

The climate in the area is relatively mild, but annual precipitation varies widely from east to west. The yearly average precipitation for Victoria is 883 mm and the mean temperature is 9.7°C. In Port Renfrew, the yearly average precipitation is 3,670 mm and the mean temperature is 9°C (Environment Canada 2004). Little snow occurs along the coast.

Wave action varies from east to west; the west end of the study area is close to the mouth of Juan de Fuca Strait and is exposed to large wave action, which diminishes toward Victoria in the east. Similarly, the coastline varies, being more rugged toward Port Renfrew in the west.

Near Port Renfrew, the coastline is dissected by surge channels and is rocky, steep, and exposed. Going east, the relatively steep and forested coastline opens at intervals into broad beaches. Near Parkinson Creek, the coastline consists of flat bedrock. Farther east, the cliffs open onto Sombrio Beach, a cobble and boulder beach. China Beach, a pebble beach, lies near Jordan River (Figure 1). Next is French Beach, also a pebble beach. To the east, the coastline becomes increasingly less steep. Sooke Harbour is a sheltered inlet with the town of Sooke on the north shore and the rural community of East Sooke on the south. The rugged coast of East Sooke Regional Park lies on the outer coast. East of Rocky Point, the coastline is similar to China Beach, with several lagoons: the largest is Witty's Lagoon, adjacent to Tower Point, then Esquimalt Lagoon. Farther east, Greater Victoria dominates the landscape with its built-up coastline. The coast is rocky but less rugged than farther west. The islands around Discovery Island are not developed and provide a refuge from the bustling city life.

The exact population size and density of marine-living Northern River Otters along the coast from Port Renfrew to Victoria is unknown, but Giere and Eastman (2000) found that the density of Northern River Otter dens was lowest in urban areas, presumably due to disturbance of rolling, feeding, and denning sites. However, local knowledge from nuisance animal trappers and others indicates that even in urban areas, this species is relatively common in the southwest coastal area of Vancouver Island.



Figure 1. Study area.

METHODS

Characterization of Northern River Otter Use

To characterize Northern River Otter use, we walked transects along stretches of the coastline, particularly in locations with easy access for Northern River Otters. The aim was to cover approximately 1.5 km of coastline in each transect. Some transects were located on islands and were accessed when boat rides were available.

We used aerial photographs from the Natural Areas Atlas (CRD 2002) as base maps to mark start and end points of the transects. All sites with otter signs such as spraint (otter scats), run-ways or trails, marking piles, rolling areas, and dens were indicated on these maps. The UTM coordinates were taken from the Natural Areas Atlas. When we could not accurately determine the location on the maps, we determined site UTM coordinates using the NAD83 datum with a handheld GPS unit (Garmin GPSmap76) in the field and later checked on the Natural Areas Atlas. The length of the transects was calculated on the Natural Areas Atlas.

When a site with Northern River Otter spraint was encountered, we collected the following data:

- Spraints were counted and categorized as fresh, medium, or old (Figure 2). "Fresh" spraints were moist and greenish. "Medium" were relatively dry and black. "Old" were dry and grey or totally washed out.
- From the number of scats, each site was categorized as a high-, medium-, or low-use site (Table 1). If a site was visited and no signs were found, it was considered to be "not used." If an otter carcass was found but there were no spraints, the site was still considered to be "not used."
- The presence of rolling places, marking mounds, run-ways, and dens were noted for each site. The following site attributes were estimated or noted: elevation, distance to high tide line, and shore substrate (rock, pebble, or boulder).



Fresh Medium Old

Figure 2. Examples of spraint age categories used.

Table 1. Categories of Northern River Otter site use.

Category	Attribute
High	15 or more scats
Medium	3–14 scats
Low	≤ 2 scats
Not used	0 scats

Northern River Otter Health Assessment Sampling

To assess the health of the Northern River Otter population in the study area, Northern River Otter carcasses and spraints were sampled for zoonotic diseases.

We obtained carcasses from local trappers in the survey area and used a protocol established by Joe Gaydos (Wildlife Health Center, U.C. Davis, Orcas Island, WA) for conducting necropsies and sampling (see Appendix 2). The histology and microbiology analyses were performed according to a preexisting protocol established by Gaydos and Stephen Raverty (Animal Health Centre, B.C. Ministry of Agriculture and Lands, Abbotsford, B.C.).

For sampling spraints, a series of 73 survey sites were established throughout the survey area (Figures 3 and 4). These sites were located during reconnaissance surveys in the spring of 2004, and most prominent headlands and other locations thought to be good sites for Northern River Otter marking were visited. If two sites were within 100 m of each other, they were considered subsites of a single site. Subsites were indicated with decimal digits (e.g., 15.1 and 15.2) in the database, but indicated as integers on the maps.

The samples sent for laboratory testing were chosen with an attempt to represent as large an area as possible to decrease the probability that samples were from the same animal.

Only fresh spraints were collected for laboratory testing. The scats were placed in 18-oz Whirl-Pak bags, and transported in a cooler with icepacks from the sites to a refrigerator where the samples were stored until they were shipped to the laboratory. Each bag was marked with a unique number, date, location, and collector's initials. Samples were shipped by overnight courier, in coolers with icepacks. The laboratory tests were conducted within 10 days of sampling, using Sheather's flotation (Gajadhar 1994; #151). The spraints were also tested with a zinc sulphate flotation (1.18 sp. gr.), in which the sucrose in the Sheather's solution was replaced with zinc sulphate solution.

Data were entered in Excel (XP) spreadsheets and descriptive statistical and *t*-tests were conducted with SPSS 7.5 statistical software.

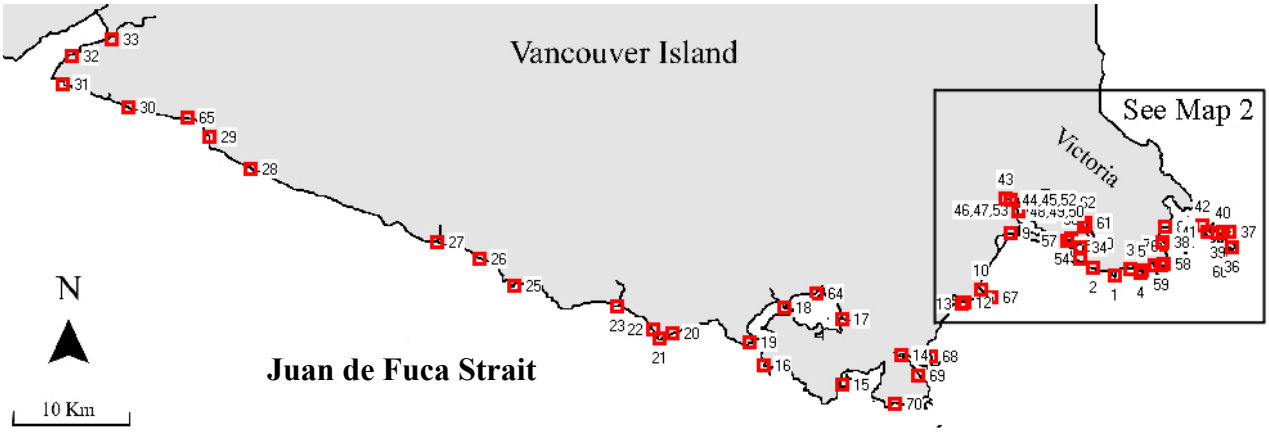


Figure 3. Northern River Otter spraint sampling sites (Map 1).

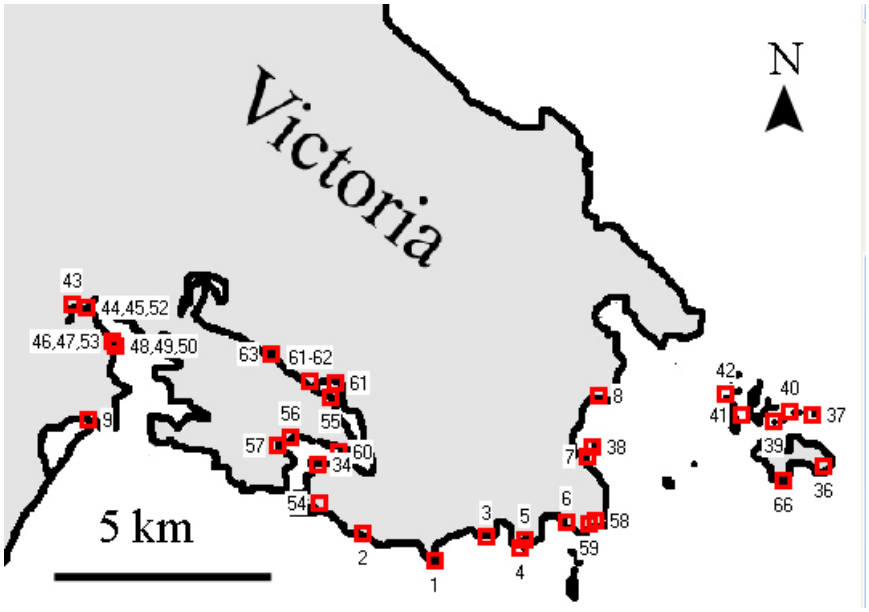


Figure 4. Northern River Otter spraint sampling sites (Map 2).

RESULTS

Signs of Northern River Otter were found throughout the study area, generally within 30 m of the high tide line, except for two sites on Discovery Island that were up to 150 m from the ocean. Most of the marking sites were within 10 m of the high tide line and only 2.5% (n = 3) were above this level (Figure 5; Appendix 3). The average elevation was 4.6 m (SD = 3.2; range, 0.5 to 20 m). Not surprisingly, all sites were accessible to Northern River Otters from the water. Generally, the routes from the water to the marking site had a relatively shallow grade, but in a few places, the passable route was quite steep, indicative of the Northern River Otter's agility on land.

Northern River Otter Transects

We surveyed eight transects throughout the study area (Figure 6). The total length of the coast surveyed on foot was 14.4 km and the average transect length was 1.9 km (SD = 1.1 km), ranging from 0.3 km on a site with a very rugged coast, to 3.3 km on sites with more accessible coast topography (Table 2). We found 76 marking sites separated by a mean distance of 110 m (SD = 105; range, 13 to 591 m; mode, 111 m; see Appendix 4). The mean distances on Vancouver Island (mean = 120 m, SD = 158, n = 34) and on smaller islands (mean = 100m, SD = 55m, DF = 35) were similar ($t_{(0.05, 2)} = 0.747$, $p = 0.458$, DF = 71). The average distance was also similar ($t_{(0.5, 2)} = 0.147$, $p = 0.883$, DF = 71) for sites on bedrock (mean = 108 m, SD = 123 m, n = 57) and other types, such as gravel and boulder (mean = 113 m, SD = 82 m, n = 16).

Spraints were the most commonly observed Northern River Otter signs, but occurrences of trails, marking piles, and rolling sites were directly correlated to the density of spraint at highly used sites (Table 2). Clearly used trails led from the ocean to marking sites or other areas used by the otters. Spraint deposition sites are commonly located on small piles of vegetation or available debris scraped together by Northern River Otters. These piles were fairly common. Northern River Otters often roll in shoreline vegetation, leaving large patches of trampled vegetation and, if the area has been used for a while, bare earth. These rolling places were common in our study area (see Appendix 4).

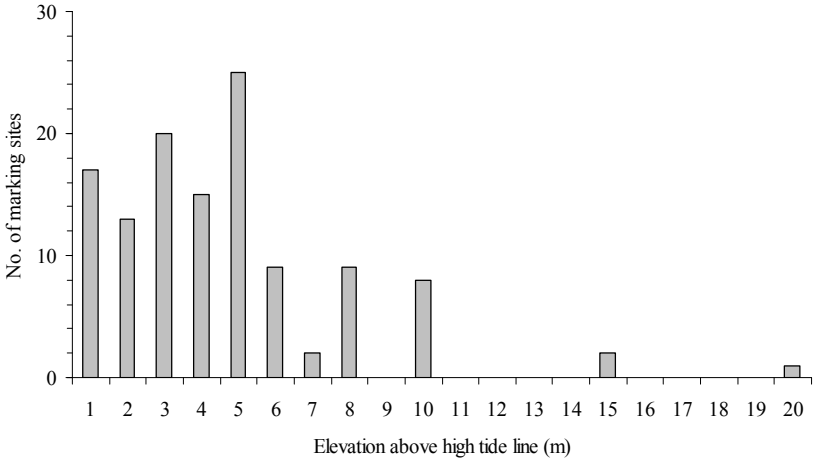


Figure 5. Elevation above sea level of Northern River Otter marking sites.

Table 2. Northern River Otter signs along surveyed transects along the coast of Juan de Fuca Strait, 2004.

	Discovery Island	Trial Island	Dallas Rd. (Victoria)	East Sooke Park	French Beach	China Beach	Sombrio Beach	Botanical Beach
Transect length (km)	3.30	1.90	2.40	1.68	0.30	3.24	1.55	0.69
Total sign locations	23	19	1	24	5	3	6	1
Low-use sites	1	6	0	6	1	1	1	0
Medium-use sites	10	7	0	9	3	2	3	1
High-use sites	12	6	1	9	1	0	2	0
Highly used sites / 100 m	0.4	0.3	0.0	0.5	0.3	0.0	0.1	0.0
Marking piles / 100m	0.2	0.5	0.0	0.7	0.3	0.0	0.0	0.0
Rolling sites / 100 m	0.3	0.6	0.0	0.6	0.0	0.0	0.0	0.0
Trails	15	10	1	7	1	0	4	0
Dens	1	2	1	3	0	0	1	0
Dominant substrate	Rock	Rock	Gravel	Rock	Rock	Gravel	Rock	Rock

A few dens were found (Table 2), mostly under logs in adjacent forest and under driftwood. One den was found under a rock. Often, it was possible only to assume that a den or resting site was located at the end of a trail that disappeared into thick vegetation.

Two dead Northern River Otters were found during the surveys. A single dead otter was found on Botanical Beach at the head of a small surge channel during a transect survey. Decomposition of the carcass prevented us from determining the cause of death and prevented us from collecting the carcass for a necropsy. The other dead Northern River Otter was found in Esquimalt Lagoon during spraint sampling; only the skull was left.

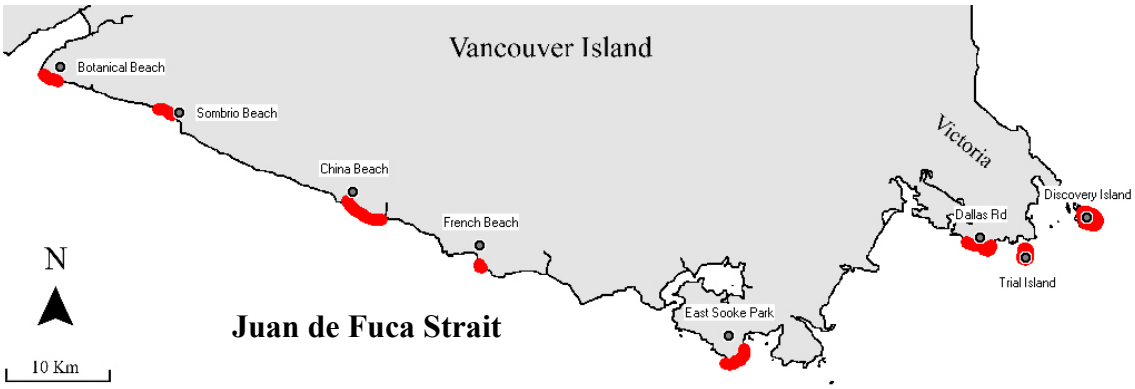


Figure 6. Location of searched Northern River Otter transects along the coast of Juan de Fuca Strait, southern Vancouver Island, 2004.

Fifteen otters were spotted during spraint sampling, but none were seen during transect surveys. One otter was seen along the Victoria coast (site 6, Figure 4) on 20 April 2004, and a group of at least four otters was seen on Mary Todd Island during fall spraint sampling. A bitch with two cubs was seen in Harris Cove on 14 November 2004, and a group of six otters was seen by Muir Creek on 15 October 2004 (Figure 3).

Northern River Otter Health

There were no active trap lines in the study area. The otters used for this study had been trapped by nuisance animal trappers because the otters had taken up residence in basements and crawlspaces. As a result, it was not possible to obtain a large number of tissue and serum samples. Necropsies were performed on seven Northern River Otters from the Victoria area. One was too decayed for sampling, but serum and tissue samples of the remaining six animals were sent to the laboratory. No results were available at reporting time.

Fresh samples were not always easy to obtain from known marking sites, which meant that samples analyzed in the laboratory did not always reflect the spatial distribution as planned, but rather reflected which sites had recent Northern River Otter activity.

A total of 94 spraint samples were sent to the laboratory to be tested, but an unforeseen heavy workload in the laboratory resulted in only 36 samples being tested with Sheather's flotation analysis. Most (30) of these samples were also tested with a zinc sulphide test. These samples were mainly obtained in the centre of the study area (Figure 7). Three of the samples were positive for *Cryptosporidium* sp., but the French Beach and Sheringham Point sites were relatively close together and it is possible that the samples were deposited by the same Northern River Otter.

The laboratory tests found eggs of *Helminth* nematodes (Strongyle and Ascaridida), and oocysts of *Sarcocystis* (Table 3). Earlier in 2004, dead Sea Otters in California were found to be infected with *Sarcocystis neurona* and *Toxoplasmodium gondii*, which may have contributed to their death (Department of Fish and Game, Marine Region, California, 20 May 2004, press release).

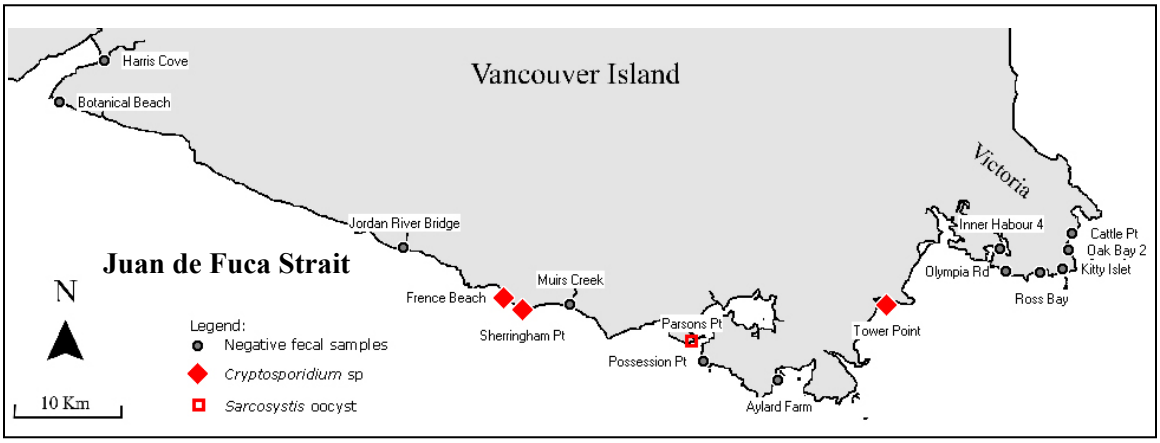


Figure 7. Results of analysis of Northern River Otter spraints from along the coast of Juan de Fuca Strait, southern Vancouver Island, 2004.

Table 3. Results of laboratory tests on Northern River Otter spraints.

Site#	Date	Location	*Crypto-sporidium*	Strongyle-type egg	*Sarcocystis* oocyt	Ascarid eggs	Mites	Louse
FB3	15-Oct	French Beach	3+	–	–	–	–	–
8	15-Oct	Cattle Pt.	–	–	–	1+	–	–
13	15-Oct	Tower Pt.	1+	–	–	–	–	1+
15	09-Jul	Aylard Farm	–	–	–	–	–	1
16	09-Jul	Possession Pt.	–	1+	–	–	–	–
16	15-Oct	Possession Pt.	–	–	–	–	–	1+
19	09-Jul	Parsons Pt.	–	–	1+	–	–	–
19	09-Jul	Parsons Pt.	–	–	–	–	1+	–
24	15-Oct	Sherringham Pt.	1+	–	–	–	–	–
27	14-Oct	Jordan River	–	–	–	1+	–	–
33	14-Oct	Harris Cove	–	–	–	3+	–	–

Note: At the Inner Harbour and Oak Bay, sites were close together.

DISCUSSION

Unfortunately, the results of analyses for environmental contaminants of otter carcasses sampled from the Victoria area were not available at reporting time, but analyses of American Mink (*Neovison vison*) and otters in the Fraser and Columbia rivers found low concentrations of dibenzo-pdioxins (PCDDs), dibenzofurans (PCDFs), biphenyls (PCBs), organochlorine (OC) pesticides, and heavy metals (Harding *et al.* 1998; Elliott *et al.* 1999; Harding 2002). It is possible that otters in the study area could be contaminated with similar compounds because these contaminants are found in "the most contaminated cetaceans in the world," the resident Killer Whales in the area (Ross *et al.* 2000).

Northern River Otters have been used as an indicator species for environmental contaminants throughout the world. The European River Otter has been shown to be a feasible candidate for monitoring the changes in environmental contaminants in Europe. For example, the population numbers of European River Otter in Sweden correlated inversely with increased PCBs (Ross *et al.* 2001), and Mason and Macdonald (1986) found high concentrations of cadmium, mercury, and lead in otter spraints in Britain. Environment Canada has recognized the Northern River Otter as a good indicator species for environmental contamination in places such as the Columbia River and Fraser River drainages (Harding et al. 1999).

Northern River Otters were used as one of the sentinel species in monitoring the recovery of the ecosystems in Prince William Sound, Alaska, after the disastrous Exxon Valdez oil spill in 1989, when the ship ran aground and leaked 39,000 metric tonnes of crude oil, which spread across 3,500 km of shoreline (Bowyer *et al.* 2003). It is very likely that Northern River Otters also would function as a good indicator of environment contaminants in the study area.

The raw sewage disposed by Greater Victoria into Juan de Fuca Strait is a potential source for zoonotic diseases. For example, *Giardia* cysts and *Cryptosporidium* oocysts have been found in marine water close to sewage outfalls in other parts of the world (Fayer *et al.* 2004). Interestingly, Northern River Otter samples from French Beach, Sherringham Point, and Tower Point by Witty's Lagoon tested positive for *Cryptosporidium* in this study. French Beach and Tower Point, although far from the sewage outlet, are public beaches visited by many people and their pets, which could be the sources of these diseases.

Recently, Kimber and Kollias (2000) reviewed infectious diseases and parasites in freshwater Northern River Otter populations and Fayer *et al.* (2004) reviewed the extent of contamination by *Giardia*, *Cryptosporidium*, and *Toxoplasmosis* in the marine environment. Studies of Northern River Otters in Puget Sound found *Giardia* in 10% of the sampled scats and *Cryptosporidium* in 5% of the sampled scats (Gaydos, pers. comm. 2003). *Giardia* and *Cryptosporidium* tests of otter spraints from the Greater Victoria watershed did not provide a clear answer about the presence of these pathogens; in a study looking at zoonotic parasites, one laboratory detected them and two did not (Aramini *et al.* 1997). The same project found positive serological evidence for *Toxoplasmosis* in a Northern River Otter from the Saanich Peninsula (Aramini *et al.* 1997). Other diseases and parasites such as nematodes and calicivirus are known to be found in Northern River Otters. Other diseases, such as *Giardia*, occur in other marine mammals (Table 4), and could be a potential problem for Northern River Otters in the study area, even though we did not find any of these diseases or parasites in the spraint samples.

We did not find *Brucella*, but it has been found in Pacific Harbour Seals (*Phoca vitulina richardsi*) and California Sea Lions (*Zalophus californianus*) (Table 4) in Washington (Garner *et al.* 1997; Lambourn *et al.* 2001b). This suggests it is likely just a matter of time before it is found in Northern River Otters in the study area.

From the eight dens or resting cavities we found during transect surveys, it appears that less built-up areas have more dens, which is a result similar to that found by Giere and Eastman (2000). Three of the dens were located on Trial and Discovery islands, suggesting that Northern River Otter might seek these islands for solitude in the Victoria urban area.

We detected two trends in Northern River Otter signs. (1) More exposed sites had fewer signs of otters (Table 2). For example, Botanical Beach, with extreme wave action from the open ocean, had few signs of Northern River Otters. (2) Otter signs were less common on gravel beaches (Table 2). For example, between Jordan River and China Beach there were very few signs of otters. This could suggest that Northern River Otters are less abundant in exposed sites and on gravel beaches, but it could also point to a paucity of clear marking sites along one or both of these shores.

Table 4. Selected nematodes, viruses, and protozoa hosted by marine animals.[1]

Disease species	Marine	Host species	Source
Helminth (nematodes)	Y	*Lontra canadensis*	Hoberg *et al.* 1997
Canine distemper	N	*Lontra canadensis*	Kimber *et al.* 2000
Brucella	Y	*Lutra lutra*	Foster *et al.* 1996
	N	*Neovison vison*	Prichard *et al.* 1971
	Y	*Phoca vitulina*	Lambourn *et al.* 2001b
Marine calicivirus(s)	Y	*Zalophus californianus*	Smith and Boyt 1990
Toxoplasmosis	N	*Lontra canadensis*	Tocidlowski *et al.* 1997
	Y	*Enhydra lutris*	Lindsay *et al.* 2001
	Y	*Zalophus californianus*	Miller *et al.* 2002
	Y	*Phoca vitulina*	Lindsay *et al.* 2001
Giardia	Y	*Zalophus californianus*	Fayer *et al.* 2004
	Y	*Phoca vitulina*	
Cryptosporidium	Y	*Zalophus californianus*	Fayer *et al.* 2004
Sarcocystis	Y	*Enhydra lutris*	Lindsay *et al.* 2001

[1] Based on J. Gaydos' description of diseases in Appendix 1.

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APPENDICES

Appendix 1: Description of Diseases.

The following descriptions were provided by Joe Gaydos, Wildlife Health Center, U.C. Davis, Orcas Island, WA.

1. **Marine *Brucella* spp.**
   Brucellosis in marine mammal species is a poorly understood yet important emerging infectious disease. *Brucella* spp. (bacteria) that differ from the recognized species within this genus recently have been isolated from various marine mammal species (Ross *et al.* 1994; Foster *et al.* 1996; Garner *et al.* 1997; Clavareau *et al.* 1998; Miller *et al.* 1999), and there are many more species of marine mammals in the Pacific, Atlantic, and Arctic oceans that are seropositive to *Brucella* (Nielsen *et al.* 2001) but from which *Brucella* has not been isolated. Very little is known about these newly recognized *Brucella* spp. despite their potential to affect the reproductive success of wildlife species and their potential to cause disease in humans and domestic animals. Infection by one or more marine *Brucella* spp. may be endemic in Pacific Harbour Seals (*Phoca vitulina richardsi*), California Sea Lions (*Zalophus californianus*), and Harbour Porpoise (*Phocoena phocoena*) in Washington's Inland Sea region (Lambourn *et al.* 2001b). Isolation of a marine *Brucella* from the closely related European River Otter (*Lutra lutra*; Foster *et al.* 1996), as well as the ability of the closely related American Mink (*Neovison vison*) to become infected with and transmit *Brucella abortus* (Prichard *et al.* 1971), suggests marine-foraging Northern River Otters in Washington's Inland Sea could be susceptible to infection by marine *Brucella* spp. Infection by marine *Brucella* spp. could have the potential to impact Northern River Otter reproductive success and Northern River Otters could play a key role in transmitting this disease into the terrestrial environment.

2. **Marine caliciviruses**
   There are at least 34 serotypes of caliciviruses that are believed to be of marine origin. San Miguel Sea Lion virus is the agent responsible for causing classic vesicular exanthema of swine (Smith *et al.* 1998). Also, it has been suggested that caliciviruses of marine origin may be responsible for skin blistering, hepatitis, diarrhea, and coagulation disorders in humans (Smith *et al.* 1998). The California Sea Lion is the marine mammal species most involved with the marine caliciviruses and the Opaleye Perch (*Girella nigricans*), a Sea Lion prey species, is the primary reservoir for marine caliciviruses (Smith and Boyt 1990). The northern Pacific Ocean is an important source of marine caliciviruses, which have the potential to infect and cause disease in marine-foraging Northern River Otters in Washington's Inland Sea. Northern River Otters could play a role in transmitting caliciviruses of marine origin into the terrestrial environment.

3. **Influenza A virus**
   Free-ranging waterfowl and other aquatic birds are the reservoirs of all 15 subtypes of influenza A viruses (Webster 1998), but usually do not exhibit signs of disease. Influenza A viruses can infect and often cause disease in an enormous number of animal species including humans, pigs, horses, domestic ferrets, mink, and marine mammals (Petrini 1992; Alexander and Brown 2000). Northern River Otters forage in areas sympatric with aquatic birds in

Washington's Inland Sea, but the effect of this virus on free-ranging Northern River Otters and the role Northern River Otters play in the epidemiology of this disease have never been examined.

4. **Canine distemper virus**
   Northern River Otters, like other mustelids, are considered susceptible to canine distemper virus (CDV) infection (Williams 2001), but information on the pathogenesis and prevalence of CDV in Northern River Otters is not available. Three of 64 Northern River Otters trapped in freshwater in New York were positive for CDV antibodies (Kimber et al. 2000). Within the Inland Sea, Raccoons (*Procyon lotor*) experience periodic outbreaks of canine distemper and may be a source of viral exposure for sympatric Northern River Otters. Although it has not been studied, modified live CDV vaccines used to vaccinate domestic dogs in the area also may be a source of viral exposure for Northern River Otters. Canine distemper virus could be a major mortality factor in marine-foraging Northern River Otters and Northern River Otters may be able to carry this terrestrial pathogen into the marine environment.

5. ***Cryptosporidium parvum* and *Giardia duodenalis***
   Intestinal infection with the protozoan parasites *Cryptosporidium parvum* and *Giardia duodenalis* are the first and second leading causes of outbreaks of waterborne disease in humans in the United States. With almost 6 million people living on the shores of Washington's Inland Sea, it is very possible that these human pathogens may be present in the near-shore marine environment and may present a danger to Northern River Otters. The susceptibility of Northern River Otters to infection by these protozoan parasites and the role that they may play in their transmission are unknown (Kimber and Kollias 2000) and warrant investigation.

6. ***Sarcocystis neurona***
   Sarcocystis neurona is a protozoan parasite that can cause equine protozoal myeloencephalitis in horses, but causes no disease in Virginia Opossum (*Didelphis virginiana*), its natural host (Dubey *et al.* 2001). Once considered only a terrestrial disease, it has caused encephalitis in Southern Sea Otters (*Enhydra lutris nereis*) in California (Miller *et al.* 2001) and in a Northern Sea Otter on Washington's coast (Lindsay *et al.* 2001). Despite its potential to cause encephalitis and be a mortality factor in Northern River Otters, they have never been tested for the disease.

7. ***Toxoplasma gondii***
   Toxoplasma gondii is a protozoan parasite that has a worldwide distribution. Domestic and wild felids are the only known definitive hosts (Dubey and Beattie 1988). Northern River Otters in fresh water environments are susceptible to infection, as demonstrated in a serologic survey where 47% of adult and 39% of juvenile Northern River Otters from North Carolina had antibodies to *T. gondii* (Tocidlowski *et al.* 1997). Within Washington's Inland Sea, 8% of Harbour Seals sampled from the southern part of Puget Sound had antibodies to *T. gondii* (Lambourn *et al.* 2001a) and it has caused encephalitis in a Sea Otter from Washington's coast (Lindsay *et al.* 2001). It is highly likely that marine-foraging Northern River Otters are exposed to *T. gondii* and it is possible that this parasite could be a significant mortality factor.

Appendix 2: Dr. J. Gaydos' Northern River Otter Necropsy and Disease-testing Protocol.

Dead Otters

Necropsy

1. Take the same measurements taken on live otters: weight (kg), nose to tail tip length (cm), tail length (cm), baculum length (cm).
2. Collect the following tissues and samples, and store them as suggested:

Tissue*	10% buffered formalin	Whirl Packs (frozen-Raverty)	Whirl Packs (frozen-*Brucella*)	Other (frozen-Raverty)
Hair				
Tongue				
Submandibular LN				
Thyroid				
Brain - cerebrum				Foil frozen
Brain - cerebellum				Foil frozen
Brain - brainstem				Foil frozen
Trachea				
Lung				
L.N. (thoracic)				
Blood from heart				Red-top tubes+
Heart				
Liver				Foil frozen
Spleen				
Kidney				Foil frozen
Stomach				
Small intestine				
Large intestine				
Fecal sample				
L.N. (mesenteric)				
Bladder				
Uterus				
Testes				
Muscle (leg)				
Bone marrow				

*Please include any abnormal-looking tissue not listed (formalin and frozen).

+aliquot serum into ½ ml vials, submit with serum from live otters.

Live Otters

1. Anaesthesia – best success to date with Telazol at 7–10 mg/kg.

2. Measurements – see attached anaesthesia and recording sheet:
   a. weight (kg)
   b. nose to tail tip length (cm)
   c. tail length (cm)
   d. baculum length (cm)

3. Samples to take:
   a. Hair sample (freeze).
   b. Fecal sample (can be difficult to get – freeze).
   c. Blood sample (20cc from adult – either jugular vein).
      Spin down blood, separate serum into ½ cc aliquots, save cells (freeze).

Disease Testing

Formalin-fixed tissues and other frozen tissues

1. Send formalin fixed tissues and appropriate frozen tissues to Stephen Raverty to perform histopathology and heavy metal screens on all cases. Additionally ancillary tests such as PCR and bacterial culture will be performed as appropriate.

2. Frozen tissue samples for *Brucella* isolation attempts can be saved for Joe Gaydos to send to NVSL or can be sent to an appropriate lab in Canada for attempted *Brucella* isolation.

Serum:

1. **Marine *Brucella* spp.** – serology using a panel of 5 standard tests for *Brucella abortus* (the old cattle tests) can be performed or / and samples can be sent to Ole Nielson for cELISA testing. Ole Nielson, Department of Fisheries and Oceans, 204-983-5126; e-mail: NielsenO@dfo-mpo.gc.ca .

2. **Marine caliciviruses**

3. **Influenza A virus**

4. **Canine distemper virus / phocid distemper virus / cetacean morbillivirus** – Serum can be sent to Dr. J. Saliki at the Oklahoma State University for this testing. Cost is $45 for sample to run virus neutralization for all 3 viruses: Dr. Jeremy Saliki, Oklahoma State University, 405-744-6623; E-mail: jsaliki@okstate.edu .

5. ***Toxoplasma gondii*, *Sarcocystis neurona*, and *Neospora caninum* –** Serum can be tested for these by Pat Conrad at UC Davis. C contact info is: Dr. Patricia Conrad, UC Davis, (530) 752-7210, paconrad@ucdavis.edu .

6. **Leptospirosis** –Can possibly be done at UC Davis.

7. **Coronaviruses** –options are currently being explored.

8. **Feces:**
   Fresh feces can be tested for ***Cryptosporidium parvum*** and ***Giardia duodenalis*** using immunomagnetic separation and direct immunofluorescence (IMS/DFA), which is highly sensitive. The DNA from positive samples can then be amplified and sequenced using PCR to determine species and genotype. This costs about $85 per sample and can only be done on fresh feces as freezing destroys the oocysts and cysts. Ideally, five samples each at two distant locations will be collected and sent for testing. If 3 to 5 fresh samples from one location can be collected at the same time, it is likely that they are from different individual animals. If the two sites are far enough apart, it is likely that they are from different animals.

Appendix 3: Attributes of Northern River Otter Spraint Sampling Sites.

Site#	Date	Easting[1]	Northing	Location	Fresh (#)	Medium (#)	Old (#)	Rating[2]	Elev. (m)	Dist. from water (m)	Trail	Den/rest	Rolling place	Marking
1	20-04	474196	5361144	Clover Point	0	0	0	N	–	–	–	–	–	–
2	20-04	472532	5361781	Dallas Rd/Olympia	1	10	10	H	1	3	–	y	n	n
3	20-04	475410	5361721	Ross Bay	0	0	10	M	2	3	–	–	n	n
4	20-04	476203	5361446	Chinese Cemetery	0	0	0	N	–	–	–	–	–	–
5	20-04	476322	5361647	Chinese Cemetery	0	0	6	M	3	3	–	–	y	y
6	20-04	477286	5362032	Kitty Islet (by Trial)	1	10	10	H	3	3	–	–	y	y
7	20-04	477771	5363605	Oak Bay Marina	0	3	10	M	3	–	–	–	n	n
8	20-04	478056	5364987	Cattle Point	2	5	10	H	–	3	–	–	n	–
9	21-04	466148	5364448	Esquimalt Lagoon	0	5	10	H	4	4	–	–	y	y
10	21-04	463844	5360131	Albert Lagoon	1	0	6	M	–	4	–	–	n	n
11	21-04	462569	5359068	Tower Point	1	0	5	M	–	10	–	–	–	–
12	21-04	462625	5359175	Tower Point (Small Island)	0	0	0	N	–	–	–	–	–	–
13	21-04	462419	5359075	Tower Point (small pt by river)	4	5	10	H	3	3	–	–	y	n
14	21-04	457675	5355113	Pedder Bay Marina	0	2	0	L	–	5	–	–	y	y
15.1	21-04	453150	5352755	Aylard Farm	0	2	4	M	2	–	–	–	n	y
15.2	21-04	453298	5352760	Aylard Farm	1	5	10	H	–	–	–	–	–	–
15.3	09-07	453326	5352730	Aylard Farm	4	20	20	H	10	10	y	den	y	y
16	29-04	447090	5354278	Possession Pt	4	10	20	H	5	15	–	–	y	y
17	29-04	453109	5357814	Roche Cove Bridge	0	2	10	M	2	2	–	–	n	n
18	29-04	448691	5358703	Billing Point	2	3	9	M	1	1	–	–	n	n
19	29-04	446061	5356073	Parsons Pt (Sooke Harbour House)	5	3	20	H	1	3	–	–	n	n
20	29-04	440071	5356710	Otter Pt	1	0	0	L	2	5	–	–	n	n
21	29-04	439109	5356306	Otter Pt	0	0	0	N	–		–	–	–	–
22	29-04	438553	5357005	Otter Pt	2	10	20	H	8	20	–	–	y	y
23.1	29-04	435833	5358834	Muir Creek (point)	1	4	20	H	2	10	–	–	n	y
23.2	15-10	435916	5359006	Muir Creek (Breakwater)	10	10	10	H	–	–	–	–	–	–
24	29-04	431806	5358581	Sherringham Pt	2	8	20	H	10	15	–	–	n	n

Site#	Date	Easting[1]	Northing	Location	Fresh (#)	Medium (#)	Old (#)	Rating[2]	Elev. (m)	Dist. from water (m)	Trail	Den/rest	Rolling place	Marking
25	03-05	427857	5360408	Point No Point	0	0	0	N	–	–	–	–	–	–
26	03-05	425155	5362461	Rock Bottom Creek	0	0	1	L	1	–	–	–	n	n
27	03-05	421890	5363762	Jordan River Bridge	1	10	8	H	3	3	–	–	n	n
28	03-05	407509	5369389	Before loss Creek	0	0	5	M	8	10	–	–	n	y
29	03-05	404437	5371845	Sombrio E Beach	0	0	0	N	–	–	–	–	–	–
30	04-05	398198	5374094	Parkingson Creek	0	4	1	M	3	10	–	–	n	y
31	04-05	393137	5375949	Botanical Beach (BB2)	1	0	0	L	–	–	–	–	–	–
32	04-05	393793	5378054	Mill Bay	0	0	0	N	–	–	–	–	–	–
33	04-05	396821	5379434	Harris Cove	2	5	10	H	2	2	–	–	n	n
34	05-05	471500	5363415	Can. Coast Guard dock	4	5	20	H	0.5	1	–	–	n	n
35	05-05	474080	5408504	Prevost (Portlock)	0	10	20	H	10	20	–	–	y	y
36	05-05	483259	5363331	Discovery Light House	0	3	20	H	4	8	–	–	n	n
37	05-05	483012	5364563	Alpha Island	0	10	20	H	–	–	y	–	y	y
38	28-06	477904	5363835	Mary Tod Island	1	20	20	H	5	–	y	–	y	y
39	28-06	482109	5364435	Little “Griffin” Island	0	10	20	H	5	–	y	–	y	y
40	28-06	482492	5364610	Griffin Island	3	20	20	H	5	–	y	–	y	y
41	28-06	481370	5364543	Little “Chatham” Island	0	20	0	H	5	–	–	–	y	y
42	28-06	480969	5365056	Little “Chatham” Island	0	0	5	M	5	–	–	–	n	n
43	25-06	465771	5367111	Cole Creek	0	20	1	H	2	3	y	–	y	y
44	25-06	466114	5367065	Cole Creek	0	20	1	H	1	3	y	–	y	y
45	25-06	466622	5366774	Cole Island	0	20	20	H	–	–	y	–	n	n
46	25-06	466439	5366678	Esquimalt Habour	0	20	20	H	3	4	y	dens	y	y
47	25-06	466718	5366259	Esquimalt Habour	0	20	20	H	5	5	y	–	y	y
48	25-06	466791	5366168	Esquimalt Habour	0	20	20	H	–	–	y	–	y	y
49	25-06	466694	5365897	Esquimalt Habour	0	0	5	M	3	4		–	n	n
50	25-06	467551	5365588	Esquimalt Habour	0	20	20	H	4	–	y	–	n	n
51	25-06	467461	5365557	Esquimalt Habour	0	20	20	H	4	–	y	–	y	y
52	25-06	467832	5366216	Portage Is (Esquimalt Habour)	3	20	20	H	–	–	y	–	y	y
53	25-06	466484	5366596	Esquimalt Habour	0	0	0	N	–	–	–	–	n	n
54	25-06	471530	5362502	Ogden Point	0	10	10	H	3	8	–	–	n	n

Site#	Date	Easting[1]	Northing	Location	Fresh (#)	Medium (#)	Old (#)	Rating[2]	Elev. (m)	Dist. from water (m)	Trail	Den/rest	Rolling place	Marking
55	25-06	471793	5364966	Bamfield Park	0	0	0	N	–	–	–	–	n	n
56	25-06	470861	5364041	West-Bay Marina Walkway	0	4	5	M	3	3	–	–	n	n
57	09-07	470548	5363850	West Bay/Hidden Hole Marina	1	10	20	H	4	5	y	–	y	y
58	09-11	477950	5362109	Oak Bay Golf Course	1	5	5	M	–	–	–	–	n	n
59	09-11	477804	5362025	Oak Bay Golf Course	0	5	5	M	–	–	–	–	n	n
60	10-11	471975	5363697	Songhees	3	10	10	H	1	3	–	–	n	n
61	10-11	471917	5365299	Jutland Rd,	0	0	0	N	–	–	–	–	n	n
62	10-11	471323	5365353	Gorge Rd Hospital	0	10	10	H	1	1	–	–	n	n
63	10-11	470407	5365967	Tillicum / gorge bridge	0	0	0	N	–	–	–	–	n	n
64	12-11	451157	5359841	Ayum Creek	0	0	0	N	–	–	–	–	n	n
65	11-11	402680	5373303	Sombrio Beach	0	0	0	N	–	–	–	–	n	n
66	17-11	482338	5363029	Discovery	3	20	20	H	–	–	–	–	n	n
67	18-11	464648	5359506	Albert Head	2	5	5	M	3	10	y	–	y	y
68	18-11	459966	5355020	Mary Hill	5	20	20	H	8	20	y	–	y	y
69	18-11	459050	5353506	Rocky Point (b)	8	10	10	H	5	8	y	–	y	y
70	18-11	457256	5351294	Rocky Point (a)	10	20	20	H	8	30	y	–	y	y

[1]UTM zone 10U based on NAD 83.

[2]N = No spraints, L = 1–2 spraints, M = 3–15 spraints, H = >15 spraints.

Appendix 4: Data from Surveyed Northern River Otter Transects along Juan de Fuca Strait, Vancouver Island, 2004.

Site#	Date	Easting	Northing	Location	Scat density	Age fresh	Age medium	Age old	Sub-strate	Elev.	Dist. from water	Trail	Den or rest	Rolling place	Marking pile
DA	28-Jun	482464	5364053	Discovery Isl.	3	0	20	12	Rocky			Y		N	N
DB	28-Jun	482683	5364050	Discovery Isl.	1	0	1	0	Rocky	5	8	N		Y	N
DC	28-Jun	482764	5363947	Discovery Isl.	3	0	20	20	Gravel	1	1	Y		Y	N
DD	28-Jun	482852	5363948	Discovery Isl.	3	0	20	20	Gravel	1	1	Y		Y	N
DE	28-Jun	482911	5364018	Discovery Isl.	3	0	0	20	Rocky	4	5	N		Y	Y
DF	28-Jun	482934	5363997	Discovery Isl.	3	0	0	20	Gravel	1	1	N		N	N
DG	28-Jun	483143	5363854	Discovery Isl.	3	1	20	20	Rocky	4	8	Y		Y	Y
DH	28-Jun	483137	5363803	Discovery Isl.	2	0	0	5	Gravel	3	5	Y		Y	Y
DI	28-Jun	483167	5363745	Discovery Isl.	3	0	5	20	Rocky	5	10	Y		Y	Y
DJ	28-Jun	483261	5363676	Discovery Isl.	3	0	5	20	Rocky	5	10	Y		Y	Y
DK	28-Jun	483349	5363601	Discovery Isl.	2	0	5	10	Rocky	5	5	N		N	N
DL	28-Jun	483360	5363462	Discovery Isl.	2	0	3	1	Rocky			N		N	N
DM	28-Jun	483204	5363307	Discovery Isl.	3	0	20	20	Rocky	5	10	Y		Y	Y
DN	28-Jun	483022	5363290	Discovery Isl.	2	0	3	5	Rocky	5	10	Y		N	N
DO	28-Jun	482955	5363379	Discovery Isl.	2	0	0	5	Rocky	4	8	N		Y	N
DP	28-Jun	482773	5363421	Discovery Isl.	2	0	0	4	Gravel	3	6	Y		N	N
DQ	28-Jun	482708	5363408	Discovery Isl.	2	0	6	2	Gravel	2	5	Y		N	N
DR	28-Jun	482643	5363368	Discovery Isl.	2	0	6	0	Gravel	4	8	N		N	N
DS	28-Jun	482520	5363427	Discovery Isl.	3	0	20	20	Gravel	3	5	Y	Rest	N	N
DT	28-Jun	482472	5363447	Discovery Isl.	3	0	9	10	Gravel	1	4	Y		N	N
DU	29-Jun	482435	5363414	Discovery Isl.	3	0	10	20	Gravel	2	5	Y		N	N
DV	28-Jun	482360	5363514	Discovery Isl.	2	5	6	0	Forest	10	100	Y		Y	Y
DX	28-Jun	482374	5363653	Discovery Isl.	1	1	1	0	Forest	10	150	N		N	N
TA	05-May	477386	5360281	Trial Isl.	2	0	0	5	Rocky	8	10	N	Den	Y	y
TB	05-May	477301	5360345	Trial Isl.	2	0	0	5	Rocky	8	10	N		Y	y
TC	05-May	477319	5360368	Trial Isl.	2	0	1	3	Rocky	10	20	Y		Y	y
TD	05-May	477250	5360412	Trial Isl.	0	0	0	0	Rocky	5	11	Y		Y	y
TE	05-May	477238	5360461	Trial Isl.	2	0	5	5	Rocky	10	20	Y		Y	y

Site#	Date	Easting	Northing	Location	Scat density	Age fresh	Age medium	Age old	Sub-strate	Elev.	Dist. from water	Trail	Den or rest	Rolling place	Marking pile
TF	05-May	477245	5360520	Trial Isl.	2	0	3	3	Rocky	5	10	Y		Y	Y
TG	05-May	477257	5360567	Trial Isl.	1	0	0	2	Rocky	5	20	Y		N	N
TH	05-May	477283	5360633	Trial Isl.	2	0	2	1	Rocky	4	10	Y		Y	Y
TI	05-May	477297	5360689	Trial Isl.	3	1	3	20	Rocky	4	10	Y		Y	Y
TJ	05-May	477352	5360690	Trial Isl.	3	2	4	20	Rocky	3	10	N		Y	Y
TK	05-May	477359	5360960	Trial Isl.	2	1	3	10	Rocky	2	10	Y		Y	Y
TL	05-May	477460	5361046	Trial Isl.	2	0	2	1	Rocky	1	5	N	Den	N	N
TM	05-May	477490	5361020	Trial Isl.	1	2	0	0	Rocky	2	4	N		N	N
TN	05-May	477490	5360955	Trial Isl.	3	1	3	20	Rocky	4	10	N		N	N
TO	05-May	477511	5360790	Trial Isl.	1	0	0	2	Rocky	2	5	N		N	N
TP	05-May	477511	5360717	Trial Isl.	3	1	5	20	Rocky	1	5	Y		Y	N
TQ	05-May	477498	5360629	Trial Isl.	1	0	1	0	Gravel	1	3	N		N	N
TR	05-May	477486	5360565	Trial Isl.	1	0	0	1	Rocky	4	10	N		N	N
TS	05-May	477476	5360504	Trial Isl.	3	0	2	20	Rocky	5	15	Y		N	N
ES1	08-Aug	452762	5351967	East Sooke Pk.	2	0	1	6	Gravel	1	3	N		N	N
ES2	08-Aug	452757	5351930	East Sooke Pk.	1	0	1	0	Rocky	3	4	N		N	N
ES3	08-Aug	452749	5351904	East Sooke Pk.	3	0	0	20	Rocky	5	18	Y	Den	N	N
ES4	08-Aug	452730	5351882	East Sooke Pk.	2	0	0	4	Gravel	4	7	N		N	N
ES5	08-Aug	452722	5351825	East Sooke Pk.	2	2	6	2	Rocky	6	10	N	Rest	Y	Y
ES6	08-Aug	452739	5351790	East Sooke Pk.	1	0	2	0	Rocky	3	5	N		N	N
ES7	08-Aug	452651	5351668	East Sooke Pk.	1	0	0	1	Rocky	8	10	N		N	N
ES8	08-Aug	452595	5351678	East Sooke Pk.	2	0	0	4	Rocky	5	8	N		N	N
ES9	08-Aug	452388	5351743	East Sooke Pk.	3	0	0	14	Rocky	5	5	Y		N	N
ES10	08-Aug	452292	5351654	East Sooke Pk.	3	0	0	20	Rocky	6	10	N		N	Y
ES11	08-Aug	452210	5351559	East Sooke Pk.	3	0	0	20	Rocky	6	8	Y		N	Y
ES12	08-Aug	452172	5351538	East Sooke Pk.	2	0	0	5	Rocky	6	8	N		N	N
ES13	08-Aug	452131	5351492	East Sooke Pk.	1	0	0	2	Rocky	6	10	n		n	N
ES14	08-Aug	452025	5351449	East Sooke Pk.	1	0	0	1	Rocky	6	8	N		N	N
ES15	08-Aug	452014	5351442	East Sooke Pk.	3	0	2	20	Rocky	6	15	N		Y	Y
ES16	08-Aug	451923	5351412	East Sooke Pk.	2	0	0	6	Rocky	7	10	N		Y	Y

Site#	Date	Easting	Northing	Location	Scat density	Age fresh	Age medium	Age old	Sub-strate	Elev.	Dist. from water	Trail	Den or rest	Rolling place	Marking pile
ES17	08-Aug	451854	5351387	East Sooke Pk.	2	0	0	4	Rocky	6	10	N		Y	N
ES18	08-Aug	451831	5351373	East Sooke Pk.	3	0	20	10	Rocky	5	8	N	Rest	Y	Y
ES19	08-Aug	451809	5351365	East Sooke Pk.	2	0	2	10	Rocky	5	10	N		Y	Y
ES20	08-Aug	451776	5351356	East Sooke Pk.	3	0	5	10	Rocky	8	10	Y		Y	Y
ES21	08-Aug	451758	5351364	East Sooke Pk.	1	0	1	0	Rocky	10	10	Y		Y	Y
ES22	08-Aug	451710	5351387	East Sooke Pk.	2	0	0	3	Rocky	15	20	Y		Y	Y
ES23	08-Aug	451591	5351384	East Sooke Pk.	2	0	0	10	Rocky	15	20	Y		Y	Y
ES24	08-Aug	451472	5351395	East Sooke Pk.	2	0	0	3	Rocky	20	30	N		N	N
FB1	07-Aug	430263	5359669	French Beach	2	0	4	3	Rocky	3	4	N		N	N
FB2	07-Aug	430265	5359656	French Beach	1	0	2	0	Rocky	4	10	N		N	N
FB3	07-Aug	430284	5359636	French Beach	3	1	11	4	Rocky	6	15	N		N	Y
FB4	07-Aug	430340	5359597	French Beach	2	0	5	4	Gravel	3	10	Y		N	N
FB5	07-Aug	430410	5359507	French Beach	2	0	4	6	Rocky	7	8	N		N	N
BB-start	10-Nov	392697	5376229	Botanical Beach											
BB1	10-Nov	392859	5376139	Botanical Beach	0	0	0	0	Gravel			Dead otter			
BB2	10-Nov	393137	5375949	Botanical Beach	2	1	5	0	Rocky			Y		N	N
BB-end	10-Nov	393725	5375627	Botanical Beach											
SB-start	10-Nov	403771	5372766	Sombrio Beach											
SB01	10-Nov	403681	5372917	Sombrio Beach	2	0	4	0	Rocky	2	5	Y		N	N
SB02	10-Nov	403168	5373211	Sombrio Beach	1	0	0	2	Gravel	1	1	Y		N	N
SB03	10-Nov	403119	5373235	Sombrio Beach	3	0	10	10	Rocky	8	3	Y	Rest	N	N
SB04	10-Nov	402680	5373303	Sombrio Beach	3	1	10	10	Rocky	3	5	N		N	N
SB05	10-Nov	402632	5373314	Sombrio Beach	2	0	0	10	Rocky	5	15	Y		N	N
SB06	10-Nov	402583	5373293	Sombrio Beach	2	0	3	10	Rocky	5	10	N		N	N
SB-end	10-Nov	402460	5373318	Sombrio Beach											
CB-start	19-Nov	421583	5363785	China Beach											
CB1	19-Nov	420479	5364064	China Beach		0	0	1	Gravel			N		N	N
CB2	19-Nov	420407	5364107	China Beach	2	3	1	0	Gravel			N		N	N
CB3	19-Nov	419974	5364422	China Beach	2	0	3	0	Gravel			N		N	N

Site#	Date	Easting	Northing	Location	Scat density	Age fresh	Age medium	Age old	Sub-strate	Elev.	Dist. from water	Trail	Den or rest	Rolling place	Marking pile
CB-end	19-Nov	418846	5365262	China Beach											
DR-start	20-Apr	474182	5361429	Dallas Rd (Vict)											
DR1	20-Apr	472532	5361781	Dallas Rd	2	0	0	8	Rocky	1	3	N	Rest	N	N
DR-end	20-Apr	472429	5361841	Dallas Rd (Vict)											