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NATURAL RESOURCES DAMAGE ASSESSMENT

DRAFT PRELIMINARY STATUS REPORT

U.S. Fish and Wildlife Service
&
Alaska Fish and Wildlife Research Center

Study Title:	Assessment of the Magnitude, Extent, and Duration of Oil Spill Impacts on Sea Otter Populations in Alaska.
Study ID Number:	Marine Mammals Study Number 6
Project Leaders:	B. E. Ballachey, J. L. Bodkin and D. Burn
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Each sample unit was classified by coastline physiography and bathymetry into one of six categories. Coastline physiography was categorized as protected bay, open coast, or island. Bathymetry was categorized as either shallow (less than 31m deep for more than 50% of the sample unit's length, 200 to 300m offshore) or deep (greater than 31m deep for more than 50% of the sample unit length). Depth determinations were based on navigational charts and fathometer readings taken during the survey.

Ratios of independent to dependent sea otters were obtained for each stratum and for each habitat type by summing over all sample units within each stratum or habitat type. Proportion of dependent sea otters was calculated for each transect. Kruskal-Wallis tests were used to evaluate differences in proportions among areas. Statistical tests were conducted at the .05 significance level.

RESULTS

Aircraft Evaluation

We conducted 98 trials, observing 329 groups of one or more sea otters for a total of 741 animals in our preliminary evaluation of the Piper Super-cub as a survey platform. Intensive searches resulted in detectability estimates greater than or equal to .90 for all patterns and altitudes investigated (Tables 2.1 and 2.2). All otters were detected in over half of the samples (Tables 2.1 and 2.2). The type of avoidance behavior observed in boat surveys (Udevitz et al. 1990), in which otters leave the search area before the survey platform arrives, was not observed in response to the aircraft. However, on some occasions it was apparent that otters were disturbed and began diving, swimming out of the area, or swimming erratically within the search area in response to the aircraft after it arrived.

For a fixed search pattern, detection probability and proportion of samples in which all otters were detected tended to decrease slightly with altitude, but differences were not significant (Table 2.1). The proportion of samples in which otters appeared to be disturbed by the aircraft was higher at 150 ft than for 300 or 450 ft., but again the difference was not significant (Table 2.1).

Detectability estimates for initial strip counts ranged from .52 to .72 (Figure 1). Detectability increased sharply with the first 2 to 3 circles or ovals after the strip count and continued to increase slightly for the next 3 to 4 circles or ovals. No new otters were ever detected after the 7th circle or oval.

Detection probability and proportion of samples in which all otters were detected tended to increase with decreasing pattern size, but differences were not significant (Table 2.2). There were no

Sea otter detection probabilities (detectabilities) for the aerial observer were estimated as

$$\hat{p}_d = \frac{\sum_{i=1}^{r} b_i}{\sum_{i=1}^{r} (b_i+g_i)}$$

where r is the number of trials. Detectabilities were also estimated separately for each trial as $b_i/(b_i+g_i)$. Kruskal-Wallis tests were used to evaluate differences in detection probabilities among altitudes and patterns. Fisher's exact test for contingency tables was used to evaluate the effect of altitude and pattern on the proportion of trials in which all otters were detected and the proportion of trials in which otters exhibited disturbance behavior. All statistical tests were conducted at the .05 significance level.

Reproduction

Estimates of annual reproduction, as indicated by ratios of independent to dependent sea otters, and patterns of habitat use were obtained from small (<10m) boat surveys. Surveys were conducted from 13 August through 11 September 1991.

Sample units corresponded to the coastline transects established by Irons et al. (1988) and extended offshore out to the 100m depth contour or 1/2 the distance to the opposing shoreline, whichever was less. A subset of sample units was randomly selected to be surveyed in each of 3 strata. Strata consisted of heavily oiled and non-oiled nearshore habitat in western Prince William Sound and non-oiled habitat in eastern Prince William Sound.

The survey vessel maneuvered about 200 to 300m offshore, and out to the offshore boundary as necessary to observe and classify all otters within each selected sample unit. Boat speed was maintained at less than 15 mph. Surveys were conducted only when viewing conditions were considered good or better (calm to light winds, sea state less than Beaufort 2).

Surveys crews consisted of two observers, including the boat operator. Crews used high resolution binoculars and a Questar telescope. Otters were classified as either dependent or independent. Dependent otters were defined as sea otters smaller than, and in close association with, an adult. This definition included, but was not limited to, pups in close physical contact, nursing, receiving food from, swimming with or being groomed by an adult sea otter. Independents were defined as all other sea otters. Crews recorded the number of dependent and independent sea otters found in each sample unit.

generally was unable to assist in visual observation due to the technical aspect of the survey procedures. Aircraft speed was maintained as close as possible to 28m/sec (55mph). The pilot used a stopwatch, airspeed and minute of turn to define the 750m diameter circle (128 seconds to complete, 32 seconds through each quadrant). The location and orientation of the circle was indicated by markers positioned at the vantage point by the ground crew. The aerial observer recorded the time, location, group size, number of pups and activity of each new sea otter or group of sea otters observed. Circling was continued until 5 minutes had elapsed without any new otters being observed.

Pattern evaluation trials were conducted using 3 different intensive search patterns in conjunction with a strip count. The same aircraft, but different pilots, were used for the altitude and pattern evaluations. All pattern evaluation trials were conducted at an altitude of 92m above sea level and at a speed of 28m/s. Each trial began with a strip count in which the plane flew along one edge of a 400m strip while the aerial observer recorded the location, group size, number of pups and activity of each sea otter or group of sea otters observed in the strip. Width of the strip was determined by the aerial observer using distance indicators marked on the wing struts. The length of the strip was either 400m, 750m or 800m, depending on the subsequent search pattern. Immediately following the strip count, the plane began one of three search patterns over the strip that had just been counted. The aircraft was piloted along the circumference of either a 400m diameter circle, a 750m diameter circle, or a 400m x 800m oval while the aerial observer viewed the circumscribed area. Selection of the search pattern was made by the ground crew according to the distribution of sea otters and the physiography of the coastline, while attempting to obtain an equal number of trials for each pattern. Ground crews indicated the location and orientation of each strip, circle and oval with markers at the vantage point. The pilot used techniques analogous to those developed for the 750m circle to maintain each of the other 2 search patterns. The aerial observer recorded the circle or oval number, location, group size, number of pups and activity of each new sea otter or group of sea otters observed during the search. Intensive search patterns were continued until 5 minutes had elapsed without any new otters being observed.

At the end of each day, ground and aerial crews compared the mapped locations of all observed otters. For the otters present in trial i, $i=1,\cdots,r$, when the aircraft arrived, the number observed by both crews (b_i), the number observed only by the ground crew (g_i), and the number observed only by the aerial observer (a_i) in the observation circle or strip were determined. The number of otters in the circle or strip before any response to the approaching aircraft was determined based on ground crew observations prior to the arrival of the aircraft.

METHODS

Aircraft Evaluation

Two series of trials were conducted to evaluate the Piper PA-18 aircraft as a platform for estimating sea otter density. All trials used ground based observers to quantify the proportion of animals detected from the air. The first series of trials was conducted in April 1991 to assess the effect of altitude (altitude evaluation) on sea otter detectability. The second series of trials was conducted in July 1991 to assess the effect of search pattern (pattern evaluation) on sea otter detectability.

Trials were conducted on areas of ocean (survey units) that did not contain canopy forming kelp, were large enough to contain a full search pattern, allowed unrestricted observation from an adjacent vantage point, and contained 1 or more otters immediately prior to arrival of the aircraft. Survey units were selected by ground crews based on previous reconnaissance and observation of the area immediately before ground crew deployment. All survey units for the altitude evaluation were located in Eastern Prince William Sound. Survey units for the pattern evaluation were scattered throughout Prince William Sound, though most were in the west.

Ground crews approached each selected survey unit after a thorough study of the area from offshore, taking care to minimize disturbance to sea otters. After deploying themselves at the vantage point, the ground crew defined the boundaries of the unit, established an orientation for the aerial search pattern within the unit and determined the position and activity of each otter within the unit. The ground crew then contacted the aircraft by VHF radio to begin the trial. Ground observations followed methods established by Estes and Jameson (1988). Immediately prior to arrival of the aircraft, the ground crew recorded the location, group size, number of dependent pups and activity of each otter or group of otters. Activity categories included swimming (changing location), resting (stationary on water surface) and diving (stationary and temporarily submerging). The ground crew also recorded the location and behavior of all otters observed outside the boundaries of the unit, observations regarding changes in sea otter activity associated with the approach of the aircraft, and the time the aircraft entered and departed the unit. Following the departure of the aircraft, the ground crew was transported by boat to the next survey unit.

Altitude evaluation trials were conducted at 46m, 92m and 137m above sea level. Trials were conducted in sets of 3, with one trial at each altitude, in random order, within each set. All altitude evaluation trials were conducted using a 750m circle intensive search pattern. In this pattern, the aircraft was piloted along the circumference of a 750m diameter circle while the aerial observer viewed the circumscribed area. The aircraft pilot

Section 1

BOAT-BASED SURVEYS OF SEA OTTERS IN PRINCE WILLIAM SOUND, ALASKA

Douglas M. Burn

SUMMARY

As part of the Natural Resources Damage Assessment (NRDA) studies conducted during spill year 3, boat-based surveys of sea otters in Prince William Sound were continued. The results of these third year surveys indicate that the otter population may have stabilized, but is still below pre-spill levels.

OBJECTIVES

The purpose of this study was to estimate post-spill sea otter population size in Prince William Sound, in order to determine initial and continuing damages related to the Exxon Valdez oil spill.

INTRODUCTION

Within the first few weeks of the Exxon Valdez oil spill, the sea otter quickly became the most vivid symbol of the damage to wildlife in Prince William Sound, Alaska. The fact that sea otters suffered injury by the spill cannot be refuted. It is only the magnitude of this injury that is in dispute. Various methods have been used to extrapolate the number of carcasses recovered to total mortality, based on carcass recovery rates. This study attempts to make direct comparisons between pre- and post-spill population estimates, in order to quantify the net change in the otter population.

STUDY METHODOLOGY

Study Area and Survey Strata

The study area consists of the waters of Prince William Sound (PWS), Alaska, exclusive of Hawkins Island Cutoff and Orca Inlet (Figure 1). Previously, the study area had been divided into 3 distinct survey strata: shoreline, coastal, and pelagic. The shoreline strata was based on shoreline transects surveyed by Irons, Nysewander and Trapp (1988) during the summers of 1984 and 1985, and is defined by the 200m-wide strip adjacent to the coastline. Areas outside of this 200m-wide strip were not systematically surveyed prior to the spill. In an attempt to quantify the PWS otter population as a whole, the areas greater than 200m from shore were divided into sampling "blocks" based on a 5-minute latitude/longitude grid system. The coastal stratum

in western males. Although there were no significant differences in hematologic parameters between eastern and western female otters, some chemistry changes were present which were consistent with changes observed in the males. However, the degree of difference was small and the data must be interpreted cautiously. As a group, western sea otter pup hematocrits, hemoglobins, and red cell counts were significantly lower than those of eastern pups, suggesting a mild anemia in the western pups. Hematologic and clinical chemistry differences between eastern and western pups were of equivocal biologic significance, and trends seen in adults were not present in the pups sampled to date.

Over 400 sea otter tissue samples, predominatly liver, fat, and blood, have been analyzed for hydrocarbon contaminants. An exploratory data analysis has been initiated. Completion of this analysis will allow identification of potential linkages between exposure and effects observed in the population.

A study on survival of sea otter pups demonstrated significantly higher post weaning mortality in western Prince William Sound compared to controls in the east. In contrast, survival of adult female sea otters was significantly higher in western Prince William Sound compared to controls in the east. However, pupping rates of adult females and survival of those pups through weaning in 1990 and 1991 were similar in eastern and western Prince William Sound, and were considered normal.

In conclusion, sea otter NRDA studies to date suggest initial damages were extensive, killing between 3,500 and 5,500 sea otters. Additionally, results suggest chronic damages to sea otters are occurring which may preclude or delay recovery of affected populations. Although the conclusions presented here should be considered preliminary, evidence of persistent damages is compelling and warrants continued investigation.

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Comparisons of pre- and post-spill estimates of sea otter abundance, based on boat surveys of shoreline areas, found non-oiled areas underwent a 13.5% increase in abundance, while oiled areas underwent a 34.6% decrease. In addition, the estimate of post-spill population in the oiled area is significantly lower than the best pre-spill estimate, indicating a real decline on the order of 1600 otters initially, and up to 2200 in subsequent years. No change in abundance was detected between July 1990 and July 1991 surveys.

Results of a 1991 field study evaluating sea otter prey selection and foraging success indicate sea otters have not altered their diet over the past decade and continue to rely primarily on clams and mussels as forage. Given hydrocarbon contamination in bi-valve mollusks, the prey study described a pathway for continued exposure of sea otters to environmental hydrocarbons. In addition, other damage assessment studies have documented decreases in abundance of mussels in oiled areas which may further impede recovery of sea otter population.

Analysis of age class composition of beach cast sea otters in western Prince William Sound from 1974-84, in 1989 and following the spill in 1990-91 detected significant differences between pre-spill and spill year distributions, and pre-spill and post-spill distributions. Spill year and post-spill distributions were not significantly different. The proportion of prime age animals dying in western Prince William Sound increased in both the spill year (1989) and post-spill years (1990 and 1991). The observed differences represent a shift from a pre-spill composition of principally young and aged animals to an increased proportion of prime-age animals during and following the spill. The observed changes in the age distributions of dying sea otters suggest a prolonged, spill-related effect on at least the western Prince William Sound sea otter population.

Results of clinical, hematologic and serum chemistry analyses of otters which died shortly (within the first 10 days) after entering the rehabilitation centers indicate that the majority of sea otters that died acutely appear to have succumbed to shock. Terminal signs generally included lethargy and hypothermia, often accompanied by anorexia, convulsions, and hemorrhagic diarrhea. Common hematologic abnormalities included lymphopenia, leukopenia, and anemia. Prevalent syndromes identified in these otters by clinical chemistry included azotemia, hyperkalemia, hypoglycemia, hepatocellular leakage, and hypoproteinemia/hypoalbuminemia.

Blood samples collected from wild caught otters in 1990 and 1991 identified significant differences in several blood parameters between eastern and western Prince William Sound. Hematologic and serum chemical analyses of adult male sea otters found significantly higher hematocrits and hemoglobins in the west. Western males had significantly higher eosinophil counts, suggesting systemic hypersensitivity reactions. Serum sodium and serum chloride were significantly higher and serum potassium lower

Preliminary Damage Assessment Report

Marine Mammal Study 6
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EXECUTIVE SUMMARY

Damages to sea otters resulting from the T/V Exxon Valdez oil spill can be categorized into two temporal components: 1) acute mortality, and 2) chronic damages.

Acute mortality was partially reflected in a total of about 1,000 sea otter carcasses collected during or shortly after the spill. It is probable that some additional number of sea otters became oiled and subsequently died, and that their carcasses were never recovered. Preliminary results of autopsies of intact carcasses indicate less than 5% of mortalities were clearly not spill related.

Three approaches were taken to estimate the total number of sea otter mortalities that resulted from acute exposure to oil. One method estimates the number of unrecovered carcasses based on the probability of carcass recovery. Available information suggests about 75% of sea otter carcasses are not recoverable. Another method compares estimates of sea otter abundance before and after the spill. These comparisons suggest a large number of otters, relative to the number of carcasses retrieved, suffered acute mortality. A third method consists of an intersection model to estimate mortality based on potential exposure to oil and observed mortality rates dependent on degree of oiling. Simulations with this model indicate that about 52% of the Kenai Peninsula sea otter population was potentially exposed to oil. This model may be applied throughout the spill zone to provide an estimate of total mortality. A synthesis of these methods of loss estimates suggest between 3,500 and 5,500 sea otters may have died as a result of acute exposure to oil following the Exxon Valdez spill.

Chronic damages to sea otters may result from sub-lethal initial exposure and continued exposure to environmental hydrocarbons. Indirect damages, either chronic or acute, may result from affected sea otter prey populations. Preliminary findings of Coastal Habitat and Shellfish studies have identified elevated levels of hydrocarbons in intertidal and subtidal sediment samples collected within the spill zone. Additionally, hydrocarbon analysis of benthic marine invertebrates indicate that high levels of hydrocarbons persist in several species previously identified as sea otter prey in western Prince William Sound.

Preliminary results of several sea otter damage assessment studies indicate that sub-lethal chronic exposure may be damaging sea otters at the biochemical, physiological and population levels.