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Evaluation of a monitoring program for detecting oiled birds on beaches

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EVALUATION OF A MONITORING PROGRAM
FOR DETECTING OILED BIRDS ON BEACHES

A Thesis

Presented to

The Faculty of the Department of Environmental Studies

San Jose State University

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

by

Karna Carlson

December 2004

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ABSTRACT

EVALUATION OF A MONITORING PROGRAM FOR DETECTING OILED BIRDS ON BEACHES

By

Karna Carlson

This thesis research analyzed the quality of data and program structure of a monitoring program for detecting oiled birds. The Department of Fish and Game organized a beach search effort and between December 2002 and January 2003 survey teams looked for oiled birds along the central California coast. The goal of the beach search effort was to produce data that would estimate the total number of birds impacted by a sunken leaking freighter. Searchers used five methods to locate birds, none of which yielded an accurate number of birds or trends for estimating total bird losses. Problems included protocols that were not specifically designed to achieve this goal and data recording that had many errors.

This analysis found that for foot surveys, searchers needed to spend approximately 100 minutes if they were to find birds. Recommendations for designing a monitoring program that provides reliable, quantitative data are provided.

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INTRODUCTION

Background

Marine ecosystem protection is the outcome of on-going public concern and government response. Threats to marine environments include over-fishing, harvesting, mining, drilling, pollution, oil spills, debris, and recreation.

Designating marine sanctuaries along the U.S. coastline is one way governments have tried to protect marine habitats (McGregor 1994). Marine sanctuary development began after 1972 when Congress passed the Marine Protection, Research and Sanctuaries Act (Act) (McGregor 1994). The Act authorized the National Marine Sanctuaries Program and empowered the U.S. Secretary of Commerce to designate sanctuaries and promote comprehensive management of their uses, such as, conservation, recreation, research and education, and aesthetic resources (NOAA 1999). The first marine sanctuary, the *U.S.S. Monitor* National Marine Sanctuary, was designated in 1975.

The Act requires sanctuary managers to develop a plan for managing each sanctuary's natural and cultural resources. Sanctuary managers, working within the Sanctuaries and Reserve Division of the Office of Ocean and Coastal Resources Management, a division of the National Oceanic and Atmospheric Administration (NOAA), work collaboratively with the public, grassroots organizations, local, state, and federal governments, researchers, and industry to

develop such plans. As part of these plans, sanctuary managers must prepare for emergencies by developing sanctuary contingency plans for various disaster scenarios and to coordinate response efforts between local, state, and federal agencies. To complement contingency plans, sanctuaries may also implement on-going monitoring efforts to survey coastal beaches for oil spills, collecting baseline data on spill locations, including dead and injured marine animals and habitats, to aid in response and restoration by incident commanders, resource agencies, and litigators. The collected data provide a tool for assessing ecosystem health, developing policy and identifying funding priorities, supporting litigation in cases of human induced disaster, and promoting public accountability.

Significant oil spill events, for which monitoring has become increasingly important, are the result of a sunken freighter that sank off the coast of the San Francisco Bay in 1953. For decades, intermittent oil spills have polluted California's central coast and killed large numbers of marine birds. For many years, the source of the oil was unknown. In 2001, the U.S. Coast Guard finally identified the oil source as the sunken freighter, the *S.S. Jacob Luckenbach* (Hampton et al. 2003), which sank on July 14, 1953, seventeen miles southwest of the Golden Gate Bridge and ten miles southeast of the Southeast Farallon Island (McCleneghan 2002) (Figure 1). The *S.S. Jacob Luckenbach* was a C-3 freighter built in 1944 and left San Francisco en route to South Korea loaded with 10,880 barrels

(457,000 gallons) of bunker fuel (Hampton et al. 2003), railroad and automotive parts, and other materials to support the Korean War (McCleneghan 2002) (Figure 2). As the freighter traveled out of the San Francisco Bay, it was struck near its stern by the *S.S. Hawaiian Pilot* and sunk in an estimated 175 feet of water.

Figure 1: Location of Sunken Freighter off the Central California Coast
(California Department of Fish and Game)

Figure 2: Photo of the *S.S. Jacob Luckenbach*
(California Department of Fish and Game)

The eroding *S.S. Jacob Luckenbach* hull is now considered the source of many mysterious, intermittent releases of oil since the 1970's, impairing the coastline and marine birds during the significant storm events that are common during the late fall and winter months (McCleneghan 2002) in the San Francisco Bay region. If assumed to be leaking since settling to the ocean floor in 1953, over time, the *S.S. Jacob Luckenbach* is estimated to be responsible for the deaths of tens of thousands of marine birds (Hampton et al. 2003), including Common Murres on the Southeast Farallon Island (Carter et al. 2003).

Government response to, and documentation of, oiled bird events was limited prior to the 1990's (Hampton et al. 2003). In November 2001, after another significant oiled marine bird event along the central coast shoreline, mostly

affecting Common Murres, the California Department of Fish and Game's Office of Oil Spill Prevention and Response (OSPR) and the U.S. Coastguard, Marine Safety Office, San Francisco (USCG), initiated a coordinated oil spill response effort (McCleneghan 2002).

After discovering and locating the final resting place of the *S.S. Jacob Luckenbach*, divers successfully pumped over 100,000 gallons of fuel from the sunken freighter (McCleneghan 2002) (Figure 3). However, the impact of oiling on the local Common Murre colonies continues to be significant, since greater than ninety-five percent of the breeding population (Hampton et al. 2003) nest on the Farallon Islands during the winter. Since no responsible party exists to pay for the cleanup efforts of the *S.S. Jacob Luckenbach*, the USCG's National Pollution Funds Center authorized the use of the Oil Spill Liability Trust Fund (Fund), created under the Oil Pollution Act of 1990, to pay for clean-up and compensatory restoration costs (Hampton et al. 2003). Compensatory restoration costs repay the public for injuries to natural resources, such as losses to marine bird populations. Natural resource trustee agencies may pursue this compensation by filing a natural resource damage claim to the Fund using a natural resource damage assessment. In the case of the *S.S. Jacob Luckenbach's* impacts to oiled birds, agencies must quantify the number of injuries (Hampton et al 2003) by determining the accurate number of beached birds, injured or dead.

Figure 3: Computer Model of Sunken Freighter on Ocean Floor
(California Department of Fish and Game)

Few coastal monitoring programs exist and little information is available to design an ideal model for a monitoring program. Although authors individually theorize about the important components of monitoring programs, few recommend a comprehensive model to guide researchers and government agencies in the development of effective data collection efforts.

Objectives

This thesis research analyzes the oiled bird data collected by searchers for the California Department of Fish and Game's Office of Oil Spill Prevention and Response between December 2002 and January 2003 along the California

coastline, between the central Sonoma and central Monterey counties (Figure 4), and the survey protocols for that effort.

Figure 4: Total California Coastal Region Searched for Oiled Birds
(California Department of Fish and Game)

This analysis is designed to address three research questions:

1. What can be inferred about the rate of oiled birds from the *S.S. Jacob Luckenbach* beach search effort data? Do the data meet the goals of the beach search effort to estimate the total number of birds impacted by the *S.S. Jacob Luckenbach*?
2. According to the literature, what are the essential components of a reliable monitoring program designed to produce quantitative data?
3. How can the *S.S. Jacob Luckenbach* beach search effort be changed to be a reliable program that meets the criteria developed for research question #2?

RELATED RESEARCH

Introduction

Monitoring studies used to assess management practices of protected ecosystems convey a program's effectiveness to fulfill the ecological, policy, and funding goals of managers, policymakers, and the public (Epstein 1995, Griffith 1998, Hockings 1998, Lee 1996, Ringold et al. 1999, Sherman 1994, Smith-Evans and Dawes 1997, and Vora 1997). Data collected from these studies communicate to managers changes in ecosystem health, resource availability, and system trends, whether those changes are human induced, such as oil spills or logging practices, or naturally occurring, like earthquakes or volcanic eruptions (Rees and Pond 1995; Vora 1997; Malone and Nemazie 1996; Gilfillan et al. 1999; and Ringold et al. 1999). However, monitoring is still an expanding ecosystem assessment application. Monitoring programs should also provide accurate and quantified assessments of ecological condition. Social and natural scientists continue to examine program development and implementation, appropriate monitoring parameters, study design, institutional research, and program barriers. Although not exhaustive, this literature review examines the various aspects of monitoring programs analyzed and discussed by scientists.

Program Development and Implementation Considerations

Monitoring surveys are just one of elements needed to evaluate ecosystem health (Vora 1997). Assessing health also includes conducting broad baseline inventories (Agnew 1997, Krogh and Koop, Ogden et al. 1994, and Lee and Pritchard 1996); defining goals and objectives for ecosystems of varying scales (Vora 1997 and Griffith 1998); identifying observable or measurable key indicators that can be used to answer assessment questions (Agnew 1997); determining the specific thresholds, values, ranges and endpoints for individual indicators; designing a monitoring program (Nelson 1993 and Ogden et al. 1994); monitoring identified indicators to detect status relative to identified diagnostic thresholds (Agnew 1997 and Malone and Nemazie 1996); and evaluating results (Nelson 1993 and Green 1979).

Researchers outline different theories behind the development and implementation of a monitoring program (Griffith 1998, Natural Resources Defense Council 1999, Wells 1999, and Ringold et al. 1999). Griffith (1998), for example, gives four reasons monitoring programs are developed: 1) To determine the present and future health of ecosystems; 2) To establish empirical limits of variation of natural resources; 3) To diagnose abnormal conditions and identify issues in time to develop effective mitigation, and 4) To identify potential agents of abnormal change. The United States Natural Resources Defense Council (NRDC) similarly believes that monitoring programs are

important to develop and implement because they 1) provide information needed to evaluate pollution abatement problems, 2) serve as early warning systems that lower cost solutions to environmental problems, 3) contribute to knowledge of ecosystems and how they are affected by human activity, 4) provide essential data for the construction, adjustment, and verification of quantitative predictive models, which are an important basis for evaluating, developing, and selecting management strategies and, 5) provide environmental managers the scientific rationale for setting environmental quality standards.

Wells (1999) also argues that periodic assessments of oceanic and marine ecosystem health and quality are essential because they reveal the current conditions and trends, especially of the problems, within these systems. These also provide environmental managers with reference points for setting priorities in controls, regulations, new developments, and research. The resulting data provide a focal point for questions, such as: What are the existing problems? How well are they understood? Are they getting better or worse? Long-term monitoring can provide trend data, especially on population change and distribution, occurrences of environmental pollution, the success of rehabilitation and restoration projects, and demographic changes taking place in the coastal zone.

However, Ringold et al. (1999) emphasize that in assessing ecosystem health, scientists must also evaluate a monitoring program's effectiveness. For example,

programs should be assessed to determine whether the objectives of the plan are being achieved; whether steps of the plan are being implemented; and whether the assumptions underlying the plan are correct.

Monitoring programs for ecological health have been established on national and local scales. One example of a national program is the U.S. Environmental Protection Agency's (EPA) Environmental Monitoring and Assessment Program (EMAP). The need to develop a more effective, large-scale, monitoring program was recognized early by the EPA (EPA 1996). In 1988, the U.S. EPA's Science Advisory Board made several recommendations to the EPA to strengthen its research on the condition of the environment. As a result, EMAP was developed, with the goal to "monitor the condition of the nation's ecological resources to evaluate the cumulative success of current policies and programs and identify emerging problems before they become widespread or irreversible" (EPA 1996). This program can be used to confirm that the nation's environmental protection programs are maintaining or improving the quality of the environment (Messer et al. 1991). EMAP's goal is applicable to evaluating the status of all protected ecosystems, including coastal systems.

Despite this large-scale effort, the NRDC found that there are significant stretches of California coastline without water quality monitoring efforts. In their annual report, "Testing the Waters – 1999 A Guide to Water Quality at Vacation Beaches", the NRDC concluded that many swimming waters remain

unmonitored along the coast and are threatened by pollution. Recognizing the need for coastal monitoring, California passed a law in 1997 mandating the monitoring of beaches beginning in 1999; to date, regulations are not in place to enforce the law. The NRDC, in their recommendations, suggests the EPA expand the monitoring efforts of their Beach Environmental Assessment, Closure and Health (BEACH) Program. However, there is concern that large, nationwide programs, intended to oversee all environmental monitoring, diminish their purpose and effectiveness when these monitoring efforts could be conducted locally, thus reducing the occurrence of turf battles between local and national agencies (Griffith 1998).

Program Design

Authors agree that a successful monitoring program is one in which its purpose and goals are clearly identified (Griffith 1998, Ringold et al. 1999, Vora 1997). Vora (1997) makes the case that monitoring should not be carried out until its design objectives, scope, and data reliability have been defined, taking note that data results should assess and communicate the effects and effectiveness of management practices. Additionally, Griffith argues that monitoring programs should be designed to address a set of hierarchical questions: 1) Purpose: What is the aim of monitoring? 2) Method: How can this be achieved? 3) Analysis: How are the data, which will be collected periodically, to be handled? 4)

Interpretation: What does the data mean, and 5) Achievement: When will the goal be achieved?

Nelson (1993) reviewed general and specific sampling design considerations. Four general conditions needed to achieve an “optimal impact study design” (Green 1979). In the case of beach restoration monitoring, these are: 1) collection of pre-impact baseline data; 2) determination of the type of impact (e.g., oil spill) and its time and place of occurrence; 3) simultaneous measurements of all relevant biological and environmental variables; and 4) identification of a control site. It is very difficult to develop statistically analyzable data with impact monitoring studies because it is impossible to randomly assign a particular treatment effect to a particular location, intersperse two types of treatments, and identify sample sites that are true treatment replicates. Using inferential statistics to analyze beach restoration, for example, remains problematic for these reasons (Nelson 1993). Instead, the investigator must be cautious with monitoring observations so that random events do not impinge solely on the replicates of one treatment.

Statistical validity can be achieved with Before and After Control Impact (BACI) designs. This technique requires multiple control sites to determine ranges of natural variation. Monitoring programs meant to determine human impacts to certain sites from unique events should try to implement a BACI design. Monitoring should incorporate long-term sampling. In Lee and

Pritchard's (1996) analysis of long-term patterns in time-limited environmental monitoring programs, the entire study focused on BACI and data was thus collected accordingly – before and after an impact at replicated control and impact locations. Thus the authors caution against making assessments in the absence of long-term data sets, especially if stochastic events (e.g., floods and fires) are not always consistent. Furthermore, Ogden et al. (1994) also make the case for long-term research, confident it will ultimately manage human impact if conducted over a time scale that incorporates variation in ecosystems, processes, and geography.

Ultimately, monitoring design to evaluate ecosystem health should be adaptive and flexible (Ringold et al. 1999). Scientists must consider the practicality of assessing an entire ecosystem. In some instances, program objectives require assessing only one parameter of an ecosystem. Thus, an indicator species, a dependent or related species likely to reflect changes in the availability of certain fauna resources, indicating the state of that part of the ecosystem most impacted by stochastic or planned activities, can be used as a monitoring tool of ecosystem health (Agnew 1997).

Monitoring programs may require changing priorities altogether to recognize changed circumstances. Armstrong et al. (1996) examine Sydney, Australia's need to change the priorities of their Beachwatch Pollution Monitoring Programme. Sydney's local officials decided to take advantage of deep ocean

currents to keep sewage away from public beaches and replaced their near-shore, cliff sewage outfalls with offshore, deepwater diffusers. As a result, the program's surveys went from monitoring impacts of gross sewage pollution to more diffuse pollution created offshore.

Several researchers have assessed the design of beach debris monitoring programs. Rees and Pond (1995) assess marine debris monitoring programs. They outline three methods used to collect debris data and evaluate the effectiveness of each method. The first collection method requires mathematical extrapolation by multiplying the number of people at sea in a given activity by the average amount of litter produced by that activity. The second approach uses transect lines from sides of research boats, counting the density and type of debris along that transect. The final approach uses volunteers and beach monitoring surveys to collect data. The authors conclude that the beach survey method is the most appropriate method because it allows a large sample size to be monitored cost-effectively and with minimal equipment. Furthermore, variations on beach sample surveys are versatile enough for varying baseline studies, trend assessment, and assess land-based and ocean-based litter.

Gilfillan et al. (1999) also examine study design in their comparison of Exxon Valdez oil spill monitoring programs. They evaluated three study designs and their statistical power by comparing programmatic elements. The first approach was designed to assess the injury and recovery of wildlife in the entire spill zone;

the second had a similar objective but focused only on moderate-to-heavily oiled shores; and the third determined the effect of hot-water cleanup techniques on shoreline biota. The researchers concluded that the number of sampling sites in the design of an oil spill study should be as high as possible; second, the statistical power to detect oiling impacts can be increased by selecting the oiled sites from only the most heavily oiled locations; and third, researchers need to evaluate for an ecosystem the pros and cons of different ways of minimizing variance.

Data Sampling and Analysis

Program design affects data sampling and analysis. In the case of biological monitoring design for beach restoration efforts, Nelson's (1993) analysis specifies that monitoring designs may not always be constructed to meet the individual biological requirements of a given area; therefore detailed baseline studies are required. However, Andrew and Mapstone (1987) argue against standardization of sampling in study design, but Nelson (1993) agrees that some consistency in sampling and methodology would provide data from which conclusions can be drawn concerning general biological impacts of beach restoration.

Krogh and Koop (1996) identify the requirements necessary to yield effective data and analysis. First, treatment comparisons should be as free as possible from systematic error, second, conclusions should have a wide range of validity,

and third, uncertainty in conclusions should be accessible. The authors emphasize that a good experiment is one which includes clear hypotheses, appropriate experimental design and statistical tests, careful consideration of the parameters to be measured, power of the study to detect statistical and ecological differences, appropriate choice of control sites, and adequate pilot studies. Effective sampling and analysis is also a condition of knowing how many samples in a given site yield effective results, using fixed versus variable sample sites along a transect, the type of equipment to procure data, and knowing when and how long to conduct sampling at a site (Nelson 1993).

Collaborative Research

Monitoring success also depends on a collaborative effort to effectively and efficiently gather and share data (Agnew 1997, Epstein 1995, Malone and Nemazie 1996, Ogden et al. 1994). In Agnew's review of the Commission for the Conservation of Antarctic Marine Living Resources Ecosystem Monitoring Programme, an argument for parallel programs of research and monitoring is made. As a result, monitoring can be modified with changing requirements and produce a strong scientific background for the interpretation of results. While the program monitored for mortality among Adelie penguin chicks on Bechervise Island, Antarctica, associated research demonstrated that krill scarcity in the

island's vicinity was the culprit. Collaborative work in this research thus yielded more robust results.

The connection between environmental change and its effect on the global resurgence of infectious disease also warrants coordinated research efforts (Epstein 1995). Although the link between environment and health may be direct or indirect, a major impediment to disease monitoring and detection is the fragmentation of epidemiology and scientific disciplines. However, with the development of geographically displayed data, new opportunities exist for multi-disciplines to coordinate their results and overlay data sets. Epstein (1995) concludes that risk assessment of anthropogenic activities must include ecological effects to ensure that indirect human effects on the environmental quality do not exacerbate disease.

Malone and Nemazie (1996) also emphasize the need for collaboration and data sharing between scientists, especially as ecosystem research has significantly increased at a time when ecosystems are being lost or degraded at accelerating rates, meanwhile government agencies are sponsoring costly monitoring programs and research publications. They further reason that the gap between national needs and the capacity of the nation's research institutions grows rapidly, thus making a case to strengthen the role of coastal laboratories to address the problems affecting coastal ecosystems. The authors suggest that the success of laboratories is in their willingness to work with federal agencies to 1)

overcome parochial attitudes and approaches – labs and agencies should no longer work independently in jurisdictions they believe to be solely theirs; 2) develop and coordinate research and monitoring programs to make optimal use of resources; and 3) respond to new demands and expectations. Malone and Nemazie (1996) further believe that coastal laboratories are in a position to 1) promote scientific programs at the local, regional and national level and 2) facilitate consensus among scientists and stakeholders. Finally, the authors stress the importance of laboratories and federal agencies to share resources and form coalitions to develop relevant and cost-effective research in the coastal zone.

A final example is the long-term study of the Florida Keys seascape. Ogden et al. (1994) concluded that effectively documenting and understanding changes to ecosystem health means integrating research across disciplines, incorporating geographic and temporal scales of natural ocean processes upon which human impact is superimposed. Therefore, it is concluded that effective data management and trend analysis in monitoring programs must consider interdisciplinary coordination.

Program Evaluation

Ecosystem management plans, although widely developed and implemented, often lack an evaluation component (Hockings, 1998). Although formal evaluation plans are considered and developed for larger agency programs, they

remain the exception for small, individualized protected areas and management plans.

Much of the literature outlines the ways in which monitoring programs should be developed and implemented (Griffith 1998, Smith-Evans and Dawes 1997, Vora 1997). Few critique and evaluate a monitoring program's power, or effectiveness to produce desired results (Gilfillan et al. 1999).

In one program evaluation, Gilfillan et al. (1999) compared the study design, analysis methods, and statistical power of three shoreline assessment programs, used in the aftermath of the Exxon Valdez spill, which assessed the effects of oil and cleanup techniques in the spill zone of Prince William Sound, Alaska. These programs were 1) the Shoreline Ecology Program (SEP) conducted by Exxon; 2) the Coastal Habitat Injury Assessment (CHIA) conducted for the Exxon Valdez Oil Spill Council; and 3) the Biological Monitoring Study (BMS) conducted for the National Oceanographic and Atmospheric Administration (NOAA).

First, the objectives and study designs were compared in a table based on the following program components: Objective, Experimental unit, Number of sites, Habitats, Oiling levels, Cleanup, Transects per site, Sample stations. Next, the authors outlined the analysis methods comparing each of the programs' comparison units, covariates, population distribution, statistical methods, and significance level. Once the authors outlined the programs based on objectives, study design, and analysis methods, they set out to establish the programs'

ability to effectively detect the impact of the oil, also known as a program's "power." The authors establish that design differences affect the ability of each program to detect the impact of oil. Therefore, the studies' power was calculated as a function of the number of sites in the design, the signal-to-noise level in the data, and the analysis method. Data were calculated by taking the site and transect numbers for the bedrock habitat assessed in each study. A series of signal-to-noise ratios (treatment mean square per the error mean square) were used to compute various design/analysis scenarios. The authors then compared the power curves of the various signal-to-noise ratios and discussed that the number of sites in an assessment plays a large role in achieving a high power to detect oil spill impacts. They concluded that several strategies be implemented in detecting spill impacts: 1) the number of research sites should be as high as possible to take into account data variation; 2) the sites researched should be heavily oiled locations, suggesting that if a program's objective is to determine that damage did occur, a well oiled site will reveal that data; 3) the pros and cons of different ways to minimize variance (e.g., matched-pair design; matching the same physical attributes for control and oiled sites) for a particular environment should be evaluated.

Barriers to Program Development and Implementation

Establishing monitoring programs to determine ecosystem health is complex as scientists, politicians, and managers, must agree on its various aspects.

Ringold et al. (1999) identify three barriers in monitoring design and implementation to be addressed for a successful program. These barriers are: the lack of clear objectives (refining existing qualitative objectives must be continuous), inconsistent, changing, or nonexistent methods (methods must exist and be consistent between organizations and agencies), and the lack of available information to estimate variability of environmental features and measurement error over relevant temporal and spatial scales (effective and relevant ecological indicators must be identified to assess the quality of the environment) (Griffith 1998).

Additionally, the inability to discriminate between natural variation and human induced changes is a major problem in marine ecosystem research (Ogden et al. 1994). Natural processes vary on a time scale different than research funding cycles; thus collecting long-term ecosystem data sets are critical to ecosystem management. BACI designs and long-term monitoring are needed to address this problem.

Finally, institutional barriers can impact the integrity of an established program. Although some studies require collecting years of data to document long-term environmental effects, changes in government priorities – both

programmatic and financial – restrict logistically expensive studies, such that only short-term results can be determined (Lee and Pritchard 1996). Social, political, and economic aspects of a monitoring program are clearly integral to the condition and management of the environment, since these are driving forces behind environmental impacts as well the inequitable distribution of these resources to address treatment (Epstein 1995).

Summary

In the field of conservation management, monitoring programs are increasingly recognized for their importance to determine the condition of the environment and identify the need for future improvements. These programs assist policymakers in policy development and funding decisions and meet expectations of the public's desire for a clean and safe environment (Griffith 1998, Hockings 1998, Ringold et al. 1999). However, once monitoring programs are designed and implemented, they, too, require evaluation to determine whether they are effective in meeting the objectives of their design. Authors (Gilfillan et al. 1999, Griffith 1998, Hockings 1998, and Ringold et al. 1999) agree that the effectiveness of a monitoring program resides not in post-data analyses, but in assessments at all phases of its design.

METHODS

Introduction

This thesis study evaluates the effectiveness of the *S.S. Jacob Luckenbach* beach search effort conducted between December 2002 and January 2003 to find oiled birds along the central California coast. Searchers representing the U.S. Fish and Wildlife Service, the California Department of Fish and Game's Office of Oil Spill Prevention and Response, the non-profit organization Oiled Wildlife Care Network, and the consulting firm, Mad River Biologists, gathered data on the numbers of beached oiled birds with the goal of using the data to generate an estimate of the total number of impacted birds. Ideally, this estimate would be used to apply for compensation under the Oil Pollution Act of 1990.

Research Study Site

The sunken *S.S. Jacob Luckenbach* lies just off the entrance of the San Francisco Bay, the converging point of the Gulf of the Farallones and Monterey Bay National Marine Sanctuaries. The Gulf of the Farallones National Marine sanctuary was dedicated by Congress in 1981 and incorporates 1,255 square miles of the San Francisco Bay region, located just north of the Monterey Bay National Marine Sanctuary. The Farallon Islands within the Gulf of the Farallones National Marine Sanctuary are a designated National Wildlife Refuge

providing resting and breeding sites for 10,000 seals and sea lions and 400,000 seabirds, who are attracted each year to the nutrient rich waters created by upwellings along the sanctuary's 35 mile extended continental shelf. Other sanctuary inhabitants include the dungeness crab, California gray whale, humpback whale, blue whale, rockfish, and abalone. The Gulf of the Farallones National Marine Sanctuary supports the largest concentration of breeding seabirds within the continental United States (Monterey Bay Aquarium Foundation 1997).

The Monterey Bay National Marine Sanctuary, dedicated by Congress in 1992, is presently the largest national marine sanctuary, spanning 5,300 square miles between San Francisco and San Luis Obispo counties, an area greater than either Yosemite or Yellowstone National Parks. The sanctuary includes one of the largest and deepest submarine canyons off North America's west coast, which, at its deepest point, 10,663 feet, is twice the depth of the Grand Canyon (Monterey Bay Aquarium Foundation 1997). Remarkably, the Monterey Bay National Marine Sanctuary not only provides breeding, feeding, and migration areas for over 26 species of marine mammals, 94 species of birds, and 345 species of fish, but is also a significant cultural site of 1,276 reported shipwrecks and 718 coastal prehistoric sites (Monterey Bay Aquarium Foundation 1997).

This methods section describes the *S.S. Jacob Luckenbach* beach search methods first and then the design and analysis methods for this thesis.

S.S. Jacob Luckenbach Beach Search Effort

The raw beach search effort survey data provided by the Department of Fish and Game was collected between December 17, 2002 and January 1, 2003 along the central California coastline between the Sonoma and Monterey counties.

Using Beach Search Effort Logs (survey logs), data were collected by searchers from non-profit organizations, government agencies, and private business. Searchers were verbally instructed by the Department of Fish and Game to survey stretches of beach along the central California coastline looking for, collecting, and recording the presence of, oiled birds, dead or alive (Table 1). Although the survey log formats varied, in general, searchers were required to record the following data: oil spill name, date of search, names of searchers, beach segment name, total distance searched per beach segment using geographic positioning system (GPS) coordinates, start and end time of beach segment searched, search method, e.g., foot, point, or vehicle scan, of each beach segment, and the number of oiled birds observed per beach segment (appendix A).

Table 1: *S.S. Jacob Luckenbach Beach Search Effort Field Methods*

Search Method	Definition	Field Equipment	Procedure for located oiled birds, dead and alive
FOOT SEARCH	<i>For two searchers with a vehicle: one searcher walks along the back of the beach and the second searcher walks</i>	GPS device, search effort log, sometimes on rain-proof paper, pillowcases or nets for capturing live birds, waterproof bags,	Un-oiled dead birds are left on the beach and noted in the search effort log.

	<p>along the wrack line. The searchers walk the beach segment in both directions to increase the possibility of finding oiled birds and to return to the searchers' vehicle. A GPS start and stop point is recorded.</p> <p><i>For one searcher with a vehicle:</i> the searcher walks the back of the beach in one direction and the wrack line in the returning direction or vice versa. The searcher walks the beach segment in both directions to increase the possibility of finding oiled birds and return to their vehicle. A GPS start and stop point is recorded. This method of using one searcher to search a beach segment is against protocol for safety concerns.</p> <p><i>For one searcher with no vehicle:</i> the searcher walks the beach in a zig-zag pattern, from the back the beach to the wrack line and back up again, to search the high and low beach simultaneously for oiled birds. The searcher walks the beach segment in one direction if they have been dropped off at the start point and</p>	<p>such as paper dog food bags which do not distort the chemical fingerprint of oil the way plastic bags do, cardboard cat carriers to carry live birds, usually kept in the searcher's vehicle, a black Sharpie pen to write the date, time, and location of bird collected on bags and boxes, oil proof gloves, boots, warm clothing, and other weather protection as needed, e.g. sunscreen.</p>	<p>Oiled dead and oiled and/or injured birds are collected and taken to the Oiled Wildlife Care Center in Cordelia at the end of the day where they are logged into the center. Live birds receive treatment and dead birds are in-taked and stored in a freezer.</p>
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	<p>will be picked up at the end point. A GPS start and stop point is recorded. This method of using one searcher to search a beach segment is against protocol for safety concerns.</p> <p>"Rate" in foot searches refers to time spent on the beach, as time spent surveying beach segments increases the chance of finding oiled birds.</p>		
Search Method	Definition	Field Equipment	Procedure for located oiled birds, dead and alive
POINT SCAN SEARCH	<p>The searcher records a GPS starting point and point scans the length of a beach segment by standing at one point of the beach segment and surveying the segment for oiled birds using binoculars.</p> <p>Searchers who did not have time to conduct foot searches of beach segments developed this method.</p> <p>"Rate" in point scan searches refers to time scanning the beach segment, as time spent on the beach increases the chance of finding oiled birds.</p>	<p>GPS device, search effort log, sometimes on rain-proof paper, pillowcases or nets for capturing live birds, waterproof bags, such as paper dog food bags which do not distort the chemical fingerprint of oil the way plastic bags do, cardboard cat carriers to carry live birds, usually kept in the searcher's vehicle, a black Sharpie pen to write the date, time, and location of bird collected on bags and boxes, oil proof gloves, boots, warm clothing, and other weather protection as needed, e.g. sunscreen.</p>	<p>Un-oiled dead birds are left on the beach and noted in the search effort log.</p> <p>Oiled dead and oiled and/or injured birds are collected and taken to the Oiled Wildlife Care Center in Cordelia at the end of the day where they are logged into the center. Live birds receive treatment and dead birds are in-taked and stored in a freezer.</p>

Search Method	Definition	Field Equipment	Procedure for located oiled birds, dead and alive
VEHICLE SEARCH	<p>The searcher drives the length of the beach segment in one direction surveying for oiled birds. A GPS start and stop point is recorded.</p> <p>Vehicles require broad, flat, open beaches with fine sand to conduct searches.</p> <p>"Rate" in vehicle searches refers to the rate of the vehicle's speed traveled along the beach segment, i.e. miles per hour.</p>	<p>GPS device, search effort log, sometimes on rain-proof paper, pillowcases or nets for capturing live birds, waterproof bags, such as paper dog food bags which do not distort the chemical fingerprint of oil the way plastic bags do, cardboard cat carriers to carry live birds, usually kept in the searcher's vehicle, a black Sharpie pen to write the date, time, and location of bird collected on bags and boxes, oil proof gloves, boots, warm clothing, and other weather protection as needed, e.g. sunscreen.</p>	<p>Un-oiled dead birds are left on the beach and noted in the search effort log.</p> <p>Oiled dead and oiled and/or injured birds are collected and taken to the Oiled Wildlife Care Center in Cordelia at the end of the day where they are logged into the center. Live birds receive treatment and dead birds are in-taked and stored in a freezer.</p>
Search Method	Definition	Field Equipment	Procedure for located oiled birds, dead and alive
COMBO FOOT/POINT SCAN SEARCH	<p>Searcher conducts a combination foot and point scan survey of the beach segment.</p> <p>Searchers who did not have time to conduct foot searches of beach</p>	<p>GPS device, search effort log, sometimes on rain-proof paper, pillowcases or nets for capturing live birds, waterproof bags, such as paper dog food bags which do not distort the chemical</p>	<p>Un-oiled dead birds are left on the beach and noted in the search effort log.</p> <p>Oiled dead and oiled and/or injured birds are collected and</p>

	segments developed this method.	fingerprint of oil the way plastic bags do, cardboard cat carriers to carry live birds, usually kept in the searcher's vehicle, a black Sharpie pen to write the date, time, and location of bird collected on bags and boxes, oil proof gloves, boots, warm clothing, and other weather protection as needed, e.g. sunscreen.	taken to the Oiled Wildlife Care Center in Cordelia at the end of the day where they are logged into the center. Live birds receive treatment and dead birds are in-taked and stored in a freezer.
Search Method	Definition	Field Equipment	Procedure for located oiled birds, dead and alive
COMBO FOOT/VEHICLE SEARCH	<p>Searcher conducts a combination foot and vehicle survey of the beach segment.</p> <p>Foot searches are used when a vehicle cannot access a beach segment because it is prohibited or impossible, e.g. cliff or stairs.</p> <p>Vehicles require broad, flat, open beaches with fine sand to conduct searches.</p>	GPS device, search effort log, sometimes on rain-proof paper, pillowcases or nets for capturing live birds, waterproof bags, such as paper dog food bags which do not distort the chemical fingerprint of oil the way plastic bags do, cardboard cat carriers to carry live birds, usually kept in the searcher's vehicle, a black Sharpie pen to write the date, time, and location of bird collected on bags and boxes, oil proof gloves, boots, warm clothing, and other weather protection as needed, e.g. sunscreen.	<p>Unoiled dead birds are left on the beach and noted in the search effort log.</p> <p>Oiled dead and oiled and/or injured birds are collected and taken to the Oiled Wildlife Care Center in Cordelia at the end of the day where they are logged into the center. Live birds receive treatment and dead birds are in-taked and stored in a freezer.</p>

Thesis Research Design and Data Analysis

The purpose of this thesis is to address the following three research objectives:

First, what can be inferred about the rate of oiled birds from the *S.S. Jacob Luckenbach* beach search effort data? Do the data meet the goals of the beach search effort to estimate the total number of birds impacted by the *S.S. Jacob Luckenbach*?

Second, according to the literature, what are the essential components of a reliable monitoring program designed to produce quantitative data?

Third, how can the *S.S. Jacob Luckenbach* beach search effort be changed to be a reliable program that meets the criteria developed for research question #2?

To address the first research question, this thesis examined whether the search data could be used to estimate the total number of birds impacted by the *S.S. Jacob Luckenbach*. And, if such an estimate could not be developed, what could the data say. The data were analyzed for quality and then the actual number of birds impacted by oiling was correlated with searcher distance, time, and rate per beach segment. Next, t-Tests were used to analyze foot and combination foot/point scan search methods (methods for which there were enough data to conduct a statistical analysis).

The raw survey data were first prepared for analysis using only entirely complete beach segment entries from each Beach Search Effort Log. Log numbers were assigned to organize the surveys in descending order by date,

starting with January 1, 2003, and ending with December 17, 2002, then, with the assistance of the U.S. Geological Survey, converted the GPS coordinates into meters to determine the length of each beach segment searched. Finally, the beach segment data was grouped by search method and organized them in ascending order by the number of birds found per search method. The summary data used for analysis included the survey log number, segment name, search method, distance searched in meters, time in minutes, number of birds observed, rate, birds per distance searched, birds present or absent, birds per time searched, and birds per distance per time (Appendix B).

Search methods were analyzed by four search method categories: foot, point, vehicle, and combination foot/point. Descriptive statistics were developed for each search method, which included its mean, standard error, median, mode, and standard deviation of each method's distance, time, number of birds, rate, birds/distance, birds/time, and birds/distance/time.

For two search methods, foot and combination foot/point searches, t-Test analyses were conducted to determine if there was a significance difference in search rate, time, or distance between when oiled birds were found and not found.

To address the second research question, essential components for a successful monitoring program were identified based on literature reviews of pre-existing

monitoring programs. Components were compiled into a table for comparison to the *S.S. Jacob Luckenbach* beach search effort.

Based on the analysis for the two research questions, recommendations for how the *S.S. Jacob Luckenbach* beach search effort can be improved are made.

Research Assumptions and Limitations

The *S.S. Jacob Luckenbach* beach search effort research analysis is based on several assumptions:

Assumption 1: Because it is unknown when releases of oil occurred from the *S.S. Jacob Luckenbach* and no one specific search method type was any more correlated with a release of oil, different search method types occurred randomly and consistently so that it did not create a bias with respect to oiling, i.e., each different search method occurred at the same time, e.g., the same day.

Assumption 2: During the winter season when the greatest numbers of marine birds migrate toward the Farallon islands to forage in the open ocean surrounding the islands before congregating there to nest and rear their young in the spring and summer months, especially the Common Murre, the number and species of bird present in the affected area is about the same on any particular day.

Assumption 3: On days when birds were found, if no entry was made in the Beach Search Effort Log column marked "Birds Collected," no birds were found along that beach segment.

Limitations in the data collected from the *S.S. Jacob Luckenbach* beach search effort affected the quantity and quality of data analyzed for this research:

Limitation 1: Inconsistent survey logs were utilized in the data collection effort. Different survey forms requested different kinds of beached bird data.

Limitation 2: Data were entered illegibly in the survey logs.

Limitation 3: Data were entered incompletely, inaccurately, or inconsistently with the Beach Search Effort Log entry requirement.

RESULTS

What can be inferred about the rate of oiled birds from the *S.S. Jacob Luckenbach* beach search effort data? Do the data meet the goals of the beach search effort to estimate the total number of birds impacted by the *S.S. Jacob Luckenbach*?

This analysis revealed that the available data were not adequate to create a quantifiable index to determine the total number of birds impacted by oil from the *S.S. Jacob Luckenbach* for these reasons:

- 1) Standardized field search methods were not established. For example, what started out as a foot search evolved into a point scan if a searcher ran out of time to complete the search, and therefore, search methods could not be compared. Additionally, the area covered in each beach segment could not be quantified.
- 2) There were not enough data for each type of search method to be statistically analyzed.
- 3) A searcher efficiency rate was not established. Regardless of search method, the area searched in each beach segment and the efficiency of the search needs to be identified to estimate the total number of impacted birds. For example, if one beach segment, representing ten percent of the total beach, is searched, and twenty impacted birds are in the beach

segment, and searchers find only ten, or half, of those birds, then the searcher efficiency calculation is $10 \times 10 \times 2$. This standard had not been established to calculate the number of birds missed by searchers and must be factored into any estimate of the actual number of birds impacted by oiling.

- 4) Some data were not adequately recorded and there was no standard quality control procedure.

Although a quantifiable index could not be determined, enough data were collected from two methods, foot searches and combination foot/point scan searches, to allow t-Test comparisons between searches when birds were found versus not found for rate, time, and distance.

t-Test analyses of the foot search method (Table 2) show that on days birds were found, searchers spent significantly more time searching and traveled significantly farther than on days when oiled birds were not found. Mean rate of travel had no effect on whether birds were found or not.

Table 2: Foot Search Method Results Comparing Data When Birds Found and Not Found

	Birds Found		Birds Not Found		P (T<=) two tail	Level of Significance
	N	Mean	N	Mean		
Mean Distances (meters)	25	2073.04	31	1146.19	0.03499939	Significant
Mean Times (minutes)	25	109.88	31	30.29	8.5981E-05	Very significant
Mean Rates of Travel	25	24.84	31	49.76	0.05967602	Not significant

Table 3 shows that, for the combined foot/point scan search method, no parameter – time searching, distance covered, and rate of search – had an effect on whether birds were found or not.

Table 3: Combination Foot/Point Scan Search Method Results Comparing Data When Birds Found and Not Found

	Birds Found		Birds Not Found		P (T<=) two tail	Level of Significance
	N	Mean	N	Mean		
Mean Distances (meters)	10	1664.00	16	1158.18	0.57838642	Not Significant
Mean Times (minutes)	10	63.4	16	32.37	0.17054228	Not significant
Mean Rates of Travel	10	246.72	16	48.42	0.40982774	Not significant

Table 4 provides a qualitative evaluation, percent of cases in which birds were found, of the effectiveness of each search method for locating oiled birds. An assumption of this analysis is that the same number of oiled birds can be found on any random day. Given this assumption, Table 4 shows that foot searches are the most efficient search method as it yielded the highest percent, 45%, of cases in which birds were found. Point scan searches yielded the lowest percentages of when birds were found. Although vehicle searches may have potential, too few data were collected to confirm whether this search method is effective.

Table 4: Percent of Cases in Which Birds Were Found by Search Method

Search Method	Cases Birds Found/ Total Cases	Percent Cases Found	Results
Foot	25/56	45%	Foot searches seem to be a good survey method.
Foot/Point Scan	10/26	39%	Adding point scan searches to foot searches seem to dilute the foot search survey data.
Point Scan	2/14	14%	Point scan searches seem to yield poor data results.
Vehicle	2/4	50%	Vehicle searches seem to have potential; too few data to know.
Foot/Vehicle	5/6	83%	Combination foot/vehicle searches seem to have potential; too few data to know.

Table 5 provides the program components from the literature for a successful monitoring program. To develop an effective monitoring program that is efficient, well planned, well documented, and statistically robust, program design, implementation, evaluation, and barriers to success must be identified. The four components of a reliable monitoring program, the design,

implementation, evaluation, and barrier considerations (Vora 1997, Griffith 1998, Wells 1999, EPA 1996, Ringold et al. 1999, Natural Resources Defense Council 1999, Rees and Pond 1995, Nelson 1993, Krogh and Koop 1996, Agnew 1997, Lee and Pritchard 1996, Ogden et al. 1994, Epstein 1995, Malone and Nemazie 1996, Armstrong et al. 1996, Gilfillan et al. 1999, Gulf of the Farallones National Marine Sanctuary n.d.), are listed in Table 5.

For each of these components, Table 5 lists the respective elements, justifications, and examples from the literature. These components and elements provide a model for an ideal monitoring program. The *S.S. Jacob Luckenbach* beach search effort is compared to this model in Table 5.

Table 5: Essential Monitoring Program Components

Programmatic Consideration	Element	Example	Citation	<i>S.S. Jacob Luckenbach</i> Oil Spill Response
1. Design Considerations Programmatic design must clearly identify why the program exists and what value it adds to policy considerations and research efforts in this field.	Purpose, goals, and objectives The purpose, goals, and objectives identify why a monitoring program exists, what is plans to achieve, and how, i.e. is it a tool for agency managers to identify priorities in research, regulations, and new developments or whether it serves as an early	EPA's Environmental Monitoring and Assessment Program	Vora 1997; Griffith 1998; Wells 1999; EPA 1996; Ringold et.al 1999; Natural Resources Defense Council 1999	Purpose: Restore seabirds to pre-Luckenbach spill levels and provide compensatory restoration to the public for interim losses. Goal: Develop a natural resource damage assessment as part of the natural resource

	warning system and identify the current and future trends of ecosystem health.			<p>damage claim by quantifying injuries to seabirds and identifying restoration actions.</p> <p>Objective:</p> <p>Quantify the actual number of beached oiled birds, injured and dead.</p>
	<p>Method</p> <p>The method identifies how the purpose of the monitoring program will be achieved.</p>	Gulf of the Farallones NMS Beachwatch Program	Griffith 1998; Rees and Pond 1995	<p>Method:</p> <p>Conduct beach surveys for the presence of oiled birds, injured and dead.</p>
	<p>Analysis</p> <p>The analysis identifies how the monitoring data will be handled.</p>		Griffith 1998; Nelson 1993; Krogh and Koop 1996	<p>Analysis:</p> <p>Unidentified</p>
	<p>Interpretation (Outcome)</p> <p>The interpretation is the impact of the data, i.e. what does the data mean?</p>		Griffith 1998; Agnew 1997	<p>Interpretation:</p> <p>Unidentified</p>
	<p>Achievement (Outcome Measurement)</p> <p>The achievement is the determination that the</p>		Griffith 1998	<p>Achievement:</p> <p>A natural resource damage claim successfully filed and compensated.</p>

	monitoring program's purpose has been met, i.e. when will the goal be achieved?			
Programmatic Consideration	Element	Example	Citation	<i>S.S. Jacob Luckenbach Oil Spill Response</i>
2. Implementation Considerations Programmatic implementation must clarify how the monitoring program exists, i.e. how it is carried out	<p>Data Sampling and Analysis</p> <p>Data sampling and analysis establish the power, or effectiveness to produce desired results of the monitoring program's efforts. Sampling design should incorporate the appropriate number of samples within a given site to yield effective results; use fixed versus variable data along a transect; identify the type of field equipment used, and know when and how long to conduct sampling at a site.</p> <p>Data collection efforts should be long term to make assessments about human</p>	<p>Gulf of the Farallones NMS</p> <p>Lee and Pritchard's Before and After Control Impact Study</p>	Nelson 1993; Krogh and Koop 1996; Lee and Pritchard 1996; Ogden et al. 1994	<p>Data Sampling and Analysis:</p> <p>Data sampling incorporated five beach survey methodologies</p> <ol style="list-style-type: none"> 1) Foot Scan 2) Point Scan 3) Vehicle Scan 4) Foot/ Vehicle 5) Foot/ Point Scan

	<p>impacts on the environment that includes variations in ecosystems, processes, and geography.</p> <p>Data analysis should reflect treatment comparisons as free as possible from systematic error; conclusions that have a wide range of validity, and uncertainties in conclusions should be widely accessible.</p>			
	<p>Collaboration</p> <p>Monitoring success depends on collaborative success to effectively and efficiently gather and share data, which yields more robust results, closes the gap between national needs and the capacity of national research institutions, and facilitates monitoring efforts.</p>	<p>Commission for the Conservation of Antarctic Marine Living Resources Ecosystem Monitoring Programme and the long- term study of the Florida Keys Seascape.</p>	<p>Agnew 1997; Epstein 1995; Malone and Nemazie 1996; Odgen et al. 1994</p>	<p>Collaboration:</p> <p>Searchers for data sampling incorporated government agencies and rehabilitation groups.</p>
	<p>Flexibility and Adaptability</p> <p>The flexibility and adaptability is the ability of a</p>	<p>Australia's Beachwatch Pollution Monitoring Program</p>	<p>Ringold et al. 1999, Armstrong et al. 1996</p>	<p>Flexibility and Adaptability:</p> <p>Unidentified</p>

	program to change priorities to recognize changed circumstances.			
	Training Training, both initial and refresher courses, reinforces the monitoring program's field protocols for volunteer surveyors to ensure proper data collection in an effort to yield a data set as free from error as possible.	Gulf of the Farallones NMS Beach Watch Program		Training: Informal training on survey field equipment and methodologies
Programmatic Consideration	Element	Example	Citation	S.S. Jacob Luckenbach Oil Spill Response
3. Evaluation Considerations Programmatic evaluation must consider a program's power, or effectiveness to produce desired results, i.e. include assessment criteria to determine the success of the monitoring program, whether the goals and objectives are being met.	Assessment Criteria The assessment criteria evaluates the coastal monitoring program's ability detect the impact of oiling on a beach. Assessment strategies should include the highest number of research sites surveyed to take into account data variation; beach sites researched should be in heavily oiled	Three shoreline assessment studies used in the aftermath of the Exxon Valdez spill: 1) Exxon's Shoreline Ecology Program 2) Coastal Habitat Injury Assessment Program conducted for Exxon 3) Biological Monitoring	Gilfillan et al. 1999	Assessment Criteria: Unidentified

	areas if the program is measuring whether damage occurred; and the pros and cons of different ways to minimize variance for a particular environment should be evaluated.	Study conducted for the National Oceanic and Atmospheric Administration.		
	Recommendations The recommendations provide options for continuous program improvement and identify lessons learned.	Three shoreline assessment studies used in the aftermath of the Exxon Valdez spill: 1) Exxon's Shoreline Ecology Program 2) Coastal Habitat Injury Assessment Program conducted for Exxon 3) Biological Monitoring Study conducted for the National Oceanic and Atmospheric Administration.	Gilfillan et al. 1999	Recommendations: Unidentified

Programmatic Consideration	Element	Example	Citation	S.S. Jacob Luckenbach Oil Spill Response
<p>4. Barrier Considerations</p> <p>Programmatic barriers must be considered and understood in an effort to 1) conduct continuous process improvements and 2) identify and recommend policy and budget implications.</p>	<p>Design</p> <p>Design barriers include the lack of clear objectives, inconsistent, changing, or non-existent methods, and the lack of available information to provide effective and relevant ecological indicators to assess environmental quality.</p>		<p>Ringold et al. 1999; Griffith 1998</p>	<p>Design:</p> <p>Inconsistent data collection methods; informal surveyor training methods; unidentified study analysis, interpretation, flexibility and adaptability, assessment criteria, and recommendations.</p>
	<p>Environmental</p> <p>Environment-al barriers includes the inability to discriminate between natural variation and human induced changes, since natural processes occur on a time scale different than research funding cycles, and choosing study sites based solely on development or access, for example, which does not accurately reflect changes to the ecosystem as a whole.</p>		<p>Odgen et al. 1994</p>	<p>Environmental:</p> <p>Limited beach access for surveyors and low observation rate due to scavenging, re-wash, burial, or surveyor efficiency of beached oiled birds.</p>

	Institutional Institutional barriers include changes in government priorities, programmatic and financial, which restrict studies to shorter time frames yielding only short-term results.		Lee and Pritchard 1996; Epstein 1995	Institutional: Lack of budget and resources for surveyor training in protocols and equipment.
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The *S.S. Jacob Luckenbach* beach search effort followed the model by including a purpose, goal, objective, method, outcome measurement, data sampling technique, means for collaboration, and informal training. However, the beach search effort was missing an analysis tool, data outcome, demonstrated flexibility and adaptability, formal training, assessment criteria, recommendations, and unidentified design, environmental, and institutional barriers to success.

Finally, how can the *S. S. Jacob Luckenbach* beach search effort be changed to be a reliable program that meets the criteria developed for research question #2?

After comparing the beach search effort field methods with the essential components of pre-existing monitoring programs, Table 6 outlines the methodological changes needed in the *S.S. Jacob Luckenbach* beach search effort to produce quantifiable data.

Table 6: Methodological Changes Needed in the *S.S. Jacob Luckenbach* Beach Search Effort

Existing Condition	Methodological Change
Ineffective program design	Establish, document, and re-affirm standardized beach search protocols.
Insufficient searcher training	Train searchers consistently and often in established field search methods, including accurate, consistent, and complete data entry methods and proper use of field equipment, e.g. GPS hand-held devices.
Unknown searcher efficiency rate	Establish prior test to determine searcher efficiency, such as placing a known number of oiled bird carcasses along beach segments and testing trained searchers to recover the birds and estimating their error recovery rate to apply to an actual search effort.

DISCUSSION

The overall goal of the *S.S. Jacob Luckenbach* beach search effort is to develop a quantitative index for estimating the total number of impacted birds.

Developing this estimate is hampered by problems with data quality and insufficient quantity.

Data quality problems began with the use of too many search methods. None of the search methods gave an estimate of the total amount of beach covered, i.e., total area searched. Also, the efficiency of all the methods is unknown. Tables 2, 3, and 4 indicate that foot searches were the most likely to reveal oiled birds and the efficiency of these searches increased with the time spent and distance covered. Point scan searches were very inefficient and the location of oiled birds did not improve with increased effort (time and/or distance). This analysis indicates that foot searches should be used as a method to find oiled birds. Program designers must determine the amount of time or distance needed to maximize finding birds.

Data entries in the Beach Search Effort Logs were often inaccurate due to the improper use of GPS hand-held devices that led to incorrectly recorded coordinate data, i.e., searched beach segments often had corresponding coordinates that indicated searchers had surveyed beach segments on the open ocean (Appendix C). Several data entries in the Beach Search Effort Logs were

also incomplete and illegible. Additionally, more than one version of a Beach Search Effort Log form was used by searchers in the field, which provided inconsistent results in the types of data collected. Therefore, data entries that were inaccurate, incomplete, illegible, or inconsistent between forms, could not be included in this research analysis, limiting the quantity of data for analysis.

However, there were enough data of adequate quality to conduct t-Test analyses of foot and combination foot/point scan search methods with respect to mean distances, times, and rates traveled by searchers only when birds were and were not observed.

The foot search field method revealed that the time searchers spent traveling each segment of beach by foot was a factor in observing the most birds, versus the distance traveled by searchers in each beach segment, and less important, the rate traveled by searchers in each beach segment. Therefore, the greater the time, approximately 100 minutes, and distance, approximately 2,070 meters, searchers spend searching beach segments by foot increases the opportunity more birds will be observed. This finding shows that greater effort produces better results, which is what is needed in a good search method. However, even the foot search method data are difficult to interpret because there was variability within the types of foot searches implemented in the field and out of three types used, only two of them were similar. Both one and two searchers with a vehicle walked the length of a beach segment in a straight line in one direction and back in the other,

whereas one searcher with no vehicle walked a beach segment in a zig-zag pattern in one direction and back in the other.

Conversely, the statistical significance of the combination foot/point scan search method revealed that this search method is less superior to searchers traveling by foot alone. In all three comparisons of mean time, distance, and rate when birds were and were not observed, revealed that combining foot searches with a point scan search does not increase the chance that birds are observed in a beach segment. Combining a point scan with a foot search appears to reduce the instances that birds are observed when searchers are not consistently walking a beach segment, but also scanning from one point along the segment to observe birds.

Comparing the percent of cases in which birds were and were not found, in all five search method categories, revealed that foot searches appear to be a good method in observing birds, followed by combination foot/point scan searches, although adding point scans to a search along a beach segment appears to dilute the foot survey data, as the t-Test results also showed. Point scan searches by themselves yielded the poorest results by searchers. In two of the four cases of vehicle and combination foot/vehicle searches, birds were observed. These methods may have potential.

Second, an analysis of the literature revealed that reliable monitoring programs require certain essential components to produce reliable, quantifiable

data. Authors agreed that monitoring programs should be developed around four key components to ensure programmatic success: design, implementation, evaluation, and barriers (Vora 1997, Griffith 1998, Wells 1999, EPA 1996, Ringold et al. 1999, Natural Resources Defense Council 1999, Rees and Pond 1995, Nelson 1993, Krogh and Koop 1996, Agnew 1997, Lee and Pritchard 1996, Ogden et al. 1994, Epstein 1995, Malone and Nemazie 1996, Armstrong et al. 1996, Gilfillan et al. 1999, Gulf of the Farallones National Marine Sanctuary n.d.) (Table 5).

Program design is the framework around which the monitoring program exists and the value it adds to its field of research. This includes a clear definition of a program's purpose, goals, and objectives, proposed method of monitoring and analysis, i.e., how the monitoring program's purpose will be achieved, analysis tool, i.e., how the data will be handled, desired data outcome, i.e., impact of the data, and outcome measure to determine the success of the program's purpose. In comparison, the *S.S. Jacob Luckenbach* beach search effort included a defined purpose, goal, objective, method, but lacked an analysis tool, outcome, and outcome measure.

Monitoring program implementation, according to the literature, includes data sampling and analysis techniques, or a program's effectiveness to produce the desired results; collaborative opportunities, the program's ability to effectively and efficiently gather data; flexibility and adaptability, the program's ability to change priorities to recognize changed circumstances, and training,

which ensures proper data collection to yield data as free from error as possible. When compared to the *S.S. Jacob Luckenbach* beach search effort, this effort identifies five sampling techniques, or search methods, to find birds, but no analysis of that data; demonstrates collaboration with the U.S. Fish and Wildlife Service, the California Department of Fish and Game's Office of Oil Spill Prevention and Response, the non-profit organization Oiled Wildlife Care Network, and the private consulting firm, Mad River Biologists; has no obvious indication from the California Department of Fish and Game how its priorities will change in the face of changed circumstances, and includes some verbal instruction by the California Department of Fish and Game in field methods and equipment use based on an earlier, multi-agency written protocol for documenting beached birds.

Evaluating a monitoring program is important if the program is to effectively produce desired results. Assessment criteria and recommendations are two methods of program evaluation. Assessment criteria, according to the literature, measure the program's statistical power and recommendations provide options for continuous program improvement, including lessons learned. Neither these evaluation tools are identified as part of the *S.S. Jacob Luckenbach* beach search effort. Testing the beach search effort's searcher efficiency rate for its effectiveness to accurately collect data and surveying searchers in field search

methods and data collection protocols are examples of evaluation tools for program design and implementation improvement.

Monitoring program barriers must be identified and understood in order to conduct continuous process improvements and recommend implications, policy and budget, for example, based on those barriers. Barriers include poor program design, e.g., lack of clear purpose and objectives or inconsistent or non-existent methods; environmental discrepancy, the ability to distinguish between natural perturbations and human induced environmental changes, and institutional changes in programmatic and financial priorities, which can restrict a program's time frame and yield short-term results. The *S.S. Jacob Luckenbach* beach search effort lacked clear program design, especially with respect to field methodologies and data analysis; the beach search effort also experienced environmental barriers with respect to beach access and loss of birds due to re-wash, burial, or scavenging, and faced institutional challenges due to lack of dedicated and consistent financial and personnel resources to conduct an effective data collection effort.

Finally, some methodological changes to the *S.S. Jacob Luckenbach* beach search effort would ensure that this is a reliable program that can produce quantifiable data. Based on the review of the literature, these changes include, providing searcher training in field methods, including consistent and standardized search methods; training searchers to enter data correctly, accurately, and completely in

the Beach Search Effort Logs to ensure a complete data set; determining a known searcher efficiency rate by incorporating a pilot study of searcher efforts and their ability to detect birds, and establishing a data quality check to ensure data is legible, correct, and complete.

RECOMMENDATIONS

The quality and quantity of data collected in the beach search effort prevented the determination of a quantifiable index for the number of birds impacted by *S.S. Jacob Luckenbach*. However, the beach search did identify a purpose, goal, objective, method, outcome measurement, data sampling technique, means for collaboration, and informal training; specific changes in data sampling methods could produce data that address the program's goal.

Data quality and quantity of the beach search effort was hampered by the use of inconsistent Beach Search Effort Logs; illegible, inaccurate, and incomplete data entries, and a lack of standardized field search methods. To ensure that future beach search efforts are quantifiable, with respect to rate of oiling by the *S.S. Jacob Luckenbach*, several programmatic changes are recommended.

First, clearly define, standardize, and document data collection protocols, i.e., field search method, how long, how far, with what equipment, and how. For example, foot searches for approximately 110 minutes covering an estimated 2,070 meters yielded the greatest number of observed birds based on the research data analysis. Collect the data on a single standardized Beach Search Effort Log using the appropriate equipment, e.g., GPS hand-held device. Test which field search methods are most and least effective and use the single method that

provides the best detection of oiled beached birds. Finally, be certain all data are collected to answer the monitoring program's research objectives.

Second, train searchers consistently and continuously in the established data collection protocols, including field search methods, data entry, and proper equipment use. For example, collecting data through consistent application of the foot search method, including time and distance, documentation of legible, accurate, and complete data into a standardized Beach Search Effort Log, and appropriate use of field equipment, will yield of highest set of quantifiable data as free from human error as possible.

Third, develop an evaluation tool to check the collected data for accuracy. The evaluation tool serves as a measure of what is 100% accurate so that a data analysis can be conducted with reliable results in determining an index for the total number of birds impacted by oiling. For example, establish a data check to ensure data are legible, correct, and complete and periodically test the beach search effort's searcher efficiency rate for its effectiveness to accurately collect data to validate existing field search method types and data collection protocols or reveal opportunities for improvement. Surveying searchers in field search methods and data collection protocols is another evaluation tool to collect data on areas for program design and implementation improvement. Finally, document and implement these lessons-learned to demonstrate effective

program management, maintain public accountability, and improve future beach search efforts.

Finally, determine a searcher efficiency rate by testing searchers with known numbers of oiled birds placed in a test area. This efficiency rate must be factored into any estimate of the actual number of birds affected by oiling from the S.S.

Jacob Luckenbach.

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APPENDIX A

Beach Search Effort Logs

Please record all beaches searched *even if no birds are found.*

Spill Name: Luckenbach

Date: January 1, 2003

Searchers: K. Jennings (OSPR) and J. Muskat (OSPR)

[illegible]

USS Jacob Luckenbach
Beach Search - Division "A"
Muskat & Jennings, 1/1/03

Search Number: _____

Beach Search Effort Log

Please record all beaches searched even if no birds are found.

Spill Name: LuckenbachDate: 12/31/02Searchers: Ward / Griehl

Note: Time should include all time spent on the beach, even when backtracking. North and south endpoints should be GPS pts. If not, please provide a good description of the area covered. For collected birds, put GPS location here and on Chain of Custody form.

	Beach Name	Start Time	End Time	North Extreme of Area Searched	South Extreme of Area Searched	Total Distance Searched	Method (foot, ATV, scan, etc.)	Birds Collected (live & dead)
A	Waddel Beach	1040	1105		N 37.09539 W 122.27704	3/4	scan & foot	2 COMU DOA
B	Greyhound Rock	1109	1116	N 37.0791 W 122.26432		3/4	scan	Ø
C	Scotts Creek	1119	1125	N 37.0387 W 122.22742		1/4	scan	Ø
D	Davenport Landing	1128	1134	N 37.01102 W 122.19440			scan	Ø
E	Wildes Ranch	1141						
F	Natural Bridges	1158	1206	N 36.94972 W 122.05588			scan	Ø
G	fishermans Landing Santa Cruz	1211	1232	N 36.96185 W 122.02096		3/4	foot & scan	Ø
H	Harbor Santa Cruz	1239	1253	N 36.96581 W 122.00052		1	foot & scan	Ø
I	Harbor Moss Landing	1427	1442	N 36.80704 W 121.78576			foot & scan	1 BR CO (LIVE) BR CO (DOA)
J	Harbor Moss Landing	1446	1620	N 36.80634 W 121.78771			foot & scan	BR CO (LIVE) BR CO (DOA) for dead birds see backside
K	Moss Landing Harbor	1627	1718	N 36.81724 W 121.78643	N 36.80918 W 121.78775		foot & scan	Ø

COMU DOA	1055	Waddel Beach	N 37.09626 W 122.27705	L
COMU DOA	1100	Waddel Beach	N 37.09625 W 122.27704	M
BRCC LIVE	1434	Moss Landing Harbor	N 36.80791 W 121.78586	N
BRCC DOA	1439	Moss Landing Harbor	N 36.80784 W 121.78576	O
BRCC LIVE	1500	Moss Landing Harbor	N 36.80663 W 121.78787	P
BRCC DOA	1515	Moss Landing Harbor	N 36.80635 W 121.78774	Q
WERR DOA	1520	Moss Landing Harbor	N 36.80538 W 121.78774	R
RHAK NOFU } BRCC } DOA	1530	Moss Landing Harbor	N 36.80520 W 121.78758	S
PALO } BRCC } DOA	1535	Moss Landing Harbor	N 36.80429 W 121.78772	T
BRCC DOA	1538	Moss Landing Harbor	N 36.80411 W 121.78755	U
NOFU DOA	1540	Moss Landing Harbor	N 36.80595 W 121.78806	V

01/02/2003

09:06

INIL BIRD RESCUE RESEARCH UNIT 7 15103240023

(5)

California Department of Fish and Game
Office of Spill Prevention and Response 3C

GPS Waypoint Logbook

Spill / Project Name:

La Ken brack IF

Operator Name:

BALLARD / Adkins

GPS Unit Serial No.:

Date Checked Out:

12-31-02

Date Returned:

Date/Time Downloaded:

Downloaded By:

Book ____ of ____

Latitude

37-05133

3760922.4

37-2-157-2

37-1058-6

5711596

37⁶ 1343

370 1350.3

37	1533
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1

37° 15.56.2

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
---	---	---	---	---	---	---	---	---	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	-----

57 1800.2

0.000000

7

Notes / Comments

Nothing Seen Feet

Mr. Leo Cox,
National Com. on Audit

George Clark

Spit - nothing there.

DRAFT

Nothing found

Bea Hime
FBI

1 Dead Dried Comm

nothing found

Paschalano Spot

Nothing found.

10/12/2008

DOWN: 100% on 3:00
!4TV

1

File No./ Waypoint No.	Date	Start Time End Time	Latitude
	12-31-02	16:15	37°29'N
	"		37°29'N
	"		37°29'N

Longitude	Notes / Comments
122°27'W	old known live ATV
122°29'W	new old island ATV
122°28'W	CHILD LIZARD ATV

(7)

Search Number: _____ 2 B

Beach Search Effort LogPlease record all beaches searched *even if no birds are found.*Spill Name: LUCKENBACHDate: 12/26/02Searchers: R.IMAI / J.HAAS

Note: Time should include all time spent on the beach, even when backtracking. North and south endpoints should be GPS pts. If not, please provide a good description of the area covered. For collected birds, put GPS location here and on Chain of Custody form.

	Beach Name	Start Time	End Time	North Extreme of Area Searched	South Extreme of Area Searched	Total Distance Searched	Method (foot, ATV, scan, etc.)	Birds Collected (live & dead)
A	OCEAN BEACH	0920	1115			3 MILE	FOOT	11 DEAD (4 OILED) TIME X2
B	FORT FUNSTON	1130	1200			1.2 MILE	FOOT	TIME X2
C	SHARPE PARK	1215	1250			0.93 MILE	FOOT	TIME X2
D	ROCKAWAY	1210	1317			0.32 MILE	FOOT	TIME X2
E	PACIFICA	1326	1347			0.74 MILE	FOOT	TIME X2
F	GREY WHALE COVE	1400	1420			0.38 MILE	FOOT	TIME X2
G	MONTARA	1426	1450			0.85 MILE	FOOT	TIME X2
H	FITZGERALD	1511	1521			0.25 MILE	FOOT	TIME X1
I	FITZGERALD / DISTILLERY	1532	1547			0.25 MILE	FOOT	TIME X2
J	PILLAR POINT	1603	1705			0.89 MILE	FOOT	TIME X1
K								note: time x1 searched together; x2 split n & S

Search Number: _____

Beach Search Effort Log

Please record all beaches searched even if no birds are found.

Spill Name: Luckenbach

Date: 12/26/02

Searchers: Sean McAllister, Manja Griebel

Note: Time should include all time spent on the beach, even when backtracking. North and south endpoints should be GPS pts. If not, please provide a good description of the area covered. For collected birds, put GPS location here and on Chain of Custody form.

	Beach Name	Start Time	End Time	North Extreme of Area Searched	South Extreme of Area Searched	Total Distance Searched	Method (foot, ATV, scan, etc.)	Birds Collected (live & dead)
A	Pillar Point	0713	0930	Entire Harborfront			Foot	2 dead WEGR 1 dead comar
B	Yankee Jim (Pigeon Pt.)	1208	1228	37.19287 122.39837	37.18991 122.39657		Foot	
C	Bean Hollow	1230	1235	37.22563 122.40766	—		Scan	1 dead WEGR 1 dead comar
D	Pebble Beach	1250	—	37.23616 122.41483	—		Scan	
E	Pescadero	1404	1440	37.27589 122.40833	37.26124 122.41312		Foot	1 dead BRCCO
F	Pomponio	1509	—	37.24980 122.40467	—		Scan	
G	San Gregorio	1540	1552	37.32298 122.40251	37.32074 122.40227		Foot	
H								
I								
J								
K								

LIT, LONG
NAME, N, E

LB

Search Number: _____

Beach Search Effort Log

Please record all beaches searched even if no birds are found.

Spill Name: Lickenbach IIDate: 12-26-02Searchers: J Hawkes, E Faubst-Dawkins

Note: Time should include all time spent on the beach, even when backtracking. North and south endpoints should be GPS pts. If not, please provide a good description of the area covered. For collected birds, put GPS location here and on Chain of Custody form.

	Beach Name	Start Time	End Time	North Extreme of Area Searched	South Extreme of Area Searched	Total Distance Searched	Method (foot, ATV, scan, etc.)	Birds Collected (live & dead)
A	Groves Creek Access	0945	1028	37 10.070 122 21.777	37 09.503 122 21.566	all	foot	0
B	Ans Union Cove Beach	1037	1133	37 07.098 122 18.790	37 06.949 122 17.271	all	foot	0
C	Wardell "Gresham"	1300	1457	37 05.815 122 14.741	37 04.448 122 15.698	all	foot	1 live gull - dead 1 dead cormorant
D	Scott Creek	1535		37 02.420 122 13.655			scan	0
E	Dunsmuir Landing Beach	1543		37 01.510 122 12.663			scan	0
F	Bonny Dean Beach	1603		37 00.047 122 10.755			scan	0
G	Three Mile Beach	1615	1632	36 38.005 122 07.840	36 37.944 122 07.198	all	foot	1 dead cormorant 1 dead gull 1 dead cormorant
H								
I								
J								
K								

28

Search Number: _____

Beach Search Effort Log

Please record all beaches searched even if no birds are found.

Spill Name: LuckenbachDate: 26 December 02Searchers: Espinosa ; Velaz

Note: Time should include all time spent on the beach, even when backtracking. North and south endpoints should be GPS pts. If not, please provide a good description of the area covered. For collected birds, put GPS location here and on Chain of Custody form.

	Beach Name	Start Time	End Time	North Extreme of Area Searched	South Extreme of Area Searched	Total Distance Searched	Method (foot, ATV, scan, etc.)	Birds Collected (live & dead)
A	Del Monte	0920	0940				Foot	
B	Lovers Pt	1030	1035	Lovers Point Beach	Lovers Point Beach	Approx 30m	Truck	
C	Pt Pinos	1040	1300	Pt Pinos	Asilomar	Approx 3. Km	Truck Foot	Dead oiled murre 36° 57.872' N 122° 01.431' W
D								
E								
F								
G								
H								
I								
J								
K								

Search Number: _____

Beach Search Effort Log

Please record all beaches searched even if no birds are found.

Spill Name: LuckenbachDate: 12/31/02Searchers: S. McAllister / A. Transeau

Note: Time should include all time spent on the beach, even when backtracking. North and south endpoints should be GPS pts. If not, please provide a good description of the area covered. For collected birds, put GPS location here and on Chain of Custody form.

	Beach Name	Start Time	End Time	North Extreme of Area Searched	South Extreme of Area Searched	Total Distance Searched	Method (Foot, ATV, scan, etc.)	Birds Collected (live & dead)
A	Pillar Point	0630	0740	Entire Harbor front	—		Foot	Ø
B	Baker Beach	1025	1103	37.79801° 122.48118°	37.78986° 122.48679°	0.7 miles	Foot	Non-oiled, Dead BRCO 37.79801° 122.48329°
C	Crissy Field	1112	1130	37.80767 122.46951	37.80654 122.45053		Foot	Non-oiled, Live BRCO 37.80456 122.45760
D	Point Richmond	1227	1316	Scanned Marina Shore.	Richmond from		Scan	1 Live, oiled WBLR collected by public at boat ramp
E	Ocean Beach	1404	1459	37.77640 122.51186	37.73392 122.50757		ATV, Foot	COMU 37.76826 122.51048
F	"	"	"	"	"		"	COMU 37.74770 122.50935
G	"	"	"	"	"		"	NOFU 37.76811 122.51044
H	"	"	"	"	"		"	NOFU 37.75563 122.57023
I	"	"	"	"	"		"	PALO 37.75215 122.50938
J	Pillar Point	1538	1615	Entire Harbor front	—		Foot	Ø
K	Fitzgerald Marine Reserve	1624	1646	37.52696 122.51596	37.51797 122.51259		Foot	Ø

Pillar Point 2130 2215 Entire Harbor

Foot Ø

Search Number: _____

Beach Search Effort Log

Please record all beaches searched even if no birds are found.

Spill Name: LuckenbachDate: 12/22Searchers: Santiago/Grichl/Metaliste/Dymtrek

Note: Time should include all time spent on the beach, even when backtracking. North and south endpoints should be GPS pts. If not, please provide a good description of the area covered. For collected birds, put GPS location here and on Chain of Custody form.

	Beach Name	Start Time	End Time	North Extreme of Area Searched	South Extreme of Area Searched	Total Distance Searched	Method (foot, ATV, scan, etc.)	Birds Collected (live & dead)
A	Pillar Pt	0500	0530	Entire			foot & scan	4 WEGR →
B	Pillar Pt. Harbor	0535	0600	Entire			foot & scan	1 WEGR →
C								
D								
E								
F								
G								
H								
I								
J								
K								

Beach Search Effort Log

Please record all beaches searched *even if no birds are found.*

Spill Name: LUCKENBACH

Date: 12/23/02

Searchers: DAVE PRICE, Jim HOAS

[illegible]

Search Number: _____

2B

Beach Search Effort Log

Please record all beaches searched even if no birds are found.

Spill Name: LuckenbachDate: 12/23/02Searchers: Sean McAllister / Rebecca Dmytryk / T. Williamson

Note: Time should include all time spent on the beach, even when backtracking. North and south endpoints should be GPS pts. If not, please provide a good description of the area covered. For collected birds, put GPS location here and on Chain of Custody form.

Sean	Rebecca		Beach Name	Start Time	End Time	North Extreme of Area Searched	South Extreme of Area Searched	Total Distance Searched	Method (foot, ATV, scan, etc.)	Birds Collected (live & dead)
✓		A	Pillar Point	0840	0929	Entire			Foot, Scan	
✓	✓	B	Montara Beach	0936	0938	N 37.55268° W 122.51183°			Scan	
✓	✓	C	Linda Mar	0950	0951	N 37.59764° W 122.49310°			Scan	
✓	✓	D	Sharp Park	1000	1003	N 37.62708° W 122.49310°			Foot, Scan	
✓	✓	E	Ocean Beach	1017	1105	37.77749 122.51320	37.75649 122.50915		Foot, Scan	
✓		F	Pillar Point	1159	1340	Entire			Foot, Scan	Live WEGR 37.50801° 122.47884°
Sean	Tina W.	G	Half Moon Bay S.B.	1540	1657	37.49219° 122.45832°	37.43820° 122.44310°		ATV	
		H	"	"	"	"	"		"	Dead COM4 37.45423° 122.44337°
		I	"	"	"	"	"		"	Dead COM4 37.44854° 122.44352°
		J	"	"	"	"	"		"	Dead BR10 37.45009° 122.44361°
		K	"	"	"	"	"		"	Dead COM4 37.48238° 122.45122°

Search Number: _____

23

Beach Search Effort Log

Please record all beaches searched even if no birds are found.

Spill Name: LuckenbachDate: 12/23/02Searchers: Deirdre Goodbe and Tim Wilkinson

Note: Time should include all time spent on the beach, even when backtracking. North and south endpoints should be GPS pts. If not, please provide a good description of the area covered. For collected birds, put GPS location here and on Chain of Custody form.

	Beach Name	Start Time	End Time	North Extreme of Area Searched	South Extreme of Area Searched	Total Distance Searched	Method (foot, ATV, scan, etc.)	Birds Collected (live & dead)
A	Davenport Landing	0711	0748	37.2462 122.21678	37.02156 122.21243		Foot	/
B	Scotts Creek	0755	0825	37.04109 122.23086	37.03342 122.22631		Foot	37.03498 122.22663
C	..	..	..	..	..		"	37.03392 122.22622
D	..	..	..	..	..		"	37.13827 122.32683
E	Big Basin	0835	0913	37.09691 28009 122.27448	37.09124 122.27448		Foot	/
F	Franklin Point	0930	1024	37.13936 122.34123	37.13530 122.33735		Foot	37.13827 122.33937
G	Gazos Creek	1046	1125	battovis dead GPS			Foot/ Scan	/
H	San Gregorio	1410	1422	37.32284 122.40364			Scan	/
I	Pomponio Beach	1445	1500	37.29975 122.40569			Scan	/
J	Pescadero	1506	1625	37.25935 122.41386	37.27599 122.40982		Foot/ Scan	/
K	Pebble Beach	1634	1642	37.23609 122.41592	37.23571 122.41614		Scan	/
	Brown Hollow	1651	1708	37.22564 122.40887			Scan	/

Search Number: 213**Beach Search Effort Log**

Please record all beaches searched even if no birds are found.

Spill Name: Luckan beach IIDate: 12-23-02Searchers: J Hawkins, L Espinoza

Note: Time should include all time spent on the beach, even when backtracking. North and south endpoints should be GPS pts. If not, please provide a good description of the area covered. For collected birds, put GPS location here and on Chain of Custody form.

	Beach Name	Start Time	End Time	North Extreme of Area Searched	South Extreme of Area Searched	Total Distance Searched	Method (foot, ATV, scan, etc.)	Birds Collected (live & dead)
A	Salinas River State Beach	0730	0835	Moss Landing Harbor	Salinas River	all	atv	1 dead comm
B	Marina State Beach	0859	0944	Salinas River	Fort Ord	all	atv	0
C	Asilomar State Beach	1035	1055			all	scan	0
D	Zenudasshi State Beach	1246	1335	Pajaro River	Moss Landing Harbor	all	atv	1 dead w/br 1 live w/br
E	Palm Beach	1415	1545	Pajaro Dunes	La Selva Beach	all	atv	2 dead w/br 4 dead comm 1 dead Perc
F								
G								
H								
I								
J								
K								

Search Number: 28**Beach Search Effort Log**

Please record all beaches searched even if no birds are found.

Spill Name: LuckenbachDate: 12/23/02Searchers: Gini/Sanguiacomo

Note: Time should include all time spent on the beach, even when backtracking. North and south endpoints should be GPS pts. If not, please provide a good description of the area covered. For collected birds, put GPS location here and on Chain of Custody form.

	Beach Name	Start Time	End Time	North Extreme of Area Searched	South Extreme of Area Searched	Total Distance Searched	Method (foot, ATV, scan, etc.)	Birds Collected (live & dead)
A	Lovers Pt	9:30	1110	GPS N/A		1 1/2	foot & scan	COMU DOA →
B	Cannery Row	1120	1150		36.61692 121.89862	1 mile	foot & scan	Ø
C	Moss Landing Harbor	1245	1315	36.81706 121.78703	36.80821 121.78851		foot & scan	Ø
D	Moss Landing Beach	1320	1350	36.81166 121.78898	36.80823 121.78850		foot & scan	Ø
E	White Horse Creek	1500	1500	37.14614 122.34598		1/4	foot & scan	3 LIVEGR LIVE 1 COMU DOA →
F								
G								
H								
I								
J								
K								

Search Number: _____

Beach Search Effort Log

Please record all beaches searched even if no birds are found.

Spill Name: LuckenbachDate: 12/24/02Searchers: S. McAllister / D. Goodfriend / M. Griehl

Note: Time should include all time spent on the beach, even when backtracking. North and south endpoints should be GPS pts. If not, please provide a good description of the area covered. For collected birds, put GPS location here and on Chain of Custody form.

	Beach Name	Start Time	End Time	North Extreme of Area Searched	South Extreme of Area Searched	Total Distance Searched	Method (foot, ATV, scan, etc.)	Birds Collected (live & dead)
A	Pillar Point	0500	0651	Entire Harbor front			Foot	2 W. Grebes live, oiled
B	Pillar Point	0810	0904	"	"		Foot	1 COMU live, oiled
C	Seal Cove	0934	0935	37.51765 122.51242			Scan	Ø
D	Fitzgerald	0950	0959	37.52319 122.51522	37.52536 122.51485	0.3 miles	Foot	Ø
E	Montara	1020	1025	37.54565 122.51345			Scan	1 WEGR live, oiled
F	Linda Mar	1039	1040	37.59811 122.50190			Scan	Ø
G	Whitehouse Creek	1132	1150	37.14619 122.34608	37.14676 122.34348		Foot/scan	2 WEGR Dead
H	Pigeon Point	1207	1344	37.19268 122.39759	37.18275 122.39318		Foot	Ø
I	Bean Hollow	1350	1417	37.22691 122.40873	37.22557 122.40711		Foot	Ø
J	Pigeon Point	1526	1539	37.19268 122.39759			Scan	Ø
K	Davenport Landing	1607	1610	37.02423 122.21598			Scan	Ø

Pillar Point 2115 2247 (Harbor front)

Foot 1 WEGR Live, oiled

Search Number: 2B**Beach Search Effort Log**

Please record all beaches searched even if no birds are found.

Spill Name: LuckenbachDate: 24 December 02Searchers: Espinosa; Veliz

Note: Time should include all time spent on the beach, even when backtracking. North and south endpoints should be GPS pts. If not, please provide a good description of the area covered. For collected birds, put GPS location here and on Chain of Custody form.

	Beach Name	Start Time	End Time	North Extreme of Area Searched	South Extreme of Area Searched	Total Distance Searched	Method (foot, ATV, scan, etc.)	Birds Collected (live & dead)
A	Aptos	0700	0740	Cement ship 36° 58.289 121° 54.709	Aptos Crk 36° 58.153 121° 54.285		Foot	
B	New Brighton State Beach	0755	0830	36° 58.725' 121° 56.090 (Approx)	Cement Ship 36° 58.290 121° 54.710		Foot	
C	Capitola Beach	0835	0850	36° 58.308 121° 57.013	36° 58.32 121° 56.930		Foot	
D	Schwan Lagoon	1030	1052			Approx 300 m	Visual from Truck	
E	Seabright Beach	1050	1110	36° 57.808' 122° 00.515	36° 57.777' 122° 00.301		Foot	
F	Santa Cruz Boardwalk	1128	1200	36° 57.758' 122° 01.312'	36° 57.858' 122° 00.785'		Truck	Live oiled gulls 36° 57.896 122° 00.940 Dead oiled Murre approx. same count. (see data on collection Tag.)
G								
H	Lowell Beach	1200	1205	Rock outcrop	Santa Cruz Pier	Approx 300 m	Visual - Binocs from pier	
I								
J								
K								

Post-It® Fax Note 7671

Date	17 Jan 03	# of pages	2
To	Steve Hampton		
From	L. Espinosa		
Co./Dept.	OSPR - Sacramento		
Co.	OSPR - Monterey		
Phone #			
Phone #			
Fax #			
Fax #			

Search Number: 28**Beach Search Effort Log**

Please record all beaches searched even if no birds are found.

Spill Name: LuckenbachDate: 12/22/02Searchers: Sean McAllister w/ Rebecca Dmytryk

Note: Time should include all time spent on the beach, even when backtracking. North and south endpoints should be GPS pts. If not, please provide a good description of the area covered. For collected birds, put GPS location here and on Chain of Custody form.

	Beach Name	Start Time	End Time	North Extreme of Area Searched	South Extreme of Area Searched	Total Distance Searched	Method (foot, ATV, scan, etc.)	Birds Collected (live & dead)
	Point	1010	1015	37.51124°	122.50643°			
B	Ocean Beach	0759	0810	37.77680° 122.51124°	37.73539° 122.50643°		ATV	1 dead COMU 1 dead WEGR
C	Linda Mar (Pacifica)	0918	0918	37.59764° 122.50179°	—		Point Scan	∅
D	Montara	0926	0927	37.50261° 122.47575°			Point Scan	∅
E	Cowell Ranch	1006	1010	37.42114° 122.43356°			Point Scan	∅
F	Tunitus Beach	1029	1029	37.35652° 122.39851°			Point Scan	∅
G	Pescadero	1035	1037	37.26585° 122.41177°			Point Scan	∅
H	North Pebble Beach	1041	1050	37.24002° 122.41819°	37.2370° 122.41569°		Foot	∅
I	Pebble Beach to Bean Hollow	1055	1125	37.23143° 122.41391°	37.22479° 122.40939°		Foot	∅
J	Pigeon Point	1132	1135	37.19286° 122.39759°			Point Scan	∅
K	Garos Creek	1140	1147	37.16625° 122.36159°			Point Scan	∅

Pigeon Point

Search Number: _____

Beach Search Effort Log

Please record all beaches searched even if no birds are found.

Spill Name: LuckenbachDate: 12/22/02Searchers: Sean McAllister, Rebecca Dmytryk

Note: Time should include all time spent on the beach, even when backtracking. North and south endpoints should be GPS pts. If not, please provide a good description of the area covered. For collected birds, put GPS location here and on Chain of Custody form.

	Beach Name	Start Time	End Time	North Extreme of Area Searched	South Extreme of Area Searched	Total Distance Searched	Method (foot, ATV, scan, etc.)	Birds Collected (live & dead)
A	Pillar Point Harbor	15:05	16:39	Included west side access to Point and ramp on south side of harbor	Point and boat ramp on south side of harbor		Foot	3 WEGR Live
B	"	21:09	22:40	Same as above			Foot	3 WEGR Live
C								
D								
E								
F								
G								
H								
I								
J								
K								

Search Number: _____

Beach Search Effort Log

Please record all beaches searched even if no birds are found.

Spill Name: LukenbachDate: 12/22/02Searchers: Williamson / Goodfriend

Note: Time should include all time spent on the beach, even when backtracking. North and south endpoints should be GPS pts. If not, please provide a good description of the area covered. For collected birds, put GPS location here and on Chain of Custody form.

	Beach Name	Start Time	End Time	North Extreme of Area Searched	South Extreme of Area Searched	Total Distance Searched	Method (foot, ATV, scan, etc.)	Birds Collected (live & dead)
A	Stinson Bch	0630	1104	37.90773 122.67562	37.89248 122.63461		foot	37.90400 122.65446
B	"	"	"	"	"		"	37.90651 122.66603
C	"	"	"	"	"		"	37.90687 122.67221
D	"	"	"	"	"		"	37.90400 122.65446
E	Drakes Beach	1207	1335	37.99531 122.97827	1/4 mile E of ① pt. on trail.		scan	
F	Drakes Bch Visitor Ctr.	/	1355	/	/		/	P. member of pub dropped at V.C. - for on Drakes Bch. in Am
G								
H								
I								
J								
K								

Beach Search Effort Log

Please record all beaches searched even if no birds are found.

4D

Spill Name: LUCKEN BACH

Date: 12/22/52

Searchers: DRUCE, J HARDWICK

[illegible]

Search Number: 21

2B

Beach Search Effort Log

Please record all beaches searched even if no birds are found.

Spill Name: LuckenbachDate: 12-21-02Searchers: Sangiacomo/Griehl

Note: Time should include all time spent on the beach, even when backtracking. North and south endpoints should be GPS pts. If not, please provide a good description of the area covered. For collected birds, put GPS location here and on Chain of Custody form.

	Beach Name	Start Time	End Time	North Extreme of Area Searched	South Extreme of Area Searched	Total Distance Searched	Method (foot, ATV, scan, etc.)	Birds Collected (live & dead)
A	Pillar Pt Harbor	0655	0913	N37.50354 W122.48053	37.50068 122.47351		foot & scan	2 WEGR LIVE 1 COMHU DEAD (See back for info)
B	Pillar Pt	0920	1029	37.49584 122.47339	37.50192 122.47350		foot & scan	1 WEGR LIVE 1 COMHU LIVE
C	Pillar Pt Harbor	1303	1321	37.50348 122.48051	37.50066 122.47348		foot & scan	Ø
D	Pillar Pt Harbor	1327	1331	37.50405 122.48046	✓		scan	Ø
F	Pillar Pt	1334	1521	37.50243 122.49141			foot & scan	1 WEGR
G	Pillar Pt Harbor	1538	1549	37.50370 122.48422	✓	1/4	foot & scan	2 WEGR
H	Pillar Pt Harbor	1643	1655	37.50368 122.48377	✓	1/4	foot & scan	Ø
I	Pillar Pt.	1700	1745	37.49563 122.49738	37.501 122.493		foot & scan	1 WEGR
J	Pillar Pt Harbor	1751	1755	37.50364 122.48371	✓		scan	Ø
K								
L								

Search Number: _____

2B

Beach Search Effort Log

Please record all beaches searched even if no birds are found.

Spill Name: LuckenbachDate: 12/21/02Searchers: Sean McAllister, Don Ballard

Note: Time should include all time spent on the beach, even when backtracking. North and south endpoints should be GPS pts. If not, please provide a good description of the area covered. For collected birds, put GPS location here and on Chain of Custody form.

	Beach Name	Start Time	End Time	North Extreme of Area Searched	South Extreme of Area Searched	Total Distance Searched	Method (foot, ATV, scan, etc.)	Birds Collected (live & dead)
A	Crissy Field	0700	0750				Foot	
B	Ocean Beach	0800	0900	37.77684° 122.51186°	37.76270° 122.51127°	~3.2 miles	ATV, Foot	4 birds Yes. (see page 2)
C	Sharp Park	0824	0836	37.62708° 122.49353°	37.62992° 122.49310°		Foot	
D	Rockaway	0931	0932					
E	Linda Mar (Pacific)	0941	0943	37.59764° 122.50179°			Point Scan	
F	Grey whale cove (McNee Ranch)	1004	1015	37.56573° 122.51319°	37.56391° 122.51260°		Foot	
G	Pedro Point overlook	0949	0950	37.59659° 122.50836°			Point Scan	
H	Montara Beach	1037	1038	37.55268° 122.51183°			Point Scan	
I	Pillar Point	1237	1511	Entire Area Searched; including west side access, boat ramp, harbor, jetties			Foot	Yes. (see page 2)
J	Half Moon Bay State Beach	1612	1649	37.49325° 122.45895°	37.44181° 122.44380°		ATV, Foot	Yes. (see page 2)
K								

out of order →

LuckenbachPage 2 of 2

Sean McAllister w/ Don Ballard

12/21/02

B. Ocean Beach 0800-0900

- 1 Live WEGR N 37.77684° / W 122.50987°
- 1 Dead COMU N 37.76390° / W 122.51030°
- 1 Dead COMU N 37.75597° / W 122.50927°
- 2 Dead COMU N 37.74729° / W 122.50767°

I. Pillar Point 1237-1511

- 1 Live WEGR N 37.50261° / W 122.47575°
- 1 Live WEGR N 37.50332° / W 122.47770°
- 1 Live WEGR N 37.50189° / W 122.49333°

J. Half Moon Bay State Beaches

- 1 Dead WEGR 37.46519° / W 122.44498°
- 1 Dead COMU 37.46049° / W 122.44445°
- 1 Dead COMU 37.44965° / W 122.44381°
- 1 Dead COMU 37.47336° / W 122.44663°

Search Number: _____

Beach Search Effort Log

Please record all beaches searched even if no birds are found.

28

Spill Name: Lucke-bachDate: 12/21/02Searchers: Deirdre Goodfellow & Bruce Adkins

Note: Time should include all time spent on the beach, even when backtracking. North and south endpoints should be GPS pts. If not, please provide a good description of the area covered. For collected birds, put GPS location here and on Chain of Custody form.

	Beach Name	Start Time	End Time	North Extreme of Area Searched	South Extreme of Area Searched	Total Distance Searched	Method (foot, ATV, scan, etc.)	Birds Collected (live & dead)
A	Stinson Beach	0630	1025	37.90297 122.65339	250 yds ③ of State Park entrance		foot	37.89640 122.63948
B	"	"	"	"	"		"	37.89885 122.64262
C	"	"	"	"	"		"	37.89959 122.64457
D	"	"	"	"	"		"	37.89958 122.64522
E	"	"	"	"	"		"	37.90259 122.65243
F	"	"	"	"	"		"	37.90729 122.67875
G	Bel-nies Lagoon (W)	1026	1141	37.90297 122.65339	37.90706 122.65455		foot/ scan	/
H	Bel-nies Lagoon (E)	1145	1206	/	37.90706 d. /		scan	/
I	Durn Beach	1335	1546	38.31084 123.02312	38.30602 123.05312		foot	38.31199 123.02743
J								
K								

Search Number: 28

Beach Search Effort Log

Please record all beaches searched even if no birds are found.

Spill Name: Ludlow 604Date: 12/20/02Searchers: Santiago/Grish

Note: Time should include all time spent on the beach, even when backtracking. North and south endpoints should be GPS pts. If not, please provide a good description of the area covered. For collected birds, put GPS location here and on Chain of Custody form.

	Beach Name	Start Time	End Time	North Extreme of Area Searched	South Extreme of Area Searched	Total Distance Searched	Method (foot, ATV, scan, etc.)	Birds Collected (live & dead)
A	Monterey Harbor	9:34	9:43	N 36.60975 W 121.83459		1/2	Scan	Ø
B	CANNERY ROW	10:45	10:53	N 36.61491 W 121.89746		1/2	Scan	Ø
C	LOVELL PT.		11:17	36.62072 121.90754	36.62243 121.91018		scan & foot	Ø surf very high
D	Monterey Wharf	11:25	12:00	36.60349 121.89246	36.60833 121.89410		Scan & foot	Ø
F	Monterey Boat Works	12:07	12:20	36.62015 121.90355			foot & scan	Ø
G	Pillars Pt	12:27	12:38	36.63409 121.93757		1/4	foot & scan	Ø
H	LOVELL PT.	12:43	13:00	36.63611 121.92820		1/2	foot & scan	Ø
I	CANNERY ROW	14:05	14:40	36.61510 121.89727	36.61687 121.89985		foot & scan	Ø
J	Mass Landing Harbor	15:50	16:01	36.81300 121.78620	36.81088 121.78431		Scan	Ø
K	Mass Landing Harbor	16:04	16:09	36.81701 121.78639	36.81088		Scan	Ø
L	Mass Landing Harbor	16:11	16:56	36.81434 121.78898	36.80822 121.78863		foot & scan	Ø
	Mass Landing Beach	17:01	17:29	36.81439 121.78889			foot & scan	Ø

see over for notes

Search Number: _____

Beach Search Effort Log

Please record all beaches searched even if no birds are found.

Spill Name: LukenbachDate: 12/20/02Searchers: Sean McAllister, Don Ballard

Note: Time should include all time spent on the beach, even when backtracking. North and south endpoints should be GPS pts. If not, please provide a good description of the area covered. For collected birds, put GPS location here and on Chain of Custody form.

	Beach Name	Start Time	End Time	North Extreme of Area Searched	South Extreme of Area Searched	Total Distance Searched	Method (foot, ATV, scan, etc.)	* Birds Collected (live & dead)
A	Crissy Field	0700	0734	37.80654° 122.45053°	37.80767° 122.46951°		Foot	
B	Ocean Beach	0759	0830	37.77706° 122.51280°	37.76270° 122.51127°			1 WEGR oiled 1 CLGR oiled 1 WEGR non-oiled
C	Sharp Park	0909	0925	(37.63022° 122.549395°)			Point Scan	
D	Rockaway Beach	0930	0933	(37.56336° 122.49744°)			Point Scan	
E	Linda Mar Beach	0938	0945	(37.59790° 122.50268°)			Point Scan	1 WEGR oiled
F	McNee Ranch	1031	1032	(N 37.56336° W 122.51275°)			Point Scan	
G	Montara State Beach	1039	1042	N 37.55647° W 122.51306°	N 37.54544° W 122.51445°		Point Scan (x2)	
H	Pillar Point	1220	1330	N/A	N/A	Entire; including Point + Harbor	Foot	4 WEGR oiled
I	Fitzgerald Marine Reserve	1353	1412	(N 37.52567° W 122.51699°)			Point Scan	
J	Distillery Beach	1450	1452	(N 37.51728° W 122.51296°)			Point Scan	
K	Pillar Point West + East (Entire)	1520	1648	N/A	N/A	Entire; including West side	Foot	2 WEGR oiled

4 Live WEGR
2 Dead 1 immrepeated visits
w 3 miles

Bryant Austin - Search Effort Log 6-21-02.doc

707-496-8790

Search Number: 11

Beach Search Effort Log

Please record all beaches searched even if no birds are found.

Spill Name: LickenbachDate: 12-19-03Searchers: Santiago and Griebel

Note: Time should include all time spent on the beach, even when backtracking. North and south endpoints should be GPS pts. If not, please provide a good description of the area covered. For collected birds, put GPS location here and on Chain of Custody form.

	Beach Name	Start Time	End Time	North Extreme of Area Searched	South Extreme of Area Searched	Total Distance Searched	Method (foot, ATV, scan, etc.)	Birds Collected (live & dead)
A	Moss Landing Harbor	0710	0735	NO GPS		1 mile	scan	Ø saw 1000 WEGR
B	Salinas River State Beach	0745	0838	NO GPS		3/4	foot & scan	Ø
C	Salinas River Harbor	0845	9:00	NO GPS		3/4	scan	Ø
D	Marina State Beach	0910	0930	N36-69886 W121-80653		3/4	foot scan	
F	Moss Landing	0945	0953	36-81514 121-79009		3/4	scan	
G	Southend Moss Landing Harbor	955	1000	36-81566 121-78914		3/4	scan	
H	II	1002	1013	36-80985 121-78732		3/4	walk scan	
I	Cannery Row II	1015	1030	36-81161 121-78846		3/4	walk scan	
J	Cannery Row	1055	1116	36-61524 121-89867		3/4	walk scan	
K	Lovers Point	1130	1300	NO GPS		1.5	walk	1 live COMU 100A COMU
L	Lucas Point	1315	1450	NO GPS		1	walk	1 live COMU

Austin - Search Effort Log 6-21-02.doc

Search Number: _____

Beach Search Effort Log

Please record all beaches searched even if no birds are found.

Spill Name: LuckenbachDate: 12-19-02Searchers: Wendy Sangiacomo / Monja Griebel

Note: Time should include all time spent on the beach, even when backtracking. North and south endpoints should be GPS pts. If not, please provide a good description of the area covered. For collected birds, put GPS location here and on Chain of Custody form.

	Beach Name	Start Time	End Time	North Extreme of Area Searched	South Extreme of Area Searched	Total Distance Searched	Method (foot, ATV, scan, etc.)	Birds Collected (live & dead)
A	Monterey Harbor	1515	1530	36.60389 121.8955			scan	0
B	Moss Landing Harbor	1550	1652	36.8175 121.7867	36.8049 121.78155		walk	0
C								
D								
F								
G								
H								
I								
J								
K								
L								

Search Number: (7.1)

2B

Beach Search Effort Log

Please record all beaches searched even if no birds are found.

Spill Name: LuckenbachDate: 12/19/02Searchers: Bruce Atkins

Note: Time should include all time spent on the beach, even when backtracking. North and south endpoints should be GPS pts. If not, please provide a good description of the area covered. For collected birds, put GPS location here and on Chain of Custody form.

	Beach Name	Start Time	End Time	North Extreme of Area Searched	South Extreme of Area Searched	Total Distance Searched	Method (foot, ATV, scan, etc.)	Birds Collected (live & dead)
A	Scott Creek	1543 1543	1556 1556	37.63983 122.22689			SCAN	/
B	Pigeon Point	1617 1617	1646 1646	37.19251 122.39648	37.18537 122.39454		SCAN	/
C								
D								
E								
F								
G								
H								
I								
J								
K								

Search Number: (20)**Beach Search Effort Log**

Please record all beaches searched even if no birds are found.

DB

Spill Name: LuckenbachDate: 12/19/02Searchers: Deirdre Goodfellow

Note: Time should include all time spent on the beach, even when backtracking. North and south endpoints should be GPS pts. If not, please provide a good description of the area covered. For collected birds, put GPS location here and on Chain of Custody form.

	Beach Name	Start Time	End Time	North Extreme of Area Searched	South Extreme of Area Searched	Total Distance Searched	Method (foot, ATV, scan, etc.)	Birds Collected (live & dead)
A	Waddel Creek	1546	1603	37.09697 122.27856	150 yds south of ② pt		SCAN
B	Been Hollow	1621	1632	37.22616 122.40802	37.2256 122.46777		SCAN
C								
D								
E								
F								
G								
H								
I								
J								
K								

Search Number: 213**Beach Search Effort Log**

Please record all beaches searched even if no birds are found.

Spill Name: LuckenbachDate: 12/19/02Searchers: Deirdre A. Goodfriend
Bruce Atkins

Note: Time should include all time spent on the beach, even when backtracking. North and south endpoints should be GPS pts. If not, please provide a good description of the area covered. For collected birds, put GPS location here and on Chain of Custody form.

	Beach Name	Start Time	End Time	North Extreme of Area Searched	South Extreme of Area Searched	Total Distance Searched	Method (foot, ATV, scan, etc.)	Birds Collected (live & dead)
A	Piller Point	0630	0944	/	/		foot	37.49627 122.49423
B	"	"	"				"	37.49582 122.49426
C	"	"	"				"	37.49584 122.49526
D	"	"	"				"	37.49574 122.49553
E	Micmar Beach	0955	1002	Viewed from access	viewed from access		SCAN	
F	Santa Cruz Boardwalk	1220	1310	36.96117 122.02395	150 yds ③ of Npt. Capitola		foot	36.96332 122.02138
G	"	"	"	"	"		"	36.96117 122.02395
H	"	"	"	"	"		"	36.96111 122.02398
I	Natural Bridges	1350	1425	/	/		foot	
J	Wilden Ranch	1445	1530	/	/		foot	Live comu No GPS
K	"	"	"	"	"			Dead comu No GPS

→ Pophar Overlook 1100 1106 37.45506
122.44221

SCAN

Search Number: _____

Beach Search Effort Log

Please record all beaches searched even if no birds are found.

Spill Name: Luken beachDate: 12/19/02Searchers: Deirdre Goodfriend
Bruce Atkins

Note: Time should include all time spent on the beach, even when backtracking. North and south endpoints should be GPS pts. If not, please provide a good description of the area covered. For collected birds, put GPS location here and on Chain of Custody form.

	Beach Name	Start Time	End Time	North Extreme of Area Searched	South Extreme of Area Searched	Total Distance Searched	Method (foot, ATV, scan, etc.)	Birds Collected (live & dead)
A	San Gregorio	1655	1715	Midpoint: 37.30004 122.40437		300 yds	Foot	/
B								
C								
D								
E								
F								
G								
H								
I								
J								
K								

Search Number: _____

Beach Search Effort Log

Please record all beaches searched even if no birds are found.

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Spill Name: LukembachDate: 12-19-02Searchers: Sean McAllister, Don Ballard

Note: Time should include all time spent on the beach, even when backtracking. North and south endpoints should be GPS pts. If not, please provide a good description of the area covered. For collected birds, put GPS location here and on Chain of Custody form.

SEAN	DON		Beach Name	Start Time	End Time	North Extreme of Area Searched	South Extreme of Area Searched	Total Distance Searched	Method (foot, ATV, scan, etc.)	Birds Collected (live & dead)
✓	✓	A	Crissy Field	0700	0736	37.80654° 122.45053°	37.80767° 122.46951°		Foot	
✓		B	Ocean Beach	0810	0920	37.46.465° 122.30.674°	37.73794° 122.50767°		ATV	
	✓	C	Ocean Beach	0810	0920	37.77706° 122.51280°	37.76270° 122.51127°		Foot	1 WEGR oiled
✓	✓	D	Sharp Park	0940	0950	N 37.63022° W 122.49396°			Point Scan	
✓	✓	E	Rockaway Beach	0954	0955	N 37.56336° W 122.49744°			Point Scan	
✓		F	Lind Mar Beach	0959	1001	N 37.59788° W 122.50269°			Point Scan	
✓		G	McNee Ranch	1002	1002	N 37.56336° W 122.51275°			Point Scan	
✓		H	Montara Beach	1004	1005	N 37.55647° W 122.51306°			Point Scan	
✓		I	Francis Beach	1209	1211				Point Scan	
✓	✓	J	Pillar Point	1240	1258	N 37° 30.109° W 122° 29.737°			Point Scan	2 comu live + oiled
✓	✓	K	Pillar Point	1402	1523			Entire	Foot	1 comu live + oiled 1 WEGR oiled fine
✓	✓	L	Ocean Beach	1604	1715	37.77706° 122.51280°	37.71598° 122.50433°		ATV, Foot	

18

Back _____ of _____

Beach Name	Start Time	End Time	North Extreme of Area Searched
A Mortuary State Beach	12:30 PM	1:05	N 36.61038 W 121.85814 Mortuary Beach Hotel
B Salinas River State Beach	3:58 PM	4:35 PM	Moss Landing Society Field N 36.61038 W 121.85814
C			
D Moss Landing State Beach Zuni Beach	4:47 PM	5:03 PM	Jensen Beach N 36.61038 W 121.85814 N 36.61038 W 121.85814

South Extreme of Area Searched	Total Distance Searched	Method (ATV, foot, scan, etc)	Birds Collected (live & dead)
N 36.61038 W 121.85814 Mortuary Wharf		foot can	Common - dead
Salinas River Mortuary N 36.61038 W 121.85814		(612)	PALL - dead Common - Alive (3)
			Common - dead

Bryant Austin - Search Effort Log 6-21-02.doc

Search Number: _____

2 P.

Beach Search Effort Log

Please record all beaches searched even if no birds are found.

Spill Name: LuckenbachDate: 12-18-02Searchers: Wendy Sangiacomo/Manya Griehl

Note: Time should include all time spent on the beach, even when backtracking. North and south endpoints should be GPS pts. If not, please provide a good description of the area covered. For collected birds, put GPS location here and on Chain of Custody form.

	Beach Name	Start Time	End Time	North Extreme of Area Searched	South Extreme of Area Searched	Total Distance Searched	Method (foot, ATV, scan, etc.)	Birds Collected (live & dead)
A	San Gregorio	0710	0715			1/4	scan	Ø
B	Pumpkin	0720	0755			3/4	foot & scan	Ø
C	Pescadero	0800	0851			1	foot & scan	Ø
D	Pescadero Rock Beach	0855	0920			3/4	foot scan	Ø
F	Park House Beach	0925	0935			3/4	scan	Ø
G	Beardell Beach Hollow	0940	0948			1/2	scan	Ø
H	Bean Hollow	0950	1000			1/2	scan	Ø
I	Pigeon Pt. Lighthouse	1004	1023			1 1/4	foot & scan	Ø
J	Gardos Creek	1030	1040			1/4	scan	Ø
K	AND NUNNO	1045				Ø		talked to ranger
L	Big Basin Redwood State Park (Walden Beach)	1105	1120			1/4	Scan	Ø

Search Number: _____

Beach Search Effort Log

Please record all beaches searched even if no birds are found.

Spill Name: LuckenbachDate: 12-18-02Searchers: Sungaramo / Grubel

Note: Time should include all time spent on the beach, even when backtracking. North and south endpoints should be GPS pts. If not, please provide a good description of the area covered. For collected birds, put GPS location here and on Chain of Custody form.

	Beach Name	Start Time	End Time	North Extreme of Area Searched	South Extreme of Area Searched	Total Distance Searched	Method (foot, ATV, scan, etc.)	Birds Collected (live & dead)
A	South of Walldorf Beach	1140	N 37.04030 W 122.22760			1/2	scan	0
B	Santa Cruz Harbor Beach	1205	1330			1.5 miles	walk	0
C	Seabright Beach	1340	1420			1 mile	walk	0
D								
F								
G								
H								
I								
J								
K								
L								

30

To: Steve Hampton

Fr: Mike Ziccardi:

Fig. 2

PHOTO LOG

[illegible]

California Department of Fish and Game
Office of Spill Prevention and Response

GRS Waypoint Logbook

Dec 18, 2002

Spill / Project Name:

San Mateo My Spill

Operator Name:

BALLARD/RUSSELL

GPS Unit Serial No.:

Date Checked Out:

Date Returned:

Date/Time Downloaded:

Downloaded By:

Book of _____

File No. / Waypoint No.	Date	Start Time End Time	Latitude
	12/8	0600 0830	N 31.6244 N 37.73127
	11	0915 0930	37° 36.668 32° 29.75
	11	0935 1000	37.36112 N 37° 35.873
	11	1031	37° 35.998
	11	1040 1100	37° 33.929 37° 33.830
	11	1110 1155	37° 33.830 37° 32.792
		1200 1220	37° 31.451 37° 31.971
	11	1240	37° 31.205

Longitude	Notes / Comments
122° 50.606	one life - N 37° 46.243 one dead - N 37° 44.2 N 37° 44.415 W 122° 50.416
	Nothing found
122.29.921 122° 30.060	Nothing found. Part of
122° 30.494	noted 6+ oil 60 Grebe - in water
122° 30.790 122° 30.757	Nothing found
122° 30.730 122° 30.785	nothing found. Monterey Beach
122° 31.004 122° 30.971	nothing found Fitzgerald Marine Res.
122° 30.871	1 oil 1 COMU LIVE Fitzgerald Bay Distillery

Search Number: _____

Beach Search Effort Log

Please record all beaches searched even if no birds are found.

Spill Name: LuckenbachDate: 12/18/02Searchers: Deirdre A. Goodfriend

Note: Time should include all time spent on the beach, even when backtracking. North and south endpoints should be GPS pts. If not, please provide a good description of the area covered. For collected birds, put GPS location here and on Chain of Custody form.

	Beach Name	Start Time	End Time	North Extreme of Area Searched	South Extreme of Area Searched	Total Distance Searched	Method (foot, ATV, scan, etc.)	Birds Collected (live & dead)
A	Stinson Beh	10:30	11:15	75 yds (N) of capture pt.	50 yds (S) of capture pt.	~125 yds	SCAN	WEGR N 37.89655 W 122.62560
B	Agate Beh (Co. beach)	11:35	11:50	viewed from access	viewed from access	~100 yds	SCAN	
C	Stinson Beh.	12:25	12:40	75 yds (N) of capture (see A)	50 yds (S) of capture (see A)	~125 yds	SCAN	
D	McDune Beh.	13:40	14:35	viewed from access pt.	viewed from access pt.	~300 yds	SCAN	
E	North Beh	15:45	16:10	viewed from N 38.07746	viewed from W 122.97413	~200 yds	SCAN	
F	South Beach	16:23	16:40	viewed from N 38.04878	viewed from W 122.98726	~300 yds	SCAN	
G								
H								
I								
J								
K								

Search Number: _____

Beach Search Effort Log

Please record all beaches searched even if no birds are found.

Spill Name: SS J LuckenbachDate: 12/18/02 28Searchers: S. McAllister / D. Goodfriend

Note: Time should include all time spent on the beach, even when backtracking. North and south endpoints should be GPS pts. If not, please provide a good description of the area covered. For collected birds, put GPS location here and on Chain of Custody form.

	Beach Name	Start Time	End Time	North Extreme of Area Searched	South Extreme of Area Searched	Total Distance Searched	Method (foot, ATV, scan, etc.)	Birds Collected (live & dead)
w/ Diende	A Limantour Beach	0756	0915	38°01.752' 122°54.403'	38.02121 122.86609		Foot	Ø
	B Salmon Creek North	1050	1127	38.35586° 123.06536°	38.35552 123.0677		Foot	Ø (Tarpatties)
	C Salmon CK South	1150	1201	(N 38.34960° W 123.06785°)			Scan	Ø
	D Salmon CK South	1217	1226	(N 38.34262° W 123.06788°)			Scan	Ø
	E Doran Beach	1239	1328	(N. 38.31233° W 123.04917°)			Scan/ Foot	Ø
	F Dillon Beach	1422	1504	(N 38.24983° W 122.96616°)			Scan	Ø
	G Drakes Beach	1602	1722		38.01213° 122.97959°		Foot	1 Live COMU
	H							
	I							
	J							
	K							

Search Number: 28

Beach Search Effort Log

Please record all beaches searched even if no birds are found.

Spill Name: LuckenbachDate: 12-17-02Searchers: Sanguacomo/Griehl

Note: Time should include all time spent on the beach, even when backtracking. North and south endpoints should be GPS pts. If not, please provide a good description of the area covered. For collected birds, put GPS location here and on Chain of Custody form.

	Beach Name	Start Time	End Time	North Extreme of Area Searched	South Extreme of Area Searched	Total Distance Searched	Method (foot, ATV, scan, etc.)	Birds Collected (live & dead)
A	Rockaway	0810	0825			.5	scan	Ø
B	Montara	0840	0850			1	scan	Ø
C	San Pedro San Pedro	0903	0915			1	scan	Ø
D	Pillar Pt Harbor	0929	0955			1.5	scan walk	Ø
F	Pillar Pt	1006	1034			1	scan walk	Ø
G	San Gregorio	1050	1100			.5	scan	Ø
H	Pescadero	1106	1142			1	walk	Ø
I	Pebble Beach	1220	1246			.5	scan	Ø
J	Bean Hollow	1310	1320			.5	scan	Ø
K	Pidgeon Pt	1325	1335			1	walk scan	Ø
L	Wardell	1435	1450			.5	scan	Ø

Austin - Search Effort Log 6-21-02.doc

Search Number: _____

Beach Search Effort Log

Please record all beaches searched even if no birds are found.

Spill Name: LuckenbachDate: 12-17-02Searchers: Sanguineto / Griebel

Note: Time should include all time spent on the beach, even when backtracking. North and south endpoints should be GPS pts. If not, please provide a good description of the area covered. For collected birds, put GPS location here and on Chain of Custody form.

	Beach Name	Start Time	End Time	North Extreme of Area Searched	South Extreme of Area Searched	Total Distance Searched	Method (foot, ATV, scan, etc.)	Birds Collected (live & dead)
A	Santa Cruz Harbor	1510	1540			walk scan	walk scan	0
B	Seabright	1550	1630			+	walk	0
C								
D								
F								
G								
H								
I								
J								
K								
L								

APPENDIX B

Summary of Raw Beach Search Effort Data

Summary of Raw Beach Search Effort Data

(1)

LOG#	SEGMENT	SEARCH METHOD	DISTANCE (METERS)	TIME (MINS)	# BIRDS	RATE	BIRDS/DISTANCE	BIRDS P/A	BIRDS/TIME	BIRDS/DIST /TIME
2	Fisherman's Wharf G0	combo fs	1207	21	0	57	0.00000	0	0.000	0.0000000
2	Moss Landing Harbor K0	combo fs	910	51	0	18	0.00000	0	0.000	0.0000000
2	Santa Cruz Harbor H0	combo fs	1609	14	0	115	0.00000	0	0.000	0.0000000
11	Ocean Beach E0	combo fs	2347	48	0	49	0.00000	0	0.000	0.0000000
12	Pescadero J0	combo fs	1880	69	0	27	0.00000	0	0.000	0.0000000
14	Fisherman's Wharf B0	combo fs	1609	30	0	54	0.00000	0	0.000	0.0000000
14	Moss Landing Harbor C0	combo fs	990	30	0	33	0.00000	0	0.000	0.0000000
14	Moss Lnding St Beach D0	combo fs	382	30	0	13	0.00000	0	0.000	0.0000000
21	Pillar Point Harbor C0	combo fs	695	18	0	39	0.00000	0	0.000	0.0000000
21	Pillar Pont Harbor G0	combo fs	402	12	0	34	0.00000	0	0.000	0.0000000
23	Bolinas Lagoon G0	combo fs	465	75	0	6	0.00000	0	0.000	0.0000000
24	Fisherman's Wharf I0	combo fs	303	35	0	9	0.00000	0	0.000	0.0000000
24	Lovers Point C0	combo fs	302	1	0	302	0.00000	0	0.000	0.0000000
24	Lovers Point H0	combo fs	804	11	0	73	0.00000	0	0.000	0.0000000
24	Monterey Wharf D0	combo fs	556	5	0	111	0.00000	0	0.000	0.0000000
24	Moss Landing Harbor L0	combo fs	679	5	0	136	0.00000	0	0.000	0.0000000
24	Pillar Point Harbor G0	combo fs	402	11	0	37	0.00000	0	0.000	0.0000000
26	Fisherman's Wharf J0	combo fs	1207	21	0	57	0.00000	0	0.000	0.0000000
26	Marina State Beach D0	combo fs	1207	20	0	60	0.00000	0	0.000	0.0000000
26	Moss Landing Harbor H0	combo fs	1207	11	0	110	0.00000	0	0.000	0.0000000
26	Moss Landing Harbor I0	combo fs	1207	15	0	80	0.00000	0	0.000	0.0000000
26	Salinas River St Bch B0	combo fs	1207	53	0	23	0.00000	0	0.000	0.0000000
32	Pescadero C0	combo fs	1609	51	0	32	0.00000	0	0.000	0.0000000
32	Pescadero D0	combo fs	1207	25	0	48	0.00000	0	0.000	0.0000000
32	Pigeon Point I0	combo fs	2011	19	0	106	0.00000	0	0.000	0.0000000
32	Pomponio Beach B0	combo fs	1207	25	0	48	0.00000	0	0.000	0.0000000
36	Pigeon Point K0	combo fs	1609	10	0	161	0.00000	0	0.000	0.0000000
36	Pillar Point Harbor D0	combo fs	2414	26	0	93	0.00000	0	0.000	0.0000000
36	Pillar Point Harbor F0	combo fs	1609	28	0	57	0.00000	0	0.000	0.0000000
36	Santa Cruz Harbor A0	combo fs	1609	30	0	54	0.00000	0	0.000	0.0000000
2	Moss Landing Harbor J0	combo fs	1146	94	1	12	0.00087	1	0.011	0.0000093
14	Lovers Point A0	combo fs	2414	200	1	12	0.00041	1	0.005	0.0000021
21	Pillar Point Harbor I0	combo fs	9239	4	1	2310	0.00011	1	0.250	0.0000271
2	Moss Landing Harbor I0	combo fs	199	15	2	13	0.01005	1	0.133	0.0006700
2	Waddell Creek A0	combo fs	1207	25	2	48	0.00166	1	0.080	0.0000663
16	Whitehouse Creek G0	combo fs	239	18	2	13	0.00837	1	0.111	0.0004649
21	Pillar Point Harbor B0	combo fs	696	69	2	10	0.00287	1	0.029	0.0000416
21	Pillar Point Harbor F0	combo fs	402	11	2	37	0.00498	1	0.182	0.0004523
21	Pillar Point Harbor A0	combo fs	696	138	3	5	0.00431	1	0.022	0.0000312
14	Whitehouse Creek E0	combo fs	402	60	4	7	0.00995	1	0.067	0.0001658
LOG#	SEGMENT	SEARCH METHOD	DISTANCE (METERS)	TIME (MINS)	# BIRDS	RATE	BIRDS/DISTANCE	BIRDS P/A	BIRDS/TIME	BIRDS/DIST /TIME
30	Ocean Beach L0	combo fv	6817	71	0	96	0.00000	0	0.000	0.0000000
7	Pacific Grove C0	combo fv	3000	140	1	21	0.00033	1	0.007	0.0000024
31	Monterey State Beach A0	combo fv	2833	35	1	81	0.00035	1	0.029	0.0000101
22	Half Moon By St. Bch. J0	combo fv	5861	37	4	158	0.00068	1	0.108	0.0000184
8	Ocean Beach E0	combo fv	4728	55	5	86	0.00106	1	0.091	0.0000192
22	Ocean Beach B0	combo fv	5149	60	5	86	0.00097	1	0.083	0.0000162
LOG#	SEGMENT	SEARCH METHOD	DISTANCE (METERS)	TIME (MINS)	# BIRDS	RATE	BIRDS/DISTANCE	BIRDS P/A	BIRDS/TIME	BIRDS/DIST /TIME
3	Pigeon Point D0	foot	836	22	0	38	0.00000	0	0.000	0.0000000
3	Ano Nuevo Reserve A0	foot	486	45	0	11	0.00000	0	0.000	0.0000000
3	Gazos Creek B0	foot	8473	47	0	180	0.00000	0	0.000	0.0000000
4	Distillery Beach I0	foot	402	15	0	27	0.00000	0	0.000	0.0000000
4	Fitzgerald Mtn Rsrsv H0	foot	402	10	0	40	0.00000	0	0.000	0.0000000
4	Fort Funston B0	foot	1931	30	0	64	0.00000	0	0.000	0.0000000
4	Gray Whale Cove F0	foot	611	20	0	31	0.00000	0	0.000	0.0000000
4	Montara State Beach G0	foot	1367	24	0	57	0.00000	0	0.000	0.0000000
4	Pacifica E0	foot	1190	21	0	57	0.00000	0	0.000	0.0000000
4	Pillar Point Harbor J0	foot	1432	62	0	23	0.00000	0	0.000	0.0000000
4	Rockaway D0	foot	514	67	0	8	0.00000	0	0.000	0.0000000
4	Sharp Park C0	foot	1496	35	0	43	0.00000	0	0.000	0.0000000
5	San Gregorio G0	foot	249	12	0	21	0.00000	0	0.000	0.0000000
5	Yankee Jim B0	foot	365	20	0	18	0.00000	0	0.000	0.0000000
6	Ano Nuevo Cove Bch B0	foot	602	56	0	11	0.00000	0	0.000	0.0000000
6	Gazos Creek A0	foot	644	38	0	17	0.00000	0	0.000	0.0000000
8	Fitzgerald Mtn Rsrsv K0	foot	1040	22	0	47	0.00000	0	0.000	0.0000000
12	Davenport Landing A0	foot	1287	37	0	35	0.00000	0	0.000	0.0000000
12	Waddell Creek E0	foot	802	38	0	21	0.00000	0	0.000	0.0000000
16	Bean Hollow I0	foot	174	27	0	6	0.00000	0	0.000	0.0000000
16	Fitzgerald Mtn Rsrsv D0	foot	482	9	0	54	0.00000	0	0.000	0.0000000
16	Pigeon Point H0	foot	1169	97	0	12	0.00000	0	0.000	0.0000000
17	Aptos A0	foot	404	40	0	10	0.00000	0	0.000	0.0000000
17	Capitola Beach C0	foot	75	15	0	5	0.00000	0	0.000	0.0000000
17	New Brighton St. Bch. B0	foot	1325	35	0	38	0.00000	0	0.000	0.0000000

Summary of Raw Beach Search Effort Data

(2)

LOG#	SEGMENT	SEARCH METHOD	DISTANCE (METERS)	TIME (MINS)	# BIRDS	RATE	BIRDS/DISTANCE	BIRDS P/A	BIRDS/TIME	BIRDS/DIST /TIME
17	Seabright Beach E0	foot	139	20	0	7	0.00000	0	0.000	0.0000000
18	Pebble Beach H0	foot	401	30	0	13	0.00000	0	0.000	0.0000000
18	Pebble Beach I0	foot	838	3	0	279	0.00000	0	0.000	0.0000000
20	Dillon Beach D0	foot	325	24	0	14	0.00000	0	0.000	0.0000000
22	Gray Whale Cove F0	foot	208	11	0	19	0.00000	0	0.000	0.0000000
22	Sharp Park C0	foot	317	12	0	26	0.00000	0	0.000	0.0000000
25	Crissy Field A0	foot	1609	34	0	47	0.00000	0	0.000	0.0000000
26	Moss Landing Harbor B0	foot	4023	15	0	268	0.00000	0	0.000	0.0000000
29	San Gregorio A0	foot	182	20	0	9	0.00000	0	0.000	0.0000000
30	Crissy Field A0	foot	1675	36	0	47	0.00000	0	0.000	0.0000000
32	Santa Cruz Harbor B0	foot	2414	85	0	28	0.00000	0	0.000	0.0000000
32	Seabright Beach C0	foot	1609	40	0	40	0.00000	0	0.000	0.0000000
33	E0	foot	113	20	0	6	0.00000	0	0.000	0.0000000
33	Fitzgerald Mrn Rsv G0	foot	53136	20	0	2657	0.00000	0	0.000	0.0000000
33	Lindamar C0	foot	300	25	0	12	0.00000	0	0.000	0.0000000
33	Montara State Beach F0	foot	598	45	0	13	0.00000	0	0.000	0.0000000
35	Limantour Beach A0	foot	4828	79	0	61	0.00000	0	0.000	0.0000000
35	Salmon Creek B0	foot	207	37	0	6	0.00000	0	0.000	0.0000000
36	Pescadero H0	foot	1609	36	0	45	0.00000	0	0.000	0.0000000
36	Seabright Beach B0	foot	1609	40	0	40	0.00000	0	0.000	0.0000000
1	Drakes	foot	2916	115	1	25	0.00034	1	0.009	0.0000030
3	Bean Hollow E0	foot	670	50	1	13	0.00149	1	0.020	0.0000299
5	Pescadero E0	foot	1677	36	1	47	0.00060	1	0.028	0.0000166
8	Baker Beach B0	foot	1126	38	1	30	0.00089	1	0.026	0.0000234
8	Crissy Field C0	foot	1675	18	1	93	0.00060	1	0.056	0.0000332
12	Franklin Point F0	foot	567	54	1	11	0.00176	1	0.019	0.0000327
23	Doran Spit Bodega I0	foot	3066	131	1	23	0.00033	1	0.008	0.0000025
26	Lucas Point L0	foot	1609	95	1	17	0.00062	1	0.011	0.0000065
30	Ocean Beach C0	foot	1598	70	1	23	0.00063	1	0.014	0.0000089
6	Wadell Creek C0	foot	1777	117	2	15	0.00113	1	0.017	0.0000096
25	Pillar Point Harbor K0	foot	4828	88	2	55	0.00041	1	0.023	0.0000047
26	Lovers Point K0	foot	2414	110	2	22	0.00083	1	0.018	0.0000075
6	Three Mile Beach G0	foot	483	18	3	27	0.00621	1	0.167	0.0003451
12	Scotts Creek B0	foot	1002	30	3	33	0.00299	1	0.100	0.0000998
20	Salmon Creek South B0	foot	539	82	3	7	0.00557	1	0.037	0.0000679
25	Ocean Beach B0	foot	1598	31	3	52	0.00188	1	0.097	0.0000606
29	Santa Cruz City Beach F0	foot	137	50	3	3	0.02190	1	0.060	0.0004380
1	Limantour Spit	foot	4828	275	4	18	0.00083	1	0.015	0.0000030
19	Stinson Beach A0	foot	4303	274	4	16	0.00093	1	0.015	0.0000034
20	Doran Spit Bodega A0	foot	1609	125	4	13	0.00249	1	0.032	0.0000199
20	Salmon Creek North C0	foot	643	81	5	8	0.00778	1	0.062	0.0000960
23	Stinson Beach A0	foot	228	235	6	1	0.02632	1	0.026	0.0001120
4	Ocean Beach A0	foot	4828	115	11	42	0.00228	1	0.096	0.0000198
15	Limantour A0	foot	2234	225	21	10	0.00940	1	0.093	0.0000418
10	Limantour Spit B0	foot	5471	284	26	19	0.00475	1	0.092	0.0000167
LOG#	SEGMENT	SEARCH METHOD	DISTANCE (METERS)	TIME (MINS)	# BIRDS	RATE	BIRDS/DISTANCE	BIRDS P/A	BIRDS/TIME	BIRDS/DIST /TIME
2	Greyound Rock B0	scan	1207	7	0	172	0.00000	0	0.000	0.0000000
2	Scotts Creek C0	scan	402	6	0	67	0.00000	0	0.000	0.0000000
12	Pebble Beach K0	scan	46	8	0	6	0.00000	0	0.000	0.0000000
17	Cowell Beach H0	scan	300	5	0	60	0.00000	0	0.000	0.0000000
17	Schwan Lagoon D0	scan	300	22	0	14	0.00000	0	0.000	0.0000000
24	Fisherman's Wharf B0	scan	804	7	0	115	0.00000	0	0.000	0.0000000
24	Monterey Harbor A0	scan	804	9	0	89	0.00000	0	0.000	0.0000000
24	Moss Landing Harbor J0	scan	314	11	0	29	0.00000	0	0.000	0.0000000
25	Montara State Beach G0	scan	1229	3	0	410	0.00000	0	0.000	0.0000000
26	Moss Landing Harbor F0	scan	1207	8	0	151	0.00000	0	0.000	0.0000000
26	Moss Landing Harbor G0	scan	1207	5	0	241	0.00000	0	0.000	0.0000000
26	Salinas River Harbor C0	scan	1207	15	0	80	0.00000	0	0.000	0.0000000
27	Pigeon Point B0	scan	1104	23	0	48	0.00000	0	0.000	0.0000000
28	Bean Hollow B0	scan	66	11	0	6	0.00000	0	0.000	0.0000000
28	Waddell Creek A0	scan	137	17	0	8	0.00000	0	0.000	0.0000000
32	Bean Hollow H0	scan	804	10	0	80	0.00000	0	0.000	0.0000000
32	Gazos Creek J0	scan	402	10	0	40	0.00000	0	0.000	0.0000000
32	Pebble Beach F0	scan	1207	10	0	121	0.00000	0	0.000	0.0000000
32	Pebble Beach G0	scan	804	8	0	101	0.00000	0	0.000	0.0000000
32	San Gregorio A0	scan	402	5	0	80	0.00000	0	0.000	0.0000000
32	Waddell Creek A0	scan	804	25	0	32	0.00000	0	0.000	0.0000000
32	Waddell Creek L0	scan	402	15	0	27	0.00000	0	0.000	0.0000000
34	Ano Nuevo Cove Bch B0	scan	91	15	0	6	0.00000	0	0.000	0.0000000
34	McClures Beach D0	scan	274	55	0	5	0.00000	0	0.000	0.0000000
34	North Beach	scan	182	25	0	7	0.00000	0	0.000	0.0000000
34	South Beach	scan	274	17	0	16	0.00000	0	0.000	0.0000000
34	Stinson Beach C0	scan	114	15	0	8	0.00000	0	0.000	0.0000000
36	Bean Hollow J0	scan	804	10	0	80	0.00000	0	0.000	0.0000000

Summary of Raw Beach Search Effort Data

(3)

LOG#	SEGMENT	SEARCH METHOD	DISTANCE (METERS)	TIME (MINS)	# BIRDS	RATE	BIRDS/DISTANCE	BIRDS P/A	BIRDS/TIME	BIRDS/DIST /TIME
36	Lindamar C0	scan	1609	12	0	134	0.00000	0	0.000	0.0000000
36	Montara State Beach B0	scan	1609	10	0	161	0.00000	0	0.000	0.0000000
36	Pebble Beach I0	scan	804	26	0	31	0.00000	0	0.000	0.0000000
36	Rockaway A0	scan	804	15	0	54	0.00000	0	0.000	0.0000000
36	San Gregorio G0	scan	804	10	0	80	0.00000	0	0.000	0.0000000
36	Waddell Creek L0	scan	804	15	0	54	0.00000	0	0.000	0.0000000
26	Moss Landing Harbor A0	scan	1609	25	1	64	0.00062	1	0.040	0.0000249
34	Stinson Beach A0	scan	114	45	1	3	0.00877	1	0.022	0.0001949
LOG#	SEGMENT	SEARCH METHOD	DISTANCE (METERS)	TIME (MINS)	# BIRDS	RATE	BIRDS/DISTANCE	BIRDS P/A	BIRDS/TIME	BIRDS/DIST /TIME
7	Lovers Point B0	vehicle	30	5	0	6	0.00000	0	0.000	0.0000000
17	Santa Cruz City Beach F0	vehicle	484	32	0	15	0.00000	0	0.000	0.0000000
30	Ocean Beach B0	vehicle	35127	70	0	502	0.00000	0	0.000	0.0000000
18	Ocean Beach B0	vehicle	4613	11	2	419	0.00043	1	0.182	0.0000394
11	Half Moon Bay G0	vehicle	6204	17	4	365	0.00064	1	0.235	0.0000379

APPENDIX C

Map of Beach Segments Searched