THE 1986 *APEX HOUSTON* OIL SPILL IN CENTRAL CALIFORNIA: SEABIRD INJURY ASSESSMENTS AND LITIGATION PROCESS

HARRY R. CARTER[1, 2], VALERIE A. LEE[3], GARY W. PAGE[4], MICHAEL W. PARKER[5], R. GLENN FORD[6], GORDON SWARTZMAN[7], STEPHEN W. KRESS[8], BERNARD R. SISKIN[9], STEVEN W. SINGER[10], & D. MICHAEL FRY[11]

[1]*Humboldt State University, Department of Wildlife, Arcata, CA 95521 USA*
[2]*Present Address: 5700 Arcadia Road, Apt. #219, Richmond, BC V6X 2G9 Canada*
[3]*Environment International Ltd., 5505 34th Avenue Northeast, Seattle, Washington 98105 USA*
[4]*Point Reyes Bird Observatory, 4990 Shoreline Highway, Stinson Beach, California 94970 USA*
[5]*U.S. Fish and Wildlife Service, San Francisco Bay National Wildlife Refuge Complex, P.O. Box 524, Newark, California 94560 USA*
[6]*R.G. Ford Consulting Company, 2735 Northeast Weidler Street, Portland, Oregon 97232 USA*
[7]*University of Washington, Applied Physics Laboratory, P.O. Box 355640, Seattle, Washington 98105 USA*
[8]*National Audubon Society, 159 Sapsucker Woods Road, Ithaca, New York 14850 USA*
[9]*Center for Forensic Economic Studies, 1608 Walnut Street, Suite 1200, Philadelphia, Pennsylvania 19103 USA*
[10]*Santa Cruz Mountains Murrelet Group, 218 Nevada Street, Santa Cruz, California 95060 USA*
[11]*University of California, Department of Avian Sciences, Davis, California 95616 USA*

Received 15 December 2002, accepted 11 August 2003

SUMMARY

CARTER, H.R., LEE, V.A., PAGE, G.W., PARKER, M.W., FORD, R.G., SWARTZMAN, G., KRESS, S.W., SISKIN, B.R., SINGER, S.W. & FRY, D.M. 2003. The 1986 *Apex Houston* oil spill in central California: seabird injury assessments and litigation process. *Marine Ornithology* 31: 9-19.

Over a decade of biological and legal efforts to address impacts to seabirds from the 1986 *Apex Houston* oil spill in central California are summarized. This relatively-small spill (616+ barrels) was conservatively estimated to have killed about 9,900 seabirds, including 6,300 Common Murres *Uria aalge*, as modified from earlier sources. Direct mortality was modeled using data from beached bird surveys, rehabilitation centers, at-sea surveys, and oil trajectories. Long-term impacts to depleted local populations of Common Murres and Marbled Murrelets *Brachyramphus marmoratus* were documented and restoration plans were developed. This incident demonstrated that small oil spills can have serious impacts to seabirds and that the amount of injury and costs of restoration must be measured before judging appropriate damages through litigation. A $6,400,000 settlement was reached in 1994 after lengthy litigation, with most funds assigned to two restoration projects in central California: a) re-establishment of breeding Common Murres at the extirpated Devil's Slide Rock colony; and b) purchase of privately-owned, old-growth forest nesting habitat for Marbled Murrelets in the Gazos Creek watershed.

Keywords: *Apex Houston*, *Brachyramphus marmoratus*, California, Common Murre, injury assessment, litigation, Marbled Murrelet, mortality, natural resource damage assessment, oil spill, pollution, rehabilitation, restoration, *Uria aalge*

INTRODUCTION

The 1986 *Apex Houston* oil spill was one of the largest and best documented oiling mortalities of seabirds in California and the world, especially for a relatively small spill (Carter 2003, Ford *et al*. 1987, Page *et al*. 1990). With new methods for estimating direct mortality and knowledge of seabird population status, a more accurate measurement of this spill's impacts to seabirds was possible, compared with prior spills. Several aspects of this incident helped launch it to national attention as one of the first large natural resource damage claims for oil spills filed under federal and state statutes, setting the stage for subsequent oil spills in western North America, including the 1989 *Exxon Valdez* oil spill. Since 1995, settlement funds have been used by trustee agencies to implement the first seabird restoration program to repair injuries to seabirds from oil spills in California. In this paper, we provide a summary of: 1) various efforts to assess seabird injuries from this spill, including modifications from earlier sources; 2) restoration plans developed during litigation; 3) a chronology of events and collation of documents related to this spill for further reference; and 4) biological considerations and legal processes involved.

INCIDENT DESCRIPTION

In late January 1986, a crew member refused to place an ill-fitting hatch cover on an oil tank of the oil barge *Apex Houston* docked at the Shell Oil Company refinery in Martinez, California. Despite this objection, a second crew member was ordered to secure the hatch cover. On 28 January, the unmanned *Apex Houston* (under tow by the tugboat *Inca*) left the refinery with a cargo of San Joaquin Valley Crude oil and passed through the Golden Gate, bound for Long Beach, California. The barge encountered rough weather on 29 January off Monterey Bay (Fig. 1). On 1 February near Long Beach, the *Inca* crew boarded the *Apex Houston* to reattach a parted tow wire and discovered the hatch cover lying

loose on the deck. Oil coated the deck and floated in the water around the barge. At least 616 barrels of oil (25,800 gallons) had been lost (CRWQCB 1986).

On 1 February 1986, staff biologists of Point Reyes Bird Observatory (PRBO) and state and federal agencies began receiving reports of dead and dying oiled birds and globules of oil on beaches in central California. By 11 February, bird beachings indicated that coastal oiling extended from Salmon Creek Beach in Sonoma County to Point Lobos in Monterey County (Fig. 1). Federal and state agencies and concerned citizens became fully occupied with clean-up and seabird rehabilitation efforts. Thousands of live oiled birds were recovered and transported to wildlife rehabilitation centers in the San Francisco and Monterey Bay areas, but large numbers of birds died at inadequate temporary facilities with poorly-trained personnel and crowded conditions.

INITIAL INJURY DETERMINATION

Prior to the *Apex Houston* oil spill, PRBO had: a) helped assess seabird impacts for the 1971 San Francisco and the 1984 *Puerto Rican* oil spills; b) conducted a beached bird survey throughout California from 1971-85 to determine baseline levels of seabird mortality and chronic oiling rates; c) provided seabird data for addressing seabird mortality (especially Common Murres *Uria aalge*) from gill-net fisheries; and d) operated a seabird research and monitoring program at the South Farallon Islands since 1971.

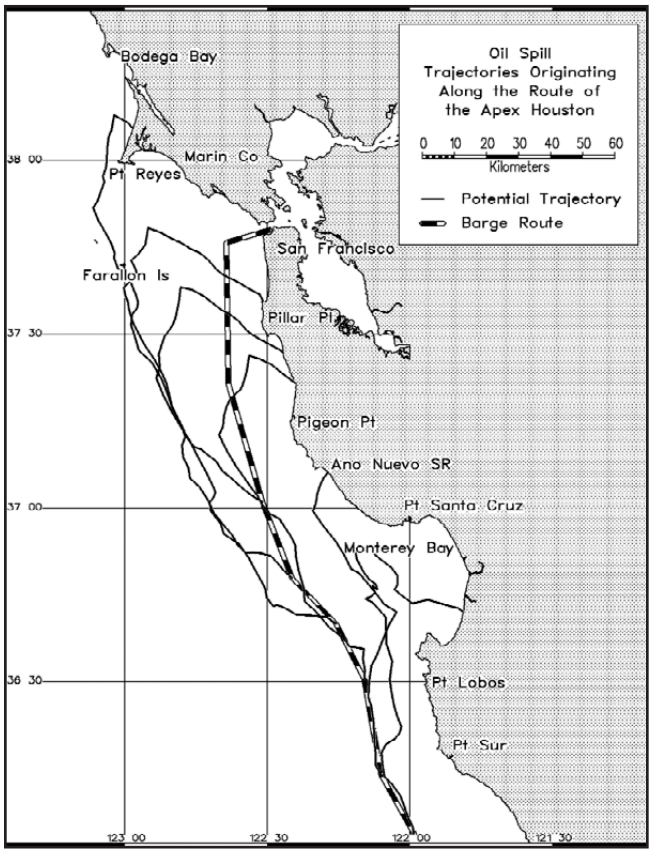

Fig. 1. Coastal and offshore areas in central California affected by the *Apex Houston* oil spill, 1-11 February 1986. The heavy dashed line shows the track of the barge *Apex Houston*. The thin lines show HAZMAT oil trajectories launched at six-hour intervals between Pigeon Point and Point Sur.

When the *Apex Houston* oil spill occurred, PRBO assumed the task of quantifying overall seabird mortality because of: a) the need to assess impacts of the oil spill on Common Murres; and b) the opportunity to further develop specific methods for estimating overall mortality from oil spills. Specific beached bird surveys from Marin to Monterey counties were conducted during the main spill period. Afterwards, rehabilitation center records of live oiled birds were collated. An aerial survey to examine the abundance and distribution of seabirds in the spill zone also was conducted on 5 February by the University of California Santa Cruz, using standard protocols (Fig. 2; Briggs *et al*. 1987). PRBO then collaborated with Ecological Consulting Incorporated (ECI) to design a specific method to estimate the total numbers of birds killed and debilitated by the spill, modified from methods used during the *Puerto Rican* oil spill (Carter *et al*. 1987, Ford *et al*. 1987, Page & Carter 1986, Page *et al*. 1990).

Total seabird mortality during the peak beaching period (1-8 February 1986) was estimated by summing separate estimates for: a) numbers of live oiled birds that came ashore, tabulated directly from accession records at rehabilitation centers; b) numbers of dead oiled birds that washed ashore, estimated with a carcass deposition model using beached bird data, carcass persistence (59.1% per day) determined on sample beaches, and extrapolation for unsearched beaches; and c) numbers of dead oiled birds for three alcid species that did not wash ashore, estimated with a carcass trajectory model using beached bird and at-sea distribution data, oil trajectories, and estimated carcass loss at sea (2.0% per

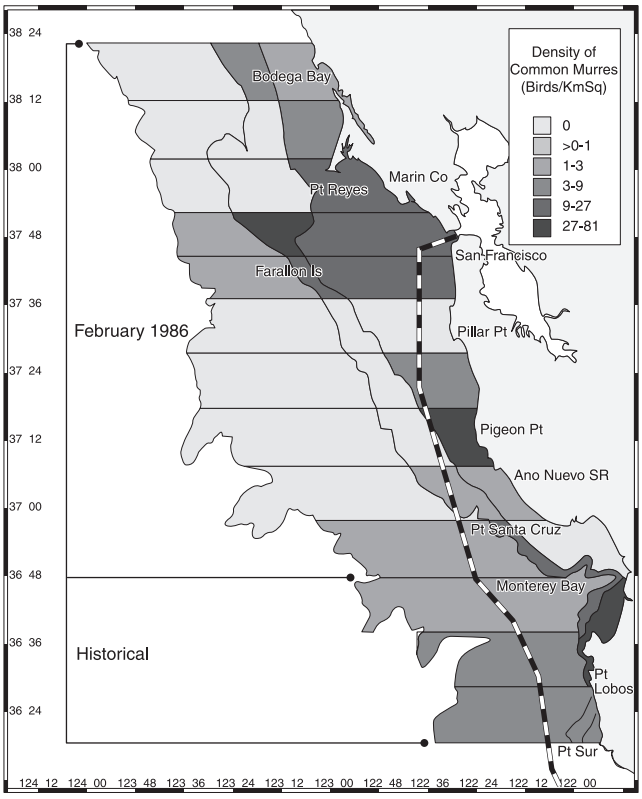

Fig. 2. At-sea densities (birds/km^2) and distribution of Common Murres, based on aerial survey transects flown on 5 February 1986. Density blocks were defined in an east-west direction by bathymetry. Historical data were used for the three southernmost transects not surveyed on 5 February.

three hours or 6.25 days floating before sinking). Only oiled beached birds were used and 61 non-oiled carcasses between 2-11 February were excluded. The coastline was divided into regions to account for possible differences in the distribution of birds at sea and beach segments were divided into beach types to reduce potential extrapolation errors. Oil spill trajectories (Fig. 1) and bird and oil beaching patterns were consistent with the *Apex Houston* as the source of the oil. Oil chemistry analyses matched oil samples from beached birds with oil samples taken from the *Apex Houston*.

By summing 3,364 live oiled birds, 5,880 dead oiled birds on beaches, and 1,333 dead oiled birds lost at sea, a total estimate of 10,577 birds debilitated or killed by oil was derived (Page & Carter 1986, Page *et al*. 1990). Large numbers of Common Murres (7,488), and Rhinoceros Auklets *Cerorhinca monocerata* (1,566) were impacted, as well as smaller numbers of Cassin's Auklets *Ptychoramphus aleuticus*, Marbled Murrelets *Brachyramphus marmoratus*, and at least 22 other species. True mortality was underestimated because: a) incomplete rehabilitation center records likely led to omissions of hundreds of birds; b) no estimate of at-sea loss was made for Common Murres, Rhinoceros Auklets and Cassin's Auklets for region 6; c) no estimate of at-sea loss was made for at least 23 other species in all regions; and d) estimated mortality applied only to the area and time period of peak beachings. Even with underestimation, the overall magnitude of the direct impacts of this spill was relatively high, given the small amount of oil spilled. In addition to improved modeling to better estimate mortality, other factors contributed to the documentation of a high level of mortality: 1) the spill occurred near shore; 2) slicks passed through high densities of birds at sea; 3) winds and currents transported carcasses towards shore over a short period of time; 4) relative ease of coastal access for beached bird surveys; and 5) extensive efforts by concerned citizens to collect live birds for rehabilitation.

EVENTS LEADING TO LITIGATION

Strong evidence of impacts to seabirds from the *Apex Houston* oil spill prompted state and federal trustee agencies to pursue compensation, well before the more recent surge in natural resource damage claims for oil and hazardous waste spills. Several wildlife areas of significance had been affected, including: Gulf of the Farallones International Biosphere Reserve; Farallon National Wildlife Refuge; Gulf of the Farallones, Cordell Banks, and Monterey Bay National Marine Sanctuaries; Point Reyes National Seashore; Golden Gate National Recreation Area; California Islands National Monument; Año Nuevo and Point Lobos State Reserves; and large numbers of other state parks and beaches. State jurisdiction at sea extended to 3 miles from shore, whereas federal jurisdiction extended to 200 miles. In December 1988, Apex Oil Company, which owned the *Apex Houston* barge, filed for bankruptcy. If federal and state governments wished to claim response costs or natural resource damages for the 1986 spill, government attorneys needed to file proofs of claims before a deadline barring such claims. Proofs were filed in the federal bankruptcy matter in St. Louis, Missouri, and companion civil actions to recover natural resource damages, response costs, and penalties in federal district court in the Northern District of California in San Francisco (Civil Actions No. C 89-0246 and No. C 89-250). The Defendants were the owners and operators of the *Apex Houston* barge (Apex Oil Company; Apex R.E. & T. dba Apex Towing Company; Goldstein Oil Company; Novelly Oil Company; GNP Barge & Tank and GNP Barge & Tanker Company), and their insurance company (West of England Ship Owners Mutual Protection & Indemnity Association, Luxembourg). The case was filed in January 1989, within the statute of limitations

The U.S. Department of Justice represented the U.S. Departments of Interior and Commerce and based federal claims on the Clean Water Act (CWA) and the Marine Protection, Research & Sanctuaries Act (MPRSA; Lee *et al*. 2002). Under the CWA, owners and operators of source vessels are liable for: a) response costs for spill clean-up; and b) recovery of costs incurred by federal and state governments for restoration or replacement of natural resources injured or lost by the spill. Under the 1986 version of MPRSA, the Secretary of Commerce had broad authority to promulgate regulations and to take actions to protect resources within a sanctuary. Amendments to MPRSA in November 1988 applied retroactively and explicitly provided a right of recovery for response costs and damages resulting from injury to the resources of a marine sanctuary. The California Attorney General's Office represented the California Department of Fish and Game and California Regional Water Quality Control Board and based state claims under the CWA and various state statutes (Water, Fish & Game, and Harbors & Navigation codes), with stronger state penalty authority than under federal law.

MULTI-DISCIPLINARY LITIGATION TEAM

In early 1989, federal and state attorneys and natural resource managers, plus scientific experts, were organized into a multi-disciplinary litigation team to provide a scientific basis for injury determination and related restoration planning. Scientific experts were selected for their specific areas of expertise, as the most qualified individuals to articulate injury determinations and restoration plans in the form of litigation reports and at trial, if necessary. Experts also needed to sign confidentiality agreements. In the context of the adversarial litigation process, litigation reports and opinions would be challenged by the Defendants and expert opinions needed at minimum to be more likely than not for acceptance in litigation settings. The initial core scientific expert team members were biologists from PRBO and ECI most knowledgeable about the spill and its direct effects on seabirds in central California. However, prior work had been limited by available funding, time, and expertise. Additional analyses were desirable to strengthen the scientific basis for the injury determination. Other experts were added to enhance: a) statistical analyses; b) modeling of population impacts; and c) restoration planning.

A streamlined and lower-cost approach for injury determination was used by working with existing data and no additional field studies were conducted. Much past and on-going research data, reports, and publications on seabirds were available for central California which bolstered this decision but, in retrospect, additional studies might have further assisted the Plaintiffs' case. Injury and restoration reports were completed in 1990-91, after two years of intensive effort. Additional outside experts assisted or reviewed reports. All raw data were scrutinized and cross-referenced with reports by government contractors. This process served to improve reports and supporting scientific and legal arguments.

Restoration plans were developed for heavily-impacted species within the spill area in tandem with injury determination to match the scale and types of injury caused by the spill. This appropriately-scaled "on-site and in-kind" restoration approach (Wickham *et al*. 1993) emphasized the direct connection between injury and restoration, achievability of predicted results, and cost effectiveness. Several projects also were considered that might repair injuries for heavily-impacted species outside the spill zone or might repair injuries for less impacted species inside or outside of the spill zone. Selected restoration plans and related expert testimony were intended to prove the actual costs of natural resource restoration from the *Apex Houston* oil spill in trial. Thus, it was necessary to provide sufficient restoration plans to restore all or most of the damages from the spill.

INJURY DETERMINATION REPORTS

Direct Injury Reports

Direct injury was documented with an estimate of the numbers of birds killed during the spill (Ford 1991, Siskin *et al*. 1993). With various changes, overall estimated mortality was reduced to 9,900 birds (Table 1). The estimated total number of live oiled birds was revised to 3,512 birds: 1) one addition error amounting to 3 birds was corrected; 2) one live Marbled Murrelet was added, based on additional information obtained after 1986; 3) the peak period of beachings from 1-11 February 1986 was used; and 4) two-thirds of birds cleaned and released were assumed to have died within 6 months. The estimated total number of dead beached birds was revised to 4,894 birds: 1) minor corrections were made to numbers of carcasses found on beach surveys; 2) the carcass persistence rate was recalculated as 58.6% per day; 3) only the peak period of beachings from 1-11 February was used; and 4) beach lengths, beach types and the southern coastline boundary used were made consistent with Carter & Page (1989). Assuming a Poisson distribution, the 95 percent confidence band for 4,894 carcasses was 4,419-5,367 carcasses. The width of this confidence band indicated a sufficient sample size for an estimate within about 10% (474/4,893 or 9.7%) of the true number of dead beached birds. The sensitivity of the estimate of dead oiled birds to several assumptions inherent in extrapolations also was examined in detail (Siskin *et al*. 1993). A separate extrapolation for Marbled Murrelets was conducted. Based on recoveries of 5 oiled murrelets and beach survey effort in Region 4, where murrelets often concentrate at sea, an additional 7 dead beached murrelets were estimated. Thus, a total of 12 murrelets was estimated to have been oiled. Since this species is distributed mainly within 1-2 km of shore, no birds were estimated to have been lost at sea. Overall, this estimate and related assumptions were quite conservative and mortality may have been several times higher than estimated (Himes Boor *et al*. 2003).

The estimated total number of birds lost at sea was revised to 1,453 birds, with corresponding changes to at-sea loss estimates for Common Murres (1,038), Rhinoceros Auklets (358) and Cassin's Auklets (57). During the aerial survey, part of Region 6 had not been surveyed. This problem was solved by substituting historical data collected in 1980-83 (Briggs *et al*. 1987) for the unsurveyed area (Fig. 2). Historical data were generally consistent with February 1986 data for surveyed areas. Further efforts to assess sensitivity of oil spill trajectory modeling included multiple runs of the model and randomly varying parameters within possible ranges for current pattern, fraction of the wind speed imparted to the oil slick, wind rotation, and carcass sinking rates. The model was found to be robust for all assumptions examined. In Regions 1 and 2, a second smaller peak of bird beachings had occurred in mid February 1986, with smaller beachings through March. Additional modeling strongly suggested an association between beachings after 11 February and the *Apex Houston* spill, due to changes in weather patterns at that time. This exercise further indicated that the overall estimate of mortality was conservative but difficulties in estimating mortality for this period precluded adding later mortality to the 1-11 February total.

TABLE 1
Estimated numbers of seabirds injured by the *Apex Houston* oil spill, 1-11 February 1986.

	Oiled and Collected Live		Dead Oiled		Total	
Species[1]	Died	Survived >6 Months After Release	Washed Ashore	Lost At Sea	Oiled[2]	Oiled and Dead[3]
Loons	106	35	133	Unknown	274	239
Grebes	156	53	412	Unknown	621	568
Scoters	52	17	187	Unknown	256	239
Common Murre	2,259	753	3,001	1,027	7,040	6,287
Small Alcids	6	2	118	56	182	180
Marbled Murrelet	2	0	10	Unknown	12	12
Rhinoceros Auklet	22	8	904	367	1,301	1,293
Other Species	31	10	129	Unknown	170	160
TOTAL	2,634	878	4,894	1,450	9,856	8,978

[1] For a detailed species list, see Page & Carter (1986) and Page *et al*. (1990).
[2] Sum of four left hand columns.
[3] Sum of first, third and fourth columns.

Common Murre Population Injury

Swartzman & Carter (1991) identified two types of long-term population injury: a) injury to population size over time; and b) injury to breeding colony integrity at Devil's Slide Rock and other small colonies. These injuries were considered in relation to the overall status of affected populations prior to and after the spill. Identifying affected populations was a central problem for assessing the significance of injuries from the spill. After review of scientific literature on murre movements and colony attendance in western North America, virtually all murres impacted by the *Apex Houston* oil spill were considered to belong to the resident Central California breeding population although the possibility that a few birds from northern populations might be present in winter could not be eliminated (Manuwal & Carter 2001). In 1988-89, the central California population constituted about 90,200 breeding birds or about 8.4% of *U. a. californica* populations (Carter *et al*. 2001). Carrying capacity was estimated at 528,000 birds, based on a conservative historical estimate of 400,000 birds at the South Farallon Islands in the late 1800s plus highest levels noted in 1980-82 at other colonies (Ainley & Lewis 1974, Carter *et al*. 2001). After many impacts in the 19th and 20th centuries, the population had been reduced to about 105,000 breeding birds (about 20% of carrying capacity) by 1986. Numbers at all colonies had recently declined to a significant degree (range = 8.7-28.5% per annum) between 1979 and 1989. By 1989, the population had declined by 50-65% from 1980-82 levels (Carter *et al*. 2001, Takekawa *et al*. 1990).

The fragile condition of the central California murre population suggested that population size would not recover soon after the *Apex Houston* oil spill (Swartzman 1996, Swartzman & Carter 1991). A population model was constructed, using a Leslie matrix based on murre reproductive success and adult survival from central California, age of first breeding and survival to breeding from the United Kingdom, and a density-dependent function for leveling off population size near carrying capacity (Ainley & Boekelheide 1990, Hudson 1985, Sydeman 1993). To calibrate the model, initial model projections were compared to adjusted colony size and trend data for the South Farallon Islands from 1970-89 (Ainley & Boekelheide 1990, Carter *et al*. 2001, Piatt *et al*. 1991). A 1982 age distribution was produced by running the model for 12 years from 1970-82. To simulate spill impacts on population size, 3,164 females (or 6,327 total birds, based on a 1991 version of Siskin *et al*. 1993) were removed from the population in proportion to their simulated age distribution at the time of the spill. Population size was simulated for 50 years under decline and increase scenarios (Fig. 3). Slow population growth occurred under the population increase scenario but lost birds were not recovered within 50 years. Population decline occurred under the population decline scenario, lost numbers were replaced within 20 years, but the population reached much lower levels closer to possible extinction. The loss of 6,327 murres (or about 4-5% of population size) was found to be considerable when future reproductive potential of lost birds was considered along with other impacts. Sensitivity analyses included multiple simulations of the population after 1982 using randomly selected parameter values (within ranges for survival, fecundity, and zero fecundity thresholds) and the range of predicted outputs provided a measure of variance for the future population. After 30 years, the oiled population averaged 9,650 + 1,618 (SD) birds less than the unoiled population (range = 5,866-14,350). After 50 years, the oiled population averaged 11,400 + 2,342 fewer birds (range 6,166-17,650). Thus, over 50 years were estimated for the population to recover.

In the early to mid 1990s, the population stopped declining and began to increase (Carter *et al*. 2001, Sydeman *et al*. 1997). By 1995, the population was about 151,400 breeding birds, reflecting partial recovery to 1980-82 levels. While larger colonies at the South Farallon Islands and Point Reyes increased, Devil's Slide Rock and San Pedro Rock colonies were not recolonized, the Castle Rocks & Mainland colony had delayed growth, and the Hurricane Point Rocks colony had no growth (Fig. 4).

Common Murre Colony Impacts

Insufficient data were available to model oil-spill effects on individual colonies. However, spill mortality of Common Murres probably contributed to the loss of the Devil's Slide Rock colony, significant reductions at the Castle Rocks & Mainland and Hurricane Point Rocks colonies, and lesser impacts to other colonies (Figs. 4, 5; Carter *et al*. 2001, Sydeman *et al*. 1997). Extensive winter colony attendance at colonies in central California has been well documented (Ainley & Boekelheide 1990, Carter *et al*. 2001, Parker *et al*. 1997, 1999). Murres probably were attending colonies and adjacent waters during the spill but most severe impacts probably occurred on the three small colonies closest to heavily-oiled coastal areas.

Available information were pieced together to best explain the demise of the Devil's Slide Rock colony. We present some detail on our considerations which were important during litigation. In May

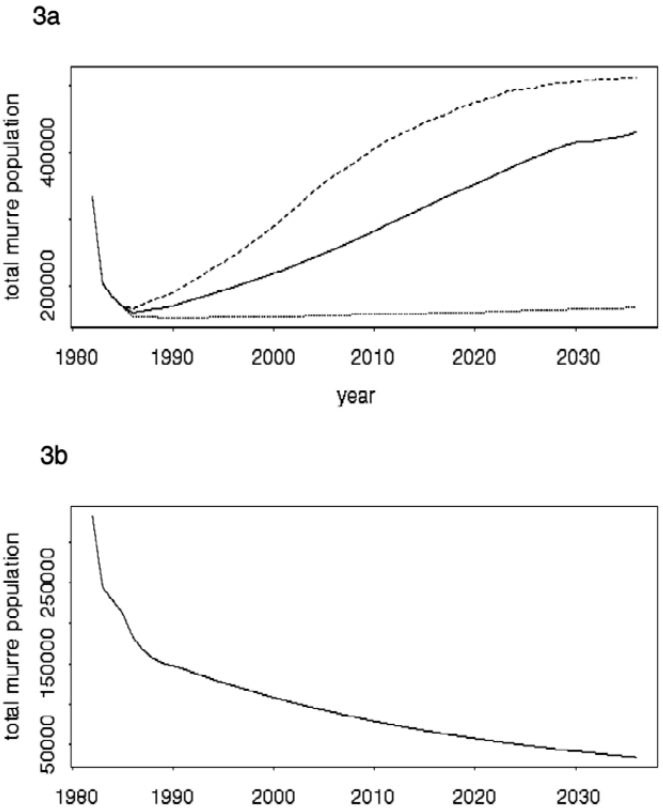

Fig. 3. Simulated responses of the central California Common Murre population after the *Apex Houston* oil spill under: a) population increase scenario (median with 25% and 75% quartiles); and b) population decline scenario (median).

and July 1982, 2,300 and 1,530 murres were counted in aerial photographs, similar to 1979-81 (Carter *et al*. 2001). In 1982 and 1983, relatively high mortality of murres in gill nets occurred in the Half Moon Bay to Bodega Bay area. Although birds killed were likely derived from several colonies, some probably belonged to the Devil's Slide Rock colony. In August 1983, a fishing closure within 15 fathoms was established between Half Moon Bay and San Pedro Point, which included the Devil's Slide Rock colony. Elevated gill-net mortality was not reported in this area between August 1983 and 1987, due in part to a series of fishing closures (Takekawa *et al*. 1990, Wild 1990). On 10 June 1984, L.B. Spear (unpublished data) recorded "24-26 pairs incubating eggs or brooding chicks" on Devil's Slide Rock, during a coast-wide study of Western Gulls *Larus occidentalis*. Hundreds of murres could have been standing nearby without eggs or chicks but were not recorded (L.B. Spear, pers. comm.). Reduced breeding activity, high numbers of non-breeding birds, and low success characterized breeding activities at the South Farallon Islands in 1984, related to gill-net mortality and continued effects from the 1982-83 El Niño (Takekawa *et al*. 1990). Similar conditions likely extended to Devil's Slide Rock, leading to many more non-breeding birds than in normal years. The colony was considered to be reduced but viable in 1984. The November 1984 *Puerto Rican* oil spill killed 1,500-2,000 murres but likely affected other colonies as the spill occurred in offshore waters and oil traveled north to Point Reyes and Bodega Bay (Carter *et al*. 2001).

Good foraging conditions returned to the Gulf of the Farallones in 1985 and murre attendance patterns and reproductive success were relatively high at the South Farallon Islands (Takekawa *et al*. 1990). The Devil's Slide Rock colony may have consisted of several hundred to over one thousand birds in 1985, based on various possible ways of interpreting 1982-87 colony information. During the *Apex Houston* oil spill, relatively large numbers of murres, perhaps on the order of hundreds, may have been killed within foraging distance of this depleted colony. Large numbers of oiled murres were found on beaches in the general vicinity of Devil's Slide Rock (i.e., between San Francisco and Pigeon Point). On 5 June 1986, 93 birds were noted during an aerial survey of Devil's Slide Rock although none were present on 4 June. Successful breeding probably did not occur in 1986 although eggs may have been laid and lost before surveys took place. A disrupted assemblage of murres could be expected to attend the colony site in 1986 without breeding after recent impacts from the spill and prior impacts from gill-net fishing. On 27 May 1987, 127 standing and sitting murres were counted at the colony. While it is possible that a few birds laid eggs, breeding probably did not occur in 1987 given apparent problems in 1986 and almost no attendance from 1988-95.

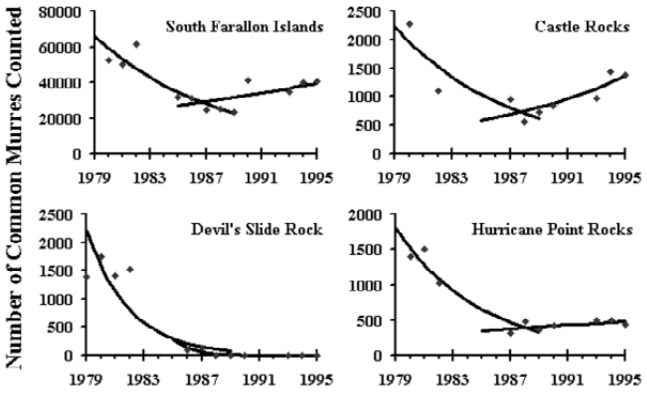

Fig. 4. Trends in colony numbers of Common Murres at four colonies in central California. Poisson regression lines from log-transformed values are presented for 1979-89 and 1985-95 periods.

The weight of available information indicated that the *Apex Houston* spill probably was the final straw leading to extirpation of the Devil's Slide Rock colony. This viewpoint more clearly assessed the relative roles of mortality from this oil spill and gill-net fishing in the demise of this colony than stated in earlier documents (Takekawa *et al*. 1990, Piatt *et al*. 1991). Rapid natural recolonization of Devil's Slide Rock after the spill was unlikely because: a) the population was much reduced; b) nearby San Pedro Rock had not been recolonized after extirpation in the early 20th century, even during population increase from the 1950s to 1970s; and c) very low levels of colony attendance occurred in 1988-95 (Carter *et al*. 2001). On the other hand, adequate nesting habitat and prey resources apparently were available, and high breeding success was evident at the South Farallon Islands (Ainley & Boekelheide 1990, Ainley *et al*. 1996).

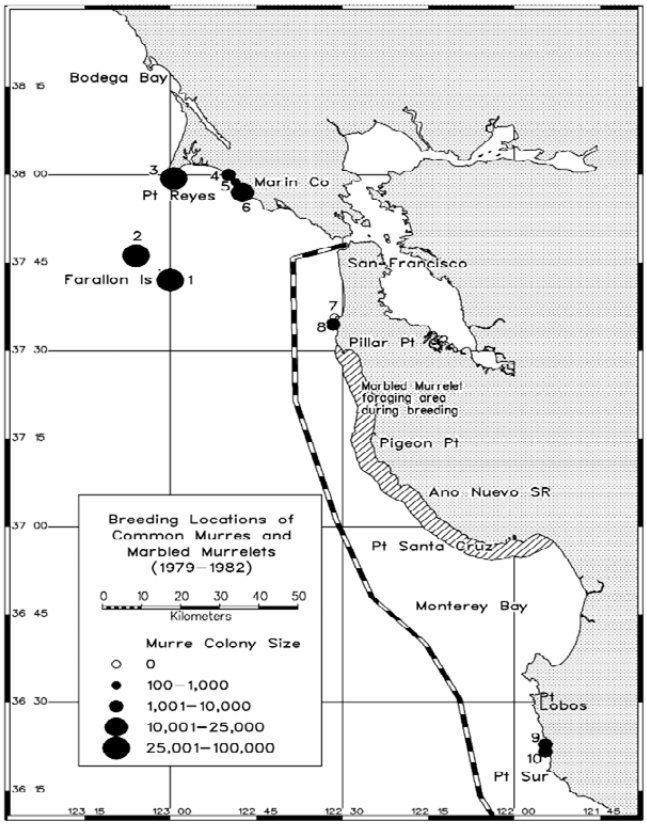

Fig. 5. Locations of breeding areas of Common Murres and Marbled Murrelets in central California, in relation to the track of the *Apex Houston.* Murre colonies are numbered: 1) South Farallon Islands; 2) North Farallon Islands; 3) Point Reyes; 4) Point Resistance; 5) Miller's Point Rocks; 6) Double Point Rocks; 7) San Pedro Rock; 8) Devil's Slide Rock; 9) Castle Rocks & Mainland; and 10) Hurricane Point Rocks. Marbled Murrelets nest in coastal old-growth forests near Pigeon Point and Año Nuevo State Reserve but forage at sea in coastal waters within 1-2 km of shore.

By 1986-89, aerial photographic surveys also established that colonies at Castle Rocks & Mainland and Hurricane Point Rocks were severely depleted since last surveyed in 1982 (Fig. 4; Carter *et al*. 2001). In 1988-89, combined numbers reached their lowest levels (Range = 1,047-1,093 birds or about 30-50% of 1980-82 numbers) and very small numbers of murres attended certain rocks with uncertain breeding. Colony depletion probably resulted from mortality from gill-net fishing in Monterey Bay, human disturbance, and mortality from the *Apex Houston* oil spill. Impacts were greatest at Hurricane Point Rocks which were attended by much smaller numbers of murres in 1987-95 than in the early 1980s. Lack of recovery at this colony also was related to low reproductive success and partial movement of murres to the neighboring Castle Rocks & Mainland colony (Carter *et al*. 2001, Parker *et al*. 1997, 1999).

Marbled Murrelet Population Injury

Due to loss of old-growth forest breeding habitats from logging and mortality in gill nets and oil spills, the Marbled Murrelet was listed as a California State Endangered Species in 1991 and as a Federal Endangered Species in 1992. Legal status heightened concerns about injury from the spill to the small, remnant central California population which did not have the capacity for recovery and was threatened with extirpation (Carter & Erickson 1992, Singer & Carter 1992, USFWS 1997). Coastal areas between Half Moon Bay and Santa Cruz were heavily oiled during the spill, especially in the vicinity of Año Nuevo Bay where murrelets concentrate (Figs. 1, 5). The entire population breeds in coastal old-growth forests in the spill zone (Carter & Erickson 1992, Paton & Ralph 1990, Singer *et al*. 1991). Oil trajectories covered the entire at-sea area where most of this population occurs in winter, associated with extensive winter attendance of nesting areas (Fig. 1; Carter & Erickson 1992, Naslund 1993). Loss of breeding adults and reduced reproductive success could have affected the continued use of certain breeding areas by small numbers of birds. The central California population of Marbled Murrelets was considered to be geographically separated from the northern California population and movements between these populations were not known. Recent estimates have placed this population between 500-1,400 birds, poor reproductive success has been noted, and additional impacts have occurred from other oil spills, raising concerns even further for the future viability of this population (Ralph and Miller 1995, Becker *et al*. 1997, USFWS 1997, Himes Boor *et al*. 2003).

RESTORATION PLANS

Common Murres and Marbled Murrelets were the most heavily impacted species. Lower impacts occurred for other species that: 1) were killed in smaller numbers; 2) bred elsewhere; or 3) did not have depleted populations. Three restoration plans were prepared for litigation: 1) colony restoration for Common Murres, especially at Devil's Slide and San Pedro Rocks; 2) acquisition of privately-owned, old-growth forest nesting habitat for the Marbled Murrelet in central California; and 3) development of a seabird center for seabird rehabilitation and captive breeding. These plans were not considered adequate by trustee agencies to fully restore spill injuries, but they aimed to restore heavily-impacted species in the spill zone to a significant degree. Other non-selected restoration options were: 1) acquisition of privately-owned land with mainland subcolonies of Common Murres and other seabirds within the Castle Rocks & Mainland colony; 2) enhancement of Rhinoceros Auklet and other seabird colonies at Año Nuevo Island; 3) acquisition of seabird colonies in San Francisco Bay; 4) acquisition of Common Murre and other seabird colonies at Cape Vizcaino and Rockport Rocks in Mendocino County; 5) land acquisitions in central California for seabird viewing facilities; and 6) various resource protection or monitoring programs in central California.

Common Murre Colony Restoration

A social attraction program was designed to re-establish Common Murre colonies at Devil's Slide and San Pedro Rocks, as well as possibly assist small depleted colonies at Castle Rocks & Mainland and Hurricane Point Rocks if warranted by their further decline or extirpation (Kress & Carter 1991). Social attraction involved the use of life-like decoys, recorded vocalizations, and other techniques to attract birds to a particular site where they may breed after a period of attendance. These techniques had been proven to be effective for attraction of Common Murres and attraction and recolonization of Atlantic Puffins *Fratercula arctica* (Kress 1992, Kress & Nettleship 1988, Kress & Schubel 1992). Several project design options were considered but 10 years were eventually considered adequate to ensure project success, although well over a decade was expected for colonies to achieve sizes reached in the early 1980s.

Successful attraction and recolonization were expected within a decade because: a) large numbers of murres at other colonies within 50-150 km of restoration sites with many foraging near and moving by restoration sites for potential attraction (Fig. 5; Ainley *et al*. 1996); b) at Devil's Slide Rock, some birds that bred or hatched on the colony prior to 1986 should still be alive and have attachment to this colony site; and c) at Castle Rocks & Mainland and Hurricane Point Rocks colonies, greater numbers of living birds would exist with attachment to these colonies. Attraction and recolonization would likely be impeded at San Pedro Rock because no birds with prior attachments were alive after colony extirpation in the early 1900s.

As captive-reared juvenile murres were to be produced in the proposed seabird center (see below), the soft release of juvenile murres ready to fly near potential recolonization sites was included (Kress & Carter 1991). Carefully-conducted soft releases (including supplemental feeding in pens near restoration sites) might improve the chances of recolonization by helping to form some level of attachment between these birds and recolonization site areas (Anderson *et al*. 1999, Newman *et al*. 1999).

Restoring murre colonies could help to partly repair the population by recolonizing Devil's Slide Rock, and the neighboring San Pedro Rock, creating a colony complex that would helpto maintain a larger breeding assemblage in this area over time; and by maintaining southern mainland colonies so that this portion of the breeding range would be safeguarded. Potential benefits of successful colony restoration were weighed against possible costs (e.g. small colonies might not persist after recolonization due to anthropogenic or natural factors; reproductive success and adult survival at small colonies might be lower than if the same birds bred at larger colonies). However, several murre colonies in central California are small because suitable nesting habitat is limited, and adequate reproductive success and persistent use of these colony sites over time likely reflected self-sustaining colonies (Carter *et al*. 2001, Parker *et al*. 2002). Restored colonies, if able to survive through the bottleneck of colony formation and initial growth, probably would persist under natural conditions.

Marbled Murrelet Nesting Habitat Acquisition

A 581 acre parcel of land forming the upper watershed of Cascade Creek, Santa Cruz County, was identified for acquisition (Singer & Carter 1992). This land had documented use by Marbled Murrelets (G.S. Strachan, *pers. comm.*) and contained 113 acres of suitable murrelet nesting habitat within 2.7 km of the ocean (i.e., old-growth Douglas fir *Pseudotsuga menziesii* and Coast Redwood *Sequoia sempervirens* trees). It was adjacent to other state-owned murrelet nesting areas in Big Basin Redwoods State Park. Population size and reproductive success within this small depleted population would be improved by protecting and managing nesting habitat in the area. At least 12 birds would be benefit from this acquisition, based on an estimate of 5 active nests producing 1.75 chicks/year.

Seabird Center

A center for rehabilitation and captive breeding of seabirds was designed after other facilities with successful captive breeding programs for alcids, with features to enhance successful rehabilitation (Fry 1991, Swennen 1977, Rhodes/Dahl 1993). It was planned with a view to rehabilitating and releasing, about 3,200 birds for incorporation into wild populations during the first 20 years of operation. This estimate was based on an initial stock of 200 Common Murres, 80 Tufted Puffins *Fratercula cirrhata* and 80 Rhinoceros Auklets, plus an annual estimate of about 300-500 oiled birds recovered. Few studies at the time of the *Apex Houston* spill had shown long-term survival and breeding by rehabilitated, captive, or captive-reared seabirds (Morant *et al*. 1981, Swennen 1977). Several experts contended that proper facilities and veterinary care would result in a greater release rate and greater post-release survival of rehabilitated birds. The relatively high cost of the seabird center was not considered inappropriate by trustee agencies (Carson *et al*. 1996).

DEFENDANTS' CRITICISMS

Soon after the spill in 1986, the Defendants began to organize a team of lawyers and experts to assist them with defense of potential liability. In 1989, first discussions between Defendants' and Plaintiffs' legal counsels resulted in a complete lack of agreement about the seriousness of the spill and its impacts to seabirds. In USCG and CRWQCB administrative hearings, as well as in subsequent litigation, Apex Oil Company would not accept responsibility of any kind for the spill. The Defendants' primary attacks on the Plaintiffs' case were presented in a multiple-chaptered report (Divoky 1993). However, additional criticism of certain aspects of injury determination or restoration also was provided in other reports (Caswell 1993, Grigalunas & Opaluch 1993, Hobbs 1993, Payne 1993, Spaulding 1993, Todd 1993). The main defendants' criticisms of injury determination were: 1) data collection and analyses were flawed; 2) baseline levels of beached birds were not accounted for; 3) accepted literature was misinterpreted; 3) impacts of gill-net fishing mortality were ignored; 4) the Devil's Slide Rock colony was extirpated due to factors other than the oil spill; and 5) central California populations of Common Murres and Marbled Murrelets were not geographically distinct from northern populations of these species. Main criticisms of restoration plans were: 1) plans were not justified based on incorrect injury determinations or natural recovery was expected; 2) plans would not benefit the species involved; and 3) plans were not feasible or too costly.

DEPOSITIONS AND SETTLEMENT

Defendants' criticisms and Plaintiffs' expert reports were examined in more detail during extensive depositions of expert witnesses from both sides in 1993-94. During the deposition process, additional information was requested from experts by attorneys: 1) to clarify and re- examine expert opinions and criticisms; 2) to examine and confirm expert qualifications; and 3) to test experts' responses to attorneys' questions under oath for later comparison to statements at trial. Months earlier, a large volume of raw data and other information relied upon by experts had been provided through the discovery process. All documents were scrutinized and many days of deposition testimony were spent going over these materials in detail. Examination of deposition transcripts is helpful to more fully comprehend the strengths and weaknesses of experts' biological opinions. Electronic or paper copies of all depositions were placed in the files of the California Department of Fish and Game (Sacramento, California).

After most depositions were completed, the case settled in principle for $6,400,000 dollars in February 1994. Depositions often result in a new round of settlement negotiations in most cases, once the opinions of Plaintiffs' and Defendants' experts have been challenged and each side has evaluated its odds of winning in trial. Although not enough to fund all proposed restoration projects, the Defendants' settlement offer was millions of dollars higher than the previous offer and was accepted by trustee agencies, after strong encouragement by the special master assigned by the judge to help bring parties to settlement. The Consent Decree was filed and entered in U.S. District Court (Northern District of California, San Francisco) on 31 August 1994. This decree allotted: $4,916,430 for the Common Murre colony restoration project; $500,000 for Marbled Murrelet nesting habitat acquisition; and $983,570 for agencies' response costs, litigation costs, and fines. Due to insufficient settlement funds, no funding was allotted to the seabird center. However, the Oiled Wildlife Care Network was formed in 1994, through funding from a new oil industry tax, to provide best achievable care to oiled wildlife in California through development of rehabilitation facilities, trained personnel, and rapid response capabilities. In 1997, the Marine Wildlife Veterinary Care & Research Center was built at the University of California Santa Cruz on the same site considered for the proposed seabird center.

EPILOGUE

For cooperative implementation of restoration projects, the U.S. Fish and Wildlife Service, National Oceanic and Atmospheric Administration, and California Department of Fish and Game entered into a Memorandum of Understanding that established the *Apex Houston* Trustee Council in 1994. A revised restoration plan for available funds was developed and published in the Federal Register (USFWS 1994). Public comment was received through responses to the Federal Register notice; at a public meeting on 17 November 1994 in Sausalito, California; and at scientific meetings in 1995 (Divoky 1996a,b, Divoky & Harrison 1995). Comments were largely constructive and included a wide range of suggested changes, approvals, disapprovals, and questions. However, no feasible or acceptable alternative restoration projects were suggested. The final restoration plan was modified to include additional information on goals and evaluation of the success of the project, a detailed budget and an education component (USFWS 1995).

In January 1996, Common Murres responded immediately to social attraction techniques at Devil's Slide Rock (Parker *et al*. 1997). Less than 24 hours after deployment, one murre landed on the rock. Within two days, four murres were observed walking among the decoys. Murre attendance at the rock increased to a peak count of 29 through the spring and summer. Although breeding was not anticipated for several years, six pairs laid eggs and three produced fledglings in 1996. Restoration efforts continued in 1997-2001, with numbers increasing each year, with 115 egg-laying sites producing 85 fledglings in 2001 (Parker *et al*. 2002). Similar efforts on San Pedro Rock began in 1998 with a similar rapid response resulting in a peak count of 24 birds (Parker *et al*. 1999). Continued attendance has been low and breeding had not occurred by 2001 (Parker *et al*. 2002). Social attraction has not yet been tried at Castle Rocks & Mainland or Hurricane Point Rocks colonies but monitoring data supported further gill-net fishing restrictions in 2000-01 and plans to reduce human disturbance (P.R. Kelly, *pers. comm.*).

Initial efforts to purchase the "A" property were not successful due largely to insufficient funds. However, the non-profit Sempervirens Fund already had targeted the "Gazos Mountain Camp" property for acquisition, located in the Gazos Creek watershed in San Mateo County (Fig. 6). This property had similar benefits as described for the "A" property, consisting of 111 acres of residual old-growth forest with numerous old-growth trees used for nesting by Marbled Murrelets (S.W. Singer, *unpubl. data*). In July 1998, a partnership was finalized to acquire the property, for later addition to Butano State Park for long-term management (Nelson 1998, P.R. Kelly, *pers. comm.*). The *Apex Houston* Trustee Council provided $500,000 of the $1,400,000 purchase price and an additional $60,000 for monitoring and development of a management plan (Singer & Hamer 1999).

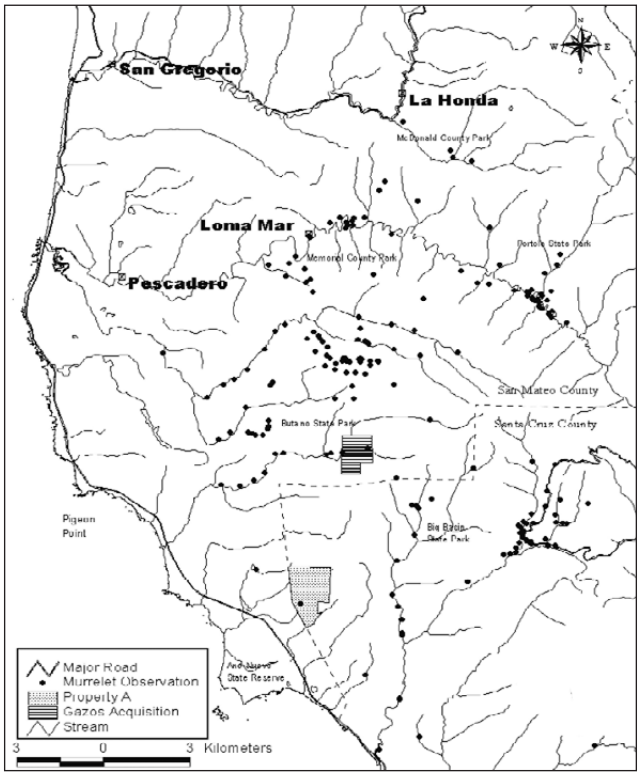

Fig. 6. Gazos Creek watershed in San Mateo County

ACKNOWLEDGEMENTS

We thank many government agencies, private organizations, and concerned citizens which helped assess the impact of the *Apex Houston* oil spill on seabirds. This summary was improved by comments from: D. Anderson, K. Briggs, A. Gaston, R. Glazer, M. Hackenbracht, P. Kelly, G. McChesney, E. Murphy, S. Newman, J. Piatt, L. Spear, G. Strachan, E. Ueber, and D. Welsh. J. Yee assisted preparation of Fig. 4. J. Muskat prepared Fig. 6, using the California Marbled Murrelet Database prepared by E. Burkett, K. Sallee, H. Johnson, and J. Lanser.

REFERENCES

AINLEY, D.G. & BOEKELHEIDE, R.J. (Eds.) 1990. *Seabirds of the Farallon Islands: ecology, structure and dynamics of an upwelling-system community*. Stanford, California: Stanford University Press.

AINLEY, D.G. & LEWIS, T.J. 1974. The history of Farallon Island marine bird population, 1854-1972. *Condor* 76: 432-446.

AINLEY, D.G., SPEAR, L.B., ALLEN, S.G. & RIBIC, C.A. 1996. Temporal and spatial patterns in the diet of the Common Murre in California waters. *Condor* 98: 691-705.

ANDERSON, D.W., NEWMAN, S.H., KELLY, P.R., HERZOG, S.K. & LEWIS, K.P. 1999. Experimental releases of oil-spill rehabilitated coots: lingering effects on survival and behavior. *Environmental Pollution* 107: 285-294.

BECKER, B.H., BEISSINGER, S.R. & CARTER, H.R. 1997. At-sea density monitoring of Marbled Murrelets in Central California: methodological considerations. *Condor* 99: 743-755.

BRIGGS, K.T., TYLER, W.B., LEWIS, D.B. & CARLSON, D.R. 1987. Bird communities at sea off California: 1975-1983. *Studies in Avian Biology* 11: 1-74.

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD. 1986. Summary of information on the *Apex Houston* oil spill. Oakland, California: Unpublished report, California Regional Water Quality Control Board, San Francisco Bay Region.

CARSON, R.T., CONAWAY, M.D., HANEMANN, W.M., KROSNICK, J.A., MARTIN, K.M., McCUBBIN, D.R., MITCHELL, R.C. & PRESSER, S. 1996. The value of preventing oil spill injuries to natural resources along California's central coast. San Diego, California: Unpublished report, Natural Resource Damage Assessment, Inc.

CARTER, H.R. 2003. Oiled seabirds in California: an overview. *Marine Ornithology* 31: 1-7.

CARTER, H.R. & ERICKSON, R.A. 1992. Status and conservation of the Marbled Murrelet in California. In: Carter, H.R. & Morrison, M.L. (Eds.). Status and conservation of the Marbled Murrelet in North America. *Proceedings of the Western Foundation for Vertebrate Zoology* 5: 92-108.

CARTER, H.R. & PAGE, G.W. 1989. Central California oil spill contingency plan: assessment of numbers and species composition of dead beached birds. Technical Memorandum NOS MEMD 25. Washington, D.C.: National Oceanic & Atmospheric Administration.

CARTER, H.R., PAGE, G.W. & FORD, R.G. 1987. The importance of rehabilitation center data in determining the impacts of the 1986 oil spill on marine birds in central California. *Wildlife Journal* 10: 9-14.

CARTER, H.R., WILSON, U.W., LOWE, R.W., RODWAY, M.S., MANUWAL, D.A., TAKEKAWA, J.E. & YEE, J.L. 2001. Population trends of the Common Murre (*Uria aalge californica*). In: Manuwal, D.A., Carter, H.R., Zimmerman, T.S. & Orthmeyer, D.L. (Eds.). Biology and conservation of the Common Murre in California, Oregon, Washington, and British Columbia. Volume 1: Natural history and population trends. Washington, D.C.: U.S. Geological Survey, Biological Resources Division, Information & Technology Report USGS/BRD/ITR-2000-0012: pp. 33-132.

CASWELL, H. 1993. Critique of: Long-term injuries to the Central California population of

Common Murres (*Uria aalge*) due to mortality from the 1986 *Apex Houston* oil spill. Woods Hole, Massachusetts: Unpublished report, Woods Hole Oceanographic Institution.

DIVOKY, G.J. 1993. Critiques of the government reports relating to the alleged *Apex Houston* oil spill. Seattle, Washington: Unpublished report.

DIVOKY, G.J. 1996a. Restoration proposals for Common Murres in central California. *Pacific Seabirds* 23: 30 (abstract).

DIVOKY, G.J. 1996b. The timing of decline of Common Murres in central California. *Pacific Seabirds* 23: 30 (abstract).

DIVOKY, G.J. & HARRISON, C. 1995. Seabird restoration: a review of needs and options. In: Proceedings of the 1995 Oil Spill Conference. Washington, D.C.: American Petroleum Institute: pp. 860-861.

FORD, R.G. 1991. Simulation of oil spill trajectories and fates of seabirds killed by oil spilled from the *Apex Houston*. Portland, Oregon: Unpublished report, Ecological Consulting, Inc.

FORD, R.G., PAGE, G.W. & CARTER, H.R. 1987. Estimating mortality of seabirds from oil spills. In: Proceedings of the 1987 Oil Spill Conference. Washington, D.C.: American Petroleum Institute: pp. 547-551.

FRY, D.M. 1991. Seabird captive breeding and rehabilitation program. Davis, California: Unpublished report, Avian Environmental Sciences.

GRIGALUNAS, T.A. & OPALUCH, J.J. 1993. Review of Trustee Restoration Plans *Apex Houston*. Peacedale, Rhode Island: Unpublished report, Economic Analysis, Inc.

HIMES BOOR, G.K., FORD, R.G., ROLETTO, J., MORTENSON, J., MAZET, J.A.K., ALLEN, S.G., CARTER, H.R., GOLIGHTLY, R.T., CAPITOLO, P.J. & NEVINS, H.R. 2003. Estimated total number of beached birds. In: Carter, H.R. & Golightly, R.T. (Eds.). Seabird injuries from the 1997-1998 Point Reyes Tarball Incidents. Arcata, California: Unpubl. report, Humboldt State University, Department of Wildlife: pp. 11-28.

HOBBS, G. 1993. A critique of 'Simulation of oil spill trajectories and fates of seabirds killed by oil spilled from the *Apex Houston*' and 'Impacts of the 1986 *Apex Houston* oil spill on marine birds in central California'. Morgantown, West Virginia: Unpublished report, West Virginia University, Statistics & Computer Science.

HUDSON, P.J. 1985. Population parameters for the Atlantic Alcidae. In: Nettleship, D.N. & Birkhead, T.R. (Eds.). The Atlantic Alcidae. New York, New York: Academic Press: pp. 233-261.

KRESS, S.W. 1992. Murre restoration begins at Matinicus Rock. *Egg Rock Update* (1992 report): 3.

KRESS, S.W. & CARTER, H.R. 1991. Recolonization of Common Murres to abandoned nesting islands on the central California coast. Ithaca, New York, and Davis, California: Unpublished report, National Audubon Society and Carter Biological Consulting.

KRESS, S.W. & NETTLESHIP, D.N. 1988. Re-establishment of Atlantic Puffins (*Fratercula arctica*) at a former breeding site in the Gulf of Maine. *Journal of Field Ornithology* 59: 161-170.

KRESS, S.W. & SCHUBEL, S.E. 1992. Matinicus Rock, Penobscot Bay, Maine: 1992 season report. Ithaca, New York: Unpublished report, National Audubon Society.

LEE, V.A., P.J. BRIDGEN & ENVIRONMENT INTERNATIONAL LTD. 2002. The Natural Resources Damage Assessment Handbook: a legal and technical analysis. Washington, D.C.: Environmental Law Institute.

MANUWAL, D.A. & CARTER, H.R. 2001. Natural history of the Common Murre (*Uria aalge californica*). In: Manuwal, D.A., Carter, H.R., Zimmerman, T.S. & Orthmeyer, D.L. (Eds.). Biology and conservation of the Common Murre in California, Oregon, Washington, and British Columbia. Volume 1: Natural history and population trends. Washington, D.C.: U.S. Geological Survey, Biological Resources Division, Information & Technology Report USGS/BRD/ITR-2000-0012: pp. 1-32.

MORANT, P.D., COOPER, J. & RANDLE, R.M. 1981. The rehabilitation of oiled Jackass Penguins (*Spheniscus dermersus*). In: Cooper, J. (Ed.). Proceedings of the Symposium on Birds of Sea and Shore. Cape Town, South Africa: African Seabird Group: pp. 267-285.

NASLUND, N.L. 1993. Why do Marbled Murrelets attend old-growth forest nesting areas year-round? *Auk* 110: 594-602.

NELSON, K. 1998. Oil spill money awarded to Sempervirens Fund. *Mountain Echo (Summer 1998)*: 3.

NEWMAN, S.H., ANDERSON, D.W., ZICCARDI, M.H., TRUPKIEWICZ, J.G., TSENG, F.S., CHRISTOPHER, M.M. & ZINKL, J.G. 1999. An experimental soft-release of oil-spill rehabilitated American Coots (*Fulica americana*): II. Effects on health and blood parameters. *Environmental Pollution* 107: 295-304.

PAGE, G.W. & CARTER, H.R. (Eds.) 1986. Impacts of the 1986 *San Joaquin Valley* crude oil spill on marine birds in central California. Stinson Beach, California: Unpublished report, Point Reyes Bird Observatory.

PAGE, G.W., CARTER, H.R. & FORD, R.G. 1990. Numbers of seabirds killed or debilitated in the 1986 *Apex Houston* oil spill in central California. *Studies in Avian Biology* 14: 164-174.

PARKER, M.W., McLAREN, E.B., SCHUBEL, S.E, BOYCE, J.A., CAPITOLO, P.J., ORTWERTH, M.A., KRESS, S.W., CARTER, H.R. & HUTZEL, A. 1997. Restoration of Common Murre colonies in central coastal California: First year results. Newark, California: Unpublished report, U.S. Fish & Wildlife Service, San Francisco Bay National Wildlife Refuge Complex.

PARKER, M.W., BOYCE, J.A., CRAIG, E.N., GELLERMAN, H., NOTHHELFER, D.A., YOUNG, R.J., KRESS, S.W., CARTER, H.R. & G.A. MOORE. 1999. Restoration of Common Murre colonies in central coastal California: Annual report 1998. Newark, California: Unpublished report, U.S. Fish & Wildlife Service, San Francisco Bay National Wildlife Refuge Complex.

PARKER, M.W., KNECTEL, H., ACORD, B., CAURANT, C., JONES, N., MURPHY, M., CARTER, H.R., KRESS, S., GOLIGHTLY, R. & COHEN, L.J. 2002. Restoration of Common Murre colonies in central coastal California: Annual report 2001. Newark, California: Unpublished report, U.S. Fish & Wildlife Service, San Francisco Bay National Wildlife Refuge Complex.

PATON, P.W.C. & RALPH, C.J. 1990. Distribution of the Marbled Murrelet at inland sites in California. *Northwestern Naturalist* 71: 72-84.

PAYNE, J.R. 1993. *Apex Houston* oil spill fate and behavior: Chemical/physical weathering and computer modeling. Encinitas, California: Unpublished report.

PIATT, J.F., CARTER, H.R. & NETTLESHIP, D.N. 1991. Effects of oil pollution on marine bird populations. In: White, J. (Ed.). The effects of oil on wildlife: research, rehabilitation and general concerns. Proceedings of the Oil Symposium, Herndon, Virginia, October 16-18, 1990. Hanover, Pennsylvania: Sheridan Press: pp. 125-141.

RALPH, C.J. & MILLER, S.L. 1995. Offshore population estimates of Marbled Murrelets in California. In: Ralph, C.J., Hunt, G.L., Jr., Raphael, M.G. & Piatt, J.F. (Eds.). Ecology and conservation of the Marbled Murrelet. Albany, California: USDA, Forest Service, Gen. Tech. Rep. PSW-GTR-152. pp. 353-360.

RHODES/DAHL. 1993. Seabird captive breeding and rehabilitation program and murre recolonization program: program budgets for construction and operations. Washington, D.C.: Unpubl. report, U.S. Dept. of Justice.

SINGER, S.W. & CARTER, H.R. 1992. Restoration of the central California population of the Marbled Murrelet after injuries from the *Apex Houston* oil spill. Santa Cruz and Davis, California: Unpublished report, Santa Cruz Mountains Murrelet Group and Carter Biological Consulting.

SINGER, S.W. & HAMER, T.E. 1999. Gazos Creek Marbled Murrelet monitoring program: 1999 annual report. Santa Cruz, California: Singer Environmental & Ecological Services.

SINGER, S.W., NASLUND, N.L., SINGER, S.A. & RALPH, C.J. 1991. Discovery and observation of two tree nests of the Marbled Murrelet. *Condor* 93: 330-339.

SISKIN, B.R., PAGE, G.W. & CARTER, H.R. 1993. Impacts of the 1986 *Apex Houston* oil spill on marine birds in central California. Philadelphia, Pennsylvania, and Stinson Beach and Davis, California: Unpublished report, Center for Forensic Economic Studies, Point Reyes Bird Observatory, and Carter Biological Consulting.

SPAULDING, M.L. 1993. Critique of Ford, R.G., 1991. Simulation of oil spill trajectories and fates of seabirds killed by the oil spilled from the *Apex Houston*. Wakefield, Rhode Island: Unpublished report, Spaulding Environmental Associates, Inc.

SWARTZMAN, G. 1996. Resource modeling moves into the courtroom. *Ecological Modeling* 92: 277-288.

SWARTZMAN, G. & CARTER, H.R. 1991. Long-term injuries to the central California population of Common Murres (*Uria aalge*) due to mortality from the 1986 *Apex Houston* oil spill. Seattle, Washington, and Davis, California: Unpublished report, University of Washington, Applied Physics Laboratory and Center for Quantitative Science, and Carter Biological Consulting.

SWENNEN, C. 1977. Laboratory research on sea-birds: Report on a practical investigation into the possibility of keeping seabirds for research purposes. Texel, Netherlands: Netherlands Institute for Sea Research.

SYDEMAN, W.J. 1993. Survivorship of Common Murres on Southeast Farallon Island, California. *Ornis Scandinavica* 24: 135-141.

SYDEMAN, W.J., CARTER, H.R., TAKEKAWA, J.E. & NUR, N. 1997. Common Murre (Uria aalge) population trends at the South Farallon Islands, California, 1985-1995. Stinson Beach, Dixon, and Newark, California: Unpubl. report, Point Reyes Bird Observatory, U.S. Geological Survey, and U.S. Fish & Wildlife Service.

TAKEKAWA, J.E., CARTER, H.R. & HARVEY, T.E. 1990. Decline of the Common Murre in central California, 1980-1986. *Studies in Avian Biology* 14:149-163.

TODD, F.S. 1993. A critique of "Seabird captive breeding and rehabilitation program" (Rhodes/Dahl), and "Seabird captive breeding and rehabilitation program" (D. Michael Fry). San Diego, California: Unpublished report, Ecocepts International.

U.S. FISH & WILDLIFE SERVICE. 1994. Restoration of nearshore breeding seabird colonies on the central California coast: draft plan. *Federal Register* 59: 213.

U.S. FISH & WILDLIFE SERVICE. 1995. Restoration of nearshore breeding seabird colonies on the central California coast: final plan. *Federal Register* 60: 81.

U.S. FISH & WILDLIFE SERVICE. 1997. Recovery plan for the threatened Marbled Murrelet (*Brachyramphus marmoratus*) in Washington, Oregon, and California. Portland, Oregon: U.S. Fish & Wildlife Service.

WICKHAM, D.A., KAHL, C.C., MAYER, G.F. & REINHARZ, E. 1993. Restoration: the goal of the Oil Pollution Act natural resources damage actions. *Baylor Law Review* 45: 405.

WILD, P.W. 1990. The Central California experience: a case history of California Halibut set net laws and regulations. In: Haugen, C.W. (Ed.). The California Halibut, *Paralichthys californicus*, resource and fisheries. Fish Bulletin 174. Sacramento, California: California Department of Fish & Game: pp. 321-339.