

Project Title: Surveys to Monitor Marine Bird Abundance in Prince William Sound during Winter and Summer 2002

Project Number: 02159
Restoration Category: Monitoring
Proposer: Migratory Bird Management, U. S. Fish and Wildlife Service
Lead Trustee Agency: U. S. Department of the Interior, Fish and Wildlife Service
Cooperating Agencies: None
Alaska SeaLife Center:
Duration: Every other year until recovered
Cost FY 02: \$~ 194.1
Cost FY 03: \$~ 25.0
Cost FY 04: \$~ 146.0
Geographic Area: Prince William Sound
Injured Resource/Service: Marine Birds and Sea Otters

ABSTRACT

We propose to conduct small boat surveys to monitor abundance of marine birds and sea otters (*Enhydra lutris*) in Prince William Sound, Alaska during March and July 2002. Seven previous surveys have monitored population trends for >65 bird and 8 marine mammal species in Prince William Sound. We will use data collected in 2002 to examine trends from summer 1989-2002 and from winter 1990-2002 by determining whether populations in the oiled zone changed at the same rate as those in the unoiled zone. We will also examine overall population trends for the Sound from 1989-2002. Due to the lack of data prior to the *Exxon Valdez* oil spill, continued monitoring of marine birds and sea otters is needed to determine whether populations injured by the spill are recovering. Data collected in 2000 indicated that bald eagles (*Haliaeetus leucocephalus*) are increasing in winter and summer throughout Prince William Sound, harlequin ducks (*Histrionicus histrionicus*) are increasing in the oiled area in winter, and black oystercatchers are increasing throughout Prince William Sound in summer. Numbers of all other injured species are either not changing or are declining in the oiled area. Common loons (*Gavia immer*), cormorants (*Phalacrocorax spp.*), and common murres (*Uria aalga*) are showing no trend in the oiled area; pigeon guillemots (*Cephus columba*) and marbled murrelets (*Brachyramphus marmoratus*) are declining in the oiled areas of Prince William Sound and Kittlitz's Murrelet (*Brachyramphus brevirostris*) is declining throughout Prince William Sound. Results of these surveys up through 1998 have been published by Irons et al. (2000) and Lance et al. (2001). Analyses of these survey data are the only ongoing means to evaluate the recovery of most of these injured species.

INTRODUCTION

The waters and shorelines of Prince William Sound support abundant marine bird and sea otter populations throughout the year (Isleib and Kessel 1973, Hogan and Murk 1982, Irons et al. 1988a). Potential injuries to marine birds from exposure to the *T/V Exxon Valdez* oil spill included, but were not limited to, death, changes in behavior, and decreased productivity. U. S. Fish and Wildlife Service, Migratory Bird Management conducted boat surveys in Prince William Sound prior to the *Exxon Valdez* oil spill in 1972-73 (Dwyer et al. 1976) and 1984-85 (Irons et al. 1988a,b). After the oil spill, Natural Resource Damage Assessment Bird Study Number 2 (Burn 1994, Klosiewski and Laing 1994) was initiated to document damage from the oil spill on the marine bird and sea otter populations of Prince William Sound. Data from these surveys indicated that populations of sea otters (Burn 1994) and several marine bird species (Klosiewski and Laing 1994) declined in the oil spill area. Thus, restoration projects 93045 (Agler et al. 1994a), 94159 (Agler et al. 1995a), 96159 (Agler and Kendall 1997), 98159 (Lance et al. 1999), and 00159 (Stephensen et al. 2001) were initiated to continue monitoring marine bird and sea otter population abundance to assess recovery of injured species. Restoration projects 93045, 94159, 96159, 98159, and 00159 continued the original *Exxon Valdez* oil spill damage assessment study (Bird Study Number 2, Burn 1994, Klosiewski and Laing 1994) from 1989-91.

Using small boat surveys, this project will collect additional information to monitor the distribution and abundance of marine birds and sea otters in Prince William Sound. These data will be combined with data collected in 1989-91 (Klosiewski and Laing 1994), 1993 (Agler et al. 1994a), 1994 (Agler et al. 1995a), 1996 (Agler and Kendall 1997), 1998 (Lance et al. 1999, Irons et al. 2000, Lance et al. 2001) and 2000 (Stephensen et al. 2001) to examine trends in marine bird and sea otter distribution and abundance. This project will benefit restoration of Prince William Sound by determining whether populations that declined due to the spill are recovering and by identifying what species are still of concern.

NEED FOR THE PROJECT

A. Statement of the Problem

Almost 30,000 marine bird (Piatt et al. 1990) and 900 sea otter (DeGange and Lensink 1990) carcasses were recovered following the *Exxon Valdez* oil spill. Based on modeling studies using carcass search effort and population data, an estimated 250,000 marine birds were killed in Prince William Sound and the northern Gulf of Alaska (Piatt and Ford 1996). Garrott et al. (1993) estimated that 2,800 sea otters also were killed. These estimates are probably low, because they only include direct mortality occurring in the first five months after the spill.

The U. S. Fish and Wildlife Service conducted boat surveys of marine bird and sea otter populations in Prince William Sound in 1972-73 (Dwyer et al. 1976), 1984-85 (Irons et al. 1988b), and several years following the spill (1989, 1990, 1991, Klosiewski and Laing 1994; 1993, Agler et al. 1994a; 1994, Agler et al., 1995a; 1996, Agler and Kendall, 1997; 1998, Lance et al., 1999; and 2000, Stephensen et al. 2001). Klosiewski and Laing (1994) documented overall declines in 15 species or species groups between 1972-73 (Dwyer et al. 1976) and the years after the spill. When comparing population estimates with 1984-85 data, Klosiewski and

Laing (1994) documented decline of 6 species or species groups.

Burn (1994), using data from the boat surveys, documented declines in sea otter abundance in shoreline habitats of Prince William Sound following the spill. Burn (1994) detected a continuing pattern of significantly lower sea otter densities in oiled coastal areas, suggesting mortality in or displacement of sea otters from these areas.

Stephensen et al. (2001) examined whether marine bird and mammal species designated as injured by the *EVOS* trustee council had shown signs of recovery by 2000. Data collected from 1989 to 2000 indicated that bald eagles (*Haliaeetus leucocephalus*) are increasing in winter and summer throughout Prince William Sound, harlequin ducks (*Histrionicus histrionicus*) are increasing in the oiled area in winter, and black oystercatchers are increasing throughout Prince William Sound in summer. Numbers of all other injured species are either not changing or are declining in the oiled area. Common loons (*Gavia immer*), cormorants (*Phalacrocorax spp.*), and common murrelets (*Uria aalga*) are showing no trend in the oiled area; pigeon guillemots (*Cephus columba*) and marbled murrelets (*Brachyramphus marmoratus*) are declining in the oiled areas of Prince William Sound and Kittlitz's Murrelet (*Brachyramphus brevirostris*) is declining throughout Prince William Sound. Analyses of these survey data are the only ongoing means to evaluate the recovery of most of these injured species.

B. Rationale/Link to Restoration

Restoration of marine bird and sea otter populations requires population estimates to determine whether recovery is occurring or if species are still affected by the oil spill. This project will benefit marine birds and sea otters by revealing species that show continuing injury due to the *T/V Exxon Valdez* oil spill. Agler et al. (1994a, 1995a), Agler and Kendall (1997), and Lance et al. (1999), and Stephensen et al. (2001) found additional populations that were not previously shown to be injured. Survey data from this project have also been used by investigators of other studies on pigeon guillemots (Greg Golet, pers. comm.), marbled murrelets (K. Kuletz, pers. comm.), Kittlitz's murrelets (B. Day, per comm.), harlequin ducks (D. Rosenberg and D. Esler, pers. comm.), sea ducks (K. Laing and D. Esler, pers. comm.), black oystercatchers (B. Andres, pers. comm.), birds and forage fish (W. Ostrand, pers. comm.), herring (E. Brown, pers. comm.), and sea otters (Burn 1994).

This project relates to the restoration objectives of several species. The *Exxon Valdez Oil Spill Restoration Plan* (*Exxon Valdez* Oil Spill Trustee Council 1994) lists each species' restoration objectives separately, and we have only included objectives relating to this project:

Cormorants - "will have recovered when their populations return to pre-spill levels in the oil-spill area. An increasing population trend in Prince William Sound will indicate that recovery is underway."

Harlequin duck - "will have recovered when breeding and post-breeding season densities and production of young have returned to estimated pre-spill levels, or when there are no differences in these parameters between oiled and unoled areas."

Bald eagle - "will have recovered when their population and productivity return to pre-spill levels."

Black oystercatchers - “will have recovered when populations attain pre-spill levels”

Marbled murrelet - “will have recovered when population trends are increasing.”

Pigeon guillemot - “will have recovered when populations are stable or increasing.”

Sea otter - “will be considered recovered when population abundance and distribution are comparable to pre-spill abundance and distribution”

All of the above recovery objectives relate to determining the population abundance of injured species. This is critical to determining recovery for most species. Common loons and Kittlitz’s murrelets were also designated as injured species, but no recovery objective has been developed due to lack of information on their populations. We propose to sample the entirety of Prince William Sound during March and July 2002 to estimate population abundance and distribution of marine birds and sea otters. Data will be comparable with pre- and post-spill data collected by the U. S. Fish and Wildlife Service (Dwyer et al. 1976, Irons et al. 1988a,b, Agler et al. 1994a, Klosiewski and Laing 1994, Agler et al. 1995a, Agler and Kendall 1997, Lance et al. 1999, and Stephensen et al. 2001) and can be used to examine trends in abundance for these species. There are currently no other studies monitoring the populations of loons, cormorants, and black oystercatchers, harlequin ducks, murrelets, pigeon guillemot, marbled murrelets, or Kittlitz’s murrelets in Prince William Sound.

Additionally, Klosiewski and Laing (1994) found evidence of oil spill damage for scoters (*Melanitta* spp.), mew gull (*Larus canus*), arctic tern (*Sterna paradisaea*), and northwestern crow (*Corvus caurinus*). These species have never been added to the list of injured species and do not have restoration objectives. At the present time, this proposed study is the only study continuing to consider these species and track their populations.

By using data from previous surveys we have conducted power analyses to examine the power to detect trends in population abundance (Taylor and Gerrodette 1993). If all other parameters are equal, power is determined by the number of surveys conducted in a given period of time. As the number of surveys increases the ability to detect a trend increases. For example if a population had a coefficient of variation (C.V.) of 0.30 (this is higher than that of 73% of the injured species; Agler and Kendall 1999) the ability to detect an average annual 10 % change in population is 40% with 6 surveys (Fig. 1). By conducting surveys in 2002 the number of surveys increases to 12 and the power to detect same population change increases to ~71% (Fig. 1). If we continue biannual surveys, when we have completed 10 surveys the power to detect this change would be 90% (Fig 1). Thus we feel it is important to continue these surveys to enable us to increase the ability to detect population trends.

C. Location

This study will be conducted in Prince William Sound. The study area includes all water within Prince William Sound, as well as land within 100 m of the shore.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

We would be happy to provide informational meetings in communities within Prince William Sound, as permitted by our survey schedule. We will use a charter vessel(s) from communities within the Sound or adjacent regions (Homer or Seward).

PROJECT DESIGN

A. Objectives

The purpose of this study is to obtain population estimates of marine birds and sea otters in Prince William Sound to monitor the recovery of species whose populations may have declined due to the *T/V Exxon Valdez* oil spill and to determine whether additional species may still be affected by the oil spill. The specific objectives of this project include:

1. To determine distribution and estimate population abundance, with 95% confidence limits, of marine bird and sea otter populations in Prince William Sound during March and July 2002;
2. To determine whether the marine bird species whose populations declined more in oiled areas than in non-oiled areas of Prince William Sound have recovered;
3. To determine whether additional species show any oil spill effects;
4. To support restoration studies on harlequin duck, black oystercatcher, pigeon guillemot, marbled murrelet, Kittlitz's murrelet, sea ducks, and sea otter by providing data on population changes, distribution, and habitat use of Prince William Sound populations.

B. Methods

1. Study Area

Our study area includes all waters within Prince William Sound and all land within 100 m of shore (Fig. 2). We exclude Orca Inlet, near Cordova, Alaska and the southern sides of Montague, Hinchinbrook, and Hawkins Islands (Klosiewski and Laing 1994).

2. Sampling Methods

Survey methodology and design will remain identical to that of post-spill surveys conducted by the U. S. Fish and Wildlife Service in 1989, 1990, 1991, (Klosiewski and Laing 1994), March and July 1993 (Agler et al. 1994a), March 1994 (Agler et al. 1995a), March and July 1996 (Agler and Kendall 1997), March and July 1998 (Lance et al. 1999), and March and July 2000 (Stephensen et al. 2001). We will conduct two surveys: one during March and another during July 2002. We will use three 7.7 m fiberglass boats traveling at speeds of 10-20 km/hr to survey transects over two 3-week periods. For each survey, two observers will survey a sampling window 100 m on either side, ahead of, and above the vessel (Klosiewski and Laing 1994). When surveying shoreline transects, observers will also record sightings on land within 100 m of shore. Observers will sample continuously and use binoculars to aid in species identification. Observers will practice estimating distances with a duck decoy, and radars on the survey vessels

will be used to assist in determining our distance from land on shoreline transects. We will survey most transects when wave height is <30 cm, and we will not survey when wave height is >60 cm.

We will continue to use a stratified random sampling design containing three strata: shoreline, coastal-pelagic, and pelagic (Klosiewski and Laing 1994). The shoreline stratum will consist of waters within 200 m of land. Irons et al. (1988b) divided this stratum, by habitat, into 742 transects with a total area of 820.74 km². We will locate shoreline transects by geographic features, such as points of land, to facilitate orientation in the field and to separate the shoreline by habitat (Irons et al. 1988a,b). Shoreline transects will vary in size, ranging from small islands with <1 km of coastline to sections of the mainland with over 30 km of coastline. Mean transect length will be 5.55 km. During winter, we plan to survey 99 shoreline transects, but this number varies among years, due to weather conditions and ice blockage. During summer, we plan to survey 212 shoreline transects. All transects were randomly chosen, and the same transects are used each survey (Klosiewski and Laing 1994).

To sample the coastal-pelagic and pelagic strata of Prince William Sound, we will divide the study area into 5-minute latitude-longitude blocks. When a block includes >1.8 km of shoreline, we will classify it in the coastal-pelagic stratum, and we will classify blocks with ≤1.8 km of shoreline in the pelagic stratum (Klosiewski and Laing 1994). When coastal-pelagic or pelagic blocks intersect the 200 m shoreline stratum, they will be truncated to avoid overlap. We plan to survey 2 north-south transect lines, 200 m wide each, located 1 minute inside the east and west boundaries of each coastal-pelagic and pelagic block. We will use Global Positioning Systems and nautical compasses to navigate transect lines. In the coastal-pelagic stratum, we plan to survey ≤29 blocks in the winter and ≤46 blocks in the summer. In the pelagic stratum, we plan to survey ≤25 blocks during both seasons.

3. Poststratification by Oiling

To examine population trends over time and to determine if populations injured by the spill are recovering, we will poststratify Prince William Sound into two zones, oiled and unoiled, based upon the pattern of oiling by the *Exxon Valdez* oil spill (Klosiewski and Laing 1994).

4. Statistical Analyses

As in previous surveys (Klosiewski and Laing 1994, Agler et al. 1994a,b,c, 1995a,b, Agler and Kendall 1997, Lance et al. 1999, Stephensen et al. 2001), we will use a ratio estimator (Cochran 1977) to estimate population abundance. Shoreline transects will be treated as a simple random sample; whereas, the coastal-pelagic and pelagic transects will be analyzed as two-stage cluster samples of unequal size (Cochran 1977). To do this, we will estimate the density of birds counted on the combined transects for a block and multiply by the area of the sampled block to obtain a population estimate for each block. We then will add the estimates from all blocks surveyed and divide by the sum of the areas of all blocks surveyed. We will calculate the population estimate for a stratum by multiplying this estimate by the area of all blocks in the strata. Population estimates for each species and for all birds in Prince William Sound will be calculated by adding the estimates from the three strata, and we will calculate 95% confidence intervals for these estimates from the sum of the variances of each stratum (Klosiewski and Laing 1994).

Population estimates for each species will be combined with other post-oil spill population estimates to determine population trends. We plan to use a homogeneity of slopes test (Freud and Littell 1981) to compare population trends between the oiled and unoiled zones of Prince William Sound to examine whether species with population estimates of >500 individuals have changed over time. To do this, we must assume that marine bird and sea otter populations increase at the same rate in the oiled and unoiled zones of Prince William Sound. The \log_{10} of each population estimate will be calculated after adding 0.5 to the estimate to prevent effects from using $\log 0$. Significantly different slopes would indicate that population abundance of a species or species group changed at different rates. For species or species groups showing a significant difference in slopes or ratios, we will determine the rate of change in each zone by linear regression analyses.

5. Statistical Justification for Proposed Monitoring Schedule

Currently, these surveys are scheduled to occur every 2 years over an unspecified time period. This schedule should be considered in light of the results of a power analysis.

To determine optimum survey frequency, we conducted a power analysis to estimate the probability of detecting trends in abundance using linear regression from a given number of samples (Taylor and Gerrodette 1993). We examined our power to detect trends when coefficient of variation (CV) of the population was 0.30 (greater than the mean CV from previous surveys for 73% of the injured species; Fig. 1) and when the CV = 0.13 (the mean summer CV for *Brachyramphus* murrelets, an injured species; Fig. 3). Models of seabird population growth predict most species increase no more than 12% per year (Nur and Ainley 1992), so we used 10% for our comparisons.

With CV=0.30 the probability of detecting an average annual change of 10% would be 55% with the 7 surveys completed to date (Fig 1). The probability would increase to ~ 71% in 2002 (8 surveys). If 10 surveys were completed the probability would be 92%. For murrelets the power to detect a 10% change is now 95% (Fig. 3). This would increase to 100% with the completion of the 2002 surveys (Fig. 3).

Based on these calculations, we recommend a monitoring schedule of every two years for these surveys.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

This project includes two contracts for a vessel to provide logistical support. We will need a vessel large enough to provide lodging and meals for 9 people and carry fuel for the small boats. During the winter survey, we will need a support vessel for 10 days. During the summer survey we can reduce our need for a support vessel to 7 days as we can use field camps in Prince William Sound for logistical support.

SCHEDULE

A. Measurable Project Tasks for FY 02 (October 1, 2001-September 30, 2002)

October-January:	Arrange logistics for surveys, train personnel
February:	Final preparations for survey
March:	Conduct winter survey in Prince William Sound
April-May:	Return to Anchorage, enter and analyze data, and store equipment
June:	Hire and train personnel, arrange logistics for summer survey
July:	Conduct summer survey in Prince William Sound
August:	Return to Anchorage, enter and analyze data, and store equipment
September:	Continue analysis of data from surveys

B. Project Milestones and Endpoints

After each set of surveys, we will examine the data for differences in trends between the oiled and unoiled zone for all designated injured marine birds and sea otters.

C. Completion Date

This project will continue biannually until population trends for the injured species show recovery from injury.

PUBLICATIONS AND REPORTS

October 2002:	Prepare draft report of 2000 surveys
January 15, 2003:	Draft Report to Peer Review
April 15, 2003:	Final Report complete

PROFESSIONAL CONFERENCES

No funds are requested for attending meetings.

NORMAL AGENCY MANAGEMENT

This project is not a part of normal agency management for the U. S. Fish and Wildlife Service in Alaska. Although considered an important ecosystem within Alaska, surveys of Prince William Sound would not be as high a priority as funding for projects within other areas of the state.

This year, Migratory Bird Management, U. S. Fish and Wildlife Service plans to provide 2 permanent personnel during the March and July surveys to help reduce costs.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

Principle investigators from other EVOS trustee council funded projects have used our survey data in the past. Data from these surveys would be helpful for the sea otter, harlequin duck, and pigeon guillemot portions of the nearshore vertebrate predator project (\025); the black-legged kittiwake, marbled murrelet (/231), and seabird foraging portions of the Alaska predator

ecosystem experiment (\163); and harbor seal monitoring (\064).

EXPLANATION OF CHANGES TO CONTINUING PROJECTS

The 2002 surveys will be identical to previous Prince William Sound Surveys.

PROPOSED PRINCIPAL INVESTIGATORS

Unknown

and

David Irons
Department of Interior, U. S. Fish and Wildlife Service
Migratory Bird Management
1011 East Tudor Road
Anchorage, Alaska 99503
Phone: (907) 786-3376
Fax: (907) 786-3641
email:David_Irons@fws.gov

PROPOSED PRINCIPLE INVESTIGATORS

1. Co-Project Leader - Unknown.
2. Co-Project Leader - David B. Irons, Ph.D., Wildlife Biologist, GS-12.

Dr. David Irons received his PhD from the University of California, Irvine in 1992. His dissertation was on the foraging ecology and breeding biology of the black-legged kittiwake in Prince William Sound. He received his M.S. from Oregon State University in 1982 where he studied foraging behavior of glaucous-winged gulls in relation to the presence of sea otters. Dr. Irons conducted marine birds and sea otter surveys in Prince William Sound in 1984 and 1985. He has been studying kittiwakes in Prince William Sound for 17 years and completed the **Exxon Valdez** oil spill kittiwake damage assessment study. Dr. Irons has overseen several seabird studies in the past few years, including marine bird and sea otter surveys of Prince William Sound and Cook Inlet, a seabird monitoring study on Little Diomedede Island, and a cost of reproduction study on kittiwakes.

Selected Seabird Publications:

Lance B. K., D. B. Irons, S. J. Kendall, L. L. McDonald. 2001. An evaluation on marine bird population trends following the Exxon Valdez oil spill, Prince William Sound, Alaska. Marine Pollution Bulletin.

Irons, D. B., S. J. Kendall, W. P. Erickson, L. L. McDonald, and B. K. Lance. 2000. Chronic

- effects of the *Exxon Valdez* oil spill on summer marine birds in Prince William Sound, Alaska. *Condor* 102:723-737.
- Golet, G. H., K. J. Kuletz, D. D. Roby, D. B. Irons. 2000. Adult prey choice affects chick growth and reproductive success of Pigeon Guillemots. *The Auk* 117:82-91.
- Hunt, G. L., F. Mehlum, R. W. Russell, D. B. Irons, M. B. Decker, and P. Becker. 1999. Physical processes, prey abundance, and the foraging ecology of seabirds. In: Adams, N. and Slowtow, R. (Eds.) 22 International Ornithological Congress, Durban, South Africa, University of Natal.
- Agler, B.A., Kendall, S.J., Irons, D.B., and Klosiewski, S.P. 1999. Declines in Marine Bird Populations in Prince William Sound, Alaska Coincident with a Climatic regime Shift. *Waterbirds* 22:98-103.
- Golet, G. H., and D. B. Irons. 1999. Raising young reduces body condition and fat stores in Black-legged Kittiwakes. *Oecologia* 120:530-538.
- Irons, D. B. 1998. Foraging area fidelity of individual seabirds in relation to tidal cycles and flock feeding. *Ecology* 70:647-655.
- Golet, G. H., D. B. Irons, and J. A. Estes. 1998. Survival costs of chick rearing in Black-legged Kittiwakes. *Journal of Animal Ecology* 67:827-841.
- Irons, D. B. 1996. Size and productivity of Black-legged Kittiwake colonies in Prince William Sound before and after the *Exxon Valdez* oil spill. Pages 738-747, *in* S. D. Rice, R. B. Spies, D. A. Wolfe, and B. A. Wright, editors. Exxon Valdez Oil Spill Symposium. Am. Fisheries Soc. No. 18.
- Hatch, S. A., G. V. Byrd, D. B. Irons, and G. L. Hunt. 1993. Status and ecology of kittiwakes in the North Pacific Ocean. Pages 140-53 *in* K. Vermeer, K. T. Briggs, K. H. Morgan, and D. Siegel-Causey, eds. The status, ecology and conservation of marine birds of the North Pacific, Can. Wildl. Serv., Spec. Publ., Ottawa, Canada.
- Irons, D. B., R. G. Anthony, and J. A. Estes. 1986. Foraging strategies of glaucous-winged gulls in a rocky intertidal community. *Ecology* 67:1460-74.
- Hogan, M. E., and D. B. Irons. 1986. Waterbirds and marine mammals. Pages *in* M. J. Hameedi, and D. G. Shaw, eds. Environmental management of Port Valdez, Alaska: scientific basis and practical results. Springer-Verlag, New York.

LITERATURE CITED

- Agler, B. A., P. E. Seiser, S. J. Kendall, and D. B. Irons. 1994a. Marine bird and sea otter populations of Prince William Sound, Alaska: population trends following the *T/V Exxon Valdez* oil spill. Restoration Project No. 93045. Final Rep., U. S. Fish and Wildl. Serv., Anchorage, Alas. 51 pp. + appendices.

- Agler, B. A., S. J. Kendall, P. E. Seiser, and D. B. Irons. 1994b. Population estimates of marine bird and sea otter populations in Lower Cook Inlet, Alaska during June 1993. Unpubl. Rep., U. S. Fish and Wildl. Serv., Anchorage, Alas. 73 pp. + appendices.
- Agler, B. A., S. J. Kendall, P. E. Seiser, and D. B. Irons. 1994c. Field report: marine bird survey of Lower Cook Inlet, February-March 1994. Unpubl. Rep., U. S. Fish and Wildlife Service, Anchorage, Alas. 17 pp.
- Agler, B. A., S. J. Kendall, P. E. Seiser, and D. B. Irons. 1995a. Winter marine bird and sea otter abundance of Prince William Sound, Alaska: trends following the *T/V Exxon Valdez* oil spill from 1990-94. Final Rep., U. S. Fish and Wildlife Service, Anchorage, Alas. 68 pp. + appendices.
- Agler, B. A., S. J. Kendall, P. E. Seiser, and J. R. Lindell. 1995b. Estimates of marine bird and sea otter abundance in Southeast Alaska during summer 1994. Draft Rep., U. S. Fish and Wildl. Serv., Anchorage, Alas. 87 pp. + appendices.
- Agler, B. A., and S. J. Kendall. 1997. Marine Bird and Mammal Population Abundance of Prince William Sound, Alaska: Trends following the *T/V Exxon Valdez* Oil Spill, 1989-96. Restoration Project No. 96159. Final Rep., U.S. Fish and Wildl. Serv., Anchorage, Alas.
- Burn, D. M. 1994. Boat-based population surveys of sea otters (*Enhydra lutris*) in Prince William Sound, in response to the *Exxon Valdez* oil spill. NRDA Marine Mammal Study Number 6. U. S. Fish and Wildl. Serv., Anchorage, Alas.
- Cochran, W. G. 1977. Sampling techniques. John Wiley and Sons, Inc., New York 428 pp.
- DeGange, A. R., and C. J. Lensink. 1990. Distribution, age, and sex composition of sea otter carcasses recovered during the response to the T/V *Exxon Valdez* oil spill. Pages 124-129 in K. Bayha and J. Kormendy, eds. Sea otter symposium: proceedings of a symposium to evaluate the response effort on behalf of sea otters after the T/V *Exxon Valdez* oil spill into Prince William Sound, Anchorage, Alaska, 17-19 April 1990. U. S. Fish and Wildl. Serv., Biol. Rep. 90(12). 485 pp.
- Dwyer, T. J., P. Isleib, D. A. Davenport, and J. L. Haddock. 1976. Marine Bird Populations in Prince William Sound Alaska. Unpubl. Rep., U. S. Fish and Wildl. Serv., Anchorage, Alas. 24 pp.
- Ecological Consulting, Inc. 1991. Assessment of direct mortality in Prince William Sound and the western Gulf of Alaska resulting from the *Exxon Valdez* oil spill. Unpubl. Rep., Ecological Consulting, Inc., Portland, Ore. 153 pp.
- Exxon Valdez* Oil Spill Trustee Council. 1994. *Exxon Valdez* oil spill restoration plan. *Exxon Valdez* Oil Spill Trustee Council, Anchorage, Alas. 56 pp. + appendices.
- Freud, R. J., and R. C. Littell. 1981. SAS for linear models: a guide to the ANOVA and GLM procedures. SAS Institute Inc., Cary, N. C. 231 pp.

- Garrott, R. A., L. L. Eberhardt, and D. M. Burn. 1993. Mortality of sea otters in Prince William Sound following the *Exxon Valdez* oil spill. *Mar. Mamm. Sci.* 9(4):343-59.
- Hogan, M. E., and J. Murk. 1982. Seasonal distribution of marine birds in Prince William Sound, based on aerial surveys, 1971. Unpubl. Rep., U. S. Fish and Wildl. Serv., Anchorage, Alas. 22 pp. + appendices.
- Irons, D. B., S. J. Kendall, W. P. Erickson, L. L. McDonald, and B. K. Lance. 2000. Chronic effects of the *Exxon Valdez* oil spill on summer marine birds in Prince William Sound, Alaska. *Condor* 102:723-737.
- Irons, D. B., D. R. Nysewander, and J. L. Trapp. 1988a. Prince William Sound sea otter distribution in relation to population growth and habitat type. Unpubl. Rep., U. S. Fish and Wildl. Serv., Anchorage, Alas. 31 pp.
- Irons, D. B., D. R. Nysewander, and J. L. Trapp. 1988b. Prince William Sound waterbird distributions in relation to habitat type. Unpubl. Rep., U. S. Fish Wildl. Serv., Anchorage, Alas. 26 pp.
- Isleib, P. and B. Kessel. 1973. Birds of the North Gulf Coast - Prince William Sound Region, Alaska. *Biol. Pap. Univ. Alaska* 14. 149 pp.
- Klosiewski, S. P., and K. K. Laing. 1994. Marine bird populations of Prince William Sound, Alaska, before and after the *Exxon Valdez* oil spill. Exxon Valdez Oil Spill State and Federal Natural Resources Damage Assessment Final Reports, U. S. Fish and Wildl. Serv., Anchorage, Alas. 89 pp.
- Lance B. K., D. B. Irons, S. J. Kendall, L. L. McDonald. 2001. An evaluation on marine bird population trends following the Exxon Valdez oil spill, Prince William Sound, Alaska. *Marine Pollution Bulletin*.
- Lance, B. K., D. B. Irons, S. J. Kendall, and L. L. McDonald. 1999. Marine Bird Population Abundance of Prince William Sound, Alaska: Trends following the *Exxon Valdez* oil spill. Restoration Project No. 98159. Final Rep., U.S. Fish and Wildl. Serv., Anchorage, Alas.
- Nur, N. and D. G. Ainley. 1992. Comprehensive review and critical synthesis of the literature on recovery of marine bird populations from environmental perturbations. Final Rep., *Exxon Valdez* Restoration and Planning Work Group.
- Piatt, J. F., C. J. Lensink, W. Butler, M. Kendziorek, and D. R. Nysewander. 1990. Immediate impact of the 'Exxon Valdez' oil spill on marine birds. *Auk* 107:387-397.
- Piatt, J. F. and R. G. Ford. 1996. How many birds were killed by the *Exxon Valdez* oil spill? Pages 712-719 in S. D. Rice, R. B. Spies, D. A. Wolfe, and B. A. Wright, eds. Proceedings of the *Exxon Valdez* oil spill symposium. American Fisheries Society Symposium 18. 931 pp.

- Sauer, J. R., and P. H. Geissler. 1990. Estimation of annual indices from roadside surveys. Pages 58-62 in J. R. Sauer and S. Droege, eds. Survey designs and statistical methods for the estimation of avian population trends. U. S. Fish and Wildl. Serv., Biol. Rep. 90(1). 166 pp.
- Stephensen, S. W., D. B. Irons, S. J. Kendall, B. K. Lance, and L. L. McDonald. 2001. Marine Bird Population Abundance of Prince William Sound, Alaska: Trends following the *Exxon Valdez* oil spill. Restoration Project No. 00159. Final Rep., U.S. Fish and Wildl. Serv., Anchorage, Alas.
- Taylor, B. L., and T. Gerrodette. 1993. The use of statistical power in conservation biology: the vaquita and northern spotted owl. *Cons. Biol.* 7(3):489-500.

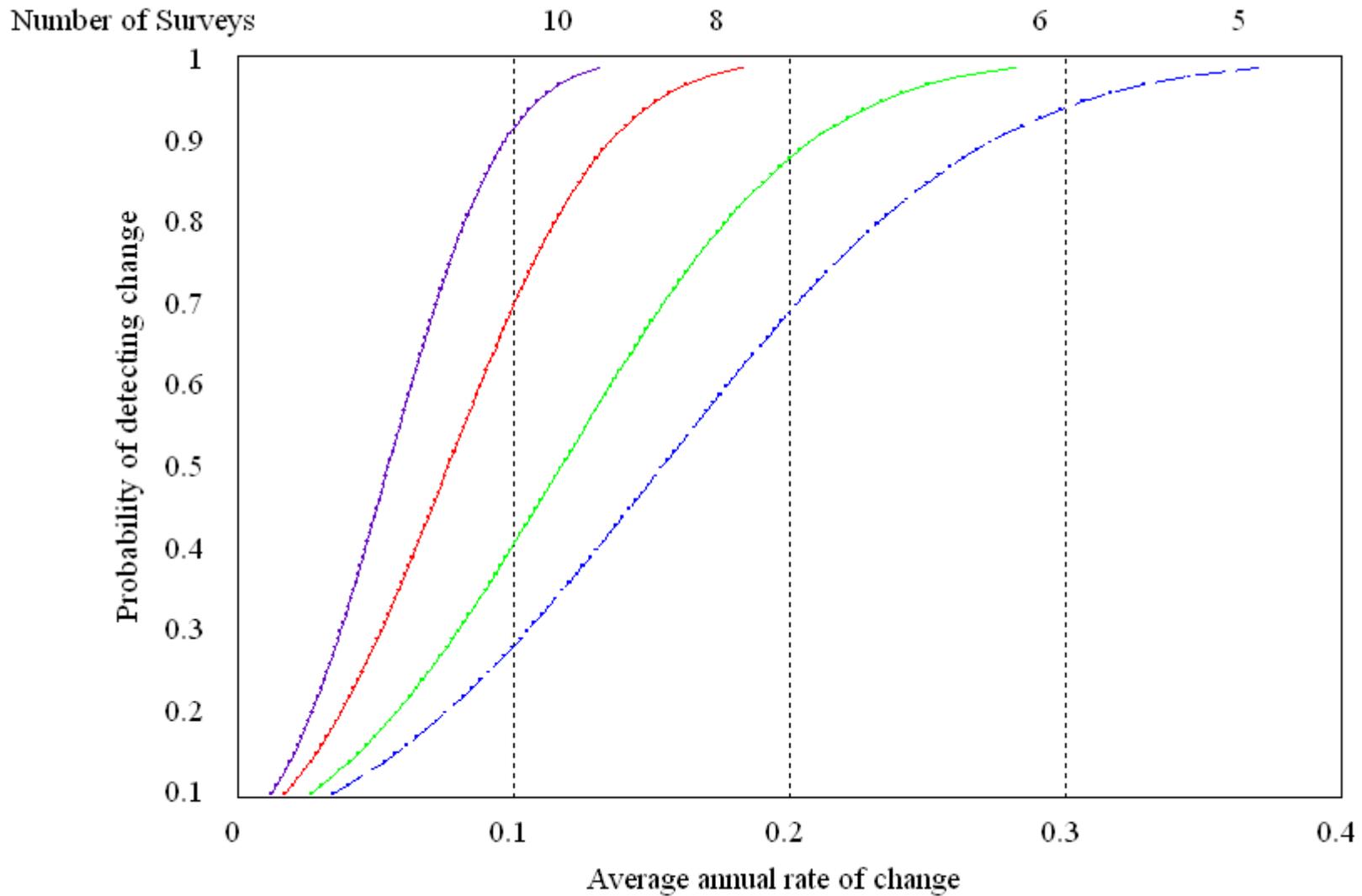


Figure 1. Estimated power (probability of detection) based on number of surveys conducted to detect a trend of marine bird and sea otter populations in Prince William Sound when $CV = 0.30$.

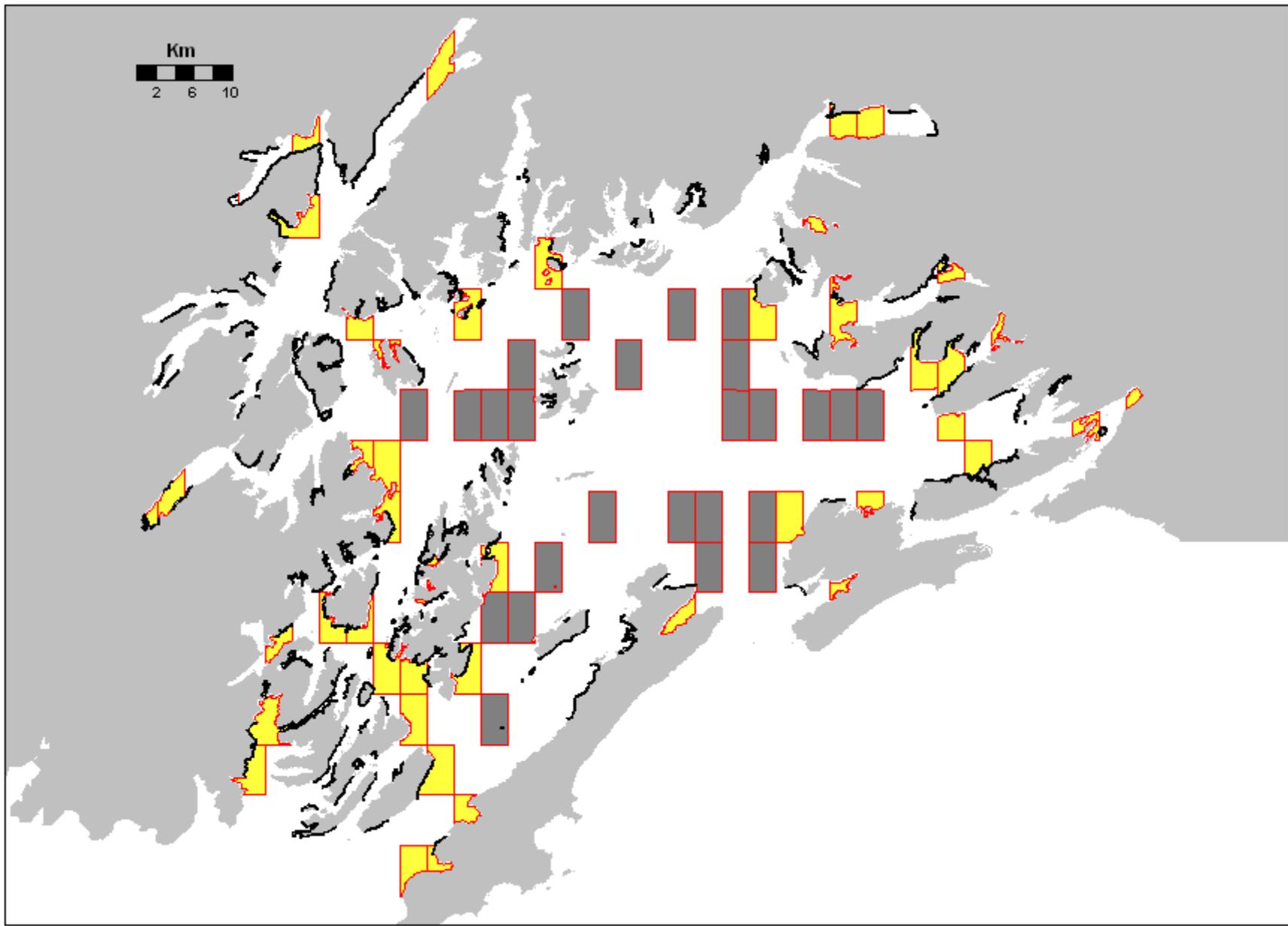


Figure 2. Transects and blocks surveyed during July small boat surveys of Prince William Sound. Transects were classified into 3 strata; the shoreline stratum, (<200 m from land), the coastal-pelagic stratum (lighter shaded blocks), and the pelagic stratum (darker shaded blocks).

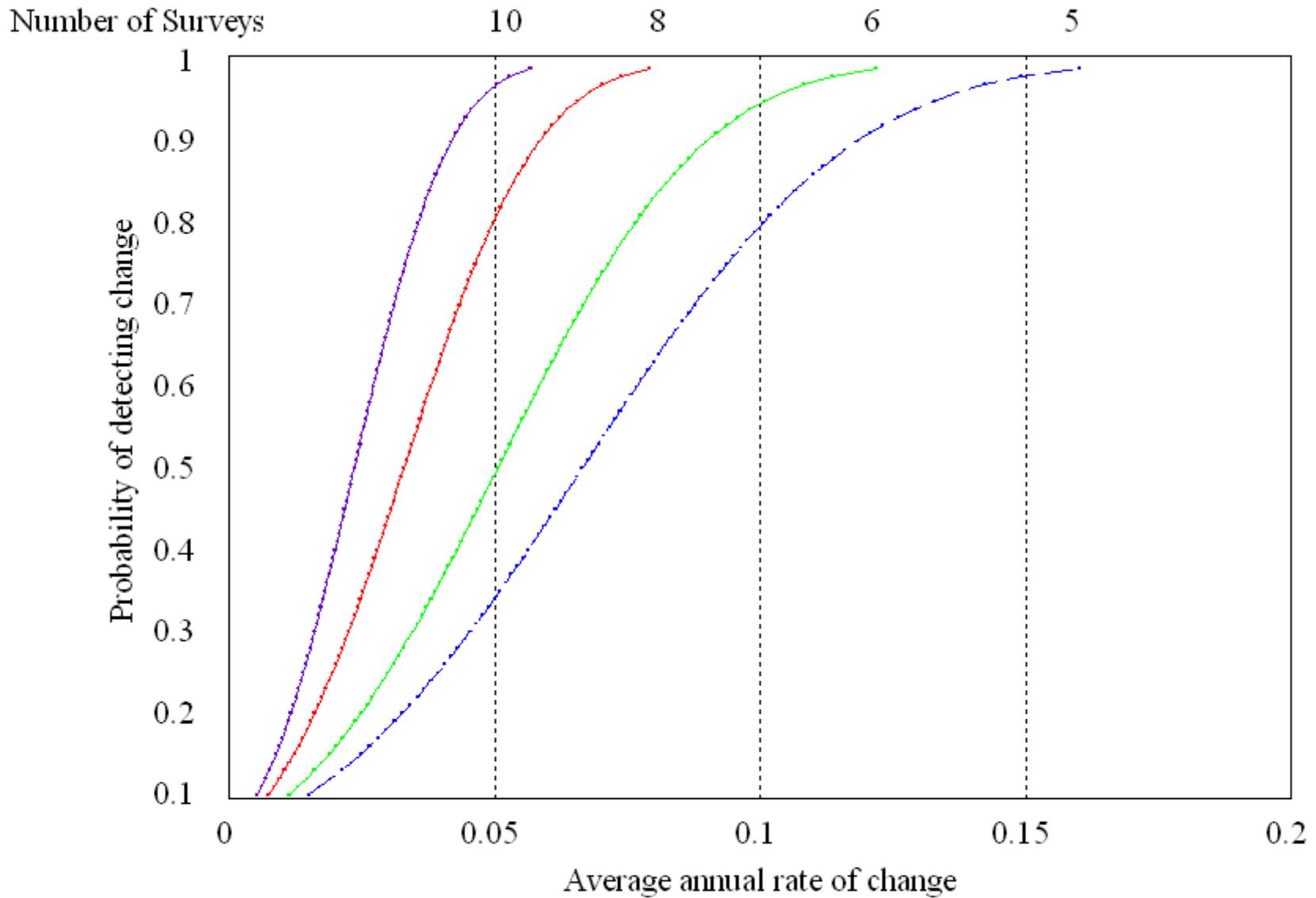


Figure 3. Estimated power (probability of detection) based on numbers of surveys conducted to detect a trend in the July *Brachyramphus* murrelet population in Prince William Sound. The CV = 0.13.

2002 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2001 - September 30, 2002

Budget Category:	Authorized FFY 2001	Proposed FFY 2002				
Personnel	\$21.7	\$93.3				
Travel		\$10.8				
Contractual		\$46.5				
Commodities		\$24.7				
Equipment	\$0.0	\$1.5	LONG RANGE FUNDING REQUIREMENTS			
Subtotal	\$21.7	\$176.8	Estimated FFY 2003	Estimated FFY 2004	Estimated FFY2005	
General Administration	\$3.3	\$17.3				
Project Total	\$25.0	\$194.1	\$25.0	\$146.0	\$25.0	
Full-time Equivalentents (FTE)		2.3				
Dollar amounts are shown in thousands of dollars.						
Other Resources						
Comments:						

2002

Project Number: 02159
 Project Title: Marine Bird Boat Surveys
 Agency: DOI - Fish and Wildlife Service

Prepared:

2002 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2001 - September 30, 2002

Personnel Costs:			GS/Range/ Step	Months Budgeted	Monthly Costs	Overtime		
PM	Name	Position Description						
	Unknown	Co-Project Leader	GS11-1	9.0	5,365			
	Unknown	Technician	GS5 - 1	3.0	2,500			
	Unknown	Technician	GS5 - 1	3.0	2,500			
	Unknown	Technician	GS5 - 1	3.0	2,500			
	Unknown	Technician	GS5 - 1	3.0	2,500			
	Unknown	Technician	GS5 - 1	3.0	2,500			
	Unknown	Technician	GS5 - 1	3.0	2,500			
Subtotal				27.0	20,365	0		
Those costs associated with program management should be indicated by placement of an *.							Personnel Total	
Travel Costs:			Ticket Price	Round Trips	Total Days	Daily Per Diem		
PM	Description							
	Truck and boat on train Portage - Whittier		40	8				
	Per diem, (camp rate), 9 people, 20 d winter; 9 people 20 d summer				360	3		
	Per diem, (travel rate), 9 people, 2 d winter; 9 people 2 d summer; 6 people, 3 days training				54	48		
	Lodging, 6 nights, 2 rooms @ \$90/night/room (Cordova, survey)				6	180		
	Lodging, 9 people, 14 nights, (Whittier, survey plus boat training)				126	45		
Those costs associated with program management should be indicated by placement of an *.							Travel Total	

2002

Project Number: 02159
 Project Title: Marine Bird Boat Surveys
 Agency: DOI - Fish and Wildlife Service

2002 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2001 - September 30, 2002

Contractual Costs:	
Description	
Charter vessel (winter), 10 days Charter vessel (summer), 7 days Harbor fees Boat repairs and parts	
When a non-trustee organization is used, the form 4A is required.	Contractual Total
Commodities Costs:	
Description	
Boat fuel (70 gal/day/boat) 60 boat-days/winter; 60 boat-days @ \$2.00/gal Outboard oil (2 gal/boat/survey) 3 boats, 2 surveys @ \$12.00/gal Food (\$10.00/person/day) 9 people for 30 days/winter; 9 people 30 days/summer Rain gear, rubber boots and gloves for 6 people @ \$200/person Scientific supplies (batteries for radios & other equipment, waterproof notebooks & paper, thermometers, wind gauges)	
	Commodities Total

2002

Project Number:02159
 Project Title: Marine Bird Boat Surveys
 Agency: DOI - Fish and Wildlife Service

2002 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2001 - September 30, 2002

New Equipment Purchases:		Number of Units	Unit Price	
Description				
	Emergency replacement of equipment			
Those purchases associated with replacement equipment should be indicated by placement of an R.				New Equipment Total
Existing Equipment Usage:		Number of Units		
Description				
	Camping supplies			
	Survival suits	9		
	Mustang suits	9		
	Float coats	9		

2002

Project Number: 02159
 Project Title: Marine Bird Boat Surveys
 Agency: DOI - Fish and Wildlife Service

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Budget Category:	Authorized FFY 2001	Proposed FFY 2002				
Personnel		\$0.0				
Travel		\$0.0				
Contractual		\$31.1				
Commodities		\$0.0				
Equipment		\$0.0	LONG RANGE FUNDING REQUIREMENTS			
Subtotal	\$0.0	\$31.1	Estimated FY 2003	Estimated FY 2004	Estimated FY2005	
General Administration		\$2.2				
Project Total	\$0.0	\$33.3	\$0.0	\$250.0	\$40.0	
Full-time Equivalent (FTE)		0.0				
Dollar amounts are shown in thousands of dollars.						
Other Resources						
Comments: Justification of Personnel Costs:						

FY 02

Received 9/17/02

Project Number: 02159
 Project Title: Surveys to Monitor Marine Bird Abundance in Prince William Sound during Winter and Summer;
 Determine minimum sample sizes needed for population trends of injured species.

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Personnel Costs:			GS/Range/ Step	Months Budgeted	Monthly Costs	Overtime		
PM	Name	Position Description						
Subtotal				0.0	0	0		
Those costs associated with program management should be indicated by placement of an *.							Personnel Total	
Travel Costs:			Ticket Price	Round Trips	Total Days	Daily Per Diem		
PM	Description							
Those costs associated with program management should be indicated by placement of an *.							Travel Total	

FY 02

Project Number: 02159
 Project Title: Surveys to Monitor Marine Bird Abundance in Prince William Sound during Winter and Summer;
 Determine minimum sample sizes needed for population trends of injured species.

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Contractual Costs:		
Description		
West Inc.		
When a non-trustee organization is used, the form 4A is required.		Contractual Total
Commodities Costs:		
Description		
		Commodities Total

FY 02

Project Number: 02159
 Project Title: Surveys to Monitor Marine Bird Abundance in Prince William Sound during Winter and Summer;
 Determine minimum sample sizes needed for population trends of injured species.

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

New Equipment Purchases:		Number of Units	Unit Price	
Description				
Those purchases associated with replacement equipment should be indicated by placement of an R.			New Equipment Total	
Existing Equipment Usage:		Number of Units		
Description				

FY 02

Project Number: 02159
 Project Title: Surveys to Monitor Marine Bird Abundance in Prince William Sound during Winter and Summer;
 Determine minimum sample sizes needed for population trends of injured species.