Exxon Valdez Oil Spill
State/Federal Natural Resource Damage Assessment Final Report

Effects of the *Exxon Valdez* Oil Spill on Fork-tailed Storm-Petrels Breeding in the Barren Islands, Alaska

Bird Study Number 7
Final Report

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Study History: This damage assessment study was initiated in 1989 as part of a comprehensive detailed study plan. The study was designed to determine the nature and extent of the injury, loss or destruction of fork-tailed storm-petrels within the oil spill zone.

Abstract: We evaluated fork-tailed storm-petrels (*Oceanodroma furcata*) at East Amatuli Island, Barren Islands, the largest storm-petrel breeding colony within the trajectory of the oil slick, to determine whether there was evidence of adverse effects, following the 1989 *Exxon Valdez* oil spill. Although we were unable to measure all possible indicators, we found insufficient evidence to conclude that there were significant adverse impacts to breeding storm-petrels in 1989. Burrow occupancy rates were above average, the timing of nesting was not delayed, and productivity was normal.

Key Words: *Exxon Valdez*, oil spill, Fork-tailed Storm-Petrel, *Oceanodroma furcata,* Gulf of Alaska, Barren Is., East Amatuli I.

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EXECUTIVE SUMMARY

Following the *T/V Exxon Valdez* oil spill, we evaluated fork-tailed storm-petrels (*Oceanodroma furcata*) at East Amatuli Island, Barren Islands, the largest storm-petrel breeding colony within the trajectory of the oil slick, to determine whether there was evidence of adverse effects. Although we were unable to measure all possible indicators, we found insufficient evidence to conclude that there were significant adverse impacts to breeding storm-petrels in 1989. Burrow occupancy rates were above average, the timing of nesting was not delayed, and productivity was normal.

Key Words: *T/V Exxon Valdez*, Oil Spill, Fork-tailed Storm-Petrel, *Oceanodroma furcata*, Gulf of Alaska, Barren Is., East Amatuli I.

INTRODUCTION

In the summer of 1989, we studied the fork-tailed storm-petrel (*Oceanodroma furcata*) at East Amatuli Island, Barren Islands, Alaska, an area surrounded in April 1989 by oil spilled by the *T/V Exxon Valdez* (Galt et al. 1991). Fork-tailed storm-petrels ingest petroleum at sea predictably enough to be used as indicators of the presence of oil in marine environments (Boersma 1986a); thus, a large concentration of oil in the vicinity of the breeding colony might have been expected to adversely affect nesting petrels.

Direct mortality of storm-petrels appeared to have been low; less than 2 percent of the dead birds retrieved following the *T/V Exxon Valdez* oil spill were petrels (Piatt et al. 1990). However, due to their small size, storm-petrels may have been more often overlooked in retrieval operations than large birds. Regardless of the actual number of birds killed directly by the oil, we wanted to determine whether there was evidence of adverse impacts at the large breeding colony on East Amatuli Island. Studies elsewhere have shown that exposure of birds to crude oil can inhibit yolk formation and egg production (Grau et al. 1977, Fry and Lowenstine 1985), reduce hatchability of eggs (McGill and Richmond 1979, Fry et al. 1986), and impair growth and reduce survival of chicks (Miller et al. 1978, Peakall et al. 1980, Peakall et al. 1982, Trivelpiece et al. 1984).

Background information on fork-tailed storm-petrels at East Amatuli Island included descriptions of breeding biology (Boersma

et al. 1980, Boersma 1986b), behavior and attendance patterns (Boersma and Wheelwright 1979, Simons 1981), and annual monitoring for burrow occupancy rates and reproductive success from 1985 to 1988 (Nishimoto et al. 1986, Nishimoto et al. 1987, Nishimoto and Beringer 1988, Nishimoto and O'Reilly 1989). In addition, Boersma (1986a) studied the incidence of fossil fuel hydrocarbons in gut samples of fork-tailed storm-petrels at East Amatuli.

During the 1989 breeding season, immediately following the *T/V Exxon Valdez* oil spill, we found that storm-petrels at East Amatuli Island did not have reduced burrow occupancy rates or lower reproductive success. Furthermore, no delay in the nesting phenology was detected. We did not measure the size of eggs, lengths of incubation shifts, chick growth rates, or other more subtle indicators that might have suggested adverse effects of oil contamination. Based upon our information, however, fork-tailed storm-petrel populations at East Amatuli Island did not seem to be adversely affected by the oil spill in 1989.

OBJECTIVES

To evaluate effects of the *T/V Exxon Valdez* oil spill on fork-tailed storm-petrels at the East Amatuli Island breeding colony by evaluating pre- and post-spill differences in burrow occupancy rates (an index to population change) and in chicks per burrow (an index to productivity).

METHODS

Study Area

East Amatuli Island is in the Barren Islands group (58 55'N, 152 10'W) located in the mouth of Cook Inlet, Alaska, between the tip of the Kenai Peninsula and Kodiak Island (Fig. 1). Seabird colonies in the Barrens contain over 500,000 breeding birds, the majority of which (325,000 birds) breed on East Amatuli (Manuwal 1980). Fork-tailed storm-petrel was the most abundant species on East Amatuli, numbering approximately 150,000 birds (Manuwal 1980).

Data Collection

During 2 visits to East Amatuli in 1989 (3-20 July and 26 Aug. to 8 Sept.) the contents of previously-marked nesting burrows at 5 plots were checked. During July, samples of regurgitated stomach oil, fresh eggs, and abandoned eggs were collected at random for hydrocarbon analysis. Results of these samples will be reported elsewhere. All marked burrows were examined to determine the presence of adults, eggs, or chicks.

The proportion of active (egg or chick present) burrows was recorded for comparison with data from prior years, and the percentage of burrows still active during late August and early September was used as an index to reproductive success. The wings of chicks were measured 29 August to 3 September to estimate approximate hatching dates for comparisons with past years.

RESULTS

Burrow Occupancy

In 1989, about 65% of the marked burrows in study areas contained eggs (Table 1). This rate of occupancy was higher than prior to the oil spill when rates ranged from 36% to 52% (Table 1).

Timing of Nesting Events

Eggs began hatching as early as 24 June in 1989, and we estimated the median hatch date was about 19 July (Table 2). Fork-tailed storm-petrels have an incubation period of about 50 days (Boersma et al. 1980); so laying must have begun about 5 May and peaked in late May. The timing of nesting events in 1989 was within the range recorded prior to the spill (Table 2).

Reproductive Success

During our survey in August and September 1989, we found chicks in about 42% of the burrows that had contained eggs or chicks in July. Most chicks were at least 30 days old. This index to productivity was similar to the average for past years (Table 3).

DISCUSSION

Boersma et al. (1988) pointed out that storm-petrels are attracted to both natural and unnatural oil slicks, and these birds ingest and feed to their chicks petroleum products (Boersma

1986a). Effects of petroleum on Leach's storm-petrel (*Oceanodroma leucorhoa*) included dysfunction of the endocrine system (Peakall et al. 1981) and reduced reproductive success from external oiling of adults (Butler et al. 1988). Ingestion of crude oil reduced hatching success of Cassin's auklet (*Ptychoramphus aleuticus*) (Fry and Lowenstine 1985), wedge-tailed shearwater (*Puffinus pacificus*) (Fry et al. 1986), and great black-backed gull (*Larus marinus*) (Miller et al. 1978) by inhibiting yolk formation, causing abandonment, or causing embryos to die.

Nevertheless, Boersma et al. (1988) predicted that storm-petrels are less affected than most birds by ingesting petroleum because they normally ingest natural long-chain hydrocarbons which are similar to fossil fuel hydrocarbons. Yet fork-tailed storm-petrel chicks usually are fed aliphatic oils, and crude oil contains a number of toxic compounds not present in storm-petrel stomach oils (D.M. Fry, pers. commun.). Boersma et al. (1988) found no adverse impacts on growth rates of fork-tailed storm-petrel chicks dosed with crude oil. Trivelpiece et al. (1984) suggested that there are differences in sensitivity to toxicants among species, and Peakall et al. (1980) pointed out that since different types of crude oil have different compositions, effects on birds vary depending upon the source.

If storm-petrels are as prone to ingest petroleum from slicks as suggested (Boersma 1986), a number of birds nesting on East Amatuli must have ingested crude oil in 1989 since the *T/V*

Exxon Valdez slick passed East Amatuli in April (Galt et al. 1991), and probably remained in the area well into the summer, as beached oil was washed back into the sea. Unfortunately, we were not able to study more factors that might have tested how storm-petrels reacted to the presence of so much oil in their environment. Nevertheless, the information we have suggest there was no obvious adverse impacts on breeding schedules or productivity.

Following the spill, common murres (Uria aalge) experienced delays in the onset of nesting (Nysewander et al. 1992). In contrast, our information suggested that egg laying for fork-tailed storm petrels was within the normal range in 1989. The suspected reason for the delayed phenology in murres was that a substantial proportion of the experienced breeding population of murres may have been killed directly by the oil (Nysewander et al. 1992). In contrast, our index to population trends for storm-petrels, i.e., burrow occupancy rates, suggested no population decline resulting from the oil spill. These differences in adult mortality might explain differences in the effects of the oil spill on nesting phenology.

We failed to measure chick growth rates of fork-tailed storm-petrels in 1989, so we were unable to test for an effect of the oil spill. As indicated above, Boersma et al. (1988) found no adverse impacts of ingestion of small doses of crude oil on fork-tailed storm-petrel chick growth, but ingestion of crude oil has reduced chick growth rates in other seabirds. For example,

herring gulls (*Larus argentatus*) (Peakall et al. 1982), black guillemots (*Cepphus grylle*) (Peakall et al. 1980), and Leach's storm-petrels (*Oceanodroma leucorhoa*) (Trivelpiece et al. 1984) all exhibited reductions in chick growth rates following ingestion of oil. Apparently the oil did not directly affect chicks, at least for Leach's storm-petrel, since direct dosing of chicks did not reduce growth rates. Instead, the implication was that the ability of the adults to secure or transfer food was impaired.

CONCLUSIONS

Despite the likelihood that fork-tailed storm-petrels ingested oil following the *T/V Exxon Valdez* oil spill, we found no evidence that populations declined or that reproductive performance was impaired.

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Table 1. Proportions of fork-tailed storm-petrel burrows that were active (i.e., contained an egg or a chick) at East Amatuli Island, Barren Islands, Alaska, before and after the *T/V Exxon Valdez* oil spill.

Year	Total Burrows Sampled	Proportion Active	Reference
1985	512	0.52	Nishimoto et al. 1986
1986	527	0.42	Nishimoto et al. 1987
1987	519	0.36	Nishimoto and Beringer 1988
1988	540	0.55	Nishimoto and O'Reilly 1989
1989	552	0.65[a]	This study

[a]Chisquare = 108.2 ($P < 0.001$) for H_o: No differences among years; Chisquare = 80.98 ($P < 0.001$) for H_o: 1989 = other years combined.

Table 2. Hatch dates for fork-tailed storm-petrel eggs at East Amatuli Island, Barren Islands, Alaska, before and after the *M/V Exxon Valdez* oil spill.

Year	Date of First Chick	Median Hatch Date	Reference
1976	24 June	27 July	Manuwal 1980
1977	5 July	18 July	Manuwal 1980
1978	9 June	29 July	Manuwal 1980
1979	23 June	24 July	Manuwal 1980
1985	10 July		Nishimoto et al. 1986
1986	25 June		Nishimoto et al. 1987
1987	>27 June	mid-August[a]	Nishimoto and Beringer 1988
1988	24 June[a]		Nishimoto and O'Reilly
1989	24 June	19 July[a]	This study

[a]Estimated from wing chord measurements of chicks.

Table 3. Indices to productivity of fork-tailed storm-petrels at East Amatuli Island, Barren Islands, Alaska, before and after the *T/V Exxon Valdez* oil spill.

Year	Total Burrows Sampled[a]	Chicks/ Active Burrow	Reference
1976	49	0.29	Manuwal 1980
1977	100	0.49	Manuwal 1980
1978	85	0.68	Manuwal 1980
1979	80	0.20	Manuwal 1980
1985	257	0.44	Nishimoto et al. 1986
1987	188	0.26	Nishimoto and Beringer 1988
1988	298	0.55	Nishimoto and O'Reilly 1989
1989	364	0.42[b]	This study

[a]Only burrows with eggs during 1st check were examined for success during 2nd check.

[b]Chisquare = 0.204 (P = 0.652) for H_o: 1989 = other years combined.

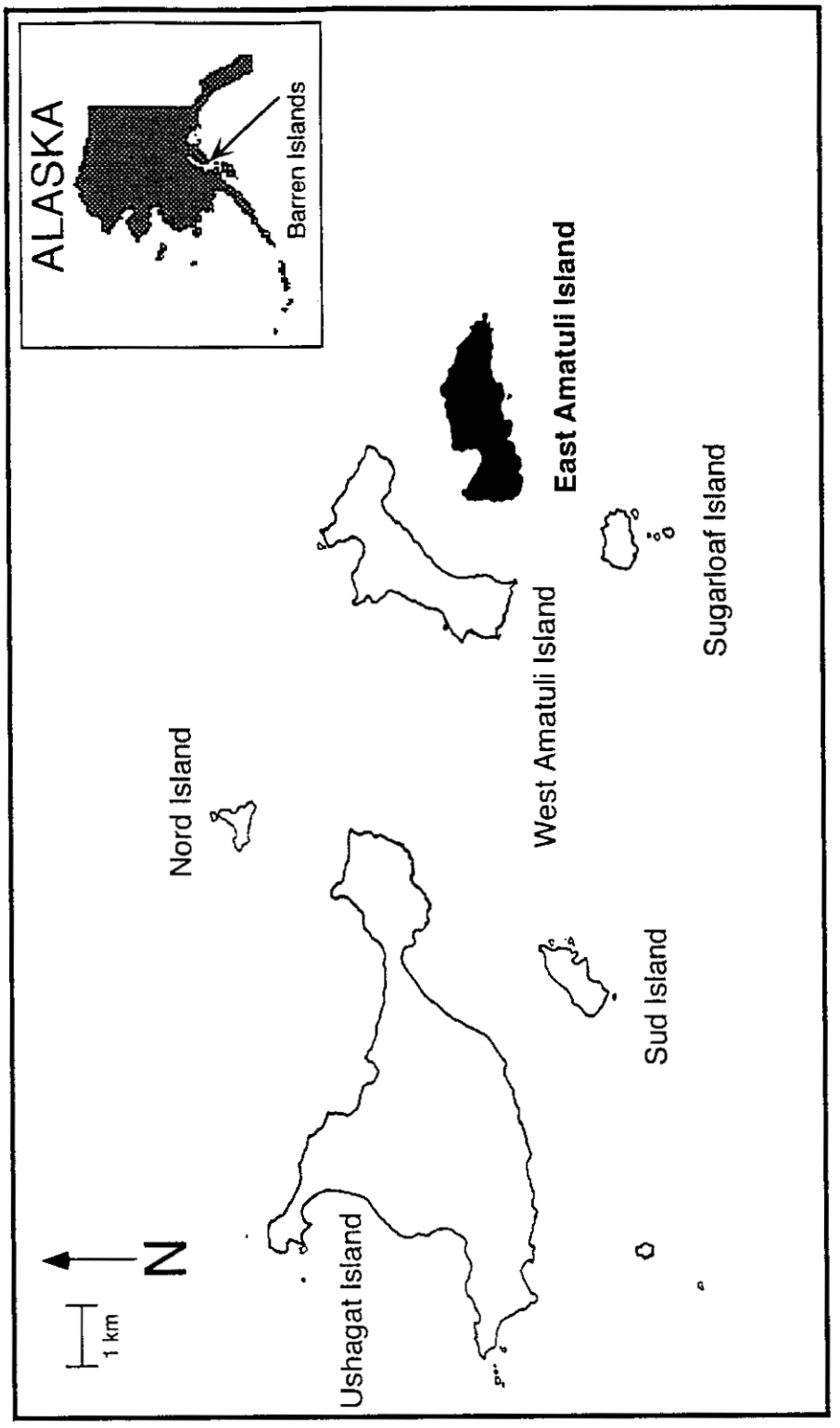

Figure 1. Map of the Barren Islands, Alaska, showing the location of East Amatuli Island, Barren Islands, Alaska.