NORTH PACIFIC RESEARCH BOARD PROJECT FINAL REPORT

COASST Alaska—A Beached Bird Monitoring Program

NPRB Project 732 Final Report

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September 2009

Abstract

Nearshore ecosystem health is increasingly threatened by the myriad human activities and their consequences, including harvest, pollution, and climate change. The Coastal Observation and Seabird Survey Team (COASST) is a beached bird monitoring program that trains citizens to survey beaches monthly and collect data in a standardized, rigorous manner. COASST data (species identification) are independently verifiable, and are used in both science and natural resource management. In this project, COASST was maintained in six (St. Paul, St. George, Cold Bay, Seward, Homer, Sitka) communities and extended to eight others (Kenai, Kodiak, Juneau, Ketchikan, Shishmaref, Nome, Unalaska, Dillingham). Between September 2007 and June 2009, COASST conducted 14 training sessions, 7 volunteer outreach events, and continued or established relationships with 16 partner organizations. Over the duration of projects 612 and 732, more than 190 participants were recruited to survey 53 year-round and 21 seasonal beaches. Preliminary data indicate that beaching patterns in Alaska are manifestly different from those in the California Current System. No Alaskan region has deposition as high as that recorded along the Pacific Northwest outer coast. In the Bering Sea and Aleutian Islands – regions with the highest carcass encounter rates in Alaska - peak deposition occurs in late summer, with no observable winterkill signal. Deposition in southeast Alaska was virtually non-existent. By contrast, peak deposition in temperate regions occurs during the post-breeding season (for local breeders), and during the winter and early spring (for migrants, including Alaskan breeders such as northern fulmars).

Key Words: seabirds, monitoring, ecosystem indicators, citizen science, community-based science

Citation: Parrish, J.K. 2009. COASST-Alaska: A comprehensive monitoring program for coastal ecosystem health. North Pacific Research Board Final Report 732, 35p.

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Study Chronology

September 2007

Training and refresher sessions (Homer)

Training session (Dillingham)

Training session (Soldotna)

Volunteer social (Homer)

January 2008

www.COASST.org website updated: program, region, beach stats in testing phase

Alaska Marine Science Symposium (Anchorage)

March 2008

COASSTLine newsletter mailed out

Training and refresher sessions (Seward)

May 2008

Outreach at the Kachemak Bay Shorebird Festival (Homer)

Alaska Maritime National Wildlife Refuge seasonal field crew training (Homer); initiated third season of data collection on beaches in the Aleutian Islands

Training and refresher sessions (Homer)

Volunteer socials (Homer, Kenai)

June 2008

COASSTLine newsletter mailed out

Presented at World Ocean Day (Juneau)

COASST volunteer calls (to ~110 volunteers)

July 2008

Submitted NPRB progress report

September 2008

Training and refresher sessions (Seward)

Training and refresher sessions (Homer)

COASST volunteer socials (Homer, Kenai)

Training session (Sitka)

Training session (Juneau/Douglas/Auke Bay)

November 2008

OSU Research Advances in Fisheries, Wildlife and Ecology Keynote (Corvallis, OR)

Northwest Fisheries Science Center Seminar (Seattle, WA)

January 2009

www.COASST.org website updated: test site for searchability developed

Alaska Marine Science Symposium (Anchorage)

Submitted NPRB progress report

March 2009

Kachemak Bay Science Conference (Homer)

University of British Columbia Fisheries Centre Seminar (Vancouver, BC)

April 2009

COASST Reports mailed out

University of Alaska School of Fisheries and Ocean Sciences Seminar (Fairbanks)

Oregon Institute of Marine Biology Science Seminar (Coos Bay, OR)

Training session (Nome)

Training session (Shishmaref)

Bering Sea Days environmental education event (St Paul Island)

May 2009

Training session (Kodiak)

Volunteer socials (Homer, Kenai)

Check-in with staff at the Alaska Maritime National Wildlife Refuge in preparation for summer field season; initiated fourth season of data collection in the Aleutian Islands

June 2009

Beached Birds, Alaska final layout and content delivered to printer

COASST volunteer calls (to ~140 volunteers)

July 2009

COASSTLine newsletter mailed out

September 2009

Beached Birds, Alaska shipped from printer

Submitted NPRB final report

Objectives

The linked objectives of NPRB Project 732 were to sustain beached bird data collection and community partnerships developed under project 612 (St. Paul, St. George, Cold Bay, Seward, Homer, Sitka) communities and expand to new locations (Kenai, Kodiak, Juneau, Ketchikan, Shishmaref, Nome, Unalaska, Dillingham). With two years of additional data and expanded geographic coverage, the goal of this project was to create an Alaska-wide nearshore monitoring program and increase our ability to track migratory patterns of northern seabird species known to winter in the CCS.

For this project, the continuation of pilot project 612, major milestones included:

- Adapt COASST protocol and field guide, publish *Beached Birds-Alaska*
- Maintain and expand partnerships (tribes, environmental organizations, state and federal agencies, community and environmental education centers)
- Expand data collection (within current communities, new communities)
- Dissemination of COASST information and results (website, *COASST Reports*, *COASSTline*, outreach materials, scientific talks and lectures)

Introduction

Ecosystem Health and Long-term Monitoring

National recognition of the need to address the intersection between human use of the marine environment and the ability to maintain healthy marine ecosystems has led to calls for better and more available science, and an ecosystem approach (USCOP 2004, Pikitch et al. 2004). It is obvious that most coastal systems are subject to some amount of pressure from human activities and/or their consequences, including fishing, pollution, anthropogenic climate change, and disturbance (Harley and Rogers-Bennett 2004, Williams 2006, Wiese and Ryan 2003). Marine ecosystems are also affected by natural forces such as climate variability and changes in biological interactions (e.g., predators, invasive species, disease; Jones et al. 2005, Ross 2002). However, it is not known which pressures are crucial to provoking change (Harley and Rogers-Bennett 2004). In fact, although some components of the marine ecosystem are monitored extensively due to the relative ease of remote monitoring (e.g., sea surface temperature), or high commercial or legal value (e.g., target species of fisheries, endangered species), the status and health of most species are only loosely known, and the complexities of ecosystem interactions are almost never known (Harley et al. 2006, De Jonge et al. 2006).

Two of the central difficulties of ecosystem-based management are the seeming necessity to monitor many aspects of the environment simultaneously, and the reality of limited effort capability of resource management agencies (Pikitch et al. 2004, USCOP 2004). In Alaska, these issues are magnified by the spatial extent of the State, as well as a myriad of known forcing factors, including: pollution (Piatt et al. 1990), changes in top predator dynamics (Estes et al. 1998, Springer et al. 2003), shifting climate and its impacts (Overland et al. 2001, 1999, Hare et al. 1999), and fisheries (Cornick et al. 2006, Dillingham et al 2006).

One potential solution to the growing need for comprehensive monitoring is public involvement. The U.S. Commission on Ocean Policy pointed to the need to increase ocean education, public awareness, and a sense of stewardship for marine resources - in essence, getting the public more substantively involved in marine science and resource management. This realization, that citizens can – and should – play an essential role in ocean governance and natural resource management and conservation is relatively new, and diverges from traditional 'top-down' management (Danielsen et al. 2005, Brossard et al. 2005).

Citizen science is one realization of public involvement.

What is collectively referred to as citizen science may vary from programs in which participants are actively doing something to change the environment (e.g., planting a tree or cleaning up trash), to those in which participants are using the deductive scientific process to collect data according to standardized protocols (Brossard et al. 2005), either in a single or short-term "bio-blitz" (e.g., Delaney et al. 2008) or as a longterm commitment to collect standardized information over a regular (e.g., monthly) interval (Litle et al. 2007). Many studies have indicated that well-trained non-experts can collect numeric data of equal quality to experts (Galloway et al. 2006, Schnoor 2007). High quality assurance – quality control (QAQC), allowing independent verification of data collected by citizens, is also crucial to 'buy-in' by scientific and management communities (Litle et al. 2007). Finally, implicit in the citizen science contract is the need for scientists to create the larger picture and provide those results back to the data-collecting communities (Cooper et al. 2007) in open, transparent form so that all community members can fully engage in an inquiry-based process of scientific discovery (Lakshminarayanan 2007). In this report, we specifically refer to ***rigorous citizen science*** as a *partnership between scientists and citizens to collect, verify, analyze, and report high-quality data of direct relevance to scientific understanding of system processes and function, and natural resource management and decision-making.* At its best, rigorous citizen science allows the participant to (1) experience deductive scientific reasoning and scientific data collection, (2) indirectly experience data analysis, (3) 'see' the data through to use in scientific and resource management contexts, and (4) make an individual decision about whether to use scientific program outcomes for further personal action.

Seabirds as Indicators of Marine Environmental Health

Marine birds have been suggested as environmental indicators because they are extremely abundant (e.g., nearly 100 million individuals of over 75 species occur regularly in Alaska; Byrd et al. 2005); collectively they feed across multiple trophic levels and are found across all coastal, nearshore, and offshore habitats; and individual species are especially sensitive to specific physical, biological, and/or anthropogenic forcing factors (Springer et al. 1996, Oedekoven et al. 2001, Carney and Sydeman 1999). In coastal systems, seabirds have been used to assess the effects of ocean productivity and climate change on nearshore ecosystems (Aebischer et al. 1990, Ainley et al. 1995, Jahncke et al. 2008), presage the collapse of fisheries (Montevecchi 1993) and bound the intensity of fishery extraction (Roth et al. 2007), document changes in predator-prey interaction where one or the other is threatened or endangered (Parrish et al. 2001, Roby et al. 2003) and detail the effects of hunting (Zador et al. 2006), ocean pollution (Burger 1993, Jarman et al. 1996, Blight and Burger 1997), harmful algal blooms (Scholin et al 2000), introduced species (Gaston 1994, Hobson 1999, McChesney & Tershy 1998) and disturbance (Carney and Sydeman 1999). When monitored as a group, the occurrence, abundance, species and age-diversity of marine birds can reveal basic information about forcing factors affecting marine ecosystem health (Furness and Camphuysen 1997, Furness and Greenwood 1993).

Because the expense and human effort required to comprehensively monitor Alaskan seabirds is large, such an effort is not possible outside of already budgeted programs and more specific short-term research-driven efforts. However, unlike monitoring of other upper trophic species (i.e., marine mammals), marine birds can be monitoring via beach-cast carcasses. Beached bird surveys are most often cited as a mechanism to create baselines against which sudden increases in mortality can be assessed. Many programs have been started in response to the threat, or actuality, of oiling events, both catastrophic and chronic (Flint et al. 1999, Burger 1993). Worldwide, beached bird survey data have been used to provide data on *oiling rates* (Stenzel et al. 1988), detect changes in *bycatch of fisheries* (Forney et al. 2001, Hamel et al. 2009), indicate mortality events associated with *biotoxins* (Scholin et al. 2000, Jessup et al 2009), and examine *climate impacts* (Bodkin and Jameson 1991, Parrish et al. 2007). Beached bird surveys have also been used to document wrecks, or mass strandings of a particular species, as a means to infer the status of local/regional ecosystem health (Camphuysen et al. 1999). Other than obvious anthropogenic causes (e.g., oil spills, Van Pelt and Piatt 1995; bycatch mortality, Robins 1991), wrecks have been associated with declines in forage fish food supply, where the exacerbating factor is poor weather (Camphuysen 1992) leading to starvation.

Several beached bird survey programs exist along the West Coast of North America, including BeachCOMBERS (11 sites ringing Monterey Bay, CA), BeachWatch (42 sites in the vicinity of Cordell Bank, Gulf of the Farallones, and Monterey Bay National Marine Sanctuaries), and COASST (~200 sites stretching from Humboldt County, CA north to the inside waters of Puget Sound, WA). Collectively, these programs allow comprehensive monitoring of the response of marine birds within the CCS, including both species that breed locally (typified by Common Murres) and species migrating to the CCS following breeding (typified by Northern Fulmars).

In 2006, NPRB funded the Coastal Observation and Seabird Survey Team (COASST) for a one-year proof-of-concept expansion into Alaska. COASST is a citizen science program based at the University of Washington, in partnership with local and regional community and environmental groups, and state and federal agencies, that trains people living in coastal communities to gather highly rigorous and independently verifiable data on beach-cast birds, human use of beaches, and beach oiling. Based primarily in the Pacific Northwest (Washington and Oregon), COASST has had citizens on beaches collecting data since 1999, and quickly expanded to become the largest beached bird citizen science program of its kind in the world. This report details the outcomes of a second (18 month) funding cycle from NPRB to expand and stabilize COASST in Alaska, including preliminary results from COASST data.

Methods

COASST recruited participants in Alaska through targeted marketing efforts within select local communities, aided in all situations by local and regional partners (Table 1). Local advertising - including newspaper and radio announcements, posters placed by local partners at community gathering locations, and solicitation by partner organizations of their members – was tuned to particular communities (e.g., radio and postering in Homer; word-of-mouth in Kenai; pre-arranged school-based visit in Shishmaref). Potential participants were trained by COASST staff, and recruited to the program once they had begun to collect data. Participants were kept in the program with a combination of communication and outreach efforts, including print materials; the COASST website; personalized email and phone contacts; refresher trainings and social events; and annual ‘thank-you’ gifts based on participation level.

Table 1. Partner organizations of COASST Alaska and their respective contributions.

	In-kind Personnel	*Organizing Assistance*	*Monetary Support*
Alaska Maritime National Wildlife Refuge	X	X	X
Alaska SeaLife Center	X	X	
Center for Alaskan Coastal Studies	X	X	
Kenai Fjords National Park	X	X	
WWF-Bering Sea EcoRegion Program		X	X
Alaska Sea Grant Marine Advisory Program	X	X	
Keen Eye Peninsula Birders		X	
Island Trails Association (Kodiak)		X	
Resurrection Bay Conservation Alliance		X	
Seldovia Village Tribe		X	
Sitka Tribe of Alaska	X	X	
St. Paul ECO	X	X	
Kachemak Bay Research Reserve		X	
Kodiak National Wildlife Refuge		X	
Izembek National Wildlife Refuge	X	X	
Sitka Conservation Society	X	X	

In COASST, training sessions instructed participants in how to: survey beaches, find and identify carcasses, photograph carcasses, and mark carcasses individually. All data, including the specific foot morphology (foot type); culmen, wingchord, and tarsus measurements; distinctive plumage characteristics; and a dorsal and ventral photograph with a photographic ruler included for scale are returned to the COASST program office at the University of Washington, either directly and/or electronically through the COASST website (www.coasst.org). Provisional carcass identification is then independently verified by COASST personnel with specific training in marine bird ornithology. Select data are sent to taxon-specific experts outside of the COASST program for further review. COASST data are assembled and analyzed on an ongoing basis, and used by a variety of stakeholders, including local, state, and federal agencies, academic scientists, environmental groups, news media, and museums and other outreach facilities. To date, more than 80 requests for data have been filled. In addition, COASST data are presented on the website, as well as in an annual report to volunteers (*COASST Reports*). Figure 1 diagrams information flow within COASST.

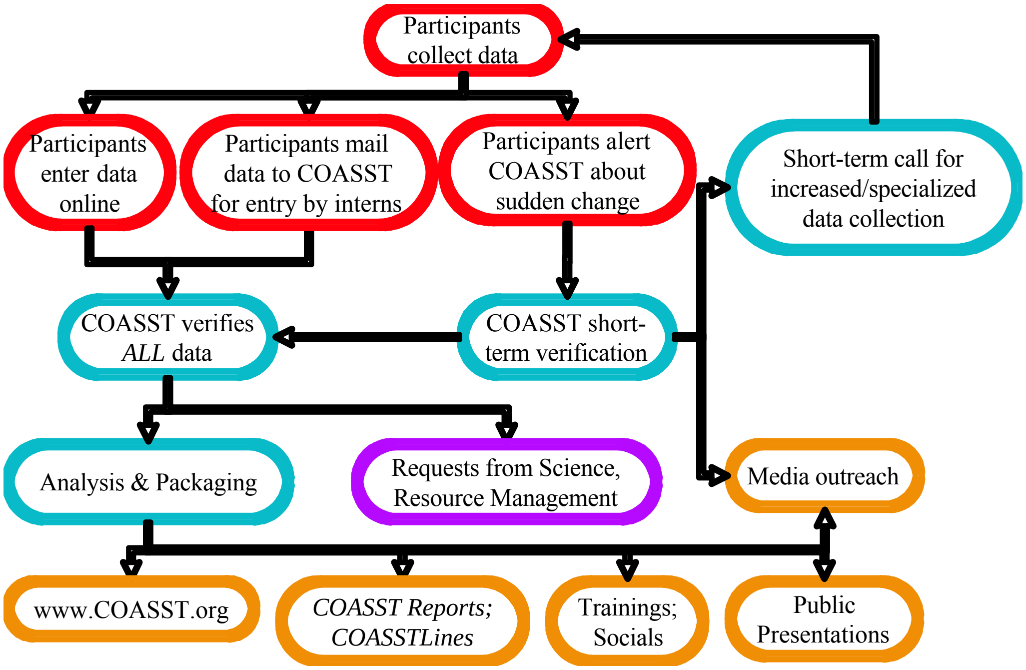


Figure 1. Information flow within the COASST citizen science program. Red – responsibility of participants, blue – responsibility of COASST staff and scientists, purple – contacts from science and resource management community outside of COASST, gold – outreach vehicles for COASST information.

To track our success at incorporating COASST into coastal Alaskan communities and Alaska-based scientific and resource-management programs, the following benchmarks were set:

- At least eight refresher and new training sessions in current locations
- At least six new volunteer training sessions in new locations
- Inclusion of at least three new locations, including at least one native community
- Publish *Beached Birds-Alaska*.
- COASST website re-design, including data query capabilities and beach-specific data summaries

Due to the extreme size and geographic diversity of the Alaskan coastline, we divided the state into four regions: Bering Sea, Aleutian Islands, Gulf of Alaska, and Southeast (Figure 2). Within each region multiple locations (settled communities, Alaska Maritime National Wildlife Refuge research islands, Kenai Fjords National Park) were chosen and participants (students; volunteers; tribal, state, and federal employees) were recruited and trained. Thus, locations each supported one or more survey beaches. In non-community locations, beaches were surveyed at least monthly, but only during the summer field season, or as seasonal access allowed. In community locations, beaches were surveyed monthly except when precluded by weather, tides, wildlife, volcanic eruption, or other factors limiting safe participant access (e.g., brown bears on the beach) and/or survey accuracy (e.g., snow covering the beach).

Encounter Rate

All COASST data (collected in Alaska and in the lower 48 West Coast outer coast regions) were converted from identified finds or refinds to a measure of overall carcass abundance – average monthly encounter rate (carcasses/km) as follows: For single monthly surveys, all newly encountered carcasses (finds) summed to a total carcass count, which was then standardized by beach length. For multiple surveys within a month, we counted all refinds found in surveys subsequent to the first, and that had been initially found and marked on the first survey of the month, as finds within that month. Total finds were then averaged over each beach. This method, while artificially ascribing carcasses to a particular month (e.g., on the first survey only new carcasses are counted), prevents the average from being deflated by multiple surveys.

Because all COASST beaches are of different length, we standardized to 1 kilometer. Most regions contained one to several short beaches (e.g., <.5km and occasionally <.25km) usually as a function of the immediate topography of the area. That is, only pocket beaches were present in the area. Because of the possibility that carcasses found on extremely short beaches would be inflated when encounter rates were standardized to 1km, monthly encounter rates were graphed, by region, as a function of beach length to assess whether inflation was occurring. Adjustments, in the form of encounter rate caps set by the upper limit of the data across beach length, were then made.

Total carcass encounter rate is reported as the average monthly value by region and COASST year (June through May), where small beach adjustments are flagged when made. To examine the role of specific species, average monthly encounter rates are presented as a function of all species, or with specific subsets of species removed. To compare the annual pattern of deposition across years and regions, we transformed average monthly encounter rates into percent of maximum month within each COASST year and regraphed the data. This standardization focuses on whether peak-to-trough pattern within year is similar among years within region, and across regions.

Finally, to examine spatial patterns of carcass occurrence, we focused on a single Alaska species common throughout COASST beaches, northern fulmars. Data are similarly presented as percent of maximum month within region, where all years (region-specific program inception through 2008) have been

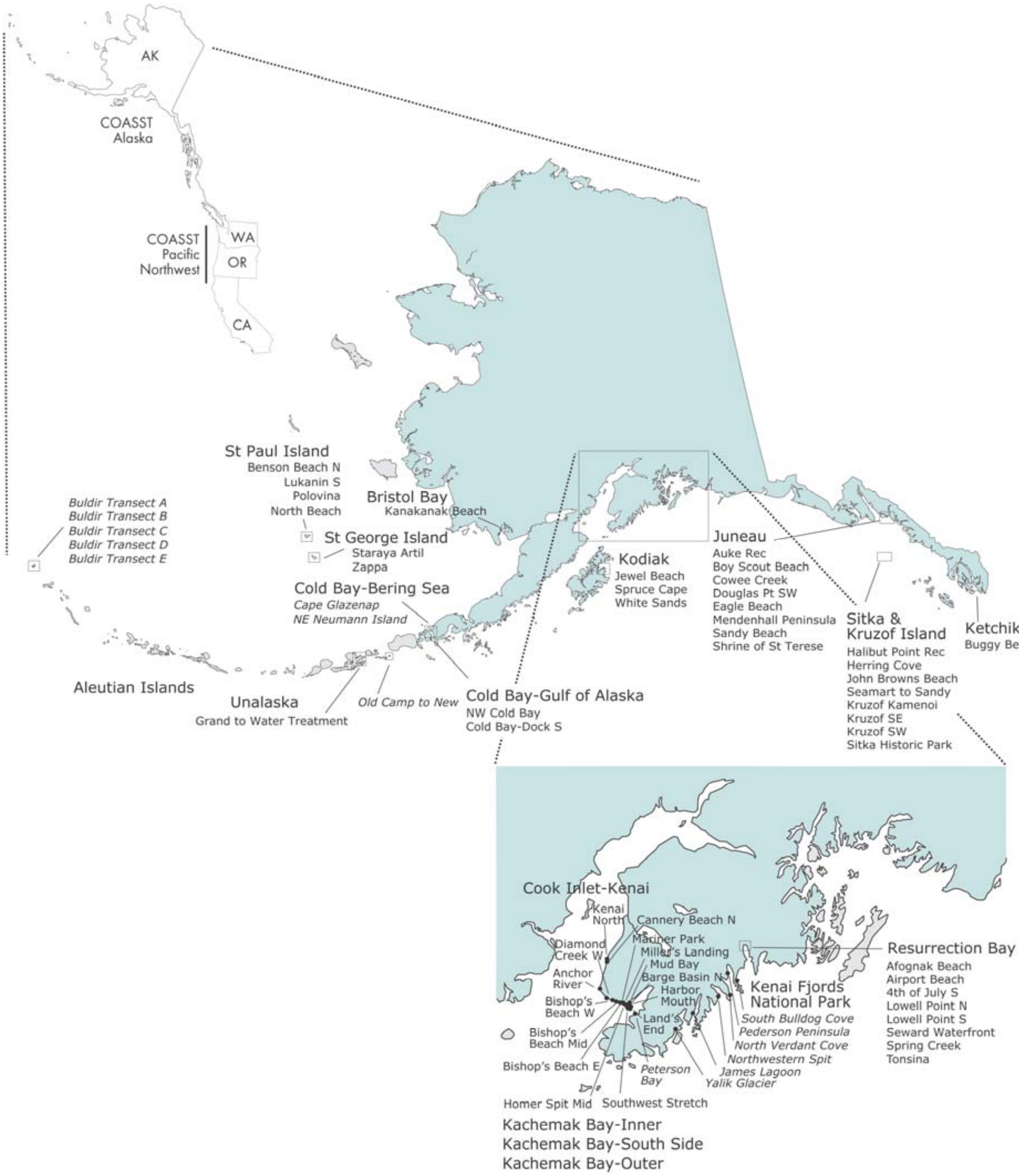


Figure 2. Map of COASST Alaska sites as of June 2009.

collapsed into a single value re-standardized to 100%. For this analysis, data from BeachCOMBERS Monterey Bay sites were also used, courtesy of Hannah Nevins and Jim Harvey.

Sampling

To examine whether observed annual pattern was a function of effort, we examined monthly sample size (that is, surveys/month) and also compiled data on attempted but failed surveys, both time of year, as reason.

Species Composition

Across all carcasses found, we report confirmed identification to the lowest possible taxon (usually species) as a function of region. Species are further classified by breeding status (local breeder, migrant to Alaskan waters).

Results

Program Expansion

Started in 1998, COASST now supports more than 500 volunteers monitoring over 300 coastal sites. In its last year of operation, COASST volunteers conducted more than 3000 surveys, walked more than 13,000 kilometers, and found more than 2,500 carcasses of 80 different species. Cumulatively, COASST has collected data on more than 18,500 carcasses. COASST volunteers range in age from 19 to 88 and represent a broad spectrum of the population.

In Alaska, COASST conducted 14 training sessions from September 2007 through June 2009, recruiting more than 100 additional participants to the program. During this time period, COASST participants conducted 720 surveys on 68 beaches (53 year-round, 15 seasonal), covering more than 1500km (round-trip) in more than 700 survey hours. Two hundred and fifty eight carcasses were recorded. In total, COASST Alaska has conducted 35 training sessions in Alaska and recruited close to 150 people to the program (Table 2).

In part as result of known species differences, and given early results as to persistence of identifiable body parts (covered in #612 report), COASST created an Alaskan-specific field guide – *Beached Birds Alaska* (Parrish et al. 2009), which is now in final production. Simultaneously, training programs and data collection protocols were modified to accommodate additional safety concerns in Alaska, including weather/exposure and animals, as well as snowfall resulting in lowered searchability. Finally, COASST significantly updated and expanded the website (www.coasst.org), adding in all Alaskan sites, and adding overall basic statistics at program, region, and beach levels. A searchable feature is still in development.

Table 2. COASST Alaska program expansion since inception.

Year	*Training Sessions*	*New Beaches*	*New Volunteers*	*Cumulative Volunteers*
2005	0	1	2	2
2006	12	43	58	60
2007	13	17	46	85
2008	7	10	74	138
2009	3+	6+	12+	140+

Partnerships have been essential to the success of COASST-Alaska (Table 1). With the COASST staff based in Seattle, we have relied heavily on the local knowledge of partner organizations and individuals for organizational assistance, including set-up and advertising of training sessions, recruiting participants, assisting in beach selection, providing a central location for COASST supplies, and acting as a local contact for participants. In addition, some partners have provided in-kind assistance in the form of staff time for COASST surveys and COASST volunteer assistance. Finally, the Alaska Maritime National Wildlife Refuge, the WWF-Bering Sea EcoRegion Program, and USFWS tribal wildlife grant program provided monetary support for COASST surveys.

Species Composition

In Alaska, COASST was able to correctly identify carcasses to species ~75% of the time. A small number of birds were misidentified. The remaining birds were either identified to a larger taxonomic grouping (e.g., large Alcids, or murres, rather than common or thick-billed murre; 13.8% of all birds), or were listed as unknown (5.5 % of all birds).

Overall, 527 carcasses nominally representing 51 species were found in 1225 Alaska surveys between August 2005 and May 2009. Alcids (138), Larids (140), and Procellariids (155) were the most abundant families, each accounting for 25-30% of the total count (Table 3). For Alcids and Larids this is not surprising, as multiple members of both families breed in Alaska. Although northern fulmars and Leach's storm-petrels do breed in Alaska, and the former represents a significant amount (11%) of the total take, Procellariids were a dominant family because of a large die-off of short-tailed shearwaters, a summer migrant to Alaska waters, particularly into the Bering Sea.

Table 3. Lowest identified taxon counts by year across all regions. Data are sorted by family and in descending order of occurrence within family. Each entry is exclusive (that is, an entry under common murre is not also entered under murres). Species groups (e.g., murres includes common and thick-billed) are right-justified for visual clarity. Within family: AL = Alcids, GR = Grebes, LA = Larids, LB = land birds, PE = perching birds, RA = raptors, PI = pigeons, GA = Gallinaceous, LO = loons, PB = pouchbills (cormorants), SB = shorebirds, TN = tubenoses (Procellariids), UNK = unknown, WB = wading birds, WF = waterfowl.

Family	*Species/group*	*0809*	*0708*	*0607*	*0506*	*Total*
AL	Murres	10	15			25
AL	Tufted Puffin	5	8	5		18
AL	Common Murre	2	12	3		17
AL	Parakeet Auklet	7	4	3		14
AL	Thick-billed Murre	6	6	1		13
AL	Crested Auklet	6	2	2		10
AL	Auklets	9				9
AL	Ancient Murrelet	3	4	1		8
AL	Puffins	2	6			8
AL	Small Alcids		3	2		5
AL	Horned Puffin	1	2	1		4
AL	Pigeon Guillemot		2			2
AL	Rhinoceros Auklet		1	1		2
AL	Cassin's Auklet	1				1
AL	Least Auklet		1			1
AL	Large Alcids			1		1
GR	Red-necked Grebe		1			1
LA	Glaucous-Winged Gull	24	16	13	1	54
LA	Black-Legged Kittiwake	21	12	11		44
LA	Large Immature Gull	5	13	1		19
LA	Kittiwakes	1	5	1		7
LA	Gulls	1	4	1		6
LA	Herring Gull	3	2			5
LA	Red-legged Kittiwake	3				3

Family	*Species/group*	*0809*	*0708*	*0607*	*0506*	*Total*
LA	Glaucous Gull		1			1
LA	Mew Gull		1			1
LB-PE	Northwestern Crow	2	4			6
LB-RA	Bald Eagle		4	1		5
LB-PI	Rock Dove		4			4
LB-RA	Peregrine Falcon		2			2
LB-GA	Ptarmigan	2				2
LB-PE	Common Raven			1		1
LO	Common Loon		2			2
LO	Red-Throated Loon		1			1
LO	Yellow-billed Loon			1		1
PB	Pelagic Cormorant	2	5			7
PB	Cormorants	1	4	1		6
PB	Red-faced Cormorant		3	1		4
PB	Small Cormorants	1	1			2
PB	Double-Crested Cormorant			1		1
SB	Bar-tailed Godwit	1				1
SB	Surfbird	1				1
SB	Western Sandpiper		1			1
SB	Partly-Webbed Shorebirds				1	1
TN	Short-tailed Shearwater	3	55	5		63
TN	Northern Fulmar	16	28	13		57
TN	Fork-tailed Storm-Petrel	5	5	4		14
TN	Sooty Shearwater	6	1	2		9
TN	Petrels	1	8			9
TN	Leach's Storm-Petrel		2			2
TN	Shearwaters	1				1
UNK	Unknown	4	5	18	2	29
WB	Sandhill Crane			1		1
WF	Canada Goose (aleutian)	1	3	1		5
WF	Brant Goose	2				2

Family	*Species/group*	*0809*	*0708*	*0607*	*0506*	*Total*
WF	White-Winged Scoter	1	1			2
WF	Common Eider	1				1
WF	Green-winged Teal			1		1
WF	Harlequin Duck	1				1
WF	Mallard			1		1
WF	Northern Pintail		1			1
WF	Surf Scoter				1	1
	Grand Total	162	261	99	5	527

As is the case in most beached bird programs, several species, or species pairs (e.g., common and thick-billed murres) dominated, whereas a long tail of species were rarely found. When only those species or groups individually totaling in excess of 5% or greater, by region, of survey totals, an interesting pattern emerges. Not only are regional encounter rates obviously different (e.g., Southeast with only two carcasses found), but the species composition shifts majorly from region to region (Table 4).

The Bering Sea was dominated by murres, fulmars, and short-tailed shearwaters, whereas sites in the Aleutians contained a greater diversity of Alcids as well as a range of Larids. Gulf of Alaska shared glaucous-winged gulls with the Aleutians, but these sites also collected other Larid species, especially juveniles, as well as storm-petrels and a landbird: crows. Rates of carcass recovery in Southeast, while reported, are simply too low to draw conclusions.

Abundance Patterns

Three years of sampling Alaskan beaches have revealed fairly consistent patterns, both in general abundance, and in the timing of peak abundance (Figure 3). In general, participants sampling sites in the Bering Sea and Aleutian Islands typically encounter almost an order of magnitude more carcasses than do those surveying beaches in the Gulf of Alaska, and especially beaches in Southeast. For the former three regions, peak encounter rates happen in the summer through fall, with no secondary peak during the winter months (e.g. the typical winterkill reported in temperate locations). Peak deposition in the Aleutians may occur slightly earlier (June-July), but this can not currently be confirmed with certainty, as sampling at those sites is curtailed in September or October (depending on year) by the conclusion of the colony field season.

Table 4. Lowest identified taxon group as a function of region for those species representing ≥5% of total carcasses found in each region.

Species/group	*Bering Sea*	*Aleutians*	*Gulf of Alaska*	*Southeast*	*Total*
Murres	13	11			24
Tufted Puffin		17			17
Parakeet Auklet		13			13
Small Alcids		13			13
Common Murre	10				10
Glaucous-Winged Gull		25	24		49
Black-Legged Kittiwake		38			38
Large Immature Gull			10		10
Gulls			6		6
Herring Gull			5		5
Northwestern Crow			6		6
Bald Eagle				1	1
Double-Crested Cormorant				1	1
Short-tailed Shearwater	60				60
Northern Fulmar	46				46
Fork-tailed Storm-Petrel			6		6
Unknown	14		7		21
				Total	326
				Percent of All Birds Found	61.9

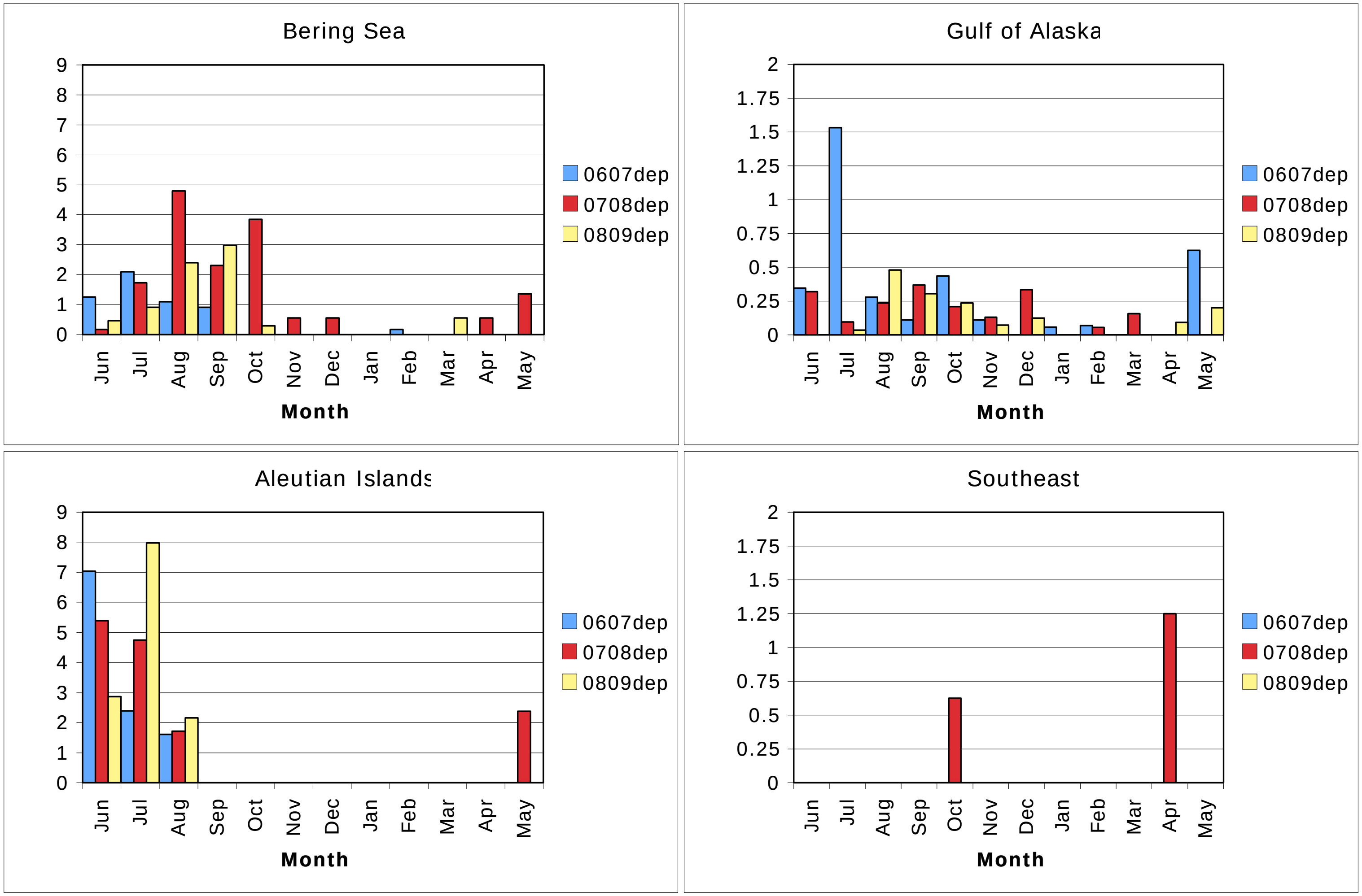
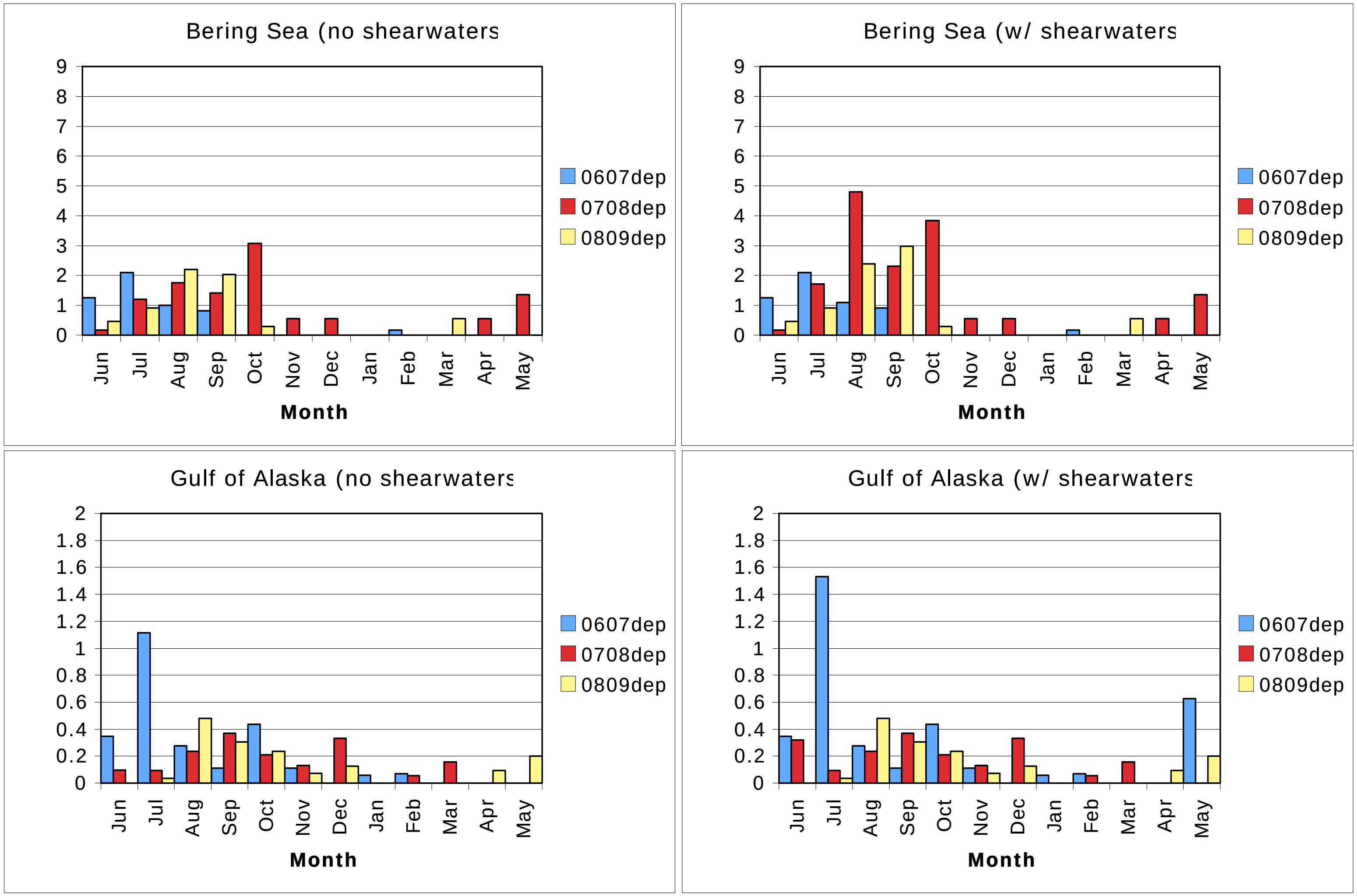


Figure 3. Monthly encounter rate (carcasses/km) average over all beaches within a region, where colors denote sequential years. Note the axis scale difference. There are no data from the Aleutian Islands November through April, as these beaches are seasonal.


Bering Sea (no shearwaters

Bering Sea (w/ shearwaters

Gulf of Alaska (no shearwaters

Gulf of Alaska (w/ shearwaters

Figure 4. Average monthly encounter rate (carcasses/km) for the Bering Sea (top row) and Gulf of Alaska (bottom row) over all species except shearwaters (left column) and ll species (right column, for comparison; a duplicate from Figure 3). Note the axis scale difference between regions.

Peak months within region*years, at least in the Bering Sea and Gulf of Alaska, are – in part – the result of shearwaters, primarily short-tailed (Figure 4). This species has been present in all years, but was particularly abundant in COASST year 2007-2008 (Table 3, Figure 4), boosting encounter rates in the Bering Sea in late summer-early fall by as much as 50%. A slightly earlier, and much smaller, shearwater die-off occurred in the Gulf of Alaska in COASST year 2006-2007 (Figure 4). Unlike many wrecks, where die-offs of a particular species occur almost to exclusion, shearwater die-offs to date on COASST Alaska beaches appear to happen in region*month*years when encounter rate is otherwise high, in general. That is, shearwaters may be a more sensitive indicator of environmental conditions affecting a wide range of species, including Alaska breeders.

Sampling Issues

Beyond the obvious seasonal aspect to sampling in the Alaska Maritime National Wildlife Refuge colony sites (e.g., Aleutian Islands, Figure 3), it is clear that monthly sampling consistently falls off during the winter and early spring (roughly December - April) in all regions (Figure 5). In the Bering Sea and the Gulf of Alaska the differential is as high as 50% of peak annual sampling.

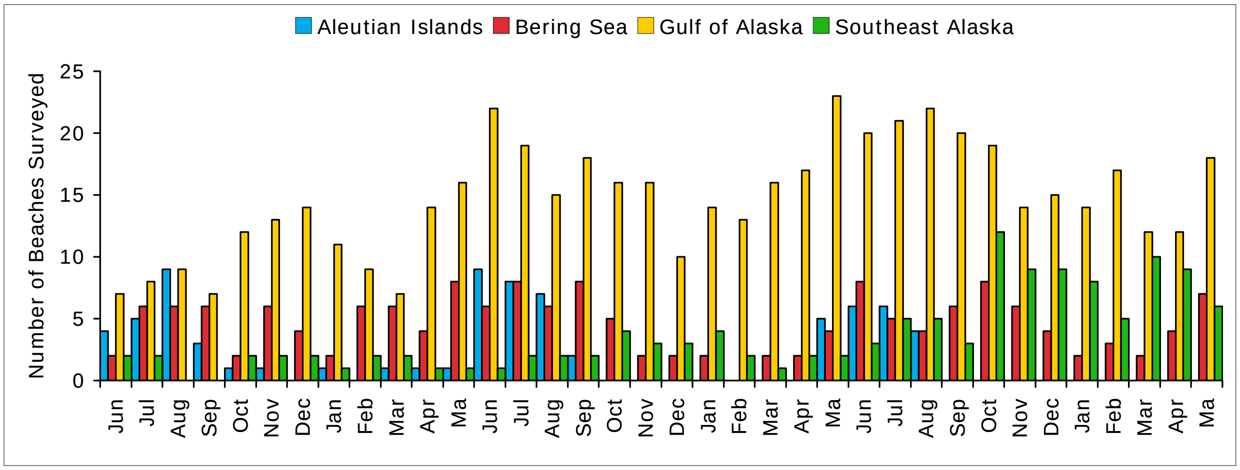


Figure 5. Seasonality of sampling in COASST Alaska. Monthly sample size, per region, from June 2006 through May 2009. Note this figure clearly shows the effects of program growth as well.

All participants attempting to survey through the winter months were asked to document beach conditions, and report any surveys attempted but failed. That is, that the participant actually went to the beach to attempt to survey. Months in which the participant simply did not survey are only recorded as a missed monthly sample. Not surprisingly, region-specific failure rates echoed the seasonal cycling in sampling reported overall (Table 5).

Table 5. Survey numbers and failure rates for attempted COASST surveys, by region.

	Total Surveys	*Succeeded*	*Failed*	*% Failure*
Bering Sea	173	164	9	5.2
Gulf of Alaska	439	414	25	5.7
Southeast	133	129	4	3

Reasons for failure were categorized into weather-based reasons, and other extreme events, where categories are non-exclusive (Table 6). Thus, extremely stormy conditions could also occur during a high tide. Of 38 survey attempts in which participants were unable to finish - or even start - their survey, the majority reason was snow and ice on the beach obscuring any carcasses present (54% of responses), followed by stormy conditions and high waves, and tides (28% of responses, respectively).

Table 6. Reasons for failed surveys, categorized by season.

	Snow/Ice	*Storm/Waves*	*Tide*	*Animals*	*Volcano*
Winter (DJF)	17	7	7	1	
Spring (MAM)	4				1
Summer (JJA)		1	2		
Fall (SON)		3	2	3	

Collectively, these data suggest that sampling beaches during late fall, winter, and early spring months in Alaska is difficult to impossible, with the potential exception of beaches in Southeast. One caveat to this is that some participants did find it possible to occasionally sample beaches during winter, especially when storms had cleared beaches of snow and ice. These samples, certainly collected under some amount of weather/climate duress, do continue to suggest that carcass deposition is truly lower during the winter relative to the late summer and early fall.

It is also possible that encounter rate could be affected by beach length, artificially inflating rates on small beaches as values are standardized to per kilometer. To address this possibility, we examined the pattern of encounter rates at the beach*month*year level as a function of beach length, by region (Figure 6). Although the Aleutian Islands did contain some small beaches, there was no appreciable inflation of rates

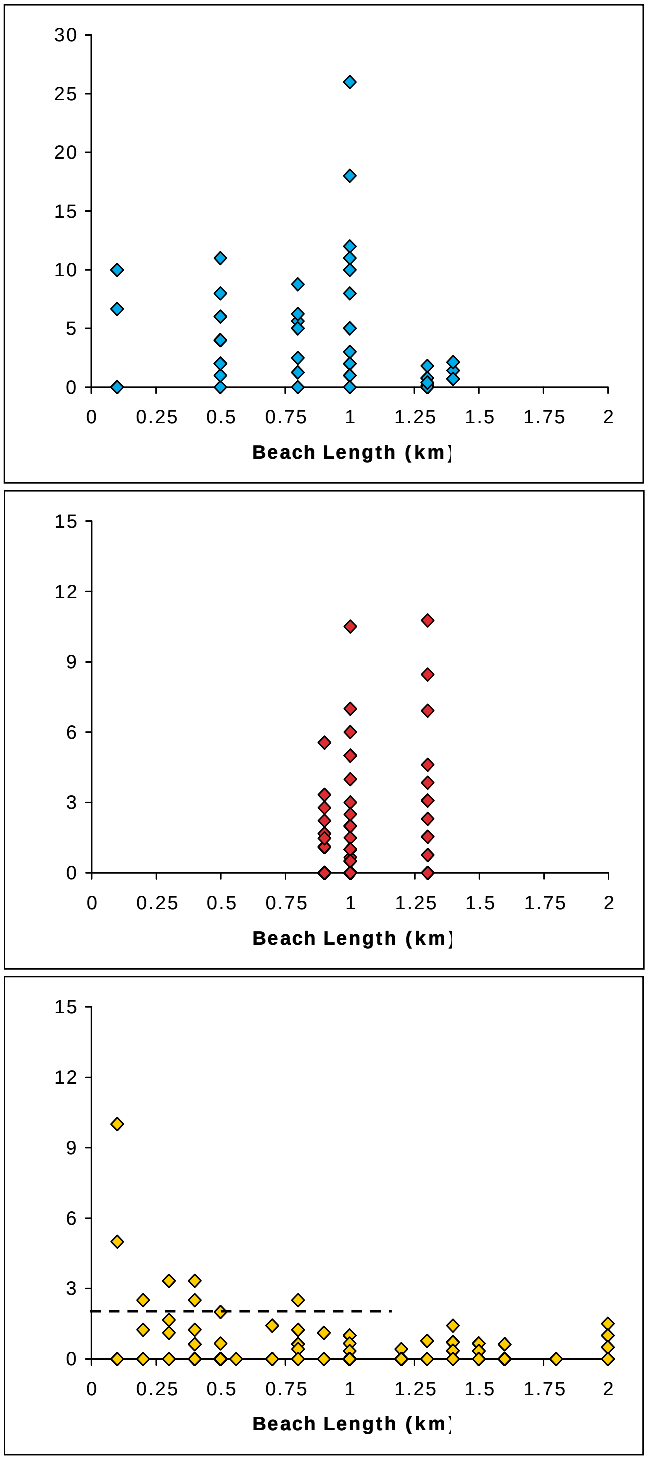


Figure 6. The association between calculated encounter rate, standardized to per kilometer, and the length of the beach. Top – Bering Sea, middle – Aleutian Islands, bottom – Gulf of Alaska. Dashed line in bottom panel indicates artificial cap used in subsequent calculations (see text).

in this region. Sites in the Bering Sea tend to be longer, on average, negating the issue. Only in the Gulf of Alaska was there evidence that rates on small beaches were artificially inflated by standardization. To combat this bias in the data, we capped rates at 1.67 (see dashed line, Figure 6, lower panel) and recalculated average monthly encounter rates. Although peak rates were certainly lower, the seasonal pattern of encounter did not change within or among years.

Inter-Region Comparisons

COASST Alaska data for the three regions showing non-trivial deposition were used as the basis for comparison with COASST regions along the outer coast of Washington, Oregon, and northern California, to determine whether the seasonal pattern in peak beaching was consistent across both space and time (Figure 7). For this analysis, encounter rate data within region*year were converted to percent of maximum month, to highlight intra-annual pattern over inter-annual and/or inter-regional (i.e., absolute abundance) pattern. For Gulf of Alaska, small beach corrected values were used. For COASST lower 48, data through COASST year 2007-2008 are presented.

In general, three sets of peaks are apparent through the COASST year, variably present from region to region (Figure 7):
Post-breeding (August-October): a signal present in all regions, with a slight tendency towards earlier months – that is, breeding season – in Alaska (see especially, Aleutian Islands). Although these peaks may include migrant species (e.g., shearwaters), the majority of this peak is locally breeding species, regardless of region.

Winterkill (November-January): a signal most apparent in Washington and Oregon, slightly accentuated in the Gulf of Alaska, and not present in either the northern (e.g., Bering Sea) or southern (e.g., northern California) extremes. This peak includes a changing mixture of species, both local and migrant to specific regions. In Alaska, the absence of a clear winterkill signal may be, in part, a consequence of compromised data due to weather (see above); however, the relatively low number of clear day, clear beach surveys during winter suggest that regular seabird deposition – at least in the Bering Sea – during this period is low to nothing. This pattern is also the case at the extreme southern end of the COASST range, in northern California and to a lesser extent in southern Oregon, and may be a function of the relatively straight and exposed coastline, affording no secure wintering areas north of San Francisco Bay. In the middle of the range, and principally off the coast of Washington, winterkill is a regular feature of the annual beached bird signal, and includes major deposition (i.e., wrecks) of a suite of species, including *migrants* (those species breeding outside of the California Current System but migrating in

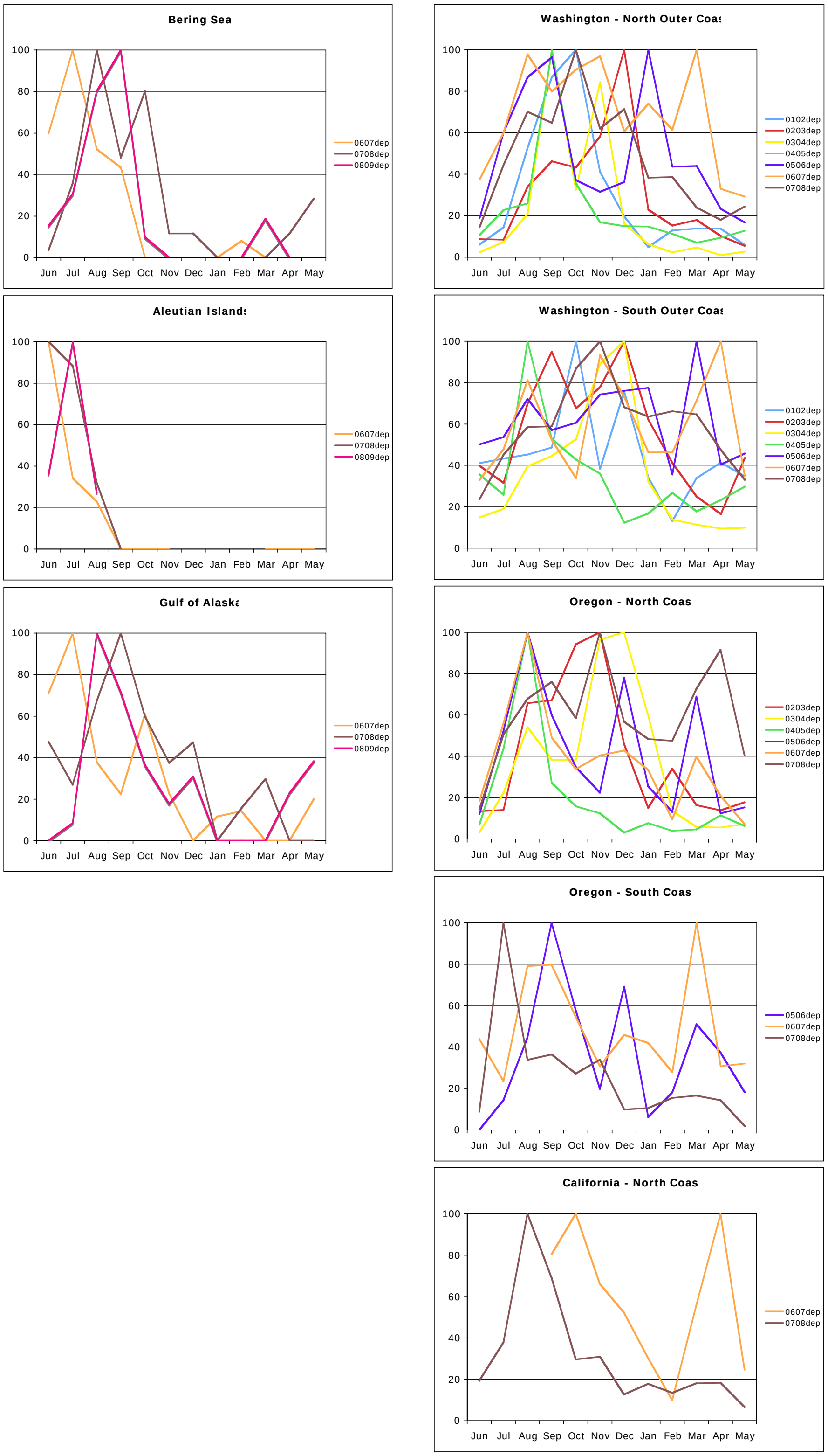


Figure 7. Regional encounter rate (carcasses/km) standardized to percent of maximum month within year.

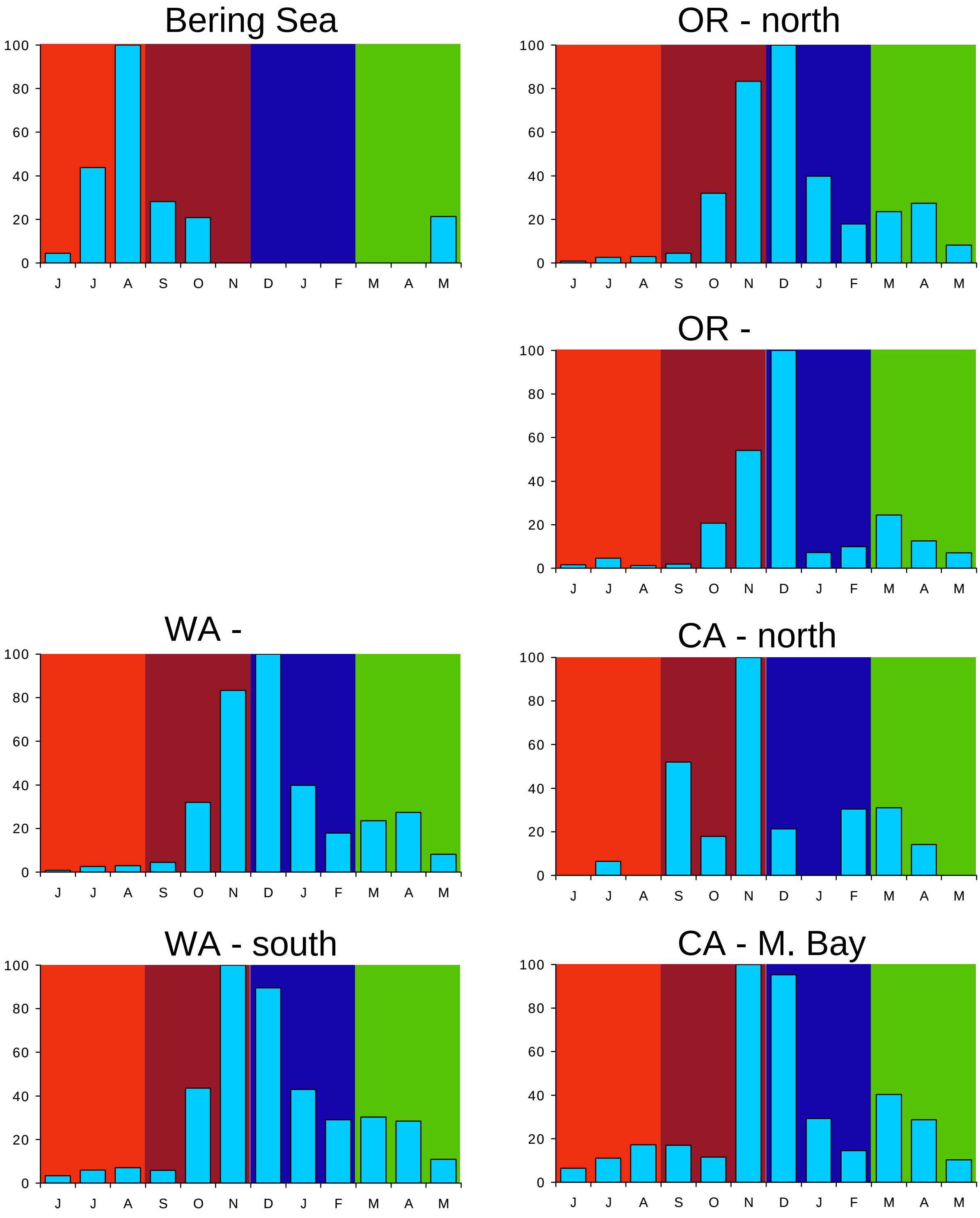


Figure 8. Regional encounter rate (carcasses/km) of northern fulmars standardized to percent of maximum month and average across all years available. Seasonal patterns are highlighted by color: orange – summer, fall – red, winter – blue, spring – green. Southernmost data (Monterey Bay provided by BeachCOMBERS courtesy of Hannah Nevins and Jim Harvey).

during the non-breeding season; e.g., northern fulmars, red-necked phalaropes, large grebes) and *breeder-migrants* (those species that do breed in California but whose population centers reside outside of the CCS (e.g., rhinoceros auklets, Cassin's auklets), and very occasionally breeders (murres, cormorants).

Spring Migration (March-April): a third peak, only occasionally present in time (i.e., from year to year) and variably present in space, falls during the period when migrants (e.g., fulmars) and/or breeder-migrants (e.g., rhinoceros auklets) are returning to northern colonies, or when southern migrants (e.g., shearwaters) are entering the Alaskan regions. Occasionally the spring peak may also be composed of local breeders, as in 2005 (Parrish et al. 2007), signaling a dramatic shift in system-wide productivity.

To examine whether these patterns were apparent in a single species, we graphed the seasonal distribution of a prominent Alaskan breeder – northern fulmars – that migrates to temperate coastal environments during the non-breeding season (Figure 8). Although it is possible that fulmars were missed in winter beaches in the Bering Sea, it is also true that this species makes up a consistently large fraction of the late summer-early fall deposition. Three-four months later, fulmar deposition peaks in the northern and central CCS, from the Olympic Peninsula in Washington south to Monterey Bay, California (Figure 8). A third, minor peak occurs during the early spring (California) through late spring (Bering Sea).

Discussion

It is clear from three years of COASST Alaska data that, although data collection is surely hampered by winter conditions, both spatial and seasonal patterns are apparent, and in the latter case, divergent from those established in the CCS. Not surprisingly, some species breeding in Alaska (and British Columbia) migrate south following breeding, which produces both a lack of winterkill peak in Alaska, and both a winterkill and occasionally spring migration peak in the Pacific Northwest. That Alaskan species migrate south is not a new finding. Recently, both Sydeman et al. (2006) using at-sea surveys, and Hatch et al. (submitted) using satellite tagging have shown, for instance, post-breeding northern fulmar migration out of the Bering Sea and Aleutian Islands and towards coastal environments in both the eastern and western North Pacific coincident with their appearance on COASST lower 48 beaches (Figure 8). Collectively, these data suggest that, as with migratory songbirds, place-based mortality is an important determinant of species survival, and can be crucial in determining conservation priorities. For instance, although northern fulmar bycatch in longline and trawl fisheries in Alaska has been documented, it is not at all clear whether this source of mortality exceeds that incurred during winterkill and spring migration.

Winterkill, including the cumulative effects of exposure, starvation, and migratory stress, is a prominent source of marine bird mortality, accounting for the majority of documented wrecks (Camphuysen et al. 1999). Clear post-breeding and winterkill peaks are apparent in temperate systems (Parrish et al. 2007, Wiese and Ryan 2003). Beaching peaks during the breeding season have, however, been reported in New Zealand (Powlesland and Powlesland 1994), and may typify higher latitude sites.

COASST Alaska data also seem to indicate that the species distribution and carcass abundance patterns across Alaskan beaches is markedly different among regions. Moving north to south, the distinct breeding-postbreeding deposition signal is lost, and a minor winter signal mainly attributable to wintering waterfowl (e.g., Gulf of Alaska, Figure 3) is picked up. What is surprising is the almost total lack of carcass deposition on beaches in southeast Alaska during winter, when elevated mortality due to exposure-starvation would be anticipated (i.e., Camphuysen et al. 1999, Parrish et al. 2007). Protected inside waters sites do sustain markedly lower deposition rates relative to more wave-exposed outer coast beaches (COASST, unpub. data), and the geomorphology of beaches in fjord-derived systems including Southeast and parts of Puget Sound – i.e., shorter width, higher inclination, larger grain size – capture absolutely fewer pieces of flotsam. Finally, the number of COASST sites in Southeast is marginal, making regional comparisons suspect. However, these early results (just over 130 attempted surveys to date) do suggest that migrating species, including Procellariids, Alcids, and Larids, skip Southeast in favor of more southern wintering locations in the CCS (e.g., Figure 7).

The extension of COASST into Alaska has allowed us to examine the entire migratory ambit of marine bird species crossing between the Alaskan and CCS large marine ecosystems, and these preliminary data suggest that deposition patterns of these species is different than that of species resident within a single system (e.g., Brandt's cormorants). In large part, the difference is the lack of a strong winterkill signal in the latter, presumably because post-breeding mortality has removed the most physiologically stressed individuals from the population. However, serious questions remain as to whether the data collected in Alaska is worth the effort required to do so.

Human settlement patterns, the demographics and socio-economics of Alaskan coastal communities, and severe winter weather especially in northern regions, combine to make beach survey programs – whether citizen or agency-based – problematic. Maintaining sample size within a region, or more correctly within a locality within region (e.g., Kenai Peninsula within Gulf of Alaska), is difficult, leaving questions about whether the data that are collected are adequate to encompass local-to-regional events (e.g., wrecks). Although COASST Alaska data within region appear so far to be fairly consistent interannually, sample size and regional site density will never approach that achieved in the lower 48. In addition, the cost of maintaining a beached bird program across Alaska is much higher than in the lower 48 as a consequence of higher travel costs combined with lower turnout at COASST training events and higher participant turnover. The latter two attributes are understandable, given the relatively small size of Alaskan communities and the relative severity of winter weather, respectively; and may limit any citizen-based program.

Conclusions

Programmatically, creating and maintaining a citizen-based beached bird program in Alaska is possible. Participants were recruited and trained, and data collection on more than 50 permanent sites initiated, for a total of over 700 completed surveys and over 500 birds found to date. To address differences in species, and in relative persistence of body parts, COASST created an Alaskan-specific guide and modified our data collection protocol to accommodate additional safety and effort concerns. Despite our current success, the relatively higher cost of maintaining a citizen-based program in Alaska calls into question the stability and longevity of COASST in Alaska.

Patterns of scavenging and persistence do not appear to be substantially different from beaches in the northern CCS (covered in #612 report), although seasonal patterns of deposition are quite different, with the major Alaskan peak occurring at the conclusion of the breeding season. For species crossing between these large marine ecosystems (e.g., northern fulmars), COASST data indicate three distinct mortality peaks annually: late breeding season in Alaska, winterkill at migratory destination, and a slight elevation during spring migration.

Publications

in prep: Parrish, JK, Nevins, H, Roletto, J, Davidson, P, Loeffel, R, Dolliver, J, Chilton, P, Lyday, S, & Harvey, J. Seasonal Patterns in Beached Bird Deposition: Establishing a Baseline (to be submitted to Marine Ecology Progress Series)

Outreach

Web page: www.coasst.org

Significant redevelopment of the COASST webpage occurred during this project, including the inclusion of all Alaskan sites, revamping the front pages, inclusion of basic statistics from all sites and regions, and a search capacity (still in development).

Conference and Academic Oral Presentations featuring COASST Alaska:
Oregon State University Research Advances in Fisheries, Wildlife and Ecology Keynote (Corvallis, OR)
Northwest Fisheries Science Center Seminar (Seattle, WA)
Alaska Marine Science Symposium (Anchorage; 2x)
Kachemak Bay Science Conference (Homer)
University of British Columbia Fisheries Centre Seminar (Vancouver, BC)
University of Alaska School of Fisheries and Ocean Sciences Wakefield Seminar (Fairbanks)
Oregon Institute of Marine Biology Science Seminar (Coos Bay, OR)

Community Meetings (including COASST trainings and COASST socials):
Training and refresher sessions (Homer)
Training session (Dillingham)
Training session (Soldotna)
Volunteer social (Homer)
Training and refresher sessions (Seward)
Training and refresher sessions (Homer)
Volunteer socials (Homer, Kenai)
Training and refresher sessions (Seward)
Training and refresher sessions (Homer)
COASST volunteer socials (Homer, Kenai)
Training session (Sitka)
Training session (Juneau/Douglas/Auke Bay)
Training session (Nome)
Training session (Shishmaref)
Training session (Kodiak)
Volunteer socials (Homer, Kenai)

Presentations at Festivals/Events:
Kachemak Bay Shorebird Festival (Homer)
World Ocean Day (Juneau)
Bering Sea Days (St Paul Island)

Acknowledgments

COASST Alaska has also been made possible by our partners (Table 1), who have contributed manpower, technical and logistical assistance, expert advice, and financial backing.

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