National Fish and Wildlife Foundation
Final Programmatic Report

Project Name and Number: Pelagic Marine Debris in the North Pacific # 2007-0088-008

Recipient Organization/Agency: Oikonos - Ecosystem Knowledge

Recipient Organization Web Address: www.oikonos.org

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Summary of Accomplishments

To quantify ingested marine debris in U.S. waters using an abundant North Pacific seabird, the Northern Fulmar, as a bio-sampler, we examined stomach contents of birds recovered as bycatch from the Bering Sea, the Gulf of Alaska / Aleutians, and beached carcasses from California. We quantified the incidence of plastic ingestion in Northern Fulmars and found a generally high level of plastic ingestion (75-80%). In addition to improving the methodology and capacity for a long-term monitoring program, this project has advanced the understanding of geographic and temporal pollution trends. The data indicated that marine debris is a continuing problem in both remote, relatively unpopulated regions (Alaska) and in areas with greater human populations (California). We found regional differences; birds sampled in California had a greater incidence of ingestion (94%) and contained more plastic by mass (89% > 0.1 g) than those sampled Alaska for incidence (63%) and mass (25% >0.1 g). Northern Fulmar plastic ingestion rates have increased in recent years in both areas; in CA-OR-WA (from 71% in 2003 to 85% in 2007) and in AK (from 62% in 2005 to 72% in 2007-08). The mass of plastics measured in this study exceed the critical value for "acceptable environmental quality objective" defined for the North Sea by EU (EcoQO target = 10% of samples contain > 0.1 g). Based on these results, we suggest the US develop and adopt an acceptable pollution level metric for the North Pacific using the fulmar as a biological monitor.

Project Activities & Results

Logic Framework:

Activities →	Project Outputs →	Post-Project Outcomes →	Indicator →	Baseline Value →	Predicted Value of Project Output →	Predicted Value of Post-Project Outcome
Quantify the incidence and type of ingested debris and compare with past studies*	Increase baseline data on marine debris occurrence in a pelagic marine bird*	Provide a tool to evaluate how waste reduction efforts are succeeding in reducing debris in pelagic regions*	% occurrence of marine debris in fulmar stomachs	AK Summer - 64%	no change	EU target is 10%

Activities

- We coordinated with NOAA Fisheries for the shipment of bycatch carcasses collected by the Fishery Observer Programs in Hawaii and Alaska.

- We evaluated beached carcass samples available from the BeachCOMBERS, and Beach Watch National Marine Sanctuary beach survey programs.

- Data confidentiality agreements were finalized to meet NOAA Administrative Order 216-100 “Protection of Confidential Fisheries Statistics”.

- We completed necropsies of 328 Northern Fulmar carcasses and collected the following information: demographics (age class, sex, breeding status), provenance (band recoveries), collection data (location, fishery), measurements of body condition (body mass, fat score, gonads), necropsy findings (injuries), food and non-food stomach contents, and disposition of specimens, tissues, and other samples.

- We hosted a week-long workshop to standardize techniques and methods with the successful program in the North Sea in September 2008.

- We conducted outreach to non-profits, school groups and presented results at scientific conferences.

Lessons Learned - Results

Seabirds and plastics

One of the main findings is that many seabird species continue to ingest floating marine debris in coastal waters of California. Of 55 species examined from CA during 2005 - 2009 (n = 1910 birds), we found plastics in 12 species, including alcids, phalaropes, storm-petrels, albatross, shearwaters and a fulmar. The Northern Fulmar (*Fulmarus glacialis;* left photo*)* was the species with the greatest incidence of plastic ingestion (75-80% of birds; right photo, stomach contents of a fulmar). During November 2007, a mass stranding of fulmars and other seabirds occurred in Monterey Bay. This event was originally called the “Santa Cruz or Moss Landing Mystery Spill” until lab analyses determined the substance was not petroleum based, but was related to proteinaceous surfactants produced by an algal bloom.

We made within and between region comparisons: the 2007 Mystery Spill samples (n = 122) were compared with fulmars collected during a winter stranding of mainly young-of-year fulmars in central CA in winter of 2003-2004 (n = 190). An additional 17 fulmars were collected by beach surveys and rehabilitation centers in the Monterey Bay area opportunistically during 2007-2009. To examine regional differences, these samples were compared with carcasses taken incidentally as bycatch in Alaska fisheries in 2007 (n = 96).

Historic Comparison – Alaskan waters

When we examined the trend in plastic ingestion among recent years compared to previous studies, we found a relatively high (>50%) level of plastic ingestion throughout the past 40 yrs. During the last three years of our study (2006-2008), we found an increasing trend in the incidence of plastic ingestion.

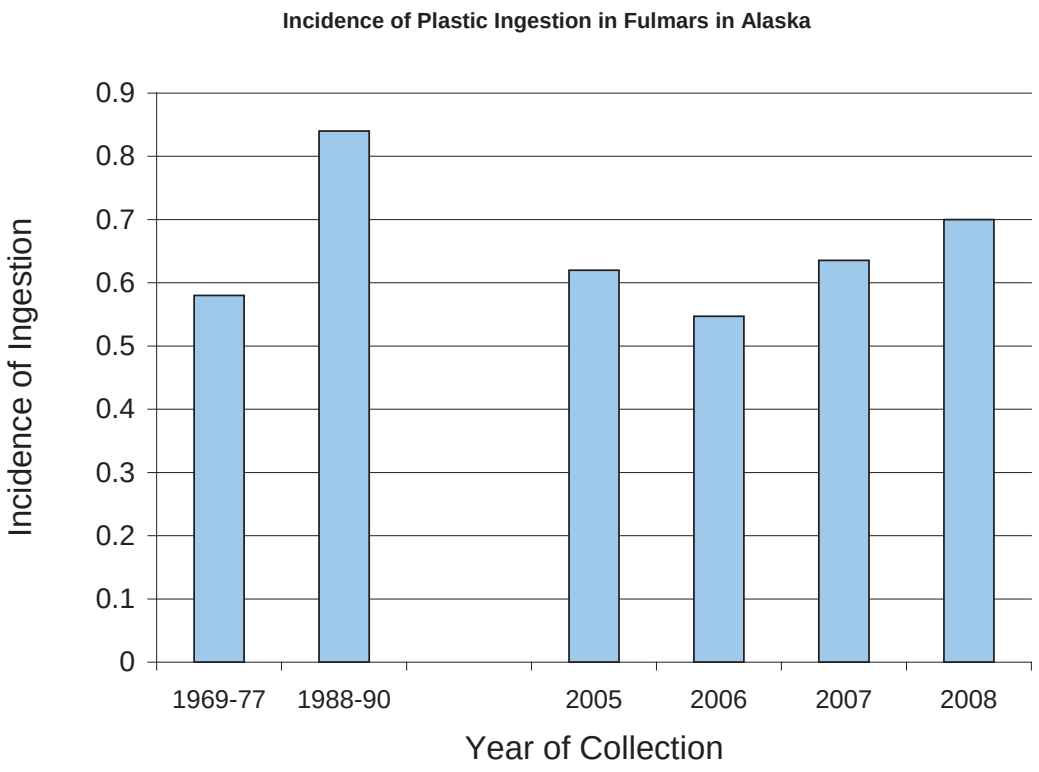

Figure 1. Comparison of the incidence of plastic ingestion of fulmars reported in the current study (2006-2008) and past studies by Nevins et al. 2005 (2005), Robards et al. 1995 (1988-90), and Day (1969-77). Incidence is the percentage of birds examined that had detectable plastic in the proventriculus and/or gizzard.

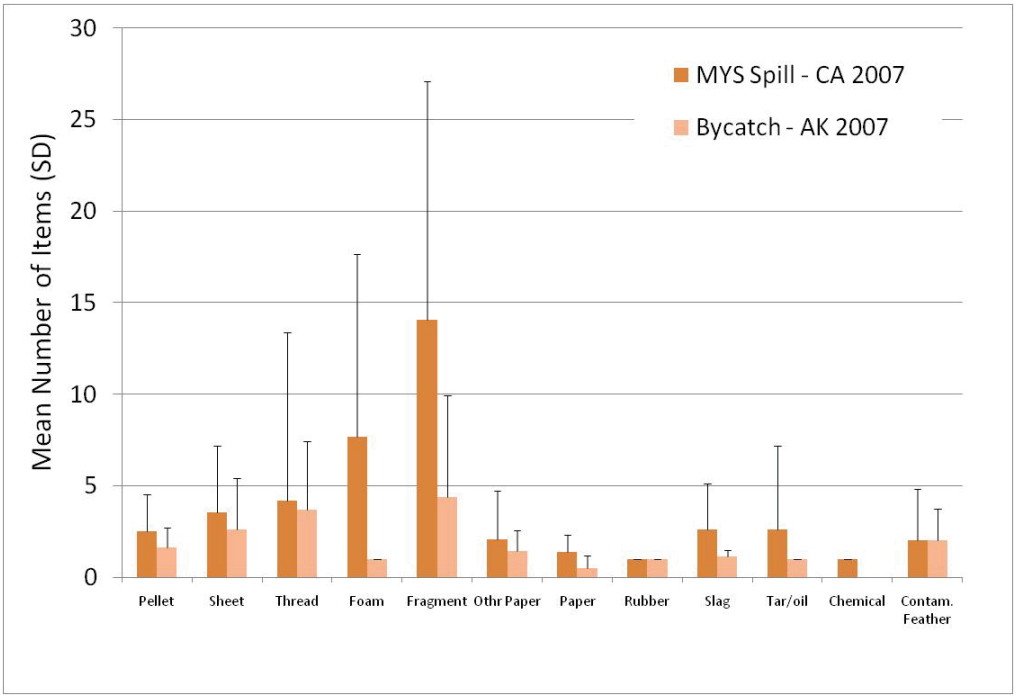

Figure 2. Comparison of mean number of plastics and other human-related items found in stomachs of fulmars collected in CA (n = 122) and AK (n = 97). Note the greater abundance of foamed and plastic fragments in CA samples, likely a reflection of land-based sources.

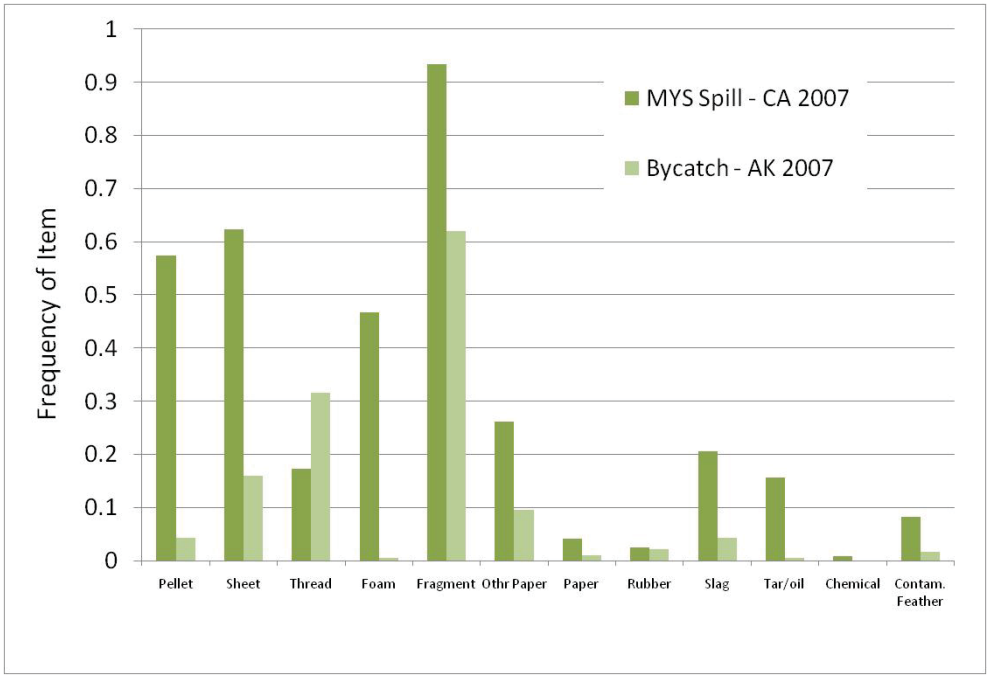

Figure 3. Comparison of the frequency of types of plastics and other human-related materials found in stomachs of fulmars in California (MYS Spill, n = 122) compared with Alaska (Bycatch, n = 97). Note the greater frequencies of most categories for CA relative to AK, except for "thread". Threads are likely derived from fishery-related rope, line and net materials.

Long-term Program Capacity

Given the vast geographic scale of the marine pollution problem, we suggest developing a network of collaborators throughout the North Pacific to monitor changes in marine debris entering the pelagic food web. We hope to do this by increasing the number of organizations measuring plastic ingestion in seabirds. We have identified the North Pacific Research Board (NPRB) as an ideal supporter of the Alaska component of this monitoring program. Through NOAA Fisheries, a collaborative team requested multi-year funding from NPRB. Three more years of data will provide rigorous results to justify the program's adoption in mandated environmental quality monitoring programs.

Dissemination

Broaden capacity

In 2008-2009, we conducted two training workshops to instruct in the proper techniques for necropsy and sample collection. This effort has increased methods standardization between more institutions: Hawaii Pacific University, Seabird Health Study-Moss Landing Marine Laboratories, University of California Santa Cruz, Algalita, Oikonos, and *Save the North Sea* consortium organizations. This project also provided research opportunities for undergraduate and graduate students at Hawaii Pacific University and Moss Landing Marine Laboratories: Erica Donnelly, Chih-Wei Chang, Andrew Titmus, and Frannie Nielsen. To raise awareness and establish partnerships, in 2009 we presented our results at two scientific conferences and four public seminars.

In an effort to standardize quantification of plastic ingestion in both the North Pacific and Atlantic, Oikonos and the Marine Wildlife and Veterinary Care and Research Center hosted a week-long workshop to standardize techniques and methods with the successful program in the North Sea managed by Jan van Franeker of IMARES in September 2008. Biologists from 7 institutions participated (see collaborators). During the workshop, participants shared results, compared methods and designed new standardized protocols to facilitate data exchange (pictured right: J. van Franeker, H. Gray, H. Nevins).

This hands-on workshop followed a September 2008 NOAA-sponsored workshop on Microplastics in Tacoma, WA. Elizabeth Phillips (Oikonos/MWVCRC) represented this study to incorporate applications using seabirds as bio-indicators.

The ultimate value of this work is to detect improvements in pollution levels as a result of multi-national efforts to reduce marine debris. Long-term funding is needed to obtain the necessary time-series.

In July 2009, we met with a consortium of non-profit organizations in Monterey to discuss educational outreach opportunities with local chapters of national organizations, including Sea Studios – Think Beyond Plastics, Monterey Bay National Marine Sanctuary, Surfrider Foundation, Save our Shores, Algalita, Sealife Conservation, Heal the Bay, Green Sangha and Earth Resource. Hannah Nevins (Oikonos) presented preliminary fulmar data and provided weblinks to Oikonos' outreach activities.

Project Personnel

- Hannah Nevins - Oikonos
- Michelle Hester - Oikonos
- Erica Donnelly, Elizabeth Phillips, Corrine Gibble - Oikonos & Moss Landing Marine Laboratories

Collaborators

- Shannon Fitzgerald & Rim Rivera, NOAA Fisheries
- Jan van Franeker, Institute for Marine Resources & Ecosystem Studies (IMARES) – North Sea Program
- Holly Gray, Algalita, Long Beach, CA
- Jim Harvey, Coastal Ocean Mammal/Bird Education and Research Surveys (BeachCOMBERS), Moss Landing Marine Laboratories
- Bill Henry, University of California, Santa Cruz, CA
- David Hyrenbach, University of Pacific, Waimanalo, HI
- Carol Keiper, Oikonos
- Jean de Marignac, Monterey Bay National Marine Sanctuary
- Maura Naughton US FWS
- Kathy Kuletz, US FWS

Project Documents

Webpage
http://oikonos.org/projects/nofu-plastic.htm

Media
2007 [Film] National Geographic's Strange Days on Planet Earth "Dirty Secrets with Edward Norton: Pollutant Soup" Interview with Michelle Hester regarding seabirds and plastics.
http://www.pbs.org/strangedays/episodes/dirtysecrets/experts/pollutantsoup.html

28 Aug 2008 [Radio Interview] David Gorn, National Public Radio interview with Hannah Nevins on plastic ingestion:
http://www.flickr.com/photos/kqedquest/sets/72157606878496245/

30 Aug 2009 [Newspaper] Editorial, David J. Terrazas: Drowning in a sea of plastic", Santa Cruz Sentinel. http://www.santacruzsentinel.com/ci_13233472?IADID=Search-www.santacruzsentinel.com-www.santacruzsentinel.com

10 Oct 2008 [Newspaper] Alia Wilson "Monarch students share clean-up exhibit with school"
http://www.scsextra.com/story.php?sid=80209

Mar 2008 [Newspaper] Good Times Article
Local newspaper story about young student activists fighting plastics in Santa Cruz. These students became irate after seeing a presentation about the effect of plastic debris on sea birds put together by Michelle Hester and Hannah Nevins of Oikonos and decided to do something

about it. This resulted in plastics display at the city museum, the city library and the marine science center.

Publications

Hyrenbach, K.D. et al. 2008. Seabirds indicate Plastic Pollution in the Marine Environment: quantifying spatial patterns and trends in Alaska. http://oikonos.org/papers/hyrenbach-Nevins-et-al-2009.pdf

Nevins et al. 2005. Seabirds as indicators of plastic pollution in the North Pacific. http://oikonos.org/papers/Nevins_etal_2005.pdf

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