National Fish and Wildlife Foundation

Final Programmatic Report

Project Name and Number: North Pacific Plastic Debris and Seabird Research

Recipient Organization/Agency: Hawaii Pacific University

Recipient Organization Web Address: http://www.pelagicos.net

Date Submitted: March 15, 2010

1) Summary of Accomplishments

In four to five sentences, provide a brief summary of the project's key accomplishments and outcomes that were observed or measured.

Collected visual observations on the concurrent at-sea distribution and abundance of marine birds and floating debris during two research cruises: a June-July crossing from Oahu to San Francisco onboard SEA's RV Robert C Seamans, and a March 2009 transect from Oahu to 36 degrees latitude N onboard NOAA's RV Oscar Sette.

Surveyed 1432 km of trackline over 36 days at-sea, and compiled sightings of 2201 birds and 1442 marine debris items using visual observations. Conducted 43 neuston surface net tows of marine debris at regularly–spaced stations and collected 4028 pieces of microdebris.

Used line transect methodologies to developed the correction factors needed to derive standardized marine debris abundance estimates corrected for varying detectability of the items (color, size, material) and changing environmental conditions (wind speed and cloud cover).

Developed a community-wide model, which related the abundance of marine debris, seabirds, and seabird prey (flying fish and flying squid) to environmental conditions. The best-fit model explained 91.4% of the observed variance, using a three-axes result.

Created species-specific models for four common species (those accounting for > 1% of all the individual birds recorded) during at-sea surveys: Black-footed Albatross, Wedge-tailed Shearwater, Murphy's petrel, Leach's Storm-petrel. While the presence of these seabird species was not significantly related to the abundance of marine debris or prey (flying fish or flying squid), three environmental variables explained their occurrence throughout the survey track: sea surface temperature (WTSH and LESP), sea surface salinity (WTSH and MUPT) and wind speed (BFAL). Overall the models performed very well, correctly assigning over 75 % of the presence / absence data (n = 145 transects).

2) Project Activities & Results

If your grant agreement included an approved logic framework, paste the logic framework table here.

The grant agreement did not include a logic framework, but there was a list of project deliverables, which we address below.

PROJECT DELIVERABLES:

A) Establish baseline of 5 years of summer plastic debris data and concurrent oceanographic data along a cruise track from Hawaii to California

OUTCOME: Achieved.

Working with our SEA colleagues, we compiled and mapped a 7-year dataset (2002 – 2008)

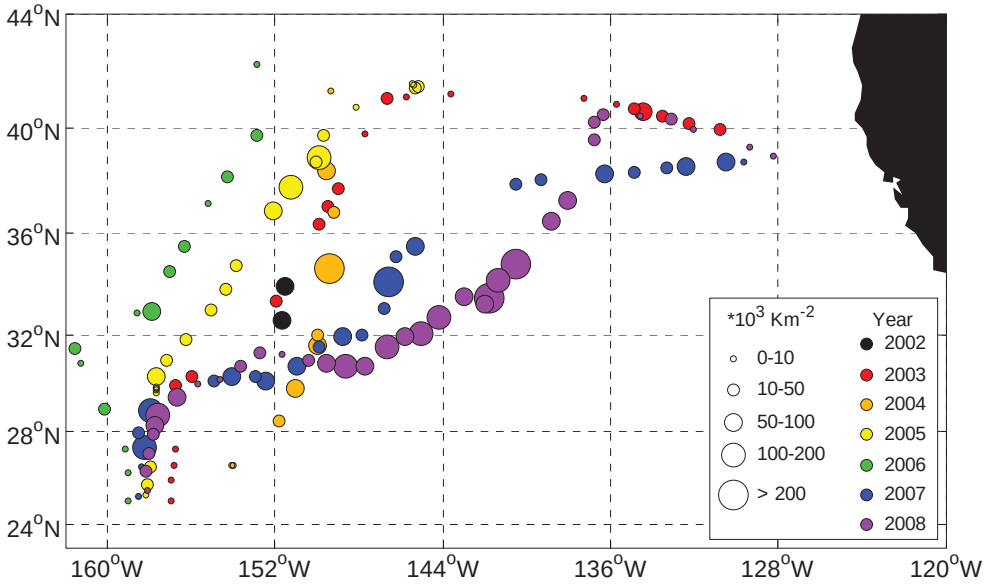

Figure 1. *Distribution of microdebris in neuston net tows, showing archived SEA data (2002-07) and samples collected during the summer 2008 cruise. Symbol size indicates debris density (pieces / km ^{2}) and color indicates year.*

B) Quantify seabird survey effort and net tows completed during the 2008-09 cruises

OUTCOME: Achieved.

Collected visual observations on the concurrent at-sea distribution and abundance of marine birds and floating debris during two research cruises: a June-July crossing from Oahu to San Francisco onboard SEA's RV Robert C Seamans, and a March 2009 transect from Oahu to 36 degrees latitude N onboard NOAA's RV Oscar Sette.

Table 1. *Surveys if macro /micro marine debris and seabird distributions during SEA cruise (June 21 - July 17, 2008).*

	Seabirds	**Macrodebris**	**Microdebris**
Method	Visual surveys	Visual surveys	Net tows
Survey days	25	25	23
Survey effort	158 1-hour transects	158 1-hour transects	43 tows
Total	2165 birds	1268 items	4028 items

Table 2. *Visual surveys of marine debris and seabird distributions during NOAA cruise (March 15-29, 2009).*

	Seabirds	Macrodebris
Survey days	13	13
Survey effort (km)	887	887
Total	136	274

C) Create predictive models relating the presence/absence and abundance of seabirds and plastic debris for the study area.

OUTCOME: Achieved.

We created two predictive models using the data collected in 2008. First, we assembled a community-wide model, which related the abundance of marine debris, seabirds, and seabird prey (flying fish and flying squid) to environmental conditions. The best-fit model explained 91.4% of the observed variance, using a three-axes result. Second, we created species-specific models for four common species (those accounting for > 1% of all the individual birds recorded) during at-sea surveys: Black-footed Albatross (BFAL), Wedge-tailed Shearwater (WTSH), Murphy's petrel (MUPT) and Leach's Storm-petrel (LESP). While the presence of these species was not significantly related to the abundance of marine debris or prey (flying fish or flying squid), three environmental variables explained their occurrence throughout the survey track: sea surface temperature (WTSH, LESP), sea surface salinity (WTSH, MUPT), and wind speed (BFAL).

D) Evaluate the performance of the best-fit models of plastic and seabird distribution and Abundance at-sea

OUTCOME: Achieved.

The best-fit community model explained 91.4% of the observed variance, using a three-axes result.

The logistic (presence / absence) models performed very well, correctly assigning over 75 % of the seabird presence / absence data (n = 145 transects).

Table 3. *Results of the logistic regression of focal seabird occurrence (presence / absence). For each species, the likelihood ratio and the proportion of correct assignments are shown, on the basis of the best-fit model including only these significant explanatory variables.*

Species	Model Likelihood	df	p value	Correct Assignment (%)
BFAL	12.353	1	< 0.001	76.8
WTSH	81.479	2	< 0.001	95.8
MUPT	27.97	1	< 0.001	89.0
LESP	13.309	1	< 0.001	89.9

E) Assess student awareness of plastic debris and seabird conservation before and after the lectures given during part of the SEA cruise

OUTCOME: Achieved.

We surveyed the 27 students who sailed on the RV Seamans cruise before / after the voyage, by asking a battery of 15 questions. These scores are expressed as a proportion of the total possible points (25).

	after	before
count	27	27
mean	72.81	38.74
median	74.00	40.00
st. dev.	12.38	13.62
minimum	40.00	12.00
maximum	94.00	64.00

The mean score almost doubled, from 38.74% to 72.81%, and all students improved their scores after the cruise (95% confidence interval of mean difference was 28.86 to 39.29). When these individual scores were compared, there was a significant increase (paired t-test, df = 26, t = 13.435, $p < 0.001$).

In particular, when we focused on the four questions aimed specifically at "marine debris", we observed marked increases in student awareness. These results are available, from Hyrenbach, upon request:

- *Define marine debris?*

  Proportion of student answers in post and pre knowledge assessment:

	after	before
correct	81.48	51.85
partial	18.52	40.74
incorrect	0	7.41

- *What percentage of marine debris world-wide is composed of plastic? 10, 25, 50, 75, 90*

  Proportion of student answers in post and pre knowledge assessment:

	post	before
correct	96.29	55.55
incorrect	3.70	44.44

- *List two ways marine debris impacts the biology of the ocean.*

  Proportion of student answers in post and pre knowledge assessment:

	post	before
two correct	59.26	48.16
one correct	33.33	25.92
none correct	7.41	25.92

- *How did you learn about the effects of marine debris on ecosystems?*

The pre-test yielded 30 responses from 27 students, seven of which (30%) were left blank or stated that they "did not know" about marine debris effects. Of the remaining 70% of the students who were aware of marine debris effects on the marine environment, the top three responses were: from classes in school (36.7%) news (16.7%) and aquarium / museum exhibits (10.0%).

The post-test yielded 43 responses from 27 students, and all the students expressed awareness of marine debris effects on the marine environment. The top three responses were: activities during the SEA cruise (27.9%), effects were observed at-sea during the cruise (27.9%), and the effects were discussed in articles included in the SEA cruise reader (20.9%).

- *List three seabird species you would expect to find on a cruise from Hawaii to California and indicate whether they are surface foragers of divers:*

	after	**before**
answers	72	40
species	15	7

The pre-test yielded 40 answers and only 7 species, while students contributed 72 answers and identified 15 species in the post-test, demonstrating a broader knowledge of seabird communities in the study area. Furthermore, the students improved their understanding of the foraging ecology of these seabirds, as revealed by the improvement in their identification of the correct feeding guild of the different species.

	before	**after**
correct	75.0	80.5
incorrect	17.5	16.7
do not know	7.5	2.8

Finally, the pre and post cruise assessments underscored the charismatic nature of the Albatross, which was the most popular seabird species mentioned by students before (47.5% of responses) and after (34.7% of responses) the cruise.

F) Create a web-page for information dissemination and share information with the public.

OUTCOME: Achieved.

We disseminated the research and outreach products online through two web-sites:

- *Project Results (HPU):*
  http://www.pelagicos.net
  Results of the project, including presentations and manuscripts are posted online

G) Disseminate project results through existing broader outreach program

OUTCOME: Achieved.

Publications: We published a public outreach article, highlighting the plight of albatross populations:

"Conservation in Action: Turning Back the Plastic Tide". Public outreach article, (Bay Nature magazine, July-September 2009), featuring our education outreach program using the Black-footed albatross as an ambassador for a clean ocean (http://baynature.org/articles/jul-sep-2009/turning-back-the-plastic-tide)

Presentations: During the duration of this project (May 2008 – Sept. 2009), we gave six presentations:

- Public Seminar: Hanauma Bay Seminar Series

  Hyrenbach, K.D. *2008. Seabirds as indicators of plastic pollution in the marine environment. Marine Debris Awareness Month - Hanauma Bay, Oahu, HI. Oct. 9, 2008.*

- Public Seminar: Marine Debris Awareness Month

  Hyrenbach, K.D. *2009. Albatross as indicators of plastic pollution in the marine environment. Plastic and Hawai`i's Marine Life Lecture & Film Series, University of Hawaii at Manoa, O'ahu, HI, April 29, 2009.*

- Public Seminar: HPU Faculty Scholarship Day

  Hyrenbach, K.D. *2009. Albatross as indicators of plastic pollution in the marine environment. Hawaii Pacific University Faculty Scholarship Day, O'ahu, HI, Sept. 2, 2009.*

- *Public Outreach Presentations*: We made three outreach presentations and made important connections for local stewardship (e.g., plastic pollution prevention)
  - June 2008: presentation for World Oceans Day event held at the Monterey Bay Aquarium in Monterey, CA
  - May 2009: presentation given at the Plastic Ocean Event held at the Richardson Audubon Center and Sanctuary, Tiburon CA
  - September 2009: presentation at the Rotary Club in Sebastopol, CA

Press Coverage: Our project was showcased in two magazine articles

- *Midwek Newspiece (September 24, 2008)*

  http://www.hpu.edu/images/ AcademicPrograms/ College_of_Natural_Sciences/HPU092408_a24292.pdf

- *Hawai'i Pacific University HPU Today" Newsletter (Fall 2008)*

  http://www.hpu.edu/images/NaturalSciences/ HPU_today_Winter2008_WestHyrenbach_a27271.pdf

H) Disseminate project results to other oceanographers and seabird ecologists throughout the world, the United States, and Canada

OUTCOME: Achieved.

During this project (May 15, 2008 - September 2009), we gave presentations at scientific conferences:

- *Scientific Presentation*: Hawai'i Conservation Alliance

  Hyrenbach, D., Nevins, H., Hester, M., Lavender, K., Zettler, E., Moret, S., Titmus, A., Keiper, C., Webb, S., Harvey, J. 2008. Seabirds indicate plastic pollution in the marine environment: Quantifying spatial patterns and trends. Hawaii Conservation Alliance Conference, Oahu, HI. July 28-31, 2008.

- *Scientific Presentation*: Wildlife Society Conference

  Nevins, H.-R., Donnelly, E., Hester, M., Hyrenbach, D. 2009. Seabirds as bio-indicators of plastic debris. Annual Conference of the Wildlife Society, Monterey, CA, September 25, 2009.

We also participated in the November 2008 meeting of the Hawai'i Marine Debris Action plan, where we shared information about our ongoing research and ideas for marine debris monitoring:

Hawaii Marine Debris Action Plan (HI-MDAP). Research and Assessment & Reef Debris Removal Focus Area Meeting, Friday, November 14, 8:30am-4:30pm

3) Lessons Learned

Describe the key lessons learned from this project, such as the least and most effective conservation practices or notable aspects of the project's methods, monitoring, or results. How could other conservation organizations adapt their projects to build upon some of these key lessons about what worked best and what did not?

Our project demonstrated the feasibility of conducting concurrent surveys of marine debris and seabirds from platforms of opportunity. We are preparing g a manuscript presenting the survey methods we used in the cruise, and discussing our recommendations for standardized surveys of marine debris at-sea.

Moreover, our cruise results revealed significant biogeographic associations between seabird species known to ingest marine debris and areas of floating plastic concentrations, as revealed by visual surveys and neuston net tows. These large-scale (10s km) associations suggest that many far-ranging surface-foraging seabirds forage within areas of marine debris concentration in the Subtropical Gyre.

However, our cruise results did not reveal significant small-scale associations between marine debris and seabird distributions at the scale of individual transects (~ 10 km), suggesting that seabirds are not directly predictably exploiting the same small-scale physical processes that aggregate floating marine debris to forage on concentrated prey.

Our final take-home lesson is that seabirds are valuable ambassadors to teach the public about the environmental effects of marine debris, as evidenced by the keen interest and increased awareness on the plight of the albatross by the students who participated in the cruise (see assessment, deliverable E).