

Liberating Data from the Smithsonian's Pacific Ocean Biological Survey Program to Support the Sustainable Management of Marine Ecosystems

OVERVIEW

The Pacific Ocean is home to extensive marine ecosystems now facing threats from increasing water temperatures, ocean acidification, and coral bleaching events. Access to historical and current species observation data is vital for effective protection of these vulnerable ecosystems. The Smithsonian's archival field notes collections hold invaluable baseline information on species distribution and abundance in the Pacific Ocean before the impacts of sea-level rise and ocean acidification. A substantial body of knowledge from the Pacific Ocean Biological Survey Program (POBSP) has been digitized, however much of the data remains unusable in unstructured formats, hindering modern scientific research. Neglecting these long-term biodiversity records undermines conservation policy effectiveness and risks misunderstanding species' niches. Understanding how, where, and when migratory species have moved in the past and comparing those records to present day GPS tracking data is essential for the development of effective and efficient conservation and management policy.

"...neglecting long-term biodiversity records in spatial analyses risks misunderstanding, and generally underestimating, species' niches, which in turn may lead to ill-informed management decisions, with significant implications for the effectiveness of conservation efforts" (Monsarrat, et. al., 2019).¹

Continued digitization of expedition logs and field notes and the conversion of past collecting data into structured formats presents an opportunity to gain critical insights into the effects of climate change over time and take informed conservation actions to safeguard the delicate balance of marine ecosystems and preserve the health of our oceans.

IMPORTANCE

Seabird populations are declining faster than those of any other group of birds, with 70% of species experiencing population reductions. Additionally, the presence of numerous low-lying atolls and islands makes them highly vulnerable to sea-level rise and coastal erosion. The Pacific region exhibits a high level of species endemism, with many species found only in specific areas. These unique species, which have evolved in isolation, are less capable of adapting to rapid environmental changes, putting them at a higher risk of extinction.

Data from past collecting events from the Pacific region will help researchers to understand and track changes in migratory community populations, feeding habits, and seasonal migration patterns. In particular, seabirds are well documented over time and offer key insights that can be broadly applied to marine species conservation as a whole:

1. Seabirds play a vital role as ecosystem engineers and are highly sensitive to changes in their environment. Monitoring their populations and understanding their responses to climate change provides insights into the overall impacts on marine ecosystems.

¹Monsarrat, S., Novellie, P., Rushworth, I., & Kerley, G. I. H. (2019). Shifted distribution baselines: neglecting long-term biodiversity records risks overlooking potentially suitable habitat for conservation management. *Philosophical Transactions of the Royal Society B*, 374(1788), 20190215.

2. Pelagic seabird populations play a vital role in the marine food web and nutrient cycling. Studying the patterns of migratory animals helps identify important foraging areas, potential biodiversity hotspots, and broader patterns of climate-driven shifts in species distribution. Changes to their environmental stressors can have far-reaching consequences for other species, including commercially important fish stocks, marine mammals, and human communities reliant on these ecosystems.
3. Pelagic seabirds travel across vast distances, connecting different oceanic regions. By studying their migratory patterns, we can uncover broader patterns of climate-driven shifts in species distribution, oceanographic changes, and potential ecosystem disruptions. This information is crucial for predicting and mitigating the effects of climate change on a global scale.

Researchers and managers at NOAA Southwest Fisheries Science Center, Scripps Institution of Oceanography, USFWS, and USGS Alaska Science Center have inquired about the availability of electronic versions of bird banding data, specimen collections, and at-sea survey data. Many researchers are interested in linking 1960s spatial and temporal patterns of marine mammals and seabirds at sea in the California Current and Gulf of Alaska with contemporary data to evaluate distribution shifts due to climate change.

Further analysis of past collecting event data will not only aid in the preservation of biodiversity hotspots but will also support global climate resilience efforts aimed at bolstering the well-being of local communities (both human and animal) whose homes are rapidly disappearing.

POTENTIAL RESEARCH THEMES

The Migratory Bird Center at the National Zoological Park, the Birds Division at the National Museum of Natural History, and the Biodiversity Heritage Library at the Smithsonian Libraries and Archives seek post doctoral fellows to leverage the data from the Pacific Ocean Biological Survey Program to elucidate the effects of temporal climate variation on migratory species populations and marine ecosystems. We encourage proposals that synthesize data from a myriad of sources including POBSP. A focus on data extraction through novel computation approaches (machine-learning and AI), data analysis, and visualization are encouraged. Comparative studies of POBSP data with other collecting events that have occurred in the region could yield particularly prescient new insights.

A list of themes that could be explored:

1. **Species Distribution and Abundance:** The POBSP data can provide information on the historical distribution and abundance of species across the Pacific islands. Researchers can analyze the data to understand the factors influencing species' presence, absence, and population sizes. This research can help identify areas of high biodiversity, endemic species hotspots, and patterns of species richness.
2. **Climate Change Impacts:** By examining the data collected during the POBSP, researchers can assess the impacts of climate change on low-lying island ecosystems under threat. Long-term trends in species composition, changes in distribution patterns, and shifts in community dynamics can provide valuable evidence of climate change impacts. This research can help predict future changes and identify additional vulnerable species and ecosystems.
3. **Migration and Connectivity:** The migratory patterns of birds and other animals in the Pacific region

can be studied using POBSP data. Researchers can investigate the routes, timing, and stopover sites of migratory species, as well as the factors influencing their migratory behavior. Understanding migratory connectivity can inform conservation strategies and highlight important areas for protection.

4. **Invasive Species Dynamics:** The data from the POBSP can contribute to studying the spread and impact of invasive species on Pacific islands. By examining records of introduced species and their interactions with native species, researchers can identify the pathways of invasion, assess the ecological effects, and develop management strategies to mitigate the impacts of invasive species.
5. **Historical Baselines and Ecosystem Restoration:** The POBSP data provides a historical baseline for assessing ecosystem changes and guiding restoration efforts. By comparing past and present data, researchers can evaluate the extent of habitat loss, identify species declines or extinctions, and determine the feasibility and approaches for ecosystem restoration and conservation.
6. **Conservation and Management:** POBSP data can inform conservation planning and management strategies for the Pacific region. It can help identify priority areas for protection, establish protected areas, and develop policies to safeguard biodiversity. The data can also aid in understanding the effectiveness of conservation measures implemented in the past and guide future conservation efforts.

PROGRAMS AND ASSETS

The comprehensive and diverse nature of the data collected by the POBSP holds immense potential for research across multiple disciplines. The Pacific Ocean Biological Survey Program (POBSP) represents an unprecedented biological survey conducted between 1962 and 1969 that covered a vast area of the Pacific Ocean from latitude 30 degrees north to 10 degrees south and longitude 150 degrees east to 180 degrees west. The fieldwork spanned over six and a half years, resulting in the banding of 1,800,000 birds and approximately 150,000 observations of pelagic birds at sea. Scientific research materials comprise 245 boxes of field notes filled with invaluable historic records which include hydrographic data, weather data, plant lists, distribution maps, sampling event data, checklist data, and specimen photos.

The hydrographic and weather data can contribute to understanding the oceanographic and atmospheric conditions in the Pacific Ocean during the program's time frame. Plant lists and distribution maps provide insights into the vegetation patterns and ecological communities in the region. The sampling event data and checklist data offer valuable information about the presence, abundance, and diversity of species, including but not limited to pelagic birds. Additionally, the specimen photos can aid in species identification and contribute to taxonomic and ecological studies. While the Biodiversity Heritage Library already provides online access to 32,267 pages from the POBSP collection, a significant amount of content remains to be digitized; onsite access to physical collections will also be provided to researchers.

Through analysis of POBSP records, researchers can harness the information to investigate a wide range of themes, including migratory patterns, population dynamics, species interactions, biodiversity conservation, and the impacts of climate change. Understanding historical baselines and long-term changes in the Pacific Ocean ecosystem, will allow for evidence-based decision-making and conservation strategies in the face of ongoing environmental challenges, directly supporting efforts related to UN Sustainable Development Goals, particularly those focusing on biodiversity conservation (Goal 15: Life on Land), climate action (Goal 13: Climate Action), and the sustainable management of marine resources (Goal 14: Life Below Water).

ADVISORS

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