ECOLOGY

Better Science Needed for Restoration in the Gulf of Mexico

In the wake of the BP oil spill, U.S. agencies need research plans to collect data that will aid in managing and assessing marine species and ecosystems.

Karen A. Bjorndal,[1]* Brian W. Bowen,[2] Milani Chaloupka,[3] Larry B. Crowder,[4] Selina S. Heppell,[5] Cynthia M. Jones,[6] Molly E. Lutcavage,[7] David Policansky,[8] Andrew R. Solow,[9] Blair E. Witherington[10]

The 2010 BP Deepwater Horizon oil spill in the Gulf of Mexico (GoM) has damaged marine ecosystems and jeopardized endangered and commercial species under U.S. jurisdiction (see the figure). Agencies that manage protected species—including the U.S. National Marine Fisheries Service and the U.S. Fish and Wildlife Service—are tasked with recovering these populations. But many populations have not been adequately assessed, so recovery cannot be measured. Achieving mandated recovery goals depends on understanding both population trends and the demographic processes that drive those trends. After the 1989 Exxon Valdez Alaskan oil spill, evaluations of effects on wildlife were ambiguous, in part because limited data on abundance and demography precluded detection of change (*1*). Sadly, the situation in the GoM is similar more than 20 years later. As concluded in the National Commission report on the BP spill (*2*) released 11 January, "Scientists simply do not yet know how to predict the ecological consequences and effects on key species that might result from oil exposure…" We argue that scientists know how to make these assessments, but lack critical data to achieve this goal.

A dead juvenile Kemp's ridley sea turtle (*Lepidochelys kempii*). It was recovered from an oil line within the BP spill area, 115 km ESE from Venice, Louisiana, 6 June 2010.

For example, the BP spill may have had a substantial impact on Atlantic bluefin tuna (*Thunnus thynnus*), because it occurred during spawning. The spill could have affected 20% of the 2010 bluefin larvae (*2*). But the impact of that loss is difficult to assess because bluefin migration paths, reproductive habits, and early life history are inadequately resolved (*3*). At the ecosystem level, long-term effects of food web alteration by oil or dispersants could suppress wildlife populations (*1*, *2*).

Tens of millions of dollars from BP intended to restore wildlife populations and ecosystems have already been disbursed (*4*, *5*), and hundreds of millions more are at risk of being distributed without a clear strategic plan to ensure that projects improve our understanding of population dynamics and the impacts of proposed management actions (*4*). In contrast, strategic national research plans for key marine species and ecosystems could guide research efforts to provide the data required to assess populations and design recovery strategies to address environmental insults before the next crisis occurs. Broad policies such as the new U.S. National Ocean Policy (*6*) are not intended to provide specific guidance. And species recovery plans often list many variables scientists could measure but do not prioritize which variables to measure and with what precision (*7*). As in medicine, you cannot efficiently produce a diagnosis and cure by measuring everything or ordering every test. We must identify and measure the most predictive variables first.

It is not too late to invest funds from BP

Assessing Sea Turtle Populations

In the United States and much of the world, sea turtle populations are monitored almost exclusively by counting nests on beaches (*27*). Adult females take decades to reach sexual maturity, do not nest every year, and are a small fraction of any sea turtle population (*10*). Florida hosts the largest nesting aggregation of loggerhead sea turtles (Caretta caretta) in the Atlantic, and nesting has been monitored consistently since 1989 (fig. S1). Until 1998, nest numbers increased. But the available data did not permit a determination of which, if any, management actions were responsible. After 1998, numbers plummeted, and by 2006, had declined by 43% (*27*). Many factors could account for this decline, but the specific cause(s) could not be determined. Therefore, developing effective management plans remains an elusive goal. Likewise, the long-term effects of the BP oil spill on this and other sea turtle species cannot be evaluated. Nest counts in the United States continue to provide essential data for population assessments, but critical data gaps, especially in demographic parameters, exist (*28*). This need not be the case. Australian researchers have 30 years of data on sex- and age-class–specific abundance and demographic parameters for loggerheads on the southern Great Barrier Reef (sGBR) (*29*) that allowed the steep decline in turtle abundance during the 1980s and 1990s in the sGBR to be attributed to two of many potential hazards: predation by foxes on the coastal nesting beaches and incidental capture in coastal trawl fisheries. Both hazards have now been mitigated by government agencies, resulting in an apparently recovering stock (*30*).

[1]Archie Carr Center for Sea Turtle Research and Department of Biology, University of Florida, Gainesville, FL 32611, USA. [2]Hawaii Institute of Marine Biology, University of Hawaii, Kaneohe, HI 96744, USA. [3]Ecological Modelling Services Pty. Ltd., University of Queensland, St. Lucia, Queensland 4067, Australia. [4]Center for Marine Conservation, Duke University Marine Lab, Beaufort, NC 28516, USA. [5]Department of Fisheries and Wildlife, Oregon State University, Corvallis, OR 97331, USA. [6]Center for Quantitative Fisheries Ecology, Old Dominion University, Norfolk, VA 23529, USA. [7]Large Pelagics Research Center, Department of Environmental Conservation, University of Massachusetts, Amherst, Gloucester, MA 01930, USA. [8]National Research Council, Washington, DC 20001, USA. [9]Marine Policy Center, Woods Hole Oceanographic Institution, Woods Hole, MA 02543, USA. [10]Florida Fish & Wildlife Conservation Commission, Melbourne Beach, FL 32951, USA.

*Author for correspondence. E-mail: bjorndal@ufl.edu

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to support teams of experts to develop effective strategic plans that identify, prioritize, and provide methodologies for collecting essential data (*8*). The plans will vary among species and ecosystems because our current knowledge varies widely. But the following seven elements should be included in most, if not all, plans.

Integrate demography with abundance trends for multiple life stages and determine environmental effects on those parameters. Both demographic and abundance data are essential to diagnose causes of population declines. Even for high-profile megafauna, too little is known about abundance of different life stages and key demographic rates: survival, breeding and recruitment probabilities; growth rates; and age at maturity. These strongly influence how perturbations like the BP spill will affect population growth (*9*). Most of these animals are long-lived and can move thousands of kilometers between seasons and life stages. Often, there is only an estimate of abundance for one easily observed life stage. This is analogous to estimating human population trends by counting women in maternity wards. Useful data would emerge, but if the children were decimated by disease, this mortality would not be detected in the maternity ward for decades. Sea turtles provide a striking example of this problem (see text box).

Emphasize analyses of cumulative effects. Too often, individual threats (e.g., pollution, fisheries bycatch, or habitat loss) are addressed separately, not as cumulative effects (*10*). A recent controversy over the suggestion that fisheries' bycatch of seabirds could be mitigated by removing egg and chick predators could not be resolved without understanding demography and cumulative effects (*11*). Management priorities for multiple threats can be set by assessing the relative impact of each threat on population growth rate (*12*).

Elucidate links among and within populations with new tools in genetics, statistical models, and tracking (*13–15*). Compared with terrestrial systems, oceans have greater rates of import and export, genetic exchange, and dispersal among life stages (*16*). Knowledge of linkages can identify human actions that may disrupt important connections within and among populations and amplify an environmental insult (*17*). For example, linkages would reveal the geographic extent of bluefin tuna populations affected by the oil spill at their GoM spawning grounds (*18*).

Revise the permitting processes that now hinder peer-reviewed studies of critical processes and management alternatives for protected species, such as impacts of petroleum on sea turtles (*19*). Prolonged reviews and restrictions on scientific research arising from unproven conservation concerns may actually impede conservation efforts (*20*, *21*). The process should be expedited without compromising legislative mandates.

Encourage data sharing. Because of proprietary issues, many databases in the United States useful for population assessments are difficult to access. Critical data held by individuals are at risk as data owners retire or die. Because these data were collected under past environmental conditions and population densities, they cannot be replaced by new research. Incentives to increase data sharing, such as making it a requirement of funding, permits, or publication, should be developed (*22*).

Improve assessment tools for evaluation of anthropogenic impacts on populations by fostering interdisciplinary research among fisheries science, marine ecology, and conservation biology and by funding opportunities for student training and continuing education for managers in the quantitative sciences (*23*). The Bering Sea Project is an excellent example of such a program (*24*).

Prioritize investments. Although difficult to set, priorities should be provided to direct funding to address long-term population management needs. This specific guidance, which will vary among species and ecosystems, is lacking in other plans and policies. Having funding priorities in place for key species and ecosystems will allow efficient, strategic use of funds that become available after a crisis.

With a growing human population and continuing habitat degradation (*25*, *26*), our ability to assess and understand changes in marine wildlife and ecosystems becomes ever more important. The United States needs strategic national research plans for key marine species and ecosystems based on evaluation of cause and effect and on integrated monitoring of abundance and demographic traits. We know how to create these research plans—what is needed now is the political will and leadership to do so and to fulfill our responsibilities under the U.S. Endangered Species, Marine Mammal Protection, and Magnuson-Stevens Fishery Conservation and Management Acts. Agencies should focus resources and expertise on research that identifies why populations change and that enables modeling future impacts. In the wake of the BP oil spill, the need for this policy shift is as clear as it is compelling. The largest offshore oil spill in U.S. history should provide the impetus and opportunity to effect this policy shift.

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Supporting Online Material

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*To whom correspondence should be addressed. E-mail: bjorndal@ufl.edu

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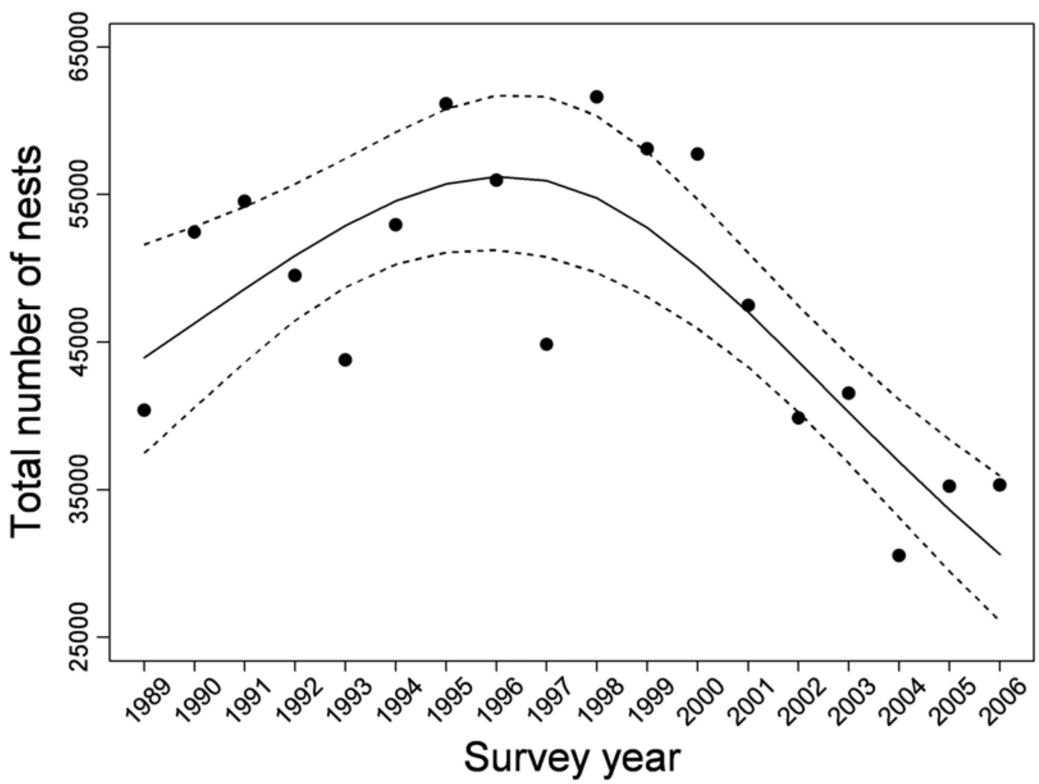
This PDF file includes

Fig. S1
Reference

Figure S1. Impending extinction, or temporary trend? Counts of loggerhead sea turtle nests in Florida suggest an approaching disaster, in spite of regulations and conservation efforts. But these nests represent an unknown number of adult female turtles. Managers lack essential data needed to evaluate this decline and identify its solutions. The data are from Witherington et al. (*S1*); the trend line and 95% confidence bands were estimated using restricted cubic spline least-squares regression.



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