Ocean Calamities: Hyped Litany or Legitimate Concern?

Conservation scientists have expressed concern that impending marine extinctions are often overlooked (Dulvy et al. 2003) and that, by the time enough data are collected to justify protection, it is too late (Taylor and Gerrodette 1993). For potentially major and difficult-to-reverse threats, there is far greater risk in failing to detect existent impacts than in having detected nonexistent impacts (Dayton 1998, Oreskes and Conway 2014). In stark contrast, Duarte and colleagues (2015) argue that, by exaggerating the significance of small, regional problems and "perpetuating the perception of ocean calamities in the absence of robust evidence," scientists and the media present an "overly negative message" that is "driving society into pessimism."

In other words, Duarte and colleagues claim that things are better off than most people think. They identify a handful of environmental issues in the oceans (e.g., the depletion of fish stocks, jellyfish blooms, harmful algal blooms, and hypoxia), label them "calamities" and "plagues" (terms uncommon to the scientific literature), and explain why each issue should or should not be a focus of public and scientific concern. They create a three-part typology for identifying "calamities"—anthropogenic cause, spread to global scale, and severe disruption to marine social–ecological systems—and then present cases that suggest "strong," "medium," or "weak" evidence for each. Overfishing, for instance, is a "calamity" for which the authors concede strong evidence in all three categories. In contrast, they suggest that other ocean problems (e.g., hypoxia, jellyfish blooms, the decline of calcifiers due to ocean acidification) present "weak" to "medium" evidence and suggest that these "calamities" are a byproduct of an increased ability to detect change or a misinterpretation of short-term data.

In this process, Duarte and colleagues misrepresent what is known on two accounts. First, they fail to provide a frequency distribution for their typology, which therefore puts the emphasis on uncertainty and implies that the majority of problems have been overstated (i.e., two-thirds of issues fall into the "weak" and "medium" evidence categories). In particular, by listing only one example that provides "strong" evidence of human attribution, they ignore that there is incontrovertible evidence for a long list of human impacts on the ocean, such as habitat destruction, including the loss of half or more of coral populations around the world; the decimation of seagrasses, marshes, and mangroves; the transformation of the seafloor into two-dimensional habitats via trawling; the extirpation of megafauna, including whales, sharks, seals, and sea turtles; numerous local and regional extinctions; and the effects of pollution on marine animals and ecosystems, including noise, plastic, and so on.

Duarte and colleagues also criticize the public and some members of the scientific community for relying on short-term evidence to make substantial claims, because that evidence might not be characteristic of the entire system over long timescales. This is not new or particularly controversial advice (Pauly 1995, Jackson 1997). However, in some cases, the authors fail to heed their own words. In particular, they ignore important scholarship that indeed includes long-term data and shows strong evidence for some issues that they suggest remain uncertain—which is the second and more egregious way Duarte and colleagues misrepresent what is known. For example, they state that the evidence showing that hypoxic events have increased in frequency is "medium" or "equivocal" because the increase could be attributed to increased detection effort. This assumption overlooks important historical ecology research (e.g., Rabalais et al. 2007, 2009) that provides strong evidence that eutrophication and oxygen stress have increased over the last century.

Duarte and colleagues also demand scientific rigor for claims about the natural world but present a list of 10 arbitrarily selected headlines from around the world published between 1999 and 2013 as sufficient evidence for their claims about the social one—namely, that the public is being driven to pessimism. Duarte and colleagues further suggest that people who publish on "ocean calamities" are meeting a demand from the publishers of their papers, the media, and even society at large, which are "eager to consume" news of "insults to the environment associated with sustained growth in human appropriation of resources." This assertion is the exact opposite of our individual experiences with the media (we have each been encouraged in public communication to avoid "doom and gloom" and focus on uplifting messages, such as #OceanOptimism, and the media also publishes prominent headlines related to positive news; see supplemental table 1). Emphasizing the negative news also ignores the efforts of many marine scientists who are working on the science as well as the implementation of solutions, such as the elimination of harmful fisheries subsidies, the listing of marine species on CITES, and the establishment of marine protected areas, to name a few.

In summary, by their failure to discuss frequency with regards to their typology, their disregard of scholarship that provides long-term data, and their generalizations about the motivations of scientists, publishers, and the media, Duarte and colleagues misrepresent what we do and do not know. We recommend that Duarte and colleagues heed their own advice and "revisit the process by which potential or isolated problems escalate."

Supplemental material

The supplemental material is available online at *http://bioscience.oxfordjournals.org/lookup/suppl/doi:10.1093/biosci/biv087/-/DC1*.

Downloaded from http://bioscience.oxfordjournals.org/ at New York University Law School Library on September 25, 2015

JENNIFER JACQUET, JAMES ESTES, JEREMY JACKSON, AYANA E. JOHNSON, NANCY KNOWLTON, LOREN MCCLENACHAN, DANIEL PAULY, AND ENRIC SALA

Jennifer Jacquet (jacquet@nyu.edu) is affiliated with the Department of Environmental Studies at New York University. James Estes is affiliated with the Department of Ecology and Evolutionary Biology at the University of California, Santa Cruz. Jeremy Jackson is with the Department of Paleobiology at the National Museum of Natural History, Smithsonian Institution, in Washington, DC, and with the Scripps Institution of Oceanography at the University of California, San Diego. Ayana E. Johnson is affiliated with the Waitt Institute, in Washington, DC. Nancy Knowlton is affiliated with the National Museum of Natural History, in Washington, DC. Loren McClenachan is with the Department of Environmental Studies at Colby College, in Maine. Daniel Pauly is affiliated with the Sea Around Us at the University of British Columbia, in Vancouver, Canada. Enric Sala is with the National Geographic Society, in Washington, DC.

References cited

Dayton P. 1998. Reversal of the burden of proof in fisheries management. Science 279: 821–822.

Duarte CM, Fulweiler RW, Lovelock CE, Martinetto P, Saunders MI, Pandolfi JM, Gelcich S, Nixon SW. 2015. Reconsidering ocean calamities. BioScience 65: 130–139.

Dulvy NK, Sadovy Y, Reynolds JD. 2003. Extinction vulnerability in marine populations. Fish and Fisheries 4: 25–64.

Jackson JBC. 1997. Reefs since Columbus. Coral Reefs 16: S23–S32.

Pauly D. 1995 Anecdotes and the shifting baseline syndrome of fisheries. Trends in Ecology and Evolution 10: 430.

Rabalais NN, Turner RE, Sen Gupta BK, Platon E, Parsons ML. 2007. Sediments tell the history of eutrophication and hypoxia in the northern Gulf of Mexico. Ecological Applications 17: S129–S143.

Rabalais NN, Turner RE, Justic D, Diaz RJ. 2009. Global change and eutrophication of coastal waters. ICES Journal of Marine Science 66: 1528–1537.

Taylor BL, Gerrodette T. 1993. The uses of statistical power in conservation biology: The vaquita and northern spotted owl. Conservation Biology 7: 489–500.

doi:10.1093/biosci/biv087

Ocean Calamities: Delineating the Boundaries between Scientific Evidence and Belief

We welcome the contributions of Jacquet and colleagues (2015) to the debate we opened (Duarte et al. 2015). They begin by pointing out that marine extinctions go unnoticed and that, by waiting to collect data before taking action, we are losing precious time. They therefore imply that, by calling for a more rigorous analysis of ocean calamities, we are slowing progress for ocean protection. This is a false dichotomy. We called for a more critical examination of data so that we may better assess the generality, severity, and immediacy of ocean calamities in order to better focus—not slow down—conservation efforts. This debate is about neither distributing shame (cf. Jacquet 2015) nor assessing who holds superior scholarship practices. Indeed, we deliberately stressed the limitations of evidence in our own work (e.g., Vaquer-Sunyer and Duarte 2008).

The core of the debate we proposed is about the collective responsibility of scientists to clearly delineate the boundaries between scientific evidence and belief, thereby separating our views as marine scientists from our beliefs and values as conservationists.

We agree with Jacquet and colleagues (2015) that there is a long list of human impacts on the ocean, which we acknowledged in our article and have discussed in detail elsewhere (Duarte 2014). However, we argued that some of the calamities composing the syndrome of collapse of marine ecosystems may not be as severe as is portrayed in some narratives and provided examples to support our point.

Jacquet and colleagues (2015) argue that our manuscript misrepresented what is known about human impacts on the ocean. A more careful reading of our article reveals that we provided an approach for assessment of whether perceived ocean problems represent ocean calamities, illustrated with a few examples. However, we did not claim to have conducted a thorough auditing exercise but rather suggested that "a robust audit of ocean calamities, probing into each of them much deeper than the few examples provided here, is imperative to weeding out the equivocal or unsupported calamities" (Duarte et al. 2015).

Jacquet and colleagues (2015) claim that we ignored important scholarship showing strong evidence for calamities that we suggested were insufficiently supported. Their charge is based, however, on a single case—that of eutrophication and hypoxia, which they support with two references. Contrary to their assertion, neither one of them provides long-term evidence that hypoxia has increased globally. Their long-term evidence refers to a single case in the Gulf of Mexico, which cannot be extrapolated globally. In addition, contrary to their statements, we acknowledged losses of habitats and marine biota as important problems, and nowhere in our manuscript did we dispute that eutrophication has increased in coastal ecosystems around the world.

Jacquet and colleagues (2009) argue that "there is far greater risk in failing to detect existent impacts than in having detected nonexistent impacts." We concur with this statement but argue that detection and attribution must conform to robust practices, as O'Connor and colleagues (2014) delineated for impacts of climate change. Whereas we believe—to continue with the example they choose—that hypoxia is likely to have increased in coastal systems globally, we acknowledge that our belief is no substitute for robust evidence. We argued that in this and in other cases, we should not be content with current evidence and that we must extend our efforts to separate a possible global spread of hypoxia from a global increase in the likelihood of detection (Duarte et al. 2015).

Jacquet and colleagues (2009) object to our belief that "things are better off

Downloaded from http://bioscience.oxfordjournals.org/ at New York University Law School Library on September 25, 2015