

AGENDA

Workshop W7: What Do Seabirds Reveal About the Effects of Climate Change on the World's Oceans? 2 June 2018, Washington Hilton, Washington D.C.

Conveners: William Sydeman (USA), John Piatt (USA), Yutaka Watanuki (Japan), Joel Durant (Norway),
Lynne Shannon (South Africa), Robert Crawford (South Africa)

The 4th International Symposium on *Effects of Climate Change on the World's Oceans* provides a unique opportunity for a workshop focused on international collaboration that will enhance knowledge and improve communication to policy-makers regarding the impacts of climate change and fisheries on seabirds and marine ecosystems more generally. Our workshop entitled What do seabirds reveal about effects of climate change on the world's oceans? seeks to:

- (1) compare marine bird response to climate change across marine ecosystems and biomes, from the tropics to the Arctic and Antarctic,
- (2) develop mechanistic understandings of these responses, including interactions between climate and forage fish fisheries, and
- (3) educate informed laypeople (including managers and policy-makers from Washington, D.C.) on recent observations of apparent marine bird responses to climatic factors globally, including unprecedented seabird die-offs in many parts of the world.

0900 - opening remarks by Conveners, introductions by participants, overview of workshop

0920 - Richard Sherley (South Africa) - Benguela Current seabirds and species redistributions.

1000 - Kate Searle (U.K.) - North Sea seabirds: responses to fisheries and ecosystem productivity.

1040 - coffee

1110 - Stephanie Jenouvrier (France/U.S.) - Modeling Antarctic penguins.

1150 - Claire Saraux (France) - Climate, seabird demography and foraging ecology.

1230 - lunch

1400 - Jarrod Santora (USA) - synthesis project: seabirds at-sea, changes in distribution.

1420 - John Piatt (USA) - synthesis project: seabird die-offs, causes of mortality events

1440 - William Sydeman (USA) - synthesis: seabird breeding success, changes in ecosystem productivity

1500 - 1800 - open discussion, potential workshop products

- (a) formation of a Seabird-Climate Working Group, sponsorship?, Terms of Reference?
- (b) scientific products?
 - (i) multi-authored volume based on workshop and presentations in theme session, speciality journal (e.g., *Marine Ecology Progress Series* or *Global Change Biology*);
 - (ii) review manuscript summarizing the state of knowledge concerning seabirds and climate?, globally, high impact journal (*Science* or *Nature*).
 - (iii) meta-analyses: seabirds at sea?, breeding success?, mortality events?, food habits?, other ideas?

Justification: Seabirds are among the most threatened marine organisms in the world (Croxall et al. 2012). Removal of seabird food from the oceans by fisheries for small coastal pelagic fish (e.g., anchovy) and crustaceans (e.g., krill), coupled with changes in marine ecosystem productivity and structure due to climate change, is perhaps the greatest synergistic threat facing seabirds today. Seabirds are highly mobile animals and ecologically flexible enough to redistribute themselves among suitable habitat and food resources when their habitats change. However, few species have a suite of life history characteristics that enable them to acclimate to both rapidly changing climate and high-impact forage fisheries at the same time. Additionally, most seabirds nest at fixed colony locations during breeding, and the rate at which adults can provision chicks is constrained by distance to food supplies. Access to abundant food resources in adjacent foraging areas is therefore especially crucial during the breeding period. Understanding how climate change (including ocean warming, acidification, and de-oxygenation) and forage-fish fisheries interact to deplete or limit seabird food resources is therefore critical for developing appropriate

management plans to conserve both forage fish and seabird populations. For example, management plans could include temporal and spatial area fishery closures that are predicated on climate, and anticipated forage and seabird responses to local climate change. Such an approach would require robust scientific consensus on the role of both fisheries and climate on various aspects of seabird biology including foraging ecology and demography. To date, we are not aware of any attempt to synthesize seabird, fishery and climate-response data with such a goal in mind. It is an ambitious goal, and we believe that global datasets may now exist that would allow us to approach and clarify the issue of climate-fishery-seabird interactions and develop novel and appropriate management and policy recommendations.

Project Description: Seabirds are the most conspicuous marine organisms living at the interface of the atmosphere and the ocean, and due to public interest, have been extremely well-studied for multiple decades at key locations around the world. The information base on seabirds globally is rich, comprehensive, and with substantial longevity. Based on these studies, recent reviews (Sydeman et al. 2015) and meta-analyses (Poloczanska et al. 2013, Keogan et al. 2018) indicate complex — and often unexpected — responses of seabirds to various manifestations of climate change. Indeed, long-term studies contributing to climate-seabird literature often include detailed demographic studies of reproductive output, recruitment, and survivorship of marked, known-age individuals, as well as information on food habits throughout the year. When combined with concurrently collected data on local forage fish stocks and fisheries, these same datasets have provided strong insights into the functional and numerical relationships between seabirds and prey (Piatt et al. 2007, Cury et al. 2011), and therefore can provide benchmarks for fishery management strategies. Other key life history attributes such as timing of breeding and movement patterns are also known to be extremely sensitive to climate variability and forage fish/food availability. In contrast to marine fish and mammals which are not so easily observed, direct seabird observations have contributed to hundreds of papers concerning individual, population, and community responses of seabirds to climate variability and change (reviewed by Sydeman et al. 2012, 2015) and impacts of forage fish fisheries (Sydeman et al. 2017c). In short, *seabirds are probably the best taxonomic group with which to synthesize climatic and fisheries effects on marine ecosystems globally*. Furthermore, given the well-established role of seabirds as ecological indicators (Cairns 1987, Piatt et al. 2007, Sydeman et al. 2017a,b), this effort may have application to other marine predators facing similar issues (e.g., marine mammals).

Intersection with Policy: The Intergovernmental Panel for Climate Change (IPCC) Assessment Report 6 (AR6) is currently under development, slated for release in 2020. In previous versions of IPCC reports, the impacts of climate change on marine ecosystems were generally neglected (Richardson and Poloczanska 2008). This was improved in the production of AR5 (IPCC 2013), which included two chapters on ocean ecosystems. Chapter 30 dealt with regional responses of marine systems to global warming (Hoegh-Guldberg et al. 2014) and Chapter 28 considered polar seas, specifically focused on the impact of warming on ice-based marine systems. The IPCC is also developing a special report on *Climate Change, The Oceans and The Cryosphere*, anticipated for release in late 2019. Our project will provide timely synthesized information on climatic and fisheries impacts on seabirds for these international policy reports.

References

- Cairns, D. K. 1987. Seabirds as indicators of marine food supplies. *Biological Oceanography* 5:261-271.
- Croxall, J. P., S. H. M. Butchart, B. Lascelles, A. J. Stattersfield, B. Sullivan, A. Symes, and P. Taylor. 2012. Seabird conservation status, threats and priority actions: a global assessment. *Bird Conservation International* 22:1-34.
- Cury, P. M., I. L. Boyd, S. Bonhommeau, T. Anker-Nilssen, R. J. M. Crawford, R. W. Furness, J. A. Mills, E. J. Murphy, H. Osterblom, M. Paleczny, J. F. Piatt, J.-P. Roux, L. Shannon, and W. J. Sydeman. 2011. Global seabird response to forage fish depletion—one-third for the birds. *Science* 334:1703-1706.
- Hoegh-Guldberg, O., R. Cai, E. S. Poloczanska, P. G. Brewer, S. Sundby, K. Hilmi, V. J. Fabry, and S. Jung. 2014. The ocean - supplementary material. In: V. R. Barros, C. B. Field, D. J. Dokken, M. D. Mastrandrea, K. J. Mach, T. E. Bilir, M. Chatterjee, K. L. Ebi, Y. O. Estrada, R. C. Genova, B. Girma, E. S. Kissel, A. N. Levy, S. MacCracken, P. R. Mastrandrea, and L. L. White, editors. *Climate Change 2014: Impacts, adaptation, and vulnerability. Part B: Regional aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*.
- IPCC. 2013. *Climate Change 2013: The physical science basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge, UK, and New York, NY, USA.
- Piatt, J. F., A. M. A. Harding, M. Shultz, S. G. Speckman, T. I. Van Pelt, G. S. Drew, and A. B. Kettle. 2007. Seabirds as indicators of marine food supplies: Cairns revisited. *Marine Ecology Progress Series* 352:221-234.
- Poloczanska, E. S., C. J. Brown, W. J. Sydeman, W. Kiessling, D. S. Schoeman, P. J. Moore, K. Brander, J. F. Bruno, L. B. Buckley, M. T. Burrows, C. M. Duarte, B. S. Halpern, J. Holding, C. V. Kappel, M. I. O'Connor, J. M. Pandolfi, C. Parmesan, F. Schwing, S. A. Thompson, and A. J. Richardson. 2013. Global imprint of climate change on marine life. *Nature Climate Change* 3:919-925.
- Richardson, A. J., and E. S. Poloczanska. 2008. Ocean science - Under-resourced, under threat. *Science* 320:1294-1295.
- Sydeman, W. J., S. A. Thompson, and A. Kitaysky. 2012. Seabirds and climate change: roadmap for the future. *Marine Ecology Progress Series* 454:107-117.
- Sydeman, W. J., E. Poloczanska, T. E. Reed, and S. A. Thompson. 2015. Climate change and marine vertebrates. *Science* 350:772-777.
- Sydeman, W. J., S. A. Thompson, T. Anker-Nilssen, M. Arimitsu, A. Bennison, S. Bertrand, P. Boersch-Supan, C. Boyd, N. A. Bransome, R. J. M. Crawford, F. Daunt, R. W. Furness, D. Gianuca, A. Gladics, L. Koehn, J. W. Lang, E. Løgerwell, T. L. Morris, E. M. Phillips, J. Provencher, A. E. Punt, C. Sarau, L. Shannon, R. B. Sherley, A. Simeone, R. M. Wanless, S. Wanless, and S. Zador. 2017c. Best practices for assessing forage fish fisheries-seabird resource competition. *Fisheries Research*, doi: 10.1016/j.fishres.2017.05.018.