EXECUTIVE SUMMARY:

Harnessing Ecological Spatial Connectivity for Effective Marine Protected Areas and Resilient Marine Ecosystems: Action Agenda & Scientific Synthesis

Submitted by the Marine Protected Areas Federal Advisory Committee to the United States Secretary of Commerce and the United States Secretary of Interior

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The Marine Protected Areas Federal Advisory Committee and the Connectivity Charge

The Marine Protected Areas Federal Advisory Committee (MPA FAC) is a 20-member committee of outside experts that advises the United States Secretaries of Commerce and Interior on matters concerning marine protected areas and networks of marine protected areas (hereafter "MPAs") in the United States. In April 2015, the Secretaries charged the MPA FAC to advise them on incorporating knowledge about ecological spatial connectivity (hereafter "connectivity" or "ecological spatial connectivity") and climate change into the design, use, and management of MPAs. Incorporating knowledge about connectivity is essential for the success of any and all ecological MPAs, i.e., MPAs that aim to restore or maintain ecological phenomena - populations, communities, ecosystems. In addition, incorporating knowledge about connectivity into ecological MPAs best equips them to achieve their conservation goals as the marine environment undergoes significant changes due to climate change.

The MPA FAC created two products in response to the Secretaries' charge.[1] The first is a comprehensive Scientific Synthesis that addresses connectivity and MPAs, as well as the use of connectivity-informed MPAs to address climate change in the marine environment. The second product is an Action Agenda for the Secretaries, which recommends six specific actions for the Secretaries and also puts forth a set of guidelines for use by any MPA program on incorporating connectivity into MPAs.[2]

SCIENTIFIC SYNTHESIS: The Central Importance of Ecological Spatial Connectivity to Effective Marine Protected Areas and To Meeting the Challenges of Climate Change in the Marine Environment

The MPA FAC's scientific synthesis paper addresses topics fundamental to understanding the role of connectivity in MPA effectiveness and to incorporating that understanding into the successful design, use and management of MPAs in a complex and dynamic marine environment. The three main parts of the paper are summarized below.

What Is Ecological Spatial Connectivity and Why Does It Matter for Effective MPAs?

This part of the paper defines ecological spatial connectivity and summarizes current knowledge about connectivity in the marine environment. It shows the critical importance of taking connectivity into account in designing, using, and managing ecological MPAs (where design includes location, size, and

[1] For composition of the MPA FAC and of the MPA FAC Connectivity Subcommittee, see Appendix 2.
[2] For a glossary of key terms, see Appendix 1.

shape of MPAs). At its core, connectivity refers to physical and biological processes that connect spatially discrete areas in the marine environment to one another in ways that are crucial to the lives of organisms, populations, ecological communities, and ecosystems. The central points here are that the realities of ecological spatial connectivity pose both challenges and opportunities to place-based conservation tools in the marine environment (i.e., MPAs), and that these challenges and opportunities can be met and exploited if knowledge about connectivity realities is built into how we design, use, and manage these place-based tools.

Design, Use and Management Principles for Enhancing Ecological Spatial Connectivity Processes Within, Around, and Among MPAs and MPA Networks.

This part sets forth specific principles for taking connectivity into account in the design, use, and management of ecological MPAs. The principles to use in a given instance depend on the ecological focus of the MPA (whether the MPA is species-focused or community- or ecosystem-focused) and on the biological and ecological characteristics of the species, communities, or ecosystems of interest. The principles address a variety of parameters, including: (1) the location of an MPA; (2) the size of an MPA; and (3) whether the MPA is an individual, stand-alone MPA or part of a set of inter-dependent MPAs, i.e., a network of MPAs. They also include: (4) whether management of an MPA aims at intended effects within MPA boundaries or outside MPA boundaries (or both); (5) attentiveness to management regimes within an MPA and to management regimes in areas outside the MPA; and (6) attentiveness to the relationships between the management regimes inside an MPA and those outside an MPA.

Climate Change in the Marine Environment: Another Compelling Reason for Connectivity-Informed MPAs and MPA Networks.

This part links the importance of taking connectivity into account in the design, use, and management of MPAs to meeting the challenges of climate change in the ocean. Physical and chemical changes in the marine environment are producing changes in species' distributions, abundances, and productivities. These ongoing and future changes in species' distributions, abundances, and productivities can greatly complicate the use of place-based conservation tools in the marine environment, i.e., ecological MPAs. However, MPAs that are built, used, and managed to foster connectivity processes - connectivity-informed MPAs - can best address the ecological changes brought about by climate change. For example, MPAs designed, used, and managed around knowledge of organisms' movements through space and their population structures across space can help facilitate changes over time in these movements and structures. These connectivity-informed MPAs and MPA networks must be monitored, evaluated, and adaptively managed, however, so that their design, use, and management can respond to and possibly further anticipate changes in species' distributions, abundances, and productivities.

While the earlier parts of the paper show that incorporating connectivity in (ecological) MPAs is essential for MPAs to meet conservation goals at any point in time, this part shows that fostering connectivity processes in (ecological) MPAs is *also* critically important for MPAs to meet conservation goals in a time of significant, ongoing changes in the marine environment.

ACTION AGENDA: Connectivity-Informed MPAs And MPA Networks For Effective Marine Conservation and for Meeting the Challenges of Climate Change in the Marine Environment

The Action Agenda contains six Recommendations for immediate action by the Secretaries of Commerce and Interior, along with Guidelines for use by any MPA program - federal, state, territorial, tribal, or local - on incorporating connectivity into MPAs. Below are the full text of the Recommendations and an outline of the Guidelines (the Guidelines' full text is in the Action Agenda).

Recommendations for Action by the Secretaries of Commerce and Interior

With proactive action by ocean agencies and MPA managers, MPAs can be more effective conservation tools. By enhancing ecological connections among sites and creating an integrated network of ecologically linked MPAs, these places and the intervening areas around them can also be more resilient to the impacts of climate change. Fortunately, we possess the knowledge and the tools right now to meet this pressing challenge, if we act soon. As the Secretaries of Commerce and Interior, you have jurisdiction over, and responsibility for, the majority of federal MPAs and you play an important leadership role for MPAs throughout the nation. For these reasons, the MPA FAC recommends that you:

1. Begin immediately to strengthen the effectiveness and resilience of all MPAs within your respective jurisdictions by enhancing ecological spatial connectivity, using the MPA FAC Guidelines for Enhancing Effectiveness, Connectivity and Resilience in MPAs and MPA Networks ("MPA FAC Guidelines").
2. Urge and aid other MPA agencies and programs (in the federal government and in state, tribal, territorial and local governments) to enhance connectivity in, around, and among their MPAs, using the MPA FAC Guidelines.
3. Develop Secretarial-level guidance, resources and expectations for implementing the MPA FAC Guidelines. Distribute the MPA FAC Guidelines, together with the MPA FAC's scientific synthesis, to MPA agencies and programs at all levels of government throughout the nation.
4. Use governmental and academic experts to develop measures of connectivity among areas and within key species populations. Make these measures available to MPA agencies and programs at all levels of government throughout the nation.
5. Lead efforts to ensure funding and capacity for monitoring, evaluation, and adaptive management of MPAs and MPA networks Lead efforts to develop best practices for adaptive management in MPAs and MPA networks, and charge the MPA FAC with convening a working group on adaptive management.
6. Improve collaboration across the Departments of Commerce and Interior by ensuring that all key offices in the Departments leverage expertise, resources, and efforts.

Guidelines for Enhancing Effectiveness, Connectivity and Resilience in MPAs and MPA Networks

To support any US MPA agency or program - - federal, state, territorial, tribal, and local – charged with managing, implementing or creating MPAs, the MPA FAC offers the following guidelines for enhancing effectiveness, connectivity, and resilience in MPAs and MPA networks:

Use Existing Scientific and Traditional Knowledge about Connectivity:

a) build a connectivity roadmap of how local ecosystems are linked;
b) examine important external inputs;
c) evaluate climate change impacts;
d) build on existing knowledge;
e) evaluate how and where connectivity should be enhanced; and,
f) engage outside experts in these endeavors.

Enhance Connectivity and Resilience in Existing MPAs:

a) act (i.e. manage) inside the box (i.e. the MPA) to sustain vital MPA ecosystems;
b) act outside the box (i.e., work with other agencies to optimize beneficial inputs to the MPAs);
c) act way outside the box (i.e., minimize harmful inputs from distant activities on land and at sea);
d) evaluate the full range of available legal and policy tools;
e) evaluate additional or modified MPA coverage;
f) consistently use adaptive management principles;
g) coordinate with other agencies to enhance connectivity at common sites and across sites;
h) collaborate with other levels of government to enhance connectivity among MPAs and MPA networks;
i) leverage the MPA FAC Scientific Synthesis to expand understanding of the importance of ecological connectivity among managers and stakeholders; and
j) use best practices and existing statutes and regulations when managing or modifying MPAs and MPA networks.

Create Resilient MPAs and MPA Networks:

a) start here and build from these guidelines;
b) anticipate climate change impacts and the capacity of existing MPAs to meet those threats;
c) use critical design principles that consider replication, important life history stages, spacing, genetic diversity, economically and socially important species;
d) build MPA stepping stones for climate-driven range shifts;
e) replicate key habitats throughout the network;
f) use adaptive management principles including regular monitoring to inform future management adjustments;
g) use best practices and existing statutes and regulations when managing or modifying MPAs and MPA networks; and,
h) use MPAs to inform ocean management in relation to the impacts of climate change and other activities.

Conclusion

The Secretaries charged the MPA FAC with helping US MPA agencies increase the effectiveness and resilience of their MPAs by enhancing ecological spatial connectivity in MPAs and MPA networks. The FAC synthesized existing scientific information and crafted a set of practical and achievable actions and priorities. It is the hope, and expectation, of the MPA FAC that the Secretaries will take immediate and tangible steps to implement the FAC's recommendations and thereby ensure connectivity in US MPAs.

APPENDIX 1: Glossary

adaptive management – a structured, iterative process of monitoring, evaluation, and management decisions in the face of uncertainty. Adaptive management in MPAs and MPA networks consists of monitoring and evaluation, and, as needed, changes in management measures in an existing MPA, including regulatory and boundary changes, and the addition or removal of MPAs in a network. Adaptive management depends on clear articulation of the specific conservation purposes of the MPA or MPA network, so that protocols for monitoring can be properly designed and so that effectiveness of the MPA or MPA network can be measured against specific, articulated aims.

connectivity-informed MPA or MPA network – an MPA or network of MPAs designed, used, and managed to foster the ecological spatial connectivity processes important to the populations, species, communities, and/or ecosystems of concern in the MPA or network of MPAs.

community connectivity – the transfer of species between ecological communities resulting from the movement of one or more species among spatially separated ecological communities.

ecological community – the collection of species that co-occur and interact with one another in a particular habitat (e.g., a coral reef, kelp forest or seagrass bed).

ecological MPA - an MPA that focuses on restoring or maintaining ecological phenomena in the marine environment, i.e., populations, species, ecological communities, ecosystems or processes.

ecological spatial connectivity – the transfer of genes, organisms, species, materials (e.g., sediment), chemicals (e.g., nutrients), or energy (ecosystem connectivity) resulting from their movement among spatially separated populations, communities or ecosystems.

ecosystem – the biotic (i.e. organisms) and abiotic (i.e. physical and chemical) components of an environment that interact with one another, including species, geological features and oceanographic features (e.g., water currents, chemistry).

ecosystem connectivity – the transfer of species, chemicals (e.g., nutrients and pollutants), energy (in the form of organisms), and materials (e.g., sediments and debris) between ecosystems, resulting from their movement between spatially separated ecosystems.

genetic connectivity – the transfer of genes among populations of a species (also called “gene flow”), resulting from the movement of organisms between spatially separated local populations, whether spores of marine algae or the larvae, juveniles or adults of marine animals.

habitat – biotic and abiotic elements of the environment used by an organism.

marine environment - "'Marine environment’ means those areas of coastal and ocean waters, the Great Lakes and their connecting waters, and submerged lands thereunder, over which the

United States exercises jurisdiction, consistent with international law" (Exec. Order 13158: 2000). "Marine environment" includes "intertidal areas, bays or estuaries" (MPA Center 2015:10).

metacommunity – A collection of spatially separated communities that are connected to each other by the movement of species (i.e. by community connectivity).

metapopulation – A collection of spatially separated local or sub-populations of a species that are connected to each other by the movement of individuals of that species (i.e. by population connectivity).

population – A collection of individuals of the same species that co-occur in space and time and interact with one another.

population connectivity – The transfer of individuals among populations of a species resulting from the movement of individuals (spores, larvae, juveniles or adults) of a single species among spatially separated local or sub-populations.

resilience – The internal capacity of a system (e.g., organism, population, ecological community, human community, ecosystem, institution) to return to its original state or condition subsequent to a perturbation.

resistance – The internal capacity of a system (e.g., organism, population, ecological community, human community, ecosystem, institution) to resist change in the face of perturbation.

sink population – A local or subpopulation within a metapopulation that receives more individuals (spores, larvae, juveniles or adults) than it contributes to other subpopulations in the metapopulation.

source population – A local or subpopulation within a metapopulation that contributes more individuals (spores, larvae, juveniles or adults to other subpopulations) than it receives from other subpopulations in the metapopulation.

US MPAs - MPAs created and maintained by federal, state, tribal, territorial, or local authorities in the United States. US MPAs include federal MPAs but are not limited to federal MPAs.

APPENDIX 2: Membership of MPA Federal Advisory Committee and the MPA FAC Connectivity Subcommittee

MPA FAC:

George J. Geiger, Chair (2009-2016)
Della Scott-Ireton, Ph.D., Vice-Chair (2009-2016)
Brian Baird (2014-2018)
Rick Bellavance (2014-2018)
Mark Carr, Ph.D. (2014-2018)
Gary Davis (2009-2016)
Martha Honey, Ph.D. (2014-2018)
John Jensen, Ph.D. (2011-2016)
Stephen Kroll (2011-2016)
Stephanie Madsen (2014-2018)
Samantha Murray, J.D. (2014-2018)
Ryan Orgera, Ph.D. (2014-2018)
Jason Patlis, J.D. (2011-2016)
Catherine Reheis-Boyd (2011-2016)
Sarah Robinson, J.D., S.J.D. (2009-2016)
Ervin Joe Schumacker (2009-2016)
Peter Stauffer (2014-2018)
Trisha Kehaulani Watson, J.D., Ph.D. (2014-2018)
Stephen Welch (2011-2016)
Margaret Williams (2014-2018)

See http://marineprotectedareas.noaa.gov/fac/membership/ for more information.

MPA FAC Connectivity Subcommittee (2015-2016):

Mark Carr, Ph.D., Co-Chair
Sarah Robinson, J.D., S.J.D., Co-Chair
Gary Davis
Stephen Kroll
Samantha Murray, J.D.
Ervin Joe Schumacker
Margaret Williams

Charles Wahle, Ph.D., National MPA Center staff liaison to Connectivity Subcommittee