Appendix
Defenders of Wildlife technical comments on the Fish and Wildlife Service Climate Change Strategic Plan and 5-Year Action Plan

In addition to the broad recommendations we provided in our cover letter, we offer the following specific comments addressing a number of the objectives outlined in the Strategic Plan and the Action Plan:

Objective 1.3: Develop Landscape Conservation Cooperatives to Acquire Biological Planning and Conservation Design Expertise

Increase coordination and direction among LCCs
It is our understanding that each LCC that is "standing up" this fiscal year is reaching out to partners and assessing its needs in a different manner. Though there are certainly regional differences in ecology, climate change impacts, institutional capacity, and strengths of existing partnerships, there simply needs to be more direction and coordination between LCCs. At the very least, many of the same partners will be participating in more than one LCC, and this diversity in approaches and goals is confusing. For instance, many states have multiple LCCs overlapping their boundaries, so state wildlife officials would have to participate in three different LCCs in some areas. More broadly, a more coordinated approach is needed to contribute to the implementation of a national adaptation strategy and to develop consistent approaches to modeling, vulnerability assessments, adaptation strategies, and other needs.

Objective 1.4 Conduct Species and Habitat Vulnerability Assessments

Vulnerability assessments are a necessary step in adaptation planning and we applaud the Fish and Wildlife Service for recognizing the importance of these assessments in prioritization of species and landscape conservation. Once the relative vulnerability of a species, habitat or other conservation target to climate change is assessed it can then be combined with information about ongoing environmental threats to set goals, determine management priorities, and inform design of appropriate adaptation strategies. Vulnerability assessments should include not only an analysis of vulnerability but also the identification of specific options for stakeholders to reduce that vulnerability, as well as information about uncertainty inherent in the assessment. We offer the following suggestions for improving the focus on vulnerability assessments.

Coordinate efforts to develop vulnerability assessment methodology and build on existing approaches
Vulnerability assessments are recognized as a critical component in conservation planning under climate change, and as such many different agencies, organizations and institutions are working to develop vulnerability assessment methodology, or conducting assessments themselves. It is imperative that the Service works in a coordinated fashion both internally and with partners such as the National Climate Change and Wildlife Science Center and state wildlife agencies to develop a widely accessible, standardized methodology for vulnerability

assessment. The LCCs could also serve as a vulnerability assessment delivery center, in which assessments are developed and carried out and tested across multiple scales for different partners. We strongly encourage the FWS to share capacity and methodology with the states and local land managers in particular through the LCCs as states will need help completing vulnerability assessments.

The 5-Year Action Plan identifies at least three separate efforts within the FWS to develop vulnerability assessments: in the Endangered Species Division, in Fisheries and Habitat Conservation, and in the National Wildlife Refuge System. We strongly encourage the service to tie these efforts more tightly together and make sure methodologies developed are coordinated. There is no reason that these assessments should be different, though they may involve some different components.

Assess range-wide vulnerability at local and regional scales

It is difficult to assess the vulnerability of a species to climate change without considering its full range. For example, though a species may be vulnerable at a particular national wildlife refuge, it may be secure throughout the rest of its range. We therefore encourage the FWS to address vulnerability of species, habitats and management units at local and regional scales. This means using information about species vulnerability within a refuge and throughout its range to make management decisions.

Reevaluate use of SLAMM

The Sea Level Affecting Marshes Model (SLAMM) has been used by the FWS and others to examine vulnerability of coastal marshes to sea level rise. While SLAMM does have utility when used regionally at a coarse landscape scale, Defenders has serious reservations about the use of SLAMM to inform coastal refuge management at the unit scale.

There are several well-recognized shortcomings of the SLAMM model that make it inappropriate for use in refuge planning and management including: 1) scaling down the results of the analysis to the local level is not feasible;[1] 2) SLAMM assumes steady accretion rates through time when in all likelihood advancing sea levels will directly affect accretion rates; 3) SLAMM does not account for infrequent events that influence wetland development such as storms and floods or for frequent elevation feedback mechanisms on inundation and sedimentation; and 4) SLAMM relies heavily on the use of elevation data, which if only Digital Elevation Model (DEM) data is available, will not provide meaningful results at the scale of sea level rise expected.

[1] Cahoon, D.R., D.J. Reed, A.S. Kolker, M.M. Brinson, J.C. Stevenson, S. Riggs, R. Christian, E. Reyes, C. Voss, and D. Kunz. 2009. Coastal wetland sustainability. In: *Coastal Sensitivity to Sea Level Rise: A Focus on the Mid-Atlantic Region.* A report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. [J.G. Titus (coordinating lead author), K.E. Anderson, D.R. Cahoon, D.B. Gesch, S.K. Gill, B.T. Gutierrez, E.R. Theiler, and S.J. Williams (lead authors)]. U.S. Environmental Protection Agency, Washington, DC, pp. 157-162.

Given these shortcomings, and the high cost of running a SLAMM model (estimates report $50,000 per refuge),[2] we strongly recommend the FWS investigate alternative approaches to assessing coastal vulnerability.

Catalog shoreline infrastructure features

Cataloging shoreline infrastructure features is also an important component of a vulnerability assessment. This information will allow FWS to determine where marsh migration and restoration is most feasible and where infrastructure needs to be altered or removed to restore natural hydrology and allow for marsh migration. Areas where natural hydrology has been severely compromised by infrastructure or areas with high development where increased shoreline armoring is likely in the future may not be the best areas for restoration efforts, land acquisition or migration facilitation.

Employ the results of vulnerability assessments to inform Refuge Strategic Growth and other policies

The strategy and action plan are largely silent as to how FWS will utilize completed vulnerability assessments. We suggest FWS use the results to inform development and implementation of the National Fish and Wildlife Adaptation Strategy and fulfillment of the near-term, on-the-ground efforts of objectives 2.2-2.10, as is explicitly stated only for Actions 2.2.1 and 2.2.4.[3]

As we recommend in our cover letter, the Service should develop a new vision for the growth of the Refuge System in response to climate change. FWS should use the information obtained from vulnerability assessments as it directs funds for strategically growing the National Wildlife Refuge System pursuant to the National Wildlife Refuge System Improvement Act of 1997.

In addition to assessing the most vulnerable locations to climate change, assessments should also identify less vulnerable locations, or locations with lower projected rates of relative exposure and sensitivity to climate change. While management of high risk systems is important, it may also be valuable to work in areas with high natural resource values and lower vulnerability so that there is more time to help the system adjust to climate change and so that these low risk areas can act as refugia. For example, a step that may be taken to help coastal marshes survive sea level rise is acquiring land upland of coastal wildlife refuges.

Determining which areas represent areas most important for FWS management objectives may help to target limited funds to the most strategic locations across the landscape.

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[2] Theoharides, K.A. G. Barnhart & P. Glick. 2009. Climate Change Adaptation Across the Landscape: A Survey of Federal and State Agencies, Conservation Organizations and Academic Institutions in the United States.

[3] *See, e.g.,* Action Plan at 7 (directing, in Objective 2.2.1, FWS units to "use the initial results of the species and habitat vulnerability assessments conducted under Objective 1.4 to begin prioritizing conservation actions to sustain these [climate vulnerable] species and habitats").

Objective 1.5 Incorporate Climate Change in Service Activities
Defenders supports FWS's commitment to considering climate change across the spectrum of its activities. Consideration in resource, operations, and administrative plans ensures that FWS addresses climate change at every opportunity and minimizes the potential for activities to compete against climate change priorities. Reviewing and revising grant criteria to prioritize climate change will also help encourage action beyond FWS. We are pleased that the Action Plan allows for climate change to be incorporated into both new and existing plans, and that revised grant criteria will be applied no later than FY 2011.

Provide guidance for incorporating climate change into plans
Under Action 1.5.5, Assistant and Regional Directors are charged with implementing the Director's Order "to incorporate climate change into new plans and decisions." The Action Plan should identify national guidelines and policies needed to standardize the types of climate change information required in various plans and ensure that important elements are not overlooked.

Objective 1.6 Provide Requested Support to State and Tribal Managers to Address Climate Change Issues that Affect Fish and Wildlife Service Trust Resources
Defenders of Wildlife strongly supports the Service's objective to provide support to the state wildlife agencies and tribal managers as they work to address climate change issues. Like the FWS, the challenges that states and tribes face in managing wildlife under climate change are immense, particularly in a time of limited agency budgets.

Use LCCs to provide states and tribes with relevant science, models and planning materials
Climate change offers a perfect opportunity for FWS to partner with state agencies and tribes through FWS regional offices or LCCs, as well as an opportunity to sit on state and tribal stakeholder groups as they develop climate change adaptation strategies. Defenders encourages FWS to use the LCCs to help build partnerships with states and tribes, to assess the needs of state and tribal land managers, and to deliver conservation tools and data to address these needs. We also encourage the FWS to use the state wildlife action plans in the context of the LCCs and deliver tools and conservation strategies that are at the scale of these plans. The FWS should look for opportunities to learn from climate change adaptation plans being prepared in the states and use these to develop models for how the FWS can provide guidance to other states which are just beginning to approach this issue. The FWS could also work to develop training material that can be delivered through LCCs and the National Conservation Training Center to increase the capacity of agency staff to understand climate change science and to develop adaptation strategies.

Objective 2.1: Implement the National Fish and Wildlife Adaptation Strategy as the Service's Long-term Adaptive Response to Climate Change.
Action 2.1.1 calls for the FWS to develop a "national memorandum of agreement to collaborate in identifying and designating landscape-level habitat linkages and wildlife

corridors across public lands." We recommend moving this action to Objective 2.3: Promote Habitat Connectivity and Integrity.

Act now to promote habitat connectivity
Defenders strongly supports actions that protect and restore habitat connectivity across the landscape and view habitat connectivity as a key climate change adaptation strategy. Though the Action Plan links this particular action to the National Adaptation Strategy, there is no reason to wait until that strategy is completed to implement this memorandum. In fact, part of this MOA was already signed in June, 2009.[4] The Department of the Interior signed a MOA with the Western Governors Associate (WGA), the Department of Agriculture and the Department of Energy to assist in the development of a wildlife corridors and crucial habitat mapping and decision support tool. The development of such a tool was a chief recommendation stemming from the WGA wildlife corridor and crucial habitat initiative.[5] The development of this information will help identify important landscape-level habitat linkages and wildlife corridors.

What is needed is action to implement protection and restoration of habitat connectivity. We recommend that the timeline for Action 2.1.1 be moved up to fiscal year 2010. In addition, because habitat connectivity is multi-jurisdictional (and not just on public lands), we recommend striking "across public lands" from Action 2.1.1.

Objective 2.3 Promote Habitat Connectivity and Integrity

Develop and implement a coordinated, national network of conservation lands
Habitat connectivity at the scale needed for climate change adaptation will require land-management agencies, land conservation groups, and administrators of conservation incentive programs to plan conservation strategically, collaboratively define priority lands and actions, and invest in these priorities first. Though the Strategic Plan suggests that landscape conservation design to achieve a functioning, connected network of habitat would be accomplished through the LCCs, the actions in the Action Plan are devoid of any reference to the LCCs to implement this important objective.

As important, the actions in the Action Plan have no national framework to bound decision making to ensure that regional actions are achieving a broader vision. As we recommend in our cover letter, we strongly recommend one action be the development of a strategic land protection policy for the Refuge System to provide this framework, including the relationship with LCCs and other institutions, partnerships, and programs. This policy would outline a process for prioritizing the expansion of existing national wildlife refuges, the creation of new refuges and the use of additional land protection tools. Through the development of a strategic land protection policy, the FWS Land Acquisition Priority System

[4] See http://www.westgov.org/wga/initiatives/corridors/wildlifeMOU.pdf
[5] See http://www.westgov.org/wga/initiatives/corridors/index.htm for more information.

(LAPS) should be revised to assist in achieving its goals. Revision of LAPS, particularly to address the impacts of climate change, should be identified in the Action Plan.

Additional funding
Finally, the Action Plan should identify the need for additional funding under the Land and Water Conservation Fund, the chief source of funding for FWS land protection besides the Migratory Bird Fund.

Objective 2.2 Take Conservation Action for Climate-Vulnerable Species.
Begin to implement adaptation strategies immediately and practice active adaptive management
Natural resource managers will face uncertainty about vulnerabilities, selection of conservation actions, and the outcomes of management strategies for climate change adaptation. Although there is consensus on the general effects of increased concentrations of greenhouse gases, it is impossible to predict the magnitude and nature of other predicted changes due to uncertainties in general circulation models, emission scenarios, and the current status of species and habitats. We understand then that planning and developing adaptation strategies to manage species and habitats in a climate change world is a daunting task. We applaud the FWS's efforts to develop and conduct vulnerability assessments to determine the most vulnerable conservation targets, but also urge the Service to begin implementing "no-regrets" management strategies that are robust to uncertainties immediately.

Managing under uncertainty requires a flexible, iterative approach. Some management strategies are likely to be beneficial under a range of future climate conditions. Increasing connectivity, restoring ecological integrity, and removing invasive species are examples of strategies that are likely to be beneficial under different climate change outcomes because they do not address a specific climate change threat. Actions that depend on specific climate change trajectories (e.g. trans-locating species) carry a higher risk of failure due to uncertainty of future conditions.[6]

Work with states and other land management agencies.
Defenders believes that the current action plan does not fully reflect the guidance of Sec. Order 3289, which states that "Because of the unprecedented scope of affected landscapes, Interior bureaus and agencies must work together, and with other federal, state, tribal and local governments and private landowner partners to develop landscape-level strategies for understanding and responding to climate change impacts." Implementing the full suite of conservation actions for climate vulnerable species will require partnerships between the Fish and Wildlife Service, the other agencies of the Department of the Interior, and working with agencies in the Department of Agriculture (particularly the Forest Service and the Natural Resources Conservation Service), Commerce (NOAA), and Defense (Army Corps

[6] Lawler, J.J., T.H. Tear, C. Pyke, M.R. Shaw, P. Gonzalez, P. Kareiva, L. Hansen, L. Hannah, K. Klausmeyer, A. Aldous, C. Bienz, and S. Pearsall. 2009. Resource management in a changing and uncertain climate. Frontiers in Ecology and the Environment 7.

of Engineers, wildlife managers on DoD lands) as well as with state fish and wildlife agencies, tribes and NGOs. We urge the FWS to more fully outline its plan for working with these diverse partners.

Use the Conservation Registry to track conservation actions.
The Action plan calls for Actions 2.2.2 and 2.2.5 to be spatially integrated with recommendations for landscape-scale habitat connectivity (Objective 2.3). To facilitate learning, track successes, and better coordinate conservation actions for climate-vulnerable species, Defenders of Wildlife recommends that FWS utilize and promote an already-existing tool, the Conservation Registry (www.conservationregistry.org). FWS, BLM, USGS, USDA, and multiple state agencies and NGOs are already partners in the Conservation registry, which is an online, centralized database that records, tracks and maps on-the-ground conservation projects. The purpose of the Registry is to help users understand the context, distribution, and effectiveness of collective efforts to protect and restore ecosystems. The Registry can also act as a project management tool for those agencies and organizations that do not have the resources to build their own tracking database or still track projects on paper.

Objective 2.4: Identify and Fill Priority Freshwater Needs
Defenders is encouraged by the FWS's recognition of the importance of helping freshwater ecosystems adapt to climate change. "Of all ecosystems, freshwater ecosystems will have the highest proportion of species threatened with extinction due to climate change."[7] FWS rightly states that water is the key to life and it will be a critical issue for all of FWS's mission areas: national wildlife refuges, national fish hatcheries, threatened and endangered species, migratory birds, and fish and aquatic species conservation. We are troubled, though, that FWS has framed its work in this area within the limited context of human adaptation to climate change: "[a]s these human adaptations [of our nation's water supply infrastructure] are crafted, we will work with partners … to ensure water resources of adequate quantity and quality to support biological objectives are incorporated."[8]

Balance human adaptation and natural resources adaptation
Climate change does offer an opportunity to re-evaluate water delivery and flood control structures and to use the same tools for reducing the vulnerabilities of both infrastructure and ecosystems to climate change. Our nation's track record, though, in recognizing and integrating the value of ecosystems in our natural resource decisions is poor. Even without

[7] Kundzewicz, Z.W., L.J. Mata, N.W. Arnell, P. Döll, P. Kabat, B. Jiménez, K.A. Miller, T. Oki, Z. Sen and I.A. Shiklomanov, 2007: Freshwater resources and their management. *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change,* M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 173-210, 192.
[8] Strategic Plan at 21.

climate change, freshwater ecosystems and species are the nation's most imperiled.[9] Fish are second to, and closely approaching, amphibians in degree of imperilment.[10] Few ecosystems are suffering greater losses of biodiversity than lakes and rivers: over 300 freshwater species are listed or proposed for listing under the ESA and the projected extinction rate of freshwater animals is five times that of terrestrial.[11] FWS will likely need to redouble its efforts to achieve this goal.

In order to do so, FWS should provide guidance for the resolution of potential conflicts among the adaptation strategies or actions of different sectors. Much has been written about the challenges and uncertainties presented by the effects of climate change on water delivery, water treatment and flood control infrastructure and on ecosystems.[12] Both water and wildlife managers are seeking complementary adaptation strategies for freshwater ecosystems and water infrastructure.[13] Unfortunately, it is equally true that these strategies may be at odds and human adaptation actions may have disastrous impacts on wildlife and their habitats.[14] In order to reverse the continuing degradation of freshwater ecosystems and to assist in their adaptation to climate change, FWS should place priority on freshwater ecosystems and mutually beneficial strategies.

Address the full range of influences on the watershed

FWS also should not artificially limit adaptation objectives for freshwater resources to collaboration with water managers and water supply infrastructure. Instead, FWS should endeavor to collaborate with the full range of watershed influences on freshwater ecosystems. For example, lands and land managers, such as our national forests and other public lands, within the watershed, are also critical to functioning riparian and aquatic ecosystems.

Employ vulnerability assessments

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[9] Shaw, R.M., Pendleton, L., Cameron D., Morris, B., Bratman, G., Bachelet, D., Klausmeyer, K., MacKenzie, J., Conklin, D., Lenihan, J., Haunreiter, E., and Daly, C. 2009. The Impact of Climate Change on California's Ecosystem Services (A Paper from California Climate Change Center), available at http://www.energy.ca.gov/2009publications/CEC-500-2009-025/CEC-500-2009-025-D.PDF.

[10] Helfman, Gene S. 2007. *Fish Conservation: A Guide to Understanding and Restoring Global Aquatic Biodiversity and Fishery Resources.*

[11] Ricciardi, A.. and J.B. Rasumssen. 1999. Extinction rates of North American freshwater fauna. Conservation Biology 13:1220-1222.

[12] Milly, P.C.D., J. Betancourt, M. Falkenmark, R.M. Hirsch, Z.W. Kundzewicz, D.P. Lettenmaier, and R.J. Stouffer. 2008. Stationarity Is Dead: Whither Water Management? *Science* 1 February 2008: 573-574; Hamlet A.F., and D.P. Lettenmaier. 2007a. Effects of 20th century warming and climate variability on flood risk in the western U.S., Water Resour. Res., 43, W06427, doi:10.1029/2006WR005099; Hulme, P.E. 2005. Adapting to climate change: is there scope for ecological management in the face of a global threat? J. of Applied Ecology. 42: 784-794.

[13] *See* California Natural Resources Agency, *2009 California Climate Adaptation Strategy, Discussion Draft* 83-84 (2009), available at http://www.energy.ca.gov/2009publications/CNRA-1000-2009-027/CNRA-1000-2009-027-D.PDF.

[14] Frederick, K.D., and P.H. Gleick. 1999. Water and Global climate change: Potential Impacts on U.S. Water Resources. Prepared for the Pew Center on Global Climate Change. 48pp.

Lastly, and as stated above, we believe the vulnerability assessments of Objective 1.4 should inform not just refuge and hatchery water and climate adaptation, as described in Action 2.4.3, but all water and climate adaptation, particularly Action 2.4.4.

Develop a refuge water resources policy

The FWS has long recognized that water quality and availability is one of the greatest challenges facing the National Wildlife Refuge System. In the 1997 Refuge Improvement Act Congress stated that "adequate water quantity and quality" must be maintained to "fulfill the mission of the system and the purposes of each refuge." As climate change and increasing human demand threatens water needs for conservation, Defenders urges the FWS to develop a strong water resources policy to address and plan for this challenge. Such a policy should help land managers secure and defend water rights on refuge lands, and establish a standardized protocol for water assessments. FWS should hire professional hydrologists for each region to assess the availability of water supply, status of existing and needed water rights and the projected water needs for each refuge. Information from this assessment should be a component of future land management and land and water acquisitions. Refuge management should also develop habitat management strategies and population targets that minimize pollution of local watersheds.[15]

Objective 2.6 Reduce Susceptibility to Diseases, Pathogens and Pests

Defenders recognizes the grave danger to wildlife from pests, diseases and pathogens, particularly in an era of changing climate. Our recent white paper, "A Plague Upon Them: Helping Wildlife Adapt to Climate Change and Disease," details the mechanisms by which several diseases, including avian malaria, West Nile virus, chytrid fungus, whirling disease, ichthyophoniasis, and others are threatening fish and wildlife, with a particular emphasis on how each disease threat is exacerbated by climate change (Delach 2009). The report found that climate changes, including warmer temperatures, precipitation changes, and lengthened growing seasons, are interacting with diseases in a number of important ways: benefit to the pathogen, benefit to the vector, stress to the host organism, and synergistic impacts, like the convergence of the first three factors, or of multiple diseases.

The report recommends a variety of measures that should be undertaken to meet this threat, including: 1) improved surveillance for diseases; 2) additional research into the dynamics of disease, climate change, and other wildlife threats; and 3) measures to ameliorate the threats of climate change and wildlife disease. Unfortunately, we also found that the threat of disease has not been at the forefront of climate change adaptation research and planning for most agencies. For instance, Defenders of Wildlife recently conducted interviews with 68 wildlife professionals from federal and state agencies, non-governmental conservation organizations and scientists who are working on climate change adaptation. The experts

[15] Keeping Every Cog and Wheel. Reforming and Improving the National Wildlife Refuge System. 2008. The Aldo Leopold Foundation, American Bird Conservancy, Defenders of Wildlife, National Audubon Society, National Wildlife Federation, National Wildlife Refuge Association, Trust for Public Land and the Wilderness Society.

interviewed were asked to discuss their planning efforts, techniques and practices related to helping wildlife adapt to climate change.[16] Not a single one of the professionals interviewed volunteered disease as one of the climate change threats, or as an issue that needed to be addressed in the context of climate change adaptation (K. Theoharides; pers. comm.). Moreover, the disconnect works in reverse as well: the most important web-based wildlife disease resource, the USGS/University of Wisconsin's Wildlife Disease Information Node, contains very little mention of climate change (WDII, undated).

Given the magnitude of the threat and the disproportionately little attention it has received, Defender of Wildlife applauds the U.S. Fish and Wildlife Service for recognizing the grave threat that diseases and pathogens pose to wildlife in the face of climate change. Defenders fully supports all of the actions outlined in Objective 2.6 (Actions 2.6.1 through 2.6.5). We offer the following comments to broaden and strengthen FWS's approach to reducing the susceptibility to diseases, pathogens and pests.

Shorten timelines

The current draft of the Action Plan lists only a single action for Fiscal Year 2010, the formation of a national disease advisory team. All other actions, including development of monitoring and surveillance, identification of vulnerable populations, development of action plans, and data analysis, are pushed to FY 2011 and beyond. While it is true that much research is still needed, much is already being done, and much is already known. Those actions already known to reduce vulnerability to disease in the face of climate change—such as acquisition and reforestation of high elevation habitats in Hawaii to provide refugia from avian malaria-- should proceed without delay. And further investigation of the viability of other strategies, like vaccinating critically imperiled bird populations for West Nile Virus, should also begin immediately.

Improve dissemination of climate and disease information

More attention to climate change and wildlife disease is also needed at other federal agencies and research centers, such as the USGS National Climate Change and Wildlife Science Center, National Wildlife Health Center, and the other federal wildlife research centers. As mentioned above, very little information on the interactions of climate change and wildlife disease is readily available to the public through channels such as the Wildlife Disease Information Node.

Work with states and a broader array of federal agencies

Disease, pest and pathogen issues associated with climate change occur across multiple boundaries of ecosystem types, landowners, agency jurisdictions, and species. Addressing disease will therefore require the effort not just of the Fish and Wildlife Service, but virtually every agency involved in natural resources management, including the National Oceanic and

[16] Theoharides, K.A. G. Barnhart & P. Glick. 2009. Climate Change Adaptation Across the Landscape: A Survey of Federal and State Agencies, Conservation Organizations and Academic Institutions in the United States.

Atmospheric Administration (e.g. coral reef diseases and algal blooms that harm marine mammals), the U.S. Forest Service (pests and disease in National Forests, state and private forestry, and research), and others. Furthermore, many of the species being impacted by diseases do not fall under the direct jurisdiction of the FWS, including many non-ESA mammals, reptiles, amphibians, and non-MBTA bird species (like prairie grouse). As described above, disease has received scant attention by state fish and wildlife agencies in their climate change adaptation planning. A comprehensive response to climate change and disease will necessitate working with all of these partners to assess vulnerabilities, monitor population changes and develop solutions that reduce vulnerabilities.

Recognize the need to integrate disease into other objectives and actions.
Wildlife and habitat health concerns overlap with multiple other objectives and actions under the Climate Change Strategic Plan, including but not limited to development and implementation of a Wildlife Adaptation Strategy (Objectives 1.1 and 2.1), species and habitat vulnerability assessments (Objective 1.4), conservation actions for climate-vulnerable species (Obj. 2.2), and managing priority freshwater needs (Objective 2.4). While we appreciate FWS calling separate attention to disease issues, we urge that in practice disease not be treated in a vacuum, but integrated with other aspects of planning and response to climate change. On the other hand, while promoting habitat connectivity (Objective 2.3), is a tremendously important objective for helping wildlife adapt to climate change, the potential exists for connectivity to have unintended consequences, namely the facilitation of pest and disease movement. In order to minimize negative side effects from beneficial actions such as increasing connectivity, we again recommend that FWS not manage its objectives independently, but should take an integrated approach to climate change actions.

Objective 2.7 Conserve Coastal and Marine Resources
Managing coastal and marine resources with sea level rise, increasing storm surges, upper ocean warming, altered freshwater distribution as well as ocean acidification will present numerous challenges to federal and state agencies as well as local governments and private landowners. Defenders commends the FWS for recognizing the magnitude of this challenge and we offer the following suggestions for conserving coastal and marine resources in a climate change future.

Develop an agency-wide policy to address and respond to the impacts of sea level rise on coastal resources
The FWS has large landholdings along the coastline that could erode or become submerged as sea level rises, and currently the FWS does not have an official policy to deal with the impacts of sea level rise though these impacts are already occurring.[17] Tidal marshes, submerged aquatic vegetation, estuarine beaches, tidal flats, freshwater tidal forest systems,

[17] Titus, J.G. 2009. Ongoing adaptation. In: *Coastal Sensitivity to Sea Level Rise: A Focus on the Mid-Atlantic Region.* A report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. [J.G. Titus (coordinating lead author), K.E. Anderson, D.R. Cahoon, D.B. Gesch, S.K. Gill, B.T. Gutierrez, E.R. Theiler, and S.J. Williams (lead authors)]. U.S. Environmental Protection Agency, Washington, DC, pp. 157-162.

marsh and barrier islands, cliffs and other coastal habitats will all lose ground with sea level rise and experience impacts such as changes in tidal range, saltwater intrusion, erosion and increases in the frequency and duration of flooding. Many acres of protected coastal habitat may be lost or change in structure and function with consequences for many species the FWS is responsible for managing including the endangered red wolf.

In addition to working to understand coastal vulnerabilities to sea level rise and developing management strategies, the FWS needs to develop an agency-wide strategy and policy-making framework for dealing with land management decisions on coastal resources undergoing sea level rise. This framework should provide national perspective on planning and decision-making for management of coastal resources with sea level rise and help the FWS engage and coordinate with other land management agencies, state and local governments, private landowners and other stakeholders.

In addition to an agency-wide policy for addressing sea level rise, the FWS should work closely with the National Park Service, the National Oceanic and Atmospheric Agency (NOAA), the Environmental Protection Agency (EPA), affected states, NGOs, and universities to develop shared research and management capabilities. It makes little sense for coastal refuges to be developing an understanding of management responses to sea level rise in isolation of other entities also developing similar strategies.

Reassess use of SLAMM
Defenders has serious concerns with the use of SLAMM for individual Refuge management decisions. See Objective 1.4 above for more specifics.

Acquire open space for coastal marshes and associated habitats to migrate inland
As the sea rises the fate of coastal marshes depends on their rate of vertical accretion and their ability to move inland. Human development and infrastructure leave little room for tidal marshes to transgress inland, and insufficient rates of sediment delivery, steep slopes, geologic barriers, and rapid rates of sea level rise can all prevent inland migration, but protecting upland habitat to allow wetlands to migrate inland is an important part of an integrated strategy to protect coastal resources. Secretarial Order No. 3289 states that strategies to address sea level rise may require acquisition of upland habitat and creation of wetlands and other natural filters and barriers to protect against sea level rise and storm surges. Dry land available for potential wetland migration is estimated to be less than 20% of the current area of wetlands in the mid-Atlantic region [18] and given current policies and land use trends may not be available in the future.[19] Existing statutes give the FWS and

[18] Titus, J.G. and J. Wang. 2008. Maps of lands vulnerable to sea level along the middle Atlantic coast of the United States: an elevation data set to use while waiting for LIDAR. Section 1.1 in: *Background Documents Supporting Climate Change Science Program Synthesis and Assessment Product 4.1: Coastal Elevations and Sensitivity to Sea Level Rise* [Titus, J.G. and E.M. Strange, (eds.)]. EPA 430R07004. U.S. Environmental Protection Agency, Washington, DC, pp. 2-44.
[19] Titus, J.G., 2009: Part III Overview: Preparing for sea-level rise. In: *Coastal Sensitivity to Sea Level Rise: A Focus on the Mid-Atlantic Region.* A report by the U.S. Climate Change Science Program and the Subcommittee

other coastal land management agencies the authority to foster the landward migration of wetlands through acquisition and land management.

Given that the effects of sea level rise are already occurring in refuges along the coast, the FWS should immediately begin the process of identifying and prioritizing upland sites adjacent to coastal refuges for strategic land acquisition and incorporate this information into the Land Acquisition Priority System. The FWS should also incorporate available information from studies examining both regional vulnerability to sea level rise and the potential use of shoreline armoring or other shoreline development. For example, the recently released study by Titus and others at EPA estimate that based on 131 state and local land use plans, almost 60% of the land below one meter along the US Atlantic Coast is expected to be developed and thus unavailable for the inland migration of wetlands. Less than 10% of the land below one meter has been set aside for conservation. Knowledge of where development and shore protection may be likely in the future can be used to guide acquisition and restoration efforts.[20]

Employ diverse adaptation strategies to address sea level rise

Adaptation includes actions that increase the resistance and resilience of a system to climate change and facilitate a change of state. Oftentimes a combination of all three types of strategies should be employed to help systems and species adapt to climate change. There are a number of actions that can slow coastal habitat loss, enhance marsh migration potential and buy time for systems losing ground. The FWS should strive to maintain a balance between the acquisition of new holdings upslope side of refuges and other properties and the use of active management strategies to increase the resiliency of a coastal system and resist some of the impacts of sea level rise. While resistance over the long-term will be an exercise in futility, employing some low-cost resistance strategies in the near-term may help marshes to expand inland.

Resistance strategies include development of living shorelines, use of oyster breakwaters, and other strategies such as the use of dredge material. While these actions can buy time for the marsh, we encourage the FWS not to sink large amounts of funds into these actions since ultimately most will fail over the long term given the current projections of sea level rise over the coming century and the serious risk of massive melting of polar ice sheets.

Enhancing vertical accretion at sites where vertical accretion is not keeping pace with sea level rise is a key strategy to increase resilience and help build marsh elevation. Vertical accretion can be impaired by human activities, such as water flow management, development

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on Global Change Research. . [J.G. Titus (coordinating lead author), K.E. Anderson, D.R. Cahoon, D.B. Gesch, S.K. Gill, B.T. Gutierrez, E.R. Theiler, and S.J. Williams (lead authors)]. U.S. Environmental Protection Agency, Washington, DC, pp. 157-162.

[20] Titus, J.G., D.E. Hudgens, D.L. Trescott, M. Craghan, W.H. Nuckols, C.H. Hershner, J.M. Kassakian, C.J. Linn, P.G. Merritt, T.M. McCue, J.F. O'Connell, J. Takski, and J. Wang. 2009. State and local governments plan for the development of most land vulnerable to rising sea level along the US Atlantic Coast. *Environmental Research Letters* 4: 1-7

that alters drainage patterns and beach nourishment and inlet modification, which thwarts barrier island overwash. Loss of vertical accretion prevents a marsh from maintaining its elevation and from expanding horizontally. In areas where accretion has been impaired, restoring natural processes before the wetlands are lost is more effective than artificially re-creating them.

Acquisition of strategically located land upslope, removal of obstacles to marsh migration, prevention and removal of shoreline armoring, and restoration of upslope habitat are all strategies that will help facilitate marsh migration. These are strategies which over the long term hold more potential to maintain some amount of coastal marsh habitat.

Address conflicts between human adaptation and natural resource adaptation
The FWS should begin to work proactively to address inevitable future conflicts between sustaining public trust values and protecting private property. Current policies allow shoreline armoring to protect private property from erosion and sea level rise. In the Coastal Zone Management Act (CZMA 1996) Congress finds and declares that it is national policy to manage coastal development to minimize the loss of life and property caused by improper development in floor-prone, storm surge, geological hazard, and erosion-prone areas, and in areas likely to be affected by vulnerability to sea level rise, land subsidence, and salt water intrusion. Congressional findings (§302) calls for coastal states to anticipate and plan for sea-level rise and climate change impacts. The FWS should strive to develop working relationships with organizations such as the Coastal States Organization who are deeply involved in the issue.

Shoreline armoring and bulk-heading will prevent coastal wetlands and other shoreline habitats from migrating to higher ground and hasten the loss of these habitats. Solutions such as rolling easements or targeting restoration efforts to locations with minimal development have been suggested, but all options need further development and honest discussion with stakeholders from all sides. The FWS should work collaboratively with stakeholders to address the potential loss of private property and the need to protect natural resources. The FWS should also immediately begin to protect land upslope for marsh migration, before it becomes developed or shoreline armoring if put in place.

Collect elevation, accretion and subsidence data to understand marsh vulnerability to sea level rise
Critical to the understanding of coastal marsh vulnerability to sea level rise is a mechanistic understanding of the processes that contribute to marsh elevation such as accretion and subsidence. A renewed emphasis on scientific measurements and monitoring will help to develop this information base, and the FWS should look for opportunities to partner with universities and other science providers to obtain this type of information.

Objective 2.8 Address Fish and Wildlife Needs in Renewable Energy Development
Defenders supports the U.S. Fish and Wildlife Service's efforts to facilitate a balanced approach between rapid renewable energy development and biological protections. The

Administration's push for renewable energy development is a cornerstone of its energy, environmental, and economic policies and a central component of the effort to combat global warming. Defenders strongly supports the development of renewable energy, but not at the expense of ecologically sensitive wildlife and habitat. We believe that renewable energy development can be done in a way that avoids and minimizes adverse impacts to wildlife and habitat and we applaud the Service for developing a comprehensive approach for wildlife and habitat impact information gathering and dissemination.

Objective 3.1 Develop a National Biological Inventory and Monitoring Partnership
Defenders applauds the FWS for elevating the importance of a national inventory and monitoring partnership and outlining a process to move this objective forward. We have the following recommendation to improve the program.

Make use of existing data
Existing long-term data sets on species and ecosystems may help managers identify changes in status or conditions occurring in response to climate change. Monitoring data has generally not been examined through the lens of climate change and there may be opportunities to use this data in new ways to assess ecological responses to ongoing climate change and to identify particularly sensitive species or ecosystems.[21] At the very least, all long-term datasets should be examined for climate change related signals and trends and used to provide baseline conditions for ongoing monitoring. FWS should not rely exclusively on its own data, but where possible access data from the scientific community, other federal and state agencies, and the conservation organizations in an effort to develop the most complete understanding of current species' status.

[21] Theoharides, K.A. G. Barnhart & P. Glick. 2009. Climate Change Adaptation Across the Landscape: A Survey of Federal and State Agencies, Conservation Organizations and Academic Institutions in the United States.