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# Economic Approaches for Managing Migratory Bird Habitat Across Multi-Owner Landscapes

*By Sonja H. Kolstoe[1], Jeffrey D. Kline[2], Luanne Lohr[3]*

**Abstract**
Migratory bird populations rely on a continuum of habitat along their migratory path. Along the Pacific Flyway in the United States, this habitat consists of land under a mix of different management entities and landownerships including federal, state, and local land management agencies, Tribes, and private landowners. Effective management of migratory bird habitat relies on coordination among these different entities to ensure both sustained flyway continuity and habitat quality sufficient to maintain healthy migratory bird populations. We consider the challenges involved in the conservation planning problem in managing migratory bird habitat and suggest how economics can inform developing and facilitating coordinated strategies.

**Short description (250-character limit):** Migratory birds rely on a continuum of habitat on land owned and managed by different entities, from various government agencies to private landowners. We discuss how economics can inform efforts to improve the coordination of conservation planning and management.

**JEL classification:** Q24, Q26, Q28

**Keywords:** Migratory birds, Pacific Flyway, habitat management, habitat enhancement, conservation, spatial and temporal coordination

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## I. Challenge of Multi-Ownership Landscapes

Migratory birds rely on continuums of habitats along their species' range, some of which may be thousands of miles in length. The individual habitats along these migratory flyways provide the landscape characteristics (e.g., food, cover, etc.) necessary to support summer breeding, winter non-breeding periods, and spring and fall migration. These factors add spatial and temporal complexity to conservation planning by expanding the areas of consideration from one to four landscapes. For optimal habitat management, conservation efforts must be coordinated across multiple types of landowners on a single landscape, a planning problem that is significantly more complex across

[1] Corresponding author and a research economist.
[2] research forester in the Pacific Northwest Research Station
[3] national program lead for economics research in the Washington Office at the USDA Forest Service

multiple landscapes. International agreements address coordination across international borders, shifting the problem focus from facilitating international cooperation across borders to coordinating domestic conservation efforts. In the United States (U.S.) the Migratory Bird Treaty and the Western Hemisphere Convention are examples of international agreements that guide the international coordination effort, and the Federal U.S. Government assumes oversight responsibilities (through federal laws and agencies) for the coordination of the country's overall bird conservation objectives across different landowner types (Anderson et al., 2018; U.S. FWS, n.d.). There are four major flyways in the U.S. (Pacific, Central, Mississippi and Atlantic shown in the reference map in Figure 1) and we focus on the Pacific Flyway as our example.

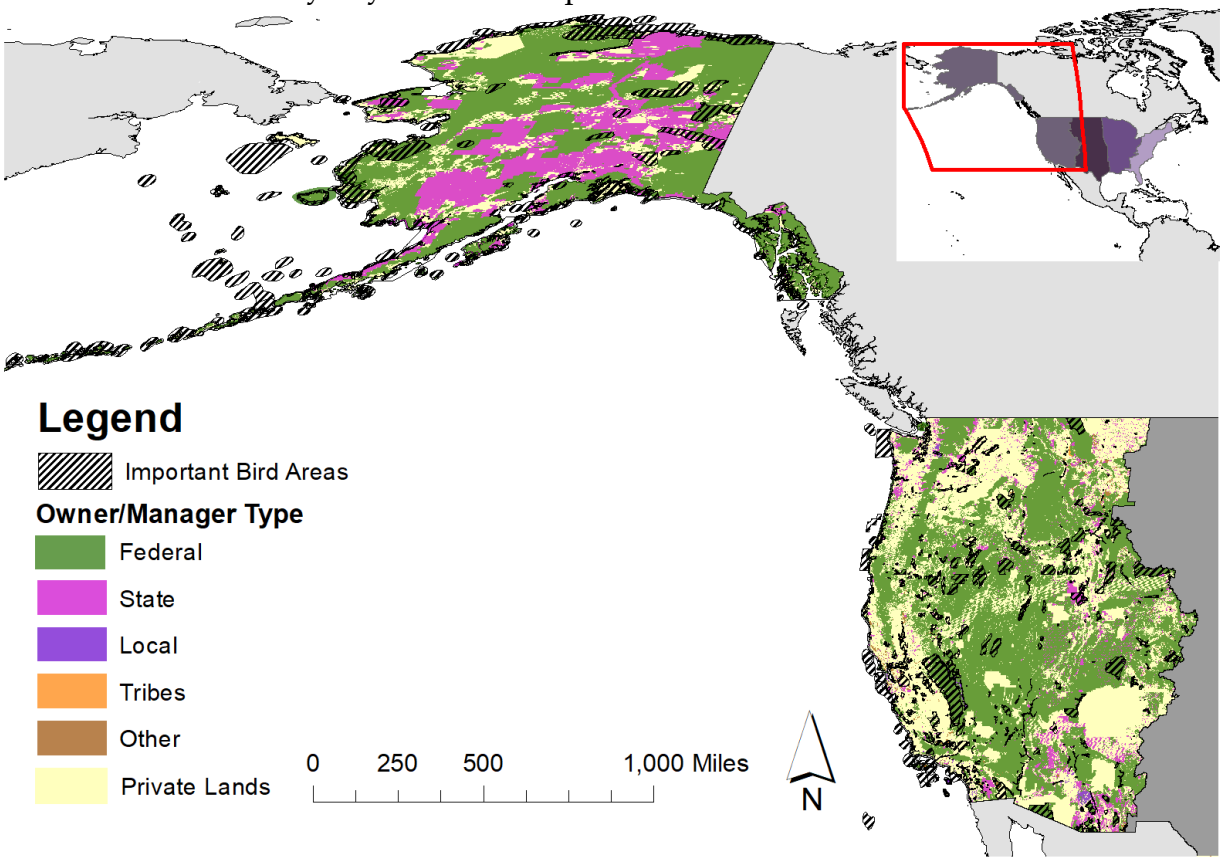


*Figure 1. The main map above shows the manager types of protected land in the Pacific Flyway, grouped by Federal, State, Local, Tribal and Other. The reference map in the upper right-hand corner is of North America and shows the portions of the Pacific Flyway in the U.S. along the west coast as well as the three other flyways in the U.S. (Central, Mississippi, and Atlantic). The two largest federal land managers in the Pacific Flyway are the Bureau of Land Management and the Forest Service. Other federal land managers are: Agricultural Research Service, Army Corps of Engineers, Bonneville Power Administration, Bureau of Ocean Energy Management, Bureau of Reclamation, Department of Defense, Department of Energy, National Ocean and Atmospheric Administration, National Park Service, Fish and Wildlife Service, Natural Resources Conservation Service, and other Federal (TVA, ARS, BPA, DOE, etc.). BirdLife International developed the IBA criteria and works with partners across the globe. More information about Important Bird Areas (IBAs) and the criteria can be found on their website: http://datazone.birdlife.org/site/ibacriteria. In the U.S., the National Audubon Society is their partner organization and more information about IBAs within the U.S. can be found on their website: https://www.audubon.org/important-bird-areas. The main map's projection is Equal Earth (Sphere Equal Earth Americas), and the geographic coordinate system is GCS Sphere GRS 1980 Mean Radius. The map uses data from the Protected Area Database (PAD) 2.1 (U.S. Geological Survey (USGS 2020)), Important Bird Areas in the U.S. (Audubon Society 2021), and the administrative flyways from the U.S. FWS (2021). The reference map projection is Compact Miller (Sphere Compact Miller).*

The Pacific Flyway (Figure 1) extends north-south through the western states of the U.S. from the U.S.-Mexico border into Alaska. Migratory birds in the Pacific Flyway have journeys spanning the

gamut of a few hundred miles within a state to the extreme of the range extending several thousand miles. The longer migratory paths in the Pacific Flyway connecting summer breeding grounds in Alaska and Northern Canada with wintering non-breeding grounds in the Southwestern U.S. or Central or South America, or in the extreme case of the Artic tern: Antarctica. Competing land and water uses, natural disturbances (e.g., wildfire) and severe drought in the American West have led to habitat degradation and population declines for migratory species (Anderson et al., 2018; Rosenberg et al., 2019). The U.S. domestic coordination problem is evident by comparing the current essential habitat identified as Important Bird Areas (IBAs), using the international criteria for migratory birds, to landownership type (Figure 1). Lands within the Pacific Flyway identified as IBAs are held under a mosaic of different ownerships and management entities. In addition, there are risks affecting habitat, including human-caused disturbance involving land-use conversion and the spread of invasive species, and natural disturbances such as fire, drought, and climate change (Kirby et al., 2008; Reynolds et al., 2017). All these effects may cause degradation of habitat suitability if the spatial and temporal effects of the conservation planning problem are ignored. Without coordination, individual land managers, whether they are public land managers or private landowners, will independently choose to pursue strategies based on their own objectives. Even with similar intentions, independent actions may fail to realize networking benefits, and may result in a suboptimal conservation effort.

We identified two main types of ownership:(1) governmental entities, including local, state, federal, tribal, and other; and (2) private landowners, including industrial and nonindustrial owners. Although there are differences in the specific goals among different entities and ownerships, the two groups may be distinguished by their objectives in providing ecosystem services. Government entities (e.g., federal, states, and tribes) are entrusted with representative, legislative, and other authorities related to bird and habitat protection to preserve populations for both the present and future. Private landowners are generally utility maximizers and focus on ecosystem service benefits that generate financial return, and/or provide individual benefit to the landowner. Sometimes this can lead to the underprovision of habitat. Private, nonindustrial landowners tend to exhibit more heterogeneous goals and pursue a mix of financial and ecosystem services objectives which often is correlated with the size of land holding among individual landowners. Landowners of smaller parcels are more likely to consider financial objectives as predominant (Butler et al., 2020). Nonindustrial landowners may incorporate habitat objectives that are compatible with their financial objectives in which they would not otherwise invest. While such "voluntary" provision of public habitat benefits is noteworthy, it does not fully address the underprovision of habitat because such investments are not deliberately and systematically applied in critical locations. A cohesive and effective strategy for protecting and enhancing migratory bird habitat all along the Pacific Flyway would address the diversity of management entities and landownerships and their heterogeneous land management goals and objectives.

Public agencies and managers in the U.S. tasked with implementing conservation strategies generally can affect conservation via three avenues.[4] The first is biophysical and involves investing in

[4] The mission of government entities relates to their responsibility in the management of land for the conservation of species and their habitat. Below are examples of the missions from the four main U.S. federal agencies who manage federal lands. The Bureau of Land Management (BLM) mission is "To sustain the health, diversity, and productivity of the public lands for the use and enjoyment of present and future generations." (U.S. DOI BLM, n.d.) The Forest Service (FS) mission states "The mission of the Forest Service is to sustain the health, diversity, and productivity of the nation's forests and grasslands to meet the needs of present and future generations" (USDA FS, n.d.). The National Park Service (NPS)

landscape manipulations which conserve and/or enhance migratory bird habitat. The second avenue is socioeconomic and involves incentivizing private landowners to conserve and/or enhance habitat on private lands through regulation, financial incentives (e.g., taxes, subsidies), or education and technical assistance. The final avenue is institutional and involves negotiating, planning, and monitoring conservation and protection strategies across a mosaic of landowners and managers. Selecting what combination of effort might be most effective requires an understanding of the objectives of different landowners, as well as the biological requirements of the species of conservation interest. In some cases, individual actions might collectively complement each other. While in other cases, they might be competitive or antagonistic to one another. The challenge is to improve complementarity of actions among different types of landowners, to cost-effectively protect and enhance migratory bird habitat across the mosaic of management entities and landownerships.

We consider the conservation planning problem involved in managing habitat for migratory birds across multiple types of landownerships along the Pacific Flyway and suggest ways in which economists can contribute to habitat protection and enhancement efforts. To provide context, we present a brief history of migratory bird conservation policy in the U.S., then offer a general conceptual approach to the conservation planner problem at the flyway scale. Then, we outline future potential areas of research to improve economists' understanding of the conservation planner problem at the flyway scale.

## II. Migratory Bird Conservation in the US

Migratory bird conservation has long been a national policy goal in the U.S., and the focus of several acts of Congress (Anderson et al., 2018). Initially, efforts focused on conserving habitat predominately on public lands (e.g., National Wildlife Refuge system, National Environmental Policy Act), regulating critical habitat (e.g., Endangered Species Act), and pollution sources (e.g., Clean Air Act and Clean Water Act whose objectives include reducing pollution to improve human and environmental health) (Kerkvliet et al., 2021; Liang et al., 2020). Over time, policy and conservation efforts evolved to also include collaborative efforts targeting conservation on private lands (e.g., Conservation Reserve Program, Sage Grouse Initiative, etc.). Apparently, conservation efforts on public lands alone were insufficient to sustain migratory bird populations (Anderson et al., 2018; Kerkvliet et al., 2021). The goal of these efforts are extended in new initiatives in the U.S. aimed at addressing declining biodiversity such as the America the Beautiful Initiative (U.S. Department of Interior (DOI), n.d.), which specifically focuses on the goal outlined in Executive Order 14008 of "conserving 30 percent of the nation's land and water by 2030.[5]" Although ambitious in its intention, this latest planned conservation effort will face the same challenges of affecting conservation across a mosaic of different ownerships and management entities.

Migratory birds throughout North America are under public trust, with oversight and management responsibilities falling to the federal government (Anderson et al., 2018). Birds provide many different ecosystems service benefits of ecological and economic importance to include

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mission states "The mission of the National Park Service is to preserve unimpaired the natural and cultural resources and values of the national park system for the enjoyment, education, and inspiration of this and future generations" (U.S. NPS, n.d.). The U.S. Fish & Wildlife Service (FWS) mission is "Working with others to conserve, protect and enhance fish, wildlife and plants and their habitats for the continuing benefit of the American people" (U.S. FWS, n.d.).

[5]Exec. Order No. 14008 3 C.F.R. 86 (7619-7633) (2021). The E.O. can be found at: https://www.federalregister.gov/documents/2021/02/01/2021-02177/tackling-the-climate-crisis-at-home-and-abroad.

recreation, seed dispersal, pest control, nutrient cycling, ecosystem engineering, and pollination, among others (Whelan et al., 2008). Birds were once viewed as an infinite resource in the U.S., though the 19th and 20th century revealed the finite nature of these populations, prompting legislative conservation action. Early on, this primarily took the form of command-and-control methods such as (1) defining hunting rules and regulations; (2) land use restrictions to protect endangered species habitat; and (3) banning of dichloro-diphenyl-trichloroethane (DDT) (Anderson et al., 2018; Ando and Langpap, 2018). More recently, conservation efforts include market-based instruments such as: (1) payment for ecosystem services; (2) auctions to keep habitat flooded during critical migration periods; (3) conservation easements; and (4) Conservation Reserve Program (Anderson et al., 2018; Ando and Langpap, 2018). With the broadening species scope of migratory bird conservation by the end of the 20th century came a gradual evolution toward partnerships and coordination of efforts, reflecting the spatial extent of migratory species' ranges. An early example of such a cooperative effort—the North American Waterfowl Management Plan—spanning North America and cross international borders marked the beginning of implementing partnerships across multiple landownership and management entities (U.S. FWS, 2017). These efforts focus on leveraging existing conservation programs (e.g., conservation easements, Conservation Reserve Program, Land and Water Conservation Fund, etc.) to provide information and financial incentives for undertaking conservation on private lands paired with efforts on public lands to address population declines. These measures are largely voluntary and require participants to opt-in, thus incentives and partnerships alone may not be enough, as evident by the findings of Rosenberg et al. (2019) who noted an overall decline in bird populations. A bright spot in the Rosenberg et al. (2019) study were the increases observed in bird populations of waterfowl and raptors where past conservation efforts have been focused.

## III. Conceptual Approach to the Conservation Planner Problem

Management and recovery efforts of migratory bird species in the U.S. occur primarily through conservation and enhancement of habitat necessary to support these populations. Ideally, cost-effective conservation investments (e.g., to acquire, protect and/or enhance necessary habitat) would consider the comparative advantages that different sites offer in terms of ensuring overall population success. The spatial and temporal dimensions of migratory birds and their habitat needs also must be considered. Conceptually, the conservation and management of migratory bird habitat can be viewed as occurring within a human and natural systems context (e.g., Kline et al. 2017) that features public land management agencies and diverse private landowners making decisions across landscape characterized by a mosaic of landownerships and land uses all along the flyway (Figure 2). Public land management agencies can influence habitat directly through the management of public lands, as well as indirectly through the implementation of policies and programs that incentivize complementary management activities on private lands. Public and private management activities affect changes in biophysical conditions of the landscape, resulting in either positive or negative outcomes for migratory bird habitat. Biophysical conditions also are influenced by disturbance factors, such as fire, insects, and disease, which influence biophysical outcomes of management. The biophysical outcomes, and potentially related economic outcomes related to agriculture, forestry, and other natural resource outputs, in turn act as feedbacks further influencing human-natural system dynamics. The whole process takes place within a broader context characterized by largely

exogenous external factors, such as markets, politics, and climate, which exert further influence on public land managers, private landowners, and biophysical (e.g., habitat) conditions.

The conservation planning problem can be conceptualized as a prioritization process to identify habitat protection and enhancement locations and activities across the multi-agency and multi-ownership landscape. The conservation planning problem necessarily calls for information concerning: (1) the spatial and temporal biophysical requirements of migratory bird species of interest under present and future conditions; (2) the objectives of public land management agencies and private landowners who control land along the flyway; (3) how disturbances and other key external factors might influence future biophysical changes and thus future habitat needs; and (4) how best to coordinate needed collaborative efforts in ways that enable complementarity among public and private land management (Figure 2). Information on these four aspects provides insights on the conservation comparative advantages of different sites on a landscape.

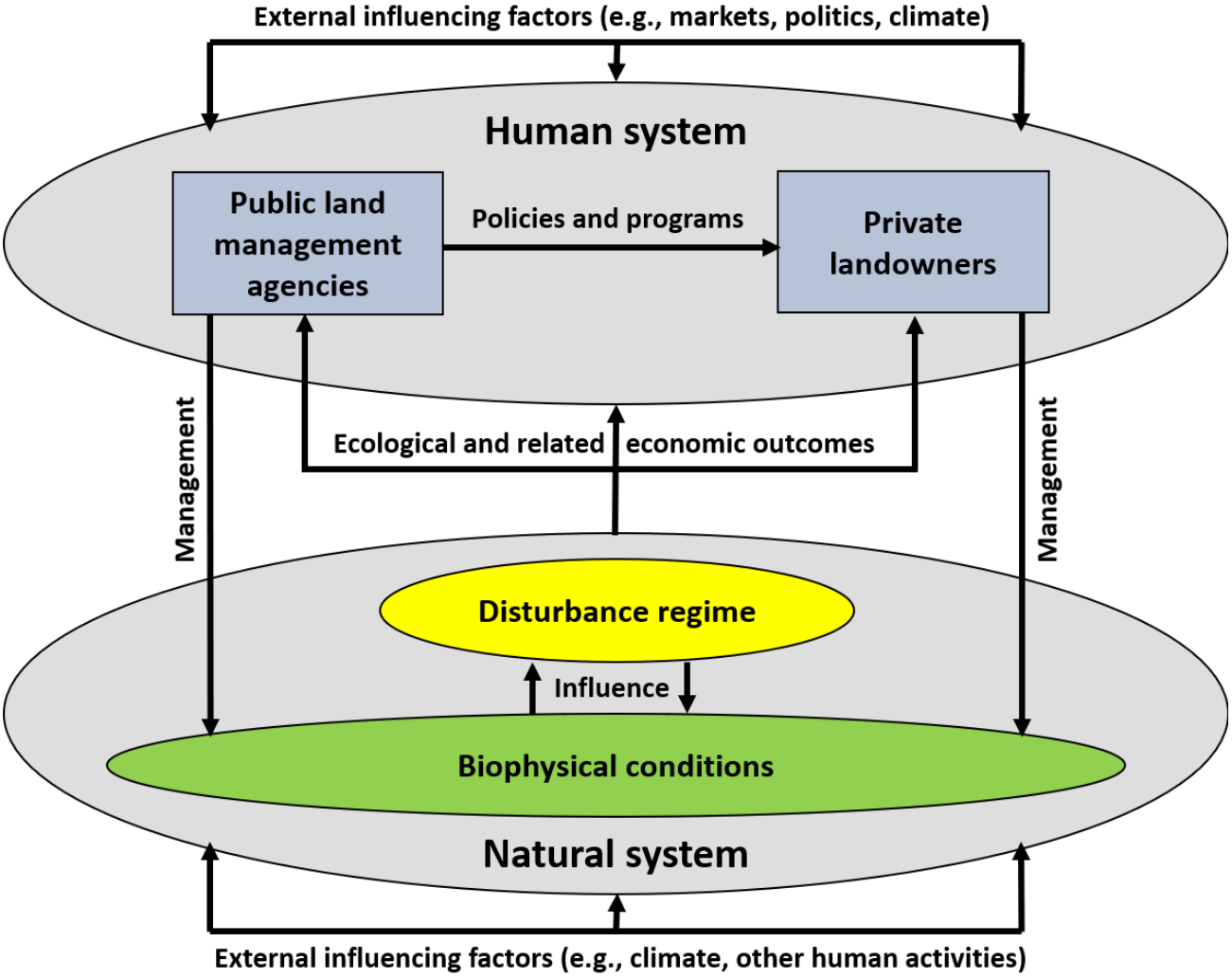


*Figure 2. Migratory bird conservation occurs within a policy and management context characterized by the interactions occurring between public land managers and private landowners interacting with temporally-dynamic, biophysical conditions and disturbance regimes, all in a broader context of external factors including climate change and socioeconomic conditions. Habitat protection and enhancement and devising effective conservation strategies, depends on gaining an understanding of the factors affecting biophysical characteristics of migratory bird habitat, and how they can be influenced through land management activities of public land management agencies and private landowners. It also depends on gaining an understanding on the biophysical and socioeconomic factors of private agency and private landowner management, and how those activities could be influenced to affect improvements in habitat protection and enhancement. Figure adapted from Kline et al. (2017).*

From a pragmatic perspective, devising cost-effective conservation strategies for landscapes accounts for the varying objectives of different public land management agencies, and different objectives and types of private landowners, as well as account for the range of potential future biophysical conditions give environmental risk factors (e.g., climate change, drought, wildfires, insects, and diseases). From a modelling perspective, we can think of the conservation planning problem for migratory birds being one where the model accounts for the landowners and landscapes spanning a migratory path. Within this path there are $i=1,\ldots,I$ different ownership types (e.g., the main two described above: (1) governmental entities, including local, state, federal, tribal, and other; and (2) private landowners, including industrial and nonindustrial owners) index by $j=1,\ldots, J$ owners within each $i$ across $t=1,\ldots,T$ time periods spent on a landscape along the path migratory birds travel (e.g., $t$ may be indexed by season, month, week, or day depending on the desired level of flexibility of the model). This model can be further indexed by migratory bird species, $n = 1, \ldots, N$ if the conservation objective is for multiple migratory bird species. Whether the model is seeking to model conservation investment for a single or multiple migratory bird species, the objective is to balance the returns where returns are to be measured in terms of ecosystem service benefits per unit of cost rather than benefits or cost alone and future risk as given by forecasted scenarios (e.g., climate change, drought, wildfires, insects, and diseases, etc.) (Alvarez et al., 2017; Ando and Mallory, 2012; Ando et al., 2018; Ando and Langpap, 2018).

Modern Portfolio Theory (MPT) model from the conservation finance literature is increasingly being used to guide decisions about where to make conservation investments on a landscape for various species' conservation efforts (e.g., fish, salamanders, birds, etc.) (Alvarez et al., 2017; Ando and Mallory, 2012; Ando et al., 2018; Ando and Langpap, 2018). Given limited conservation funding, the idea behind using MPT over a simple strategy of diversification is to increase the cost-effectiveness of conservation efforts and investments by selecting conservation investments which optimize the expected return of the portfolio and minimize the risk (Ando and Mallory, 2012). The expected return in this case is typically defined as a measure of benefit per unit of cost (Ando et al., 2018; Ando and Langpap, 2018). The weights of the portfolio are based on the investments on the landscape. Thus, a portfolio's expected return value is the weighted average of the return of all assets held in each scenario (Ando and Mallory, 2012).

The focus of the MPT model's optimization problem is the asset's future expected performance across a range of future scenarios given the conservation planning objective(s). The MPT results give the expected return and variance (which may be reported in standard deviations) for each portfolio across future forecasted scenarios. Plotting them on a graph identifies the set of efficient portfolios located on the frontier (Alvarez et al., 2017; Ando and Mallory, 2012; Ando, Howlader, and Mallory, 2018; Ando, Fraterrigo, et al., 2018; Ando and Langpap, 2018). This frontier identifies the menu of options and can be thought of as the "protection possibility" frontier, by identifying the land parcels on a landscape to protect or enhance. MPT may help in improving the cost-effectiveness of conservation investments relative to a simple diversification strategy when (1) investments have negatively correlated outcomes across scenarios; (2) the second-best expected return is almost as good of a return as identified under the first-best expected return; and (3) there is little uncertainty in the outcomes of the assets across future scenarios (Ando, Fraterrigo, et al., 2018). Also, if the conservation planning is for multiple species and/or objectives, then scenario correlations between objectives need to be considered, as different issues may arise if the objectives respond similarly or differently to

forecasted scenarios (Ando, Howlader, and Mallory, 2018). Other hierarchical models such as Multi-Decision Criteria Analysis may also prove useful to understand the tradeoffs and constraints in the conservation planner problem and may be used in conjunction with MPT (Eaton et al., 2019).

## IV. Existing Partnership Efforts

Partnership efforts across governmental agencies and private landowners are increasingly common in practice as stakeholders have shown the ability to unite behind a common goal (e.g., North American Waterfowl Management Plan, Sage Grouse Initiative, etc.). However, to date it is not well understood why partnerships are successful (or not) about achieving their objective(s), indicating this is an area that merits further study. For an example of an analysis of a recent partnership effort, we can look at the study by Wollstein and Davis (2017) who conducted a qualitative analysis of the Sage-Grouse Initiative (SGI) to understand private landowners' voluntary conservation actions and efforts in Lake County, Oregon, as sage grouse were being considered for listing under the ESA. Their results reveal private landowner participation was largely motivated by a complex combination of incentives, both positive and negative, to include landowners' desire to reduce future uncertainty and avoid being subject to ESA restrictions. In this instance, the threat of regulatory action under the ESA provided an upper bound to the cost private landowners may incur in the future if ESA restrictions were to be implemented and the status quo with conservation actions provided a set of lower bound alternatives. Governmental agencies provided financial and technical assistance to support these voluntary conservation measures being undertaken by these private landowners in their Candidate Conservation Agreements with Assurances (CCAAs) (Wollstein and Davis, 2020). In Oregon alone, over 150 private landowners signed CCAAs whose commitment represented protection and enhancement on over 2.3 million acres of sage grouse habitat on private land (Wollstein and Davis, 2020). Partnerships such as those developed under the SGI represent what is feasible when there are focused efforts on a particular objective. Such efforts provide a template of how to promote a continuum of habitat across land parcels and ownerships needed to sustain a biodiverse ecosystem for migratory birds and other species.

## V. Moving Forward

Given the complex nature of the conservation planning problem, we suggest that economists can most effectively address identified issues around migratory bird habitat by: (1) describing the preferences of landowners toward conservation of migratory birds; (2) characterizing costs and benefits of ecosystem services associated with migratory birds and their habitats; (3) evaluating comparative advantages for habitat protection and enhancement; and (4) evaluating partnership cooperation opportunities to increase habitat continuity and quality (i.e., decrease habitat fragmentation and increase restoration) along the spatial and temporal extent of the flyway. Economists, working collaboratively with wildlife and other biophysical scientists, may devise decision frameworks recognizing net flows of benefits resulting from habitat protection and enhancement. In addition, economists can determine optimal applications of protection and enhancement efforts (e.g., spatial subsidies, education, and technical assistance, etc.). Understanding tradeoffs across land ownerships requires being able to characterize the benefits and costs for individual and joint action when seeking to determine what conservation efforts to prioritize such as protect and/or enhance.

Due to the nonmarket nature of many ecosystem service benefits, Mallory and Ando (2014) and Alvarez et al. (2017) point to complications in estimating benefits of assets for models such as MPT when they are measured in different units (e.g., monetary and non-monetary). Provisioning, regulating, and supporting ecosystem services as well as other cultural ecosystem services could be quantified to describe the net benefits from actions taken on both public and non-public lands. To date, valuation estimates exist primarily for benefits from birdwatching and hunting and typically in specific locations. Data collection on bird populations over time has provided information needed for scientists to calculate nonmarket benefits of migratory birds and associated ecosystem services. Crowd-sourced data (e.g., citizen science projects, social media, wildlife webcam viewing, etc.) complement existing data collected by governmental agencies and provide additional resolution on a larger spatial and temporal extent than previously available (Keeler et al., 2015; Fisher et al., 2018; Kolstoe and Cameron, 2017; Kolstoe et al., 2018; Loomis et al., 2018). Designing appropriate methods for testing the validity and reliability of crowdsourced data will unlock a large source of value information pertaining to migratory birds, a current void in the literature (Bagstad et al., 2019). Statistically testing the data, as well as addressing the sample selection bias present in such samples of convenience, is critical to confident modeling with the data (e.g., Cameron and Kolstoe, 2022; Kolstoe, Vander Naald, Cohan, 2022). Ideally, future valuation work will consider the interdependence of species within ecosystems and the importance of diverse ecosystems as biodiverse landscapes have been found to be more ecologically resilient (Baumgärtner and Strunz, 2014; Ando and Langpap, 2018). This could enable providing information regarding the value of migratory birds to the U.S. public, and more general biodiversity values, and how the ecosystem services are affected by natural and human-caused disturbance. These valuations could also factor into models of cooperation to better understand the set of possible bargaining solutions to obtain a given objective.

## VI. Conclusion

Economists can likely make their greatest contribution to migratory bird habitat protection and enhancement by focusing research efforts on select aspects of the conservation planner problem. Addressing the spatial and temporal coordination challenge of the conservation planner problem for migratory birds involves both biophysical and socioeconomic considerations. Biophysical considerations include knowledge about the specific habitat needs of different migratory bird species and identifying those locations along the Flyway that will provide the greatest chance for continued success of different species of management interest. Socioeconomic considerations include identifying the mix of investments and incentives necessary to attain the desired biophysical characteristics, given the heterogeneity in the goals and objectives of the various public land management entities and private landownerships involved. The key tasks for economists seeking to help resolve this challenge include: (1) assisting in evaluating the comparative advantages of habitat protection and enhancement in different locations; (2) providing decision support to public land managers to effect protection and enhancement activities where desired; and (3) developing approaches to incentivizing desired activities among private landowners while recognizing the mix of landownership objectives. These tasks become more critical as climate change and other disturbance factors increasingly shift and impact bird ranges and habitats (Anderson et al., 2018; Rosenberg et al., 2019).

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