Instructions:
Following, you will find five brief descriptions of decision problems, all of which were topics of structured decision making workshops at NCTC. For each problem, (a) develop a decision sketch (a rough sense of the objectives and alternatives, and the nature of the predictions needed), (b) diagnose the class of problem, and (c) summarize the central challenge the decision-maker has. You have about an hour to discuss 5 problems, so this will necessarily be a fairly fast assessment; focus on recognizing the central form of the problem.

Great Lakes Fish Passage

The U.S. Fish and Wildlife Service's Fish and Wildlife Conservation Office in Ashland, Wisconsin (Ashland FWCO) works with local partners to restore habitat for fish and other aquatic species within the Bad River Watershed (BRW) in northern Wisconsin. There are over 1,100 perched culverts within the watershed and many of these are barriers to fish passage. The Service's restoration work in the BRW is conducted under the authority of the Great Lakes Fish and Wildlife Restoration Act (as well as other enabling federal legislation and policies) and is consistent with the culvert inventory and remediation component of the Bad River Watershed Association's Strategic Plan.

In general, the removal or modification of barriers to allow for fish passage has beneficial impacts to the watershed (e.g., improving connectivity, restoring hydrology, and increasing spawning access for fish). However, in certain cases, it may also be detrimental to ecosystem health (e.g., opening habitat for invasive species such as sea lamprey [*Petromyzon marinus*] and allowing passage of migratory fish with elevated contaminant levels that may subsequently impact piscivorous wildlife such as bald eagles [*Haliaeetus leucocephalus*]). In collaboration with local partners, the Ashland FWCO decides how to best manage barriers and restore fish passage within the BRW. Management options include: barrier removal, barrier replacement, barrier modification, and barrier construction.

Decisions involving the potential to increase sea lamprey spawning habitat within the watershed must include concurrence from the Service's Sea Lamprey Control Program. Decisions should also be made in collaboration with the Service's Ecological Services Program to determine the risk of upstream migration of contaminants to fish-eating wildlife.

Fender's Blue Butterfly

The USFWS Oregon Fish and Wildlife Office, in collaboration with its management partners, must decide on an affordable, effective monitoring design for the Fender's blue butterfly (FBB) that specifies measurable attributes to be estimated, the level of precision required from the resulting analysis, what data are needed, and how the data are to be collected. The design of the monitoring program needs to stem from the decision contexts in which the information will be used. There are a number of decision contexts in which monitoring information might be used; we focus on two primary settings: 1) evaluation of the status of FBB under the Endangered Species Act (ESA), with possible consideration of reclassification; and 2) evaluation and adaptive guidance of habitat management. The intent is to develop a standardized, systematic, rangewide, long-term monitoring program to evaluate decisions in these contexts.

Status review under the ESA is implicitly tied to a classification decision; species status can influence how scarce recovery resources are allocated between various recovery objectives. The current recovery plan includes quantitative recovery criteria using FBB abundance thresholds and trends as proxies for species persistence. Given the costs and variability associated with current monitoring, however, it is not clear if the monitoring is appropriately designed to effectively assess status.

Several land management agencies and organizations provide site-level habitat management in support of FBB recovery, and face difficult decisions in the face of uncertainty about which practices best promote recovery. Suitable data on FBB abundance relative to site-level habitat management may aid in discerning more effective treatments from among the available options.

Wildlife and Sport Fish Restoration

The Service's WSFR Programs administrative funding has not kept pace with inflation, and new required national expenditures and other costs have further reduced the budgets of the regions. Regions have all been asked to maintain one to three vacancies in GS 12 or higher to compensate for the budget reductions. The current allocation methodology for WSFR administrative funds has drawn criticism because it is viewed as inequitable, not transparent, and not defensible.

The administrative budget funds the fiscal and grant administrators and their support systems in awarding over $700 million annually to state fish and wildlife agencies to manage 440 million acres of wildlife habitat and to outright purchase 5.2 million acres of wildlife habitat nationwide. The funds WSFR staff administer provide 75% of the salaries of most Department of Natural Resources (DNR) staff working on fish and wildlife restoration in all 50 states and seven territories. This is a significant amount of the total wildlife and fish population and habitat management nationwide.

The WSFR administrative budget must conform to the requirements of Pittman-Robertson (PR), Dingell-Johnson (DJ) and Wallop-Breaux Acts and congressional appropriation language. Administrative funding is capped in the various transportation appropriations acts and in the Improvement Act of 2001. The program is currently facing financial shortfalls due to low caps on administrative spending (under 2%), increases in salaries due to step raises, an unmoved or even declining CPI, Improvement Act requirements that WSFR pay the Office of Inspector General (OIG) for audits of about 12 states per year, and expenses associated with developing a new data tracking system compatible with Financial and Business Management System (FBMS). If the budgets allocated among the eight regions are not proportional to each region's share of the total national effort, the shortfall is intensified and the integrity of the program nationwide is at risk. The allocation method is not based on full-time-equivalent (FTE) staffing levels and makes no judgment on or changes to how a region converts its allocation into staffing. The existing base budget allocation method is FTE based.

Mr. Hannibal Bolton, Assistant Director for the Wildlife and Sport Fish Restoration Program determined that a new approach to nation-wide administrative funding was needed. He requested that the regional chiefs appoint representatives to a team comprised of Regional Office and Headquarters staff from the U.S. Fish and Wildlife Service (Service) Wildlife and Sport Fish Restoration (WSFR) Programs. This team, named the Next 75th Team (Team), was assigned the responsibility of developing a methodology for allocating future increases in administrative funding for the WSFR Programs among the eight Regions and Headquarters. The intent is to allocate the new funds so they will be allocated proportional to regional workload and to decrease any inequity. The objective is to develop a methodology to allocate these funds that is broadly acceptable because it is equitable, defensible, and transparent.

Headwater Stream Management

Headwater stream ecosystems are vulnerable to numerous threats associated with climate and land use change. In the northeastern US, many headwater stream species (e.g., brook trout and stream salamanders) are of special conservation concern and may be vulnerable to climate change influences, such as changes in stream temperature and streamflow. Federal land management agencies (e.g., US Fish and Wildlife Service, National Park Service, USDA Forest Service, Bureau of Land Management and Department of Defense) are required to adopt policies that respond to climate change and may have longer-term institutional support to enforce such policies compared to state, local, non-governmental, or private land managers. However, federal agencies largely make management decisions in regards to headwater stream ecosystems independently. This fragmentation of management resources and responsibilities across the landscape may significantly impede the efficiency and effectiveness of conservation actions, and higher degrees of collaboration may be required to achieve conservation goals. This project seeks to provide an example of cooperative landscape decision-making to address the conservation of headwater stream ecosystems. We identified shared and contrasting objectives of each federal agency and potential collaboration opportunities that may increase efficient and effective management of headwater stream ecosystems in two northeastern US watersheds. These workshops provided useful insights into the adaptive capacity of federal institutions to address threats to headwater stream ecosystems. Our ultimate goal is to provide a decision-making framework and analysis that addresses large-scale conservation threats across multiple stakeholders, as a demonstration of cooperative landscape conservation for aquatic ecosystems. Additionally, we aim to provide new scientific knowledge and a regional perspective to resource managers to help inform local management decisions.

Laysan Duck

Conservation of oceanic island species presents many ecological and logistical challenges. The Northwestern Hawaiian Islands (NWHI) include 300,000 km^2 of ocean waters and 10 groups of sub-tropical islands and atolls of high conservation value. Designated as Papahanaumokuakea Marine National Monument, the islands provide habitat for four endangered species of terrestrial birds. Despite their protected status, many of these species are faced with the ongoing threat of extinction due to stochastic catastrophes such as disease, invasive mammal introductions, tsunamis, and hurricanes. To reduce the risk that a single catastrophe would lead to extinction, managers propose to restore multiple "insurance" populations on islands currently unoccupied by these species to increase their range and overall numbers.

A longer term threat to NWHI species is sea level rise associated with global climate change. Unfortunately, establishment of populations on multiple low-lying islands is unlikely to provide long-term protection against this threat. On a 50-year time scale, many low-lying NWHI may be partially inundated or totally submerged by rising sea levels. To maintain viable populations of endemic endangered island species in the wild, managers must design and implement a strategy that considers both the longer-term risk of inundation due to sea level rise as well as the ongoing risk of catastrophes, while integrating considerations such as budget limitations, complex logistics, and public opinion of management actions needed to establish species on higher elevation islands.

The set of management actions to balance extinction risks could include translocations of wild populations, habitat restoration, predator eradication (on high elevation sites), development of captive breeding and release programs, or habitat engineering at low elevation sites (e.g., sea walls, dredging, artificial islands). Multiple combinations of these actions could be implemented in space and time. State-dependent decision-making will be necessary to determine the optimal management actions to protect species facing rising sea levels. This decision-making will take place under several sources of uncertainty, including the magnitude and time scale of sea level rise; the cost, uncertainty of success, and political difficulty of management actions such as translocation, captive breeding and release, and exotic predator removal on high islands; disease risk; and the genetic viability of both source and translocated populations.

The Laysan Duck (LADU; *Anas laysanensis*) is one of the terrestrial species in the NWHI faced with these ecological threats. For 150 years, the species' distribution was restricted to a single remote island, Laysan Island. Biologists carried out a successful wild translocation from Laysan Island to Midway Atoll, establishing a second viable population 400 miles to the northwest of the source population. Additional translocations to other atolls have been proposed; however, no management plan has been established to deal with the long-term threat of sea level rise. It is expected that much of the current LADU range will be partially submerged within the next 100 years and many of the currently proposed translocation sites will experience inundation as well. There are currently no captive breeding programs managed for reintroduction of the LADU.

The purpose of this project is to identify the optimal sequence of decisions that will protect the LADU in perpetuity in the face of sea level rise and other identified threats. As part of a larger U.S. Geological Survey-funded research project, "Predicting risks of island extinctions due to sea level rise: Model based tools to mitigate terrestrial habitat losses in

the Northwestern Hawaiian Islands," we are interested in developing decision-support tools to help Papahanaumokuakea Marine National Monument and recovery managers decide how to best manage endemic birds vulnerable to extinction from sea level rise. Managers will need to work together with state and other federal wildlife agencies to develop and implement a sea level rise management plan. Developing such a plan for the LADU will provide a prototype management tool useful for the three other endangered terrestrial birds in the NWHI (the Laysan Finch, *Telespiza cantans*; the Nihoa Finch, *Telespiza ultima*; and the Nihoa Millerbird, *Acrocephalus familiaris kingi*), as well as seabirds and endangered terrestrial plants.