O.1: Waterfowl and Water 1: The Crisis is Now (Organizer: Mark Petrie)

O.1.1: Petrie

Introduction to the Session

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Recent droughts in Texas, the Central Valley of California, and Oregon's Klamath Basin are at the forefront of water shortages that will challenge waterfowl managers in the 21st century. Conservation efforts for migrating and wintering waterfowl often focus on providing adequate foraging habitat. At the Joint Venture scale, this involves "stepping down" waterfowl population objectives from the NAWMP and describing the landscape characteristics needed to support these populations. The habitat objectives that emerge from this process have helped guide traditional activities like wetland restoration and agricultural enhancement. As a result, the waterfowl management community has rightly focused on creating additional opportunities for wetland restoration and forming strong relationships with agricultural groups. Although the need for adequate water supplies to properly manage these natural and agricultural habitats has long been recognized, the recent droughts in Texas, California, and Oregon have exposed the vulnerability of major migration and wintering areas to long-term water shortages. It is no longer enough to add habitat in the absence of reliable sources of water. Yet, the regulatory nature of water allocation poses a serious challenge for the waterfowl management community. Most conservation gains for non-breeding have relied on incentive based programs, not regulation. Special interests representing long-standing water rights, the needs of endangered fish species, and the growing demands of expanding urban centers are frequently immune to even the best waterfowl and hydrologic science. It is not yet clear how waterfowl advocates will succeed in future environments characterized by less water and more demand. The intent of this session is to highlight water shortages that are now afflicting continentally important migration and wintering areas, and describe water issues that are emerging outside of these areas. Finally, we discuss possible solutions to meeting the needs of non-breeding waterfowl in landscapes where recurring water shortages are likely to be the norm.

O.1.2: Zarzycki^

Evidence for Cross Seasonal Effects: Insights from Long-Term Data on Northern Pintail

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Migratory waterfowl use a wide variety of habitats throughout their annual cycle, often distributed across broad spatial scales. The influence conditions in previous seasons have on a populations demographic rates or abundance in another are termed cross-seasonal effects and have been demonstrated in a wide variety of taxa. Waterfowl present an ideal model system for exploring the role of cross-seasonal effects on population dynamics. Work by Raveling and Heitmeyer found that the size of the breeding population of Northern pintail and the apparent reproductive success was influenced by habitat conditions in the California Central Valley the previous winter. Since that publication, researchers have developed a better understanding of the migratory connectivity of pintail across the landscape, and have highlighted the importance of the Southern Oregon North Eastern California (SONEC) region during spring migration. In this presentation we will expand on the work of Raveling and Heitmeyer to evaluate the importance of a major spring migration staging area (the SONEC region) to pintail productivity. The main objectives of this research are to 1) evaluate the importance of non-breeding season habitat conditions in SONEC on Northern pintail productivity and 2) compare the relative importance of winter habitat vs spring staging habitat to productivity.

A variety of publicly available information were obtained to explore the effects of non-breeding season habitat in years 1961-2012. Published fall age-ratios were used as an index of productivity in pintail. To examine the seasonal importance of available habitat, May pond counts for strata 26-40 were used as an index of the breeding ground conditions and average monthly precipitation as an index of habitat conditions on the wintering and spring staging grounds for the previous year. Habitat in the SONEC region is influenced by snowmelt and artificial flooding, which will be included in the index of SONEC habitat availability to reflect actual conditions pintail experience during migration.

Preliminary findings suggest winter precipitation in the California Central Valley may influence the productivity of pintail. Inclusion of spring precipitation in SONEC improved the fit of the model. With the addition and improvement of habitat indices for both wintering and staging grounds for the pintail population we hope to expand our understanding of cross-seasonal effects in waterfowl populations and speak to the role and importance of the non-breeding season in the productivity of this species.

O.1.3: Yarris

The California Drought: The Effects of the Current Drought on Waterfowl Habitat in the Central Valley

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The Central Valley of California (CVC) has lost approximately 95% of its original wetlands due to flood control, urbanization and conversion to agriculture. Despite these loses, remaining wetlands are intensively managed for food production and, together with post-harvest flooded grain fields (especially rice), continue to support 5-6 million wintering waterfowl annually. However, increasing demands for water, exacerbated by drought, has made procuring water for wetlands and beneficial agricultural habitats more difficult in recent years. California is experiencing its most severe drought in history. Since 2011, precipitation has been well below average throughout the state, and the winter of 2014-2015 was the driest on record for the CVC. Managed wetlands rely heavily on state and federal water projects for surface water to provide habitat for breeding and wintering waterfowl. Because reservoir levels were less than 50% of their capacity during the drought, water use was restricted to some degree for all users and allocated based on California's complicated system of water rights and environmental regulations. In general, wetland surface water supplies have been reduced by 25-50%. The California drought has reduced waterfowl habitat values and carrying capacity of the CVC in several ways. Wetland habitats were impacted by: 1) reduced summer irrigation to promote moist-soil plants, 2) delayed or eliminated fall/winter flooding, and 3) decreased flows to maintain water quality (and minimize conditions for disease outbreaks). Agricultural habitats were impacted by: 1) widespread fallowing of crops important to waterfowl, 2) reduced post-harvest flooding, and 3) detrimental and potentially long-term changes to agricultural practices beneficial to waterfowl. The impacts of these changes relative to habitat availability and waterfowl populations will be a major consideration in conservation planning for anticipated future drought and climate change scenarios.

O.1.4: Brasher

Implications of Limited Water Supplies for Waterfowl Habitats on the Texas Coast

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Waterfowl habitats along the Texas coast are expected to support greater than 5.3 million ducks and geese during the non-breeding period. Marshes and ricelands are the dominant habitat types in this region and are counted on to provide >88% of total food resources for migrating and wintering waterfowl. Like essentially all waterfowl habitats, annual variation in their quality and quantity is heavily influenced by the abundance and timing of water. While the abundance of water to influence marsh conditions is affected primarily by climatic events that are beyond management and policy control, riceland-based habitats have a more direct tie to the regulation of limited water supplies. The decline of rice along the Texas coast (i.e., >500,000 acres of planted rice during 1970s and <200,000 acres during the 2000s) has been well-documented, yet interestingly, little of this historical decline can be exclusively attributed to water supplies. However, looking into the future, competition for limited water supplies is likely to be the single most important determinant of the sustainability of rice production and rice-based habitats on the Texas coast. In fact, the effects are already being felt. As a result of the record-setting drought from autumn 2010 – spring 2015, regional water authorities reduced the amount of irrigation water available to rice farmers for an unprecedented four consecutive growing seasons (2012-2015), leading to an immediate 52,000 acre reduction in planted rice acreage. Although water levels in storage lakes recently recovered sufficient to permit normal irrigation releases during 2016, the extent to which lost rice acreage will return is uncertain. Moreover, the prospects for more frequent droughts and continued human population growth in this region foreshadow intensified competition for limited water supplies. Diverse solutions are needed to ensure reliable water supplies for a sustainable Texas rice industry; without it, the remaining habitat will be unable to support wintering waterfowl at desired levels.

O.1.5: Vest

Water Issues for the Great Salt Lake: Implications to Wetlands and Waterfowl

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The Great Salt Lake landscape (GSL) is among the largest and most diverse wetland complexes in the western US and recognized internationally for its importance to wetland dependent migratory birds. Several million waterfowl use the GSL as a primary migration hub in the Pacific Flyway as they move between key breeding (e.g., prairie Canada) and wintering (e.g., Central Valley of California) areas on the continent. The GSL is a terminal lake basin in a xeric environment yet is surrounded by ≥ 470,000 acres of wetlands maintained by three primary river systems which are dependent on annual snowpack accumulations. More than 160,000 acres of these wetlands are actively managed for waterfowl and other wetland birds. However, development of water resources for agriculture, energy, industrial, and municipal use has reduced the amount and quality of fresh water reaching the lake and its marshes. Over the past decade, hydrologic inputs to GSL were 44% lower than the long-term (1955–2010) average due to both climatic inputs and water resource developments. Rapid human population growth in the region will place increasing demands on scarce water resources and result in more water use conflicts. This pattern is likely to be exacerbated if current climatic trends persist. We will discuss potential impacts to GSL waterfowl populations from a suite of hydrologic scenarios and energetic carrying capacity evaluations. Preliminary estimates suggest available waterfowl habitat could be reduced by 40–60% within the next several decades as a result of climatic and water-use trends. Potential implications to waterfowl populations in the Pacific Flyway from reductions in GSL habitats will also be discussed.

O.1.6: James

Future Implications of Groundwater Depletion on Waterfowl Foraging Capacity in the Mississippi Alluvial Valley

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It is estimated that approximately 40% of the waterfowl food energy within the Mississippi Alluvial Valley (MAV) landscape is provided through harvested crop fields (e.g., rice, soybeans, corn) subject to natural flooding or managed through impoundments on private land. With nearly 80% of the total land use in agriculture, it is currently the largest user of water resources. Approximately 8 billion gallons/day of groundwater are pumped each year to meet the irrigation requirements of Arkansas, Mississippi and Louisiana. As irrigation of cropland has become more extensive in some areas of the MAV, there are indications that the current level of water withdrawal from irrigation is unsustainable. In the region's two primary aquifers, Alluvial and Sparta, water use exceeds aquifer recharge, and in certain areas has caused water-level declines of at least 40 feet in the last 40 years. This reduced availability of water could potentially lead to a landscape of less water-intensive agriculture, thereby reducing the availability of surface water and providing less energy rich crops of little to no benefit to migrating and wintering waterfowl. Reduction of water resources and consequences to waterfowl populations have been ongoing throughout the United States for years including areas such as California's Central Valley, the Colorado River Basin, the Ogallala Aquifer in the High Plains, and the coastal prairies of Texas. As water demand continues to increase, understanding and modeling future impacts from reduced water availability coupled with agricultural changes that may occur will help determine how carrying capacity for waterfowl in the MAV will change through time. We will discuss the current and projected water resource conditions in the MAV, potential land use changes as a result of declining water availability and consider future solutions to this on-going issue.

P.1: Waterfowl and Water 2: The Crisis is Now (Organizer: Mark Petrie)

P.1.1: Dugger

Current and Future Water Shortages in Southern Oregon/Northeastern California (SONEC)

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The southern Oregon-northeastern California region (SONEC) provides critical habitat for migrating waterfowl in the Pacific Flyway. An estimated 80% of all waterfowl that winter in the Central Valley migrate through SONEC in spring or nearly five million ducks when waterfowl populations are at NAWMP goals. Most ducks migrating through SONEC have primarily relied on publicly managed habitats such as Lower Klamath NWR during fall migration and complexes of public wetlands and privately managed agricultural habitats during spring migration. Within SONEC, the Tule Lake and Lower Klamath NWR complex support large numbers of migrating waterfowl and serves as a pivotal hub for waterfowl moving to and from the Central Valley in both fall and spring. Additionally, private lands used for hay production and grazing that are flood-irrigated provide critical habitat for spring migrants. Flood irrigation is a common practice throughout SONEC and occurs mostly on altered seasonal wetlands that were historically dependent on natural flooding from snowmelt. However, these flood irrigated habitats are unavailable during fall migration.

Curtailed water deliveries to Lower Klamath NWR, due to persistent drought and water allocations for native fish, have drastically reduced the amount of habitat provided by the refuge in spring, as well as fall. This has presumably increased the importance of and reliance on flood-irrigated habitats, and other public wetlands by spring migrating ducks throughout SONEC due to the magnitude of historic use at Lower Klamath (>1,000,000 birds). The amount and distribution of flood-irrigated habitat available to spring waterfowl appears strongly related to snowpack amount and timing of snow melt. However, snowpack is expected to decline in the region under forecasted climate scenarios though changes in other precipitation patterns are less certain (e.g., winter rain). This presentation examines possible changes in carrying capacity for spring migrating waterfowl in SONEC that may result from reduced deliveries of water to Lower Klamath NWR and declining regional snowpack.

P.1.2: Fleming, S.

Overview of Water Quality Issues in the Upper Mississippi River, Great Lakes, and Chesapeake Bay and Long Term Implications for Diving Duck Distribution

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Diving ducks primarily consume submerged aquatic vegetation (SAV), plant tubers, and invertebrates to fuel migration and survive winter. Due to increased turbidity from pollution and sedimentation, there were substantial reductions in SAV biomass from the 1950s through 1980s in Chesapeake Bay and portions of the Great Lakes and upper Mississippi River. Since the introduction of filter feeding zebra and quagga mussels in the mid-1980s, water clarity has increased and some SAV recovery occurred throughout the Great Lakes. Watershed-level restoration efforts in Chesapeake Bay and the upper Mississippi River have provided moderate improvements in water quality and recovery of SAV. Concurrent with changes in water quality, there also has been an increased frequency of below average lake and river ice coverage on the upper Mississippi River and Great Lakes Basin. In response to increased food abundance and possibly reduced ice coverage, diving duck use of the upper Mississippi River and Great Lakes increased substantial during the 1990s and 2000s. Diving duck use of Chesapeake Bay has decreased by approximately 50% since the 1950s and there has been little recovery in abundance of these birds following improvements to water quality and return of SAV to portions of the bay. We will discuss historical and future regional water quality issues and information needs about how invasive species, landscape practices, and ice coverage influence forage, distributions, and survival of diving ducks that stage and winter in the upper Mississippi River, Great Lakes, and Chesapeake Bay. Water quality is an important factor that can influence carrying capacity for staging and wintering diving ducks; therefore, understanding and modeling future impacts of water quality will help guide long-term conservation efforts.

P.1.3: Eadie

Using an Agent-based Model (SWAMP) to Predict the Response of Waterfowl to Drought, Urban Expansion and Reduced Water for Agriculture and Managed Wetlands in California

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We developed a spatially-explicit waterfowl agent-based modeling program (SWAMP) to evaluate alternative landscape scenarios in the Sacramento Valley, CA arising due to urban expansion, drought, and concordant shifts in water allocation priorities. Scenario 1 represents the current management regime, while all other scenarios consider increased urbanization and/or moderate to severe drought. Scenario 2 examines the effects of drought, but with wetland restoration goals being met and current rice acreage; Scenario 3 examines the impact of wetland restoration not being met; and Scenario 4 examines the effect of extensive idling of rice acreage. Scenario 5 represents a worst-case situation with expansive urbanization, wetland restoration goals not met, and extensive rice acreage idled. We used SWAMP to simulate the foraging activities, time activity budgets, lipid reserves, and mortality of 1.2 million ducks under each scenario. In SWAMP, birds select and consume food in patches at a rate that is dependent on the density of food on that patch, modeled as a type II functional response. Birds leave patches based on current energy stores and patch depletion, modeled as an approximation of the marginal value theorem. We parameterized the model using published values for true metabolizable energy (TME) of foods, metabolic rates and expenditures under different activities, lipid metabolism and conversion, and food storage capacity. Models were run for 180 simulated days – the duration of time over which most waterfowl overwinter in the Central Valley. Our results indicate that rice idling due to restricted water supplies would have the greatest impact on body condition and survival of waterfowl. Under Scenarios 4 and 5, birds entered into energy deficit by late December and mortality rates escalated exponentially (assuming birds did not leave Butte Basin). Failure to meet wetlands restoration goals was not as severe if those acreages remained in rice, but energy deficits and mortality increased substantially if rice acreage was instead idled. Our study helps inform managers of the potential implications of restricted water conditions in CA using a novel spatially-explicit agent based modeling approach.

P.1.4: Smith

Water Will Go Where it is Legally Required to Go: Being Realistic about Future Wetland Water Supplies and Exploring a New Path of Collaborative Working Lands Conservation

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Provision of habitat needed to meet the annual cycle needs of migrating, wintering, and breeding waterfowl at North American Waterfowl Management Goal (NAWMP) levels in portions of the West currently hinges on delivery of adequate water supplies to managed wetlands. Yet, many of the iconic public wetlands of the region were historically the sumps that served to take excess floodwaters and agricultural irrigation return flows, thus possess limited or junior water rights. In recent years, escalating demand for this declining resource among municipal, agricultural, and environmental water users has resulted in significant water supply reductions for lands with junior water rights. Climate change, human population growth, and an array of environmental and sociopolitical factors are expected to exacerbate the situation in the future. This tests the fundamental assumption in Joint Venture planning that refuges, wildlife areas, and other protected wetlands will receive the water needed to meet the habitat demands of waterfowl at levels demonstrated in the past. Lessons of the past decade at certain wetland complexes indicate that this assumption may be overly optimistic. Joint Ventures have long recognized the importance of wetland water supplies and some have established water supply objectives or engaged in water policy work. However, even in the instance of landmark legislation allocating federal project water to managed wetlands, massive challenges remain in securing a reliable base of wetland habitat given the highly volatile water policy environment. In short, water will flow where it is legally mandated to flow. The situation calls for a re-thinking of the NAWMP community's approach to conservation planning and delivery in the West. Herein, we offer a new way of looking at this problem: Focus investments in waterfowl habitat conservation on those lands providing waterfowl habitat that exhibit the strongest legal rights to water, rather than simply the lands providing the highest current waterfowl values. This approach inherently emphasizes working collaboratively with private landowners on working lands with senior water rights, thereby marrying agricultural and wildlife objectives in ways that foster increased support for waterfowl conservation from the agricultural community, a goal of NAWMP public engagement.

P.1.5: Overton^

Is California's Wintering Waterfowl Habitat Drought Proof?

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California is in the midst of an historic drought while also being relied upon by millions of waterfowl for winter habitat. We examined whether these extreme drought conditions have impacted the body condition of wintering waterfowl. During the 2014-15 hunting season we collected data at hunter check stations and private duck clubs on 23,869 individual birds consisting of 23 different waterfowl species. We identified species, sex, and age, measured (flattened wing chord, culmen, short tarsus [± 0.01 mm]), and weighed (±1 g) hunter-shot waterfowl. Waterfowl were weighed and measured in four California regions: Sacramento Valley, San Joaquin Valley, Suisun Marsh, and Northeastern California. We used body mass as a condition index as it is highly correlated with body lipids, and compared body mass for 5 species of dabbling ducks including northern pintails (*Anas acuta*), mallards (*Anas platyrhynchos*) American wigeon (*Anas americana*), green-winged teal (*Anas crecca*), and northern shovelers (*Anas clypeata*) with similar data collected during 2006–2008 in the Sacramento Valley, San Joaquin Valley, and Suisun Marsh. Results indicate that habitat conditions during 2014-15 were adequate to maintain body mass similar to 2006-2008 (prior to extended drought). Significant rainfall in early December of 2014 may have alleviated some of the drought impacts by flooding habitats in the northern and central valley regions. This combined with water deliveries in October and November for rice decomposition and wildlife habitat was apparently adequate to maintain waterfowl body mass similar to that in 2006-2008. If the California drought continues beyond 2015, additional impacts such as changing agricultural practices may play a larger role in answering how drought proof California is for wintering waterfowl.

P.1.6: Symmank

From the Duck Marsh to the Water Faucet: Constructed Wetlands are Becoming a Critical Component of the Texas Municipal Water Supply

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Reservoirs supply most municipal water in Texas. With the state's recent drought and growing population, regional water planners are proposing new reservoirs to ensure a reliable supply and meet the increasing water demand. One of the most destructive impacts of reservoir development is the loss of bottomland hardwood habitats with an estimated 80% already lost statewide. As a solution to the water supply problem, Texas Parks & Wildlife Department (TPWD) partnered with Tarrant Regional Water District (TRWD) on a project designed to provide a reliable water supply to Fort Worth and surrounding cities without the construction of a new reservoir. The G. W. Shannon Wetland Water Recycling Facility on Richland Creek Wildlife Management Area (RCWMA) was completed in September of 2013 at a cost of $75+ million and is a model for the future water supply needs because it provides additional water while lessening or eliminating reservoir impacts to bottomland habitat. This project is a unique approach of harnessing the ecological function of filtration, provided by wetlands, to meet our needs for clean water. Nutrient-rich water from the Trinity River is pumped through shallow, constructed wetland cells growing emergent vegetation at a rate of up to 100MGD where it is cleaned by the natural processes of soil nutrient absorption. During the drought year of 2014, this project successfully provided 20% of TRWD's water supply to 1.8 million customers. Twenty wetland cells totaling 1,730 acres are highly productive wetlands ideal for waterfowl, wading birds and shorebirds. The entire area is open to bird watching and waterfowl hunting, providing a low cost, quality hunting experience to a growing constituency of Texas waterfowl hunters. During the 2014-2015 hunting season, RCWMA was one of the most utilized public hunting areas in Texas with approximately 2,600 man-days of duck hunting and 8,000 ducks harvested.