INTERMOUNTAIN WEST
JOINT VENTURE

conserving habitat through partnerships

IDENTIFYING SCIENCE PRIORITIES: 2013–2018

Wetland Focal Strategies

The Intermountain West Joint Venture is a self-directed partnership that conserves priority bird habitats through partnership-driven, science-based projects and programs.

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PREFACE

This document is the third in a series of step-down plans that characterizes the scope and context of the Intermountain West Joint Venture's (IWJV) science investments. The plan prioritizes wetland conservation science strategies as an initial step towards the development of biological planning that will identify information needs and habitat objectives required to sustain avian populations at regional and continental scales. The intent of the plan is to identify how IWJV will prioritize science planning activities relative to wetland habitats over the next five years. This effort is intended to inform conservation science investments and enable limited resources to be focused on priority wetland landscapes with the expectation of returning measurable biological outcomes (e.g., population demographics, habitat productivity) at multiple scales. This strategic approach will strengthen linkages between continental avian population goals, regional habitat objectives, and local conservation actions. Continued development in biological planning and conservation science will ensure investments made at local levels have relevance to regional and continental scales. The results of this process and the methods used to identify and prioritize wetland conservation strategies have been reviewed by the IWJV Technical Committee to ensure that the conclusions reached are appropriate and provide clear justification of IWJV priorities. The planning horizon for this document is not indented to exceed five years without formal review by IWJV science staff and Technical Committee.

To obtain additional information regarding the content of this document or the data generated to support it, please visit us at our website at: www.iwjv.org.

Bradley Bales / 08-17-2012

Approving Technical Committee Chair / Date

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TABLE OF CONTENTS

Introduction 2

Background: Wetlands as Priority Habitat for IWJV Science 2

Identifying Priorities for Wetland Conservation Science 5

- **Phase I: Wetland Assessment** 6
- **Phase II: Avian Species & Wetland Landscapes** 10

Additional Wetland Conservation Considerations 12

Discussion 14

Next Steps 14

Supplemental Material 14

Literature Cited 15

INTRODUCTION

As the largest U.S. Habitat Joint Venture, the IWJV provides habitat that supports the needs of birds across all major annual cycle events: breeding, migration, and wintering. The task of working across a landscape as large and ecologically diverse as the IWJV imposes formidable challenges to avian conservation planning. Indeed, the requirement to develop locally relevant conservation objectives across the Intermountain West for four bird guilds outstrips the current capacity of the IWJV. To develop and achieve long-term avian population and habitat conservation goals in the Intermountain West it is essential that limited resources be allocated strategically in ways that maximizes the integrity of priority landscapes (Bottrill et al. 2008, Thogmartin et al. 2011). This reality necessitates the adoption of a strategic framework by the IWJV to guide planning efforts (National Ecological Assessment Team 2006, Donnelly and Vest 2012a). Strategic conservation planning involves geographic prioritization at continental, regional, and local scales. Because regions are heterogeneous with respect to resource values for birds in the Intermountain West, choices must be made among competing opportunities to prioritize how to strategically invest science-based planning efforts. Identifying strategies that maximize species benefits would ideally be selected as higher priorities, realizing that it is rarely, if ever, possible to maximize benefits for the full suite of species at local or site-specific scales.

The conservation of wetland habitats has been a focus of the IWJV since its inception (Ratti and Kadlec 1992; IWJV 1995, 2005). Wetland habitats are widely dispersed across the Intermountain West and characterized by high biological diversity and productivity which make them among the most important wildlife habitats in the Intermountain West (IWJV 1995, McKinstry 2004, Donnelly and Vest 2012b). Indeed, at least 67% of IWJV priority species are directly dependent on wetland habitats (IWJV 2005, Donnelly and Vest 2012b). However, wetland systems in the Intermountain West have been highly modified by anthropogenic forces and remain at considerable risk to loss and degradation (IWJV 1995, McKinstry 2004, Copeland et al. 2010). Consequently, science-based conservation strategies linked to measurable objectives are required to ensure adequate wetland resources are provided to meet the needs of trust resources (Thogmartin et al. 2011).

This plan outlines initial steps taken to develop strategic conservation planning for wetland systems in the Intermountain West relative to migratory birds and attempts to provide clear justification of strategies and priorities identified from a structured, science-based framework. The goal of this plan is to identify how IWJV science resources and planning activities will be prioritized over the next 5 years (2013–2018). The intent of the analytical exercise described herein is to identify outliers among landscapes in relation to wetland and bird resources in the Intermountain West that present clear opportunities for science and biological planning investments by the IWJV. Specifically, the objectives of this plan include:

OBJECTIVE 1: Develop and communicate a science-based strategic process that identifies and prioritizes wetland landscapes important for avian conservation investments in the Intermountain West.

OBJECTIVE 2: Define the initial scope or geographic extent of IWJV conservation science priorities over the next five years (2013–2018).

BACKGROUND: WETLANDS AS PRIORITY HABITAT FOR IWJV SCIENCE

The IWJV is responsible for the regional implementation of four continental avian conservation plans, including the **North American Waterfowl Management Plan**, **US Shorebird Conservation Plan**, **North American Waterbird Conservation Plan**, and the **North American Landbird Conservation Plan**. Three of these four plans are focused on wetland or aquatic obligates. Over 140 wetland dependent and wetland associated bird species from 25 families rely on wetland habitats in the region (Gammonley 2004). As many as 12–18 million ducks, 1–2 million geese, and 60,000 swans utilize wetlands of the Intermountain West for roosting and feeding habitat during fall migration with similar numbers occurring during spring (IWJV 1995). Wetlands of the Intermountain West are regularly used by 33 of 50 species of shorebirds that commonly occur in North America (Oring et al. 2000, Brown et al. 2001) as well as approximately 40 species of waterbirds (Ivey and Herziger 2006). Furthermore, wetland complexes in the Intermountain West host substantial proportions of continental populations for many of these bird guilds (Table 1.)

Much of the Intermountain West is characterized as North American Desert Biome (58%) resulting in water limited systems (CEC 1997; Figure 1). Limited precipitation combined with high evaporation rates also constricts the distribution of water resources. Consequently, historical (1870s) estimates indicate only 8 % of all wetland acres identified in the coterminous lower 48 states occurred in the Western United States (Dahl 1990). However, wetland systems (including riparian habitats) of the Intermountain West are among the region's most important natural resources due to their biological, economical, and social value. Despite their limited abundance,

wetland systems in the Intermountain West can be described as keystone habitats because they help drive ecosystem form and function, and they structure biotic communities far beyond their areal extent (McKinstry 2004). Over 80% of wildlife species common to the region depend on wetlands to meet some portion of their annual cycle needs though these habitats encompass a small footprint in the Intermountain West (Brown et al. 1977, Williams and Dodd 1979, Ratti and Kadlec 1992, McKinstry 2004). Wetlands also provide important ecological goods and services beyond fish and wildlife habitat including temporary storage of surface water (i.e., flood control/attenuation), aquifer recharge, stream flow maintenance, sediment retention, shoreline stabilization, carbon storage, and transformation of nutrients and pollutants (Dugan 1990, McKinstry et al. 2004, Copeland et al. 2010). Wetland systems also provide important outdoor recreational opportunities in the Intermountain West including hunting, fishing, wildlife viewing, and nature photography which are significant economic drivers for many western communities (Ingram and Lewandowski 1999). Additionally, wetland systems are critical to ranching economies in the West (e.g., wet meadow, flood-irrigated habitats; Lovvorn and Hart 2004). Some have argued wetlands provide a higher level of ecosystem services than other systems stating that wetlands may be 15 times more valuable than forests and 64 times more valuable than grasslands and rangelands (Costanza et al. 1997). Given the limited distribution and critical functions they support, wetlands are inordinately valuable to wildlife and people in the Intermountain West. Consequently, the conservation of wetland systems remains a high priority for the IWJV (IWJV 1995, 2005, 2012; Donnelly and Vest 2012b).

TABLE 1. **Percent of continental bird populations of note occurring in the Intermountain West Joint Venture.**

GUILD	SPECIES	LIFE CYCLE			DATA SOURCE
		BREEDING	MIGRATION	WINTER	
WATERFOWL	Cinnamon Teal	>60%			Sum of unpublished breeding waterfowl survey estimates from CA, OR, NV, UT; Based on N̂ of 300,000 identified in Bellrose (1980), Gammonley (1996), NAWMP (2004)
	Northern Pintail		30%		Fleskes and Yee (2007), IWJV (2012), Utah Division of Wildlife Resources unpublished data
	Tundra Swan (*Western*)		80%		Pacific Flyway Council (2001), Aldrich and Paul (2002), Fleskes and Yee (2007),
	Trumpeter Swan (Rocky Mountain)	10%		>80%	Subcommittee on Rocky Mountain Population Trumpeter Swans (2008), Olson (2010)
	Greater White-fronted (*Pacific Flyway*, Tule) Geese		>50%		Pacific Flyway Council (2003), Fleskes and Yee (2007), IWJV (2012)
SHOREBIRDS	American Avocet	56%	93%		Shuford et al. (2002), Morrison et al. (2006), IWJV (2012)
	Black-necked Stilt	69%			Shuford et al. (2002), Morrison et al. (2006), IWJV (2012)
	Snowy Plover (*Interior*)	75%			Shuford et al. (2002), Morrison et al. (2006), IWJV (2012), USFWS unpublished data (2007-08 Western Survey)
	Long-billed Curlew	57%			Shuford et al. (2002), Morrison et al. (2006), IWJV (2012)
	Marbled Godwit		75%		Shuford et al. (2002), Melcher et al. (2006), Morrison et al. (2006), IWJV (2012)
	Wilson's Phalarope		50%		Shuford et al. (2002), Morrison et al. (2006), Lesterhuis and Clay (2010), IWJV (2012)
	Dowitchers		53%		Shuford et al. (2002), Morrison et al. (2006), IWJV (2012)
WATERBIRDS	White-faced Ibis	73%			Ivey & Herziger (2006), Moulton (2009), USFWS unpublished data (Western Waterbird Survey 2009-2011)
	California Gull	75%			Ivey & Herziger (2006), USFWS unpublished data (Western Waterbird Survey 2009-2011)
	Eared Grebe		90%		Cullen et al. (1999), Aldrich and Paul (2002), Ivey & Herziger (2006)
	American White Pelican	32%			King & Anderson (2005), Ivey & Herziger (2006)
	Greater Sandhill Crane				
	Central Valley	42%	>90%		Pacific Flyway Council (1997), Ivey & Herziger (2006)
	Lower Colorado River Valley	100%	>90%		Pacific Flyway Council (1995), Ivey & Herziger (2006)
	Rocky Mountain	100%	100%	90%	Ivey & Herziger (2006), Subcommittee on Rocky Mountain Greater Sandhill Cranes (2007)
	Lesser Sandhill Crane				
	Pacific Flyway		>90%		Pacific Flyway Council (1983), Ivey & Herziger (2006)

FIGURE 1. Commission for Environmental Cooperation (CEC) Level I Ecoregions. Figure illustrates IWJV intersection of three major North American biomes: Northwestern Forested Mountains, North American Deserts and Temperate Sierras. North American Desert biome encompasses approximately 58% of the IWJV area.

Although wetland abundance is relatively low compared to other regions of North America, wetlands occur throughout the Intermountain West and primarily occupy areas of high hydrologic discharge within and adjacent to high elevation mountainous regions. Wetland systems in the Intermountain West are largely driven by accumulating winter snowpack (Lemly et al. 1993, Engilis and Reid 1996, Lovvorn et al. 1999). Snowmelt in mountain streams peak from late spring to early summer and result in intermittent surface flows that feed many wetland basins. Stream discharge rates can vary widely and are affected by annual and decadal shifts in precipitation patterns. Additionally, high evaporative rates in many areas result in intermittent and ephemeral wetland patterns. Combined, these characteristics sustain exceptionally dynamic wetland cycles that exhibit high annual rates of temporal and spatial variability across regional scales. The dynamic nature of these wetland systems results in very high rates of biological productivity when favorable environmental conditions occur (Kadlec and Smith 1989, Ratti and Kadlec 1992, McKinstry 2004). However, the importance of these habitats has historically been challenging to recognize due to their ephemeral nature and relatively low density across the region. In part, these characteristics make wetland habitats in the Intermountain West especially important to migratory bird populations.

In stark contrast to the dynamic nature of wetland cycles in the west was the need by American settlers moving into the region during the early 1900s to have dependable water sources. This disparity ultimately transformed the Intermountain West landscape. The major impact on wetland and riparian areas in the Intermountain

West has been from the development and subsequent depletion of water resources for energy, agricultural, industrial, and domestic uses (McKinstry 2004). Wide-scale and systematic development of water resources began in earnest with the passage of the Federal Reclamation Act in 1902. Large water projects in the west that were intended to stimulate expansion of agricultural industries had tremendous impacts on wetland systems. Damming and diversion of streams and rivers reduced or stabilized historic discharge rates and attenuated peak runoff periods to the benefit of downstream irrigators. Consequently, these and other anthropogenic modifications reduced the abundance of wetlands in western states 30–91% between the 1780s and mid-1980s (Dahl 1990; Table 2).

The exact rate of wetland loss that has occurred since the 1870s is currently unknown, but has likely accelerated in response to increased human development in the region. Population growth rates in the Intermountain West have increased dramatically since the 1990s (Hansen et al. 2002). For example, the cities of Albuquerque NM, Boise ID, Denver CO, and Salt Lake City UT observed an average growth rate of 18.5% between 2000 and 2010 (U.S. Census Bureau 2011). Population projections for some states such as Utah indicate the human population will double by 2050 . In many parts of the West, population growth has not followed a traditional pattern of concentrated growth in areas adjacent to urban centers but has grown in more rural and remote locations (Ingram and Lewandrowski 1999, Hansen et al. 2002). Correspondingly, limited wetland habitat continues to be impacted by anthropogenic modifications (Dahl 2009, Copeland et al. 2010). Long-term wetland loss has placed increased pressure on remaining wetland habitats to provide most of the resources required to sustain wildlife populations.

TABLE 2. Percent of total wetland loss, by state, between the 1870s and mid-1980s from Dahl (1990).

State	Loss 1870s-1980s
Arizona	-36%
California*	-91%
Colorado	-50%
Idaho	-56%
Montana*	-27%
Nevada	-52%
New Mexico	-33%
Oregon	-38%
Utah	-30%
Washington	-31%
Wyoming	-38%

* Majority of wetland loss occurred in areas of the state outside the IWJV.

Despite the significance of wetland resources to society and wildlife, especially migratory birds, in the Intermountain West significant information gaps remain regarding inventories to adequately assess regional distribution and trends of wetland habitats (IWJV unpublished data, McKinstry 2004). In perhaps the most comprehensive review of Intermountain West wetland systems, McKinstry et al. (2004) emphasized the dearth of recent information and research regarding wetland and riparian habitats in the Intermountain West. Much of our understanding of wetland function, management, and conservation is derived from research over 30 years old and from systems outside of the Intermountain West which may have limited applicability to this region (McKinstry 2004). Additionally, avian population and wetland habitat relationships at landscape scales are less well quantified and understood in the Intermountain West compared to other biomes (Robinson and Warnock 1996, Haig et al. 1998, Gammonley 2004). As a result, we are challenged to measure or understand the cumulative impacts of wetland loss or conservation at landscape scales. The need to identify effective conservation strategies capable of addressing complex water and land use needs related to wetland habitats of the West is imperative given the likelihood of continued wetland loss and demands on water resources (McKinstry 2004, Copeland et al. 2010). Consequently, additional science investments are required to develop the information which will inform effective conservation strategies for wetland resources in the Intermountain West that are linked to continental and regional objectives.

IDENTIFYING PRIORITIES FOR WETLAND CONSERVATION SCIENCE

To achieve the objectives stated in this document, we used a two-phase approach, detailed below, to identify priority strategies for investment in wetland conservation science and planning. The first was an ecoregional-based assessment which evaluated the relative extent, distribution, abundance, and ownership patterns of wetland habitats in the Intermountain West. Secondly, we evaluated the relative annual cycle dependence of a suite of wetland birds within a suite of wetland associated landscapes identified through an ecoregional assessment. These species and landscape values were combined in a model to inform the relative significance of landscapes for further investment of IWJV science resources over the next 5 years (2013–2015).

PHASE I: WETLAND ASSESSMENT

The ecological diversity and scale of the Intermountain West pose considerable challenges to biological planning. The relatively sparse human population and perception of limited natural resource value in the Intermountain West has resulted in a lack of interest for the development of data important to characterizing landscape settings when compared to other regions of the U.S. (McKinstry 2004). Therefore, a number of data summaries and analyses were conducted to evaluate wetland abundance, distribution, and land ownership patterns across the region. These assessments were identified as a high priority for the IWJV in the 1995 Implementation Plan (IWJV 1995, page 21). Outcomes of these exercises provide further justification for this plan proposal to invest resources in wetlands conservation and identify characteristics important to conservation strategies. The results of these summaries were used as data inputs to complete conceptual landscape prioritization models described later in the 'Phase II: Avian Species & Wetland Landscapes' section of this plan (page 15).

WETLAND DATA, RELATIVE DENSITY, AND DISTRIBUTION

The most extensive wetland inventory available for the Intermountain West was conducted by the U.S. Fish and Wildlife Service's National Wetlands Inventory (NWI) Program. The NWI program was established in 1974 to conduct a nationwide inventory of wetlands to aid in conservation efforts. The inventory utilizes a wetland habitat classification originally described by Cowardin et al. (1979) that has been accepted as the federal standard for wetland delineation (adopted by the Federal Geographic Data Committee on July 29, 1996: 61 Federal Register 39465 and updated in 2009). To date, the NWI program has completed digital[1] wetland inventories for 63% of the Intermountain West. Summarization of NWI data revealed the mean acquisition date of this data to be 1981. The current status of NWI data creates two challenges to planning; (1) data extent and (2) relevance to current conditions. The current extent of NWI data leaves substantial portions of Idaho, Montana, Utah, Colorado, Arizona, and New Mexico without digital NWI coverage; however, the majority of these areas are not known to contain high wetlands densities. A series of national wetland status and trends reports conducted by Dahl (1990, 2000, 2006, 2009) indicate a loss and declining trend of fresh water palustrine wetland systems over the past three decades within the U.S. Consequently, existing NWI data likely over represents the current extent of palustrine wetlands in the Intermountain West. Regardless of these shortcomings, NWI data still provides the best available representation of wetland habitats within the region and for the purposes of the biological planning conducted here it is assumed adequate.

[1] Digital wetland inventory are those inventories that are available in a geographic information system (GIS) data format.

To assess wetland abundance and distribution, a grid summary analysis was conducted using NWI data. Wetland density was summarized by measuring wetland abundance within an array of 16 km² grid cells. Results were interpolated using an inverse weighted distance technique for mapping and display (Figure 2).

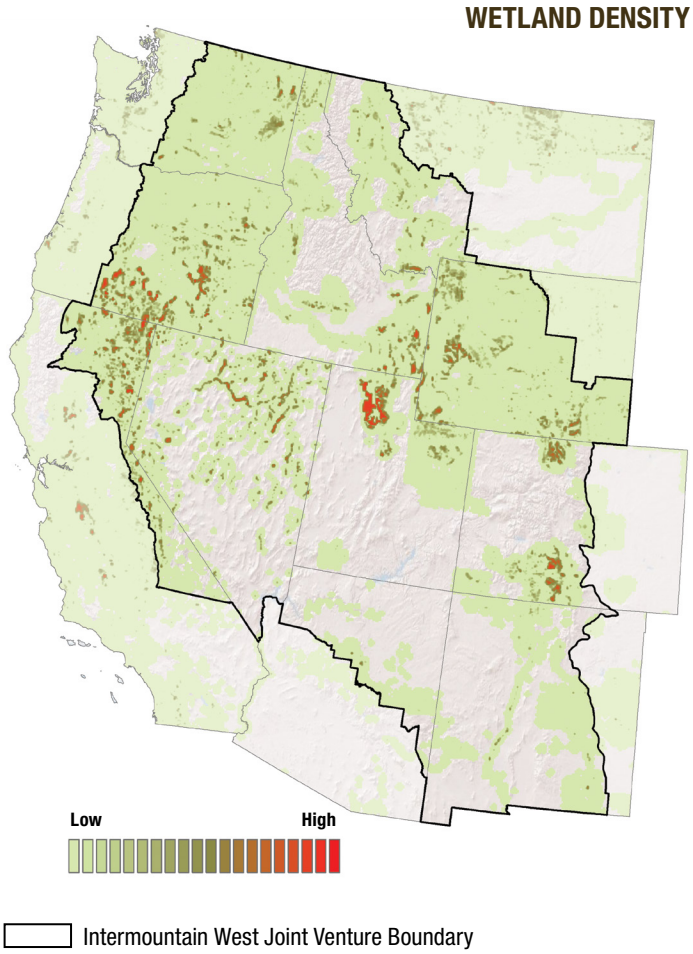


FIGURE 2. Wetland density and distribution assessed using available digital National Wetlands Inventory (NWI) data and 16 Km² sampling grid. Results were interpolated using an inverse weighted distance technique. Data was obtained from the NWI program at http:www.fws.wetlands/Data//Download.html.

The results indicate a clear pattern of wetland clustering occurring across the region. Wetlands in the Intermountain West are largely concentrated in areas of high hydrologic discharge within and adjacent to mountainous regions containing abundant winter snowpack (Laubhan 2004, Lovvorn et al. 1999). Analysis of wetland clustering patterns derived from the grid summary indicate approximately 87% of wetland abundance across the Intermountain West occurs in only 10% of the landscape area (Figure 3).

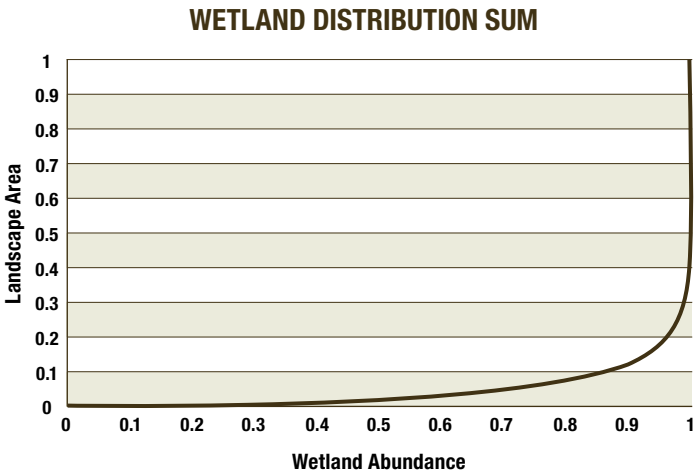


FIGURE 3. **Data distribution summary calculated from National Wetlands Inventory 16 km² grid summary within the geographic boundary of the Intermountain West Joint Venture. Results indicate a concentrated pattern of wetland distributions across the region.**

IDENTIFYING WETLAND LANDSCAPES

Results were aggregated into ecological regions (Commission for Environmental Cooperation 1997) in order to integrate wetland abundance and distribution patterns into a landscape context. Ecological regions (ecoregions) are defined by discreet boundaries that encompass similar biotic, abiotic, anthropogenic, terrestrial, and aquatic capacities and potentials (Omernik 1987). Defining wetland patterns within this framework provides additional insight to regional ecological drivers and stressors associated with system processes (e.g., physiographic setting, hydrology, and land use practices; Donnelly and Vest 2012b). Wetland associated ecoregions were identified through evaluation of wetland abundance and distribution data. Existing IWJV and partner planning documents were also evaluated as ancillary inputs to this process to ensure all regionally significant wetland landscapes were included. From this exercise, 18 areas of high relative wetland abundance and importance to partners in migratory bird conservation were identified (Figure 4.)

Ecoregional extents and wetland distributions exhibited strong spatial correlations. The extent of the 18 wetland associated landscapes encompasses approximately 6% of the Intermountain West, but account for 50% of the inventoried emergent palustrine wetland systems in the region. Understanding the pattern of wetland distribution provides important insight to conservation strategies. Regions of concentrated wetlands provide essential habitats to a broad range of wildlife species and present likely

WETLAND LANDSCAPES

1. Bear River-Eastern Idaho
2. Carson-Lahontan Valleys
3. Centennial Valley
4. Channeled Scablands
5. Colorado Peaks
6. Columbia Basin
7. East Front Sierras
8. Goshen Hole
9. Great Salt Lake
10. Greater Yellowstone
11. Idaho Panhandle
12. Laramie Basin
13. Middle-Upper Rio Grande
14. NE Nevada
15. NW Montana Valleys
16. SONEC
17. Snake River Plain
18. Upper Green River

Intermountain West Joint Venture Boundary

FIGURE 4. **Distribution and extent of wetland ecoregions across the Intermountain West. Wetland landscape boundaries were derived by intersecting wetland grid summary results with Level IV Commission for Environmental Cooperation (CEC, 1997) ecoregional classes.**

conservation targets due to their high ratio of species dependence and small habitat footprint. Conservation actions targeting these areas are likely to provide higher returns on species and habitat benefits while diversifying the potential for favorable conservation outcomes (e.g., benefits to multiple species; Bottrill et al. 2008).

WETLAND OWNERSHIP

Wetland abundance and distribution was also summarized in the context of the conservation estate (surface land ownership) to further inform potential conservation strategies. Understanding land ownership patterns provides insight to the levels of wetland habitat protection or vulnerability that affect the range of potential conservation strategies. This analysis is particularly informative in that the percentage of public land ownership in the west is far greater than in other regions of the United States. A total of 70% of the Intermountain West surface ownership falls within federal, state, or tribal trust (Figure 5).

Summarizing wetland habitats by current ownership patterns is the first step in identifying stakeholder demographics (e.g., private, state, or federal resource ownership). Data provided by the U.S. Bureau of Land Management (BLM) was used to summarize surface ownership and wetland ownership. The results showed that 70% of emergent wetland resources in the Intermountain West occur on privately owned lands (Figure 6, see page 9). This suggests land ownership patterns do not occur randomly and that they are correlated to the distribution of wetland ecosystems. It supports the notion that early settlement patterns of the west were strongly associated with the limited distribution and abundance of water needed for the development of agricultural, grazing, and mining operations (Marzluff 2001, Lovvorn and Hart 2004, Leu et al. 2008). These results also highlight the potential vulnerability of wetland systems occurring in the Intermountain West. Wetland resources on private lands are more susceptible to environmental threats than those that occur on public lands (Odell et al. 2003). The potential impact to wetlands is alarming when considering issues of water supply and demand across the West. The continued expansion of human development (i.e. urbanization, mining, and energy extraction) places significant strains on water supplies that in many areas are already over allocated (Downard 2010).

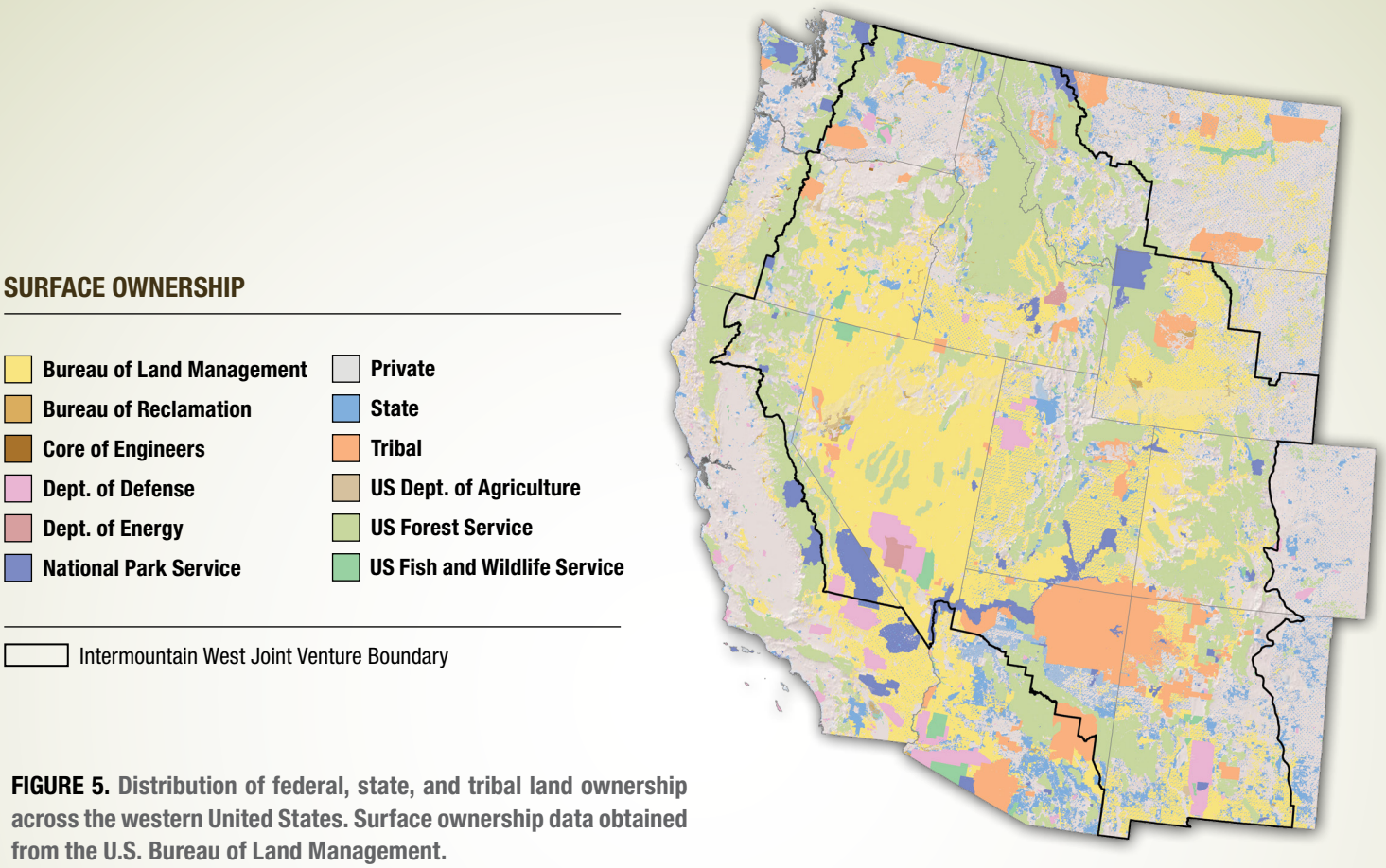
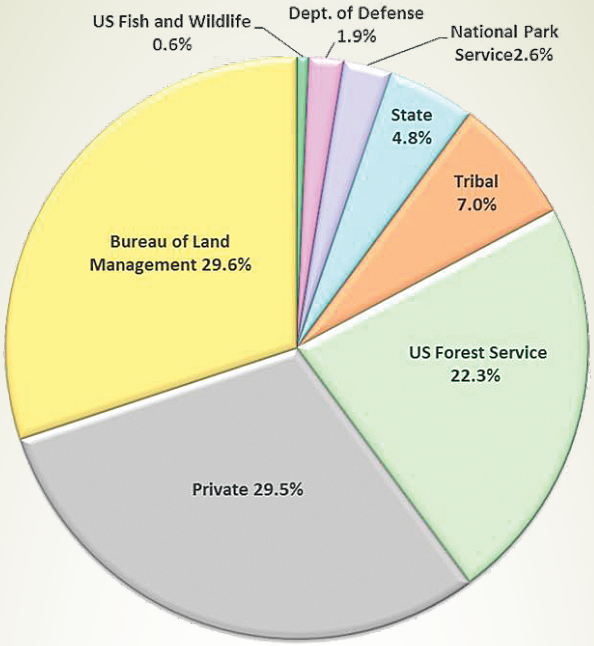
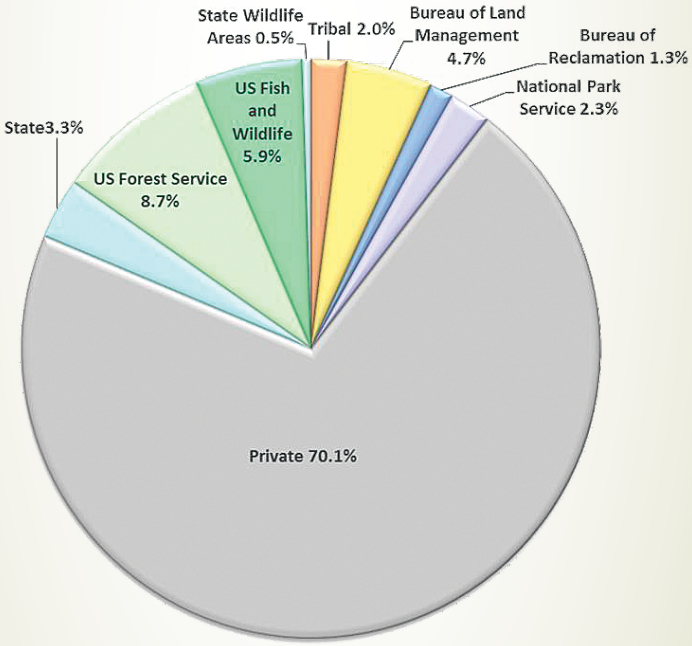


FIGURE 5. Distribution of federal, state, and tribal land ownership across the western United States. Surface ownership data obtained from the U.S. Bureau of Land Management.



Intermountain West land ownership demographic



Intermountain West palustrine wetland ownership demographic

FIGURE 6. **Surface ownership demographics (left) and palustrine wetland area by ownership (right) within the Intermountain West Joint Venture. Private land ownership comprises 29.5% of the regions area, but encompasses 70.1% of the wetland acres.**

WETLAND LANDSCAPES AND ANTHROPOGENIC IMPACTS

The impact of human development in the Intermountain West can be described by examining Human Footprint data developed by the U.S. Geological Survey (Leu et al. 2008; Figure 7). The Human Footprint is an amalgamation of spatially explicit models developed to aid landscape conservation planning efforts by quantifying potential ecological impacts across the West. The models account for direct habitat impacts (e.g., invasion of exotic plant species, human caused fire, energy extraction, and wildland fragmentation) as well as influences of synanthropic predators (i.e., presence and risk of corvids, domestic cats, and domestic dogs).

HUMAN FOOTPRINT WETLAND LANDSCAPES

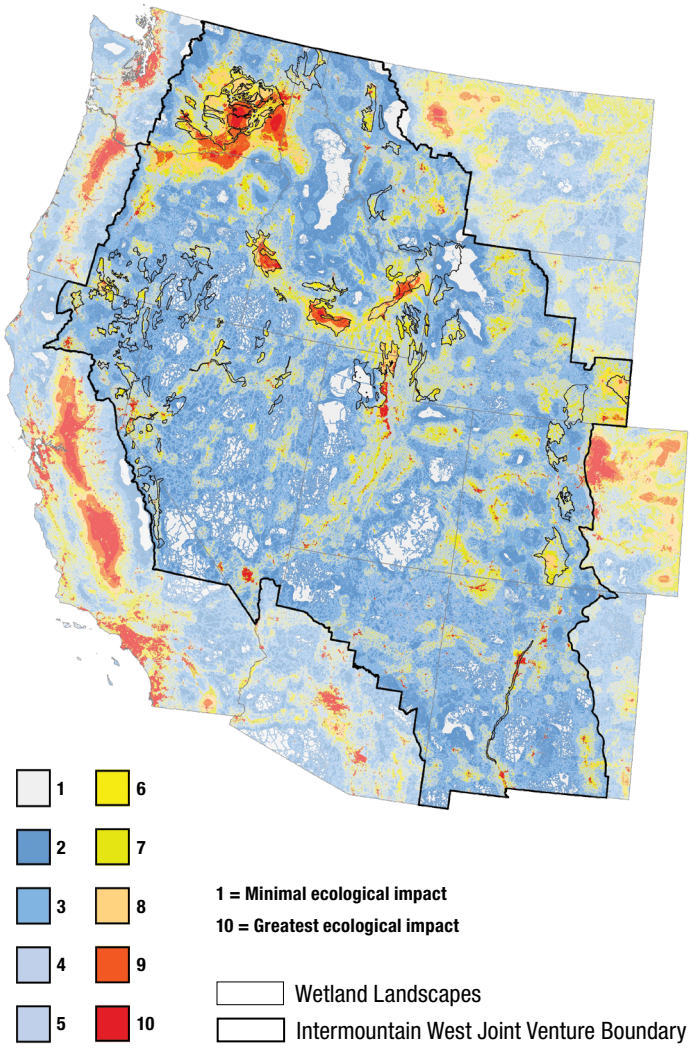


FIGURE 7. **Human Footprint model results indicating levels of anthropogenic impacts across the Western United States (Leu et al. 2008) overlaid with 18 wetland ecoregional boundaries. Spatial correlation among wetland landscapes and regions of higher ecological impact are apparent.**

Human footprint data from Leu et al. (2008) was summarized within the boundaries of 18 wetland associated ecoregions (identified earlier in this document) to measure anthropogenic impacts among wetland habitats. The results indicate a strong association with areas of higher anthropogenic affects and suggest that areas of high wetland values are associated with regions of considerable human development (Figure 8). Among wetland landscapes, the mean human footprint class was six, indicating substantial anthropogenic impacts compared to the remainder of the region (mean = 3). This information further supports the notion that human development in the West has been closely associated with the abundance and distribution of water and wetland resources. High human impact zones are typically characterized by relatively longer growing seasons, lower elevations, and flat river floodplains necessary to provide productive soil and irrigation for agricultural development (Leu et al. 2008). Therefore, the human settlement pattern in the Intermountain West has disproportionately affected areas of high biological productivity and biodiversity because these regions are generally more productive than the surrounding landscapes (Leu et al. 2008). These areas have historically provided crucial habitats for vertebrate species that breed in adjacent high elevations but winter at lower elevations or for migratory bird species that require stopover sites during migration periods (Skagen et al. 1988, Skagen and Knopf 1993).

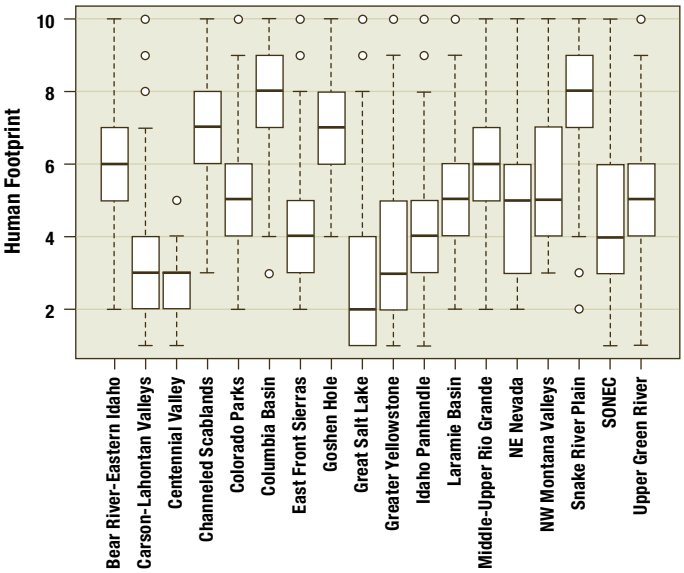


FIGURE 8. Human Footprint data results summarized within 18 IWJV wetland associated landscapes. Results indicate wetland landscapes are often characterized by considerable anthropogenic impacts associated with agriculture, irrigation infrastructure, and rural urban development (Leu et al. 2008). (Note: Great Salt Lake and Carson Sink human footprint scores are low as a result of the considerable area of open water and/or dry playa that contributed to the summary results and does not reflect the adjacent urban footprint and effects of Salt Lake City and Reno metropolitan areas.)

These summaries have provided a better understanding of basic wetland distribution, ownership, and human development patterns in the Intermountain West. From the continental scale, the ecological integrity of the Intermountain West is often characterized as more intact than other regions of the United States (Sanderson et al. 2002). This broad representation can be misleading when taken out of context to the limited distribution and potential threats associated with wetlands in this region. High private ownership rates and high spatial correlation with regions of human development increase the likelihood of future wetland habitat loss (Copeland et al. 2010). These findings suggest successful wetland conservation strategies should be focused geographically in a manner that targets regions of high wetland abundance. These regions provide disproportionately high habitat values and conservation efforts focused in these regions should be expected to yield higher returns on conservation investments. The findings also acknowledge the importance of incorporating private landowners and local stakeholders into wetlands conservation strategies. High rates of private wetland ownership highlight the vulnerability of these habitats to increased human development pressure and the uncertainty of future environmental threats. Biological planning must also continue to address the considerable information needs of the Intermountain West that are required to constructively engage policy decisions that impact wetland conservation (IWJV 1995). Wetlands occupy areas of historically high biological productivity and contain highly valued natural resources required for maintaining urban and industrial growth within this region. Increased levels of conservation will be needed to address continued reallocation of limited natural resources (e.g., water) that will undoubtedly impact wetlands in the future (IWJV 1995, Copeland et al. 2010).

PHASE II: AVIAN SPECIES & WETLAND LANDSCAPES

Evaluations of the abundance and distribution of known wetlands across the Intermountain West identified 18 wetland associated landscapes (i.e., approximately 50% of wetland abundance in the Intermountain West) that aligned with landscapes identified in prior IWJV and existing partner planning documents. However, that process did not explicitly consider bird utilization or annual cycle dependence. Additional inputs were therefore required to further assess these landscapes in the context of avian habitat value.

A modeling approach consistent with Structured Decision Making (Clemen et al. 1996, Clemen and Reilly 2001) was used to evaluate relative landscape value via a suite of representative wetland dependent birds in the IWJV. We used a suite of species with high population reliance on habitats and landscapes within the Intermountain West (i.e., strong continental scale linkage) and represented the diversity of wetland and aquatic habitats within the IWJV. We identified 5 waterfowl, 7 shorebird, and 5 waterbird

species to use in model development (Table 1). Each of these species have been previously identified as species of importance by at least one planning document including continental bird plans (NAWMP, USSCP, NAWCP), regional plans such as Pacific and Central Flyway Management Plans, State Wildlife Action Plans (i.e., State Wildlife Conservation Strategies), USFWS Migratory Bird Conservation Plans, Partners for Fish and Wildlife Strategic Plans, Regional Bird Habitat Conservation Plans (e.g., Intermountain West Regional Shorebird Plan), and prior IWJV planning documents. Many of these species possess attributes (e.g., broad geographic extent, heterogeneous habitat use, socio-political importance) consistent with criteria used to identify "landscape species" for conservation planning (Sanderson et al. 2002, Coppolillo et al. 2004, USFWS 2012).

Landscape values were assessed by individual species dependence and utilization during major annual cycle events (breeding, migration, winter). For each landscape, species dependence and utilization were ranked within annual cycle events on a 0–3 scale where 0 = no/minimal, 1 = low, 2 = moderate, and 3 = high. Available population information was used to inform annual cycle assessments to limit subjectivity and bias. Although our knowledge of population level relationships to each of these landscapes was inconsistent and often lacking, this approach was consistent with a Structured Decision Making and Rapid Prototyping Framework that facilitated landscape assessments (Starfield 1997).

Annual cycle scores were summed by species for each landscape and multiplied by a wetland habitat variable. Wetland habitat variables were calculated for each landscape as a proportion of their wetland habitat area relative to the total wetland area contained within the identified 18 wetland landscapes:

$$L = \sum_{i=1}^{s} Species_{ac} \times w_j$$

Where: L = Landscape Assessment Score, $Species_{ac}$ = sum of individual species annual cycle scores, where i = individual species, and s= number of species, and

$W_j = \frac{wetland\ acres_j}{\sum wetland\ acres_j}$ where j = acres in individual landscape.

Results were then scaled to a 0–100 range to facilitate interpretation. Subsequently, boxplots were used to evaluate the variation in scaled species-landscape assessment scores (Figure 9).

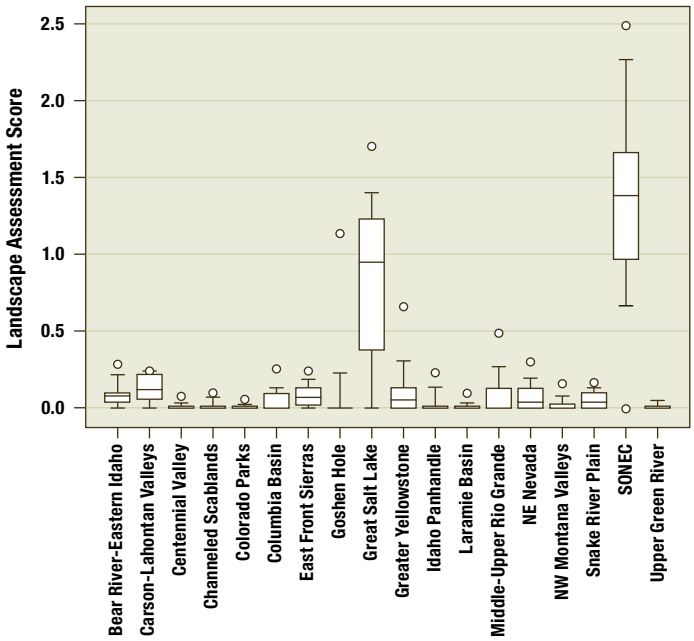


FIGURE 9. Boxplot of landscape assessment scores for 18 wetland associated landscapes in the Intermountain West based on relative wetland abundance and annual cycle dependence for a suite of umbrella avian species including waterfowl, shorebirds, and waterbirds. Boxes represent 25th–75th quartiles (i.e., 50% of the data), line in box represents median, whiskers represent lower (0–25th) and upper (75–100th) quartiles, and circles represent outliers.

Evaluation of scores and boxplots identified two landscapes with distinctly high values, the Great Salt Lake (GSL) and Southern Oregon-Northeast California (SONEC). The disproportionately high values for these two landscapes were influenced by the diversity of wetland dependent birds that rely on these ecoregions during multiple annual cycle events (primarily breeding and migration) as well as the overall abundance of wetlands within each landscape. These two landscapes alone comprised 49% of the wetland area among the 18 landscapes that were assessed within the IWJV. Consequently, approximately 25% of overall wetland abundance in the IWJV occurs in GSL and SONEC landscapes. Consequently, GSL and SONEC landscapes should be considered high priority landscapes for science-based planning and conservation by the IWJV in both near and long-term planning horizons.

ADDITIONAL WETLAND CONSERVATION CONSIDERATIONS

Focus of IWJV science resources on SONEC and GSL in the near-term is expected to develop conservation strategies in a strategic fashion which will have significant biological benefits at continental and regional scales. However, not all species may be equally served by focusing on two ecoregions. Consequently, an evaluation of alternative wetland conservation strategies was explored.

The use of surrogate conservation strategies focuses on a single or small group of biological resources as a proxy for a broader suite of species or ecological benefits (Wiens et al. 2008, USFWS 2012). This approach is meant to maximize conservation efficiency by minimizing conservation planning needs to those individual species characterized by large scale and heterogeneous habitat needs (i.e., landscape species). The use of landscape species confers an important umbrella role in securing the habitat conservation needs of many other species, species assemblages, and larger-scale ecological processes (Sanderson et al. 2002). Therefore, use of a surrogate species approach to conservation planning was identified as a suitable alternative planning framework to the focused SONEC and GSL approach.

> "The use of landscape species confers an important umbrella role in securing the habitat conservation needs of many other species, species assemblages, and larger-scale ecological processes."
>
> **(Sanderson et al. 2002)**

Appropriate landscape species were identified through a two-step process. First, the suite of wetland species used in the original analyses (Phase II) were reevaluated by summing their SONEC and GSL landscape assessment scores and then evaluating the distribution of these summed values across all species. Individual species scores at or below the median value of summed SONEC and GSL scores were assumed to benefit least from a focal landscape conservation strategy in SONEC and GSL. Based on these criteria Greater Sandhill Crane, Cinnamon Teal, Trumpeter Swan, White-faced Ibis, and American White Pelican were identified for further evaluation as to their efficacy as vehicles for broader landscape-scale wetland conservation strategies through development of an information matrix. Secondly, a set of variables were developed which sought to characterize each species' geopolitical connectivity, relevance to conservation partners, population dependence within the Intermountain West, and degree of population/habitat information available for planning efforts. Specifically, the following variables were included in the evaluation matrix:

1. **GEOPOLITICAL CONNECTIVITY** – the number of states where the species commonly occurs (scale: 0–11).

2. **PARTNER RELEVANCE** – the number of conservation and management plans the species is referenced or identified with some level of importance or prioritization (scale: 0–∞). Refer to section 'Phase II' (page 16) for types of planning documents.

3. **POPULATION & ANNUAL CYCLE DEPENDENCE** – Relative score (0–5) of how dependent the species is upon habitats within the Intermountain West (e.g., percent of continental population found within IWJV), and the number (0–3) annual cycle events (i.e., breeding, migration, winter) the species undertakes in the IWJV. Final score results from multiplying population dependence score (0–5) by annual cycle events score (0–3).

4. **AVAILABLE DATA** – the relative amount of existing population demographic (0–3) and habitat/landscape inventory (0–3) available to inform or develop population-habitat models. Final score results from multiplying the 2 independent scores.

Scores were assigned to each of these variables based on information assessed from partner planning documents described previously. Scores were normalized to facilitate graphical interpretation of the relative value of each species within assessment variables. Scores were normalized by calculating the ratio of each species score to the summed value across all species within each assessment variable.

The evaluation identified Sandhill Cranes as a landscape species most appropriate to a surrogate conservation strategy. Sandhill Cranes had the broadest connectivity to partners across the Intermountain West, had high population reliance on Intermountain West landscapes, exhibited strong relationships to wetland habitats amenable to existing conservation programs, and possessed sufficient population-habitat data to inform planning models (Figure 10, see page 13). While other species may have scored relatively high within individual assessment categories, Sandhill Cranes possessed relatively high scores for all categories. Consequently, development of habitat conservation planning based on the biological needs of Sandhill Cranes may be valuable to the IWJV partnership and likely achievable in a meaningful timeline within the limits of current capacity.

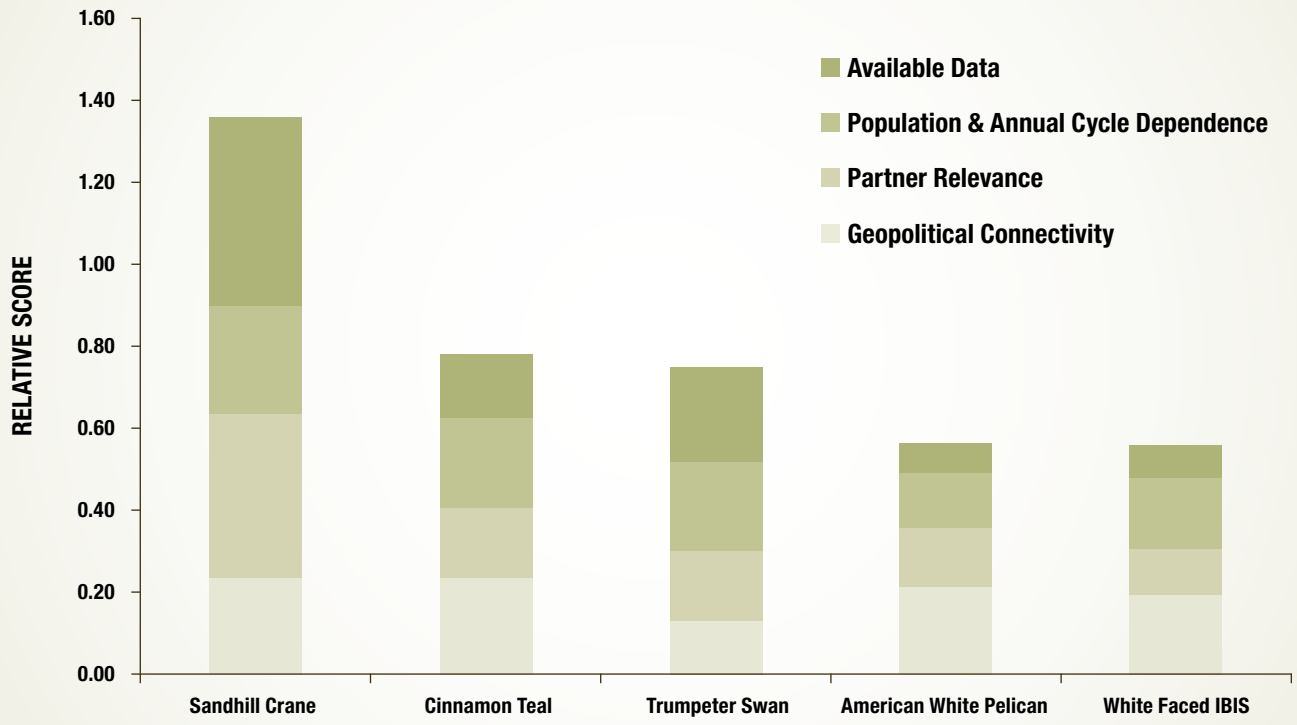


FIGURE 10. Summary of compatibility assessments for wetland obligate species in the Intermountain West.

Sandhill Cranes occupy wetland and upland complexes with close association to privately owned, working ranchlands throughout the Intermountain West. Wet meadows and flood-irrigated pastures are especially important by providing nesting, foraging, and colt-rearing habitat. In winter, they rely heavily upon agricultural waste grain to meet energetic demands. Consequently, sustaining populations of Sandhill Cranes will be closely tied to ranching and agricultural land use patterns which are hallmarks of the Intermountain West landscape and culture. These associations provide ample opportunity to link to existing conservation programs and further develop cooperative conservation partnerships with this community.

Sandhill Crane populations in the Intermountain West historically experienced significant population declines due to pressures of human development and wetland modifications. This ultimately resulted in contracted and fragmented breeding distributions across the region. The ability of Sandhill Cranes to recover from population perturbations due to landscape scale habitat modifications is limited because they exhibit naturally low recruitment rates (i.e., delayed maturity, small clutch size, long-term monogamy). Recruitment rates in the Intermountain West are among the lowest for North American Cranes and believed to be an important factor limiting population growth (Drewien et al. 1995).

Population targets have been identified by the Pacific and Central Flyway Councils and reliable population survey data exists to inform landscape scale planning efforts for Sandhill Cranes. Additionally, several regional and local planning documents have identified key information needs to develop conservation strategies that can sustain these populations of birds:

1. **Association of Fish and Wildlife Agencies (AFWA) -Priority Information Needs for Sandhill Cranes:**
   - Assessing effects of habitat change on Rocky Mountain Population of Sandhill Cranes
2. **Central and Pacific Flyway management plans for Sandhill Cranes:**
   - Inventory and prioritize habitat needs to better understand changes and threats to species
   - Measure habitat fragmentation and urbanization rates
   - Conserve and improve private wetland complexes utilizing a variety of wetland protection and enhancement strategies
3. **State Conservation Plans (New Mexico, Washington):**
   - Predicted impacts to crane populations resulting from changes in farming and land management practices (e.g., irrigation practices).

These planning documents recognize the majority of Sandhill Crane habitat occurs on private lands. Consequently, they also recognize trends in agricultural programs, intensity of agricultural activities, and rural development will primarily determine long-term trends of populations in the Intermountain West.

DISCUSSION

Organizations are forced to allocate resources that account for the benefits, cost, and outcomes associated with those investments to develop effective conservation strategies. This philosophy is important to the IWJV which operates at a geopolitical and ecological scale that exceeds the limited capacity of the organization and partnership to meet all conservation needs. Therefore, it becomes essential to identify strategies that allocate limited resources within priorities to maximize conservation returns (Bottrill et al. 2008). This document has explored and identified three wetland conservation science priorities focusing on SONEC, Great Salt Lake, and Greater Sandhill Cranes that embrace the principles central to a strategic conservation framework. The IWJV believes the initiation of this strategic approach for the subsequent planning horizon demonstrates a logical process to resource allocation based on the high biological value, trends in habitat loss, and private land ownership patterns associated with wetland habitats in the Intermountain West. The consequence of this approach will be the restriction of IWJV science support for conservation needs that fall outside the context of the identified strategies in the immediate future. Focusing science resources within the proposed wetland conservation strategies does not disregard the value of other wetland landscapes or avian habitats. These strategies simply define the bounds under current levels of science capacity in which development of habitat objectives and conservation strategies linked to regional and continental population goals are likely to be effective.

Conservation science investments in SONEC, Great Salt Lake, and Greater Sandhill Crane strategies are anticipated to yield high conservation returns at multiple scales. These priorities define the geographic and contextual scope of science-based conservation investments being proposed by the IWJV over the near-term planning horizon. However, these priority strategies do not identify more detailed habitat objectives or information needs. The next steps of stakeholder outreach, biological planning, and conservation design remain to be identified or developed within these priorities before specific conservation needs can be met.

NEXT STEPS

Development of more detailed conservation objectives within SONEC, Great Salt Lake, and Greater Sandhill Crane strategies will require engagement of regional, local, and issue-based stakeholders. This action is necessary to gather information and develop consensus regarding conservation information needs and priorities required to support biological planning. In order for conservation science to be meaningful (e.g., addresses population and/or landscape limiting factors), linkages among local, regional, and continental priorities must be synthesized and prioritized among stakeholders. These steps will help ensure conservation actions that occur at local levels have relevant conservation impacts (i.e., support population goals and habitat objectives) at regional and continental scales. Development of individual working groups for each strategy is anticipated. Outreach will occur through associated State Conservation Partnerships, the IWJV partnership network, and known stakeholder groups and individuals. Invitations to participate in working groups will be inclusive and will be extended to all interested stakeholders willing to participate. Additional details associated with the development and formalization of SONEC, Great Salt Lake, and Greater Sandhill Crane working groups will be forthcoming in the following months, available on our website (www.iwjv.org).

SUPPLEMENTAL MATERIAL

Supplemental information regarding geodatabase of wetland landscapes available at: **http://www.iwjv.org/**

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