North American Waterfowl Management Plan Science Support Team
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Information needs to inform net landscape change assessment and cost-effective habitat allocation decision-making

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Introduction:

Initially, we considered reviewing a variety of habitat types (wetlands and coastal habitats, forest, and grassland and scrub-shrub) to assess net landscape change assessment information needs. For some of these habitat groupings it appeared that alternate sources of data allowed for cost-effective, alternative approaches to assessing changes in landscape composition. Eventually, we gravitated to a set of key habitat elements viewed as showing the greatest need for such information. Those elements resulted in the following identified needs:

1. Fulfill agency mandates to update NWI
2. Improve classification and quality assessment of grassland and shrubland habitats
3. Increase communication with NRCS NRI regarding data needs and accessibility
4. Increase opportunities to update NLCD

Our objective for this whitepaper was to focus efforts to pursue data where alternate sources do not provide the requisite information to assess landscape composition change. Each section presents a brief description of limitations of existing data, what data is needed and at what resolution, the importance and value the desired data holds for JV conservation planning with examples showing how JVs intend to use the data in their net landscape change assessments and ultimately its value in habitat allocation decision making. To the extent possible, this will be supplemented with cost estimates.

In each section, we provide recommendations for the US NABCI committee to consider in their efforts to interact with agency leaders to address the paucity of information limiting more transparent and effective habitat conservation delivery. Those ten recommendations are summarized immediately below.

Recommendations for NWI:

1. Fulfill FWS mandates to update NWI as fully as practicable considering the following elements:
    a. Strive to fund $25 million annually to allow an average of 10% completion of the U.S. each year, and
    b. Strive for a seamless national digital database of wetlands consistent with the Emergency Wetlands Resources Act of 1986, including remapping wetlands in ecoregions that have been subject to significant wetland losses or gains since 1980 and that are priorities for FWS trust resource conservation. Existing hardcopy NWI maps should be converted to digital format in areas without digital data that are not scheduled for remapping.

2. Review NAWMP priorities for NWI mapping and remapping project needs annually with an objective to maximize project completion.

Recommendations for Grassland and Scrub-Shrub Habitat Quality:

3. Continue to develop remote sensing techniques to more accurately depict quality of grassland and shrubland habitat as it pertains to priority bird species.

4. Disseminate information on existing techniques and their utility for classifying grasslands and shrublands.
5. Identify priority grassland and shrubland areas where availability of more accurate grassland and shrubland land cover would be of the highest use for bird conservation.

Recommendations for NRCS NRI:

6. Communicate with NRCS regarding data needs for JV regional assessment of grassland and pastureland conditions.
7. Communicate with NRCS and Joint Venture science staff regarding accessibility of NRI data to JVs at scales appropriate for conservation planning.

Recommendations for NLCD:

8. At a minimum, continue to support production of NLCD on a 5-year frequency. This dataset is essential to work that Joint Ventures undertake for biological planning and conservation design.
9. Determine increased value of NLCD produced on a 2-year frequency. If value is deemed significant compared to existing frequency, pursue increased funding for a 2-year update cycle.
10. If feasible, pursue development of finer resolution imagery (e.g., 10-m) and better accuracy. Without adequate fine-resolution data or imagery, we are unable to adequately link changes in populations (size, demography, etc.) with changes in habitat. Higher resolution imagery would allow each region to do the landscape-scale analysis that is needed, as well as to roll up individual efforts into a collective net landscape change analysis.

Fulfill agency mandates to update NWI

Background:

The National Wetlands Inventory (NWI) data is a public resource which enables federal, state, nonprofit, and academic institutions to develop the tools and programs integral for effective wetland conservation. The availability of NWI data saves a significant amount of time and expense to conservationists and it allows for a more efficient conservation decision-making process in states with limited and/or declining revenues. The NWI provides the historical background for spatially explicit wetland loss and wetland change assessments. These efforts are increasingly important to inform conservation strategies as landscapes (e.g., the U.S. Plains & Prairie Region) are altered by loss and degradation from urbanization, agricultural expansion, energy development, and climate change.

In 2006, the North American Waterfowl Management Plan Science Support Team unanimously passed a recommendation that the "NAWMP Plan Committee work with the Association of Fish and Wildlife Agencies to increase support for creation of NWI digital wetlands data in all areas of the U.S. and to update wetland data in high priority areas for waterfowl." They viewed state and NGO support as essential to revitalizing the NWI because the US Fish and Wildlife Service (FWS) would require additional dedicated funding. The FWS's Division of Habitat and Resource Conservation, which oversees NWI, estimated that $25 million would be required annually to complete 10% of the U.S. each year.

A revitalized NWI should provide for a seamless national digital database of wetlands consistent with the Emergency Wetlands Resources Act of 1986, including remapping wetlands in ecoregions that have been subject to significant wetland losses or gains since 1980 and that are priorities for FWS trust resource conservation. As part of that effort, existing hardcopy NWI maps should be converted to digital format in areas without digital data that are not scheduled for remapping.

In a FWS memo dated April 28, 2010 the Assistant Director of Fisheries and Habitat Conservation wrote to the Assistant Director of Migratory Birds and to the Co-chairs of the NAWMP Plan Committee indicating NAWMP priorities for NWI mapping and remapping needs, highlighting seven key regions. However, lack of funding has limited project completion. More recently, new projects for updating the NWI have been identified but limited funds for projects remain a factor.

In 2013, the Association of State Wetland Managers (ASWM) reported results of outreach to private and public organizations which utilize the NWI data to: collect stories which highlight various projects which use or have used the NWI mapping service; discern who is using the data and what it is used for; and to estimate the cost and time savings benefits of using the NWI as well as the potential consequences of not having NWI maps with up-to-date data. Respondents unanimously reported NWI needed increased funding to catch up on the backlog of areas which still do not have any digitized mapping or current data available as well as to update areas of rapid environmental change (e.g., Louisiana and New Jersey coastlines). The ASWM was overwhelmed with stories of successful collaborations, increased ability to track wetland changes and typology, and advances in strategic planning for habitat restoration as well as development. The tools and staff support provided by the NWI were identified as integral to their various projects' success and to conserving priority wetlands.

The critical value that NWI data represents for Joint Venture (JV) conservation planning may be reflected in efforts to assess changes in landscape composition and ultimately to provide for transparent and efficient habitat allocation decision making. The issues we are facing from climate change, population growth and habitat loss require partnerships, collaboration, and open source data to

conserve our nation's wetlands and wildlife, whose boundaries do not usually fall neatly into local, regional or state boundaries.

Joint Ventures have had to apply novel approaches to assessing wetland conditions because requisite data were not available. In some cases, JVs have had to assess wetland conditions based on ground-truthing or alternate data since, for example, NLCD was not providing the required resolution.

The NWI offers Americans the opportunity to work together effectively, share resources and knowledge efficiently, to ensure sustainable wetland habitats for the future. The ASWM strongly endorsed support for funding the NWI and encouraged users to promote continued support and funding for NWI.

Recommendations for NWI:

1. Fulfill FWS mandates to update NWI as fully as practicable considering the following elements:
    a. Strive to fund $25 million annually to allow an average of 10% completion of the U.S. each year, and
    b. Strive for a seamless national digital database of wetlands consistent with the Emergency Wetlands Resources Act of 1986, including remapping wetlands in ecoregions that have been subject to significant wetland losses or gains since 1980 and that are priorities for FWS trust resource conservation. Existing hardcopy NWI maps should be converted to digital format in areas without digital data that are not scheduled for remapping.

2. Review NAWMP priorities for NWI mapping and remapping project needs annually with an objective to maximize project completion.

Improve classification and quality assessment of grassland and shrubland habitats

Background:

Multiple North American bird habitat Joint Ventures identify grassland and shrubland birds and their habitats as priorities for conservation action. Joint Venture Science Coordinators identify a range of grassland and shrubland habitat types as important bird habitats, ranging from cultivated grasses, native prairies, arid grassland, sagebrush shrublands, and pine or oak savannahs. Existing, readily available land cover datasets, such as the National Landcover Dataset (NLCD) and NASS Crop Data Layers (CDL) vary regionally with regards to how useful they are in determining quantity of grassland and shrubland habitats. Generally, they fall short of accurately classifying grassland landcover and defining grassland quality in terms that are useful to Joint Venture Science Coordinators.

Joint Venture Science Coordinators were asked to describe additional features not currently monitored that would be helpful to set conservation goals for grassland/shrubland birds. Responses included imagery or landcover that would enable differentiation between grassland, shrubland, and open woodlands, intact grasslands versus plowed, and exotic versus native grasses. Currently, many specific grassland or shrubland habitat types important to priority bird species are not defined through readily available land cover. The ability to discern percent forbs and bare ground in grasslands, encroachment by woody species into native grasslands, rates of habitat conversion, and grassland structure related to grazing intensity were noted as well.

Joint Venture Science Coordinators expressed the desire for grassland and shrubland land cover data at a finer resolution than NLCD (currently 30 meters), ideally 10 meters or less, available at the county-level scale and possibly smaller (e.g., township scale). Desired frequency was approximately 5 years. Most Joint Ventures felt land cover analysis from spring/summer would be most valuable, but there is also need for analysis of grassland/shrubland land cover during fall and winter in some regions (e.g., the Sonoran and Mexican highlands and Gulf coast prairies).

Improved grassland and shrubland land cover data would assist conservation planning and implementation for priority birds in a number of ways. It would assist with either setting "bottom-up" species objectives, based on the amount of existing quality habitat and potential for improvement of lower quality habitat, as well as assisting with assessment of the landscape to support "top-down" derived population and habitat objectives from continental scale planning documents, such as the Partners in Flight Landbird Conservation Plan. Improved land cover information would assist Joint Venture Science Coordinators and conservation partners to identify and prioritize areas for conservation action, ranging from protection of existing high habitat values, to targeting management actions to improve degraded grasslands and shrublands. Additionally, the improved land cover would enable Joint Venture Science Coordinators to better interpret the effectiveness of management actions.

Wang et al. (2010) summarized remote sensing technology, both instruments and techniques, relevant to ecology, biodiversity and conservation. Instruments discussed included high spatial resolution, hyperspectral, thermal infrared, small-satellite constellation, and light detection and ranging (LIDAR). Techniques covered included image classification, vegetation index, inversion algorithm, data fusion, and integration of remote sensing and geographic information systems. Some of these instruments and techniques have potential application for better classifying grassland and/or shrubland quality as described above. Commercially available high spatial resolution systems can achieve resolution in the range of 0.5 – 1.0 meters, however, the estimated price in 2010 for acquisition was approximately \$3,000 – \$5,000 for a 10 km^2 area (i.e., 1,000 hectares or approximately 2,471 acres) (Wang et al. 2010). To place that figure into a Joint Venture-scale perspective, the 2010 National Oceanic and Atmospheric Administration's Coastal Change Analysis Program (CCAP) land cover estimates that there are approximately 7,123 km^2 of grassland/herbaceous habitat in the Gulf Coast Joint Venture region. It would cost \$21,360,000 – \$35,600,000 to acquire high resolution imagery for that amount of grassland habitat, and analysis of the imagery would increase the total cost. Wang et al. noted that prices of high resolution imagery would be expected to decrease over time due to increased numbers of sensors and marketplace competition.

Hyperspectral sensors have proven useful in several studies aimed at detecting invasive species or landcover characteristics (Ramsey et al. 2005, Lawrence et al. 2006, Guerschman et al. 2009) but it is likely that their utility in assessing species composition of grasslands would require fairly intensive field work to correlate remotely-sensed reflectivity with field observed species-specific reflectivity (Nicholas Enwright, U.S. Geological Survey, Mark Parr, U.S. Fish and Wildlife Service, personal communication). Also, there might not be significant differences in reflectivity of different plant species (Elijah Ramsay, U.S. Geological Survey, personal communication). Similar to high resolution imagery, hyperspectral imagery acquisition and analysis is currently fairly cost-prohibitive on the scale of a Joint Venture. However, relatively low cost hyperspectral systems have been developed for use at smaller scales (Abd-Elrahman et al. 2011).

Some studies have used a combination of hyperspectral and high resolution technology for analysis of ecological systems with promising results (Walsh et al. 2008). Similarly, a combination of hyperspectral or optical imagery, and radar or LIDAR (Light Detection and Ranging Data) could prove useful to determine grassland and/or shrubland species composition and structural characteristics (Wang et al. 2010, Elijah Ramsey, U.S. Geological Survey, personal communication). Researchers at Texas A&M are experimenting with Unmanned Aerial Systems (UAS) (drones) equipped with a combination of sensors including hyperspectral, LIDAR, and thermal infrared cameras to monitor conditions in agricultural settings (Texas A&M University 2017). These techniques may not be transferable to scales that are relevant to Joint Venture conservation planning but may be useful for ground-truthing or other site-level work.

The Prairie Pothole Joint Venture (PPJV) and Prairie Habitat Joint Venture (PHJV) are examples of regions that required spatial information on grassland extent and quality at a resolution and/or accuracy greater than provided by NLCD or CDL. Each organization conducted on the ground vegetation monitoring and/or used higher resolution remotely sensed products to quantify quality, extent, and change in grassland landcover within their geographies.

To improve landcovers classification within their geography, the PPJV hired the Earth Resources Observation and Science (EROS) Center to build an improved NLCD with ground-truthed data collected by the PPJV, however the resulting 80% accuracy in grassland classification was still marginal for conservation planning (Sean Fields, personal communication). Landcover accuracy was further improved by aggregating classes and by the inclusion of several ancillary datasets (e.g., National Wetlands Inventory, urban/developed, fields enrolled in the Conservation Reserve Program). Dahl (2014) used a sample-based approach with a combination of high resolution imagery to classify landcover coupled with extensive ground-truthing data to estimate wetland and grassland status and loss rates in the US portion of the Prairie Pothole Region. They sampled 755 plots with high resolution aerial imagery and conducted ground verification on 27%. Imagery was collected using the 4 mi^2 plot sampling design developed for the USFWS–National Wildlife Refuge System to assess changes in landcover and monitor breeding waterfowl populations (Loesch et al. 2012). This methodology allowed them to spatially track changes in extent of multiple types of wetland and upland grasslands, with upland grasslands declining 2.6%, (229,980 ha) between 1997–2009, mostly due to agricultural conversion (Dahl 2014).

The Prairie Habitat Joint Venture designed a prairie monitoring program to provide an evaluation of habitat trends throughout their delivery area with the goal of establishing a long- term habitat monitoring program. The JV and partners conducted grassland transects in 1985 and 2001 which were designed to assess habitat change in conjunction with annual spring duck counts. The survey design sampled 0.41% of the landscape with 153 transects selected in a stratified systematic random sample in the grassland and boreal transition zone. Landcover was classified using high resolution aerial photography repeated every 10 years and manually digitized with heads up stereo 3D digitizing. Data from Statistics Canada Census of Agriculture for 4 additional years was also used to quantify changes in upland grassland landcover. These methods are similar to those employed for the USFWS wetlands status and trends analysis. The major cost was flight time required to obtain the photography. This method provided a highly detailed accounting of landcover change over time. In comparison, automated methods of classifying landcover had an accuracy between 60–75% which was not sufficient for tracking change. These methods were able to detect changes in upland landcover, as well as how the changes occurred spatially. Shifts in landcover included a 6% decrease in cultivated land, a < 1%

decrease in natural pasture land, a 3% decrease tame/seeded pasture, and a 4% increase in tame hay. Specifically, native grasslands declined by 10% largely due to removal of small grassland remnants within landscapes dominated by cultivation while large blocks of native grasslands remained largely stable (Watmough and Schmoll 2007).

Accuracy of these estimates still remains a concern due to difficulties in classifying native grasslands, especially due to the presence of exotic tame grasses which are difficult to separate spectrally from native grasses. However, while the magnitude of loss is difficult to pinpoint, the declining trend in this landcover was clear. In 2004 an additional 81 transects were added, bringing the total sampled area up to 0.57% of the PHJV (Watmough and Schmoll 2007). A report on grassland landcover trends from 2001–2011, that includes these additional transects, is in prep (Michael Watmough personal communication).

Further, a national scale assessment of grazing lands by the NRCS began in 2003 and details on these efforts are outlined in the following section.

Recommendations for Grassland and Scrub-Shrub Habitat Quality:

3. Continue to develop remote sensing techniques to more accurately depict quality of grassland and shrubland habitat as it pertains to priority bird species.
4. Disseminate information on existing techniques and their utility for classifying grasslands and shrublands.
5. Identify priority grassland and shrubland areas where availability of more accurate grassland and shrubland land cover would be of the highest use for bird conservation.

NRCS National Resources Inventory Regarding Data and Accessibility

Congress passed the Rural Development Act in 1972 which directed the creation of a land inventory and monitoring program to “study and survey damage from soil erosion and sedimentation, floodplain identification and use, land use change, and potential environmental damages resulting from the misuse of soil, water, and related natural resources” and publish a report at 5 year intervals (Schnepf and Flannagan 2008). The Soil Conservation Service (SCS) created the Natural Resources Inventory (NRI) with the primary purpose of gathering landcover data on non-federal lands to assess what land could be converted into cropland. Nationwide data has been collected at the county scale every 5 years since 1977. Landcover is identified as either cropland, pasture, rangeland, forestland, or small built-up land at 300,000 primary sampling units (PSUs) and 800,000 points distributed nationwide by county (Schnepf and Flannagan 2008). Data on all landcovers is available for download to the public at the state scale at www.nrcs.usda.gov/wps/portal/nrcs/main/national/technical/nra/nri/results/, and additional summaries are available by request. NRCS reports change in grassland, cropland, and other landcovers over time (USDA 2015). Specifics on landcover classification methods are outlined in (Schnepf and Flannagan 2008).

Rangelands and wetlands are examples of landcovers identified as important and in need of additional field sampling. The first special NRI focused on assessing the status of wetlands relative to observations in 1982 and 1987 in response to controversy over conversion of wetlands for agricultural purposes (Schnepf and Flannagan 2008). This special wetland NRI was designed to track the rate of

conversion of wetland landcover. In the 1987 NRI 22,000 points in ~ 7,000 PSUs were selected for additional wetland field measurements over a 3-week period. Results showed that rate of wetland conversion had slowed and this effort resulted in the draft bulletin "1991 Update of National Resources Inventory, Wetlands Data for Non-federal Rural Lands," but it never received widespread distribution to the public and is not available. The results from this project are not available to the public (Schnepf and Flannagan 2008). Trends in wetland landcover from 1992–2007 are available at national and state scales at www.nrcs.usda.gov/wps/portal/nrcs/detail/national/technical/nra/nri/results and https://www.nrcs.usda.gov/wps/portal/nrcs/rca/national/technical/nra/rca/ida.

In 2003 and 2007 respectively, NRI added Rangeland Resource Assessment (RRA) throughout rangelands in 17 western states and pastureland assessment throughout 13 eastern states (Sanderson et al. 2011). Rangeland data and pastureland data was collected on site in the field and a description of variables is available in Sanderson et al. (2016, see Table 1). Rangeland field data was collected at over 18,000 field locations and is available for the years 2004–2011 at the county scale upon request via https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/technical/nra/nri/results. Data collection and analysis of eastern pastureland is ongoing and not information was available on projected release date. These surveys of non-federal grazing lands may provide the data we need to assess continental changes in pasture/grassland condition over time.

6. Communicate with NRCS regarding data needs for JV regional assessment of grassland and pastureland condition.
7. Communicate with NRCS and Joint Venture science staff regarding accessibility of NRI data to JVs at scales appropriate for conservation planning.

Increase Opportunities to Update National Land Cover Dataset (NLCD)

Background:

Several national-scale land cover datasets exist that North American bird habitat Joint Ventures often use in their biological planning to measure landscape attributes. However, these data are often at temporal scales and resolutions that only allow relatively coarse modeling approaches. In discussions among Joint Venture science coordinators concerning tools used or needed for assessing landscape change, it was apparent that the National Land Cover Dataset (NLCD) and the similar Coastal Change Analysis Program (CCAP) were widely used. The NLCD is a 30-meter resolution, Landsat-based national land cover database produced by the Multi-Resolution Land Characteristics (MRLC) Consortium, a Federal agency partnership, and available at no cost to the public.

The first iteration of NLCD depicted 1992 land cover, and was followed by 2001, 2006, and 2011 iterations. The current frequency of updates is a 5-year cycle, but there is desire to increase frequency to 2-year intervals. Discussions with MRLC representatives indicate that the cost to update NLCD land cover products is approximately $10 million per epoch.

NLCD products are used by Joint Venture for various planning purposes. General uses include assessment of landscape capacity to meet habitat objectives for priority birds, identification of priority areas for conservation or management, and quantification of landscape change over time. In 2009, USGS completed the 1992/2001 Land Cover Change Product which allows direct comparison between

1992 and 2001 products despite differences in methodologies (Fry et al. 2009). The Upper Mississippi River/Great Lakes Joint Venture compared general landscape trends between 2001 and 2006 NLCD to assess landscape ability to support bird population and habitat targets and management implications. The results enabled the Joint Venture to focus habitat planning and implementation to address habitat shortfalls in some areas, or to maintain or enhance existing habitat values where adequate amounts of habitat exist. The Gulf Coast Joint Venture partnership has used CCAP, the coastal version of NLCD, to identify priority areas to maintain or restore Mottled Duck nesting and brood-rearing habitat, identify potentially important stopover habitat for migrant forest landbirds, identify potential source populations for Seaside Sparrows, and to identify priority areas for summer, fall, and winter shallow flooded agricultural habitat for waterfowl and shorebirds.

Recommendations for NLCD:

Given that national-scale datasets currently exist, creating new data does not seem efficient. One proposed solution is improvement of existing NLCD data.

8. At a minimum, continue to support production of NLCD on a 5-year frequency. This dataset is essential to work that Joint Ventures undertake for biological planning and conservation design.
9. Determine increased value of NLCD produced on a 2-year frequency. If value is deemed significant compared to existing frequency, pursue increased funding for a 2-year update cycle.
10. If feasible, pursue development of finer resolution imagery (e.g., 10-m) and better accuracy. Without adequate fine-resolution data or imagery, we are unable to adequately link changes in populations (size, demography, etc.) with changes in habitat. Higher resolution imagery would allow each region to do the landscape-scale analysis that is needed, as well as to roll up individual efforts into a collective net landscape change analysis.

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