Fall Inland/Managed Shorebird Habitat Assessment

Relationship to Gulf Coast Joint Venture (GCJV) Habitat Conservation:

**Priority Species:** Long-billed Curlew (*Numenius americanus*), Buff-breasted Sandpiper (*Caladris subruficollis*), Stilt Sandpiper (*C. himantopus*), Western Sandpiper (*C. mauri*), and Short-billed Dowitcher (*Limnodromus griseus*)

**Planning Objective:** To implement land use and conservation practices to ensure sufficient inland/managed habitat (primarily flooded agricultural lands and moist-soil impoundments) to meet foraging requirements for target numbers of shorebirds during fall. Shorebird habitat objectives were generated using an energetics-based model. Objectives are partitioned into early [15 Jul – 9 Sep] and late [10 Sep – 5 Nov] based upon migration chronology of priority species. Model assumes depletion of food base over time resulting in the need for cumulative additions of habitat. Target habitat objective for early period is half of total objective acres; and target habitat objective for late period is the total objective acres.

**Type of Monitoring:** Habitat

**Monitoring Metric:** Acres of inland/managed habitat

**Monitoring Objective:** Estimate the acres of inland/managed habitat during the early and late fall periods in all GCJV Initiative Areas (IA) with the exception of Laguna Madre for which habitat estimation is only conducted for the portion of the IA that intersects Bird Conservation Region 37. Habitat deficits relative to objectives provide impetus for intensifying the promotion and delivery of habitat conservation actions described in GCJV IA plans.

**Brief Methodology:** Landsat Surface Reflectance Climate Data Record (CDR) satellite imagery is inventoried for each Landsat scene (Figure 1) and time period for each GCJV initiative area. Seamless mosaics are created for each initiative area for each period (i.e., IA assessment) with preference given to highest quality cloud-free images that are chronologically as close together as possible. Ideally, there would be equal representation across years for seamless imagery from the early (15 Jul – 9 Sep) and late (10 Sep – 5 Nov) fall migration periods. For each IA assessment, we report the range of acquisition dates for TM scenes classified (e.g., 15 Sep – 28 Sep) and estimate a mean weighted acquisition date for imagery used (e.g., 21 Sep; Figure 1).

The image mosaic is preprocessed and classified using ArcMap and ERDAS IMAGINE (ERDAS Inc., Norcross, GA) software. The GCJV coastal marsh and permanent water exclusion mask is combined with Coastal Change and Analysis Program (C-CAP) data and is applied to the image mosaic to restrict the classification to only those areas that may contain agricultural-based, moist-soil habitats, and temporarily and seasonally flooded palustrine emergent wetlands. Standardized threshold-based models are used to classify the masked composite image into habitat classes. The classification scheme consists of Water, Vegetated Water, Palustrine Emergent Wetland, Saturated Soil, and Other. Classifications are reviewed and glaring commission errors (i.e.,
impervious surfaces associated with developed areas being classified as habitat) are manually recoded to the correct class. A minimum mapping unit of one acre is applied to habitat areas (i.e., any combination of habitats including Water, Vegetated Water, and/or Saturated Soil). C-CAP land cover classification (i.e., closest to the date of shorebird assessment) is used to determine acreage of Vegetated Water class that is palustrine emergent wetlands (i.e., intersects the C-CAP palustrine emergent vegetated wetland class). Pixels that do not intersect the C-CAP palustrine emergent vegetated wetland class are left classified as Vegetated water. Final shallow water acreages for both the Water and Vegetated Water classes and percent open (i.e., available) within Vegetated Water and Palustrine Emergent Wetland classes are estimated by applying parameter estimates derived from field validation.

Figure 1. Coverage of Landsat TM scenes within the GCJV Chenier Plain, Coastal Mississippi-Alabama, Laguna Madre, Mississippi River Coastal Wetlands, and Texas Mid-Coast Initiative Areas.

Monitoring Responsibilities:

Data Collection: GCJV Remote Sensing and GIS Analysts acquire satellite imagery from the U.S. Geological Survey Earth Resources Observation and Science Center.
Data Compilation and Analysis: GCJV Remote Sensing and GIS Analysts compile and classify satellite imagery.

Report Development: Acreage estimates are compiled in a chronological database by year, initiative area, and state within initiative area by the GCJV Monitoring Coordinator. Tables and graphs are produced by the GCJV Monitoring Coordinator.

Report Distribution: Data, tables, and graphs are made available upon request to the GCJV Monitoring Coordinator. Annually updated tables and graphs may be posted on the GCJV website.

Timing and Frequency:

Data Collection: Depending upon availability of cloud-free Landsat TM satellite imagery, data are collected and processed annually for two fall shorebird migration periods (i.e., early [15 Jul – 9 Sep] and late [10 Sep – 5 Nov]).

Data Analysis: Classification of satellite imagery for the fall shorebird migration period of the current year is initiated at the beginning of the following year.

Report Development: Data, tables, and graphs depicting estimated fall inland/managed shorebird habitat relative to GCJV objectives are updated annually upon the completion of the data analysis.

Detailed Methodology:

Data Sources, Seamless Mosaic, and Data Extrapolation: Landsat Surface Reflectance Climate Data Record (CDR) satellite imagery is inventoried for each Landsat scene (Figure 1), time period (i.e., early [15 Jul – 9 Sep] and late [10 Sep – 5 Nov]), and relevant initiative area. Seamless mosaics are created for each initiative area for each period with preference given to highest quality cloud-free images that are chronologically as close together as possible. It is recognized that the probability of obtaining two full sets of cloud-free, seamless imagery per year for the entire GCJV region is very low. The Texas Mid-Coast IA and the Chenier Plain IA are a priority because they have the largest acreage of inland/managed habitat objectives allocated to them. For classifications prior to 2011, Landsat TM 5 will be used. From 2013 onwards, Landsat 8 will be used. Where CDR imagery is not available, Landsat Thematic Mapper (TM) data from Landsat 5 and Landsat Operational Land Imager (OLI) data from Landsat 8 will be used. SPOT 4/5 may be used to fill gap between Landsat 5 and Landsat 8. Imagery is selected to develop seamless image mosaics for GCJV IAs for each time period. Preference is given to cloud-free images nearest the mid-point of each time period (Early: ~8 Aug; Late: ~8 Oct). Occasionally, cloud-free imagery may only be available for parts of an initiative area. Table 1 identifies the minimum scene requirements for image classification based on Landsat footprints for seamless mosaics. When a seamless mosaic is missing a scene
that is not essential for image classification, the estimate of fall shorebird habitat is derived from available imagery and extrapolated to areas of the IA for which imagery is unavailable. If any essential scenes in a seamless mosaic are unavailable because of cloud cover, fall shorebird habitat is not estimated for that IA and time period. For each IA assessment, we report the range of acquisition dates for TM scenes classified (e.g., 15 Sep – 28 Sep) and estimate a mean weighted acquisition date for imagery used (e.g., 21 Sep; Figure 1). The mean weighted acquisition date is estimated for the IA assessment by: (1) reclassifying classified pixels per TM scene to Julian dates; (2) mosaicking reclassified TM scenes used per IA assessment into a seamless Julian date raster; and (3) using zonal statistics to determine mean weighted acquisition date for classified areas (i.e., unmasked area) within the IA. The classified area per assessment per IA is determined by multiplying the count of pixels classified by the cell size (i.e., 900 square meters [0.222 acres] for TM).

Table 1. Scenes required, at a minimum, for seamless mosaics for each GCJV Initiative Area.

<table>
<thead>
<tr>
<th>Initiative area</th>
<th>Scenes</th>
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</thead>
<tbody>
<tr>
<td>Coastal Alabama-Mississippi</td>
<td>P21R39</td>
</tr>
<tr>
<td>Chenier Plain</td>
<td>P25R39 &amp; P24R39 &amp; P23R39</td>
</tr>
<tr>
<td>Laguna Madre</td>
<td>P26R41 &amp; P26R42</td>
</tr>
<tr>
<td>Mississippi River Coastal Wetlands</td>
<td>P22R39 &amp; P23R39</td>
</tr>
<tr>
<td>Texas Mid-Coast</td>
<td>P25R40 &amp; P26R39 &amp; P26R40</td>
</tr>
</tbody>
</table>

Preprocessing and Classification: The image mosaic is preprocessed and classified using ARCMAP (Esri, 2015; Redlands, CA) and ERDAS IMAGINE (ERDAS Inc., Norcross, GA) software. For each scene in an IA assessment, preprocessing involves creating a composite image of non-thermal bands, reprojecting the composited image if necessary, removing any no data pixels around the edge of the image, and subsequently shifting composites to match the exclusion mask and adjacent imagery. Where CDR imagery is not available, images are first atmospherically corrected to top of atmosphere level. Images are then mosaicked together into a new raster covering the IA. Mosaicked CDR scenes are multiplied by the designated scale factor (i.e. 0.0001; CDR imagery only), shifted and snapped to match the appropriate mask, and subset to the IA footprint. The following indices are then calculated from the mosaicked and subsetted image: the modified normalized water index (MNDWI; Xu 2005), the normalized difference vegetation index enhanced vegetation index (NDVIEVI; Torbick, 2015), the land surface water index (LSWI; Torbick, 2015) and the normalized difference built-up index (NDBI; Zha et al, 2003). The classification is then run using thresholds of the calculated indices in order to make decisions (Figure 2). The GCJV coastal marsh and permanent water exclusion mask, combined with C-CAP classes is applied to the image mosaic to restrict the classification to only those areas that may contain agricultural-based, moist-soil habitats, and temporarily and seasonally flooded palustrine emergent wetlands. For more information see: Y:\Monitor\GCJV Documents\Coastal Marsh and Permanent Water Mask - Version Final.doc. Note, SPOT 5 imagery has a 10-meter spatial resolution and is
resampled to 20 meters to match the spatial resolution of SPOT 4 imagery. We have created a mask with a spatial resolution of 20 meters for use with SPOT imagery by resampling the original 30-meter mask. Initial classifications of Water, Vegetated Water, Palustrine Emergent Wetland, Saturated Soil, and Other for satellite imagery are created using a standardized ERDAS threshold-based model. Results from the unsupervised classifications are reviewed and glaring commission errors (i.e., impervious surfaces associated with developed areas, upland forest, cloud and cloud shadow, and areas of obvious river misalignment with the mask) are manually recoded to the correct class.

Figure 2. Chart depicting how classification decisions were made based on threshold values of the NDVIEVI, NDBI, LSWI, and MNDWI indices.
**Post Processing:** Areas of contiguous habitat of any or all types (i.e., Water, Vegetated Water, and/or Saturated Soil) less than an acre are removed. C-CAP land cover classification (i.e., closest to the date of shorebird assessment) is used to determine acreage of Vegetated water class that is palustrine emergent wetlands (i.e., intersects the C-CAP palustrine emergent vegetated wetland class). Pixels that do not intersect the C-CAP palustrine emergent vegetated wetland class are left as Vegetated water. Final shallow water acreages for both the Water and Vegetated Water classes and percent open (i.e., available) within Vegetated Water and Palustrine Emergent Wetland classes are estimated by applying parameter estimates derived from field validation.

**Landsat Scene Exclusions:** The Chenier Plain and Texas Mid-coast IAs have small areas that are not covered by the Landsat scenes listed in Table 1. The scenes overlapping these areas (i.e., Path 23 Row 40, Path 25 Row 40, Path 27 Row 40) are excluded from classification because the acreage within them available for classification as potential seasonal surface water (i.e., not covered by the exclusion mask) is insignificant to the overall landscape estimates for those initiative areas.

The portion Path 23 Row 40, located in southeastern Chenier Plain IA and in southwestern Mississippi River Coastal Wetlands IA, is not included in assessments for either IA (Figure 1). This scene contains only 1,607 classifiable acres within the Chenier Plain IA, accounting for only 0.0003% of the total classifiable acres in the Chenier Plain IA. All areas found within Path 23 Row 40 in the Mississippi Coastal Wetlands IA are estuarine wetlands that fall under the exclusion mask. Path 25 Row 40 contains the southern half of Bolivar Peninsula in the southwest portion of the Chenier Plain IA. This scene contains about 9,782 classifiable acres within the Chenier Plain IA, which accounts for only 0.002% of the total classifiable acres in the Chenier Plain IA. An earlier classification of this area suggests the potential bias resulting from exclusion of Path 25 Row 40 from the Chenier Plain IA image mosaic is small. Specifically, seasonal surface water for this area was classified using imagery for Path 25 Row 40 that was acquired on 9/4/2008. Climatological data suggested the preceding month (August 2008) was particularly wet with 8 to 12 inches of rainfall (PRISM Climate Group). Thus, seasonal surface water estimated from this image would likely be near the high end of potential shorebird habitat available in this portion of Path 25 Row 40. Classification of this image revealed only 40 acres of seasonal surface water in this portion of Path 25 Row 40, providing evidence that potential bias resulting from exclusion of this scene is low.

Path 27 Row 40 (Figure 1) covers a small portion of the Texas Mid-coast IA. This scene contains 3,398 classifiable acres within the Texas Mid-coast IA, and accounts for only 0.0004% of the total classifiable acres in the Texas Mid-coast IA.
Data and Report Archival:

Y:\Monitor
  • Contains a readme.doc file that describes directories and the files within them.

Y:\Monitor\Surface Water\Shorebird
  • Contains compiled data (Excel spreadsheets), tables (Word documents), and graphs relating to estimates of acres of flooded agricultural lands and moist-soil habitats during fall period by IA.

Monitoring Related Issues to Consider:

None

References:


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\textsuperscript{a} Monitoring objective, brief methodology, and detailed methodology sections were updated in October 2017 by Allston and Enwright.

\textsuperscript{b} Edits were made to the detailed methodology sections and stylistic edits to ensure general consistency with the waterfowl habitat assessment monitoring summary in July 2019 by Wollerson and Enwright.