Fall Saturated Soil, Shallow Open Water, and Flooded Grassland 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 saturated soil, shallow open water, and flooded grassland 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. The model assumes depletion of food base over time resulting in the need for cumulative additions of habitat. Target habitat objectives for the early period range from approximately 52–59% of total objective acres depending on the GCJV Initiative Area (IA; fig. 1). The differences in IA early period targets are due to individual shorebird species migration chronology and distribution. Target habitat objective for late period is the total objective acres.

Type of Monitoring: Habitat

Monitoring Metric: Acres of inland saturated soil, shallow open water, and flooded grassland habitat

Monitoring Objective: Estimate the acres of inland saturated soil, shallow open water, and flooded grassland habitat during the early and late fall periods in all GCJV 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 satellite imagery is inventoried for each Landsat scene (fig. 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 Landsat scenes classified (e.g., 15 Sep–28 Sep) and estimate a mean weighted acquisition date for imagery used (e.g., 21 Sep; fig. 1).

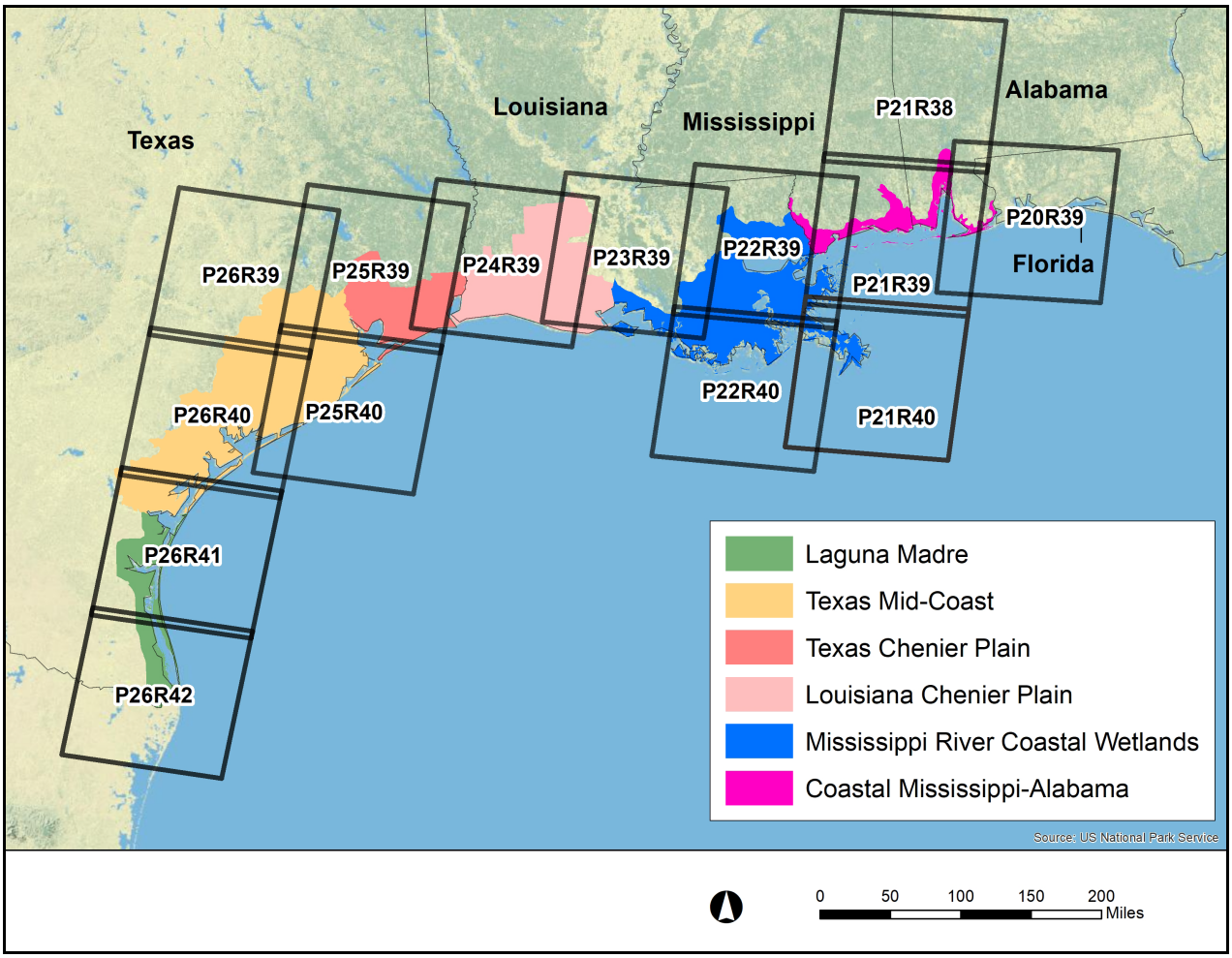

Figure 1. Coverage of Landsat TM scenes within the GCJV, Laguna Madre, Texas Mid-Coast, Texas Chenier Plain, Louisiana Chenier Plain, Mississippi River Coastal Wetlands, and Coastal Mississippi-Alabama Initiative Areas.

The image mosaic is preprocessed and classified using ArcMap and ERDAS IMAGINE (ERDAS Inc., Norcross, GA) software. The GCJV coastal marsh, forested, 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, flooded grasslands, 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, and Saturated Soil. 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). Final shallow water acreages for both the Water and Vegetated Water classes and percent open (i.e.,

available) within the Vegetated Water class is estimated by applying parameter estimates derived from field validation.

Some assessments may be developed even if cloud-free imagery is not available for the entire IA. For each IA, rules were developed to highlight which scenes are mandatory for developing a habitat assessment. If an assessment does not have full coverage, then linear extrapolation is used to estimate the amount of habitat that may cover the missing area. This is calculated by multiplying the quotient of the habitat areal coverage and the total IA area assessed (i.e., the areal coverage of the IA that was assessed with imagery) by the unassessed IA area. This step is repeated for each habitat class (i.e., Water, Vegetated Water, and Saturated Soil). See Appendix 1 (Overview of Waterfowl and Shorebird habitat classifications) for classification Standard Operating Procedure.

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 saturated soil, shallow open water, and flooded grassland 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 satellite imagery is inventoried for each Landsat scene (fig. 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 (TMCIA), Texas Chenier Plain IA (TXCPIA), and Louisiana Chenier Plain IA (LCPIA) are a priority because they have the largest acreage of saturated soil, shallow open water, and flooded grassland habitat objectives allocated to them. For classifications prior to 2011, Landsat 5 will be used. From 2013 onwards, Landsat 8 will be used. SPOT 4/5 may be used to fill the 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. This is calculated by multiplying the quotient of the habitat areal coverage and the total IA area assessed (i.e., the areal coverage of the IA that was assessed with imagery) by the unassessed IA area. This step is repeated for each habitat class (i.e., Water, Vegetated Water, and Saturated Soil). 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.

Initiative area	Scenes
Coastal Alabama-Mississippi	P21R39
Chenier Plain (Louisiana)	P24R39 & P23R39
Chenier Plain (Texas)	P25R39 & P24R49
Laguna Madre	P26R41& P26R42
Mississippi River Coastal Wetlands	P22R39 & P23R39
Texas Mid-Coast	P25R40 & P26R39 & P26R40

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

For each IA assessment, we report the range of acquisition dates for Landsat scenes classified (e.g., 15 Sep–28 Sep) and estimate a mean weighted acquisition date for imagery used (e.g., 21 Sep; fig. 1). The mean weighted acquisition date is estimated for the IA assessment by: (1) reclassifying classified pixels per Landsat scene to Julian dates; (2) mosaicking reclassified Landsat 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 Landsat). See Appendix 1 (Overview of Waterfowl and Shorebird habitat classifications) for detailed Standard Operating Procedure for creating scene mosaics and performing data extrapolation.

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 atmospherically corrected 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 Landsat scenes are multiplied by the designated scale factor (i.e. 0.0001), shifted and snapped to match the appropriate mask, and subset to the IA footprint. The following indices are then calculated from the mosaicked and subset 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 (fig. 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, flooded grasslands, 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, 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. See Appendix 1 (Overview of Waterfowl and Shorebird habitat classifications) for detailed Standard Operating Procedure for conducting preprocessing and habitat classifications.

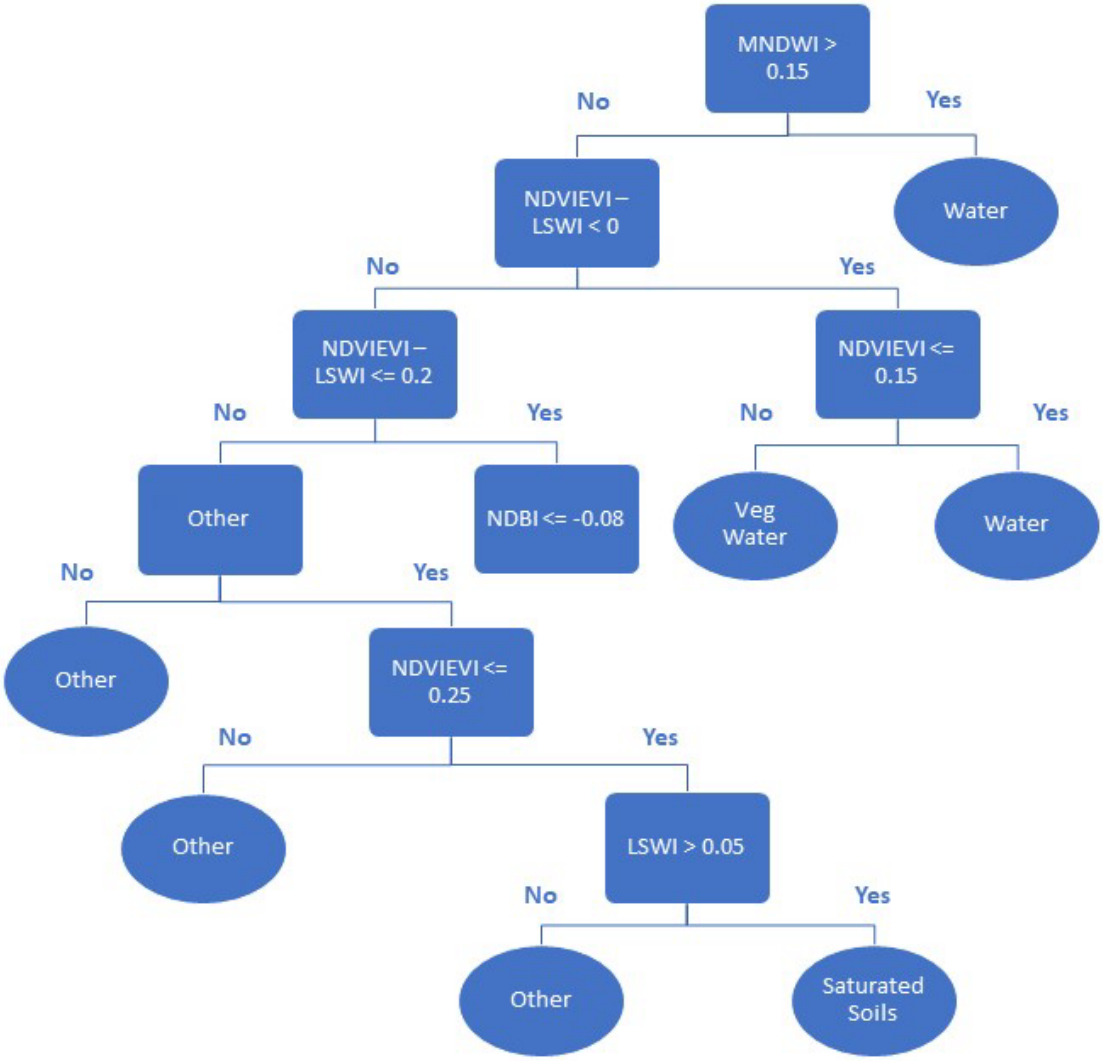

Figure 2. Chart depicting how shorebird saturated soil, shallow open water, and flooded grassland classification decisions were made based on threshold values of the normalized difference vegetation index enhanced vegetation index (NDVIEVI), normalized difference built-up index (NDBI), land surface water index (LSWI), and the modified normalized water index (MNDWI).

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. Final shallow water acreages for both the Water and Vegetated Water classes and percent open (i.e., available) within the Vegetated Water class is estimated by applying parameter estimates derived from field validation. See Appendix 1 (Overview of Waterfowl and Shorebird habitat classifications) for detailed Standard Operating Procedure for post processing.

Landsat Scene Exclusions: The TXCPIA and TMCIA 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 LACPIA and in southwestern Mississippi River Coastal Wetlands IA (MRCWIA), is not included in assessments for either IA (fig. 1). This scene contains only 1,607 classifiable acres within the LACPIA, accounting for only 0.0001% of the total classifiable acres in the LACPIA. All areas found within Path 23 Row 40 in the MRCWIA 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 TXCPIA. This scene contains about 9,782 classifiable acres within the TXCPIA, which accounts for only 0.002% of the total classifiable acres in the TXCPIA. An earlier classification of this area suggests the potential bias resulting from exclusion of Path 25 Row 40 from the TXCPIA 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 (fig. 1) covers a small portion of the TMCIA. This scene contains 3,398 classifiable acres within the TMCIA, and accounts for only 0.0004% of the total classifiable acres in the TMCIA.

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:

Torbick, N, and W. Salas. 2015. Mapping agricultural wetlands in the Sacramento Valley, USA with satellite remote sensing. Wetlands ecology and management 23: 79–94.

Xu H. 2005. A Study on Information Extraction of Water Body with the Modified Normalized Difference Water Index (MNDWI). Journal of Remote Sensing 5: 595.

Zha Y., J. Gao, and S. Ni. 2003. Use of normalized difference built-up index in automatically mapping urban areas from TM imagery. International Journal of Remote Sensing 24: 583–594.

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[a] Monitoring objective, brief methodology, and detailed methodology sections were updated in October 2017 by Allston and Enwright.

[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.

[c]Edits were made to the brief and detailed methodology sections in July 2020 by Enwright and Byerly. Additionally, edits were made to the planning objective section by Vermillion.

[d]Figure 1 was updated to split Texas Chenier Plain and Louisiana Chenier Plain into two separate IAs, methodology sections were updates, and full standard operating procedure was added as Appendix 1 by Enwright, Byerly, and Faulk in December 2020

Appendix 1. Waterfowl and shorebird classifications

Note: Complete statement of procedures. Procedures specific to shorebirds are those in the sections entitled "Overview of Shorebird Classifications" and "Preprocess Imagery" Section 10: "Shorebird Classifications." All other procedures outlined in the appendix are shared for both taxa.

Overview of Waterfowl Classifications

Initiative Areas and Imagery Used

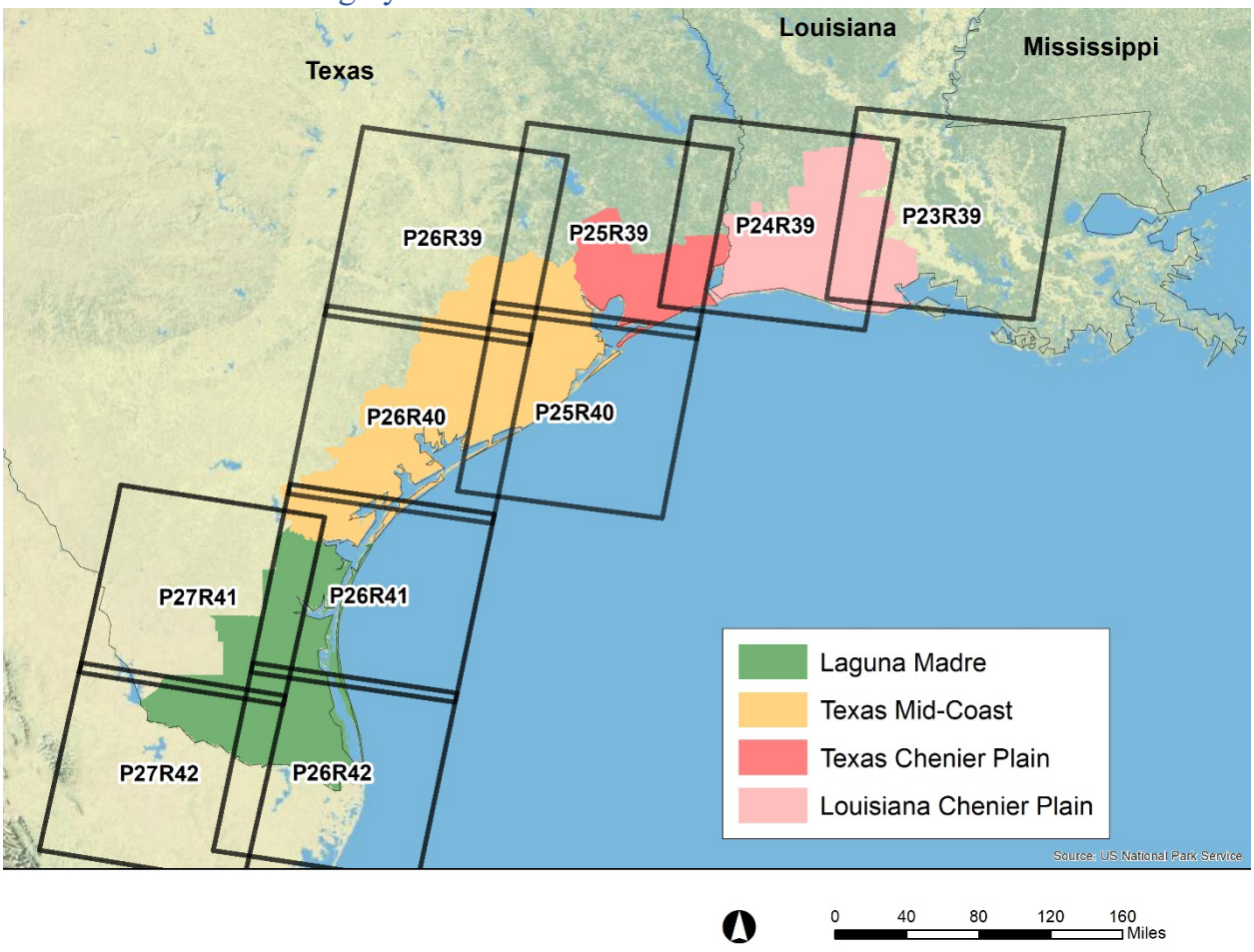


Figure 1. Coverage of Landsat scenes within the GCJV Laguna Madre Texas Mid-Coast, Texas Chenier Plain, and Louisiana Chenier Plain Initiative Areas.

The following is a list of Initiative Areas (IAs) and imagery needed to create a mosaic for classification. Note, all images are required for classification unless otherwise noted. The coordinate system for each IA is also included.

Initiative Area	Imagery	Coordinate System
Laguna Madre (LAG)	• P27R42 (Not necessary if P27R41 is available • P27R41 (Not necessary if P27R42 is available • P26R42 • P26R41	WGS 84 UTM 14N
Texas Mid-Coast (TMC)	• P26R41 (Not Necessary) • P26R40 • P26R39 • P25R40 • P25R39 (Not necessary)	WGS 84 UTM 14N
Texas Chenier Plain (TXCHEN)	• P25R39 • P24R39	WGS 84 UTM 15N
Louisiana Chenier Plain (LACHEN)	• P24R39 • P23R39	WGS 84 UTM 15N

Table 1. Waterfowl classification IAs, imagery, and coordinate systems.

Periods

Waterfowl habitat data is collected and processed 3 times per year for each IA.

Early Period: August 16 to October 31 (Mid-point is September 23)

Middle period: November 1 to January 15 (Mid-point is December 8)

Late period: January 16 to Mar 31 (Mid-point is February 21)

Masks

Waterfowl Mask		
Imagery Year	CCAP/NLCD[1,2]	Census
2020-2021	2016	2010
2019-2020	2010	2010
2018-2019	2010	2010
2017-2018	2010	2010
2016-2017	2010	2010
2015-2016	2010	2010
2014-2015	2010	2010
2013-2014	2010	2010
2012-2013	2010	2010
2011-2012	2010	2010
2010-2011	2010	2010
2009-2010	2010	2010
2008-2009	2010	2010
2007-2008	2006 - Post Katrina	2010
2006-2007	2006 - Post Katrina	2010
2005-2006	2006 - Post Katrina[3]	2010
2004-2005	2006 - Pre Katrina	2000
2003-2004	2001	2000
2002-2003	2001	2000
2001-2002	2001	2000
2000-2001	2001	2000
1999-2000	2001	2000
1998-1999	1996	2000
1997-1998	1996	2000
1996-1997	1996	2000
1995-1996	1996	2000
1994-1995	1996	1990
1993-1994	1992	1990
1992-1993	1992	1990
1991-1992	1992	1990
1990-1991	1992	1990
1989-1990	1992	1990
1988-1989	1992	1990
1987-1988	1992	1990
1986-1987	1992	1990
1985-1986	1992	1990

[1]1992 Data is NLCD data, as CCAP was unavailable after 1996

[2]Used to mask out upland forests and high and medium intensity urban areas

[3]Hurricane Katrina made land fall in late Aug 2005, towards the end of the Early shorebird habitat assessment period.

For future classifications, if new land cover or census data becomes available, then the mask will be updated for the next full assessment period. For example, if new 2020 census urban data becomes available in November 2021, then the mask would be updated for the 2022–2023 assessment.

Overview of Shorebird Classifications

Initiative Areas and Imagery Used

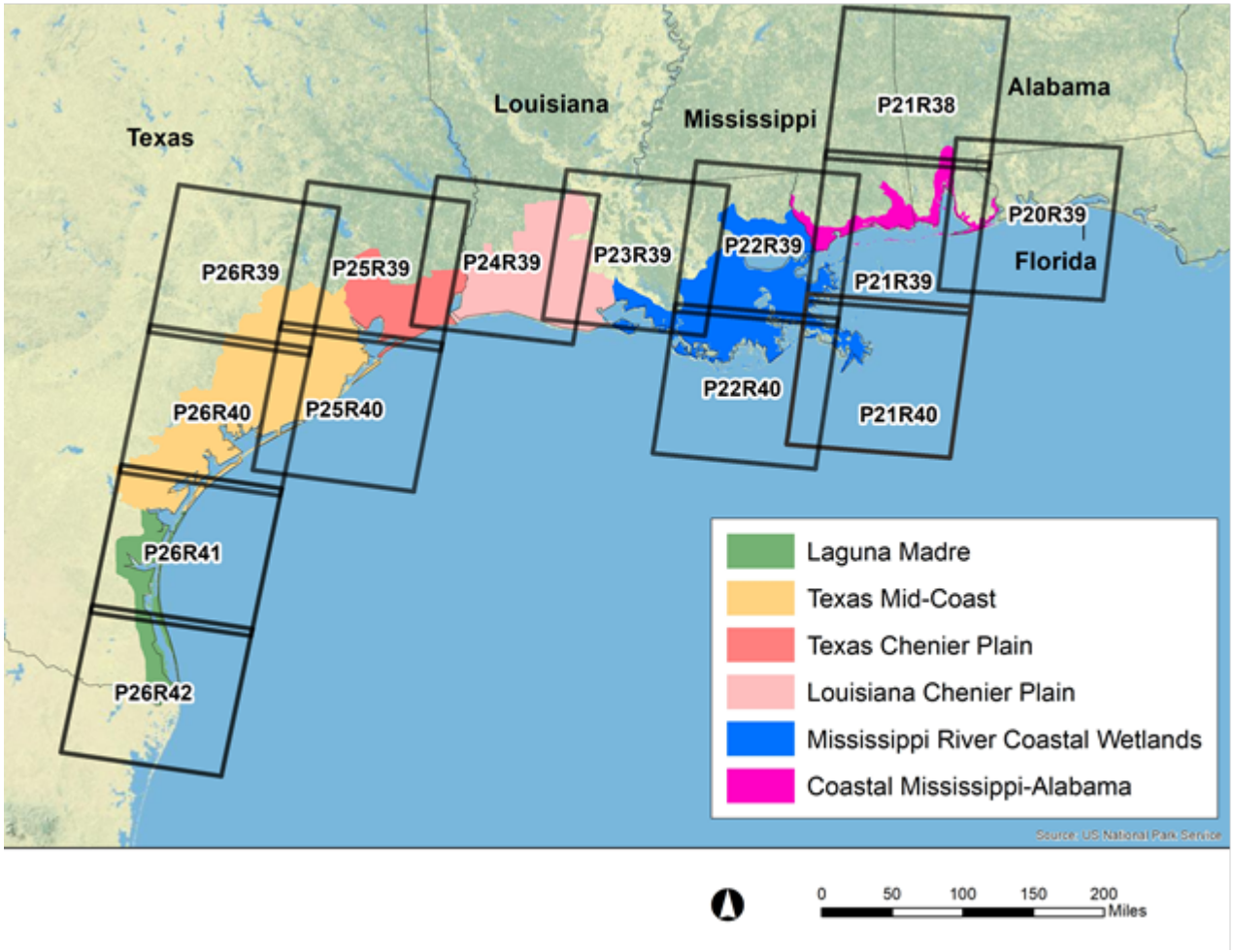


Figure 1. Map of IAs used in shorebird classification and associated Landsat images.

The following is a list of Initiative Areas and imagery needed to create a mosaic for classification. Note, all images are required for classification unless otherwise noted. The coordinate system for each IA is also included.

Initiative Area	Imagery	Coordinate System
Laguna Madre (LAG)	• P26R42 • P26R41	WGS 84 UTM 14N
Texas Mid-Coast (TMC)	• P26R41 (Not Necessary) • P26R40 • P26R39 • P25R40 • P25R39 (Not necessary)	WGS 84 UTM 14N

Texas Chenier Plain (TXCHEN)	• P25R39 • P24R39	WGS 84 UTM 15N
Louisiana Chenier Plain (LACHEN)	• P24R39 • P23R39	WGS 84 UTM 15N
Mississippi River Coastal Wetlands (MRCW)	• P23R39 • P23R40 (Not necessary) • P22R39 • P22R40 (Not Necessary) • P21R40 (Not Necessary)	WGS 84 UTM 15N
Coastal Mississippi-Alabama (CMA)	• P22R39 • P21R38 (Not necessary) • P21R39 (Not necessary) • P20R39 (Not necessary)	WGS 84 UTM 16N

Table 2 Shorebird IAs, imagery, and coordinate systems

Periods

Shorebird spring habitat data is collected and processed once per year for each IA.

Period: March 15 to June 5 (Mid-point is April 26)

Masks (Updated as needed)

Shorebird Mask		
Imagery Year	CCAP/NLCD[1]	Census
2020	2016	2010
2019	2010	2010
2018	2010	2010
2017	2010	2010
2016	2010	2010
2015	2010	2010
2014	2010	2010
2013	2010	2010
2012	2010	2010
2011	2010	2010
2010	2010	2010
2009	2010	2010
2008	2010	2010
2007	2006 - Post Katrina	2010
2006	2006 - Post Katrina	2010
2005	2006 - Post Katrina[3]	2010

2004	2006 - Pre Katrina	2000
2003	2001	2000
2002	2001	2000
2001	2001	2000
2000	2001	2000
1999	2001	2000
1998	1996	2000
1997	1996	2000
1996	1996	2000
1995	1996	2000
1994	1996	1990
1993	1992	1990
1992	1992	1990
1991	1992	1990
1990	1992	1990
1989	1992	1990
1988	1992	1990
1986	1992	1990
1985	1992	1990

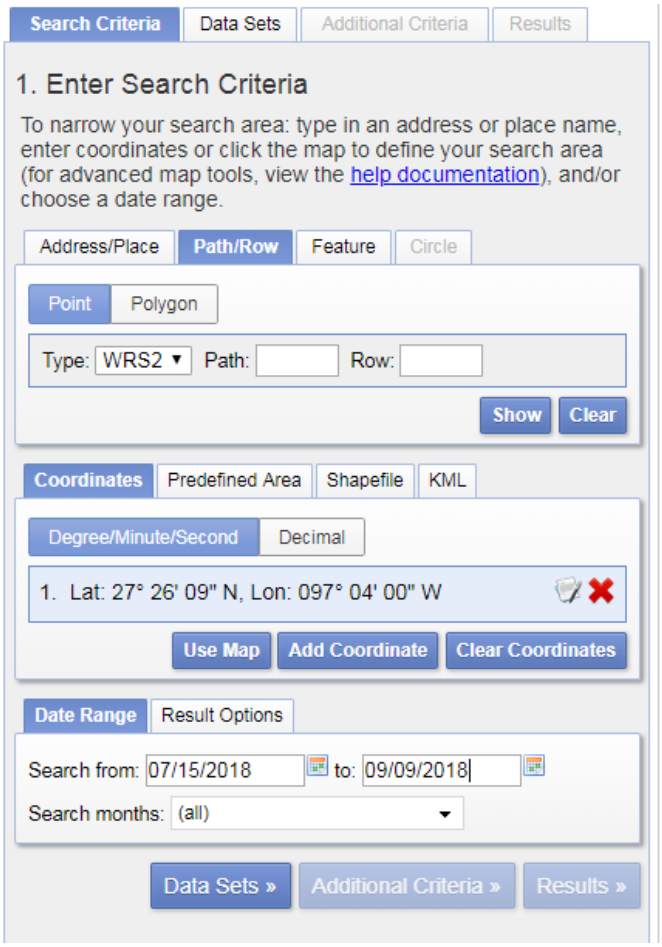
[1]1992 Data is NLCD data, as CCAP was unavailable after 1996
[2]Used to mask out upland forests and high and medium intensity urban areas
[3]Hurricane Katrina made land fall in late Aug 2005, towards the end of the Early shorebird habitat assessment period.

For future classifications, if new land cover or census data becomes available, then the mask will be updated for the next full assessment period. For example, if new 2020 census urban data becomes available in November 2021, then the mask would be updated for the 2022 assessment.

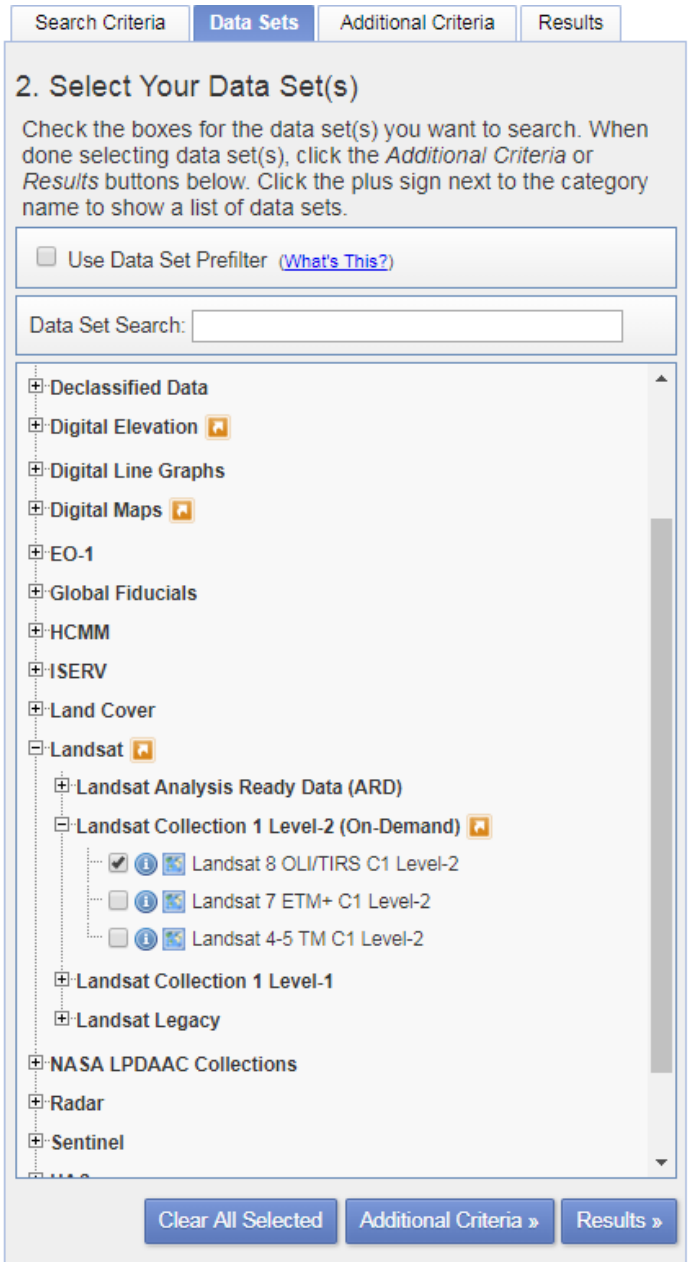
Download and Inventory Imagery

Using Earth Explorer

1) Go to USGS Earth Explorer
    a. https://earthexplorer.usgs.gov/
    b. Create and account or log in
2) Fill out the Search Criteria tab
    a. Enter the path and row of the image you are searching for. Choose “show”.
        i. If show is not clicked, every path/row will be searched!
    b. Enter the date range for a period. In the image we are searching for Path 26 Row 41 during the shorebird early period.



3) Fill out the Data Sets tab
    a. Select Landsat Imagery. Choose Level 2 On Demand imagery
        i. Landsat 4-5 is used for imagery before 2011
        ii. Landsat 8 is used for imagery after 2013
    b. In 2017 and 2018, Landsat has been reorganizing and changing their imagery product names. If this occurs in the future, it is important to use imagery that is surface reflectance corrected.



4) Choose the Results tab
    a. Browse through the available imagery choosing one with the lease amount of cloud coverage
    b. Make sure the images are all the same path/row and were all acquired during the appropriate time period
    c. If all images are cloud free, choose the image with the acquisition date closest to the middle point of the period
    d. It's OK if all images are very cloudy. Some periods are not classified due to a lack of available imagery. Refer to Tables 1 and 2 to see if the imagery is necessary for classification.
    e. Preview images by clicking on the image thumbnail.

f. Click the shopping cart button to add an image to your cart
g. In the below image, the first and third images are too cloudy to classify. Upon further examination, the second image has the least amount of cloud cover and will be used for classification.

5) Return to the Search Criteria page to continue searching for images. Add all imagery needed for classification of the time period (ex. Shorebird early 2018 will have a maximum of 14 images added in the cart) to your cart.

6) Review your order and submit. Orders take a few hours to a few days to process. You will receive an e-mail with a link once the imagery is available for download.
    a. Once images are available for download, you have 10 days to download them before you must re-order.
7) Place imagery in the appropriate folder once it is downloaded (See appendix 1.A)

Image Inventory

1) Create a new Image Inventory spreadsheet by copying a previous year.
2) Copy image thumbnails from the Earth Explorer and add relevant details to the inventory.
3) Open .mxd files containing image footprints in Arcmap.
    a. R:\SC009NO\12\Working\GCJV\mxds\TM
    b. Re-order the images in the mxd document and copy the map into the inventory spreadsheet

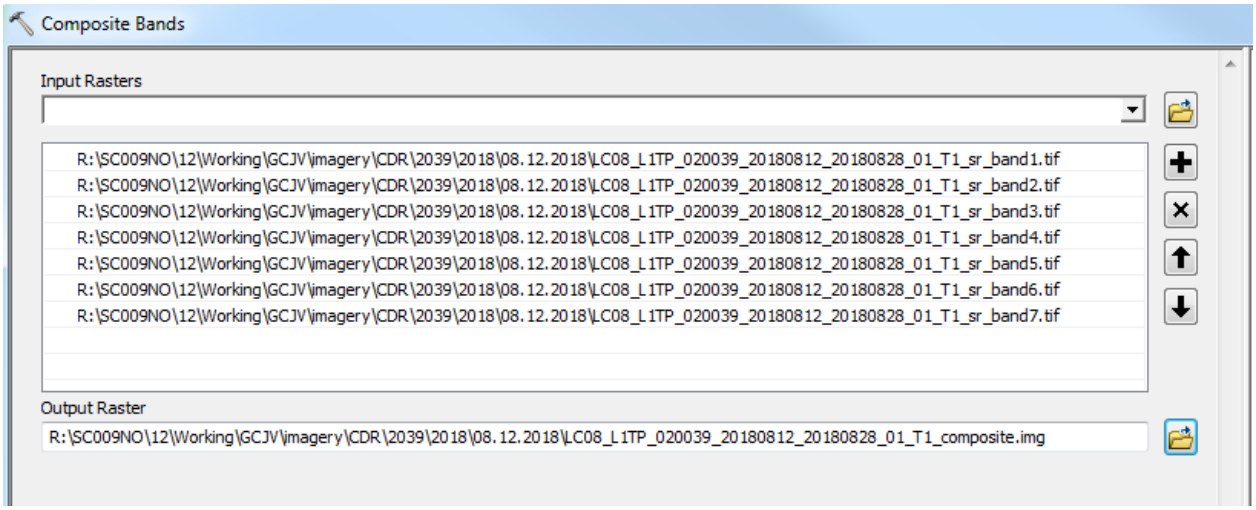
Pre-Process Imagery

*A note about processing imagery: Mosaicking and shifting imagery in ArcMap takes some time. You can "queue" processes in ArcMap by Enabling Background Processing. This will allow you to run a tool then open and set a new tool to run afterwards. For more information see http://desktop.arcgis.com/en/arcmap/latest/analyze/executing-tools/foreground-and-background-processing.htm

Geoprocessing > geoprocessing Options > Background Processing > Check Enable

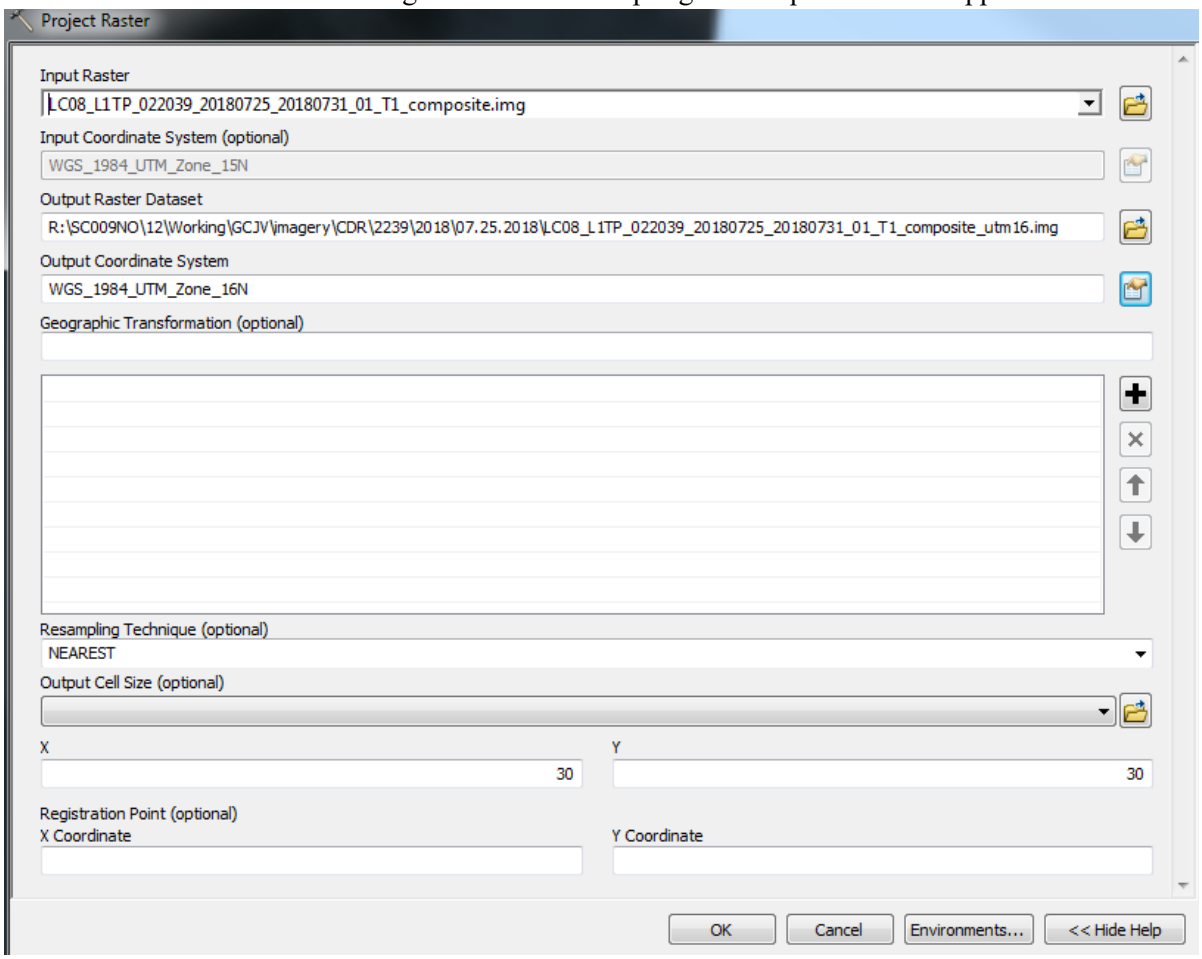
Mosaicking Landsat imagery

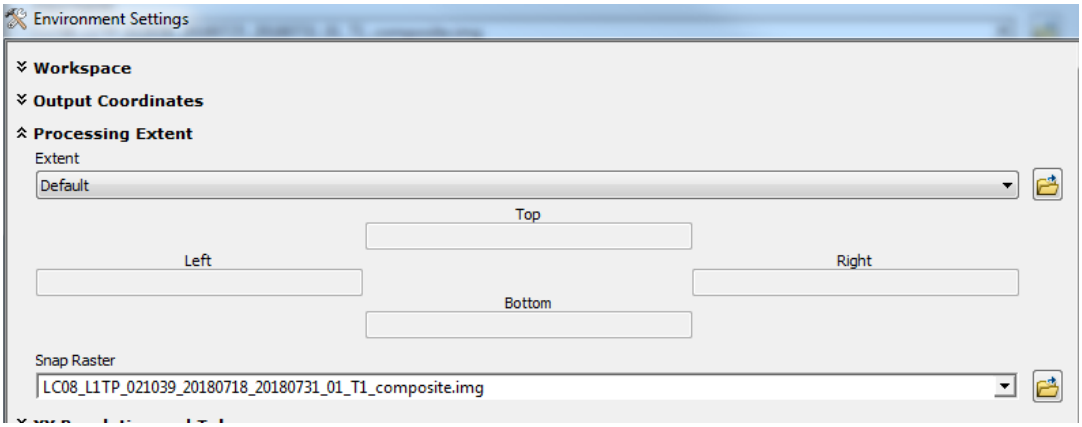
1) Download imagery from online.
2) File the imagery into an appropriate folder and unzip the file.
    a. Using Windows Explorer **Right-click .tar.gz file > 7-Zip > Extract Here**
    b. **Right-click .gz file > 7-zip > Extract Here**
3) In ArcMap, use the **Composite Bands** tool to composite the first 7 bands (Landsat 8) or the first 6 bands (Landsat 5). Save this file as IMGNAME + "_composite.img" in the appropriate image folder.
    a. Tip: When adding multiple input rasters, click the first raster, hold shift, and click the last raster. All rasters in between should be added. Since these rasters are labelled consecutively, this makes adding 6 or 7 rasters easy.



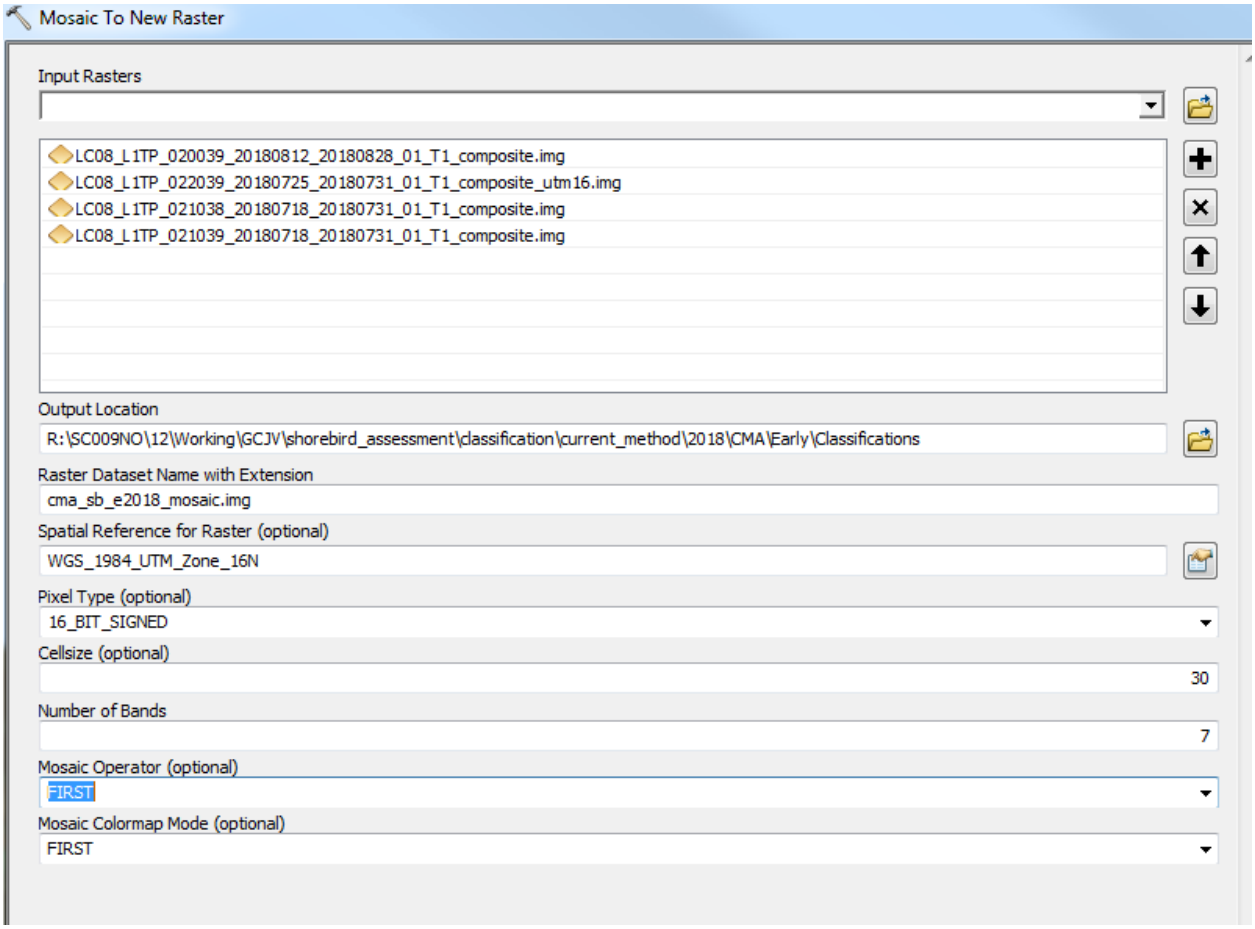
4) If any images are in the incorrect coordinate system, use the Project tool to correct this now. Be sure to project the already extracted image if necessary. The output should end with "_utm##.img"
    a. Set the snap raster to be an adjacent image. For example, if you are projecting P25R40, snap the raster to P26R40.
        i. In the Project Raster tool window, **Environments > Processing Extent > Snap Raster**

b. When choosing a coordinate system: **Projected > UTM > WGS 1984 > select the appropriate zone**
c. The following images will be projected:
    - TMC – P25R40 and P2539 to UTM Zone 14N
    - MRCW – P21R40 to UTM Zone 15N
    - CMA – P22R39 to UTM Zone 16N
d. The default setting of Nearest Resampling Technique should be applied

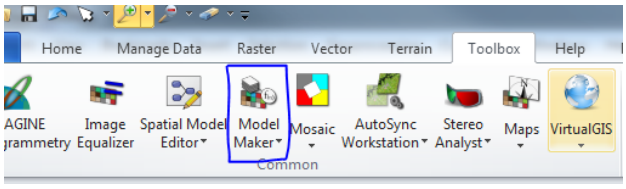




5) Mosaic together the shifted imagery by using the **Mosaic to New Raster tool**.
    a. Rearrange the images in ArcMap to find the clearest mosaic order
        i. Sometimes there may be a very cloudy image and a very clear image side by side. You'd want to put the clear image on top of the cloudy image.
    b. Input rasters should be in order from top to bottom, where the first listed image is on top of the others.
    c. Output Location: appropriate folder in the classification folder
    d. Raster Dataset Name: IA_ + wf or sb + _PdYrYr + "_mosaic.img"
    e. Spatial Reference: Choose appropriate coordinate system
    f. Pixel Type: 16_BIT_SIGNED
    g. Cellsize: 30
    h. Number of Bands: 7 -- Landsat 8; 6 -- Landsat 5
    i. Mosaic Operator: FIRST



6) Use the "Times for Composite" model in Erdas Imagine to correctly scale the mosaic. The output should have a type of Float Single, Continuous. End the output name with "_scaled.img".

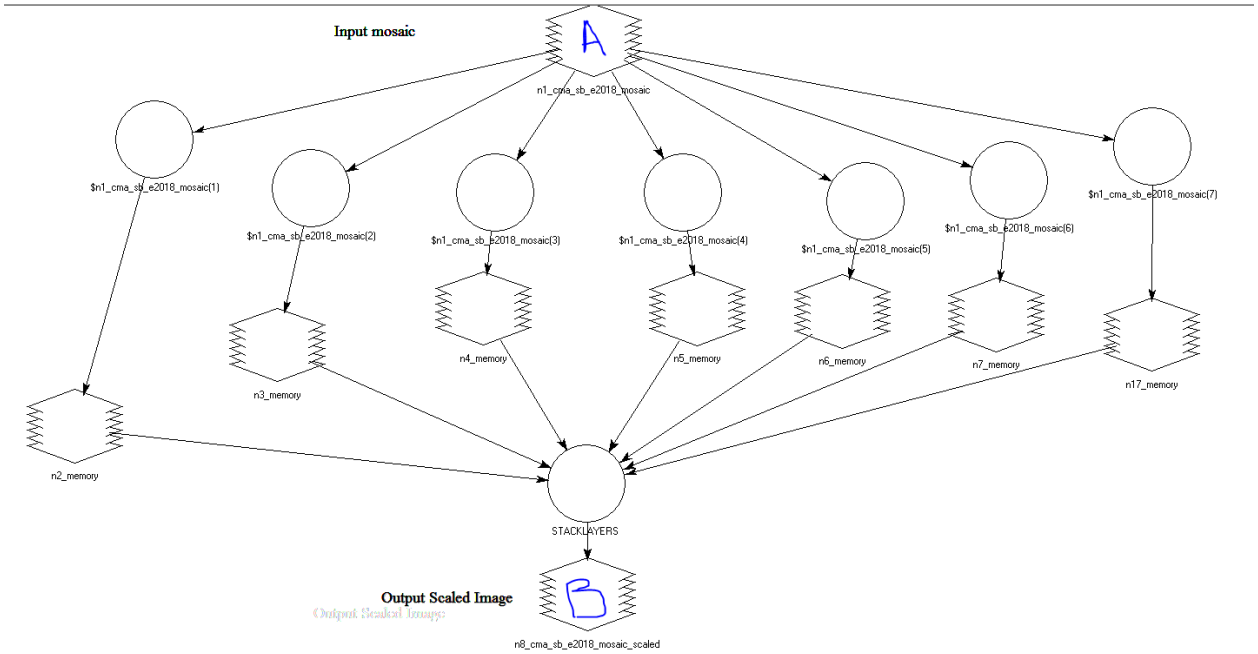


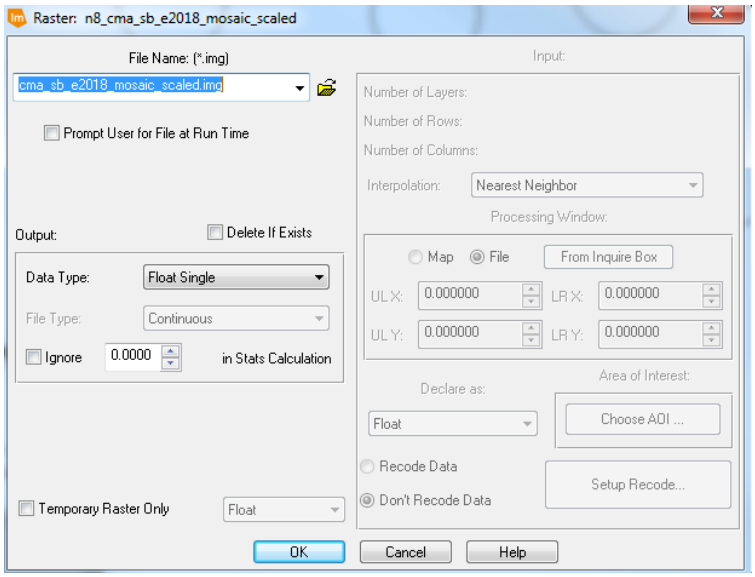
a. Toolbox > Model Maker > File > Open "….GCJV\models\Landsat5 or Landsat 8\times_for_composite.gmd"

i. Double click the A and B bubbles to change them.

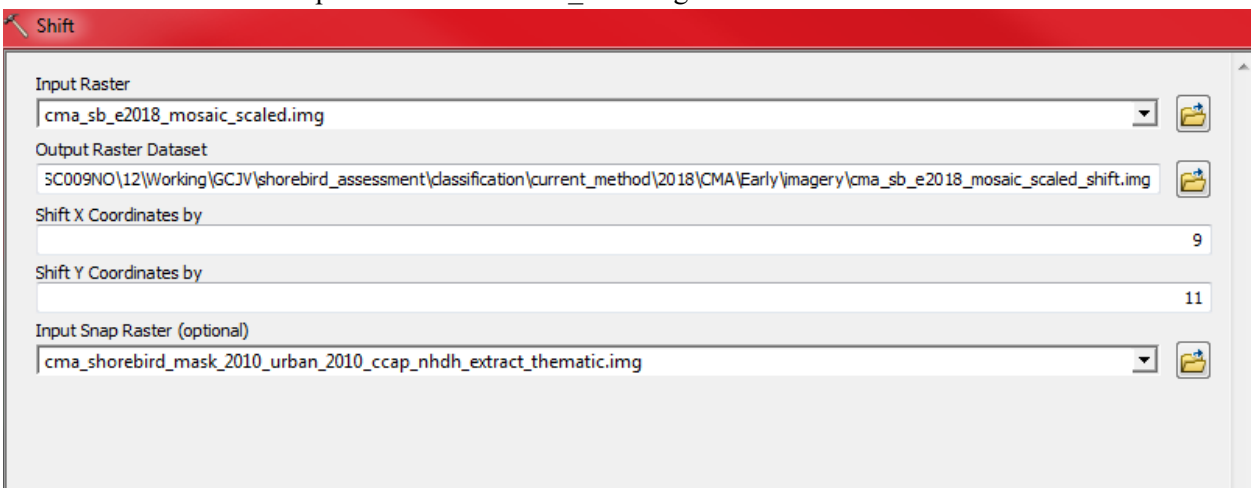
ii. Below, A: Input the image mosaic. Do not check temporary raster. Default settings are fine.

iii. Below, B: Output the image mosaic name + "_scaled.img" to the same imagery directory. Change the Output Data Type to Float Single, Continuous data type.



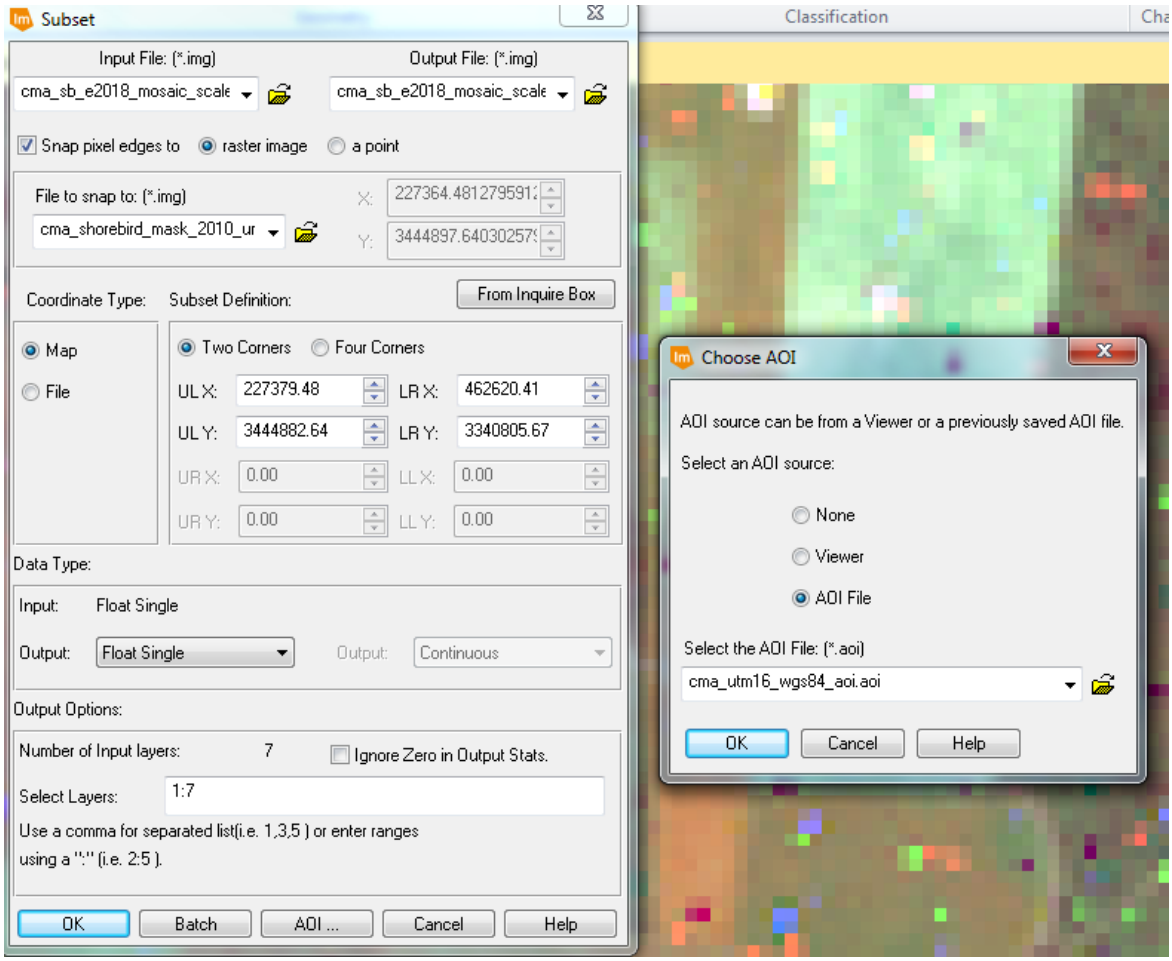


7) In ArcMap, **shift** the scaled mosaic to align with the appropriate mask. Be sure to set the snap raster to the mask. The output should end with "_shift.img"

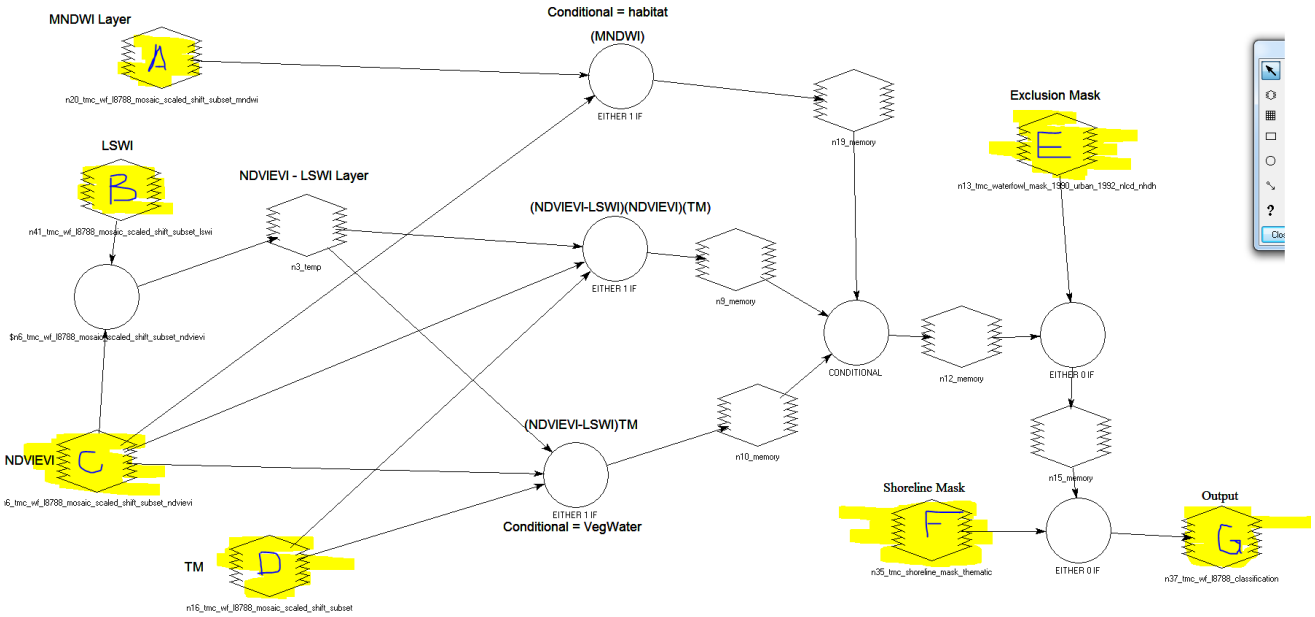


   a. It might be necessary to change ArcMap to the correct Projection
      i. Right click the name of the data frame in the Table of Contents window (by default, the data frame is called "Layers")
      ii. Choose coordinate System, pick the correct coordinate system
   b. Use the Measure tool to measure how far the pixels need to be shifted 
      i. Measurements don't need to be exact
      ii. In the below image, the red is the mask. The goal is to get the pixels to align with the pixels in the mask. An easy place to measure is along coastlines or water bodies. The below image needs to be shifted up and to the right.
   c. Use the Shift tool
      i. Input: scaled mosaic
      ii. Output: scaled mosaic name + "_shift.img"
      iii. Shift x coordinates: positive numbers shift the image right, negative values shift the image left
      iv. Shift Y coordinates: Positive values shift the image up, negative values shift the image down
      v. Snap Raster: Mask raster

8) In Imagine, use the subset tool to subset the image to the appropriate IA. Be sure to set the snap raster to be the appropriate mask. The output should end with "_subset.img"
    a. **Raster tab > Subset & Chip > Subset**
    b. **Input**: Scaled, shifted mosaic
    c. **Output**: Input mosaic name + "_subset.img"
    d. Check the **Snap Pixel edges to raster** image boxes
    e. **File to snap to:** Mask file
    f. **Output Data Type**: Float Single
    g. **Choose the AOI** Button and select the AOI File bubble
    h. AOIs are a specific file type to Erdas Imagine. The AOI files for IA boundaries are located in "…GCJV\aoi"
        i. Laguna waterfowl: Use laguna aoi
        ii. Laguna shorebird: Use Laguna_bcr37 aoi



9) **Waterfowl Classifications** -- Run the following models in Imagine:
   a. LSWI
      i. Input: subset mosaic
      ii. Output: subset mosaic name + _lswi.img", continuous data type
   b. NDVIEVI
      i. Input: subset mosaic
      ii. Output: subset mosaic name + _ndvievi.img", continuous data type
   c. MNDWI
      i. Input: subset mosaic
      ii. Output: subset mosaic name + _mndwi.img", continuous data type
   d. Waterfowl_classification (Model shown in image below)
      i. Inputs: MNDWI (A), LSWI (B), NDVIEVI (C), subset image (D), mask (E), coastline mask (F)
      ii. Output (G): iA_wf_pdYRYR_classification.img
         1. Ex: LAG_wf_e1819_classification.img for Laguna early 2018/2019
      iii. Output should be unsigned 1 bit thematic data
      iv. Coastline masks can be found at "…GCJV\coastline_mask.img"



10) **Shorebird Classifications** -- Run the following models in Imagine: LSWI, NDVIEVI, NDBI, MNDWI, and Shorebird_classification.

e. LSWI
   i. Input: subset mosaic
   ii. Output: subset mosaic name + _lswi.img", continuous data type

f. NDVIEVI
   i. Input: subset mosaic
   ii. Output: subset mosaic name + _ndvievi.img", continuous data type

g. NDBI
   i. Input: subset mosaic
   ii. Output: subset mosaic name + _ndbi.img", continuous data type

h. MNDWI
   i. Input: subset mosaic
   ii. Output: subset mosaic name + _mndwi.img", continuous data type

i. Shorebird_Classification
   i. Inputs: LSWI, NDVIEVI, NDBI, MNDWI, subset/mosaicked image, mask file, coastline mask
   ii. Output: iA_sb_pdYRYR_classification.img
      1. Ex: LAG_sb_e2018_classification.img for Laguna early 2018
   iii. Output should be 2 bit thematic data
   iv. Coastline masks can be found at "…GCJV\coastline_mask.img". Shorebird and waterfowl coastline masks are the same.

Mosaicking Spot Imagery

1) Obtain imagery.

2) File the imagery into an appropriate folder and unzip the file.

3) Use the spot_rfl_correction.py file (located in the GCJV\models folder) to reflectance correct each image. The output should end with "_rfl.img". Note: GST level images cannot be corrected and therefore cannot be used.

4) Use ArcMap to **resample** each image to 20m x 20m using the Nearest Neighbor technique.

5) Use the **set raster properties** tool to set each band to have a no data value of 0. This allows the images to be mosaicked without the black collar around the edges.
>>>>Steps 4 and 5 can be done using the spot_no_data_resample.py code in the GCJV\models folder. This takes a directory as an input and makes changes to any image ending with "_rfl.img" in the directory and any subdirectories. It will output an image with the following name: "IMGNAME_rfl_20m.img"

6) If any images are in the incorrect coordinate system, use the Project tool to correct this now. Be sure to project the already extracted image if necessary. The output should end with "_utm##.img"

7) **Shift** imagery together. All images should be shifted to match any neighboring/overlapping imagery. Be sure to shift the projected imagery.
    a. Choose an image in the IA to act as a reference image and starting point. Do not shift this image but shift all bordering images towards it. For any non-neighboring imagery, use an already shifted image as reference.
    b. Be sure to set the snap raster to the reference image.
    c. Moving Up and Right are positive (+) shifts; moving Down and Left are negative (-) shifts.
    d. The output should end with "_shift.img"

8) Mosaic together the shifted imagery by using the **Mosaic to New Raster tool**.
    a. Input rasters should be in order from top to bottom, where the first listed image is on top of the others.
    b. Output Location: appropriate folder in the classification folder
    c. Raster Dataset Name: IA_ + wf or sb + _PdYrYr + "_mosaic.img"
    d. Spatial Reference: Choose appropriate coordinate system
    e. Pixel Type: 32_BIT_FLOAT
    f. Cellsize: 20
    g. Number of Bands: 4
    h. Mosaic Operator: FIRST

9) In ArcMap, **shift** the scaled mosaic to align with the appropriate mask. Be sure to set the snap raster to the mask. The output should end with "_shift.img"
    a. It might be necessary to change ArcMap to the correct Projection
    b. Use the Measure tool to measure how far the pixels need to be shifted
    c. Use the Shift tool

10) In Imagine, use the subset tool to subset the image to the appropriate IA. Be sure to set the snap raster to be the appropriate mask. The output should end with "_subset.img"

11) Use the base SPOT classification model and tweak thresholds until habitat appears correct. Save the model with a new number and record the number of the model, as well as the thresholds, in a spreadsheet.

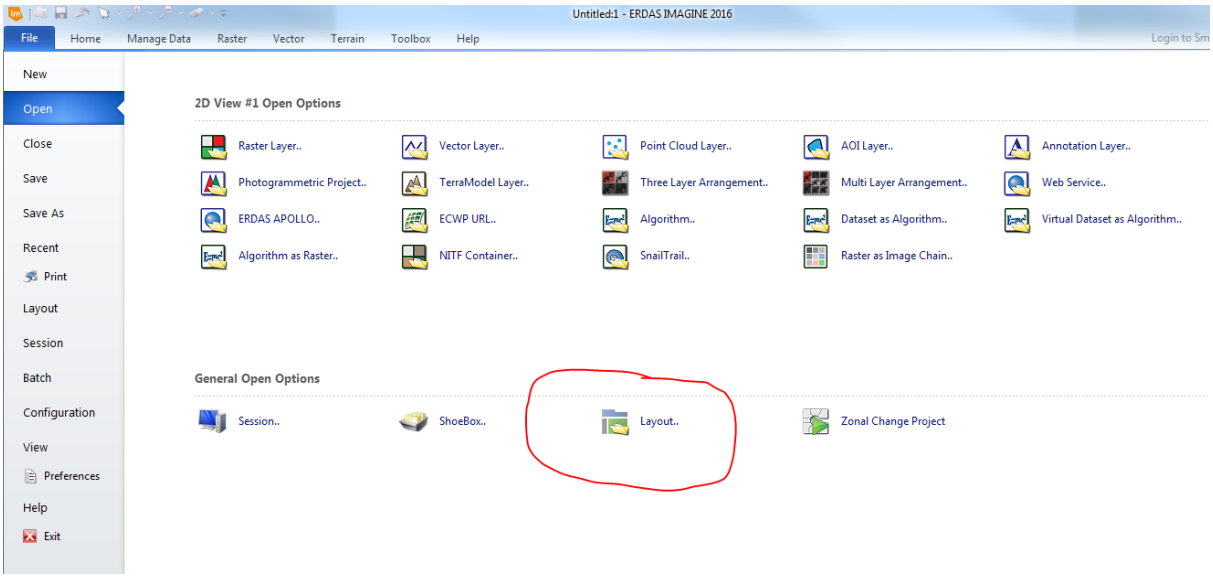
Editing a Classification in ERDAS Imagine

These instructions are for ERDAS Imagine 2016.

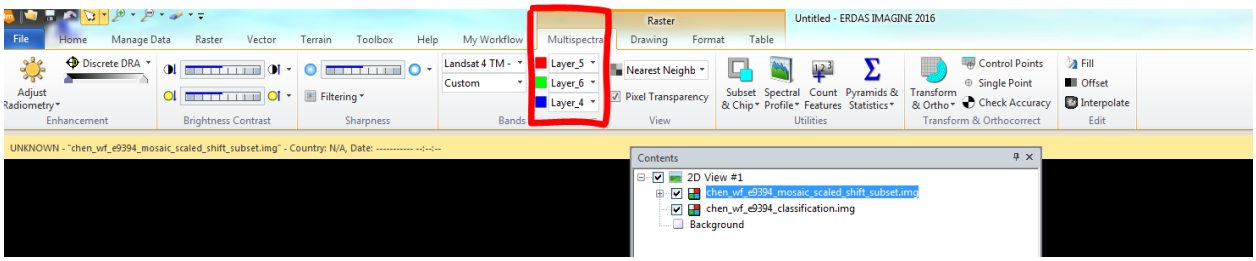
Set up and Display

1) Open Imagine and layout files.
    a. **File > Open > Layout**
    b. Browse to R:\.....GCJV\models\ imagineLayout_forClassifying.ixw

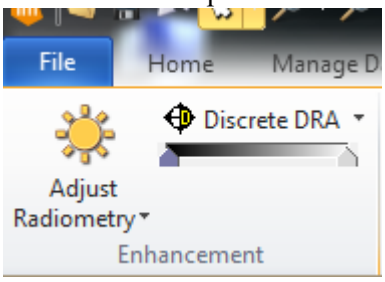
    *Opening the layout file is optional. These directions indicate where to locate tools on both the preset layout and the custom layout mentioned above; however, images in these instructions are strictly from the custom layout. Feel free to make your own custom layout once you are familiar with the tools necessary to create and edit classifications!



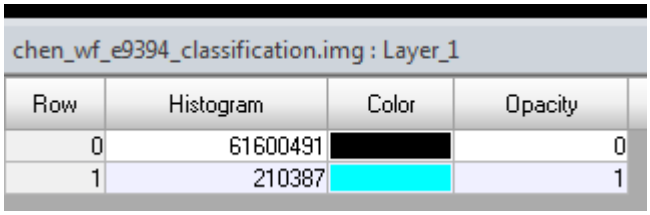
2) Open the subset image and display with the Land/Water band combination
    a. **File > Open > Raster Layer** > browse to and choose a subset image OR **drag and drop** the .img file from Windows Explorer into the Table of Contents
    b. With the image name selected (it will be highlighted in blue) in the Contents window, choose **Multispectral** under the Raster toolbar.
    c. Assign the Red, Green, Blue display to be the following bands for LandSAT 8 imagery
        i. Red – Layer_5
        ii. Green – Layer_6
        iii. Blue – Layer_4
    d. Assign the Red, Green, Blue display to be the following bands for LandSAT 5 imagery
        i. Red – Layer_4
        ii. Green – Layer_5
        iii. Blue – Layer_3
    e. Right click the image name and choose **Fit Layer to Window**



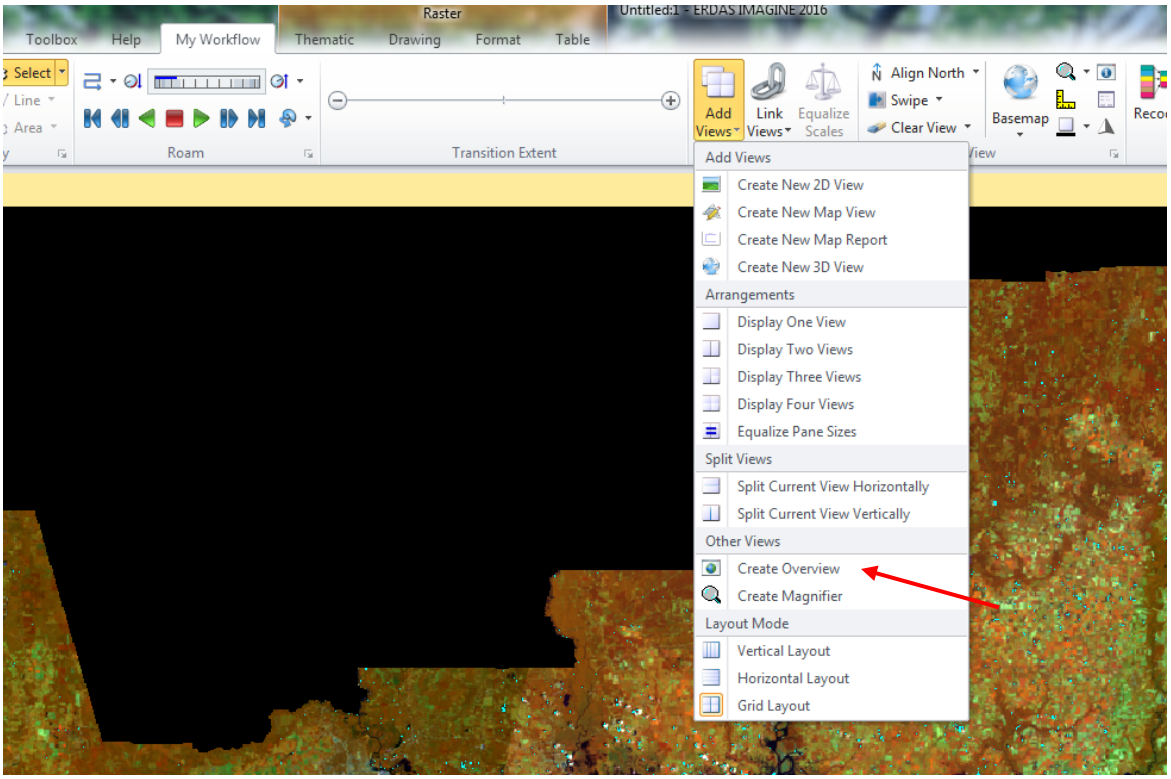
f. Adjust the image as needed using **Adjust Radiometry** in the **Enhancement** section of the Raster/Multispectral tab.



3) Open the classification file and display appropriately.
   a. Open the classification file which corresponds to the image and place it on top of the image.
   b. Right click the classification file name in the Contents window.
   c. **Choose Display Attribute Table**.
   d. Set the Opacity of the 0 values (Row = 0) to be 0. This means it is completely transparent.
   e. Choose a color of your choice for the pixels with a value of 1 (Row = 1). These pixels have been classified as habitat.
   f. Click the 'x' to **exit** out of the Attribute Table box and save changes made.

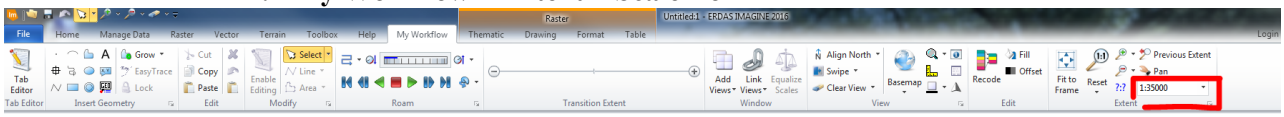


4) (Optional) Set up tracking
   a. My Workflow tab > Add Views (in the Windows section) > Create Overview
      i. A new window will appear. This will be used to view how much of the Initiative Area you have reviewed.



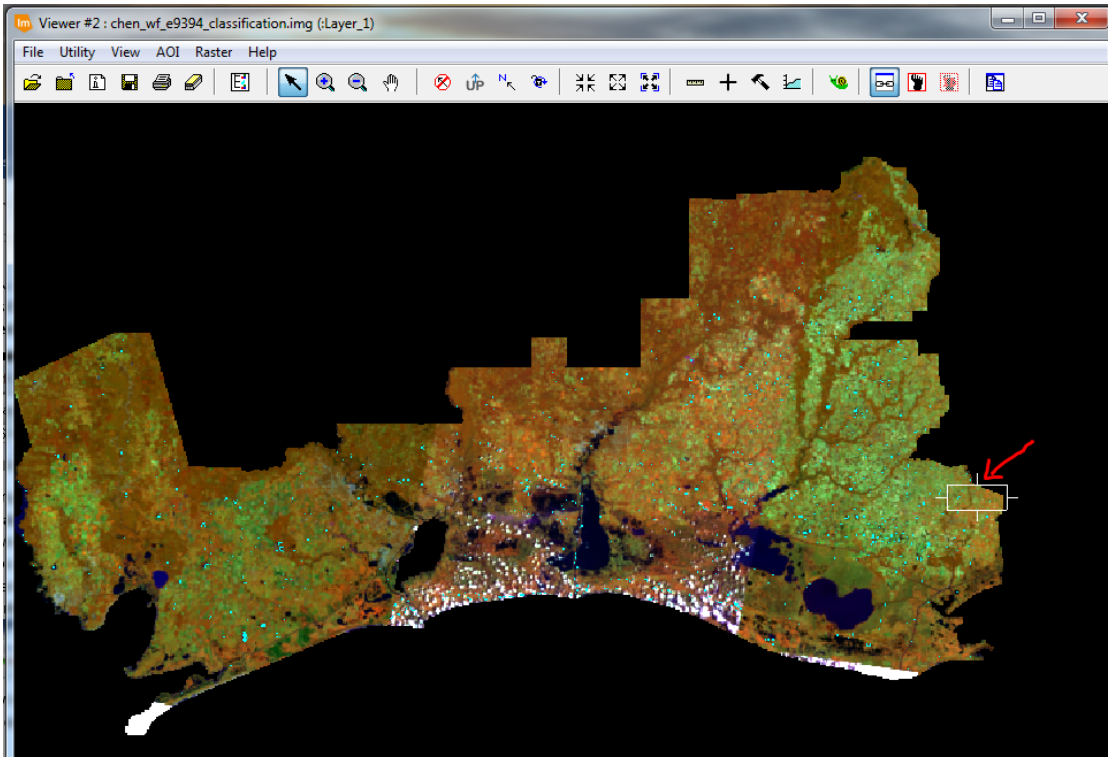
b. Change the Extent to a size you prefer.

i. My Workflow > Extent > Scale Box

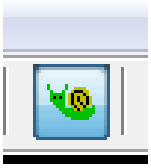


c. In the Overview window, click and drag the view box to a starting point. This should probably be an edge of the image.

i. In the below image, I will start at the current position of the box and go down to the bottom of the image, to the left, back up, etc. Feel free to start where you like.



d. In the **Overview** window, choose the **Snail Trail** option.

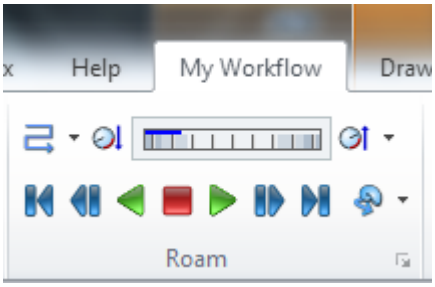


   i. This creates a light highlight in the Overview window over the part of the image you have reviewed.

e. Use the **Roam** buttons to pan through the imagery.

   i. My Workflow > Roam section

   ii. If you choose to use the basic Imagine layout, this tool is located under **Home tab > Roam section**



   iii. The green arrows will pan without stopping. The outside arrows will pan to the end of the image. You will want to use the **middle Step Forward arrow** to step forward one viewing extent.

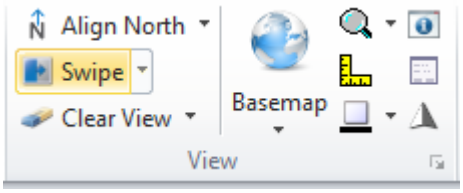
   iv. You can pan horizontally or vertically by setting the direction. Do this by clicking the 'squiggly' arrow button to the left of the speed buttons.

   v. You can change the speed by clicking the up or down clock buttons.

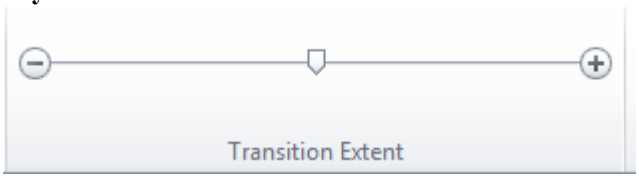
   vi. Note: These buttons are kind of finnicky. You might want to start by using the **Go to End arrow** and pan from there. The first time you pan, make sure no polygons are selected. If you get off track, you can always stop the snail trail and resume it later.

   vii. There are other ways to pan through the imagery (covered later), but the Roam tool saves your place (see Tips) if you need to save your work for later.

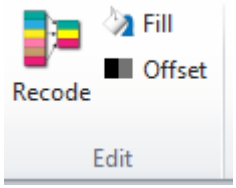
5) Set up the **Swipe**
   a. **My Workflow > View section > Swipe**
   b. If you choose to use the basic Imagine layout, this tool is located under the **Home > View Section > Swipe**



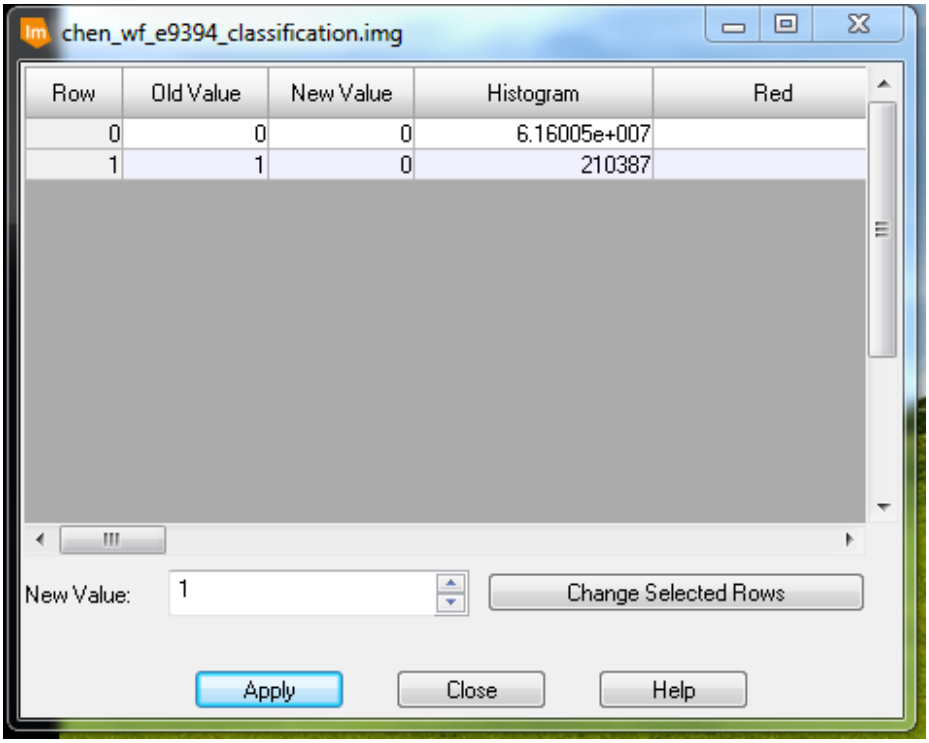
   c. This will open a new panel called the **Transition Panel.** Drag this panel by clicking the bar with the name and dragging.
   d. Layers selected in the Transition Panel will be able to be swiped on and off. Check the 'W' box next to the classification layer.
   e. To see the imagery underneath a classified pixel, use the Swipe Bar to do so.
      i. **My Workflow/Transition > Transition Extent section > Location slider**



6) Set up the **Recode** tool
   a. Select the classification layer in the **Contents** panel
      i. **My Workflow > Edit section > Recode**
      ii. If you choose to use the basic Imagine layout, this tool is located under the orange **Raster tab > Thematic > Edit section > Recode**



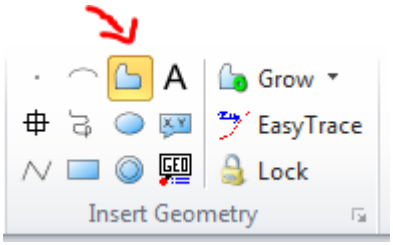
      *The Recode tool is always available in the My Workflow tab, should you choose to use the already made custom layout from step 1. In the preset layout, the classification layer must be selected to find this Recode tool button. Do not use the Recode tool button in the grey raster tab/Raster GIS section/ Thematic menu. This is a different tool.
   b. A new panel will appear. This tool allows you to change pixel values. The "Old Value" column is the current value of the pixel. The "New Value" column is the value you want the pixels to be. In the below image, the pixels with a value of 1 will be changed to 0. Changes will take place when Apply is chosen.
      i. Note: If you choose Apply and no Area of Interests are selected, changes will be applied to EVERY pixel in the classification. Step 7 details creating Area of Interests (AOI).



Editing a classification

***Familiarize yourself with types of errors using Appendix 1.B before editing.

1) In the Imagine main screen, select the AOI button to create a new AOI.
    a. **My Workflow > Insert Geometry section > Polygon button**
    b. If you choose to use the basic Imagine layout, this tool is located under the **Orange Raster tab > Drawing > Insert Geometry section > Polygon**



2) Select the **lock** button so that you can continue to draw polygons without being interrupted. If the lock button is not selected, every time you draw a polygon, you will need to click the polygon button. If the polygon button is not selected, you will not be able to draw.

3) Pan through the image using the **Roam** buttons.
    a. If you choose not to use the Roam buttons, there are several ways to pan.
        i. **My Workflow or Home tabs > Extent section > Pan** tool will allow you to click and drag on the screen.
            1. This will turn your cursor to a hand
        ii. **Home > View section > Smart Control** will set up a compass on the screen. You can click the arrows to pan through the image.
        iii. Use the slide bars/arrows on the side of the screen to scroll through the image.

4) If you see a glaring error, use the Polygon tool to **draw a polygon around the erroneous pixels.**
    a. When drawing polygons, your cursor will be a cross

5) The polygon should already be selected. If it is not selected, use the select tool to do so now. A selected polygon will have a box around it which allows you to rotate or resize it.
    a. My Workflow/Home > Modify section > Select tool
    b. This should turn your cursor back to a white arrow.

6) Use the **Recode** tool to recode the selected pixels as specified. Most of the time, you will be reclassifying 1 values to 0 values and 0 values will stay 0 values.
    a. ALL SELECTED POLYGONS will be affected by the Recode tool when you hit apply
    b. If no polygons are selected, ALL PIXELS will be affected by the Recode tool so make sure a polygon is selected

7) Continue panning through the image and recoding pixels as necessary.
    a. Familiarizing yourself with the Editing Tips section right now may help anticipate any software oddities before you continue.

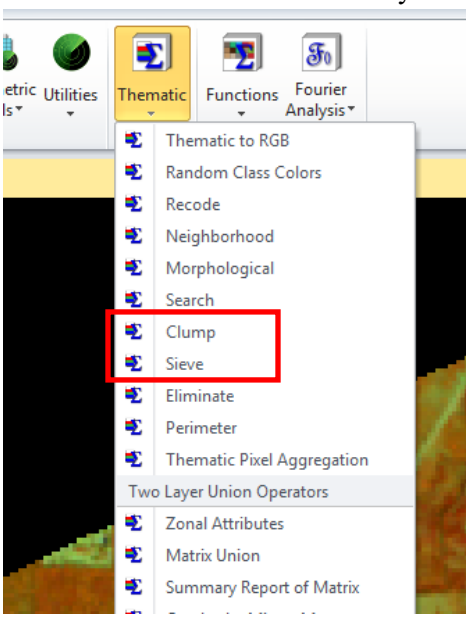
8) **Save** the classification when you are finished.
    a. Right click the classification layer in the Contents panel and choose **Save.**
    b. Make sure the overview window is not open when you save the layer!

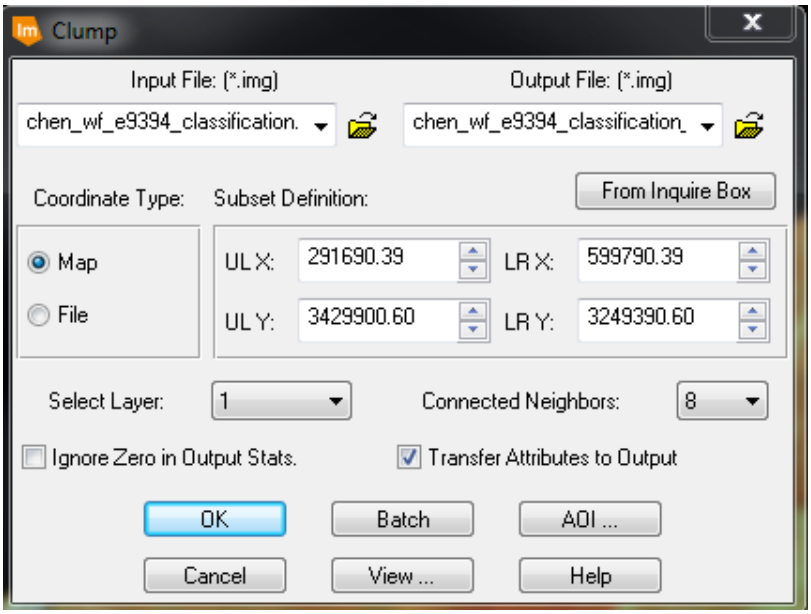
9) If necessary, break up Chenier Plain into Louisiana Chenier and Texas Chenier Subset (Erdas Imagine)
    a. Raster > Geometry > Subset & Chip > Create Subset Image
    b. Input: Chen Classification
    c. Output: Check name standards depending on wf vs. sb
    d. Check snap pixel edges to raster
        i. File snapto: same as input
    e. Output data Type: Unsigned 1-bit Thematic
    f. AOI: to specific area (lachen or txchen)

10) **Shorebird Classifications ONLY**:
    a. After saving the classification, **deselect any AOI polygons** that may be selected
    b. **Recode** classes 1, 2, and 3 to be 1. Keep class 0 as 0.
    c. Right click the classification name in the Contents panel and choose **SAVE AS**.
        i. DO NOT SAVE. ONLY CHOOSE SAVE AS. YOU WANT AN EDITED COPY WITH 1/2/3 VALUES AND AN EDITED COPY WITH ONLY 1 VALUES.
    d. Save the copy adding a _1 to the file name.
        i. Ex. Chen_sb_early2018_classification_1.img

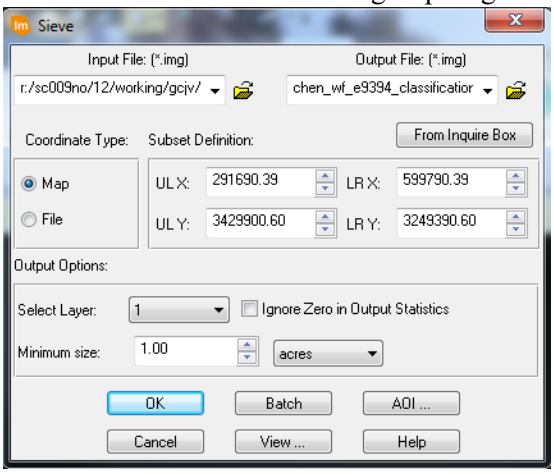
Finalize the classification

1) **Clump** together pixels classified as habitat.
    a. **Raster tab > Raster GIS section > Thematic > Clump**
    b. This function groups together pixels classified as 1 that are touching.
    c. Input: The saved, edited classification file. For shorebird, this will be the "…classification_1.img" file.
    d. Output: "….classification_cl.img" (waterfowl) OR "…..classification_1_cl.img" (shorebird)
        i. Select Layer: 1



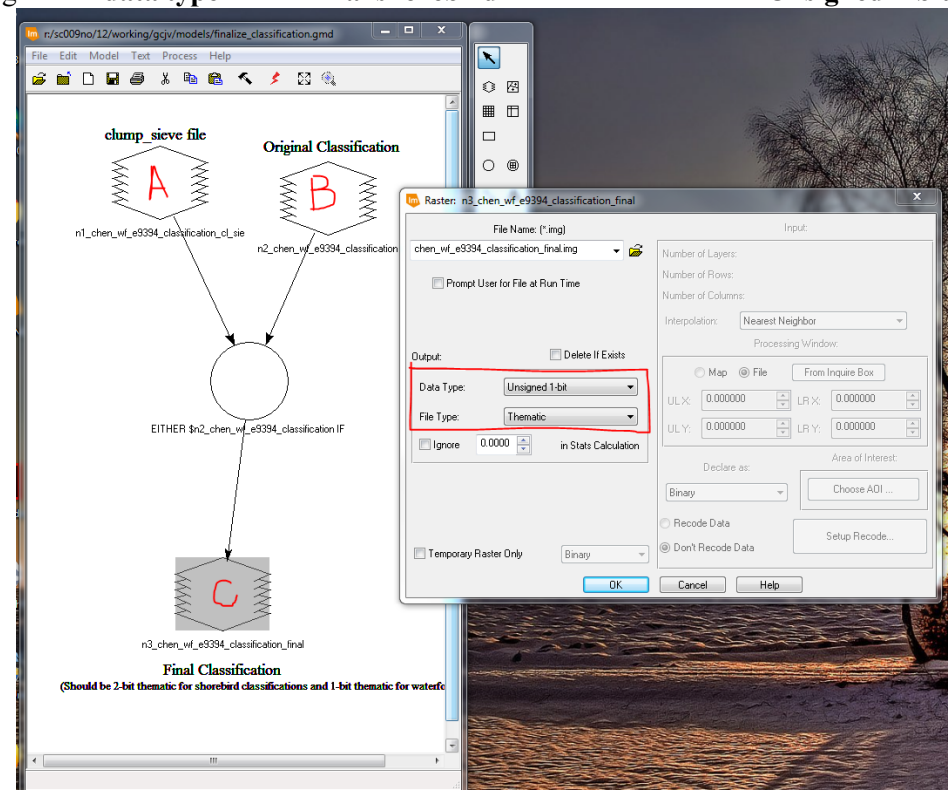


    e. Connected Neighbors: 8 (This is important. It makes sure that the tools groups together pixels that share all edges, N/E/S/W directions, AND pixels that share corners, NW/SW/SE/NE directions)



2) **Sieve** clumped file.
    a. **Raster tab > Raster GIS section > Thematic > Sieve**
    b. This function filters all groups of pixels, leaving only groups of pixels 1 acre or greater in size. 1 acres is the minimum mapping unit used by the GCJV.
    c. Input: The clumped classification file. "….classification_cl.img"
    d. Output: "….classification_cl_sie.img" (waterfowl) OR "…..classification_1_cl_sie.img" (shorebird)
    e. Select Layer: 1
    f. Minimum size: 1.00 Acres (THIS IS IMPORTANT)

3) Use the "**Finalize Classification"** model.
   - **a. Toolbox > Model Maker**
   - **b. In the Model Make window > File > Open >** browse to the GCJV models directory and open the finalize classification model ("….GCJV\models\finalize_classification.gmd")
   - c. Once the model opens, double click the jagged input/output bubbles to change the inputs and outputs.
     - i. (A) The **clump_sieve** file will always be the file ending in " _cl_sie.img"
   - d. (B) The **Original Classificaiton** file will be the file ending in "…_classification.img" that you originally edited. Do not use the shorebird file with only 1 values.
   - e. (C) Name the **final classification** in the following format InitiativeArea_wf/sb_pdYrYR_classification_final.img
   - **f.** The **data type** for the **final waterfowl** classifications will be **Unsigned 1-bit Thematic**
   - g. The **data type** for the **final shorebird** classifications will be **Unsigned 2-bit Thematic**

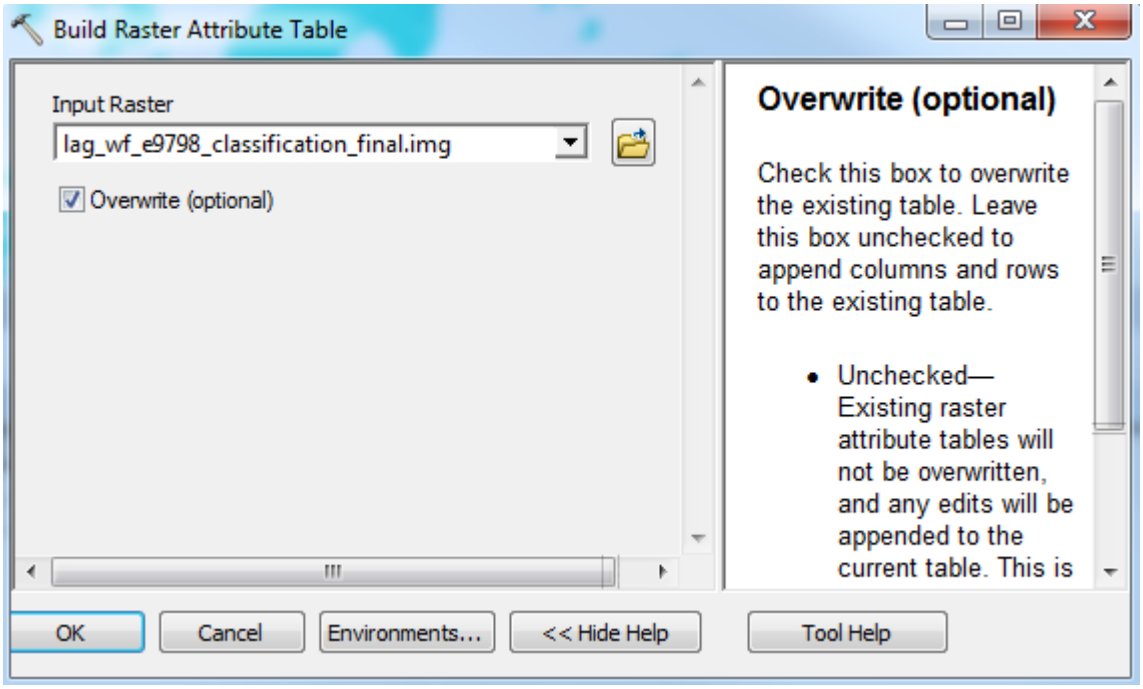


Proof the classification and make any additional edits

When making final edits, make sure you do not edit any segments to be less than the minimum mapping unit. **All clumps of habitat must be >= 4 pixels (Landsat imagery only)

h. View the image, final classification file, and corresponding mask file in Erdas Imagine and scan through the classification looking for any additional areas that need to be edited.
i. I like to view the image at a smaller scale, 1:50,000. The different perspective sometimes reveals things you wouldn't have noticed before (maybe a cloud that was off screen is revealed and you can now clearly notice a cloud shadow).

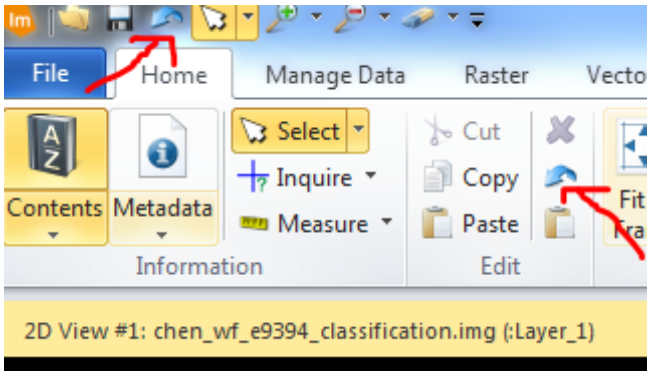
4) In ArcMap, use **the Build Raster Attribute Table** tool on the final classification
   a. If this is not done, the attribute table will reflect the number of pixels in the classification before any edits were made.
   b. Check the Overwrite button.



5) **Input** the amount of habitat into the correct summary spreadsheet
   a. Landsat imagery - put the following formula into the excel spreadsheet
      i. # pixels (from attribute table) * 900 * 0.000247105

Editing Tips/Things of Note

- **Undo** a mistake if you accidentally recode incorrect pixels
  a. Select the classification in the **Contents** window
  b. Choose the **Undo Arrow** which can be found in a variety of places
     i. Upper toolbar next to the save icon



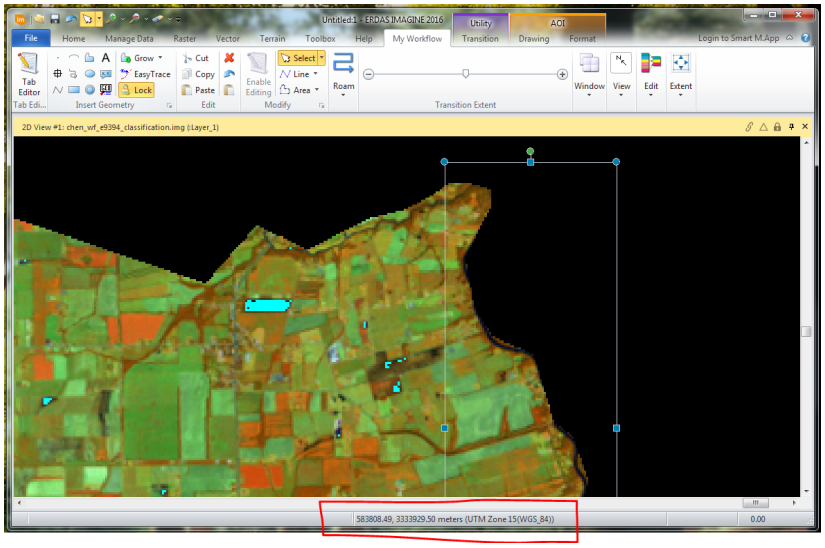
ii. My Workflow > Edit Section > Undo
iii. Home > Edit section > Undo
iv. Orange Raster tab > Drawing > Edit section > Undo

- You can pan, draw, recode without having to delete any polygons you draw (In ERDAS Imagine 2016. This may change in future versions), though you can choose to delete them. 
    a. Delete a polygon by selecting it and choosing the **Red Delete X** button in an edit section of any tab
    b. Make sure the AOI layer in the Contents window is selected

- Saving mid-way through a classification and you are using Overview to track your place:
    a. If you wish to save part way through editing a classification, make sure the Overview window is not open. You can close the Overview window, save, and create a new Overview later.

- The Roam tool keeps your place if you need to save mid-way through a classification
    a. You will not be in the same place as when you saved, but when you use one of the step forward Roam tool buttons, it will take you to the exact place you left off (If you've already been using the Roam tool…).
        i. The Roam tool will NOT save your place if you exit out of the Imagine software completely. <u>This only works if you minimize Imagine or lock your screen.</u>
    b. If you are not using the Roam tool, be sure to note the location where you saved your work using the coordinates in the bottom right of the screen.

- Noting Coordinates
    a. You may want to take note of the coordinates of a specific area. You can do this by placing your cursor on the screen and jotting down the coordinates in the bottom right of the screen.
    b. You can change the coordinate system by clicking on the numbers and choosing a desired system.
    c. Fun fact, you can type Lat/Long Decimal degrees coordinates into Google Earth to view an area close up if needed.



Maximum Extent (waterfowl only)

Whenever all the classifications for a period for an initiative area are finalized, maximum extent must be created for early/middle/late and middle/late:

1) Raster Calculator (ArcMap)
   a) Input all Classifications for a current period for the specific Initiative area
   b) Go to ArcToolbox > Spatial Analyst Tools > Map Algebra >Raster Calculator
      i) Example input syntax for 2002–03: Con(("lag_wf_e0203_classification_final.img" == 1) | ("lag_wf_m0203_classification_final.img" == 1) | ("lag_wf_l0203_classification_final.img" == 1), 1, 0)
   c) Input the specific classifications for the Initiative area you wish to create max extent for.
   d) For Early Middle Late maximum extent, include all three Early Middle Late classifications, and for Middle Late maximum extent only include the Middle and Late classifications in the syntax.
   e) Output location: R:\SC009NO\12\Working\GCJV\waterfowl_assessment\classifications\current_method\YYYY\Max_Extent
   f) Output Name: IA_wf_EML(or ML)YYYY_classification_final.img

Finding Unmasked Initiative Area Acres

1) Use the appropriate subset image, **model**, and mask to compute the total possible area classified for each unique initiative area/mask combination.
   *Only needs to be done once per mask

a. In ERDAS: "….\GCJV\models\unmasked_area\find_total_unmasked_area_using_inverse_mask.gmd"

   a. **Mask input**: Input the mask that **is** subset. This will ensure that imagery used is standardized for ERDAS Imagine as there can be discrepancies when working between ArcGIS and ERDAS.

   b. **Imagery input**: IA vector rasterized in ERDAS (tab: manage data → Vector to Raster)
      IE:
      "R:\SC009NO\12\Working\GCJV\IA_Bounds\IA_Bounds_Update*IA**IA*_utm14_wgs84_raster.img" → "**IA*_utm14_wgs84_raster_erdas.img"
   c. **Output** to appropriate mask folder for shorebird/waterfowl
      Name the output:
      *IA*_shorebird_mask_2010_urban_2010_ccap_nhdh_extract_thematic_subset_inverse.img
2) **Review** the unmasked area raster to ensure all pixels were correctly classified by the model.
   a. Clouds can cause pixels to have odd values. Sometimes the software updates, causing the values around subset imagery to be different. Sometimes Landsat will change how they process imagery, too. Make sure all unmasked pixels of the image are classified as 0
3) If there are discrepancies (ie, pixels outside the mosaic imagery, this will most likely be the case), correct with the extract by mask tool:
   a. **Mask input:** subset mosaic from the appropriate IA
   b. **Imagery Input**:
      *IA*_shorebird_mask_2010_urban_2010_ccap_nhdh_extract_thematic_subset_inverse_mask_erdas.img
   c. **Output** to appropriate mask folder: add "extract" to inverse mask
4) **Convert** the number of pixels in the image to acres.
   a. Value goes into the Unmasked Initiative Area Acres column of the habitat summary spreadsheets.
   b. # pixels * 900 * 0.000247105 = # acres (Landsat)
   c. # pixels * 400 * 0.000247105 = # acres (SPOT)

Finding Number of Acres Classified

Perform the following for each classification in which a portion of the IA could not be classified:

*This will be done for most every classification.

*If an image mosaic has all images and no part of the boundary is cut off (For example, the Laguna Madre classifications are typically completely covered by available imagery), copy the Unmasked Initiative Area Acres value into the Acres of Initiative Area Classified column.

1) Use the Raster Calculator tool in ArcGIS to find number of acres classified:
   a. **Mask input**: inverse mask generated in previous step (in mask folder, ie: "*IA*_shorebird_mask…inverse_mask_erdas.img" OR the inverse_extracted mask created in step 3)
   b. **Scene input**: Julian Date mosaic for IA/Period* in "…**classifications\current_method\YRYR\IA\Period\other**" (if there is no existing julian date layer for historical classification years, mosaic together relevant composite images & save as "IA_pyYr_raster_layer.img")
   c. ***Note**: julian date raster for TX Chen cuts off part of the IA, use the subset mosaic layer as scene input instead

d. **Output**: "…**classifications\current_method\YRYR\IA\Period\other\IA_sb/wf_pdYrYr_con_classified.img**

e. Con syntax:

Con(("tmc_shorebird_mask_2010_urban_2010_ccap_nhdh_extract_thematic_subset_inverse_mask_erdas.img" == 1) & ("tmc_sb_e2009_julian_date.img" > 0),1,0)

2) Convert the number of pixels in the image to acres to find the actual area classified by the available imagery.

a. Value goes into the Acres of Initiative Area Classified column of the habitat summary spreadsheets.

b. # pixels * 900 * 0.000247105 = # acres (Landsat)

c. # pixels * 400 * 0.000247105 = # acres (SPOT)

Finding Mean Julian Date

1) Use the **Con** tool in arc map to create a raster with a constant value reflecting the Julian date of each individual image. *Note, for middle period for waterfowl, we'd add 365 plus the julian date for images from January.*

Inputs:

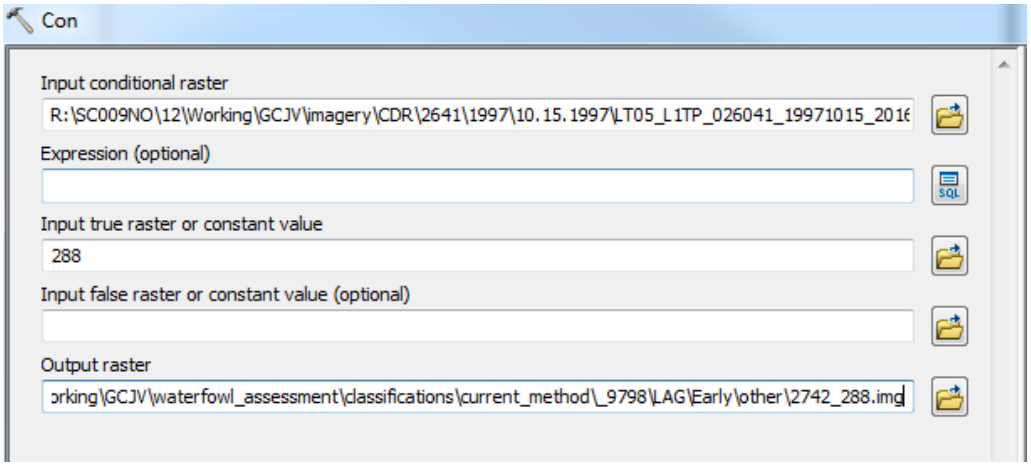
a. Conditional Raster: Composite of the image used in the mosaic (will be shifted/projected if necessary)

b. Expression: none

c. Constant Value: Julian Date of the image

d. Output: into the "other" folder of each classification with the name 'PR_julian_date.img'

e. Make sure to set the snap raster to the appropriate mask in the environments tab

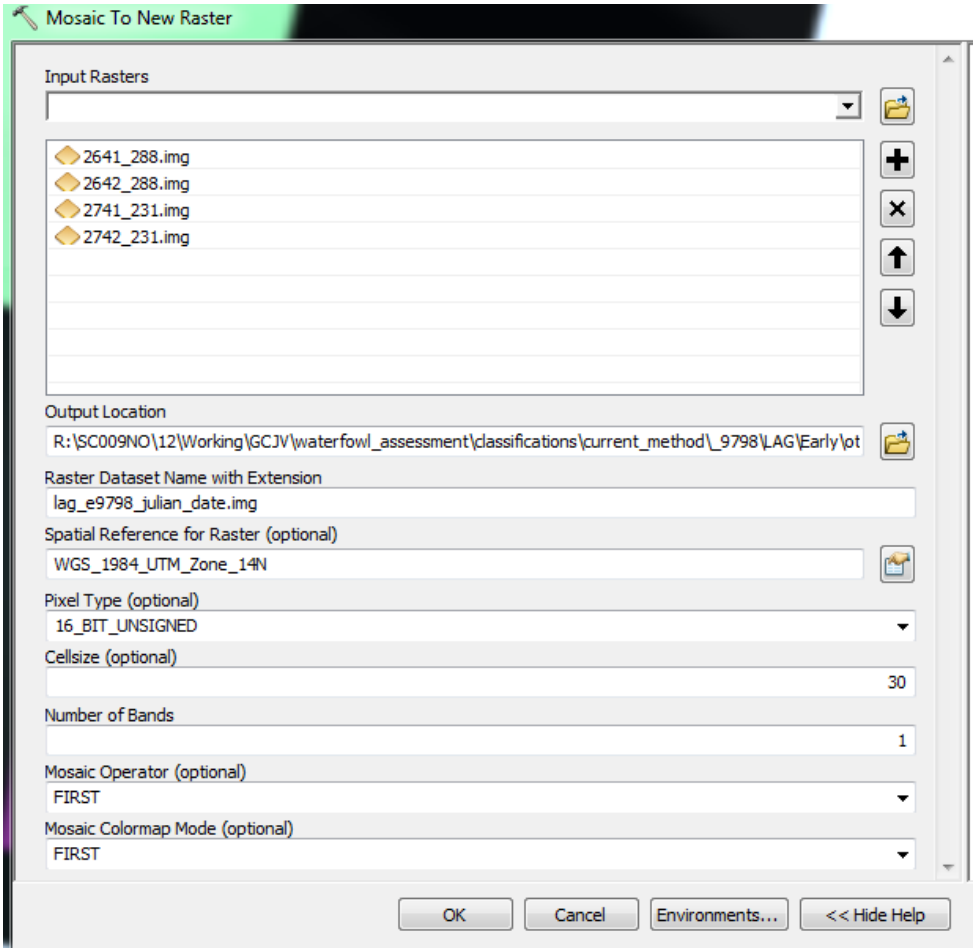


2) **Mosaic to New Raster** the Julian date images in the same order as the mosaic used for classification

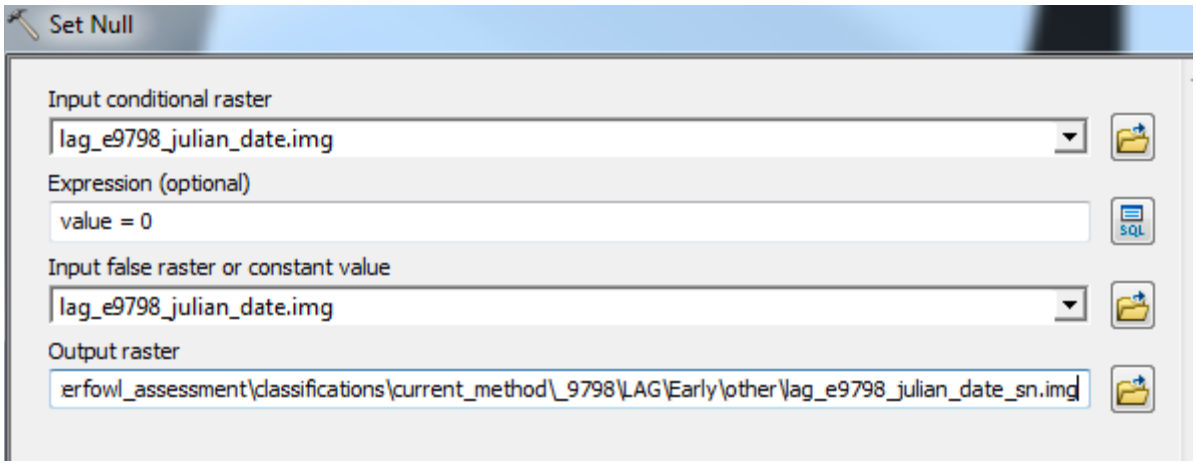
a. Place the date rasters in the same order the images were mosaicked together

i. Look in the image inventory spreadsheet if the order is unknown

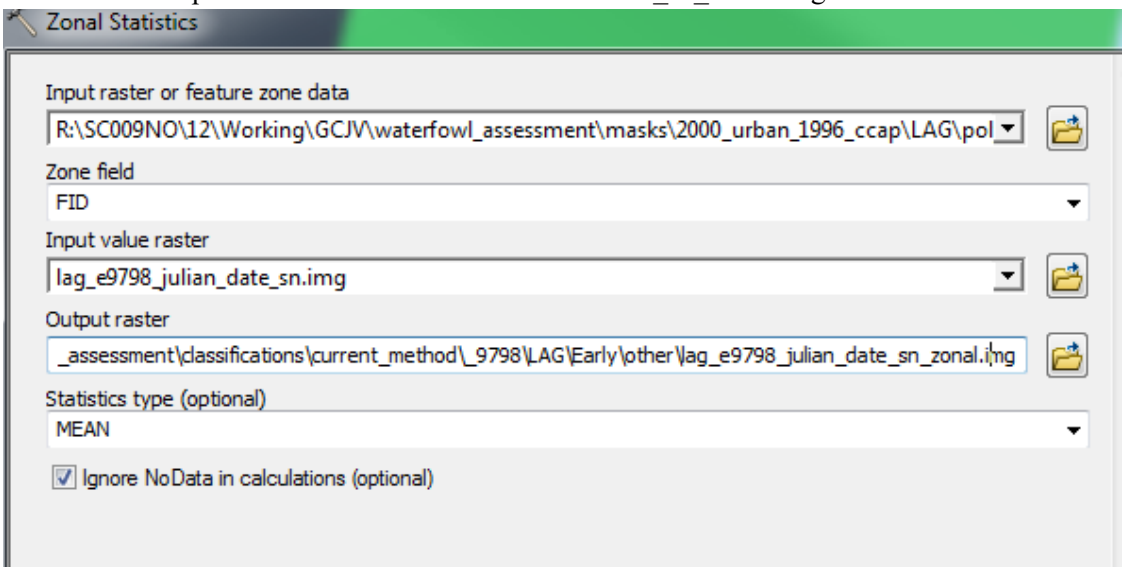
b. Pixel Type: 16 bit unsigned
c. Mosaic Operator FIRST
d. Number of Bands 1
e. Set the appropriate output location and name, spatial reference, and cell size.
    i. Location: the "other"
    ii. Name: IA_PdYrYr_julian_date.img
    iii. Cell size: Landsat imagery = 30, SPOT = 20
f. Make sure to set the snap raster to the appropriate mask in the environments tab



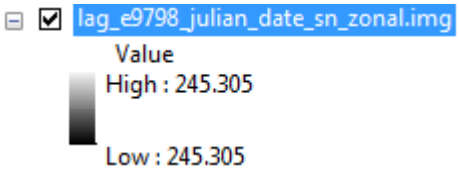
3) Use the **set null** tool to set 0 values to null
    a. Conditional Raster: Julian date mosaic for the IA/period
    b. Expression: Value = 0
    c. False raster: Julian date mosaic for the IA/period
    d. Output: JULIAN DATE NAME +" _ sn.img"



4) Use the **zonal statistics** tool to get the mean Julian date
   a. Input: Shapefile of unmasked areas in the initiative area
   b. Zone field: FID
   c. Input Raster: JULIAN DATE NAME + "_sn.img"
   d. Statistics type: MEAN
   e. Check the "Ignore NoData in calculations" box
   f. Output Raster: JULIAN DATE NAME + "_sn_zonal.img"



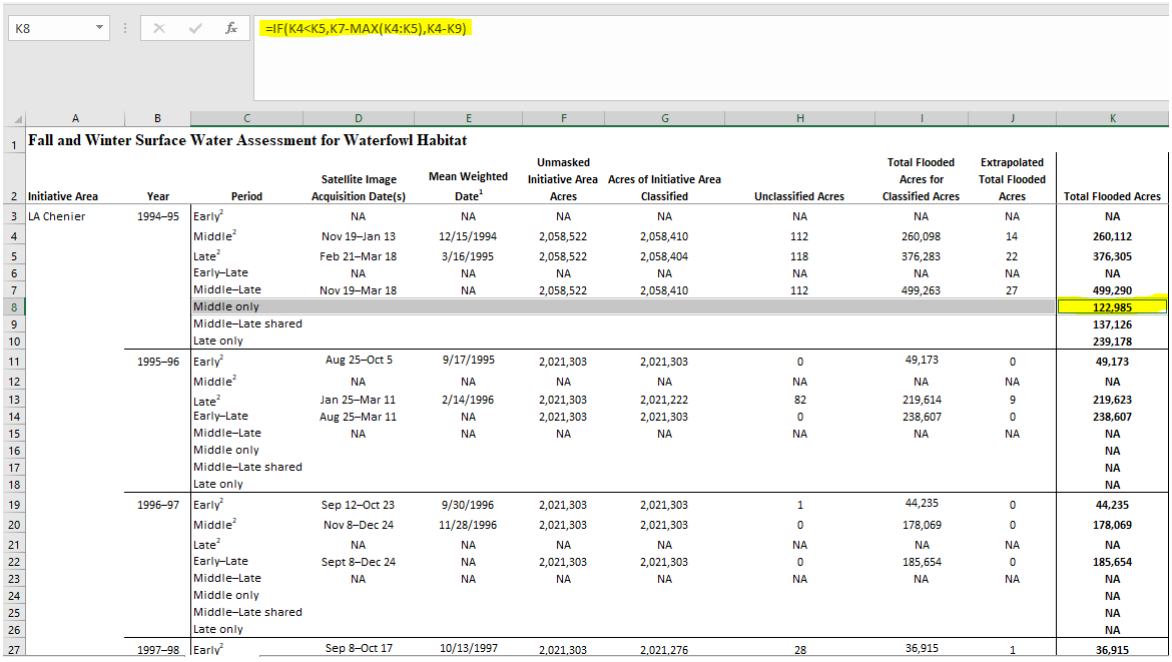
5) The output should have one mean Julian Date. Use truncated integer as the mean date. Do not round the date up.
   a. Use the Mean Julian Date calendar to find the date and record the month, day, and year on the summary spreadsheet (Appendix 1.C)
   b. The below example is equivalent to September 2, 1997.



Calculating Mid Only/Late Only/Shared (waterfowl only)

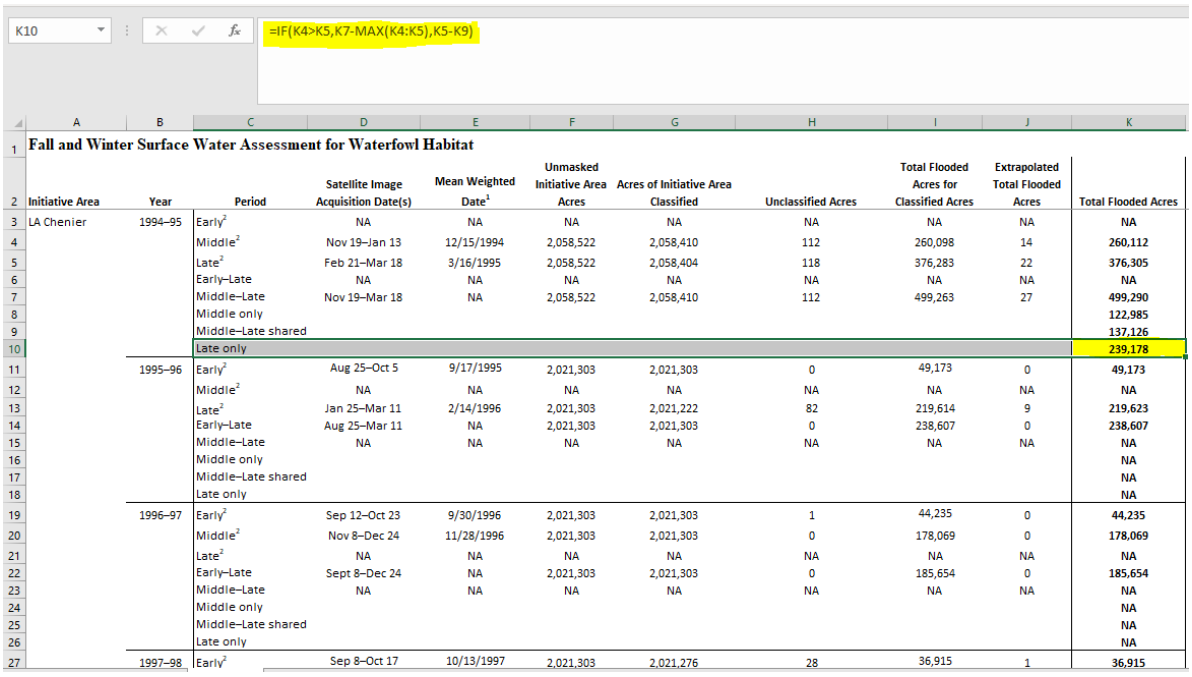
To determine the amount of maximum extent acres being shared from the middle and late periods, and to determine the number of acres coming from each period, a simple calculation must occur within the Fall and winter surface water assessment for waterfowl habitat spreadsheet.

1. Determining the amount of Maximum Extent acres that come from the middle period classification (**Middle only**):
    a. If the Middle period acres are less than the late period acres, Subtract the late period acres from the maximum extent acres to get the middle only acres. If late period acres are greater than the middle period acres, calculate the late only acres first and then subtract the late only acres from the middle period acres.
        i. Use this formula in the spreadsheet to automatically calculate**:**
        =IF(middle cell<late cell,maximum extent cell-MAX(middle cell:late cell),Middle cell-Late only cell)



	A	B	C	D	E	F	G	H	I	J	K
1	**Fall and Winter Surface Water Assessment for Waterfowl Habitat**										
2	Initiative Area	Year	Period	Satellite Image Acquisition Date(s)	Mean Weighted Date[1]	Unmasked Initiative Area Acres	Acres of Initiative Area Classified	Unclassified Acres	Total Flooded Acres for Classified Acres	Extrapolated Total Flooded Acres	Total Flooded Acres
3	LA Chenier	1994–95	Early[2]	NA	NA	NA	NA	NA	NA	NA	NA
4			Middle[2]	Nov 19–Jan 13	12/15/1994	2,058,522	2,058,410	112	260,098	14	260,112
5			Late[2]	Feb 21–Mar 18	3/16/1995	2,058,522	2,058,404	118	376,283	22	376,305
6			Early–Late	NA	NA	NA	NA	NA	NA	NA	NA
7			Middle–Late	Nov 19–Mar 18	NA	2,058,522	2,058,410	112	499,263	27	499,290
8			Middle only								122,985
9			Middle–Late shared								137,126
10			Late only								239,178
11		1995–96	Early[2]	Aug 25–Oct 5	9/17/1995	2,021,303	2,021,303	0	49,173	0	49,173
12			Middle[2]	NA	NA	NA	NA	NA	NA	NA	NA
13			Late[2]	Jan 25–Mar 11	2/14/1996	2,021,303	2,021,222	82	219,614	9	219,623
14			Early–Late	Aug 25–Mar 11	NA	2,021,303	2,021,303	0	238,607	0	238,607
15			Middle–Late	NA	NA	NA	NA	NA	NA	NA	NA
16			Middle only								NA
17			Middle–Late shared								NA
18			Late only								NA
19		1996–97	Early[2]	Sep 12–Oct 23	9/30/1996	2,021,303	2,021,303	1	44,235	0	44,235
20			Middle[2]	Nov 8–Dec 24	11/28/1996	2,021,303	2,021,303	0	178,069	0	178,069
21			Late[2]	NA	NA	NA	NA	NA	NA	NA	NA
22			Early–Late	Sept 8–Dec 24	NA	2,021,303	2,021,303	0	185,654	0	185,654
23			Middle–Late	NA	NA	NA	NA	NA	NA	NA	NA
24			Middle only								NA
25			Middle–Late shared								NA
26			Late only								NA
27		1997–98	Early[2]	Sep 8–Oct 17	10/13/1997	2,021,303	2,021,276	28	36,915	1	36,915

2. Determining the amount of maximum extent acres that come from late period classification (**late only**):
    a. If the middle period acres are greater than the late period acres, subtract the middle period acres from the maximum extent acres. If the middle period acres are less than late period acres, subtract the shared acres from the late period acres.
        i. Use this formula in the spreadsheet to automatically calculate:
        =IF(middle cell>late cell,maximum extent cell-MAX(middle cell:late cell),Late cell-Shared cell)

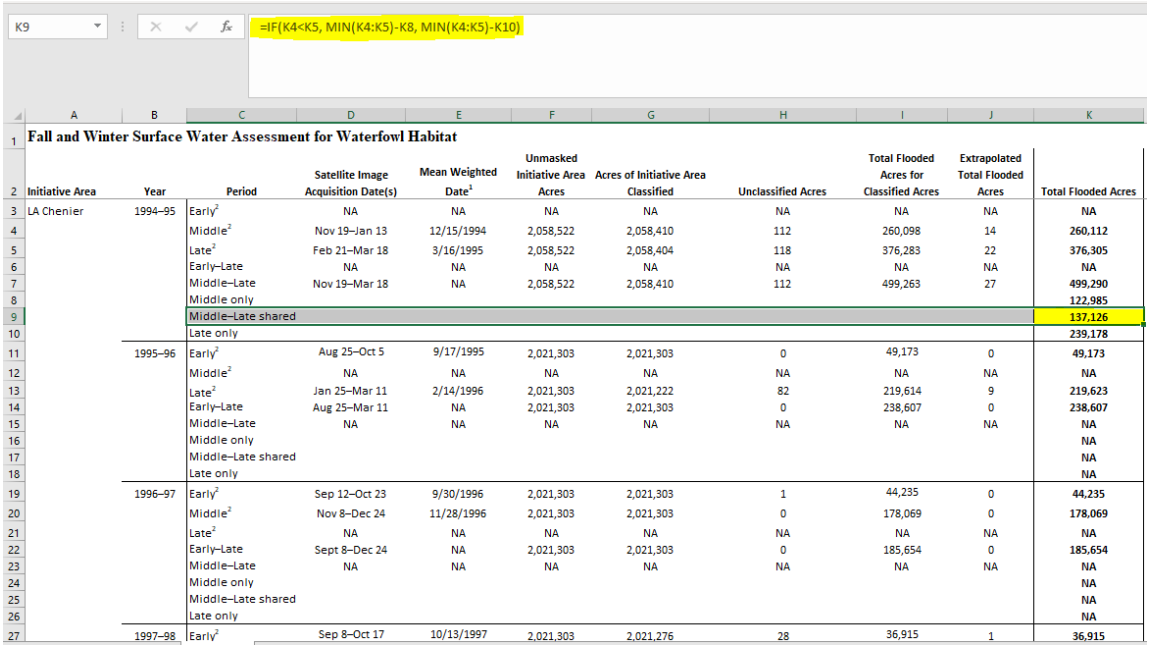


K10 =IF(K4>K5,K7-MAX(K4:K5),K5-K9)

Fall and Winter Surface Water Assessment for Waterfowl Habitat

Initiative Area	Year	Period	Satellite Image Acquisition Date(s)	Mean Weighted Date[1]	Unmasked Initiative Area Acres	Acres of Initiative Area Classified	Unclassified Acres	Total Flooded Acres for Classified Acres	Extrapolated Total Flooded Acres	Total Flooded Acres
LA Chenier	1994–95	Early[2]	NA	NA	NA	NA	NA	NA	NA	NA
		Middle[2]	Nov 19–Jan 13	12/15/1994	2,058,522	2,058,410	112	260,098	14	**260,112**
		Late[2]	Feb 21–Mar 18	3/16/1995	2,058,522	2,058,404	118	376,283	22	**376,305**
		Early–Late	NA	NA	NA	NA	NA	NA	NA	NA
		Middle–Late	Nov 19–Mar 18	NA	2,058,522	2,058,410	112	499,263	27	**499,290**
		Middle only								**122,985**
		Middle–Late shared								**137,126**
		Late only								**239,178**
	1995–96	Early[2]	Aug 25–Oct 5	9/17/1995	2,021,303	2,021,303	0	49,173	0	**49,173**
		Middle[2]	NA	NA	NA	NA	NA	NA	NA	NA
		Late[2]	Jan 25–Mar 11	2/14/1996	2,021,303	2,021,222	82	219,614	9	**219,623**
		Early–Late	Aug 25–Mar 11	NA	2,021,303	2,021,303	0	238,607	0	**238,607**
		Middle–Late	NA	NA	NA	NA	NA	NA	NA	NA
		Middle only								NA
		Middle–Late shared								NA
		Late only								NA
	1996–97	Early[2]	Sep 12–Oct 23	9/30/1996	2,021,303	2,021,303	1	44,235	0	**44,235**
		Middle[2]	Nov 8–Dec 24	11/28/1996	2,021,303	2,021,303	0	178,069	0	**178,069**
		Late[2]	NA	NA	NA	NA	NA	NA	NA	NA
		Early–Late	Sept 8–Dec 24	NA	2,021,303	2,021,303	0	185,654	0	**185,654**
		Middle–Late	NA	NA	NA	NA	NA	NA	NA	NA
		Middle only								NA
		Middle–Late shared								NA
		Late only								NA
	1997–98	Early[2]	Sep 8–Oct 17	10/13/1997	2,021,303	2,021,276	28	36,915	1	**36,915**

3. Determining the amount of Maximum extent acres that are shared between Middle and Late (**Middle-Late Shared**):
    a. If the middle period acres are less that the late acres value, subtract the middle only acres value from the middle acres value. If middle period acres are greater than late period acres, then subtract late only acres from the late period acres value.
        i. Use this formula in the spreadsheet to automatically calculate:
        =IF(middle cell<late cell, MIN(Middle cell:Late cell)-Middle only cell, MIN(Middle cell:Late cell)-Late only cell)



K9 =IF(K4<K5, MIN(K4:K5)-K8, MIN(K4:K5)-K10)

Fall and Winter Surface Water Assessment for Waterfowl Habitat

Initiative Area	Year	Period	Satellite Image Acquisition Date(s)	Mean Weighted Date[1]	Unmasked Initiative Area Acres	Acres of Initiative Area Classified	Unclassified Acres	Total Flooded Acres for Classified Acres	Extrapolated Total Flooded Acres	Total Flooded Acres
LA Chenier	1994–95	Early[2]	NA	NA	NA	NA	NA	NA	NA	NA
		Middle[2]	Nov 19–Jan 13	12/15/1994	2,058,522	2,058,410	112	260,098	14	**260,112**
		Late[2]	Feb 21–Mar 18	3/16/1995	2,058,522	2,058,404	118	376,283	22	**376,305**
		Early–Late	NA	NA	NA	NA	NA	NA	NA	NA
		Middle–Late	Nov 19–Mar 18	NA	2,058,522	2,058,410	112	499,263	27	**499,290**
		Middle only								**122,985**
		Middle–Late shared								**137,126**
		Late only								**239,178**
	1995–96	Early[2]	Aug 25–Oct 5	9/17/1995	2,021,303	2,021,303	0	49,173	0	**49,173**
		Middle[2]	NA	NA	NA	NA	NA	NA	NA	NA
		Late[2]	Jan 25–Mar 11	2/14/1996	2,021,303	2,021,222	82	219,614	9	**219,623**
		Early–Late	Aug 25–Mar 11	NA	2,021,303	2,021,303	0	238,607	0	**238,607**
		Middle–Late	NA	NA	NA	NA	NA	NA	NA	NA
		Middle only								NA
		Middle–Late shared								NA
		Late only								NA
	1996–97	Early[2]	Sep 12–Oct 23	9/30/1996	2,021,303	2,021,303	1	44,235	0	**44,235**
		Middle[2]	Nov 8–Dec 24	11/28/1996	2,021,303	2,021,303	0	178,069	0	**178,069**
		Late[2]	NA	NA	NA	NA	NA	NA	NA	NA
		Early–Late	Sept 8–Dec 24	NA	2,021,303	2,021,303	0	185,654	0	**185,654**
		Middle–Late	NA	NA	NA	NA	NA	NA	NA	NA
		Middle only								NA
		Middle–Late shared								NA
		Late only								NA
	1997–98	Early[2]	Sep 8–Oct 17	10/13/1997	2,021,303	2,021,276	28	36,915	1	**36,915**

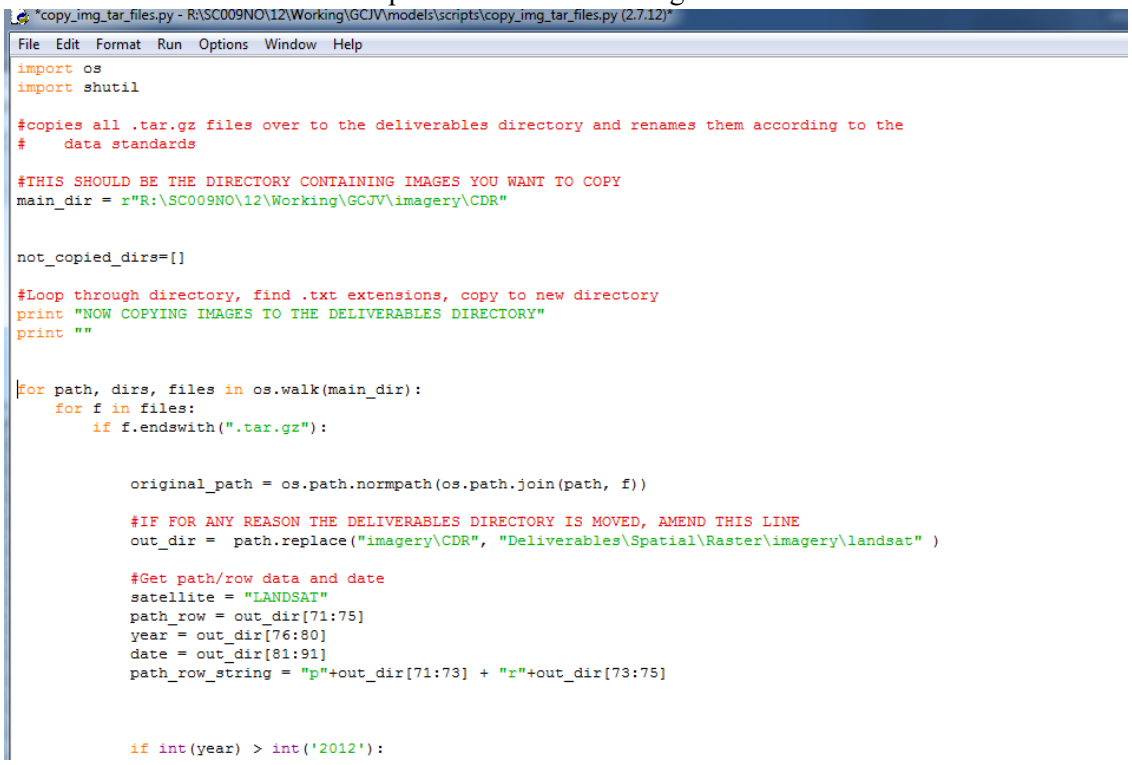
Add Files to Deliverables Folder **Not currently done using this script*

The Deliverables directory is located at R:\SC009NO\12\Working\GCJV\Deliverables.

Copying imagery to the deliverables directory

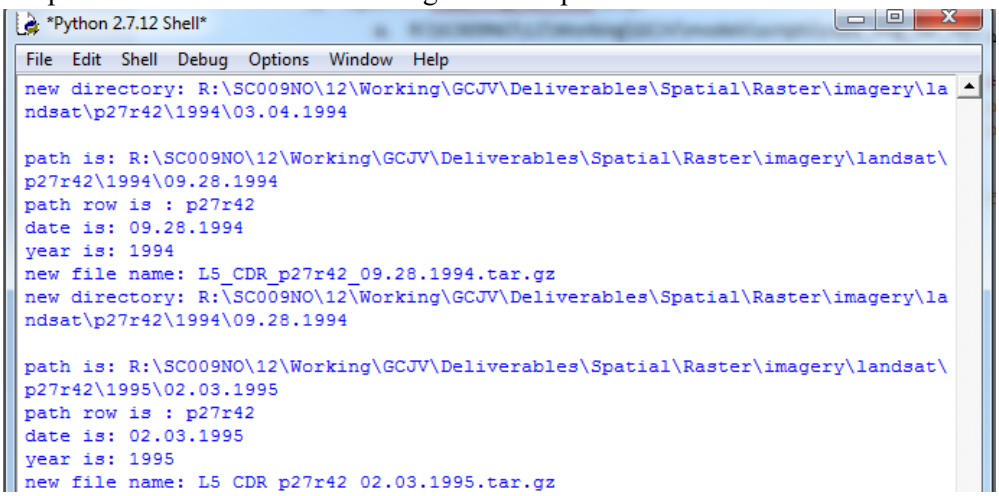
While manually creating all new image directories, copying .tar.gz files, and subsequently renaming all of the files is possible, it is easiest to copy images from the GCJV\imagery directory to the "GCJV\Deliverables\Spatial\Raster\Imagery directory using a python script.

1) Open the copy_img_tar_files script
    a. R:\SC009NO\12\Working\GCJV\models\scripts\copy_img_tar_files.py
    b. Right click in Windows explorer and choose Edit With Idle
        i. Do not choose to Edit With Idle in ArcGIS Pro as this script uses a different version of Python
        ii. The script will look like the image below



2) Choose **Run > Run Module**
    a. Nothing needs to be changed unless the imagery directory or the deliverables directory changes

b. Output will look like the below image. The script will end with “Finish”

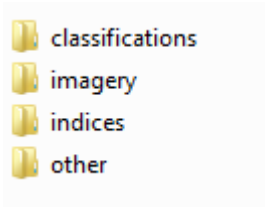


Appendix 1.A.: Imagery Directory and Deliverables

1) All images are located in the **GCJV\imagery** folder
    a. **\CDR**: contains Landsat imagery composites and/or tar files
    b. **\SPOT_wf_update**: contains SPOT imagery processed for the updated SPOT waterfowl classifications. If SPOT images are used for historic shorebird classifications, a new directory will need to be created
    c. **\shorebird_old**: archived imagery for shorebird classifications. Images are not surface reflectance corrected
    d. **\waterfowl_old**: archived imagery for old waterfowl classifications. Images are not surface reflectance corrected
2) Images are organized by **Path/Row → Year → Date**
3) Each date contains one of the following:
    a. .tar.gz compressed image file
    b. image composite (all bands together)

Classifications Directory

1) Within the **GCJV\Waterfowl** or **GCJV\Shorebird** directories, you can find the **classifications\current_method** folders.
2) Classifications are organized by year then by initiative area
3) Within each **year\IA\Period** directory, there are 4 folders. Use the folders for the following files (**To save space on the network, delete all files that are not the final product once the classification is finalized.**)
    a. \Classifications
        i. Original classification file
        ii. Clumped classification
        iii. Sieved classification
        iv. Final classification
        v. Final subset classifications (Chenier Plain waterfowl classifications)
        vi. Sometimes final classifications have errors and must be fixed. Keep those changes in this folder too. Put any erroneous final classifications into an "old" directory. (For example, there may be a final classification and a final_masked classification, which is the amended and "true" final product.)
        vii. Delete the clumped and sieved classifications once final classification is completed



    b. \Imagery
        i. Image mosaic
        ii. Scaled mosaic
        iii. Shifted mosaic
        iv. Subset mosaic
        v. Delete the initial mosaic, scaled mosaic, and shifted mosaic once final classification is completed.
    c. \Indices
        i. MNDWI
        ii. NDVIEVI

iii. LSWI
iv. NDBI (Shorebird only)

d. \Other

i. Julian date images
ii. Julian date mosaic
iii. Julian date set null mosaic
iv. Julian date zonal mosaic
v. Area classified raster
vi. Delete all files besides the final Julian date zonal mosaic and the final area classified file.

File Naming Conventions

Type	Abbreviation
IA = Initiative Area	lachen = Louisiana Chenier txchen = Texas Chenier chen = Chenier Plain lag = Laguna Madre tmc = Texas Mid-Coast cma = Coastal Mississippi-Alabama mrcw = Mississippi River Coastal Wetland
Type	sbs = shorebird spring sbf = shorebird fall wf = waterfowl
pYYYY	Period, Year(s) (last two digits of both years for wf and full year for sb)
Periods (if applicable, Shorebird spring assessments do not have a period)	e = early m = middle l = late
Max Extent (waterfowl only)	eml = early middle late ml = middle late

Indices	LSWI = Land Surface Water Index MNDWI = Modified Normalized Difference Water Index NDBI = Normalized Difference Built-up Index NDVI = Normalized Difference Vegetation Index NDVIEVI = Normalized Difference Vegetation and Enhanced Vegetation Index

Generic file names with examples

Type	Generic file name with examples
Mask (with same year for data sources)	IA_type_mask_YYYY_urban _ccap_nhdh_thematic_DDMMYY.img eg., chen_waterfowl_mask_2010_urban_ccap_nhdh_thematic.img
Mask (with two years for data sources	IA_type_mask_YYYY_urban_YYYY_ccap_nhdh_thematic_DDMMYY.img eg., chen_waterfowl_mask_2010_urban_2010_ccap_nhdh_thematic.img
Final classification	IA_type_pYYYY_classification_final_DDMMYY.img eg., for sb: chen_sbf_e2017_classification_final.img eg., for wf: txchen_wf_e1718_classification_final.img
Final Max Extent Classification	IA_type_maxextentYYYY_classification_final_DDMMYY.img Eg., for wf early middle late: lag_wf_eml1920_classification_final.img
Mosaic/Imagery	IA_type_pYYYY_mosaic_scaled_shift_subset.img eg. for sb: lachen_sb_e2018_mosaic_scaled_shift_subset.img eg., for wf: lachen_wf_e1819_mosaic_scaled_shift_subset.img
Indices	IA_type_pYYYY_mosaic_scaled_shift_subset_index.img eg., for sb: lachen_wf_e2018_mosaic_scaled_shift_subset_lswi.img eg., for wf: lachen_wf_e1819_mosaic_scaled_shift_subset_lswi.img

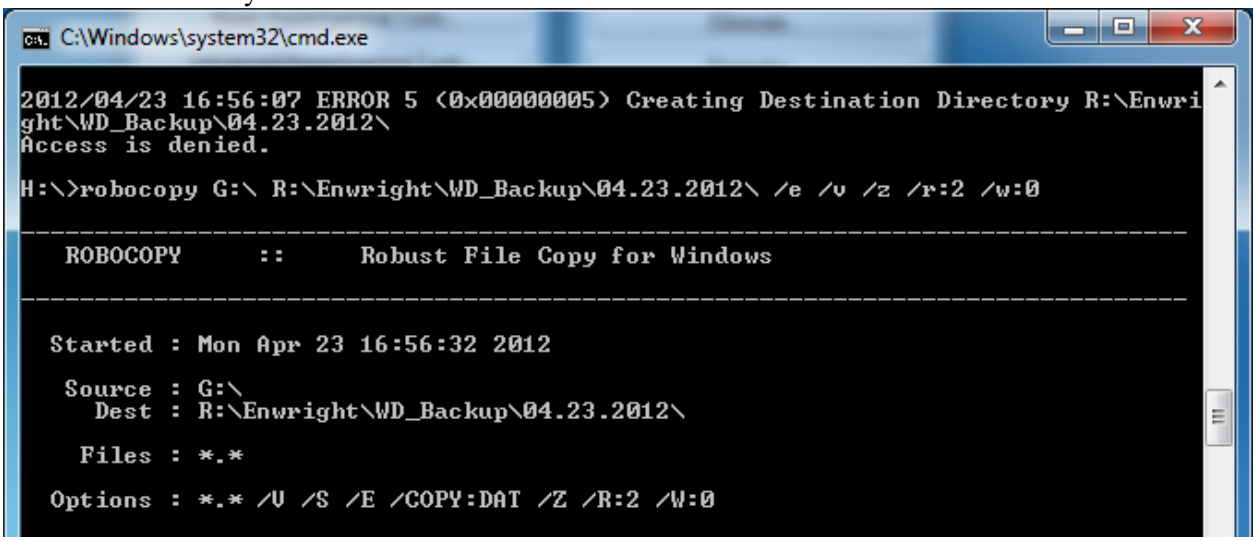
Deliverable Directory

1) R:\SC009NO\12\Working\GCJV\Deliverables
    a. Put finalized classifications into it's correct folder within this directory, along with imagery inventory spreadsheets for each initiative area.
    b. Also put finalized maximum extents into it's correct folder within this directory
    c. Robocopy this directory.

Robocopy Files

After the deliverables directory is ready on the USGS server, it must be transferred to the GCJV server. Using the Robocopy command in Windows, you can easily copy only files which are new or have changed from one directory to another.

1) Open the Command Prompt
    a. Start Menu > Run > Search "cmd"
    b. Start Menu > Programs > Accessories > Command Prompt
2) To copy the Deliverables folder to the external hard drive type the following and hit enter
    a. robocopy SourceDirectory DestinationDirectory /e /v /z /r:2 /w:0
    b. robocopy R:\SC009NO\12\Working\GCJV\Deliverables E:\GCJV\Deliverables /e /v /z /r:2 /w:0
    c. Step B will copy all new and changed files from the Deliverables folder in the GCJV directory to the Deliverables folder on the external drive. The below image is an example of what you will see.



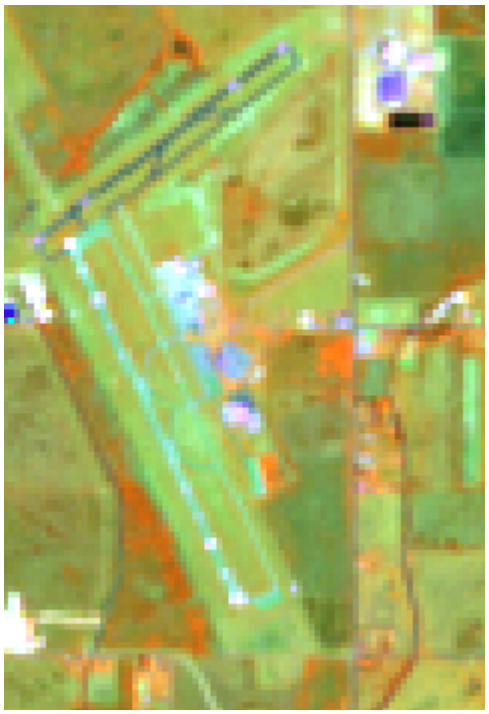
3) Repeat the robocopy to copy the files from the external hard drive to the correct folder on the GCJV server. You will need to robocopy the waterfowl classifications, shorebird classifications, and imagery separately since they are not consolidated in one directory.

This process will run for a while, depending on how many files are being copied.

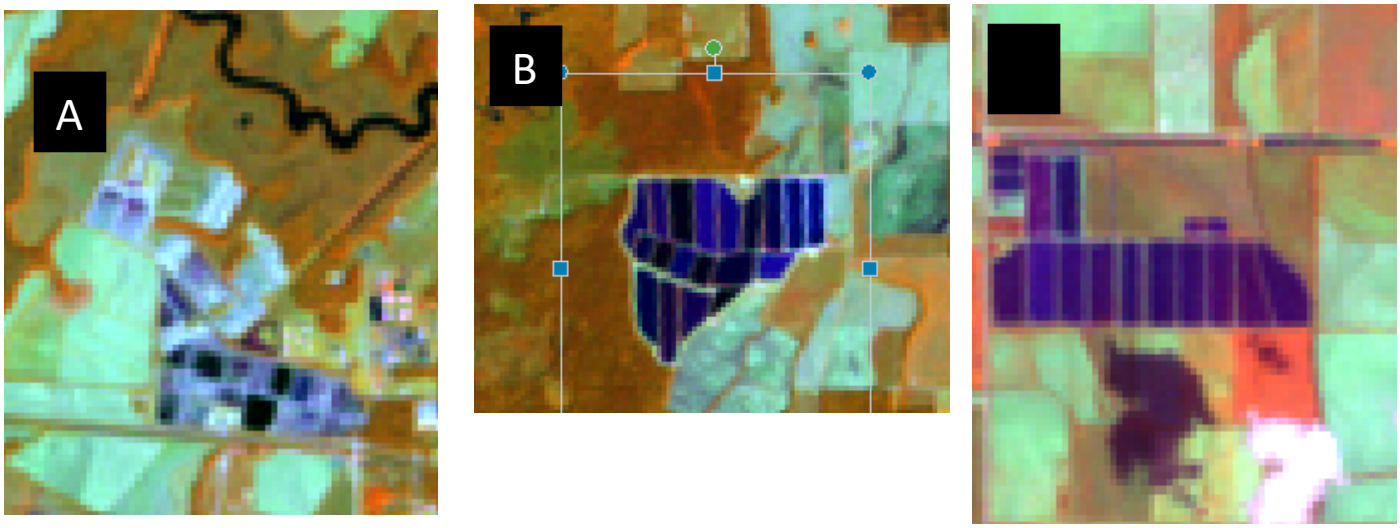
Appendix 1.B.: Signature Dictionary

Airstrips

Airstrips are usually L shaped features. They are characteristic of man-made features as they have straight edges and appear bright (They reflect all bands). These are often erroneously classified as habitat and should be recoded to “not-habitat”.



Aquaculture



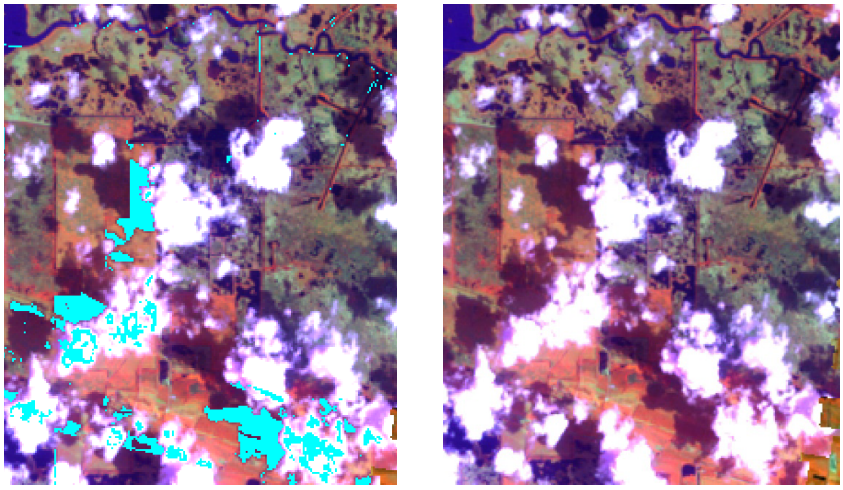
A: LA Chenier Plain 538081.69, 3340407.30 UTM Zone 15 WGS 84

B: LA Chenier Plain 544951.49, 3352020.30 UTM Zone 15 WGS 84

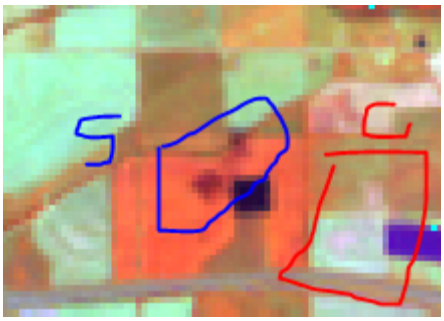
C: LA Chenier Plain 501661.89, 3335615.10 UTM Zone 15 WGS 84

Aquaculture ponds are many man-made ponds grouped closely together. The ponds are usually rectangular, have straight edges, are medium sized and have one or two pixels between them. These will always be wet when they are falsely classified as habitat. These should be coded as not-habitat.

Clouds & Cloud Shadow

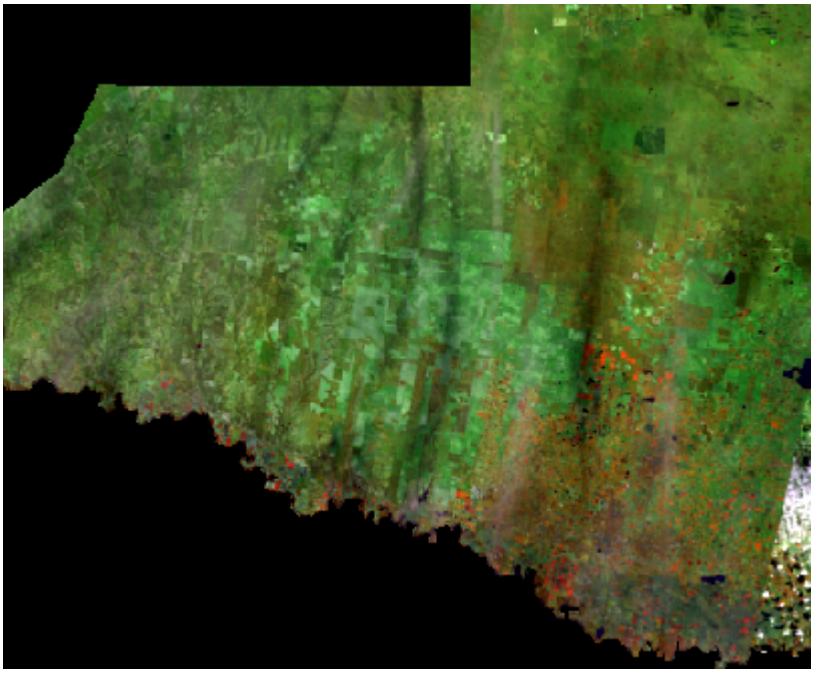


None of the cyan colored pixels are habitat. It is all cloud, cloud shadow, or mask misalignment. Clouds can appear puffy white with a dark shadow, as seen above.



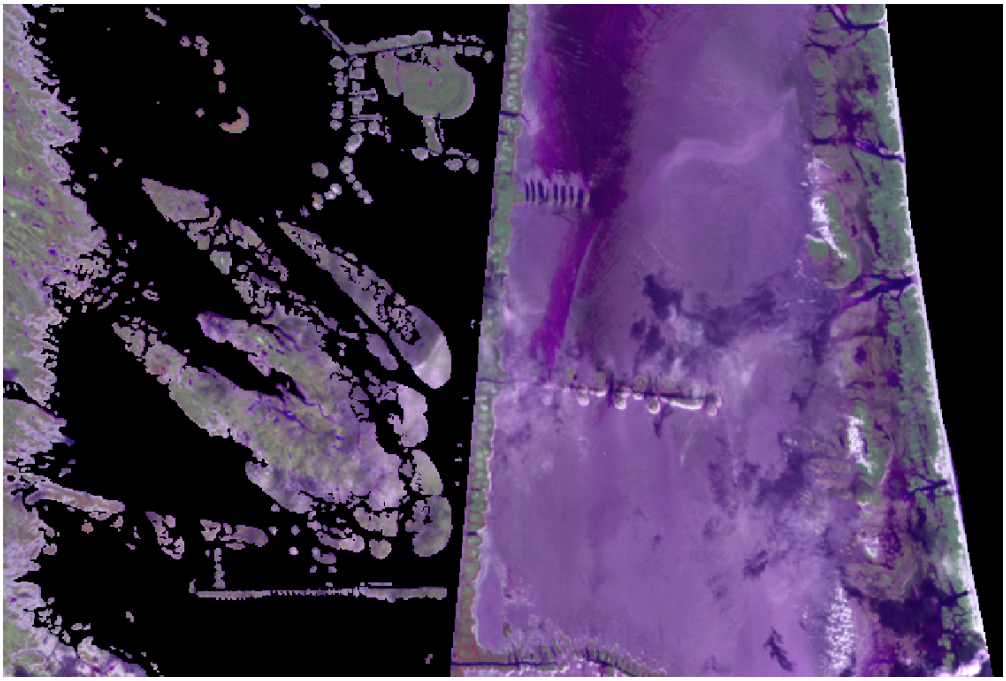
Clouds can be very faint. An example of faint cloud shadow (marked in blue by the S) and clouds (marked in red by the C) is seen above. Note that all cloud shadow in a specific image will be at the same angle from a cloud due to the angle of the sun and the photograph.

When you can see through the cloud shadow it is ok to add in habitat that was overlooked by the model or to leave in habitat if it is there. In the above image, you can clearly see the field is dry and the cloud shadow should be classified as “not habitat”.

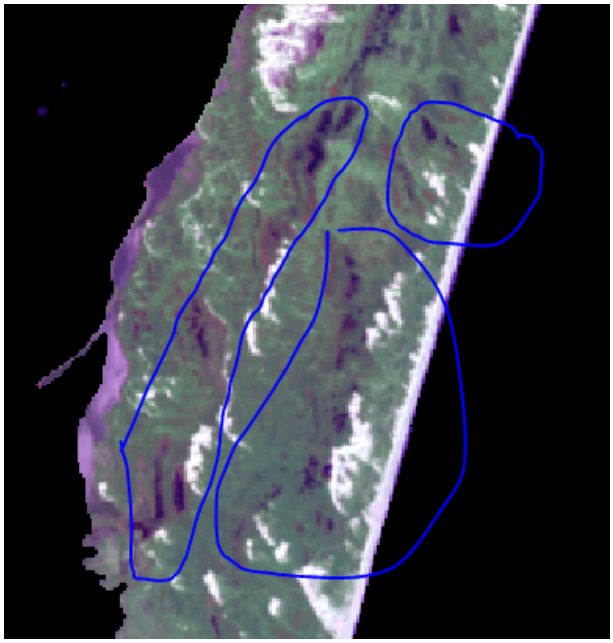


Sometimes clouds can be large and hazy. In the above image, large areas of clouds and cloud shadow are visible; however, once zoomed into the image, it becomes difficult to discern the darker cloud shadow and hazy cloud visually. It is important to take note of areas that may have haze over them before editing a classification for errors. Haze may cause errors of inclusion, where pixels are erroneously included in the habitat class, and errors of exclusion, where pixels are erroneously classified as non-habitat.

Laguna Madre Barrier Islands

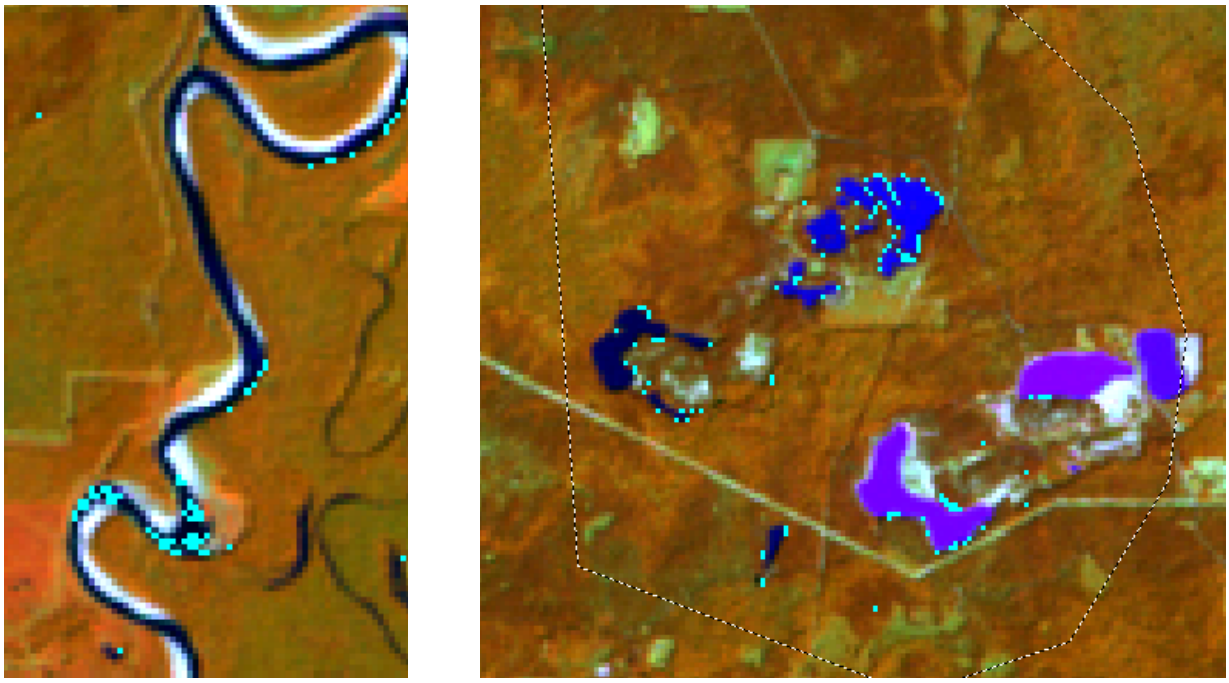


Wet areas located along barrier islands on the Eastern shore of LAG are not considered habitat if they are flooded from the Laguna Madre. In the above image, all of the purple habitat is potentially mis-classified as habitat by the model; however, this should be recoded as not-habitat.



Purple pixels circled in blue are habitat. These are independent of the surrounding salt water bodies (the Gulf of Mexico to the East and Laguna Madre to the West) and should be classified as habitat. Light purple pixels along the western edge that are not circled in blue are not habitat.

Mask Misalignment Along Permanent Water Bodies



(Left) TX Chenier Plain – 324441.69, 3327922.10 UTM Zone 15 WGS 84

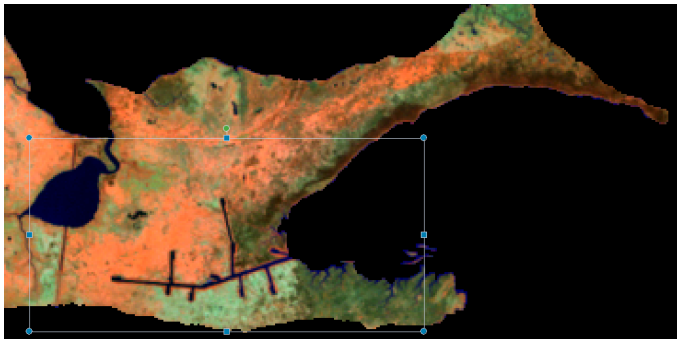
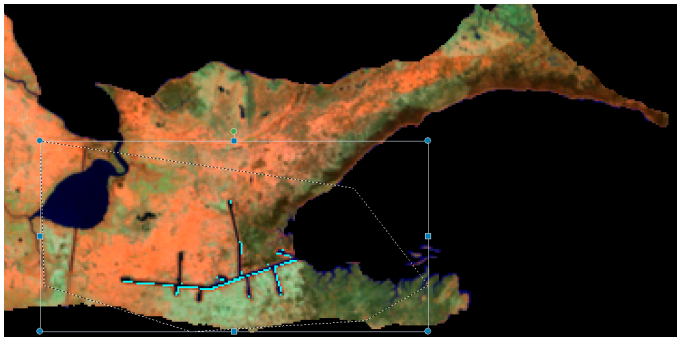
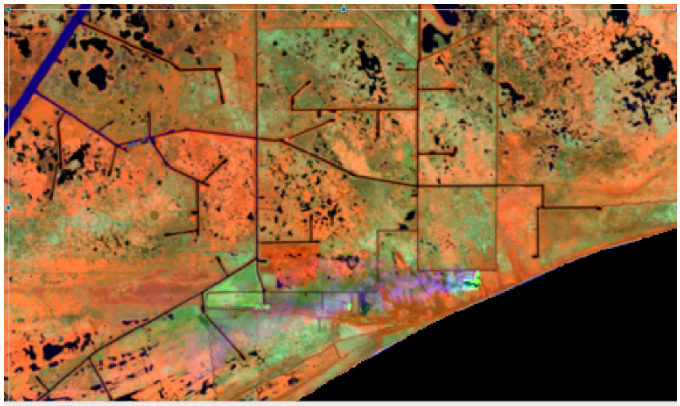
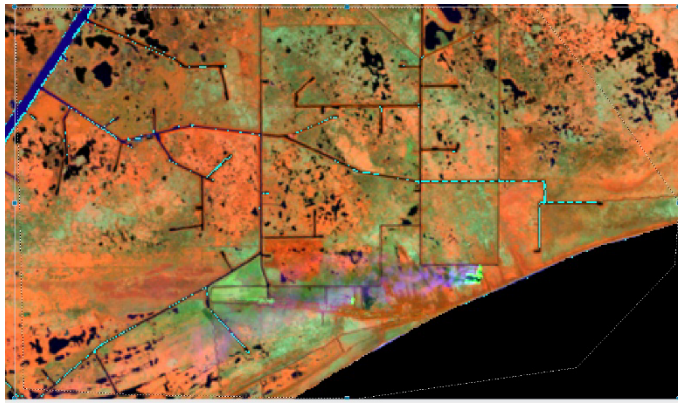
(Right) LA Chenier Plain -- 553105.09, 3417739.10 UTM Zone 15 WGS 84

Water bodies are fluid and change from year to year. This causes erroneous habitat classification along river edges and ponds. Mask misalignment along rivers is no larger than one or two pixels wide and follows the river or pond. When the mask is viewed on top of the imagery, it is clear the mask was meant to cover the entire water body, but it is shifted over. T

Mask misalignment is especially prominent in images that have been projected. For example, there are a lot of rivers in TMC that do not align with the mask. LAG and MRCW also have a lot of mask misalignment along water bodies due to having a lot of water bodies. Mask misalignment is seen along both man-made and natural bodies of water.

Note: River flooding is considered habitat. If the habitat along the river is more than a few pixels wide, do not recode it.

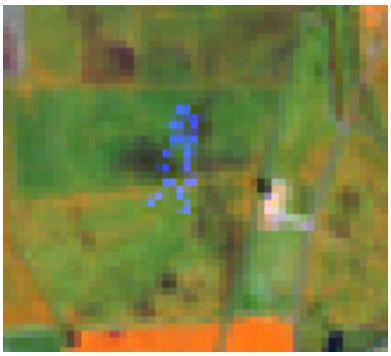
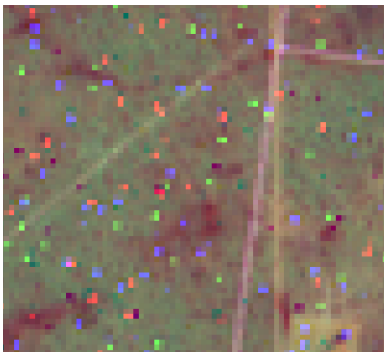
(Left) In the lower part of the image you can see the model has classified a river meander as habitat (cyan). However, since it is part of a permanent water body, it is not considered habitat. It is not river flooding, but simply the river meandering.

Above are some examples of mask misalignment along man made canals. This error is prominent in southern CHEN and MRCW.

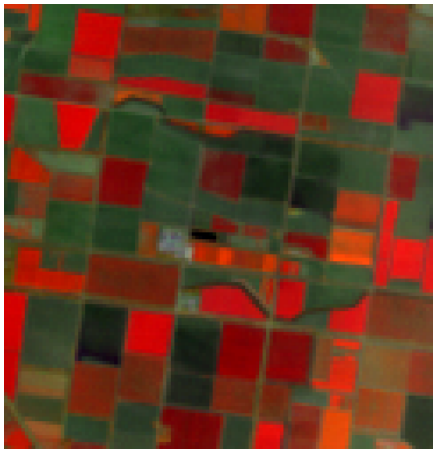
Odd Pixels

Sometimes pixels are not good quality, especially in older imagery. These will often be neon colors. Sometimes only one or two bands will have data making the pixel bright or neon colors. Interpolate habitat based on surrounding pixels.

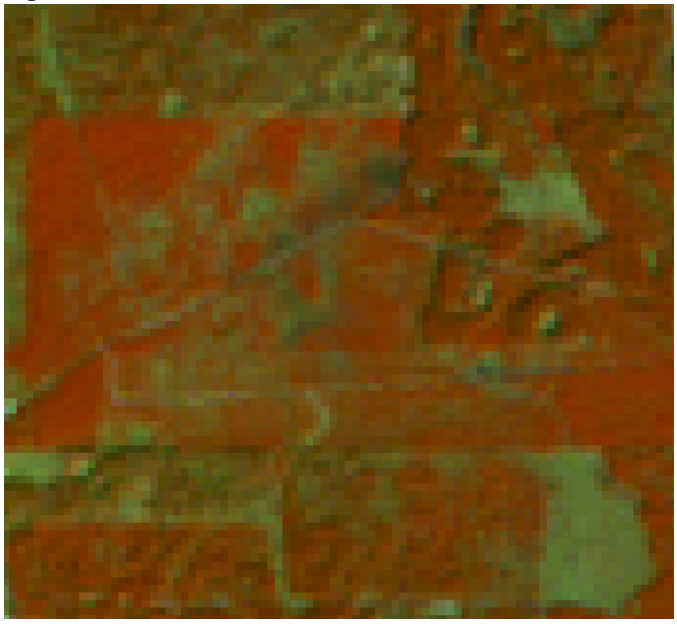



Red Soils

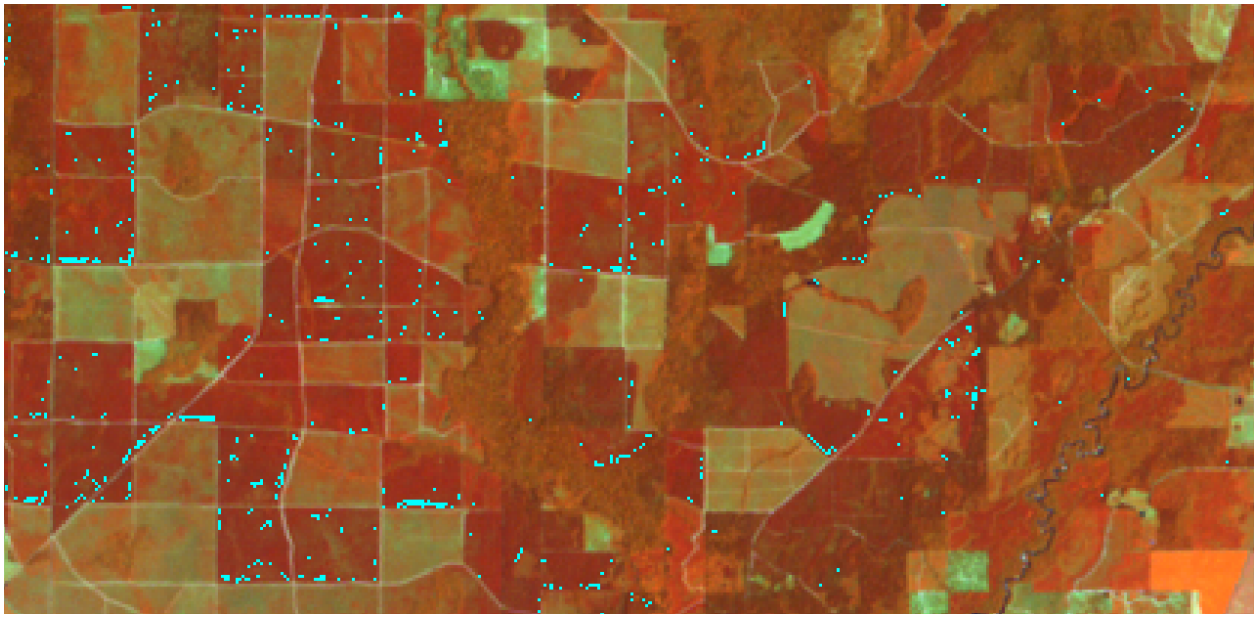
Red soils are unique to the Southern Laguna Madre region. They are bright, almost neon, red fields and are often erroneously classified as habitat due to specific soil properties. Wet vegetated areas that appear red-ish are often classified as habitat in other IA's, especially the Chenier Plains. These fields are habitat. The only time you should remove bright red fields is in the Laguna Madre IA.



Upland Forests

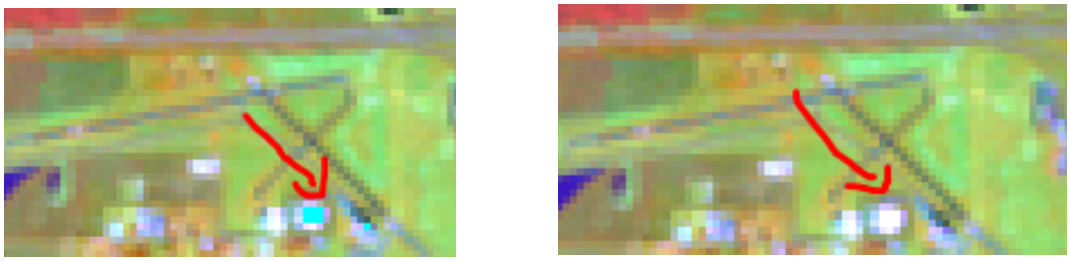


Upland forests appear as red, red-brown, or red with green patches. Unlike red fields, which appear flat, these patches will be textured. A close view of the texture you can expect from forest patches is visible in the top image. The bottom image is an overview of a large section of upland forest and some erroneous habitat (cyan).



Upland forest is most common in the Northern Chenier Plains IAs. It is also found in the Northern areas of other IAs such as TMC and CMA. Look out for very small patches of forest in mid to southern Chenier Plain regions.

Urban Areas



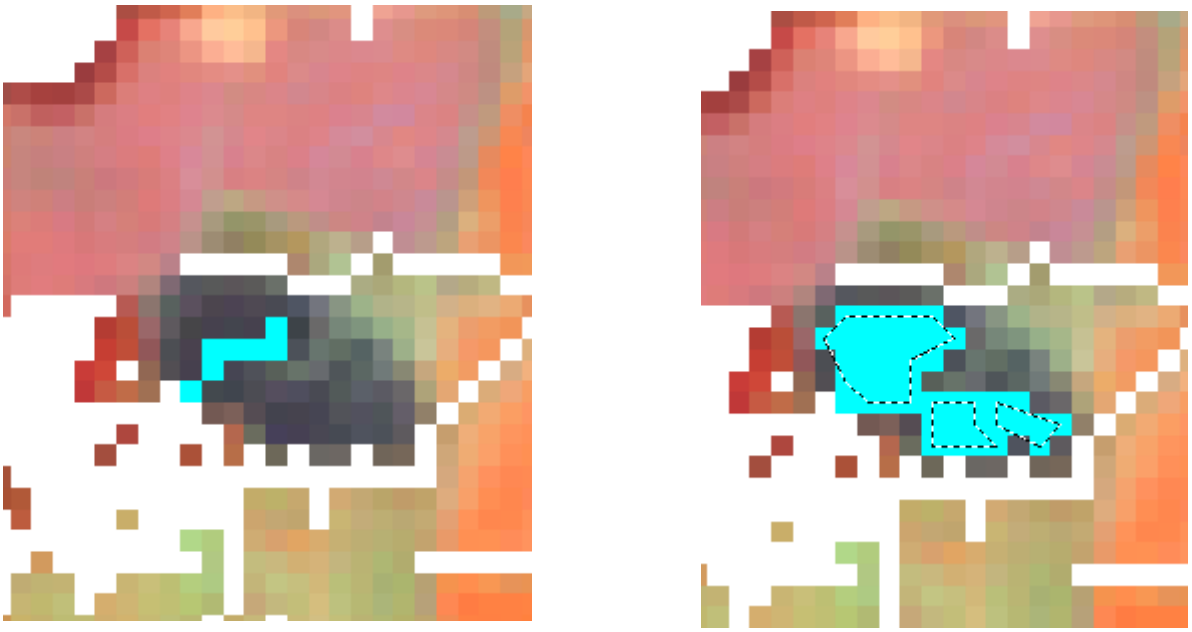
Urban areas are often erroneously classified as habitat. Buildings and other urban areas appear bright white or dark grey. They will have straight boundary lines. Above is an example of a building at an airport that was erroneously classified as habitat (left) and recoded to be not-habitat (right).

Streets, as pictured in the top of the above images, are also often erroneously classified as habitat. These are usually light grey in color, are very straight, and often have right angles where they intersect with other roads. Habitat in a thin (one pixel wide), straight line is often a road or man-made water body that has erroneously been classified as habitat.

Adding in habitat

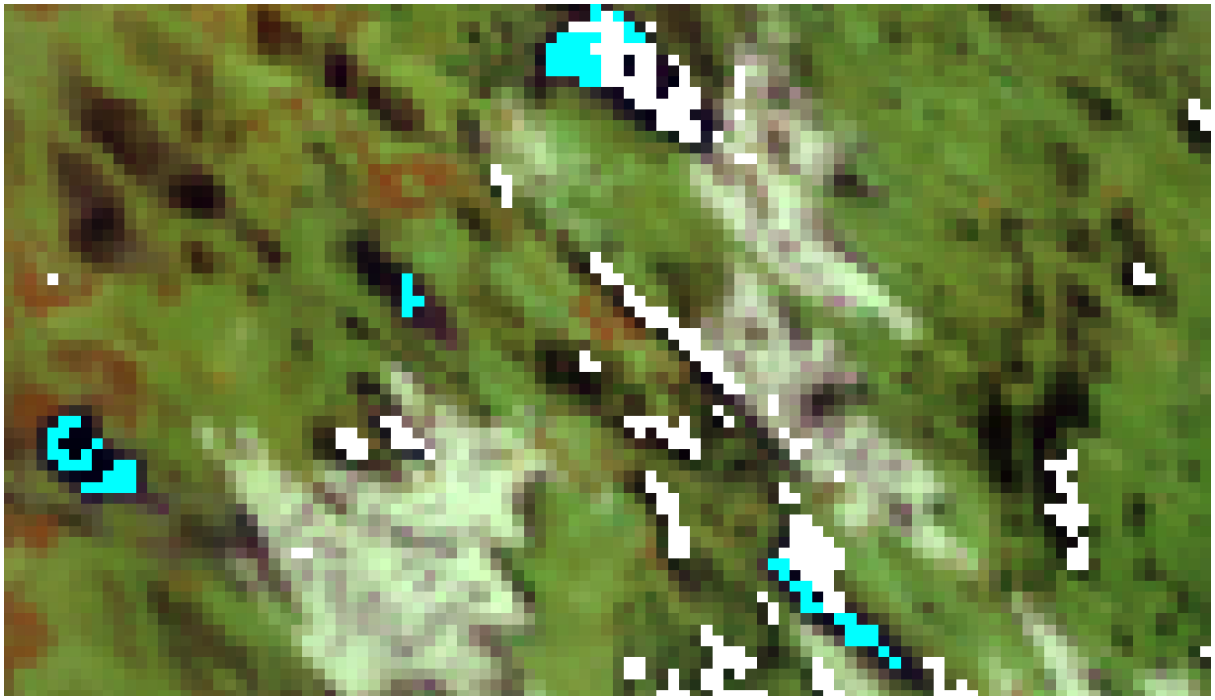
Very few cases require manually adding habitat.

A haze over the habitat



Sometimes a haze or cloud will cause habitat to be mis classified as non-habitat. It is important to recode these areas as habitat. An example of haze over habitat is seen above. Notice that the dark purple area of habitat is muted by the haze and only some was classified as habitat (top left). In the top right image, the error has been corrected.

Laguna Madre



Often hurricane ponds in the Laguna Madre IA will be erroneously classified as non-habitat. In the above image, the dark purple areas should be classified as habitat. It is important to recode these pixels to be classified as habitat.

Note: There is a model for classifying waterfowl habitat named "waterfowl_classification_laguna.gmd". This model can be used to classify habitat in Laguna Madre in wet seasons to cut back on the amount of habitat you need to "add in". This model will classify a lot more clouds and cloud shadow than the original waterfowl classification. For this reason, it is not recommended you use this model for cloudy periods. The Laguna waterfowl classification model will also classify dryer/redder areas as habitat and this will need to be corrected. Using this model during dry periods is not recommended because it may increase the amount of editing necessary.

Appendix 1.C.: Julian Date Calendar

JULIAN DATE CALENDAR

PERPETUAL

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Day
1	001	032	060	091	121	152	182	213	244	274	305	335	1
2	002	033	061	092	122	153	183	214	245	275	306	336	2
3	003	034	062	093	123	154	184	215	246	276	307	337	3
4	004	035	063	094	124	155	185	216	247	277	308	338	4
5	005	036	064	095	125	156	186	217	248	278	309	339	5
6	006	037	065	096	126	157	187	218	249	279	310	340	6
7	007	038	066	097	127	158	188	219	250	280	311	341	7
8	008	039	067	098	128	159	189	220	251	281	312	342	8
9	009	040	068	099	129	160	190	221	252	282	313	343	9
10	010	041	069	100	130	161	191	222	253	283	314	344	10
11	011	042	070	101	131	162	192	223	254	284	315	345	11
12	012	043	071	102	132	163	193	224	255	285	316	346	12
13	013	044	072	103	133	164	194	225	256	286	317	347	13
14	014	045	073	104	134	165	195	226	257	287	318	348	14
15	015	046	074	105	135	166	196	227	258	288	319	349	15
16	016	047	075	106	136	167	197	228	259	289	320	350	16
17	017	048	076	107	137	168	198	229	260	290	321	351	17
18	018	049	077	108	138	169	199	230	261	291	322	352	18
19	019	050	078	109	139	170	200	231	262	292	323	353	19
20	020	051	079	110	140	171	201	232	263	293	324	354	20
21	021	052	080	111	141	172	202	233	264	294	325	355	21
22	022	053	081	112	142	173	203	234	265	295	326	356	22
23	023	054	082	113	143	174	204	235	266	296	327	357	23
24	024	055	083	114	144	175	205	236	267	297	328	358	24
25	025	056	084	115	145	176	206	237	268	298	329	359	25
26	026	057	085	116	146	177	207	238	269	299	330	360	26
27	027	058	086	117	147	178	208	239	270	300	331	361	27
28	028	059	087	118	148	179	209	240	271	301	332	362	28
29	029		088	119	149	180	210	241	272	302	333	363	29
30	030		089	120	150	181	211	242	273	303	334	364	30
31	031		090		151		212	243		304		365	31

JULIAN DATE CALENDAR

FOR LEAP YEARS ONLY

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Day
1	001	032	061	092	122	153	183	214	245	275	306	336	1
2	002	033	062	093	123	154	184	215	246	276	307	337	2
3	003	034	063	094	124	155	185	216	247	277	308	338	3
4	004	035	064	095	125	156	186	217	248	278	309	339	4
5	005	036	065	096	126	157	187	218	249	279	310	340	5
6	006	037	066	097	127	158	188	219	250	280	311	341	6
7	007	038	067	098	128	159	189	220	251	281	312	342	7
8	008	039	068	099	129	160	190	221	252	282	313	343	8
9	009	040	069	100	130	161	191	222	253	283	314	344	9
10	010	041	070	101	131	162	192	223	254	284	315	345	10
11	011	042	071	102	132	163	193	224	255	285	316	346	11
12	012	043	072	103	133	164	194	225	256	286	317	347	12
13	013	044	073	104	134	165	195	226	257	287	318	348	13
14	014	045	074	105	135	166	196	227	258	288	319	349	14
15	015	046	075	106	136	167	197	228	259	289	320	350	15
16	016	047	076	107	137	168	198	229	260	290	321	351	16
17	017	048	077	108	138	169	199	230	261	291	322	352	17
18	018	049	078	109	139	170	200	231	262	292	323	353	18
19	019	050	079	110	140	171	201	232	263	293	324	354	19
20	020	051	080	111	141	172	202	233	264	294	325	355	20
21	021	052	081	112	142	173	203	234	265	295	326	356	21
22	022	053	082	113	143	174	204	235	266	296	327	357	22
23	023	054	083	114	144	175	205	236	267	297	328	358	23
24	024	055	084	115	145	176	206	237	268	298	329	359	24
25	025	056	085	116	146	177	207	238	269	299	330	360	25
26	026	057	086	117	147	178	208	239	270	300	331	361	26
27	027	058	087	118	148	179	209	240	271	301	332	362	27
28	028	059	088	119	149	180	210	241	272	302	333	363	28
29	029	060	089	120	150	181	211	242	273	303	334	364	29
30	030		090	121	151	182	212	243	274	304	335	365	30
31	031		091		152		213	244		305		366	31

USE IN 2004, 2008, 2012, 2016, 2020, 2024, ETC.