GIS Mapping for the Sandhill Crane Recovery Strategy

I. Objectives

The Geographic Information Systems (GIS) objectives were threefold: (1) mapping Greater Sandhill Crane breeding and wintering distribution within California; (2) to overlay distribution maps with land ownership; and (3) to overlay distribution maps with landuse.

II. Methods and Data Sources

(1) Mapping Breeding and Wintering Distribution

Greater Sandhill Crane survey data (Ivey and Herziger 2001) were used to create the breeding distribution maps. Ivey also marked locations of territorial crane pairs and areas of potential breeding habitat on 1:100,000 scale Bureau of Land Management surface maps. These maps were digitized using a digitizing table to bring them from paper to electronic format. Subsequent work with the data was performed using UNIX and PC based Arc/Info and ArcView GIS. All coverages (data layers) were projected to Albers California Projection, which has the following specifications:

- Projection: Albers
- Units: meters
- Datum: NAD27
- 1st Standard Parallel: 34 00 00
- 2nd Standard Parallel: 40 30 00
- Central Meridian: -120 00 00
- Latitude of Origin: 0.0
- X-shift (false eastings): 0.0
- Y-shift (false northings): -400000

The positional error associated with projecting averaged 20 meters, the maximum being 35 meters.

Wintering distribution was mapped in a similar manner. Wintering distribution data came to Ivey from a variety of sources, including Littlefield (1993), California Department of Fish and Game and National Wildlife Refuge employees, and Audubon Society members. Ivey also identified “core” wintering habitat, mostly under private ownership, which is at risk of land conversion to incompatible crops (orchards and vineyards) due to the soil types.

Salton Sea National Wildlife Refuge (2000, unpubl. data) provided GPS coordinates for two crane roost locations and seven feeding sites in the Colorado River Basin. The GPS coordinates were imported directly into ArcView for processing.

(2) Overlaying distribution with land ownership

The land ownership coverage was obtained from the Gap Analysis of Mainland California (GAP 1995). The coverage represents land ownership as of the early 1990’s, and has a resolution of 1:100,000. More information about this coverage can be obtained by accessing the California GAP website at http://www.biogeog.ucsb.edu/projects/gap/gap_home.html. Since more current and accurate data were
available from Gary Ivey and Paul Hoffman (pers. comm. and unpubl. data), the GAP ownership coverage was used only for display purposes in the breeding areas.

(3) Overlaying distribution with landuse

Two different landuse datasets were used: National Land Cover Data (NLCD 1999) for the breeding areas, and Department of Water Resources (DWR) for the wintering areas.

The NLCD coverage was a 30 x 30 m resolution grid represented a mosaic of two seasonally distinct sets of data (summer, and spring/fall) collected in 1992. Landuse types were broken into 21 categories. Landuse types were then regrouped to more appropriately represent crane habitat, resulting in 14 categories. Appendix A lists all 21 landuse categories, with notes as to how the categories were grouped.

The DWR coverages were 1:24,000 scale, and included a wide variety of agricultural landuse classifications (see Appendix B for the landuse classifications). Since counties were surveyed in different years, each county coverage represented landuse for one year between 1993 and 1997. Again, landuse types were grouped to more appropriately represent crane habitat. Based on a discussion with recovery team members, landuse categories were further grouped to obtain maps of suitable habitat within crane wintering habitat in the Central Valley. Appendix C shows how the landuse categories were reclassified for the landuse and suitability maps. Since these coverages represented landuse during only one year, they were considered not to be an accurate picture of landuse over time. This being the case, DWR coverages were used to produce statistics for general landuse patterns across the wintering range, and for maps of core wintering areas.

III. Results

For congruency, results are grouped by breeding, wintering, and Lower Colorado River populations.

(1) Breeding Population

Figures 1 and 2 show the distribution of territorial pairs and potential breeding areas. The breeding distribution spans six counties: Siskiyou, Modoc, Shasta, Lassen, Plumas, and Sierra. As shown in Table 1, the majority of the 1,120 km² of potential breeding habitat is located in, Modoc (41%), Siskiyou (27%), and Lassen (22%) counties. The distribution of the 465 territorial pairs surveyed in the year 2000 (Ivey and Herziger 2001) was, in pairs: Modoc County (251), Lassen County (123), Siskiyou County (51), Plumas County (20), Shasta County (10), and Sierra County (10).

The majority of Greater Sandhill Crane potential breeding habitat is owned privately (71%), with lesser amounts managed by federal (~22%) and state (7.5%) agencies, as well as by Native Americans (<1%) (Figure 3). Figure 4 shows the distribution potential suitable crane breeding habitat in relation to land ownership in northeastern California. [Information needed from Gary Ivey: land ownership for territorial crane pairs.]

Figure 5 shows the overall pattern of landuse within Greater Sandhill Crane potential breeding habitat in California. As shown in Table 2, the 1,120km² of potential breeding areas encompass mostly pasture / hay (32.1%), grasslands / herbaceous (17.5%), emergent herbaceous wetland (17.2%), and scrubland (15.7%).
(2) Wintering Central Valley Population

Figures 6 and 7 show the current range of Greater Sandhill Crane wintering habitat and roosting areas within the Central Valley. [Needed from Paul Hoffman: land ownership of wintering areas (Table 3)—MINGHUA—PLEASE GET FROM PAUL FOR YOUR REVISION]. Close-up views of these areas are shown in the subsequent figures: Sacramento Valley (Fig. 8), Sacramento-San Joaquin Delta region (Fig. 9), Grasslands Region (Fig. 10), and San Joaquin River and Pixley National Wildlife Refuges (Fig. 11). As shown in Table 4, Central Valley roosting areas and wintering habitat are located within 11 counties: Butte, Colusa, Contra Costa, Glenn, Merced, Sacramento, San Joaquin, Solano, Stanislaus, Sutter, and Tulare. The majority of the 3,364km$^2$ of wintering habitat is found within Butte (21%), Merced (20%), Sacramento (18%), San Joaquin (14%), and Glenn (10%) counties. The majority of the 21 roosting areas are located within Butte (29%), San Joaquin (24%), Colusa (10%), and Sacramento (10%) counties.

Table 5 shows the DWR landuse statistics for the entire wintering range. The majority of the 3,364km$^2$ of wintering habitat is composed of rice crops (21.7%), native vegetation (19.1%), corn crops (10.5%), and miscellaneous field crops (9.1%). There are 335km$^2$ of core wintering range located within the Sacramento Valley and the Sacramento-San Joaquin Delta Region. Landuse within core wintering habitat in the Sacramento Valley is shown in Figure 12. Landuse within core wintering habitat in the Sacramento-San Joaquin Delta Region is shown in Figure 13. Areas of suitable habitat within the wintering range are shown in the subsequent figures: Sacramento Valley (Fig. 14), Sacramento-San Joaquin Delta Region (Fig. 15), Grasslands Region (Fig. 16), and San Joaquin River and Pixley National Wildlife Refuges (Fig. 17). These figures show that nearly all land within the wintering range is suitable.

(3) Lower Colorado River Population

Figures 18 and 19 show the distribution of two roosting and seven feeding areas in the Salton Sea area of Imperial County, within the Lower Colorado River Basin. The majority of the 981km$^2$ of land within five miles of roosting and feeding areas is used for alfalfa (25.2%), grains (13.3%), vegetable crops (12.7%), and field crops (10.9%).

In the Salton Sea area, one roosting area is located on Fish & Wildlife Service land, while the other is on private land. Approximately 90% of the 981km$^2$ of land within five miles of roosting and feeding areas is private.

IV. References

California GAP Analysis website: http://www.biogeog.ucsb.edu/projects/gap/gap_home.html

California Department of Water Resources (DWR) landuse categories and their details: http://amargosa.water.ca.gov/dopout/landuse/legend

Ivey, G. and Herziger, C. 2001. Title???
Appendix A: National Land Cover Data (30 x 30 m resolution) Legend

Landuse Categories, with landuse code number and landuse type:

Water
  11 Open Water
  12 Perennial Ice/Snow

Developed
  21 Low Intensity Residential
  22 High Intensity Residential
  23 High Intensity Commercial/Industrial/Transportation
  ** All residential areas were grouped and labeled “urban.”

Barren
  31 Bare Rock/Sand/Clay
  32 Quarries/Strip Mines/Gravel Pits (**grouped with orchards and vineyards)
  33 Transitional

Natural Forested Upland (non-wet)
  41 Deciduous Forest
  42 Evergreen Forest
  43 Mixed Forest
  ** All forest types were grouped and labeled “forest.”

Natural Shrubland
  51 Deciduous Shrubland
  52 Evergreen Shrubland
  53 Mixed Shrubland
  ** All shrubland types were grouped and labeled “shrubland.”

Non-Natural Woody
  61 Planted/Cultivated (orchards, vineyards, groves)
  ** Labeled “orchards, vineyards, industrial.”

Herbaceous Upland Natural/Semi-Natural Vegetation
  71 Grassland/Herbaceous

Herbaceous Planted/Cultivated
  81 Pasture/Hay
  82 Row Crops
  83 Small Grains
  84 Bare Soil (none existing within the study area)
  85 Other Grasses (urban/recreational; e.g. parks, lawns, golf courses) (** grouped with urban areas.)

Wetlands
  91 Woody Wetlands
  92 Emergent Herbaceous Wetlands
Appendix B: California Department of Water Resources Landuse Legends

II. AGRICULTURAL CLASSES

The vast majority of crops grown in California are irrigated. Unless preceded with an "n" if it is non-irrigated, all agricultural classes are considered irrigated. (This statement is for the agricultural classes and does not apply to the other non-agricultural classes of semi-agricultural, urban, or native.)

G - GRAIN AND HAY CROPS

1. Barley
2. Wheat
3. Oats
4. Miscellaneous and mixed grain and hay

R - RICE

F - FIELD CROPS – reclassified as Corn and Miscellaneous Field Crops (all others)

1. Cotton
2. Safflower
3. Flax
4. Hops
5. Sugar beets
6. Corn (field & sweet)
7. Grain sorghum
8. Sudan
9. Castor beans
10. Beans (dry)
11. Miscellaneous field
12. Sunflowers

P - PASTURE – reclassified as Alfalfa and Miscellaneous Pasture (all others)

1. Alfalfa & alfalfa mixtures
2. Clover
3. Mixed pasture
4. Native Pasture
5. Induced high water table
6. Misc. grasses (normally grown for seed)
7. Turf farms
T - TRUCK, NURSERY AND BERRY CROPS

1. Artichokes
2. Asparagus
3. Beans (green)
4. Cole crops (when further breakdown is not needed)
6. Carrots
7. Celery
8. Lettuce (all types)
9. Melons, squash, and cucumbers (all types)
10. Onions and garlic
11. Peas
12. Potatoes
13. Sweet Potatoes
14. Spinach
15. Tomatoes
16. Flowers, nursery & Christmas tree farms
17. Mixed (four or more)
18. Miscellaneous truck crops
20. Strawberries
21. Peppers (chili, bell, etc.)
22. Broccoli
23. Cabbage
24. Cauliflower
25. Brussels sprouts

D - DECIDUOUS FRUITS AND NUTS

1. Apples
2. Apricots
3. Cherries
4. Peaches and nectarines
5. Pears
6. Plums
7. Prunes
8. Figs
9. Miscellaneous deciduous
10. Almonds
11. Walnuts
12. Pistachios

C - CITRUS AND SUBTROPICAL

1. Grapefruit
2. Lemons
3. Oranges
4. Dates
5. Avocados
6. Olives
7. Miscellaneous subtropical fruits
8. Kiwis
9. Jojoba
10. Eucalyptus

V - VINEYARDS

1. Table grapes
2. Wine grapes
3. Raisin grapes

I - IDLE

(Preceded with "n" in non-irrigated area, and must include subclass)
1. Land not cropped the current or previous crop season, but cropped within the past three years.
2. New lands being prepared for crop production.
III. SEMIAGRICULTURAL CLASS
   (Not preceded with "n")

S - SEMIAGRICULTURAL & INCIDENTAL TO AGRICULTURE
   (Must include subclass)

1. Farmsteads
2. Livestock feed lots
3. Dairies
4. Poultry farms

IV. URBAN CLASSES
   (Not preceded with "n")

U - URBAN
   Residential, commercial, and industrial (may be used alone when further breakdown is not required)

UR - RESIDENTIAL
   Single and multiple family units, including trailer courts (may be used alone when further breakdown is not required)

1. Single family dwellings with lot sizes greater than 1 acre up to 5 acres (ranchettes, etc.)
2. Single family dwellings with a density of 1 unit/acre up to 8+ units/acre.
3. Multiple family (apartments, condos, townhouses, barracks, bungalows, duplexes, etc.)
4. Trailer courts

WATER USE FACTOR (% of total area irrigated - will be the second digit of UR Subclass when water factor is used)

1. 0% to 25% area irrigated
2. 26% to 50% area irrigated
3. 51% to 75% area irrigated
4. 76% or greater

Example: UR32 indicates multiple family with water use factor of 26% to 50% of area irrigated.

UC - COMMERCIAL
   (May be used alone when further breakdown is not required)

1. Offices, retailers, etc.
2. Hotels
3. Motels
4. Recreation vehicle parking, camp sites
5. Institutions (hospitals, prisons, reformatories, asylums, etc., having a reasonably constant 24-hour resident population)
6. Schools (yards to be mapped separately if large enough)
7. Municipal auditoriums, theaters, churches, buildings and stands associated with race tracks, football stadiums, baseball parks, rodeo arenas, amusement parks, etc.
8. Miscellaneous high water use (to be used to indicate a high water use condition not covered by the above categories.)

UI - INDUSTRIAL
(May be used alone when further breakdown is not required)

1. Manufacturing, assembling, and general processing
2. Extractive industries (oil fields, rock quarries, gravel pits, rock and gravel processing plants, etc.)
3. Storage and distribution (warehouses, substations, railroad marshalling yards, tank farms, etc.)
6. Saw mills
7. Oil refineries
8. Paper mills
9. Meat packing plants
10. Steel and aluminum mills
11. Fruit and vegetable canneries and general food processing
12. Miscellaneous high water use (to be used to indicate a high water use condition not covered by other categories.)
13. Sewage treatment plant including ponds.
14. Waste accumulation sites (public dumps, sewage sludge sites, landfill and hazardous waste sites, etc.)
15. Wind farms, solar collector farms, etc.

UL - URBAN LANDSCAPE
(May be used alone when further breakdown is not required)

1. Lawn area - irrigated
2. Golf course - irrigated
3. Ornamental landscape (excluding lawns) - irrigated
4. Cemeteries - irrigated
5. Cemeteries - not irrigated

UV - VACANT
(May be used alone when further breakdown is not required)

1. Unpaved areas (vacant lots, graveled surfaces, play yards, developable open lands within urban areas, etc.)
3. Railroad right of way.
4. Paved areas (parking lots, paved roads, oiled surfaces, flood control channels, tennis court areas, auto sales lots, etc.)
6. Airport runways

V. NATIVE CLASSES
(Not preceded with "n")
NC - NATIVE CLASSES UNSEGREGATED
(May be used alone when further breakdown is not required)

NV - NATIVE VEGETATION
(May be used alone when further breakdown is not required)

1. Grass land
2. Light brush
3. Medium brush
4. Heavy brush
5. Brush and timber
6. Forest
7. Oak grass land

NR - RIPARIAN VEGETATION
(May be used alone when further breakdown is not required)

1. Marsh lands, tules and sedges
2. Natural high water table meadow
3. Trees, shrubs or other larger stream side or watercourse vegetation
4. Seasonal duck marsh, dry or only partially wet during summer
5. Permanent duck marsh, flooded during summer

NW - WATER SURFACE
Lakes, reservoirs, rivers, canals, etc.

NB - BARREN AND WASTELAND
(May be used alone when further breakdown is not required)

1. Dry stream channels
2. Mine Tailing
3. Barren land
4. Salt flats
5. Sand dunes
## Appendix C: Crane Landuse and Suitability Legends based on California Department of Water Resources Landuse Classifications

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