# Arundo Mapping and Eradication in the Sacramento / San Joaquin Delta

Arundo Control and Restoration Program

- Funding provided by:
    - California Department of Water Resources
    - Sacramento/San Joaquin Delta Conservancy
- Phase 1:
    - Map all Arundo within the Legal Delta
    - Develop an eradication prioritization
   - Work in partnership with Solano RCD on a focused eradication and revegetation project in Cache Slough Complex

Sacramento / San Joaquin Delta

Sacramento-San Joaquin Delta
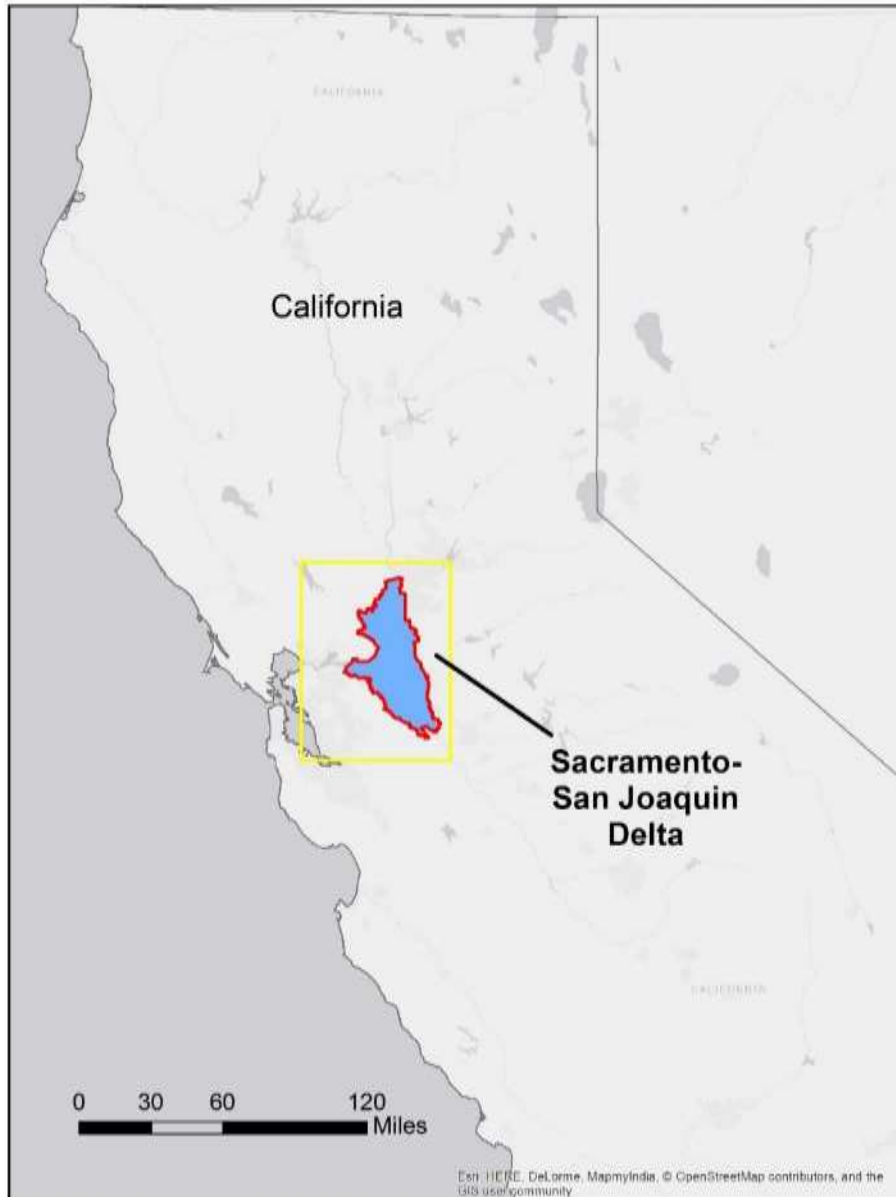
- 119,269 acres
- +/- 1,100 miles of waterways
- +/- 1,300 acres of riparian (50ft buffer)
- Miles and miles of levees
- Many private access roads

Imagery Analysis GIS Digital Mapping

- GIS Digitizing from Aerial Imagery
  - Multiple, free, hi-res imagery sources
  - Dual Monitors (side-by-side comparison)
  - ArcGIS and Google Earth
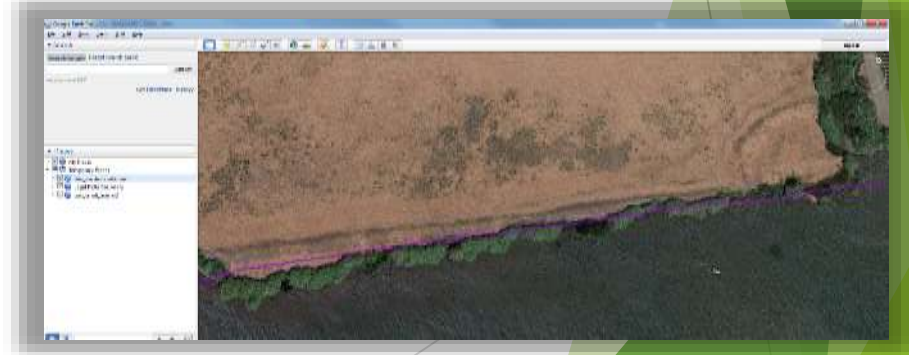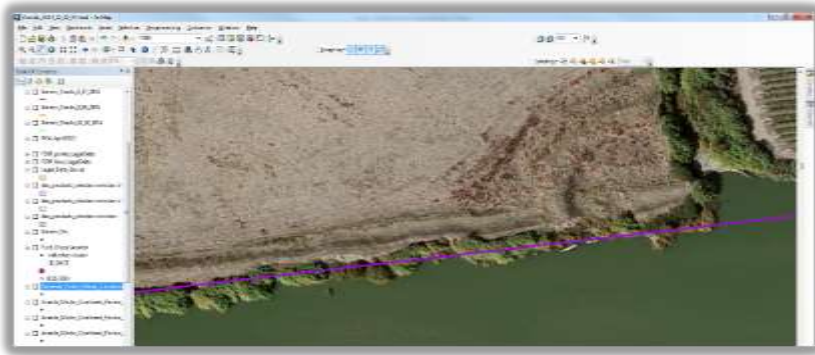
Aerial Imagery Sources:

Primary Source:

► ## ESRI World Base-map

- ► Esri online, accessed through ArcGIS Desktop
- ► 0.3m (or better) resolution throughout the continental United States
- ► Imagery dates for area of interest = 11/2011 and 2/2012

Secondary Sources:

► ## Google Earth

- ► High Res Imagery
- ► Multi-Year Imagery Slider
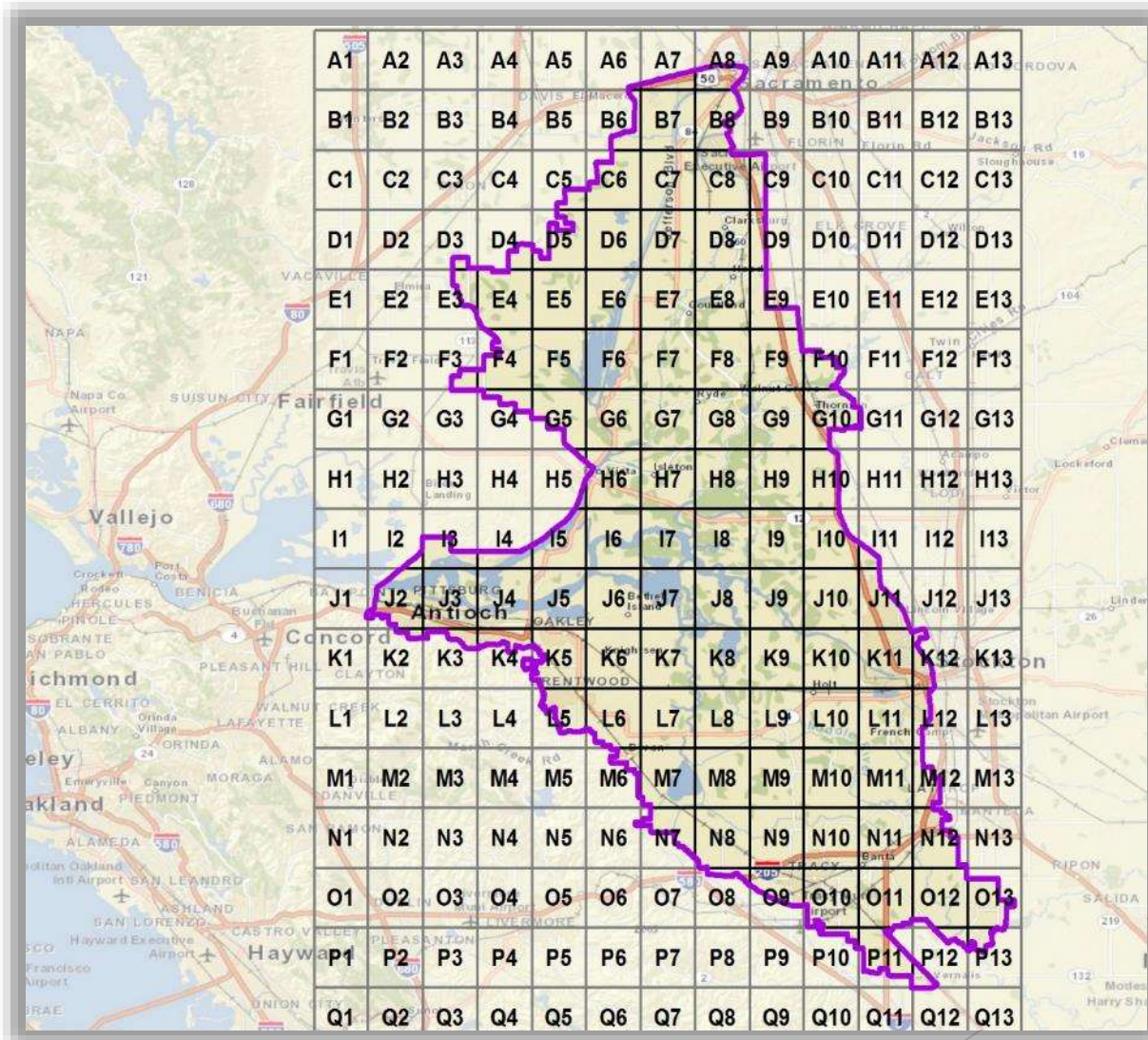- ► Can upload index grid and mapping extent GIS Feature Classes (KML)

► ## Bing Maps

- ► High Res Imagery
- ► "Bird's Eye" extra high res available in some locations

► ## Google Maps Street View

- ► High Res Imagery
- ► Multiple angles
- ► Can verify anything in view of main roads

USGS DOQQ Index Grid
used to help organize the mapping task

Initial Mapping

▶ SEC created a point style feature class in an ArcGIS geodatabase (GDB) with key attribute fields developed in previous mapping efforts.

▶ Arundo was identified from the aerial imagery at a scale of 1:1000 or better and digitized on screen with attributes noted.

▶ Multiple points per infestation were recorded with a cluster tolerance of approximately 30ft.

Attributes Captured

- Observation Date (Imagery date)
- Confidence Rating
- Length / Width
- DOQQ Number
- Identifier
- ID Date
- Notes
- Scale

Field Mapping and Ground Truthing

- Windshield Survey where road access is available
- By Boat where access is limited
- Tablet computer with streaming imagery and data points
- Mapistry field mapping software
- Google Earth streaming data

Points to Polygons:

- ► To ensure compatibility with other state-wide mapping efforts, carefully checked and verified points were converted to polygons.

- ► The ArcMap freehand digitizing tool was used to create polygons around mapped points and attributes were cross-walked to match California Invasive Plant Council (CalIPC) attribute fields.

- ► Total infestation area was then calculated based on the polygon area and percent cover.

- ► Conversion to polygons had the added advantage of giving the analyst one more pass at data quality assurance.

Mapping Results

▶ A total of 2073 infestation polygons were digitized, with a size range of .0002 – 1.94 acres in size, for a total of 98.3 acres.

▶ The highest concentrations are in the Cache Slough Complex and near the Western Delta boundary along the Montezuma Hills.

▶ The total number of Arundo acres is relatively small given the total acreage of the Delta. However, Arundo has a high density in very long narrow riparian corridors on many of the Delta waterways.

Mapped Arundo donax
in the Sacramento-San Joaquin Legal Delta
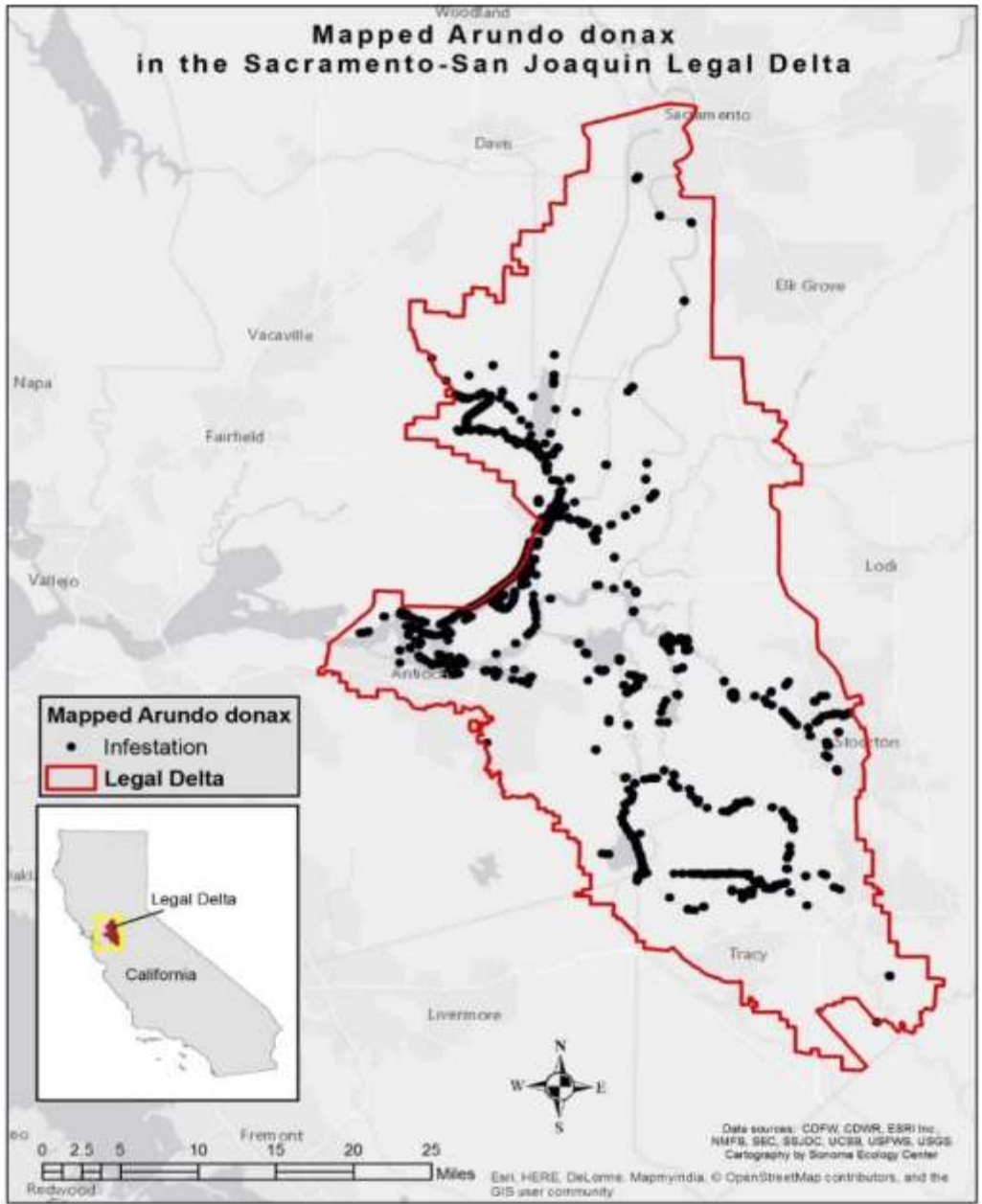
Habitat Valuation

▶ Index-based Multi-species Conservation Value (IMCV) analysis (Root, et al (2003, A multispecies approach to ecological valuation and conservation. *Conservation Biology, 17*(1), 196-206)).

▶ Assign a habitat value to the vegetation surrounding the Arundo infestation for specific species.

▶ Stack multiple species habitat rankings for the same location in GIS

▶ Calculate total value of habitat for the greatest number of species at each location

▶ Target areas with the highest value to the greatest number of species for Arundo removal

Amphibian

Fish

Bird

Reptile

Mammal

Plant
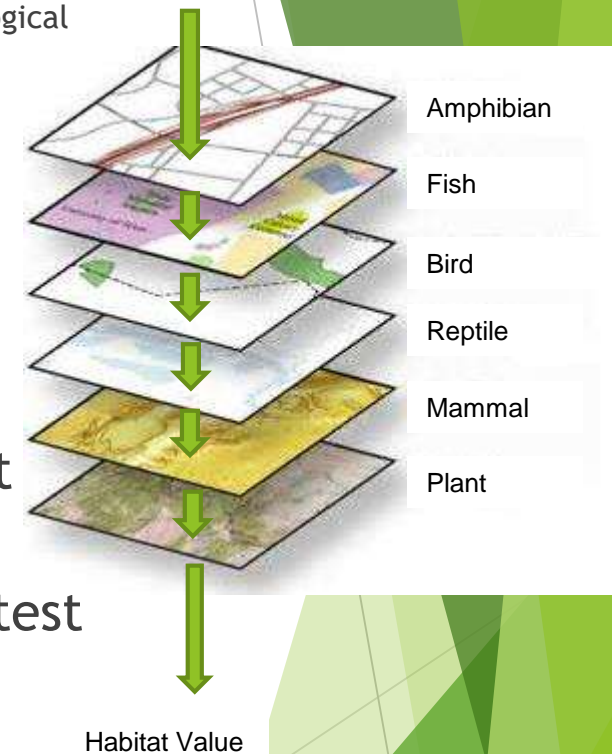
Habitat Value

Habitat Valuation Methodology

- Objective: Use the value of threatened habitat as basis for recommending eradication priorities

- Method combines maps of habitat suitability for selected species into single GIS layer of an index based multispecies conservation value (IMCV)

- For each species, habitat suitability is weighted with endangerment indices (extinction threat risk). This results in greater habitat value being assigned to species at risk.

IMCV Formula

$$iMCV_j = \frac{\sum_{i=1}^{n} (S_{ij} \times E_i)}{\sum_{i=1}^{n} E_i},$$

where n is the number of species,
S$_{ij}$ is the habitat suitability for species *i* at location *j*,
and *E$_i$* is the endangerment index value for species *i*

Index Species

- 23 Delta-specific riparian species, (7 taxa)
  - Amphibian
  - Bird
  - Fish
  - Mammal
  - Reptile
  - Insect
  - Plant
- Habitat suitability data for terrestrial species obtained from CDFW VEGCamp
- Habitat suitability data for fish obtained from NOAA NMFS Salmonid Critical Habitat
- Endangerment indices data obtained from federal and state threat listings

Delta Specific Riparian Species Selected

Table 1. Delta Arundo Prioritization Species				
Species Code	**Common Name**	**Scientific Name**	**Taxon**	**Listing Status**
ONMY	Cal. Central Valley Steelhead DPS	*Oncorhynchus mykiss*	Fish	FT
ONTS	Central Valley Winter Run Chinook ESU	*Oncorhynchus tshawytscha*		FE
ACME	North American Green Sturgeon, Southern DPS	*Acipenser medirostris*	Fish	FT
HYTR	Delta Smelt	*Hypomesus transpacificus*	Fish	FT & SE
HYRE	Pacific Tree Frog	*Hyla regilla*	Amphibian	
BAAT	California Slender Salamander	*Batrachoseps attenuatus*	Amphibian	
SCHA	Western Spadefoot	*Scaphiopus hammondi*	Amphibian	
BUBO	Western Toad	*Bufo boreas*	Amphibian	
CLMA	Western Pond Turtle	*Clemmys marmorata*	Reptile	
LAGE	Common Kingsnake	*Lampropeltis getulus*	Reptile	
THGI	Giant Garter Snake	*Thamnophis gigas*	Reptile	FT & ST
MEME	Song Sparrow	*Melospiza melodia*	Bird	
BUSW	Swainson's Hawk	*Buteo swainsoni*	Bird	ST
PACA	Blue Grosbeak	*Passerina caerulea*	Bird	
GACH	Common Moorhen	*Gallinula chloropus*	Bird	
MUVI	Mink	*Mustela vison*	Mammal	
LUCA	River Otter	*Lutra canadensis*	Mammal	
SYBARI	Riparian Brush Rabbit	*Sylvilagus bachmani riparius*	Mammal	FE & SE
DECA	Valley Elderberry Longhorn Beetle	*Desmocerus californicus dimorphus*	Insect	FT
HILA6	California Hibiscus	*Hibiscus lasiocarpus var. occidentalis*	Plant	
LIMA7	Mason's Lilaeopsis	*Lilaeopsis masonii*	Plant	SR
SYLE2	Suisun Aster	*Symphyotrichum lentum*	Plant	
LAJE	Delta Tule Pea	*Lathyrus jepsonii*	Plant	

Habitat Suitability Data Transformations

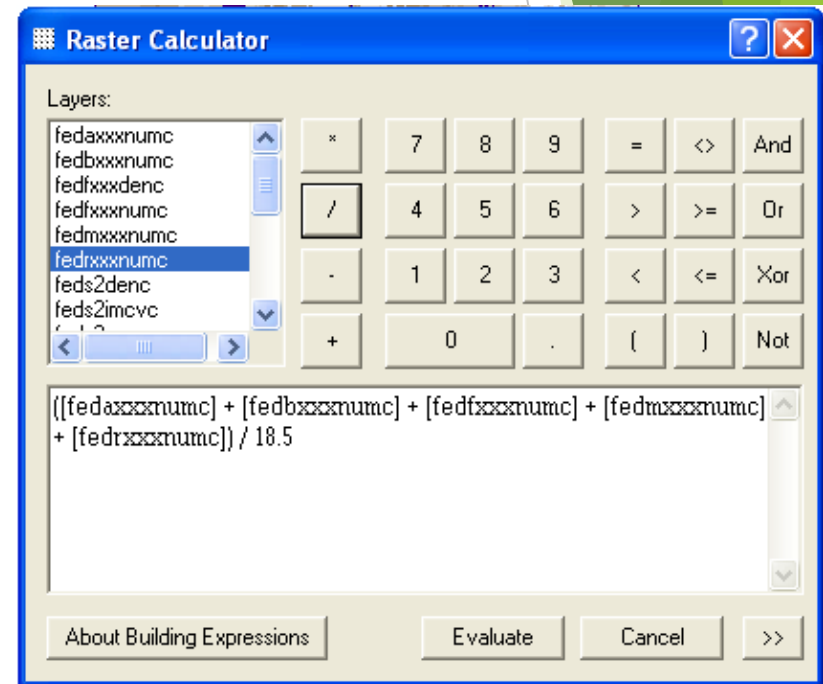| VEGCamp Data	
Habitat Criteria	Score
>50% of area is High Suitability	5
>50% of area is Medium or High Suitability	4
>50% of area is Low, Medium or High Suitability	3
50% < area of Low, Medium or High Suitability but >0%	2
Suitable Habitat in wetland/riparian habitats only (no areal estimate)	1
No suitable habitat	0

Conversion of Status Listing to Endangerment Index

Federal Listing Level	Federal Endangerment Index	State Listing Level	State Endangerment Index
Endangered	3	Endangered	3
Threatened	2	Threatened	2
		Special Concern	1.5
none	1	none	1

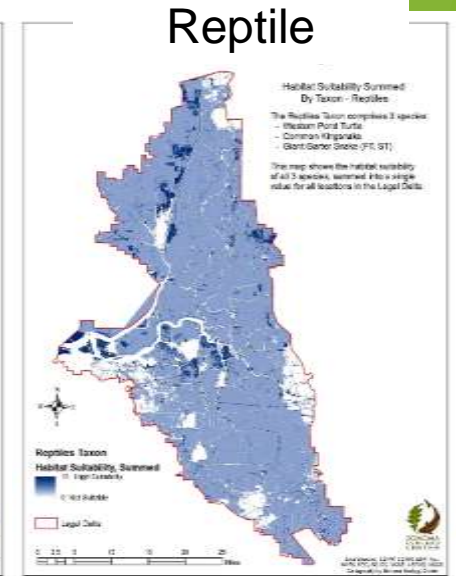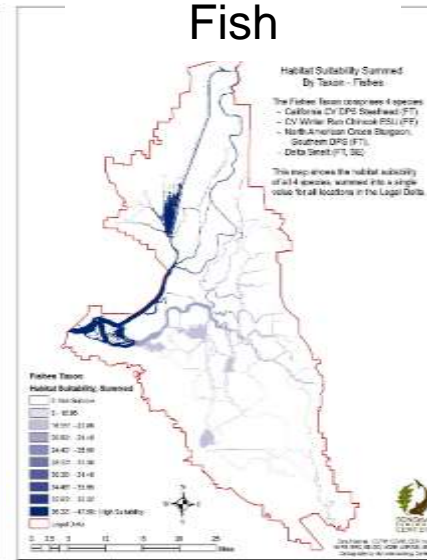| Derive CGAP compatible score from NMFS SPAWN/NATAL data		
SPAWN UTILIZATION NATAL UTILIZATION	+ SPAWN QUALITY + NATAL QUALITY	→ Spawn Habitat Score → Natal Habitat Score
Blank	blank	0
No	Not suitable	0
Probable, undocumented	Periodic, Poor	2
Probable, undocumented	Periodic, Fair	2
Probable, undocumented	Periodic, Good	3
Probable, undocumented	Consistent, Poor	2
Probable, undocumented	Consistent, Fair	3
Probable, undocumented	Consistent, Good	4
Yes	Periodic, Poor	2
Yes	Periodic, Fair	3
Yes	Periodic, Good	4
Yes	Consistent, Poor	3
Yes	Consistent, Fair	4
Yes	Consistent, good	5

Deriving IMCV in ArcMap

▶ Fish habitat suitability data transformed to match VEGCamp analysis format

▶ Habitat suitability data for each species weighted by its endangerment index and rasterized for ease of following calculations

▶ Fish habitat suitability data transformed to match other inputs (VEGCamp)

▶ Habitat suitability data for each species weighted by its endangerment index and rasterized for ease of following calculations

▶ In Raster calculator:
  ▶ Species rasters summed by taxon.
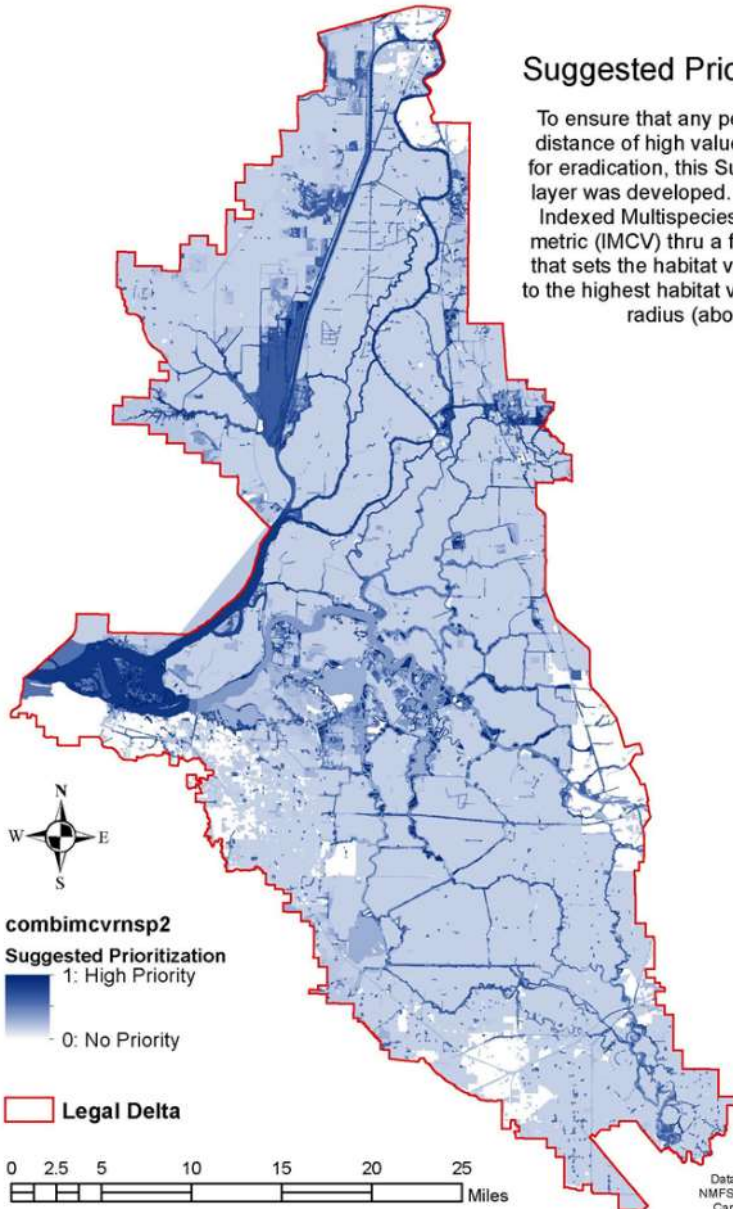 ▶ Taxon rasters then summed and the total divided by sum of endangerment indices.

Riparian Habitat Suitability by taxon and IMCV. Darker areas have higher habitat value.
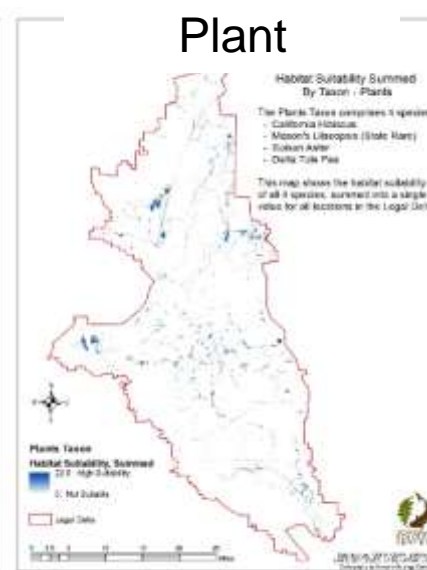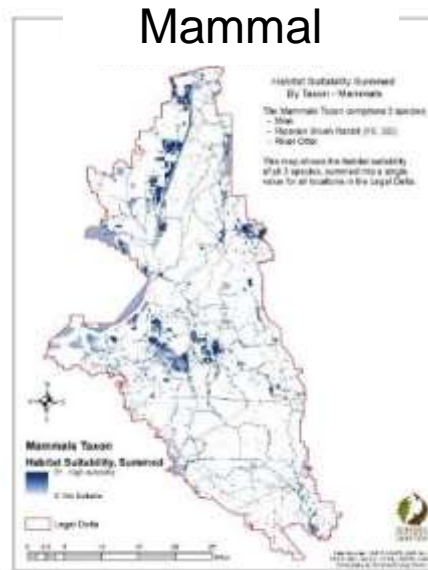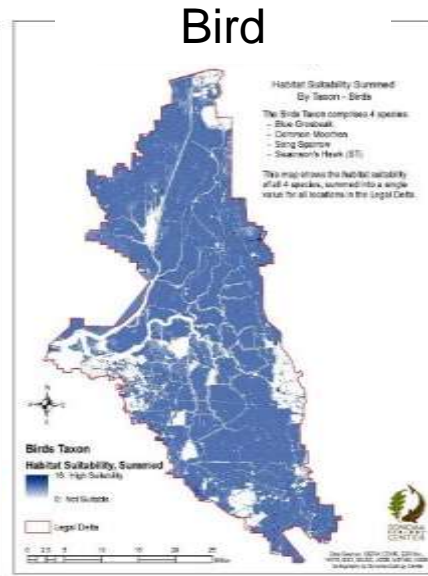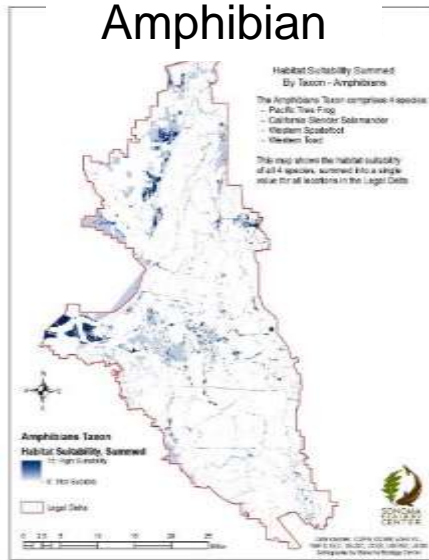
Combined IMCV

IMCV Habitat Values joined to Arundo Infestation points
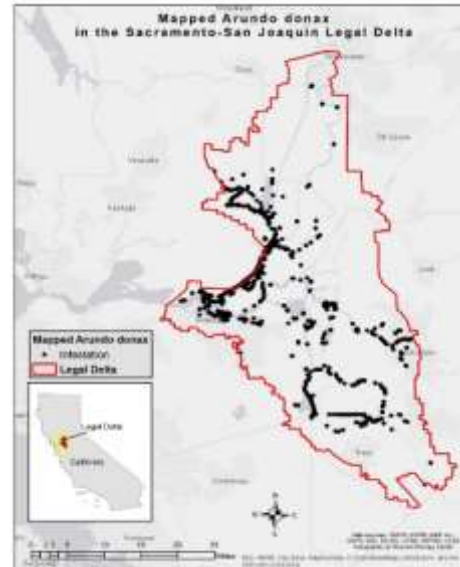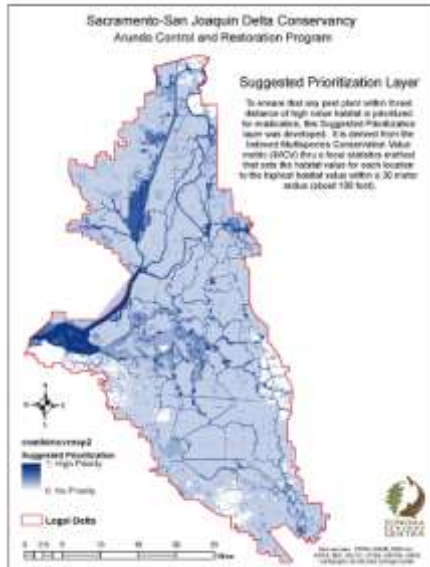
IMCV Ranked Arundo Infestations

Eradication Priority Use

▶ This habitat value based threat level is one of a number of factors necessary to derive priorities. Other necessary factors are:

- ▶ Known legal and permitting obstacles.

- ▶ Presence of other impairments that are likely to compromise restoration success.

- ▶ Presence of capable and willing local partners to perform actual eradication work.

- ▶ Permission to perform eradication work from private landowners or public land managers.

- ▶ Hazard potential caused by presence of Arundo, such as flooding and fire.

- ▶ Local expert opinion about Arundo infestation size and invasion rates, propagule sources, and stream dynamics.

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