# 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



- 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

A CARE		40	4.0		C.	4.0	47	40		0.40		12	142	
Stre Value	A1	AZ	AJ	A4	AS	Ab	AI	50	acra	m en	A11	AIZ	AIJ	RDOVA
St. Mal	B1	B2	<b>B</b> 3	B4	B5	<b>B6</b>	B7 .	BB	<b>B</b> 9	B10	B11	B12	B13	5
10	C1	C2	C3	C4	C5	C6		C8	C9	C10	C11	C12	C13	iousa 16
	D1	D2	D3	D4	p5	D6	D7	D8	D9	D10	D11	D12	D13	
121) VAC	E1	E2	ES	E4	E5	E6	E7 .		E9	E10	E11	E12	E13	104
Napa	F1.	F2	F3	74	F5	F6	F7	F8	F9	F-19	F11	F12	F13	18 miles
Napa Co. SUISUN CTLY Fai	r fiel G1	d G2	G3	G4	G5	G6	G7	G8	G9	G10	G11	G12	G13	
	H1	H2	H3	H4	H5	H6'	H7	H8	H9	H10	H11	H12	H13	Lock stord
Vallejo	11	12	-18	14	15	16	17	18	19	110	111	112	113	1
Rodeo BENICIA HERCULES BUNCIA	J1	J2	J3	R J4	<b>J</b> 5	J6	tra <b>J</b> 7	J8	J9	J10	UN	J12	J13	
SOBRANTE AN PABLO PLEASANT HIL	nco K1	K2	К3	K4	K5	K6"	° K7	K8	К9	K10	K11	K12	K13	on
CHINICITU EL CERRITO ALBANY VIIIgge LAFAYETTE	LI	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11 French	112	L13	on Malitan Airport
eley 24 ORINDA ALAMO Employeille Canyon MORAGA	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	
ALAMEDA SUT	N1	N2	N3	N4	N5	N6	NT	N8	N9	N10	N11	NT2	N13	A 27
Int Auport SAN LEANDRD	01	02	03	04	05	06	07	08	99	010	011	012	013	RIPON
Francisco	ap1	P2	P3	P4	P5	P6	P7	P8	P9	P10	PIT	P12	P13	219
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Harry

# **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

Internet from these Contents			
- William Party (Conductor Conductor Conductor			
1 - michal (brain - 1) - big with life count pach, standard	Scale   Area	Cod R	
- Bulline	11:1000 205/5	sind_illumber_1 kle	intifier Initials
	to arge patch close by 111090 36 ( E4	B	1 lu_date
- Constant Abart - Constant A and A	1.1050 200 50	8	6/21/2014
H	1.1030 405 154	B	8/21/2014
- Oprican appen - N N's - Wie contracts seen	1:1000 208 5		8/21/2014
1 - and the annual - 2 - 11 - 10 the contracts sets	111000 348 84	6	8/21/2014
And the factor of the sector and Alex	1/1000 440 54		8/21/2014
H Bill Real - 192000 - 20 K - A DODALAND AND	17.1050 400 54		8/21/2014
- Phy Sec - Prove - Arriver - West Contraction Callon	1.1050 304 154	8	B21/20++
The second secon	1.1000 320 104	18	BOUDDA
2017 - 2019 - 2 3	1:1000 575 154		812+112014
an in the second s	11.1000 480 184	- IR	ami-
- 40 Met	1.1050 400 184	8	0/21/2014
Anitan 2000 2 no contrast and	1.1050 300 10	0	W21/2014
Stilling August State By cash cash by the	11000 400 10		8/21/2014
12000 U 20 U Improve pace	1:1000 3001		B/21/2014
ALLY APPLOUM	1.1090 300 1	0	8/21/2014
With South Date	1.1050 00 174	8	8/21/2014
	1 1909 Min 1		80100
	111000 300 44	8	8/14
	11000 300 Fa	8	8421/2014
	11000 400 F4		0/21/2014
	MM2   F4	8	8/21/2014
		B	8/21/2014
		and the second sec	8/21/2014
			30100
			1/2014

### 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.



# 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

n  $\sum_{i=1}^{\sum} (S_{ij} \times E_i)$ iMC n

where n is the number of species,

Sij is the habitat suitability for species *i* at location *j*, and *Ei* 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				Listing		
Code	Common Name	Scientific Name	Taxon	Status		
ONMY	Cal. Central Valley Steelhead DPS	Oncorhynchus mykiss	Fish	FT		
ONTS	Central Valley Winter Run Chinook ESU	Oncorhynchus tshawytscha		FE		
	North American Green Sturgeon, Southern					
ACME	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	/		
LI MA7	Mason's Lilaeopsis	Lilaeopsis masonii	Plant	SR		
SYLE2	Suisun Aster	Aster Symphyotrichum lentum				
LAJE	Delta Tule Pea	Lathyrus jepsonii	Plant			

### Habitat Suitability Data Transformations

VEGCamp Data			
Habitat Criteria			
>50% of area is High Suitability			
>50% of area is Medium or High Suitability	4		
>50% of area is Low, Medium or High Suitability			
50% < area of Low, Medium or High Suitability but >0%			
Suitable Habitat in wetland/riparian habitats only (no areal estimate)			
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.





### 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.

Alex Young <u>alex@sonomaecologycenter.org</u> (707) 996 0712

