RMA RESOURCE MANAGEMENT ASSOCIATES
WATER RESOURCES ENGINEERING

Effects of Levee Breaching on the Hydroecology of Suisun Marsh and the Delta

CWEMF Presentation

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Overview

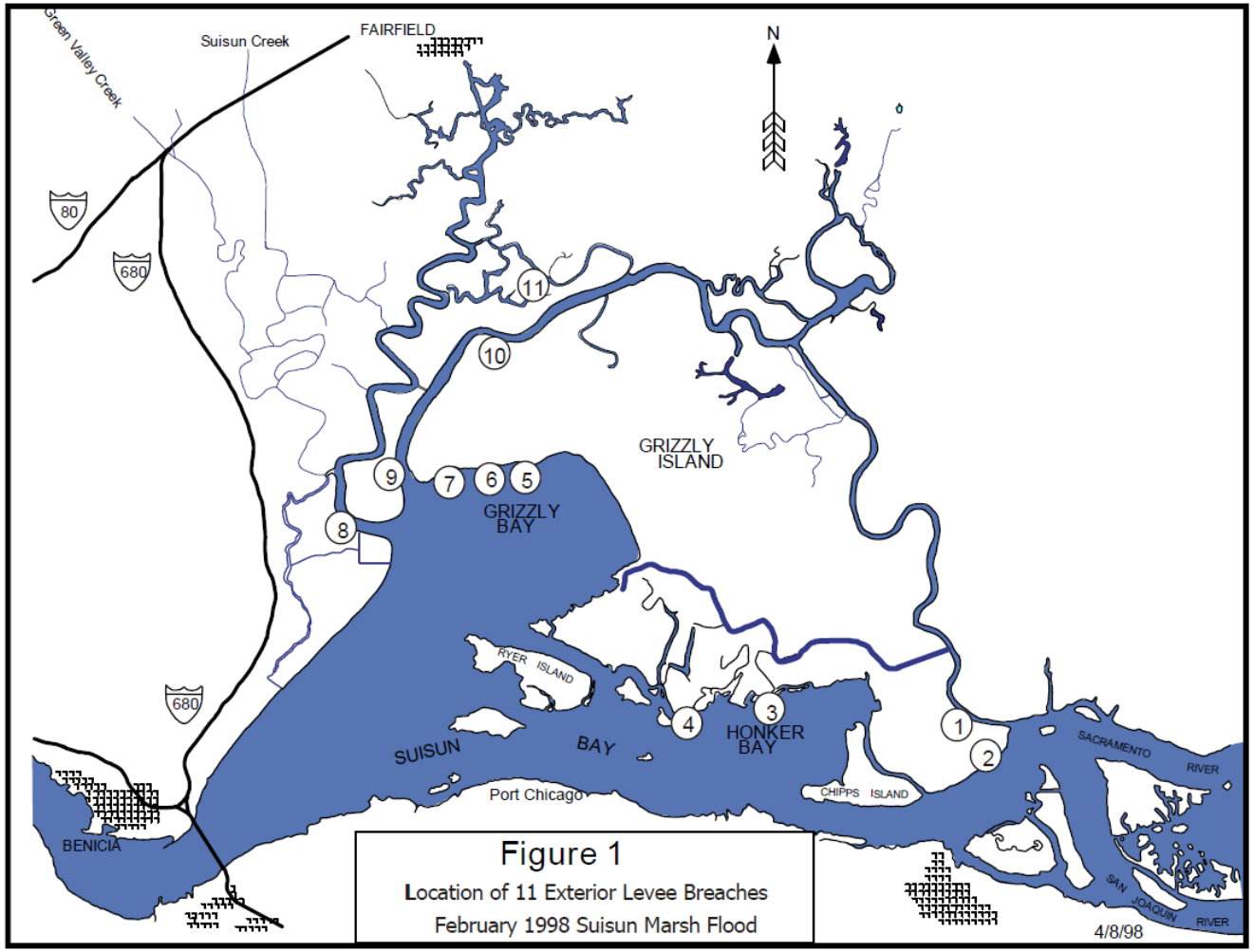
- Suisun Marsh ecological importance
- Levees breach risk
- Hydrodynamic simulation of levee breach scenarios
- Consequences of breaches
- Joint project with Suisun Resource Conservation District
  - John Takekawa (SRCD)
  - Richelle Tanner (Chapman University)

Suisun Marsh Ecological Importance

- Suisun Marsh is important ecologically
  - Hosts endangered species
    - Delta Smelt
    - Salt Marsh Harvest Mouse
    - Soft Bird's Beak
  - 200 species of birds
  - 320 vertebrate species
- Part of the Upper San Francisco Estuary
- Tidal wetlands
- Managed wetland habitat
  - Duck ponds

Suisun Marsh Levees

- Levees in Suisun Marsh are maintained by individual landowners
  - Not part of Federal Levee Protection Program
- Under increasing stress from:
  - Sea level rise
  - Increasing king tides
  - Increased frequency of extreme rainfall events
  - erosion



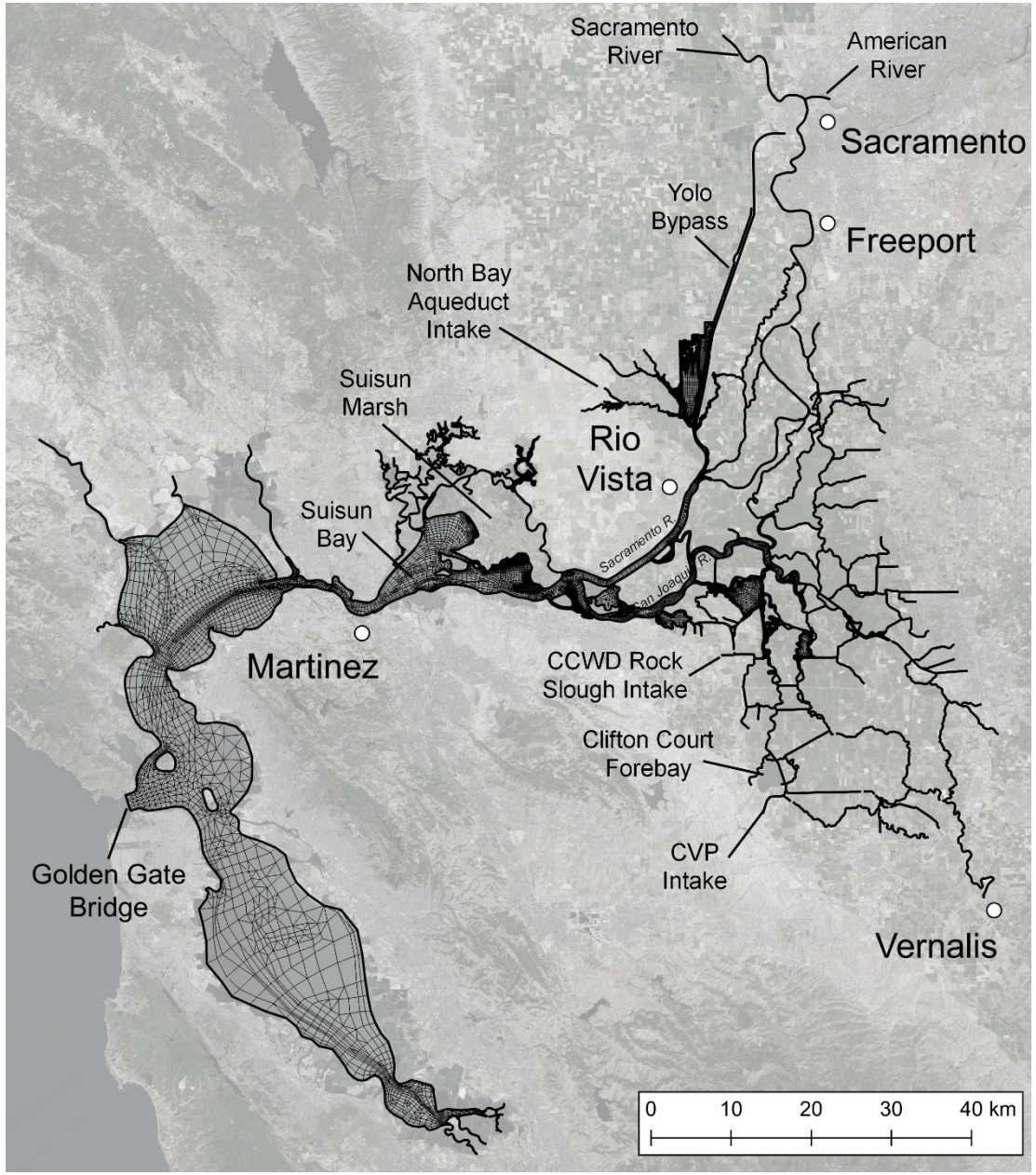
1998 Flood Event with 11 Levee Breaches
(Fig from Enright, 1999)

Project Objectives

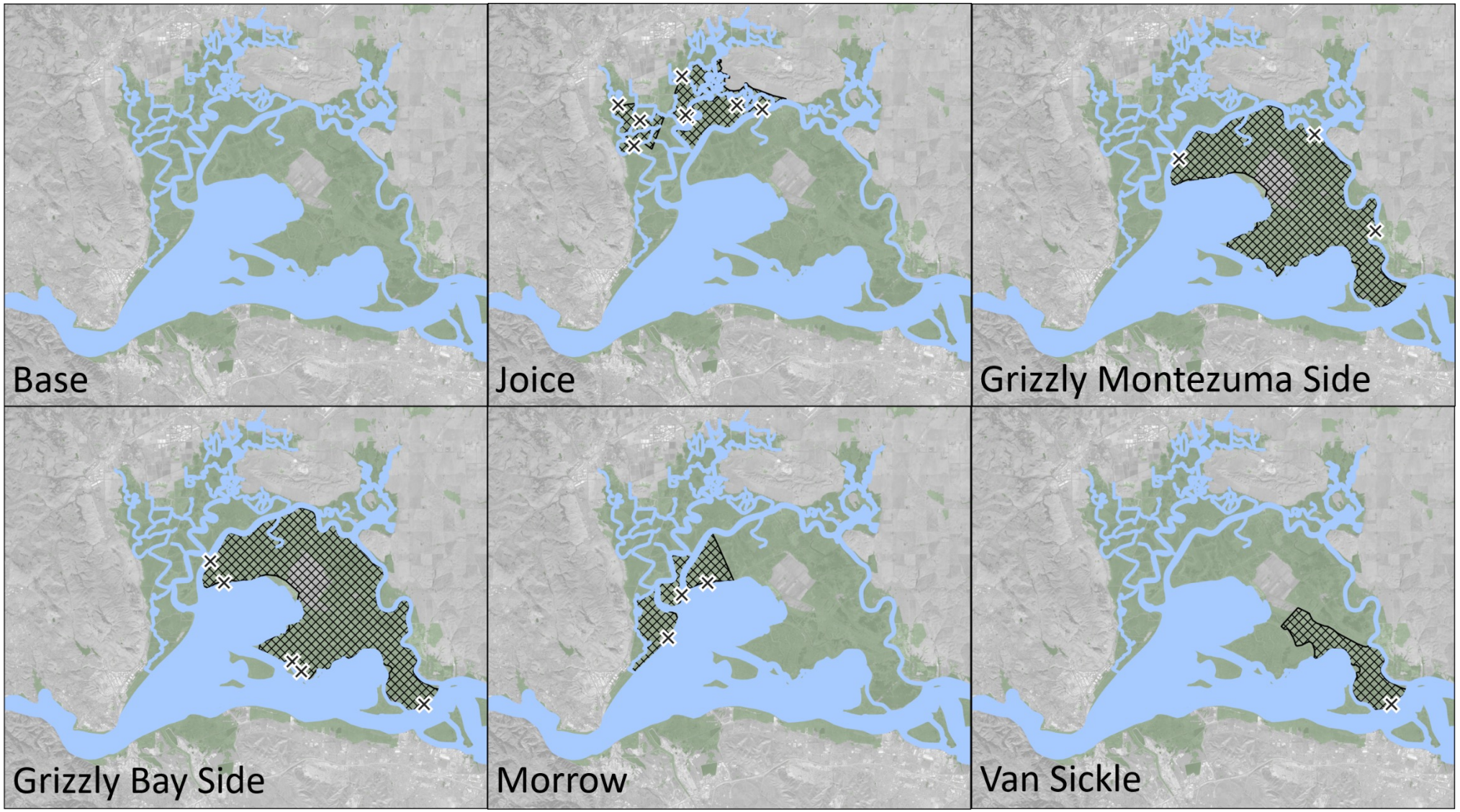
- Explore consequences of levee breaches
  - Hydrodynamic
  - Water Quality
  - Ecological Consequences
- See impact of geographical location of breaches
- See impact of time of the year

Simulations

- Simulations run with the RMA Bay-Delta Model
  - 2D depth-averaged finite element model
  - Developed over 20 years
- Simulated 2009
  - Water year type Below Normal
- Simulate hydrodynamics (water levels, velocities), EC, water temperature

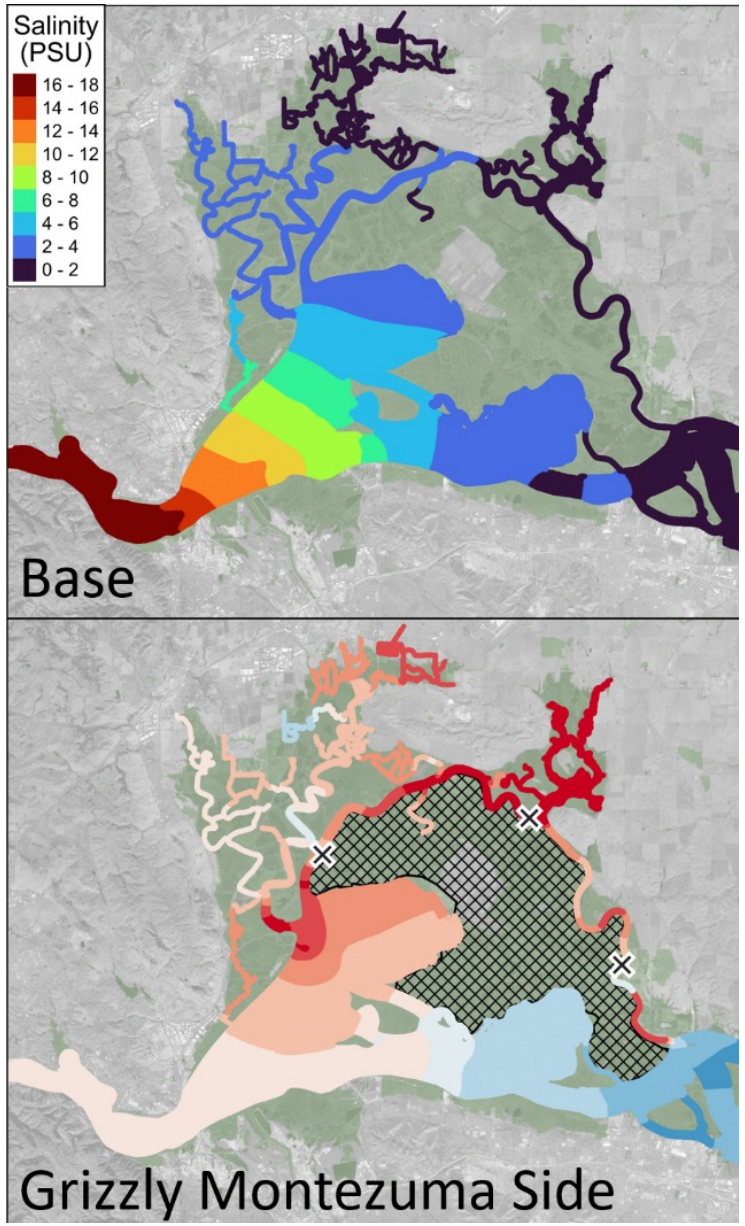


Levee Breach Scenarios



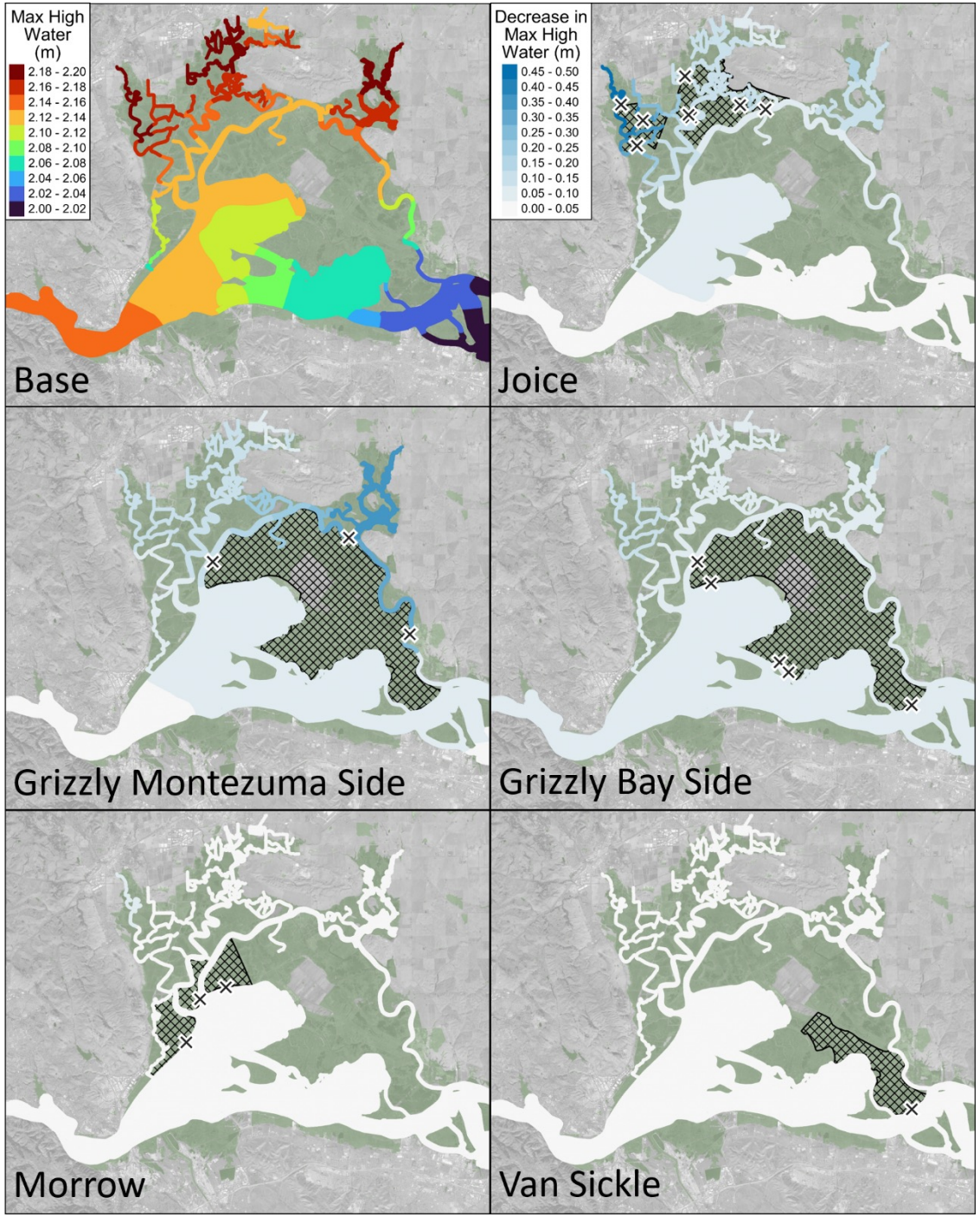
Heatmap Figure

- Base plot shows simulation results for a given metric (e.g., monthly average salinity) without any levee breaches
- Heatmap plot shows change from Base conditions for a given levee breach scenario (as a %, or absolute value)
- Monthly averaged point values interpolated over a 10m regular grid



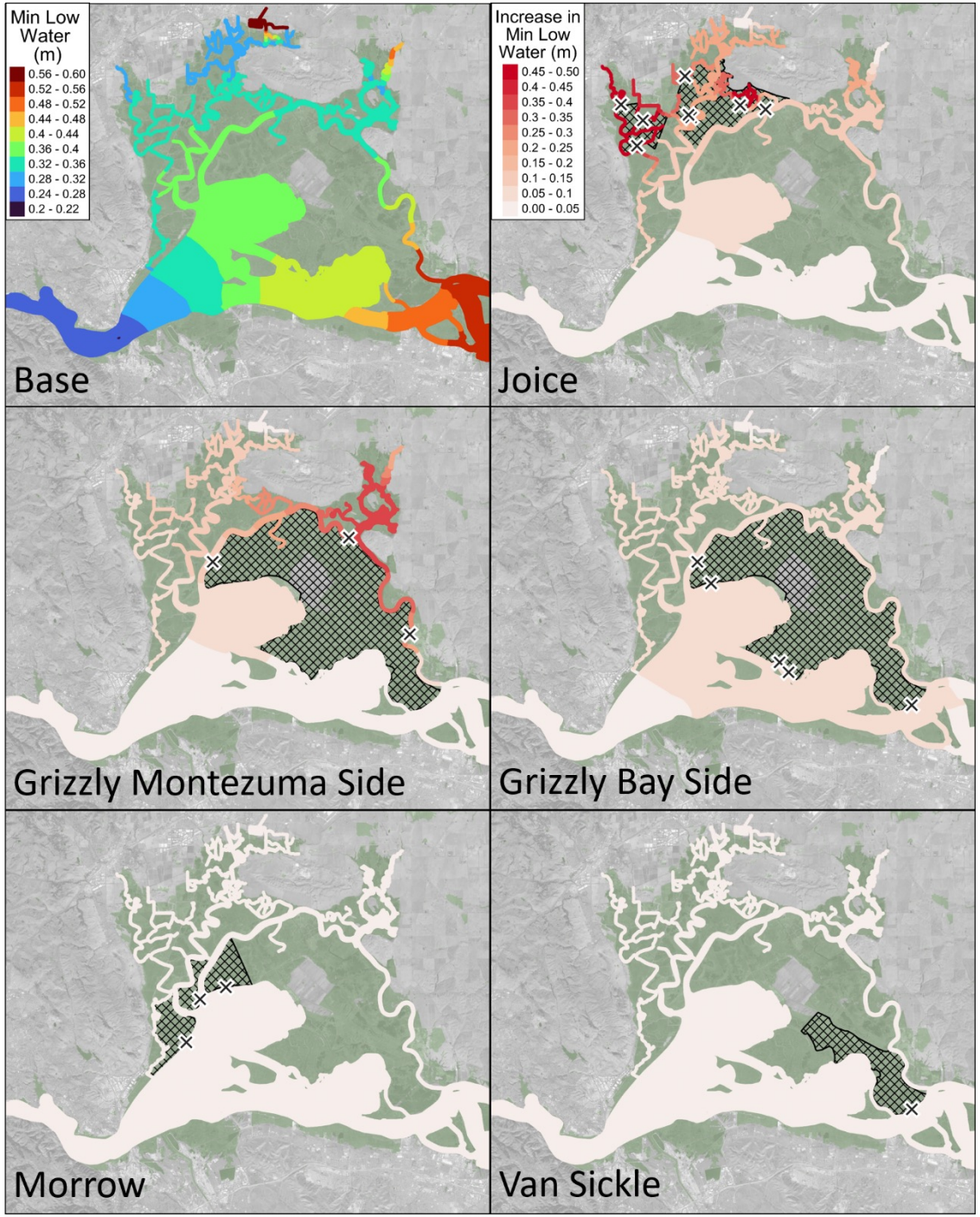
Results – High Water Levels

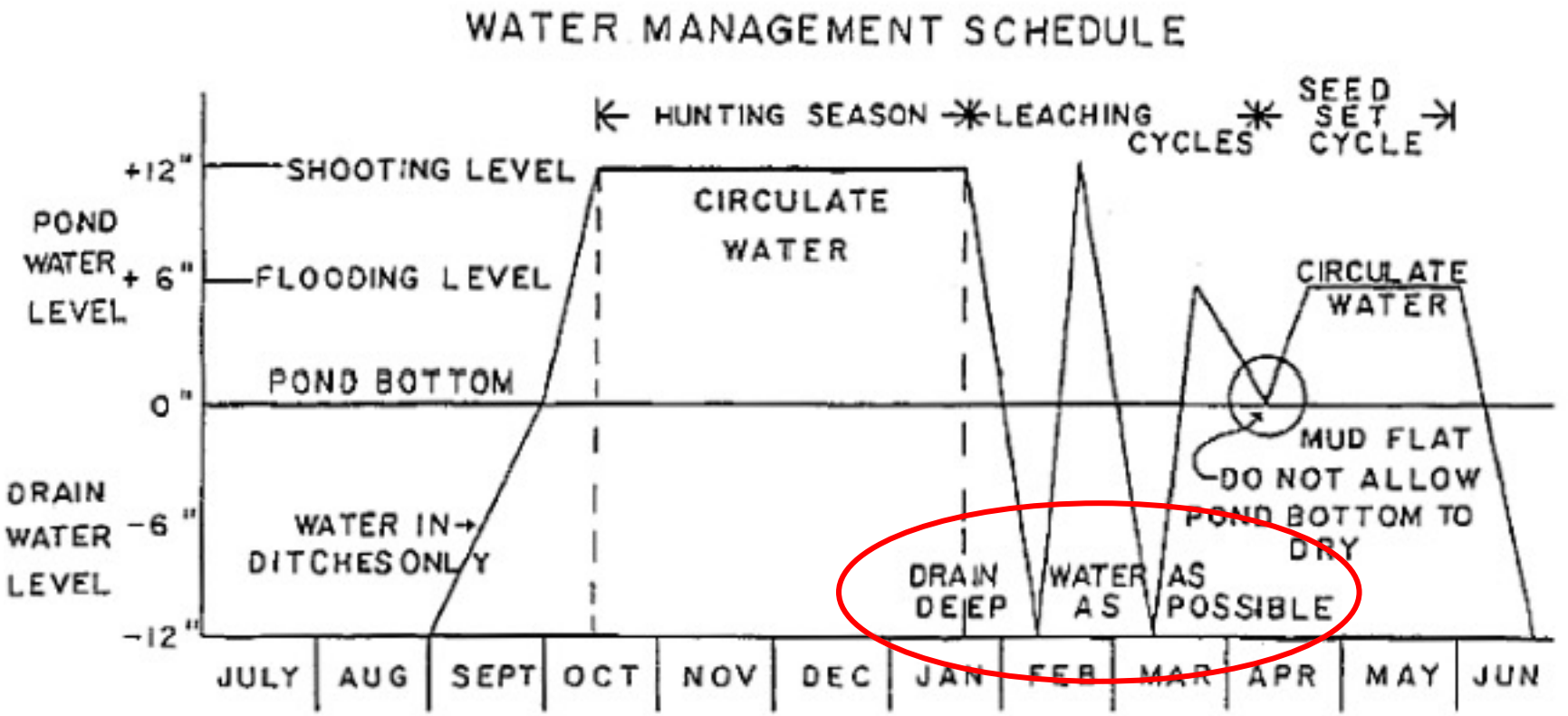
- Breaches can decrease mean high water locally
- Breaches off Grizzly or Honker Bay generally saw little/no decrease
- Breaches up in the marsh saw large decreases (up to 0.5 m)
- Ecological consequences:
  - Breached area creates novel intertidal or subtidal habitat
  - But may decrease existing intertidal habitat
  - Impacts plant recruitment, shorebird foraging



Results – Low Water Levels

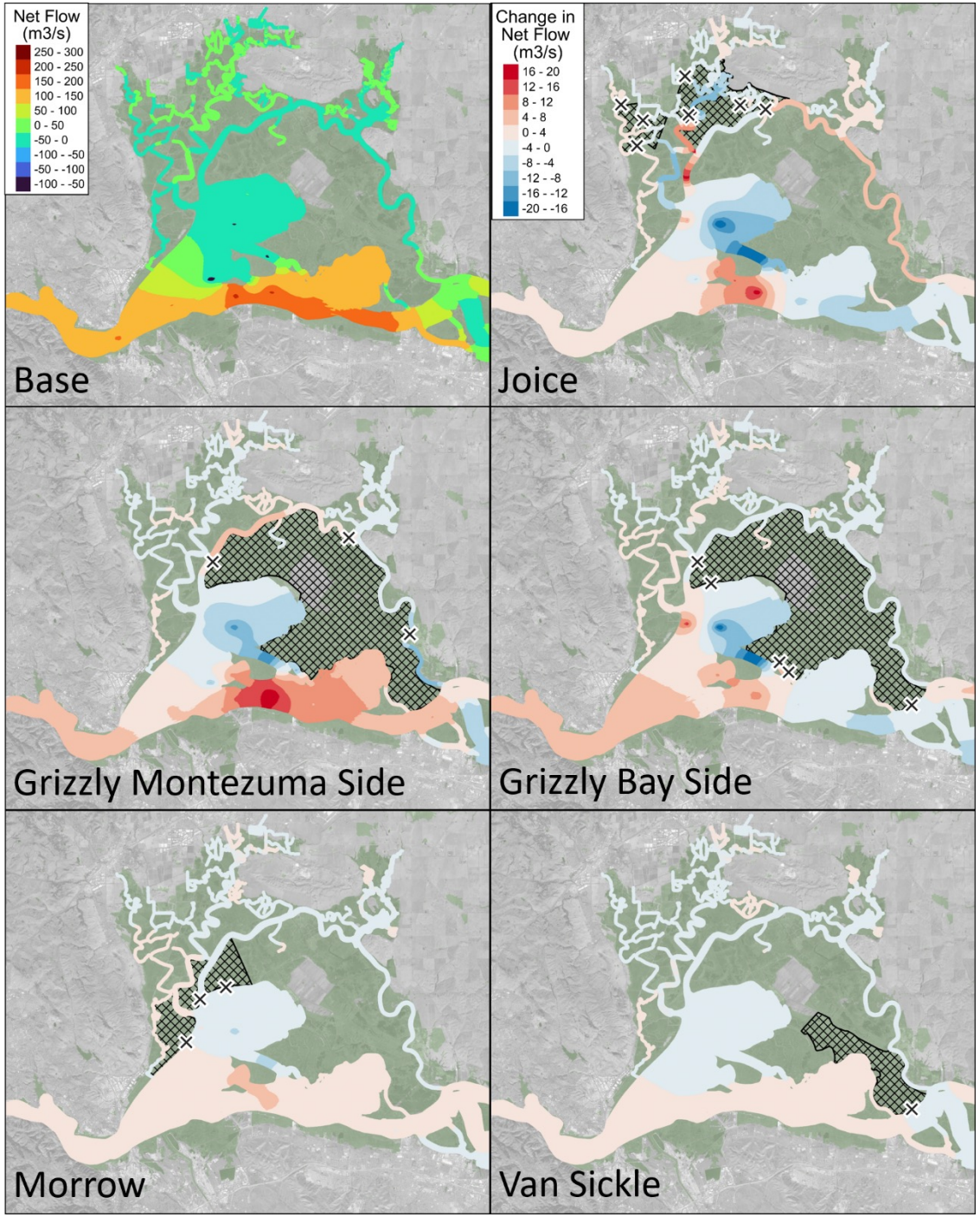
- Breaches can increase mean low water locally
- Differences between breaches off Grizzly or Honker Bay vs. in the marsh similar to high water level impacts
- Impacts to managed wetlands
  - Harder to drain ponds in spring
- Ecological consequences:
  - Increase in inundated areas
  - Loss of intertidal marshes




WATER MANAGEMENT SCHEDULE
HUNTING SEASON
LEACHING CYCLES
SEED SET CYCLE
+12"
SHOOTING LEVEL
POND WATER LEVEL
+ 6"
FLOODING LEVEL
CIRCULATE WATER
CIRCULATE WATER
POND BOTTOM
0"
MUD FLAT
DO NOT ALLOW POND BOTTOM TO DRY
DRAIN WATER LEVEL
-6"
WATER IN→ DITCHES ONLY
DRAIN DEEP
WATER AS POSSIBLE
-12"
JULY
AUG
SEPT
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN

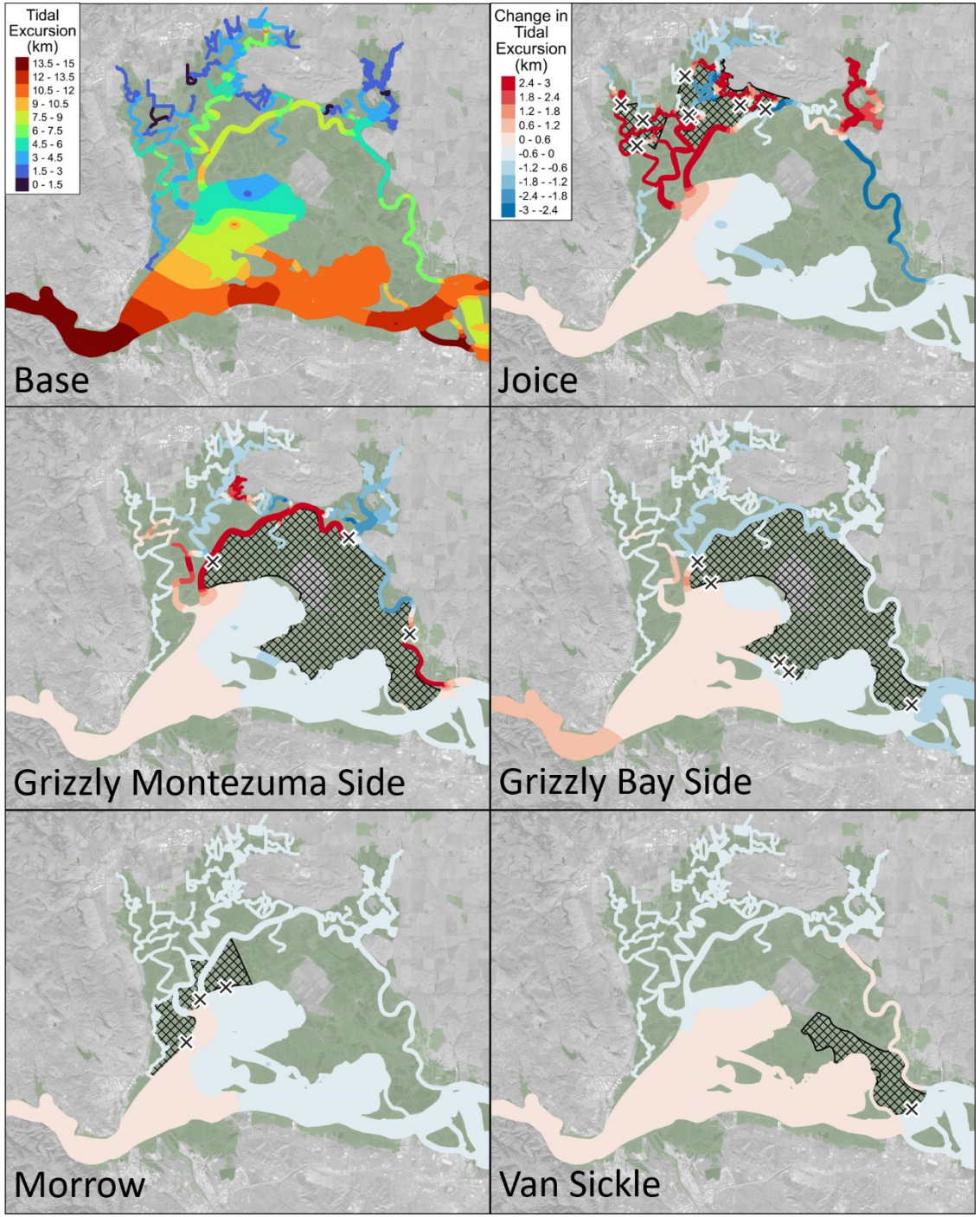
Results – Net Flow

- Breaches can change net flow splits through Montezuma Slough and Suisun Cut
- For breaches off Montezuma Slough, less net flow from Sacramento River into Montezuma
- Breaches in NW marsh increase Montezuma Slough flow
- Ecological Consequences
  - Salinity changes from Sacramento/Bay split
  - Transport and plant recruitment



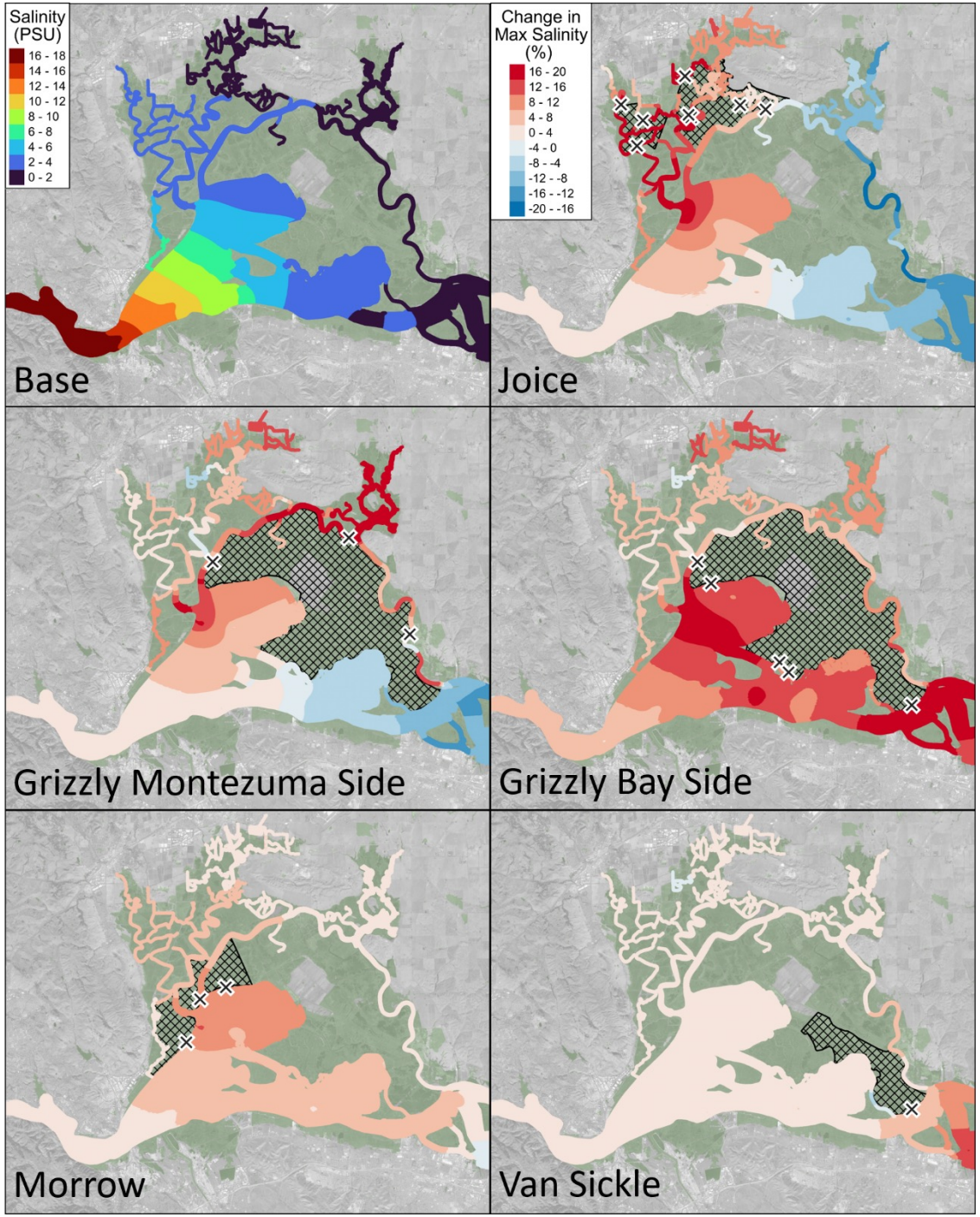
Results – Tidal Excursion

- Tidal Excursion – the distance water sloshes back and forth with the tides
- Increase along Suisun Slough for breaches along Grizzly Montezuma side
- Similar increases in NW marshes off Joice
- Ecological consequences:
  - Salinity
  - Sediment transport
  - Changes in travel distance through a reach
    - Predator-prey interactions
    - Dispersive transport



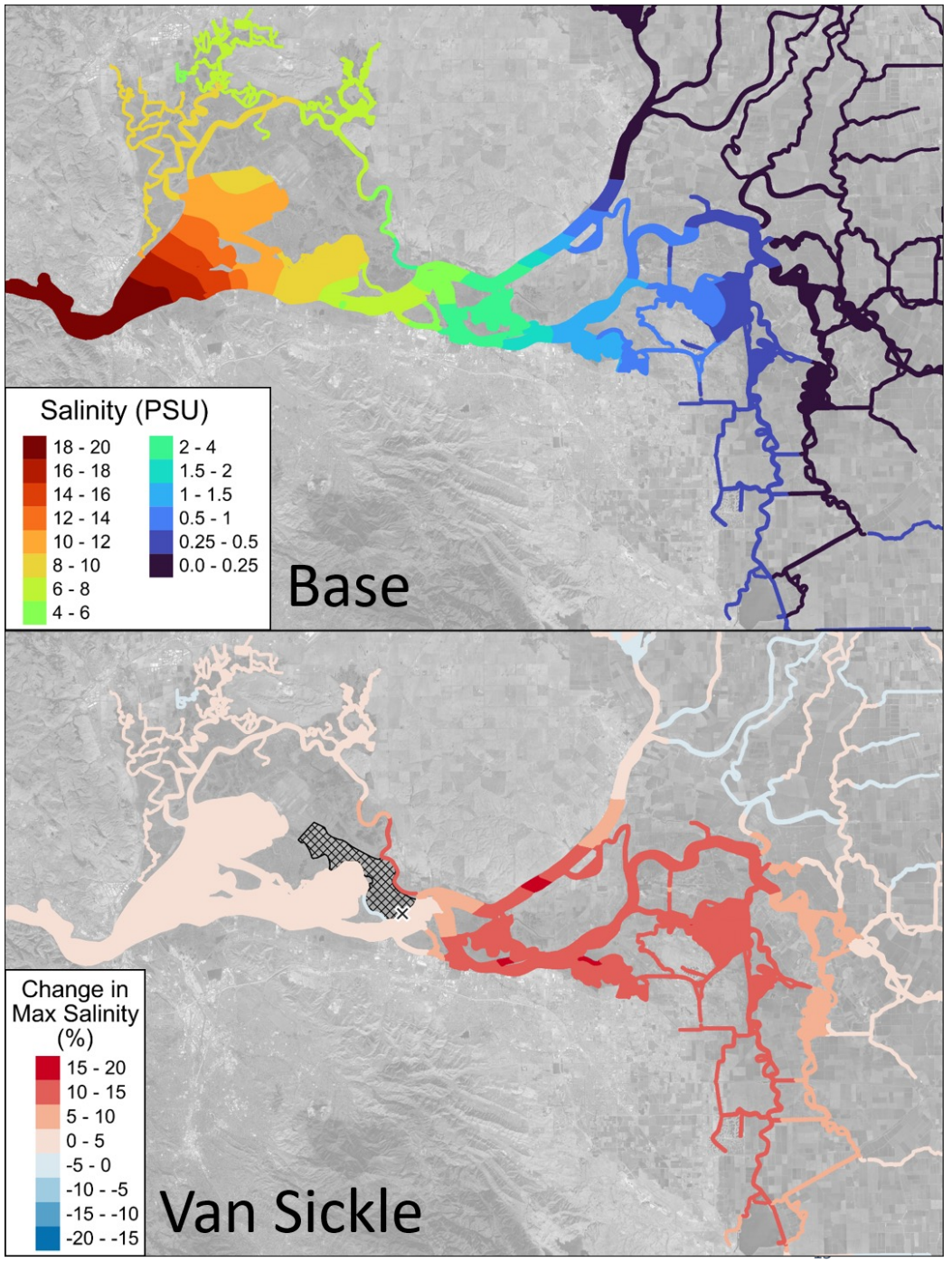
Results – Salinity, Local Impacts

- Breaches change net flows, tidal excursion
- Breaches typically increase tidal mixing/dispersion on the seaward side, decrease dispersion on landward side
- Generally results in significant increases in Suisun Marsh max salinity
- Ecological consequences:
  - Range of tolerance for different species
  - Higher salinity potentially leads to decrease in microbial C and N cycling
  - Changes are region dependent

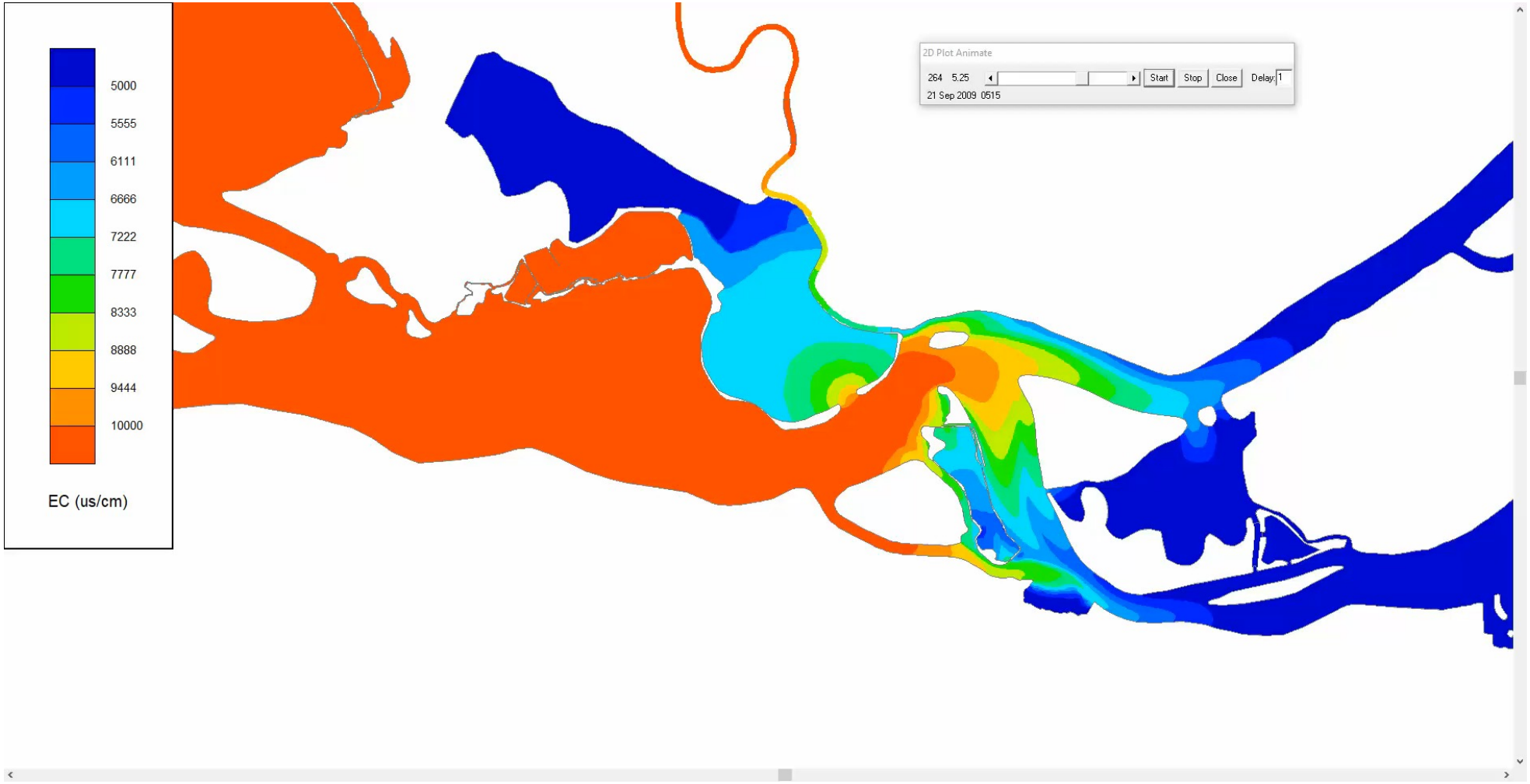


Results – Salinity, Regional Impacts

- Van Sickle Island breach can significantly increase salinity in Delta through tidal pumping mechanism
  - Water supply and regulatory impacts
- Other levee breach scenarios didn't show much increase in salinity intrusion to Delta
- Tidal pumping mechanism
- Potentially beneficial from salinity reduction in North Delta
- X2 at this time about 87 km

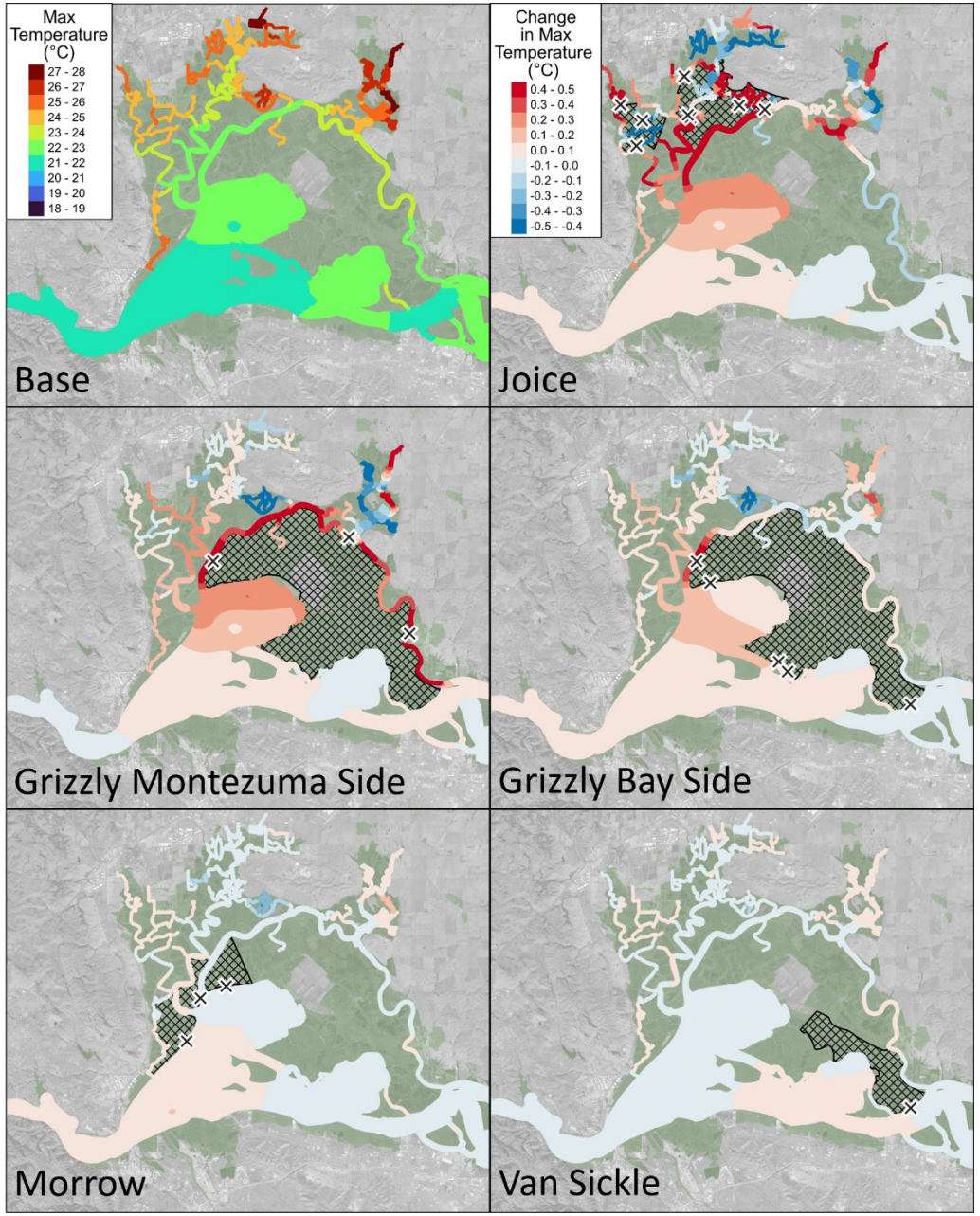


Tidal Pumping Animation



Results – Water Temperature

- Adding intertidal area can cause local cooling during summertime
  - Water inundates marsh at night, loses heat, returns to channel
- Changing net flows and dispersive transport impacts water residence times
  - Impacts exchange with cooler Bay water
- Ecological consequences:
  - Range of tolerance for specific species
  - Impacts on metamorphic lifecycles
  - Effects on microbial nutrient cycling (C, N)
  - Greenhouse gas emissions



Conclusions

- Suisun Marsh has a balance of cold, salty Bay water and warmer, fresher Sacramento River water
- Highest impacts from levee breaches on Grizzly Montezuma and near Joice NW marsh
- Breaches lead to tidal dampening and water quality redistributions (Salinity, sediment, water temperature)
- Disruptions in managed wetland and duck ponds
- Changes in flow patterns effect other parameters

Questions?

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