Ecological Context for the Delta: A Lot Can Happen in 150 Years…

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Photo: Francis Parchaso, USGS
This Talk

• Brief overview of “pre-Gold Rush” conditions
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• Salmonids covered next
  – Not my field of expertise
Simple-minded view of landscape change we (…or at least I) started with in the 1990s

Tidal Wetlands in 1990 (90% loss in SFE and 95% in Delta)
Utterly Fails to Convey Loss of Complexity

Flood basins/natural levees
Tidal freshwater emergent wetlands
Nontidal freshwater emergent wetland
Seasonal wetlands

Best Delta History ever!

Whipple et al. 2012
Extensive Floodplain Available

Whipple et al. 2012
Utterly Fails to Convey Loss of Complexity

Whipple et al. 2012

Tidal Islands

Tidal freshwater emergent wetlands

North Delta: flood basins

Central Delta: tidal islands

South Delta: distributary rivers
Utterly Fails to Convey Loss of Complexity

Whipple et al. 2012

Distributary rivers
Tidal freshwater emergent wetlands
Nontidal freshwater emergent wetland

Waterway
Pond/lake
Seasonal pond/lake
Tidal freshwater emergent wetland
Nontidal freshwater emergent wetland
Willow
Valley foothill riparian
Wet meadow/seasonal wetland
Vernal pool complex
Alkali seasonal wetland complex
Inland dune scrub
Grassland
Woodland/savanna
Extensive low-order channel networks in wetland areas

Provides access to wetland areas
Dead-end sloughs

Whipple et al. 2012
Native Predators on Juvenile Salmonids

Birds
Herons
Egrets
Cormorants
Mergansers
Etc.

Thicktail chub, globally extinct 1950s

Sacramento pikeminnow, still common

Bull trout, extinct in California 1970s, only McCloud River

Sacramento perch, extirpated from native range

Rainbow trout? Other salmonids?
What Happened?

• Filled the rivers with mud
• Delta
  – Drained it
  – Farmed it
  – Re-plumbed it
  – Deliberate and accidental introductions
Hydraulic mining sediment

Levees and altered channels

Land use change
Tidal freshwater emergent wetland

Agriculture
Dams for water storage, flood control, and hydropower

1400 ‘large’ DAMS

1000s of small dams

Figure 1.1 Dams in the state of California.
Source: California Department of Fish and Game (DFG) 2012.
70+% of anadromous salmon habitat above dams
The Delta Today Is a Human Construct

Not a Good Environment For Most Native Fishes
Riprap (1,100 miles of Delta levees, Mount et al. 2012)

Clifton Court Forebay

Delta Cross Channel
Introduced Species...Lots!
50 species
30 alien (60%) species
Usually > 90% by number

Mostly freshwater
FW species dominated by aliens
natives present but rare

Sources:
Feyrer and Healey 2003
Grimaldo et al. 2004, 2012
Nobriga et al. 2005
Brown and May 2006
Brown and Michniuk 2007
Gewant and Bollens 2011
44 species

28 alien (64%)

Mostly freshwater
FW species dominated by aliens but natives present

Sources:
USFWS, unpubl data, 2002-04, 2010-12
Harrell and Sommer 2003
Sommer et al. 2004
McLain and Castillo 2010
Introduced Predators

- Introduced in 1879 (135 fish)
- 10 years later: commercial fishery till 1935
- Adapted for high turbidity from mining
- Estimated population
  - 1960s: 2-3 million adult fish
Egeria densa, invasive Ecosystem Engineer (ca. 13% of surface area of Delta)
Egeria densa, Ecosystem Engineer
*Egeria densa*, Ecosystem Engineer

*Egeria densa* extremely important because it provides ideal habitat for many alien fishes.
Introduced Predators

- Introduced in 1890s
- Increased in abundance as *Egeria densa* spread
  - 1980s-2000s
- World class fishery
Introduced Predators

Brown and Michniuk 2007
SWP salvage data

Largemouth Bass (non-native freshwater predator)

Two-way ANOVA:
Year < 0.001
Region < 0.001
Year*Region < 0.001

Centrarchids per km

Salinity?

Brown and Michniuk 2007
SWP salvage data
FW tidal wetlands, *Egeria* can cause a disconnect

- White arrows = movement
- Red arrows = predation
- Red spp. are alien
- Dark green = dense *Egeria*
- Light green = sparse SAV

(L. Brown 2003)
Invasive Clams Have Caused Changes in Food Web

*Corbicula fluminea* freshwater, 1940s

*Potamocorbula amurensis* brackish water, 1986
The Delta Has Never Been a Productive System (light limited)

Clams Suppressing Phytoplankton Biomass

Potamocorbula invasion
Neomysis mercedis a key prey for many species collapsed (competition and predation)
What About All That Mud...Gone!

- 50% decrease in Sep-Oct 1994-2011
  - Morgan and Schoellhamer, unpublished data
- 50% decrease in Delta TSS 1975-1995
  - Jassby et al. 2002
- 36% decrease in SSC in SF Bay, as mining sediment depleted
  - Schoellhamer 2011
What About All That Mud…Gone!

Water clearer by 10+ cm
What About All That Mud...Gone!

Physical Sediment Trap

Prevent Bank Erosion
The Future of Delta Ecology

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The Future of Delta Ecology

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• Restoring and reconnecting habitats likely a good idea for aquatic ecosystems
  – Challenge: our desire to channel benefits to a subset of currently rare consumers
The Future of Delta Ecology

• We can’t go back
• Habitat restoration will be an important tool in the way forward
• Restoring and reconnecting habitats likely a good idea for aquatic ecosystems
  – Challenge: our desire to channel benefits to a subset of currently rare consumers
• Expect change, it is inevitable
  – Climate change, invasions, other?
  – Retain flexibility to adapt