Delta Landscape Metrics

Creating a Spatial Framework to Inform Restoration Planning

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Sam Safran

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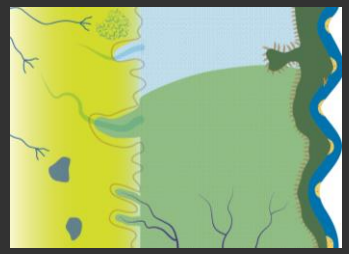
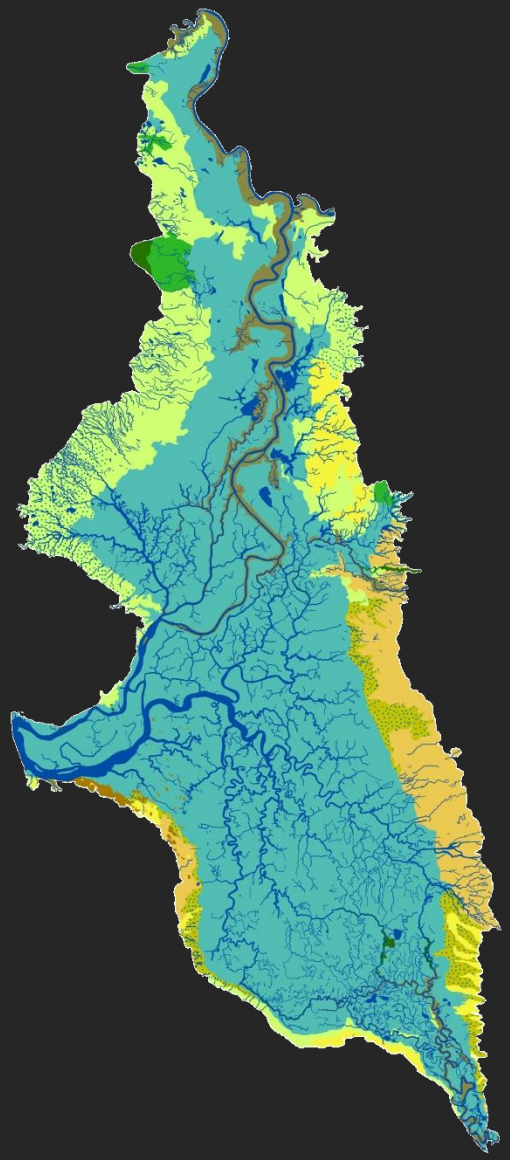
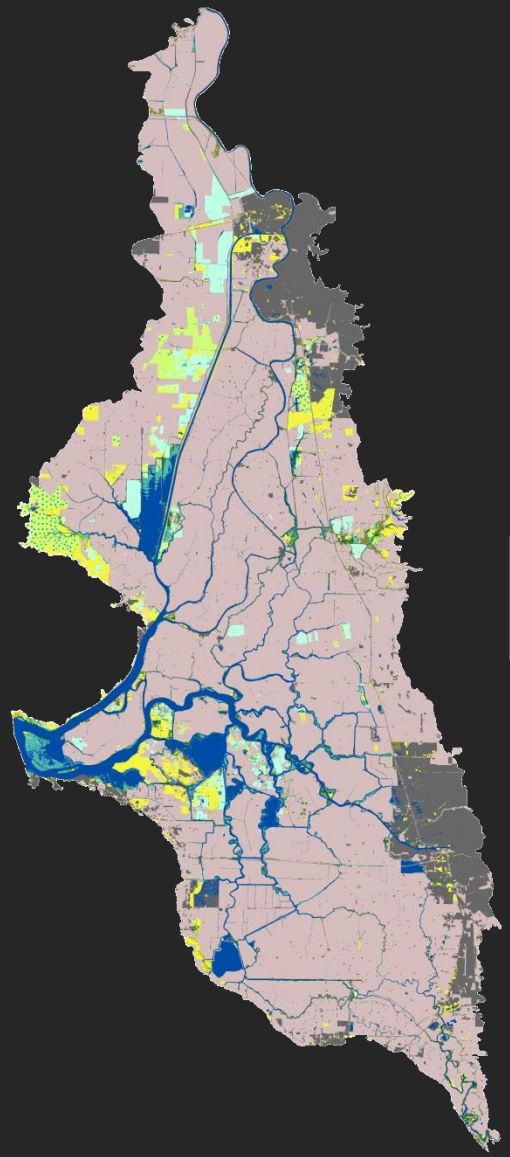


DSP-ERP-SWAMP Brown Bag Seminar
July 28, 2014

AQUATIC SCIENCE CENTER

How do we create ecologically functional, resilient *landscapes*? (not just nice projects)





?

The Delta Landscapes Project

Management Tools

for Landscape-Scale Restoration

Funded by the Ecosystem Restoration Program

What are we trying to accomplish?

1. **Provide a framework that helps individual projects add up to a larger functional landscape** (pieces of the puzzle)

2. **Provide guidance for what kinds of projects make sense where** (avoid one-size-fits-all)

3. **Reduce conflicts and mistakes** (shared understanding of priorities and current science)

4. **Make better use of long-term physical/climatic trajectories** (work with processes, not against them)

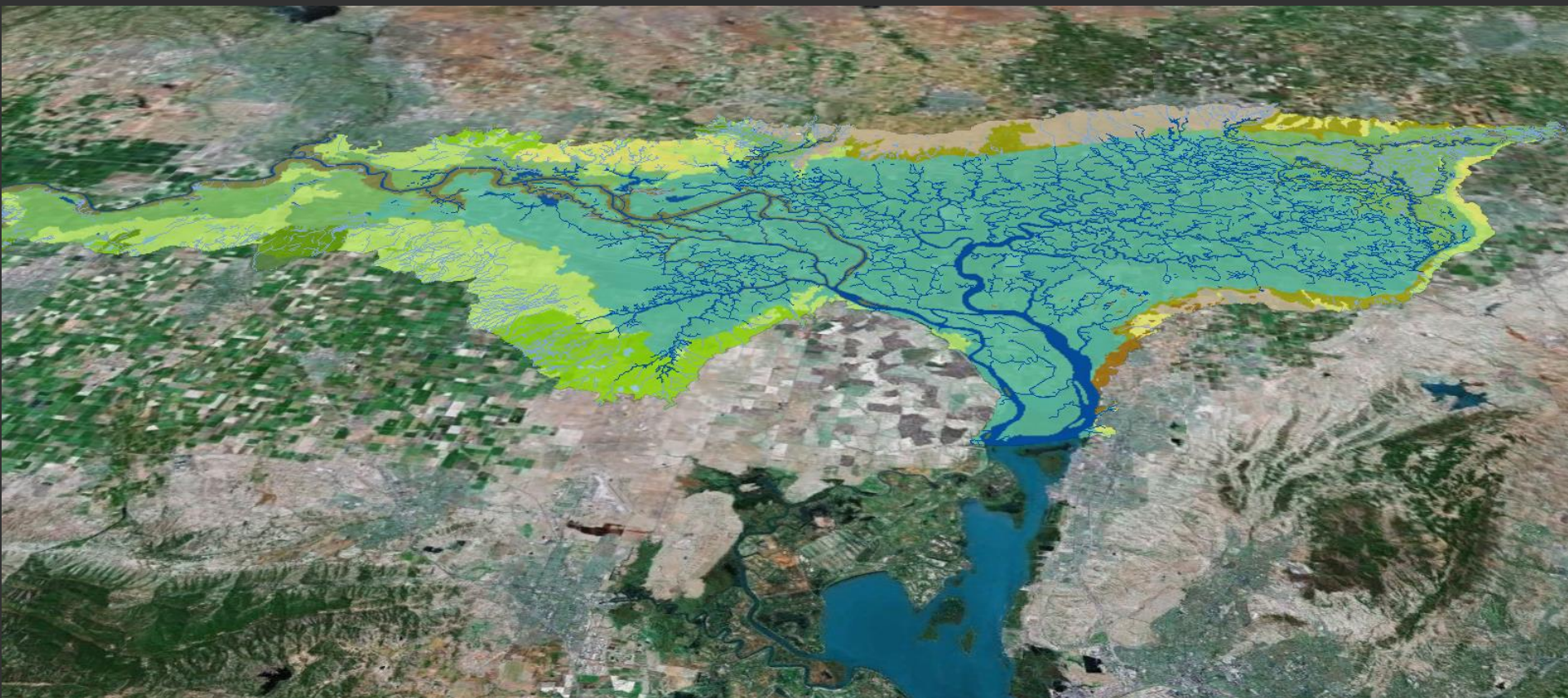
5. **Meet landscape-scale species needs** (connectivity, migration)

Central concept

Use an understanding of pattern and process…

to inform landscape scale restoration…

that supports ecological function



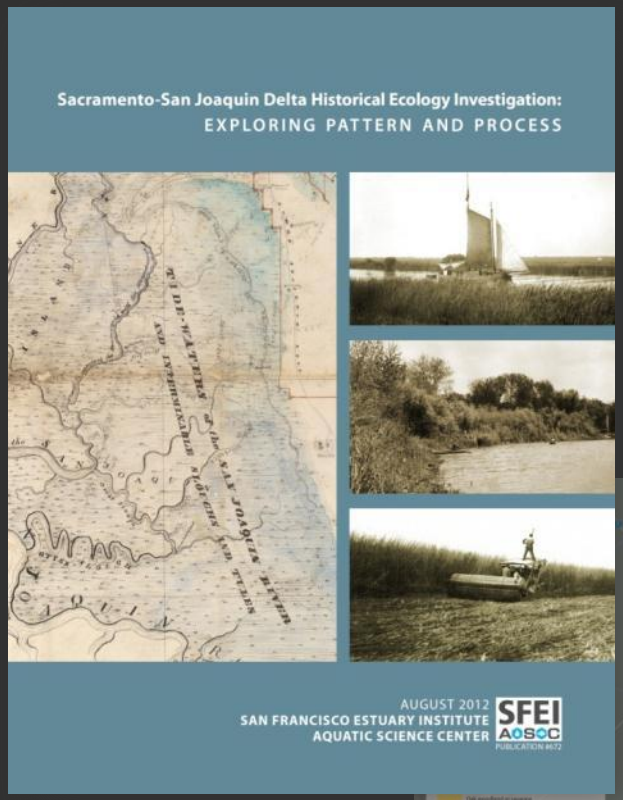
What constitutes a functional landscape?

ecological functions + **physical drivers** = **operational landscape unit**

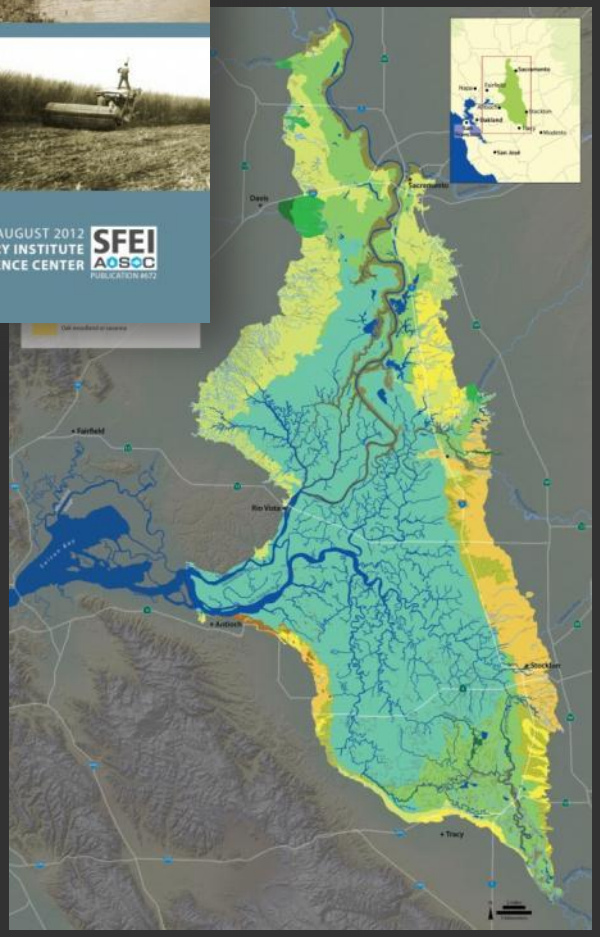
(Verhoeven et al. 2008)

with specific Landscape Metrics and associated Ecological Functions at Regional and Subregional scale

- Conceptual design for restoration projects
- Performance measures
- Regional vision products
- Test thru research (field, modeling, experiments)



Sacramento-San Joaquin Delta Historical Ecology Investigation: Exploring Pattern and Process



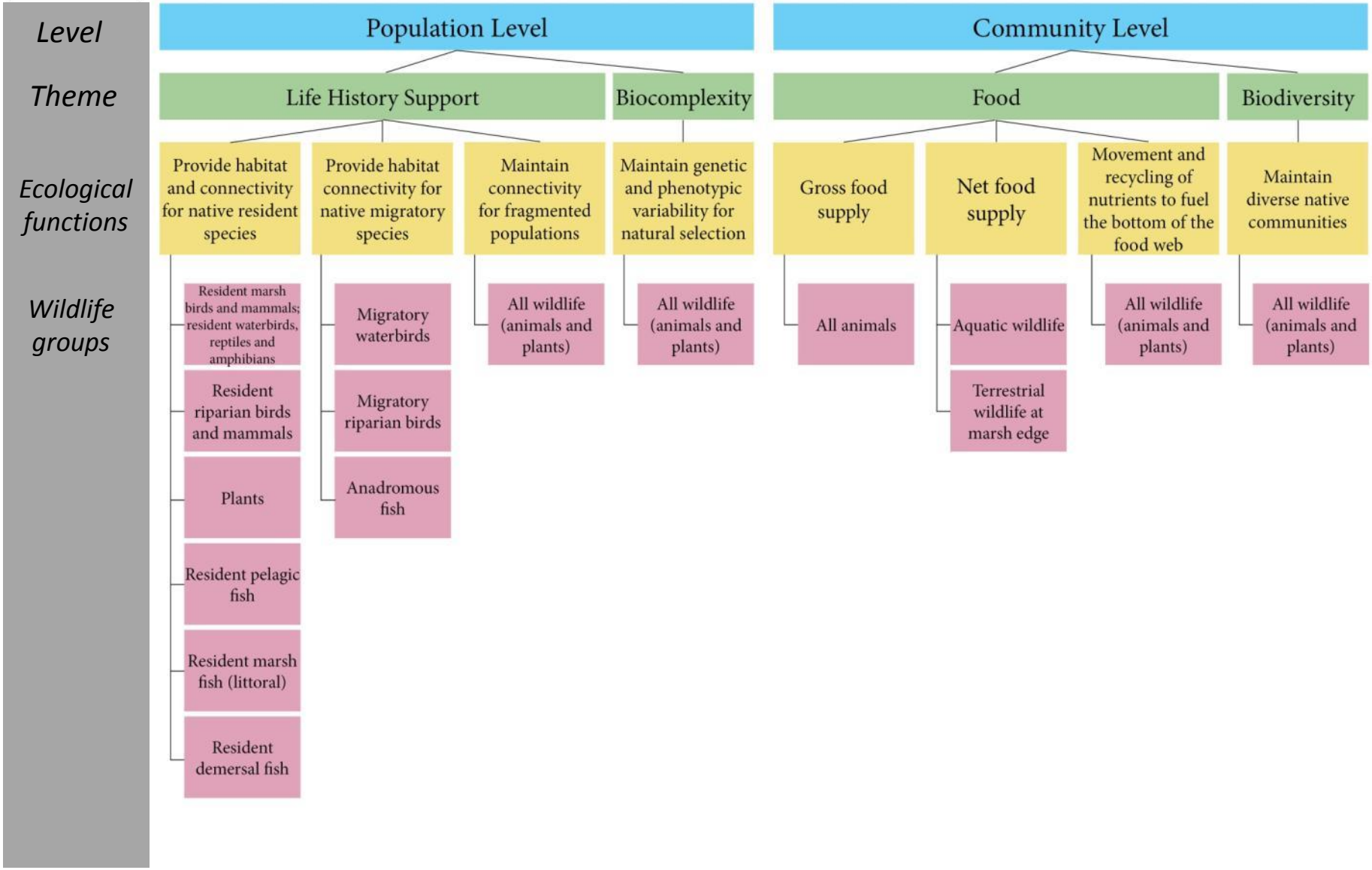
- Funded by Ecosystem Restoration Program (CDFG, NOAA, US FWS)
- Final Report/GIS Available: www.sfei.org/DeltaHEStudy
- Collaboration with KQED QUEST and Stanford's Bill Lane Center for the American West: science.kqed.org/quest/delta-map/

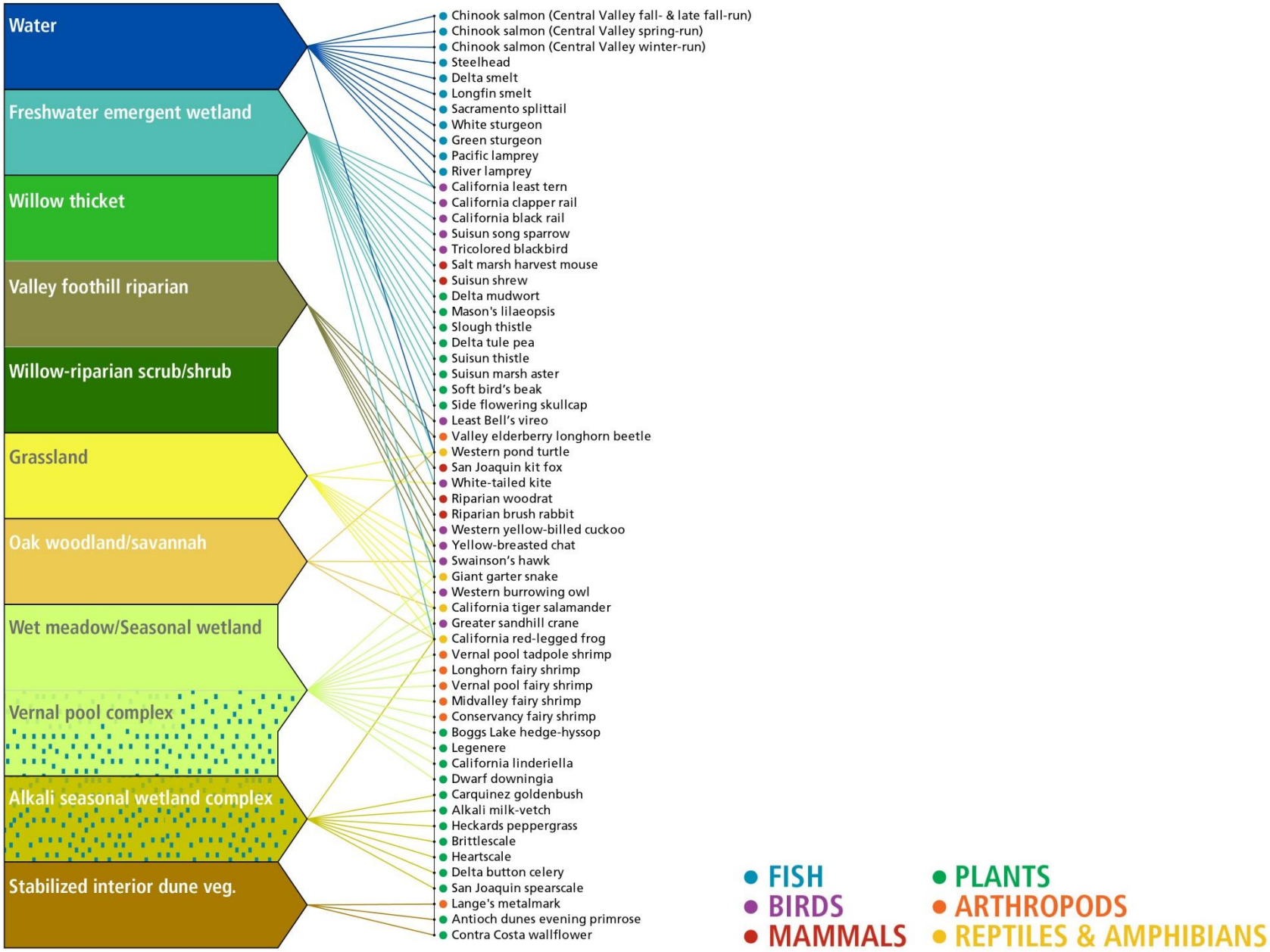
1. Define target ecological functions
2. Identify associated system attributes (spatial metrics)
3. Quantify landscape change metrics
4. Describe subregional potential (physical drivers, opportunities)
5. Create conceptual Operational Landscape Units (e.g. “archetypes”)
6. Produce restoration guidelines and potential performance metrics

Landscape Interpretation Team (LIT)

Stephanie Carlson (UC Berkeley)
Jim Cloern (USGS)
Brian Collins (University of Washington)
Chris Enright (Delta Science Program)
Joseph Fleskes (USGS)
Geoffrey Geupel (PRBO Conservation Science)
Todd Keeler-Wolf (CDFW)
William Lidicker (UC Berkeley)
Steve Lindley (NMFS)
Jeff Mount (UC Davis)
Peter Moyle (UC Davis)
Anke Mueller-Solger (USGS)
Eric Sanderson (Wildlife Conservation Society)
Dave Zezulak (CDFW)

Ecological Functions framework (Task 3)




Water
Freshwater emergent wetland
Willow thicket
Valley foothill riparian
Willow-riparian scrub/shrub
Grassland
Oak woodland/savannah
Wet meadow/Seasonal wetland
Vernal pool complex
Alkali seasonal wetland complex
Stabilized interior dune veg.
Chinook salmon (Central Valley fall- & late fall-run)
Chinook salmon (Central Valley spring-run)
Chinook salmon (Central Valley winter-run)
Steelhead
Delta smelt
Longfin smelt
Sacramento splittail
White sturgeon
Green sturgeon
Pacific lamprey
River lamprey
California least tern
California clapper rail
California black rail
Suisun song sparrow
Tricolored blackbird
Salt marsh harvest mouse
Suisun shrew
Delta mudwort
Mason's lilaeopsis
Slough thistle
Delta tule pea
Suisun thistle
Suisun marsh aster
Soft bird's beak
Side flowering skullcap
Least Bell's vireo
Valley elderberry longhorn beetle
Western pond turtle
San Joaquin kit fox
White-tailed kite
Riparian woodrat
Riparian brush rabbit
Western yellow-billed cuckoo
Yellow-breasted chat
Swainson's hawk
Giant garter snake
Western burrowing owl
California tiger salamander
Greater sandhill crane
California red-legged frog
Vernal pool tadpole shrimp
Longhorn fairy shrimp
Vernal pool fairy shrimp
Midvalley fairy shrimp
Conservancy fairy shrimp
Boggs Lake hedge-hyssop
Legenere
California linderiella
Dwarf downingia
Carquinez goldenbush
Alkali milk-vetch
Heckards peppergrass
Brittlescale
Heartscale
Delta button celery
San Joaquin spearscale
Lange's metalmark
Antioch dunes evening primrose
Contra Costa wallflower
FISH
PLANTS
BIRDS
ARTHROPODS
MAMMALS
REPTILES & AMPHIBIANS

Ecological Functions list (Task 3)

ecological functions list

Habitat and connectivity for pelagic fish

Habitat and connectivity for resident mammals

Habitat and connectivity for native plants

Maintain genetic/phenotypic diversity

Nutrient movement and recycling

Habitat and connectivity for demersal fish

Habitat and connectivity for marsh birds

Habitat and connectivity for anadromous fish

Maintain connectivity for fragmented populations

Gross food supply

Habitat and connectivity for littoral fish

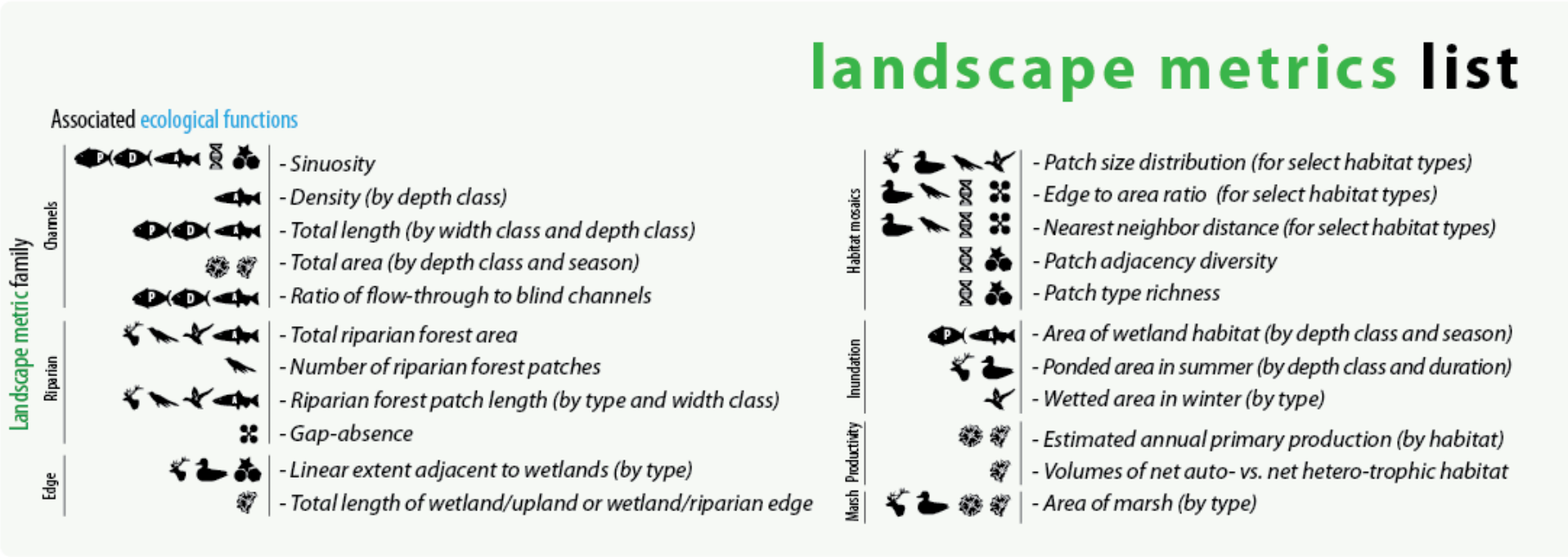
Habitat and connectivity for riparian birds

Habitat and connectivity for migratory waterfowl

Maintain diverse native communities

Net food supply

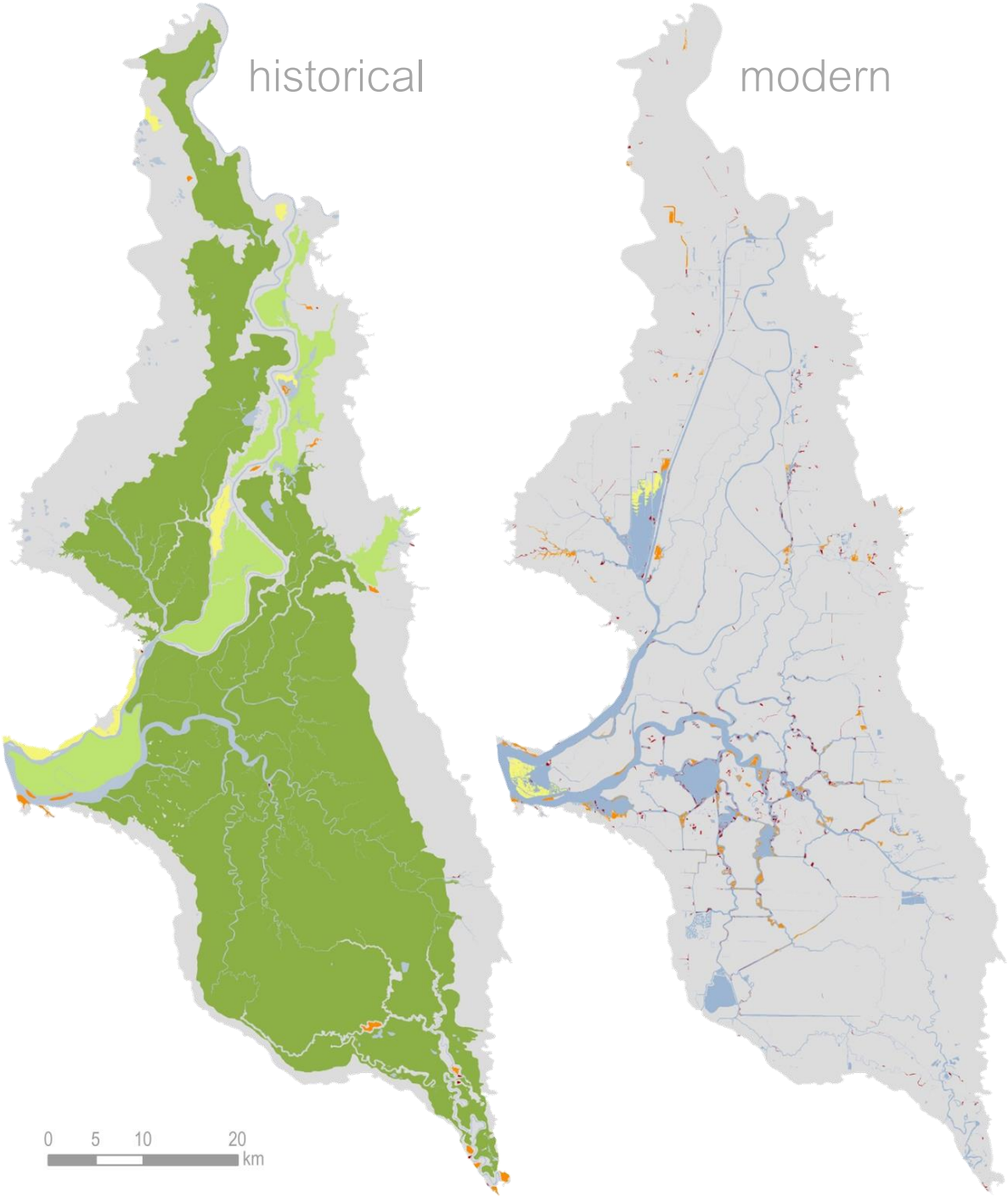
Landscape Metrics list (Task 3)



Support for:

- marsh wildlife
  - marsh patch size
- native fish
  - marsh:open water ratio
  - length of marsh-water edge
  - inundated areas
- riparian wildlife
  - riparian forest width
- edge wildlife
  - marsh-terrestrial transition zone

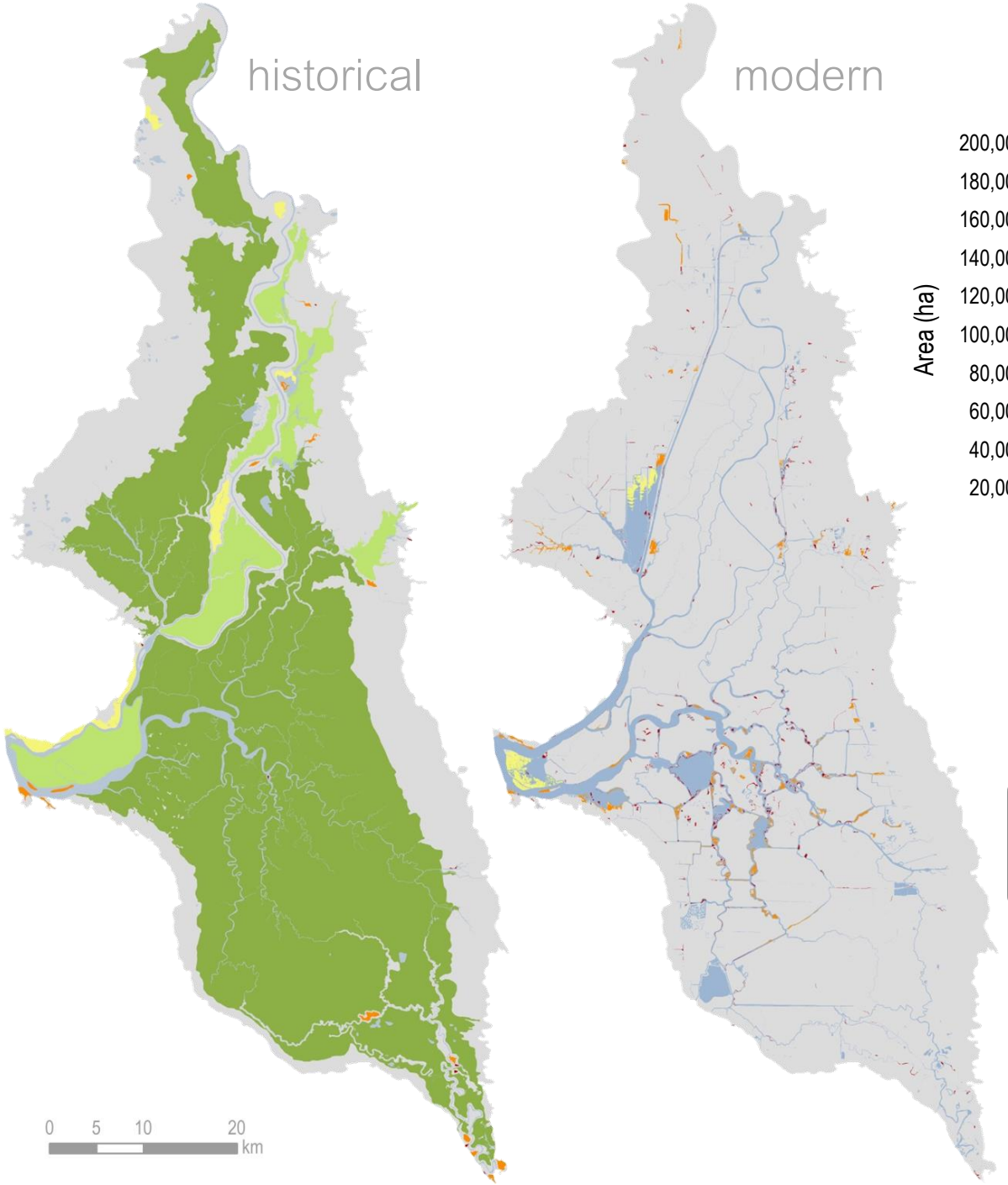
support for marsh wildlife

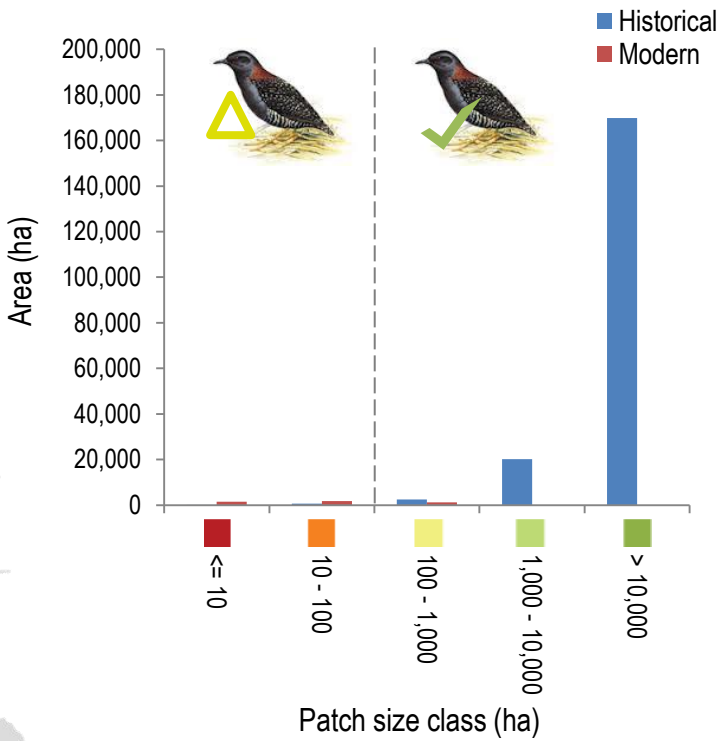


marsh patch size class (hectares)

- <= 10 ha
- 10 - 100
- 100 – 1,000
- 1,000 – 10,000
- > 10,000

support for marsh wildlife





Marsh in patches large enough to fully support rails (based on Liu et al. 2012, Spautz & Nur 2002):

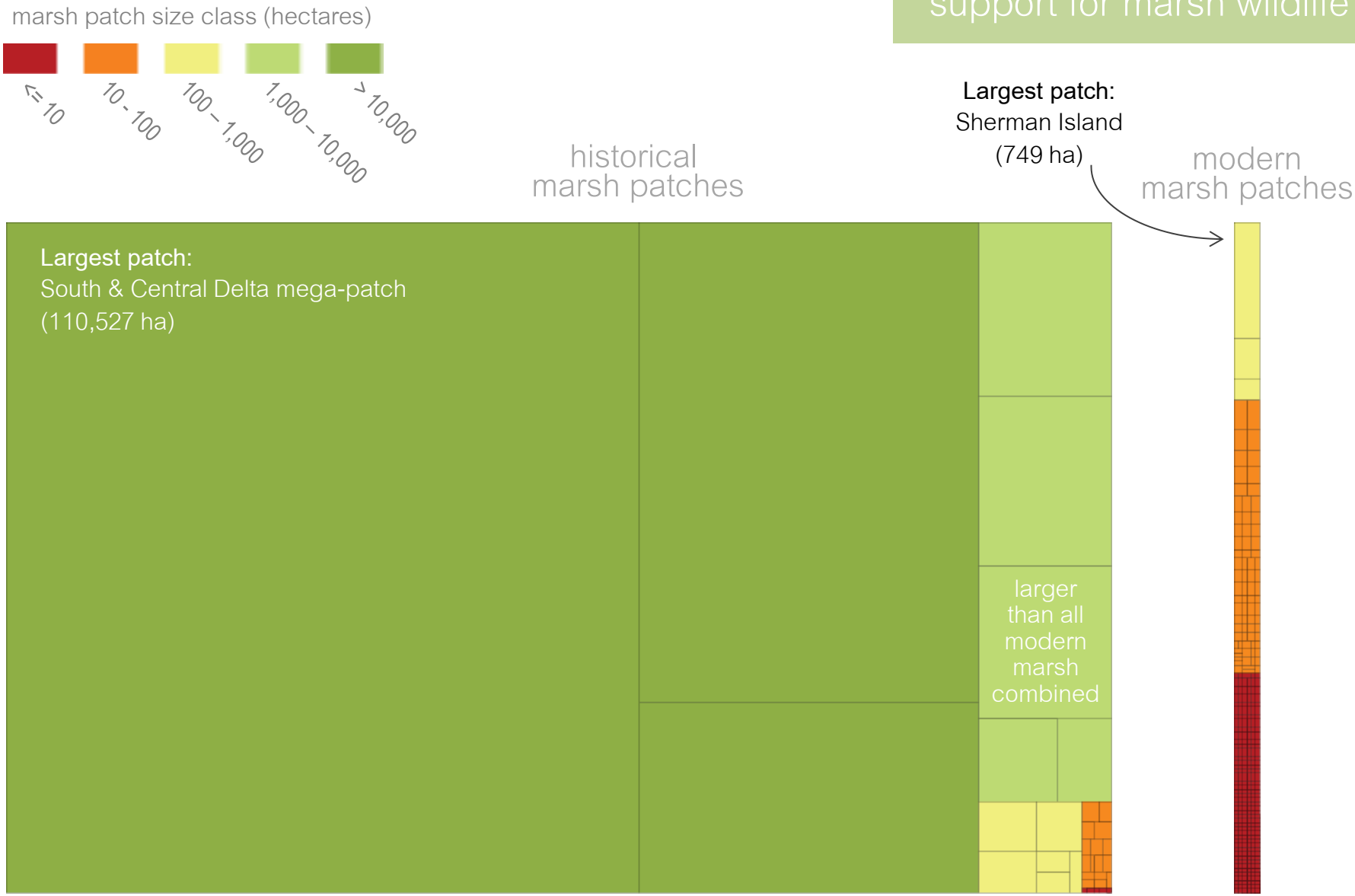
Historical: 192,000 ha

Modern: 1,000 ha

marsh patch size class (hectares)

- <= 10 ha
- 10 - 100
- 100 – 1,000
- 1,000 – 10,000
- > 10,000

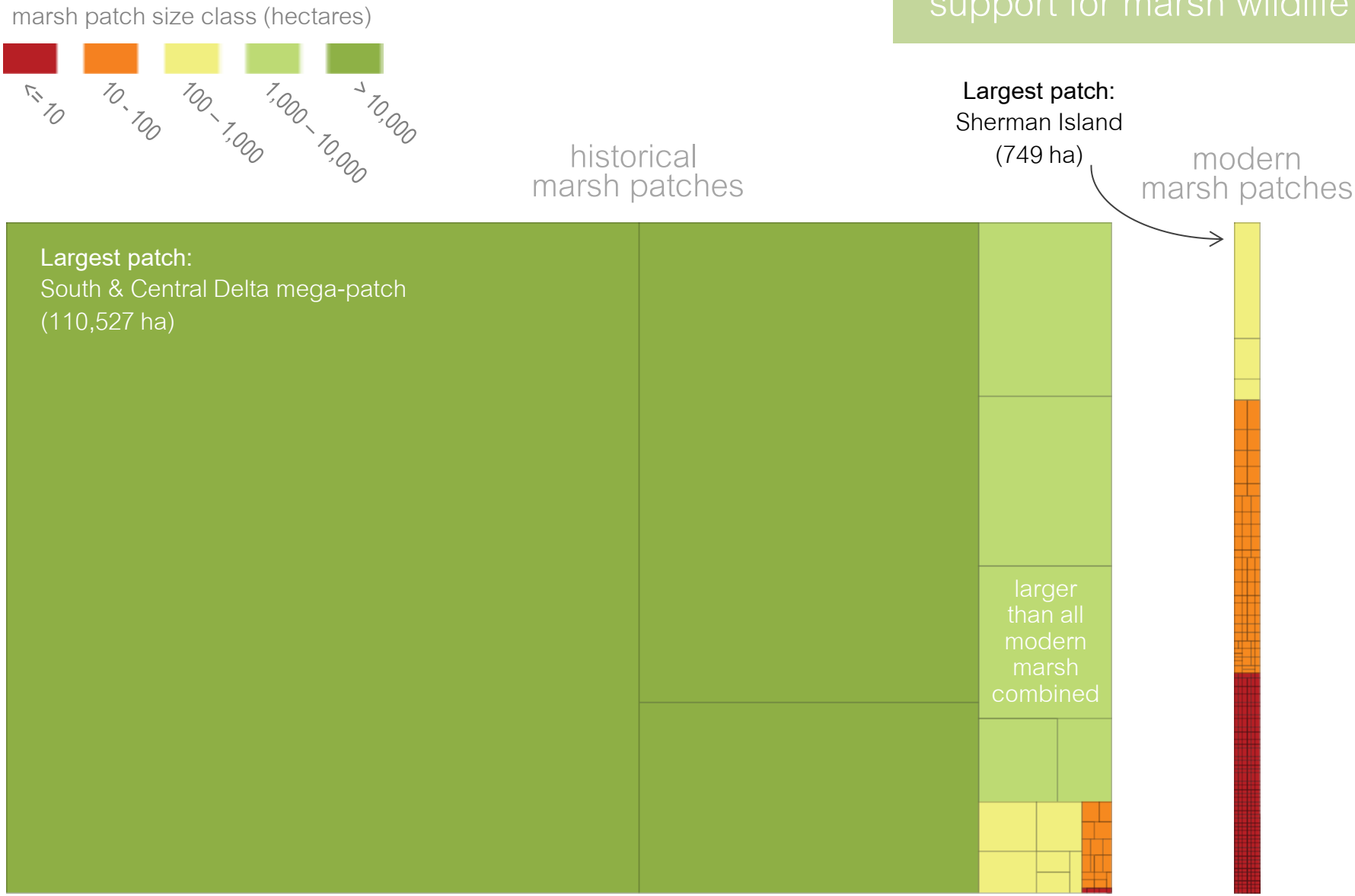
support for marsh wildlife



43
patches

1,211
patches

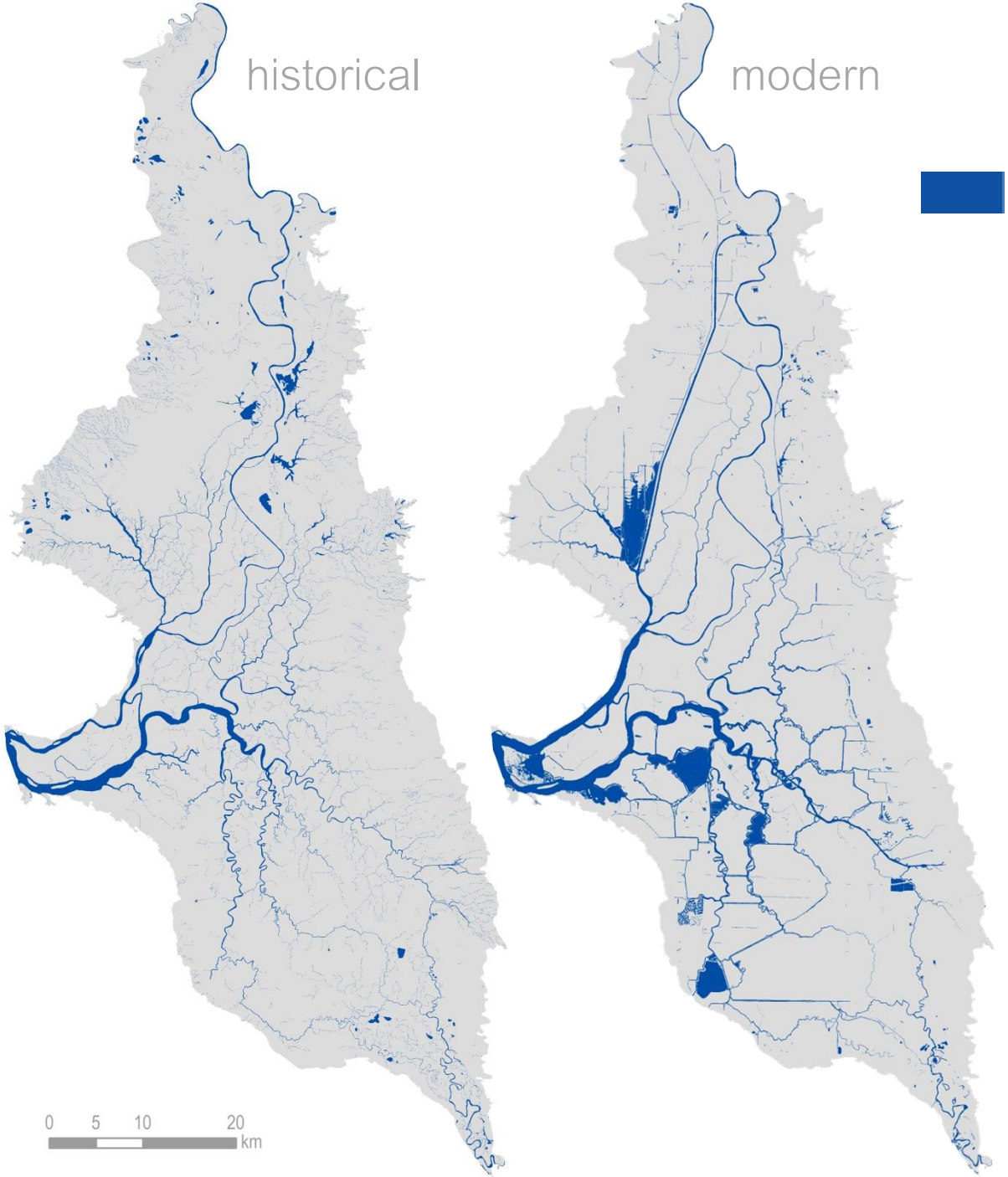
support for marsh wildlife



4,493 ha
average patch size

4 ha
average patch size

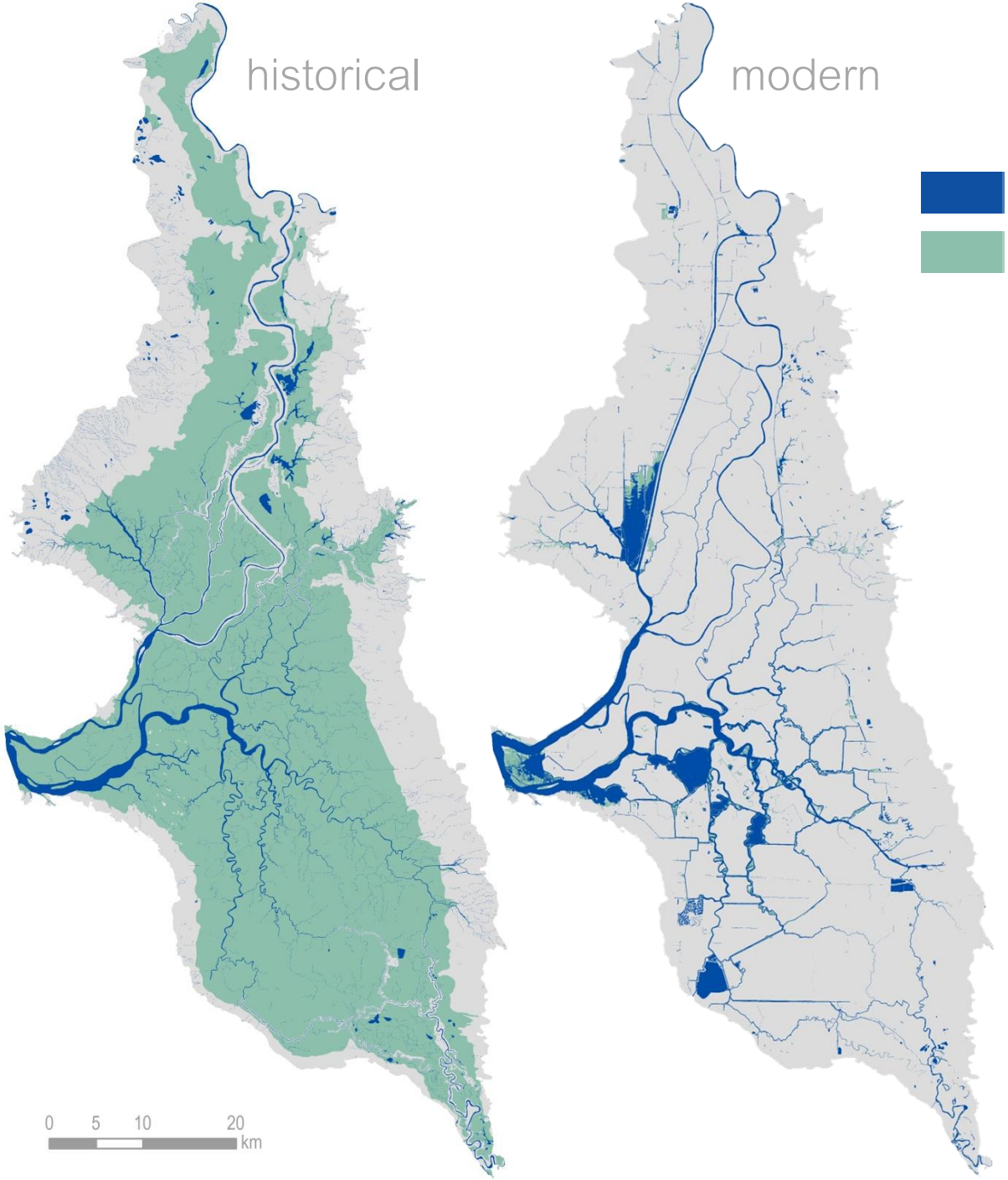
support for native fish



	historical	modern
open water	16,300 ha	26,600 ha

+ 63%

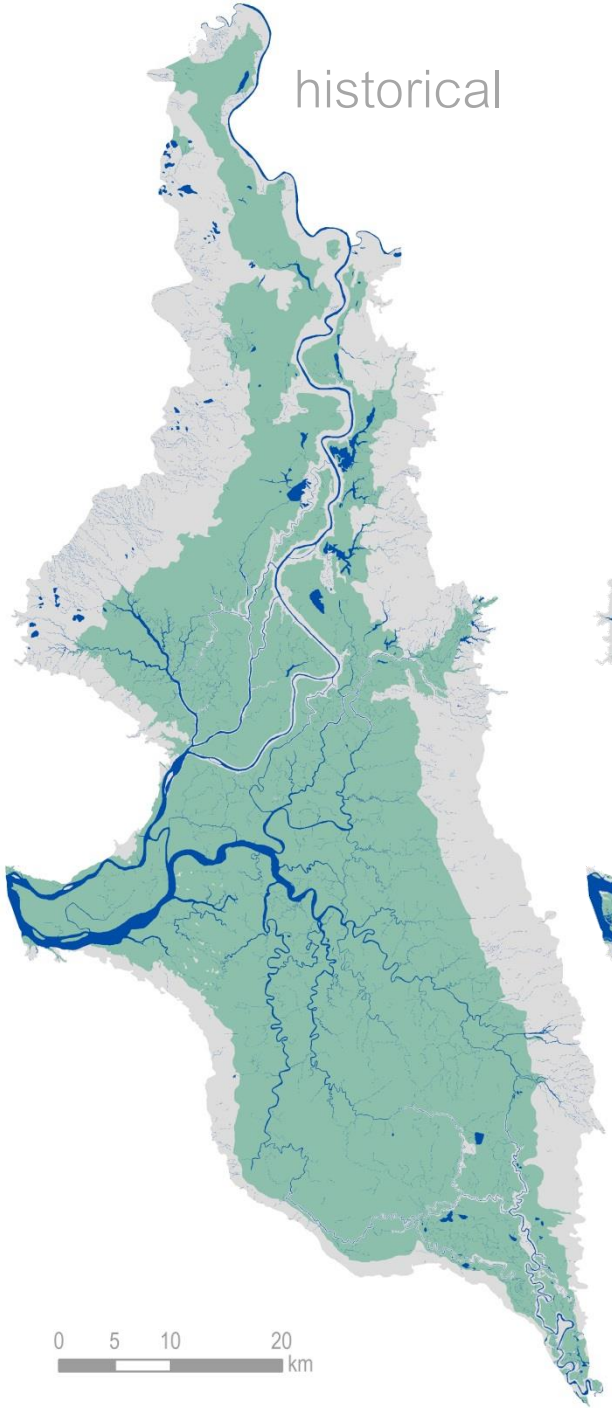
support for native fish

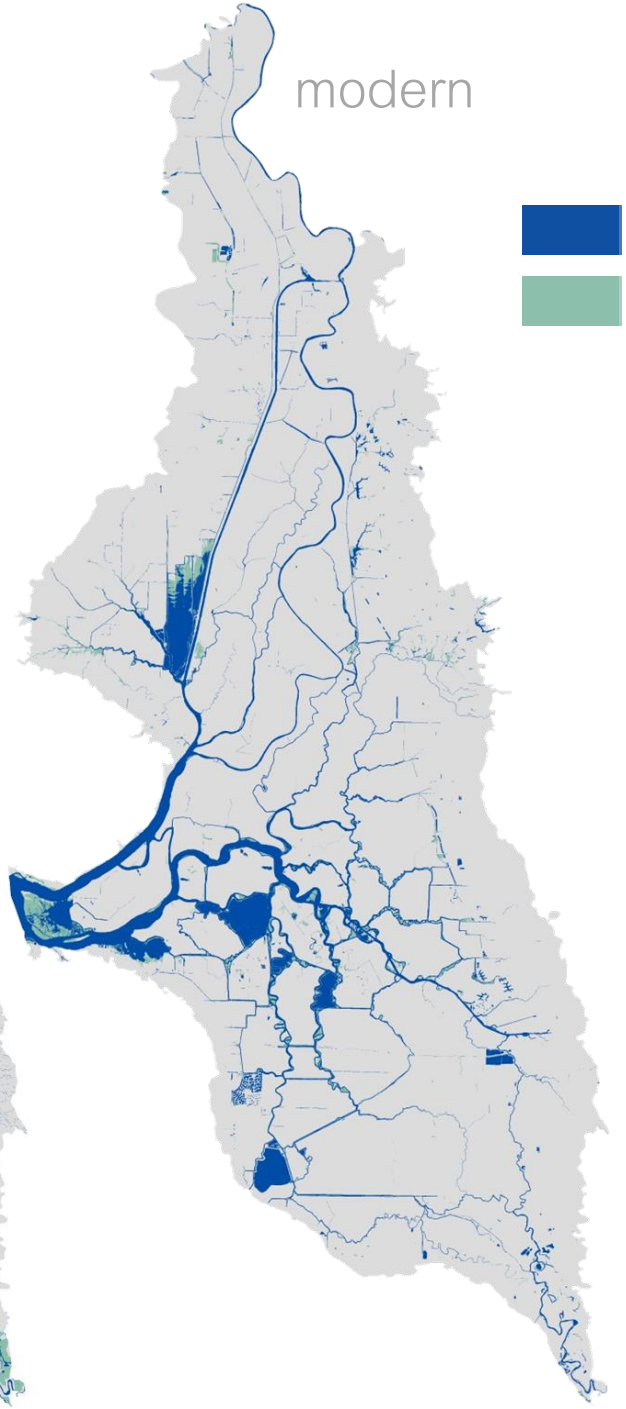


	historical	modern
open water	16,300 ha	26,600 ha
marsh	193,200 ha	4,300 ha

- 98%

support for native fish





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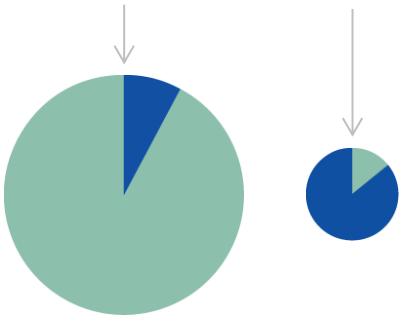
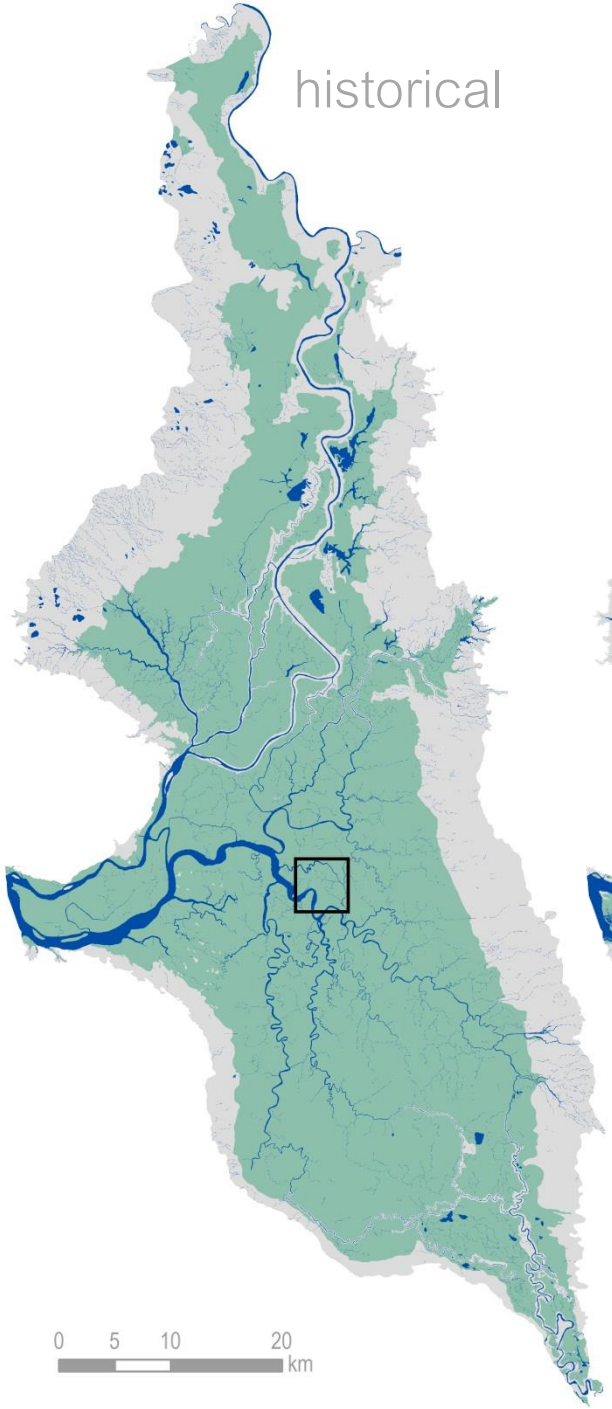
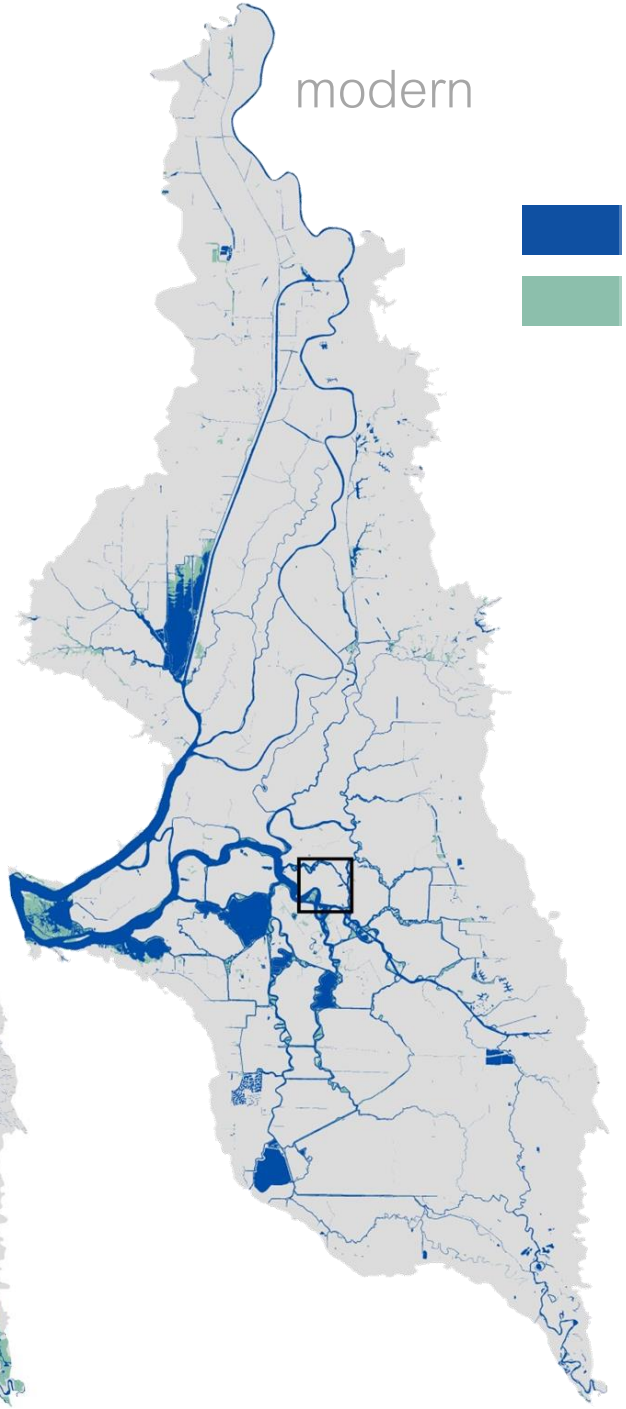


100 : 1,182 100 : 16

74x decrease in marsh to open water ratio

support for native fish





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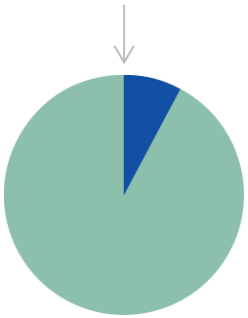
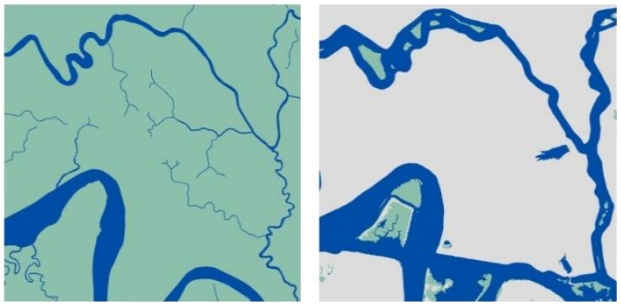


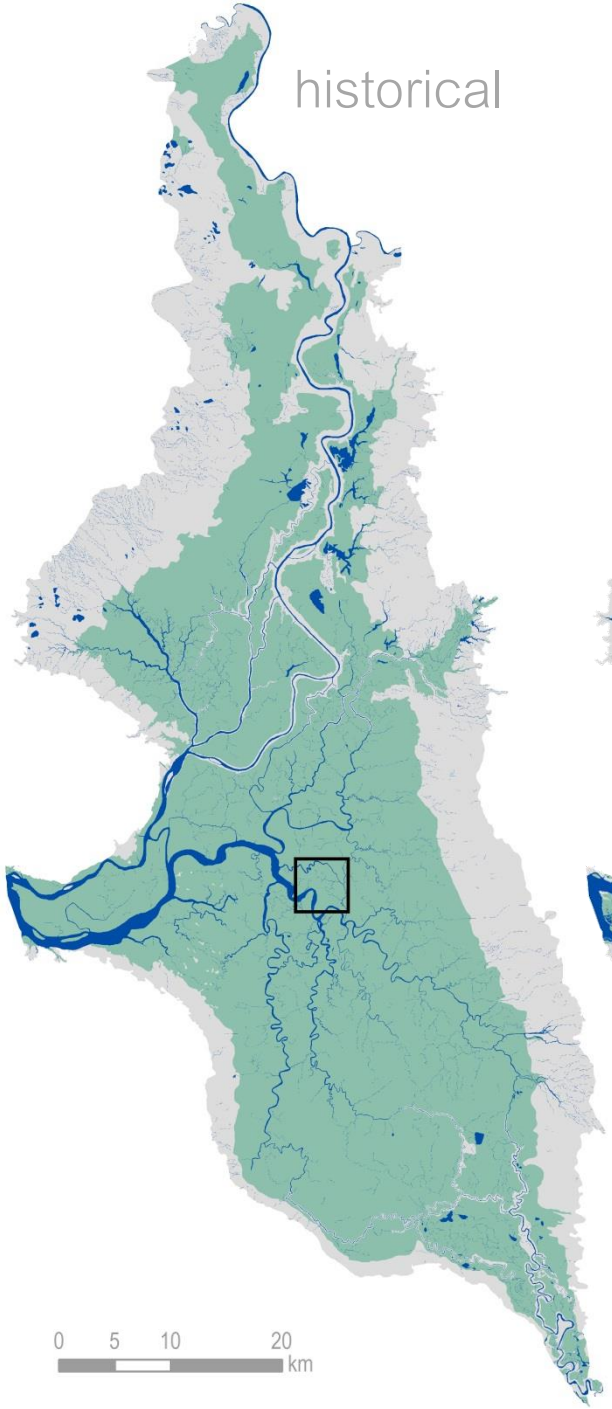
100 : 1,182 100 : 16

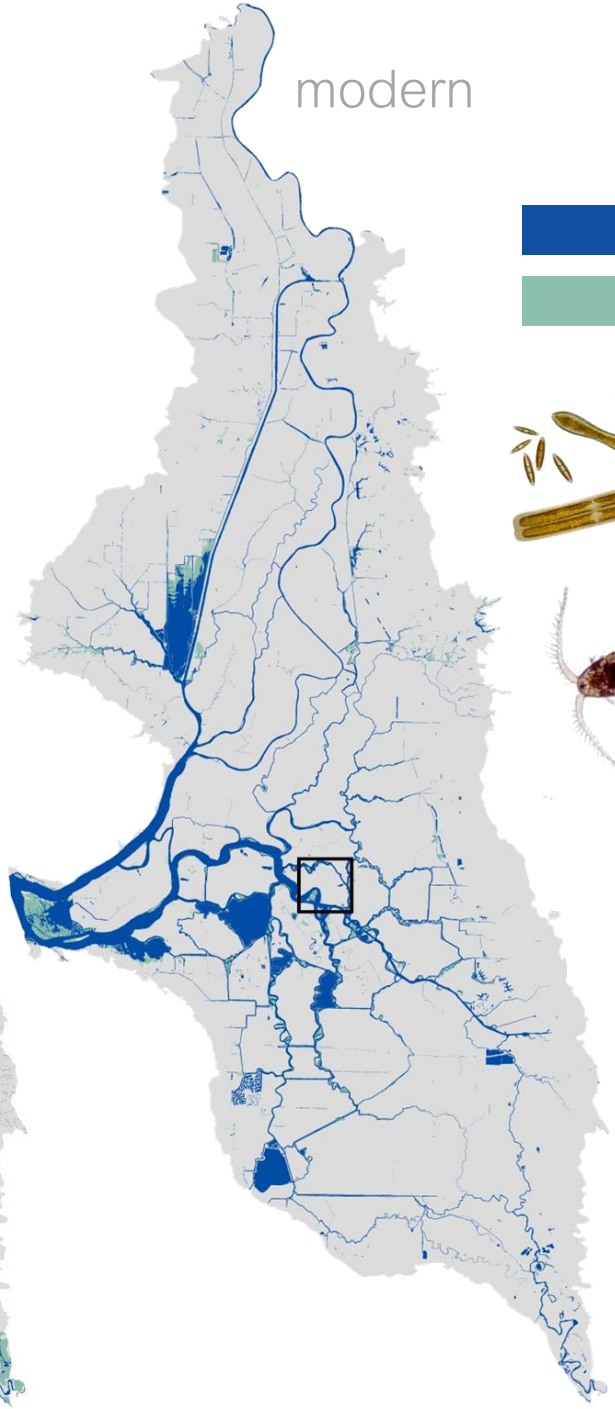
74x decrease in marsh to open water ratio

"channels in marsh" → "marsh in channels"



support for native fish





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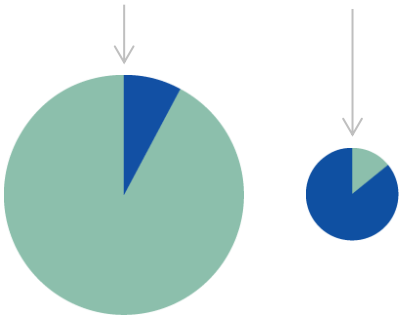

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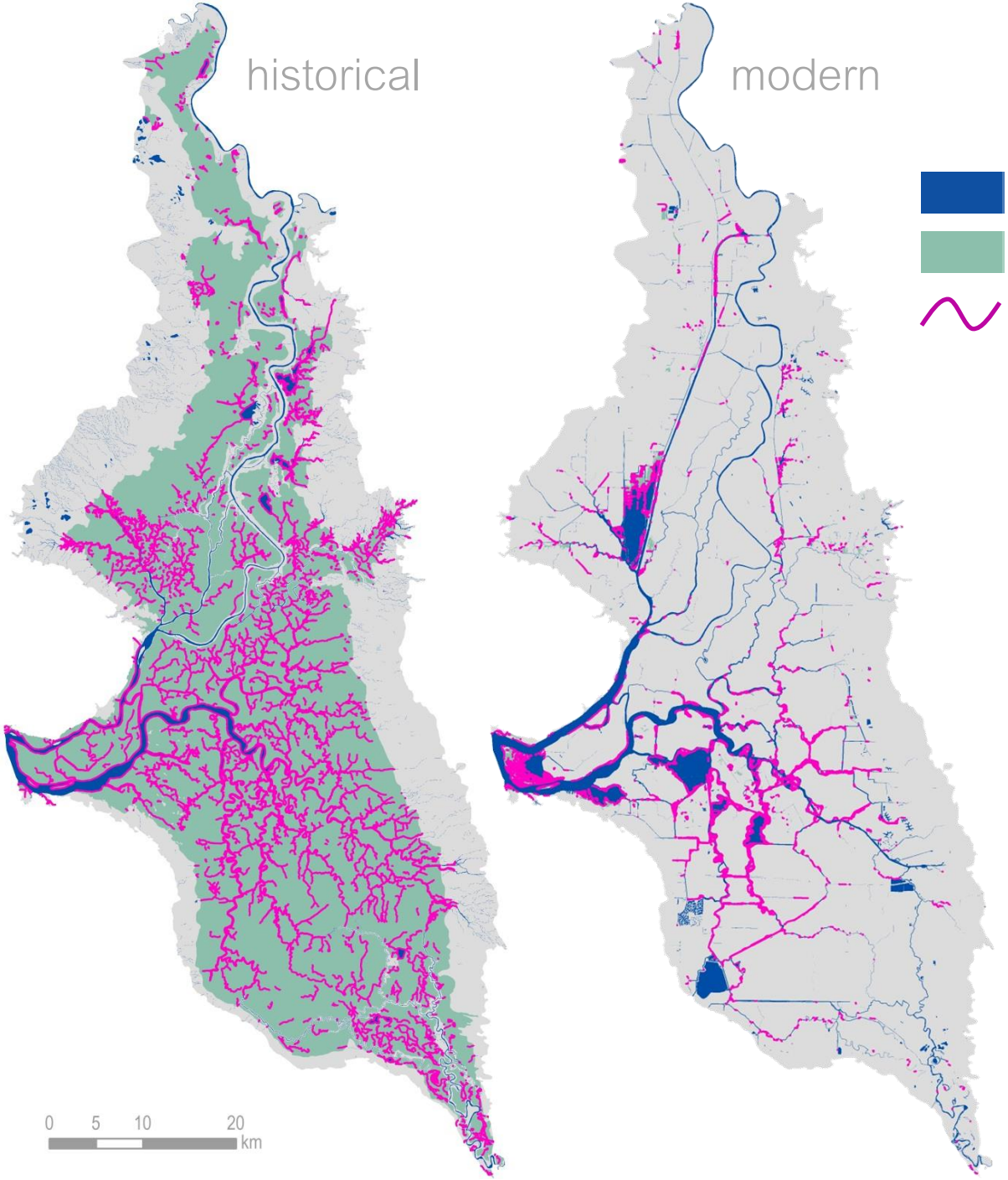

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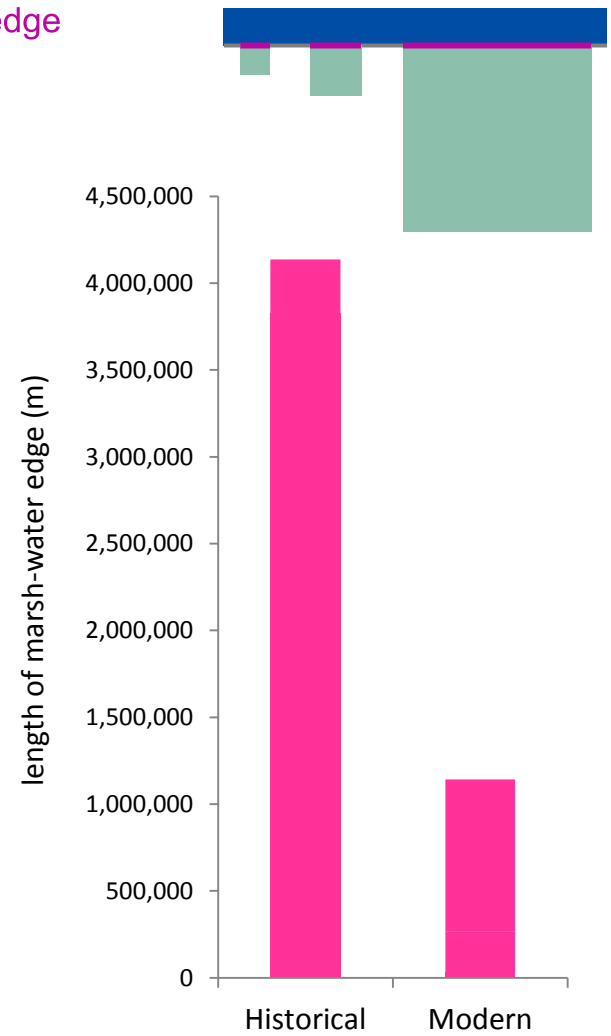
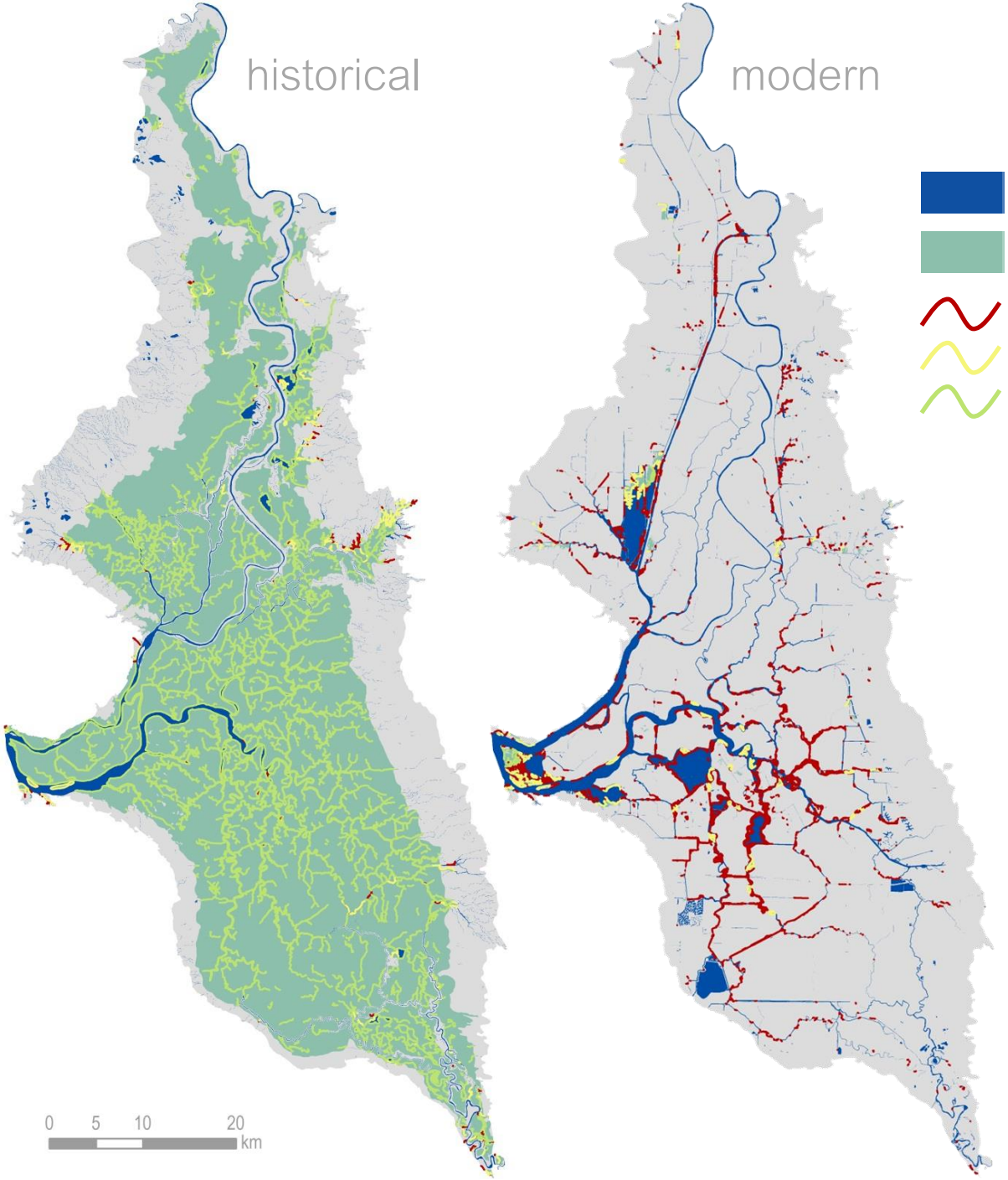
edge		



support for native fish



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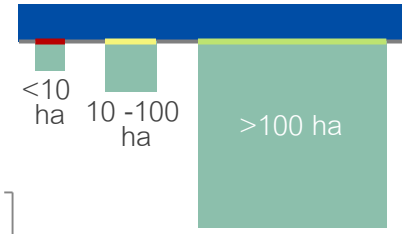
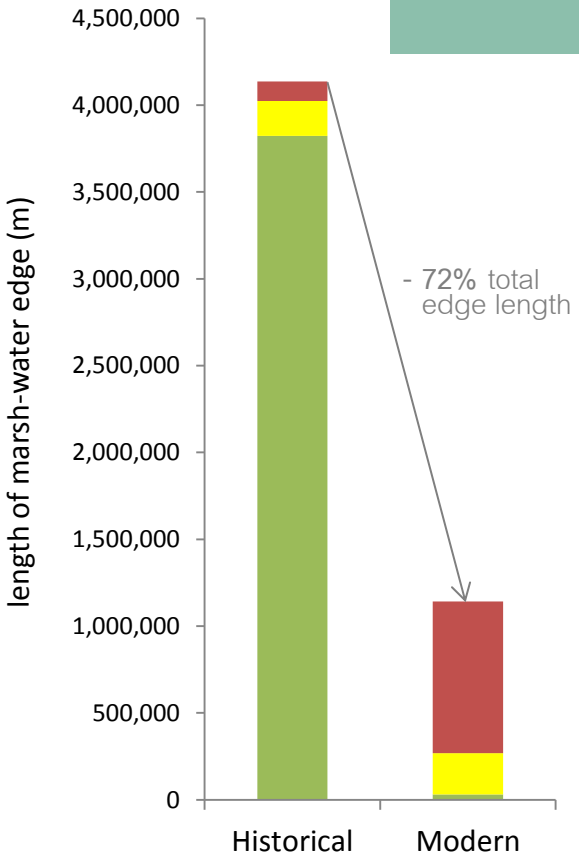
edge classified by marsh size





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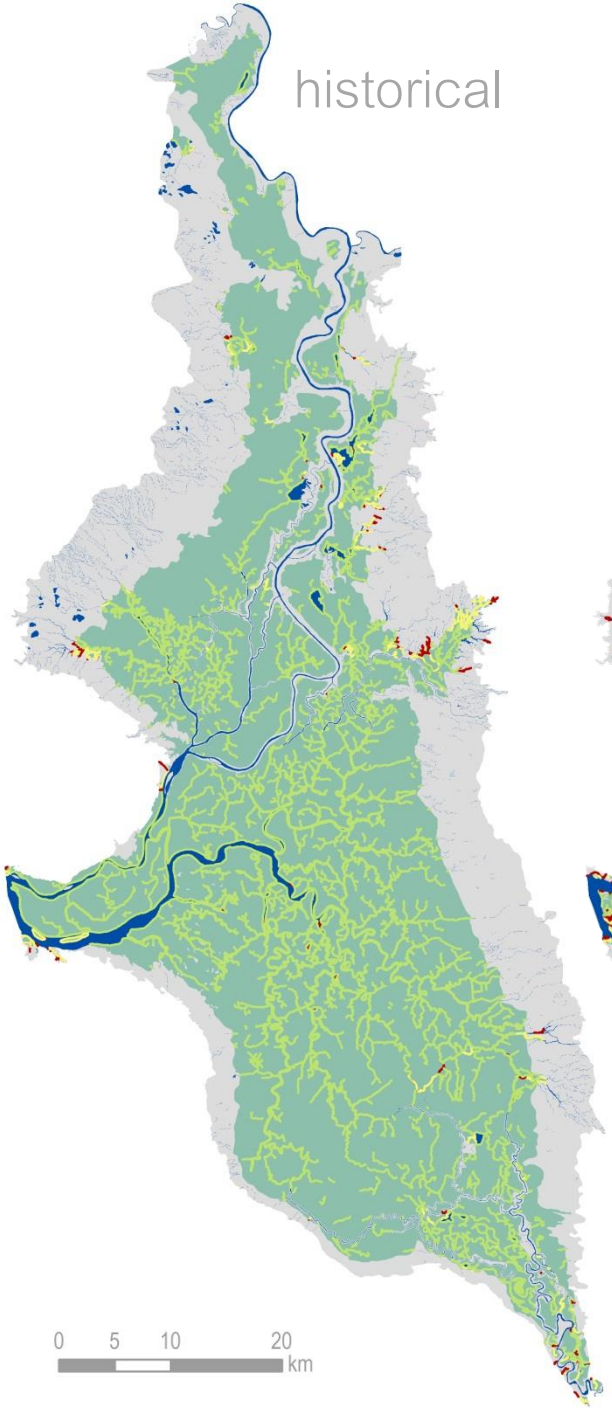

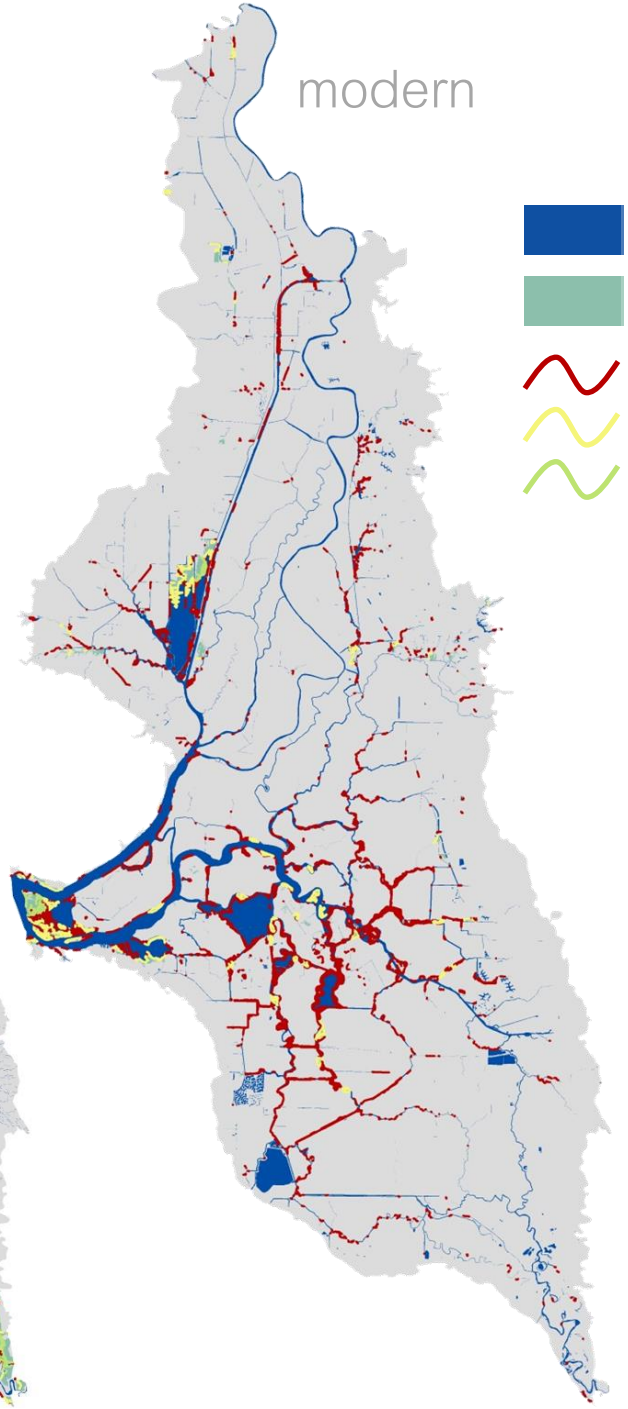

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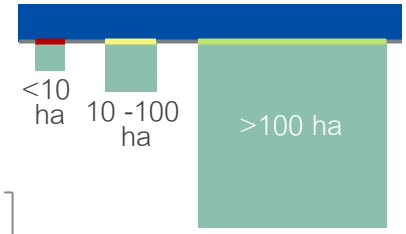
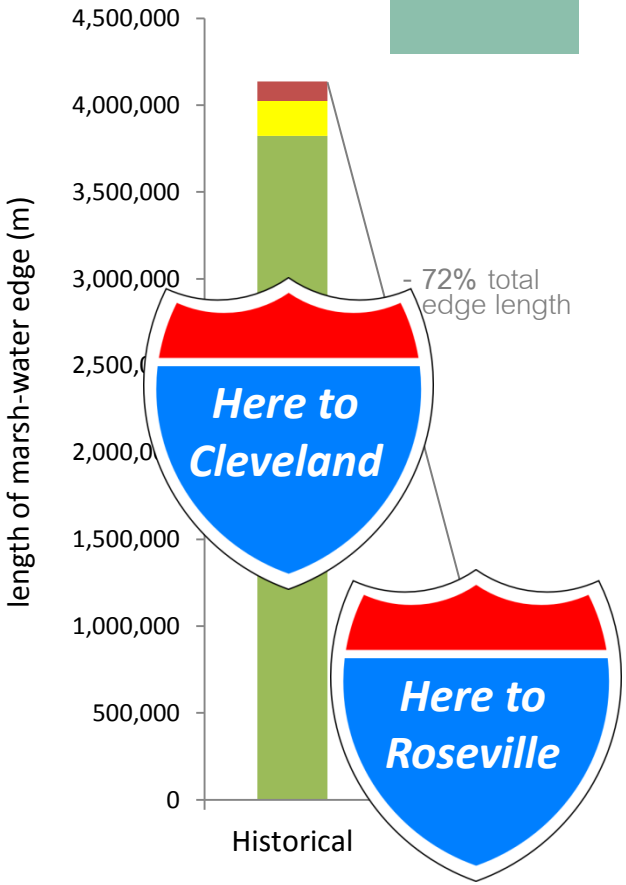
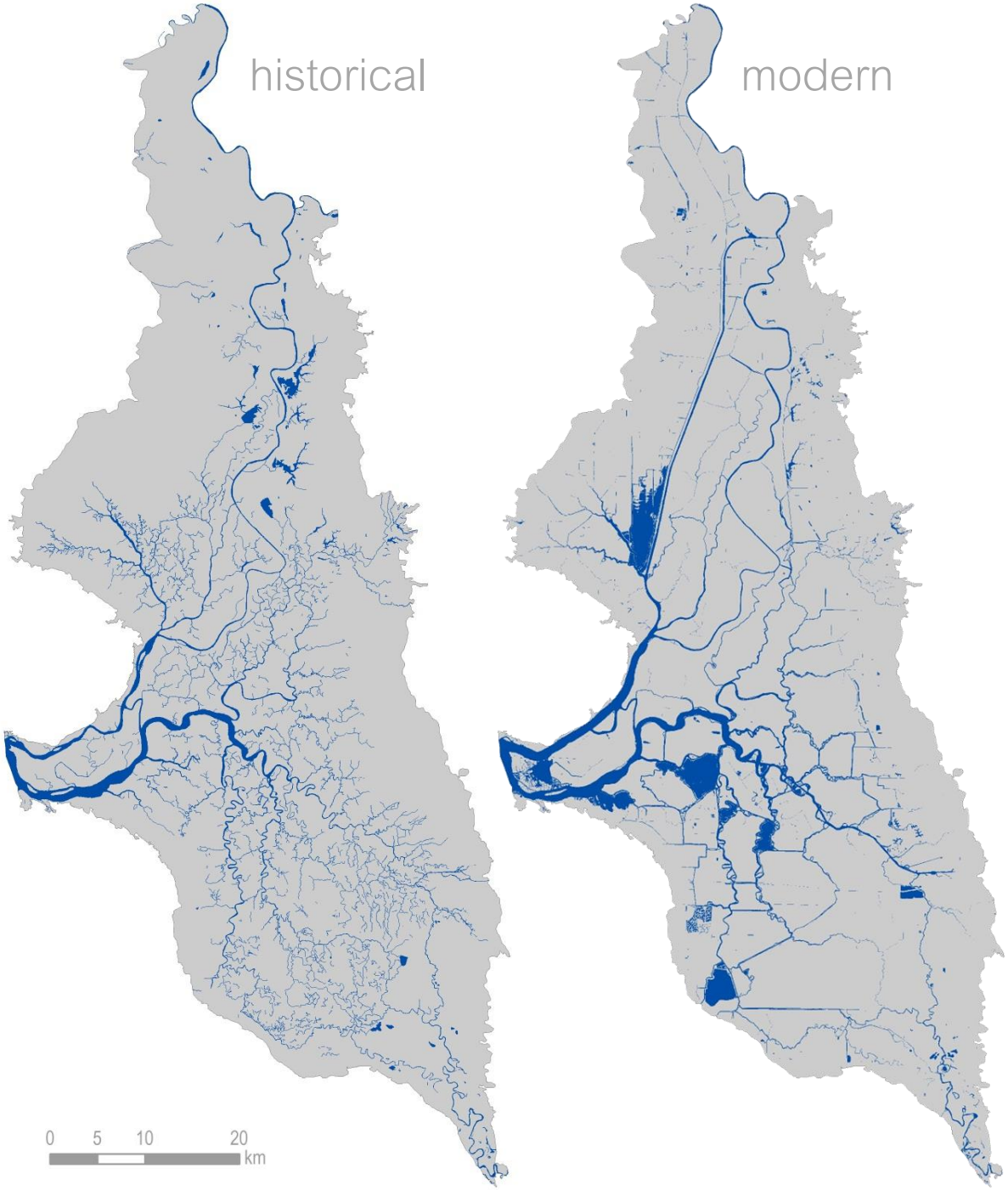




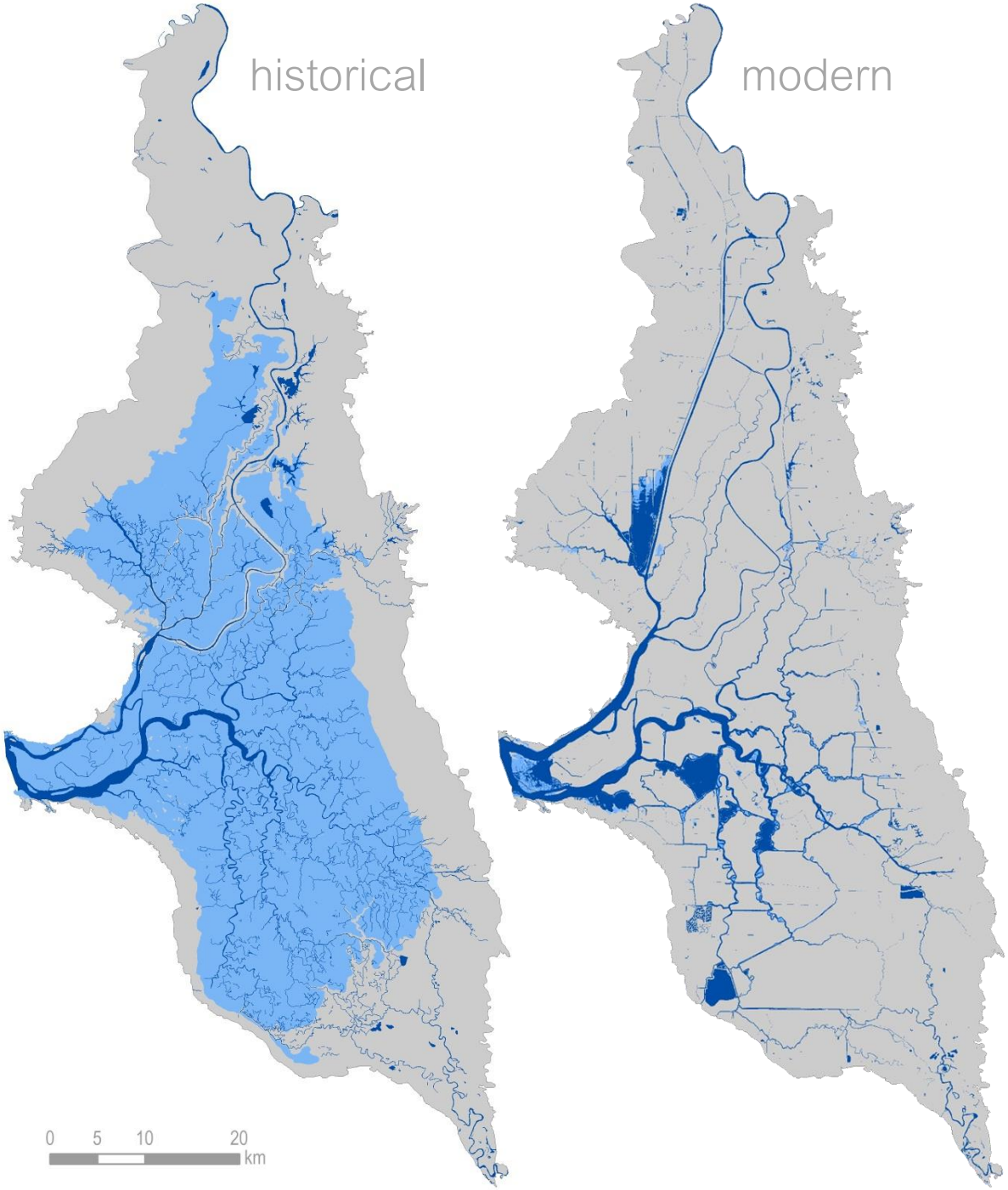


PONDS, LAKES, CHANNELS, FLOODED ISLANDS

Mostly perennial open water features

- variable depth

support for native fish



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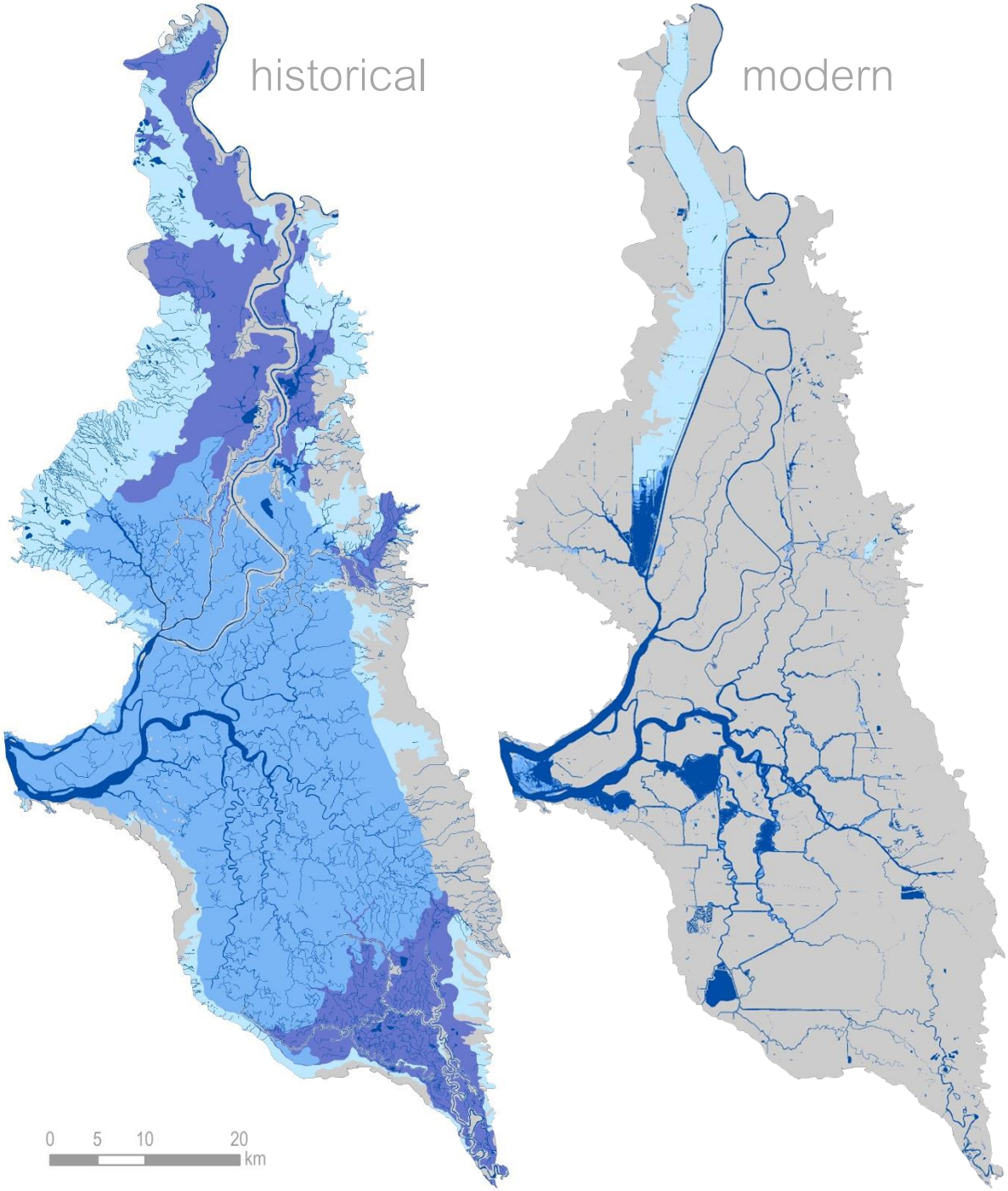
Mostly perennial open water features

- variable depth

TIDAL INUNDATION

Diurnal overflow of tidal sloughs into marshes

- high recurrence (2x daily to monthly)
- low duration (< 6 hrs per event)
- low depth ("wetted" up to .5 m)



support for native fish

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SEASONAL LONG DURATION FLOODING

Prolonged inundation from river overflow into flood basins

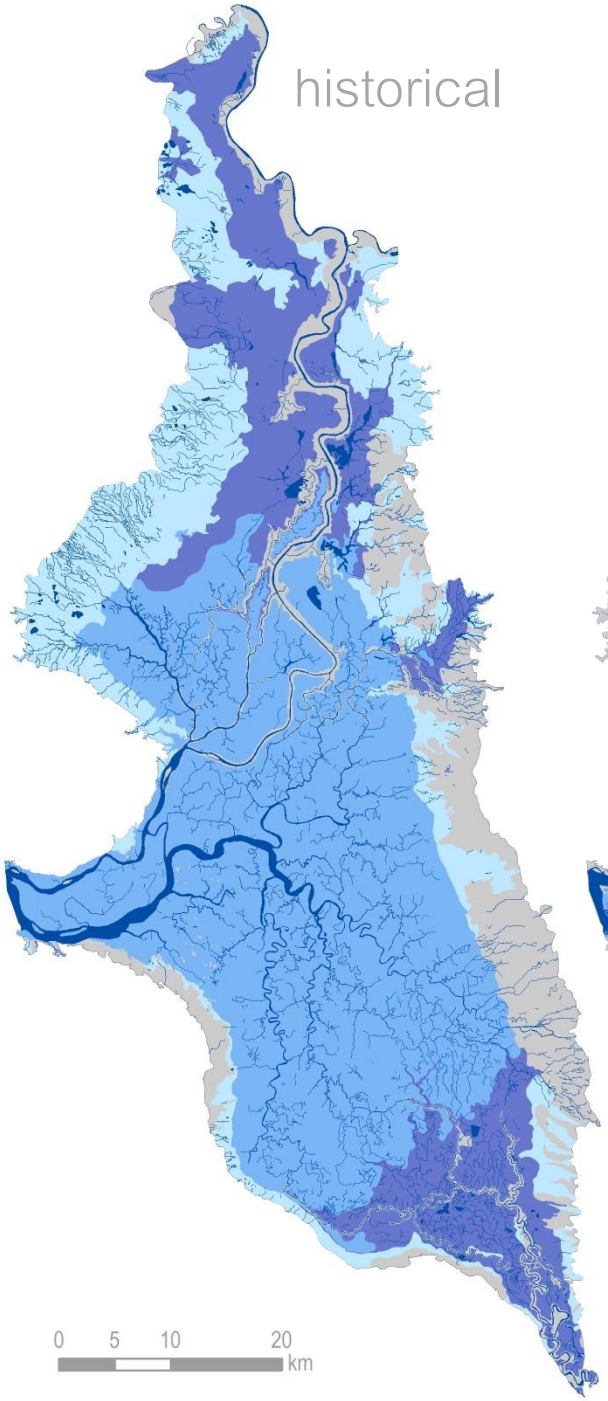
- low recurrence (~1 event per year)
- high duration (persists up to 6 month)
- generally deeper than 'seasonal short-term flooding'

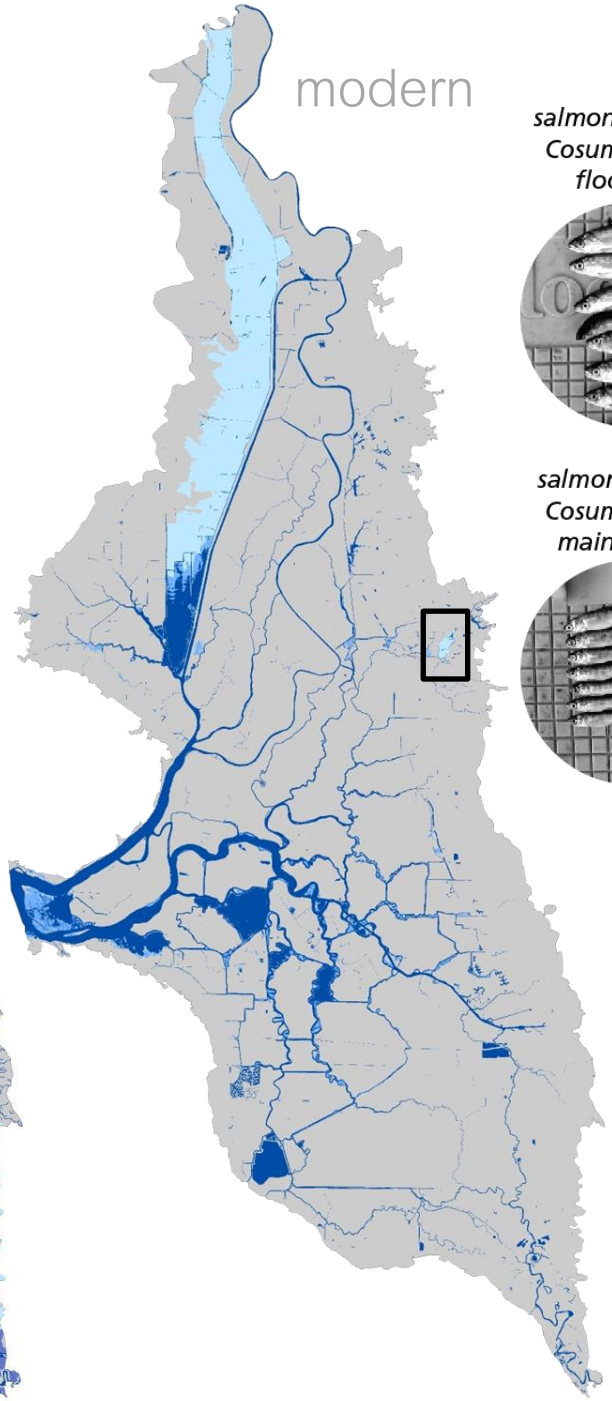
SEASONAL SHORT-TERM FLOODING

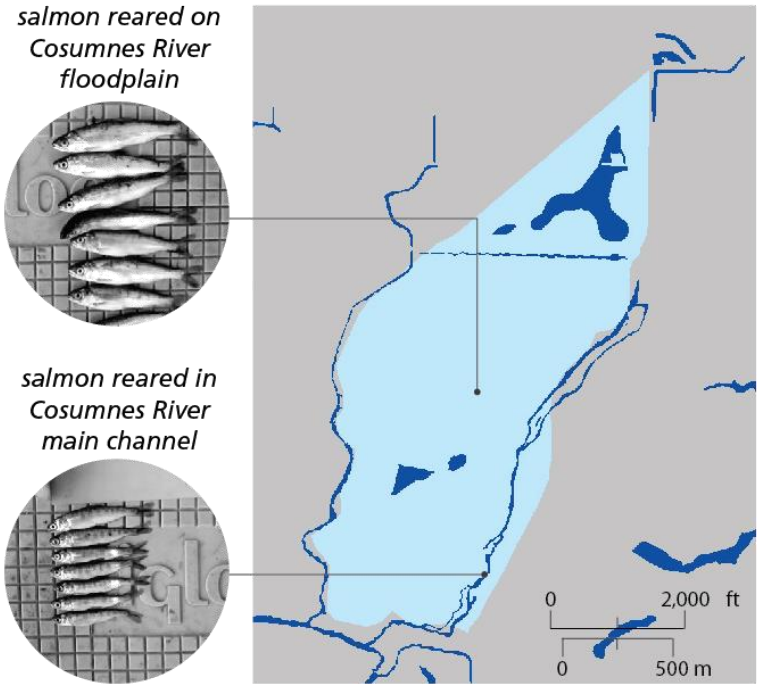
Short-term fluvial inundation

- can be multiple events per year
- low duration (days-weeks per event)
- generally shallower than 'seasonal long duration flooding'

support for native fish





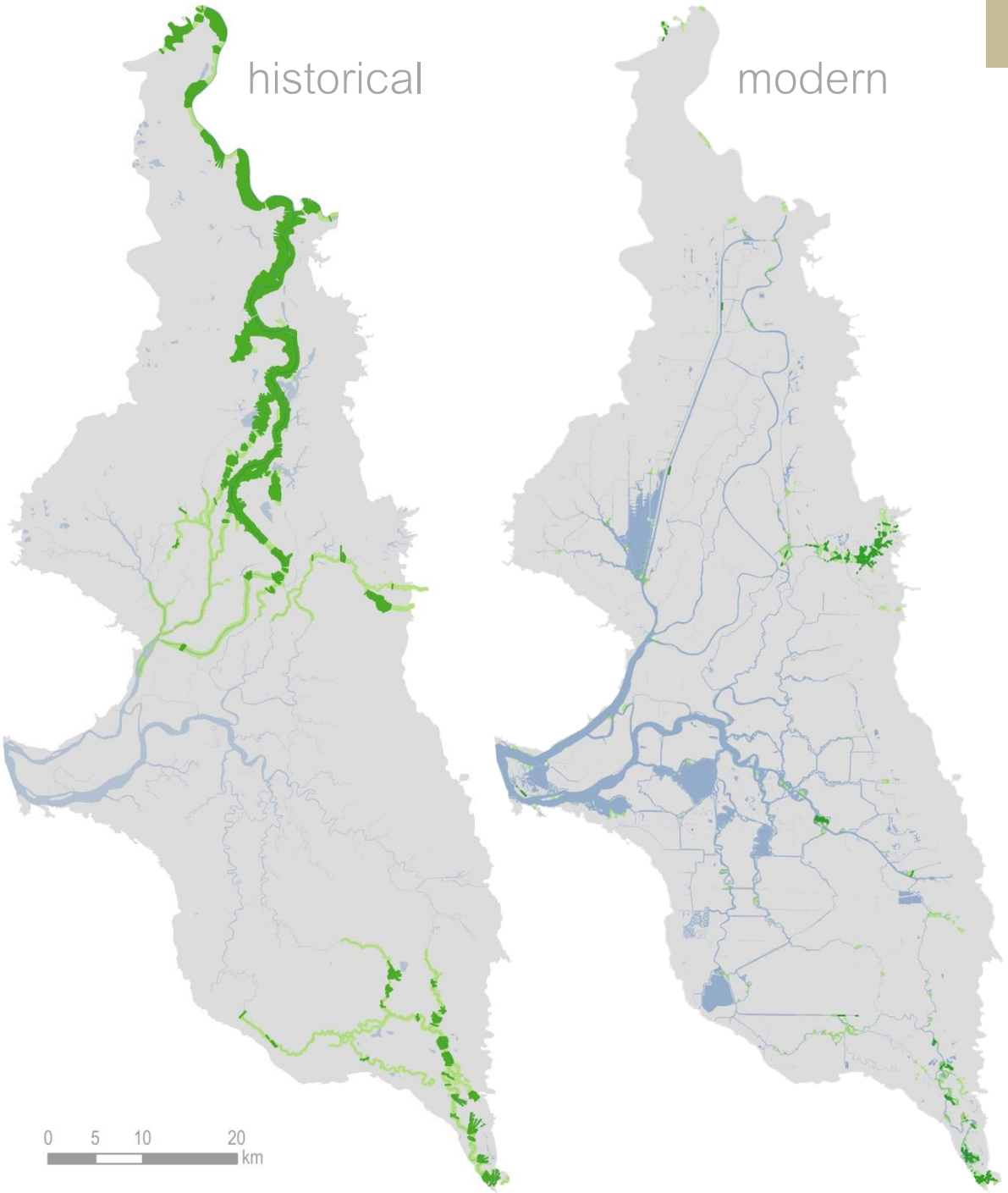


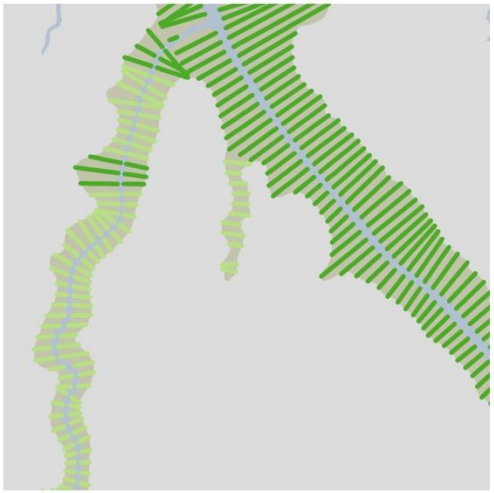
photos by Jeff Opperman, 2006

Juvenile salmon reared in ephemeral floodplain habitats of the Cosumnes River have been found to grow significantly larger than juvenile salmon reared only within the Cosumnes River (Jeffres et al. 2008).

- **PONDS, LAKES, CHANNELS, FLOODED ISLANDS**
- **TIDAL INUNDATION**
- **SEASONAL LONG DURATION FLOODING**
- **SEASONAL SHORT-TERM FLOODING**

support for riparian wildlife





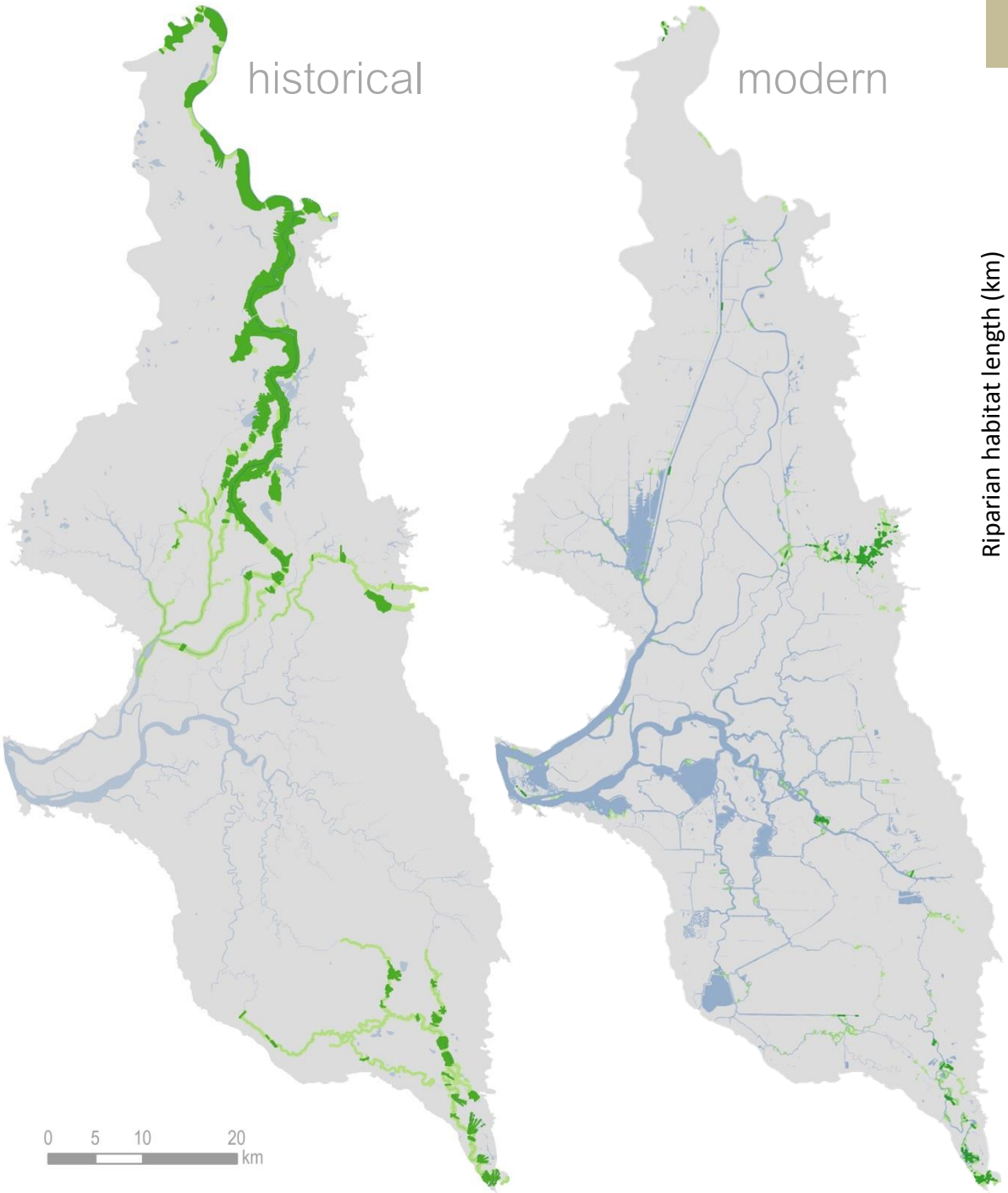
riparian forest width (transects)

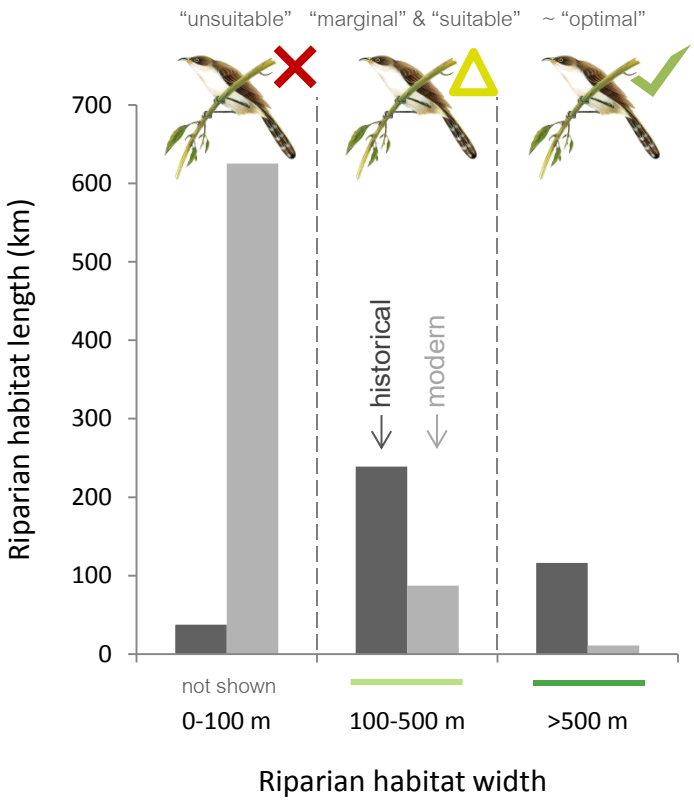
> 100 m wide

> 500 m wide

riparian forest < 100 m wide not shown

support for riparian wildlife





Majority of riparian habitat today is of "unsuitable" width to support yellow billed cuckoos (Laymon & Halterman 1989). Length of forest of "optimal" width has decreased by 91%

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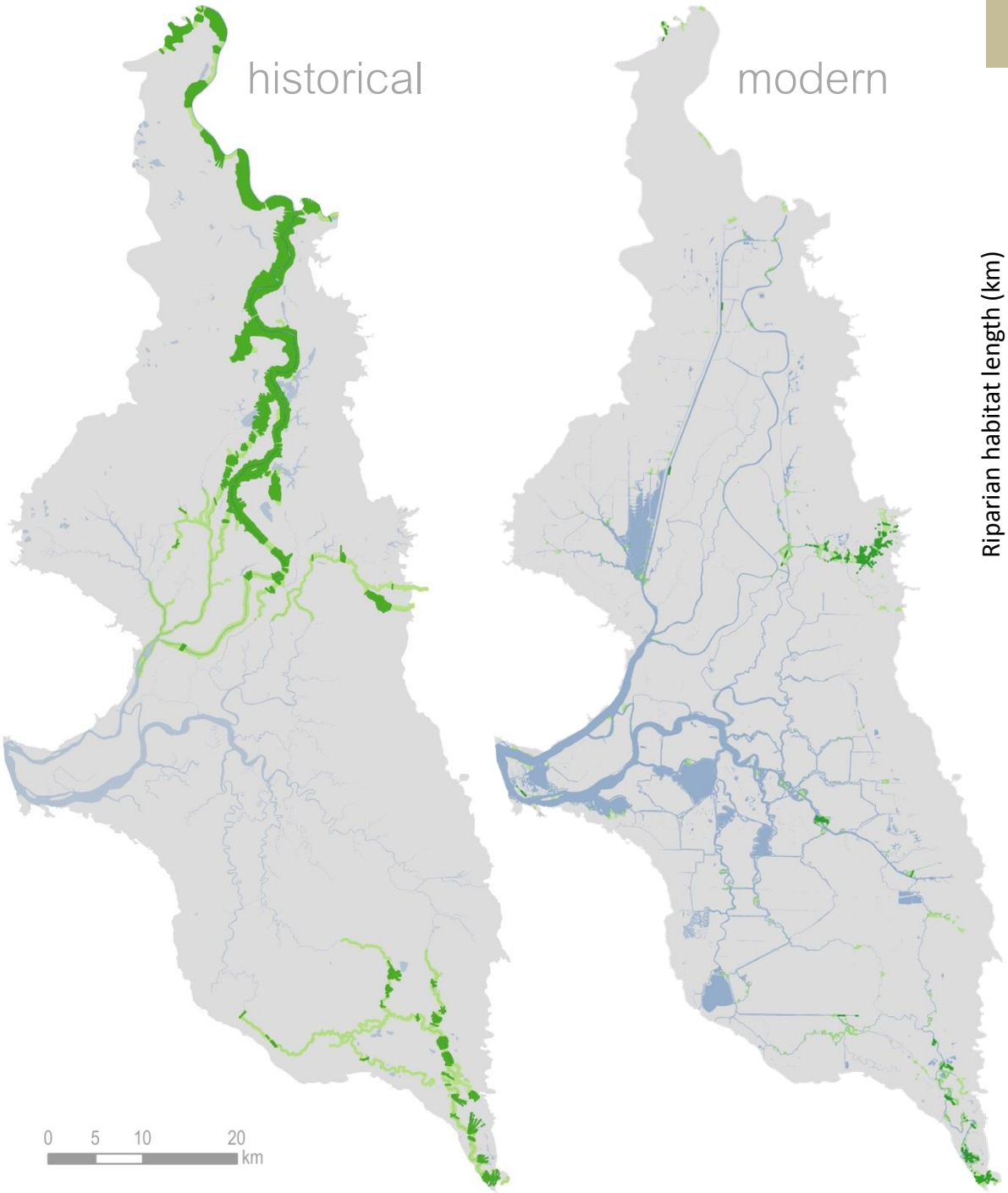
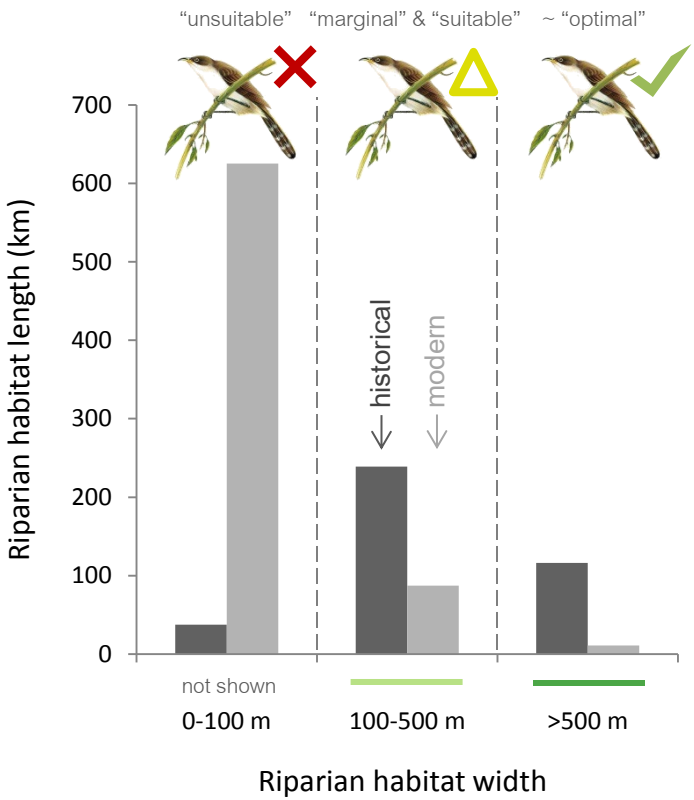
1. Define target ecological functions in HL
2. Identify desired system attributes or characteristics (spatial metrics)
3. Quantify landscape change metrics
4. Describe subregional potential (physical drivers, opportunities)
5. Create conceptual Operational Landscape Units
6. Produce restoration guidelines and potential performance metrics

support for riparian wildlife





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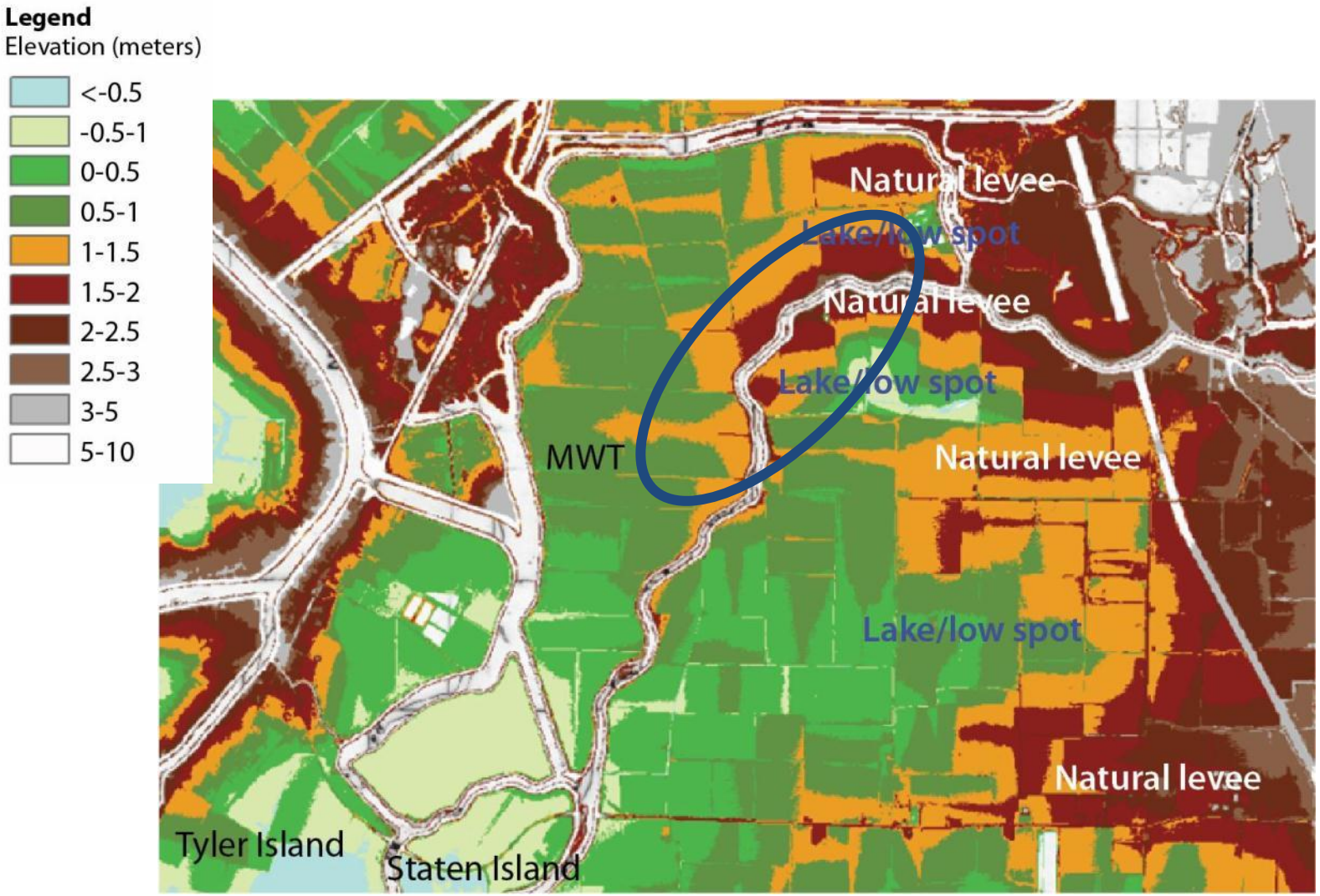
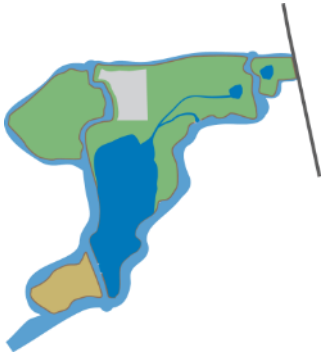
Case study: McCormack-Williamson Tract

- **Opportunities**
- Large restoration opportunity
- Variable topography
- Connection to uplands and tides
- Remnant historical features

Topographic Variability



MWT proposed



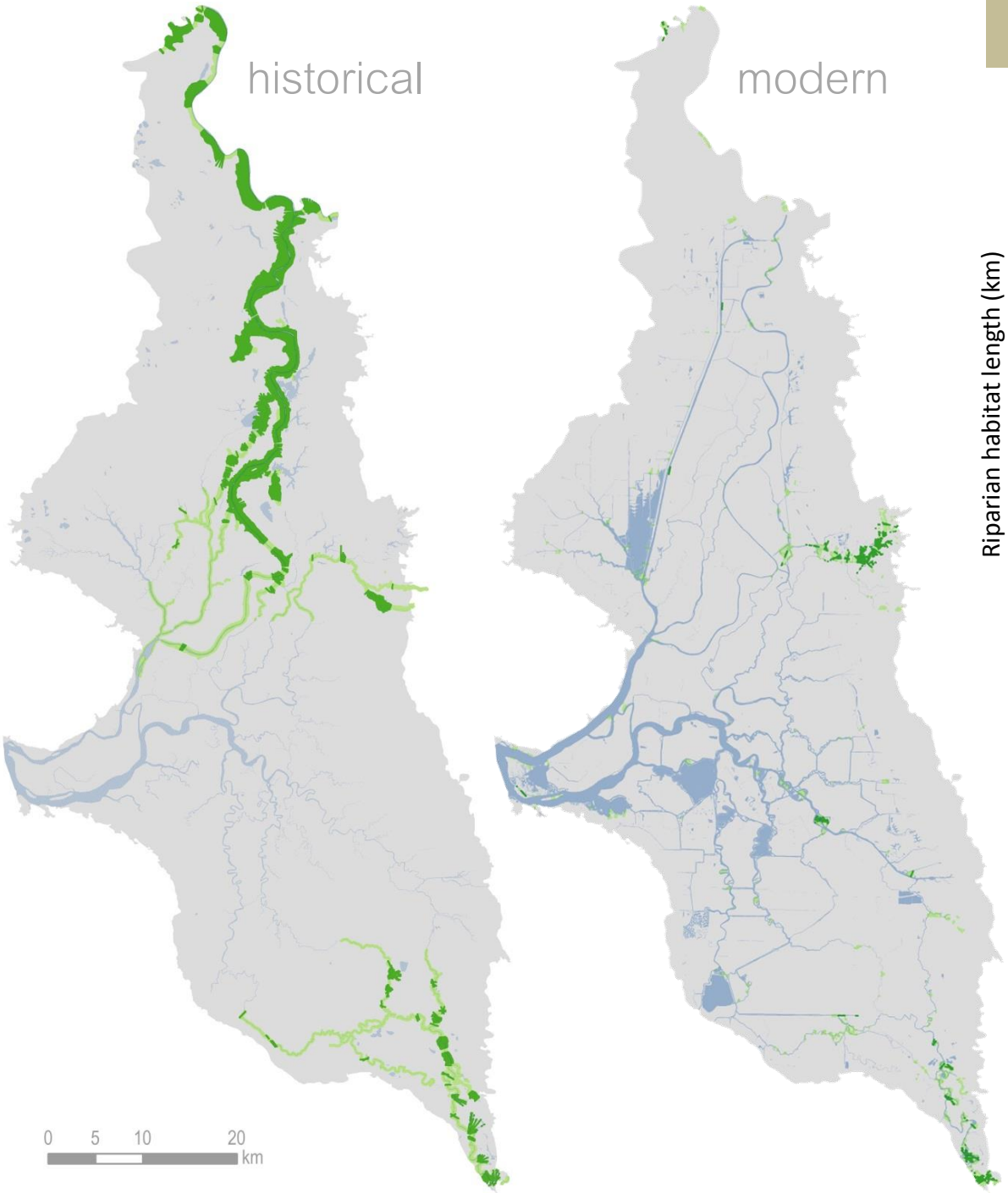
MWT as part of OLU

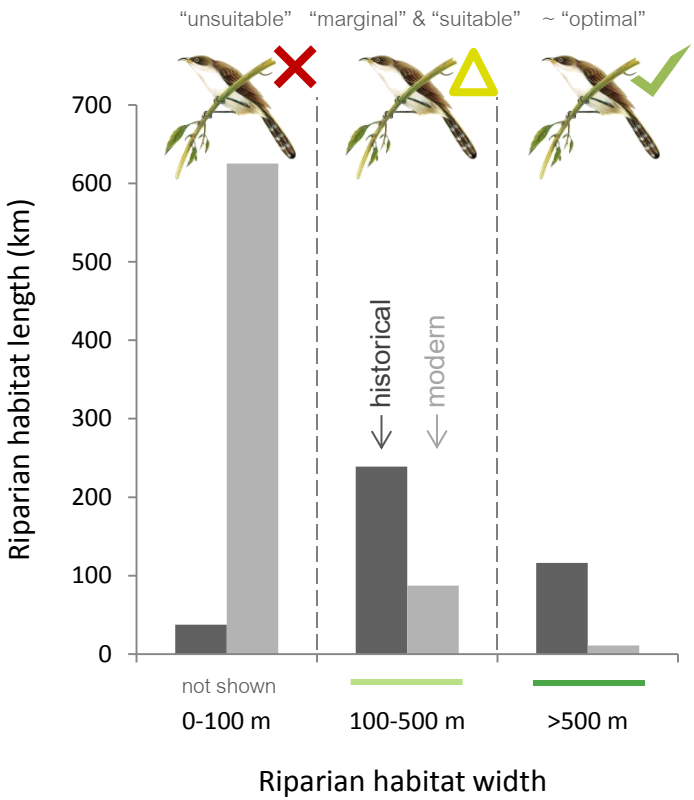
Habitat and Connectivity for Native Species

Wide Riparian Forest (>500m)	**none**	**2 km?**
Wide and Connected Riparian Forest	**none**	**>10 km**

note: sample #s

support for riparian wildlife





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What constitutes a functional landscape?

ecological functions + **physical drivers** = **operational landscape unit**

(Verhoeven et al. 2008)

with specific Landscape Metrics and associated Ecological Functions at Regional and Subregional scale

THANKS

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