



Baseline Technical Review

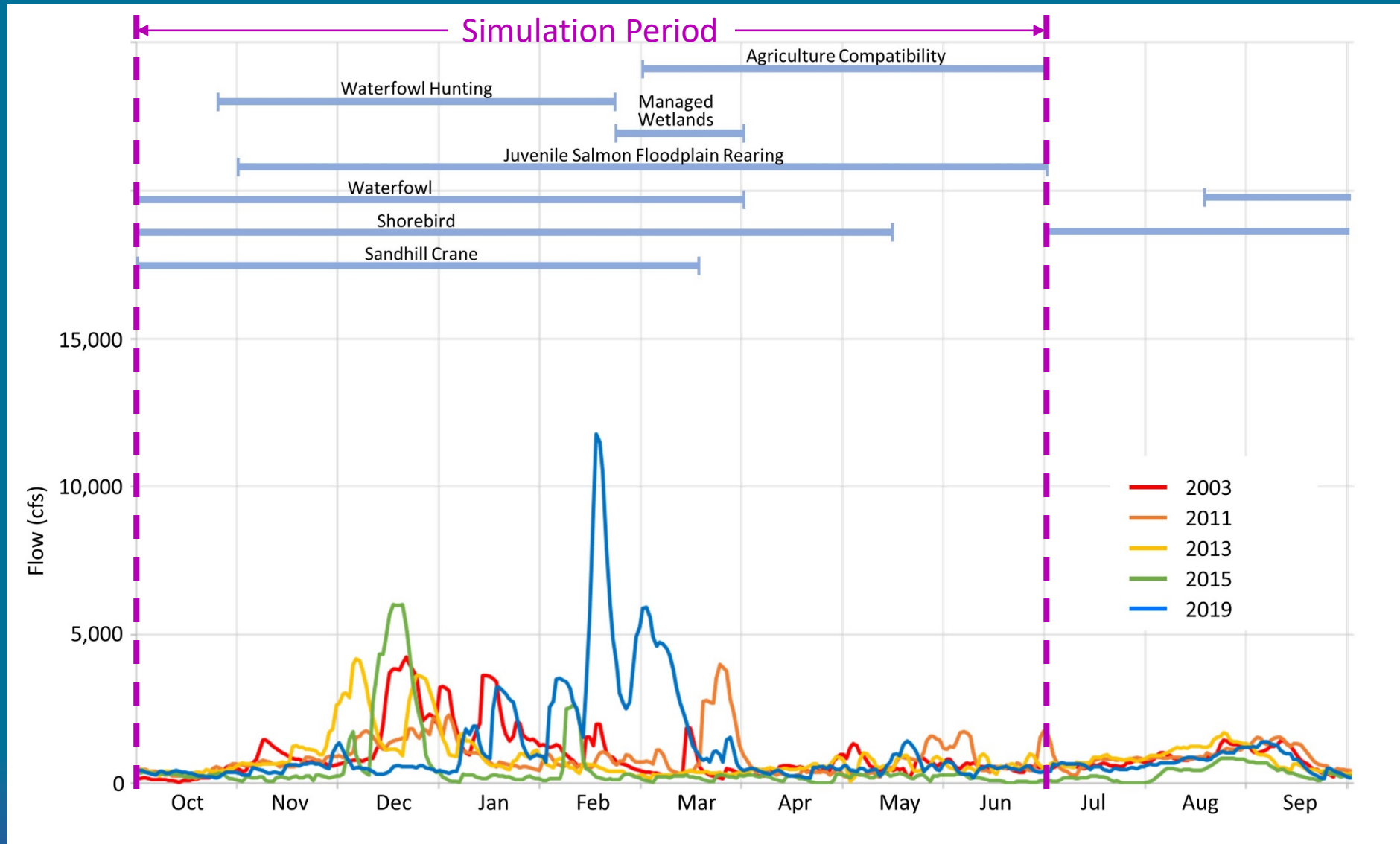
Floodplains Reimagined



Overview

- **Key Findings**
- **Result Discussion**
 - **Ecosystem**
 - Floodplain Juvenile Salmon HSI
 - Waterfowl HSI
 - Salmon & Waterfowl Overlap HSI
 - Salmon Benefits Model
 - Shorebird HSI
 - Sandhill Crane HSI
 - Roosting
 - Foraging
 - **Secondary Productivity**
 - Secondary Productivity HSI
 - Productive Export Potential
 - **Impacts**
 - Agricultural Compatibility
 - Waterfowl Hunting
 - Managed Wetland

Selected Water Years: Colusa Drain at Highway 20



Key Findings – Spatial Results

- **Hot spot areas – greater impacts to ag/wetlands, better habitat**
 - Butte Sink – managed (flow-through)
 - Lower Sutter – unmanaged (not as good for birds)
- **Proximity to channel in Butte and Colusa matters**
 - **Farther from channel**
 - Better for birds
 - Better for productivity (managed water is disturbed less, but exports less too)
 - **Near channel**
 - Better for salmon due to being deeper & connected
 - More productive export potential due to more frequent activation
 - More impacts
- **Sutter is flood bypass system, looks like Butte & Colusa near channels**
 - Greater impacts in Agriculture and Managed Wetlands/Hunting
 - More widespread salmon habitat (higher depths + connectivity) & export potential
 - Less widespread habitat for birds (need lower depths)
 - Greater variability from year to year in Sutter than Butte/Colusa

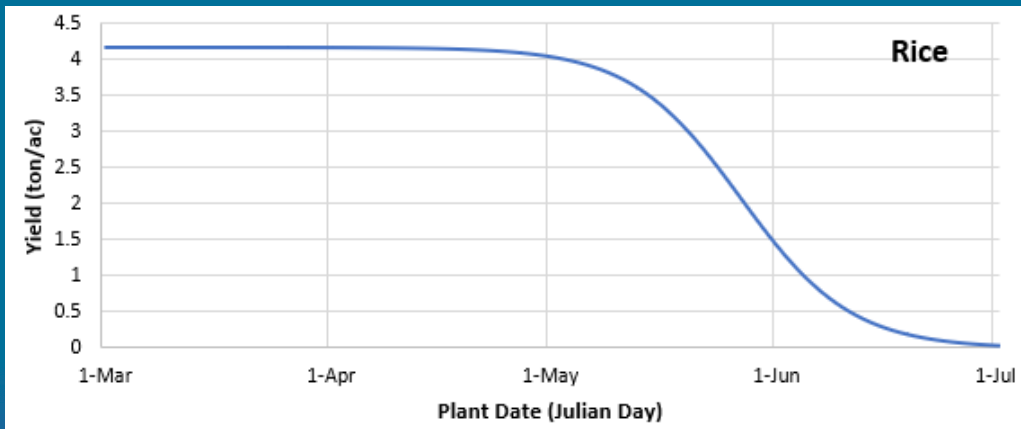
Criteria Review – Habitat

	Cover Types	Depth (in)		Velocity (ft/s)		Connectivity	Optimal Duration (days)
		Min	Max	Min	Max		
Floodplain Juvenile Salmon	Riparian, Wetlands, Rice, Other Ag	7.2	None	None	1.5	Required	14
Secondary Productivity	Wetlands, Rice, Grassland, Other Ag, Riparian	None	None	None	0.33	Assumed	10
Waterfowl	Wetlands, Rice, Other Ag	None	12	None	None	None	None
Shorebird	Wetlands, Rice, Other Ag	None	4	None	None	None	None
Sandhill Crane - Roosting	Wetlands, Rice, Other Ag	None	8	None	None	None	None
Sandhill Crane - Foraging	Wetlands, Rice, Other Ag, (< 5 km from known roost locations)	Dry	2	None	None	None	None

Criteria Review – Impacts

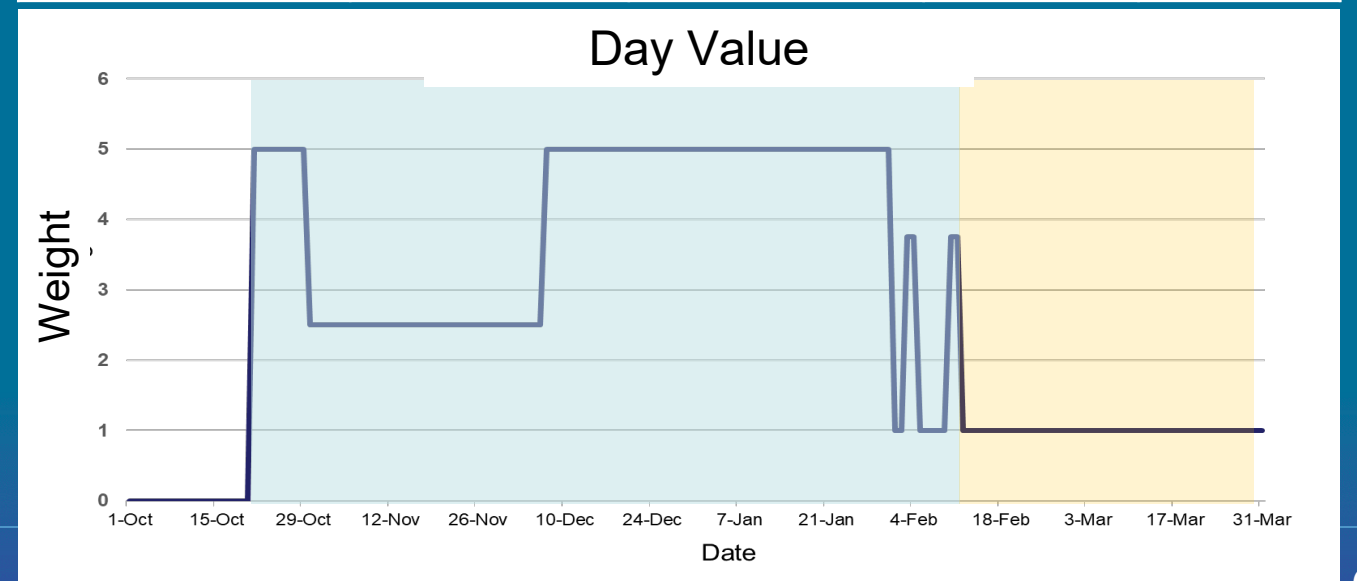
Agricultural Compatibility

- Late season inundation
 - Number of days fields are wet (>30% area) after March 1
 - Last Day Wet



Waterfowl Hunting & Managed Wetland Impacts

Impact	Depth		Depth Multiplier (ω) Hunting	Depth Multiplier (ω) Management
	Winter Flooded Rice	Managed Wetlands		
No impact	< 12"	< 12"	0	0
Bird use declines	12"-14"	12"-22"	1.5	0
Access reduced	14"-20"	22"-28"	2.5	2.5
Infrastructure damage	>20"	>28"	5.0	5.0

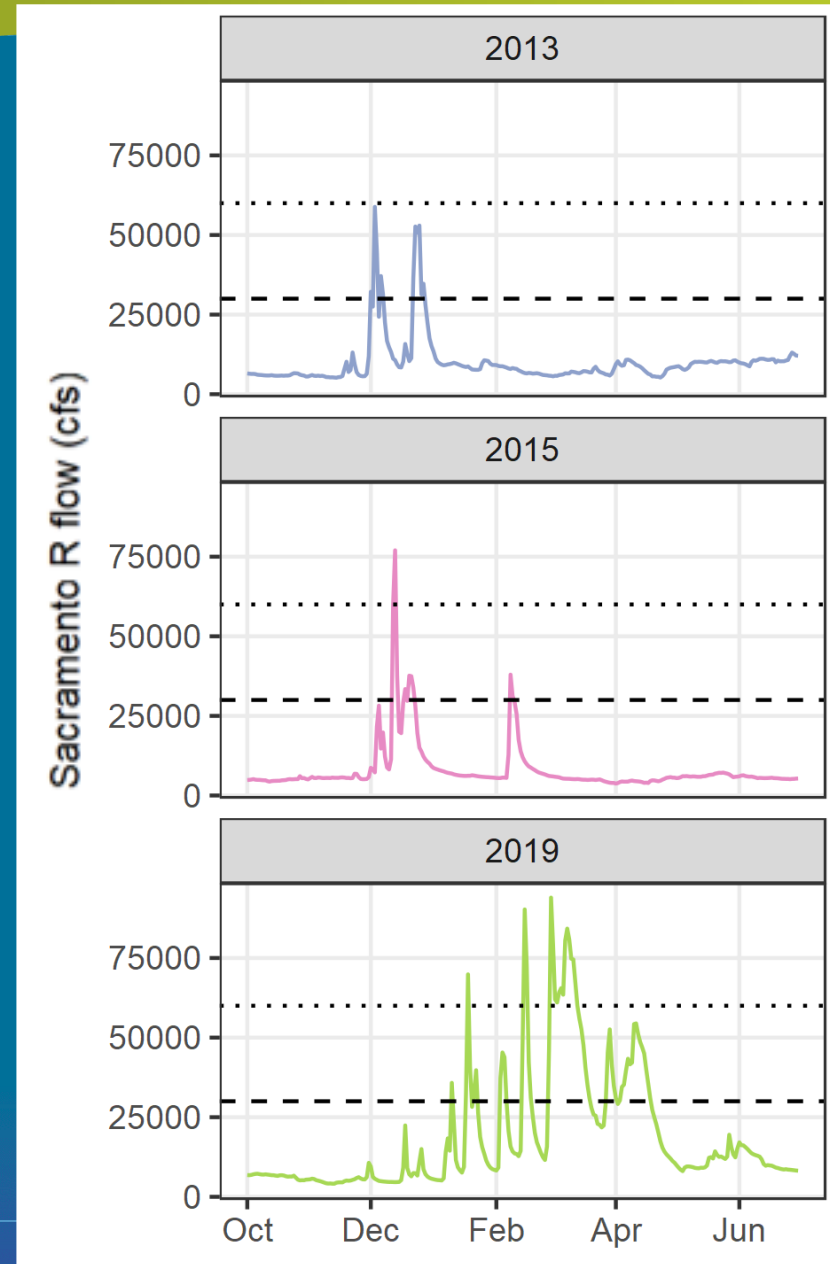
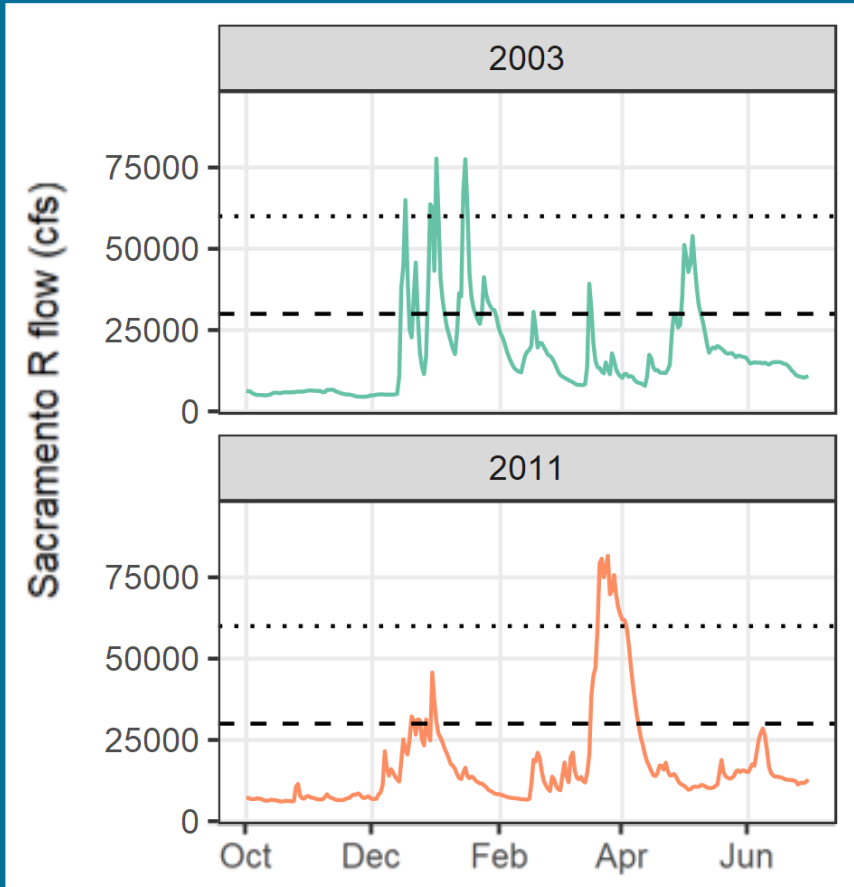


Results Discussion – Floodplain Juvenile Salmon HSI

Key Findings

- **Key Findings from TM**
 - **Connectivity often limiting factor**
 - Salmon WUA (weighted acre-days) over full year roughly half connected acre-days in both basins
 - Salmon WUA time series trends with connected area well
 - **Suitability more variable in Sutter than Butte due to reaching max suitability faster**
 - **Butte has earlier and later suitable area than Sutter (likely Butte Sink)**
- **Supplemental Observations**
 - **Ratio Salmon WUA to Basin Area:**
 - 10.2 for Butte
 - 28.0 for Sutter
 - **Butte has 9.3x basin area as Sutter, but only 3.4x salmon WUA**
 - Large footprint of area in Butte that sees little inundation and floodplain salmon suitability
 - **Timing of pulses matter relative to managed field schedules**
- **Notes**
 - **Previously reported on Colusa, but should be removed from Juvenile Salmon Analysis**

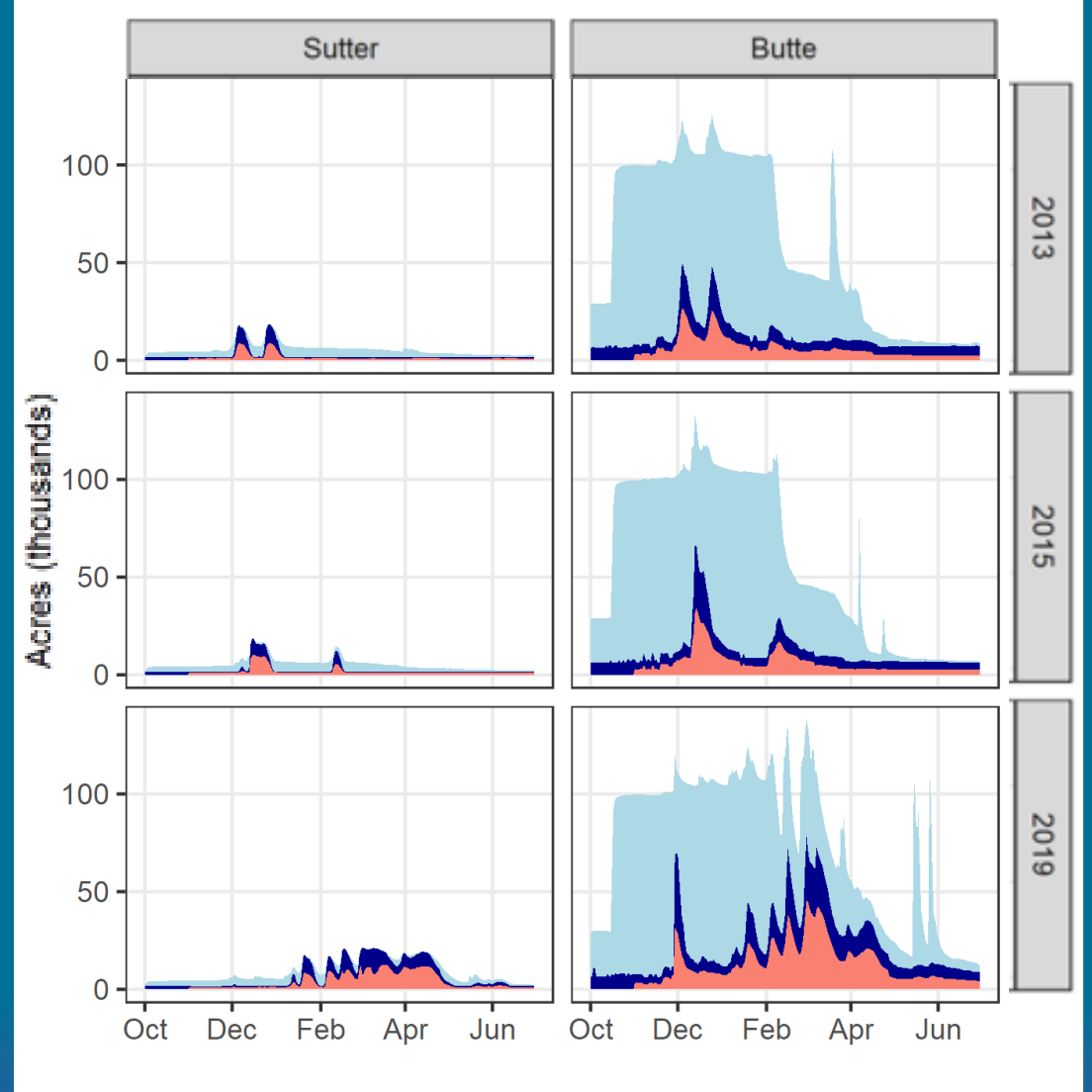
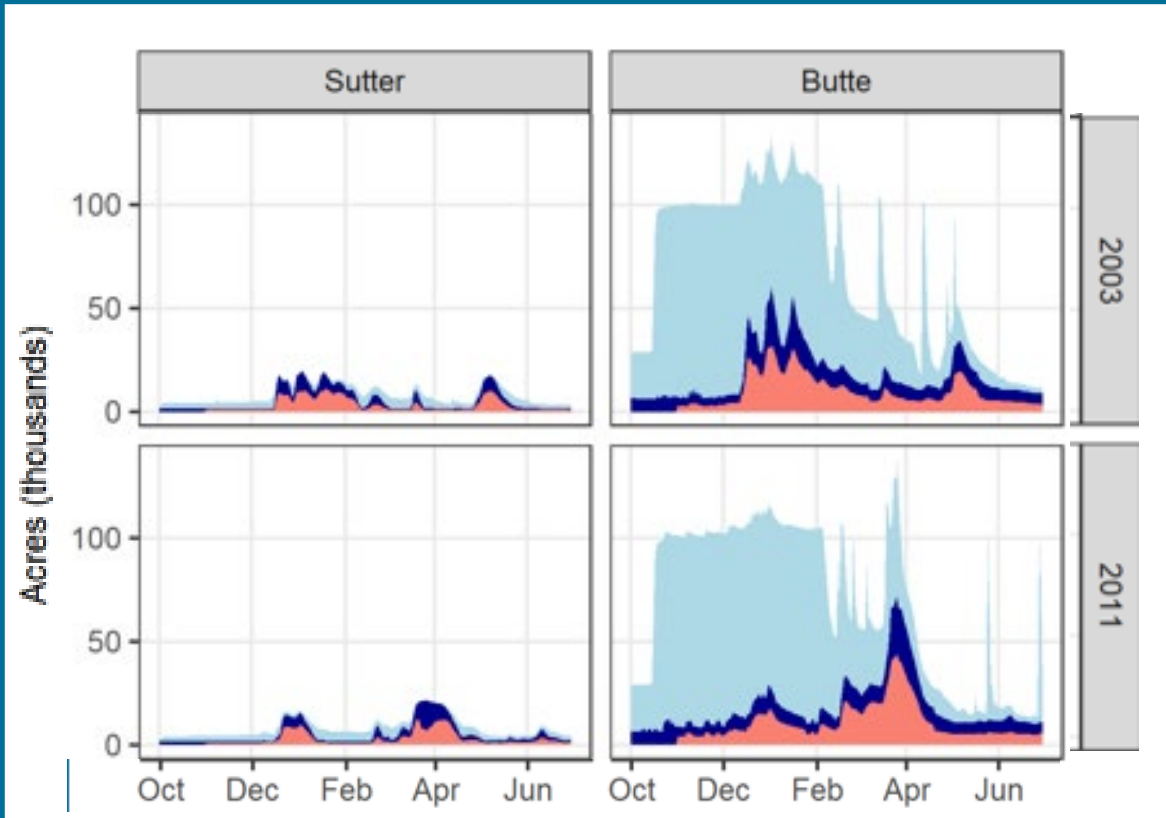
Results Discussion – Floodplain Juvenile Salmon HSI



Moulton Weir OT

Colusa Weir OT

Results Discussion – Floodplain Juvenile Salmon HSI

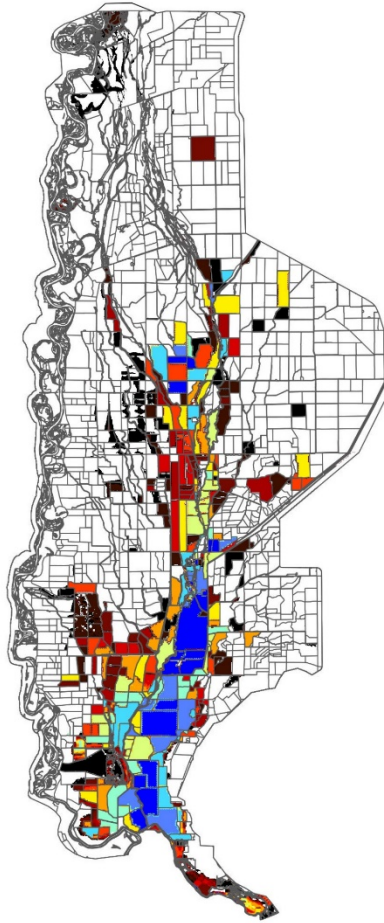


Results Discussion – Floodplain Juvenile Salmon HSI

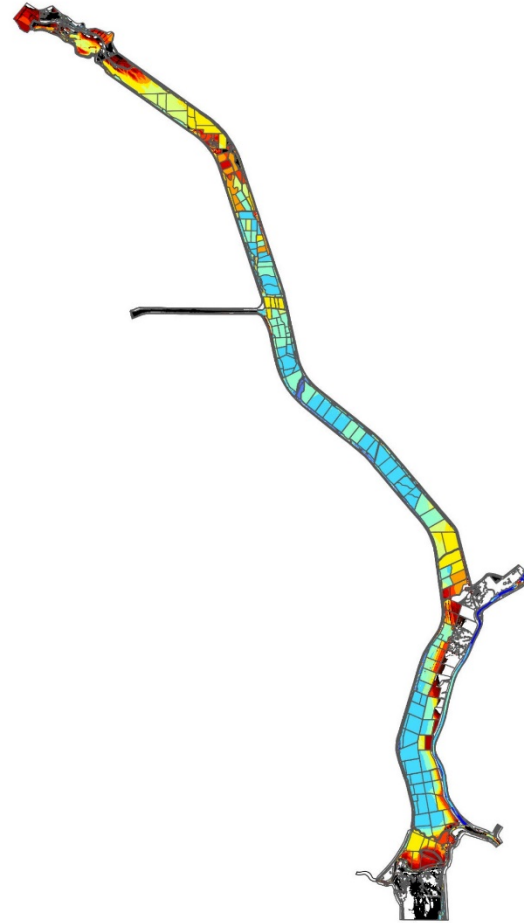
Salmon Suitability Sum - Baseline

2003

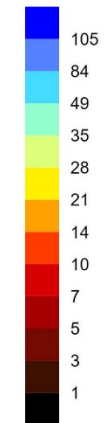
Butte



Sutter



Suitability Sum

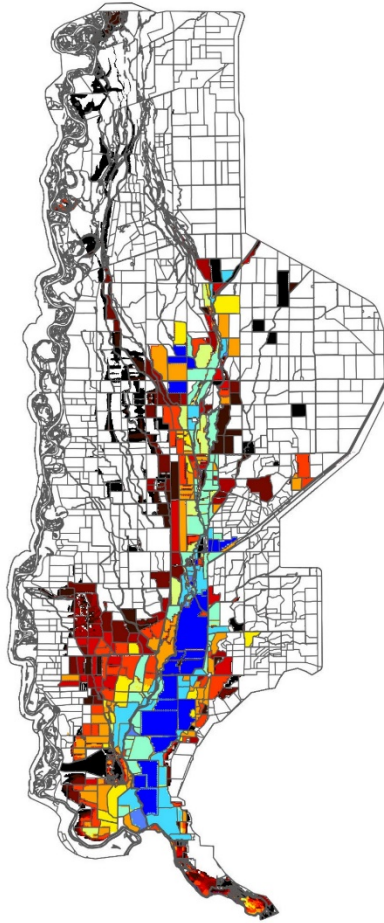


Results Discussion – Floodplain Juvenile Salmon HSI

Salmon Suitability Sum - Baseline

2011

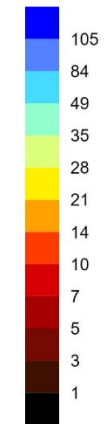
Butte



Sutter



Suitability Sum

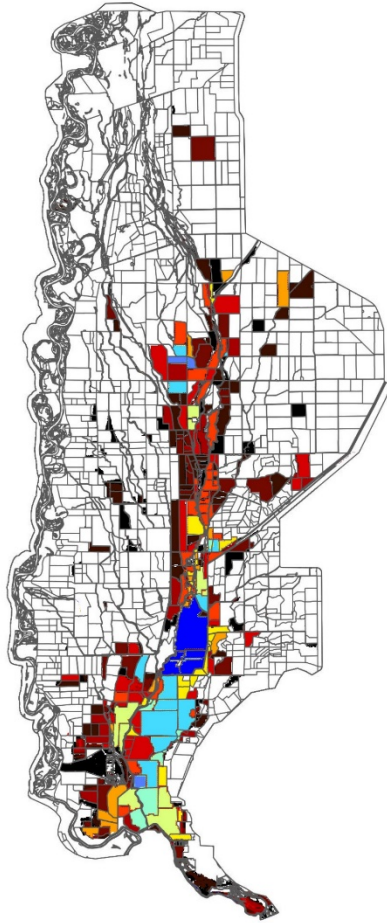


Results Discussion – Floodplain Juvenile Salmon HSI

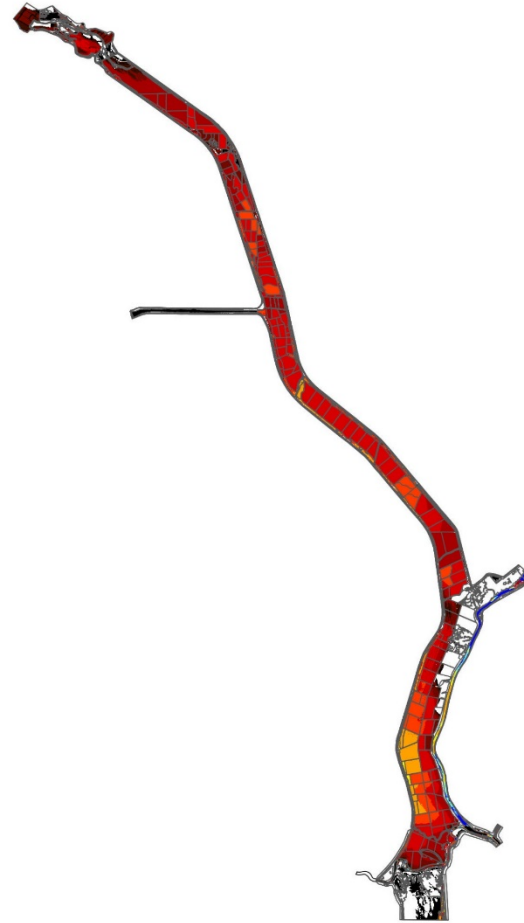
Salmon Suitability Sum - Baseline

2013

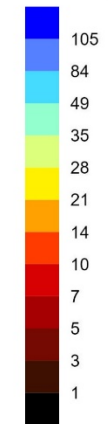
Butte



Sutter



Suitability Sum

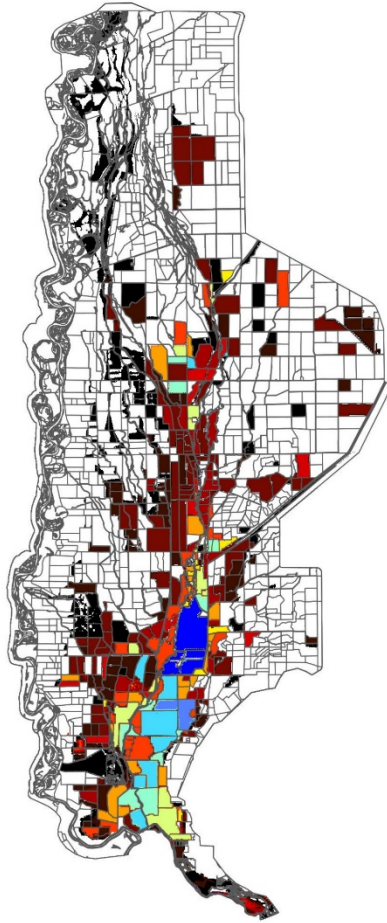


Results Discussion – Floodplain Juvenile Salmon HSI

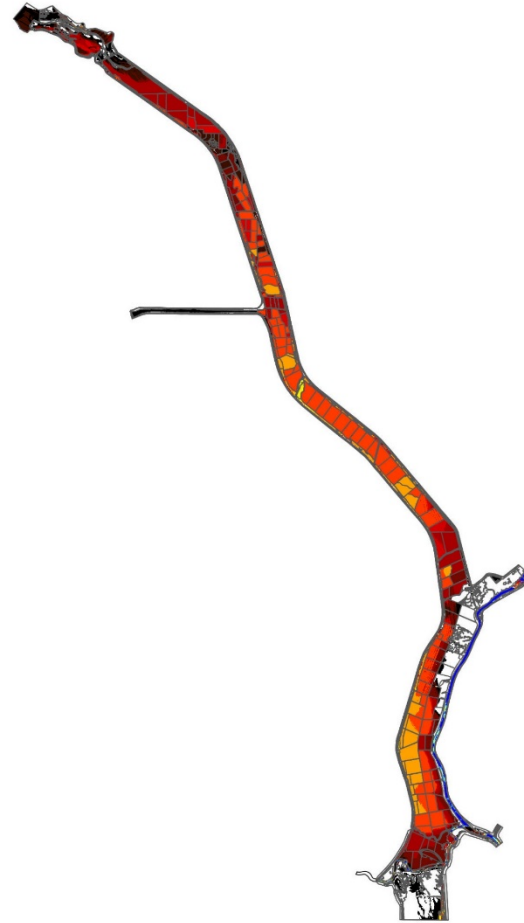
Salmon Suitability Sum - Baseline

2015

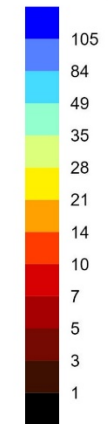
Butte



Sutter



Suitability Sum

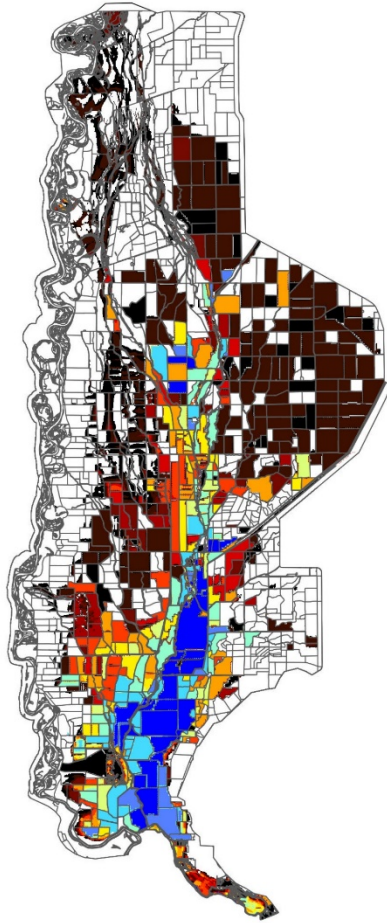


Results Discussion – Floodplain Juvenile Salmon HSI

Salmon Suitability Sum - Baseline

2019

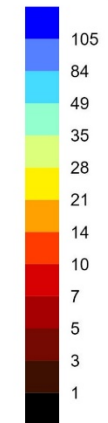
Butte



Sutter



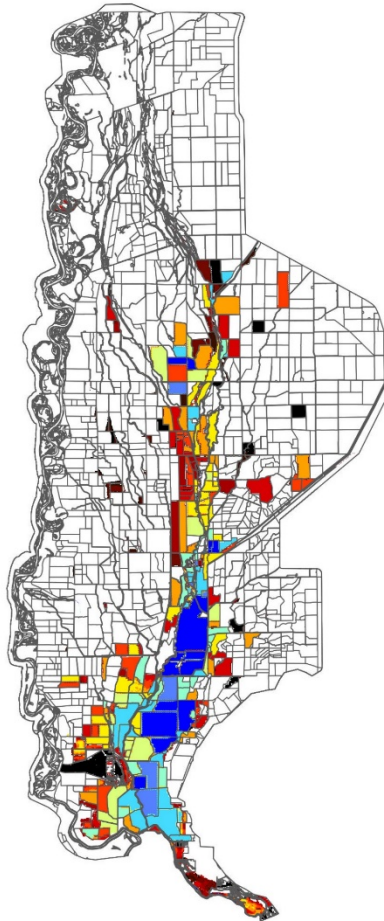
Suitability Sum



Results Discussion – Floodplain Juvenile Salmon HSI

Salmon Suitability Sum - Baseline Mean Across 2003, 2011, 2013, 2015, 2019

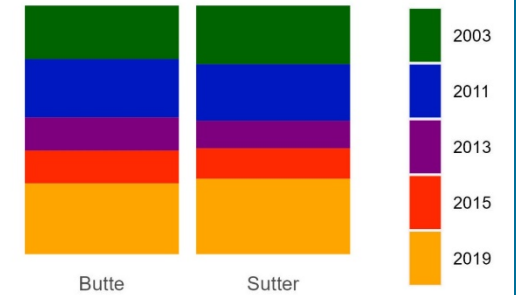
Butte



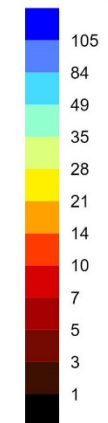
Sutter



Contributions By Year



Suitability Sum



Results Discussion – Waterfowl HSI

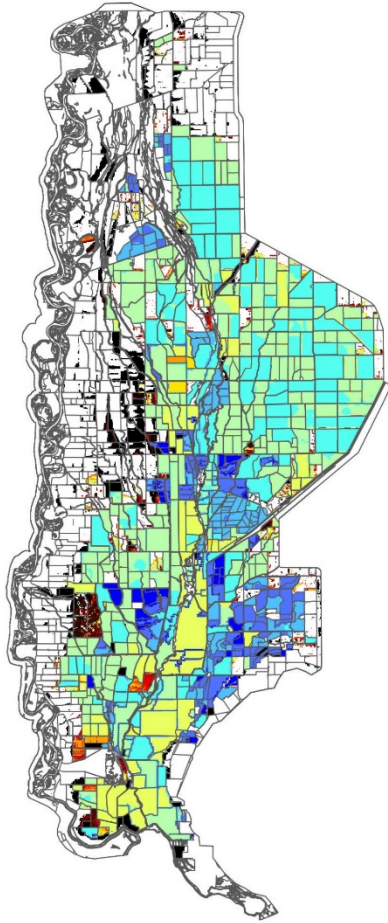
Key Findings

- **Key findings from TM**
 - 2019 worst in Sutter, 2nd best in Butte & Colusa
 - Sutter has the largest variability in habitat
- **Supplemental Observations**
 - Managed fields stand out, managed depth is suitable
 - Greater footprint of managed flooding in Butte than Sutter
 - Unmanaged areas are not as suitable due to less control of inundation
 - **Ratio Waterfowl WUA to Basin Area**
 - 53.4 for Butte
 - 30.4 for Colusa
 - 22.6 for Sutter
 - **Sutter being a flood bypass limits quality of habitat**
 - Flood pulses make nearly full bypass too deep, while in Butte/Colusa floods can spread out
 - Managed fields in Sutter similar suitability to Butte Sink area

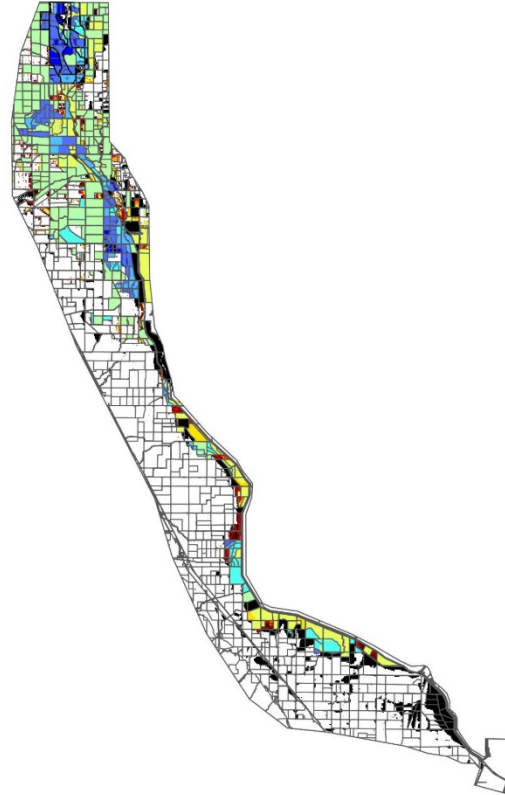
Results Discussion – Waterfowl HSI

Waterfowl Suitability Sum - Baseline 2003

Butte



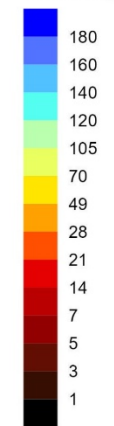
Colusa



Sutter



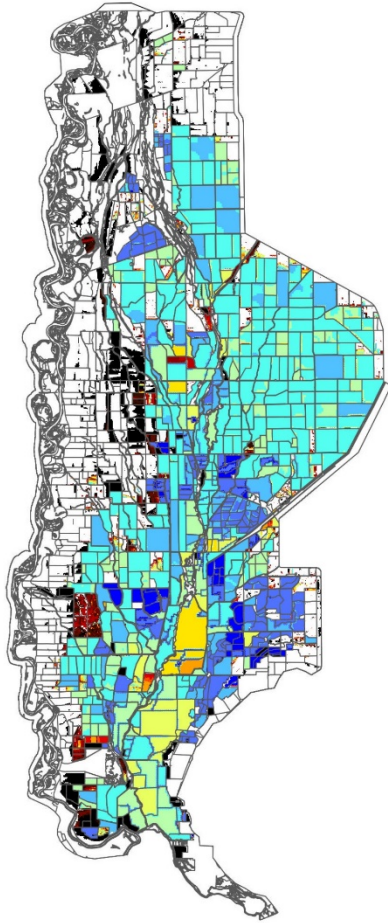
Suitability Sum



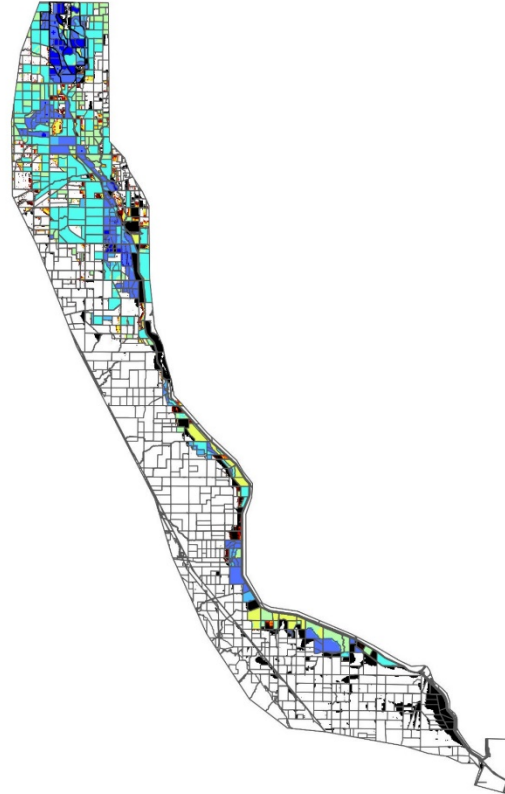
Results Discussion – Waterfowl HSI

Waterfowl Suitability Sum - Baseline 2011

Butte



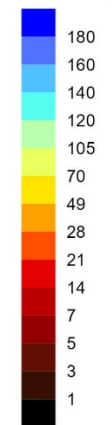
Colusa



Sutter



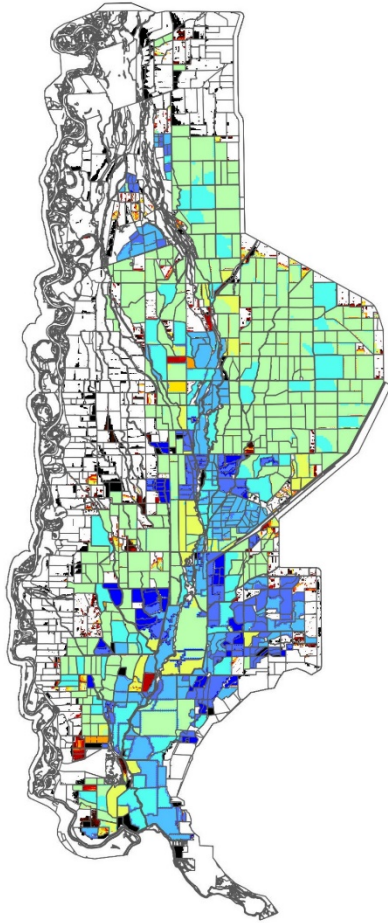
Suitability Sum



Results Discussion – Waterfowl HSI

Waterfowl Suitability Sum - Baseline 2013

Butte



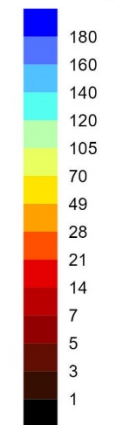
Colusa



Sutter



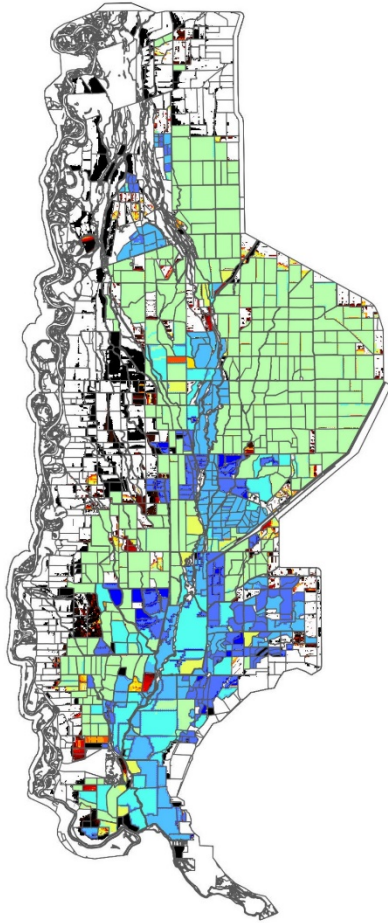
Suitability Sum



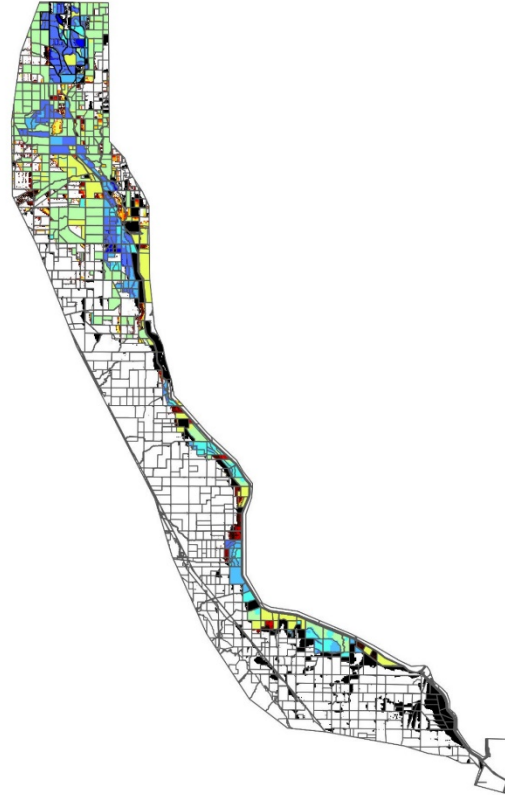
Results Discussion – Waterfowl HSI

Waterfowl Suitability Sum - Baseline 2015

Butte



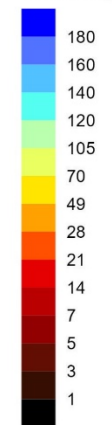
Colusa



Sutter



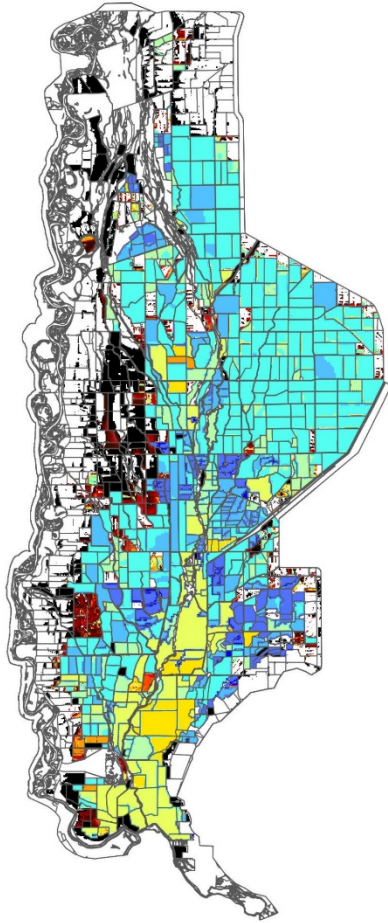
Suitability Sum



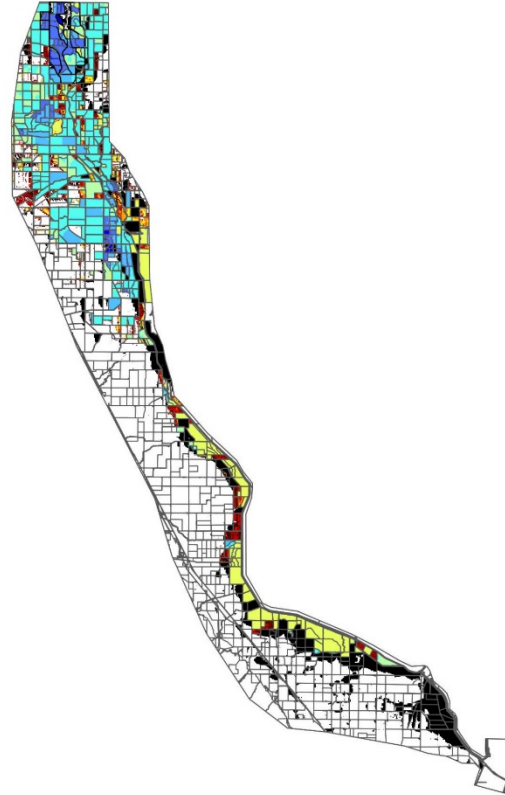
Results Discussion – Waterfowl HSI

Waterfowl Suitability Sum - Baseline 2019

Butte



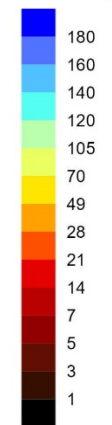
Colusa



Sutter



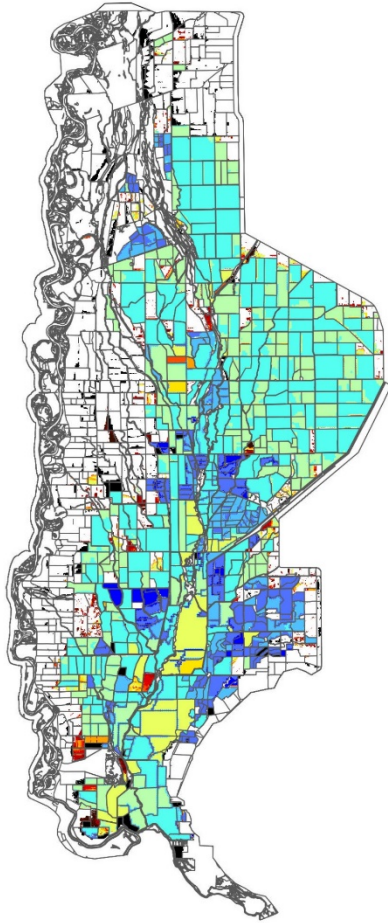
Suitability Sum



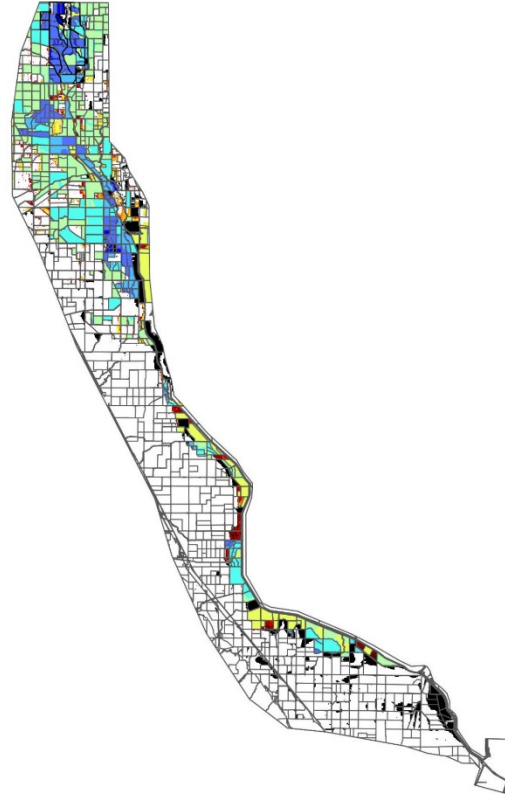
Results Discussion – Waterfowl HSI

Waterfowl Suitability Sum - Baseline Mean Across 2003, 2011, 2013, 2015, 2019

Butte



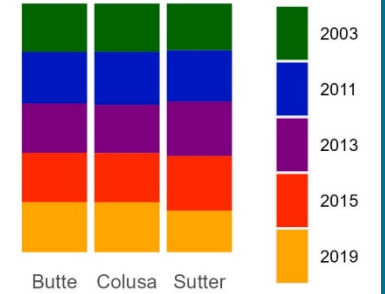
Colusa



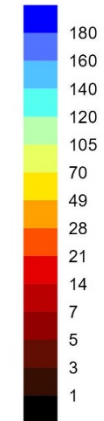
Sutter



Contributions By Year



Suitability Sum



Results Discussion – Salmon & Waterfowl HSI

Overview

- Depth criteria of salmon & waterfowl leave very little overlap
- Managed depth = 10 inches
 - Good for waterfowl
 - Not connected, so bad for salmon
- Where/when does good habitat overlap?
- Quality overlap in space
 - Binned total year suitability sum into low, medium, high
 - Mapped habitat quality overlap
- Quality overlap in space & time
 - Maps of number of days when suitable habitat occurred in both species

	Min Depth (in)	Max Depth (in)
Juvenile Floodplain Rearing (salmon)	7.2	None
Waterfowl	None (must be wet)	12

Results Discussion – Salmon & Waterfowl HSI (in Space)

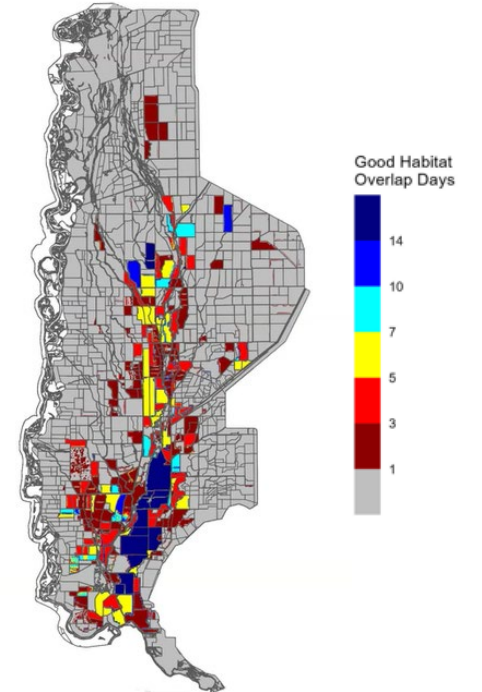
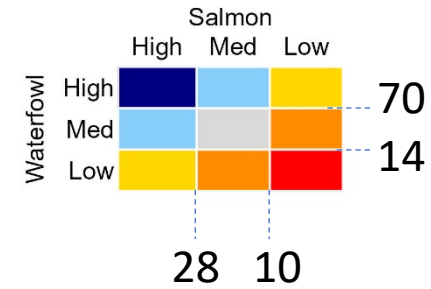
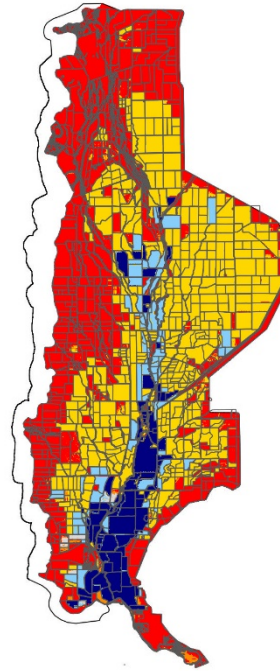
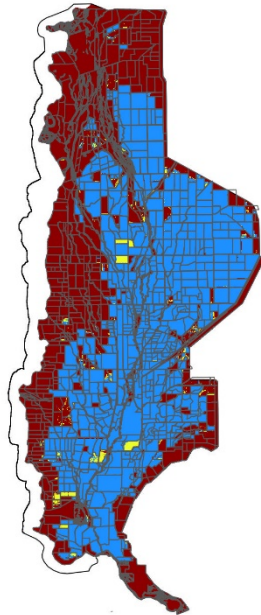
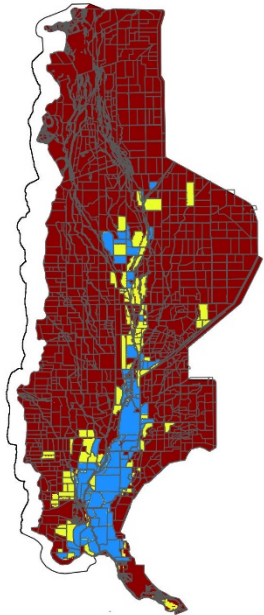
Mean Across 2003, 2011, 2013, 2015, 2019

Salmon
10 - 28 Weighted Days

Waterfowl
14 - 70 Weighted Days

Quality Overlap

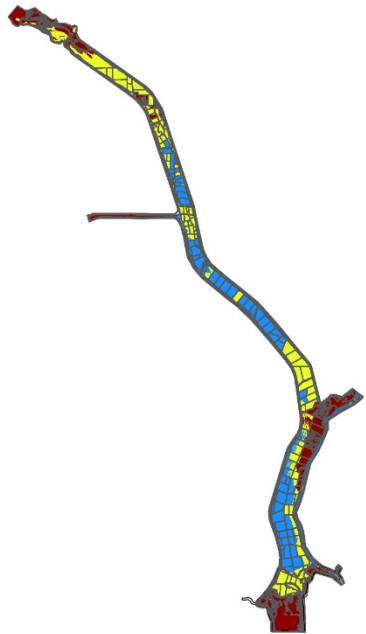
Days of Quality Habitat Overlap



Results Discussion – Salmon & Waterfowl HSI (in Space)

Mean Across 2003, 2011, 2013, 2015, 2019

Salmon
10 - 28 Weighted Days



Overall
Habitat
Quality

Low	< 10
Medium	10 - 28
High	> 28

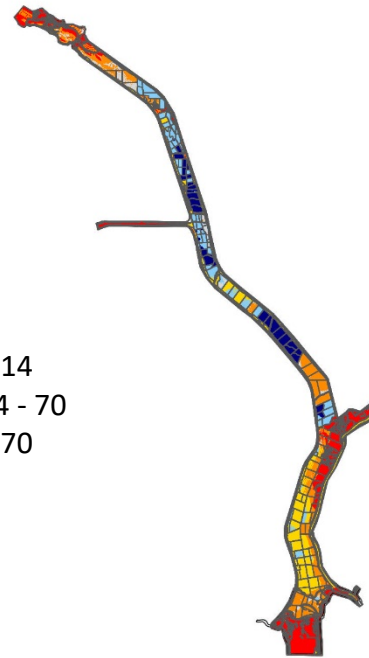
Waterfowl
14 - 70 Weighted Days



Overall
Habitat
Quality

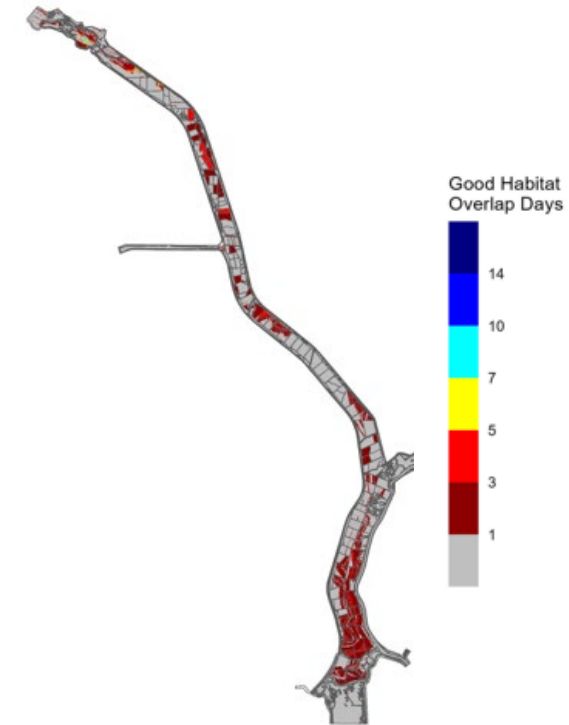
Low	< 14
Medium	14 - 70
High	> 70

Quality Overlap



	Salmon			
	High	Med	Low	
Waterfowl	High	Dark Blue	Light Blue	Yellow
	Med	Light Blue	Grey	Orange
	Low	Yellow	Orange	Red

Days of Quality Habitat Overlap



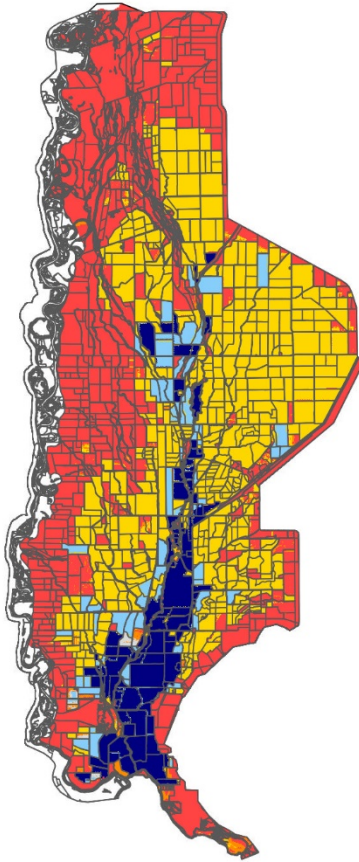
Good Habitat
Overlap Days

14
10
7
5
3
1

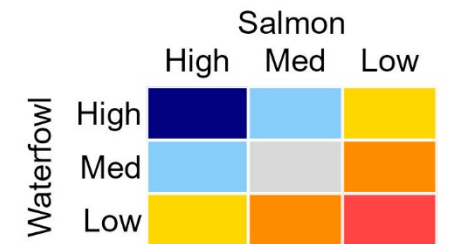
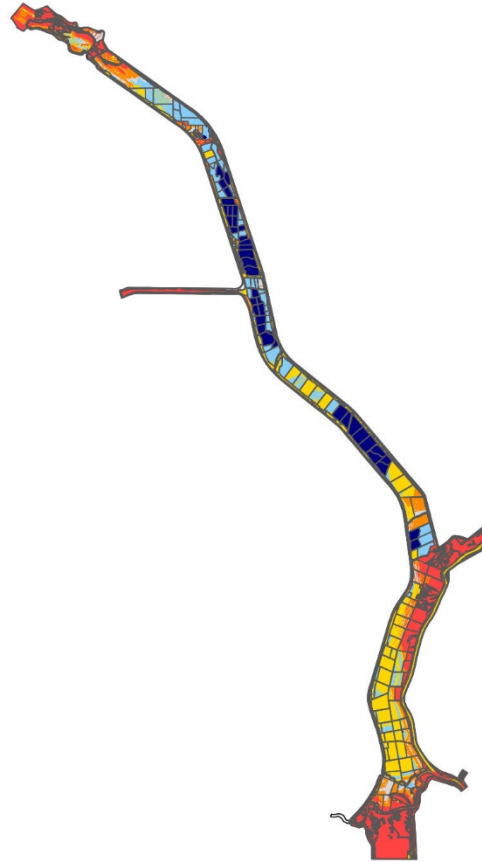
Results Discussion – Salmon & Waterfowl HSI (in Space)

Habitat Quality Overlap - 2003
Salmon (10 - 28 Weighted Days) & Waterfowl (14 - 70 Weighted Days)

Butte



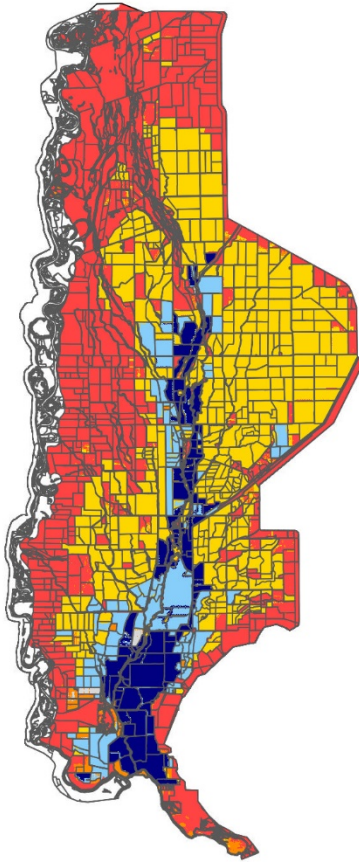
Sutter



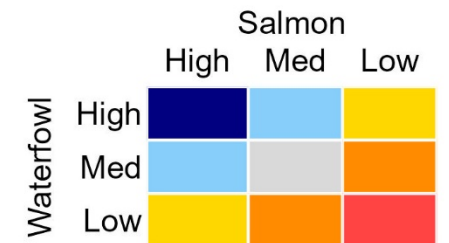
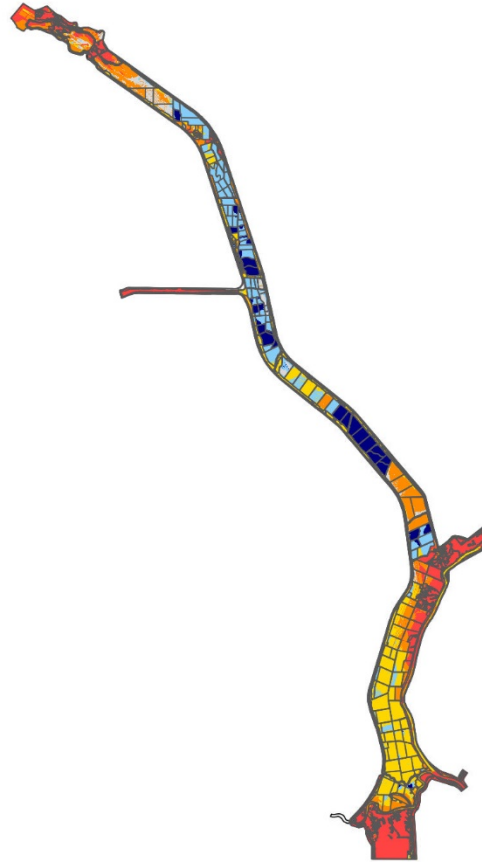
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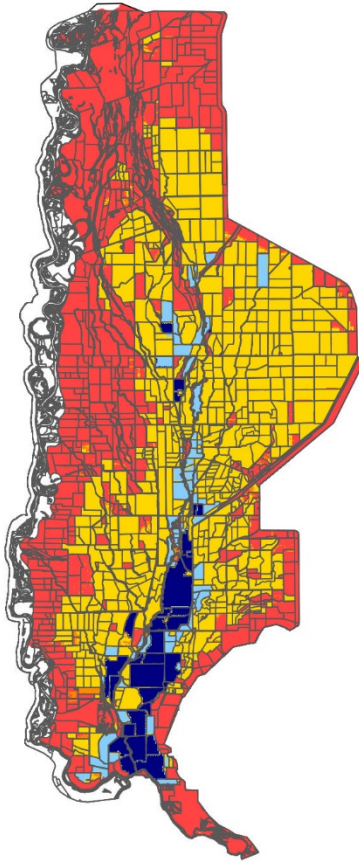
Sutter



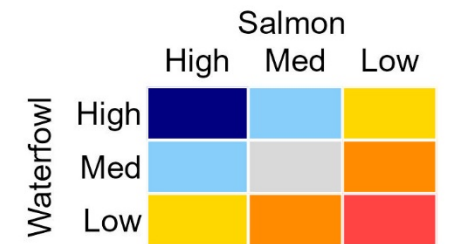
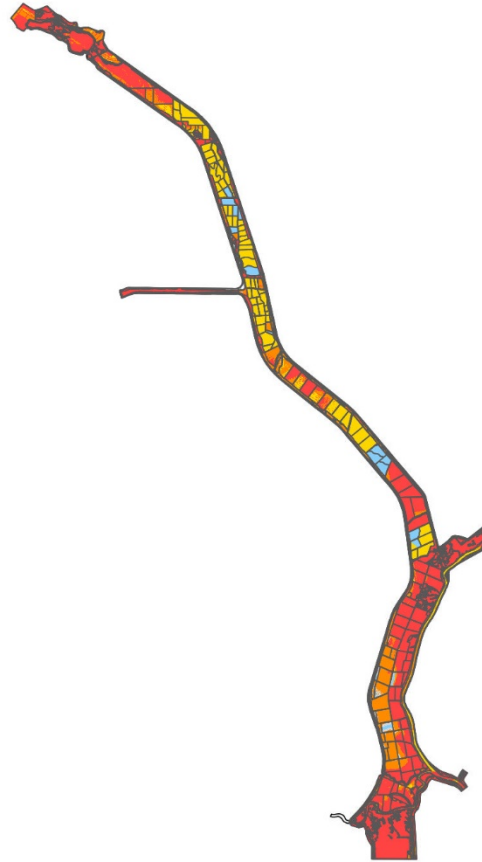
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Habitat Quality Overlap - 2013
Salmon (10 - 28 Weighted Days) & Waterfowl (14 - 70 Weighted Days)

Butte



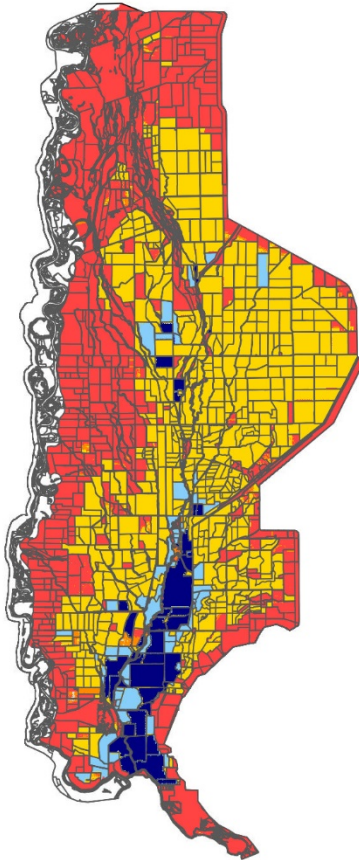
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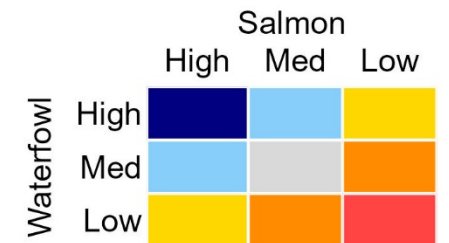
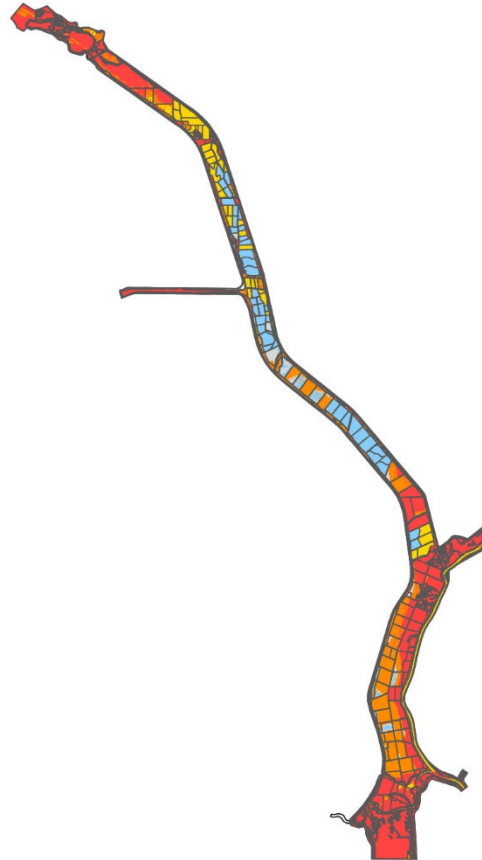
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Salmon (10 - 28 Weighted Days) & Waterfowl (14 - 70 Weighted Days)

Butte



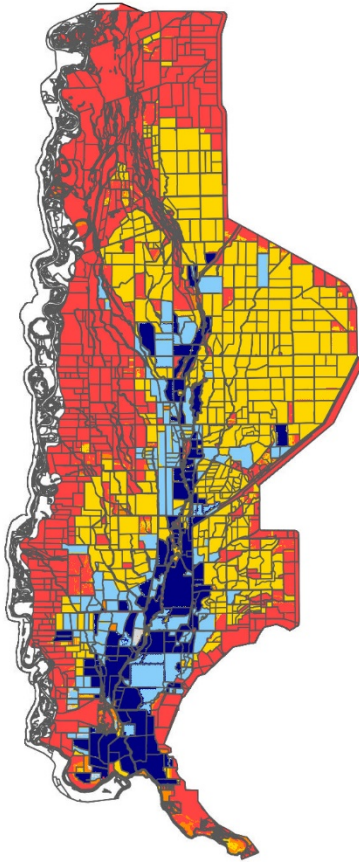
Sutter



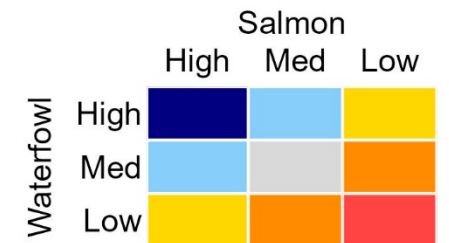
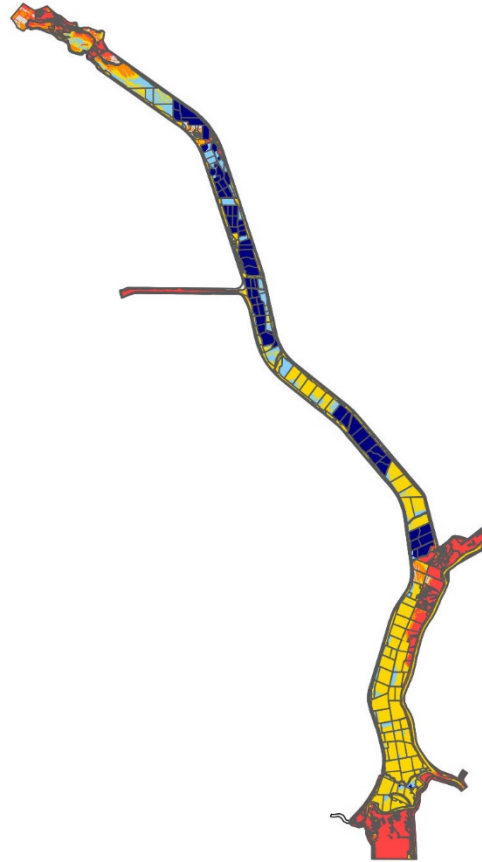
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Butte



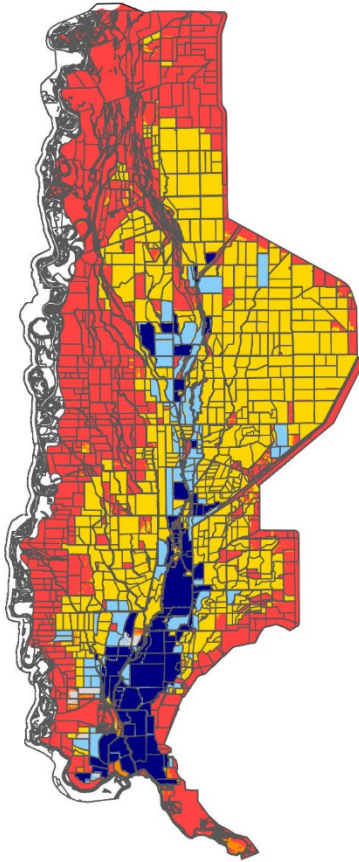
Sutter



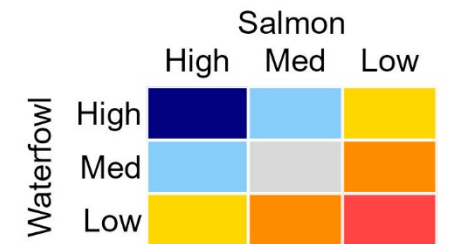
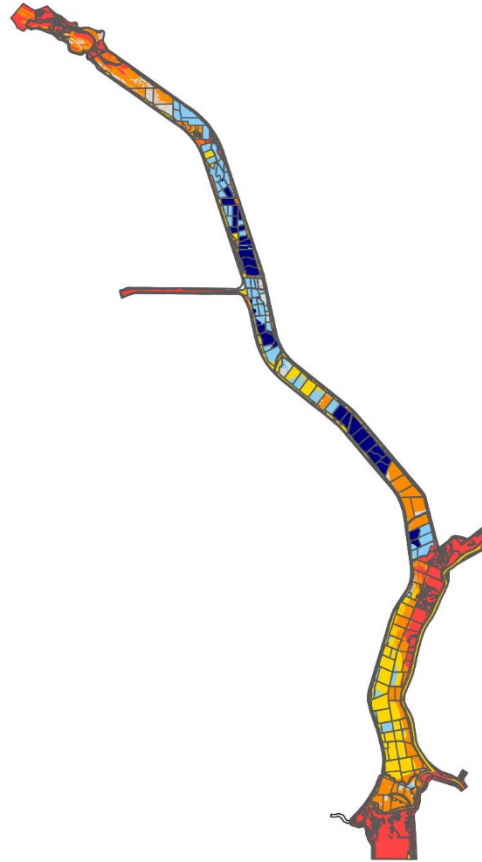
Results Discussion – Salmon & Waterfowl HSI (in Space)

Habitat Quality Overlap - Mean Across 2003, 2011, 2013, 2015, 2019
Salmon (10 - 28 Weighted Days) & Waterfowl (14 - 70 Weighted Days)

Butte



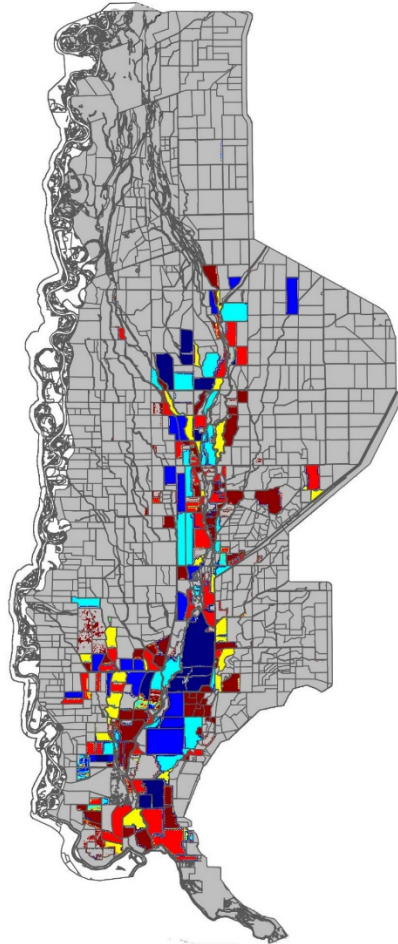
Sutter



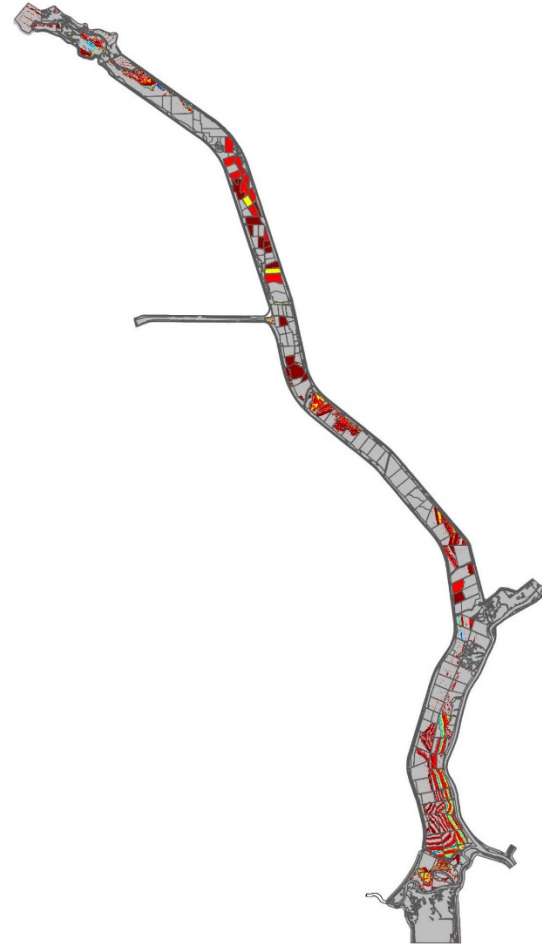
Results Discussion – Salmon & Waterfowl HSI (in Space & Time)

Days of Quality Habitat Overlap Salmon & Waterfowl - 2003

Butte



Sutter



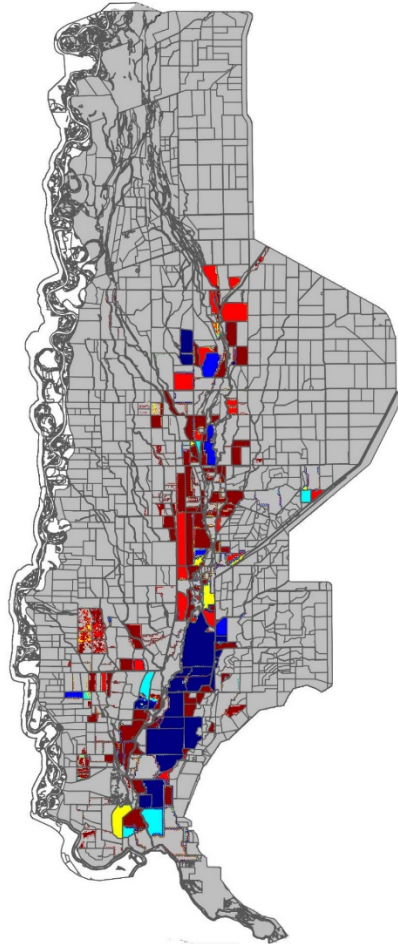
Good Habitat
Overlap Days



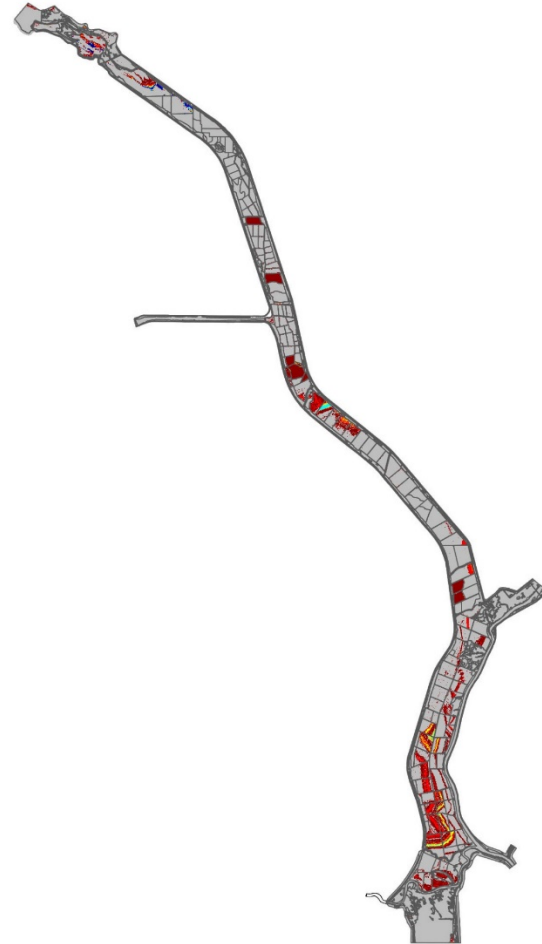
Results Discussion – Salmon & Waterfowl HSI (in Space & Time)

Days of Quality Habitat Overlap Salmon & Waterfowl - 2011

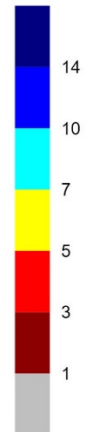
Butte



Sutter



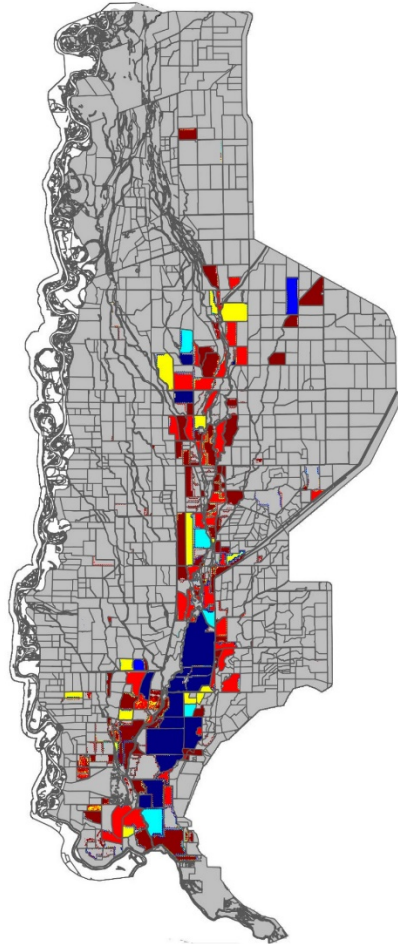
Good Habitat
Overlap Days



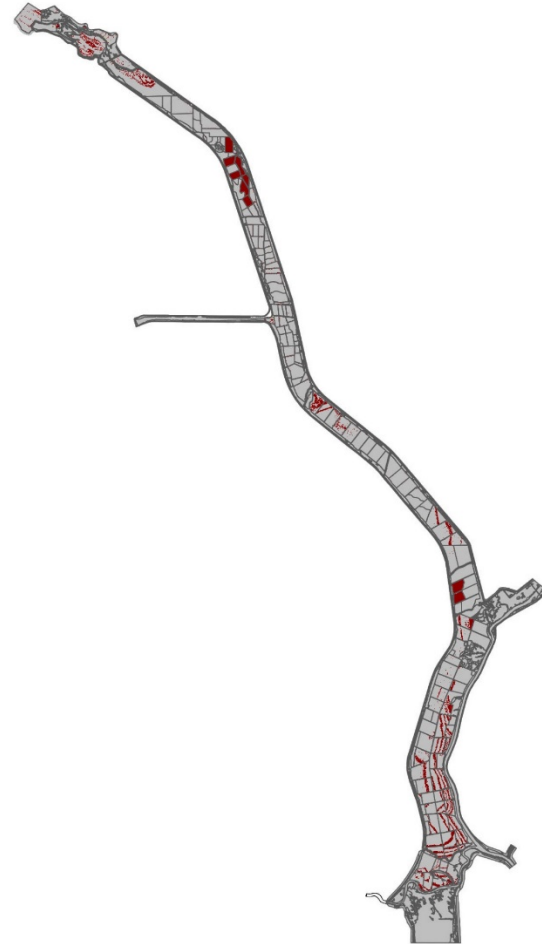
Results Discussion – Salmon & Waterfowl HSI (in Space & Time)

Days of Quality Habitat Overlap Salmon & Waterfowl - 2013

Butte



Sutter



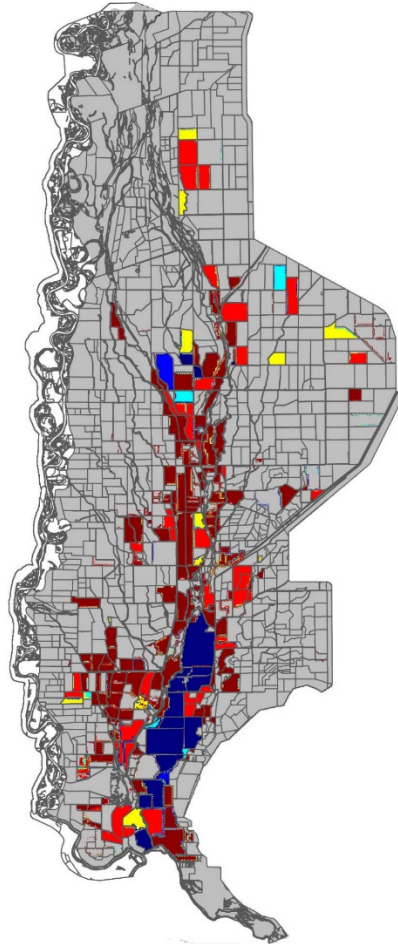
Good Habitat
Overlap Days



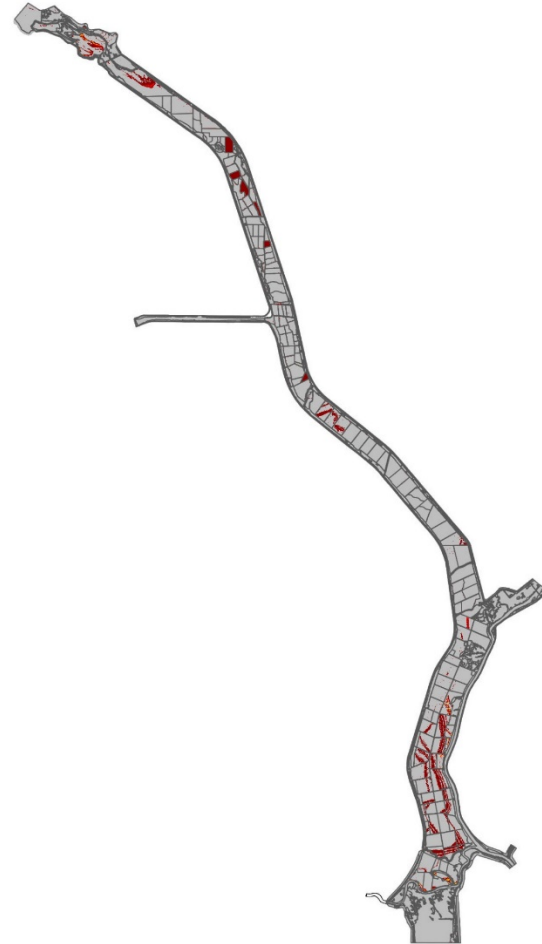
Results Discussion – Salmon & Waterfowl HSI (in Space & Time)

Days of Quality Habitat Overlap Salmon & Waterfowl - 2015

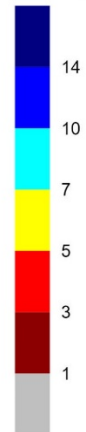
Butte



Sutter



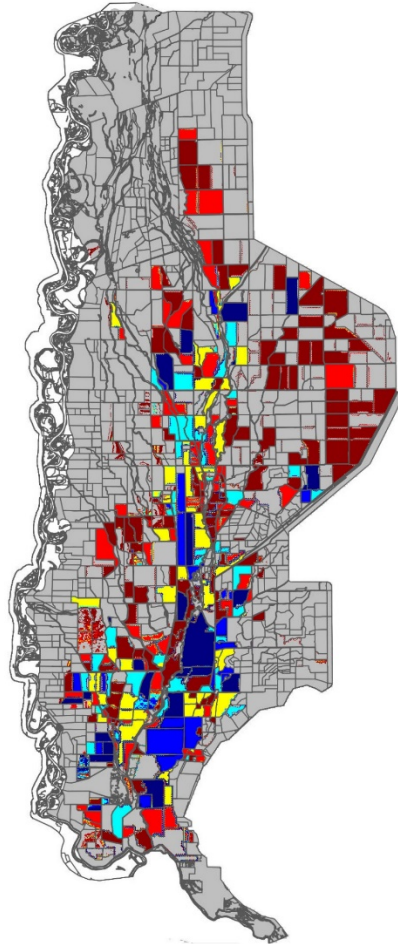
Good Habitat
Overlap Days



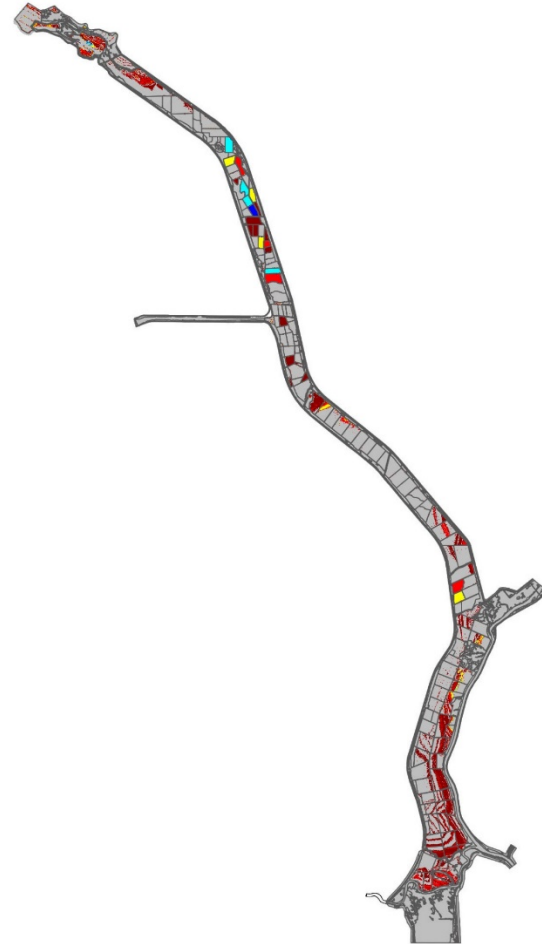
Results Discussion – Salmon & Waterfowl HSI (in Space & Time)

Days of Quality Habitat Overlap Salmon & Waterfowl - 2019

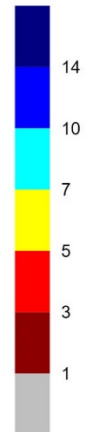
Butte



Sutter



Good Habitat
Overlap Days



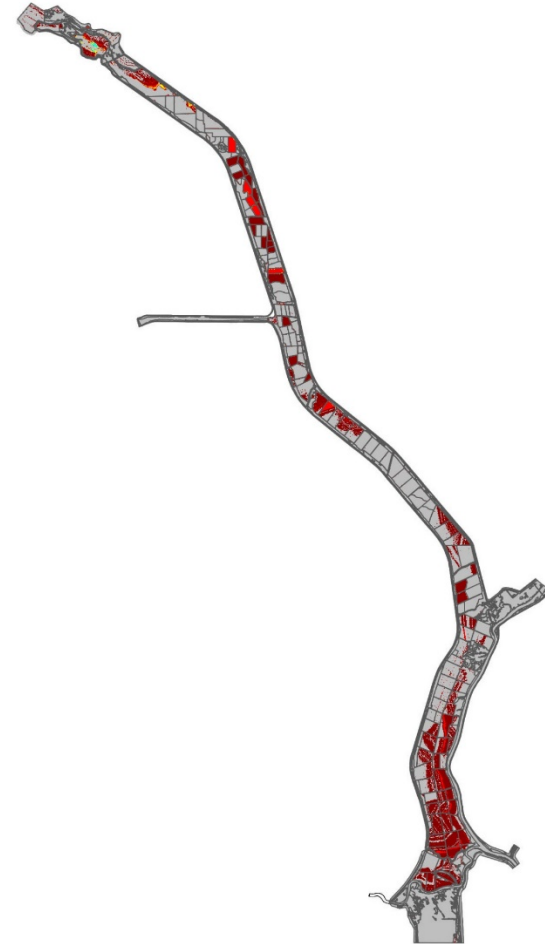
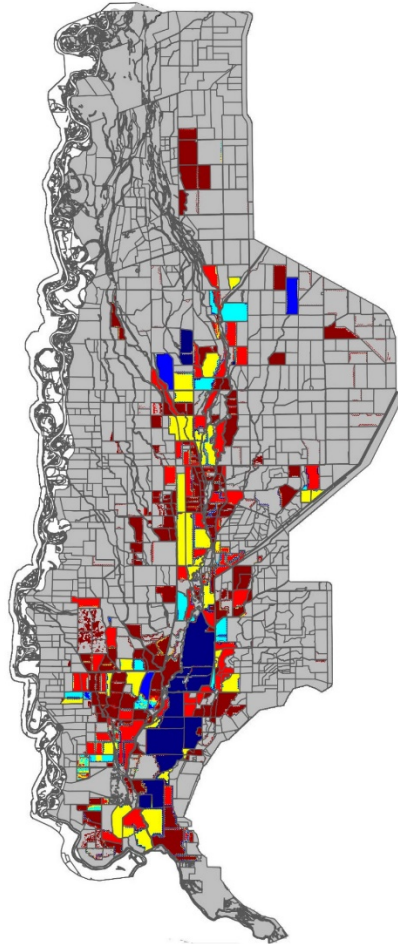
Results Discussion – Salmon & Waterfowl HSI (in Space & Time)

Days of Quality Habitat Overlap

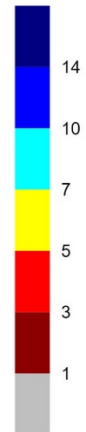
Salmon & Waterfowl - Mean Across 2003, 2011, 2013, 2015, 2019

Butte

Sutter



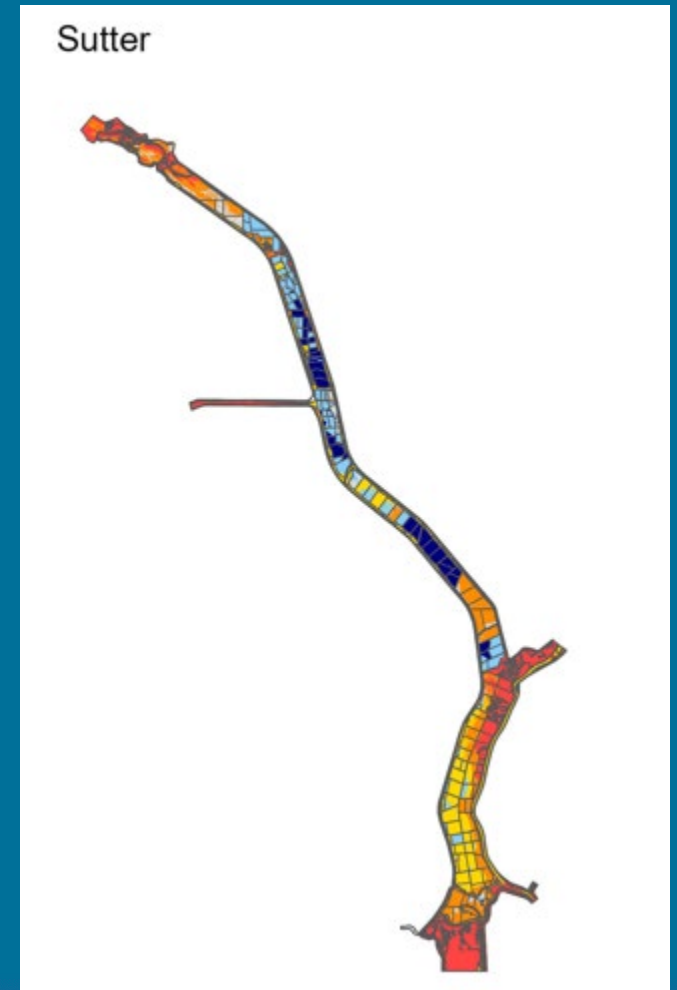
Good Habitat
Overlap Days



Results Discussion – Salmon & Waterfowl HSI

Key Findings

- **Butte Sink good in space & time for both species**
 - At managed depth (10 in), flow-through management maintains connectivity
 - Salmon habitat limited farther from Butte Creek since connectivity is more difficult
 - Suggests future alternatives could enhance or increase flow-through opportunities like Butte Sink
- **Sutter offers good habitat to both species at different times of year**
 - NWR only area >1-3 days of overlap (in 2015 only)
 - Lower Sutter very good for salmon, too deep for waterfowl
 - Managed fields show high quality habitat for both species
 - Suggests future alternatives could focus on increasing managed footprint & enhancing flow-through like Butte Sink (see SBMP alternatives)



Results Discussion – Salmon Benefits Model

Key Findings

- **Compare Baseline to 1000 cfs and 2000 cfs capacity notch in Moulton Weir**
- **Key Findings from TM**
 - Results much more dependent on year than presence of notch
 - **Entrainment**
 - Highest entrainment occurs at Colusa Weir, Moulton lowest
 - Moulton Weir entrainment increased with notches, Colusa & Tisdale decreased
 - Largest Moulton increase in 2003
 - Notches created entrainment in 2011 & 2013 at Moulton, none in Baseline
 - **Fork length (FL)**
 - Increased in 2003 & 2015 with notches at Moulton, decreased in 2019
 - Mostly within error bounds of each scenario
 - Increased in 2003 at Colusa with Moulton notch, decreased or the same in other years
 - Relatively little effect at Tisdale or Sac Slough

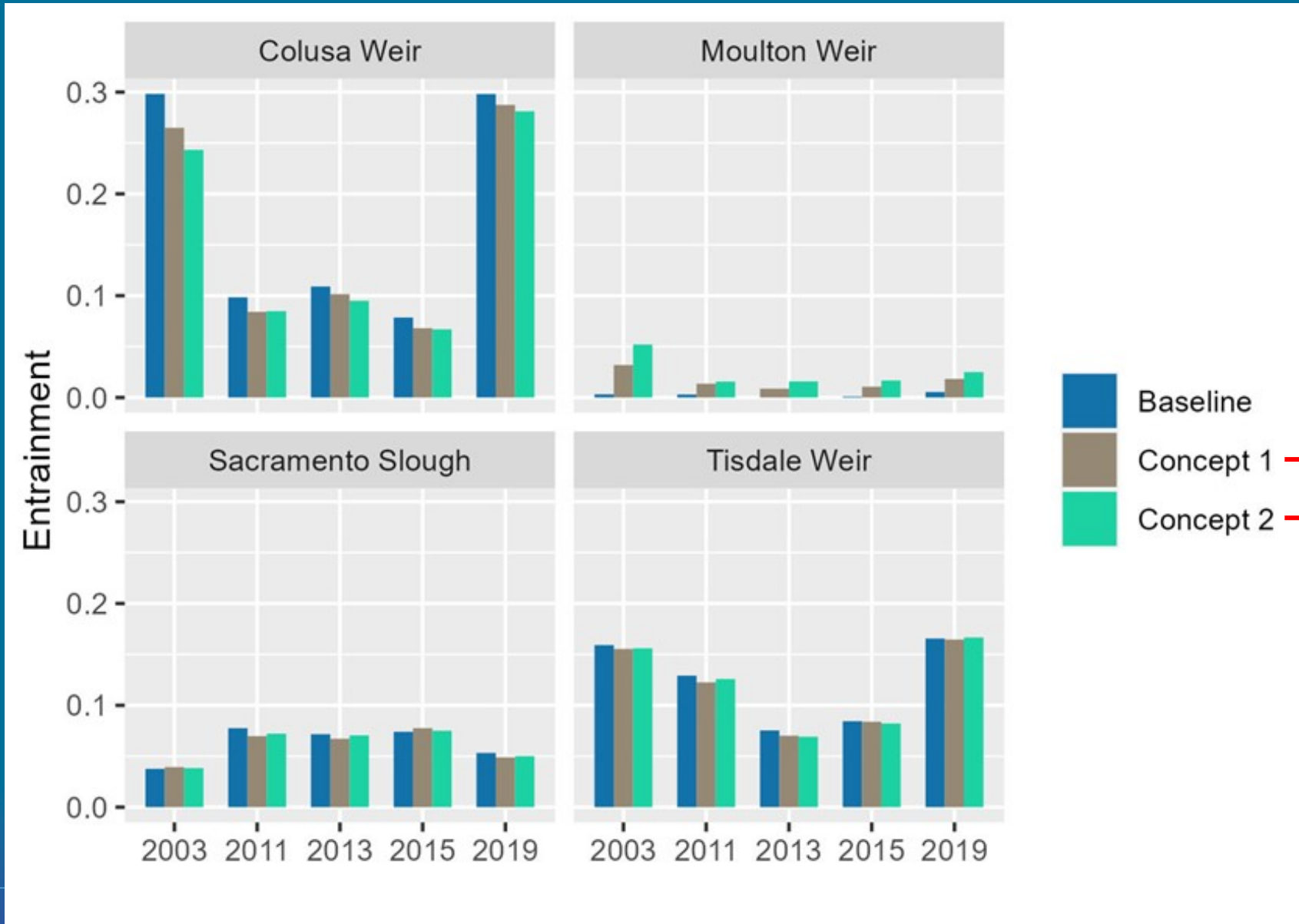
Results Discussion – Salmon Benefits Model

Key Findings

- **Compare Baseline to 1000 cfs and 2000 cfs capacity notch in Moulton Weir**
- **Key Findings from TM**
 - **Relative Smolt to Adult Ratio (rSAR)**
 - Mostly within error bounds between scenarios except decrease at Colusa in 2019
 - In 2011, 2013, 2015 for Fall/Spring and 2013 for Winter, rSAR decreased from 1k to 2k notch at Moulton
 - Slight increase in 2003, large decrease in 2019 at Moulton, Colusa, & Tisdale
 - **Fall/Spring vs Winter**
 - Trends between scenarios similar for 2 runs
 - Greater entrainment for winter, 2013 & 2011 highest in Winter, 2003 & 2019 for F/S
 - 2019 had largest FL in both runs, 2011 greater in Winter than F/S

Results Discussion – Salmon Benefits Model

Fall/Spring Run Entrainment

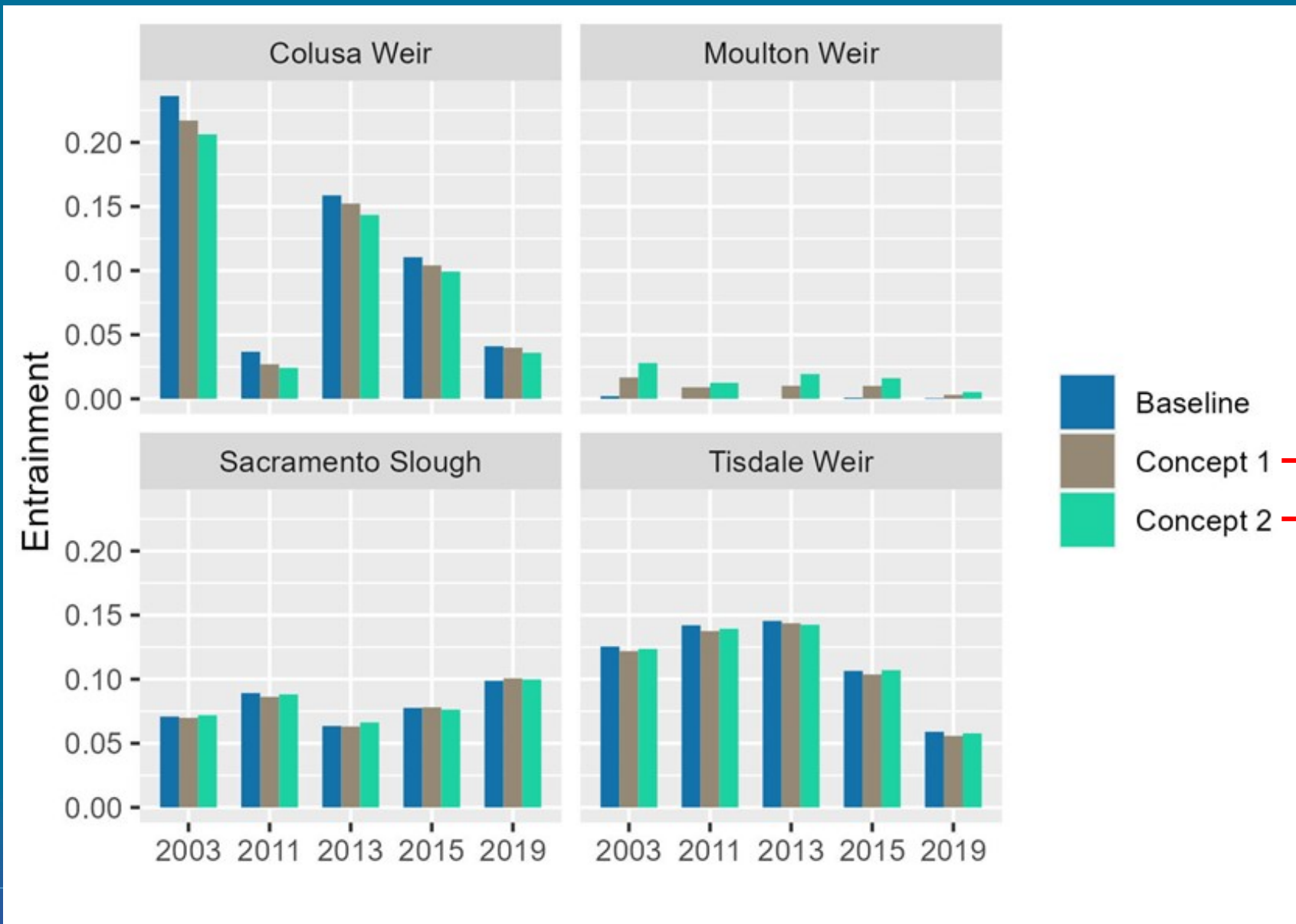


Capacity of Moulton Weir Notch:

- Baseline
- Concept 1 — 1000 cfs
- Concept 2 — 2000 cfs

Results Discussion – Salmon Benefits Model

Winter Run Entrainment

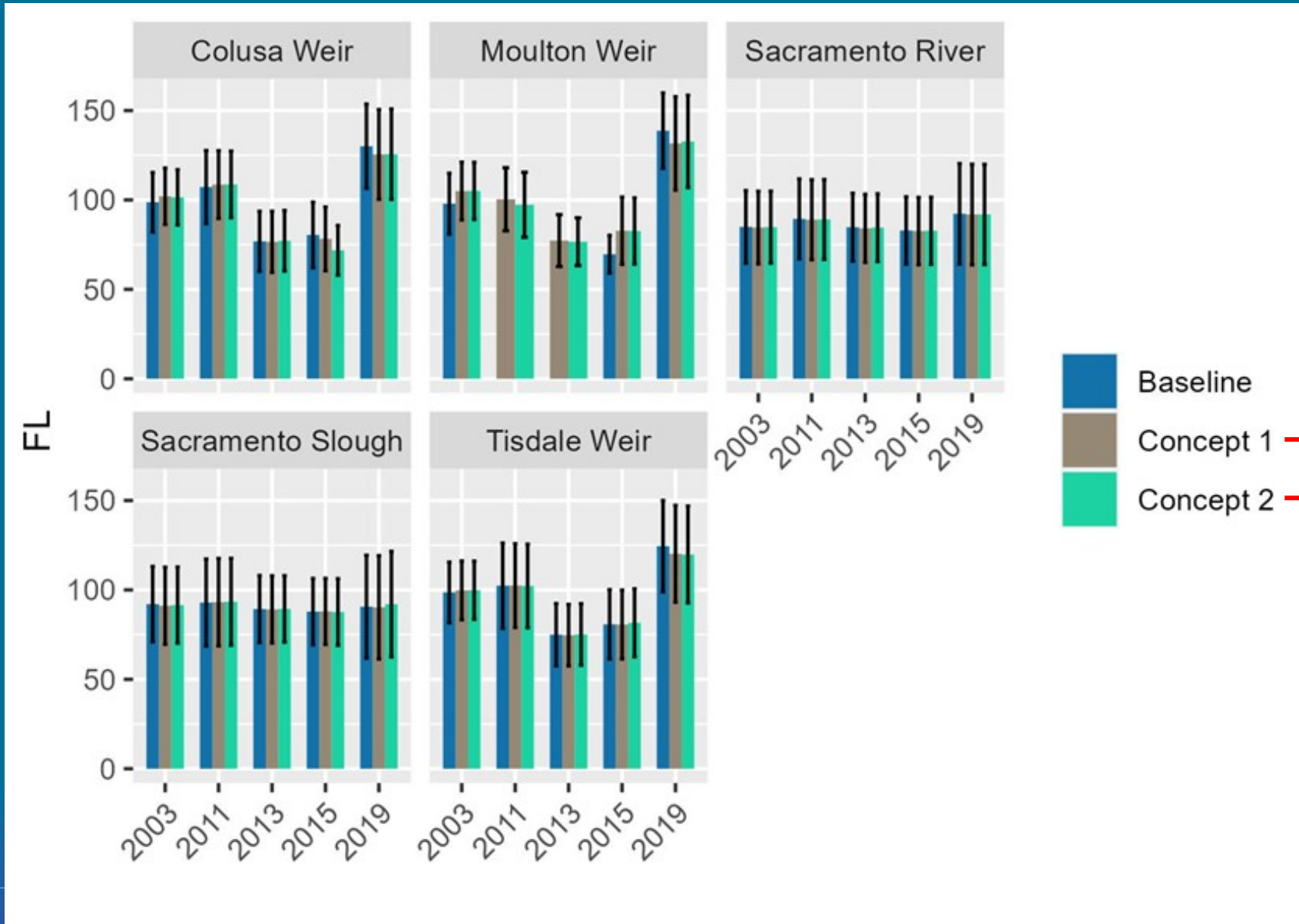


Capacity of Moulton Weir Notch:

- Baseline
- Concept 1 — 1000 cfs
- Concept 2 — 2000 cfs

Results Discussion – Salmon Benefits Model

Fall/Spring Run Fork Length

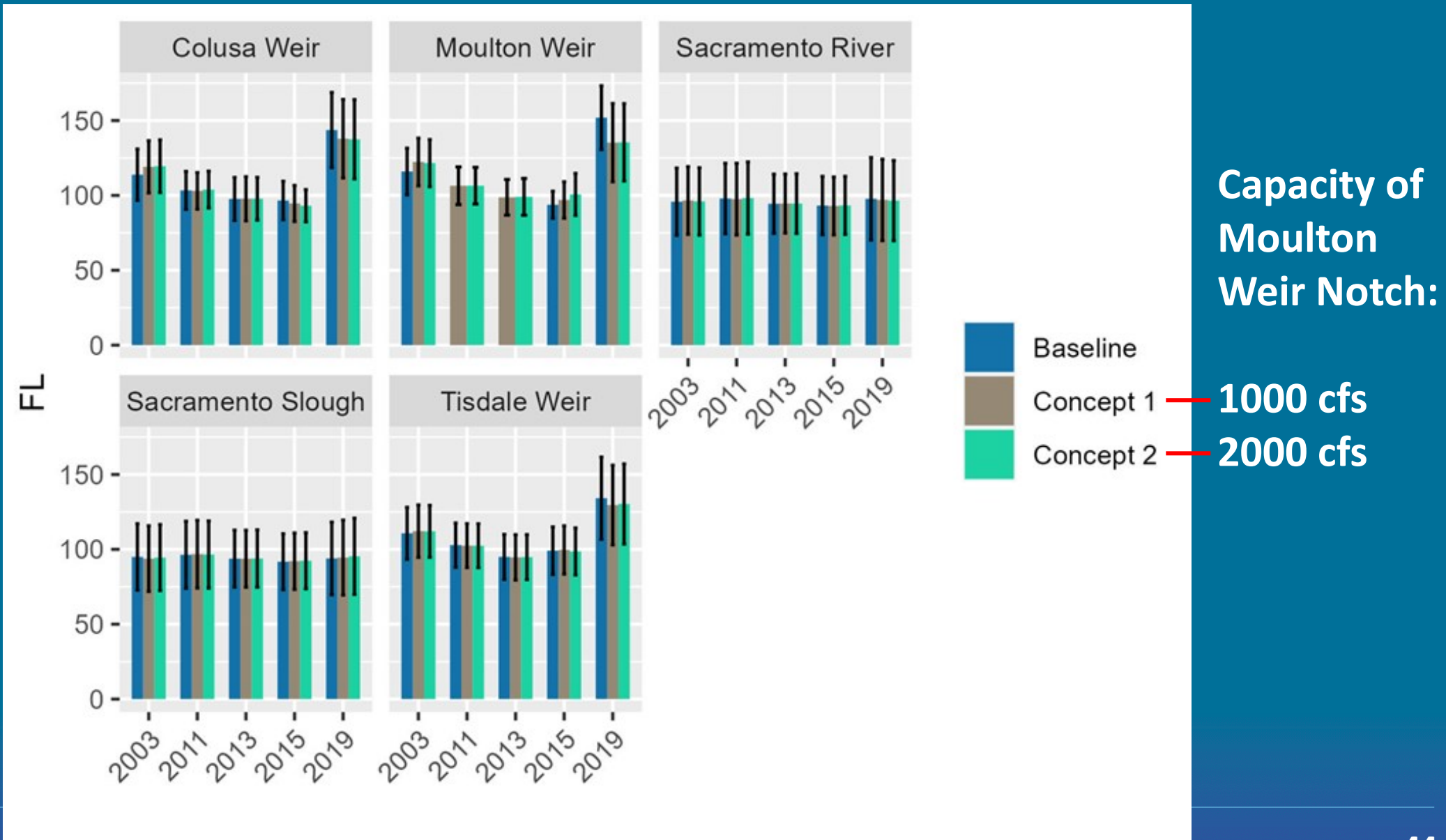


Capacity of Moulton Weir Notch:

- Baseline
- Concept 1 — 1000 cfs
- Concept 2 — 2000 cfs

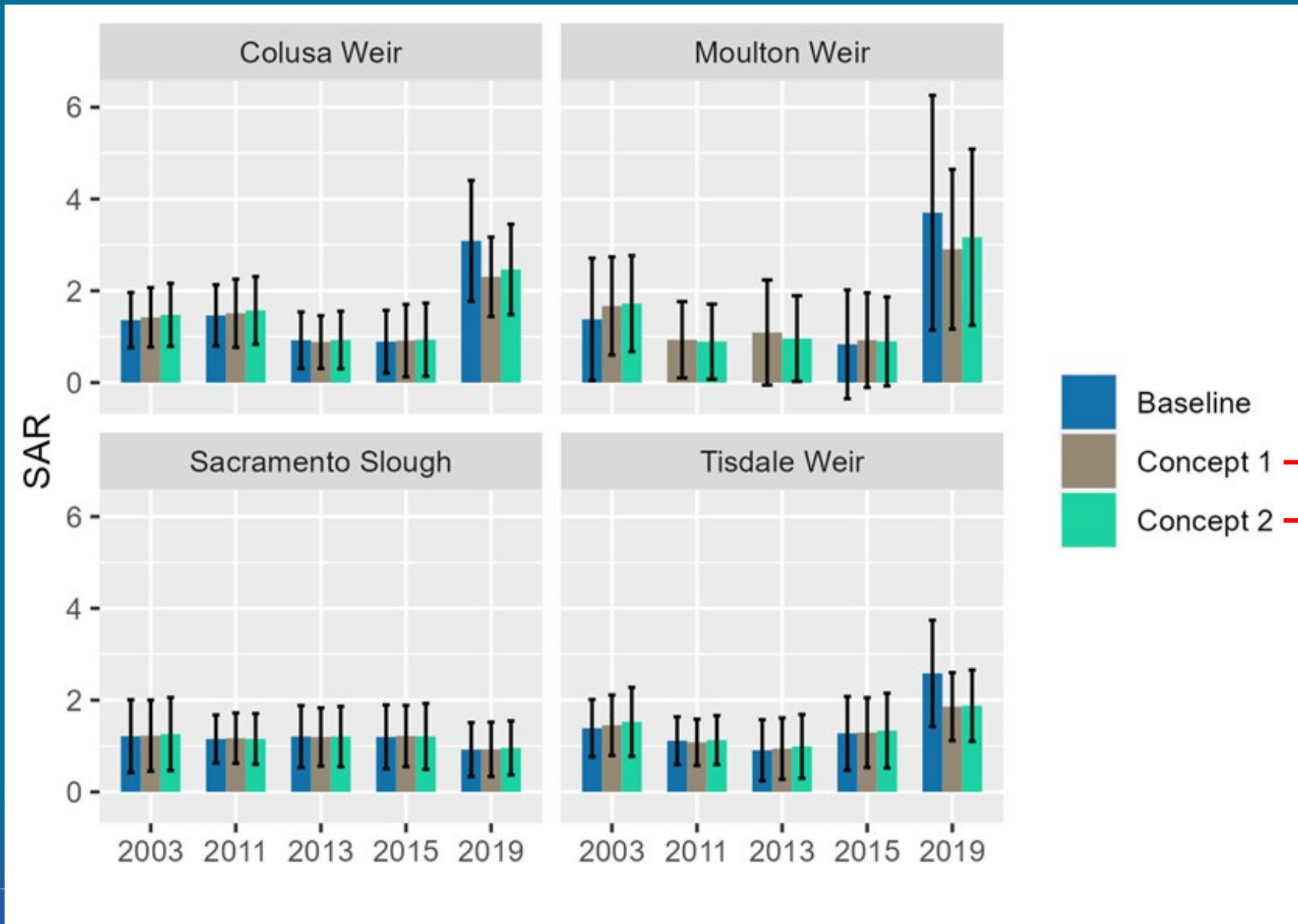
Results Discussion – Salmon Benefits Model

Winter Run Fork Length



Results Discussion – Salmon Benefits Model

Fall/Spring Run relative Smolt to Adult Ratio

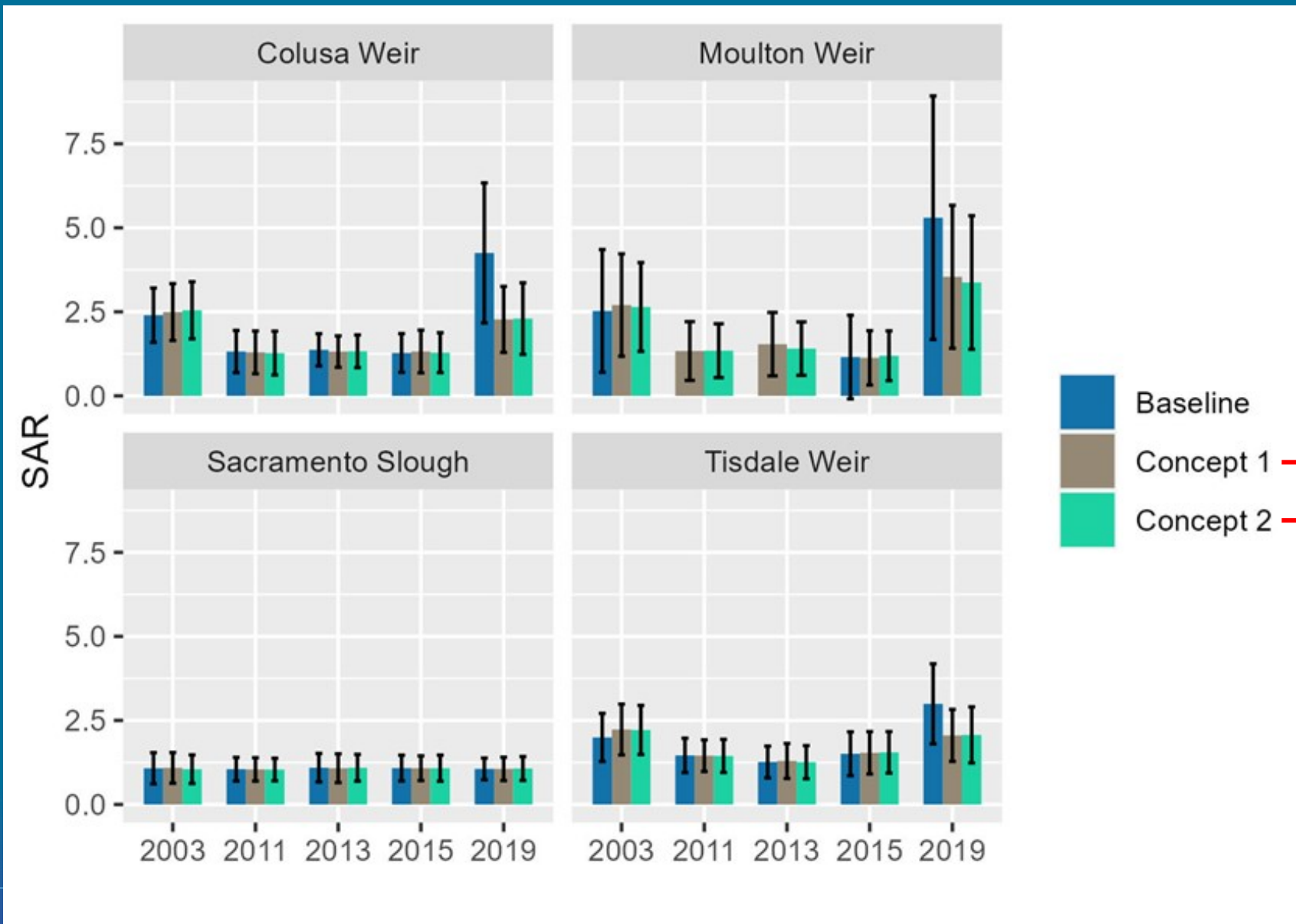


Capacity of
Moulton
Weir Notch:

- Baseline
- Concept 1 — 1000 cfs
- Concept 2 — 2000 cfs

Results Discussion – Salmon Benefits Model

Winter Run relative Smolt to Adult Ratio



Capacity of Moulton Weir Notch:

- Baseline
- Concept 1 — 1000 cfs
- Concept 2 — 2000 cfs

Results Discussion – Shorebird & Sandhill Crane HSI

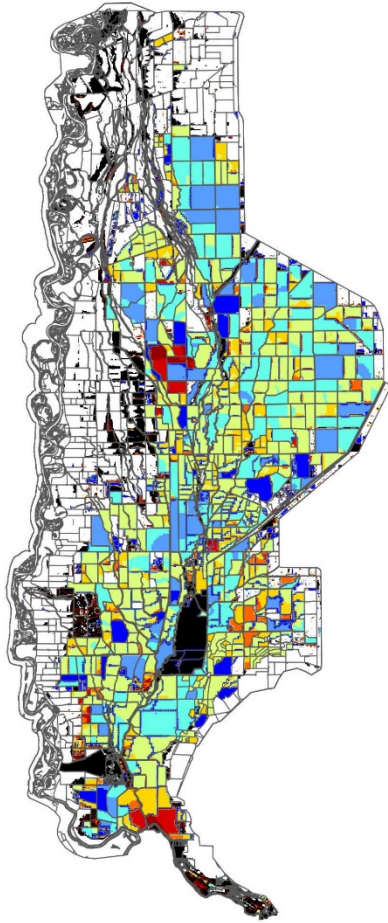
Key Findings

- **Key findings from TM**
 - WUA is 1/3 of that of waterfowl
 - Higher variability by year than in waterfowl
 - Butte had highest WUA in 2019 for Shorebird & SH Roosting
 - Foraging had lowest in 2019
 - Sutter showed lowest in 2019 for all three
- **Supplemental Observations**
 - Ratio Shorebird WUA to Basin Area
 - 10.9 for Butte, 6.6 for Colusa, 4.0 for Sutter
 - Butte Sink area has no sandhill crane roosting habitat due to being flooded for time Sandhill evaluated (Oct 1 – Mar 15)
 - Lower Sutter not good for either
 - Both species have best habitat during managed field flood-up and/or drawdown

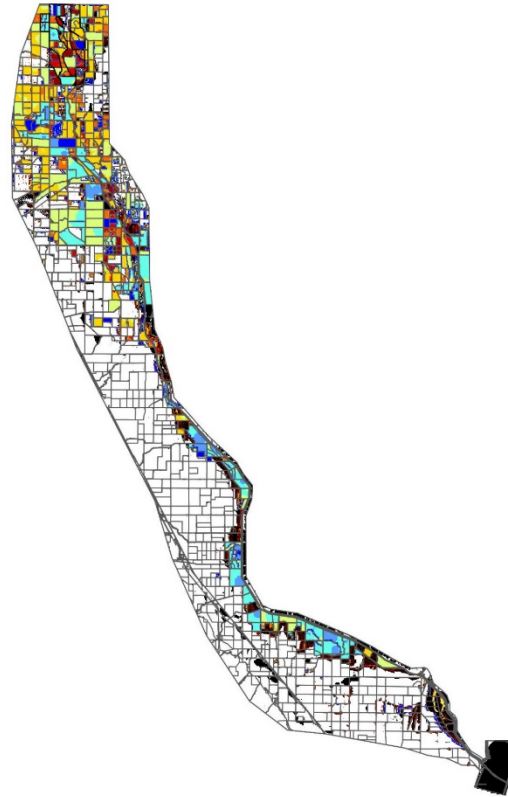
Results Discussion – Shorebird HSI

Shorebird Suitability Sum - Baseline 2003

Butte



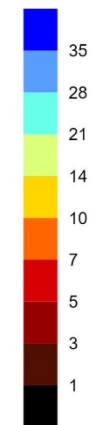
Colusa



Sutter



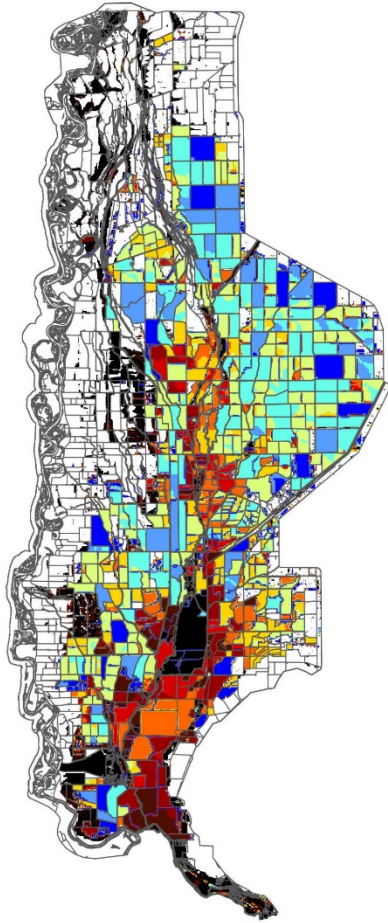
Suitability Sum



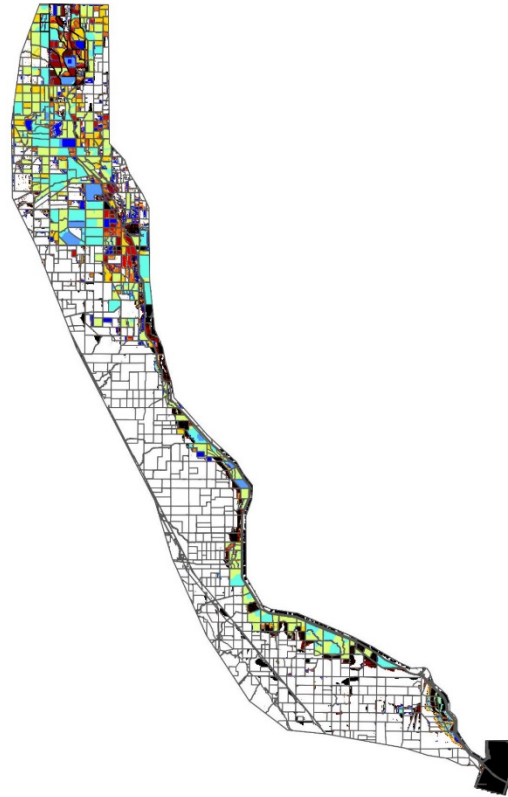
Results Discussion – Shorebird HSI

Shorebird Suitability Sum - Baseline 2011

Butte



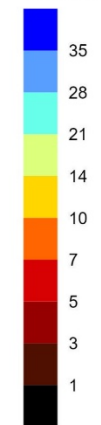
Colusa



Sutter



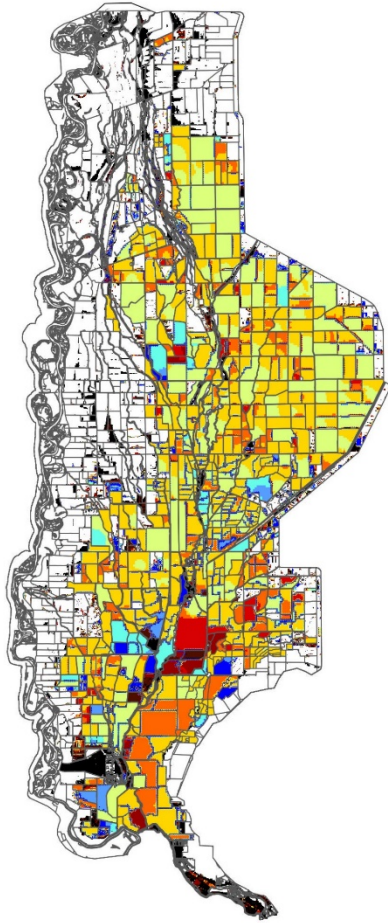
Suitability Sum



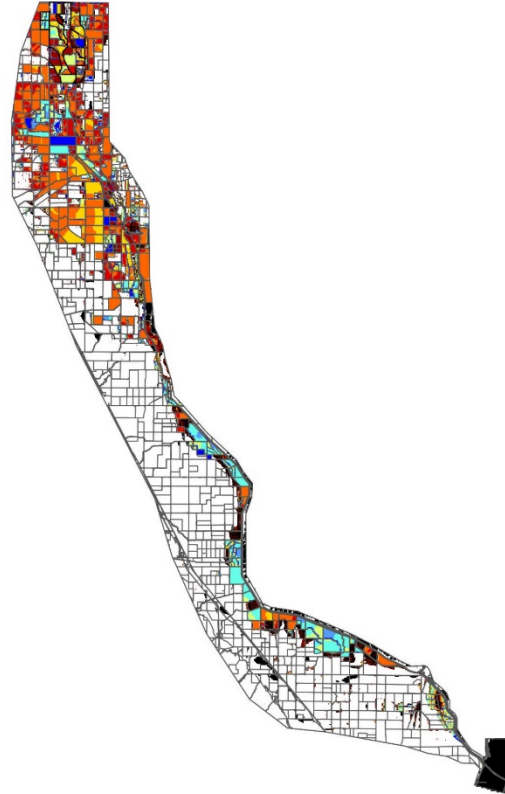
Results Discussion – Shorebird HSI

Shorebird Suitability Sum - Baseline 2013

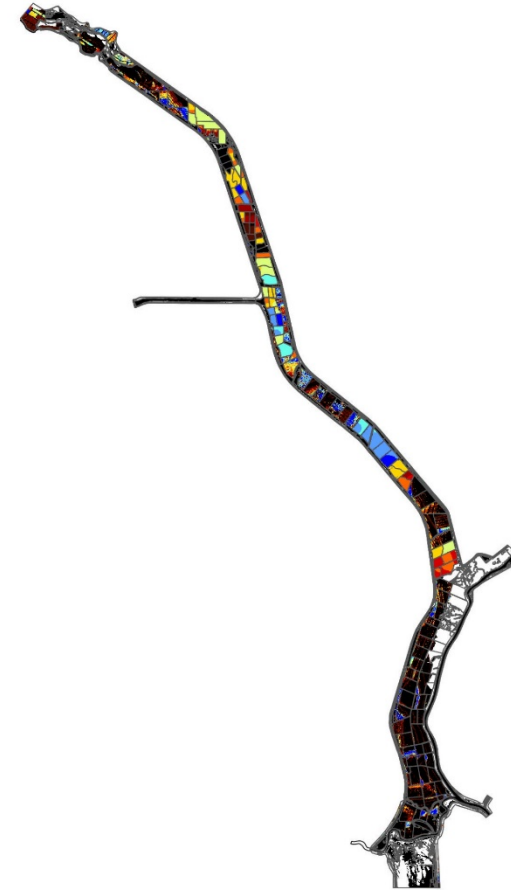
Butte



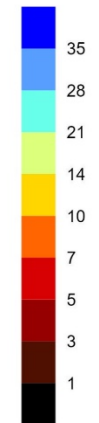
Colusa



Sutter



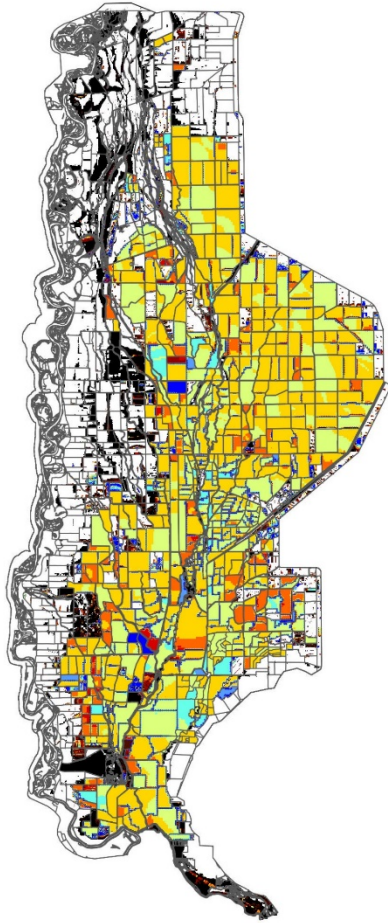
Suitability Sum



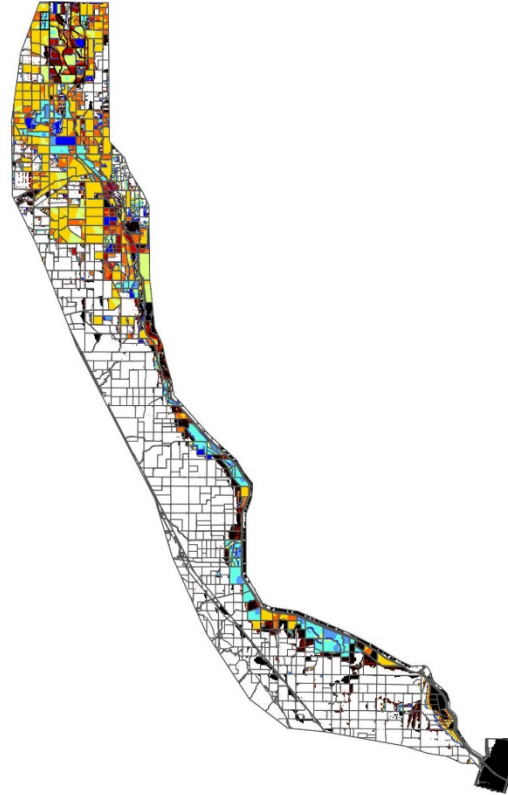
Results Discussion – Shorebird HSI

Shorebird Suitability Sum - Baseline 2015

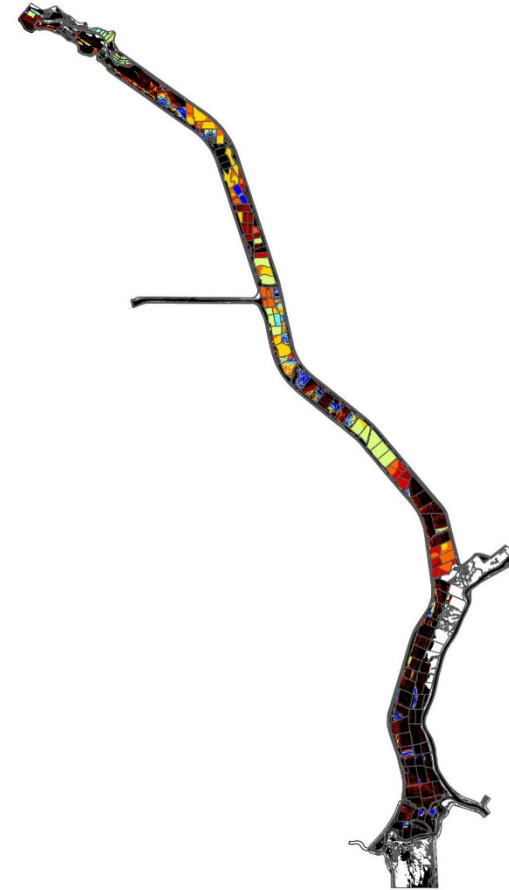
Butte



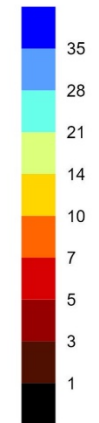
Colusa



Sutter



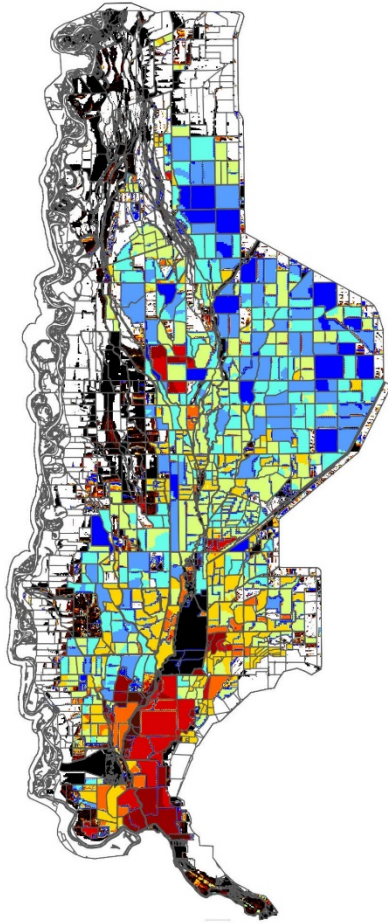
Suitability Sum



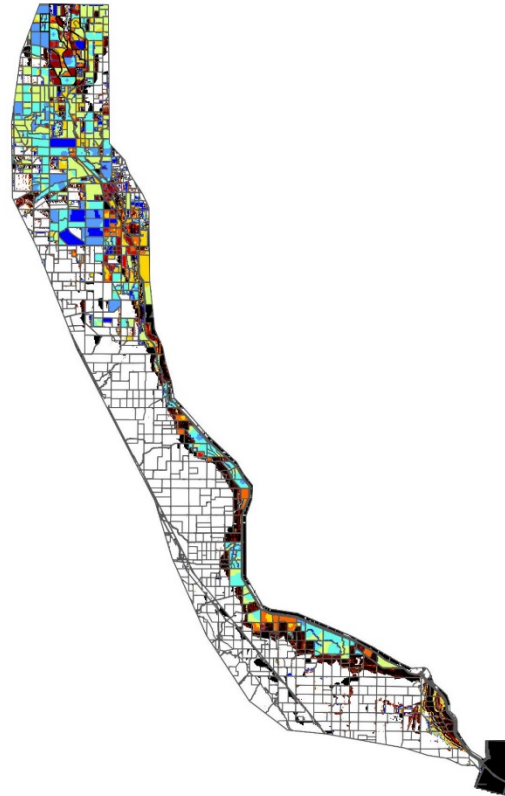
Results Discussion – Shorebird HSI

Shorebird Suitability Sum - Baseline 2019

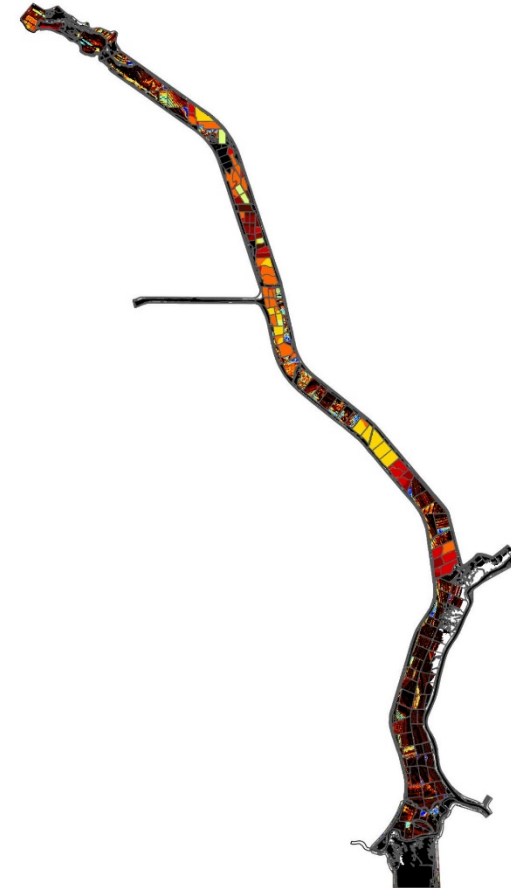
Butte



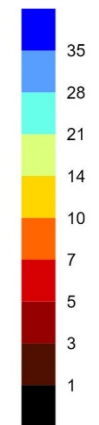
Colusa



Sutter



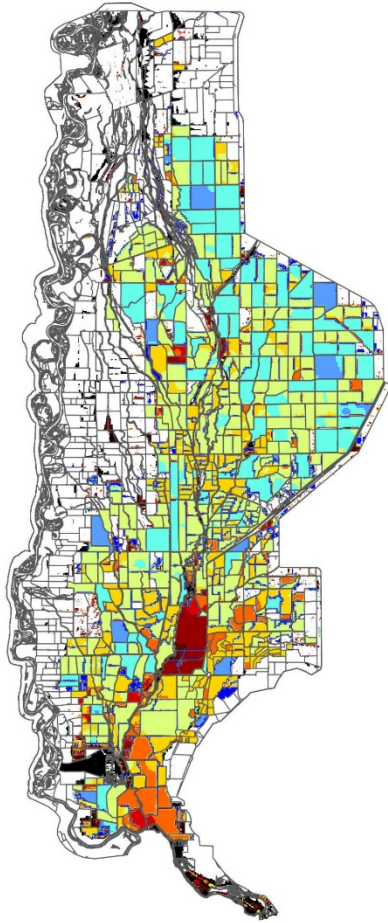
Suitability Sum



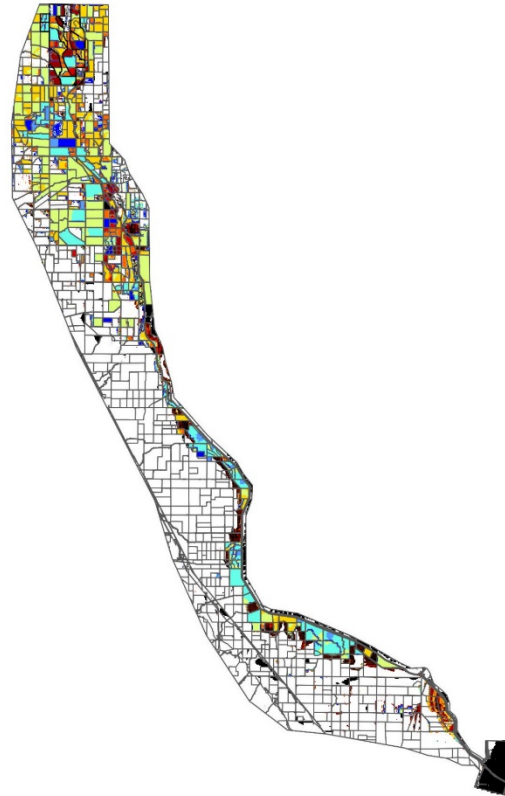
Results Discussion – Shorebird HSI

Shorebird Suitability Sum - Baseline Mean Across 2003, 2011, 2013, 2015, 2019

Butte



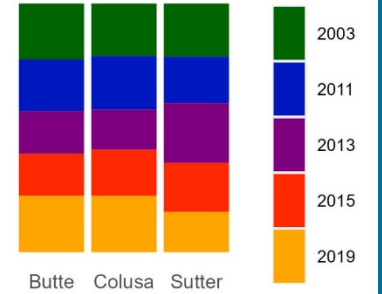
Colusa



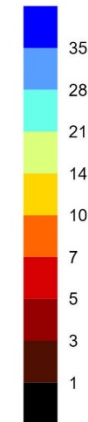
Sutter



Contributions By Year



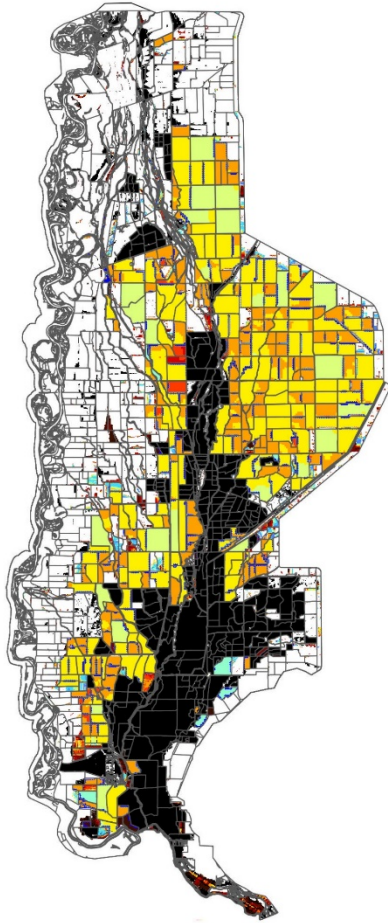
Suitability Sum



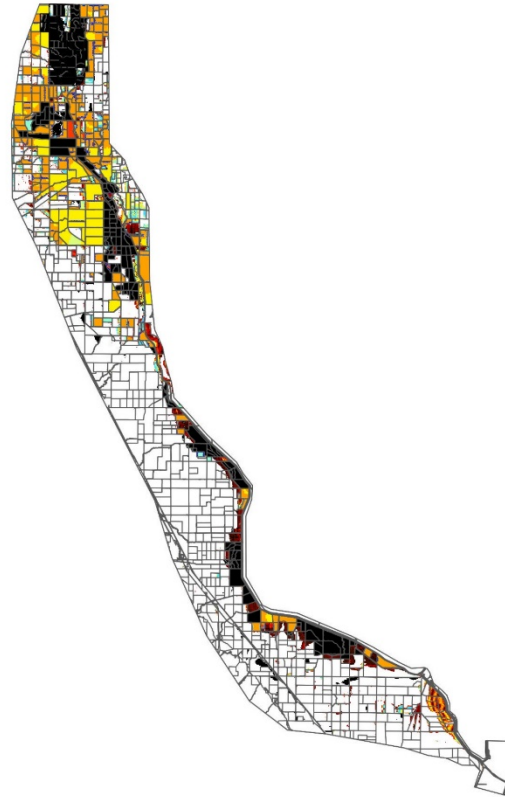
Results Discussion – Sandhill Crane Roosting HSI

Sandhill Roosting Suitability Sum - Baseline
Mean Across 2003, 2011, 2013, 2015, 2019

Butte



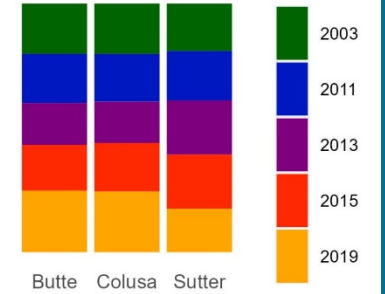
Colusa



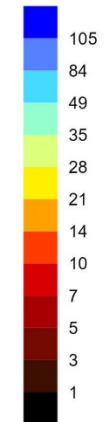
Sutter



Contributions By Year



Suitability Sum

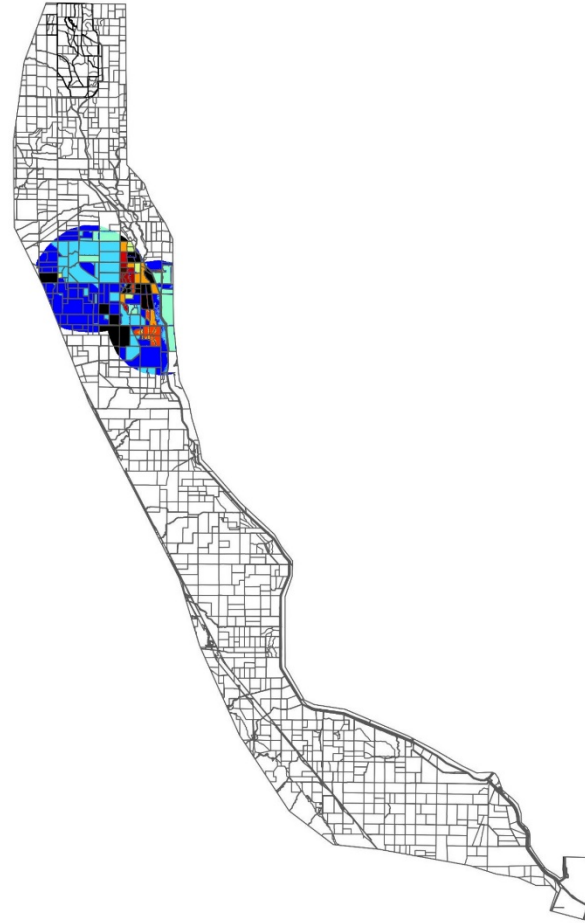
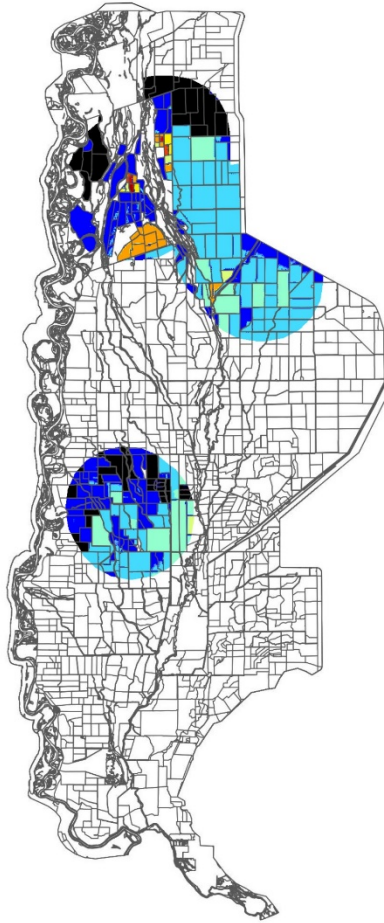


Results Discussion – Sandhill Crane Foraging HSI

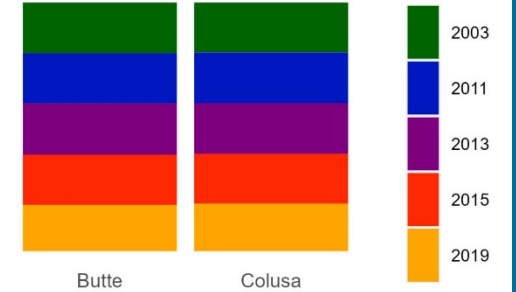
Sandhill Foraging Suitability Sum - Baseline Mean Across 2003, 2011, 2013, 2015, 2019

Butte

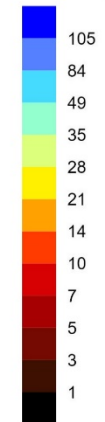
Colusa



Contributions By Year



Suitability Sum



Results Discussion – Secondary Productivity & Export Potential

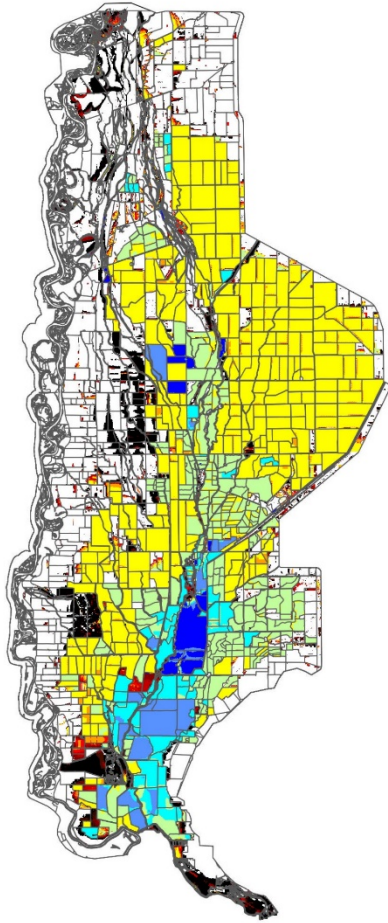
Key Findings

- **Key findings from TM**
 - **Secondary Productivity**
 - Low variability across years, highest in Sutter
 - 2019 has highest productivity in Butte & Colusa, not Sutter
 - Wet area is more tied to productivity than connected area
 - **Export Potential**
 - Highest export volume in Butte
 - More variable, still highest variability in Sutter
 - 2019 highest of years in all basins
 - Export follows river flows on rising limb, quickly drop to 0 on falling
- **Supplemental Observations**
 - **Ratio Productivity WUA to Basin Area**
 - 67.9 in Butte, 39.9 in Colusa, 42.3 in Sutter
 - **Ratio Export Potential Volume to Basin Area**
 - 1.9 in Butte, 0.7 in Colusa, 4.6 in Sutter
 - Productivity driven by managed inundation, especially in Sutter
 - Butte Sink still usually better than surrounding despite being closer to the channel

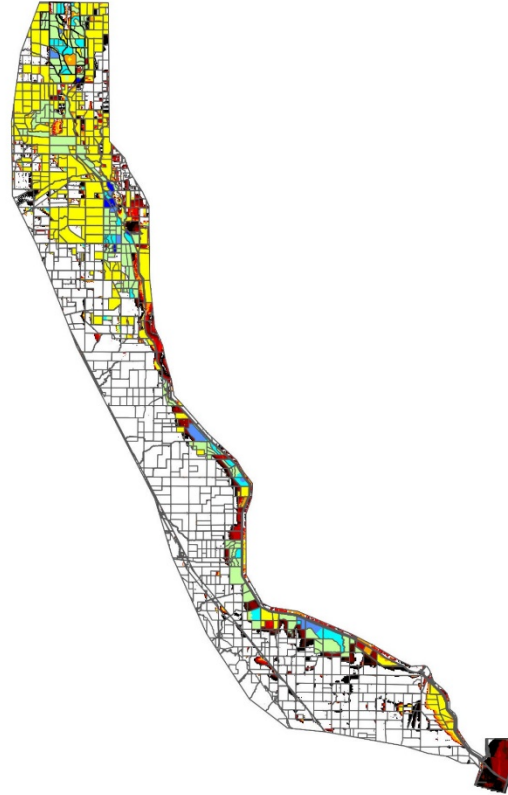
Results Discussion – Secondary Productivity HSI

Secondary Productivity Suitability Sum - Baseline 2003

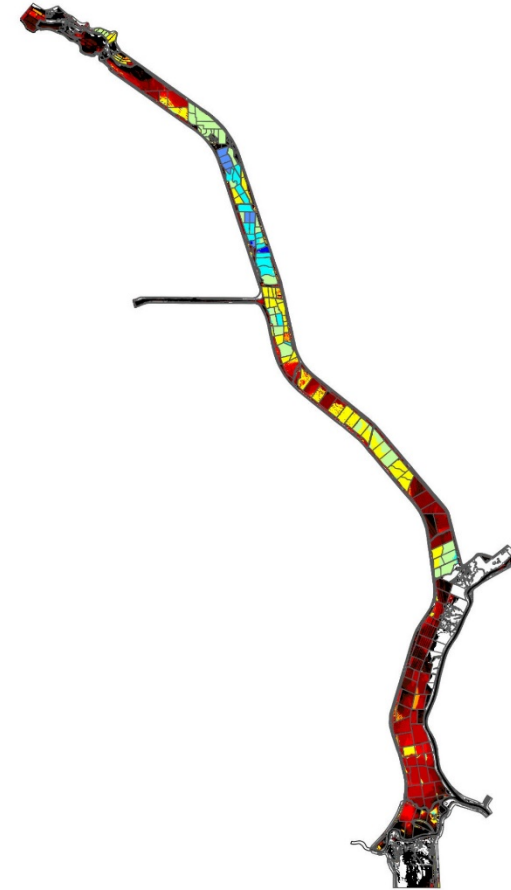
Butte



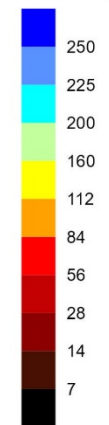
Colusa



Sutter



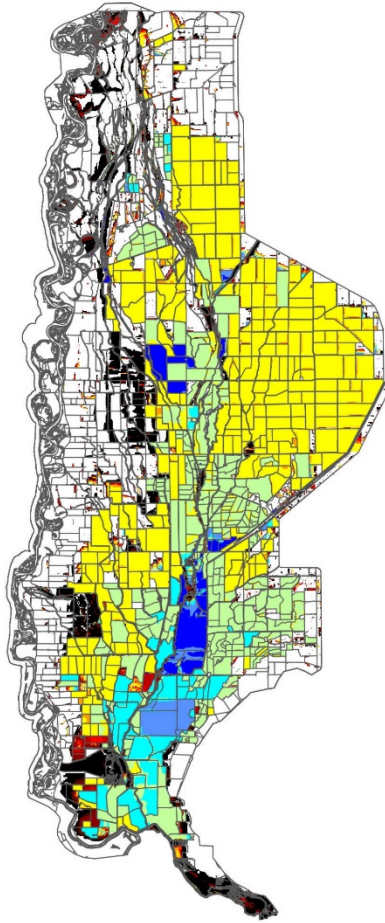
Suitability Sum



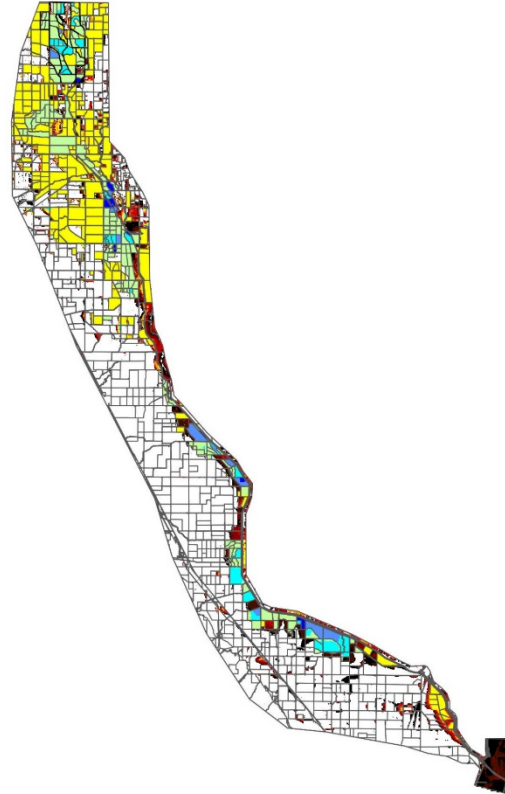
Results Discussion – Secondary Productivity HSI

Secondary Productivity Suitability Sum - Baseline 2011

Butte



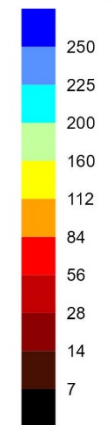
Colusa



Sutter



Suitability Sum

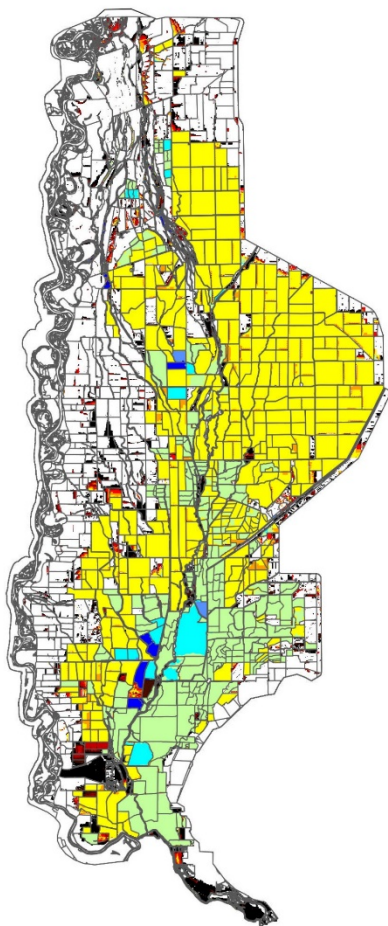


Results Discussion – Secondary Productivity HSI

Secondary Productivity Suitability Sum - Baseline

2013

Butte



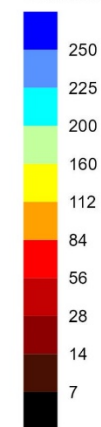
Colusa



Sutter



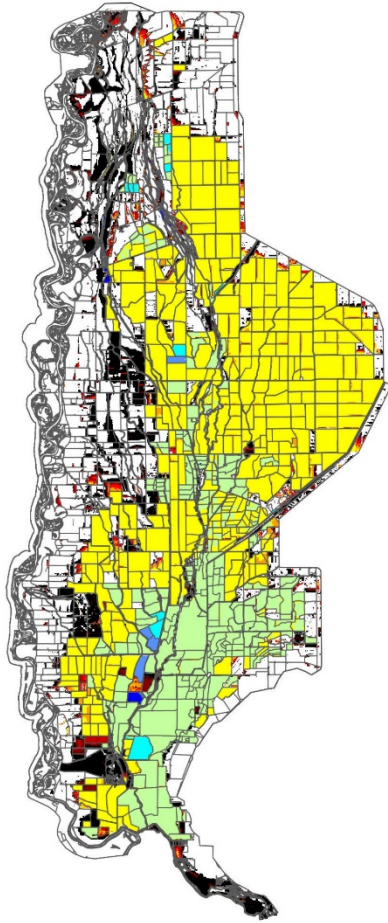
Suitability Sum



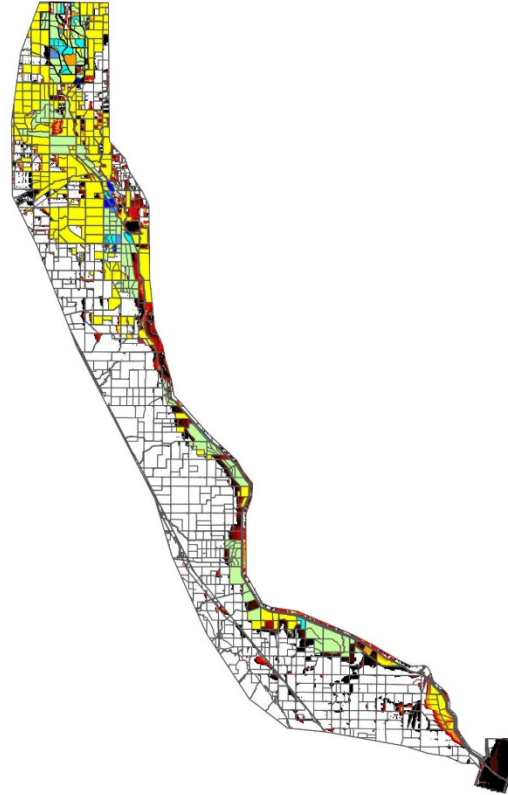
Results Discussion – Secondary Productivity HSI

Secondary Productivity Suitability Sum - Baseline 2015

Butte



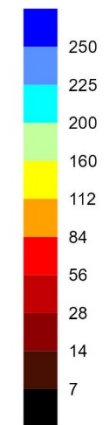
Colusa



Sutter



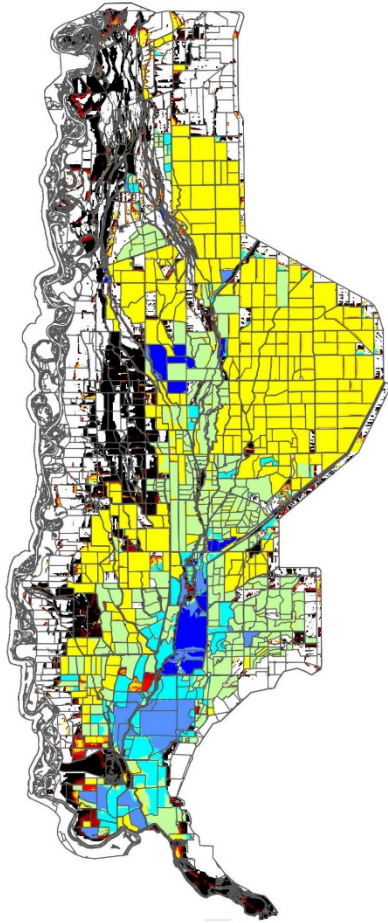
Suitability Sum



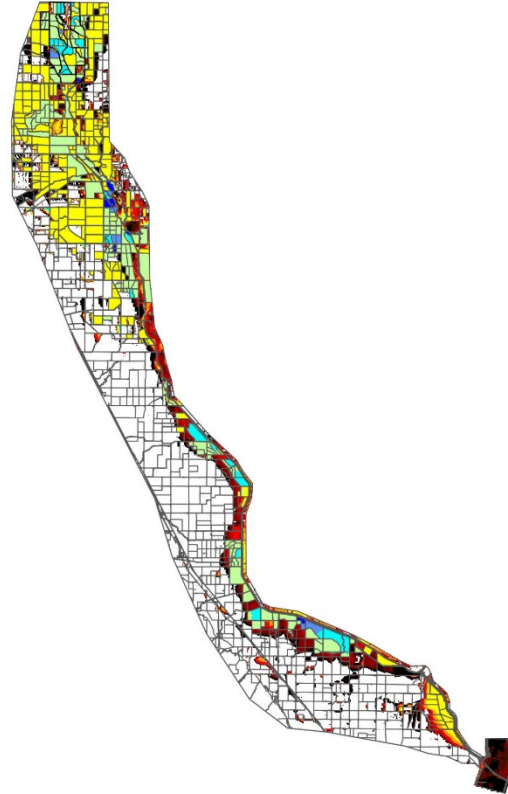
Results Discussion – Secondary Productivity HSI

Secondary Productivity Suitability Sum - Baseline 2019

Butte



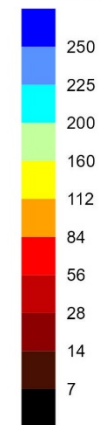
Colusa



Sutter



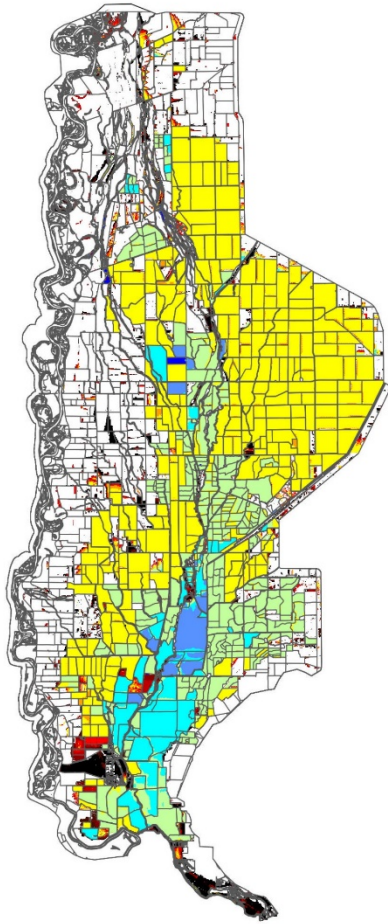
Suitability Sum



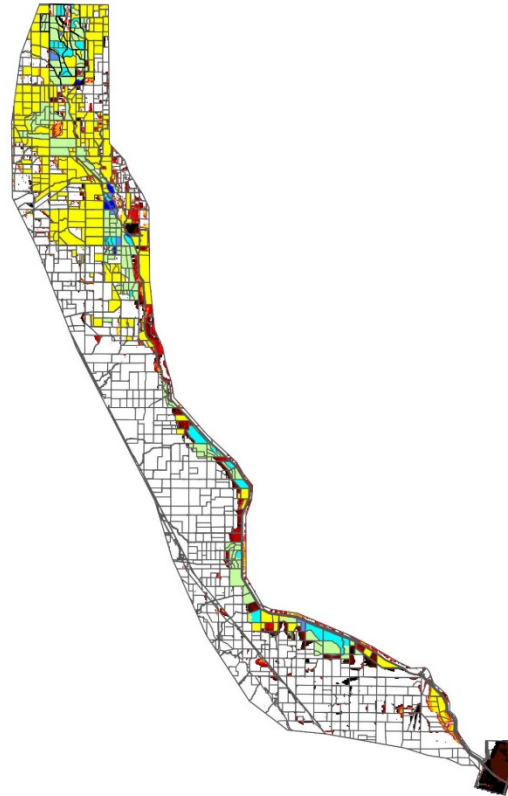
Results Discussion – Secondary Productivity HSI

Secondary Productivity Suitability Sum - Baseline Mean Across 2003, 2011, 2013, 2015, 2019

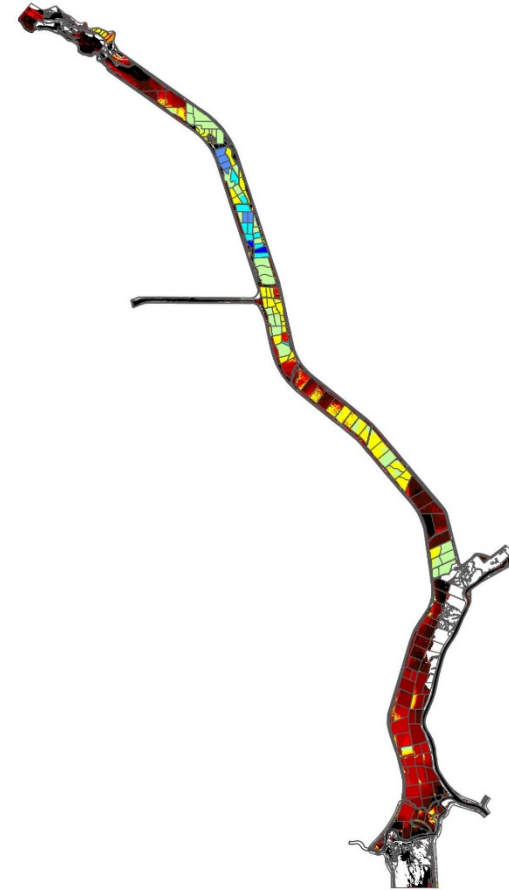
Butte



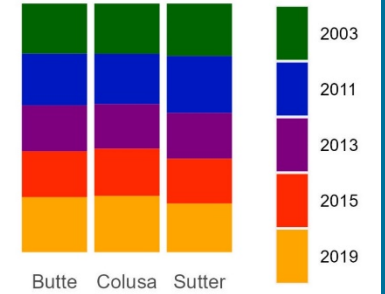
Colusa



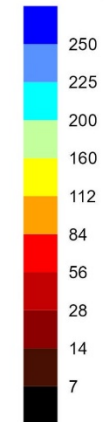
Sutter



Contributions By Year



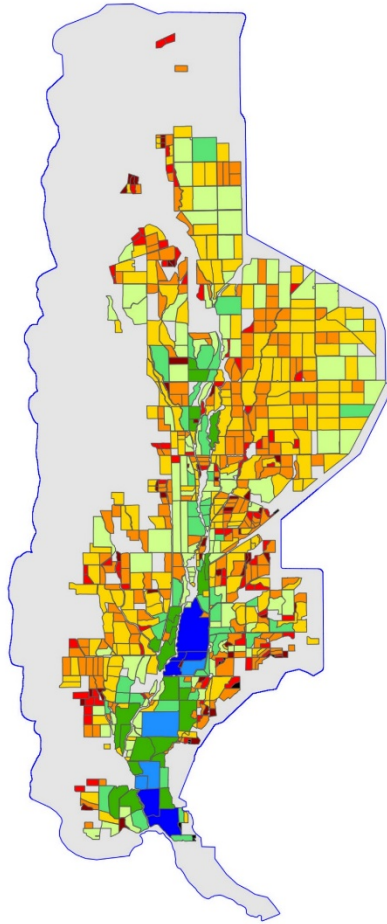
Suitability Sum



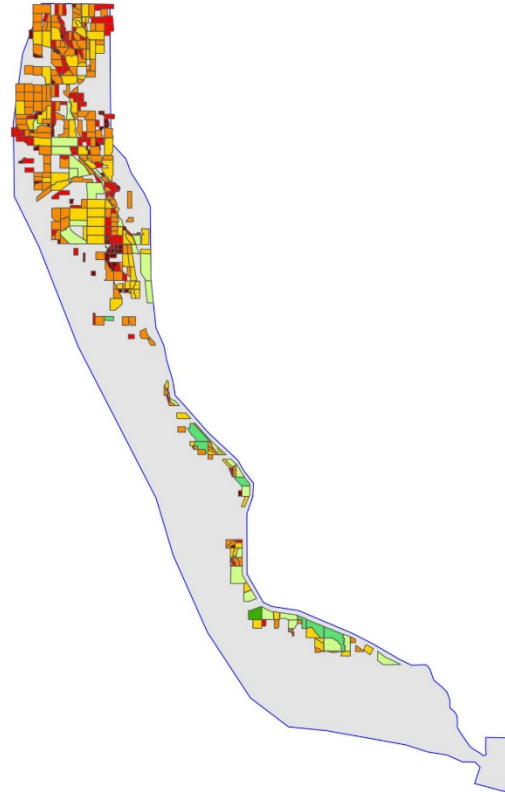
Results Discussion – Secondary Production Export Potential Volume

Total Export Potential from Managed Fields 2003

Butte



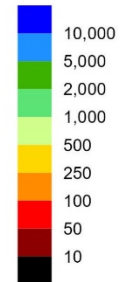
Colusa



Sutter



Export Volume (ac-ft)

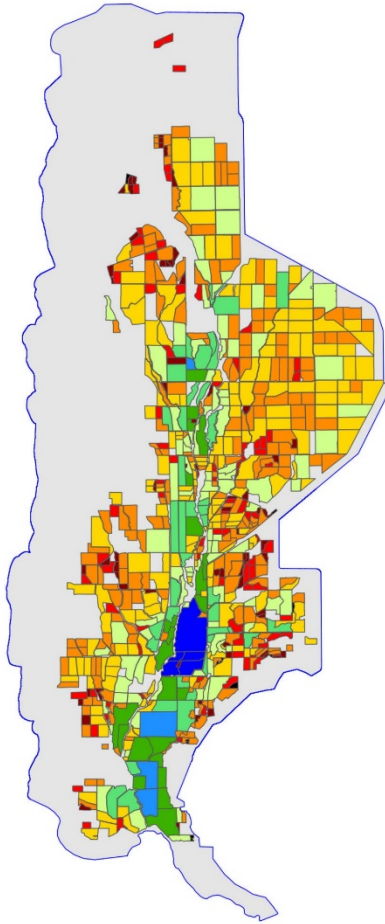


Results Discussion – Secondary Production Export Potential Volume

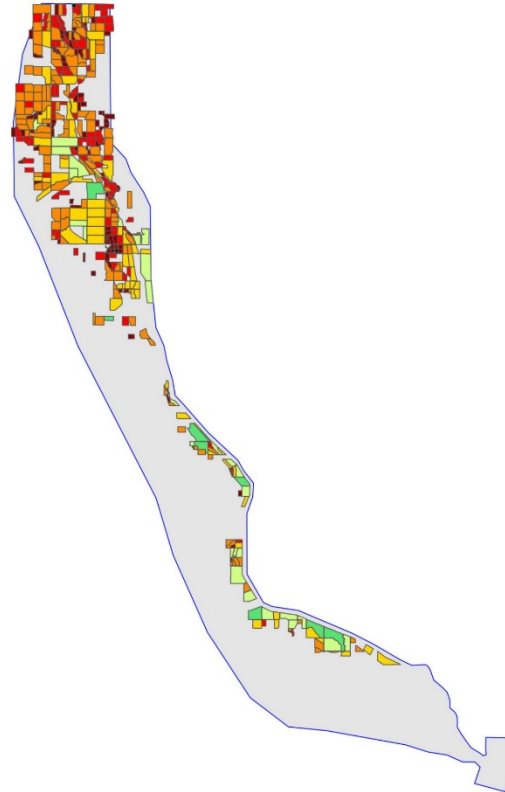
Total Export Potential from Managed Fields

2011

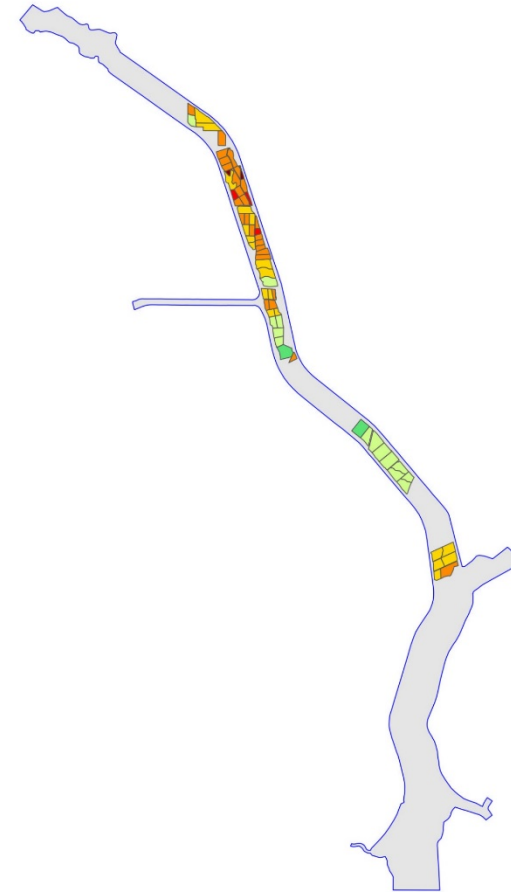
Butte



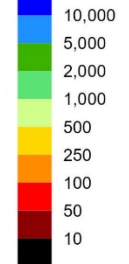
Colusa



Sutter



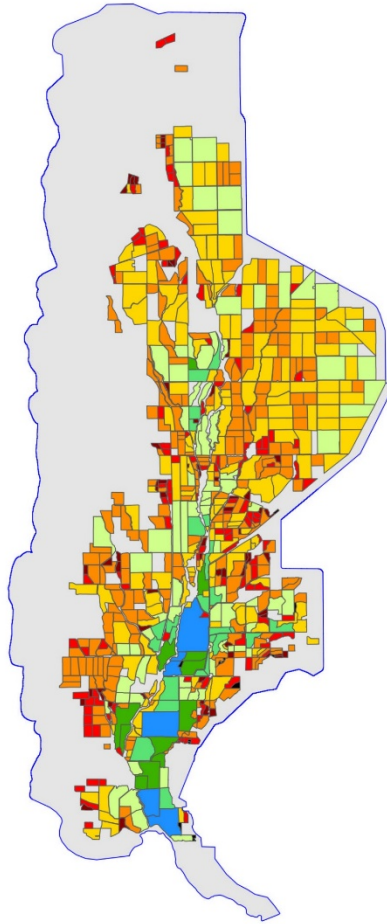
Export Volume (ac-ft)



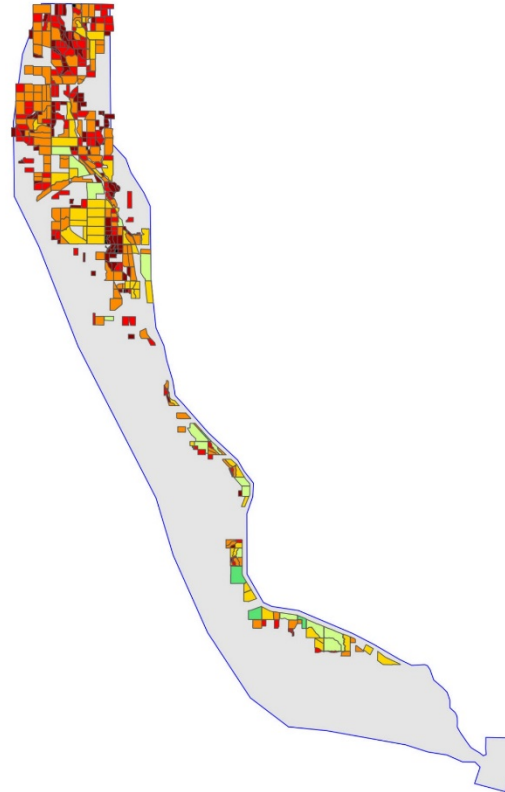
Results Discussion – Secondary Production Export Potential Volume

Total Export Potential from Managed Fields 2013

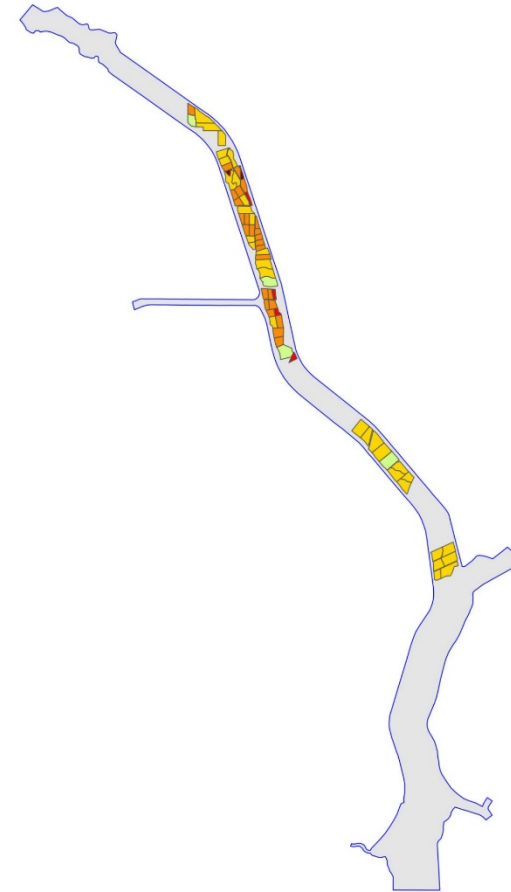
Butte



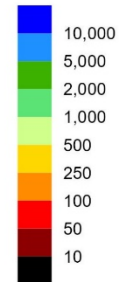
Colusa



Sutter



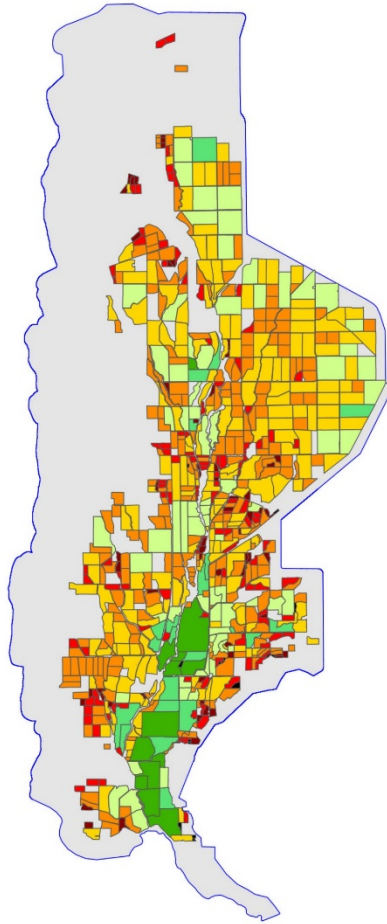
Export Volume (ac-ft)



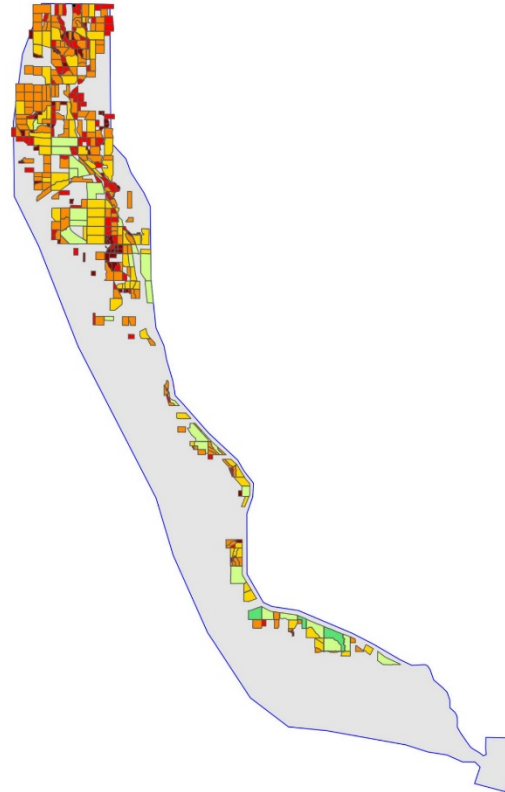
Results Discussion – Secondary Production Export Potential Volume

Total Export Potential from Managed Fields 2015

Butte



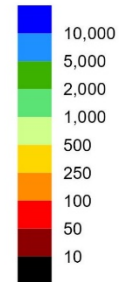
Colusa



Sutter



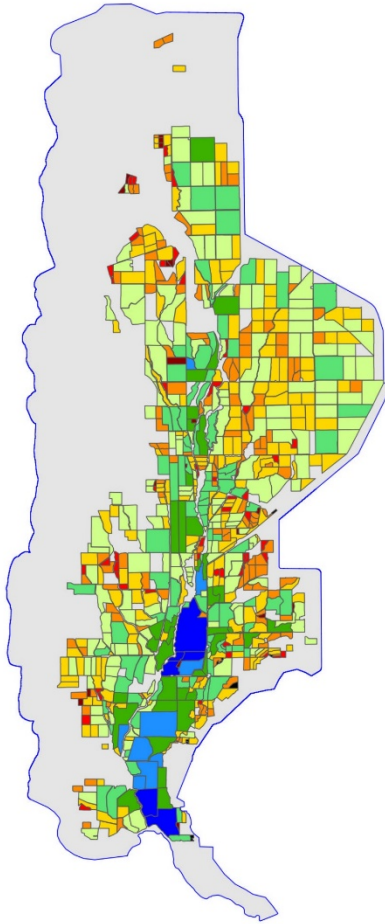
Export Volume (ac-ft)



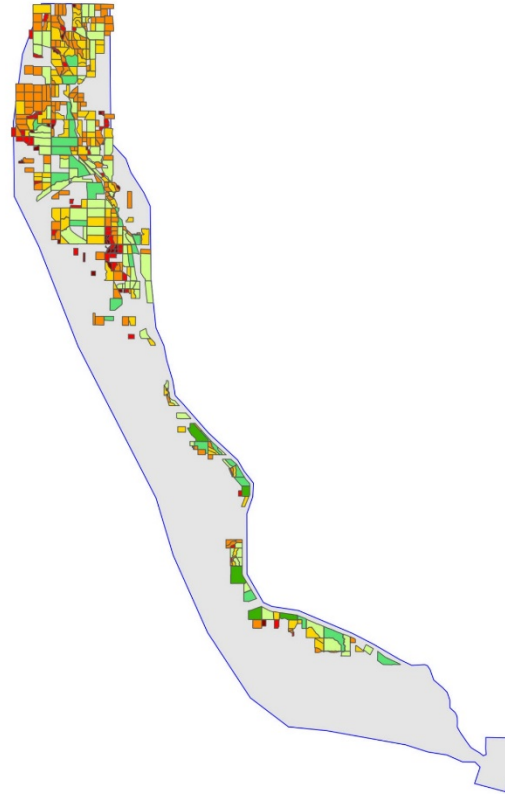
Results Discussion – Secondary Production Export Potential Volume

Total Export Potential from Managed Fields 2019

Butte



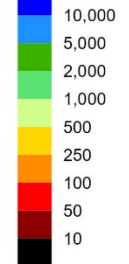
Colusa



Sutter



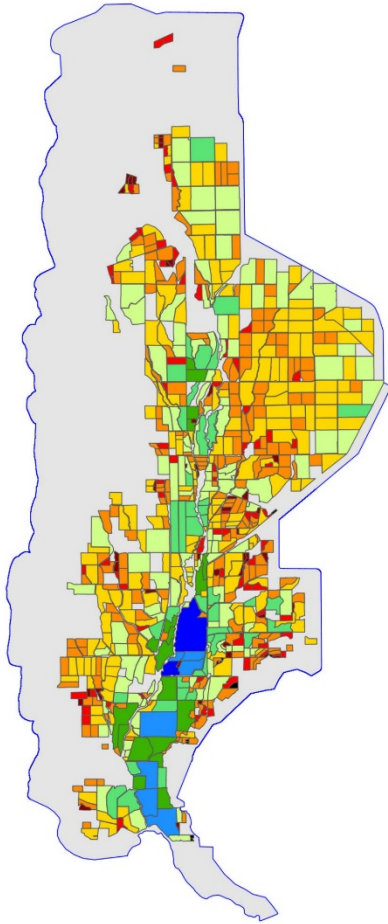
Export Volume (ac-ft)



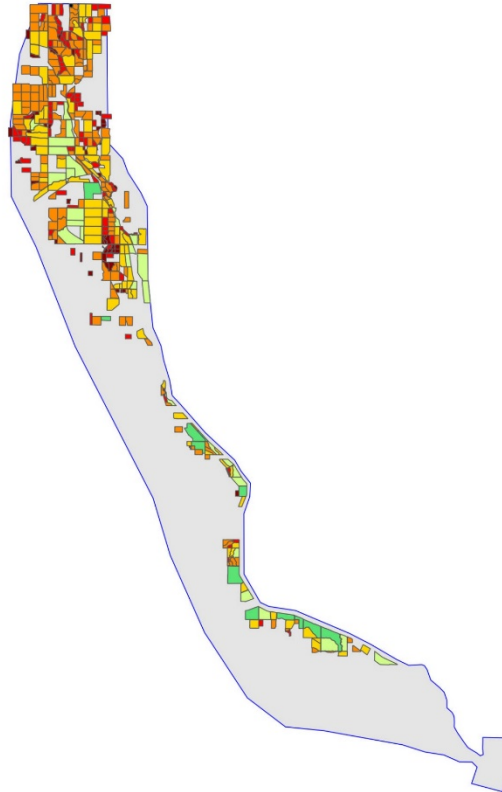
Results Discussion – Secondary Production Export Potential Volume

Total Export Potential from Managed Fields
Mean Across 2003, 2011, 2013, 2015, 2019

Butte



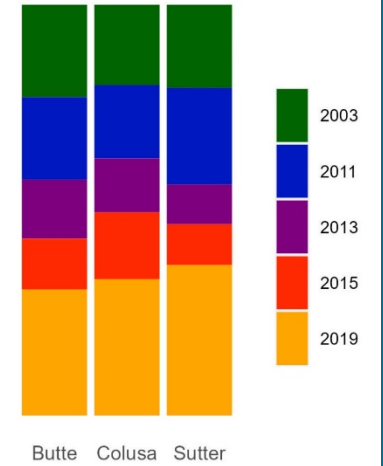
Colusa



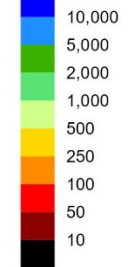
Sutter



Contributions By Year



Export Volume (ac-ft)



Results Discussion – Export Potential Depth

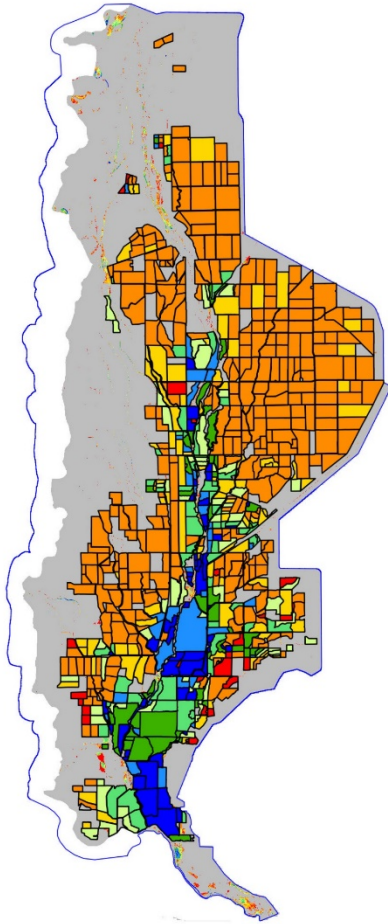
- Large fields contribute more to total export volume
- Can normalize results by calculating export depth by dividing productive export potential by area
 - Areas exporting more productive water will stand out
 - Allows unmanaged areas (cell by cell instead of field) to be compared to managed fields
 - Can be conceptualized as a depth of water (weighted by suitability)

$$\text{Export Depth} \left(\frac{\text{ac ft}}{\text{ac}} \text{ or } \text{ft} \right) = \frac{\text{Export Volume (ac ft)}}{\text{Area (ac)}}$$

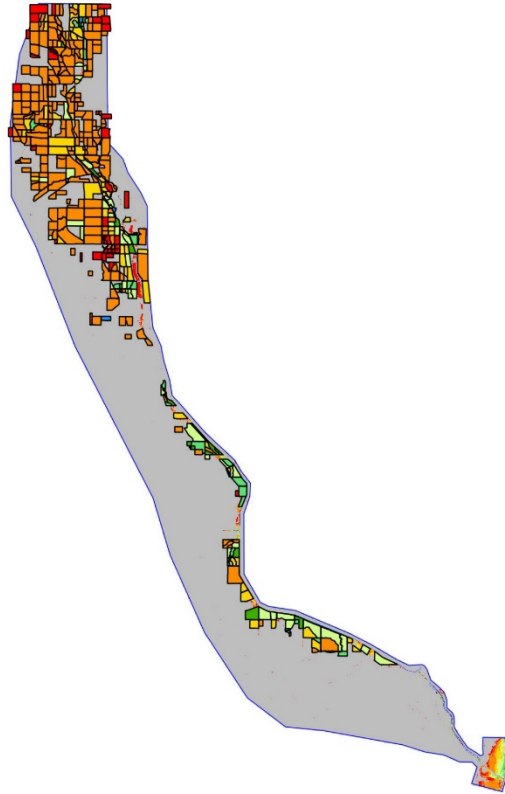
Results Discussion – Secondary Production Export Potential Depth

Total Export Depth Potential - Baseline 2003

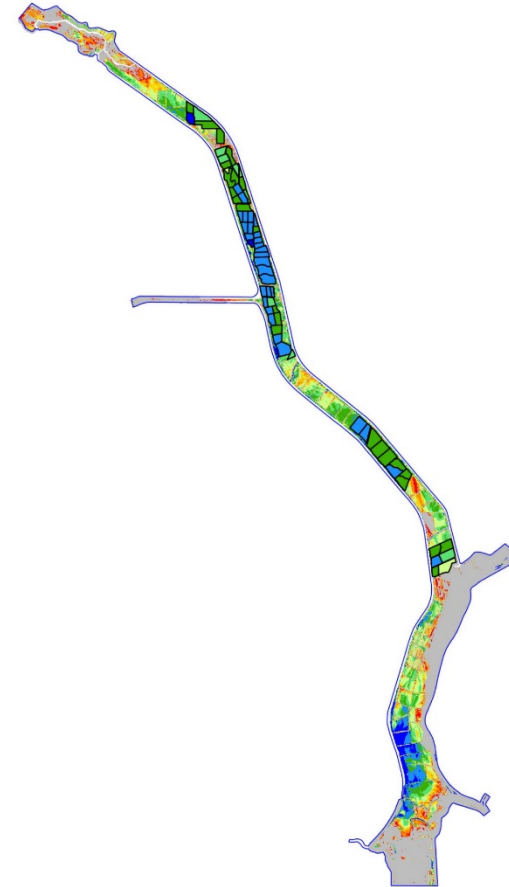
Butte



Colusa



Sutter



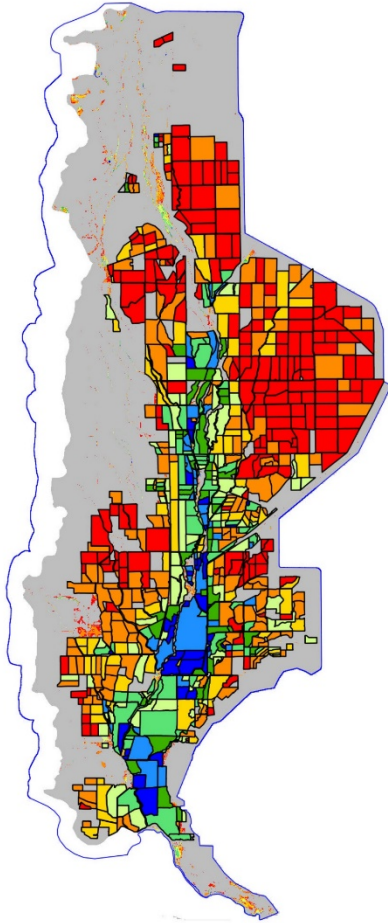
Export Depth
(ac-ft/ac)



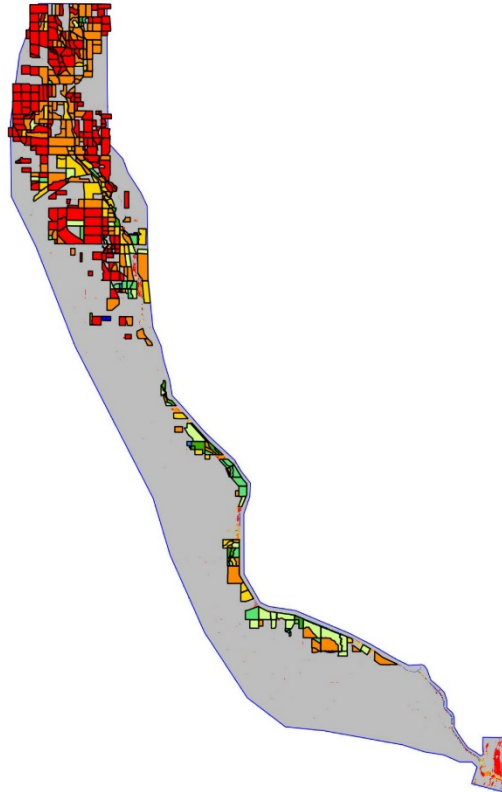
Results Discussion – Secondary Production Export Potential Depth

Total Export Depth Potential - Baseline
2011

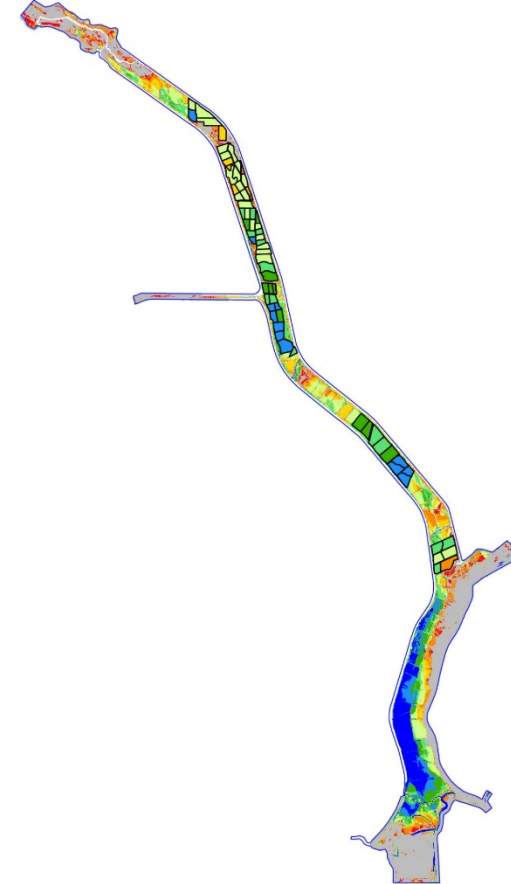
Butte



Colusa



Sutter



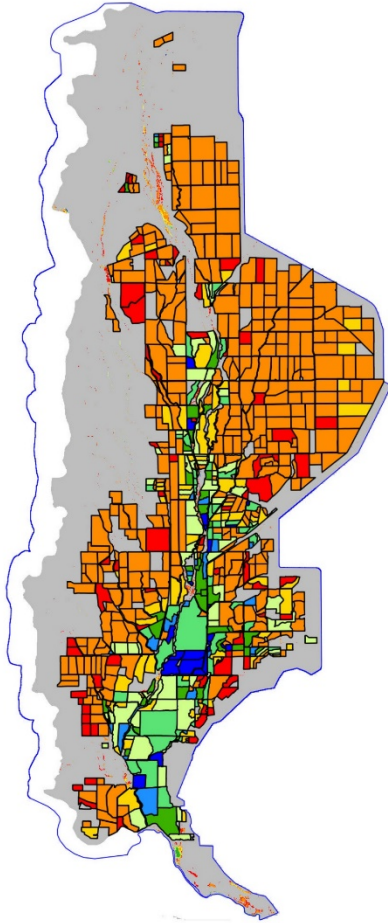
Export Depth
(ac-ft/ac)



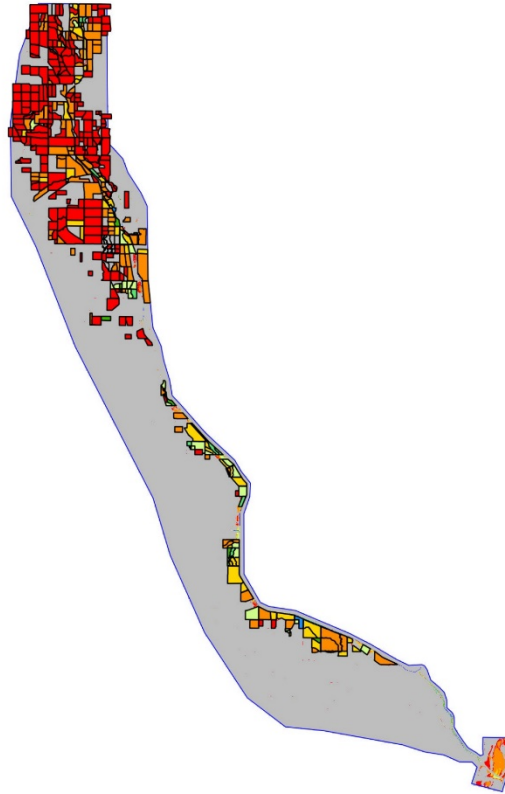
Results Discussion – Secondary Production Export Potential Depth

Total Export Depth Potential - Baseline 2013

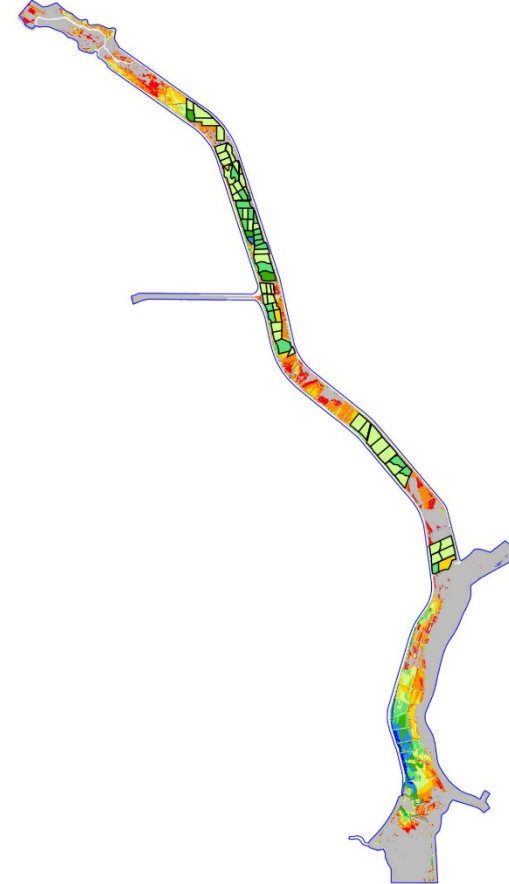
Butte



Colusa



Sutter



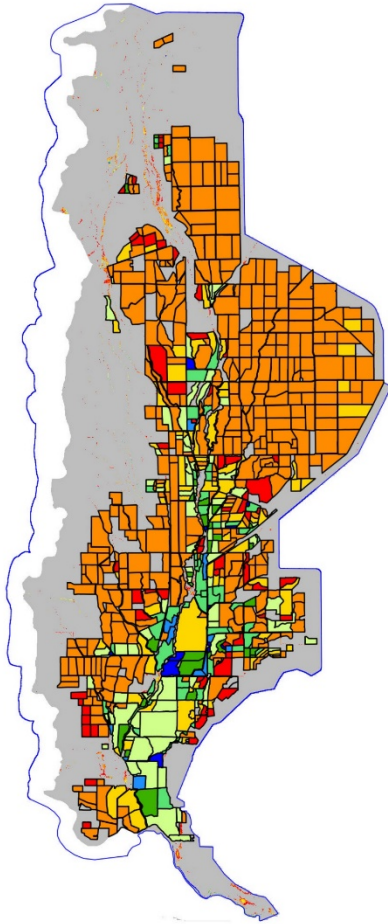
Export Depth
(ac-ft/ac)



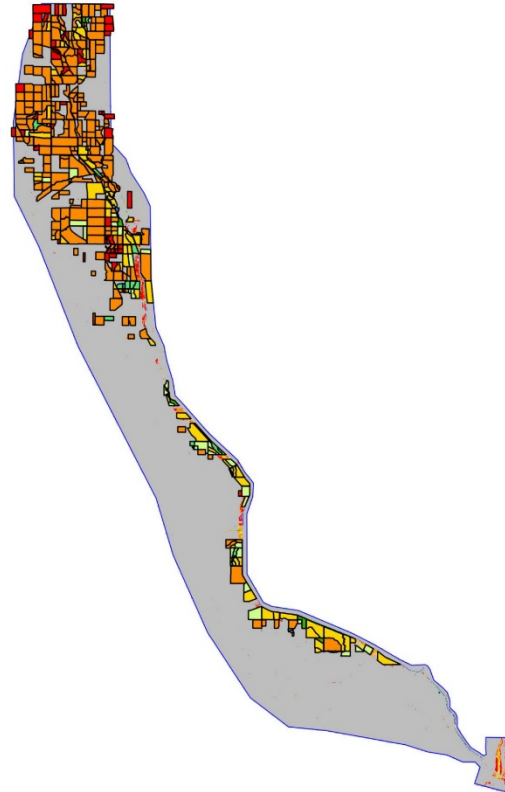
Results Discussion – Secondary Production Export Potential Depth

Total Export Depth Potential - Baseline
2015

Butte



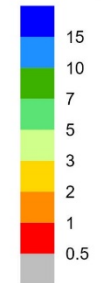
Colusa



Sutter



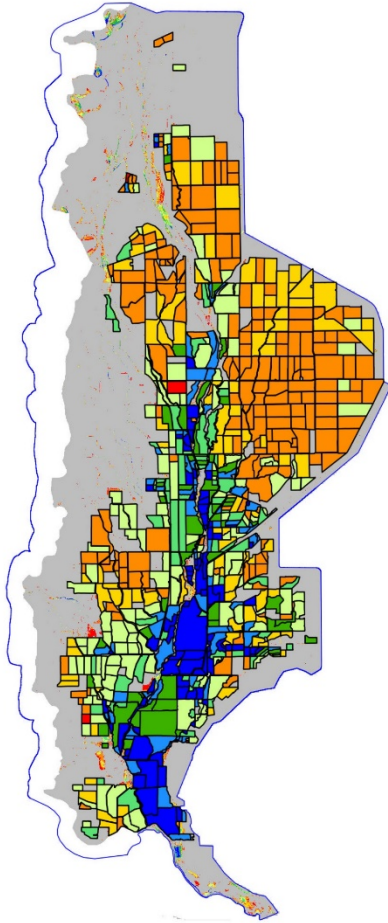
Export Depth
(ac-ft/ac)



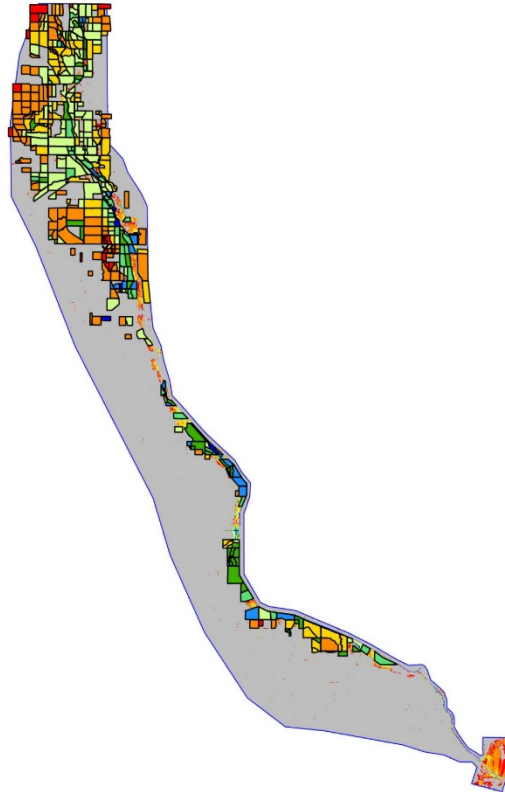
Results Discussion – Secondary Production Export Potential Depth

Total Export Depth Potential - Baseline 2019

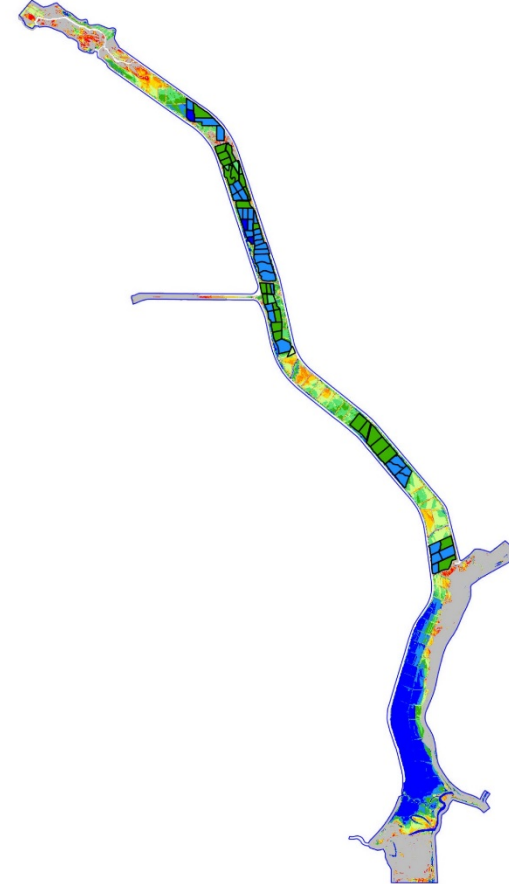
Butte



Colusa



Sutter



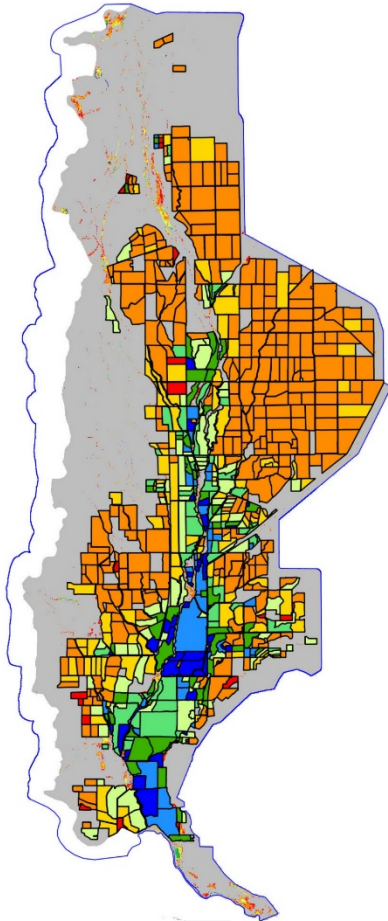
Export Depth
(ac-ft/ac)



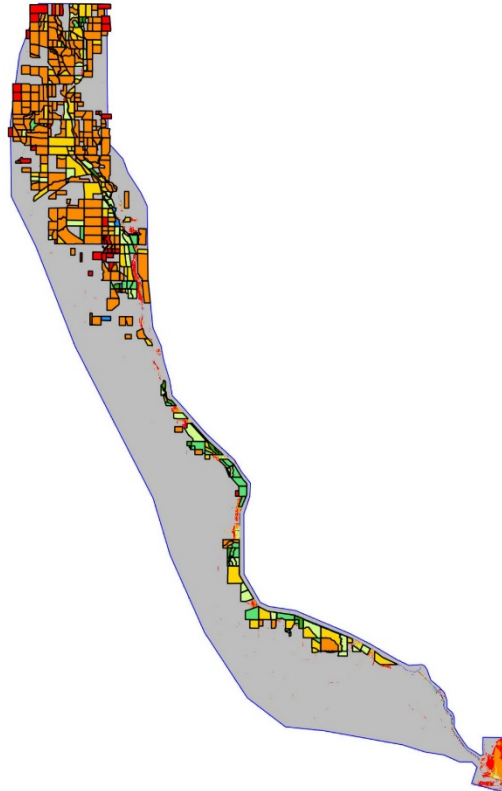
Results Discussion – Secondary Production Export Potential Depth

Total Export Depth Potential - Baseline
Mean Across 2003, 2011, 2013, 2015, 2019

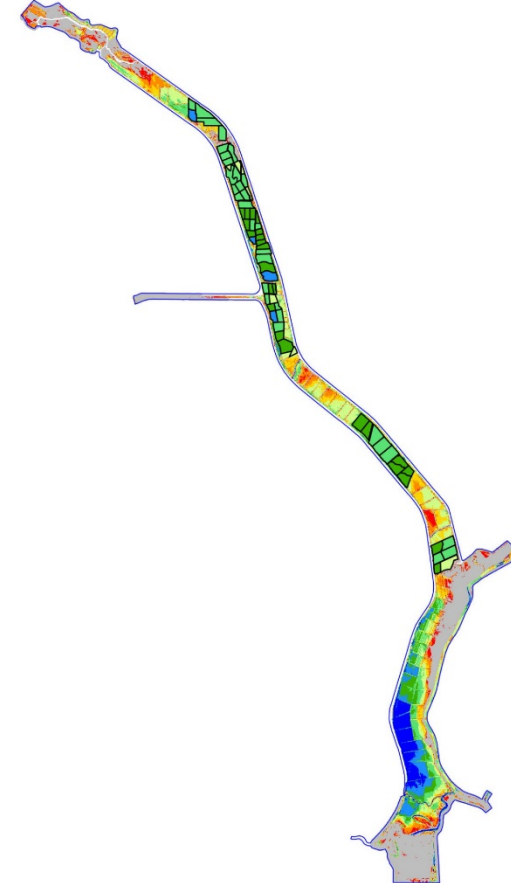
Butte



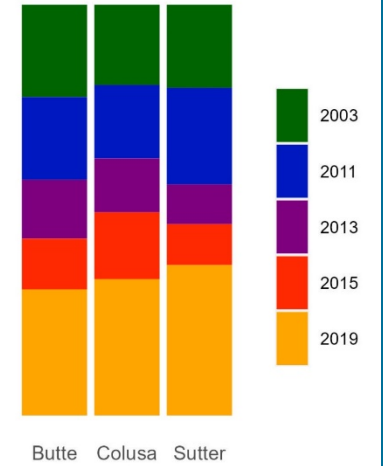
Colusa



Sutter



Contributions By Year



Export Depth
(ac-ft/ac)



Results Discussion – Agricultural Compatibility

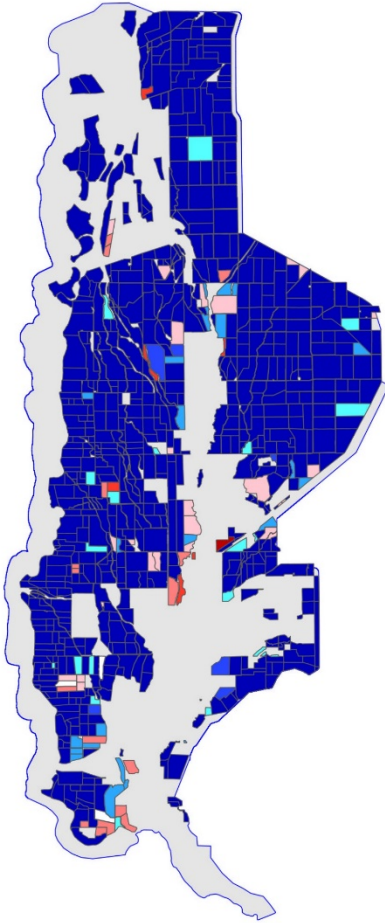
Key Findings

- **Key findings from TM**
 - **Generally 2019 and 2011 have late events – impactful to Ag**
 - **Sutter has more widespread impacts than Butte and Colusa**
 - Tisdale weir overtopping more directly affects fields
 - Inundation lasts longer in Sutter due to characteristics as flood bypass
 - **Lower Sutter high impact**
 - Sensitive to backwatering effects of Fremont Weir
 - ~10 ft grade change from West to East in Lower Sutter
 - **Higher impacts closer to channel**

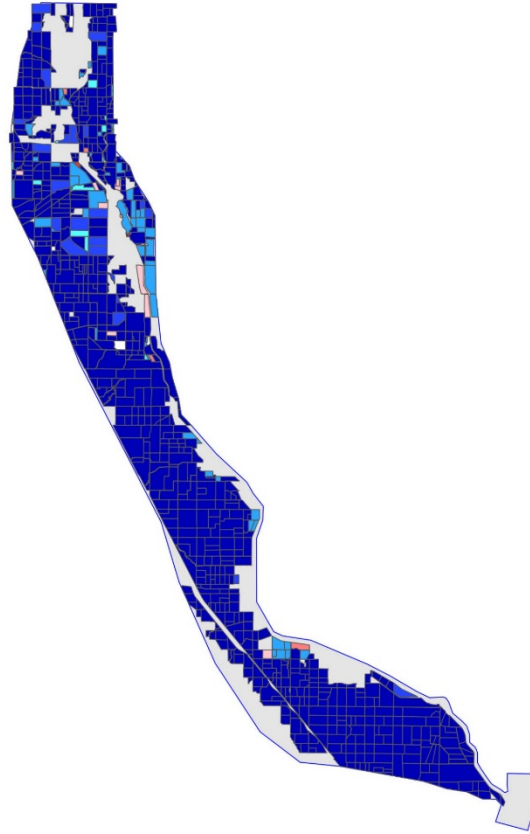
Results Discussion – Agricultural Compatibility (LDW)

Last Day Wet - 2003

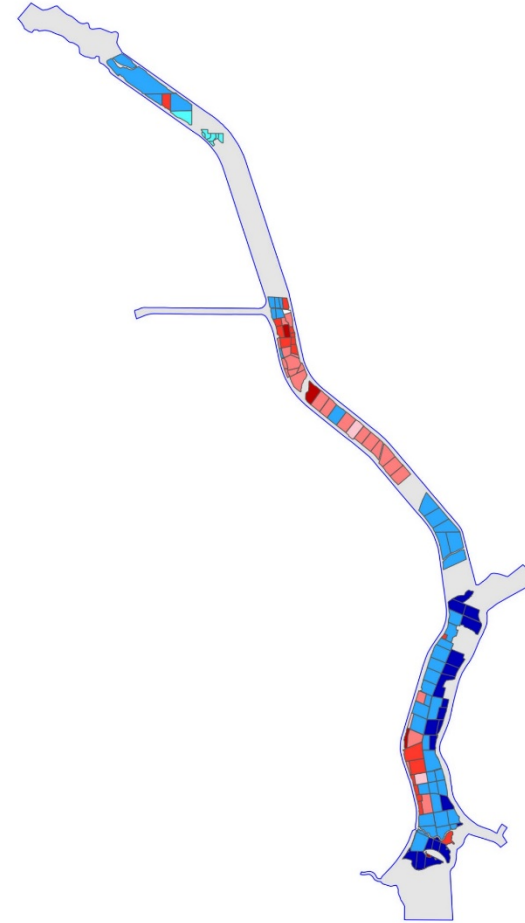
Butte



Colusa



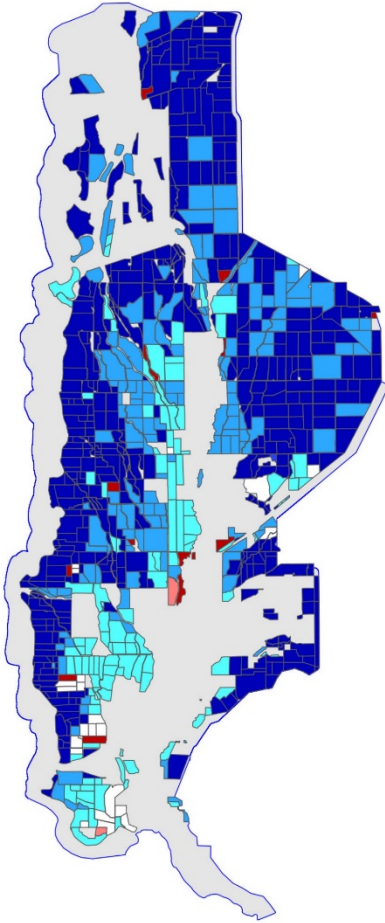
Sutter



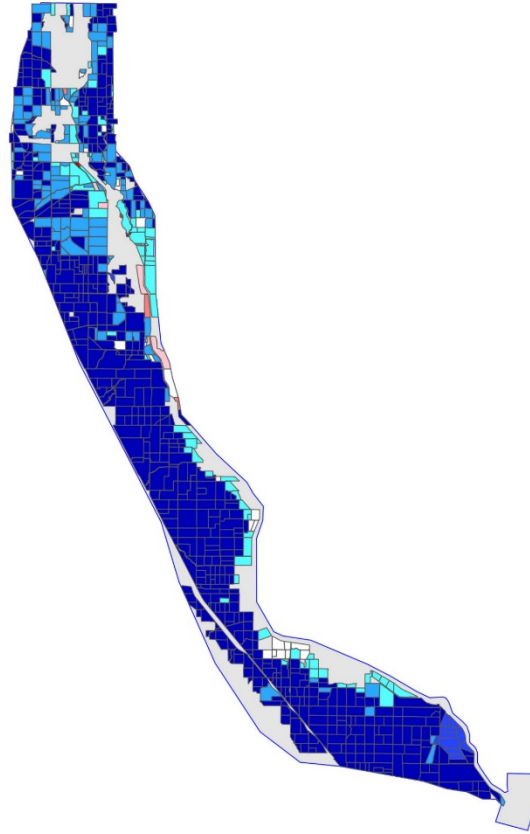
Results Discussion – Agricultural Compatibility (LDW)

Last Day Wet - 2011

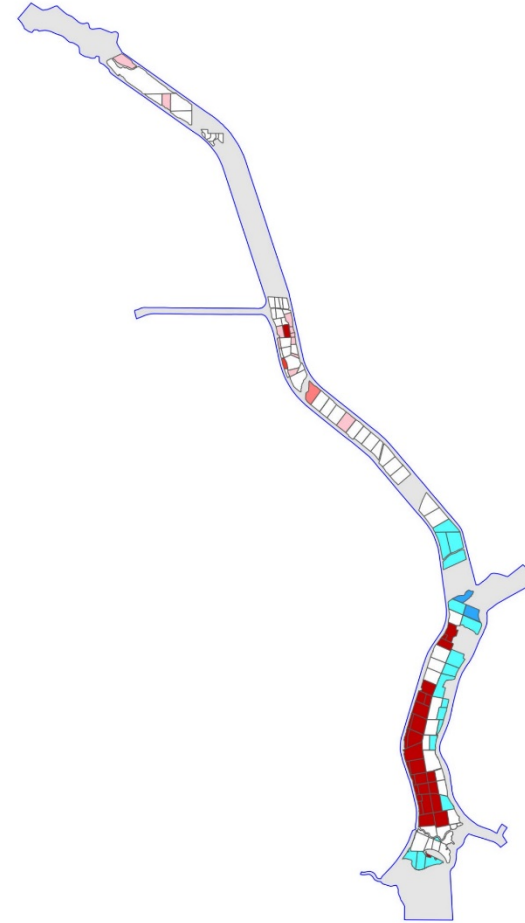
Butte



Colusa



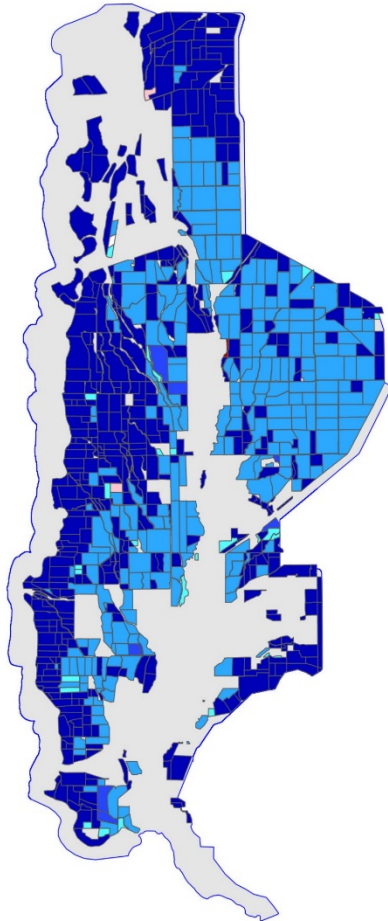
Sutter



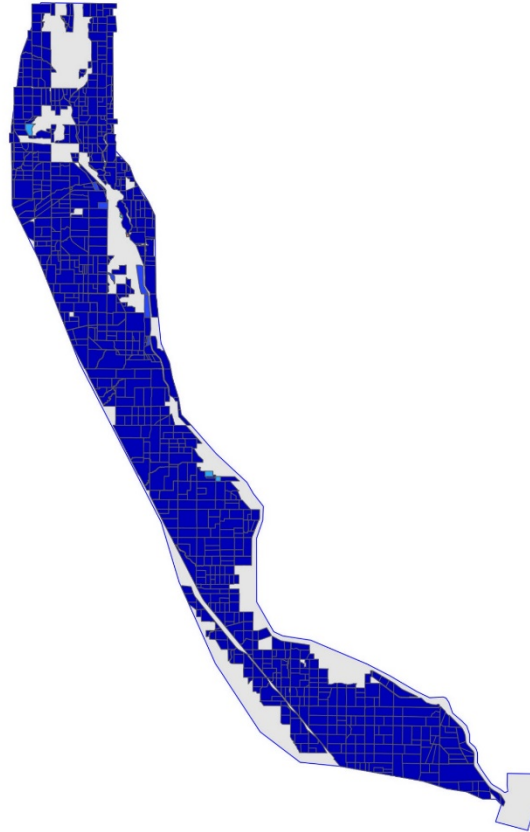
Results Discussion – Agricultural Compatibility (LDW)

Last Day Wet - 2013

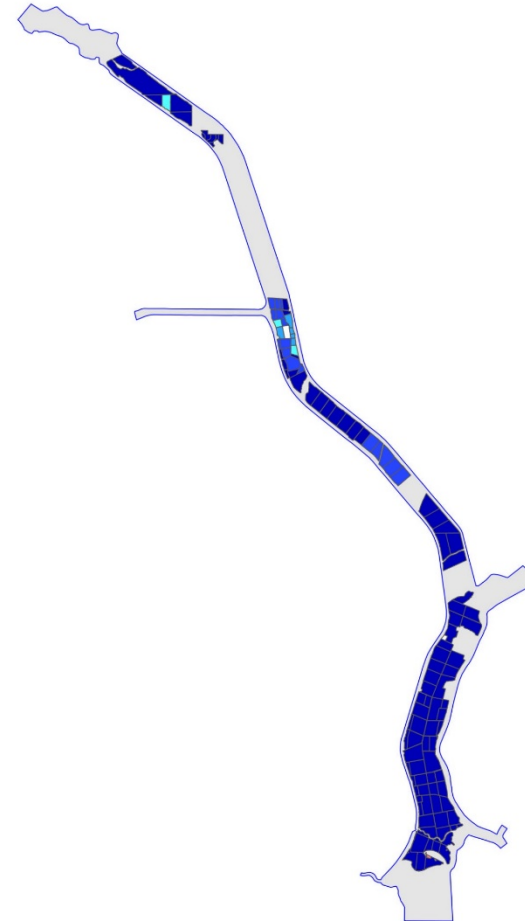
Butte



Colusa



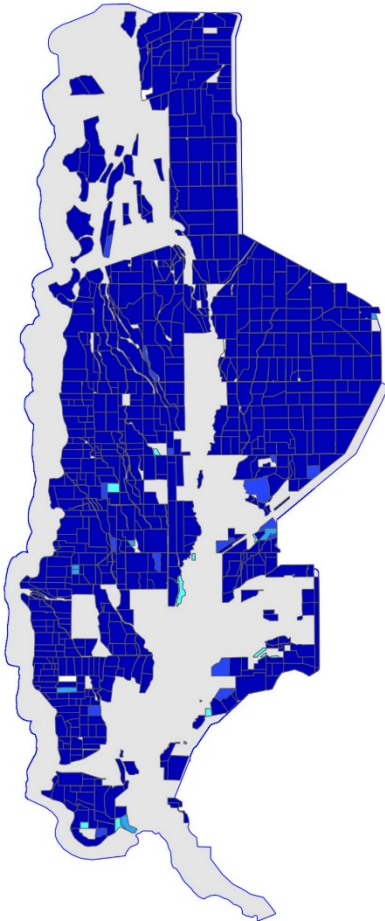
Sutter



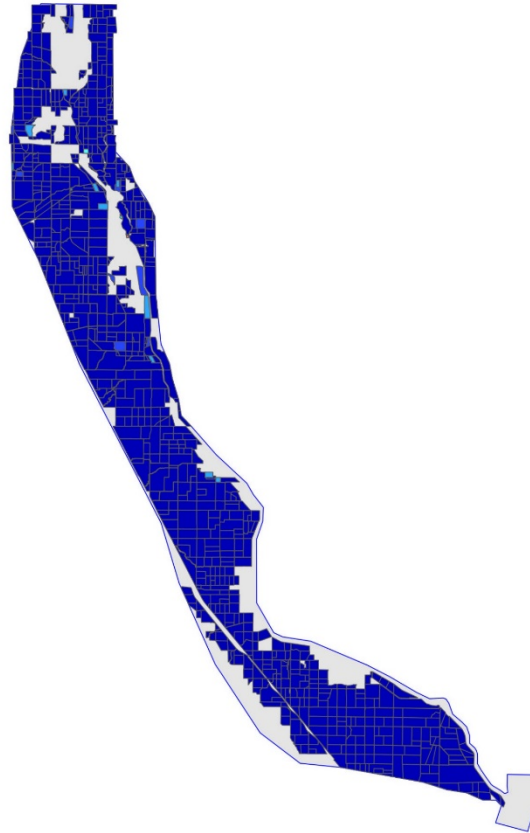
Results Discussion – Agricultural Compatibility (LDW)

Last Day Wet - 2015

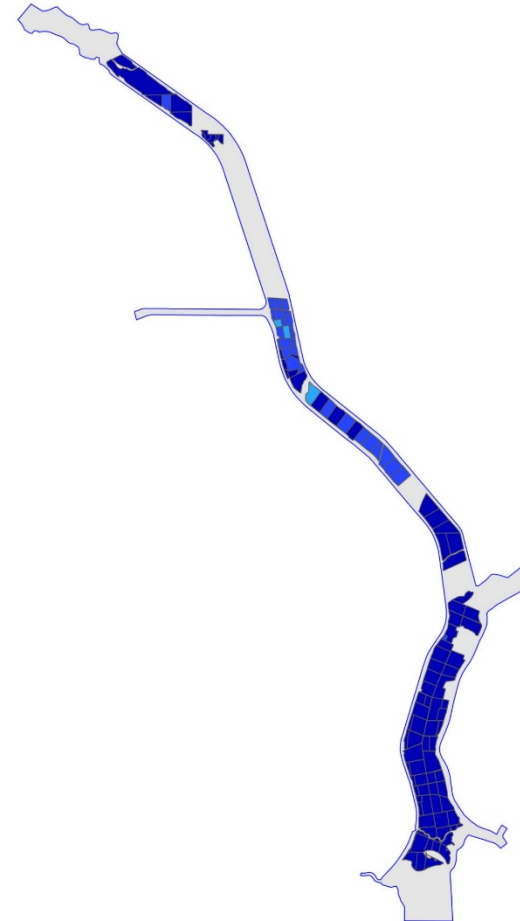
Butte



Colusa



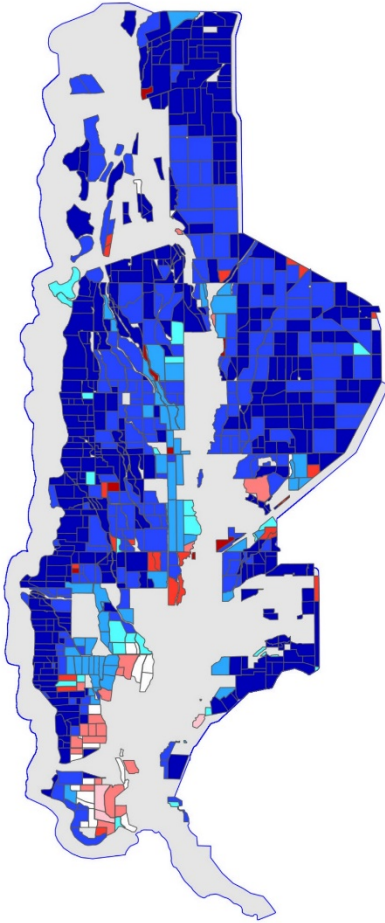
Sutter



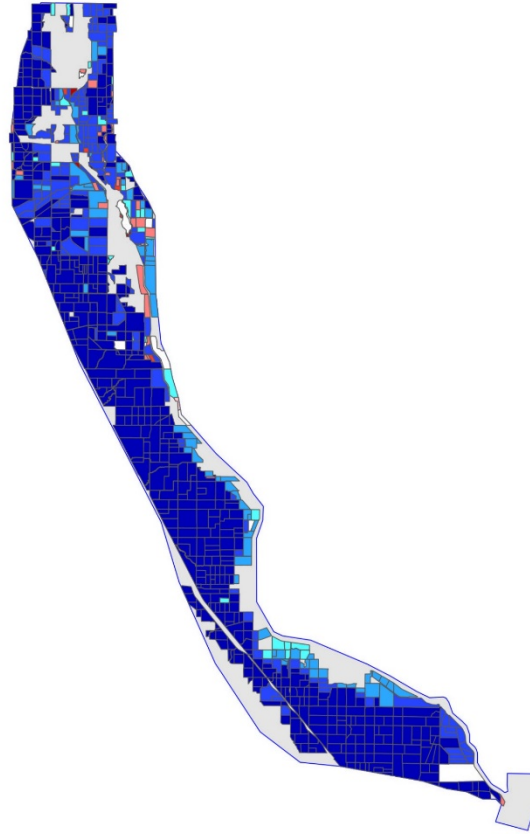
Results Discussion – Agricultural Compatibility (LDW)

Last Day Wet - 2019

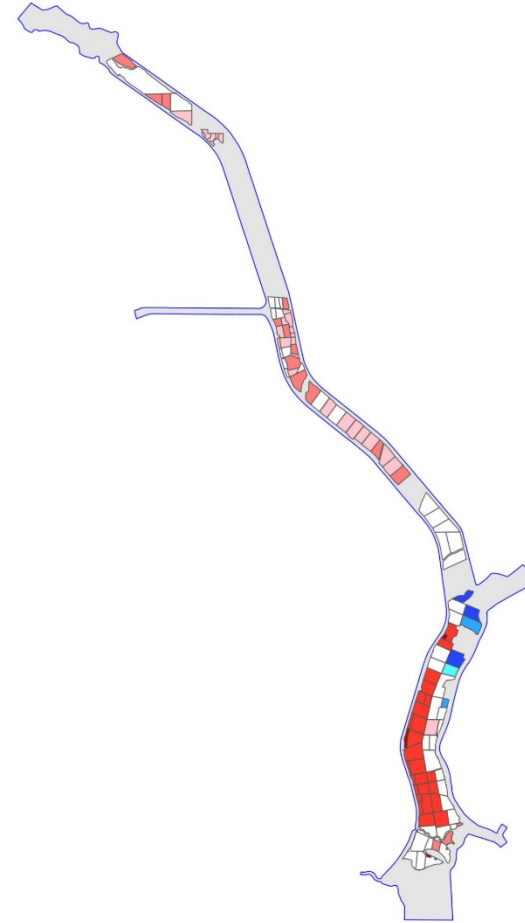
Butte



Colusa



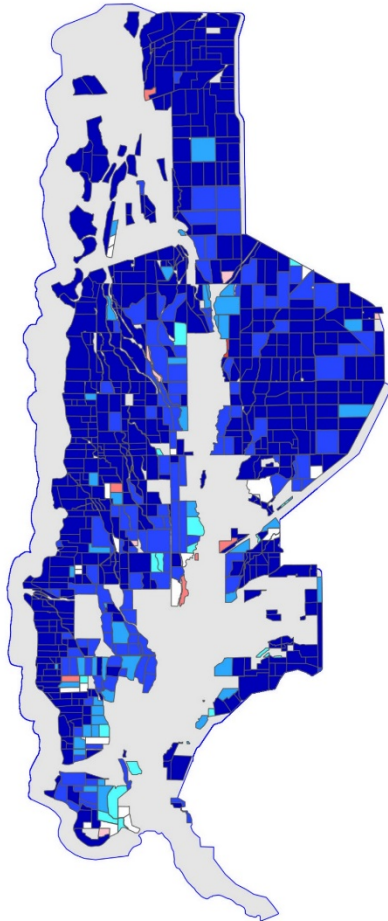
Sutter



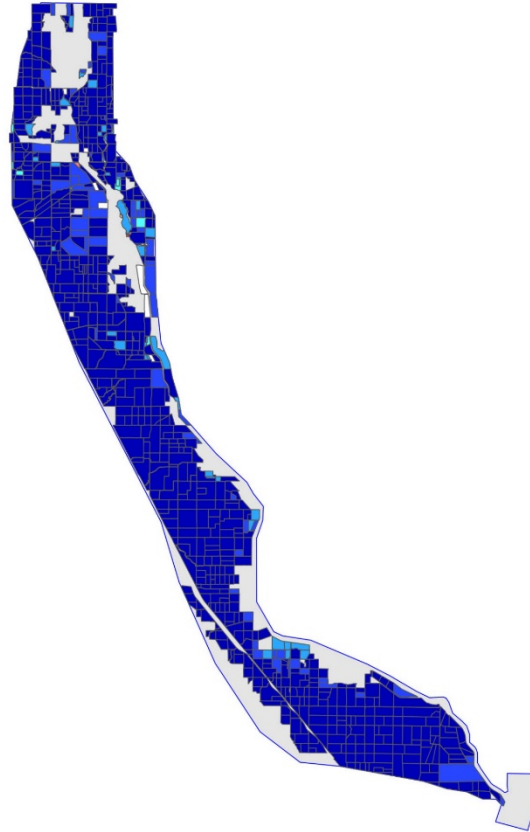
Results Discussion – Agricultural Compatibility (LDW)

Last Day Wet - Mean Across 2003, 2011, 2013, 2015, 2019

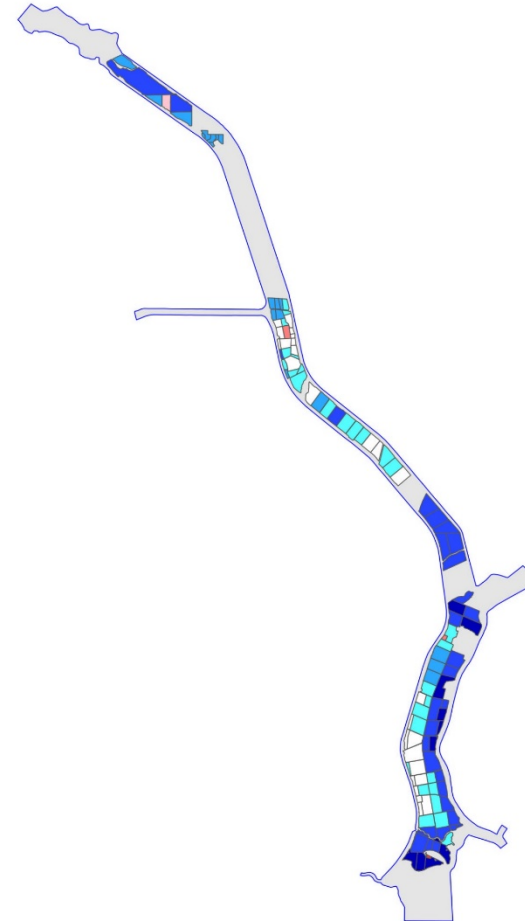
Butte



Colusa



Sutter

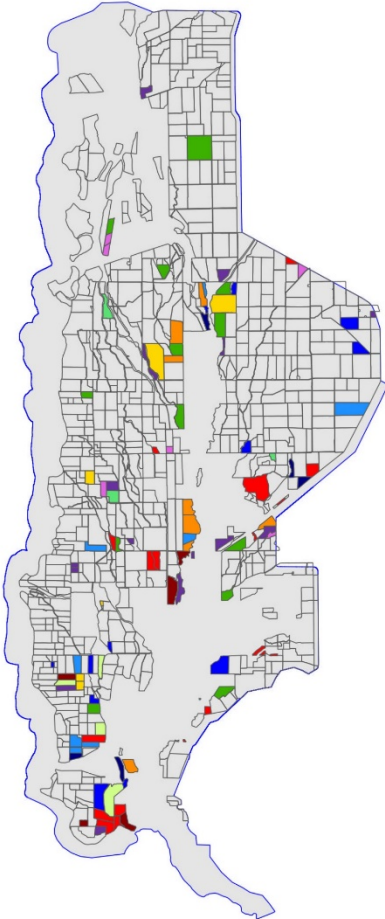


Results Discussion – Agricultural Compatibility (Cumulative Days)

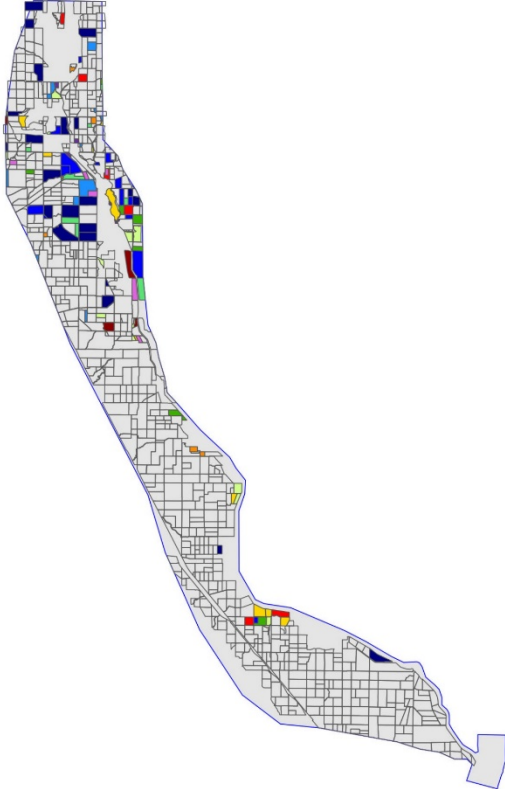
Cumulative Days of Agriculture Impacts - Baseline

2003

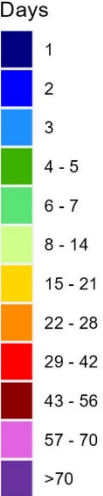
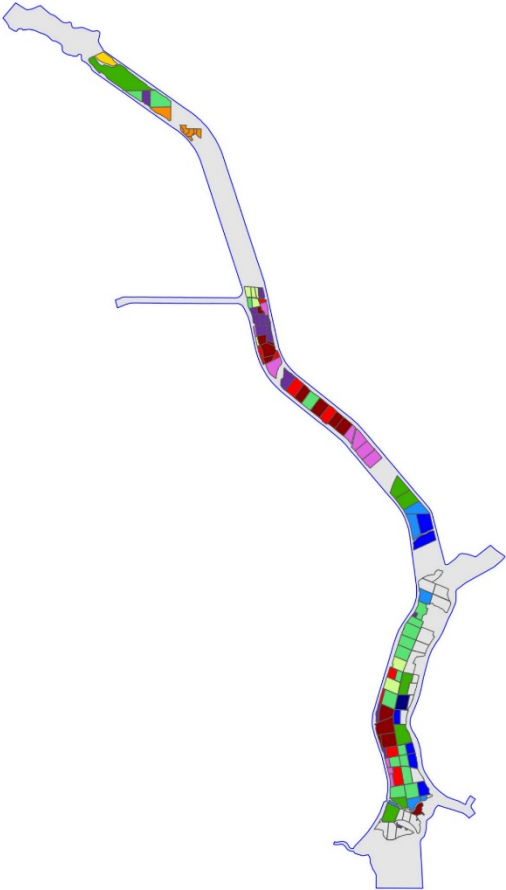
Butte



Colusa



Sutter

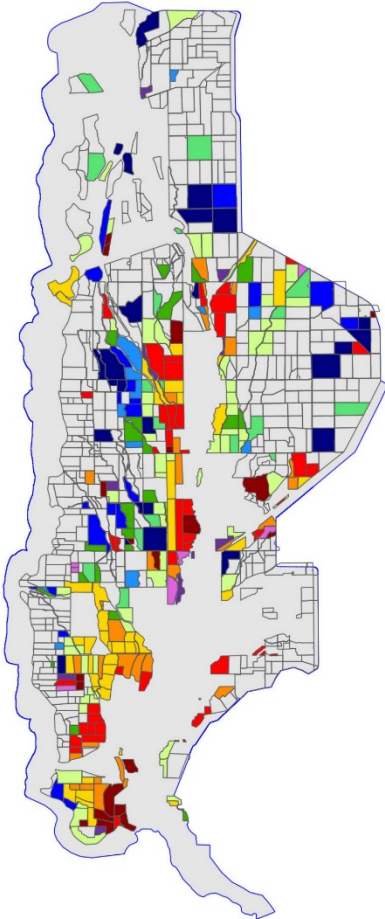


Results Discussion – Agricultural Compatibility (Cumulative Days)

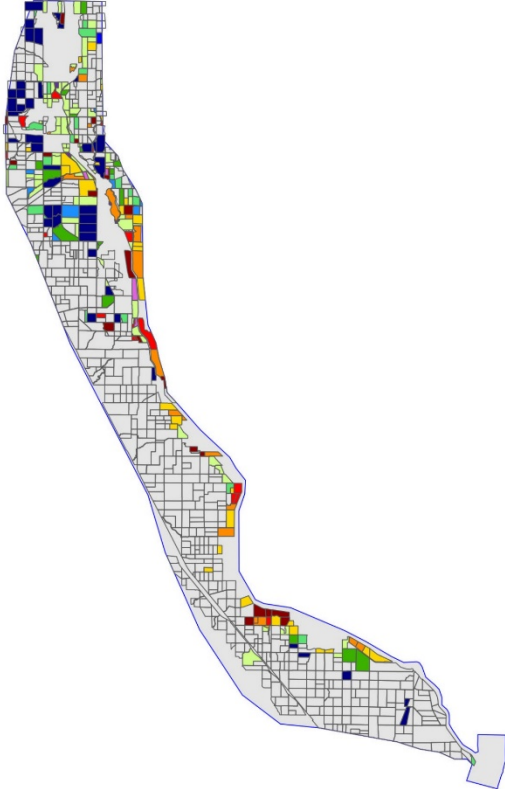
Cumulative Days of Agriculture Impacts - Baseline

2011

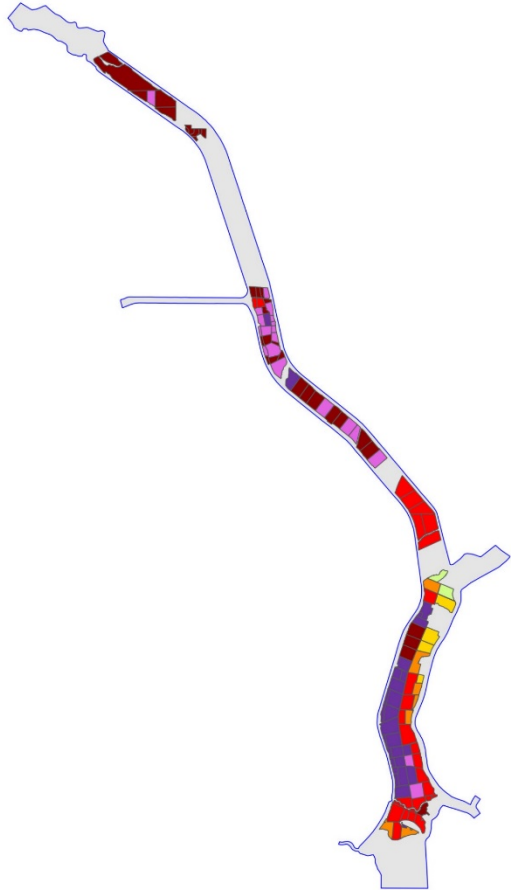
Butte



Colusa



Sutter



Days

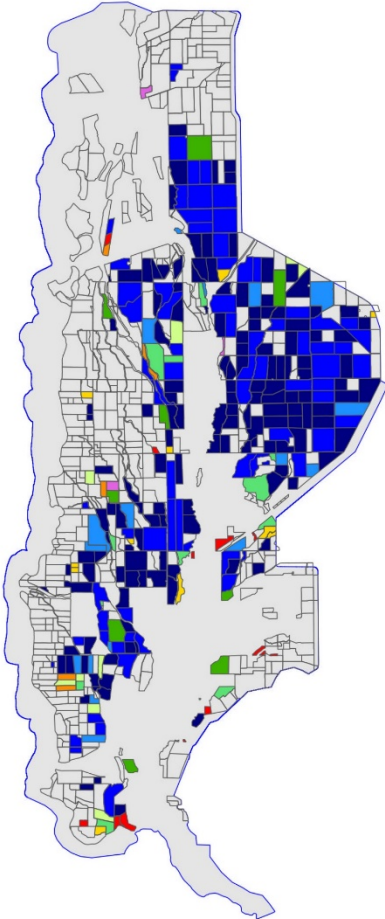


Results Discussion – Agricultural Compatibility (Cumulative Days)

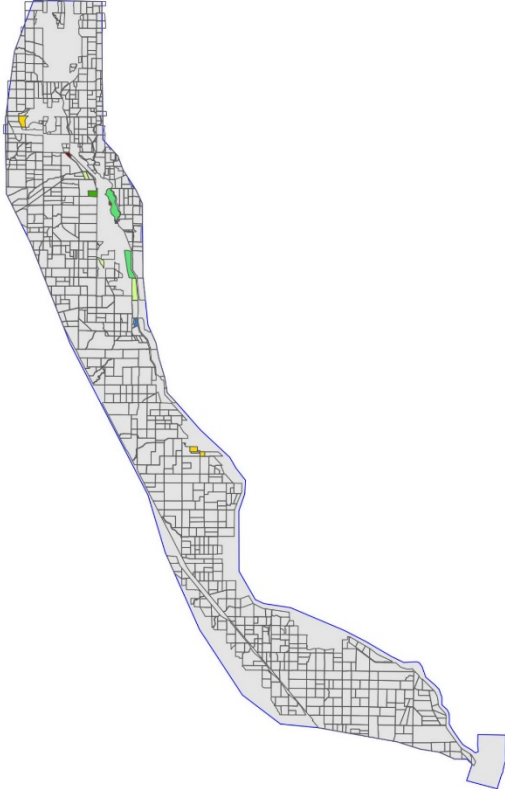
Cumulative Days of Agriculture Impacts - Baseline

2013

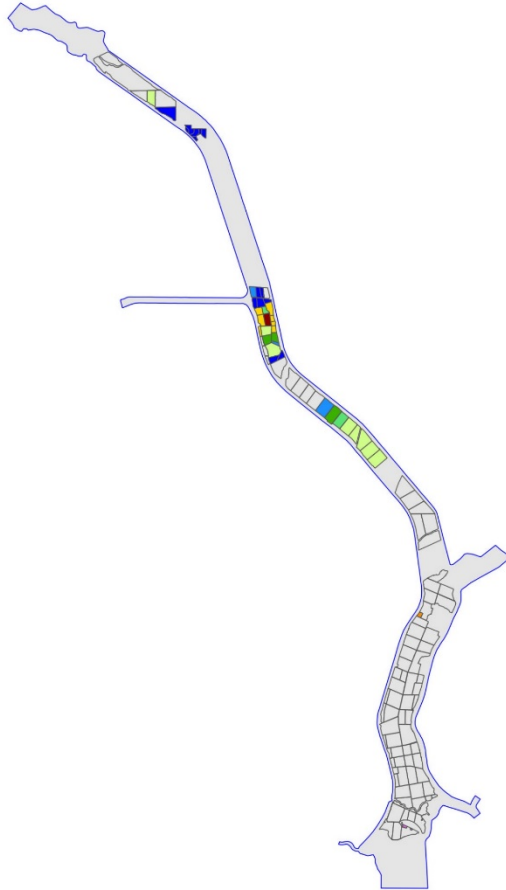
Butte



Colusa



Sutter



Days

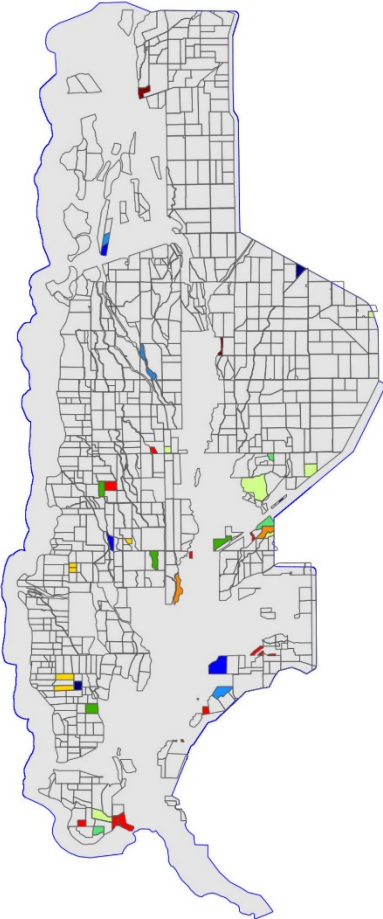


Results Discussion – Agricultural Compatibility (Cumulative Days)

Cumulative Days of Agriculture Impacts - Baseline

2015

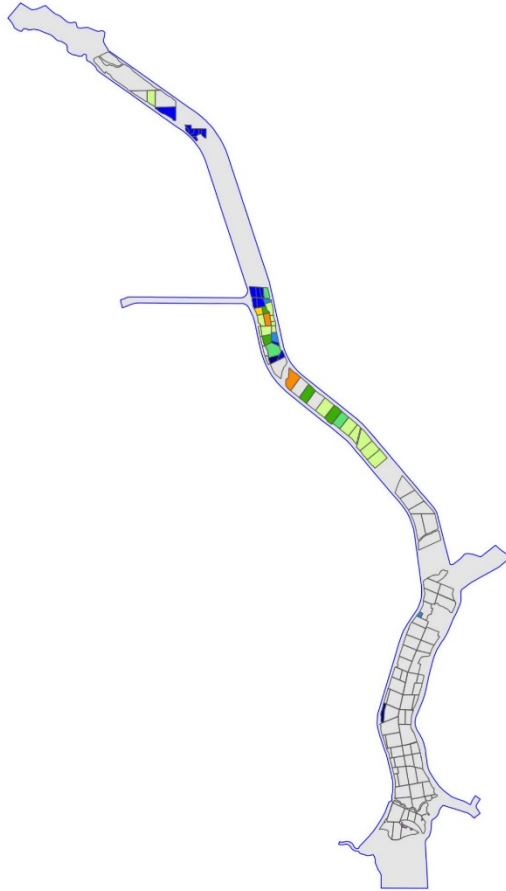
Butte



Colusa



Sutter



Days

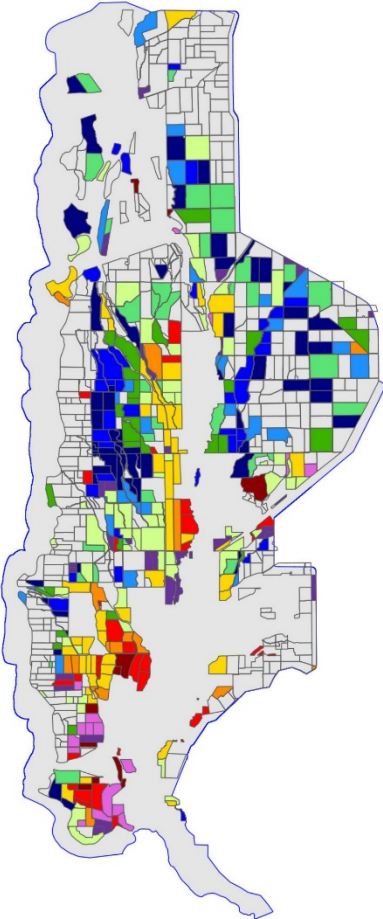


Results Discussion – Agricultural Compatibility (Cumulative Days)

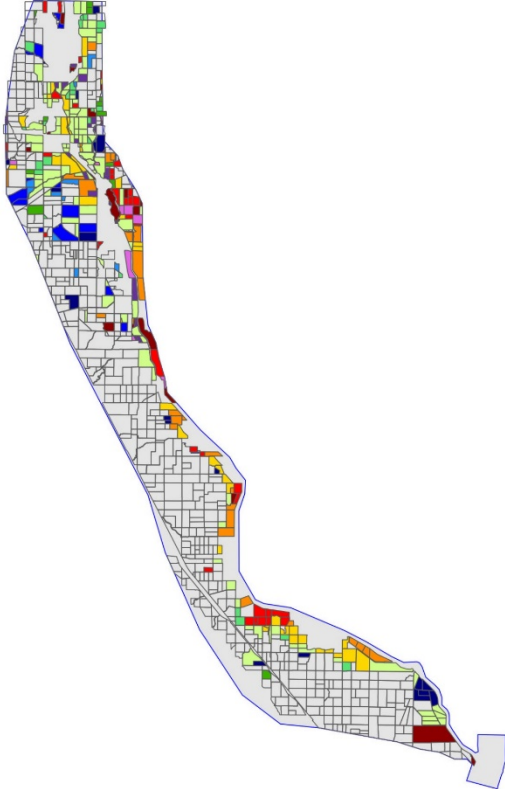
Cumulative Days of Agriculture Impacts - Baseline

2019

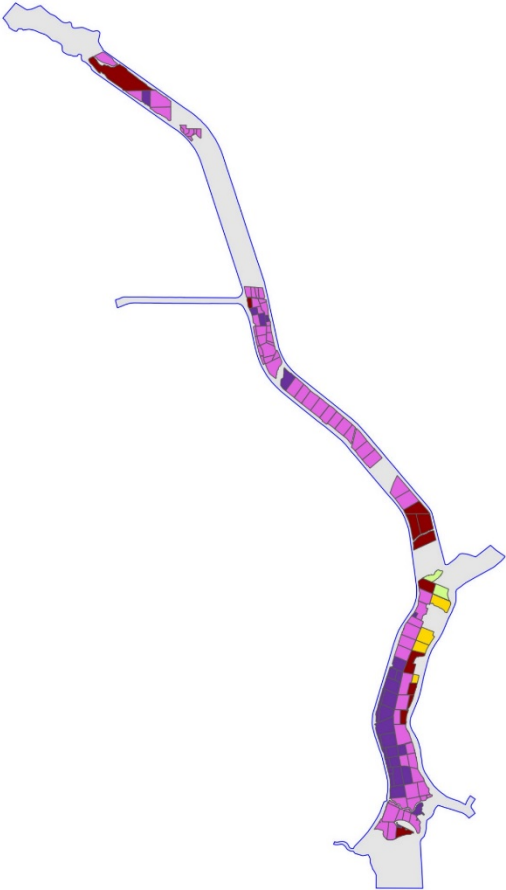
Butte



Colusa



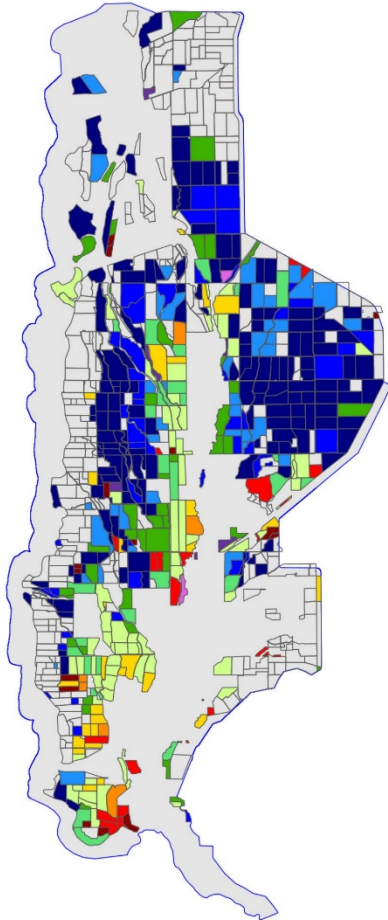
Sutter



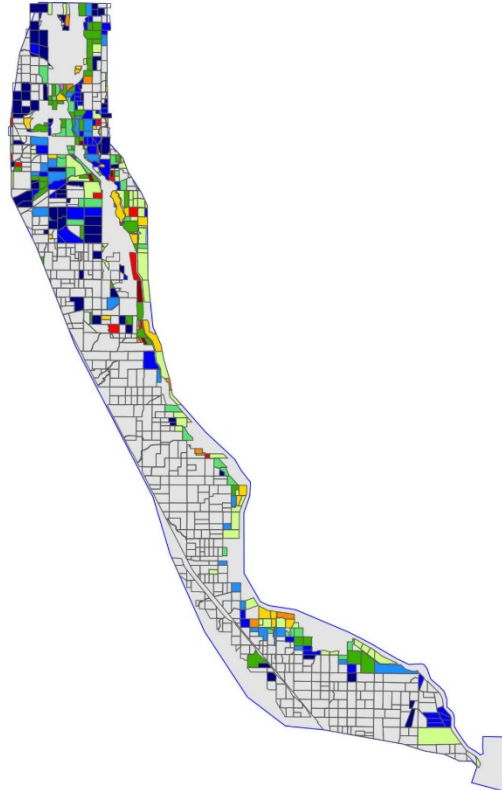
Results Discussion – Agricultural Compatibility (Cumulative Days)

Cumulative Days of Agriculture Impacts - Baseline
Mean Across 2003, 2011, 2013, 2015, 2019

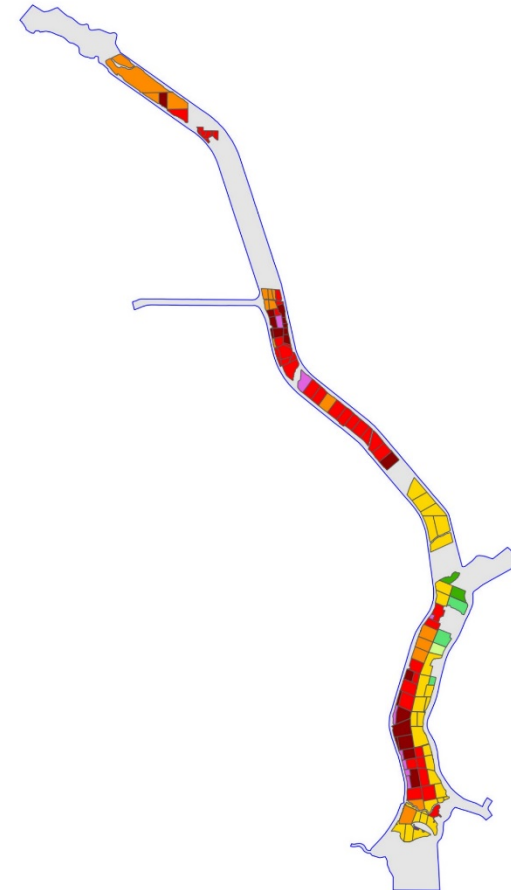
Butte



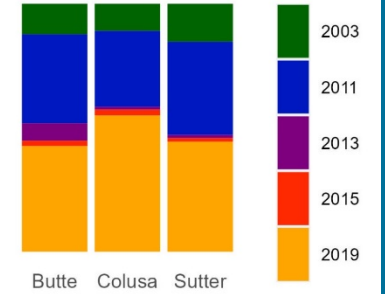
Colusa



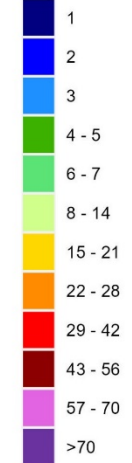
Sutter



Contributions By Year



Days



Results Discussion – Waterfowl Hunting Baseline Impacts

Key Findings

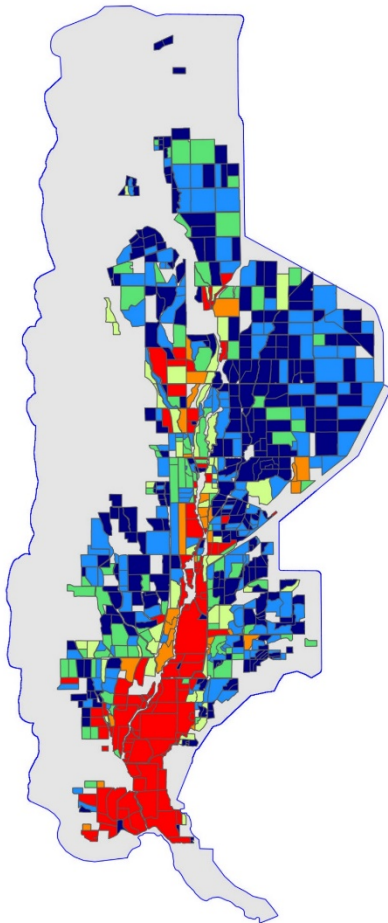
- **Key findings from TM**
 - Longer duration events lead to greater impact scores
 - 2003 had highest hunting impacts, 2011 had lowest
 - Greater proportion of total Sutter area impacted
- **Supplemental Observations**
 - Butte Sink & more southern fields in Sutter saw greatest impacts
 - Farther from channel fields very rarely affected
- **Notes**
 - Evaluated during waterfowl hunting season (late Oct to late Feb), so maps show different trends than late season-focused metrics

Results Discussion – Waterfowl Hunting Baseline Impacts

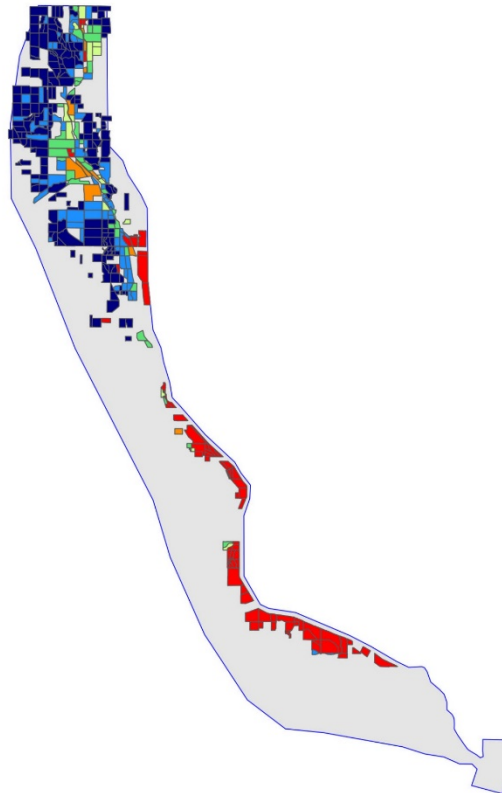
Wetland Hunting Impact Score - Baseline

2003

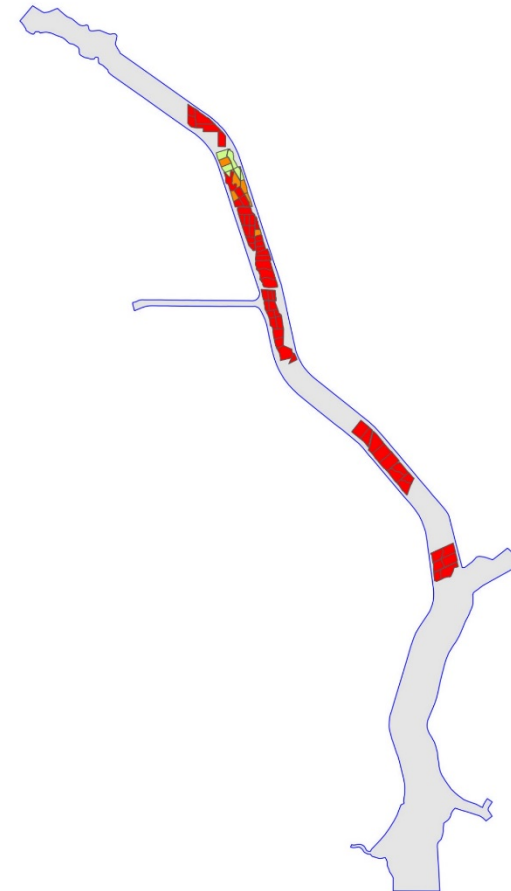
Butte



Colusa



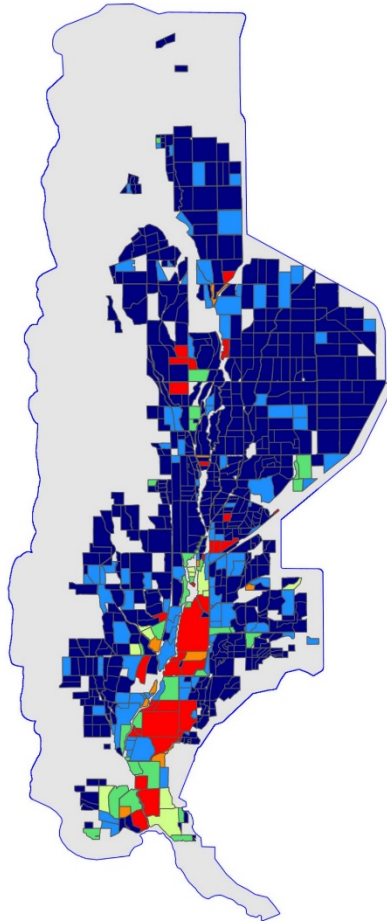
Sutter



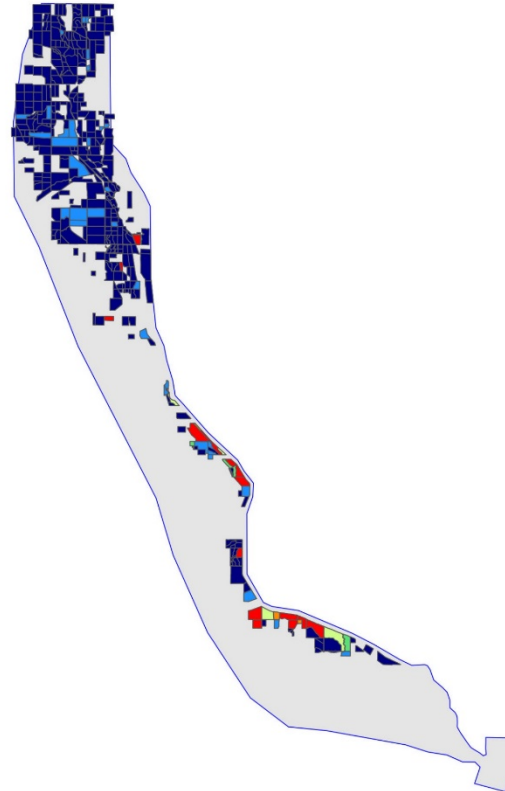
Results Discussion – Waterfowl Hunting Baseline Impacts

Wetland Hunting Impact Score - Baseline
2011

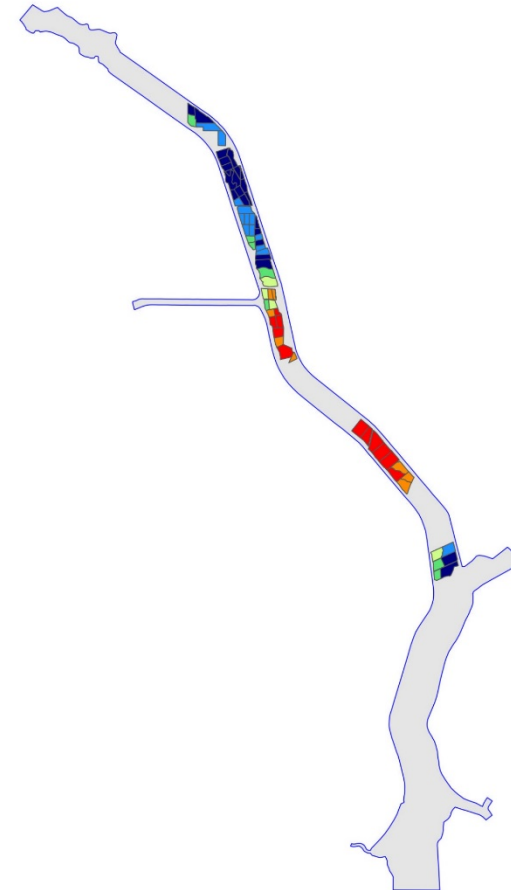
Butte



Colusa



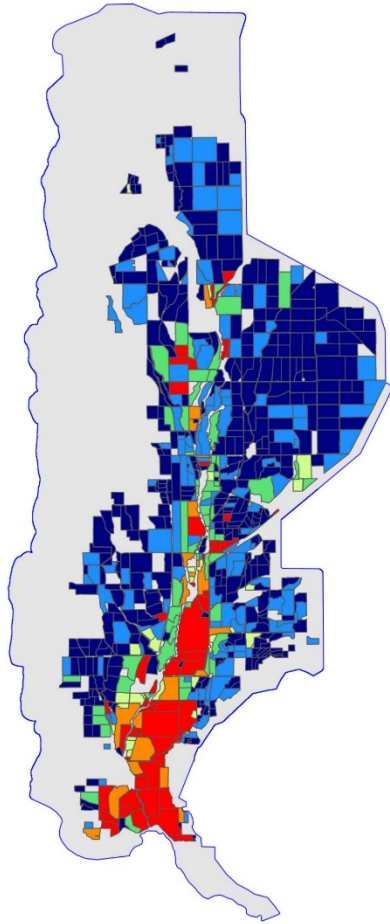
Sutter



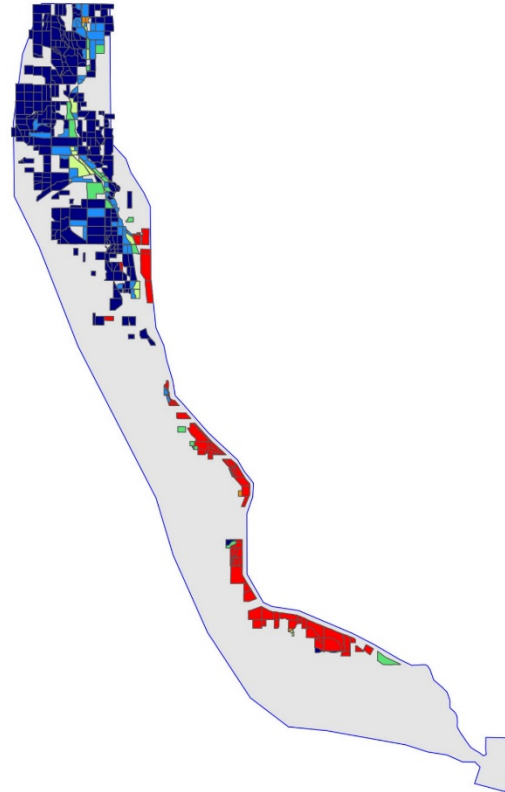
Results Discussion – Waterfowl Hunting Baseline Impacts

Wetland Hunting Impact Score - Baseline 2013

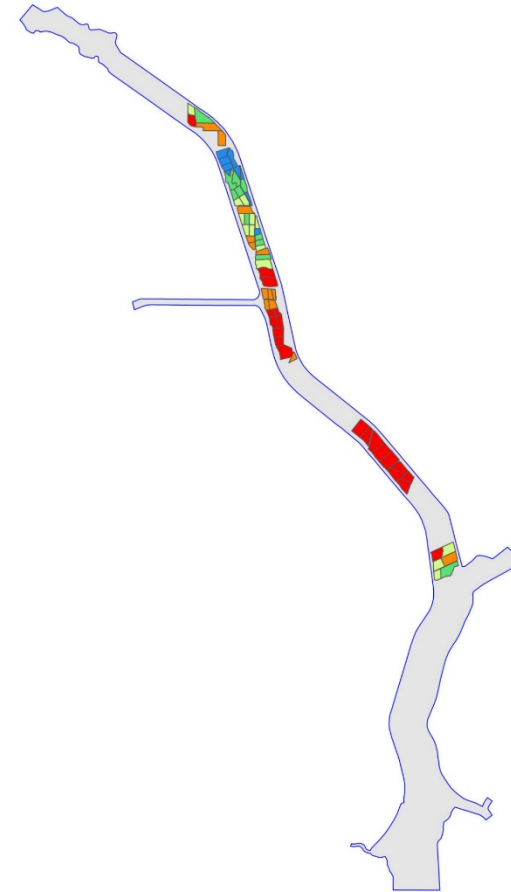
Butte



Colusa



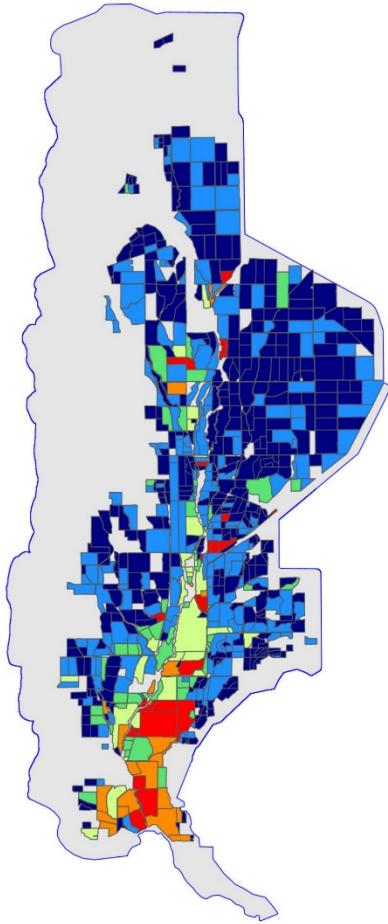
Sutter



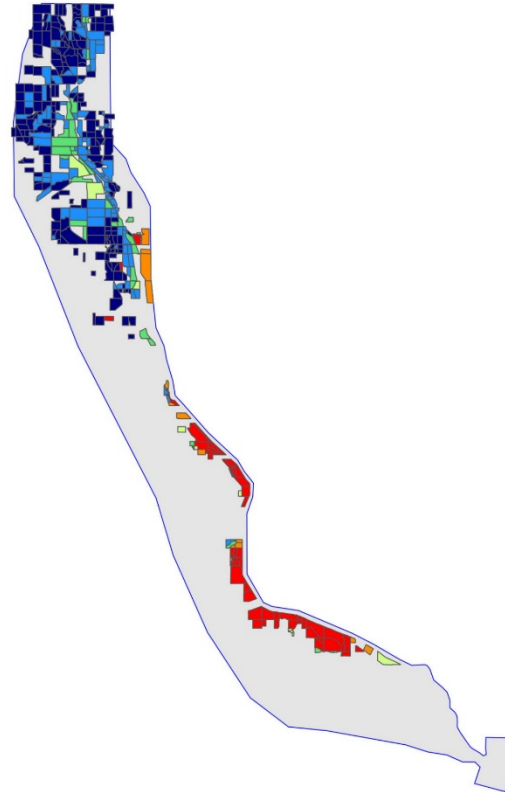
Results Discussion – Waterfowl Hunting Baseline Impacts

Wetland Hunting Impact Score - Baseline 2015

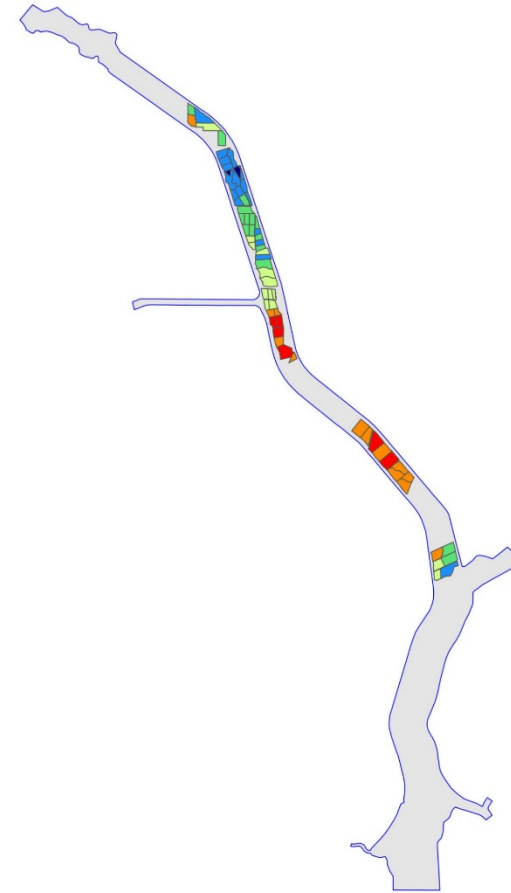
Butte



Colusa



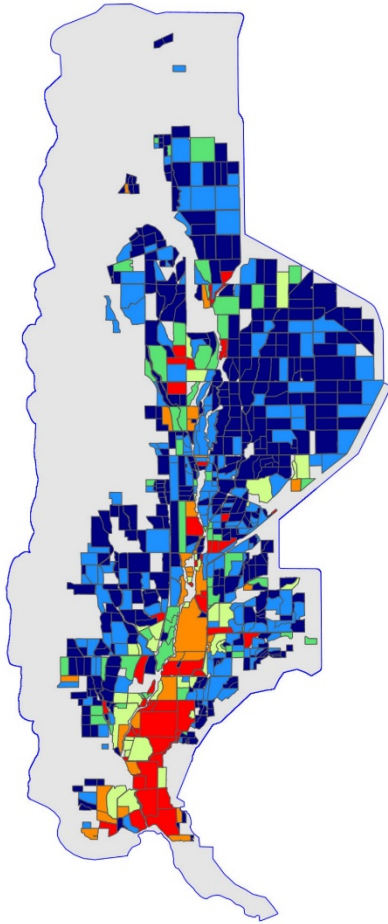
Sutter



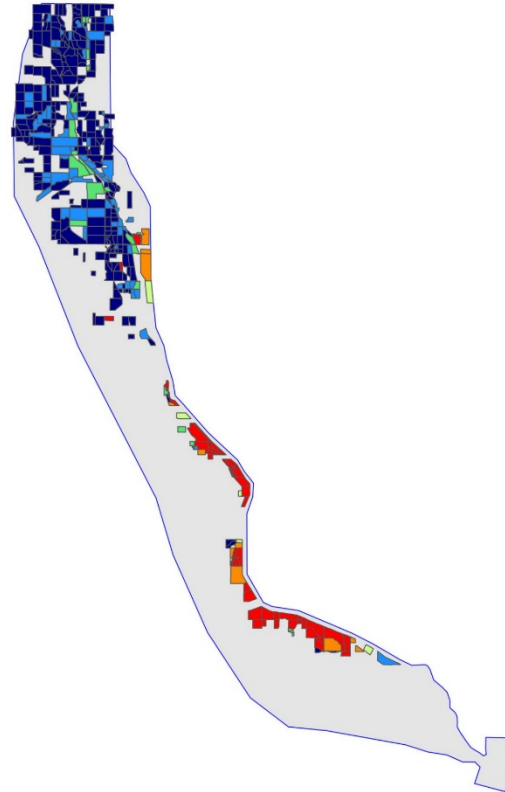
Results Discussion – Waterfowl Hunting Baseline Impacts

Wetland Hunting Impact Score - Baseline 2019

Butte



Colusa



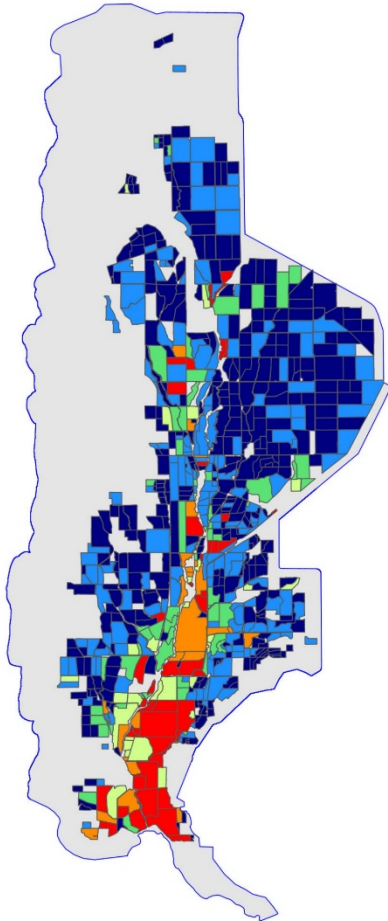
Sutter



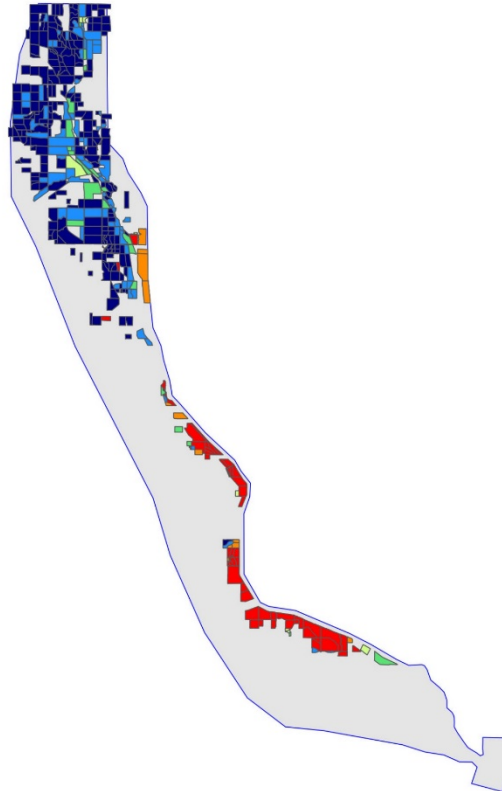
Results Discussion – Waterfowl Hunting Baseline Impacts

Wetland Hunting Impact Score - Baseline
Mean Across 2003, 2011, 2013, 2015, 2019

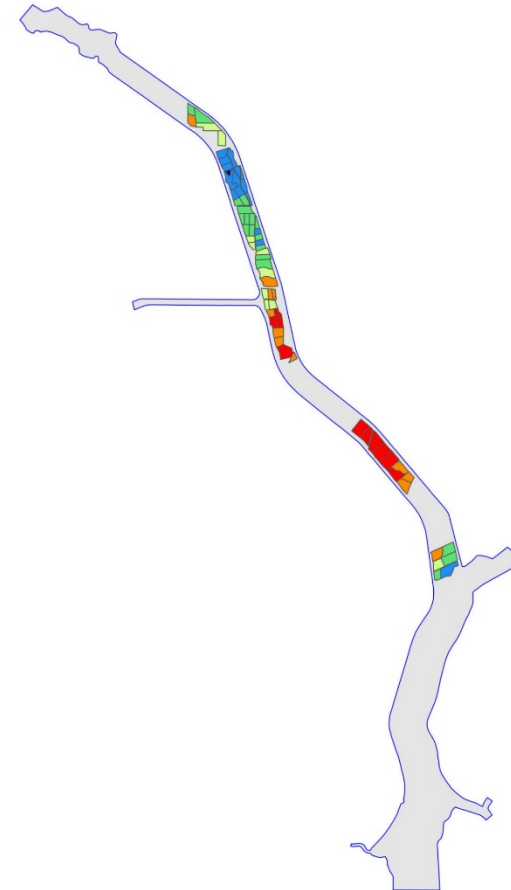
Butte



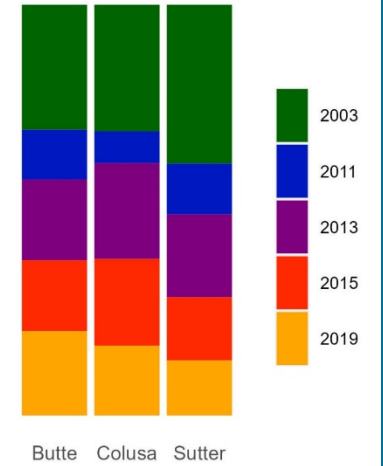
Colusa



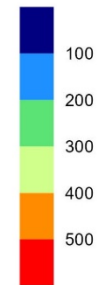
Sutter



Contributions By Year



Score



Results Discussion – Managed Wetland Baseline Impacts

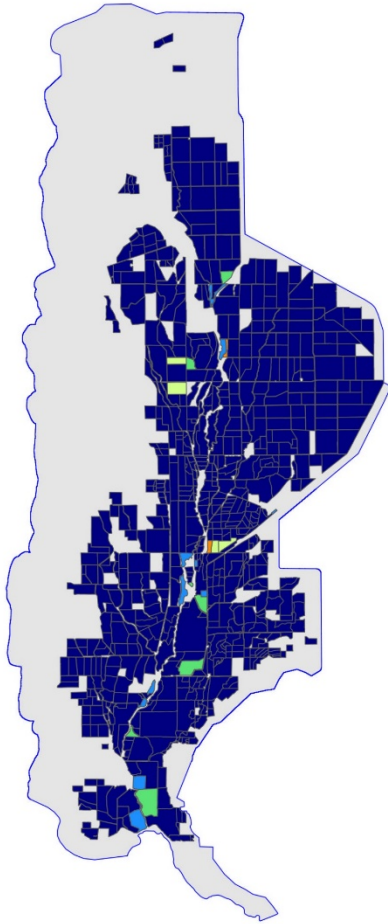
Key Findings

- **Key findings from TM**
 - Longer duration events lead to greater impact scores
 - 2019 had highest management baseline impacts, 2013 lowest (virtually zero)
- **Supplemental Observations**
 - Only 2019 and 2011 have Butte Sink impacts
 - When they do occur, they translate downstream to full Sutter
 - Butte Sink is impacted similarly to Colusa South of Hwy 20
 - Almost none in 2013 & 2015
 - Farther from channel fields very rarely affected
- **Notes**
 - Tied to later inundation than Waterfowl Hunting impacts (late Feb to Mar 31)

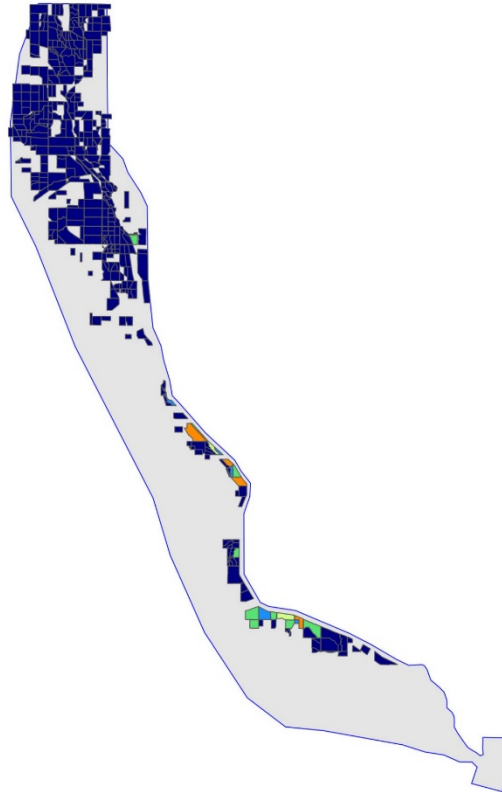
Results Discussion – Managed Wetland Baseline Impacts

Wetland Management Impact Score - Baseline 2003

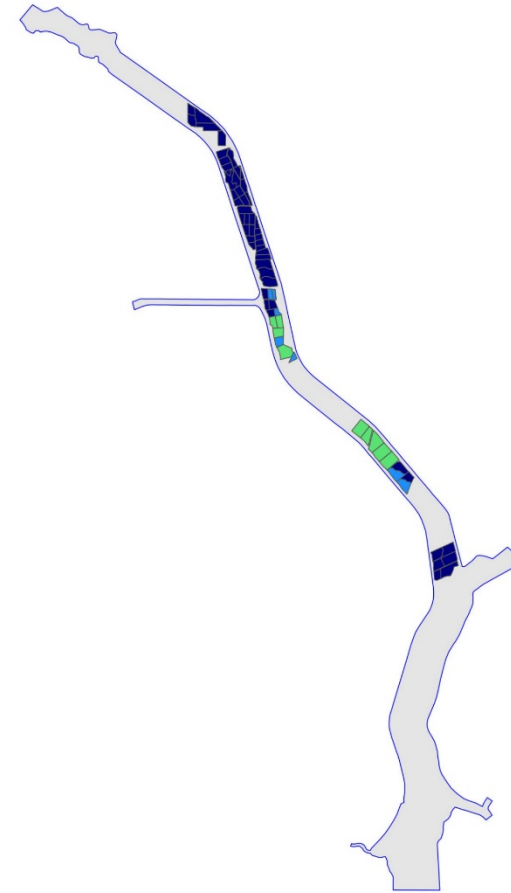
Butte



Colusa



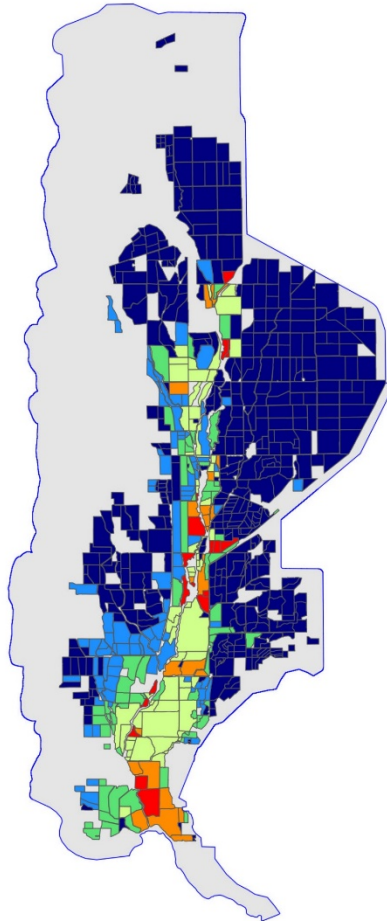
Sutter



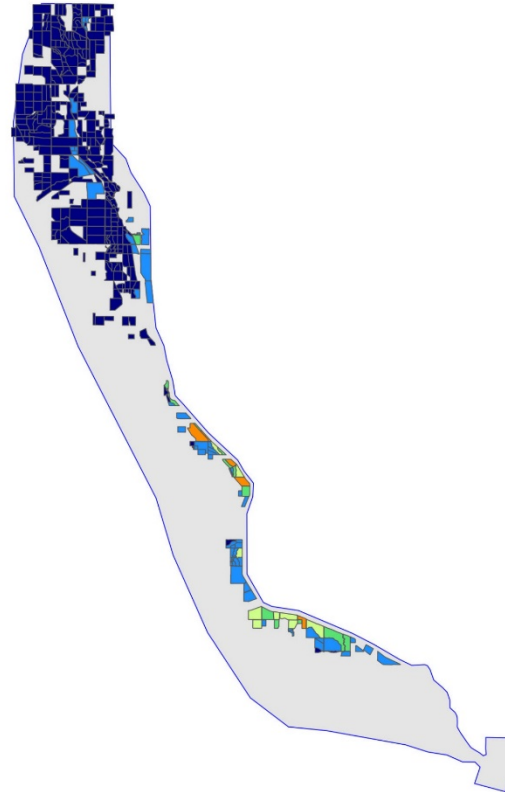
Results Discussion – Managed Wetland Baseline Impacts

Wetland Management Impact Score - Baseline 2011

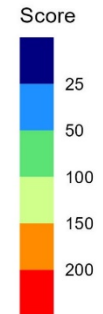
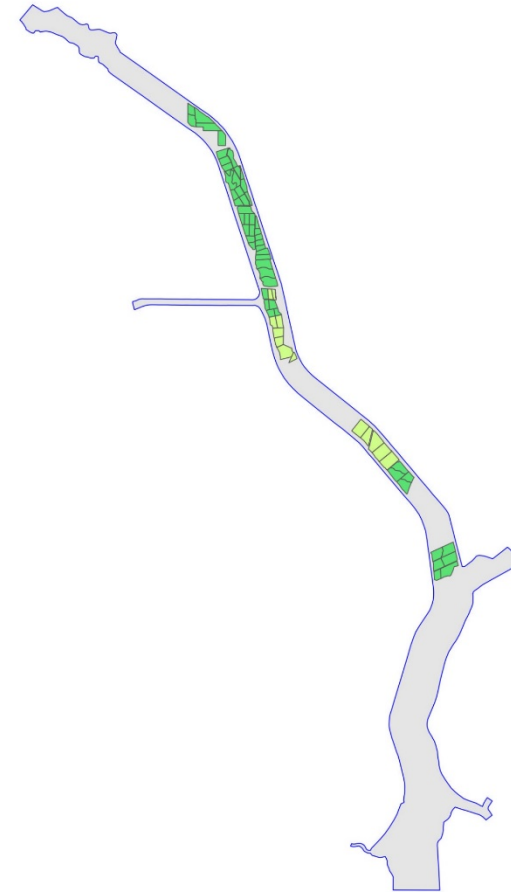
Butte



Colusa



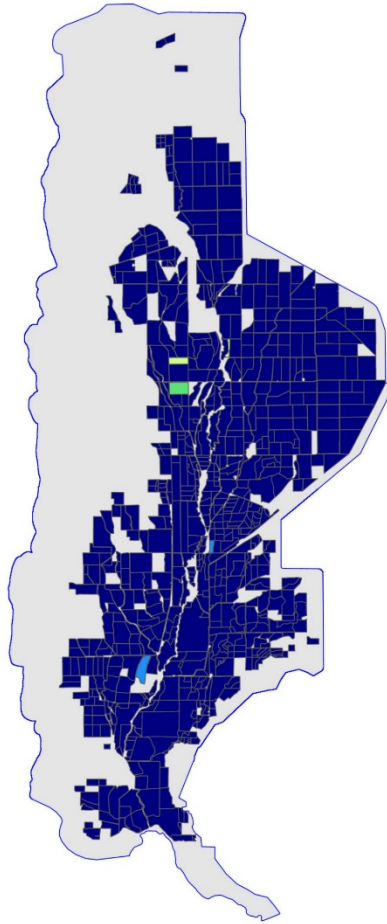
Sutter



Results Discussion – Managed Wetland Baseline Impacts

Wetland Management Impact Score - Baseline 2013

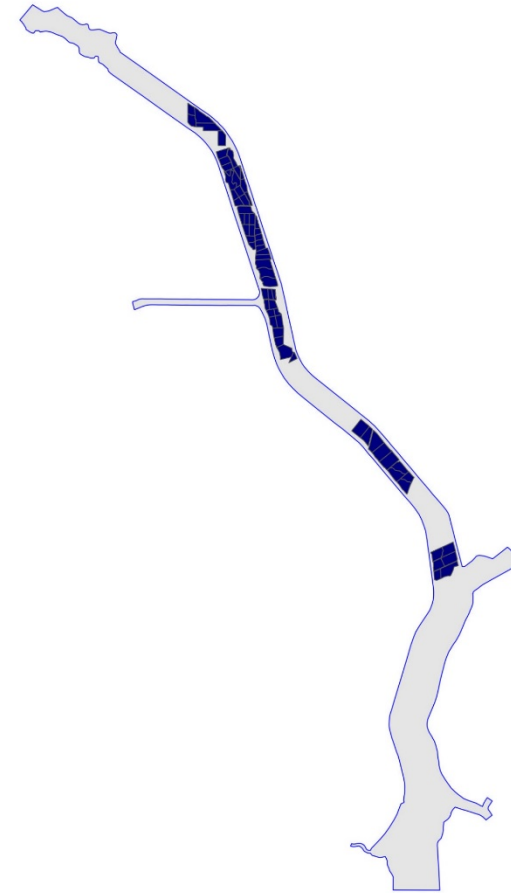
Butte



Colusa



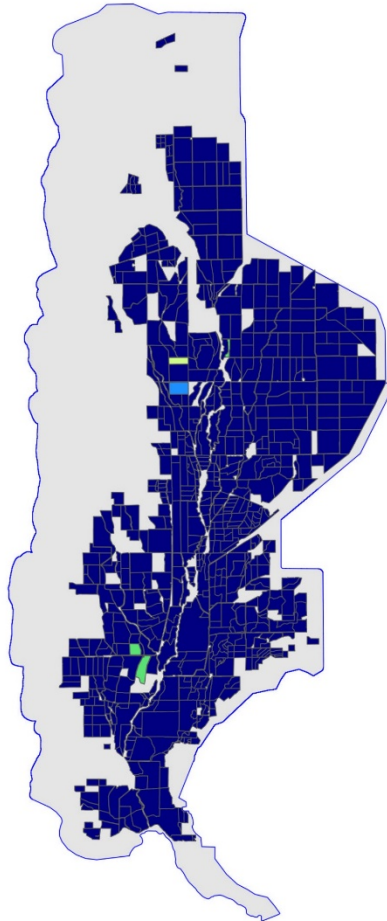
Sutter



Results Discussion – Managed Wetland Baseline Impacts

Wetland Management Impact Score - Baseline 2015

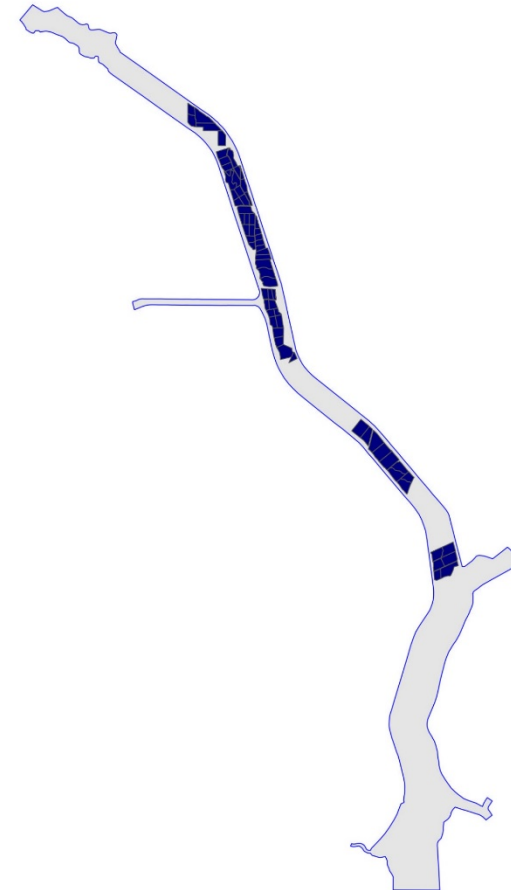
Butte



Colusa



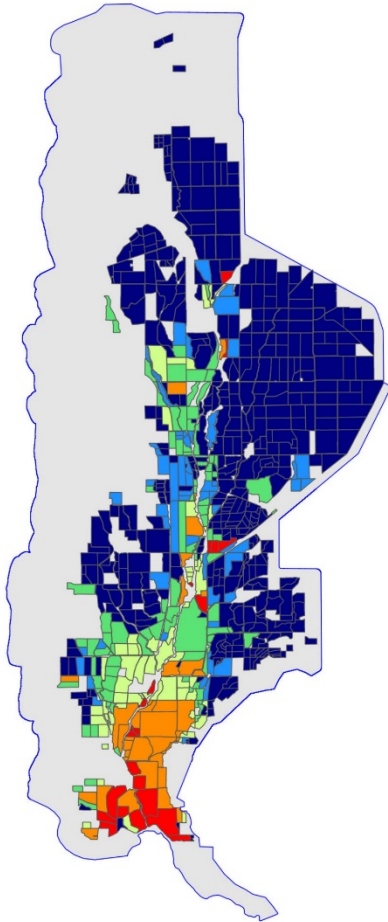
Sutter



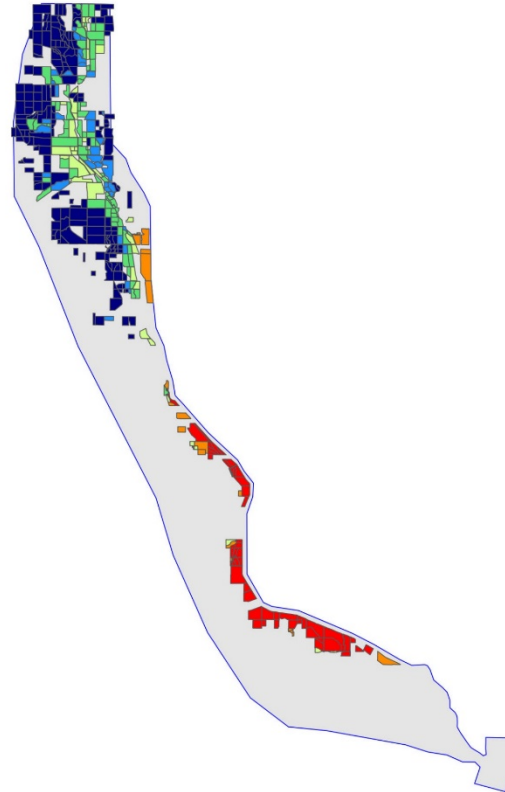
Results Discussion – Managed Wetland Baseline Impacts

Wetland Management Impact Score - Baseline 2019

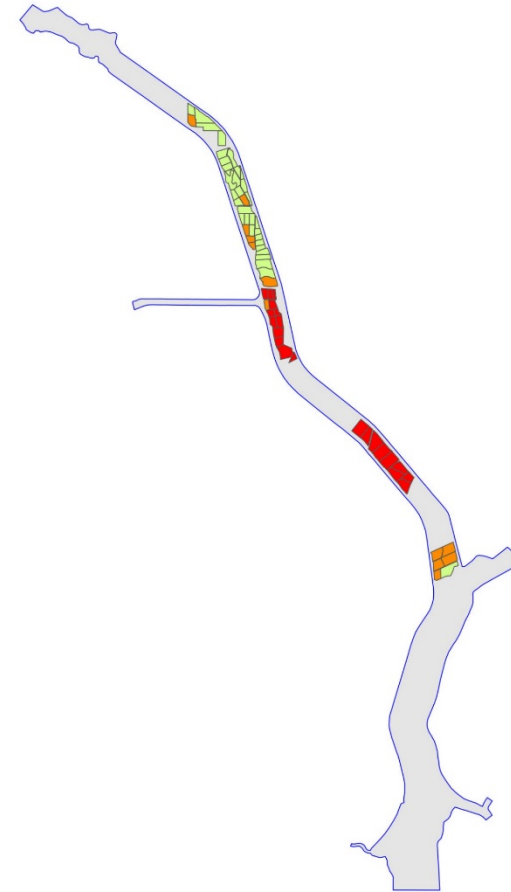
Butte



Colusa



Sutter

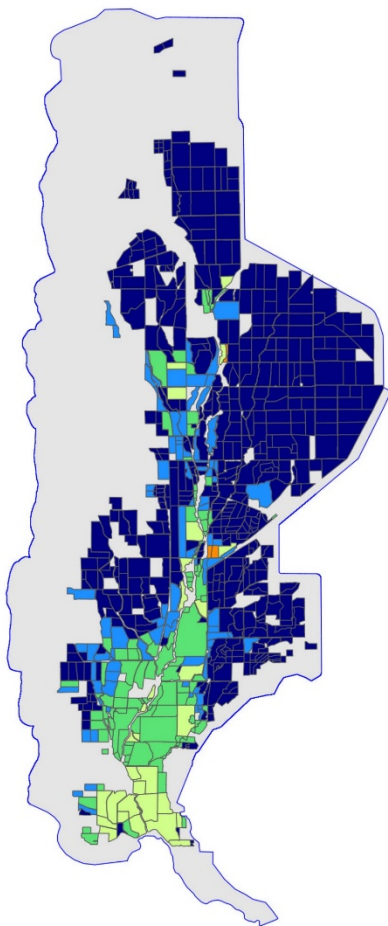


Results Discussion – Managed Wetland Baseline Impacts

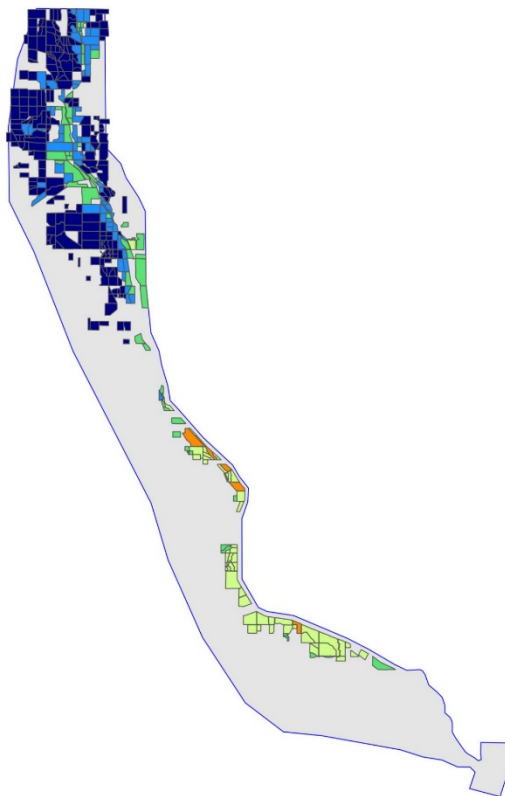
Wetland Management Impact Score - Baseline

Mean Across 2003, 2011, 2013, 2015, 2019

Butte



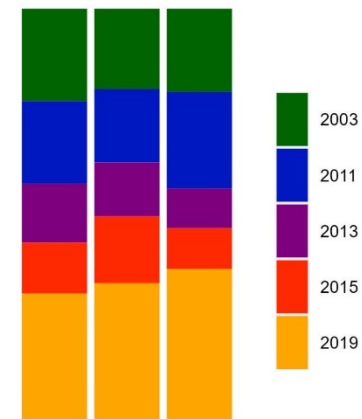
Colusa



Sutter

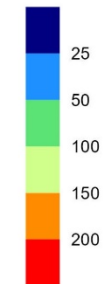


Contributions By Year



Butte Colusa Sutter

Score



Key Findings – Spatial Results

- **Hot spot areas – greater impacts to ag/wetlands, better habitat**
 - Butte Sink – managed (flow-through)
 - Lower Sutter – unmanaged (not as good for birds)
- **Proximity to channel in Butte and Colusa matters**
 - **Farther from channel**
 - Better for birds
 - Better for productivity (managed water is disturbed less, but exports less too)
 - **Near channel**
 - Better for salmon due to being deeper & connected
 - More productive export potential due to more frequent activation
 - More impacts
- **Sutter is flood bypass system, looks like Butte & Colusa near channels**
 - Greater impacts in Agriculture and Managed Wetlands/Hunting
 - More widespread salmon habitat (higher depths + connectivity) & export potential
 - Less widespread habitat for birds (need lower depths)
 - Greater variability from year to year in Sutter than Butte/Colusa

Supplemental Notes

- **Butte Sink and Lower Sutter highlighted with frequent, connected, inundation**
- **Basin differences**
 - **Butte covers widest range of inundation conditions**
 - **Colusa doesn't see much inundation except immediately bordering Colusa Drain**
 - **Sutter has most widespread baseline impacts of flood pulses**