Welcome to the Conservation Lecture Series

https://www.wildlife.ca.gov/Conservation/Lectures

Questions? Contact Margaret.Mantor@wildlife.ca.gov

Improving monitoring: from design to evaluation

Zan Rubin
Matt Kondolf
Blanca Ríos-Touma
Mary E. Power
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University of California, Berkeley

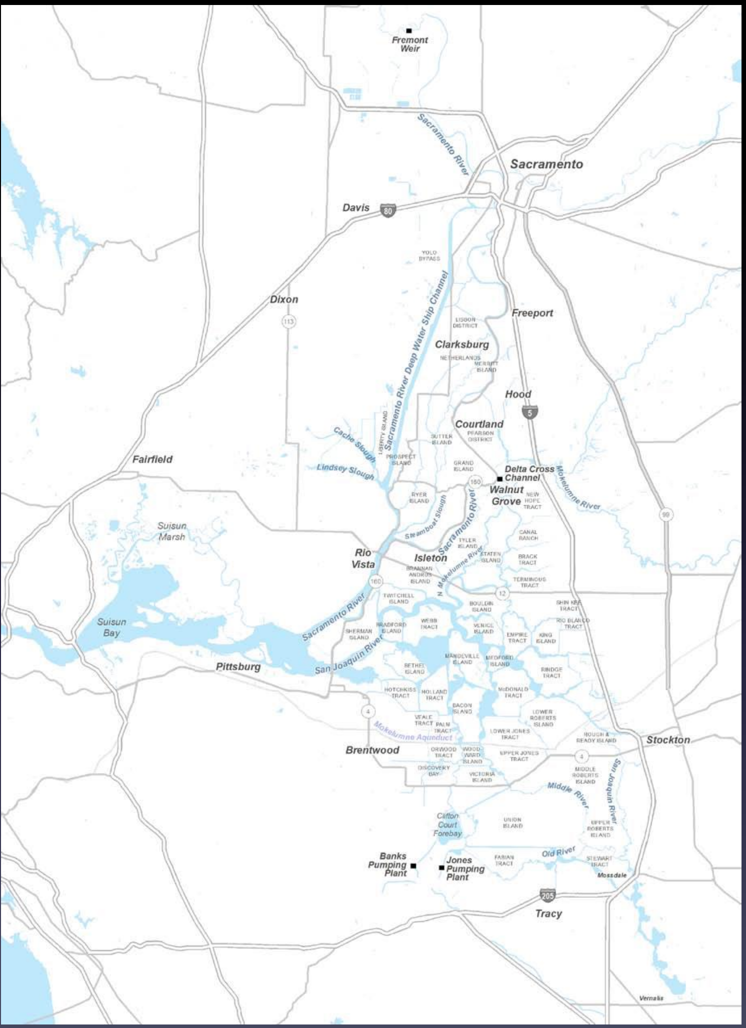
What is an acre?

Outline:

1) Thoughts on evaluation

2) Example: lower Colorado River

The Sacramento-San Joaquin River Bay Delta Conservation Plan



Habitat restoration will be closely monitored and implemented over time using established adaptive management principles.

Habitat Protection and Restoration:

New Floodplain in the south Delta	10,000 acres
Tidal Habitat	65,000 acres
Channel Margin	20 levee miles
Riparian Habitat	5,000 acres
Grassland Habitat	10,000 acres
Other Habitats	5,000 acres
Managed Wetlands	6,500 acres
Cultivated Lands	~45,000 acres
Enhanced Floodplain Habitat in the Yolo Bypass	

Restoration Approach

Process

Form (Limiting Habitat)

Restoration Basis

Process

Habitat

Biota

Habitat

Biota

What to measure?

Process

Habitat

Biota

Habitat

Biota

Questions

- Are there universal metrics of success
- What do we measure?
- How do we set targets?

Are there universal metrics of success

- If you say yes… then what is it? And how much of that do we want? Is more always better?
- If you say no… then we rely on the project goals to define success (and project goals may be overly modest or entirely misguided)

Failure!

“Restored” channel 1996

1997

Uvas Creek, CA

Matt Kondolf, 2006

Failure = Movement

Success≠ No Movement

Process -> Habitat

Habitat (Heterogeneity)

Freshwater Biology

Freshwater Biology (2012) 57, 1076–1095 doi:10.1111/j.1365-2427.2012.02763.x

APPLIED ISSUE

Range of variability of channel complexity in urban, restored and forested reference streams

BRIAN G. LAUB*, DANIEL W. BAKER[†], BRIAN P. BLEDSOE[‡] AND MARGARET A. PALMER[§]

Laub et al., 2012

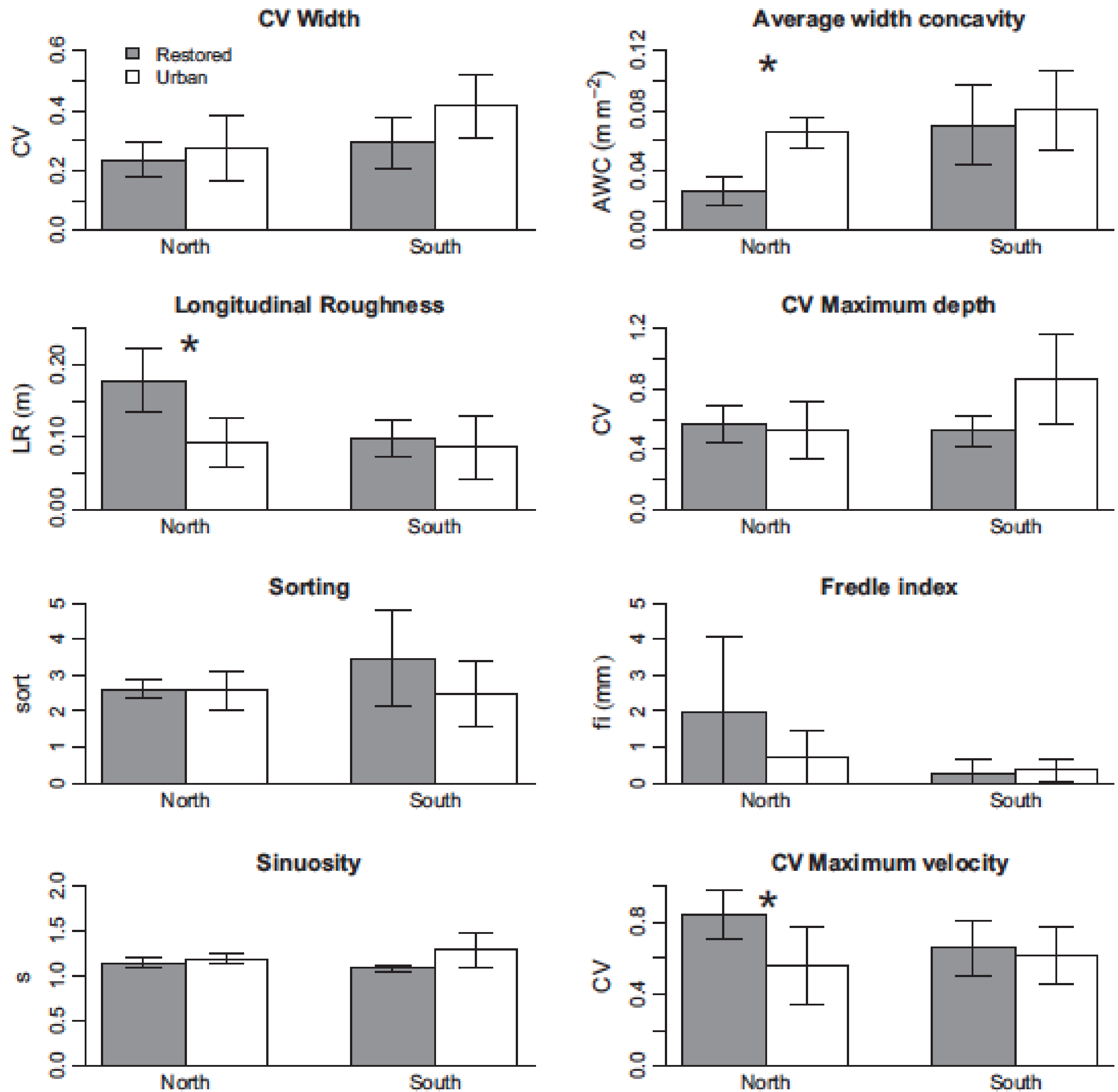


Fig. 6 Comparison of individual complexity metrics for northern restored (n = 5), northern urban (n = 8, except longitudinal roughness, n = 7), southern restored (n = 4) and southern urban streams (n = 5) in Anne Arundel County, Maryland. * above bars indicates a significant difference between restored and urban streams within that region (north or south) at α = 0.05. Error bars are standard deviations.

Measures of “Success”

QHEI Pool/Riffle Development Metric

Excellent Pool/Riffle Development:

Pools - > 1 m Deep
Glides - Only Transitional Habitats
Runs - > 0.5 m Deep
Riffles - Deep, Large Substrates
Morphology - All Habitats Easily Definable, Riffles Narrow and Deep, Pools Wide with Deep and Shallow Sections

Good Pool/Riffle Development:

Pools - > 0.7 m Deep
Glides - Mostly Transitional Habitats
Runs - Deep, but < 0.5 m
Riffles - Some Deep Areas, Large Substrates (At Least Large Gravels)
Morphology - All Habitats Fairly Well Definable, Riffles Typically Narrower Than Most Pools

Measures of "Success"

Table 2. Metrics and scoring ranges for the old version and the new version of the QHEI.

"Old" QHEI		"New" QHEI	
Substrate	15 pts	*Substrate*	20 pts
1) Type	2-14	1) Type	0-20
2) Quality	-2-2	2) Quality	-5-3
Instream Cover	15 pts	*Instream Cover*	20 pts
1) Type	0-8	1) Type	0-9
2) Amount	1-7	2) Amount	1-11
Channel Quality	15 pts	*Channel Quality*	20 pts
1) Sinuosity	1-4	1) Sinuosity	1-4
2) Development	1-4	2) Development	1-7
3) Channelization	1-4	3) Channelization	1-6
4) Stability	1-3	4) Stability	1-3
Riparian/Erosion	15 pts	*Riparian/Erosion*	10 pts
1) Width	0-5	1) Width	0-4
2) Floodplain Quality	1-5	2) Floodplain Quality	0-3
3) Bank Erosion	1-5	3) Bank Erosion	1-3
Pool/Riffle	15 pts	*Pool Riffle*	20 pts
1) Max. Depth	0-3	1) Max Depth	0-6
2) Cover Quality	0-3	2) --	- -
3) Current Available	-2-4	3) Current Available	-2-4
4) Pool Morphology	0-2	4) Pool Morphology	0-2
5) Riffle/Run Depth	1-3	5) Riffle/Run Depth	0-4
6) Riffle Substrate Stability	0-1	6) Riffle Substrate Stab.	0-2
7) Riffle Embeddedness	0-1	7) Riffle Embeddedness	-1-2
Drainage Area	0-15 pts	*Drainage Area*	*Not included*
Gradient	0-10 pts	*Gradient*	0-10 pts
Total Score	0-100 pts.	Total Score	0-100 pts.

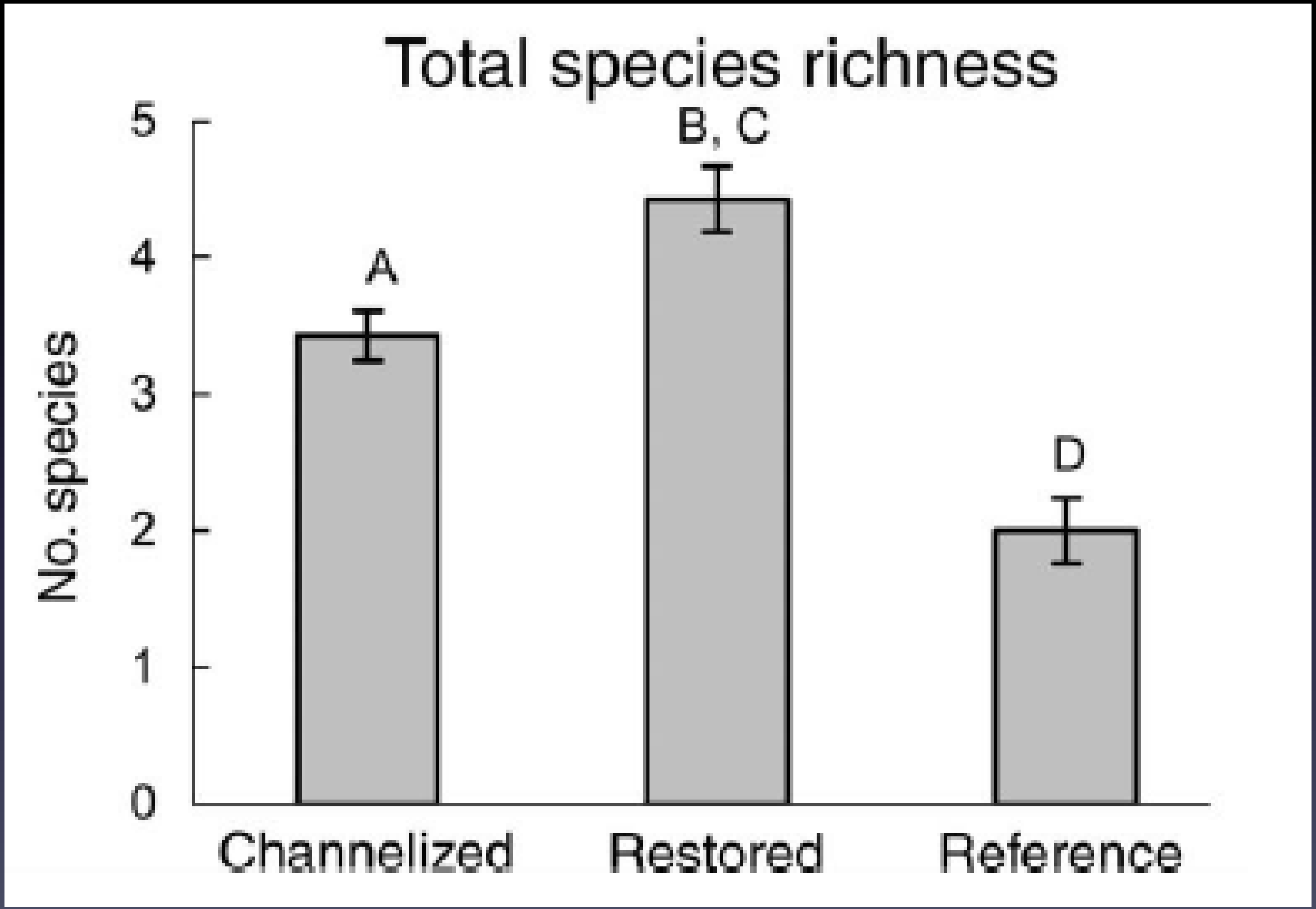
Measures of "Success"

- Generic habitat assessments (EPA Rapid Bioassessment Protocol or Ohio Qualitative Habitat Evaluation Index)
- What is optimal? How do we know?
- Many metrics imply more/less is good…
- Some metrics can be "rigged" through channel alteration

8. Bank Stability (score each bank) Note: determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.			Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.			Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.			Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.	
SCORE ___ (LB)	Left Bank	10	9	8	7	6	5	4	3	2	1	0
SCORE ___ (RB)	Right Bank	10	9	8	7	6	5	4	3	2	1	0

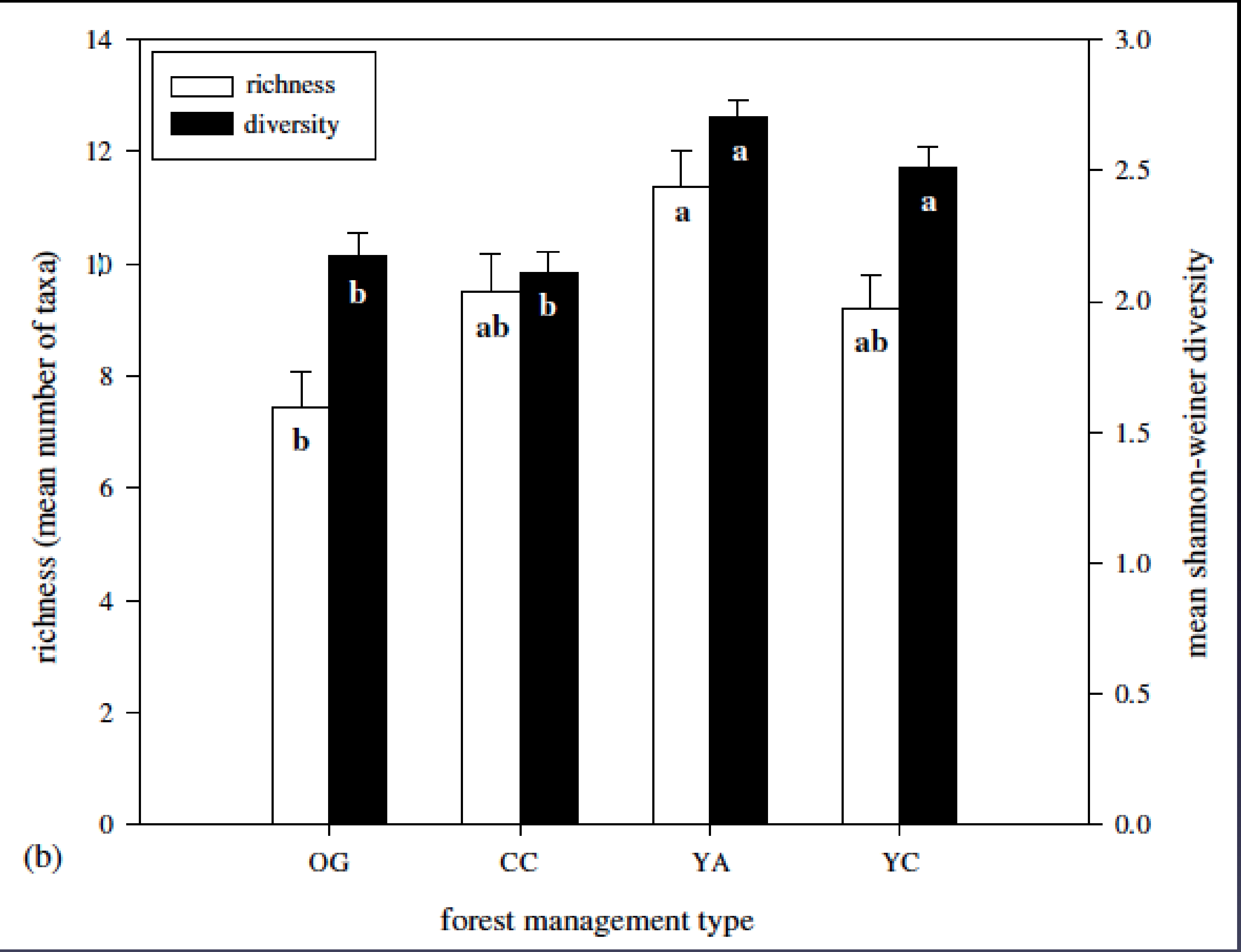
EPA Rapid Bioassessment Protocol

Biotic Surrogates
The Problem with "More is Better"



Lepori et al., 2005

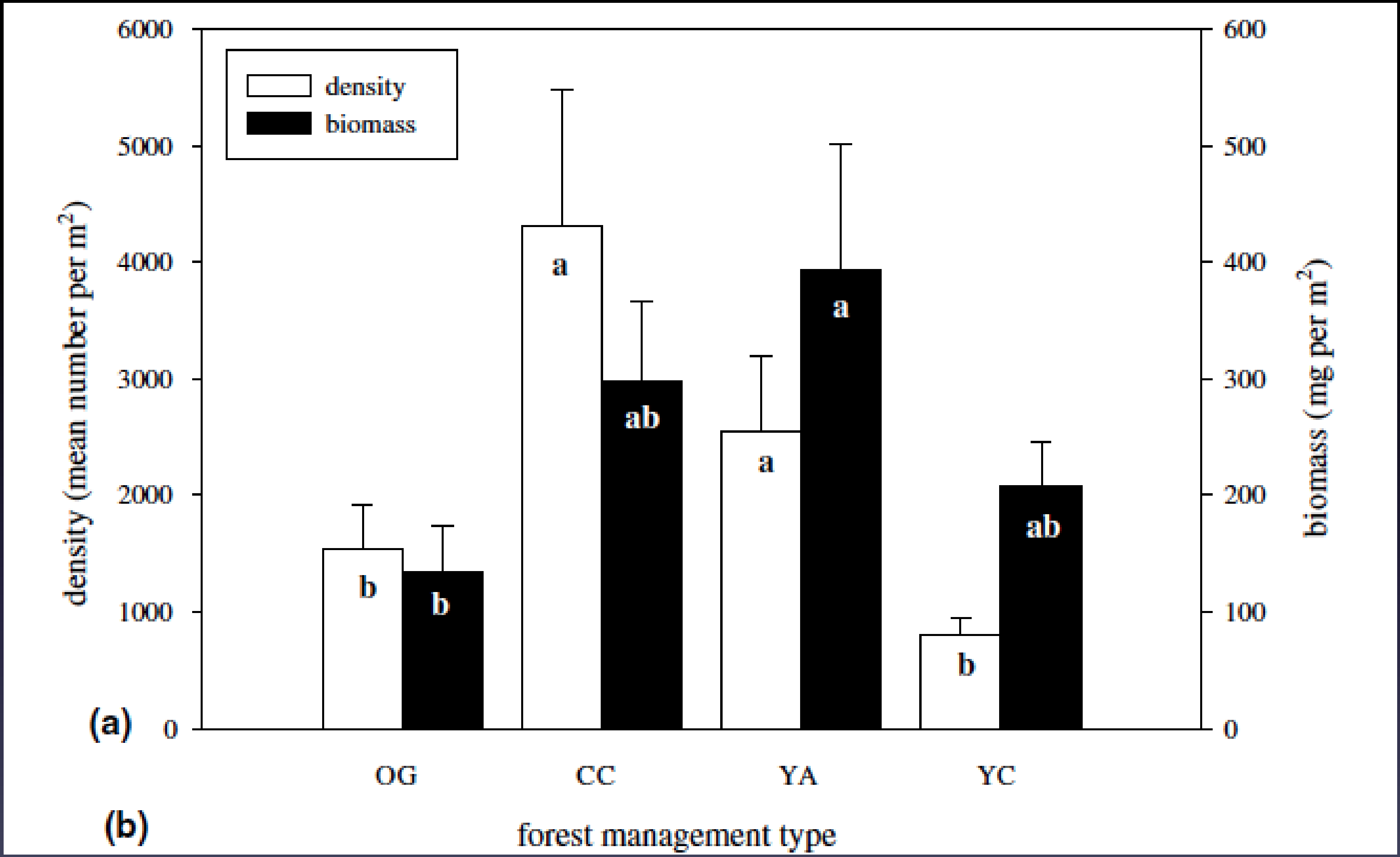
The Problem with "More is Better"



OG- Old Growth, **CC**- Clearcut, **YA**- Young Alder, **YC**- Young Conifer

Hernandez et al., 2005

The Problem with “More is Better”



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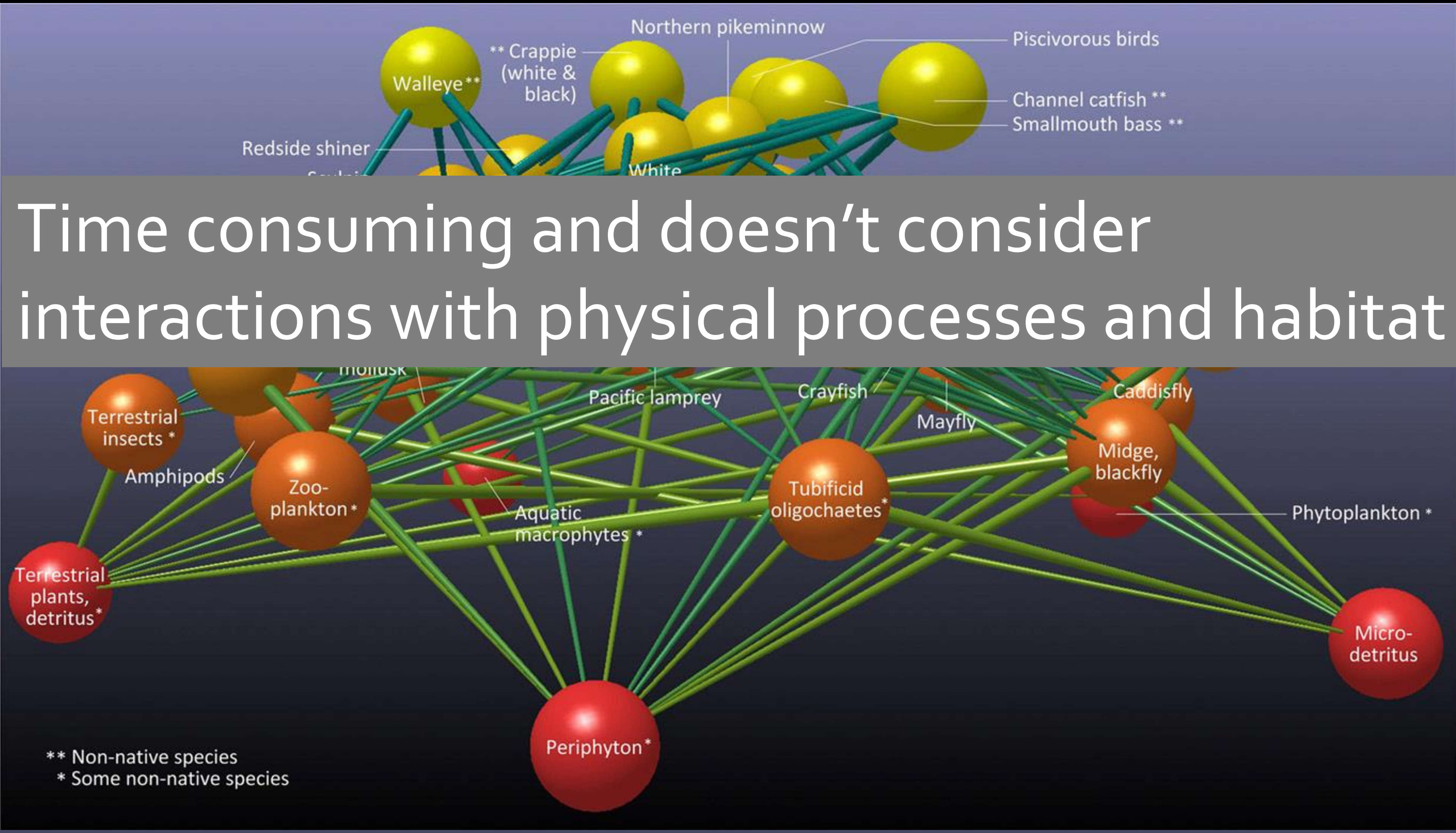
Measures of "Success"



Time consuming and doesn't consider interactions with physical processes and habitat

Naiman et al. 2012

Restoration

Evaluation Metrics

Area of habitat
Trees planted
Length of channel
Project stability

Easy to measure, but may not be relevant

Habitat quality
Biodiversity
Ecosystem functions

More appropriate but harder to measure and difficult to set targets

What to measure?

Process

Habitat

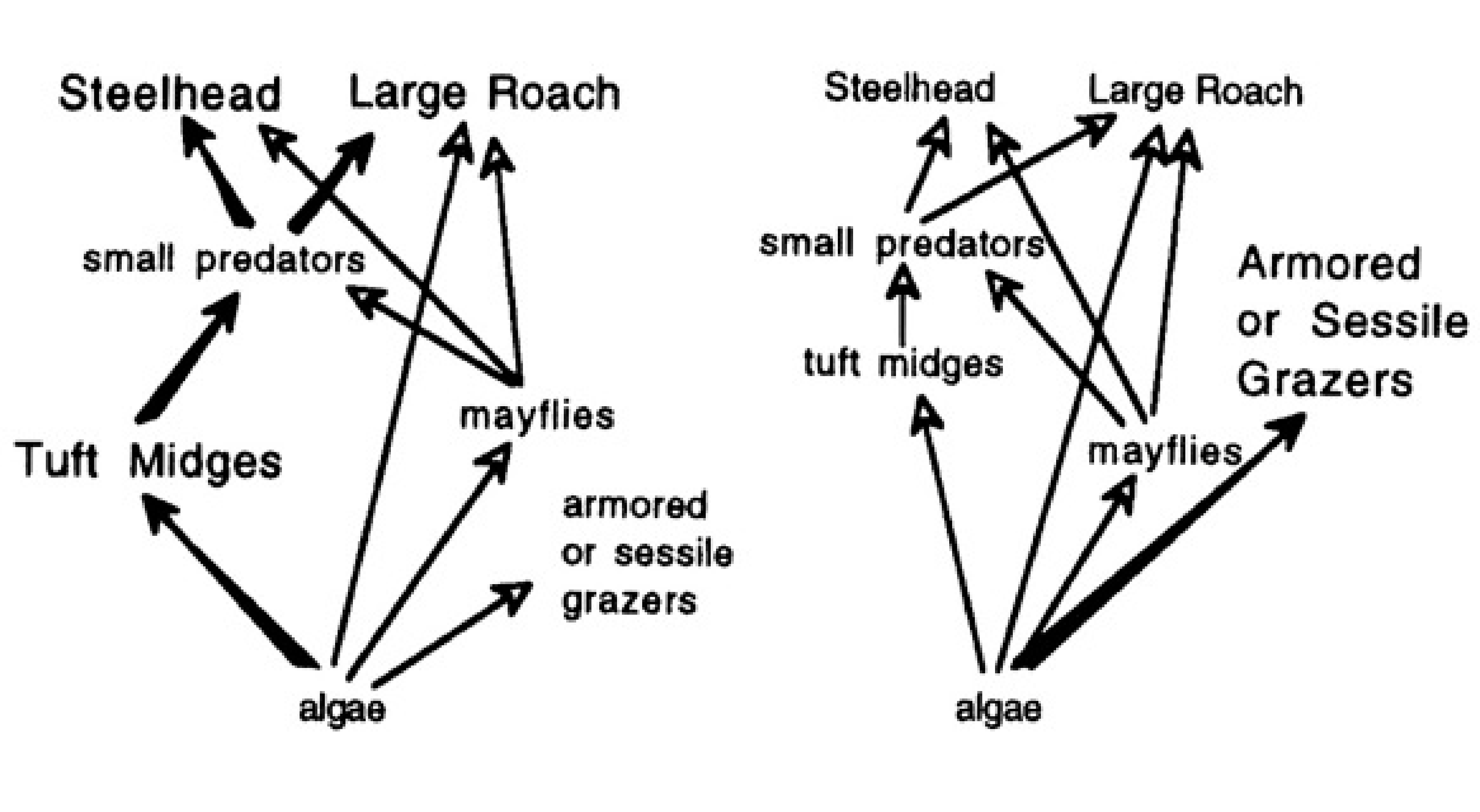
Biota

Habitat

Biota

Measures of “Success”

Scouring winter floods | Drought or artificial regulation



Power, Parker, and Wootton, 1996

Measures of “Success”

Project acceptance	Acceptance by interest group *												○		1.5	1-15
	Acceptance by entire public *												○		3	1-15
	Acceptance by project work group *												○		1	1-15
Stakeholder participation	Satisfaction of interest groups with the design of the participation process													○	1-2.5	1-5
	Satisfaction of the public with participation opportunities													○	1-2.5	1-5
	Satisfaction of interest groups with participation opportunities													○	1-2	1-5
Recreational use	Number of visitors		□												1	1-15
	Variety of recreational opportunities *		○												0.5	1-15
	Public site accessibility for recreation		□												0.5	1-15
Landscape	Diversity and spatial arrangement of habitat types *		●	●			●	●	●	●	●	●			3.5-5.5	3-15
	Aesthetic landscape value *		○												1.5-3	1-15
Longitudinal connectivity	Barrier-free migration routes for fish						○								1	1-5
Hydrogeomorphology and hydraulics	Inundation dynamics: duration, frequency and extent of flooding							●				●			0.5	1-15
	Variability of measured wetted channel width *			□	■			□							2.5	1-15
	Variability of visually estimated wetted channel width *			○	●			○							1	1-15
	Variability of flow velocity			○	●										2.5-5	1-15
	Depth variability at bankfull discharge			○	●					●	●				2.5	1-15
Bed load	Bedload regime			●	○		●				●				1-18	1-15
Organic material	Short-term leaf retention capacity			●				●				○			1.5	1-15
	Quantity of large wood	●						●				○			1	1-15
	Quantity and composition of floating organic matter and abundance and diversity of colonizing snails						○	●		●	●	●			1.5	1-5
River bed	Permeability of river bed	●		●	●				○						2.5	3-15
	Diversity of geomorphic river bed structures *			○	●		●	●	●	●	●	●			1.5	1-15
	Temporal changes in diversity of geomorphic river bed structures *			○	●		●	●	●	●	●	●			2	1-15
	Clogging of hyporheic sediments	■		■	■				□						1-1.5	1-15
	Grain-size distribution of substratum *			○	●				●		●				1.5	1-15
	Degree and type of anthropogenic modification			○							●				1	1-15

Measures of “Success”

Shore	Width and degree of naturalness (vegetation, composition of ground) of riparian zone		○		●		●		●	●	●	1	1-15
	Quantity and spatial extent of morphological units	●	○			●	○			●		1.5	1-15
	Temporal changes in the quantity and spatial extent of morphological units	●	○			●	○			●		1.5-2.5	1-15
	Shoreline length			■			□				■	2	1-15
	Degree and type of anthropogenic modification		○				●	○	●	●	●	1	1-15
Transition zones	Food subsidies across land-water boundaries						●					5.5	1-2
	Exchange of dissolved nutrients and other solutes between river and groundwater	●	●	●	●			○				5.5	3-15
	Community composition and density of small mammals on floodplain						●			○		1	1-15
Refugia	Availability of three types of refugia (hyporheic refugia, shoreline habitats, and intact tributaries)			●		●	●	●	●	●		5.5	1-5
Temperature	Spatial and temporal variation in water temperature *	●			○		●	●				1	1-15
Fish	Age structure of fish population		●	●		●	●			○		4	1-15
	Fish species abundance and dominance		■	■	■	■				□		4	1-15
	Diversity of ecological guilds of fish		■	■	■	■				□		4	1-15
Fish habitat	Presence of cover and instream structures		●	●			●			●	●	1.5	1-15
Macroinvertebrates	Richness and density of terrestrial riparian arthropods						●			○		1.5	1-5
	Occurrence of both surface water and groundwater organisms in the hyporheic zone			●				●		○		4	1-15
	Taxonomic composition of macroinvertebrate community		●	●		●	●	●		○		0.5	1-15
	Presence of amphibiontic species in the groundwater			●				●		○		4	1-15
Vegetation	Presence of typical floodplain species					●			○			0.5	1-15
	Succession and rejuvenation of plant species on floodplains *						●		○			7	3-15
	Temporal shift in the mosaic of floodplain vegetation categories					●			○			2	3-15
	Composition of floodplain plant communities						●		○			0.5	1-15

Measures of "Success"

All parts of an ecosystem must be present and functioning.
9/10 parts might not be good enough…

Metrics Checklist

- Because of organizational specialization and agency divisions, etc. Geomorph/Hydro/Eco are studied separately.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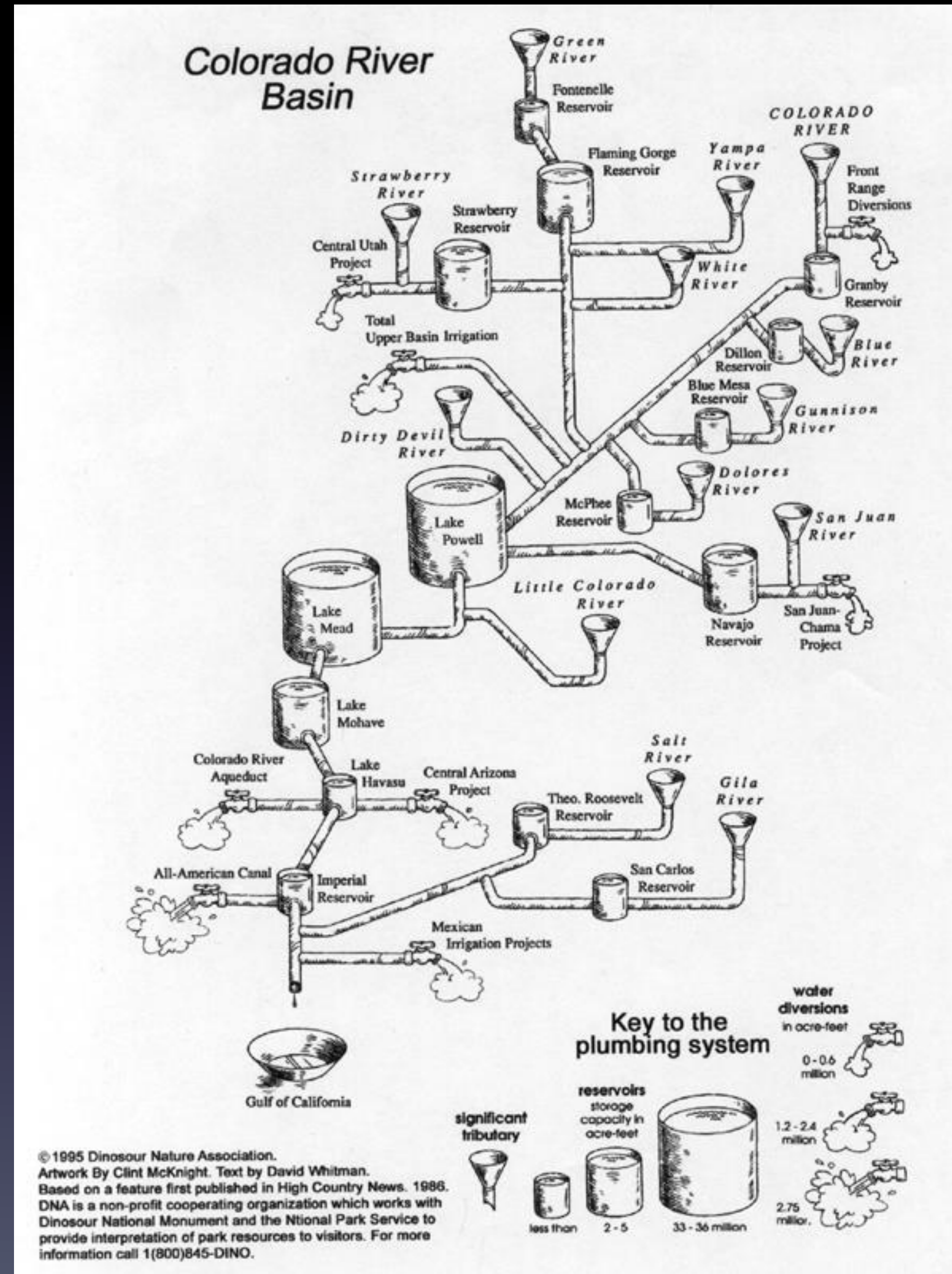
?

2) The Colorado: A Tamed River



The Colorado: A Tamed River

The Colorado: A Tamed River

- Diversions
- No floods since mid 80's
- Sediment trapping in reservoirs

The Colorado: A Tamed River

- Channel straightening
- Bank protection

The Colorado: A Tamed River

- Tamarisk
- Incision

Effects of Regulation

Impounded Runoff index IR = $\dfrac{\text{reservoir capacity}}{\text{mean annual runoff}}$

Humid climate rivers

Potomac, Elbe, Rhein Rivers: IR 0.05-0.20

Mediterranean climate rivers

Ebro, Sacramento, San Joaquin: IR = 0.57-1.20

***Colorado River :* IR = *4-7* (depending on estimates)**

Colorado River Compact of 1922

Mean Annual Flow= 16.5 Million Acre Feet (MAF)

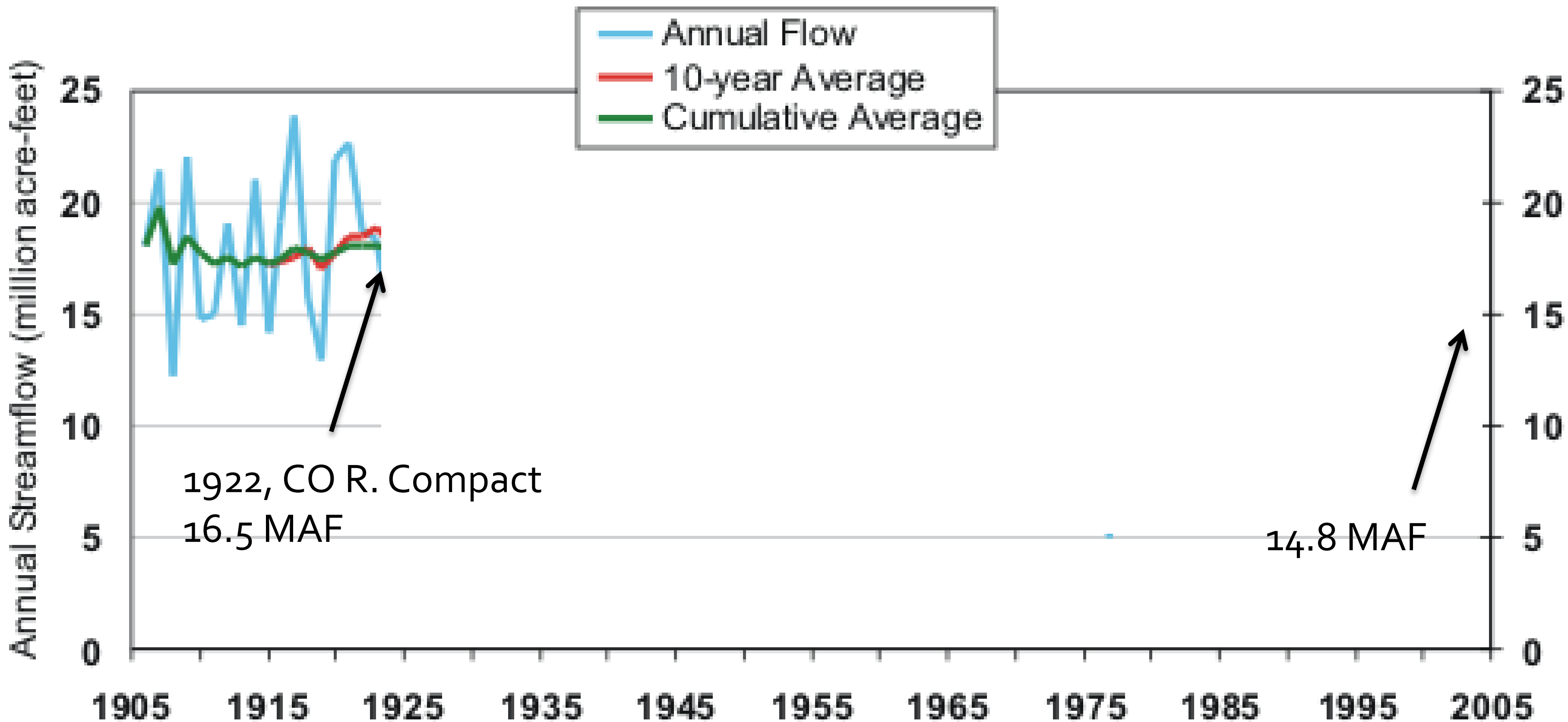
Upper Basin States (CO, WY, UT, NM) receive 7.5 MAF

Lower Basin States (AZ, NV, CA) receive 7.5 MAF

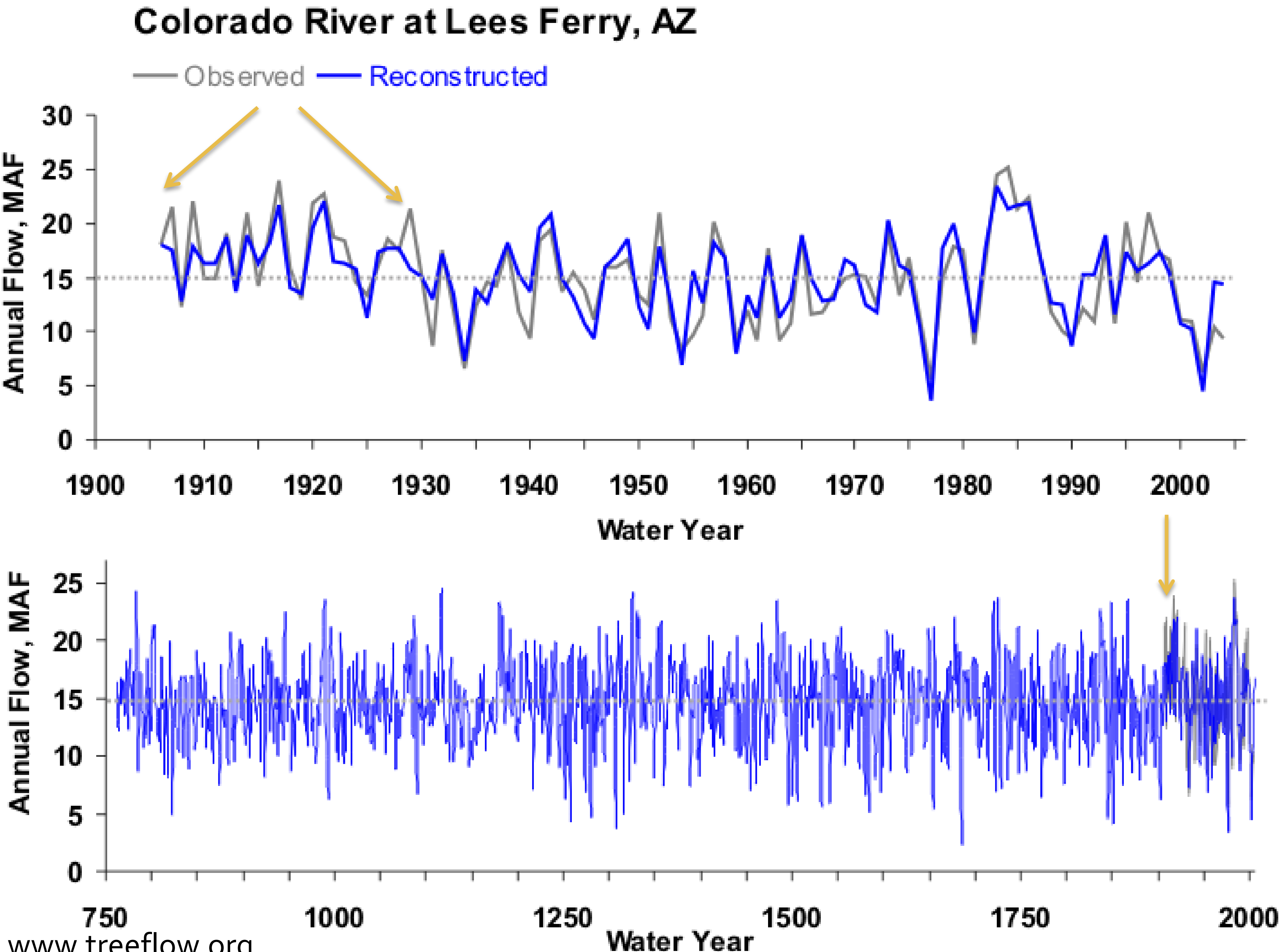
Mexico receives 1.5 MAF

Colorado River Indian Tribes: ~660,000 (5% of the river!)

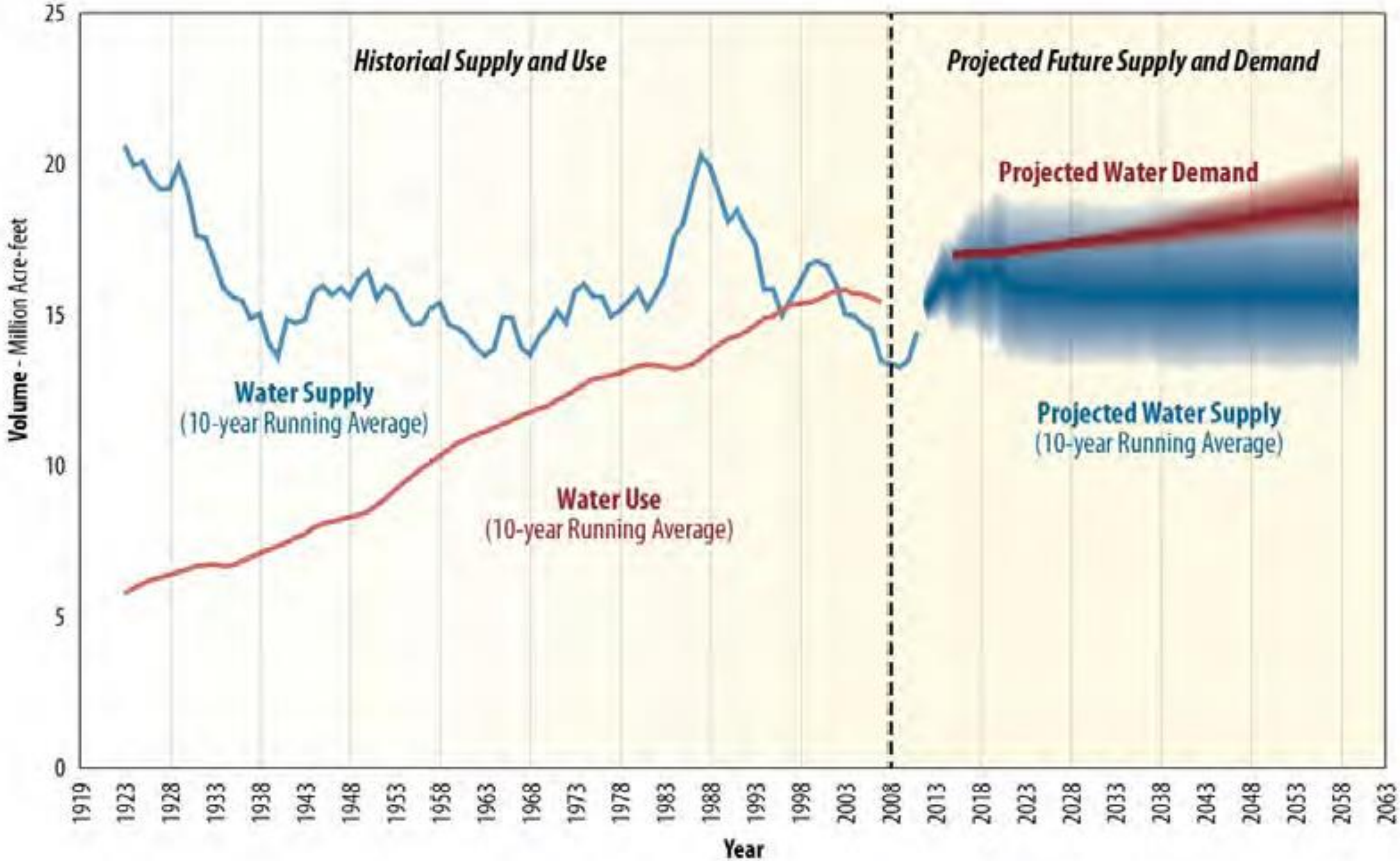
Discharge



http://www.colorado.edu/treeflow/lees/gage.html



www.treeflow.org



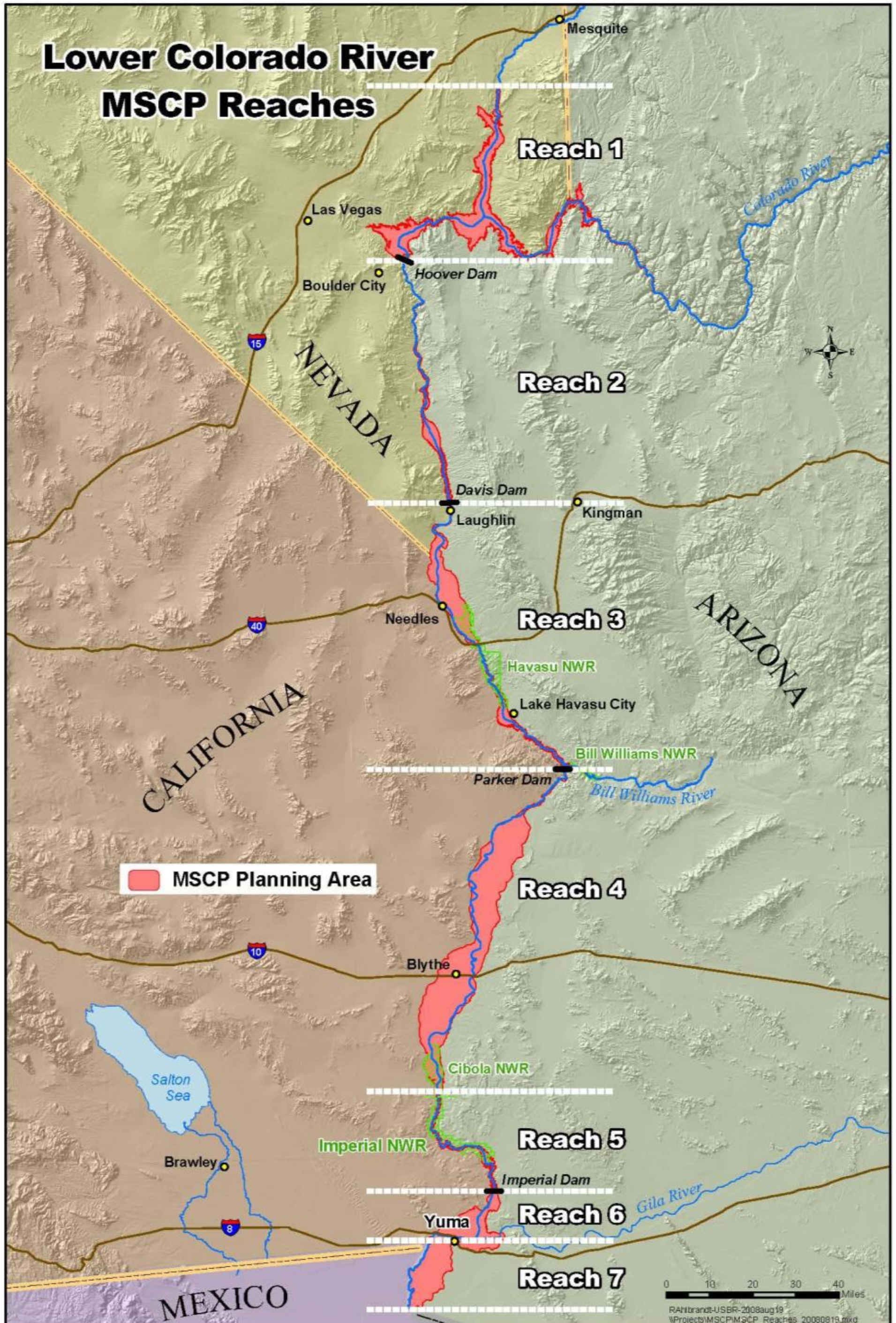
US Bureau of Reclamation 2012

The Colorado: A working river

The Colorado River supplies water for:

Municipal use for 40 million people
Irrigation 5.5 million acres of land
4,200 megawatts of hydropower

These uses are unlikely to stop anytime soon.



400 miles
Lake Mead to Mexico

50 years

$626 million

Habitat
construction+
Fish hatchery

http://www.azgfd.gov/

Arizona Bell's Vireo
Bonytail Chub
California Black Rail
California Leaf-Nosed Bat
Colorado River Cotton Rat
Colorado River Toad
Desert Pocket Mouse
Desert Tortoise (Mojave Population)
Elf Owl
Flannelmouth Sucker
Flat-Tailed Horned Lizard
Gila Woodpecker
Gilded Flicker
Humpback Chub
Least Bittern
Lowland Leopard Frog
MacNeill's Sootywing
Razorback Sucker
Relict Leopard Frog
Sonoran Yellow Warbler
Southwestern Willow Flycatcher
Sticky Buckwheat
Summer Tanager
Threecorner Milkvetch
Townsend's Big-Eared Bat
Vermilion Flycatcher
Western Red Bat
Western Yellow Bat
Yellow-Billed Cuckoo
Yuma Clapper Rail
Yuma Hispid Cotton Rat

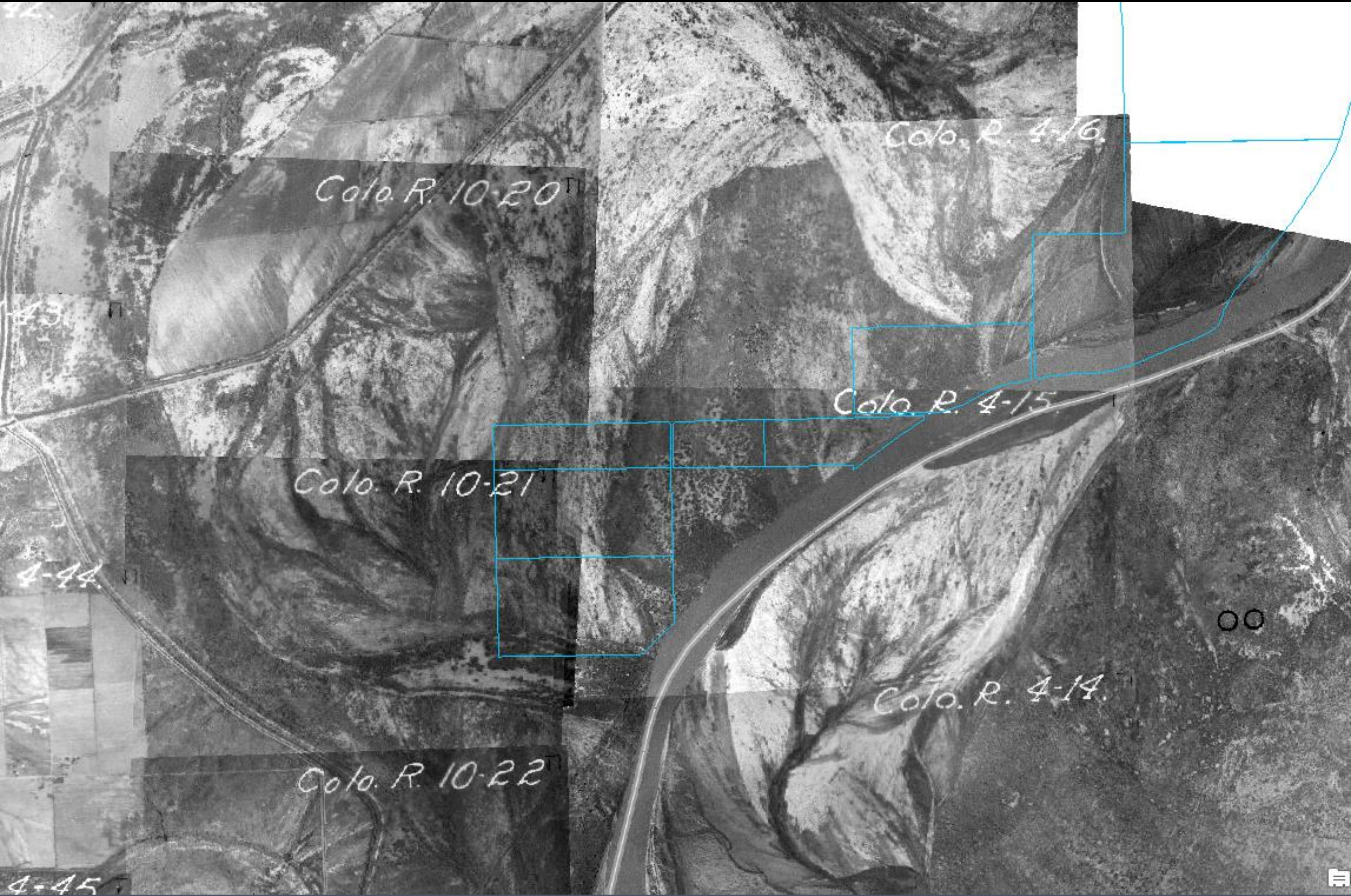
Imperial Ponds Backwater

6000 acres of Willow-Cottonwood

MSCP

Palo Verde Conservation Area

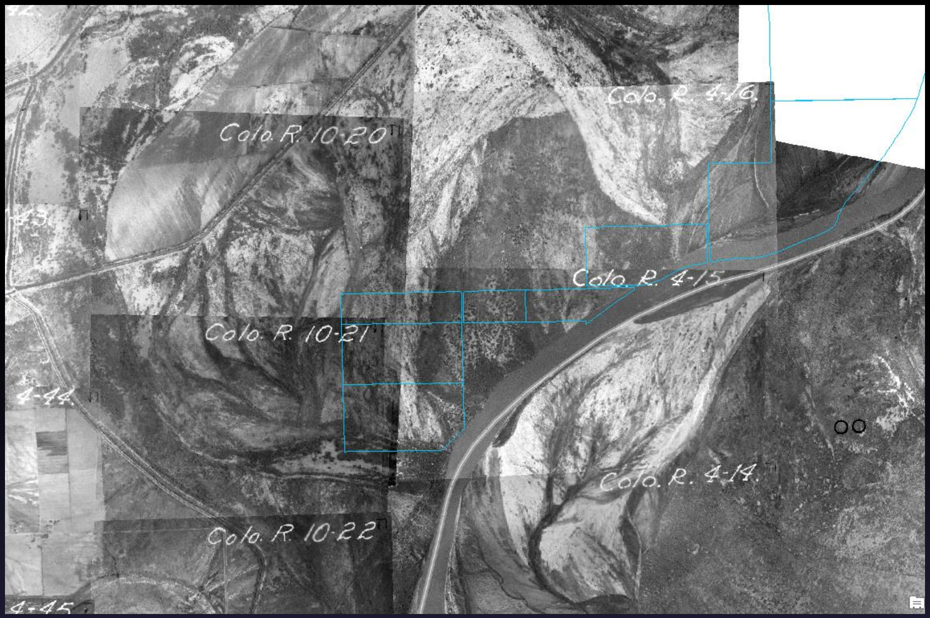
Palo Verde Conservation Area



Cibola Valley Conservation Area

Conceptual Model

- Dynamic
- Connected
- Bare sediment
- Arguably less vegetation throughout basin (Webb, 2007)



Functions missing in riparian plantations?
- Emerging veg.
- Channel complexity
- Aquatic insects

Aquatic-Terrestrial Subsidies

Ecology, 67(3), 1986, pp. 629–638

SECONDARY PRODUCTION, EMERGENCE, AND EXPORT OF AQUATIC INSECTS OF A SONORAN DESERT STREAM[1]

JOHN K. JACKSON[2] AND STUART G. FISHER
Department of Zoology, Arizona State University, Tempe, Arizona 85287 USA

Jackson and Fisher (1986): 97% of aquatic insect emergence biomass transferred to terrestrial habitat and prey for terrestrial consumers such as bats, birds, and ants (Sycamore Creek, AZ).

Sanzone et al (2003): isotopes in Sycamore Creek, AZ. Web weaving spiders along the stream channel obtain almost 100% of their carbon and 40% nitrogen from instream sources. Ground-hunting spiders obtained ~68% of their carbon and 25 % nitrogen. Three times more spiders at the stream edge than at 25m from the bank.

Hypotheses and potential limiting factors

The following decrease with distance from the river:

1) Aquatic insect abundance
2) Percentage of insects that are aquatic in origin
3) Total abundance of insects
4) Insect diversity (# of orders present)

Methods

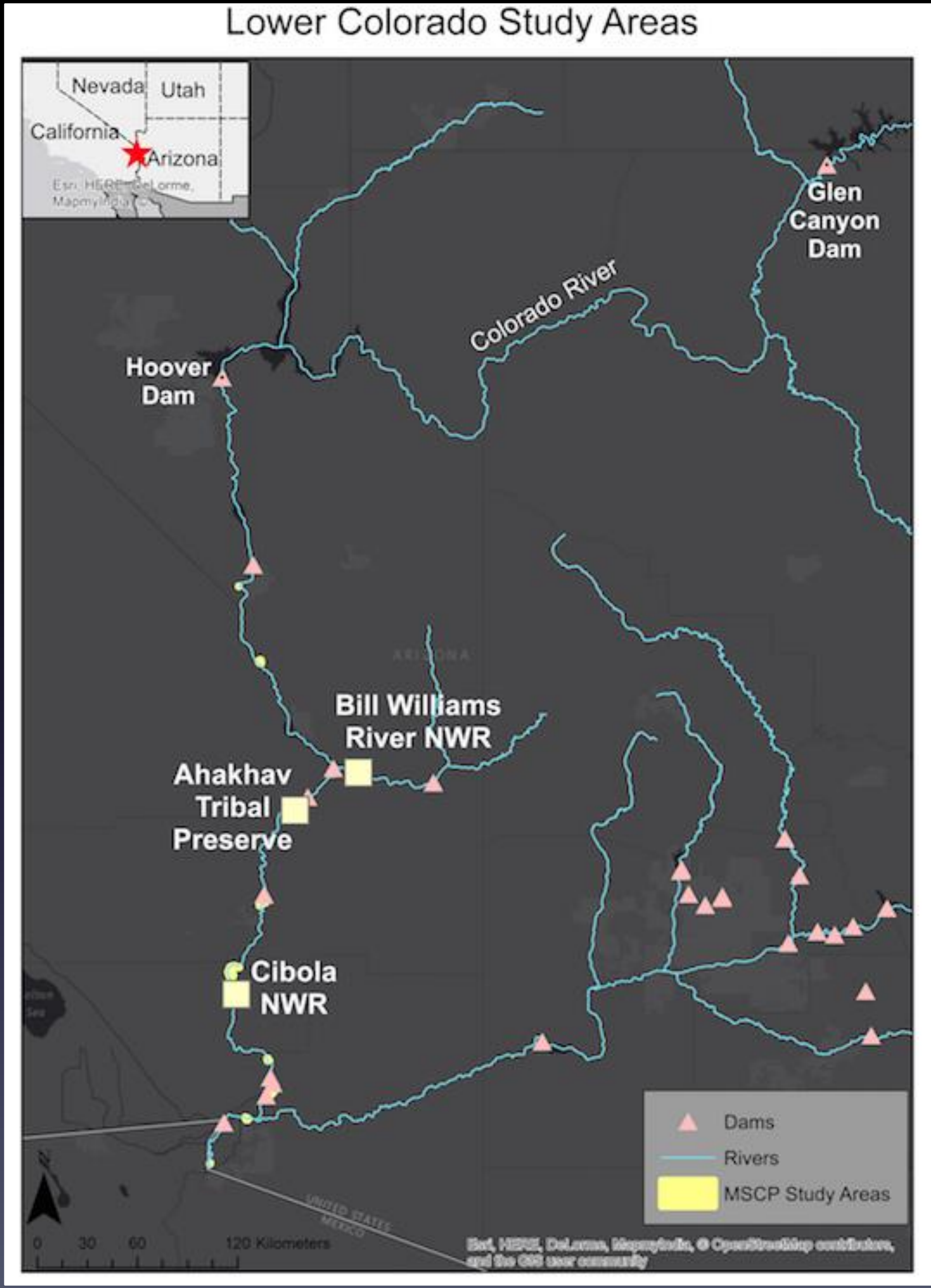
2 restoration sites:

Ahakhav (A)

Cibola NWR (C)

1 reference site:

Bill Williams River (B)

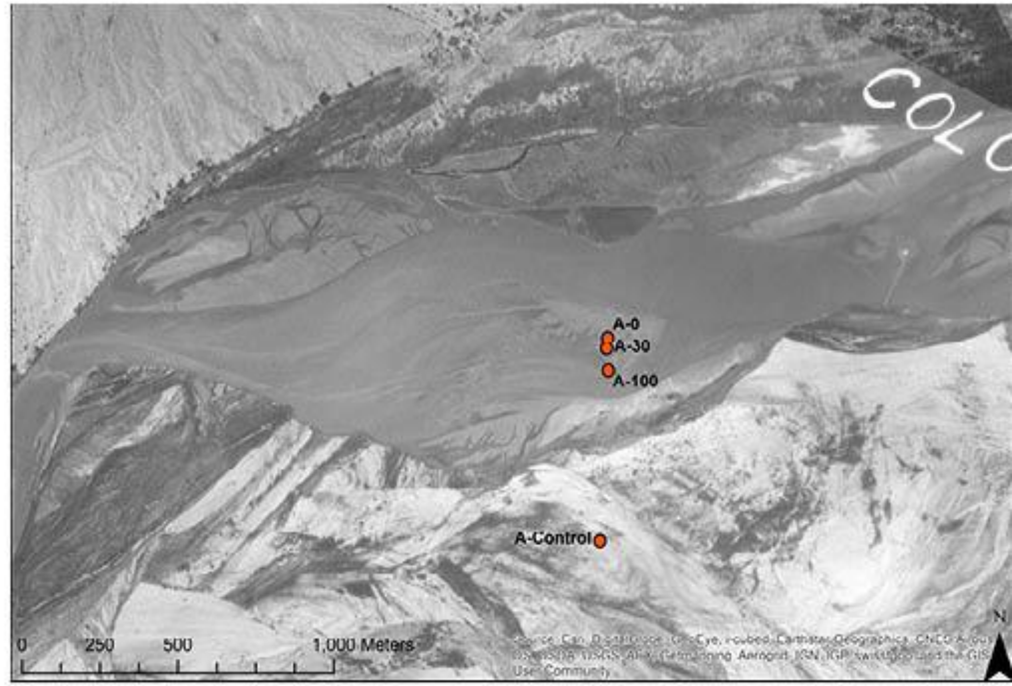


Methods

Non-attracting sticky traps- each trap left for 48 hours. 3-6 stations along each transect with 8 sheets at each station. 3 visits (May, July, September). 0, 30, and 100 m from river's edge.

Ahakhav (A)

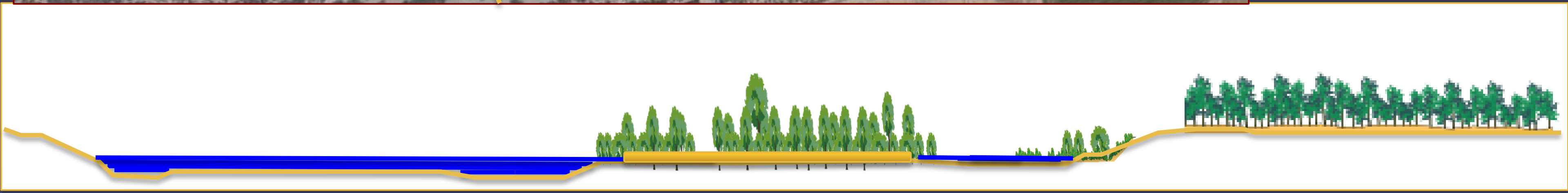
A)
1938



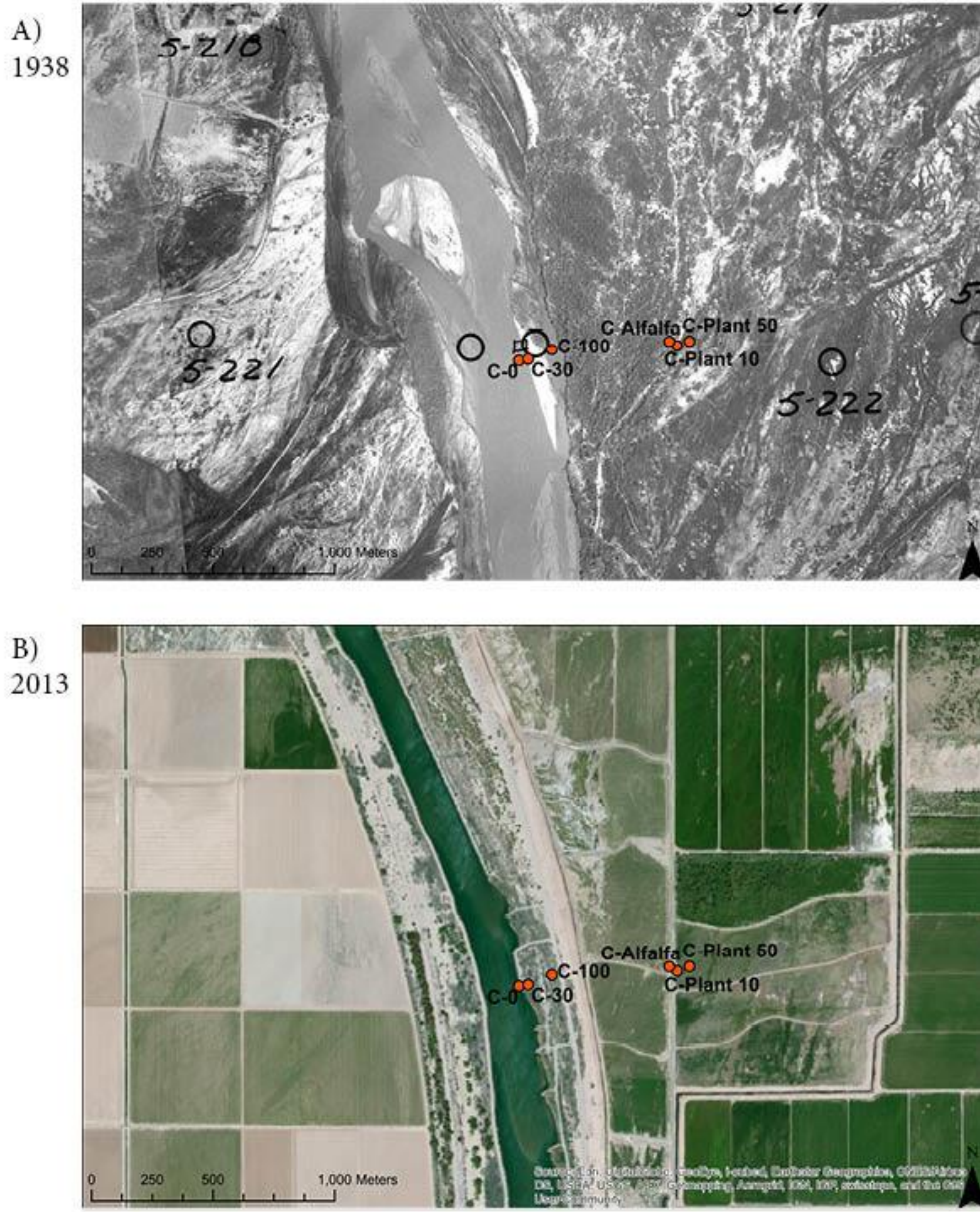
B)
2013

Ahakhav Tribal Preserve

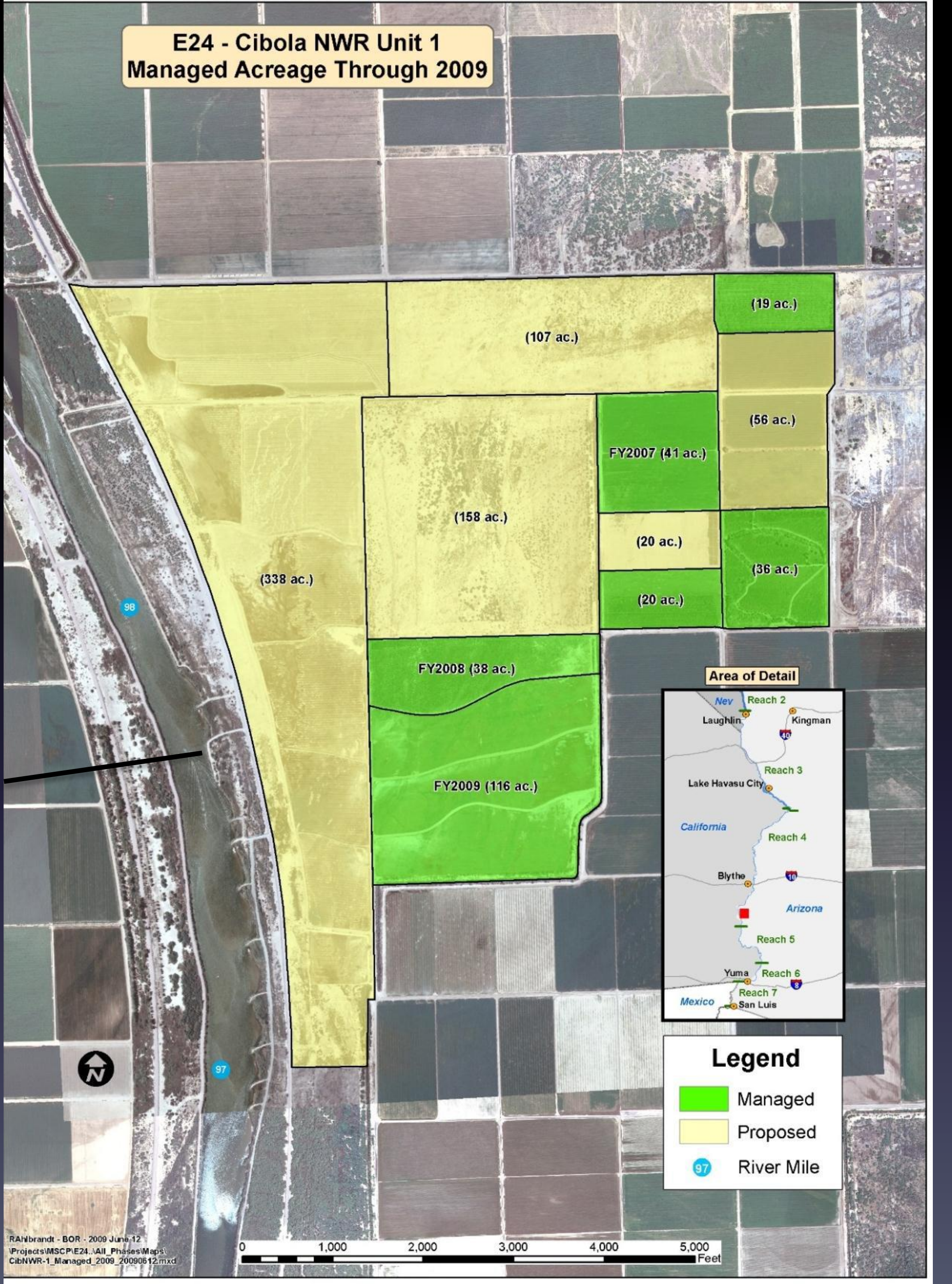
Built as a park, with willow, cottonwood, mesquite, and arroweed. Dredged and reconnected side-channel, minimally irrigated vegetation.



Cibola (C)

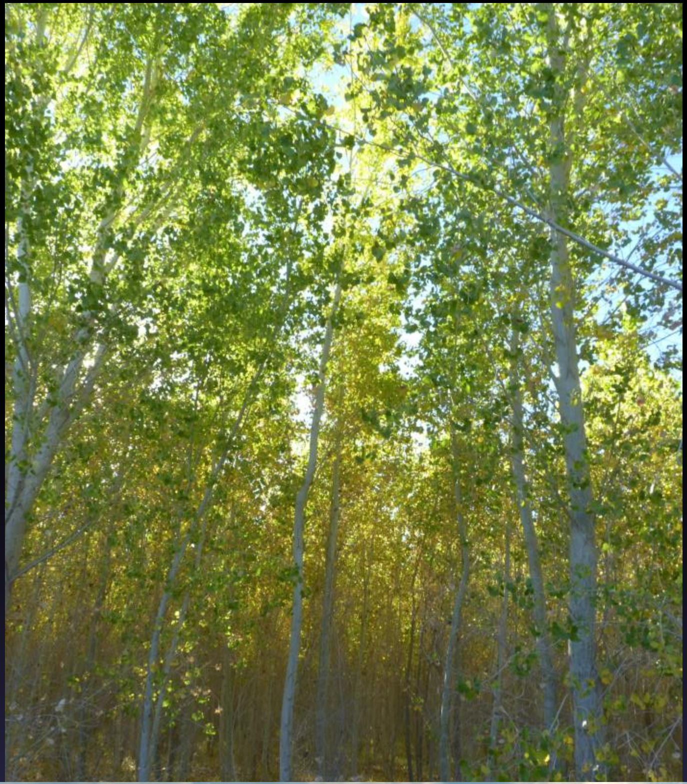

A)
1938
5-210
5-221
C-Alfalfa
C-Plant 50
C-100
C-0
C-30
C-Plant 10
5-222
0
250
500
1,000 Meters
B)
2013
C-Alfalfa
C-Plant 50
C-100
C-0
C-30
C-Plant 10
0
250
500
1,000 Meters

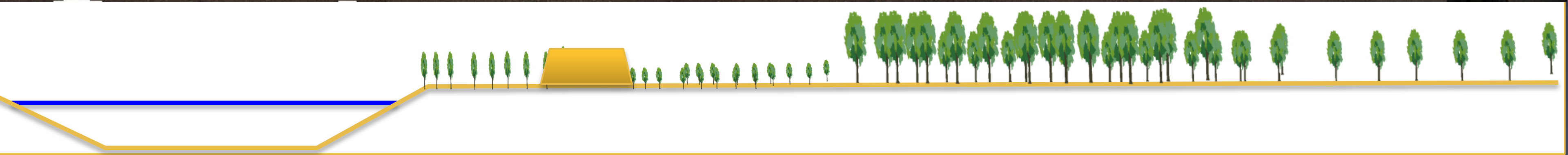
Cibola (C)



E24 - Cibola NWR Unit 1
Managed Acreage Through 2009
(19 ac.)
(107 ac.)
(56 ac.)
FY2007 (41 ac.)
(158 ac.)
(20 ac.)
(36 ac.)
(338 ac.)
(20 ac.)
FY2008 (38 ac.)
FY2009 (116 ac.)
98
97
Area of Detail
Nev
Reach 2
Laughlin
Kingman
Reach 3
Lake Havasu City
California
Reach 4
Blythe
Arizona
Reach 5
Yuma
Reach 6
Reach 7
Mexico
San Luis
Legend
Managed
Proposed
River Mile
0
1,000
2,000
3,000
4,000
5,000
Feet
RAhlbrandt - BOR - 2009 June 12

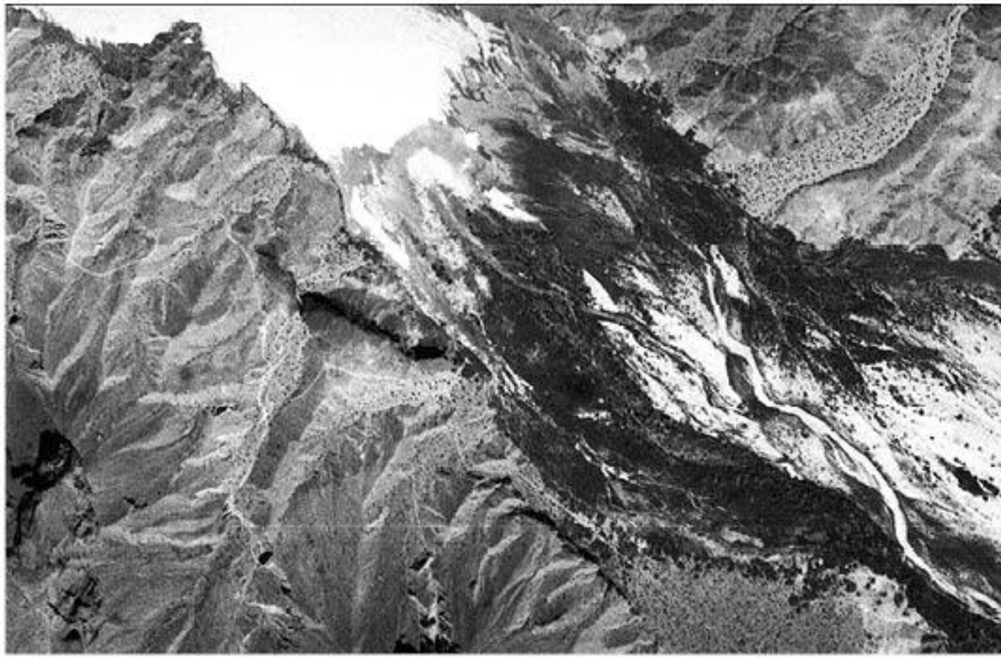
Cibola: Disconnected floodplain plantation





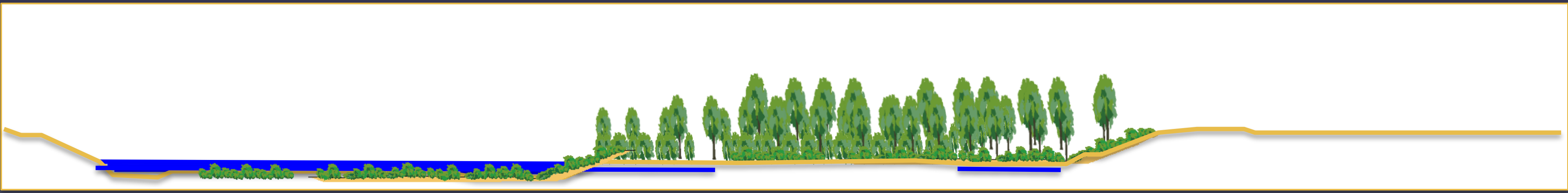
Bill Williams (B)

A)
1947

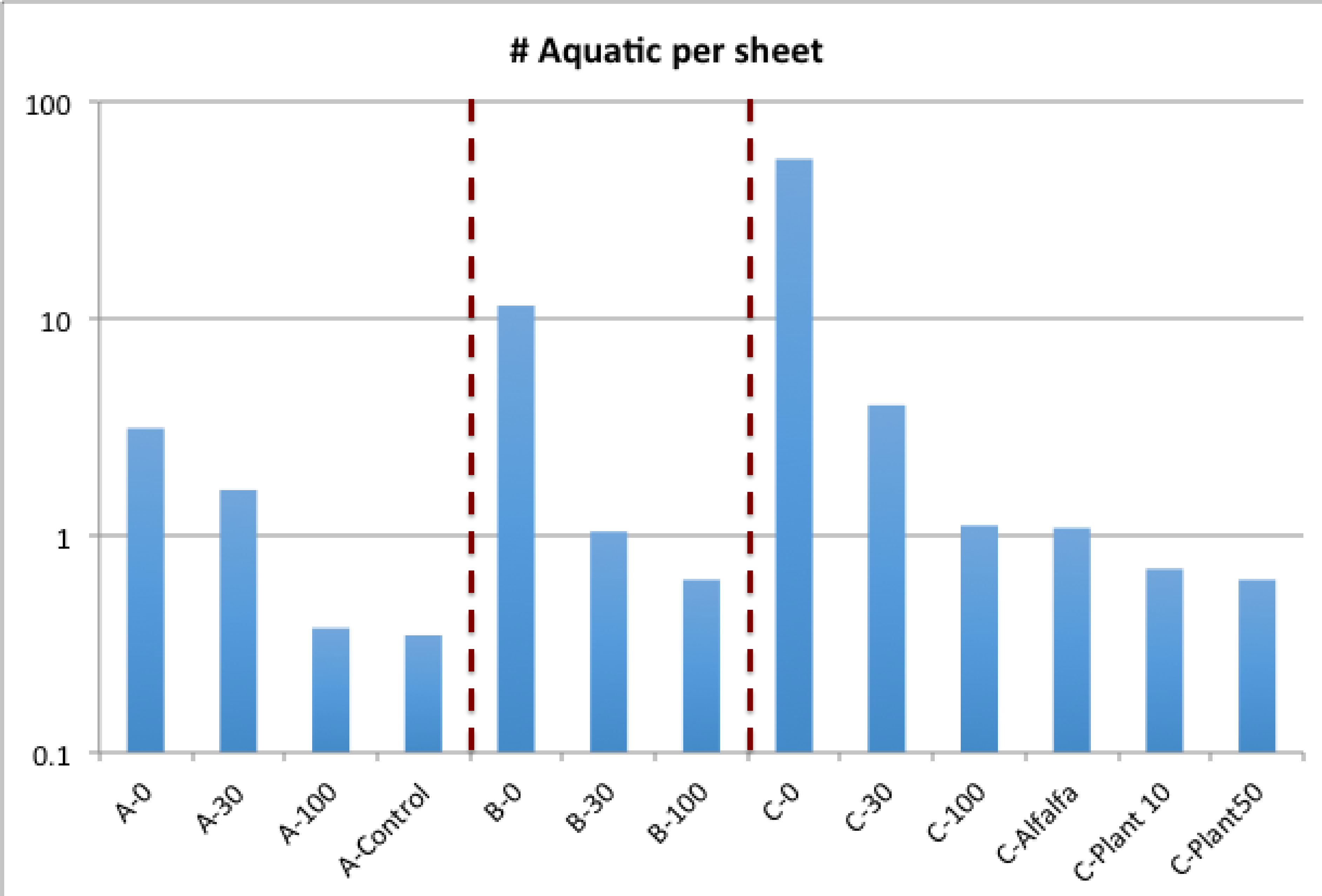


B)
2013

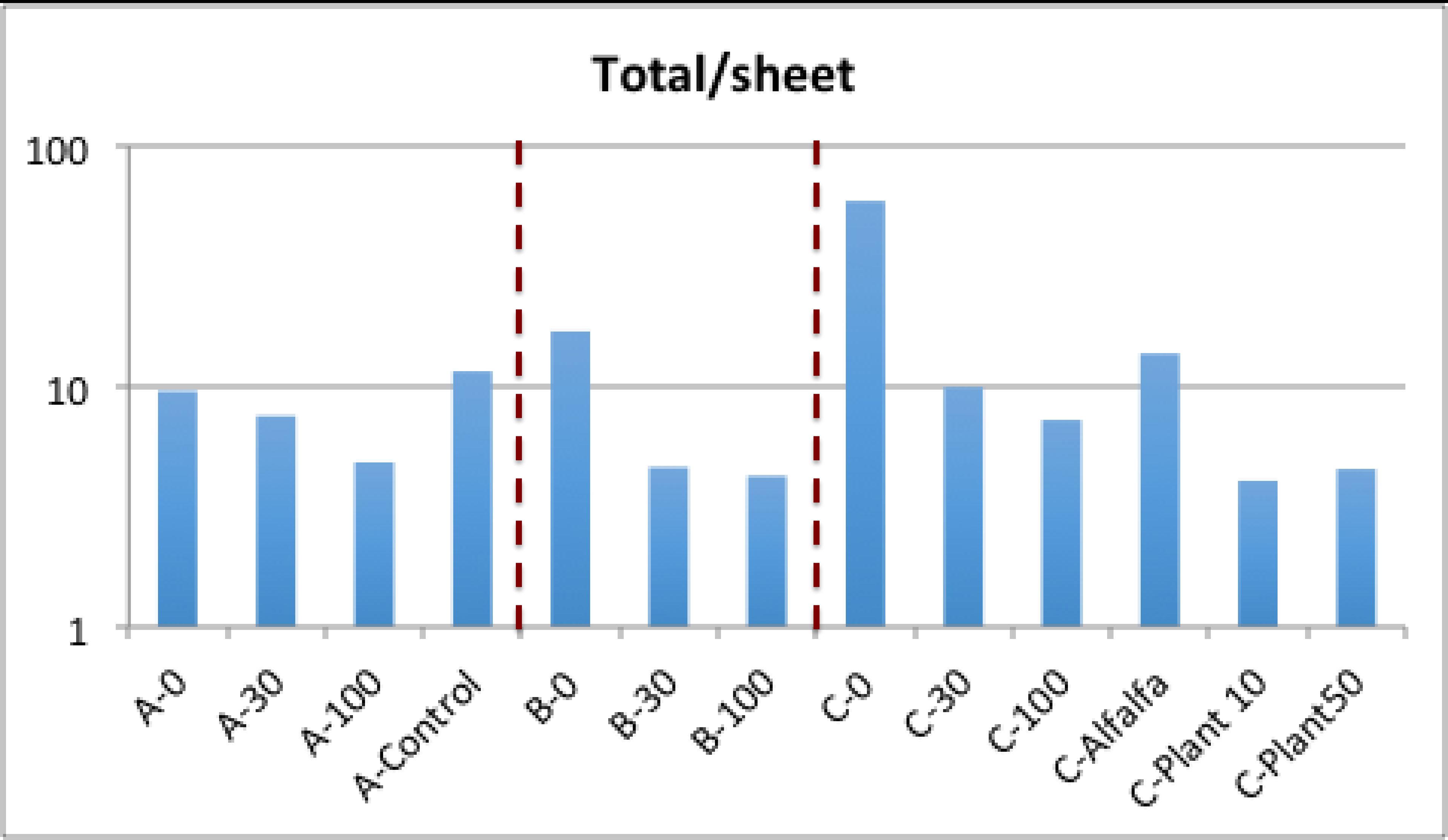
Bill Williams River: Connected Floodplain



Bill Williams River: Connected Floodplain

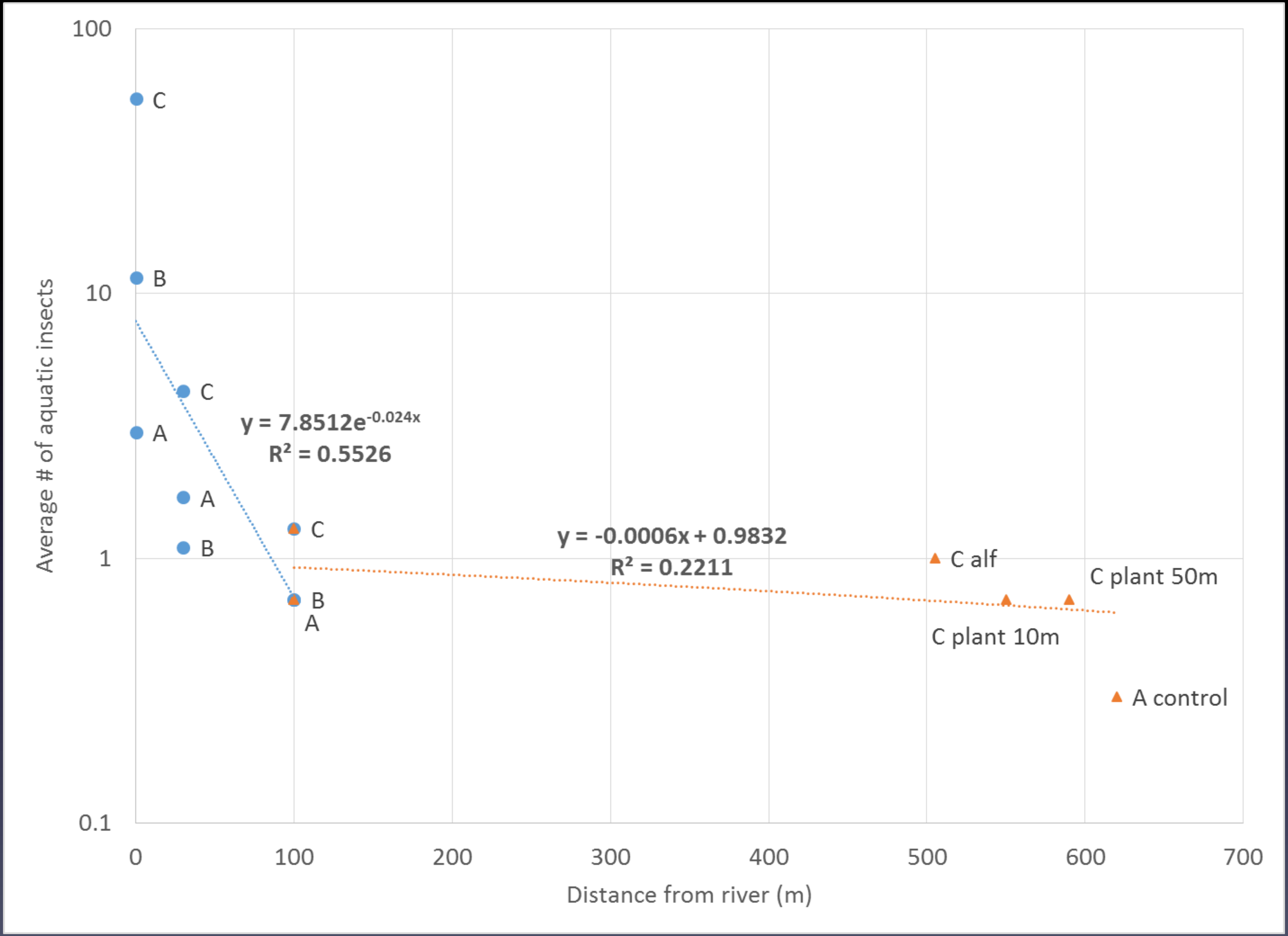


Aquatic per sheet
100
10
1
0.1
A-0
A-30
A-100
A-Control
B-0
B-30
B-100
C-0
C-30
C-100
C-Alfalfa
C-Plant 10
C-Plant50

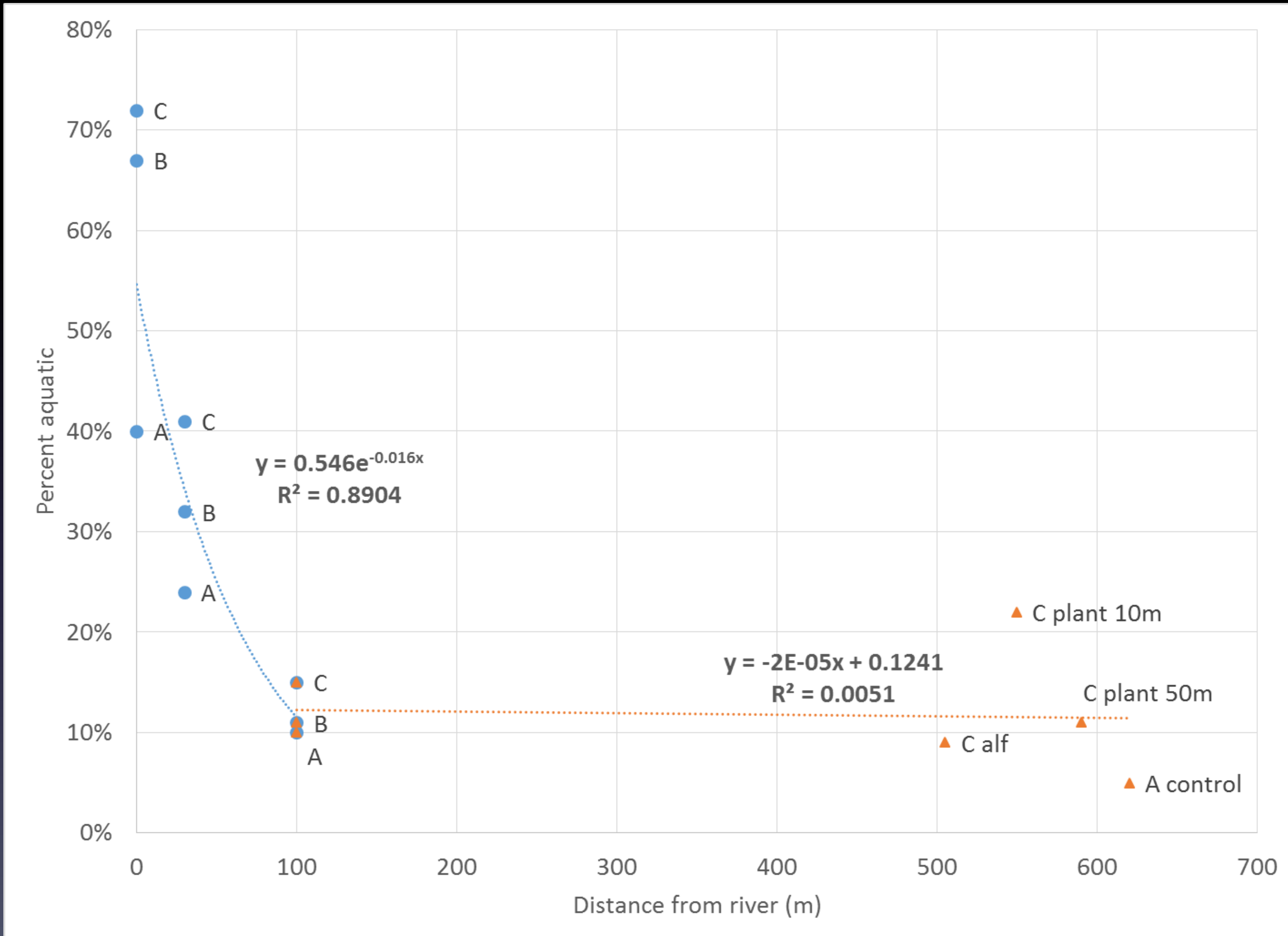


Total/sheet
100
10
1
A-0
A-30
A-100
A-Control
B-0
B-30
B-100
C-0
C-30
C-100
C-Alfalfa
C-Plant 10
C-Plant50

of Aquatic Insects

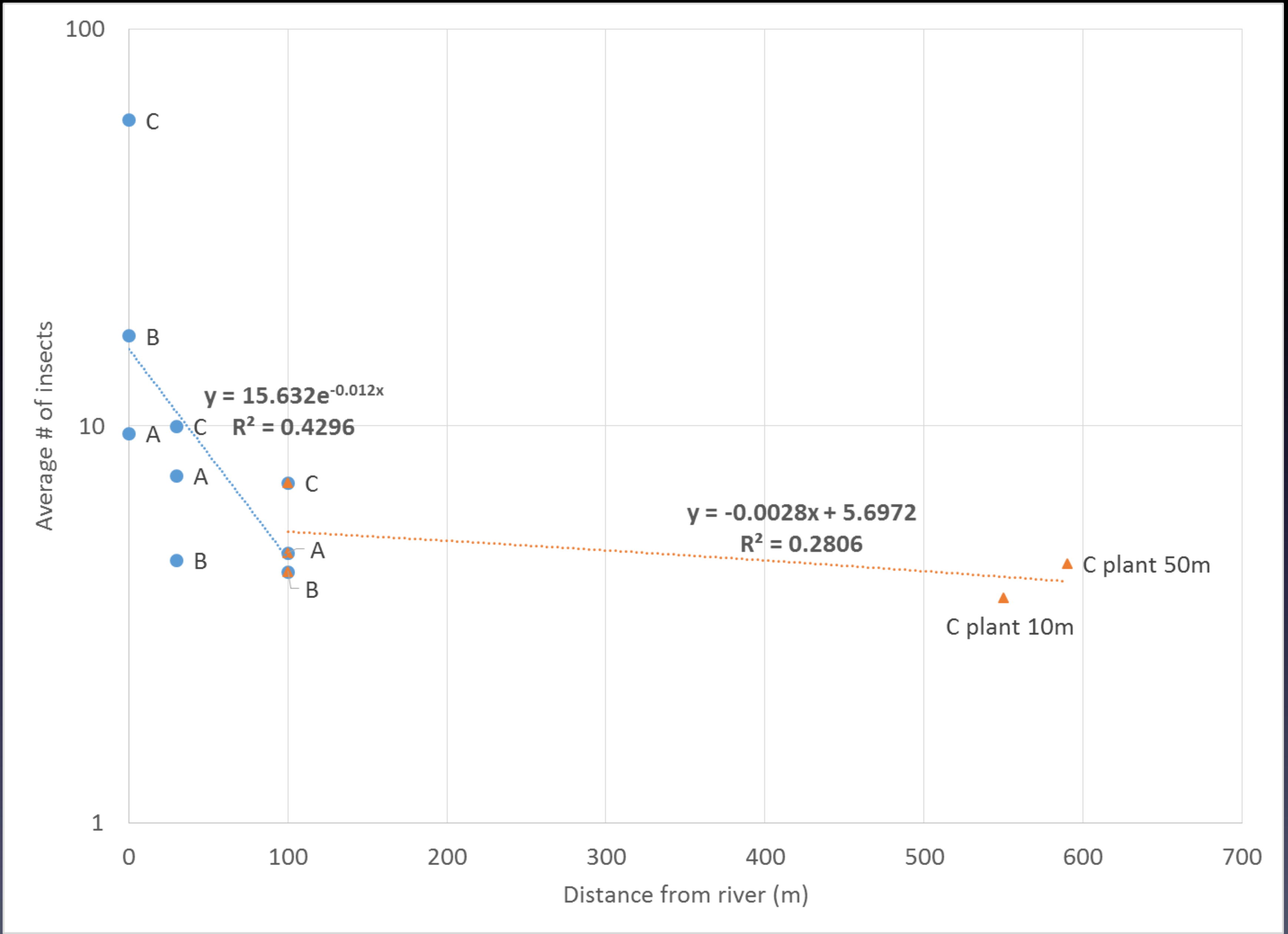


% Aquatic

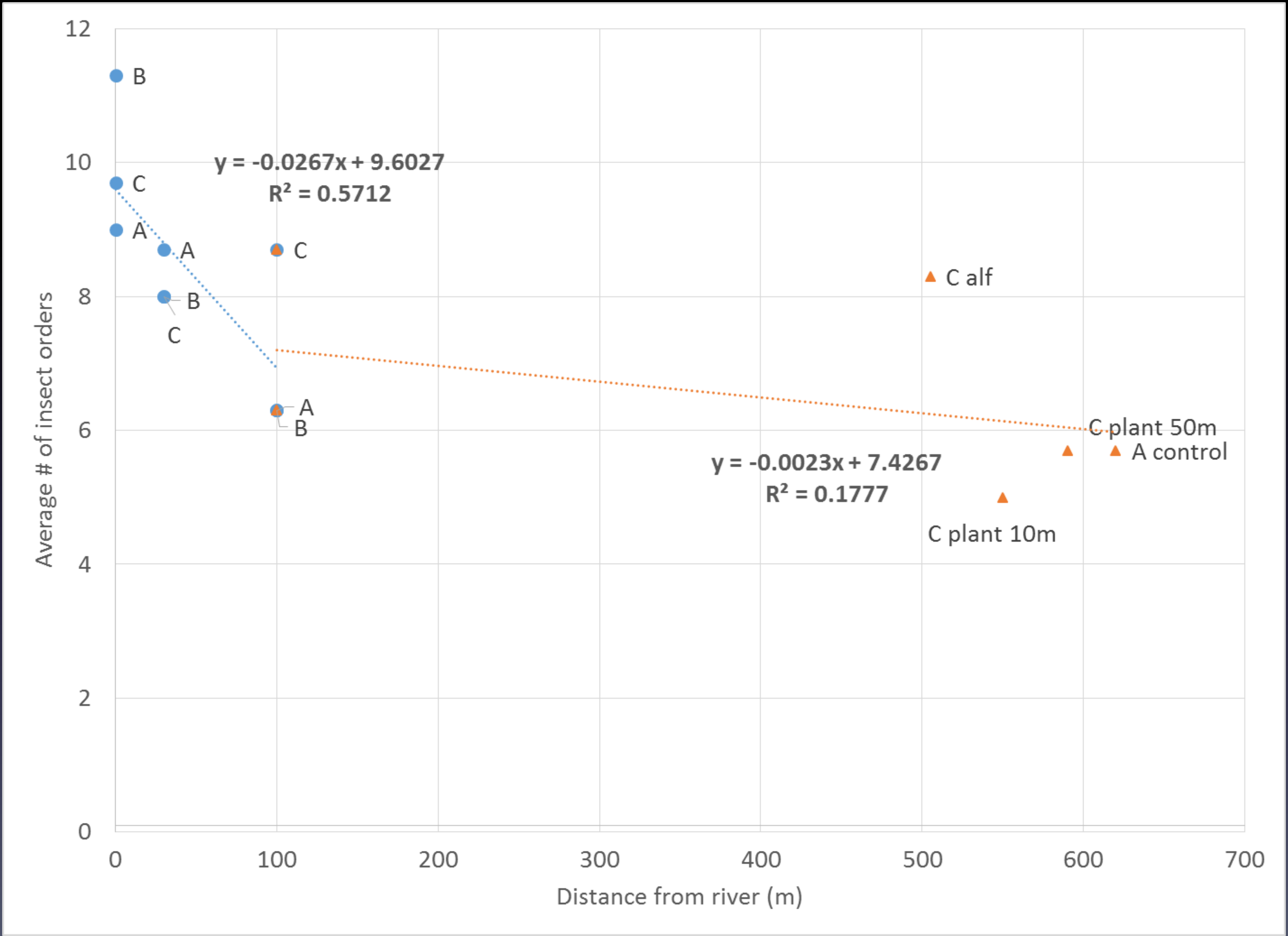


80%
70%
60%
50%
40%
30%
20%
10%
0%
Percent aquatic
C
B
A
C
B
A
C
B
A
y = 0.546e^-0.016x
R² = 0.8904
y = -2E-05x + 0.1241
R² = 0.0051
C plant 10m
C plant 50m
C alf
A control
0
100
200
300
400
500
600
700
Distance from river (m)

Average# of Insects Per Sheet



of Insect Orders



Conclusions

Intermediate functional metrics useful for evaluating restoration.

Question assumptions and make sure we are testing hypotheses with monitoring (perhaps *don't* monitor)

Prey availability studies are time consuming, but even a minimalist approach may yield useful insights.

Tree plantations more than 100m from desert rivers may not support insectivores such as southwestern willow flycatcher

Ideally: Levee set backs, flood pulse…

Minimally: trees planted along the river for improved ecosystem function and water quality

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“Far better an approximate answer to the *right* question, which is often vague, than an *exact* answer to the wrong question, which can always be made precise."

-John Tukey, 1962. “The Future of Data Analysis”

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