“Assessments for designing fish habitat programs and restoration”

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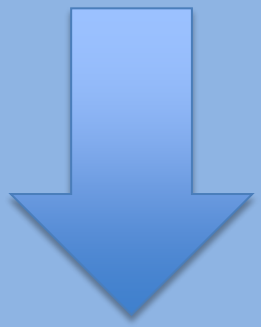
This talk

- Framing monitoring of aquatic systems in terms of reconciliation ecology
- Comparing diverse indices of stream ‘health’
  - Sierra Nevada meadows
  - Jucar River, Catalonia (Spain)

“Assessments for designing fish habitat programs and restoration”



Assessments for reconciled stream ecosystems

Reconciliation Ecology

"The science of inventing, establishing and maintaining new habitats to conserve species diversity in places where people live, work or play." **Michael Rosenzweig** *NOT* RESTORATION…..

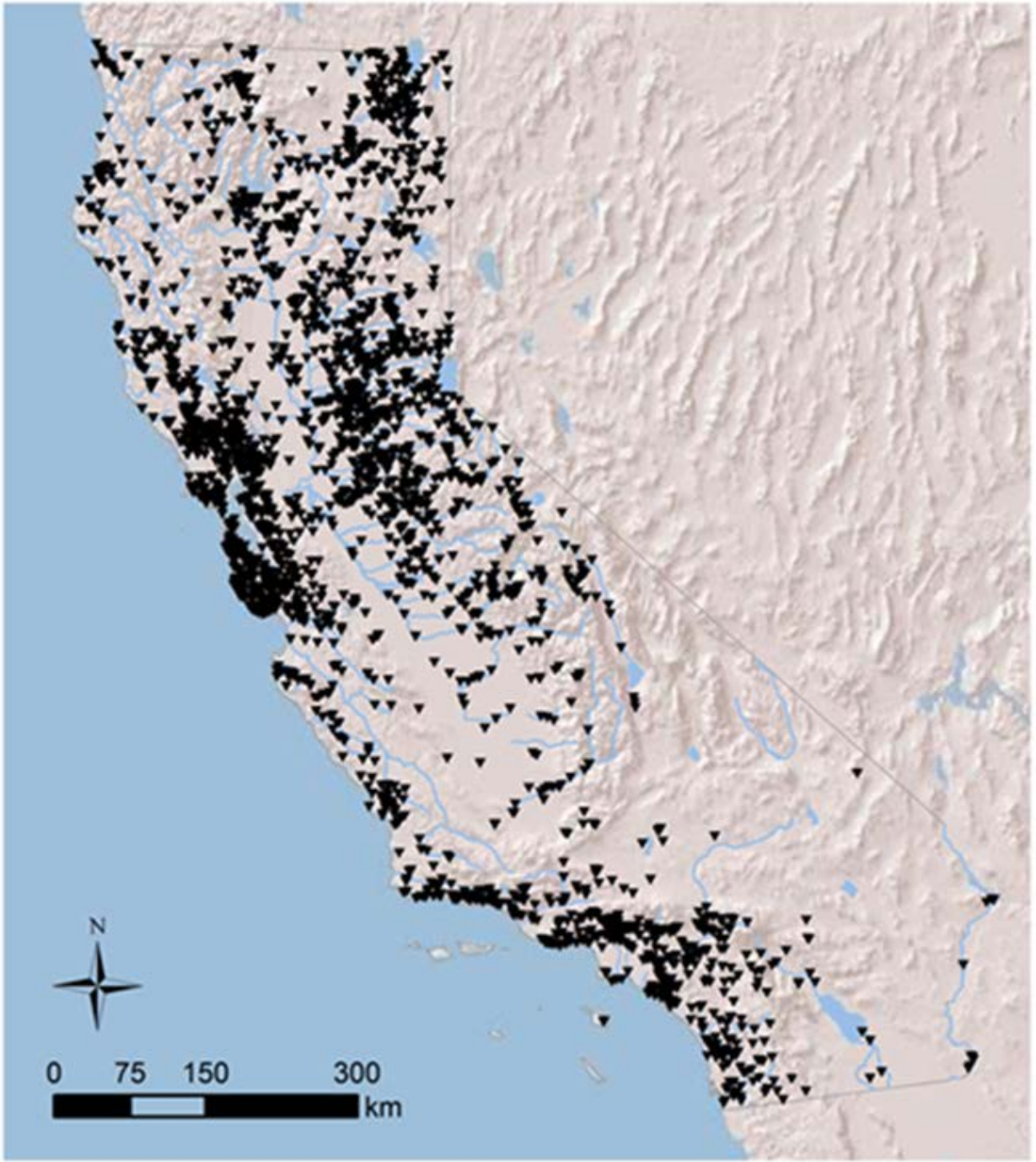
RECONCILED ECOSYSTEMS

- highly altered (novel)
- enhance native biodiversity
- contain alien species
- provide ecosystem services
- inhabited by humans

March 2007

Most (all?) streams in California are NOVEL ECOSYSTEMS

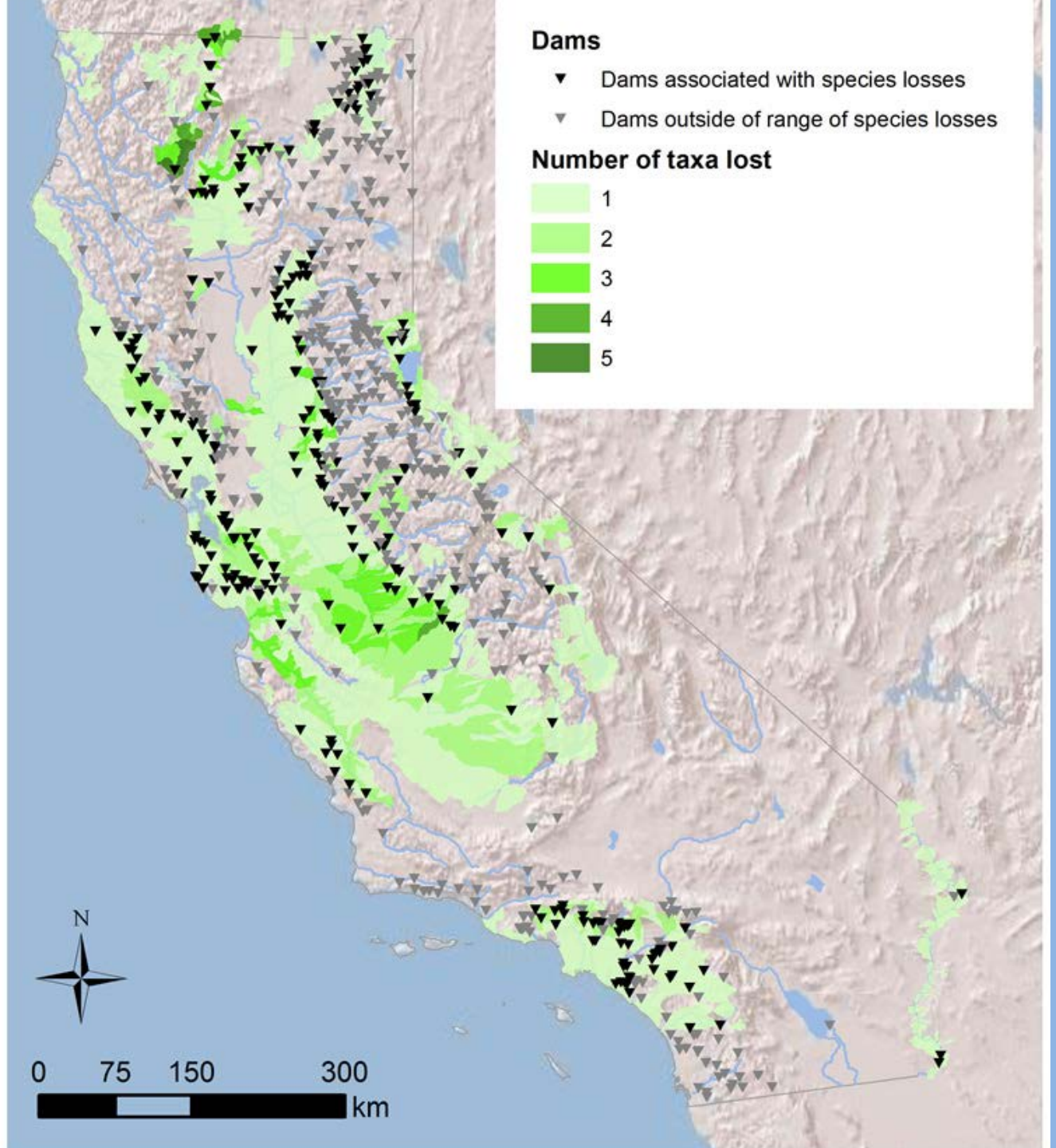
- superficial resemblance to historic ecosystems
- Irreversibly altered
  - Dams, dikes, diversions
- Native & alien species



Major dams in California

3100 registered

Grantham and Moyle in progress

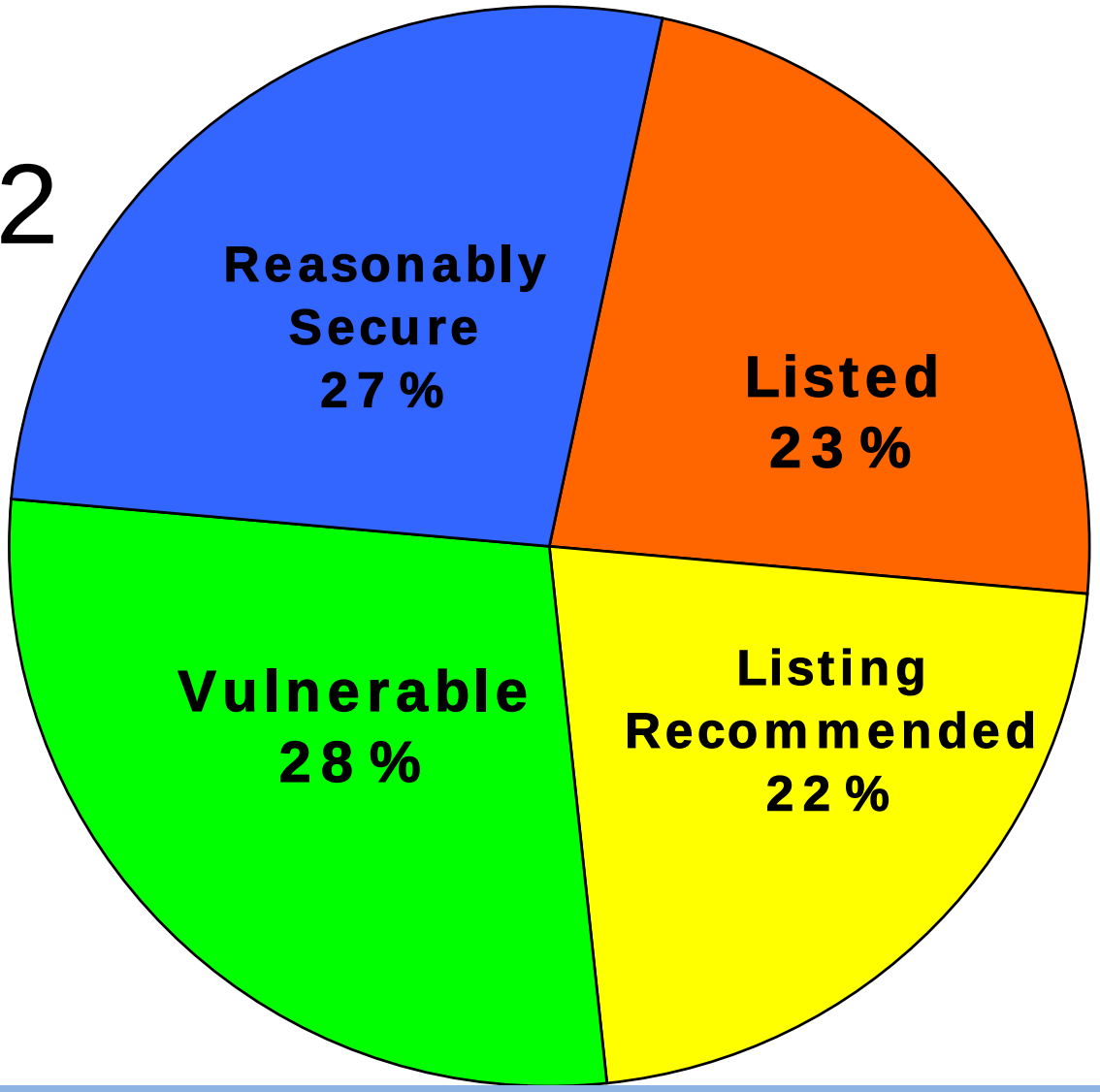


Fish species lost below major dams.

N =28 spp

73% of extant fishes in decline

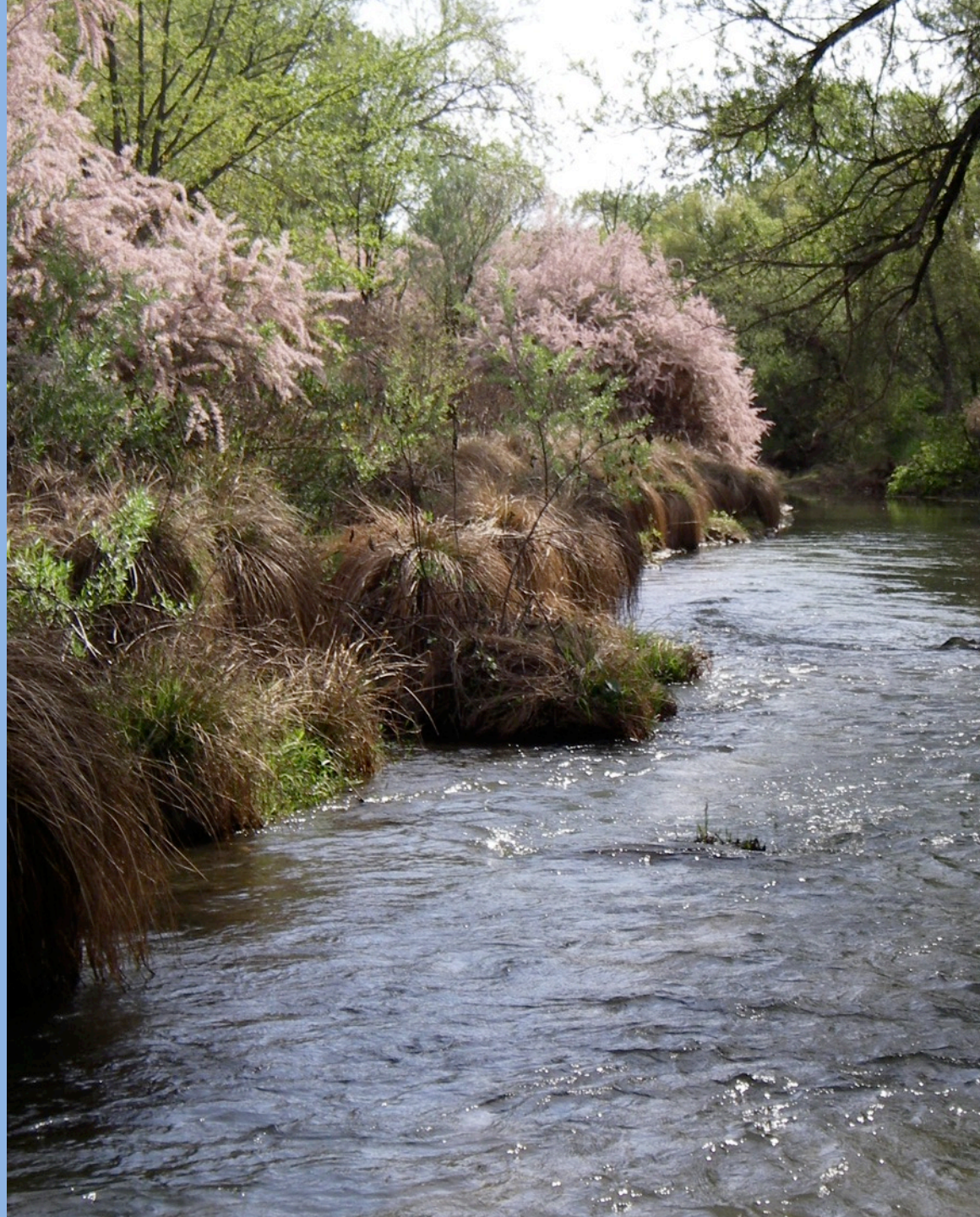
N = 122

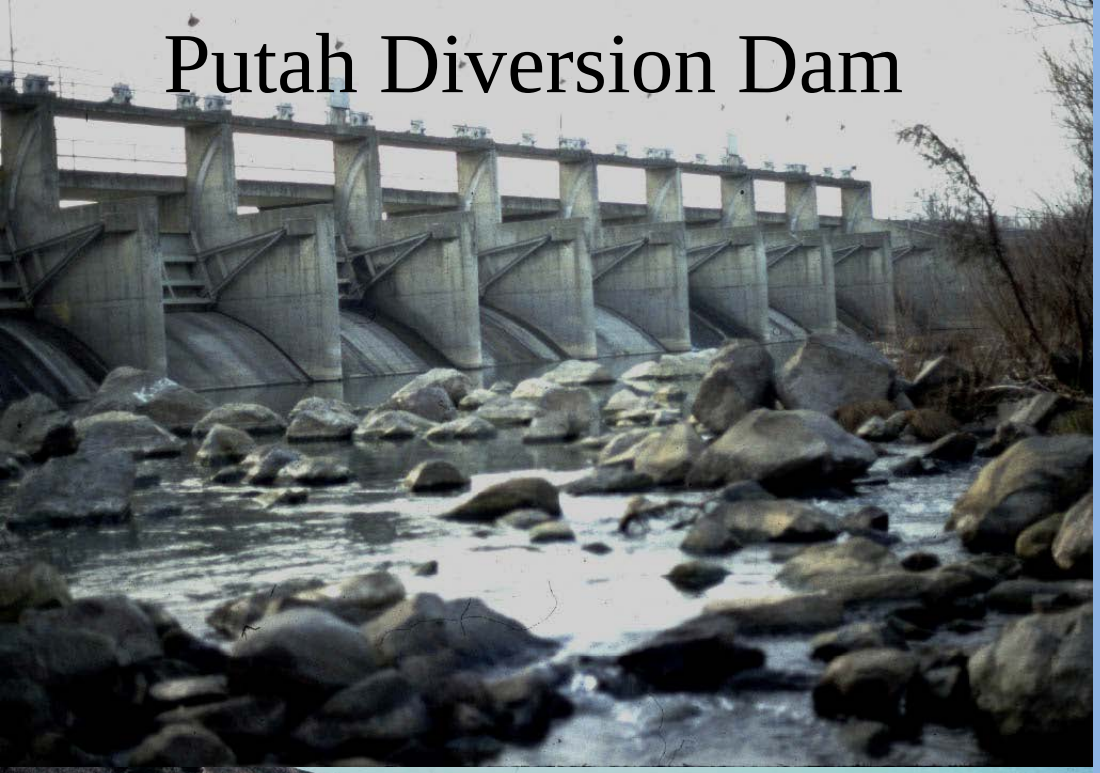


Moyle, Quinones & Katz. 2011

Alien fishes =50
Increases species richness. N = 172

PUTAH CREEK: A NOVEL , RECONCILED ECOSYSTEM





PUTAH CREEK

95% OF WATER DIVERTED

100% CHANNELIZED

IN HIGHLY DEVELOPED WATERSHED

Species group	Percent alien species
Trees (46)	35
Shrubs (39)	23
Herb. plants (198)	61
Butterflies (31)	25
Fish (35)	63
Amphibians (3)	33
Reptiles (10)	10
Birds (92 breeding)	3
Mammals (31)	11

Percent aliens of recorded species, Putah Creek, UCD

hitch

Tule perch

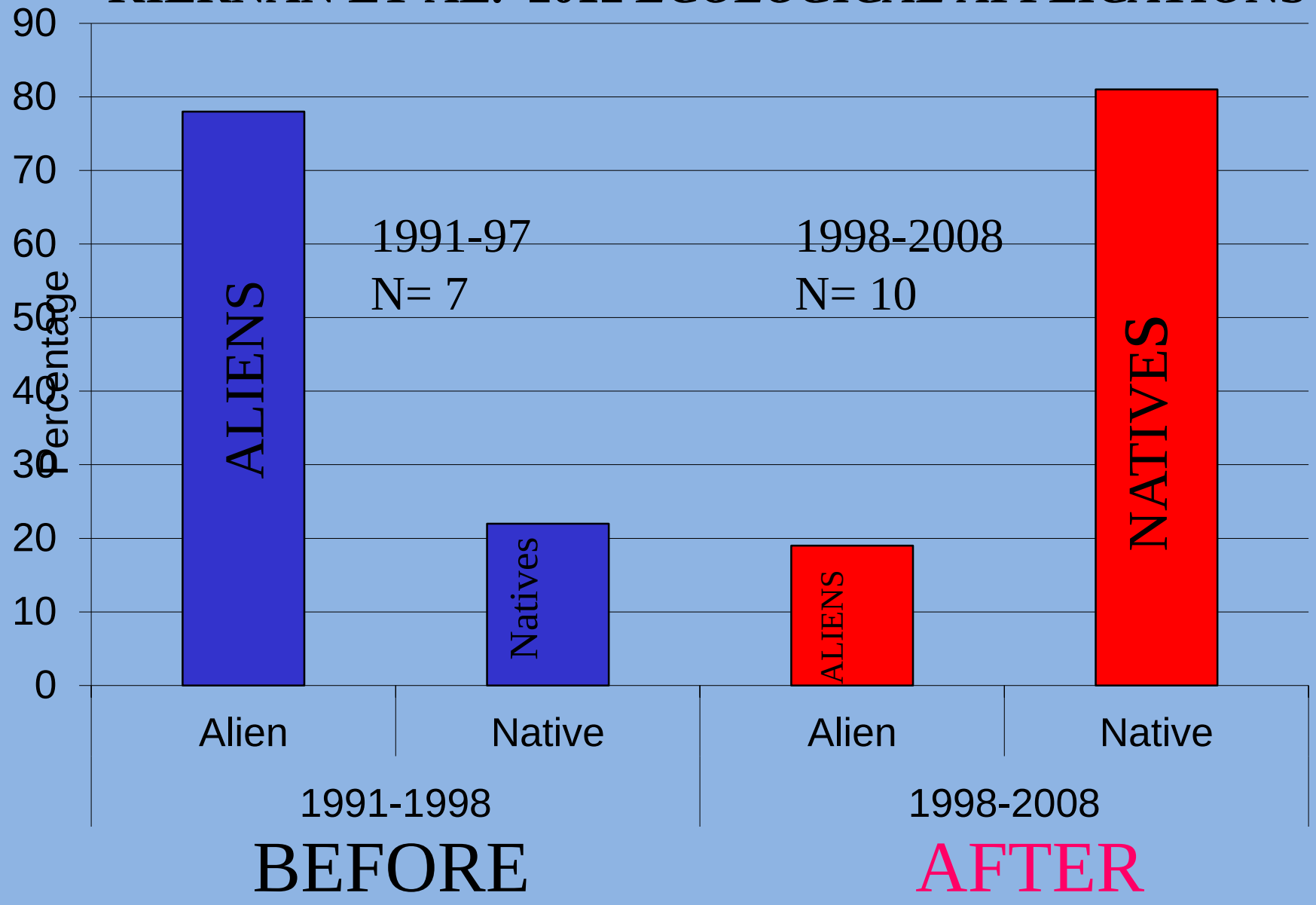
Rainbow trout

Sacramento pikeminnow

Sacramento sucker

PUTAH CREEK IS A REFUGE FOR NATIVE FISHES

RESULTS OF ADOPTING 'NATURAL' FLOW REGIME
KIERNAN ET AL. 2012 *ECOLOGICAL APPLICATIONS*



WHAT DOES IT TAKE TO MANAGE PUTAH CREEK AS A RECONCILED ECOSYSTEM?

- BOLD VISION
- Flow regime
- Water Agency Cooperation
- Stream keeper
- Community involvement
- Landowner co-operation
- MONITORING

GOALS OF MONITORING

What do we want from aquatic ecosystems?

- Native species (PUTAH)
- Fisheries
- "Healthy" ecosystem
  - Self-sustaining
  - Reconciled?
- Ecosystem services
  - Aesthetics
  - Water quality
  - Recreation

What method so we use for monitoring?
Different methods give different answers

- Intensive, quantitative = research
  - Standard for comparison
  - Putah Creek (21 yrs annual)
  - Martis Creek (30 yrs annual)
  - Suisun Marsh (32 yrs, monthly)
  - Sagehen Creek (55 yrs, intermittent)

- Extensive surveys, semi-quantitative (indices)
  - Sierra Nevada Meadows
  - Jucar River, Spain

Indices of Biotic Integrity

- Developed by J. Karr, 1980s
- Compared existing fish fauna to presumed reference fauna
- 5-12 metrics per index
- Sites scores 20-100
- Rated: Poor , marginal, fair, good ‘ integrity’

How does fish-based IBI compare to other indices as a monitoring tool?

- Developed to monitor water quality (EPA)
  - Eastern USA
  - Limited application in West
- Assumes that fish integrate many stressors
- Comparative studies
  - Sierra Nevada Meadow streams
  - Jucar River watershed, Spain

Study Regions
Sierra Nevada

167 sites

Jucar R Basin
114 sites

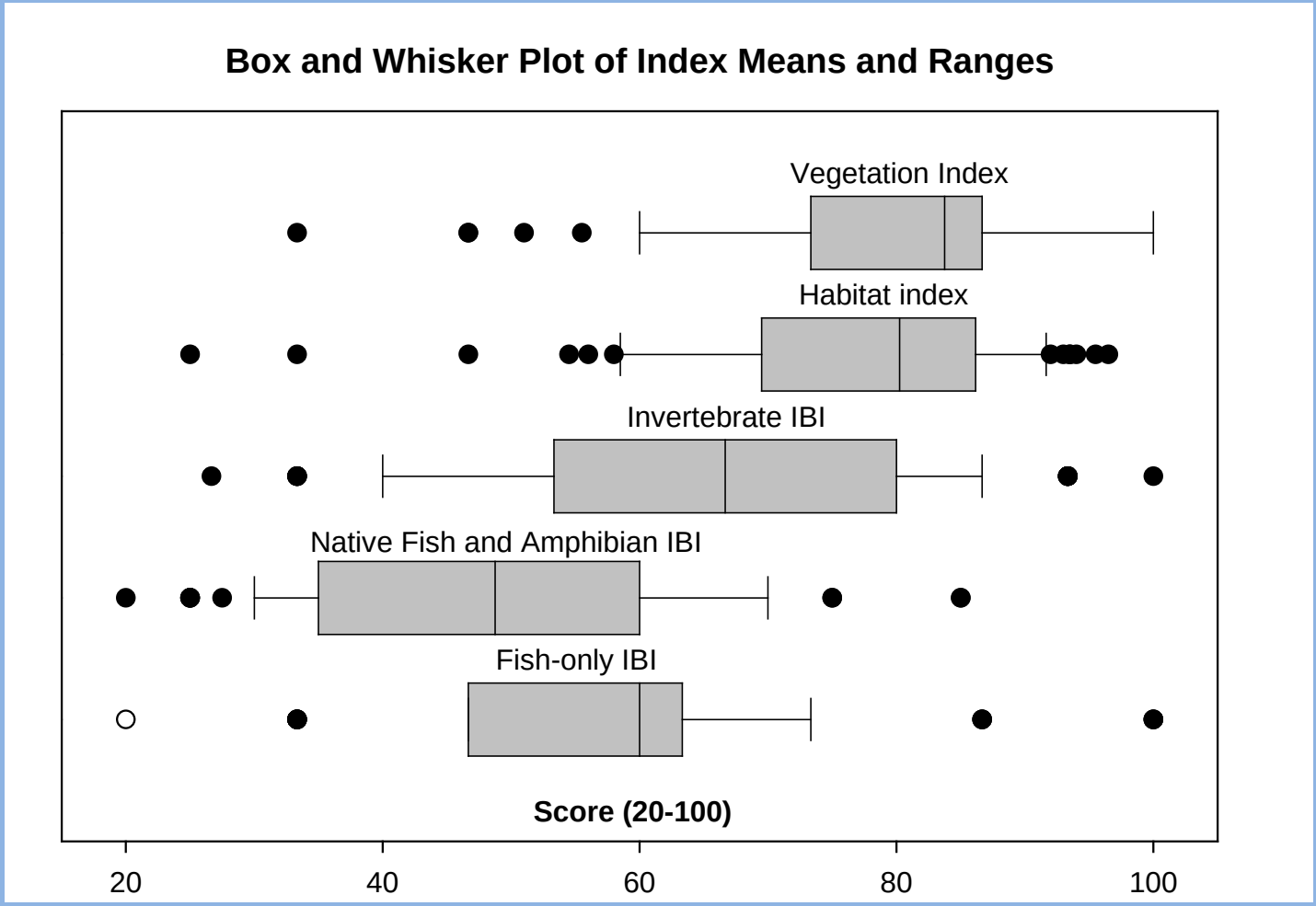
Meadow Streams: Project Goals

Develop a standardized protocol for assessing condition of meadow streams

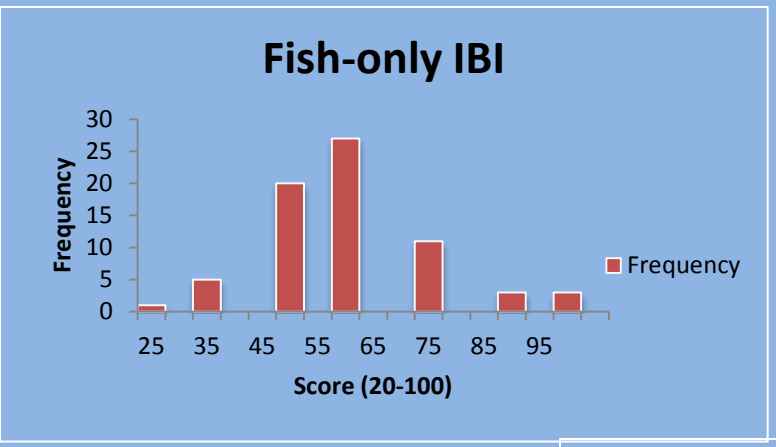
Develop and compare multiple biotic indices

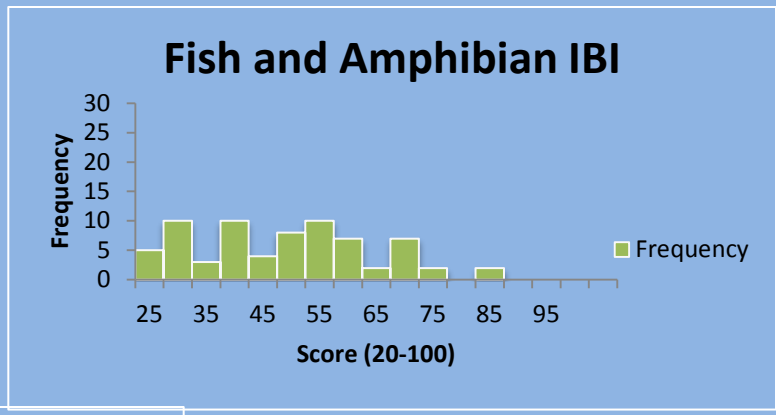
Compare indices with prior vegetation surveys and EPA habitat assessment protocols

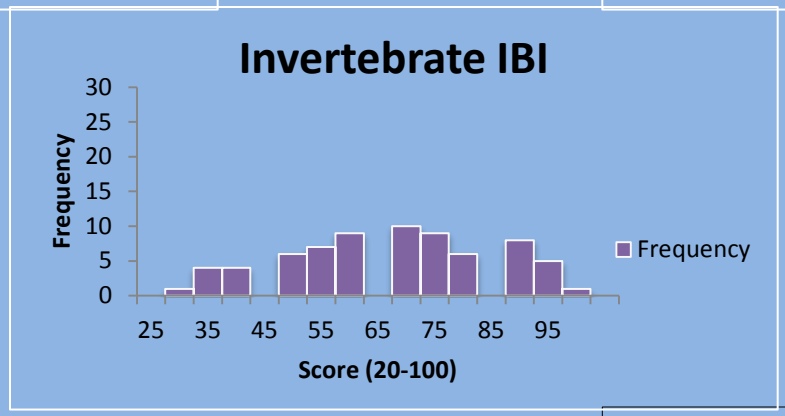
Index means and ranges

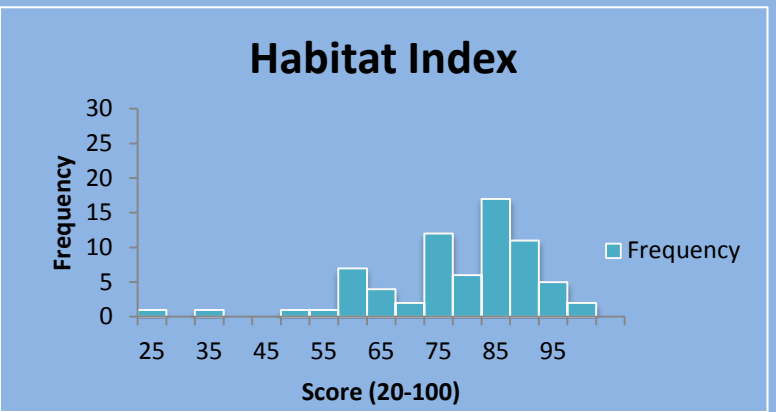


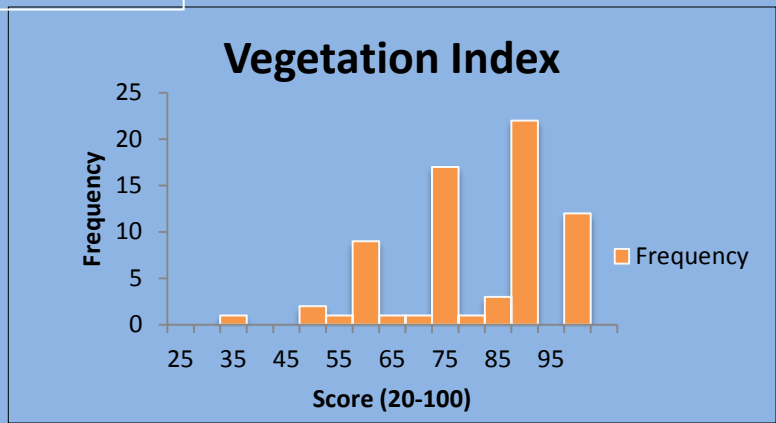
Index Frequency Distributions











Pearson Correlations between Indices

Pearson correlations	Fish-only IBI	Fish/Amphibian IBI	Invertebrate IBI	Habitat Index	Vegetation Index
Fish-only IBI	—	0.7135	-0.0249	-0.0456	-0.2123
P-value	—	0.00000	0.8518	0.7319	0.1064
Fish/Amphibian IBI	0.7135	—	-0.0253	-0.1890	-0.1503
P-value	0.0000	—	0.8494	0.1516	0.2559
Invertebrate IBI	-0.0249	-0.0253	—	0.3724	0.0790
P-value	0.8518	0.8494	—	0.0037	0.5522
Habitat Index	-0.0456	-0.1890	0.3724	—	0.5518
P-value	0.7319	0.1516	0.0037	—	0.0000
Vegetation Index	-0.2123	-0.1503	0.0790	0.5518	—
P-value	0.1064	0.2559	0.5522	0.00001	—

Willow Creek, Plumas Co.

- Fish only: 60
- Native Fish/Amphib: 48
- Invertebrate: 80
- Habitat: 82
- Vegetation: 100

Cedar Creek, Lassen Co.

- Fish only: 60
- Native Fish/Amphib: 60
- Invertebrate: 40
- Habitat: 56
- Vegetation: 47

CONCLUSIONS

MOUNTAIN MEADOW STUDY

- DIFFERENT MONITORING TECHNIQUES GIVE DIFFERENT RESULTS
- USFS VEG. SURVEYS GIVE HIGHER SCORES THAN AQUATIC SURVEYS
- MEADOWS ON PUBLIC LAND MOSTLY OK

CONCLUSIONS II

MOUNTAIN MEADOW STUDY

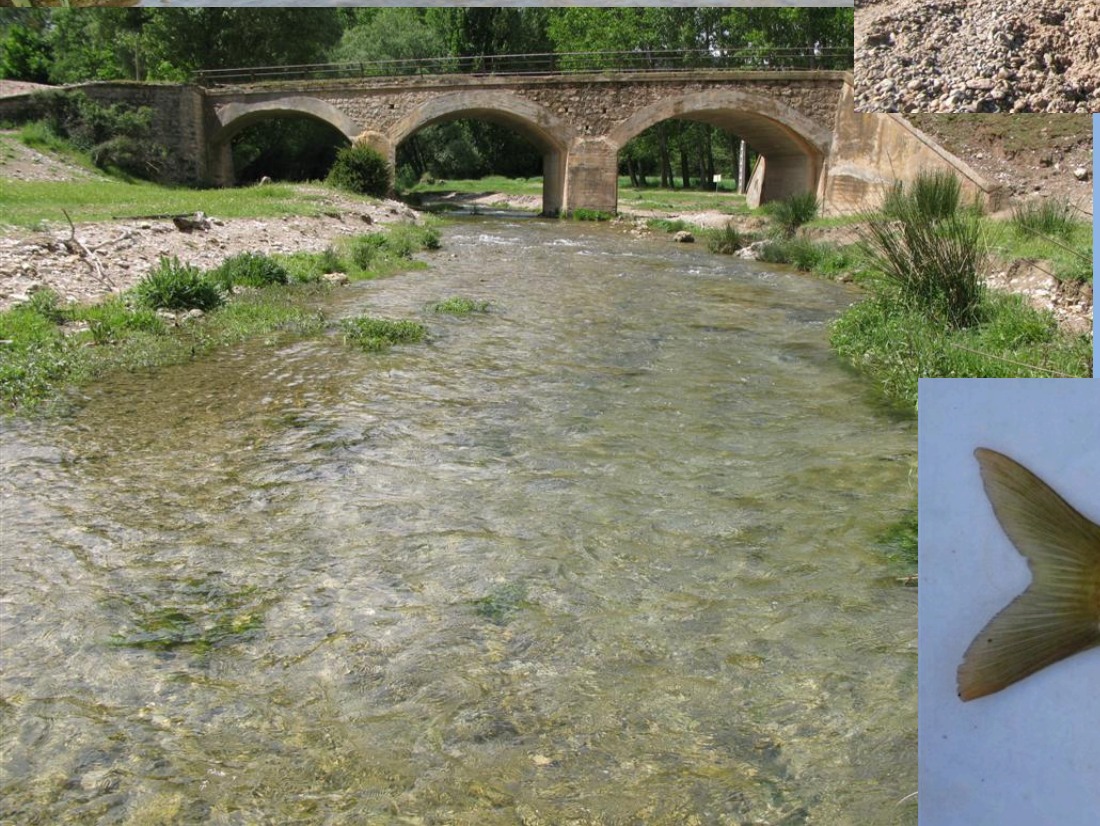
- MEADOWS NEED A RECONCILIATION APPROACH TO MANAGEMENT
  - ALIEN SPECIES
    - Trout
    - Plants
  - GRAZING
  - FOREST ENCROACHMENT
  - HUMAN USE

- PERIODIC AQUATIC MONITORING NEEDED

Purdy, S.E., P. B. Moyle, and K. W. Tate. 2012. Montane meadows in the Sierra Nevada: comparing terrestrial and aquatic assessment methods. **Environmental Monitoring and Assessment 184**: 6967-6986.

Development and evaluation of a fish-based index to assess biological integrity of Mediterranean streams.

ENRIC APARICIO, GERARD CARMONA-CATOT , PETER B. MOYLE AND EMILI GARCÍA-BERTHOU. 2010 Aquatic Conservation: Marine and Freshwater Ecosystems 21:324-337



JUCAR RIVER, CATALONIA

METRICS: JUCAR IBI

1. % FISH WITH ANOMALIES
2. SIZE (AGE) STRUCTURE OF POPULATION
3. ABUNDANCE OF NATIVE FISHES
4. # OF MISSING NATIVE SPECIES
5. % NATIVE FISHES IN CATCH

BASED ON MOYLE ET AL. 1996 “FISH IN GOOD CONDITION”

Indices compared to IBI- JUCAR

Fluvial habitat index	IHF
EPA's Rapid Bioassessment Protocols (Habitat)	HABITAT_EPA
Riparian Vegetation Quality Index	QBR
Specific Pollution Sensitivity Index (Diatom)	IPS
Diatom Biological Index	IBD
Iberian Biological Monitoring Working Party (Macroinvertebrate)	IBMWP
European Fish Index	EFI+

EUROPEAN 2 STEP FISH INDEX

STEP 1 : 12 ENVIRONMENTAL VARIABLES TO DETERMINE IF

CYPRINID STREAM

SALMONID STREAM

EUROPEAN 2 STEP FISH INDEX STEP 2

IF A CYPRINID STREAM

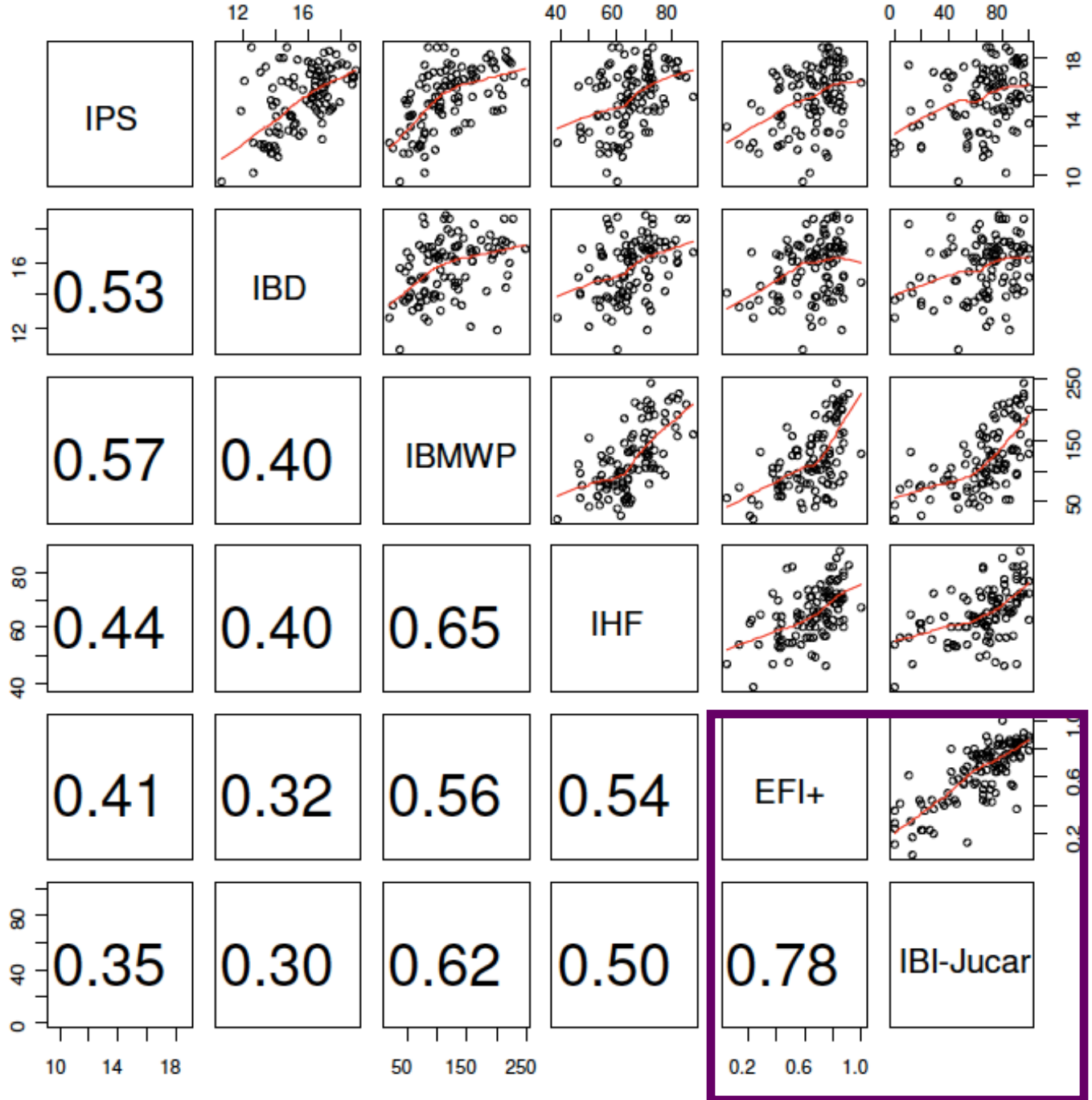
METRIC 1- NUMBER OF RHEOPHILIC SPAWNING SPECIES

METRIC 2- DENSITY OF LITHOPHILIC SPAWNING SPECIES

IF A SALMONID STREAM

METRIC 1 –DENSITY OF FISH WITH POOR TOLERANCE OF LOW DO

METRIC 2- DENSITY OF 150+ MM FISH INTOLERANT OF HABITAT DEGRADATION


IPS
IBD
IBMWP
IHF
EFI+
IBI-Jucar
0.53
0.57
0.40
0.44
0.40
0.65
0.41
0.32
0.56
0.54
0.35
0.30
0.62
0.50
0.78
12
16
40
60
80
0
40
80
10
14
18
50
150
250
0.2
0.6
1.0

EFI VS. IBI

1. HIGHLY CORRELATED
2. EFI
    1. FOR COMPARING ALL EUROPEAN STREAMS
    2. WELL TESTED (not in Spain)
    3. GENERAL MEASURE OF STREAM HEALTH

        less useful at local level
3. IBI
    1. MORE USEFUL AT LOCAL LEVEL (INDICATES WHY)
    2. ALIEN SPECIES CONSIDERED
    3. BETTER FOR COMPARING LOW-DIVERSITY STREAMS

JUCAR: CONCLUSIONS

- MOST AQUATIC INDICES HIGHLY CORRELATED
    - Reflects long history of human use
- DIFFERENT SENSITIVITIES

OVERALL CONCLUSIONS

1. **DON'T RELY ON ONE METHOD**
   Fish+ bugs + habitat best

2. **USE METHODS THAT ANSWER YOUR QUESTIONS**

3. **THINK IN TERMS OF RECONCILIATION ECOLOGY**


THANK YOU