# Fish Assemblage Sampling Considerations

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# Outline

- Why include fish as a core indicator in rivers?
- Fish sampling considerations
- How are fish data converted to assessments?

# Why Include Fish (1)?

- Stable if environment is stable
- Recover rapidly from droughts & floods
- Purely aquatic & many are continuous residents (monitors)
- Occur in nearly all rivers
- Taxonomy is reasonably well-known to species
- Relatively easy to identify in field

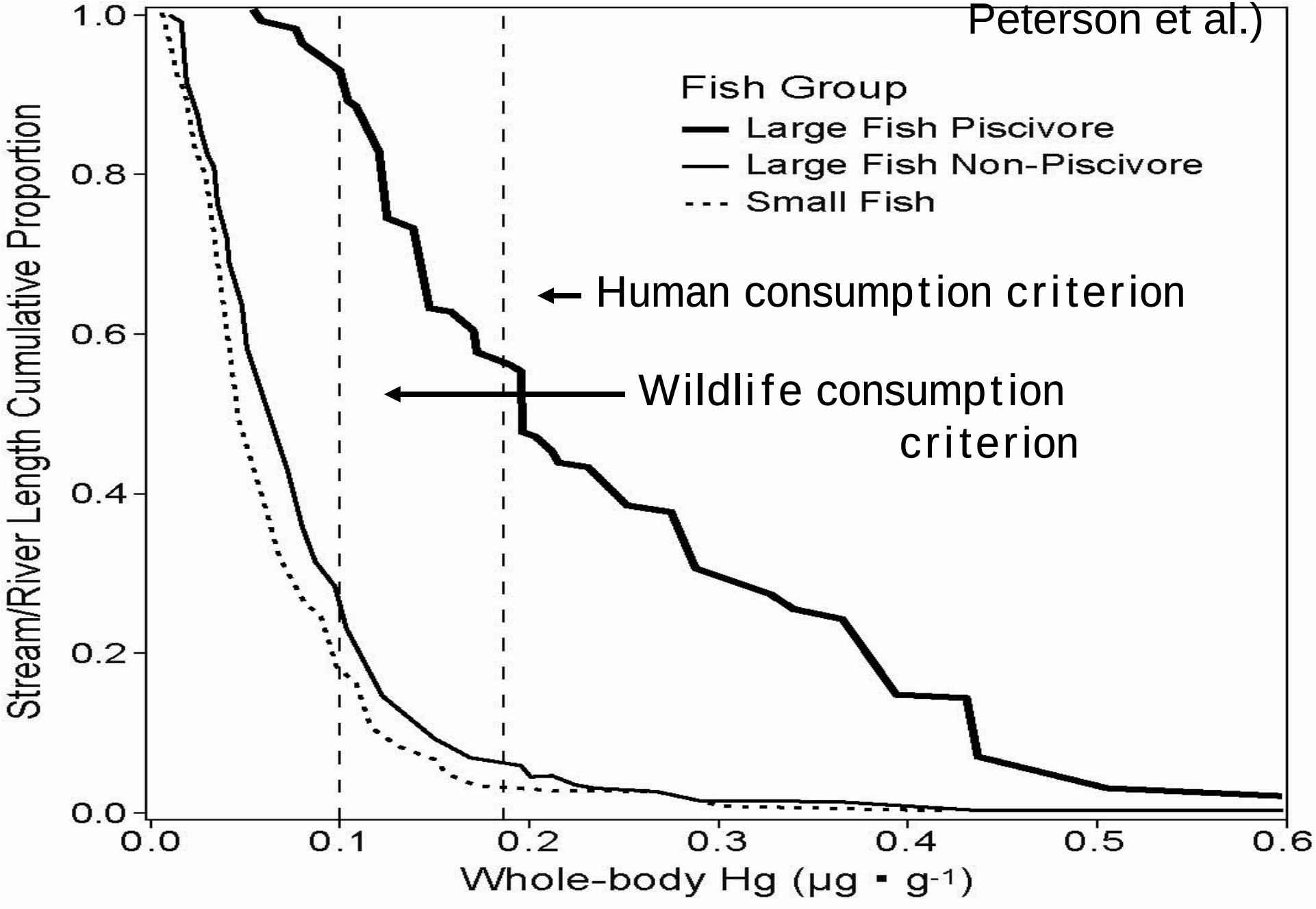
# Why Include Fish (2)?

- Many are long-lived (reflect long-term & current conditions)
- Many have large ranges (reflect regional & macrohabitat conditions)
- Biology reasonably well-known (multiple tolerance, life history, trophic, habitat, and reproduction guilds)
- Integrate lower trophic levels
- Bioaccumulate toxic chemicals
- Have experienced precipitous declines

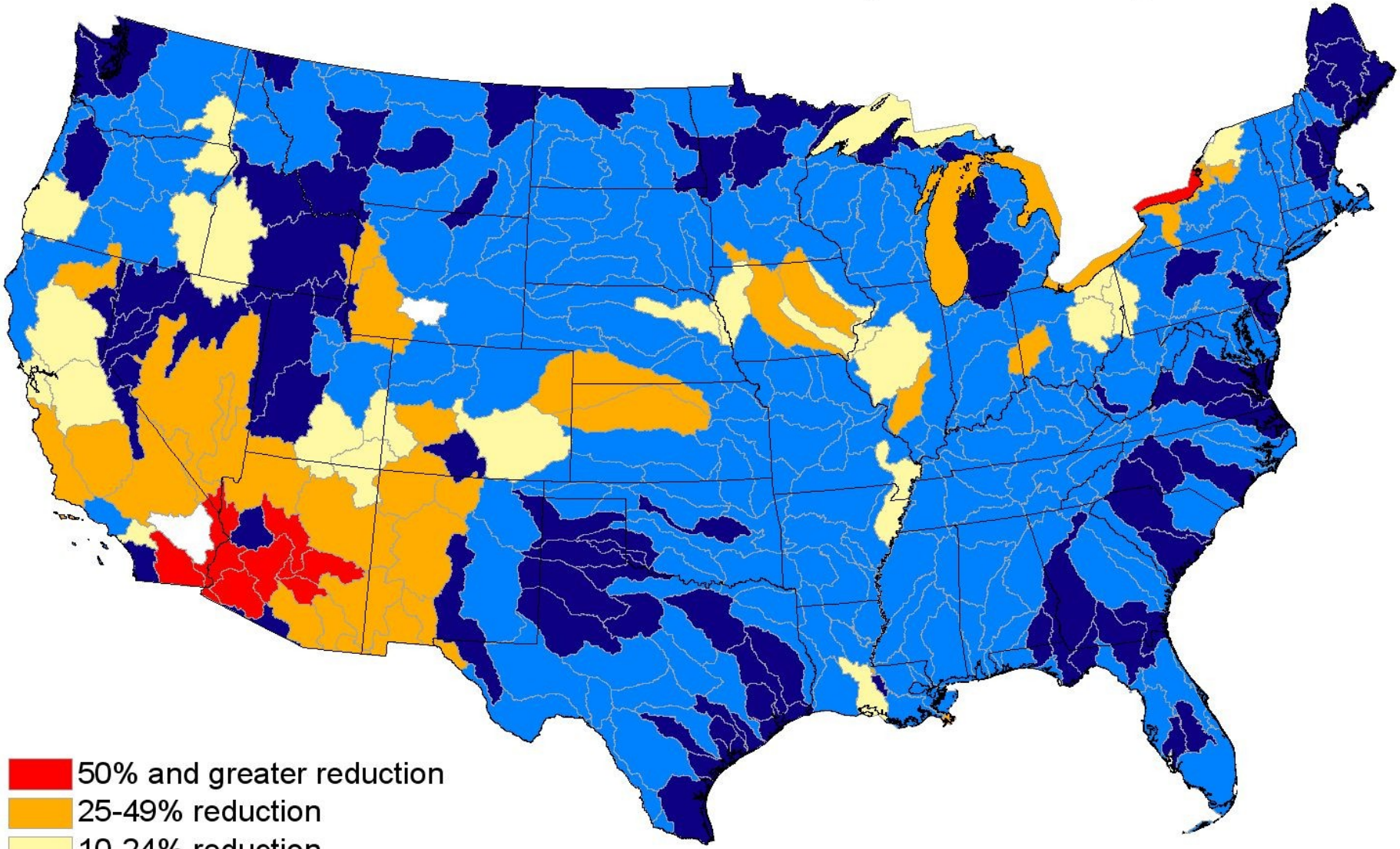
(from Aadland
et al. 2005; 184 kg)

(from Maret & Mebane
2005; 286 kg)

# Mercury Concentrations in Western USA Fish (from Peterson et al.)



# % Reduction in Native Fish Fauna Diversity Within a 6-digit HUC



50% and greater reduction
25-49% reduction
10-24% reduction
1-9% reduction
0% reduction
Fishless

NOTE: Current species numbers are based on a count of species that have at least one "current" record for that species within any 8-digit HUC within the 6-digit HUC

100 0 100 200 300 Miles

NatureServe
A Network Connecting Science With Conservation

Map Created 3/2005

# Causes of Endangerment (from Kelly Reed)

| Rank | Cause of Endangerment | # Species | % Listed Fish |
|---|---|---|---|
| 1. | Water Diversions | 111 | 98% |
| 2a. | Invasive/Alien Species | 56 | 49% |
| 2b. | Pollution | 56 | 49% |
| 4. | Agriculture | 47 | 41% |
| 5. | Urbanization | 26 | 23% |
| 6. | Mining, Drilling | 24 | 21% |
| 7. | Logging & Silviculture | 17 | 15% |

# Why Include Fish (3)?

- Of great concern to citizens (food, sport, fish kills)
- Considerable economic value
- Basis for many State use designations
- Subjects of 8 professional journals in USA
- Focus of 3 professional societies in USA
- May stimulate interagency collaboration

CLUB
SPORTS

# State Agencies Assessing Fish Assemblages

AL, AR, AZ, CA, CO, FL, ID, IA, KS, KY, MD, MI, MO, NC, ND, NE, NV, OH, OK, OR, PA, TX, NY, VT, WI, WV

# Sampling Considerations (1): What to Avoid

- Biomarkers
- Genetic diversity
- Biomass
- Absolute abundance
- Production
- Subspecies

# Sampling Considerations (2): What to Sample

- Representative sample of entire fish assemblage
- Species & their abundances
- Species size ranges
- Anomalies (disease, deformities, eroded fins, lesions, tumors)

# VERTEBRATE COLLECTION FORM - STREAMS / RIVERS

Reviewed by (Initials): SP

SITE ID: WXXP99-9999 DATE: 07/05/2003 PAGE: 1 of 1

○ NOT FISHED NO PERMIT ○ NOT FISHED OTHER ○ FISHED NONE COLLECTED ○ FISHED ALL 10 SUBREACHES ● FISHED 5-9 SUBREACHES ○ FISHED <5 SUBREACHES

F3 FLAG for Fished/Not Fished

Vertebrate Sample ID 99502 Total Shock (button) Time (s) 2250 Total Fishing Time (min) 80 Sample Distance (m) 150

Gear: ● bp ○ bank/tow ○ boat ○ seine length (m) ____, mesh (mm) ____; length (m) ____, mesh (mm) ____

Water Visibility: ● Good ○ Poor Water Temp.(C) 16 Cond (uS) 220

Anodes: Number 1 Diameters 11 ● in. ○ cm Wave Form: ○ AC ○ DC ● Pulsed DC

FLAG for other Sampling Information

Volts: (50-1000) 700 Watts: likely 400 (bp), 2500 or 5000 (raft) 400 Pulse Rate: pps or Hz 60 Amps: (may not provided for bp) 2 Pulse Width (ms) (not available for raft) 6

| Tag No. | Common Name | Tally | Total Count | Vouch. Count | LENGTH (mm) * Minimum | Maximum | Anom. Count | Mortality Count | Flag | Subreaches |
|---|---|---|---|---|---|---|---|---|---|---|
| 01 | MOTTLED SCULPIN | 卌 卌 卌 卌 卌 卌 卌 卌 \|\| | 37 | 20 | 70 | 95 | 0 | 0 | | ●A ○C ○E ○G ○I ○B ●D ●F ○H ○J |
| 02 | CUTTHROAT TROUT | 卌 卌 卌 \|\|\| | 18 | 3 | 60 | 200 | 0 | 0 | | ●A ●C ●E ●G ●I ●B ●D ●F ●H ○J |
| 03 | SPECKLED DACE | 卌 \|\|\| | 8 | 8 | 60 | 70 | 0 | 0 | | ○A ●C ●E ○G ○I ●B ●D ●F ○H ○J |
| 04 | UNKNOWN SUCKER 1 | \|\|\| | 3 | 3 | 40 | 40 | 1 | 3 | F1 | ○A ●C ○E ○G ○I ○B ○D ○F ○H ○J |
| 05 | UNKNOWN SUCKER 2 | 卌 卌 \|\| | 12 | 12 | 45 | 50 | 0 | 1 | | ○A ●C ●E ○G ○I ○B ○D ●F ○H ○J |
| 06 | TAILED FROG | 卌 | 5 | 2 | 40 | 55 | 0 | 0 | | ○A ○C ●E ○G ○I ○B ●D ○F ○H ○J |
| 07 | UNKNOWN CRAYFISH | 卌 卌 \|\| | 12 | 5 | | | | | | ○A ○C ○E ●G ○I ○B ○D ●F ●H ○J |
| 08 | UNKNOWN LAMPREY | \| | 1 | 1 | 50 | | 0 | 0 | | ○A ○C ○E ●G ○I ○B ○D ○F ○H ○J |
| 09 | TUI CHUB | \|\| | 2 | 1 | 80 | 90 | 0 | 0 | F2 | ○A ○C ○E ○G ○I ○B ○D ○F ●H ○J |
| 10 | NORTHERN PIKE MINNOW | 卌 卌 \|\|\| | 13 | 5 | 90 | 190 | 1 | 2 | | ○A ○C ○E ○G ●I ○B ○D ○F ●H ○J |
| 11 | MOTTLED SCULPIN | 卌 \|\| | 7 | 2 | 40 | 75 | 0 | 0 | | ○A ○C ○E ○G ●I ○B ○D ○F ●H ○J |
| 12 | UNKNOWN CRAYFISH | \|\| | 2 | 2 | | | | | | ○A ○C ○E ○G ●I ○B ○D ○F ○H ○J |

| Flag | Comment |
|---|---|
| F1 | POSSIBLE MINNOW |
| F2 | PHOTOGRAPHED AND RELEASED |
| F3 | DID NOT FISH SUBREACH J - IT WAS DRY. |

40231

Flag codes: K = No measurement made, U = Suspect measurement., F1,F2, etc. = flags assigned by each field crew. Explain all flags in commentx. LENGTH* - Enter single fish as minimum.

Reviewed by (Initials): ZP

# VERTEBRATE COLLECTION FORM - STREAMS / RIVERS (continued)

SITE ID: WXP99-9999 DATE: 07/04/2002 PAGE: 1 of 1

| Tag No. | Common Name | Tally | Total Count | Vouch. Count | LENGTH (mm) * Minimum | Maximum | Anom. Count | Mortality Count | Flag | Subreaches |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | ○ A ○ C ○ E ○ G ○ I ○ B ○ D ○ F ○ H ○ J |
| | | | | | | | | | | ○ A ○ C ○ E ○ G ○ I ○ B ○ D ○ F ○ H ○ J |
| | | | | | | | | | | ○ A ○ C ○ E ○ G ○ I ○ B ○ D ○ F ○ H ○ J |
| | | | | | | | | | | ○ A ○ C ○ E ○ G ○ I ○ B ○ D ○ F ○ H ○ J |
| | | | | | | | | | | ○ A ○ C ○ E ○ G ○ I ○ B ○ D ○ F ○ H ○ J |
| | | | | | | | | | | ○ A ○ C ○ E ○ G ○ I ○ B ○ D ○ F ○ H ○ J |
| | | | | | | | | | | ○ A ○ C ○ E ○ G ○ I ○ B ○ D ○ F ○ H ○ J |
| | | | | | | | | | | ○ A ○ C ○ E ○ G ○ I ○ B ○ D ○ F ○ H ○ J |
| | | | | | | | | | | ○ A ○ C ○ E ○ G ○ I ○ B ○ D ○ F ○ H ○ J |

## FISH TISSUE SAMPLES

Flag if too few collected

| Sample ID | Common Name | Total Length (mm) | Number of Small | Sample Type | Sample ID | Common Name | Total Length (mm) | Number of Small | Sample Type |
|---|---|---|---|---|---|---|---|---|---|
| 229001 | LARGEMOUTH BASS | 200 | | ● Big ○ Small | 229006 | NORTHERN PIKEMINNOW | 350 | | ● Big ○ Small |
| 229002 | LARGEMOUTH BASS | 310 | | ● Big ○ Small | 229007 | LARGEMOUTH BASS | 400 | | ● Big ○ Small |
| 229003 | NORTHERN PIKEMINNOW | 130 | | ● Big ○ Small | 229008 | RAINBOW TROUT | 300 | | ● Big ○ Small |
| 229004 | NORTHERN PIKEMINNOW | 270 | | ● Big ○ Small | 229009 | RAINBOW TROUT | 150 | | ● Big ○ Small |
| 229005 | RAINBOW TROUT | 200 | | ● Big ○ Small | 229010 | SPECKLED DACE | | 40 | ○ Big ● Small |

| Flag | Comment |
|---|---|
| | |
| | |
| | |

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Flag codes: K = No measurement made, U = Suspect measurement., F1,F2, etc. = misc. flags assigned by each field crew. Explain all flags in comment section.

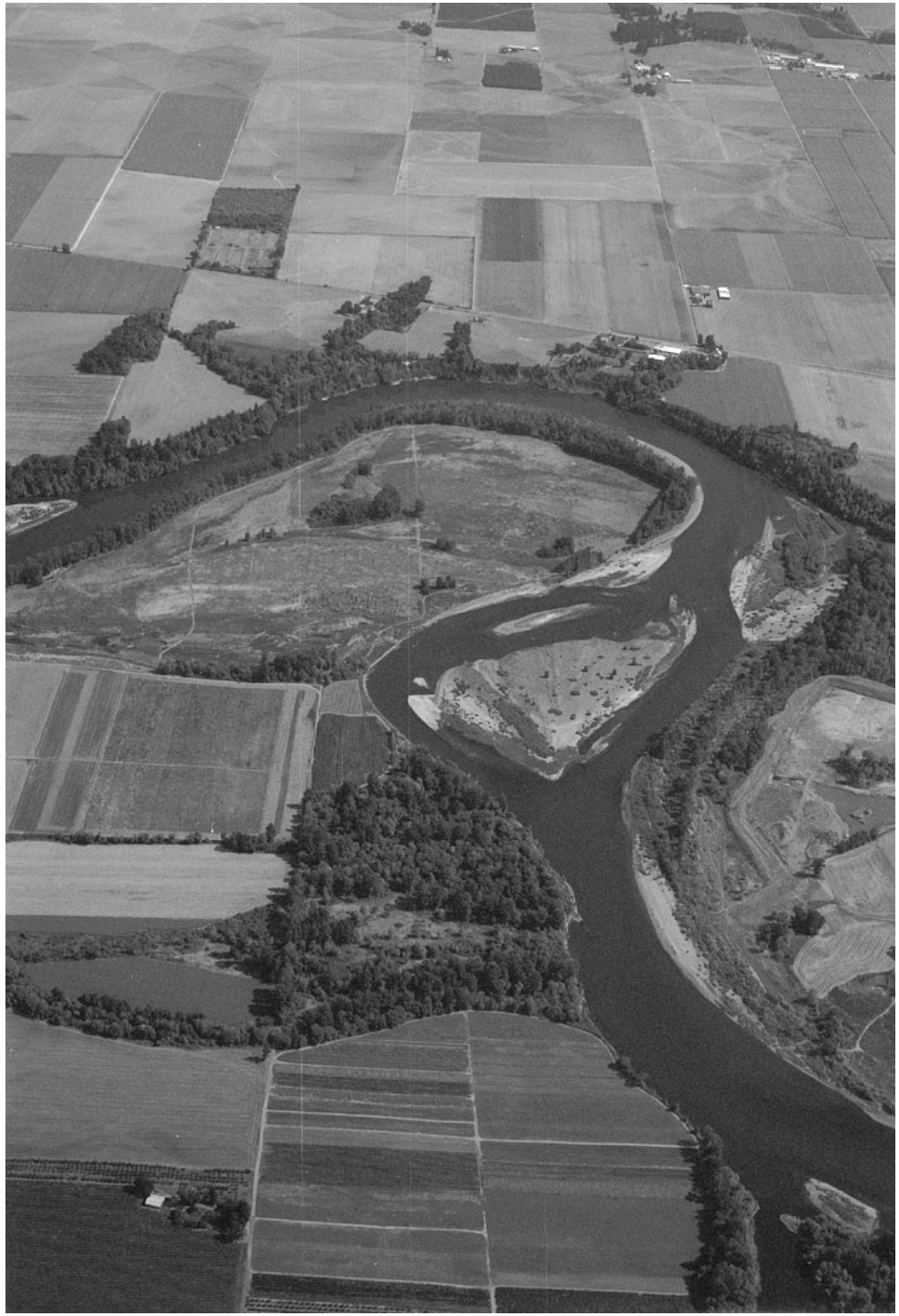
# Sampling Considerations (3): Issues

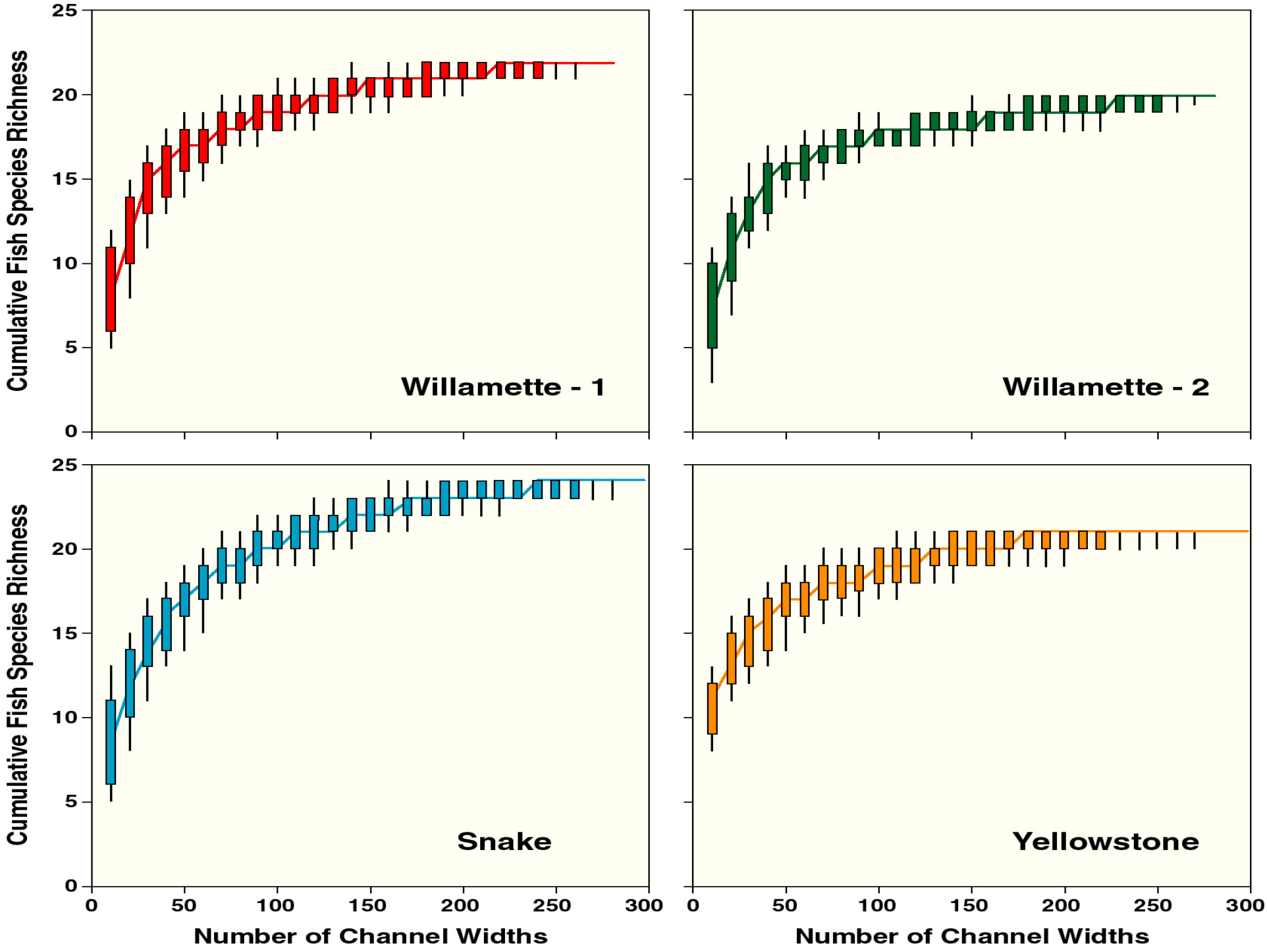
- Off-channel habitats (sloughs, lakes, tributaries, wetlands)
- Saline/brackish estuaries
- Tidal reaches
- Run of river reservoirs
- Mid-channels vs. nearshore
- Day vs. night

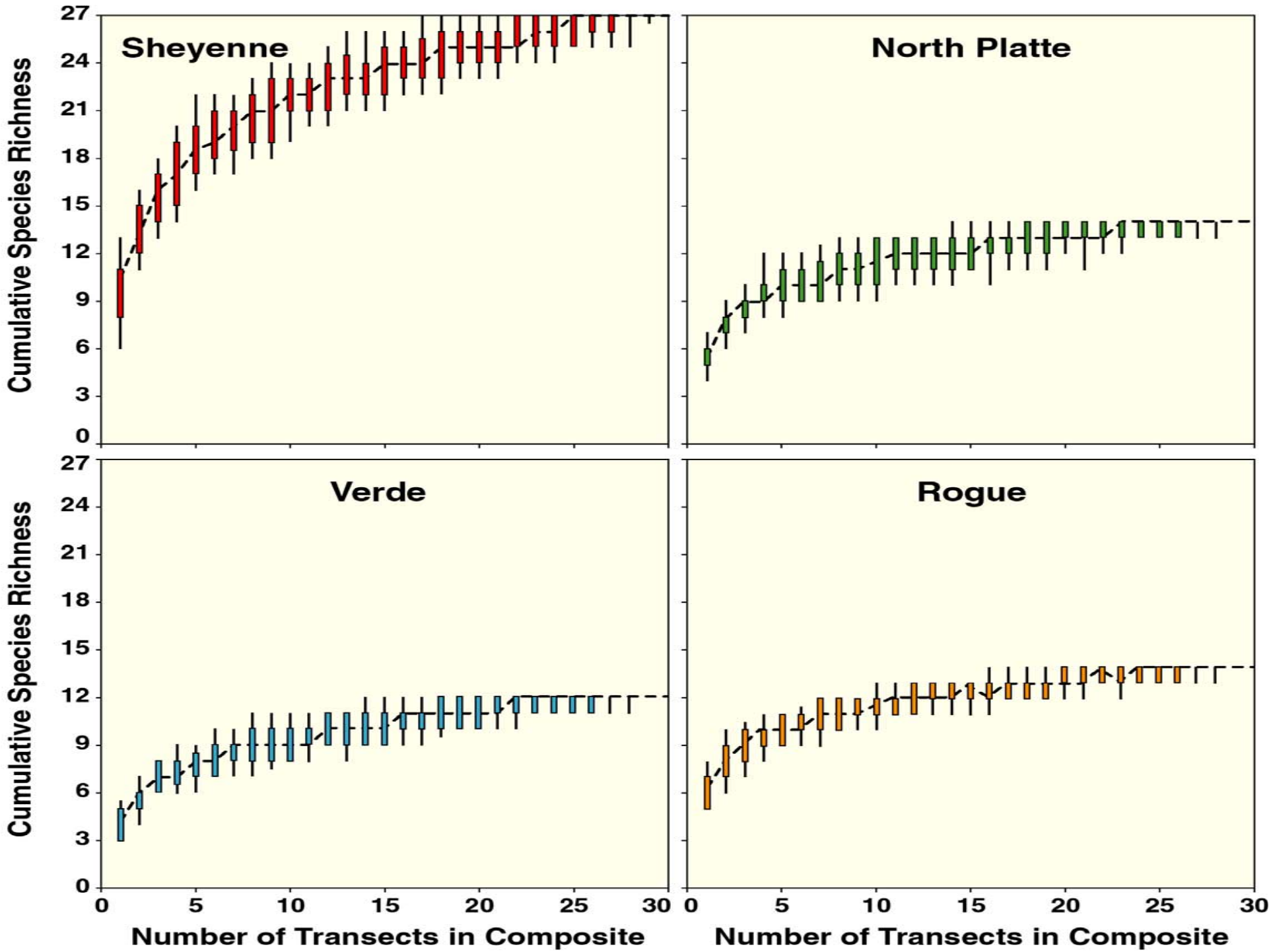
# Sampling Considerations (4): More Issues

- Collection permits
- Museum vouchers
- Tissue samples
- Gear (passive, active)
- Platform (boats, rafts)
- Reach length (effort)
- Logistics (access, egress, barriers)

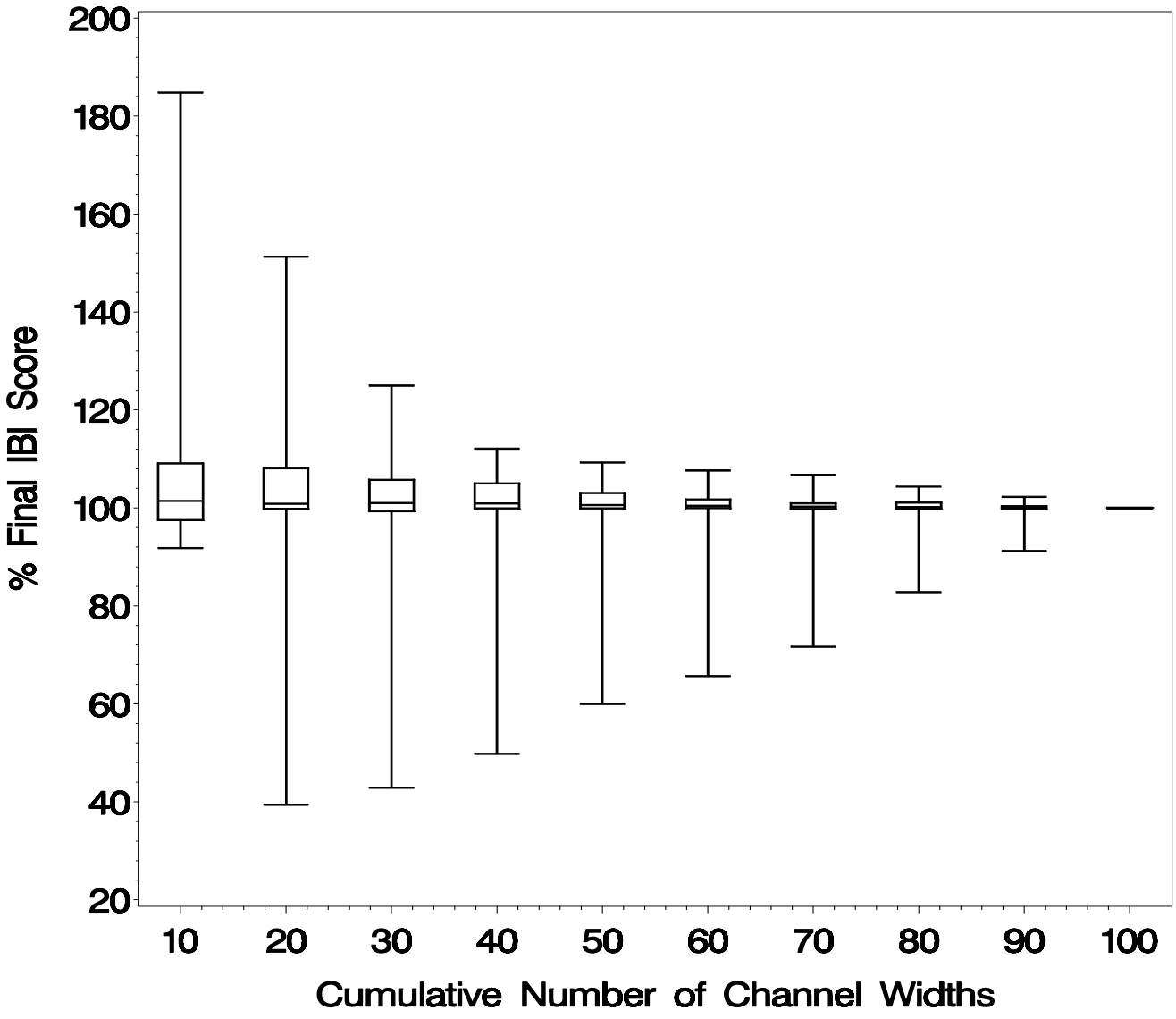
MARAVIA




Cumulative Fish Species Richness
Number of Channel Widths
Willamette - 1
Willamette - 2
Snake
Yellowstone
0
5
10
15
20
25
0
50
100
150
200
250
300


Sheyenne
North Platte
Verde
Rogue
Cumulative Species Richness
Cumulative Species Richness
0
3
6
9
12
15
18
21
24
27
0
5
10
15
20
25
30
Number of Transects in Composite
Number of Transects in Composite

# Estimating Adequate Electrofishing Distance for IBI Calculation (from Hughes & Herlihy 2007)



# How are Data Converted to an Assessment: What is a Fish IBI (1)?

- Quantitative assessment
- Of the ecological quality
- Of an entire fish assemblage
- Based on ichthyological judgement
- Using multiple metrics (variables)
- That are rigorously evaluated (range, responsiveness, signal/noise, & redundancy for each metric class)
- Yielding a single number sensitive to multiple stressors & disturbances

# Fish IBI (2) Metric Classes

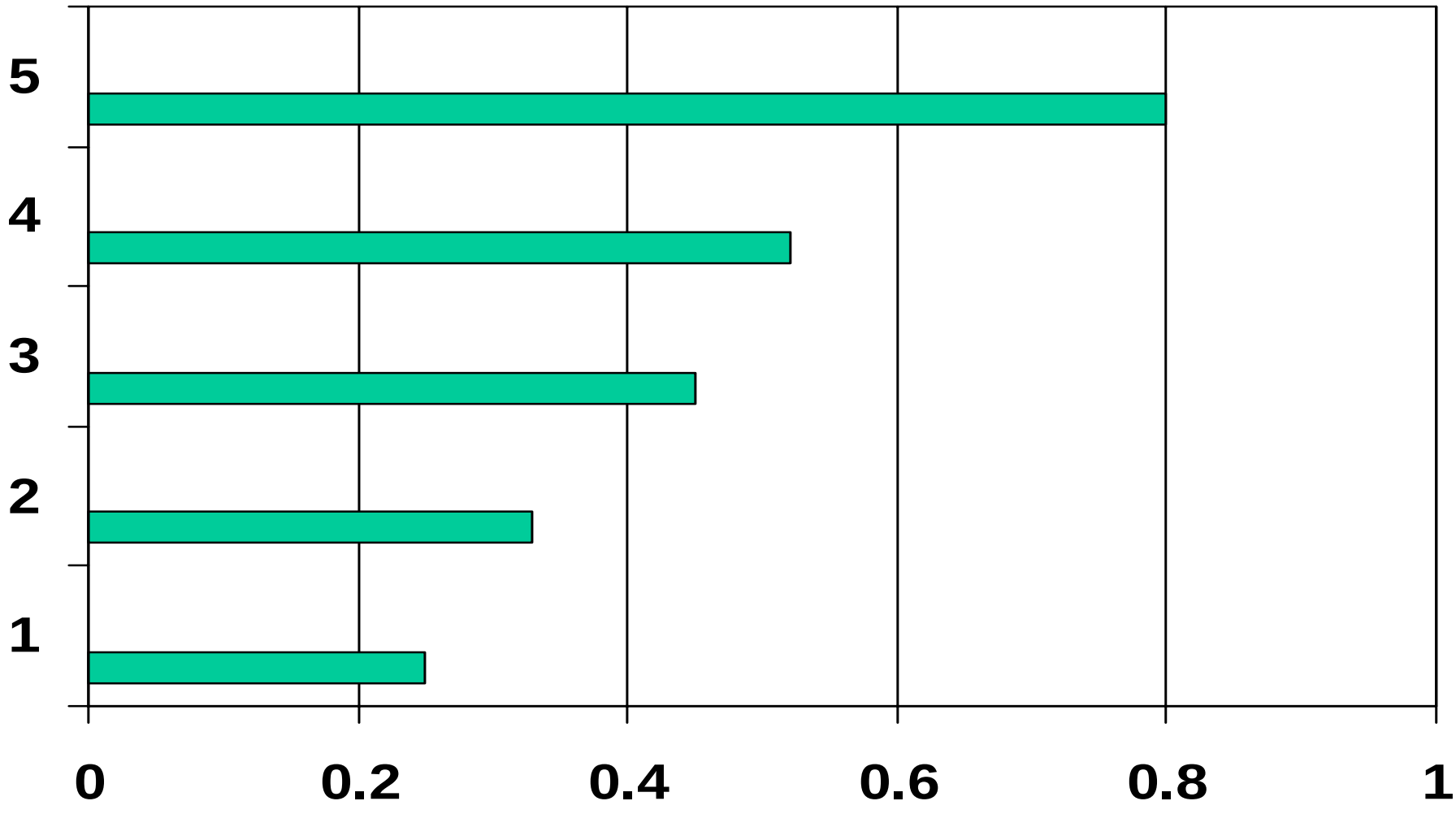
- Taxonomic richness
- Species composition
- Trophic guilds
- Habitat guilds
- Reproduction guilds
- General tolerance
- Life history
- Size, life span
- Abundance
- Aliens
- DELTS

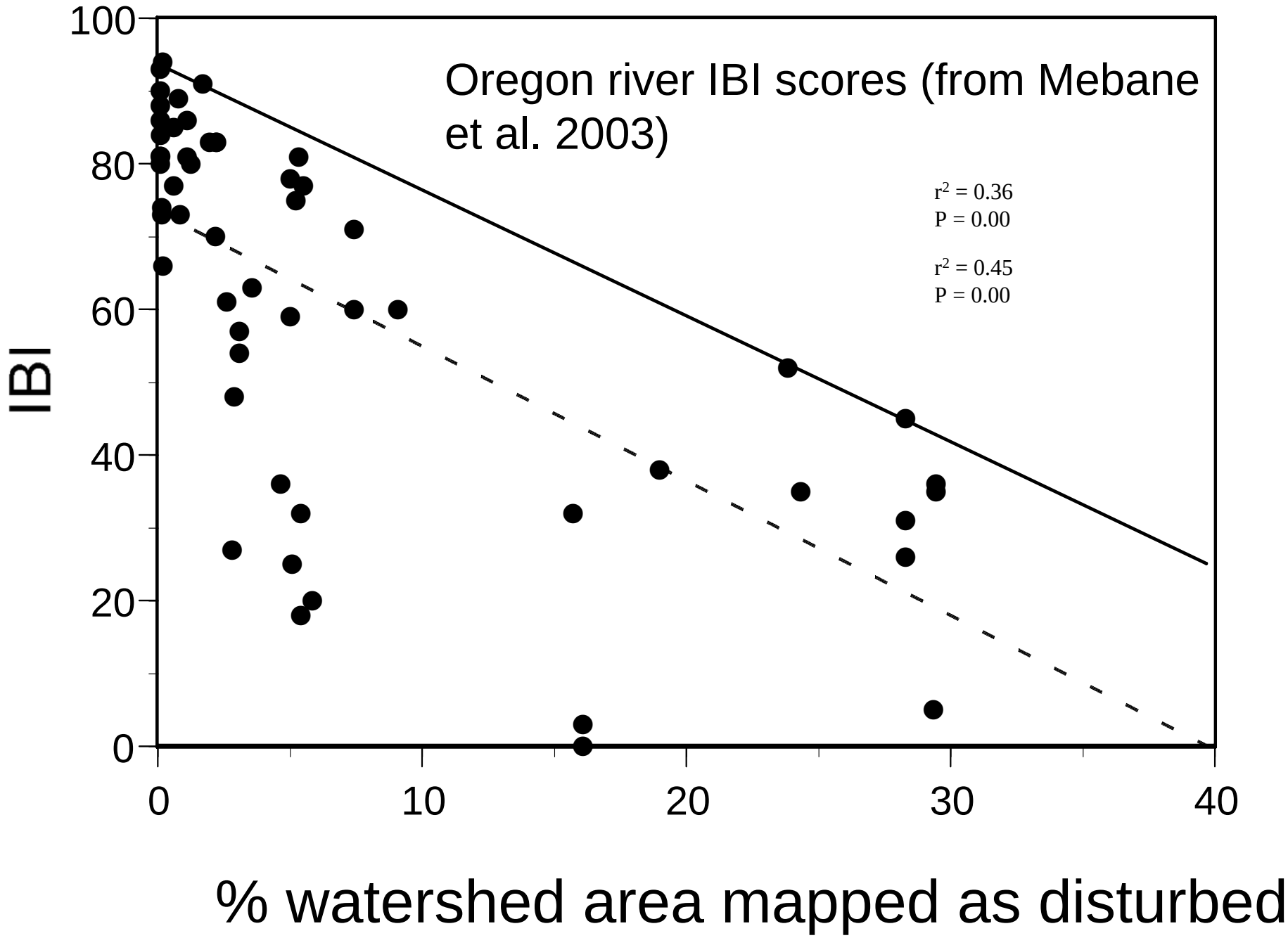
# Fish IBI (3): Metric Assumptions

- Intolerants (-)
- Maximum sizes & size classes (-)
- Specialists (-)
- Anadromy & potamodromy (-)
- Native species (-)
- Abundance (-)
- Cosmopolitans (+)
- Generalists (+)
- Tolerants (+)
- Aliens (+)
- DELTS (+)

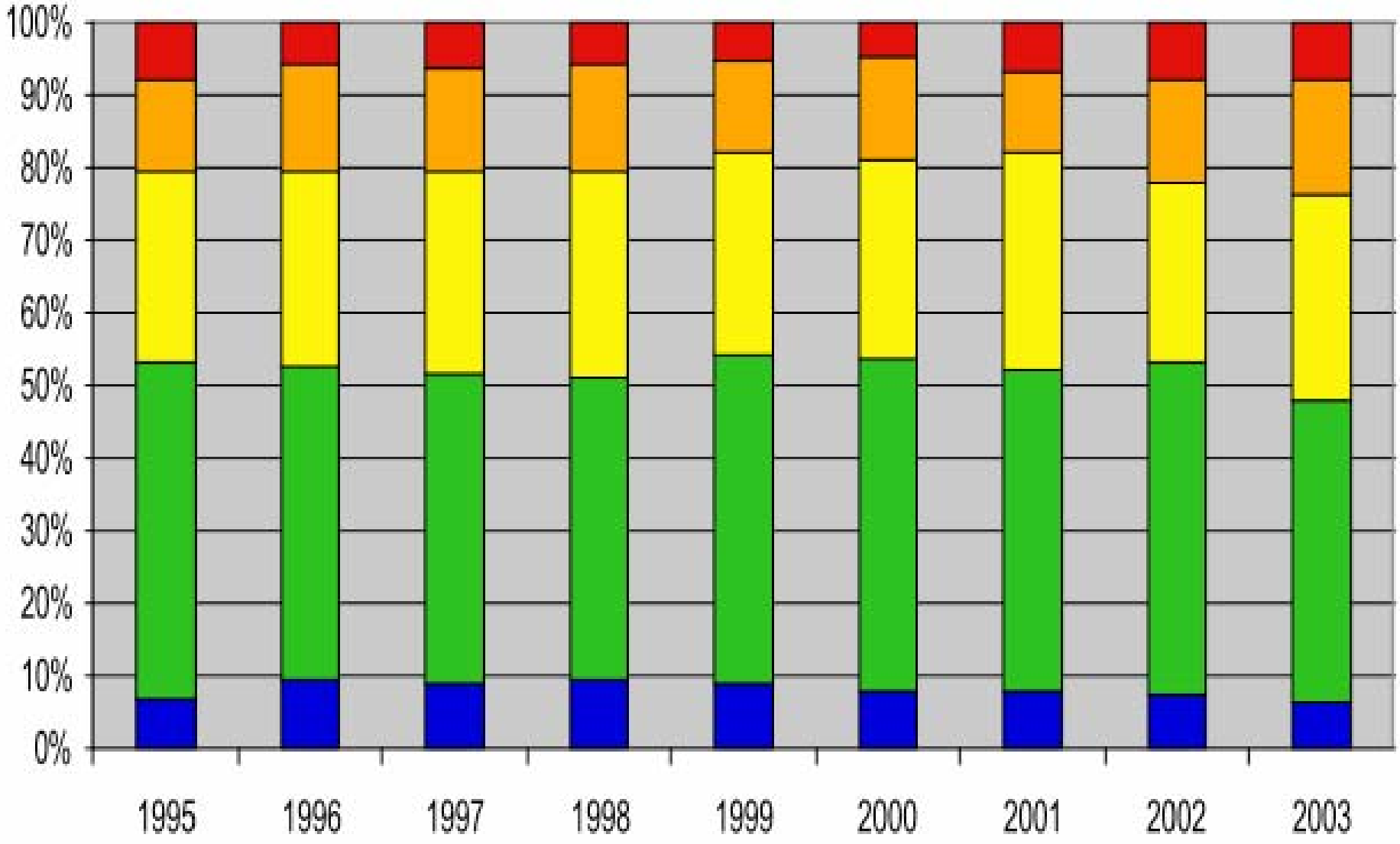
OREG
8 STATE

# EMAP-West Nonnative Occurrence by Stream Order

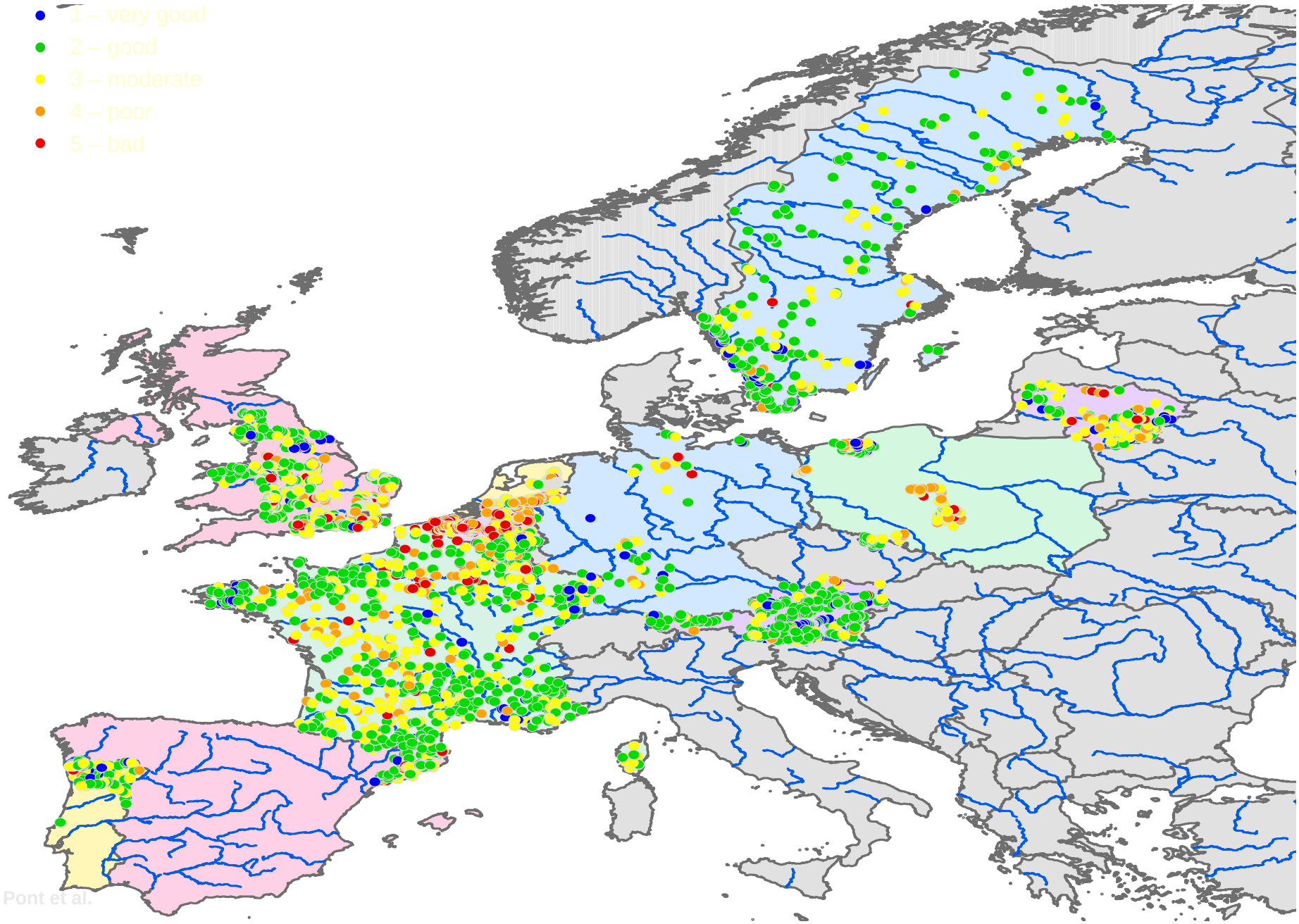


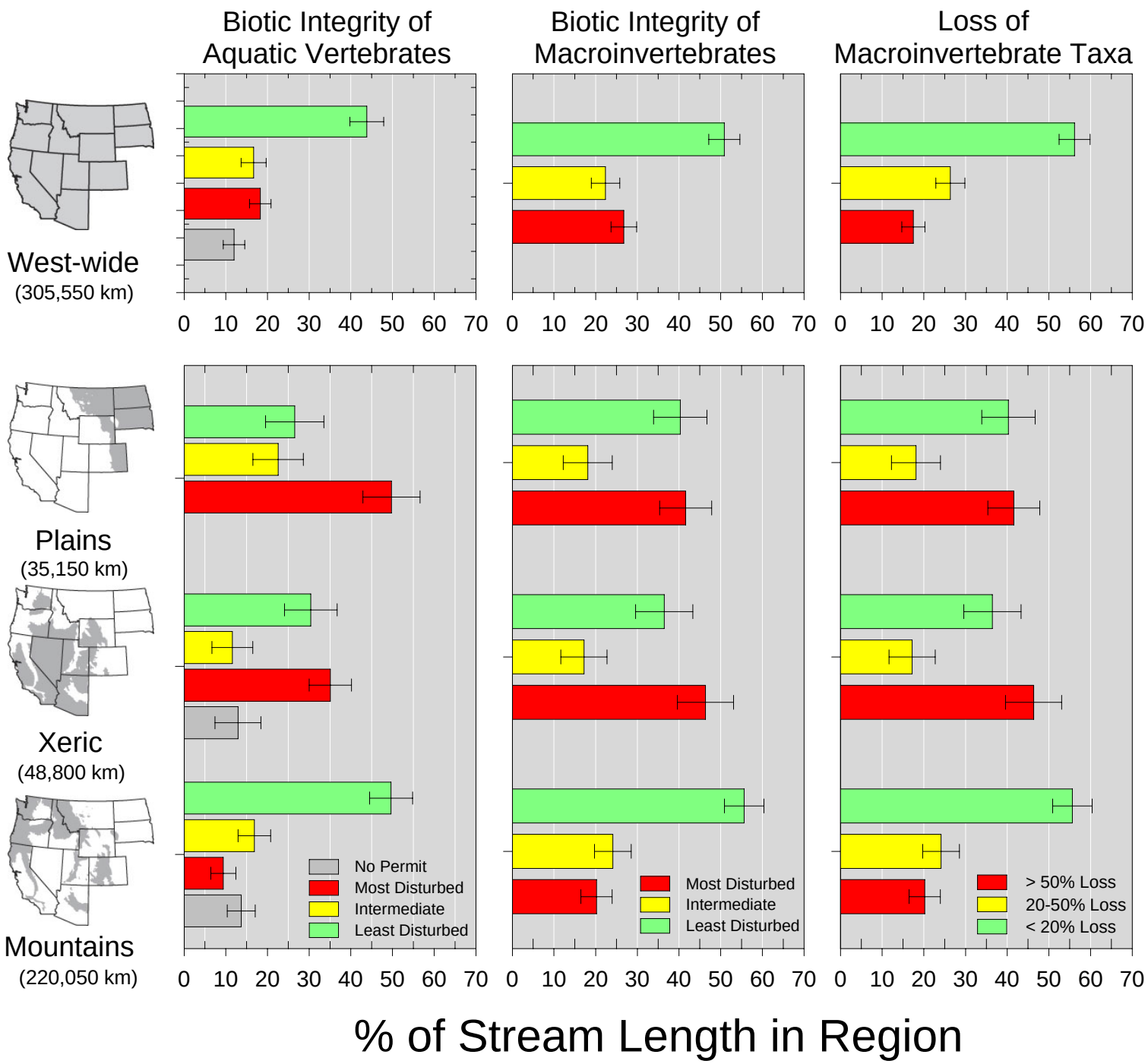

Oregon river IBI scores (from Mebane et al. 2003)
r2 = 0.36
P = 0.00
r2 = 0.45
P = 0.00
IBI
100
80
60
40
20
0
0
10
20
30
40
% watershed area mapped as disturbed

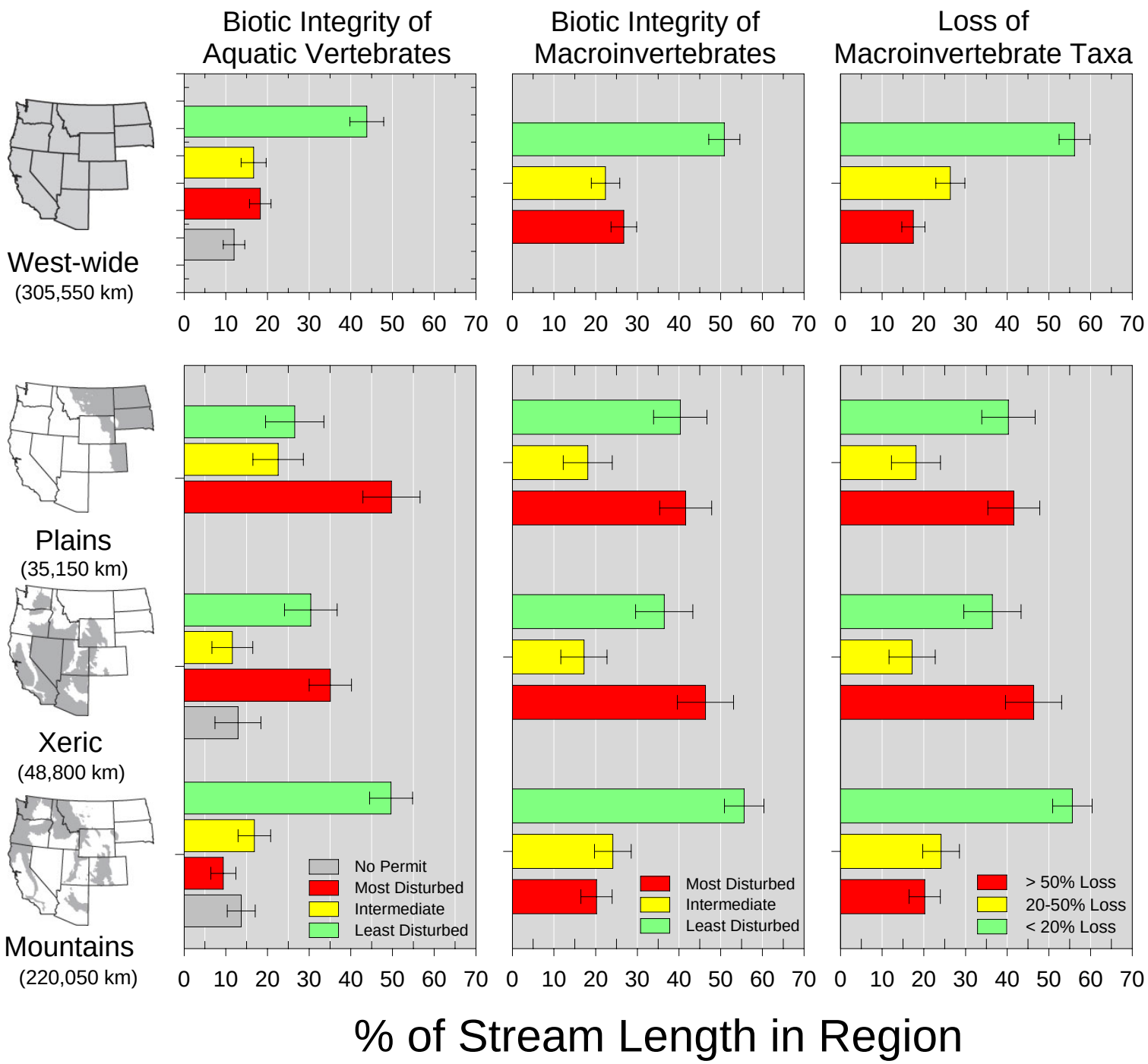
Change in FBI scores across a network of 700 French rivers (from Didier Pont)



# European FBI scores (from Stefan Schumtz)




Biotic Integrity of Aquatic Vertebrates
Biotic Integrity of Macroinvertebrates
Loss of Macroinvertebrate Taxa
West-wide
(305,550 km)
Plains
(35,150 km)
Xeric
(48,800 km)
Mountains
(220,050 km)
0 10 20 30 40 50 60 70
No Permit
Most Disturbed
Intermediate
Least Disturbed
Most Disturbed
Intermediate
Least Disturbed
> 50% Loss
20-50% Loss
< 20% Loss
% of Stream Length in Region


Biotic Integrity of Aquatic Vertebrates
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Loss of Macroinvertebrate Taxa
West-wide
(305,550 km)
Plains
(35,150 km)
Xeric
(48,800 km)
Mountains
(220,050 km)
0 10 20 30 40 50 60 70
No Permit
Most Disturbed
Intermediate
Least Disturbed
Most Disturbed
Intermediate
Least Disturbed
> 50% Loss
20-50% Loss
< 20% Loss
% of Stream Length in Region

# Possible Research Questions

- What is the optimum reach length?
- What is the optimum sampling gear?
- How are effects of water diversions best quantitatively evaluated?
- How are effects of alien species best quantitatively evaluated?
- How might an ESA Section 10 IAG consultation be implemented among EPA, FWS & NMFS?