A scenic photograph of a sunset over a large body of water, likely a lake or wide river. The sun is low on the horizon, partially obscured by dark silhouettes of trees on the left. The sky is a gradient of warm colors from orange to a pale, hazy blue. The water in the foreground is calm, reflecting the light from the sun. In the distance, dark, rolling hills or mountains are visible against the horizon.

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Using Relative Risk for Regional-Scale Assessment of Stressor Effects

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How important is an aquatic stressor?

- An important stressor has **broad extent** (high percentage of river length has elevated stressor levels).

AND

- At elevated levels, an important stressor **impacts biota**.
 - Cannot directly assess stressor impact from survey data.
 - Indirect assessment:
 - Relative risk** measures the strength of association between elevated stressor levels and degraded biota.

Why “relative risk”?

-- Widely used in human health assessment.

Relative risk setup:

Stressor: Painkilling drug.

Drug is either taken, or not taken.

Response: Cardiovascular event (stroke).

Stroke either occurs, or does not occur.

Naproxen least risky

According to a report in the Journal of the American Medical Association, the painkiller naproxen has less of a cardiovascular risk than other drugs.

Relative risk estimates*

Naproxen	0.97
Celebrex	1.06
Ibuprofen	1.07
Other anti-inflammatory	1.10
Mobic	1.25
Vioxx	1.35
Voltaren	1.40

* Relative risk is measured against a baseline of one, which in this case is people not on painkillers

SOURCE: JAMA

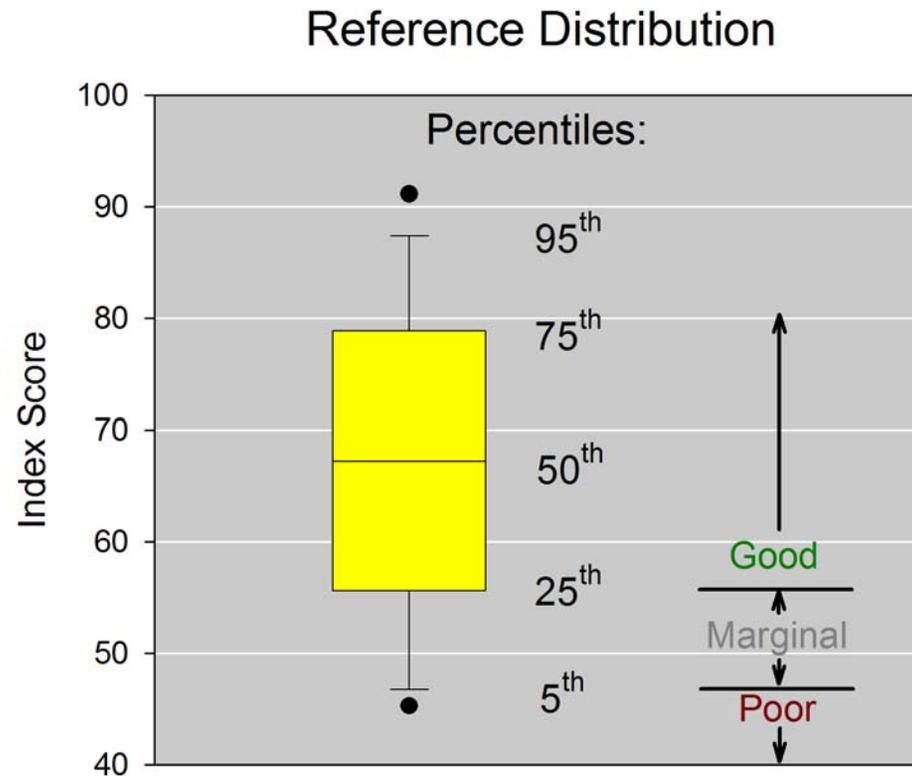
AP

Corvallis, OR, “Gazette-Times”,
Sept. 13, 2006

Applying relative risk to rivers

- For each sampled site, determine condition classes:
“Poor” (Most disturbed), “Marginal”, or “Good” (Least disturbed)
(Assign condition classes independently for each stressor and response).
- Estimate number of sites (or river miles) in various condition classes.

-- Note: Can use distributions of continuous stressor/response index scores at reference sites to define thresholds for “Good”, “Marginal”, “Poor”.



Example: Relative risk of Poor macroinvertebrate IBI when the excess-sediment (ExSed) stressor is also Poor.

Percent of stream length

	ExSed GOOD	ExSed POOR
IBI GOOD	59	4
IBI POOR	18	19
Total	77	23

(Risk of **Poor** IBI, given **Poor** ExSed) =
 $19/23 = 0.83$

Also --

(Risk of **Poor** IBI, given **Good** ExSed) =
 $18/77 = 0.23$

Result: The risk of Poor IBI when ExSed is Poor is higher than the risk when ExSed is Good.

Relative Risk (RR) is the ratio of these 2 risks

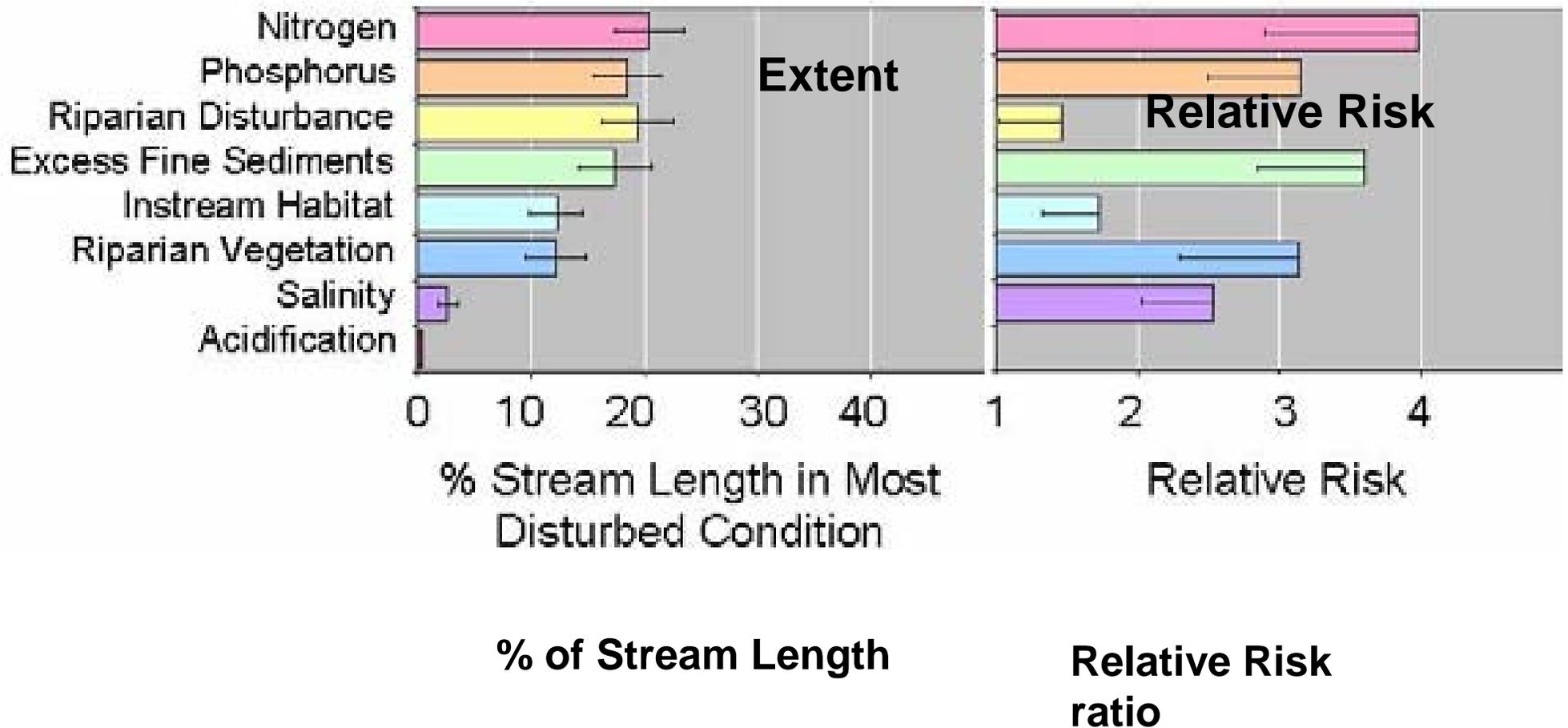
$$RR = \frac{\text{Pr}(\text{Poor IBI, given Poor ExSed})}{\text{Pr}(\text{Poor IBI, given Good ExSed})} = \frac{0.83}{0.23} = 3.6$$

So: “The risk of Poor IBI is 3.6 times greater in streams with Poor ExSed than in streams with Good ExSed.”

Notes –

- If stressor has no effect then $RR = 1$.
- Use a confidence interval to express uncertainty in RR.
(EMAP software for the R language calculates RR and its confidence interval. Free, at www.epa.gov/nheerl/arm/.
Also, see Van Sickle et al., *Environmental Management*, in press).
- Sites in “Marginal” condition for either the stressor or the response were not included in RR estimate.

WSA Western region: Extent of Poor condition for 8 stressors, and relative risk of stressors for Poor macroinvertebrate IBI



Summary

Challenges in using relative risk –

- May not capture joint effects of multiple, correlated stressors.
- Employs condition classes ('Poor' vs. 'Good').

Advantages of using relative risk –

- Familiar language for general public.
- Employs condition classes ('Poor' vs. 'Good').
- Together, RR and stressor extent can assess the relative importance of different stressors.