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Presentation

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The development and validation of an Estuarine Health Index using fish community characteristics



Chris Hallett, Fiona Valesini



What is 'Estuarine Health'?



- Assessment of ecosystem condition / state
- Comparison to 'Reference condition'

Key Feature:

- The extent to which
- (i) Appropriate environmental conditions are maintained
 - (ii) Appropriate species, populations and communities are supported
 - (iii) Ecological processes and interactions occur at appropriate rates and scales



Multimetric biotic indices

Characteristics of aquatic communities reflect both acute and chronic changes to their environment.

Characteristics (metrics):

- Species diversity, abundance, composition
- Nursery function
- Trophic structure

Stage 1: Metric selection

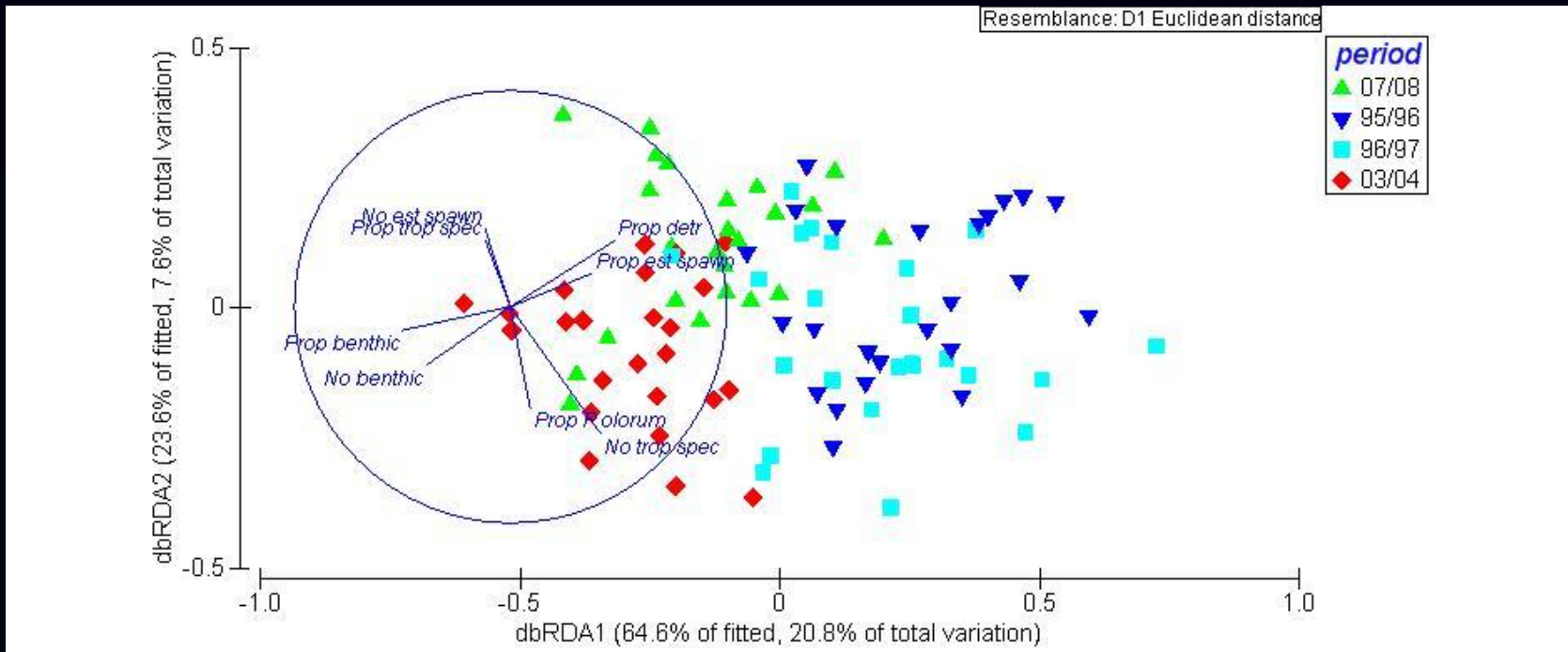
Eliminate highly correlated / redundant metrics

+

Select metrics which consistently highlight inter-annual change

=

Select suite of metrics which most efficiently represents ecosystem health



- Distance-based linear modelling
- Non-linear multivariate techniques
- Weight of evidence approach

Stage 2: Establishing reference conditions

Ideally, the biotic integrity of an ecosystem should be assessed in comparison to an 'undisturbed' reference condition, representing the state of a pristine system unmodified by anthropogenic influences, incorporating natural variability.

(Harris and Silveira 1999)

BUT

Few aquatic systems are free from human impact

Therefore two possible approaches:



**'Least disturbed' or 'Best available'
reference sites**

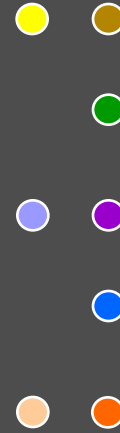
- Select sites minimally impacted by human influence
- Define reference conditions for each metric from values for these "best" sites

**Best values from many sites,
(no independent pre-selection of reference sites)**

- A large number of sites are sampled to provide a representation of the region
- Define reference conditions for each metric as the "best" values from among all selected sites

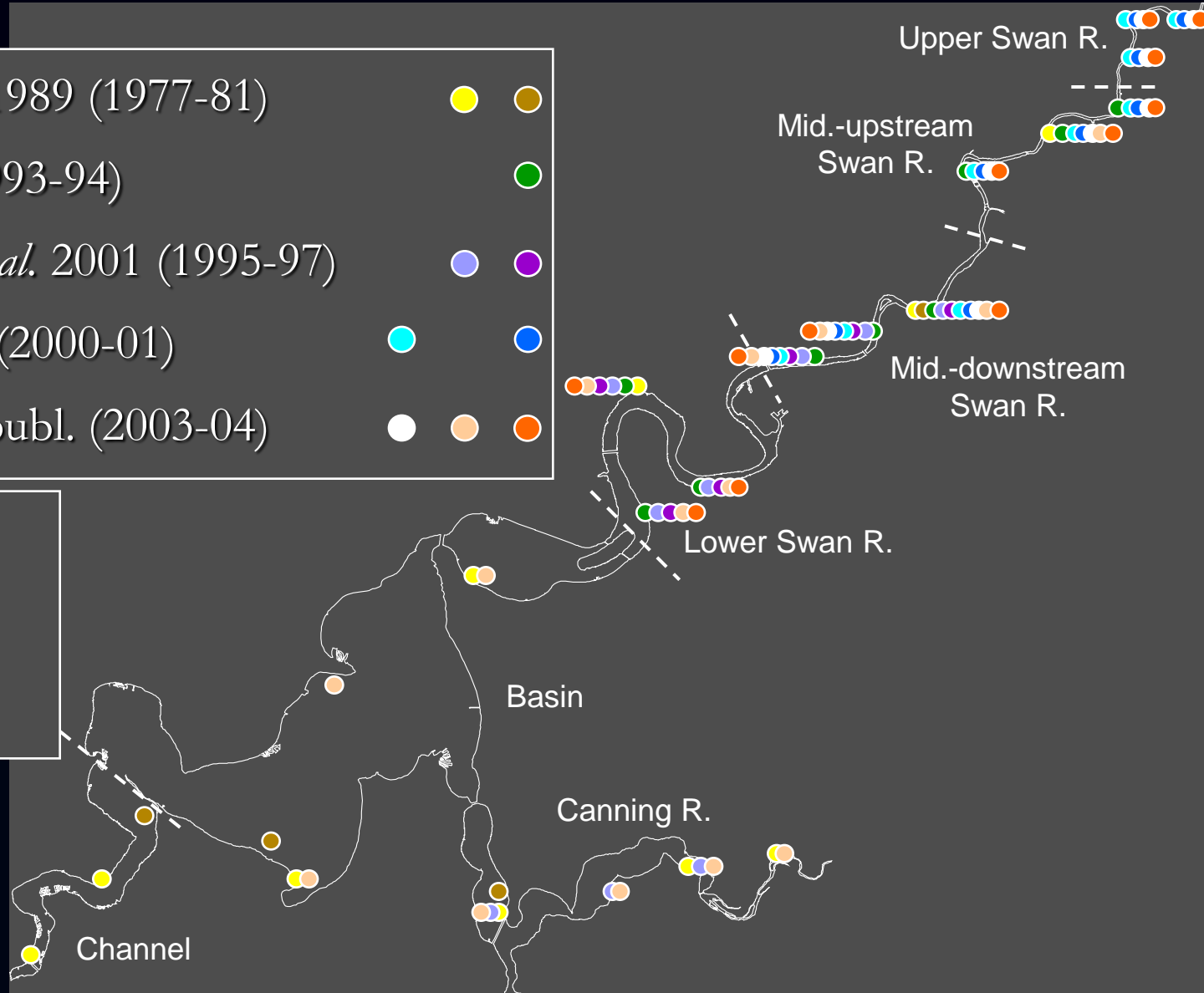
Previous studies of fish fauna in the Swan Estuary

- Loneragan *et al.* 1989 (1977-81)
- Sarre unpubl. (1993-94)
- Kanandjembo *et al.* 2001 (1995-97)
- Hoeksema 2006 (2000-01)
- Valesini *et al.* unpubl. (2003-04)



Sampling methods:

- Beach seine
- Otter trawl
- Multimesh gillnetting



Stage 3: Metric scoring

e.g. method exemplified by Harrison & Whitfield 2004

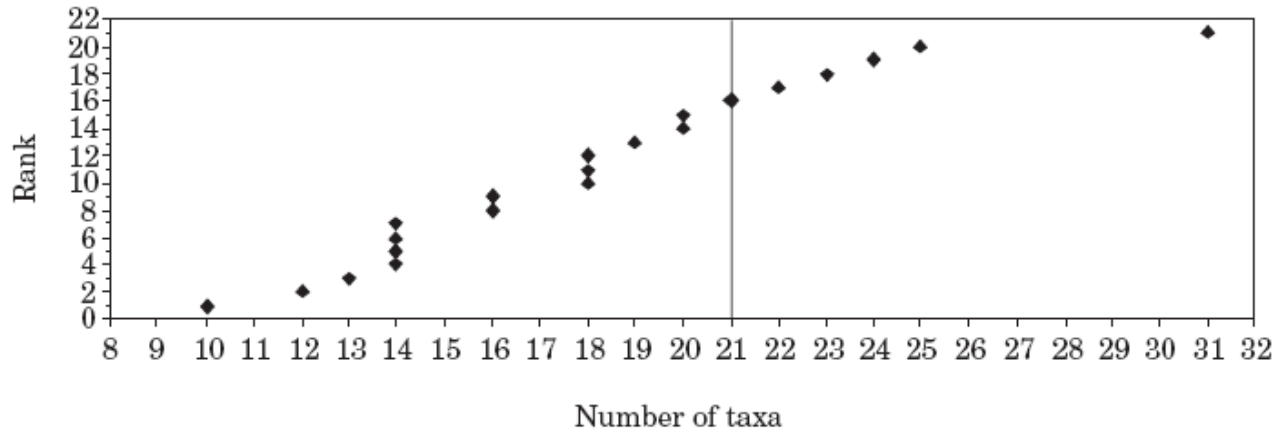


FIG. 7. Ranked species richness data for predominantly closed, moderately sized estuaries in the subtropical region. The vertical line represents the cut-off of the upper quartile of the data. The mean (reference value) of the upper quartile = 24 species.

- E.g. Reference value for each metric = mean of upper quartile of values from reference sites for that metric
- Score samples for each metric (0-5) in comparison to the reference value for that metric

Stage 4: Calculate index by summing scores for all metrics

Stage 5: Index validation - sensitivity

Sensitivity - the ability of the index to correctly distinguish between samples (e.g. locations, times) which differ significantly in terms of estuarine health

Approach: Test the degree to which index values are able to track demonstrated changes in the system over time

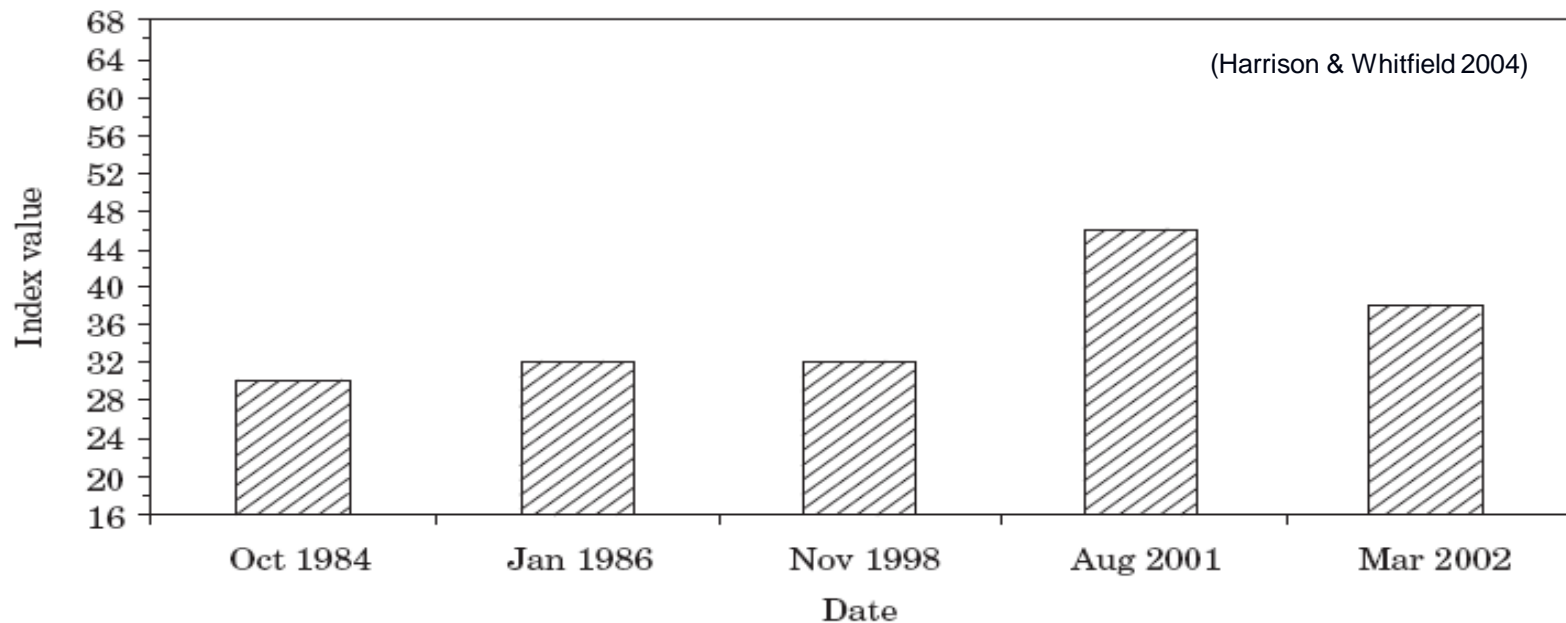


FIG. 14. The Estuarine Fish Community Index for the Sezela Estuary, October 1984 to March 2002.

Stage 5: Index validation - reliability

Reliability - ability to generate a consistent signal which is not disrupted by background variability (noise)

Approach: Test the repeatability of index scores

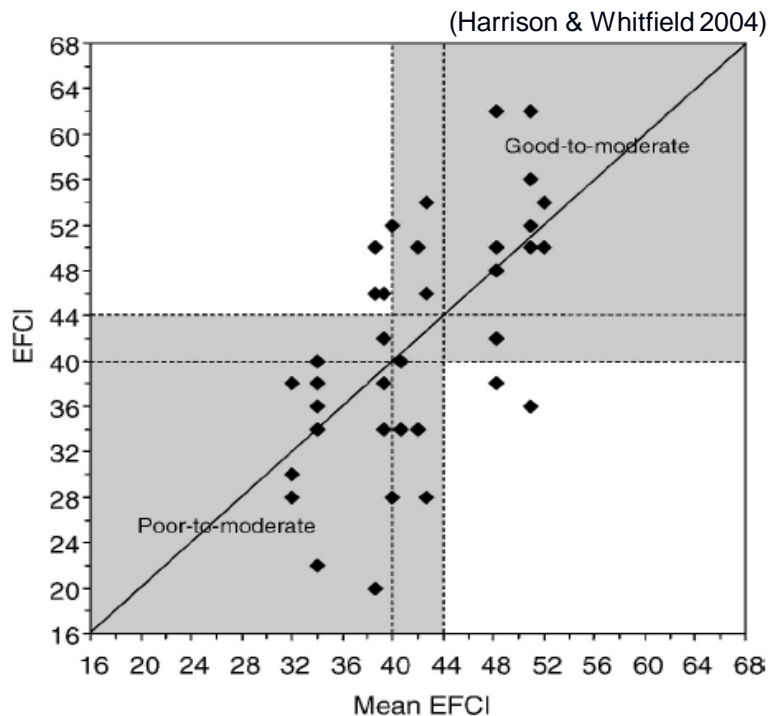


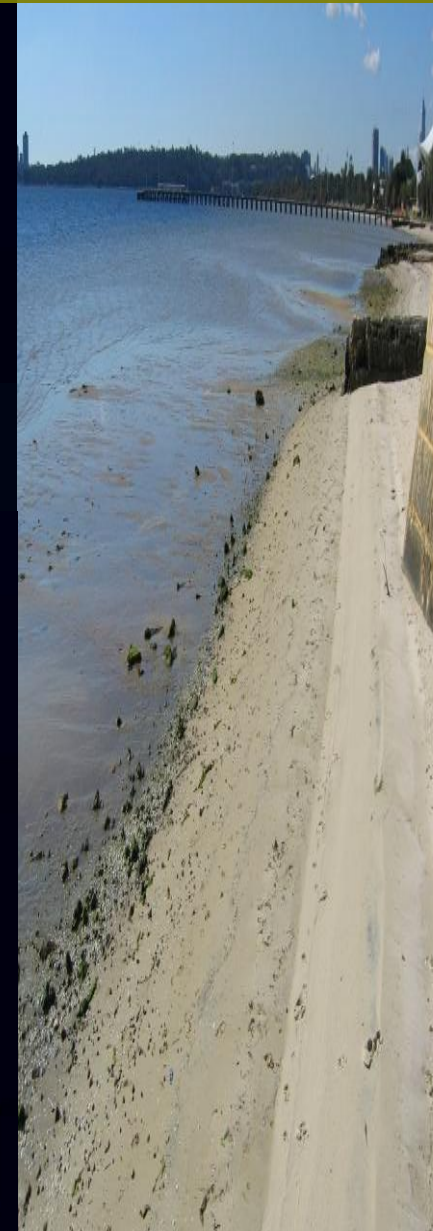
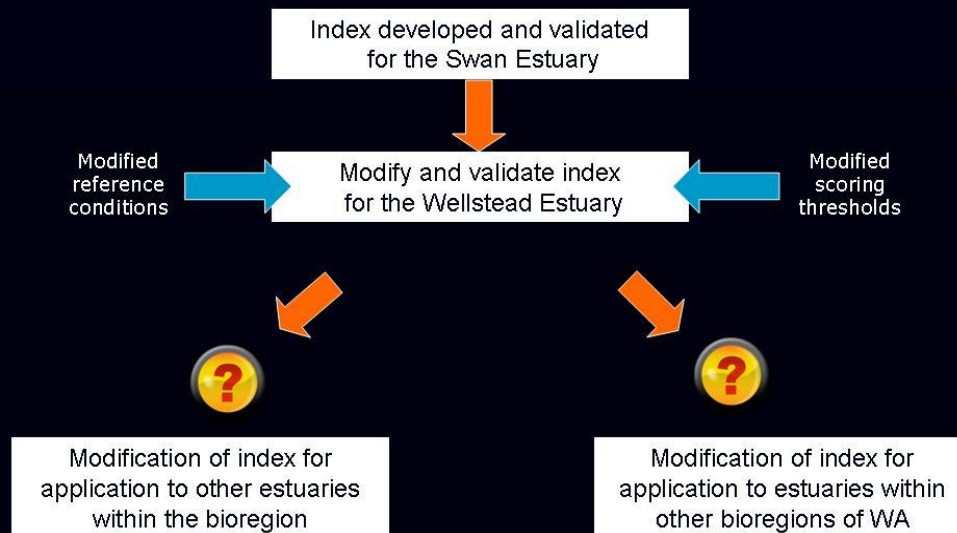
Fig. 7. Mean EFCI values versus EFCI scores for estuaries that were repeatedly sampled. Diagonal line represents the 1:1 EFCI score to mean EFCI relationship. Vertical and horizontal lines represent the boundary of moderate EFCI ratings; shaded areas include EFCI ratings of poor-to-moderate and good-to-moderate.

(e.g. compare index value
vs
mean value of repeated
samples)

Outcomes: Implications for Management

- Quantitative assessment of estuary health
- Monitor changes in health over time
- Inform management decisions
- Communication tool for public
- Potential for wider applicability

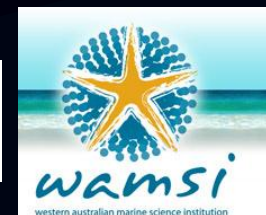
Index outcomes – wider applicability



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Examples of candidate metrics for testing

METRIC TYPE		
Species diversity, abundance, composition	Nursery function	Trophic integrity
Species richness (total no. of taxa)	No. of estuarine resident taxa	Feeding guild composition
Presence of 'indicator species'	No. of estuarine-spawning taxa	No. of benthic invertebrate feeding taxa
Dominance (no. of taxa that make up 90% of the abundance)	Proportion of 'nursery species'	No. of piscivorous taxa
No. of introduced pest species		Proportion of individuals as macrophagic carnivores
No. of intolerant species		Proportion of piscivores
Species composition, relative to reference assemblage		Proportion of top carnivores
Presence of rare or threatened species		Proportion of detritivores
Diversity indices		Proportion of omnivores
		Number of trophic specialist taxa

Provisional metric suite

Nearshore (Seine nets)	Offshore (Gill nets)
Assemblage composition (BC) Shannon-Weiner diversity	Assemblage composition (BC) Species richness
No. trophic specialist spp. No. trophic generalist spp. Proportion detritivores Feeding Guild Composition	No. trophic specialist spp. No. trophic generalist spp. Proportion detritivores
No. benthic associated spp. No. estuarine spawning spp.	Proportion benthic associated spp. Proportion estuarine spawning spp.
Proportion <i>P. olorum</i>	

Metric selection

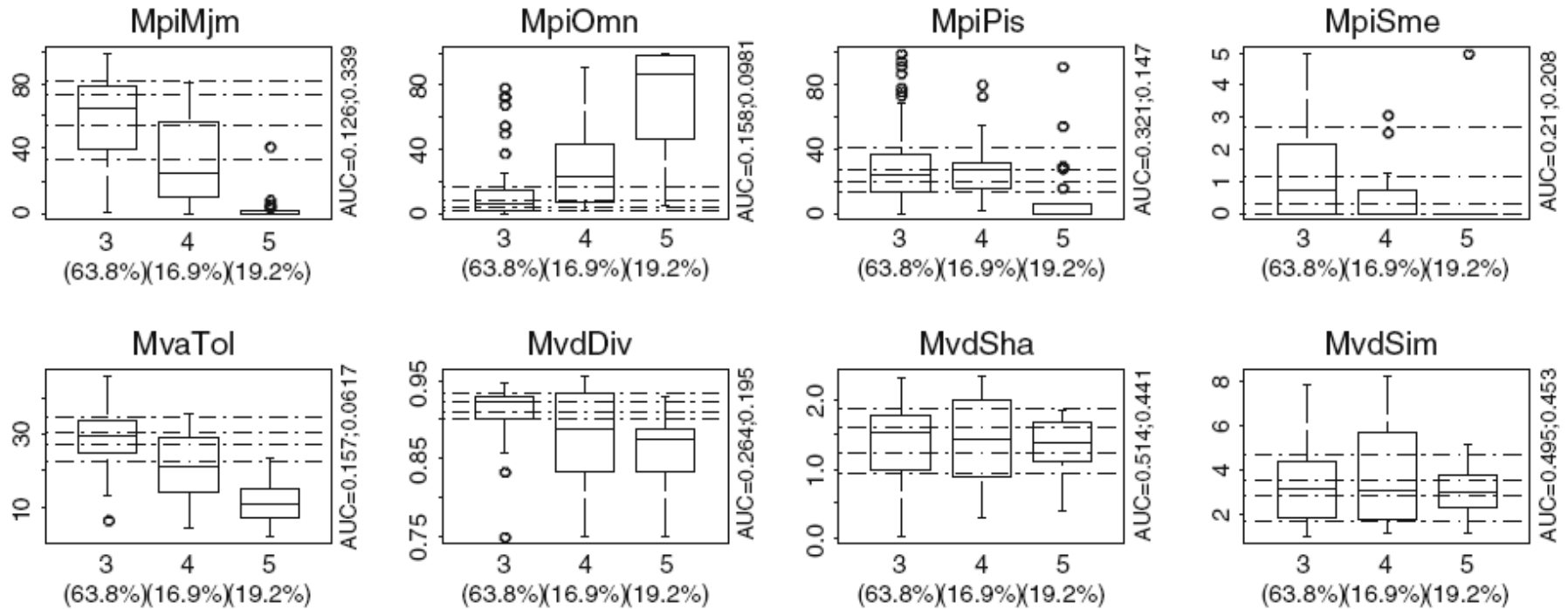


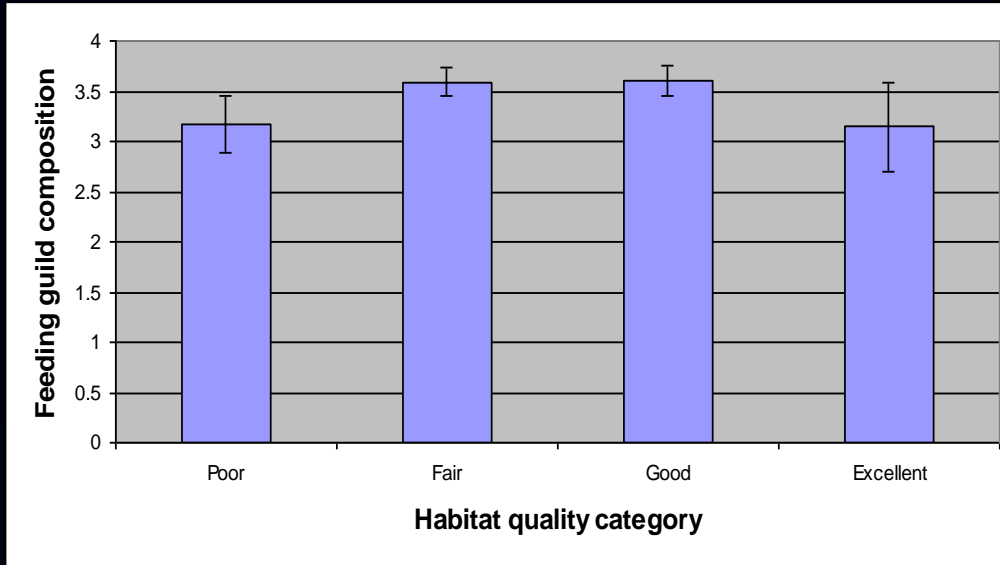
Fig. 4 Graphical screening of the candidate metrics as a function of the pre-classification of the habitat (Hscore) by boxplots + quintiles of the reference distribution to score (for abbreviations of the metrics see Table 3)

Habitat Quality Assessment:

Habitat quality category	No. of sites
Excellent	7
Good	46
Fair	65
Poor	18

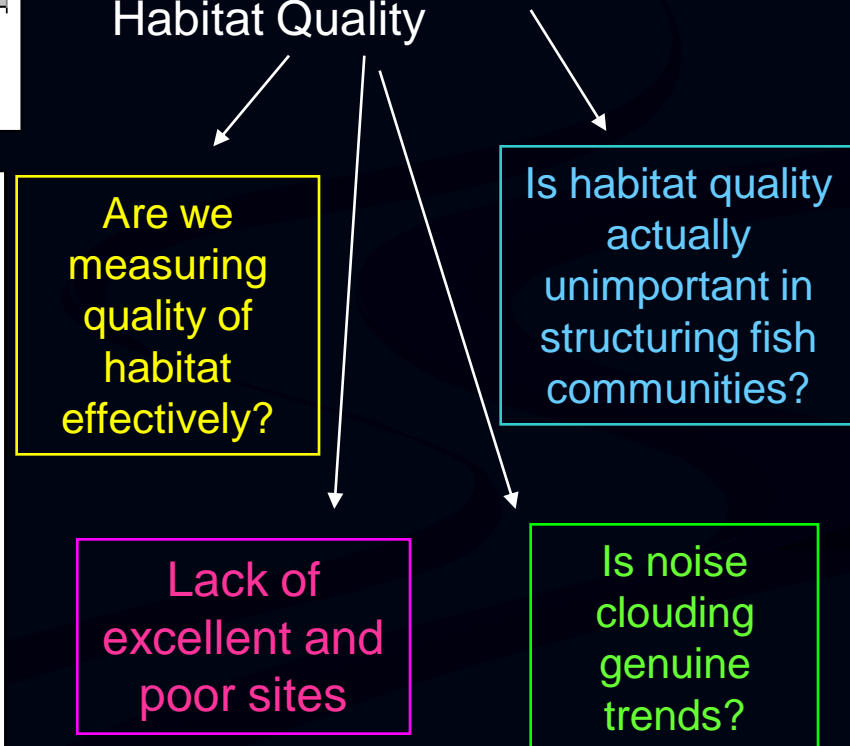


Inability to select responsive metrics

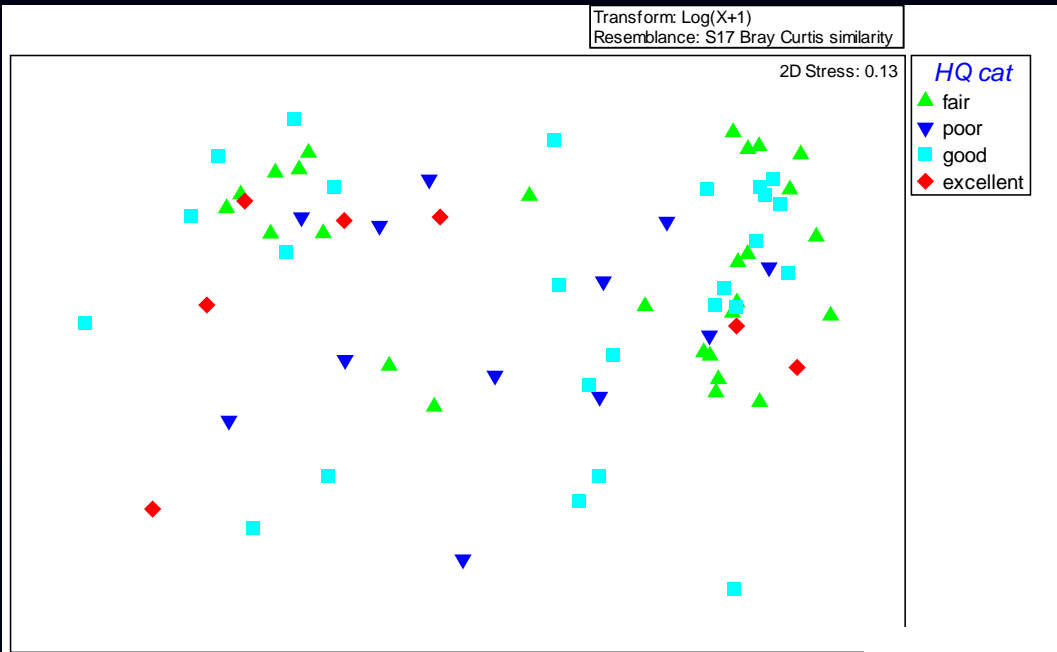


- Inconsistent trends in metrics across HQ categories

- Metrics displayed no monotonic response to differing Habitat Quality



Inability to select responsive metrics

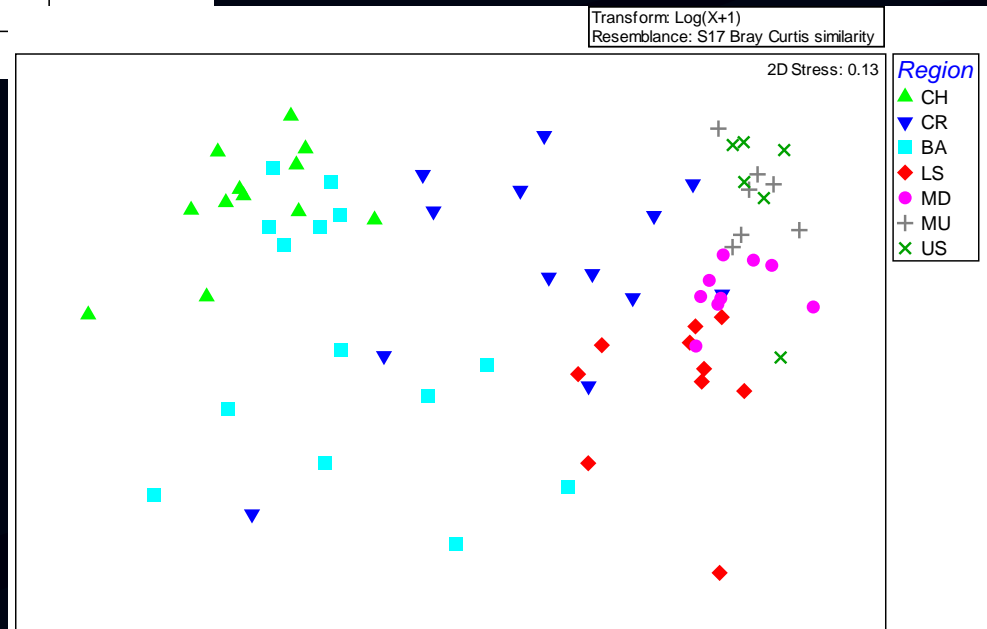


MDS of raw fish composition:
– no evidence of grouping by
habitat quality category

MDS of raw fish composition:
– samples group by region

ANOSIM:

- no sign. diff's in fish composition
between HQ categories



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