Fish monitoring in estuaries (there's a whole lot of wading going on)

STEVE COATES

PRINCIPAL AQUATIC ECOLOGIST



Thames Estuary

- Thames is a recovering estuary and 'Devoid of fish life' Alywne Wheeler (1959).
- Fish started to return to the estuary in late 1960's.
- West Thurrock fish power station survey started in 1974 (Thames Water).
- National Rivers Authority (NRA) started 'multiple-method' Tideway Fisheries Survey in 1992.
- EC Fair Programme (2000), 'Commercial Fish and European Estuaries- Priorities for Management & Research'.
- 'Best Practice' in relation to fish sampling in European estuaries.



WFD back to basics..... What is a 'Transitional Water'?

'Transitional waters are bodies of surface water in the vicinity of river mouths which are partly saline in character as a result of their proximity to coastal waters but which are substantially influenced by freshwater flows'.

DIRECTIVE 2000/60/EC, ARTICLE 2 (6)



WFD RECAP

ECOLOGICAL STATUS



TW Fish WFD normative definitions

Element	High Ecological Status	Good Ecological Status	Moderate Ecological Status
Fish fauna	Species composition and abundance is consistent with undisturbed conditions	The abundance of the disturbance-sensitive species shows slight signs of distortion from the type-specific conditions attributable to anthropogenic impacts on physiochemical or hydromorphological quality elements	A moderate proportion of the type-specific disturbance-sensitive species are absent as a result of anthropogenic impacts on the physiochemical or hydromorphological quality elements

Q. How do you survey a TW fish population in relation to the above?



A. Convert the WFD normative definition so that it makes sense?

TW Fish structure & relevanceU	High Status	Good Status	Moderate Status
'Species Composition & abundance'	Species composition &	The abundance of the	A moderate proportion of
there is a high degree of taxonomic	abundance is consistent	disturbance sensitive	the type-specific
breadth present.	with undisturbed	species shows slight signs	disturbance-sensitive sp.
	conditions.	of distortion from type	are absent as a result of
Use Mike Elliott's:		specific conditions	anthropogenic impacts on
Functional Guilds which describe the	Also key life stages of	attributable to	the physiochemical or
interaction and function of the fish	'disturbance sensitive	anthropogenic impacts on	hydomorphological quality
faunal assemblage within an estuary.	species' are present.	physico- chemical or	elements.
Each species is allocated a functional	Successful migration	hydomorphological	
category	within and through the	quality elements.	
CA = diadromous species	transitional water		Removal/absence of
FW = freshwater species	associated with patterns		disturbance sensitive sp.
ER = estuarine residents	of migration consistent	Distortion of disturbance	Including disruption of key
MA = marine adventitious	with undisturbed	sensitive sp. & key life	life stages.
MJ = marine juveniles	conditions.	stages. May be in terms of	Major disruption to
MS = marine seasonal		age structure as well as	migration patterns within &
	e.g. salmon, smelt, shad,&	presence.	through the trans water.
Structural changes within the	sturgeon.	Some disruption to	Functional Guilds absent in
community are often associated with		migration patterns within	relation to reference
seasonal patterns.	Why sturgeon – went back	& through the transitional	conditions.
	to 1800 for reference	water.	Non-native fish may be
Species richness i.e. number of taxa is	conditions'.	One or more sp within a	present.
not a useful measure as this is often		guild may be absent	
dependant upon sampling effort.	HOW – Yarrell & NHM.		

v1.0 of the UK-ROI WFD TW Fish Tool

Species diversity and composition

- 1) Species composition
- 2) **Presence of rare/threatened species**

Species abundance

- 3) Species relative abundance
- 4) Number of taxa that make up 90% of the abundance

Nursery function

- 5) Number of estuarine resident taxa
- 6) Number of estuarine-dependent marine taxa

Trophic integrity

- 7) Functional Guild Composition
- 8) Number of benthic invertebrate feeding taxa
- 9) Number of piscivorous taxa
- **10)** Feeding Guild Composition

Evidence base



Development of an Estuarine Class Directive: Phase 1 & 2 – Transition R&D Technical Summary E1-131/TS

The Water Framework Directive (WFD) is to establ a European framework for the protection of init surface waters, transitional waters, coastal waters, a groundwater (European Council Direct 2000/80/EC). The principal objective of the WFD is protect, enhance, and restore all bodies of surfit water, including 'Transitional Waters' (estuaries), v the aim of achieving good surface water status 2015.

The WFD will also introduce for the first time international commitment to assess the ecologi status of transitional waters, within which 1 communities are a key biological monitor component.

Transitional Waters have five biological qua elements to be assessed, which indiphytoplankton, macro-algae, angiosperms, bent invertebrates & fish. The fish quality element is to assessed by taking account of the composition a abundance of the fish fauna.

This report describes the first two stages of a th Phase development of an Estuarine Fish Commun Index (EFCI). Phase 1 (R&D Project E1-1 comprised of a literature review and evaluation of & world-wide estuarine classification schemes alk with a fish data gathering exercise from UK & Ir transitional waters.

Phase 2 (R&D Project E1-131) incorporated the furt development and analysis of these datasets along v establishing a standard suite of monitoring techniqu This has led to the development of a comm biological database for the five biological qua elements and forms part of a wider study to develo biological classification scheme to support requirements of the WFD.

Two project boards have been established; an inter Agency group with representatives from each Reg and an external board comprising of representati



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Efficacy of a multi-metric fish index as an analysis tool for the transitional fish component of the Water Framework Directive

Steve Coates *, Adam Waugh, Alice Anwar, Matthew Robson

Environment Agency, River's House, Crossness Works, Belvadere Road, Abbeywood, London SE2 9AQ, UK

Abstract

The WFD has introduced an international commitment to assess the ecological status of transitional waters (TWs), within which fish communities are a key biological monitoring component. The Transitional Fish Classification Index (TFCI) outlined in this paper uses to ecological measures to analyse fish populations caught from various ecological niches using a variety of gear types within the Thames estuary. These reach and method-specific communities are then compared to a reference population created from a 'healthy' population from TWs of a similar type. The results indicate a progressive downstream increase the quality of fish communities, consistent with previous work; variation between methods can be accounted for by gear selectivity. Overall, the TFCI is an effective communication tool for converting ecological information into an easily understood format for managers, policy makers and the general public. © 2006 Elsevier Ltd. All rights reserved.

Keywords: WFD; Thames estuary; IBI; Biological indicators; Ecosystem health; Fish

1. Introduction

The Water Framework Directive (WFD) has introduced an international commitment to assess the ecological status of transitional waters (estuaries), within which fish communities are a key biological monitoring component (European Council Directive, 2000). Fish communities can be described according to a variety of characteristics such as composition, trophic structure and diversity of the assemblage, as well as abundance and biomass of the individuals (Harrison et al., 2000; Lobry et al., 2003; Coates et al., 2004; Harrison and Whitfield, 2004). Trends in one or more of these community attributes can be used to monitor the ecological functioning and 'health' of a particular ecosystem (Whitfield and Elliott, 2002).

The WFD specifies that the transitional fish quality element is to be assessed by taking account of the composition and abundance of the fish fauna and that of disturbancesensitive taxa. In order to carry out an integrated approach

E-mail address: steve.coates@environment-agency.gov.uk (S. Coates).

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to assess the fish community of the Thames estuary, a number of attributes have been incorporated into a single multimetric index. This methodology has been used in many other studies, (Miller et al., 1988; Deegan et al., 1997; Harrison et al., 2000; USEPA, 2000; Goethals et al., 2002; Borja et al., 2004; Breine et al., 2004).

As part of the assessment of the fish faunal assemblage within an estuary, a number of monitoring techniques and sampling strategies have been developed (Hemingway and Elliott, 2002). Environment Agency, Thames Region has established a long-term monitoring programme based on the recovery of the Thames estuary, with the initial survev work based on power station fish impingement (Wheeler, 1979; Attrill, 1998; Kirk et al., 2002). However, with the decommissioning of the Thames power stations and the need to address the data gaps caused by this single-strand survey approach, a multi-method monitoring programme was established (Colclough et al., 2000, 2002). This approach combines a variety of methods such as seine netting, beam trawling and otter trawling. Different survey techniques have varying gear selectivities so it is important to incorporate a suite of techniques (von Brandt, 1964) to obtain a comprehensive picture of each



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^{*} Corresponding author.

What does this mean in relation to fish monitoring ?

For WFD surveillance monitoring in Transitional Waters we need to assess fish:

Species composition.

Abundance.

Disturbance sensitive taxa.

We do not have to record length or age information **BUT** we do take fish length as a surrogate for age in case of any future WFD 'Investigative monitoring'.

OK we understand the above so "Lets go monitoring".





GET A BOAT

Well it's because it's chemically clean but biologically dead

Before you start wading you need to.....

....design a monitoring programme that can assess fish communities,

..... and also considers:

Temporal variability – time of year/seasons.

Spatial variability – mosaic of habitats

Gear selectivity – beam trawl (benthic species) vs. seine (pelagic).

Limitations i.e. you can't use every method everywhere.

Monitoring methods are habitat and species specific.

Sampling across the salinity gradient and across habitat types.

Monitoring programme needs to adopt a 'tool-kit' approach for each estuary type.

So what are the techniques we can use.....

Seine Netting

Beam Trawling

Fyke Netting

Otter Trawling

Push Netting

Kick Sampling

UK Typology and TW Fish Sampling

- Within the UK there are 6 WFD TW types based upon tidal regime, salinity & intertidal area & also two WFD Eco-Regions (1 & 4).
- Problem with above system was that it did not take into account Ria's TW fish community does respond to this habitat (WFD Pilot Project) so habitat specific reference created for Ria's e.g Fal & Milford TW.
- In England & Wales there are 132 TW's and a typology system was applied to each estuary of these types.
- Only 25% of WB in E&W are monitored for fish 'WFD Surveillance'
- The above data is used to generate WFD 'Reference conditions'.
- Spatial coverage was it enough?
- Monitoring how many sites 8, 5, 3.
- A better way of developing data would have been to survey all the TW's and generate data i.e. The Irish Approach rolling monitoring programme.
- Why was this not done in the UK?
- Cost!

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Development of an estuarine multi-metric fish index and its application to Irish transitional waters

Trevor D. Harrison^{a,*}, Fiona L. Kelly^b

^a Marine Division, Department of the Environment (Northern Ireland), 17 Antrim Road, Tonagh, Lisburn, Northern Ireland BT28 3AL, Uni ^bInland Fisheries Ireland, Swords Business Campus Swords, Co., Dublin, Ireland

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ABSTRACT

An estuarine multi-metric fish index (EMFI) was developed and ap index comprised a balanced and complimentary set of 14 metrics attributes: species diversity and composition, species abundance, e position. Reference conditions and metric scoring thresholds we historical records, best available data, and expert judgement. The in and robust fish monitoring data collected using a suite of methods and conditions. To ensure consistency and comparability, all system ary level. A sensitivity analysis was carried out to assess the response of metric change; five metrics were consistently among the most in of metric manipulation. The overall EMFI was significantly correla measured by two separate indicators of ecological state, Ecologica based on the relationship between the EMFI and an index of human sensitive, and integrated measure of the ecological status of fishes requirements of the EU Water Framework Directive.

1. Introduction

Estuaries are dynamic transitional environments, formed where rivers enter the sea. They are highly variable systems and often experience changes in freshwater flows, tidal currents, sediment transport, salinity, temperature, turbidity, and nutrients, which can vary over tidal cycles or seasonally. These hydrological, physical, and chemical processes, together with biological interactions all serve to produce a variety of habitats in estuaries; these include saltmarsh, reed beds, subtidal and intertidal sea grass beds, and subtidal and intertidal muds and sands (Phil et al., 2002). Estuaries are also highly productive (Odum, 1983; McHugh, 1985) and this, together with the variety of sheltered habitats provided, serve an important nursery function for fishes and invertebrates many of which are of direct or indirect commercial importance to man (Elliott et al., 2007; Franco et al., 2008a).

Their proximity to the coast and sheltered waters has made estuaries popular sites for human development and exploitation, Estuaries are impacted by multip fishing and aquaculture, dredging ping, wetland reclamation and la development, and residential an are also used for water abstractic and domestic effluents. In additio ities in the catchments of rivers dam construction, flood defence cultural runoff and effluent disc Vasconcelos et al., 2007).

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Fig

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Growing environmental awa international, national, and region and/or restoration of aquatic syst the Water Framework Directive the protection and restoration tional waters (including estuaries (Directive 2000/60/EC), A key of ber States must achieve good e 2015, According to the WFD, ecc based on several physical and che several biological elements (e.g. p thic invertebrates). Fish are one required in the assessment of ti the WFD. This paper describes th

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An approach to intercalibrate ecological classification tools using fish in transitional water of the North East Atlantic

Mario Lepage^{a,*}, Trevor Harrison^b, Jan Breine^c, Henrique Cabral^d, Steve Coates^e, Cristina Galván^f, Pilar García^g, Zwanette Jager^h, Fiona Kellyⁱ, Eva Christine Mosch^j, Stephanie Pasquaud^d, Jörg Scholle^k, Ainhize Uriarte¹, Angel Borja¹

^a Irstea, UR EABX, 50 av. de Verdun, F-33612 Cestas, France

^bMarine Division, Department of the Environment (Northern Ireland), 17 Antrim Rd, Tonagh, Lisburn BT28 3AL, United Kingdom

* Research Institute for Nature and Forest, Duboislaan 14, B-1560 Groenendaal, Belgium

- ⁴ Centro de Oceanografia, Faculdade de Ciências da Universidade de Lisboa, Campo Grande, 1749-016 Lisbon, Portugal
- * SLR Consulting, G3 7QF Glasgow, Scotland, United Kingdom
- ¹ Instituto de Hidráulica Ambiental "IH Cantabria", Universidad de Cantabria, Q/Isabel Torres nº 15, Parque Científico y Tecnológico de Cantabria, 39011 Santander, Spain

* INDUROT, Universidad de Oviedo, Campus de Mieres, 33600 Mieres, Asturias, Spain

hZiltWater Advies, 9905 TD Holwier de, The Nether lands

1 Inland Fisheries Ireland, Swords Business Campus Swords, Co., Dublin, Ireland

1 Lower Saxony State Office for Consumer Protection and Food Safety, Dep.34 - Department of Inland Fisheries, Eintrachtweg 19, D-30173 Hannover, Germany

* BIOCONSULT Schuchardt & Scholle GbR, 28757 Bremen, Germany

¹ AZII-Tecnalia, Marine Research Division, Herrera Kaia, Portualdea s/n, 20110 Pasaia, Spain

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ABSTRACT

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A simple procedure to harmonise and intercalibrate eight national methods classifying the ecological status using fish in transitional waters of the North East Atlantic is described. These methods were initially intercalibrated and a new method recently developed was added to this exercise. A common human pressure index pre-classified the status of each water body in an independent way. Ecological class boundaries values were established according to the level of anthropogenic pressure using regression analyses. A simulated dataset was used to assess the level of agreement between the fish classification methods. Fleiss' multi-rater kappa analysis indicated that boundary harmonisation was achieved; all classifications fell within one class of each other and class agreement between methods exceeded 70%. The use of a pressure index to establish boundary thresholds provides a practical method of defining and harmonizing the quality classes associated with human pressures, as required by the European Water Framework Directive.

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1. Introduction

The European Water Framework Directive (WFD; 2000/60/EC) outlines a framework for the assessment of European surface and ground waters, including transitional waters (estuaries) (Hering et al., 2010). Member States are required to assess the ecological status of water bodies using biological, hydromorphological and physico-chemical quality elements, Biological quality elements are assessed by comparing data obtained from monitoring programmes to some form of reference (natural) condition based on

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a network of reference sites, on historical data or on modelling, or a mixture of all of them (Borja et al., 2012). The ecological status of a particular water body is assessed on the basis of an Ecological Quality Ratio (EQR), which ranges from zero to one. The water body is then assigned to one of five status classes (high, good, moderate, poor, bad), where EQR values close to zero representing 'bad' status and EOR values close to one representing 'high' status.

Fish is one of the biological quality elements for transitional waters and numerous fish-based indices have been developed for transitional waters across Europe, as part of the requirements of the WFD (Birk et al., 2012; Pérez-Domínguez et al., 2012a,b), However, since many of these classification methods differ across member states, the results may not necessarily be comparable. To this end, the WFD requires that the various biological

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Pressure index Classification Ecological class

^{*} Corresponding author. Tel.: +44 (0) 2892623242.

E-mail addresses: Trevor.Harrison@doeni.gov.uk (T.D. Harrison), Fiona.Kelly@fisheriesireland.ie (F.L. Kelly).

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^{*} Corresponding author, Tel.: +33 557890810.

E-mail address: mario.lepage@irstea.fr (M. Lepage).

v2.0 Ireland TW Fish Classification Tool

Table 1

Metrics that make up the estuarine multi-metric fish index (EMFI).

-

Metric	Measurement				
Species diversity and composition					
1	Species richness	Number of estuarine-associated taxa			
2	No. of introduced species	Number of non-benign non-native species			
3	Species composition	% Similarity (presence/absence) to reference assemblage			
Abundance					
4	Species abundance	% Numerical similarity to reference community			
5	Dominance	Number of taxa that make up 90% of the abundance			
Estuarine utilisation					
6	No. of diadromous species	Number of anadromous and catadromous species			
7	Estuarine species richness	Number of estuarine species			
8	Marine migrant species richness	Number of marine migrant species			
9	Estuarine species abundance	Relative (%) numerical abundance of estuarine species			
10	Marine migrant species abundance	Relative (%) numerical abundance of marine migrant species			
Trophic integrity					
11	Zoobenthivore species richness	Number of estuarine-associated zoobenthivore species			
12	Piscivore species richness	Number of estuarine-associated piscivore species			
13	Zoobenthivore abundance	Relative (%) numerical abundance of estuarine-associated zoobenthivore to the total abundance.			
14	Piscivore abundance	Relative (%) numerical abundance of estuarine-associated piscivorous species to the total abundance.			

Summary

- A variety of techniques can be used in transitional waters/estuaries hence the multiple method "tool-kit" sampling to assess TW Fish up a picture.
- The timing of your surveys is critical (season/tide species change).
- If your transitional water is at a higher latitude (further north consider a late spring early autumn strategy).
- It took about 5 years to gain an impression of what was going on with the Thames estuary fish community and 10 years to gain an understanding Be Patient!
- Spatial coverage across the salinity regime and how many samples do you monitor? UK 8, 5, 3 sites was not scientifically validated.
- A different approach would have been to survey all WB's and generate data e.g. Ireland.
- You can use power station data to detect background changes in fish communities.
- Just because you haven't recorded it doesn't mean that it isn't there e.g. Lamprey & shad.

.....and also

Transitional Fish monitoring has to be carried out using consistent 'quality assured' sampling methodology in relation to BSi, CEN / ISO standards.

It is essential the fish taxonomy is quality assured so that fish ID is consistent as it drives the WFD classification tool.

Why? WFD 2000/60/EC, ANNEX V, 1.3.6.

Need to know more.....

CIEEM Guidance - Fish and Habitats Read Elliott & Hemingway <u>Fishes in Estuaries</u>

THANK YOU

Steve Coates Principal Aquatic Ecologist – SLR Consulting

() +44 (0) 141 353 5037

- e scoates@slrconsulting.com
- www.slrconsulting.com

