

Briefing Paper



The Importance of Intertidal Habitat to Fish

Globally intertidal habitats comprise of some of the most distinctive and prolific systems of earth, this include seagrass beds, mangrove habitats, kelp beds and saltmarshes. Estuarine systems also represent one of the most valuable ecosystems on earth because they have a unique biodiversity and high levels of productivity, which perform vital functions for different kinds of species (Costanza *et al.*, 1997).

Intertidal habitat in the UK typically comprises of mudflat and saltmarsh habitats, which form in areas with sufficient shelter from wave energy, e.g. inlets and estuaries. Initially, pioneer halophytic plants (plants adapted to living in salty conditions) stabilise and bind the mudflat sediments and reduce the water velocity through their stem network, aiding a succession to saltmarsh vegetation.

Estuaries are highly dynamic systems with continual larvae/ juvenile fish immigration and emigration from fluvial and marine habitats. They are also very vulnerable systems affected by both the quality and quantity of fresh and marine water they receive. It is estimated that 85% of British estuaries have lost individually up to 80% of their intertidal area through anthropogenic land claim, for reasons such as agriculture, port developments, harbours, industry, dredging and housing (Atrill *et al.*, 1999; McLusky and Elliott, 2004). Habitat loss can also be temporary as the result of water removal or water quality barriers e.g. caused by pollutant inputs (McLusky and Elliott, 2004). It is thought loss of intertidal habitat is also being exacerbated by sea-level rise in a phenomenon known as coastal squeeze; when habitat on the seaward side is lost through sea-level rise, because hard sea-line defences prevent the marshes' compensatory inland encroachment. It is estimated this currently results in the loss of 2% of English saltmarshes every year (Dixon *et al.*, 1998). However, contrary evidence in the south-east England suggests saltmarsh erosion may be amplified by changes to the intertidal biota, and an increase in abundance of the infaunal polychaete *Nereis diversicolor* (Hughes and Paramor, 2004).

Value of Intertidal habitat

Intertidal habitats have long been recognised as key feeding and roosting grounds for birds, and as possessing a wide range of key functions, including nutrient and carbon storage, and as providing primary flood defence, by attenuating wind wave height and tidal amplitude. Unpublished work from an Interreg ComCoast PhD project has also recently found intertidal areas are important in removing atmospheric particulate matter, in particular PM₁₀, meaning under the right conditions they can improve air quality (ComCoast, 2007).

The importance of these areas for fish however, has only recently been documented in the UK, despite an extensive body of work on the issue in North America. Elliott and Taylor (1989) reported that intertidal habitats in the Forth Estuary were nearly twice as productive as their subtidal equivalents. Nixon (1980) produced evidence that commercial landing of estuarine dependent species correlated with marsh area available to them in the area. Its importance for fish is strongly linked to the mixture of many distinct habitat types such as grass and reed beds and hard and soft substratum and, the high food availability and low predation pressure (Miller *et al.*, 1985; Pihl *et al.*, 2002).

A 2007 study, by Gray, in collaboration with Environment Agency (EA), of intertidal habitat in the Thames Estuary confirmed previous work by Kelley (1986:1988:2002), showing juvenile bass (*Dicentrarchus labrax*) actively favoured saltmarsh habitat in their first summer, as it provided high foraging profitability and predator avoidance. The study also found that fish species utilising intertidal saltmarsh varied with the changes in fluvial flow, demonstrating that both marine estuarine dependent and freshwater species could make opportunistic use of this intertidal resource (Gray, 2007).

Intertidal habitats are highly regarded as important sites for fish, as nurseries and over-wintering sites and migration routes for anadromous and catadromous fish (Elliott and Hemingway, 2002; McLusky and Elliott, 2004). They support critical life stages of migrating fish, by providing refugia, rich foraging, and a suitable environment for Atlantic salmon (*Salmo salar*) parr to undergo smoltification. Evidence from the River Frome has shown early autumn movements into tidal habitats in 19.1% of the total 0+ parr year class (Pinder, *et al.*, 2006). This sizeable proportion of parr relocating downstream highlights the importance of the estuary as an over-wintering habitat. The use of estuarine habitats by distinct cohorts of autumn parr migrates (Cunjak *et al.*, 1989) and remnant individuals from the previous year's smolt run (Power and Shoener, 1966), has also been found in Canadian estuaries. Research from Hutching (1986) even found despite the lower initial quantities, over-wintering estuarine parr dominated the total output for system in Newfoundland, Canada, due to the enhanced growth and survival rates associated with the estuarine habitat.

Intertidal habitats within estuaries are continuations of our river habitats, they're conservation should be viewed as an important step in re-establishing the river corridor for migrating species. In the UK these migratory fish include Habitat Directive protected species such as the twaite shad (*Alosa alosa*), sea lamprey (*Petromyzon marinus*), river lamprey (*Lampetra fluviatilis*) and Atlantic salmon.

Despite the obvious value of intertidal habitats, little work has been done to economically quantify their value, although Costanza *et al.*, (1997) estimated estuaries as one of the most expensive global habitats to recreate, due to the large amount of functions they perform both naturally and for humans, and valued them accordingly at \$22,832 per hectare per year.

Protection

Saltmarshes are now designated as UK Biodiversity Action Plan (BAP) habitat and form part of Defra's High Level Target Habitat Series. This has resulted in initiatives requiring no further net loss of saltmarsh habitat, and a growing appreciation for protecting the UK coastlines with soft-engineering methods such as managed realignments.

The Habitats Directive supplies a statutory requirement to obtain compensatory habitat if the proposed development can be shown to have a deleterious impact on the site. However, this protection only occurs in Natura 2000 designated sites e.g. SSSI and SACs.

Protection is also set to change with the introduction of the Water Framework Directive (WFD), which requires that all Member States must achieve 'good ecological status/potential' in all freshwater, transitional and coastal water-bodies by the end of 2015. This is the first time transitional waterbodies (estuaries) have been included within required monitoring programmes. Under these new guidelines, the preservation and restoration of intertidal habitats within estuaries could be required to obtain 'good ecological status/potential'. The high association of fish with the habitats shown in recent EA studies could be developed as an argument under WFD to protect all extant saltmarsh as a necessary element within existing good ecological status/potential.

Effect of Removing Intertidal Habitat

Evidence from the Humber Estuary shows the removal of intertidal saltmarsh and mudflat markedly reduces the carbon and nutrient trapping capacity of the estuary (Andrews *et al.*, 2000). With the UK now required to implement large-scale decreases in nutrient inputs reaching the North Sea under the OSPAR Convention, and EC Nitrates from Agricultural Directive (91/676/EEC), this in itself has huge monetary value. Global pressure to reduce carbon footprints also highlights the need to value and assess the carbon storage abilities of intertidal areas within coastal management schemes (Andrews *et al.*, 2006).

In terms of fisheries benefits, each part of the intertidal habitat within estuaries could indirectly contribute to commercial offshore fisheries through increased recruitment (Tinch, 2003) and directly contribute to recreational fisheries (Bell, 1997). Therefore, removing these nursery habitats could significantly affect juvenile recruitment, as well as reducing species diversity as many endemic fish species are associated with estuarine habitats.

Call for Further Action

The destruction of intertidal habitat is resulting in the loss of important nursery and feeding grounds for a wide range of fauna, including fish species. We feel further action and political will is required to prevent further intertidal habitat loss. Compensatory habitat should not be used as an acceptable solution to mitigate the large scale loss of extant intertidal habitat. Intertidal habitat is intrinsically linked to the health of surrounding environment, river and marine networks, by the export of energy, refuge corridor for migratory species and its role as a key nursery habitat.

The S&TA calls for:

- Further protection for intertidal habitat by making them candidates for Marine Protected Areas (MPA). The MPA network should be working to help safeguard different stages of commercial/recreational fish's life history. Designating intertidal habitat will help achieve maximum recruitment through nursery protection, which will help boost fisheries in the future.
- Further action is also required to address water quality, water removal and sediment problems affecting intertidal habitat survival.

Conclusion

The protection of intertidal habitats is a vital step in improving local commercial and recreational fisheries, through increased juvenile recruitment and production. Intertidal habitats have the ability to achieve a range of ecosystem functions from increasing biodiversity to improving air quality, carbon storage and flood defence simultaneously. The benefits provided by intertidal habitats are extremely important and topical in light of current proposals to harness tidal energy. It seems illogical that all these natural functions of intertidal habitat should be put at threat in order to harvest the one resource of tidal energy.

Acknowledgements

Thanks for the expertise and guidance from Ana Silva, third year PhD student at Plymouth University, Dr Roger Herbert, Bournemouth University and Dr Rob Hughes, Queen Mary, University of London.

References

- Andrews, J.E., Samways, G., Dennis, P.F. and Maher, B.A. (2000). Origin, abundance and storage of organic carbon and sulphur in the Holocene Humber Estuary: emphasizing human impact on storage channels. In: Shennan, I. and Andrews, J. (Eds). *Holocene Land-Ocean Interaction and Environmental Change around the North Sea*. Geographical Society of London, Special Publications, London 144: 145-170.
- Atrill, M.J., Bilton, D.T., Rowden, A.A., Rundle, S.D. and Thomas, R.M. (1999). The impact of encroachment and bankside development on the habitat complexity and supralittoral invertebrate communities of the Thames Estuary foreshore. *Aquatic Conservation- Marine and Freshwater Ecosystems* **9**: 237-247.
- Bell, F.W. (1997). The economic valuation of saltwater marsh supporting marine recreational fishing in the South-eastern United States. *Ecological Economics* **21**: 243-254.
- ComCoast. (2007). Project updates. [Online]. Available from: <http://www.comcoast.org> [Assessed 7th December 2007].
- Costanza, R., D'Arge, R., De Groot, R., Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neill, R.V., Paruelo, J., Raskin, R.G. Sutton, P. and Van Den Belt, M. (1997). The value of the world's ecosystem services and natural capital. *Nature* **387**: 253-260.
- Cunjak, R.A., Chadwick, E.M.P. and Shears, M. (1989). Downstream movements and estuarine resident by Atlantic salmon parr (*Salmo salar*, L). *Canadian Journal of Fisheries and Aquatic Sciences* **46**: 1466-1471.
- Dixon, A.M., Leggett, D.J. and Weight, R.C. (1998). Habitat creation opportunities for landward coastal re-alignment Essex case studies. *Journal of Chartered Institute of Water and Environmental Management* **12**: 107-111.

- Elliott, M. and Hemingway, K.L. (Eds). (2002). *Fishes in Estuaries*. Blackwell Science, Oxford.
- Elliott, M. and Taylor, C.J.L. (1989). *The Structure and Functioning of an Estuarine/marine Fish Community in the Forth estuary, Scotland*. Proceedings of the 21st European Marine Biology Symposium, Gdansk, September 1986. Gdansk: Polish Academy of Sciences, Institute of Oceanology: 227-240.
- Gray, J. and the Environment Agency. (2007). Fish Utilisation of restored intertidal habitat in a tidal backwater of the Thames Estuary. (Unpublished).
- Hughes, R.G. and Paramor, O.A.L. (2004). On the loss of saltmarshes in south-east England and methods for their restoration. *Journal of Applied Ecology* **41** (3): 440-448.
- Kelley, D.F. (1986). Bass nurseries on the west coast of the U.K. *Journal of Marine Biology* **68**: 179-214.
- Kelley, D.F. (1988). The importance of estuaries for sea-bass, *Dicentrarchus labrax* (L.). *Journal of Fish Biology* **33** (Suppl. A): 25-33.
- Kelley, D.F. (2002). Abundance, growth and first- winter survival of young bass in nurseries of the south-west England. *Journal of the Marine Biological Association of the UK* **82**: 307-319.
- McLusky, D.S. and Elliott, M. (2004). *The Estuarine Ecosystem: ecology, threats and management, Third edition*. Oxford University Press, Oxford.
- Miller, J.M., L.B. Crowder & M.L. Moser. (1985). Migration and utilization of estuarine nurseries by juvenile fishes: an evolutionary perspective. *Contr. Mar. Sci.* **27** (Suppl.): 338-352.
- Nixon, S.W. (1980). Between coastal marshes and coastal waters- a review of twenty years of speculation and research on the role of saltmarsh in estuarine productivity and water chemistry. In: Hamilton, P. and MacDonald, K.B. (Eds). *Estuarine and Wetland Processes*. Plenum, New York.
- Pihl, L., Cattrijsse, A., Codling, I., Mathieson, S., McLusky, D.S. and Roberts, C. (2002). *Habitat use by fishes in estuaries and other brackish areas*. In: Elliott, M. and Hemingway, K.L. (eds). (2002). *Fishes in Estuaries*, Blackwell Science, Oxford, pp. 10-53
- Pinder, A.C., Riley, W.D., Ibbotson, A.T. and Beaumont, W.R.C. (2006). Evidence for an autumn downstream migration and the subsequent estuarine residence of 0+ year juvenile Atlantic salmon *Salmo salar* L., in England. *Journal of Fish Biology* **71**: 260-264.
- Power, G. and Shooner, G. (1966). Juvenile salmon in the estuary and lower Nabisipi River and some results of tagging. *Journal of Fisheries Research Board of Canada* **23**: 947-961.
- Tinch, R. (2003). Managed Re-alignment, Intertidal Zones and Offshore Fishery Production. In: Ledoux, L. (Eds). *Proceedings of a workshop organised for the Environment Agency by Environmental Future Ltd. And CSERGE*. UK.

For Further Details please contact Janina Gray, Research and Policy Manager, at: janina@salmon-trout.org or 0207 2835838