The Implications of Bait-Digging and Crab-Tiling Activities on the Waterbirds of the Exe Estuary

2015

EXE

ESTUARY MANAGEMENT PARTNERSHIP

The Implications of Bait-Digging and Crab-Tiling Activities on the Waterbirds of the Exe Estuary

Introduction

The collection of bait for fishing is a common use of the estuarine system. There are two main types practiced in the South West, firstly crab-tiling which involves the distribution of objects such as guttering, tyres and tiles in the intertidal that shore crabs, *Carcinus maenas* (Linnaeus, 1758), can use for shelter. Here the crabs moult their shell to become "peeler crabs". During low tide, crab-tilers overturn these artificial shelters and collect the moulting crabs for use as bait (Sheehan, 2007). Over 1 million peeler crabs are removed for bait each year in the south-west UK, making it a major commercial use of estuaries in this area (Sheehan, 2008).

The other method used to collect bait is bait-digging. This is generally done by hand using a fork or spade to find lugworms (*Arenicola spp*.) and ragworms (*Nereis* and *Nephtys spp)* (Ukmarinesac.org.uk, 2015). The bait digger first must search for signs of a worm burrow, usually by the coiled casts of sand left by lugworms (OpenLearn, 2015).

The Exe Estuary is an important site, locally, nationally and internationally, and as such has a great deal of legislative protection. The Exe Estuary is a Ramsar site, a Special Protection Area for birds and a Site of Special Scientific Interest due to its international importance for waders and wintering wildfowl. In addition to this, it encompasses Dawlish Warren, a European Special Area of Conservation and National Nature Reserve, and the Exmouth Local Nature Reserve (Exe Estuary Management Partnership, 2015). As such, this means that the impacts of commercial activities, such as crab-tiling and bait-digging, must be properly assessed and controlled.

Many of the studies into bait-digging and crab-tiling are based on the disturbance of infauna, not on bird numbers. This is because species in the sediment tend to be more abundant and less mobile, making them easier to sample. However, it is possible to directly link the change in infauna to the activities of waterbirds as many species of waterbirds rely on infaunal species for food. Table 1 shows the diversity of prey that are targeted by birds found on the Exe Estuary. From this table, you can see that the most common source of food for Exe waterbirds is worms, which are abundant in estuarine mud.

Bird	Crustacea	Worms	Insects	Fish	Snails	Shellfish	Shrimp	Vegetation	Other
Avocet	Yes	Yes	Yes						
Black Headed Gull		Yes	Yes	Yes					Yes
Black Tailed Godwit		Yes	Yes		Yes				
Brent Goose								Yes	
Curlew		Yes				Yes	Yes		
Dunlin		Yes	Yes		Yes				
Golden Plover		Yes	Yes						
Grey Plover		Yes				Yes			
Grey Heron				Yes					Yes
Little Egret				Yes					
Oystercatcher						Yes			
Redshank	Yes		Yes			Yes			
Widgeon								Yes	
Totals	2	7	6	3	2	4	1	2	2

Table 1: Food sources of the prominent bird species in the Exe Estuary. Information taken from "Your guide to....Wild birds by train" leaflet compiled by the RSPB and the Avocet Rail Users Group and the RSPB website (RSPB.org.uk, 2015)

Crab-Tiling

The last crab-tile count undertaken on the Exe Estuary was in 2012 by Devon & Severn Inshore Fisheries and Conservation Authority (D&SIFCA). 20,997 crab-tiles were counted on the estuary, however, this figure has dropped from its peak of 30,302 in 2004 (See figure 1).

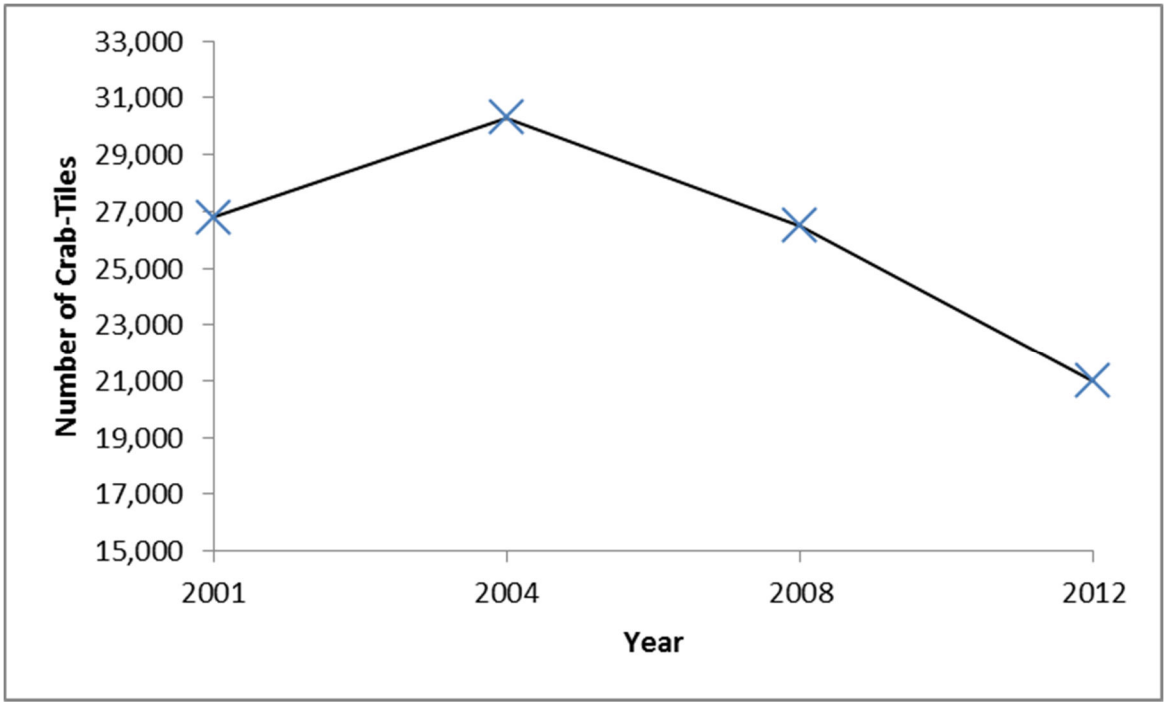

Figure 1: The number of crab-tiles on the Exe Estuary per year, compiled from data collected by Devon and Severn IFCA for their crab-tiling surveys.

A study in 2007 focused on how crab-tiling influenced nematode species. This showed that there was a significant reduction in the density of nematodes after crab-tiles were laid, although this also corresponded to a 12-36 hour recovery time in which density dramatically increased. This therefore suggested that the main cause of disturbance during crab-tiling was vibration-induced burying caused by trampling whilst setting the crab-tile, not from the crab-tile itself (Johnson et al., 2007).

This was then furthered by a comprehensive study carried out by E.V. Sheehan et al. in 2010 which looked at the impact of crab-tiling on the diversity of infaunal species. In this study, different areas were divided into sections with 3 different treatments; crab-tiles, just trampling and control areas. This showed that the diversity of infaunal species decreased when crab-tiling was practiced, however, the majority of this was caused by trampling as there was little difference between the crab-tile and trampled treatments. In addition to this, the effect of grain-size was also studied. This showed that crab-tiling increased the ease of penetration of the sediments resulting in the impact of trampling being exaggerated in estuaries with finer grain sizes.

However, it was found that crab-tiling had positive effects on the populations of shore crabs. An increased abundance of shore crabs was found in estuaries where crab-tiling is practiced, thought to be due to the addition of habitat which protects the moulting crabs from predation. The downside to this being that tiling does have an inverse effect on the mean size of the crabs, with the mean size group being 30-39mm in non-tiled estuaries compared to 20-29mm in areas where crab-tiles were present. There was no noticeable impact on the sex ratio (Sheehan et al., 2008).

Bait-Digging

Bait-digging tends to have an adverse effect on a wider range of species than crab-tiling, due to the fact that it involves physically disturbing the sediment that many organisms depend upon. An example of this is the consequences that bait-digging has on cockle populations. M.J. Jackson and R. James' study on this discovered that increased digging in an area caused higher cockle mortality, especially on smaller individuals. Through laboratory experiments it was deduced that bait-digging causes mortality to cockles due to the increased likelihood that cockles get buried at a depth deeper than 10cm deep. Few cockles that were buried this deep under laboratory conditions could survive.

It is also important to study the repopulation rates of affected species, not just the initial effect. In 1987, Cryer, Whittle and Williams studied the repopulation of lugworms after periods of intense digging. This was done by removing all lugworms in an area by digging, then counting the number of worm casts that reappeared in the dug zone over subsequent weeks and months. This study concluded that after heavy bait-digging, lugworm population recovery rates are slow.

In 1987, Taco van den Heiligenberg then broadened the investigation, studying the repopulation rates of a range of different infaunal species. He concluded that bait-digging reduces the abundance of all major species in area. Despite this, some species (e.g *Macoma baltica* – Baltic Clam and *Scoloplos armiger*- a deposit feeding polychaete) recovered very quickly, in less than 50 days after hand digging for *Scoloplos armiger*. In addition, areas that were dug had a higher juvenile recruitment. This is important for birds as it means that the repopulated food supply consists of younger and therefore smaller individuals, so a greater number need to be consumed to provide the same amount of energy.

An important point is that the effect of bait digging on the infaunal species is not uniform between estuaries. A study looking at the South Iberian coast concluded that the mud content of the estuary has a big impact on the amount of disturbance caused by bait digging. Estuaries with low mud content generally have a greater infaunal diversity and therefore were able to recover within 7 days. Areas with high mud content were dominated by key species and took longer to recover (Carvalho et al., 2013). The Exe Estuary is a relatively sandy estuary (Sheehan, 2007), and therefore will have a lower mud content suggesting a better recovery rate. The issue with this study is that it is from the South Iberian coast so may not be relevant to the Exe Estuary.

Impact on Birds

The evidence presented so far has shown a definitive impact of both crab-tiling and bait-digging on communities of infauna; however, it has not proved a significant bearing on the bird species found on the Exe Estuary.

Leo Zwarts (1993) was important in demonstrating the link between the biomass, and therefore energy content, of estuarine infauna and the behaviour of wading birds. It was shown that wading birds extend their feeding period, increase their attack rate, broaden the prey they will eat or move to different areas to cope with seasonal reduction in infaunal biomass. It can therefore be hypothesised that the reduced biomass caused by crab-tiling and bait-digging will have a similar impact on the estuary's wading birds.

The impact of bait-digging on estuarine birds was measured in the Bay of Fundy, Canada, investigating how digging for bloodworms affected populations of Semipalmated Sandpipers (*Calidris pusilla*). Despite bloodworms not being the sandpipers' source of food, it was found that foraging efficiency decreased by 68.5% which related to a reduction in the amphipod *Corophium volutator*, their food source. These changes were seen after just one season of bait-digging, and it was observed that sandpipers on dug regions of the estuary took longer to build up fat deposits needed for migration, meaning that they either left late or left without sufficient fat deposits (Shepherd and Boates, 1999).

More recently, a similar study has been published looking at the effect of crab-tiles on estuary birds. This showed no significant influence of crab-tiles on bird species richness, abundance or assemblage composition (Sheehan et al., 2012). However, it is worth noting that shorebird abundance has been rejected as a

suitable method of measuring the disturbance of birds (Lafferty 2001). In addition to this, Sheehan observed curlew (*Numenius arquata*) and redshank (T*ringa tetanus*) to discover changes to their distribution and behaviour based on the presence of crab-tiles. It was found that behaviour of both birds changed, but these changes differed dependant on the species. Redshanks were more often found near the crab-tiles, although they did not alter their feeding effort. Curlews, on the other hand, were not found near the crab-tiles, but when crab-tiles were present did spend more time feeding. It was noted that crab-tiles offer the birds protection from the wind, meaning that the birds spent more time preening and resting on the estuary (Sheehan et al., 2012).

Exe Disturbance Study

The Exe Disturbance Study (Liley et al., 2011) was commissioned by the Exe Estuary Management Partnership to consider human disturbance from water sports and shore-based activities to wintering waterfowl on the Exe Estuary. 32% of the observed disturbance events were from activities on the intertidal, with bait-diggers and crab-tilers contributing to 7% of the events. It is worth noting that this is only a count of number of events, not the proportional severity. However, the report suggests that although fewer activities are taking place on the intertidal, these activities are much more likely to result in major flight events, with bait-digging accounting for 16% of all major flight events recorded during the study. For crab-tilers, it often appeared that the person walking out to the tiles caused more disturbance than the actual checking under the tiles.

There is evidence that bird distributions are related to access, with hard to reach areas having the highest abundance of birds. This is also shown at a small temporal scale in various places around the estuary, as numbers of birds were proportional to the numbers of people visiting the site with a 45 minute lag time. The number of birds appeared to be relatively low at the Duck Pond and at Topsham, whilst areas with lower levels of access, such as the Bight to the north of Dawlish Warren and at Powderham, had higher bird counts.

The area of disturbance was calculated for various activities, kitesurfing disturbed 8 Ha and dog walking on the intertidal disturbed 3 Ha, whilst walking along the coast path only disturbed 0.1 Ha. Unfortunately, no data was collated to suggest the disturbance area caused by bait-digging or crab-tiling, but it can be assumed that the area of disturbance would be smaller than that caused by dog walking, but greater than that caused by walking on the shore.

Conclusion

The evidence base suggests that the overall impacts of bait-digging are far worse than those of crab-tiling. Although, crab-tiling is a vastly uninvestigated commercial output from the important estuary system and therefore it would be beneficial for more research to be conducted. The damaging effect of both forms of bait-collection is their impact on the infaunal species that the birds rely on for an energy supply; bait-digging causes a more permanent disturbance to the sediment which causes the larger mortality to infauna, as shown in the literature. Additionally, the Exe Disturbance Study suggests that both forms of bait-collection causes disturbance of birds, with bait-digging having a more significant effect on major flight events.

There is no simple solution to this problem as it is a classic example of the driving force of people and the economy against environmentalism and conservation, and therefore a compromise is required. To mitigate against bait-digging, it is suggested that the practice should be halted or reduced during important times for birds, such as before the winter migrations. For crab-tiling, the main damage is caused by trampling from the crab-tilers themselves. This means that a suitable arrangement could be to mark out walkways for the crab-tilers to use, therefore concentrating the damage on select areas and allowing the rest of the sediment to recover.

References

Carvalho, S., Constantino, R., Cerqueira, M., Pereira, F., Subida, M., Drake, P. and Gaspar, M. (2013). Short-term impact of bait digging on intertidal macrobenthic assemblages of two south Iberian Atlantic systems. Estuarine, Coastal and Shelf Science, 132, pp.65-76.

Clark, S. (n.d.). A Voluntary Approach to Crab Tile Management in Devon.

Cryer, M., Whittle, G. and Williams, R. (1987). The impact of bait collection by anglers on marine intertidal invertebrates. Biological Conservation, 42(2), pp.83-93.

Exe Estuary Management Partnership, (2015). Designations. [online] Available at: https://www.exe-estuary.org/exe-designations [Accessed 21 Aug. 2015].

Jackson, M. and James, R. (1979). The Influence of Bait Digging on Cockle, Cerastoderma edule, Populations in North Norfolk. The Journal of Applied Ecology, 16(3), p.671.

Johnson, G., Attrill, M., Sheehan, E. and Somerfield, P. (2007). Recovery of meiofauna communities following mudflat disturbance by trampling associated with crab-tiling. Marine Environmental Research, 64(4), pp.409-416.

Lafferty KD. (2001). Birds at a Southern California beach: seasonality, habitat use and disturbance by human activity. Biodiversity and Conservation, 10(1), pp.1949-1962.

Liley, D., Cruickshanks, K., Waldon, J. & Fearnley, H. (2011). Exe Disturbance Study. Footprint Ecology.

OpenLearn, (2015). Beach life. [online] Available at: http://www.open.edu/openlearn/nature-environment/natural-history/beach-life [Accessed 21 Aug. 2015].

RSPB, (2015). Exe Estuary. [online] Available at: http://www.rspb.org.uk/discoverandenjoynature/seenature/collections/exeestuary.aspx [Accessed 24 August 2015].

RSPB & Avocet Line Rail Users Group. 2009. Freeline Graphics. [online] Exeter (Published 2009) Available at: http://www.avocetline.org.uk/wp-content/uploads/Where-to-watch-birds-leaflet.pdf [Accessed August 24, 2015]

Sheehan, E. (2007). Ecological impact of the Carcinus maenas (L.) fishery 'crab-tiling' on estuarine fauna. PhD. University of Plymouth.

Sheehan, E., Attrill, M., Thompson, R. and Coleman, R. (2012). Changes in shorebird behaviour and distribution associated with an intertidal crab fishery. Aquatic Conserv: Mar. Freshw. Ecosyst., 22(5), pp.683-694.

Sheehan, E., Coleman, R., Thompson, R. and Attrill, M. (2010). Crab-tiling reduces the diversity of estuarine infauna. Marine Ecology Progress Series, 411, pp.137-148.

Sheehan, E., Thompson, R., Coleman, R. and Attrill, M. (2008). Positive feedback fishery: Population consequences of 'crab-tiling' on the green crab Carcinus maenas. Journal of Sea Research, 60(4), pp.303-309.

Shepherd, P. and Boates, J. (1999). Effects of a Commercial Baitworm Harvest on Semipalmated Sandpipers and Their Prey in the Bay of Fundy Hemispheric Shorebird Reserve. Conservation Biology, 13(2), pp.347-356.

Ukmarinesac.org.uk, (2015). Methods of hand digging for bait. [online] Available at: http://www.ukmarinesac.org.uk/activities/bait-collection/bc2_3.htm [Accessed 21 Aug. 2015].

van den Heiligenberg, T. (1987). Effects of mechanical and manual harvesting of lugworms Arenicola marina L. on the benthic fauna of tidal flats in the Dutch Wadden sea. Biological Conservation, 39(3), pp.165-177.

Zwarts, L. and Wanink, J. (1993). How the food supply harvestable by waders in the Wadden Sea depends on the variation in energy density, body weight, biomass, burying depth and behaviour of tidal-flat invertebrates. Netherlands Journal of Sea Research, 31(4), pp.441-476.