The effects of intertidal oyster (*Crassostrea gigas*) culture on the spatial distribution of waterbirds

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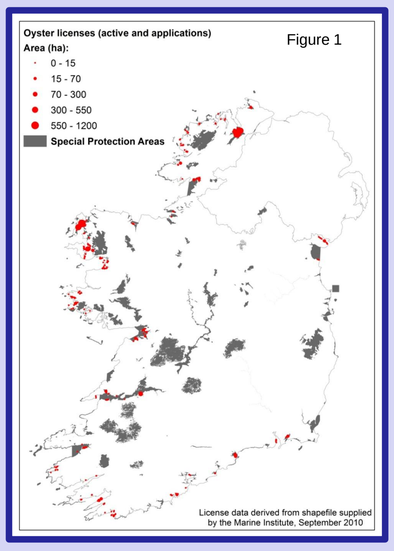
Introduction

Intertidal culture of the Pacific Oyster using oyster trestles is widespread in Ireland. It occurs in 16 SPAs occupying a total area of 2262 ha and another 45 ha of applications for licenses. The potential impact of this activity on waterbird populations will be an issue in a number of Appropriate Assessments. There is little published information available about this potential impact. Therefore, a research programme was designed by Atkins, in consultation with the Marine Institute, to fill this information gap. This research programme included extensive and intensive studies of the relationship between waterbird distribution and intertidal oyster culture



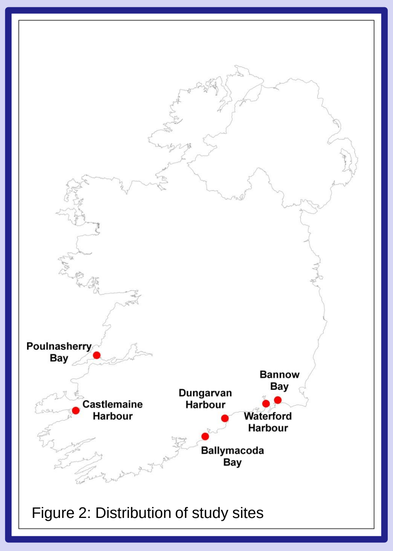


Figure 2: Distribution of study sites

Study Design

The objective was to identify consistent patterns across sites of positive and/or negative associations between waterbird distribution and the presence of oyster trestles. The study included an extensive study across six sites (Figure 2) and an intensive study at one site.

Extensive study: Between seven and fourteen count sectors were defined in each site to include the main areas of trestle activity and most, or all, areas of similar substrate type (controls). An example of the arrangement of count sectors at one site is shown in Figure 3. Counts were carried out on four count days at each site during spring low tide periods in January and February 2011.

Intensive study: The study area was a 2 km stretch of shore that was divided into seven longitudinal sectors and five lateral bands (Figure 3). The study area was designed so that the tideline passed through each sector with broadly similar timing.

On each count, the numbers, location (within or outside trestle blocks), position (tideline or intertidal) and activity (feeding or roosting/other) of all waterbird species were recorded in each count sector (extensive study) or each band of each sector (intensive study), and the position of the tideline was mapped.

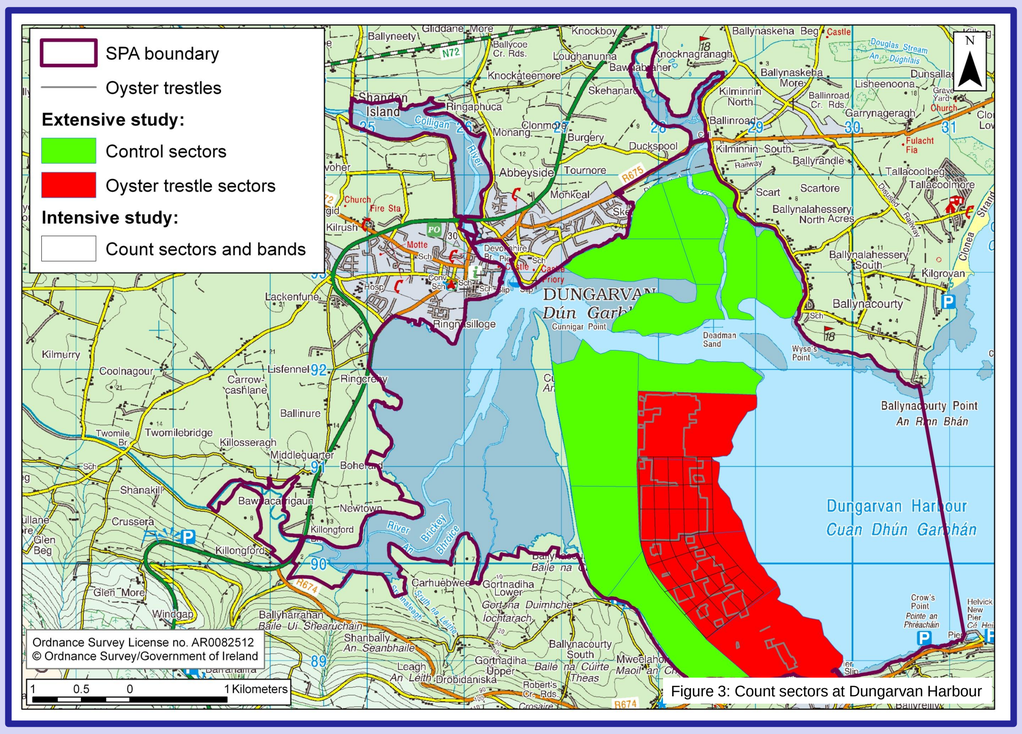


Figure 3: Count sectors at Dungarvan Harbour

Data analysis

The tideline positions recorded on each count were used to calculate the amount of available habitat in the control and impact sectors.

We used Non-metric multidimensional scaling analyses (NMS) and Canonical Correspondence Analysis (CCA)on the extensive study dataset to examine the overall response of the waterbird assemblage to intertidal oyster cultivation. For these analyses, we grouped the sectors in each site into three groups: 1. oyster trestle areas, 2. close controls and 3. distant controls.

We analysed data for individual species to test the null hypothesis that bird distribution within our study areas was not affected by the presence of oyster trestles. We calculated the expected number of birds in areas of oyster trestles, as follows:

Expected number = (total number in intertidal away from tideline * proportion of intertidal habitat area within oyster trestles) + (total number on tideline * proportion of tideline within oyster trestles)

For each species, we carried out three analyses: one on the intensive study dataset, and two on the extensive study dataset, one using all the sectors and the other using the oyster trestle sectors and close controls. We used scattergraphs to compare the data visually and to identify any differences between sites in the relationship between observed and expected numbers.

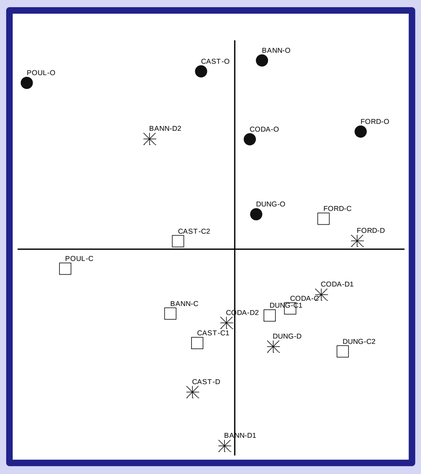


Figure 4: NMS ordination of variation in the all species assemblage across all sites. Oyster trestle groups are indicated by closed circles, close controls by open squares and distant controls by asterisks.

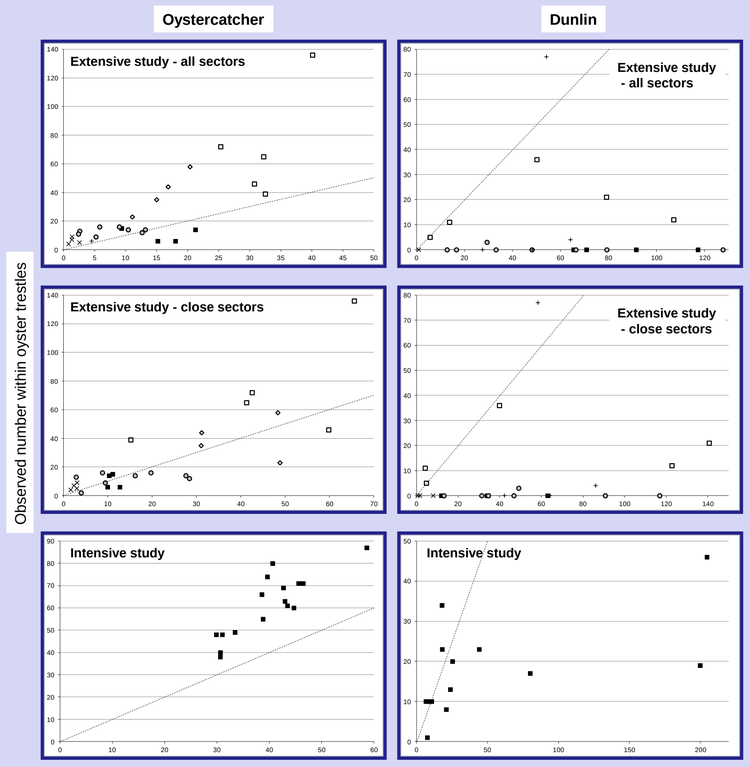


Figure 4: Observed compared to predicted occurrence of Oystercatcher and Dunlin within oyster trestle blocks

Results

The NMS (Figure 4) and CCA analyses produced similar arrangements of samples in the ordination space, showing clear separation between the oyster trestle groups and the control groups. The final CCA model included SITE and OYSTER as explanatory variables and had high eigenvalues and species-environment correlations. These ordinations show that the assemblage of waterbirds occurring within an oyster trestle area is significantly different to the assemblages outside such an area at the same site.

In the species analyses most species showed similar patterns of association with oyster trestle blocks between the extensive and intensive datasets, and between the all sectors and close sectors analyses. Examples of species showing neutral/positive (Oystercatcher) and negative (Dunlin) responses are shown in Figure 4.

Patterns of waterbird association with intertidal oyster cultivation

Based on our results, we classified species' responses to intertidal oyster cultivation as follows (italics indicate that the classification is based on limited data):

Neutral/positive response: Oystercatcher, Curlew, Redshank, *Greenshank* and Turnstone

Variable response (response varies between sites): Light-bellied Brent Goose, Black-headed Gull, Common Gull and Herring Gull

Negative response: *Shelduck*, *Ringed Plover*, *Lapwing*, *Sanderling*, Dunlin, *Black-tailed Godwit*, Bar-tailed Godwit, *Great Black-backed Gull*

Exclusion (completely excluded from oyster trestles blocks): Grey Plover and Knot

The species that showed a neutral/positive response are all waders that tend to feed in small flocks or as widely dispersed individuals/loose flocks. The species that showed a negative response are mainly species that tend to feed in large flocks of tightly packed individuals. The negative response to oyster trestle blocks may be a behavioural response by species where the oyster trestles interfere with their flocking behaviour.

Species that show a negative response to oyster trestles generally favour open mudflats or sandflats and usually do not occur in large numbers in mixed sediment or rocky shores.

Conclusions

Waterbird species show a mixture of responses to the presence of oyster trestles.

Some species show strong negative responses and could be significantly affected by intertidal oyster cultivation.

We have developed a methodology for o provide a consistent approach to the assessment of the potential impact of intertidal oyster cultivation in the context of Appropriate Assessment of aquaculture activities in coastal SPAs (Figure 5).

Selection of mixed sediment or rocky shore sites for intertidal oyster culture would be likely to reduce the potential impact on waterbirds and would also simply the appropriate assessment requirements.

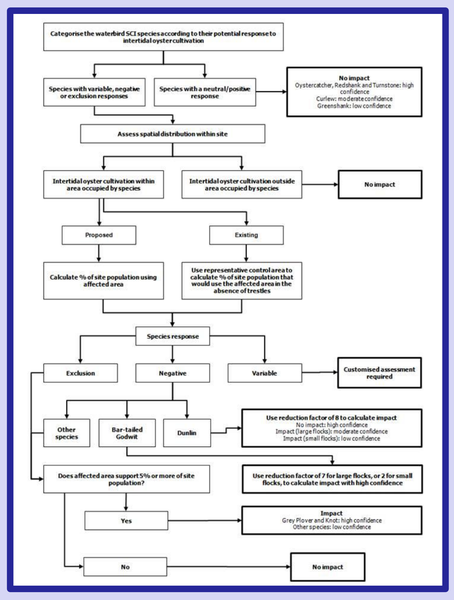


Figure 5: Flowchart showing procedure for assessing the impact of intertidal oyster cultivation.

Acknowledgements

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