

## Context of Cumulative Effects

The continual growth of more, larger windfarms in UK coastal waters will lead to a substantial area of the sea being used to generate renewable energy. With windfarms being sited in relative proximity to one another, the interaction of environmental impacts, or cumulative environmental impacts, is becoming an increasing concern. The assessment, or lack, of such collective impacts have previously led to delays in granting consent for windfarm development. This can have a negative implication on the start of construction and operation, costing time and money.

The environmental effects of offshore windfarms can be direct (e.g. mortality, injury) or indirect (e.g. behavioural and habitat changes), as well as positive and negative. Individual effects can be small, but when combined with effects from other projects, can be quite significant and surpass thresholds of reversible change.

## Objectives and Aims

- To detect environmental changes in the North Sea caused by the presence of multiple offshore windfarms.
- To use data readily collected by windfarm developers to investigate the cumulative environmental impacts across key species and trophic levels.
- To detect adverse impacts and generate suggestions for mitigation practices at existing windfarms.
- To suggest measures to prevent adverse impacts and enhance benefits of new windfarms.

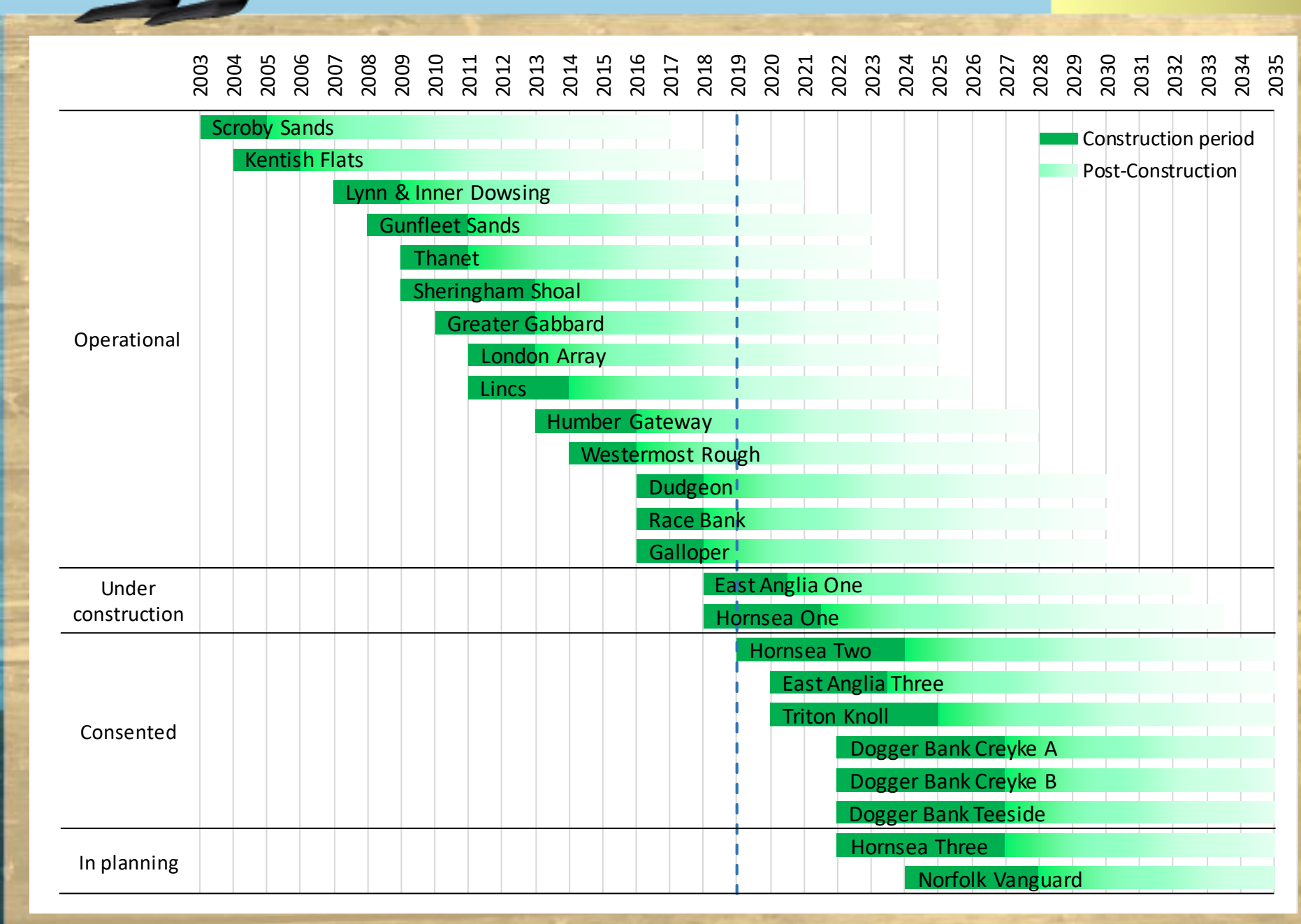
## The Problem

Cumulative Effects Assessments (CEA) are often based on a snapshot in time and space. However, ecological changes can take time to occur and potentially longer to be detected. They can also be translated spatially with highly mobile species.

The graph shows the continual addition of offshore windfarms in the North Sea. How have the effects of these windfarms interacted to date, and how will the addition of more windfarms have an impact? Are impacts additive ( $A+B=C$ ), synergistic ( $A+B>C$ ) or antagonistic ( $A+B<C$ )?

## Key Questions

- How far spatially are effects seen?
  - How long temporally are effects seen?
  - What are the negative impacts?
    - How can they be mitigated?
  - What are the positive impacts?
    - How can they be enhanced?



## Methodology for Assessing Cumulative Impacts

GIS and ecosystem modelling approach using open source data:

- Pre-construction and Environmental Impact Assessment (EIA) data
- Post-construction monitoring data
- Environmental databases

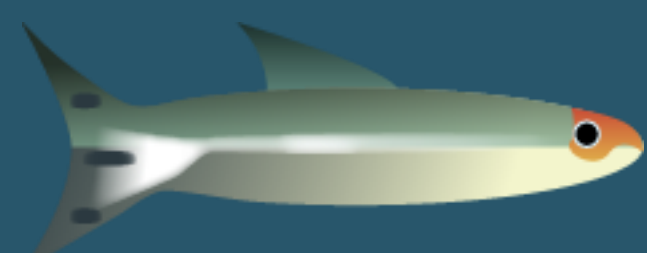
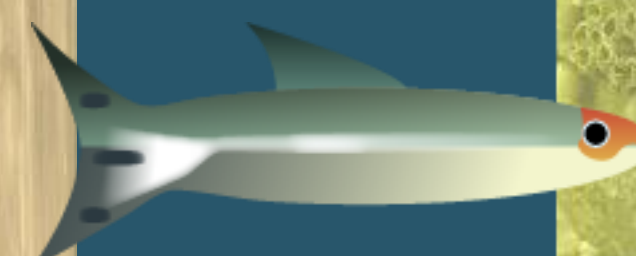
The research will be split into four stages, the results of each informing the exact nature of the next.

**Stage 1:** What are the drawbacks of offshore windfarm CEAs and how can they be improved?

**Stage 2:** How can EIA and post-construction monitoring data be used to detect and predict cumulative environmental impacts of offshore windfarms?

**Stage 3:** How do cumulative environmental impacts of offshore windfarms effect trophic levels?

**Stage 4:** How can cumulative environmental impacts of offshore windfarms be mitigated?



## Implications of the Research

Knowledge of what changes are happening and why they are occurring will allow mitigation of adverse impacts from existing windfarms.

This knowledge could also predict future changes within CEA during the process of gaining consent to construct and operate a new offshore windfarm. Future wind farms could then be optimised to prevent negative impacts before they occur. Any positive impacts could be enhanced to increase environmental benefits.