Factsheet No. 5, July 2017

CERES storyline - oysters in the North Sea

What do we expect under climate change?

Two species of oysters are produced in the North Sea area; the Pacific oyster *Crassostrea gigas* and the European oyster *Ostrea edulis*. Main production techniques are fisheries (e.g. in Limfjord Denmark), bottom culture (SW Netherlands), off-bottom culture (bags on trestles in UK and Netherlands, cages on longlines in Netherlands) and ponds in Norway.

Oyster culture depends on either natural recruitment and environmental factors such as food supply, temperature and salinity, or hatchery production.

Our goal in CERES is to determine and predict the changes in oyster productivity (and resulting socio-economic effects) from direct and indirect climate-driven environmental factors on physical, biochemical and biological components. Climate change is expected to affect the health and growth performance of oysters directly via physiological responses, immunobiological performance and acclimation to the new environmental conditions and indirectly via potential pressure from Harmful Algal Blooms (HABs), jellyfish outbreaks, invasive species and diseases. The most important effects of climate change on oyster production concern more frequent occurrence of diseases and toxic algal blooms

How vulnerable are oysters?

Direct effects on Pacific oysters are less likely since the species seem to withstand a wide range of temperatures and salinities. European oysters are sensitive to low salinities. Thus, extra inflow of fresh water as a result of rain may be a problem. Indirect effects such as toxic algae and diseases are expected to cause problems. Expansion of the distribution range of non-native species such as the Japanese oyster drill (*Ocenebra inornata*) can cause mortality among juveniles.

What is the economic value of this species?

According to the FAO statistics, oyster production in the North Sea area was 2008 tonnes in 2015. Production was largest in the UK, followed by the Netherlands. Production in the Netherlands is most probably Pacific and European oysters combined. The value of the total landings was over 9 million US dollars.

Production and economic values of oyters (www.fao.org)

Country	Species	Quantity (tonnes)	Value (1000 USD)
Germany	Pacific cupped oyster	80	799
Netherlands	European flat oyster	350	1806
Norway	European flat oyster	10	72
United Kingdom	European flat oyster	28	287
United Kingdom	Pacific cupped oyster	1540	6200
Total		2008	9163

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This project receives funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 678193 (CERES, Climate Change and European Aquatic Resources).

What are the challenges?

Differences between native European oyster and non-native Pacific oyster in adaptation to changed environmental conditions are important in determining potential competition between the two species.

What is the working program in CERES?

Multi-stressor laboratory experiments (e.g. temperature vs food concentration) will be conducted on oysters.

Two model approaches are used to predict the oyster productivity under various climate scenarios. After reviewing and collating the knowledges on climate-driven environmental factors affecting oyster productivity, and performing experiments to fill gaps, data will be used to improve process parameterization needed for projecting climate-driven changes in oyster production potential:

Direct effect of climate change: models for productivity and connectivity

- Physiological modelling: Net Energy Balance (NEB) and generic Dynamic Energy Budget (DEB) models will be calibrated using new experimental data to improve the prediction of climate change effects on individual oyster growth.
- Population models at farm and local scale, e.g. Farm Aquaculture Resource Management (FARM) model will be used to examine direct climate-driven responses on population growth, harvest, environmental effects of culture and production analysis, using a layout which reflects typical culture practices for oysters in Northern Europe.
- Collections of farms (farm areas) at the system scale outputs that for instance combine increased susceptibility to disease with connectivity patterns

Indirect effects of climate change: models for mitigation and early warning

- Development and application of theoretical & statistical early warning techniques long-time series of Harmful Algal Bloom (HAB) occurrence in European waters and dynamic linear programming techniques to model the prevalence of HABs in coastal waters
- Model of the spreading of diseases through aquaculture facilities as a result of climate change, providing unique risk assessments of the cumulative impacts on aquaculture productivity both on farm and large scale, as a result of climate change

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