EFFECTS OF ALTERED HABITATS AND FISHING PRACTICES IN WIND AND WAVE FARMS

Dan Wilhelmsson, PhD
Swedish Secretariat for Environmental Earth System Sciences

Photo: J. Lokrantz, Azote
Wind and wave energy devices

- as artificial reefs?

- as Fish Aggregation Devices?

- and effects of fisheries exclusion
Based on a true story....:


ARTIFICIAL REEFS

Solid structures intentionally or unintentionally placed on the sea floor
Reasons for deploying ARs:

- Enhance fisheries (Seaman et al. 1991)
- Protection of fish stocks/habitats (Jensen 2002)
- Restore marine habitats (including spawning areas) (Clark & Edwards 1995, Chojnacki 2000 Samuel et al. 2005,)
- Create sites for recreational diving and fishing (Wilhelmsson et al. 1998)
- Research (Seaman et al. 1991)
Influencing factors:

• **Location** (depth, isolation) (*McArthur & Wilson 1967, Moffit et al. 1989*)

• **Complexity** (*Sale 1974*)

• **Size** (*Ambrose & Swarbrick 1989*)

• **Epibiota** (habitat forming, food) (*Bailey-Brock 1989*)

• **Surrounding habitat** (*Einbinder 2006*)

• **Reef height** (*Jesse et al. 1985, Rilov and Benayahu 2002*)
Generally greater fish densities, biomass, and catch rates compared to surrounding bottoms/open ocean or natural reefs
Solid structures intentionally or unintentionally placed on the sea floor…

”Secondary artificial reefs” (Pickering et al. 1998)

- Breakwaters (Stephens et al. 1994)
- Pier pilings (Connell & Glasby 1999, Rilov & Benayahu 1998)
Offshore wind and wave energy devices as artificial reefs?
Aggregation around wind turbines showed for e.g.:

- **Gravity Foundations** (Bergström et al. 2012):

  - *Eelpout* (*Zoarces viviparus*)
  - *European eel* (*Anguilla anguilla*)
  - *Cod* (*Gadus morhua*)
  - *Short-horn sculpin* (*Myoxocephalus scorpius*)
  - *Goldsinny wrasse* (*Ctenolabrus rupestris*)

- **Monopiles with scour protection:**
  - *Pouting* (*Trisopterus luscus*) (Reubens et al. 2011)
  - *Cod* (Couperus et al. 2010.)

- **Monopiles without scour protection:**
  - *Benthic fish* (Wilhelmsson et al. 2006)
Seabased Ltd. wave power foundations
25 m, Skagerack

(Langhamer & Wilhelmsson 2009a)

Photos: Kalle Heikkonen
Crustaceans

- Crabs
- Lobsters
- Gammarids

FISH AGGREGATION DEVICES (FADs)

Bouys/rafts etc. midwater or at the surface, anchored in deep water.

- 50-70% of tuna catches in the WIO
- 2.4 million metric tonnes in the Pacific
- 30% of the landings in Sicily
  (e.g. Seaman & Sprague 1991, Marsac et al. 2000)
- 330 fish species
FAD effects of wind turbines?

(e.g. Fayram and deRisi 2006, Wilhelmsson et al. 2010)
FAD effects of wave energy devices?  
*(e.g. Wilhelmsson and Langhamer 2010)*

<table>
<thead>
<tr>
<th>Organisms</th>
<th>Seabased</th>
<th>Pelamis</th>
<th>Wavebob</th>
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</thead>
<tbody>
<tr>
<td>Benthic fish</td>
<td>+</td>
<td>0</td>
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</tr>
<tr>
<td>Pelagic fish</td>
<td>++</td>
<td>++</td>
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<tr>
<td>Crustaceans</td>
<td>++</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Blue mussels</td>
<td>++</td>
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Risks with ARs and FADs

- Aggravate overfishing (direct or redirected fishing) (e.g. Polovina 1991)
- Conflicts over user rights (e.g. Milon 1989)
- Seabed changes (i.e. locally increased predation pressure) (e.g. Davis et al. 1982)
- Ecological traps (FADs) (e.g. Brock 1985, Hallier & Gaertner 2008)
- Alien species (Bulleri & Airoldi 2005, Glasby et al. 2007)
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Design/configuration

- Complexity (scour protection, foundation, frond mats)
- Colour
- Texture/inclination
- Specific features
- Resemble natural habitats?
- Minimise impacts?

etc.
Langhamer & Wilhelmsson, 2009b.

Langhamer et al. 2009

etc.
SCALE AND IMPORTANCE OF EFFECTS?
Effects of exclusion/inhibition of fisheries

• **MPA:**

Any area of intertidal or subtidal terrain, together with its overlying water and associated flora, fauna, historical and cultural features, which has been reserved by law or other effective means to protect part or all of the enclosed environment (*IUCN* 1988)
“MPA effects” in wind farms

Denmark, Netherlands, Belgium and Sweden:

Results basically indicate either increased abundances for some species (e.g., sand eels Ammodytidae, cod Gadus morhua, whiting Merlangius merlangus, red mullet Mullus surmuletus, sole Solea solea) or no effects (Leonhard et al., 2011, Lindeboom et al. 2011, Bergström et al., 2012).
COMBINATIONS OF ARs AND MPAs
(e.g. Roberts 2000, Pitcher et al. 2002)