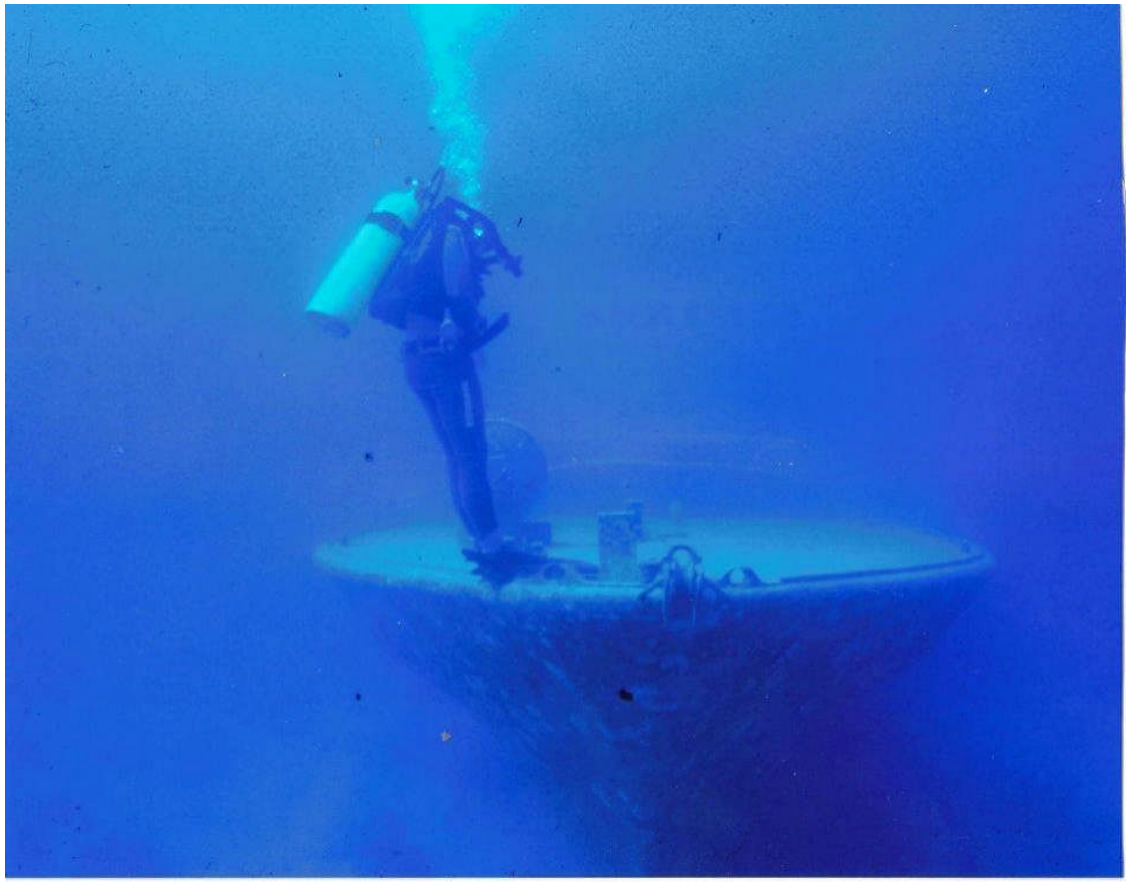
RISKS AND OPPORTUNITIES OF ARTIFICIAL HABITATS IN RELATION TO OFFSHORE RENEWABLE ENERGY

Dan Wilhelmsson, PhD
Swedish Secretariat for Environmental Earth System Sciences

SWEDISH SECRETARIAT FOR ENVIRONMENTAL EARTH SYSTEM SCIENCES

Wilhelmsson, D. **Diversity and Density of Corals and Fish on Artificial and Natural Reefs in Eilat**, Red Sea. Master Thesis, Göteborg University.

Wilhelmsson, D., Öhman, M.C., Stahl, H. & Shlesinger, Y. 1998.
Artificial Reefs and Dive Tourism in Eilat, Israel. AMBIO 27, 764-766.



Wilhelmsson, D., Malm. T. & Öhman, M. 2006. The Influence of **offshore wind power** on **demersal fish**. ICES Journal of Marine Science 63: 775-784.

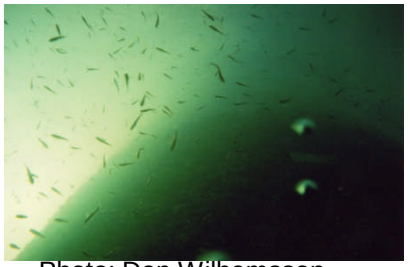


Photo: Dan Wilhemsson

Wilhelmsson, D. & Malm, T. 2008. **Fouling assemblages** on offshore **wind power plants** and adjacent substrata. Estuarine, Coastal and Shelf Science 79: 459-466.

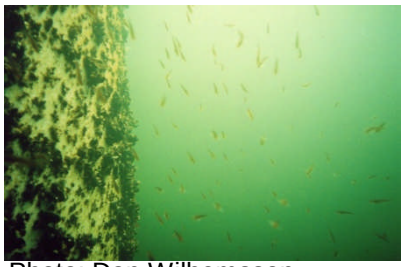


Photo: Dan Wilhemsson

Langhamer O., Wilhelmsson D. & Engström J. 2009. **Artificial reef effect and fouling** impacts on offshore wave power foundations and buoys: a pilot study. Estuarine, Coastal and Shelf Science 82: 426-432.

Photo: Olivia Langhamer

Wilhelmsson, D. Yahya, S. & Öhman, M.C. 2006. Effects of **high-relief structures** on cold-temperate **fish assemblages**: a field experiment. Marine Biology Research 2: 136-147.

Andersson, M.H., Berggren, M., Wilhelmsson, D. & Öhman, M.C. 2009. Epibenthic **colonization** of **concrete** and **steel** pilings in a cold-temperate embayment: a field experiment. Helgoland Marine Research 63: 249-260.

Photo: Mathias Andersson

Langhamer, O. & Wilhelmsson, D. 2009. Colonisation of **fish and crabs** of wave energy foundations and the effects of **manufactured holes**: a field experiment. Marine Environmental Research 68: 151-157.

Photo: Olivia Langhamer

Wilhelmsson, D., Malm, T., Thompson, R., Tchou, J., Sarantakos, G., McCormick, N., Luitjens, S., Gullström, M., Patterson Edwards, J.K., Amir, O. and Dubi, A. (eds.) 2010. Greening Blue Energy: Identifying and managing the **biodiversity risks and opportunities** of **offshore renewable energy**. Gland, Switzerland: IUCN. ISBN: 978-2-8317-1241. 102pp.

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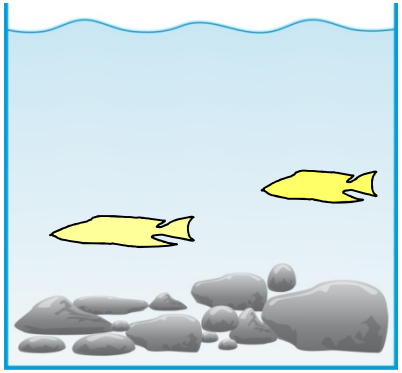
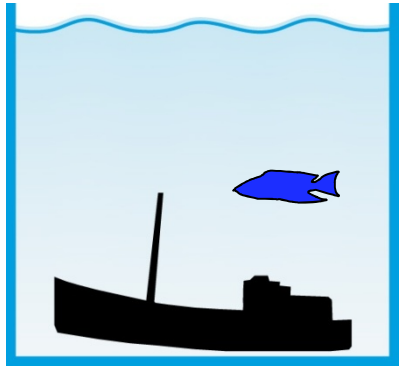
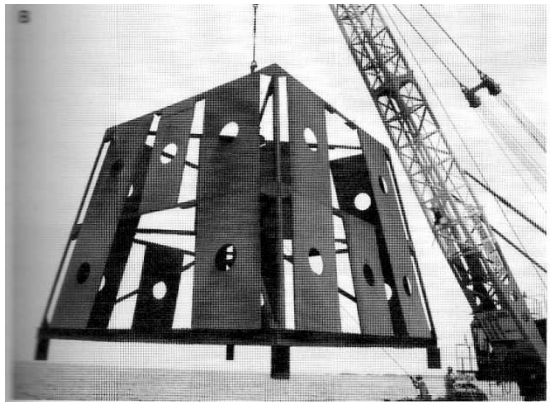
ARTIFICIAL REEFS

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 denstities, biomass, and catch rates compared to surrounding bottoms/open ocean or natural reefs

Solid structures intentionally or unintentionally placed on the sea floor…

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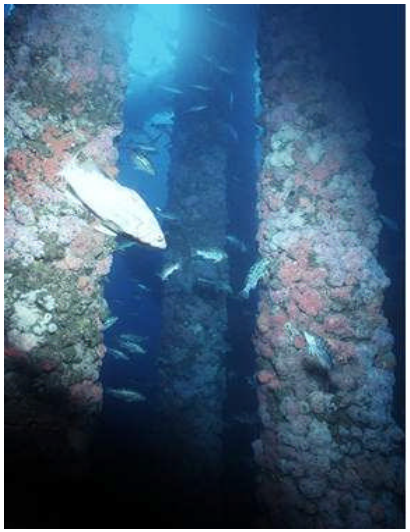
”Secondary artificial reefs”

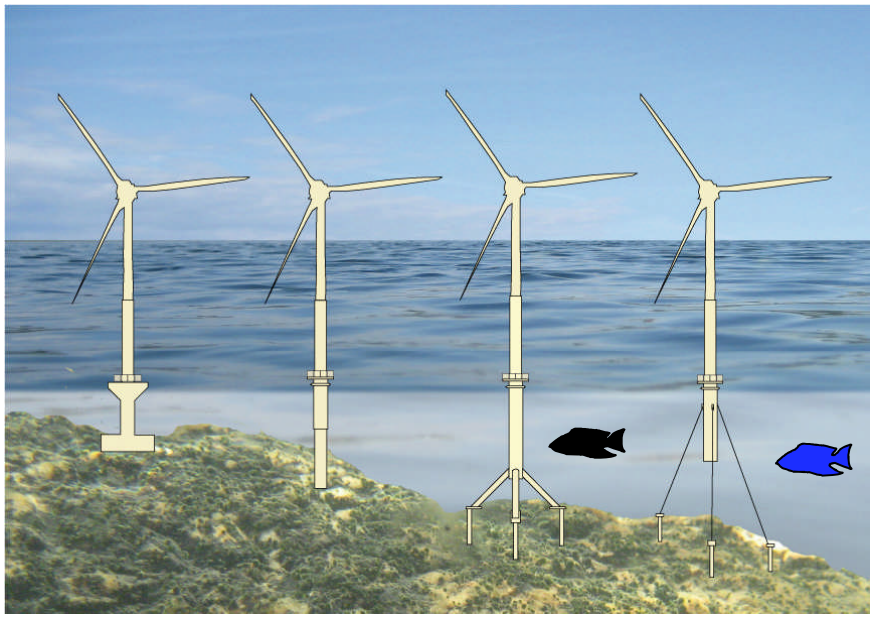
(Pickering et al. 1998)

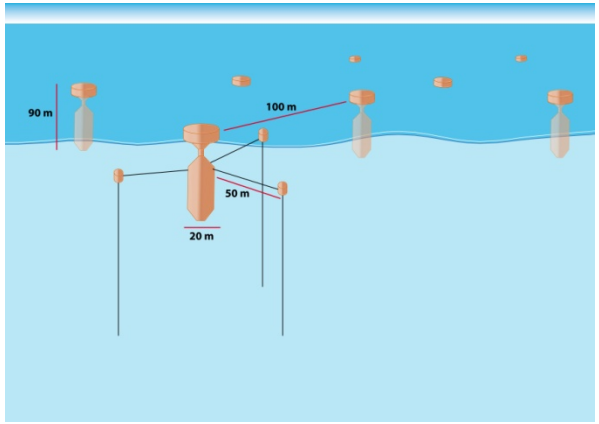
e.g.

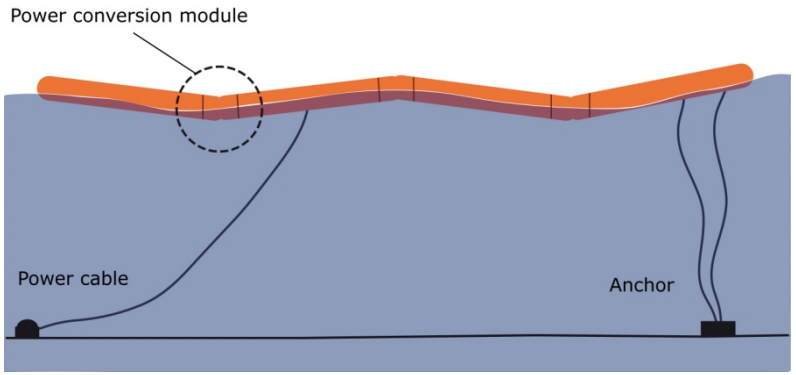
- Petrolium platforms (Helvey 2002, Love et al. 1999, Ponti et al. 2002)
- Breakwaters (Stephens et al. 1994)
- Pier pilings (Connell & Glasby 1999, Rilov & Benayahu 1998)

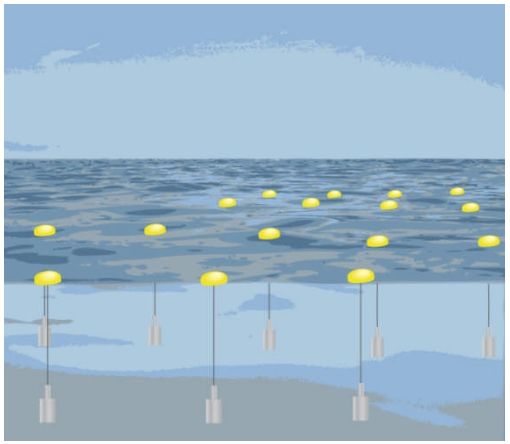


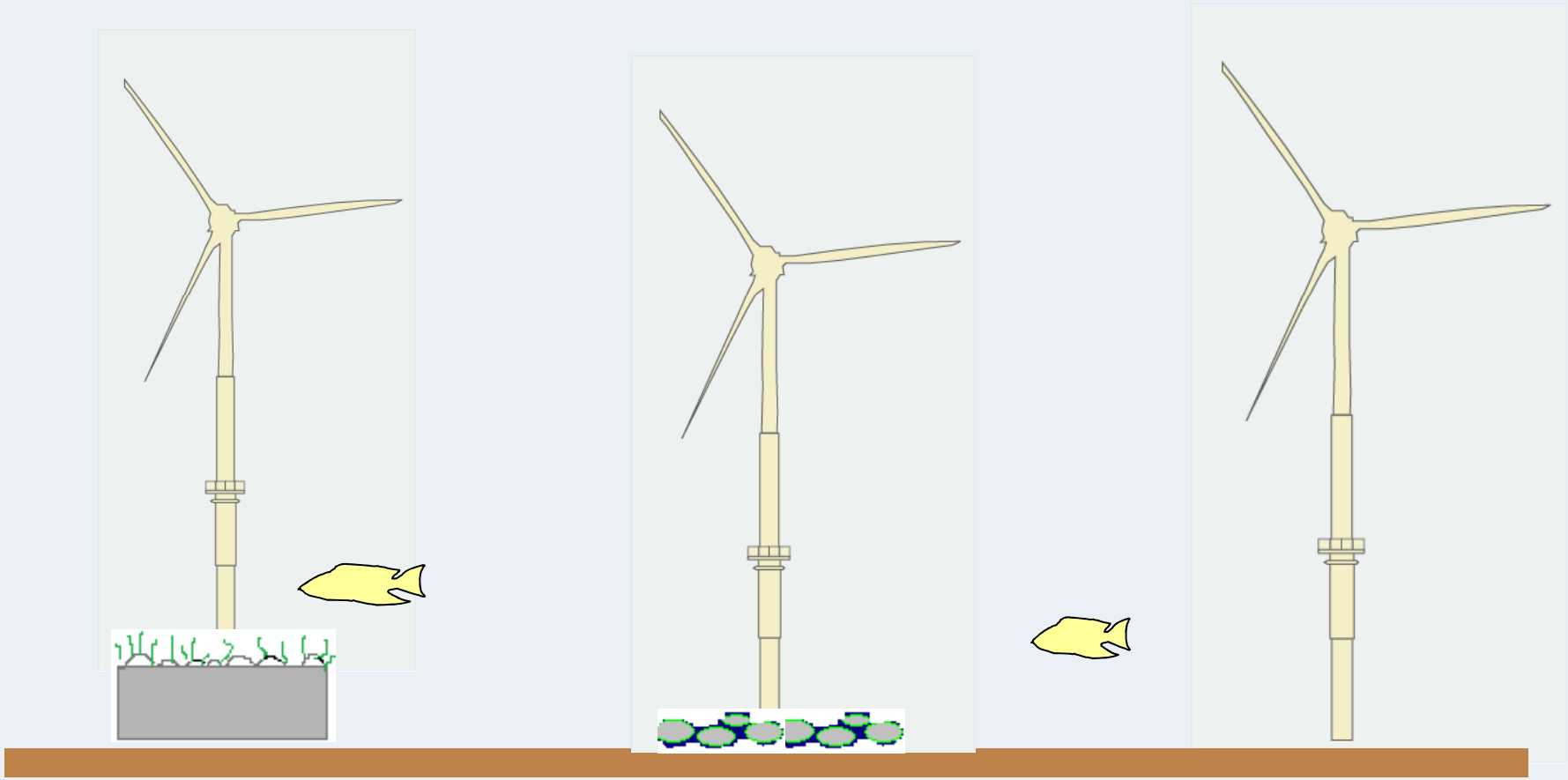
Offshore wind and wave energy devices as artificial reefs





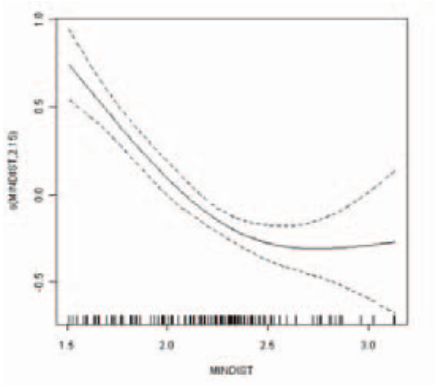




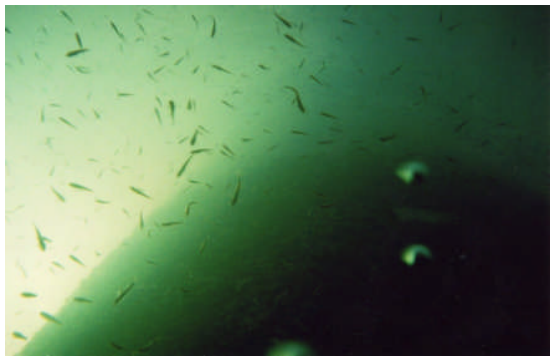


Aggregation around wind turbines showed for e.g.:

- Gravity Foundations (Bergström et al. 2012):



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



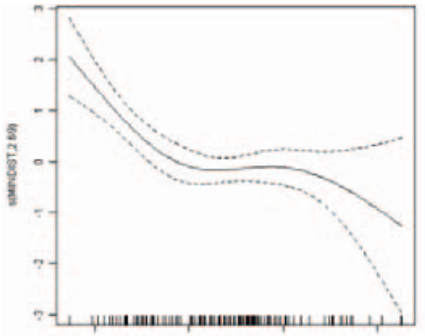
European eel (*Anguilla anguilla*)

- Monopiles with scour protection:

Pouting (*Trisopterus luscus*) *(Reubens et al. 2011)*
Cod (Couperus et al. 2010.)

-Monopiles without scour protection:

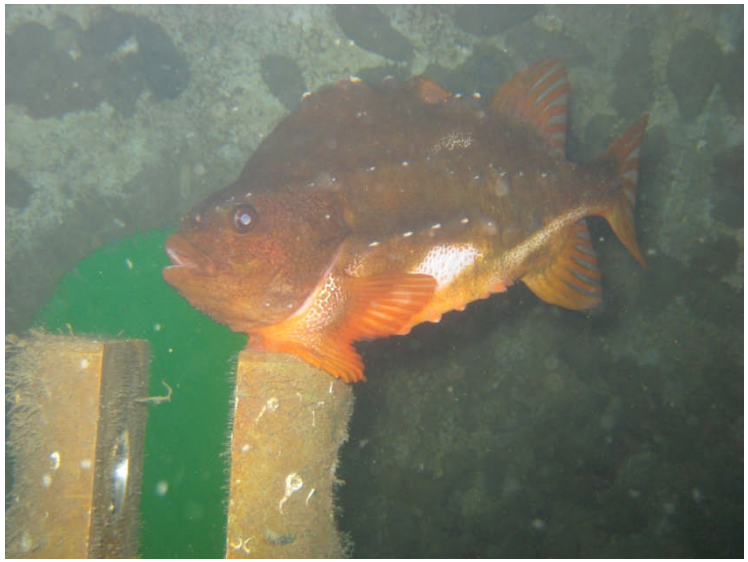
(Wilhelmsson et al. 2006)
Benthic fish



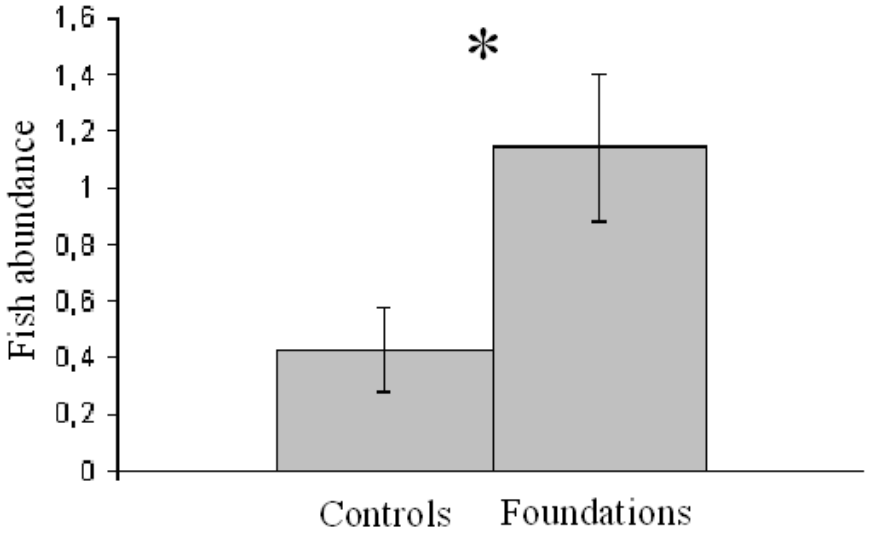
Bergström et al. 2012

Seabased Ltd. wave power foundations
25 m, Skagerack

Photos: Kalle Heikkonen



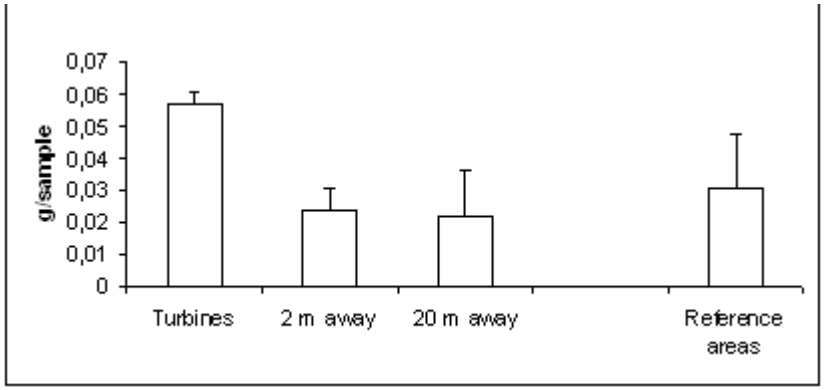
(Langhamer & Wilhelmsson 2009a)



Crustaceans

- Crabs
- Lobsters
- Gammarids

Wilhelmsson & Malm 2008, Maar et al . 2009, Langhamer & Wilhelmsson 2009, Langhamer et al 2009, Bergström et al. 2012



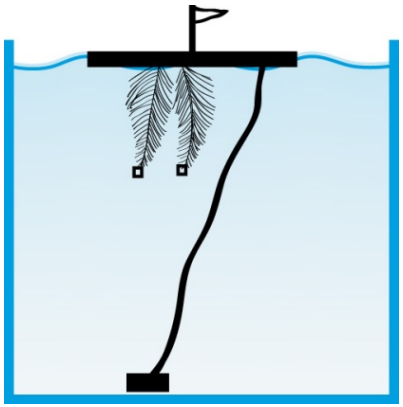
FISH AGGREGATION DEVICES (FADs)

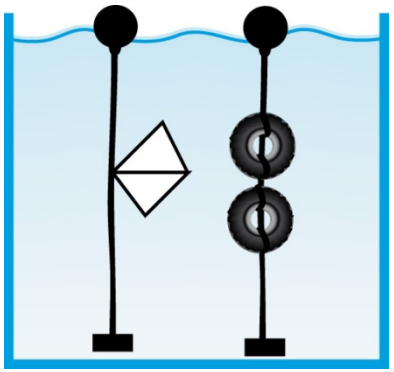
Bouys/rafts etc. midwater or at the surface, anchored in deep water.

- 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)

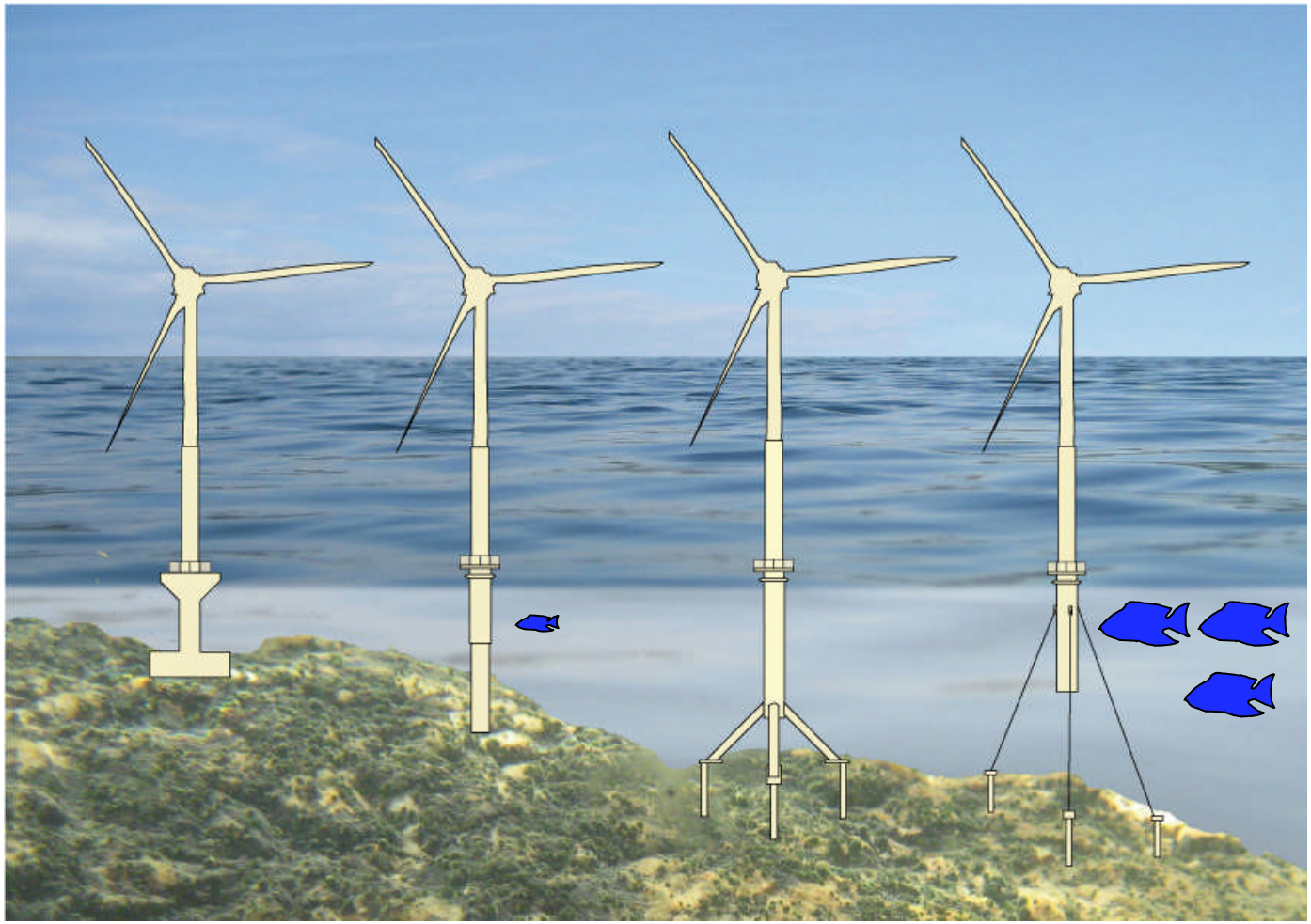
- 330 fish species





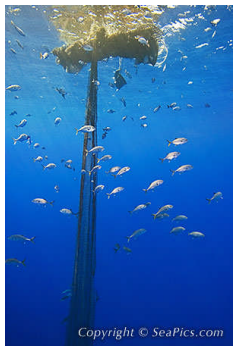
FAD effects of wind turbines?

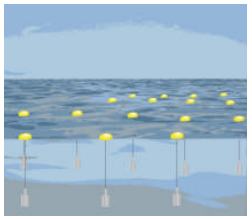
(e.g. Fayram and deRisi 2006, Wilhelmsson et al. 2010)

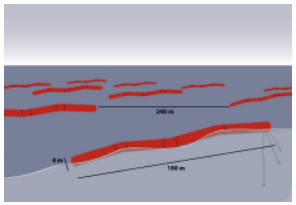


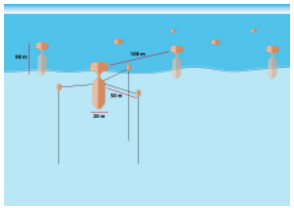
FAD effects of wave energy devices?

(e.g. Wilhelmsson and Langhamer 2010)









Organisms	Seabased	Pelamis	Wavebob
Benthic fish	+	0	0
Pelagic fish	++	++	+++
Crustaceans	++	0	0
Blue mussels	++	+++	+++

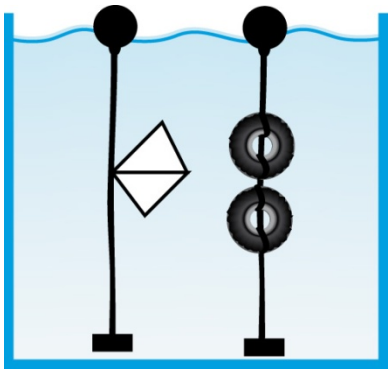
Influencing factors:

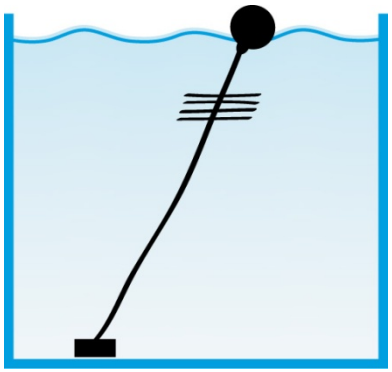
- **Location** (depth, isolation) *(McArthur & Wilson 1967, Moffit et al. 1989*
- **Complexity** *(Sale 1974)*
- **Size** *(Ambrose & Swarbrick 1989)*
- **Epibiota** (habitat forming, food) *(Bailey-Brock 1989)*
- **Surrounding habitat** *(Einbeinder 2006)*
- **Reef height** *(Jesse et al. 1985, Rilov and Benayahu 2002)*

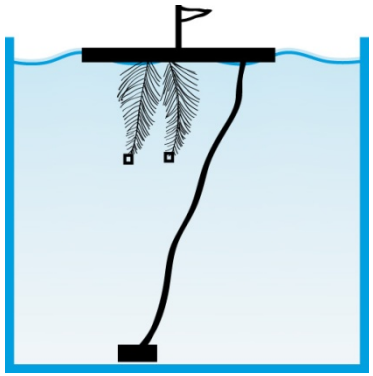
Design/configuration

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

etc.







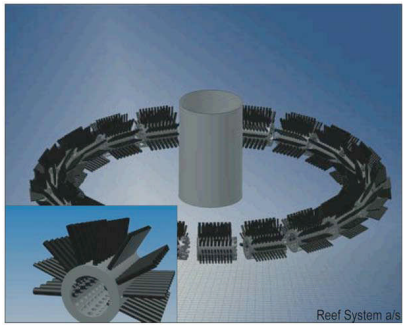
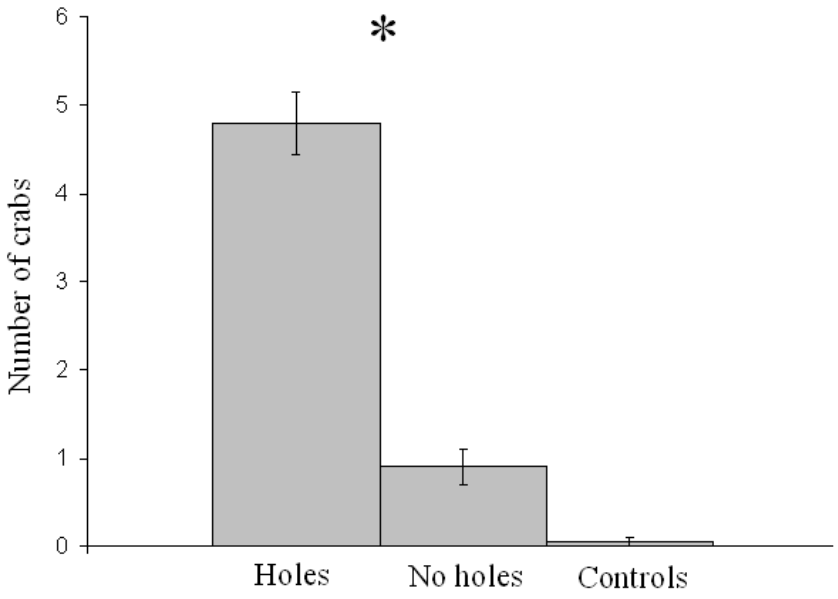


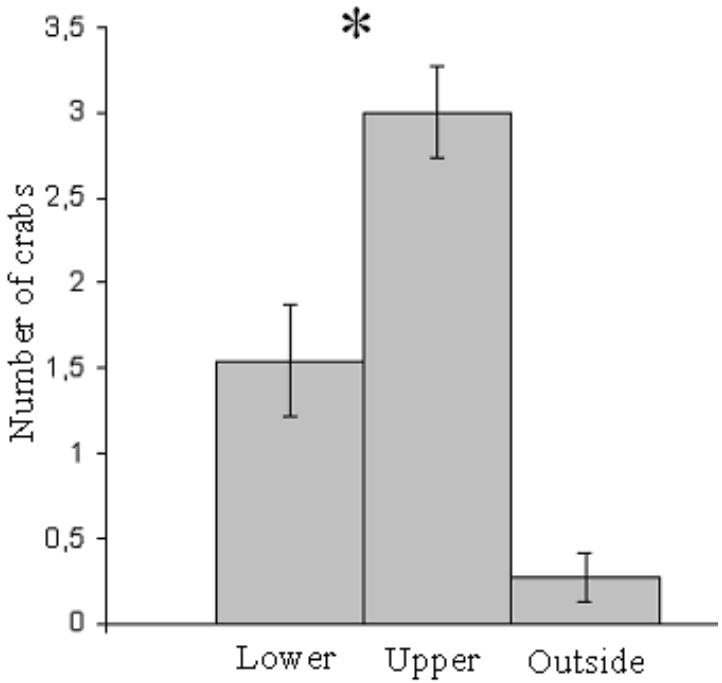
Photo: Olivia Langhamer

Langhamer & Wilhelmsson, 2009b.

Langhamer et al. 2009

etc.





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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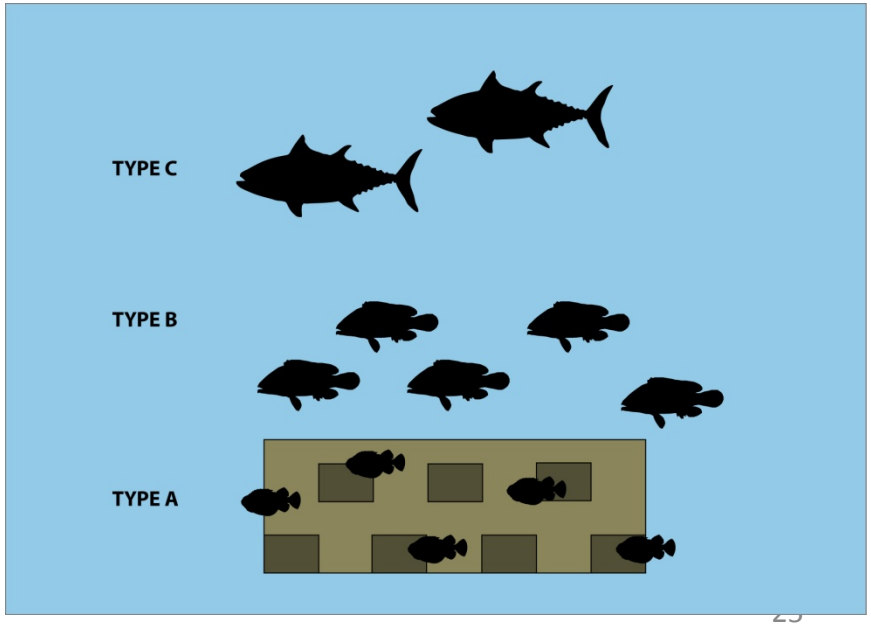
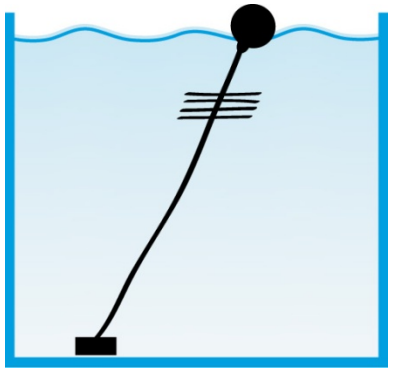
Why these ”artificial reef effects”?:

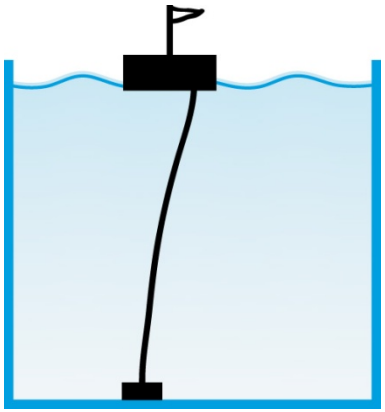
- **Shelter:** main structure, epibiota, shade
- **Food:** epibiota, water velocity, surrounding soft bottom
- **Behavioral cues**

(*Bohnsack & Sutherland 1985, Jessee 1985, Grove et al. 1991, Einbinder et al. 2006)*

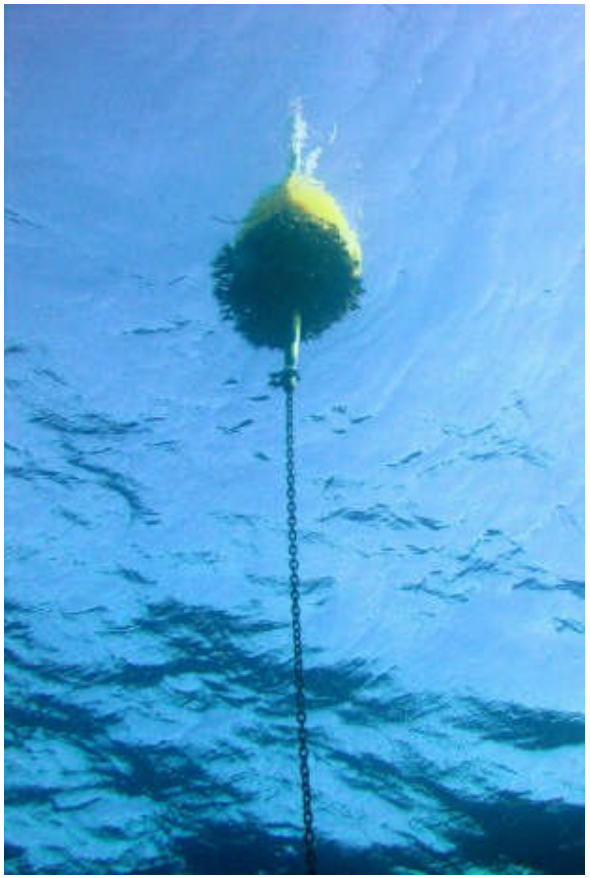


Reasons for fish to aggregate





- Food, shelter
- Camouflage
- Visual enhancement
- ”Hitchhiking”
- Spawning
- Reference point for pelagic searches
- Meeting point



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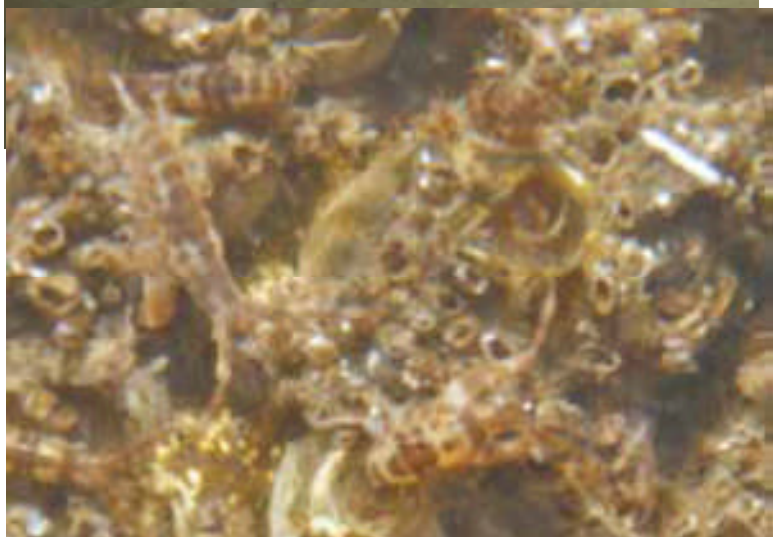
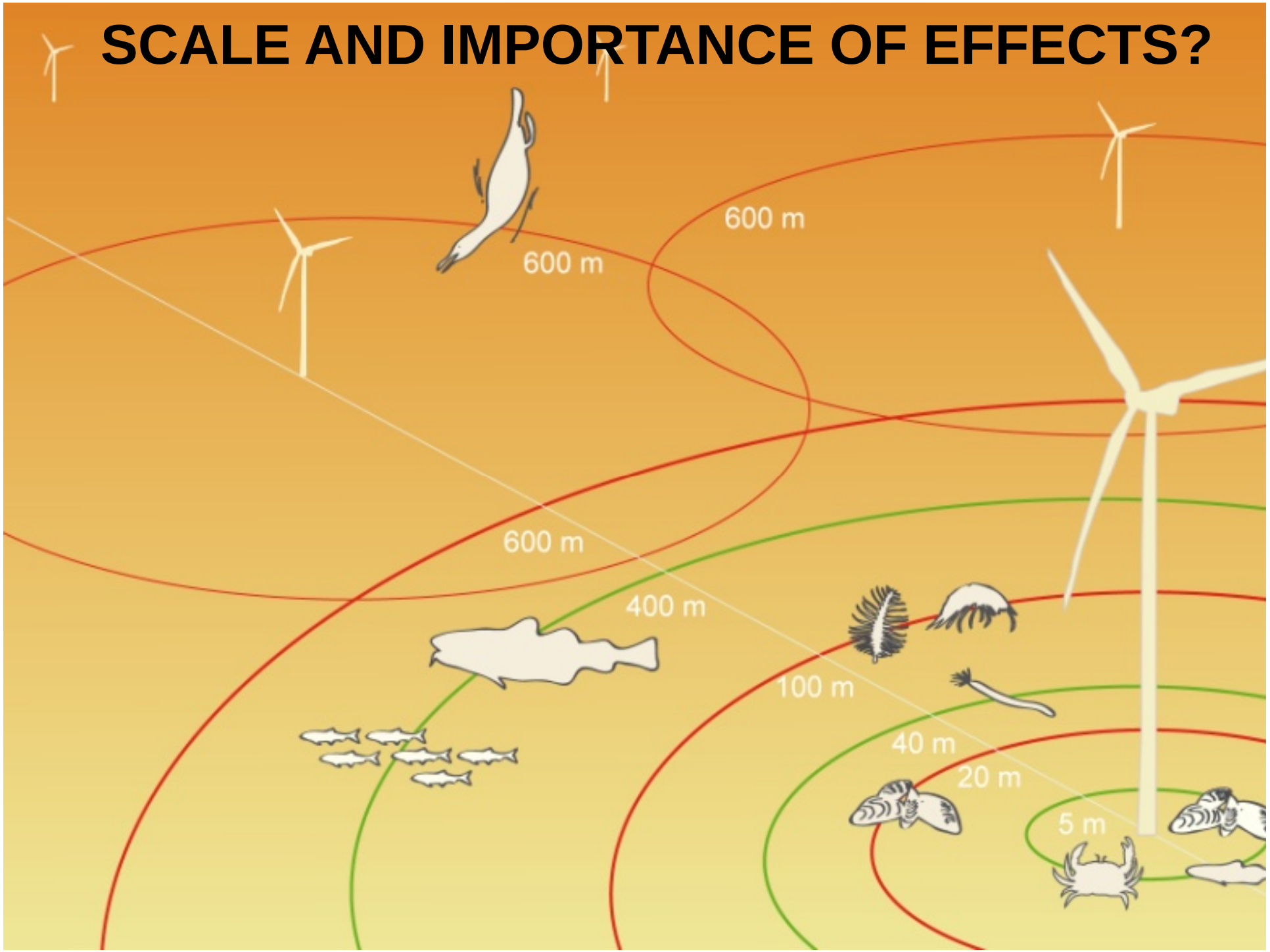
Stepping stones for invasive species?



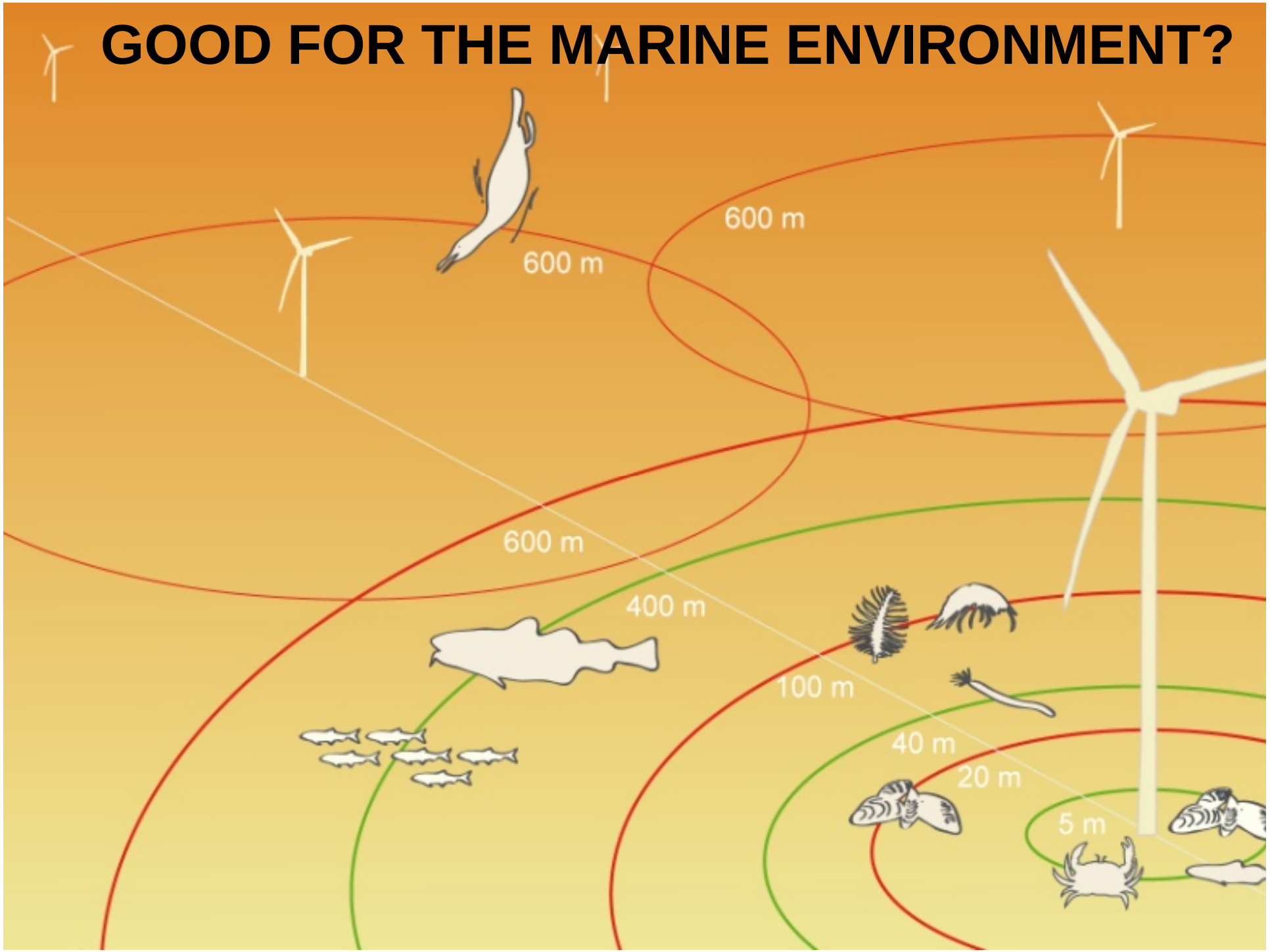
Dong Energy et al. 2006,

Brodin & Andersson 2008

SCALE AND IMPORTANCE OF EFFECTS?



GOOD FOR THE MARINE ENVIRONMENT?



THANK YOU!

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