Porpoises and offshore windfarms – conflict, co-existence or refuge?

11 October 2012, OWEZ Congress

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based on the work & contributions of: Geert Aarts, Arnold Bakker, Sophie Brasseur, Jacob Carstensen, Piet Wim van Leeuwen, Han Lindeboom, Mardik Leopold, Tamara van Polanen Petel, Peter Reijnders, Jonas Teilmann, Jakob Tougaard, Hans Verdaat & many others

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Aim

Aim was to:

determine if the operation of the OWEZ windfarm has an effect on the local harbour porpoise occurrence.

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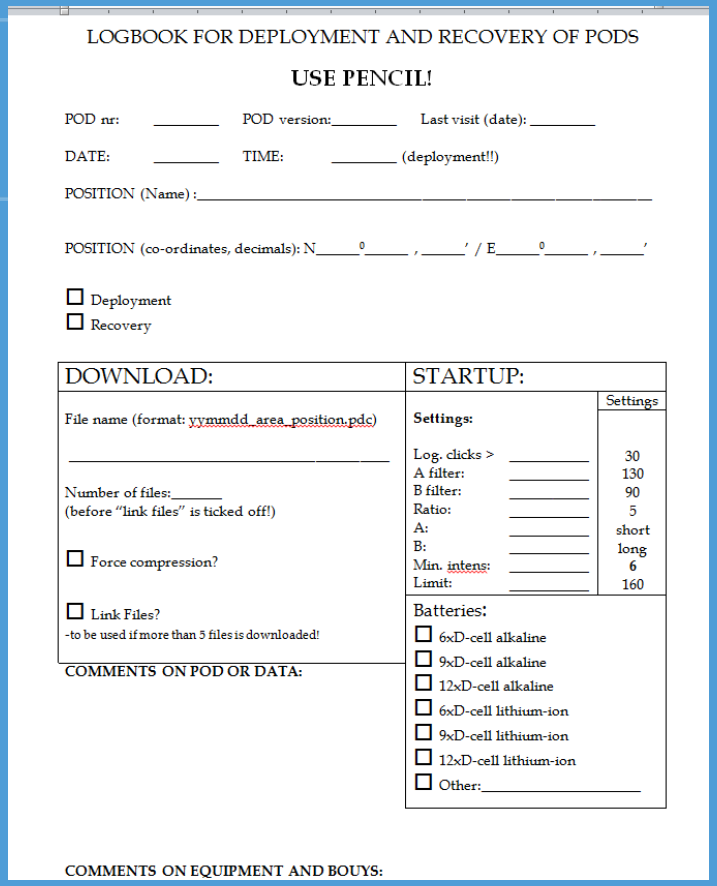
Methods

Methods

- During the T_0 and T_1 study stationary acoustic monitoring with T-PODs was used.
  - T-PODs record the acoustic activity of harbour porpoises
  - They need to be serviced on a regular basis to exchange batteries and download the data



LOGBOOK FOR DEPLOYMENT AND RECOVERY OF PODS

USE PENCIL!

POD nr: _____ POD version: _____ Last visit (date): _____

DATE: _____ TIME: _____ (deployment!!)

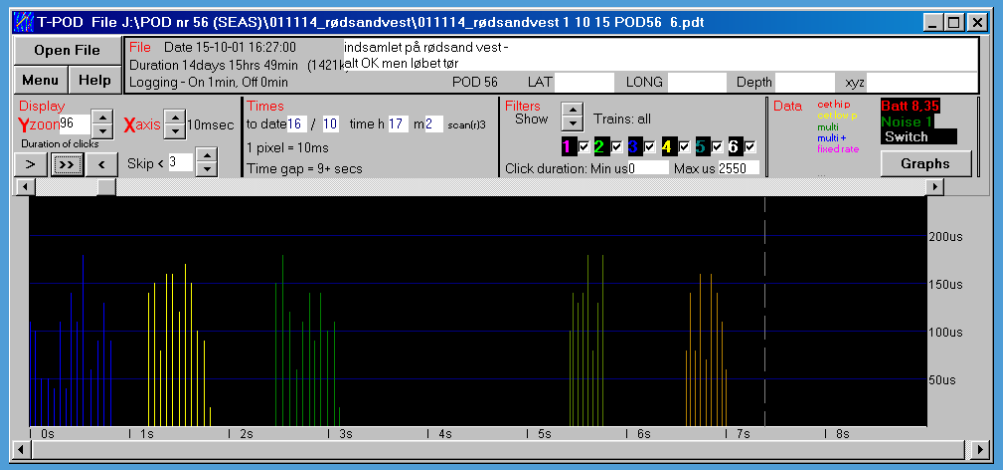
POSITION (Name) : _____

POSITION (co-ordinates, decimals): N_____°_____ , _____' / E_____°_____ , _____'

☐ Deployment
☐ Recovery

DOWNLOAD:	STARTUP:	
File name (format: yymmdd_area_position.pdc)	Settings:	Settings
_____	Log. clicks > _____	30
Number of files: _____ (before "link files" is ticked off!)	A filter: _____	130
	B filter: _____	90
	Ratio: _____	5
☐ Force compression?	A: _____	short
	B: _____	long
☐ Link Files? -to be used if more than 5 files is downloaded!	Min. intens: _____	6
	Limit: _____	160
COMMENTS ON POD OR DATA:	Batteries:	
	☐ 6xD-cell alkaline	
	☐ 9xD-cell alkaline	
	☐ 12xD-cell alkaline	
	☐ 6xD-cell lithium-ion	
	☐ 9xD-cell lithium-ion	
	☐ 12xD-cell lithium-ion	
	☐ Other: _____	

COMMENTS ON EQUIPMENT AND BOUYS:



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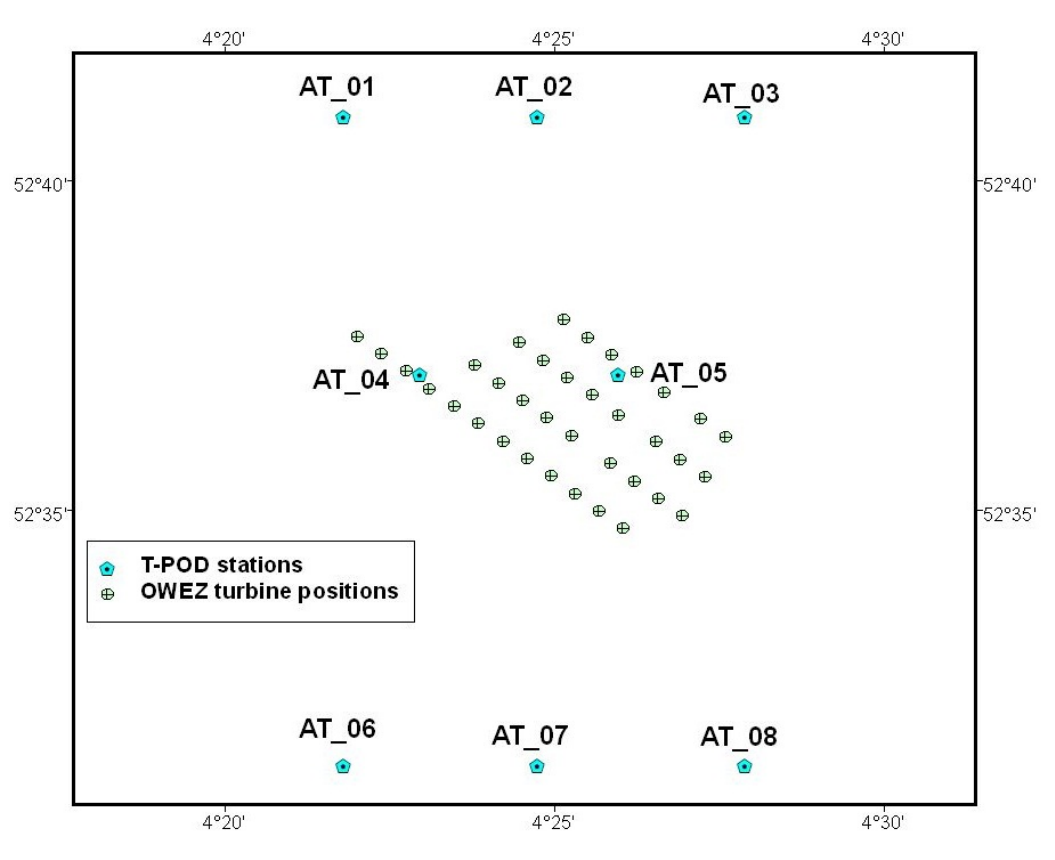
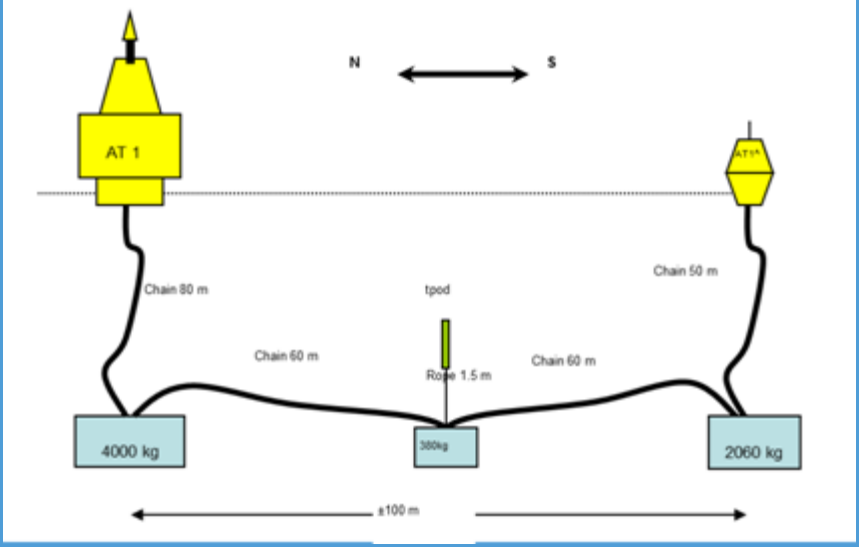
Methods

- A total of 8 stations were deployed
- Deployment lasted 12 months in T_0 and 24 months in T_1



Methods

- This was the first time T-PODs were deployed in an offshore environment
- To avoid loss they were anchored using two large buoys and heavy weights
- Deployment and retrieval was done with the *Terschelling* crew



Data analyses

- Data analyses was done in cooperation with the NERI (National Environmental Research Institute) in Roskilde, Denmark
- Four indicators were chosen for the analyses of the data

Indicators used

- PPM – Porpoise Positive Minutes
- Clicks per PPM
- Encounter duration
- Waiting time

PPM – Porpoise Positive Minutes

- Proportion of minutes recorded within a day in which one porpoise click train or more could be detected.
- **Indicator for occurrence of porpoises in an area**

$$\frac{\text{Number of minutes with clicks}}{\text{Total number of minutes}} = \frac{N\{x_t > 0\}}{N_{total}}$$

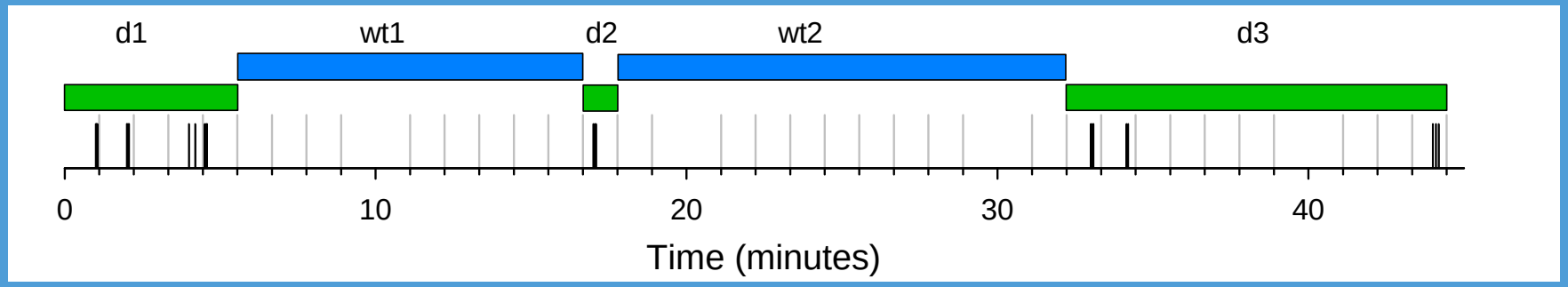
Clicks per PPM

- Daily average number of clicks (x_t) in those minutes where clicks were detected (N $\{x_t > 0\}$).
- **Indicator for click activity of porpoises in an area**

$$\frac{1}{N\{x_t > 0\}} \sum_{x_t > 0} x_t$$

Encounter time

- An **encounter** is defined as a sequence of porpoise clicks separated by more than 10 minutes of silence
- Encounter time is the length of an encounter (number of minutes between two silent periods)
- **Indicator for porpoise occurrence in the area**



Schematic illustration of encounter durations (green) and waiting times (blue) for a sequence of 10 click trains.

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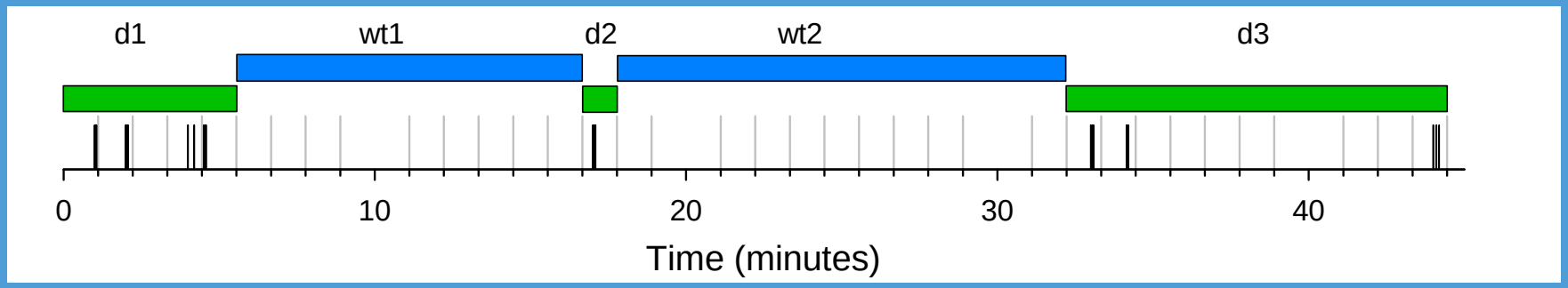
Waiting time

- An encounter is defined as a sequence of porpoise clicks separated by more than 10 minutes of silence
- **Waiting time** is the length of a silent period (number of minutes in a silent period) between encounters.
- **indicator for porpoise occurrence in the area**



Schematic illustration of encounter durations (green) and waiting times (blue) for a sequence of 10 click trains.

Clicks = occurrence ?

In this study we use measurements of acoustic activity to determine the occurrence of porpoises.

Although not directly quantifiable at this point in time, several studies have shown a direct relationship between the amount of acoustic activity recorded and the number of porpoises present.

➢ **Thus, we assume that our four acoustic indicators are a proxy for harbour porpoise occurrence.**

BACI analyses

- The four indicators were analysed according to a modified **BACI (Before After Control Impact)** design
- 5 fixed and 3 random factors and combinations thereof were considered
- This analyes assures that station-specific as well as seasonal variation is taken into account

Factors considered

Factor		levels	description
Area	Fixed	2	impact (wind park) vs. control
Subarea	Fixed	3	control N, control S, impact
Station	Random	8	AT1 to AT8
Period	Fixed	2	baseline (T_0) vs. operation period (T_1)
Year	Random	5	2003, 2004, 2007, 2008, 2009
Month	Fixed	12	January - December
Podtype	Fixed	2	V3 and V5 T-PODs
Podid	Random	20	Individual T-POD numbers

BACI analyses

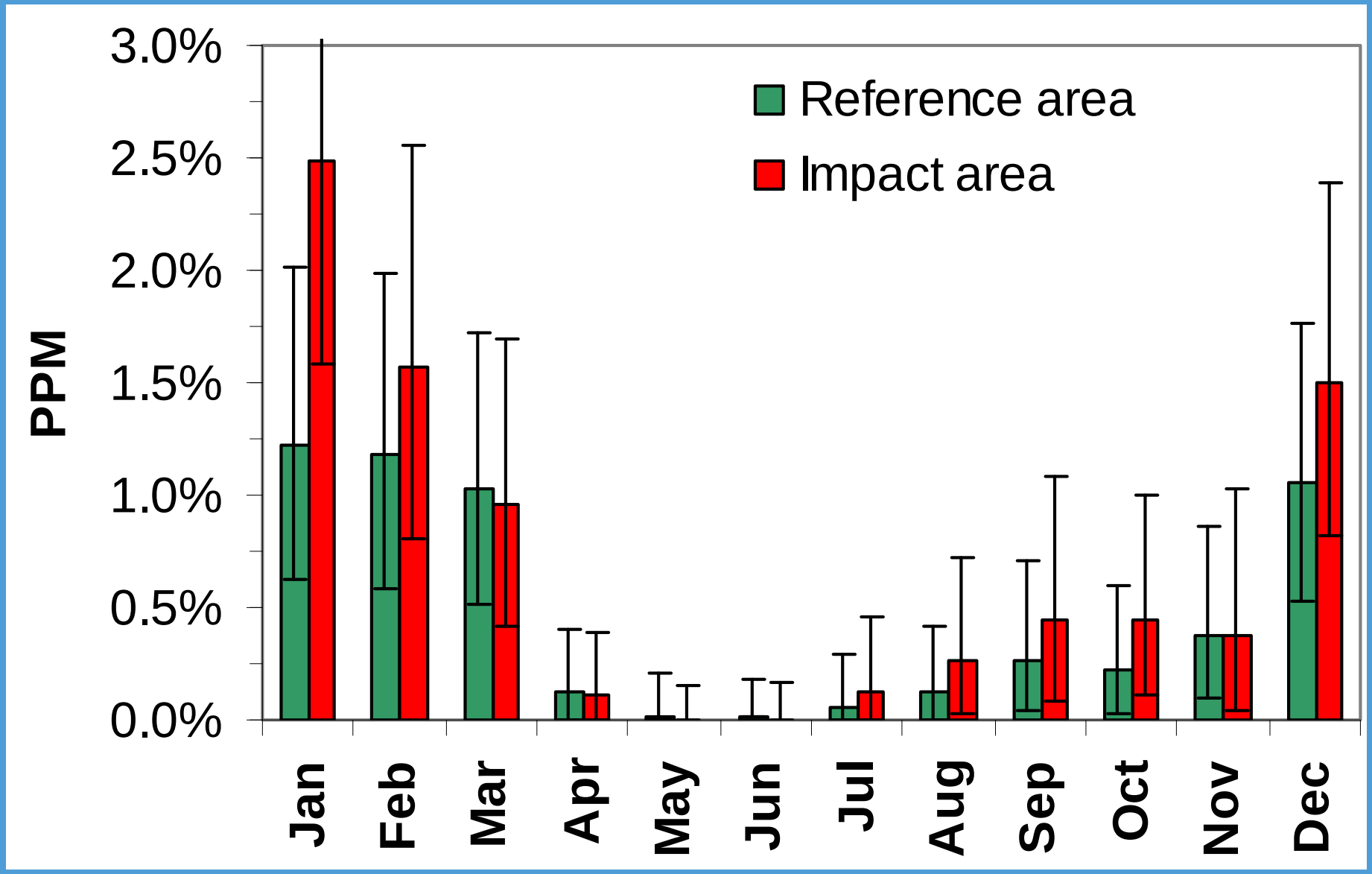
- The factor $\boldsymbol{area_i \times period_k}$, also referred to as the **BACI effect**, describes a step-wise change (from T_0 to T_1) in the wind farm different from that in the control areas.
- A **significant BACI effect** implies that **changes in activity in the wind farm area from T_0 to T_1 can not be explained alone by general changes in the area, but must be ascribed to the impact** (i.e. the presence of the wind farm).

Results

seasonality

Significant for all four indicators

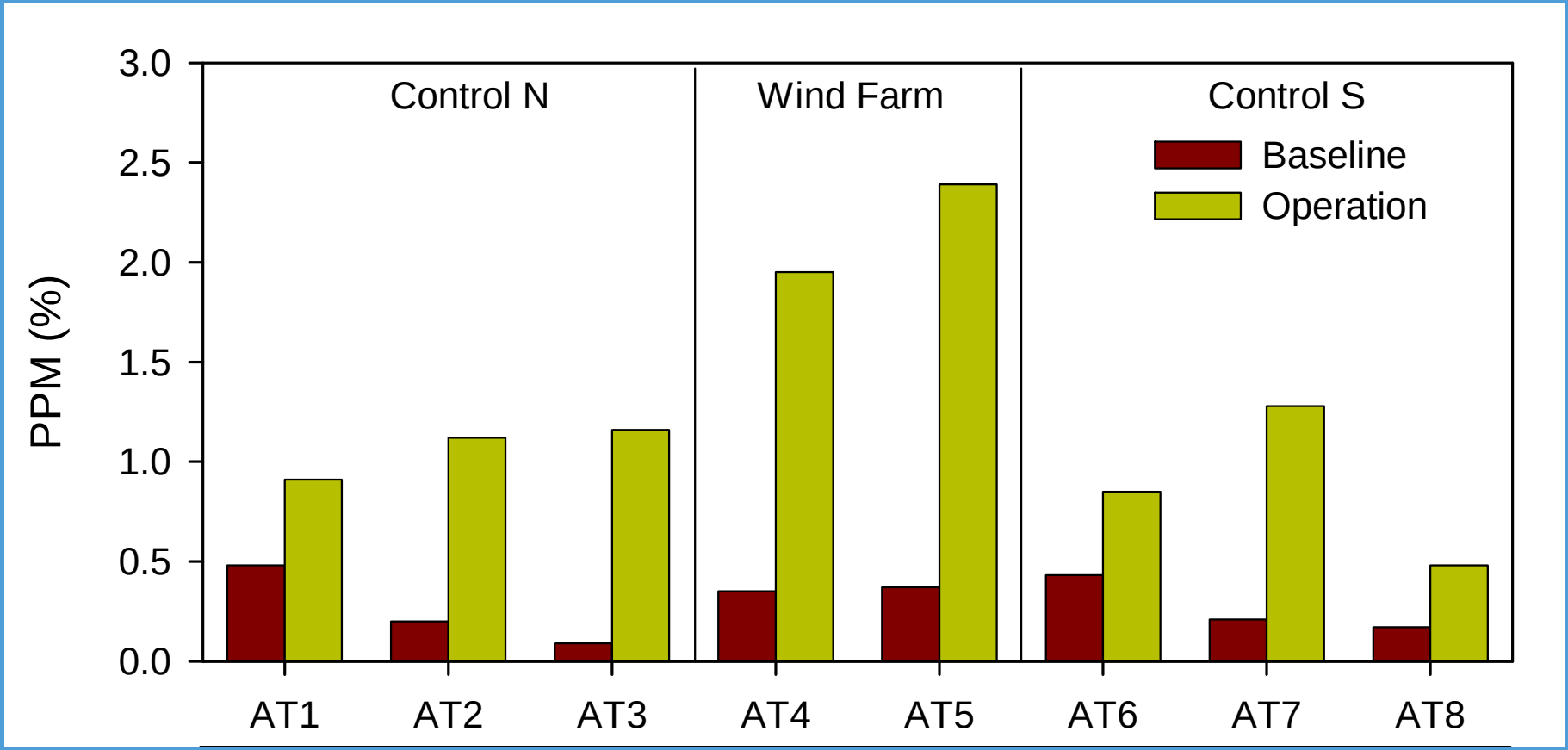
seasonality



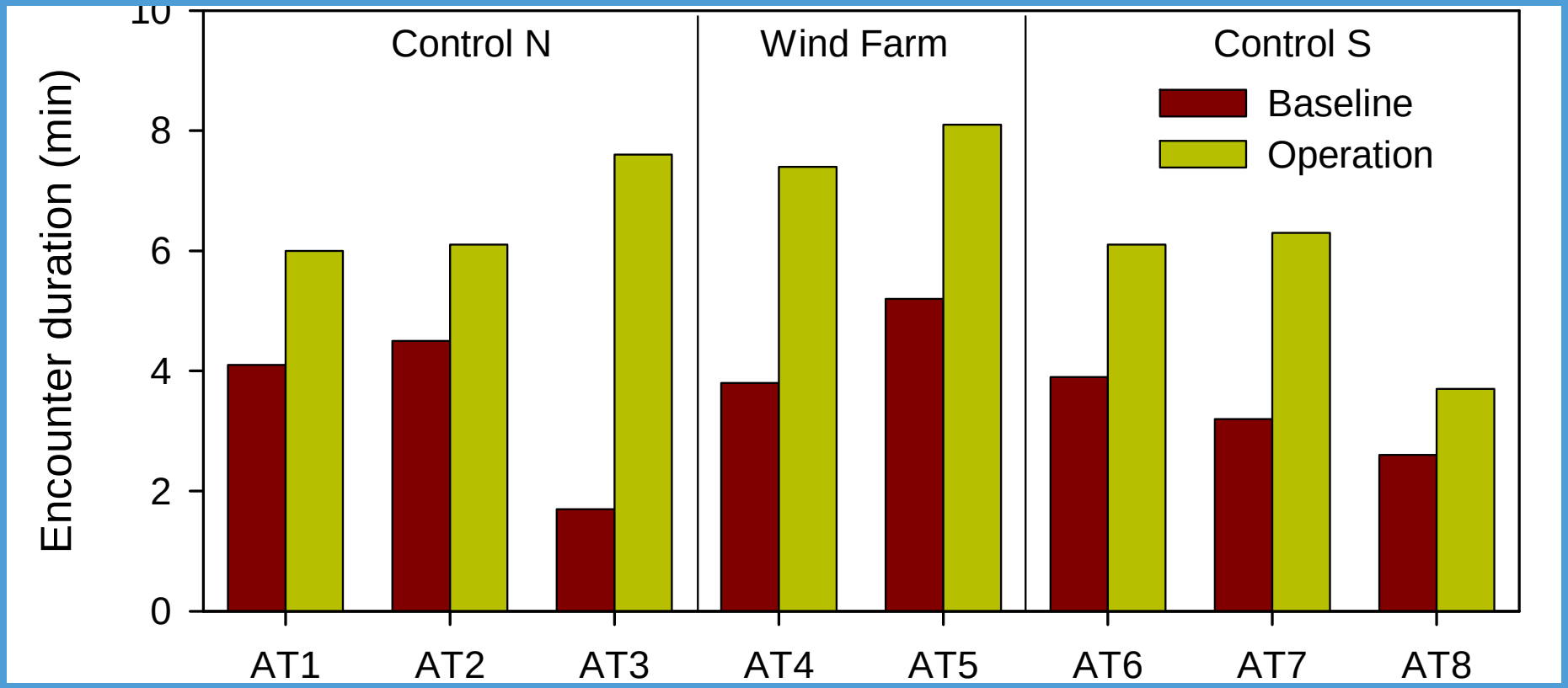
changes between T_0 and T_1

Significant for all four indicators

Results – porpoise positive minutes (%)



Results – encounter duration



Results - encounter duration

	Area	Pos.	Encounter duration (minutes)				
			N	Min	Median	Mean	Max
BASELINE	Control N	AT1	496	1	1	4.1	45
		AT2	242	1	1	4.5	97
		AT3	116	1	1	1.7	19
	Impact	AT4	750	1	1	3.8	91
		AT5	312	1	1	5.2	108
	Control S	AT6	879	1	1	3.9	88
		AT7	408	1	1	3.2	44
		AT8	403	1	1	2.6	20
OPERATION	Control N	AT1	1416	1	1	6.0	264
		AT2	2686	1	1	5.9	166
		AT3	1845	1	1	6.6	193
	Impact	AT4	3496	1	3	7.9	**329**
		AT5	4274	1	3	7.6	**332**
	Control S	AT6	1624	1	1	6.3	299
		AT7	1301	1	1	3.9	72
		AT8	1933	1	1	3.8	142

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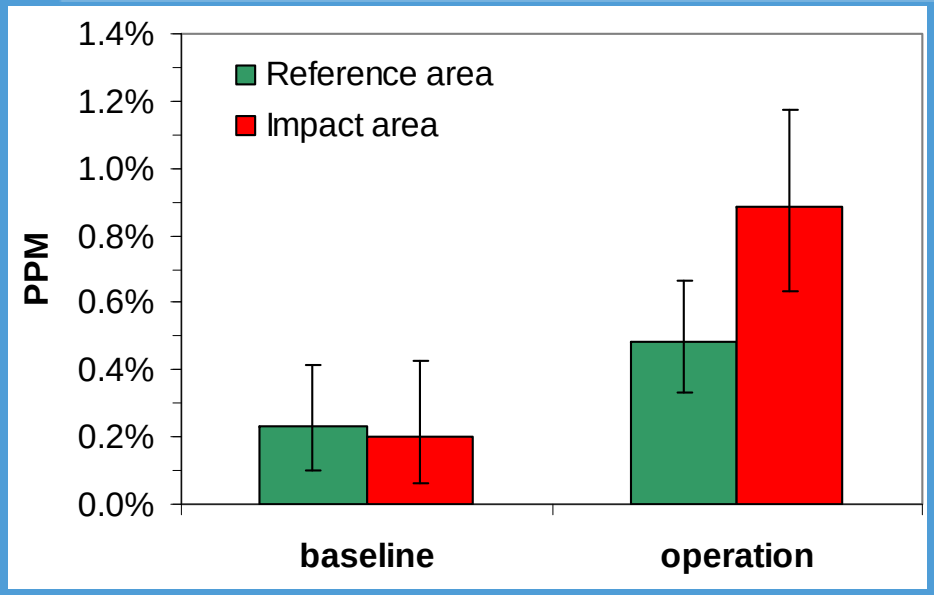
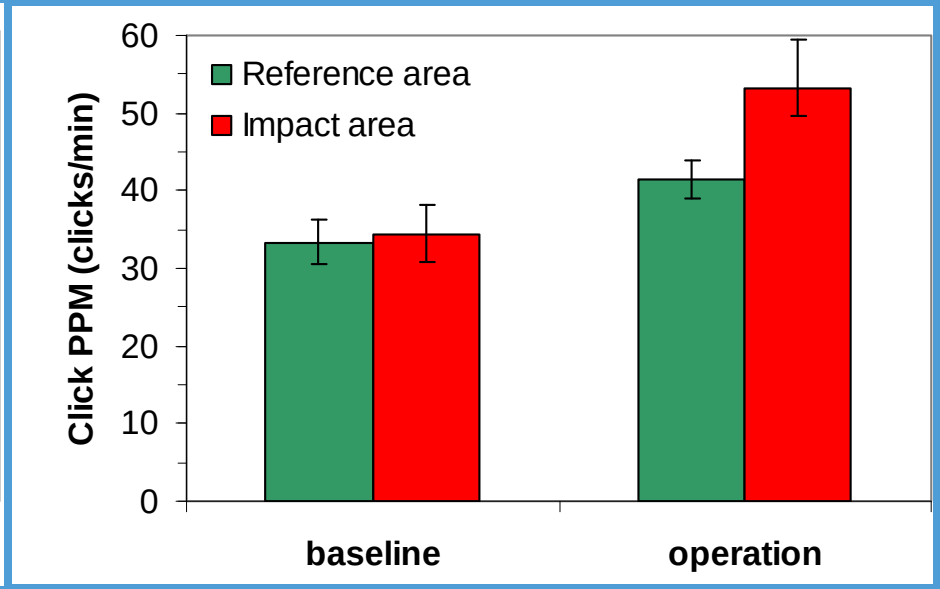
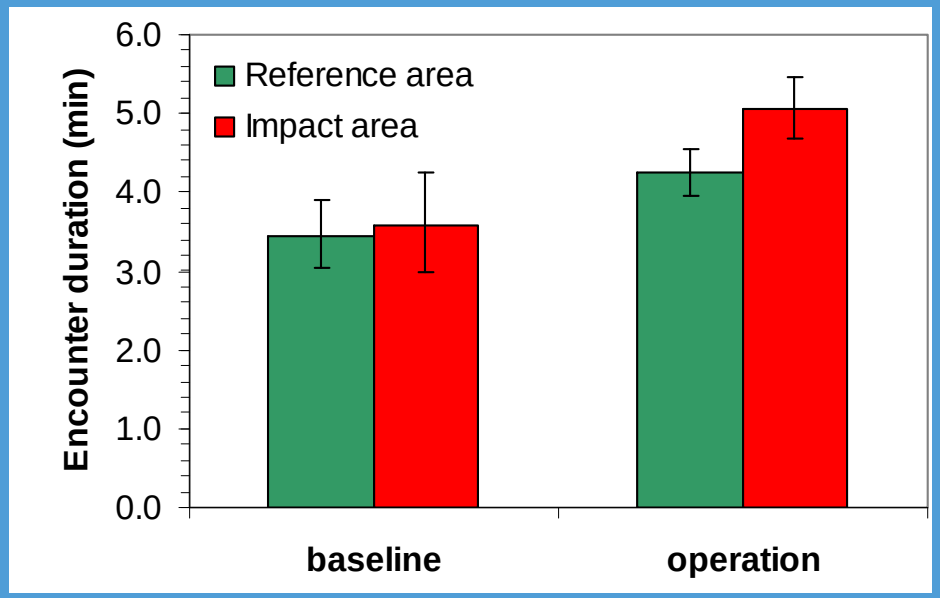
BACI factor (area*period)

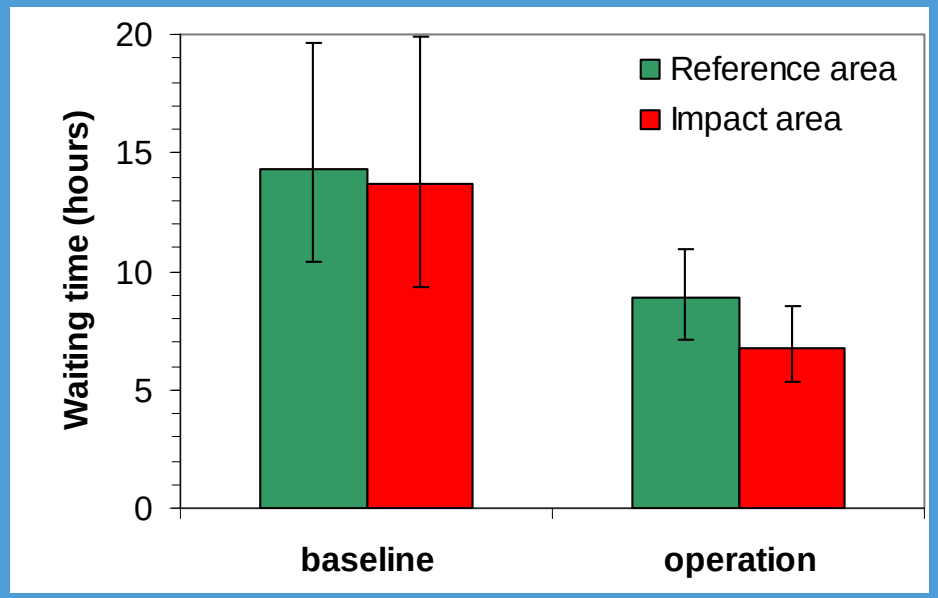
Significant for two indicators

Results of the model – BACI factor





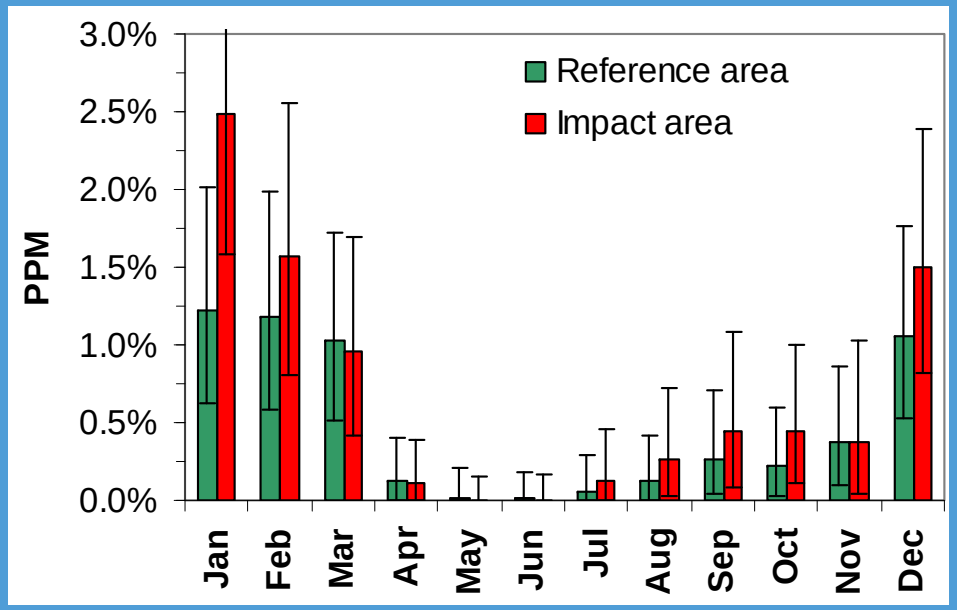


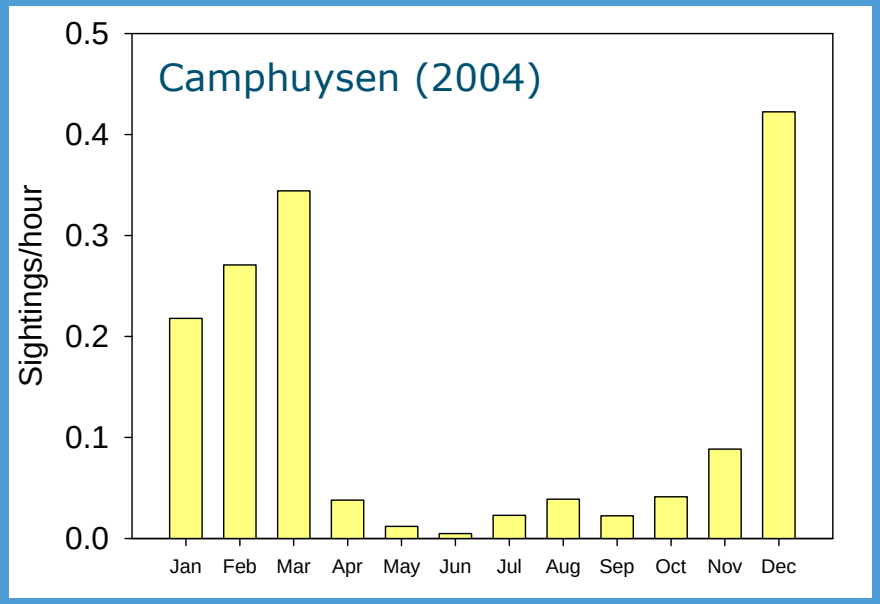


Conclusions

Conclusions

I. Significant seasonal pattern of porpoise occurrence with most animals occurring in winter

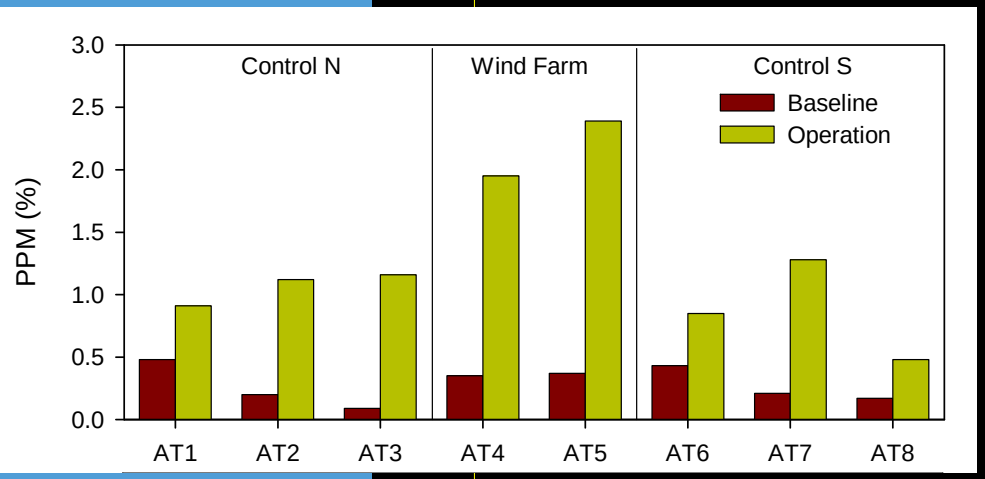


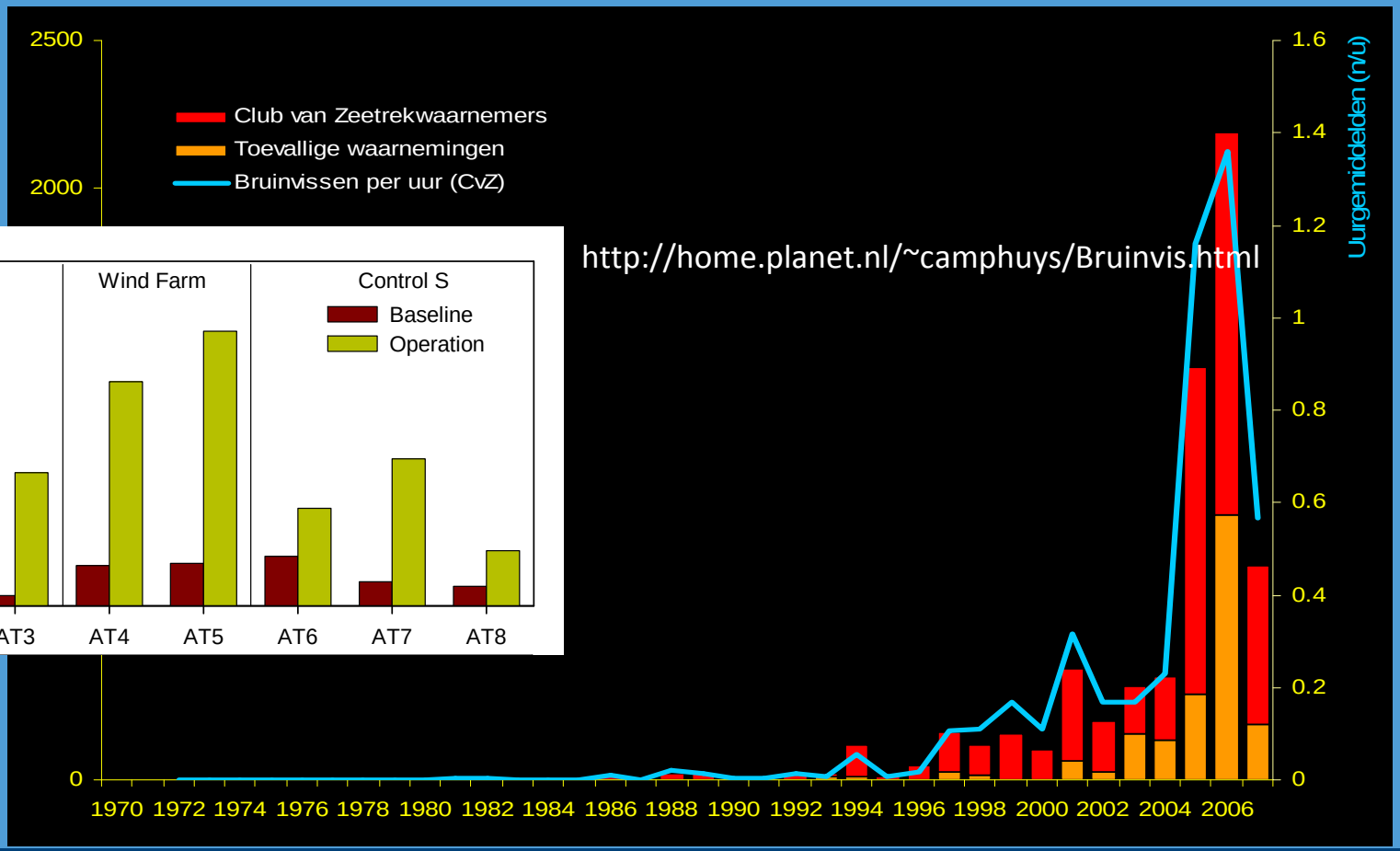


- this fits well in the known seasonal occurrence of porpoises in Dutch waters

Conclusions

II. Significant increase in porpoise occurrence between the baseline and the operation period

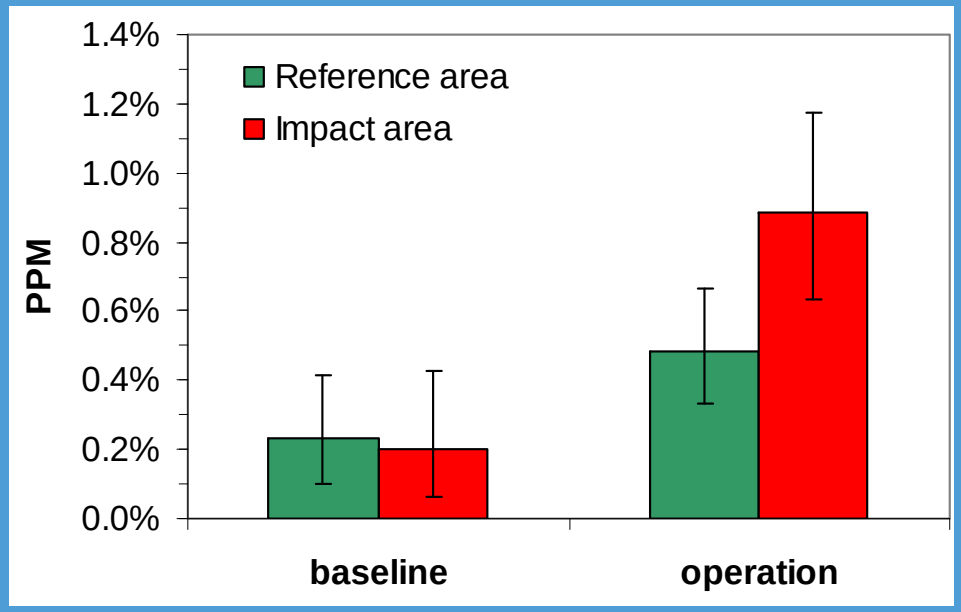


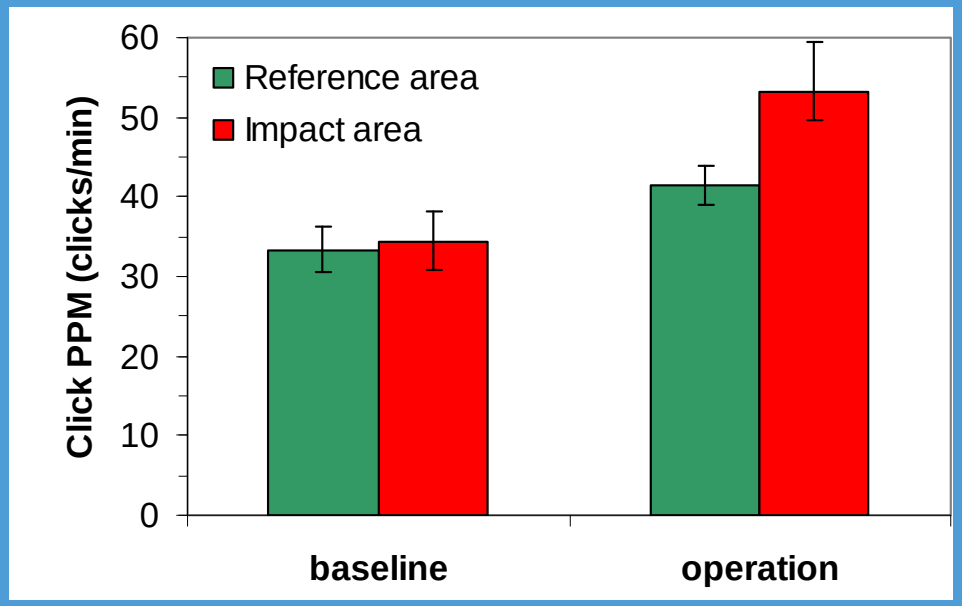


- this fits well with the known overall increase in porpoises over the last decades

Conclusions

III. Significant increase of harbour porpoise occurrence (for two indicators) in the impact area vs. the control areas during the operation phase





➢ New result with unknown causes

Conclusions

- **What does this mean?**
  - There was a change in habitat use in the study area during the operation phase with more porpoises occurring in the wind park than outside

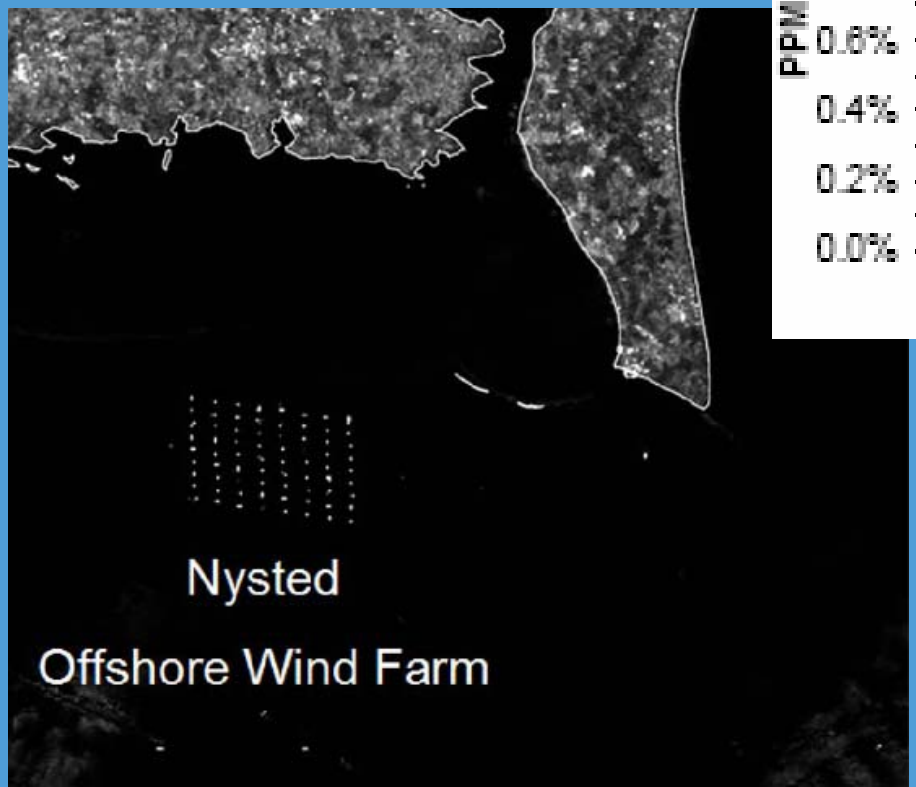
Conclusions

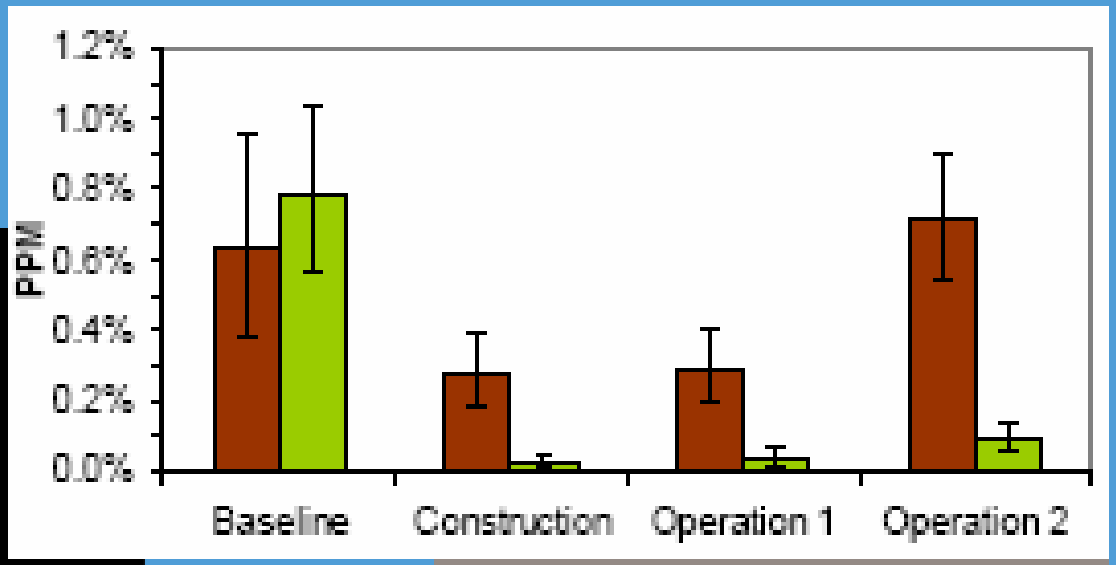
- **What does this not mean?**
  - The animals during the operation phase are necessarily the same as the one during the baseline phase
  - OWEZ had a positive impact on a local population level (e.g. an increase in numbers of animals)

Conflict, co-existence or refuge?

Conflict, co-existence or refuge?

Conflict: has been shown in Nysted. Probably highly dependent on the population, area, type of park etc.

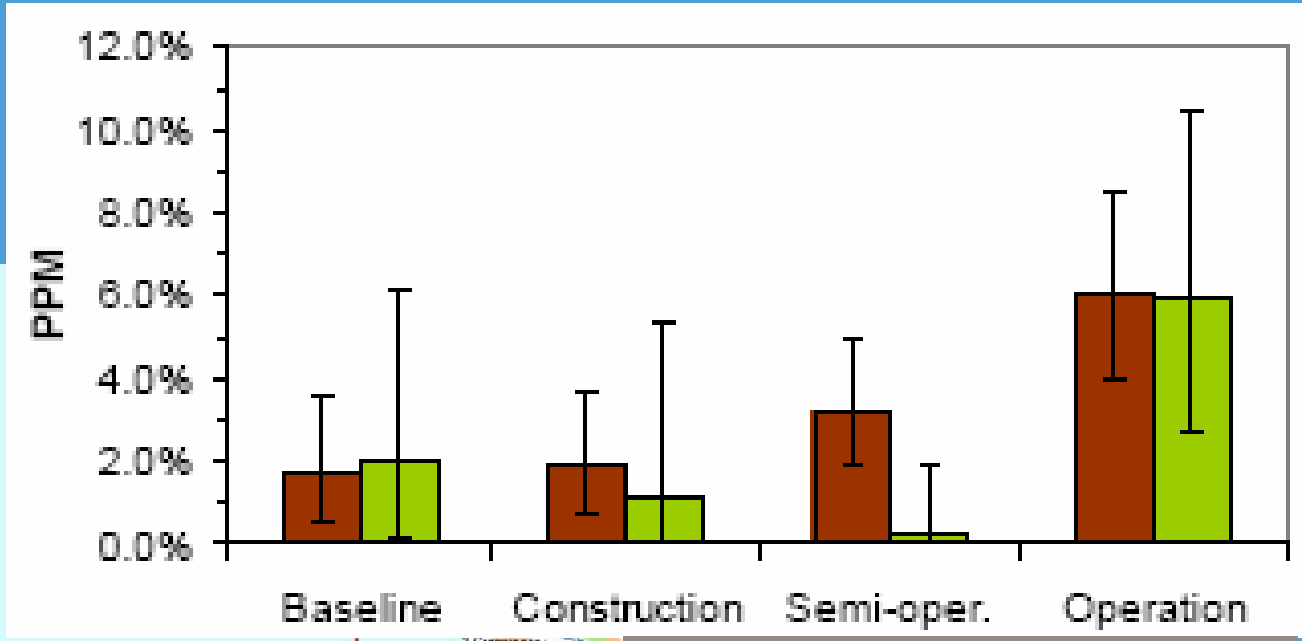




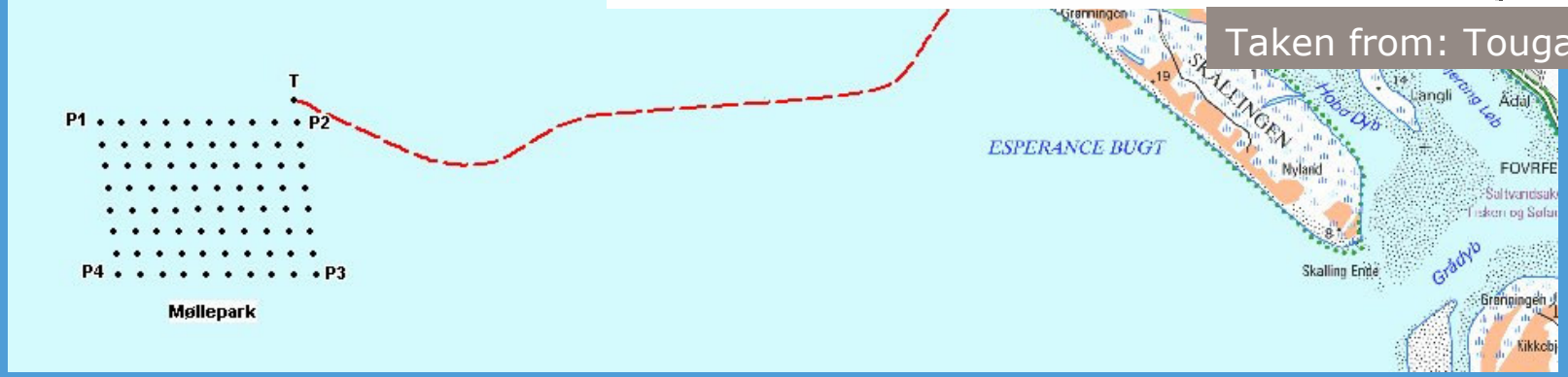
Taken from: Tougaard et al. 2005

Conflict, co-existence or refuge?

Co-existence: at Horns Rev wind farm in Denmark, porpoises used the wind farm (again) during operation.

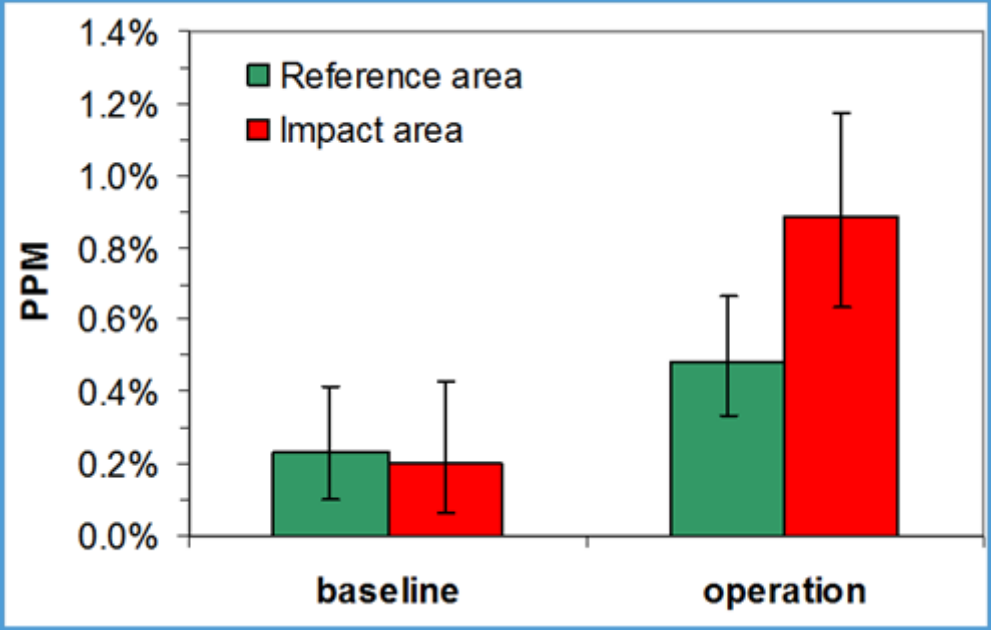


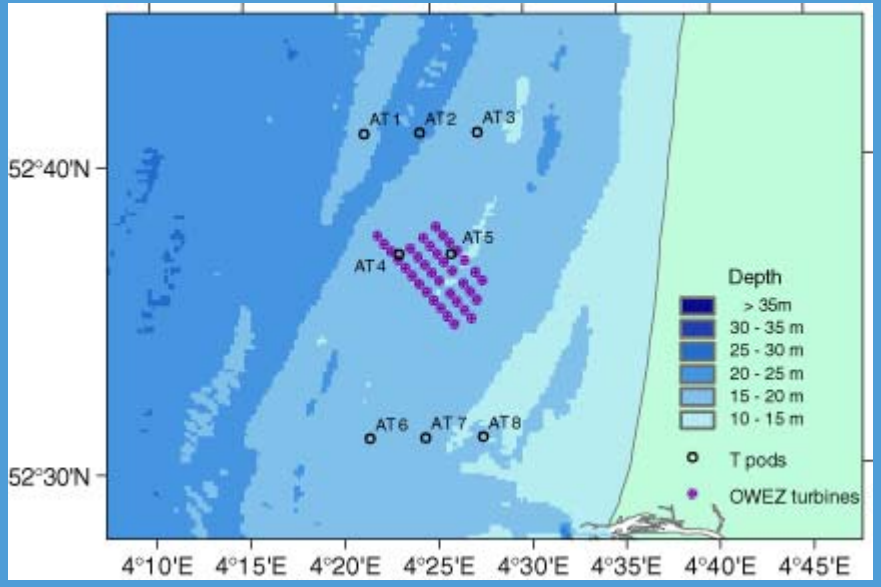
Taken from: Tougaard et al. 2006



Conflict, co-existence or refuge?

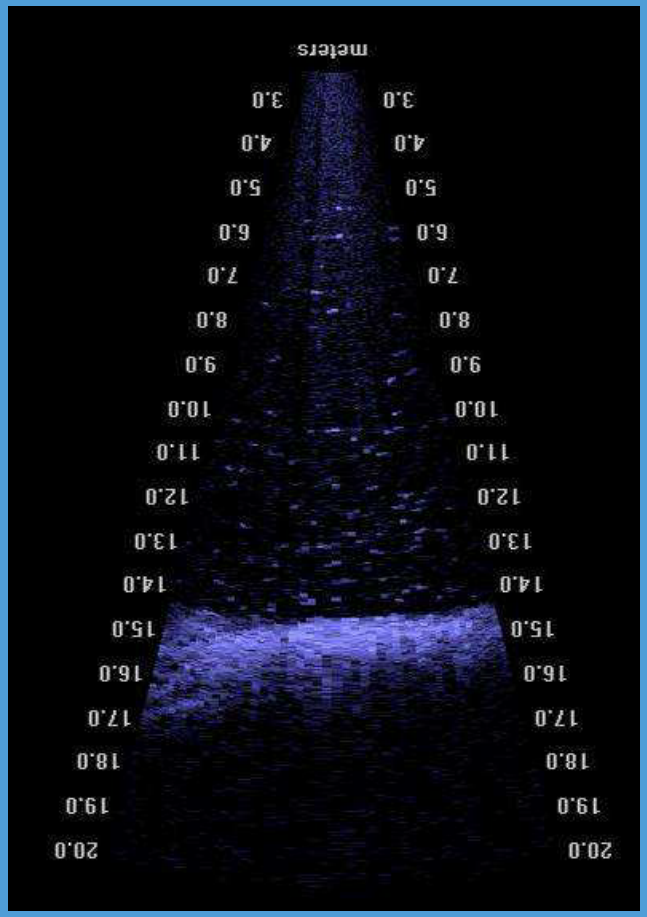
Refuge: porpoise occurrence increased inside the operating OWEZ park in relation to the surrounding areas.





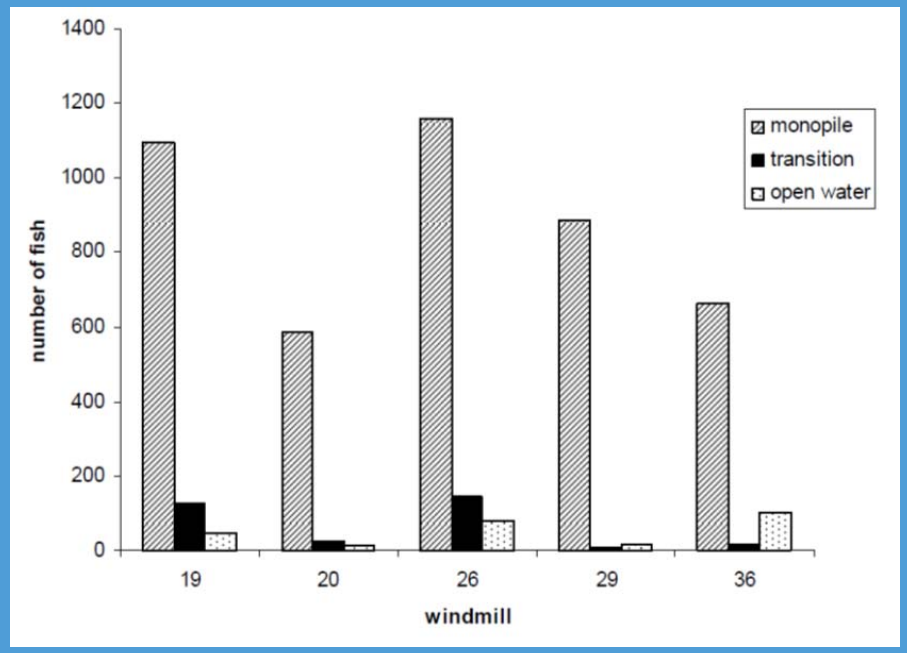
Conflict, co-existence or refuge?

a. Attraction of the wind farm: more food?



Didson image of fish swarm in front of wind farm pole. (Couperus et al. 2010)

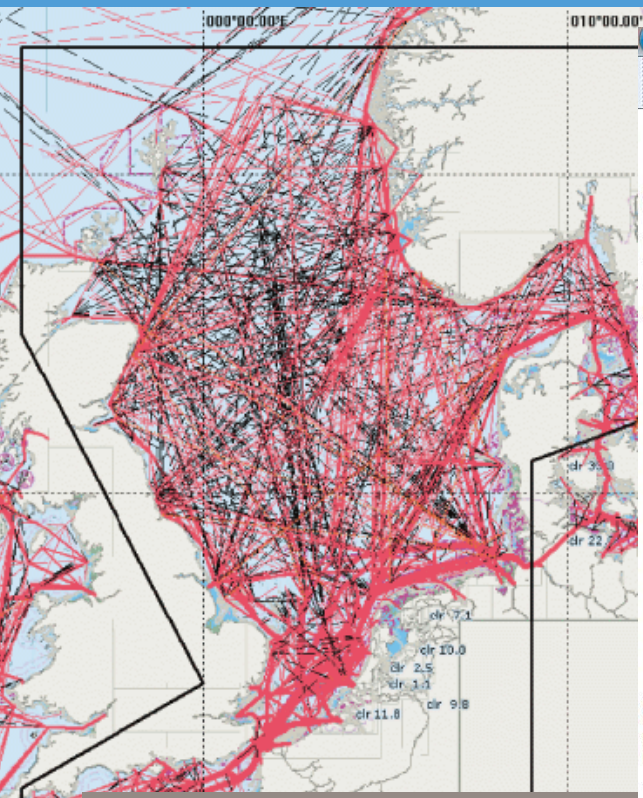
- Does the wind farm provide more potential prey species for porpoises (hard substrate / no fishing)?

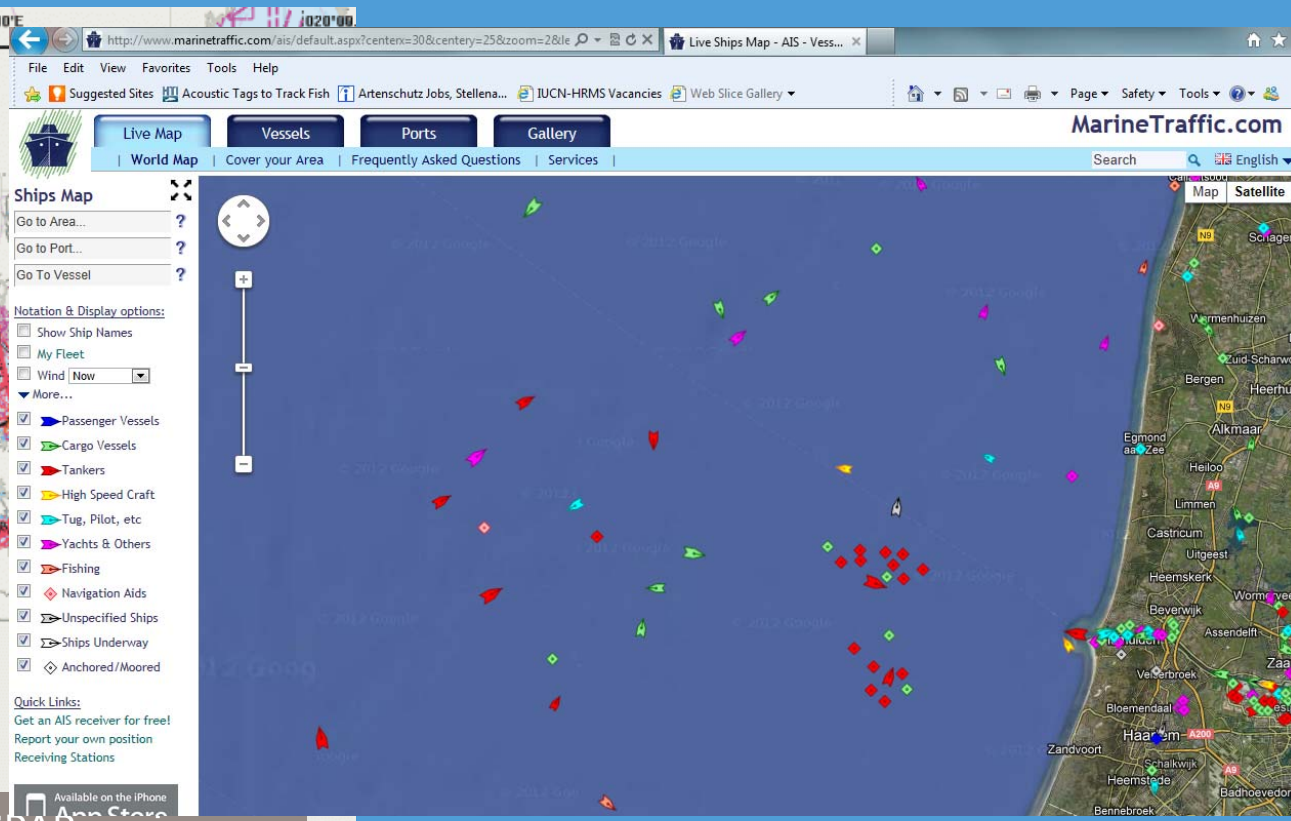


Total number of fish per monopile (Couperus et al. 2010)

Conflict, co-existence or refuge?

b. Avoidance of areas outside the wind farm: the area outside the farm is “worse”, e.g. due to high shipping and fishing activities.





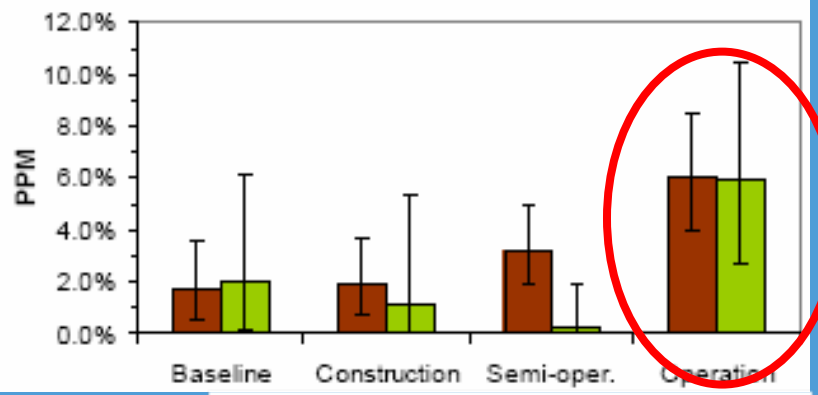
Shipping activities in the OSPAR region. Taken from the 2010 OSPAR QSR

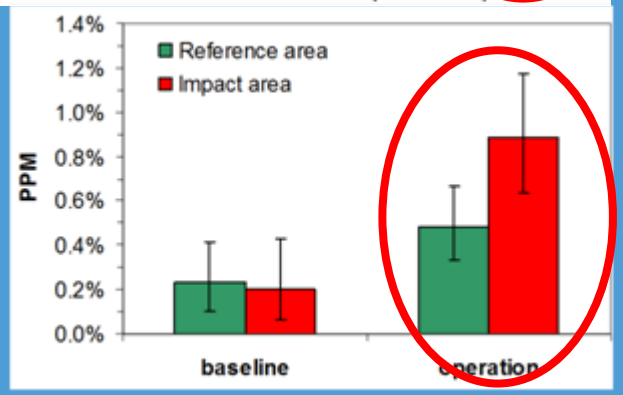
Summary

Conflict: has been shown in Nysted. Probably highly dependent on the population, area, type of park etc.

Co-existence: seems to be the case in Horn's Rev. Porpoises use the park.

Refuge: although porpoise occurrence has increased inside the OWEZ park, it is not clear if this is because the outside is "worse".





Conclusions

- Case specific results
- No long term follow up was possible
- Cumulative impacts need to be considered
- Very dynamic system, so other processes are on top of this one (regime shift North Sea)
- Question remains why and how porpoises use the wind farm

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- No long term follow up was possible
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- Very dynamic system, so other processes are on top of this one (regime shift North Sea)
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Research question:
What do the porpoises (now) do in OWEZ?

- Investigate the small scale habitat use and behaviour of porpoises in the OWEZ wind farm
- Use of passive acoustics to investigate click behaviour in more detail (e.g. feeding click trains)
- Other ideas?

Thanks to:

The crew of the Terschelling for their dedication and safe work.

All people involved in data collection & analysis.

H. Kouwenhoven for support throughout the study (and beyond).

TNO colleagues for their comments on the report.

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