

NS14 & JG22 2026

Passive acoustic monitoring

- investigating the power to detect changes in relative density of harbour porpoises

Sveegaard S, Owen K, Kyhn LA, Galatius A, Jørgensen PB, Mikkelsen L, Teilmann J, van Beest FM (**in press**) Passive acoustic monitoring - optimising the power to detect temporal changes in relative density of a cetacean population under pressure. Mar Ecol Prog Ser :0-0 <https://doi.org/10.3354/meps15155>

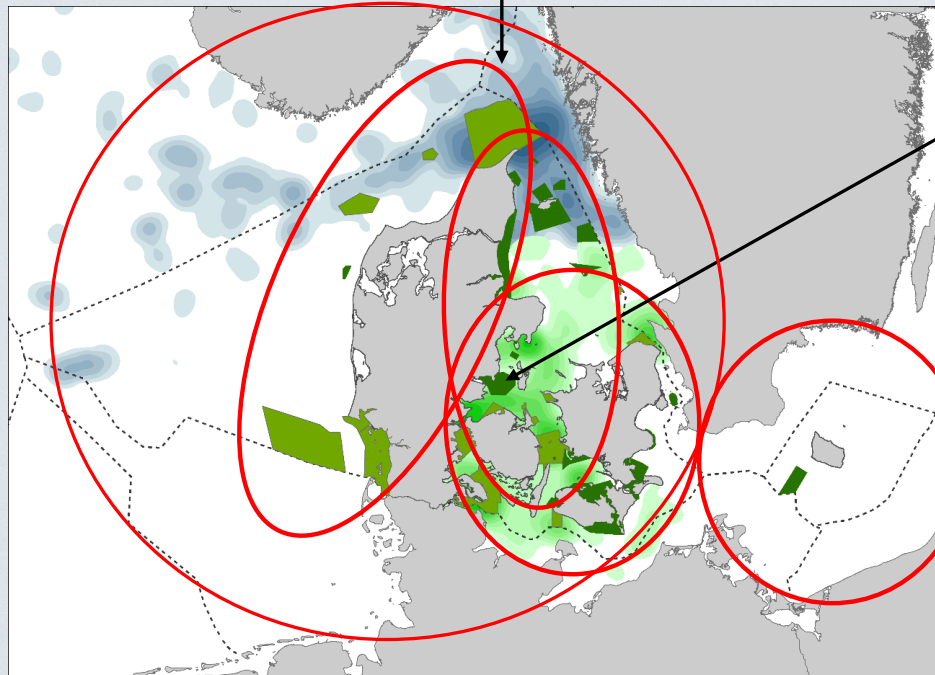
DK MONITORING PORPOISES

Abundance survey
(1 every 6. year)



Skagerrak/North Sea population

Aerial survey every year



Belt sea population

Passive acoustic monitoring
1 every 6 year / areas



Honnef

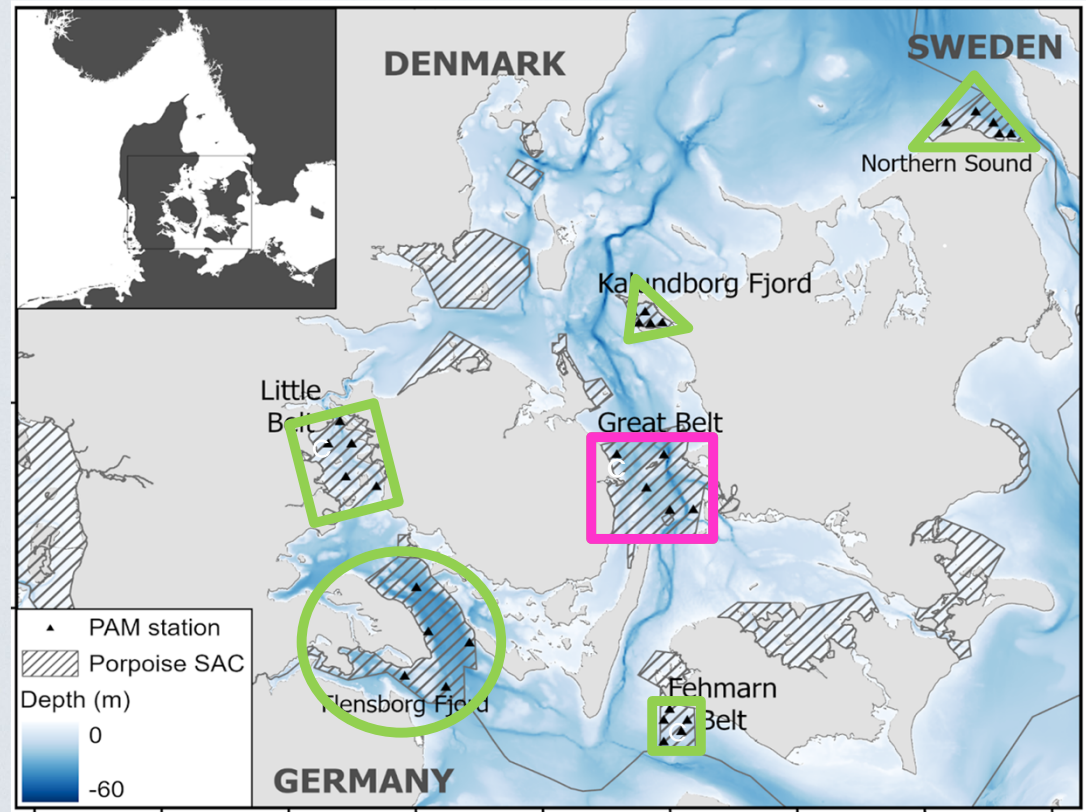
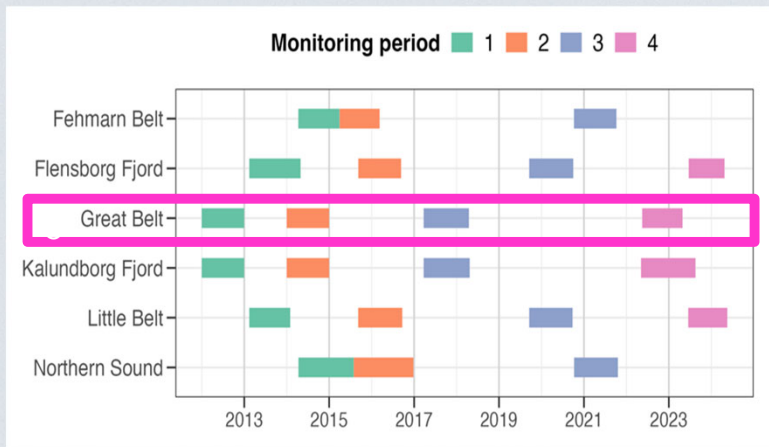
Baltic population

Passive acoustic monitoring

METHODS

Danish National monitoring:

- Passive acoustic monitoring (C-PODs)
- 2012-2024
- 5 C-PODs per SAC, 1 year



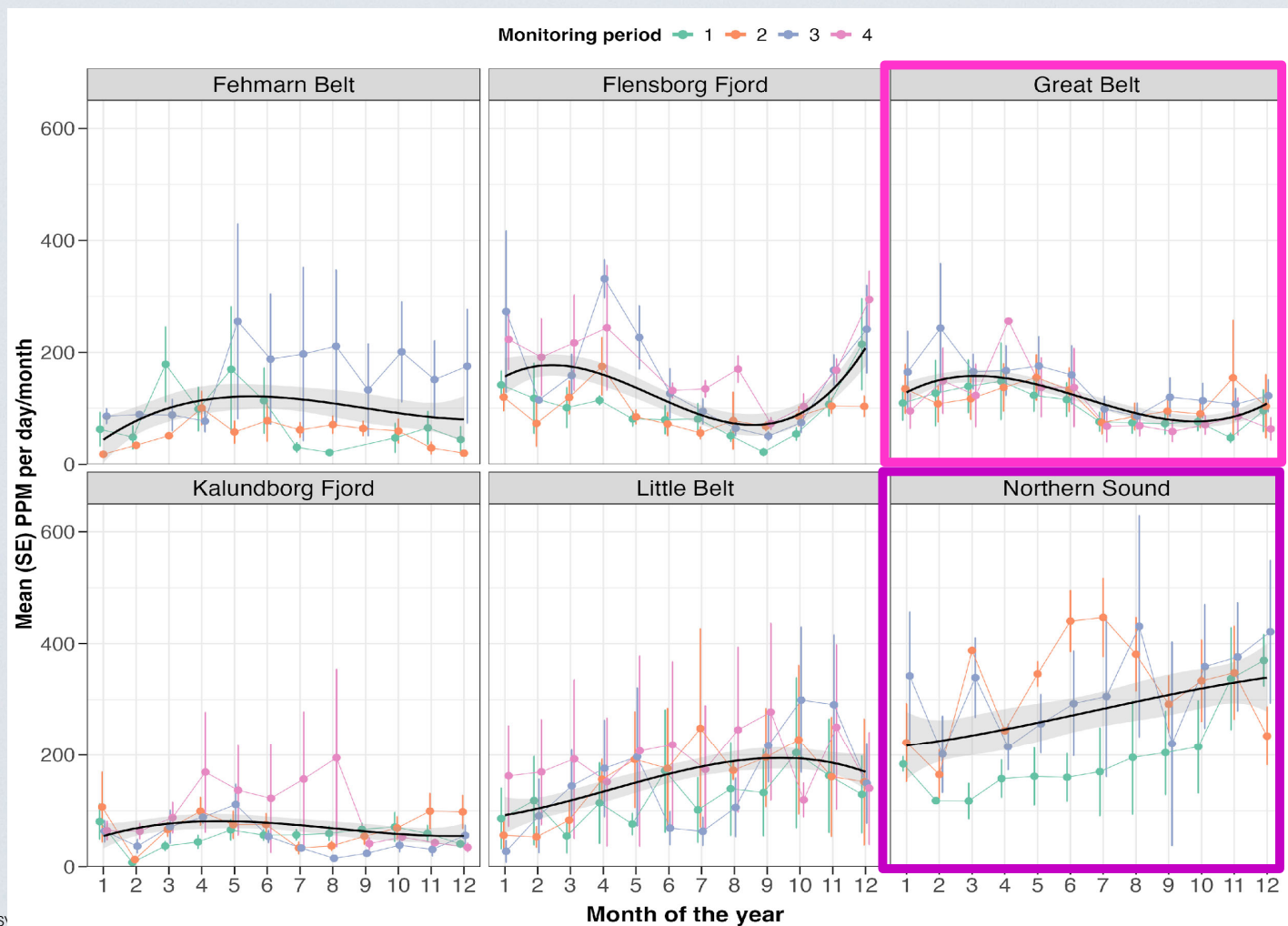
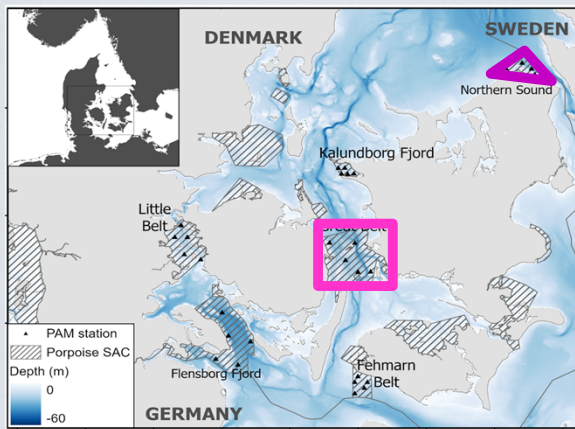
AIMS

- 1) Assess the trend in relative density for each SAC
- 2) Determining the statistical power to detect changes
- 3) Evaluate how number of PAM stations and deployment duration affect this power



RESULTS

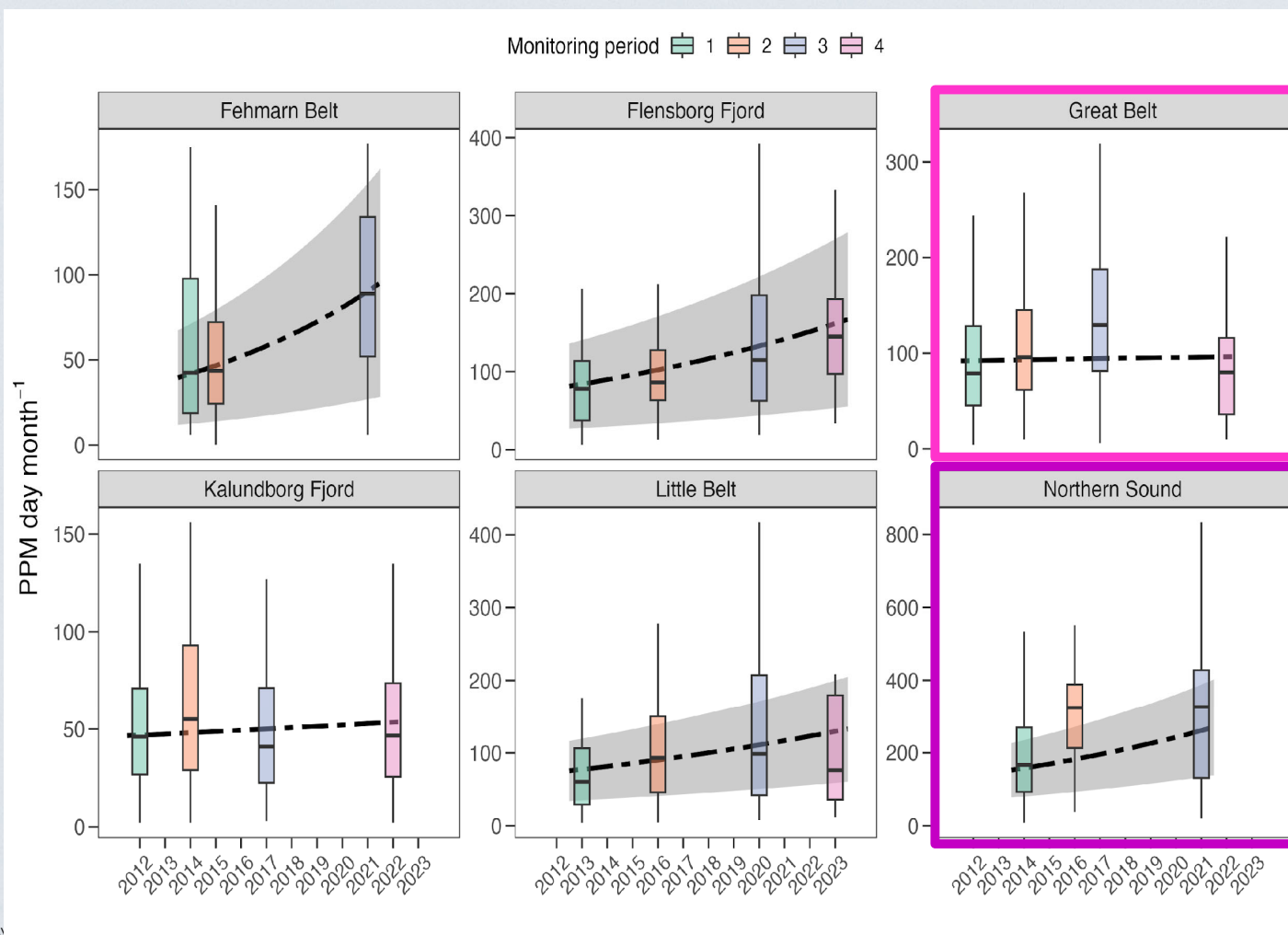
Seasonal variation



RESULTS

Trend analysis

Generalized linear mixed-effects regression



RESULTS

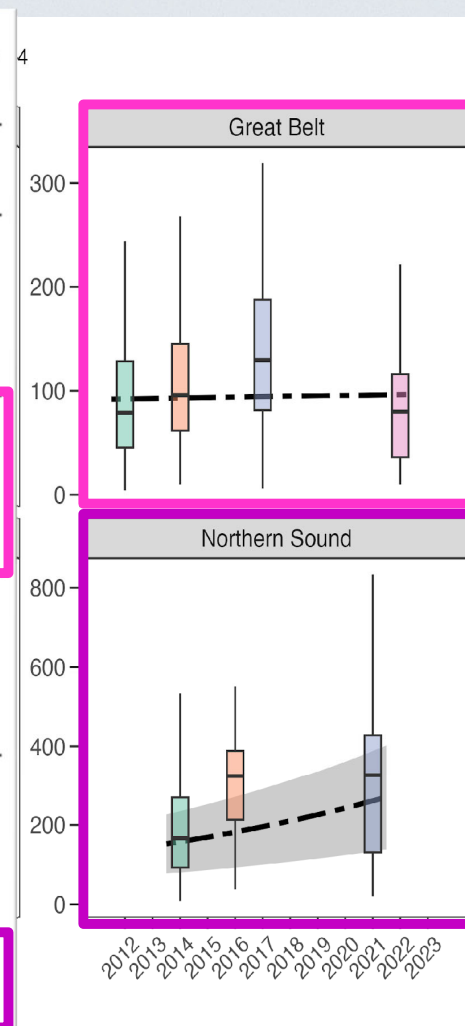
Changes between periods

Tukey HSD tests

Power = 80%, Alpha = 0.2



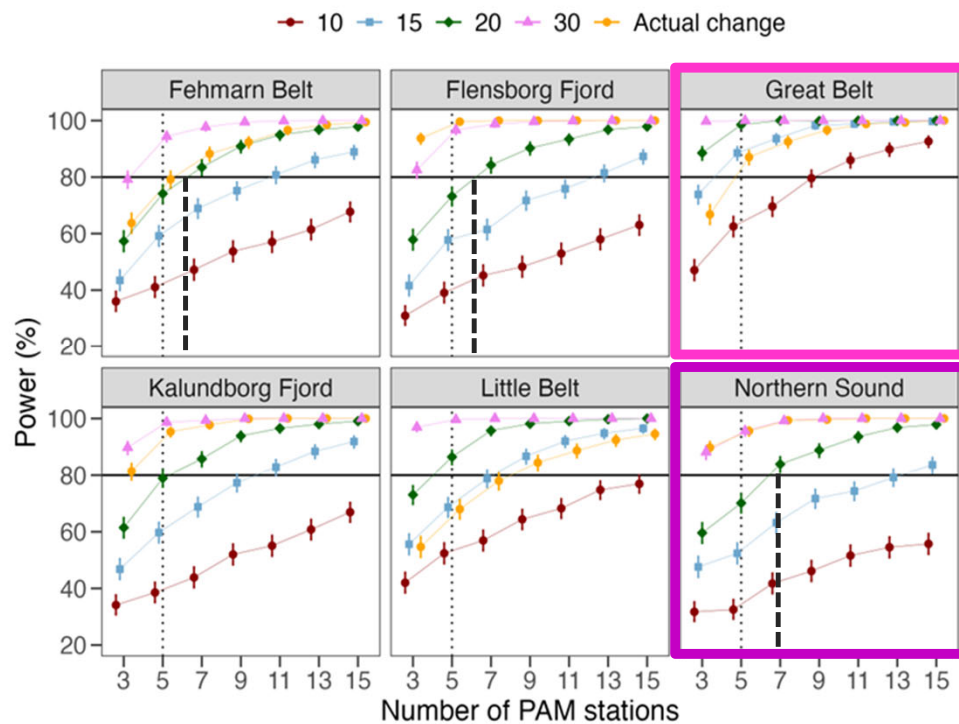
SAC	Period comparison	Year comparison	Change in PPM/day (%)	Tukey HSD p-value	Obs. power (%)
Fehmarn Belt	P1-P2	2014-2015	-22.4	0.235	82
	P1-P3	2014-2021	45.8	<0.001	100
	P2-P3	2015-2021	55.7	<0.001	100
Flensburg Fjord	P1-P2	2013-2016	36.7	0.143	100
	P1-P3	2013-2020	37.7	<0.001	100
	P1-P4	2013-2023	54.6	<0.001	100
	P2-P3	2016-2020	20.3	0.225	82
	P2-P4	2016-2023	42.8	<0.001	100
Great Belt	P3-P4	2020-2023	19.2	0.166	70
	P1-P2	2012-2014	14.7	0.261	88
	P1-P3	2012-2017	29.6	0.001	97
	P1-P4	2012-2022	2.2	0.996	21
	P2-P3	2014-2017	13.6	0.263	60
Kalundborg Fjord	P2-P4	2014-2022	-27.8	0.442	67
	P3-P4	2017-2022	-43.1	0.008	97
	P1-P2	2012-2014	26.5	0.309	96
	P1-P3	2012-2017	-8.5	0.959	29
	P1-P4	2012-2022	18.2	0.491	50
Little Belt	P2-P3	2014-2017	-44.4	0.119	94
	P2-P4	2014-2022	-4.8	0.981	23
	P3-P4	2017-2022	23.3	0.221	65
	P1-P2	2013-2016	14.6	0.519	71
	P1-P3	2013-2020	42.7	<0.001	100
Northern Sound	P1-P4	2013-2023	35.0	<0.001	100
	P2-P3	2016-2020	35.5	<0.001	100
	P2-P4	2016-2023	23.4	0.006	92
	P3-P4	2020-2023	-14.7	0.518	57
	P1-P2	2014-2016	31.2	0.003	97
Northern Sound	P1-P3	2014-2021	46.3	<0.001	100
	P2-P3	2016-2021	21.8	0.046	96



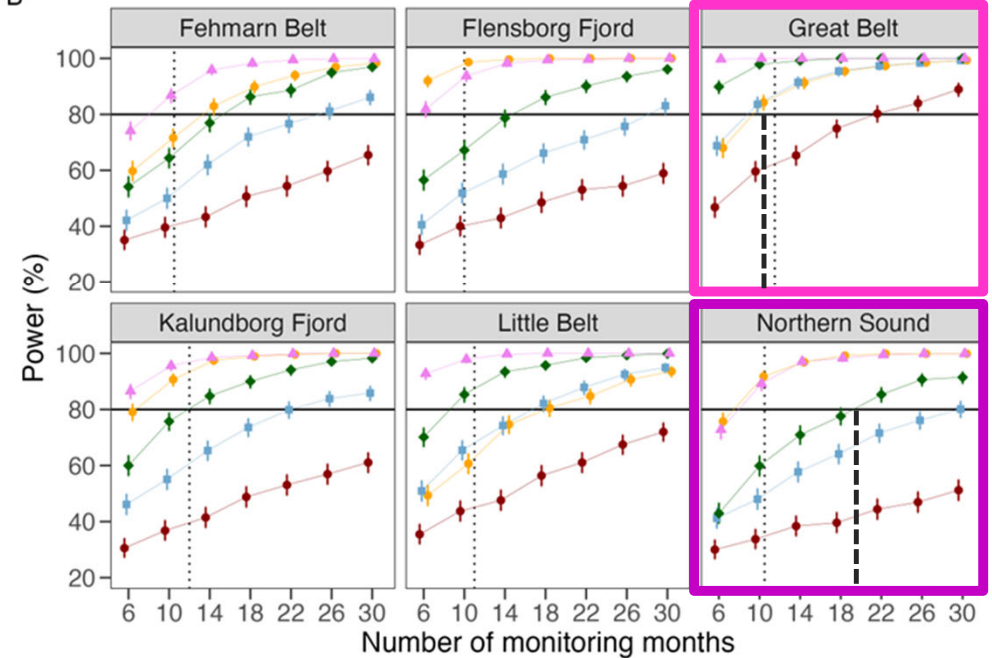
RESULTS - POWER

Power analysis => to avoid Type I and Type II error

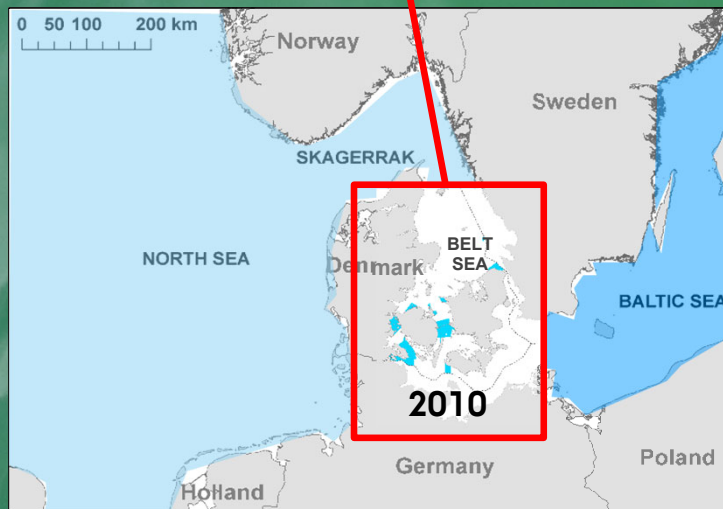
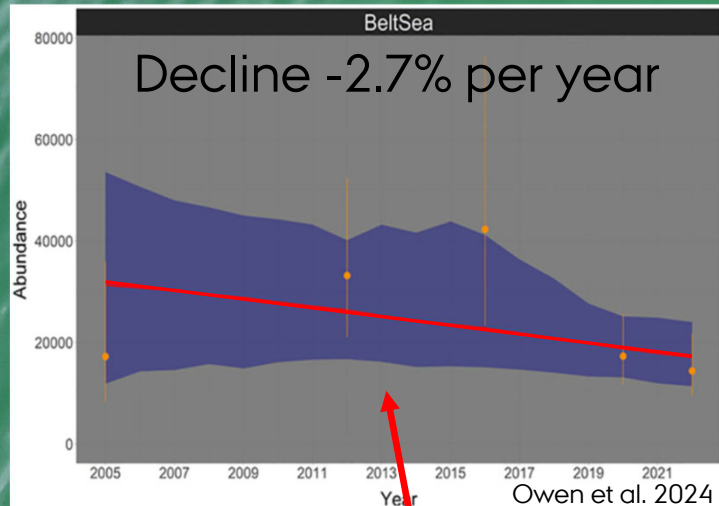
A



B



POPULATION STATUS



CONCLUSION

- SACs monitored 2012-2024
- Positive trend in 4 out of 6 SACs ➡ contrast to population trend ➡ suggesting congregation in SACs
- Current design can detect 30% change
- BUT only sufficient power to detect the actual change (14.6-36,2%) in 5 SACs
- To improve this number of PAM stations or deployment length can be increased
- **Perspective:** pilot studies or prior knowledge of porpoise density is needed in order to design future PAM studies of porpoises

TAKE HOME MESSAGE:

- Monitoring **both** key habitats and the entire population is vital for a comprehensive understanding of conservation status for cetacean populations
- Implement protection in SACs





**Ministry of Environment
of Denmark**

Environmental
Protection Agency

THANK YOU!

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