Tussenstand Wozep feb 2017

Dit document is een compilatie van presentaties die gehouden zijn op 21 februari 2017 i.k.v. het project Wozep (wind op zee ecologisch programma). De rapporten, behorende bij deze presentaties, zullen na afronding eveneens op het Noordzee Loket verschijnen.

Ingeborg van Splunder, projectleider Wozep

Rijkswaterstaat
Ministerie van Infrastructuur en Milieu

Wind op Zee ecologisch programma - WoZep

Tussenstand 2016-2017
21 februari 2017 - Utrecht

Waar staan we nu

- 2016 aantal voorbereidende onderzoeken (no regret)
- Vaststellen doelen en kennisvragen
- Vaststellen Meerjarenprogramma Wozep 2017-2021
- Vertalen MJP naar onderzoek
- Inzoomen en uitzoomen

Tussenstand Wozep 2016

- Wind op zee ecologisch programma 2016-2021
- Eerste bijeenkomst delen van resultaten
- Opdracht EZ t.b.v. ecologische effecten windparken op zee
- Waar staan we nu

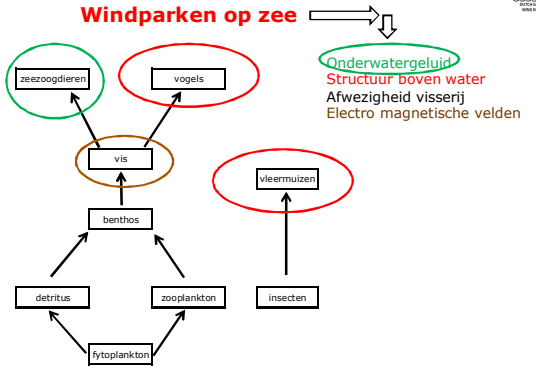
Doelen Wozep:

- Reduceren onzekerheid aannames MERren, PB'n en het KEC voor betere besluiten
- Effectiviteit mitigerende maatregelen (kostenreductie)
- Reduceren onzekerheid opschaling Windparken na 2023

Wozep en z'n omgeving

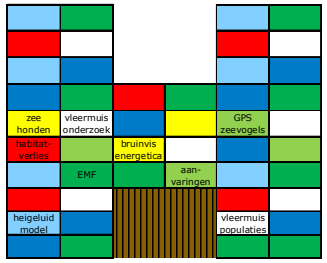
- Oude onderzoekslijnen oppakken in Wozep-verband
- Samenwerking met windparkeigenaren
- Samenwerking met buitenlandse partijen en
  - onderzoeksprojecten
- Verbinding zoeken met dossiers zoals KRM, Natuur inclusief bouwen, doorvaart en medegebruik
- In context van cumulatieve effecten nationaal en internationaal

Windparken op zee



Tussenstand 2017:

de eerste lego-blokjes



Programma

9:30	Inloop	
10:00	Ingeborg van Splunder (RWS)	Welkom
10:15	Maarten Platteeuw (RWS)	Displacement van vogels door offshore windparken
10:35	Sjoerd Dirksen (SDE)	Review van systemen voor detectie van aanvaringen/sterfte onder vogels en vleermuizen
10:55	Pauze	
11:15	Ruben Fijn (BuWa)	Inventarisatie GPS-gegevens zeevogels
11:35	Roelant Snoek (Waterproof)	Effecten van elektromagnetische velden op vis
11:55	Christ de Jong (TNO)	Validatie TNO heigeluidmodellen
12:15	Lunch	
13:15	Sander Lagerveld (WMR)	Vleermuisonderzoek met radiotelemetrie en warmtebeeldcamera's
13:50	Herman Limpens (Zoogdierver.)	Onderzoek vleermuispopulaties
14:10	Pauze	
14:30	Geert Aarts (WMR)	Ontwikkeling zeehondenkaart
14:50	Ron Kastelein (Seamarco)	Energetica van de bruinvis
15:10	Einde	

Review van systemen voor detectie van aanvaringen/sterfte en metingen fluxen van vogels en vleermuizen

Sjoerd Dirksen

opdracht RWS WVL in kader Wozep
uitgevoerd door
Sjoerd Dirksen Ecology

waarom is dit relevant?

- op land gedaan, offshore nog (vrijwel) niet; ooit zal gebruik van getallen 'ordegrootte land' voor offshore met veldmetingen verantwoord moeten worden
- huidige generatie CRM's (Collision Risk Modelling) is gevoelig voor waarden van sommige invoer-parameters: nauwkeurige(r) veldvalidatie is gewenst, zeker voor cumulatieve effecten huidige omvang plannen Wind op Zee (Nederland) en Noordzee als geheel

- Wozep 2016, onderdeel 5A
- Fase 1 inventarisatie en review methoden/technieken/systemen om te meten:
  1. sterfte / aanvaringsslachtoffers
  2. flux op 3 schaalniveaus: buiten windpark, in windpark en in RSA (rotor swept area)
- voor vogels en vleermuizen

rapport is af en zal binnenkort beschikbaar zijn

dit is niet de eerste review...

In 2012 concludeerden Collier, Krijgsveld & Dirksen (Bureau Waardenburg) in een rapport voor SOSS (Crown Estate, UK) over systemen voor aanvarings-detectie van vogels:

'Currently, no system offers all the requirements specified in […] and only two are known to be undergoing testing at offshore turbines'

Gelukkig is de handschoen opgepakt!

detectie sterfte onder vogels en vleermuizen

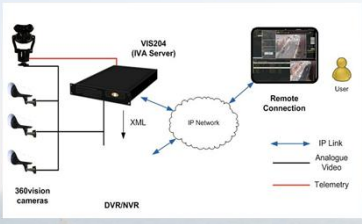
verschillende sensoren als basis van systemen:

- geluid/trillingen: microfoons, acoustische sensoren, accelerometers – WT-Bird, ID-Stat, Oregon State University
- beeld/beweging: camera's (daglicht, warmtebeeld) – TADS, VARS, DT-Bird, ATOM, ACAMS, WMR

altijd remote toegankelijk

software die sensors stuurt tot 'triggers'

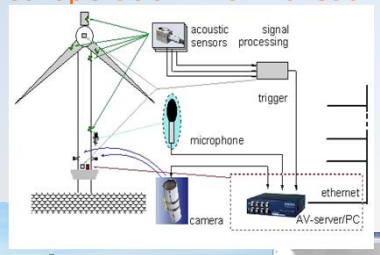
Thermal Animal Detection System – TADS ORJIP: NIRAS, DHI, Birdlife DK

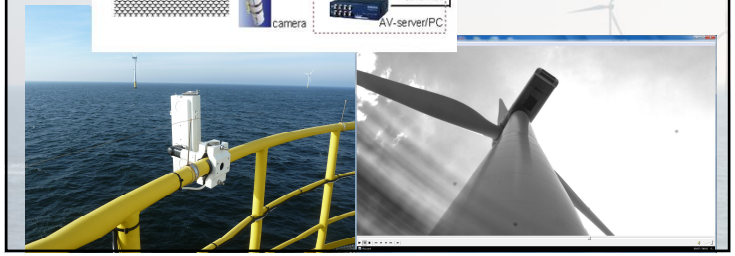


2 warmtebeeldcamera's en een daglichtcamera

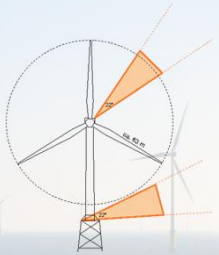
gekoppeld aan software die positie registreert, koppeling aan radar mogelijk

WT-Bird, ECN (NL), field tests in close co-operation with Bureau Waardenburg





Visual Automatic Recording System –VARS, IfAÖe (D)



camera net achter rotor

software detecteert vogels, exacte flux

Band-model voor collision rate

andere systemen met camera's als centrale sensor

DT-Bird, Liguen (E)

Acoustic and Thermographic Offshore Monitoring – ATOM, Normandeau Ass. (USA)

Aerofauna Collision Avoidance Monitoring System – ACAMS, Biodiversity Research Institute en HiDef (USA)

en hoe zat het nu met vleermuizen?

- sommige systemen kunnen ook slachtoffers onder vleermuizen detecteren, maar geschiktheid en bruikbaarheid verschillen
- bijvoorbeeld ATOM specifiek op getest, Oregon State University ontwikkelt
- in ontwikkeling: Wageningen Marine Research – Sander Lagerveld vanmiddag!

in ontwikkeling

Oregon State University - combinatie van sensoren: accelerometers, contact microfoons, daglicht en IR camera's, bioacoustics microfoons

ID-Stat, Calidris (F) - microfoons

fluxmetingen

- systemen gebaseerd op camera's zijn in principe geschikt voor metingen fluxen – maar alleen op kortere afstanden
- radar is zeer geschikt voor meten fluxen, ook op grote(re) afstanden, maar niet vlakbij windturbine (RSA)
- conclusie is dat voor meten fluxen op 3 schaalniveaus eigenlijk altijd combinatie van systemen noodzakelijk is

geautomatiseerde vogelradars geschikt voor gebruik offshore

- 3D Flex, Robin Radar (NL)
- Merlin Bird and Bat Radar, DeTect Inc (USA)
- BirdScan MR1, Swiss Birdradar (CH)
- Birdtrack, Strix (P)
- DHI Bird Detection System with Scanter 5000 or LAWR 25, DHI (DK)

Merlin Bird and Bat Radar

combinatie van horizontale S-band radar en verticale X-band radar

algorithmes selecteren vogels, tracken deze en slaan data op in database

3D Flex Robin Radar

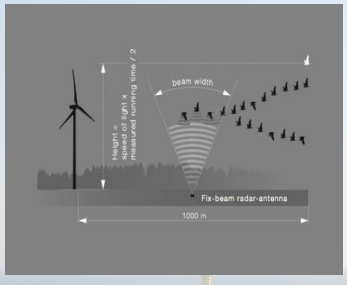
horizontaal:
grotere vogels en groepen tot c. 10 km
kleinere vogels tot 4,5 km

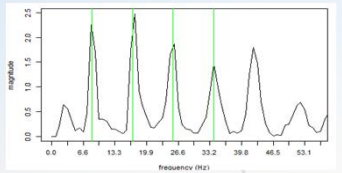
verticaal:
tot max. 2 km

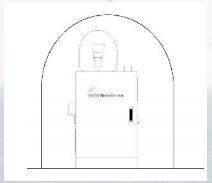
S-band horizontale radar gecombineerd met FMCW radar voor verticaal: tracks, fluxen, vlieghoogtes

algorithmes selecteren vogels, tracken deze en slaan data op in database

Birdscan MR1







vertically directed conically shaped wide aperture beam with a nutating movement

overige vogelradars in review

Birdtrack, Strix (P)

DHI Bird Detection System with Scanter 5000 or LAWR 25, DHI (DK)

	collisions		flux	
	birds	bats	birds	bats
WT-Bird	+			
TADS	+	+	A(B)	A
VARS	+	+	A(B)	A
DT-Bird	+			
ATOM	+	+	A	A
3D Flex Robin Radar			BC	B?
Merlin Bird and Bat Radar			BC	B?
BirdScan MR1			BC	B?
Birdtrack			BC	B?
DHI Scanter 5000			BC	B?
DHI LAWR 25			BC	B?
in development, tests ongoing				
ACAMS	+	+	AB	A
Oregon State	+	+	A	A
in development				
ID-Stat	+			
Wageningen Marine	+	+	A	A

A: RSA B: in windpark C: buiten windpark

fluxmetingen vleermuizen

- camera-systemen: flux in RSA, mogelijk flux in windpark
- radar-systemen: mogelijk flux in windpark, maar leveranciers hebben hier nog werk te doen

kanttekeningen, disclaimers enzovoort

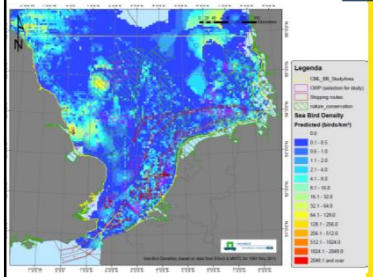
- van systemen die gebruikt zijn in projecten of waarmee veldtesten zijn uitgevoerd vandaag geen resultaten gepresenteerd
- systemen niet systematisch vergeleken, niet alle kenmerken en beperkingen
- systemen voortdurend in ontwikkeling
- rapport lezen geeft eerste indruk, maar ieder project is anders en voor ieder concreet project zul je zelf de leveranciers om specificaties en mogelijkheden moeten vragen

conclusies

- aanvaringsslachtoffers vogels kunnen worden gedetecteerd, net als sterfte vleermuizen
- fluxen op verschillende schaalniveaus kunnen worden gemeten
- meeste technieken/apparaten/systemen hebben limiteringen (grootte, soortspecifiek meten, detectiebereik etc.)
- systemen worden nog steeds verbeterd en nieuwe zijn in ontwikkeling
- door gebruik te maken van combinatie komen we een flinke stap op weg naar uiteindelijke doel, en bandbreedte in voorspellingen kan dan al flink omlaag

vragen welkom,
ook in pauze

na vandaag:
sjd@sjoerddirksenecology.nl



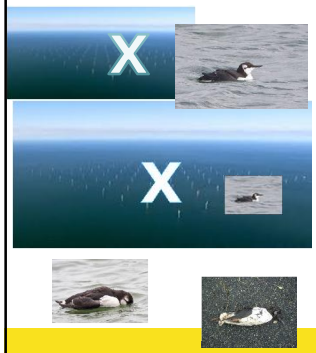
Rijkswaterstaat
Ministerie van Infrastructuur en Milieu

Aanpak thema 'zeevogels en habitatverlies' als gevolg van offshore windparken

Maarten Platteeuw[1], Mardik Leopold[2]

[1]Rijkswaterstaat, Ministry of Infrastructure and Environment
[2]Wageningen Marine Research

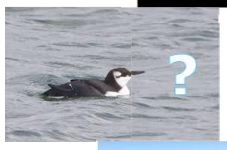
Hoe is hier tot dusver mee omgegaan?



- Vanwege voorzorgsbeginsel '*worst case*' scenario's geschetst
- 100% verstoring aangenomen voor ieder (bestaand en aan te leggen) OWP en een buffer van enkele kilometers
- Aangenomen dat die verstoring optreedt gedurende gehele levensduur van OWP (c. 30 jaar)
- Dichtheden ter plaatse vóór OWP doorgerekend naar aantallen verstoorde dieren
- Aanname: 10% verstoorde vogels sterft

Inleiding; wat is het knelpunt?

- Bepaalde soorten zeevogels herkennen offshore windparken (OWP'en) niet als leefgebied en wijken uit
- Kan bij verdere uitrol van wind op zee (WoZ) leiden tot structureel verlies van leefgebied (habitatverlies)
- Gevolg kan zijn: afname individuele fitness
- Hierdoor kunnen negatieve trends in substantiële delen van populaties optreden



Welke onzekerheden zijn benoemd?

- Exacte mate van verstoring door OWP niet bekend
- Invloed van onderlinge afstand tussen turbines op mate van verstoring onbekend
- Mate waarin, op populatieniveau, 'gewenning' kan optreden onbekend (en ook: gedragen dieren in OWP zich anders dan daarbuiten)
- Exacte invloed van verlies aan leefgebied op individuele fitness en overige factoren die dat beïnvloeden
- Verband reductie individuele fitness en populatietrends

Hoe kunnen die onzekerheden worden verkleind?

- Betere kwantificatie van invloed OWP'en en ruimtelijke configuratie ervan op verspreiding/gedrag vogels
- Weten welke broedpopulaties waar op zee pleisteren
- Identificatie van meetbare parameters die helpen effecten op niveau van (sub)populatie beter te voorspellen
- Vervolgens meten van die parameters en modellen verbeteren via iteratieslagen

… en dan hebben we eind 2021 hopelijk…

Een behoorlijk betrouwbare modellering populatie-effecten van habitatverlies door WoZ op zeevogels !!

… en wat gaan we dan concreet doen?

- Opstellen modellen habitatgebruik en populatiedynamica zeevogels
- Inzet bestaande en toekomstige zeevogelmonitoring (verspreiding in relatie tot OWP'en) voor vullen modellen
- Kwantificering mate van verstoring (internationale workshop zeekoeten, april 2017)
- Meten verspreiding en gedrag zeevogels binnen en buiten OWP

Wat kunnen we met betere voorspellingen?

- Beter doorrekenen wat de cumulatieve effecten zijn van de uitrol van WoZ op andere tijd- en ruimteschalen dan de huidige
- Daardoor beter kunnen inbedden van WoZ in Marine Spatial Planning
- Meer inzicht in vraag of 'sluipende' effecten van habitatverlies werkelijk populatie-effecten (kunnen) hebben
- Mogelijk zelfs kansen in beeld voor effectieve mitigatie, bv. door OWP'en anders vorm te geven?

Tracking data voor betere aanvaringsberekeningen

Ruben Fijn, Abel Gyimesi, Mark Collier

Project in progress….

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

Table 1 *Species highlighted in the KEC study (Rijkswaterstaat 2015) as having an expected collision probability higher than 1% of the potential biological removal (PBR). Size of the species is indicated as mean weight (g; source: BTO Birdfacts), where ranges are given for species with distinctive differences between males and females. Species in bold are discussed in present study.*

Species group	Species	% Collision of PBR	Mean weight (g)
Wildfowl	**Bewick's Swan**	42%	5300-6400
	Pink-footed Goose	2%	2500
	Brent Goose	2%	1500
	Common Shelduck	4%	1000-1200
	Greater Scaup	3%	1000
	Tufted Duck	1%	760
Waders	**Curlew**	57%	770-1000
	Bar-tailed Godwit	6%	300-370
	Woodcock	1%	280
	Lapwing	3%	230
	Knot	10%	140
	Redshank	4%	110-130
	Turnstone	2%	120
	Snipe	2%	110
	Sanderling	20%	59
Terns	Black Tern	50%	73
Passerines	Starling	12%	78
	Skylark	3%	35-42

Waarom?

- **KEC**
  - ***Zilver-, Kleine Mantel-***, Grote Mantel-, Dwergmeeuw en Grote Jager

Waarom?

- **KEC**
  - ***Zilver-, Kleine Mantel-***, Grote Mantel-, Dwergmeeuw en Grote Jager
  - steltlopers, zwanen, ganzen, eenden

Waarom?

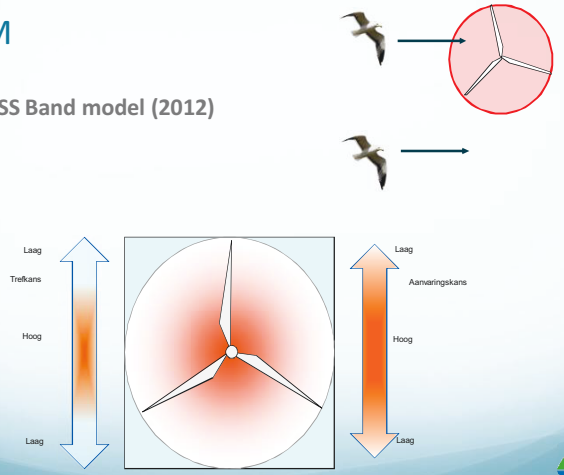
- KEC
  - *Zilver-, Kleine Mantel-*, Grote Mantel-, Dwergmeeuw en Grote Jager
  - steltlopers, zwanen, ganzen, eenden
- CRM

Aannames CRM

- Dichtheid van vogels
- Uitwijking
- Vogelgrootte
- Vliegsnelheid
- Vlieghoogte
- Vliegactiviteit

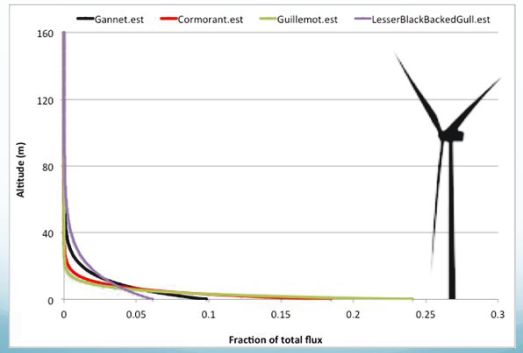
CRM

- SOSS Band model (2012)



CRM

- SOSS Band model (2012)



Waarom?

- KEC
  - *Zilver-, Kleine Mantel-*, Grote Mantel-, Dwergmeeuw en Grote Jager
  - steltlopers, zwanen, ganzen, eenden
- CRM
- **Review aannames**
  - Vlieggedrag zilver- en kleine mantelmeeuwen
  - Vlieggedrag overige soorten

Welke soorten?

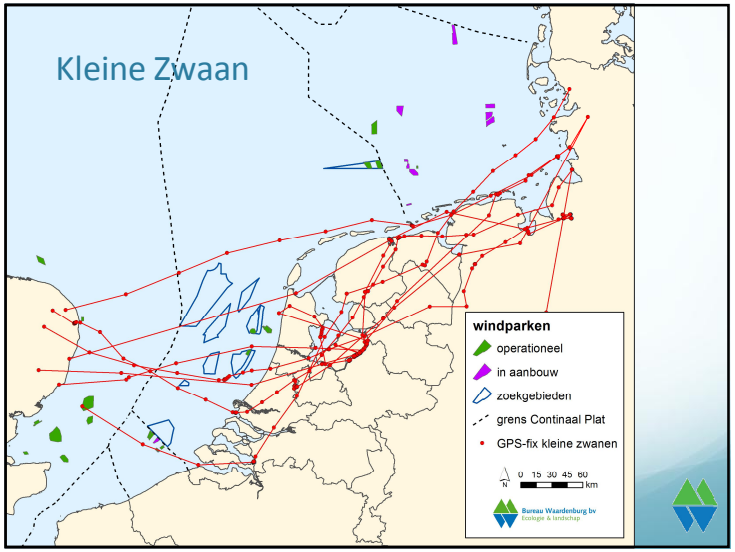
Veel data over de Zuidelijke Noordzee

- Kleine Zwaan - WWT
- Rotgans – NIOO
- Zilvermeeuw – NLD, BEL, GER
- Kleine Mantelmeeuw – NLD, UK, BEL, GER

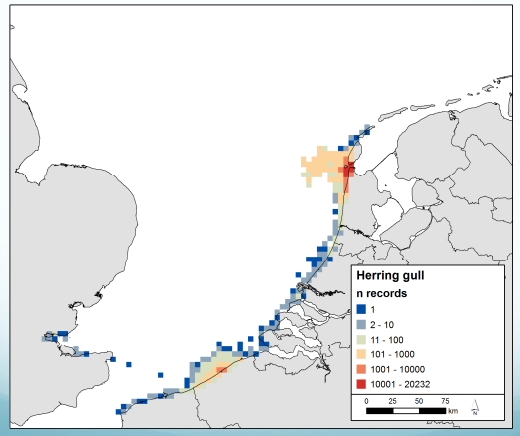
Daarom

- **Bureau Waardenburg**
  - Review on tracking studies to delineate migration routes, flight speed and flight altitude of birds at the Southern North Sea
- **Doel**
  - Review van gepubliceerde literatuur en ongepubliceerde datasets met daarin relevante data
  - Analyse van beschikbare data om parameters te bepalen.

Kleine Zwaan



Zilvermeeuw



Welke soorten?

Veel data over de Zuidelijke Noordzee

- Kleine Zwaan - WWT
- Rotgans – NIOO
- Zilvermeeuw – NLD, BEL, GER
- Kleine Mantelmeeuw – NLD, UK, BEL, GER

Intermediate data over de Zuidelijke Noordzee

- Kleine Rietgans - DK
- Bergeend -BEL
- Wulp – FRA, GER
- Houtsnip - UK
- Kanoet - NIOZ
- Grote Mantelmeeuw – UK, DK, SWE
- Grote Jager – UK, NOR

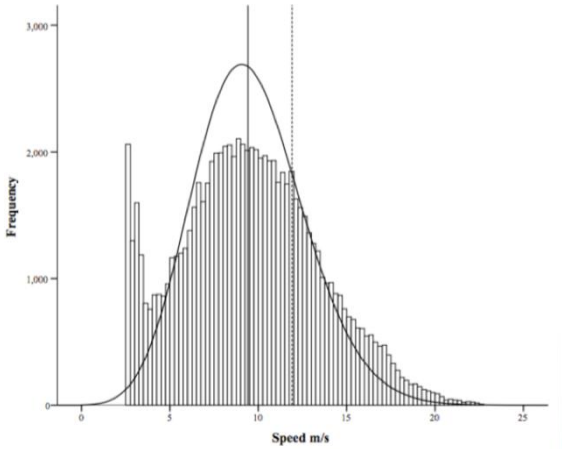


Figure 3.4a Frequency distribution (number of occasions) of flight speed of Herring Gulls at sea. Vertical solid line reflects the median of the measurements, vertical dashed line the flight speed determined by Alerstam et al. (2007). Curve shows Poisson distribution.

Welke soorten?

Veel data over de Zuidelijke Noordzee

- Kleine Zwaan - WWT
- Rotgans – NIOO
- Zilvermeeuw – NLD, BEL, GER
- Kleine Mantelmeeuw – NLD, UK, BEL, GER

Intermediate data over de Zuidelijke Noordzee

- Kleine Rietgans - DK
- Bergeend -BEL
- Wulp – FRA, GER
- Houtsnip - UK
- Kanoet - NIOZ
- Grote Mantelmeeuw – UK, DK, SWE
- Grote Jager – UK, NOR

Beperkte of geen data over de Zuidelijke Noordzee

- Topper - USA
- Kuifeend - absent
- Rosse Grutto – Alaska >> NZE
- Kievit - absent
- Dwergmeeuw - absent

Toekomst

- **Validatie van aannames**
- **Realistischere schattingen van aanvaringsslachtoffers**
- **Betere inschattingen van effecten**
- **Kennislacunes invullen door aanvullend onderzoek**
  - Gedrag meeuwen binnen windparken
  - Tracking data voor bv dwergmeeuw, wulp, kievit

Project in progress….

- *Suzanne Lubbe, Maarten Platteeuw (Rijkswaterstaat)*
- *Job de Jong (BuWa)*
- *Willem Bouten, Judy Shamoun-Baranes (Universiteit van Amsterdam), Eric Stienen (Instituut voor Natuur en Bos Onderzoek), Kees Camphuysen (Nederlands Instituut voor Onderzoek der Zee), Niall Burton, Chris Thaxter (Brtitish Trust for Ornitholgy), Wildfowl and Wetlands Trust, Severtsov Institute for Ecology & Evolution, Royal Belgian Institute of Natural Sciences, Alaska Science Center US Geological Survey, Aarhus University, University of Bristol, NABU, Y. Takekawa, J. Madsen, Max Planck Institute for Ornithology, DHI, BioConsult, Movebank Data Repository, Linnaeus University of Sweden, USGS Western Ecological Research Center, M. Parjo, C. Overton, W. Fiedler, M. Van Toor, J. Waldenström, R. Zydelis, E. Scragg, D. Cimiotti, D. Vangeluwe, A. Dokter, M. Chudzinska, C. Mitchell, B. Nolet, Game & Wildlife Conservation Trust, J. Alves, University of East Anglia, N. Senner, University of Groningen, R. Bom, Sultan Qaboos University, M. Exo, Institute of Avian Research "Vogelwarte Helgoland", T. Aarvak, P. Bocker, University of La Rochelle, Norwegian Ornithological Society, T. Piersma, German Federal Agency of Nature Conservation, E. Kok, Norwegian Polar Institute, Ecotone, H. Strøm, L. Iliszko, Lund University, T. Evans, R. Borrman, M. Frederiksen, J.F. Ljinnebjerg, I.K. Petersen.*

Rijkswaterstaat
Ministerie van Infrastructuur en Milieu

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

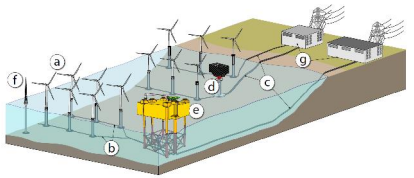
Elektromagnetische velden

Verkenning potentiele effecten in de Nederlandse Noordzee

Roelant Snoek

Introductie

- Toename Wind op Zee
- Stroomkabels transporteren stroom van zee naar land
  - Kabels generen elektromagnetische velden (EMFs)
- Effecten EMFs op mariene ecosysteem onbekend



WATER PROOF Marine Consultancy & Services BV.
Roelant Snoek
Rinse de Swart

Bureau Waardenburg bv
Ecology & landscape
Karin Didderen
Malenthe Teunis

Doel

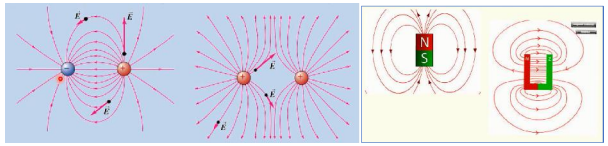
Inzicht verkrijgen in de potentiele effecten van EMFs van offshore stroomkabels op soorten in de Nederlandse Noordzee (haaien, roggen, bruinvissen).

Onderzoeksvragen

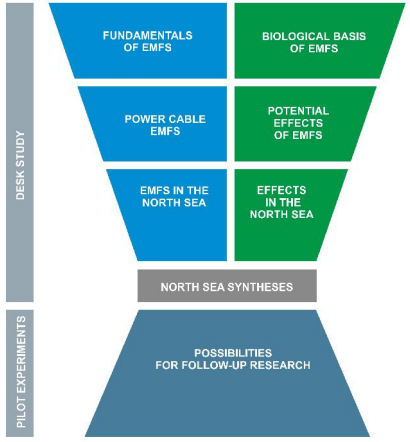
1) Wat zijn EMFs, in welke sterktes komen ze in de Noordzee voor en welke factoren beïnvloeden ze?
2) Hebben EMFs in de Noordzee mogelijk een negatieve invloed op het mariene leven? Zo ja, welke soorten worden dan vooral beïnvloed en kan dit tot gevolgen op populatieniveau leiden?
3) Is zinvol onderzoek hiernaar mogelijk?

Resultaten

- Offshore stroomkabels creëren elektrische velden (EFs) en elektromagnetische velden (EMFs)
- Door afscherming van de kabels bereiken alleen EMFs het mariene milieu

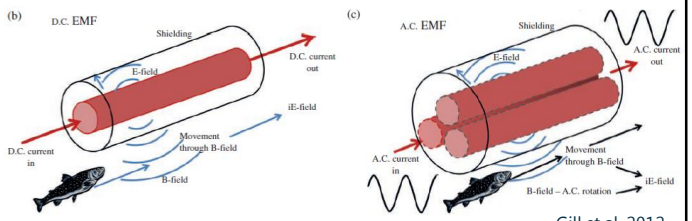


Aanpak



Resultaten

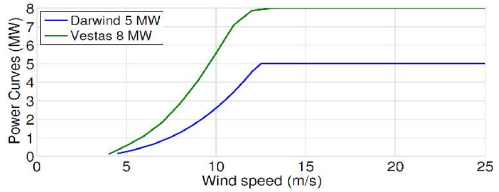
- AC stroomkabels genereren lage, variabele EMFs
- DC stroomkabels genereren sterke, statische EMFs
- Bewegingen in EMFs induceren iEFs
- WoZ: momenteel alleen AC kabels relevant



Gill et al. 2012

Resultaten

- Sterkte van EMFs hangt af van:
  - Type kabel
  - Voltage
  - Stroom
- Toename EMF sterkte tot ca. 6 Bft.



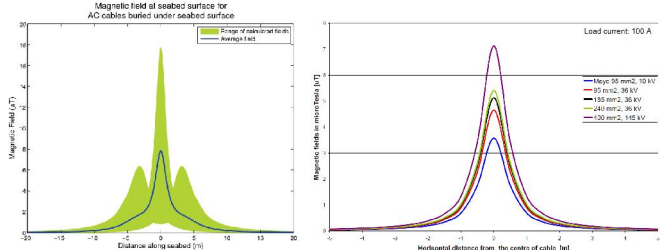
Noordzee

Name	Type	Voltage (kV)	Maximum power (MW)	Indication of EMF strength (µT)
Norned	HVDC	450	700	100-300
Britned	HVDC	450	1000	100-300
OWEZ	MVAC	34	108	5
PAWP	HVAC	150	120	5-50
Luchterduinen	HVAC	150	129	5-50
Gemini	HVAC	220	600	5-50
Wind area Borssele	HVAC	220	700 + 680 + 20	5-50
Wind area Holland Kust Zuid	HVAC	220	700 + 700	5-50
Wind area Hollandse Kust Zuid	HVAC	220	700	5-50
Doggersbank*	HVDC	-	-	100-300

Resultaten

Sterkte in het mariene milieu hangt af van:

- Afscherming kabel
- Afstand van de kabel
- Onderlinge afstand & fase



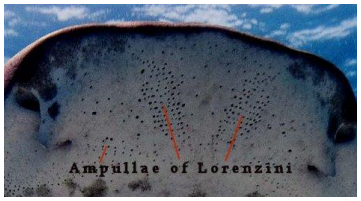
Mitigatie mogelijkheden

- Begraafdiepte
- Slimme positionering (optimale onderlinge afstand)
- Lagere stromen (= hoger voltage)
- Betere afscherming

Effecten

Bureau Waardenburg bv
Ecology & landscape

- Algemeen bekend in literatuur dat mariene soorten gebruik maken van EMFs
  - Elasmobranchs (haaien en roggen)
  - Zeezoogdieren (bruinvis)
  - Benthos
- Effecten nog grotendeels onbekend



Noordzee

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Samengevat:

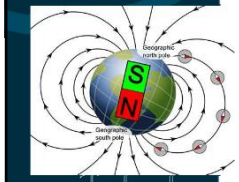
- Veel soorten in Noordzee gevoelig voor EMFs (beperkt zich niet tot haaien en roggen)
- Voldoende bewijs over potentiele effecten van EMFs op mariene soorten, echter:
  - beperkt aantal studies met realistische EMF waarden
  - doorvertaling populatieniveau niet mogelijk
- Lagere EMF waarden hebben niet per definitie minder effect
- Exacte effect van het type EMF (statisch, variabel) is grotendeels onbekend

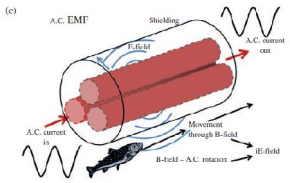
Effecten

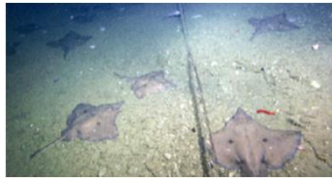
Bureau Waardenburg bv
Ecology & landscape

Belangrijkste potentiele effecten:

- Verstoring van gedrag en beweging (aantrekking, vermijden)
- Verstoring van navigatie en migratiegedrag
- Verstoring van roofdier/prooi interacties en verspreiding van prooien
- Verstoring van de embryonale en cellulaire ontwikkeling







Longnose skate aggregation near MARS cable in 2008 (source: Barry et al., 2008).

Vervolg mogelijkheden

Is zinvol onderzoek naar EMFs mogelijk?

Uitgevoerde verkenning:

1) Ontwikkeling meetinstrument EMF onderwater
2) Benthos experimenten met verschillende veldsterktes (krabben, alikruiken)

Meten van EMFs

Ontwikkeling meetinstrument EMF onderwater

1) Werkt boven water
2) Testen onder water
3) Towed systeem & duikers

Conclusies

- EMF niveaus in Noordzee zijn sterk genoeg om tot effecten op mariene soorten te leiden
- Range aan effecten mogelijk (migratie, predatie,…)
- Door gebrek aan kennis kunnen effecten (op populatieniveau) niet worden uitgesloten / bevestigd
- Zinvolle vervolgonderzoeken zijn mogelijk

- Gezien de toename van WoZ, kennisopbouw EMFs essentieel

Vervolg mogelijkheden

Is zinvol onderzoek naar EMFs mogelijk?

Uitgevoerde verkenning:

1) Ontwikkeling meetinstrument EMF onderwater
2) Benthos experimenten (krabben, alikruiken)

Aanbevelingen

- Belangrijkste kennishiaten;
  - EMF sterktes in het veld
  - Daadwerkelijke effecten van EMFs op Noordzee soorten
  - Mitigatiemogelijkheden & effectiviteit
- Onderzoek effecten van realistische EMF waarden op soorten.

Vragen?

Roelant.snoek@waterproofbv.nl

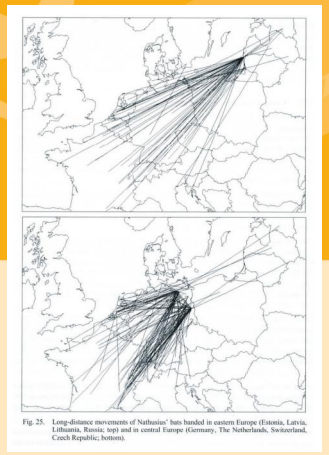


Fig. 25. Long-distance movements of Nathusius' bats banded in eastern Europe (Estonia, Latvia, Lithuania, Russia; top) and in central Europe (Germany, The Netherlands, Switzerland, Czech Republic; bottom).

Prototype estimator migrating bats

case study: Pipistrellus nathusii

Tussenstand WoZep 2017

Herman Limpens ***et al.***

Estimator population size migrating bats?

Expert colleagues participating in the first loop of feedback for designing and gathering of data:

Hans Baagøe, Lothar Bach, Katherine Boughey, Marie-Jo Dubourg-Savage, Eric Jansen, Jeroen van der Kooij, Sander Lagerveld, Herman Limpens, Tore Michaelsen, Gunārs Pētersons, Niamh Roche, Luisa Rodrigues, Jon Russ, Marcel Schillemans, Esben Terp Fjederholt, Bob Vandendriessche;

Expert colleagues participating in the second loop of feedback on flow model, and basic data:

Ingemar Ahlén, Tina Aughney, Diane Anxionnat, Petra Bach, Jan Boshamer, Thomas Le Campion, Morten Christensen, Julie Dahl Møller, Jasja Dekker, Theo Douma, Jan Durinck, Morten Elmeros, A-J Haarsma, John Haddow, Daniel Hargreaves, Johanna Hurst, Thomas Johansen, Johnny de Jong, Dorothee Jouan, Eeva-Maria Kyheröinen, Fiona Mathews, Susan Swift, Peter Twisk;

The work on the model estimator was only possible through the great collaboration of may colleagues in Europe.

Estimator population size migrating bats?

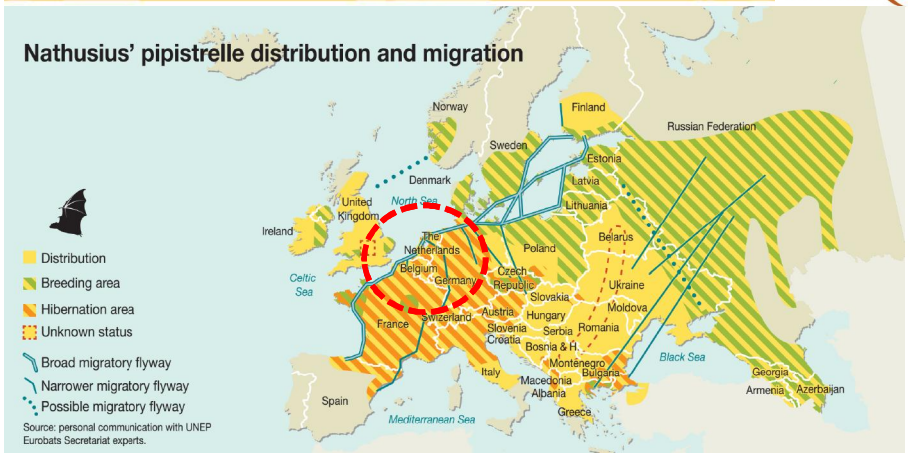
Basic technical report:

Limpens, H.J.G.A., S. Lagerveld, I. Ahlén, D. Anxionnat, T. Aughney, H.J. Baagøe, , L. Bach, P. Bach, J.P.C. Boshamer, K. Boughey, T. Le Campion, M. Christensen, J.J.A. Dekker, T. Douma, M.-J. Dubourg-Savage, J. Durinck, M. Elmeros, A.-J. Haarsma, J. Haddow, D. Hargreaves, J. Hurst, E.A. Jansen, T.W. Johansen, J. de Jong, D. Jouan, J. van der Kooij, E.-M. Kyheroinen, F. Mathews T.C. Michaelsen, J.D. Møller, G. Pētersons, N. Roche, L. Rodrigues , J. Russ, Q. Smits , S. Swift, E.T. Fjederholt, P. Twisk, B. Vandendriesche & M.J. Schillemans, 2017. Migrating bats at the southern North Sea - Approach to an estimation of migration populations of bats at southern North Sea. Rapport 2016.031. Zoogdiervereniging, Nijmegen/ Wageningen Marine Research.

Support note:

Lagerveld, S., H.J.G.A. Limpens, M.J. Schillemans & M. Scholl 2017. Bat 1: Estimate of bat populations at the southern North Sea. Supporting note to ZDV report no. 2016.031 Migrating bats at the southern North Sea. Wageningen, Wageningen Marine Research (University & Research Centre), Wageningen Marine Research report no. C014/17/ Dutch Mammal Society report no. 2017.08. 14 pp.

Population size migrating bats?



This image is not representing the actual situation, but sketches the difference between eastern/north eastern European areas with maternity sites and wester/southwestern regions with predominantly territorial males and hibernation. UK and ROI have maternity sites, territorial sites and hibernation.

Population size migrating bats?

Which bat species occur on sea (southern North Sea)?

Are they foraging?
Are they migrating? …. combination?

Do they suffer a fatality risk near off shore wind turbines?

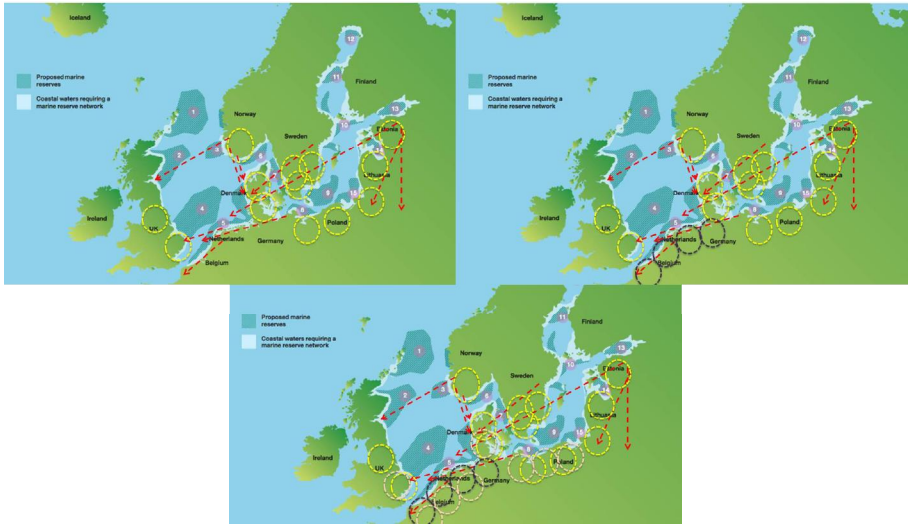
What is the size of the population migrating over e.g. SNS?

What is the size of the ***source population*** of the migrating population?
+ ***target***

The is a relation between off shore wind parks and bats. But there are more questions than answers

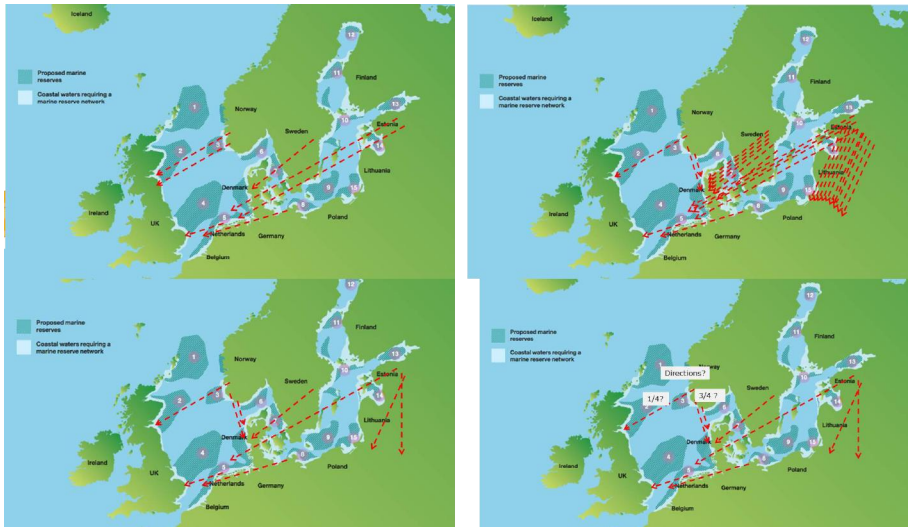
Estimator population size migrating bats?

Where are source populations, intermediate populations/populations of territorial males, and hibernating populations?

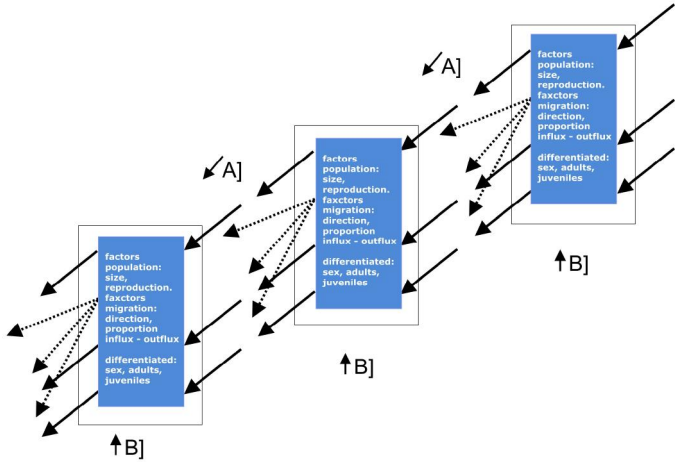


Estimator population size migrating bats?

Migration directions? Quantitative distinction? Specific flyways? Fronts? Funneling?



Estimator population size migrating bats?



Basic model for assessment of basic data B] and estimation of migration flow A].
Are basic data on occurrence, population size, dynamics dynamics and migration direction available for the different countries?

Example of questionnaire for assessment of basic data..?

Table 1: Questionnaire to collect data on bat maternity roosts/colonies.

MATERNITY COLONIES
occurrence
is the species present in your country?
can you give an already existing estimate of the population size (EHD/EUROBATS reporting e.g. all individuals year round)?
please add sources and publications
maternity colonies/roosts (colony = network of roosts)
Are there maternity colonies (network of roosts)?
can you give an estimate of how many maternity colonies exist?
can you give an estimate of the number or proportion of 'investigated' maternity colonies?
can you give an estimate of the average number of individuals (females) in one colony (network of roosts)? If only the number of total individuals (females and offspring) is known, please indicate so under remarks
can you indicate whether the number of juveniles per female differs from 1? -if known
population estimates / your expert interpretation of above information
estimate of population (females) based on numbers of maternity roosts and average number in maternity roosts
Does this number provide a good estimation of the population number (of females) in your expert opinion? If not: what would be a good number?
Area's if possible
can you describe preferable foraging grounds for the species?
can you give an estimate of the average area ([foraging] home range) used by one colony?
can you give an estimate (hectares or %tage region/country) of the available area that could be qualified as habitat (roosts and foraging) for the species?
please add a sketch/sketches on a map where appropriate?
please add sources and publications

Table 2: Example of the estimation of a source population. The numbers in the table are just examples for the calculation.

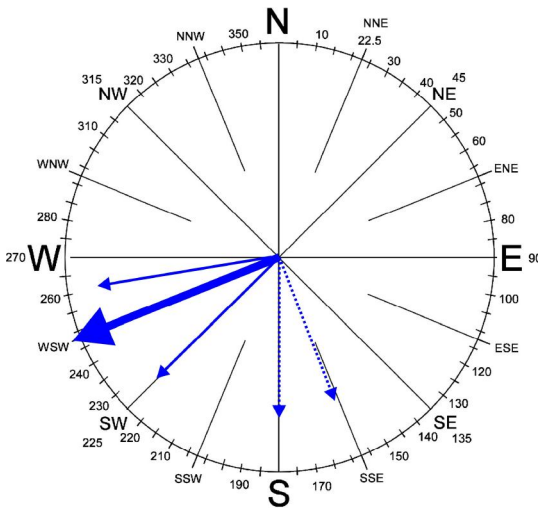
	Approach to quantification of source population for a specific region		
	Maternity colonies (network of roosts) / summer roosts		
A	estimate # known maternity colonies:	15 - **35** - 60	roughly 1/3
B	estimate # unknown maternity colonies:	30 - **70** - 120	roughly 2/3
C	estimate average # individuals/colony:	100 - **150** - 200	
	preferable foraging grounds for the species: Wetlands, shores, broadleaved forest,....		
D	estimate average area ([foraging] home range) one colony?	8 – **12** – 16 km^2	
E	estimate available area qualified habitat (roosts and foraging)?	500 - **1500** -2500	
	(A+B)*C → source population :	4500 – **16.000** – 36.000	

Table 2: Example of the estimation of a source population. The numbers in the table are just examples for the calculation.

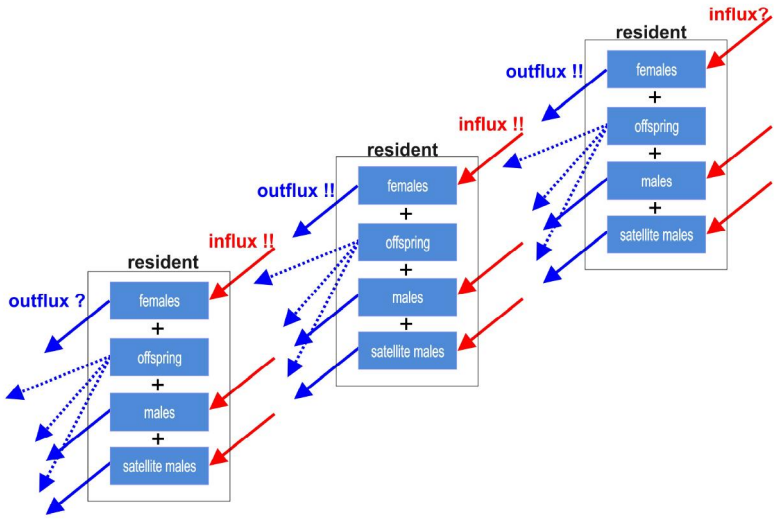
	Approach to quantification of source population for a specific region		
	Maternity colonies (network of roosts) / summer roosts		
	Cross checks		
		B*C	E/D*C
	Is B*C roughly similar to E/D*C **?**	3000 – **10.500** – 24.000	6.250 – **18.750** – 31.250
	If the numbers chosen for this example would be true numbers/sub-estimates, this comparison indicates the need for more information and adjustment of the estimates.		
	Is (A+B)*D roughly similar to E **?**	(A+B)*D	E
		360 – **1.260** – 2.880	500 - **1500** -2500
	If the numbers chosen for this example would be true numbers/sub-estimates, this comparison indicates a reasonable similarity.		
	(A+B)*C → source population :	4500 – **16.000** – 36.000	

Example of potential of using basic data for estimation of regional population size

Team input regarding (known info on) migration directions

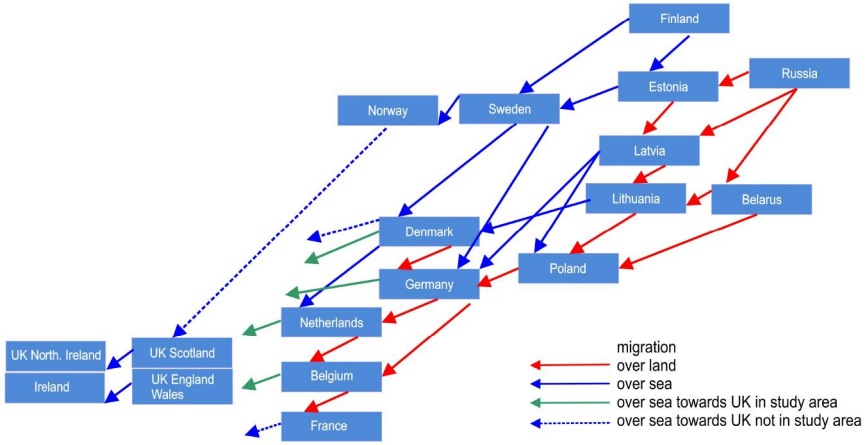


Estimator population size migrating bats?



Basic model for using basic data for estimation of migration flow A].

Estimator population size migrating bats?



Countries connected in flow model A]
to generate an output for migration flow on Southern North Sea

Table 5: components of the flow model A] for the migration population of *Pipistrellus nathusii* relevant for the estimation of the population migrating on the southern North Sea.

summer population	+	reproduction	+	immigration (influx)	-	emigration (Outflux)	=	hibernation population
resident females resident males + floating population = SM/M ratio*		females males		# females # males # juveniles		% females % males % juveniles		# females # males # juveniles
		J/F ratio		# are % from different neighbouring countries		% of # to neighbouring countries		
		Ratio f/m = approx. 1				ratio migrating / non migrating ratio different countries		

factors per country

% flow to .. (over sea) % flow to .. (over land)			
bandwidth migration out of country	-	males females	Juveniles follow J/F ratio**

= Estimate (lower, upper) per country — Expert judgement + Input expert team contributors

= General parameter (lower, upper) , set for all countries

= Result calculation by model

** SM/M ratio = satellite males/male ratio
*J/F ratio = juvenile/female ratio

Detail of flow model A] for estimation of migration flow

Estimator population size migrating bats?

NETHERLANDS

colour code — these are estimates where we want the expert-team/country expert to give comment; they are now filled in with first input experts + judgement/interpretation Herman Limpens
NOTE: DO NOT ALTER THE VALUE IN THE TABLE, BUT GIVE YOU COMMENT/YOUR ESTIMATE SEPARATELY !!
EITHER BY COPYING THIS TAB AND FILL IN THE BRIGHT GREEN CELLS, OR BY USING THE REPLY TAB.
NOTE: please give us sources: expert judgement - or - literature

colour code — these values are based on other tabs: general parameters, values defined in tab for country north and northeast of your own, values on %flow (below), and bandwidth male and female mig
NOTE: do not alter the value in the table !!!

Summer population in	Ad male	Sources	Ad female	Sources	Juv	Sources	Ad male min	Sources	Ad female	Sources	Juv min	Sources	Ad male max	Sources	Ad female	Sources	Juv max
Maternity colonies			100		60				0		0				1.000		800
Male roosts (late summer)	18.450						3.180						56.700				
Satellite adult males	36.900						636						283.500				
Total	55.350		100		60		3.816		0		0		340.200		1.000		800

Migration from	Ad male	Sources	Ad female	Sources	Juv	Sources	Ad male min	Sources	Ad female	Sources	Juv min	Sources	Ad male max	Sources	Ad female	Sources	Juv max
Denmark to Netherlands (over sea)	64		477		283		0		3		1		3.638		7.114		5.691
Germany to Netherlands	21.026		44.200		26.520		181		222		89		346.234		882.212		705.770
Total	21.090		44.672		26.803		182		226		90		349.872		889.326		711.461

Migration to	Ad male	Sources	Ad female	Sources	Juv	Sources	Ad male min	Sources	Ad female	Sources	Juv min	Sources	Ad male max	Sources	Ad female	Sources	Juv max
Netherlands to UK (over sea)	**4.777**		**8.395**		**5.037**		**50**		**14**		**6**		**86.259**		**222.582**		**178.065**
Netherlands to Belgium	14.332		25.184		15.110		150		42		17		258.777		667.745		534.196
Total	19.110		33.579		20.147		200		56		23		345.036		890.326		712.261
	balance male		balance female		balance juveniles		balance male min				balance juv min		balance male max		balance fem max		balance juv
Winter population in	Ad male	Sources	Ad female	Sources	Juv	Sources	Ad male min	Sources	Ad female	Sources	Juv min	Sources	Ad male max	Sources	Ad female	Sources	Juv max
Winter roosts	57.330		11.193		6.716		3.798		169		68		345.036		0		0

note: '0' mean that all individuals would migrate out of t

balance check	0	0	0	0	0	0	0	0	0

Netherlands to UK (over sea)	0,250
Netherlands to Belgium	0,750

total = 1

			min		max	
bandwidth migration Netherlands	males		0,050	**0,250**	0,500	max = equal or smaller 1
	females		0,250	**0,750**	1,000	max = equal or smaller 1

note: these values, %flow / outflux and bandwidth, are values where the regional/country expert should give feed back
however, when you have data/expert judgment regarding your influx (= outflux country north/northeast) please give your input

Example of table to assess data for flow model A]

Estimator population size migrating bats?

ZOOGDIER VERENIGING

DENMARK

colour code	these are estimates where we want the expert-team/country expert to give comment; they are now filled in with first input experts + judgement/interpretation Herman Limpens
	NOTE: do not alter the value in the table, but give you comment/your estimate separately !!
	NOTE: DO NOT ALTER THE VALUE IN THE TABLE, BUT GIVE YOU COMMENT/YOUR ESTIMATE SEPARATELY !!
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colour code	these values are based on other tabs: general parameters, values defined in tab for country north and northeast of your own, values on %flow (below), and bandwidth male and f
	NOTE: do not alter the value in the table !!!

Summer population	*Ad male*	*Sources*	*Ad female*	*Sources*	*Juv*	*Sources*	*Ad male m*	*Sources*	*Ad female*	*Sources*	*Juv min*	*Sources*	*Ad male m*	*Sources*	*Ad female*	*Sources*
Maternity colonies			2.500		1.500				250		100				25.000	
Male roosts (late summer)	500						50						5.000			
Satellite adult males	1.000						10						25.000			
Total	1.500		2.500		1.500		60		250		100		30.000		25.000	

Migration from	*Ad male*	*Sources*	*Ad female*	*Sources*	*Juv*	*Sources*	*Ad male m*	*Sources*	*Ad female*	*Sources*	*Juv min*	*Sources*	*Ad male m*	*Sources*	*Ad female*	*Sources*
Sweden to Denmark(over sea)	1.405		7.234		4.341		13		51		21		84.308		88.875	
Lithuania to Denmark (over sea)	288		2.059		1.235		1		30		12		6.943		28.403	
Total	1.693		9.293		5.576		14		82		33		91.250		117.278	

Migration to	*Ad male*	*Sources*	*Ad female*	*Sources*	*Juv*	*Sources*	*Ad male m*	*Sources*	*Ad female*	*Sources*	*Juv min*	*Sources*	*Ad male m*	*Sources*	*Ad female*	*Sources*
Denmark to UK (over sea **outside** study area)	128		943		566		1		7		3		7.275		14.228	
Denmark to UK (over sea within study area)	**128**		**943**		**566**		**1**		**7**		**3**		**7.275**		**14.228**	
Denmark to Netherlands (over sea)	64		472		283		0		3		1		3.638		7.114	
Denmark to Germany	958		7.076		4.245		6		50		20		54.563		106.708	
Total	1.277		9.434		5.661		7		66		27		72.750		142.278	
	balance male		balance female		balance juveniles		balance male min				balance juv min		balance male max		balance fem max	
Winter population	*Ad male*	*Sources*	*Ad female*	*Sources*	*Juv*	*Sources*	*Ad male m*	*Sources*	*Ad female*	*Sources*	*Juv min*	*Sources*	*Ad male m*	*Sources*	*Ad female*	*Sources*
Winter roosts	1.916		2.359		1.415		67		266		106		48.500		0	

note: '0' mean that all individuals would mig

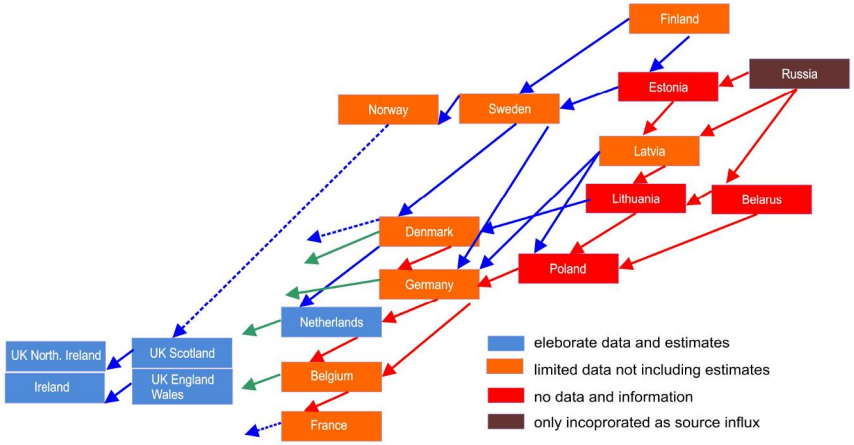
balance check	0	0	0	0	0	0	0	0

% flow to UK (over sea **outside** study area)	0,100
% flow to UK (over sea within study area)	**0,100**
% flow to Netherlands (over sea)	0,050
% flow to Germany	0,750

total = 1

			min		max	
bandwidth migration Denmark	males		0,100	0,400	0,600	max = equal or smaller 1
	females		0,200	0,800	1,000	max = equal or smaller 1

Example of table to assess data for flow model A]



Overview of availability of basic data B] for estimation of national population sizes.

RELEVANT FOR CURRENT STUDY

TOTAL # FOR SOUTHERN NORTH SEA

	Ad male	*Ad female*	*Juv*	*Ad male lower*	*Ad female lower*	*Juv lower*	*Ad male upper*	*Ad female upper*	*Juv upper*
Denmark to UK (over sea **within** study area)	128	943	566	1	7	3	7.275	14.228	11.382
Germany to UK (over sea)	1.402	2.947	1.768	12	15	6	23.082	58.814	47.051
Netherlands to UK (over sea)	4.777	8.395	5.037	50	14	6	86.259	222.582	178.065
Belgium to UK (over sea)	3.121	6.941	4.165	17	8	3	46.888	225.775	180.620
	Ad male	*Ad female*	*Juv*	*Ad male lower*	*Ad female lower*	*Juv lower*	*Ad male upper*	*Ad female upper*	*Juv upper*
total	**9.428**	**19.226**	**11.536**	**80**	**43**	**17**	**163.504**	**521.399**	**417.119**

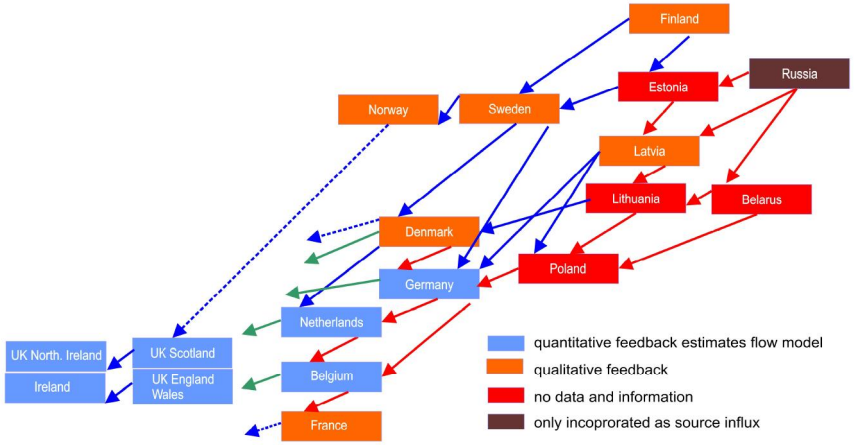
now with default choice	estimate	min	max
Number of juv per female per year	0,60	0,40	0,80
Number of satellite males (adults!) per territorial male	2,00	0,20	5,00

NOT IN CURRENT STUDY AREA

TOTAL # FOR NORTHERN NORTH SEA

	Ad male	*Ad female*	*Juv*	*Ad male lower*	*Ad female lower*	*Juv lower*	*Ad male upper*	*Ad female upper*	*Juv upper*
Denmark to UK (over sea **north of** study area)	128	943	0	1	7	3	7.275	14.228	11.382
Norway to UK Scot (over sea **north of** study area)	170	4.050	2.430	6	14	5	2.255	4.500	3.600
Norway to UK Eng/Wal (over sea **north of** study ar	19	450	270	1	2	1	251	500	400
total	**317**	**5.443**	**2.700**	**7**	**22**	**9**	**9.780**	**19.228**	**15.382**

Example output of flow model A]
Note: these are results of test runs with currently available limited data!



Overview of availability data to give input estimates of population sizes for flow model A] sizes.

Estimator population size migrating bats?

	← bandwidth →			← bandwidth →			← bandwidth →			← bandwidth →		
juv/female 0.6 - **0.7** - 0.8	*male low*	***male***	*male up*	*fem low*	***female***	*fem up*	*Juv low*	***Juv***	*Juv up*	*tot low*	***tot***	*tot up*
satellite 3 - **4** - 5	267	**15.525**	163.504	43	**19.226**	521.399	26	**13.458**	417.119	336	**48.209**	1.102.022
satellite 2 - **3** - 4	200	**12.477**	139.066							269	**45.161**	1.077.584
satellite 1 - **2** - 3	134	**9.428**	114.628							203	**42.112**	1.053.146
satelite 0.2 - **1.2** -2.2	80	**6.989**	95.077							149	**39.673**	1.033.595
juv/female 0.5 - **0.6** - 0.7	*male low*	***male***	*male up*	*fem low*	***female***	*fem up*	*Juv low*	***Juv***	*Juv up*	*tot low*	***tot***	*tot up*
satellite 3 - **4** - 5	267	**15.525**	163.504	43	**19.226**	521.399	22	**11.536**	364.979	332	**46.287**	1.049.882
satellite 2 - **3** - 4	267	**12.477**	139.066							332	**43.239**	1.025.444
satellite 1 - **2** - 3	134	**9.428**	114.628							199	**40.190**	1.001.006
satelite 0.2 - **1.2** -2.2	80	**6.989**	95.077							145	**37.751**	981.455
juv/female 0.4 - **0.5** - 0.6	*male low*	***male***	*male up*	*fem low*	***female***	*fem up*	*Juv low*	***Juv***	*Juv up*	*tot low*	***tot***	*tot up*
satellite 3 - **4** - 5	267	**15.525**	163.504	43	**19.226**	521.399	17	**9.613**	312.839	327	**44.364**	997.742
satellite 2 - **3** - 4	200	**12.477**	139.066							260	**41.316**	973.304
satellite 1 - **2** - 3	134	**9.428**	114.628							194	**38.267**	948.866
satelite 0.2 - **1.2** -2.2	80	**6.989**	95.077							140	**35.828**	929.315
Min/max values tested settings	← bandwidth →			← bandwidth →			← bandwidth →			← bandwidth →		
juv/female 0.4 - **0.6** - 0.8	*male low*	***male***	*male up*	*fem low*	***female***	*fem up*	*Juv low*	***Juv***	*Juv up*	*tot low*	***tot***	*tot up*
satellite 0,2 - 2 - 5	**80**	9.428	**163.504**	**43**	19.226	**521.399**	**17**	11.536	**417.119**	**140**	40.190	**1.102.022**

Example output of flow model A] for different settings for juvenile/female and sat male/male
Note: these are results of test runs with currently available limited data!

Estimator population size migrating bats?

Table 8: the current preliminary estimate for the number of Nathusius' pipistrelle potentially migrating across the southern North Sea.

	lower	***central***	***upper***
male	80	**9.428**	163.504
female	43	**19.226**	521.399
Juv	17	**11.536**	417.119
total	140	**40.190**	1.102.022

settings juvenile/female: 0,4 - **0,6** - 0,8
satellite males/male: 0,2 - **2** - 5
(current lowest and highest settings tested)

Example output of flow model A]
Note: these are results of test runs with currently available limited data!

Example output of flow model A] regarding summer populations.

Note: these are results of test runs with currently available limited data!

Table 7: overview estimated summer population per country = source population(s) for migration.
M= males, MS= Male satellites, F= Females, J= Juveniles

	central			lower			upper		
	Male + sat	***fem***	***juv***	***male***	***fem***	***Juv***	***male***	***fem***	***Juv***
Finland	1.500	5.000	3.000	150	50	20	30.000	50.000	40.000
Estonia	900	1.800	1.800	36	300	120	18.000	30.000	24.000
Belarus	3.000	10.000	6.000	120	1.000	400	6.000	100.000	80.000
Latvia	1.500	5.000	3.000	60	500	200	30.000	50.000	40.000
Lithuania	1.500	3.000	1.800	60	300	120	30.000	30.000	24.000
Poland north-western	4.500	10.000	6.000	120	1.000	400	60.000	100.000	80.000
Sweden	300	1.000	600	12	10	4	60.000	10.000	8.000
Denmark	1.500	2.500	1.500	60	250	100	30.000	25.000	20.000
Germany northern	48.000	5.000	3.000	4.800	500	200	384.000	50.000	40.000
Netherlands	55.350	100	60	3.816	0	0	340.200	1.000	800
Belgium	30.000	50	30	1.200	25	10	24.000	100	80
sub total	**148.050**	**43.450**	**26.790**	**10.434**	**3.935**	**1.574**	**1.012.200**	**446.100**	**356.880**
Norway	252	5.000	3.000	25	50	20	2.505	5.000	4.000
UK Scot	150	0	0	6	0	0	3.000	0	0
UK Northern Ireland	3.000	8.000	4.800	120	2.000	800	60.000	14.000	11.200
UK England/Wales	6.000	5.000	3.000	600	2.000	800	30.000	10.000	8.000
RO Ireland	3.200	10.000	6.000	700	2.000	800	9.000	18.000	14.400
sub total	**12.602**	**28.000**	**16.800**	**1.451**	**6.050**	**2.420**	**104.505**	**47.000**	**37.600**
Total	**160.652**	**71.450**	**43.590**	**11.885**	**9.985**	**3.994**	**1.116.705**	**493.100**	**394.480**

	M+MS+F+J central	M+MS+F+J lower	M+MS+F+J upper
sub Relevant for SNS	218.290	15.943	1.815.180
sub Northwest/West SNS	57.402	9.921	189.105
Total	275.692	25.864	2.004.285

Calculated with the following settings and bandwidth	**Estimate**	**lower**	**upper**
Number of juv per female per year	0,60	0,40	0,80
Number of satellite males (adults!) per territorial male	2,00	0,20	5,00
Number of Males per Female (not yet used as variable)	1,00	0,90	1,10

Estimator population size migrating bats?

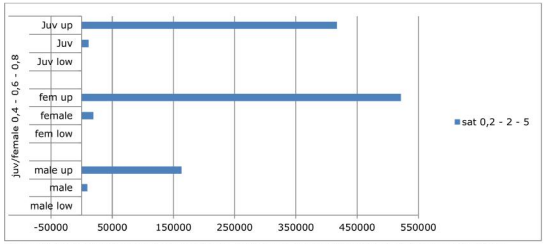


Figure 7: the current preliminary estimate for the number of Nathusius' pipistrelle potentially migrating across the southern North Sea (linear scale).

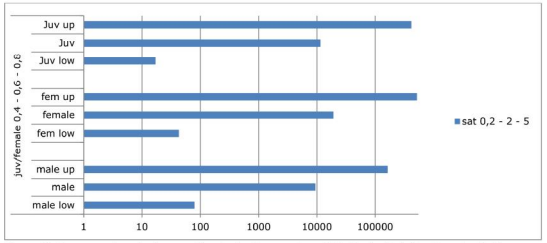


Figure 8: the current preliminary estimate for the number of Nathusius' pipistrelle potentially migrating across the southern North Sea in a logarithmic scale. Consider that a

Example output of flow model A]

Note: these are results of test runs with currently available limited data!

Estimator population size migrating bats?

Table 3: overview of **bandwidth factors** of the output of the test runs for estimations of the migrating population of the Nathusius' pipistrelle over the southern North Sea, status January 2017 (see excel table, sheet estimates overview rearranged). Presented are bandwidth factors which inform how many times, upper is higher than lower, upper is higher than central and central is higher than lower.

	Upper/Lower = U/L factor = factor upper is higher than lower				
	lower	←← Bandwidth factor →→			*upper*
	lower		***central***		*upper*
M			<<<		600 – 1.200
F			<<<		1200
J			<<<		16.000 – 18.500
T			<<<		3.000 – 7.000

			Upper/Central = U/C = factor upper is higher than central		
			←← Bandwidth factor →→		
	Central/Lower = C/L = factor central is higher than lower				
	←← Bandwidth factor →→				
	lower		***central***		*upper*
M		<<<	60 - 90	<<<	10 - 14
F		<<<	450	<<<	27
J		<<<	520 - 565	<<<	30 - 33
T		<<<	130 and 270	<<<	22 - 26

Example output of bandwidth factors of flow model A]

Note: these are results of test runs with currently available limited data!

Estimator population size migrating bats?

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Flight behaviour of migrating bats
Technical Feasibility studies

Sander Lagerveld

21 feb 2017

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Contents

- Introduction
- Feasibility study telemetry
- Feasibility study analysis of bat flight around wind turbines
- Conclusions

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Bat migration over the North Sea

- Bats regularly migrate over sea, as shown by studies with ultrasonic recorders, findings at oil rigs and ships, ringing recoveries and sightings during surveys at sea and coastal bird migration counts
- Risk for barotrauma / collision with offshore wind turbines
- Population effects not excluded for at least Nathusius' Pipistrelle, Noctule and Particoloured Bat (Leopold et al. 2014)
- Bats are relevant in (spatial) planning and operating of offshore wind farms

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Assessing the overall effect

1. Population size of source populations
2. Which part of these (sub)populations migrate over sea, and which part over land?
3. Are bats migrating over sea attracted to offshore wind farms, and if so, up to what distance, and what is their travelling speed?
4. What is the flight behaviour of bats in the vicinity of offshore wind turbines, i.e. how long do they stay, at which heights and at what distances from the rotor blades?
5. What is the risk of individual bats to collide with an offshore wind turbine or become victim of barotrauma?

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Behavioural research at two spatial scales

- At the scale of a wind farm and beyond with telemetry (2 & 3)
- At the scale of an individual turbine and its immediate surroundings, using thermal imaging cameras and bat detectors (4 & 5)

=> Two technical feasibility studies as a first step

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Telemetry – approach/technology

- Radio (VHF) transmitter tags; other devices would exceed the 5%-weight threshold (Aldridge & Brigham 1988, O'Mara et al. 2014)
- A stationary network of SensorGnome receivers (Janssen et al. 2016)

http://motus.org

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Telemetry

Main questions:

- Which approach/technology?
- Exchange of data (detections by others)?
- Detection range?
- Assessing spatial locations of detections?
- Reconstruct flight paths?

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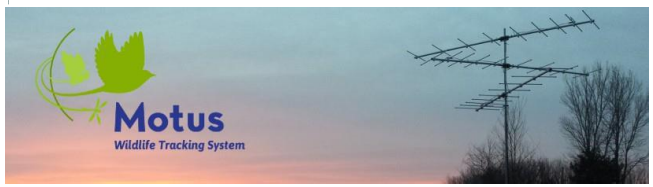
Telemetry – exchange of data



- Motus is a system to track the movements of animals equipped with a radio transmitter (tag).
- It has a central data repository for users all over the world and facilitates the exchange of data amongst its users.
- Motus is operated by Bird Studies Canada

BIRD STUDIES CANADA
ÉTUDES D'OISEAUX CANADA

http://motus.org

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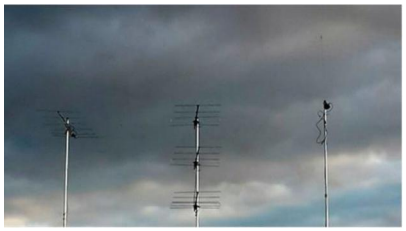
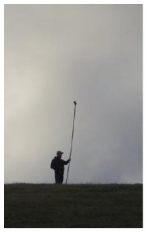
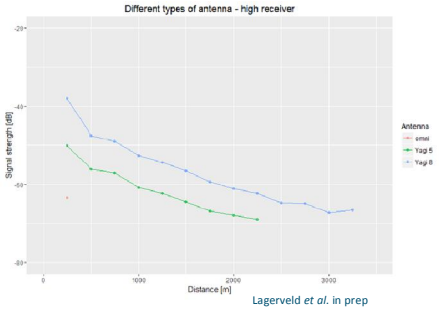
Telemetry – detection range





- Depends on numerous factors (antennas, receiver, angle, height, terrain, weather)
- Range in optimal conditions up to 10 km, otherwise less



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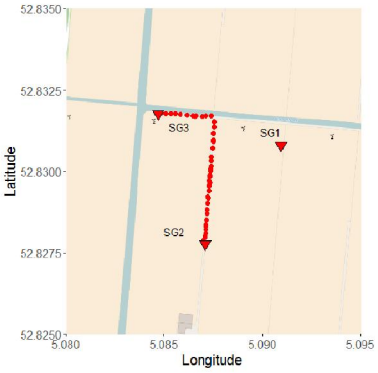
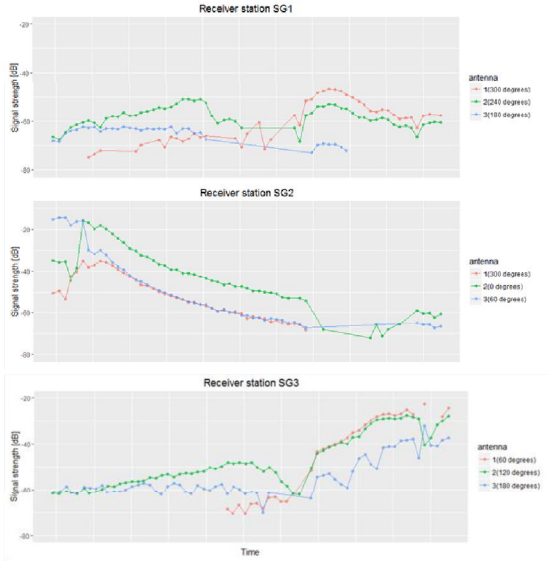
Telemetry - signals per receiver/antenna

Track 1





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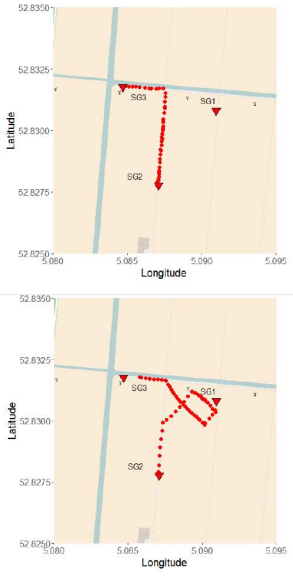
Telemetry – assessing spatial locations



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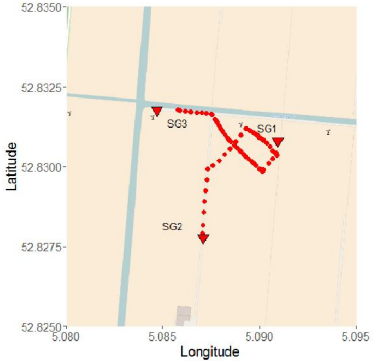
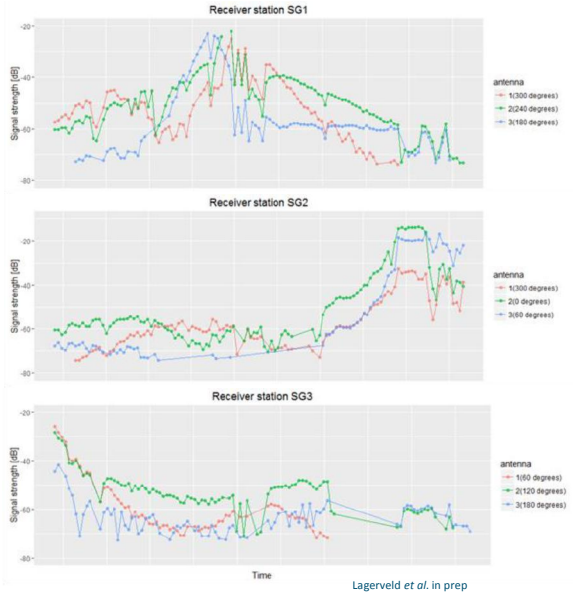
Telemetry - signals per receiver/antenna

Track 2





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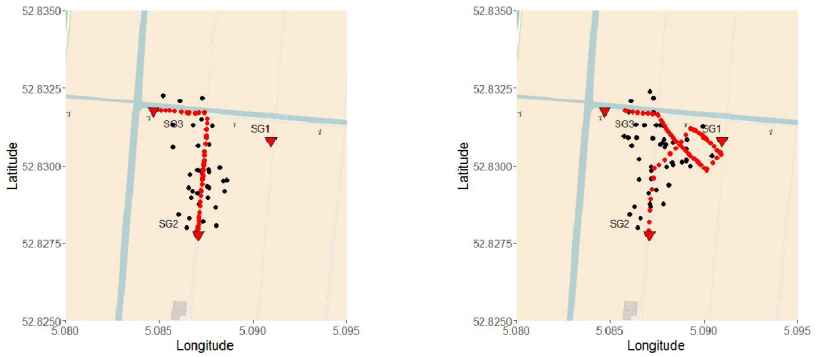
Telemetry - estimated locations



- Accuracy on average 104 and 119 m respectively
- Improvements likely
- Determine flight path by state-space model (to be developed)

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Bat flight analysis around wind turbines

Approach:

- Assess 3D flight paths with thermal cameras and computer vision algorithms
- Verification 3D flight paths and species identification with acoustic measurements by bat detector

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Conclusions telemetry

- Technology: coded radio (VHF) transmitter tags in combination with stationary receivers
- International exchange of data (detections) through Motus
- Estimating locations is possible; accuracy likely to be improved
- Estimating flight paths with a state-space model
- No objections to large-scale implementation!

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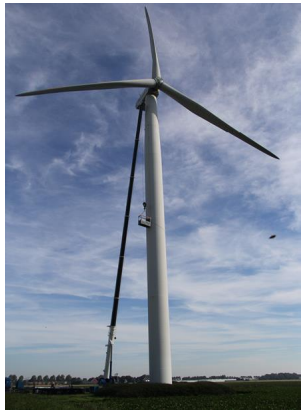
Study area

- Wind Turbine Test Site Wieringermeer
- Nordex N80: hub height and rotor 80 m, 2.5 MW



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Acoustic monitoring - requirements

- The immediate surroundings of the wind turbine should be monitored acoustically as complete as possible
- The recordings at different locations at/near the wind turbine should be synchronized in time
- Weatherproof (storm, rain, frost)
- No interference with operating systems wind turbine
- Remote access (monitoring data & performance)
- Suitable for automated identification of bat calls

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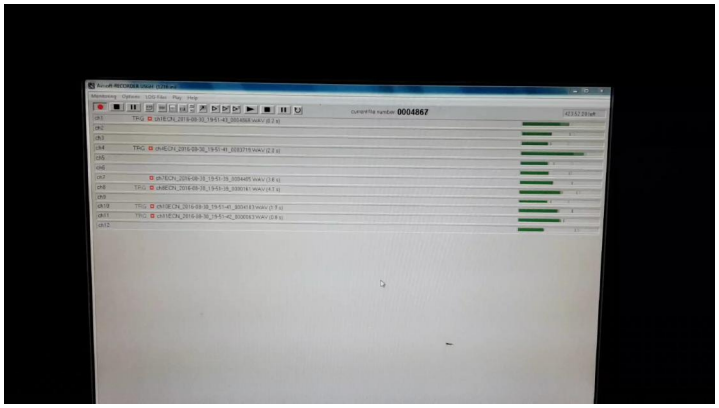
Acoustic monitoring - results



> 170.000 recordings 25 Aug – 1 Dec 2016 (c. 80% bats)

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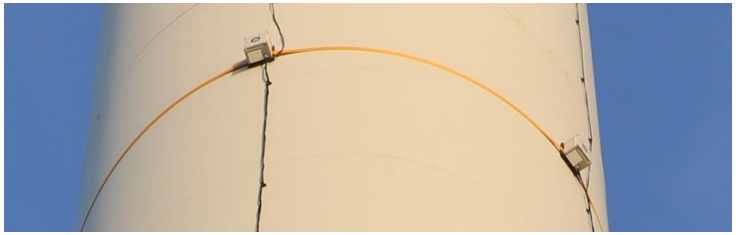
Acoustic monitoring - equipment

- 12 channel Avisoft-UltraSoundGate

http://www.avisoft.com/

- Ultrasound microphones in four different directions at three different heights (5, 35 & 65 meter)



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Thermal cameras – stereo set

AXIS Thermal cameras 30 Hz –640x480 synchronized

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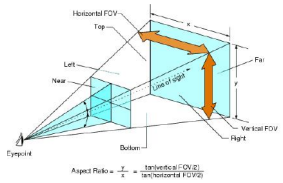
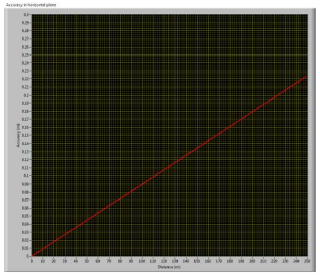
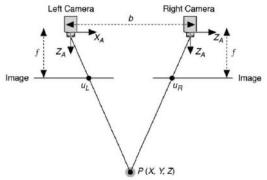
Thermal cameras - accuracy

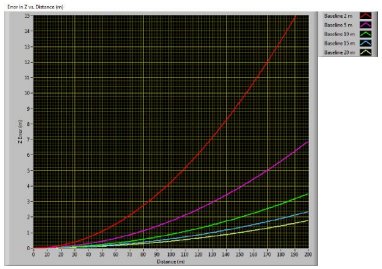
- XY direction





- Z direction





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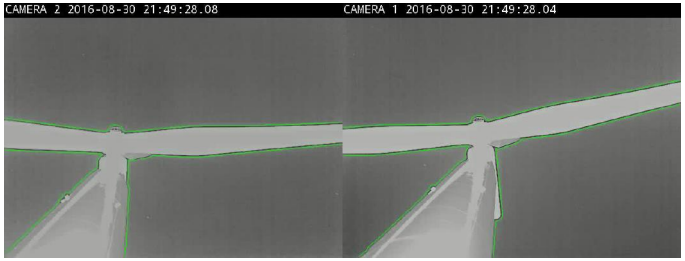
2D tracking

- Match objects in multiple consecutive frames
- 2D trajectories in the left and right camera images



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Thermal cameras – calibration

- Intrinsic calibration
  - Radial distortion (deformations in the lens)
  - Tangential distortion (misalignments sensor)

- Stereo calibration

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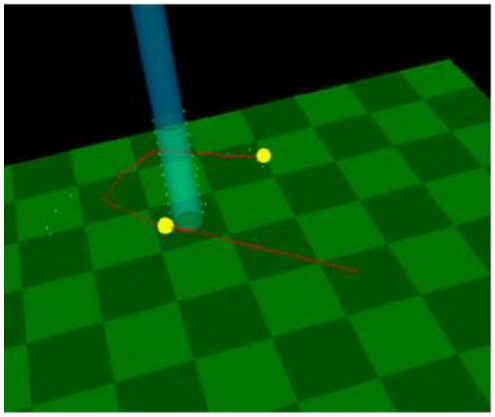
3D tracking

- 3D position can be determined by corresponding points in left and right camera (still manually at this moment)



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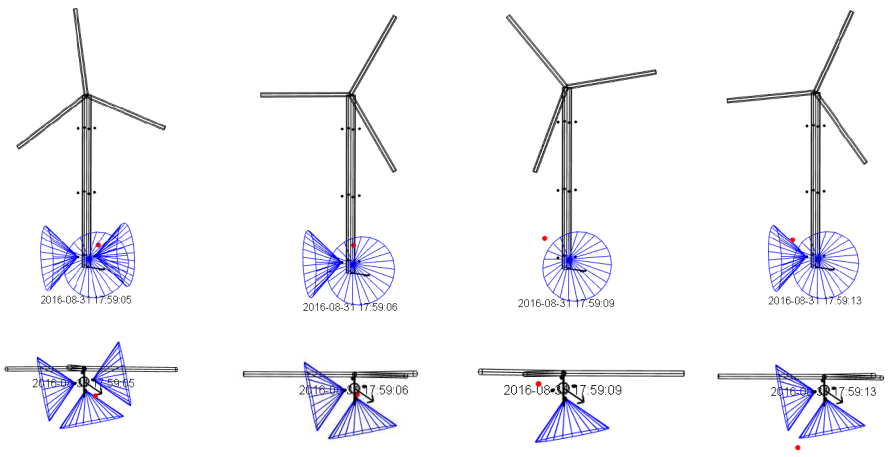
3D flight path and acoustic measurements



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Conclusions bat flight analysis

- The results of the feasibility study are very promising, but improvements are necessary before application at sea:
  - automatic selection of 3D bat tracks (and not of the insects and/or clouds)
  - Monitoring the entire RSA with multiple cameras
  - Synchronisation of cameras and bat detector
  - Offshore proof
- Possibly also applicable for birds

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Comparison of 3D flight path and acoustic measurements

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In collaboration with:

FOOD & BIOBASED RESEARCH
WAGENINGEN UR

Bionet
Natuuronderzoek

Batweter
VLEERMUISONDERZOEK EN ADVIES

ECN
Energy research Centre of the Netherlands

museum

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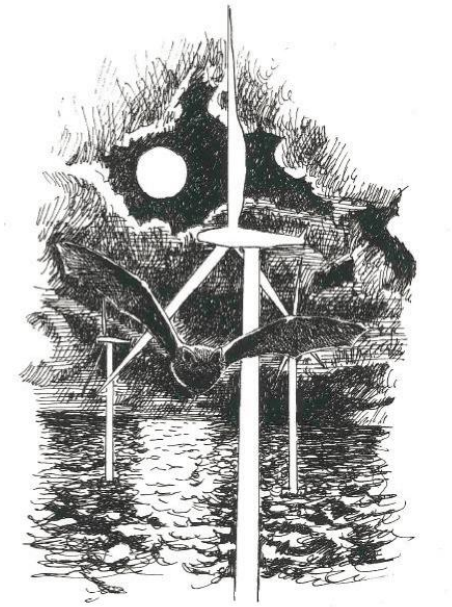
Thanks for your attention!

Any questions?



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Spatial distribution and habitat preference of harbour seals (*Phoca vitulina*) in the Dutch North Sea

Geert Aarts, Jenny Cremer, Roger Kirkwood, Jan Tjalling van der Wal, Jason Matthiopoulos & Sophie Brasseur

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February 2017

Harbour seal natural history

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Why is knowledge on spatial distribution relevant?

- Spatial planning: Where to (or not to) build windfarms?
- Impact assessment: How many seals are impacted?
- Mitigation: When, where and how to mitigate against negative effects.

- Ecology: where do seals feed or travel?

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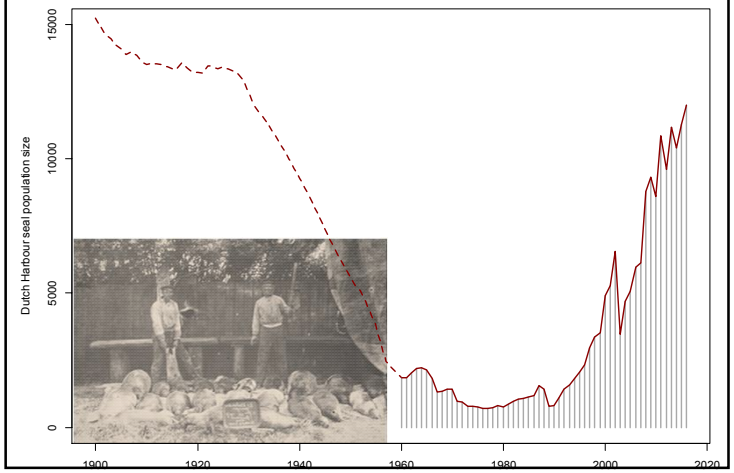
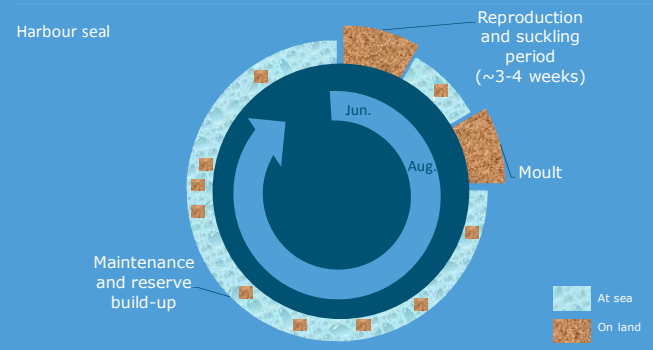
Development harbour seal population



Harbour seal annual life cycle



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Use haul-out sites

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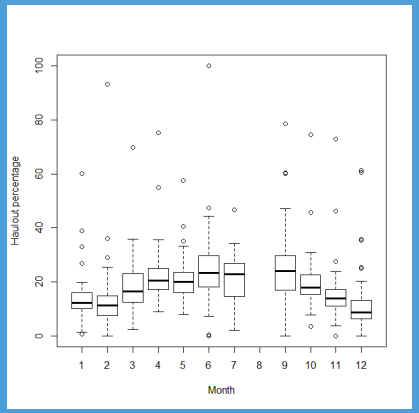
Haul-out probabilities varies within year



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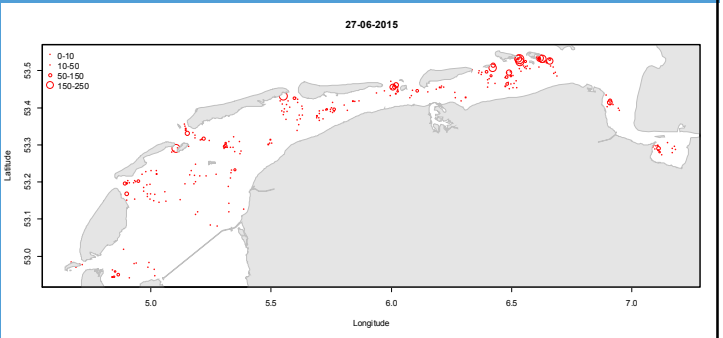
Wadden Sea counts (Pupping)



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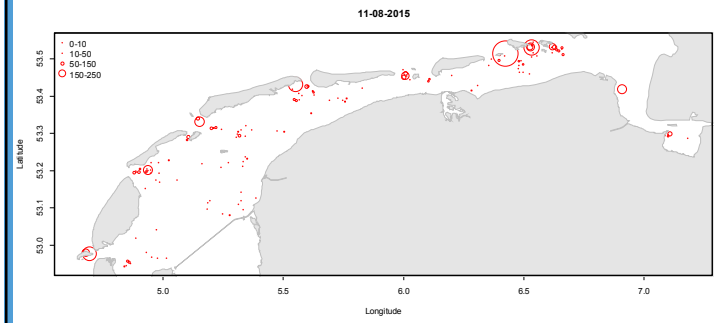
Wadden Sea counts (Late moult)



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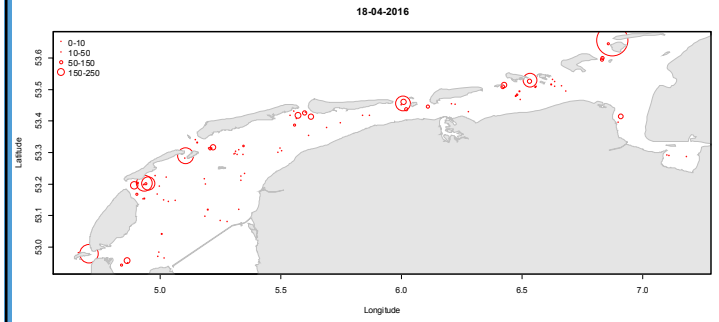
Wadden Sea counts ('winter')



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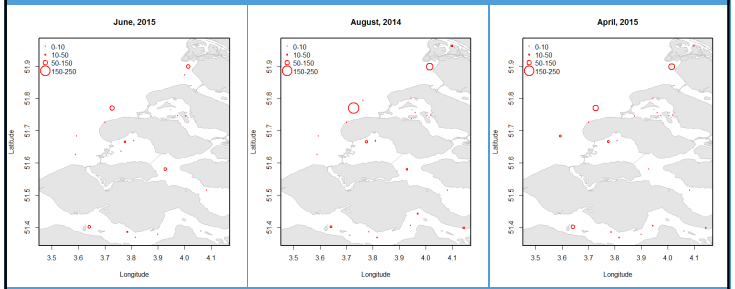
Delta counts

Pupping season | Moult | April



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Making trips from haul-out sites

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Making trips from haul-out sites

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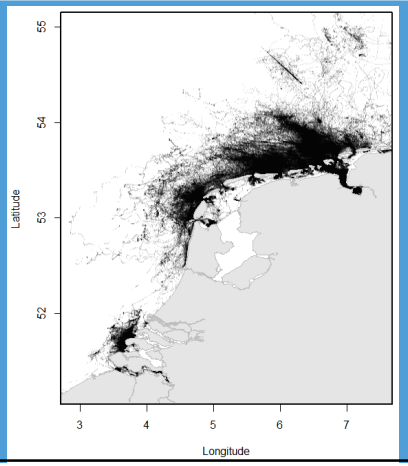
Biased sampling effort



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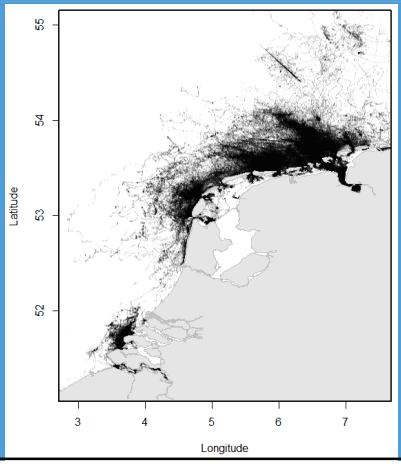
Distribution of **all** tracked harbour seals



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Habitat model, why and how?

Why:

- Correct for unequal sampling effort
- Predict for places with seals present, but no tracking data

How:

- Model seal density as function of environmental variables
- Use model and aerial counts to predict distribution of all seals

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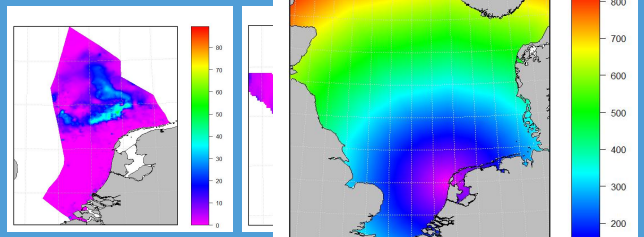
Environmental variables

- Depth
- Sediment type
- Distance to haul-out



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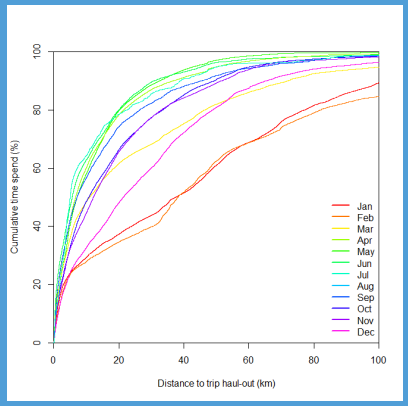
Seasonal variation in distance to haul-out?



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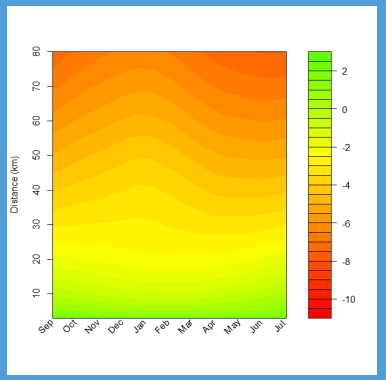
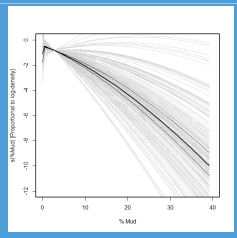
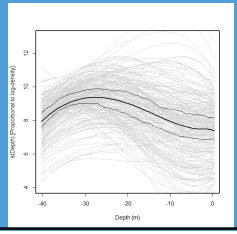
Results: Habitat model







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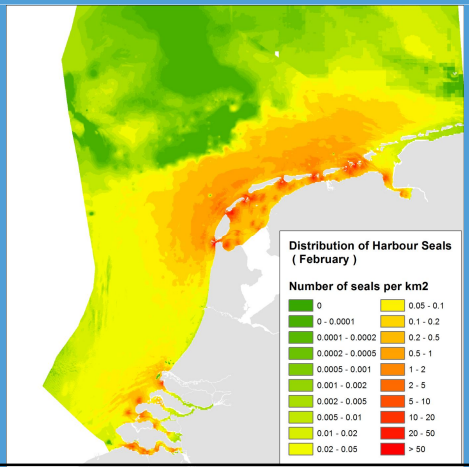
Predict absolute distribution (February)



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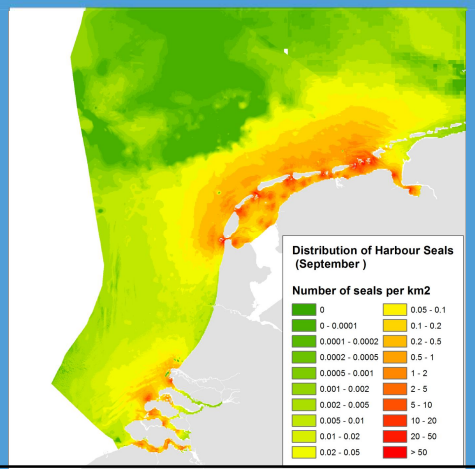
Predict absolute distribution (September)

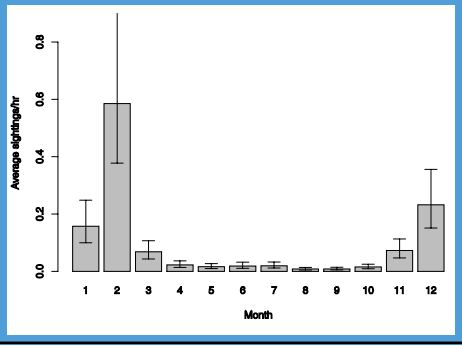


Discussion

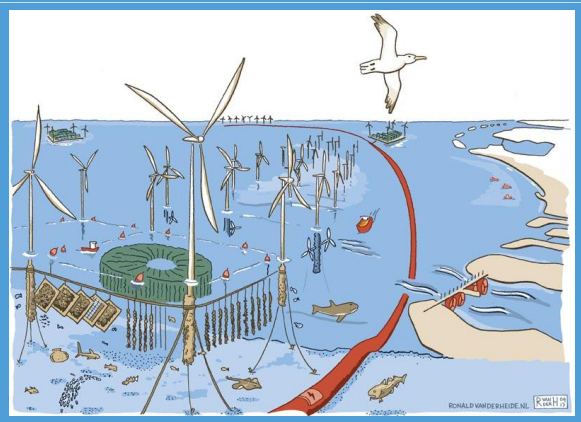
- Model estimates **absolute** density of seals at sea
- Most variation in seal distribution explained by distance to the haul-outs.
- Also preference for regions of ~30 m deep, and low mud-content.
- Harbour seal distribution varied between seasons: In winter (Dec-Feb) further away from the haul-out sites, and less time at haul-out sites.
- Habitat model describes density/time spent = more important?
- Model describes current situation, possibly influenced by human use, how does this change?

In winter: harbour seals venture further away from haul-out sites

Harbour seal sightings from North Sea coast



What next?



What we need

- Model framework that can include
  - short and long-term impact of human activities
  - both natural and human processes
  - cumulative effect

What we need

- Model framework that can include
  - short and long-term impact of human activities
  - both natural and human processes
  - cumulative effect

Individual-based models

- Monitoring and basic (ecological) research to understand what is happening

Example of importance cumulative effects

Baiji river dolphin (Extinct 2006)

- Hunting (historically)
- Habitat degradation (e.g. construction of dams)
- Pollution
- Disturbance (e.g. heavy shipping)
- Bycatch in local (illegal) fishing

Future research

- Development individual-based model
- Understanding role of food availability and density dependence
- Continue monitoring population trend & changes in habitat use in relation to developments

Other proposed research

- Cumulative effect, e.g. also effect of shipping.
- What are pups doing?
- Understanding energy and time budget
- Monitoring program to validate individual-based model

Acknowledgement

- Groningen Sea Port (GSP), ENECO and Gemini for funding the seal GPS transmitters used in this study
- RWS (Aylin Erkman, Inger van den Bosch and Suzanne Lubbe) for funding this research project and constructive comments
- Ministry of EZ for funding the aerial surveys in the Wadden Sea and we thank the pilots, in particular Aad Droge.
- MWTL (Floor Arts) for recent seal counts in the Delta region
- Sytse van Heeteren and Patrick Kiden (TNO) and Jennifer Valerius (BSH) for sediment data
- Everyone who assisted in the field, particularly Piet-Wim van Leeuwen, Andre Meijboom, Hans Verdaat, and the crew of the Wadden Unit.

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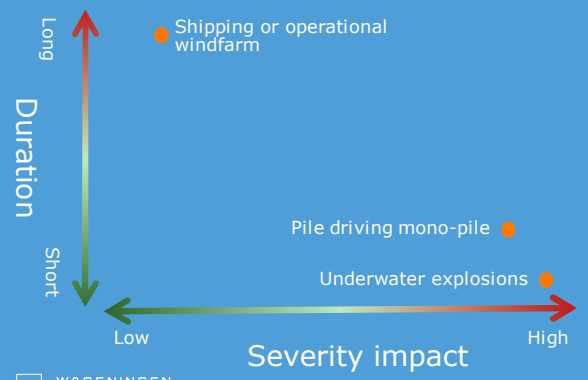
Duration versus severity



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Thanks for listening

Questions?

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Harbor porpoise energetic studies for WOZEP

Ron Kastelein
SEAMARCO

WOZEP progress meeting
Utrecht
21 February 2017

Background

Harbor porpoise research so far focused on:

- Effect of pile driving sound on hearing (TTS)
- Effect of sound on behavior (dose-response)

Research on the effect of sound on individuals

Ultimate goal: Effect sound on population dynamics

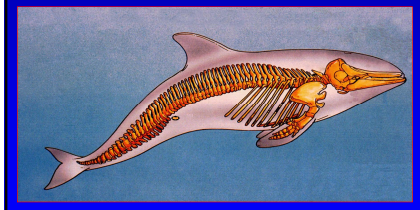
- PCOD model developed to estimate effects on populations
- Effect of sound on fitness, longevity and reproduction
- Important input parameter for PCOD model: energetics

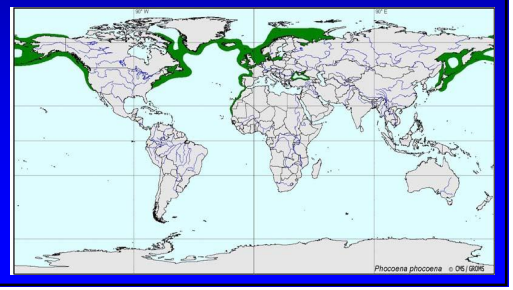
Structure of talk

- Background
- Food consumption & growth in a harbor porpoise (2016, completed)
- Effect of 24-hour fasting on harbor porpoises (2016-2017, ongoing)
- Potential future energetic studies for WOZEP

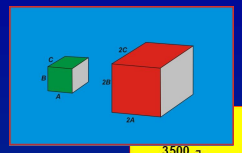
Why focus on the harbor porpoise ?

1) Occurs in large numbers in the North Sea
2) Small odontocete (37 °C). Very unfavorable body weight/body surface ratio
3) Requires a very high food intake (high metabolism)
4) A disturbance affecting food intake can have quick and large repercussions

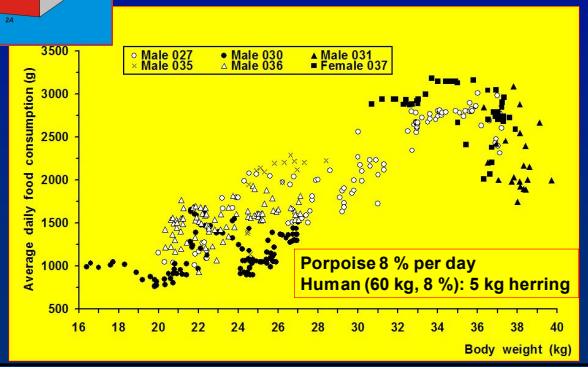




Food consumption



Relatively large loss of energy through contact of skin with cold water



SEAMARCO Research Institute, The Netherlands

Remote, quiet location & pools designed for acoustic research. Water and air temperatures similar to those of areas in which wild porpoises occur (*i.e.*, on the other side of the dyke)

Food consumption and growth in a harbor porpoise (2016, completed)

9 years of husbandry data of a male harbor porpoise housed in water & air temperatures similar as those experiences by conspecifics in the wild

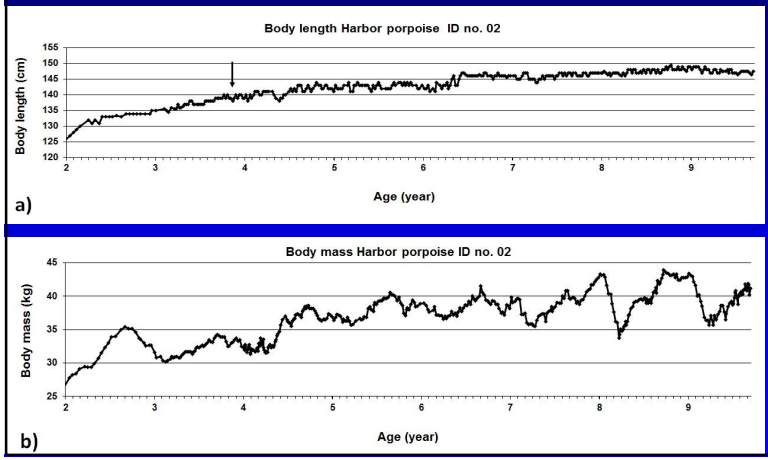
Daily:

- Air temperatures
- Water temperatures
- Food consumption
- Respiration rates (4x)

Weekly:

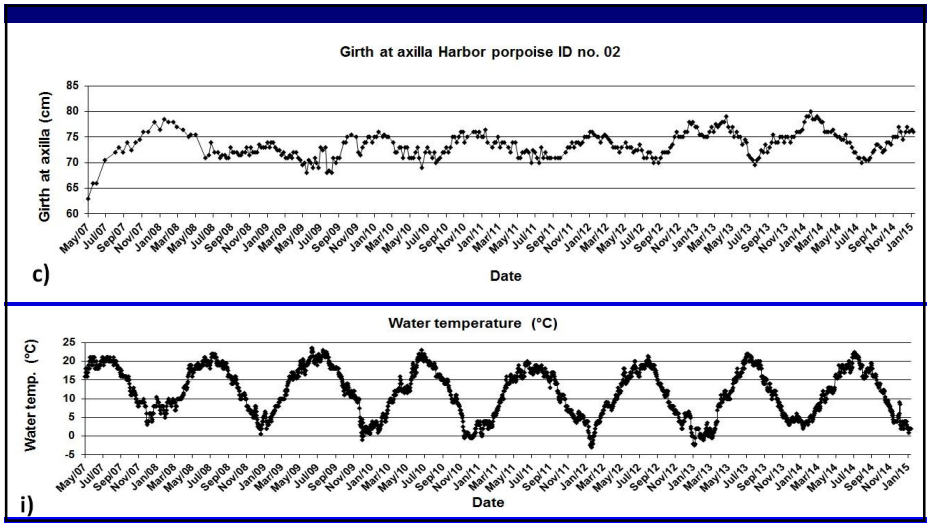
- Body length
- Body mass
- Blubber thickness
- Girth at axilla

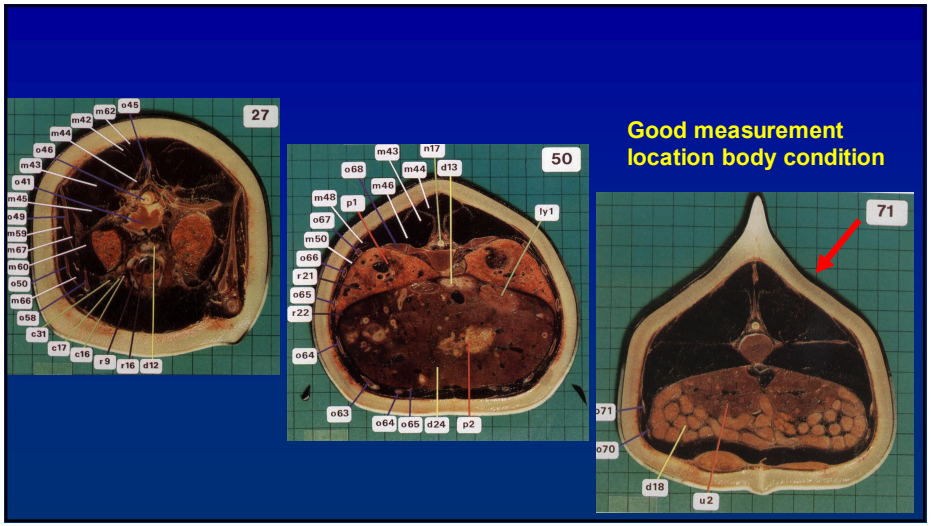
Energetics: growth (body measurements)



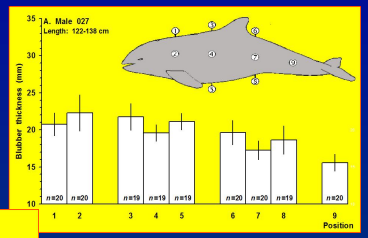
Weaning around 100 cm

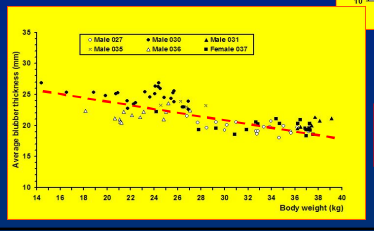
Combination of length growth and seasonality



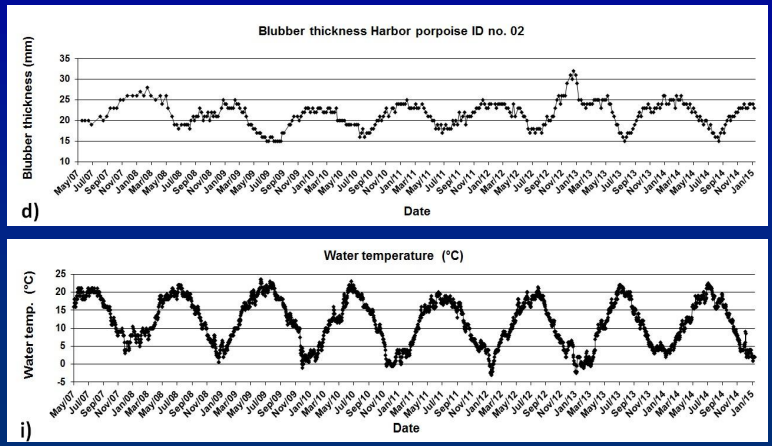


Energetics: Blubber thickness (Insulation & energy storage)

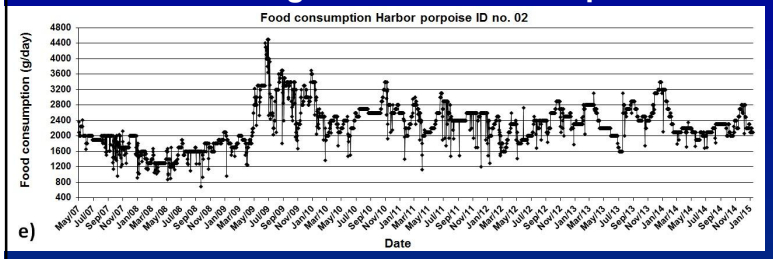


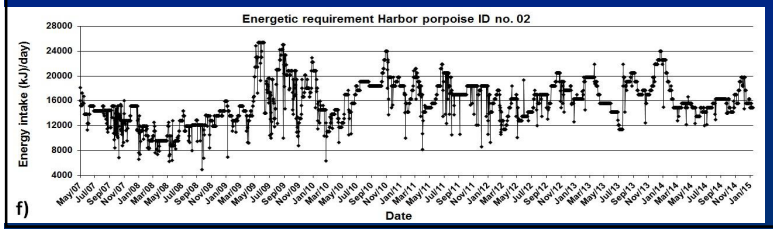


The larger the porpoise, the thinner its blubber layer

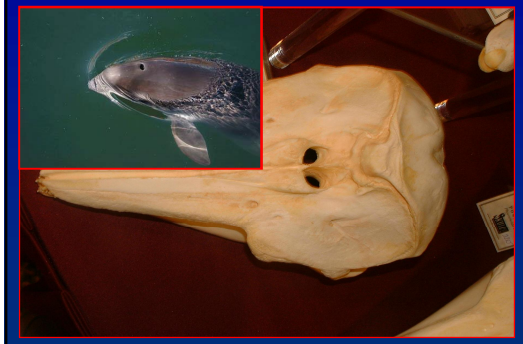


Energetics: food consumption

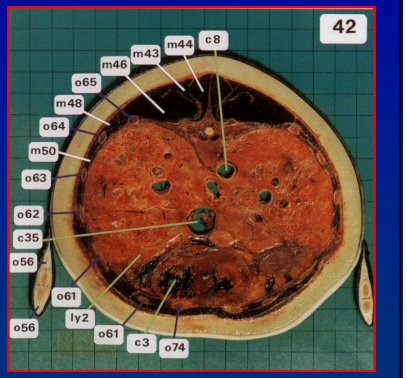




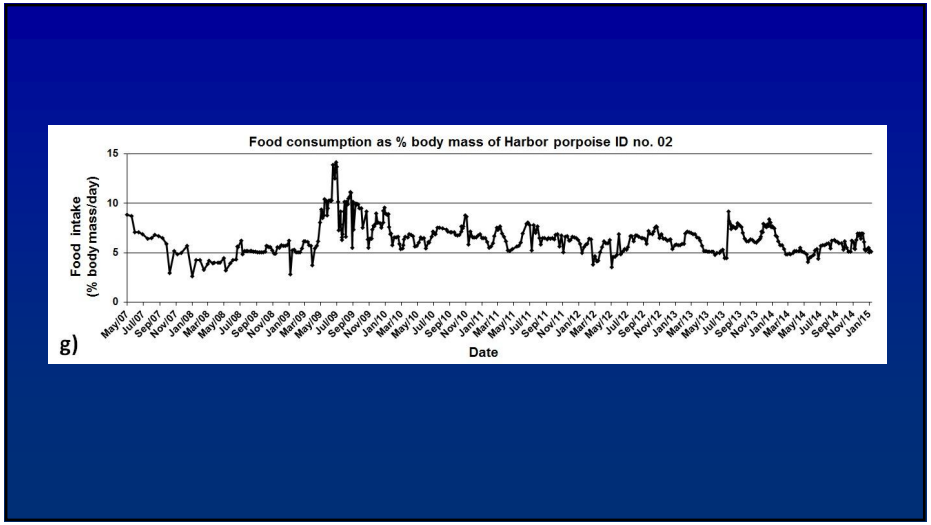
Energetics: Respiration



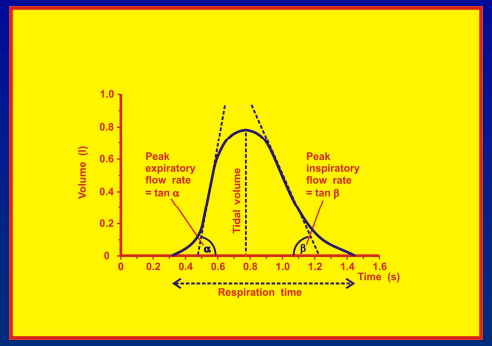
Two nares below a singular blowhole



Lungs

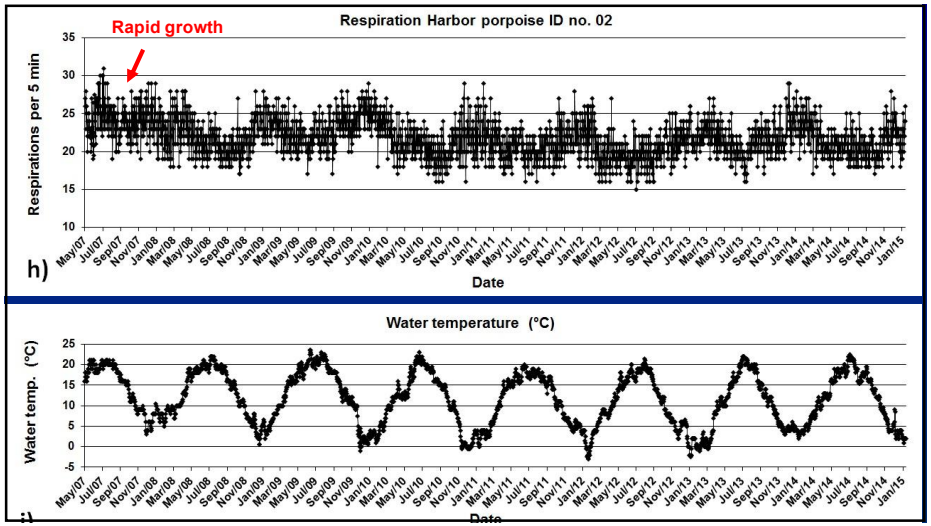


Lung ventilation



Per breath, large % of air in lungs replaced

Data collection: 4 x times per day, respiration rate in 5 min



Effect of fasting in harbor porpoises (2016-2017, ongoing)

Porpoise lift (trained behavior)

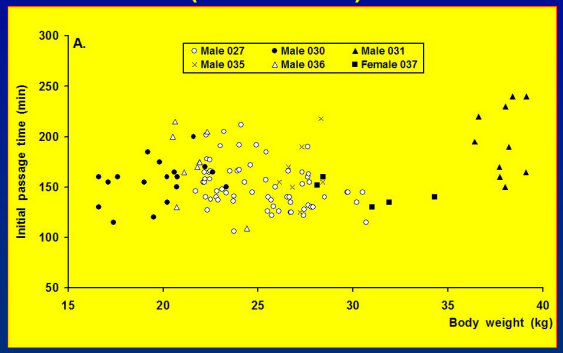
ADVERTISEMENT !

SEAMARCO has similar food consumption, body mass and growth data are available for 2 harbor seals (13 years)

Weighing platform

This is usually done once a week

Energetics: Food passage time
(Carmine red)



After 2.5 to 3 hours food has passed the digestive tract
Start weight loss ~ 3 hrs after last meal

Potential studies on harbor porpoise energetics

- Food consumption & growth (now of 1 male)
  - Seasonal fluctuation
  - Effect maturation
  - Effect water temperature
  - Effect of food deprivation (weight loss, blubber thickness)
- Food preference
- Maximum food intake after food deprivation
- Digestive efficiency of various fish species
- Metabolism (respiration rate, oxygen consumption)
- Swimming speed during pile driving sound
- Swimming and diving energetics
- Effect pile driving sound on foraging efficiency (pelagic fish, bottom fish) Proposals available

Potential future studies in WOZEP by SEAMARCO (apart from some remaining acoustic studies)

Harbor porpoises

Harbor seals

Potential studies on harbor porpoise reproduction

- Fertilization
- Gestation (duration, weight gain mother, blubber thickness changes)
- Birth
- Suckling (times/day, duration suckling period)
- Milk composition changes during suckling period
- Onset and duration transition to solid food (fish)
- Echolocation development
- Development fish catching technique
- Growth calf


Research to reduce environmental impacts of human activities at sea
researchteam@zonnet.nl
SEAMARCO
SEA MAMMAL RESEARCH COMPANY
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MODELLEREN HEIGELUID

- **2009-2015 studies:** data puntbron (Q7) & '*Aquarius* 1.0' propagatiemodel
- **2010-2011 'short list Wind op Zee' :**
  - Gedetailleerd bronmodel geluiduitstraling heipaal (*Zampolli et al.*)
  - Experimentele validatie testpaal IHC
- **2012-2015 'VUM':**
  - '*Aquarius* 2.0' propagatiemodel
  - Verificatie in internationale workshop 'COMPILE' (organisatie TUHH & TNO)
- **2015-2016:**
  - Experimentele validatie (ENECO Luchterduinen & Gemini)

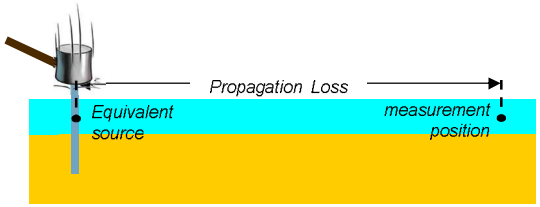
INLEIDING

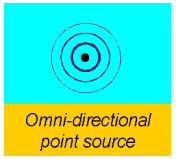
- Kader Ecologie en Cumulatie t.b.v. uitrol Windenergie op Zee:
- Redeneerlijn voor het bepalen van cumulatieve effecten van impulsief onderwatergeluid op zeezoogdierpopulaties
- Stap 1: Bereken geluidverspreiding per heiklap
  - → bruinvisverstoringsdagen
  - → populatie-effect
  - → geluidsnorm in kavelbesluit
- *Hoe nauwkeurig is Stap 1?*

AQUARIUS 1.0 / 3.1

$$SEL = SL_E - PL$$

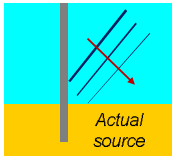
- Propagatiemodel berekent propagatieverlies (PL)
  - 1.0: Weston 'flux' model)
  - 3.1 '*SOPRANO*' propagatiemodel (NWO-ZKO onderzoek Özkan Sertlek)
- Bronsterkte (SL) voor een 'equivalente puntbron'
  - Uit metingen bij aanleg Prinses Amaliawindpark (Q7)
  - SL geschaald met heiklap-energie

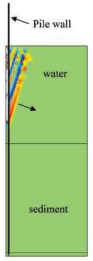


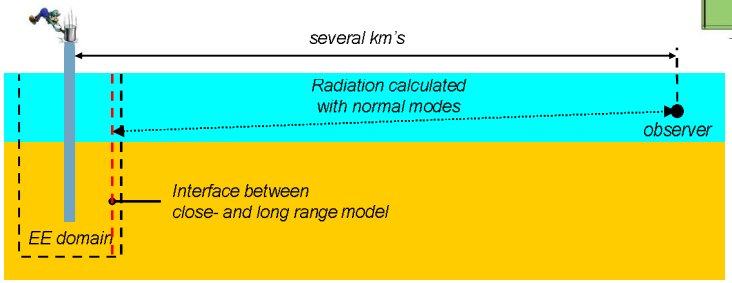


AQUARIUS 2.0

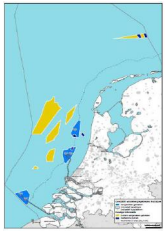
- Nabij paal: 'eindige-elementen' model
  - Gedetailleerd (*Comsol MultiPhysics*)
- Grotere afstanden: 'normal modes' model
  - Efficiënt propagatiemodel (*Aquarius* 2.0)







VALIDATIE

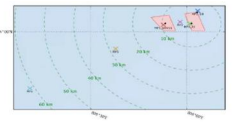


- AQUARIUS 1: data OWEZ/PAWP, maximale afstand 5.6 km
- AQUARIUS 2: data IHC testpaal, haven Kinderdijk, < 100 m
- **Nieuwe data** (gemeten door ITAP):

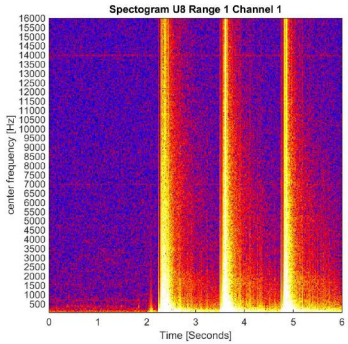
windpark	#	jaar	MP1	MP2	MP3	MP4
Luchterduinen	2	2014	750 m	5 km	13 km	47 km
Gemini	3	2015	700-900 m	4-7 km	20-31 km	54-66 km

- WOZEP project:
  - Vergelijken metingen met modelberekeningen
  - Analyse van verschillen

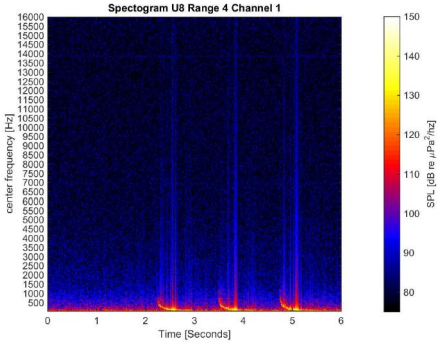
GEMINI U8 PILING



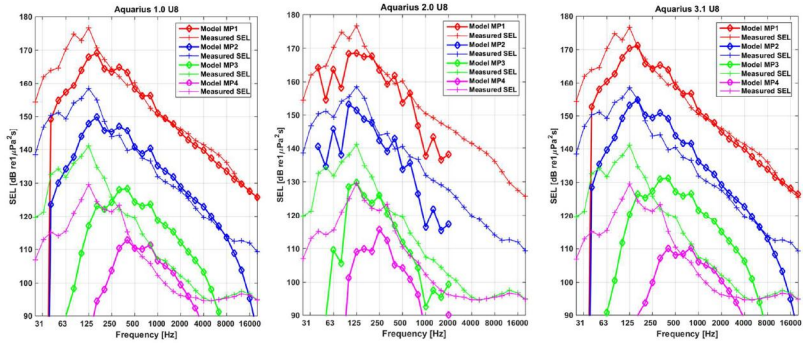
731 m



66 km

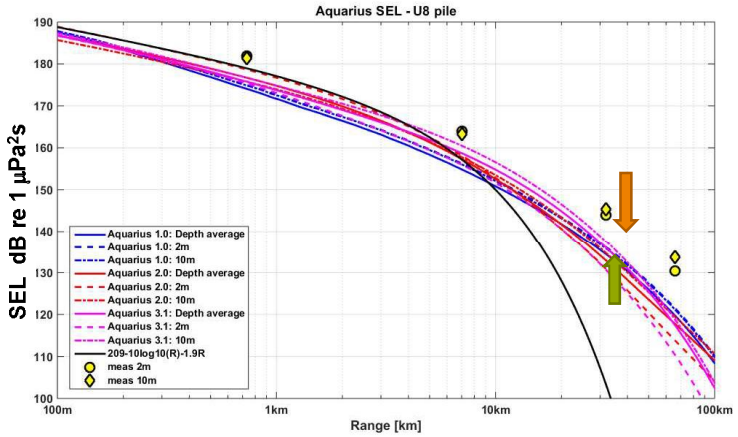


MODELVERGELIJKING (GEMINI U8)



Gemeten: —+—
Berekend: —◊—

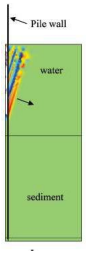
MODELVERGELIJKING (GEMINI U8)



VERSCHILLEN MODEL – METING: BRON

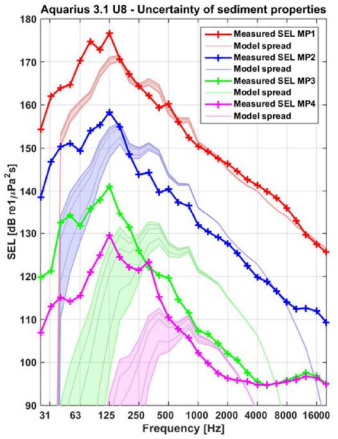
Bronbeschrijving:

- Aquarius 2.0 beschrijft de fysica (Mach-cone) beter (> ~200 Hz, < ~10 km)
- Aquarius 1.0/3.1 bronspectrum (Q7: 4m paal diameter) onderschat gemeten spectra voor de 5-7 m diameter palen bij Gemini / LUD
  → *schalen met hamerklapenergie én diameter*
- Aquarius 2.0 input: aanstootkrachtspectrum (niet direct gemeten)
  → *verbeteren hamermodel*



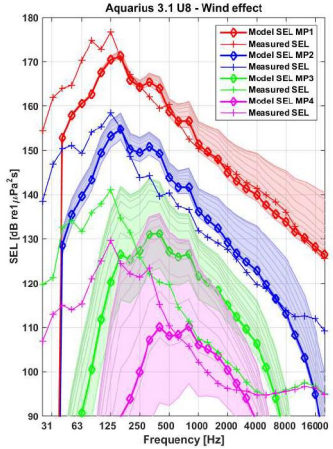
VERSCHILLEN MODEL – METING: SEDIMENT

- Sediment-modellering bij lage frequenties:
  - onzekerheid parameters ?
  - gelaagdheid bodem?



VERSCHILLEN MODEL – METING: ZEEWATER EN WIND

- Geluidsnelheidsprofiel en absorptie in water ~OK
- Effect van wind (golven en luchtbelletje bij wateroppervlak) is overschat
- Lijkt Aquarius 1.0/3.1 onderschatting door punt ipv lijnbron te compenseren



CONSEQUENTIES?

- LF (< ~200-400 Hz) SEL onderschatting:
  - bron onderschat en propagatieverlies overschat → *relevant* ?
- HF (> ~200-400 Hz) SEL overschatting: → *conservatief* ?
- Frequentieweging bij effectbepaling?

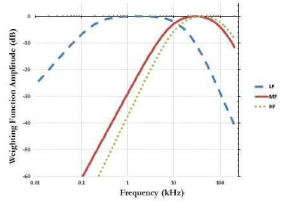
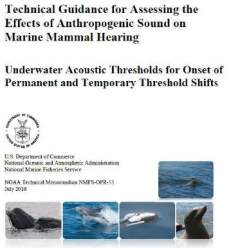
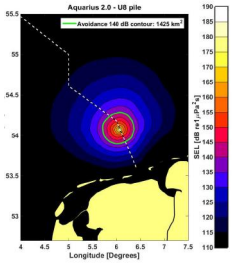


Figure ES1: Auditory weighting functions for low-frequency (LF), mid-frequency (MF), and high-frequency (HF) cetaceans.



VERVOLG ...



- Verbeteren bronbeschrijving:
  - Schaling met paaldiameter (Aquarius 3.1 puntbron)
  - Hamermodel of schaling met meetdata (Aquarius 2.0)
- Verbeteren propagatiemodellering:
  - Sediment en wind
- Uitbreiden met mitigatie (‘ mantel’, ‘bellenscherm’, …)
- Uitbreiden naar trillen en operationeel geluid
- Uitbreiden naar deeltjessnelheid en bodemtrilling (benthos)
- Valorisatie: ‘Aquarius’ tools voor derden?