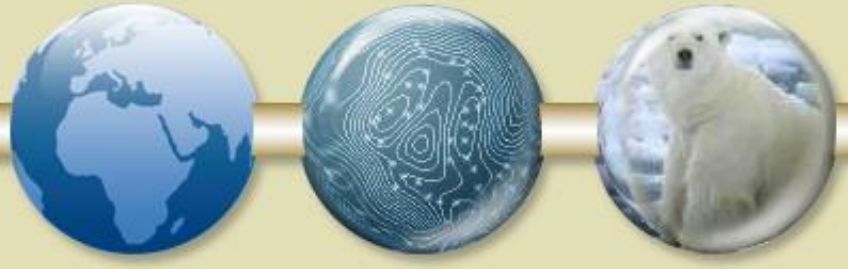
CREEM

Centre for Research into
Ecological and Environmental Modelling



Counting critters: why and how we monitor populations

Catriona M. Harris

University of St Andrews

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SCOTTISH OCEANS INSTITUTE

University of St Andrews

Talk outline

- Monitoring abundance of wildlife populations
  - Why it can be difficult
  - Some example survey methods
  - Accounting for species' biology
- Trends in abundance
  - What might be causing trend?
- What else should we be monitoring?

University of St Andrews

- Develop mathematical and statistical methods for collecting and analysing ecological and environmental data
- Particular focus on development of methods for estimating animal abundance and development of methods for environmental impact assessment

- Research into the distribution, abundance and biology of seals, dolphins and whales
- Advises government about issues concerning the management of marine mammals

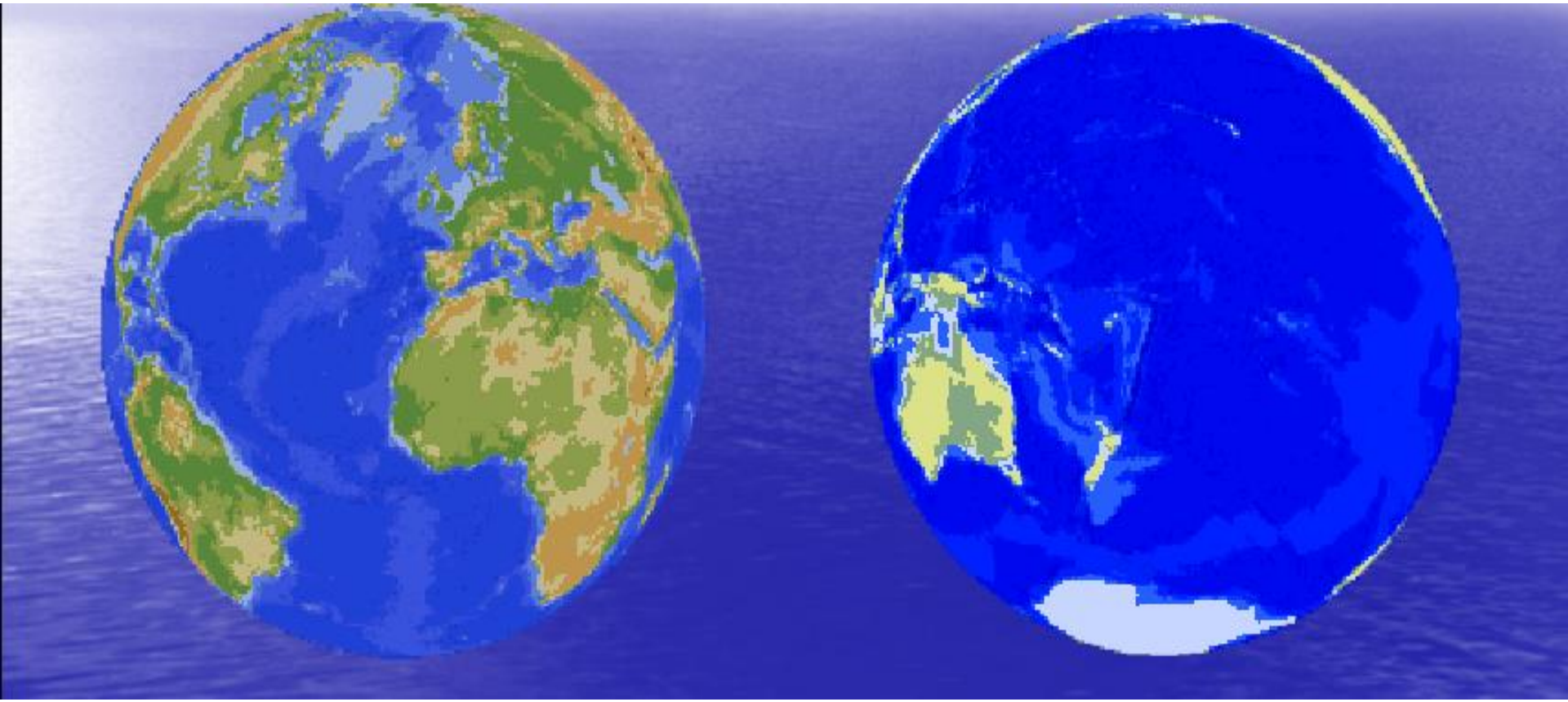
Why monitor?

- To detect changes in population size and health
- For planning conservation and management strategies
- To detect the impact of human activities
- To assess effectiveness of intervention or mitigation methods

Monitoring abundance

- In most situations in nature we can't count every individual
- We have to sample, and have to ensure our sample is representative of the whole population
- Must carefully consider the appropriateness of sampling methods for different species in different habitats

An example of why we can't count everything…….. Looking for Whales



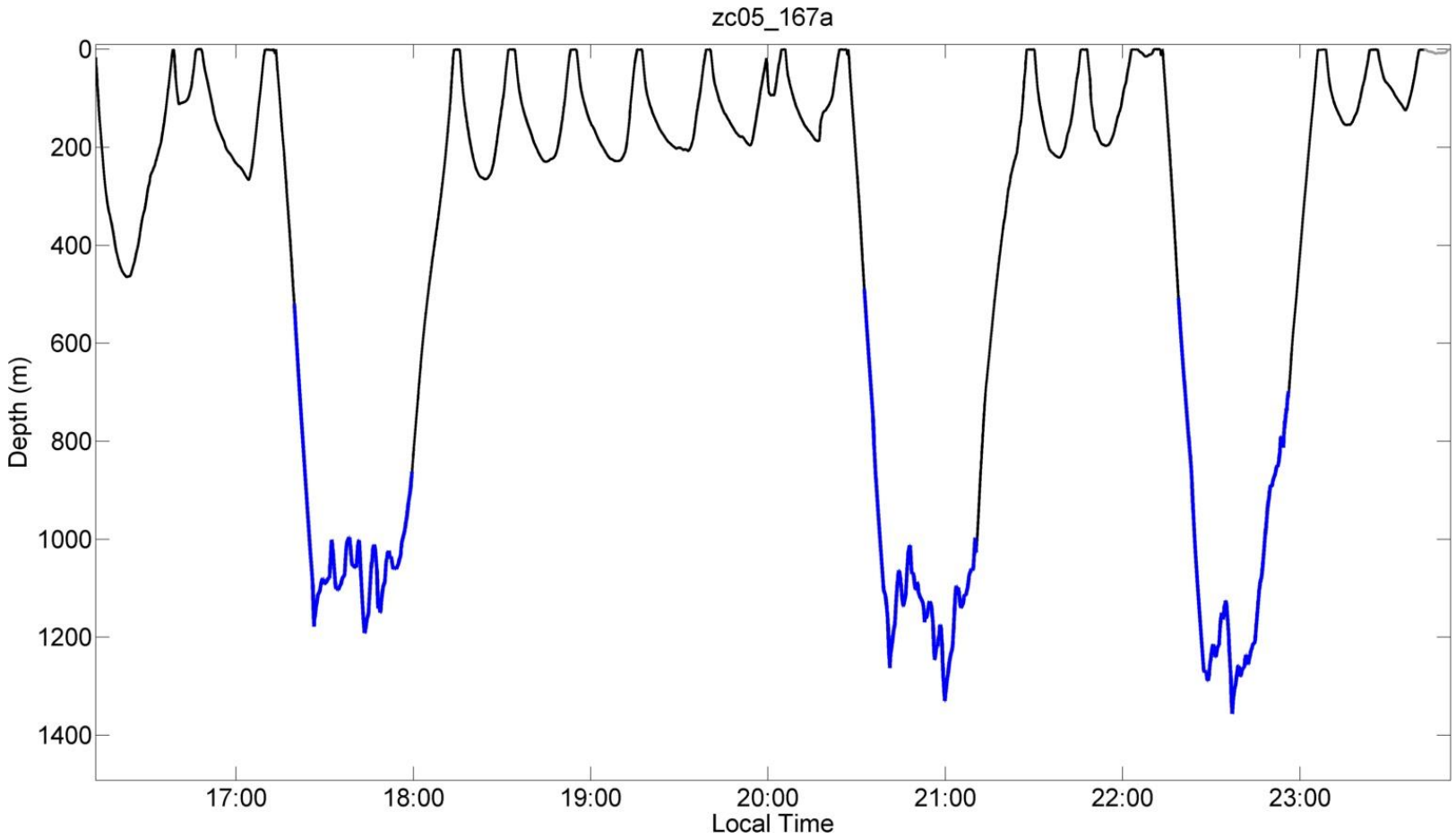
There's a **LOT** of sea out there!

If the UK had the same population density as blue whales in the Southern Ocean, there would be just 10 people in the UK!

… and whales can be difficult to spot

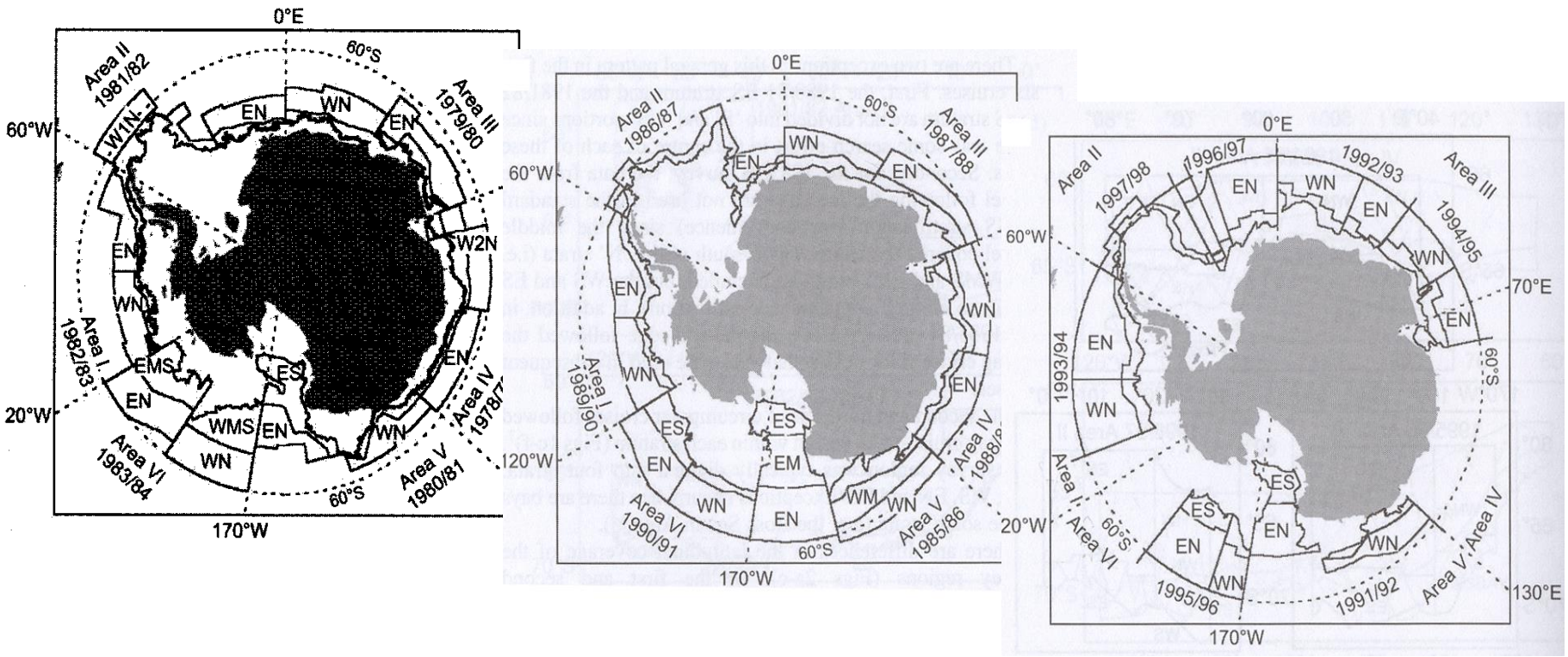
… whales can be difficult to identify

…and aren't always available to be spotted



Data from Tyack PL, Johnson M, Soto NA, Sturlese A, Madsen PT. Extreme diving of beaked whales. 2006. J Exp Biol. 209(21):4238-53.

It takes about 7 years for 2 ships…



… to search just **a hundredth**

of the Southern Ocean!!

… and the Southern Ocean is just one of five!

You have to ESTIMATE the total number of whales from the few that you count.

Estimates have uncertainty

- The number you count varies, depending on where you look and who is looking.
- Hence the Estimate varies.
- You're not being honest if you don't say how much your estimate varies – i.e. how uncertain it is.

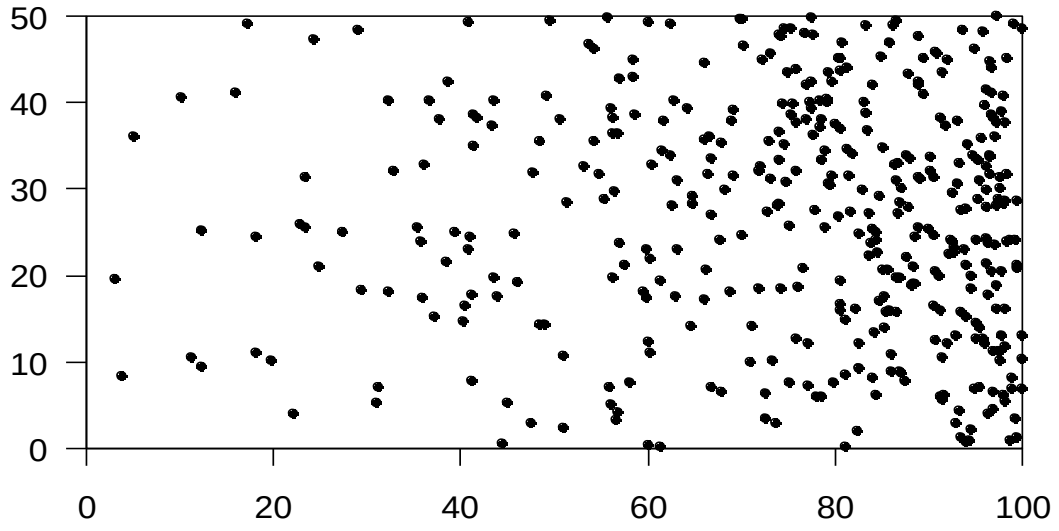
Survey methods

Given the difficulties, what methods can we use to minimise uncertainty and reduce bias in our estimate of abundance

See http://www.ruwpa.st-and.ac.uk/distance/ for more information. The following slides are taken from the introduction to distance sampling course

Census

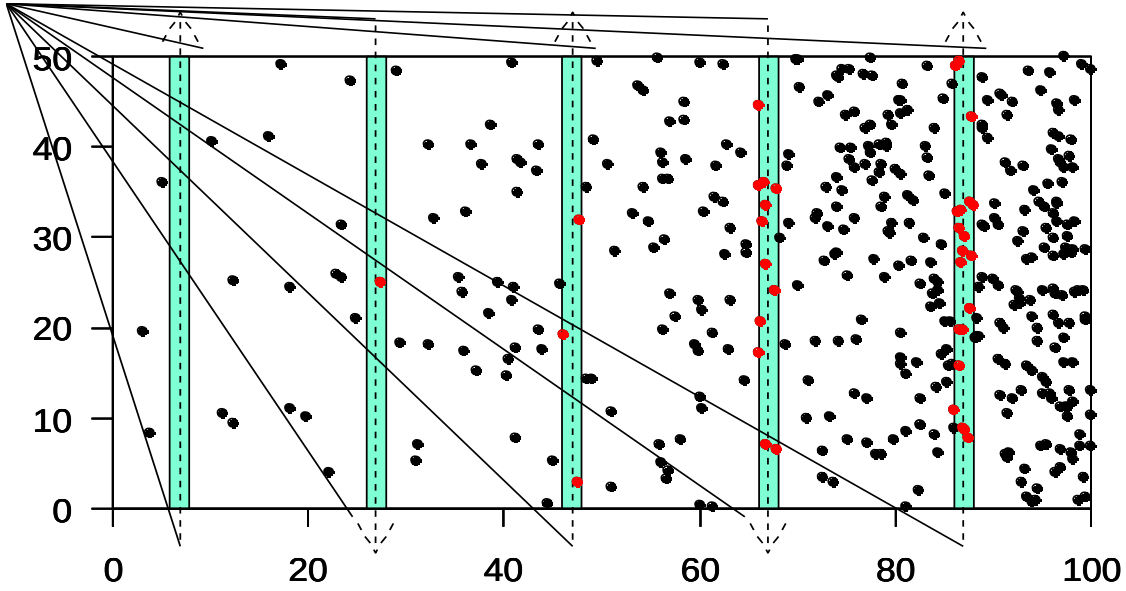
- Method = count everything



- Rarely possible in practice!

Plot sampling

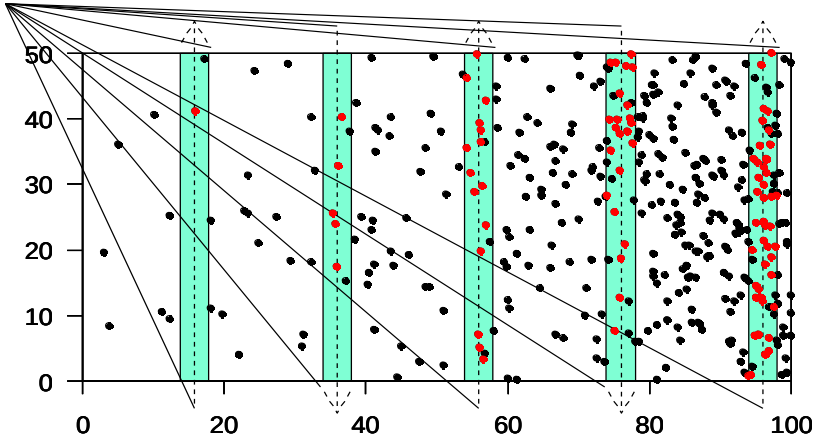
- E.g. strip transect



- Count in strips = 36
- Area covered by strips = 1/10th
- Abundance in total area = 360
- Assumes we see everything in the transect

Line-transect surveys

- An extension of plot sampling where not all the animals in the covered region are detected



- E.g. proportion detected = 0.7

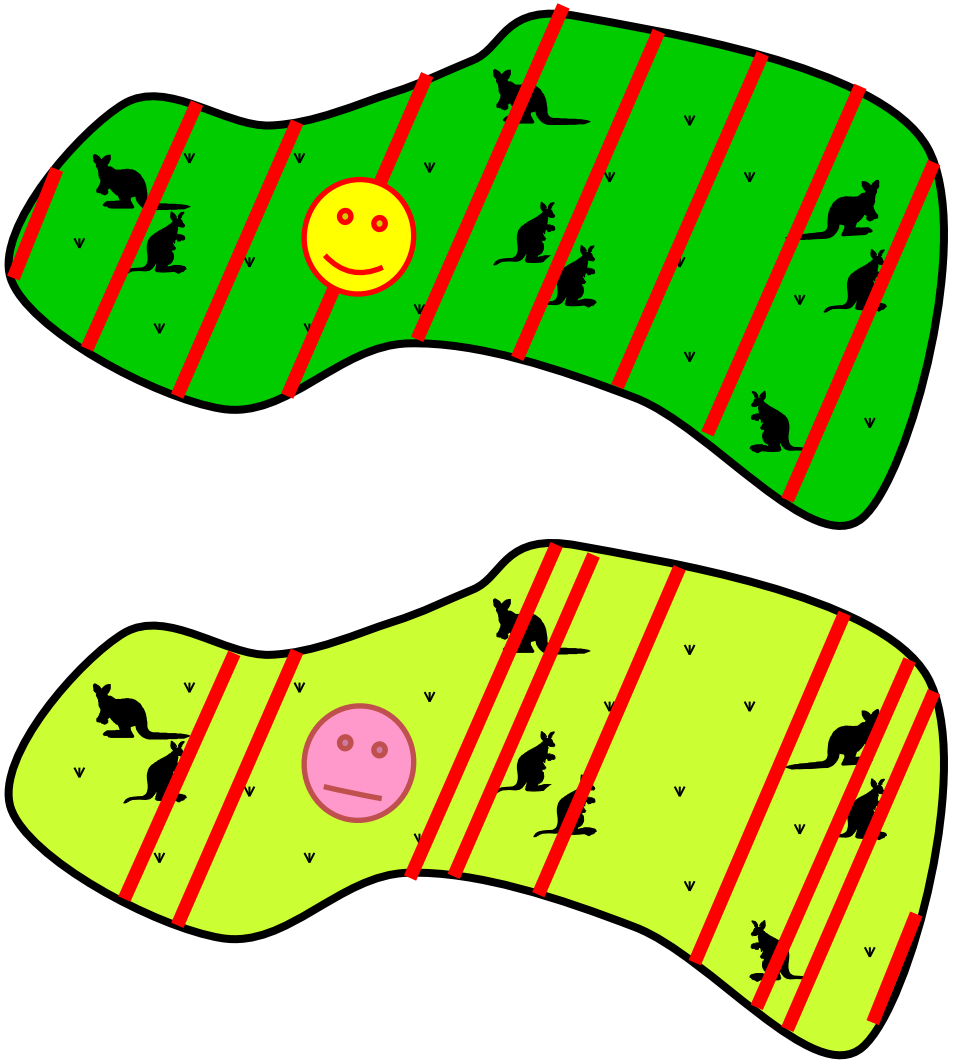
Line-transect surveys

- Ideally we'd like to survey an area many times to generate a mean estimate with a measure of uncertainty
- But often doing repeat surveys isn't realistic
- If we only have one opportunity to estimate abundance then we have to do it well!
  - High precision (low uncertainty)
  - Low bias

Survey design - Controlling variance

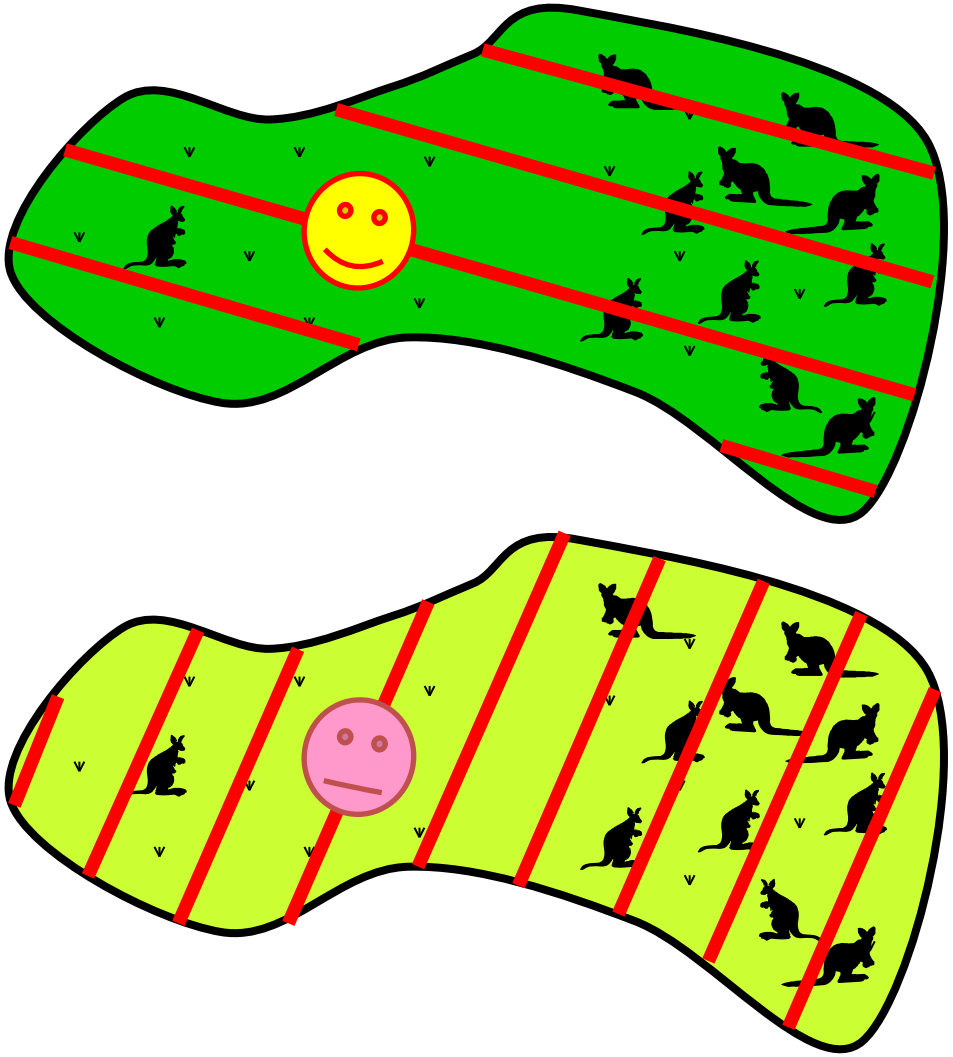
1. **Use systematic survey designs**

- These give lower variance than completely random designs
- More likely to give even coverage of the survey region



Survey design - Controlling variance

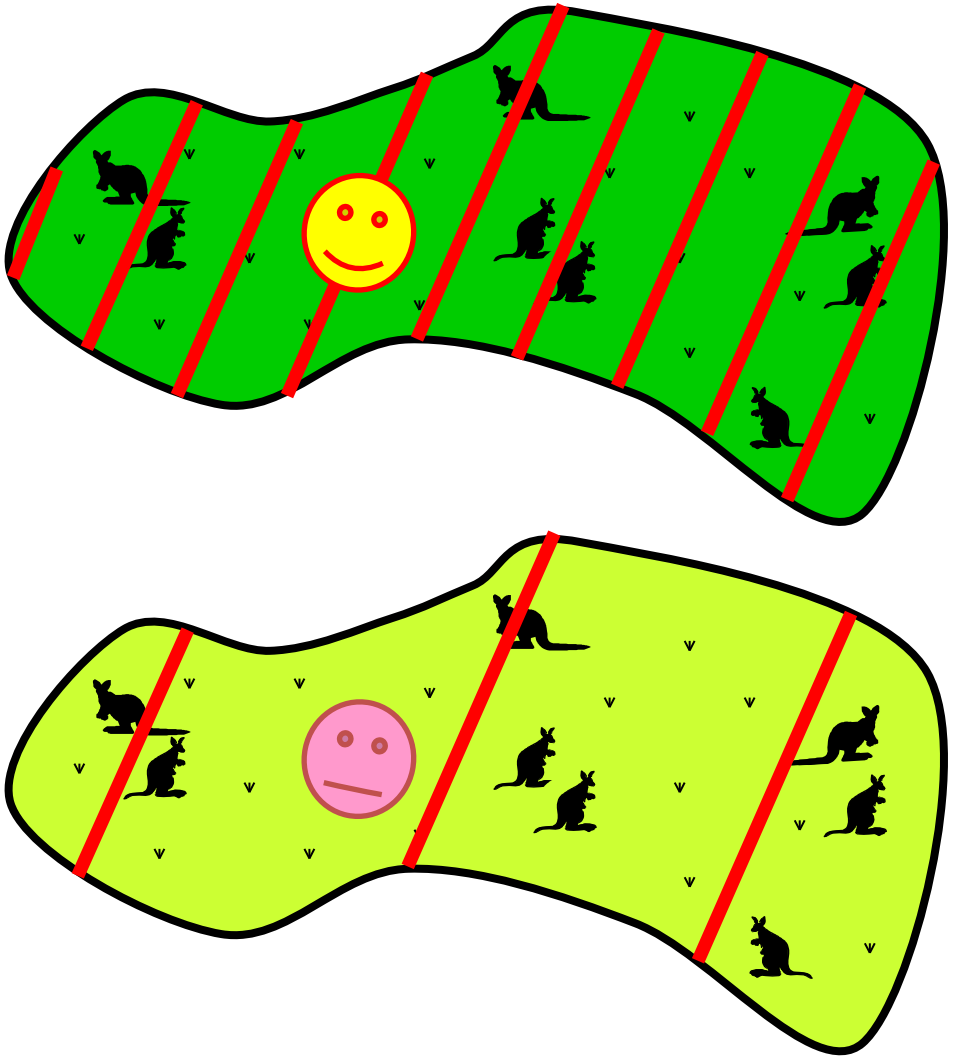
2. **Run transects parallel to known density gradients**



Survey design - Controlling variance

3. Use many lines

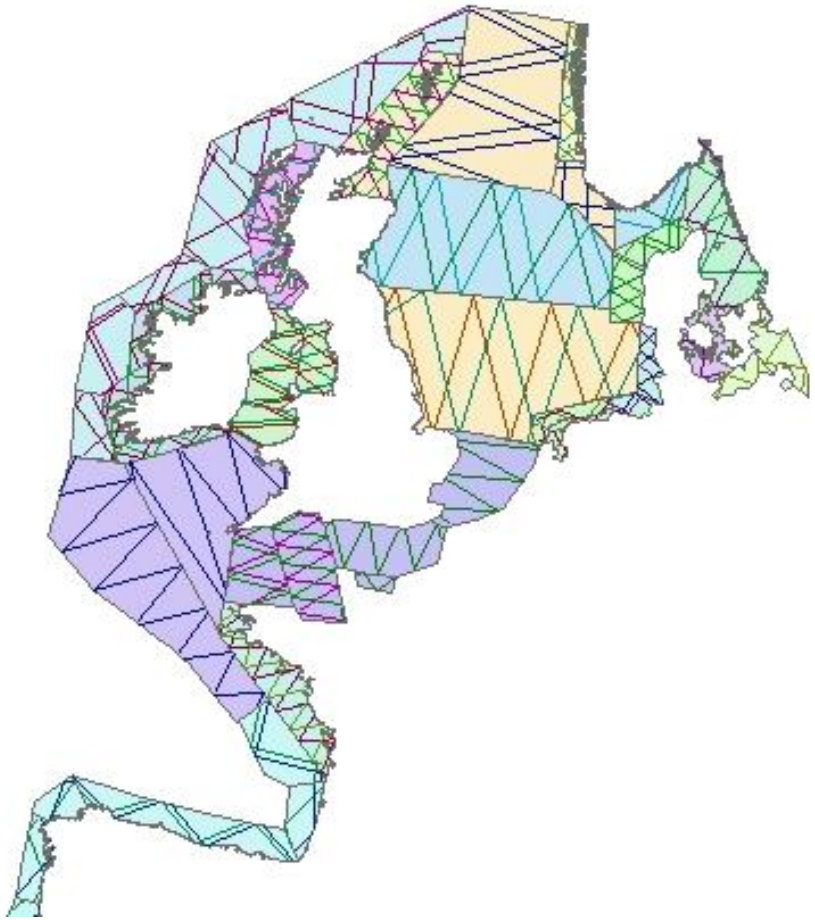
- This will give good spatial coverage



Line-transect surveys

Stratification is also used to:

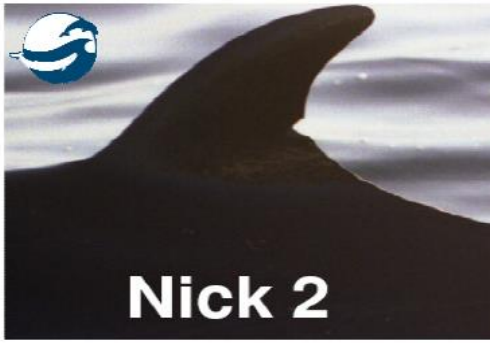
- reduce variance and improve precision
- and for producing estimates in regions of interest



Small Cetacean Abundance North Sea (SCANS) is an example of a geographically stratified survey

For more information about the SCANS project and surveys see: http://biology.st-andrews.ac.uk/scans2/inner-scans-II.html

Mark-Recapture



- Photo-identification uses natural markings to identify individuals
- Non-invasive method of “marking”
- Can collate large catalogue of images over years
- Can use re-sightings to estimate population parameters other than just abundance, e.g. survival, movement, calf production

Hebridean Whale and Dolphin Trust

- http://www.whaledolphintrust.co.uk
- HWDT use photo-id to monitor whales and dolphins off the west coast of Scotland
- School resources downloadable including photo-id exercise

Using photo-id for mark-recapture

Do survey and take photos of 6 individuals with good natural markings

- Next survey you see……..
- 3 known “marked” individuals

- + 3 unknown individuals

How many dolphins are there?

- Marked population = 6
- Number “captured” during survey = 6 (3 of which were marked)
- You’re seeing half the marked dolphins so assume you’re seeing half of all dolphins
- so you estimate there are 12 dolphins.
- Repeat many times…….

Taking account of species' biology

Seals in the UK

Grey seals

- 112,300 grey seals around the UK (95% CI 90,600-142,900)
- 90% of these are in Scotland
- This is 40% of the world's population

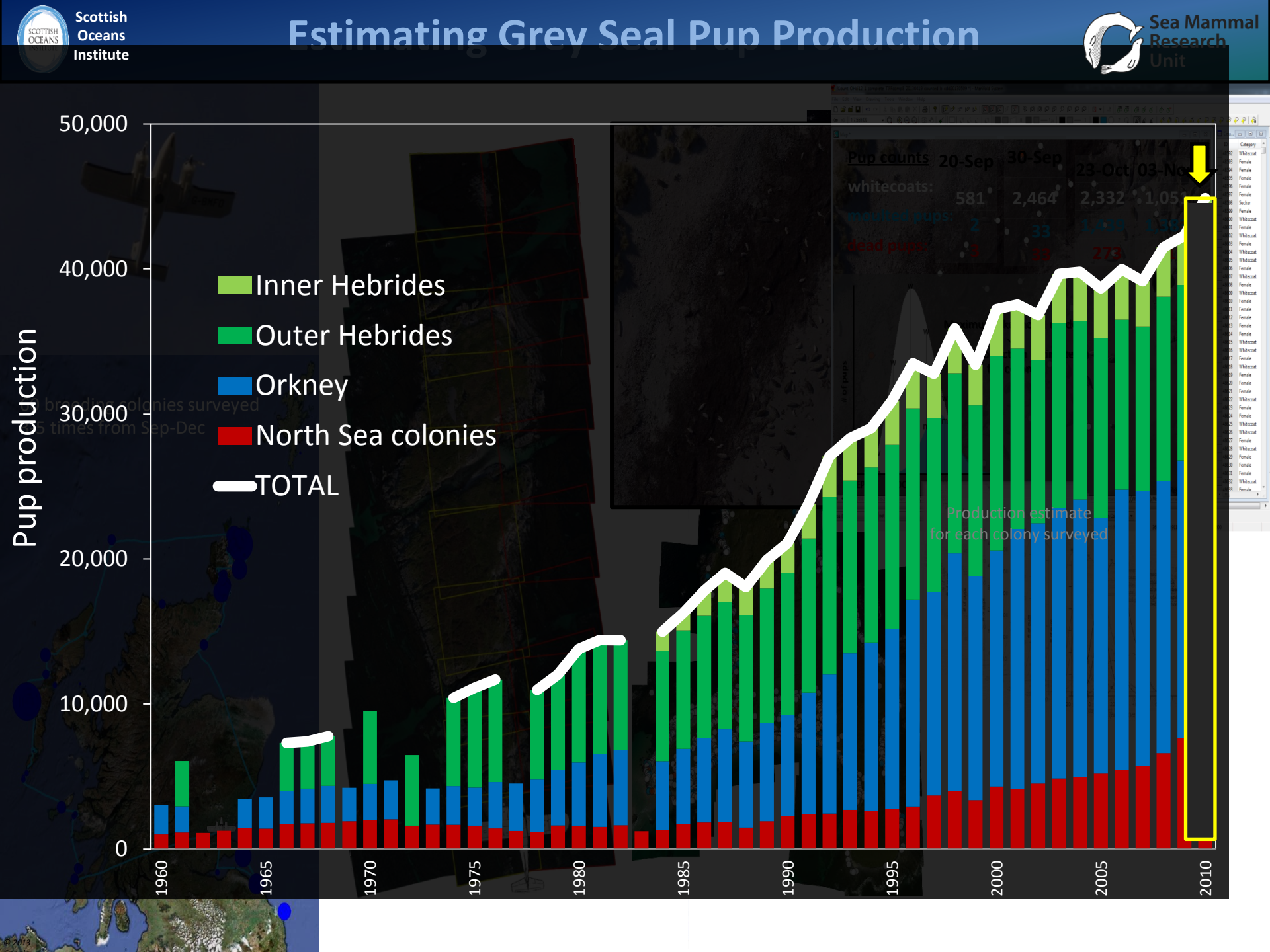
Grey seal biology

- Females congregate on land during the breeding season
- They give birth to a single, white coated pup between September and December each year
- Pups stay on land for ~1 month

Scottish Oceans Institute

Estimating Grey Seal Pup Production

Sea Mammal Research Unit



Harbour seals

- Minimum population estimate of 37,300 around the UK (95% CI 30,500 – 49,700)
- Found around the northern hemisphere
- <10% of world population in UK

Harbour seal biology

- Females give birth to precocious pups, which enter the water and follow their mothers from birth
- Therefore, harbour seals are counted during their moult season in August which is when they spend the most time ashore.

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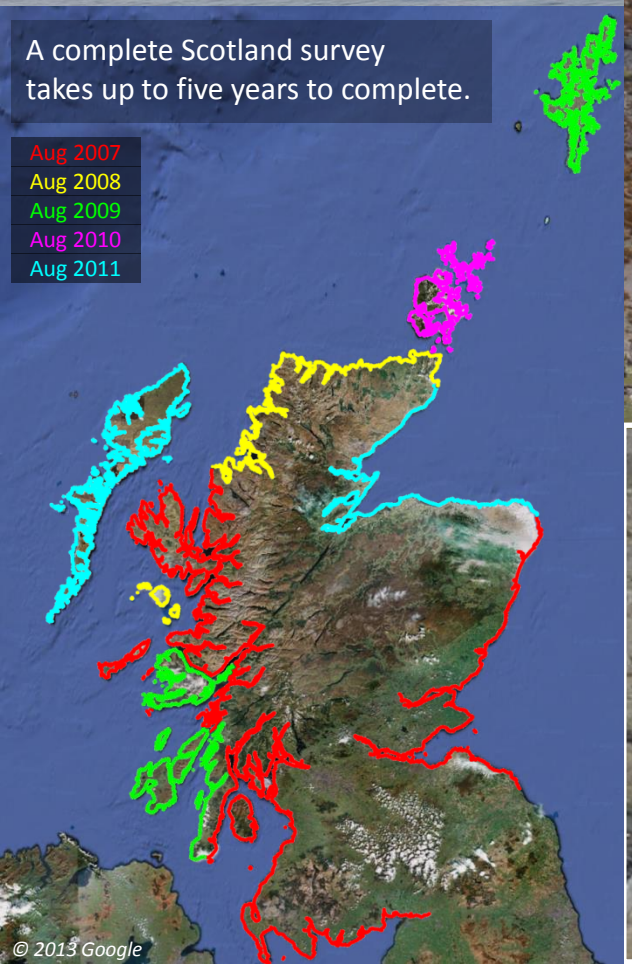
thermal image

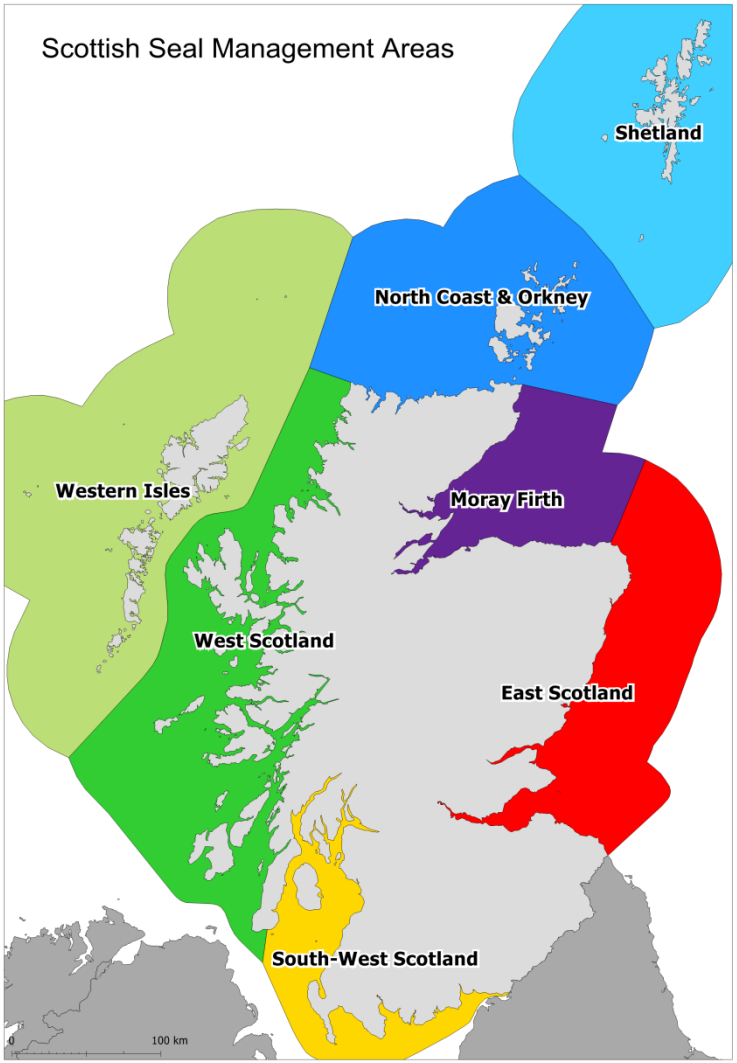
A complete Scotland survey takes up to five years to complete.

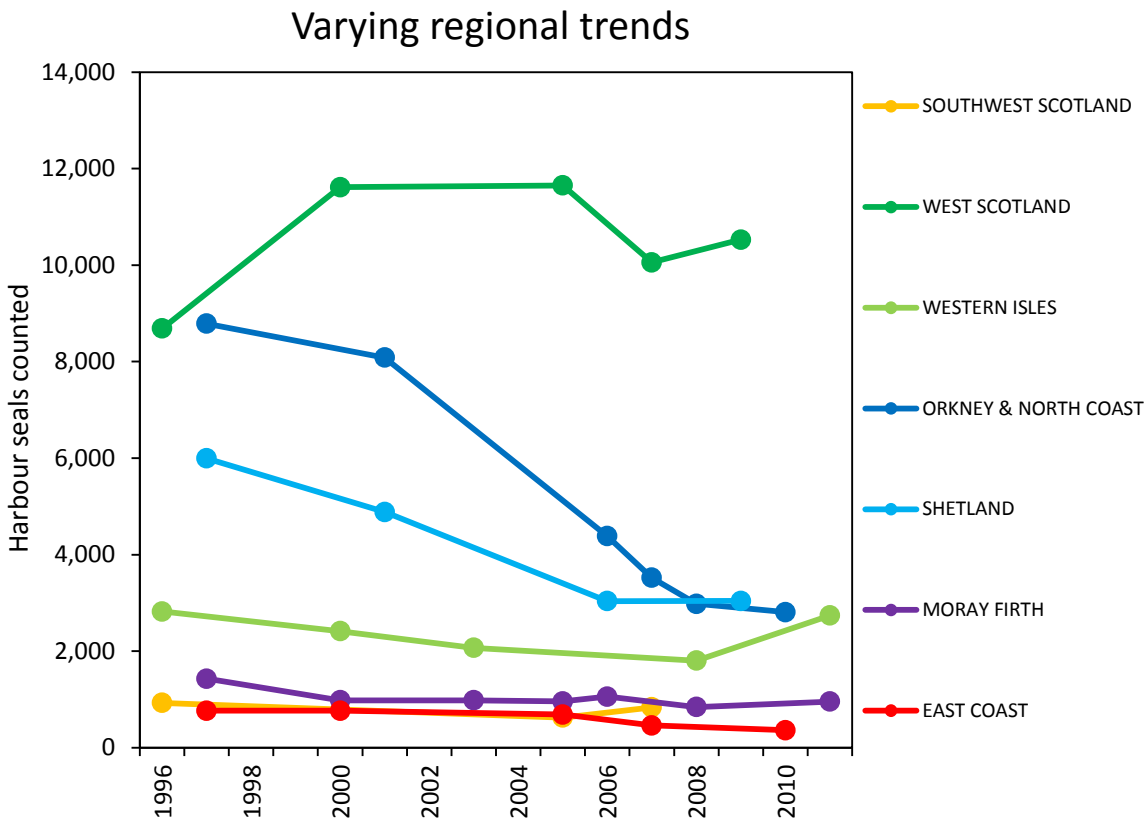
Aug 2007
Aug 2008
Aug 2009
Aug 2010
Aug 2011



Harbour seal counts in Scottish regions

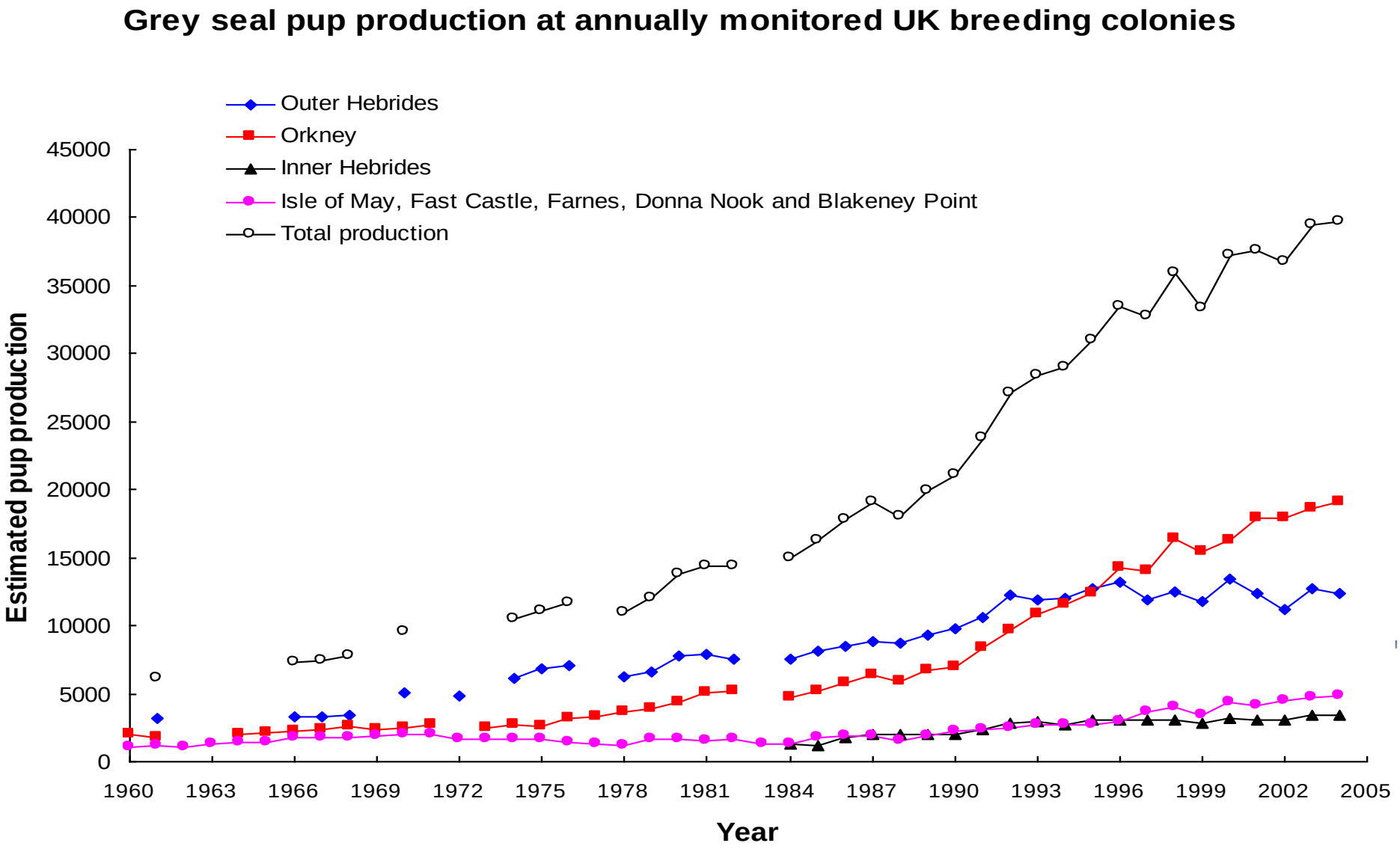
Available at http://www.smru.st-and.ac.uk/documents/1619.pdf





Long-term trends

information and plots available in SCOS reports at http://www.smru.st-andrews.ac.uk/pageset.aspx?psr=411



Harbour seal decline – perception or reality?

- Change in survey methodology?
- Change in behaviour (e.g. change in timing of moult)?
- Displacement from preferred habitat? By competitors or disturbance by humans

- Decrease in fecundity or increase in mortality as a result of:
  - Decreased food availability?
  - Disease?
  - Pollution?
  - Predation?
  - Bycatch?

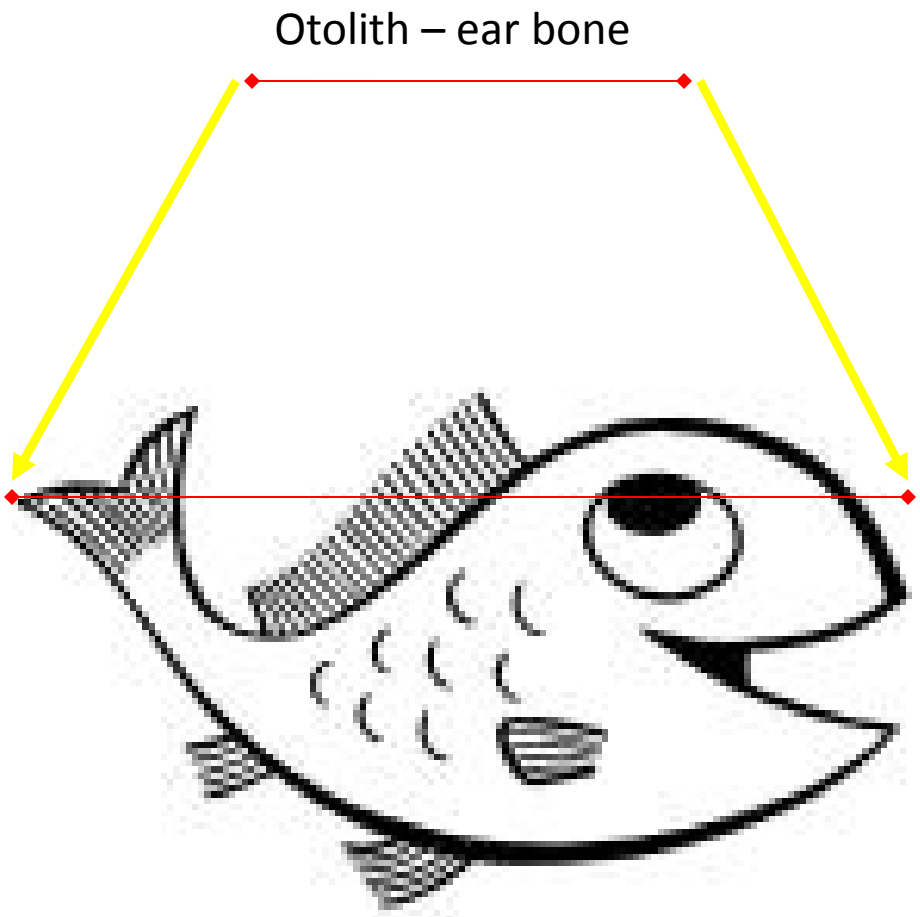
How can we detect what is affecting the population growth rate?

- Through monitoring
  - Health
  - Diet
  - Habitat usage
  - Distributional overlap and responses to human activities
  - Deaths (strandings)

What are they eating?

Otoliths (fish ear bones) from different species of fish are different shapes. Therefore, we can collect and sieve seal scats and find all the otoliths. Using a key we can identify which species of fish the seals have been eating. There is also a relationship between the length of the otolith and the length of the fish, so we can determine size of fish being eaten.

See seal diet fact sheet:
http://www.smru.st-andrews.ac.uk/documents/SealDiet.pdf



Diet composition

Includes more than 50 different prey species, the contribution of each varies seasonally and regionally

North Sea – top 5

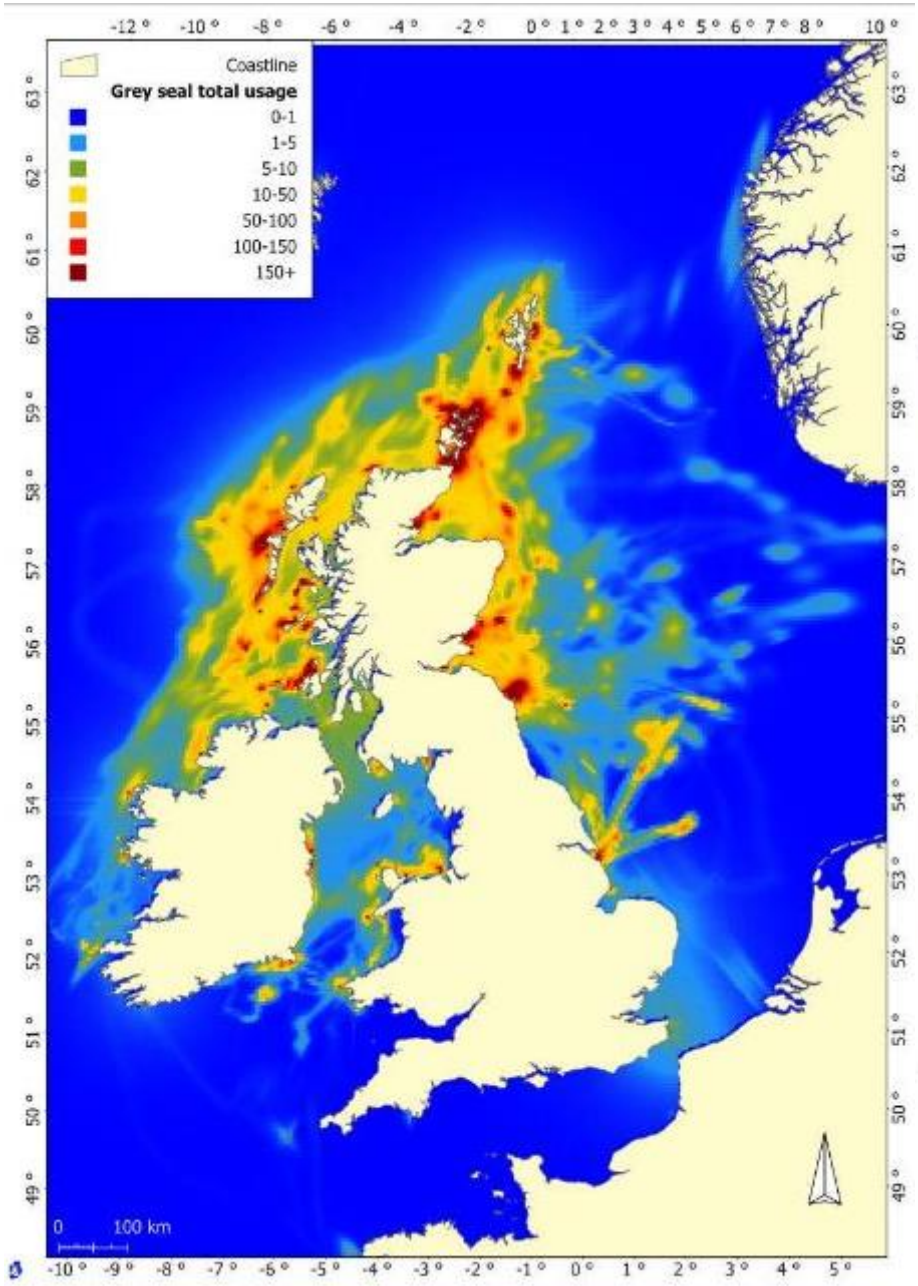
Grey seals	**Harbour seals**
Sandeels	Sandeels
Cod	White fish
Haddock	Flatfish
Sea scorpion	Herring / Sprats
Plaice	Cephalopods

Monitoring habitat usage

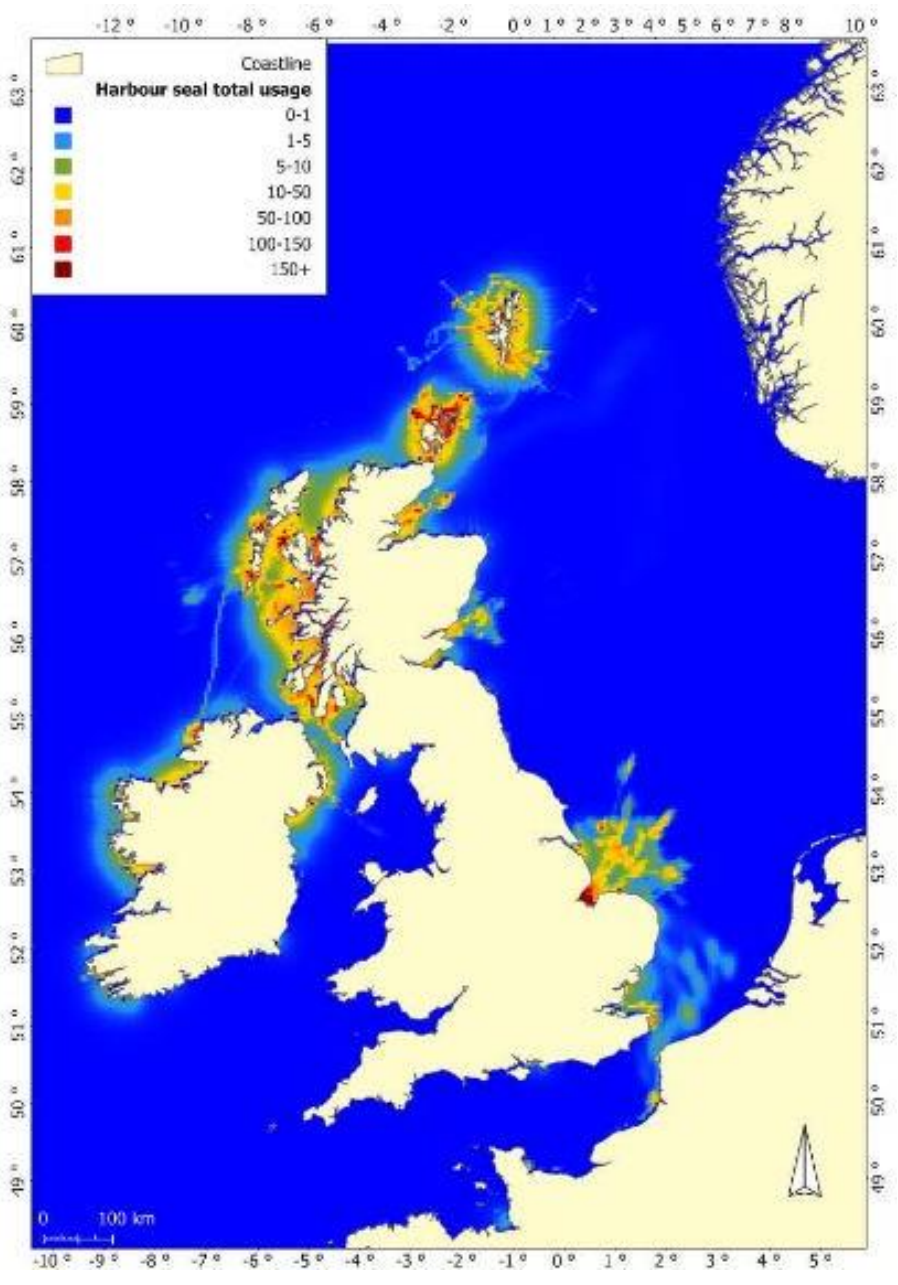
See http://www.smru.st-and.ac.uk/Instrumentation/Overview/
For information on tagging technology and deployments

Available at http://www.smru.st-and.ac.uk/documents/1619.pdf

Grey seal usage



Harbour seal usage



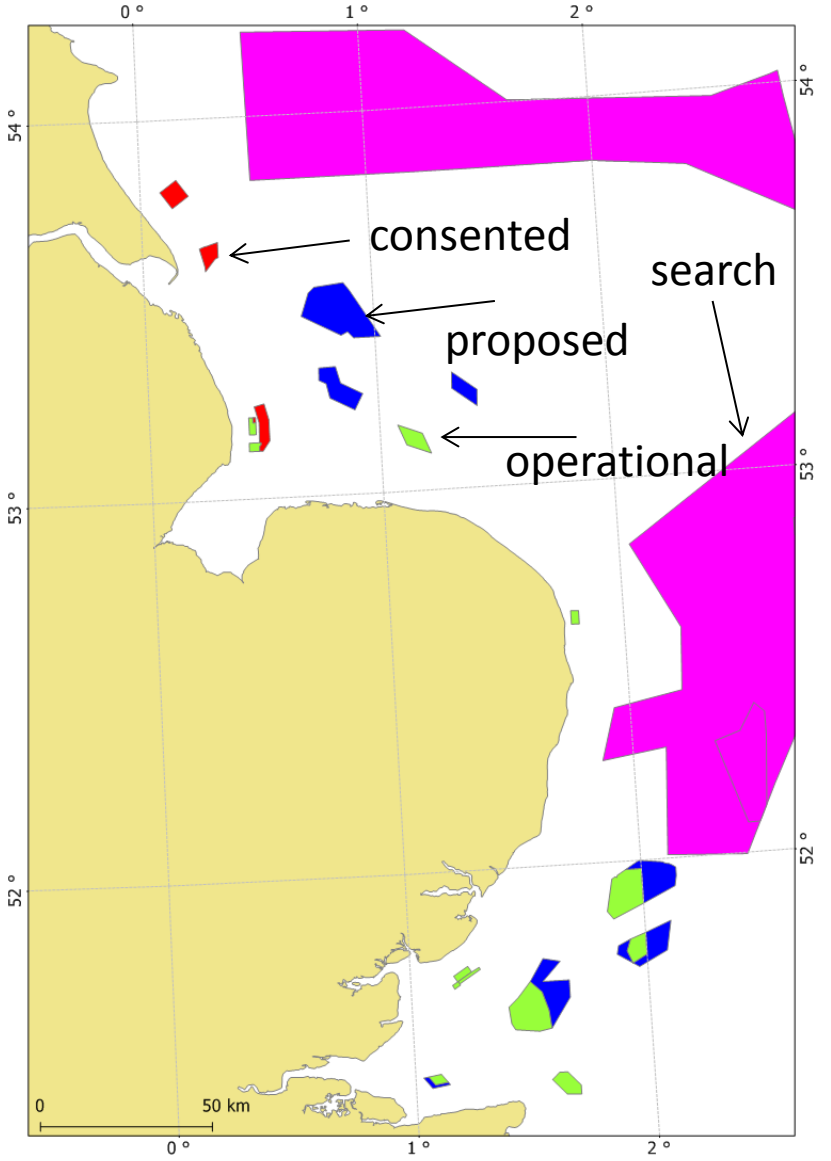
Monitoring responses to man's activities

- Windfarm development
- Main concern is during construction phase – known as pile driving, which creates a lot of noise in the marine environment

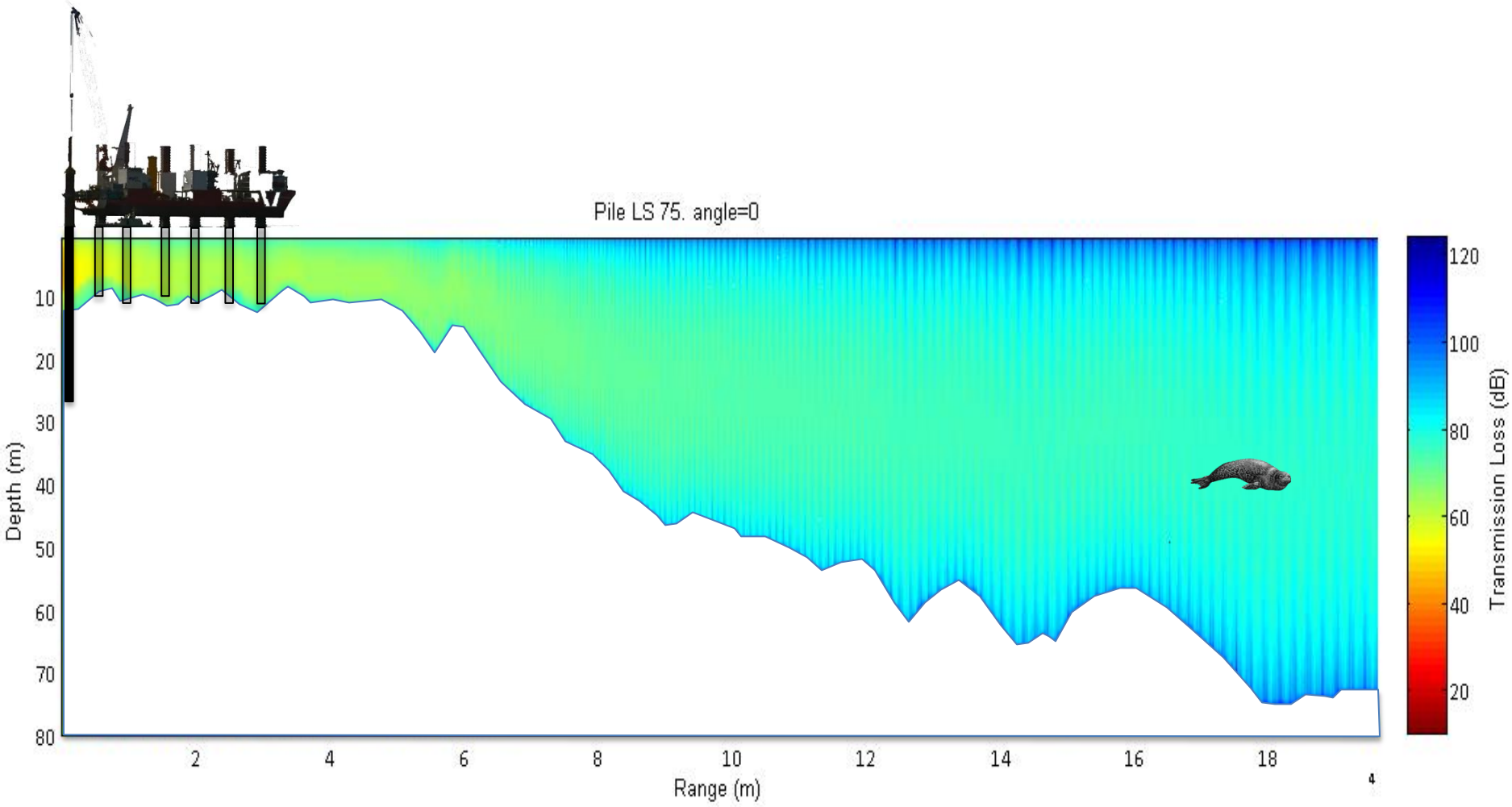
Example from 2012

- Wash, SE England
  - High and increasing harbour seal population
  - Special Area of Conservation (SAC)
  - Historic tracking data
    - 24 seals tracked with tags (2003-2005)
  - Wind farms
    - Lincs (under construction)
    - Sheringham Shoal (partially operational)

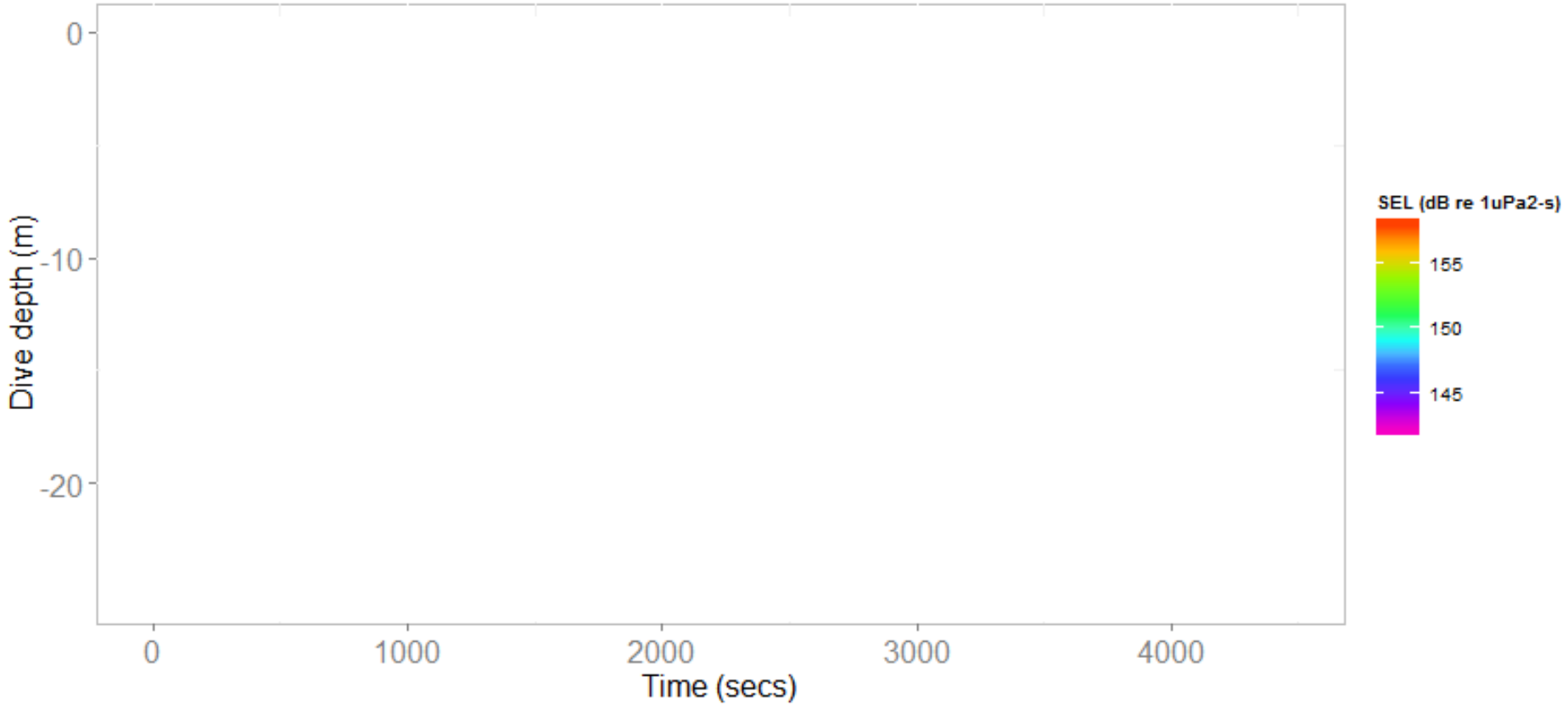
- 2012
  - 24 seals tracked with tags



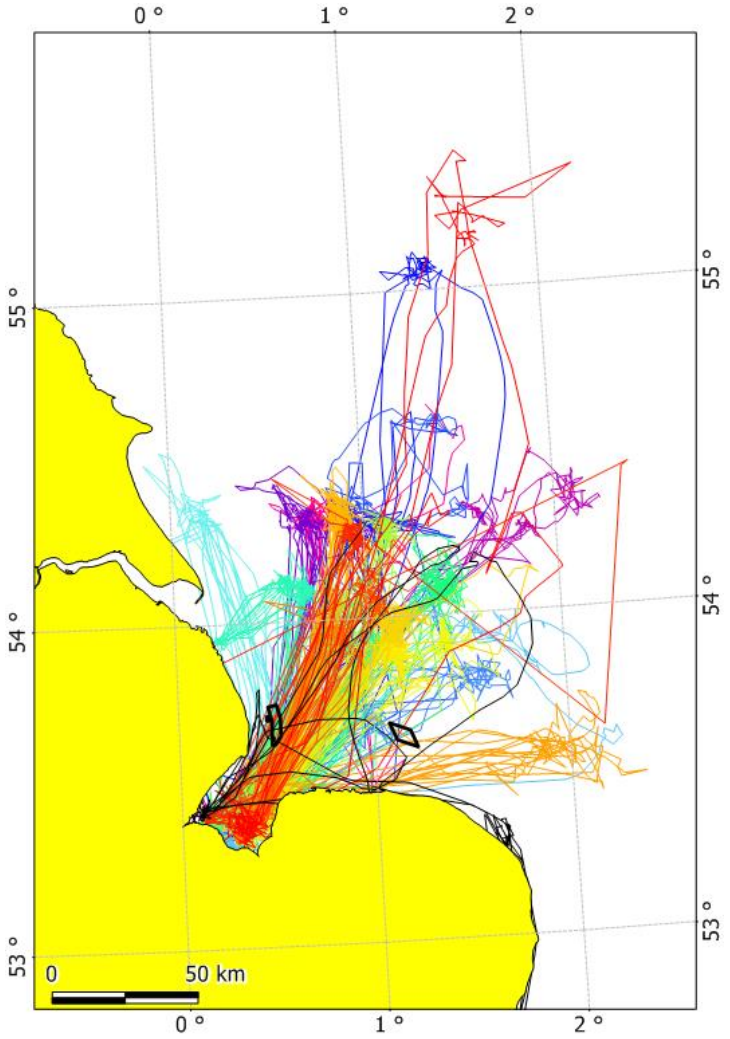
Modelling sound levels during piling



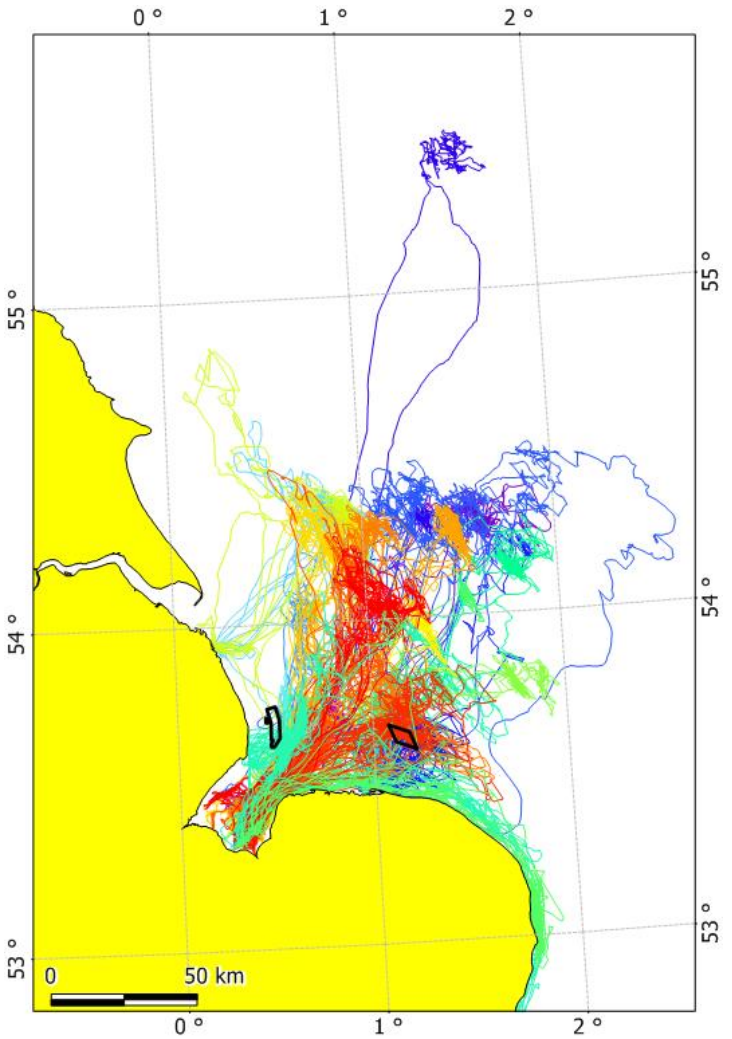
Integrating Received Levels and seals



Historic (2003-2005)



Current (2012)



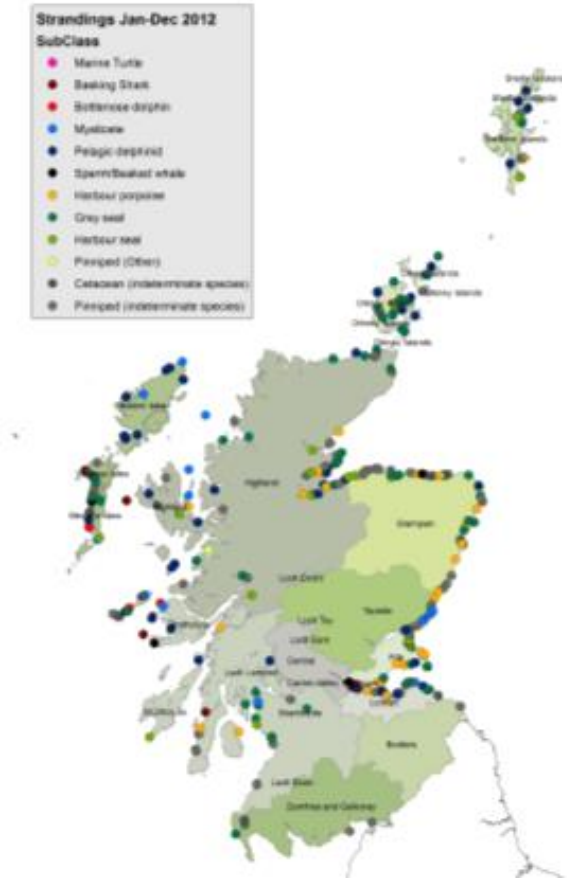
Conclusions

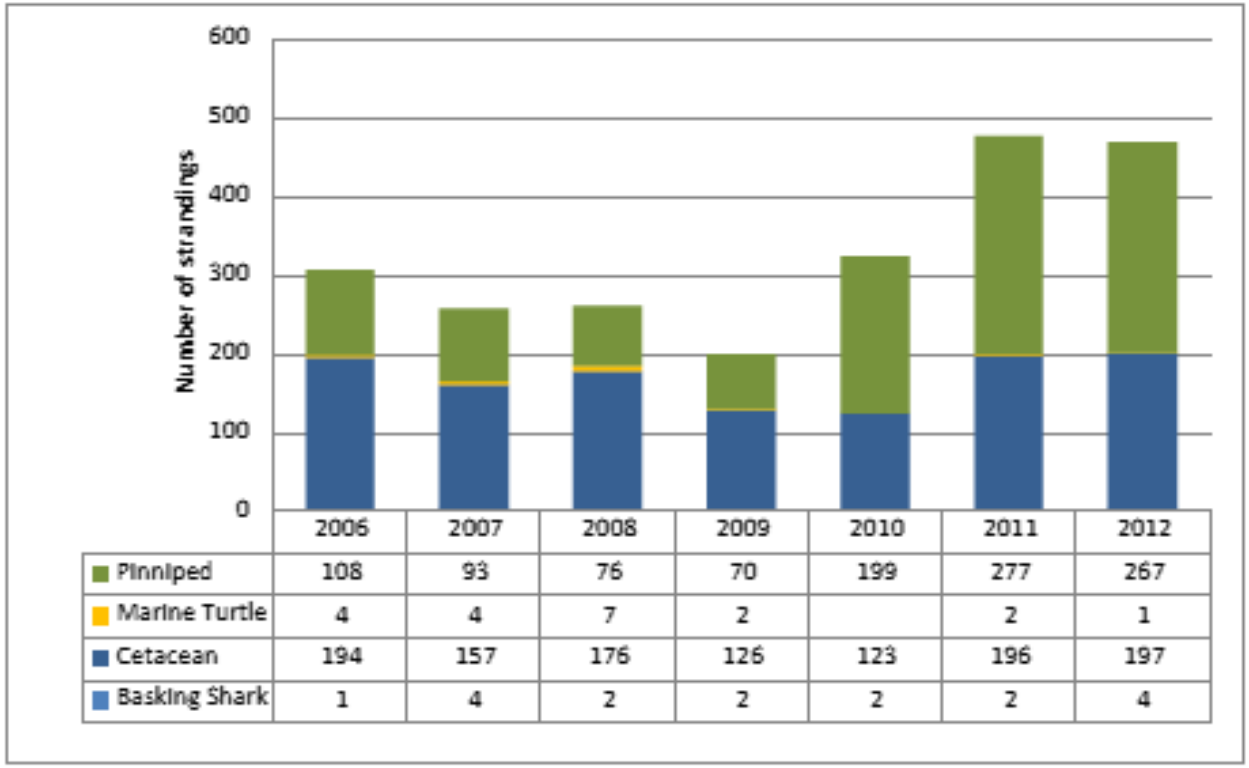
- During wind farm construction
  - No dramatic or large scale change in at-sea distribution
    - Historically and 2012
    - Non-piling and piling

- Comparison to data on hearing ability of seals suggests that around half of the seals may have suffered permanent hearing damage

Monitoring strandings

- Scottish Marine Animal Stranding Scheme



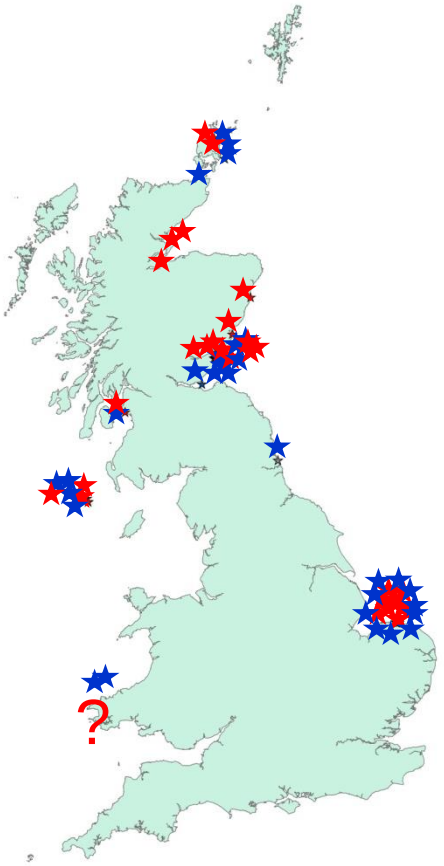


	2006	2007	2008	2009	2010	2011	2012
Pinniped	108	93	76	70	199	277	267
Marine Turtle	4	4	7	2		2	1
Cetacean	194	157	176	126	123	196	197
Basking Shark	1	4	2	2	2	2	4

http://www.strandings.org/images/SMASS_Annual_Report_2012.pdf

Corkscrew seals – investigating unusual deaths

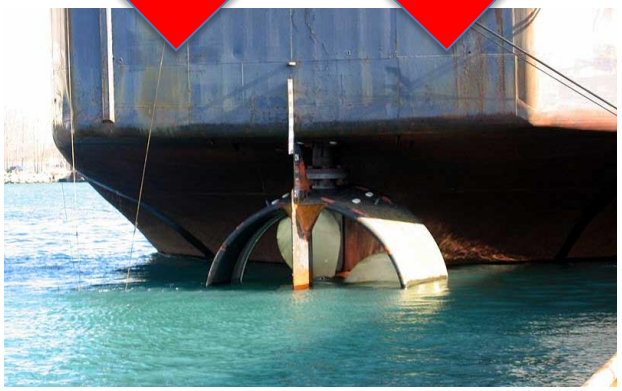
Single smooth-edged cut starts at head and spirals around body (all clockwise)



Report available on SMRU website: http://www.smru.st-andrews.ac.uk
and additional information available at http://www.strandings.org/
and http://www.smru.st-and.ac.uk/documents/1619.pdf

Possible causes:

- Natural (predator)
- Man-made (deliberate)
- Man-made (accidental)



The only candidate mechanism that fits is a rotating blade within a confined space e.g. a tunnel or cowling.

The only such devices available at widely dispersed stranding locations are ducted propellers on ships.

- Kort Nozzles

- DP Azimuth thruster
- Tunnel thruster – bow or stern thruster


DALMENY
LEITH
DALMENY


Ballast Nedam


MarineTraffic.com

SVANEN


subsea7
ACERGY DISCOVERY
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However, cause remains speculative until either

- a seal is observed being killed by a device

or

- there is a clear demonstration that such wounds can be inflicted on seals by some specific device or range of devices.

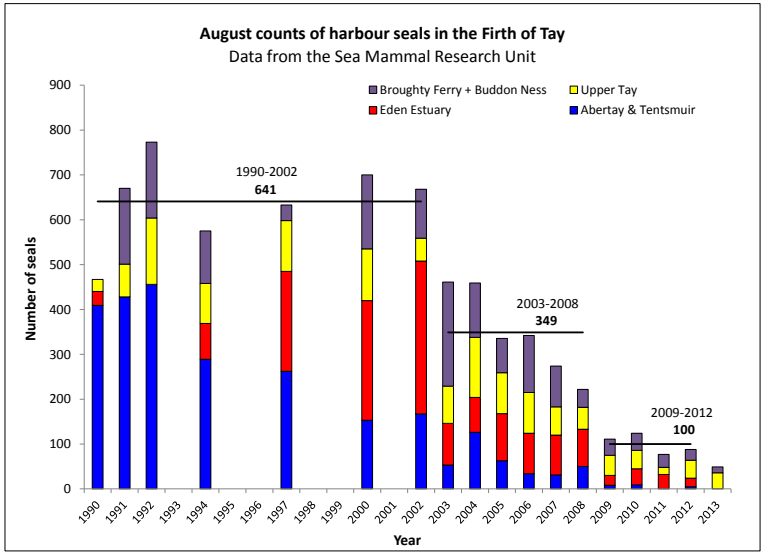
- Tests been conducted in test facility with model seals, results are convincing.

- Still don’t know why seals are attracted to these devices – are the sounds made by these propellers interesting to the seals? Doing some playback experiments to look at seal responses to different types of sounds.

Does it matter?

Are observed mortalities sufficient to explain population changes?

- Simple answer – don't know…
- Unlikely that we're seeing all deaths, impossible to know proportion washing ashore



Plot available at http://www.smru.st-and.ac.uk/documents/1619.pdf

- BUT given local declines e.g. in St Andrews Bay and Firth of Tay, the current observed levels of mortality are not sustainable

Summary

- Important to monitor status of wildlife populations (numbers and health), particularly to assess any effects of human activities
- Need to carefully consider most appropriate and effective method for producing accurate and reliable population estimates (i.e. low uncertainty)
- There can be many factors influencing population growth rate.
- All factors should be considered in combination rather than isolation.

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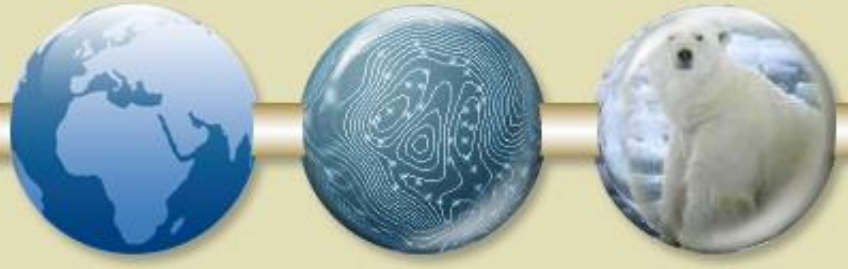

- Thanks to all my colleagues at CREEM and SMRU for providing material on their research
- A wide array of government, industry and research council funders

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- To find out more about the work carried out by CREEM and SMRU visit
  - http://www.smru.st-andrews.ac.uk/
  - http://creem2.st-andrews.ac.uk/
- To find out more about my current project visit:
  - http://www.creem.st-and.ac.uk/mocha/