Use of population models to assess the impact of additional mortality

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Project in progress....

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DUTCH GOVERNMENTAL OFFSHORE WIND ECOLOGICAL PROGRAMME

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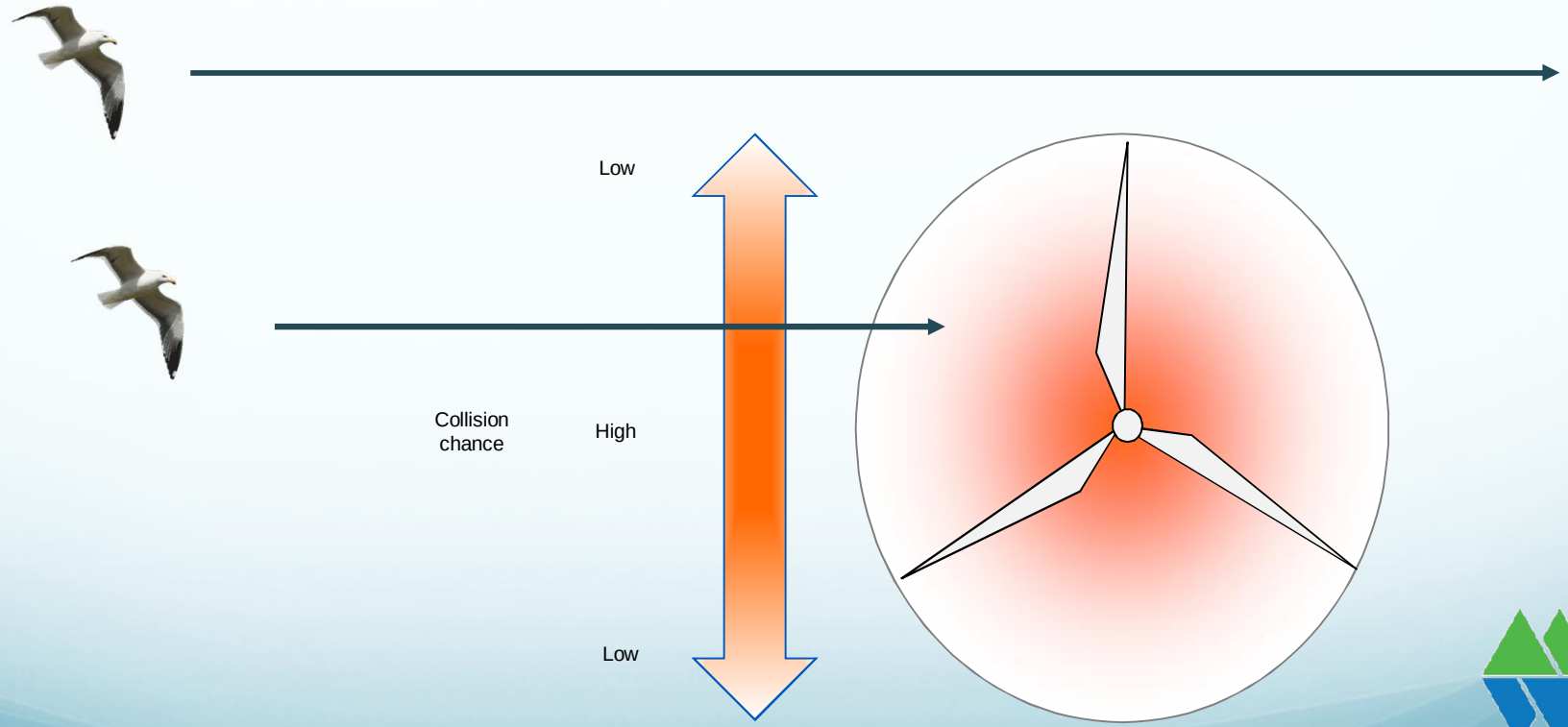
Overview

- Background
  - Collision risk modelling (CRM)
  - Kader Ecologie en Cumulatie (KEC)

- Population modelling approach
  - General introduction matrix models
  - Species-specific population models
  - Assessing effects of additional mortality on population level

CRM

- SOSS Band model (2012)



KEC framework (Rijkswaterstaat 2015)

- Impact assessment
- Southern North Sea
- Density predictions
  - ESAS
  - MWTL
- Mortality rates

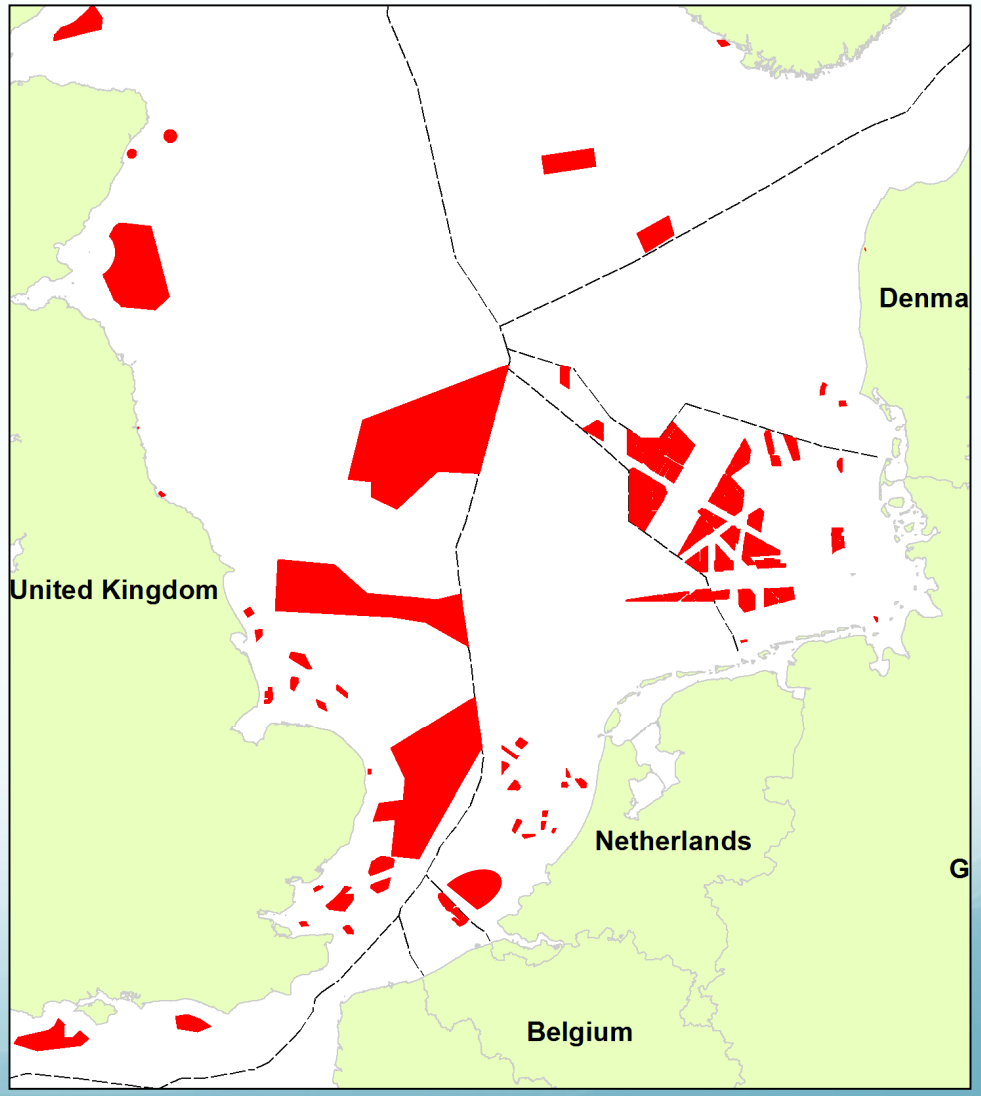


*Table 4.23. Total number of collisions per **seabird species** in the southern North Sea, compared with the applicable Potential Biological Removal level (based on the status of the population, see Annex D4) and the Ornis committee criterion of 1% of the annual mortality. This criterion is used to determine whether the calculated number of victims can be regarded as a true impact in terms of increased mortality. In the last column those species are indicated with green of which the number of collision victims is below this 1% of the annual mortality and for these species the number of collision has no impact on the populations. In the third column the percentage is presented of the total number of collision victims relative to the PBR level. For the species for which the percentage are above 100 % are indicated with red and above 10% with orange.*

Species	Total n collisions southern North Sea	applicable PBR	% collision/PBR	Ornis criterion 1% of annual mortality	% collision/1% annual mortality
Common Eider	1735	22082	7,86%	293	592,15%
Common Scoter	13	27730	0,05%	1167	1,11%
Velvet Scoter	0	408	0,00%	50	0,00%
Loon spec.	130	1550	8,39%	53	245,28%
Great Crested Grebe	1	10705	0,01%	402	0,25%
Northern Fulmar	8	5934	0,13%	99	8,08%
Sooty Shearwater	0	++	-	-	-
Manx Shearwater	0	++	-	-	-
European Storm Petrel	0	++	-	-	-
Leach's Storm Petrel	0	++	-	-	-
Northern Gannet	2631	5245	50,16%	143	1839,86%
Great Cormorant	3	4919	0,06%	144	2,08%
European Shag	0	++	-	-	-
Parasitic Jaeger	2	812	0,25%	28	7,14%
Great Skua	12	120	10,00%	5	240,00%
Black-headed Gull	43	58986	0,07%	1180	3,64%
Little Gull	295	3971	7,43%	139	212,23%
Mew Gull	1524	22534	6,76%	724	210,50%
Lesser Black-backed Gull	23674	7560	313,15%	220	10760,91%
European Herring Gull	3381	4184	80,81%	531	636,72%
Great Black-backed Gull	5441	4144	131,30%	107	5085,05%
Black-legged Kittiwake	5930	16473	36,00%	493	1202,84%
Little Tern	1	39	2,56%	5	20,00%
Sandwich Tern	133	2378	5,59%	52	255,77%
Tern spec.	288	10076	2,86%	295	97,63%
Common Murre	13	26641	0,05%	681	1,91%
Razorbill	29	7129	0,41%	249	11,65%
Little Auk	1	++	-	-	-
Atlantic Puffin	0	++	-	-	-

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

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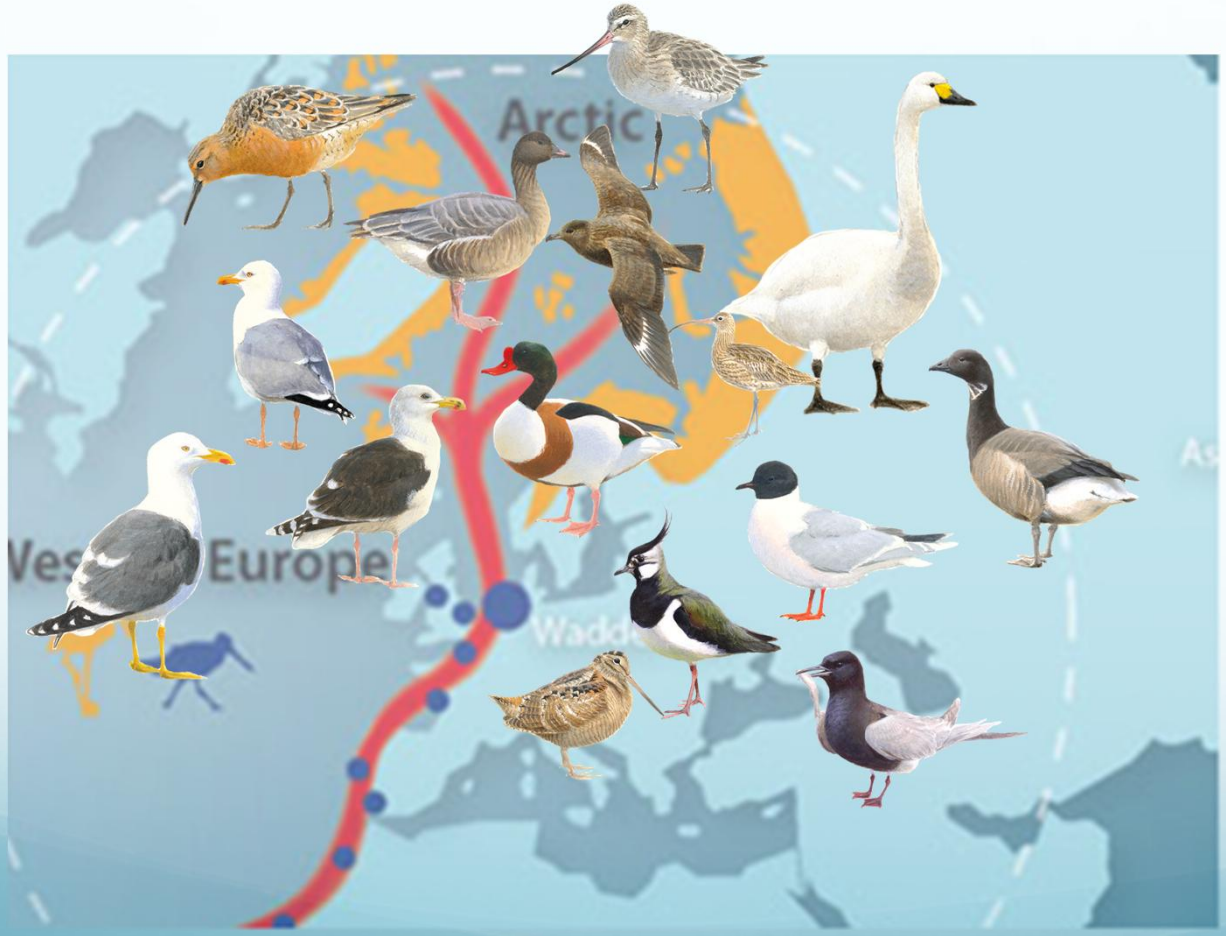
- Review of tracking data (Gyimesi *et al.* 2017)



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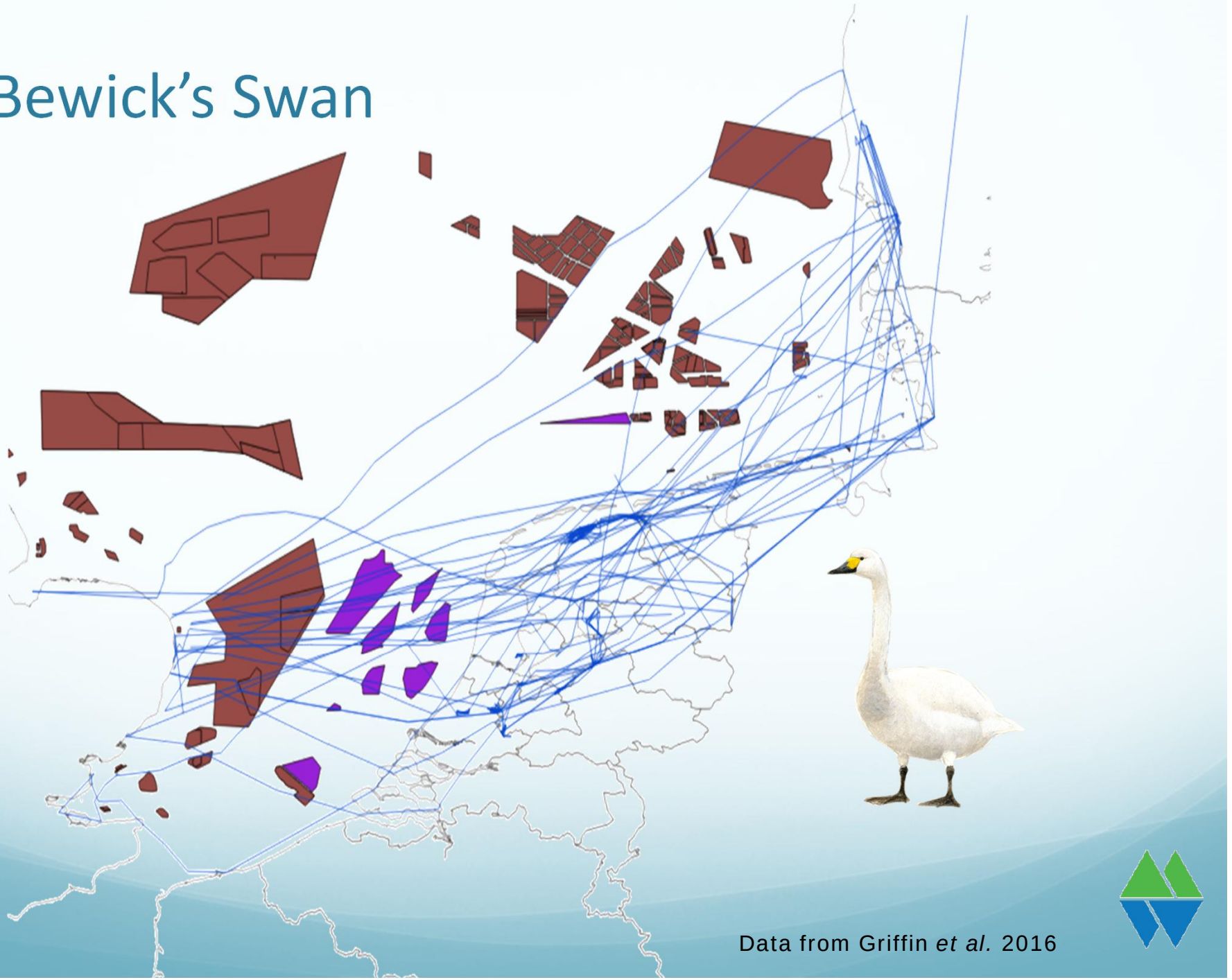
Bewick's Swan



Data from Griffin *et al.* 2016

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- Review of tracking data
- Improved CRM output (and mortality habitat loss – Tobias)

  but…
- Questions regarding PBR
- Effects on population level via population modelling

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Population-level impact

- Aim:
  - Assessing the impact on the population level

Life history strategies:

Slow --- Fast

Wandering albatross

Blue tit

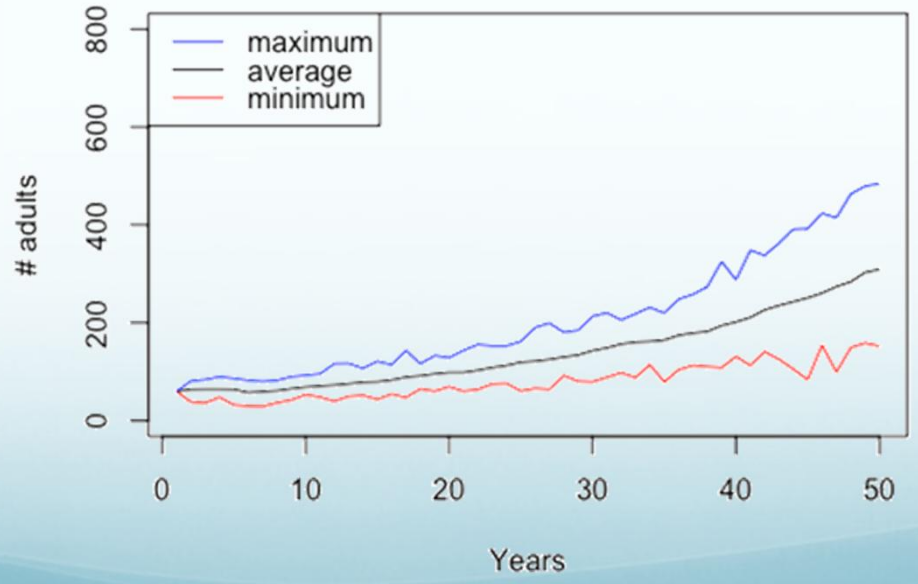
Population-level impact

- Aim:
  - Assessing the impact on the population level

- Approach:
  - Population model
  - Add additional mortality:
    - Turbine collisions: based on KEC-estimates
    - Habitat loss: based on habitat model and energy budget model

Population model

- Matrix models
- Widely used in conservation ecology
  - Project population trend



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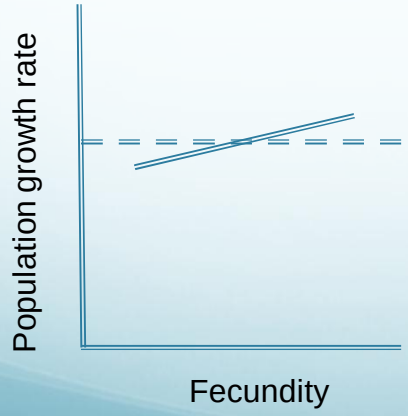
  - Identify potential threats
  - Assess the sensitivity of the population trend to changes in different parameters



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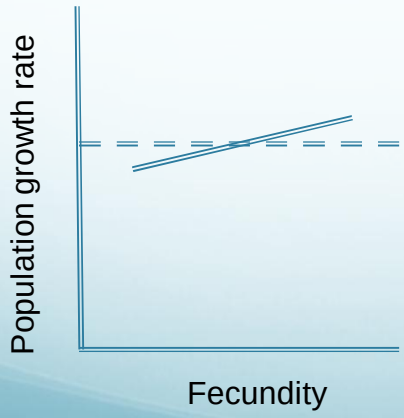
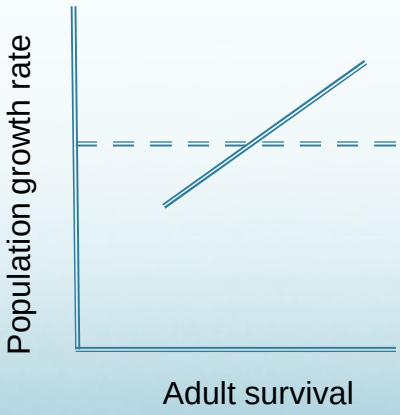
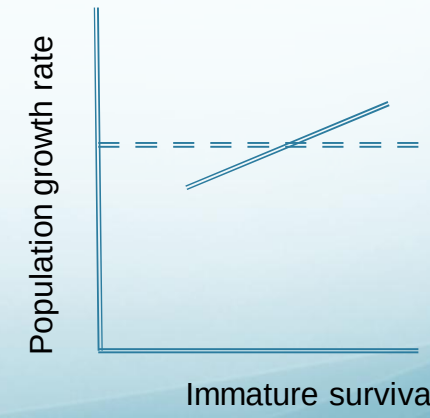






Population model

- Matrix models
- Widely used in conservation ecology
  - Project population trend
  - Identify potential threats
  - Assess the sensitivity of the population trend to changes in different parameters
    - Predict efficiency of different management strategies

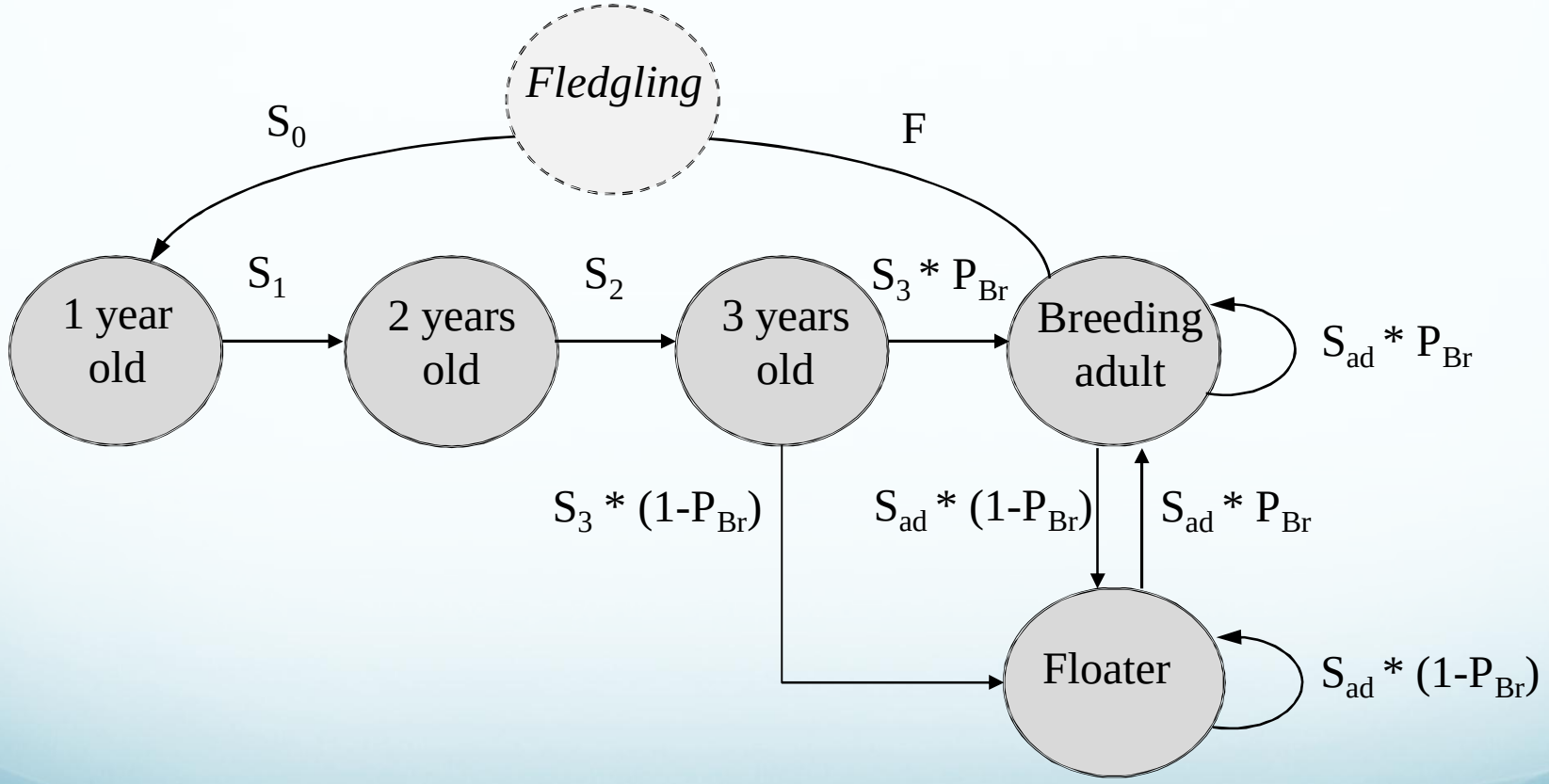
Population model

- Matrix models
- Widely used in conservation ecology
- Age- or stage-based; only females

Population model

Population model

- Example, time step is 1 year, pre-breeding census



Population model

- Example

1) Initial population

year 1

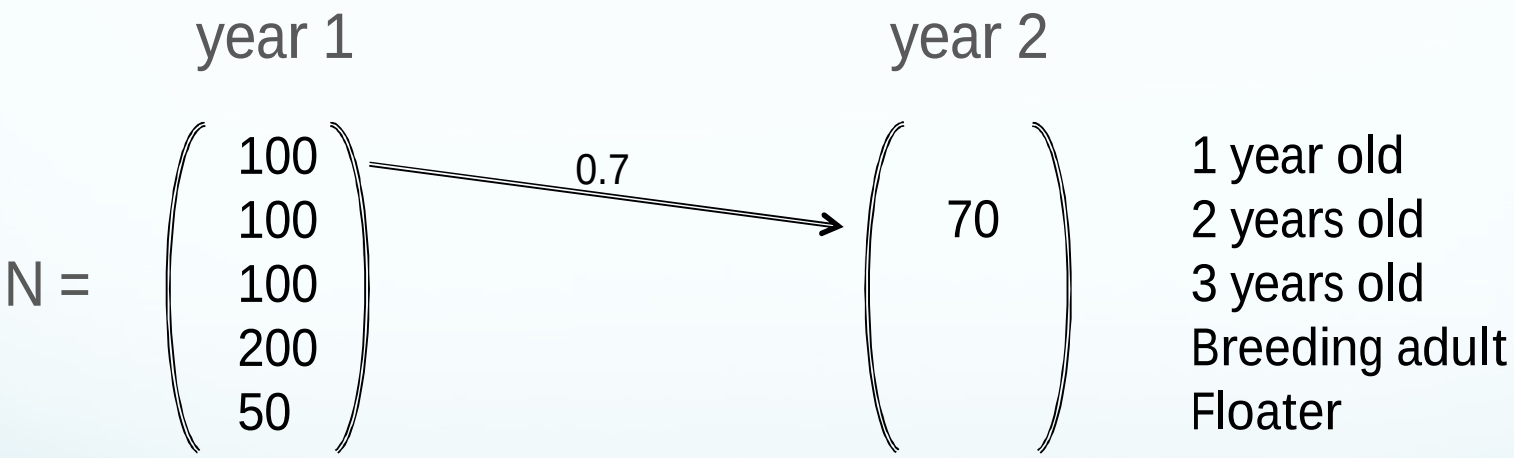
$$N = \begin{pmatrix} 100 \\ 100 \\ 100 \\ 200 \\ 50 \end{pmatrix}$$

1 year old
2 years old
3 years old
Breeding adult
Floater

Population model

- Example

1) Initial population; 2) Survival



Population model

- Example

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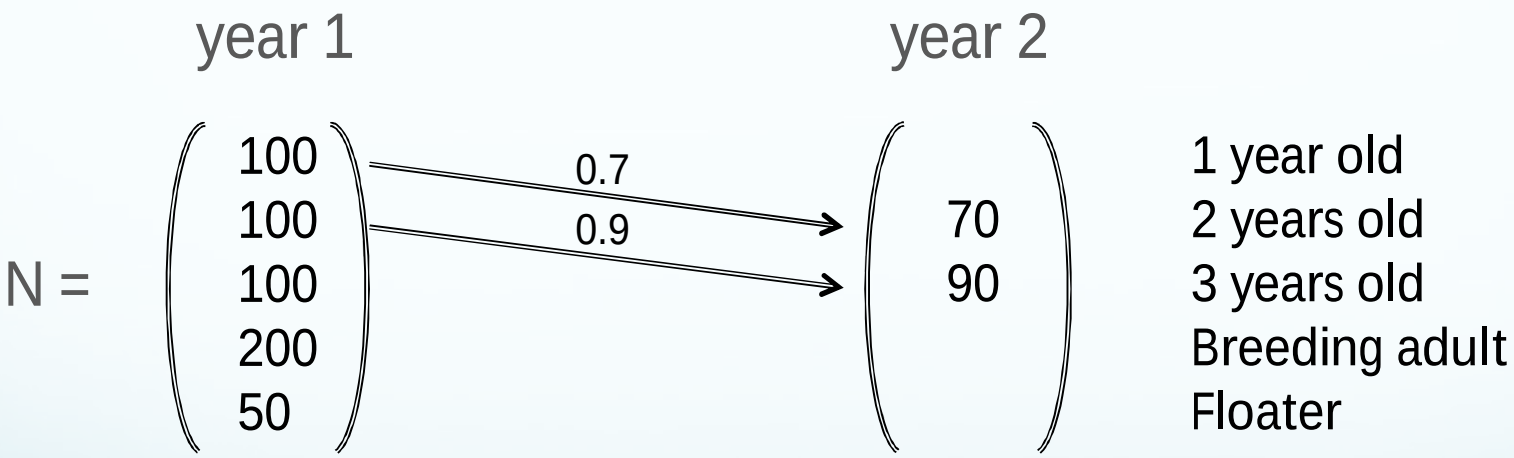

Population model

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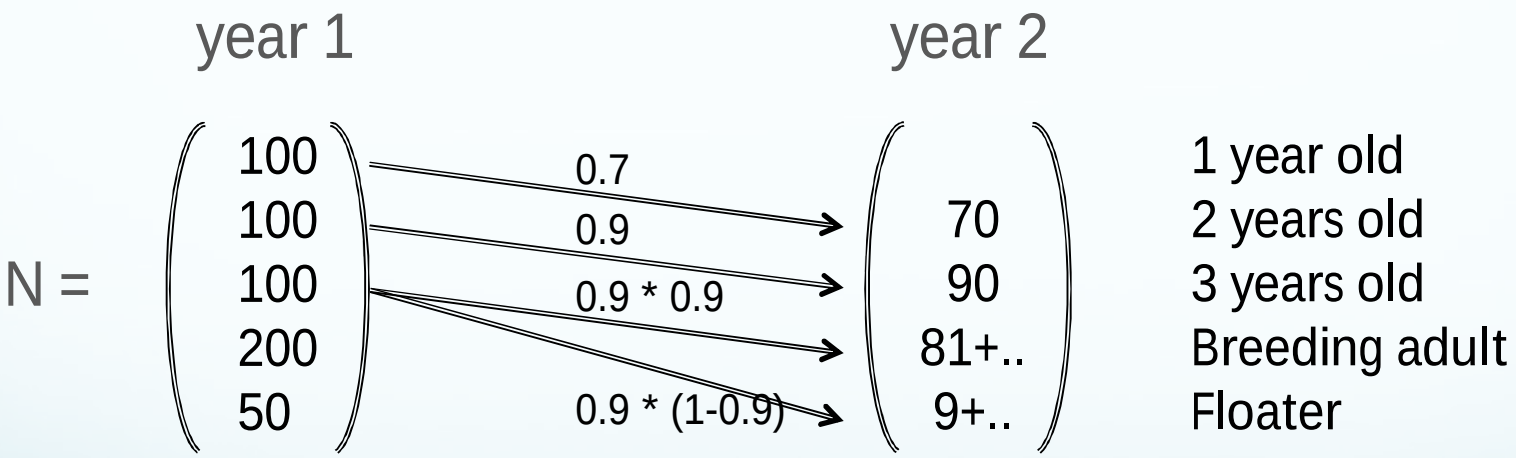

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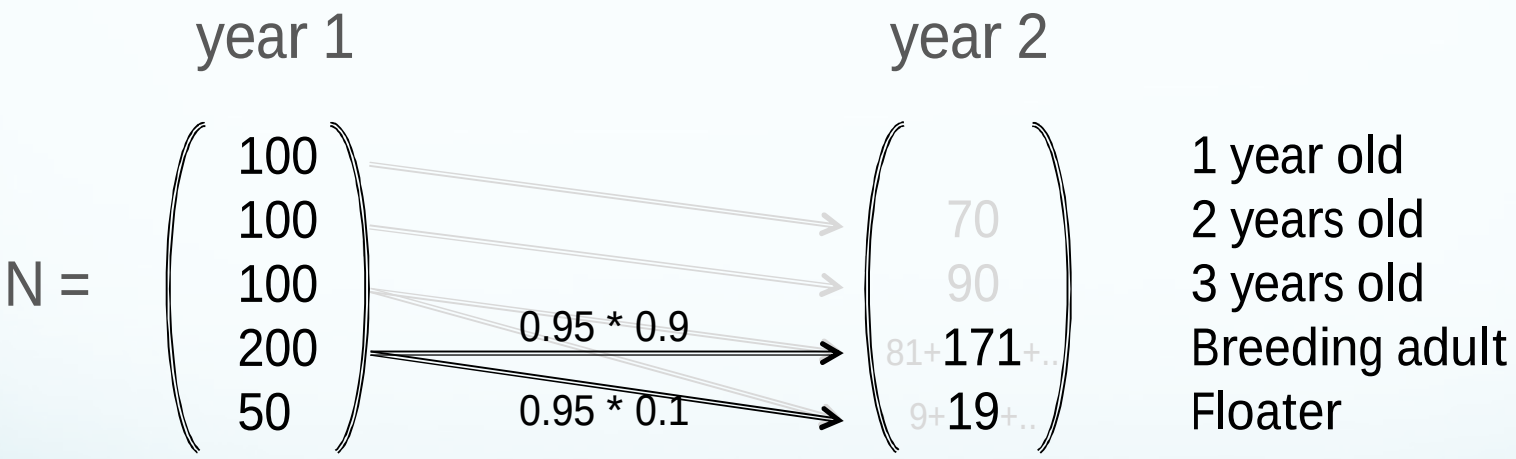
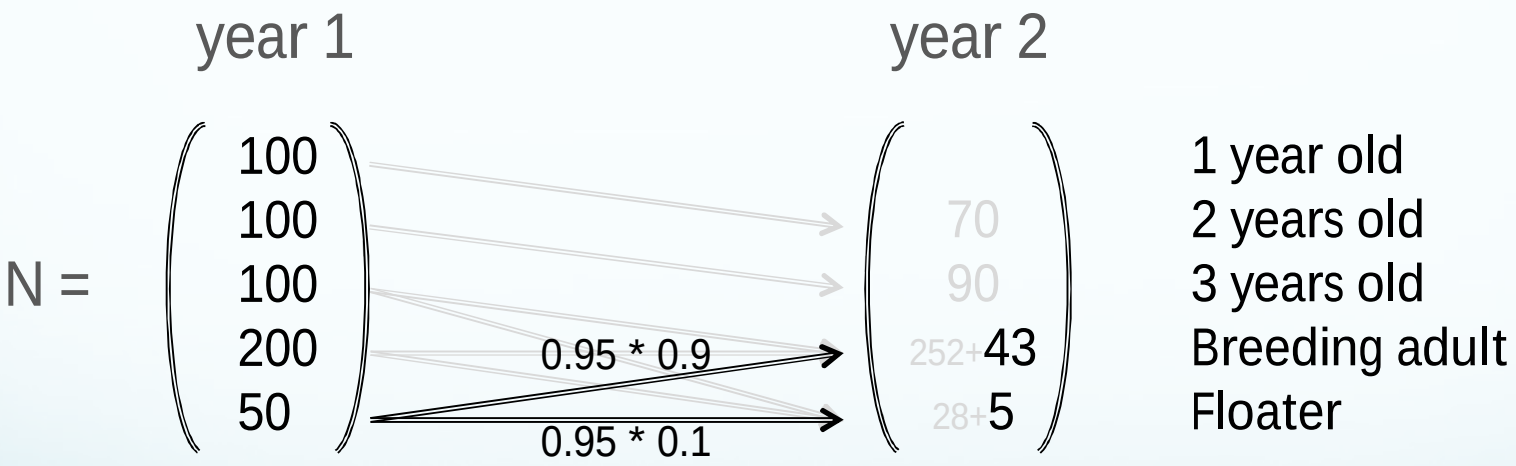


Population model

- Example

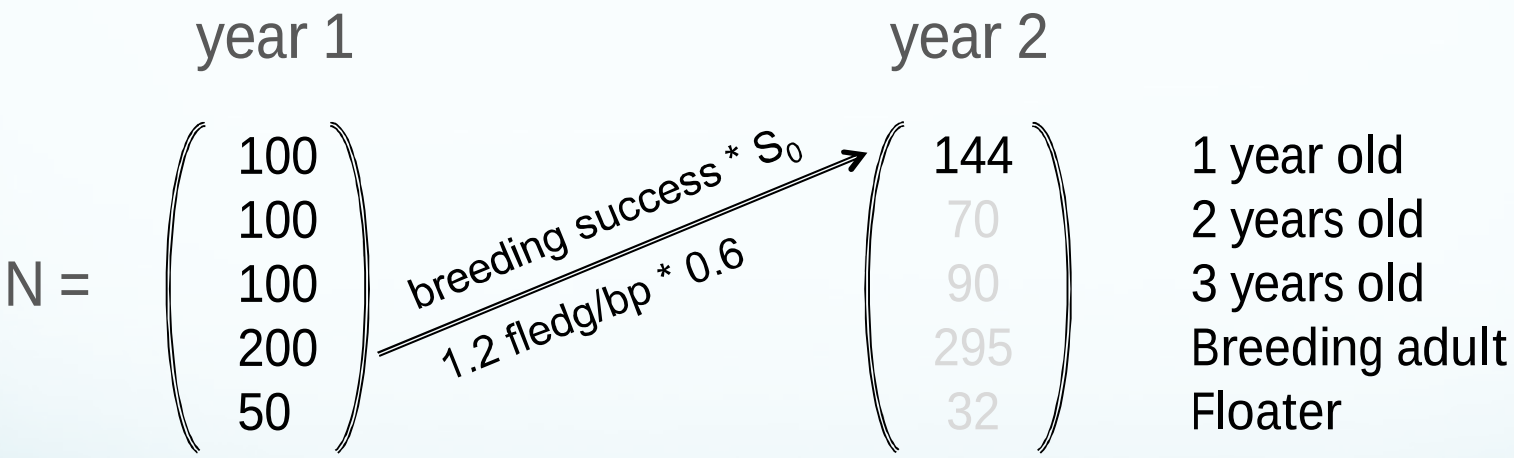
1) Initial population; 2) Survival



Population model

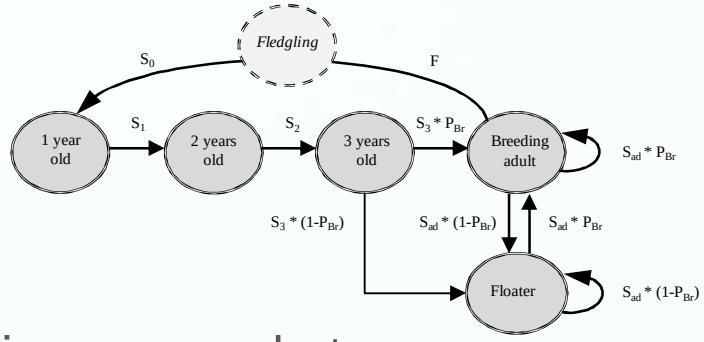
- Example

1) Initial population; 2) Survival; 3) Reproduction



Species-specific population model

1. Model structure
   - Age of first breeding
     - Kittiwake, Herring gull: 4
     - Great skua: 7
   - Incorporation of floaters; proportion can vary between years



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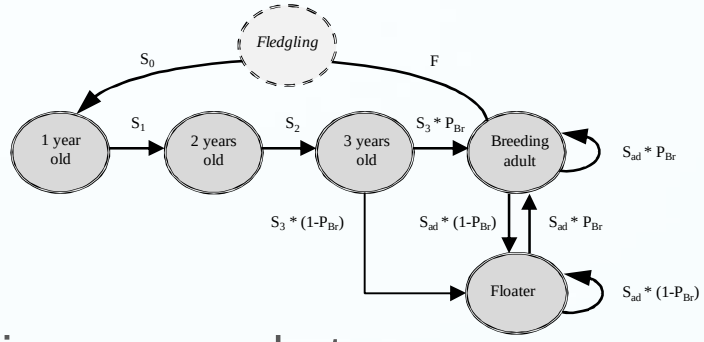

2. Defining input parameters
   - Survival: S_0, S_1, S_2, S_3, S_{ad}
   - Reproduction: F, P_{Br}
   - Stochasticity: variation between years (and runs)
   - Uncertainty
   - Density dependence

Species-specific population model

- Variation between years: stochasticity
  - ‘Good’ and ‘Bad’ years

Species-specific population model

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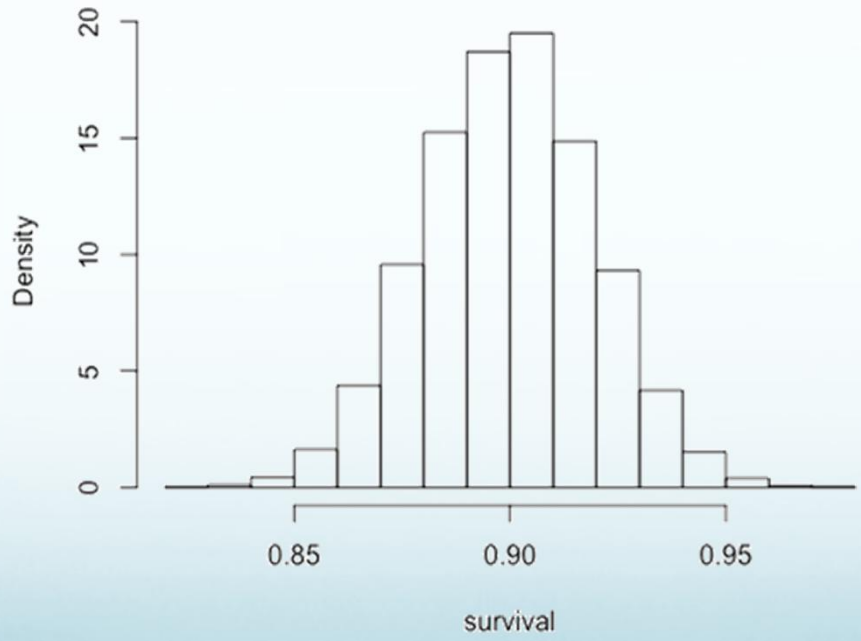

mean: 0.9
sd: 0.02

Species-specific population model

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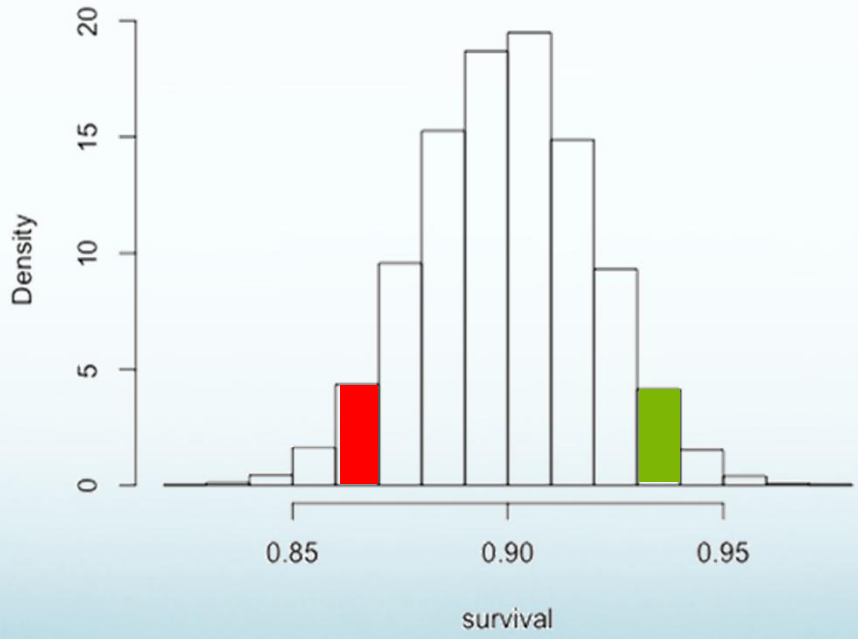

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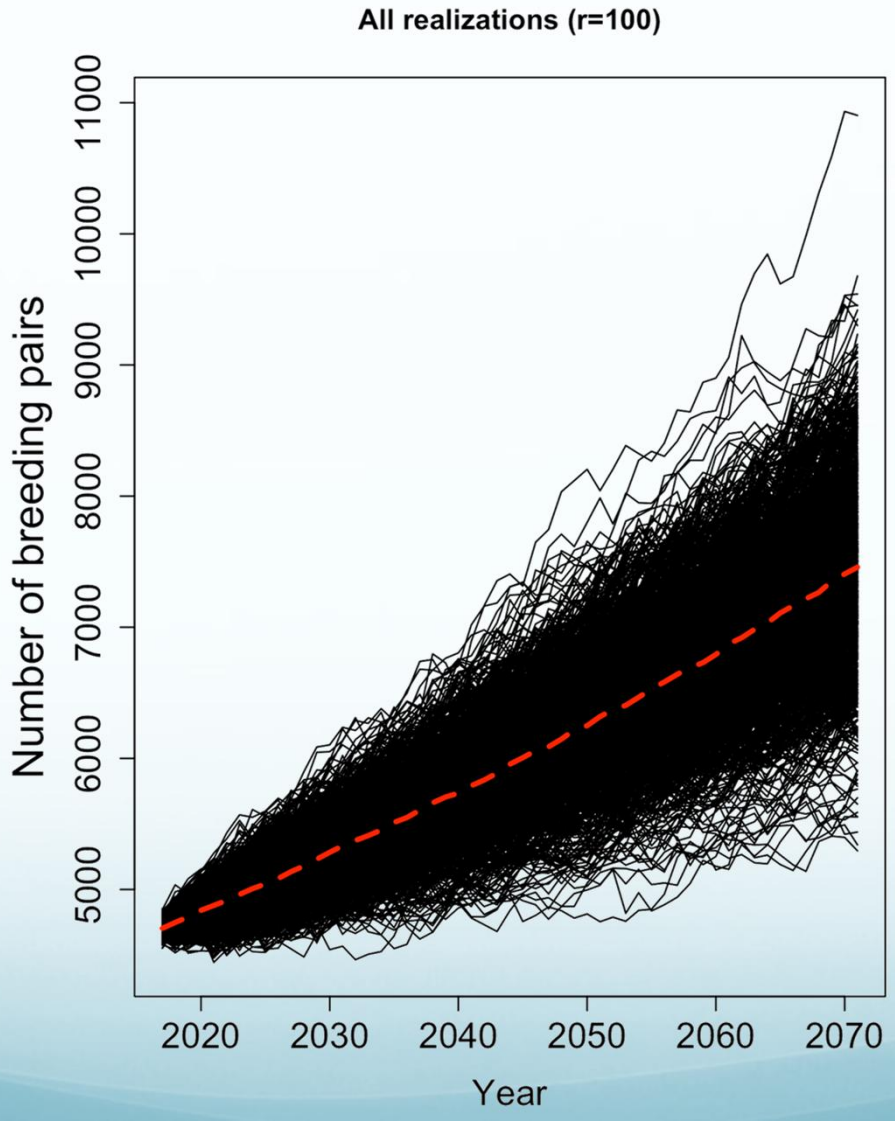
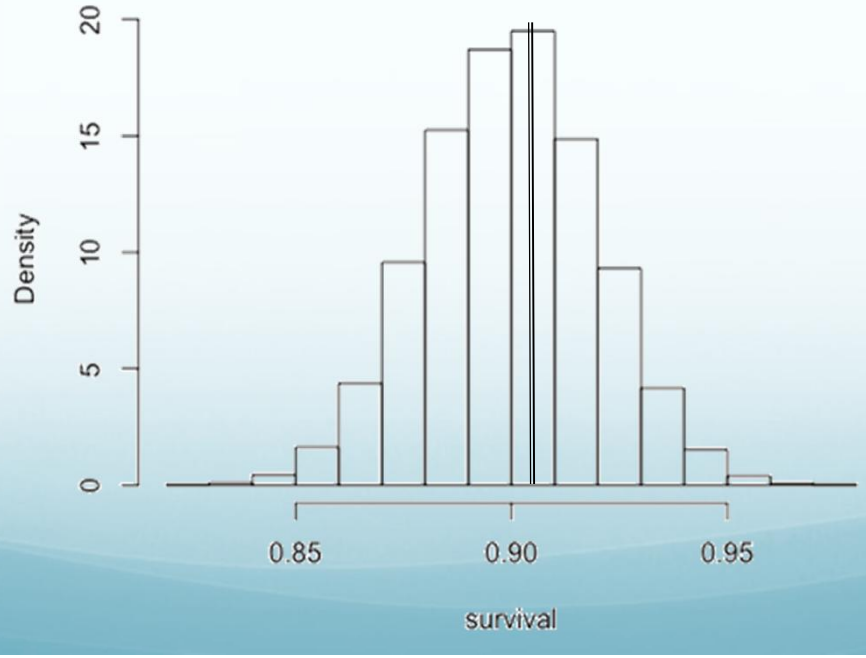


Species-specific population model

- Variation between years: stochasticity
  - ‘Good’ and ‘Bad’ years
- Uncertainty in parameters
  - Quality of data; Standard error



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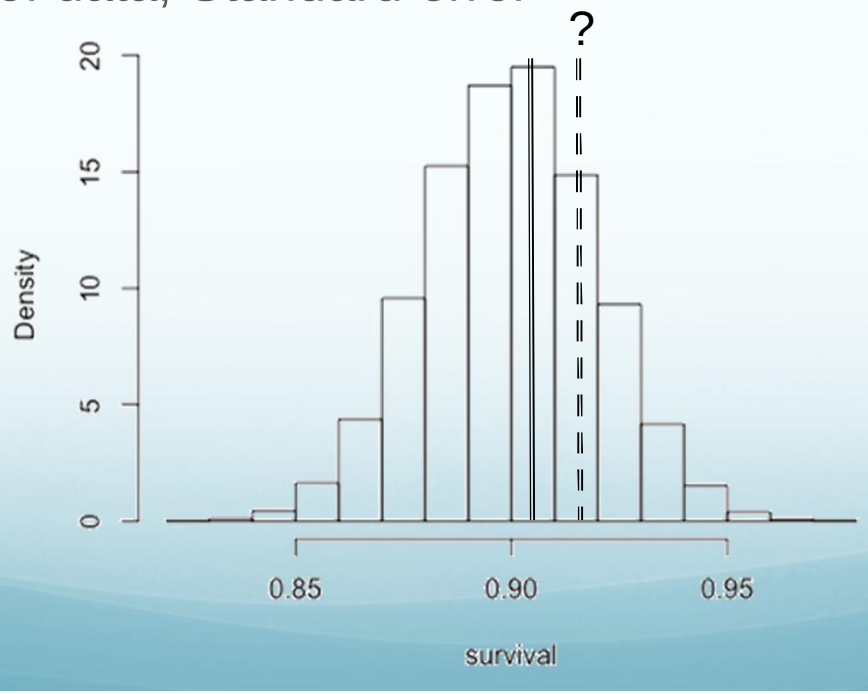


Species-specific population model

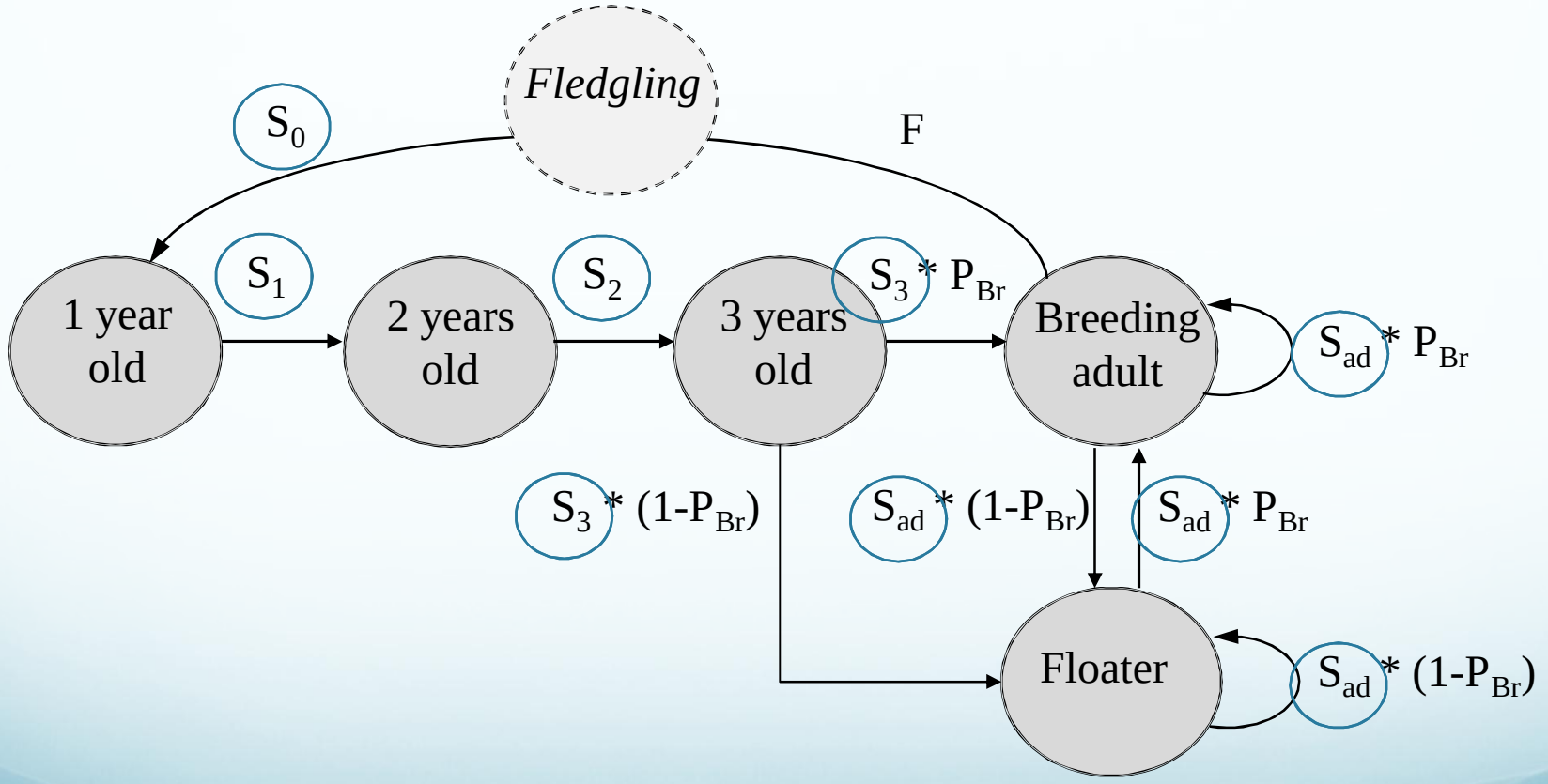
- Variation between years: stochasticity
  - ‘Good’ and ‘Bad’ years
- Uncertainty in parameters
  - Quality of data; Standard error
  - Sensitivity of population trend to input parameters

Additional mortality

	Institute	Source of estimates
Collision mortality	BuWa	KEC
Mortality due to habitat displacement	WMR	Habitat model, energy budget model

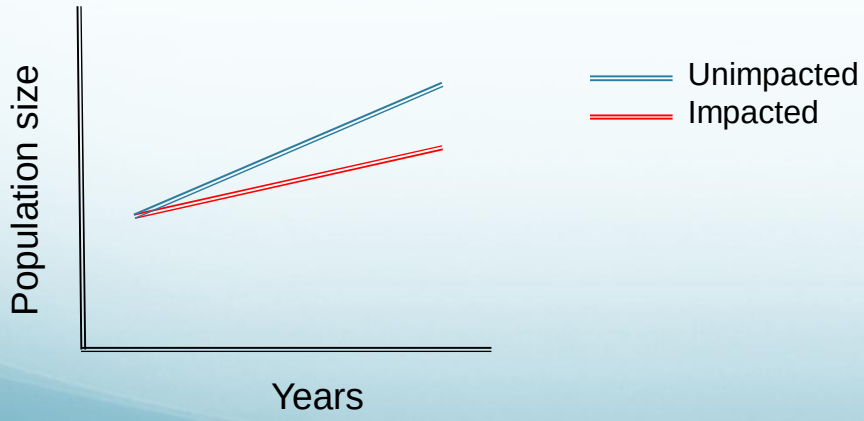
Note: different species

Additional mortality



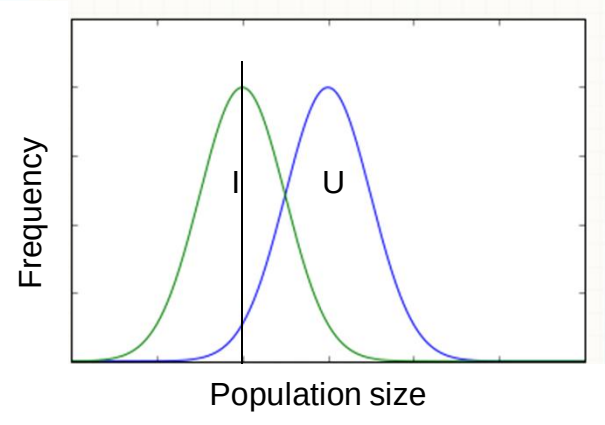
Population model

- Examples model output:
  - Average population trend with vs. without impact
  - Average population size after 50 years



Population model

- Examples model output:
  - Average population trend with vs. without impact
  - Average population size after 50 years
  - Comparison of distribution impacted vs. un-impacted population size



I: Impacted
U: Unimpacted

Population model

- Examples model output:
  - Average population trend with vs. without impact
  - Average population size after 50 years
  - Comparison of distribution impacted vs. un-impacted population size
  - Sensitivity of population trend to input parameters

Current status

- Finishing up Phase 1:
  - Assessment existing population models, and available information for development of population models
- Phase 2:
  - Development of species-specific population models

Project in progress....

- *Suzanne Lubbe, Marijke Warnas, Maarten Platteeuw (Rijkswaterstaat)*
- *Mark Collier, Abel Gyimesi, Job de Jong (BuWa)*
- *Ingrid Tulp, Mardik Leopold (WMR)*
- *Hal Caswell, Judy Shamoun-Baranes (Universiteit van Amsterdam)*

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