A negative trend in abundance and an exceeded mortality limit call for conservation action for the Vulnerable Belt Sea harbour porpoise population

Owen, K., Gilles, A., Authier, M., Carlström, J., Genu, M., Kyhn, L.A., Nachtsheim, D.A., Ramírez-Martínez, N.C., Siebert, U., Sköld, M., Teilmann, J., Unger, B., Sveegaard, S.

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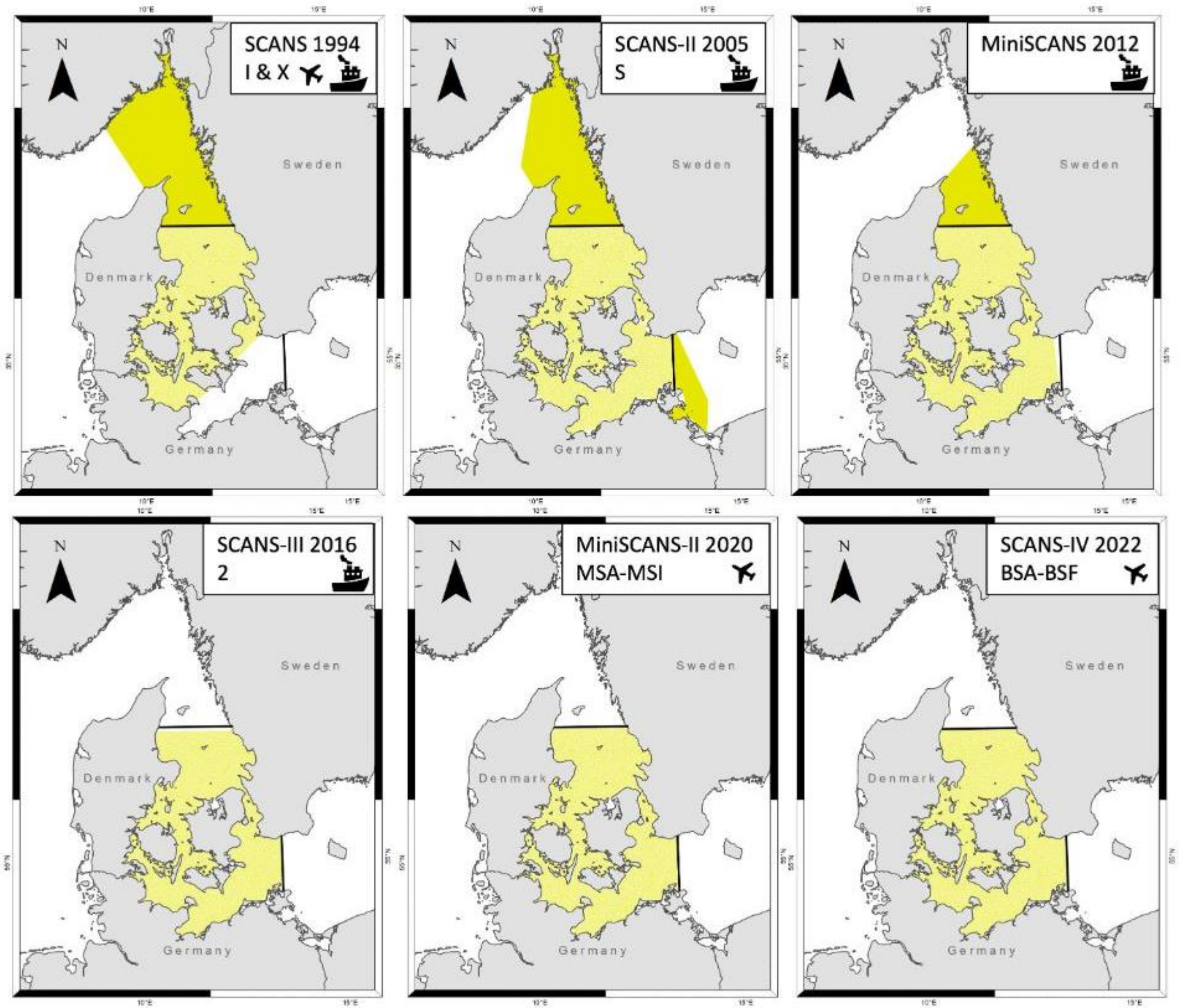
Line-transect surveys

- Six surveys 1994-2022
- Ship-based and/or aerial
- All corrected for observer and porpoise availability bias
- Differences in survey area:
  - 1994 not included in trend analysis
  - 2005, 2012 post-stratified



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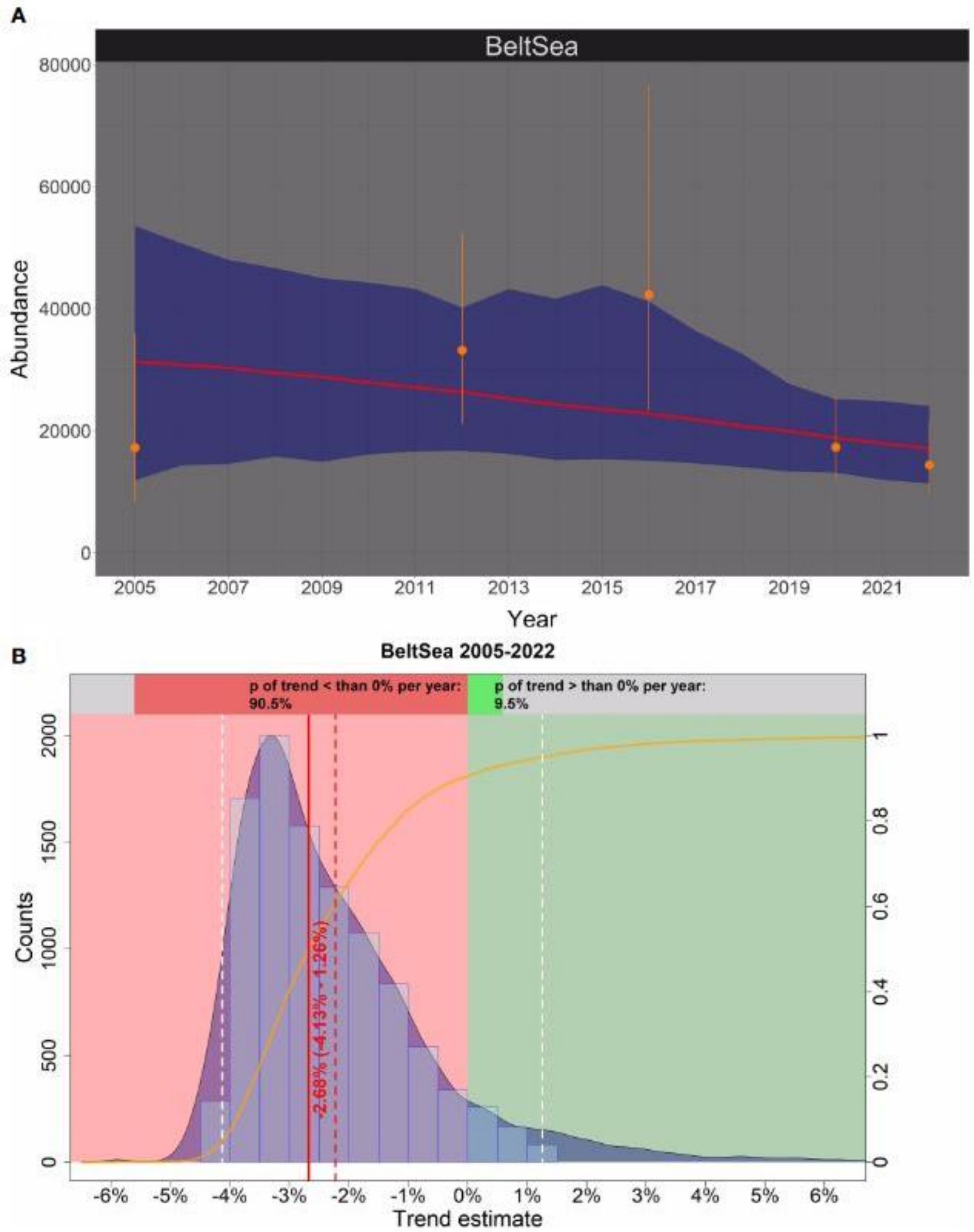
Bayesian trend analysis

- Incorporates all sources of uncertainty
- High CV → low influence, low CV → high influence

- 2005-2022 = 18 years
- Trend: -2.68% (95% CI -4.13 to +1.26%)/year
- 90.5% probability of a negative trend



Mortality limit calculation

Population model based on:

- Bycatch vulnerability sex ratio
- Birth rate sex ratio
- Age distribution sexually mature females
- Max longevity
- Age-specific bycatch risk
- Age-specific survival^{N}

N = from North Sea pop

Mortality limit calculation

1. Run the model for unmanaged bycatch for 60 years until today (1963-2022).
   Aim: Get starting points to calculate scenarios for today's depleted population.

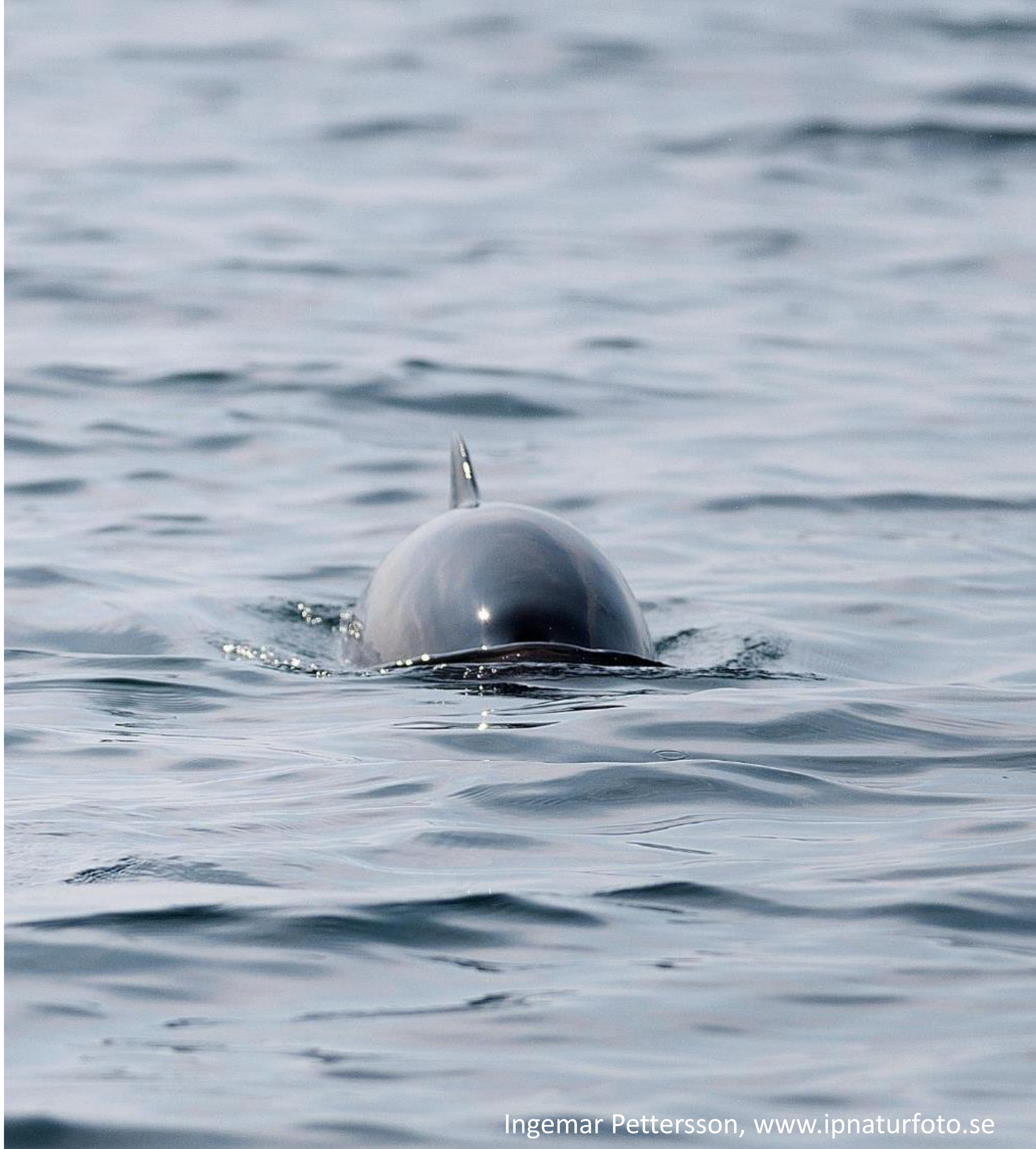
2. Run the model managed bycatch during 100 years from today (2022-2121).
   Managed = no bycatch above mPBR mortality limit: N_{min} * ½ R_{max} * F_r.
   Test recovery factor (F_r) = 0.1, 0.2, … , 1.0.
   Aim: Find which F_r is needed to reach the conservation goal.

3. Calculate mPBR limit using the F_r needed to reach the conservation goal.

Mortality limit calculation

Step 1: Run model during unmanaged bycatch, i.e. up to today

- Rough starting point K = 50,000 animals
- Stochastic removals 0.1% to 5% of K
- Run model 10,000 times for 60 years
- Selected all end points 30%-70% of K = starting points in step 2



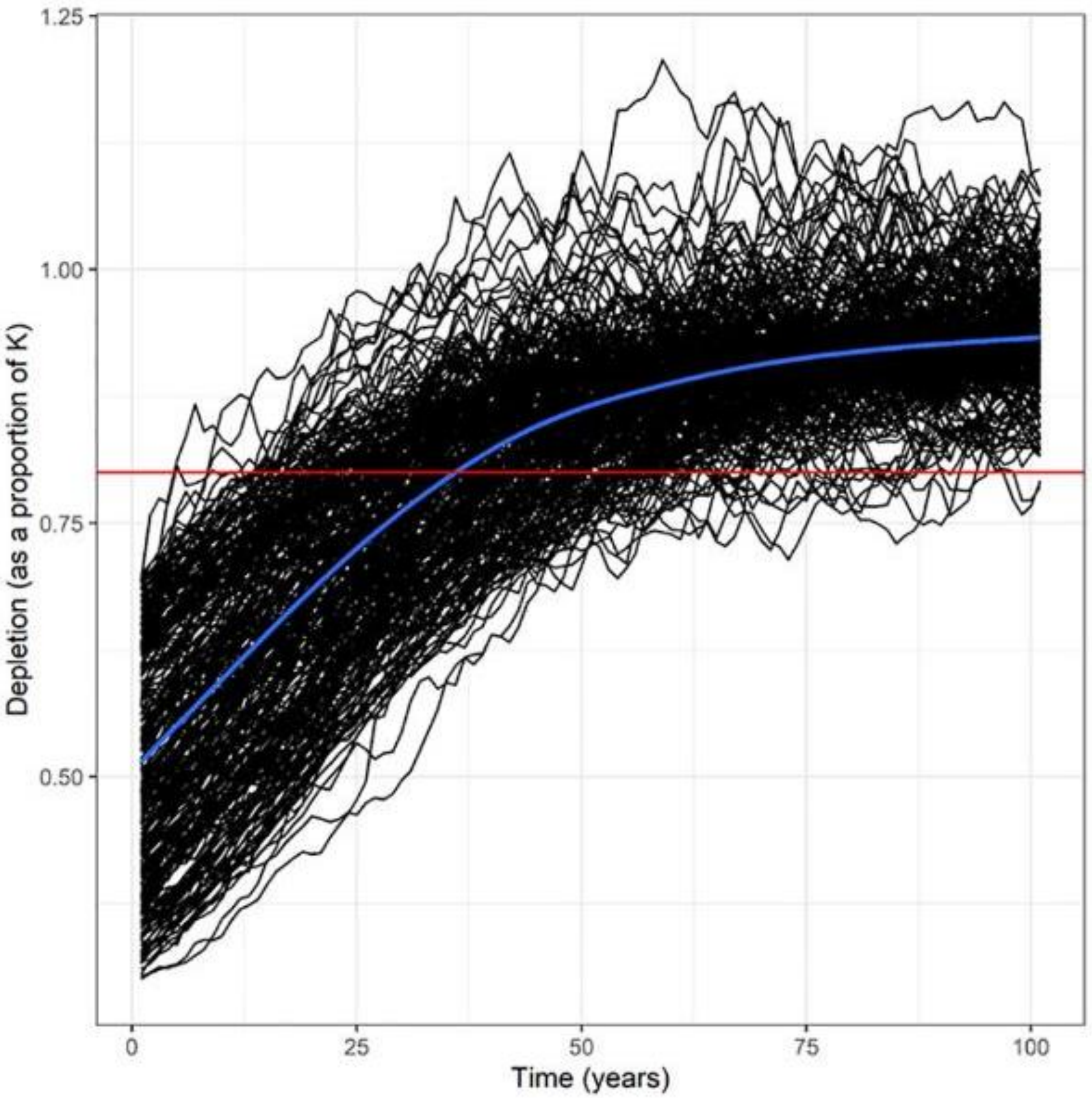
Ingemar Pettersson, www.ipnaturfoto.se

Mortality limit calculation

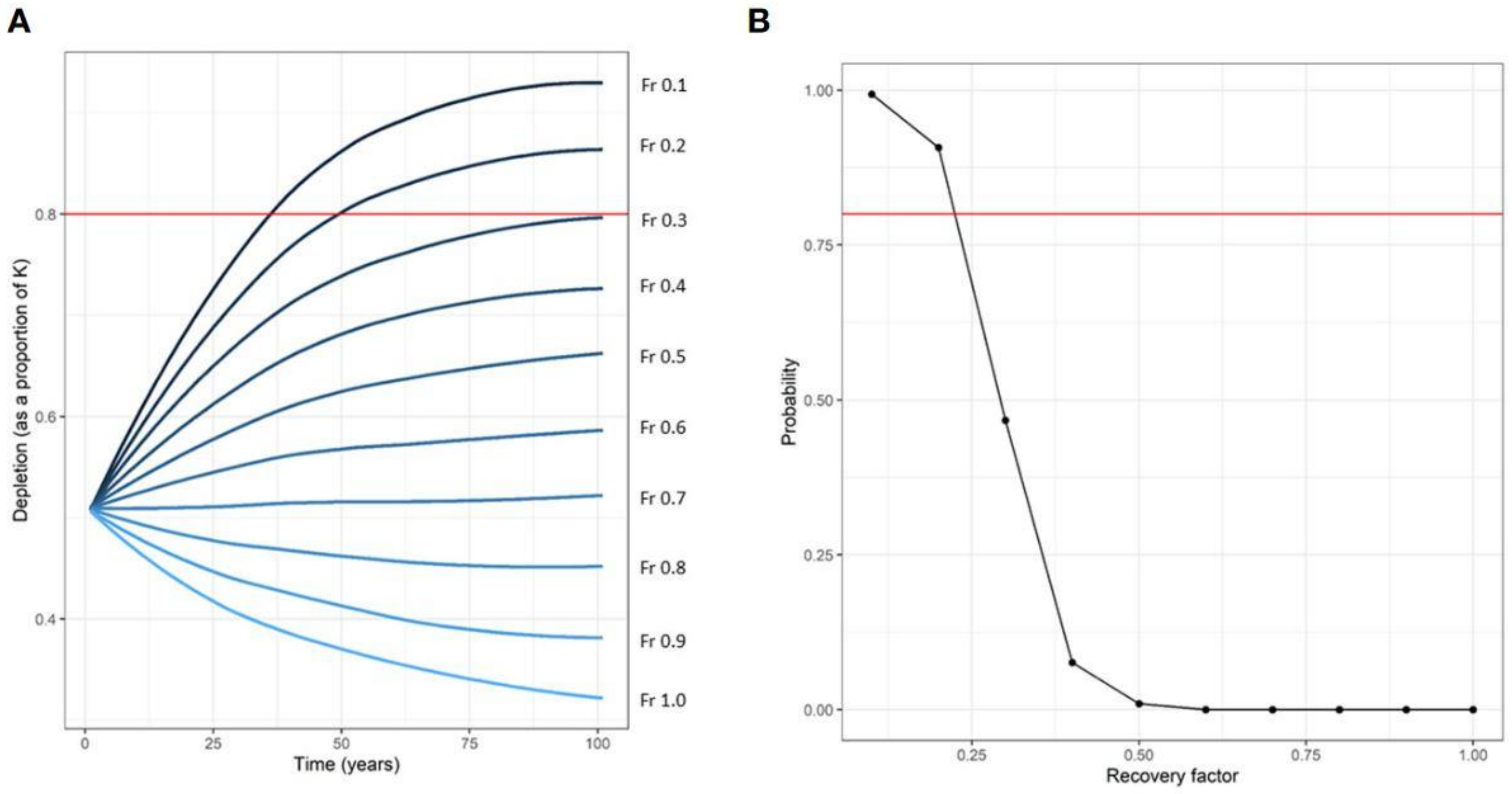
Step 2: Run the model during managed bycatch, calculating future scenarios, using:

- End points from step 1 as starting points
- Base-case scenario no bias + bias in 8 single parameters + bias in 2 parameters, for CV abundance = 0.2 and 0.4 ⇨ 20 combinations
- For F_r from 0.1, 0.2 … 1.0
- Run for 100 years

- Check which F_r is needed to reach the conservation objective **80% K with 80% probability in 100 years**



Base-case scenario: CV abundance = 0.2, no other bias (all default values), F_r = 0.1



Finding Fr for base-case scenario with CV = 0.2: Fr = 0.2 is OK

Robustness trial	Scenario	n	q	MNPL	K_{trend}	Frequency	R_{max}	CV	b.byc	b.abund	$b.R_{max}$	byc.CV	cata.	F_r
Base case scenario	0A	302	0.2	0.5	1	6	0.04	0.2	1	1	1	0.3	0	0.2
	0B	298	0.2	0.5	1	6	0.04	0.4	1	1	1	0.3	0	0.3
Bycatch underestimation	1A	302	0.2	0.5	1	6	0.04	0.2	2	1	1	0.3	0	0.1
	1B	298	0.2	0.5	1	6	0.04	0.4	2	1	1	0.3	0	0.1
Abundance overestimation	2A	302	0.2	0.5	1	6	0.04	0.2	1	2	1	0.3	0	0.1
	2B	298	0.2	0.5	1	6	0.04	0.4	1	2	1	0.3	0	0.1
Maximum Productivity rate underestimation	3A	302	0.2	0.5	1	6	0.04	0.2	1	1	0.5	0.3	0	0.4
	3B	298	0.2	0.5	1	6	0.04	0.4	1	1	0.5	0.3	0	0.6
Higher bycatch coefficient of variation	5A	302	0.2	0.5	1	6	0.04	0.2	1	1	1	1.2	0	0.2
	5B	298	0.2	0.5	1	6	0.04	0.4	1	1	1	1.2	0	0.2
Lower survey frequency	6A	302	0.2	0.5	1	10	0.04	0.2	1	1	1	0.3	0	0.2
	6B	298	0.2	0.5	1	10	0.04	0.4	1	1	1	0.3	0	0.2
Lower MNPL	7A	289	0.2	0.45	1	6	0.04	0.2	1	1	1	0.3	0	NA
	7B	311	0.2	0.45	1	6	0.04	0.4	1	1	1	0.3	0	0.1
Higher MNPL + bycatch underestimation	8A	298	0.2	0.7	1	6	0.04	0.2	2	1	1	0.3	0	0.4
	8B	302	0.2	0.7	1	6	0.04	0.4	2	1	1	0.3	0	0.4
Catastrophic events happening	9A	302	0.2	0.5	1	6	0.04	0.2	1	1	1	0.3	0.1	0.2
	9B	298	0.2	0.5	1	6	0.04	0.4	1	1	1	0.3	0.1	0.2
Carrying capacity degradation	10A	302	0.2	0.5	0.5	6	0.04	0.2	1	1	1	0.3	0	0.4
	10B	298	0.2	0.5	0.5	6	0.04	0.4	1	1	1	0.3	0	0.5

mPBR limit

Mortality limit results

- N_{min} = 12,091 animals, from SCANS-IV (14,403; CV = 0.21)

F_r needed to reach conservation objective with CV = 0.2:

- 3 scenarios: $F_r = 0.4$
- 7 scenarios: $F_r = 0.1$ or 0.2
- Bycatch underestimation scenario: $F_r = 0.1$

- Step 3: $mPBR = N_{min} * ½ R_{max} * F_r$

F_r	Mortality limit
0.1	**24**
0.2	48
0.3	72
0.4	96
0.5	120
0.6	144
0.7	168
0.8	192
0.9	216
1	240

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Conclusions

- Population is in decline
- Mortality limit to reach conservation objective with bias in e.g. bycatch: 24 animals/year
- Current bycatch in DK and SE, excluding DE: ~900 animals/year
- Confirm Vulnerable status, conservation actions needed