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Adaptive monitoring, probabilistic impact assessment

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Introduction: key statements

1. *Truism?*: The level of monitoring should depend on the relative importance and sensitivity of the area.
2. *Scientifically puffed up*?: Monitoring surveys and analysis of data need to take natural variability into account.
3. *Clients' wish?*: Monitoring should be cheap.
4. *Please no interference!*: Information gained during monitoring can be used to adjust the execution of the work.

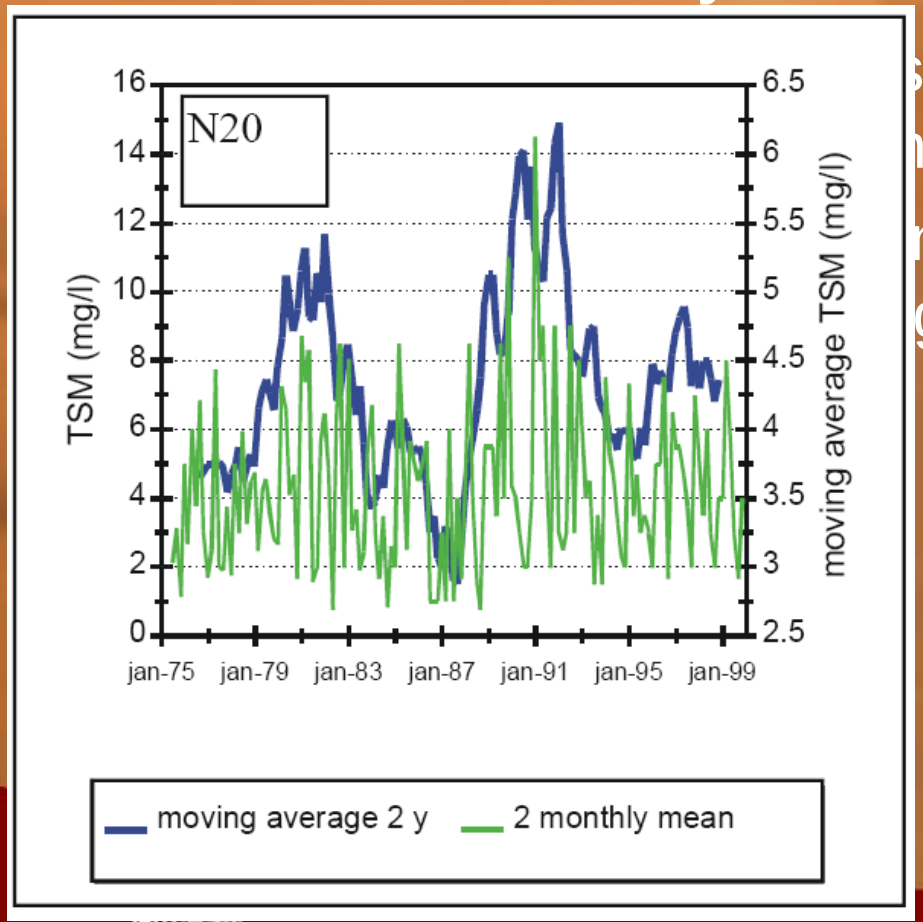
The level of monitoring is based on the sensitivity of the area?

- In practice, this is not a truism.
- In many projects, monitoring guidelines and even environmental standards are ‘copy and paste’.

BwN research questions

- How does one determine the relative importance, size and sensitivity of an impacted area?
  - What information is minimally required?
  - How do you determine a reference site?
  - How do you score and weigh physical, biological and anthropogenic variables?
  - Does a classification system for world-wide marine systems exist?

Monitoring surveys and analysis of data need to take natural variability into account?



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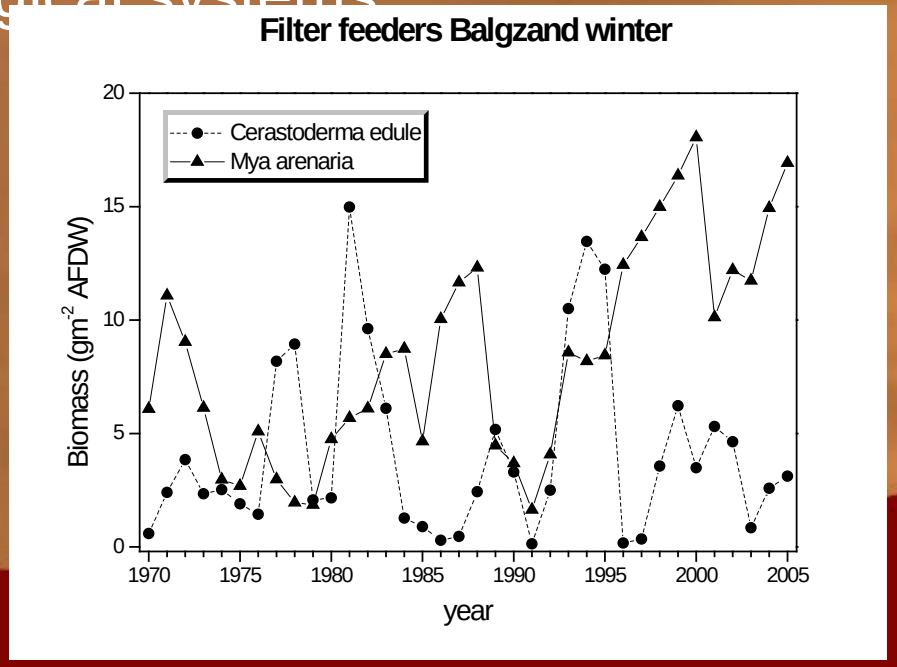

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BwN research questions

- How does one take natural variability into account?
  - understanding of the mechanisms behind variability.
  - incorporate variability in risk assessments via statistical and probabilistic techniques.

Monitoring should be cheap?

- Clients are inclined to want monitoring as cheap as possible.
- We think monitoring can be made more cost-effective by careful prior definition of the monitoring programme.
- We want to increase knowledge on the sea and seabed, so we can mitigate possible detrimental effects, or even improve habitat quality.

Information gained during monitoring can be used to adjust the execution of the work?

- The Dutch have agreed upon gas mining underneath the Wadden Sea under the condition of “keep a hand on the tap”
- In other words: the precautionary principle has been translated into a practicable way of working in which the effects are continuously monitored and action is taken if necessary.
- We explore the ‘adaptive execution’ of projects.

“Gone are the days where environmental considerations were second to economic interest…” (Bray, 2008)

- 1. Projects take place in complex and dynamic systems
- 2. The world is constantly and unpredictably changing
- 3. Clients and financers are changing, issuing more restrictions
- 4. Unclear environmental impacts (and restrictions) exist
- 5. Non-dredgers interfere with environment at increasing rates
- 6. Immediate action is required to stop worldwide ecosystem degradation
- 7. There is no such thing as complete information
- 8. We can learn and improve

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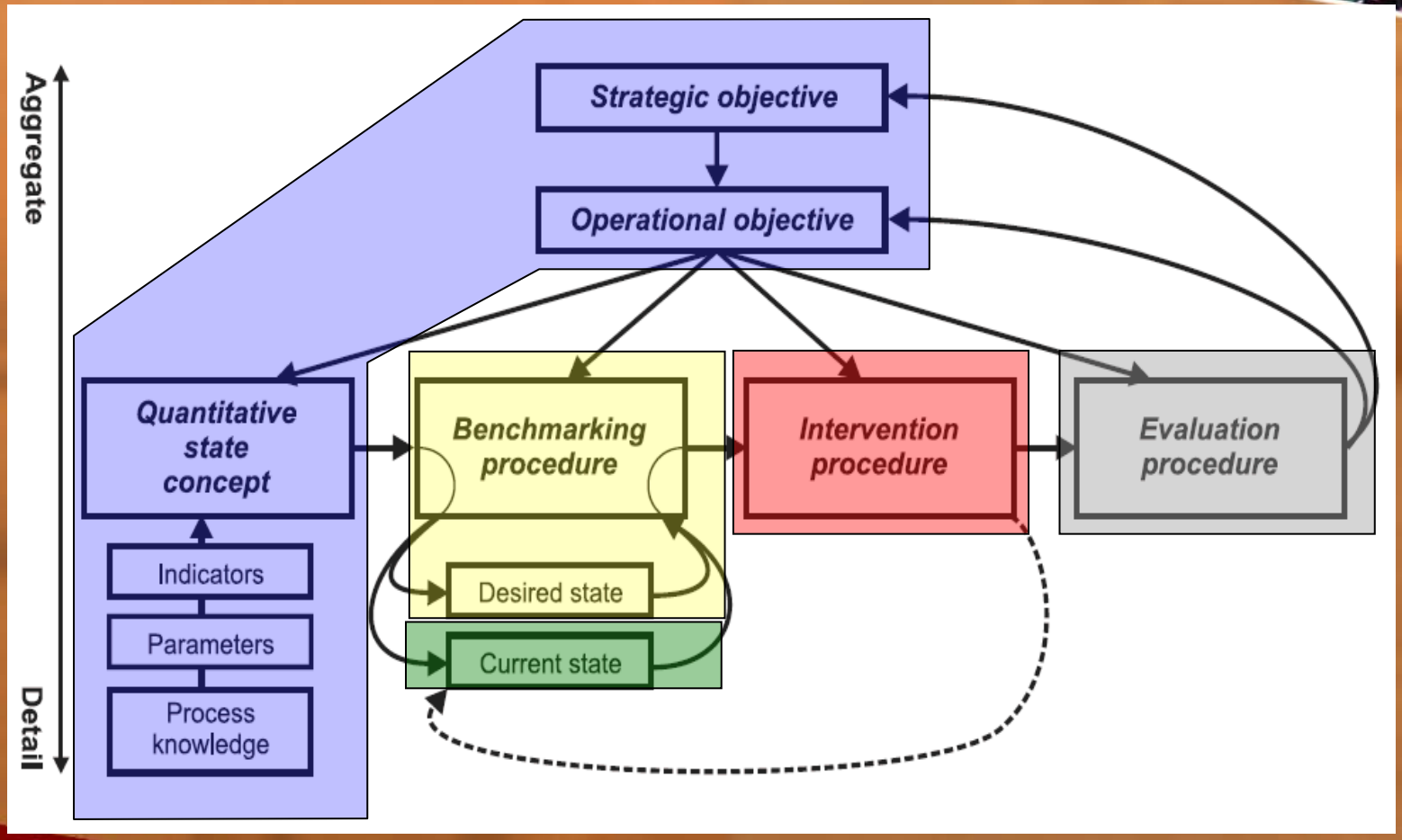

Frame of Reference (Van Koningsveld, 2003)

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General cause-effect chain of dredging

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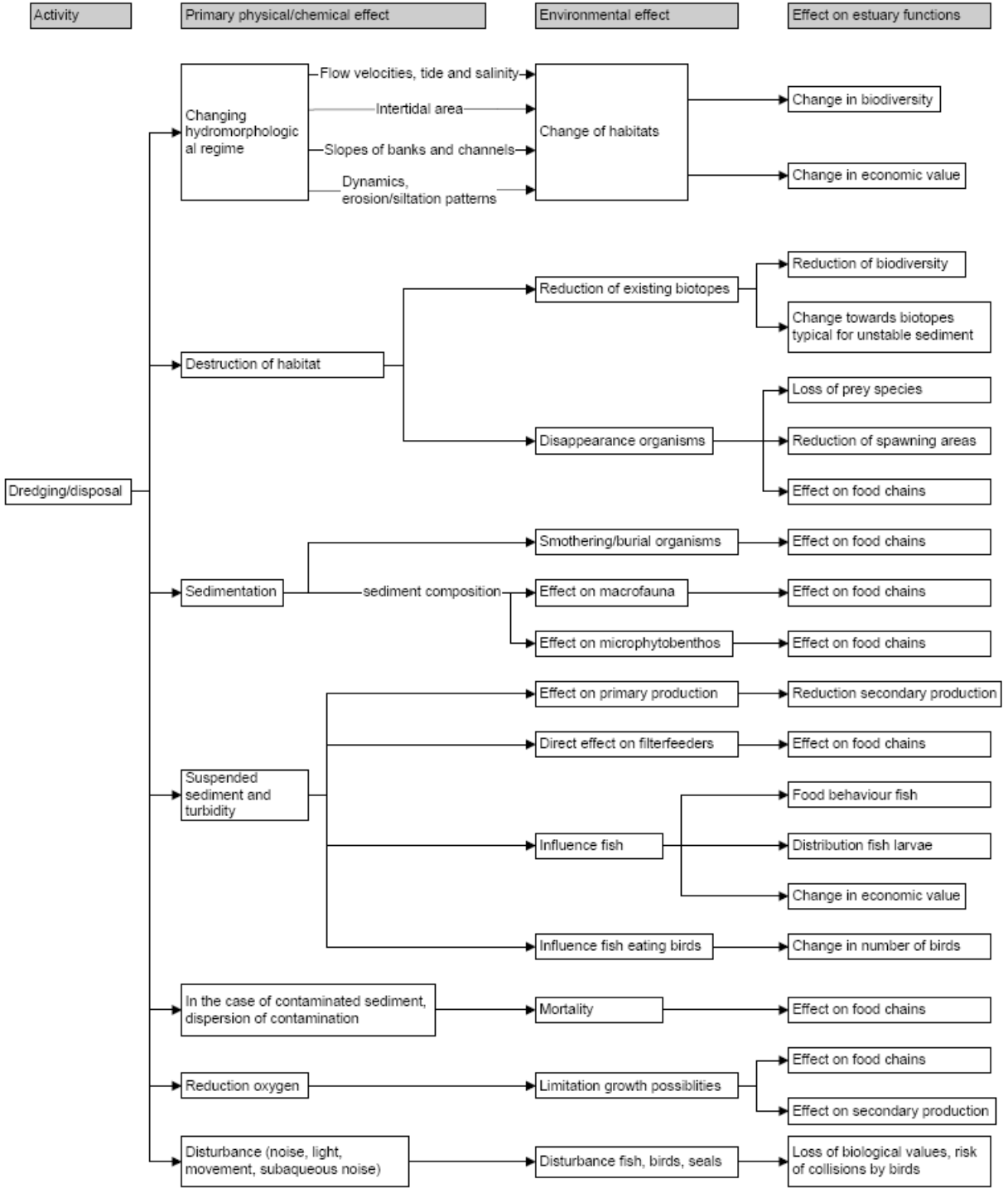
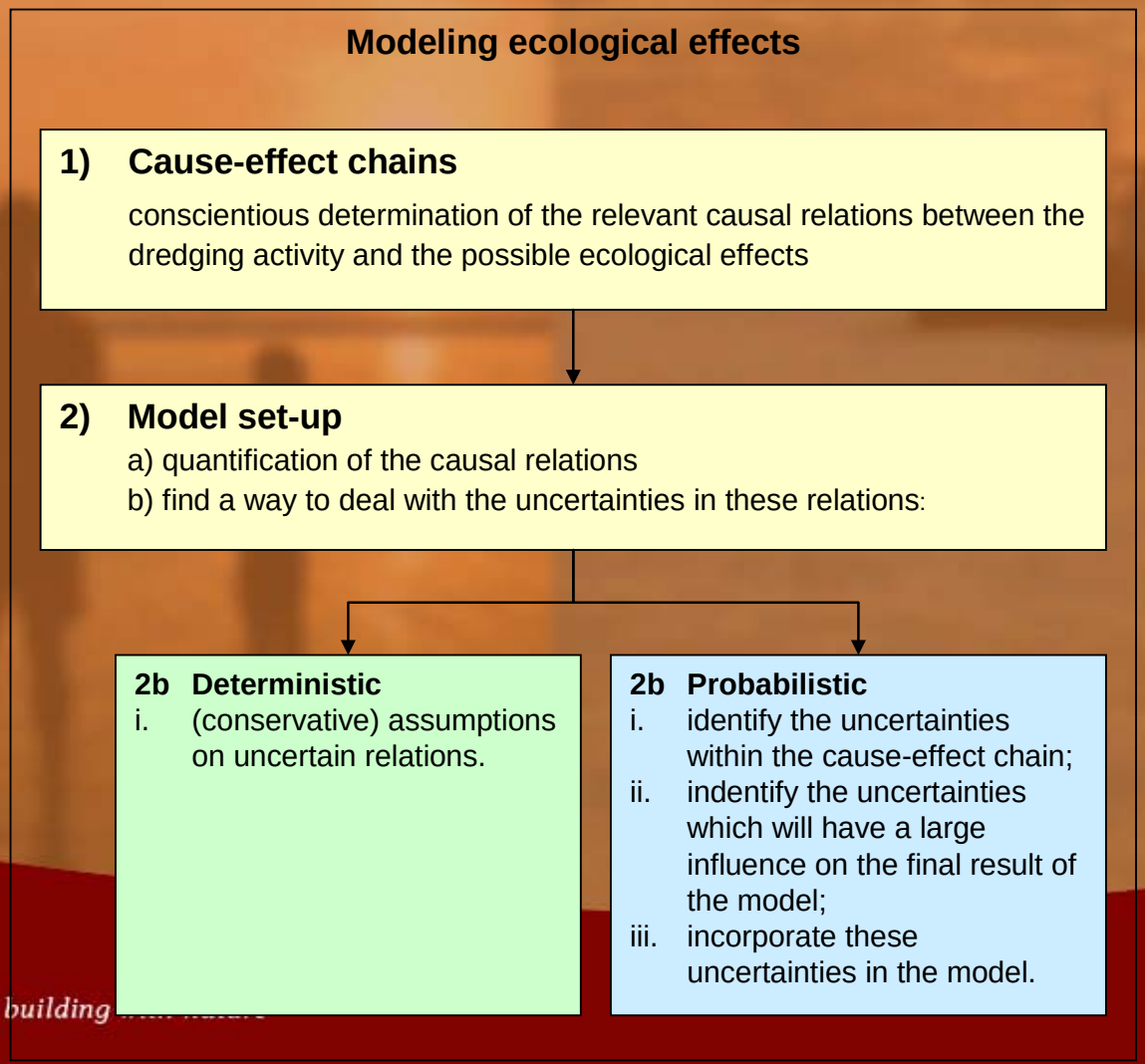


Quantitative modeling of ecological effects



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Uncertainties

- **Different types of uncertainties, asking for a specific approach:**
  - **Uncertainties on quantitative relations;** → **pdf of uncertain parameter**
  - **Uncertainties caused by natural variations;** → **Monte Carlo simulation of variation**
  - **Uncertainties caused by a lack of knowledge;** → **estimate + uncertainty margin**
  - **Uncertainties as impacts only occur in case of specific conditions.** → **probability of occurence of conditions**

Monte Carlo analysis

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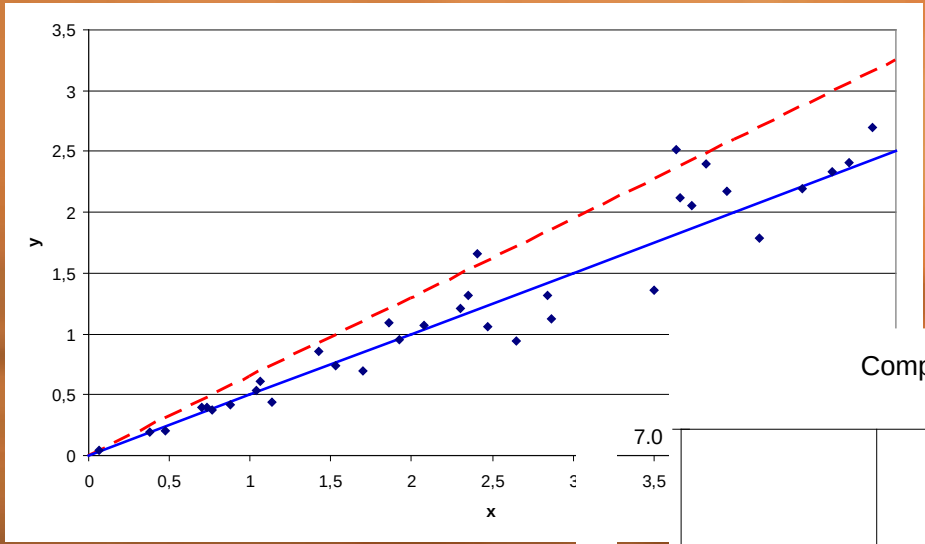
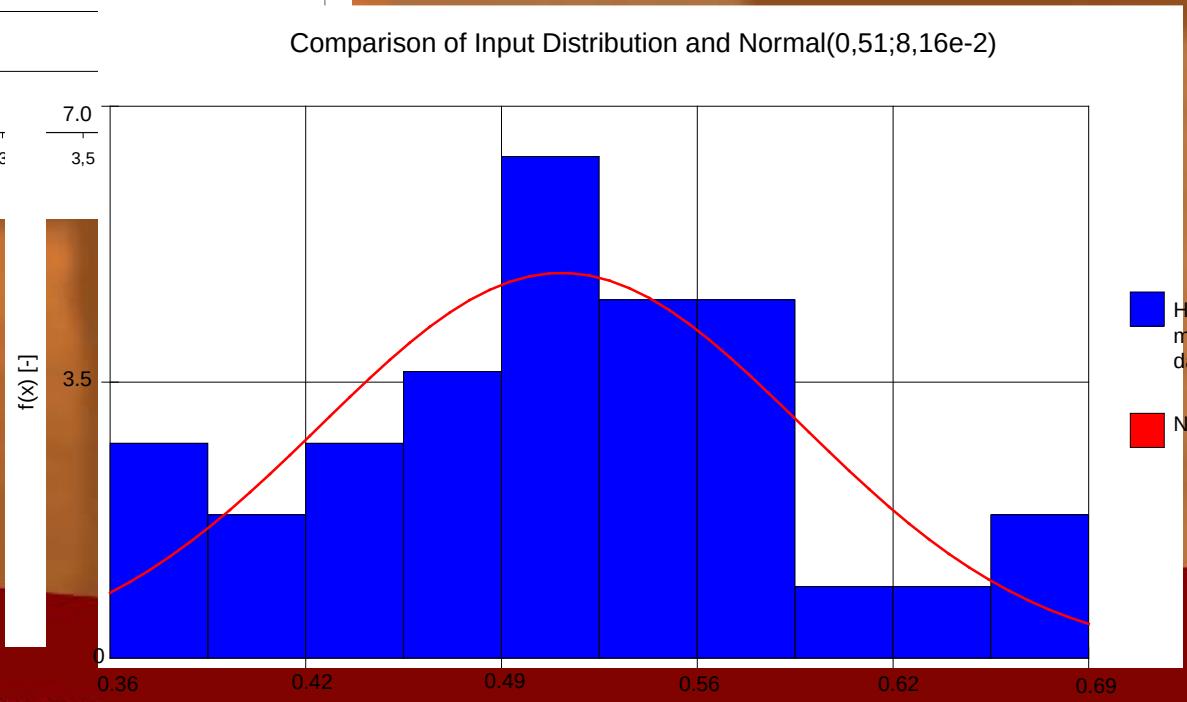
Uncertainties on quantitative relations





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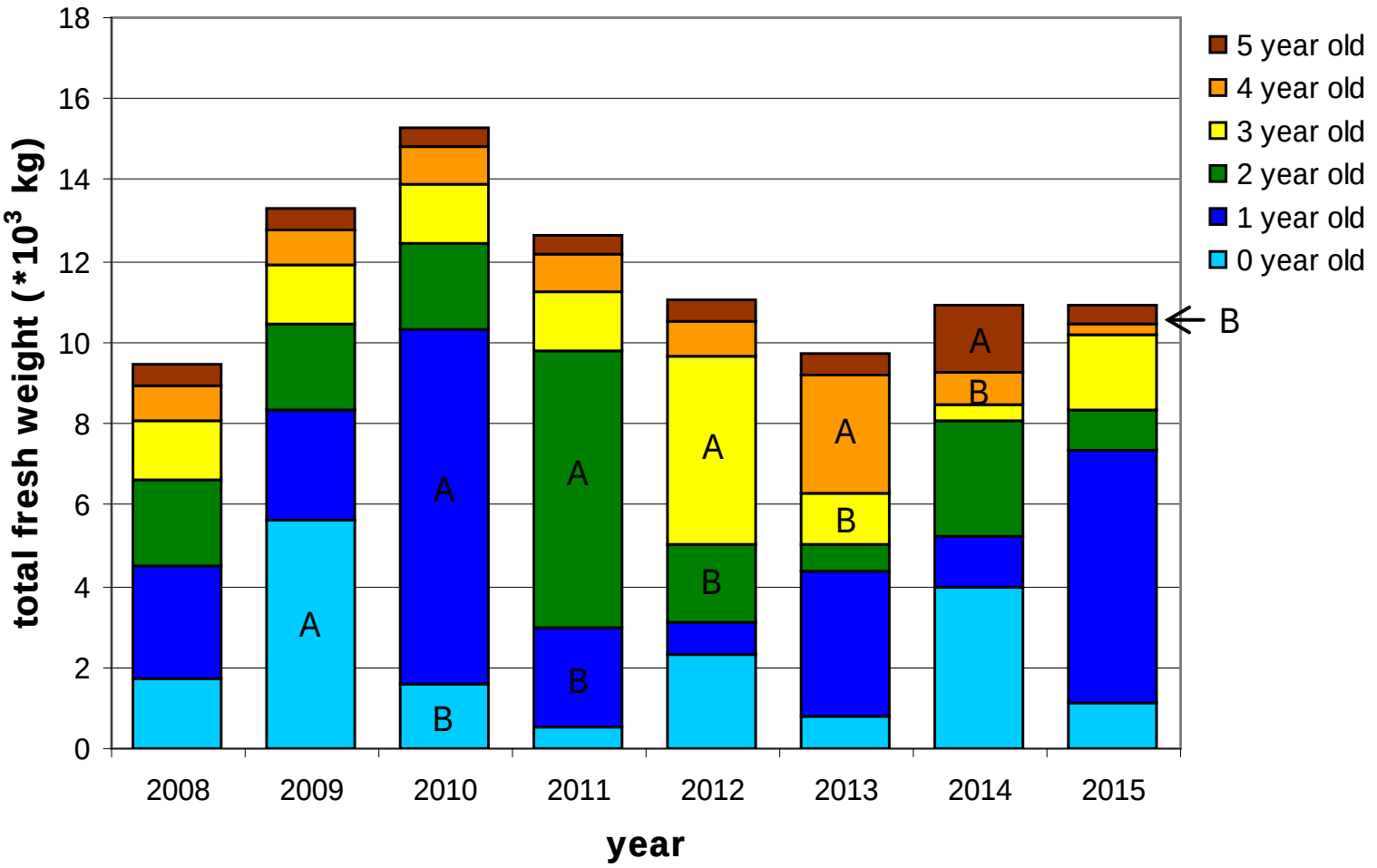
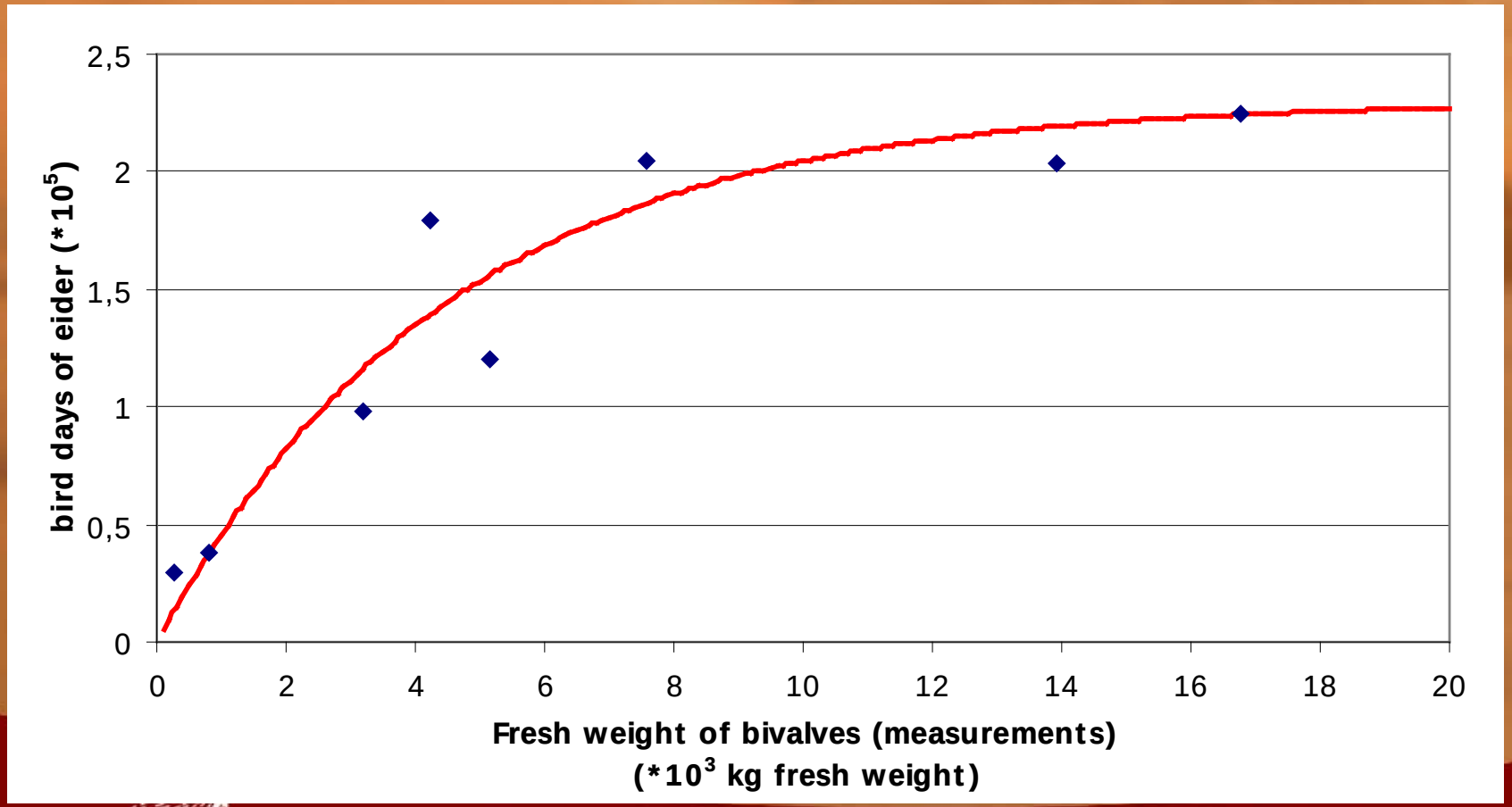
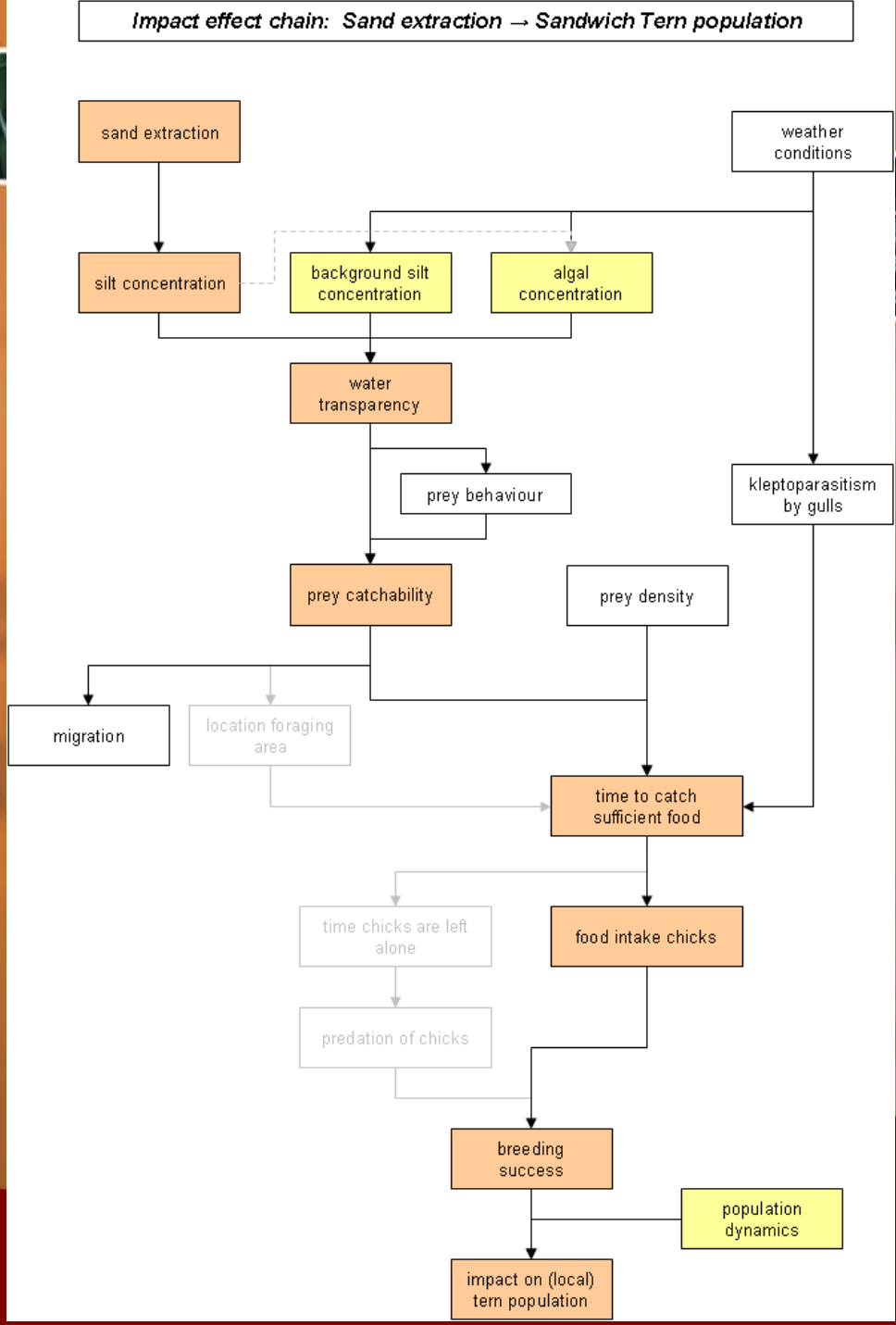
Uncertainties caused by natural variations



Uncertainties due to specific conditions



- **Case study Sandwich Terns**
  - **Impact-effect chain**



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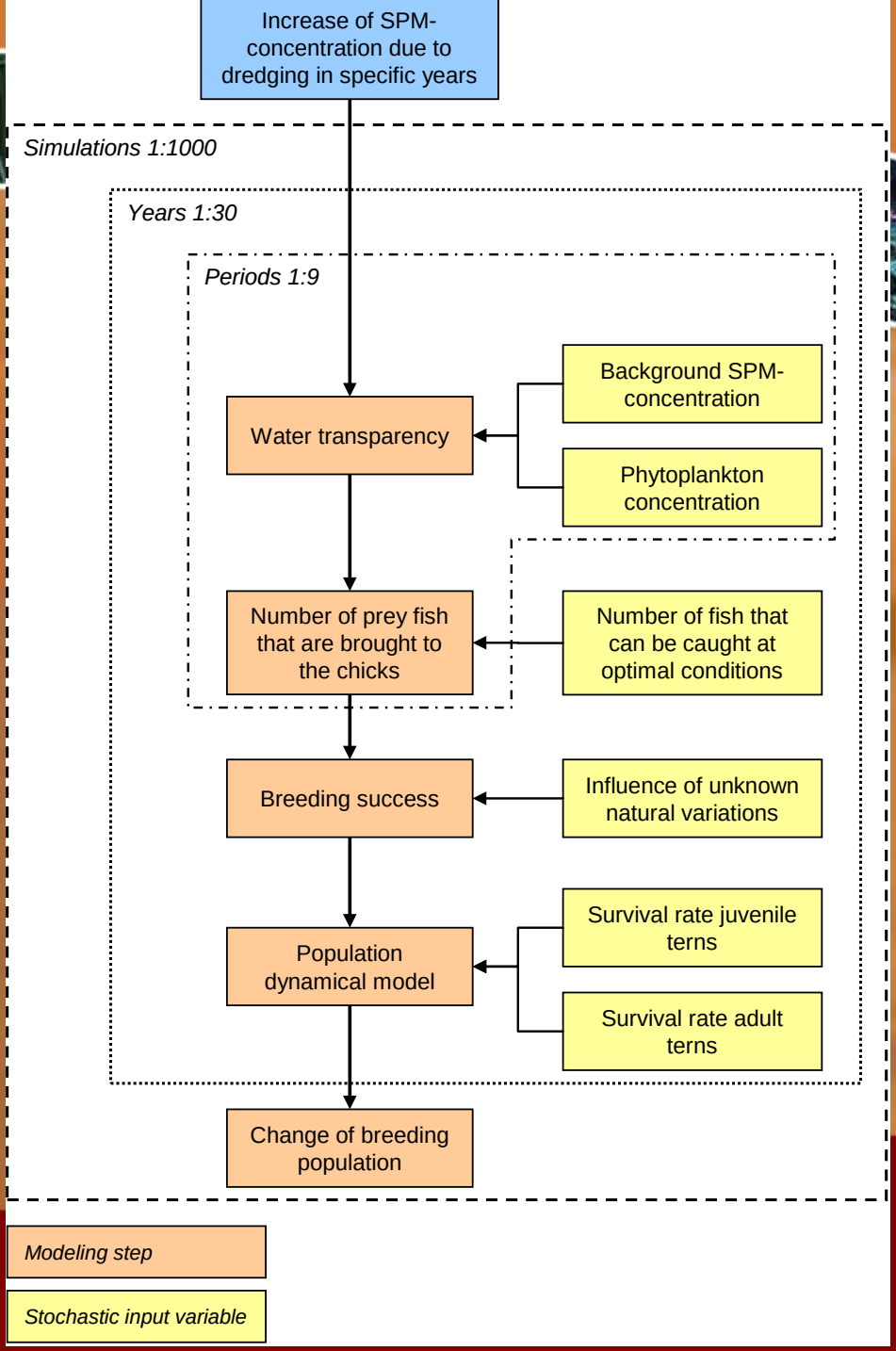
- **Case study Sandwich Terns**
  - **Impact-effect chain in the probabilistic model**



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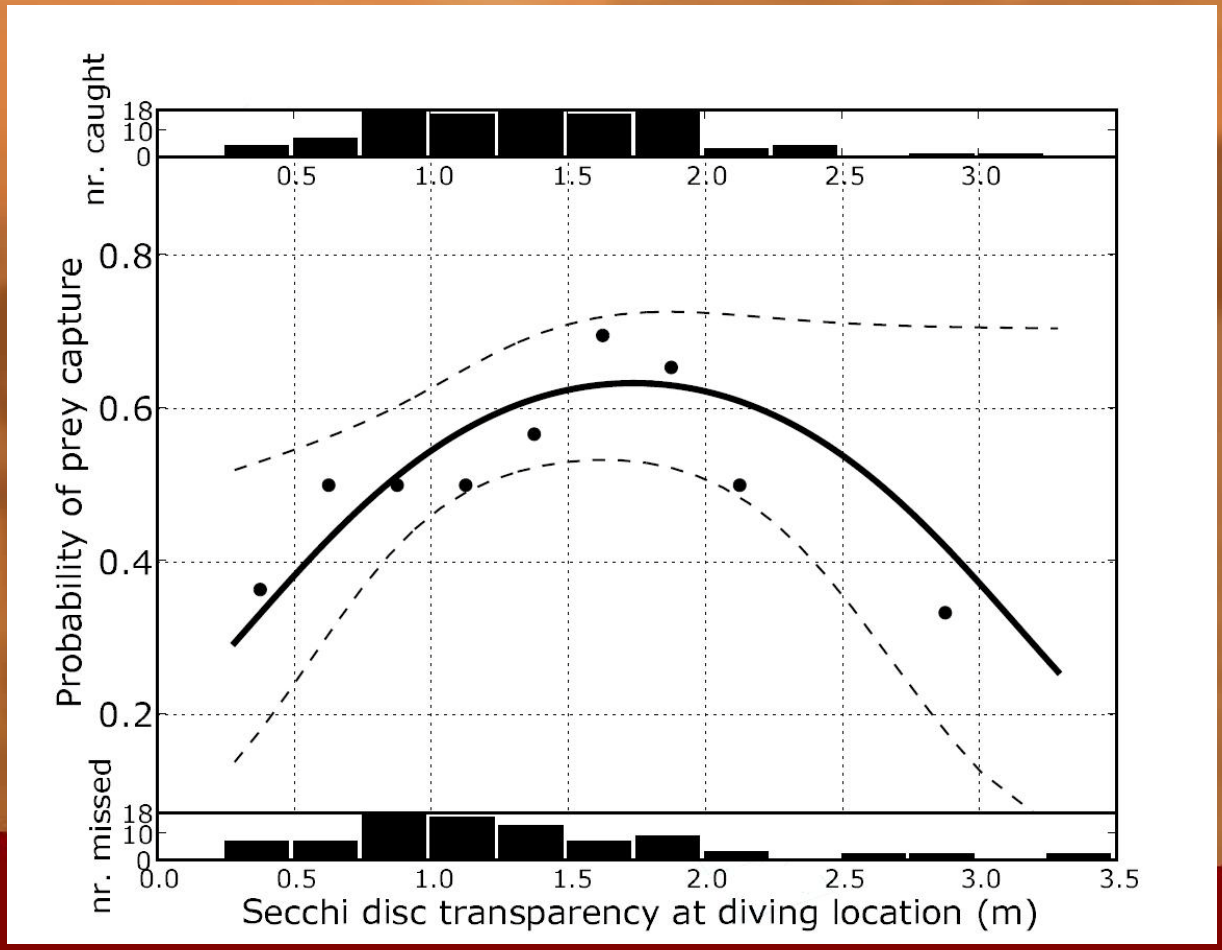
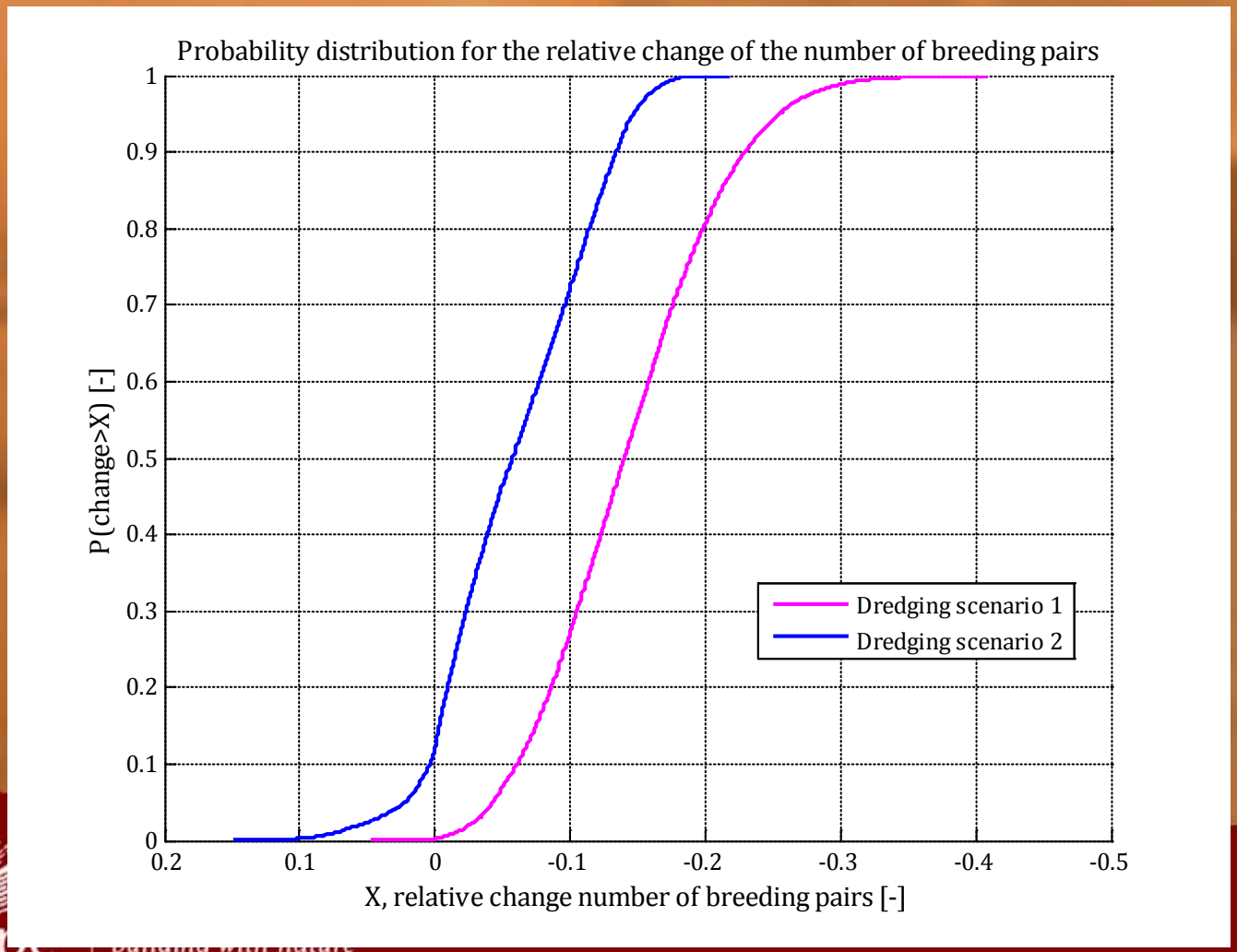
Prey capture probability



Result for Sandwich Terns



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