Taming the Intractable

how to control the cormorant and other unmanageable wildlife

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Outline

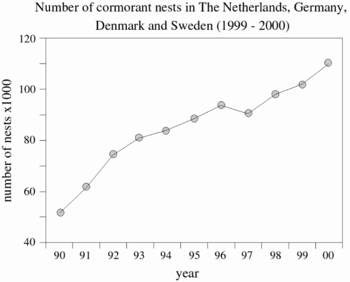
Background story: the conflict

The conflict

- Fishery suffers losses by cormorants
- Cormorant is a protected species

The conflict

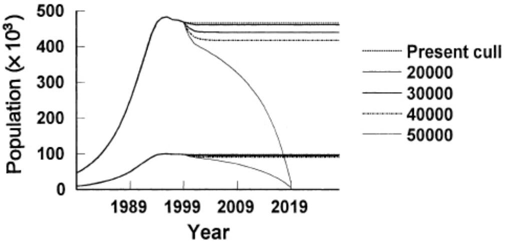
Numbers of cormorants is increasing



T. Bregnballe et al.

The conflict

Standard approach for reduction is to cull, but culling is dodgy



M. Frederiksen, J.-D. Lebreton & T. Bregnballe

The buffer structure

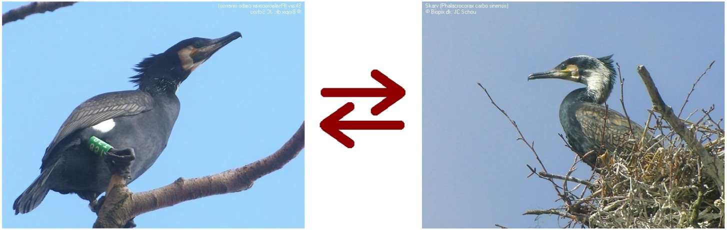
Breeding cormorant

The buffer structure

Some mature cormorants do not breed (floaters)

The buffer structure

Floaters can fill vacancies in breeding sites



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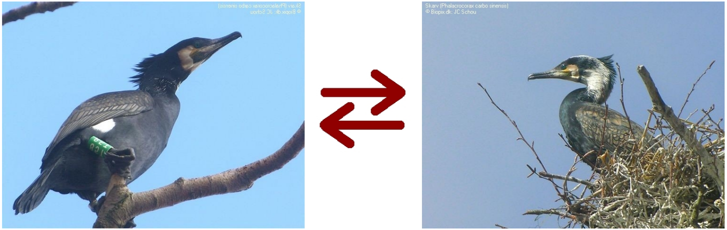

Ecosystem functioning influences regulation effectiveness

From the special to generity
the relevance of buffer structure

A common structure

Floaters are known from many species

Spanish imperial eagle

A common structure

Floaters are known from many species

Otter

A common structure

Floaters are known from many species

Some lizard species

A common structure

Floaters are known from many species

Badger

A common structure

Floaters are known from many species

Raven

A common structure

Floaters are known from many species

Mink

A common structure

Floaters are known from many species

Canada goose

A common structure

- Why not try to get a general understanding of the buffer structure?
- Of special interest: the context of regulation
  - conserving viability
  - being effective
  - being efficient

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Question

- What are the dynamical effects of the buffer structure?
- Given a buffer stock is to be regulated, how could this be done in an effective and efficient way?
  - Are there any principle limitations or pitfalls?
  - Are there rules of thumb?
- How can the cormorant be regulated?

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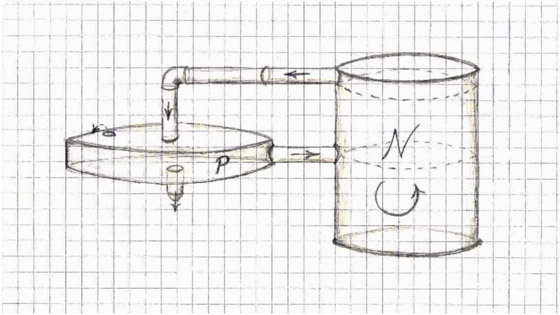

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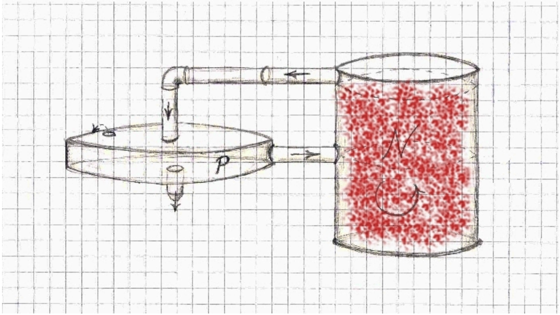

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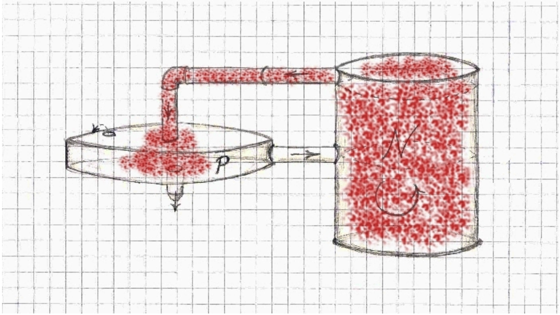

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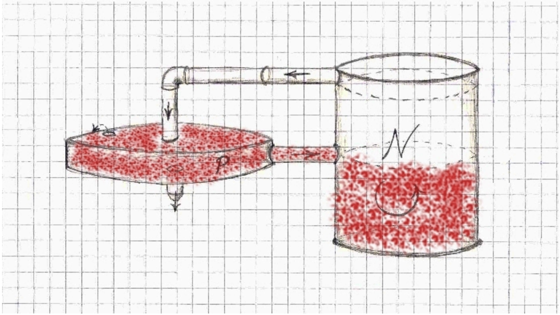
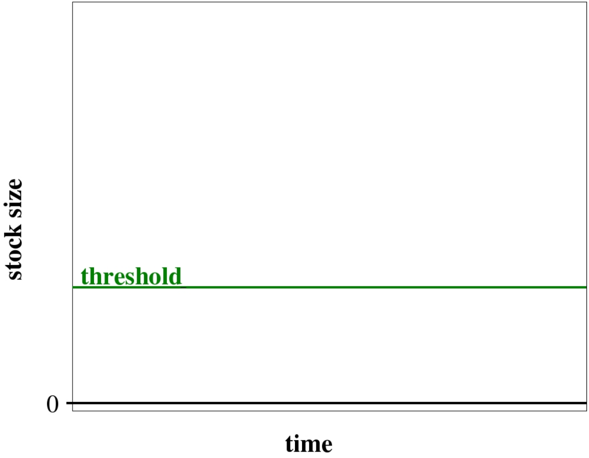


Stock regulation



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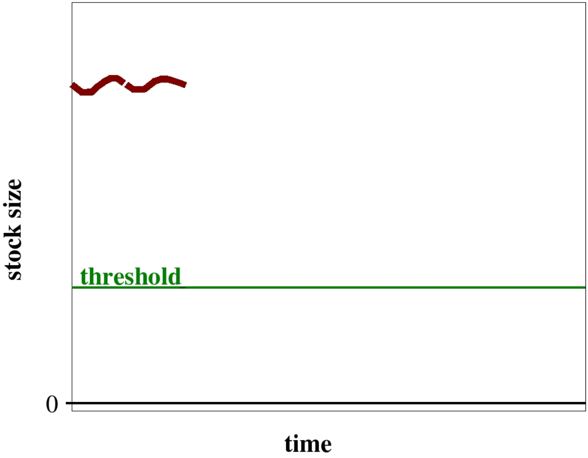

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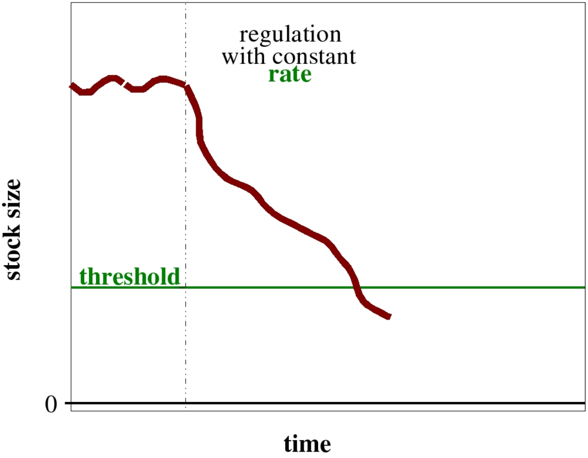

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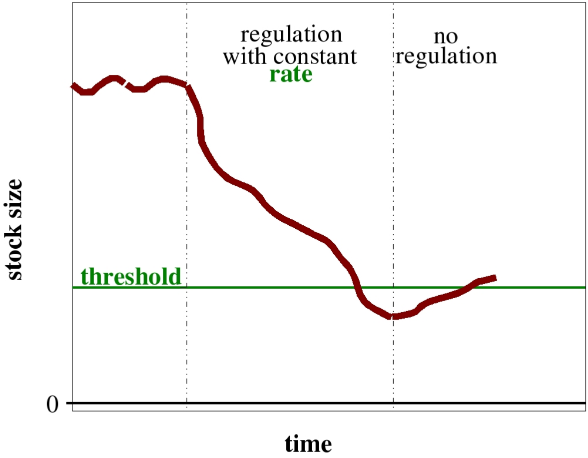

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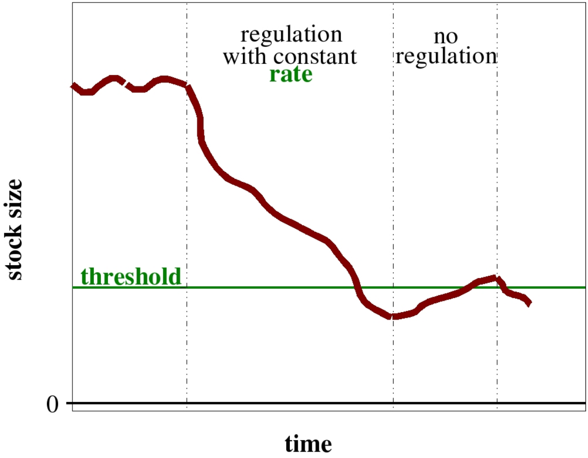

Ways to regulate a stock

- Culling of adults
- Egg oiling, chicks suffocate before hatching
- Reducing environmental capacity for breeders

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Principle insights

Question reminder

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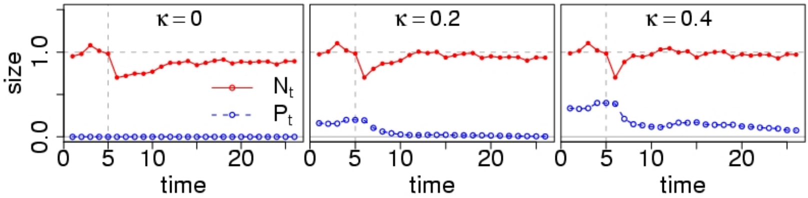
Result: buffer structure and resilience

The bigger the buffer, the faster breeders recover from catastrophes



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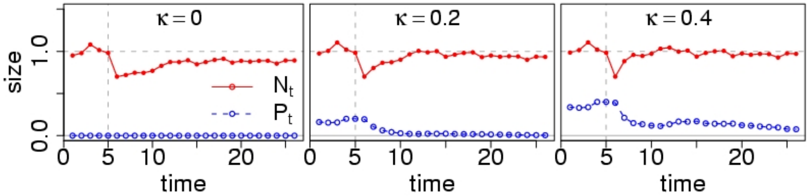

⇒ The buffer structure is a resilience mechanism.

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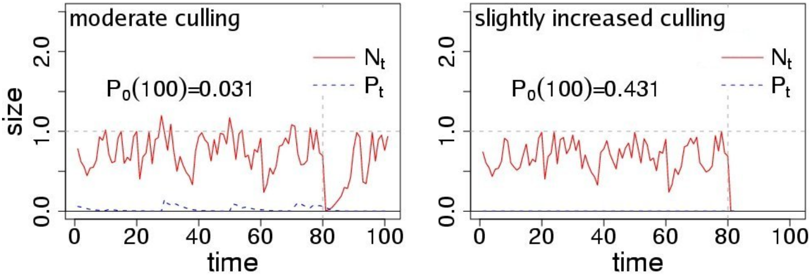
Result: culling and buffer destruction

Slightly increased culling destroys the buffer



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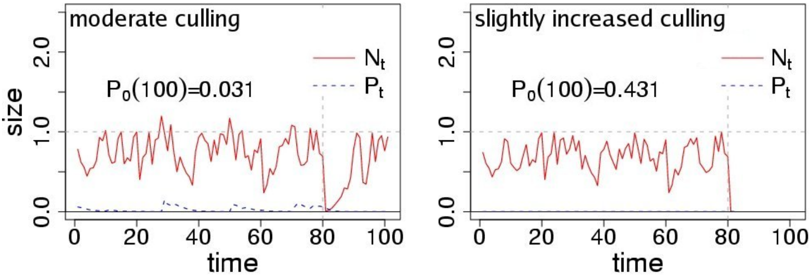
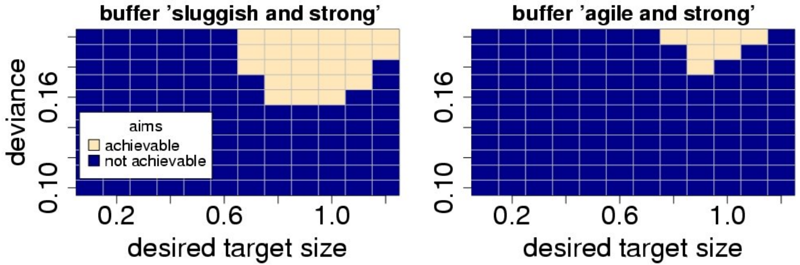


$\Rightarrow$ Loss of resilience!

Result: buffer types and achievable targets

Sluggishness of buffer response to breeders loss determines achievable regulation targets



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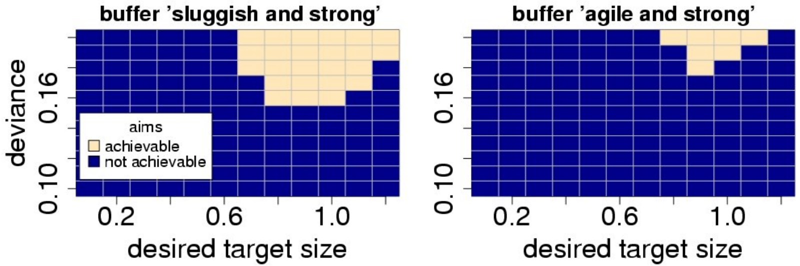
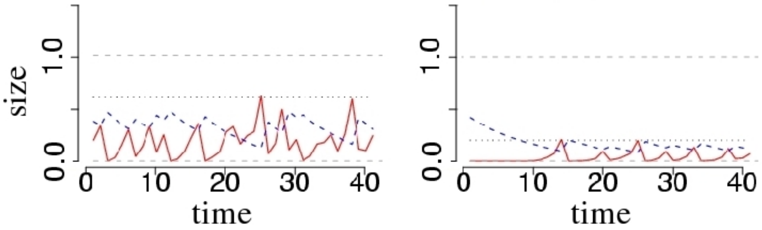


$\Rightarrow$ Margin for normative decisions is limited.

Result: working regulation strategies

Reducing environmental capacity for breeders



- Broad range of target sizes ecologically possible
- Buffer structure is conserved
- Low fluctuations in stock size, i.e. regulation effort well predictable

Result: working regulation strategies

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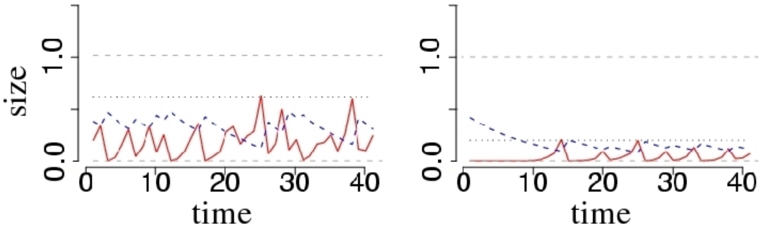

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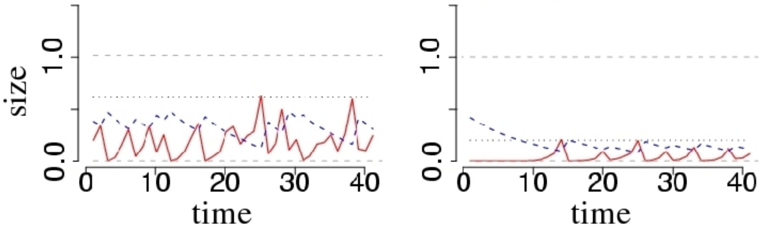

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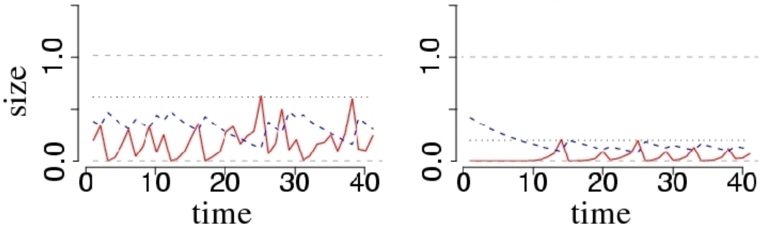

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Lessons learnt

In general

- Buffer structure provides a resilience mechanism
- Regulation should not alter system structure to maintain resilience
- There are limitations for achievability of normative settings

- Understanding ecosystem functioning as basis for design of conflict reconciliation strategies
- Thus, need for structurally explicit dynamic models

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Thank you for your attention!

Conceptional model

- Logistic growth dynamic of the reproductive part

$$N_{t+1} = N_t + r_t N_t \left(1 - \frac{N_t}{K}\right)$$

- Simple cut-off dynamic of the buffer

$$P_{t+1} = min\{\kappa, P_t - \delta P_t\}$$

Conceptional model

- Flux into the buffer

$$f_{rb}(N_t) = \lambda max\{0,(1+r_t)N_t - K\}$$

- Flux forth the buffer

$$f_{br}(N_t,P_t) = \beta(P_t - \delta P_t)\frac{max\{0,(K-N_t)\}^2}{k^2+(K-N_t)^2}$$

Conceptional model

- First calculation of gross growth

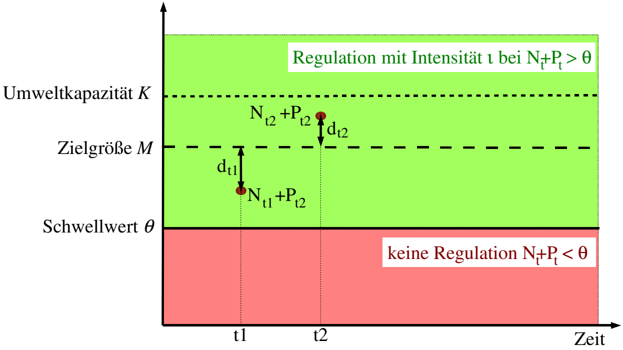
$$N_{g,t} = r_t N_t - f_{rb}(N_t) + f_{br}(N_t, P_t)$$

$$N_{t+1} = N_t + N_{g,t}\left(1 - \frac{N_t}{K}\right)$$

- Buffer dynamic

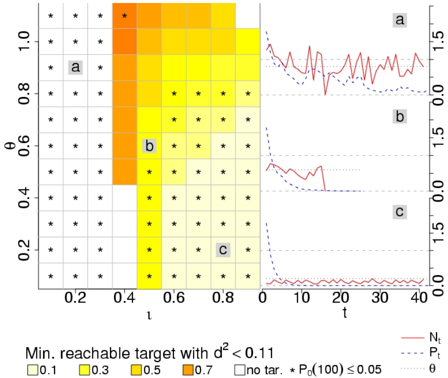
$$P_{t+1} = min\{\kappa, P_t - \delta P_t + f_{rb}(N_t) - f_{br}(N_t, P_t)\}$$

Regulation strategies



„bang-bang"-strategy with „stop-loss-rule"

Regulation strategies: achievable targets, costs, risk



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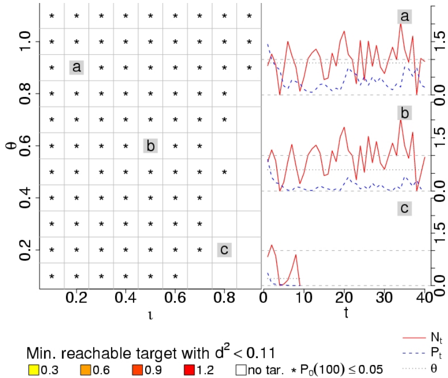

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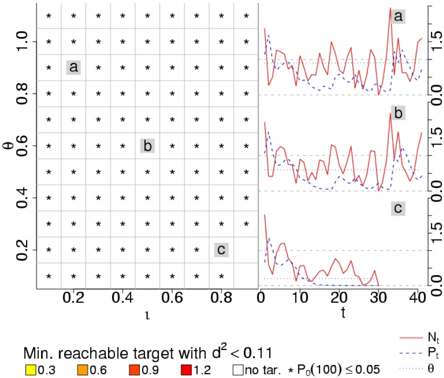

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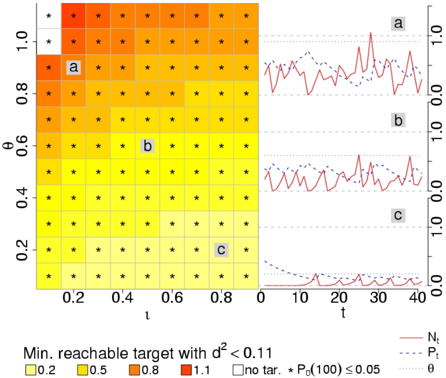

Rules of thumb for regulation

1. If risk of catastrophes is unknown, conserve the buffer
2. If possible, reduce environmental capacity for breeders
3. If not, breeders number may be reduced carefully
4. Medium reductions of breeders number lead to strong fluctuations and thus are risky
5. Stronger breeders reduction removes the buffer
6. Manipulating the buffer directly or the reproduction rate is not effective

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