Radboud Universiteit Nijmegen

Geese grazing in seagrass transplants: Experimental geese exclosures in *Zostera noltii* transplants in the Eastern Scheldt

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Introduction

1. Exclosures at the transplant location

Seagrass species are known to be foraged by geese. This has been observed in Izenbeck Lagoon, Alaska, USA (McRoy 1966), Essex, UK (Charman 1977) and many other locations spread over the northern hemisphere. For Brent Geese *Branta bernicla*, seagrass is the preferred food source out of breeding season when the seagrass is available as a food source (growing season of seagrass, in the summer); reasons for this are the high digestibility and nutritive value of *Zostera* species compared to other potential food plants (Ganter 2000). Brent geese are also one of the smallest geese species. Combined with being herbivorous this has the effect that they need stopovers for feeding while on their migration between the high Arctic and the temperate wintering grounds (Ganter 2000). There are also other birds that feed on seagrass. In the Eastern Scheldt the main seagrass eating birds are the Brent geese and the dabbling duck (*Anas penelope*), further there are Mute swans (*Cygnus olor*), Mallards (*Anas platyrynchos*), Pintails (*Anas acuta*) and Coots (*Fulica atra* (Stucker et al. 2007).

For several years, Brent geese have been observed feeding in seagrass meadows in the Eastern Scheldt, including areas transplanted as part of the mitigation project being implemented by RU and NIOZ for Projectbureau Zeeweringen (Giesen 2010). There are two populations of Brent geese, a small resident population (200) and a much larger migratory population (av. 6000-8000), and it is especially the latter that feeds on seagrass meadows. Usually they feed on seagrass from the moment they arrive in the Netherlands in September until seagrass coverage is too sparse (usually around November). In early spring they again feed on freshly sprouted seagrass.

Brent geese have several methods of feeding on seagrass. They can stand in the water and stick their beak in the sediment to dig out the rhizomes whilst trampling the sediment surface to liquefy the sediment. This creates typical feeding pits (Giesen 2009). They also do this when there is no standing water on the seagrass. Brent geese can also take the seagrass out of the sediment straight away, which they do with and without standing water. There has also been an observation of Brent geese consuming seagrass that is floating on the water (Mather et al. 1998). On average, they have been observed to consume 134g dry weight of food sources per day (Madsen 1988).

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Most of their feeding techniques result in removal of all seagrass (rhizome, roots and shoots), and this results in the forming of 'so-called' feeding pits, that range from 15-56 cm diameter and can be 3-10 cm deep (Nacker & Reise 2000).

2. A geese feeding pit

When they feed in a destructive method for the seagrass in autumn, seagrass can only re-colonise the grazed area from the next spring onwards. In the meantime these pits are susceptible to erosion processes, while they can also act as traps for macro algae and attract and encourage geese to feed on and enlarge the initial feeding pit, especially if rhizomes lie exposed along a pit edge.

From literature (Jacobs et al. 1981) and personal communication (Dick de Jong) it is known that even after heavy grazing a seagrass meadow will survive the winter without disastrous losses in area. Feeding of Brent geese is thought to not have a significant negative effect on seagrass beds due to a reduced sedimentation rate. When seagrass is consumed, the rate of sediment trapping is lower, which causes the sediment level to remain suitable for seagrass instead of rising (Ganter 2000). Feeding pits can even act as positive sinks for seeds (Zipperle 2010). However, present effects on Eastern Scheldt seagrass are not really known as the seagrass population in this location appears to grow slowly compared to other seagrass populations (example: Sylt(Ger.)). Besides, the effects on and the resilience of relatively small seagrass populations (several square meter like transplants / one year old seedlings) are not clear yet.

Research questions:

1. What percentage of the seagrass transplant area is directly affected by geese feeding?
   - survey of feeding pit area

2. Is the affected area stable over time or are there indirect effects?
   - Survey on succession of feeding pits (regrowth of seagrass and sedimentation).

3. In the long term: Do geese feeding in a slow growing, small transplant accelerate seagrass collapse?

4. And does this depend on initial (Sep. 2011) seagrass density / area/ perimeter or configuration?

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Approach

In this experiment geese will be excluded from half of our one season-old transplants (RH11) and a temporal survey of the transplants will be conducted.

Number, location and depth of newly formed feeding pits will be monitored weekly using dGPS and pictures will be taken for further analysis of what happens with the feeding pits and what happens to the seagrass due to the feeding pits.

3. Establishing the exclosures

Expert judgement / checked literature on geese exclusion:

Peter Meininger (ornithologist with RWS): No experience in exclusions in aquatic environment. Suggested ropes at 20cm height. Beware of algae sink and fish / bird trapping side effects.

Karsten Reise: Experience in German Wadden Sea; caging works the best. Ropes don't work.

Kelly Elschot : Experience on salt marshes; boundary ropes at 20cm and 50cm work, might also use cross ropes to exclude aerial entrance of geese.

Andreas Zipperle: Experience in German Wadden Sea (Zipperle et al. 2010); bamboo with tape flag works for smaller plots, bigger size plots → use ropes. No cages → those will have negative side effects such as trapping algae.

RU-team: Pilot showed that rope method works for small(er) water birds. Birds do intrude the adjacent un-exclosed plot. To prevent a total physical obstruction of the experimental area, plots are excluded pair-wise, so geese can still walk through the transplant site instead of being completely redirected around it (fig.4).

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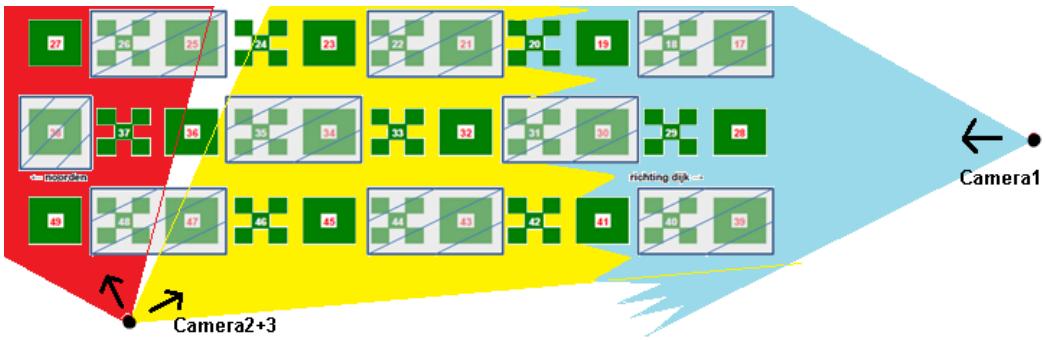
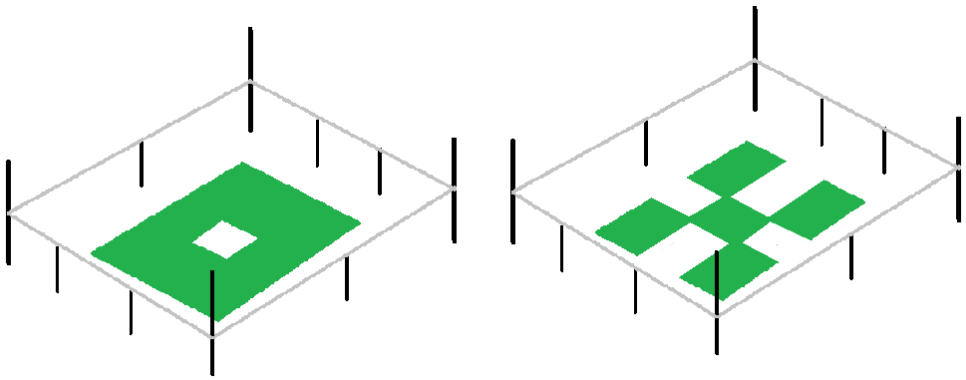
Methods

The areas (plots) with the blue rectangles around them are the areas where geese exclosures were established.



4. Overview of the transplant location RH11

The exclosures consisted of a nylon rope attached to poles to obstruct entry of geese from the sides. This rope was placed at a height of approximately 25-30 centimetres.



5. Sketch of the exclosures, around a donut shaped plot (left) and a checkerboard shaped plot (right)

dGPS:

With a dGPS system the feeding pits were measured and mapped. This will be compared to the seagrass coverage data of 2011 and 2012. The outlines of the feeding pits are monitored. The measuring of the feeding pits has been done from 16 September till 18 December 2011 with an interval of 6-9 days. 2012 Data comparison to seagrass coverage isn't included in this report.

Photographs:

Photographs of the feeding pits and the plots were taken to assess changes over time. In addition, photos were also taken by plantcams over-looking the plots to monitor bird activity; these plantcams took pictures at 1 minute intervals. These pictures were taken during the whole period where we expect geese feeding on the seagrass (September-December) with an interval of 6-9 days.

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Seagrass transplant location RH11

In June 2011 seagrass was transplanted as part of a mitigation process linked to a dike improvement programme that threatens seagrass meadows growing near the dike. (Giesen 2010)

Seagrass was transplanted to two locations at Roelshoek (figure 6), RH11, where seagrass was transplanted in June 2011, and RH08 where transplantation took place in 2008.

The RH11 transplant consisted of 33 plots of which 18 were placed in a donut shape and 15 in a checkerboard pattern. (Figure 4).

6. Transplantation Location

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Results until January 2012

7. Geese on the landward side of the transplant

Feeding pits:

The number of geese feeding pits was very low and appeared to be quite random and not specifically in the plots with or without an exclosure. In total 5 geese feeding pits were counted over a period of 2.5 months. Most of these feeding pits (3) were located in plots with an exclosure, but due to the low amount of feeding pits in total this doesn't appear to be representative.

The effects of the feeding on the seagrass will be looked at in spring 2012, when the seagrass starts to grow again.

The sediment surface of the geese feeding pits that were found quickly recovered (within 2-3 weeks) to a similar sediment surface state as the surrounding area. However, this is quite dependant on the weather conditions. It took a bit longer for the feeding pits to visibly disappear; this was up to 5 weeks, but on average the recovery of the sediment surface took arround 4 weeks

Total number of geese feeding pits observed: 5

Bird behaviour:

Looking at the bird behaviour provided some interesting results, as there seemed to be patterns in bird behaviour. Deducted from the 3 plantcams (Fig 4) it could be seen that the geese seemed to be moving around the transplant area rather than through the plots, that also includes the control treatment, this was also avoided. It also appeared that the geese mainly followed the water line with the tidal movement, preferably from the water side, thus swimming along with the upcoming or outgoing tide.

8. Geese mainly going past the transplant

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Most of the geese activity inside the plots was recorded during the period in which there was a small layer of water for the geese to swim in, which was around the same height as we placed the wires. The geese have several methods of feeding, but there is only one that damages the seagrass severely and causes the geese feeding pits. This is at the time they feed from the seagrass when there is no water or just a tiny amount (<5cm) of water on the seagrass. At this time they use their feet to disturb the sediment and dig into the sediment with their beaks to find the rhizomes. Observations of geese feeding which we made consisted out of pecking the leaves from the sediment surface, this was observed with cameras. Furthermore we observed geese feeding pits in the field when visiting the field locations itself, which we did every 6 to 9 days.

9. Geese have passed the transplant

The other methods of feeding are less destructive. These consist of several methods of grazing, which geese can do with water on the seagrass or without the water on the seagrass. As seagrass loses most of its leaves during winter anyway, this doesn't have a major impact.

From observations we made with the cameras which we placed at the field location we noticed several things. Feeding on the seagrass while swimming over the meadow seemed to occur on a regular, nearly daily, basis. The Brent geese are there nearly every day, it can be seen that the geese are following the waterline along a large stretch of mudflat, mainly avoiding the transplant location. Other bird species that occur at the transplant location follow the water line on the dry side and do not seem to mind the poles or the wires from the transplant location as much as the geese do.

There even seems to be an extra interest in the areas around the poles, as there is some collection of seaweed around the poles, which creates a niche for macrofauna, upon which the birds feed. The birds seen at the transplant location are the generalist mudflat bird species such as stilts and oystercatchers, although on occasion a crow or (unidentified) bird of prey was observed as well.

10. Geese feeding on seagrass in a transplant.

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Conclusions

It appears to be easy to scare the geese off, although to completely exclude them from the transplantation sites is complicated to achieve without disturbing the seagrass too much.

The geese exclosures could be considered as effective, though not exactly in the way which was intended and expected. **The exclosures didn't just limit the geese from entering the plots; they prevented the geese from entering the transplant location due to the scarecrow effect of the poles and wires**.

Recommendations for excluding geese in future transplants would be to make the transplant setup in a way that the corner poles which are used to mark transplants to cause a scarecrow effect for the geese. The plots where the seagrass is transplanted in should not be placed far apart from each other, the closer together everything is placed the better the scarecrow effect is. This is a balance between not getting too close to the seagrass to prevent scouring to happen in the seagrass due to the poles or that the poles affect the seagrass due to the algae and seaweeds that gets attached to them. Using wires doesn't give a significantly increased protection from grazing and using a net covering the seagrass transplant would cause too much algae and seaweed catch.

Though if you want to exclude geese from a seagrass meadow completely, this could be achieved by setting up the exclosures slightly different. Instead of using one wire, using two wires at different heights. This would result in a lot more maintenance to the field site, this has to be taken into consideration. The latter approach should be effective in keeping geese out of seagrass meadows during the destructive feeding period, that is when there is a thin layer (less than 5cm) of water on the seagrass, or no water.

For future geese exclosure setups it should also be kept in mind that it should be taken into consideration that an exclosure setup will always result in a scarecrow effect for the neighbouring area and thus placing a control plot next to an exclosure plot would be always result into an effect on the control plot. Advised distances would be more than 5m between the poles of a control and the control at least also 5m away from the exclosure. The smaller the poles are means you can reduce the distance between the poles without causing an effect on the geese behaviour. One of the transplants from 2008 suffered from geese feeding in the autumn and winter of 2009/2010. Here the poles were placed further apart with more spacing between the plots as well. The poles of the plots were placed 5-10 meter apart.

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