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Factors influencing the breeding success of two ecologically similar gulls the Lasser black-backed gull *Larus f. fuscus* and Herring gull *Larus argentatus* at Stora Karlsö

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Degree project thesis

Factors influencing the breeding success of two ecologically similar gulls the Lesser black-backed gull *Larus f. fuscus* and Herring gull *Larus argentatus*, at Stora Karlsö

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Contents

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Abstract

During the last three years the breeding success of the nominate lesser black-backed gull, *Larus f. fuscus,* at Stora Karlsö has been monitored. Results indicate that the breeding success is too low to sustain the colonies (0.08 chicks/pair). This year herring gulls, *Larus argentatus*, were also studied and their breeding success was also surprisingly low (0.14 chicks/pair). The expected breeding success to maintain a sustainable population is 0.45 chicks/pair. For both species 83% of the chicks in the census disappeared without a known cause. The most likely reason for chick disappearance was predation.

Predation by *Larus argentatus* explained the most of the chick disappearances for both species but didn't alone explain the reproductive failure and the large number of chicks found dead. Starvation did not appear to be a significant factor as a majority of the chicks exhibited good growth rates. Only those chicks that were found dead did not exhibit good growth.

Factors influencing the breeding success negatively are cormorant (*Phalacrocorax carbo*) colonies that compete for same nesting space with the herring gulls. Our presence in the hides from where we performed observations had a disturbing effect especially when we approached or left the colony. The presence and predation of greater black-backed gulls (*Larus marinus*) was a stressful factor for both gull species. Factors affecting the breeding success positively were experienced parents (i.e. parents that arrived early and chose nest sites in vegetated areas with few neighbouring birds).

Introduction

The aim of this study was to investigate the breeding success of lesser black-backed gull and herring gull and discuss potential factors that can affect breeding success, chick survival and population trends.

The lesser black-backed gull population in Sweden has decreased from 17,000 breeding pairs in the seventies to 4,000-5,000 today (Gärdenfors 2005) and is now on the Swedish red list, classified as vulnerable. This species is also on the red list in Norway, Finland, Estonia and Russian Karelia and their situation is thought of as critical (Gärdenfors 1999, Lorentsen 2004, Hario 2005). A study in 2003-04 (Lif et al. 2005) showed that the lesser black-backed gulls have recovered from the decrease in the nineties but had for unknown reasons an unsustainable low breeding success. Lesser black-backed gulls breed in Sweden, Norway, Finland, Estonia, Russia, Britain, Ireland Spain and France and on a few spots in Northern Africa (Wernham 2002) and there are about 240,000-260,000 birds in Europe (Papazoglou 2004). After the breeding season is over (about the end of July) the birds from Scandinavia migrate down to East Africa (Hario 2004) whereas the birds from the western part of Europe migrate to Southern Morocco and Western Sahara (Wernham 2002). The population in the Baltic Sea is regarded as separate sub-species.

The herring gull has been viewed as pests and a general nuisance species. It has locally been subject to intensive control measures (Wernham 2002). This is probably why the species hasn’t been studied thoroughly in Sweden. Today they are on the red list in Sweden, classified as least concern (Gärdenfors 2005). By the end of the nineties there where 50,000- 100,000 pairs in Sweden (Svensson 1999) and 500,000-590,000 pairs in Europe (Papazoglou 2004). In 1996 in Holland it was noted that their colonies had dropped in numbers by 75% (Bukacinska 1996). Herring gulls have a holarctic distribution, nesting at middle and boreal latitudes (Wernham 2002), i.e. North America, Island and the British Isles east to northeast Siberia, west Manchuria and in the Northern coast of Africa (Urban 1986). Of the argentatus group, which breeds in the northwest of Europe, the northerly populations are the most migratory; birds from the White Sea move to the Baltic during winter and those from the Murmansk coast winter around the southern North Sea. The Baltic populations move down south of Scandinavia or south of Europe. More southerly populations are thought to generally stay on the same coast throughout the whole year (Wernham 2002).

Plausible mechanisms

An unexpected high mortality in adult seabirds, mainly herring gulls, has caused concern during the last few years about the status of the Baltic Sea and its seabird species, yet little is known about the basic ecology of lesser black-backed and herring gulls. High mortalities have been observed mainly in the southern province Blekinge south in Sweden (Mörner 2005). To date we have very limited knowledge on the factors that control the population trends and breeding success in the Baltic Sea colonies of these two gull species, although a number of plausible mechanisms have been suggested, e.g.:

1. Predation by greater black-backed gull (*Larus marinus*) has been observed previous years (Lif 2005).

2. Competition for nesting grounds between herring gulls and lesser black-backed gulls. Herring gulls are bigger, more aggressive and have a wider range in their food source (Strann 1992) and are expected to have a higher frequency of nests and breeding success.

3. Starvation due to the lack of food. Lesser black-backed gulls are surface predators and feed mainly on herring and sprat (*Sprattus sprattus*) (Strann 1992) while herring gulls feed in the intertidal zones on e.g. bivalves, crustaceans or on garbage dumps (Kubetzki 2003).

4. Diseases or toxins. The Baltic Sea has since the seventies been known for its pollution problems (Olsson 2005) but the signs of recovery from known toxic substances are clear e.g. rapid increase of seals.

The competition, predation and starvation hypothesis (1-3 above) were investigated by comparing breeding success for lesser black-backed gulls and the ecologically similar herring gulls. To our knowledge, this is the first detailed study of herring gulls breeding ecology in Sweden. The studies were performed at Stora Karlsö, one of the largest breeding colonies in the Baltic Sea area, where population data for the lesser black backed gull exists from the years 1976 to 2004. The area is a nature reserve and hence the breeding sites are relatively undisturbed. Hereafter the lesser black-backed gull will be referred to as LG and herring gulls HG.

Material and methods

The study was performed on Stora Karlsö (57°17`N, 17°58`E) an island on the west coast of Gotland. Analogous to previous years the study was done from the beginning of May until the beginning of August (Lif et al 2005). On the island there were we six areas with both HG and LG colonies (map 1). We had our study colonies in area 1 (Langdal) and 3(Gjaushäll). The two species generally coexisted in the areas. In area number 1 we had colony 1, which consisted only of LG. In area 3 we had colony 2 where the two species had their nests close together. In area 1 the vegetation was dense and consisted of high grass and shrubs, juniper (*Juniperus communis*) and mahaleb cherry (*Prunus mahaleb*). This area has the largest colony of LG (276 breeding pairs). Area 2, 3 and 4 consisted of both dense vegetation and rocky beach. In area 4 most of the nests where found on open gobble stone beach and under scarce shrubs. Area 6 had scarce vegetation and rocky beach. Area 5 and 6 had in common that they consisted of very few nests.

During the nest count four persons searched the whole island for nests with eggs. The nests were marked with sugar cubes in order to avoid them being counted twice. Sugar was used because it melts away after a few days. The two study colonies were observed from hides with telescopes (Map 2). We performed several independent observations that lasted fours hours and also dusk-dawn observations on three occasions each one lasted 20h, changing observer every four hours. In total we observed 92 h in Langdal and 146 h in Gjaushäll. We registered attacks i.e. which bird (and of what species) attacked which nest and if the attack was successful or not. When the chicks were one day old they were ringed with a metal ring and thereafter they were weighed on a daily basis (spring balance of 100g, 500g and 1000g depending on the size of the chick). We did not go out on rainy days in order to minimize disturbance (it might affect the chicks not having the parents protecting them from the water). Chicks that grew older than three weeks were ringed with a red plastic ring with white letters and numbers. The chicks that were found dead were frozen or iced and sent for autopsy at SVA. When the fledglings were counted one person walked around the island for four hours staking out the fledglings with a telescope and binoculars and this was repeated for three days in a row.

Lesser black-backed gull

The nest count was done during 2nd of June. Many of the LG nests were hidden under shrubs of juniper and mahaleb cherry. Later in the season when mahaleb cherry starts to bloom it is very difficult to find some of the nests. The LG nest and eggs are quite similar to HG nest, but HGs build bigger nests in more open spaces and most of their eggs had already hatched at the time of egg counting. The fledgling count was done during 29th to 31st of July.

Herring gull

The nest count was done during 18th of May. There was also a colony in Östra Suderslätt (area 3) that consisted mostly of HG nests. From this colony we recorded data on the chicks weight and counted fledglings. We were not allowed to put rings on them. Instead we put a numbered white paper scotch tape on one leg when the chicks were one day old. The tape would loosen and fall of easily when in contact with rain or water. A new tape was put on it if the tape got to dirty or loose during the period of weighing. The fledgling count was done during 28th to 30th of June, a month earlier than the LG count as they hatched a month earlier.

Statistical analysis

For analysis of data of hatching success I excluded nests that were only found once or twice during the study. To compare chick weights between colonies, variances were compared with Excel's F-test Two-Sample for variances and means were compared with T-Test: two-sample assuming equal variances. To compare the breeding success of HG and LG and to compare the breeding success in different areas for each species, I used paired t-test. A non-paired t-test was done to compare LG colonies with and without hides. The mean birth weight of both species was tested with a paired t-test. Linear regression analysis was used to investigate the relationship between weight and age in LG

Results

Number of breeding pairs and breeding success

The first HG chick hatched in Ö. Suderslätt 16th of May and in Gjaushäll the 21st of May. The first LG chicks hatched June 1st in Langdal and in Gjaushäll the hatching didn't start until the 8th of June. We found 562 LG nests and 46 fledglings (2 fledglings in colony Langdal and Gjaushäll with 130 of pairs), which results in a breeding success of 0.08 chicks /pair. There were 546 HG nests on the island and we counted 75 fledglings (of which 5 in total are in Gjaushäll and Ö. Suderslätt with 111 of pairs and an average of 0.14 chicks/pair, table 1) but there was no significant difference between the species in breeding success ($P > 0.19$). Altogether, the numbers of breeding pairs of LG have been estimated through nest counting six occasions (table 2) and the numbers of pairs have not changed dramatically.

The breeding success of both species varied between the areas 1-6, but had an equal rate within the area (figure 1). The breeding success for both species is equally low in area 1-4 and relatively high in area 5 and 6. The number of pairs and breeding success have been put together and there seems to be a pattern (figure 2), with higher breeding success in colonies with few breeding pairs.

Disappearing eggs and chicks

A large proportion of all eggs disappeared and they were assumed to have been predated. The hatching success for LG and HG averaged at 31% and 36% (table 3). Estimated hatching rates for LG in 2003 and 2004 (Lif et al.2005) were higher because disappearing eggs were assumed to have hatched and therefore not found. In 2005 the disappearing eggs were assumed to be predated, with the argument that the egg were not old enough to hatch. If they had been old enough to hatch the chicks would be too small to run of far enough for it not to be found. If we had assumed that the disappeared eggs had hatched the hatching rate would be 99% (table 4).

There were two data sets to make calculations from: the observed chicks, which is data gained from the hides. The second data set were we assumed that disappeared chicks were dead. The fates of the observed chicks were divided in four categories: found dead, observed predated, disappeared and fledged. Of the hatched chicks 3.6% of the LG chicks and 7.8% of the HG chicks were found dead. Only HG was observed predating on LG chicks and they took 12% of the hatched chicks. Herring gulls chicks were also predated and we saw 17% of the chicks being taken by conspecifics. Attempts by greater black-backed gulls to take chicks were observed on both LG and HG but they were not successful at the time (table 5). The amount of missing chicks averaged at 83% for both species. Out of all the chicks only 2% of the LG and 5% of the HG chicks survived to fledglings in the study colonies. If we only look at the observed data the result for LG was: 21% found dead, 68% predated and 11% fledged. Of the HG chicks 33% were found dead, 47% were predated and 20% fledged (table 6a and 6b). This may be representative in the group of chicks with unknown fate. To test what else could be affecting the colonies four factor were proposed: hides, mixed colonies, the presence of greater black-backed gull nests and cormorant colonies.

These factors were thought to affect the breeding success and the important factors for each area were marked with an x in the areas in which they occur (table 7). The areas that had several of the potential affecting factors had the lowest breeding success. Mixed with HG means that the nests were about 1-3 meters apart. A non-paired t-test comparing area 1 and 3 (with hides) to the rest of the areas was performed and there was no significant difference in the breeding success ($P>0,32$, non paired t-test). There was no significance in a two-tailed t-test assuming unequal variance either ($P>0,19$) but the lack of significance could be due to the lack of enough data.

Growth and weight of chicks

There was no statistical significant difference between the mean birth weights of the chicks in the colonies ($P>0,15$ for both species; T-test for samples with the same variance). More of the HG eggs survived and hatched successfully and had also a higher survival rate until day seven and also to fledglings (Table 8). LG chicks in colony 1 grew equally well (22g, first day, figure 3) as reported by Lif (2005). Colony 2 had few surviving LG individuals to produce a corresponding trend line (figure 3).

Autopsy results

Unfortunately some of the chicks had defrosted and started decaying before the autopsy. Despite this, studies were done on bacteria, parasites and tissue samples. Three of the LG were thin in body but no microscopical changes were seen on their inner organs one had a broken neck. Out of the five HG chicks two were thin but without microscopical changes on inner organs. One had blood in its abdominal–intestine channel and one had signs of an infection. The last one was too rotten to be properly examined (table 9).

Discussion

There was no significant difference in breeding success between the two species studied. HG appeared to have a significant influence on the survival of LG through predation. There was no evidence of nesting site competition between the two species, due to different preference in choice of habitat in the areas. However some of the different surrounding factors between the areas had a negative effect on breeding success. It seems that the hides that where put up for observations of the colonies, in addition with cormorant colonies and density of nests within the species are interfering factors. Starvation did not seem to be an issue as the chicks' growth rate was good. However all the chicks that were found dead were classified as being of poor condition, which may indicate that a disease or toxin had affected these chicks. Poor parental care (i.e. adults eating their own eggs or neglecting to feed their chicks, Hario 1990) may also have had a negative impact on the breeding success.

We studied two colonies, one that contained only LG and one where HG and LG were mixed. The two species did not have their nests close to each other and did not appear disturbed by the neighbouring species. In Gjaushäll where the two species breed together some of the LG eggs didn't hatch until eighteen days later than the HG eggs. According to Kim (2003 and 2005) the HG and LG that arrived late to a location are most likely first year breeders and subsequently their chicks hatch later. Hatching late could deprive the chicks the protection of the colony from predators as the adults loose interest in protecting the colony as soon as their chicks become older (pers.obs.). The LG in Gjaushäll could be young breeders as they chose such an unsuitable site, by the seashore on the rocks unlike the colony 1 in Langdal where the vegetation consisted of juniper and tall grass. The breeding success in colony 2 was zero.

Out estimates of the number of fledglings can have been biased in three ways. During the assessment, some birds flew away and might have been counted twice. It is also possible that fledglings move from their colony into other areas due to the territories not being guarded when the chicks are older. In addition, juvenile HGs and LG are very similar and therefore may have been mis-identified. In this study the number of breeding LG pairs was 562 with a breeding success of 0,08 fledglings per pair. This could be seen as a small increase from the previous year, 477 and 0,02 fledglings. I did not take into account the late breeders as was done in Lif et al. (2005) where the numbers were estimated to 600 pairs at Stora Karlsö. It appears that the size of LG population on Stora Karlsö has been the same over the last three years. Even thou we spent substantially more time observing LG this year (238h of which

146h in Gjaushäll) compared to previous year (52h) we were unable to determine the fate of all chicks. Most of the chicks of both species disappeared. The possible causes for the chicks' disappearances were: predation or dying of unknown cause, a few of the dead chicks that we found were quite hidden in the scrubs and it's likely that there were more chicks that we didn't find.

Predation

Herring gull was the main predator on LG chicks, with a successful attack rate of 60%. A smaller number of attacks on LG were done by conspecifics, but these attacks could also have been territorial markings and not an attempt to eat the chicks. Very few attacks by greater black-backed gulls were observed, which could be due to our presence in the hides that appeared to stress them. It is not impossible that the Greater black-backed gulls eat a substantial amount of the LG chicks. Lif observed four LG chicks being eaten by Greater black-backed gulls in 2004. From my own observations and as shown by Hario (1996), it appears that only healthy chicks were predated on. In our study 68% of the observed healthy chicks of the LG and 47% of the HG chicks were predated. There were no predation attempts on the chicks that were observed dying. If fewer chicks are healthy the few that are healthy will probably be eaten. This would mean that the viability of the colony would be reduced and the breeding success would decrease. The high percentage of predation by HG could also be the result of an observer being present and making the LG parent nervous and leaving the nest unattended.

A way to get an indication to the fate of the disappearing chicks is to look at the weight curves. Hario (1996) illustrated a weight curve of chicks with five different fates: fledged, predated, died 0-4 days, died >4 days and disappeared. The data in our study of LG was not enough to do a similar graph although for HG we had more data (figure 4). Hario (1996) showed that chicks that died from other causes than predation whatever the age, didn't gain weight. Chicks that fledged or got preyed on followed a healthy curve. However Hario (1996) put all the disappeared chicks in one category together, which may have biased the results. Instead of putting them together one could take the weight curve of each individual chick and place it in the graph with the compatible category (i.e. the weight curve that matches the unknown-fate chick weight curve) and be able to predict the fate of each individual. If the unknown-fate chick has a healthy weight curve then one can possibly rule out that it has died of disease.

Starvation

When comparing the weight curves with Lif (2005) and Hario (1990) the results in this study indicates that 2005 was a “better-quality year”, which means that there was enough food for the parents to feed their chicks. According to life-history theory, birds are less likely to breed when food availability is low (Erikstad et al 1998) as this would decrease fitness and put their survival at risk, so it is not likely that the chicks were starving. The only time chicks would starve is if the parents left or if a sudden ecosystem change or catastrophe would occur. In Hario (1996) the LG chicks were provided supplementary food but this had no effect on the breeding success, an equal amount of chicks died in the supplement fed group as in the control group. The chicks that were autopsied had empty alimentary tracts. One could believe that this was due to starvation, but they may also have been sick and therefore too weak to eat (Hario et al. 2004).

Competition and other surrounding factors

HG are larger and more aggressive than LG and were expected to be dominant in areas where species shared nesting grounds. This was expected to give the HG higher reproductive success rates than LG in colonies with both species. The results however indicate that both species are equally successful and that breeding success rate varies among the areas. HG have their nesting sites on gobble stones in open areas and should therefore not compete for the LG habitats as they prefer to build their nest under bushes and in sites with more surrounding vegetation (Kim 2005). Even thou HG feed on LG there was not significant difference in the two species breeding success. This indicates that the populations are also being affected by other factors such as cormorant colonies, the hides, the presence of greater black-backed gulls and vegetation (table 8).

In 2001 there were 50 Cormorant nests on the island of Stora Karlsö and in 2004 there were 978 nests (Andersson 2004). When comparing maps with the distribution of HG and LG from 1998 and today it is clear that HG have become less frequent in the areas where the cormorants colonies have increased in size (Map 2). The HG decreased substantially (68%). This is probably because the Cormorants have taken over the attractive nesting sites. LG has however increased in numbers, probably because they use other habitat and thus are not affected by cormorants. Increased numbers of cormorants could thus explain the decreased total number of nesting HG, but it does not explain the decrease in breeding success.

It seems that the birds react very differently to the hides that were used in this study (pers.obs.). Some birds flew off and stayed away during the whole observation period, which lead to the eggs getting cold and therefore not hatching. Eventually the parents abandoned the nest. Other birds didn't seem to mind hides, but curiously approached them and even landed on them. This was the case for both LG and HG. Although this was not statistically verified, this study indicates that hides can disturb the breeding gulls, and the hides have been used for three years and may have contributed to the low breeding success in the areas.

In the areas 2, 5 and 6, where HG pairs exceeded the numbers of LG, I had expected that LG would fail due to the predation by HG. The breeding success of LG in these areas was higher than that of HG. This doesn't coincide with the theory that the pressure of HG predation would lower the breeding success. The areas 5 and 6 had high breeding success. These areas have in common that there were few nests, especially area 6 (18 HG, 6 LG). Chicks raised on large territories will most likely avoid neighbour interference and survival rates will be high (Hunt 1976). It could also be an indication of density being too high in the areas 1-4 (figure 2) for the adults to be able to protect the chicks. There was also the lack of a hide and greater black-backed gull nests in these areas. There is also the possibility that these chicks were fed by tourist as this area was close to the harbour. At least two of the HG chicks were observed being fed.

Vegetation is also a factor that affects LG and HG breeding success (Kim 2003, 2005). Unfortunately we did not take note of what was surrounding each and every nest. Although HG build their nests closer to the shoreline and LG breed further inland. Kim's (2003 and 2005) studies show that early breeders seemed to pick the vegetated areas that protect the chicks from predators, wind and keeps a steadier microclimate and these are usually more experienced and "better-quality individuals". All this gives a positive affect on the breeding success. In this way colony 1 and 2 seem to fit the theory. Colony 1 had high grass and Juniper bushes while colony 2 with nests on bare rocks hatched a week later. In colony 2 the LG had no fledglings while colony 1 had 2 fledglings. This is not enough data to make any statistical calculations but it gives leads on were to look further.

Dieses and toxins

The nine chicks sent to be autopsied arrived in a bad state but some analysis could still be done. The cause of death was from starvation, physical violence and lesser infections. The chicks did thus not have a common cause of death, and we can rule out the increased mortality among waterfowl that has been occurring in the province Blekinge area south in Sweden (Mörner 2005) as neither chicks or adults had the symptoms commonly seen with this plague. We were unable to do any toxin or organochlorine tests the chicks, but Hario (2004) shows that the levels of organochlorines like DDE and PCB were quite high in the LG chicks compared with other seabirds. Especially the levels of DDE were high which was surprising as these levels were decreasing in the Baltic Sea. In HG the levels of organochlorines were much lower and reflected the levels of the sea. Hario's theory is that the LG accumulate DDE in the winter quarters outside the Baltic Sea for e.g. in Africa. This theory could not be confirmed in our study as both HG and KG had low breeding success but the toxin levels would be important to reveal, as it might be high in both species and give a clue to the dead chicks with unknown cause.

Other observations

From this study it is difficult to determine any population trend. If the breeding success doesn't increase within the next few years, as there are not enough chicks surviving. For a colony to survive one would expect a gull to produce at least one surviving chick during its lifetime, preferably more than one. Assuming a breeding success of any of these species in a good scenario (i.e. assuming a higher number of breeding success that we got in the study) at 0,15 chicks per pair and year, this means that if (in a very optimistic scenario) an LG and HG have a lifetime of about 20 years (The oldest ones found in Sweden were 24 and respectively 25 years, Fransson 2005) minus the four years that it takes before it starts breeding, then a pair would produce 16x 0,15 = 2,4 chicks during their lifetime. Today's low fledgling production is most likely not sufficient for the colony to persist, as too few young are surviving to compensate for the adult mortality. Hario (1994) recommends a breeding success that is 0,45 chicks/pair/year (7,2 chicks during their lifetime). This would cover the 44% survival from first winter to maturity and the 10% annual adult mortality.

I don't know if the breeding success that I found was characteristic only for 2005, or if it has been at this level also before. But if the numbers of pairs stay the same or increase and the breeding success continues to decrease or stay at the same level, then immigration from other colonies can be assumed. It has been seen in Spain (Galván 2003) and the UK (Rock 2005) that LG and HG are adapting and increasing in these warmer areas were food is available (i.e. at rubbish dumps). In 2004 there were 120.000 LG urban roof-nesting pairs in the UK (Rock

2005). If the birds from these two countries are staying in Europe during the winter season it means they no longer migrate down to Africa and this would increase these birds' condition for the breeding season. This and the fact that these birds don't feed from the Baltic Sea, which is more polluted than the North Sea and Mediterranean Sea, can explain why the colonies in Spain and UK are increasing in numbers. The theory of influx of course needs to be monitored.

The quantity of sprat (*Sprattus sprattus*) in the Baltic Sea has changed substantially (ICES 2005) and the numbers of breeding pairs of LG on Stora Karlsö appears to correlate to this. Unfortunately there isn't a complete data set for the number of pairs. However, there is a significant correlation between clupeid (sprat and herring) biomass and the number of breeding pairs at Lilla Karlsö, the neighbouring island (H. Österblom pers.obs.). The amount of sprat in the Baltic Sea could give an explanation to the population trends. If there is a shortage of food at sea it is likely that HG, having a wider food range, increase predation on land, which could be an explanation for the high predation rates on LG. Votier (2004) expresses concerns that reduced fishing in the Baltic Sea may have an impact on the gulls, as many gull species seem to depend on the discards from the fisheries. This does not however explain the reason for the unexplainable deaths of chicks. No observations have been done at knight but the frequencies of feedings are higher at dusk and dawn (pers.obs.). Because these gulls are surface feeders (Strann 1992) it is likely that the gulls fly off to find food at knight when the fish is closer to the surface and easier to catch.

Conclusion

The low breeding success of LG and HG does not appear to be a result of food availability as the chicks gained weight, but is more affected by predation, surrounding factors like site competition and human interference. However, the amount of sprat and herring could help predict the fluctuations of the breeding pairs in the Baltic Sea. But for the chicks to survive other requirements are necessary such as experienced parents that are good at fishing, able to select a good nest sites and aggressive enough to keep predators away. The result in this study were not sufficient to draw conclusions about if parents were being negligent due to factors like DDE and PFOS (Perfluorooctanesulfonate) in the Baltic Sea, climate change that could affect the seasons starting point and affect the migration timing or bad conditions in the winter quarters which was suggested by Hario (2004).

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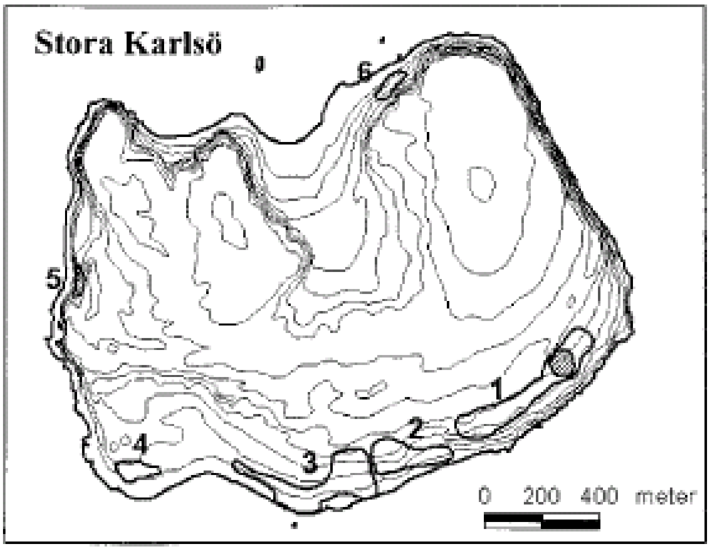
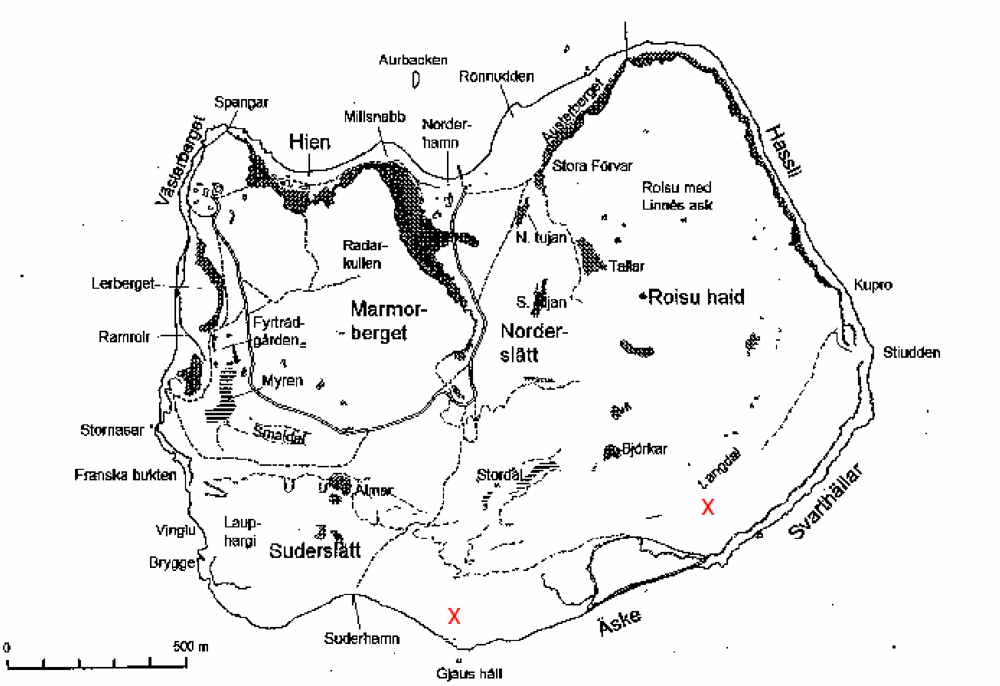
Figures

Map1. The colony areas for LG and HG on Stora Karlsö. (Lif 2005)



Map 2. The cross marks the placement of the hides.



Map 3. HG nests 1998 in where there were 238 pairs there is now an increasing number of Cormorants. The number of HG in the same area 2005 is 75 pairs (only 32% left, Hedgren 2000).

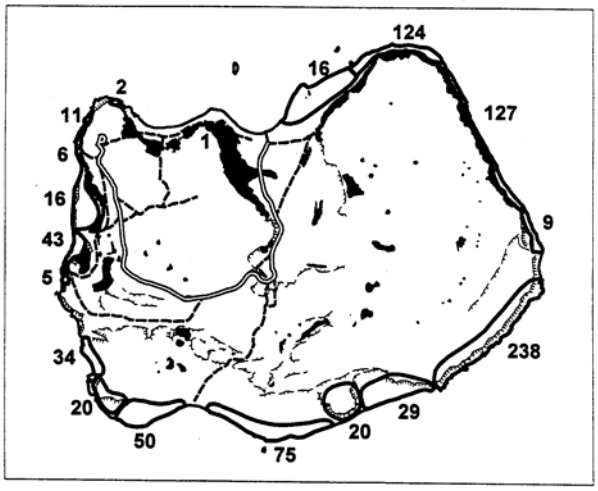


Table 1
Number of nests, fledglings and breeding success on Stora Karlsö 2005.

Area	HG No of pairs	Fledglings	HG	LG No of pairs	Fledglings	LG
1	75	3	0,04	276	5	0,02
2	133	1	0,01	65	3	0,05
3	102	17	0,17	113	3	0,03
4	82	2	0,02	91	15	0,16
5	31	6	0,19	11	9	0,82
6	18	14	0,78	6	11	1,83
Average			**0.14**			**0.08**

Comparing the breeding success between the two species: Paird T-Test P>0.19. The HG breeding success was only counted in the areas were there were LG nests.

Table 2a
Number of breeding LG pairs at Stora Karlsö. Data for 1976- 2003 from Lif et al. (2004).

Area	**1976**	**1985**	**1998**	**2003**	**2004**	**2005**
1 Fanterna- Lilla Äske	303	93	199	277	246	276
2 Lilla Äske, vik och udde	77	52	16	43	65	65
3 Stora Äske-Suderhamn	121	110	62	146	108	113
4 S och SO Lauphargi	153	95	44	49	36	91
5 Ramroir	-	-	2	10	12	11
6 NO Stora Förvar	-	-	-	7	10	6
Total	654	350	323	532	477	562

2b Number of HG pairs at Stora Karlsö. Data for 1998 from Hedgren (2000)

Area	**1998**	**2005**
Total	826	**546**

Table 3
Hatching success in the study colonies 2005.

	LG			HG		
	Langdal	Gjaushäll	Total	Gjaushäll	Östra Suderslätt	Total
-No of nests in the colony	98	32	130	70	41	111
-Mean clutch size	2,8	2,47	2,71	2,52	2,66	2,58
-No of eggs	274	79	353	177	109	286
-No of failed piping or dead eggs	2	-	2 (1%)	1	3	4 (1%)
-No of assumed predated or missing eggs	175 (64%)	66 (84%)	241 (68%)	135 (76%)	45 (41%)	180 (63%)
-No of hatched eggs	97 (35%)	13 (16%)	110 (31%)	41 (23%)	61(56%)	102 (36%)
-Chicks found dead	3	1	4 (4%)	6	2	8 (7,8%)
-Observed predated chicks	11	2	13 (12%)	7 (17%)	No data	-
-Missing chicks	81	10	91 (83%)	26	58	84 (83%)
-Fledglings	2	-	2 (2%)	4	1	5 (5%)

Table 4
Lesser black-backed gull clutch size and hatching rate compared with previous years.

	2003	**2004**	**2005**
Clutch size	2,81± 0,41	2,91± 0,29	2,59 ± 0,64
Unhatched eggs	2,5%	2,9%	0,5%
Hatching rate	91%	84,1%	31% (99%)*
Predated eggs	6,5%	13%	3,7%

* If all disappeared chicks are assumed to have hatched.

Table 5
Predation observed at colony 1 and 2. HG attacks are both on LG and other HG. The LG attack was on its own species. The greater black-backed gull attacks were on both species.

Species	HG	GG	LG	Total
No of attacks	15	3	8	26
Successful attacks	9 (60%)	0	1 (13%)	10 (38%)

Table 6a
Calculations without the disappeared LG chicks. In colony 1 and 2.

Total numbers observed after hatching	19	100%
Found dead	4	21 %
Predated	13	68 %
Fledglings	2	11 %

Table 6b
Observed HG chicks in colony 2.

Total numbers observed after hatching	15	100%
Found dead	5	33 %
Predated	7	47 %
Fledglings	3	20 %

Table 7 Affecting factors for the two species.

Area	HG	LG	Hides	Mixed colony with HG	GG nest	Cormorant colony
1	0.04	0.02	x			x
2	0.03	0.05				x
3	0.17	0.03	x	x	x	
4	0.04	016				
5	0.19	0.82				
6	0.78	1.83				

Breeding success in colonies with hides compared with colonies without hides did not differ significantly P= 0,189971.

Table 8

Area/ species	Mean birth weight	Hatchling survival 1st day	7th day	Fledglings	St.Dev on birth weight
1 LG	54,38	43 % (42/97)	5% (5/97)	2% (2/97)	3.8
3 LG	54.2	31% (4/13)	-	-	4.3
3 HG	62.16	63% (26/41)	41% (17/41)	4% (4/97)	6.9
2 HG	65.07	56% (34/61)	16% (10/61)	1,6% (1/61)	8.4

There was no significant difference in either of the species comparing the birth weight. HG: T-test two-sample equal variance P> 0,17. LG P>0,50.

Table 9

	Area	Age (d)/ Gender	Body / Hull
1 LG	Langdal	3/ M	Thin
2 LG	Langdal	3/F	Very thin
3 LG	Langdal	??	Thin
4 LG	Gjaushäll	2/M	Average
5 HG	Gjaushäll	9/M	Thin
6 HG	Gjaushäll	15/?	Thin
7 HG	Gjaushäll	3/M	Thin
8 HG	Gjaushäll	8/M	Thin
9 HG	Gjaushäll	8/M	Thin

Figure 1
Breeding success of LG and HG in the areas 1-6.

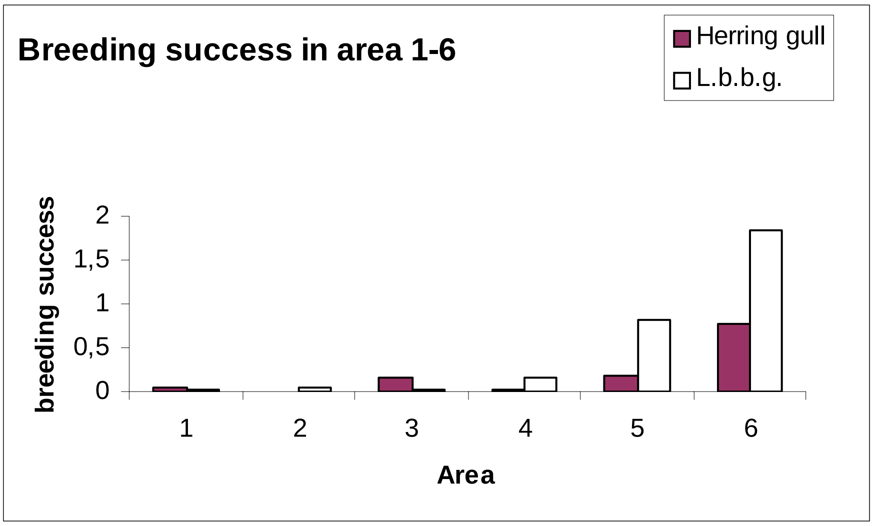


Figure 2
Breeding success and number of pairs of both species in areas 1-6

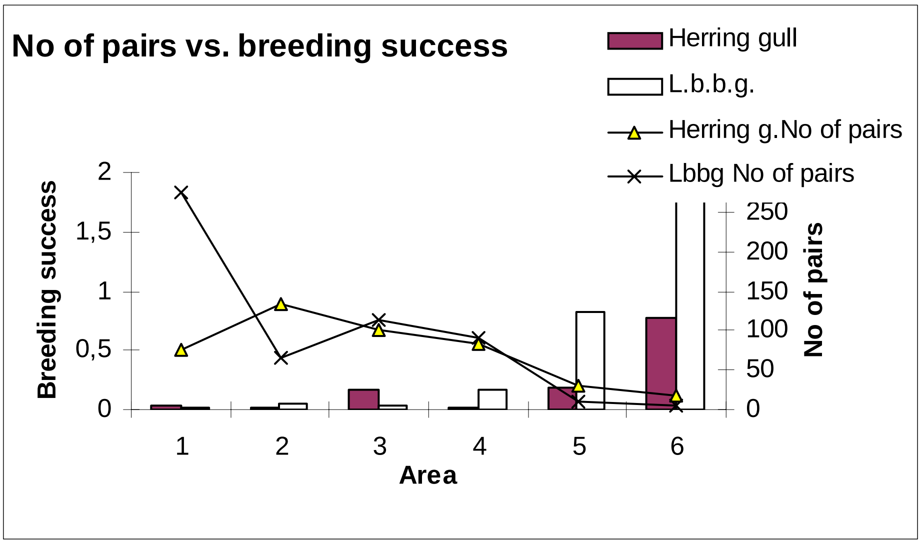


Figure 3

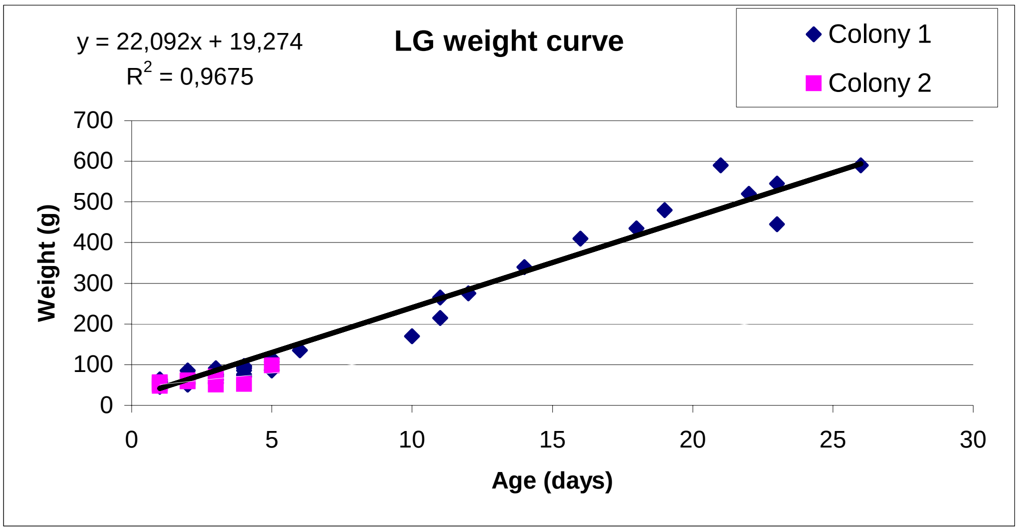


Figure 4
LG chick fate. In this study there wasn't enough data to make the statement clear.