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# The Caspian terns of Fågelsundet – a report on Caspian terns in Björns archipelago



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“The Caspian tern is a spectacular bird which, due to its rare and charismatic nature, has sometimes been used as a colorful symbol for a healthy and clean Baltic Sea.

The species' behavior, aggregating in highly productive shallow areas, both limnological and marine, during different seasons, makes it an appropriate indicator species for biologically rich areas”.

(Quote from the World Wildlife Fund (WWF) in the Action Program for the Conservation of Caspian terns (ÅGP Skräntärna))

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## Summary

The world's largest tern, the Caspian tern, breeds in Europe in three areas, the Baltic Sea (1700 pairs), the Black Sea (800-1200 pairs) and the Caspian Sea (historically many, > 2500 pairs). Since the 1970s the Swedish population has decreased from 1,000 pairs to 500 pairs as of today. Reasons for this decrease are, amongst others, the spread of American mink to our archipelagos during the late 1970s and 1980s. As the tern is an endangered bird species, the Swedish Environmental Protection Agency has commissioned the County Administrative Boards to develop and implement a national action program for the species, ÅGP Skräntärna. The program has been ongoing since 2007 in 5 year periods, and the current period is 2017-2021. Within the framework of this program, the Uppland Foundation (Upplandsstiftelsen) conducts mink hunting in Björns archipelago and extensive monitoring, including the use of webcams (operated and maintained by BirdLife Sweden) at the Stenarna colony in Björns archipelago in northern Uppland.

The colony has ancient origins and has been documented since the 1930s. At the end of the 2000s, the colony grew and has occasionally during this period been Sweden's largest colony with about 200 pairs. During the 2000s, the colony accounted for up to 25-40% of the Swedish population. Stenarna is the colony where most juvenile Caspian terns are ringed in Sweden, over 215 of all ringed Caspian terns have been ringed on Stenarna.

The second half of the 2000s was eventful for the Caspian tern colony on Stenarna. During January 2007, the colony was very strongly affected by storm Per washing almost the entire large gravel bank on which the terns normally nest out to sea. Breeding in 2007 therefore spread throughout the island, resulting in no documented fledged chicks.

In December 2007, the County Administrative Board restored the gravel bank. The Caspian terns accepted the newly restored gravel bank and the colony has been concentrated there during subsequent breeding periods.

During 2007-2009, no chicks fledged on Stenarna. Increased monitoring efforts using a webcam found that white-tailed eagles predated eggs and herring gulls predated chicks, explaining the lack of fledged chicks.

ÅGP Skräntärna then decided on measures against the predatory herring gulls. Eggs were removed from gull nests and after a year or so they moved to the neighbouring island and predation ceased. Predation by white-tailed eagle has continued and unfortunately has become more frequent. At present, a doll in a boat is used to deter the eagles. Time will tell if this works. So far, it has shown positive results and in 2020, a total of 190 Caspian tern pairs nested in the colony, yielding approximately 240 fledged chicks.

The Upplands Foundation has conducted an effective mink hunt in Björns archipelago. Since its inception in 1997 there has only been one occasion (2003) when mink have swum out to the colony and bitten Caspian terns, killing approximately 50 chicks on this occasion.

BirdLife Sweden, together with the Department of Biology at Lund University and Novia University of Applied Sciences and the Turku Academy in Finland, have conducted studies on the terns. GPS loggers attached to specific individuals have yielded high resolution data on the terns' movements and habitat use. These studies have been carried out at the *Stenarna* colony in Björns archipelago, but also at Finnish colonies in Ostrobothnia and at other Swedish colonies including Bråviken, Luleå archipelago and Oskarshamn.



*Figure 2. Adult Caspian terns having 'a discussion' about boundaries between nests at the Stenarna colony. Photo Ulrik Lötberg*

Analysis of data from the GPS loggers has revealed a lot of new knowledge about Caspian terns and their behavior. It has been believed that females and males form lifelong pairs, and while this does occur, it is more common for terns to change partners at the beginning of each new breeding season. Additionally, females and males tend not to overwinter in the same locations. The process of courtship and forming pairs must therefore be important to the terns and only takes place in proximity with the nesting area (i.e. the colony). Areas adjacent to the colony during courtship need therefore to be undisturbed and contain plenty of forage fish. Analysis of information on tern fishing grounds shows that the undoubtedly most important areas are the inner part of Lövstabukten, Ledkärsviken and Karlhomsviken. These areas are frequently used throughout the breeding cycle and are particularly important during the initial mating portion of the breeding season. These areas in combination with area immediately surrounding the colony at *Stenarna* are key reasons for the terns' high occurrence in Northern Uppland.

Another important fishing area includes the eastern Hållnäs coast from the inner part of the Slada-Kungsten archipelago down to Kallrigafjärden, in particular the inner archipelago of Barknårefjärden and Skaten-Rångsen.

Towards the end of the breeding season the juveniles need to prepare for their first migration south. Aside from Ledskärs- and Karlhomsviken, the large and shallow lake Tämnaresjön is important during this period. Adult terns tend to join their young at such locations, of which a few major ones outside of Uppland include lakes Hjälmarén, Tåkern and Hornbogasjön.



## Background

### The Caspian tern – the largest tern in the world

The Caspian tern is the largest tern species in the world, roughly the size of a small gull (slightly smaller than a lesser black-backed gull). It has a body length of 48 - 56 cm, a weight of 570-780 gram and a wing span of 127-140 cm (taken from the Action Program for the Conservation of the Caspian tern). It is easily recognizable in our region due to its large size, black crown, large long red beak, black legs, white body and light gray back and upper wing and shallowly split white tail. Even its hoarse loud call is unmistakable. Juveniles differ from adults by having orange legs, white spots dotted in the otherwise black forehead / crown and slightly dark spots on their gray back. Their call also differs, with the juvenile making a strong yet squeaky piping sound.



*Figure 1. The Caspian tern, with its size, heavy red beak and light mantle, is unmistakable. Its loud and hoarse call that can be heard from a distance, contributes to this. Photo Ulrik Lötberg.*

The Caspian tern can get quite old, with individuals over 30 years of age having been recorded. Breeding begins with courtship of the females by males offering them fish. Typically two to three eggs are laid between May and June and are incubated by both sexes for 22-27 days. Chicks fledge after approximately 30-35 days post-hatching. The terns leave the colony shortly after the chicks fledge. In some cases the first longer chick flight (more than a few metres) is the one where the chick leaves the island together with one of its parents. During migration south, the parents



divide the chicks between them and move separately from each other with chicks in tow. Parents accompany their chicks for the duration of migration to over-wintering sites, where the adults stop feeding the chicks and contact is eventually ceased.

The Caspian tern feeds mainly on fish and regularly flies several tens of kilometres in order to seek out rich fishing grounds. These are often sheltered and shallow inland lakes, rivers and bays. Fish are caught by plunge-diving from a height of ca. 10 meters. Diet studies have been conducted in Finland and this has included some material from Sweden. Analysis of pellets collected at nesting sites revealed 12 different species, of which roach, perch and herring were the most common. Roach dominated diet in early May, with perch becoming just as prevalent in June. (Koli & Soikkeli 1974). Due to salmon and trout tagging efforts it has also been found that exposed smolts occasionally make up a portion of the terns' diet. Fishing usually takes place in shallow bays or nutrient-rich lakes with a water-depth of less than 2 meters (Martin Beal, pers. comm.), the exception being fishing for spawning herring which takes place at locations with greater depths.



*Figure 2. A Caspian tern with a freshly caught roach. The Caspian tern exclusively feeds on fish, preferring 10-15 cm size fish, mainly roach, perch and herring, which are caught by the tern plunge-diving from about 10 m height into the water (Photo Ulrik Lötberg).*

## The Caspian tern is distributed globally with three populations in Europe

The Caspian tern occurs throughout the world. It breeds on all continents except South America (where it over-winters) and Antarctica, where it has never been reported. In the Baltic Sea there is a population that is quite distinct from others. In Europe, there are three populations/areas where the species breeds: the Baltic Sea, the Black Sea/Lake Azov, and the Caspian Sea. The largest of these populations is that of the Caspian Sea that spreads into Asia. The Volga Delta alone in the Caspian Sea previously held 2,500 pairs, however these data are old (1970's/1980's) and the species has since declined in the area. More recent estimates indicate closer to 1,000 pairs. The species is named for the Caspian Sea in Latin (*Hydroprogne caspia*) and English (Caspian tern). The Black Sea and Baltic Sea populations are smaller, the Black Sea population consisting of 800-1200 pairs and declining as of 2010 (Olga Yaremchenko, BirdLife Ukraine, pers. comm.).

The Baltic Sea population consists of approximately 1600-1700 pairs, of which just over 500 are found in Sweden, with ca. 850 in Finland (Patrik Byholm, pers. comm.) and ca. 250 in Estonia (Trinus Haitjema, pers. comm.). There are also a few single pairs in Russia around Ladoga/St. Petersburg and a small colony on the island of Saltholm in Denmark.

## The Baltic Sea population is the only occurrence of the species in the EU

The Baltic Sea population is shared between Finland, Sweden, Estonia and Russia. This means that birds born in one of these countries can breed in a neighbouring country. Once terns have established themselves in a colony they are usually site faithful as long as the colony is viable (Staaay 1979). The Black- and Baltic Sea birds partially share the same wintering areas south of the Sahara: the Niger delta in Mali, Lake Chad in Chad and the Nile delta in Egypt. Despite the expectation that the populations overlap there, there are no confirmed exchanges between these populations. The Baltic Sea population, especially the Swedish birds, overwinter to a fairly large extent in West Africa and then mainly in coastal rivers and wetlands in Senegal, Mauritania and The Gambia, as well as in southwestern Spain and southeastern Portugal. The majority of terns that breed in Svealand and Götaland overwinter in West Africa, especially in Senegal and Mauritania. The terns from Norrbotten (North Bothnia), on the other hand, tend to overwinter in the Niger delta in Mali and lake Chad, and to some extent in the Nile delta in Egypt and in Sudan. The Finnish terns have their main overwintering grounds in Egypt, Chad, Sudan and along the Red Sea, but are also found in Mali and in Senegal/Mauritania together with our Swedish terns (Patrik Byholm, pers. comm.).

## The Caspian tern in Sweden

In 1984, Project Caspian tern was started under the auspices of BirdLife Sweden (then the Swedish Ornithological Society) and the World Wildlife Fund, under the leadership of Roland Staav. The project focused primarily on further developing the work Roland Staav started already in the 1970s with mapping the terns' occurrence in Sweden and studying the species' biology. The project developed, among other things, guidelines for monitoring of Caspian tern breeding locations-attempts which are mostly still followed today in Sweden. An important part of tern monitoring is the ringing of chicks and nest-counts during the incubation period.

During the early 1970s, there were about 1,000 pairs of terns, which in the next two decades fell sharply to just over 400 in the mid-1990s. Since then, some recovery has taken place and around 2006/2007 the population had increased to just over 600 pairs. Since then, the population has decreased again and now stands at just over 500 pairs. The first major decline correlates with the establishment and spread of the American mink in archipelagos in southern and central Sweden. The mink was certainly a strong contributing factor to the decline of the tern, but recent studies, carried out within the framework of BirdLife Sweden's Project Caspian tern, have shown that other predators, such as herring- and great black-backed gull and white-tailed eagle, can also have a major impact on tern breeding success.



Figure 3. A Caspian tern on *Sterna* colony with newly-hatched chicks. (Photo Ulrik Lötberg).

In Finland (the Åboland archipelago), reproduction has been studied in 380 pairs during the years 1970-1972. The study showed that an average of 1.83 eggs per nest were hatched and 1.57 chicks per breeding pair fledged, 13-20% of the eggs did not hatch and 13-14% of the chicks died before they reached fledging age (Soikkeli 1973a).

This can be compared with studies from the Helsinki archipelago during the 1990s, where the number of fledged chicks per pair was 0.8 chicks/ pair (Martti Hario, pers. comm.).

Caspian terns only nest on select low rocky islands with flat slabs or gravel banks, which almost always completely lack trees, located some distance off the coast or in the outer archipelago. As the terns don't build nests, instead scraping the ground that forms a small depression once sat in, when sat in, there are not many islands in the archipelago with suitable substrate for the terns' nests. The most appropriate islands for colonies are those with substantial gravel so that the terns have more freedom choice in nest placement. On rocky islands the terns can only 'build' nests at the edge of sparse vegetation, which thickens over time, thereby displacing the terns. Colonies on such islands are often more scattered and less dense as the vegetation often follows cracks in the rock, resulting in loss of the anti-predator effect of a dense colony. Caspian terns often nest in proximity with other smaller gull species (i.e. black-headed gull).

## National Action Program for the conservation of the Caspian tern (ÅGP Skrântärna)

Since the 1990s, the Swedish Environmental Protection Agency has developed an action program (ÅGP) for endangered species. After many years of hiatus, work was restarted and in 2003 the work was outsourced to the county administrative boards after the Species Data Bank, on behalf of the Swedish Environmental Protection Agency, produced a list of the species that need action programs. Each county administrative board has thereby been given the national coordination responsibility for the development and implementation of a certain number of action programs. The purpose of the program is to improve the survival prospects of the species in the country, mainly by organizing and implementing concrete measures that benefit the species for which the program issued. One of the bird species that has received an action program is the Caspian tern. ÅGP Skrântärna was initially applicable for 2007-2011. The program has been extended twice and the current program applies to the period 2017-2021. The fact that the Caspian tern is covered by action programs for its conservation is well justified as it has a small population of about 10 colonies throughout the country and that threats in the form of human disturbance and predation from e.g. mink, gulls and white-tailed eagle can interfere with the Caspian terns' ability to reproduce.

Within ÅGP Skrântärna, it has been decided that the monitoring of all Swedish Caspian tern colonies will take place through four visits to the nesting sites per year. A visit is made in May to count the number of pairs. After that, one to two visits take place in June to ring the chicks and finally a visit in July to report breeding success. Monitoring can be conducted from a boat, but it is preferable to go ashore especially in larger colonies as the possibility of counting nests is often very limited from a vessel. During visits two three and four, disembarkation must occur in order to perform ringing and assess predation and count dead chicks. Furthermore, observations that indicate the presence of mink on the breeding island and/or surrounding islands must be noted.



ÅGP Skrântärna collaborates closely with BirdLife Sweden's Project Caspian tern. Project Caspian tern is responsible for much of the follow-up monitoring, as well as knowledge acquisition and research that is otherwise not normally included in Action Programmes.

## Caspian terns of the Stenarna colony in Björns archipelago

### History of the Caspian tern colony at Stenarna in Björns archipelago

Sweden's largest colony of Caspian terns lies on the island of 'Stenarna' in Björns archipelago in northern Uppland. In the 2000's it was comprised of just over 200 pairs, i.e. about 12% of the entire Baltic Sea population, but has in recent years varied between 120 and 190 pairs, mostly depending on how much disturbance white-tailed eagle causes in the colony in early /mid-May. There are two other such large colonies, one in northern Finland in the northern Gulf of Bothnia (Patrik Byholm, pers. comm.) and one in Estonia (Trinus Haitjema pers. comm).

The Caspian tern has been documented as a breeding bird in Björns archipelago since 1938 when three pairs were photographed. There is every reason to believe that the species was present earlier than this in the archipelago. Knowledge about the colony at Stenarna is great as it has been followed by ringers since 1942. This makes the colony one of the oldest known colonies in both Sweden and the Baltic Sea. During the period 1930-1960, there were several colonies in Björns archipelago, both at Klubbarna, Stenarna (where the colony is today) and Västerskian. Today, only Stenarna is a suitable nesting habitat, other areas do not suit the terns due to land uplift and above all overgrowth.



Figure 4. Two newly hatched Caspian tern chicks. Their powerful orange bill is noticeable even at this young age (Photo Ulrik Lötberg).

Sven A. Mellquist was the first ringer at Stenarna, who at the time also ringed terns on the island of Hättan in Lövstabukten, where there was a colony until the 1950s. He has been followed by a number of ringers; Svante Lundgren (who also ringed terns on the island of Hättan in Lövstabukten), Rolf Zetterberg (1947-49), Robert Bünsow (1952-53), Erik Norling (1952-65), Sture Gustafsson (1953), Göran Hansson (1958), Staffan Westerlund (1959) and Lars Gustavsson (1969-2006). In recent years, ringing has been carried out by Lennart Söderlund (2007 and onwards). During 1976-1982, annual studies were conducted in the colony under the auspices of Roland Staav, where birds were color-ringed (one color per colony) and these color rings and ordinary metal rings were read from hides in the colonies with binoculars. Color marking has started again since 2011 in the colony and now cameras and above all a webcam on the island are used to read the rings. The color rings used nowadays have a clear and easily legible code.

## Stenarna – where most Caspian terns are ringed in Sweden

Table 1. The table shows numbers of ringed Caspian tern chicks in Björns archipelago. No other colony in Sweden has more ringed Caspian tern chicks. (The ringing center, The Swedish Museum of Natural History pers. comm.).

### Caspian tern chick ringing at Björns archipelago

1941	1942	1943	1944	1945	1946	1947	1948	1949	1950
	3					42	80	46	

1951	1952	1953	1954	1955	1956	1957	1958	1959	1960
	94	153		83			5	172	159

1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
71	115	119	107	10				25	109

1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
40	141	167	111	98	83	148	135	104	140

1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
0	23	44	90	44	79	55	99	88	107

1991	1992	1993	1994	1995	1996	1997	1998	1999	2000

95	130	45	56	70	174	186	151	216	236
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2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
278	292	173	240	242	205	127	37	14	6

2011	2012	2013	2014	2015	2016	2017	2018	2019	
103	139	128	125	207	200	153	160	179	

Total                      Over  
7556 ex                      65 years

Red numbers = no fledged chicks due to predation  
 Blue numbers = no fledged chicks due to sickness  
 Green numbers = no fledged chicks due to extraordinarily strong snowstorms in April/May

The colony at Stenarna has been a well-functioning colony with high breeding success. From 2007 onwards, this changed radically, as no chicks fledged in either 2007, 2008 or 2009. Never before has breeding failed for three years in a row on this colony. Historically, the colony has failed in total only three times in the last 60 years before 2007. Partly in 1981 when a snowstorm hit the island during egg laying and all the terns gave up breeding and in 1993 when a disease affected the colony and virtually all chicks died, and once in the early 1950s when extremely high tide flooded the eggs at one point. When breeding failed in 1993, the terns switched from the island of southern Stenarna to northern Stenarna, skerries about 200 m apart from each other. The colony has thus been quite spared from major disturbances during the breeding season. The only other known major disturbance was in 2003 when a mink ravaged the colony in early July. It killed a large number of the then recently fledged or almost fledged chicks, about 30-50, but a number of chicks managed to fledge this year as well.

Stenarna has had and continues to have great importance for the survival of the species in Sweden. The colony is one of the most well-studied as well, as documented by ringing statistics. No less than 21% (7556 of 36888 up to 2019) of all Caspian terns in Sweden have been ringed at Stenarna (Information from the Ringing Center, The Swedish Museum of Natural History).

## Storm 'Per' January 2007 – storm of the century in Björns archipelago



A very important event for the colony at Stenarna was storm Per that hit the colony in January 2007. The storm came in with great force and the strong NW wind in combination with the extremely high water level, 1.40 m above normal levels, flushed most of the gravel bank, that the terns normally nested on, out to sea. According to information from local fishermen who have lived in the area for more than 60 years, the gravel bank on Stenarna had not changed until storm Per hit the area. On the island of Örskär, which is located 20 km SE of Björns archipelago at northern Gräsö, the sea broke the harbor pier, which has not happened since it was built in the early / middle of the 20th century. Many were the boathouse owners who had their boathouses destroyed and washed up by the sea. When the colony was visited at the beginning of June the same year, it could be stated that the terns colony was divided into a few small groups where remnants of the gravel bank remained and that the number of terns decreased very sharply since the biotope changed so drastically. The number of chicks was low and there were many nests where there seemed to be late egg laying often with only 1 egg. On the second visit towards the end of June, no chicks from the first visit were seen, all chicks were small or there were eggs in the nest, which with the knowledge at the time was very surprising. At a third visit in July, there were no chicks left and virtually all the terns had disappeared, only a few older birds lingered in the colony.

Breeding success thus plummeted in the summer of 2007, having been low in the previous two years but were exacerbated by the storm. Low breeding success persisted for three years before the underlying cause could be ascertained and was remedied within the framework of ÅGP Skräntärna.

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## **Part 1 – Foraging and roosting grounds of Caspian terns in northern Uppland**

### **BirdLife Sweden's 'Project Caspian tern' uses modern technologies to map tern distributions**

As of 2012, BirdLife Sweden's 'Project Caspian tern', in collaboration with the Department of Biology at Lund University (Professor Susanne Åkesson) and Novia University of Applied Sciences at Åbo Academy in Finland (Patrik Byholm) has conducted studies in which the terns' movements are recorded with GPS loggers, including flight altitude, flight speed, temperature and GPS position. In the first years, the data was transmitted via a base station that was placed on the colony. This meant that data on migration and over-wintering could not be collected until the terns came within range of the base station the following year. Unfortunately, many loggers malfunctioned during the winter.

Technological development has progressed and since 2016 only GPS loggers are used that instead communicate via the GSM (mobile) network. These loggers transmit information a few times a day regardless of location on the globe and record GPS position every 5 minutes. The resulting data is extremely high resolution and also provides information on when and where a tern dies.



Figure 5. Natalie Isaksson mounts a GPS logger on a juvenile Caspian tern while Lennart Söderlund assists at the *Stenarna* colony 2018. (Photo Ulrik Lötberg).

## Caspian tern distribution maps via analysis of GPS data

Positional data collected from the GPS loggers have been processed and so-called "utilization distribution" layers were extracted. These GIS layers show where the terns are likely to be found, with the darker the shade of red of an area, the likelier the tern is to be in it. The utilization distribution levels shown are:

- 90% of the area, the weakest red color on the maps
- 75% of the area, the medium-red color on the maps
- 50% of the area, the strongest red color on the maps. These are the most important core areas for the terns or "hot spots".

Prior to analysis, the data was divided into different biologically relevant phases of the terns' breeding season. Of course, not all birds are synchronous, however, a majority of terns have been engaged in the activities described in each phase. Each phase is approximately 25 days long, in

line with the time spent on each individual phase during breeding. Many terns choose to have their post-breeding phase at a shallow lake such as Hjälmmaren, Tåkern or Hornborgasjön, and have then completely left the colony; this phase is therefore absent in many cases.

The phases selected in the analysis are:

- Courtship and mating. Applies to the period end of April to the middle of the May.
- Incubation. Applies to the period mid-May to early June.
- Chick feeding. Applies to the period mid-June to early July.
- Chick fledging. Applies to the period from the beginning of July to the end of July.
- Pre-migration. Applies to the period from the beginning of August to the middle of August.

## Courtship and mating

This phase begins when the terns arrive in the breeding area at the end of April. Previously the belief was that the terns have lifelong relationships between partners, however, recent studies with GPS loggers from Finland show that it is more common for terns to pick new partners each year, and this applies to both solitary breeding birds as well as birds that nest in a colony (Patrik Byholm, pers. comm.). This means that the areas used by the terns during this period are especially important as the terns need both good access to fish so that the males can easily procure "courtship gifts" (i.e. fish prey) with which they can impress the females, but also so that the terns are undisturbed during courtship. This phase ends with the laying of eggs, which takes almost a week if they lay three eggs, the usual number early in the breeding season. When re-laying in June, it is most common for them to lay only two eggs, but clutches of three eggs also occurs. The female usually lays an egg every other day so it takes five to six days before the whole clutch is laid.

The analyses below are based on data from movements of two adult birds. Even though there are few individuals, the behaviour agrees well with the picture that emerges from observations of terns from this period.

Many of the areas used for courtship are not unknown but are rather very well-known bird sanctuaries. In these areas the terns often gather in small groups and are quite noisy. The more famous bird sites are Ledskärsviken, Karlholmsviken and the shallow bay north of Kallerö, lesser known bird areas are Ängskärsviken and Barknårsfjärden. Most of these places are located 15-20 km away from the colony, the exception being Kallerö which is 35 km from the colony.



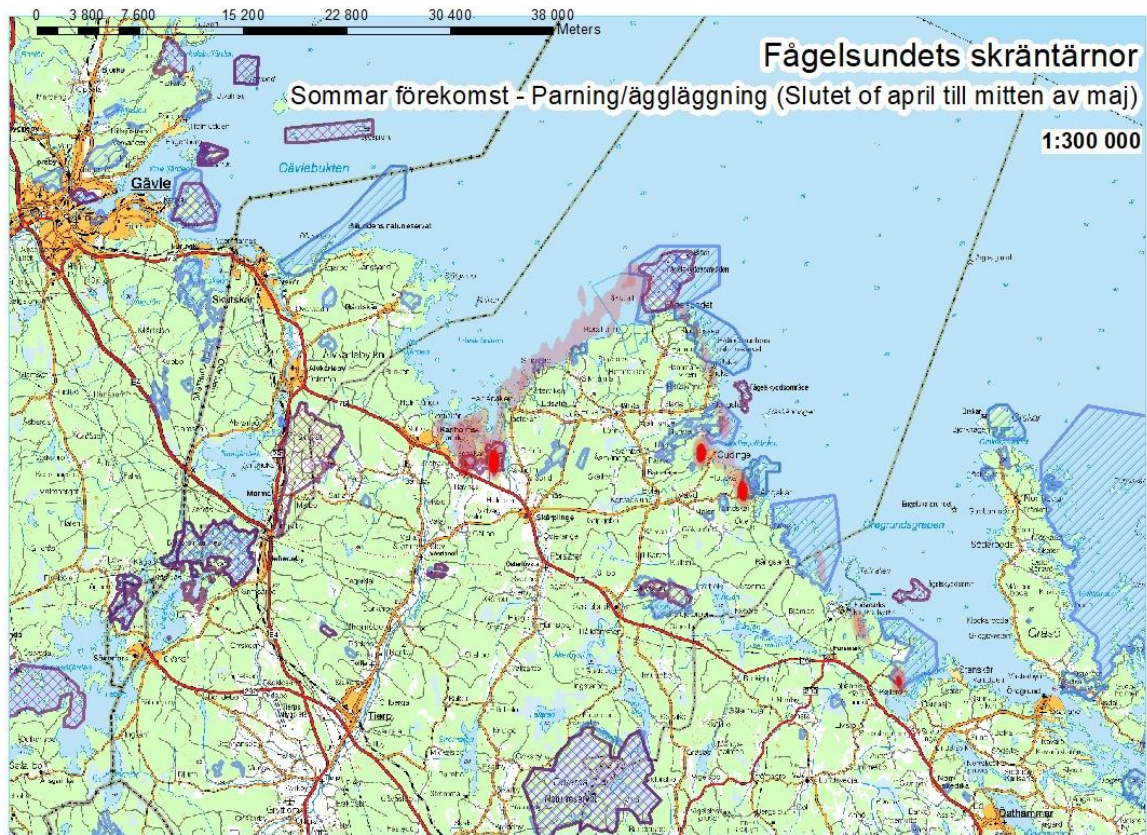
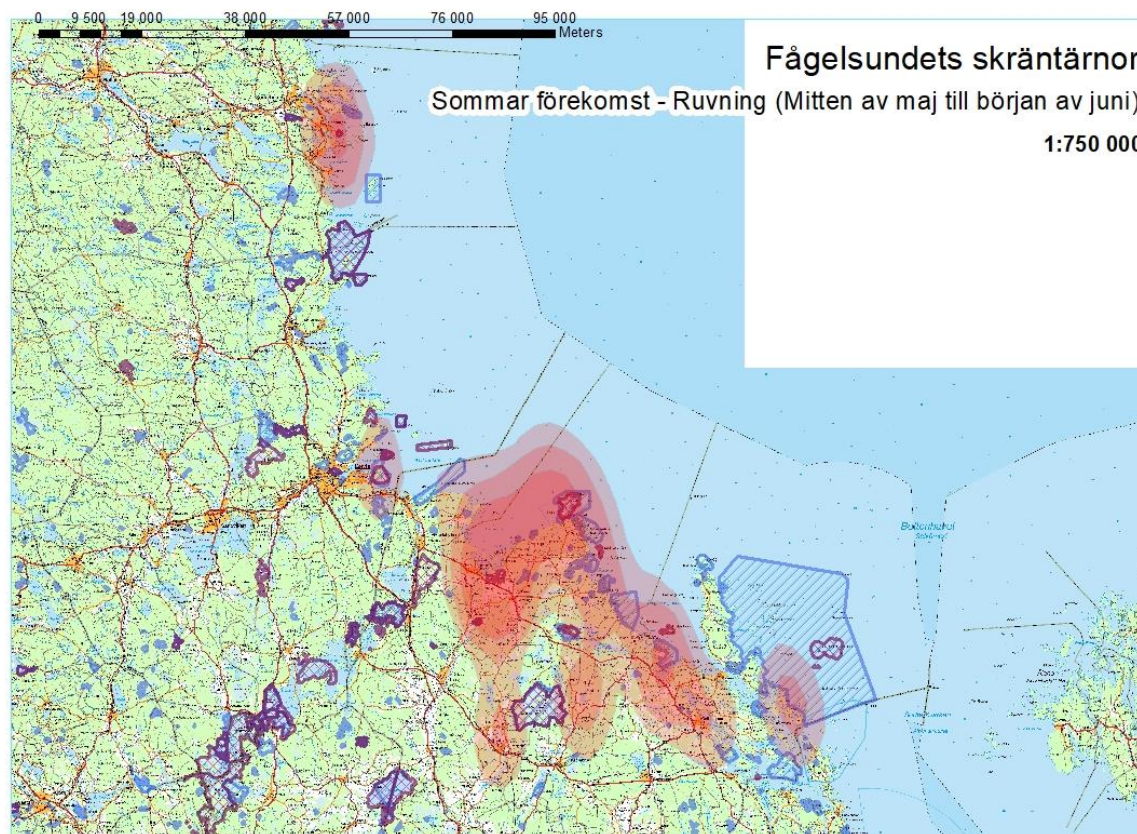


Figure 6. The courtship of the terns is concentrated in a few optimal habitats where the terns may be relatively undisturbed and that also have good access to fish prey. The analyses are based on data from movements of two adult birds. Hashed areas with purple border and purple pattern are Natura 2000 areas and areas with blue diagonal lines and blue border are nature reserves. Map Ulrik Lötberg.

## Incubation

Both the male and the female take turns incubating the eggs, although the female usually takes greater responsibility in this and is usually the one who incubates at night. During this phase, one partner can be away for a few hours from the colony to fish and rest in a good resting place. These areas are similar to the ones used in the previous phase. During this phase the terns only need to fish for themselves. Unlike what is sometimes described in older literature, the males do not feed the females at the nest. Instead, upon 'changing of the guard' for incubation duty, the other partner leaves fairly immediately to fish and rest. Sometimes a bird is seen standing with a fish next to an incubating bird and these are unpaired males who are trying to solicit incubating females, but the females are then usually very uninterested in these courtships. This has been established through webcam studies and color ring resightings. As the terns are efficient foragers

and often use places that are not too far from the colony, both of the adult birds spend a lot of time together in the colony.



*Figure 7. During the incubation phase, the number of places visited increases but is still concentrated to areas such as Ledskärs- and Karlholmsviken. During this period herring also begins to spawn, which the terns exploit, and visits to shallow bays are therefore complemented with fishing over more open water. The analyses are based on data from movements of 16 adult individuals. Hashed areas with purple border and purple pattern are Natura 2000 areas and areas with blue diagonal lines and blue border are nature reserves. Map Ulrik Lötberg.*

The most visited areas during this phase are very similar to those during the previous phase - courtship and mating: Ledskärsviken, Karlholmsviken and Kallerö. At the end of this period, however, the herring begins to spawn and then a lot of terns switch to fishing for herring and this takes place all over Lövstabukten and north to the open sea closest to the colony. If the terns' nests are predated at this time (usually by white-tailed eagles), they often flee to a fish-rich area that can be up to 100 km away and there they reload before they make a new breeding attempt a few weeks later.



One such place that the terns frequent in addition to Ledskärsviken and Karlholmsviken is Ljusnan's outlet at Sandarne (Söderhamn). Terns that have their nests predated until the beginning of June almost always re-lay.

## Chick feeding

Both the male and the female take turns catching prey to feed the chicks. The focus changes so that it is usually one of the parents that is away fetching food and the other parent remains in the colony and protects/warms the chicks.

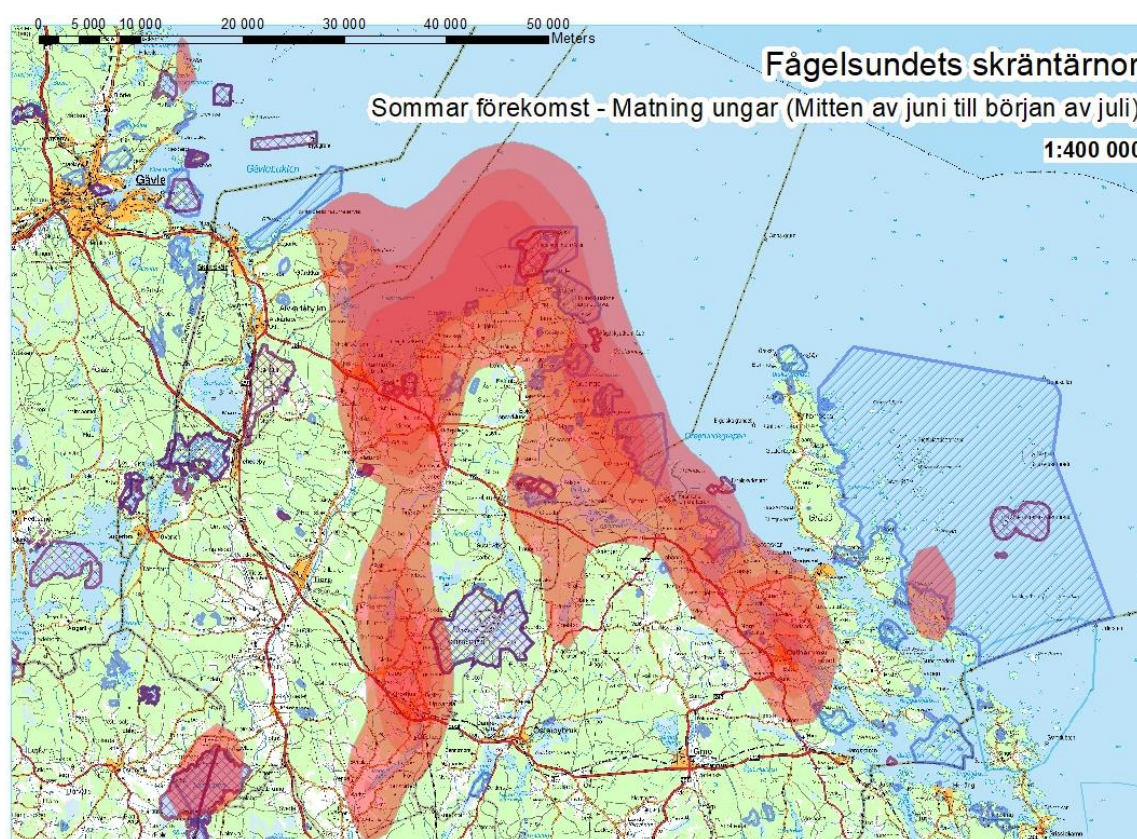


Figure 8. Herring fishing also continues over this period. The analyses are based on data from the movements of 16 adult individuals. Hashed areas with purple border and purple pattern are Natura 2000 areas and areas with blue diagonal lines and blue border are nature reserves. Map Ulrik Lötberg.



During this phase, the number of fishing grounds increases significantly and many more inland areas and more shallow bays will be used for fishing than in previous phases. Of course, the fishing grounds from the previous two phases are still used: Ledskärsviken, Karlholmsviken, Barknårefjärden, Ängskärsfjärden and Kallerö. The fishing areas are primarily expanded along the eastern Hållnäs coast and new areas are the inner parts of the Slada-Klungsten archipelago from Killskär south to Barknårsfjärden and the inner parts of the Skaten-Rångsen nature reserve. Now even more distant fishing spots are visited, up to 50 km from the colony, such as Granfjärden and Östhammarsfjärden by Östhammar and the lakes Strömmaren (southern part), Vendelsjön (northern part) and especially Kyrksjön by Örbyhus. During this phase it is common for a particular individual to have favorite places to fish.

## Chick fledging

Both parents catch prey to feed the chick(s). During this phase, the large young can sometimes be left alone in the colony as both parents are out fishing. Some chicks and parents leave the colony as soon as the cubs fledge, while others stay for a longer time and make greater than 24-hour long excursions from the colony. Data from GPS loggers have shown that it is common for the female to leave the colony during this phase and the male alone takes care of the chick(s). Sometimes females take a chick with them when they leave the colony and migrate south, but this is quite unusual. Usually the male only takes one chick on southward migration, although it does occur that two chicks are escorted. Juveniles abandoned by their parents do not survive, they usually become white-tailed eagle food. There have been cases where the female in a pair leaves the nest and the male with two chicks. The male eventually escorts one of the chicks while the other chick is adopted by a male from another nearby island whose chicks were predated by white-tailed eagles (Patrik Byholm, pers. comm.). The chicks are escorted by their parents down to the wintering area before they are abandoned there to fend for themselves.

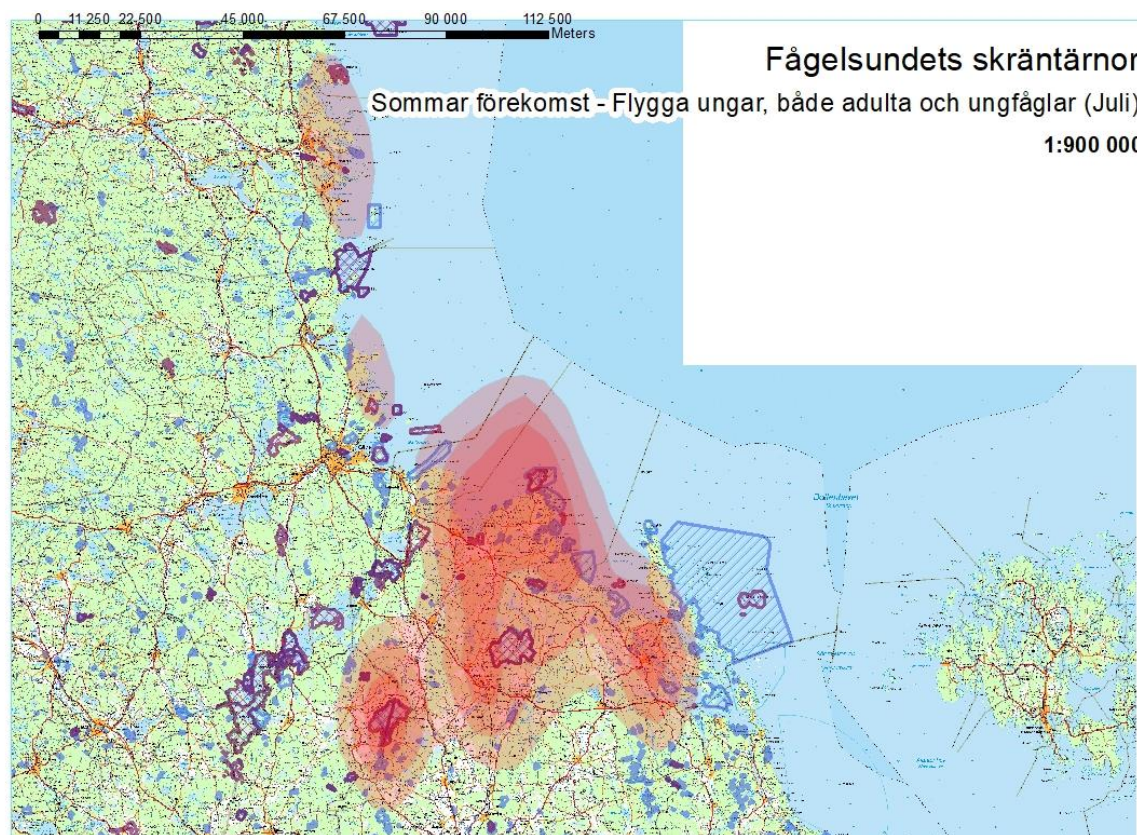


Figure 9. During this period, adult terns often bring their chicks to the fishing grounds and then areas are used where several terns can fish at the same time without too much competition between them. The number of fishing spots is reduced and the larger areas that combine good opportunities for chicks and parents to rest together increase in importance, such as Ledskärs- and Karlholmsviken, but also the large very fish-rich lakes such as Tämnaaren are used. The analyses are based on data from the movements of 9 adult individuals and 18 juveniles. Hashed areas with purple border and purple pattern are Natura 2000 areas and areas with blue diagonal lines and blue border are nature reserves. Map Ulrik Lötberg.

When the chicks start to fledge, the number of fishing spots is reduced. Of course, Björn's archipelago will be an important fishing area for the now recently fledged chicks where the first flights go around the colony and many adults take their chick(s) from the colony and stand on a skerry in the archipelago. It is not uncommon for the chick(s) to swim away from the colony, thus leaving it for the season, and stand on an islet up to a few km from the colony. Ledskärsviken and Karlholmsviken are still among the most important fishing and resting places for the terns. A new area where many terns gather is Lake Tämnaaren, especially for longer than 24-hour visits with the juveniles. The terns like to gather in small groups with their chicks during this time on a skerry or exposed mud bank out in the water and there some adult individuals stay with the juveniles and guard while other adult birds go and get fish for the juveniles, a kind of "collective babysitting" which the terns employ when the chicks have grown up and even after they have fledged.

## Pre-migration

During this phase the females have already left the breeding area. This also applies to many males as well. However, some males remain in the area with their chicks and prepare for southward migration. The birds that have left the area often move on to one of the shallow lakes Hjälmarén, Tåkern /Roxen or Hornborgasjön or they migrate down to the Hiddensee and Rügen area in northeastern Germany, which is the main resting and stop-over site for the Baltic Sea Caspian terns, and there prepare for migration across the European continent.

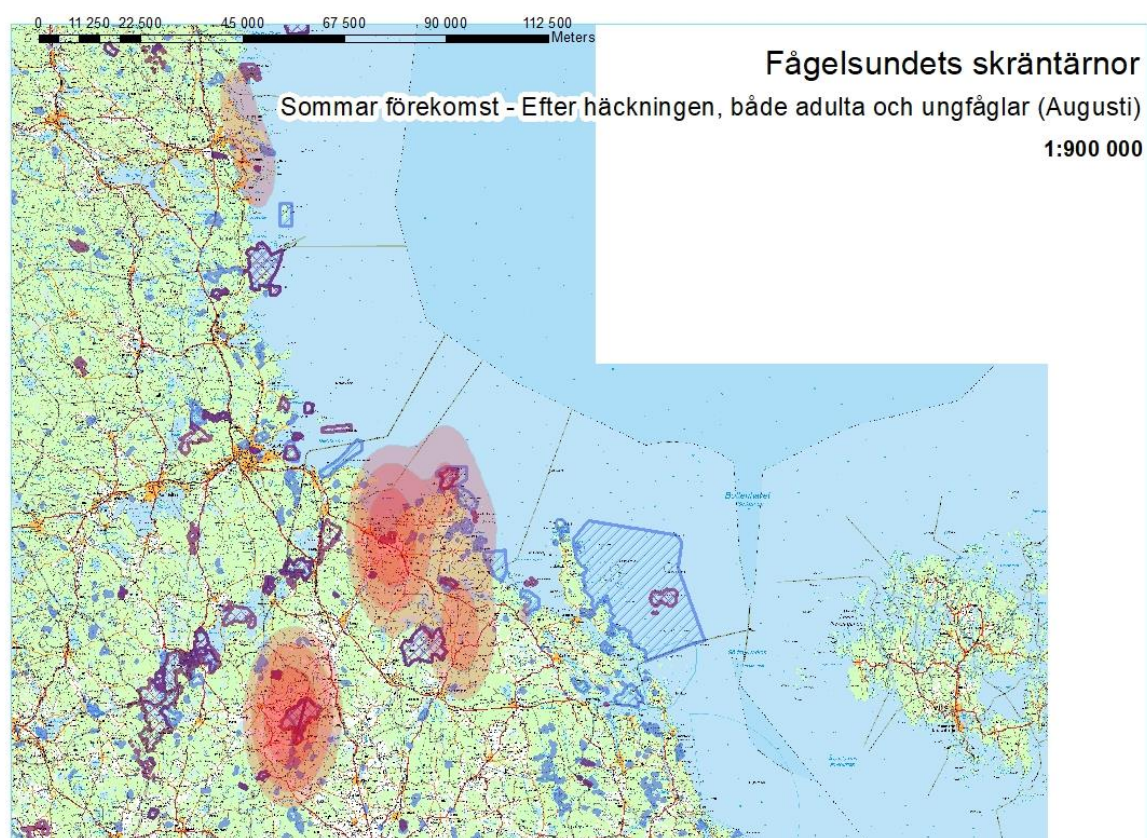
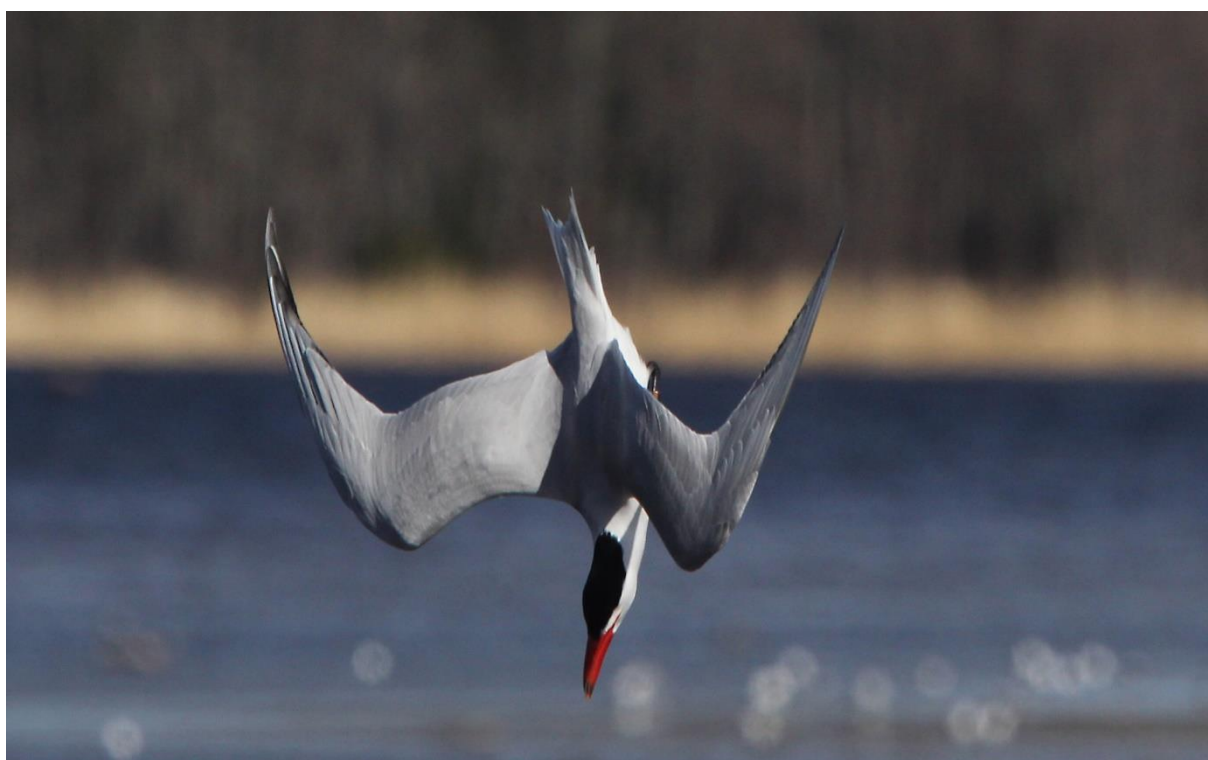


Figure 10. During this period the adult terns often take the juveniles to the fishing grounds and then areas are used where several terns can fish at the same time without too much competition. The number of fishing spots is reduced and the larger areas that combine good opportunities for chicks and parents to rest together increase in importance, such as Ledskärs- and Karlholmsviken, but also the large very fish-rich lakes such as Tämnaren is used. The analyses are based on data from the movements of 3 adult individuals and 8 juveniles. Hashed areas with purple border and purple pattern are Natura 2000 areas and areas with blue diagonal lines and blue border are nature reserves. Map Ulrik Lötberg.



During this period the terns are often concentrated in small groups that often make long trips, often several days long, to good resting and fishing spots. The areas chosen in the first place are larger, very fish-rich areas. The two areas preferred areas are Ledskärs- and Karlholmsviken and the large shallow lake Tämnaren, which during this time of year often also attracts terns from Finnish Ostrobothnia.

## Summary of the most important feeding areas for the Caspian terns of Fågelsundet



*Figure 11. Caspian tern plunge-diving for fish on a beautiful evening in May. Photo Ulrik Lötberg.*

When summarizing which areas are used by the terns during the breeding season, there is a certain area that consistently appears as the terns' favorite area throughout the season and that is Ledskärsviken and Karlholmsviken in the inner part of Lövstabukten. Without a doubt this area is one of the key factors in the long-standing success story for Fågelsundets terns.

Other important areas for the terns are the large fish-rich shallow lakes where the terns move post-breeding. Here the terns often gather in groups and stand on banks or small skerries / islets / large rocks out in the water of these lakes. The terns use so-called collective care of the chicks,

which means that there are always some adult birds that rest with the group of juveniles, even if a particular juvenile's parent can be out fishing. The main example of such an area in Uppland is lake Tämnaaren. Not only terns from Fågelsundet come here to forage but also terns from Finnish Ostrobothnia, as shown by data from GPS loggers on Finnish terns (Patrik Byholm pers. Comm.). Other well-known gathering places for the terns are lake Hjälmarén, which has decreased somewhat in importance, and lake Tåkern, and to some extent lake Roxén and lake Hornborgasjön, where the shallow lakes in Östergötland and Västergötland have a higher number of terns now than previously.

Table 2. Summary of the most important fishing spots for the terns in Björns archipelago. When assessing priority, consideration has been given to whether the fishing area is included in the areas within the 50% utilization distribution, i.e. is most important for the terns. Distance to the colony and whether the area is visited during any of the very important phases (mating, egg-laying, chick fledging or pre-migration) was also taken into account. Lake Tämnaaren is an example of a fishing ground that is very important for the terns before they move south. Priority 1 is the most important and importance declines with higher numbers.

Fishing ground	Distance to colony (km)	Nature reserve	Natura 2000	Priority level
Ledskärsviken	18	No	Yes	1
Karlahomsviken	20	No	Yes	1
Björns skärgård	2	Yes	Yes	2
norra Lövstabukten	5	No	No	2
Barknärefjärden, östra Hållnäs kusten	14	No	No	2
Ängskär/Bondskäret, östra Hållnäs kusten	17	Yes	No	2
Tämnaaren	60	Partially	Yes	2
Sladafjärden, östra Hållnäs kusten	12	Yes	No	3
Skaten-Rångsen, östra Hållnäs kusten	21	Yes	No	3
Kallerö, Kallrigafjärden	35	Yes	Yes	3
Själgrund, Gårdskär	16	Yes	No	4
Kyrksjön Tegelsmora	44	No	No	4
Östhammarsfjärden/Granfjärden	48	No	No	4
Norra Åsjön	25	No	No	5
Älgsjön	36	No	No	5
Strömmaren	39	No	No	5
Vendelsjön	54	No	No	5



*Figure 12. Stenarna 12/11 2007. View of the northern part of the tern colony on Stenarna. Previously, a gravelbank covered this part of the island and was the main part of the tern colony earlier in the 2000s. The colony spread and became very sparse and scattered in small groups in 2007 as after storm Per there were so few suitable nesting places and above all no larger, continuous areas suitable for tern nests. Photo Ulrik Lötberg.*

## **Part 2 – Measures at the colony**

### **Restoring gravel bank**

In the autumn of 2007, the County Administrative Board of Uppsala County decided within the framework of ÅGP Skräntärna that the gravel bank at Stenarna would be restored. Various methods around the restoration were discussed, including a helicopter and a barge with an excavator. When both availability of equipment and costs were taken into account, it was decided that a helicopter would be used for the restoration. Because the surrounding water around Stenarna is shallow, a barge with diggers would be very difficult to get close enough to the island to be possible to carry out a restoration that way. Dredging around the island to access a digger was out of the question as this could change how the island is affected by the sea in the future. Also in terms of cost, a barge with excavators would be expensive, especially to get it in place at Stenarna.



*Figure 13. Stenarna 19/12 2007. The helicopter, from Osterman's Helicopter in Östersund, that was used to transport 150 tonnes of gravel in two days to Stenarna. Here it has just landed to drop off the people who will be on Stenarna during the day to receive the gravel. Photo Uppsala County Administrative Board, Niina Salmén.*

The restoration was carried out on 18-19 December 2007. For two days, approximately 150 tonnes of pebble gravel was transported to the island and distributed to mimic how the area previously looked. The restoration turned out to be very successful and the entire colony reassembled and moved to the restored gravel bank during the coming breeding seasons.





*Figure 14. Stenarna 19/12 2007. The Helicopter approaching Stenarna with a barrel loaded with gravel. Photograph by Uppsala county administrative board, Niina Salmén..*





Figure 15. Stenarna 19/12 2007. Ulrik Lötberg and Per Nordkvist guide a barrel of gravel to the ground and empty its contents. Now the gravel must be quickly distributed before the next delivery. Photo by Uppsala county administrative board, Niina Salmén.



Figure 16. It seems that the restored bank was accepted by the Caspian terns. Photo Webcamera.



## Expanded monitoring methods

The situation with low reproductive success in the two largest colonies in the country, Stenarna (Norduppland) and Grässkären (Oxelösund) during the years 2005 - 2010, which accounts for a large part of the Swedish population, led the county administrative boards in Uppsala and Södermanland counties to decide on increased monitoring of both these colonies to try to determine the cause of the reproductive problems. The ringing visits that took place in 2007 and 2008 did not provide sufficient information about what was happening on the islands. Images from the camera were saved for later review. In addition to reviewing the images afterwards, the webcam was occasionally monitored in real time and then mainly by BirdLife Sweden's Project Caspian Tern by Lennart Söderlund, Roland Staav, Carin Staav and Ulrik Lötberg. The original webcam was large and awkward, about the size of a larger suitcase and weighing ca. 90 kg.



*Figure 17. Stenarna 19/4 2009. The ladder was a necessary tool to move the heavy camera. In the image from left to right Kjell Holmkvist, Roland Staav, Gunnar Hjertstrand and Lennart Söderlund. Photo by Ulrik Lötberg.*

The webcam became the key to determining what was happening in the colonies. Already in the first season it could be seen why the terns failed to breed. The cause was partly white-tailed

eagles predated eggs of the terns, especially in May, but also there were some pairs of herring gulls that took all the small chicks in June. Herring gulls that exhibit this kind of behaviour, specializing in picking chicks from birds as large as Caspian terns and lesser black-backed gulls, have previously been documented in Finland (Martti Hario, pers. comm.). Over time the webcam camera has been upgraded to a lighter, remote controlled version with 360-degree coverage and zoom function. This has expanded the camera's area of use so that it can now be used to, for example, count nests but also to read color rings, in addition to monitoring day-to-day activity at the colony.



*Figure 18. The upgraded webcam camera on Stenarna. This camera can rotate and zoom in on details, for example rings. This has made it possible to read a large number of color rings as well as some metal rings. Reading the metal rings is more difficult as the code on them wraps around the entire ring, meaning that the terns need to cooperate and turn 180 degrees in order for them to be read. Photo by Ulrik Lötberg.*

## Predation by herring gulls and white-tailed eagle

Thanks to the webcam camera at Stenarna, the reasons for the many unsuccessful breeding attempts could be ascertained. It was due to two adult sea eagles, a pair, who visited the colony in May and ate Caspian tern and black-headed gull eggs, as well as two herring gull pairs that ate Caspian tern chicks during the month of June. During the years 2007-2009, the herring gulls predated virtually all Caspian tern chicks. No chicks fledged during these years. The County Administrative Board



then decided that it fell within the framework of ÅGP Skräntärna to reduce predation from herring gulls, which was done by removing the gulls' eggs for a few years. The predation from herring gull ceased and after a year or so the pairs moved to the neighboring island south of Stenarna.



*Figure 19. A herring gull takes a Caspian tern chick during parental change-over during chick guarding (bottom of the picture). Not only do the parents defend the chick but also other adult terns rush there to ward off the intruder, but the gull was too strong and most often emerged victorious from this battle. Without a webcamera, this predation would be very difficult to capture. The gull attack is over in a few seconds. The County Administrative Board decided to remove the eggs of the predating herring gull pairs and after that their predation on Caspian tern chicks ceased. Photo Webcamera.*

In recent years, white-tailed sea eagles, two old eagles that are probably a pair, have been into the Caspian tern colony and eaten eggs and young chicks during May and early June. It is clear that the effect of eagle predation in colonies in the early stages of breeding unfortunately has a greater effect than just the nests that are predated. The eagles scare away terns that are establishing themselves in the colony and that have not yet laid eggs. When the eagles visit the colony early in the season the number of terns often decreases by 50-100, sometimes more. Through GPS-loggers and/or color ring data, it can be determined that just over half of those who have had their nest looted choose to try to lay eggs again in the colony after about 1-2 weeks, while half do not make a new attempt.

*Table 3. Numbers of Caspian tern nests predated by white-tailed eagles on Stenarna in May / June. The fact that the white-tailed eagles ceased predation in June is probably due to the fact that this is when goosander, goldeneye, and greylag geese begin to moult and these constitute more easy-to-catch and filling prey.*

**Number of Caspian tern nests predated by white-tailed eagle on Stenarna in May-June**

2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
30				25			30	40	50	50	2

Of those terns who move elsewhere, some try to lay eggs in a new place, like one Caspian tern with a GPS logger that moved to Åland and nested there on a former tern colony. Unfortunately it did not go well, so that tern is back to Stenarna and breeding in 2020.



Figure 20. An old white-tailed eagle eating a Caspian tern egg. Photo webcamera.

During most of June and the beginning of July, there are often no white-tailed eagles in the colony, but from mid-July on they often return and hunt large Caspian tern chicks. Since very many chicks are fledging during this, they often get away by leaving the colony with their parents. The terns that have laid eggs a second time and are late in their breeding usually have their nests plundered at this time. Small chicks and eggs often disappear in mid-July. To counteract the negative impact that the eagles' predation has on the Caspian tern colony, BirdLife Sweden's Project Caspian tern together with the Uppland Foundation has tested an "eagle scarecrow" at Stenarna. The eagle scarecrow is a wooden cross dressed with clothes and mounted in a boat. Because the boat is only moored in the bow, the boat is constantly moving with the wind and waves. The boat has been anchored just south of northern Stenarna where it is sheltered from strong winds by both northern and southern Stenarna. The nesting birds do not mind the "eagle scarecrow".





*Figure 21. The "Eagle Scarecrow" at northern Stenarna. It was tested for the first time in mid-May 2019 and has been in place during 2020. Since it was released, the number of occasions when white-tailed eagles have been present and eaten Caspian tern and black-headed gull eggs has decreased to almost zero. However, eagles have visited the colony again at the end of July 2019. The clothes have been changed between the years. It is currently difficult to draw any conclusions as to whether it was the "eagle scarecrow" or some coincidence that caused the number of eagle visits to decrease since the boat was launched. The coming years will show if this method works. Photo Ulrik Lötberg.*

After the "eagle scarecrow" was tested in mid-May 2019, which took place after a period of very extensive predation from the eagles, the number of eagle visits decreased to zero. No white-tailed eagles visited the colony until the second half of July. There were only a few nests left with small chicks and eggs in mid-July. The vast majority of chicks from all species on the island fledged and were able to leave the island when the eagles began to visit the island again. In 2020, the boat was put out again after a white-tailed eagle visited the colony on one occasion in early May. This time the eagle was mostly in the black-headed gull part of the colony so only two Caspian tern nests were looted. The "eagle scarecrow" was released after this and since then the eagles were not back in the colony for the rest of May and June. Only in late mid-July did the eagles return. In 2020 the majority of the 220 pairs of terns succeeded to breed and about 240-250 chicks fledged. The "eagle scarecrow" has changed clothes between the years. Time will tell if this method works or if it

is only a coincidence that the predation by white-tailed eagles in the colony decreased in 2019 and 2020.

## The Uppland Foundation introduces mink hunting in Björns archipelago

In the early 1980s Björns archipelago had, amongst others, an abundance of breeding species of ducks, waders, gulls and terns. During the 1980s the American mink, an invasive species introduced in Sweden via escaped / released animals from commercial mink farms, migrated into the archipelago and the number of nesting birds dropped drastically. In 1997, the Uppland Foundation started a project where mink hunting was introduced in Björns archipelago and in areas along the eastern Hållnäs coast and in Gräsö archipelago.

In conjunction with the mink hunt commencing, inventories of bird life in the archipelago were carried out annually. In Björns archipelago the response was rapid as soon as mink decreased. The mink hunt was conducted throughout Björns archipelago, including Fågelsundet, which is the most used migration route for mink in the archipelago. For a long time, mink decreased a lot in the area and there were few mink that lived in Björn's archipelago, but from 2011 the number of mink in the area increased again and then mainly in Fågelsundet and on nearby islands. This coincides with when otter increased in earnest in North Uppland. It seems that the otters drove mink away from areas where the otters established themselves. It appeared that a lot mink migrated from the south to the archipelago. In 2018, otters began to establish themselves in Fågelsundet and since then mink have largely disappeared completely from the area. So far in 2020 no observation has been made of mink in Björns archipelago.

Since the Uppland Foundation started the mink hunt in Björns archipelago in 1997, mink have only on one occasion gone out to Stenarna; in 2003 when about 50 chicks were bitten to death.

*Table 4. Shooting of mink in Björns archipelago 1997 - 2020 (Martin Amcoff, Upplandsstiftelsen pers. comm.). The number decreases rapidly after the hunt was introduced. Around 2011, the number of mink in the archipelago increased again and this is believed to be due to the increase in otters in northern Uppland that drove mink out into the archipelagos. As of 2018, otters have established themselves in the archipelago and since then, mink has rapidly declined again and in 2020, no mink have been seen in the archipelago. The hunt has been carried out by the Uppland Foundation and is part of the measures the County Administrative Board has chosen to take within the framework of ÅGP Skräntärna.*

### Hunting of mink in Björns archipelago

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	

American mink	22	28	23	8	7	4	5	10	2	7	
	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>	<b>2014</b>	<b>2015</b>	<b>2016</b>	
American mink	5	3	8	8	20	8	7	13	23	7	
	<b>2017</b>	<b>2018</b>	<b>2019</b>	<b>2020</b>							<b>Total</b>
American mink	9	5	1								<b>233</b>

As described above, the number of birds in the archipelago increased when the mink hunt started and this also applies to Stenarna (North Island). More about this can be read in "The development of the bird fauna in the Uppsala county archipelago after the introduction of hunting mink - Staffan Roos, Martin Amcoff".

The decrease of primarily Caspian tern from 2007 on was partly due to the storm Per which decimated the breeding area in January 2007, but also to the predation that some pairs of herring gulls constituted when they specialized in predated tern chicks. The County Administrative Board within the framework of ÅGP Skräntärna decided to remedy this by removing the herring gulls' eggs, and after a few years the gulls that predated moved over to the neighboring island, southern Stenarna. This was determined both by color ring readings and bird-borne GPS logger data. After this, the Caspian tern colony on Stenarna has grown again.

Table 5. The number of nesting pairs of gulls and terns on northern Stenarna during the period 2002 - 2020. The number of pairs of Caspian tern decreased rapidly after 2006 when the predation of chicks from herring gulls started in earnest. The number of pairs decreased rapidly to 40 pairs, but after the predation ceased, in 2011 and onwards, the number of pairs of gulls and terns has increased rapidly on the island and the number of Caspian terns is soon at the same levels prior to predation.

### Numbers of pairs of gulls and terns per year, Northern Stenarna

	2002	2003	2004	2005	2006	2007	2008	2009	2010
Great black-backed gull	1	1	1	1	1	1	1	1	1
Herring gull		3	15	2	3	2	2	1	3
Lesser black-backed gull		12	3	5	4	10	8	1	3
Common gull	25	42	45	27	8	4	6	4	5
Black-headed gull	1	1	1	1					
Little gull									
Caspian tern	220	180	200	235	270	225	160	110	40
Common tern									
Arctic tern		4			5	2	2		3

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Great black-backed gull	1	1	1	1						
Herring gull	4	3	2	1	1					
Lesser black-backed gull	1	3	1	2	1	3	2	1	3	6
Common gull	2	2	2	5	10	20	20	25	30	40
Black-headed gull	30	150	500	700	650	900	650	850	800	700
Little gull				2	1	1	1			
Caspian tern	90	80	90	110	140	150	140	130	120	190
Common tern	80	60	150	200	140	120	120	90	145	250
Arctic tern	35	5	20	50	80	140	100	115	35	70

## Björns archipelago is protected

The protection of Björns archipelago has long been due to it being Natura 2000-classified, which it has since the inception of the Natura2000. Several of the most sensitive islands, such as Stenarna, have been bird protection areas since the 1970s / 1980s. What has been missing for a long time is

a formal protection in the form of a nature reserve. The advantage of an area being a nature reserve is that there is then a management plan, which, in an area like Björns archipelago, is very important as the over growth of islands is far greater than the formation of new islands in the archipelago. An archipelago like this has long been a cultural land that has been kept open by grazing animals and by the human population's need for firewood when they have been out fishing.

After a long and sustained effort by the Uppland Foundation and Tierp municipality, Björns archipelago became a nature reserve in 2018. An important factor in the reserve being formed was of course that the World Wildlife Fund contributed money so that the land could be bought. The Uppland Foundation have been appointed managers of the reserve and with the management plan that exists, the future looks bright for the Caspian terns in terms of breeding environment.

## Color rings provide information about survival and migration routes in Europe

Since 2011 BirdLife Sweden's Project Caspian Tern has conducted color ringing on Caspian terns all over the country. At Stenarna 1149 out of 1394 ringed chicks, just over 82%, were fitted with a color ring during 2011 - 2019. The color rings are red with white text and have a unique code that allows for the individual to be identified when resighted. The color rings have their code on three sides of the ring, which means that a bird does not have to turn around for the ring to be read. Many controls, even of flying birds, are made today thanks to the Caspian terns having been photographed. The number of color rings read is more than 50-100 times more compared to the readings of the metal rings that the birds also carry.





*Figure 22. A color-ringed Caspian tern chick on Stenarna. The ring can be read from all sides and the large text makes it easy to read and many readings are taken from photographs and with the webcamera. Re-sightings made in Europe are in good agreement with where the terns rest according to the GPS data, which means that color ring re-sightings contribute to information about terns resting places in Europe in a very positive way. Photo Ulrik Lötberg.*

The first time a color ring is re-sighted occurs mainly on one of two occasions, either during first autumn migration for the juveniles or when the tern is in its 4th or 5th calendar year and returns from the wintering area to the breeding site for the first time. Most re-sighting are made at resting areas in Europe, often photographed birds, or at the breeding site and then usually with the webcamera. Looking at cohorts that have passed their 4th calendar year, almost 25% have been read since they fledged and left the colony, which can be considered a very good figure in this context.

*Table 6. Number of color-ringed birds re-sighted. The trend is clear that many juveniles are re-sighted during their first autumn migration and the next time is during the terns' 4th calendar year, when they migrate to the breeding area for the first time.*

### **Color-ring resightings of Caspian terns ringed on Stenarna**

#### **First year a ring is read**

Year	Breeding pairs	Number of ringed chicks	Number of color-ringed chicks	Number of fledged chicks	Number of juveniles re-sighted during first migration	2011	2012	2013	2014	2015	2016	2017	2018	2019
2011	90	103	48	60	2	2			2	1	1			1
2012	80	139	77	79	3		3	1	2	11	6	1		
2013	110	128	117	90	7			7	1	5	8	8	3	
2014	110	125	113	110	6				6	2	7	9	5	2
2015	140	207	204	170	12					12	1	5	14	3
2016	150	200	164	170	14						14	3	4	13
2017	140	153	129	110	10							10	3	2
2018	130	160	124	100	10								10	4
2019	120	179	173	150	15									15

In total, 207 individual Caspian terns from Stenarna have been re-sighted as of winter 2019/2020 in 43 different places /areas. In total, there are 285 distinct areas, i.e. an individual has been re-sighted at a unique location 285 times. The most common re-sighting locations are shown in the table below:

*Table 7. Locations where more than five different color rings on Caspian terns from Stenarna have been re-sighted.*

Location	Country	Number of individuals re-sighted as of winter 2019/2020
Björns archipelago	Sweden	126
Rügen-Swinoujscie	Germany/Poland	59
Faro-Huelva-Cadiz	Spain/Portugal	18
Gabes Bay	Tunisia	17
Camargue	Franch	6

It is evident that the *Stenarna* terns have a tendency to move more in Western Europe, but the predominance shown by the color re-sighting is affected by the fact that the number of birdwatchers is much higher in Western Europe than in Eastern Europe. In Germany there are people who go to the Rügen-Swinoujscie area every late summer to read color rings on birds during the holidays, mainly gulls, but also terns.



*Figure 23. A juvenile Caspian tern with color ring CT6, read in august of 2013 at Gravelotte in lake Kummerov, located close to Rügen in northeastern Germany. Color rings are predominantly re-sighted from resting terns in western Europe. Photo Ulrik Lötberg.*

## Concluding remarks on the conservation of Caspian terns in Northern Uppland

There are three main factors limiting the Caspian tern population during the breeding season.

1. The Caspian terns require a very specific breeding habitat and only nest on low, flat rocky islands or on gravel. They prefer islands that are some distance from the coast or in the outer archipelago and lack trees. The largest colonies are often located on gravel islands or on a gravel covered part of an island. Here the terns can choose relatively freely where to nest whereas on rocky islands the choice is greatly limited to crevasses covered in light vegetation. These islands are important for the population and often terns will be found nesting on the same islands year after year, be it in solitary pairs or colonies. Interestingly, solitary pairs nesting on an island are often replaced by a different pair the subsequent breeding season. The new birds pick the same island, and often almost the same spot for the nest (Patrik Byholm pers. comm.).
2. Predation from predominantly American mink, white-tailed eagle, herring gull and great black-backed gull. These predators can greatly reduce breeding success and sometimes prevent any reproduction for several years.
3. Reliable access to prey such as areas of shallow sea or lakes with plenty of fish and access to rocks where the terns can rest in between foraging trips or during the courtship phase.

The first point now is well on its way to no longer being a concern as Björns archipelago has become a nature reserve and has a management plan that allows for the terns' breeding islands to be protected. However, as the terns place such high demands on their nesting sites, it is very important that there are resources for the maintenance of the breeding islands, where it is partly about ensuring that the nesting island does not become overgrown and that there is a good gravel bank where the terns can make their simple nests. It is also about ensuring that there are alternative suitable nesting islands with gravel banks in Björns archipelago nature reserve or within nearby protected archipelagos such as Gräsö archipelago where the former nesting site on the island of Blåbådan could be restored.

The second point is partially dealt with, as the mink hunt that the Uppland Foundation conducts ensures that no mink come out to the breeding sites. Within the framework of the ÅGP, the County Administrative Board has dealt with the problem of predatory herring gulls and the gulls have chosen to move to adjacent islands and therefore predation on the Caspian terns by herring gulls is now non-existent. The predator that currently constitutes the greatest threat to the terns is the white-tailed eagle. The white-tailed eagle has been responsible for significant predation in recent years. Attempts are now being made to solve this through simpler intimidation measures.

Regarding the third point, several of the most important fishing areas for the terns either lack protection at all, e.g. Barknårefjärden and Östhammarsfjärden or have only partial protection like



Ledskärsviken and Karlholmsviken, which are Natura2000, but not full nature reserves and therefore lack funds for the management of the area and there is no maintenance plan. It would be desirable to strengthen the protection of the most important fishing areas in the inner part of Lövstabukten, Ledskärsviken and Karlholmsviken with very shallow archipelagos outside. Furthermore, measures that promote the reproduction of roach and perch in the fishing areas along the eastern Hållnäs coast down to Kallrigafjärden are desirable. Good fishing areas near the colony means that the terns need to spend less time flying to / from the fishing grounds and thus can spend more time in the colony and ward off predators such as gulls.

As Tämnaaren is the only large shallow lake in the region that the terns use extensively after nesting, it would be good if some islands could be cleared and gravelled, for example one in the western and one in the eastern part of Tämnaaren. These islands could then be used by the Caspian terns for resting. During the breeding season, it would benefit the local population of common tern that would have more suitable islands to nest on. Currently such islands are almost completely absent in Lake Tämnaaren.



Figure 24. This time this Caspian tern failed to catch a fish in Ledskärsviken (Photo Ulrik Lötberg).

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