Local Birds in and around the Offshore Wind Park Egmond aan Zee (OWEZ) (T-0 & T-1)

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Cover Photo: Great Cormorant in the wind farm OWEZ (Hans Verdaat, IMARES).

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Contents

Summary

This report gives a second, and preliminary, summary of results of seabird counts conducted in and around the OWEZ wind farm, after this offshore wind farm became operational in the Dutch sector of the North Sea. After a series of eight “Before” or T-0 surveys (2002-2004)and a first set of six “After” or T-1 surveys were conducted (2007-2008), a second series of six T-1 surveys was carried out (2008-2009). All surveys followed the same (ten) pre-determined transect lines running from E-W through a survey area of about 20x20 nm, with the wind farm situated centrally.

In this second interim report, a first comparison is made between the T-0 and the two T-1 surveys. Raw data are plotted for all surveys, showing firstly all birds seen along the survey lines, and secondly only those birds that could be used for density estimations. When sufficient data were collected for a given seabird species and month, Generalised Additive Mixed Models (GAMM) or Generalised Additive Models (GAM) models were used to explore the relative contributions of location, expressed as distance to shore and latitude and the presence of the OWEZ wind farm and the adjacent Princess Amalia Wind Farm, to the distribution patterns found.

Acknowledgement

The Offshore Wind Farm Egmond aan Zee has a subsidy of the Ministry of Economic Affairs under the CO_2 reduction scheme of The Netherlands.

Assignment

This study has been commissioned by Noordzeewind. Noordzeewind owns and operates the first offshore wind farm in Dutch North Sea waters. This 'T-1' study is a follow up of the 'T-0' study, commissioned by the Dutch government and aims at determining reactions of local (sea)birds to the wind farm, during its operational phase.

Quality Assurance

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Introduction

The Dutch consortium "NoordzeeWind" operates the first offshore wind farm in Dutch North Sea waters. The park, consisting of 36 turbines on monopiles, is located NW of IJmuiden harbour, some 8 NM off the Dutch mainland coast. Named after the nearest town ashore, the park will be known as "Offshore Wind farm Egmond aan Zee" (OWEZ; Figure 1). A second offshore wind farm has also become operational, at a short distance to the west of OWEZ. This park, Princess Amalia Windfarm (PAWF) has a smaller total surface area, but nearly twice the number of turbines (60), also on monopiles. The OWEZ turbines are taller and more powerful than the PAWF turbines, but are spaced more widely at sea, giving the impression of a more “open” site.

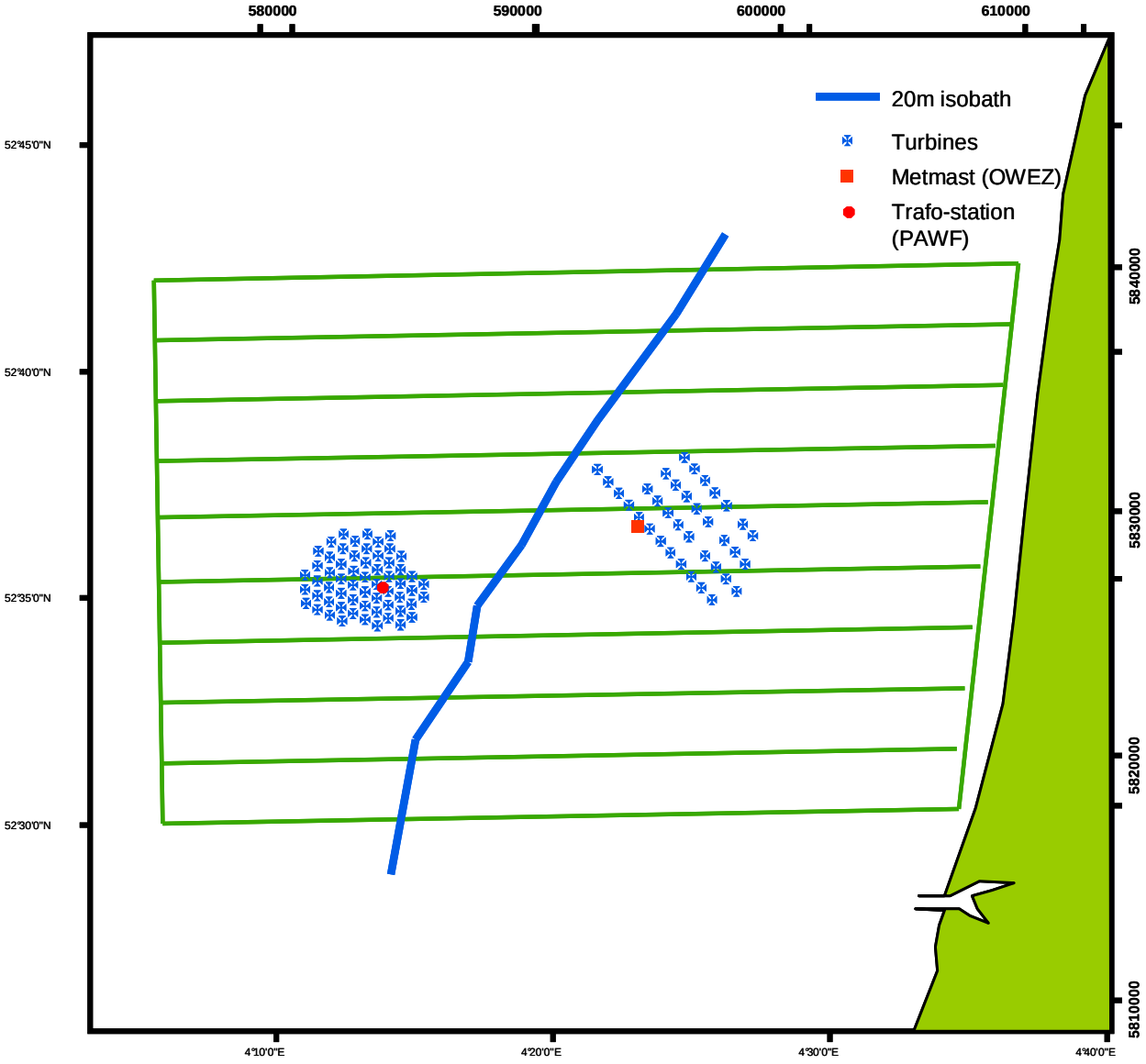


Figure 1. Location of OWEZ with 36 turbines and of PAW with 60 turbines, to the northwest of the port of Ijmuiden. The two wind farms are situated on either side of the 20 depth line (blue thick line). In addition to the turbines, OWEZ has a tall met-(meteo)mast situated on the seaward side of the park, and PAWF has a transformator platform within the park (both indicated by red symbols).

This report has been commissioned by Noordzeewind, and deals specifically with the possible impact on local seabirds of OWEZ. However, the presence of PAWF at a short distance from OWEZ cannot be ignored and the combined impact of both wind farms on the local seabirds is therefore also explored. No specific further reference is made in this report to PAWF.

The OWEZ site has 36 turbines (at 70 m asl), each equipped with three rotor blades (reaching up to 115 asl, NoordzeeWind 2003). Electricity cables trenched into the sea floor connect the turbines to each other and the wind farm to the mainland. Operations also involve frequent servicing, using small, fast personnel ships and large maintenance and repair ships, barges and cranes; aerial supervision by the Dutch coastguard (by low-flying planes and helicopters) and scientific research visits (by various ships). Both the moving turbine blades and the aircraft and ships connected to the wind farm may impact local seabirds. These impacts may range from attraction to deterrence from the site and, in a worst case scenario (collisions), to the death of some individuals.

This report deals with distribution patterns of local seabirds in an area of approximately 885 km^2 around the OWEZ and PAWF parks (Figure 1). A total of 20 surveys of this area is now available for analysis, comprising 8 so-called T-0 surveys (see Leopold et al. 2004 for a full analysis) and 12 T-1 surveys. The T-0 surveys were carried out before the windfarms were in place, while the T-1 surveys were conducted after OWEZ became operational. Distribution patterns of seabirds in the general area may thus be compared in situations before (T-0) and after (T-1) the construction of the parks in the study area. Adjustments of distribution patterns may occur over time, as local birds may get used to the presence of a windfarm (Petersen & Fox 2007). For this reason, distribution patterns are presented and analysed separately for each individual survey. Comparisons are made between the appropriate T-0 survey (month) and two consecutive T-1 surveys, named T-1a and T-1b.

The OWEZ wind park is situated well away from known seabird hotspots and other sites of special ecological interest (Skov et al. 1995, 2007; Lindeboom et al. 2005; Arends et al. 2008). Still, the general area may still hold important numbers of seabirds at certain times of year. The site is within reach of some birds breeding on the Dutch shores (including species breeding in protected nature reserves); may be within the coastal migration route of other (protected) seabirds and may provide an important habitat to birds migrating offshore and wintering offshore ('offshore' meaning here: outside the most turbid, nearshore waters, generally outside the -20m isobath). The Dutch government, NoordzeeWind and other parties developing plans for more offshore wind farms in Dutch waters were thus keen to learn more about possible effects of this first wind farm on the local seabirds and this study addresses this problem during the post-construction, or operational phase of OWEZ.

Wind farms are unnatural structures at sea. The open sea is –in a way- a more two-dimensional environment than many terrestrial landscapes: lacking tall vertical structures such as mountains, forests (trees) or tall buildings. Only the sea's surface itself may become quite three-dimensional at times, during stormy weather. However, obstacles on top of the sea's surface are rare: passing ships, islands and (cliff)-coasts. Seabirds may spend many consecutive months at sea, in the non-breeding season and may thus be ill-adapted to deal with obstacles in their environment. This is a situation that is quite different from terrestrial habitats, such as forests or urban environments. Wind turbines are alien objects in the marine environment, and are large structures that are also moving objects. Therefore, turbines may scare off seabirds from a wind farm area and thus reduce or degrade seabird habitat.

The first wind farm impact studies have suggested that some birds in particular may avoid the impacted site. At Horns Rev (Jutland, Denmark), (Elsam Engineering & Energi, 2005; Elsam Engineering, 2005), some bird species such as divers, gannets, seaducks and auks appeared to keep away from the wind farm, possibly even for several km outside the perimeter of the wind farm. Other species (gulls and terns) ignored the turbines or even were more abundant around them, possibly seeking easy pickings around maintenance vessels or in turbulent waters at the lee side of the monopiles. There may also be habituation after some time as seaducks were first found to avoid the wind farm, but later assembled between the turbines, possibly after successful recruitment of benthic prey (Petersen & Fox 2007). An important finding of the Horns Rev studies, however, was that some birds clearly avoided the site (divers, gannet and auks) and this is generally seen as a problem for future developments of more offshore windfarms (Dierschke & Garthe 2006). The first Dutch wind farm (OWEZ) is situated in waters that are somewhat similar to the Danish site, in that both divers and auks may winter here in good numbers, while gannets pass by in large numbers in autumn (Camphuysen & Leopold 1994; Leopold *et al.* 2004). Divers are protected under the EU's Bird Directive (Annex I) and so are gannets and auks, as migrating birds. It is therefore

important to learn effects of wind farms in Dutch waters and to map effects on local seabirds. Effect of a study in Danish waters cannot simply be extrapolated to other sites, as circumstances may be different. For instance, the Dutch sector of the North Sea has more shipping traffic than Horns Rev and birds may be more habituated to disturbance. Alternatively, birds that are disturbed more frequently, may be more inclined to leave the area altogether after another source of disturbance is added, and effects may thus be more severe. A site-specific study is therefore required.

This study deals with the so-called local seabirds, that is the birds that reside for some time within the study area. Impacts on migrating birds (both seabirds and landbirds) are considered in a separate study (Krijgsveld et al. 2009). Migrants generally avoid flying through offshore wind farms, thus avoiding collisions (Kahlert et al. 2004ab; Arends et al. 2008; Krijgsveld et al. 2009). Local seabirds, particularly while in flight, may do the same, but may also respond differently. They may use vantage points within the park for resting or (while swimming) may drift into the park and e.g. continue feeding within its perimeter. They may also use changed hydrography (turbid patches of water to the lee side of the turbines) or seabed morphology (boulders supplied around the base of the turbines) for feeding. No seabird remains in the study area for its entire life span, and all "local" birds may thus also be regarded as passers by. The distinction between local birds and migrants is therefore not clear-cut and in the field, this distinction cannot be made with certainty. This report treats all seabirds seen in the area as local birds.

The wind farms themselves are seen as single entities. Disturbance levels probably vary through time, but to what extend is not clear, and cannot unambiguously be measured from a passing survey ship. Sources of variation in this respect are due to weather: light and visibility conditions; wind force, to maintenance activities in the park (additional ships of different sizes, different shipping activities, people visiting turbines or the met-mast) or to performance of the park (often one or more turbines did not work during passages through a park). Effects of these on seabird presence or behaviour, if any, can only be studied by prolonged presence in the park itself and fall outside the scope of this study. Hence, all variation in disturbance is here ignored, and included in the factor "park".

Study Methods

This 'T-1' study builds on the so-called T-zero study (Leopold et al. 2004) and follows the same methods as much as possible (see also Leopold & Camphuysen 2009). Seabird distributions are known to be notoriously patchy, both in time and in place. At-sea seabird counts usually contain many zero values, with some positive counts intermingled. This makes analyses difficult. Large-scale variation in occurrence is usually easy to spot, such as a reliance on coastal waters in so-called nearshore species. As seabirds are highly mobile, fine-scale variation is often not discernable from noise in the data. It should be noted at the onset of at-sea seabird studies, that variation at the spatial level of an offshore wind farm, will be difficult to quantify.

This study uses two means of identifying possible impact of the OWEZ windfarm on local seabirds. First, differences in distribution patterns between the T-0 and T-1 situation may be apparent. Second, within individual surveys deviations from a general distribution pattern at the location of OWEZ may be present. For modeling purposes, local bird densities were used (n/km^2). Data on densities were collected at sea, using strip-census techniques (Tasker et al. 1984; and see Leopold et al. 2004 for an extensive explanation of the particular techniques used in the OWEZ studies). In summary, birds were counted in two, 300 m wide strips on either side of the survey vessel, while sailing through the area along fixed survey lines. As considerable numbers of seabirds were also seen beyond the 300 m limits, or at close range but outside the snap-shots used in the strip counts (Tasker et al. 2004), a larger sample of birds was available than used in the density constraint. Distributions were therefore also plotted using all birds seen and are expressed as birds/km. Note that total n-values are larger in these n/km plots, giving mostly a fuller impression of the distribution patterns. However, these pictures contain more "noise" because birds may have been seen at considerable distances from the location of the observers, where they were plotted.

During the T-0 surveys, distribution patterns were found to be influenced by location within the study area (Leopold et al. 2004). In particular, distance to the 20m depth isobath was found to be important. Northing, or the location along the N-S axis of the study area was also found to be important. Distance to the 20m depth isobath is equivalent to the distance to the mainland shore, and strongly related to gradients in water depth, salinity and temperature. Any of these factors may thus be used as a smoother in distribution models. Distance to the 20m depth isobath was selected for the T-0 distribution pattern analyses (Leopold et al. 2004). In the present report, we use distance to shore, to avoid problems of symmetry around the 20 m isobath situated centrally in the study area. Because the analysis is different to the analysis in the T-0 report, the T-0 results have been re-analysed, but the methodology is largely the same. Bird distributions were modeled in R, using distance to coast and northing as smoothers and windpark (counts within OWEZ, within PAWF or outside either park) as an additional factors. The data were analysed at the level of individual surveys, after a selection for sufficient data. Sufficient data was taken as surveys with at least 10 counts with birds of a given species. This was a conservative precaution, allowing for 137 bird/month combinations to be analysed, out of a total of 340.

For all bird/month combinations, Generalised Additive Mixed Models (GAMM) were first applied. If the amount of data was insufficient to apply a GAMM, a more simple Generalised Additive Model (GAM) was used. Both models predict bird distribution for the entire study area on the basis of all data gathered (separately for each individual survey), using Distance to coast and Northing as predictors ("smoothers"). A GAM uses just these two smoothers, while a GAMM also considers the spatial autocorrelation within the dataset. P-values of the effects of distance to coast, northing and OWEZ were estimated.

Data quality

As seabird distribution patterns vary over time, and may also vary within an observation week, care was taken to sail transects in such a sequence, that the whole survey area effectively surveyed several times. The ten transects , if numbered 1-10 from North to South were sailed in this order: 1-3-5-7-9-10-8-6-4-2. We always aimed to survey each line twice, so this sequence was repeated. However, due to spells of bad weather a full second coverage was not always possible. The minimum requirement, that each transect line was covered once, was met in all surveys.

Ideally, bird counts are conducted in good weather, as spotting birds on a rough sea surface during a storm is difficult. Beaufort sea states of 6 and more are thus less suitable for survey work (Camphuysen et al .2004). This division in “good” and “bad” survey conditions is not always clear-cut, however. Working from a large ship, in coastal waters and with good light conditions may prove usefull in Bft 6 conditions and even worse. In some situations, work had to be conducted in high winds (6-7 Bft) but this was only done if other conditions permitted collection of useful data. Note that there is always a trade-off between working in less than optimal conditions and not working. The logistics of the surveys were such, that the full set of 20 survey lines could only be sailed within one observation week, if conditions were good throughout. Loss of survey time because of weather, also results in loss of data. During windy weeks, optimal solutions were always sought, by first and foremost covering all transects once. Some weeks, however, were windy throughout and in such cases the whole survey had to be done in 5-7 Bft sea states. As the aim of this project is to discriminate between bird densities inside and outside the wind farm perimeter, in other works, to compare relative densities, this was generally not seen as a very large problem. However, it is pointless to keep surveying in very bad weather, and in some cases (see below) surveys had to be terminated.

Results

Completed surveys

A total of eight T-0 surveys were carried out, but only six of these were repeated during the T-1 phase of the project (Table 1). The T-0 surveys of October 2002 and May 2003 cannot be used for comparison with T-1 surveys as no matching surveys were conducted during T-1, and are omitted from the analysis. The mid-winter T-0 survey (February 2004) was repeated slightly earlier in the year (January) and has been kept for analysis.

Survey	Month	Year	From	To	Area surveyed
T0	9	2002	23	27	444.92
T0	10	2002	21	24	278.26
T0	4	2003	7	11	533.35
T0	5	2003	19	23	477.32
T0	6	2003	23	27	590.65
T0	8	2003	11	15	506.20
T0	11	2003	4	7	341.34
T0	2	2004	12	19	412.34
T1a	4	2007	9	12	480.98
T1a	6	2007	27	29	375.51
T1a	8	2007	19	22	413.25
T1a	9	2007	24	27	129.07
T1a	11	2007	5	6	55.93
T1a	11	2007	20	24	377.62
T1a	1	2008	14	18	315.84
T1b	4	2008	7	10	468.17
T1b	6	2008	23	26	483.04
T1b	8	2008	11	14	449.63
T1b	9	2008	30	30	83.84
T1b	11	2008	3	7	399.69
T1b	1	2009	19	22	221.83

Table 1. Dates (From…To) of the conducted T-0 and T-1 surveys. Two T-0 surveys were not used for further analysis. The T-1 survey of November 2007 had to be terminated after two days, because of severe weather, but could be carried out in full several weeks later, within the planned month. The first two survey days were omitted from analysis. A similar situation occurred in September 2008, without the possibility of repetition; these data have been kept for want of better data. Area surveyed gives the sum of strip area (300 wide times transect length times number of repetitions), summed for the whole survey, in km^2.

Several surveys were hampered by bad weather, particular high winds. The aim was to survey all ten transect lines within the study area twice, keeping watch on both sides of the ship (port and starboard). However, high winds and heavy rain prevented this on some parts of the surveys, and cut some surveys short. This inevitably resulted in some data loss, but the minimum requirement, that during each survey, each transect line was covered at least once, was met in every survey, except the T1b-September survey.

On the following pages, maps of the survey effort are given, graded by seastate conditions encountered. These range from seastate 0 Bft (completely flat) in green to seastate 6 and above (large waves with lots of white foam) in read. Comparable surveys (same month or nearly same month) are plotted from top to bottom.

The mid-winter surveys (Feb in T-0; Jan in T-1) had rather poor weather. The T-0 survey was conducted under better average conditions than both T-1 surveys.

The April surveys were all conducted under good conditions.

The first T-1 June survey had unexpected bad conditions; both the T-0 and T-1b surveys had good seastates, generally.

The three August surveys had progressively worse weather, as had the September surveys. The T-1b survey had to be terminated after two days of poor weather.

The November surveys had a mix of good and moderate to poor conditions, the latter mainly during the T-1a survey.

Generally, seastate conditions were best close to the shore, where the sea is more shallow and where the coast gives some protection from easterly winds. A summary of seastate conditions encountered is given in Table 2 & Figure 2.

Bft	T0	T1a	T1b	Sum-T1
0	1.8	4.0	0.9	2.4
1	5.9	2.8	5.6	4.2
2	23.2	9.5	15.3	12.4
3	27.3	20.4	20.3	20.4
4	31.3	13.9	32.7	23.3
5	10.0	31.1	17.8	24.4
>=6	0.5	18.3	7.4	12.8
Total	100	100	100	100
AVG	3.4	4.1	3.7	3.9

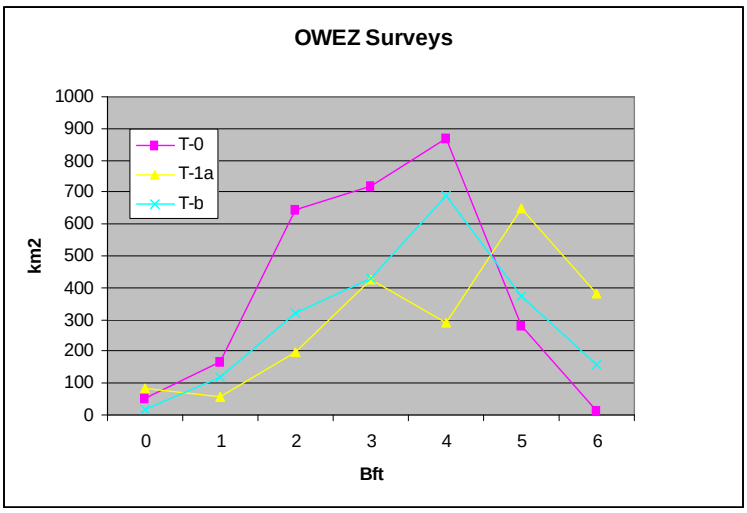
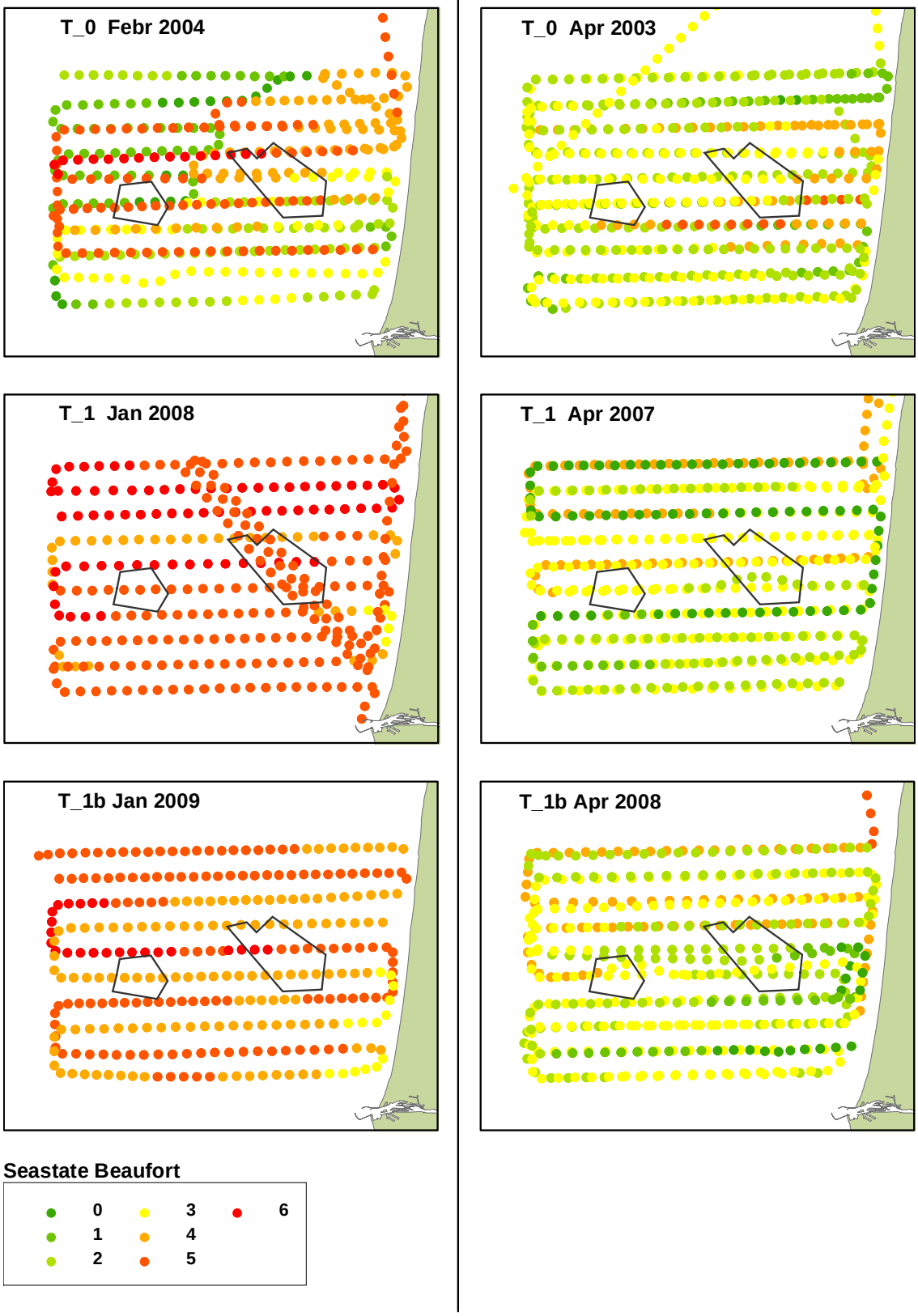
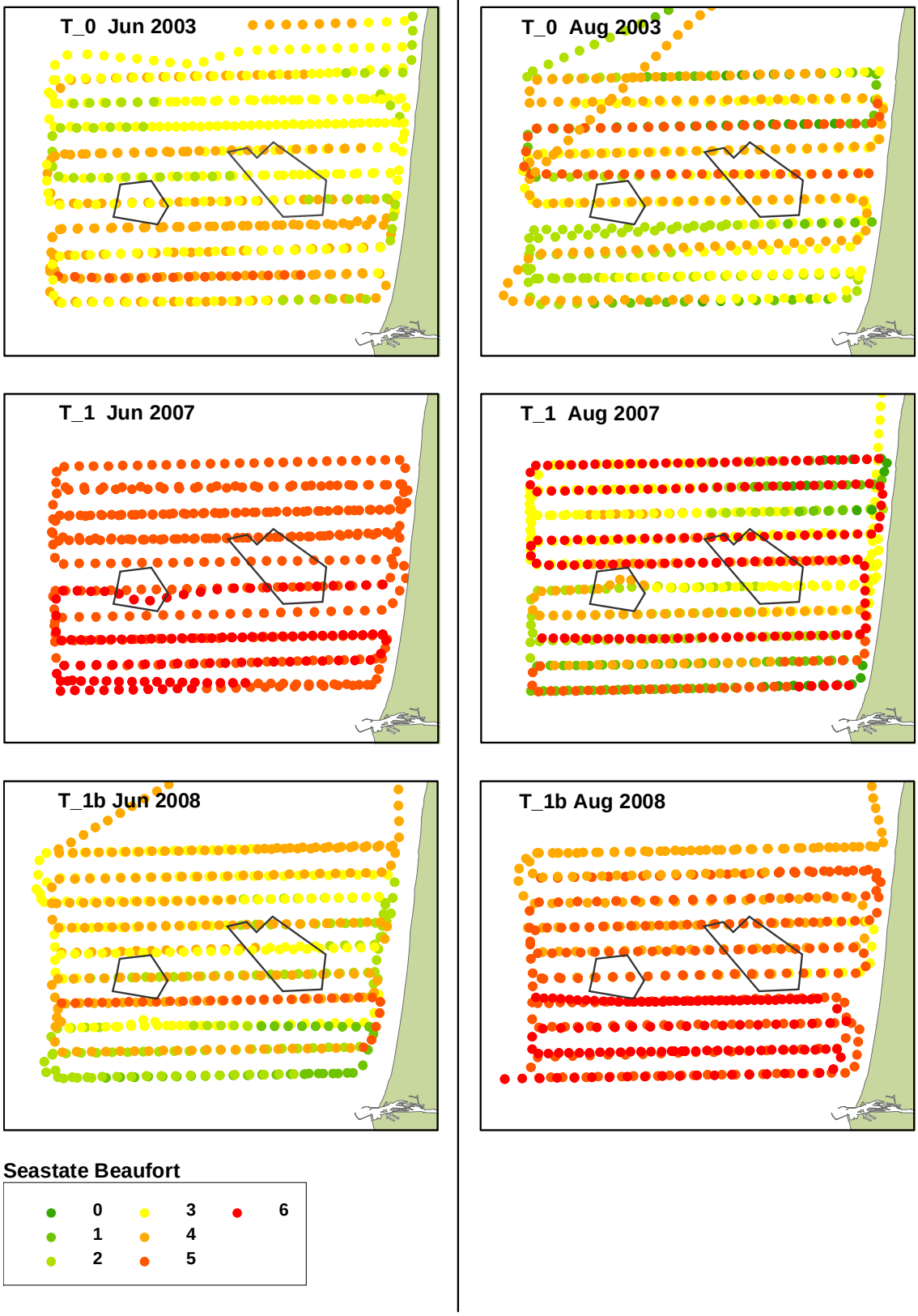


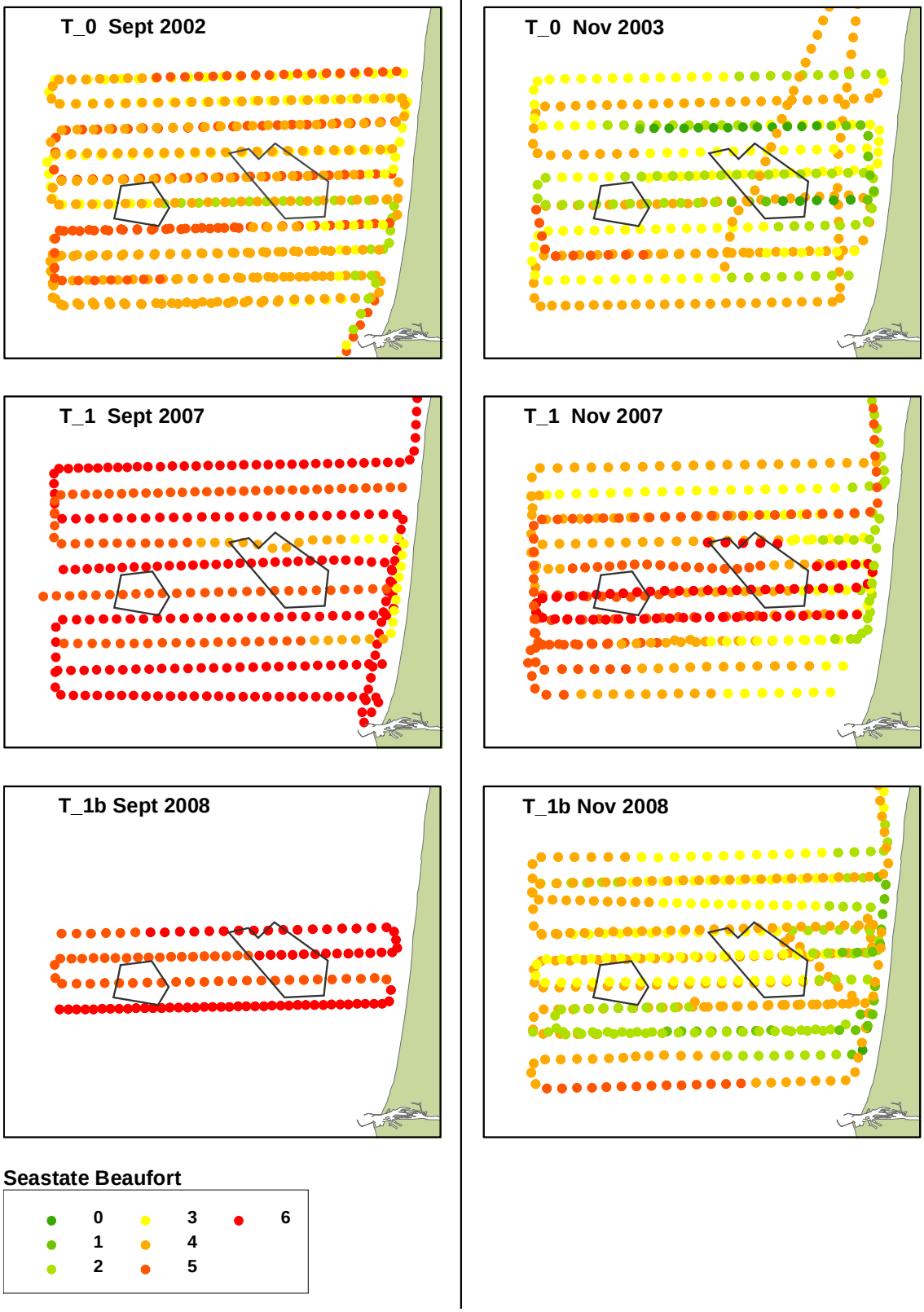
Table 2 & Figure 2. Seastates encountered during the surveys listed in Table 1 (surveys with grey background omitted). The table gives the percentages of total surveyed area (km2) for each set of surveys, per Beaufort seastate. The Figure gives this distribution in actual km2 surveyed. The T-0 survey had a higher proportion of good conditions (seastates 0-3); the T-1 survey had, overall, the worst conditions.

Figure 3 (overleaf): Seastate conditions (broken up in 5 minute counts) for all surveys (read top to bottom, and left to right).



Maps Seastate 1


T_0 Jun 2003
T_0 Aug 2003
T_1 Jun 2007
T_1 Aug 2007
T_1b Jun 2008
T_1b Aug 2008
Seastate Beaufort
0
1
2
3
4
5
6


T_0 Sept 2002
T_0 Nov 2003
T_1 Sept 2007
T_1 Nov 2007
T_1b Sept 2008
T_1b Nov 2008
Seastate Beaufort
0
1
2
3
4
5
6

Species accounts

Divers *Gadidae* (duikers)

Three species of divers were noted during the surveys. The vast majority were certain or probable Red-throated Divers *Gavia stellata*. Some Black-throated Divers *G. arctica* were seen, mostly during their spring migration in April (cf seawatching data; see: Camphuysen & van Dijk 1983; Platteeuw et al. 1994; www.trektellen.nl). Some 8% of the two smaller species (Red- or Black-throated) could not be identified to species (Table 3). In November, Great Northern Divers *G. immer* were seen on two occasions. Divers were absent in summer and most numerous during the mid-winter surveys. For modeling purposes, all diver species were summed.

Month	year	Survey	Red-throated	Black-throated	Red/Black	Great Northern
2	2004	T0	197	7	34	
1	2008	T1a	729	6	4	
1	2009	T1b	475	5	14	
4	2003	T0	263	14	67	
4	2007	T1a	57	13	15	
4	2008	T1b	5	6	4	
9	2002	T0	3	2	1	
11	2003	T0	86	2	10	1
11	2007	T1a	78		20	1
11	2008	T1b	60	1	2	

Table 3. Total numbers of divers seen during the surveys (surveys without diver observations omitted).

Diver distribution patterns were mostly rather coastal, with OWEZ being situated in the offshore part of the area occupied by divers and PAWF offshore of these parts. The pattern during the spring (April) surveys was markedly different, particularly during the T-0 survey in 2003, when relatively large numbers were seen. In spring, divers were seen far offshore, to the western border of the study area. In fact, diver densities decreased towards land in April 2003, in contrast to the other surveys.

Some divers were seen within the perimeter of OWEZ during T-1 survyes, but mostly near the edges of the park. This shows that avoidance, if this is a reality, is less than 100% (contra the preliminary results of the studies at the Horns Rev wind farm, off Blåvandshuk, Denmark). Modeling results showed significant contributions of the smoothers Distance to coast and, in some cases, Northing (Appendix II). Effects related to the presence of wind farms on the distribution pattern of local seabirds were mostly insignificant.

Interestingly, a significant positive effect of wind farms was found for the April T-0 survey (Table 4). Inspection of the distribution map (Appendix I) shows a clustering of divers around PAWF, which, at the time, was not yet built. Therefore, this clustering of divers had nothing to do with a presence of a wind farm and must be considered a random event. The situation in April 2003 may have been rather exceptional anyway, in that large numbers of divers were seen far offshore (but see Baptist & Wolf 1993 for similar results two decades ago). Numbers of divers occurring offshore during the two T-1 April surveys were much lower than in April 2003, as they were during earlier ship-based surveys in the area (Camphuysen & Leopold 1994).

Survey	Month	p_Coast	p_North	p_OWEZ	Effect_OWEZ	Model	anova_parks
T-0	2	**0.00000**	**0.00181**	0.99999	-	GAM	1.00000
T-1a	1	**0.02551**	0.76936	0.66735	-	GAMM	0.91163
T-1b	1	**0.00000**	**0.00173**	1.00000	-	GAMM	1.00000
T-0	4	**0.00596**	0.44491	0.51732	+	GAMM	**0.00000**
T-1a	4	NA	NA	NA	NA	NA	NA
T-1b	4	NA	NA	NA	NA	NA	NA
T-0	11	**0.01371**	**0.06652**	1.00000	-	GAMM	1.00000
T-1a	11	NA	NA	NA	NA	NA	NA
T-1b	11	**0.00001**	0.17728	1.00000	-	GAMM	1.00000

Table 4. Modeling results for divers. Significant contributions (P<0.1) are put in **bold**. GAMM: Full model applied (Generalised Additive Mixed Model); GAM: Generalised Additive Model (without considering possible autocorrelation in the data). The last column gives the result (p-value) of an analysis of variance (anova) comparing bird densities within the two wind parks and in the remaining part of the study area. Note that "positive" or "negative" effects of the presence of OWEZ are in fact negligible effects if p_OWEZ is larger than 0.1.

Great Crested Grebe *Podiceps cristatus* (Fuut)

Grebes take to North Sea coastal waters in winter and usually stick to very nearshore waters (Appendix I). Relatively small numbers were seen during the T-0 mid-winter survey, in February 2004 (less than 100), compared to much larger numbers during both T-1 mid-winter surveys (over 3000 birds sighted), both conducted in January (Table 5).

The distribution patterns were always very similar. The highest densities were found very close to the shore, tapering off very quickly to zero a few kilometers into the sea (Appendix II). The location of OWEZ is clearly beyond the realm of the Grebes and it follows, that no impact of the park on Grebe densities is to be expected. This is corroborated by the modeling results that show no significant impact of the parks (Table 6).

Survey	Month	Year	N-total
T0	9	2002	1
T0	10	2002	2
T0	4	2003	9
T0	5	2003	1
T0	6	2003	0
T0	8	2003	0
T0	11	2003	10
T0	2	2004	92
T1a	4	2007	2
T1a	6	2007	0
T1a	8	2007	3
T1a	9	2007	0
T1a	11	2007	32
T1a	1	2008	3806
T1b	4	2008	3
T1b	6	2008	0
T1b	8	2008	0
T1b	9	2008	0
T1b	11	2008	6
T1b	1	2009	3440

Table 5. Total numbers of Great Crested Grebes seen during all surveys. Only the data of the mid-winter surveys are sufficient for further modeling (Table 6). Note that the October and May T-0 surveys (grey bars) were not repeated in the T-1 phase, and are not further analysed in this report.

Survey	Month	p_Coast	p_North	p_OWEZ	Effect_OWEZ	Model	anova_parks
T-0	2	**0.000000**	**0.000000**	0.999989	-	GAM	1.000000
T-1a	1	**0.000000**	**0.000000**	0.999997	-	GAM	1.000000
T-1b	1	0.232454	**0.000000**	0.999999	+	GAM	1.000000

Table 6. Modeling results for Great Crested Grebe. Significant contributions (P<0.1) are put in **bold**. GAM: Generalised Additive Model (without considering possible autocorrelation in the data). Note that "positive" or "negative" effects of the presence of OWEZ are in fact negligible effects if p_OWEZ is larger than 0.1.

Fulmar *Fulmarus glacialis* (Noordse Stormvogel)

Fulmars were seen in most surveys, but never in very large numbers and typically in the western parts of the study area (Appendix I &II). Most were seen during the T-0 and T-1a winter and spring surveys, but a remarkable drop in numbers was noted during all T-1b surveys (Table 7). This hampers the possibilities of modeling distribution patterns: this could only be done for the mid-winter and for the April surveys (note that the T-0 May survey is not further analysed here, despite the rather large numbers seen, because this survey was not repeated during T-1. The modeling results (Table 8) show a clear influence of distance to coast (birds mostly occurring far offshore) and of northing (more birds were generally seen in the northern part of the study area). No impact of OWEZ could be detected during any of the T-1 surveys, but numbers of Fulmars present in the study area were too low to perform any modeling on the T-1b data.

The locations of the wind farms were clearly situated within the realm of Northern Fulmars, although higher densities tended to occur further west. Fulmars were seen within the OWEZ area in September 2002 and within the PAWF area in April 2003 (both T-0; Appendix I) but at the time the parks were not yet present. Later, in the operational phase of the parks, Fulmars were never spotted again in either wind farm.

Survey	Month	Year	N-total
T0	9	2002	51
T0	10	2002	24
T0	4	2003	92
T0	5	2003	136
T0	6	2003	12
T0	8	2003	12
T0	11	2003	5
T0	2	2004	76
T1a	4	2007	146
T1a	6	2007	45
T1a	8	2007	6
T1a	9	2007	30
T1a	11	2007	4
T1a	1	2008	11
T1b	4	2008	3
T1b	6	2008	0
T1b	8	2008	0
T1b	9	2008	0
T1b	11	2008	0
T1b	1	2009	2

Table 7. Total numbers of Fulmars seen during all surveys.

Survey	Month	p_Coast	p_North	p_OWEZ	Effect_OWEZ	Model	anova_parks
T-0	2	**0.00000**	**0.00004**	0.999991	-	GAM	1.00000
T-1a	1	NA	NA	NA	NA	NA	NA
T-1b	1	NA	NA	NA	NA	NA	NA
T-0	4	**0.00002**	**0.02207**	0.956073	+	GAMM	**0.017256**
T-1a	4	**0.00741**	0.98743	0.999999	-	GAMM	1.00000
T-1b	4	NA	NA	NA	NA	NA	NA

Table 8. Modeling results for Northern Fulmar. Significant contributions (P<0.1) are put in **bold**. GAMM: Full model applied (Generalised Additive Mixed Model); GAM: Generalised Additive Model (without considering possible autocorrelation in the data). Note that "positive" or "negative" effects of the presence of OWEZ are in fact negligible effects if p_OWEZ is larger than 0.1.

Northern Gannet *Morus bassanus* (Jan van Gent)

Gannets were seen in good numbers in most surveys (Table 9) and the data usually showed some geographical structure, with significant contributions of the smoothers distance to coast and northing to the distribution. Gannets showed varying distribution patterns, often tending towards a slightly offshore distribution but they also occurred widely spread with nearshore concentrations at other times. Generally, Gannets occurred on all sides of the wind farms, but only rarely within the perimeters of either park during the T-1 surveys (Appendix I). The modeling results therefore show avoidance in two T-1 situations (Table 10). Note however, that 'avoidance' was also found during one of the T-0 surveys. The latter is probably an artifact of the rather clear-cut distribution pattern during that (September 2002) T-0 survey, as the OWEZ perimeter was more or less situated at the edge of the Gannets' distribution which, at the time, was concentrated further offshore (Appendix I). Avoidance during the T-1 surveys was also apparent in the Gannets' behaviour (cf Krijgsveld et al. 2009): birds on a flight path towards the park mostly veered off course shortly before they would have entered the park. Only some birds cut through the park, mostly just around one of the outer turbines, and mostly during high winds. Such birds would go down to a low altitude, stop apparent searching behaviour (which in Gannets is characterized by flying at 10-40 m above sea level with the bill pointing downward), and cut through the park quickly and at only 1 or 2 m above sea level. No feeding (dives) or resting (swimming on the water's surface) was seen in any of the parks during any of the T-1 surveys.

Survey	Month	Year	N-total
T0	9	2002	378
T0	10	2002	70
T0	4	2003	293
T0	5	2003	119
T0	6	2003	42
T0	8	2003	647
T0	11	2003	103
T0	2	2004	34
T1a	4	2007	82
T1a	6	2007	55
T1a	8	2007	65
T1a	9	2007	708
T1a	11	2007	277
T1a	1	2008	22
T1b	4	2008	364
T1b	6	2008	51
T1b	8	2008	191
T1b	9	2008	141
T1b	11	2008	423
T1b	1	2009	2079

Table 9. Total numbers of Gannets seen during all surveys.

Survey	Month	p_Coast	p_North	p_OWEZ	Effect_OWEZ	Model	anova_parks
T-0	2	NA	NA	NA	NA	NA	NA
T-1a	1	NA	NA	NA	NA	NA	NA
T-1b	1	0.258653	**0.004841**	**0.002488**	-	GAMM	**0.047275**
T-0	4	0.000667	0.104573	0.357101	-	GAMM	0.635687
T-1a	4	NA	NA	NA	NA	NA	NA
T-1b	4	**0.000000**	**0.000000**	1.00000	-	GAM	1.000000
T-0	6	NA	NA	NA	NA	NA	NA
T-1a	6	NA	NA	NA	NA	NA	NA
T-1b	6	**0.021023**	0.526685	1.00000	-	GAMM	1.000000
T-0	8	**0.073022**	**0.000000**	0.24883	-	GAM	0.999996
T-1a	8	NA	NA	NA	NA	NA	NA
T-1b	8	**0.001394**	**0.000152**	0.99999	-	GAM	1.000000
T-0	9	**0.007296**	0.749043	**0.004143**	-	GAMM	**0.008830**
T-1a	9	**0.000000**	0.265019	**0.00024**	-	GAM	0.999997
T-1b	9	**0.043448**	0.200739	0.999994	-	GAM	1.000000
T-0	11	**0.000000**	**0.000090**	0.99999	-	GAM	1.000000
T-1a	11	NA	NA	NA	NA	NA	NA
T-1b	11	**0.000019**	**0.016694**	0.999995	-	GAM	1.000000

Table 10. Modeling results for Northern Gannet. Significant contributions (P<0.1) are put in **bold**. GAMM: Full model applied (Generalised Additive Mixed Model); GAM: Generalised Additive Model (without considering possible autocorrelation in the data). Note that "positive" or "negative" effects of the presence of OWEZ are in fact negligible effects if p_OWEZ is larger than 0.1.

Great Cormorant *Phalacrocorax carbo* (Aalscholver)

Great Cormorants were seen during all surveys (Appendix I), with good numbers from spring through autumn and lower numbers in winter (Table 11) and the data usually showed clear geographical structure, with significant

contributions of the smoothers distance to coast (more birds nearshore than offshore) and northing (most birds centrally in the study area in this respect) to the distribution (Appendix II). Cormorants usually showed a clear-cut distribution pattern. Birds commuted between two breeding colonies on the mainland (Zwanenwater and Castricum) to OWEZ and further on, to PAWF. These birds used the parks for resting and feeding. Typically, several dozens of birds rested on the met-mast on the seaward side of OWEZ and made short feeding trips to the sea below, both around the park and inside the park. Cormorants flew often, and without any visible hesitation, through the park, at varying altitudes, including rotor height (cf Krijgsveld et al. 2009). Cormorants also used the entrance structures to the monopiles for resting and occurred throughout OWEZ (flying, swimming, resting and feeding). The modeling results (Table 12) confirm these observations, tending towards attraction. However, Cormorants also occurred in large numbers around OWEZ, particularly on the landward side (commuting birds to and from colonies). Just one km north of OWEZ birds used an offshore gas-production platform as an alternative resting location for the met-mast on some occasions. Over 100 birds could be resting on this platform and this shows up in the modeling results as 'avoidance of OWEZ'. In reality, however, the combination of the gas platform and the wind farms clearly attracted hundreds of Great Cormorants to the site. Other concentrations occurred near the coast (unrelated to the wind farm) and in the wake of fishing vessels, where Cormorants competed with gulls for fishery waste (also unrelated to the wind farm). This hampers the statistical analysis as concentrations of Cormorants were found in different areas within the study area. Still, birds resting on the monopiles and met-mast could not have done this if the park had not been built, so these birds at least were attracted to the site.

Survey	Month	Year	N-total
T0	9	2002	338
T0	10	2002	92
T0	4	2003	323
T0	5	2003	1082
T0	6	2003	1393
T0	8	2003	483
T0	11	2003	75
T0	2	2004	20
T1a	4	2007	1080
T1a	6	2007	2247
T1a	8	2007	1234
T1a	9	2007	512
T1a	11	2007	40
T1a	1	2008	81
T1b	4	2008	683
T1b	6	2008	1171
T1b	8	2008	1242
T1b	9	2008	152
T1b	11	2008	309
T1b	1	2009	217

Table 11. Total numbers of Cormorants seen during all surveys.

Survey	Month	p_Coast	p_North	p_OWEZ	Effect_OWEZ	Model	anova_parks
T-0	2	NA	NA	NA	NA	NA	NA
T-1a	1	NA	NA	NA	NA	NA	NA
T-1b	1	0.695404	0.997024	0.036941	+	GAMM	0.109349
T-0	4	**0.000000**	**0.000001**	0.999990	-	GAM	1.000000
T-1a	4	**0.000000**	**0.000000**	0.269989	NA	GAM	0.999996
T-1b	4	**0.001713**	**0.000000**	0.871596	-	GAM	0.999995
T-0	6	**0.000000**	**0.000000**	0.999991	-	GAM	1.000000
T-1a	6	**0.060937**	0.996482	0.744928	+	GAMM	0.657863
T-1b	6	**0.001014**	**0.089233**	0.396803	+	GAMM	0.521595
T-0	8	**0.000000**	**0.000000**	0.999991	-	GAM	1.000000
T-1a	8	**0.000017**	0.246641	**0.000000**	-	GAMM	**0.000000**
T-1b	8	**0.000003**	**0.000054**	**0.000000**	-	GAM	0.999997
T-0	9	**0.000018**	**0.000000**	**0.025240**	-	GAM	0.999995
T-1a	9	0.914284	0.674050	**0.038196**	+	GAMM	**0.000132**
T-1b	9	NA	NA	NA	NA	NA	NA
T-0	11	NA	NA	NA	NA	NA	NA
T-1a	11	NA	NA	NA	NA	NA	NA
T-1b	11	**0.000001**	**0.000000**	0.999991	-	GAM	1.000000

Table 12. Modeling results for Great Cormorant. Significant contributions (P<0.1) are put in **bold**. GAMM: Full model applied (Generalised Additive Mixed Model); GAM: Generalised Additive Model (without considering possible autocorrelation in the data). Note that "positive" or "negative" effects of the presence of OWEZ are in fact negligible effects if p_OWEZ is larger than 0.1.

Common Scoter *Melanitta nigra* (Zwarte Zee-eend)

Common Scoters (and Velvet Scoters *M. fusca* and Eiders *Somateria mollissima*) have used the coastal waters off Noord-Holland at times in large numbers (up to circa 100,000; Leopold et al. 1995) and because of this, the parts north of the town of Bergen have been designated as a Natura 2000 site (see: Lindeboom et al. 2005). In recent years however, the staple food of these ducks, *Spisula subtruncata*, was largely absent and no large flocks of seaducks have been using the area (Craeymeersch & Perdon 2006; Goudswaard et al. 2008; Baptist & Leopold 2009). When *Spisula* stocks were large off Noord-Holland, these shellfish occurred over a wide area, and the ducks, feeding on this resource were also found quite far offshore in these parts. OWEZ was within the range of these ducks when *Spisula* were plentiful, but after numbers dwindled, the area around the wind park was no longer of interest to the ducks. No significant numbers of seaduck were encountered during any of the T-0 or T-1 surveys, but this may, of course, change in future years. Scoters still migrate through the study area in large numbers (www.trektellen.nl). Most of these birds follow the coastline and pass through the corridor between the shore and the wind park. Surveys at sea, such as our own or aerial surveys have not found any offshore concentrations lately and at present, the offshore waters around the wind farms appear unattractive for seaduck.

Scoters were seen in all surveys (Table 13, Appendix I), mostly flying up and down the coast, in groups ranging in size from several individuals to circa 100 birds. Such groups are mostly quite wary, and avoid obstacles at sea, including wind farms (Krijgsveld et al. 2009) but also survey ships. Most groups, and particularly the larger groups, were seen at rather large distances from the ship and mostly in nearshore waters. Scoters were never seen to fly through OWEZ. Sightings of scoters that got located inside wind parks (Appendix I) were in all cases birds flying outside the perimeter of the wind farm. Such artifacts are caused by the survey protocol in which birds are counted in time periods of 5 minutes and plotted at the mid-points of the counts. Small displacements of depicted sightings may thus occur. Some small groups flying further offshore were seen on a heading that would take them into the park initially, but these always reacted strongly when they apparently first noticed the park and changed course markedly to avoid the park. As most observations occurred outside the 300 m wide counting strips, only relatively few data are available for modeling effects and significant results were not found (Table 14). This is due to low numbers residing in offshore waters and avoidance of both park and ship at large distances. In all likelihood, Common Scoters avoid the park but in the situations studied, this affected only migrating birds. These are dealt with separately by Krijgsveld et al. (2009).

When looking through the distribution maps (Appendix I) it should be kept in mind that scoters were often seen at considerable distances from the ship. However, observations are plotted at the ship's position at the time and this may be several kilometers away from where the birds were actually flying. For density calculations this does not matter, as only birds seen within 300 m from the ship are used (right panels in the maps). When all birds seen are plotted (left panels), some birds may "appear" within the perimeter of OWEZ, that were in fact seen quite far outside the park. The maps do show, that scoters occur at the longitudes of OWEZ PAWF and also, that they tend to fly around the parks as numbers of observations are clearly relatively low when sailing through these parks.

The apparent concentration of scoters in April 2008 was a modeling artifact, resulting from 4 groups of ducks passing by at close range to the ship (Appendix I). These groups were thus used for density calculations, while most other groups were not as they were seen at greater distances from the ship.

Survey	Month	Year	N-total
T0	9	2002	667
T0	10	2002	189
T0	4	2003	1325
T0	5	2003	93
T0	6	2003	443
T0	8	2003	67
T0	11	2003	1137
T0	2	2004	641
T1a	4	2007	2080
T1a	6	2007	133
T1a	8	2007	171
T1a	9	2007	176
T1a	11	2007	28
T1a	1	2008	108
T1b	4	2008	626
T1b	6	2008	126
T1b	8	2008	0
T1b	9	2008	19
T1b	11	2008	108
T1b	1	2009	234

Table 13. Total numbers of Common Scoters seen during all surveys.

Survey	Month	p_Coast	p_North	p_OWEZ	Effect_OWEZ	Model	anova_parks
T-0	4	NA	NA	NA	NA	NA	NA
T-1a	4	NA	NA	NA	NA	NA	NA
T-1b	4	**0.008936**	**0.000000**	0.999995	-	GAM	1.000000

Table 14. Modeling results for Common Scoter. Significant contributions (P<0.1) are put in **bold**. GAM: Generalised Additive Model (without considering possible autocorrelation in the data). Note that "positive" or "negative" effects of the presence of OWEZ are in fact negligible effects if p_OWEZ is larger than 0.1.

Little Gull *Larus minutus* (Dwergmeeuw)

Little Gulls are mainly migrants through Dutch waters although some might winter off our coast (Camphuysen & Leopold 1994). Most Little Gulls are seen in autumn and spring, with a spectacular migration peak in April (Camphuysen & van Dijk 1983; Platteeuw et al. 1994; www.trektellen.nl). During spring migration, nearly the entire European population of Little Gulls may pass along our mainland shoreline and thousands may stage in these waters for several weeks in April, if conditions are favourable (den Ouden & Stougie 1987, 1990; Keijl & Leopold 1997).

In accordance to this know phenology, Little Gulls were seen in largest numbers during the April surveys (Table 15). During their spring migration, Little Gulls may occur quite far offshore, over the entire study area and feeding flocks several dozens to hundreds strong are scattered over a large area (Keijl & Leopold 1997; Leopold et al. 2004). During the T-0 April survey such a pattern was found, with relatively low numbers in the central part, where the wind farms were to be constructed. This pattern was found again during the T-1b survey in April 2008, but even more pronounced: Little Gulls may have been avoiding a large area around the two wind farms (Table 16). However, some birds were also seen within OWEZ, as an extension of the nearshore concentration area and the model picked this up as a positive contribution of OWEZ. Caution is needed to interpret this result (see maps in Appendix I). In April, concentrations of birds were found on the OWEZ site when the park was not yet present (T-0). During the T-1 surveys numbers were generally much lower, and during the second T-1 survey an apparent concentration was found in the NW sector of the survey area (Appendix I). Such patterns are probably best explained as temporary concentrations during migration that might occur anywhere en route to the breeding sites if good feeding conditions are encountered. Some avoidance may thus have occurred but this was less than 100% (some birds seen in the park) while birds were also probably attracted to locations outside the park.

Survey	Month	Year	N-total
T0	9	2002	65
T0	10	2002	109
T0	4	2003	2029
T0	5	2003	0
T0	6	2003	254
T0	8	2003	0
T0	11	2003	0
T0	2	2004	19
T1a	4	2007	1788
T1a	6	2007	0
T1a	8	2007	22
T1a	9	2007	82
T1a	11	2007	38
T1a	1	2008	29
T1b	4	2008	6698
T1b	6	2008	0
T1b	8	2008	0
T1b	9	2008	2
T1b	11	2008	30
T1b	1	2009	7

Table 15. Total numbers of Little Gulls seen during all surveys.

Survey	Month	p_Coast	p_North	p_OWEZ	Effect_OWEZ	Model	anova_parks
T-0	4	**0.000029**	**0.000208**	0.443016	-	GAM	0.645127
T-1a	4	**0.001206**	**0.003390**	0.711554	-	GAMM	0.933660
T-1b	4	**0.000000**	**0.000147**	**0.000217**	-	GAM	0.999999
T-0	11	**0.000000**	**0.003982**	0.246382	-	GAM	0.999995
T-1a	11	NA	NA	NA	NA	NA	NA
T-1b	11	**0.000037**	**0.003559**	0.999991	-	GAM	1.000000

Table 16. Modeling results for Little Gull. Significant contributions (P<0.1) are put in **bold**. GAMM: Full model applied (Generalised Additive Mixed Model); GAM: Generalised Additive Model (without considering possible autocorrelation in the data). Note that "positive" or "negative" effects of the presence of OWEZ are in fact negligible effects if p_OWEZ is larger than 0.1.

Black-headed Gull *Larus ridibundus* (Kokmeeuw)

Black-headed Gulls are mainly coastal gulls in Dutch waters but they show complex moult migrations that involve crossings to the British Isles (Camphuysen & Leopold 1994). Most Black-headed Gulls are therefore seen closely to the coast, but groups of migrants might be seen anywhere in the study area (Appendix I). Black-headed Gulls were seen during all surveys, in varying numbers without a clear temporal pattern (Table 17).

Black-headed Gulls distribution could only be modeled for the survey in which the largest numbers (of groups) were seen, i.e. November 2003 (T-0; Table 17). There was a clear influence of distance to coast (Table 18) and a rather conspicuous gap in the distribution at the OWEZ location (Appendix I). However, the GAMM did not pick this anomaly up as something significant as most birds were seen at distances of >300 m and were thus not used in density calculations and modeling (and note that OWEZ was at that time no more than a contour line on the map!).

Survey	Month	Year	N-total
T0	9	2002	32
T0	10	2002	329
T0	4	2003	76
T0	5	2003	27
T0	6	2003	59
T0	8	2003	63
T0	11	2003	531
T0	2	2004	32
T1a	4	2007	94
T1a	6	2007	3
T1a	8	2007	108
T1a	9	2007	272
T1a	11	2007	33
T1a	1	2008	107
T1b	4	2008	28
T1b	6	2008	66
T1b	8	2008	39
T1b	9	2008	41
T1b	11	2008	15
T1b	1	2009	23

Table 17. Total numbers of Black-headed Gulls seen during all surveys.

Survey	Month	p_Coast	p_North	p_OWEZ	Effect_OWEZ	Model	anova_parks
T-0	11	**0.001627**	0.773677	0.999999	-	GAMM	0.778564
T-1a	11	NA	NA	NA	NA	NA	NA
T-1b	11	NA	NA	NA	NA	NA	NA

Table 18. Modeling results for Black-headed Gull. Significant contributions (P<0.1) are put in **bold**. GAMM: Full model applied (Generalised Additive Mixed Model); GAM: Generalised Additive Model (without considering possible autocorrelation in the data). Note that "positive" or "negative" effects of the presence of OWEZ are in fact negligible effects if p_OWEZ is larger than 0.1.

Common Gull *Larus canus* (Stormmeeuw)

Common Gulls occur in the study area throughout the year, often with the highest densities in nearshore waters (Appenidix I & II, Table 19). The largest numbers were seen in autumn and winter and the modeling results clearly indicated the importance of the smoother distance to coast (Table 20). The presence of wind parks had little impact on the occurrence of Common Gull. One case of "attraction" was identified (Jan 2009) and a similar result was obtained for January 2008 for PAWF (Appendix I); all other impacts of the wind farms were considered insignificant by the models applied (Table 20). Looking at the maps for January 2008 and 2009, it becomes clear that the "attraction" is based on very few data points and may rather be caused by a lack of sightings of Common Gulls in the area between OWEZ and PAWF. Given the lack of attraction (or avoidance) in all other situations, often with many more birds, the impact of the wind farms on this species is probably very small at best.

Survey	Month	Year	N-total
T0	9	2002	35
T0	10	2002	340
T0	4	2003	1484
T0	5	2003	25
T0	6	2003	416
T0	8	2003	40
T0	11	2003	3841
T0	2	2004	508
T1a	4	2007	5520
T1a	6	2007	5
T1a	8	2007	6
T1a	9	2007	36
T1a	11	2007	797
T1a	1	2008	290
T1b	4	2008	2764
T1b	6	2008	61
T1b	8	2008	1
T1b	9	2008	8
T1b	11	2008	1169
T1b	1	2009	822

Table 19. Total numbers of Common Gulls seen during all surveys.

Survey	Month	p_Coast	p_North	p_OWEZ	Effect_OWEZ	Model	anova_parks
T-0	2	**0.000001**	**0.000662**	0.999995	-	GAM	0.999995
T-1a	1	**0.014888**	0.658865	0.908969	+	GAMM	0.357468
T-1b	1	**0.000007**	**0.018433**	**0.005104**	+	GAMM	0.018509
T-0	4	**0.000430**	0.194803	0.512871	+	GAMM	0.000000
T-1a	4	**0.000002**	0.126786	0.790430	+	GAMM	0.965099
T-1b	4	**0.000094**	**0.044661**	0.521270	-	GAMM	0.761794
T-0	6	0.365389	0.931377	1.000000	-	GAMM	1.000000
T-1a	6	NA	NA	NA	NA	NA	NA
T-1b	6	NA	NA	NA	NA	NA	NA
T-0	11	**0.000002**	0.934037	0.489471	-	GAMM	0.785864
T-1a	11	**0.016048**	**0.019737**	1.000000	+	GAMM	1.000000
T-1b	11	**0.000074**	0.876346	0.791955	+	GAMM	0.922365

Table 20. Modeling results for Common Gull. Significant contributions (P<0.1) are put in **bold**. GAMM: Full model applied (Generalised Additive Mixed Model); GAM: Generalised Additive Model (without considering possible autocorrelation in the data). Note that "positive" or "negative" effects of the presence of OWEZ are in fact negligible effects if p_OWEZ is larger than 0.1.

Lesser Black-backed Gull *Larus fuscus* (Kleine Mantelmeeuw)

Lesser Black-backed Gulls are sea-going birds that breed in large colonies in the dunes along the Dutch coastline. Colonies near Egmond are small (IJmuiden) or have become small after Red Foxes entered the area and are now rather insignificant. Recent work with gps loggers put on a limited number of birds and modeling work on the birds' dispersal at sea during the breeding season, however, has shown that breeders from as far away as Texel and Maasvlakte/Europort will reach the OWEZ location (Ens 2007; Camphuysen et al. 2008; Arends et al. 2008). Non-breeders and passing migrants obviously also cross the general area in large numbers. These colonies are home to tens of thousands of breeding Lesser Black-backed Gulls and are probably the source of most of the gulls sighted in and around the offshore wind farms. Most Lesser Black-backed Gulls winter in SW Europe and numbers start to drop in the study area from September onwards (Table 21).

While present in the area, Lesser Black-backed Gulls are often associated with, looking out for or resting in the wake of active fishing vessels. Concentrations of over 1000 birds have been noted in the study area against a "background density" of around 1 bird per square kilometer. Such concentrations, if encountered during a seabird survey, greatly impact modeled distribution patterns. Part of the contributions of the smoothers distance to coast and northing (Appendix II) is without doubt attributable to the presence of fishing vessels in certain parts of the study area. Lesser Black-backed Gulls were often seen within the perimeters of the wind parks (Appendix I), sometimes resting on the water or on the monopole structures, sometimes feeding in the tidal wakes of the monopiles. From the perspective of these gulls, probably the largest impact of the parks is that fishing vessels never operate within their boundaries. Large, fishing-vessel related concentrations of gulls therefore by definition occur only outside the parks and this should, with sufficient data, result in apparent avoidance of the parks. This, however was not (yet) found in the modeling results (Table 22).

Survey	Month	Year	N-total
T0	9	2002	1896
T0	10	2002	285
T0	4	2003	10384
T0	5	2003	8090
T0	6	2003	5899
T0	8	2003	8274
T0	11	2003	104
T0	2	2004	44
T1a	4	2007	6610
T1a	6	2007	4237
T1a	8	2007	5303
T1a	9	2007	1282
T1a	11	2007	3
T1a	1	2008	6
T1b	4	2008	4652
T1b	6	2008	5957
T1b	8	2008	1603
T1b	9	2008	143
T1b	11	2008	44
T1b	1	2009	3

Table 21. Total numbers of Lesser Black-backed Gulls seen during all surveys.

Survey	Month	p_Coast	p_North	p_OWEZ	Effect_OWEZ	Model	anova_parks
T-0	4	**0.023531**	0.117834	0.985152	+	GAMM	0.779264
T-1a	4	0.756094	0.633863	0.744839	-	GAMM	0.914934
T-1b	4	**0.000000**	**0.000000**	0.116711	+	GAM	**0.000555**
T-0	6	0.679011	0.878734	0.849872	-	GAMM	0.954102
T-1a	6	0.940072	0.854179	0.838807	-	GAMM	0.933104
T-1b	6	**0.000011**	**0.000000**	0.551191	-	GAM	0.774540
T-0	8	0.994462	0.443947	0.634917	-	GAMM	0.839765
T-1a	8	0.034085	0.717019	0.692863	+	GAMM	0.921078
T-1b	8	**0.000000**	**0.000000**	0.276368	+	GAM	**0.001013**
T-0	9	**0.000000**	**0.000000**	0.102561	-	GAM	0.999999
T-1a	9	0.732094	0.207979	0.999999	-	GAMM	0.999999
T-1b	9	NA	NA	NA	NA	NA	NA
T-0	11	**0.000000**	**0.000197**	0.999992	-	GAM	1.000000
T-1a	11	NA	NA	NA	NA	NA	NA
T-1b	11	NA	NA	NA	NA	NA	NA

Table 22. Modeling results for Lesser Black-backed Gull. Significant contributions (P<0.1) are put in **bold**. GAMM: Full model applied (Generalised Additive Mixed Model); GAM: Generalised Additive Model (without considering possible autocorrelation in the data). Note that "positive" or "negative" effects of the presence of OWEZ are in fact negligible effects if p_OWEZ is larger than 0.1.

Herring Gull *Larus argentatus* (Zilvermeeuw)

Herring Gulls are less sea-going than Lesser Black-backed Gulls, at least in the breeding season (Appendix I). Wintering birds however, are found throughout Dutch offshore waters (Camphuysen & Leopold 1994) and Herring Gulls were found in all surveys, be it in widely fluctuating numbers (Table 23). Like the Lesser Black-backed Gulls discussed in the previous paragraph, Herring Gulls are often associated with fishing vessels. Concentrations of over 1000 birds have been noted in this species as well, particularly closely inshore. The smoother distance to coast therefore has a profound impact on most distribution patterns found (Table 24, Appendix II)

No significant impact of OWEZ was found in any of the T-1 surveys (Table 24), but like in the Lesser Black-backed Gull, the data show a great deal of noise. All large concentrations of gulls (any species) during the T-1 phase of the project were found outside the perimeters of the parks, often in association with fishing vessels.

Survey	Month	Year	N-total
T0	9	2002	2474
T0	10	2002	3486
T0	4	2003	3910
T0	5	2003	2910
T0	6	2003	2714
T0	8	2003	327
T0	11	2003	11024
T0	2	2004	344
T1a	4	2007	2418
T1a	6	2007	278
T1a	8	2007	1602
T1a	9	2007	386
T1a	11	2007	465
T1a	1	2008	340
T1b	4	2008	983
T1b	6	2008	1200
T1b	8	2008	164
T1b	9	2008	37
T1b	11	2008	4399
T1b	1	2009	484

Table 23. Total numbers of Herring Gulls seen during all surveys.

Survey	Month	p_Coast	p_North	p_OWEZ	Effect_OWEZ	Model	anova_parks
T-0	2	**0.000000**	**0.000000**	0.999995	-	GAM	1.000000
T-1a	1	0.297055	0.425350	0.384363	+	GAMM	0.361193
T-1b	1	**0.022570**	0.968213	0.706149	-	GAMM	**0.000113**
T-0	4	**0.025701**	0.888870	0.626421	+	GAMM	0.819469
T-1a	4	**0.000003**	**0.082370**	0.689311	-	GAMM	0.999999
T-1b	4	0.212123	0.000007	0.999996	-	GAM	0.999996
T-0	6	**0.000000**	0.993378	0.822612	+	GAMM	**0.000000**
T-1a	6	**0.001586**	**0.000000**	0.999991	-	GAM	1.000000
T-1b	6	**0.000000**	**0.005079**	0.843687	-	GAMM	0.980308
T-0	8	**0.000000**	**0.000000**	**0.038356**	-	GAMM	**0.038356**
T-1a	8	**0.000000**	**0.000000**	0.871916	+	GAM	0.975367
T-1b	8	NA	NA	NA	NA	NA	NA
T-0	9	0.338928	0.601076	0.832920	-	GAMM	0.964417
T-1a	9	NA	NA	NA	NA	NA	NA
T-1b	9	NA	NA	NA	NA	NA	NA
T-0	11	**0.000187**	**0.000000**	0.999999	-	GAM	1.000000
T-1a	11	NA	NA	NA	NA	NA	NA
T-1b	11	NA	NA	NA	NA	NA	NA

Table 24. Modeling results for Herring Gull. Significant contributions (P<0.1) are put in **bold**. GAMM: Full model applied (Generalised Additive Mixed Model); GAM: Generalised Additive Model (without considering possible autocorrelation in the data). Note that "positive" or "negative" effects of the presence of OWEZ are in fact negligible effects if p_OWEZ is larger than 0.1.

Greater Black-backed Gull Larus marinus (Grote Mantelmeeuw)

Greater Black-backed Gulls visit Dutch waters mainly in the non-breeding season and they occur dispersed over the entire North Sea (Camphuysen & Leopold 1994). Like the Lesser Black-backed and Herring Gulls discussed in the previous paragraphs, Greater Black-backed feed around fishing vessels but their numbers were often lower than those of other species in the associated flocks. Numbers encountered were generally largest during the autumn surveys (Table 25). Greater Black-backed Gulls tended to be slightly more numerous in nearshore wates, but concentrations also occurred in different parts of the study area at times (Table 26, Appendix I).

Significant impact of OWEZ were found in several T-1 surveys (Table 26), but only in low density situations (Table 25) when a few gull resting on park structures (attraction) or a few gulls resting on a gas platform outside the park or feeding behind a trawler would make this difference. In high density situations, with gull spread out over the entire study area, no effect of OWEZ was found.

Survey	Month	Year	N-total
T0	9	2002	3257
T0	10	2002	1042
T0	4	2003	370
T0	5	2003	169
T0	6	2003	12
T0	8	2003	388
T0	11	2003	2357
T0	2	2004	64
T1a	4	2007	106
T1a	6	2007	157
T1a	8	2007	265
T1a	9	2007	1294
T1a	11	2007	611
T1a	1	2008	352
T1b	4	2008	74
T1b	6	2008	169
T1b	8	2008	184
T1b	9	2008	165
T1b	11	2008	3222
T1b	1	2009	652

Table 25. Total numbers of Greater Black-backed Gulls seen during all surveys.

Survey	Month	p_Coast	p_North	p_OWEZ	Effect_OWEZ	Model	anova_parks
T-0	2	NA	NA	NA	NA	NA	NA
T-1a	1	0.213236	0.772653	0.858073	-	GAMM	0.971555
T-1b	1	0.584498	0.169057	**0.000001**	+	GAMM	**0.000001**
T-0	4	**0.000000**	**0.000000**	0.999995	-	GAM	1.000000
T-1a	4	**0.000000**	**0.000983**	**0.000085**	-	GAM	0.999992
T-1b	4	**0.024599**	0.888048	0.299463	+	GAMM	**0.000023**
T-0	6	NA	NA	NA	NA	NA	NA
T-1a	6	0.992288	0.202163	0.256214	+	GAMM	**0.000011**
T-1b	6	**0.000002**	**0.000002**	**0.000001**	-	GAM	0.999991
T-0	8	**0.031031**	**0.003577**	0.196458	-	GAM	0.999996
T-1a	8	**0.000000**	**0.000042**	0.658496	+	GAM	**0.095135**
T-1b	8	**0.014672**	0.168379	0.412213	+	GAMM	0.439838
T-0	9	**0.000000**	**0.000000**	0.575937	-	GAM	0.758940
T-1a	9	0.991073	0.283969	0.823467	+	GAMM	0.941120
T-1b	9	**0.068019**	0.485514	0.999999	-	GAMM	1.000000
T-0	11	**0.000000**	**0.000023**	0.230022	-	GAM	0.999998
T-1a	11	NA	NA	NA	NA	NA	NA
T-1b	11	**0.000000**	**0.000000**	0.558164	-	GAM	0.999998

Table 26. Modeling results for Greater Black-backed Gull. Significant contributions (P<0.1) are put in **bold**. GAMM: Full model applied (Generalised Additive Mixed Model); GAM: Generalised Additive Model (without considering possible autocorrelation in the data). Note that "positive" or "negative" effects of the presence of OWEZ are in fact negligible effects if p_OWEZ is larger than 0.1.

Kittiwake Rissa tridactyla (Drieteenmeeuw)

Kittiwakes also visit Dutch waters mainly in the non-breeding season (Table 27) and like other wintering gulls they occur dispersed over the entire North Sea (Camphuysen & Leopold 1994). However, unlike many other wintering gulls, they normally avoid nearshore waters. Distance to coast often greatly influences distribution patterns (Table 28), but this pattern broke down during the autumn migration period (all three November surveys; see Appendix I). Kittiwakes join mixed feeding flocks with larger gulls less readily and fishing vessels probably have less impact on their general distribution, in a study area where large gulls predominate. They readily entered OWEZ and an effect of the wind farm on their distribution pattern could not be detected in the collected data (Table 28).

Survey	Month	Year	N-total
T0	9	2002	15
T0	10	2002	243
T0	4	2003	197
T0	5	2003	50
T0	6	2003	0
T0	8	2003	16
T0	11	2003	1298
T0	2	2004	108
T1a	4	2007	16
T1a	6	2007	12
T1a	8	2007	0
T1a	9	2007	164
T1a	11	2007	1739
T1a	1	2008	385
T1b	4	2008	3
T1b	6	2008	0
T1b	8	2008	4
T1b	9	2008	15
T1b	11	2008	93
T1b	1	2009	800

Table 27. Total numbers of Kittiwakes seen during all surveys.

Survey	Month	p_Coast	p_North	p_OWEZ	Effect_OWEZ	Model	anova_parks
T-0	2	**0.000088**	**0.023776**	0.999989	-	GAM	1.000000
T-1a	1	**0.000100**	0.631551	0.406901	-	GAM	0.659840
T-1b	1	**0.000000**	**0.000606**	0.647243	-	GAM	0.999997
T-0	4	**0.000004**	**0.005937**	0.999992	-	GAM	1.000000
T-1a	4	NA	NA	NA	NA	NA	NA
T-1b	4	NA	NA	NA	NA	NA	NA
T-0	11	0.912542	0.559009	0.549950	-	GAMM	0.778564
T-1a	11	0.905351	**0.066161**	0.852036	-	GAMM	0.977072
T-1b	11	0.010545	0.403093	0.999990	-	GAM	1.000000

Table 28. Modeling results for Kittiwake. Significant contributions (P<0.1) are put in **bold**. GAMM: Full model applied (Generalised Additive Mixed Model); GAM: Generalised Additive Model (without considering possible autocorrelation in the data). Note that "positive" or "negative" effects of the presence of OWEZ are in fact negligible effects if p_OWEZ is larger than 0.1.

Sandwich Tern *Sterna sandvicensis* (Grote Stern)

Sandwich Terns are summer visitors to Dutch coastal waters that come here to breed and to pass through, to more northerly breeding sites. Terns were therefore only seen from spring to autumn in the breeding season (Table 29) and mostly in nearshore waters. Breeding birds that are attached to colonies in the Wadden Sea or in the Delta are unlikely to reach OWEZ on their foraging trips (Arends et al. 2008) but non-breeders, failed breeders, birds (parents and fledged young) after the breeding season and particularly migrants are fully capable of using the site (Leopold et al. 2004). Therefore, numbers seen were highest during spring migration (April) and after fledging (August) (Table 29) and modeling was only possible for these survey months (Table 30, Appendix I).

Sandwich Terns do not normally flock in large numbers behind fishing vessels. They prefer median water clarity (Baptist & Leopold 2007) and are mostly found in highest densities in nearshore waters. Particularly on migration however, Sandwich Terns have been found far offshore, sometimes exploiting surfacing schools of small fish (Leopold et al. 2004).

Both distance to coast and northing influenced distribution patterns (Table 28, Appendix II). A few Sandwich Terns were seen inside OWEZ, many more outside the park. No clear influence of the presence of the wind parks could be detected in the data. This is in contrast to work in Denmark (offshore wind farm Horns Rev) where terns supposedly flocked around the outer turbines, to feed in the tidal wakes behind the monopiles (Elsam Engineering & Energi 2005; Elsam Engineering 2005; Petersen & Fox 2007). At no time during the surveys was this type of behaviour noted in terns in or near the wind farm.

Survey	Month	Year	N-total
T0	9	2002	46
T0	10	2002	0
T0	4	2003	362
T0	5	2003	142
T0	6	2003	114
T0	8	2003	306
T0	11	2003	0
T0	2	2004	0
T1a	4	2007	59
T1a	6	2007	20
T1a	8	2007	111
T1a	9	2007	132
T1a	11	2007	0
T1a	1	2008	0
T1b	4	2008	160
T1b	6	2008	127
T1b	8	2008	326
T1b	9	2008	2
T1b	11	2008	1
T1b	1	2009	0

Table 29. Total numbers of Sandwich Terns seen during all surveys.

Survey	Month	p_Coast	p_North	p_OWEZ	Effect_OWEZ	Model	anova_parks
T-0	4	**0.009209**	**0.000728**	**0.080664**	-	GAMM	0.999999
T-1a	4	NA	NA	NA	NA	NA	NA
T-1b	4	**0.000001**	**0.006487**	0.999993	-	GAM	1.000000
T-0	8	0.516027	0.856027	1.000000	-	GAMM	1.000000
T-1a	8	NA	NA	NA	NA	NA	NA
T-1b	8	**0.000000**	**0.005031**	0.999996	-	GAM	1.000000

Table 30. Modeling results for Sandwich Tern. Significant contributions (P<0.1) are put in **bold**. GAMM: Full model applied (Generalised Additive Mixed Model); GAM: Generalised Additive Model (without considering possible autocorrelation in the data). Note that "positive" or "negative" effects of the presence of OWEZ are in fact negligible effects if p_OWEZ is larger than 0.1.

Common *Sterna hirundo* & Arctic Tern *Sterna paradisaea* (Visdief en Noordse Stern)

As it is often not possible to separate Common and Arctic Terns, these two species are treated together as "Comic" Terns (cf Leopold et al. 2004). Like the Sandwich Terns discussed above, Common and Arctic Terns are summer visitors to Dutch coastal waters. Comic Terns were only seen in significant numbers from April through September, with the largest numbers just after the breeding season, in August (Table 31).

Comic Terns tended to occur slightly closer inshore than Sandwich Terns, but were fully capable of reaching OWEZ although this location is clearly beyond the coastal stretch where the majority of Common and Arctic Terns feed and migrate (Appendix I). Breeding birds that are attached to colonies in the Wadden Sea or in the Delta range less far afield than Sandwich Terns and cannot reach OWEZ on their foraging trips (Arends et al. 2008). Modeling was only possible for the results of the summer survey months (June and August; Table 32). After effects of distance to coast and northing were removed, no significant effect remained of the wind farms in the study area.

Survey	Month	Year	N-total
T0	9	2002	32
T0	10	2002	0
T0	4	2003	122
T0	5	2003	102
T0	6	2003	50
T0	8	2003	1248
T0	11	2003	1
T0	2	2004	0
T1a	4	2007	31
T1a	6	2007	116
T1a	8	2007	259
T1a	9	2007	56
T1a	11	2007	0
T1a	1	2008	0
T1b	4	2008	110
T1b	6	2008	87
T1b	8	2008	370
T1b	9	2008	1
T1b	11	2008	1
T1b	1	2009	0

Table 31. Total numbers of Comic Terns seen during all surveys.

Survey	Month	p_Coast	p_North	p_OWEZ	Effect_OWEZ	Model	anova_parks
T-0	6	NA	NA	NA	NA	NA	NA
T-1a	6	**0.000000**	**0.000004**	0.999991	-	GAM	1.000000
T-1b	6	NA	NA	NA	NA	NA	NA
T-0	8	1.000000	1.000000	1.000000	-	GAMM	1.000000
T-1a	8	**0.000000**	**0.094093**	0.999990	-	GAM	1.000000
T-1b	8	**0.000707**	0.414432	0.881387	-	GAMM	0.987585

Table 32. Modeling results for Comic Tern. Significant contributions (P<0.1) are put in **bold**. GAMM: Full model applied (Generalised Additive Mixed Model); GAM: Generalised Additive Model (without considering possible autocorrelation in the data). Note that "positive" or "negative" effects of the presence of OWEZ are in fact negligible effects if p_OWEZ is larger than 0.1.

Common Guillemot *Uria aalge* (Zeekoet)

Guillemots breed on cliff-coasts and visit Dutch waters only in the non-breeding season (Camphuysen & Leopold 1994). They arrive only after their summer moult of their flight feathers in the Southern Bight of the North Sea and do not occur in the study area in significant numbers from May through August (Table 33). Guillemots are relatively abundant, do not feed around fishing vessels and spend much time swimming, which makes them ideally suited for spatial modeling. The studies at Horns Rev wind farm suggested that Guillemots avoid offshore wind farms to a large extent (Elsam Engineering & Energi 2005; Elsam Engineering 2005; Petersen & Fox 2007) but densities in those studies were much lower than in the present study area.

In our study, no indication was found in the modeled results of the data that Guillemots avoided the wind farm OWEZ or the combination of OWEZ and PAWF (Table 34; anova). Guillemots were seen swimming inside OWEZ on several occasions, underlining that avoidance, if occurring, is less than 100% (contra the Danish results). Even inside PAWF, where the turbine density is much higher than in either OWEZ or Horns Rev wind farm, Guillemots were seen swimming (Appendix I). Year to year variation was sometimes large: compare for instance the September results when few were seen in the T-0 survey, many during the T-1a survey and few again during the T-1b survey (limited effort; see Table 33 and Appendix I).

Survey	Month	Year	N-total
T0	9	2002	12
T0	10	2002	287
T0	4	2003	72
T0	5	2003	1
T0	6	2003	0
T0	8	2003	8
T0	11	2003	1328
T0	2	2004	502
			0
T1a	4	2007	20
T1a	6	2007	2
T1a	8	2007	5
T1a	9	2007	533
T1a	11	2007	2480
T1a	1	2008	1086
T1b	4	2008	30
T1b	6	2008	0
T1b	8	2008	15
T1b	9	2008	3
T1b	11	2008	190
T1b	1	2009	2524

Table 33. Total numbers of Common Guillemots seen during all surveys.

Survey	Month	p_Coast	p_North	p_OWEZ	Effect_OWEZ	Model	anova_parks
T-0	2	**0.000000**	0.423166	**0.062964**	+	GAMM	**0.026321**
T-1a	1	**0.042475**	0.411975	0.220946	-	GAMM	0.423637
T-1b	1	**0.014690**	0.045668	0.547519	-	GAMM	0.723604
T-0	4	**0.000001**	0.000002	0.999991	-	GAM	0.999991
T-1a	4	**0.000786**	0.661029	0.999999	-	GAMM	1.000000
T-1b	4	**0.000000**	0.000000	0.999988	-	GAM	1.000000
T-0	9	NA	NA	NA	NA	NA	NA
T-1a	9	0.620686	0.266320	0.909499	-	GAMM	0.848023
T-1b	9	NA	NA	NA	NA	NA	NA
T-0	11	**0.000000**	0.040355	0.669167	+	GAMM	0.870331
T-1a	11	0.635668	0.000003	0.129213	-	GAMM	0.228955
T-1b	11	**0.000000**	0.000213	0.999994	-	GAM	0.999994

Table 34. Modeling results for Common Guillemot. Significant contributions (P<0.1) are put in **bold**. GAMM: Full model applied (Generalised Additive Mixed Model); GAM: Generalised Additive Model (without considering possible autocorrelation in the data). Note that "positive" or "negative" effects of the presence of OWEZ are in fact negligible effects if p_OWEZ is larger than 0.1.

Razorbill *Alca torda* (Alk)

Razorbills are in many ways similar to Guillemots and also visit Dutch waters only in the non-breeding season (Camphuysen & Leopold 1994). They are probably more dependent on a specialised diet of small schooling fish

such as Herring, Sprat or Sandeel than Guillemot, that have a much broader diet in the general wintering area in the Southern Bight (Ouwehand et al. 2004). This may make them more susceptible to between-year differences in preferred prey stocks. Indeed, considerable year to year variation was found, e.g. in the September data, but these were not much different from those in the Guillemot (Tables, 33, 35).

As in Guillemots, our results do not indicate that Razorbills avoided the wind farm OWEZ or the combination of OWEZ and PAWF to a large extent (Table 36; anova and Appendix I). Concentrations of Razorbills were found at varying locations throughout the study area at different times, without a clear repeating pattern (Appendix 1). This impacted the relative contributions of the smoothers distance to coast and northing differently in different surveys (Appendix II).

Survey	Month	Year	N-total
T0	9	2002	0
T0	10	2002	15
T0	4	2003	23
T0	5	2003	1
T0	6	2003	0
T0	8	2003	0
T0	11	2003	36
T0	2	2004	90
T1a	4	2007	5
T1a	6	2007	0
T1a	8	2007	1
T1a	9	2007	712
T1a	11	2007	156
T1a	1	2008	32
T1b	4	2008	13
T1b	6	2008	2
T1b	8	2008	0
T1b	9	2008	3
T1b	11	2008	11
T1b	1	2009	145

Table 35. Total numbers of Razorbills seen during all surveys.

Survey	Month	p_Coast	p_North	p_OWEZ	Effect_OWEZ	Model	anova_parks
T-0	2	**0.000000**	**0.000000**	0.243987	-	GAM	0.999994
T-1a	1	NA	NA	NA	NA	NA	NA
T-1b	1	**0.000000**	**0.060544**	0.102059	-	GAM	0.999996
T-0	9	NA	NA	NA	NA	NA	NA
T-1a	9	**0.000000**	0.161253	0.999998	-	GAM	1.000000
T-1b	9	NA	NA	NA	NA	NA	NA
T-0	11	**0.000004**	**0.017725**	**0.000036**	-	GAM	0.999992
T-1a	11	**0.014673**	**0.012688**	0.999999	-	GAMM	1.000000
T-1b	11	NA	NA	NA	NA	NA	NA

Table 36. Modeling results for Razorbill. Significant contributions (P<0.1) are put in **bold**. GAMM: Full model applied (Generalised Additive Mixed Model); GAM: Generalised Additive Model (without considering possible autocorrelation in the data). Note that "positive" or "negative" effects of the presence of OWEZ are in fact negligible effects if p_OWEZ is larger than 0.1.

Discussion and Conclusion

This report describes the preliminary results of the first and second year of T-1 Local Bird surveys around the OWEZ wind farm in comparison to the results of the T-0 study. Contrary to expectation (based on earlier studies around Horns Rev that clearly indicated avoidance, in some birds even beyond the park's perimeter), these first results do not suggest large effects on many of the birds species studied. Other, topographical factors were of overriding importance as was the influence of fishing vessels on some of the birds. Clearly, birds also respond to variables that could not be included in the models, such as temporary concentrations of fish (food) or weather (either in the study area or much further away, displacing birds), that have very little to do with a response to a wind farm. Seabird distribution data show considerable noise, year to year variation and patchiness (i.e. birds often occur in dense but rather unpredictable concentrations while such temporary "hotspots" may be devoid of birds only moments later in time), which makes finding effects of an offshore wind farm difficult. With the influences of gross topography, i.e. distance to coast and northing removed, few indications of avoidance became apparent.

Several effects that were reported in the Danish studies at Horns Rev were not corroborated by the results of this study in Dutch waters. Divers and auks (Guillemot and Razorbill) did not show a 100% avoidance as some birds were noted swimming between the monopiles. Terns did not seek out the turbid zones behind the monopiles to feed and did not concentrate around the edges of the OWEZ wind farm, nor did they avoid the inner parts of the wind farm. This may be due to the fact that terns rarely occurred this far offshore, but on the other hand OWEZ is clearly visible to terns from their nearshore feeding zone but the park did not attract birds from there. Like in Denmark, Common Scoters probably avoided the wind farm, but their densities have become very low in the area at large in recent years that the park mainly affected passing migrants. Gannets and Little Gulls probably avoided the wind farm, but again, numbers of observations are still low and modeling power is low. On rare occasions, a Gannet was seen flying through the park (conform Krijgsveld et al. 2009), but only through the outermost parts. Such birds never foraged in the park (bills never pointed downward, which is indicative for prey searching) so even if some birds did not completely avoid the park, feeding was never seen. However, for such birds that are rather scarce in the study area, more data are needed from within the wind farms to get a better comparison with densities in the larger area around these parks. Many Cormorants on the other hand, were attracted to the wind farms (producing many sightings in the wind farms) and use these sites as a new platform for offshore foraging.

The two present wind farms are situated in waters that mark the transition zone between coastal and offshore waters. As such, they are of little importance to species that clearly prefer the nearshore zone, such as grebes, divers, seaduck and terns. However, certain conditions (offshore winds, good offshore feeding possibilities) may at times attract or displace such birds offshore. Similarly, birds with a clear preference for deeper, more saline offshore waters will not often occur at the park sites in high densities. Northern Fulmars are an example of the latter guild of seabirds. Some gulls and auks (Guillemot en Razorbill) habitually visit the wind park zone in high numbers. Gulls may respond more to fishing vessels in the area than to more natural feeding opportunities, or at least fishing vessels are often abundant and easy targeted by gulls. Auks feed without the help of fishing vessels and their distribution probably is more related to local, natural feeding opportunities. These factors should always be kept in mind when looking at bird distribution patterns. Concentrations of gulls are often related to fisheries. As fishery is not permitted within the wind park, such concentrations are always situated outside the parks and thus, in the present situation, fishing activity will attract birds away from the parks. In a statistical analysis, this may show up as "avoidance" of the park, while in reality it is rather attraction to fishing vessels elsewhere. Birds that are rather extreme in their habitat choice, such as grebes that rarely wander more than a few km offshore, or Fulmars that normally avoid a broad strip of coastal waters, will always "avoid" the park, i.e. mainly live somewhere else. Attraction to the park, as is evident for some Cormorants, is masked by birds commuting between the coast and the wind farms as these produce data points in the zone between the coast and the park. Concentrations in other parts of the study area, on gas platforms, behind trawlers and near the coast, further obscure the pattern of attraction. Or stated differently, some birds are attracted to the park, while other prefer to go somewhere else.

Some of the T-0 data already suggested an impact of the wind farm in that bird densities tended to be rather low in the central part of the study area, where later the wind farms would be realised. As an impact of a not yet existing wind farm is an impossibility, the central part of the study area might be less suitable for some seabirds, in some situations. Seabird numbers tended to be higher towards the shore, and towards the outer rim of the study area. Given this situation, and the relative low number of data points within the actual wind farms in the current set up, modifications to the survey design have been proposed for the third year of gathering T-1 data. More effort will be spent in additional survey lines that follow the distance to coast isolines and that pass through the parks to generate more data in the parks themselves and at comparable parts of the study area at either side of the parks (Figure 3).

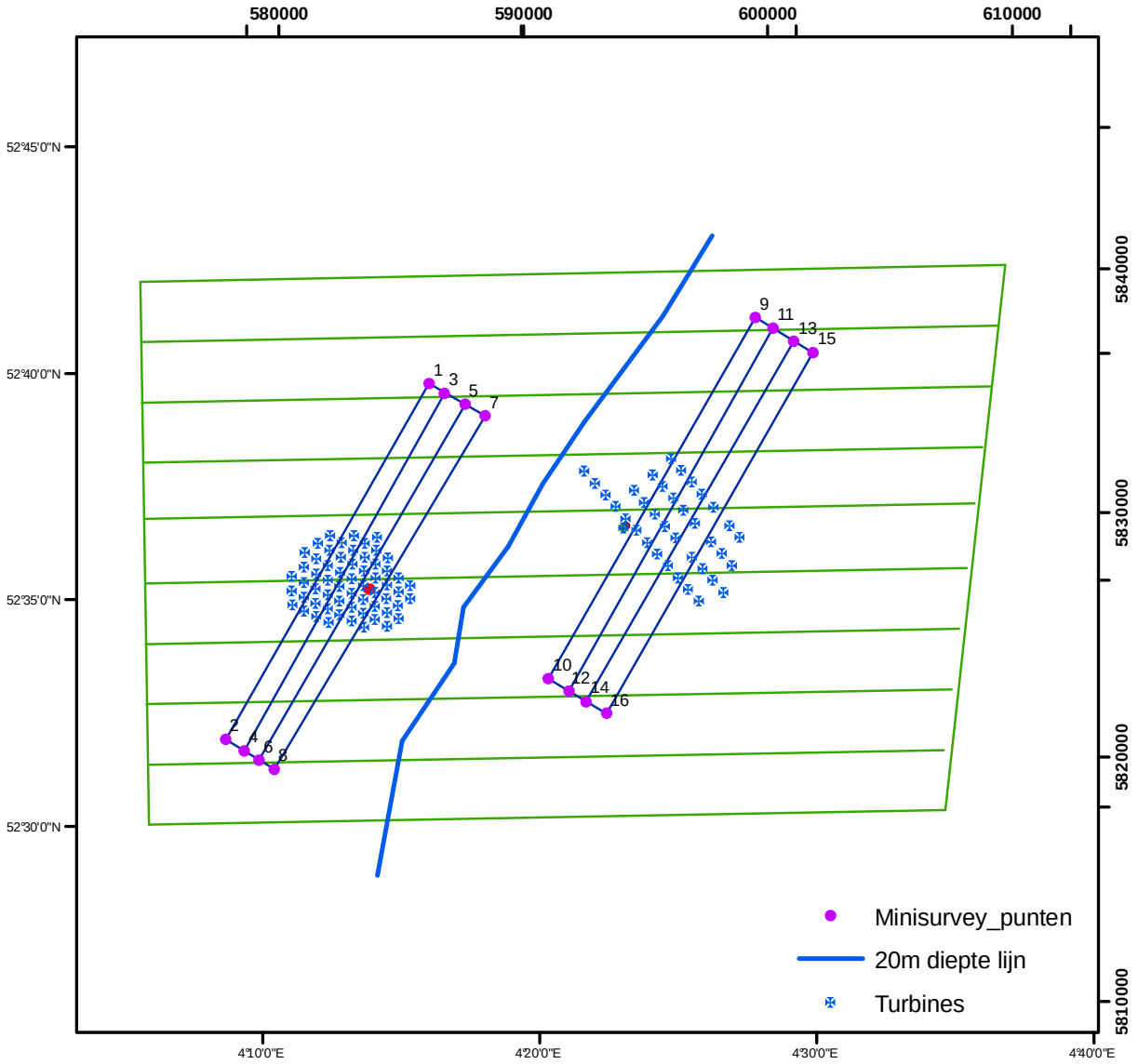


Figure 3. New survey design for the T-1c surveys, with additional survey lines parallel to the shore and to the main isobaths (-20 m isobath depicted).

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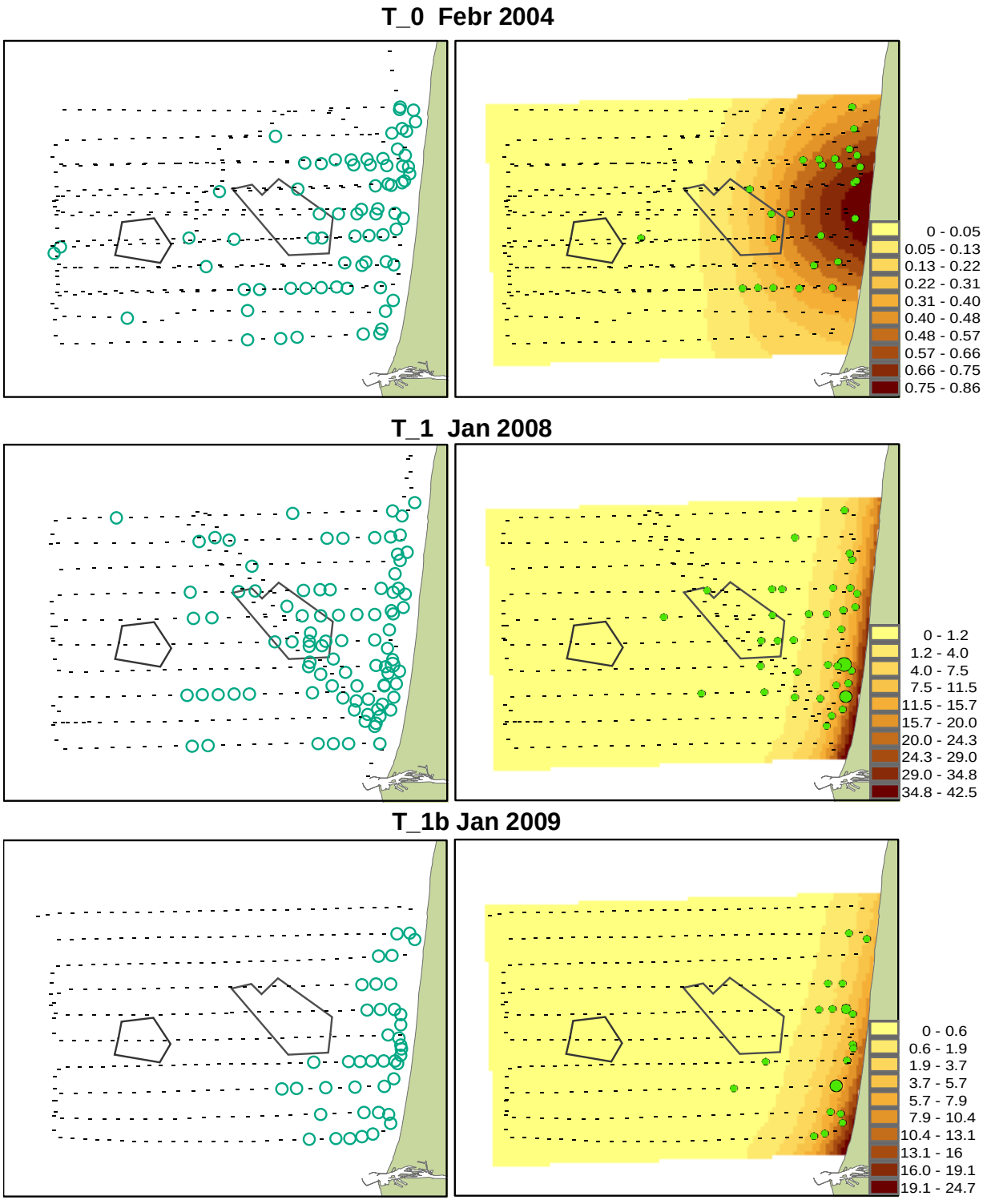
Appendix I – Distribution maps and modeling results

On the following pages, distribution maps are given for all species discussed in the main document. All maps show the coastline of Noord-Holland, the outlines of the two wind parks and an indication of the survey routes.

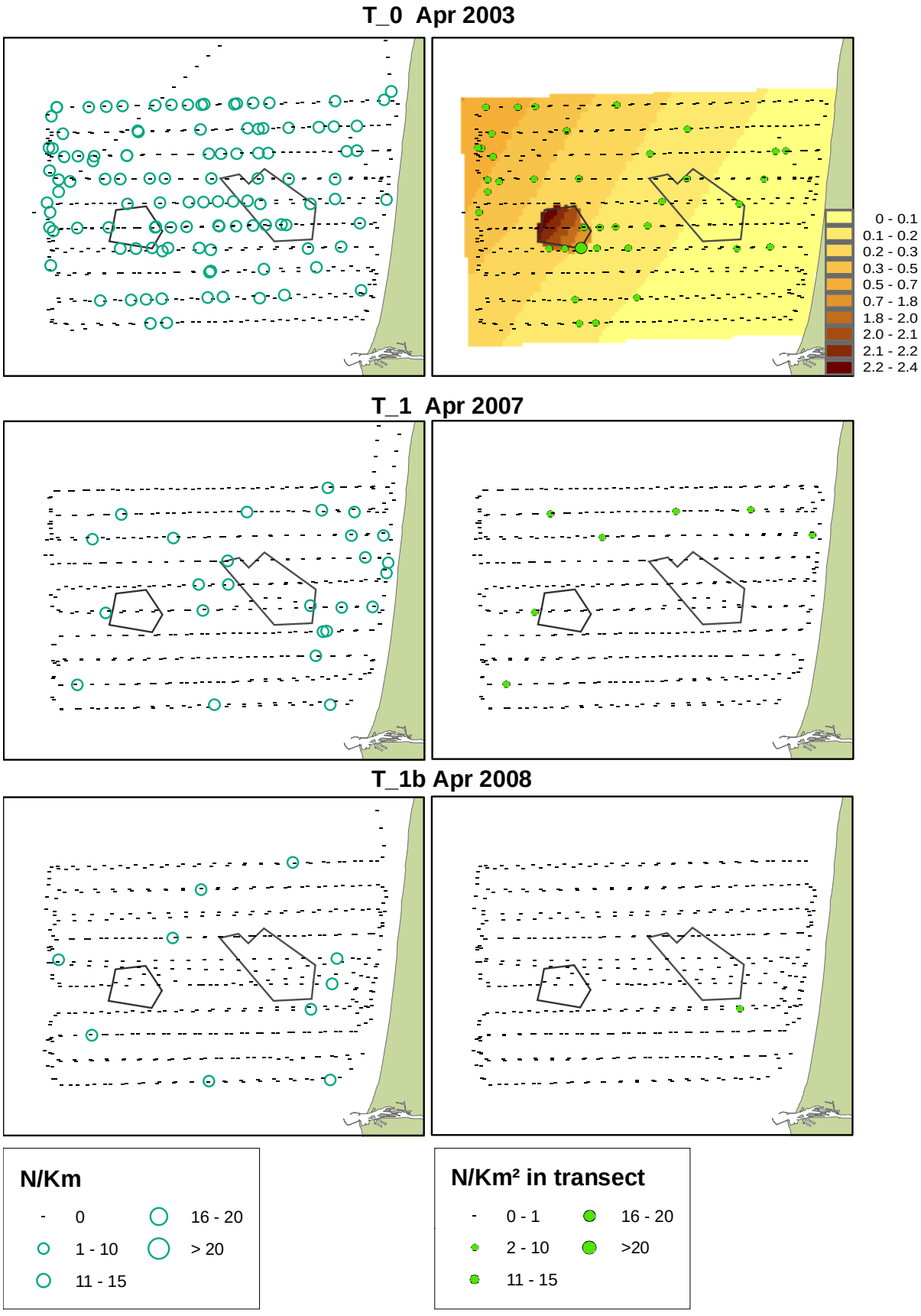
Left panels depict all birds seen (green circles against a background of the routes sailed while counting); right panels show only the route sailed and the data points used for density estimates and modeling. Modeling was attempted for all species (or species combinations such as divers or terns). If sufficient data were available for modeling, the modeling results are depicted as a yellow to brown colored background under the sightings used (right panels). The colors represent different densities of birds, in numbers per km^2 (not corrected for birds missed by the observers).

Sets of matching surveys are presented on the same page: one T-0 survey and two T-1 surveys for the same time of year. If a given species was not seen in either survey of a given set of matching surveys, these (empty) maps are not included.

Divers

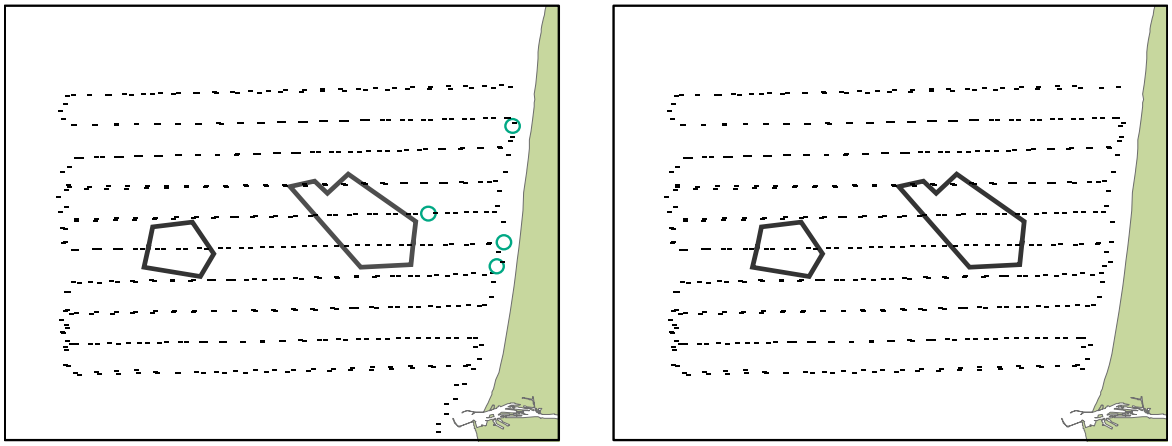

T_0 Febr 2004
0 - 0.05
0.05 - 0.13
0.13 - 0.22
0.22 - 0.31
0.31 - 0.40
0.40 - 0.48
0.48 - 0.57
0.57 - 0.66
0.66 - 0.75
0.75 - 0.86
T_1 Jan 2008
0 - 1.2
1.2 - 4.0
4.0 - 7.5
7.5 - 11.5
11.5 - 15.7
15.7 - 20.0
20.0 - 24.3
24.3 - 29.0
29.0 - 34.8
34.8 - 42.5
T_1b Jan 2009
0 - 0.6
0.6 - 1.9
1.9 - 3.7
3.7 - 5.7
5.7 - 7.9
7.9 - 10.4
10.4 - 13.1
13.1 - 16
16.0 - 19.1
19.1 - 24.7
N/Km
0
1 - 10
11 - 15
16 - 20
> 20
N/Km² in transect
0 - 1
2 - 10
11 - 15
16 - 20
>20

Divers


T_0 Apr 2003
0 - 0.1
0.1 - 0.2
0.2 - 0.3
0.3 - 0.5
0.5 - 0.7
0.7 - 1.8
1.8 - 2.0
2.0 - 2.1
2.1 - 2.2
2.2 - 2.4
T_1 Apr 2007
T_1b Apr 2008
N/Km
0
1 - 10
11 - 15
16 - 20
> 20
N/Km² in transect
0 - 1
2 - 10
11 - 15
16 - 20
>20

Divers

T_0 Sep 2002



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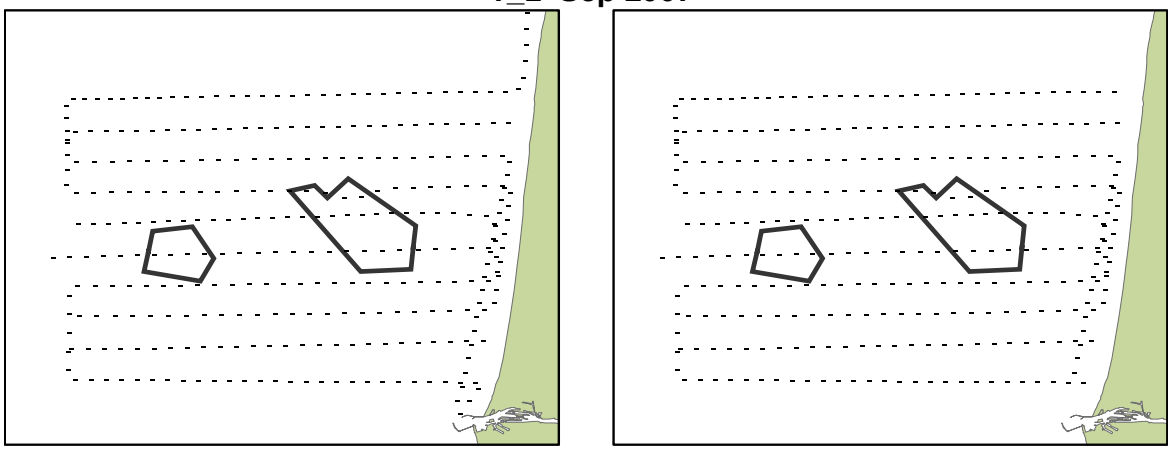
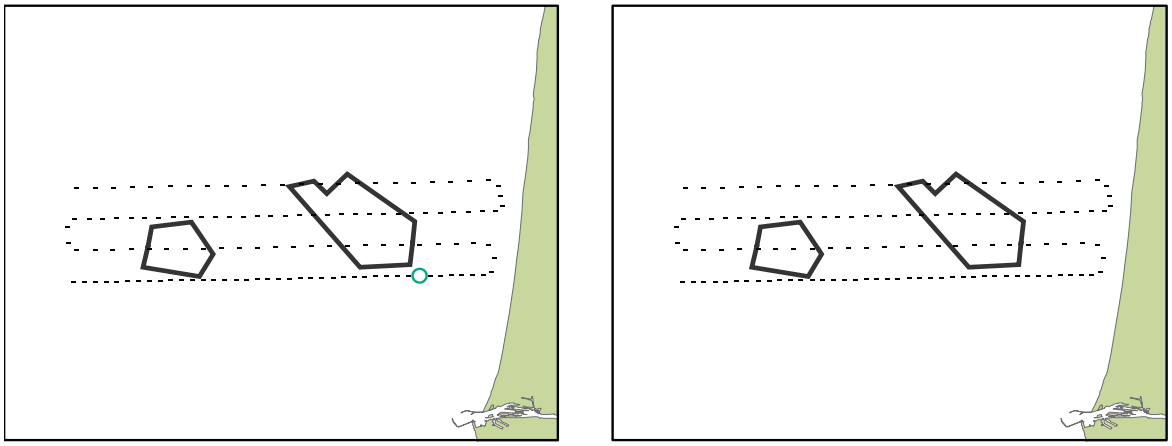
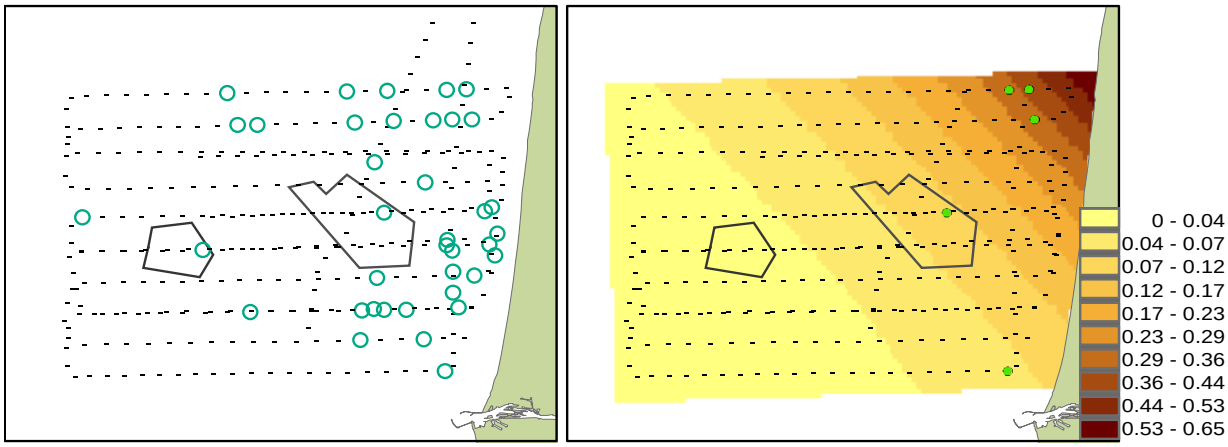


T_1b Sep 2008



Divers

T_0 Nov 2003



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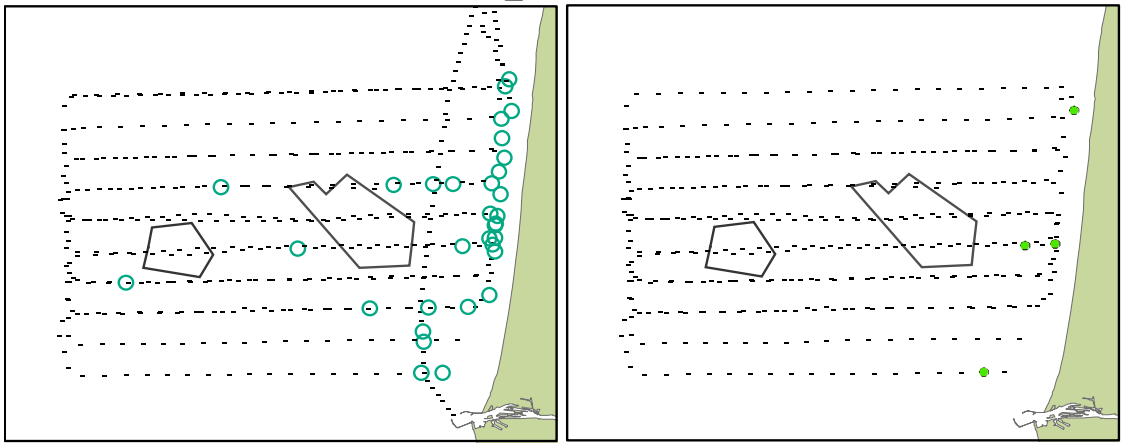

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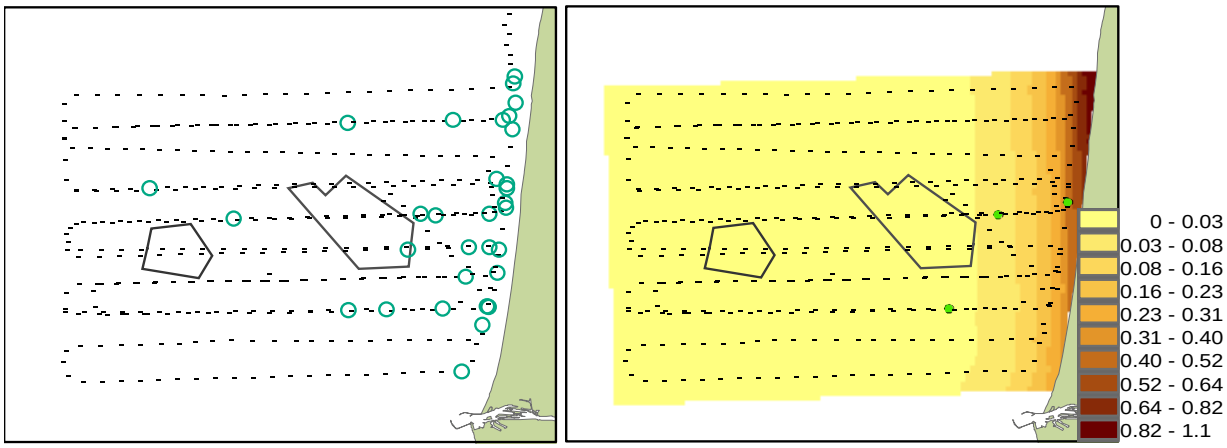


N/Km

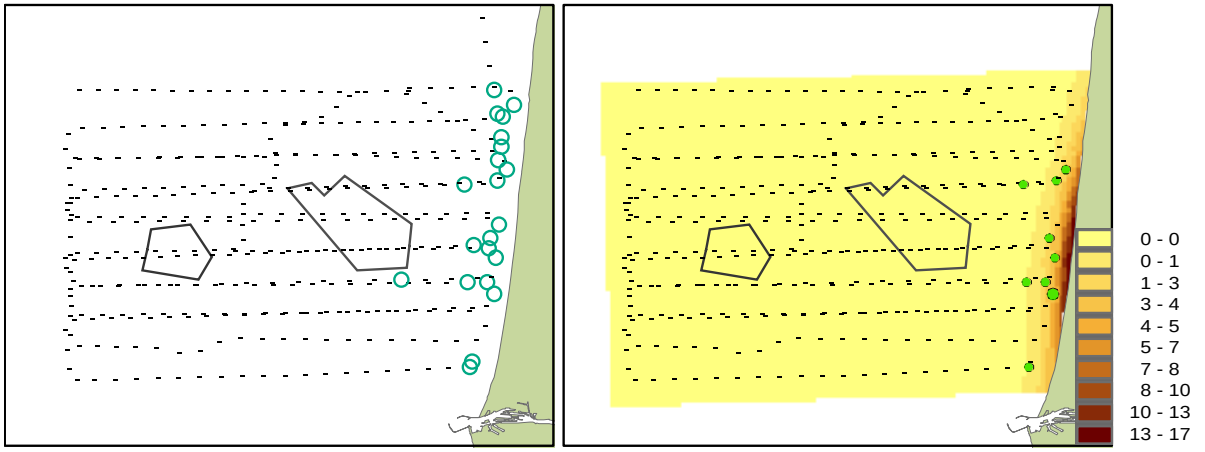
- 0
- 1 - 10
- 11 - 15
- 16 - 20
- > 20

N/Km² in transect

- 0 - 1
- 2 - 10
- 11 - 15
- 16 - 20
- > 20

Great Crested Grebe

T_0 Febr 2004



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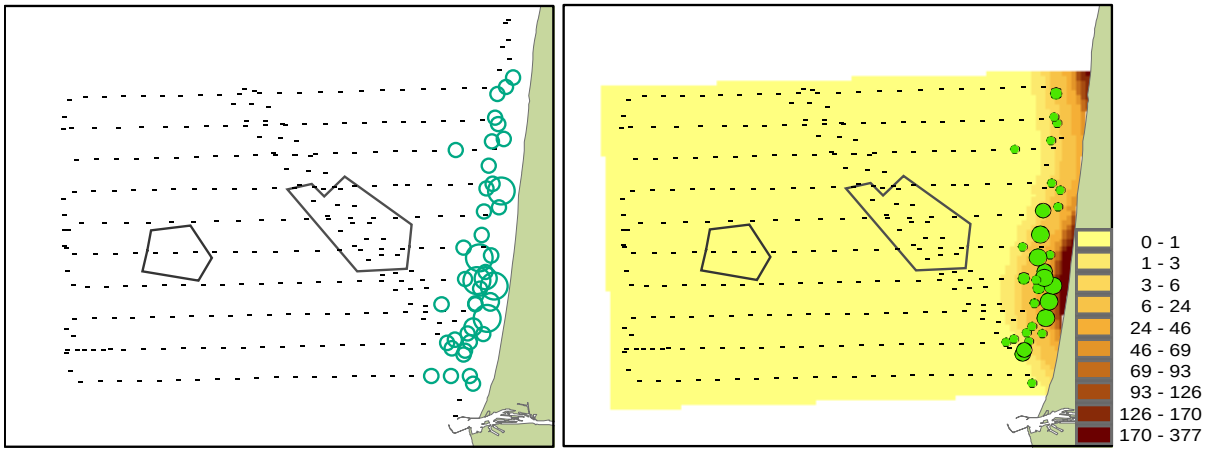
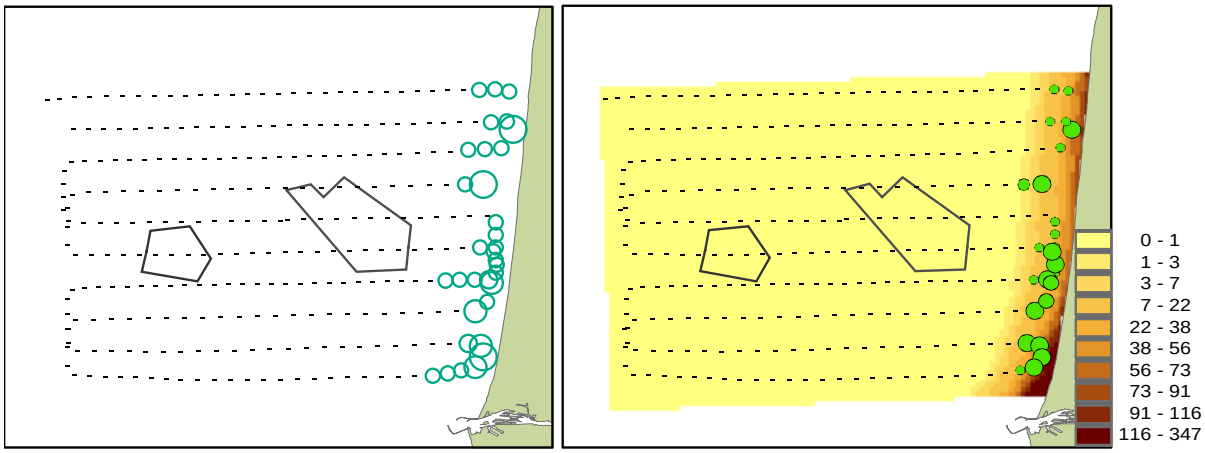
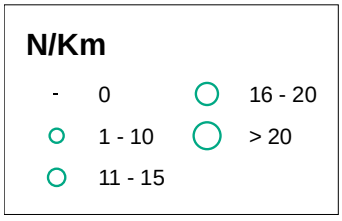
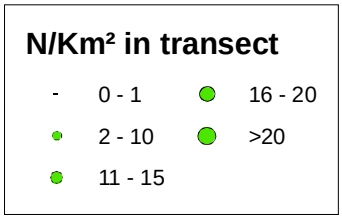


T_1b Jan 2009

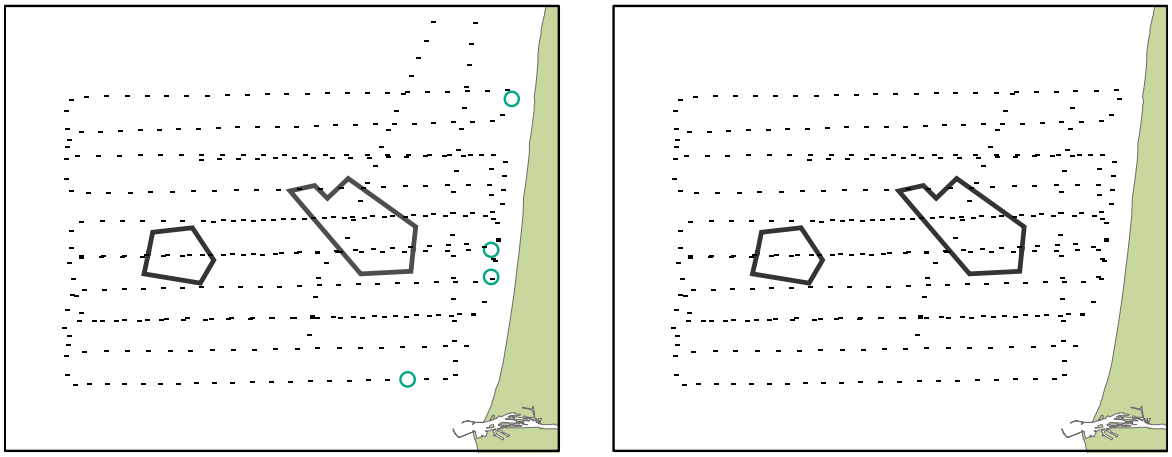




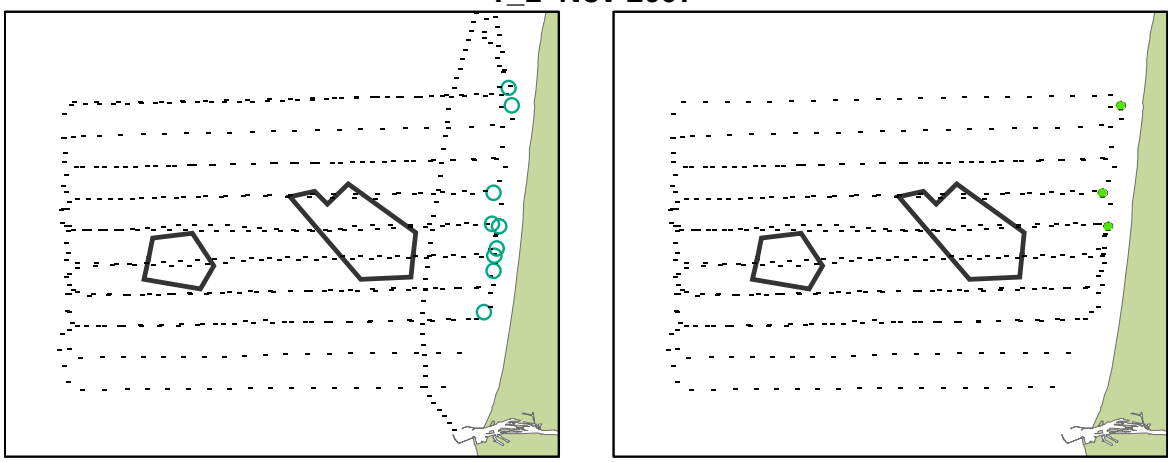


Great Crested Grebe

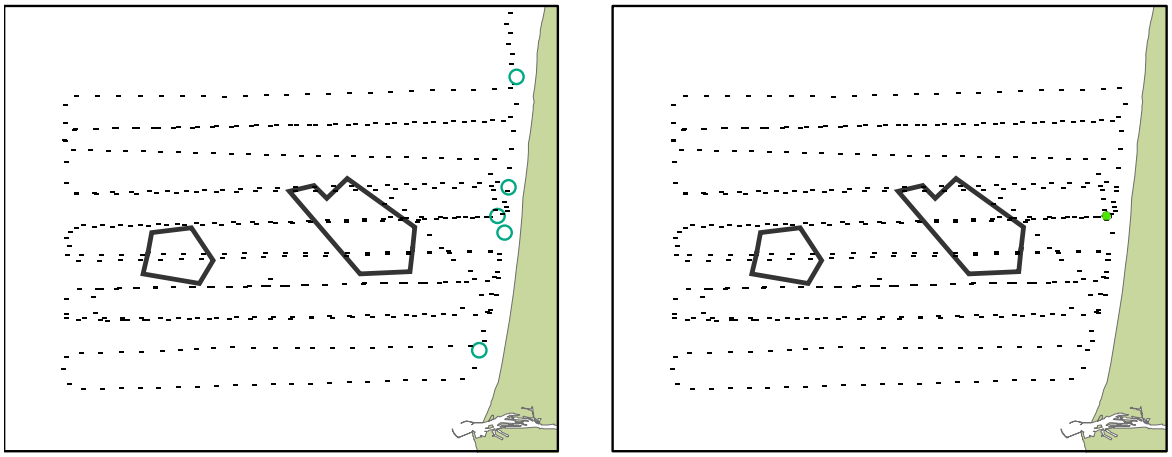
T_0 Nov 2003



T_1 Nov 2007

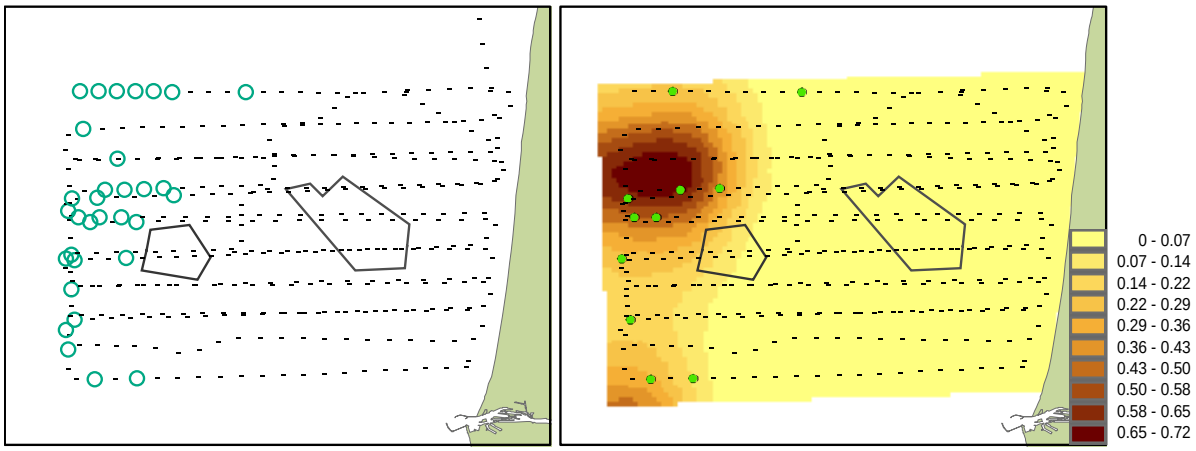


T_1b Nov 2008

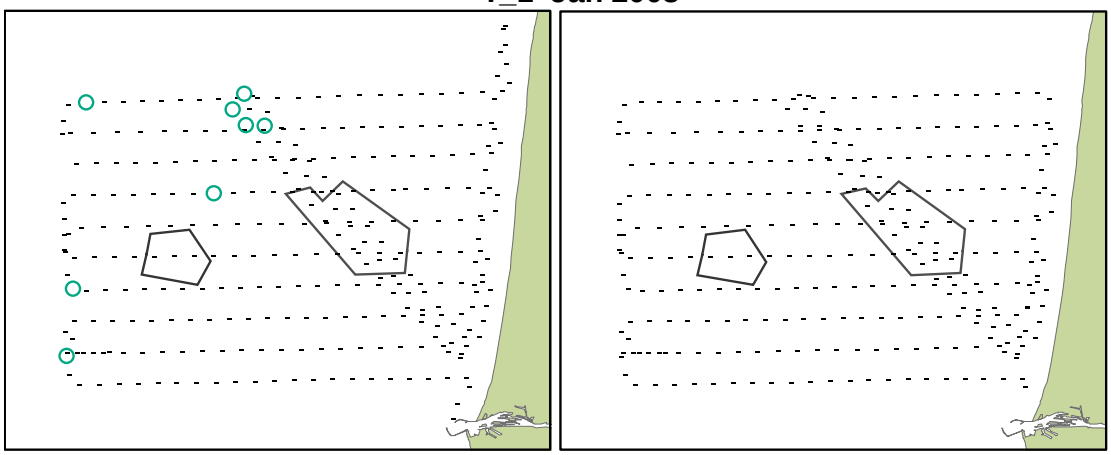


Northern Fulmar

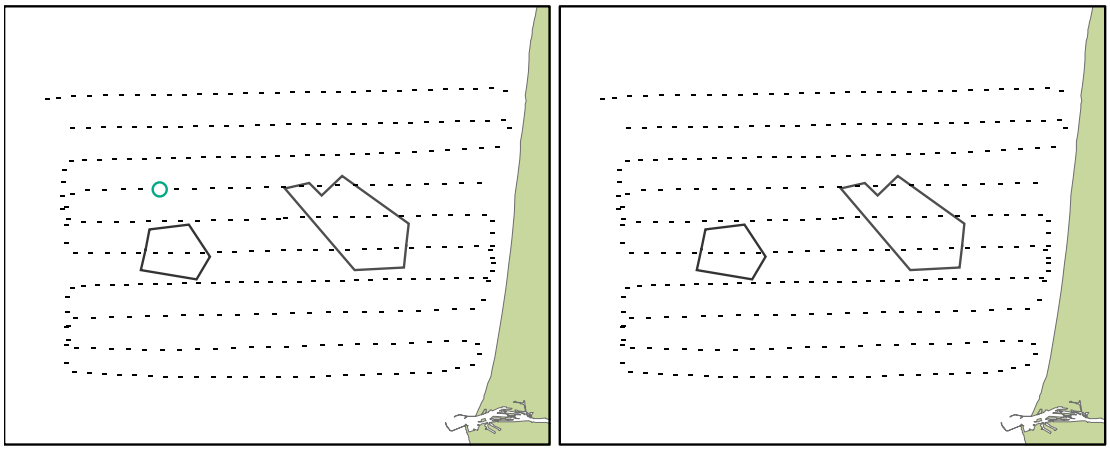
T_0 Febr 2004



T_1 Jan 2008



T_1b Jan 2009



N/Km

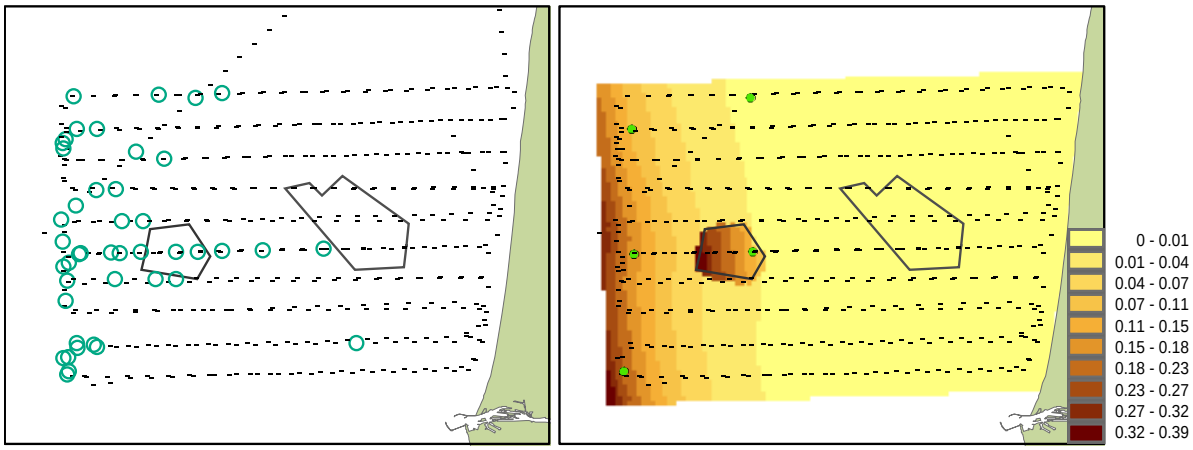
0	16 - 20
1 - 10	> 20
11 - 15	

N/Km² in transect

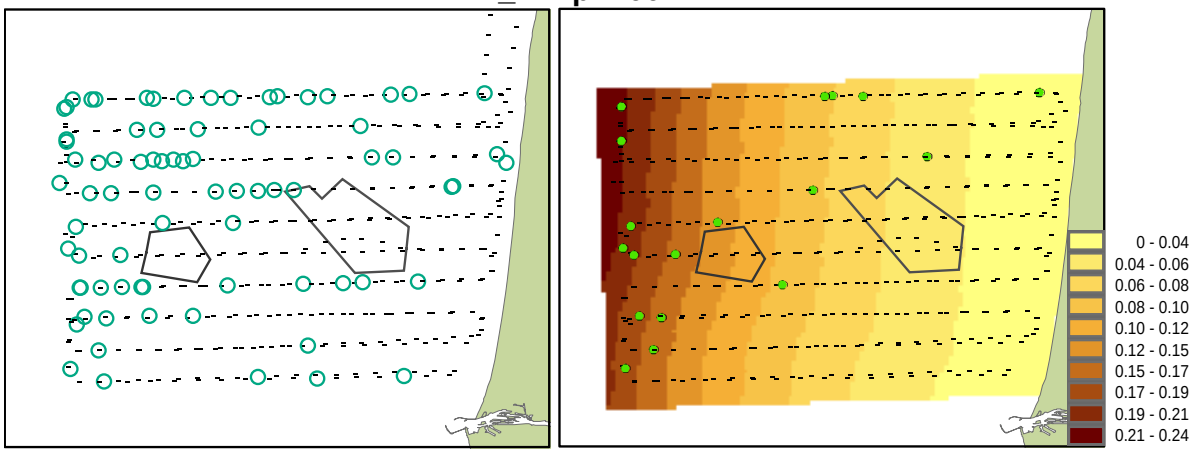
0 - 1	16 - 20
2 - 10	>20
11 - 15	

Northern Fulmar

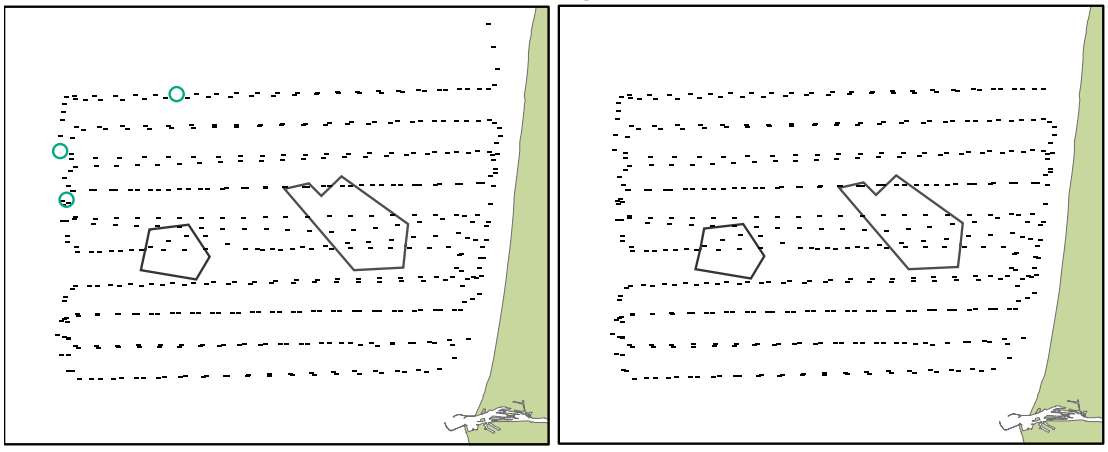
T_0 Apr 2003



T_1 Apr 2007



T_1b Apr 2008



N/Km

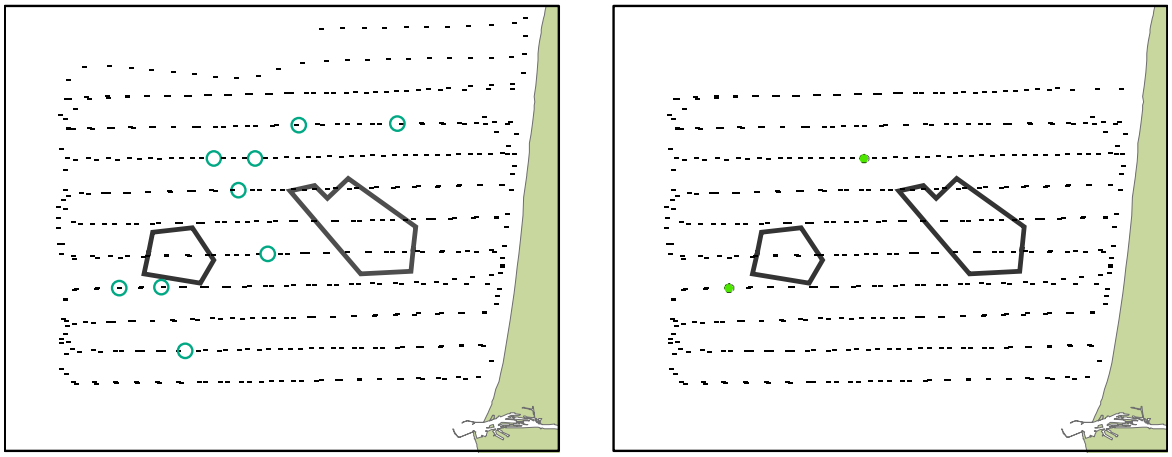
- 0
- 1 - 10
- 11 - 15
- 16 - 20
- > 20

N/Km² in transect

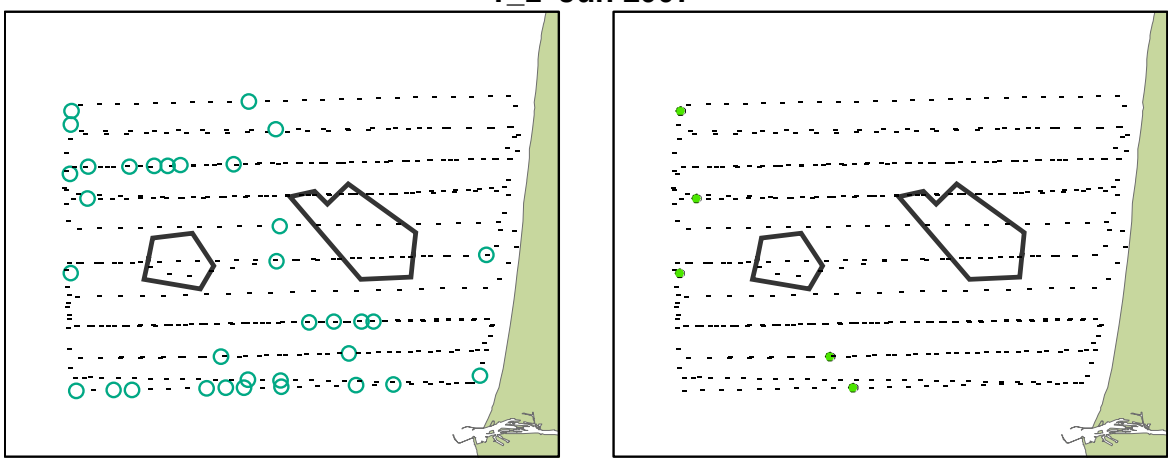
- 0 - 1
- 2 - 10
- 11 - 15
- 16 - 20
- >20

Northern Fulmar

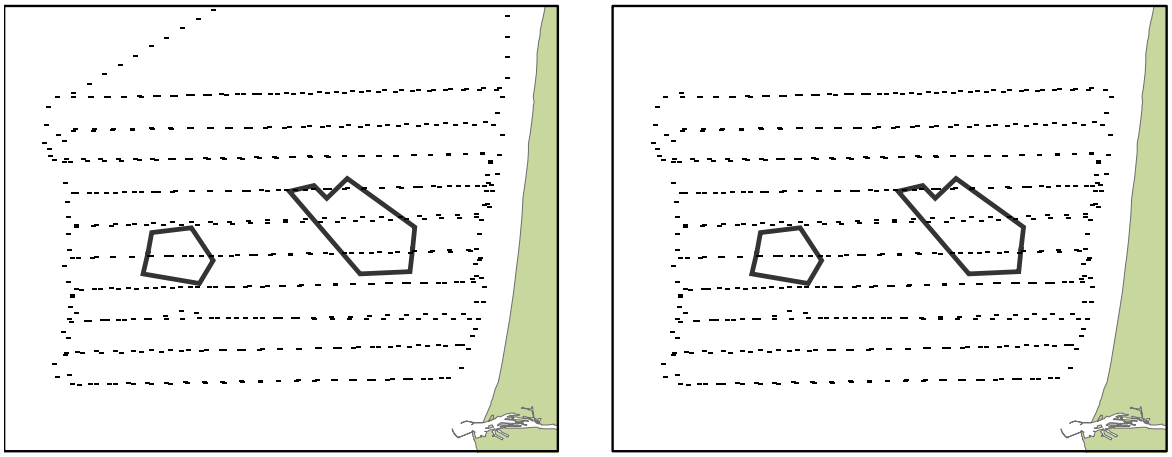
T_0 Jun 2003



T_1 Jun 2007

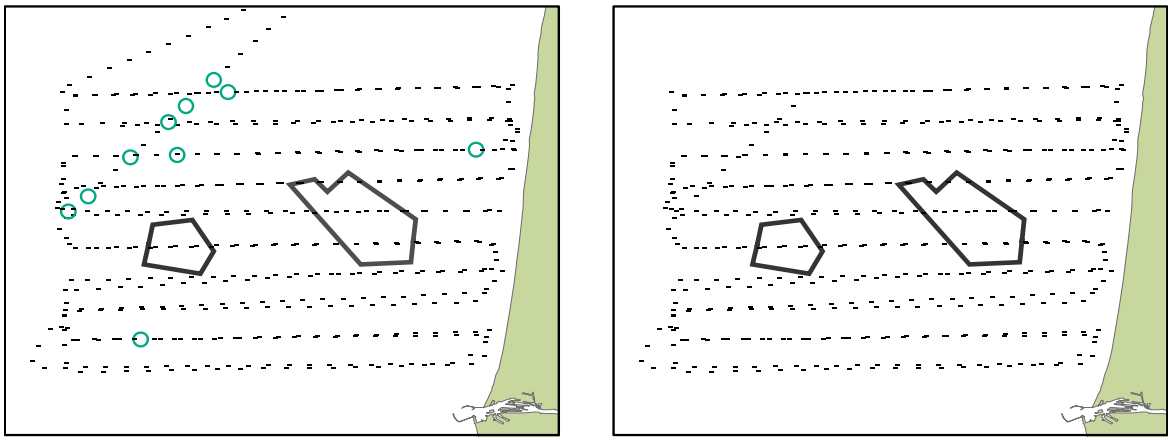


T_1b Jun 2008

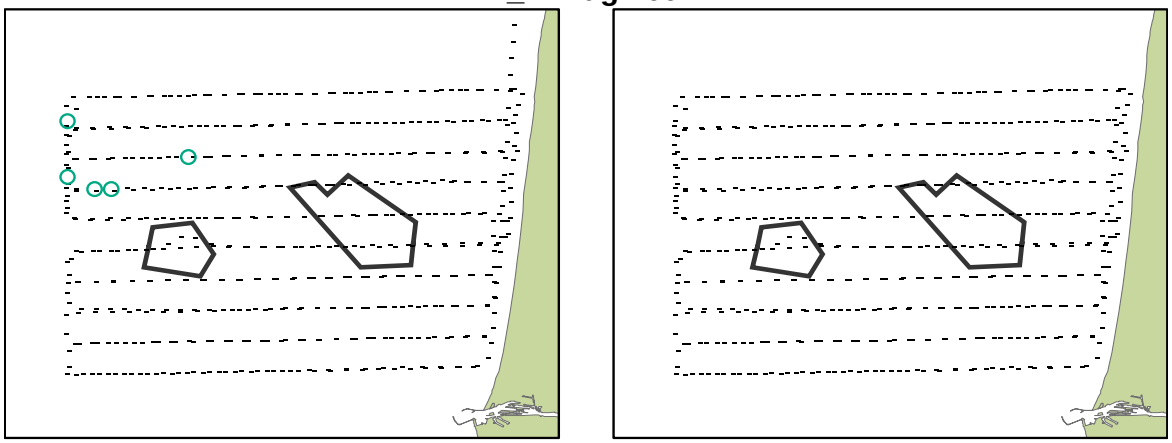


Northern Fulmar

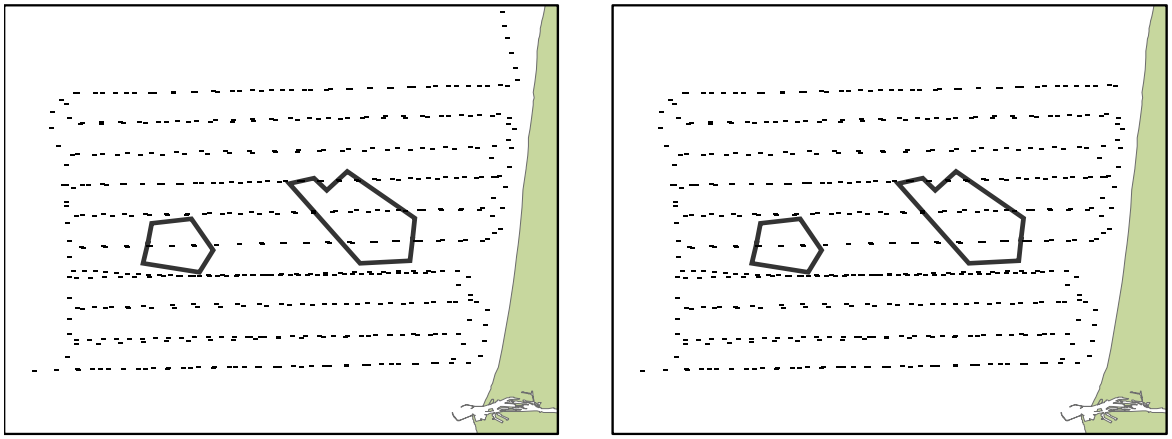
T_0 Aug 2003



T_1 Aug 2007

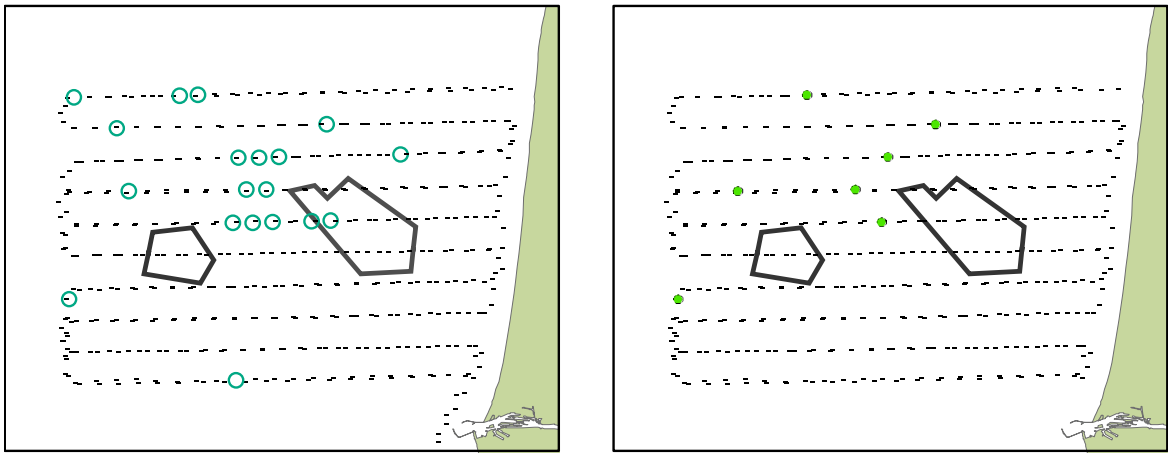


T_1b Aug 2008

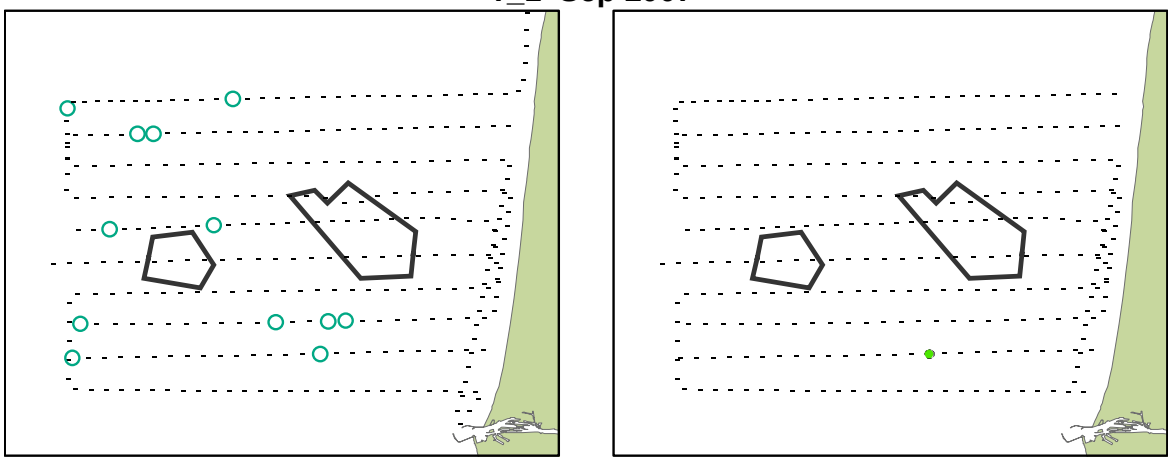


Northern Fulmar

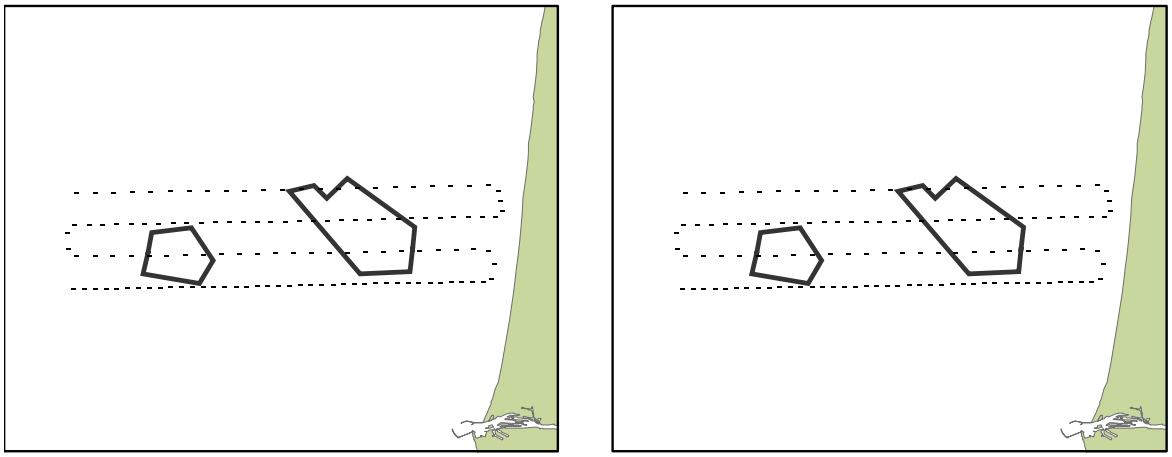
T_0 Sep 2002



T_1 Sep 2007

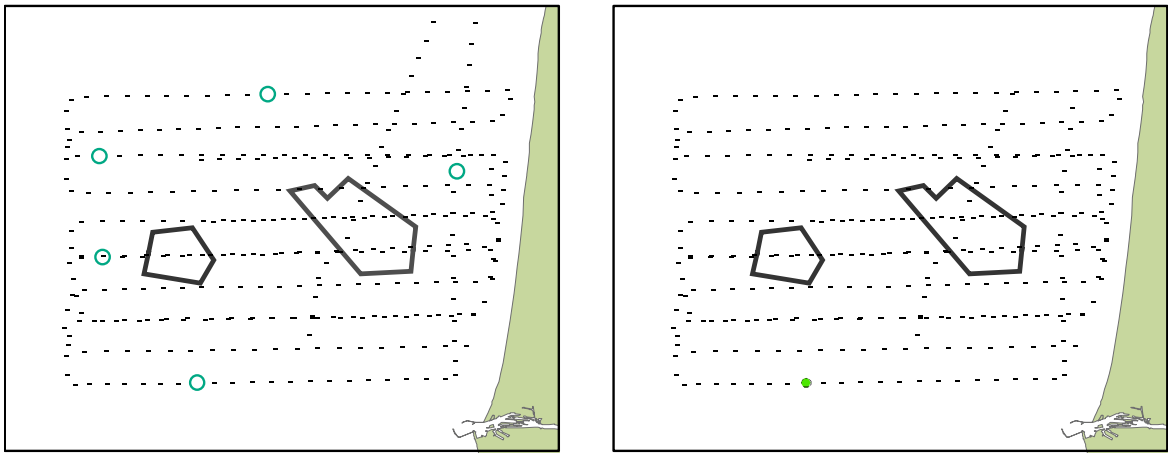


T_1b Sep 2008

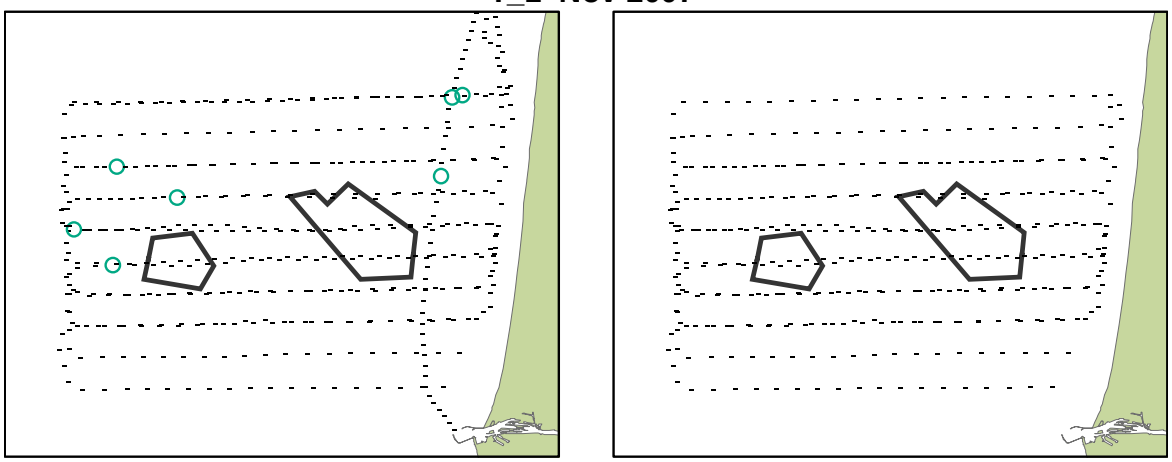


Northern Fulmar

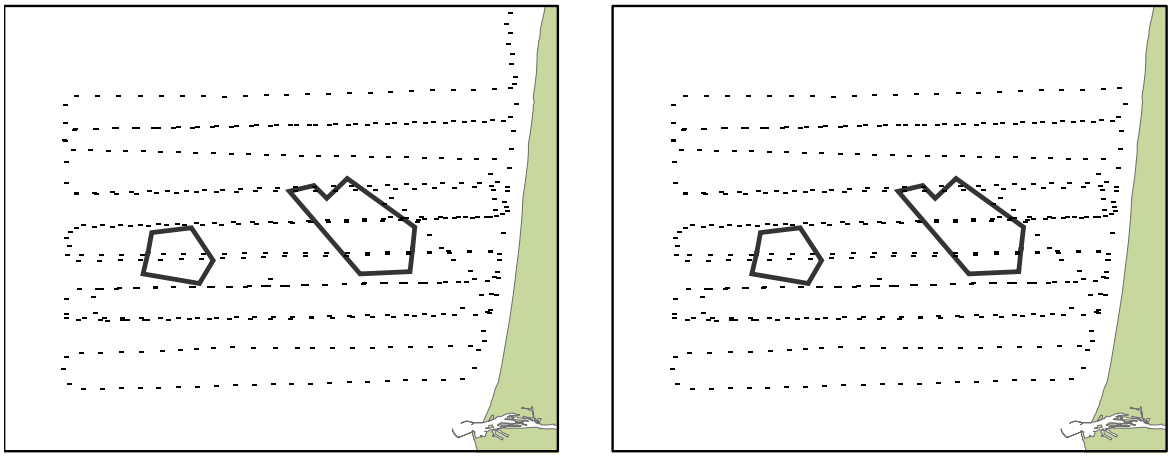
T_0 Nov 2003



T_1 Nov 2007

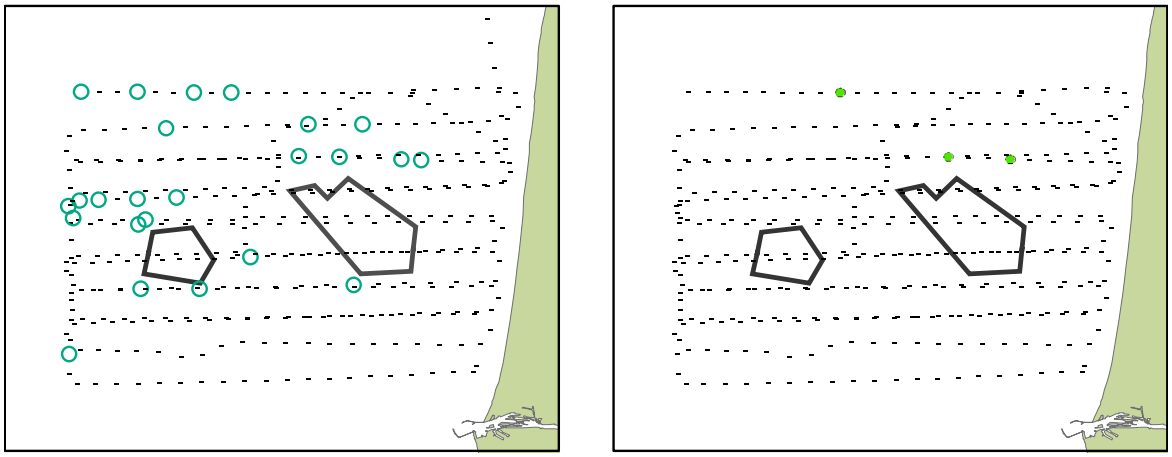


T_1b Nov 2008

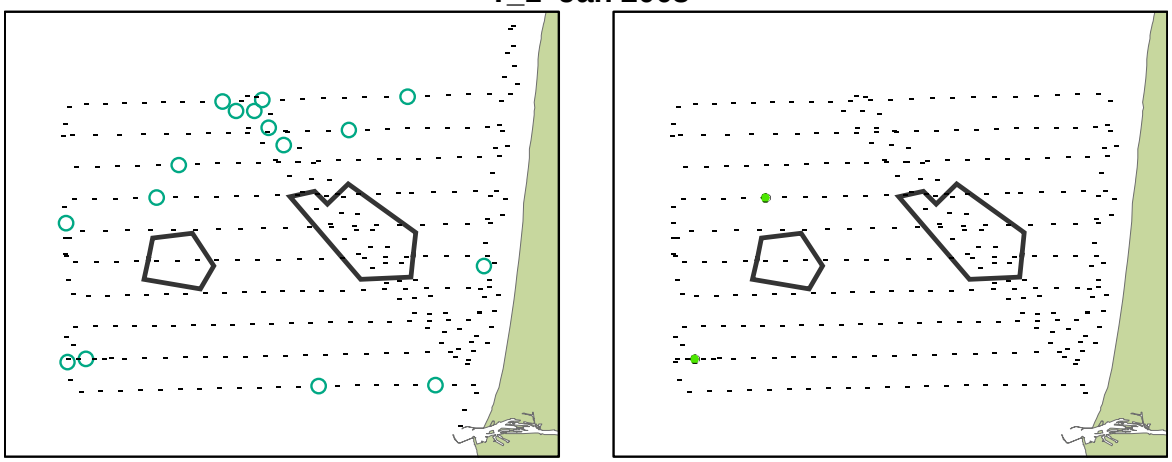


Northern Gannet

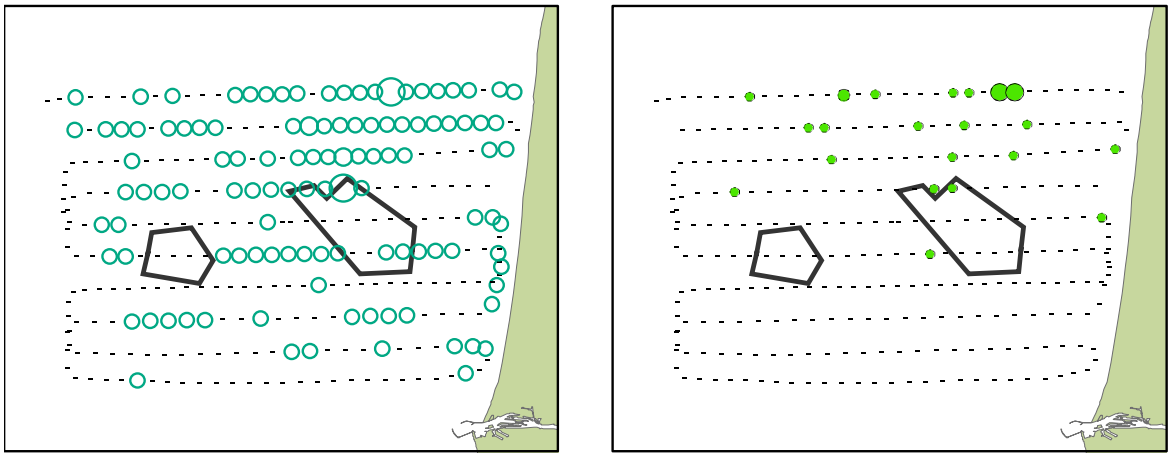
T_0 Febr 2004



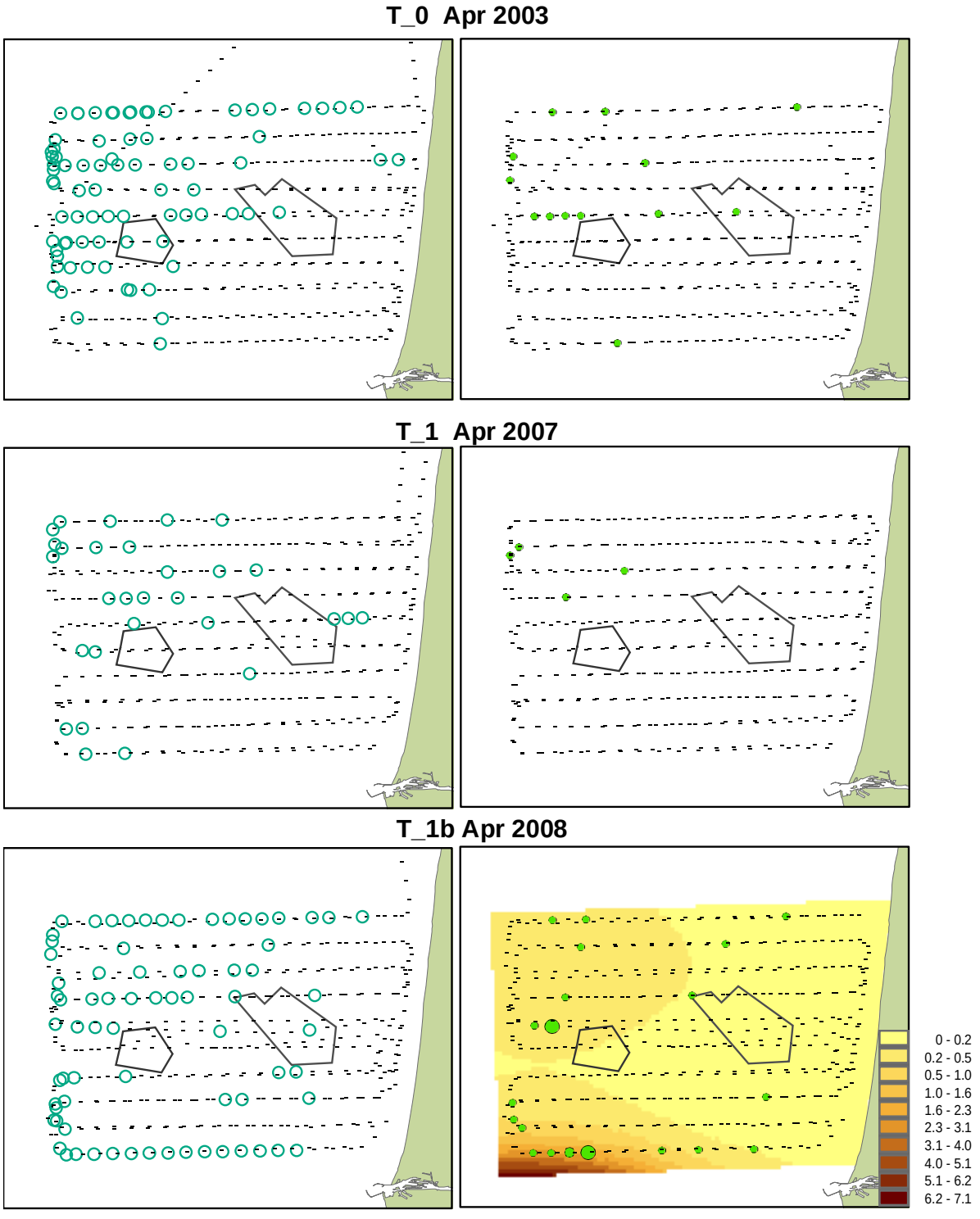
T_1 Jan 2008



T_1b Jan 2009

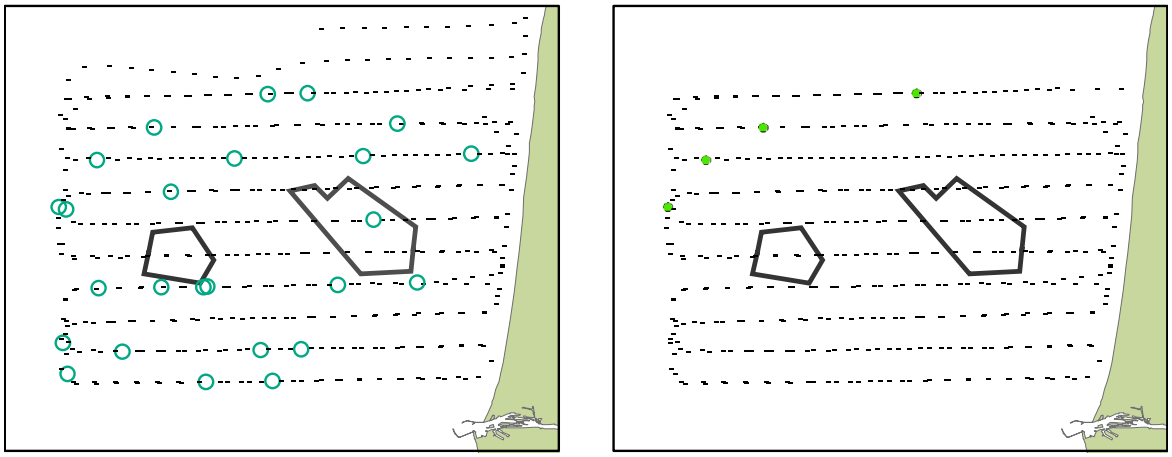


Northern Gannet

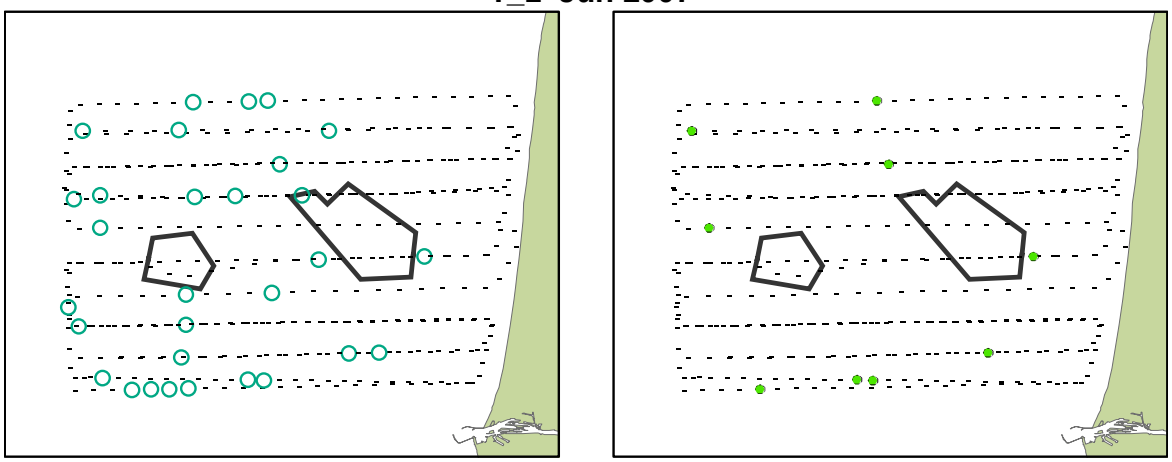


Northern Gannet

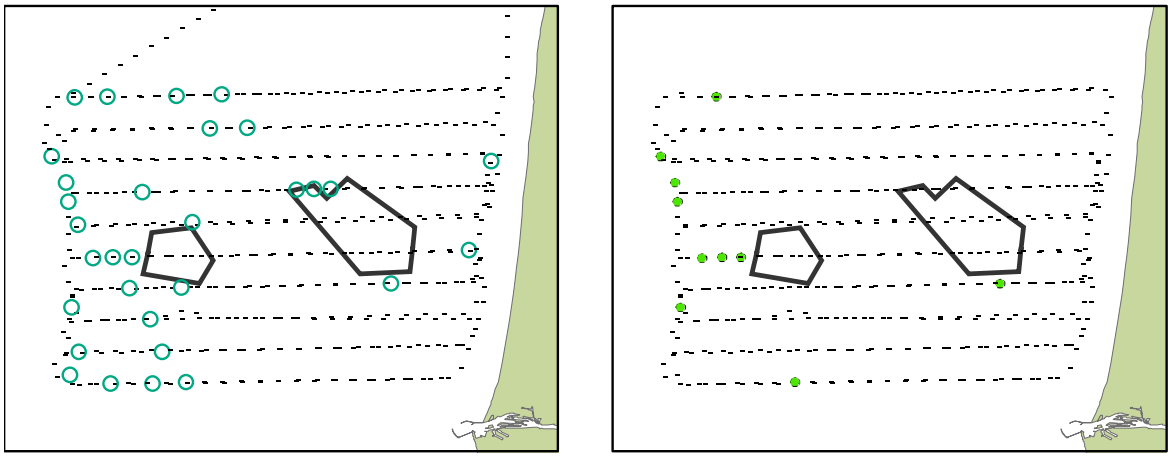
T_0 Jun 2003



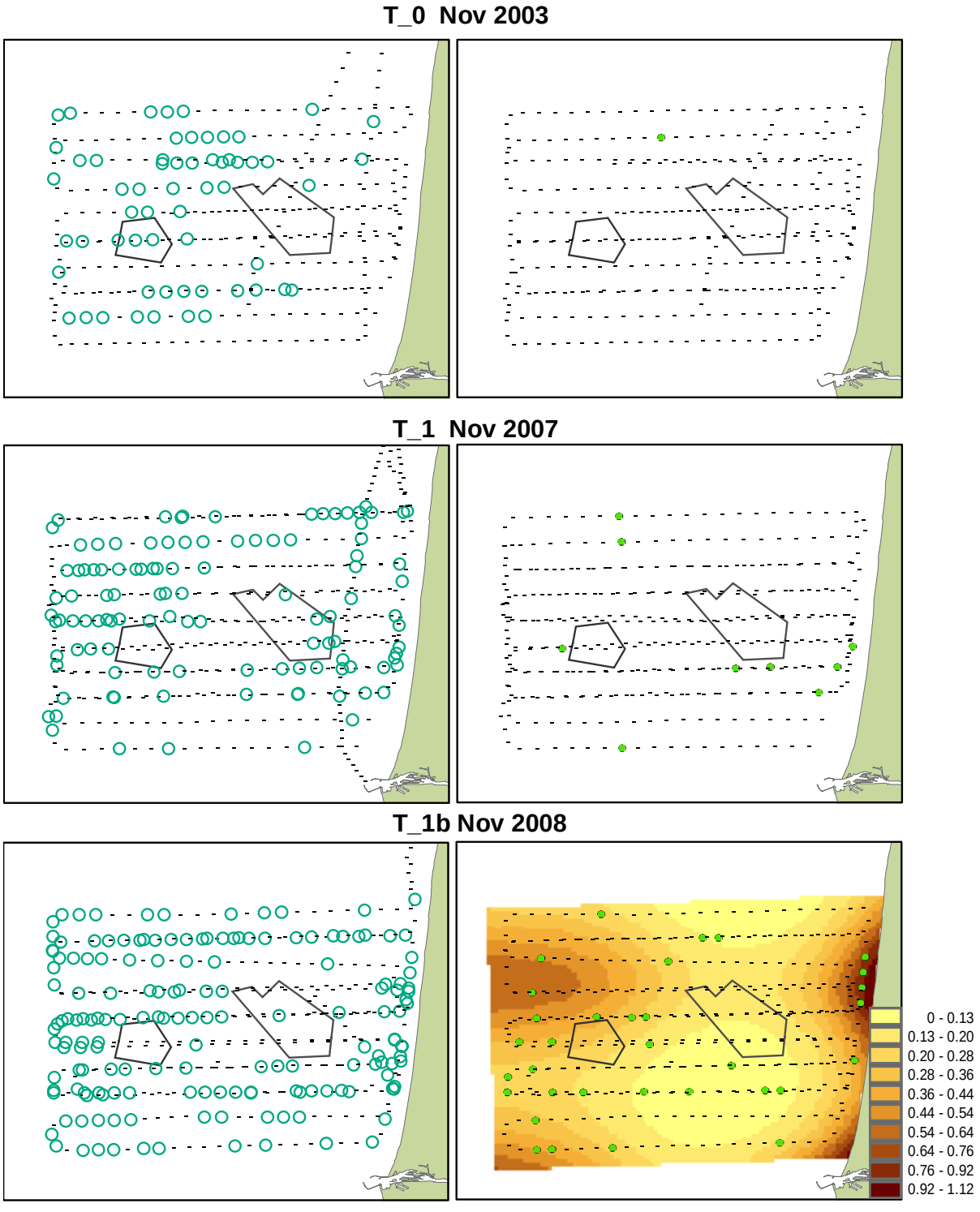
T_1 Jun 2007



T_1b Jun 2008

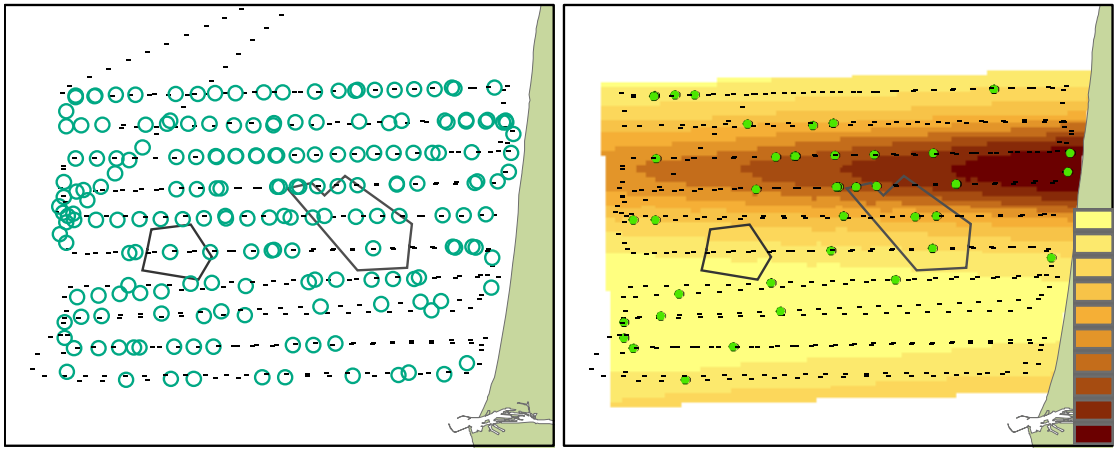


Northern Gannet

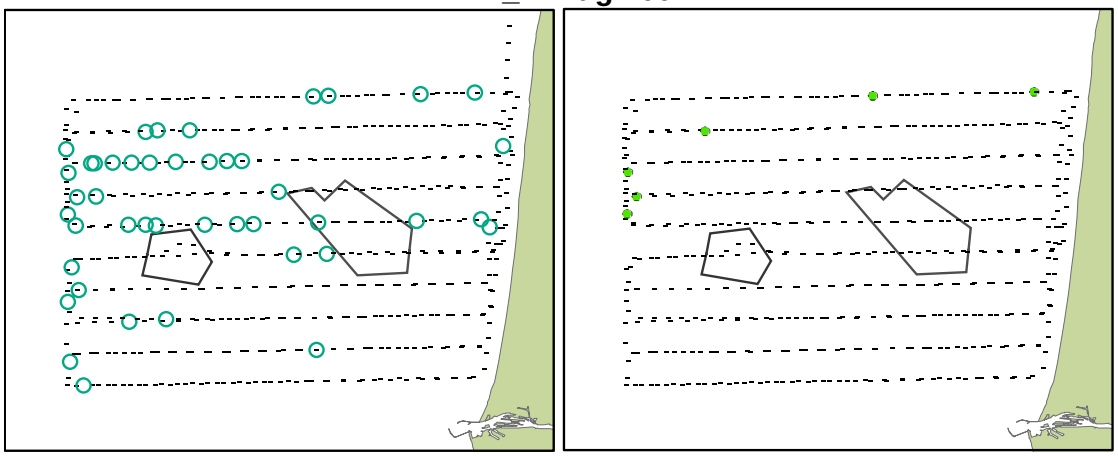


Northern Gannet

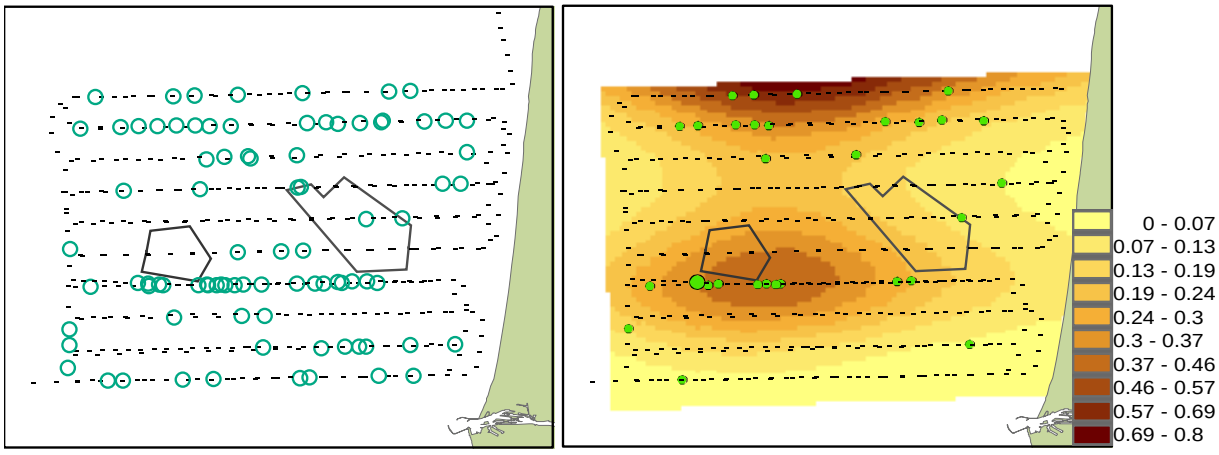
T_0 Aug 2003

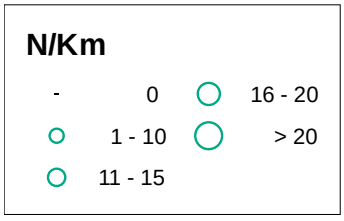


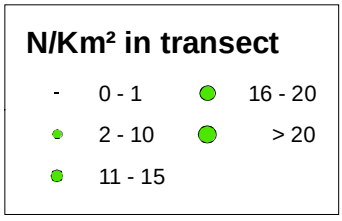
T_1 Aug 2007



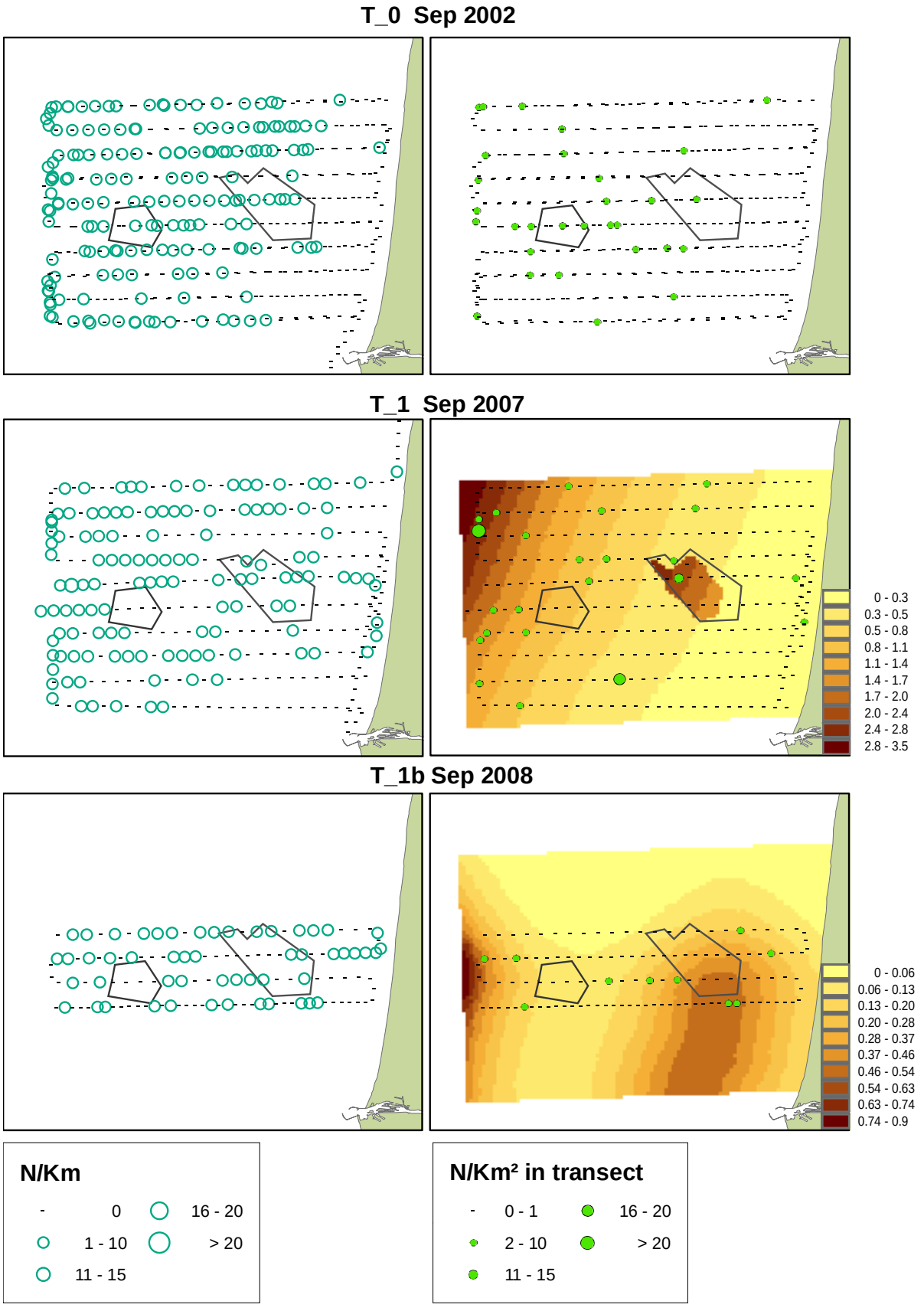
T_1b Aug 2008



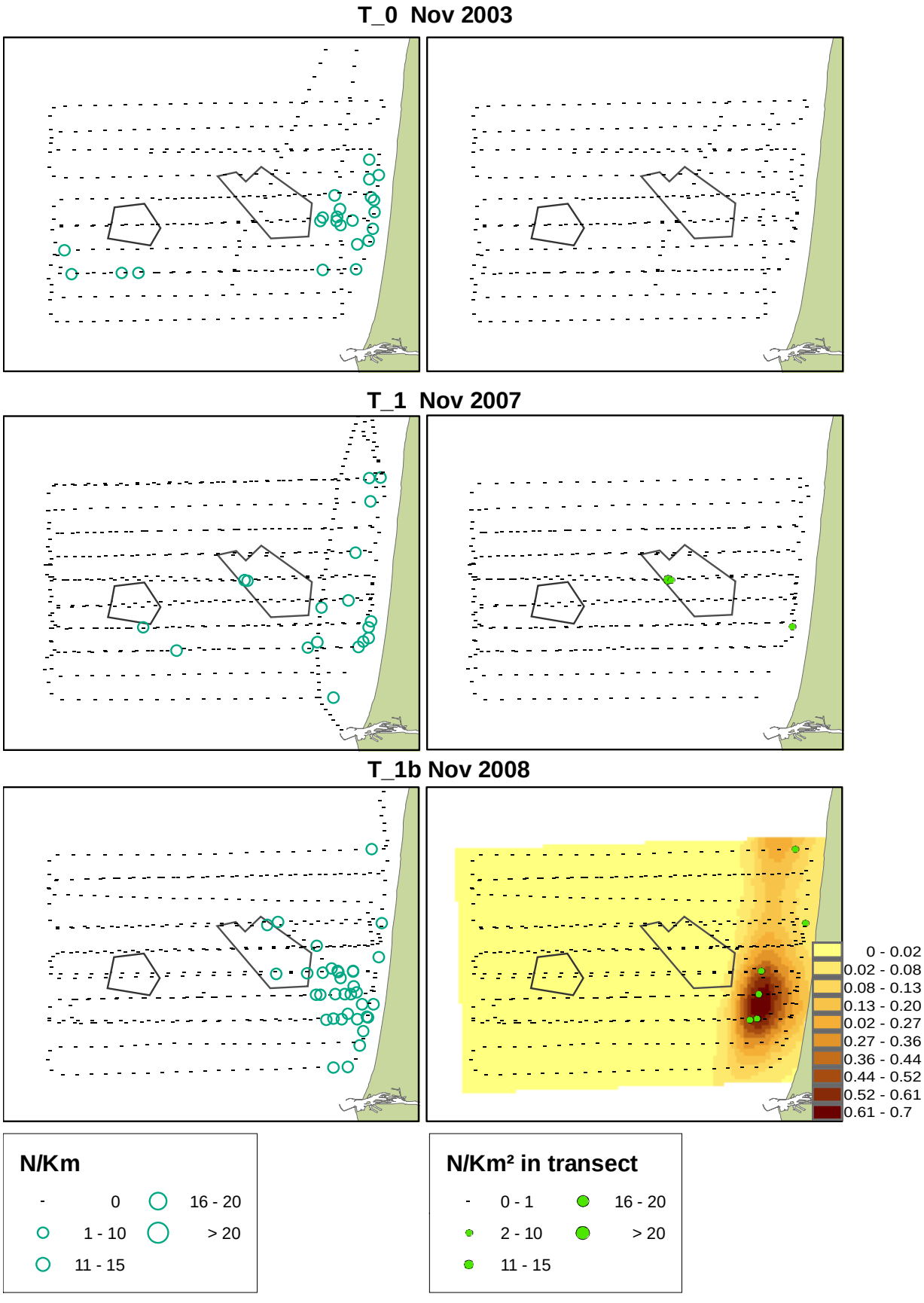




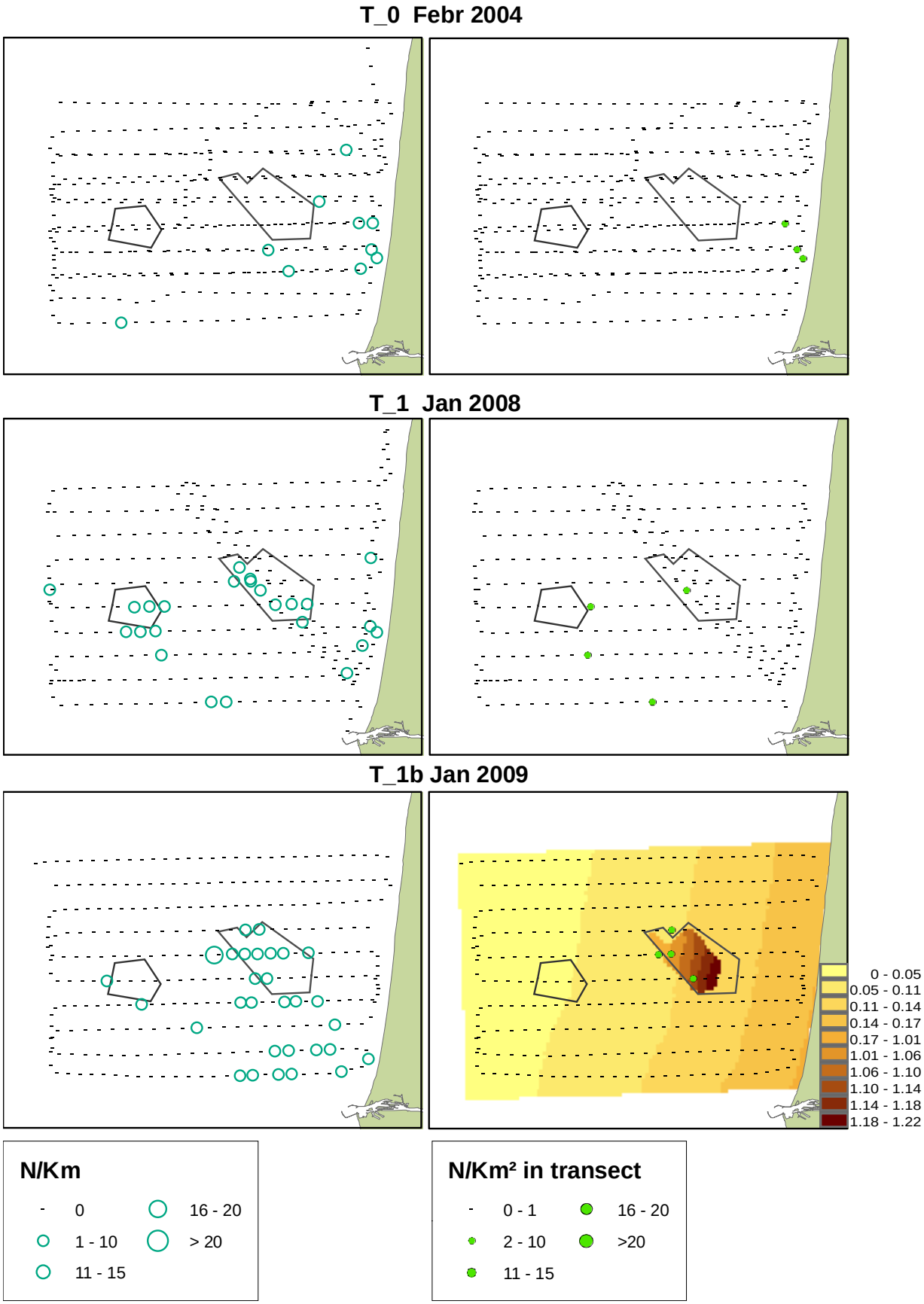
Northern Gannet



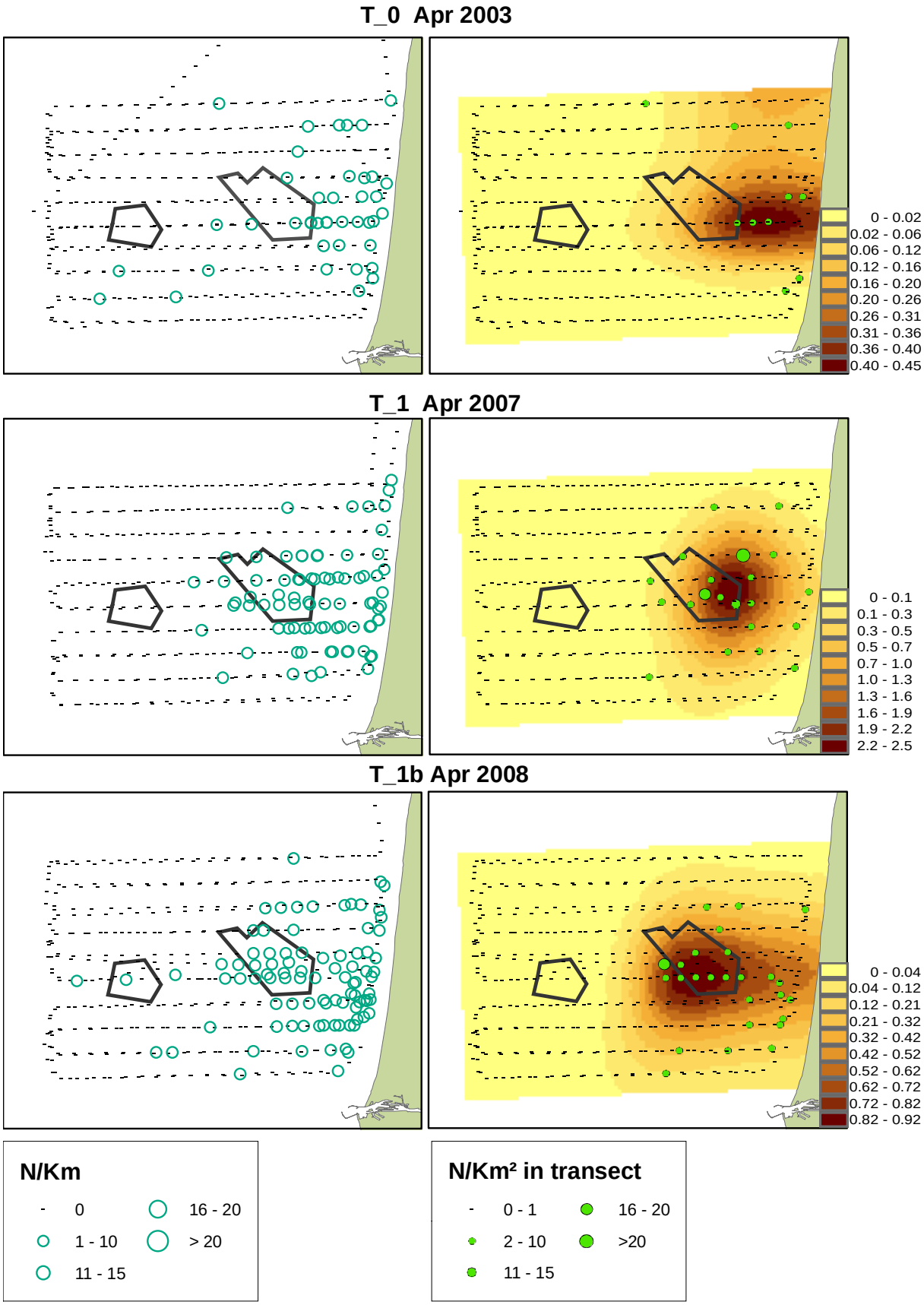
Great Cormorant



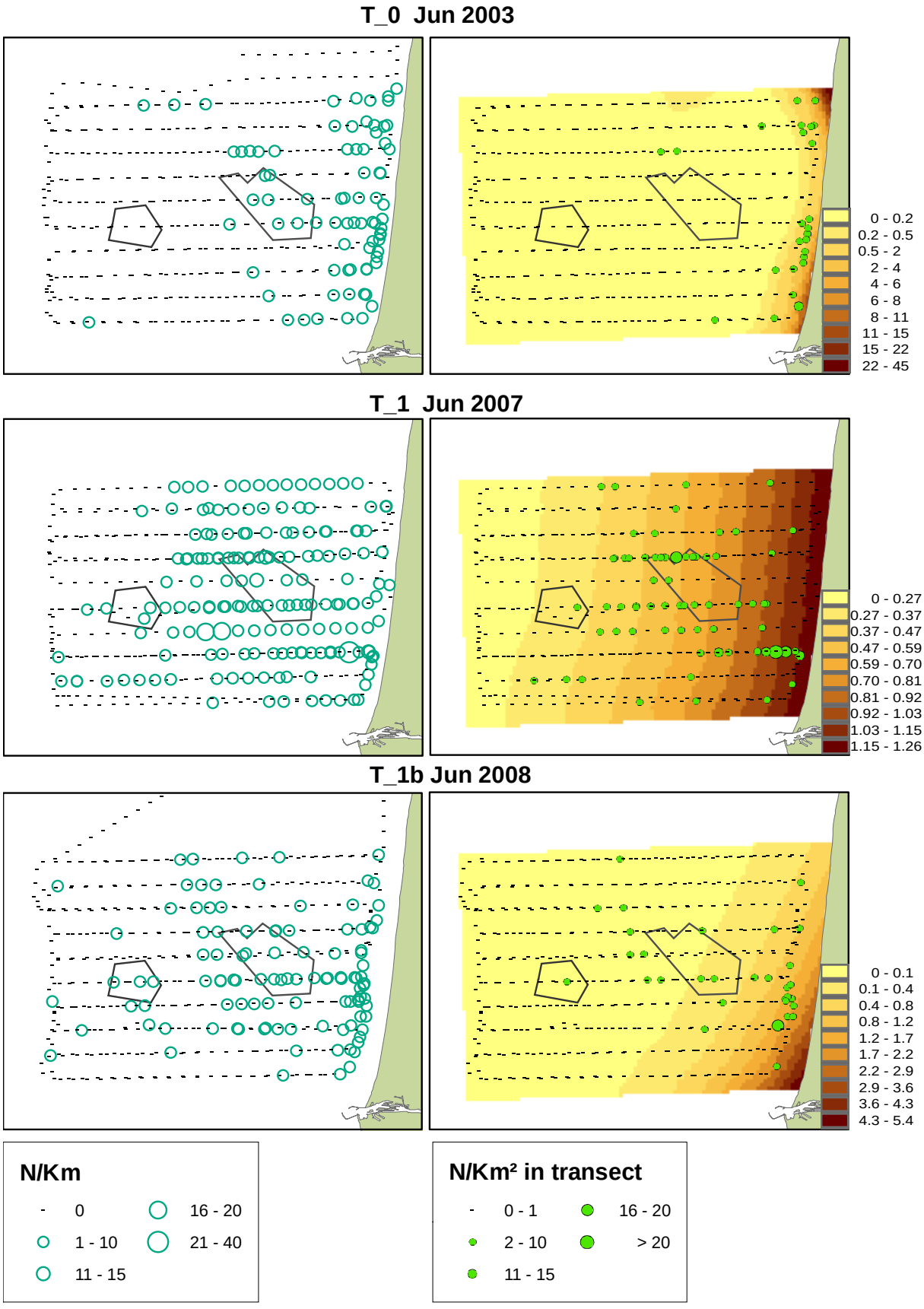
Great Cormorant



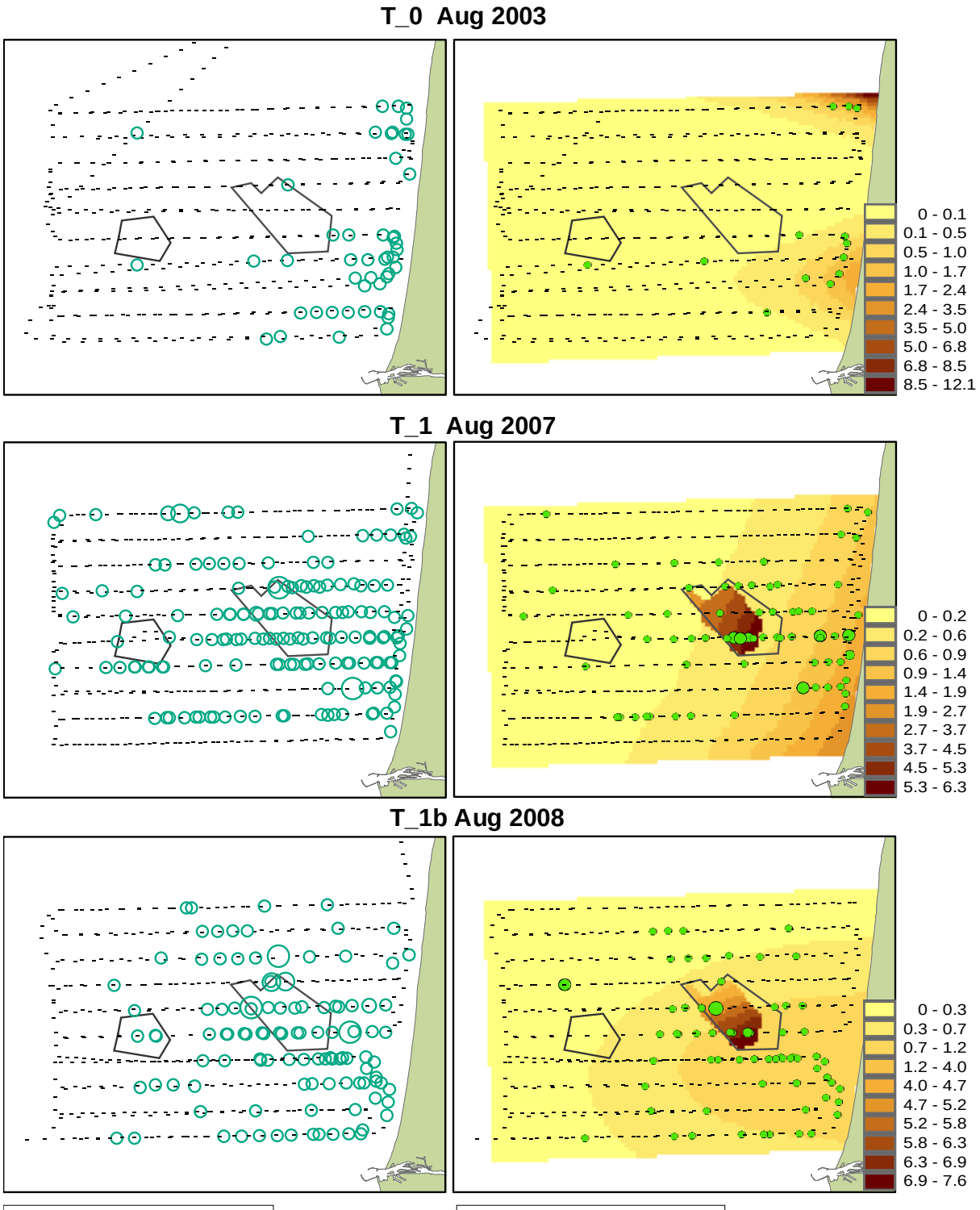
Great Cormorant



Great Cormorant

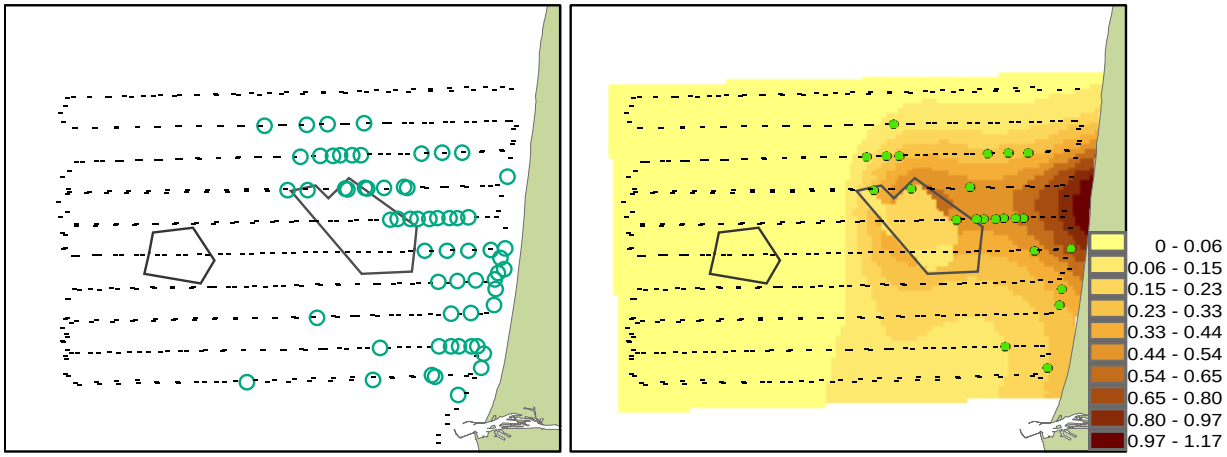


Great Cormorant

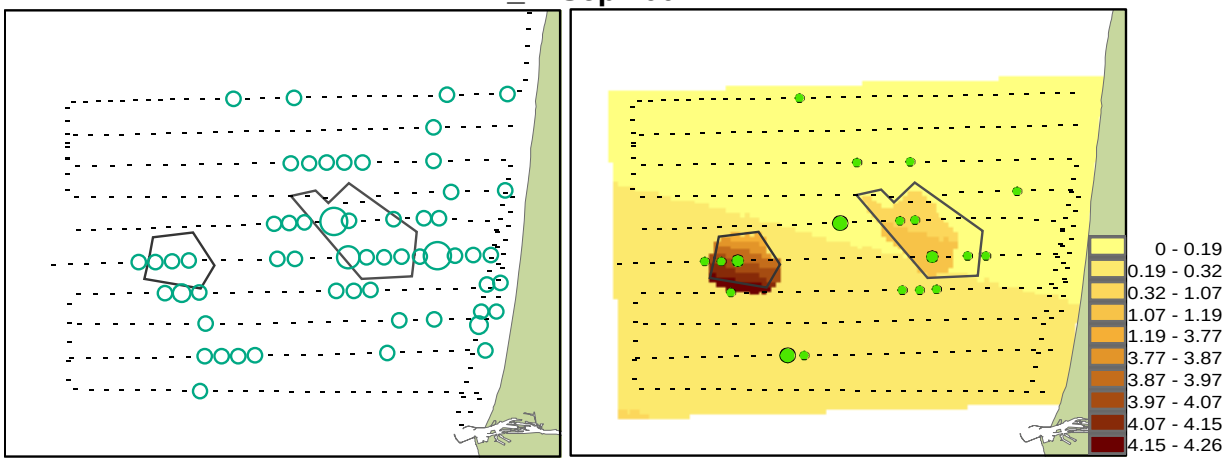


Great Cormorant

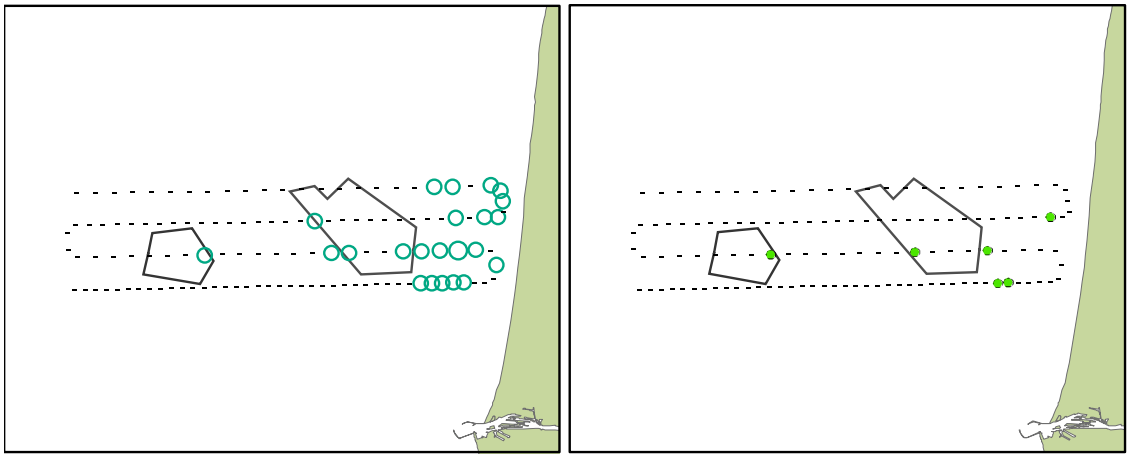
T_0 Sep 2002



T_1 Sep 2007

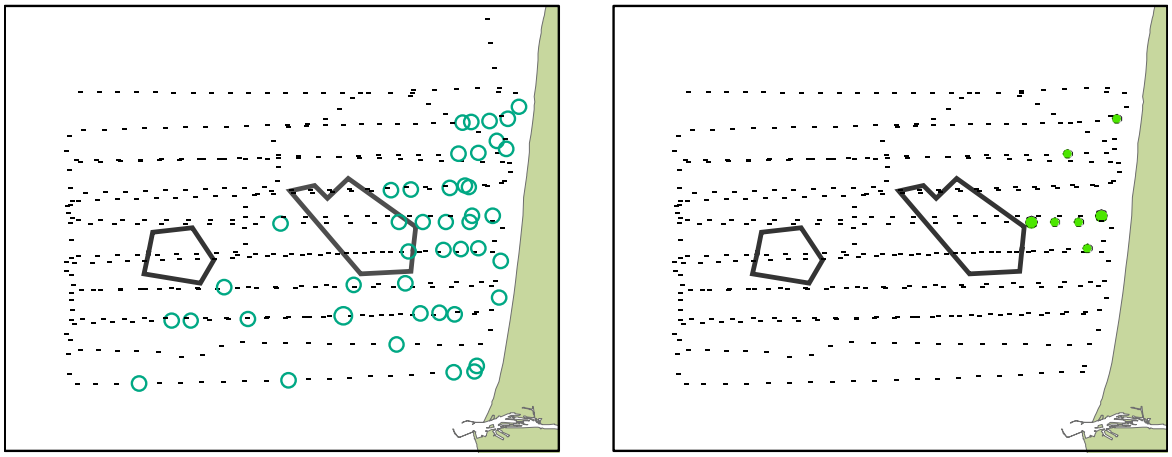


T_1b Sep 2008

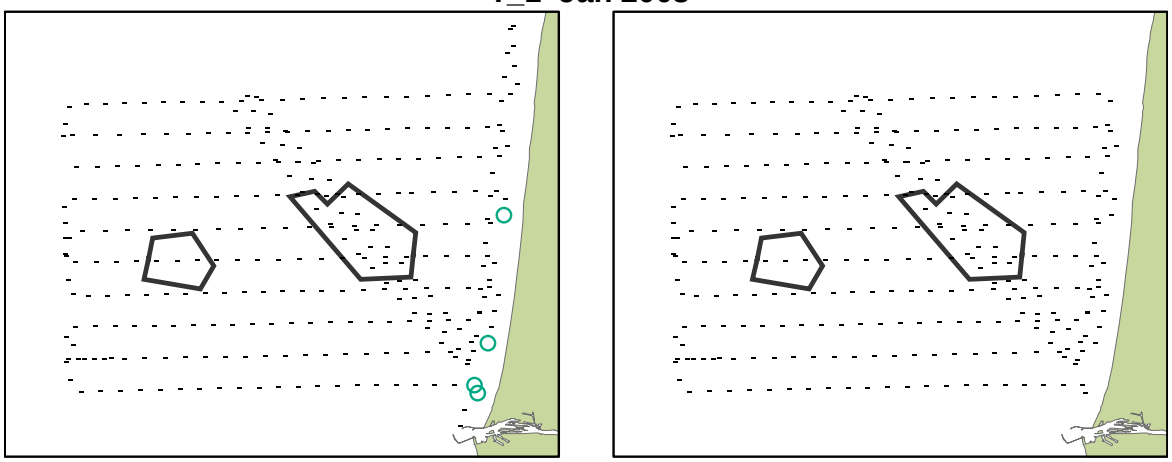


Common Scoter

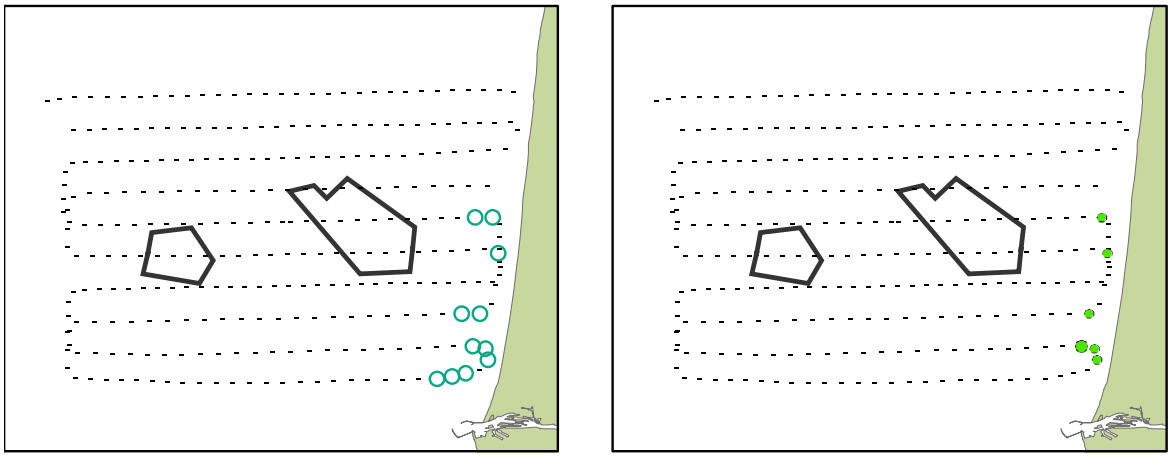
T_0 Febr 2004



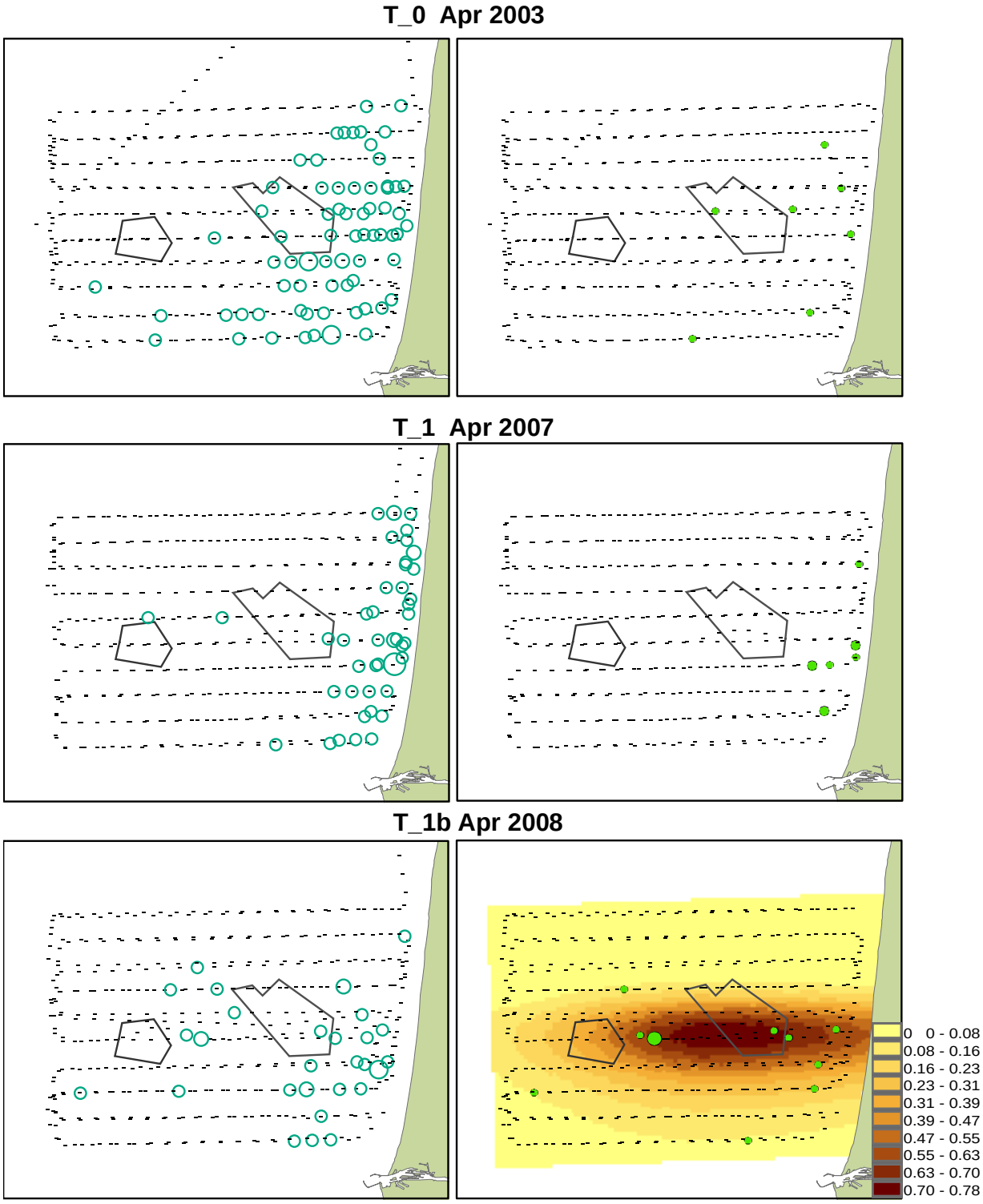
T_1 Jan 2008



T_1b Jan 2009

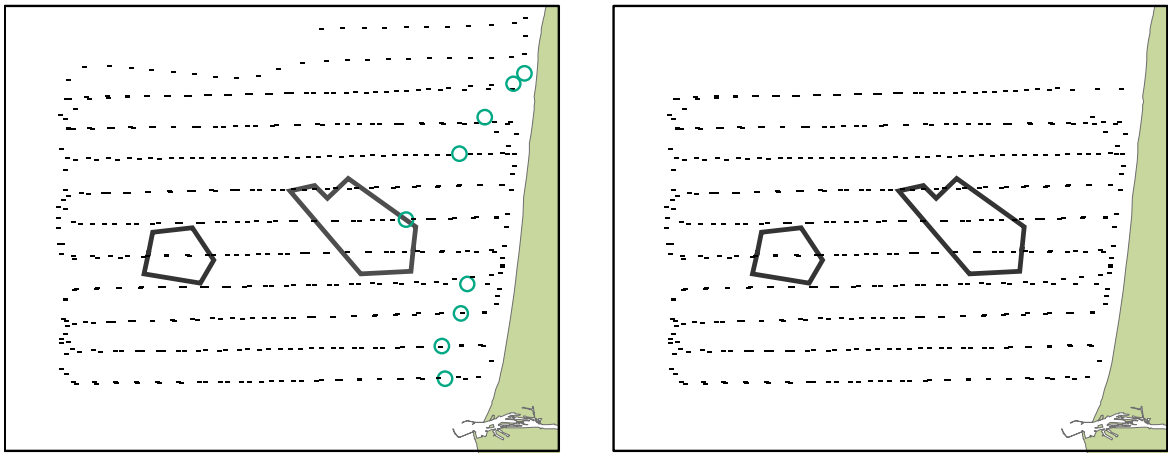


Common Scoter

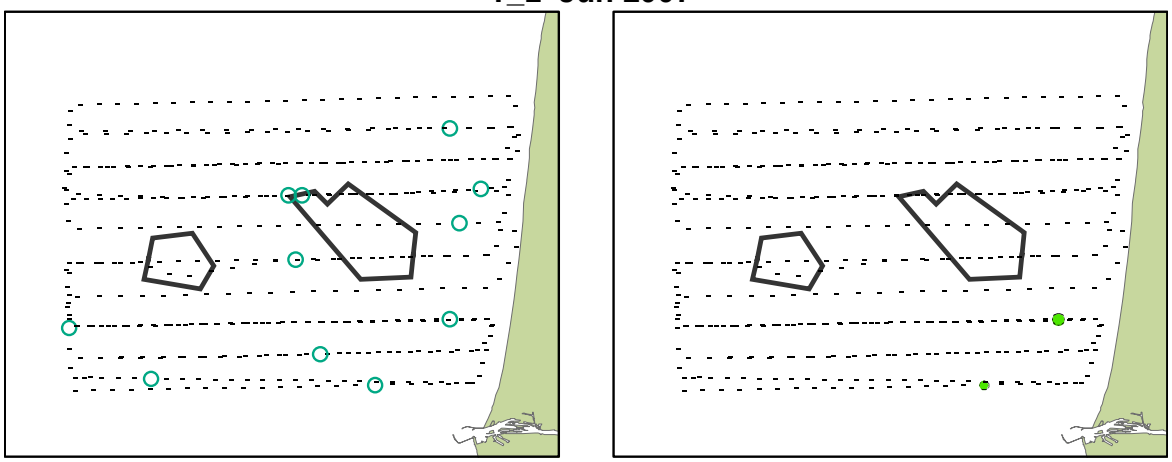


Common Scoter

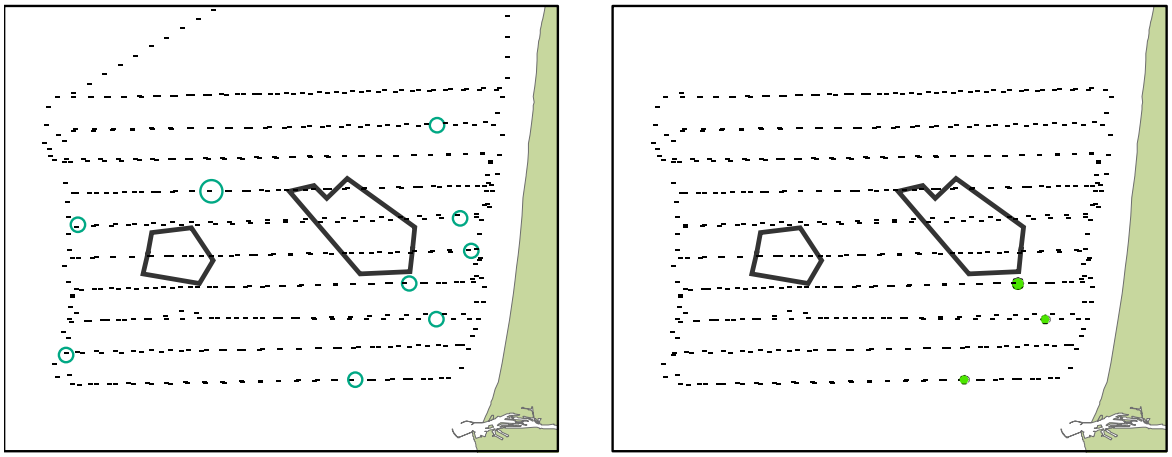
T_0 Jun 2003



T_1 Jun 2007

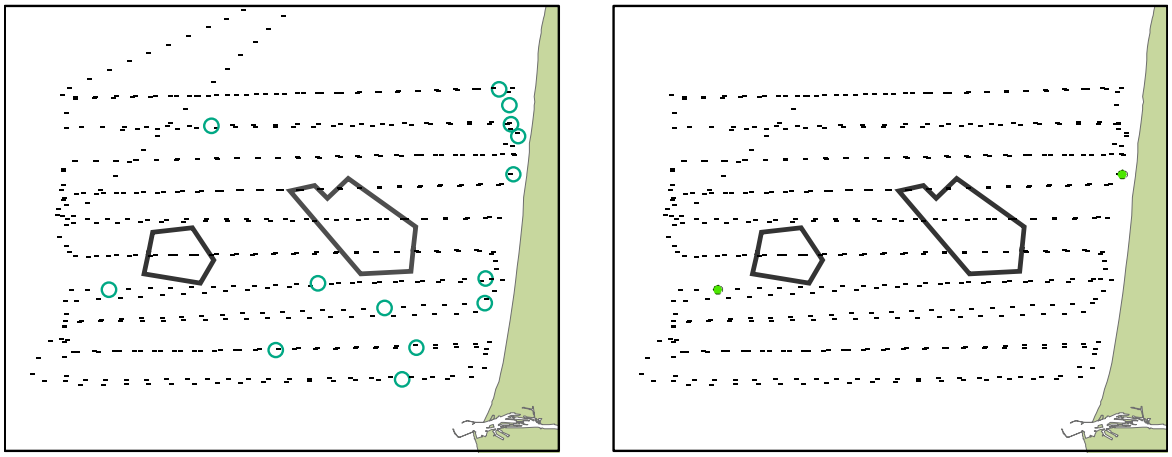


T_1b Jun 2008

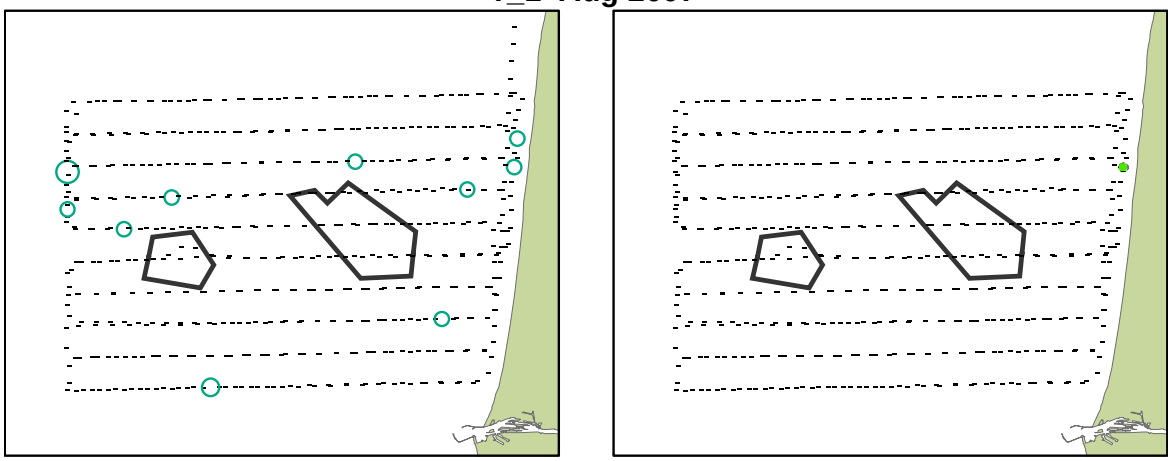


Common Scoter

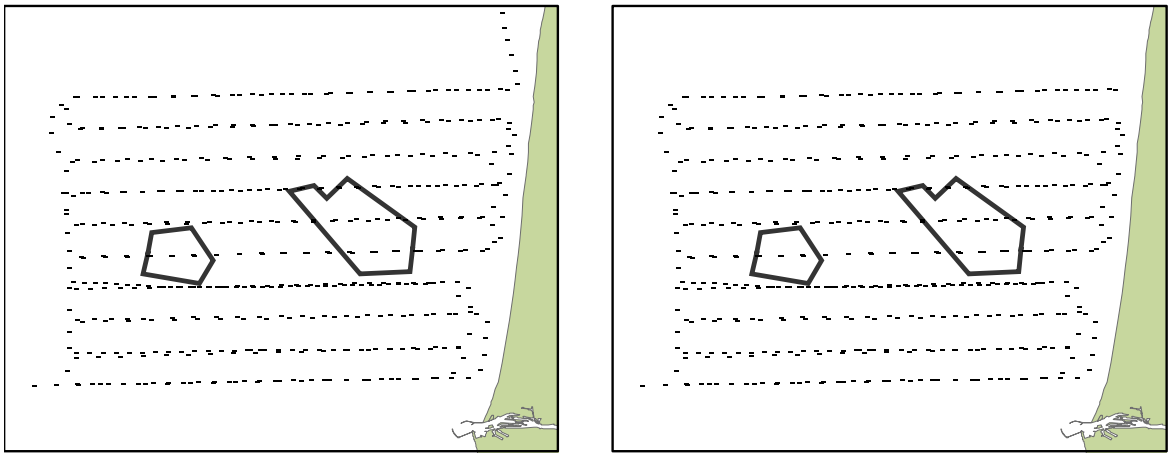
T_0 Aug 2003



T_1 Aug 2007

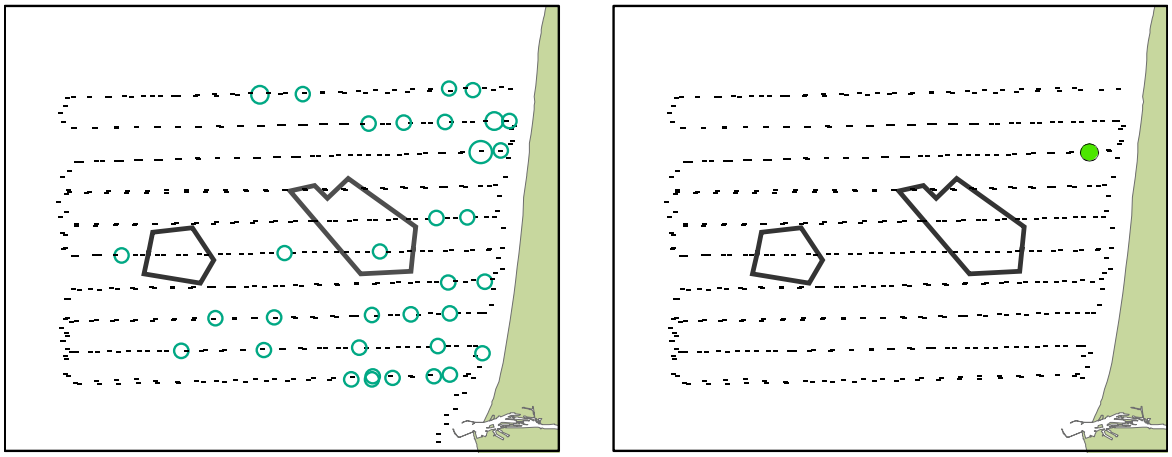


T_1b Aug 2008

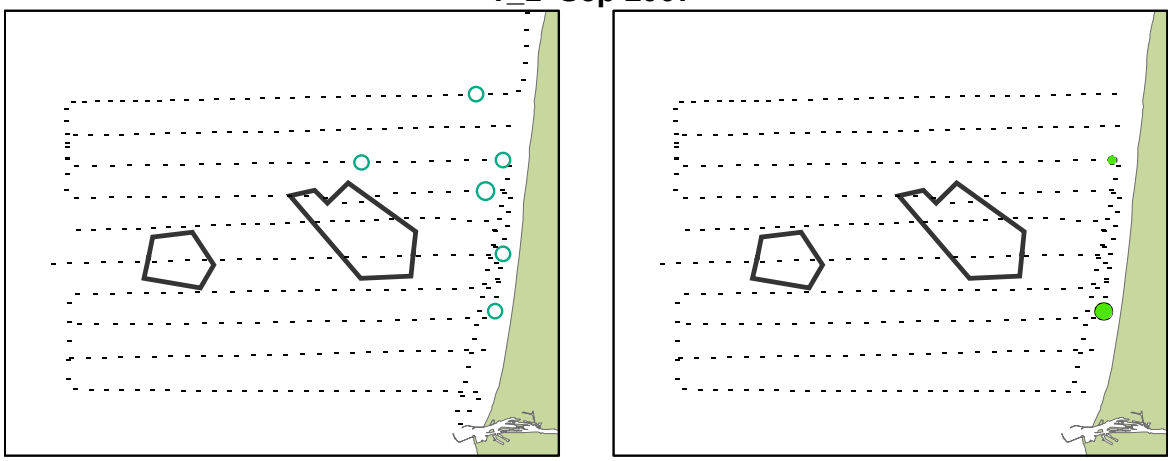


Common Scoter

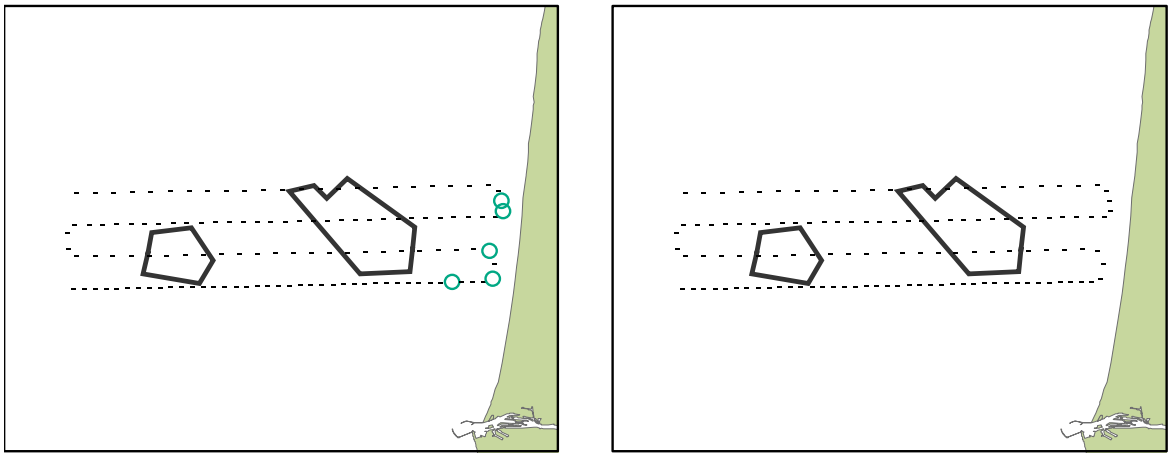
T_0 Sep 2002



T_1 Sep 2007

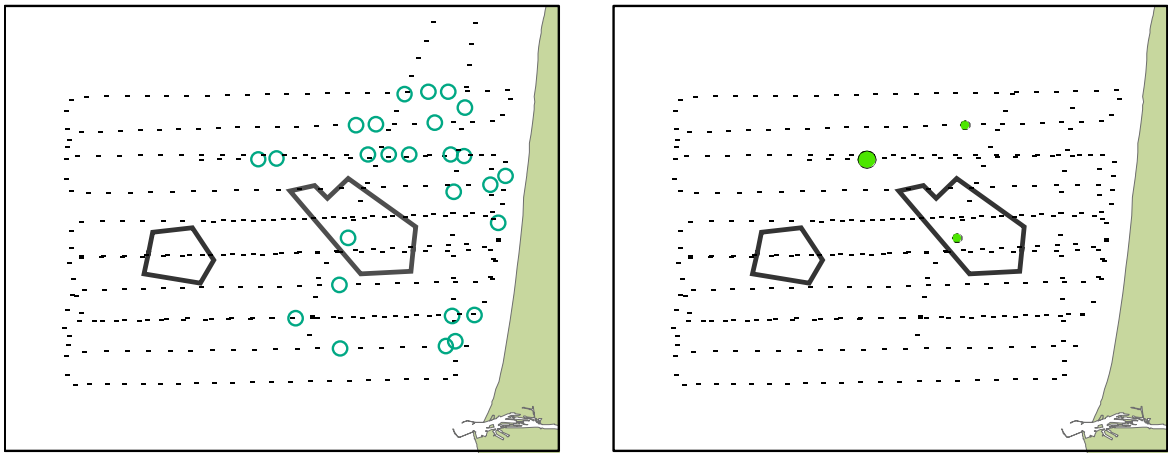


T_1b Sep 2008

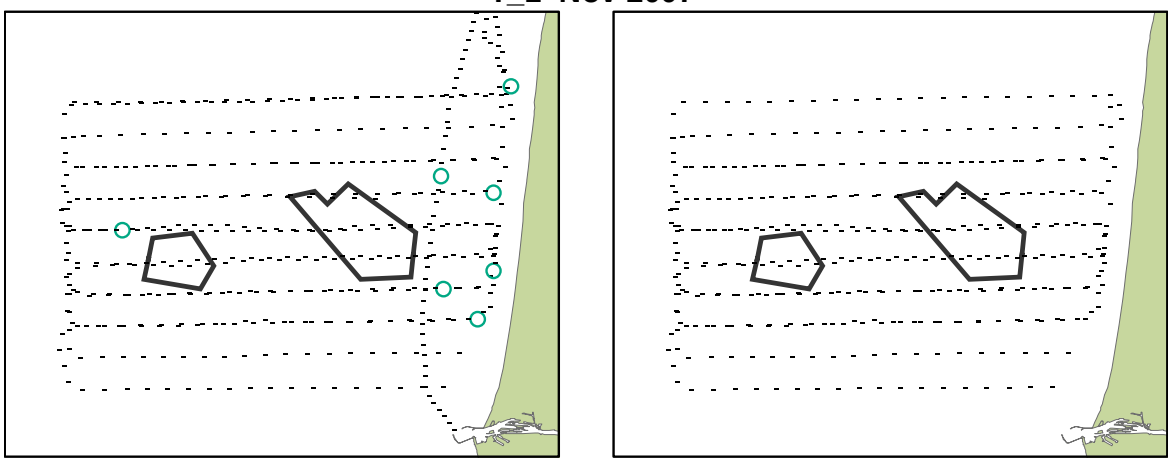


Common Scoter

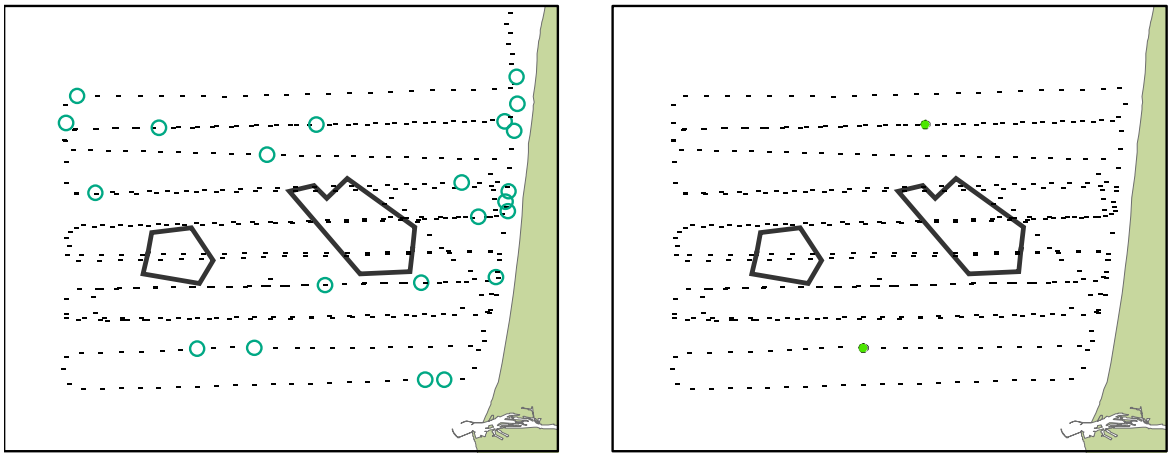
T_0 Nov 2003



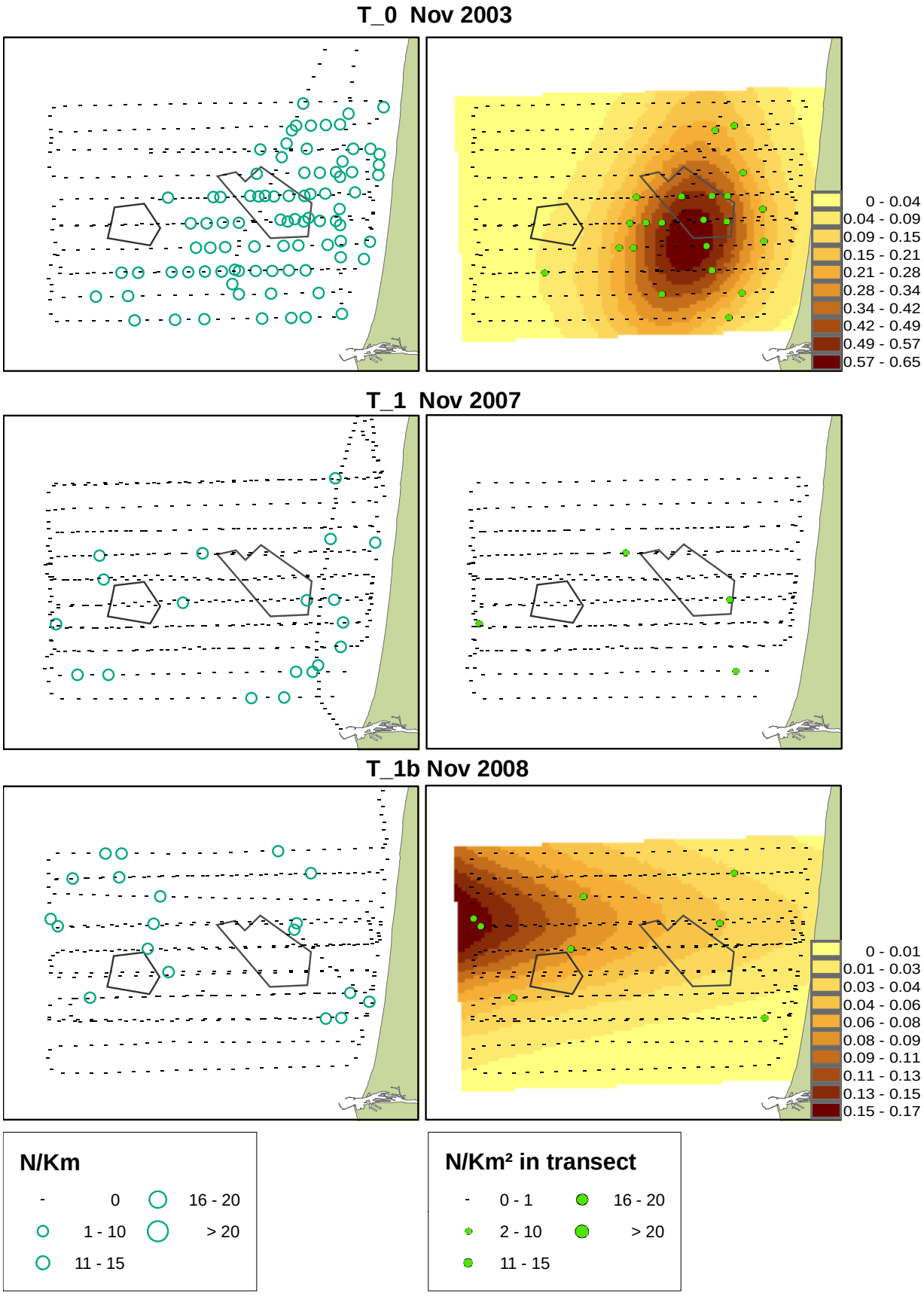
T_1 Nov 2007



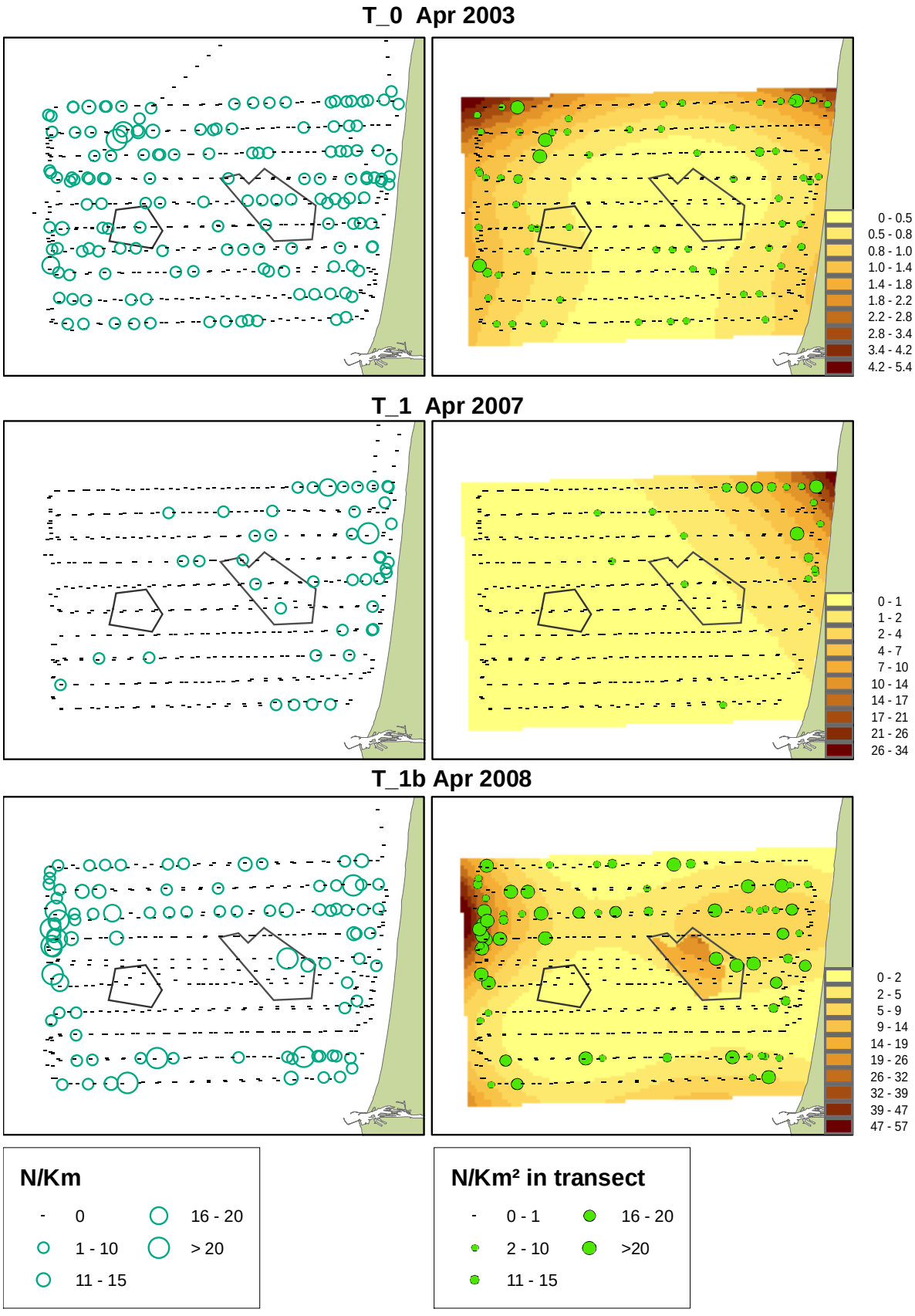
T_1b Nov 2008



Little Gull

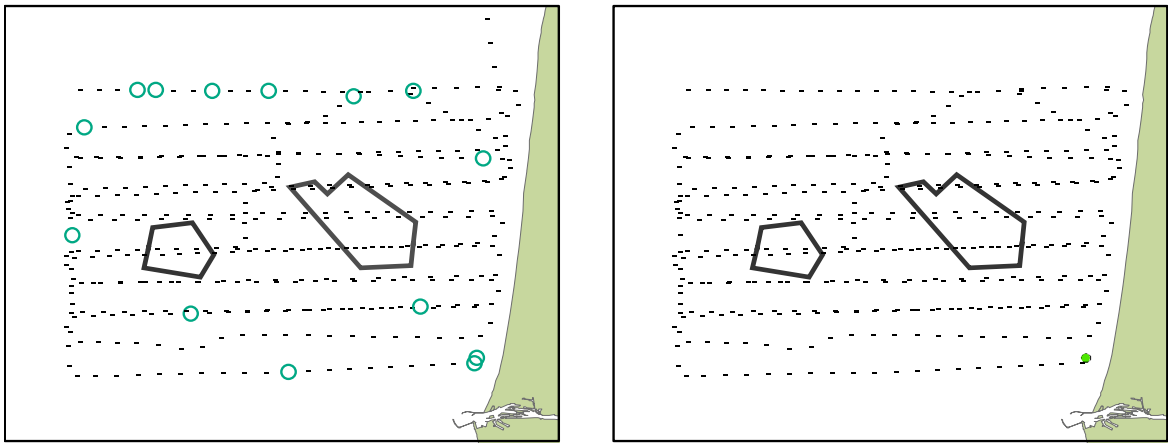

T_0 Nov 2003
0 - 0.04
0.04 - 0.09
0.09 - 0.15
0.15 - 0.21
0.21 - 0.28
0.28 - 0.34
0.34 - 0.42
0.42 - 0.49
0.49 - 0.57
0.57 - 0.65
T_1 Nov 2007
T_1b Nov 2008
0 - 0.01
0.01 - 0.03
0.03 - 0.04
0.04 - 0.06
0.06 - 0.08
0.08 - 0.09
0.09 - 0.11
0.11 - 0.13
0.13 - 0.15
0.15 - 0.17
N/Km
0
1 - 10
11 - 15
16 - 20
> 20
N/Km² in transect
0 - 1
2 - 10
11 - 15
16 - 20
> 20

Little Gull

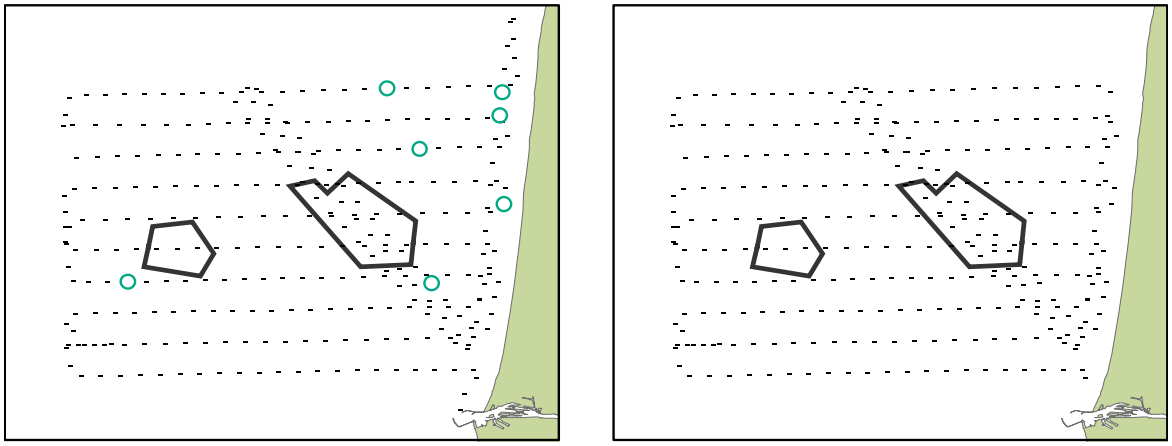

T_0 Apr 2003
0 - 0.5
0.5 - 0.8
0.8 - 1.0
1.0 - 1.4
1.4 - 1.8
1.8 - 2.2
2.2 - 2.8
2.8 - 3.4
3.4 - 4.2
4.2 - 5.4
T_1 Apr 2007
0 - 1
1 - 2
2 - 4
4 - 7
7 - 10
10 - 14
14 - 17
17 - 21
21 - 26
26 - 34
T_1b Apr 2008
0 - 2
2 - 5
5 - 9
9 - 14
14 - 19
19 - 26
26 - 32
32 - 39
39 - 47
47 - 57
N/Km
0
1 - 10
11 - 15
16 - 20
> 20
N/Km² in transect
0 - 1
2 - 10
11 - 15
16 - 20
>20

Black-headed Gull

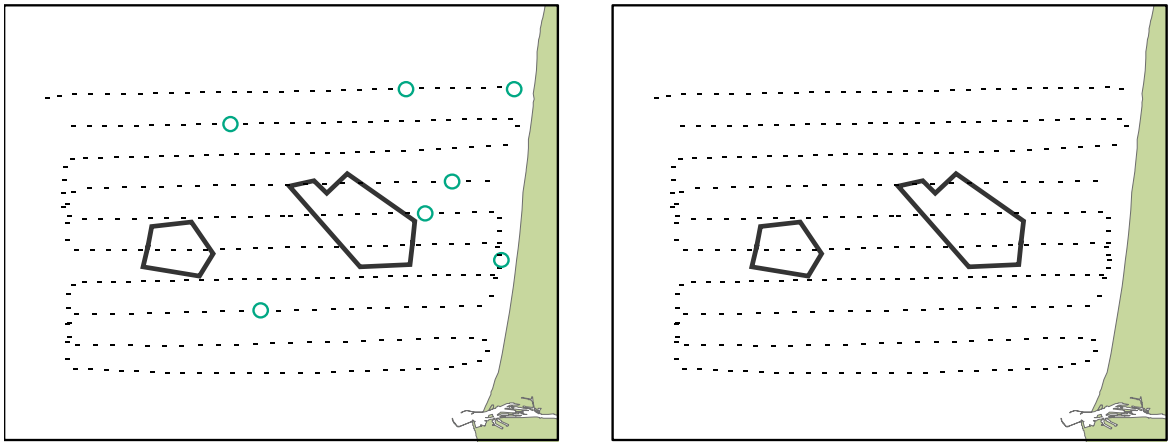
T_0 Febr 2004



T_1 Jan 2008

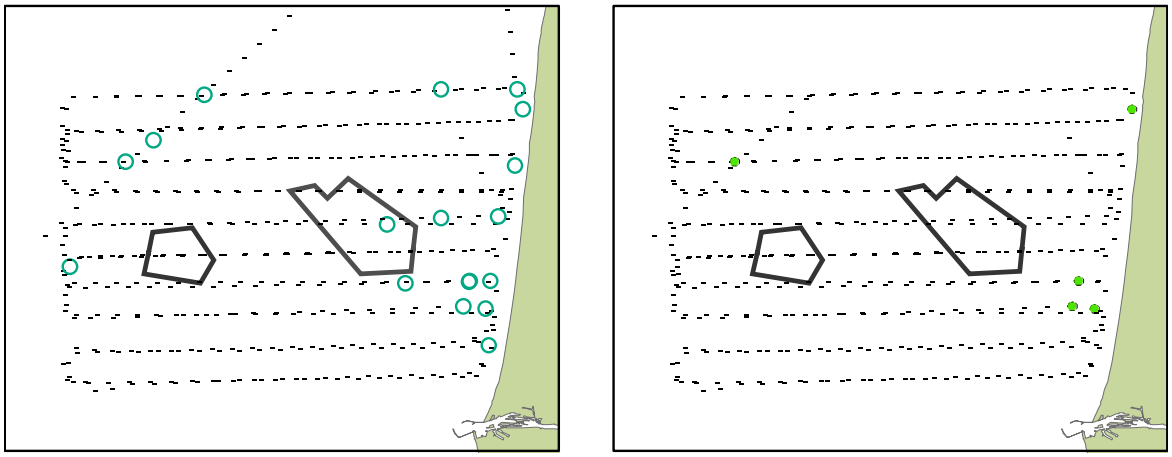


T_1b Jan 2009

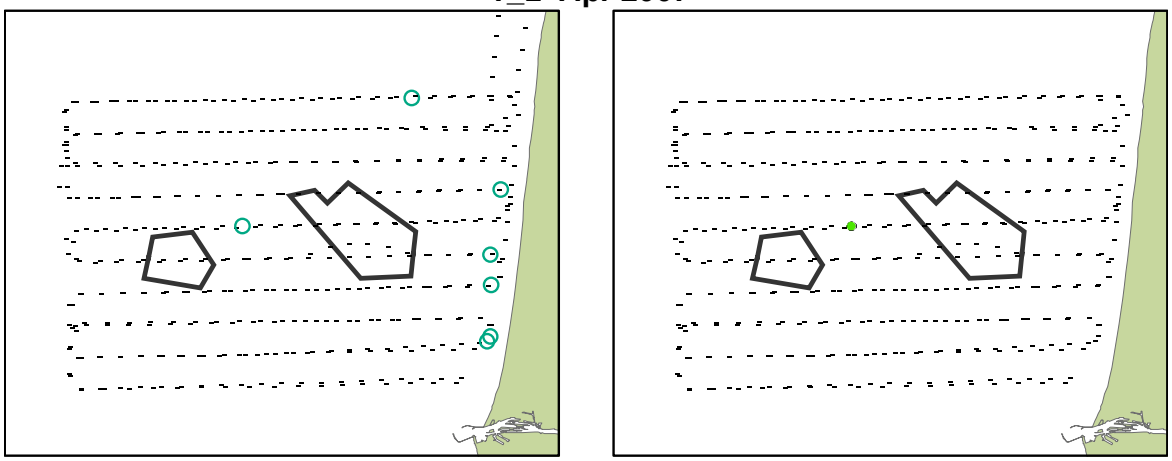


Black-headed Gull

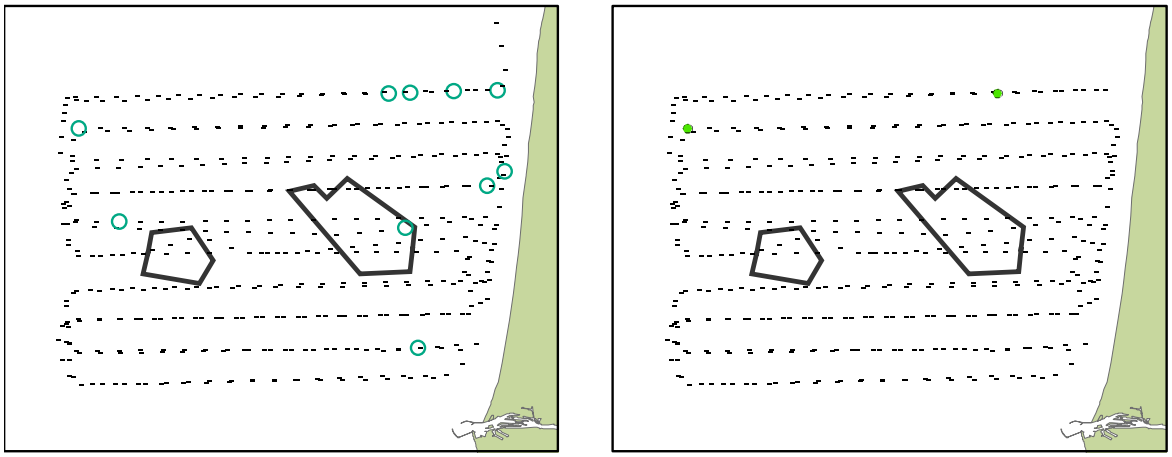
T_0 Apr 2003



T_1 Apr 2007

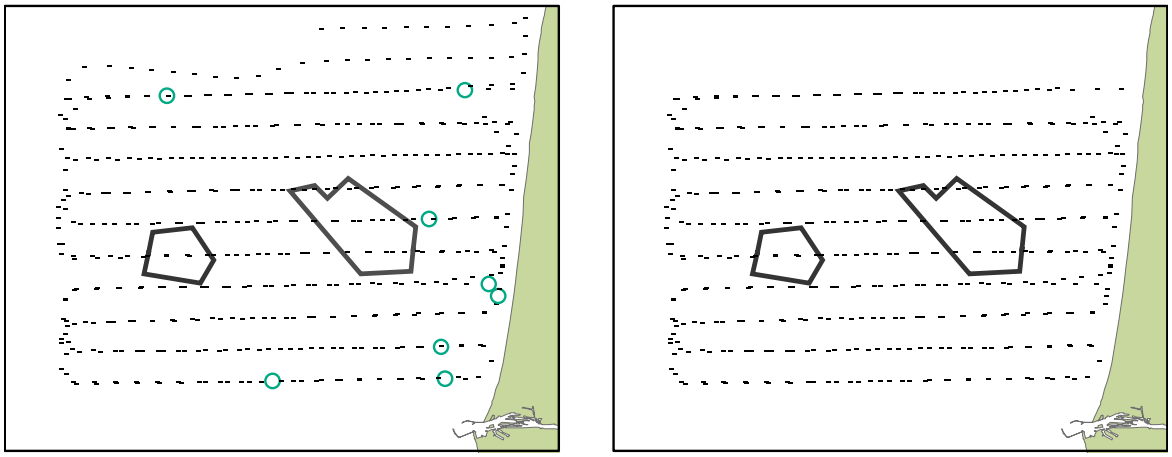


T_1b Apr 2008

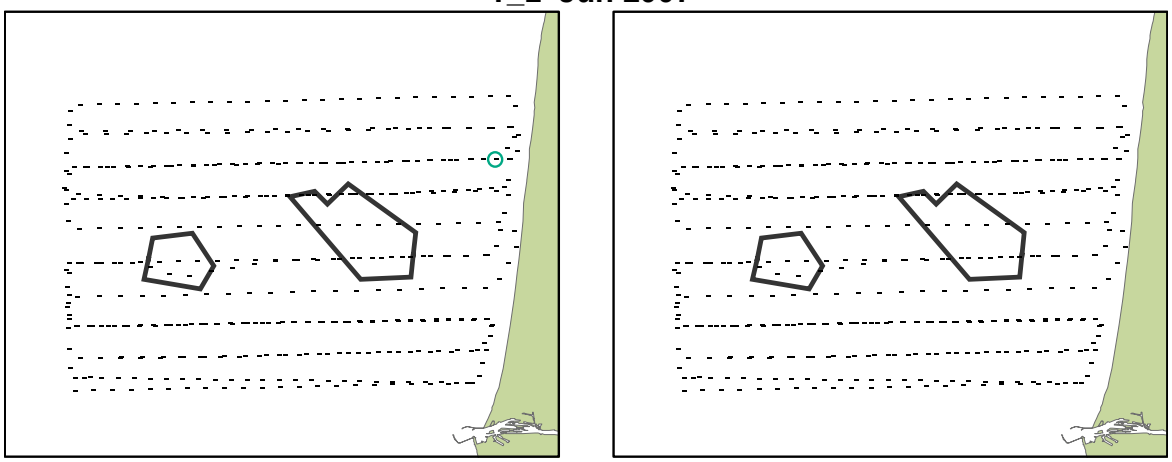


Black-headed Gull

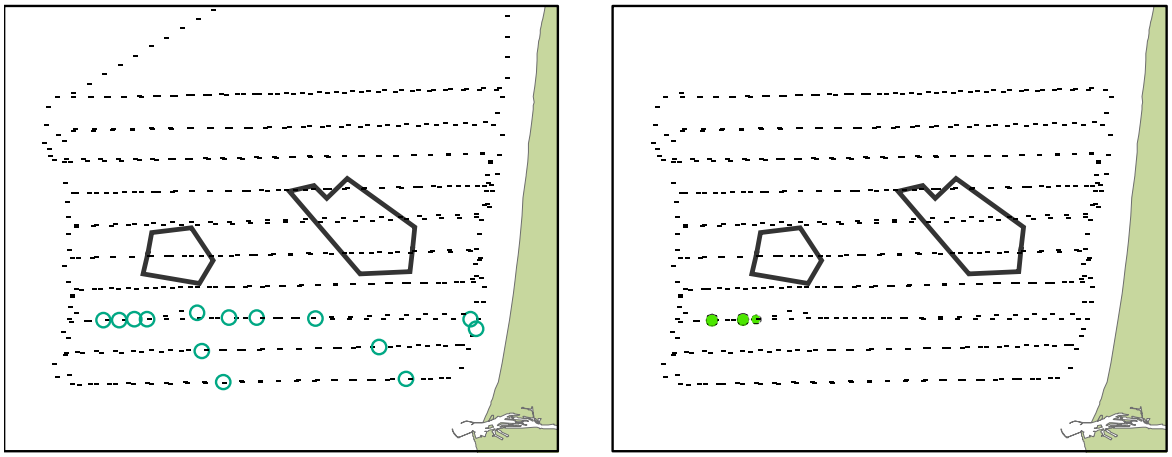
T_0 Jun 2003



T_1 Jun 2007

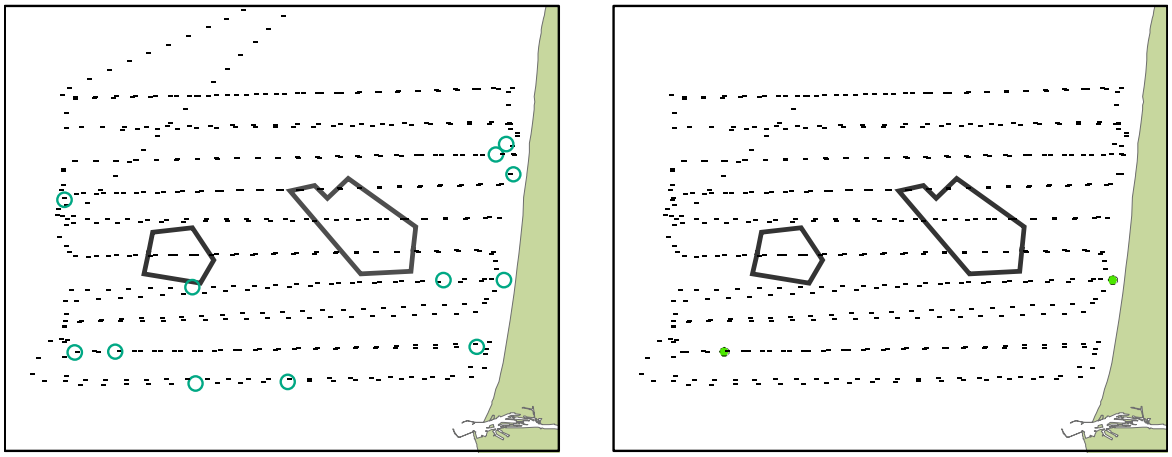


T_1b Jun 2008

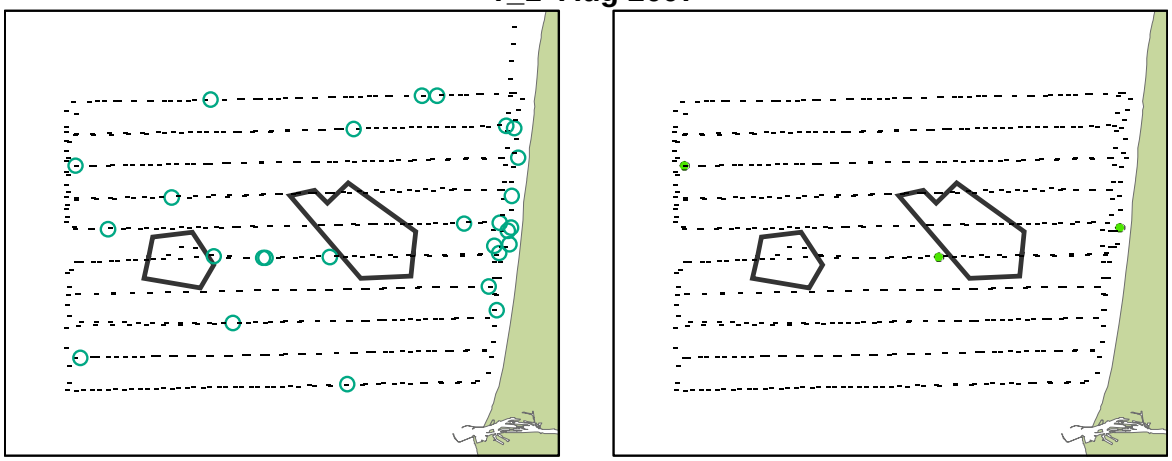


Black-headed Gull

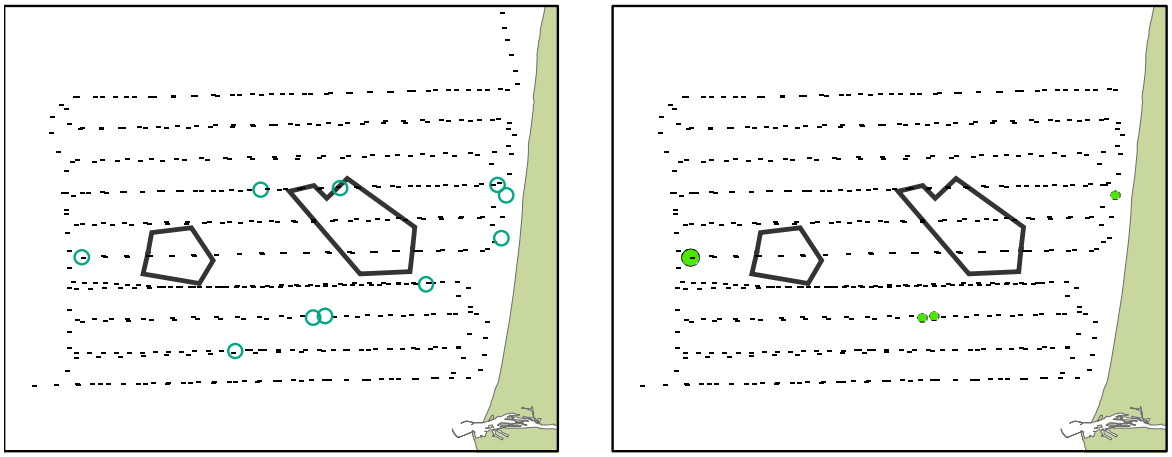
T_0 Aug 2003



T_1 Aug 2007

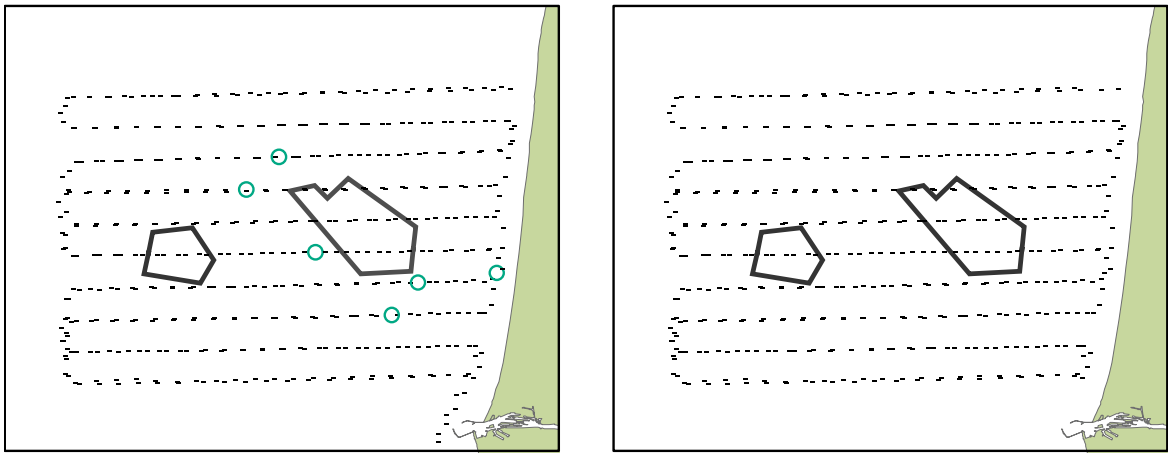


T_1b Aug 2008

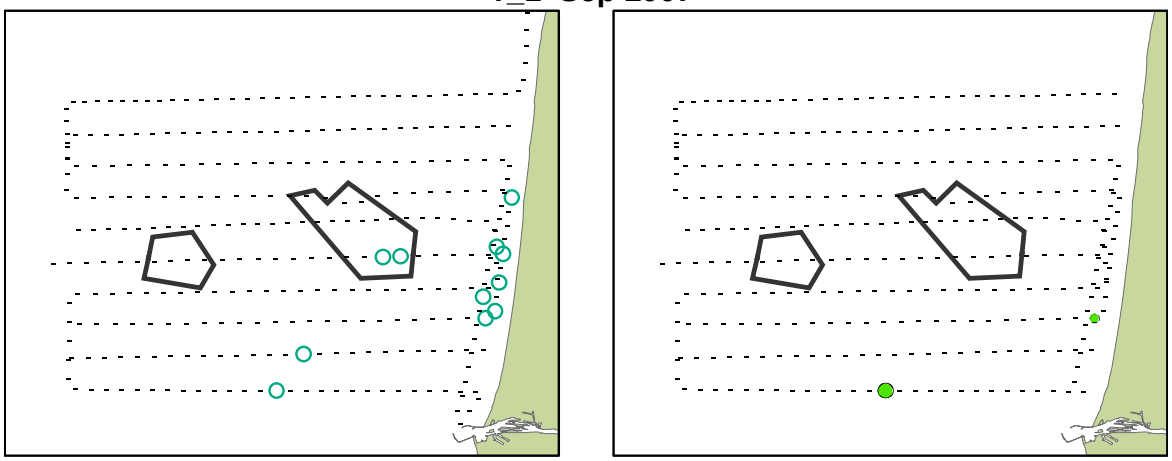


Black-headed Gull

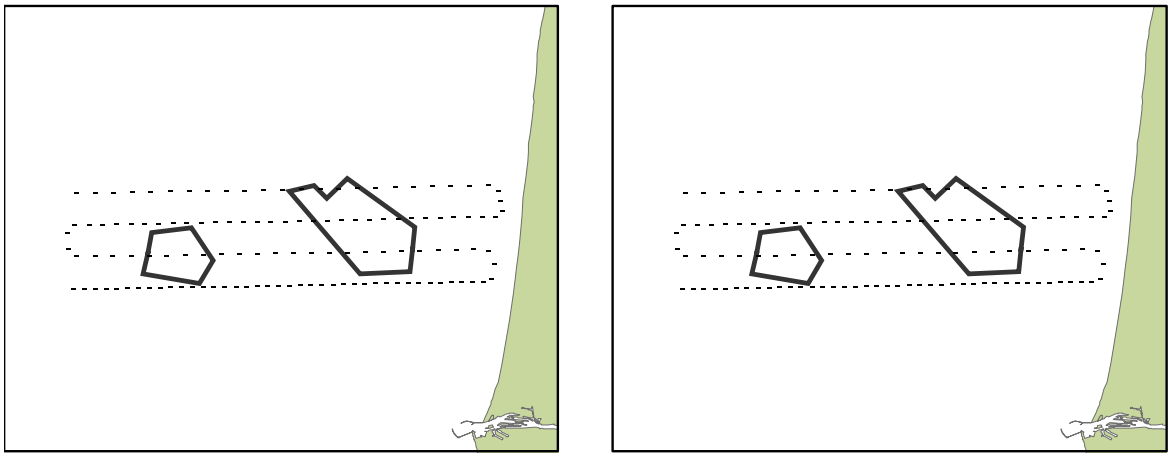
T_0 Sep 2002



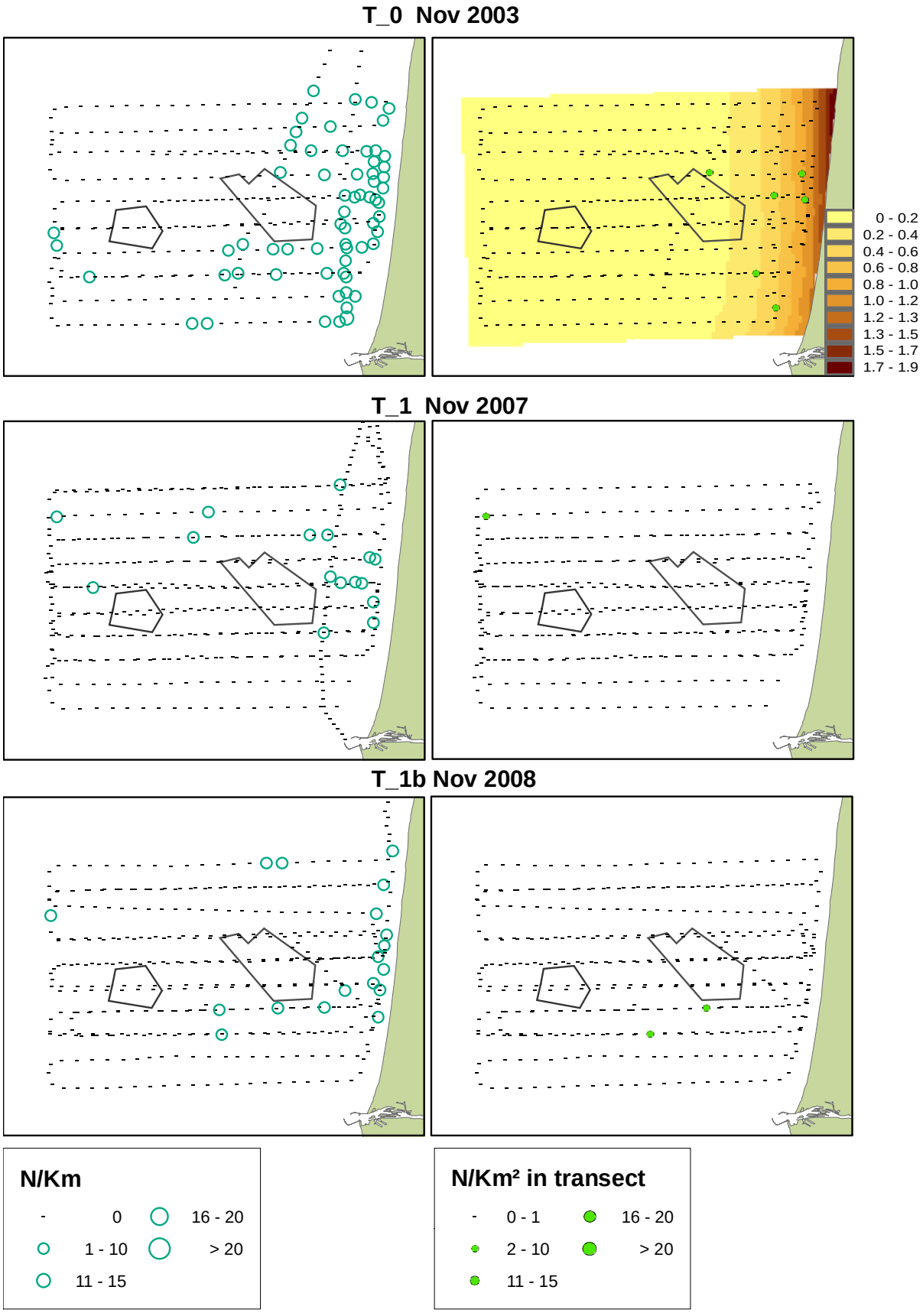
T_1 Sep 2007



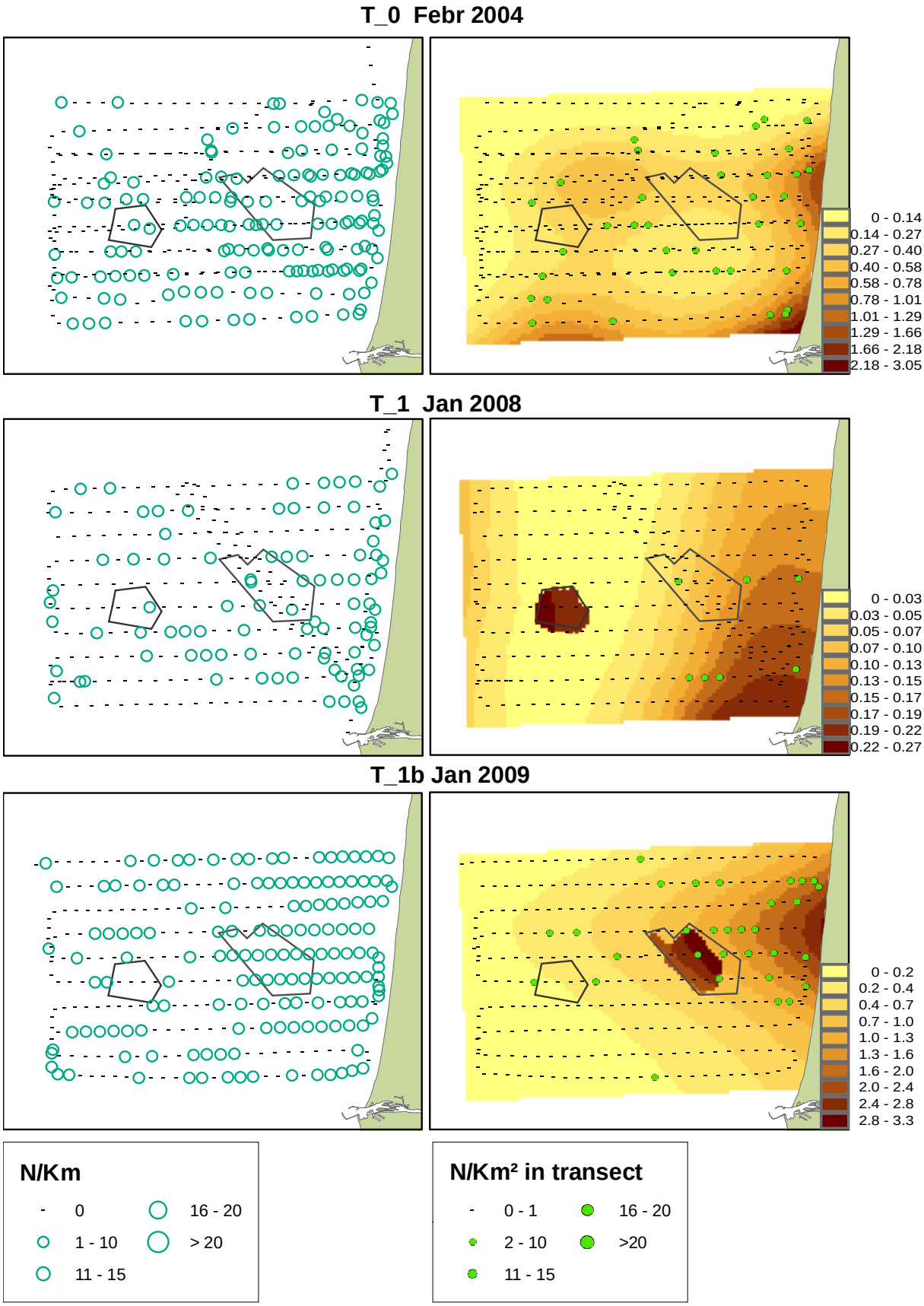
T_1b Sep 2008



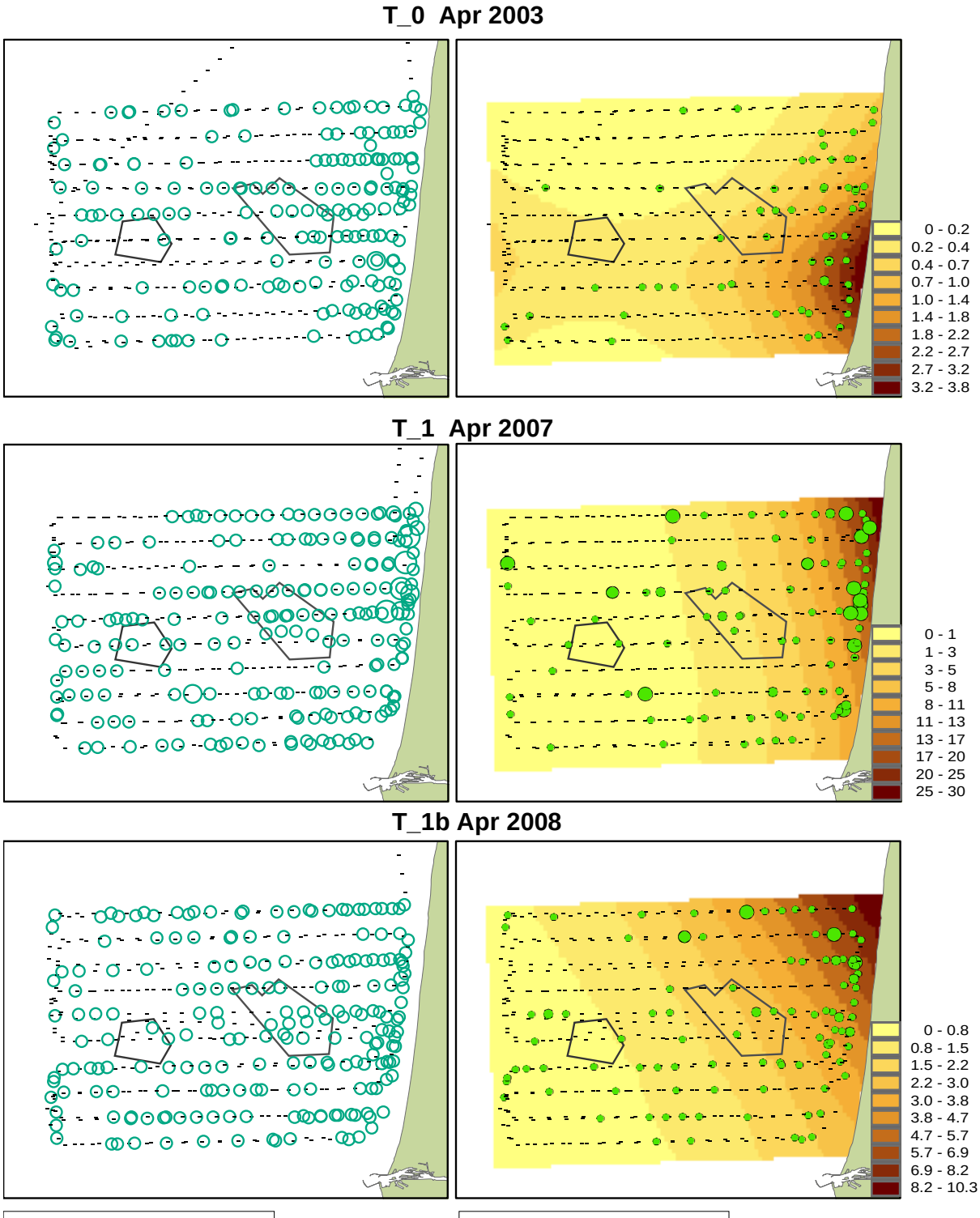
Black-headed Gull



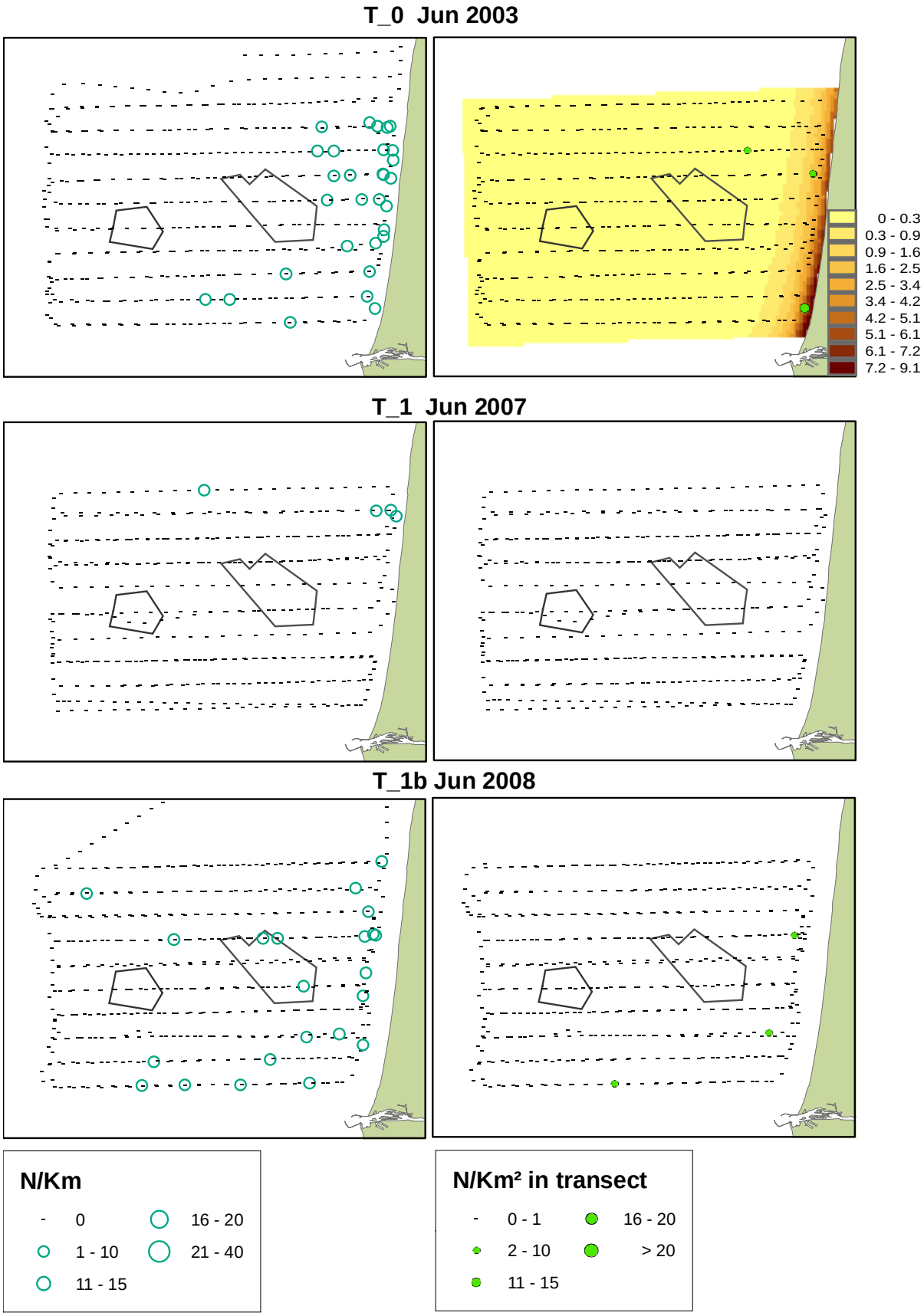
Common Gull


T_0 Febr 2004
0 - 0.14
0.14 - 0.27
0.27 - 0.40
0.40 - 0.58
0.58 - 0.78
0.78 - 1.01
1.01 - 1.29
1.29 - 1.66
1.66 - 2.18
2.18 - 3.05
T_1 Jan 2008
0 - 0.03
0.03 - 0.05
0.05 - 0.07
0.07 - 0.10
0.10 - 0.13
0.13 - 0.15
0.15 - 0.17
0.17 - 0.19
0.19 - 0.22
0.22 - 0.27
T_1b Jan 2009
0 - 0.2
0.2 - 0.4
0.4 - 0.7
0.7 - 1.0
1.0 - 1.3
1.3 - 1.6
1.6 - 2.0
2.0 - 2.4
2.4 - 2.8
2.8 - 3.3
N/Km
0
1 - 10
11 - 15
16 - 20
> 20
N/Km² in transect
0 - 1
2 - 10
11 - 15
16 - 20
>20

Common Gull

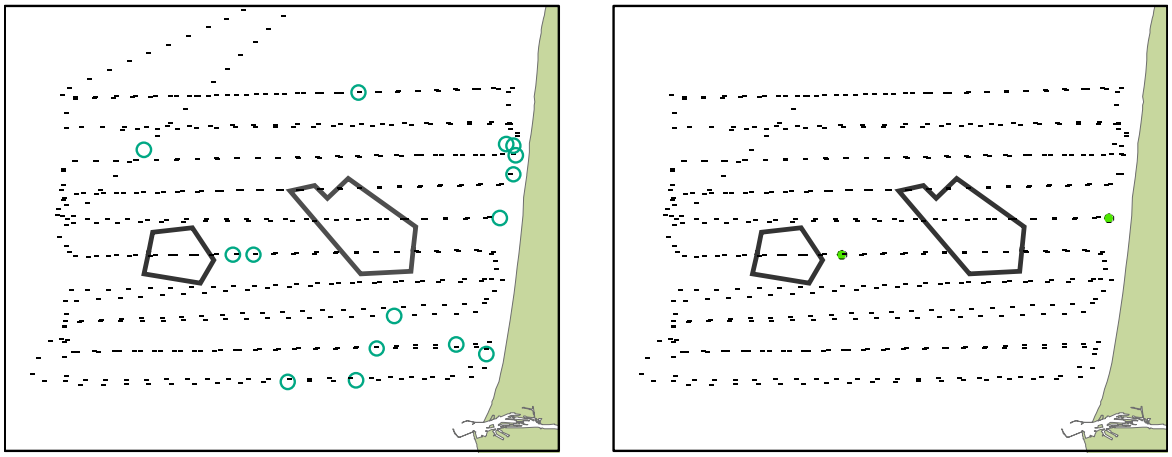

T_0 Apr 2003
0 - 0.2
0.2 - 0.4
0.4 - 0.7
0.7 - 1.0
1.0 - 1.4
1.4 - 1.8
1.8 - 2.2
2.2 - 2.7
2.7 - 3.2
3.2 - 3.8
T_1 Apr 2007
0 - 1
1 - 3
3 - 5
5 - 8
8 - 11
11 - 13
13 - 17
17 - 20
20 - 25
25 - 30
T_1b Apr 2008
0 - 0.8
0.8 - 1.5
1.5 - 2.2
2.2 - 3.0
3.0 - 3.8
3.8 - 4.7
4.7 - 5.7
5.7 - 6.9
6.9 - 8.2
8.2 - 10.3
N/Km
0
1 - 10
11 - 15
16 - 20
> 20
N/Km² in transect
0 - 1
2 - 10
11 - 15
16 - 20
>20

Common Gull

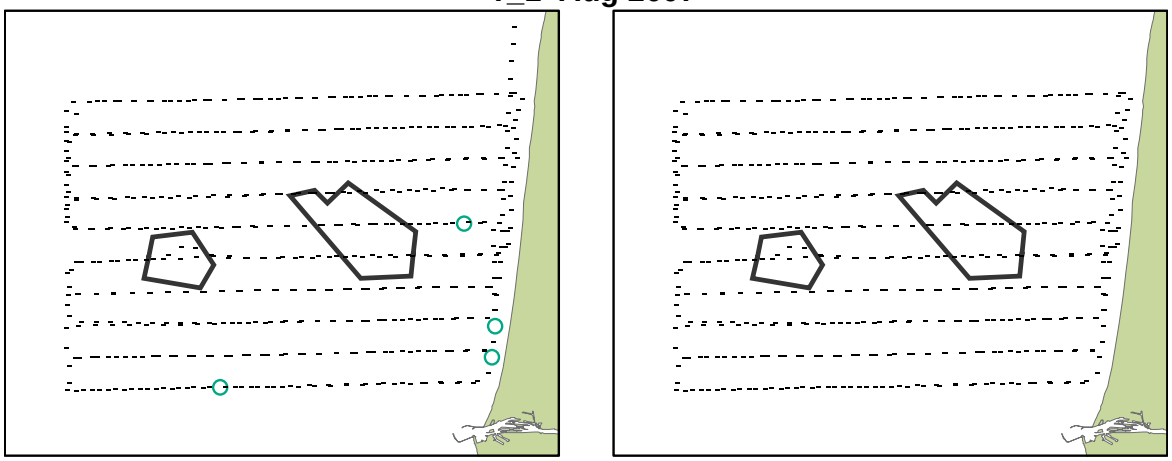

T_0 Jun 2003
0 - 0.3
0.3 - 0.9
0.9 - 1.6
1.6 - 2.5
2.5 - 3.4
3.4 - 4.2
4.2 - 5.1
5.1 - 6.1
6.1 - 7.2
7.2 - 9.1
T_1 Jun 2007
T_1b Jun 2008
N/Km
0
1 - 10
11 - 15
16 - 20
21 - 40
N/Km² in transect
0 - 1
2 - 10
11 - 15
16 - 20
> 20

Common Gull

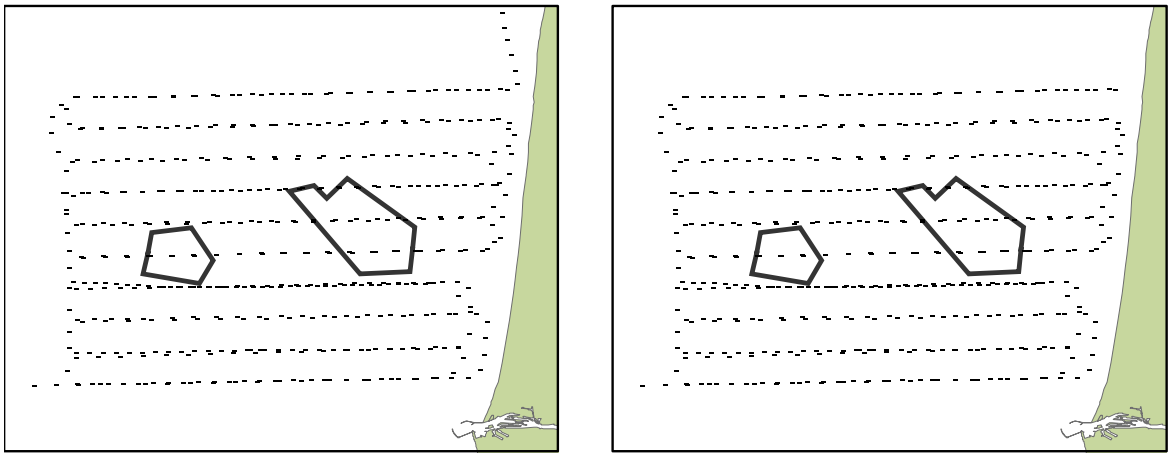
T_0 Aug 2003



T_1 Aug 2007

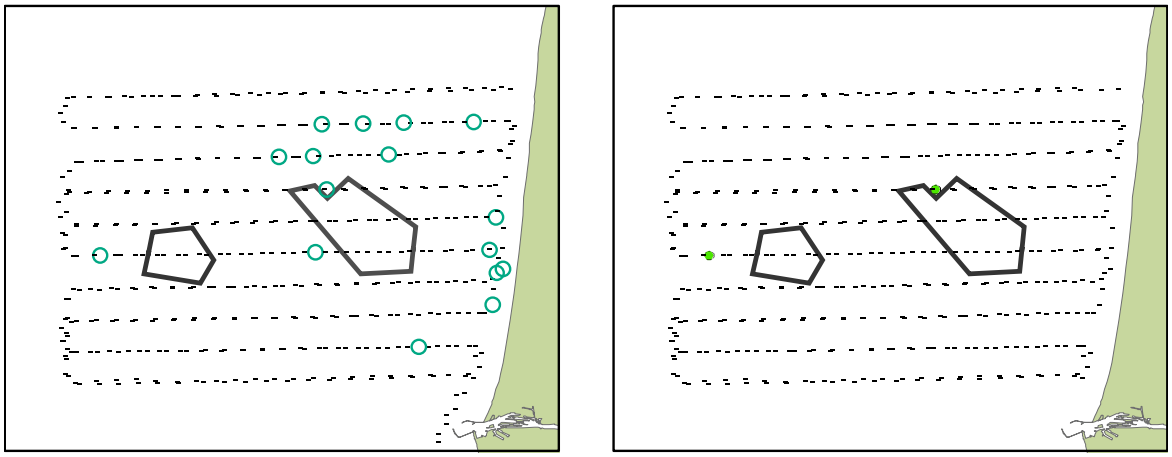


T_1b Aug 2008

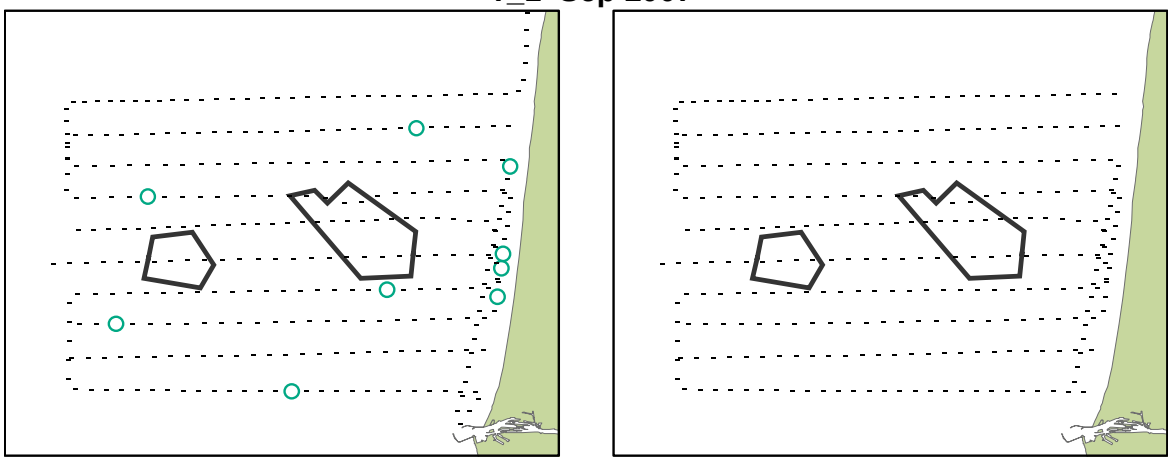


Common Gull

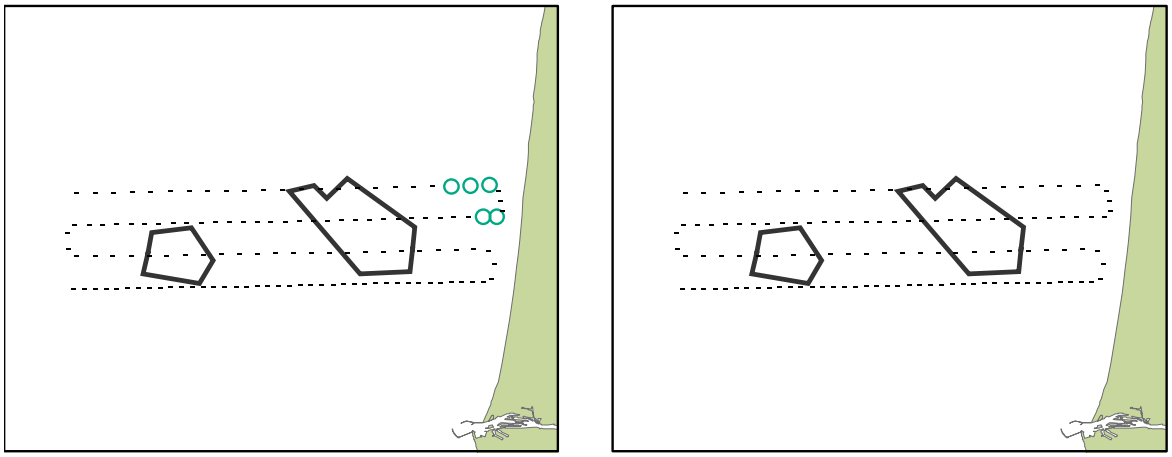
T_0 Sep 2002



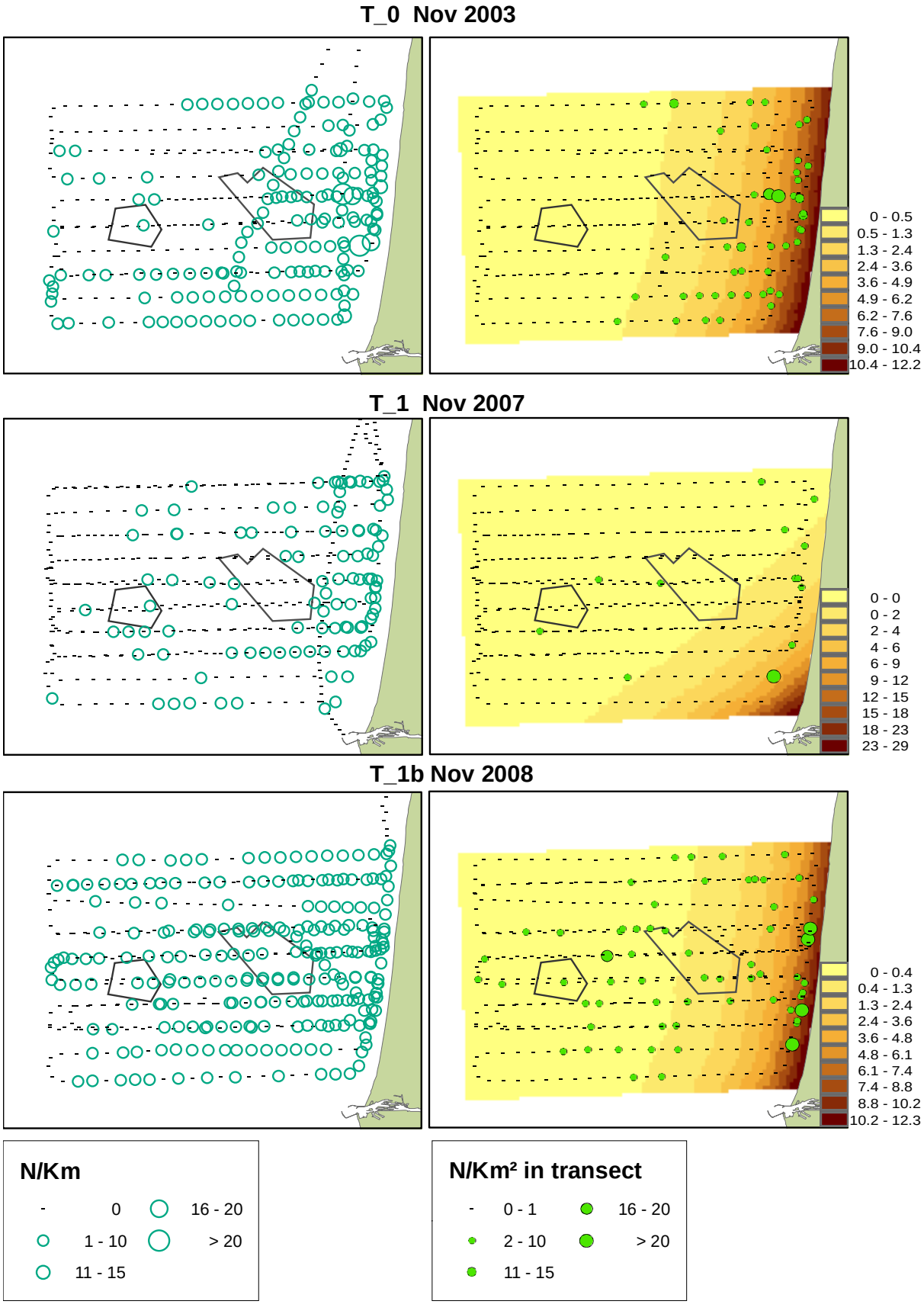
T_1 Sep 2007



T_1b Sep 2008

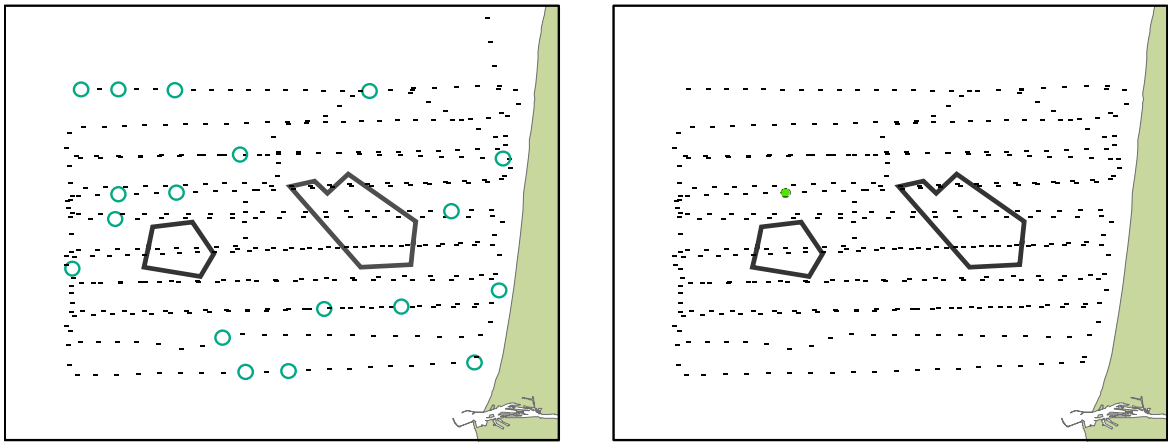


Common Gull

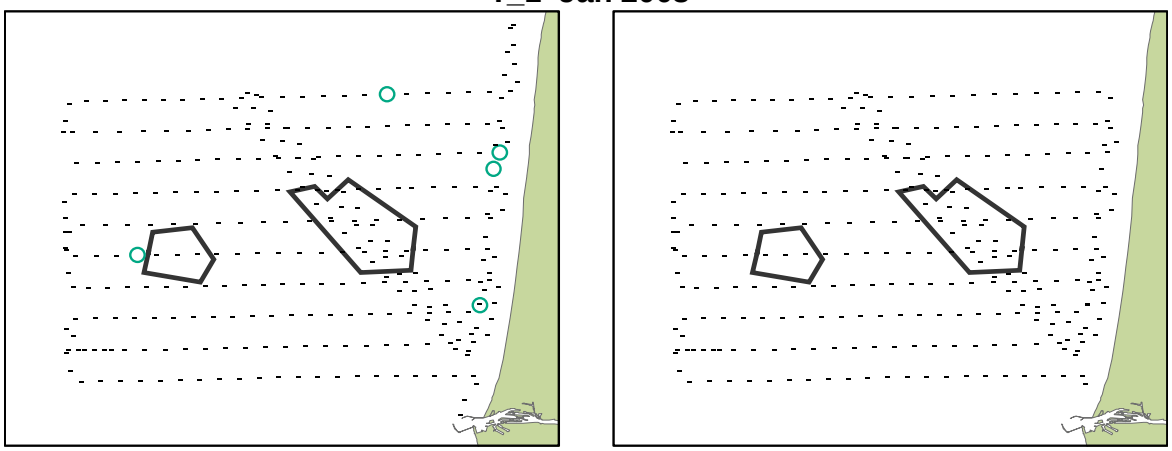

T_0 Nov 2003
0 - 0.5
0.5 - 1.3
1.3 - 2.4
2.4 - 3.6
3.6 - 4.9
4.9 - 6.2
6.2 - 7.6
7.6 - 9.0
9.0 - 10.4
10.4 - 12.2
T_1 Nov 2007
0 - 0
0 - 2
2 - 4
4 - 6
6 - 9
9 - 12
12 - 15
15 - 18
18 - 23
23 - 29
T_1b Nov 2008
0 - 0.4
0.4 - 1.3
1.3 - 2.4
2.4 - 3.6
3.6 - 4.8
4.8 - 6.1
6.1 - 7.4
7.4 - 8.8
8.8 - 10.2
10.2 - 12.3
N/Km
0
1 - 10
11 - 15
16 - 20
> 20
N/Km² in transect
0 - 1
2 - 10
11 - 15
16 - 20
> 20

Lesser Black-backed Gull

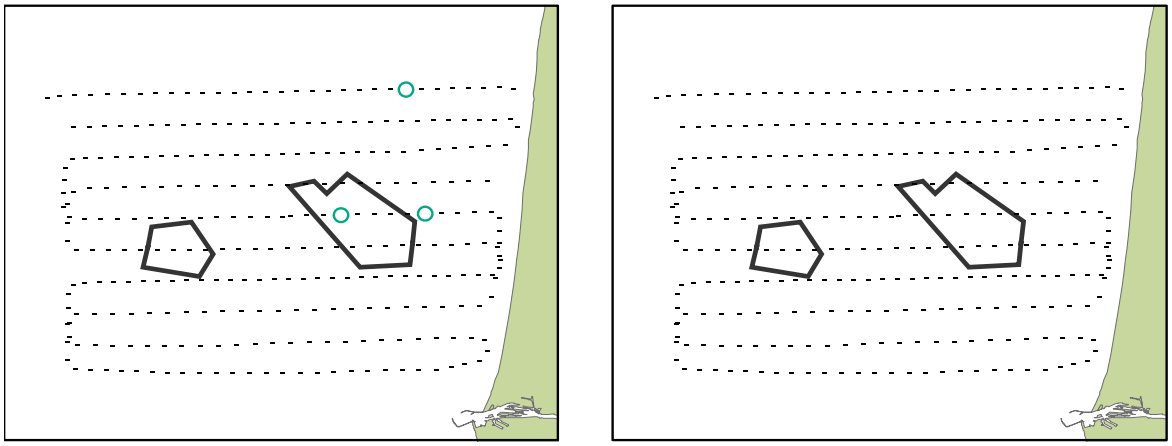
T_0 Febr 2004



T_1 Jan 2008

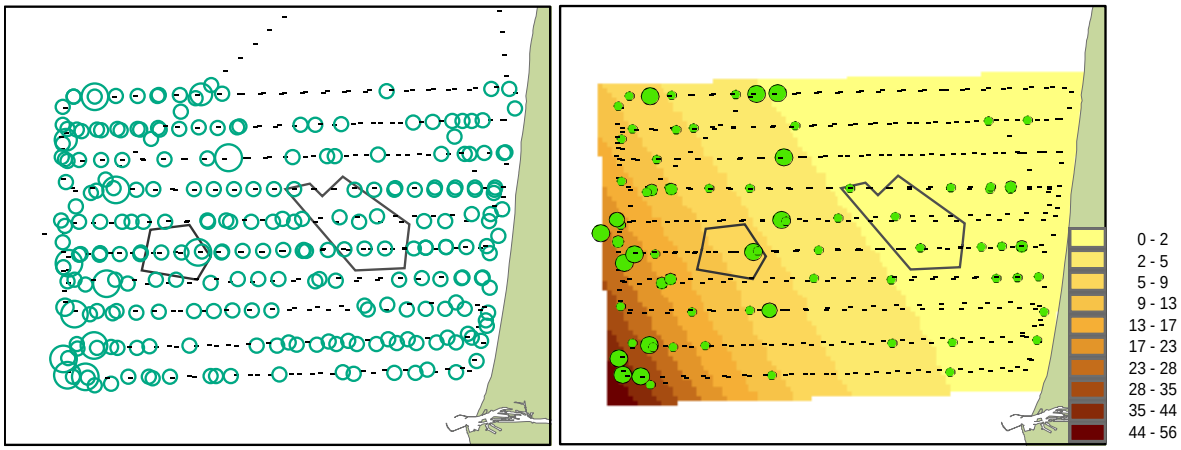


T_1b Jan 2009

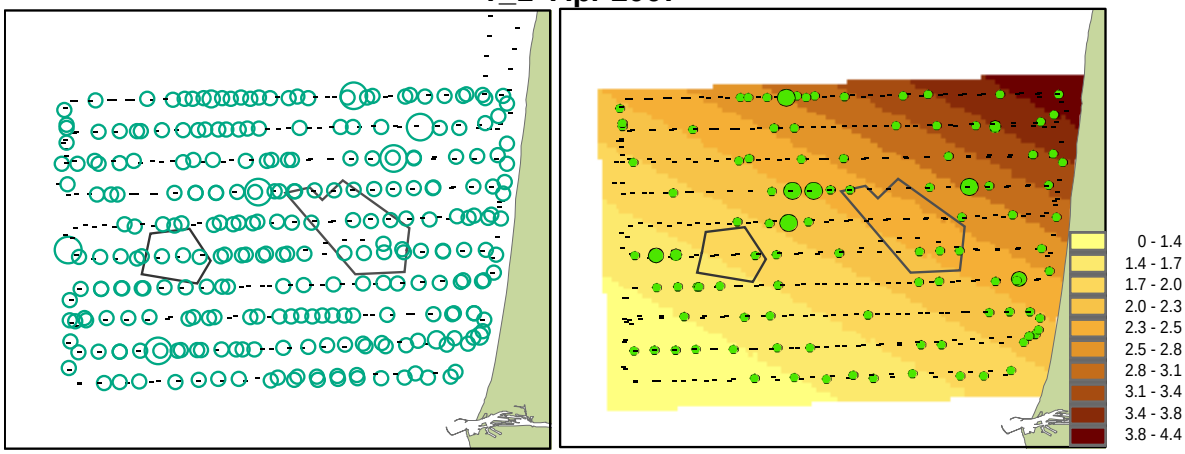


Lesser Black-backed Gull

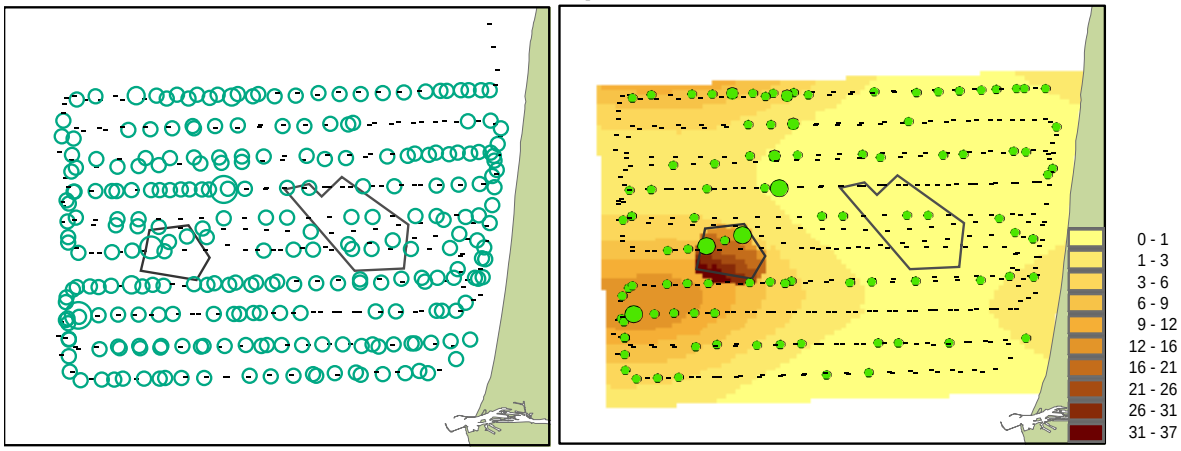
T_0 Apr 2003

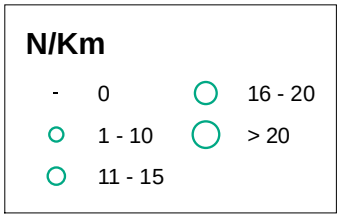


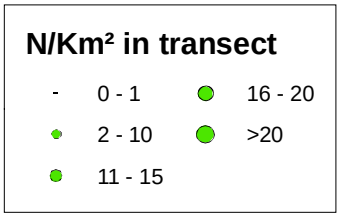
T_1 Apr 2007



T_1b Apr 2008

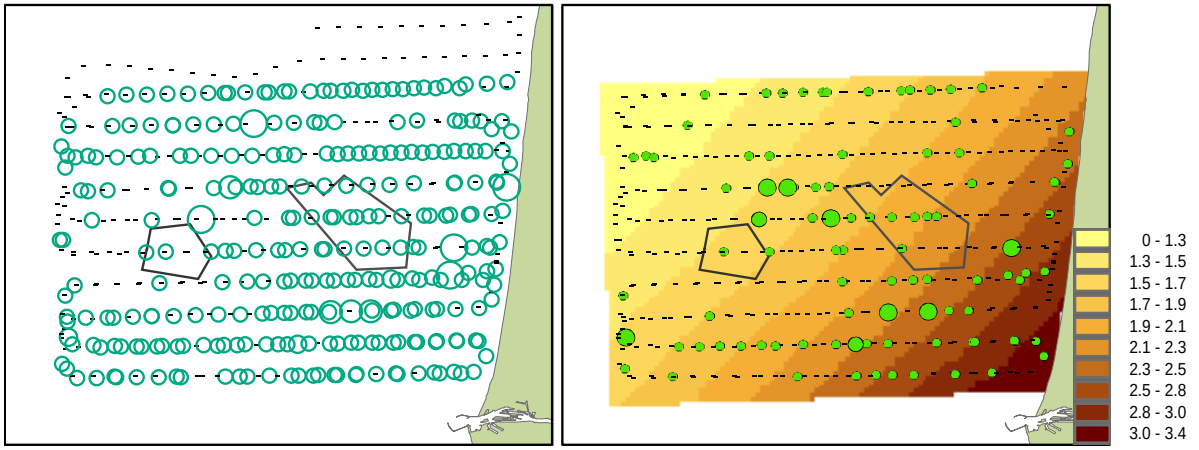




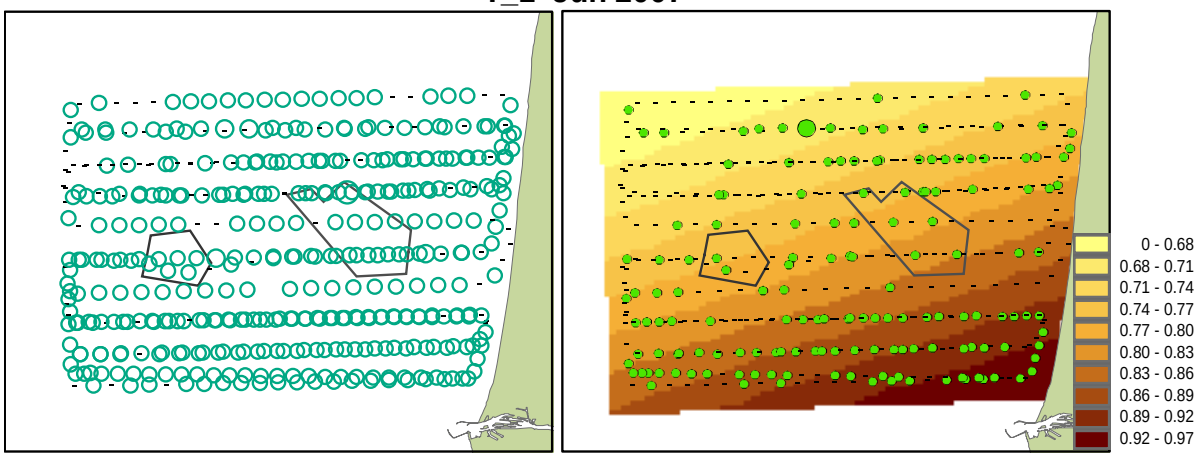


Lesser Black-backed Gull

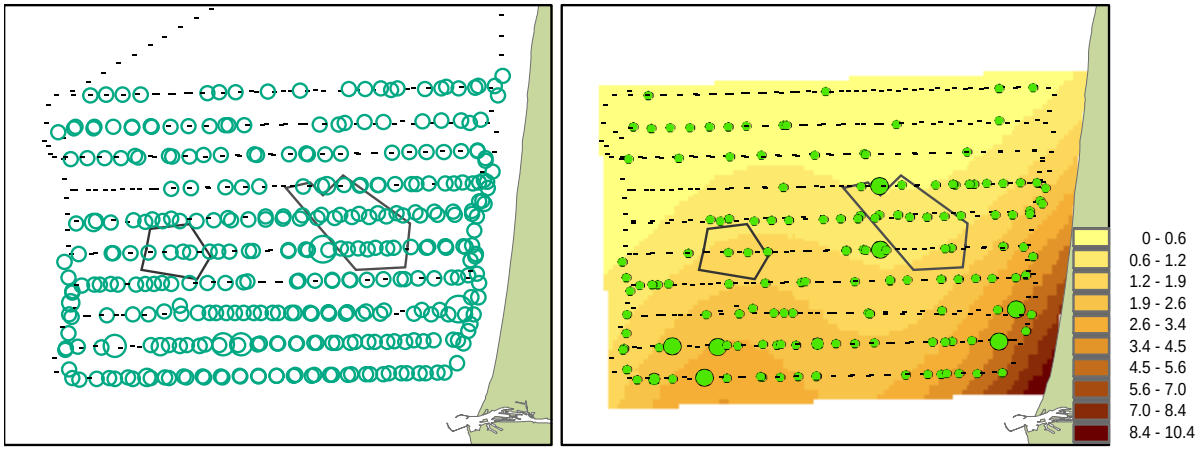
T_0 Jun 2003

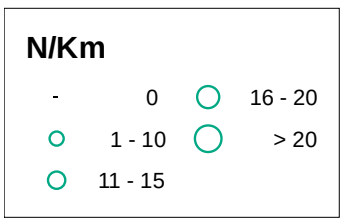


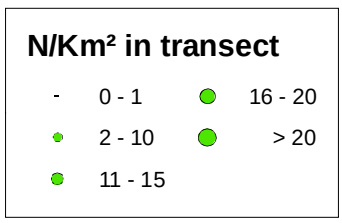
T_1 Jun 2007



T_1b Jun 2008

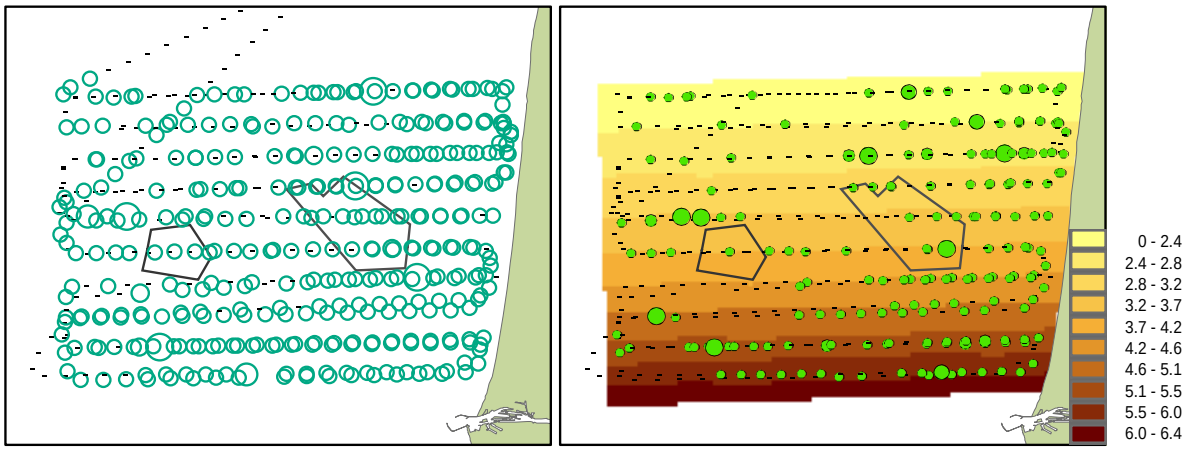




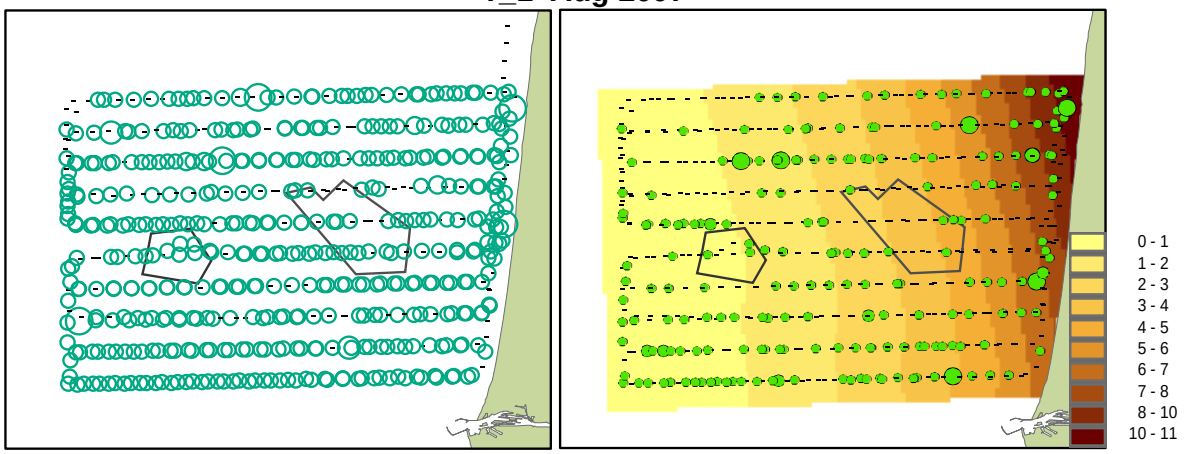


Lesser Black-backed Gull

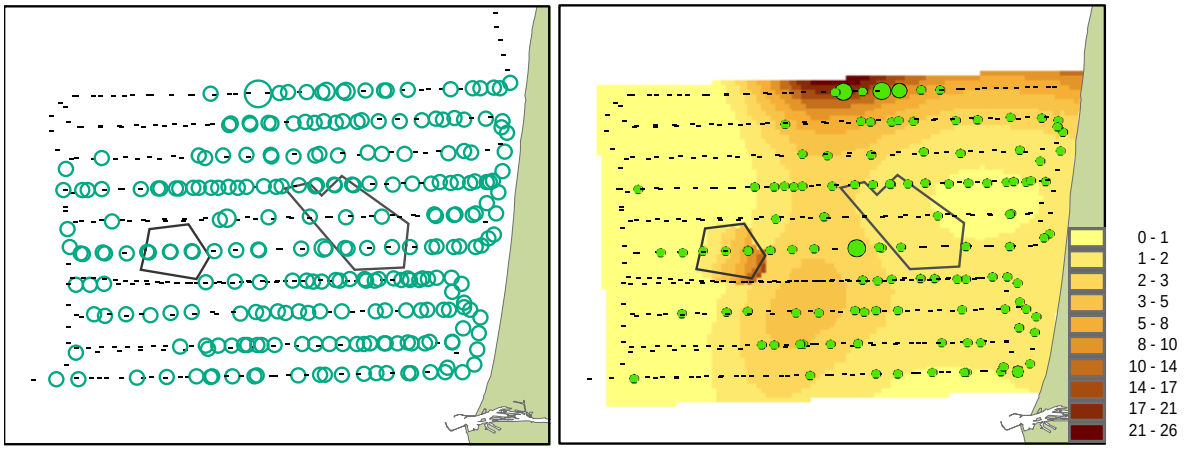
T_0 Aug 2003



T_1 Aug 2007

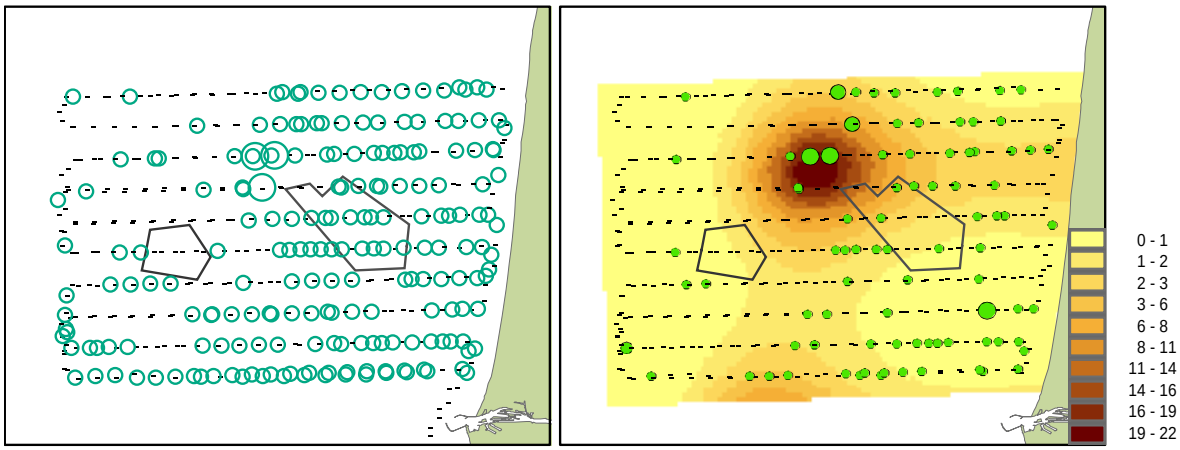


T_1b Aug 2008

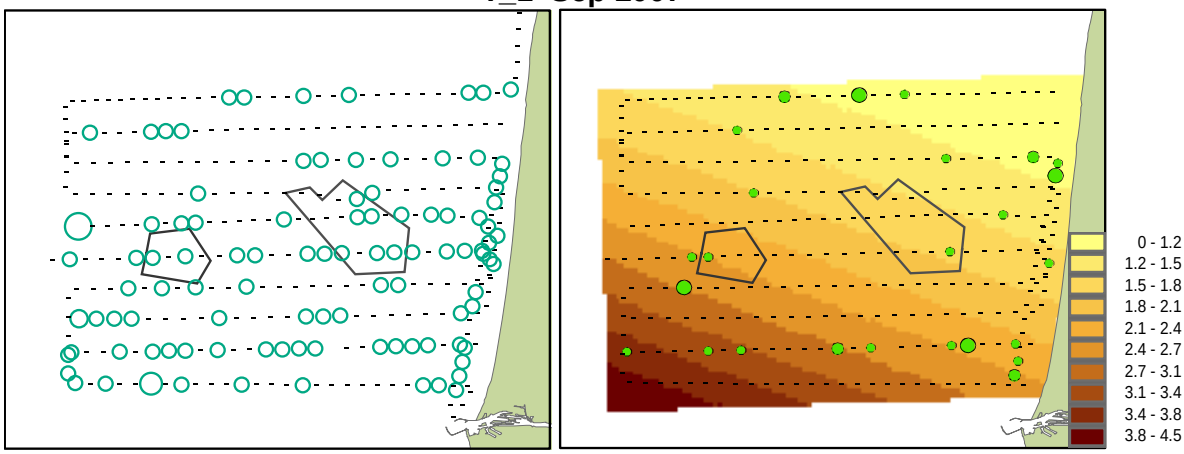


Lesser Black-backed Gull

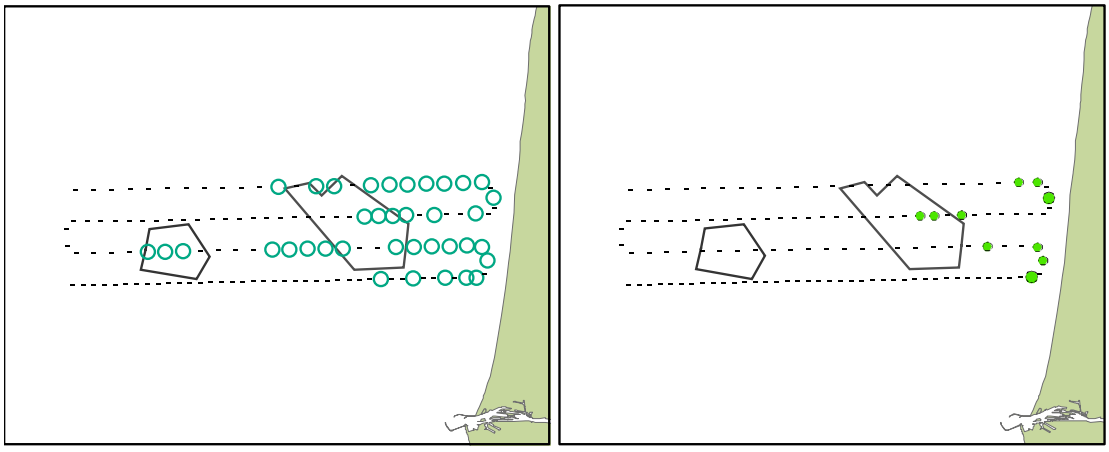
T_0 Sep 2002



T_1 Sep 2007

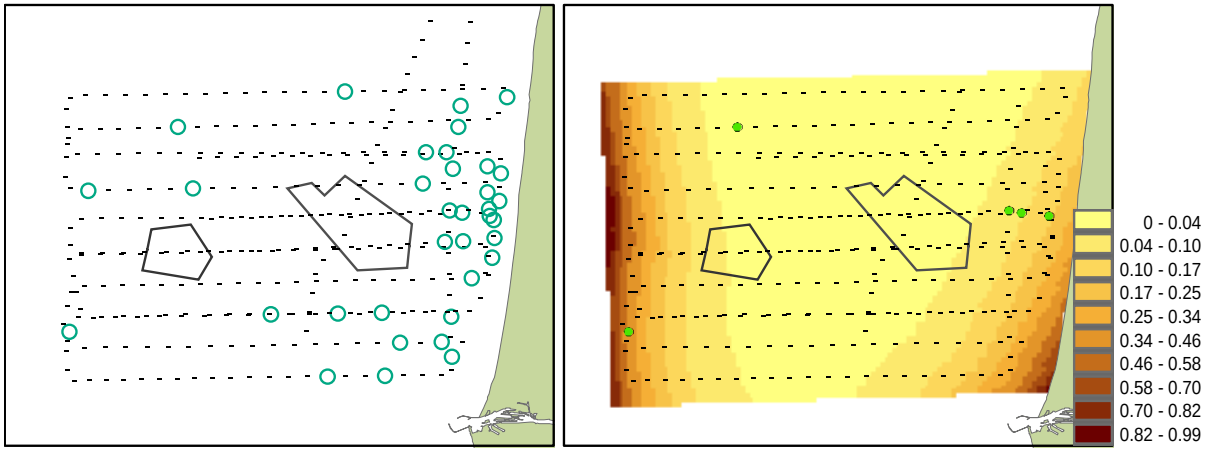


T_1b Sep 2008

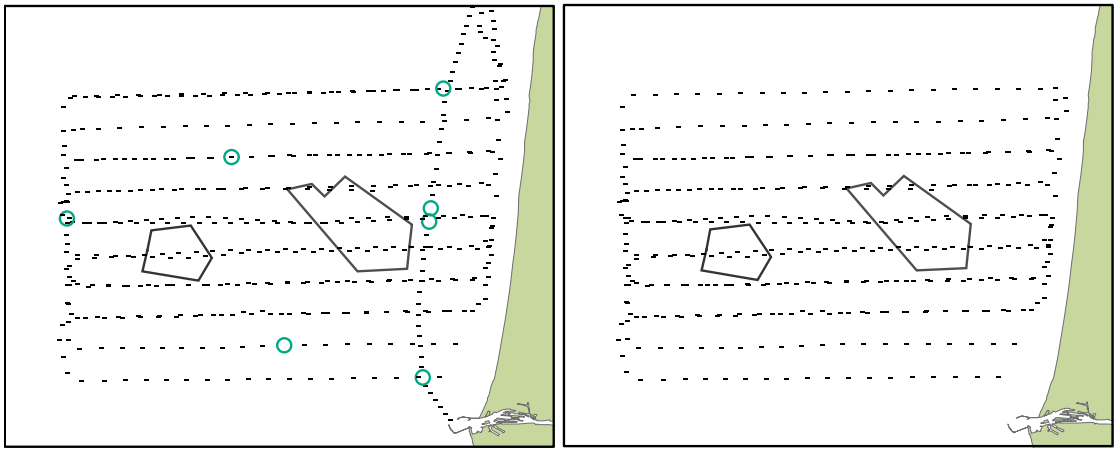


Lesser Black-backed Gull

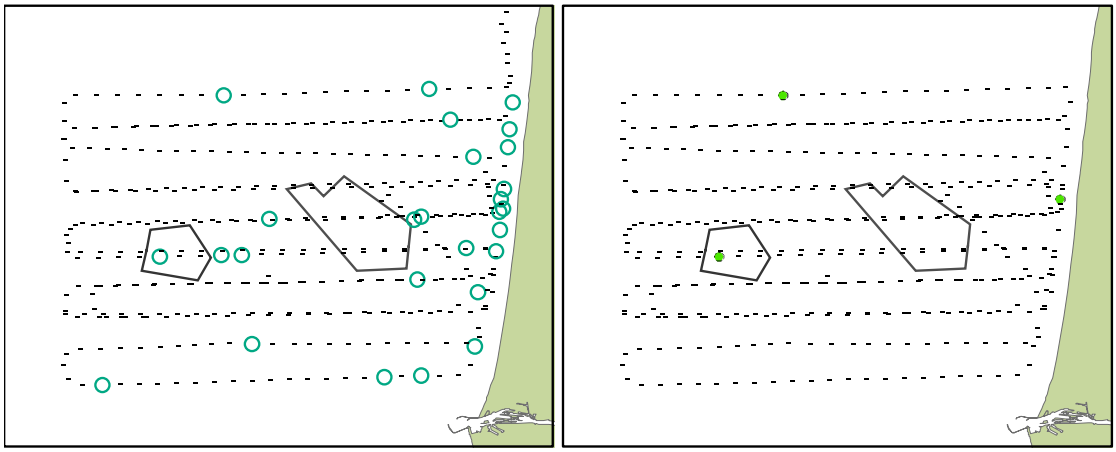
T_0 Nov 2003



T_1 Nov 2007



T_1b Nov 2008



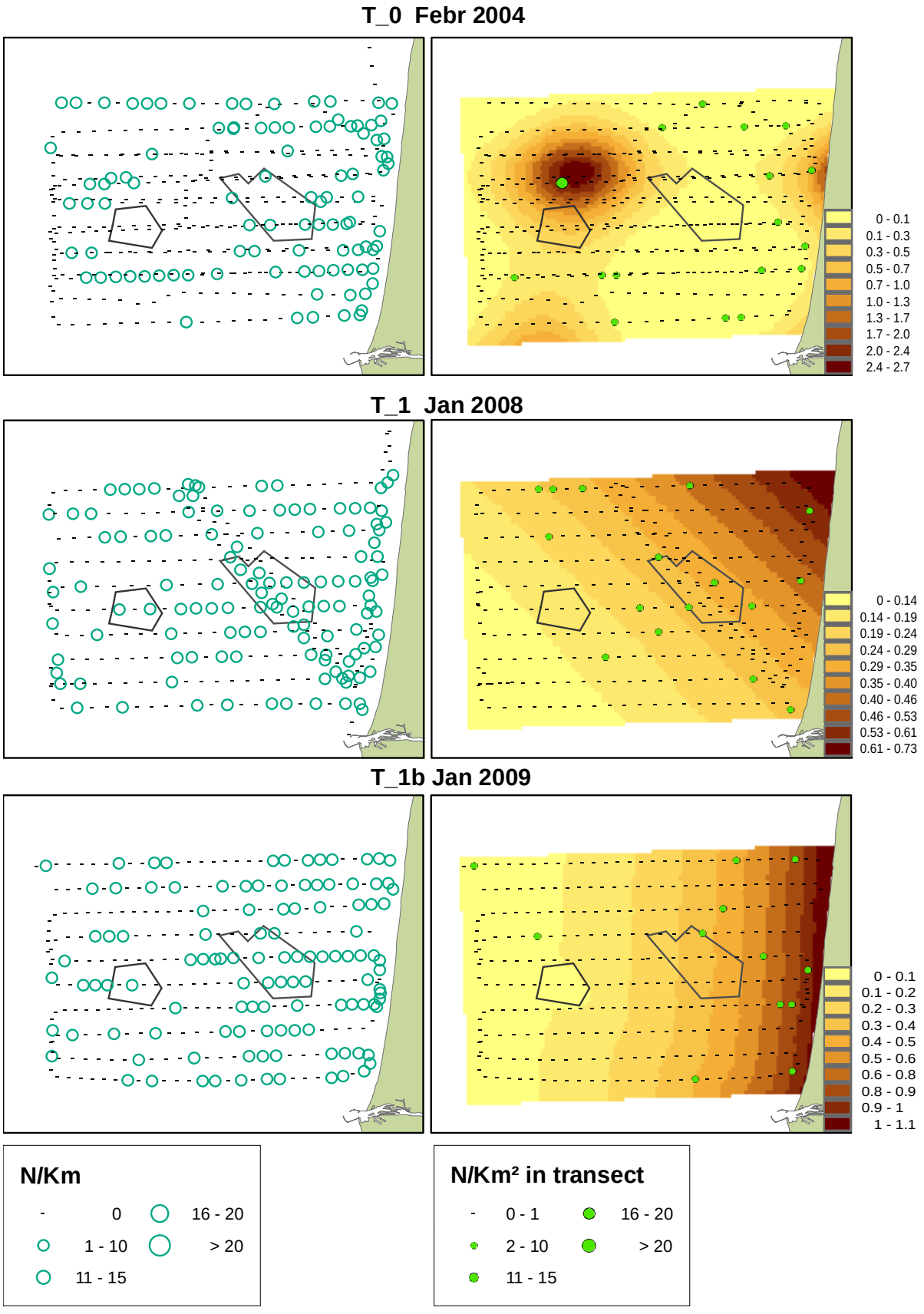
N/Km

- 0
- 1 - 10
- 11 - 15
- 16 - 20
- > 20

N/Km² in transect

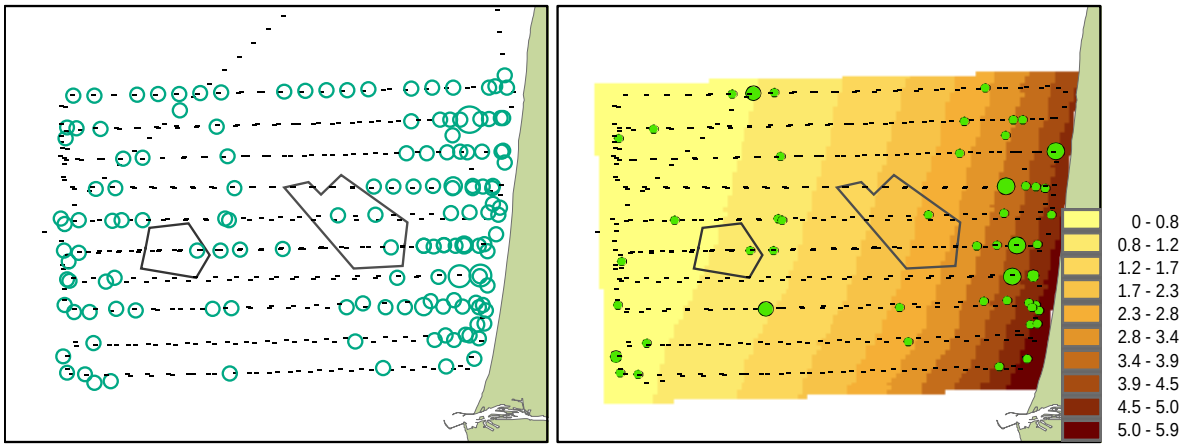
- 0 - 1
- 2 - 10
- 11 - 15
- 16 - 20
- > 20

Herring Gull

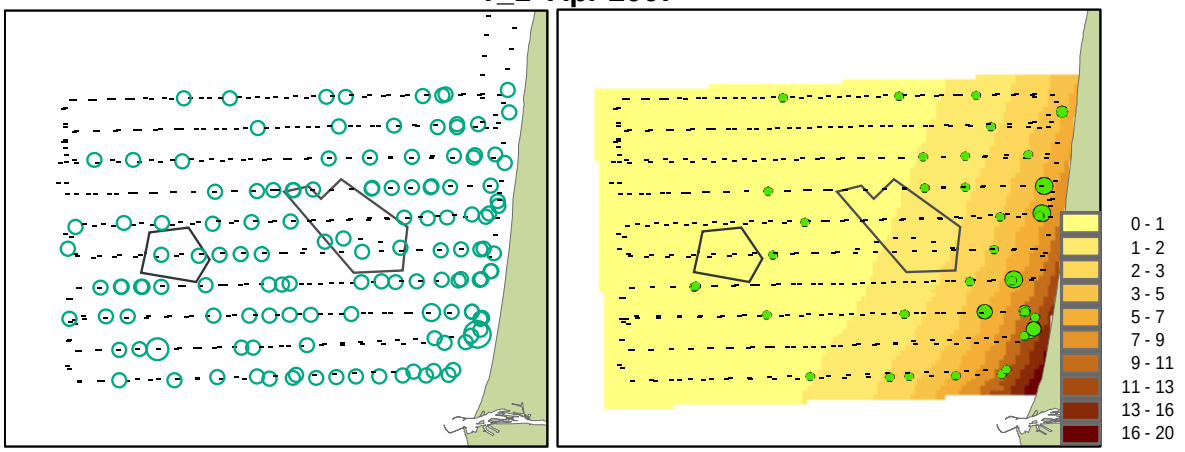


Herring Gull

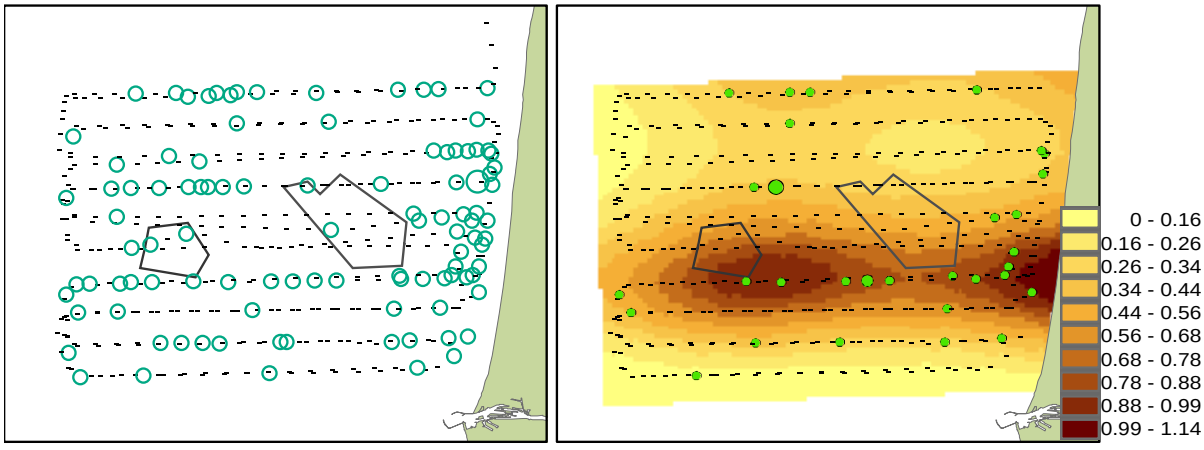
T_0 Apr 2003



T_1 Apr 2007



T_1b Apr 2008



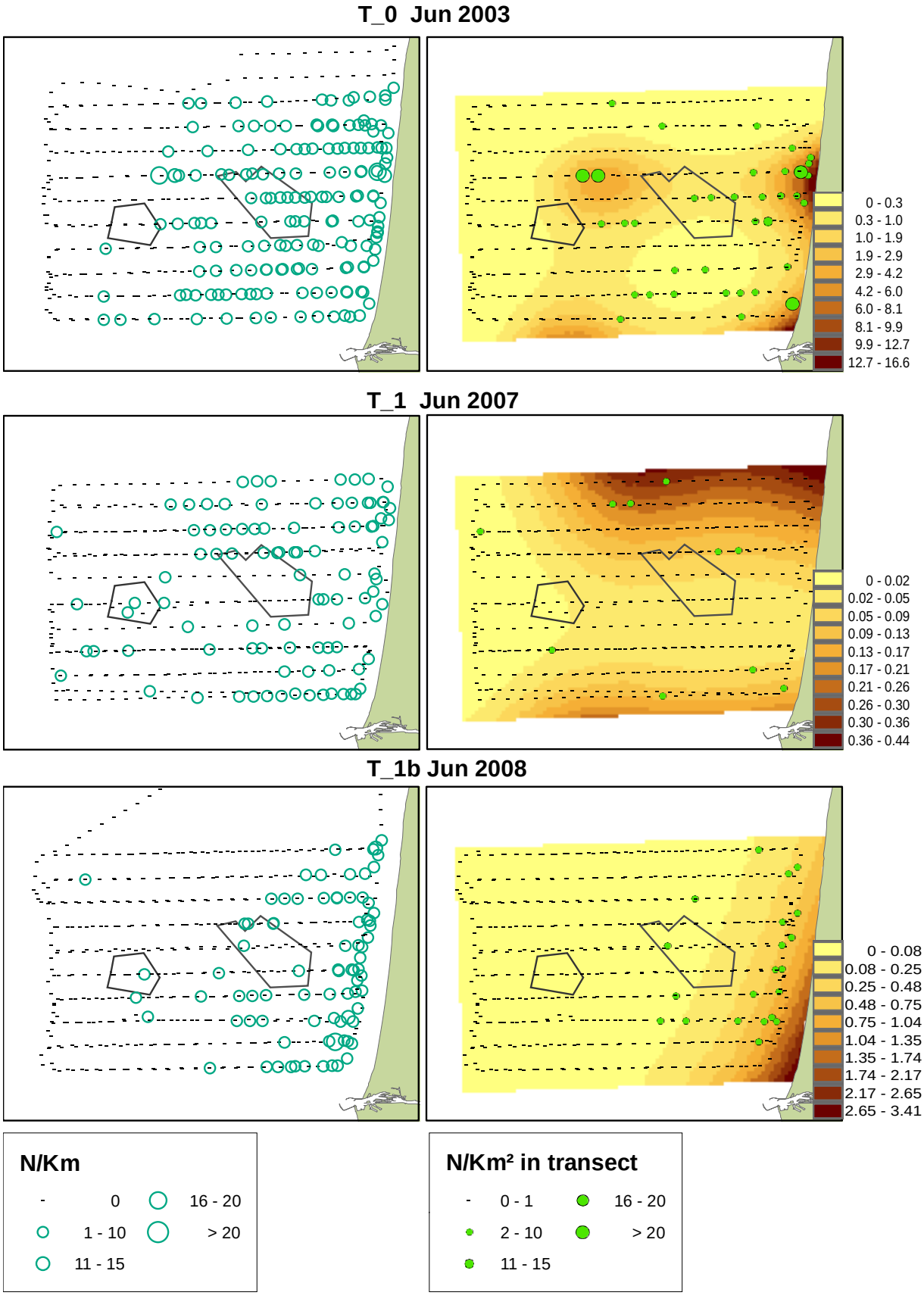
N/Km

0	16 - 20
1 - 10	> 20
11 - 15	

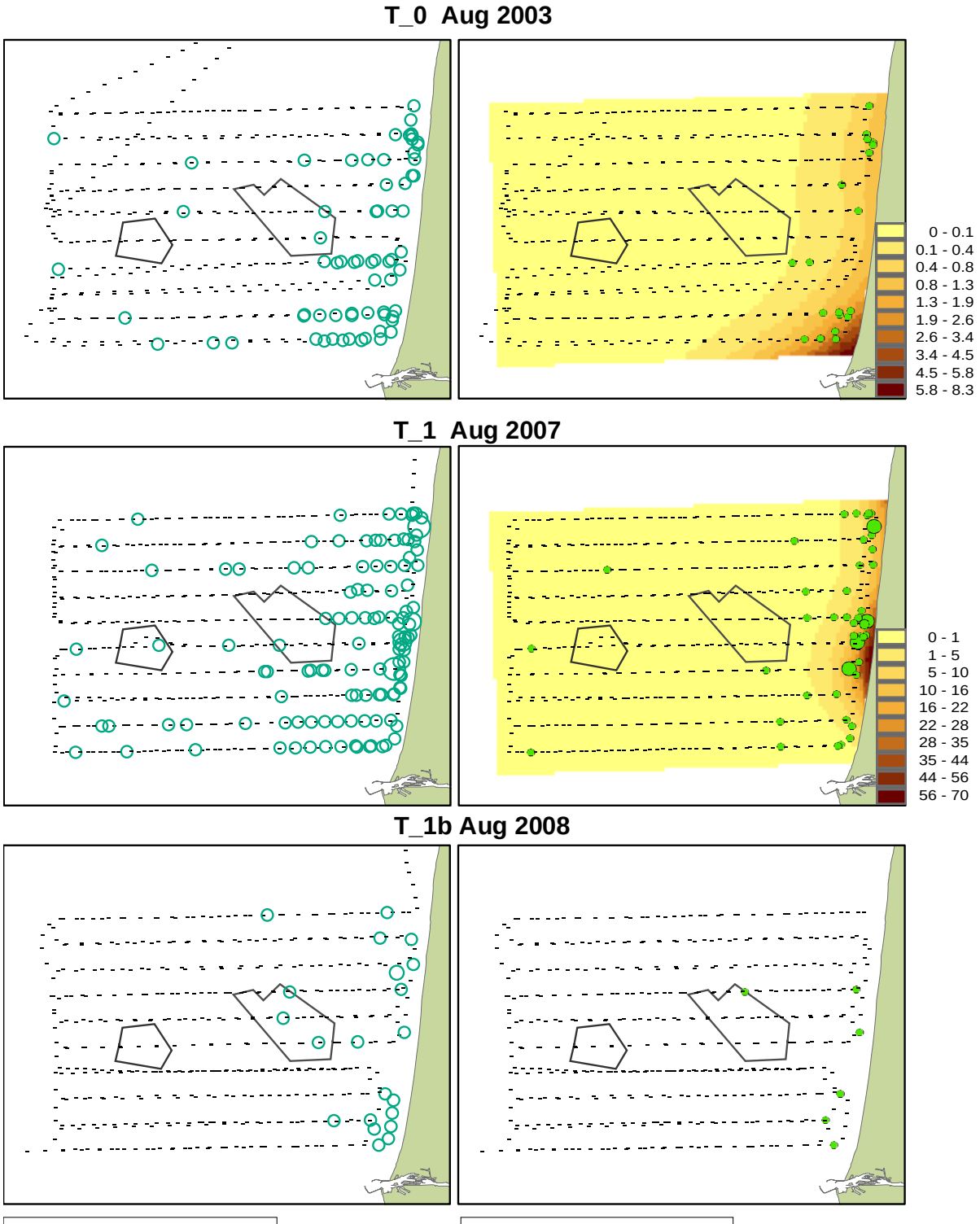
N/Km² in transect

0 - 1	16 - 20
2 - 10	> 20
11 - 15	

Herring Gull

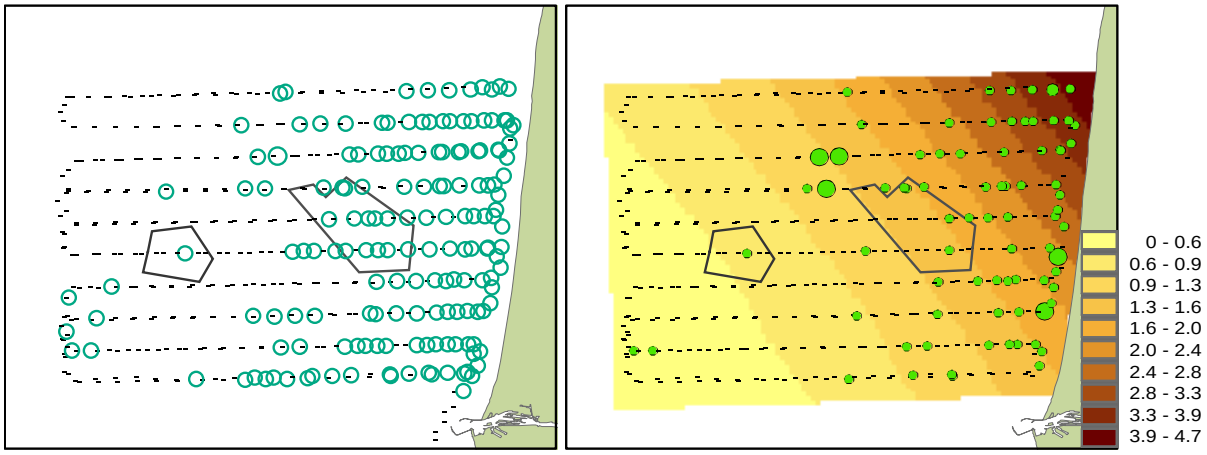


Herring Gull

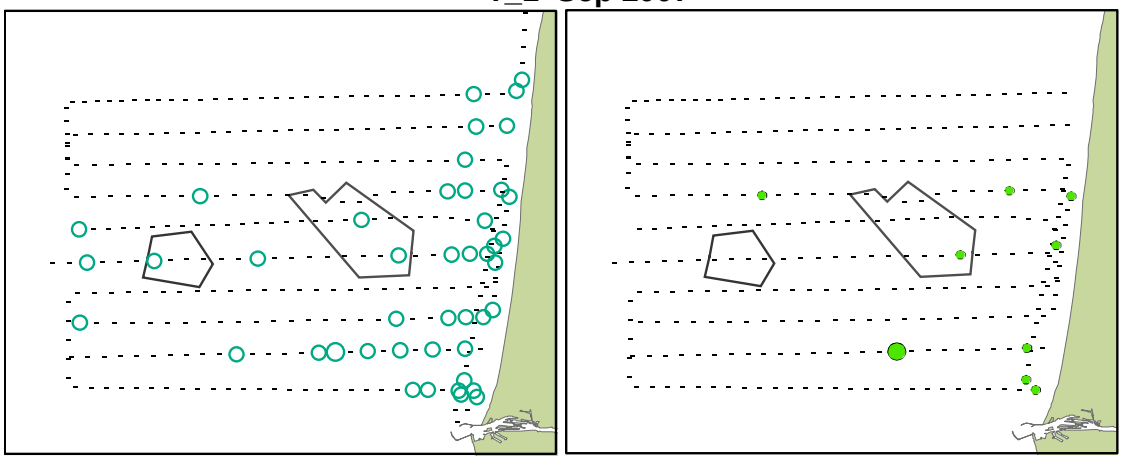


Herring Gull

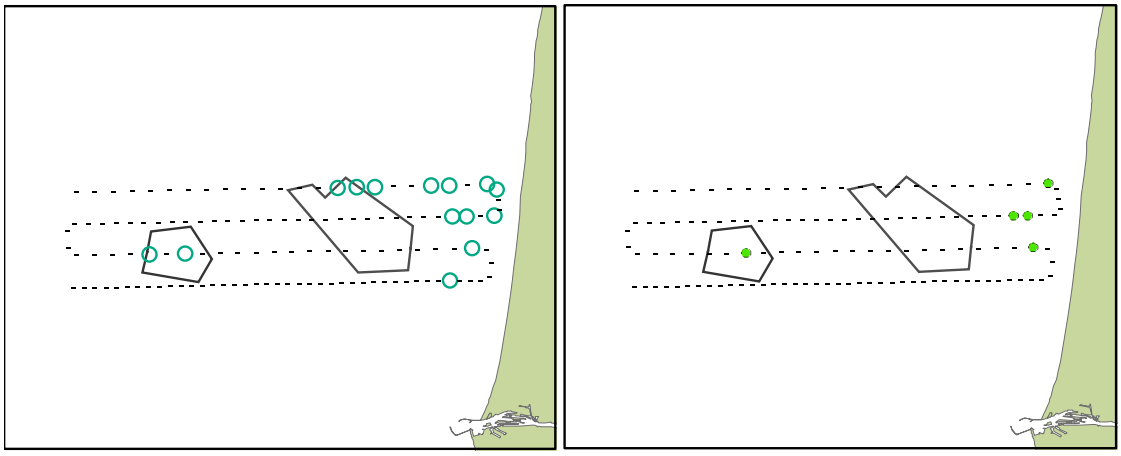
T_0 Sep 2002



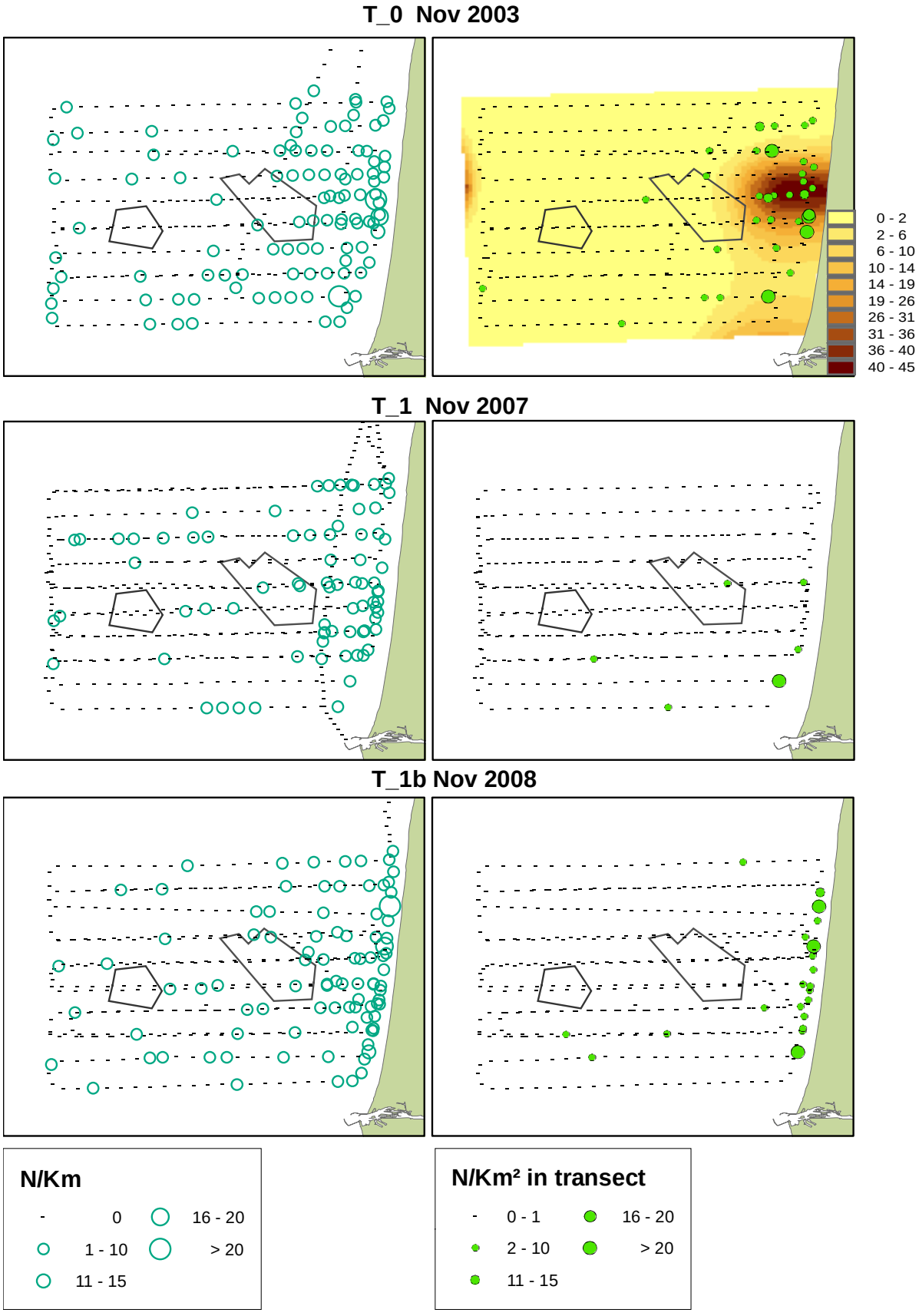
T_1 Sep 2007



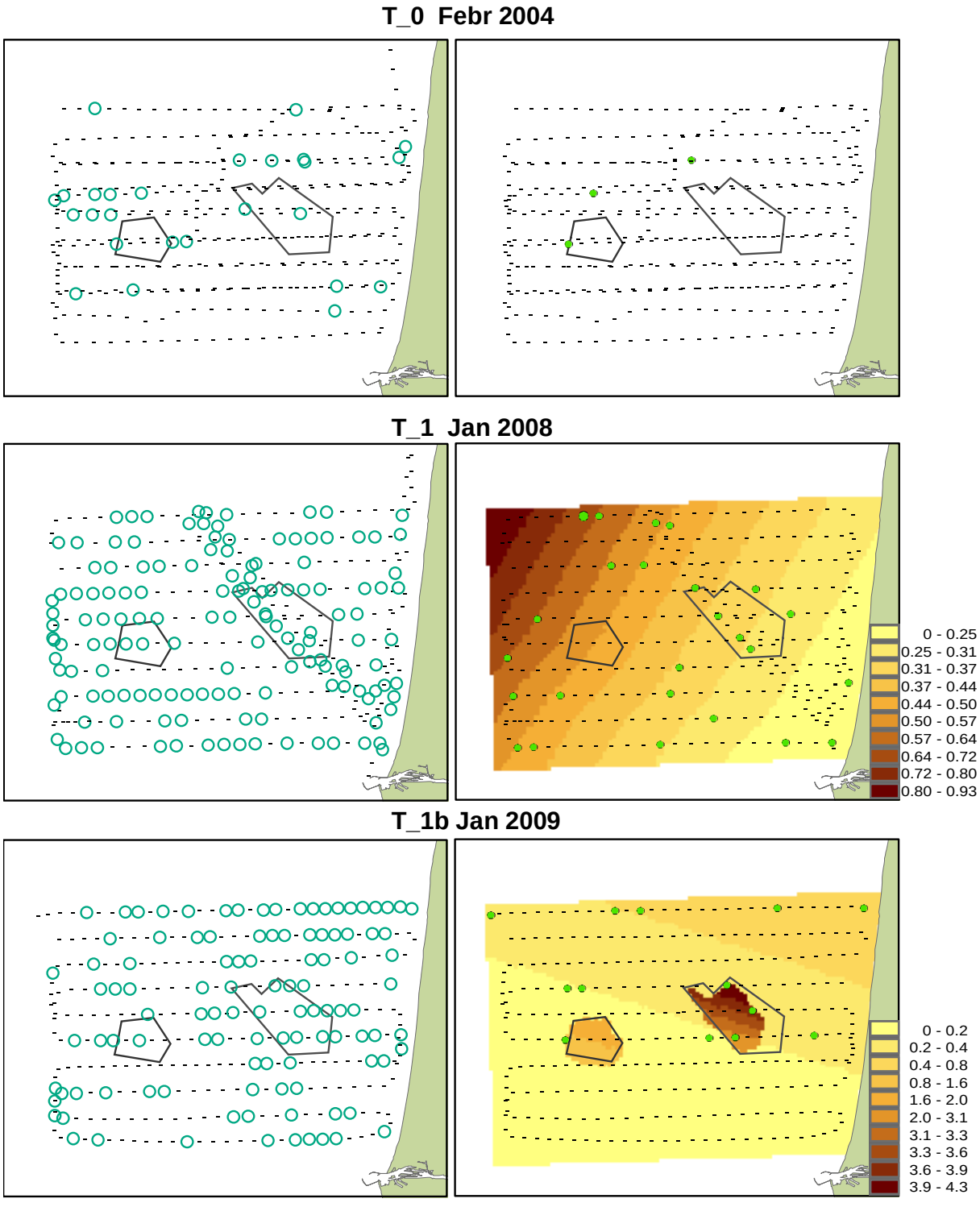
T_1b Sep 2008



Herring Gull

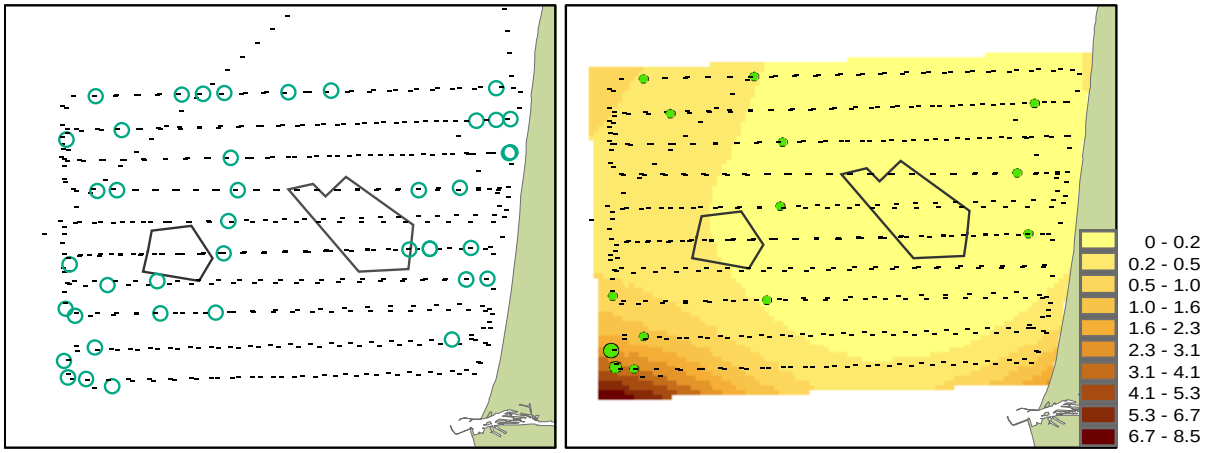


Greater Black-backed Gull

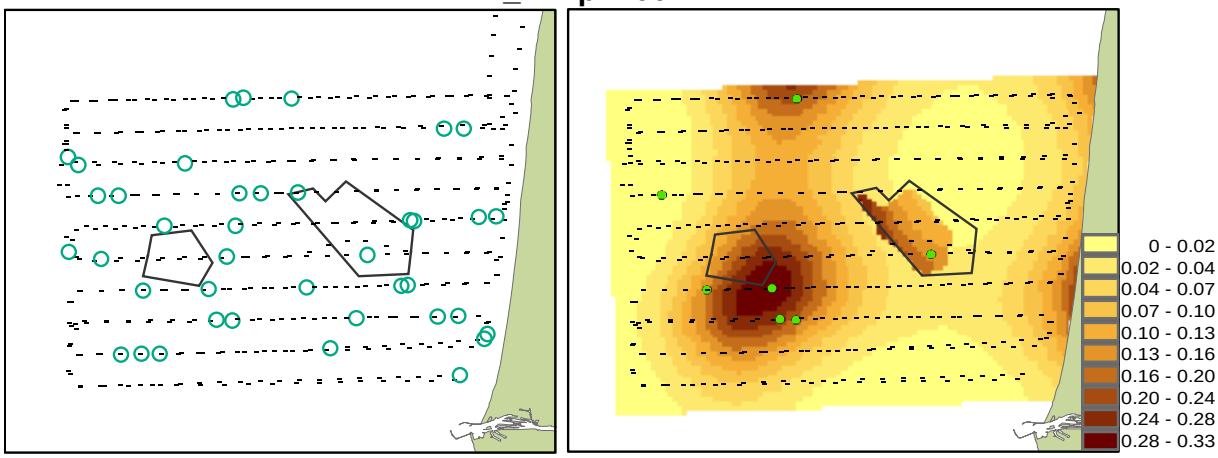


Greater Black-backed Gull

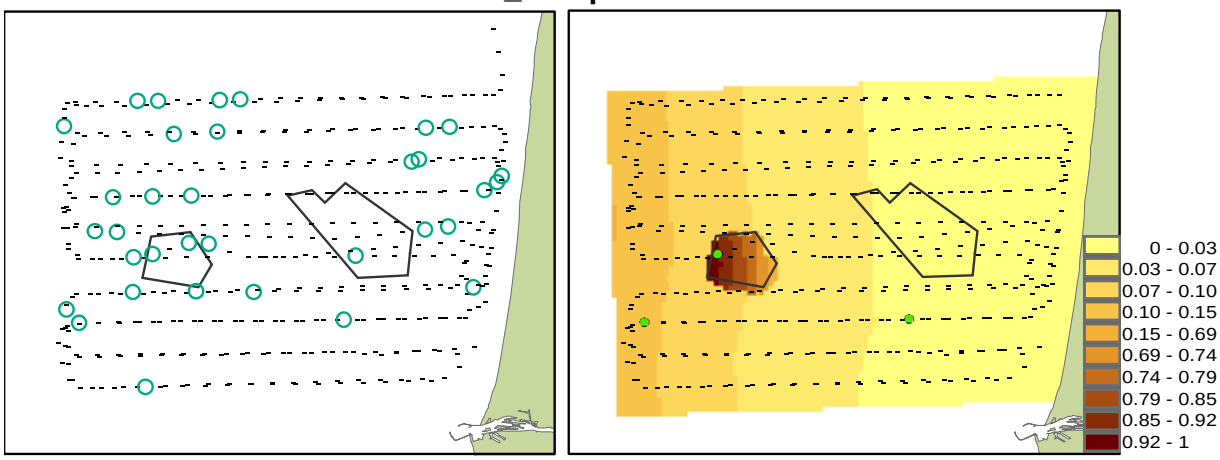
T_0 Apr 2003

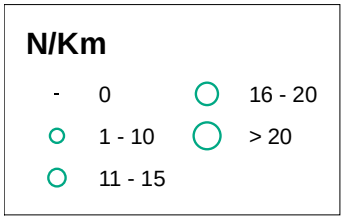


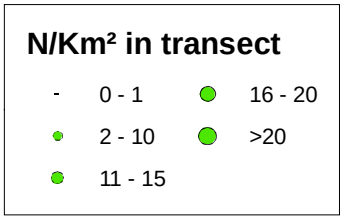
T_1 Apr 2007



T_1b Apr 2008

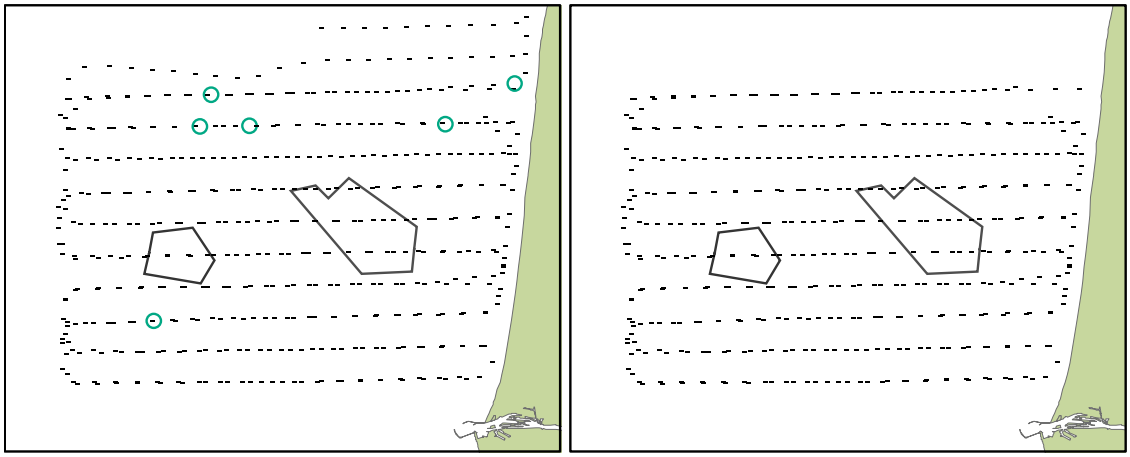




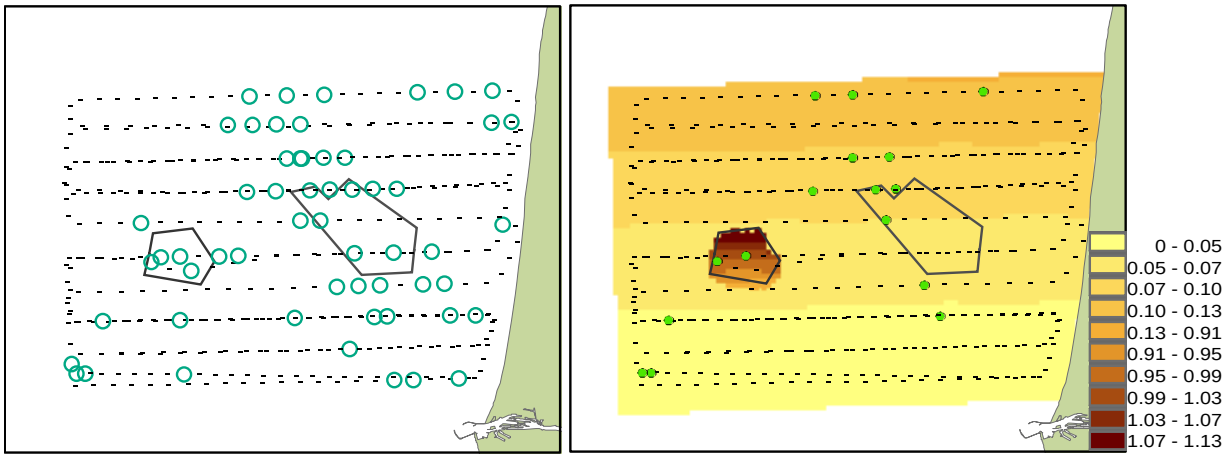


Greater Black-backed Gull

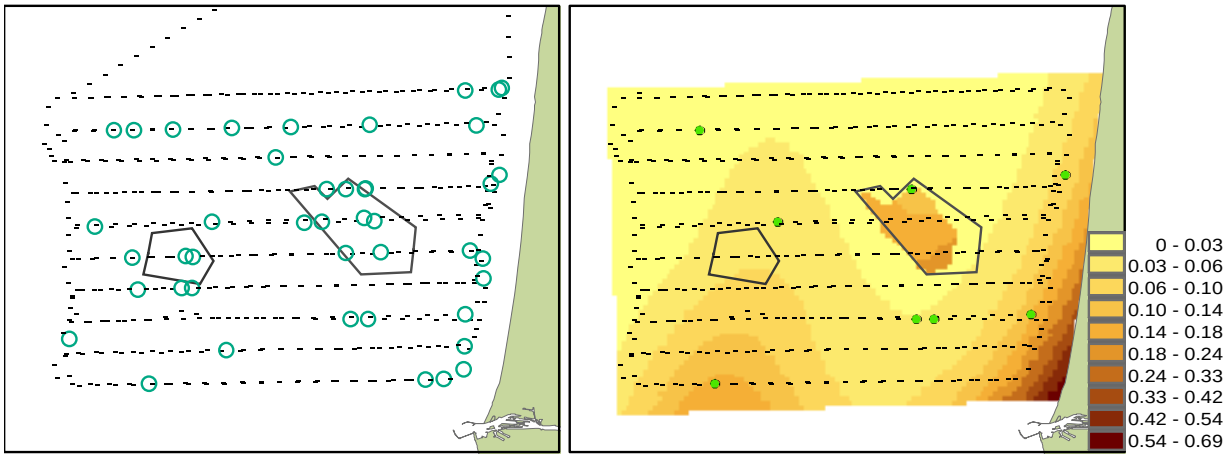
T_0 Jun 2003

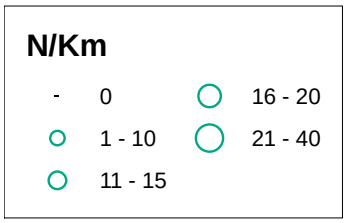


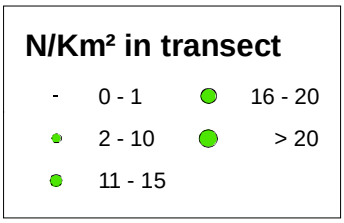
T_1 Jun 2007



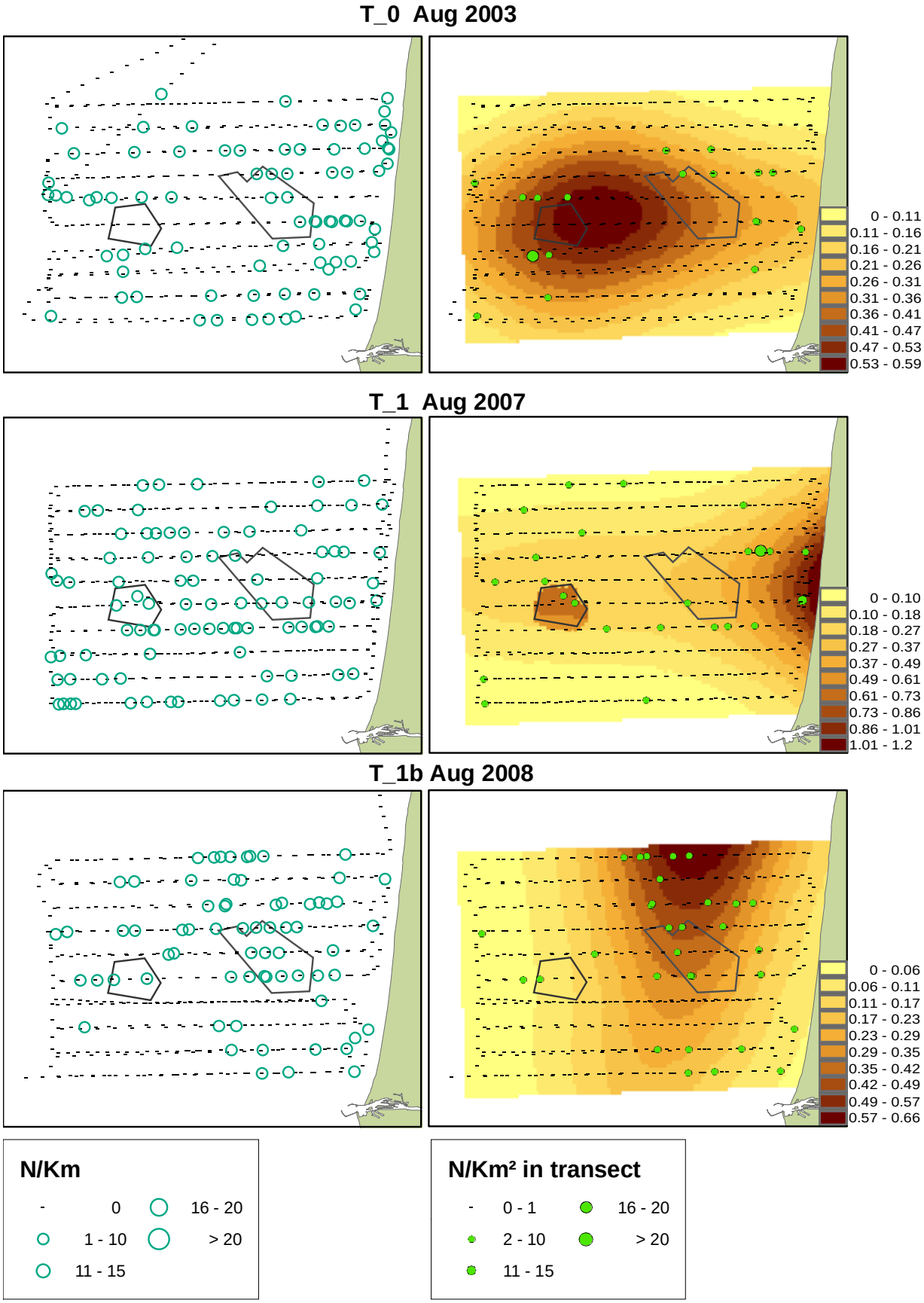
T_1b Jun 2008



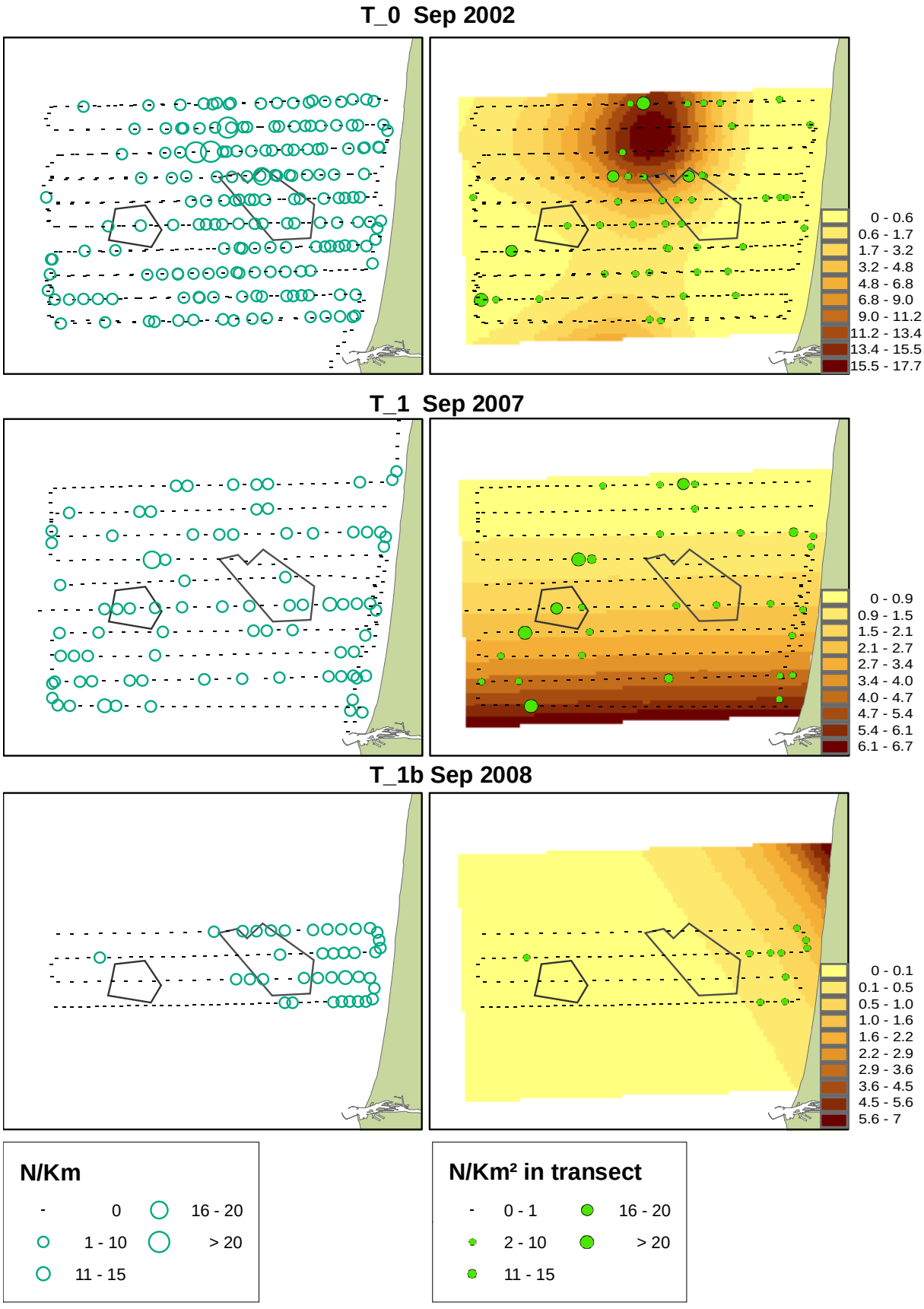




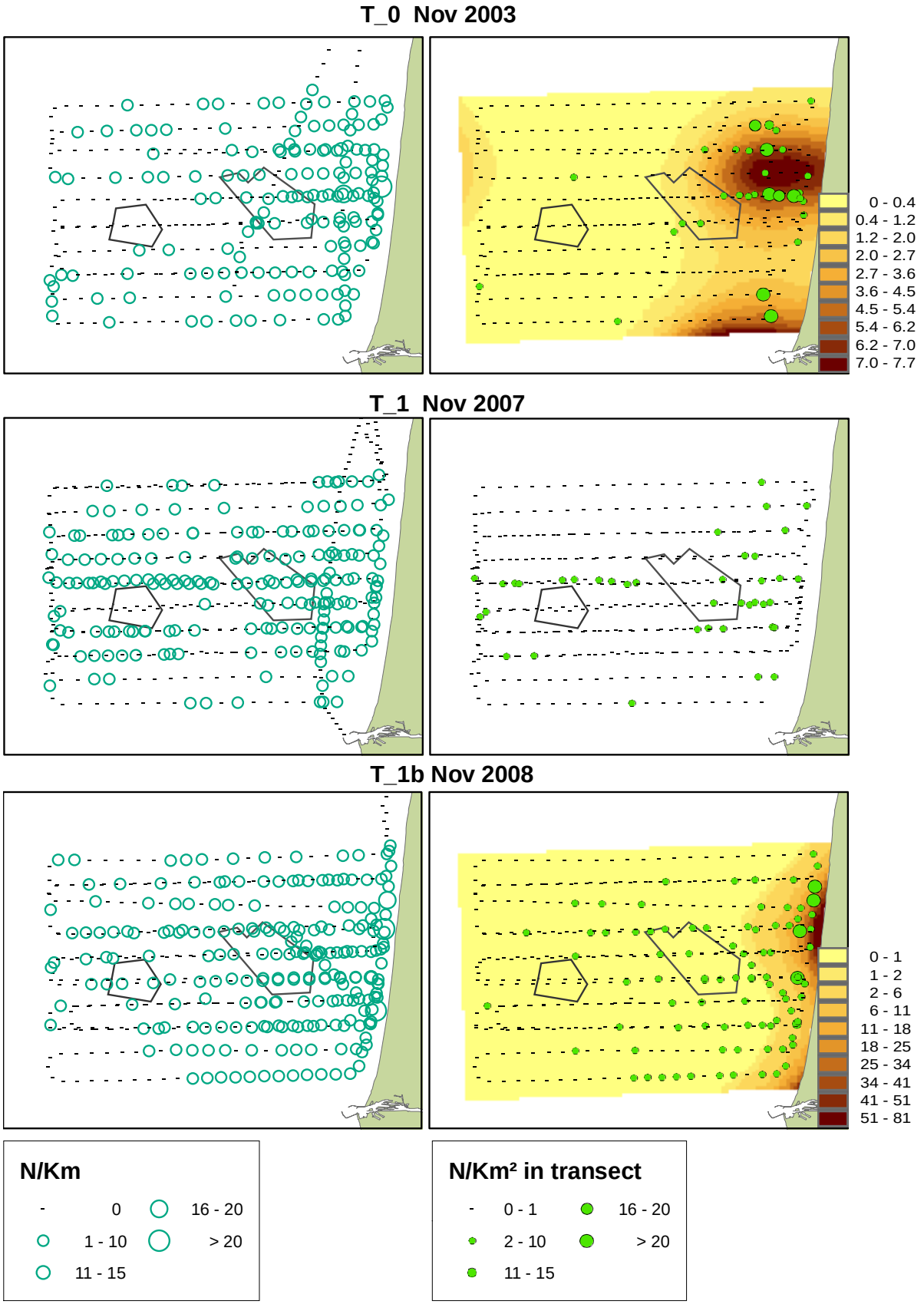
Greater Black-backed Gull



Greater Black-backed Gull

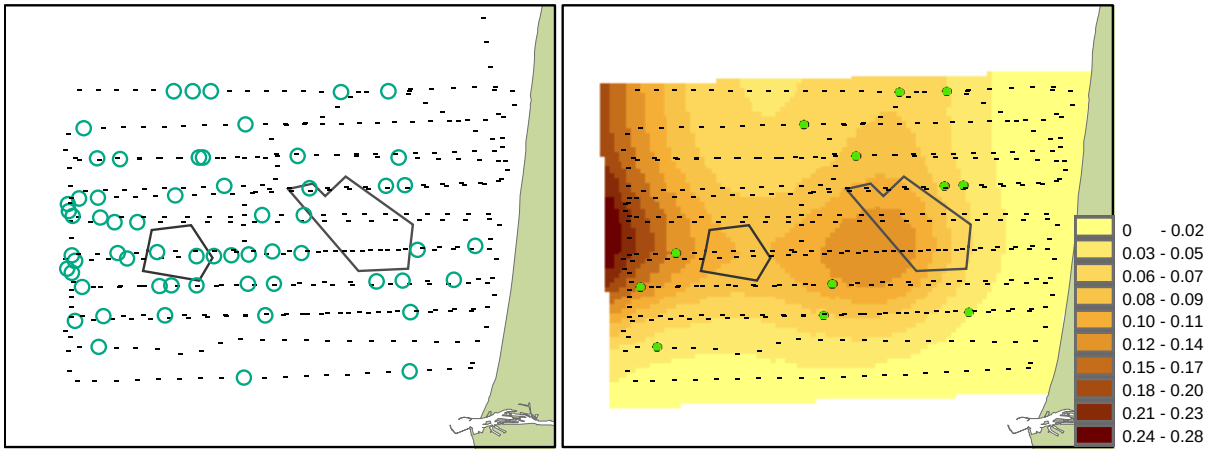


Greater Black-backed Gull

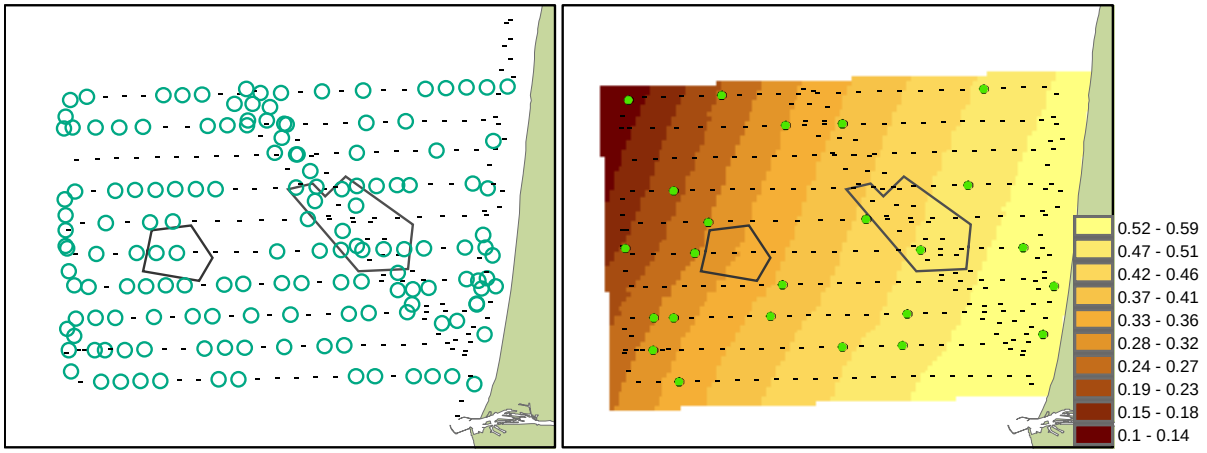


Kittiwake

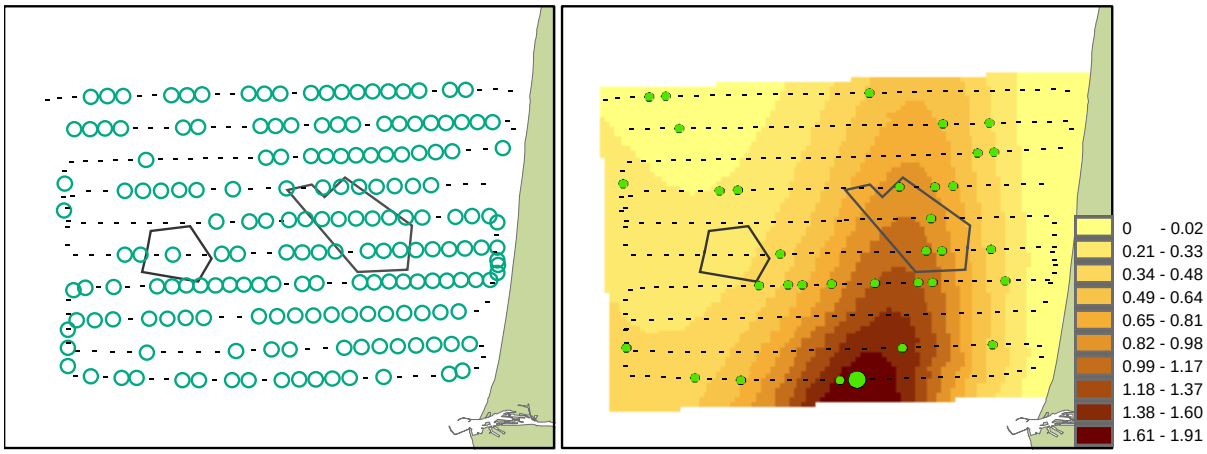
T_0 Febr 2004

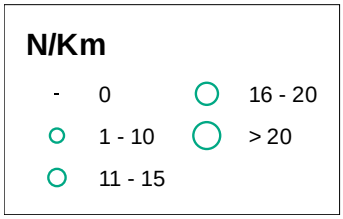


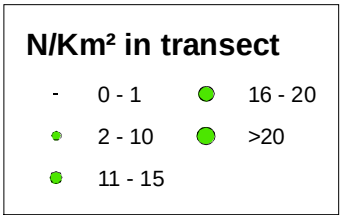
T_1 Jan 2008



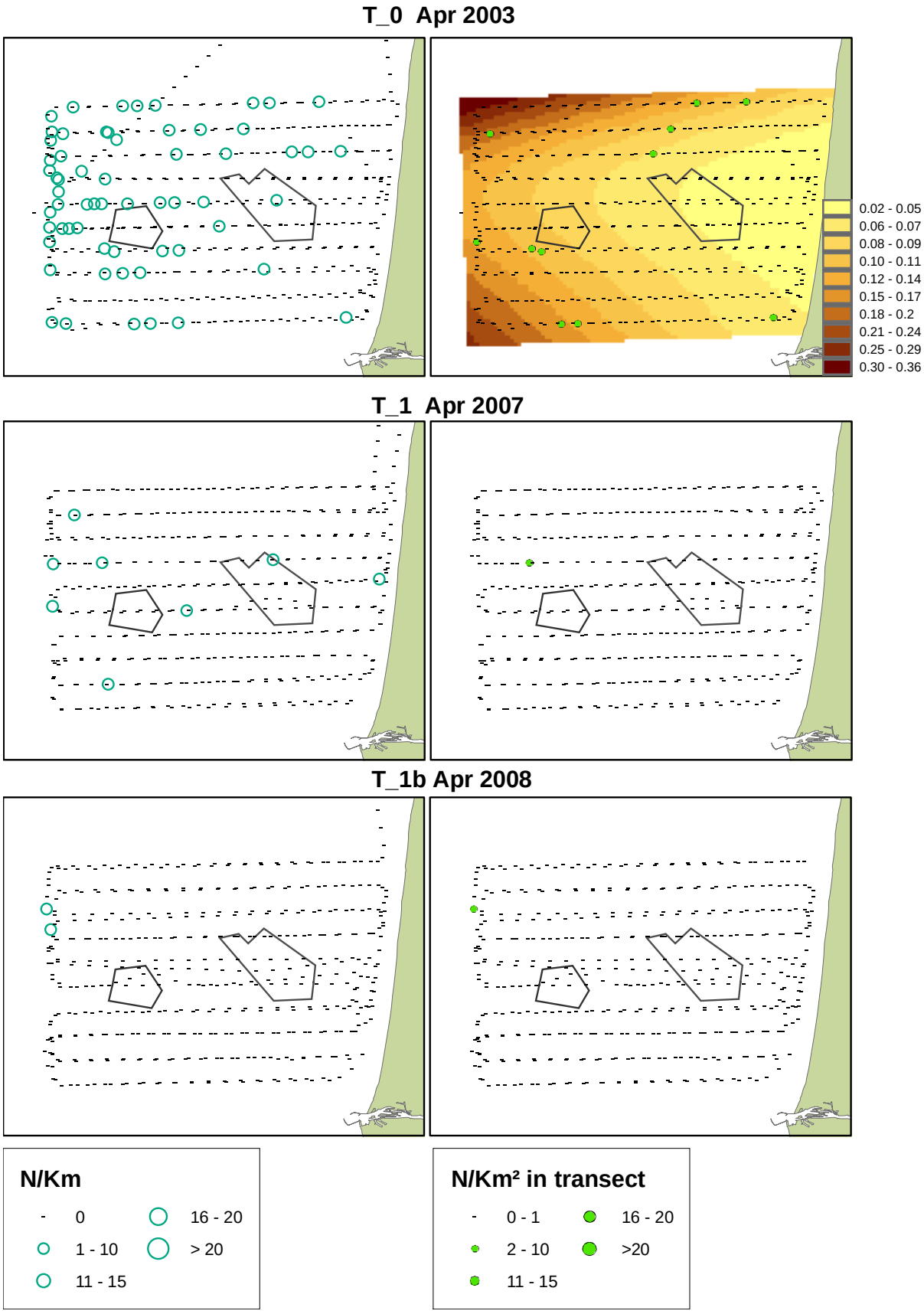
T_1b Jan 2009





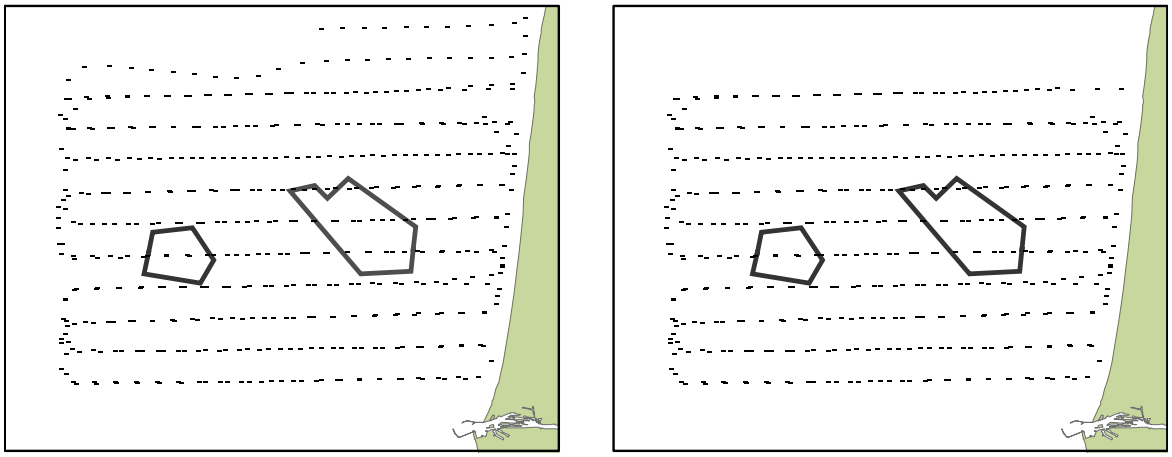


Kittiwake

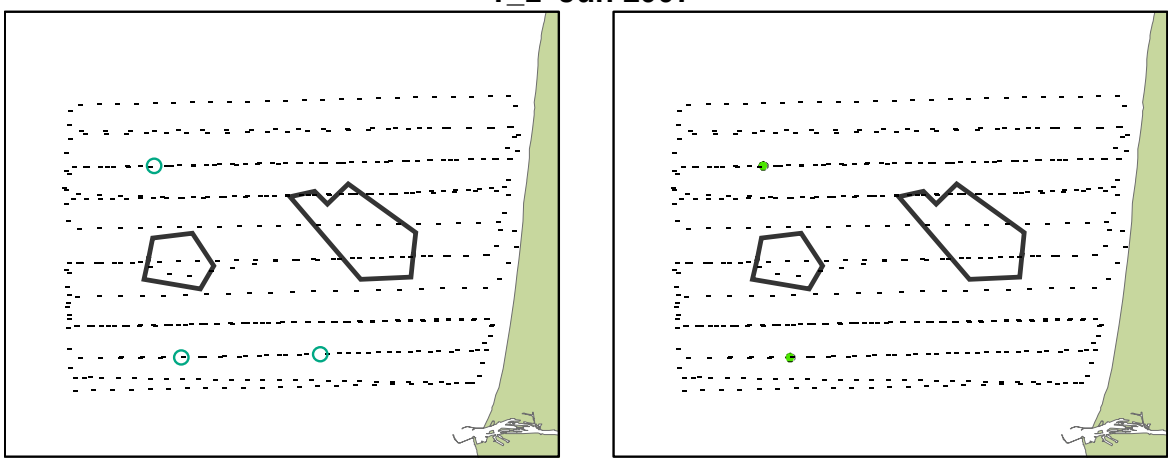

T_0 Apr 2003
0.02 - 0.05
0.06 - 0.07
0.08 - 0.09
0.10 - 0.11
0.12 - 0.14
0.15 - 0.17
0.18 - 0.2
0.21 - 0.24
0.25 - 0.29
0.30 - 0.36
T_1 Apr 2007
T_1b Apr 2008
N/Km
0
1 - 10
11 - 15
16 - 20
> 20
N/Km² in transect
0 - 1
2 - 10
11 - 15
16 - 20
>20

Kittiwake

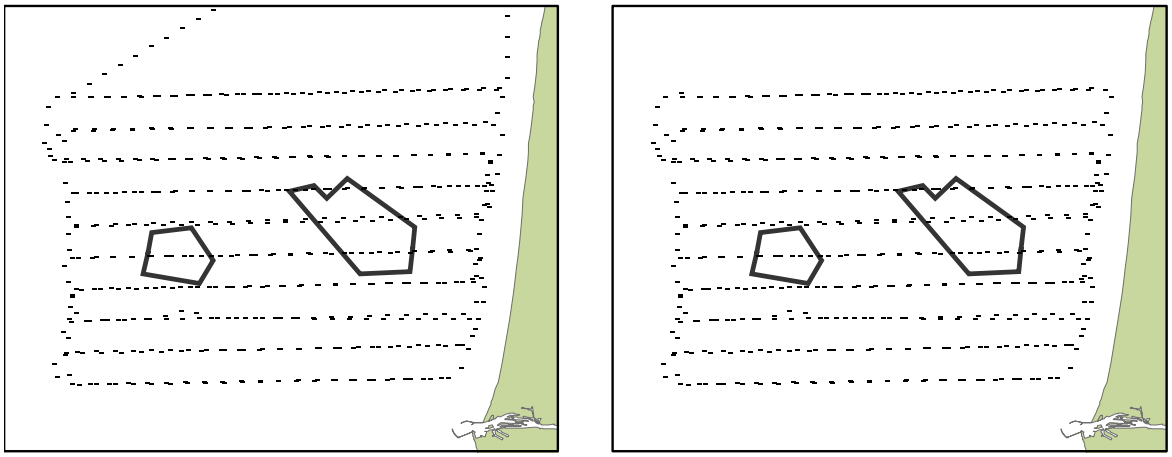
T_0 Jun 2003



T_1 Jun 2007

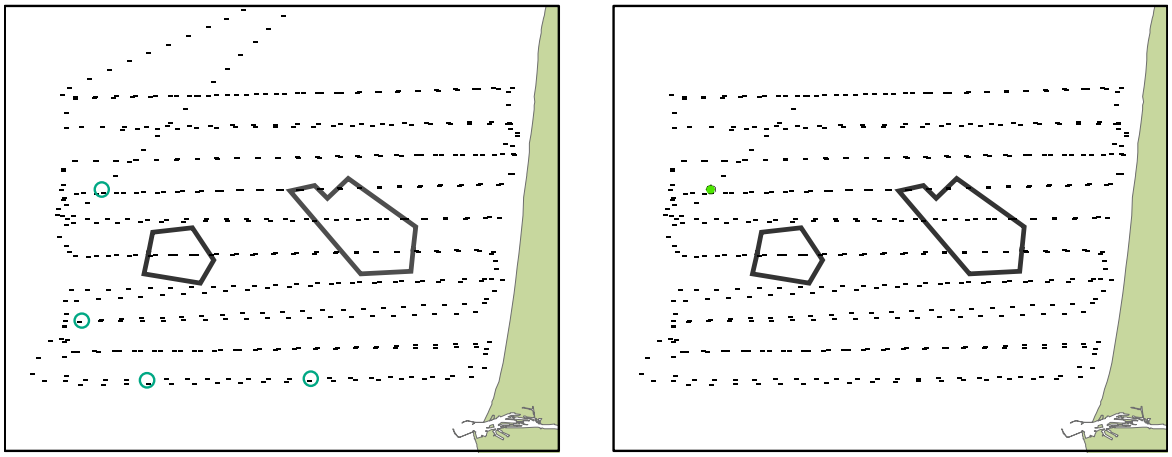


T_1b Jun 2008

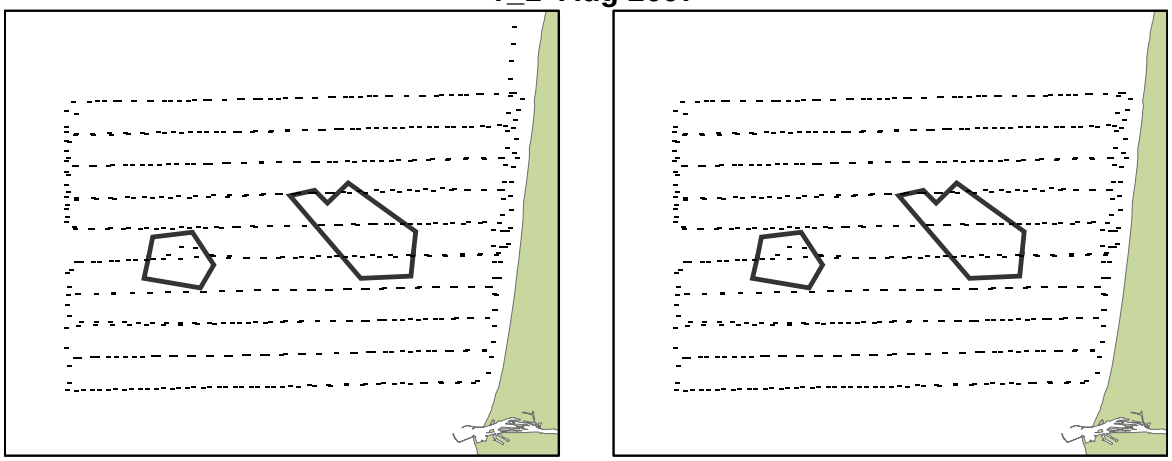


Kittiwake

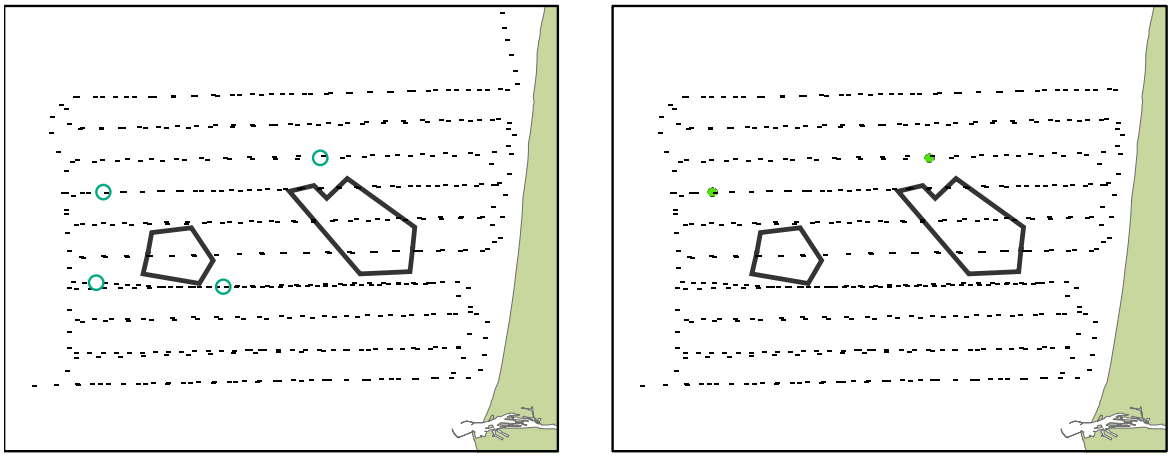
T_0 Aug 2003



T_1 Aug 2007

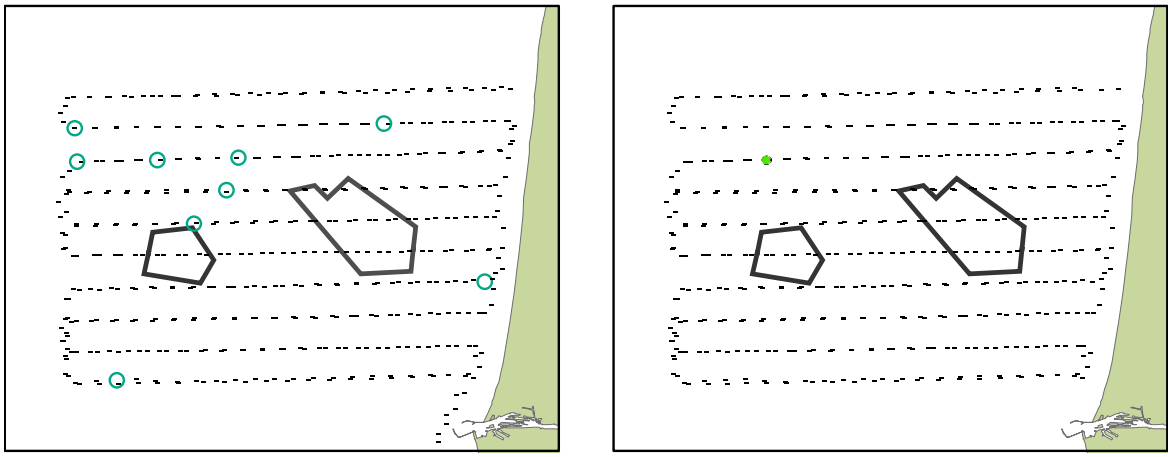


T_1b Aug 2008

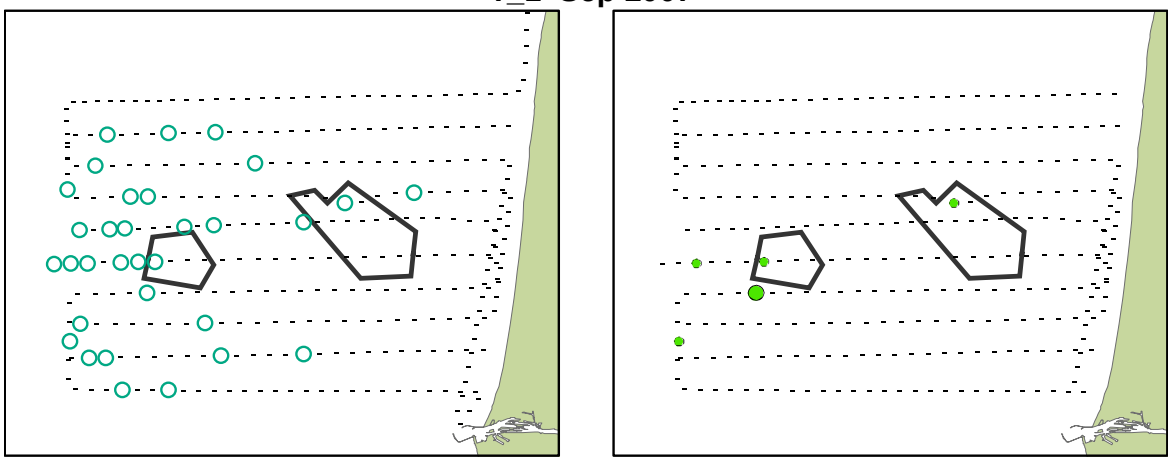


Kittiwake

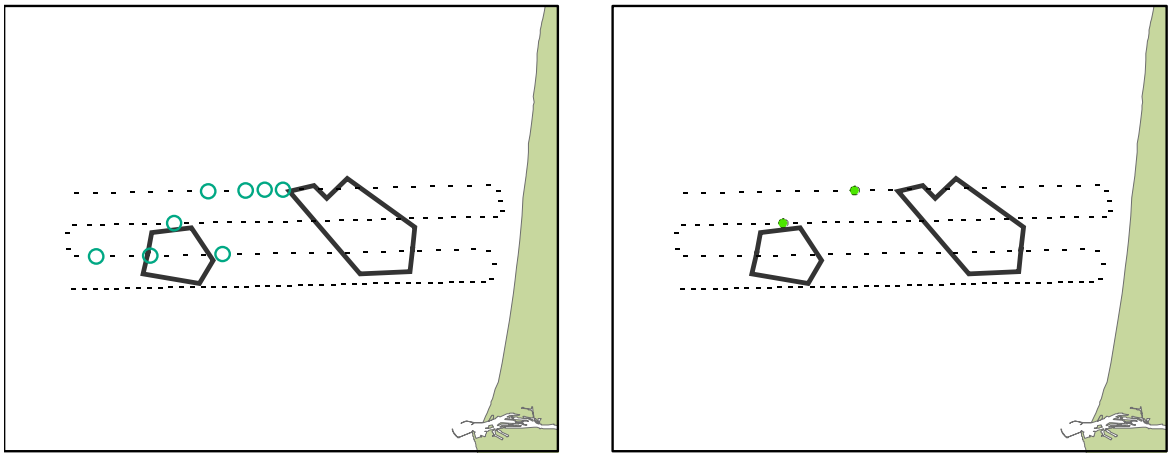
T_0 Sep 2002



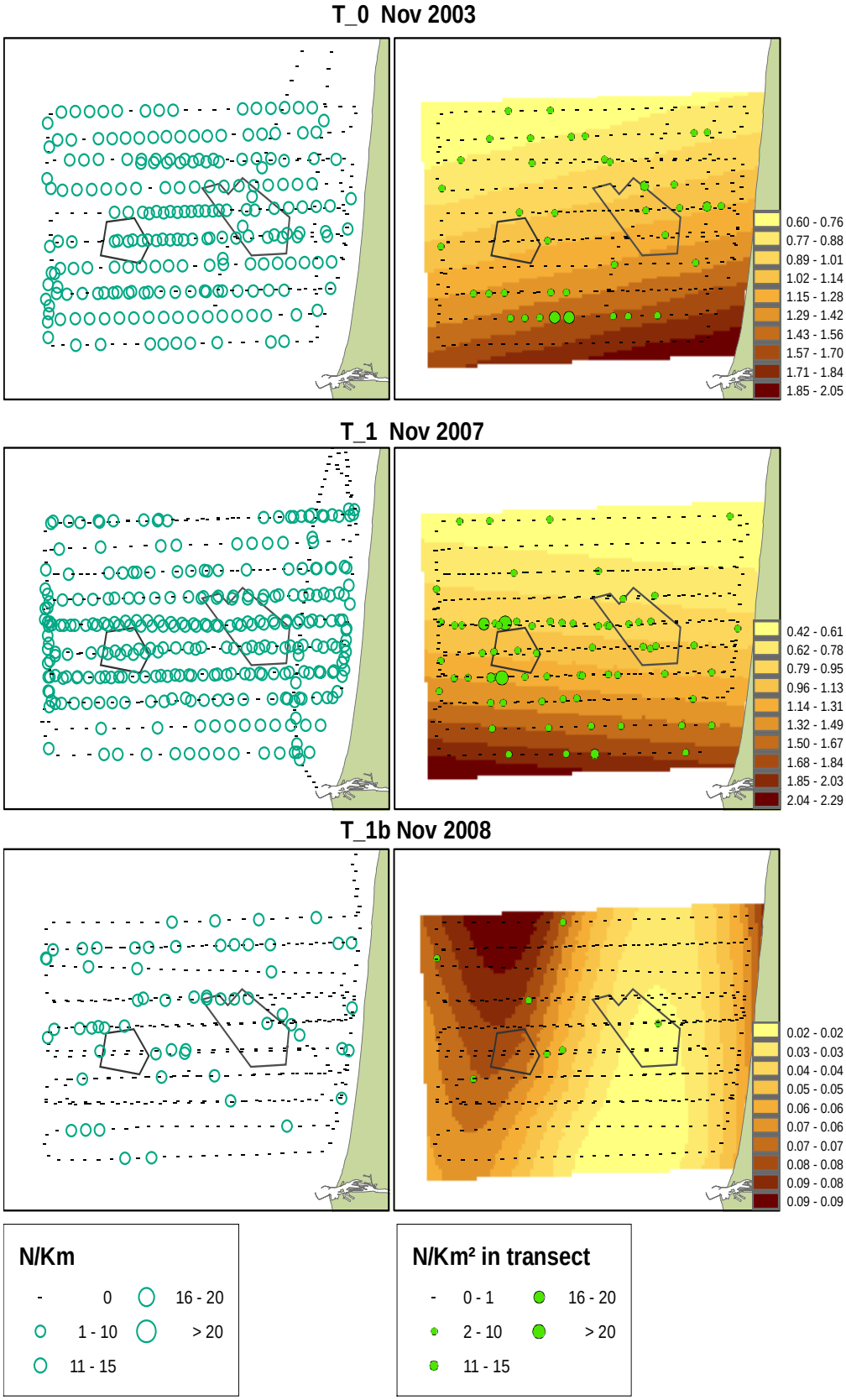
T_1 Sep 2007



T_1b Sep 2008

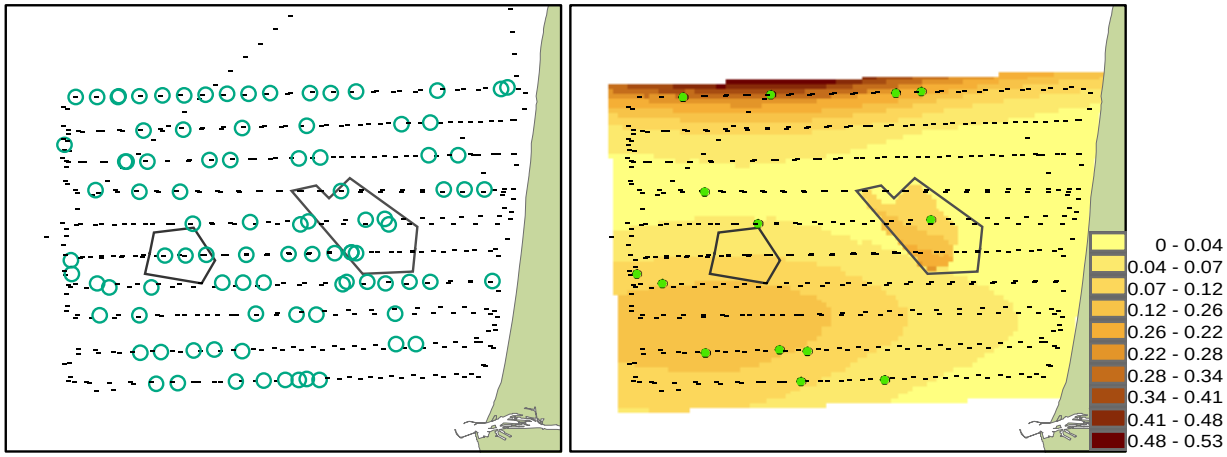


Kittiwake

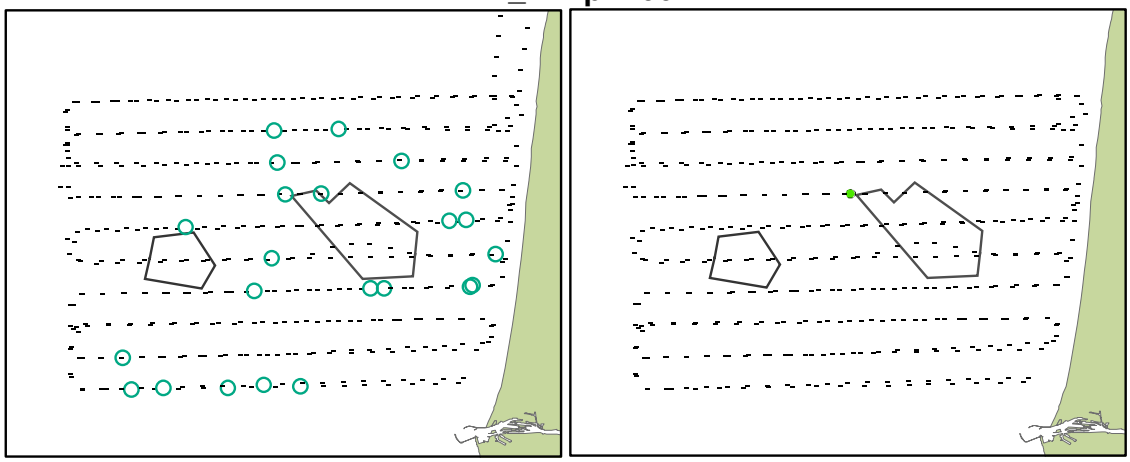

T_0 Nov 2003
0.60 - 0.76
0.77 - 0.88
0.89 - 1.01
1.02 - 1.14
1.15 - 1.28
1.29 - 1.42
1.43 - 1.56
1.57 - 1.70
1.71 - 1.84
1.85 - 2.05
T_1 Nov 2007
0.42 - 0.61
0.62 - 0.78
0.79 - 0.95
0.96 - 1.13
1.14 - 1.31
1.32 - 1.49
1.50 - 1.67
1.68 - 1.84
1.85 - 2.03
2.04 - 2.29
T_1b Nov 2008
0.02 - 0.02
0.03 - 0.03
0.04 - 0.04
0.05 - 0.05
0.06 - 0.06
0.07 - 0.06
0.07 - 0.07
0.08 - 0.08
0.09 - 0.08
0.09 - 0.09
N/Km
0
1 - 10
11 - 15
16 - 20
> 20
N/Km² in transect
0 - 1
2 - 10
11 - 15
16 - 20
> 20

Sandwich Tern

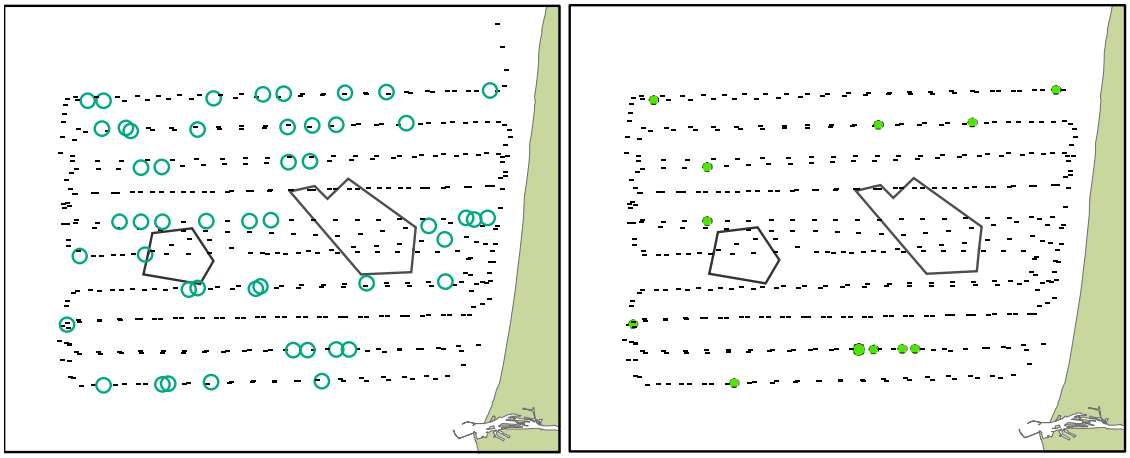
T_0 Apr 2003



T_1 Apr 2007



T_1b Apr 2008



N/Km

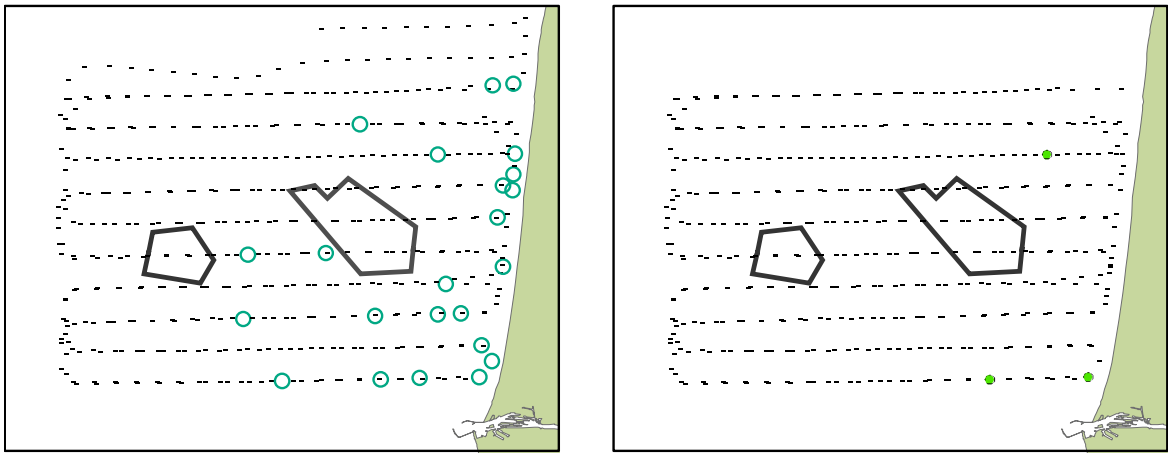
- 0
- 1 - 10
- 11 - 15
- 16 - 20
- > 20

N/Km² in transect

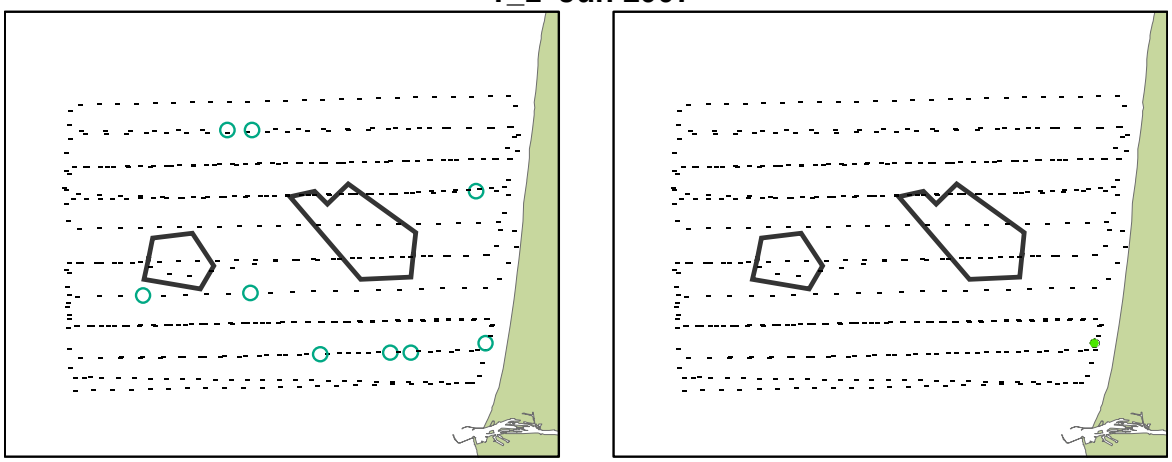
- 0 - 1
- 2 - 10
- 11 - 15
- 16 - 20
- >20

Sandwich Tern

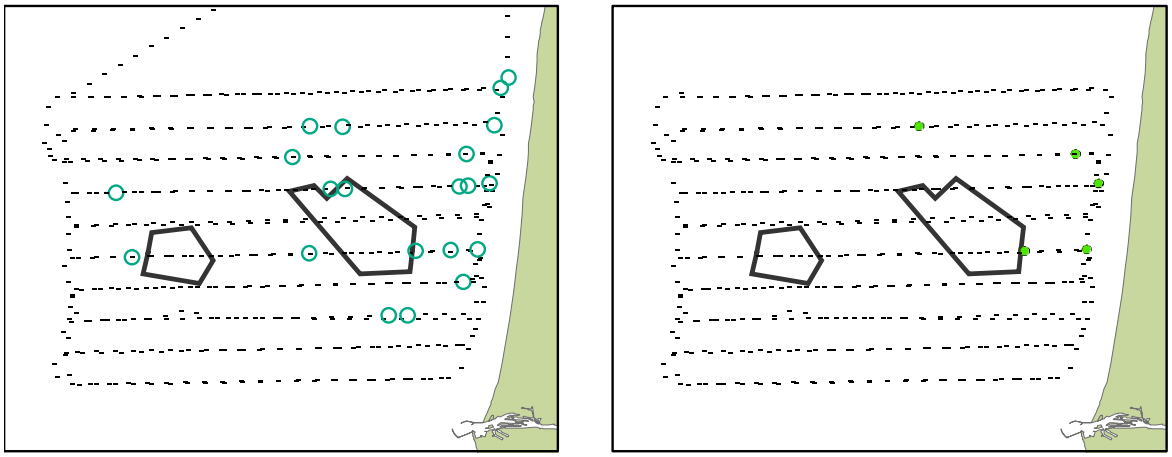
T_0 Jun 2003



T_1 Jun 2007

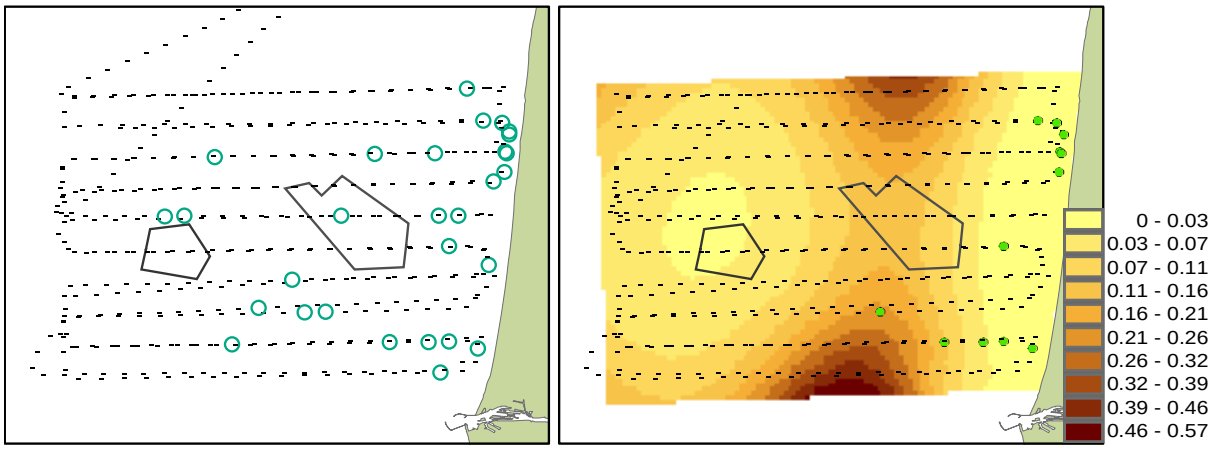


T_1b Jun 2008

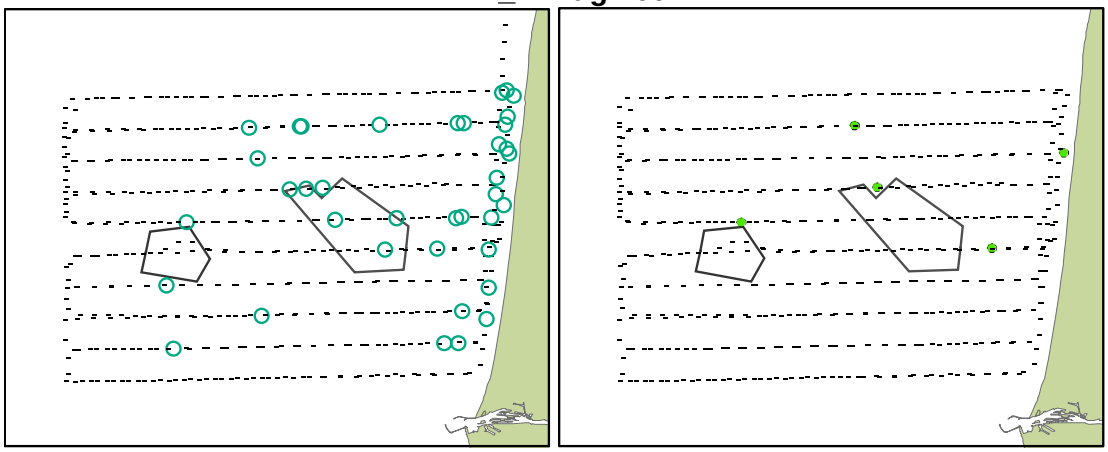


Sandwich Tern

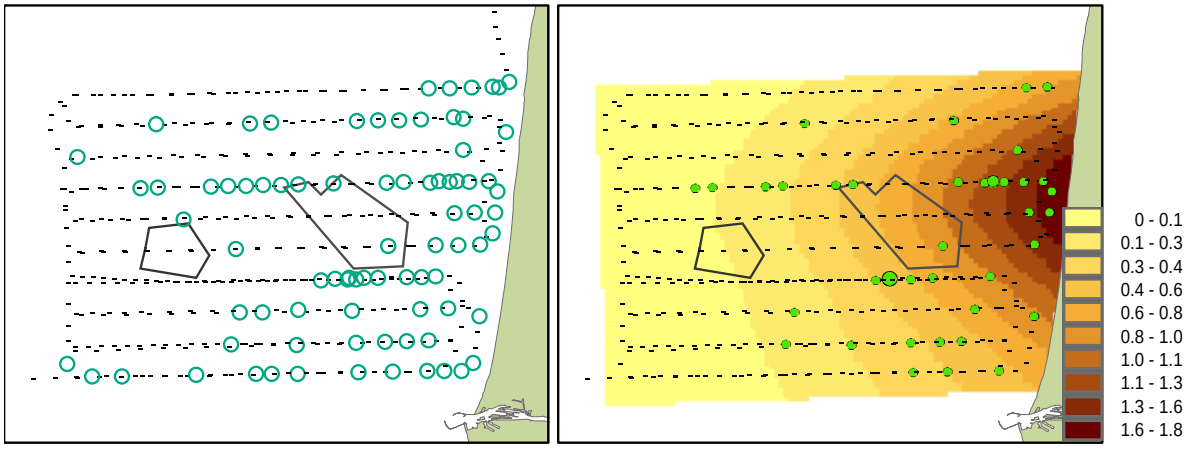
T_0 Aug 2003

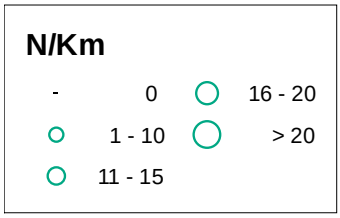


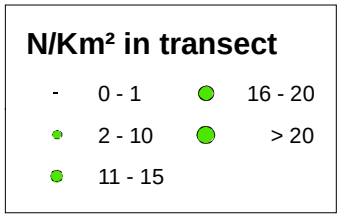
T_1 Aug 2007



T_1b Aug 2008

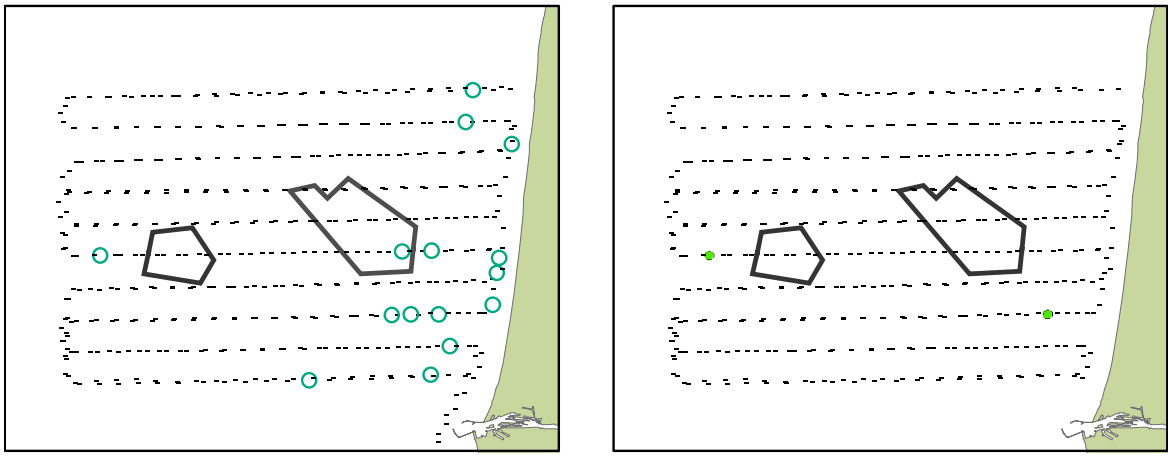




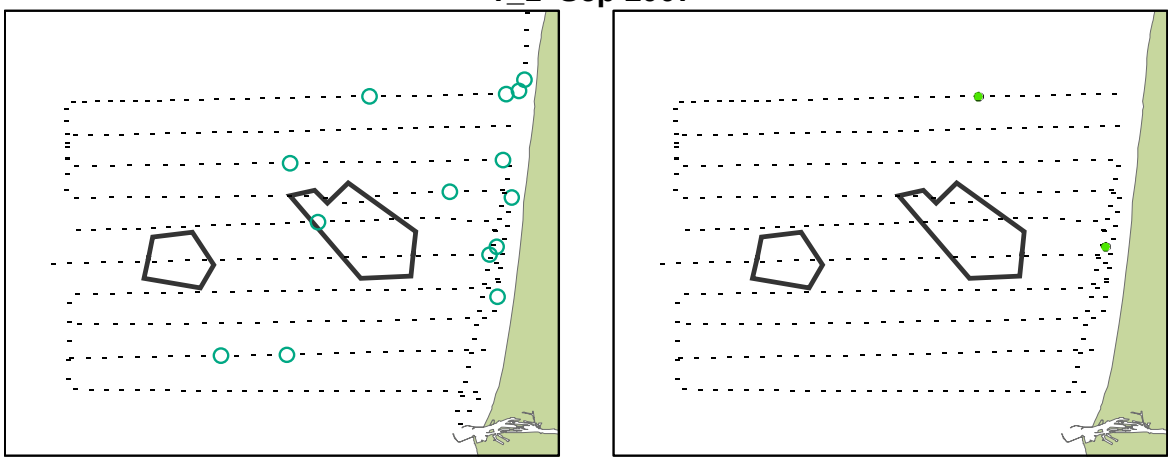


Sandwich Tern

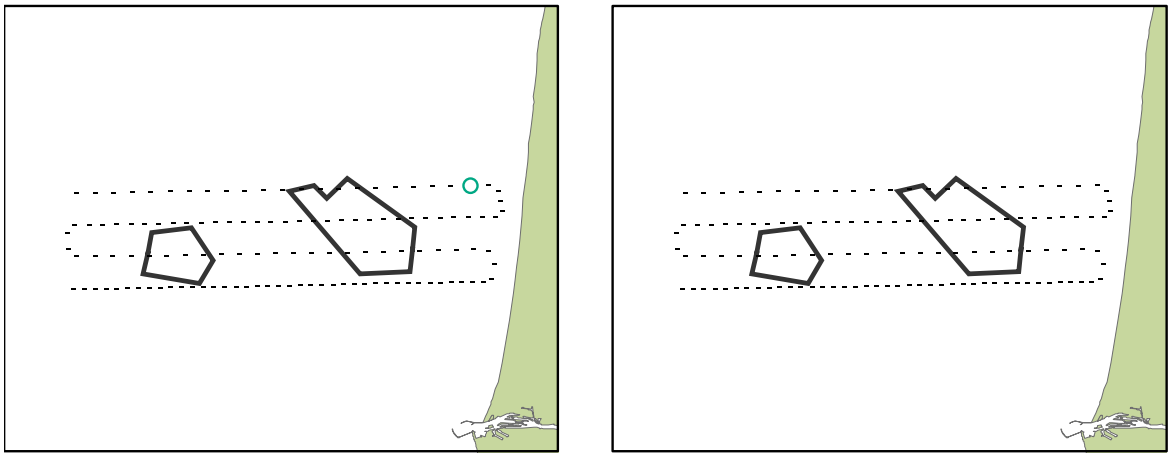
T_0 Sep 2002



T_1 Sep 2007

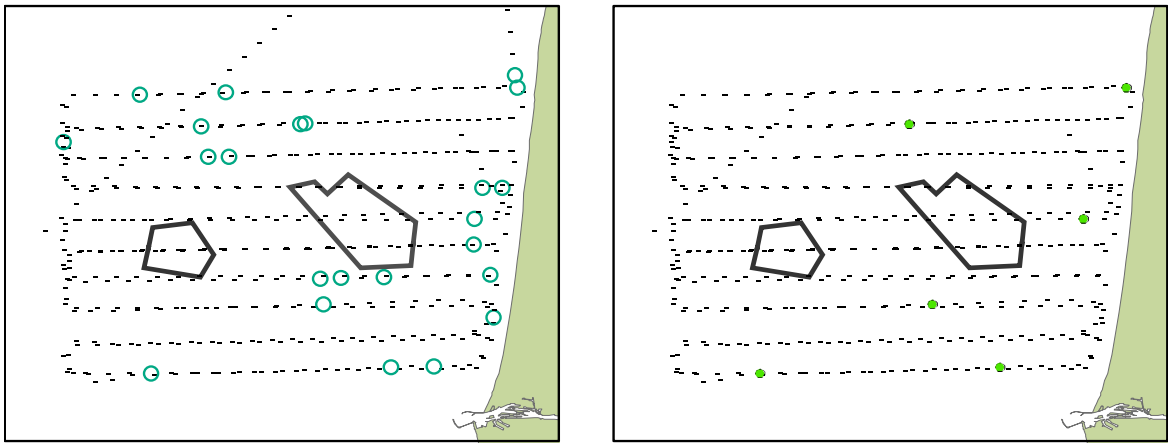


T_1b Sep 2008

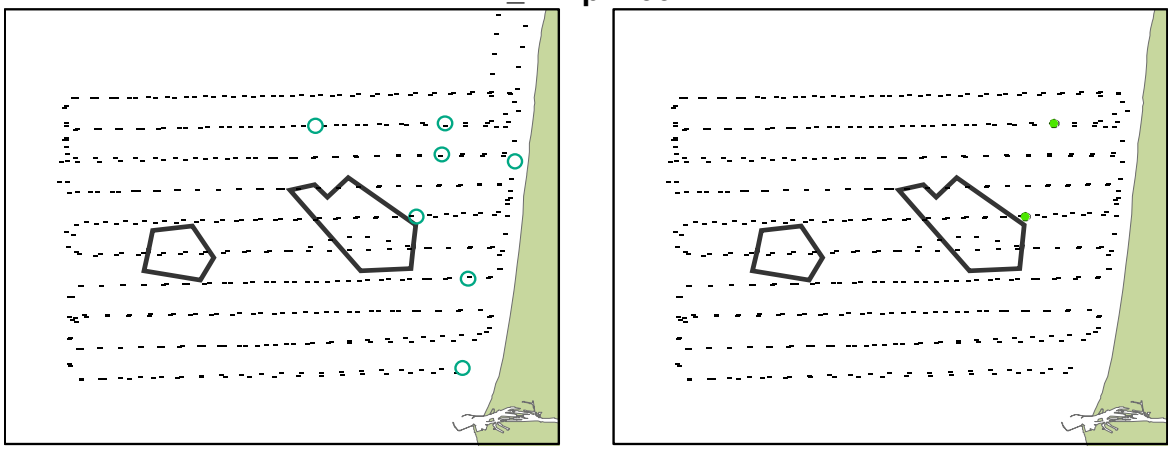


"Comic" Tern

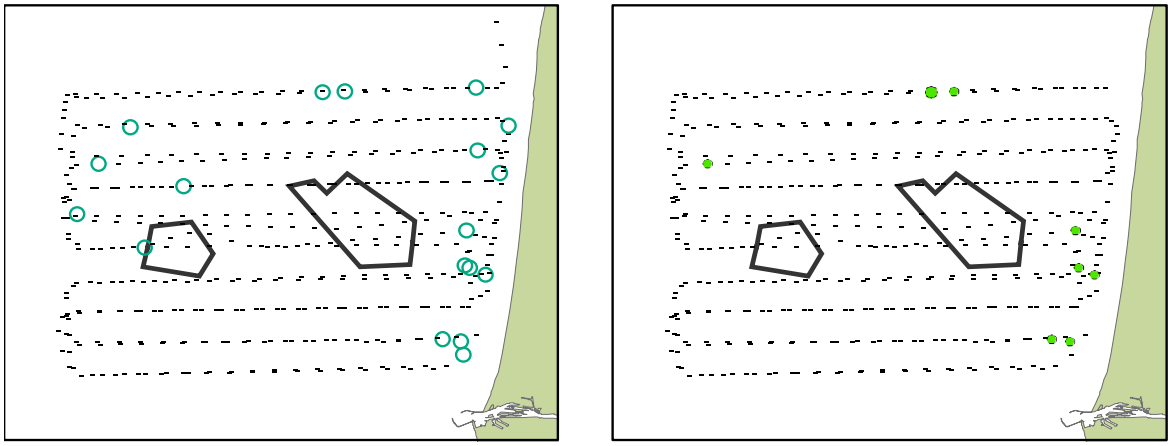
T_0 Apr 2003



T_1 Apr 2007

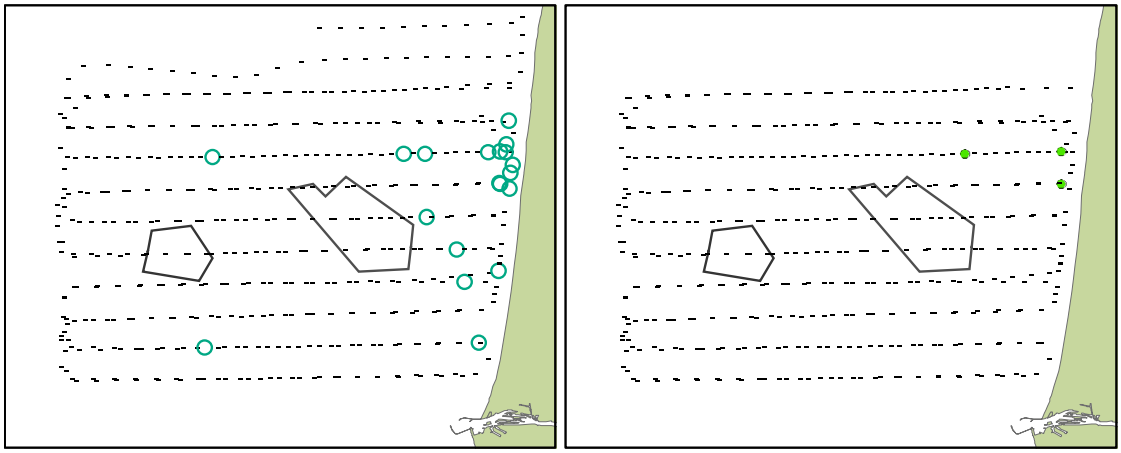


T_1b Apr 2008

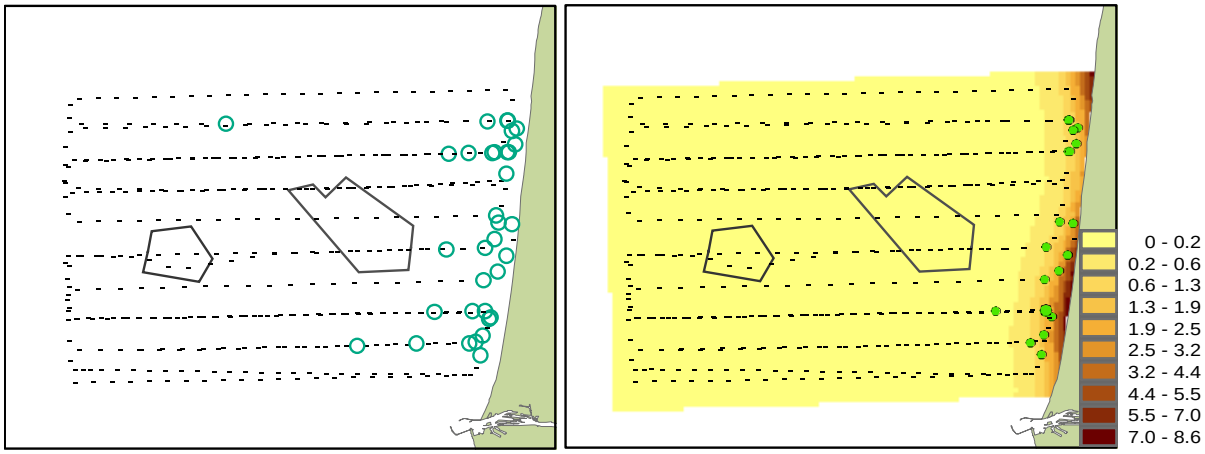


"Comic" Tern

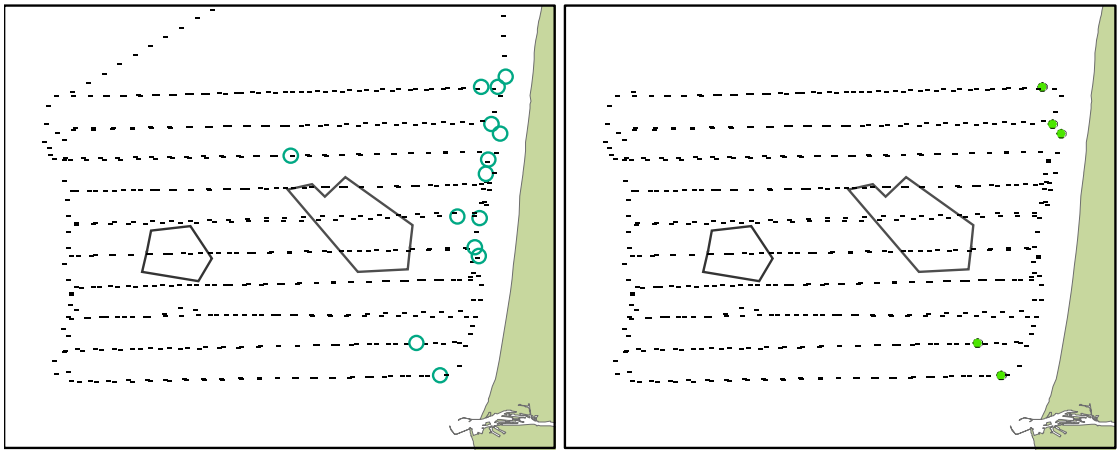
T_0 Jun 2003



T_1 Jun 2007

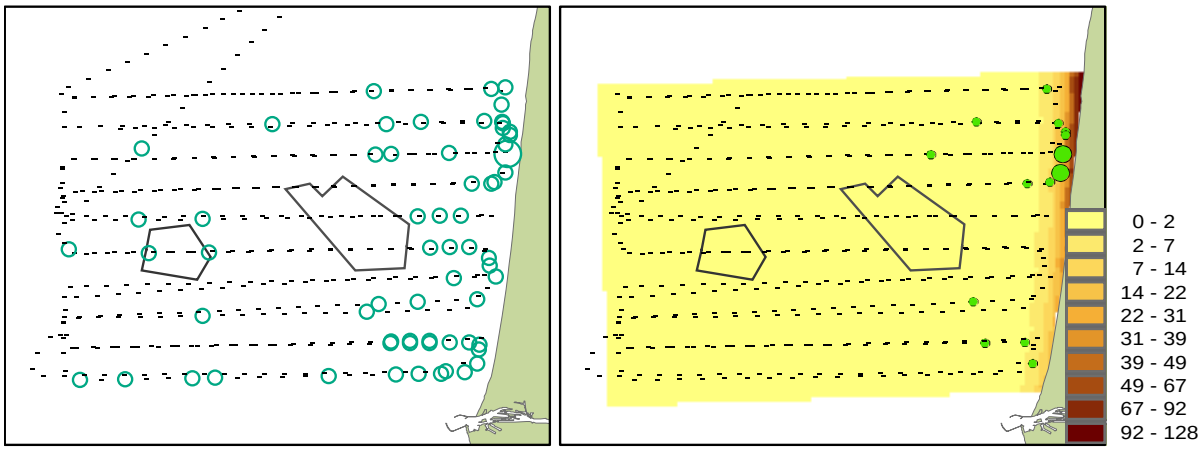


T_1b Jun 2008

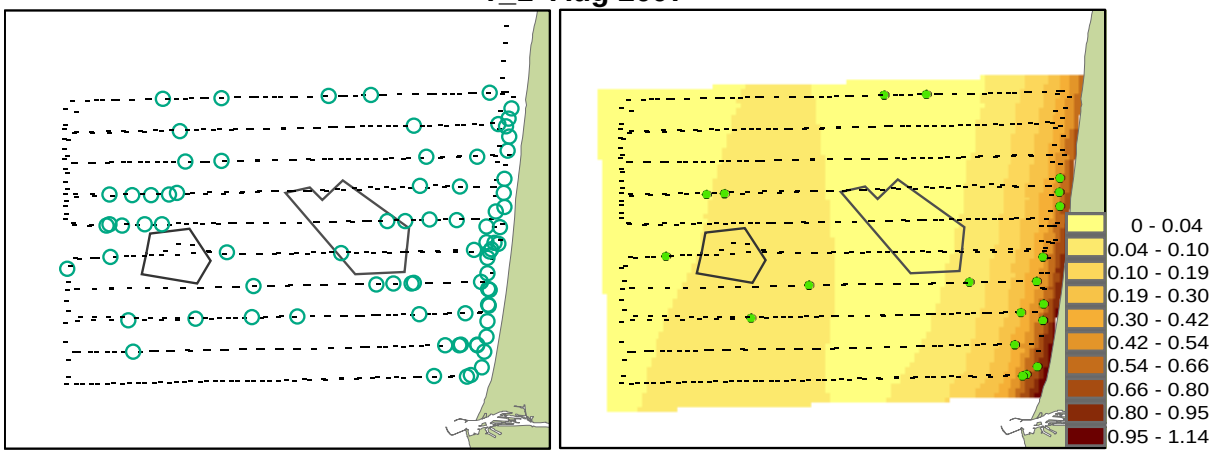


"Comic" Tern

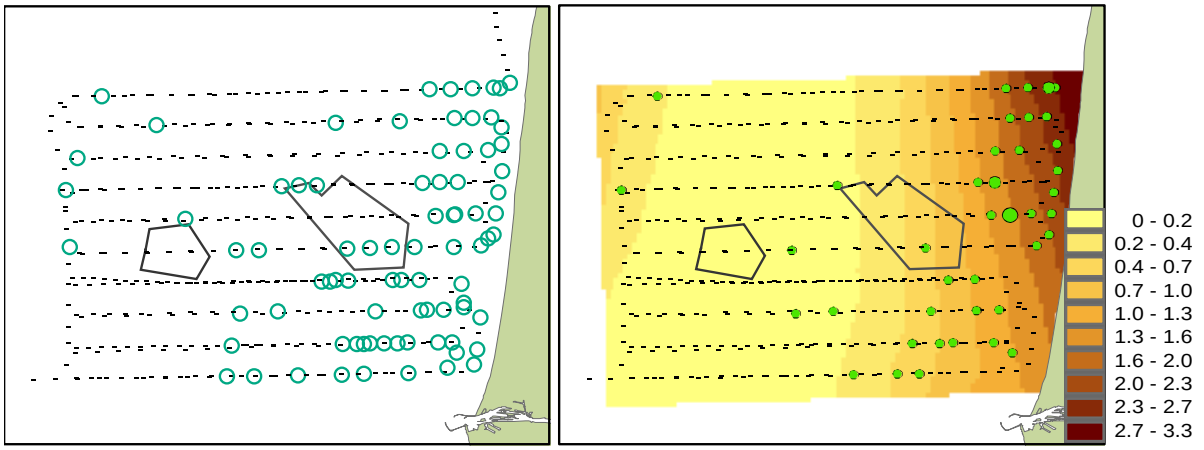
T_0 Aug 2003

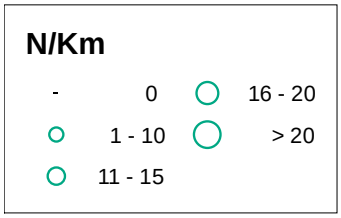


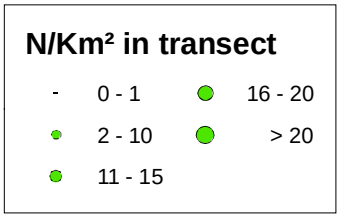
T_1 Aug 2007



T_1b Aug 2008

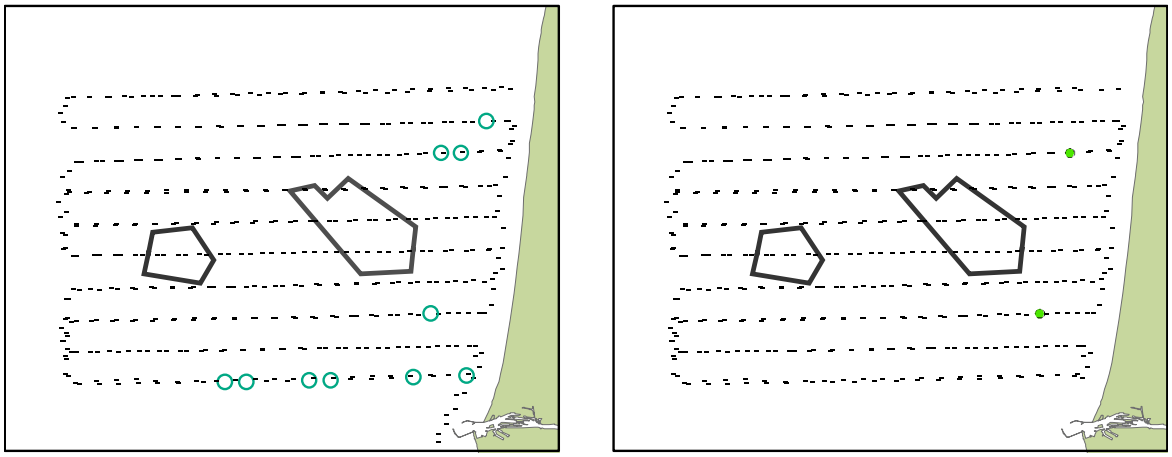




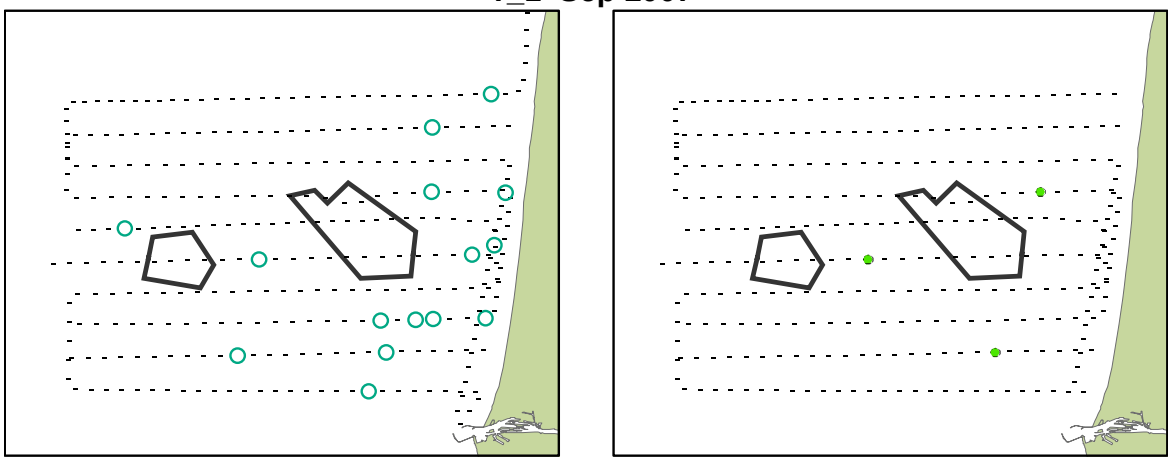


"Comic" Tern

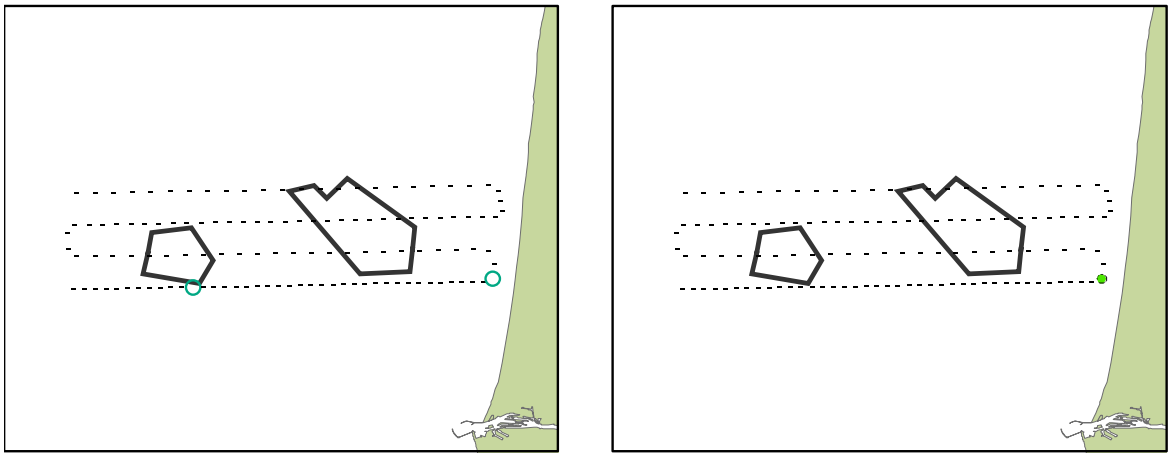
T_0 Sep 2002



T_1 Sep 2007

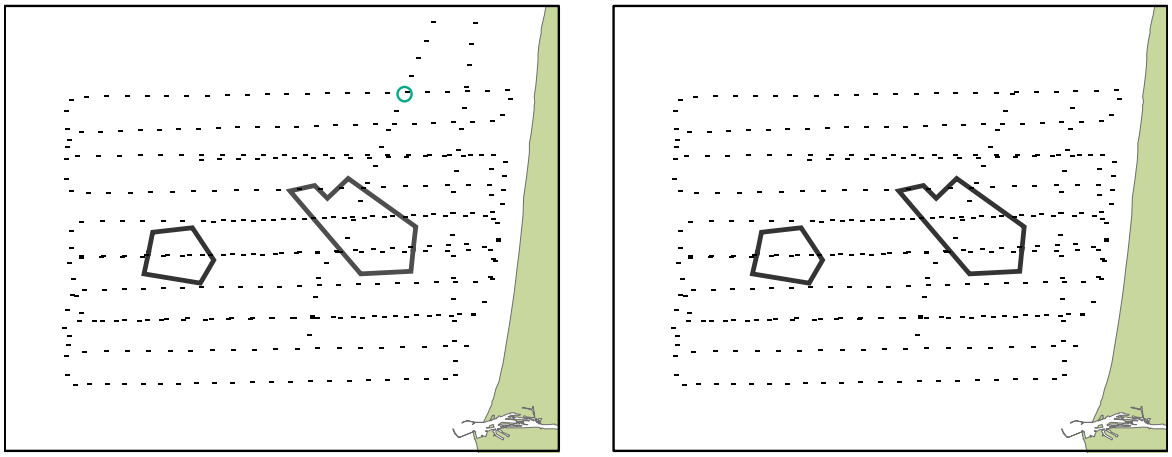


T_1b Sep 2008

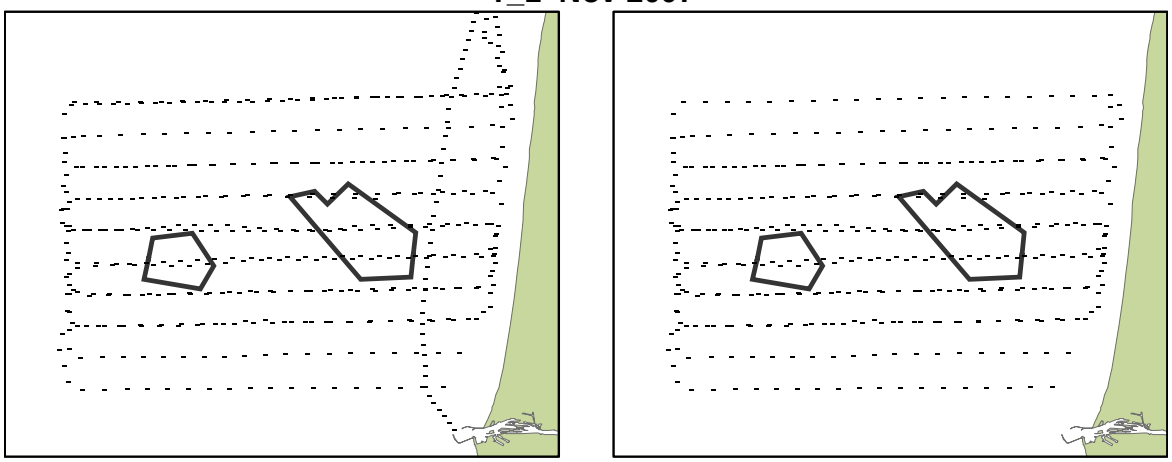


"Comic" Tern

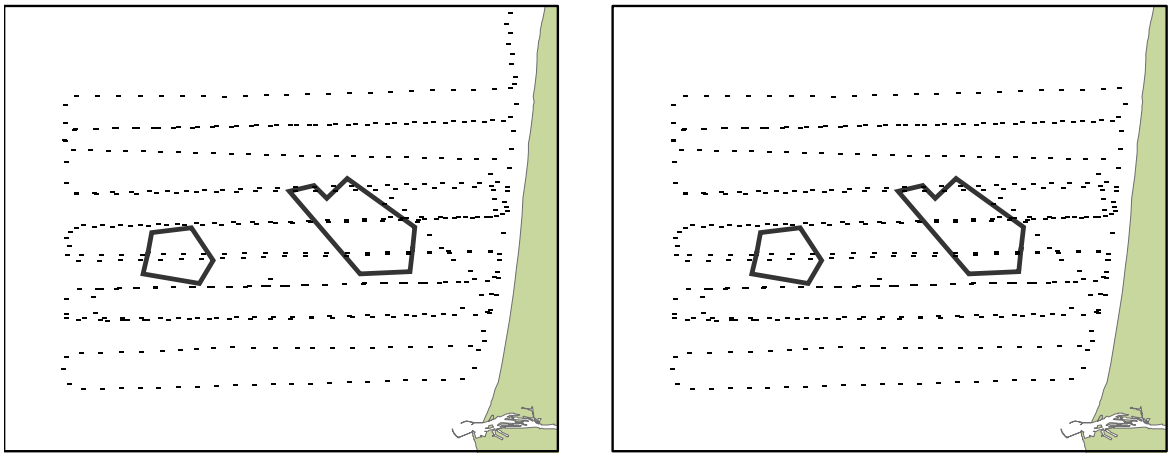
T_0 Nov 2003



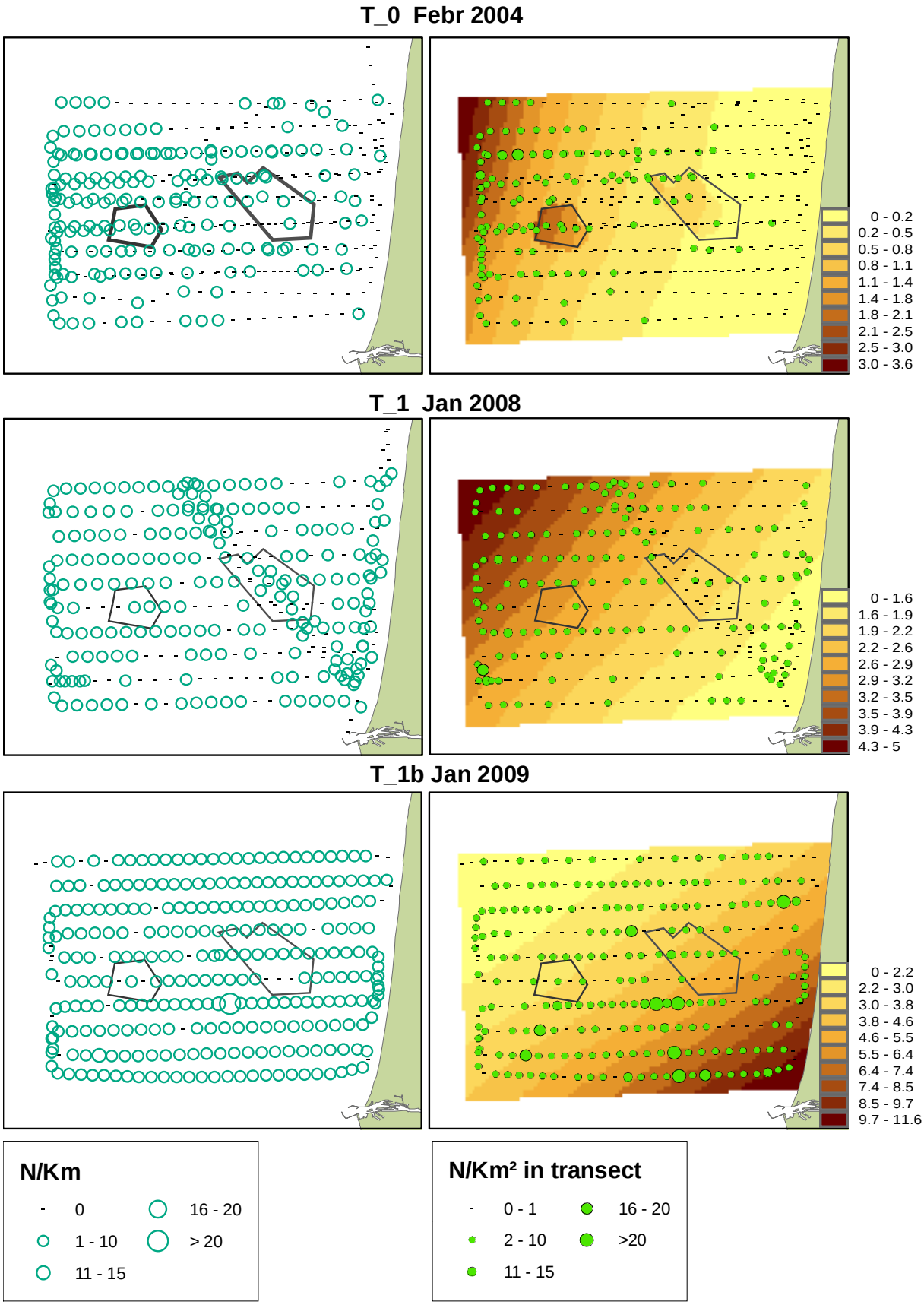
T_1 Nov 2007



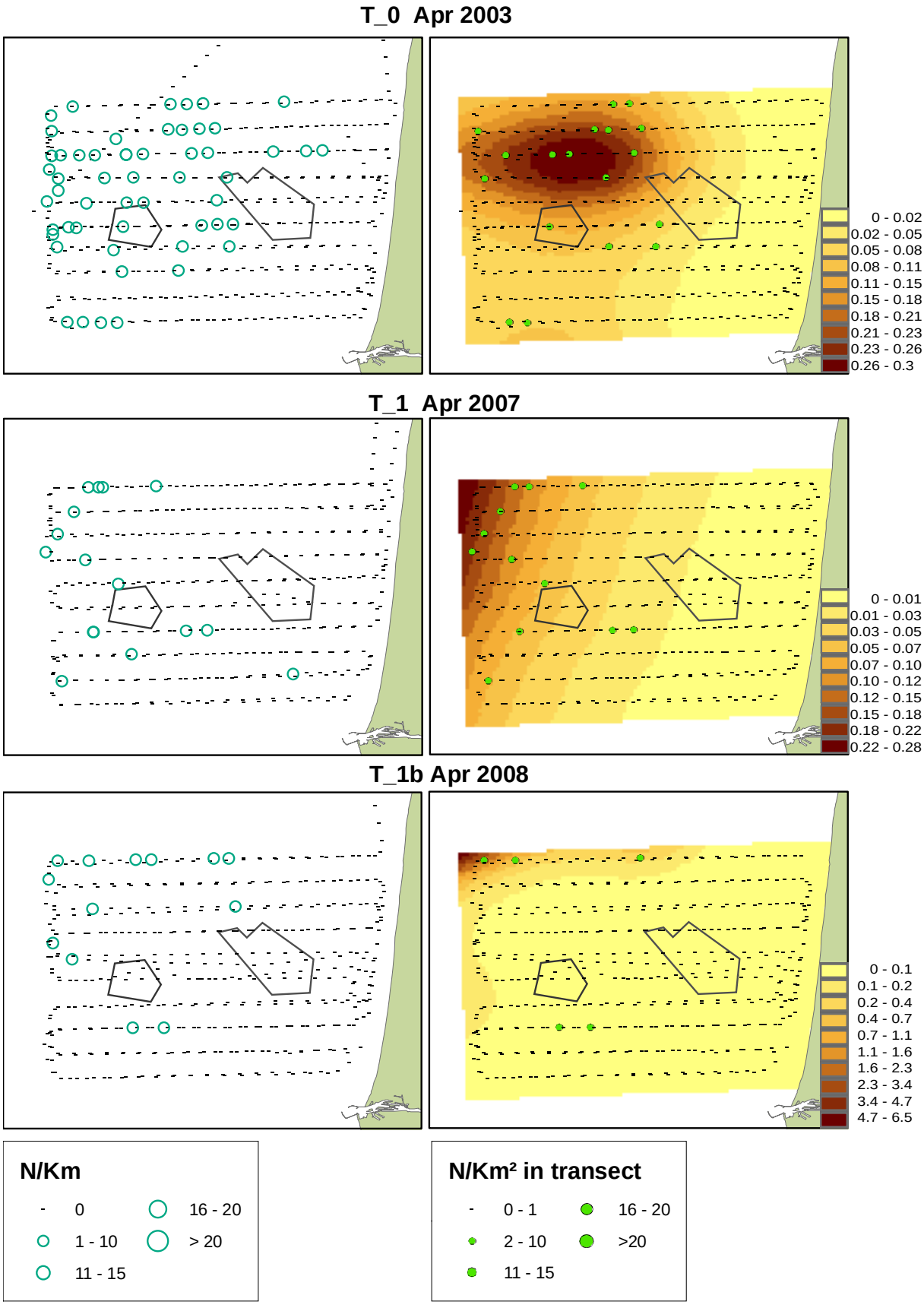
T_1b Nov 2008



Guillemot

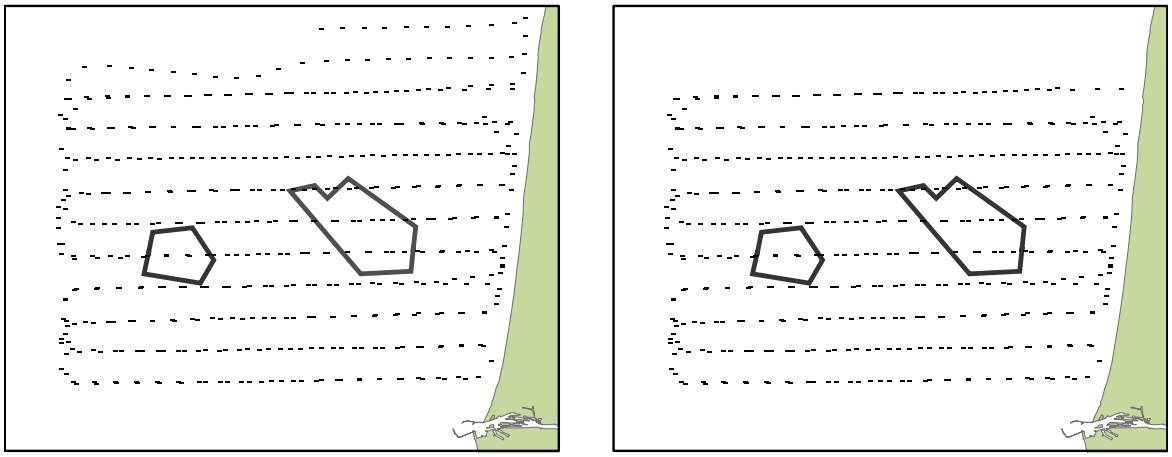

T_0 Febr 2004
0 - 0.2
0.2 - 0.5
0.5 - 0.8
0.8 - 1.1
1.1 - 1.4
1.4 - 1.8
1.8 - 2.1
2.1 - 2.5
2.5 - 3.0
3.0 - 3.6
T_1 Jan 2008
0 - 1.6
1.6 - 1.9
1.9 - 2.2
2.2 - 2.6
2.6 - 2.9
2.9 - 3.2
3.2 - 3.5
3.5 - 3.9
3.9 - 4.3
4.3 - 5
T_1b Jan 2009
0 - 2.2
2.2 - 3.0
3.0 - 3.8
3.8 - 4.6
4.6 - 5.5
5.5 - 6.4
6.4 - 7.4
7.4 - 8.5
8.5 - 9.7
9.7 - 11.6
N/Km
0
1 - 10
11 - 15
16 - 20
> 20
N/Km² in transect
0 - 1
2 - 10
11 - 15
16 - 20
>20

Guillemot

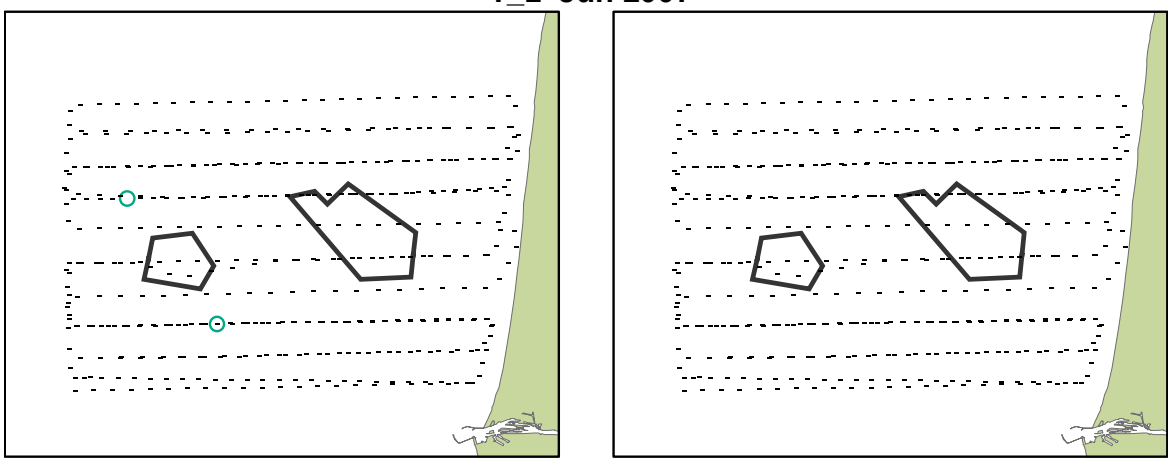

T_0 Apr 2003
0 - 0.02
0.02 - 0.05
0.05 - 0.08
0.08 - 0.11
0.11 - 0.15
0.15 - 0.18
0.18 - 0.21
0.21 - 0.23
0.23 - 0.26
0.26 - 0.3
T_1 Apr 2007
0 - 0.01
0.01 - 0.03
0.03 - 0.05
0.05 - 0.07
0.07 - 0.10
0.10 - 0.12
0.12 - 0.15
0.15 - 0.18
0.18 - 0.22
0.22 - 0.28
T_1b Apr 2008
0 - 0.1
0.1 - 0.2
0.2 - 0.4
0.4 - 0.7
0.7 - 1.1
1.1 - 1.6
1.6 - 2.3
2.3 - 3.4
3.4 - 4.7
4.7 - 6.5
N/Km
0
1 - 10
11 - 15
16 - 20
> 20
N/Km² in transect
0 - 1
2 - 10
11 - 15
16 - 20
>20

Guillemot

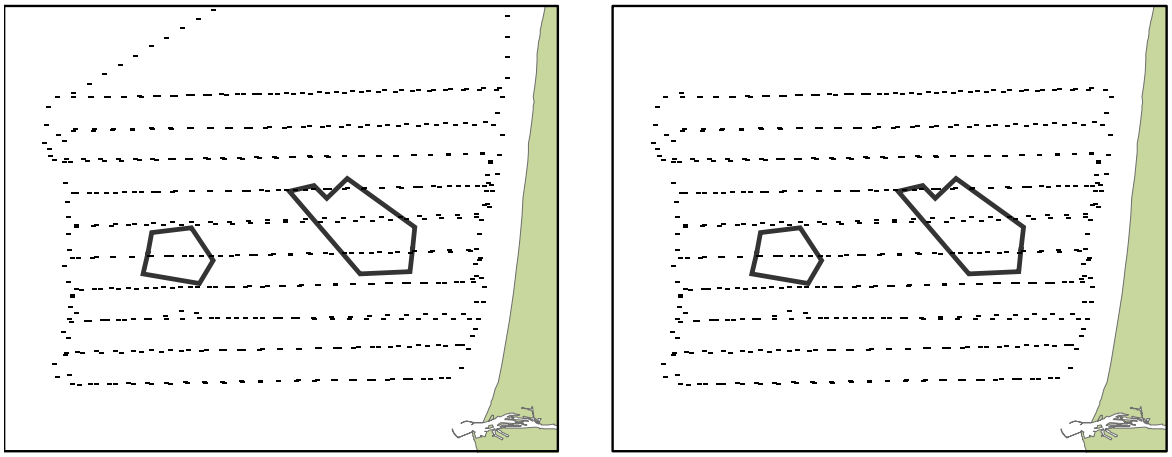
T_0 Jun 2003



T_1 Jun 2007



T_1b Jun 2008



N/Km

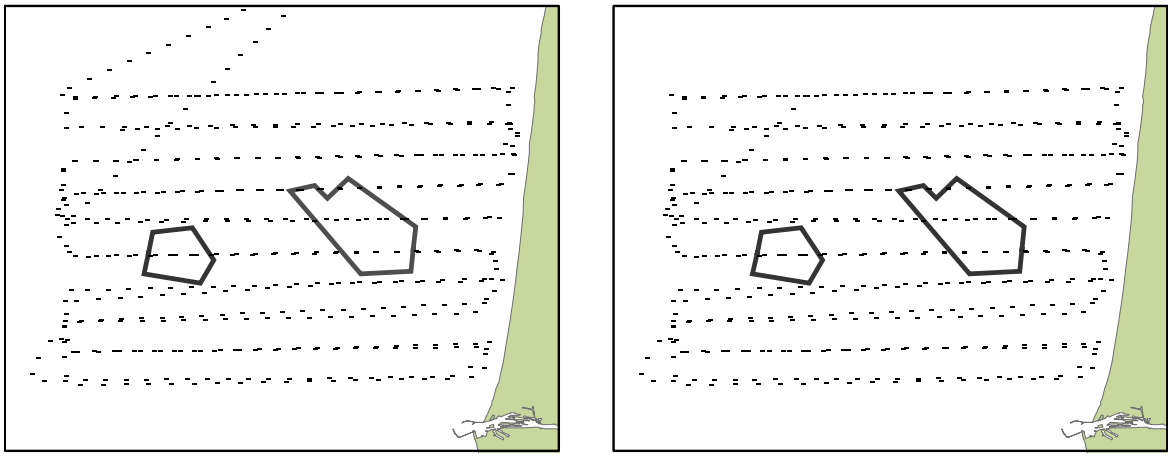
- 0
- 1 - 10
- 11 - 15
- 16 - 20
- 21 - 40

N/Km² in transect

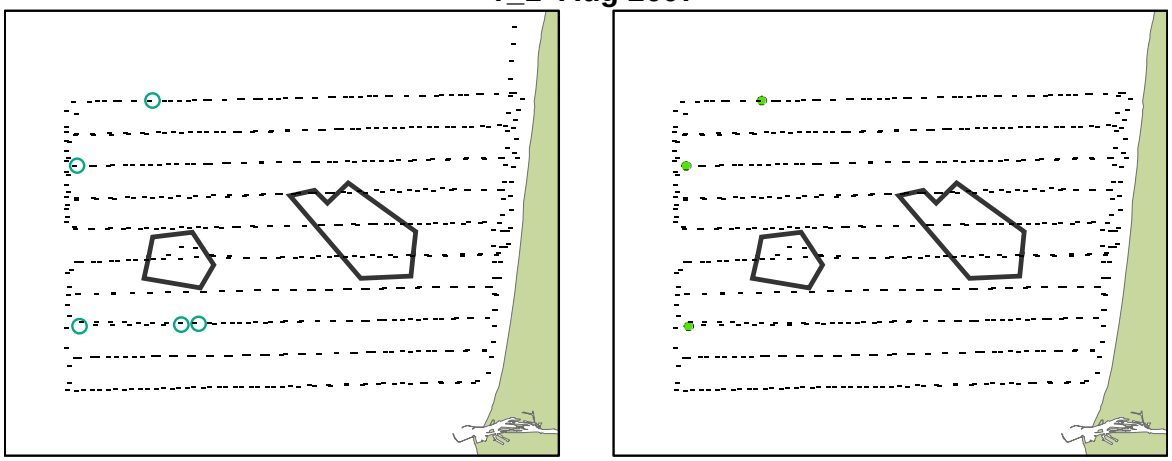
- 0 - 1
- 2 - 10
- 11 - 15
- 16 - 20
- > 20

Guillemot

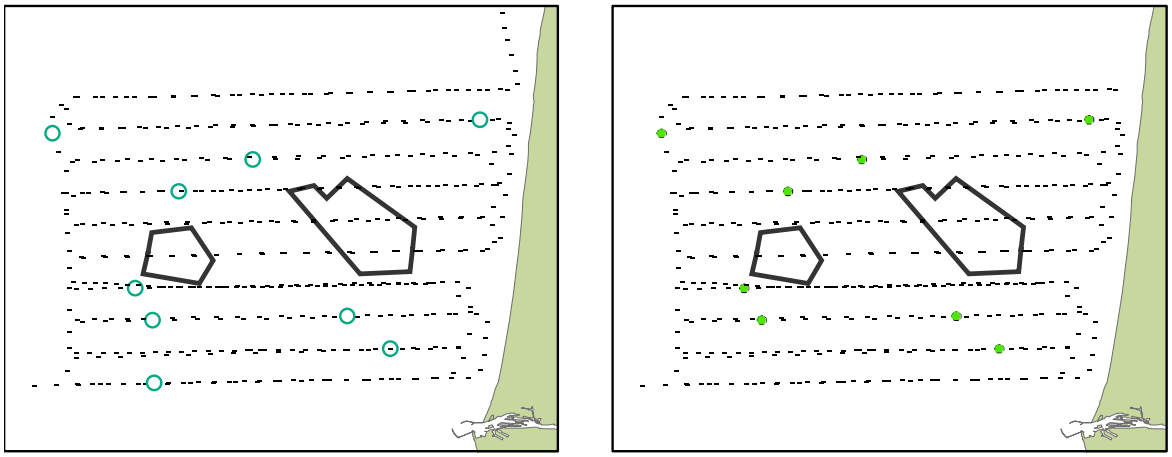
T_0 Aug 2003



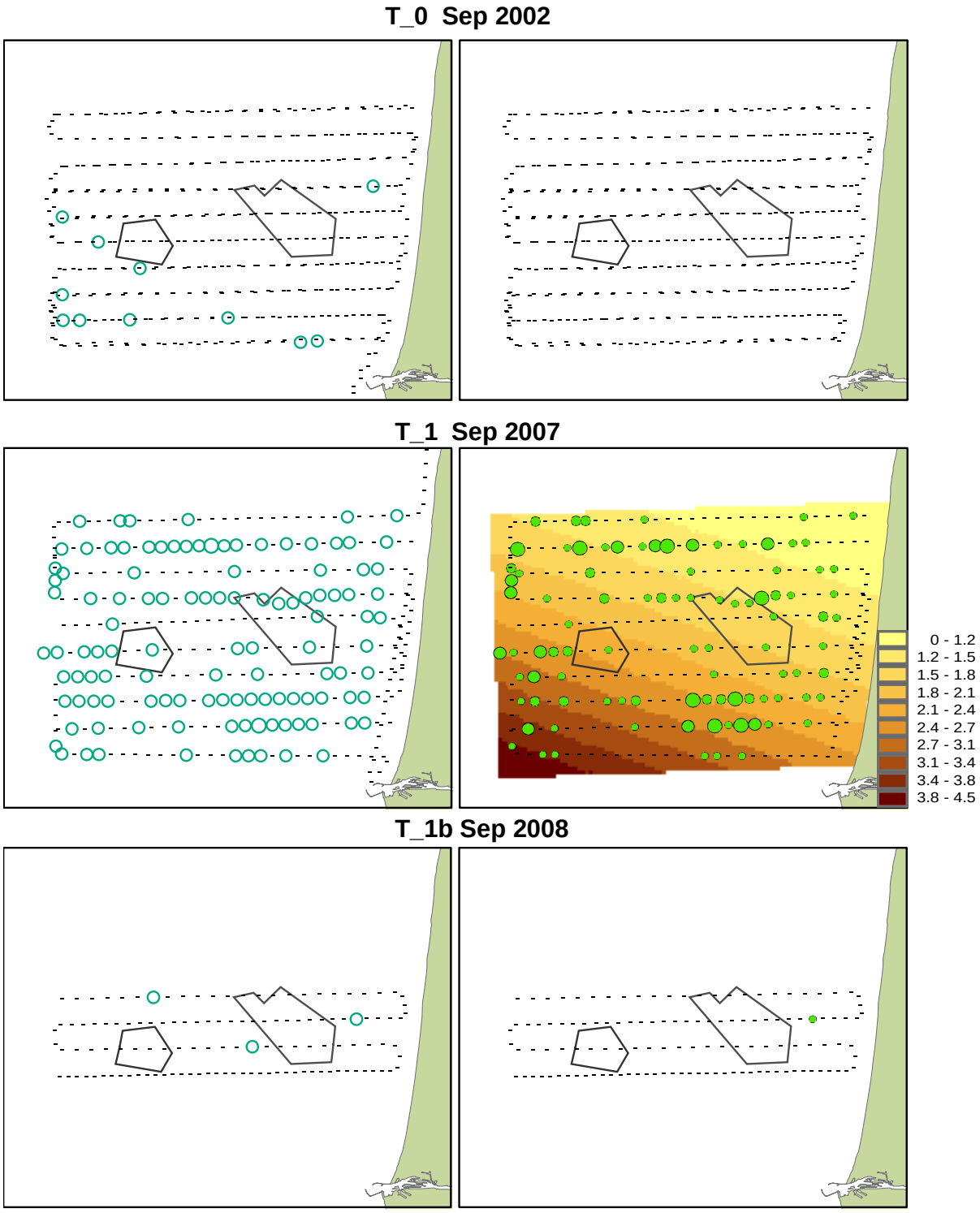
T_1 Aug 2007



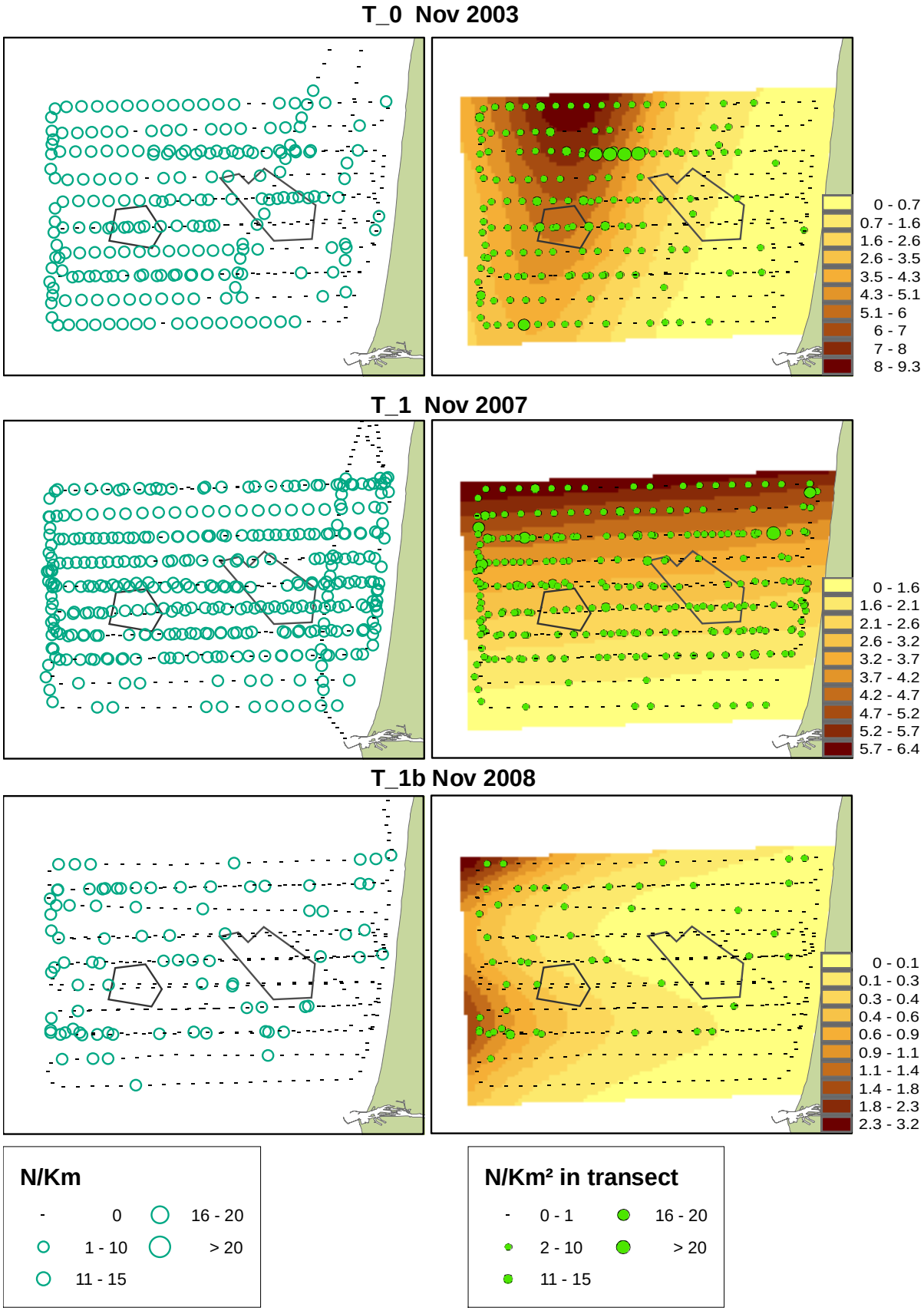
T_1b Aug 2008



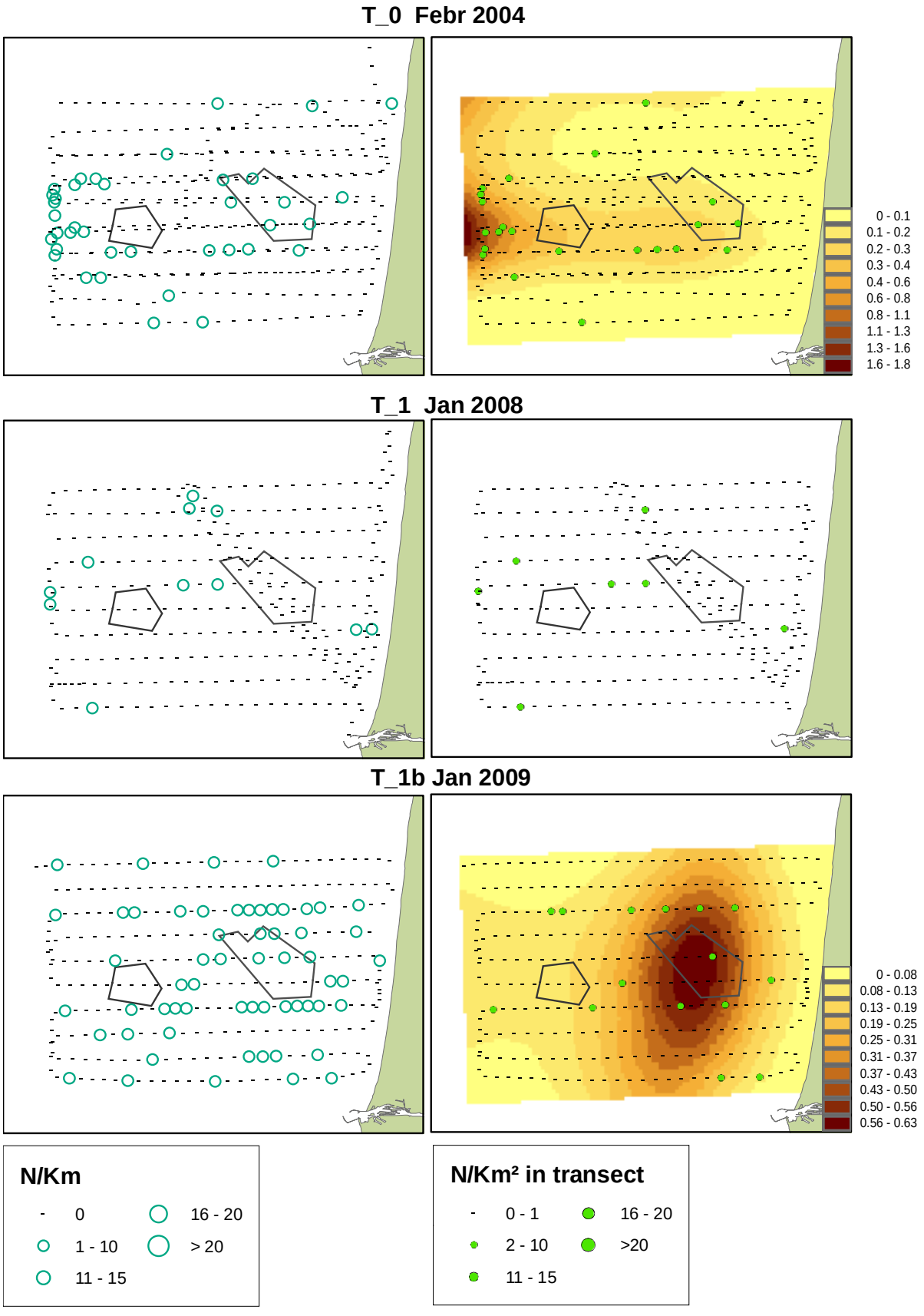
Guillemot


T_0 Sep 2002
T_1 Sep 2007
T_1b Sep 2008
0 - 1.2
1.2 - 1.5
1.5 - 1.8
1.8 - 2.1
2.1 - 2.4
2.4 - 2.7
2.7 - 3.1
3.1 - 3.4
3.4 - 3.8
3.8 - 4.5
N/Km
0
1 - 10
11 - 15
16 - 20
> 20
N/Km² in transect
0 - 1
2 - 10
11 - 15
16 - 20
> 20

Guillemot

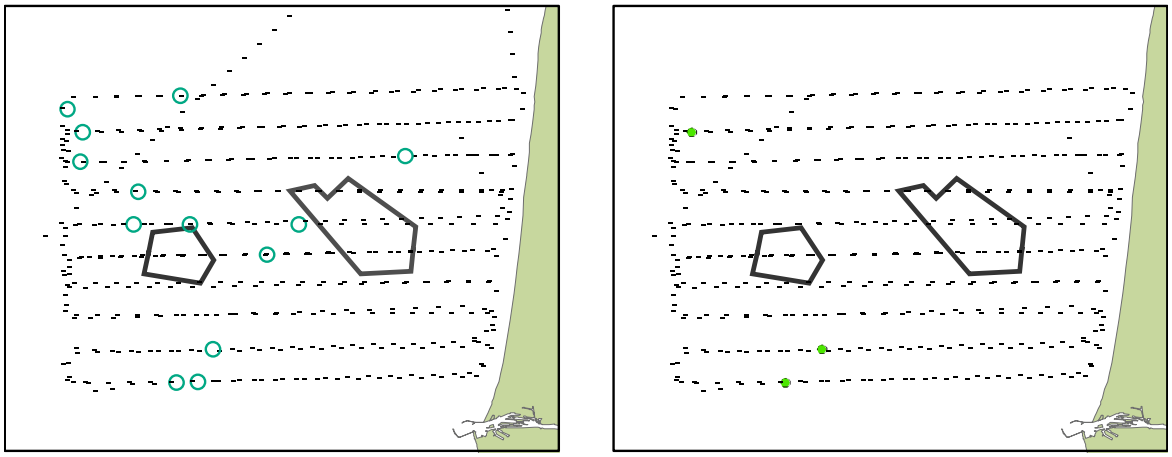

T_0 Nov 2003
0 - 0.7
0.7 - 1.6
1.6 - 2.6
2.6 - 3.5
3.5 - 4.3
4.3 - 5.1
5.1 - 6
6 - 7
7 - 8
8 - 9.3
T_1 Nov 2007
0 - 1.6
1.6 - 2.1
2.1 - 2.6
2.6 - 3.2
3.2 - 3.7
3.7 - 4.2
4.2 - 4.7
4.7 - 5.2
5.2 - 5.7
5.7 - 6.4
T_1b Nov 2008
0 - 0.1
0.1 - 0.3
0.3 - 0.4
0.4 - 0.6
0.6 - 0.9
0.9 - 1.1
1.1 - 1.4
1.4 - 1.8
1.8 - 2.3
2.3 - 3.2
N/Km
0
1 - 10
11 - 15
16 - 20
> 20
N/Km² in transect
0 - 1
2 - 10
11 - 15
16 - 20
> 20

Razorbill

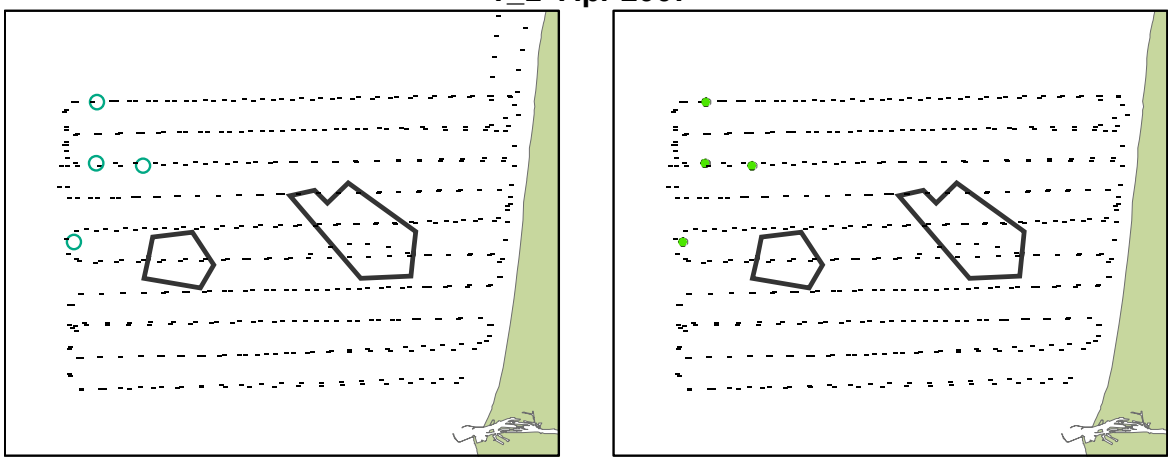

T_0 Febr 2004
0 - 0.1
0.1 - 0.2
0.2 - 0.3
0.3 - 0.4
0.4 - 0.6
0.6 - 0.8
0.8 - 1.1
1.1 - 1.3
1.3 - 1.6
1.6 - 1.8
T_1 Jan 2008
T_1b Jan 2009
0 - 0.08
0.08 - 0.13
0.13 - 0.19
0.19 - 0.25
0.25 - 0.31
0.31 - 0.37
0.37 - 0.43
0.43 - 0.50
0.50 - 0.56
0.56 - 0.63
N/Km
0
1 - 10
11 - 15
16 - 20
> 20
N/Km² in transect
0 - 1
2 - 10
11 - 15
16 - 20
>20

Razorbill

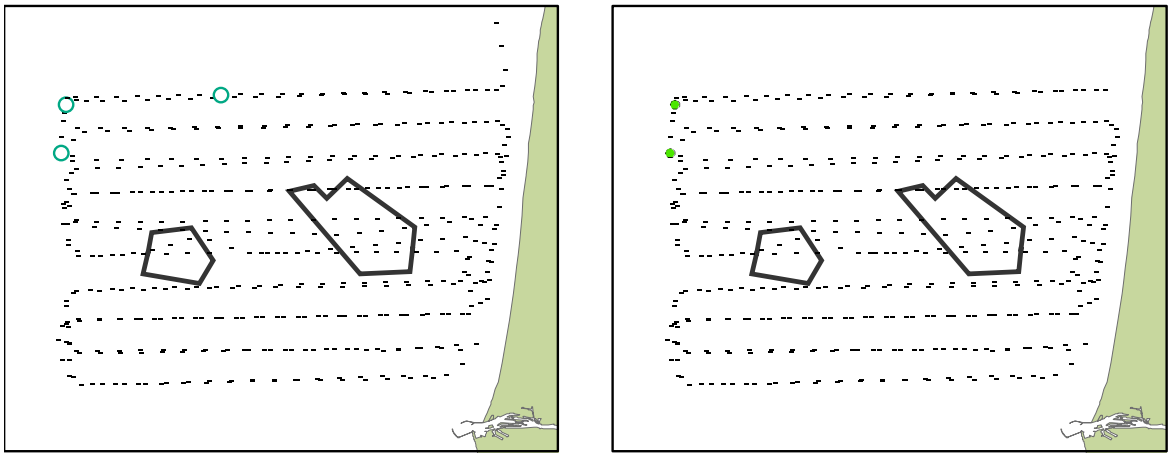
T_0 Apr 2003



T_1 Apr 2007

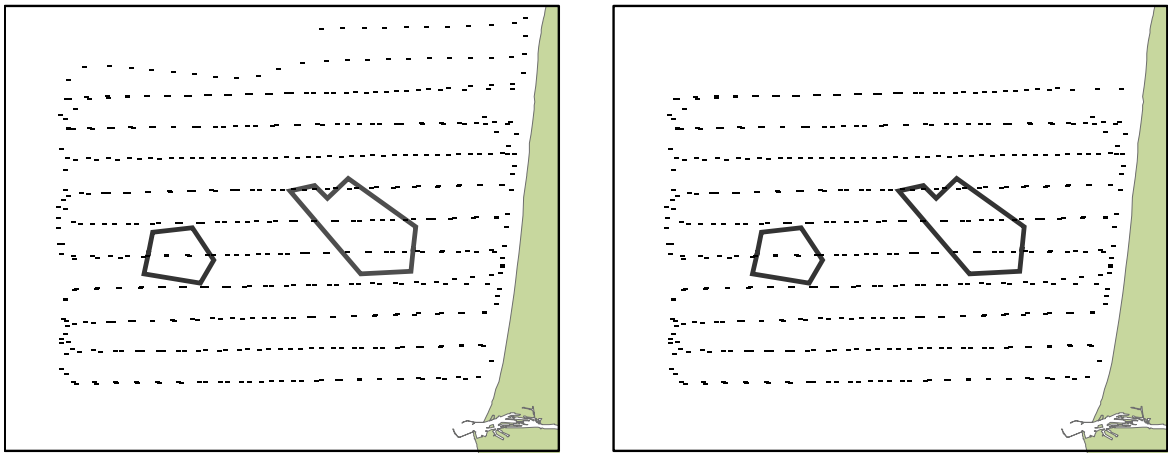


T_1b Apr 2008

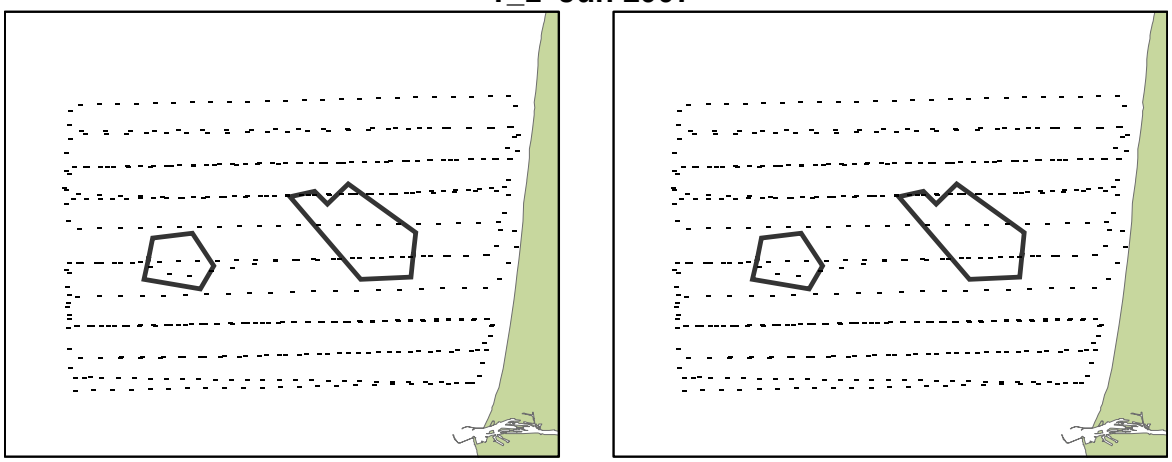


Razorbill

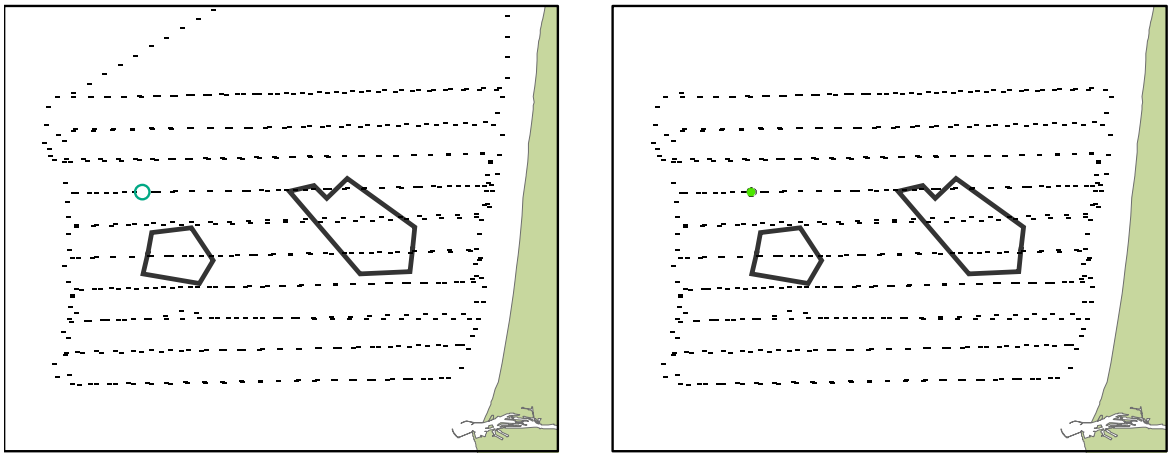
T_0 Jun 2003



T_1 Jun 2007

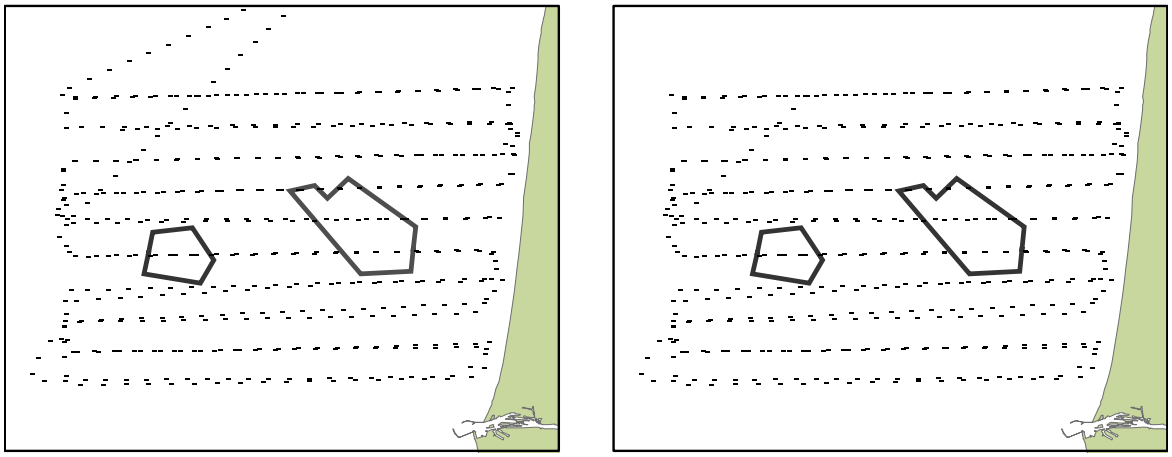


T_1b Jun 2008

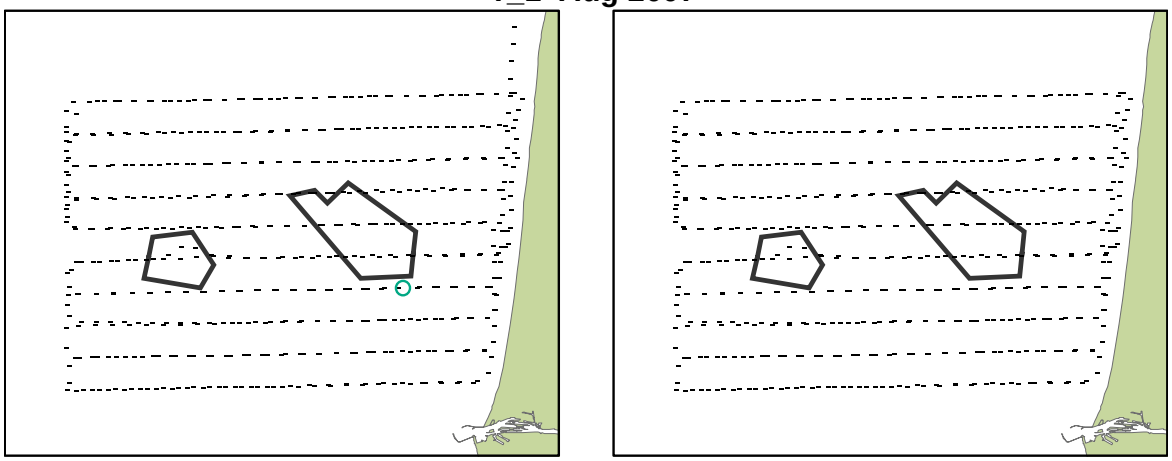


Razorbill

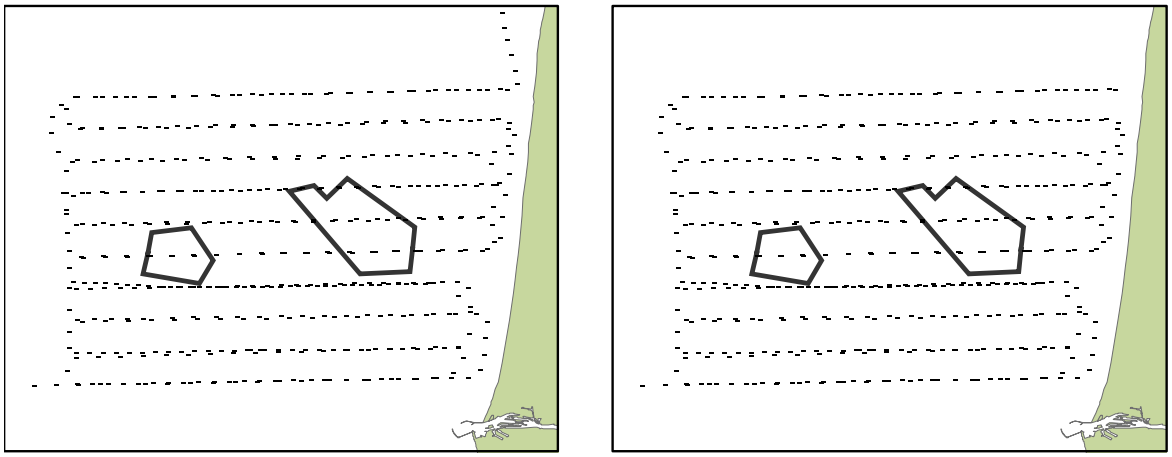
T_0 Aug 2003



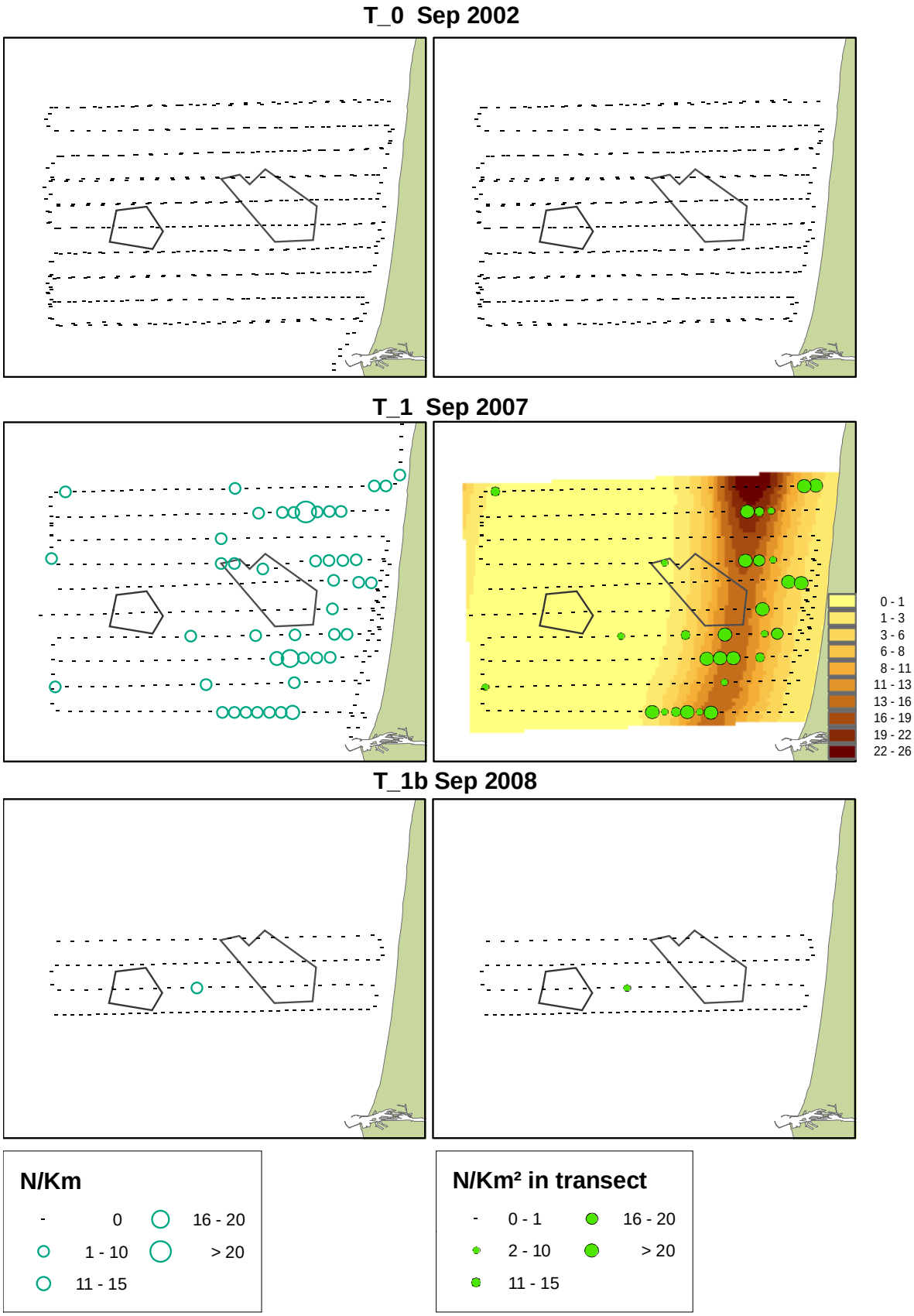
T_1 Aug 2007



T_1b Aug 2008

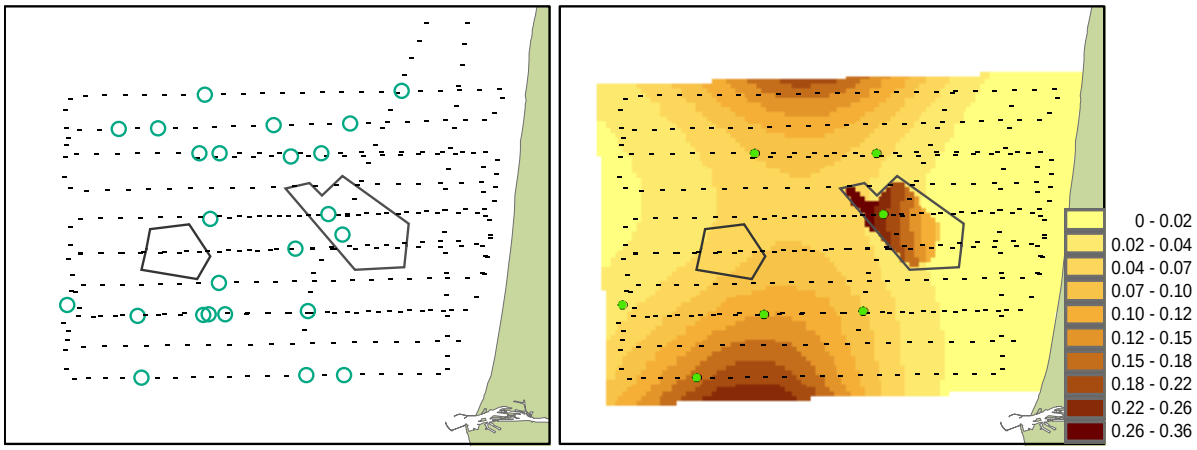


Razorbill

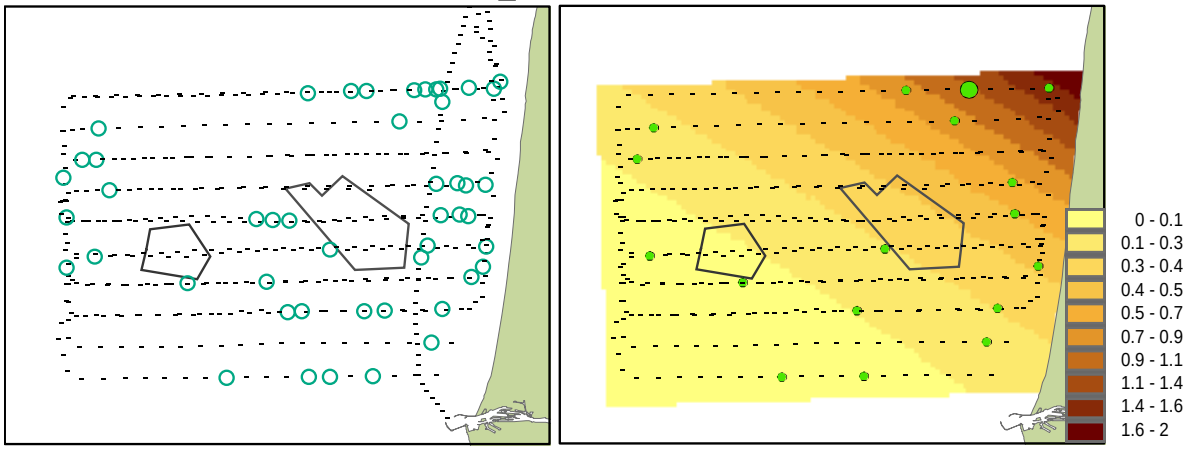

T_0 Sep 2002
T_1 Sep 2007
0 - 1
1 - 3
3 - 6
6 - 8
8 - 11
11 - 13
13 - 16
16 - 19
19 - 22
22 - 26
T_1b Sep 2008
N/Km
0
1 - 10
11 - 15
16 - 20
> 20
N/Km² in transect
0 - 1
2 - 10
11 - 15
16 - 20
> 20

Razorbill

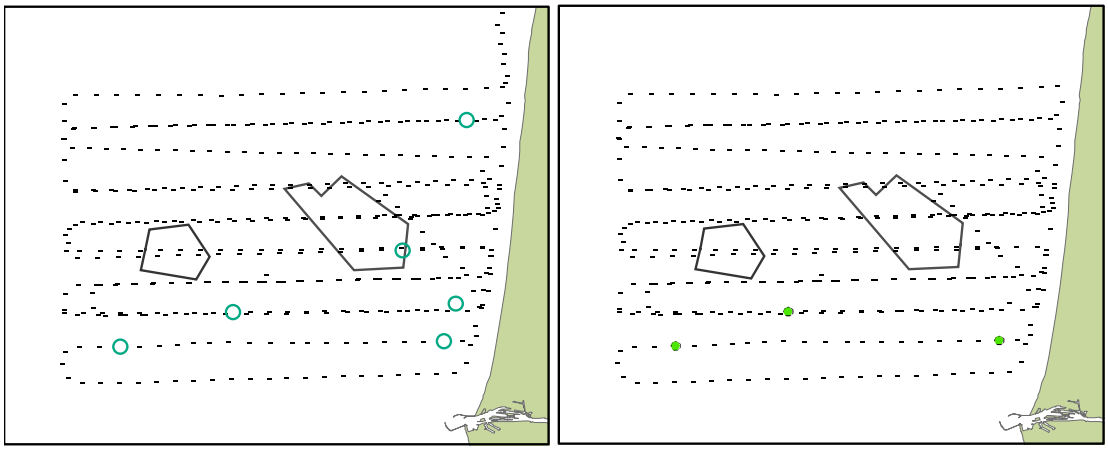
T_0 Nov 2003



T_1 Nov 2007



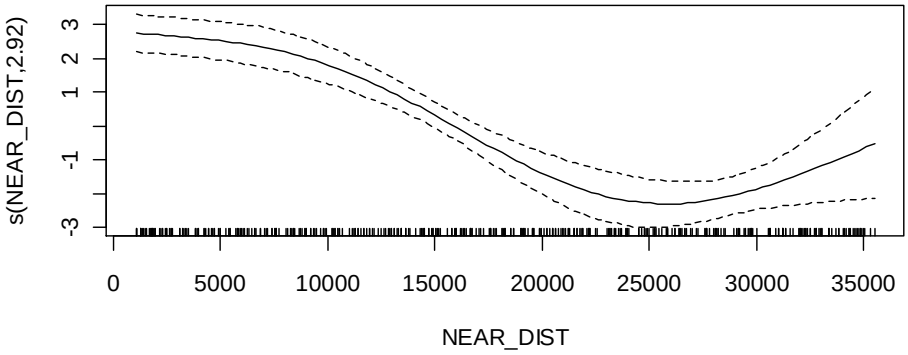
T_1b Nov 2008

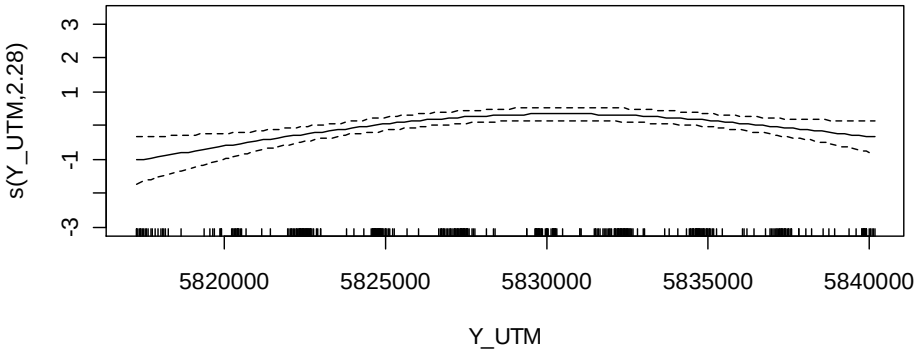


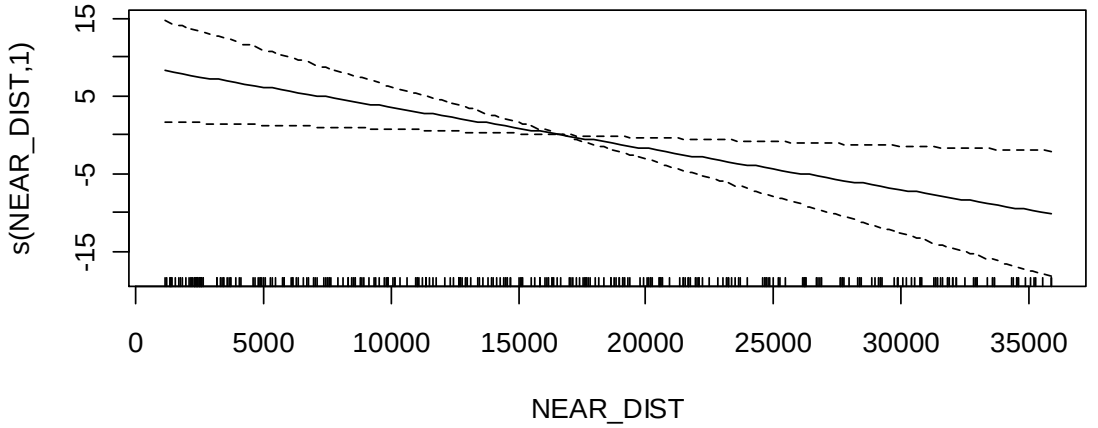
Appendix II – Distribution maps and modeling results

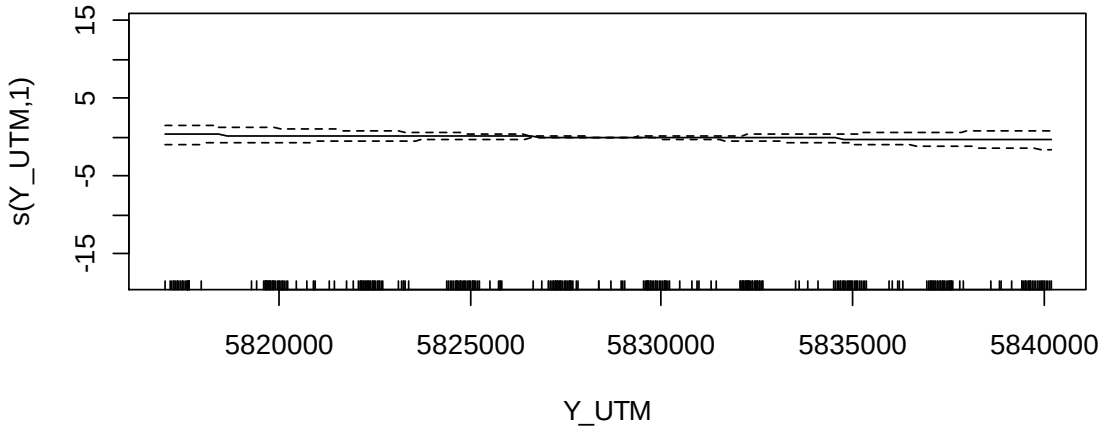
On the following pages, the relative influences of the smoothers distance to coast (near_dist) and northing (UTM) are depicted, with confidence intervals. Lines that run horizontally over the entire range of values indicate no influence along the gradient. Positive values indicate relative concentrations; negative values indicate relative low numbers of birds at that particular distance.

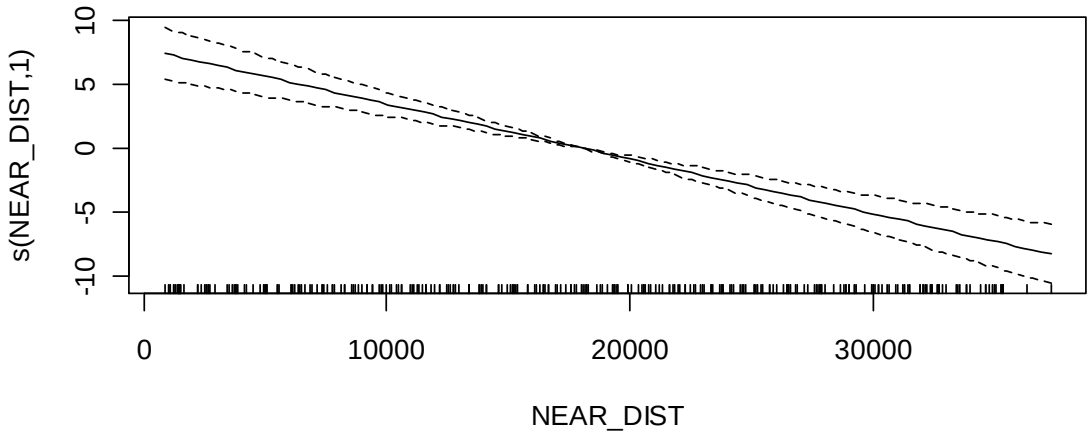
Divers 2004_2 gam

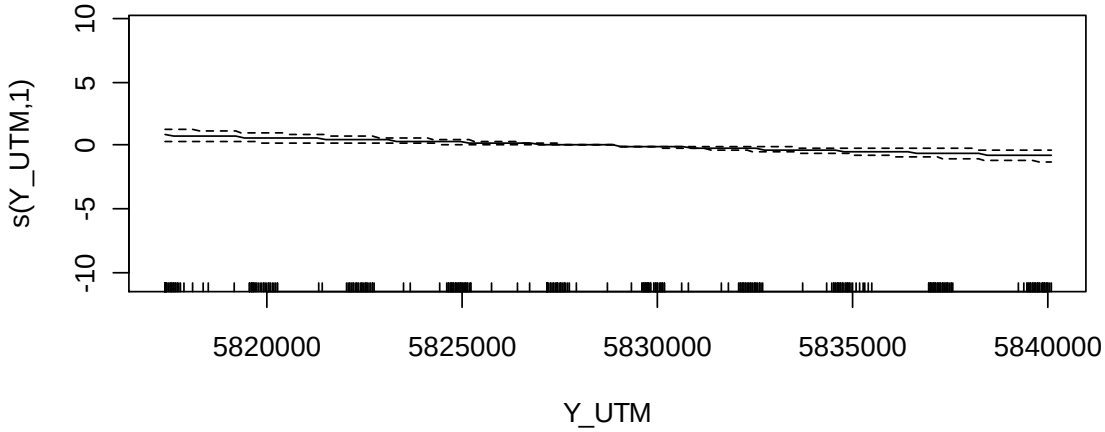


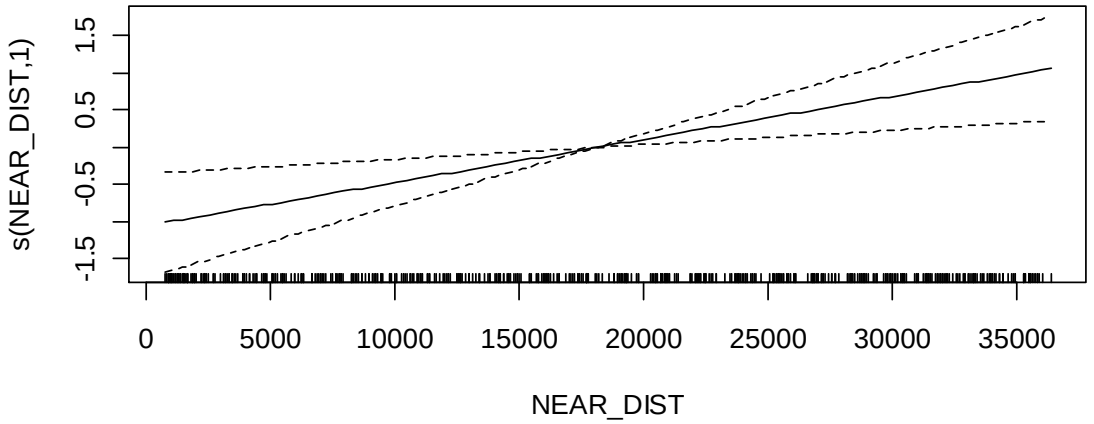


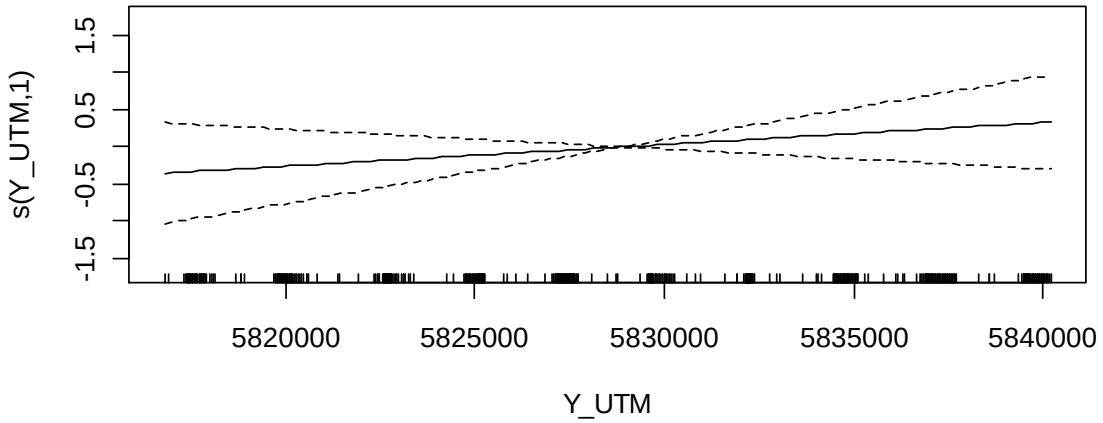

s(NEAR_DIST,1)
15
5
-5
-15
0
5000
10000
15000
20000
25000
30000
35000
NEAR_DIST


s(Y_UTM,1)
15
5
-5
-15
5820000
5825000
5830000
5835000
5840000
Y_UTM

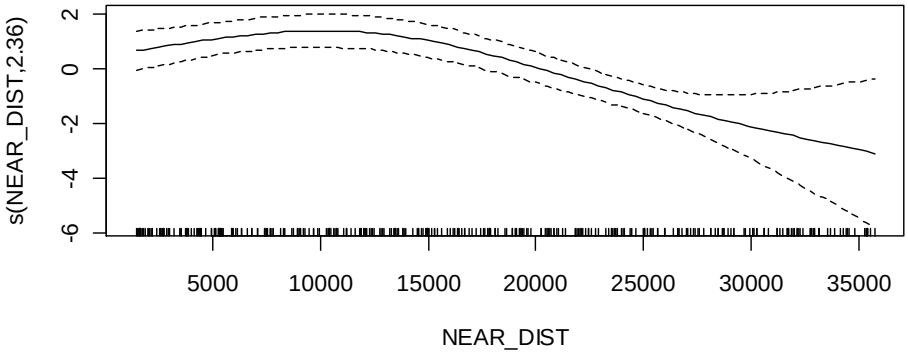

s(NEAR_DIST,1)
10
5
0
-5
-10
0
10000
20000
30000
NEAR_DIST

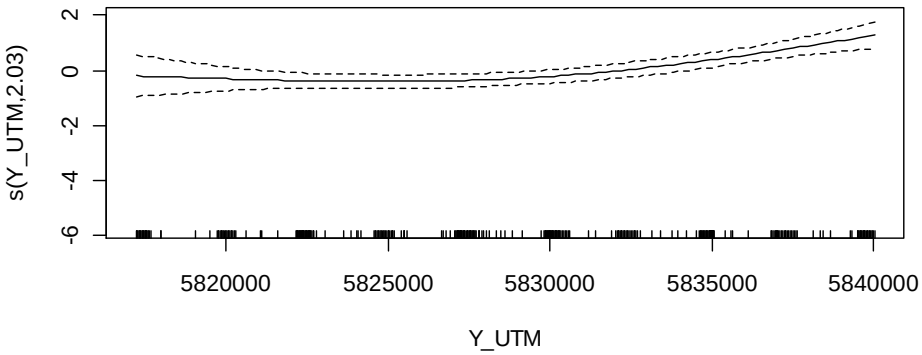

s(Y_UTM,1)
10
5
0
-5
-10
5820000
5825000
5830000
5835000
5840000
Y_UTM

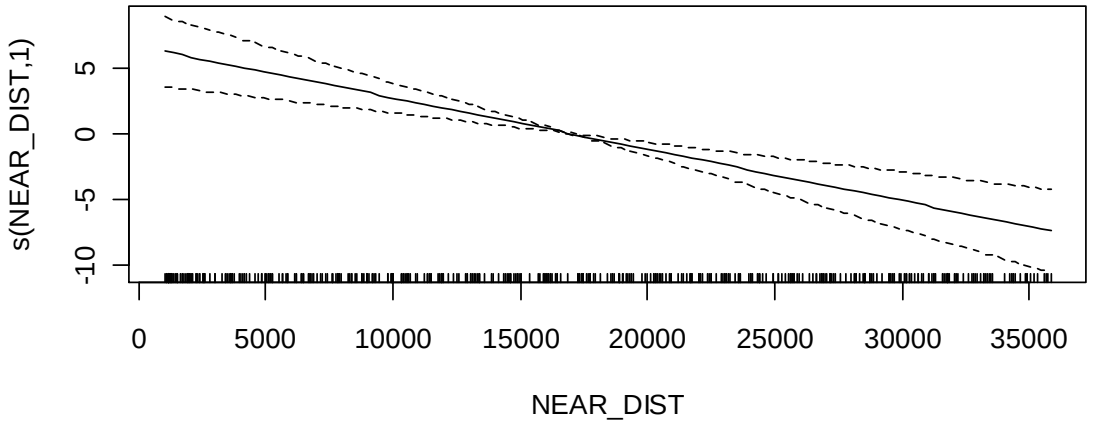

s(NEAR_DIST,1)
-1.5
-0.5
0.5
1.5
0
5000
10000
15000
20000
25000
30000
35000
NEAR_DIST


s(Y_UTM,1)
-1.5
-0.5
0.5
1.5
5820000
5825000
5830000
5835000
5840000
Y_UTM

Divers 2003_11 gamm



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10000
15000
20000
25000
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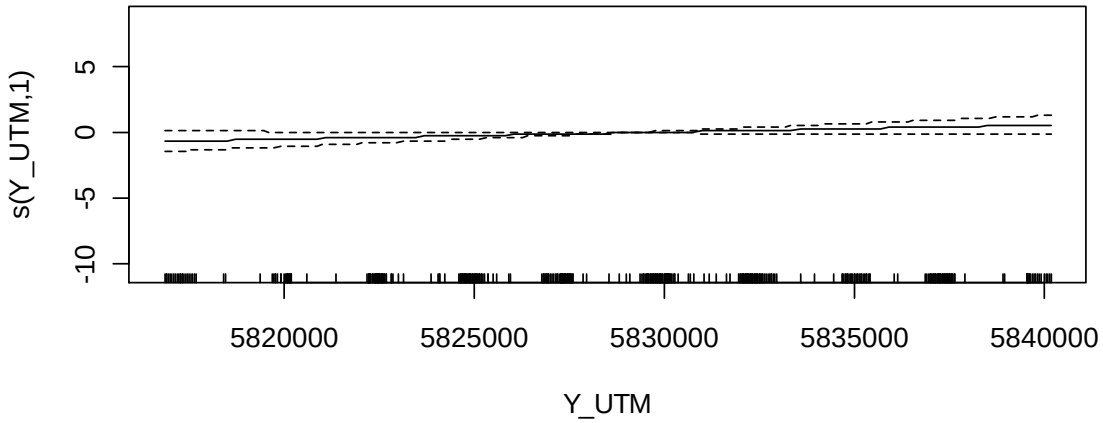
NEAR_DIST


s(Y_UTM,1)
5
0
-5
-10
5820000
5825000
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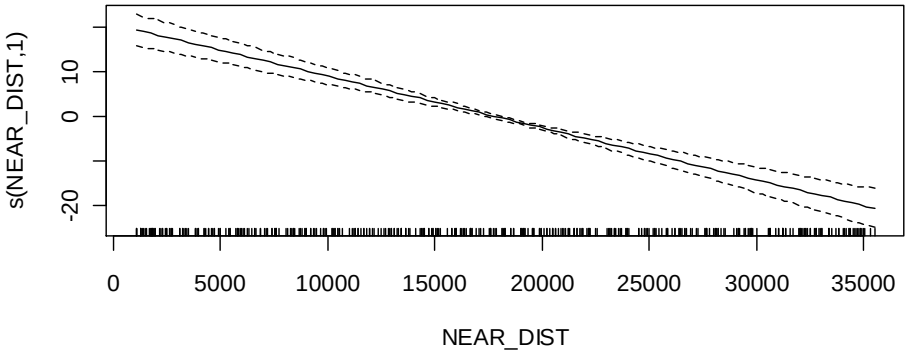
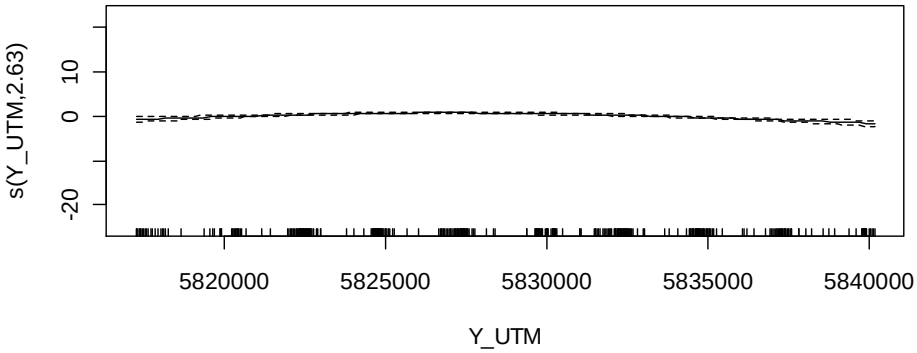
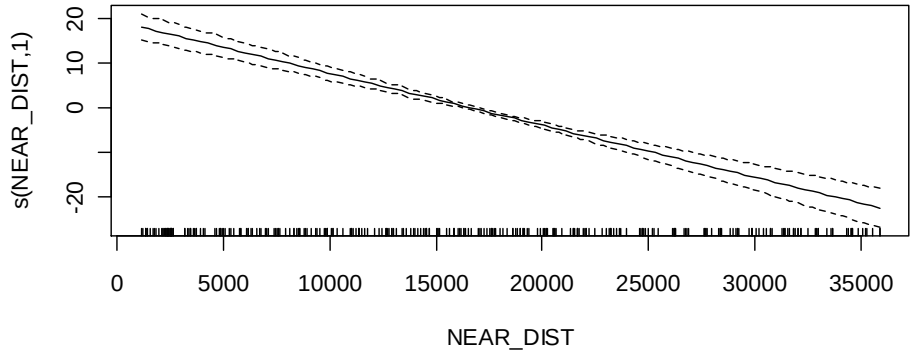
5835000
5840000
Y_UTM

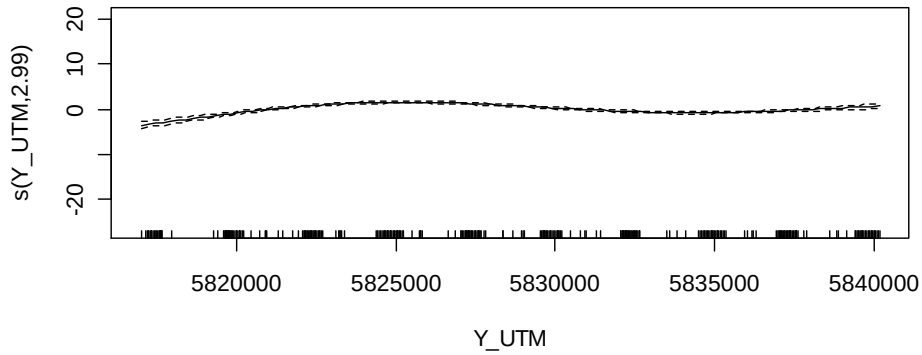
Great Crested Grebe 2004_2 gam



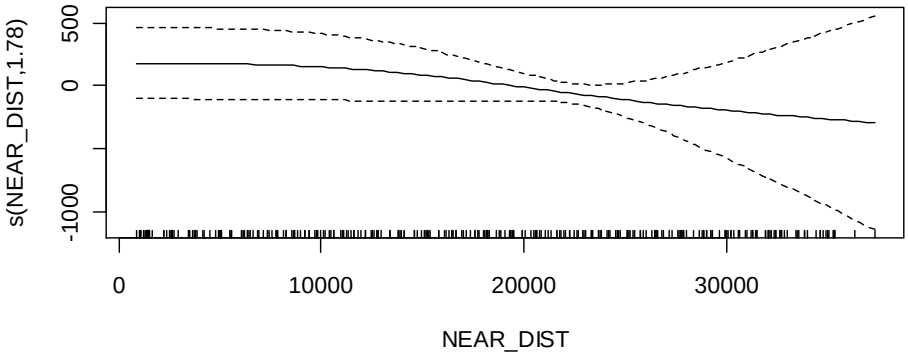


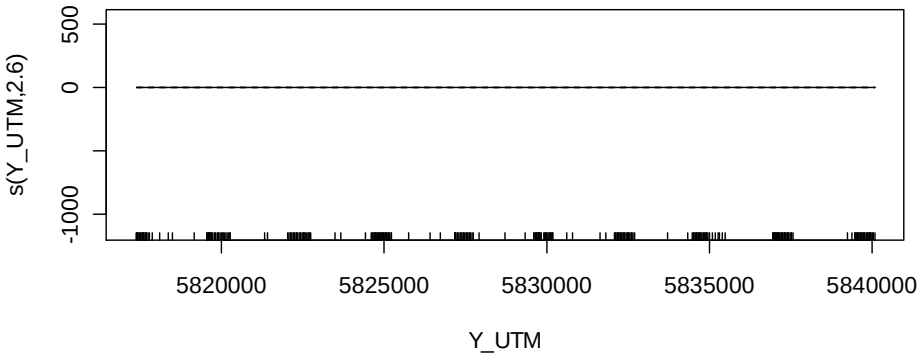
Great Crested Grebe 2008_1 gam



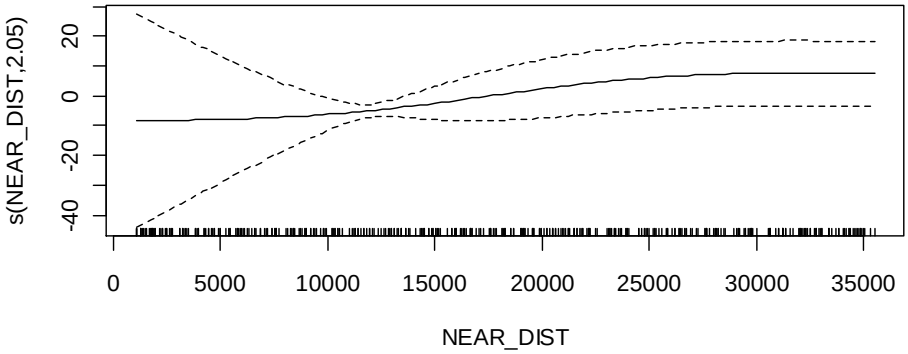


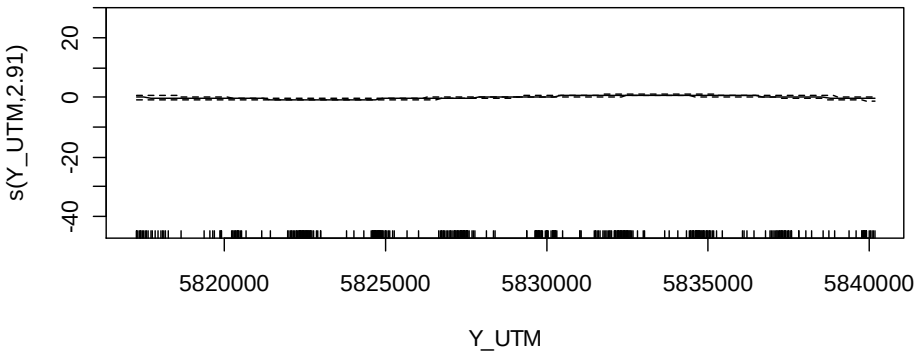
Great Crested Grebe 2009_1 gam

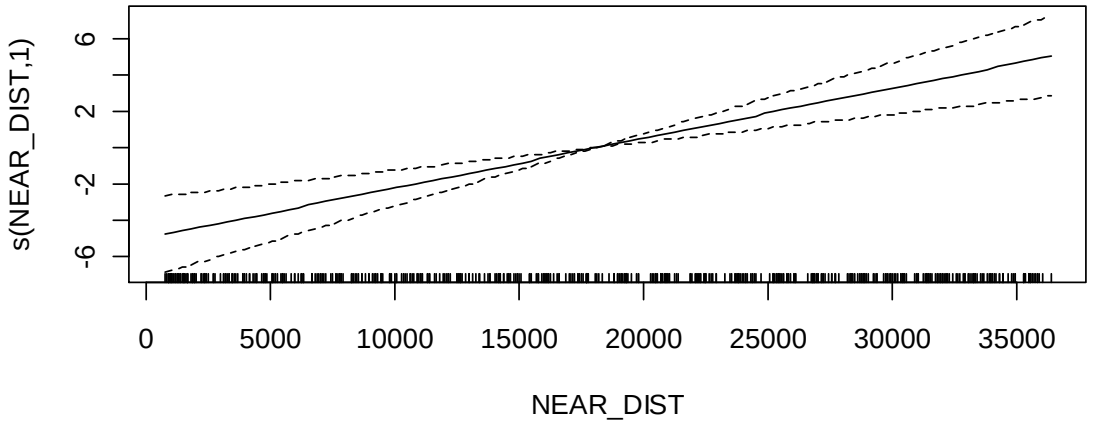




Fulmar 2004_2 gam



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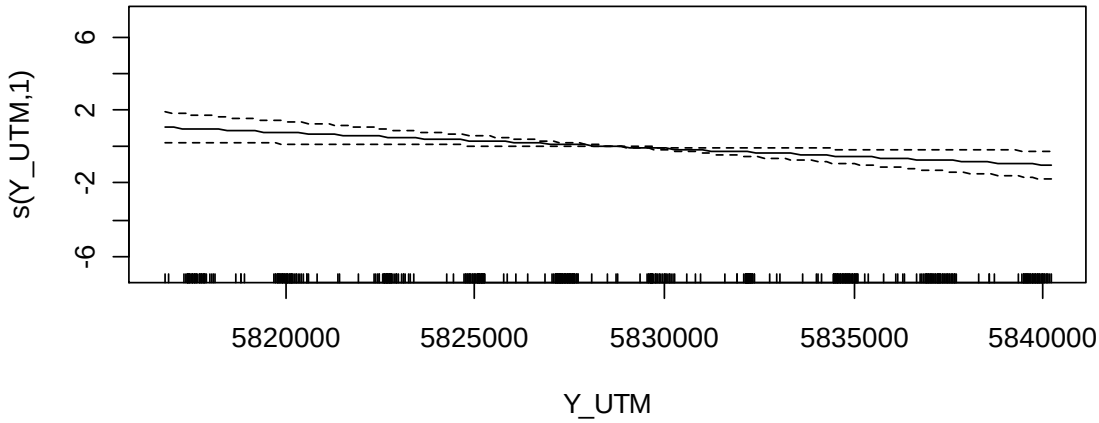
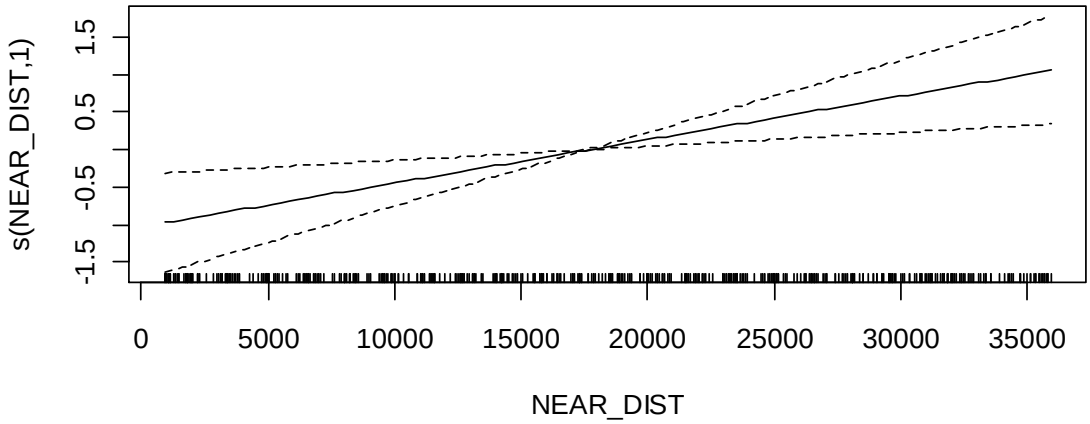
20000
25000
30000
35000
NEAR_DIST


s(Y_UTM,1)
6
2
-2
-6
5820000
5825000
5830000
5835000
5840000
Y_UTM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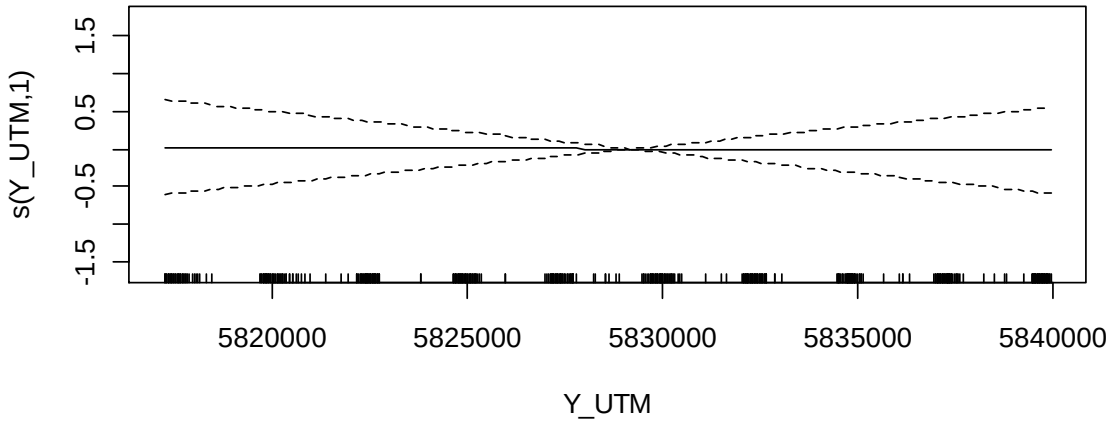
0.5
1.5
0
5000
10000
15000
20000
25000
30000
35000
NEAR_DIST


s(Y_UTM,1)
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0.5
1.5
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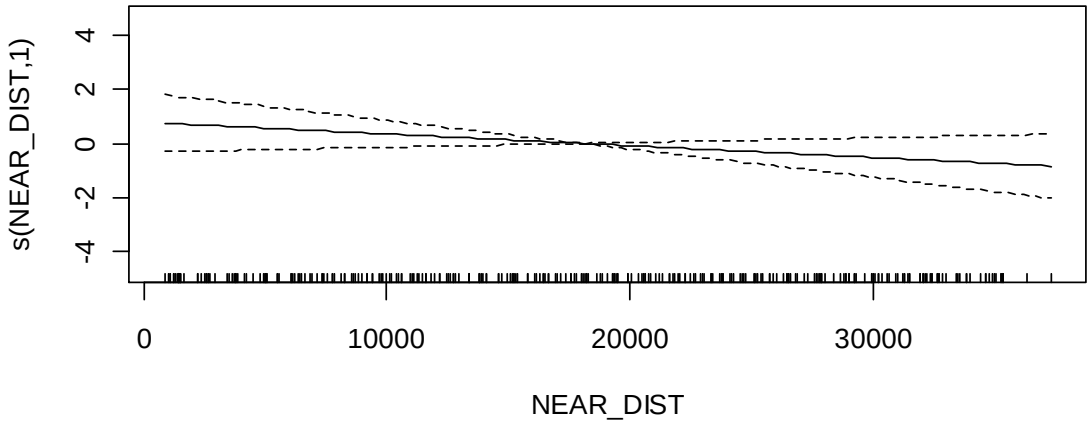
5825000
5830000
5835000
5840000
Y_UTM


s(NEAR_DIST,1)
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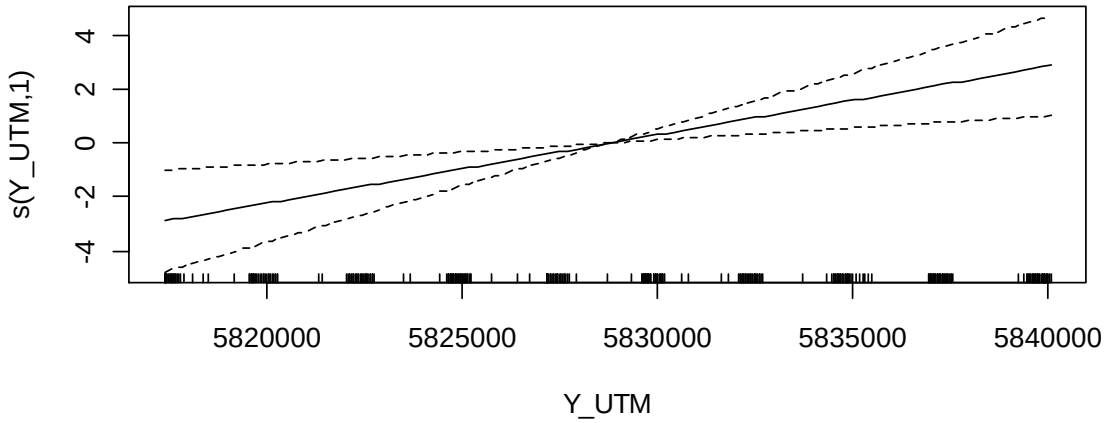
20000
30000
NEAR_DIST


s(Y_UTM,1)
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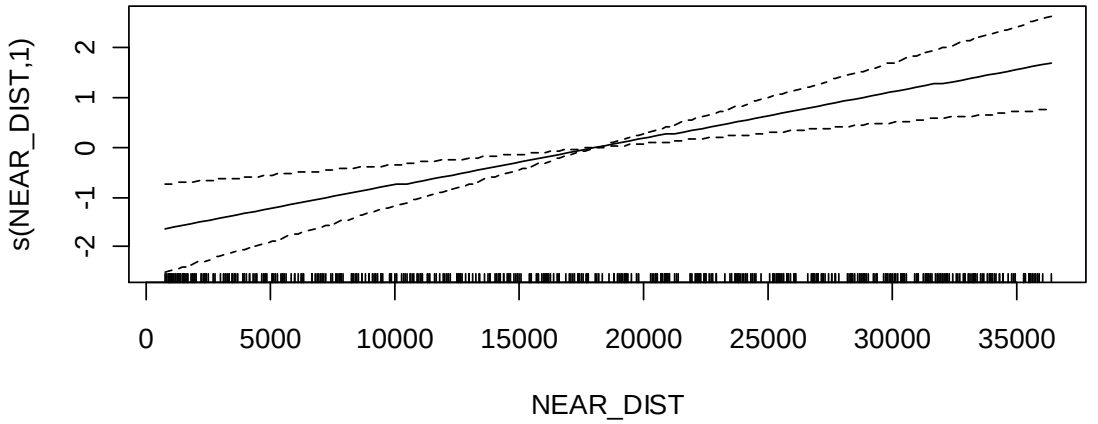
0
2
4
5820000
5825000
5830000
5835000
5840000
Y_UTM


s(NEAR_DIST,1)
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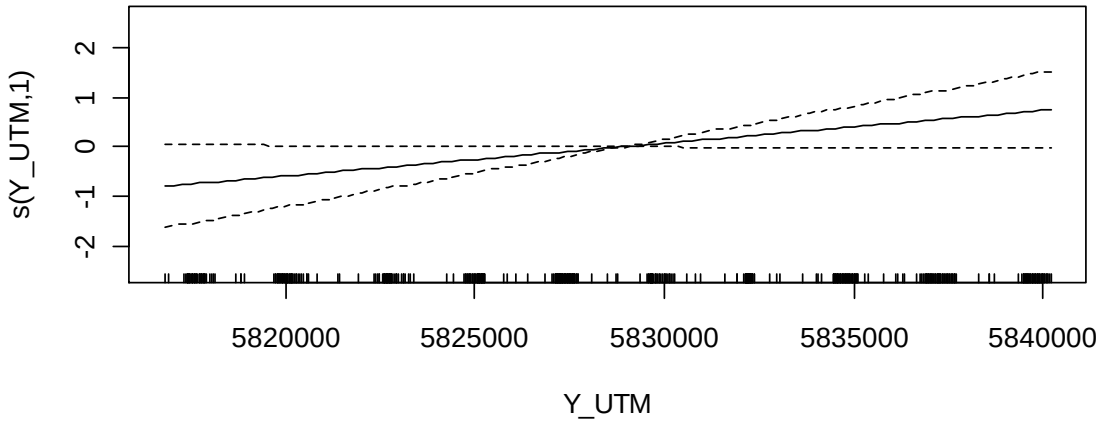
0
1
2
0
5000
10000
15000
20000
25000
30000
35000
NEAR_DIST


s(Y_UTM,1)
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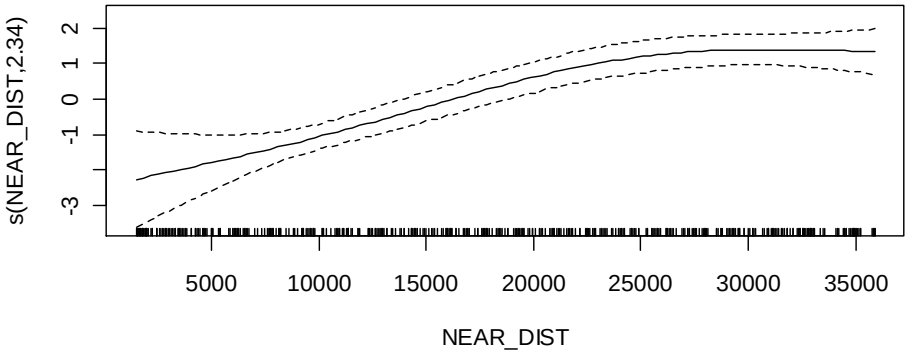
-1
0
1
2
5820000
5825000
5830000
5835000
5840000
Y_UTM


s(NEAR_DIST,2.34)
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1
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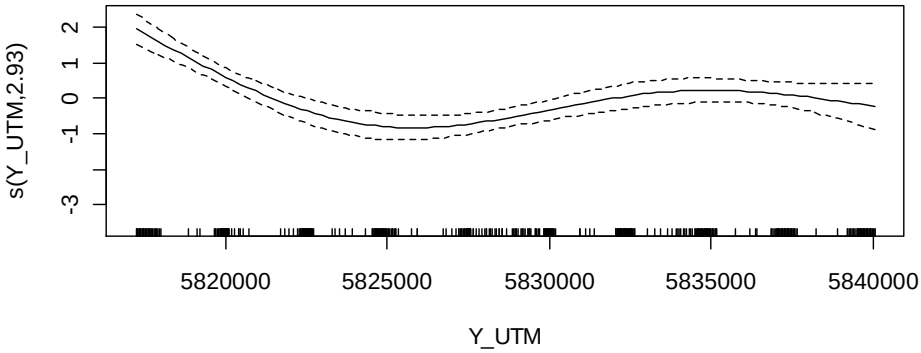
15000
20000
25000
30000
35000
NEAR_DIST


s(Y_UTM,2.93)
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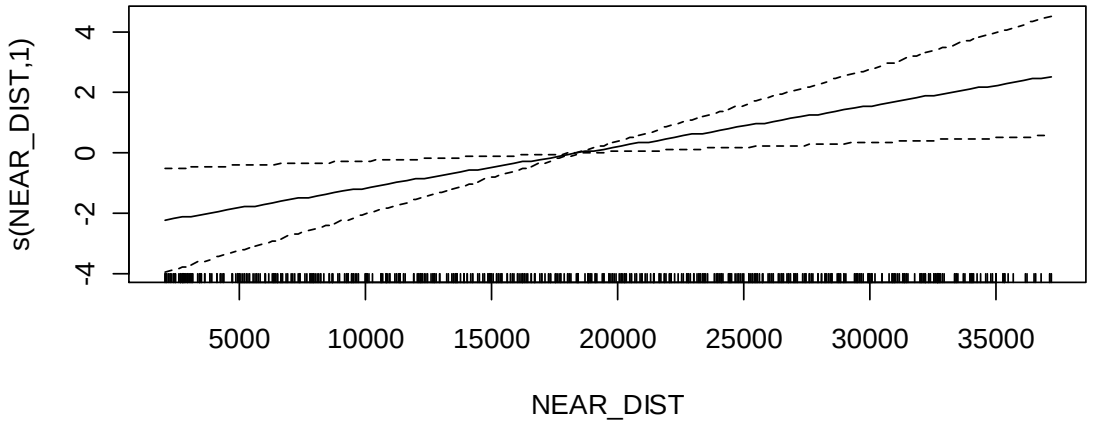
-1
0
1
2
5820000
5825000
5830000
5835000
5840000
Y_UTM


s(NEAR_DIST,1)
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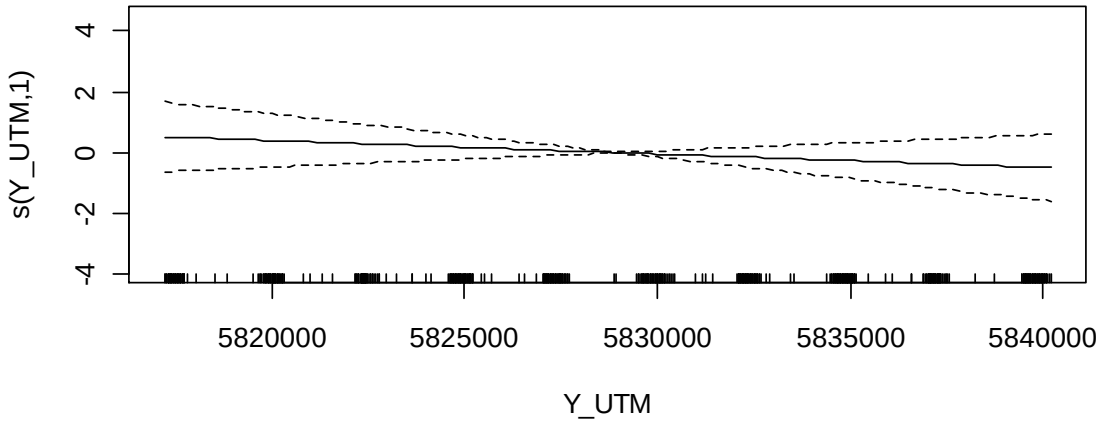
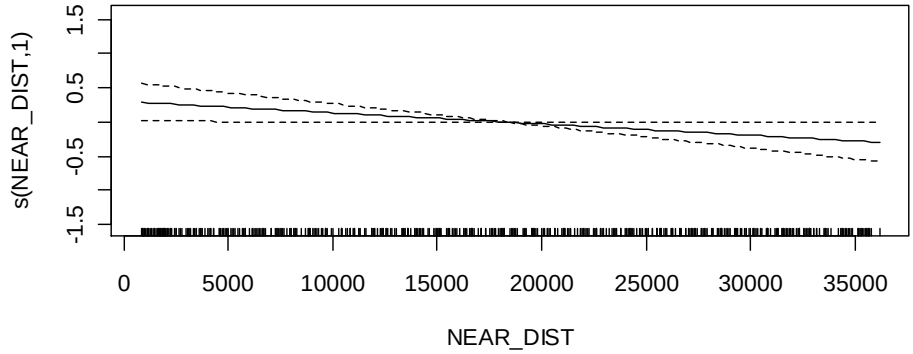
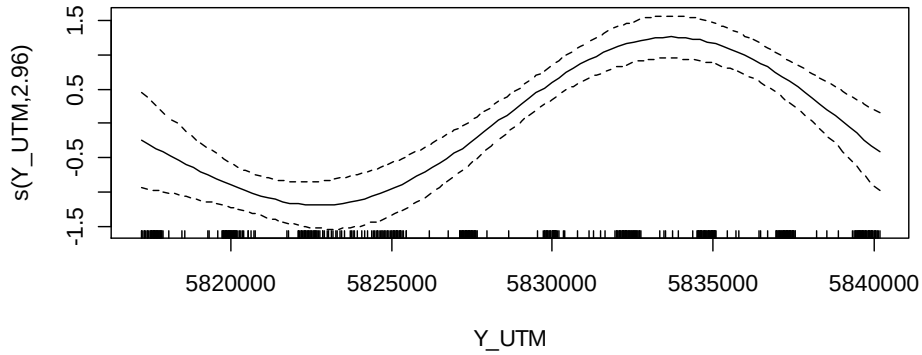
-2
0
2
4
5000
10000
15000
20000
25000
30000
35000
NEAR_DIST

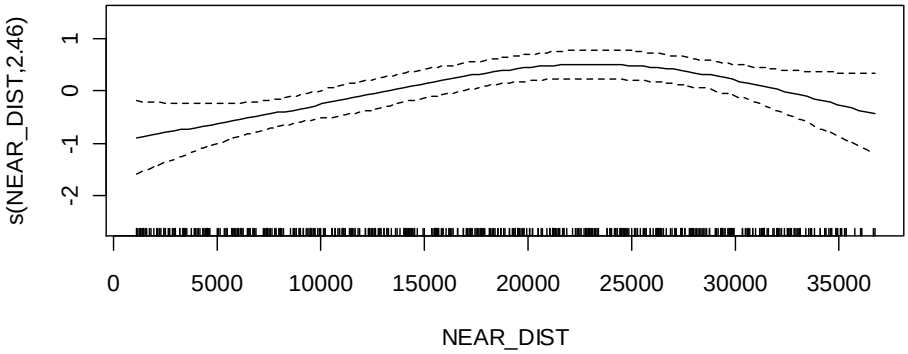

s(Y_UTM,1)
-4
-2
0
2
4
5820000
5825000
5830000
5835000
5840000
Y_UTM

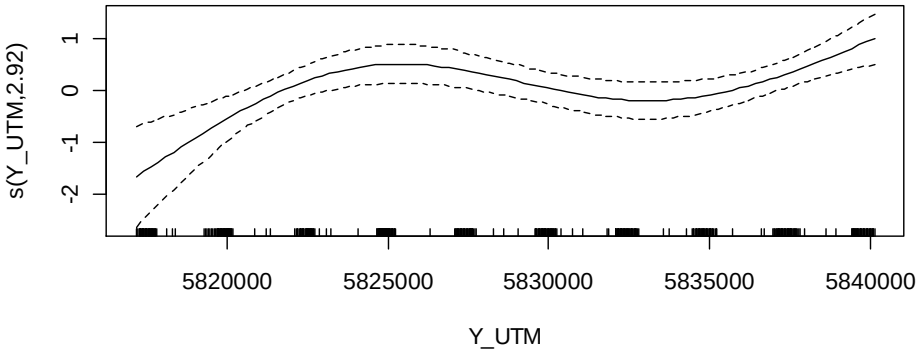
Gannet 2003_8 gam



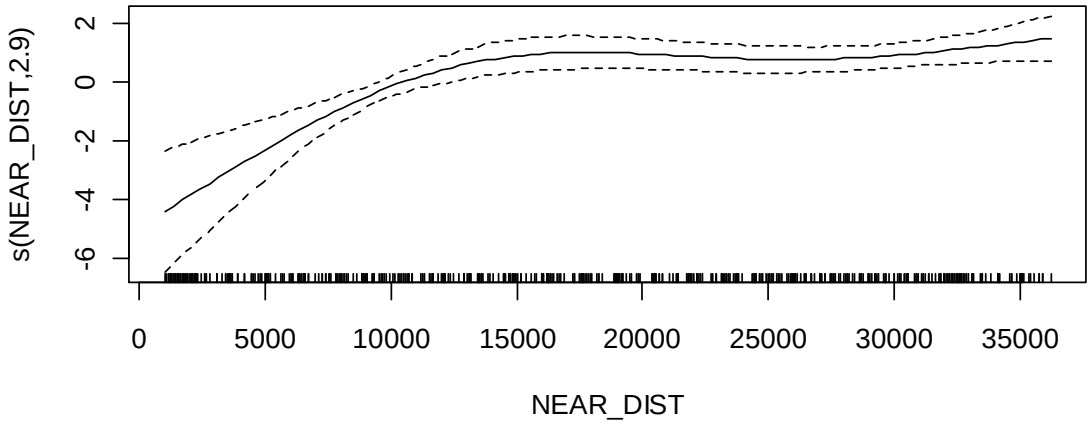


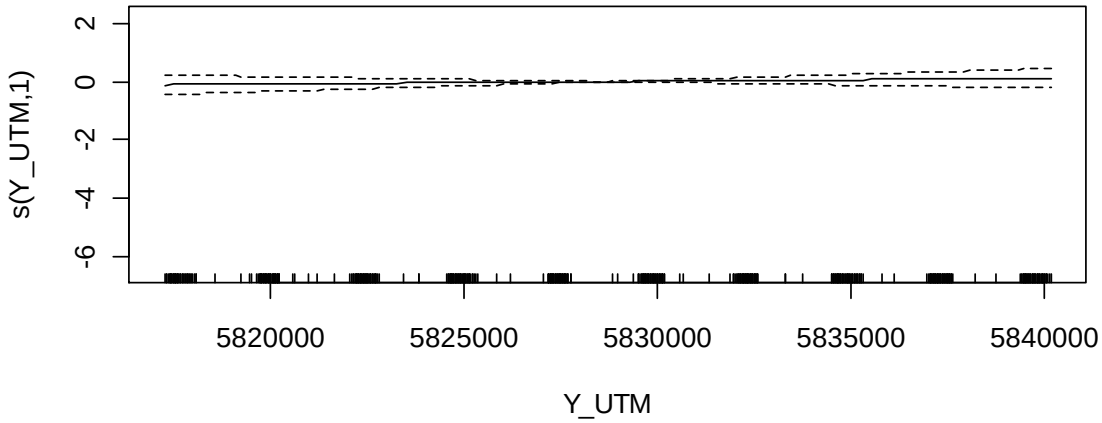
Gannet 2008_8 gam

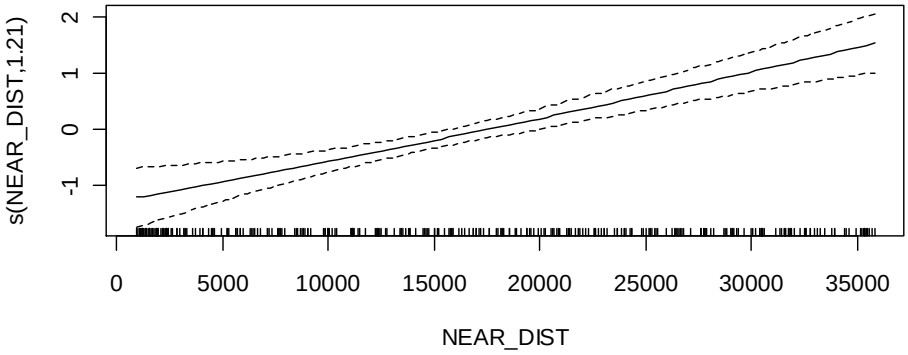




Gannet 2002_9_gam






s(NEAR_DIST,1.21)
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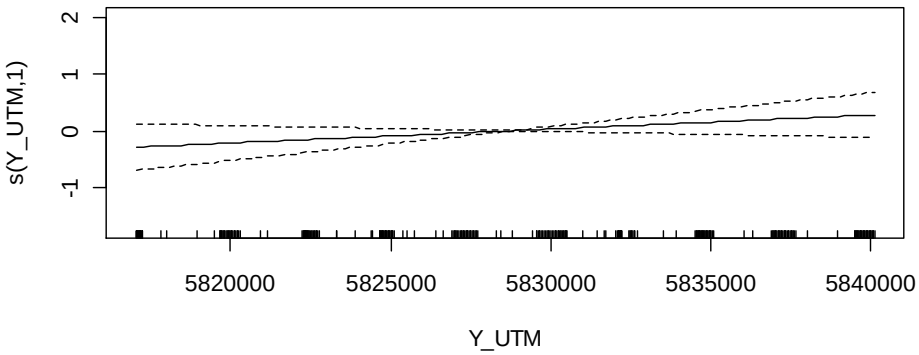
1
2
0
5000
10000
15000
20000
25000
30000
35000
NEAR_DIST


s(Y_UTM,1)
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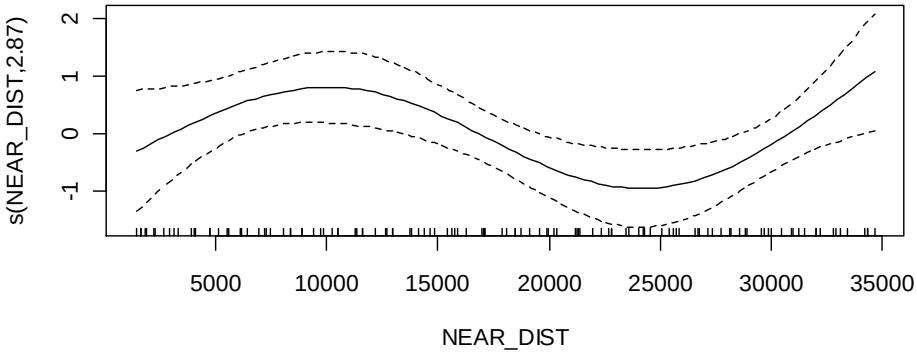
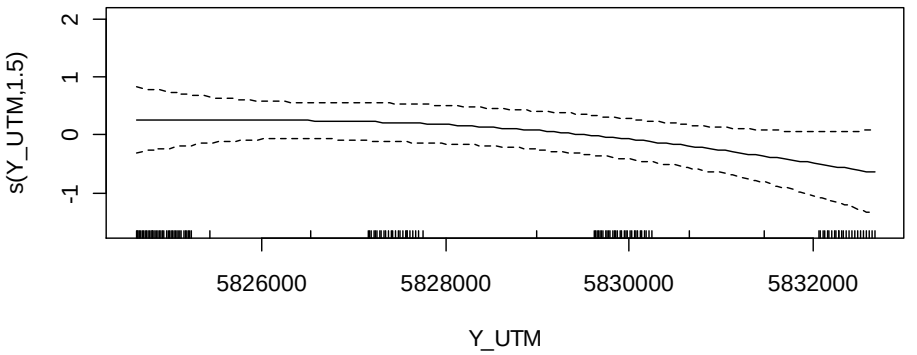
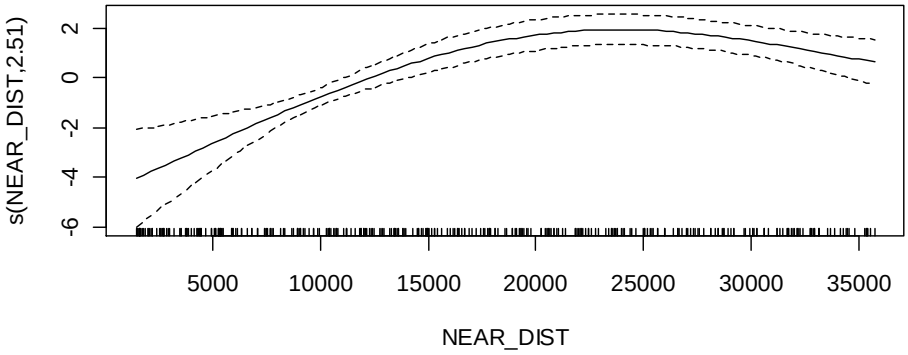
0
1
2
5820000
5825000
5830000
5835000
5840000
Y_UTM

Gannet 2008_9 gam



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-4
-6
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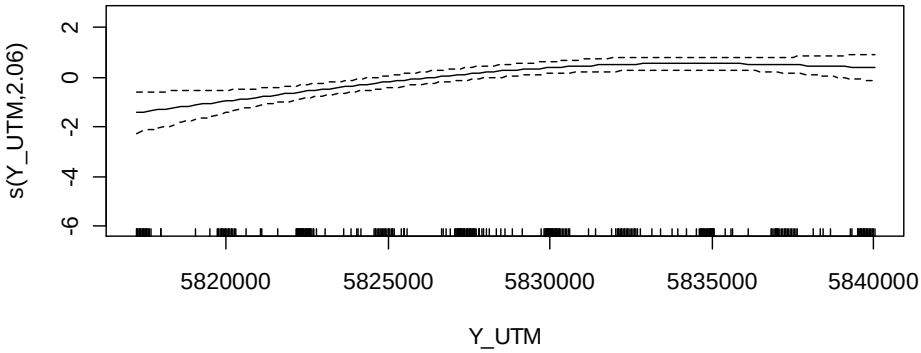
10000
15000
20000
25000
30000
35000
NEAR_DIST


s(Y_UTM,2.06)
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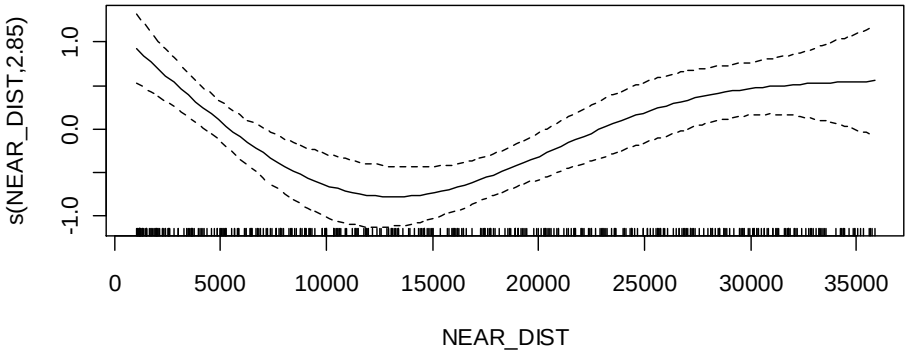
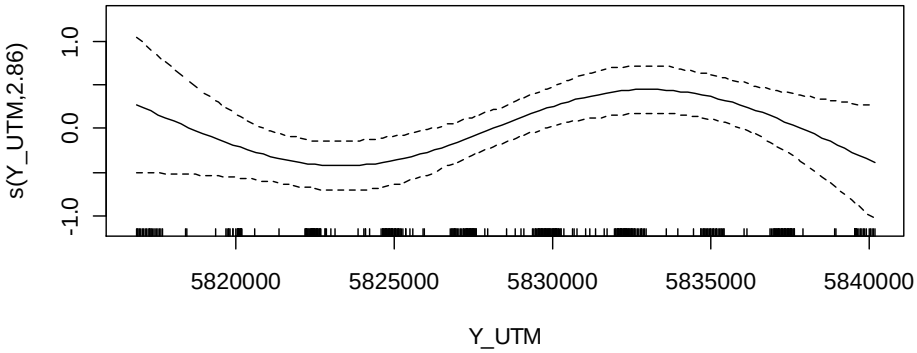
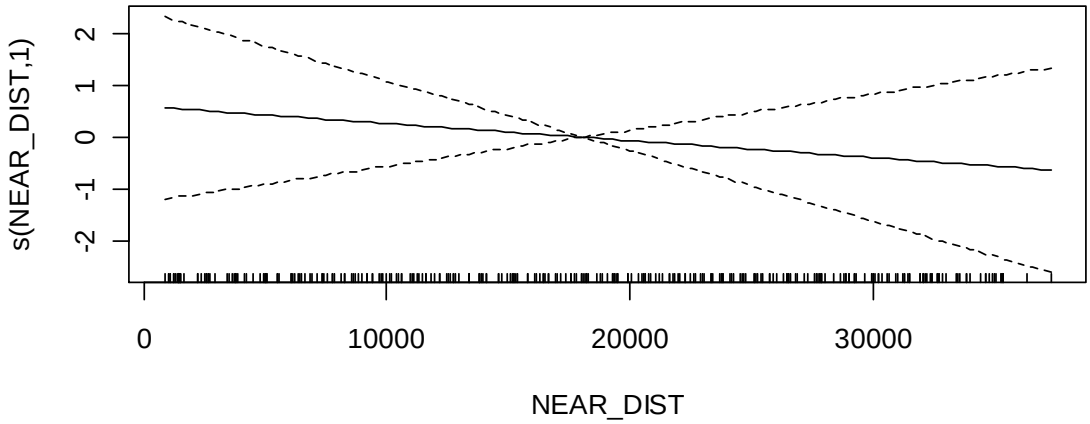
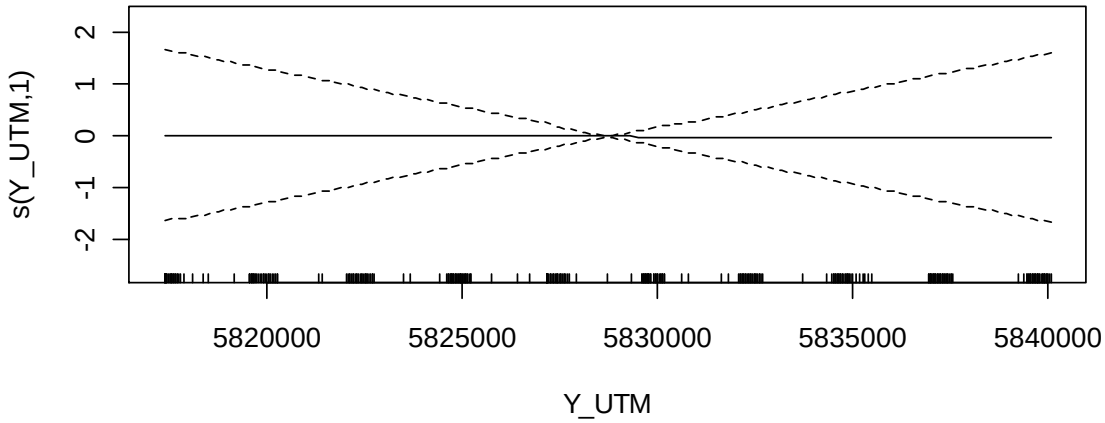
0
-2
-4
-6
5820000
5825000
5830000
5835000
5840000
Y_UTM

Gannet 2008_11 gam

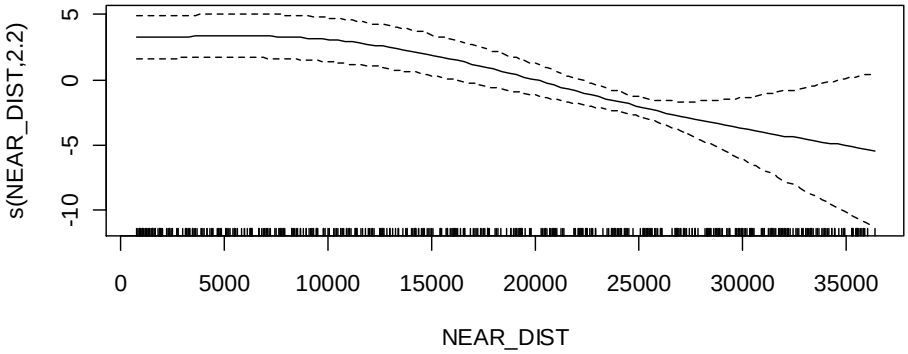


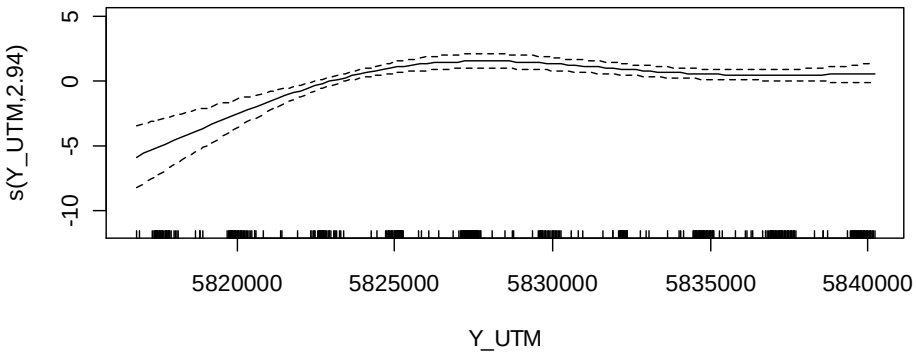



s(NEAR_DIST,1)
-2
-1
0
1
2
0
10000
20000
30000
NEAR_DIST

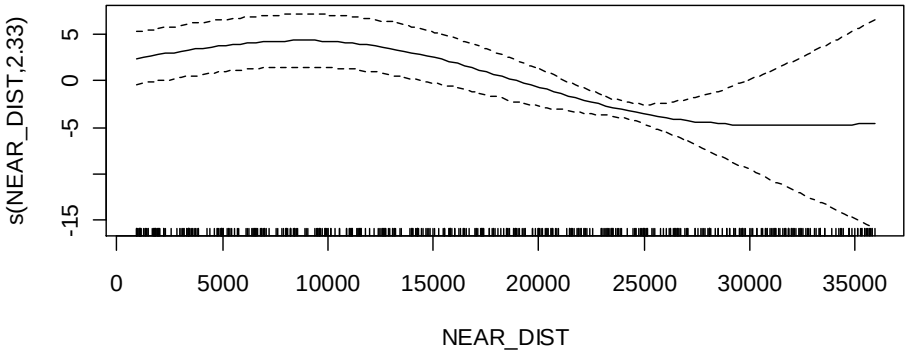

s(Y_UTM,1)
-2
-1
0
1
2
5820000
5825000
5830000
5835000
5840000
Y_UTM

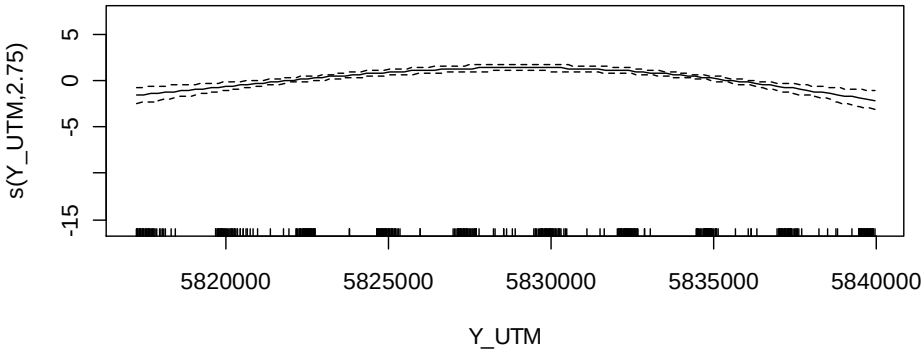
Cormorant 2003_4 gam



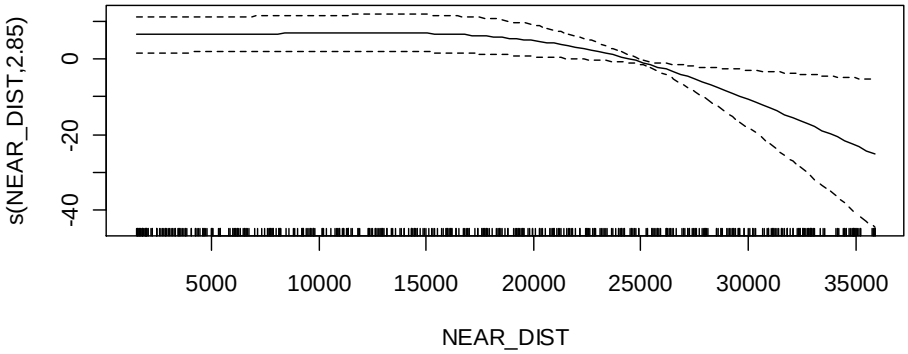


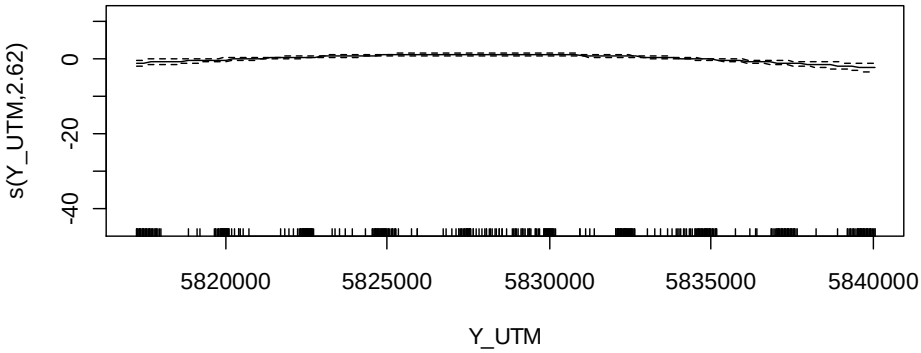
Cormorant 2007_4 gam



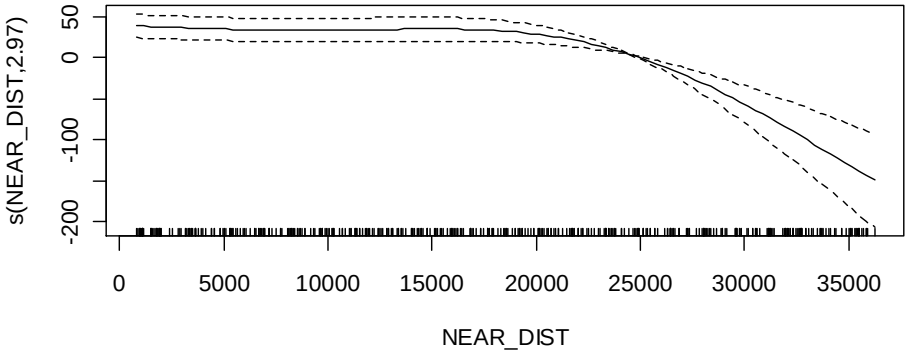


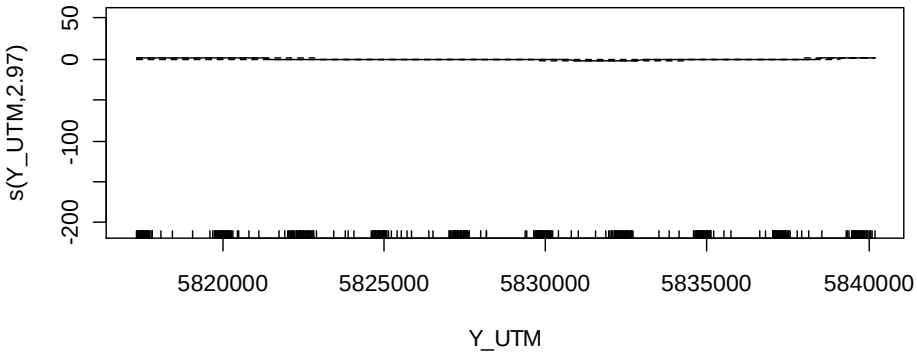
Cormorant 2008_4 gam

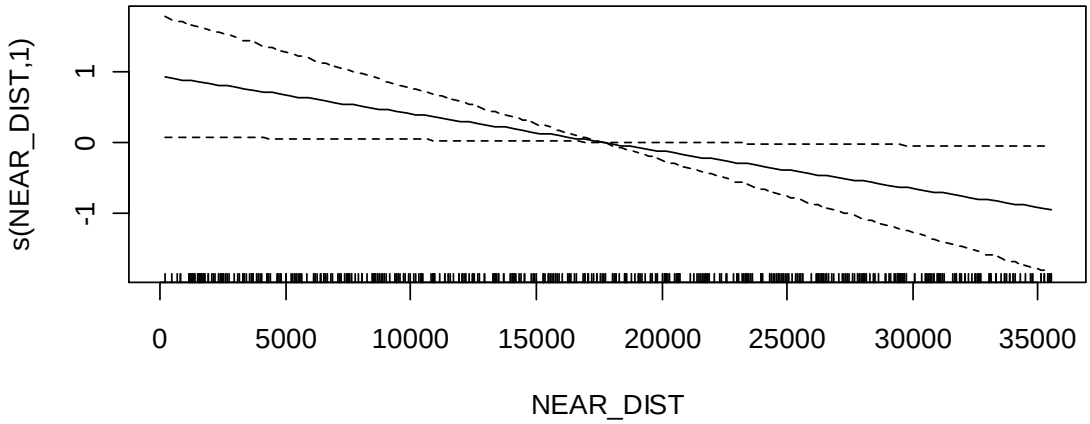


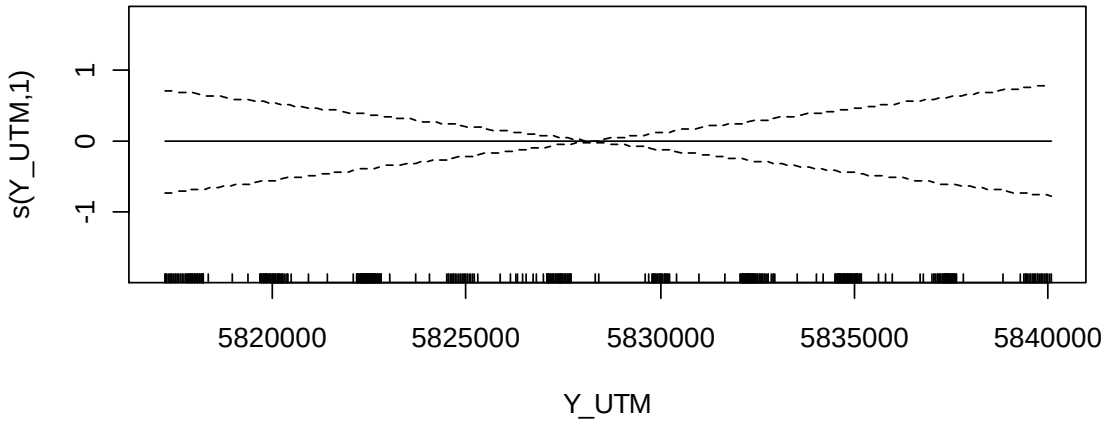


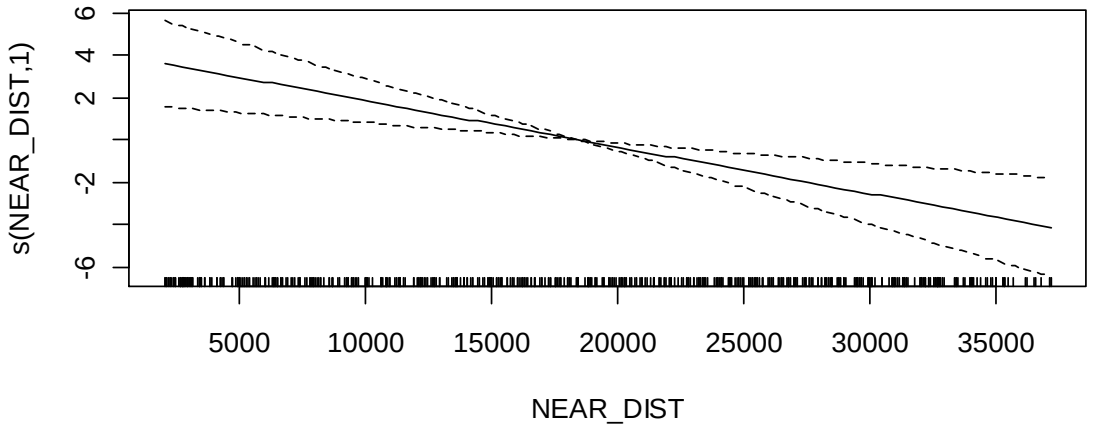
Cormorant 2003_6 gam

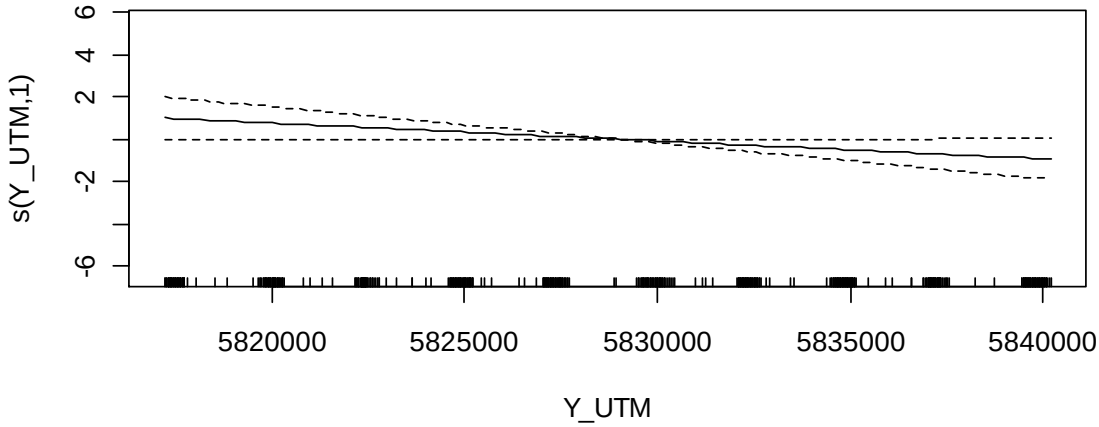




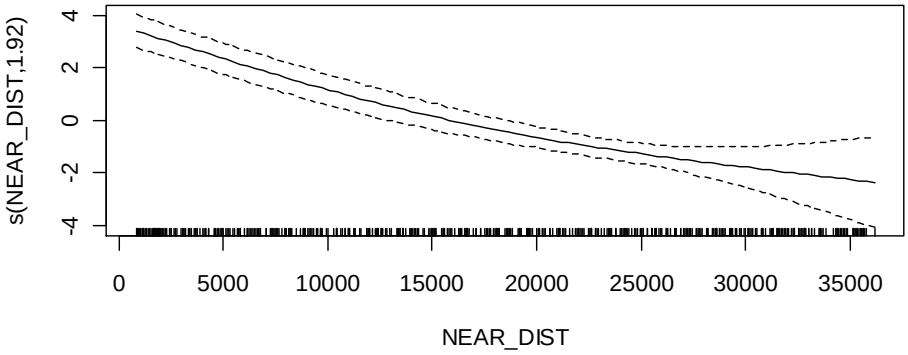

s(NEAR_DIST,1)
-1
0
1
0
5000
10000
15000
20000
25000
30000
35000
NEAR_DIST

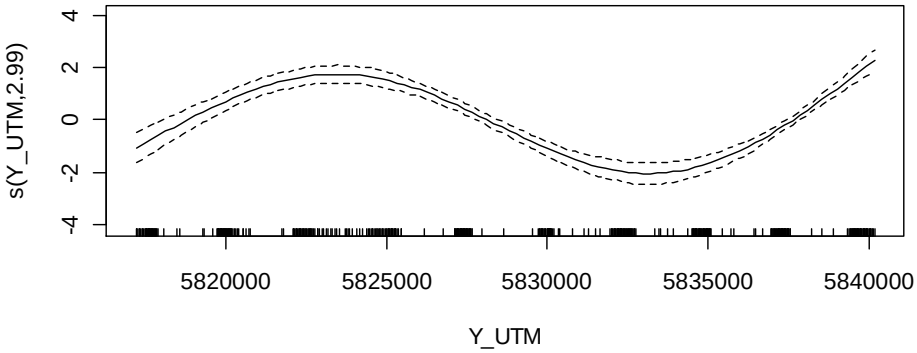

s(Y_UTM,1)
-1
0
1
5820000
5825000
5830000
5835000
5840000
Y_UTM

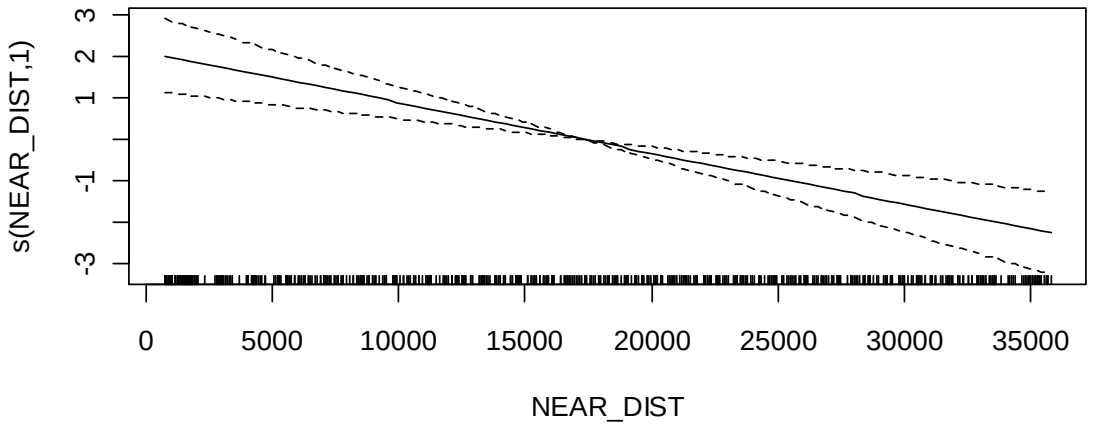

s(NEAR_DIST,1)
6
4
2
-2
-6
5000
10000
15000
20000
25000
30000
35000
NEAR_DIST

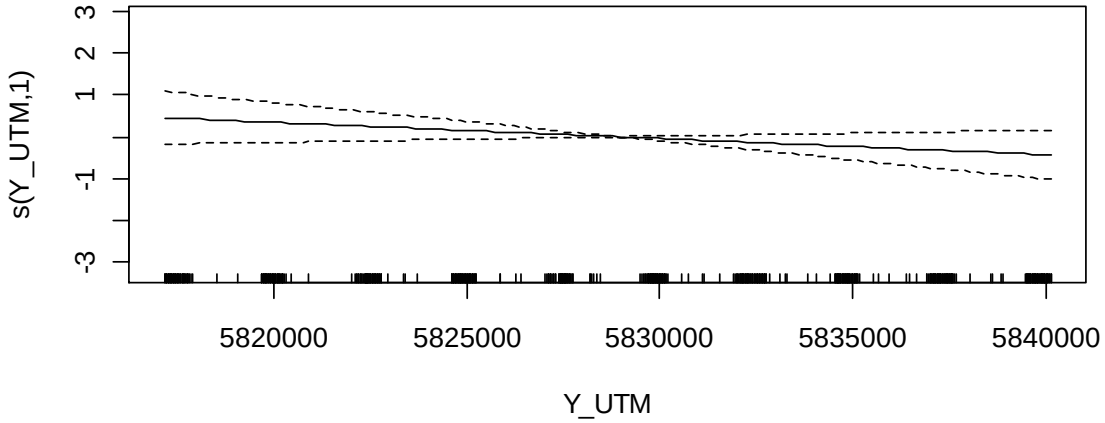

s(Y_UTM,1)
6
4
2
-2
-6
5820000
5825000
5830000
5835000
5840000
Y_UTM

Cormorant 2003_8 gam

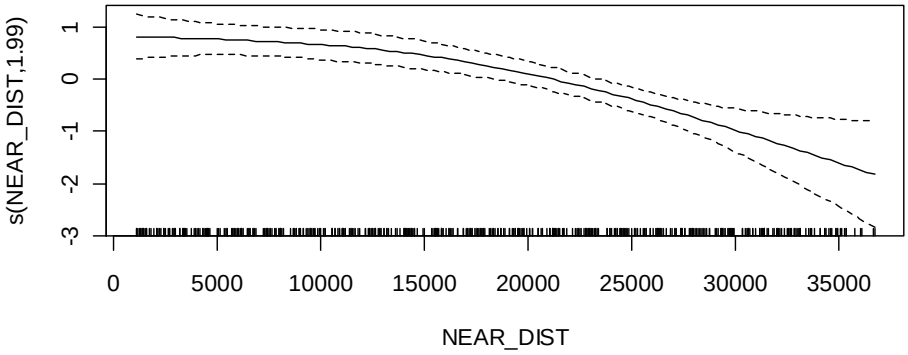


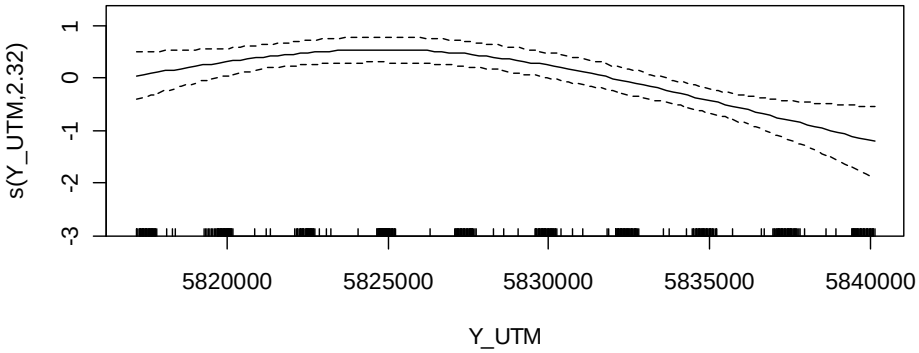



s(NEAR_DIST,1)
3
2
1
-1
-3
0
5000
10000
15000
20000
25000
30000
35000
NEAR_DIST

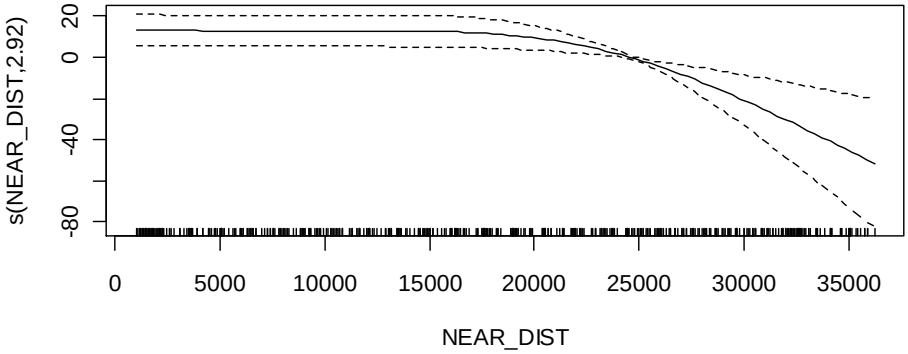

s(Y_UTM,1)
3
2
1
-1
-3
5820000
5825000
5830000
5835000
5840000
Y_UTM

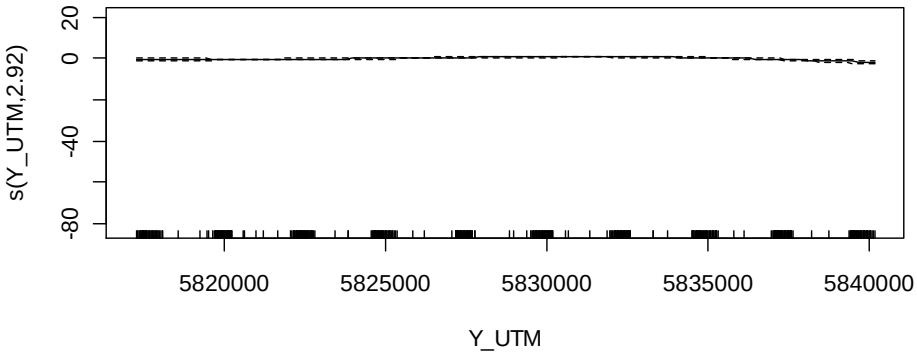
Cormorant 2008_8 gam

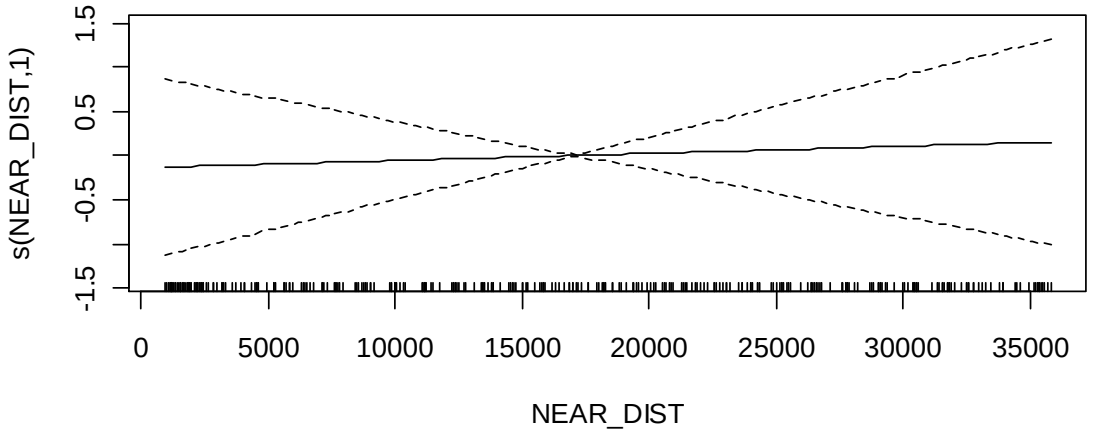


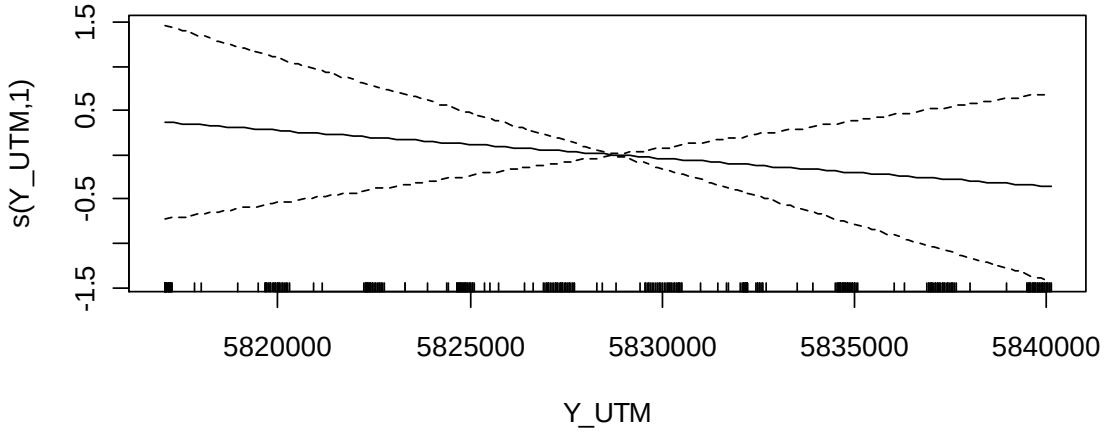


Cormorant 2002_9 gam

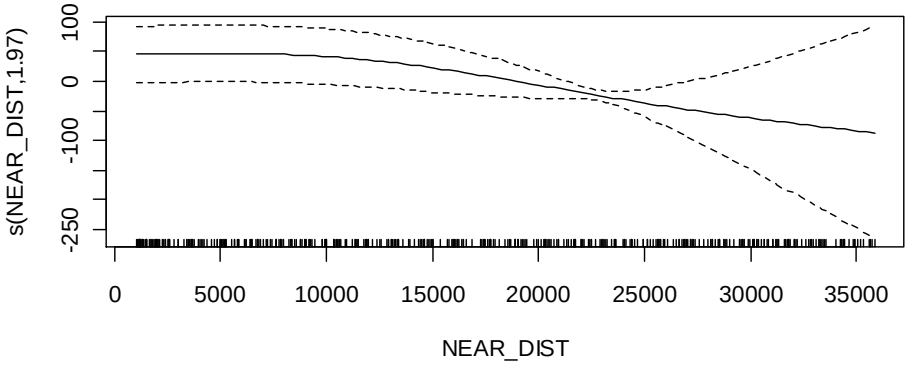


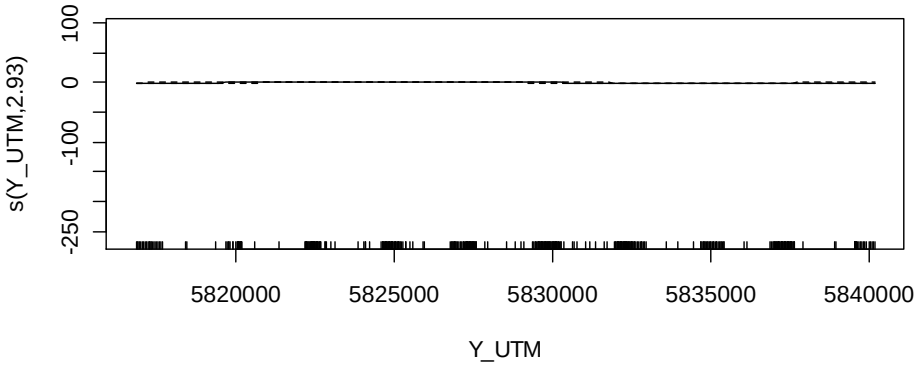



s(NEAR_DIST,1)
1.5
0.5
-0.5
-1.5
0
5000
10000
15000
20000
25000
30000
35000
NEAR_DIST

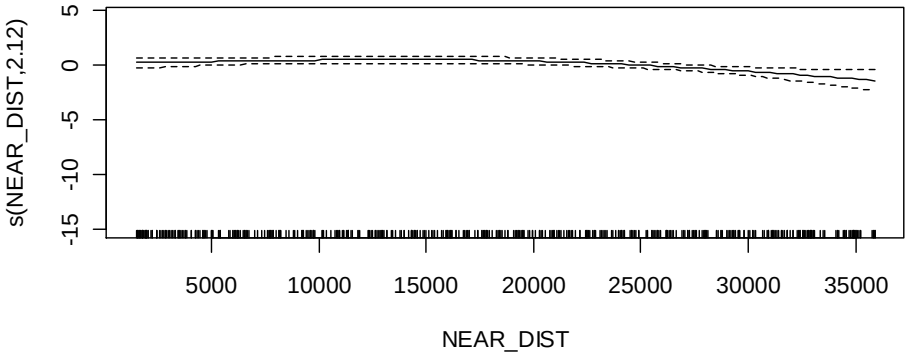

s(Y_UTM,1)
1.5
0.5
-0.5
-1.5
5820000
5825000
5830000
5835000
5840000
Y_UTM

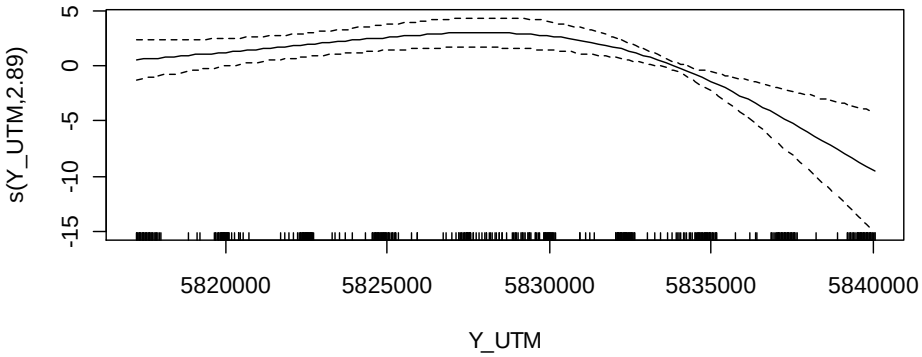
Cormorant 2008_11 gam

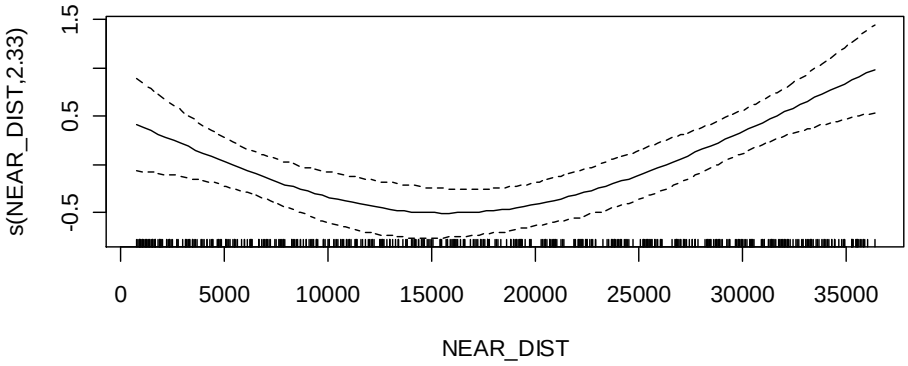


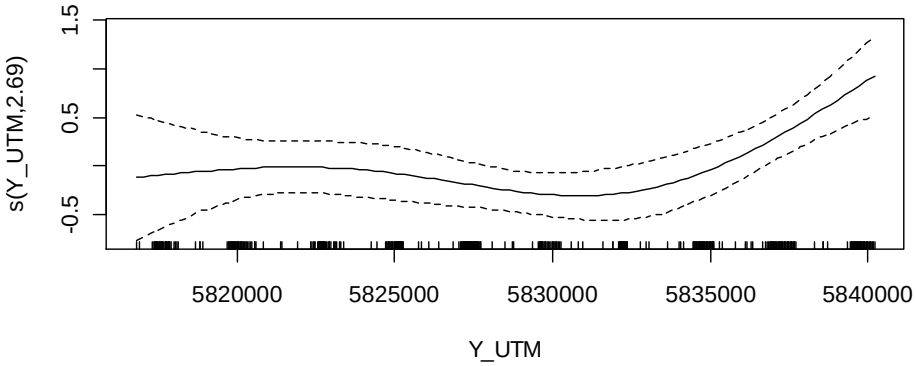


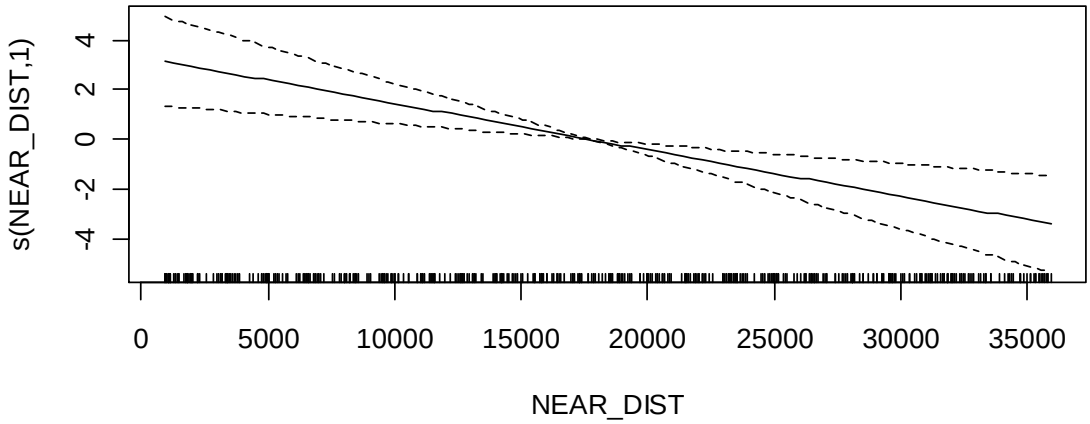
Common Scoter 2008_4 gam

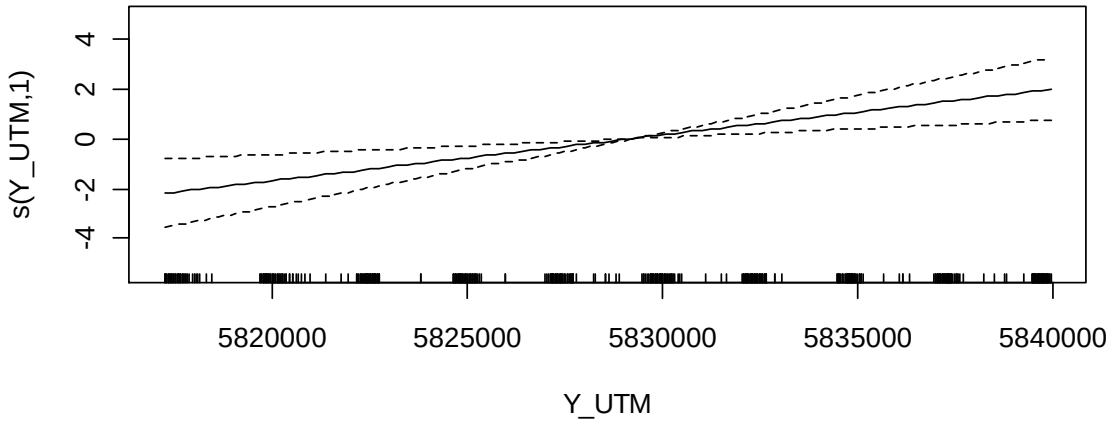


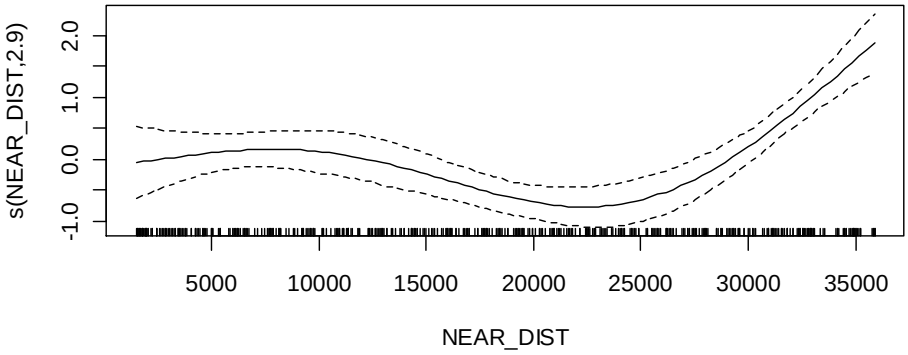


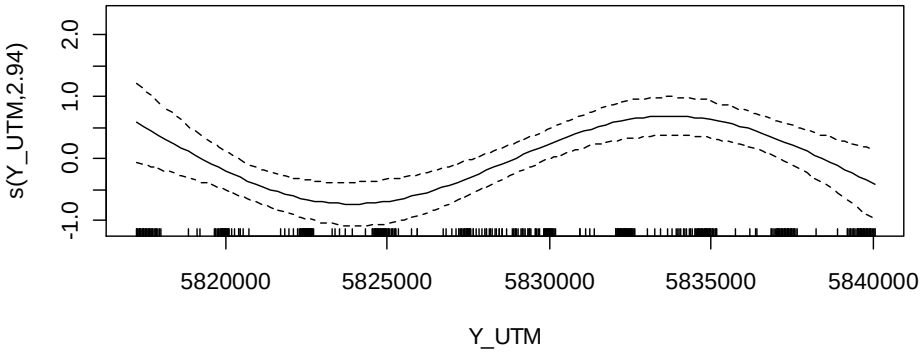

s(NEAR_DIST,2.33)
1.5
0.5
-0.5
0
5000
10000
15000
20000
25000
30000
35000
NEAR_DIST

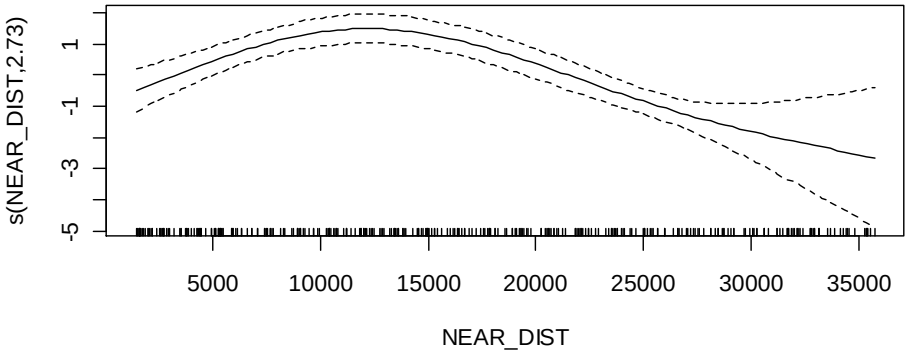

s(Y_UTM,2.69)
1.5
0.5
-0.5
5820000
5825000
5830000
5835000
5840000
Y_UTM

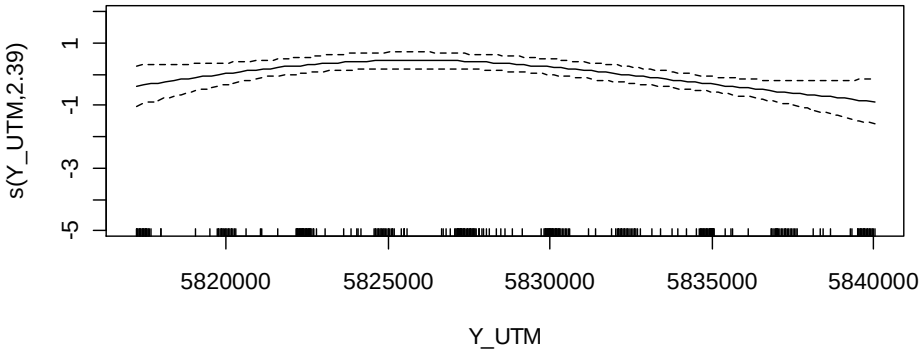

s(NEAR_DIST,1)
4
2
0
-2
-4
0
5000
10000
15000
20000
25000
30000
35000
NEAR_DIST

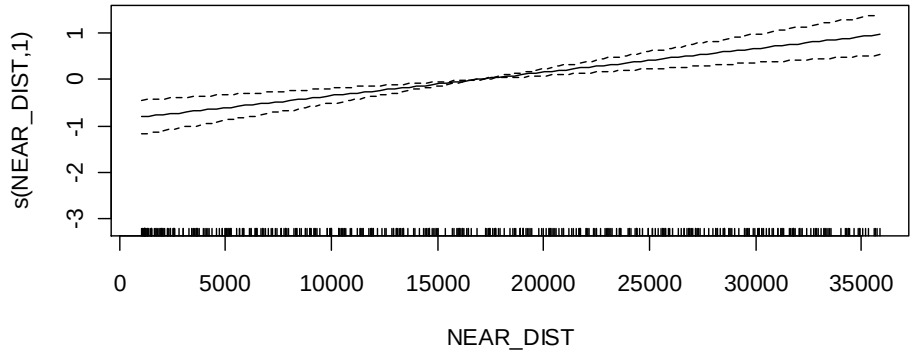

s(Y_UTM,1)
4
2
0
-2
-4
5820000
5825000
5830000
5835000
5840000
Y_UTM

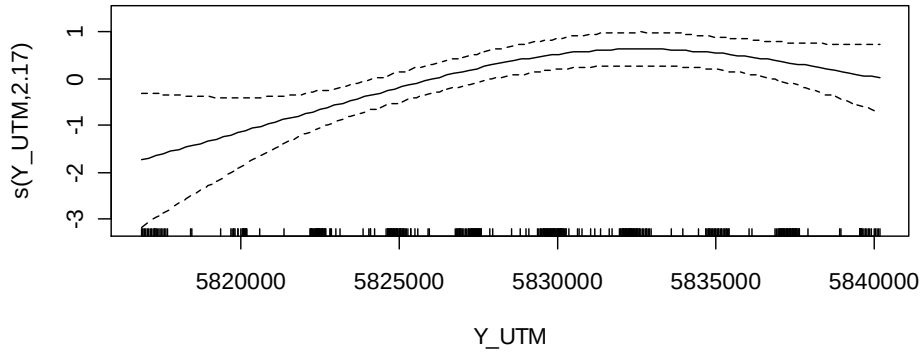

s(NEAR_DIST,2.9)
-1.0
0.0
1.0
2.0
5000
10000
15000
20000
25000
30000
35000
NEAR_DIST


s(Y_UTM,2.94)
-1.0
0.0
1.0
2.0
5820000
5825000
5830000
5835000
5840000
Y_UTM

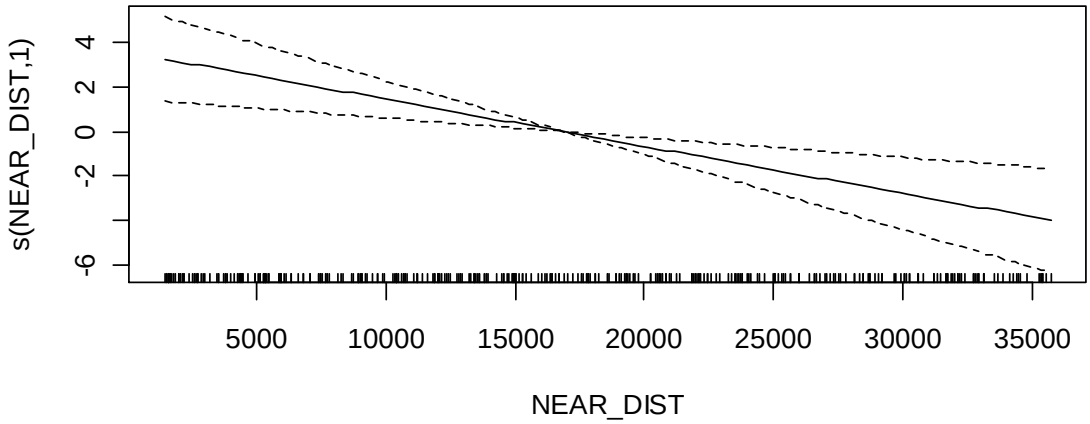

s(NEAR_DIST,2.73)
1
-1
-3
-5
5000
10000
15000
20000
25000
30000
35000
NEAR_DIST

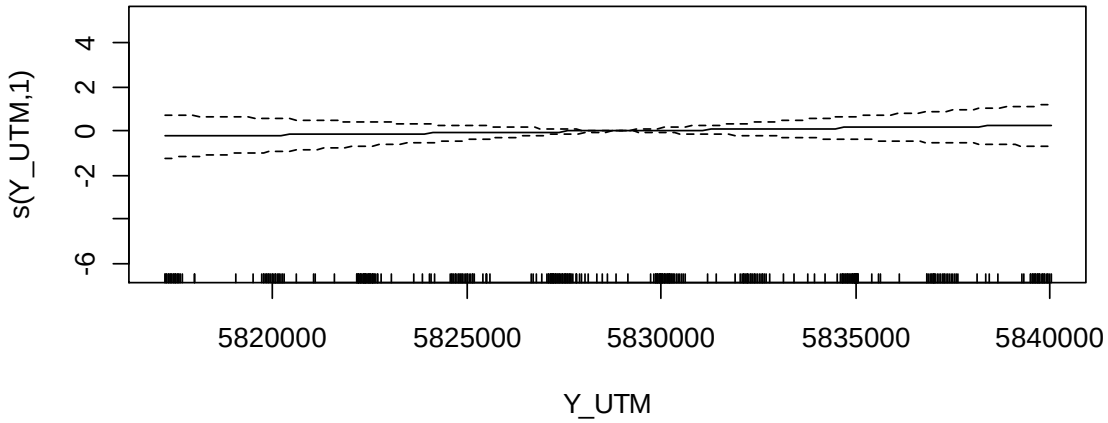

s(Y_UTM,2.39)
1
-1
-3
-5
5820000
5825000
5830000
5835000
5840000
Y_UTM

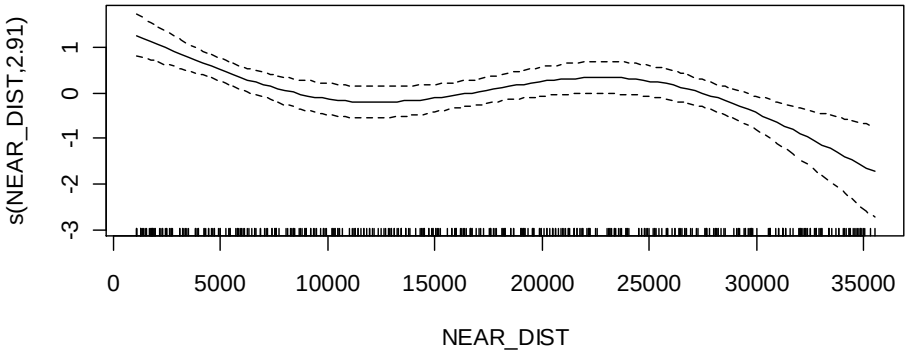

s(NEAR_DIST,1)
-3
-2
-1
0
1
0
5000
10000
15000
20000
25000
30000
35000
NEAR_DIST


s(Y_UTM,2.17)
-3
-2
-1
0
1
5820000
5825000
5830000
5835000
5840000
Y_UTM

Black.headed Gull_2003_11_gamm






s(NEAR_DIST,2.91)
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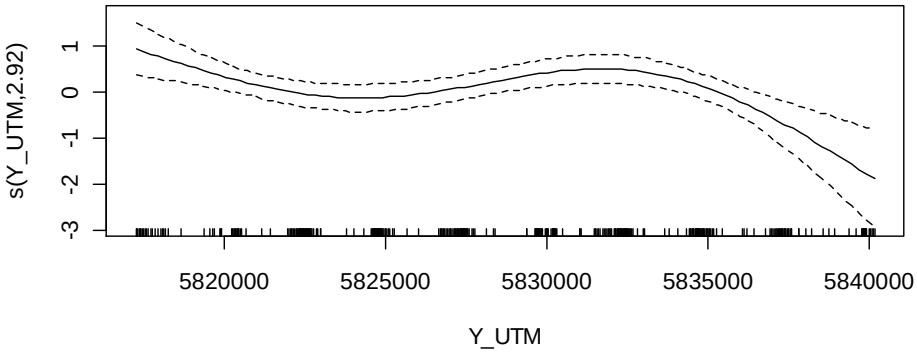
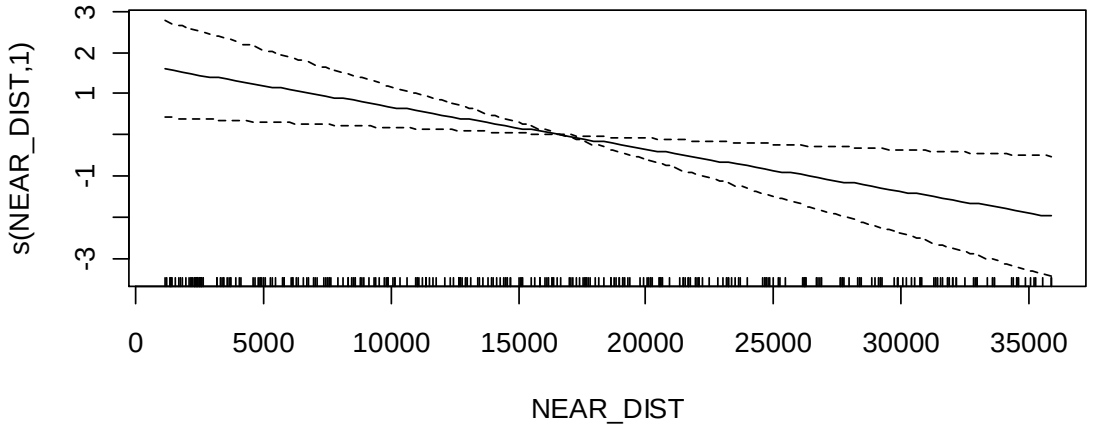
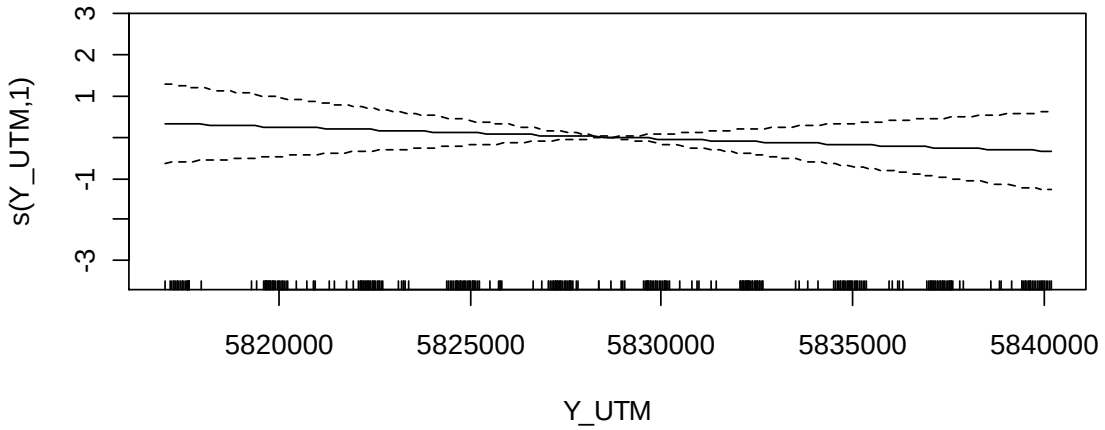
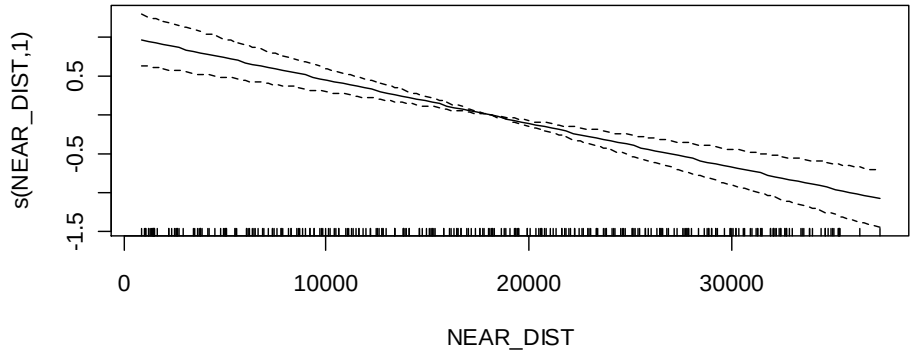
-1
-2
-3
0
5000
10000
15000
20000
25000
30000
35000
NEAR_DIST


s(Y_UTM,2.92)
1
0
-1
-2
-3
5820000
5825000
5830000
5835000
5840000
Y_UTM


s(NEAR_DIST,1)
3
2
1
-1
-3
0
5000
10000
15000
20000
25000
30000
35000
NEAR_DIST


s(Y_UTM,1)
3
2
1
-1
-3
5820000
5825000
5830000
5835000
5840000
Y_UTM


s(NEAR_DIST,1)
0.5
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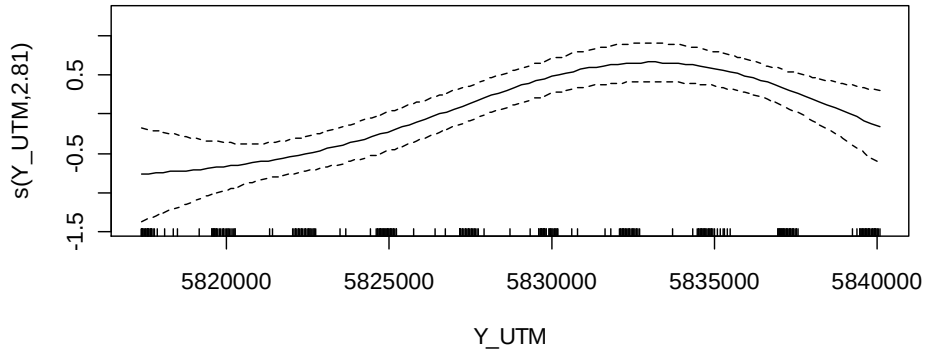
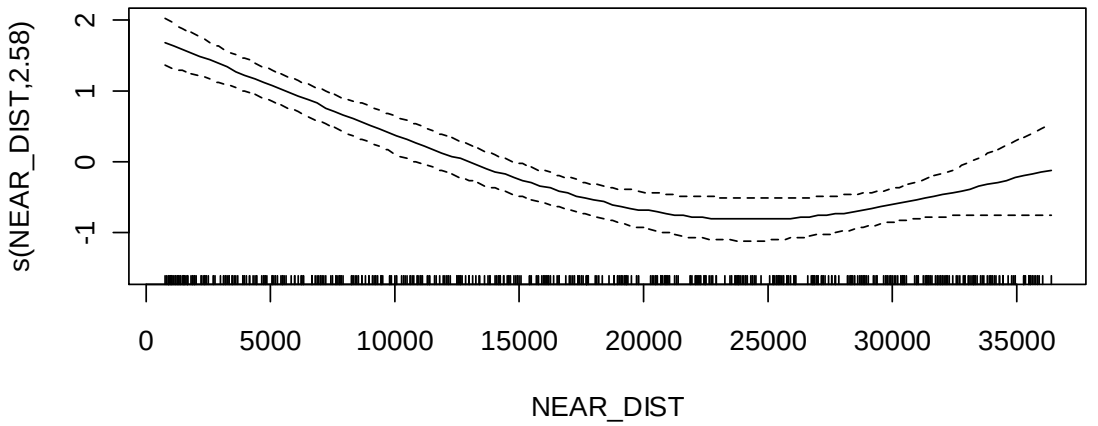
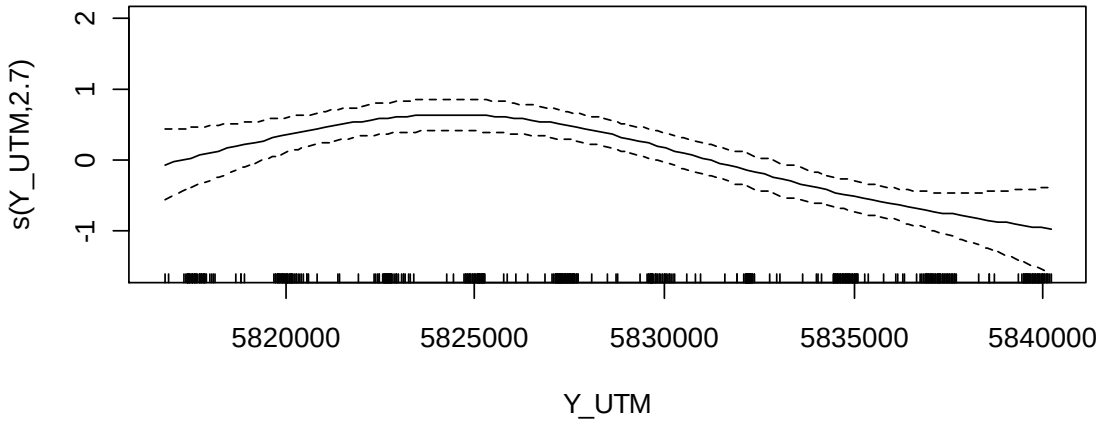
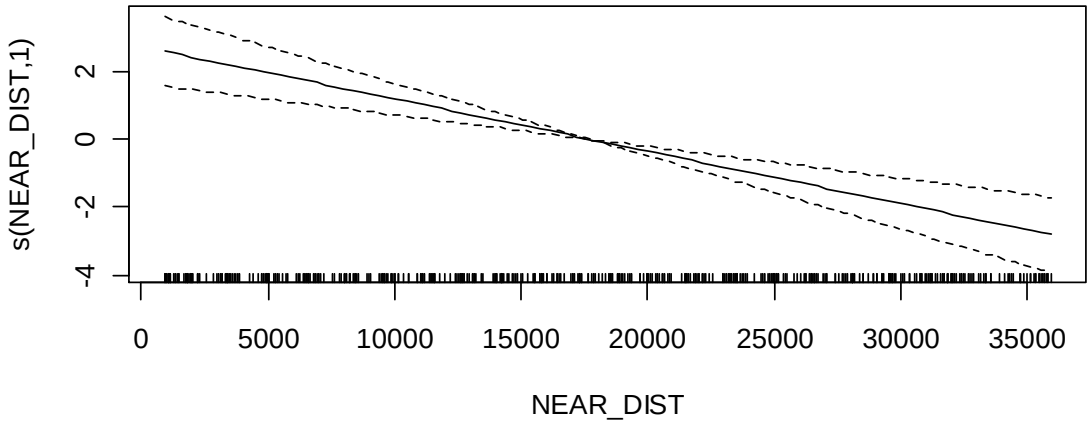
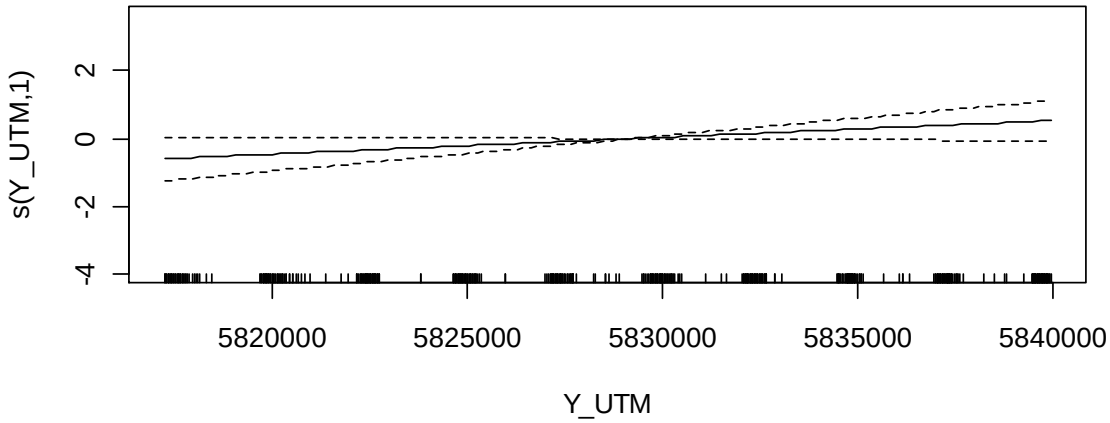
-1.5
0
10000
20000
30000
NEAR_DIST

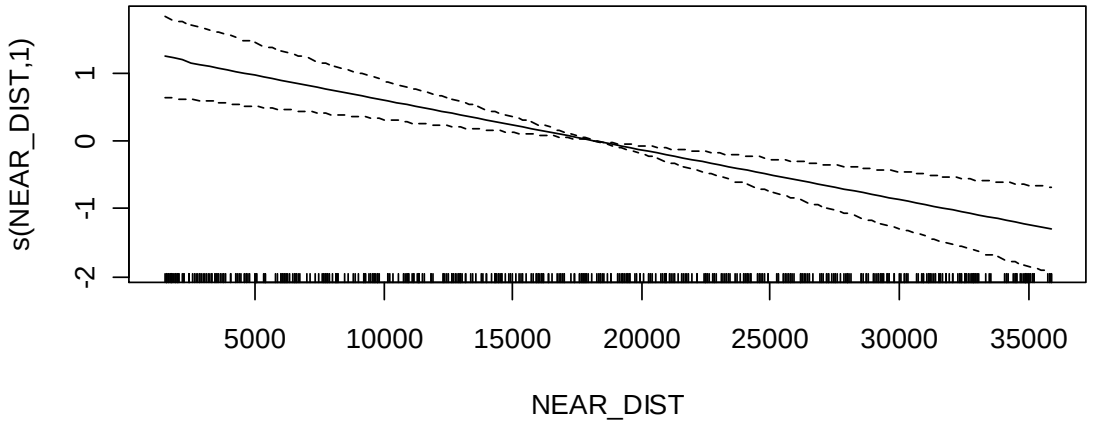

s(Y_UTM,2.81)
0.5
-0.5
-1.5
5820000
5825000
5830000
5835000
5840000
Y_UTM

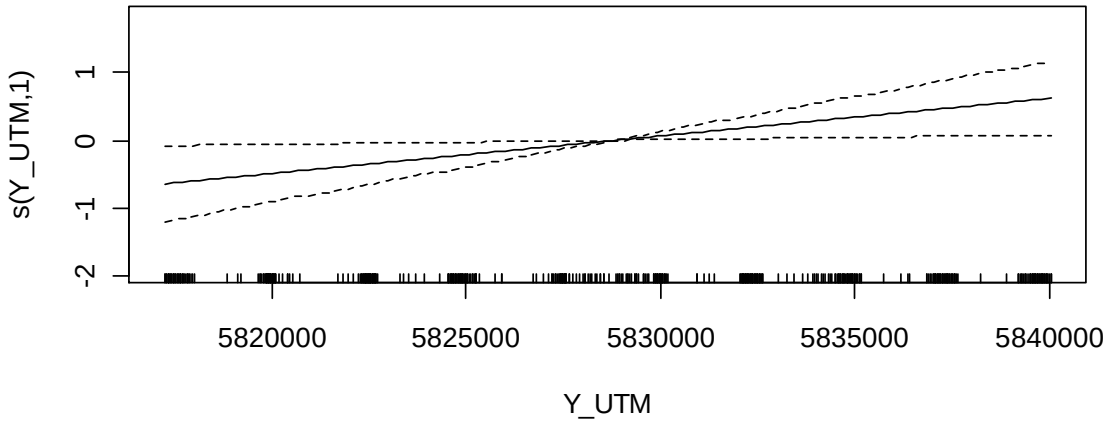

s(NEAR_DIST,2.58)
2
1
0
-1
0
5000
10000
15000
20000
25000
30000
35000
NEAR_DIST

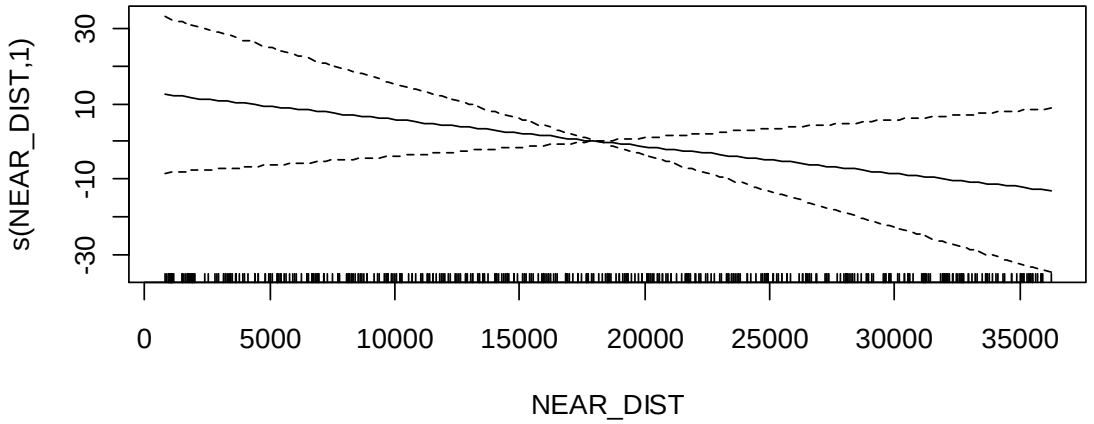

s(Y_UTM,2.7)
2
1
0
-1
5820000
5825000
5830000
5835000
5840000
Y_UTM

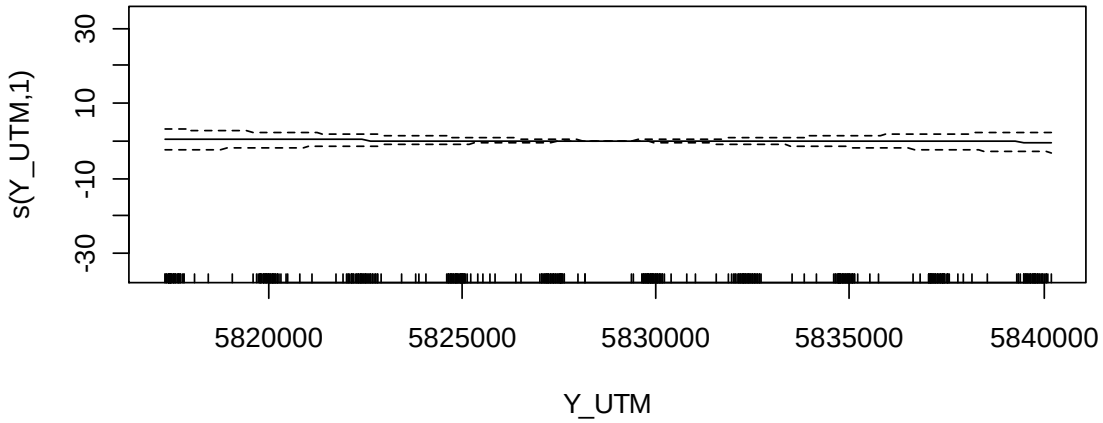

s(NEAR_DIST,1)
2
0
-2
-4
0
5000
10000
15000
20000
25000
30000
35000
NEAR_DIST

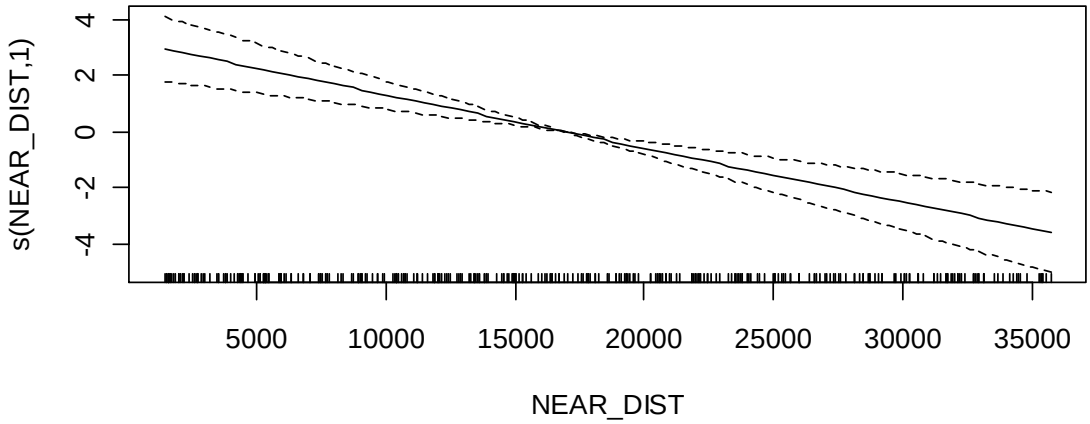

s(Y_UTM,1)
2
0
-2
-4
5820000
5825000
5830000
5835000
5840000
Y_UTM

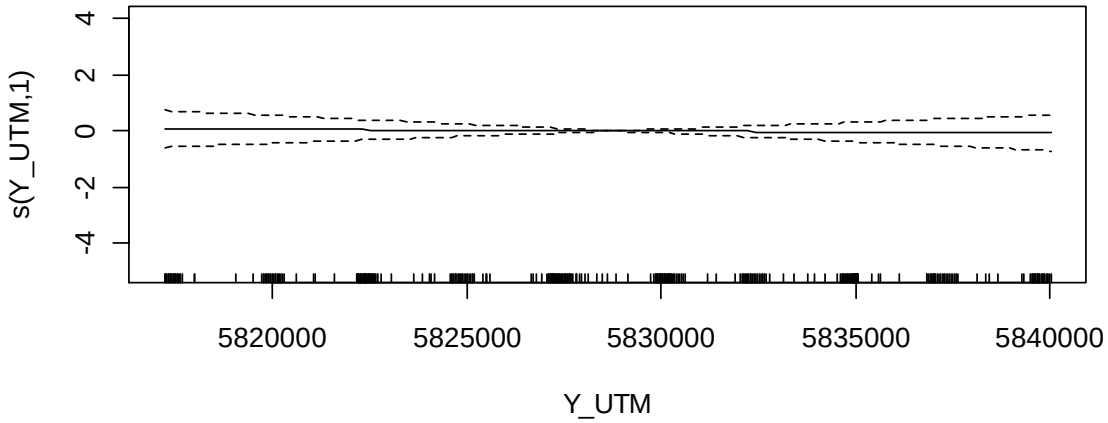

s(NEAR_DIST,1)
-2
-1
0
1
5000
10000
15000
20000
25000
30000
35000
NEAR_DIST

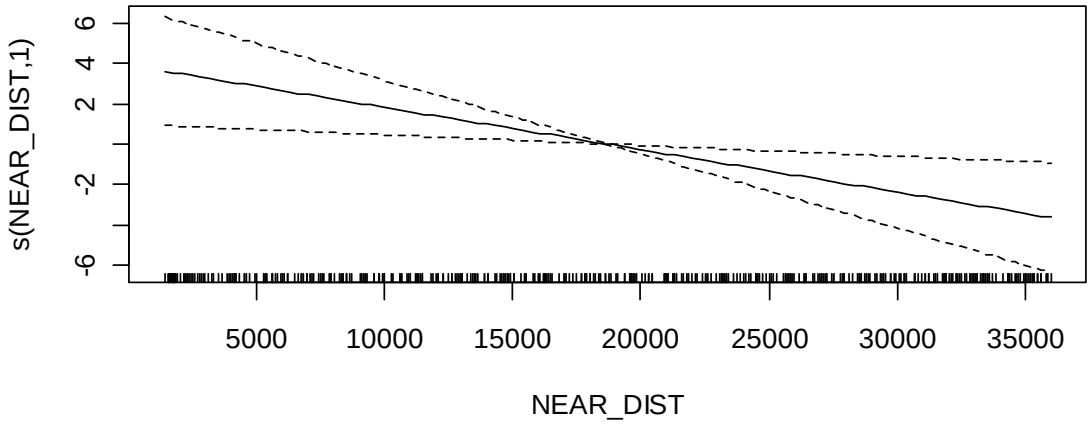

s(Y_UTM,1)
-2
-1
0
1
5820000
5825000
5830000
5835000
5840000
Y_UTM

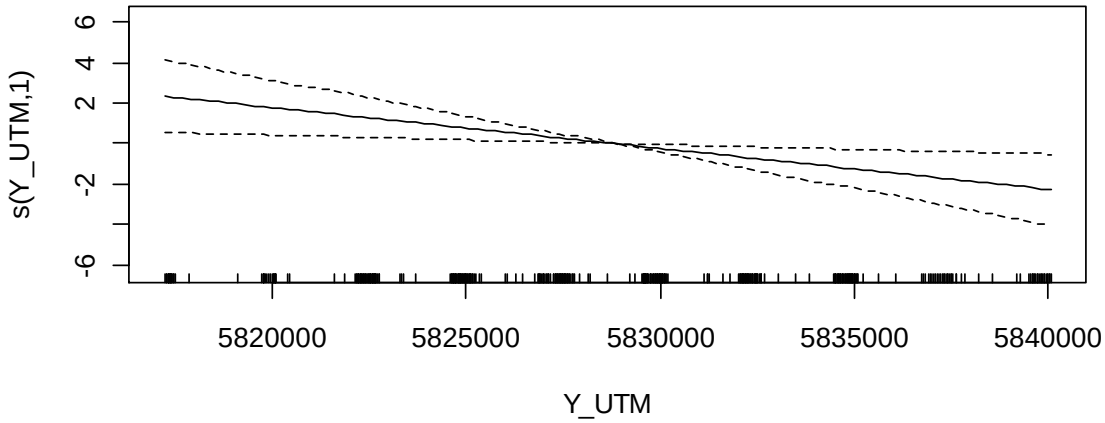

s(NEAR_DIST,1)
30
10
-10
-30
0
5000
10000
15000
20000
25000
30000
35000
NEAR_DIST

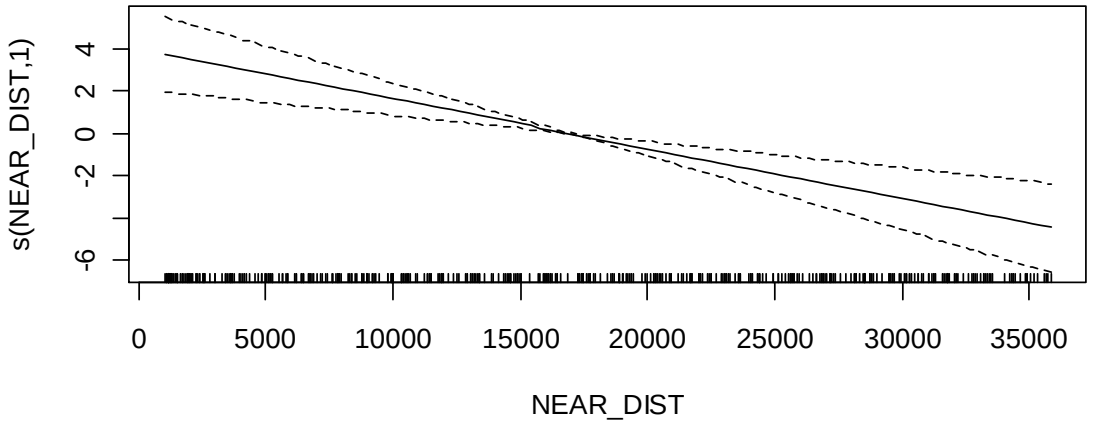

s(Y_UTM,1)
30
10
-10
-30
5820000
5825000
5830000
5835000
5840000
Y_UTM

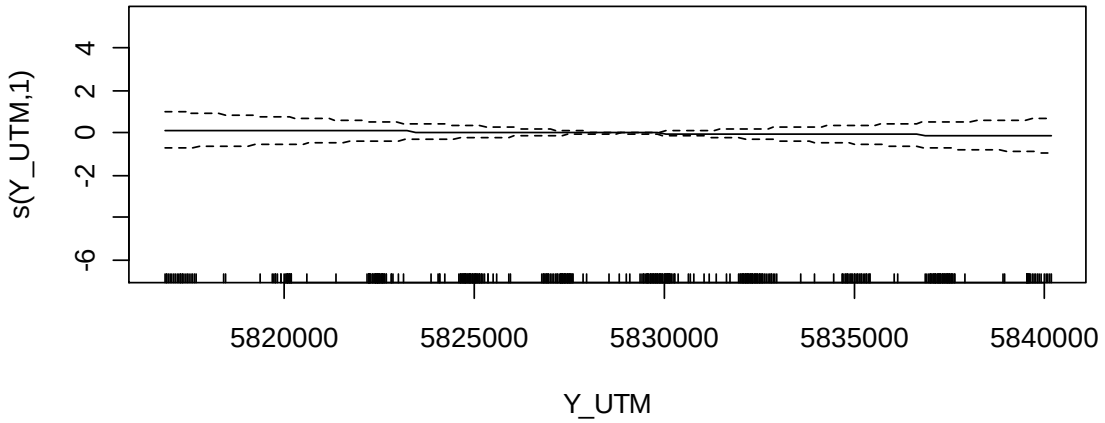

s(NEAR_DIST,1)
4
2
0
-2
-4
5000
10000
15000
20000
25000
30000
35000
NEAR_DIST

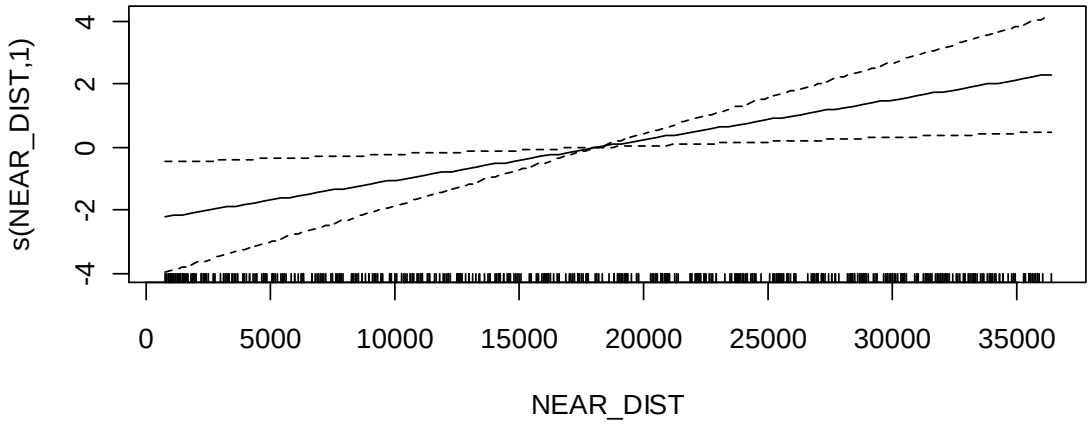

s(Y_UTM,1)
4
2
0
-2
-4
5820000
5825000
5830000
5835000
5840000
Y_UTM

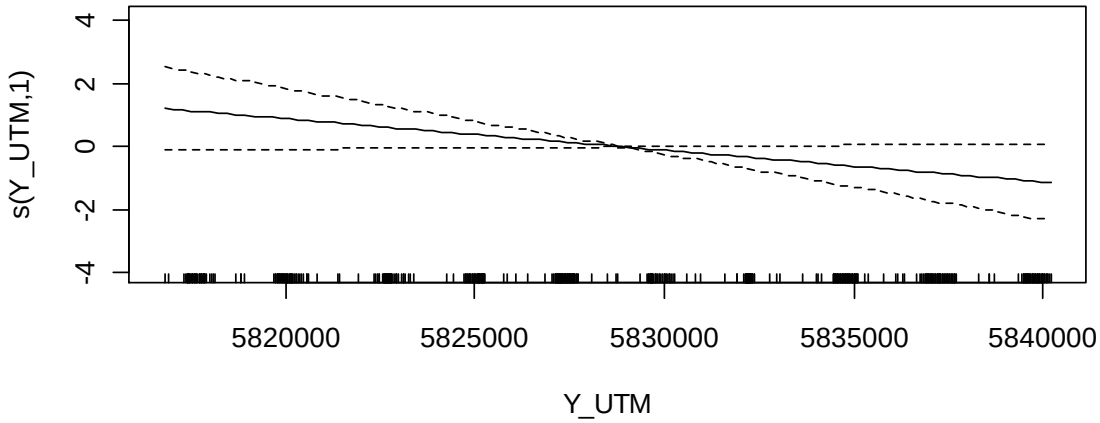

s(NEAR_DIST,1)
6
4
2
-2
-6
5000
10000
15000
20000
25000
30000
35000
NEAR_DIST


s(Y_UTM,1)
6
4
2
-2
-6
5820000
5825000
5830000
5835000
5840000
Y_UTM

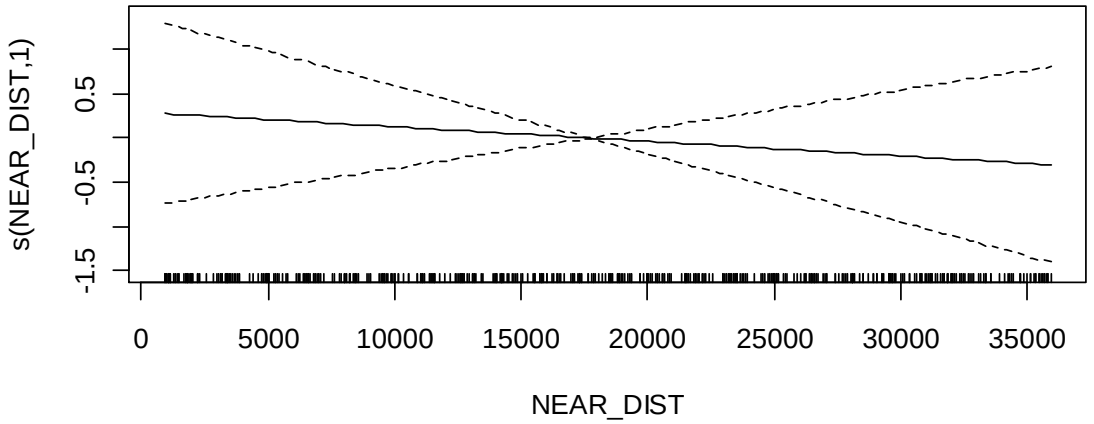

s(NEAR_DIST,1)
-6
-2
0
2
4
0
5000
10000
15000
20000
25000
30000
35000
NEAR_DIST

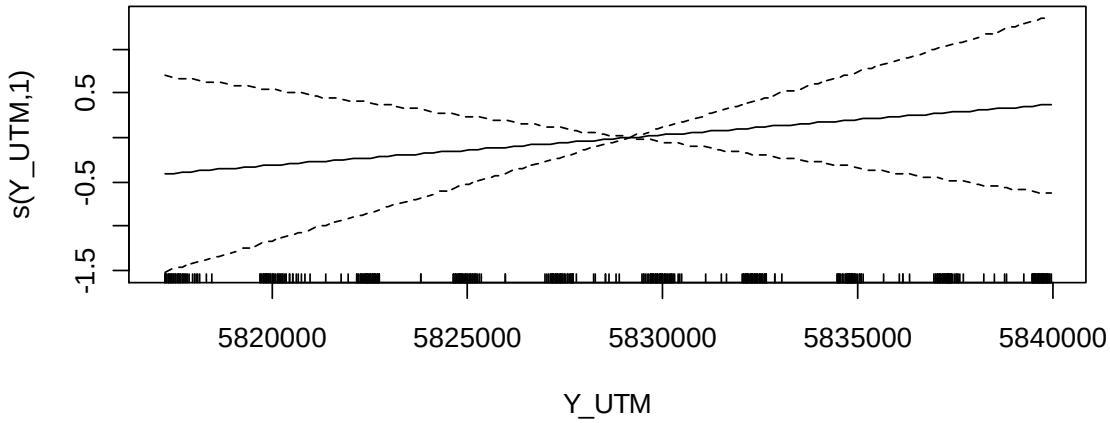

s(Y_UTM,1)
-6
-2
0
2
4
5820000
5825000
5830000
5835000
5840000
Y_UTM


s(NEAR_DIST,1)
-4
-2
0
2
4
0
5000
10000
15000
20000
25000
30000
35000
NEAR_DIST

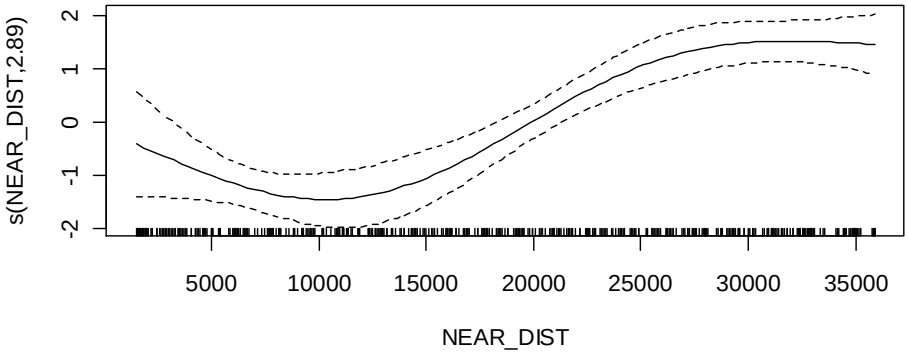

s(Y_UTM,1)
-4
-2
0
2
4
5820000
5825000
5830000
5835000
5840000
Y_UTM

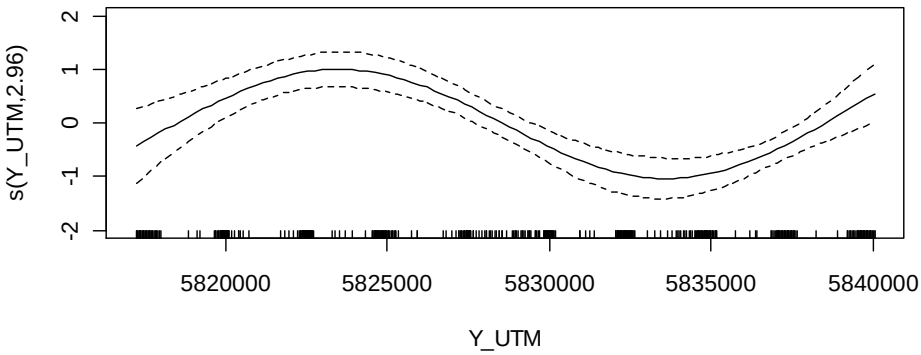
Lesser Black-backed Gull_2007_4_gamm

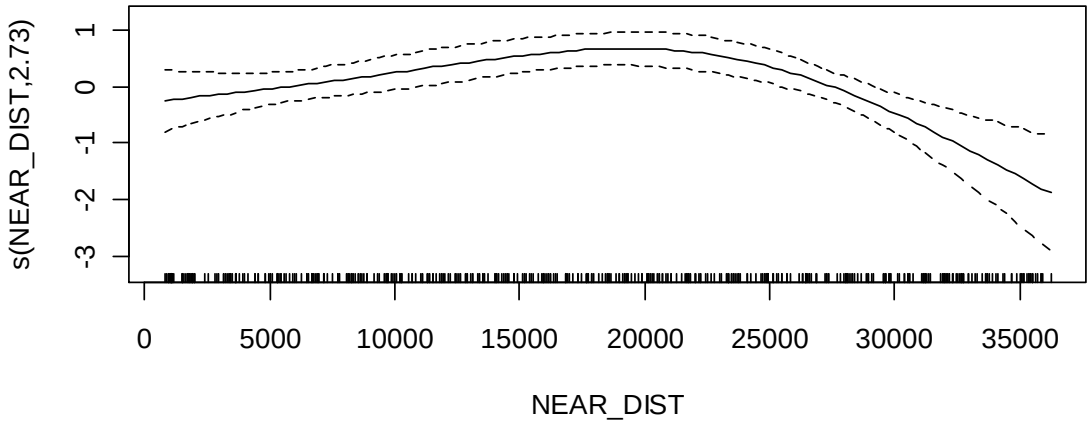




Lesser Black-backed Gull 2008_4 gam






s(NEAR_DIST,2.73)
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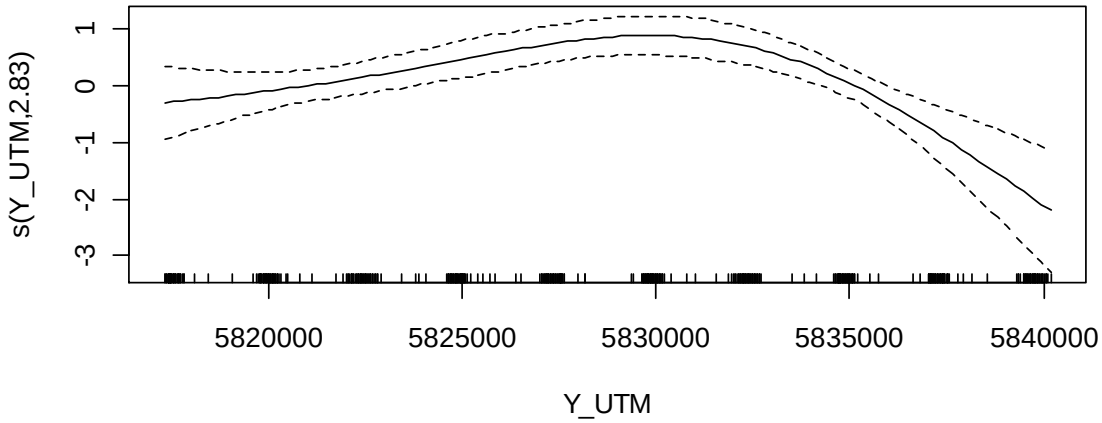
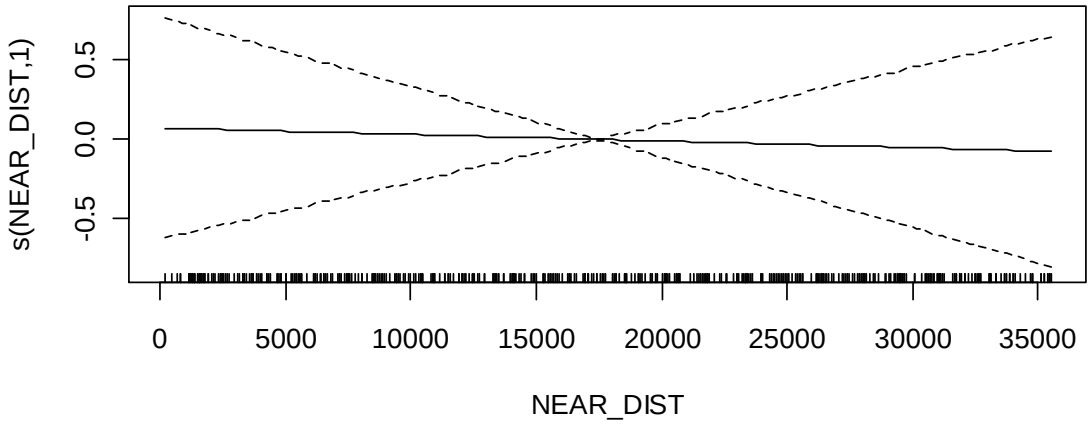
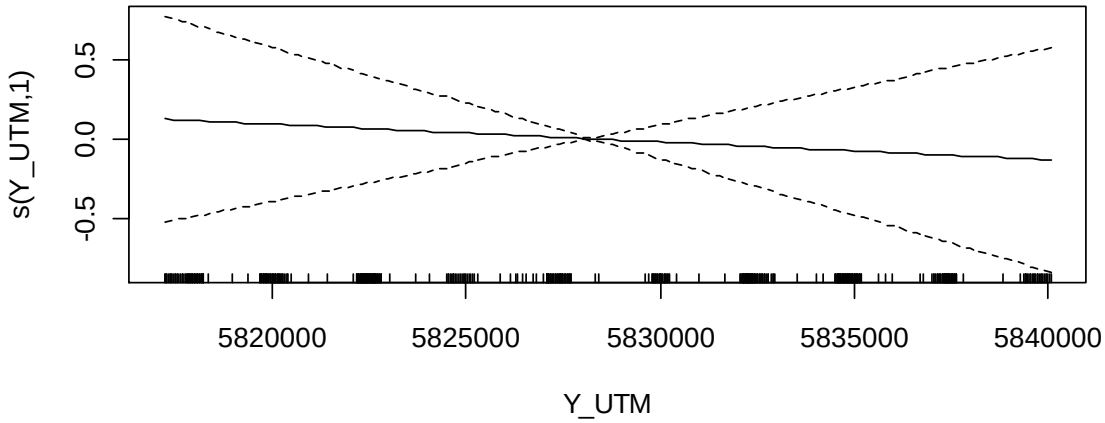
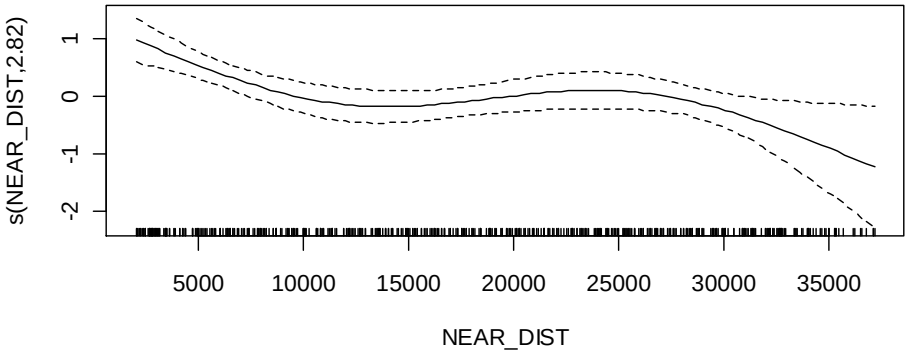
-2
-1
0
1
0
5000
10000
15000
20000
25000
30000
35000
NEAR_DIST

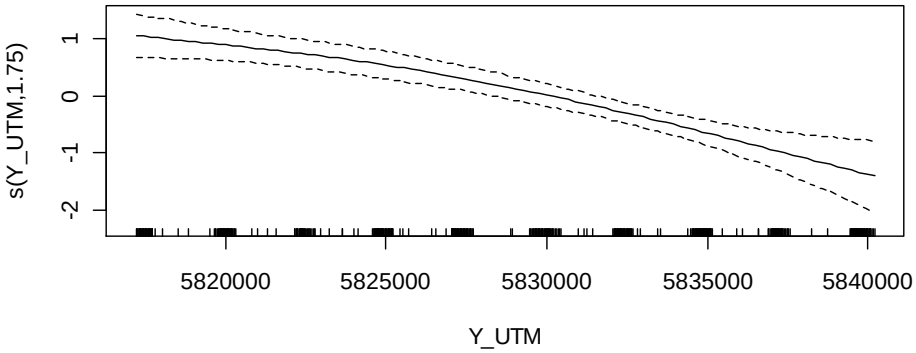

s(Y_UTM,2.83)
-3
-2
-1
0
1
5820000
5825000
5830000
5835000
5840000
Y_UTM

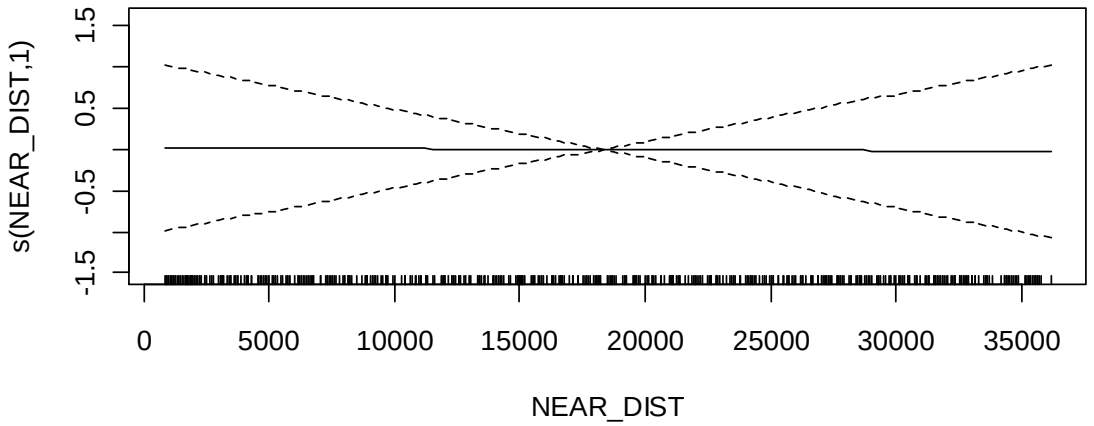

s(NEAR_DIST,1)
0.5
0.0
-0.5
0
5000
10000
15000
20000
25000
30000
35000
NEAR_DIST

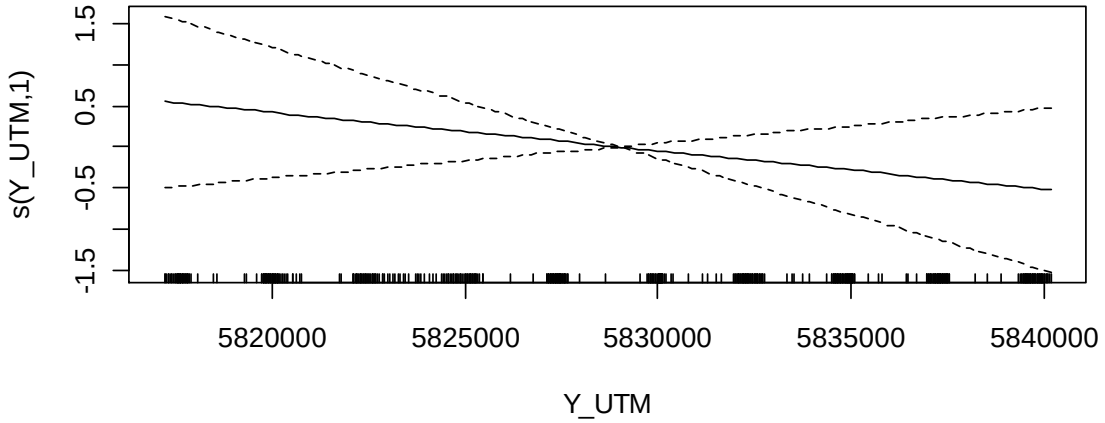

s(Y_UTM,1)
0.5
0.0
-0.5
5820000
5825000
5830000
5835000
5840000
Y_UTM

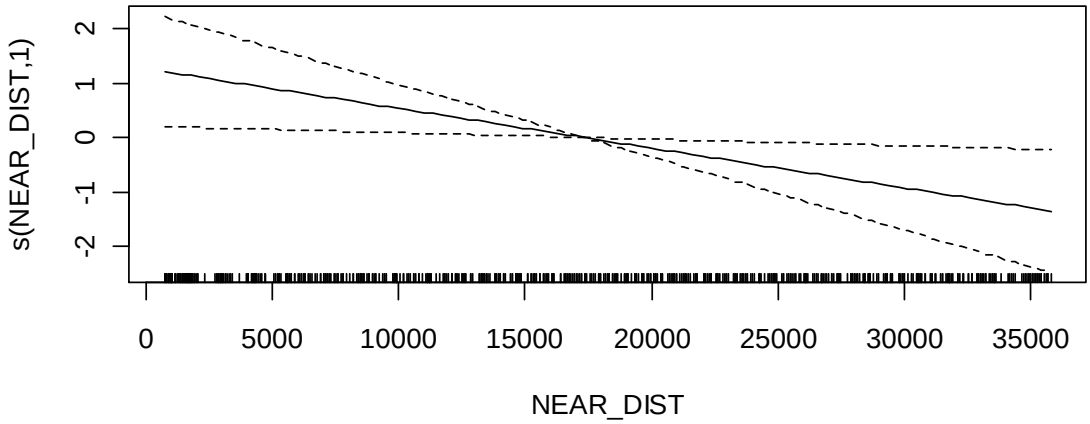
Lesser Black-backed Gull 2008_6 gam

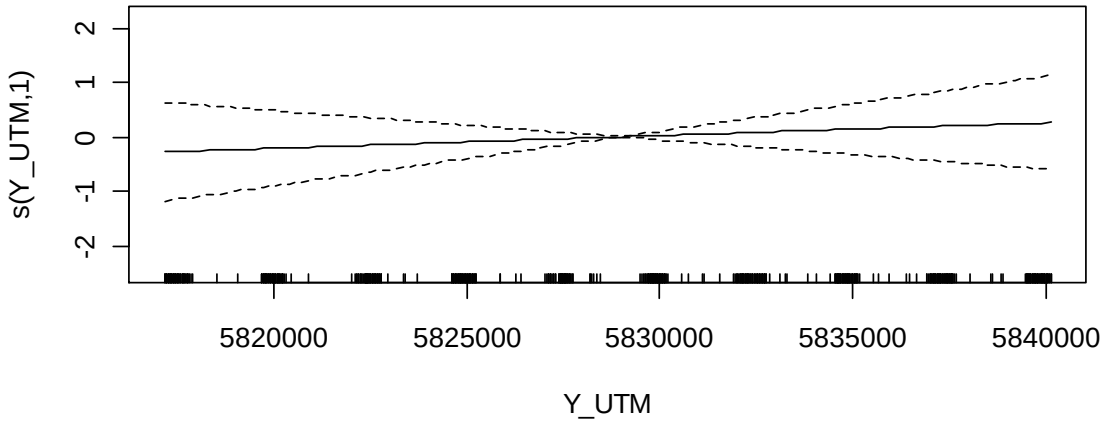




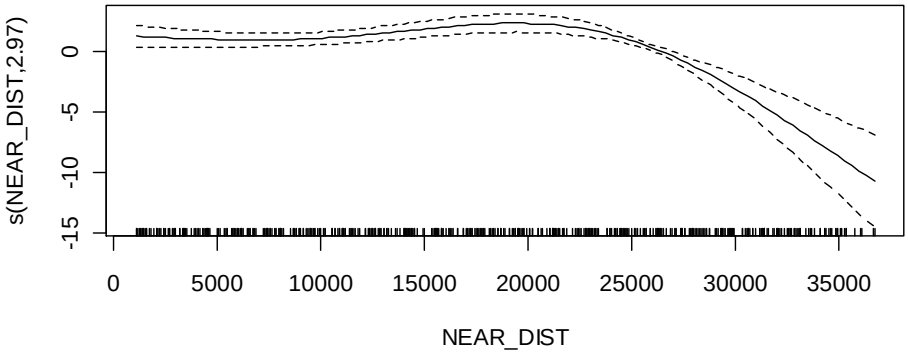

s(NEAR_DIST,1)
1.5
0.5
-0.5
-1.5
0
5000
10000
15000
20000
25000
30000
35000
NEAR_DIST

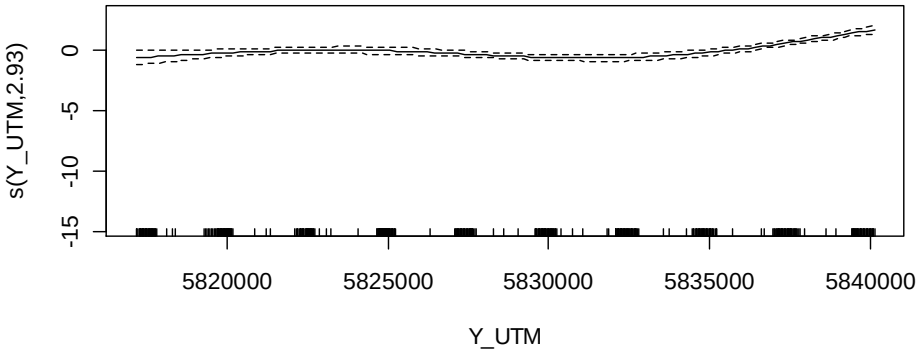

s(Y_UTM,1)
1.5
0.5
-0.5
-1.5
5820000
5825000
5830000
5835000
5840000
Y_UTM


s(NEAR_DIST,1)
-2
-1
0
1
2
0
5000
10000
15000
20000
25000
30000
35000
NEAR_DIST

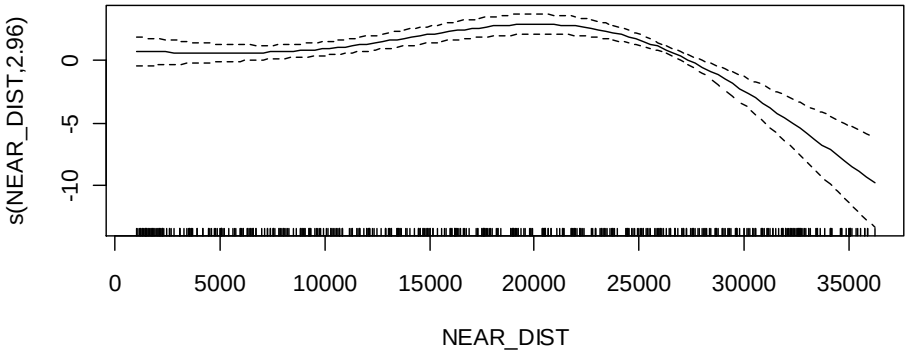

s(Y_UTM,1)
-2
-1
0
1
2
5820000
5825000
5830000
5835000
5840000
Y_UTM

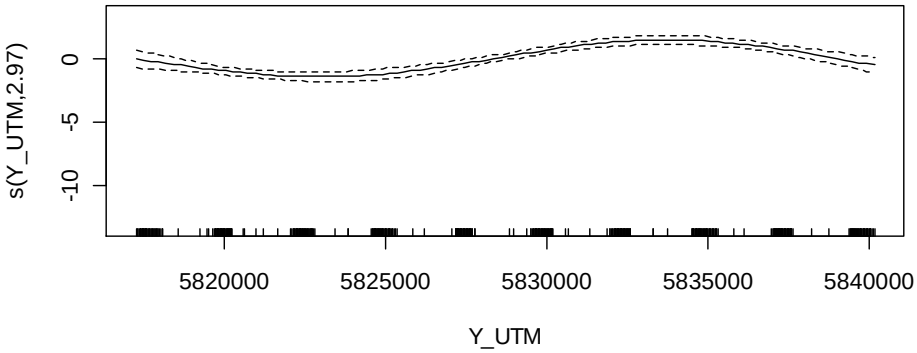
Lesser Black-backed Gull 2008_8 gam

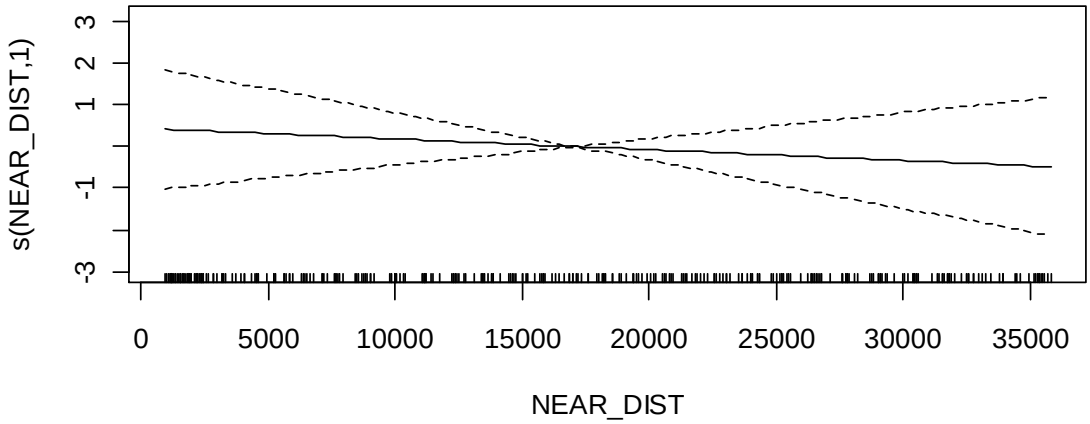


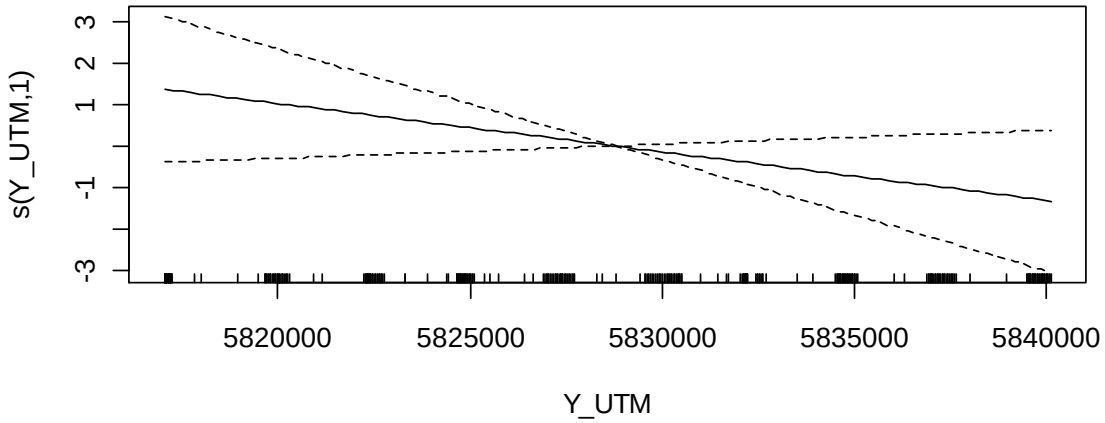


Lesser Black-backed Gull 2002_9 gam

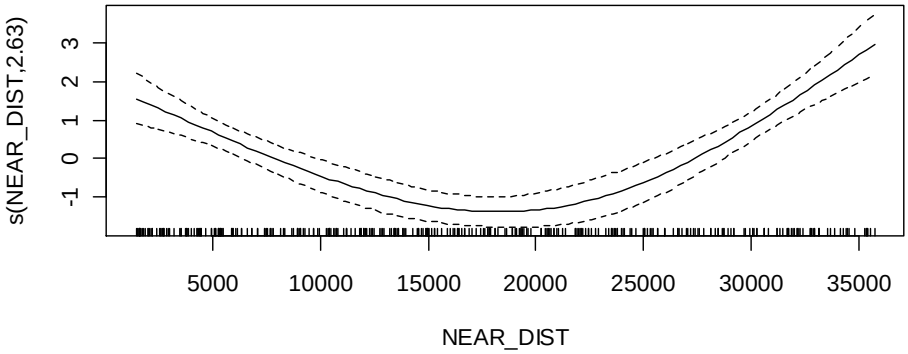


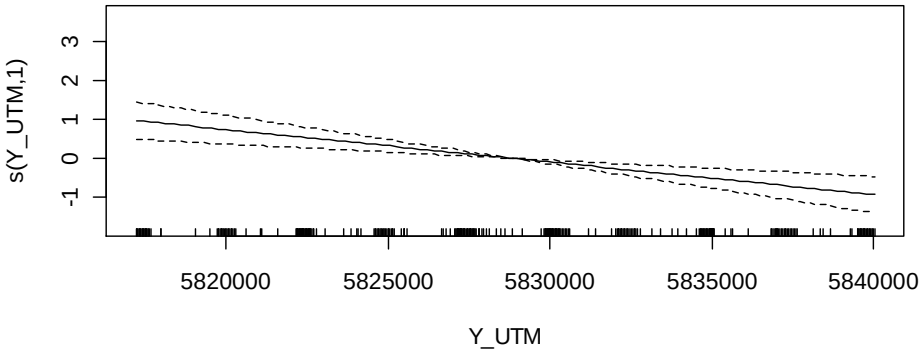


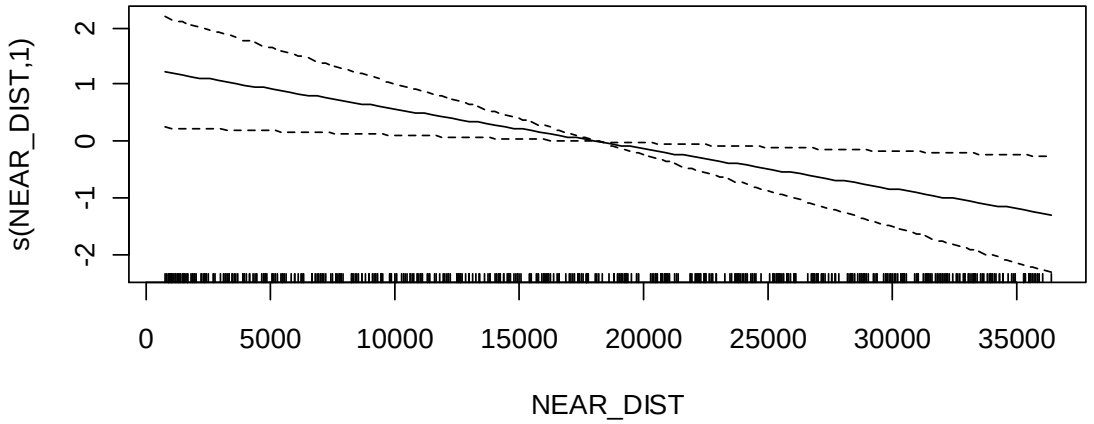

s(NEAR_DIST,1)
-3
-1
1
2
3
0
5000
10000
15000
20000
25000
30000
35000
NEAR_DIST


s(Y_UTM,1)
-3
-1
1
2
3
5820000
5825000
5830000
5835000
5840000
Y_UTM

Lesser Black-backed Gull 2003_11 gam






s(NEAR_DIST,1)
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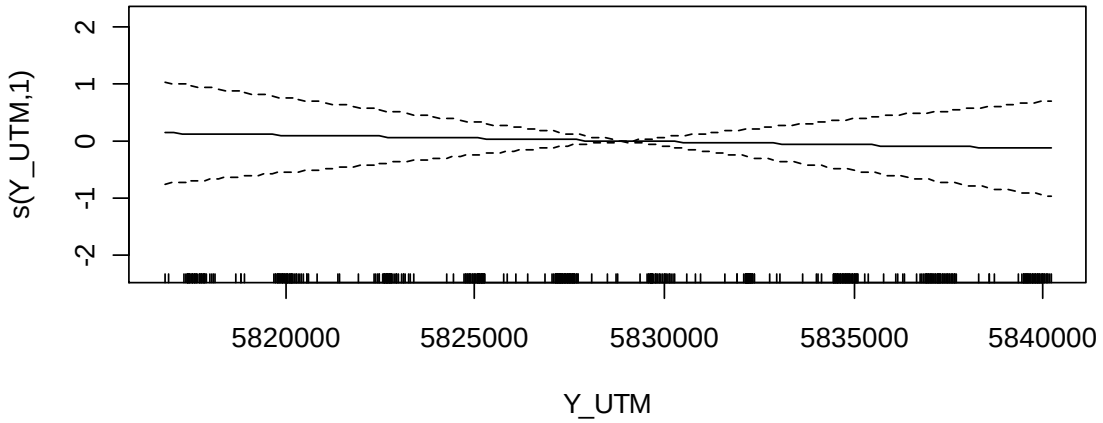
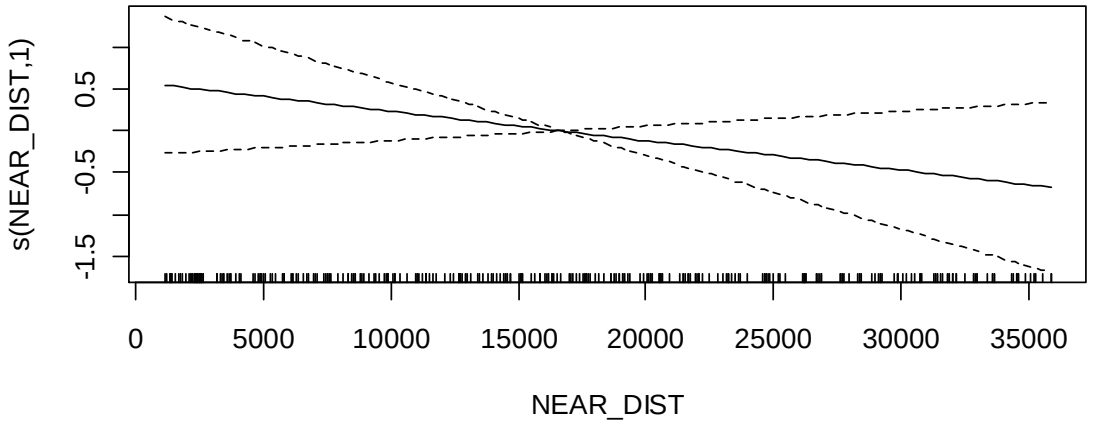
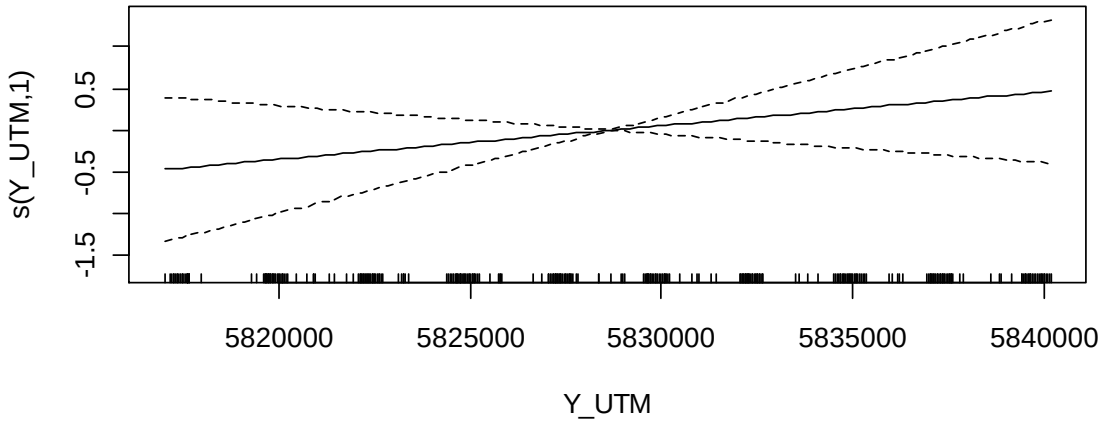
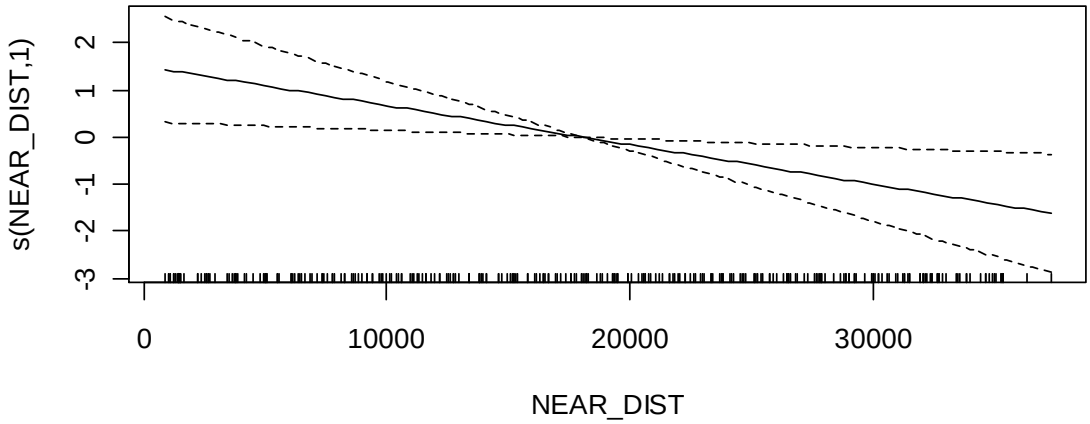
-1
0
1
2
0
5000
10000
15000
20000
25000
30000
35000
NEAR_DIST

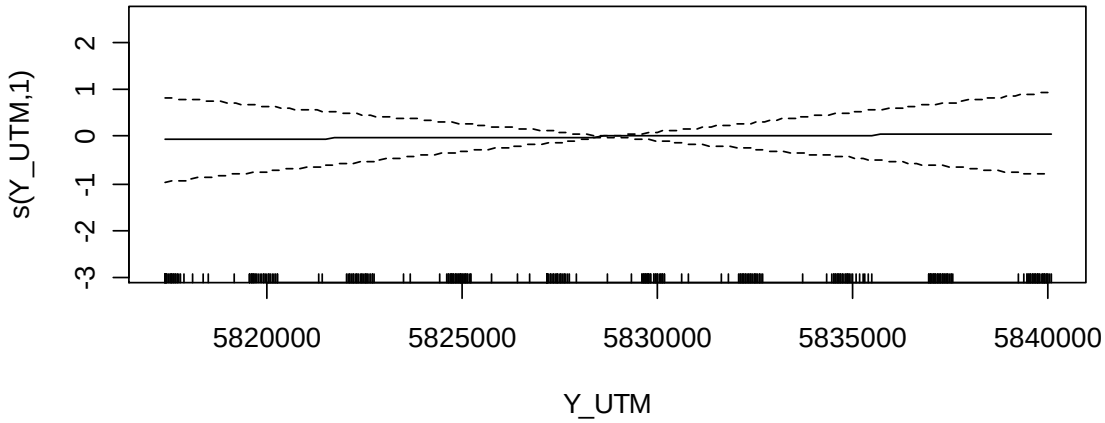

s(Y_UTM,1)
-2
-1
0
1
2
5820000
5825000
5830000
5835000
5840000
Y_UTM

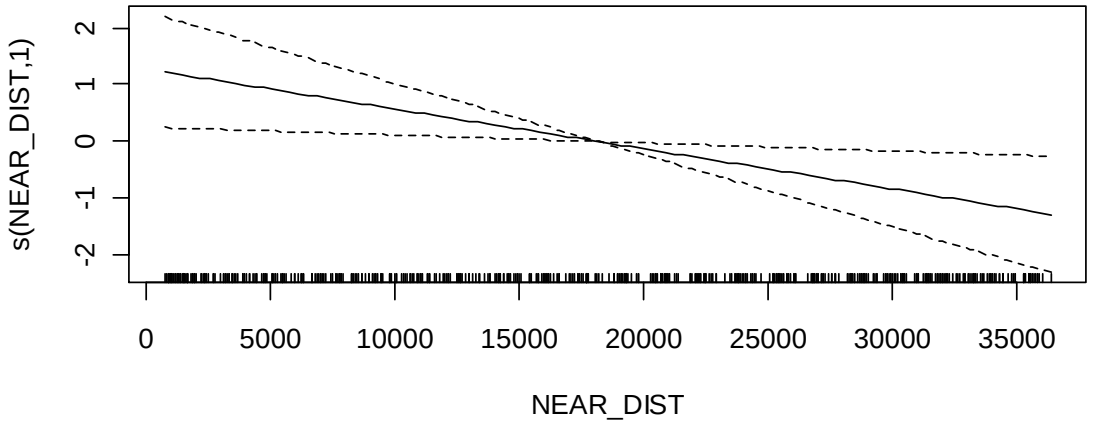
Herring_Gull_2008_1_gamm

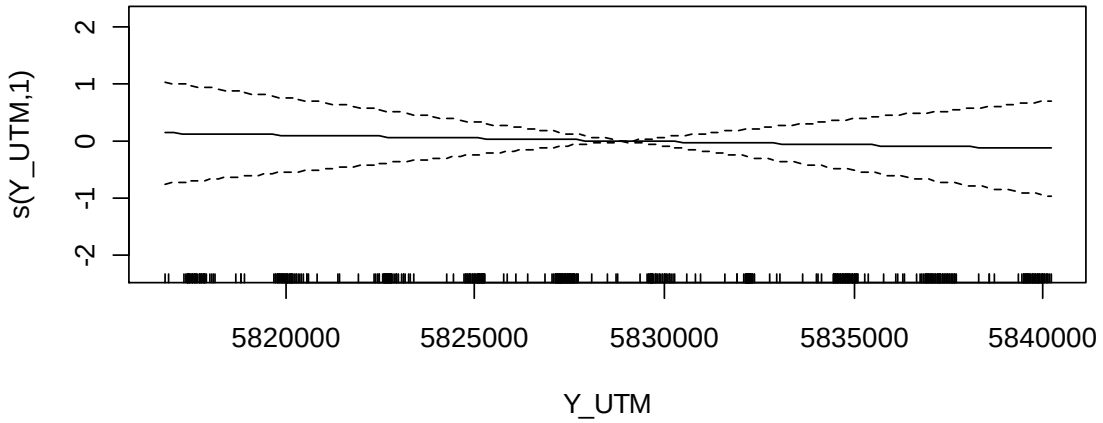


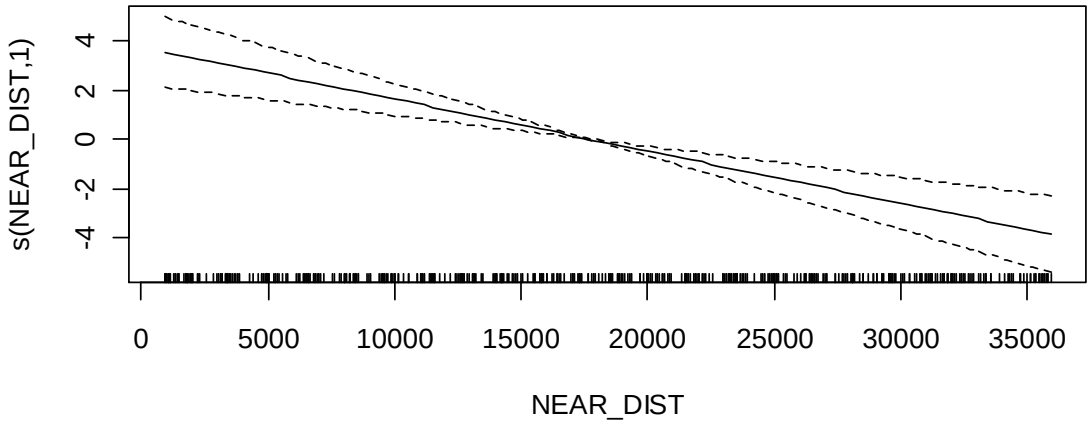


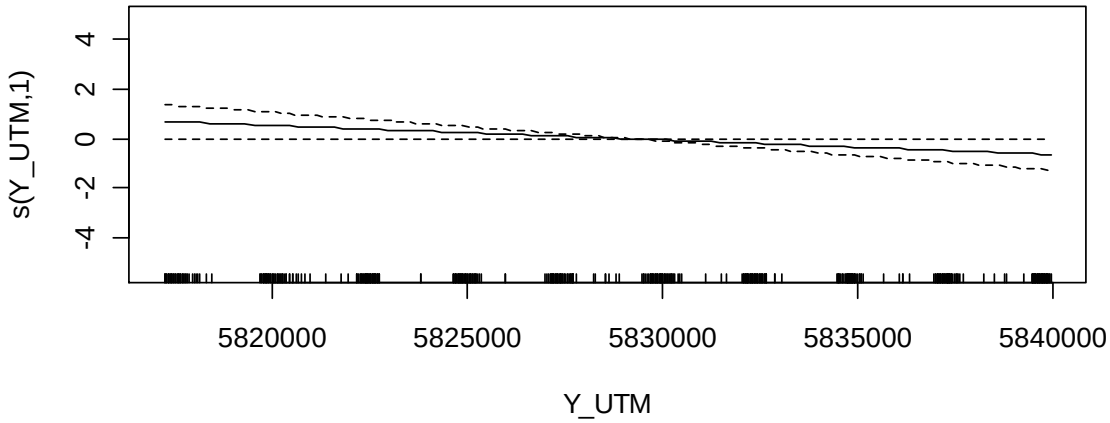

s(NEAR_DIST,1)
-3
-2
-1
0
1
2
0
10000
20000
30000
NEAR_DIST


s(Y_UTM,1)
-3
-2
-1
0
1
2
5820000
5825000
5830000
5835000
5840000
Y_UTM

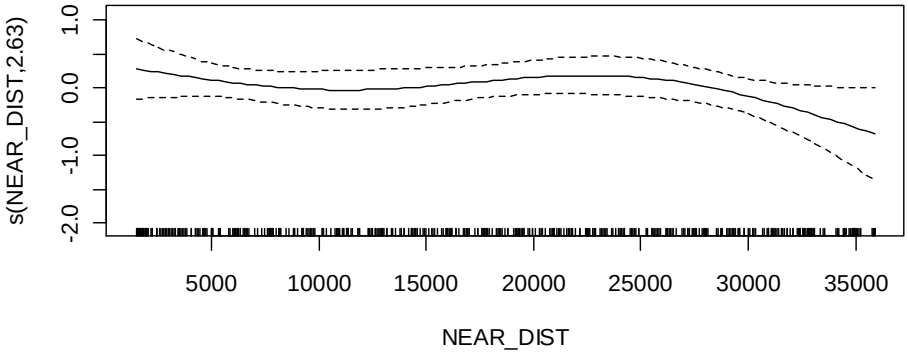

s(NEAR_DIST,1)
-2
-1
0
1
2
0
5000
10000
15000
20000
25000
30000
35000
NEAR_DIST

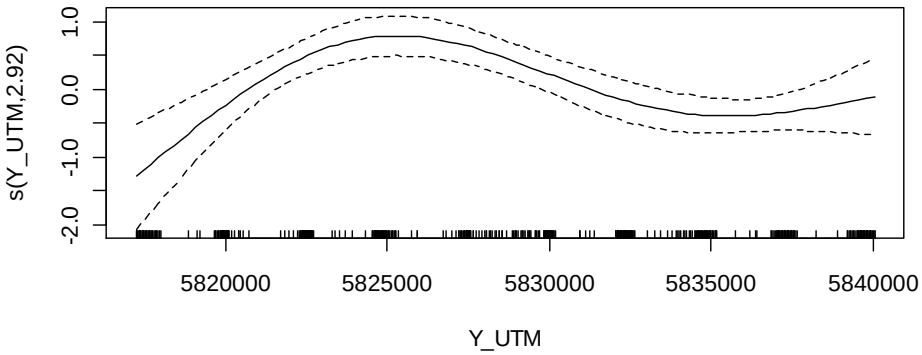

s(Y_UTM,1)
-2
-1
0
1
2
5820000
5825000
5830000
5835000
5840000
Y_UTM

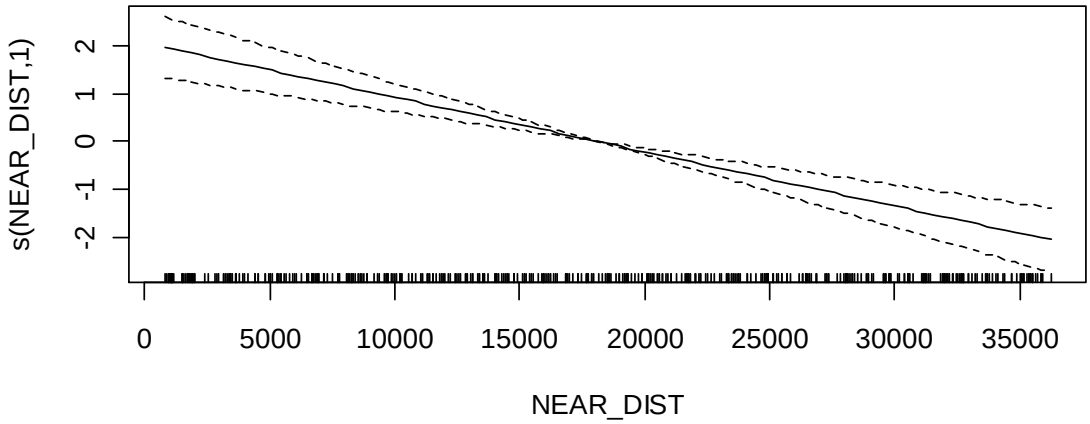

s(NEAR_DIST,1)
4
2
0
-2
-4
0
5000
10000
15000
20000
25000
30000
35000
NEAR_DIST

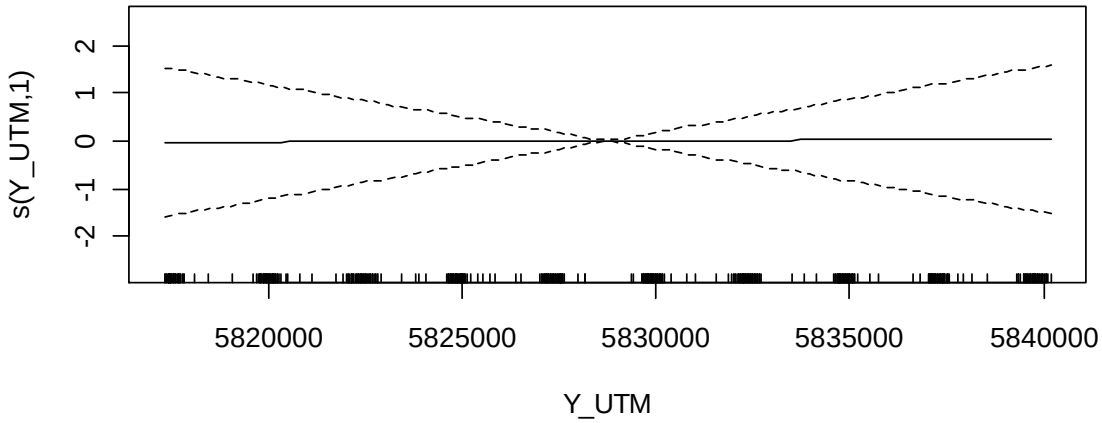

s(Y_UTM,1)
4
2
0
-2
-4
5820000
5825000
5830000
5835000
5840000
Y_UTM

Herring Gull 2008_4 gam

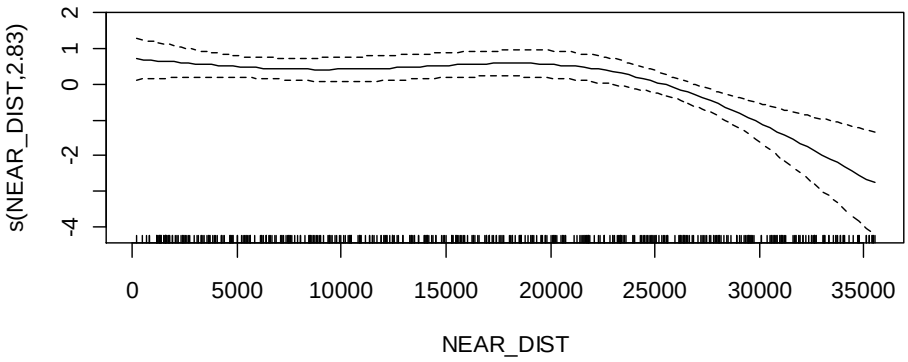


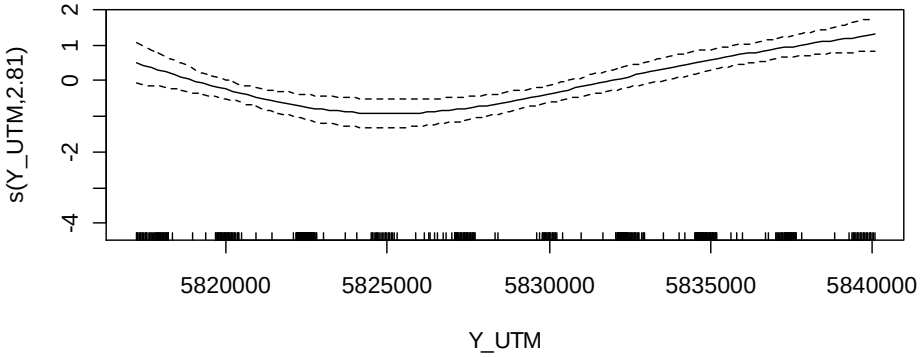


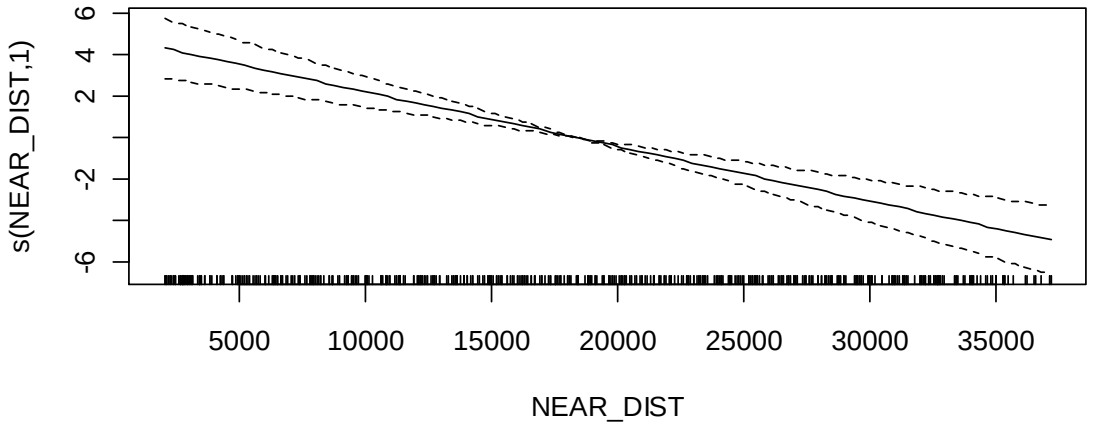

s(NEAR_DIST,1)
-2
-1
0
1
2
0
5000
10000
15000
20000
25000
30000
35000
NEAR_DIST

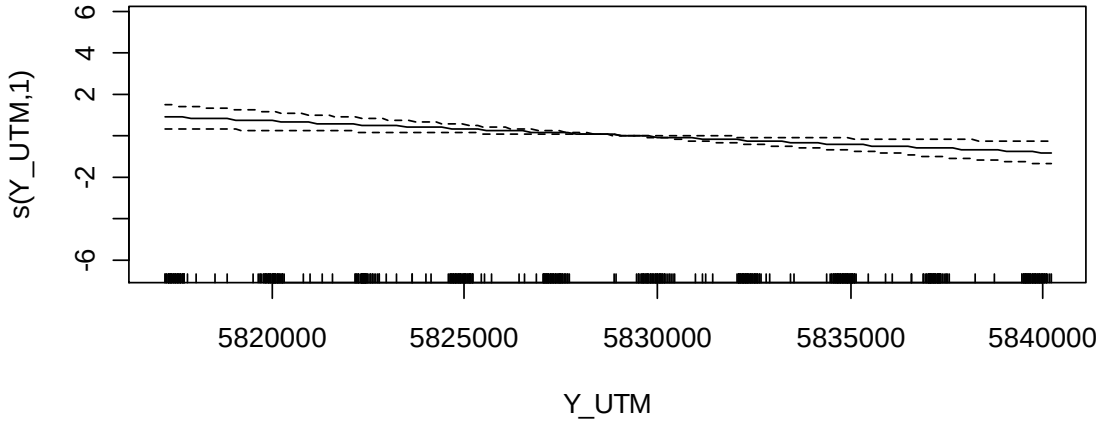

s(Y_UTM,1)
-2
-1
0
1
2
5820000
5825000
5830000
5835000
5840000
Y_UTM

Herring Gull 2007_6 gam

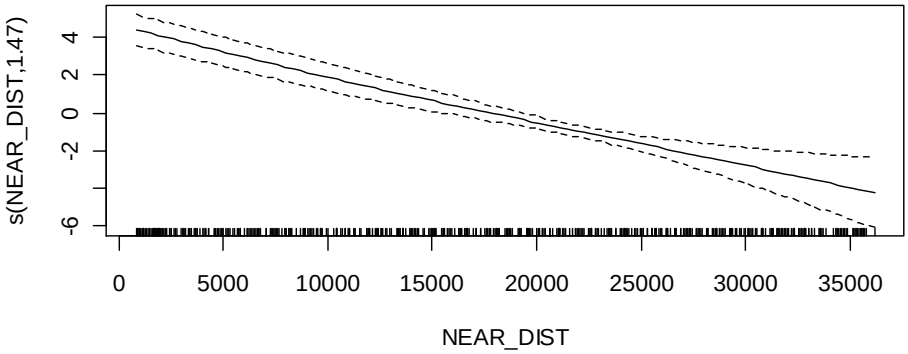


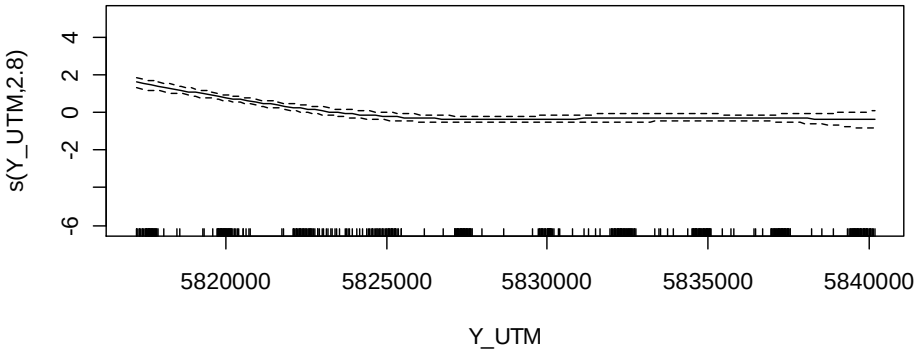


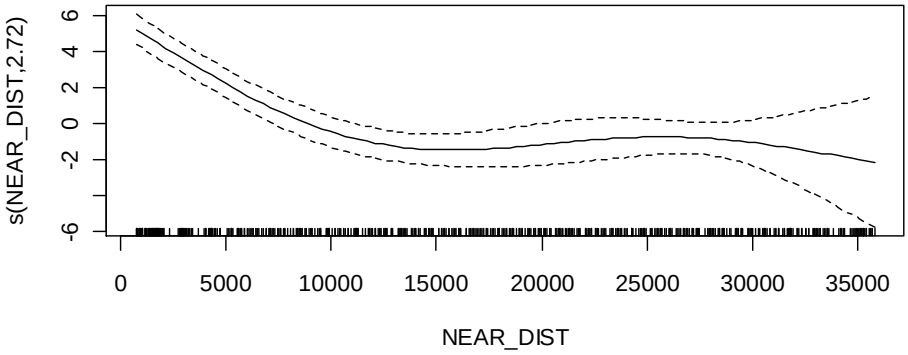

s(NEAR_DIST,1)
6
4
2
-2
-6
5000
10000
15000
20000
25000
30000
35000
NEAR_DIST

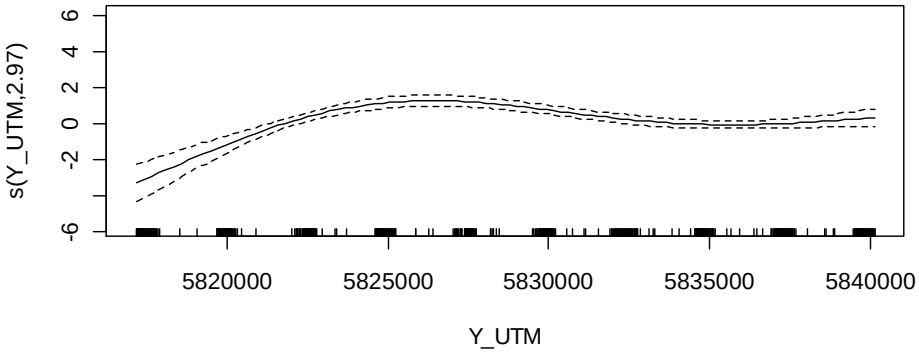

s(Y_UTM,1)
6
4
2
-2
-6
5820000
5825000
5830000
5835000
5840000
Y_UTM

Herring Gull 2003_8 gam






s(NEAR_DIST,2.72)
-6
-2
0
2
4
6
0
5000
10000
15000
20000
25000
30000
35000
NEAR_DIST


s(Y_UTM,2.97)
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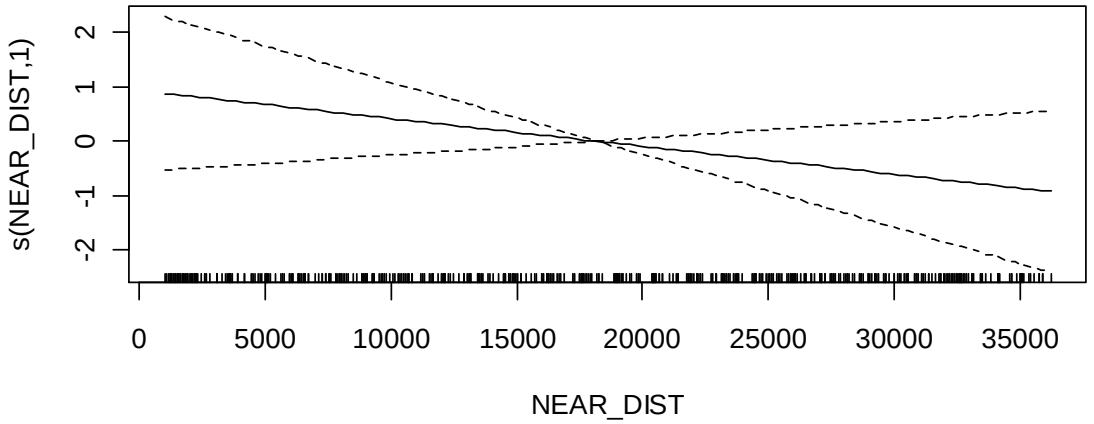
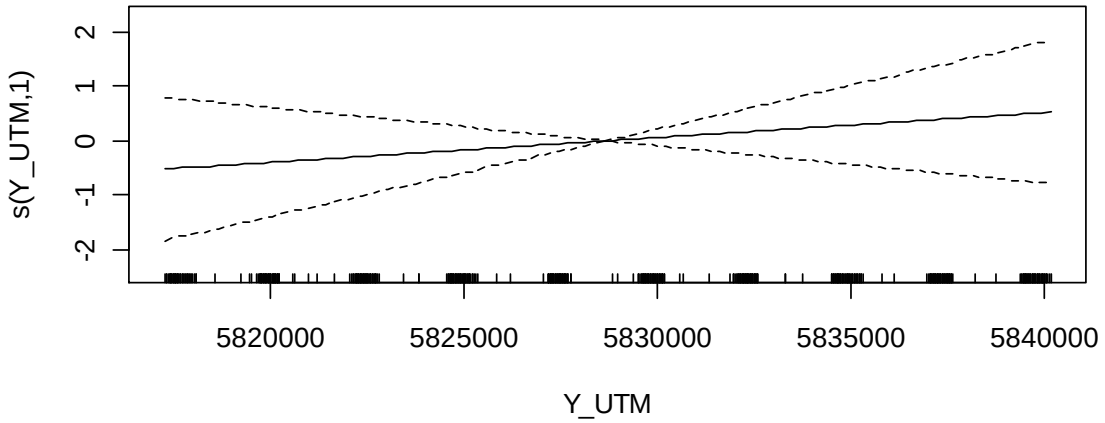
-2
0
2
4
6
5820000
5825000
5830000
5835000
5840000
Y_UTM


s(NEAR_DIST,1)
-2
-1
0
1
2
0
5000
10000
15000
20000
25000
30000
35000
NEAR_DIST


s(Y_UTM,1)
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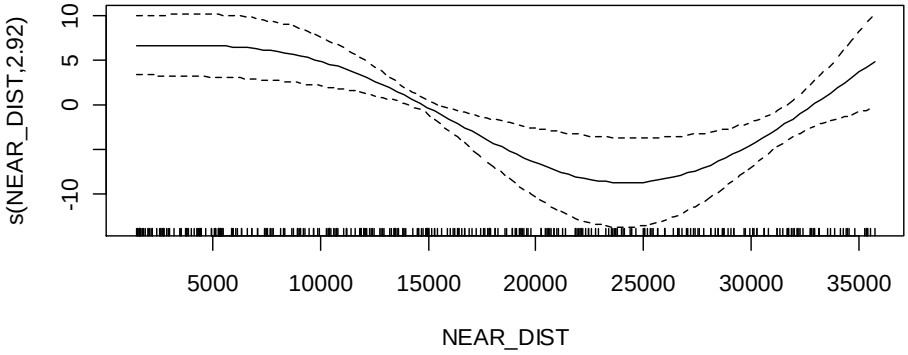
5840000
Y_UTM


s(NEAR_DIST,2.92)
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20000
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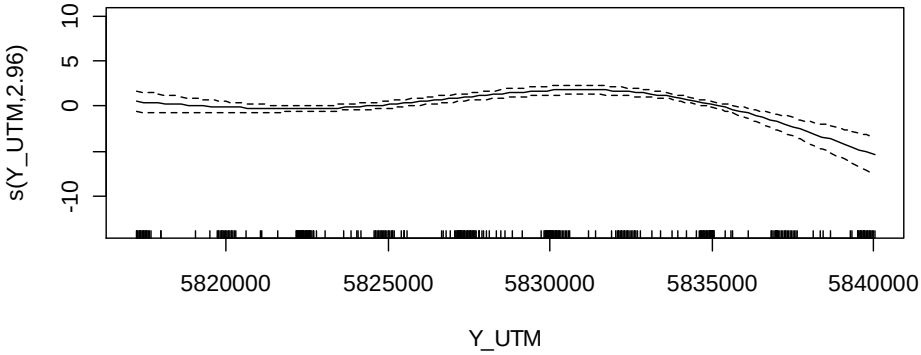
35000
NEAR_DIST


s(Y_UTM,2.96)
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5
0
-10
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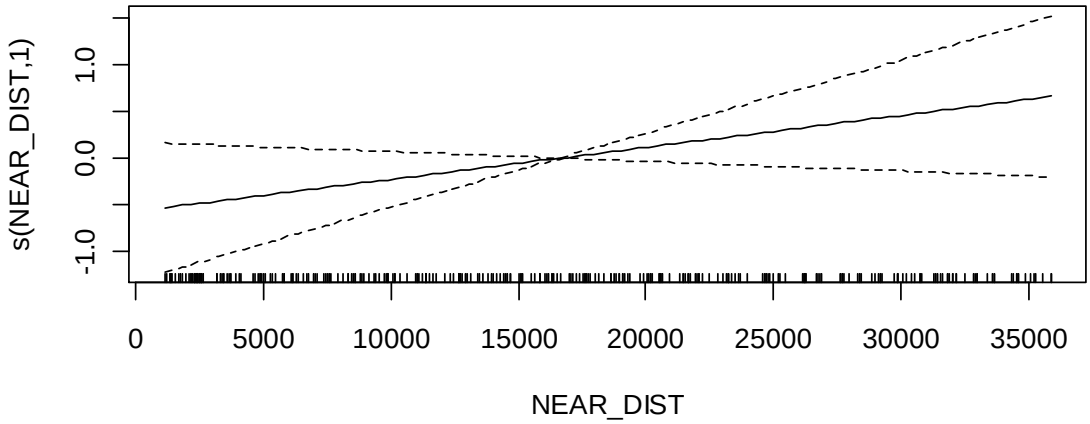
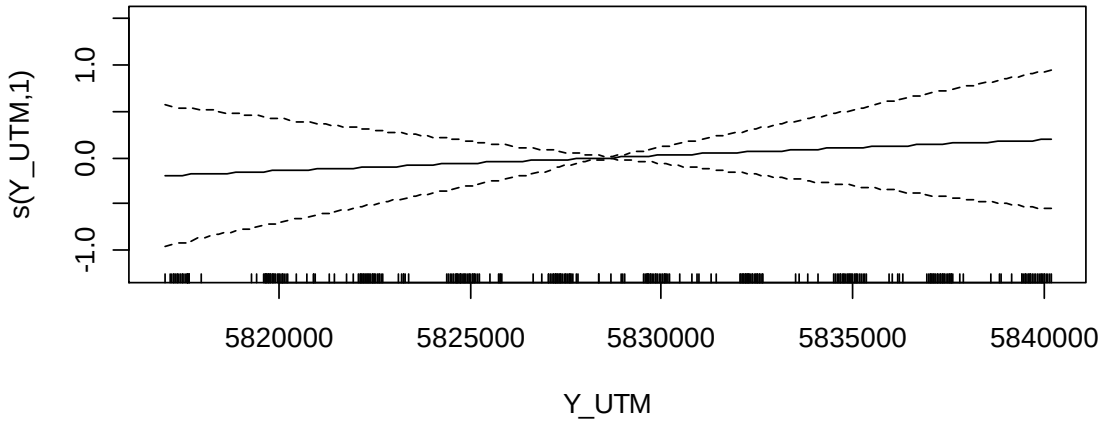
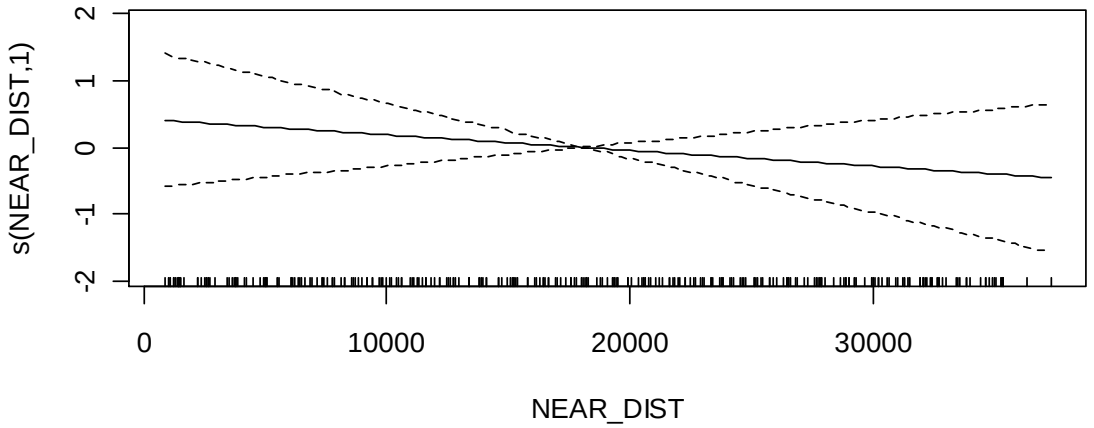
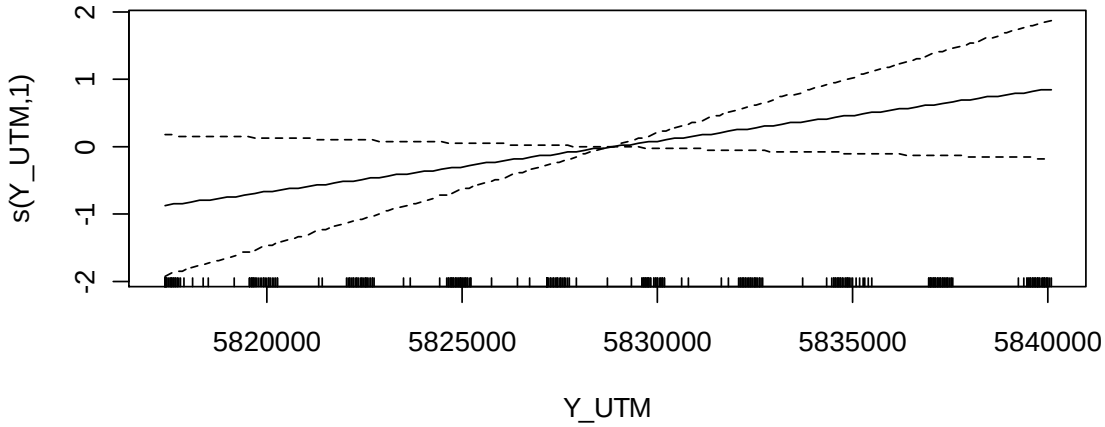
5830000
5835000
5840000
Y_UTM

Greater Black-backed Gull_2008_1_gamm

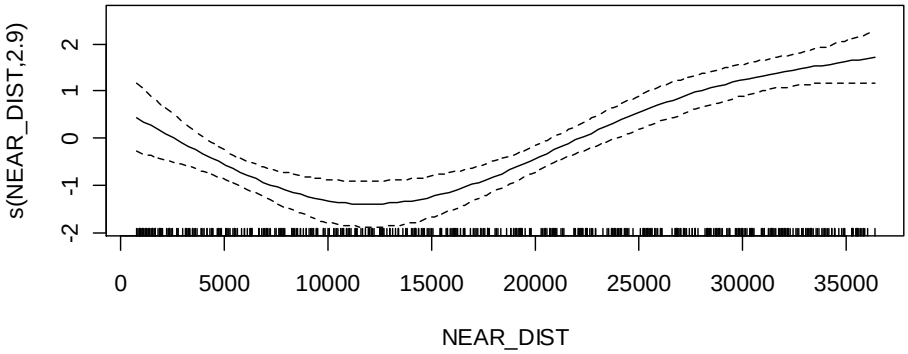


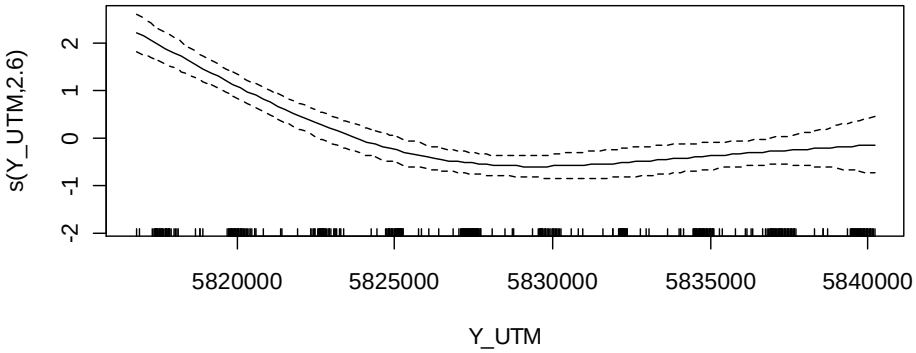



s(NEAR_DIST,1)
2
1
0
-1
-2
0
10000
20000
30000
NEAR_DIST

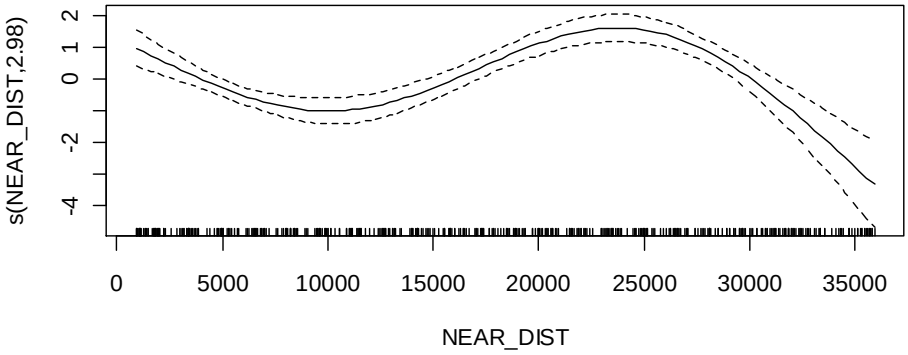

s(Y_UTM,1)
2
1
0
-1
-2
5820000
5825000
5830000
5835000
5840000
Y_UTM

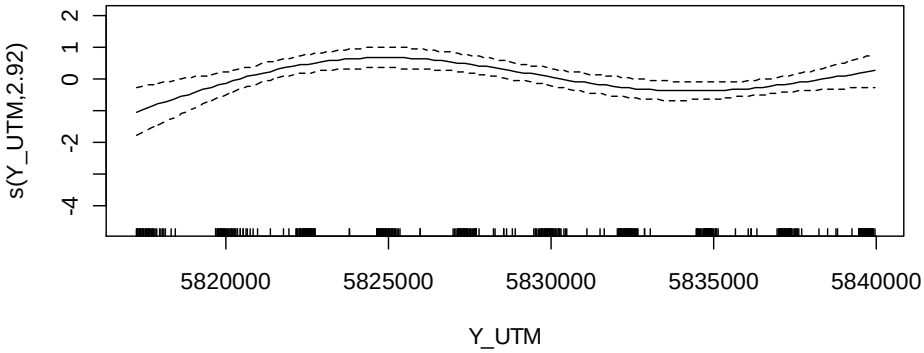
Greater Black-backedGull 2003_4 gam



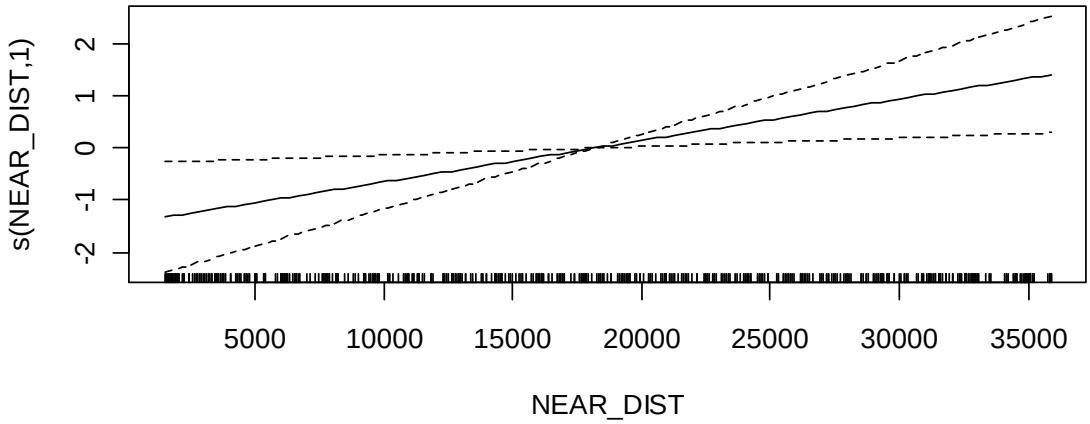


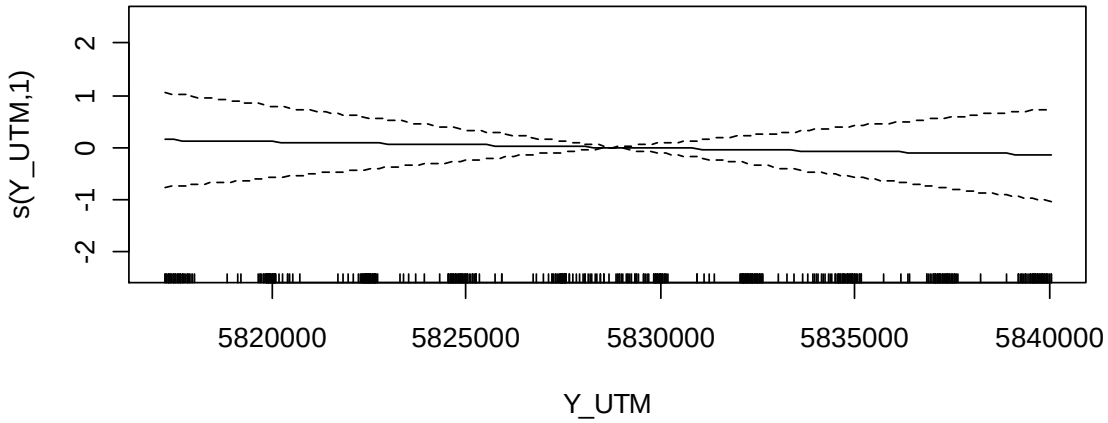
Greater Black-backed Gull 2007_4 gam

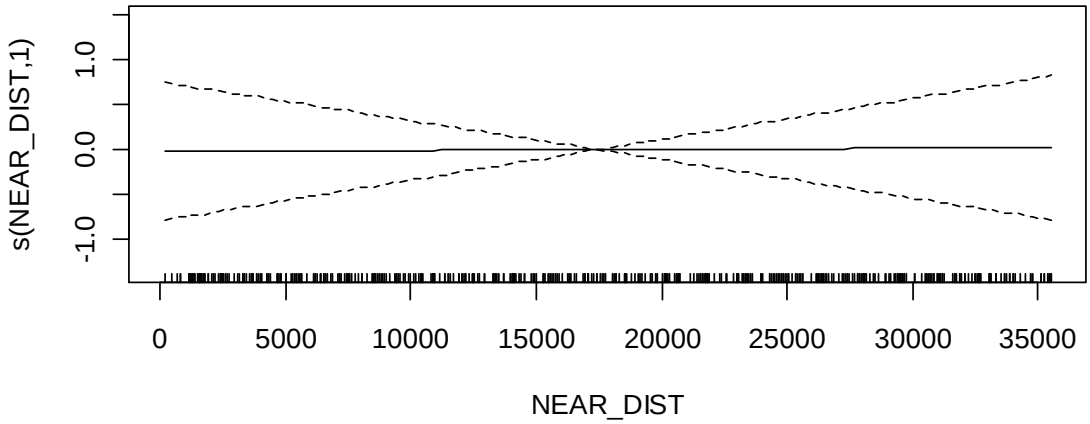




Greater Black-backed Gull_2008_4_gamm






s(NEAR_DIST,1)
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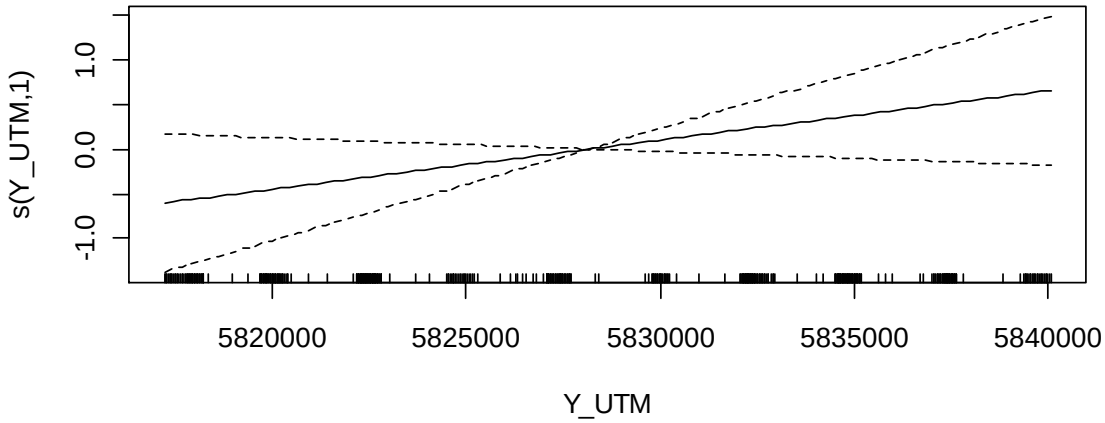
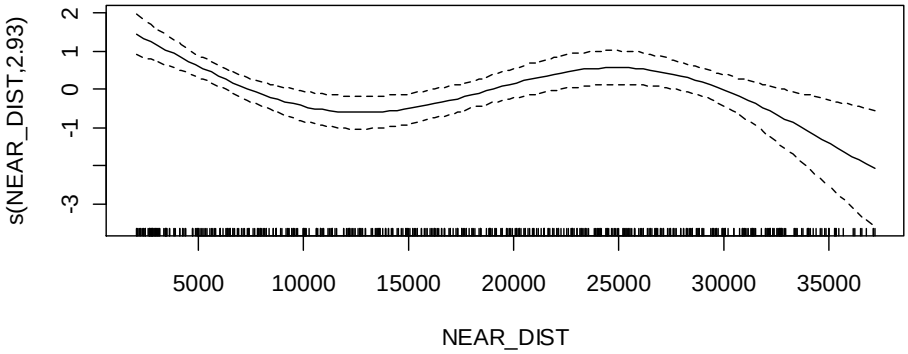
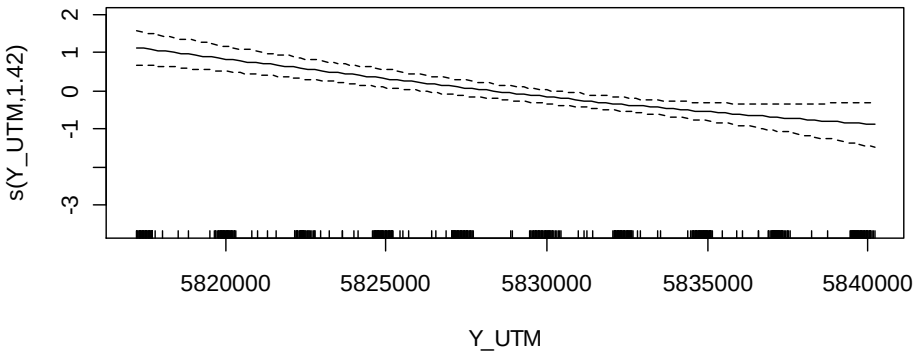
0.0
-1.0
0
5000
10000
15000
20000
25000
30000
35000
NEAR_DIST

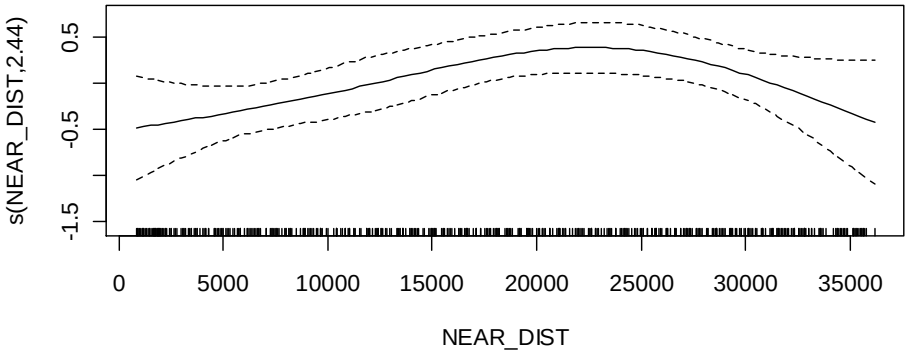

s(Y_UTM,1)
1.0
0.0
-1.0
5820000
5825000
5830000
5835000
5840000
Y_UTM

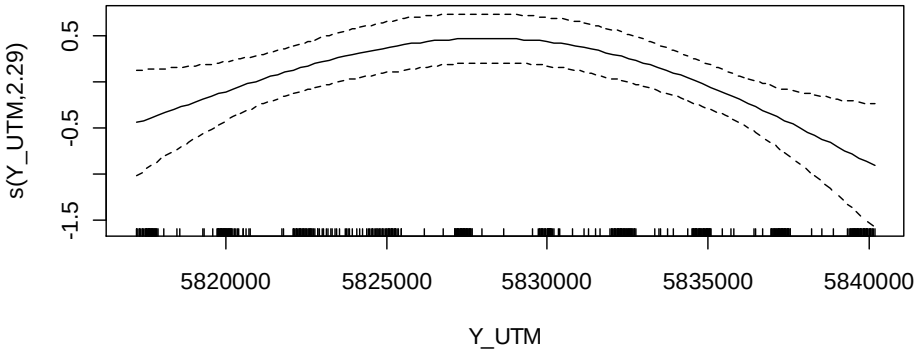
Greater Black-backed Gull 2008_6 gam



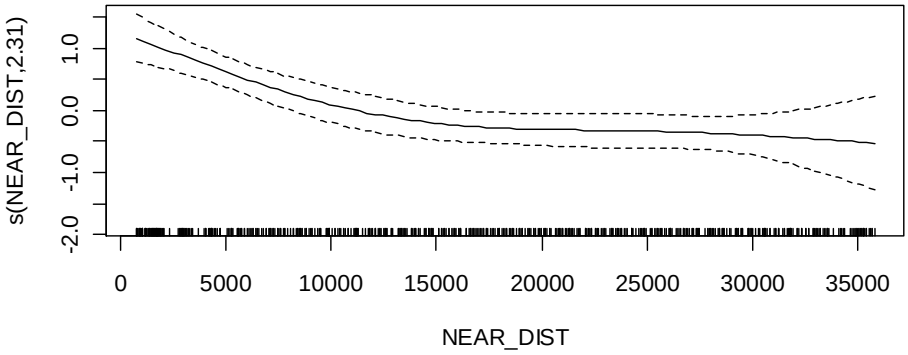


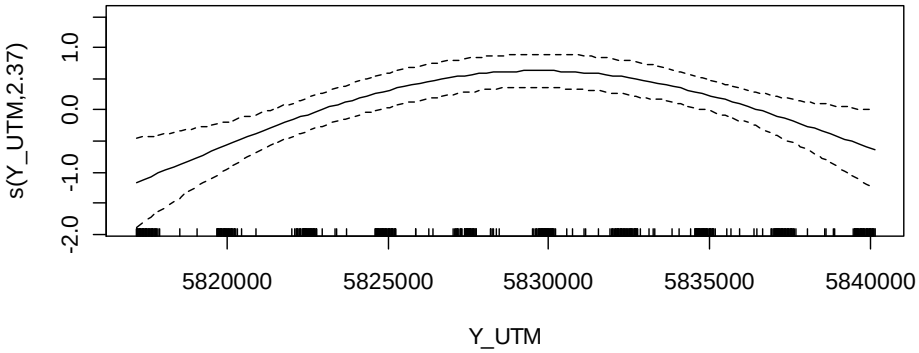
Greater Black-backed Gull 2003_8 gam

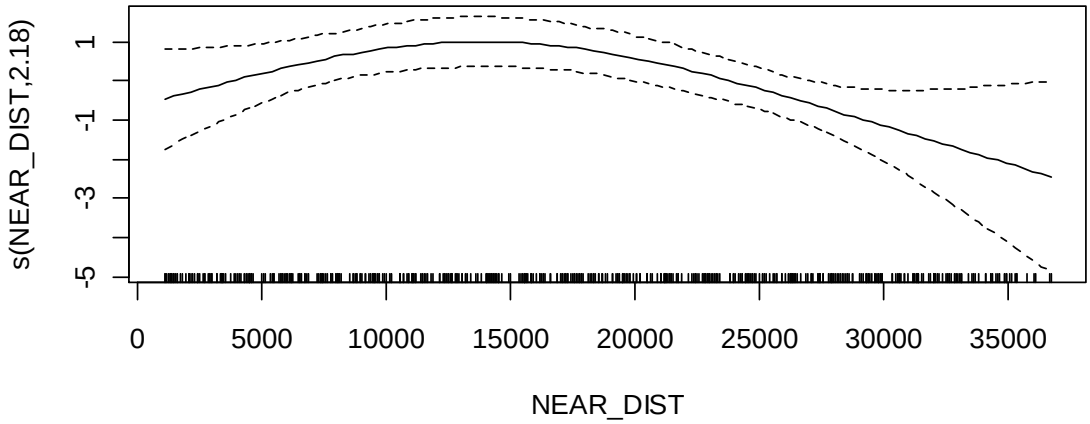




Greater Black-backed Gull 2007_8 gam



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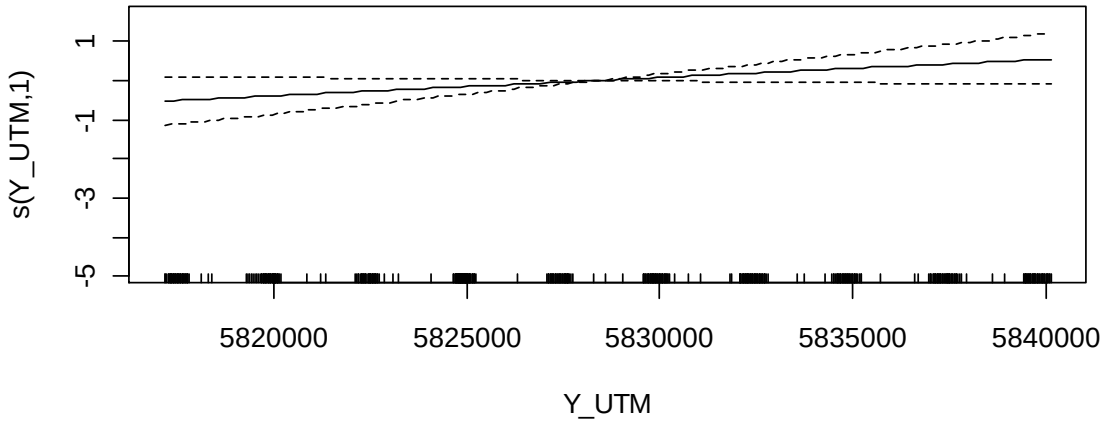
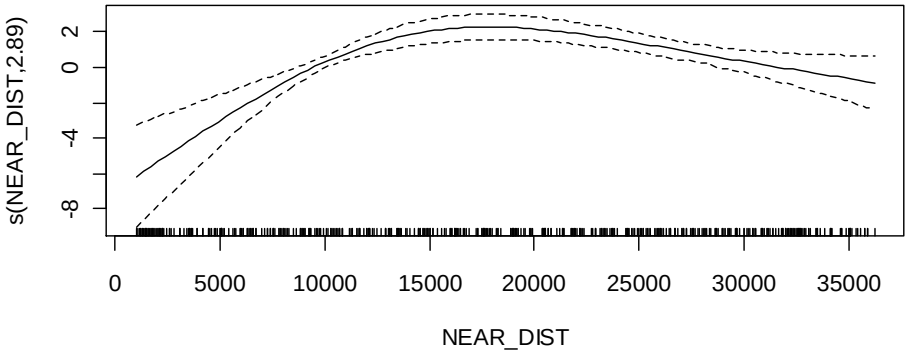
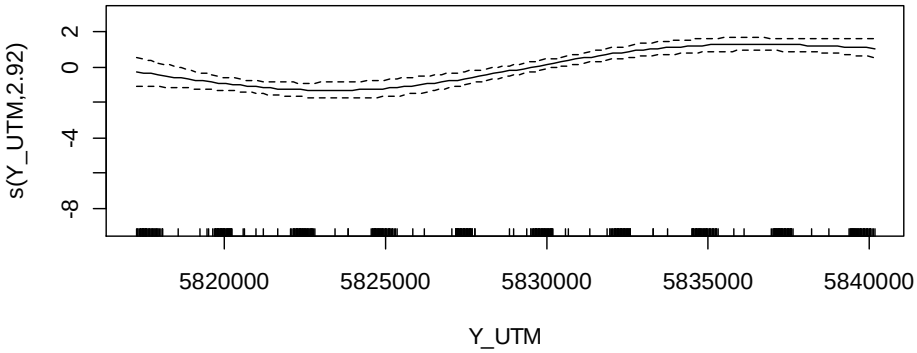
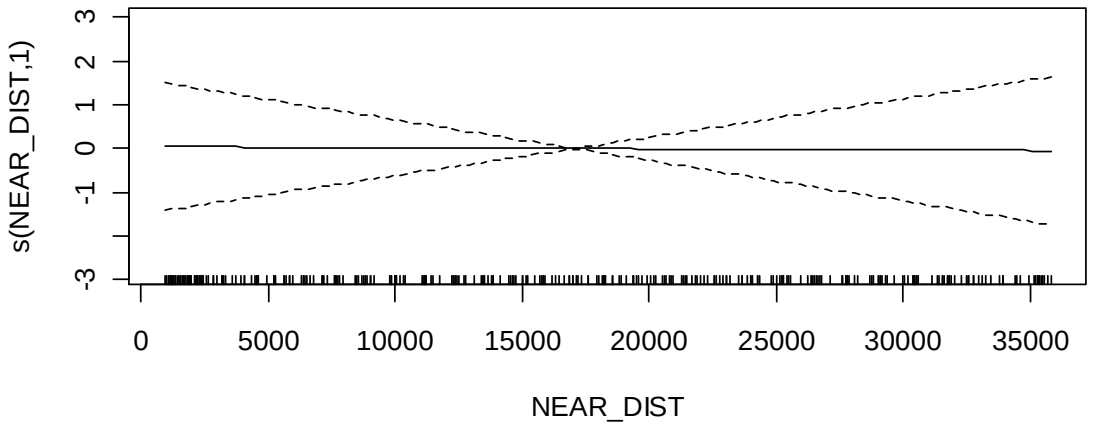
-5
0
5000
10000
15000
20000
25000
30000
35000
NEAR_DIST


s(Y_UTM,1)
1
-1
-3
-5
5820000
5825000
5830000
5835000
5840000
Y_UTM

Greater Black-backed Gull 2002_9 gam






s(NEAR_DIST,1)
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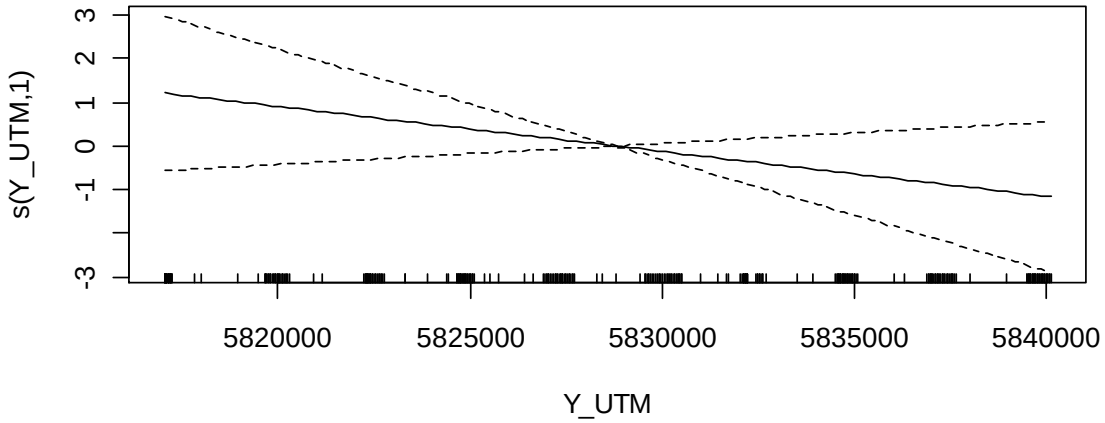
0
1
2
3
0
5000
10000
15000
20000
25000
30000
35000
NEAR_DIST


s(Y_UTM,1)
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0
1
2
3
5820000
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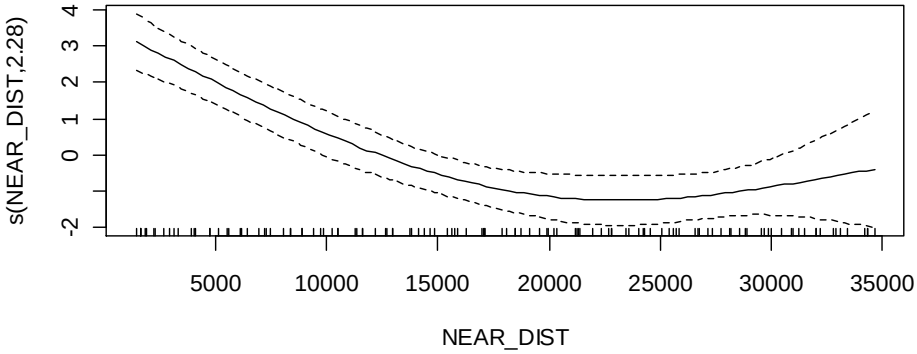
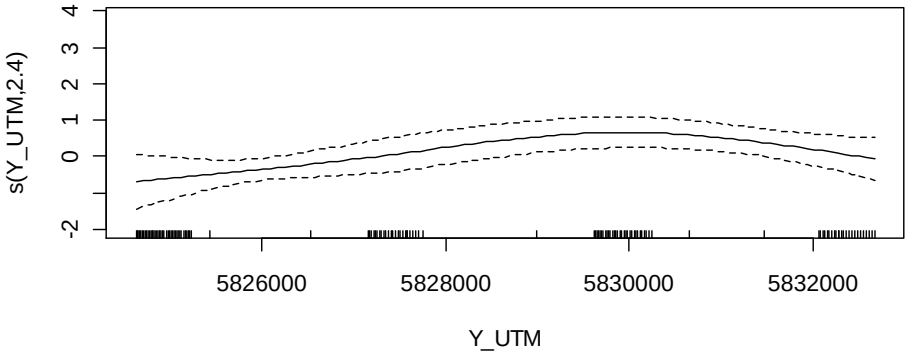
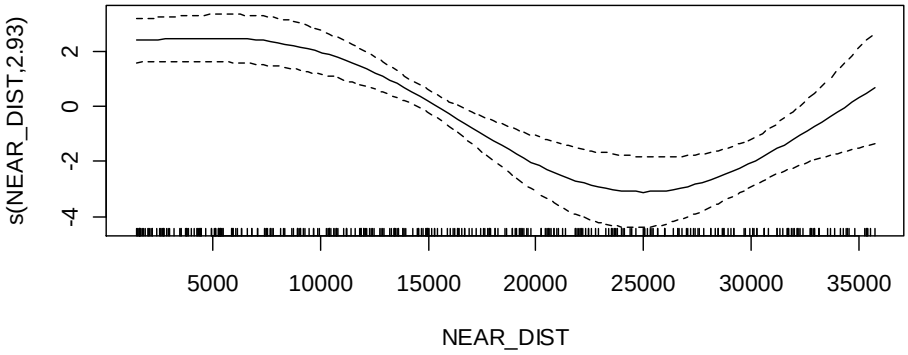
5840000
Y_UTM

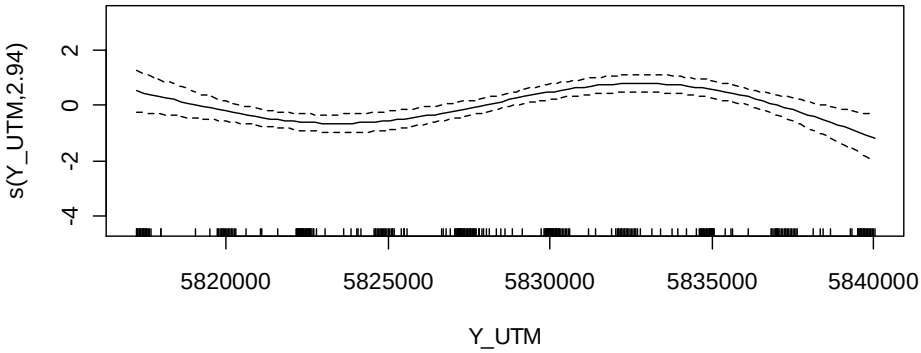
GreaterBlack-backed Gull 2008_9 gam



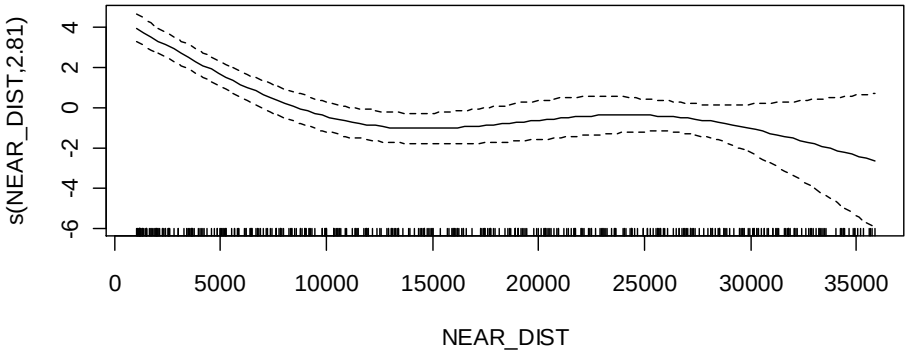


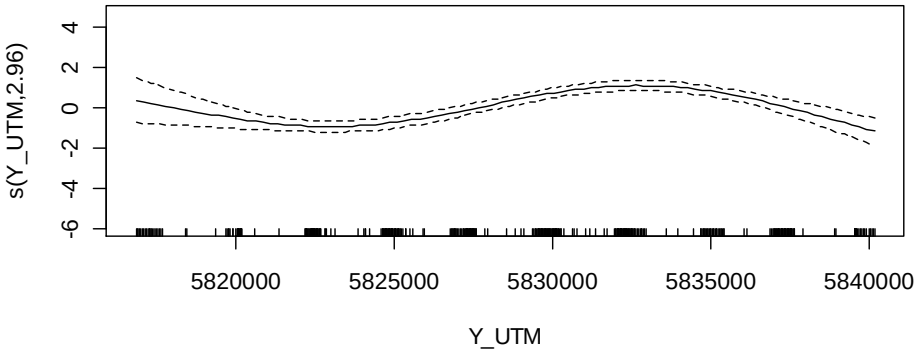
Greater Black-backed Gull 2003_11 gam



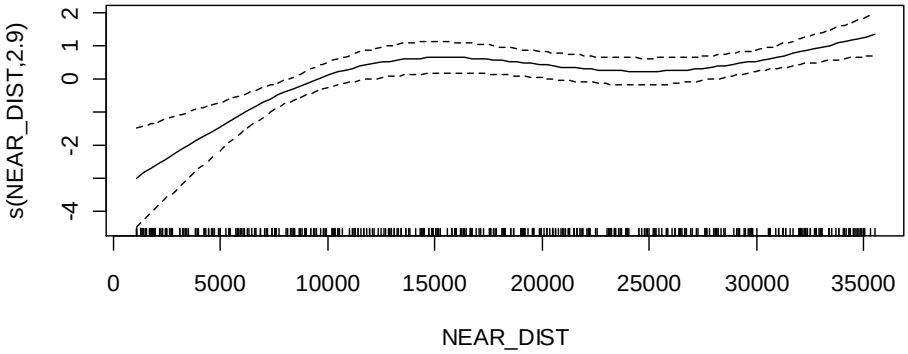


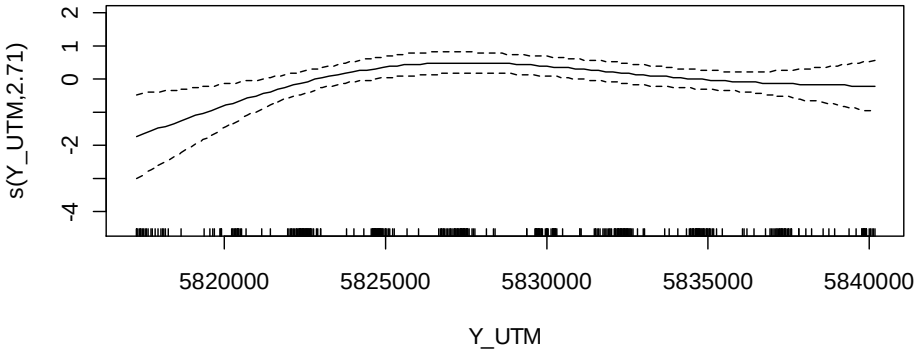
Greater Black-backed Gull 2008_11 gam



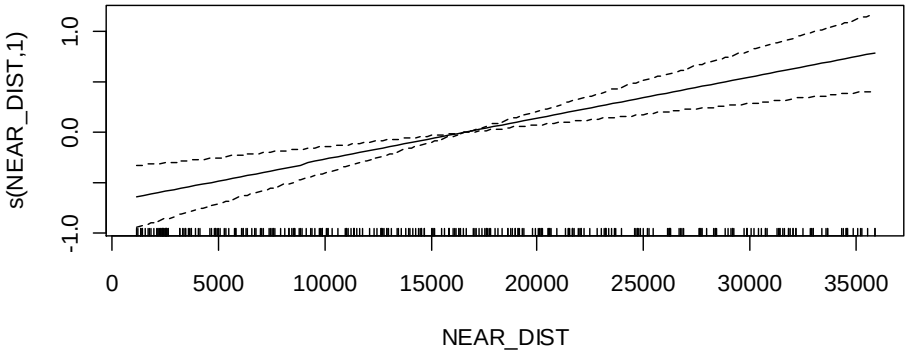


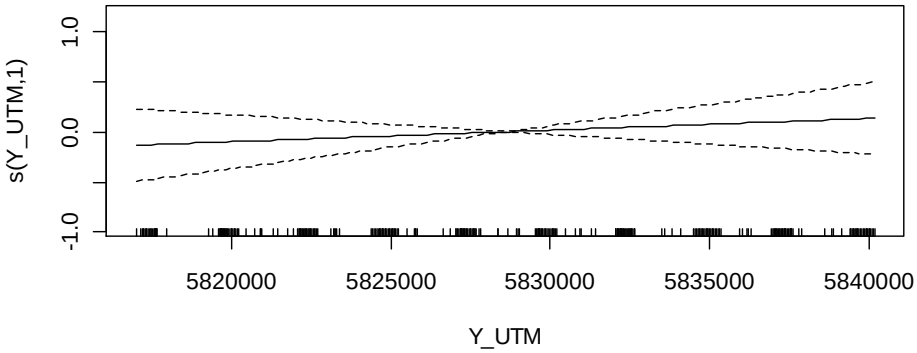
Kittiwake 2004_2 gam



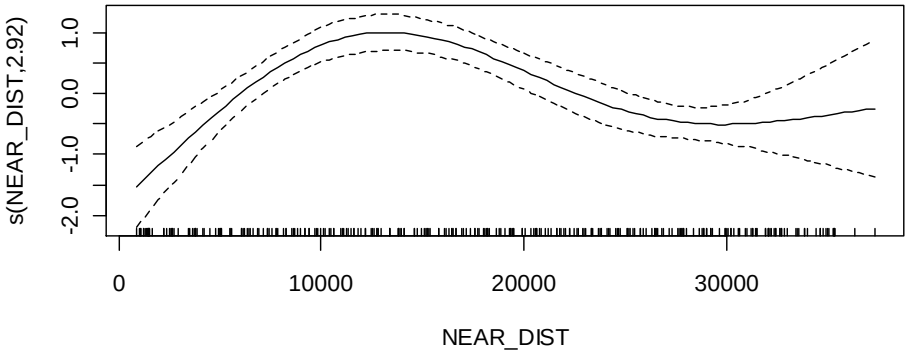


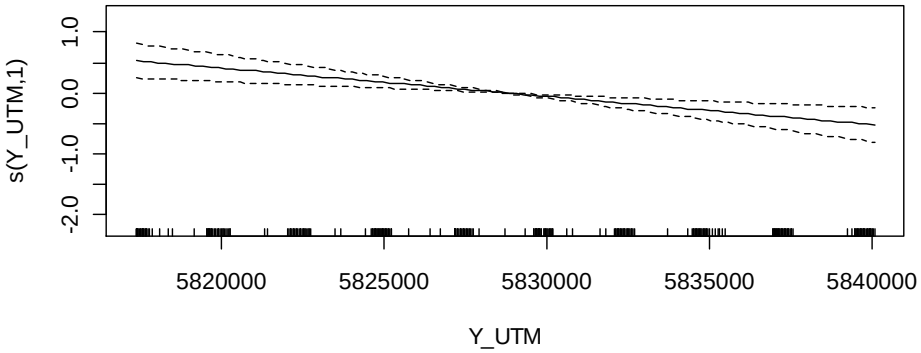
Kittiwake 2008_1 gam



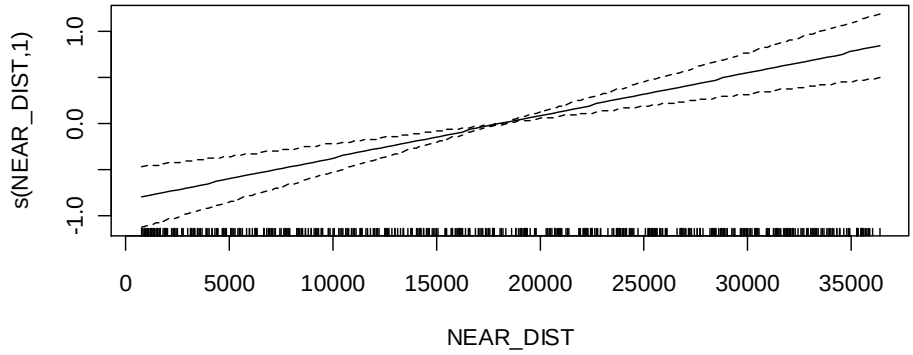


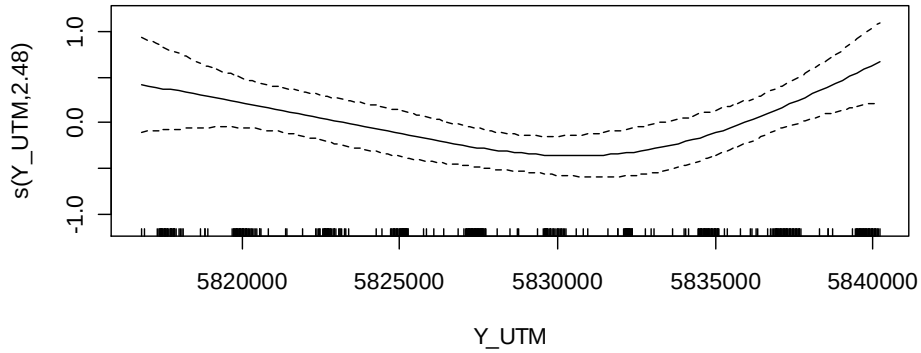
Kittiwake 2009_1 gam

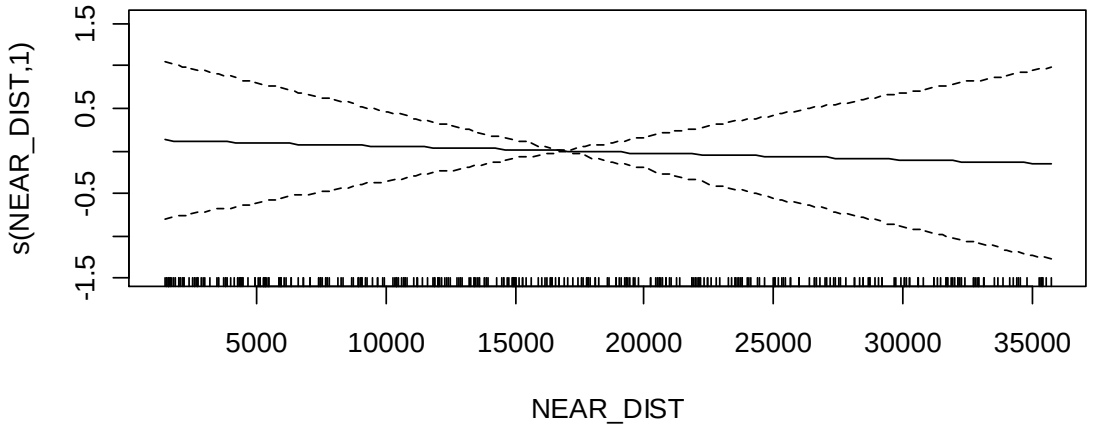




Kittiwake 2003_4 gam






s(NEAR_DIST,1)
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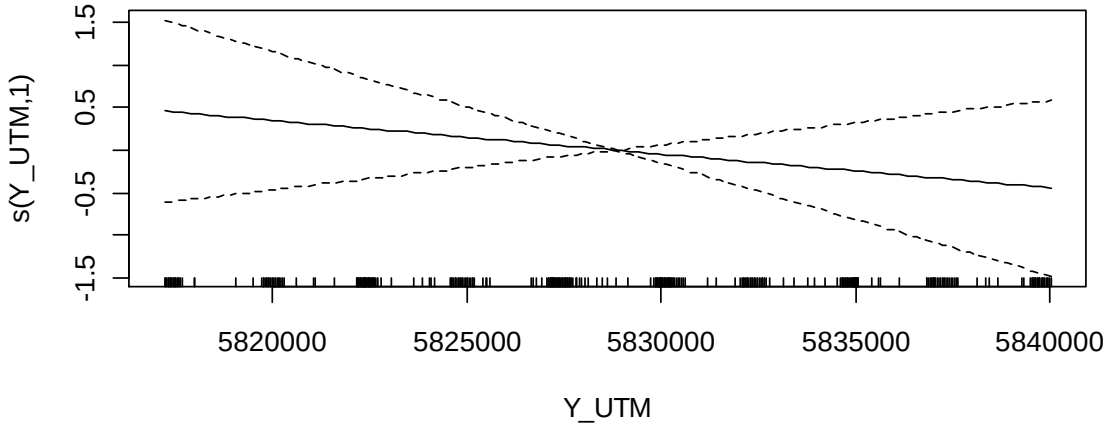
0.5
-0.5
-1.5
5000
10000
15000
20000
25000
30000
35000
NEAR_DIST


s(Y_UTM,1)
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-0.5
-1.5
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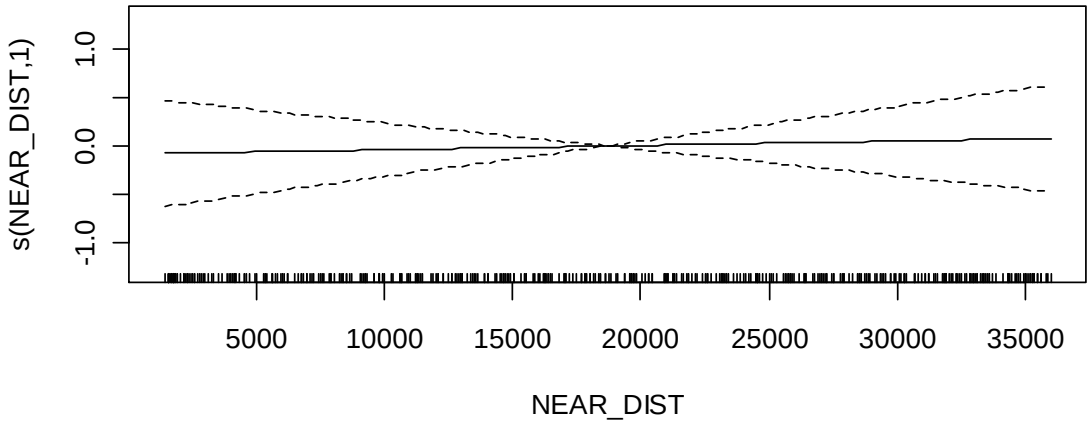
5825000
5830000
5835000
5840000
Y_UTM


s(NEAR_DIST,1)
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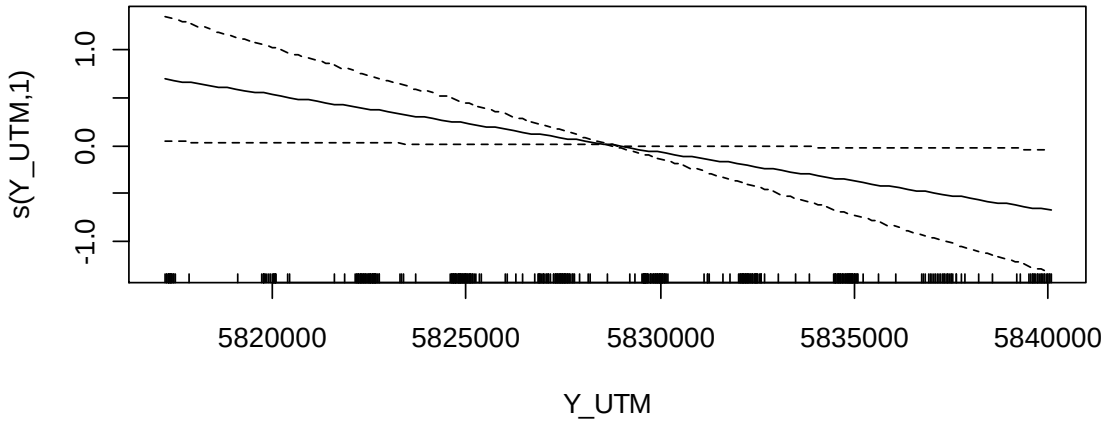
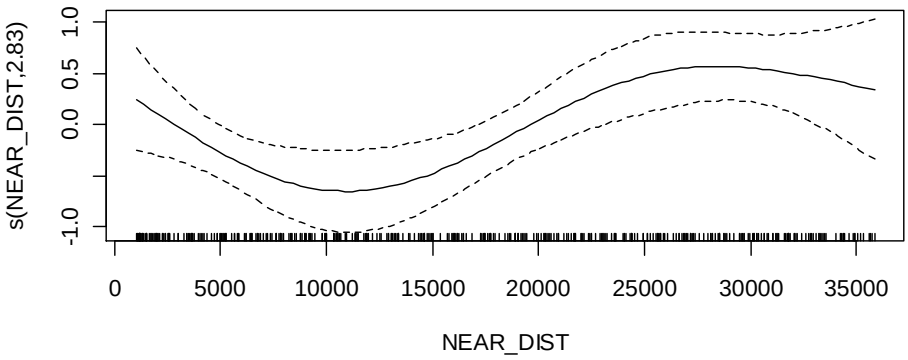
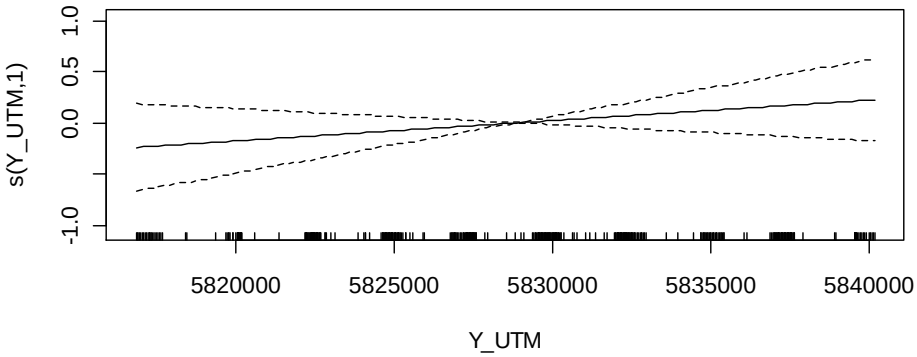
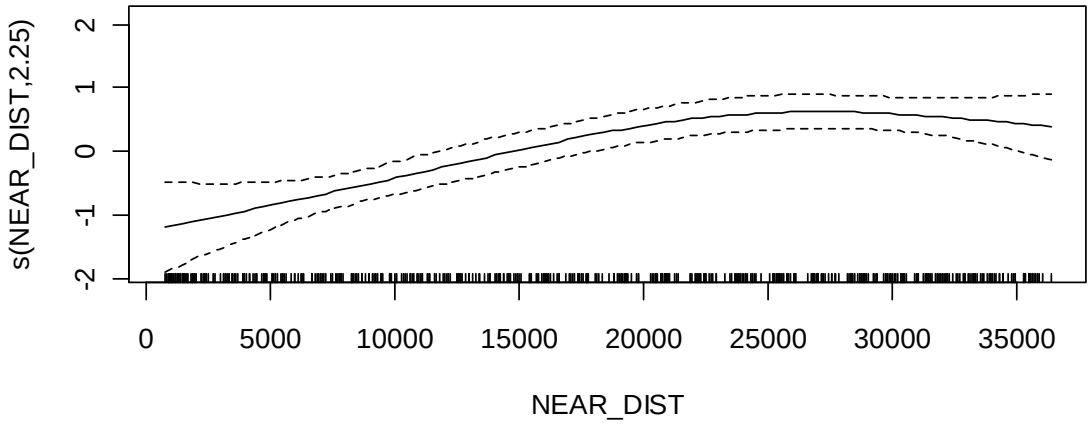
0.0
-1.0
5000
10000
15000
20000
25000
30000
35000
NEAR_DIST

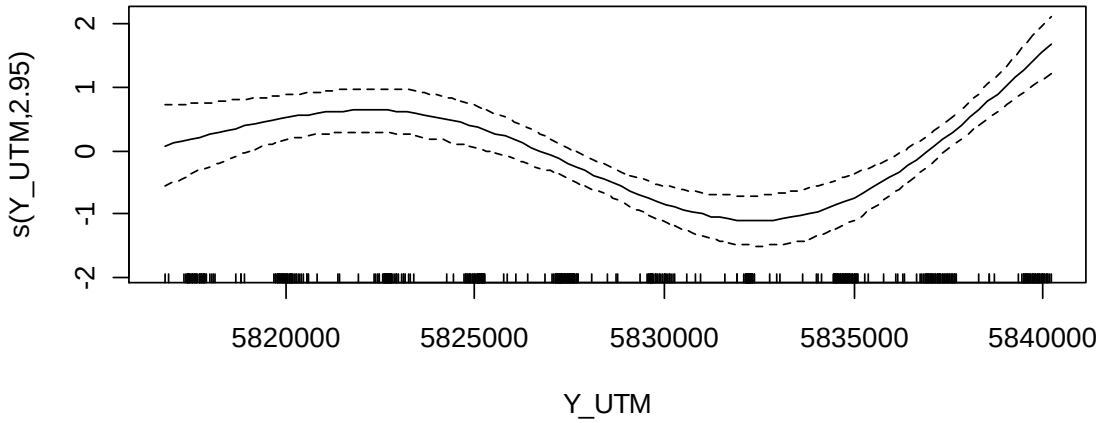

s(Y_UTM,1)
1.0
0.0
-1.0
5820000
5825000
5830000
5835000
5840000
Y_UTM

Kittiwake 2008_11 gam

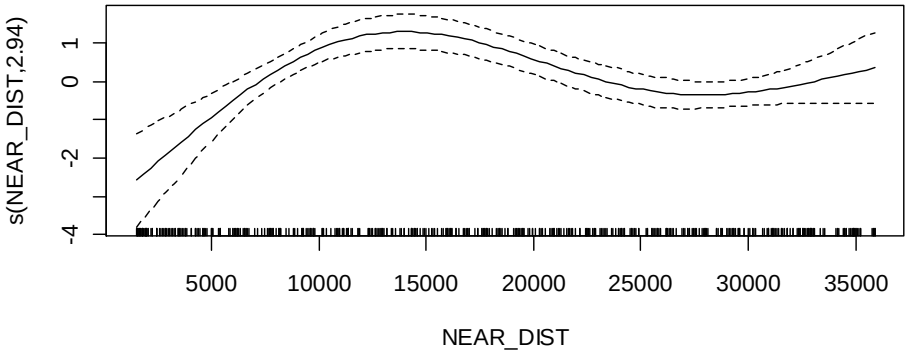


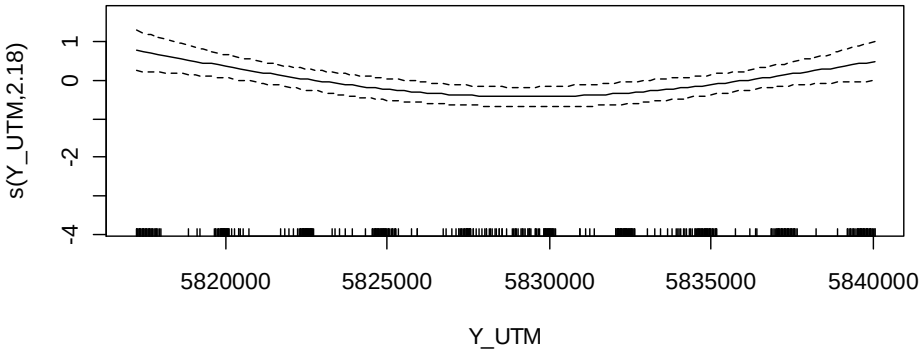


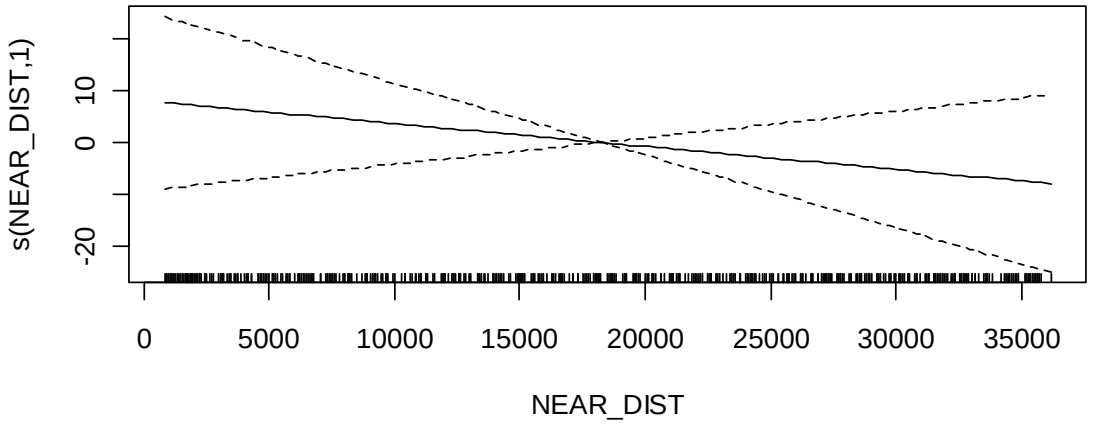

s(NEAR_DIST,2.25)
-2
-1
0
1
2
0
5000
10000
15000
20000
25000
30000
35000
NEAR_DIST

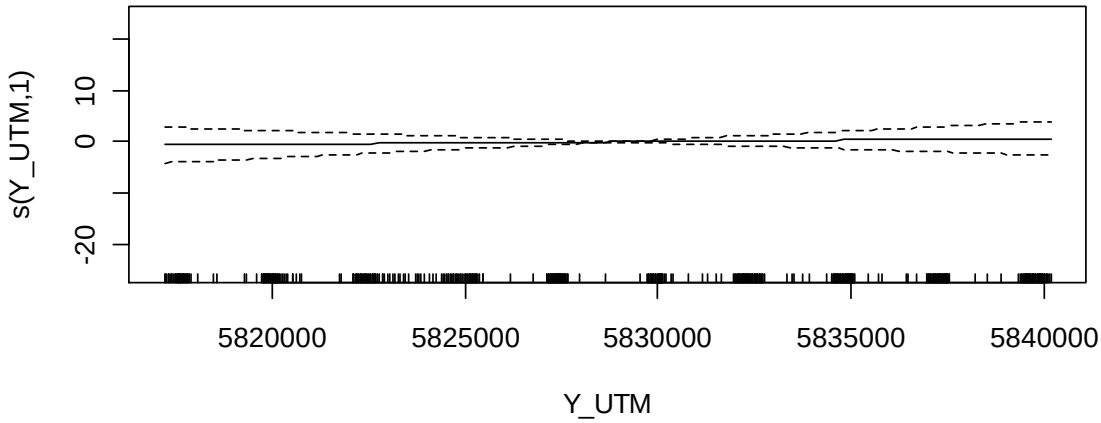

s(Y_UTM,2.95)
-2
-1
0
1
2
5820000
5825000
5830000
5835000
5840000
Y_UTM

Sandwich Tern 2008_4 gam

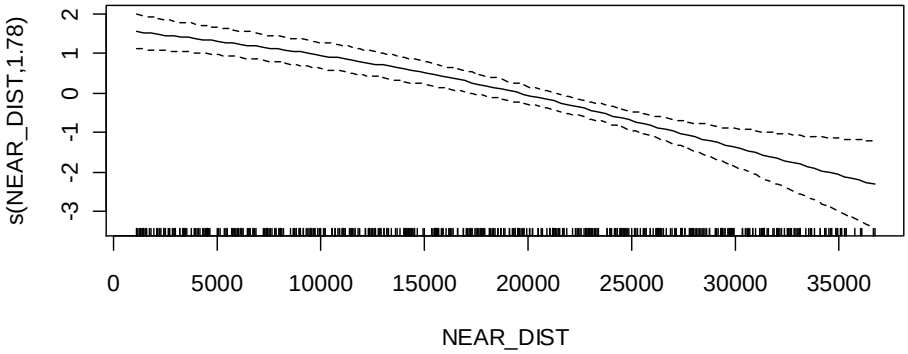


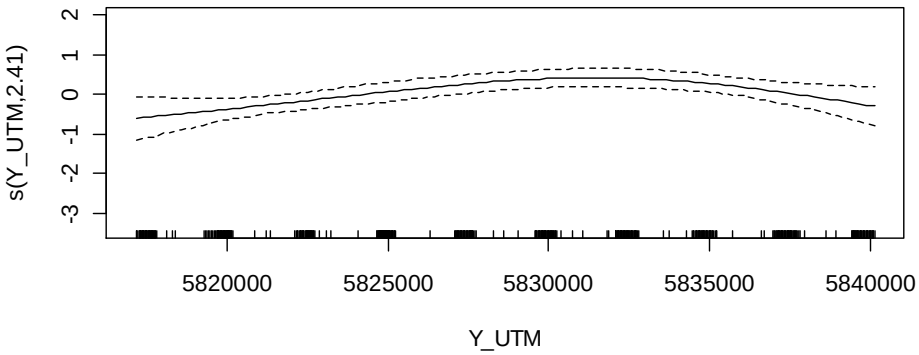



s(NEAR_DIST,1)
10
0
-20
0
5000
10000
15000
20000
25000
30000
35000
NEAR_DIST

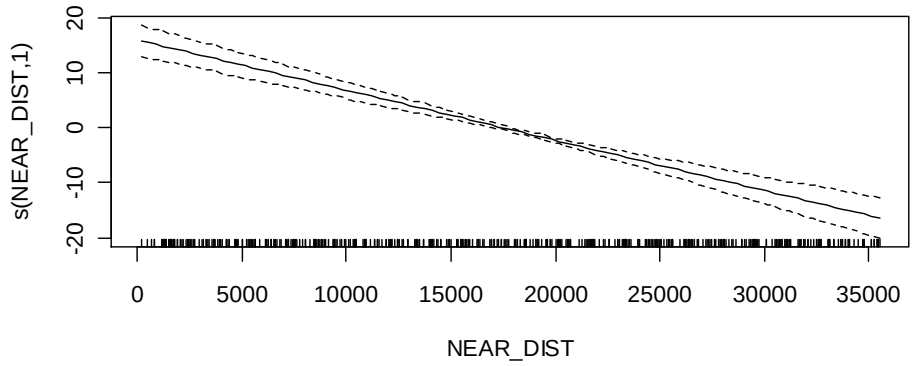

s(Y_UTM,1)
10
0
-20
5820000
5825000
5830000
5835000
5840000
Y_UTM

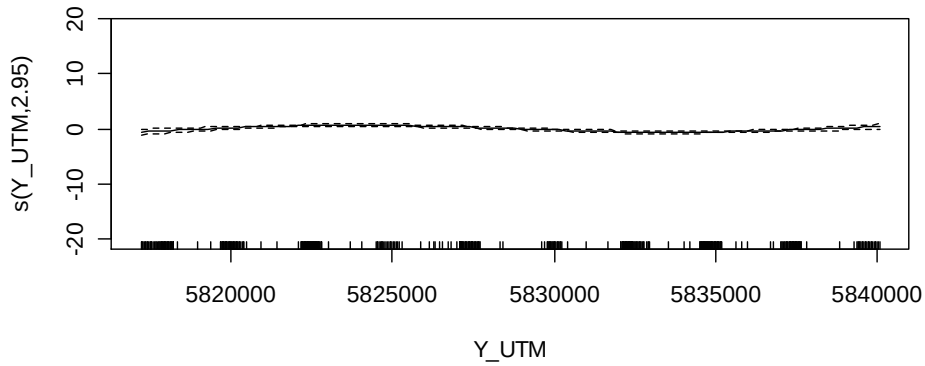
Sandwich Tern 2008_8 gam

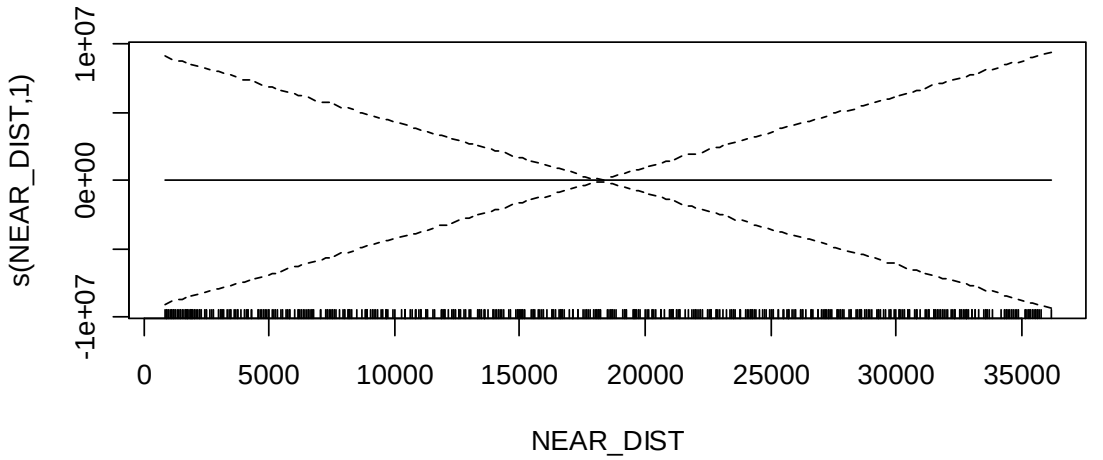




Commic Tern 2007_6 gam



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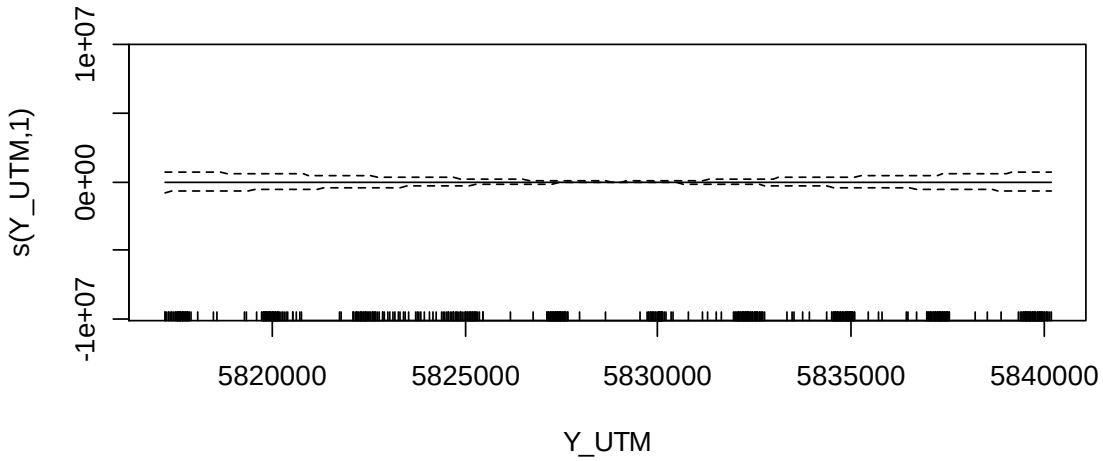
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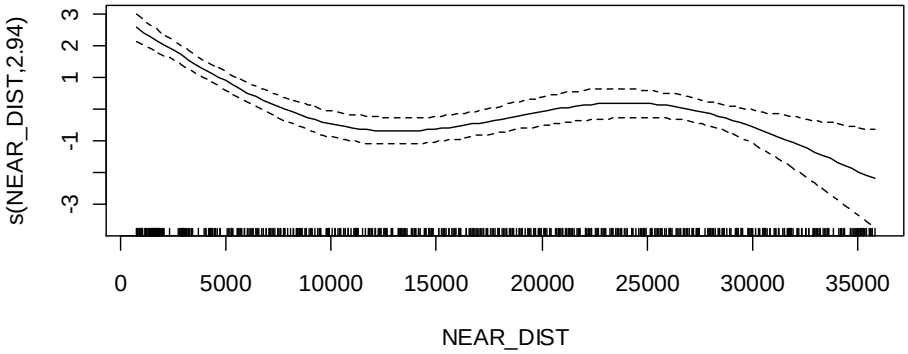
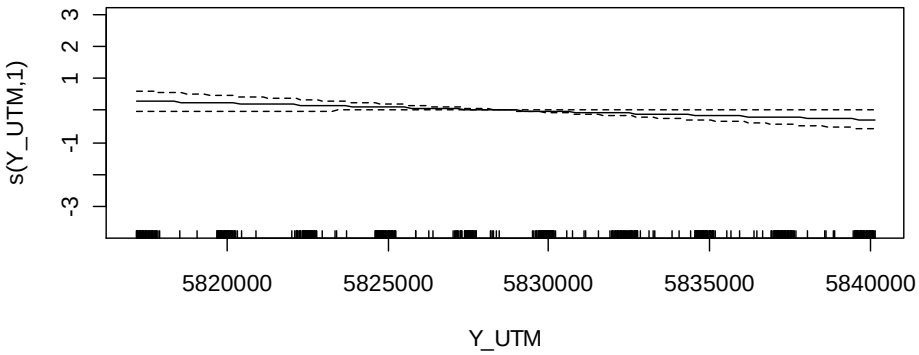
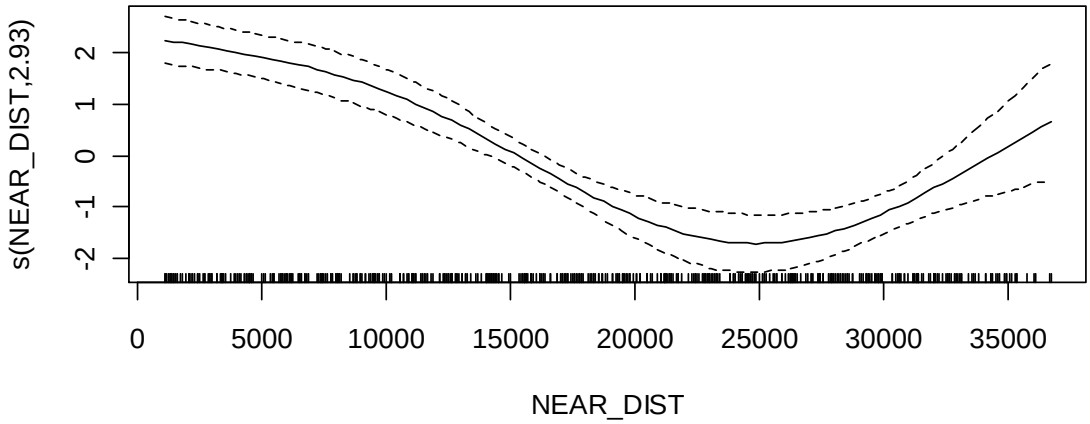
Y_UTM

Commic Tern 2007_8 gam



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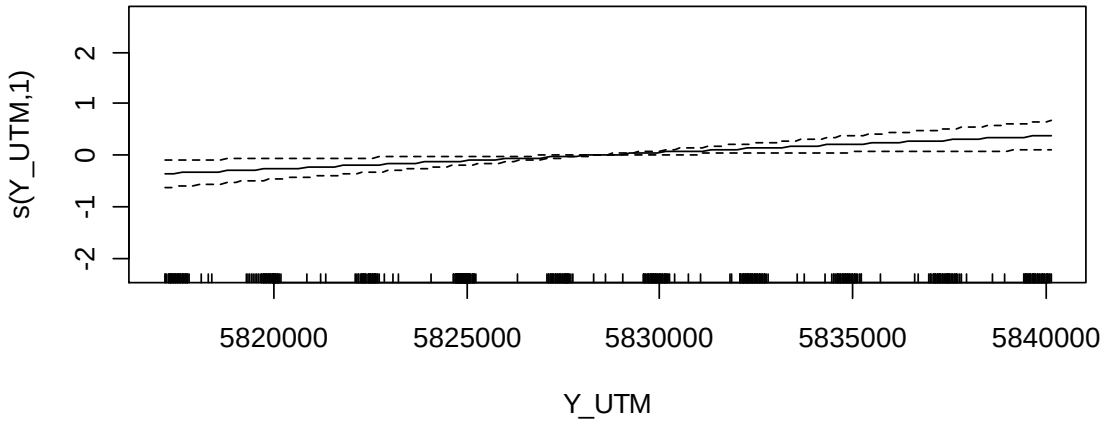
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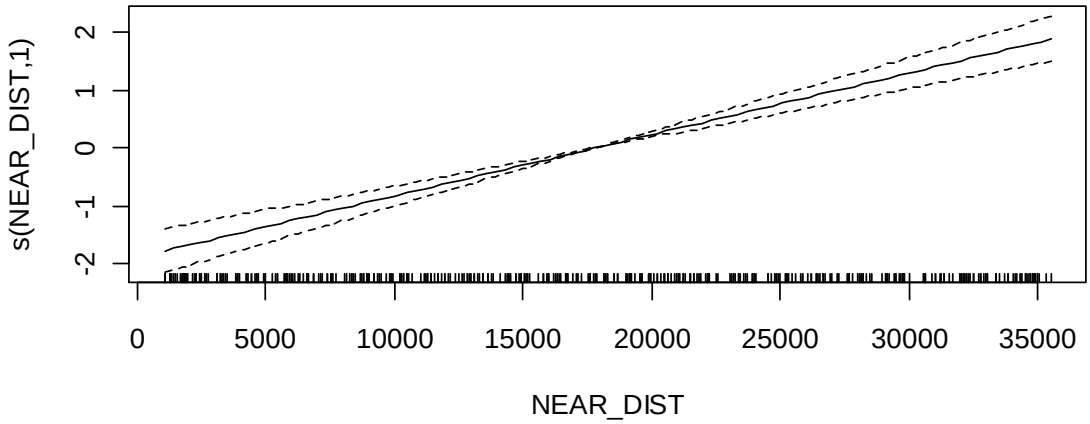
Y_UTM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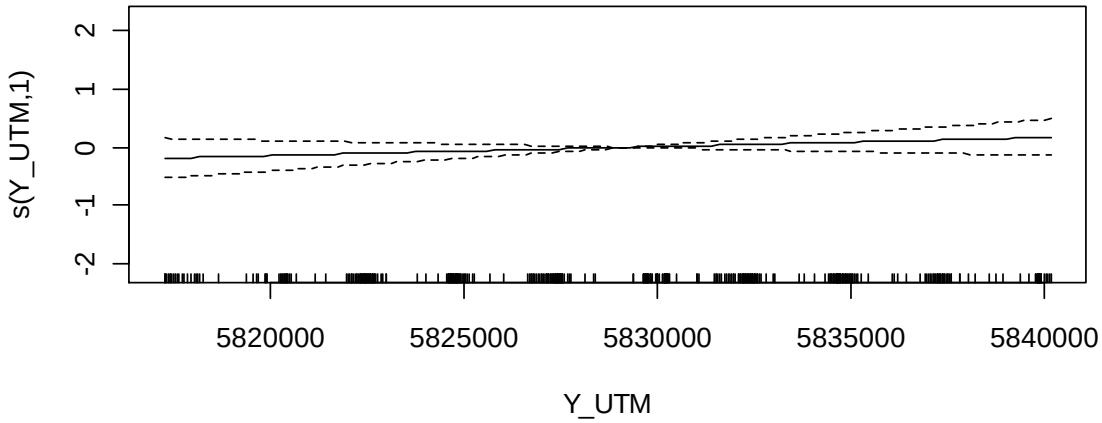
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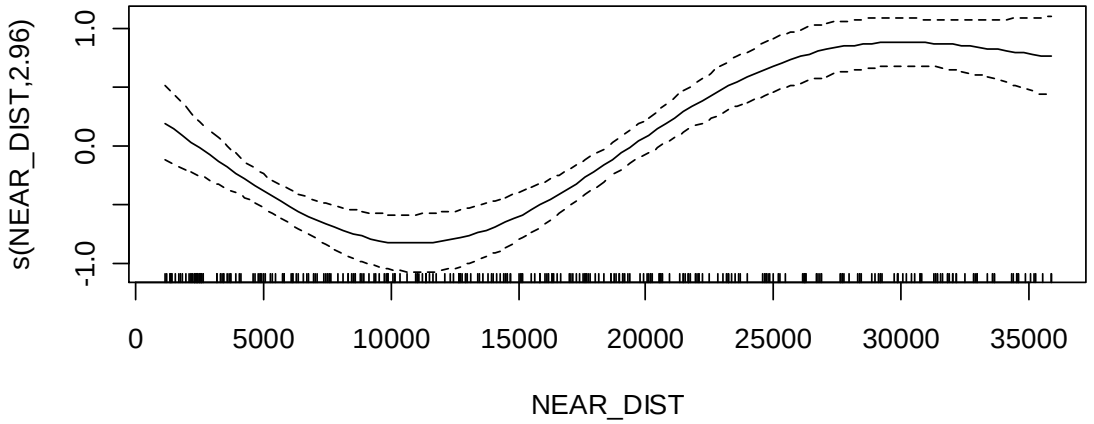
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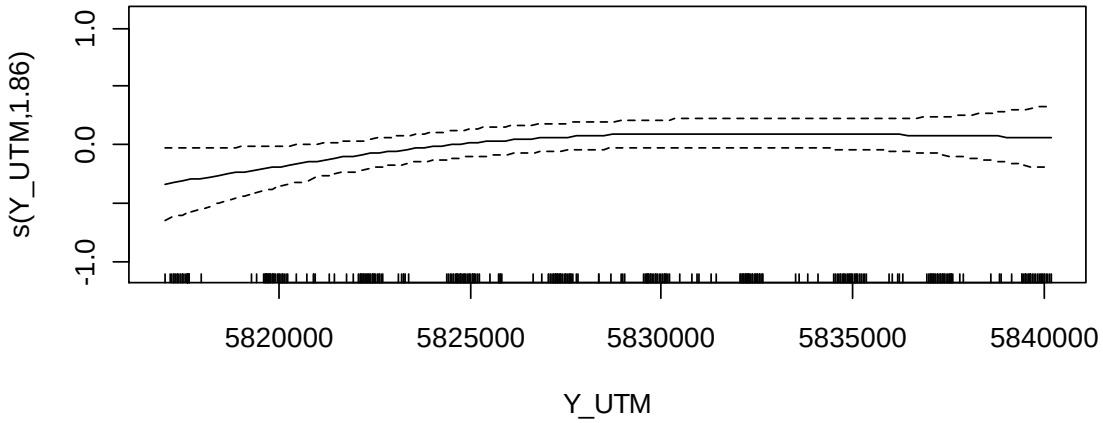
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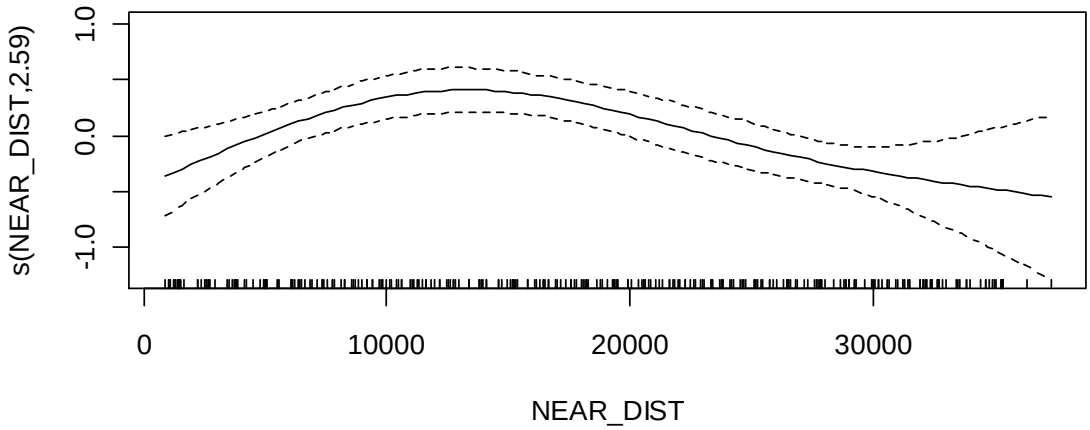
Y_UTM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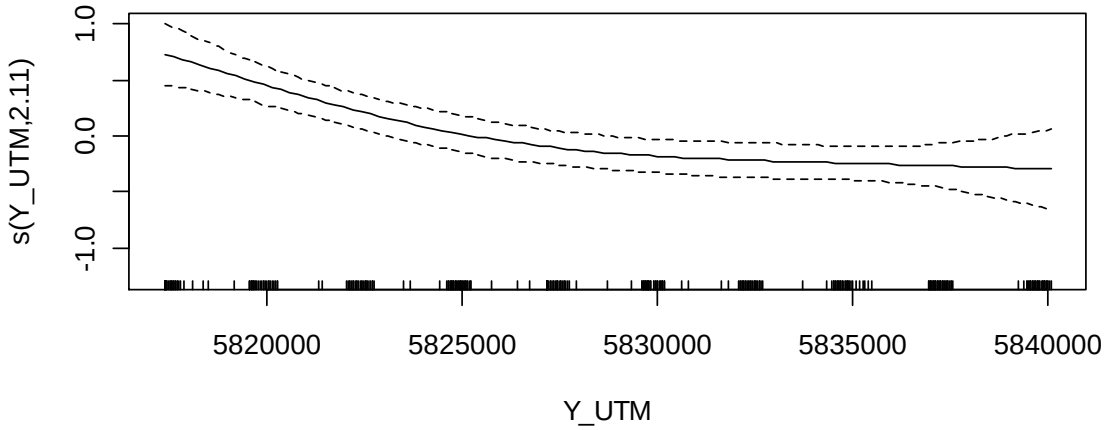
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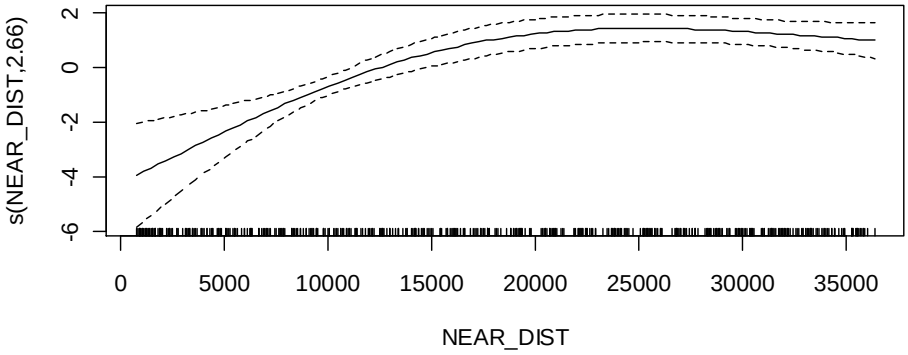
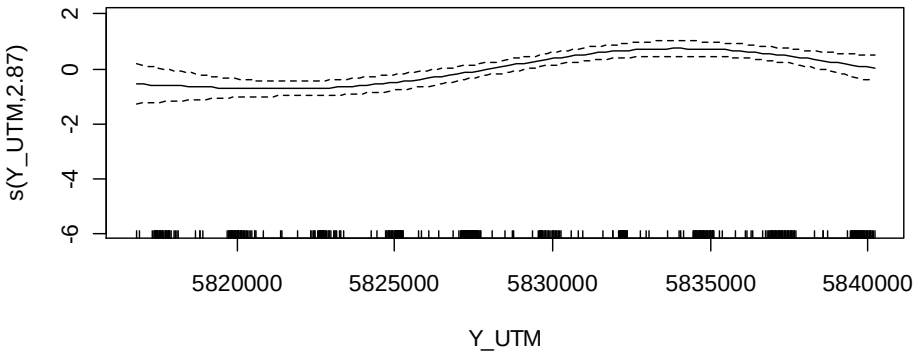
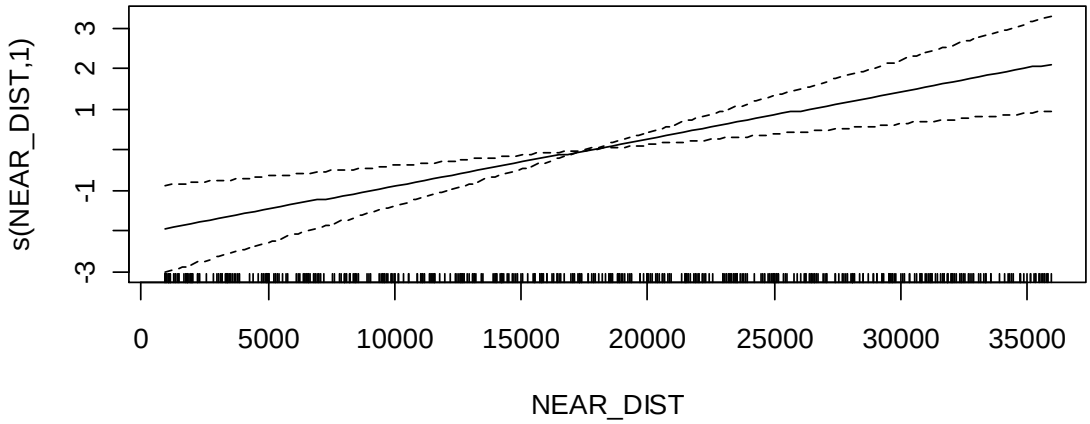
Y_UTM

Guillemot 2003_4 gam



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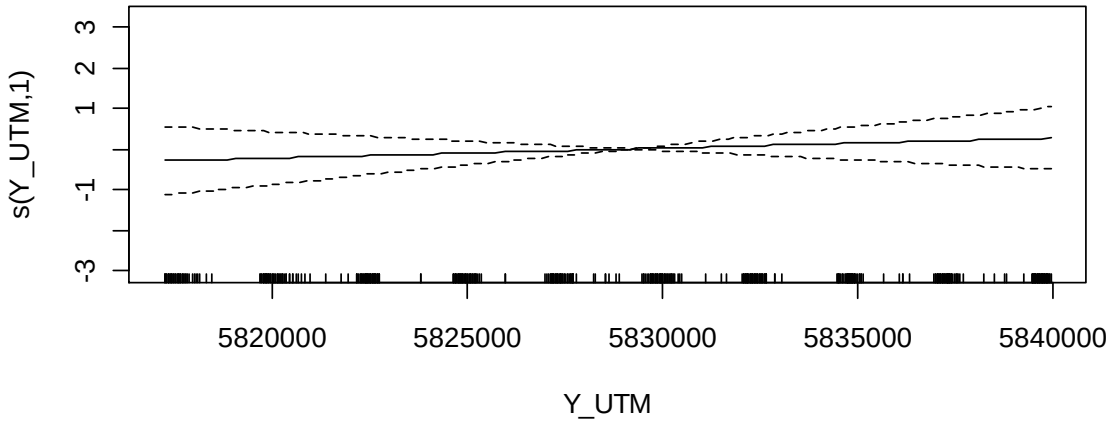
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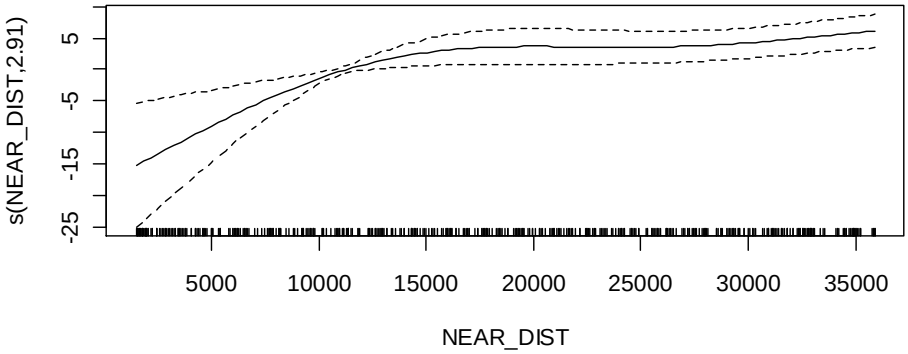
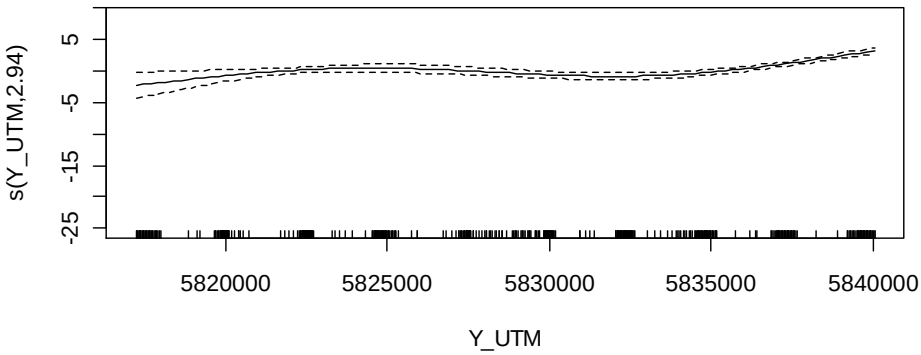
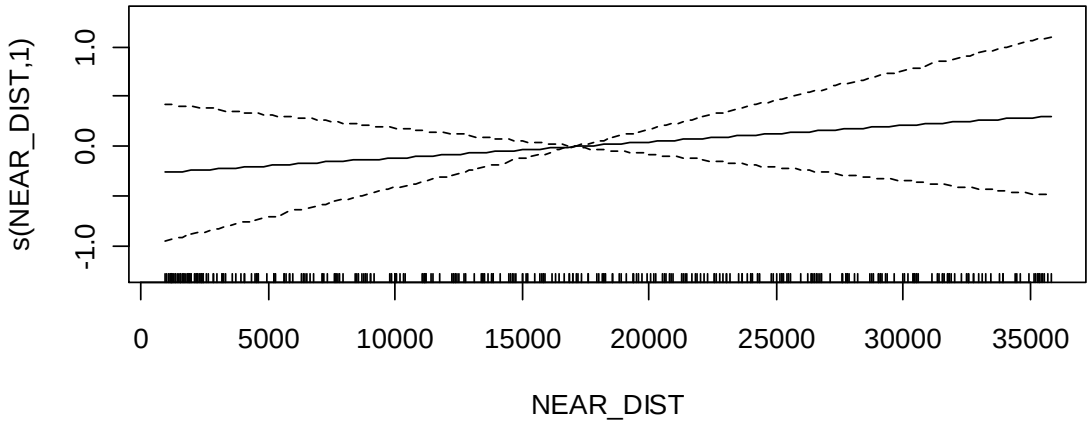
Y_UTM

Guillemot 2008_4 gam



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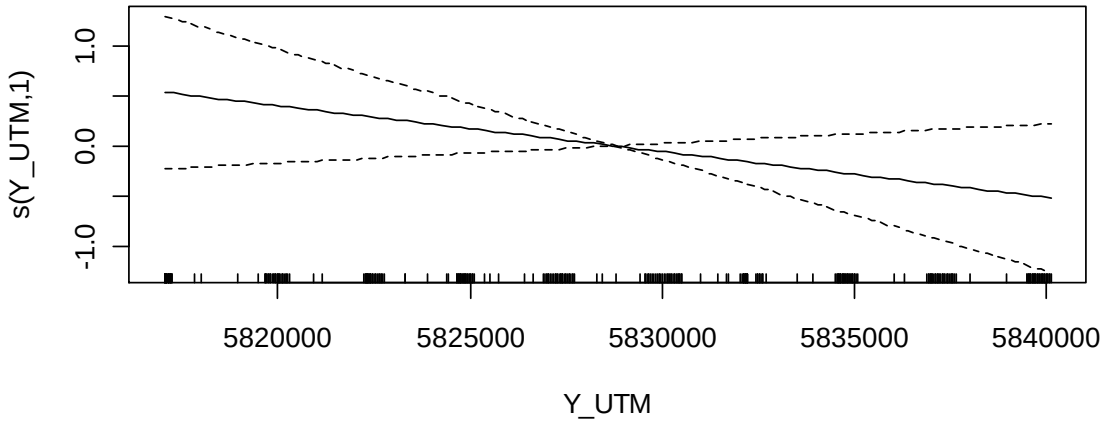
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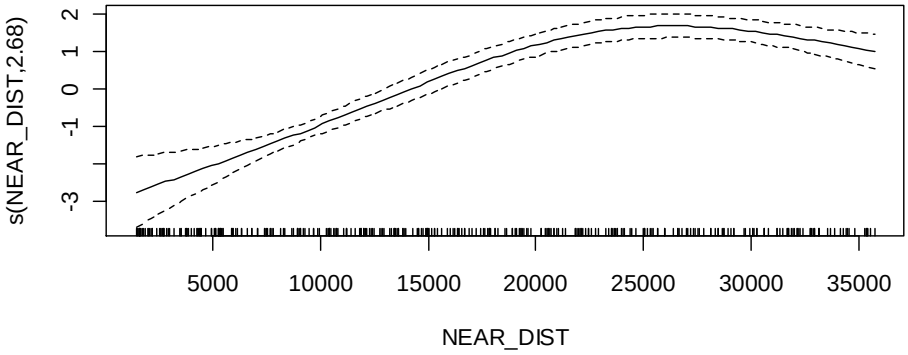
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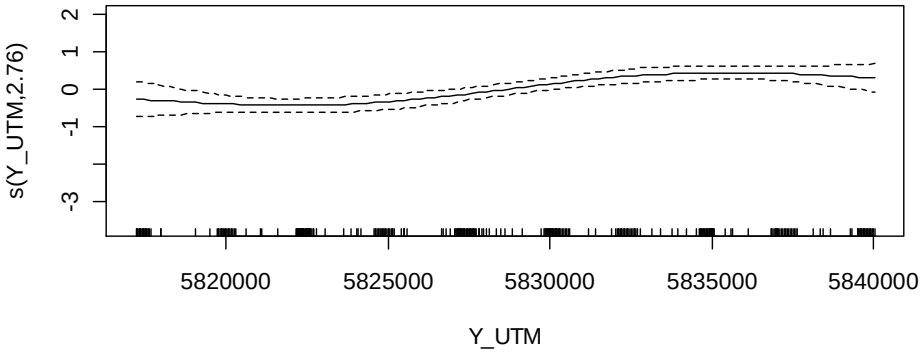
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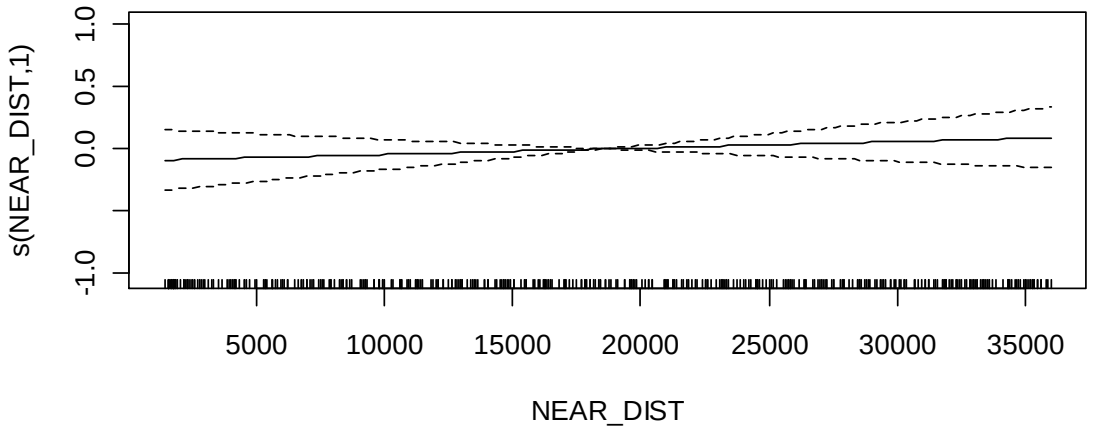
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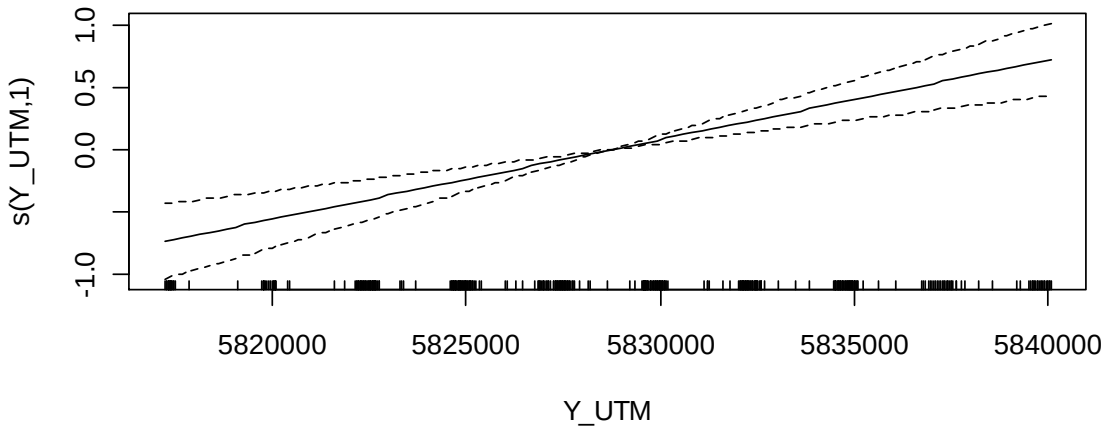
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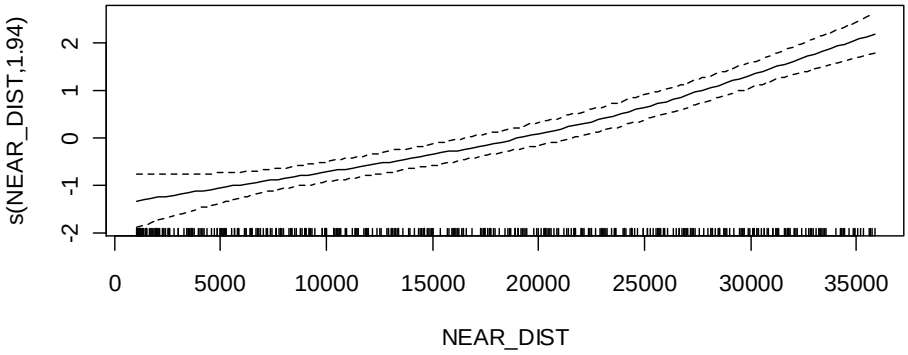
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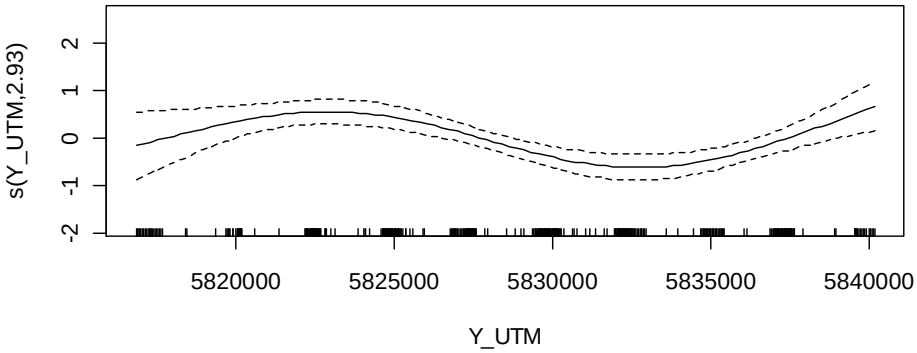
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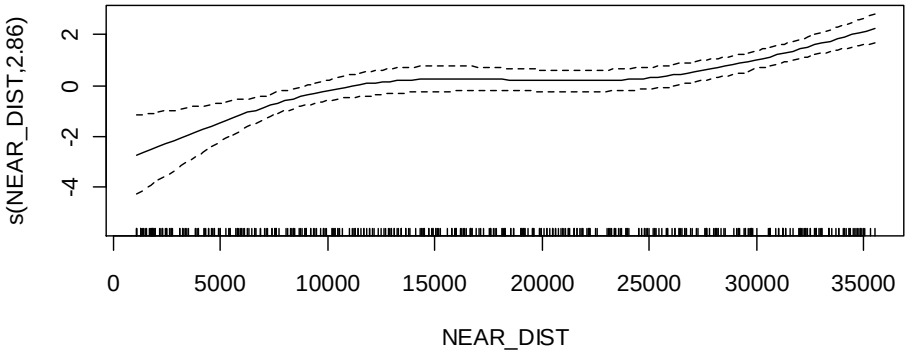
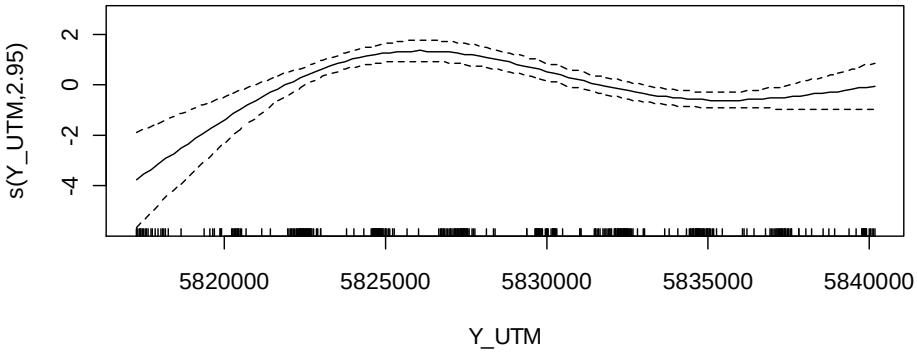
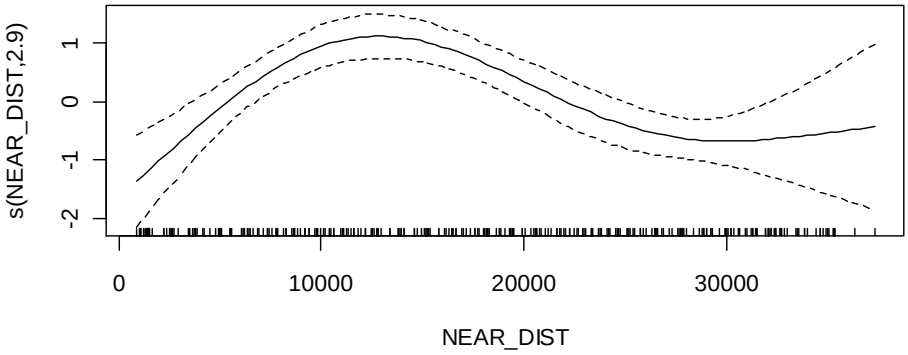
Y_UTM

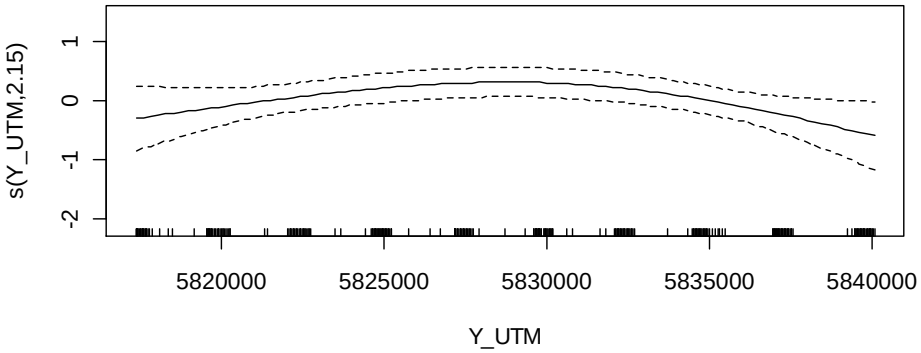
Razorbill 2004_2 gam



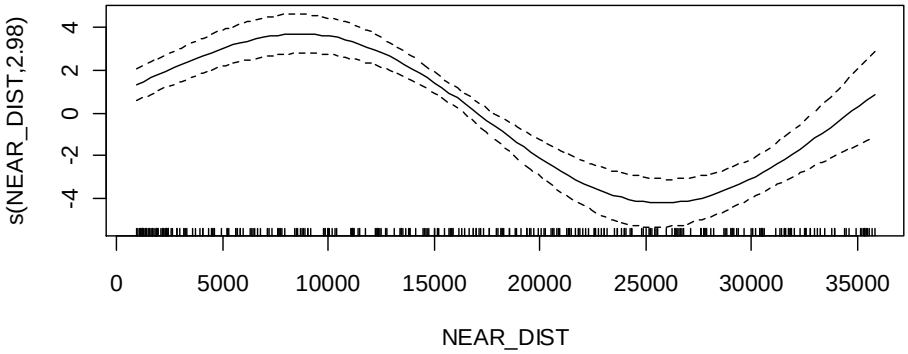


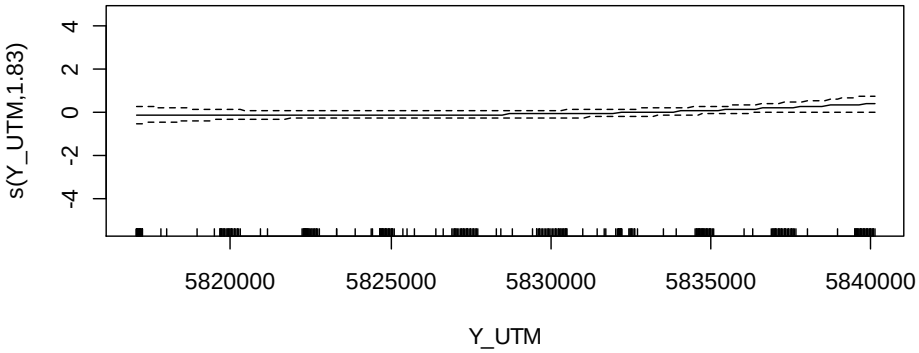
Razorbill 2009_1 gam



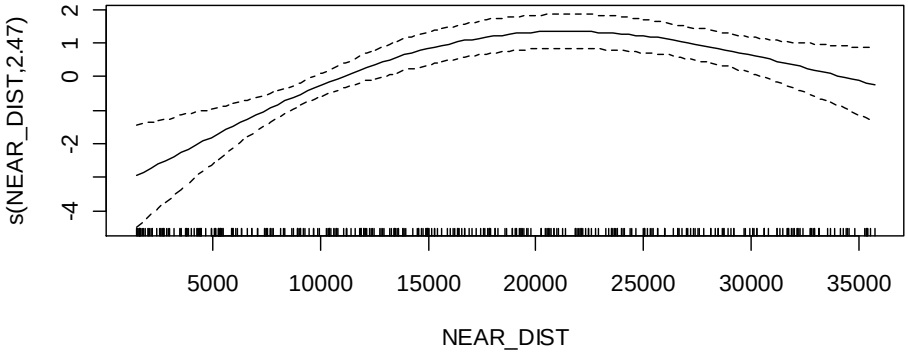


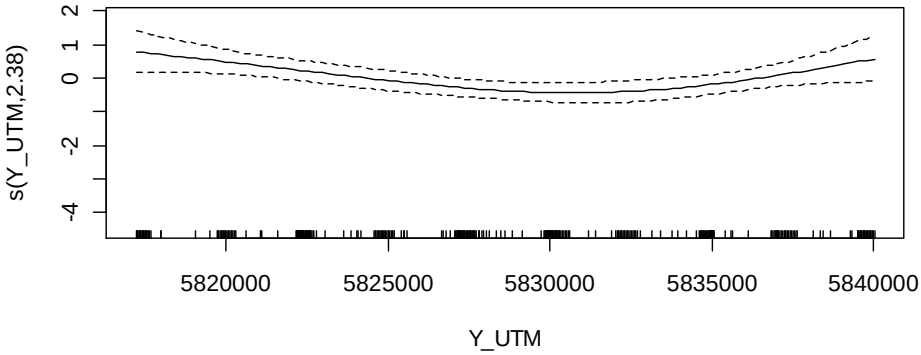
Razorbill 2007_9 gam

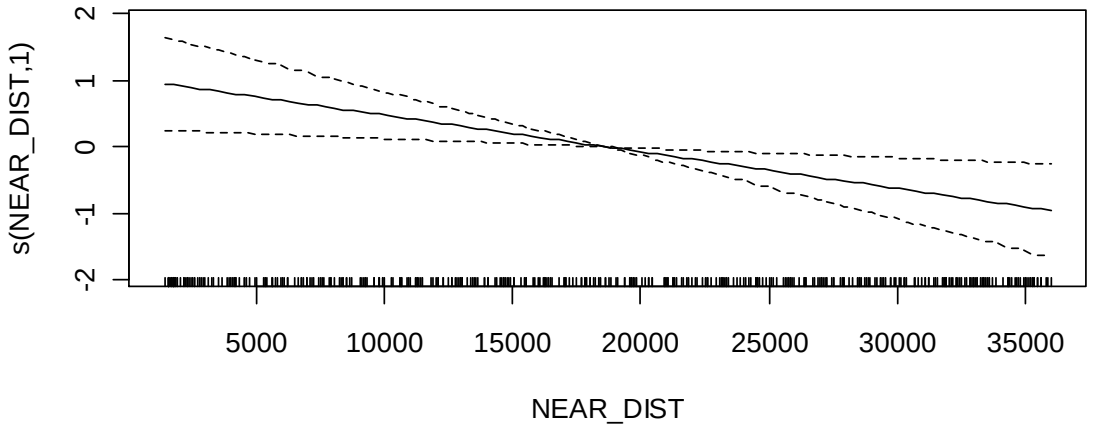




Razorbill 2003_11 gam



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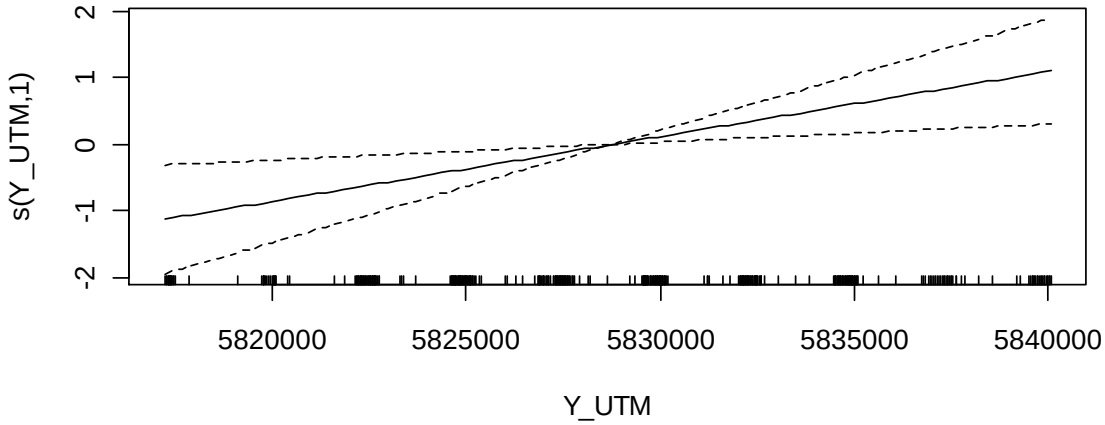
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5840000
Y_UTM

Justification

Referees Steve Geelhoed & Rob van Bemmelen

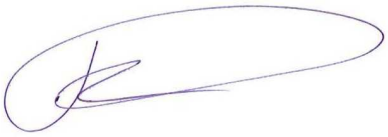
Rapport C034/10
Project Number: 4306101811

This report has been professionally prepared by Wageningen IMARES. The scientific validity of this report has been internally tested and verified by another researcher and evaluated by the Scientific Team at Wageningen IMARES.

Read by: Steve Geelhoed & Rob van Bemmelen
Seabirds biologists, IMARES

Date: January 2010

Approved: drs F.C. Groenendijk
Head of Department Ecosystems

Signature: 

Date: 29-3-2010

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