Assessing the impact of the Tunø Knob wind park on sea ducks: the influence of food resources

Neri Technical Report No 263
February 1999

Magella Guillemette
Jesper Kyed Larsen
Ib Clausager
Department of Coastal Zone Ecology

Datablad

Title:	Assessing the impact of the Tunø Knob wind park on sea ducks: the influence of food resources
Authors:	Magella Guillemette, Jesper Kyed Larsen & Ib Clausager
Department:	Department of Coastal Zone Ecology
Serial title and number:	NERI Technical Report No 263
Publisher:	Ministry of Environment and Energy National Environmental Research Insitute©
URL:	www.dmu.dk
Date of publication:	February 1999
Editor:	Karsten Laursen
Referee:	Jesper Madsen & Thomas Kjær
Layout:	Helle Jensen
Proofreading:	Tove Ørts Pedersen
Please quote:	Guillemette, M. Larsen, J.K. & Clausager, I. (1999): Assessing the impact of the Tunø Knob wind park on sea ducks: the influence of food resources. National Environmental Research Institute, Denmark. 21 pp. - NERI Technical Report no 263. Reproduction permitted only when quoting is evident.
Key words:	Birds, seaducks, offshore wind park, environmental impact assessment, BACI, food resources, Århus Bugt
ISBN:	87-7772-444-5
ISSN:	0905-815X
Printed by:	Phønix-Trykkeriet A/S, Århus
Circulation:	800
Pages:	21
Pris:	kr. 40,- (inkl. 25% moms, ekskl. forsendelse)
Købes hos:	Danmarks Miljøundersøgelser Grenaavej 12 Kalø 8410 Rønde Tlf. 89 20 17 00 Fax 89 20 15 15 Miljøbutikken Information og Bøger Læderstræde 1 1201 København K Tlf. 33 92 76 92 (information) Tlf. 33 37 92 92 (bøger)

Contents

Abstract

This study deals with the influence of benthos abundance when assessing the potential impact of a small wind park on wintering sea ducks. Using the Before-After-Control-Impact design, it was suggested in a recent study (Guillemette et al. 1998) that the wind park provoked a decline in the abundance and a change in the distribution of common eiders *Somateria mollissima* and common scoters *Melanitta nigra*. However, the observed decline in sea duck abundance occurred concomitantly with a decline of benthic food supplies. We measured concomitant food and common eider abundance for a fourth year at Tunø Knob to test the hypothesis that, if food abundance increases again, we should also observe an increase in duck abundance. The methods used in this study are similar to those applied in the aforementioned study. The results showed that the average number of common eiders increased considerably in 1997-98 (3,361 individuals) compared to 1996-97 (458), even surpassing the level observed during the baseline year in 1994-95 (1,821). A significant increase in the abundance of common scoters occurred in 1997-98 compared to 1995-96 and 1996-97, but not in relation to the baseline year. The abundance of food for sea ducks also increased in 1997-98 where the frequency of occurrence of most potential prey reached the level observed during the baseline year. The density of blue mussels, a preferred prey species, was 1,113 individuals m^{-2} in 1997-98 compared to 11,111 individuals m^{-2} during the baseline year and only 100 individuals m^{-2} in 1996-97. Computations of the amount of food supply eaten by wintering common eiders suggest that, during the baseline year, prey were superabundant. This may explain why we observed a great abundance of common eiders in 1997-98 despite the fact that mussel abundance did not reach the level observed during the baseline year. Finally, the distribution of common eiders in 1997-98 on the study site as a whole was very similar to the distribution observed during the baseline year. A similar observation was made around the wind park. These results support the hypothesis that the decline of sea ducks observed during the two *After* years was not caused by the wind park. We conclude that without measuring the abundance and the distribution of food supply, it will remain difficult to make any reliable impact assessment of an offshore wind park on sea ducks.

1. Introduction

In the period 1994-95 to 1996-97, an impact assessment was conducted at Tunø Knob in order to find out if a small wind park could disturb wintering sea ducks (Guillemette et al. 1998). The conceptual approach used was based on a BACIP design for Before-After-Control-Impact study with Paired sampling. The control area in this case was Ringebjerg Sand (RS) located on the coast of the island of Samsø. This area was compared with Tunø Knob (TK), the presumed impact area (Fig. 1), during the (baseline) year 1994-95 and two years after the construction of the park (1995-96 and 1996-97). The results showed that the abundance of common eiders *Somateria mollissima* was similar for both sites during the baseline year and then decreased steadily for TK in the second and third years of the study. In contrast, the abundance of common eiders increased at RS in 1995-96 and then decreased in 1996-97 to a level similar to the observed baseline level. The results suggested that the wind park had an impact on common eider abundance. Concomitantly, we

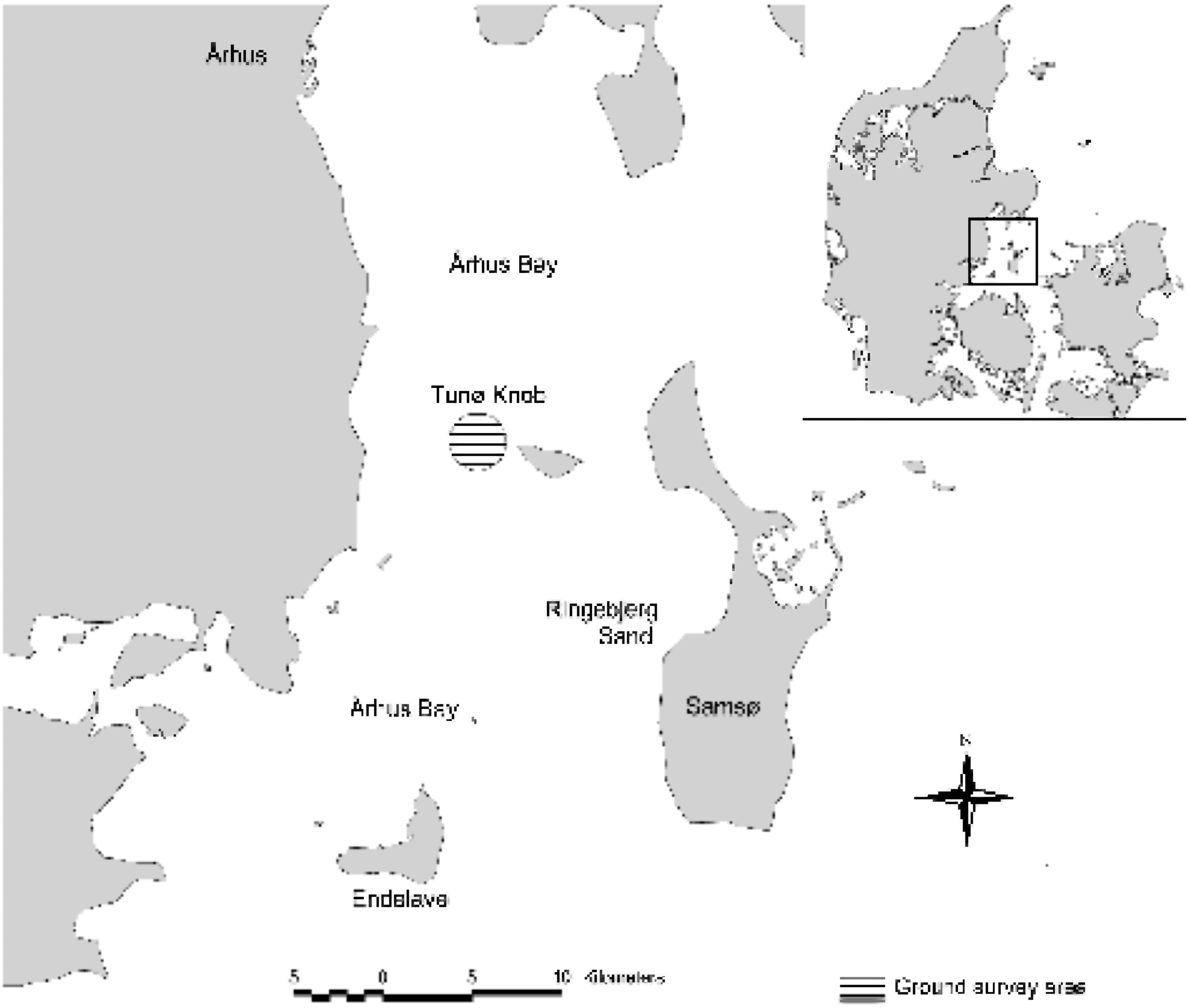

Figure 1. Map showing the region of Tunø Knob covered in this study.

measured the amount of food supply and showed that small and intermediate sized blue mussel *Mytilus edulis*, a preferred prey species, was very abundant at TK during the baseline year, much reduced in 1995-96 and nearly absent in 1996-97. In contrast, this prey was largely available at RS during the baseline year and in 1995-96 and, although its abundance was reduced, a small population of this prey was still present there in 1996-97. Therefore, the difference in abundance pattern of common eiders between TK and RS may well be caused by the differential variation in food supply observed on both sites (Guillemette et al. 1998). One obvious hypothesis arising from these results is that common eiders would return to TK during a good year of mussel settlement. This hypothesis is tested in this study.

1.1 Acknowledgements

We would like to thank Ebbe Bøgebjerg and Laus Gro-Nielsen for their assistance in the field and Lars Knudsen of Bioconsult a/s for the diving work. Thank you to Captain H. Ole Grau for expert advice on sea conditions and punctuality. Thanks to Jens Søren Michelsen Kragh, Simon Rosenkilde Waagner for the benthic life forms identified, weighed, and measured. Finally, we thank Thomas Kjær Christensen and Jesper Madsen for their review and comments. This project was financed by the Ministry of Environment and Energy.

2. Methods

The methods used in this study are strictly similar to those described in Guillemette et al. (1998). Briefly, at TK the data were solely collected from a tower standing on the sea bottom, from which common eiders and scoters were counted and their distribution mapped using laser and compass binoculars. The abundance of benthos and food for sea ducks was assessed using SCUBA by sampling at permanent stations running along three parallel transects (see Fig. 2 of Guillemette et al. 1998).

Data analyses were constrained by the fact that the additivity and the

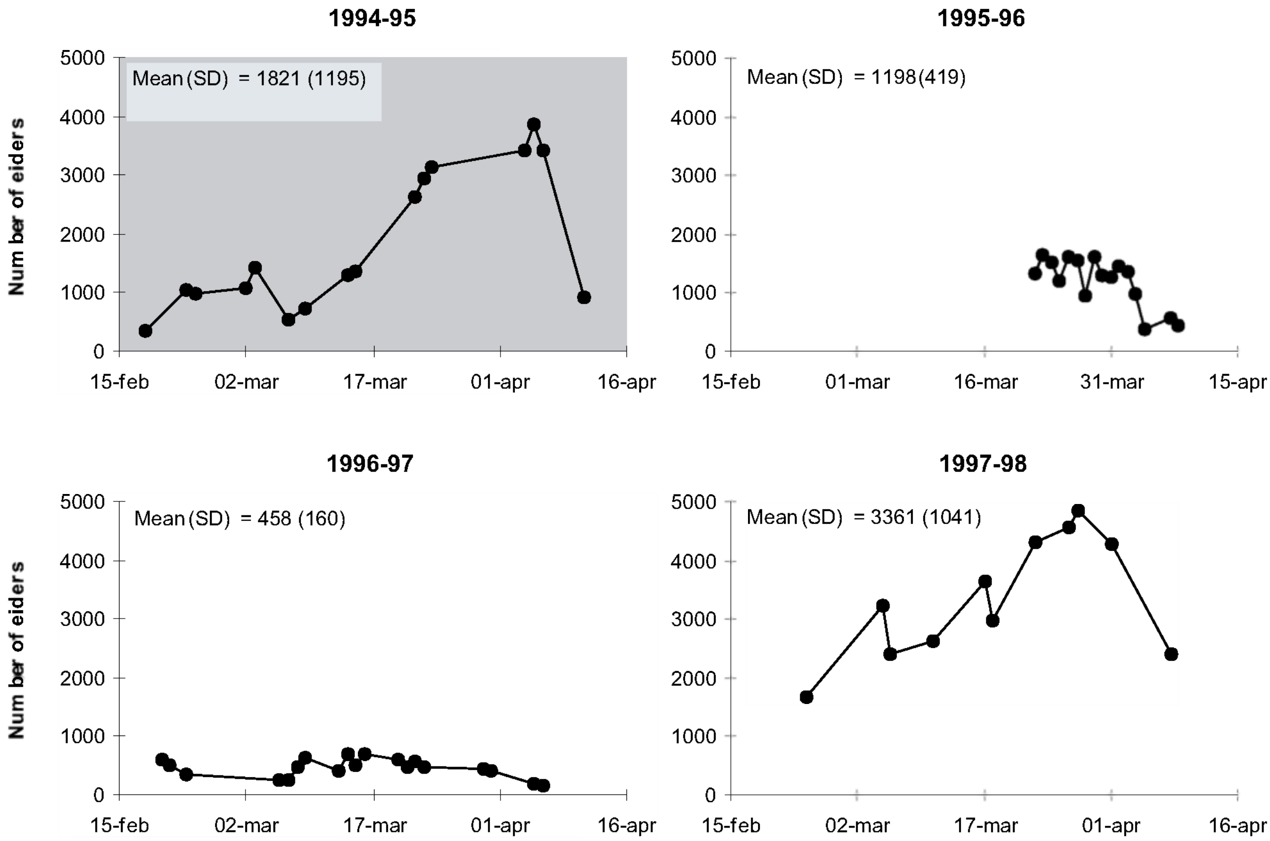

Figure 2. Abundance of common eiders at Tunø Knob as counted from the wet tower during four years (baseline year shaded). The mean (SD) number of individuals is written for each year and site. Note that the study period used in this investigation spans from mid-February to mid-April, except for TK in 1995-96 where surveys were conducted only from mid-March to mid-April.

independence assumption of the t-tests were violated (Guillemette et al. 1998, p. 18). In lieu of a t-test on the simultaneous differences between the presumed impact and control area, we used confidence intervals and correlation analysis to detect any impact. To circumvent any problem related to serial correlation when calculating confidence intervals, we used a low alpha level in the computation. Hatfield et al. (1996) suggested using a lower nominal alpha level to mitigate any impact of serial correlation. From simulations of the effect of serial correlation on randomisation t-test, Stewart-Oaten et al. (1992) showed that for a sample size of 15 and a correlation coefficient of 0.600 a nominal alpha level of 0.010 would correspond to a real alpha level of about 0.120. In our confidence interval calculations of mean number of birds, we thus used a nominal level of 0.010 in order to get an alpha level of about 0.100. Finally, in the case of benthic samples we did not use statistics and we arbitrarily set at 50% the effect size between two samples to be declared biologically different. For example, two samples differing by 52%, and for which we could not apply statistics, were declared biologically significant although it was not be possible to determine whether this effect size is the result of random variation or not.

3. Results

We first report data concerning the abundance of sea ducks and benthos for TK as a whole. Subsequently, the abundance and distribution of common eiders is given for different subareas within TK.

3.1 Abundance of sea ducks at TK

A total of 11 surveys has been conducted during the period mid-February 1998 to mid-April 1998 (hereafter the study period 1997-98). The seasonal variation in common eider abundance in 1997-98 was characterised by a steady increase from 24 February (1,684 individuals)

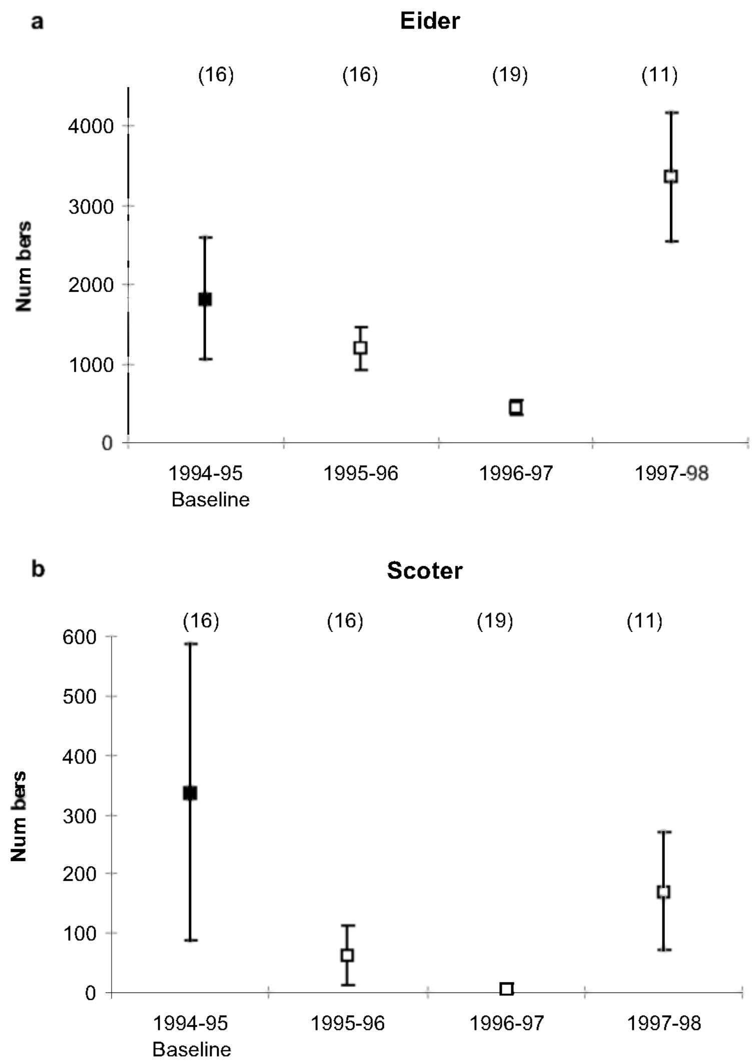

Figure 3. Average abundance of common eiders and common scoters and 90 % confidence intervals for four years. Numbers in parentheses are sample sizes for each year and site.

to a peak number at the end of March (4,851) and then a marked decrease by 10 April (271) (Fig. 2). When compared with the three former years, the resemblance in the seasonal variation in abundance between the baseline year (1994-95) and 1997-98 is striking. However, the average number of common eiders for 1997-98 (3,361 individuals) is substantially higher than for the baseline year (1,821). We show that the confidence intervals for 1997-98 did not include the average of 1994-95 (Fig. 3a) and conclude that common eider numbers at TK were significantly higher in 1997-98 than during the baseline year.

For common scoters, the situation was slightly different from that of the common eider (Fig. 3b). The confidence intervals of average abundance for the common scoters during the baseline (338 ± 250) included the average number (171 ± 98) for 1997-98, indicating that these two years were not different from each other. Nevertheless, the average abundance of scoters was higher in 1997-98 than for both 1995-96 (67 ± 51) and 1996-97 (7 ± 8).

Table 1. Frequency of occurrence (%) of all benthic species or groups of species for samples collected over three years (1994-95 = baseline) at Tunø Knob. Note that the number of stations (n = 34) and their location were similar for the three years. When one value pertaining to one of the two *After* years is in italics, it means that this value differs by at least 50 % from the baseline (1994-95) value. Overall, the frequency of occurrence decreased from 1994-95 to 1996-97 and then increased again in 1997-98 (see text).

Potential prey	Before 1994-95	After 1996-97	After 1997-98
Bivalves	100	**91.2**	100
Mytilus edulis	85.3	*32.4*	67.6
Cardium spp.	88.2	79.4	91.2
Ensis spp.	20.6	*5.9*	20.6
Mya arenaria	64.7	*20.6*	64.7
Macoma spp.	58.8	47.1	61.8
Spisula subtruncata	14.7	*26.5*	*29.4*
Other bivalves	61.8	*14.7*	32.4
Gastropods	**73.5**	**41.9**	**55.9**
Littorina littorea	47.1	*23.5*	32.4
Acmaea testudinalis	47.1	*20.6*	*17.6*
Other gastropods	29.4	0.0	23.5
Echinoderms	67.6	38.7	58.8
Asterias rubens	50.0	*20.6*	29.4
Ophiura spp.	26.5	*5.9*	26.5
Echinicyamus pusillus	32.4	*5.9*	*14.7*
Other echinoderms	20.6	*2.9*	*0.0*
Polychaetes	**82.4**	**82.4**	**88.2**
Crustaceans	**32.4**	**35.3**	**29.4**

3.2 Abundance of potential prey

The frequency of occurrence of potential prey sampled over the years is presented in Table 1. We compare the years sampled using 50 % difference as a useful benchmark for comparison. The picture is striking as the frequency of occurrence of most bivalves was at the same level in 1997-98 as during the baseline year. Only *Acmaea* and *Echinicyamus* had a lower frequency of occurrence in 1997-98 when compared to the baseline year.

Excluding the blue mussels, the density of bivalves and gastropods increased in 1997-98 compared to 1996-97 while densities of echinoderms and crustaceans remained low or even decreased (Fig. 4). Bivalves made an obvious increase in 1997-98 by reaching the densities observed during the baseline year whereas gastropod density more than doubled (see Fig. 4).

A prey species of major importance for sea ducks is the blue mussel. Although the frequency of that prey increased from 32.4% in 1996-97 to 67.6% in 1997-98, it did not reach the high frequency observed during the baseline year (85.3%). This fact is illustrated in Fig. 5. The increase is due mostly to the settlement of young (< 10 mm) individuals mostly at depths < 7 m. However, when we look at biomass of blue mussels over the years, the situation did not appear to improve in 1997-98 (see Fig. 5). Indeed, we show that biomass was about 3.9 kg m^{-2} during the baseline year and decreased steadily to about 1.2 kg m^{-2} in 1997-98.

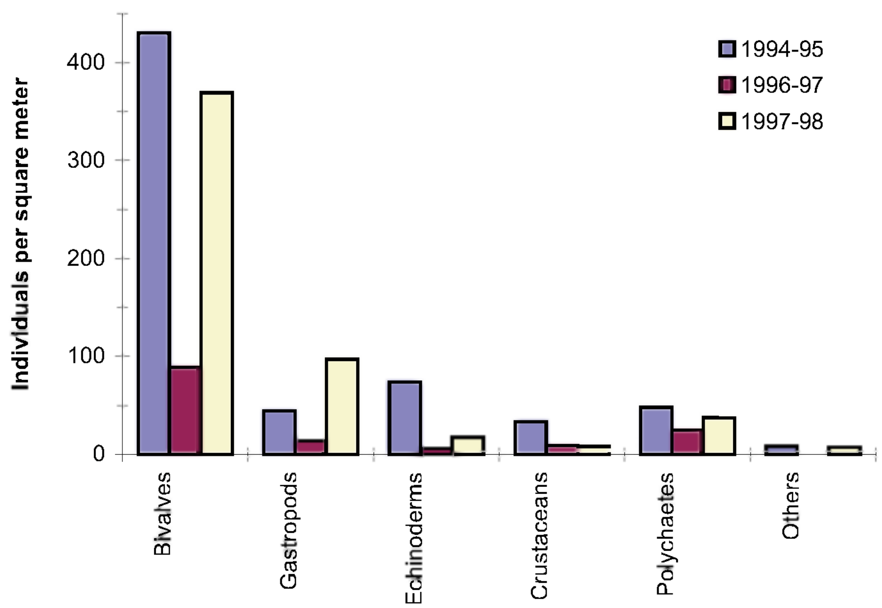

Figure 4. Density of all benthic groups, excluding the blue mussels for the bivalves, for 34 permanent stations over three years at Tunø Knob. The year 1995-96 is not shown because only blue mussels were surveyed during that year.

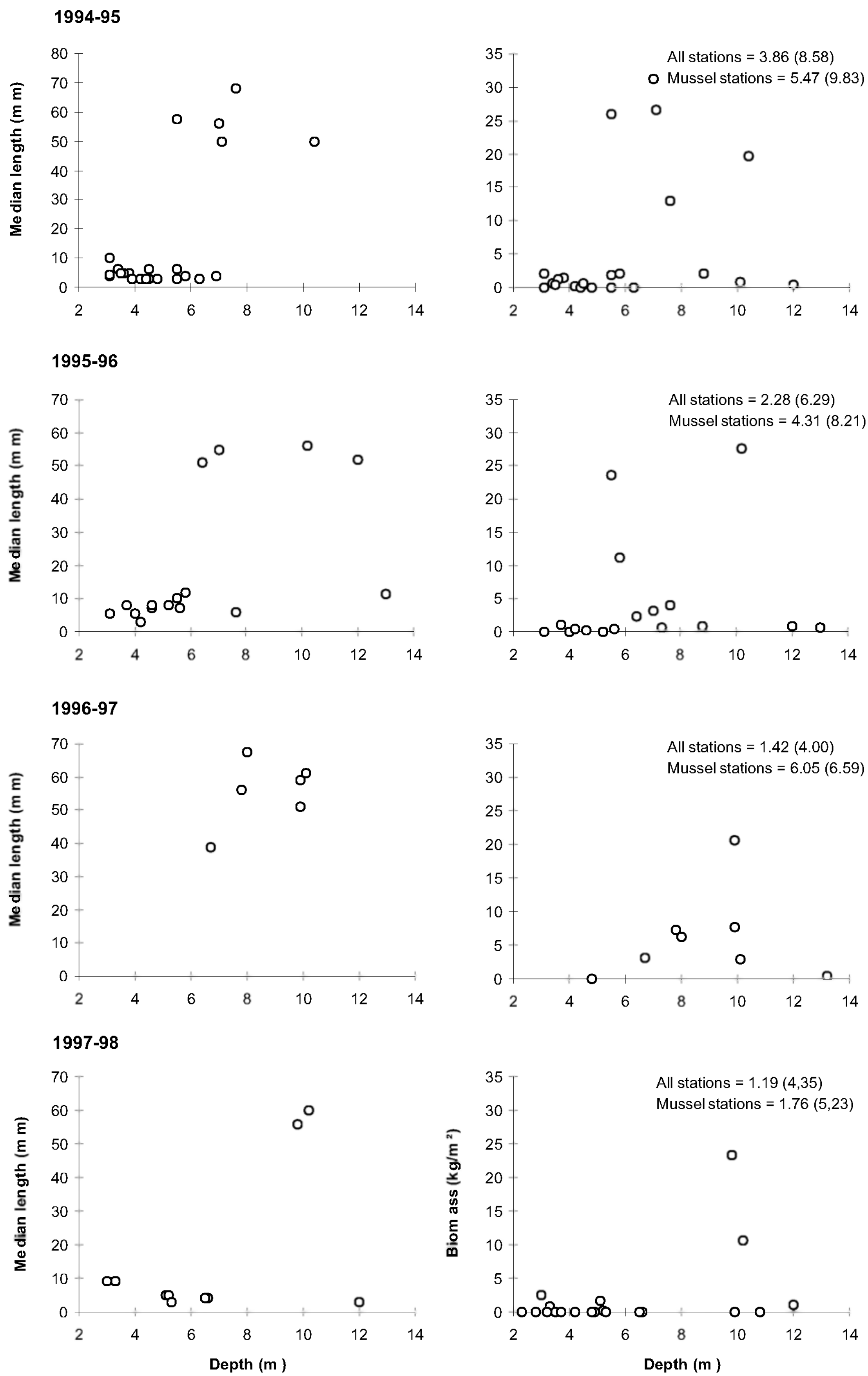

Figure 5. Size and biomass (wet mass) of blue mussels in relation to depth at Tunø Knob over four years. Note that the same number of stations (n = 34) with approximately the same positions (accuracy of about 10 m) were sampled over the years. For comparative purposes, the biomass of mussels was averaged (SD) over all stations (All s.) and averaged (SD) for stations with mussels only (Mussel s.).

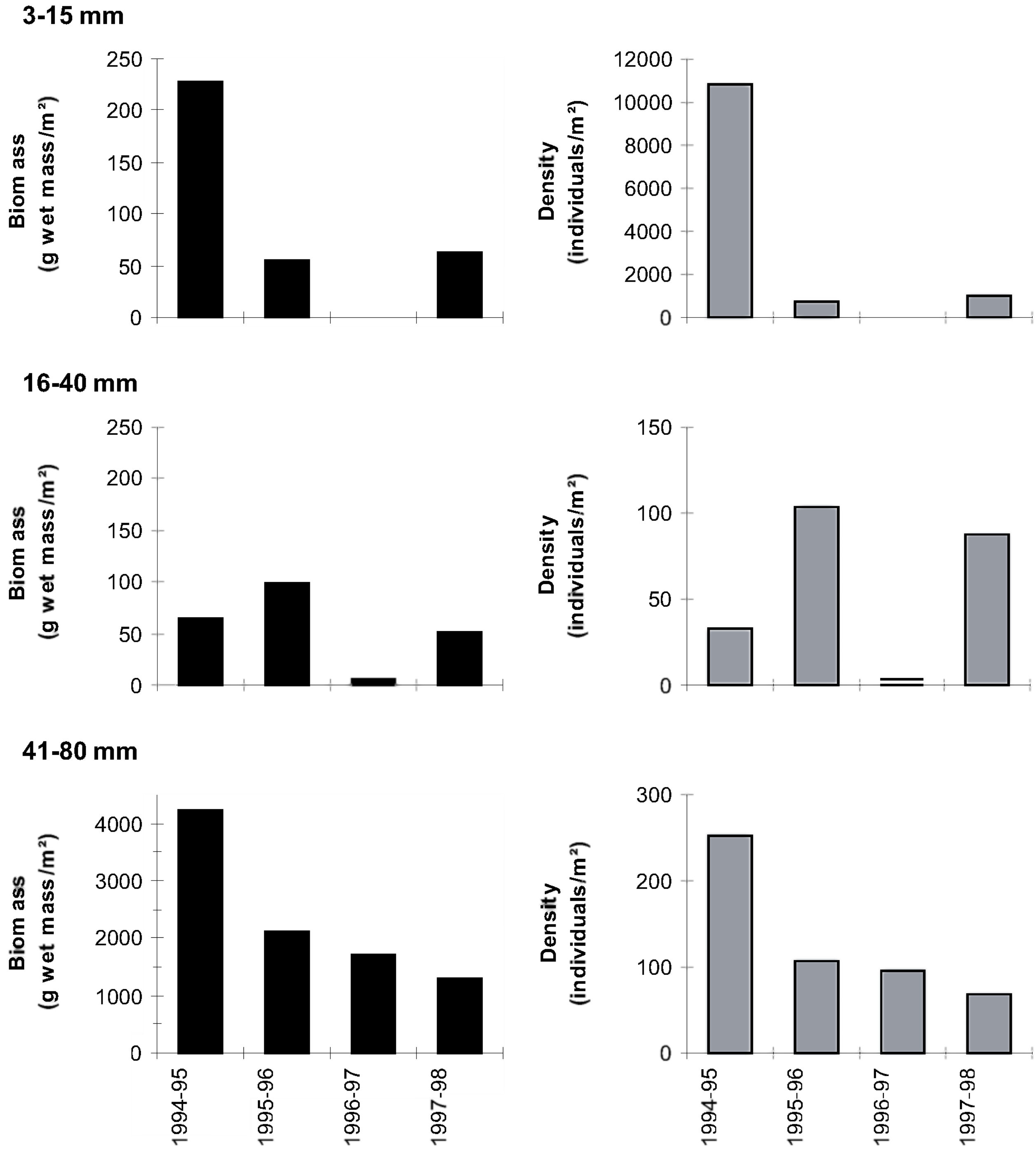

Figure 6. Biomass (wet mass) and density of three size categories of blue mussels over the years.

Splitting the biomass of blue mussels into three different size categories showed that small (3-15 mm) and intermediate (16-40 mm) sized mussels, the size presumably preferred by common eiders (Guillemette 1998), contribute little to total biomass which was mostly influenced by large (41-80 mm) individuals (Fig. 6). This is true not only for 1997-98 but for all four years sampled. Summing the biomass of small and intermediate sized mussels of Fig. 6 is giving about 300 g m^{-2} of available biomass during the baseline year compared to about 120 g m^{-2} in 1997-

98. Therefore, it cannot be concluded that the preferred size (3-40 mm) of blue mussels was present in sufficient numbers in 1997-98 to equal the level observed during the baseline year (1994-95).

3.3 Abundance and spatial distribution of common eiders within TK

Analysing the abundance of common eiders within TK enables us to look more closely at the situation around the wind park. In addition, dividing TK into four areas of about the same size permits comparison of the wind park area (NW) with three sister areas where no wind turbines are located. As expected from abundance data for the whole TK area, the abundance of common eiders in most subareas increased substantially in 1997-98 compared to 1995-96 and 1996-97 (Fig. 7). Although the smallest increase occurred in the presumed impact area (NW subarea), the abundance of common eiders there was significantly higher in 1997-98 than 1995-96 and 1996-97 but not different from the baseline year. The abundance of common eiders observed for the sister subareas in 1997-98 was substantially higher than the one observed during the baseline year (see Fig. 7).

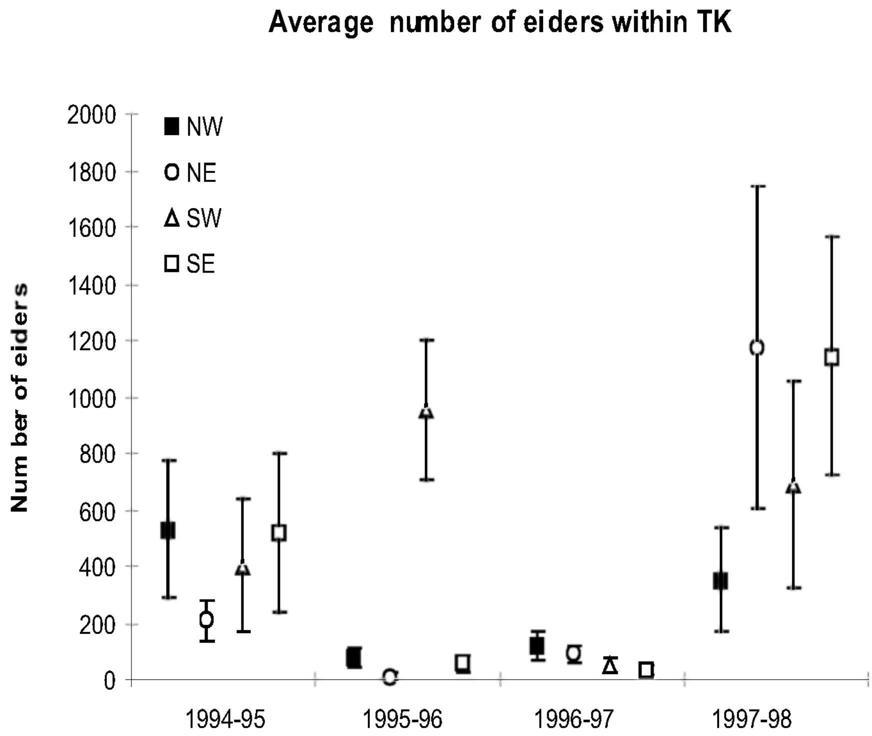

Figure 7. Average abundance of common eiders within four subareas of Tunø Knob (see Fig. 8) and 90 % confidence intervals based on ground surveys over four years (baseline year = 1994-95). When the mean of one set of values fell within the confidence intervals of another, it was concluded that these two sets of data did not differ significantly.

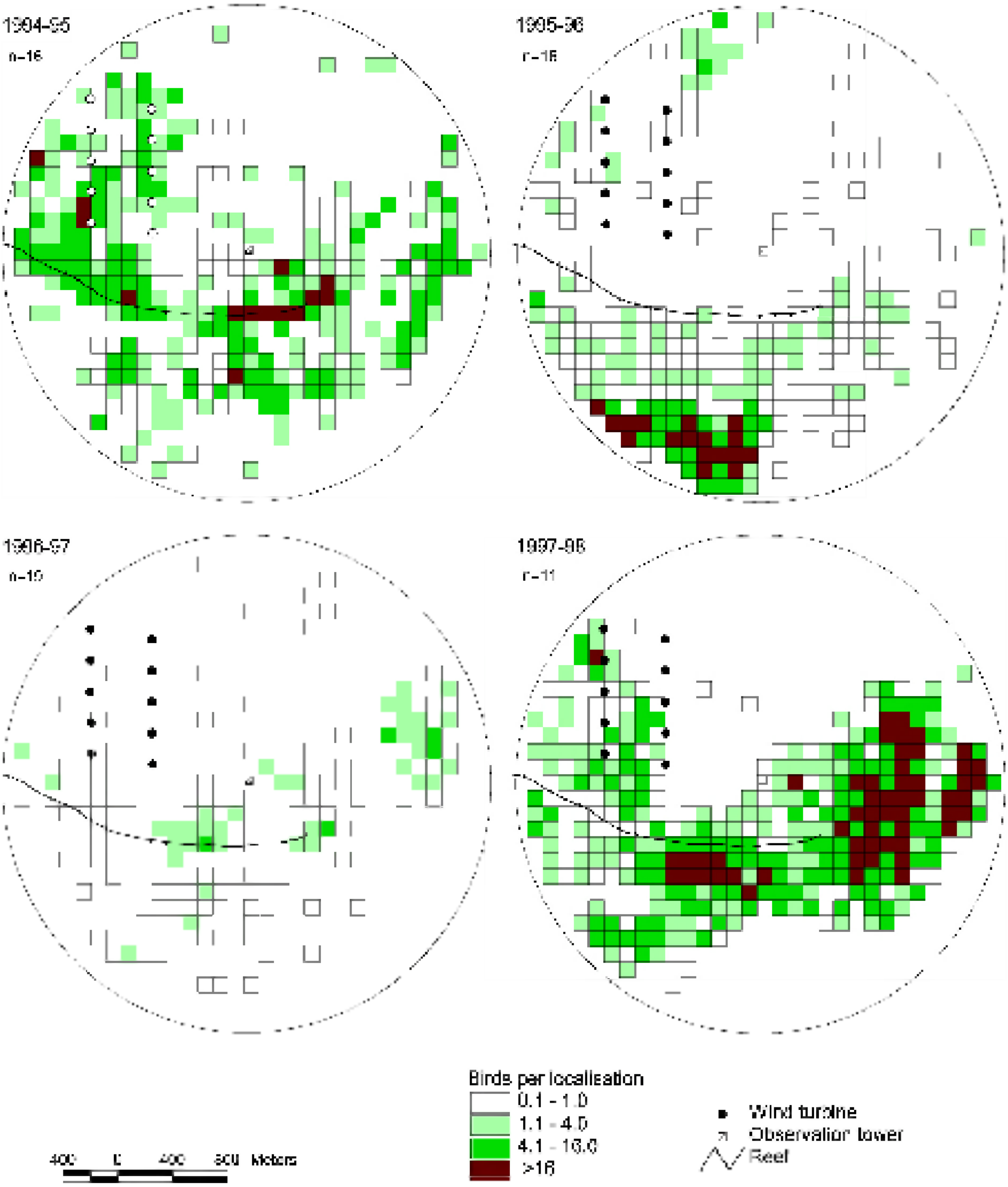

Figure 8. Spatial distribution of common eiders localised from the observation tower at Tunø Knob over four years (baseline = 1994-95). The number of localisations (n) is the number of surveys conducted within the study period (mid-February to mid-April). The density of common eiders shown on these maps is calculated as the mean number of individuals per ha (each grid is 100 x 100 m) per localisation. Note that the North-South division of Tunø Knob (solid line) and the reef define the four subareas of Fig. 7. When the three first years are compared, the distribution of individuals shown suggests that eiders avoided the wind park in 1995-96 and in 1996-97. The fourth year of data refutes that interpretation.

The spatial distribution of common eiders within TK over four years is presented in Fig. 8. On the whole, this map clearly shows that the distribution of common eiders was much different in 1997-98 compared to 1995-96, and 1996-97. Interestingly, there is some resemblance between

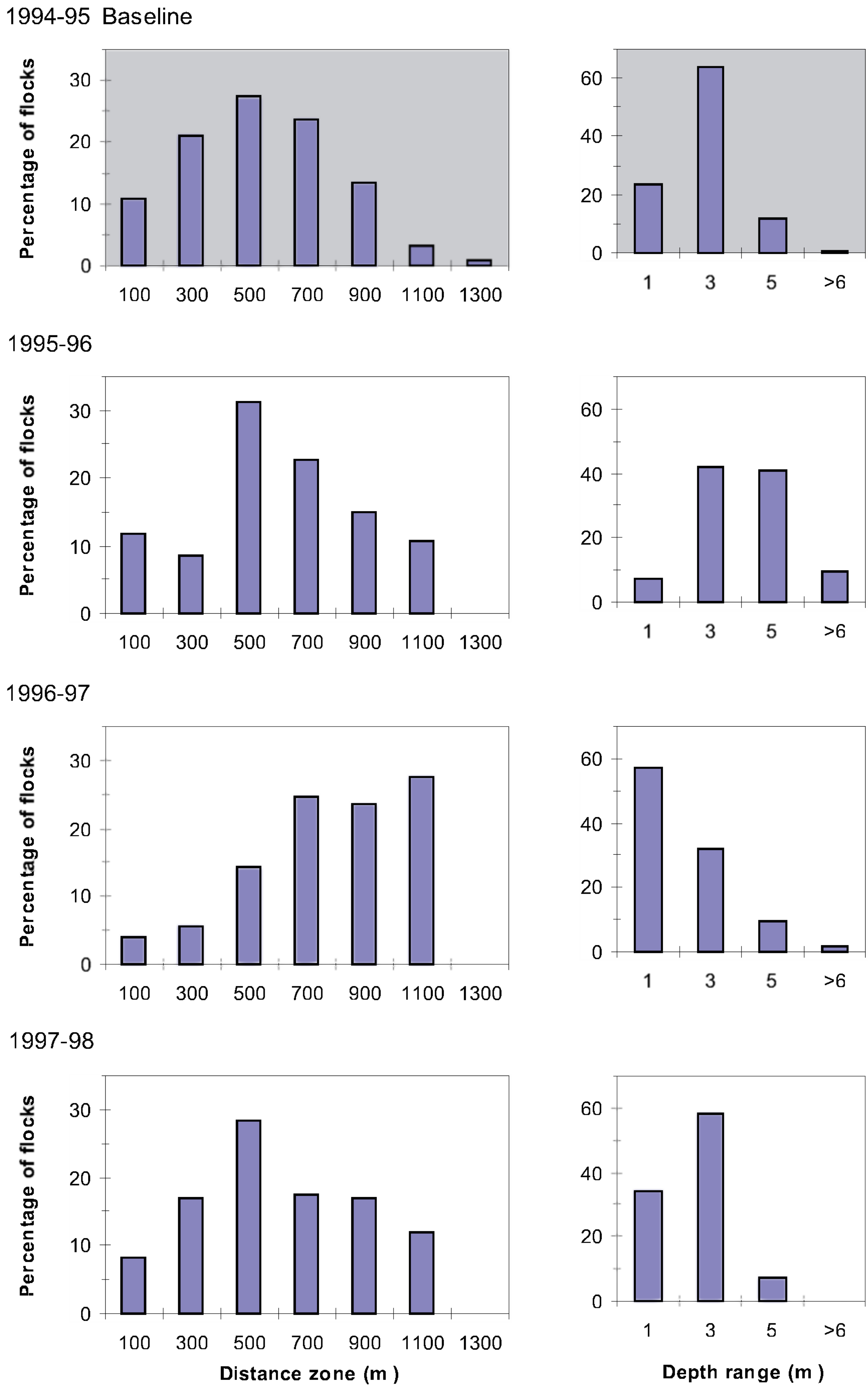

Figure 9. Frequency distribution of depths (2 m classes) used and distances (200 m classes) from the centre of the wind park at which flocks of common eiders were localised in the impact (NW) subarea. The number of flocks positioned is 225 for the baseline (shaded) year, 93 for 1995-96, 195 for 1996-97 and 194 for 1997-98.

the baseline year and 1997-98, although during the latter the highest densities of birds were mostly located in the northeastern part of the study area. Within the wind park, the density of common eiders in 1997-98 was comparable to the baseline year when no wind park was present (see Fig. 8). Since the distribution of common eiders in 1997-98 was similar to that of the baseline year, this suggests that the presumed avoidance of the wind park in 1995-96 and 1996-97 was caused by natural variation.

A detailed illustration of this phenomenon is presented in Figure 9 showing the distance of individual flocks from the centre of the wind park. Again, compared to the baseline year, the position of flocks in 1995-96 and 1996-97 suggests an impact from the wind park. However, this was apparently coincidental as the frequency distribution of flock distances in 1997-98 was very similar to those found in the baseline year (see Fig. 9).

4. Discussion

The data pertaining to the abundance of common eiders at the scale of the whole study site are unequivocal. The total number of common eiders in 1997-98 was the highest number in four years of data, surpassing the baseline average by about 1,500 individuals (see Fig. 3). Even the fluctuations in abundance in 1997-98 were strikingly similar to the baseline year (see Fig. 2). In addition, there is no evidence that disturbance occurred in the vicinity of the park since the number and density of common eiders in 1997-98 were comparable to that of the baseline year, when there was no wind park (see Figs. 7 and 8). For common scoters, the average abundance observed in 1997-98 was similar to the baseline year. Therefore, this further supports our (Guillemette et al. 1998) interpretation that the wind park was not the cause of the observed decline of sea ducks during the two *After* years. However, this interpretation was based on another observation showing that food decreased concomitantly with birds numbers.

In general, the amount of food for common eider in 1997-98 increased comparatively to the two *After* years but did not reach the level of abundance observed during the baseline year. This was due mainly to the fact that, despite a successful spatfall of blue mussels, the biomass of small and intermediate individuals did not reach the abundance measured during the baseline year. Indeed, the average biomass of small and intermediate sized blue mussels was about 300 g m^{-2} in 1997-98 compared to 120 g m^{-2} during the baseline year. The obvious question arising from this observation is how to explain the high abundance of common eiders during the fourth year of the study?

A potential answer to that question is related to the possibility that the study area does not need 300 g m^{-2} of blue mussels to sustain an average of 3,300 common eiders. In other words, a year characterised by a spatfall as considerable as during the baseline year could be considered as being a year of superabundance of food for the common eider. Computations based on a bioenergetic model and conducted for the 0-6 m depth range (covering 85% of the study site where small and intermediate sized mussels are found, Larsen & Guillemette in prep.) showed that the percentage of blue mussel biomass consumed by common eiders over an entire winter (6 months) was 58% during 1997-98. Unfortunately, we do not have a similar estimate for the baseline year since birds were not counted for an entire winter in 1994-95. Nevertheless, it is very likely that predation rate achieved by common eiders was much lower than 58% during the baseline year as more food and a lower abundance of common eiders were present compared to 1997-98. However, this estimate does not take into account the influence of other predators, especially the sea stars (Guillemette et al. 1993), which together with the common eiders may deplete blue mussel populations.

The present study further supports the interpretation that the wind park was not responsible for the observed decline of common eiders and common scoters between 1994-95 and 1996-97. Indeed, we suggest that the baseline year and our study started at a peak abundance of blue mussels in the environment, which subsequently decreased considerably in 1995-96 and 1996-97 and increased again in 1997-98. Typically, bivalves populations are characterised by large inter-annual variation in recruitment (Beukema 1982, Möller & Rosenberg 1983). In a 15-year study, Beukema (1982) reported intervals of 2-5 years between peaks of recruitment in *Mytilus*, *Macoma*, *Mya* and *Cardium*. Moreover, he observed that poor years of settlement were roughly the same for these species suggesting that recruitment in bivalves is governed by a common factor. Similarly, we observed that blue mussel populations decreased and increased synchronously with other bivalves in our study area. We therefore conclude that, without evaluating the abundance and the distribution of food supply, it will remain difficult to make any reliable impact assessment of offshore wind parks on abundance and distribution of sea ducks.

5. Bibliography

Beukema , J. J. 1982: Annual variation in reproductive success and biomass of the major macrozoobenthic species living in a tidal flat area of the Wadden Sea. - Netherlands J. of Sea Research 16: 37-45.

Guillemette, M., Himmelman, J.H., Barrette, C. & Reed. A. 1993: Habitat selection by common eiders in winter and its interaction with flock size. - Canadian Journal of Zoology 71: 1259-1266.

Guillemette, M., Larsen, J.K. & Clausager, I. 1998: Impact assessment of an off-shore wind park on sea ducks. - Unpublished report no 227 from Danmarks Miljøundersøgelser, 61 pp.

Guillemette, M. 1998: The effect of time and digestion constraints in Common Eiders while feeding and diving over Blue Mussel beds. - Functional Ecology 12: 123-131.

Hatfield, J.S., Gould, W.R., Hoover, B.A., Fuller, M.R. & Lindquist, E.L. 1996: Detecting trends in raptor counts: power and type I error rates of various statistical tests. - Wildlife Societey Bulletin, 24: 505-515.

Larsen, J.K. & Guillemette, M. (in prep.): The influence of inter-annual variation in food supply on the abundance of wintering common eiders Somateria mollissima.

Möller, P. & Rosenberg, R. 1983:. Recruitment, abundance and production of Mya arenaria and Cardium edule in marine shallow waters, western Sweden. - Ophelia 22: 33-55.

Stewart-Oaten, A., Bence, J.R. & Osenberg, C.W. 1992: Assessing effects of unreplicated pertubations: no simple solutions. - Ecology, 73: 1396-1404.

National Environmental Research Institute

The National Environmental Research Institute, NERI, is a research institute affiliated to the Ministry of Environment and Energy. In Danish, NERI is called *Danmarks Miljøundersøgelser (DMU)*.
NERI's tasks are to conduct research, perform monitoring, and give advice on issues related to the environment and nature.

Addresses:

URL: http://www.dmu.dk

National Environmental Research Institute
Frederiksborgvej 399
PO Box 358
DK-4000 Roskilde
Denmark
Tel: +45 46 30 12 00
Fax: +45 46 30 11 14

Management
Personnel and Economy Section
Research and Development Secretariat
Department of Policy Analysis
Department of Atmospheric Environment
Department of Environmental Chemistry
Department of Marine Ecology and Microbiology

National Environmental Research Institute
Vejlsøvej 25
PO Box 413
DK-8600 Silkeborg
Denmark
Tel: +45 89 20 14 00
Fax: +45 89 20 14 14

Department of Terrestrial Ecology
Department of Lake and Estuarine Ecology
Department of Streams and Riparian areas

National Environmental Research Institute
Grenåvej 12, Kalø
DK-8410 Rønde
Denmark
Tel: +45 89 20 17 00
Fax: +45 89 20 15 14

Department of Landscape Ecology
Department of Coastal Zone Ecology

National Environmental Research Institute
Tagensvej 135, 4
DK-2200 København N
Denmark
Tel: +45 35 82 14 15
Fax: +45 35 82 14 20

Department of Arctic Environment

Publications:
NERI publishes professional reports, technical guidelines and an annual report on activities. A catalogue of R&D projects is available on the World Wide Web.
A list of publications from the current year is included in the annual report which is available on request.

Faglige rapporter fra DMU/NERI Technical Reports

1998

Nr. 233: Anskydning af vildt. Status for undersøgelser 1997-1998. Af Noer, H., Madsen, J., Hartmann, J., Kanstrup, N. & Kjær, T. 61 s., 60,00 kr.
Nr. 234: Background Concentrations for Use in the Operational Street Pollution Model (OSPM). By Jensen, S.S. 107 pp., 125 DKK.
Nr. 235: Effekten på sangsvane ved etablering af en vindmøllepark ved Overgaard gods. Af Larsen, J.K. & Clausen, P. 25 s., 35,00 kr.
Nr. 236: The Marine Environment in Southwest Greenland. Biological Resources, Ressource Use and Sensitivity to Oil Spill. By Mosbech, A., Boertmann, D., Nymand, J., Riget, F. & Acquarone, M. 202 pp., 250,00 DKK (out of print).
Nr. 237: Råvildt og forstyrrelser. Af Olesen, C.R., Theil, P.K. & Coutant, A.E. 53 s., 60,00 kr.
Nr. 238: Indikatorer for naturkvalitet i søer. Af Jensen, J.P. & Søndergaard, M. 39 s., 50,00 kr.
Nr. 239: Aromater i spildevand. Præstationsprøvning. Af Nyeland, B.A. & Hansen, A.B. 64 s., 60,00 kr.
Nr. 240: Beregning af rejsetider for rejser med bil og kollektiv trafik. ALTRANS. Af Thorlacius, P. 54 s., 74,00 kr.
Nr. 241: Control of Pesticides 1997. Chemical Substances and Chemical Preparations. By Krongaard, T., Køppen, B. & Petersen, K.K. 24 pp., 50,00 DKK.
Nr. 242: Vingeindsamling fra jagtsæsonen 1997/98 i Danmark. Af Clausager, I. 50 pp., 45,00 kr.
Nr. 243: The State of the Environment in Denmark 1997. By Holten-Andersen, J., Christensen, N., Kristensen, L.W., Kristensen, P. & Emborg, L. (eds.). 288 pp., 190,00 DKK.
Nr. 244: Miljøforholdene i Tange Sø og Gudenåen. Af Nielsen, K., Jensen, J.P. & Skriver, J. 63 s., 50,00 kr.
Nr. 245: The Danish Air Quality Monitoring Programme. Annual Report 1997. By Kemp, K., Palmgren, F. & Mancher, O.H. 57 pp., 80.00 DDK.
Nr. 246: A Review of Biological Resources in West Greenland Sensitive to Oil Spills During Winter. By Boertmann, D., Mosbech, A. & Johansen, P. 72 pp., 95,00 DKK.
Nr. 247: The Ecology of Shallow Lakes - Trophic Interactions in the Pelagial. Doctor's dissertation (DSc). By Jeppesen, E. 358 pp., 200,00 DKK.
Nr. 248: Lavvandede søers økologi - Biologiske samspil i de frie vandmasser. Doktordisputats. Af Jeppesen, E. 59 s., 100,00 kr.
Nr. 249: Phthalater i miljøet. Opløselighed, sorption og transport. Af Thomsen, M. & Carlsen, L. 120 s., 45,00 kr.
Nr. 250: Faunapassager i forbindelse med større vejanlæg, III. Feltundersøgelser og litteraturudredning. Af Jeppesen, J.L., Madsen, A.B., Mathiasen, R. & Gaardmand, B. 69 s., 60,00 kr.
Nr. 251: Ferske vandområder - søer. Vandmiljøplanens Overvågningsprogram 1997. Af Jensen, J.P., Jeppesen, E., Søndergaard, M., Lauridsen, T.L. & Sortkjær, L. 102 s., 125,00 kr.
Nr. 252: Landovervågningsoplande. Vandmiljøplanens Overvågningsprogram 1997. Af Grant, R., Blicher-Mathiesen, G., Andersen, H.E., Laubel, A.R., Paulsen, I., Jensen, P.G. & Rasmussen, P. 154 s., 150,00 kr.
Nr. 253: Ferske vandområder - vandløb og kilder. Vandmiljøplanens Overvågningsprogram 1997. Af Windolf, J., Svendsen, L.M., Ovesen, N.B., Iversen, H.L., Larsen, S.E., Skriver, J. & Erfurt, J. 102 s., 150,00 kr.
Nr. 254: Marine områder. Åbne farvande - status over miljøtilstand, årsagssammenhænge og udvikling. Vandmiljøplanens Overvågningsprogram 1997. Af Ærtebjerg, G. et al. 246 s, 250,00 kr.
Nr. 255: Atmosfærisk deposition af kvælstof. Vandmiljøplanens Overvågningsprogram 1997. Af Frohn, L., Skov, H. & Hertel, O. 97 s., 100,00 kr.
Nr. 256: Emissioner fra vejtrafikken i Danmark 1980-2010. Af Winther, M. & Ekman, B. 73 s., 75,00 kr.
Nr. 257: Landbrugsscenarier - integreret miljøøkonomisk modelanvendelse. Af Andersen, J.M., Wier, M., Hasler, B. & Bruun, H.G. 93 s., 100,00 kr.
Nr. 258: Tungmetaller i tang og musling ved Ivittuut 1998. Af Johansen, P., Riget, F. & Asmund, G. 29 s., 40,00 kr.
Nr. 260: Afløbskontrol af dambrug. Statistiske aspekter og opstilling af kontrolprogrammer. Af Larsen, S.E. & Svendsen, L.M. 86 s., 150,00 kr.
Nr. 261: Udvidet pesticidmetode i forbindelse med grundvandsovervågning. Af Vejrup, K.V. & Ljungqvist, A. 52 s., 50,00 kr.
Nr. 262: Proceedings of the 16th Mustelid Colloquium, 9th - 12th October 1997, Århus, Denmark . Ed. by Madsen, A.B., Asferg, T., Elmeros, M. & Zaluski, K. 45 pp., 40,00 DKK.