ICES 1989 paper C.M. 1989/N:8

SEABIRDS IN THE NORTH SEA: DISTRIBUTION AND ECOLOGICAL ROLE.

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Abstract

Seabirds were counted during 511 standard one hour periods in the North Sea, between 1971 and 1980. This paper presents a summary of the data gathered, first as number of birds encountered per station, than as density and biomass, and finally as calculated food intake and energy flux. Their ecological role is discussed in the frame of a general ecological description of the ecosystems (carbon cycling) and in comparison with the fisheries.
The main conclusion is that seabirds play a minor role only in the flux of energy through the ecosystem or when compared with fisheries: they can mainly be utilized as ecological indicators. On the one hand, they allow to recognize water masses with different ecological structure ("complete" planktonic food chain leading to pelagic fish and seabirds *versus* shortcut food chain where primary production is mainly recycled by planktonic and benthic bacteria). On the other hand, changes in their density and/or breeding success reflect modifications in the ecology of the marine ecosytems: the recent important decline of the seabirds breeding populations in northern Norway and the Shetlands provides a striking example of this type of information.

Introduction

In marine ecology, there exists a tendency to give too little attention to the higher trophic levels -- seabirds, pinnipeds and cetaceans.

The knowledge of seabirds is generally good as far as their breeding colonies are concerned, but much less is known about their distribution at sea. Such data provide however important information, not only for the seabirds' ecology, but also for the ecological structure and the functioning of the ecosystems involved (Joiris, 1978; Joiris *et al.*, 1982).

The main problems in determining seabirds densities are the existence of "followers" accompanying the ship, sometimes for long periods, and the possible movements of birds, e.g. between breeding place and feeding grounds or from one zone to another (migration). This second type of observations clearly represents a flux and cannot be expressed as density; more especially, such results are not influenced by the speed of the ship and should not be extrapollated in time nor in space.

The third type of observations only, concerning birds belonging to the immediate zone (showing local movements or no movement), can be translated into density, knowing the ship's speed and evaluating for each species the width of the transect actually surveyed.

Counts were realized from the bridge, during standard one hour stations, without any width limit. The vast majority of counts were realized from the moving ship.

Results and discussion

A summary of the information gathered from 1971 till 1980 during 511 standard one hour counts is presented in table 1, as far as the main pelagic species are concerned (less common species were not included because of their limited ecological significance and *Larus* gulls because they depend much more on terrestrial and fisheries offal than on "natural" marine food). The data were separeted in two zones: Atlantic water expanding into the North Sea from the North West, characterized by high salinity, and North Sea water with salinity lower than 34.9 °/oo (Joiris, 1978).

The main conclusions are:

- the good reproducibility of the results within each geographical zone, with two exceptions in January 1972 for the Fulmar and the Kittiwake in North Sea water (these results were not taken into account nor incorporated in the further calculations);
- the clear difference between Atlantic and North Sea water, with much higher density of pelagic seabirds in the former.

Table 1: Summary of the seabirds counts (main species; number per hour; see text).

Atlantic water

						mean
Month		2	5-6	7	8-9	mean
Year		1978	1980	1975	1979	
Nber stations		66	52	12	136	266
Ref		3	5	2	5	
Fulmar	*Fulmarus glacialis*	52.5	44.5	44.5	30.6	**43.0**
Gannet	*Sula bassana*	4.9	1.1	1.4	9.1	**4.1**
Skuas	*Σ Stercorarius*	-	2.5	3.7	1.4	**2.5**
Kittiwake	*Rissa tridactyla*	31.5	12.3	29.3	15.0	**22.0**
Guillemot	*Uria aalge*	13.0	11.6	16.1	15.0	**13.9**
Alcids°	*Σ Alcidae*	18.7	36.0	21.5	21.6	**24.5**

North Sea water

Month		1	2	4-6	5-6	6-7	7	8-9	8-9	mean
Year		1972	1978	1976	1980	1971	1975	1971	1979	
Nber stations		18.5	60	80	11	23.2	24	18	10	244.7
Ref		1	3	4	5	1	2	1	5	
Fulmar	*Fulmarus glacialis*	0.1*	7.1	17.9	14.7	0.9	19.0	1.0	13.4	**10.6**
Gannet	*Sula bassana*	3.5	0.5	0.8	0.3	0.3	0.7	1.7	0.5	**1.0**
Skuas	*Σ Stercorarius*	-	-	0.4	-	-	0.8	1.8	0.3	**0.8**
Kittiwake	*Rissa tridactyla*	151.5*	11.0	8.4	3.7	4.1	6.0	5.1	1.6	**5.7**
Guillemot	*Uria aalge*	0.3	9.2	1.3	1.5	-	0.8	1.2	1.7	**2.3**
Alcids°	*Σ Alcidae*	0.9	14.0	2.5	1.9	-	1.8	1.3	1.7	**3.4**

Ref: 1: Joiris, 1973; 2: Joiris, 1978; 3: Joiris, 1983a ; 4: Joiris, 1983b; 5: Joiris, unpublished.
°: including Guillemot, Puffin Fratercula arctica and Razorbill Alca torda
*: "abnormal" results, excluded from the mean and further calculations.

In order to express these figures as density, one has to evaluate the distance at which the different species were detected. The other solution to this problem is to limit the counting zone to a fixed distance from the ship (often 300 m; e;g; Tasker *et al.*, 1984), but I decided not to apply this rule because on the one hand, I found it very difficult to fix such a distance correctly, and on the other hand, because I cannot loose the information provided by the birds observed at greater distances. Correction factors were used, generated by personal experience and by more objective arguments like the total population present in an area or the comparison with helicopter data (Diamond *et al.*,1986). Information on the individual weight of the seabirds was gathered from the literature (Bauer and Glutz, 1966; Glutz and Bauer, 1982). Taking into account a ship's speed of 10 knots (approximatively 18.5 km/hour), correction factors for the distance from which the birds were detected and their biomass (table 2), the density of the seabirds was established and their ingestion rate was calculated by equation

$$I = 254 \times W^{0.723}$$

with I = daily ingestion in kg fresh weight and W = biomass in kg.

This equation is derived (Schneider *et al* ,1987), from the allometric formula of Lasiewski and Dawson (1967) for the standart metabolic rate (SMR), a conversion factor of 2.8 SMR for calculating the daily food intake (Kooyman *et al.*, 1982), and conversion factors of 6.37 kJ/g fresh weight and 1.33 for a 75% assimilation efficiency.

The results are presented in table 3, for the complete year, for the breeding season ("summer": March-August) and for the non breeding season ("winter": September-February). The most striking conclusion is that the figures of energy flow through the seabirds are very low compared with primary production or with values of fish biomass and fisheries (table 4): on an annual basis, the seabirds considered here consume less than 0.01 % of the primary production or about 3% of the (pelagic + demersal) fisheries.

Table 2: Correction factor for the distance at which seabirds species can be detected (1) and biomass (kg)(2). See text.

	1	2
Fulmar *Fulmarus glacialis*	1.0	0.8
Gannet *Sula bassana*	0.8	3.2
Skuas Σ *Stercorarius*	1.7	1.0
Kittiwake *Rissa tridactyla*	1.1	0.4
Alcids Σ *Alcidae*	1.8	0.9

Table 3: Summary of the data on seabirds density and energy uptake in the North Sea (see text).

		Birds/hour winter	summer	year	Birds/km2 winter	summer	year	Ingestion (g fw/km2/day) winter	summer	year	(kgC/km2/year) winter	summer	year
Atlantic water													
Fulmar	*Fulmarus glacialis*	41.6	44.5	43.0	2.2	2.4	2.3	485.5	519.9	502.7	22.1	23.7	**22.9**
Gannet	*Sula bassana*	7.0	1.3	4.1	0.3	0.1	0.2	178.3	33.1	105.1	8.1	1.5	**4.8**
Skuas	*Σ Stercorarius*	1.4	3.1	2.5	0.1	0.3	0.2	32.7	72.4	59.1	1.5	3.3	**2.7**
Kittiwake	*Rissa tridactyla*	23.3	15.8	22.0	1.4	0.9	1.3	131.0	131.0	131.0	6.0	6.0	**6.0**
Alcids	*Σ Alcidae*	20.2	28.7	24.5	2.0	2.8	2.4	461.5	657.3	559.9	21.1	30.0	**25.5**
total											58.8	64.5	**61.9**
North Sea water													
Fulmar	*Fulmarus glacialis*	5.4	17.2	10.6	0.3	0.9	0.6	63.1	201.0	123.5	2.9	9.2	**5.6**
Gannet	*Sula bassana*	1.6	0.5	1.0	0.1	0.0	0.0	39.5	12.7	26.4	1.8	0.6	**1.2**
Skuas	*Σ Stercorarius*	1.1	0.3	0.8	0.1	0.0	0.1	24.5	7.0	19.3	1.1	0.3	**0.9**
Kittiwake	*Rissa tridactyla*	42.3	5.6	5.7	2.5	0.3	0.3	131.0	131.0	131.0	6.0	6.0	**6.0**
Alcids	*Σ Alcidae*	4.5	1.6	3.4	0.4	0.2	0.3	102.5	36.6	78.8	4.7	1.7	**3.6**
total											16.4	17.7	**17.3**

Table 4: Comparison between the energy input by seabirds and the main ecological parameters of the southern North Sea (North Sea water); biomasses in gC/m2, fluxes in gC/m2/year (see Joiris *et al.*, 1982; Hannon and Joiris, 1989).

Period	summer	winter	year
Phytoplankton biomass	5.5	2.8	3
Zooplankton biomass	0.4	0.2	0.4
Pelagic fish biomass	0.4	0.4	0.4
Demersal fish biomass	1.7	1.7	1.7
Primary production	637	160	320
Zooplankton production	59	33	42
Pelagic fish production (fishery)	0.12	0.12	0.12
Demersal fish production (fishery)	0.6	0.4	0.5
Seabirds food intake	0.018	0.016	0.017

Conclusions

The results obtained during 511 one hour counts of seabirds at sea and their good reproducibility (with two exceptions only), seem sufficient for sustaining a general discussion on their quantitative distribution and their ecological role, expressed as food intake.

The main conclusion is that the flux of energy through the main seabirds species is very low: less than 0.01% of the annual primary production or 3% of both pelagic and demersal fisheries. This comparison with fisheries represents a maximal evaluation, since a significant part of the seabirds' diet consists in zooplakton (e.g. Fulmar and Kittiwake). On the other hand, *Larus* gulls were not taken into account because of their coastal distribution (Black headed Gull *L. ridibundus* and Common Gull *L. canus*) and of their feeding habits: they depend much on terrestrial and fisheries offal. Their consumption of "natural" food is however not nihil, so that our evaluation, from this point of view, is a minimal one.

Our results lay clearly lower than the evaluation by Evans (1973) for the whole North Sea (13% of the annual fish production)., but his conclusion was mainly based on a rough evaluation of the seabird breeding populations. Furness (1978) suggested a consumption by seabirds around their breeding colonies at Foula of 29% of the annual fish production. In his calculations, however, the densities of seabirds are very high around the colonies, which suggests that he overestimated the local density by integrating too many moving birds flying between the colony and the feeding grounds. Anyway, much lower densities must, in his model, strongly limit the role of seabirds at greater distances, so that his figures are not necessarily in contradiction with ours for the whole North Sea

Since seabirds play only a minor role in the flux of energy through the ecosytem, or even when compared with the fisheries, they can mainly be utilized as bioindicators. On the one hand, their distribution reflects the existence of water masses with different ecological structures: the Atlantic water with a "complete" food chain leading to zooplankton, pelagic fish and pelagic seabirds, and the North Sea water where the primary production is mainly recycled by planktonic and benthic bacteria (40% each; Joiris *et al.*, 1982), so that seabird density is much lower. On the other hand, the recent dramatic decline of seabird breeding populations in northern Norway and in the Shetland islands reflects important modifications in the ecology of these marine ecosystems.

References

Bauer, K.M. und Glutz von Blotzheim, U.N. 1966. *Handbuch der Vögel Mitteleuropas.* Band 1. Akademische Verlagsgesellschaft, Frankfurt.

Diamond, A.W., A.J. Gaston and R.G.B. Brown. 1986. Converting PIROP counts of seabirds at sea to absolute densities. Canadian Wildlife Services, *Progress Notes* n° 164, September 1986. 21 pp.

Evans, P.R. 1973. Avian resources of the North Sea. In *North Sea Science*, ed E.D. Goldberg. Cambridge, Massachusets.

Furness, R.W. 1983. *The birds of Foula.* Brathay, Ambleside.

Glutz von Blotzheim, U.N. und K.M. Bauer. 1982. *Handbuch der Vögel Mitteleuropas.* Band 8/1 Akademische Verlagsgesellschaft, Frankfurt.

Hannon, B. and C. Joiris. 1989. A seasonal analysis of the southern North Sea ecosystem. *Ecology*, in press.

Joiris, C. 1973. Observations ornithologiques réalisées dans le Sud-Est de la Mer du Nord entre juin 1971 et janvier 1972. *Aves*, 10: 19-25.

Joiris, C. 1978. Seabirds recorded in the northern North Sea in July: the ecological implications of their distribution. *Le Gerfaut*, 68: 419-440.

Joiris, C. 1983a. Seabirds recorded in the Fladenground area, northern North Sea, in April, May and June 1976. In *North Sea Dynamics*, ed by Sündermann and Lenz. Springer Verlag, Berlin Heidelberg. Pp 677-686.

Joiris, C. 1983b. Winter distribution of seabirds in the North Sea: an oceanological interpretation. *Le Gerfaut*, 73: 107-123.

Joiris, C., G. Billen, C. Lancelot, MH. Daro, JP. Mommaerts, A. Bertels, M. Bossicart, J. Nijs and JH. Hecq. 1982. A budget of carbon cycling in the Belgian coastal zone: relative roles of zooplankton, bacterioplankton and benthos in the utilization of primary production. *Neth. J. Sea Res.*, 16: 260-275.

Joiris, C. and J. Tahon. 1989. Distribution of seabirds and cetaceans in the Northeast Atlantic and Arctic oceans, June-August 1985. *Rapp. P.-v. Réun. Cons. int. Explor. Mer*, 188: 251

Kooyman, G.L., R.W. Davis, J.P. Croxall and D.P. Costa. 1982. Diving depths and energy requirements of King Penguins. *Science*, 217: 726-727.

Lasiewski, R.C. and W. R. Dawson. 1967. A re-examination of the relation between standard metabolic rate and body weight in birds. *Condor*, 69:13_23.

Schneider, D.C., G.L. Hunt Jr and K.D. Powers. 1987. Energy flux to pelagic birds: Bering Sea and Northwest Atlantic. pp 259-277. In *Seabirds: feeding ecology and role in marine ecosystems*. ed J.P. Croxall. Cambridge University Press.

Tasker, M.L., P. Hope-Jones, T. Dixon and B.F. Blake. 1984. Counting seabirds at sea from ships: a review of methods employed and a suggestion for a standardized approach. *The Auk*, 101: 567-577.