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Planning a census of the Harbour Seal (*Phoca vitulina* L.) on the coasts of the Netherlands*)

by

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Scientific research into the occurrence and population density of the Harbour Seal (*Phoca vitulina* L.) in the coastal regions of the Netherlands, necessary for any efficacious nature conservancy programme, was started in September 1953 by the author.

A reliable calculation of the total number of Harbour Seals in the coastal regions of the Netherlands soon proved to be extremely difficult. Estimations of the number of Harbour Seals occurring in these regions had been made several times before. BROUWER (1927) took the total number of seals in the Netherlands part of the Waddenzee at 1500 and the total number of seals in the estuaries of the provinces of Zuid-Holland and Zeeland at 800. The first number had been arrived at by means of countings in the field, the latter had been computed from the number of dead animals brought in on account of a bounty system existing for more than twenty years. HAVINGA (1931, 1933) also based his most ingenious calculations on the number of animals killed for bounties. He found that, should the total number of seals stay at the same level, the total population should amount to at least 4000 animals, the bounty killings amounting to 1100 animals annually. At the moment HAVINGA published his report, there was no direct evidence of a decrease in the number of seals, but even so HAVINGA obviously felt a slight doubt in this respect. ERNA MOHR (1952) compared HAVINGA's calculations with Russian calculations concerning the Harp Seal (*Phoca groenlandica* FABR.). Her conclusions are that only a total number of 8500 animals was sufficient to endure an annual killing of 1100 animals without decreasing. To my opinion ERNA MOHR was mistaken in using these calculations, concerning a species with quite another biology and a shorter span of life than the Harbour Seal. So, taking into account the Harbour Seal only, the various authors came to different estimations in the coastal

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regions of the Netherlands. Therefore it seemed worthwhile to attempt a more exact census of this species.

CALCULATION OF POPULATION-DENSITY FROM THE FIGURES OF ANNUAL KILLINGS.

HAVINGA assumed that during the period of his research the total population was not decreasing or increasing, as the annual killings remained at nearly the same level. He argued that, with a decreasing population, the annual killings would decrease too. This seems quite acceptable, but HAVINGA overlooked one thing. The population of the Netherlands part of the Waddenzee is not an isolated one. There is a direct contact with the population in the German part of the Waddenzee and perhaps even an indirect contact with the population on the Jutland coast. So, if the number of seals in the Netherlands part of the Waddenzee is decreasing, the thinned ranks may very well be replenished from the stock in the German part of the Waddenzee. This seems the more acceptable as the hunting pressure in the German coastal region is quite low.

On the other hand, though the annual killings of late years stay at the same level, it must be noted that the price of the skins is on the increase. Therefore, hunters will be more eager to get the young animals, which will make better prices. Therefore more man-days will be devoted to hunting. At the same time, countings in recent years if compared with the countings done by HAVINGA 25 years ago, seemed to show a decrease of numbers in the Netherlands part of the Waddenzee, especially in the eastern part where hunting-pressure is highest. Nature conservancy aims at keeping the population of the Harbour Seal at the same level. Therefore HAVINGA's method, which starts from the premise of a stable population, cannot be used for our purpose, because we must get an idea of the course of the population under the influence of various factors.

In the first place we had to ascertain the permittable annual killing in a random population of the Harbour Seal, considering this population must remain stable. If the percentage of the total population, which is available for annual killing, can be calculated, comparison with actual figures may give information about the actual hunting pressure.

In calculating this percentage we start from the following considerations. The exact distribution of age-classes is not known. We may assume that mortality is highest in the first year of life. Bad weather during the first weeks of life is known to make quite a lot of victims among the pups. After weaning, the pups take hardly any food for some fourteen days, they get rather feeble during this period and death risks will be great. There are some indications that youth mortality often is high as a consequence of heavy infections by longworms and other endoparasites. Mortality during the first year of life can readely be assumed to be 20%. From our calculations we may assume that the rate of mortality will remain stable after the first year of life, although in reality mortality during the second year of life will be somewhat higher than in older animals in the prime of life. Other data available are: the maximum age of a Harbour Seal is twenty years, the animals are sexually mature on the fourth year (sometimes perhaps in the 5th year)

of life, a female produces only one pup a year (twins need not considered because as a rule only one will grow up). Most possibly a Harbour Seal is promiscuous or polygamous; nevertheless, the sex-ratio can be estimated to be 1 : 1. In the following calculations we take the rate of mortality in the 1st year of life to be 20%, in subsequent years 7½%, 10% or 12½%.

TABLE 1. Theoretical calculations as to the results of a presumed annual mortality of 7½, 10 or 12½% respectively, after the first year of life.

	Year-class	Mortality	Total number of individuals in one year-class	Mortality	Total number of individuals in one year-class	Mortality	Total number of individuals in one year-class
Immatures	1	20 %	1000	20%	1000	20 %	1000
	2	7½%	800	10%	800	12½%	800
	3	7½%	740	10%	720	12½%	700
Adults (50% females)	4	7½%	684	10%	648	12½%	613
	5	7½%	633	10%	583	12½%	536
	6	7½%	586	10%	525	12½%	469
	7	7½%	542	10%	473	12½%	410
	8	7½%	501	10%	426	12½%	359
	9	7½%	463	10%	383	12½%	314
	10	7½%	428	10%	325	12½%	275
	11	7½%	396	10%	292	12½%	241
	12	7½%	366	10%	263	12½%	211
	13	7½%	339	10%	237	12½%	185
	14	7½%	313	10%	213	12½%	162
	15	7½%	290	10%	192	12½%	142
	16	7½%	218	10%	174	12½%	124
	17	7½%	201	10%	156	12½%	107
	18	7½%	186	10%	141	12½%	94
	19	7½%	172	10%	127	12½%	82
	20	7½%	159	10%	114	12½%	72
Total			9017		7792		5896

If the rate of mortality after the first year of life is assumed to be 7½%, 1000 pups are necessary to maintain a total population of 9017 individuals. The total production of pups in this population however, if we take into account the data cited above, is as much as 3238 pups a year. So an annual killing of 2238 pups would allow the population to be stable. An annual killing moreover, of older animals, as actually is the case in the Netherlands, would render the annual permissable killing rate less high.

In the same way we find that a mortality of 10% after the first year of life would allow 1000 pups to maintain a population of 7792 animals. This corresponds with a production of 2636 and the permitted annual killing rate would be 1636.

If the annual mortality after the first year is assumed to be 12½% we find again a number of 1000 pups to be necessary for maintaining a population of 5896 animals, a production of 1698 pups and a permissable killing rate of 698 pups only. The annual killing rate allowed may

be assumed to be 25% of the total population if the annual mortality is assumed to be 7½% ; in the same way the annual killing rate may be assumed to be 21% of the total population if annual mortality amounts to 10%, and 12% if the annual mortality amounts to 12½%.

It will be clear that any estimation of numbers, taking the annual killings as a base, will be impossible if we do not know which is the natural annual mortality rate. The only numbers to go at are those of the annual

FIGURE 1. Distribution of the Harbour Seal in the coastal regions of the Netherlands. The figures represent the maximal number of animals counted on the resting places during the years 1953—1955.

killings and those of animals estimated by counting in the field. From the latter we may conclude to a population in Zuid Holland and Zeeland of about 1000, from the former to an annual killing of 150 specimens, which means 15%. Comparison with the figures of HAVINGA (1931) shows us that the numbers of seals in the different resting places have increased slightly. In 1954 and 1955 the annual killing rate was much higher and accordingly we did find a sudden decrease of the number of animals at the resting places last year.

Things are different in the Waddenzee west of the border between the Netherlands and Germany. From countings in the field (fig. 1) we arrived at an estimation of about 1200 animals in this region. This means that the annual killing rate would amount to not less than 54% of this estimated population. A very serious decrease could theoretically be expected here. Comparing again with the countings of HAVINGA (1931) we do find a decrease, and a rather serious decrease even in the eastern part of this region, though not as serious as could be theoretically expected. Now the following facts should be taken into account here. In the German part of the Waddenzee countings of the seals by airplanes amounted to 1500 animals. The annual killing rate in this region amounts to only 7% of this figure. The considerable increase one could expect in this region cannot be found. As has been said above, there is a free exchange of the animals at both sides of the border. If we take the population of the whole Waddenzee to number 2700 animals, the annual killing in the whole Waddenzee would amount to about 27%. Even if natural mortality should be annually 7½%, a slight decrease could be expected. And indeed, in the total population countings seem to point to a decrease.

The only conclusion is that the very high hunting-pressure in the Netherlands is compensated by immigration from Germany where hunting-pressure is low. Another conclusion is that an annual killing rate of 20% may be considered permittable. This would mean that annual natural mortality of 10% after the first year of life is within the range of reality. These conclusions seem to be more likely if we take into account that most of the hunting is done at the Netherlands-German border and the annual killing rate in this limited region is twice as high as the largest number of seals ever counted in this region. These considerations are only valid of course, if countings in the field are assumed to give a more or less exact picture of the actual number of animals present.

VALUE OF COUNTINGS IN THE FIELD.

HAVINGA (1931, 1933) assumes that only a proportionally small percentage of the number of animals present at a given time, will be found at the resting places at low tide. Now we do not know anything about the social relations of seals, we do not even know if there is such a thing as a herd. May be the number of seals on a resting place is only a function of the quantity of food available at a given time. May be the animals, present at a certain resting place at a certain time only are a random sample of the total number of animals present in a certain region. But one fact cannot be denied : if countings are performed during a couple of days in succession, always the same number of animals will be found at the same moment of the low tide if weather

conditions are favourable. This fact is much more striking if countings are performed in a region where the accessability of the resting place is not dependent from the tide. At the resting places at the isle of Anholt in the Kattegat (Denmark) the animals arrived every day at the same moment and always in the same number, as the author could observe during a visit May 1954. In the Kattegat there is hardly any difference between high tide and low tide. Somewhat different conditions are present at the north coast of the isle of Schiermonnikoog (Waddenzee, Netherlands) where the animals are resting on the beach during high tide and on a tidal bank off the beach at low tide, but where the animals arrive always at the same moment of the day and in the same number. As it is hardly acceptable that every day the same percentage of the whole population should come to the resting place, the others staying offshore, and not the same animals, it must be assumed that every animal of the population comes ashore at a moment at which tide, time and weather are favourable. Dr. H. FRANK (Bonn) kindly informed me that he arrived at the same conclusion during the many years he made researches on the Harbour Seal. So we may conclude that it is possible to get an exact idea of the number of seals in a certain region by counting.

Another difficulty remains. In summer the number of animals at a

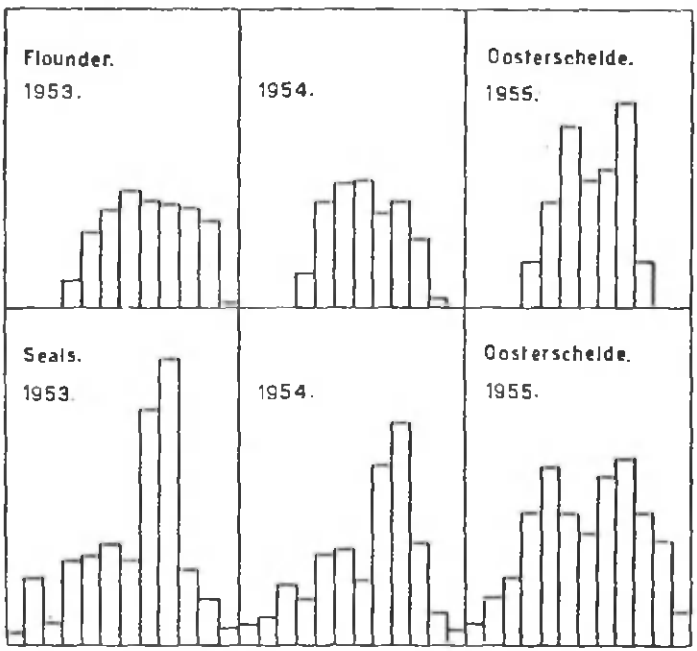

FIGURE 2. Upper row: Figures of Flounder (*Pleuronectidae*) caught in the Oosterschelde during 3 successsive years. Lower row: Figures of the total number of Harbour Seals during the same months and years.
The diagram shows that food certainly is not the only factor determining the population density of the seal. The lower row also indicates a decrease of the maximal number of seals since 1953.

certain resting place in the tidal region is much higher than in winter. HAVINGA quite correctly remarked that seals hunt their prey by means of sight and so, the winterday being only short, in winter the period of feeding is so short that no time for rest is left during daytime. Therefore counting should be performed in summer only. But not only the lenght of the day is determining the number of animals on the resting places. Seasonal migration of the fish will also be of great influence. Correlation between the number of seals and the quantity of fish, present at a certain time, can be expected. But the diagram (fig. 2) shows that this correlation is only partial. Furthermore there seems to be a sort of seasonal movement correlated with sexual periodicity. Last but not least human influence such as hunting, fishing and dredging causes disturbance, and may rendering countings useless.

Therefore countings can give an excellent picture of the number of seals present in a limited area if they can be repeated during a couple of days in succession. But for the whole of the coastal region it would be possible only to get an exact idea of the total number of seals if countings could be performed by airplane during some days in succession and in the whole coastal region at the same time and tide and if this could be repeated during at least three years in succession. The figures given on the map (fig. 1) therefore only give a rough idea of the density of seals in the coastal regions of the Netherlands.

SEASONAL MOVEMENTS OF *PHOCA VITULINA* L. IN THE OOSTERSCHELDE.

A special research has been carried out in the Oosterschelde, a part of the estuary in the province Zeeland. The aim of this research was to get an idea of the seasonal movements of the seals and to try to find a correlation between the number of seals on the resting places and the sexual and reproductive cycle. I do not think I succeeded in obtaining a solution, owing to lack of technical possibilities. Nevertheless, the scarce results which could be obtained are presented here.

The Oosterschelde was chosen because it is possible to reach the whole of it during one single tide by boat, the tidal flats west of Neeltje Jans (fig. 3, A) excepted. Thus we could count all the animals present on the resting places during one single tide.

My own observations were performed on board of a vessel of the fisheries police, whilst countings performed by officers of the fisheries police during the years 1953, 1954 and 1955 were put at my disposal.

The countings are compliled in a diagram (fig. 4). In this diagram the principal resting places of Harbour Seals are given from west (left) to east (right). Only those resting places are mentioned where seals are found regularly. Other places, where one or two seals can be found incidentally are not mentioned here. The diagram only gives a rough picture of the real distribution. The location of the resting places, mentioned in the diagram, can be found on the map (fig. 3).

The Kaasboergat is the most western resting place which has been visited. East of this follows a resting place in the Hammen. In fact the resting place in the Hammen is somewhat variable, but for the sake of simplicity all these places are considered one. The resting place at Schelphoek is kept apart. Next are the resting places at Brabantse Vaarwater, the principal of which lies at the northern end of the Galgenplaat. To the

east the next resting places are those at the Dortsman, which again are considered a single one. Usually the resting place at mussel parcel 107 is frequented by the seals. These are the principal resting places in the western part of the Oosterschelde. The next one, a small tidal flat at the Roomkil, is situated in the narrowest part of the Oosterschelde. In the eastern part of the Oosterschelde we find the resting places at the large tidal flat Kraayer, which are considered here as a single one, a resting place at the Geul near Pietermanskreek and the most eastern resting place at the Zilverput. The resting places in the eastern part are all situated in the region where the famous oysterbanks are found.

The diagram contains the average number at low tide taken during one month. I found that average numbers from observations during fourteen days only came to the same.

The diagram (fig. 4) shows us the following facts. In December and January the total number of seals is low. The animals present are scattered over the whole region, at least if there is no ice-drift. Severe frost drives the seals to the west. During February and March gradual increase of the number of seals may be observed. Under normal circumstances the increase is largest in the western part. After the terrible floods of February 1st, 1953 the seals were disturbed by extensive repairs naar Schelphoek and Ouderkerk, so as to be found much more to the east in that year than normally. A gradual increase may be observed till the month of June, more and more seals arriving from the west. Till the end of April most seals are found about Kaasboergat, if they are not disturbed. During the month of May the seals move eastward. It is rather conspicious that the seals in the eastern part during this month are full-grown animals,

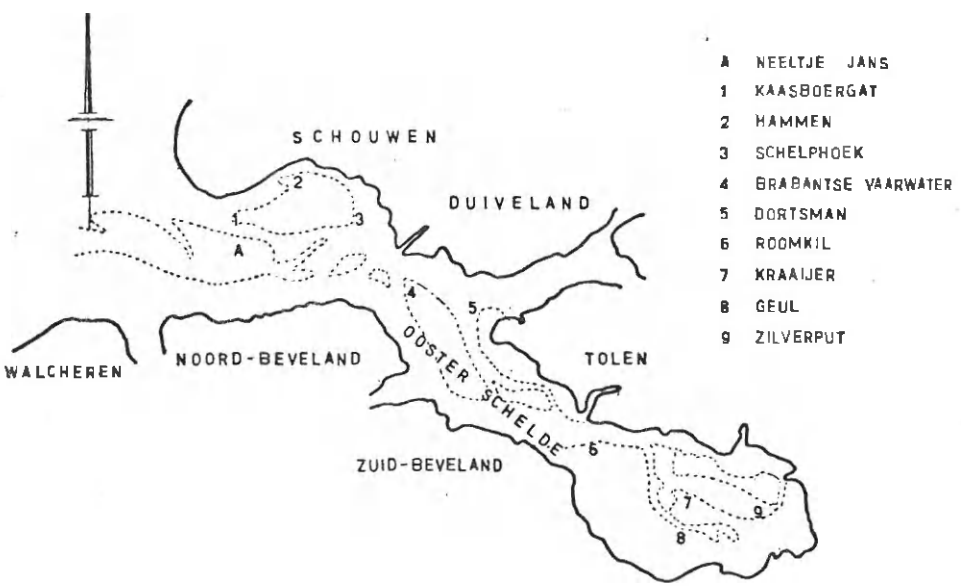

FIGURE 3. The principal resting places of the Harbour Seal in the Oosterschelde, province Zeeland, Netherlands.

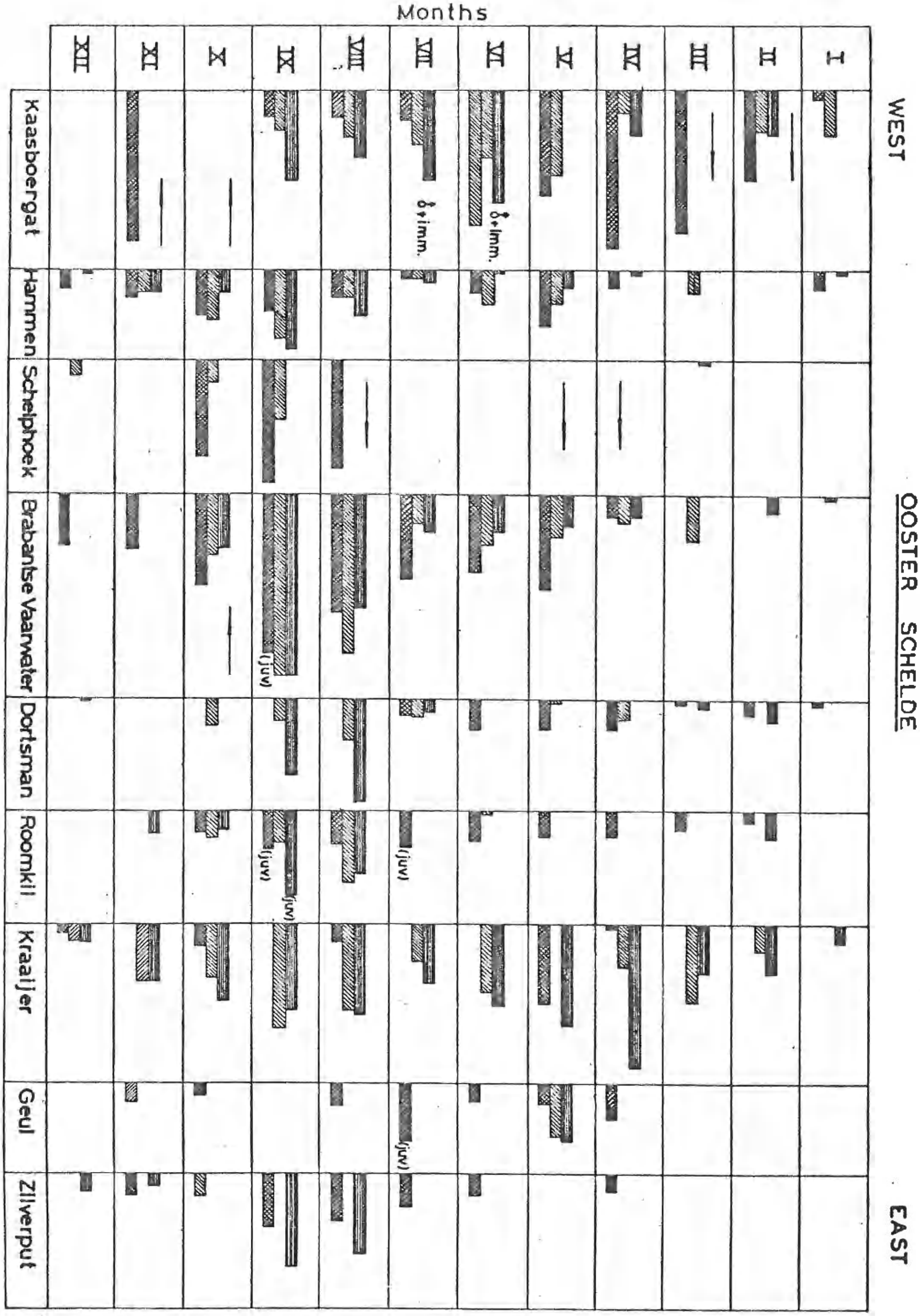

FIGURE 4. Diagram of the total number of seals on the resting places of fig. 3 during the years 1953—1955. The resting places in the western part of the Oosterschelde to the left, those in the eastern part to the right.

in the western part both full-grown animals and seals at the age of one or two years can be found, the latter category comprising about 20—25% of the total number. As during the month of July pups are found only in the eastern part, as long as the animals are not disturbed by hunters, it is likely that the animals in the eastern part mostly are pregnant females. In July 1954 a number of 54 full-grown seals was shot during one and the same tide on a western resting place in the Grevelingen. All these seals proved to be males. Perhaps this is an indication that females go east earlier than males and males linger at the tidal flats in the west till later in the year. During the months of May and June one noteworthy change is observed. In July I observed a decrease, which is most surprising. An increase seems more likely, because the pups are born in this month. However, in this month a couple of professional hunters start hunting in this region, with the aim of collecting the valuable skins of the newly born pups. Hunting is rather intensive during this month and so the whole of the picture is spoiled. Soon after hunting has started, females with pups may be found even in the most western parts, the groups being scattered everywhere. A considerable number of pups fall victims to these hunters. August 1954, after hunting came to an end, I hardly found a single pup anymore. The diagram shows that no seals were found at the Kraayer during the months of June and July 1955. This may be explained by the weir-fishery practised there at the time so as to prevent the seals reaching their habitual resting places. The seals shifted to other resting places in the neighbourhood, such as Roomkil, Geul and Zilverput. It is most likely that human activity is the reason of the decrease in numbers during July. Of course possibly some correlation with sexual behaviour is present here. VENABLES & VENABLES (1955), investigating the seals of the Shetland Islands, found that shortly before pups are born a curious behaviour of probably sexual meaning was displayed, accompanied with playpairing. Although the biology of the seals in the Shetland Islands is quite different from that in Zeeland and the breeding season in the Shetland Islands is earlier, there seem to be various stages in the sexual cycle of seals, up till now insufficiently known, which may be reflected in their seasonal movements.

In August a sudden increase in numbers may be observed. Mating takes place, according to FISHER (1954), immediately after the end of the lactation period. In Zeeland the lactation period must have ended in the second half of August. Most probably at that moment an invasion of the males can be expected. This invasion from the open continues till the middle of September. In this month young animals from the same year may already be found on the tidal flats in the mouth of the Oosterschelde, and it may be assumed that these young animals have started on their way outwards. In October the number of seals decreases rapidly. Numbers on the western flats temporarily increase, but in the eastern part only small numbers remain. In November most seals have left the Oosterschelde. If the weather is favourable, as was the case in 1955, the seals may linger for a long while on the western flats. In December only a few animals remain and these leave in western direction during the month of January.

It would be most interesting to know all about distribution and numbers of seals in the mouth of the Oosterschelde and outside in the zone of

the surf. On the very few aerial photographs of that region which I could secure, gatherings of 50 seals and more are seen. These photographs have been taken in August, during the period in which numbers in the Oosterschelde are highest. It would be worthwhile to try to complete the diagram of this paper with figures of this western region. Air reconnaissance will be indispensable for that purpose.

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