Monthly Counts as a Measure of Population Changes in Some Species of Anatidae in South Sweden
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Monthly waterfowl counts on selected waters during (August) September to April have been undertaken in South Sweden during 1959/60–1974/75 with the exception of 1965/66. Various methodological aspects of monthly waterfowl counts are discussed. Indices based on monthly counts and indices based on country-wide midwinter counts showed the same trends even if individual years showed deviations. It is concluded that midwinter counts are as good a measure of long-term changes in the non-breeding populations of species wintering in the country as monthly counts are. Increasing trends were found in *Anas crecca, Aythya fuligula,* and *Cygnus olor* (also increasing midwinter indices). *Cygnus olor* showed a decrease after the hard 1969/70 winter followed by an increase. Hitherto, the Swedish waterfowl counts have not revealed any decreases in resting and wintering populations; some populations have increased, whereas most species have fluctuated around a steady level.

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Introduction

Monthly waterfowl counts during August/September to April have been undertaken in South Sweden from 1959/60 to 1974/75 with the exception of 1965/66. The main aim of the first series of counts was to study seasonal fluctuations in numbers of waterfowl in South Sweden (Nilsson 1968). When the International Waterfowl Counts started in 1966/67, monthly counts were restarted, now with the aim of elucidating annual fluctuations of South Swedish waterfowl populations as a complement to the midwinter counts (Nilsson 1975a) and November counts.

The present paper gives an analysis of annual fluctuations of some species of Anatidae in South Sweden with special reference to the suitability of using monthly counts as a measure of changes in wintering waterfowl populations. Data on *Anas platyrhynchos* will be analysed separately in conjunction with another project. Preliminary results were, however, reported by Nilsson (1974) and some of these data will be included here for completeness.

Methods

During the first years, rather few localities were included in the counts (Nilsson 1968). In 1961/62–1964/65 between 60 and 90 localities were counted each month. In 1966/67–1974/75 the number of regularly counted localities increased from 90–120 in the first three years to about 200 during the remainder of the period. The geographical distribution of the localities is seen from Fig. 1.

Most localities were counted for a number of years in succession. Changes in localities were unavoidable as counts were made by voluntary helpers in their spare time. However, the most important localities have been counted over a number of years, and there have been no major shifts in the geographical distribution of localities during these years. Special studies on methodological aspects were also undertaken in two study areas in SW Scania, southernmost Sweden (the coast of the Sound and the South coast; Fig. 1) in connection with general ecological studies on diving ducks (Nilsson 1970, 1975b).

The Swedish waterfowl counts were under-

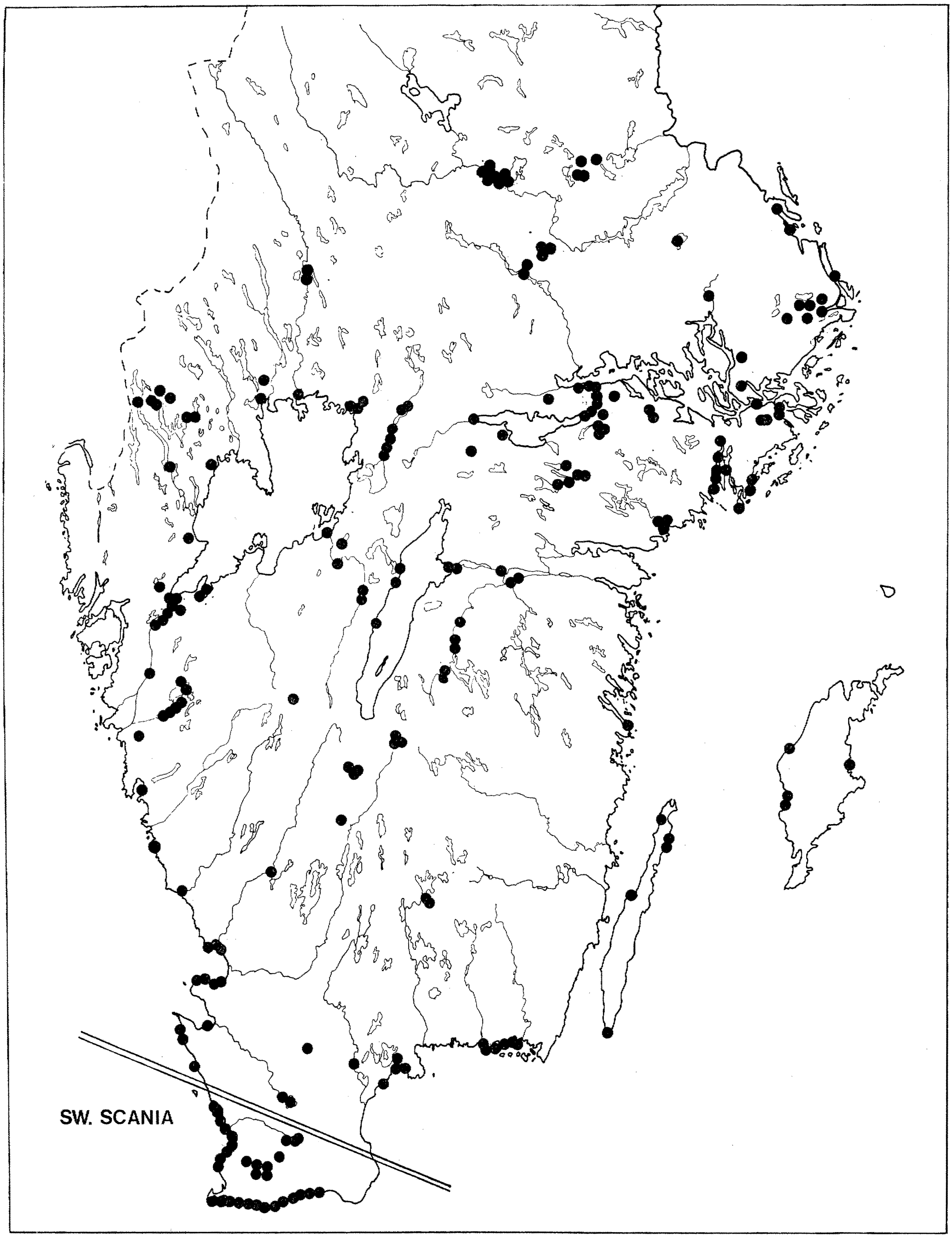


Fig. 1. Map of South Sweden showing the geographical distribution of the monthly count localities used in the index calculations in the present paper. SW Scania (with special study areas) is especially marked out.

taken on the internationally agreed dates, i.e. the Sunday nearest to the 15th of each month during August/September to April (counts in August were undertaken in 1967 and from 1969 to 1974). In general the same observer or team of observers counted the same locality at all counts, thus reducing errors due to changes of observers. The methods used in the field work have been discussed elsewhere (Nilsson 1970, 1973).

Results

Weather situation

The first years showed a fairly normal weather situation, followed by the extremely hard winter of 1962/63. During midwinter, most Swedish waters even at the coasts were frozen. The winters of 1963/4 and 1964/65 were fairly normal, whereas 1965/66 was another cold winter, the cold period starting in November and lasting till February. The winters of 1966/67 and 1968/69 were again fairly normal. The winter of 1969/70 was another cold winter with low temperatures in January and especially in February. 1970/71 and 1971/72 showed normal winter conditions in South Sweden, whereas the three last winters in the study period were exceptionally mild with many lakes in southernmost Sweden almost free of ice throughout the winter and with no coastal ice at all in South Sweden.

Estimation of the mean error in the counts

In the duck counts in the special study areas in SW Scania a marked variation was found between the counts on different days (Nilsson 1970, 1975b), representing real changes in the populations of these areas, but also, in part, counting errors. This error component can be expected to be largely constant for various intervals between two arbitrary counts as long as they are made in the same manner by the same observer, whereas the deviations between two counts caused by real changes in the populations will be larger for longer intervals (or at least for certain of these intervals if the real change is not linear). This provides a mean of estimating the maximum error affecting the counts of different species.

For all species occurring in sufficiently large numbers the percentage change in numbers for

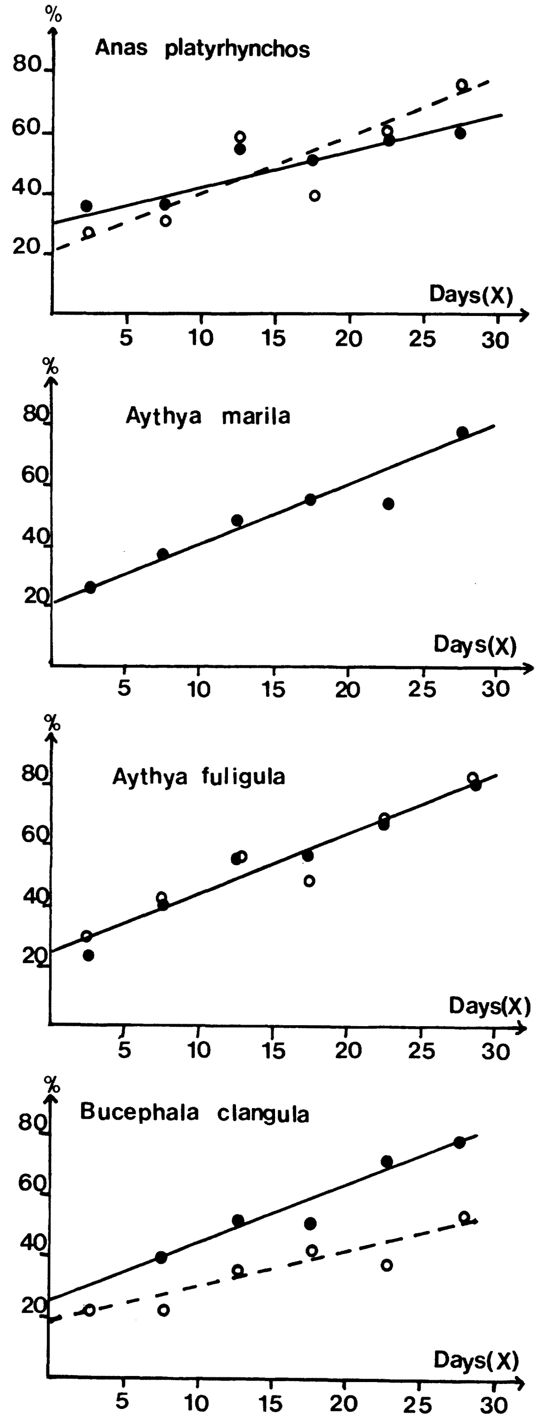


Fig. 2. Mean change (in per cent) from day 0 to day 0+X in counts of *Anas platyrhynchos, Aythya marila, Aythya fuligula,* and *Bucephala clangula* in special study areas in SW Scania (cf. Nilsson 1975 b). Open symbols and broken lines=south coast of Scania; filled symbols and whole lines=Öresund.

Table I. Mean changes in numbers of ducks between a count on day 0 and a count on day 0+X in study areas in SW Scania (see Nilsson 1975b). N=number of comparisons

Species	Area	X=1−5			X=6−10		
		Mean change (%)			Mean change (%)		
		Without considering sign	Considering sign	N	Without considering sign	Considering sign	N
Anas platyrhynchos	Öresund	34	− 1	9	36	− 6	29
	South coast	27	−10	5	31	−17	9
Anas crecca	Öresund	–	–	–	35	− 3	5
Aythya marila	Öresund	26	+ 6	15	38	− 3	45
Aythya fuligula	Öresund	23	+ 2	20	41	+ 1	60
	South coast	29	+19	7	41	+ 2	13
Aythya ferina	Öresund	60	+ 1	4	54	+ 1	10
Bucephala clangula	Öresund	32	+ 3	20	40	− 3	56
	South coast	22	− 9	7	23	−14	17
Clangula hyemalis	South coast	40	+ 1	6	59	+12	10
Mergus serrator	South coast	43	+42	6	41	+12	12
Mergus merganser	Öresund	35	− 9	15	45	−30	23
	South coast	39	0	7	35	−13	11

whole study areas between counts on day 0 and after 0+X days was calculated. The absolute (i.e. without considering signs) means of these deviations were calculated for five-day periods of X and depicted in Fig. 2. Extrapolation to the intersection with the ordinate gives an estimate of the maximum error affecting the counts. Only days with more than 50 individuals were used as day 0.

In *Anas platyrhynchos* the estimated error was 20 % and 30 % for the two study areas, respectively. In *Aythya marila* and *A. fuligula* this method yielded an estimated error of 20 %, whereas the estimated error for *Bucephala clangula* in the two study areas was 20–25 % and 25–30 %, respectively.

The mean change between counts exceeded the double estimated error after one month, whereas no species reached this level after 15 days.

Most variation was in both positive and negative directions, and when the means (considering signs) of the changes were calculated, most variations tended to cancel out (Table I). The mean of a series of counts may therefore be considered as an accurate estimate of the true number of birds even if the individual counts suffer from some errors, or in other words, the counts constitute unbiased estimates of the population size in an area.

The interval between counts

In the International Waterfowl Counts monthly intervals were chosen for practical reasons. Shorter intervals were considered to involve too much work for the voluntary helpers in relation to the gain in exactness, while longer intervals would give no indications of seasonal fluctuations.

Since the counting errors average zero, the mean of a series of counts is the best estimate of the average population level in that period. When comparing the monthly means with the counts obtained on the International Waterfowl Count dates (Table II), a marked tendency for the variations to cancel out was found. Over a long series, monthly counts will thus give a quite accurate picture of population levels even if some months show deviating values (Matthews 1960). It may also be mentioned that only slight differences were found between annual indices based on monthly counts and on counts twice a month (Table III).

Table II. Comparison between monthly counts of Anatidae in SW Scania (cf. Nilsson 1975b) and mean values calculated from repeated counts in the same months. Mean coefficients of variation (V) within months are also shown. Months with more than three counts were used in the calculations

Species	Number of months	Counts	Mean deviation (%) of monthly counts from average for month		Mean coefficients of variation within months
			Without considering sign	Considering sign	
Öresund					
Anas platyrhynchos	21	81	34	+ 8	37
Anas crecca	9	29	29	+13	41
Anas penelope	9	27	26	+ 3	42
Aythya marila	12	50	24	+ 4	42
Aythya fuligula	22	84	25	+ 7	45
Aythya ferina	5	17	25	− 8	37
Bucephala clangula	22	84	26	+ 7	51
Mergus merganser	5	24	16	+ 5	50
Tadorna tadorna	4	14	8	+ 1	19
Cygnus olor	9	31	14	− 5	26
Cygnus cygnus	3	11	9	+ 7	26
South coast					
Anas platyrhynchos	9	30	31	+31	52
Aythya fuligula	9	31	39	− 5	40
Bucephala clangula	9	31	9	+ 5	24
Clangula hyemalis	5	17	26	−14	38
Mergus serrator	9	31	28	+12	46
Mergus merganser	7	25	30	+ 7	55
Tadorna tadorna	5	15	20	+19	30
Cygnus olor	7	21	24	+ 7	32

Table III. Comparison between indices based on counts made once and twice a month in the two coastal study areas in SW Scania. *=significant for $P<0.05$, **=significant for $P<0.01$ and ***=significant for $P<0.001$

Species	Area	Counts/month	Indices						
			62/63	63/64	64/65	65/66	66/67	67/68	R
Anas platyrhynchos	Lommabukten	1	140	144	60	56	100	59	0.41
		2	149	210	77	67	100	94	
	South coast	1	–	–	74	131	100	97	0.62
		2	–	–	80	93	100	88	
Aythya marila	Lommabukten	1	61	181	210	129	100	115	0.93**
		2	70	151	126	119	100	106	
Aythya fuligula	Lommabukten	1	104	48	55	74	100	71	0.98***
		2	109	61	63	88	100	84	
	South coast	1	–	–	45	125	100	165	0.51
		2	–	–	63	153	100	200	
Bucephala clangula	Lommabukten	1	98	67	50	128	100	82	0.87*
		2	72	79	56	115	100	79	
	South coast	1	–	–	73	123	100	96	0.99*
		2	–	–	73	115	100	95	
Mergus merganser	Lommabukten	1	31	100	74	78	100	161	0.96**
		2	20	76	50	61	100	122	
	South coast	1	–	–	64	167	100	144	0.96*
		2	–	–	73	137	100	142	

Table IV. Indices based on monthly waterfowl counts in Sweden 1966/67–1971/72 calculated from comparisons between paired years (primary indices then recalculated in relation to the index of the master year, see text) and between the different years and a master year (see text). *=excluding SW Scania coast

Species	Type of index	Indices					
		66/67	67/68	68/69	69/70	70/71	71/72
Anas platyrhynchos	Paired years	103	104	112	100	90	98
	Master year	122	109	113	100	90	119
Anas crecca	Paired years	55	90	93	100	127	68
	Master year	56	84	93	100	127	74
Anas penelope	Paired years	100	162	98	100	115	104
	Master year	53	123	98	100	115	100
*Aythya fuligula**	Paired years	52	59	82	100	92	125
	Master year	43	89	82	100	92	125
Aythya ferina	Paired years	56	108	75	100	94	161
	Master year	43	72	75	100	94	130
*Bucephala clangula**	Paired years	72	92	104	100	95	96
	Master year	74	96	104	100	95	108
Mergus merganser	Paired years	59	81	96	100	93	78
	Master year	68	87	96	100	93	92

Table V. Comparison between November and January indices for *Anas platyrhynchos* for the localities in the monthly count scheme and the November and January indices for the country-wide surveys in November and January

Season	November indices		January indices	
	Monthly count localities	Country-wide surveys	Monthly count localities	Country-wide surveys
66–67	–	–	125	100
67–68	–	–	95	81
68–69	–	–	109	98
69–70	108	92	93	82
70–71	105	114	99	79
71–72	111	122	114	112
72–73	100	100	100	100
73–74	139	137	79	99
74–75	–	–	119	126
Correlation coefficients	0.80 P=0.1		0.56 0.2>P>0.1	

Calculations of the coefficient of variation (V), i.e. the standard deviation as percentage of the mean of the counts, showed the variation to be fairly high (Table II, cf. also Matthews 1960).

The calculation of annual indices from the counts

Annual indices for each species were calculated by comparing the total for all months for all localities in one year with the total for the same localities in the preceding year. The ratios so obtained were then recalculated in relation to the index of a master year (1969/70 = 100).

In an analysis of British data, Atkinson-Willes & Frith (1965) and Eltringham & Atkinson-Willes (1961) calculated indices by comparing the total for all localities in one year with the total for the same localities in the master year. As the number of localities in Sweden varied during the study period and as there were some shifts of localities, the use of this method would reduce the sample size appreciably. In the full series of counts in 1966/67–1974/75 the number of localities available for calculation of indices based on direct comparisons with the master year was sufficiently large to yield reliable indices for some important species. A comparison of the annual indices based on this sample with the indices based on the larger sample available for paired-year comparisons revealed only slight differences (Table IV). Thus, the shift in localities between years in the paired-year

Table VI. Comparison between indices based on monthly counts in special study areas in SW Scania (SW) (cf. Nilsson 1975b) and midwinter indices based on counts along the entire coast of the province of Scania (M) in 1963/64–1971/72. *=significant för P<0.05

Species		63/64	64/65	65/66	66/67	67/68	68/69	69/70	70/71	71/72	r
Anas platyrhynchos	SW	173	91	102	123	90	114	100	89	84	0.80*
	M	194	184	81	145	84	139	100	114	149	
Aythya fuligula	SW	42	49	80	78	79	118	100	48	59	0.77*
	M	57	82	59	78	118	134	100	50	41	
Bucephala clangula	SW	45	34	68	56	49	67	100	47	51	0.79*
	M	71	47	62	63	41	92	100	73	64	
Mergus serrator	SW	–	50	74	77	56	73	100	82	61	0.31
	M	–	71	68	101	73	152	100	114	120	
Mergus merganser	SW	40	30	79	45	70	88	100	54	30	0.78*
	M	32	15	28	22	32	46	100	35	17	
Somateria mollissima	SW	–	35	58	55	58	80	100	70	111	0.79*
	M	–	63	104	92	109	110	100	104	181	
Cygnus olor	SW	–	–	70	93	79	94	100	45	72	−0.21
	M	52	50	45	97	71	72	100	116	116	
Cygnus cygnus	SW	–	–	104	41	53	78	100	26	75	−0.17
	M	124	131	195	186	163	287	100	195	93	

sample did not influence the indices. It is therefore considered justified to use the paired-year comparisons to obtain annual indices, thus making use of all data available.

Monthly counts versus November and January counts

The representativeness of the indices based on monthly counts can be checked for *Anas platyrhynchos* by comparing the November and January indices for the monthly count localities with the corresponding indices for the International November and January counts (the latter cover most localities of importance in the country (Nilsson 1973, 1975a)). In general a good agreement was found between the two sets of indices (Table V).

Indices based on monthly counts in the special study areas in SW Scania were compared with midwinter indices for the entire province of Scania. For the winters of 1963/64–1971/72 (1972/73 and 1973/74 were not included here due to highly abnormal weather conditions) a close correlation was found between the two sets of indices for five important species (Table VI). No correlation was found for *Mergus serrator*, which is a difficult species to count, nor in the two species of swans. *Cygnus olor* has its peak in autumn, whereas *Cygnus cygnus* moves between inland and coastal waters according to weather conditions and is not adequately covered by the counts. In the other species that use the special study areas as a winter area the correlation with the midwinter indices was significant. Thus annual fluctuations of ducks in winter areas can be studied by full-cover annual midwinter surveys as well as by monthly counts in selected areas. It should be noted that these areas comprise the most important waterfowl areas in SW Scania and harbour an appreciable proportion of the total waterfowl population of the province in winter (Nilsson 1975b); this is of course the main cause of the high correlation coefficients found.

Comparing the national indices based on monthly counts and national midwinter indices, significant correlations were found for *Anas platyrhynchos* and *Cygnus olor* (Table VII). In the other species the indices were widely different. However, national indices based on monthly counts for *Aythya fuligula, Bucephala clangula*, and *Mergus merganser* were mainly based on counts in typical resting areas, whereas the midwinter indices were based on counts in wintering areas mostly not included in the monthly index calculations.

However, the population trends measured by the two sets of indices did not show any significant differences (comparison by t-test of the regression coefficients for annual indices) except for *Mergus merganser* (Table VII). In this species, midwinter indices indicate a significant increase, whereas the monthly count indices indicate an insignificant decrease (for further discussion of this species, see p. 204).

The series of November counts is too short to allow comparisons with monthly count indices. In most cases November indices gave a rather different picture (Table VII).

Annual fluctuations and population changes

The annual fluctuations of the different species will be discussed separately below. For most species, only counts from 1966/67 to 1974/75 can be used as too few data were available for the previous years. Moreover, except in *Anas platyrhynchos*, it was not possible to connect the first series with the series started in 1966/67 due to few common localities.

For *Aythya fuligula, Bucephala clangula,* and *Cygnus olor* separate indices have been calculated for the special study areas in SW Scania and the rest of the country. The numbers counted of these species in the special study areas were so high compared to the totals for all other localities together (cf. Nilsson 1975b) that indices including these areas would not be representative for the whole of South Sweden but would merely reflect changes in the populations of these study areas. The need for this separate treatment is apparent from the discussion of the indices of *Aythya fuligula* below. In all other species SW Scania was included. For separate indices for SW Scania, see Nilsson (1975b). Midwinter indices for 1967–1974 were discussed in detail by Nilsson (1975a). For comparison, midwinter indices for 1967–1975 and November indices for 1969–1973 are shown in Table VII. The annual indices based on monthly counts are shown in Fig. 3.

In *Anas platyrhynchos* the monthly count indices indicate fluctuations around a steady level in the numbers staying in the country during August/September to April. The highest index was calculated for 1961/62 and the lowest for 1970/71. The high indices for 1961/62 were partly due to exceptionally high numbers in November 1961 compared to November 1960 and 1962. In 1974/75 counts were high both during September–November and during midwinter, which resulted in the highest annual index after 1961/62. It may be noted that 1974/75 also yielded high indices for *Anas crecca* and *A. penelope*, the other two dabbling ducks studied.

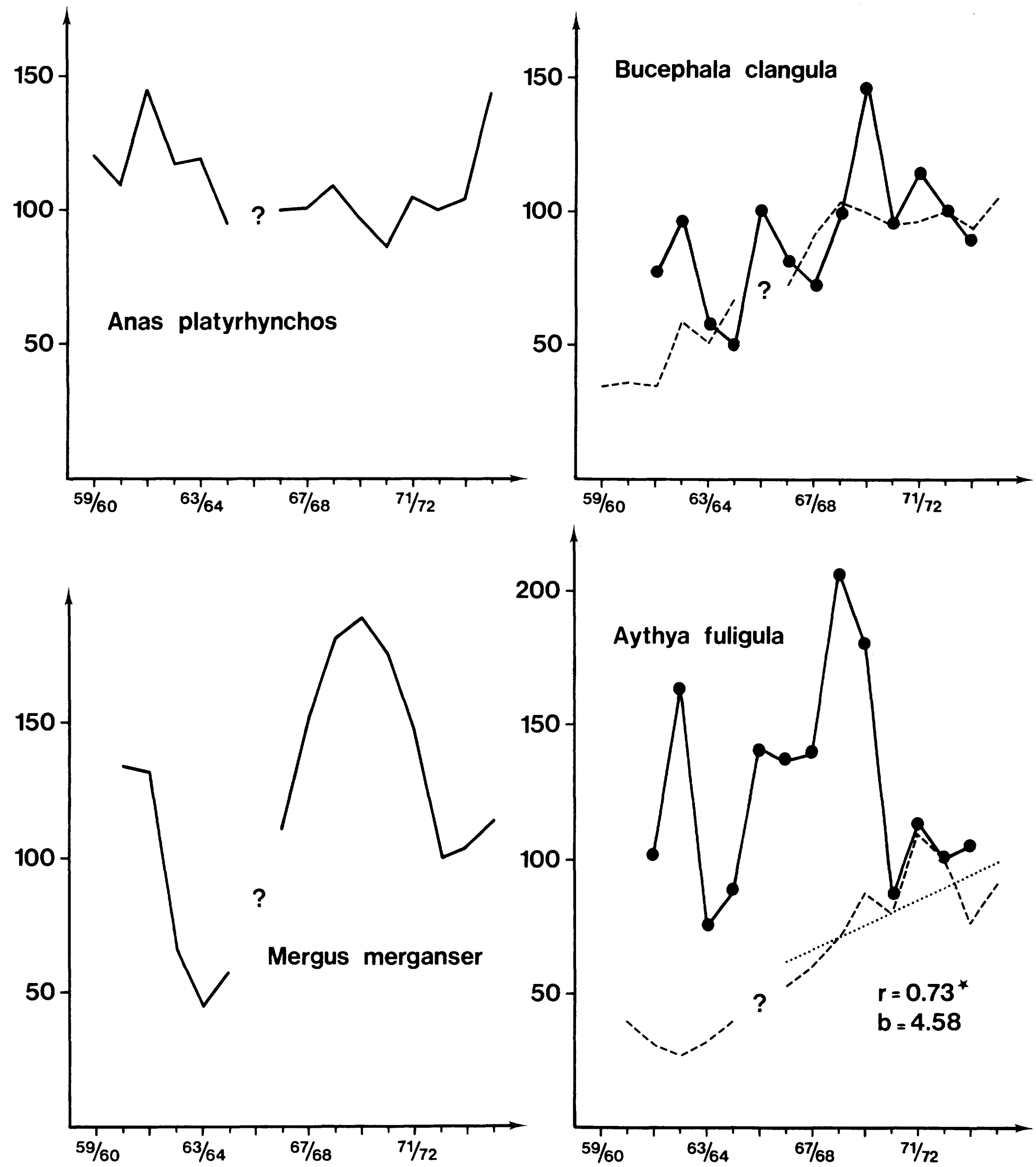
For *Anas crecca*, indices were only obtained for nine years, the indices showing a significantly increasing tendency over this period interupted by low indices during 1971/72. As almost all *A. crecca* were counted in the autumn, the indices reflect changes in the numbers resting in South Sweden at that time, the increase being due either to more *A. crecca* resting in South Sweden having shifted from other areas, or to an increase in breeding populations passing South Sweden on migration.

Indices for *Anas penelope* show two marked peaks in 1966/67 and 1973/74–1974/75, whereas the indices for the other years have been more or less constant. As in *A. crecca*, the majority were counted during the autumn migration.

For *Aythya fuligula*, indices were calculated separately for SW Scania and the other monthly count localities. The indices for the areas north of Scania indicate a significant increase although the indices were low in 1973/74. Indices for 1961/62–1964/65 only showed slight changes but their connection with the later series is uncertain. Indices for SW Scania showed marked fluctuations with high indices during the cold winters of 1962/63 and 1969/70 but also in 1968/69. The indices in the special study areas showed an insignificantly decreasing tendency, probably due to the mild winters in the latter part of the study period with more *Aythya fuligula* wintering further north and an earlier departure in spring for those wintering in Scania, this probably also being the main cause of the increase in areas north of Scania. The difference between the regression coefficients of annual indices for Scania ($b = -9.45$) and the localities north of Scania ($b = 5.39$) was significant ($t = 2.43$, $P < 0.05$). Midwinter indices fluctuated in relation to the severity of the winter (Nilsson 1975a, Table VII); a reduction in wintering populations followed by a recovery was noted after the 1969/70 winter. The increasing trend in the monthly indices was also seen in the midwinter indices, but it was not significant

Table VII. Annual indices for some species of Anatidae in South Sweden 1966/67–1974/75 according to monthly counts on selected waters (September–April) and the international waterfowl counts in November (1969–1973) and January. b and r=regression and correlation coefficients for the indices versus year. *, ** denote significance for P<0.05 and P<0.01, respectively. SW Scania not included for *Aythya fuligula* and *Bucephala clangula* (see text)

Species	Type of index	66/67	67/68	68/69	69/70	70/71	71/72	72/73	73/74	74/75	b	r	t for diff. betw. b of Jan. and Monthly	r between Jan. and Monthly
Anas platyrhynchos	Monthly	100	101	109	97	87	106	100	105	144	2.98	0.52	0.03	0.83**
	Jan.	100	83	100	82	84	113	100	99	126	3.05	0.57		
	Nov.	–	–	–	92	114	122	100	137	–				
Anas crecca	Monthly	72	80	82	88	112	71	100	109	160	7.60	0.75*		
	Nov.	–	–	–	138	101	121	100	99	–				
Anas penelope	Monthly	102	165	100	102	112	106	100	159	265	10.60	0.05		
	Nov.	–	–	–	279	51	82	100	39	–				
Aythya fuligula	Monthly	53	60	71	87	80	104	100	76	94	4.78	0.75*	0.76	0.19
	Jan.	70	84	86	82	63	65	100	99	101	3.00	0.55		
	Nov.	–	–	–	115	99	82	100	114	–				
Aythya ferina	Monthly	71	91	63	84	79	106	100	92	89	2.85	0.58	0.66	0.10
	Jan.	47	21	57	30	28	18	100	117	45	5.90	0.46		
	Nov.	–	–	–	80	97	62	100	92	–				
Bucephala clangula	Monthly	72	92	104	100	95	96	100	89	110	2.18	0.56	0.90	0.31
	Jan.	59	38	75	81	64	72	100	92	72	4.25	0.64		
	Nov.	–	–	–	116	124	116	100	122	–				
Mergus merganser	Monthly	111	152	181	189	175	147	100	104	113	−5.67	−0.44	2.83*	−0.40
	Jan.	36	44	63	78	53	52	100	92	106	7.86	0.84		
	Nov.	–	–	–	33	49	103	100	80	–				
Tadorna tadorna	Monthly	82	112	63	61	51	43	100	80	76	−1.07	−0.13		
Cygnus olor	Monthly	75	86	96	97	61	88	100	122	126	5.18	0.69*	0.99	0.83**
	Jan.	73	71	74	70	73	77	100	138	129	8.07	0.83**		
	Nov.	–	–	–	100	82	95	100	133	–				
Cygnus cygnus	Monthly	130	143	194	189	125	192	100	106	126	−5.20	−0.38	0.16	0.09
	Jan.	152	153	183	89	112	96	100	97	172	−4.11	−0.30		
	Nov.	–	–	–	236	209	154	100	201	–				



there. November indices also showed some decrease after 1969/70 but it was not so marked as in the midwinter indices.

Monthly count indices for *Aythya ferina* indicate fluctuations of autumn and winter populations as do November and January indices; the fluctuations were not parallel in the different sets of indices. However, the numbers counted were rather small.

In *Bucephala clangula* monthly count indices increased from 1966/67 to 1968/69; they then remained fairly steady. The same picture was found in the November indices (Table VII). As almost all *Bucephala clangula* included in

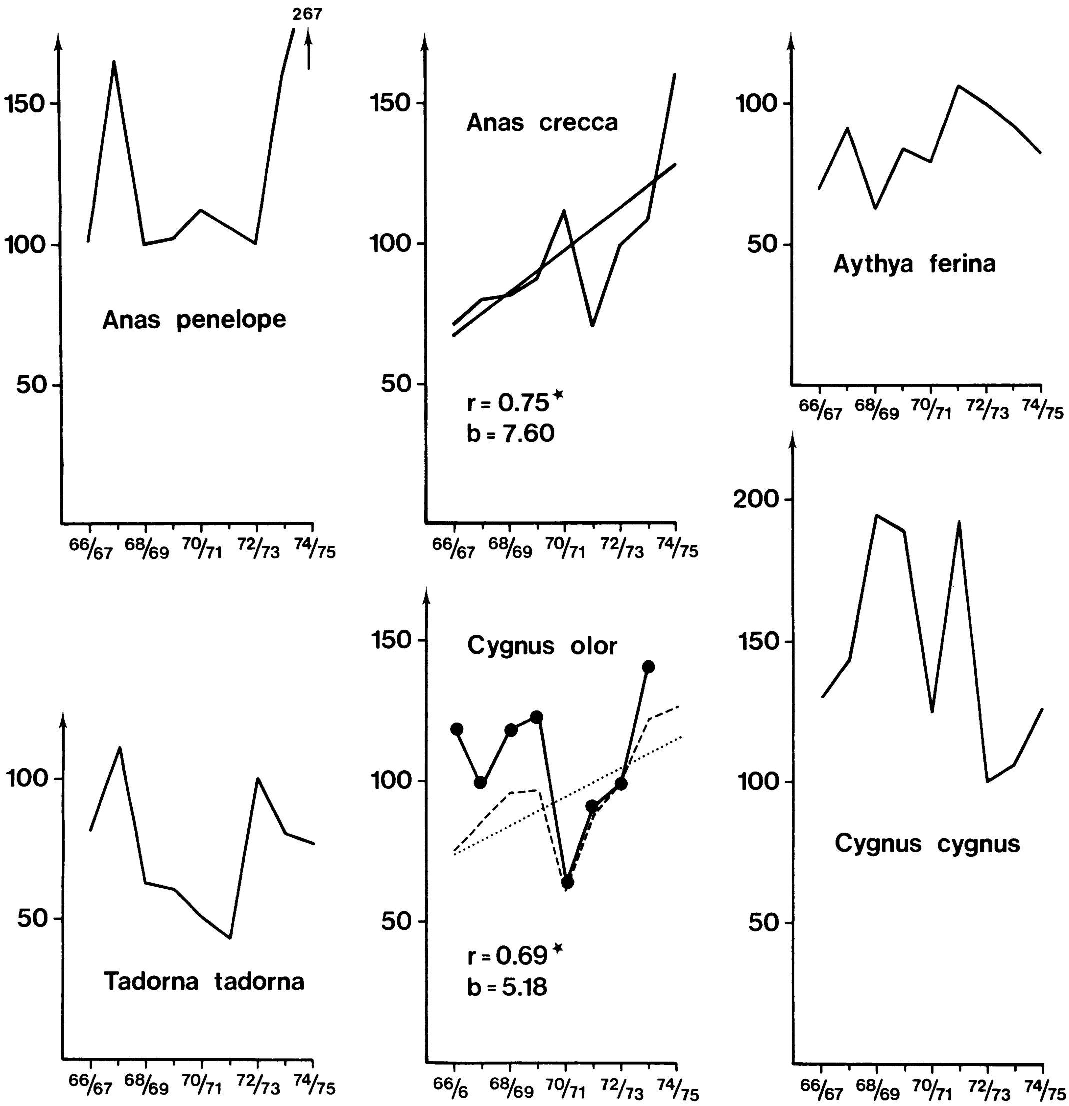


Fig. 3. (Previous page and above) Annual indices for different species of Anatidae in South Sweden based on monthly waterfowl counts on selected waters (Fig. 1) during September to April. ———— indices based on all localities, — — — — indices based on all localities except SW Scania, ●——● indices for SW Scania for those species where separate indices were calculated. For species showing significant trends, correlation and regression coefficients (and lines) are shown in the graphs. *=significant for P<0.05.

the index calculations were counted on inland waters in South Sweden (SW Scania being excluded) the indices probably reflect the situation in the Swedish breeding population, the majority of the counts being obtained in autumn and spring. Indices for 1961/62–1964/65 show some increase, but their level in relation to the later series is uncertain. Indices for the special study areas in Scania showed marked fluctuations with peaks in cold winters (Fig. 3, Nilsson 1975b). The general tendencies of the two sets of monthly counts were similar; the regression coefficients for annual indices were 2.63 and 1.55 for the special study areas and the other monthly counts, respectively. The difference was not significant (t = 0.27). Swedish midwinter indices showed a significant increase during the period 1967–1974 (Nilsson 1975a) probably being caused by a shift in winter distribution in relation to mild winters (Nilsson unpubl.). The regression coefficients for the monthly count indices and midwinter indices were, however, not significantly different.

In *Mergus merganser* the indices from the monthly counts and the midwinter counts give highly different pictures (Fig. 3, Table VII). Midwinter indices for 1967–1975 showed a significant increase even though the winter population was probably reduced during the cold winter of 1969/70 (Nilsson 1975a). Monthly count indices showed the same increase during 1966/67–1969/70 that might have been a recovery after a reduction during the hard winter of 1965/66. The difference between the two sets of indices is probably due to the exceptionally mild winters causing many *Mergus merganser* to stay further north on open waters not covered in the monthly count sample. Moreover, spring migration was much earlier in these years. In the midwinter counts, on the other hand, most localities of importance for the species were covered, and the indices are thus more reliable even during mild winters. In the first series of monthly counts a marked reduction in indices was noted from 1960/61 to 1962/63, low indices lasting to 1964/65. The low indices for 1962/63 were certainly due to emigration during the cold winter and low indices thereafter to heavy mortality during the cold winter.

Indices for *Tadorna tadorna* showed marked peaks in 1967/68 and 1972/73.

In *Cygnus olor*, indices for the special study areas in SW Scania and the rest of the country show the same pattern, i.e. a reduction of the populations using South Sweden as a resting and wintering area (i.e. probably to a large extent Swedish breeding populations) after the hard winter of 1969/70 followed by a recovery. The same pattern was found in the November indices (Table VII), whereas the January indices did not show any reduction after the 1969/70 winter (Nilsson 1975a). The mild winter which followed caused a larger proportion of *Cygnus olor* than normal to remain in the country, thus masking the effect of a reduction during the cold winter. The overall trends for both the monthly count indices and the midwinter indices show a significant increase.

The indices for *Cygnus cygnus* show marked fluctuations without any clear tendency. In the midwinter indices there seemed to be a decrease from 1967–1969 to 1970–1974, but indices for 1975 were back on the same level as before the decrease (Table VII), which was probably only apparent due to different distributions of wintering populations.

Conclusions

Sweden is situated on the northernmost fringe of the winter distribution of many anatid species (Atkinson-Willes 1969, 1972, 1974, 1975, Nilsson 1975a). The winter populations of ducks and swans therefore show marked fluctuations in relation to the severity of the winter (Nilsson 1970, 1975a, 1975b).

Accordingly, indices based on waterfowl counts during the non-breeding season will show marked fluctuations due to, among other factors, influence by weather conditions. This applies both to the monthly counts on selected waters considered here and to the country-wide surveys in the international November and January counts. Thus true annual changes in the populations studied will be difficult to detect even if long-term changes are revealed. Indices based on monthly counts as those discussed here will measure both the level, and the period of stay for wintering populations studied. A change in the indices between two years might thus be due either to true changes in the population levels or to changes in distribution and/or changes in the period of stay of the population in the regions studied.

Midwinter indices will also be affected by changes in winter distribution due to the effect of weather and ice conditions. As the counts are run on an international scale, changes in the distribution will be detected. Considering the national midwinter indices for Sweden, the situation is simpler than for the monthly count indices as Sweden is at the northernmost limit of the winter distribution of the various species. Thus, taking the country as a whole, changes due to different weather conditions will be fairly simple. Cold weather and ice will result in emigration and low indices, but in areas further to the south the index can either decrease due to emigration of local populations or increase due to accumulations of birds coming from areas further to the north. Finally, as no significant differences were found between trends measured by monthly counts and midwinter counts, one midwinter count each year is considered to be fully adequate to measure long-term changes in resting and wintering populations of waterfowl that use Sweden as a winter area. The possibilities of supplementing the midwinter counts with autumn counts to follow changes in populations that leave the country during the winter or that become mixed with other populations at that time, will be examined in another context.

The marked fluctuations in the indices found in the present material were to be expected. But even so, some trends were detected. Indices for *Cygnus olor* indicated a decrease during the hard winter of 1969/70 followed by an increase. This was also found in the midwinter indices for *Aythya fuligula* and *Mergus merganser*. Moreover, increasing trends were noted for the autumn and winter populations of *Anas crecca, Aythya fuligula*, and *Cygnus olor*. The increasing trend for *Mergus merganser* found in the midwinter indices had no parallel in the monthly count sample, whereas *Cygnus olor* showed increases in both samples.

In conclusion, no waterfowl species studied show any significant decreasing trends. Some increases were noted, whereas most autumn and winter populations seem to fluctuate around a quite steady level. It is at present uncertain whether the changes found reflect changes in the breeding populations using South Sweden as a resting and wintering area or if they reflect changes in autumn and winter distribution, or a combination of both. More data on these questions will be available when the International Midwinter Counts have been fully analyzed.

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