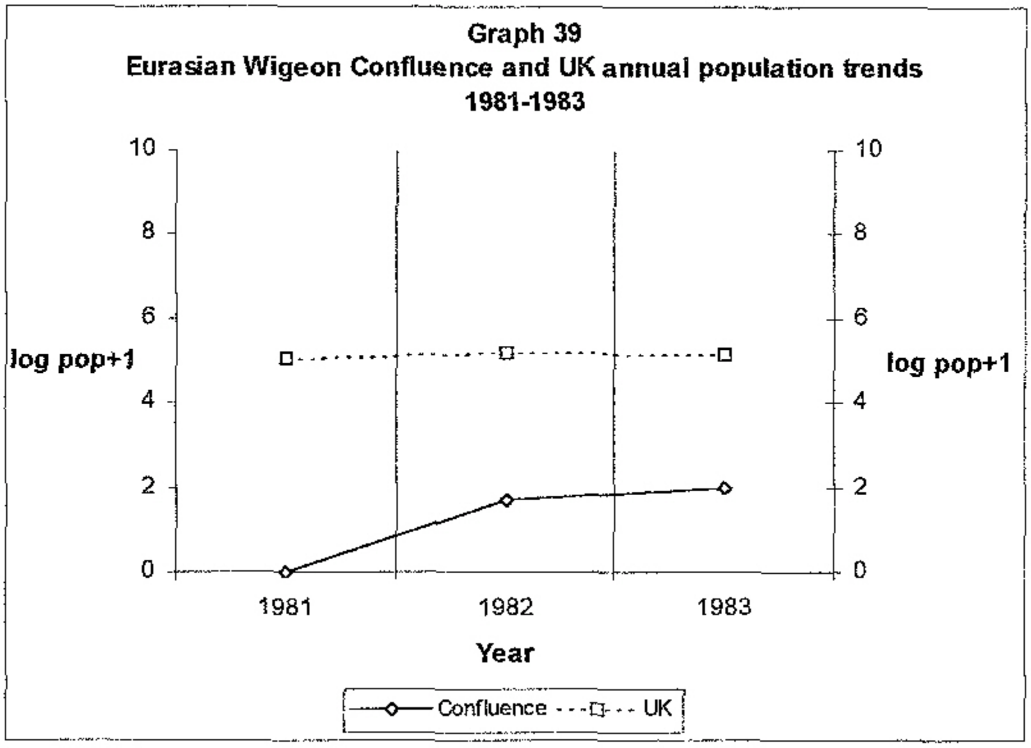
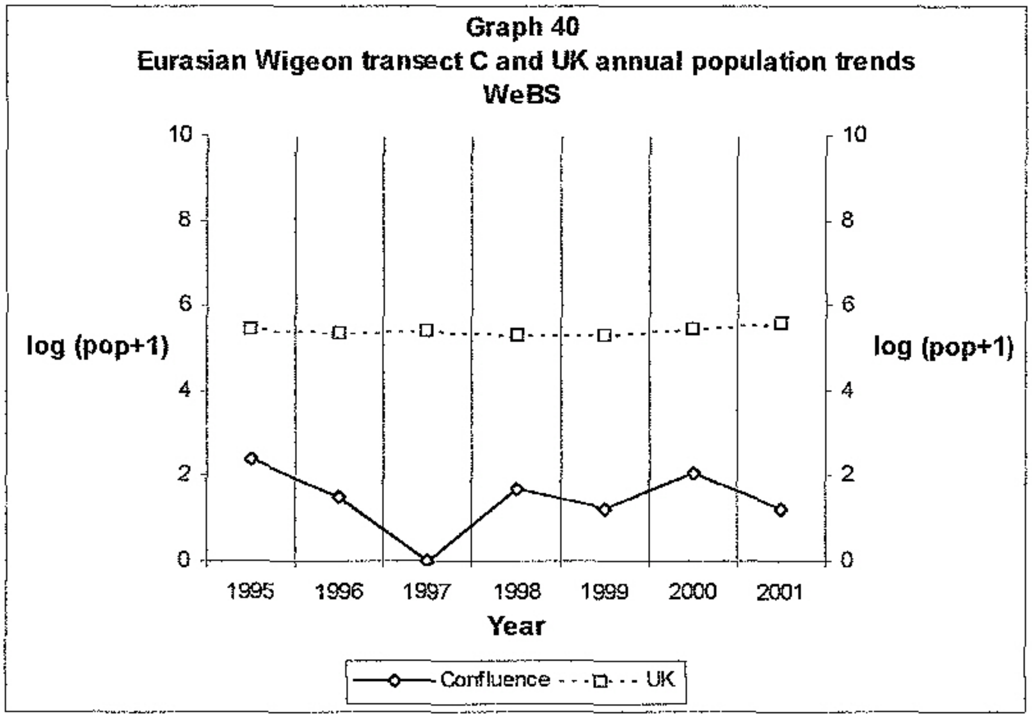
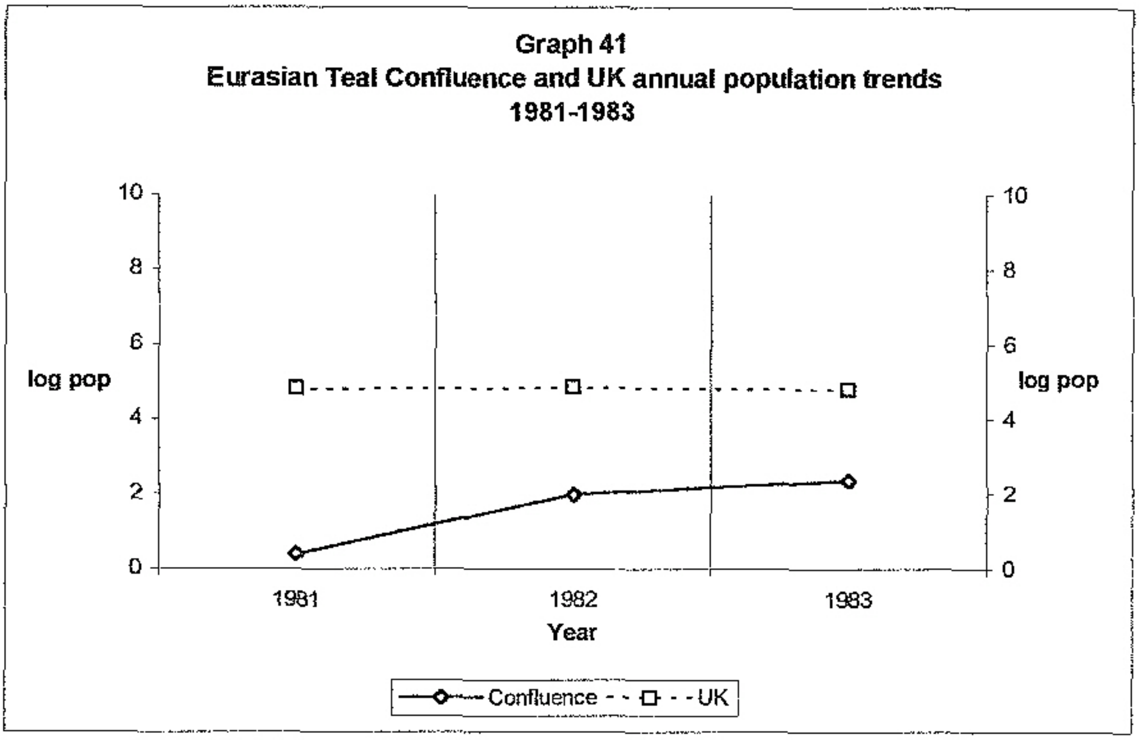
increased by 0.31 and 0.41 respectively. There were major differences during and between surveys.

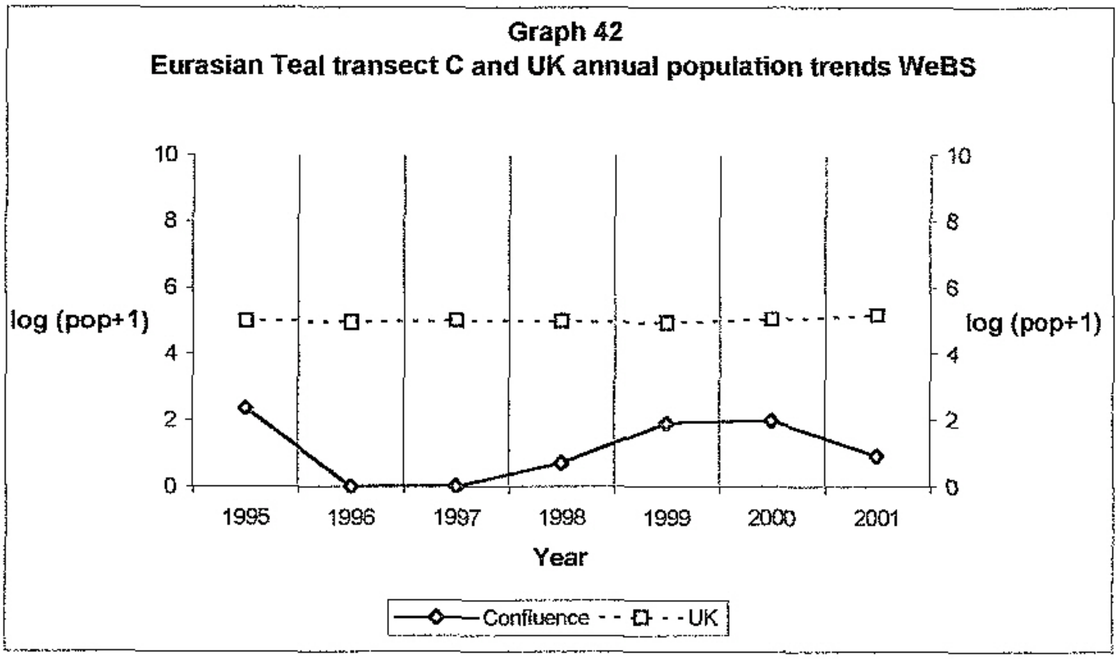




Eurasian Teal *Anas crecca*

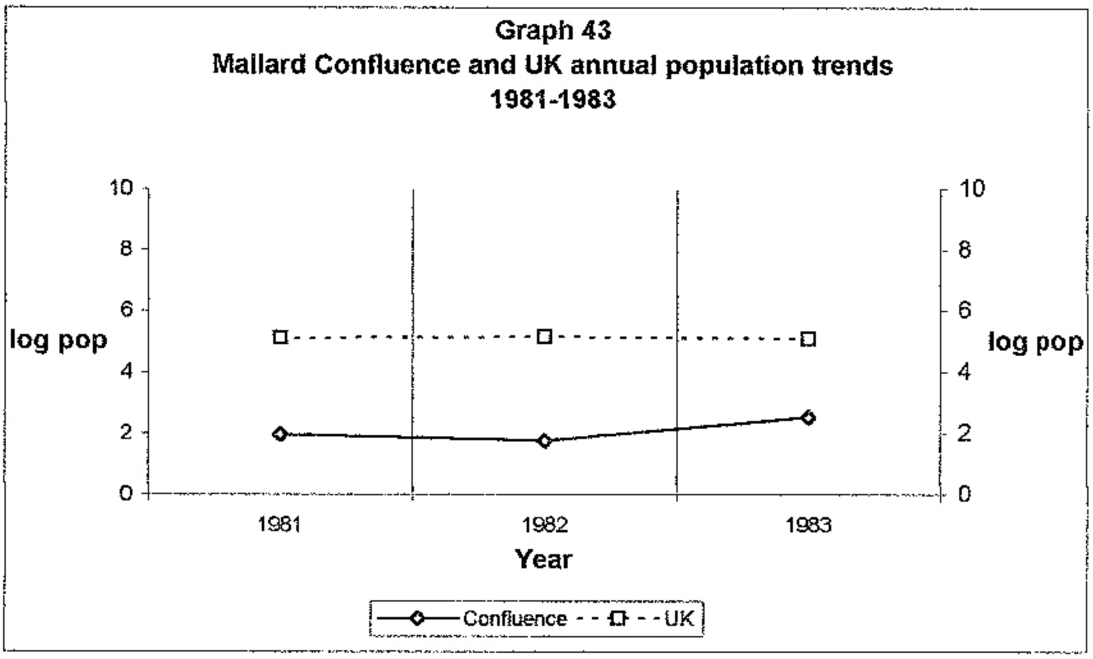
1981-1983 UK and Confluence populations decreased 0.02 and increased 1.95 respectively, shown on graph 41. WeBS UK and transect C populations rose 0.19 and diminished by 1.42, shown in graph 42. Both local populations movements were large in relation to UK's populations. The inter-survey populations increased 0.17 and diminished 0.0058 respectively.

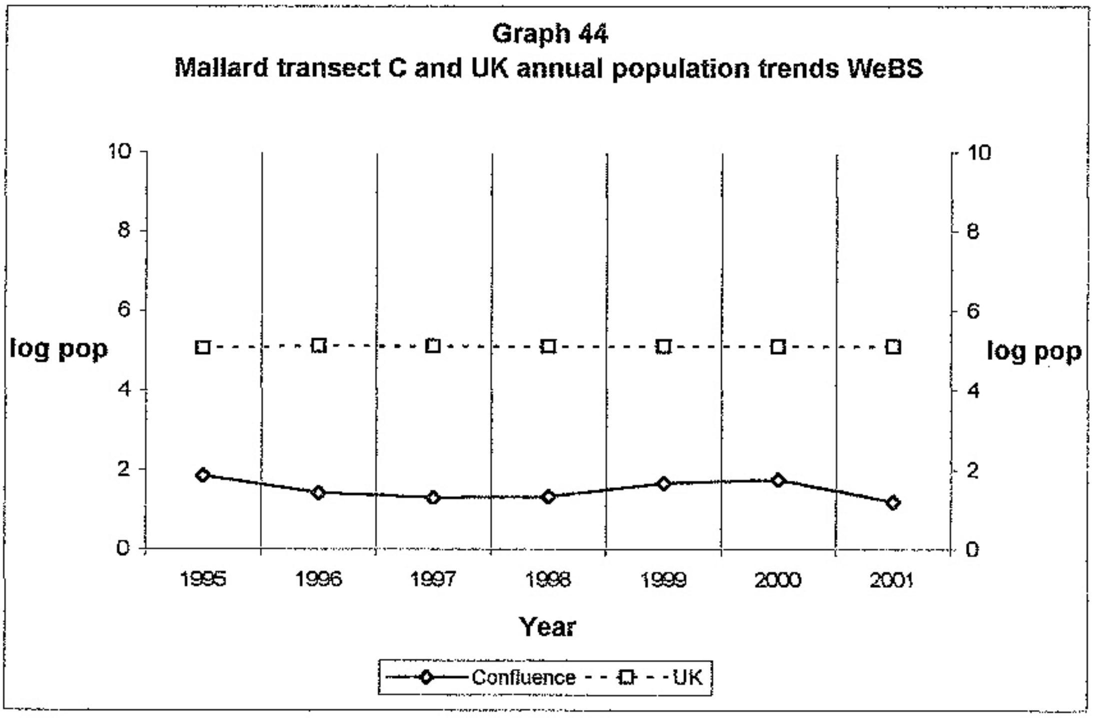




Mallard *Anas platyrhynchos*

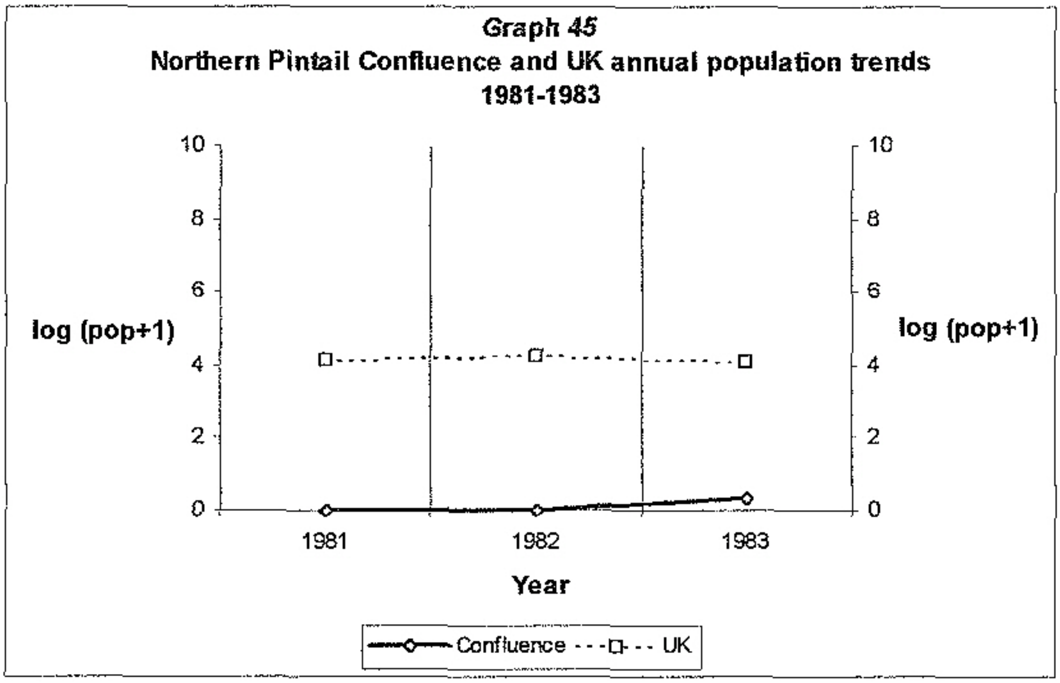
Mallard are shot over the Loton Loop basin (Leighton pers. com.2000). 1981-1983 UK and Confluence populations declined 0.02 and increased 0.56 respectively, shown in graph 43. WeBS UK and transect C populations increased 0.04 and diminished 0.66 respectively, shown in graph 44. Inter-survey populations decreased 0.04 and 0.66 respectively.

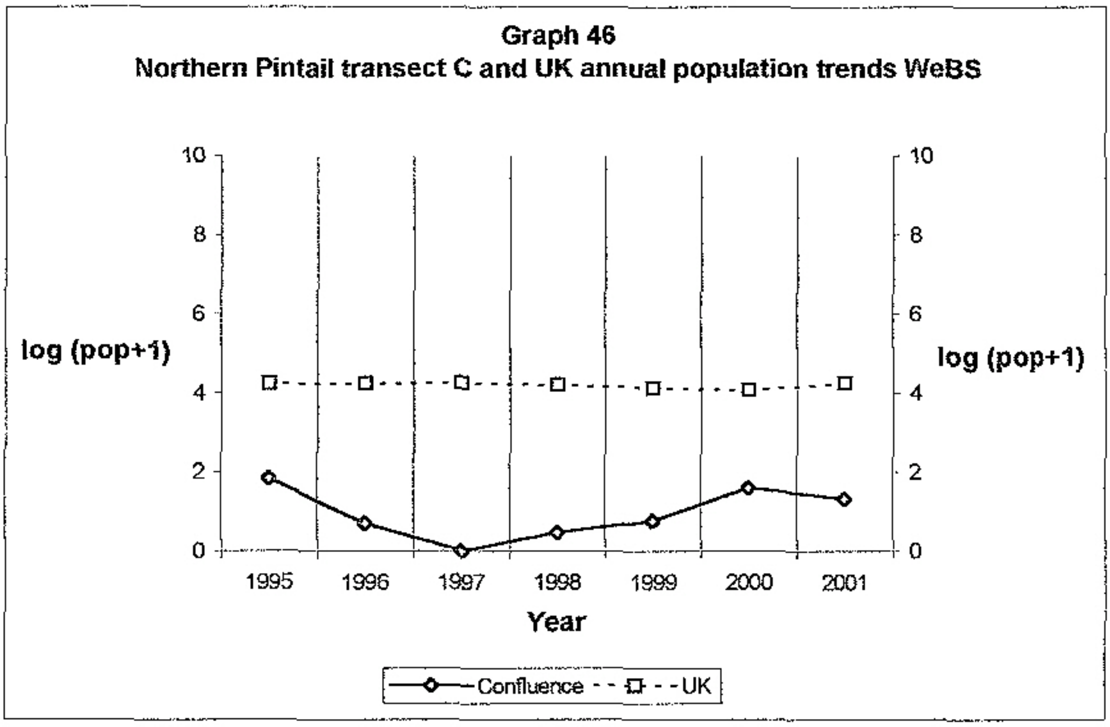




Northern Pintail *Anas acuta*

1981-1983 UK and Confluence populations declined 0.05 and increased 0.30 respectively, shown in graph 45. WeBS UK and transect C populations increased 0.02 and diminished 0.51 respectively, shown in graph 46. Inter-survey populations increased 0.11 and 1.53 respectively.

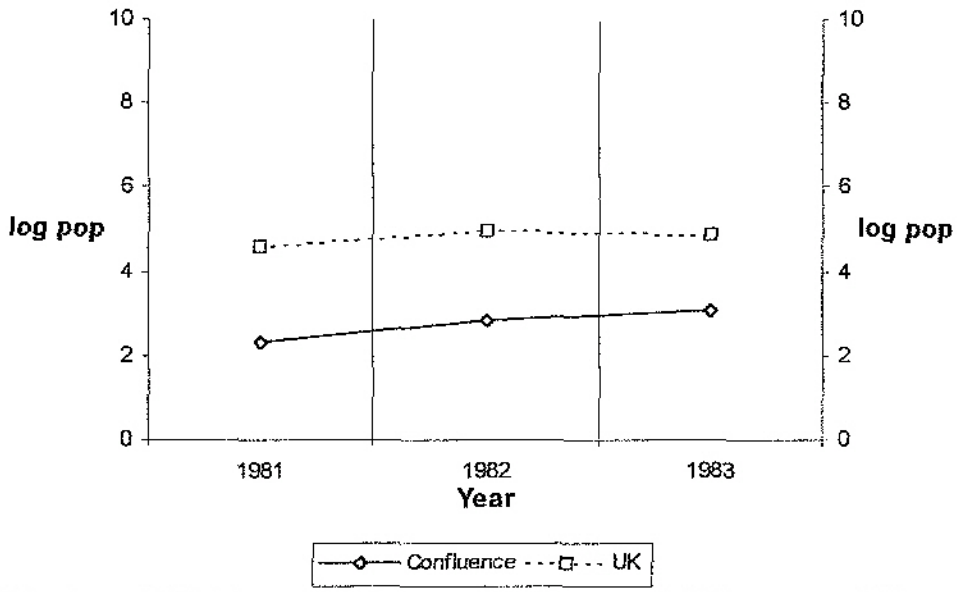




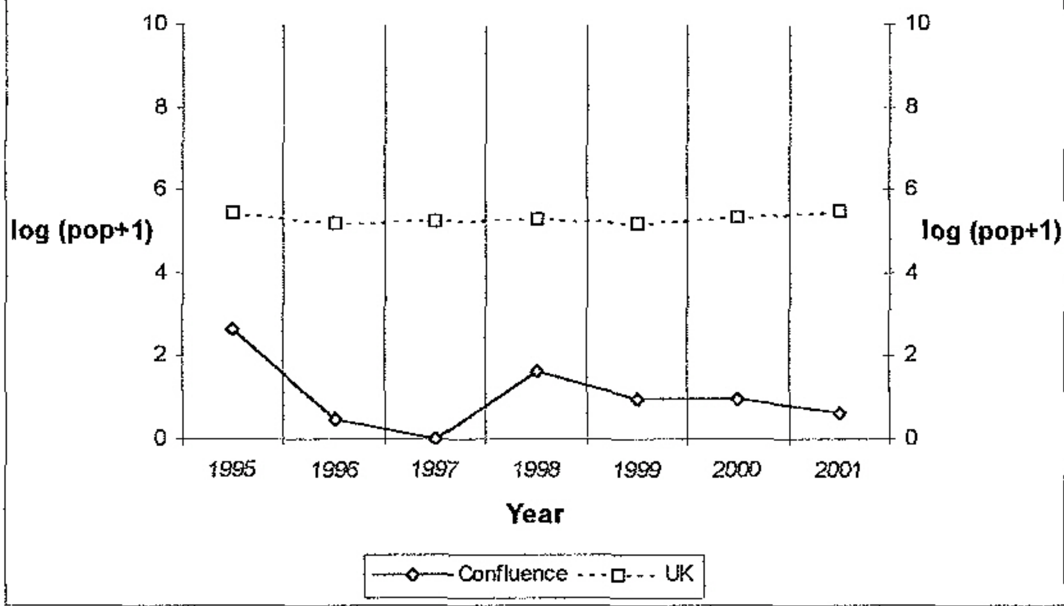
Northern Lapwing ***Vanellus vanellus***

1981-1983 UK and Confluence populations had large increases, namely 0.28 and 0.79 respectively, shown in graph 47. WeBS UK and transect C populations had sizeable movements, rose 0.04 and decreased 2.05 respectively, shown in graph 48. Inter-survey populations changes were considerable and opposite, increased 0.55 and declined 0.43 respectively.

Graph 47
Northern Lapwing Confluence and UK annual population trends 1981-1983

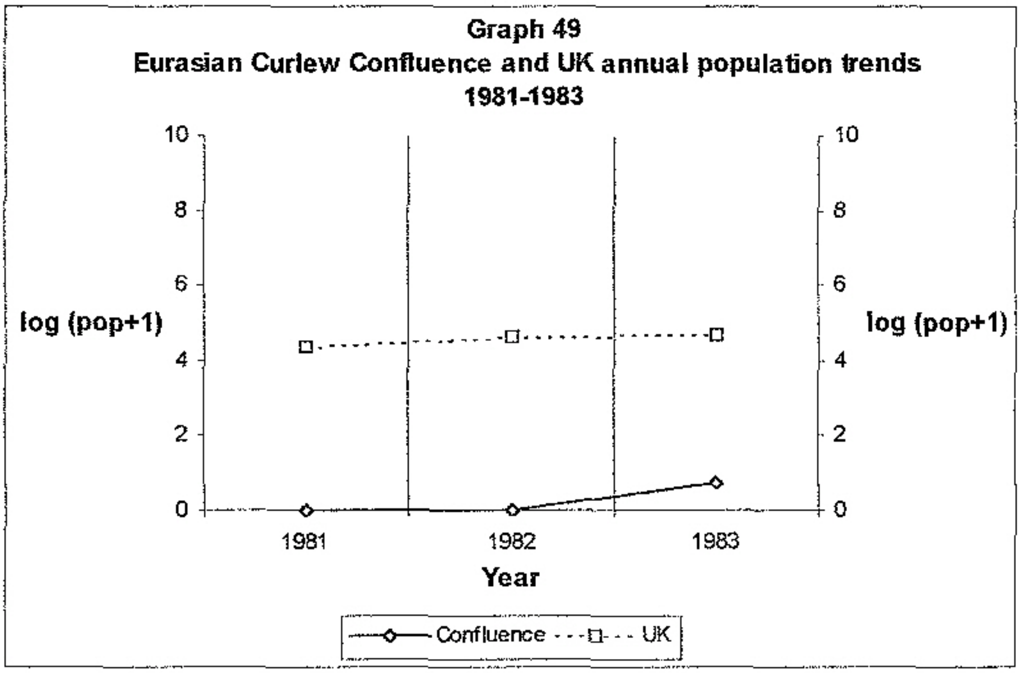


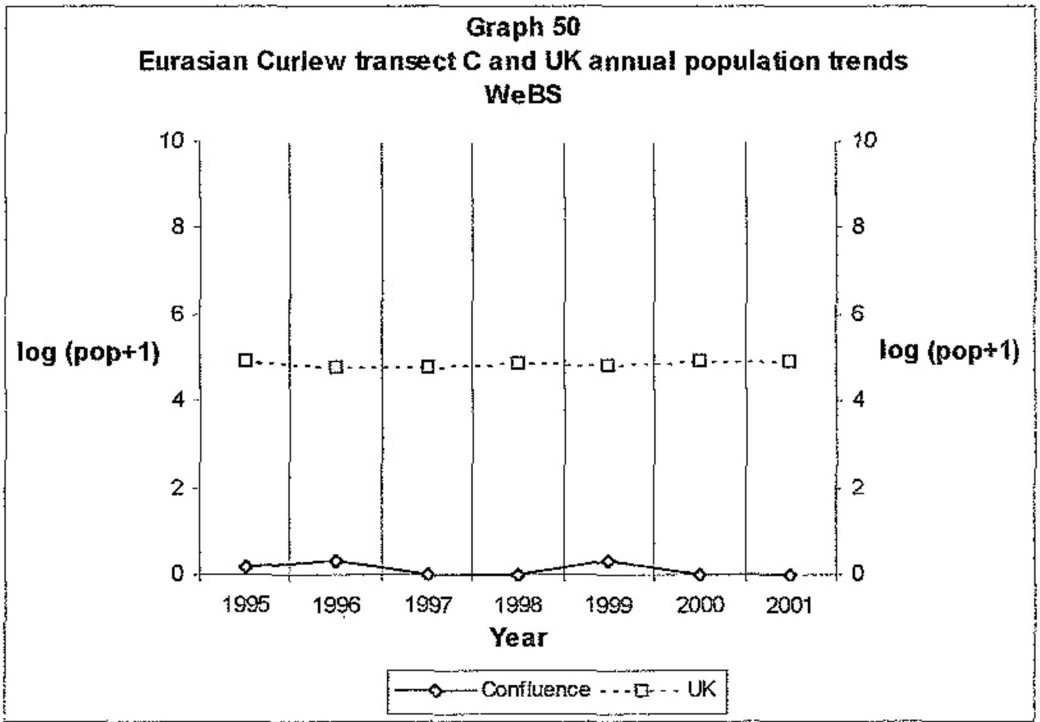
Graph 48
Northern Lapwing transect C and UK annual population trends WeBS



Eurasian Curlew *Numenius arquata*

1981-1983 UK and Confluence populations increased 0.32 and 0.65 respectively, shown in graph 49. WeBS UK and transect C populations declined 0.01 and 0.18 respectively, shown in graph 50. Inter-survey populations increased 0.24 and diminished 0.56 respectively.





Summary

Cycles were difficult to detect due to brief time scales of surveys. Table 23 summarizes trends statistical properties, namely: (i) modality, indicated populations of all species were more dynamic during WeBS and (ii) skewness, six negative and seven positive species illustrated greater and lesser populations at the termination of 1981-1983 survey and WeBS respectively.

Table 23

Statistical properties of species Confluence and transect C annual populations 1981-1983 and WeBS

	1981-1983		WeBS	
Species	Modality	Skewness	Modality	Skewness
Mute Swan	unimodal	symmetrical	multi-modal	negative
Whooper swan	stationary	symmetrical	bimodal	positive
Eurasian Wigeon	unimodal	negative	multi-modal	positive
Eurasian Teal	unimodal	negative	bimodal	positive
Mallard	unimodal	negative	bimodal	positive
Northern Pintail	unimodal	negative	bimodal	positive
Northern Lapwing	unimodal	negative	bimodal	positive
Eurasian Curlew	unimodal	negative	bimodal	positive

Table 24 summarizes population trends, namely: (i) three species inter-survey populations increased and (ii) overall, four species populations of two guilds increased.

Table 24

Summary of analysis of species annual population trends 1981-1983 and WeBS

Species	Log (base 10) fold change of poulation change		1983-WeBS inter-survey population trend range	1981-WeBS overall population trend range
	1981-1983 survey	WeBS		
Mute Swan	1.14 (0)	0.08 (+1.2)	0.49 (-3.09)	0.60 (-3.1)
Whooper Swan	0 (0)	0.1 (-1.29)	0.87 (+6.5)	0.78 (+5)
Eurasian Wigeon	1.96 (+ 92)	1.15 (-15)	0.41 (+2.5)	1.23 (+16)
Common Teal	1.95 (+91)	1.42 (-29.7)	0.0058 (-0.98)	0.48 (+3)
Mallard	0.56 (+3.6)	0.66 (-4.54)	0.66 (-4.6)	0.76 (-5.7)
Northern Pintail	0.3 (+2)	0.51 (-3.3)	1.53 (+33.75)	1.32 (+20)
Northern Lapwing	0.79 (+6.22)	2.05 (-151)	0.44 (-2.75)	1.82 (-66.7)
Eurasian Curlew	0.65 (+4.5)	0.18 (-0.5)	0.56 (-9)	0.00 (0)

log (base 10) transformed by antilog procedures
fold change: = (+ increase); (- decrease)
Logarithmic differences represent: 0.3 a doubling or halving,
0.7 a 5-fold change and 1.0 a 10-fold change

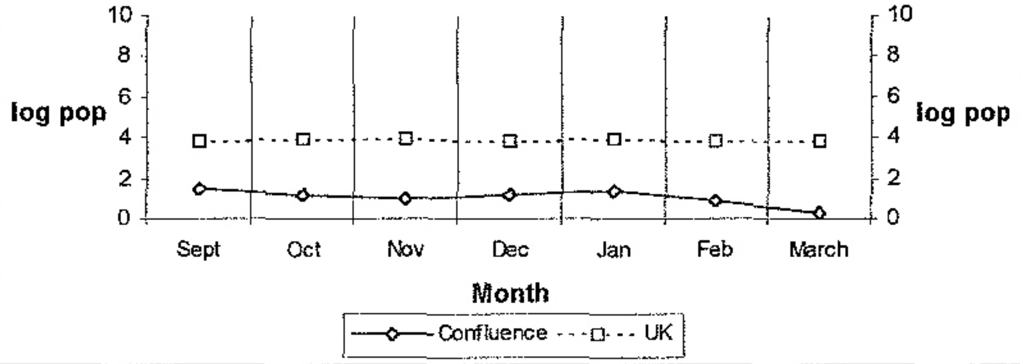
Chapter 8
Time series analysis of species seasonal population trends

Detection of local and UK seasonal population cycles and trends is required for the same reasons as annual populations; consequently the analytical methods and results are in similar formats. 1981-1983 season is September-March, which for WeBS is extended to April. Northern lapwing and Eurasian curlew UK 1981-1983 populations are based on available data, December-February only. Populations are expressed as logarithms to base 10.

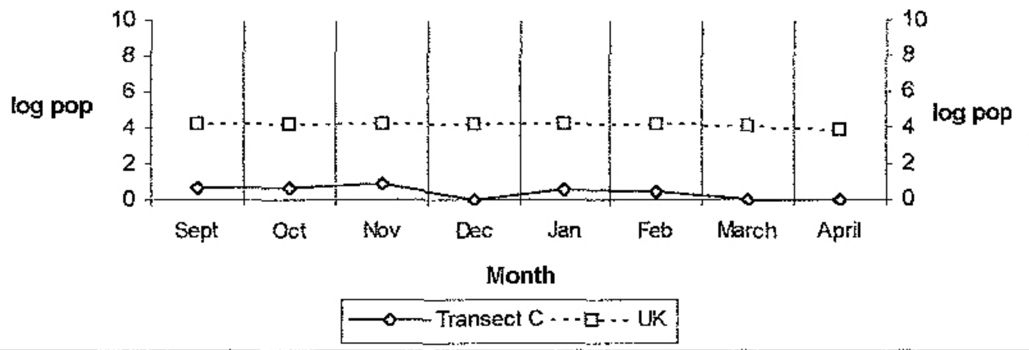
Mute Swan *Cygnus olor*

1981-1983 Confluence population peaked at 1.46 in September and declined 1.16 to March, shown in graph 51; the UK population increased by 0.06 to peak in November and subsequently diminished 0.11. WeBS transect C population rose 0.15 to a November peak, then diminished 0.84, shown in graph 52; the UK population increased 0.02 to an October peak, then declined 0.35.

Graph 51
Mute Swan Confluence and UK seasonal population trends 1981-1983

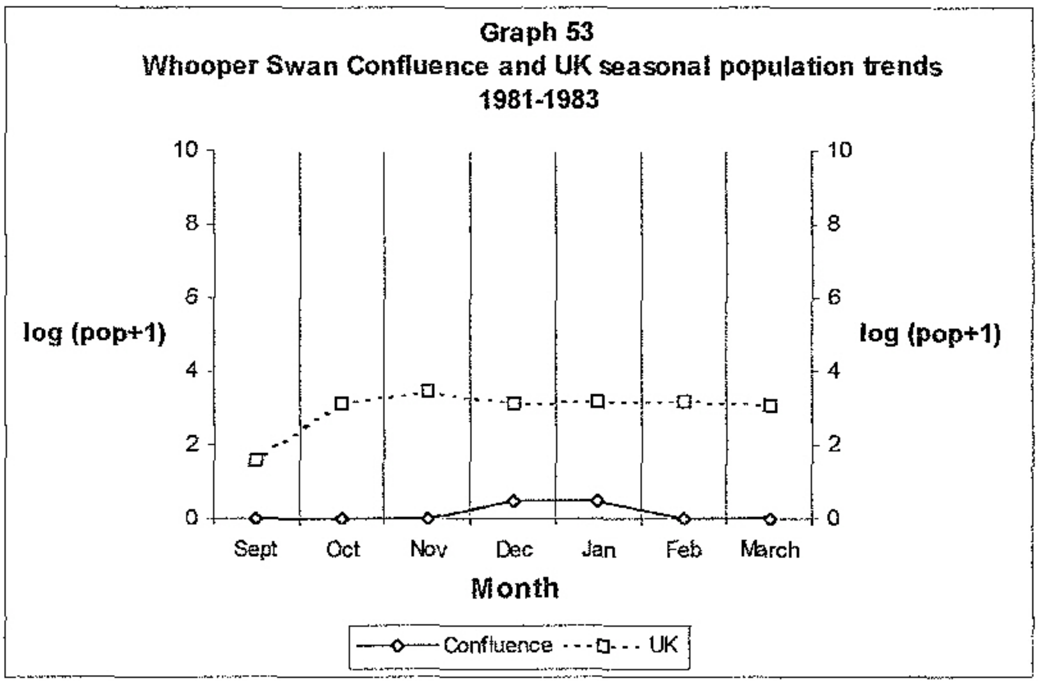


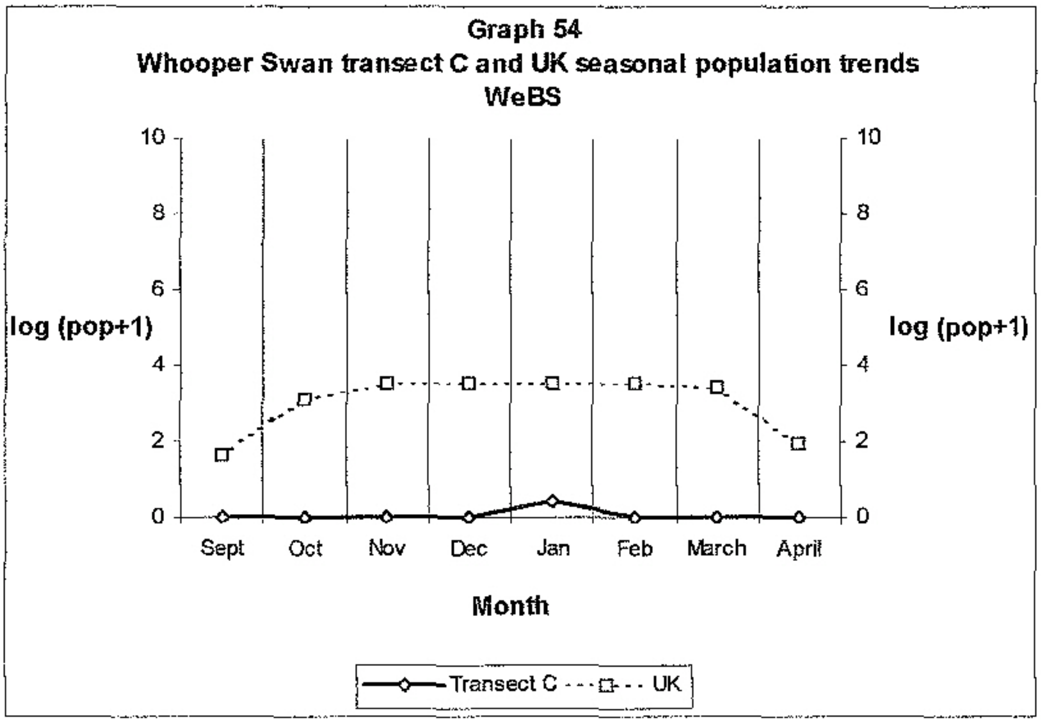
Graph 52
Mute Swan transect C and UK seasonal population trends WeBS



Whooper Swan *Cygnus cygnus*

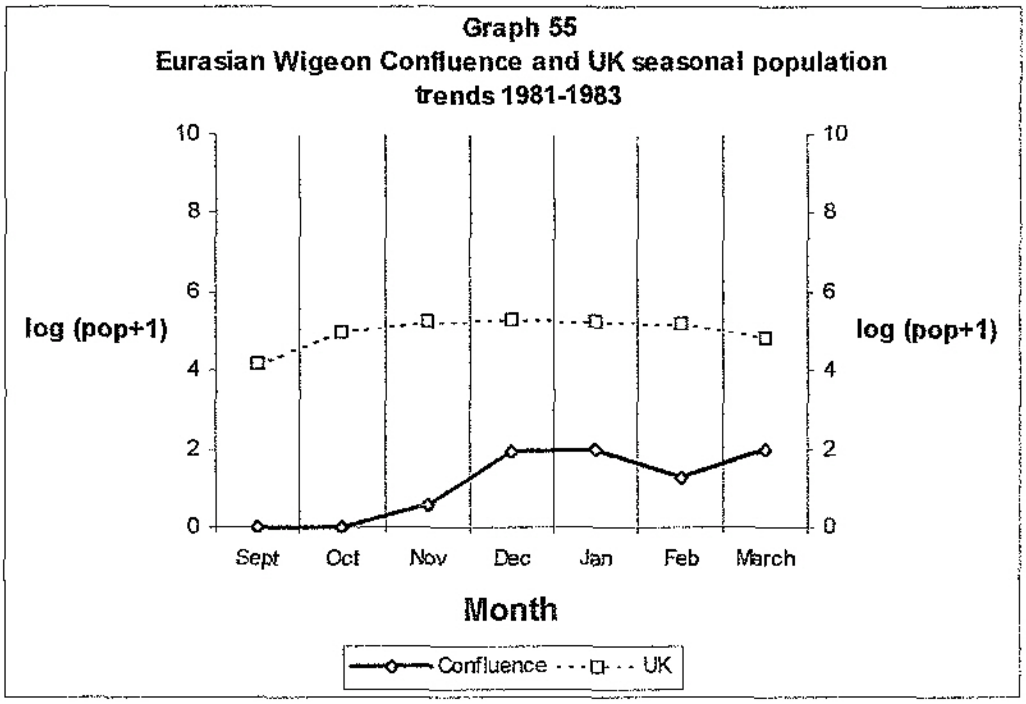
1981-1983 Confluence population rose 0.47 to peak during December-January and subsequently declined to 0.0 whereas the UK population increased 1.88 to a November maximum, then declined 0.37, shown in graph 53. WeBS transect C population increased from 0 to 0.39, a January peak, subsequently decreased to 0.0, shown in graph 54; contrastingly, the UK population rose 1.91 to a February maximum and then declined 1.58.

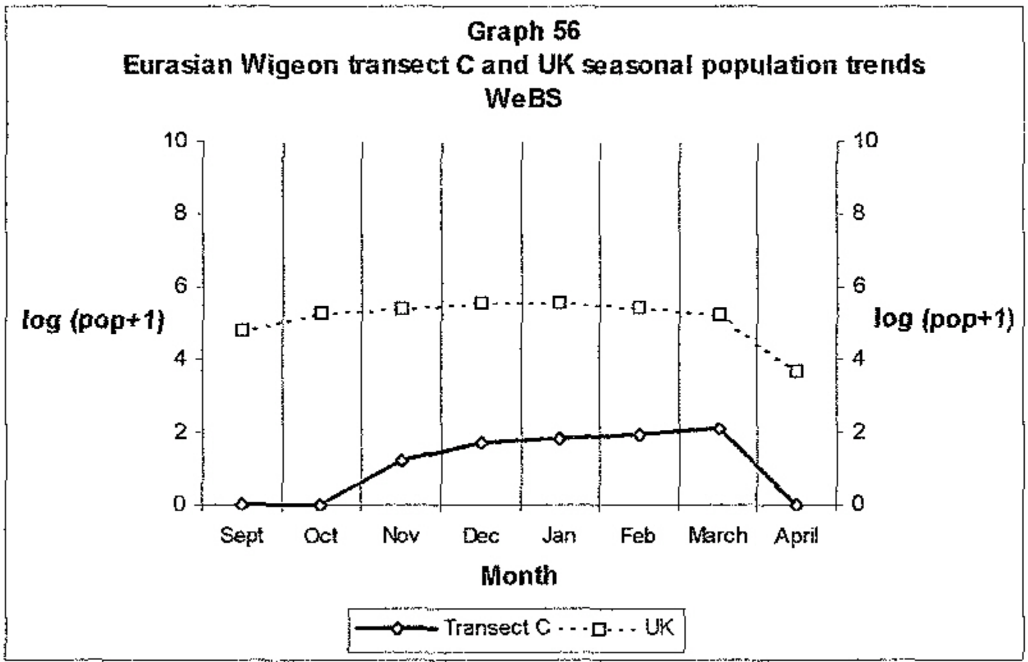




Eurasian Wigeon ***Anas penelope***

1981-1983 Confluence population increased 1.98 to a March maximum while the UK population rose 1.15 to a December peak and then declined 0.46 to March, shown in graph 55. WeBS transect C population increased 2.07 to March, subsequently decreased 0.0 in April and that of the UK 0.80 to a January maximum, then diminished 1.86 to April, shown in graph 56. Confluence and transect C first arrivals were in November compared to September for the UK.

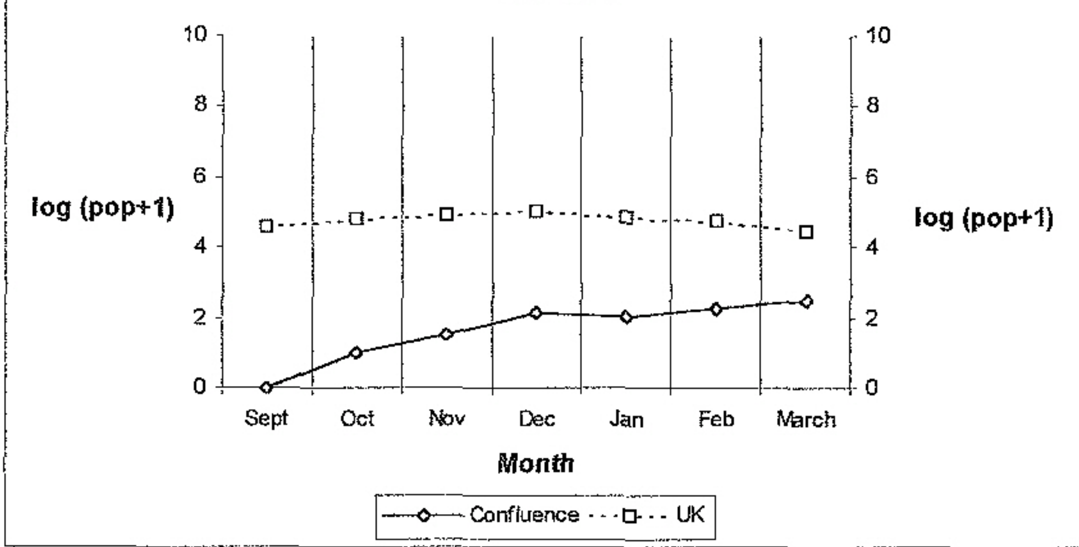




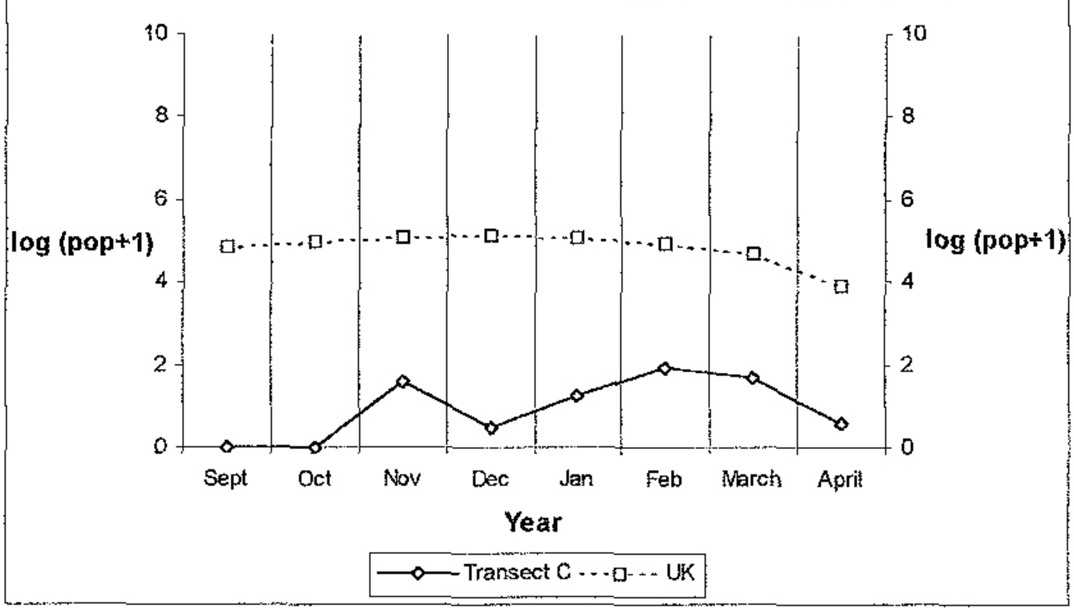
Eurasian Teal ***Anas crecca***

1981-1983 Confluence population increased 2.46 to March while the UK population rose 0.408 to December, subsequently decreased 0.54, shown in graph 57. WeBS transect C population increased 1.92 to February, then declined 1.32 to April whereas the UK population rose 0.28 to December, then declined 1.22 to April, shown in graph 58. Both graphs showed different transect population patterns compared to the UK's.

Graph 57
Eurasian Teal Confluence and UK seasonal population trends 1981-1983

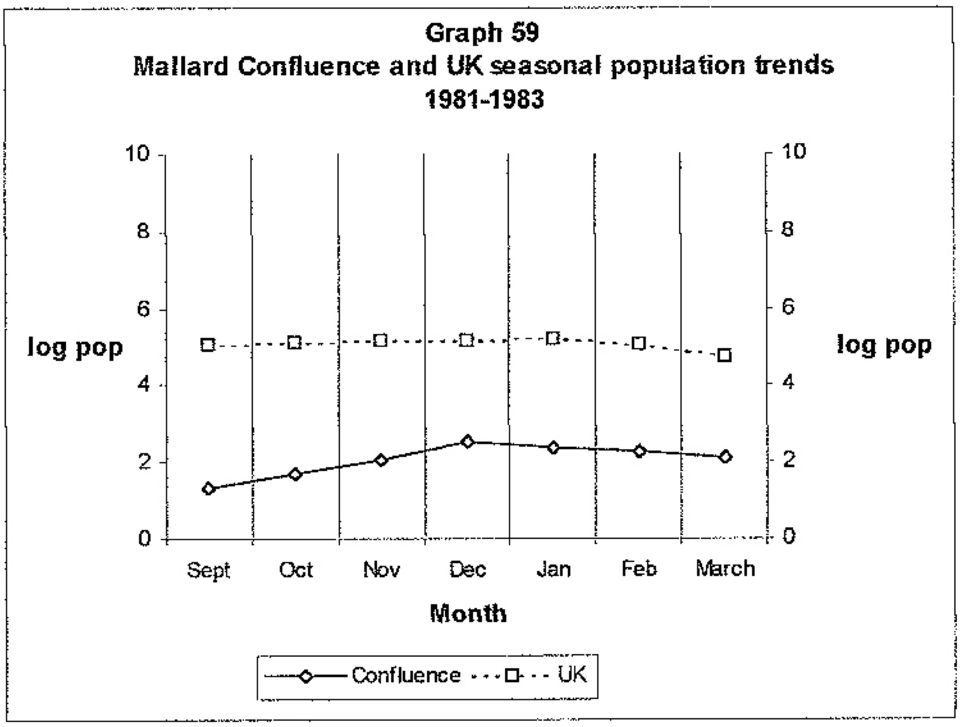


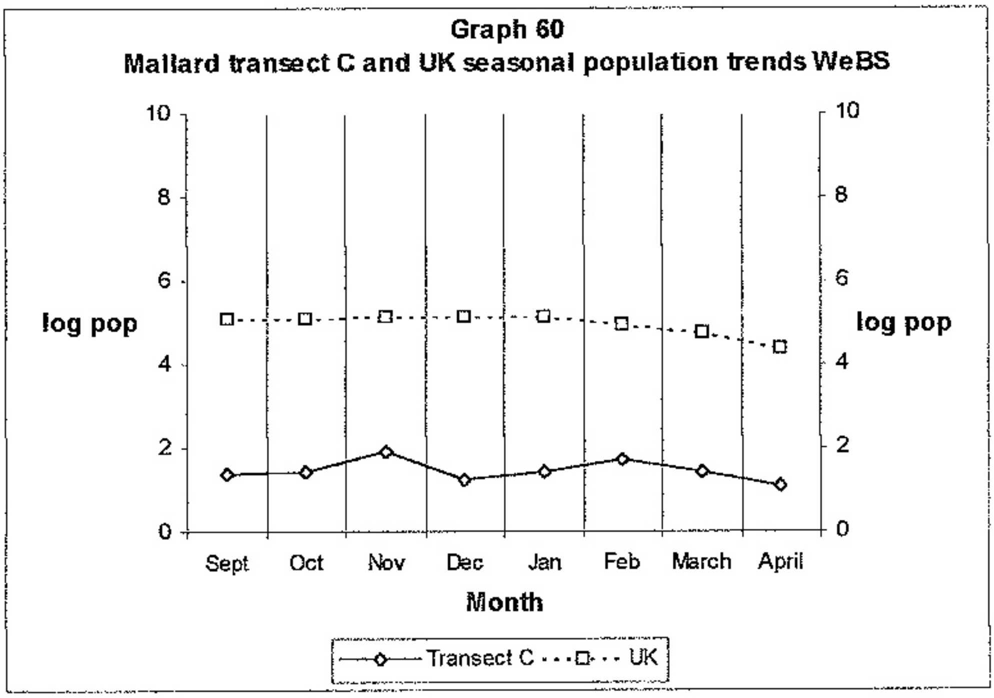
Graph 58
Eurasian Teal transect C and UK seasonal population trends WeBS



Mallard ***Anas platyrhynchos***

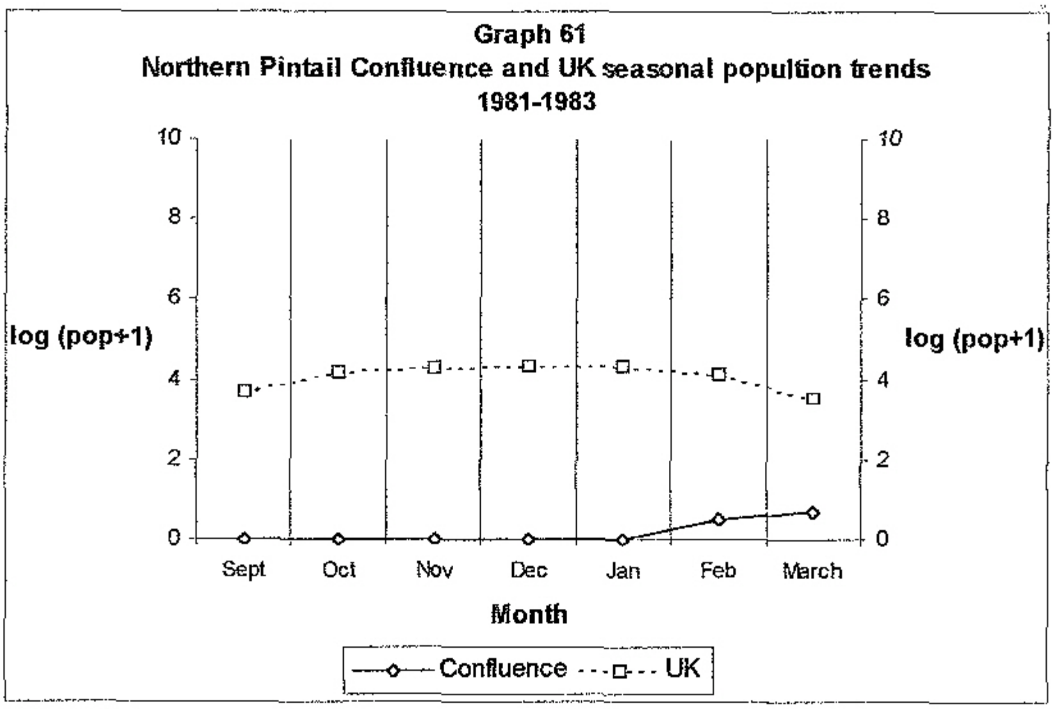
1981-1983 Confluence population increased 1.14 to December peak and then declined 0.37 to March while the UK population rose 0.15 to January, subsequently diminished 0.47 to March, shown in graph 59. WeBS transect C population increased 0.54 to November and then decreased 0.84 and the UK population rose 0.08 to December, subsequently declined 0.78 to April, shown in graph 60.

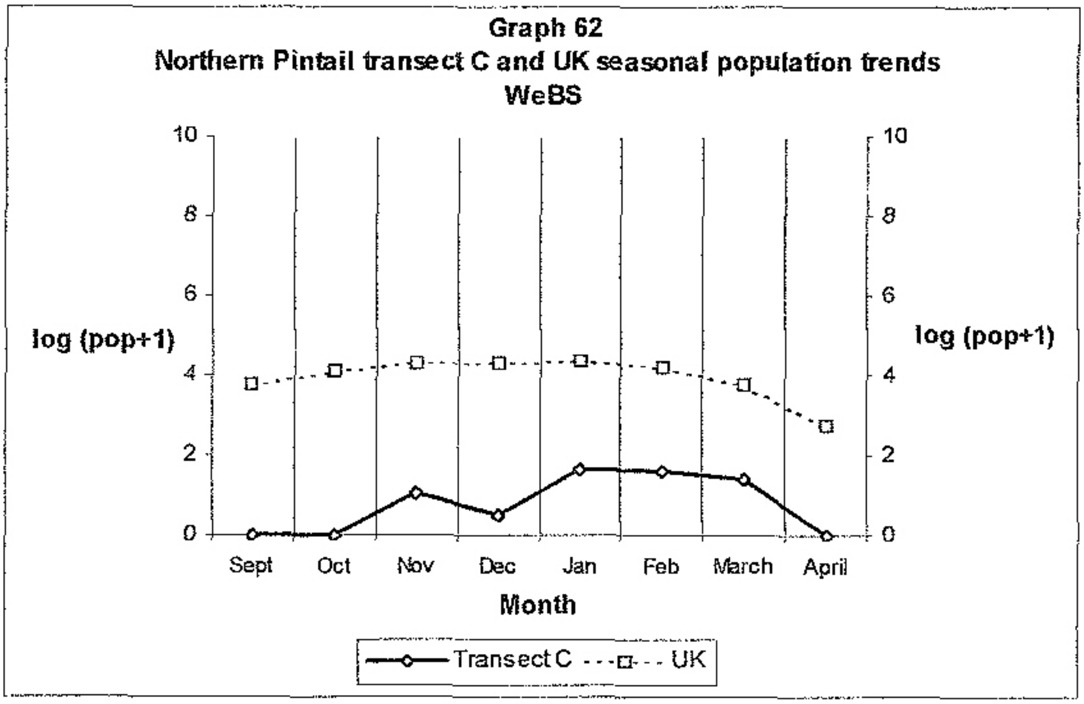




Northern Pintail ***Anas acuta***

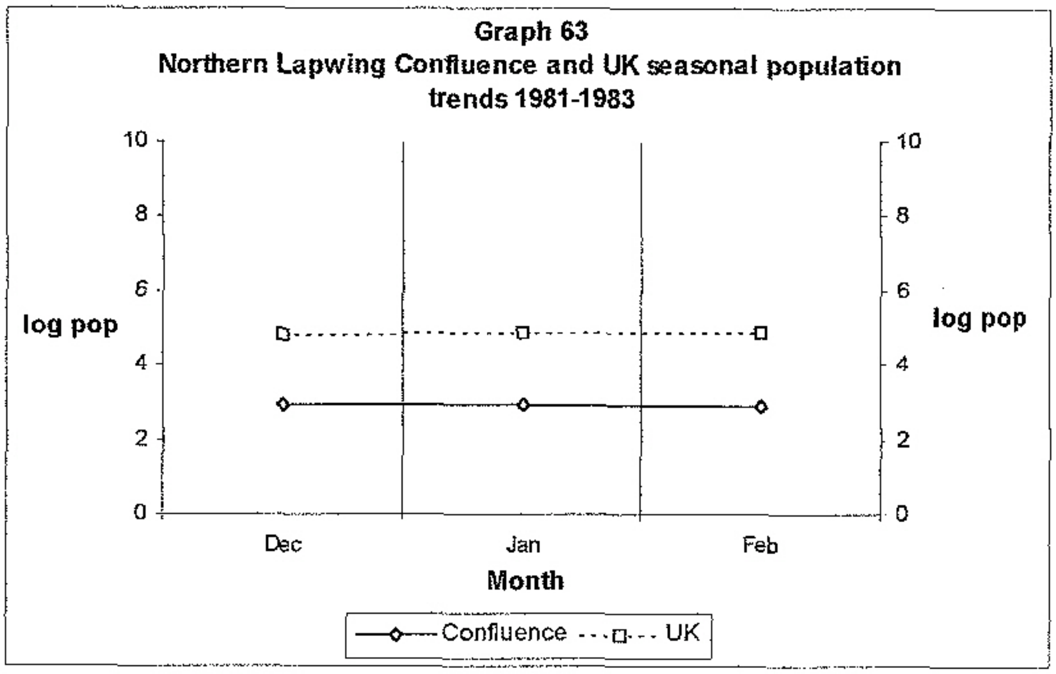
1981-1983 Confluence population increased from 0 to peak at 0.69 in March whereas the UK population rose 0.64 to January subsequently declined 0.81 to March, shown in graph 61. WeBS transect C population increased 1.65 to January, then decreased to 0.0 in April and the UK population rose 0.60 to January, then diminished to 1.61, shown in graph 62.

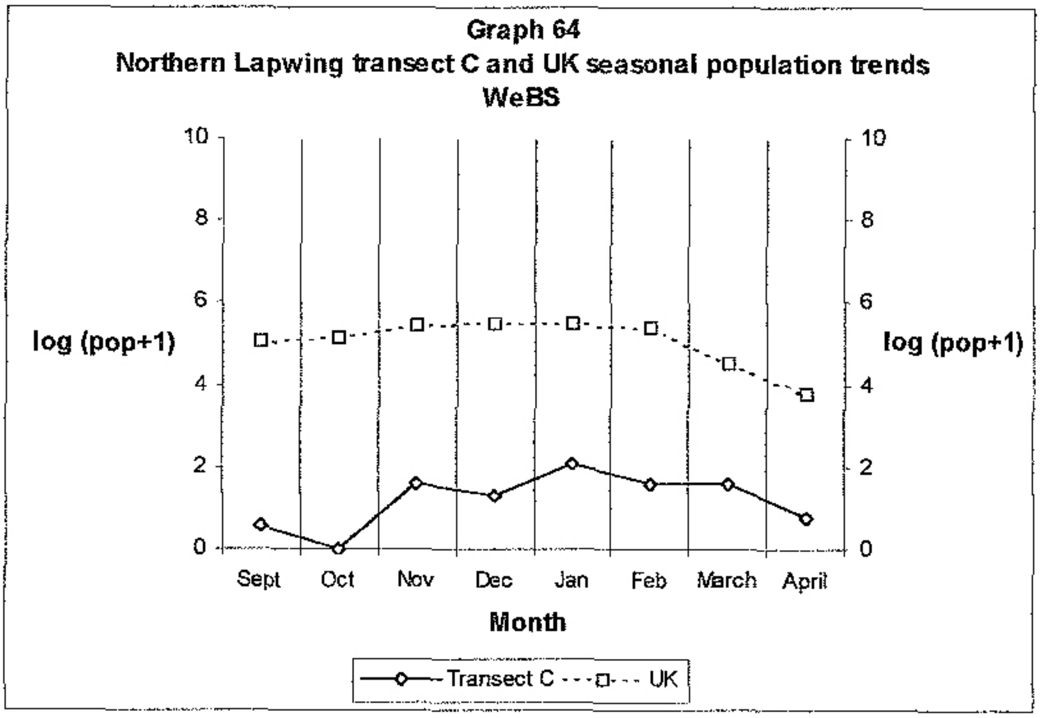




Northern Lapwing *Vanellus vanellus*

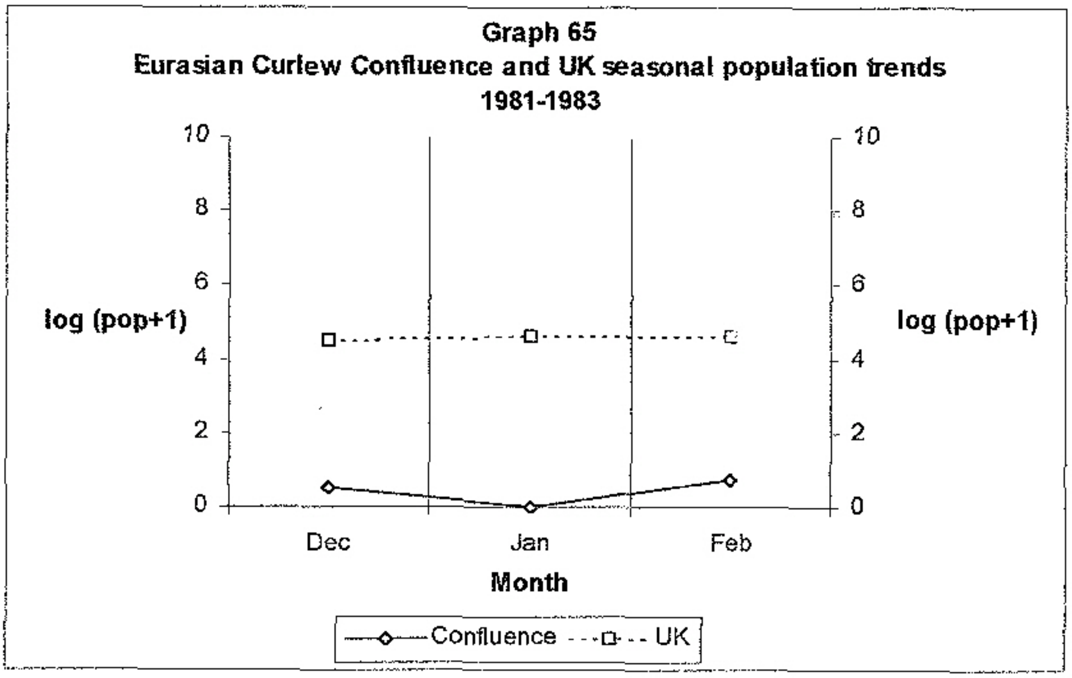
1981-1983 Confluence population peaked in December at 2.91 and diminished 0.03 to February; conversely the UK population rose 0.02 to a February maximum, shown in graph 63. WeBS transect C December-February population peaked at 2.06 in January and declined 0.45 to February whereas the UK maximum population was in January at 5.49 and diminished 0.09 to February, shown in graph 64.

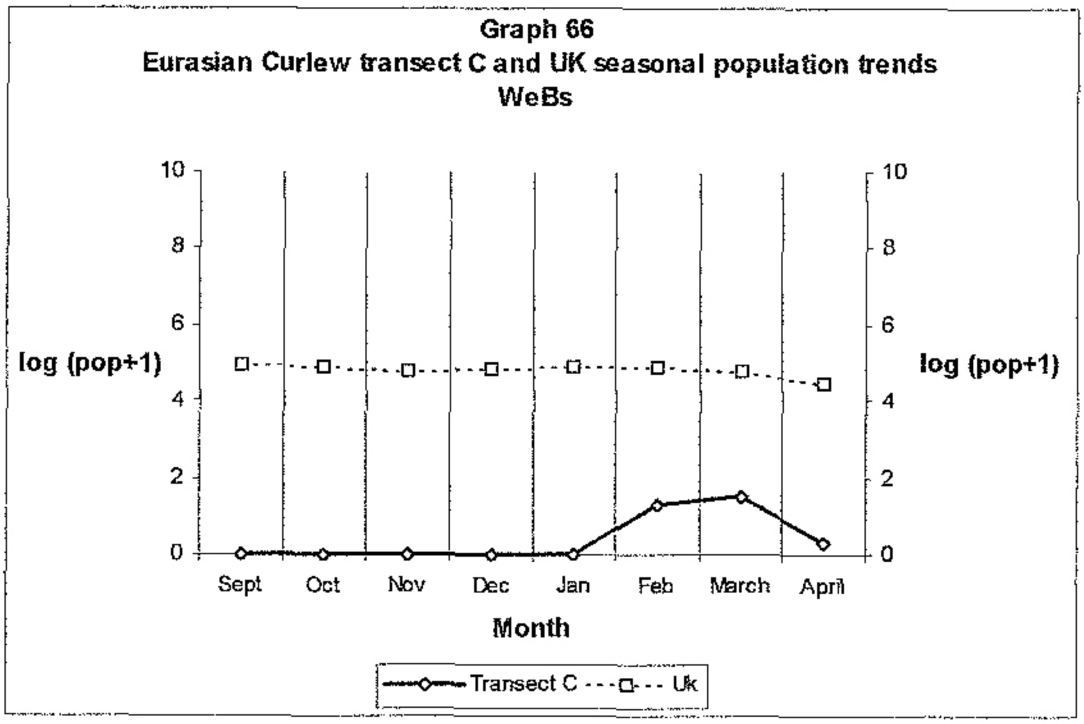




Eurasian Curlew *Numenius arquata*

1981-1983 Confluence and UK population increased 0.2 and 0.1 respectively to February, shown in graph 65. WeBS transect C December-February population increased from 0 to 1.27 and 0.08 to February respectively, shown in graph 66. Transect C population trend showed a January-March 1.51 increase that declined 1.21 to April.





Summary

Table 25 summarises populations' statistical properties, namely: (i) modality, Eurasian wigeon was more dynamic during 1981-1983 compared to WeBS and conversely for mallard and Northern pintail and (ii) positive and negative skewness illustrated population peak trends early and late season respectively.

Table 25

Statistical properties of Confluence and transect C species seasonal population trends 1981-1983 and WeBS

	1981-1983 Confluence		WeBS Transect C	
Species	Modality	Skewness	Modality	Skewness
Mute Swan	bimodal	positive	bimodal	positive
Whooper swan	unimodal	symmetrical	unimodal	symmetrical
Eurasian Wigeon	bimodal	negative	unimodal	negative
Eurasian Teal	bimodal	negative	bimodal	negative
Mallard	unimodal	negative	bimodal	positive
Northern Pintail	unimodal	negative	bimodal	negative
Northern Lapwing	unimodal	positive	unimodal	negative
Eurasian Curlew	bimodal	negative	unimodal	negative

In summary populations trend ranges, shown on table 26, were: (i) 1981-1983 greatest increases were by Mute swan, Eurasian wigeon and Eurasian teal on the Confluence and Whooper swan, Eurasian wigeon and Northern pintail in the UK; during WeBS Eurasian teal, Northern pintail and Eurasian curlew on transect C and Whooper swan, Eurasian wigeon.

Table 26

Summary of Confluence and transect C seasonal population trend ranges 1981-1983 and WeBS

Species	1981-1983				WeBS			
	Confluence		UK		Transect C		UK	
	log (base10) population increase	fold increase	log (base10) population increase	fold increase	log (base10) population increase	fold increase	log (base10) population increase	fold increase
Mute Swan	1.1614	14.5	0.1031	1.26	0.8451	7	0.3533	2.25
Whooper Swan	0.47*	2*	1.8837^	76.50^	0.3979*	1.5*	1.9153^	82.28^
Eurasian Wigeon	1.9845	95.5	1.0968^	12.49^	0.8488*	6.05*	1.8576	72.04
Eurasian teal	2.4676	292.5	0.5366	3.44	1.9294	84	1.2166	16.46
Mallard	1.14	13.8	0.4725	2.96	0.8451	7	0.7817	6.05
Northern Pintail	0.6990*	4*	0.8141	6.51	1.6484*	44.5*	1.6132^	41.11^
Northern Lapwing	0.0349	1.08	0.0232	1.05	0.746*	5.57*	0.0886	1.23
Eurasian Curlew	0.7404	4.5	0.0983	1.25	1.2788*	18*	0.0805	1.2

* : de-transformed from computed log (base10) (n+ 1)

^ : computed to 4 decimal places; when computed to 8 decimal places in agreement with arithmetical computation

Northern Lapwing and Eurasian Curlew UK populations were based on only available data December-February 1981-1983 and WeBS were computed for the similar months

Chapter 9

Time series analysis of species seasonal population trends and *temperature trends*

The purpose of time series analysis of species and temperature datasets, the variables, is to determine the:

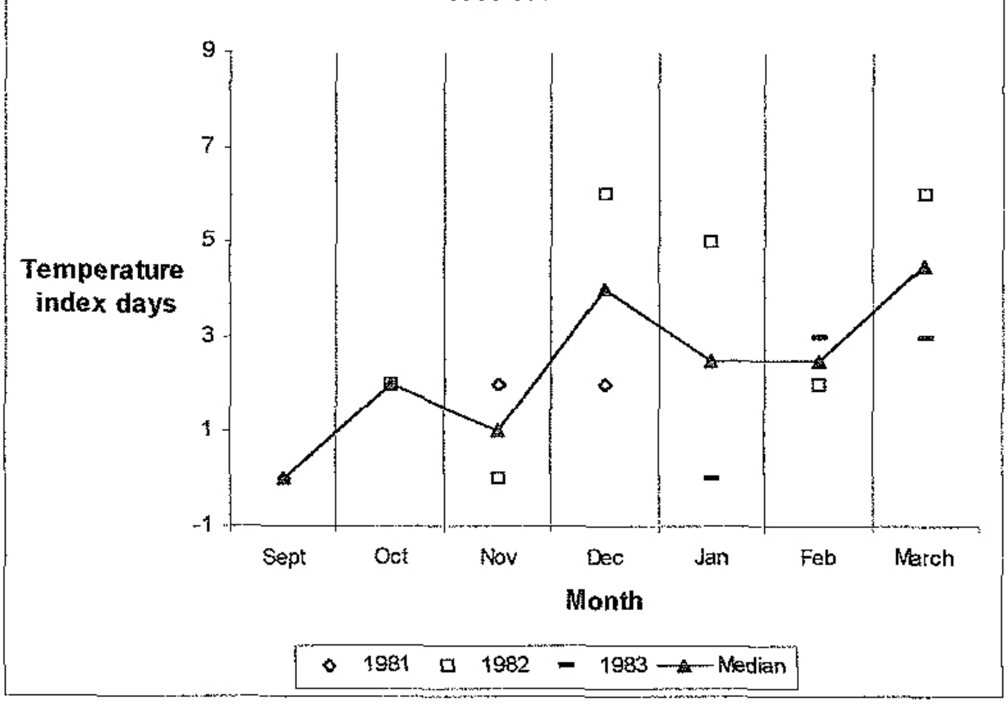
i) similarity of trend directions of the variables;
ii) associations between trends of the variables by comparison of above median, median and sub-median species abundances to two temperature classifications during 11-day term per month and
iv) detection of noise in datasets of the variables.

Temperatures

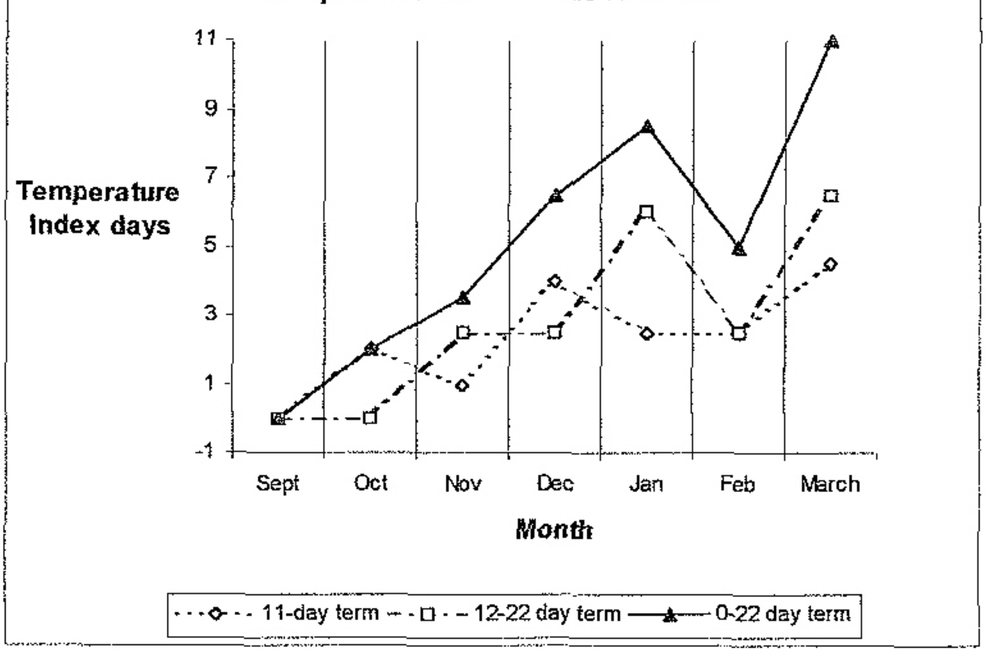
Temperature datasets are extensive and are available from the author. Minimum daily temperatures were classified as an index: (i) zero and sub-zero Celsius, "low temperature day", for any period of the 24 hour day and (ii) above zero Celsius for all of the 24 hour day. When a low temperature was recorded, one was registered; zero was registered for temperatures above zero Celsius. The index was 0-11, index days, 1 for each day of the 11-day term per month on and preceding the survey day. A secondary 11-day period, 12-22 day term, was similarly classified and the two terms summed to a 0-22 day term for data elucidation. Population outliers are shown are shown in graphs in chapter 13.

The 11-day term temperature index trend for: (i) 1981-1983 had a multimodal, asymmetrically negatively skewed distribution that peaked in March and was minimum in September, as shown on graph 67. The trend increased during September-December and decreased during December-February. The three indices' trends were similar, as shown on graph 68.

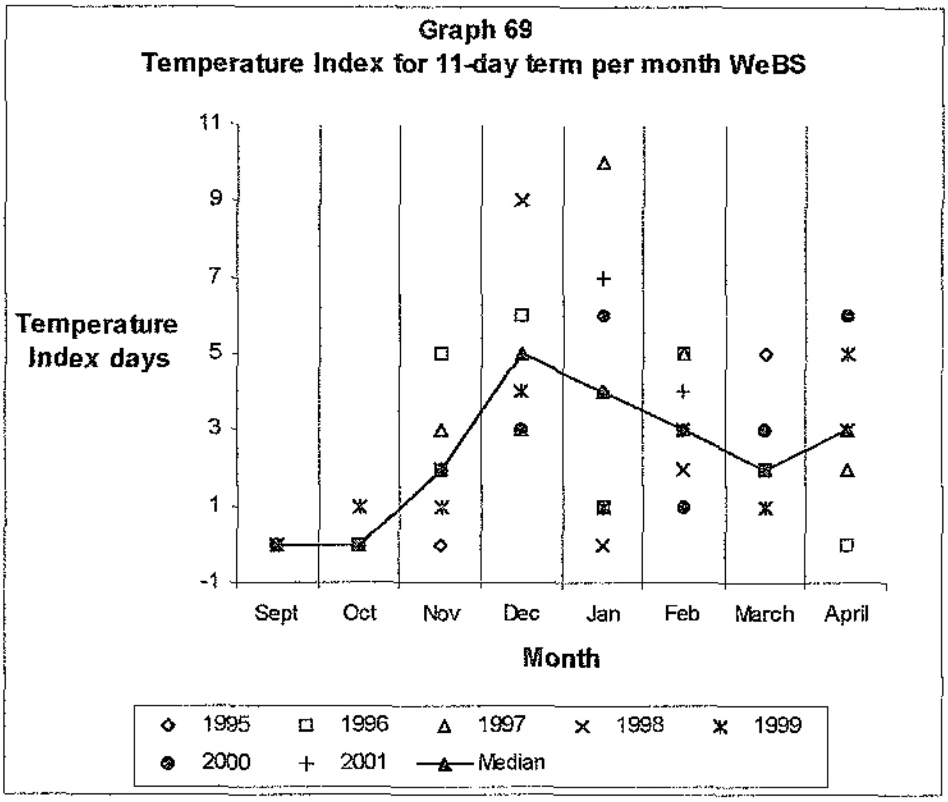
Graph 67
Temperature index for 11-day terms per month
1981-1983

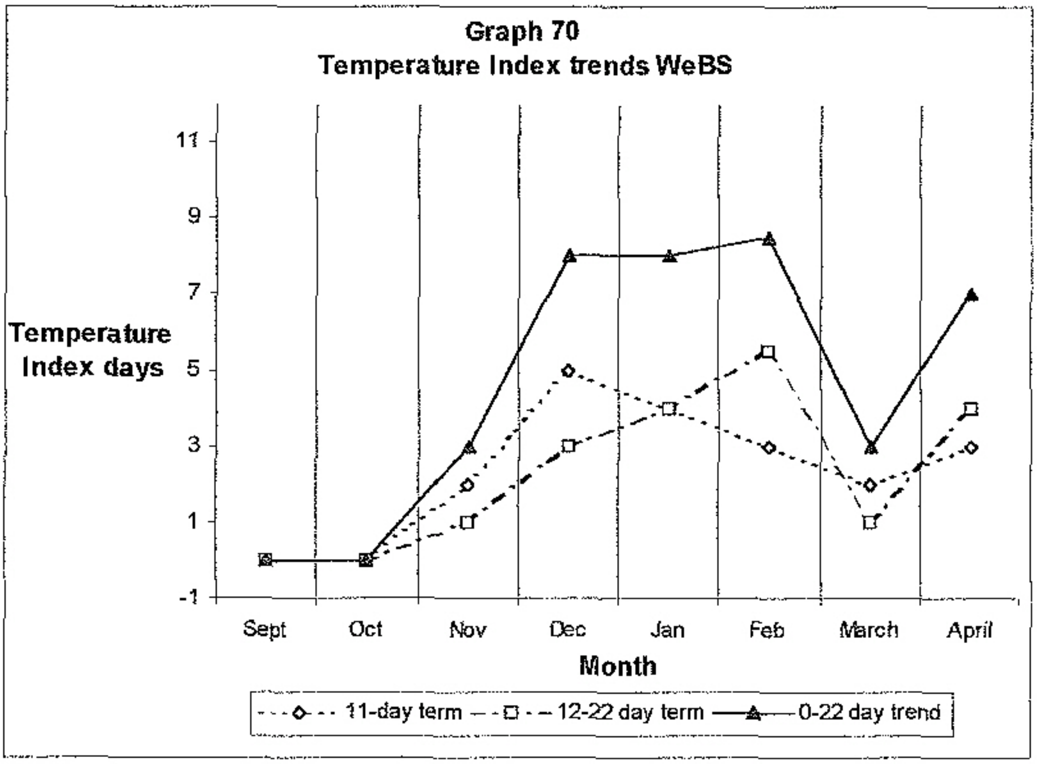


Graph 68
Temperature index trends 1981-1983



(ii) WeBS was mono-modal, asymmetrically negatively skewed distribution, characterized by the autumnal rise to peak in December, diminished to March and with a March-April terminal increase, as shown on graph 69. The three indices' trends are shown on graph 70.





Trends of species populations and 11-day term per month temporal distributions corresponding and reverse corresponding outliers were examined to detect patterns of species temporal distributions.

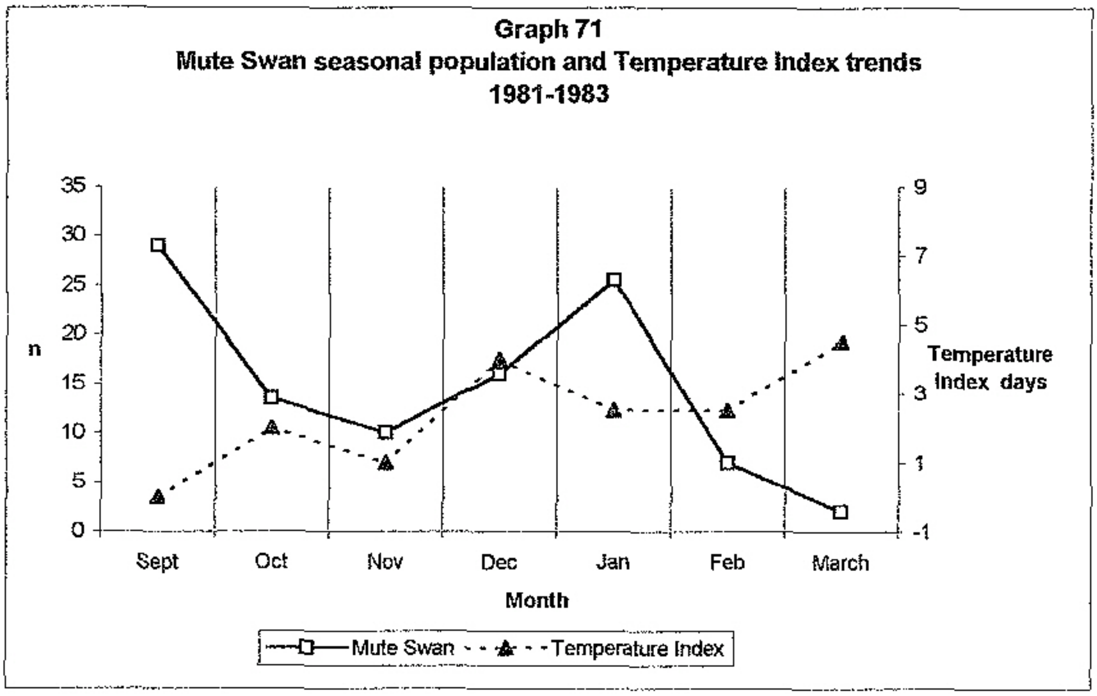
For ease of presentation, WeBS tables are in appendix 21, and the following footnote is applicable to species seasonal population and temperature index *tables:*

---

a: above trend b: below trend m: median ( ): numbers of low temperature days
c: corresponding outliers _: no count and no temperature data
r: reverse corresponding outliers

Mute Swan *Cygnus olor*

1981-1983 seasonal population and index temperature trends were similarly *dynamic during October-December and populations peaked in September*, the lowest index term, shown on graph 71.



Above median population outliers were in correspondence with higher index temperature days, *for example* November 1981, *shown in table* 27, *and were* in reverse correspondence with lower index days, such as January 1983, shown in table 28.

Table 27

Corresponding outliers of Mute Swan and Temperature Index 1981-1983

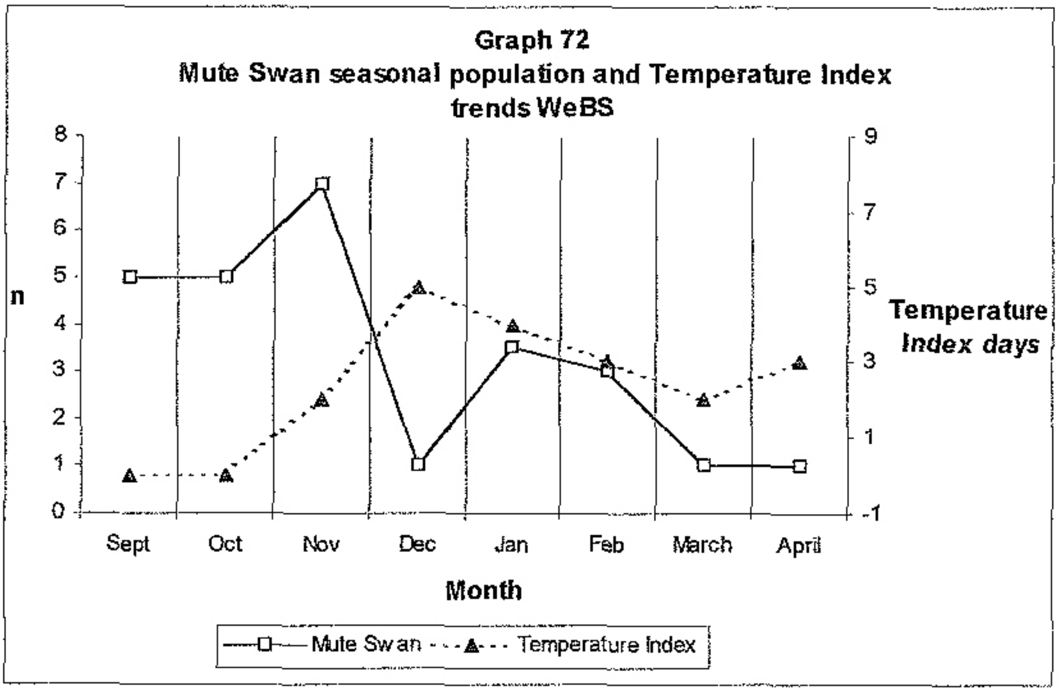
Month	Species numbers			Temperature index		
	1981	1982	1983	1981	1982	1983
September	29 m	_	_	0	_	_
November	14 a	6 b		(2) -1.4	0	_
December	8 b	24 a	_	(2) -2.0	(6) -6.9	_
February	_	0	14 a		(2) -1.8	(3) -8.8

Table 28

Reverse corresponding outliers of Mute Swan and Temperature Index 1981-1983

Month	Species numbers			Temperature index		
	1981	1982	1983	1981	1982	1983
October	14 a	13 b	_	(2) -2.8	(2) -1.8	_
January	_	20 b	31 a	_	(5) -6.4	0
March	_	0 b	4 a	_	(6) -4.1	(3) -4.9

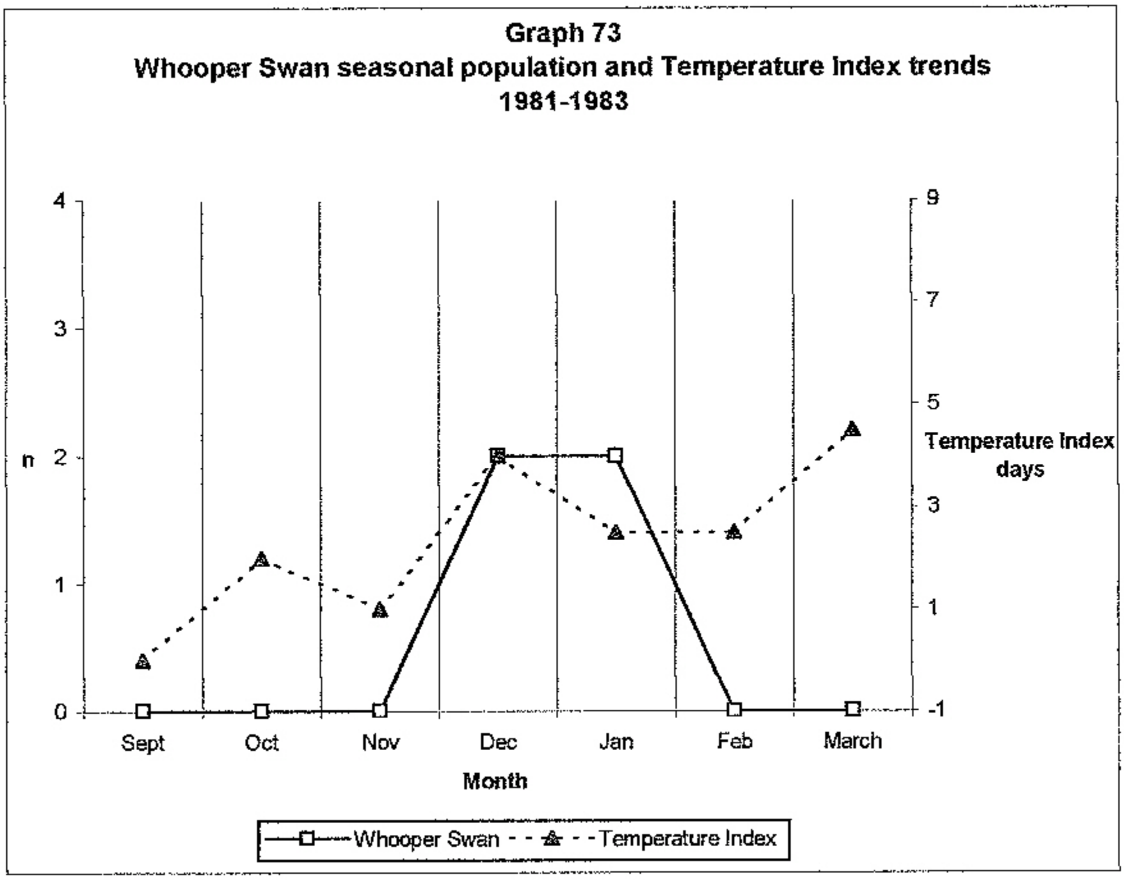
(2) WeBS trends similarly increased during October-November and declined in January-March and populations peaked in November, the second joint lowest index temperature term, shown on graph 72.



Above median population outliers were in correspondence with higher index temperature days, such as December 1998, shown in appendix 21 table C and were in reverse correspondence with lower index days, for example October 2000, shown in appendix 21 table D. Overall, larger populations preferred milder conditions but corresponding outliers illustrated ability to withstand temperatures to $-8.8\,^{\circ}C$, as in February 1983.

Whooper Swan Cygnus cygnus

1981-1983 trends, shown on graph 73 were similar during November-December and populations peaked in December-January.



Above median population outliers corresponded with higher index temperature days, for example December 1982, shown in table 29, and were in reverse correspondence with lower index days, such as January 1983, shown in table 30.

Table 29

Corresponding outliers of Whooper Swan and Temperature Index 1981-1983

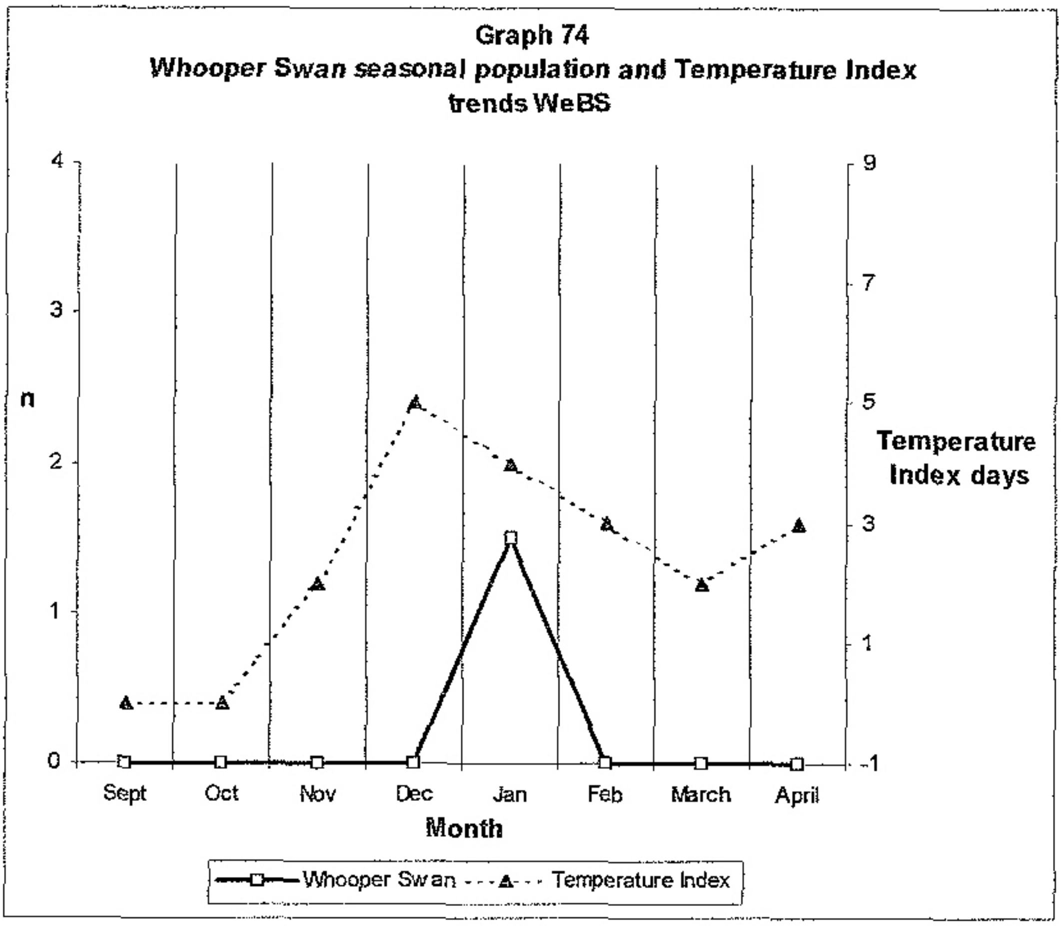
Month	Species numbers			Temperature index		
	1981	1982	1983	1981	1982	1983
December	0 b	4 a	_	(2) -2.0	(6) -6.9	_

Table 30

Reverse corresponding outliers of Whooper Swan and Temperature Index 1981-1983

Month	Species numbers			Temperature index		
	1981	1982	1983	1981	1982	1983
January	_	*0 b*	*4 a*	_	(5) -6.4	(0)

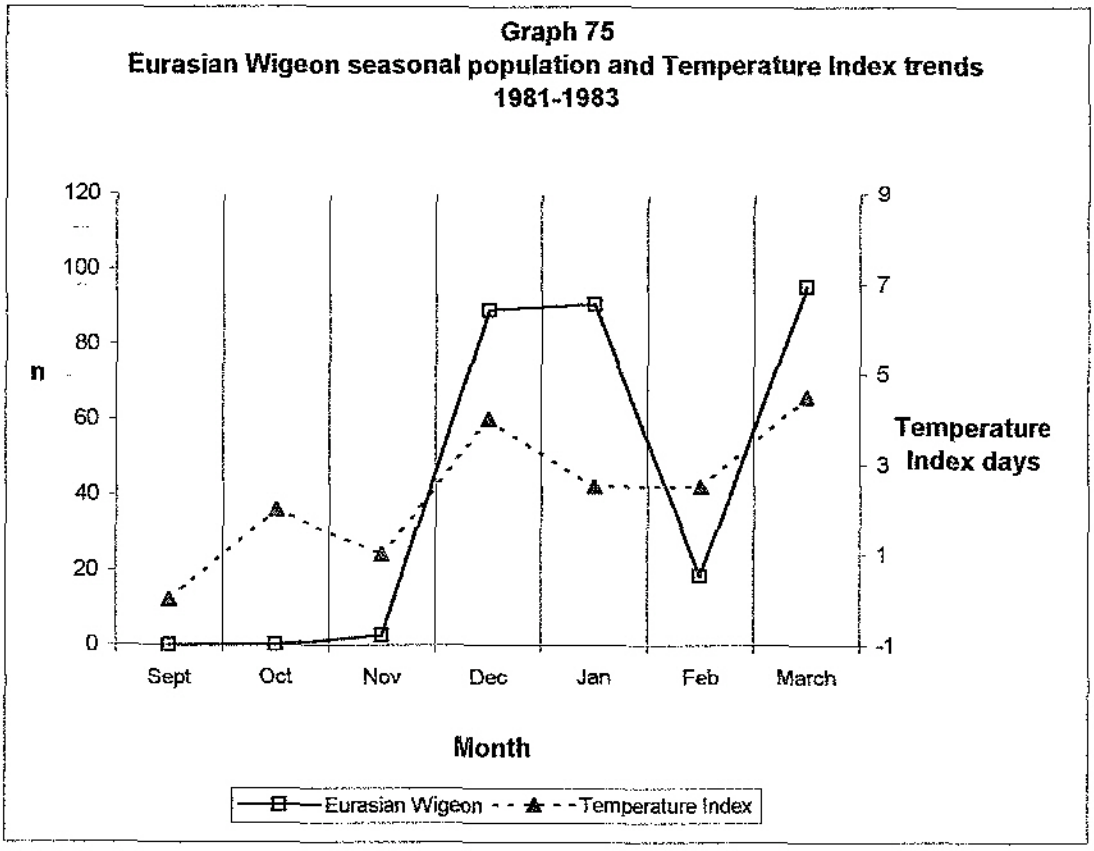
WeBS trends, shown on graph 74, were similar during January-February and *numbers peaked in January, the second highest index term.*



Above median population outliers corresponded discontinuously with higher index temperature days, for example January 2001, shown in appendix 21 table G, and were in reverse correspondence with lower index days, for instance January-February 1995 sequentially, shown in appendix 21 table H, with exceptions, notably February 1999. Overall, Whooper swans demonstrated temperature tolerance to –10° C but preferred ameliorating conditions. Cautious interpretation of datasets is required due to predominance of zeros and low population numbers.

Eurasian Wigeon Anas penelope

1981-1983 trends, shown on graph 75, were similar during November-December and February-March and populations peaked in March, the highest index term.



Above median population outliers corresponded with higher temperature index days, for example December 1982, shown in table 31, and were in reverse correspondence with lower index days, such as January 1983, shown in table 32.

Table 31

Corresponding outliers of Eurasian Wigeon and Temperature Index 1981-1983

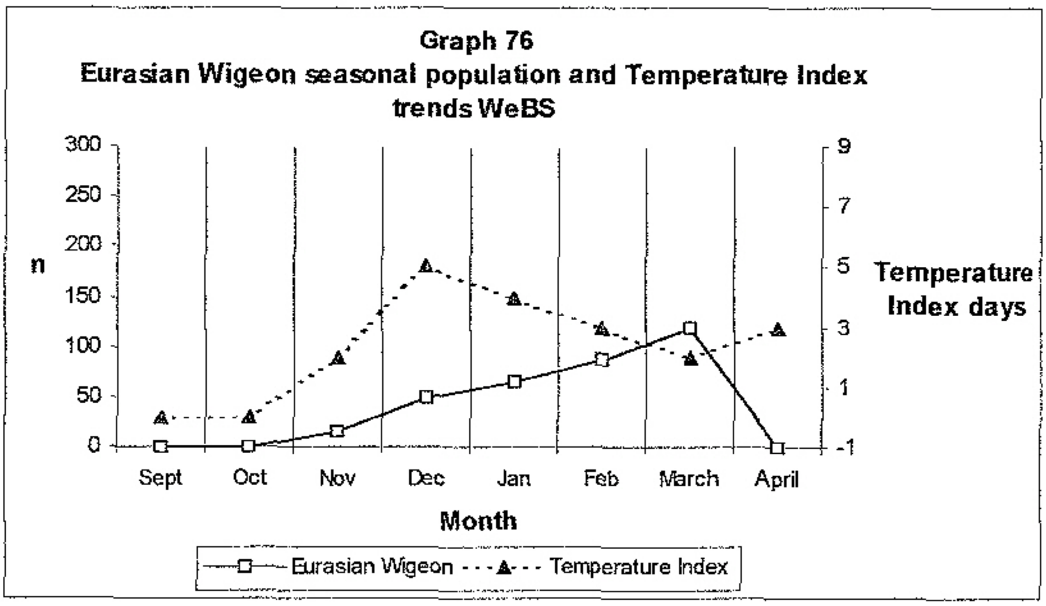
Month	*Species frequencies*			*Temperature index*		
	1981	1982	1983	1981	1982	1983
December	55 b	123 a	_	(2) -2.0	(6) -6.9	_
March	_	99 a	92 b	_	(6) -4.1	(3) -4.9

Table 32

Outliers in reverse correspondence of Eurasian Wigeon and Temperature Index 1981-1983

Month	Species frequencies			Temperature Index		
	1981	1982	1983	1981	1982	1983
November	*0b*	5a	_	(2) -1.4	0	_
January	_	60b	121a	_	(5) -6.4	0
February	_	33a	4b	_	(2) -1.8	(3) -6.8

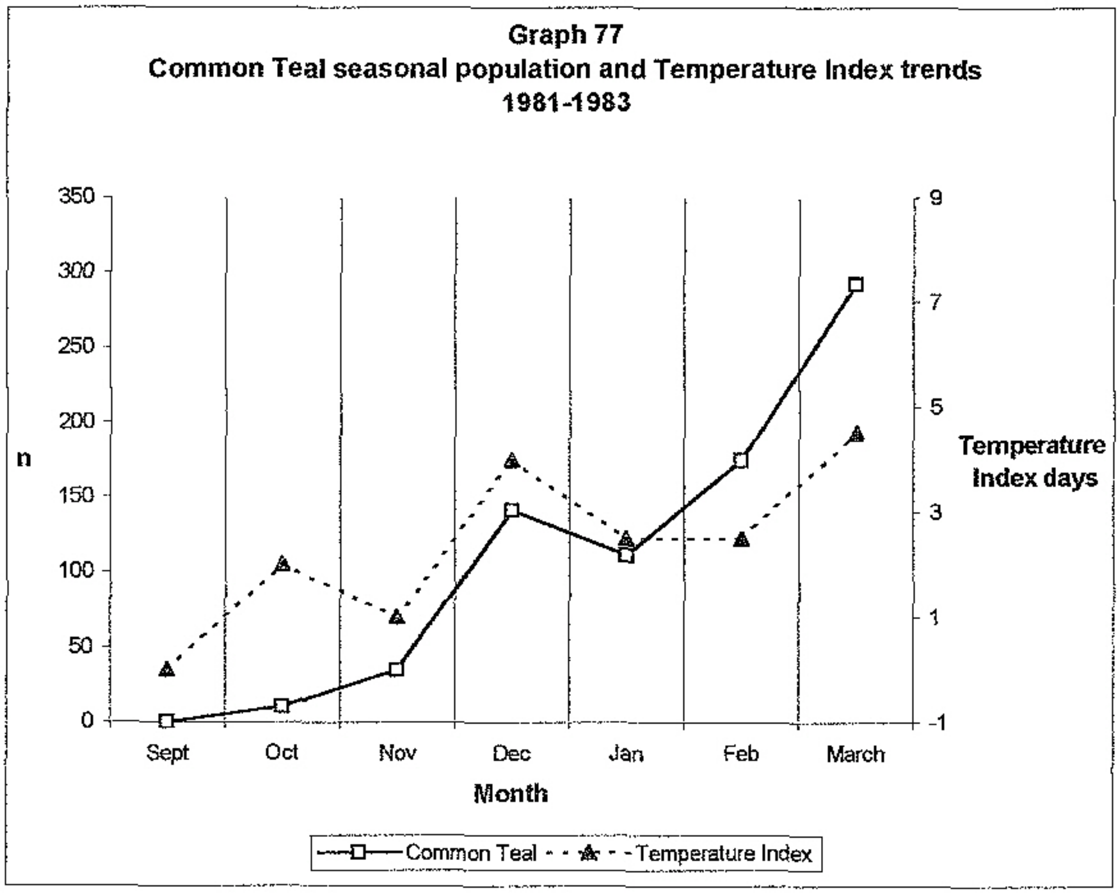
WeBS trends, shown on graph 76, were similarly increased during October-December and peaked in March, the fourth joint highest index temperature month.



Above trend population outliers corresponded with higher index days, for *example March 1995, shown in appendix 21 table I, and were in reverse* correspondence with lower index days, such as February 1995, shown in appendix 21 table J. During both surveys wigeon preferred ameliorating weather but demonstrated temperature tolerance to –9.8° C.

Common Teal Anas crecca

1981-1983 trends were similarly dynamic during September-October and November-January and numbers peaked in March, the highest index term, shown in graph 77.



Above median population outliers corresponded with higher index days, such as December 1982, shown in table 33, and were in reverse correspondence with lower index days, for example March 1983, shown in table 34.

Table 33

Corresponding outliers of Common Teal and Temperature Index 1981-1983

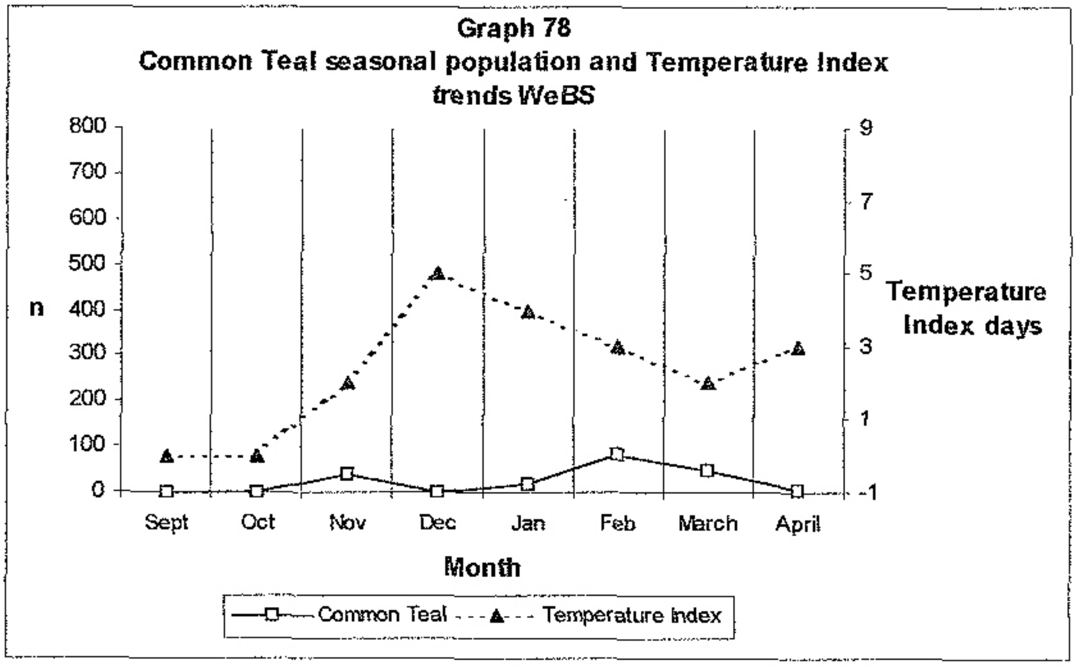
Month	Species numbers			Minimum temperature° C		
	1981	1982	1983	1981	1982	1983
December	54b	228a	_	(2) -2.0	(6) -6.9	
February	_	122b	227a	_	(2) -1.8	(3) -8.8

Table 34

Reverse corresponding outliers of Common Teal and Temperature Index 1981-1983

Month	*Species numbers*			*Minimum temperature° C*		
	1981	1982	1983	1981	1982	1983
October	1b	19a	_	(2) -2.8	(2) -1.8	_
November	4b	65a	_	(2) -1.4	(0)	_
January	_	15b	207a	_	(5) -6.4	(0)
March	_	139b	446a	_	(6) -4.1	(3) -4.9

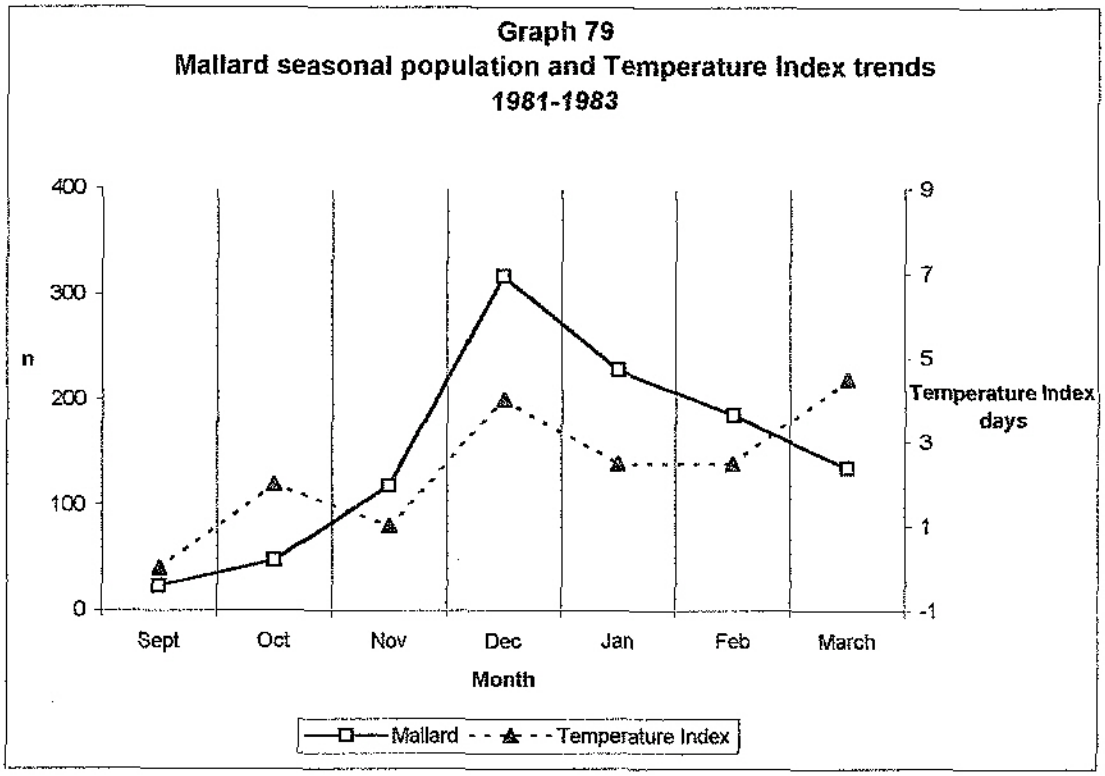
WeBS trends, shown on graph 78, were similarly dynamic during September-November and February-March and populations peaked in February, the third highest index term.



Above median population outliers corresponded with higher index days, for example March 1995, shown in appendix 21 table K, and were in reverse correspondence with lower index days, such as January 1995, shown in appendix 21 table L. Overall, teal demonstrated temperature tolerance to –10° C but preferred ameliorating conditions.

Mallard Anas platyrhynchos

1981-1983 trends, shown on graph 79, were similarly dynamic during September-October, November-January and peaked in December, second highest index term.



Above trend population outliers corresponded with higher index days, for instance December 1982, shown in table 35, and were in reverse correspondence with lower index days, such as March 1983, shown in table 36.

Table 35

Corresponding outliers of Mallard and Temperature Index

1981-1983

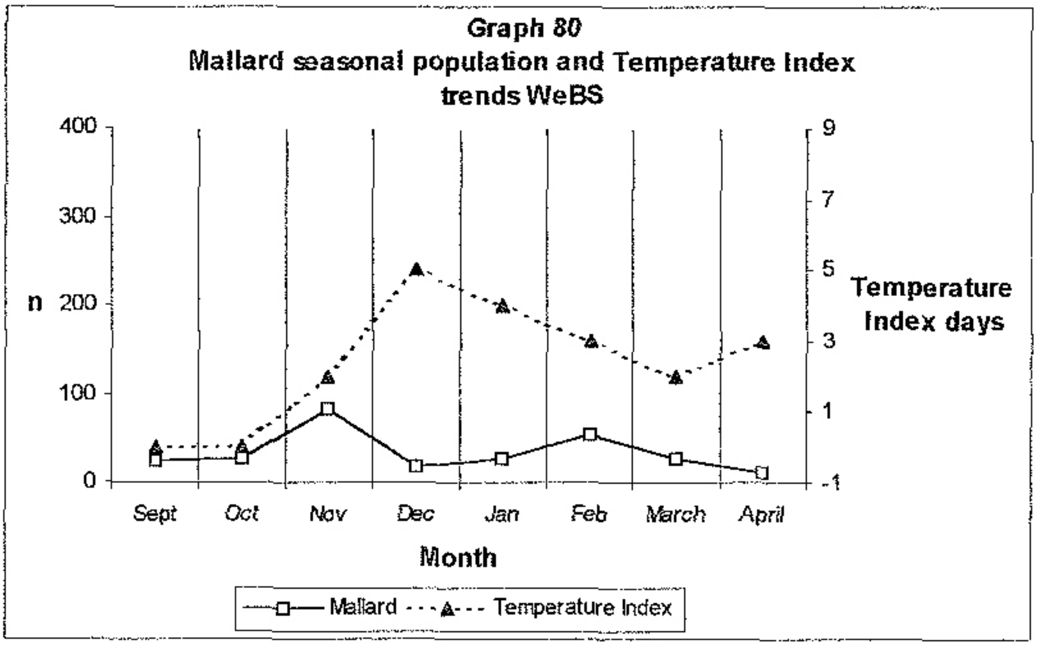
Month	Species numbers			Temperature index		
	1981	1982	1983	1981	1982	1983
September	23 m	_	_	(0)	_	_
November	128 a	109 b	_	(2) -1.4	(0)	_
December	229 b	406 a	_	(2) -2.0	(6) -6.9	_
February	_	45 b	326 a	_	(2) -1.8	(3) -8.8

Table 36

Reverse corresponding outliers of Mallard and Temperature Index 1981-1983

Month	Species numbers			Minimum temperature		
	1981	1982	1983	1981	1982	1983
October	51 a	44 b	_	(2) -2.8	(2) -1.8	_
January	_	37 b	420 a	_	(5) -6.4	(0)
March	_	67 b	205 a	_	(6) -4.1 [(2) -4.0]	(3) -4.9 [(11) -5.5]

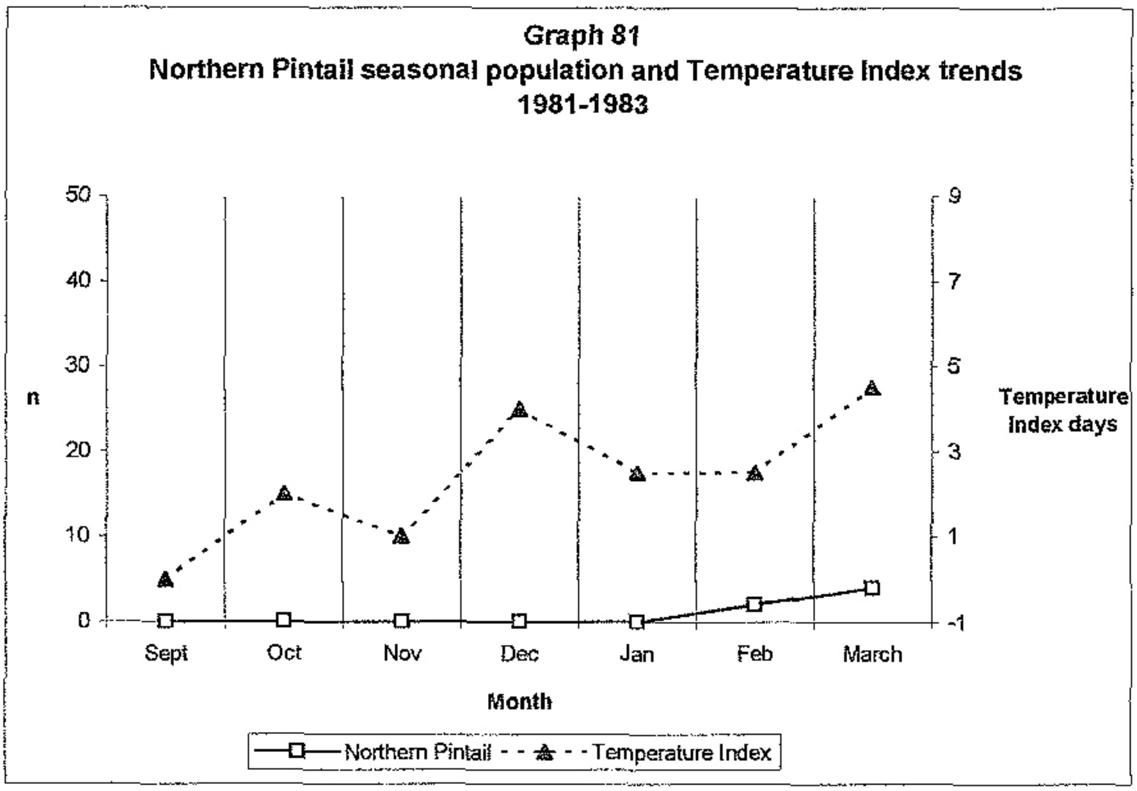
WeBS trends were similarly increased during October-November and declined in February-March; populations peaked in November, the second joint index term, shown in graph 80.



Above trend population outliers corresponded with higher index days, for instance January 2000, shown in appendix 21 table M, and were in reverse correspondence with lower index days, such as January 1995, shown in appendix 21 table N. Overall, above and sub-median abundances occurred at higher and lower indices respectively.

Northern Pintail ***Anas acuta***

1981-1983 trends similarly increased during February-March and peaked in March, the highest index term, shown in graph 81.



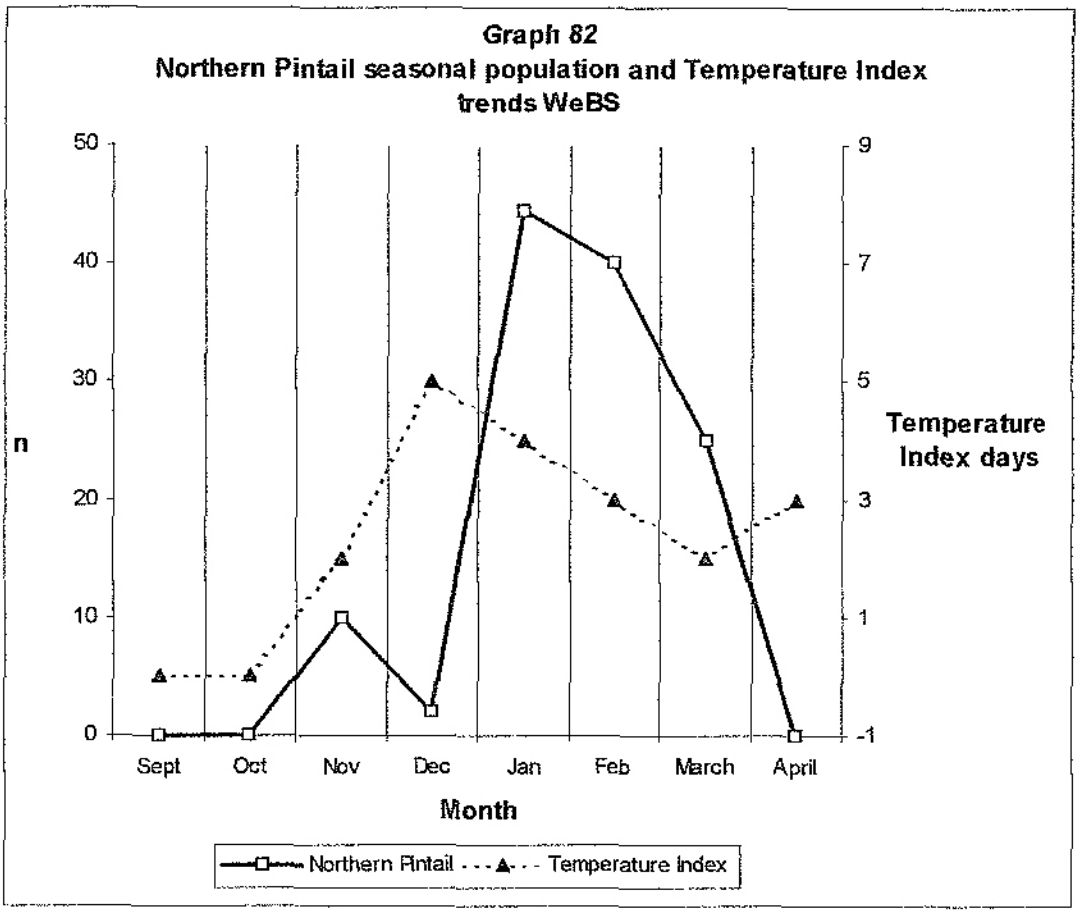
The four populations were medians and were in reverse correspondence with higher and lower index days, and occurred at sub-zero temperatures, shown in table 37.

Table 37

Reverse corresponding outliers of Northern Pintail and Temperature Index 1981-1983

Month	Species numbers			Temperature index		
	1981	1982	1983	1981	1982	1983
February	_	2 m	2 m	_	(2) -1.8	(3) -8.8
March	_	4 m	4 m	_	(6) -4.1	(3) -4.9

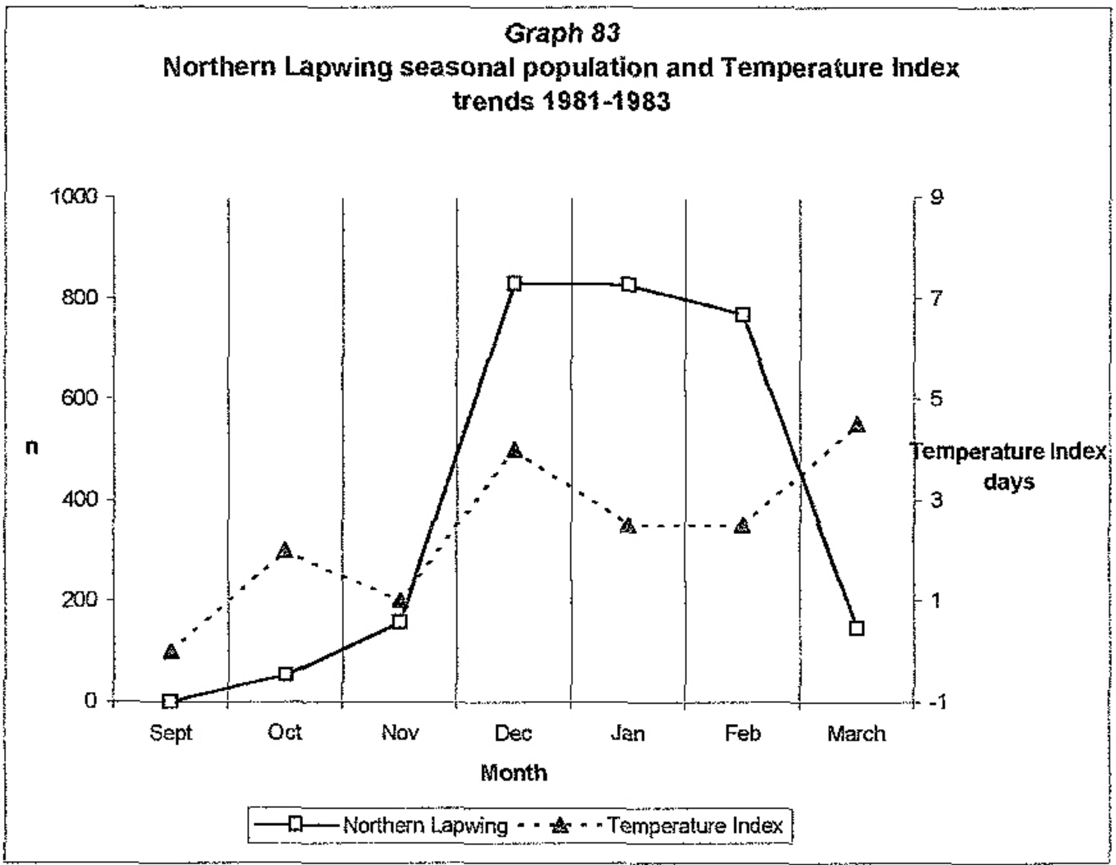
WeBS trends similarly increased during October-November and declined in February-March; populations peaked in January, the second highest index term, shown in graph 82.



Above trend population outliers corresponded with higher index days, for example February 1996, shown appendix 21 table O, were in reverse corresponding with lower index days, such as January 1995, shown appendix 21 table P. Overall, trends and above trend *reverse corresponding outliers* indicated pintail preferred milder conditions but corresponding outliers illustrated tolerance to –10° C.

Northern Lapwing *Vanellus vanellus*

1981-1983 trends were similarly increased during September-October and November-January. Populations peaked in December, the second highest index term, shown on graph 83.



Above trend population outliers corresponded with higher index days, for *example December* 1982, shown in table 38, and were in reverse correspondence with lower index days, for instance January 1983, shown in table 39.

Table 38

Corresponding outliers of Northern Lapwing and Temperature Index 1981-1983

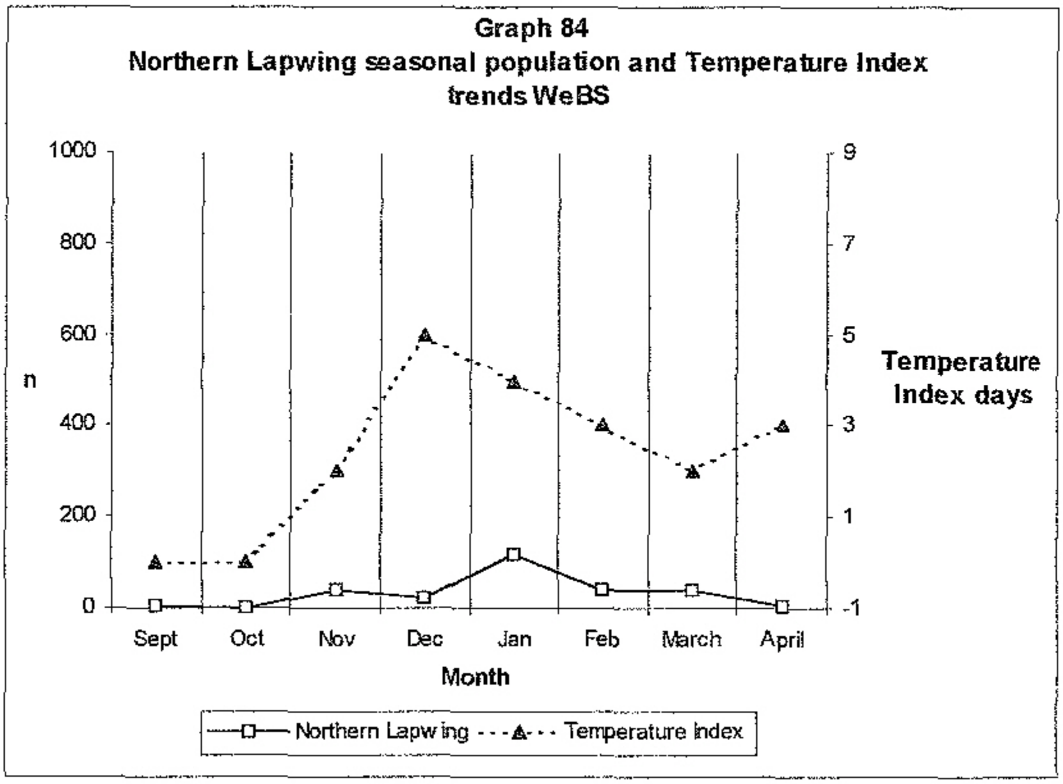
Month	Species numbers			Temperature index		
	1981	1982	1983	1981	1982	1983
December	200 b	1458 a	_	(2) -2.0	(6) -6.9	_
February	_	0 b	1531 a	_	(2) -1.8	(3) -8.8

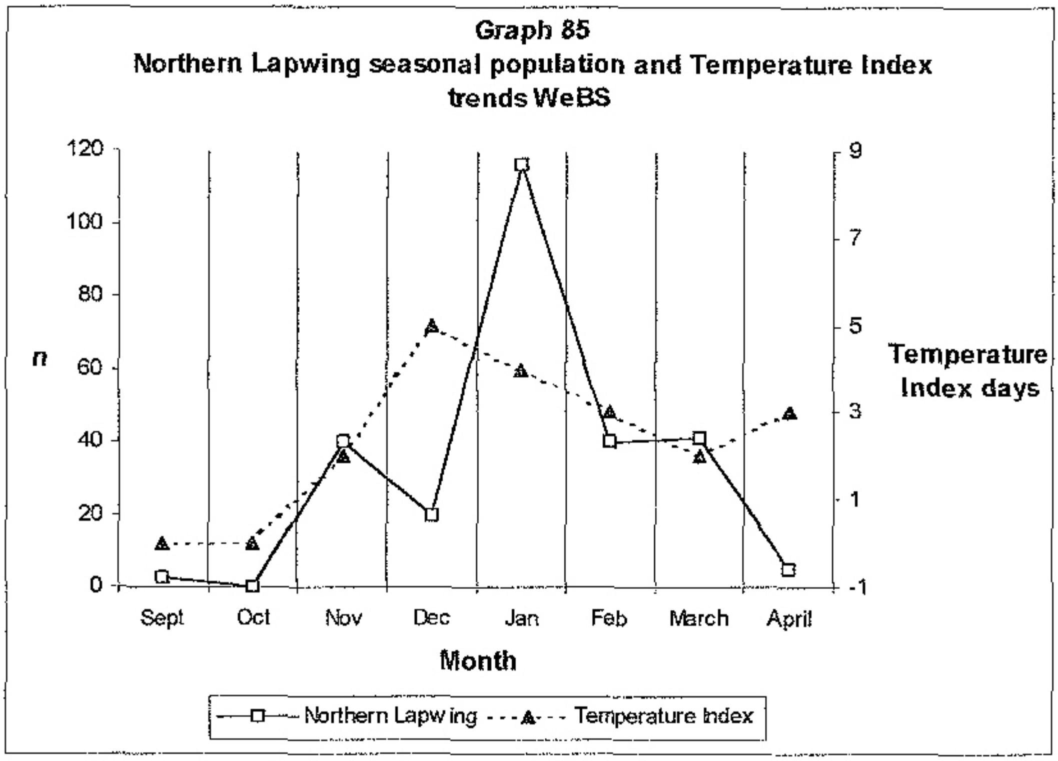
Table 39

Reverse corresponding outliers of Northern Lapwing and Temperature Index 1981-1983

Month	Species frequencies			Temperature index		
	1981	1982	1983	1981	1982	1983
October	73 a	32 b	_	(2) -2.8	(2) -1.8	_
November	150 b	167 a	_	(2) -1.4	(0)	_
January	_	693 b	960 a	_	(5) -6.4	(0)
March	_	119 b	174 a	_	(6) -4.1	(3) -4.9

WeBS trends were similarly dynamic during September-November and January-February, shown on graphs 84 and 85. Trend population peaked in January, the second highest index term.





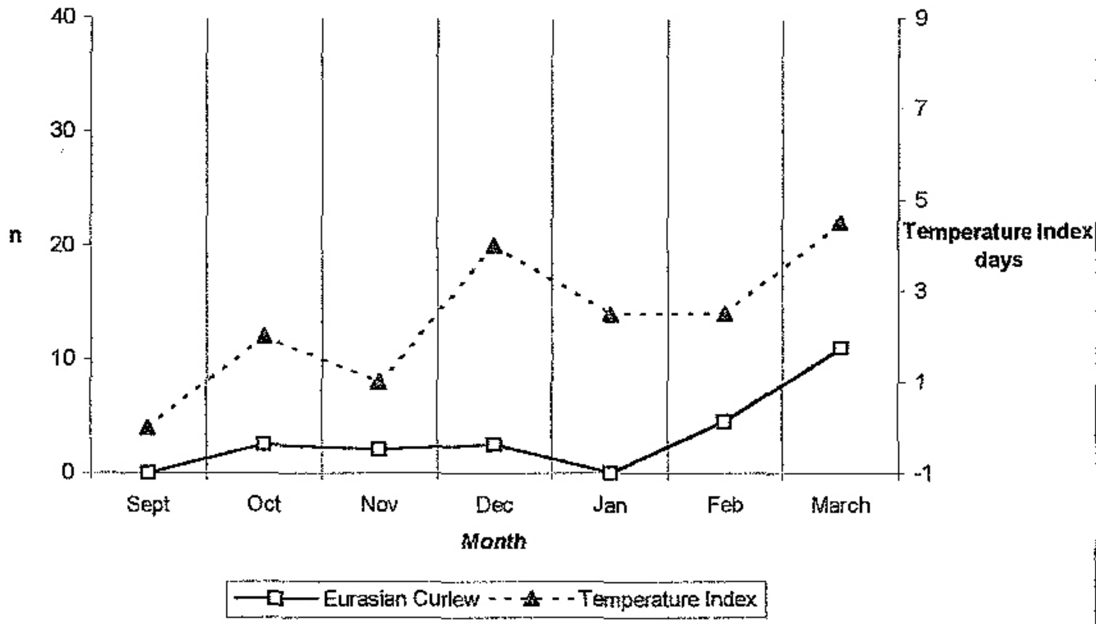
Above trend population outliers corresponded higher index days, for instance March 1995, shown in appendix 21 table Q, and were in reverse correspondence with lower index days, for example January 1998, shown in appendix 21 table R. Generally, lapwing preferred mild conditions but demonstrated low temperature tolerance to –10° C, February 1996.

Eurasian Curlew *Numenius arquata*

1981-1983 trends were similarly dynamic during September-January and February-March, shown on graph 86. Trend population peaked in March highest index term.

Graph 86

Eurasian Curlew and Temperature Index trends 1981-1983



Above trend population outliers corresponded with higher index days, such as February 1982, shown in table 40, and were in reverse correspondence with lower index days, for example March 1983, shown in table 41.

Table 40

Corresponding outliers of Eurasian Curlew and Temperature Index Days 1981-1983

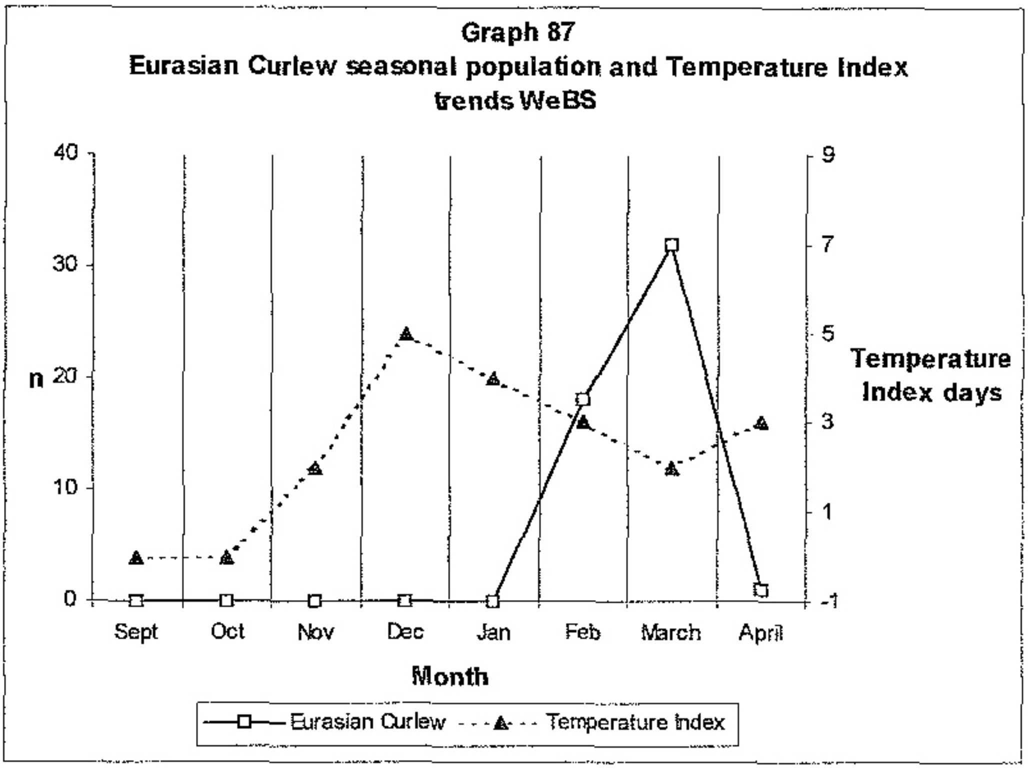
Month	Species numbers			Temperature index		
	1981	1982	1983	1981	1982	1983
December	0 b	5 a	_	(2) -2.0	(6) -6.9	_
February	_	0 b	9 a	_	(2) -1.8	(3) -8.8

Table 41

Reverse corresponding outliers of Eurasian Curlew and Temperature Index days 1981-1983

Month	Species numbers			Temperature index		
	1981	1982	1983	1981	1982	1983
October	0 b	5 a	_	(2) -2.8	(2) -1.8	_
November	0 b	4 a	_	(2) -1.4	(0)	_
March	_	5 b	17 a	_	(6) -4.1	(3) -4.9

WeBS trends were dissimilar, shown on graph 87. Population trends peaked in March, the second highest index term.



Above trend outliers corresponded with higher index days, for example March 1995, shown in appendix 21 table S, and were in reverse correspondence with lower index days, such as March 1996, shown in appendix 21 table T. Overall, ameliorating temperatures were preferred but temperatures to -10° C, February 1996, were tolerated. A high proportion of zeros necessitates cautious interpretation.

Summary

Table 42 summarises species temporal distributions during the primary 11-day terms. Conclusions are: (i) 1981-1983 species abundance classes were evenly distributed between temperature index classifications due to the dataset of 12 counts; the single September count was excluded from *abundance classes. (ii) Four and five species populations of* 1981-1983 and WeBS respectively peaked at higher temperature indices, lower temperatures; a notable exception was the curlew March peak common to both surveys. (iii) *Mid-winter peaks, such as January for lapwing, demonstrated seasonality.*

(iv) Mid-winter peaks and above median outliers at higher indices indicted low temperature tolerance, such as wigeon and teal in 1981-1983. Conversely, low trend and above median outliers in reverse correspondence demonstrated intolerance, for example curlew in both surveys. (v) Absence of migrants early and late in the seasons was attributable to migration.

Table 42

Summary of 1981-1983 and 1995-2002 species abundance classes and Temperature Index associations

Species	1981-1983					WeBS				
	Species abundance class			Temperature Index		Species abundance class			Temperature Index	
	Above trend class	Trend class	Sub-trend class	Nos corres-ponding outliers	Nos reverse corres-ponding outliers	Above trend class	Trend class	Sub-trend class	Nos corres-ponding outliers	Nos reverse corres-ponding outliers
Mute Swan	6 (50%)	–	–	3 (25%)	3 (25%)	19 (45%)	–	–	6 (14%)	13 (31%)
[12]	–	–	–	–	–	–	5 (12%)	–	2 (5%)	3 (7%)
{42}	–	–	6 (50%)	3 (25%)	3 (25%)	–	–	18 (43%)	5 (12%)	13 (31%)
Whooper	2 (50%)	–	–	1 (25%)	1 (25%)	10 (34%)	–	–	3 (10%)	7 (24%)
Swan	–	–	–	–	–	–	14 (49%)	–	3 (10%)	11 (39%)
[4]	–	–	2 (50%)	1 (25%)	1 (25%)	–	–	5 (17%)	2 (7%)	3 (10%)
{29}										
Eurasian	5 (50%)	–	–	2 (20%)	3 (30%)	19 (55%)	–	–	7 (20%)	12 (34%)
Wigeon	–	–	–	–	–	–	4 (11%)	–	3 (9%)	1 (3%)
[10]	–	–	5 (50%)	2 (20%)	3 (30%)	–	–	12 (34%)	4 (11%)	8 (23%)
{35}										
Common	6 (50%)	–	–	2 (17%)	4 (33%)	19 (46%)	–	–	7 (17%)	12 (30%)
Teal	–	–	–	–	–	–	6 (15%)	–	5 (12%)	1 (2%)
[12]	–	–	6 (50%)	2 (17%)	4 (33%)	–	–	16 (39%)	3 (7%)	13 (32%)
{41}										
Mallard	6 (50%)	–	–	3 (25%)	3 (25%)	18 (43%)	–	–	7 (17%)	11 (26%)
[12]	–	–	–	–	–	–	5 (12%)	–	4 (10%)	1 (2%)
{42}	–	–	6 (50%)	3 (25%)	3 (25%)	–	–	19 (45%)	6 (14%)	13 (31%)
Northern	0 (0%)	–	–	–	–	15 (38%)	–	–	5 (12.5%)	10 (25%)
Pintail	–	4 (100%)	–	0 (0%)	4 (100%)	–	11 (27%)	–	6 (15%)	5 (12.5%)
[4]	–	–	0 (0%)	–	–	–	–	14 (35%)	4 (10%)	10 (25%)
{40}										
Northern	6 (50%)	–	–	2 (17%)	4 (33%)	20 (48%)	–	–	5 (12%)	15 (36%)
Lapwing	–	–	–	–	–	–	6 (14%)	–	3 (7%)	3 (7%)
[12]			6 (50%)	2 (17%)	4 (33%)			16 (38%)	5 (12%)	11 (26%)
{42}										
Eurasian	6 (50%)	–	–	2 (17%)	4 (33%)	11 (37%)	–	–	5 (17%)	6 (20%)
Curlew	–	–	–	–	–	–	11 (37%)	–	5 (17%)	6 (20%)
[12]	–	–	6 (50%)	2 (17%)	4 (33%)	–	–	8 (26%)	2 (6%)	6 (20%)
{30}										

[ ] : 1981-1983 survey number of counts considered

{ } : 1995-2002 WeBS number of counts considered

Chapter 10

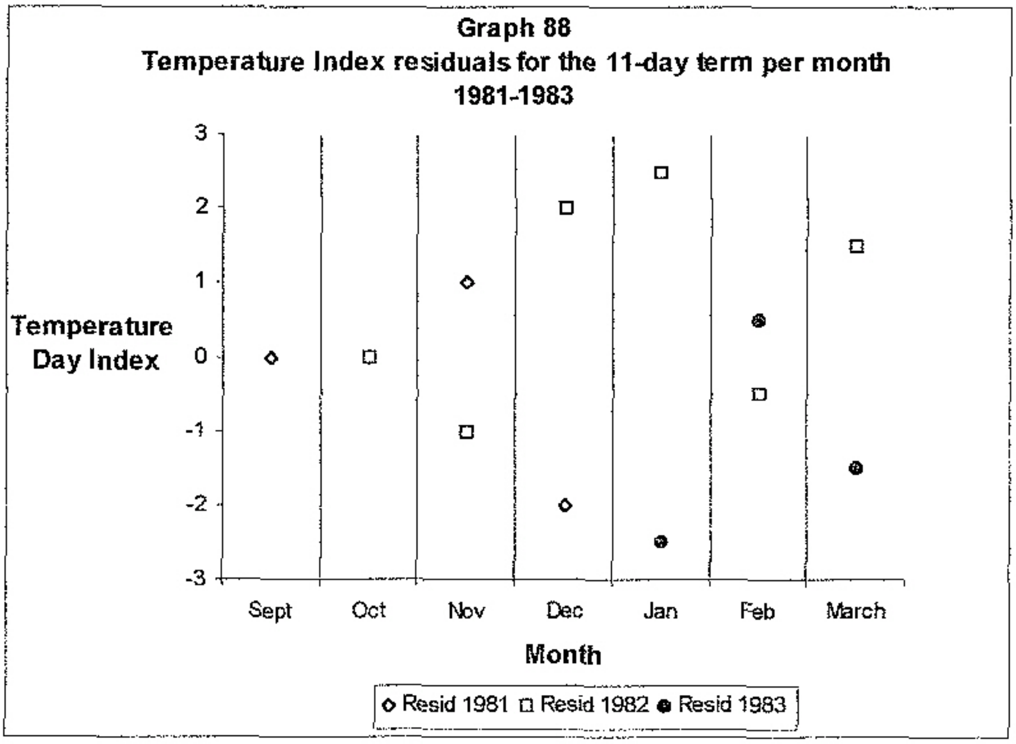
Statistical analysis of species seasonal population residuals and temperature index 11-day term per month residuals

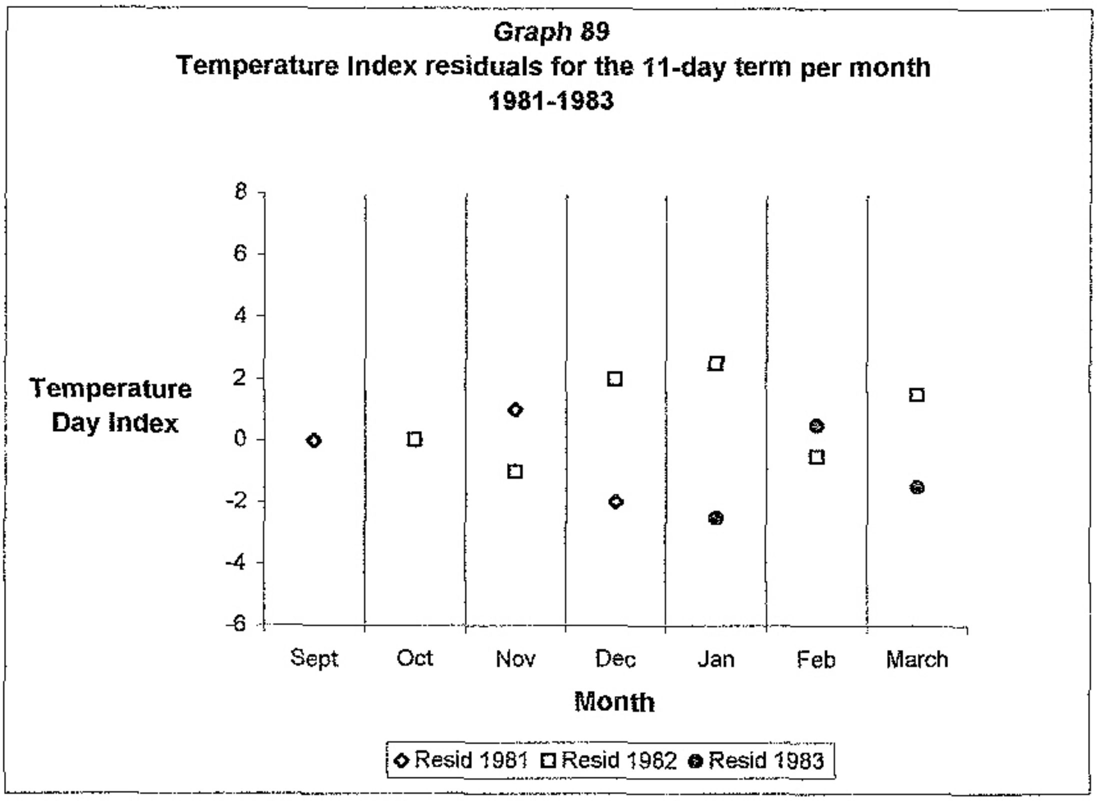
Hypothesis

The null hypothesis: if, on the sites, waterbird abundances were not less when local temperatures were below 0° C compared to temperatures above 0° C, then the null hypothesis was not rejected. The alternative hypothesis: if waterbird abundances were greater when to local temperatures were below 0° C compared to temperatures above 0° C, then the null hypothesis was rejected in favour of the alternative hypothesis.

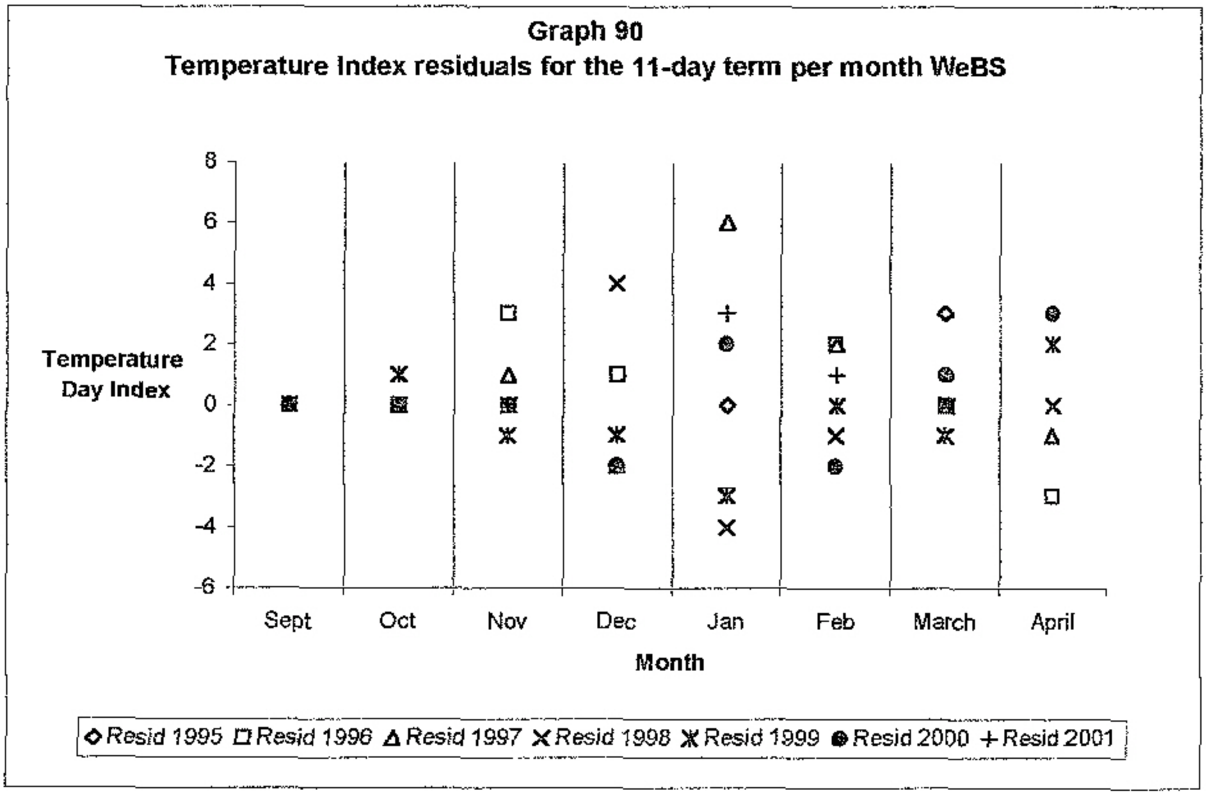
Temperature Index residuals

The 11-day term was considered the appropriate period of temperature influence on birds; day 11 was the survey day. The temperature index 11-day *term residuals were computed for* 1981-1983 *and* WeBS *for which the ranges* were –2.5 to 2.5 and – 4 to 6 respectively and are shown on graphs 88, 89 and 90 and in appendix 20. 1981-1983 residuals peaked in January 1982 and *WeBS in January* 1997.





Graph 89
Temperature Index residuals for the 11-day term per month
1981-1983
Temperature Day Index
8
6
4
2
0
-2
-4
-6
Sept
Oct
Nov
Dec
Jan
Feb
March
Month
Resid 1981
Resid 1982
Resid 1983



Graph 90
Temperature Index residuals for the 11-day term per month WeBS
Temperature Day Index
8
6
4
2
0
-2
-4
-6
Sept
Oct
Nov
Dec
Jan
Feb
March
April
Month
Resid 1995
Resid 1996
Resid 1997
Resid 1998
Resid 1999
Resid 2000
Resid 2001

Species Accounts

For both surveys, the probability during the temperature index 11-day terms was non-significant ($P > 0.05$); thus the null hypothesis was accepted for each species.

Summary

There was no statistical relationship between below zero Celsius temperatures and greater abundances of each species.

Chapter 11

Time series analysis of species seasonal population trends and wind velocity trends

The purpose of time series analysis of species seasonal population trends and wind index trends of both surveys is to determine the:

(i) trend directions of species seasonal populations in relation to 4-day wind index term per month;

(ii) to determine associations between species trends and wind index trends and by examination of medians, corresponding and reverse corresponding outliers to detect reasons for distribution patterns;

(iii) detection of noise in datasets of species and wind indices.

The wind datasets are extensive (Meteorological Office, Shawbury 2003) and are available from the author. The 4-day wind index term per month consisted of day 1 as the survey date and by counting backwards each day for three days. Wind index was constructed as the highest recorded daily wind velocity, excluding gusts, in accordance with the scale shown in table 43, a single index was assigned per day. The wind index datasets for 1981-1983 and WeBS are in appendix 22. Wind index abundance classes were computed as above trend, median and sub-trend.

Table 43

Wind Index

Wind strength	Velocity knots	Index
Calm	0	0
Light	1 - 10	1
Moderate	11 - 16	2
Fresh	17 - 21	3
Strong	22 - 27	4
Near gale	28 - 33	5
Gale	34 - 40	6
Strong gale	41 - 47	7
Storm	48 - 55	8

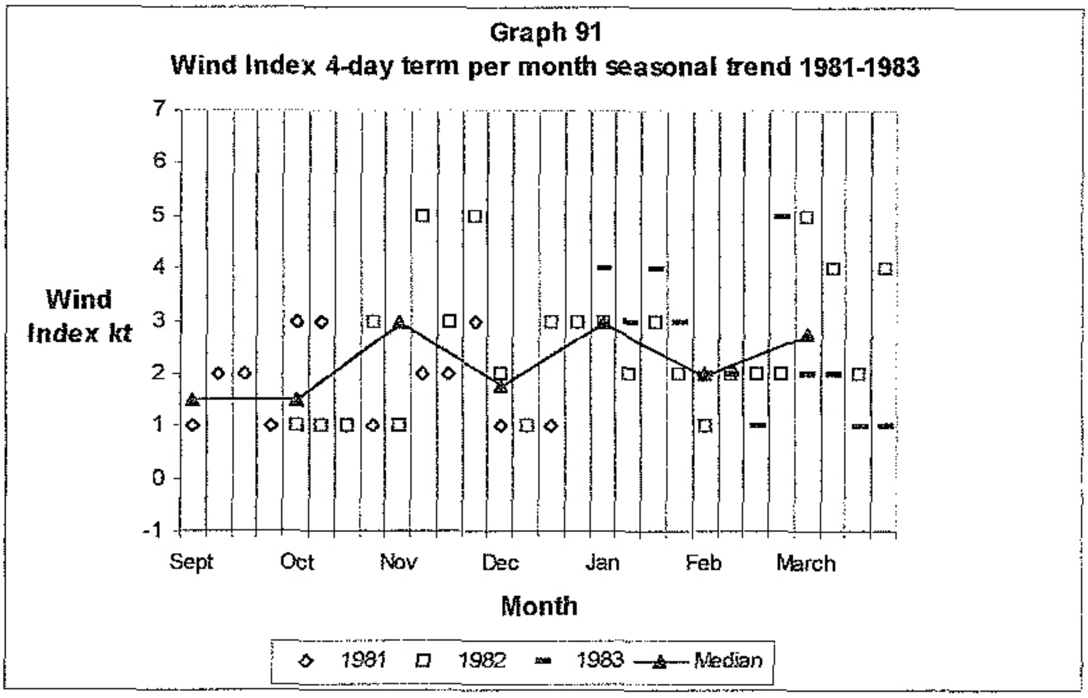
(Meteorological Office, Shawbury 2003).

For ease of presentation the following footnote is applicable to species seasonal population and wind index tables:

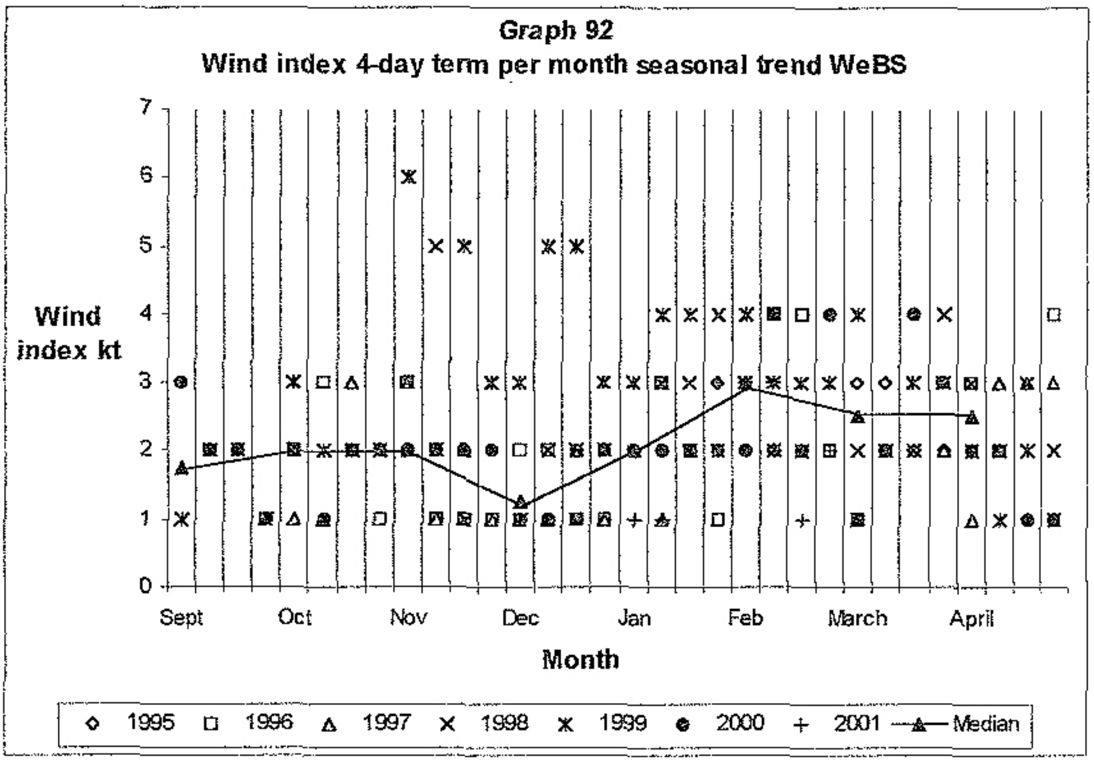
a: above median abundance; b: below median abundance
Wind index first line: above trend; m: median; second line: - sub-trend
c: corresponding outlier; r: reverse corresponding outlier

Wind Index

The 1981-1983 4-day wind index term trend: (i) was a multi-modal asymmetrical distribution, shown on graph 91; (ii) index trend range was 1.5 to 2.75 knots; (iii) joint peaks were in November and January; (iv) pattern was: stable during September-October, increased in October-November, December-January and February-March.

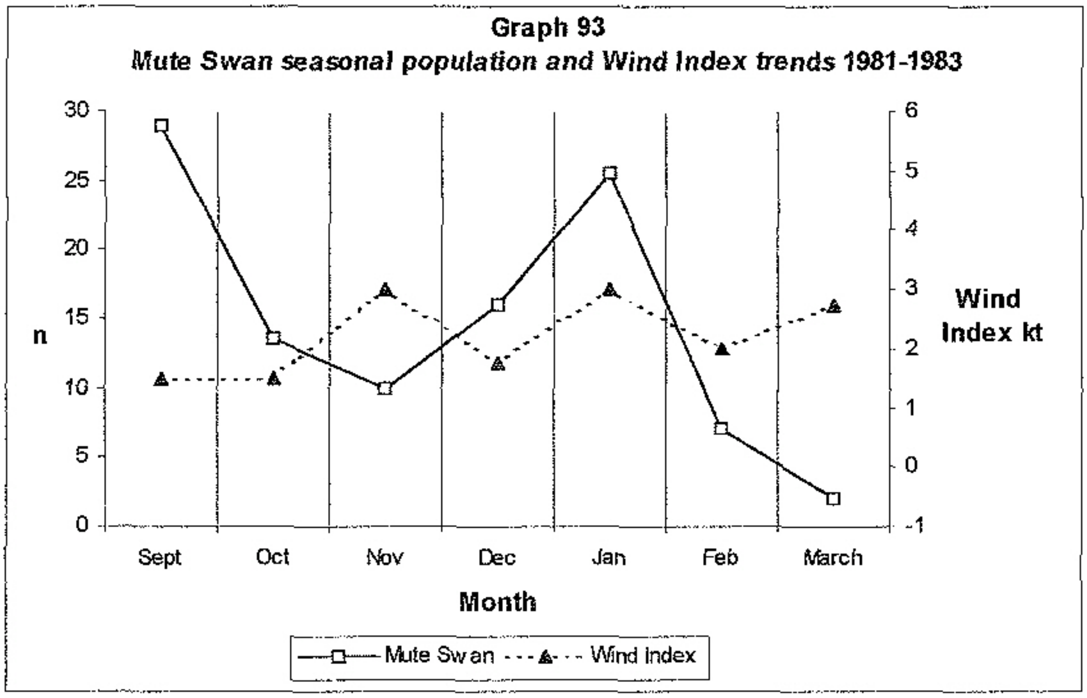


WeBS 4-day wind index term trend was: (i) unimodal, negatively skewed distribution, shown on graph 92; (ii) range was 1.25-3 knots; (iii) peaked in February and the minimum was in December; (iv) index pattern was: stable during October-November and March-April and increased during December-February.



Mute Swan *Cygnus olor*

1981-1983 trends were dynamically similar during December-February, shown on graph 93. Populations peaked in September, the joint lowest index term and sub-peaked during January, the joint highest index term.



Corresponding variables were dominant in October-January and were half the dataset, shown on table 44. Variables in reverse correspondence were more frequent during February and March, shown on table 45. Above and sub-trend abundances were equally frequent at higher and lower indices.

Table 44

Corresponding outliers of Mute Swan and Wind Index 1981-1983

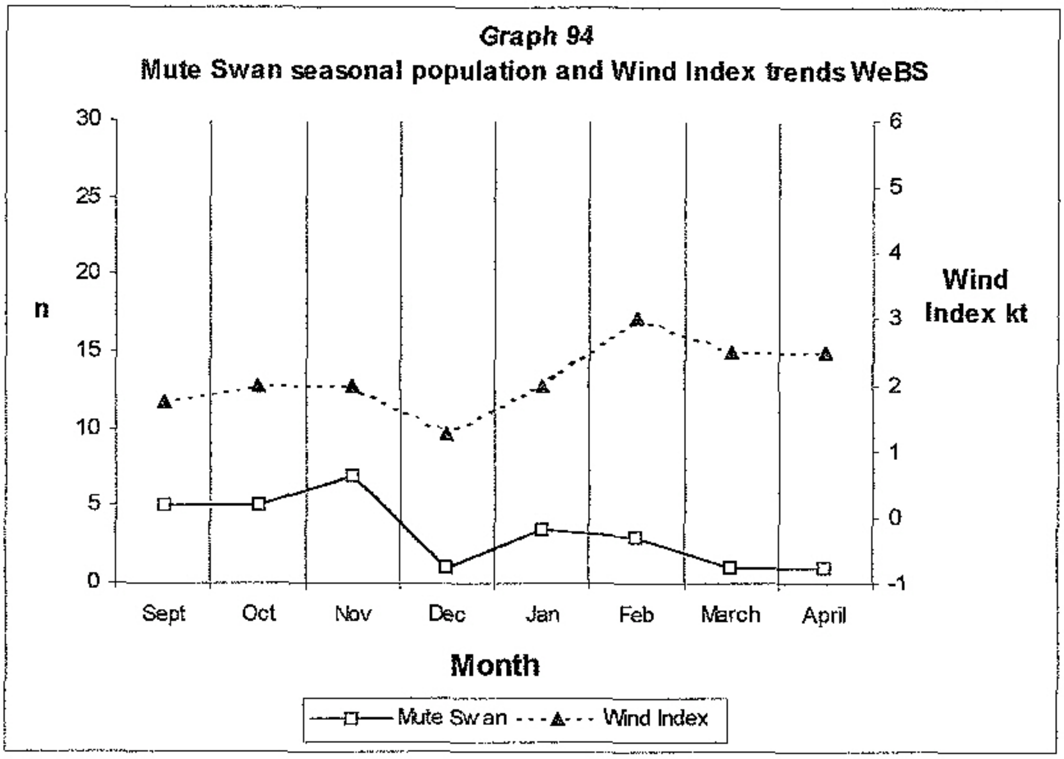
Month	Mute Swan populations			Wind Index		
	1981	1982	1983	1981	1982	1983
October	14 a	13 b	_	2 -2	1 -3	_
December	8 b	24 a	_	1 -3	3 -1	_
January	_	20 a	31 a	_	2 m -2	2 2 m

Table 45

Reverse corresponding outliers of Mute Swan and Wind Index 1981-1983

Month	Mute Swan populations			Wind Index		
	1981	1982	1983	1981	1982	1983
November	14 a	6 b	_	1m -3	2 1m -1	_
February	_	0 b	14 a	_	3 m -1	1 2 m -1
March	_	0 b	4 a	_	3 -1	0 -4

WeBS trends were dynamically similar during November-January and declined in February-March, shown on graph 94. Populations peaked in November, the joint highest index term.



Corresponding outliers were predominant during October-December, shown in table 46; reverse correspondence was more frequent in January-April trend decline, shown in table 47. Sub-trend and median abundances occurred more frequently with lower indices, notably February-April.

Table 46

Corresponding outliers of Mute Swan and Wind Index WeBS

Month	Mute Swan abundances							Wind Index						
	1995	1996	1997	1998	1999	2000	2001	1995	1996	1997	1998	1999	2000	2001
October	_	r	3 b	r	r	28 a	_	_	r	1 1 m -2	r	r	3 m -1	_
November	_	0 b	2 b	13 a	r	9 a	_	_	1 -3	1 1 m -2	3 -1	r	4 m 0	_
December	0 b	2 a	0 b	14 a	r	r	_	1 -3	2 -2	1 -3	3 -1	r	r	_
January	r	0 b	r	9 a	_	r	0 b	r	2 1 m -1	r	4 0	_	r	1 1m -2
February	r	r	r	r	r	r	9 a	r	r	r	r	r	r	2 m -2
March	2 a	r	r	0 b	r	7 a	_	2 -2	r	r	1 -3	r	2 -2	
April	_	2 a	r	5 a	r	0 b	_	_	2 -2	r	2 -2	r	0 -4	_

Table 47

Reverse corresponding outliers of Mute Swan and Wind Index WeBS

Month	Mute Swan abundances							Wind Index						
	1995	1996	1997	1998	1999	2000	2001	1995	1996	1997	1998	1999	2000	2001
September	_	_	_	_	8 a	2 b	_	_	_	_	_	2 -2	3 -1	_
October	_	7 a	c	3 b	5 m	c	_	_	1 2 m -1	c	1 3 m	1 3 m	c	_
November	_	c	c	c	7 m	c	_	_	c	c	c	3 1 m	c	_
December	c	c	c	c	0 b	2 a		c	c	c	c	4 0	1 -3	_
January	5 a	c	5 a	c	_	2 b	c	1 3 m	c	3 m -1	c	3 1 m	4 m 0	c
February	10 a	0 b	0 b	3 m	3 m	2 b	c	1 m -3	3 -1	4 m 0	2 m -2	1 3 m	2 -2	c
March	c	0 b	4 a	c	0 b	c	_	c	2 -2	1 -3	c	3 -1	c	_
April	_	c	1 m	c	1 m	c	_	_	c	3 -1	c	0 -4	c	_

In summary, 1981-1983 as overall trends increased to mid-winter and subsequently declined, species above and sub-trend abundances occurred during higher and lower index classes respectively at approximately equal frequencies. WeBS period of trend increase, December-January, above trend outliers corresponded; during diminution, January-April, lower indices were four times more frequent.

Whooper Swan *Cygnus cygnus*

Zeros were dominant in the datasets. 1981-1983 trends declined during January-February, shown on graph 95. Populations peaked during