

Preliminary Study on Bird Migration on Po Toi Island

(Spring 2007)

Final Report



Submitted by
Hong Kong Bird Watching Society
to Agriculture, Fisheries & Conservation Department
Hong Kong SAR Government

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The Hong Kong Bird Watching Society

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1. Executive Summary

This study is the first specific to land bird migration in Hong Kong. Po Toi Island was chosen as a known but little recorded migration site. A carefully selected route was identified to cover the best migrant habitats on the island and a daily census of all non-resident birds was made around this route on 66 days between 13th February and 31st May 2007. In addition, a census of sea bird migrants was made over the same period from a suitable sea watching point.

A total of 141 land bird species and 23 sea bird species was recorded, which represents more than 95% of these species types seen in Hong Kong over the same period and confirms Po Toi as the premier location in Hong Kong for the study of spring migration of land and sea birds (Mai Po remains the premier location for the study of water birds). Various analyses of species seen by frequency, area and over time are presented in the report together with the complete daily record file.

An analysis of the number of land bird species seen each day and the weather conditions on and immediately preceding that day shows that a significantly larger number of species (a 'bird influx') occurs on the day following the passage of a cold weather front through Hong Kong. Analysis of the weather conditions around the South China Sea and the species seen on these bird influx days indicate that the birds' origin is North Philippines and that they have been blown westwards off their normal northerly migration route by the cold front passage to arrive in Hong Kong.

A similar analysis of the number of sea birds seen each day, although less conclusive, indicates that sea bird migration past Po Toi occurs most often with calm conditions or winds from the south.

In addition, certain common land bird species which are considered resident on Hong Kong are seen at least as partial migrants on Po Toi.

The main recommendation is to continue the detailed recording of spring migration on Po Toi to enhance our understanding of spring bird migration in the South China area, and to extend the study to include autumn migration also.

2. Background

2.1 Past Observations on Bird Migration in Hong Kong

Water and sea birds in Hong Kong have been the object of several studies because of the international significance of Deep Bay and with the 2006 Sea Bird Survey. However, no specific study seems to have been done on land bird migrants in Hong Kong or South China. Neither place receives a mention in the migration study of birds of Asia by McClure (1998). Raptor migration in Hong Kong is more adequately covered in Zalles and Bildstein (2000) but raptors only constitute a small proportion of all land birds and no specific conclusions are drawn.

An unusual characteristic of land bird migration in Hong Kong was noted as early as 1913 (Vaughan and Jones, 1913). To quote from their report 'It is very interesting to note the fact that several species of birds which are easily and abundantly observed on their spring migration were never seen on their autumn passage, and that in rarer instances the converse obtained'. This was restated by Chalmers in 1986, 'One of the most intriguing (mysteries) is the relative abundance of many migrant species in spring compared to autumn' (Chalmers, 1986).

The first tentative explanation of this mystery was given by Lam and Williams in 1993, 'Typically, spring is marked by a succession of influxes of migrants. All these influxes were associated with easterly or northerly surges arriving in Hong Kong', and further '(one influx) was notable for the occurrence of birds wintering primarily in the Philippines' (Lam and Williams, 1993). Lam and Williams suggested that in this influx, 'a trough lying between south China and the Philippines caused northbound migrants from the Philippines to be drifted into Hong Kong'.

2.2 Po Toi as a Migration Site

Po Toi started to feature on the Hong Kong birding map with a 1996/7 study done by Leader (unpublished). Twice-monthly visits were made during the period November 1996 to November 1997, and detailed data on all birds seen was recorded. Leader calculated that 73% of birds seen by him on Po Toi during the year were migrants, and correctly predicted this number would rise as a result of more detailed survey work. As a result, Leader identified Po Toi as 'an excellent site for the study of bird migration' and stated that 'a systematic monitoring programme would have high conservation value'.

Unfortunately, the absence of a regular ferry service which provided time to count birds on the island prevented this from being pursued, and

consequently records from Po Toi in Hong Kong Bird Watching Society annual and quarterly reports are relatively few and unsystematic. However, since December 2005, changes in the ferry service have allowed more regular visits to be made and the conclusions drawn by Leader have been validated.

A less formal study done in spring 2006 confirmed Leader's observations (see Appendix 1). The purpose of the 2007 study was to obtain preliminary but systematic information on birds on Po Toi Island during the spring migration period of 2007 with a view to understanding the bird migration pattern there.

2.3 Survey Details

The survey was conducted on 66 days between 13th February and 31st May 2007, a coverage of 61% of days available. See Appendix 2 for details.

The first significant observation of spring migration was seen on 5th March. The period 1st March to 31st May has therefore been taken as the spring migration period in this report in order to avoid confusion with the movements of wintering species prior to 1st March. The survey coverage in this period was 58 days or 63% of days available.

2.4 Survey Methodology

A daily census of all non-resident birds was made using a set route around the accessible southern part of the island. Two counts were done daily, one in the morning and one in the afternoon. A single daily total for each species was taken as the maximum of the two counts.

Two habitat areas were counted separately (see map in Appendix 3)

Area 1 - Fung shui trees and woodland scrub with an inter-tidal pond

Area 2 - Bush scrub, grassland and bare rock

Individual counts of all winter visitors (species known to have wintered on Po Toi in winter 2006/7) and spring migrant species (non-resident species which did not winter on Po Toi in 2006/7) were made each day for land birds. In addition, a separate record was made of visible migrants (land birds seen migrating over the sea or flying directly over Po Toi without stopping). Separate counts of migrant seabirds were done on a regular basis from a sea-watching position at the south point.

Data on wind speed and direction and average temperature was taken from the Hong Kong Observatory data for Waglan Island. Hong Kong Observatory weather maps were saved in electronic format on a daily basis to record general weather conditions in the Hong Kong and the South China

Sea area and Hong Kong Observatory provided satellite photographs to complement the weather maps.

3. Results

3.1 Species Totals and Breakdown

A total of 164 migrant species was seen as given in Table 1.

Table 1: Overall Breakdown of Species Seen

	Area 1	Area 2	Total Land (Different Species)	Visible Migrant	Total Land+VisMig (Different Species)	Sea Bird Species	Total Different Species
Winter Visitor/Spring Migrant	21	13	23		23		23
Spring Migrant only	98	42	104	38	120	23	141
Total Migrant Species	119	55	127	38	143	23	164

‘Winter Visitor/Spring Migrant’ is a species known to have over-wintered in that area.

‘Spring Migrant only’ is a species which did not over-winter in that area.

Visible Migrant means land birds seen migrating over the sea or flying directly over Po Toi without stopping.

A breakdown of the 164 species by species type is as follows

Land Birds	124 species
Sea Birds	23 species
Waders	17 species

Appendix 4 has a detailed list of species included in each category.

With the exception of waders, for which Mai Po is the premier site in Hong Kong for spring migration, these species numbers represent more than 95% of the species seen in Hong Kong this spring and confirm Po Toi as the premier site for land and sea bird spring migration in Hong Kong.

3.2 Species Frequency

Appendix 4 lists the species seen in each category Land Bird, Sea Bird and Waders and the frequency with which they were seen in the migration period, 1st March to 31st May. Barn Swallow was the most frequent land bird, seen on 98% of all days, Red-necked Phalarope the most frequent sea bird (46%) and Common Sandpiper the most frequent wader (53%).

Of the 164 species, 2 land birds and 1 sea bird are potential first records for Hong Kong – Common Cuckoo, Red-breasted Flycatcher and Bulwer's Petrel. Other rare spring records include Black Bittern, Malayan Night Heron, Drongo Cuckoo, Thick-billed Warbler and Purple-backed Starling.

3.3 Weekly Sequence of Bird Species

Appendix 5 lists the species seen by week from 1st March to 31st May. Charts at the end of Appendix 5 summarise this data and show a breakdown of species numbers by week and by type.

3.3.1 Land Birds

Week 3 of March was the main week for the migration of species which were winter visitors, mostly thrushes and chats. Week 2 and week 4 of April were the main weeks for spring passage migrants, with a slight drop in species numbers in week 3 of April. This result is consistent with data from Po Toi Spring 2006.

The following are potentially the latest ever spring records for Hong Kong

Ferruginous Flycatcher – 26th April
Pallas's Leaf Warbler – 1st May
Eastern Crowned Warbler – 1st May
White-cheeked Starling – 15th May
Yellow-browed Warbler – 18th May
Swinhoe's Minivet – 21st May
Black-faced Bunting – 29th May

3.3.2 Unexpected Land Bird Migrants

Certain species which are usually regarded as resident in Hong Kong were noted as migrants, both coming into Po Toi and leaving Po Toi

Outgoing migrants – Chinese Bulbul (late April and May), Japanese White-eye (late April), Crested Myna (early May)
Incoming migrants – Black-crowned Night Heron (late May), Black Kite (late February and early March), White-breasted Waterhen (late May), Eurasian Tree Sparrow (April and May), Large-billed Crow (early April).

The Eurasian Tree Sparrow is perhaps the most interesting, the dates of arrival suggest migration from the Philippines (see section 4.5).

3.3.3 Sea Birds

No sea birds were seen until week 2 of March. This is not consistent with 2006, when spring migrants such as Heuglin's Gull were seen from early February. No reason can be given for this difference between the two years and observations in future years will be necessary to decide which is more normal.

Main weeks for species were week 2 in March, week 4 in April and week 2 in May. Different species types were involved in each of these weeks, gulls in March, skuas and early terns in April and the main tern movement in May.

A major migration of 687 Heuglin's Gulls was seen between 13th and 22nd March, and of 939 Red-necked Phalarope in 2 hours on 26th March. A migration of 38 Short-tailed Shearwaters was seen between 30th April and 23rd May. Two very late immature Black-tailed Gulls were seen on 2nd and 14th May and are potentially the latest spring records for this species since 1986.

4. Discussion

The purpose of this study was to obtain preliminary but systematic information on birds on Po Toi Island during the spring migration period of 2007 with a view to understanding the bird migration pattern there. Section 3 above together with Appendices 4 to 6 and the basic data file provide the systematic information of the study. The purpose of this section is to try to understand the bird migration pattern behind the data.

Because birds fly long distances on migration, weather is a main determining factor, and in particular the wind direction and strength. This section will attempt to relate the number of birds seen during the survey with the weather conditions. Land birds and sea birds are investigated separately because of the different circumstances in which they are seen (see section 4.6).

4.1 Land Bird Influxes

The first chart in Appendix 6 shows the number of spring migrant species seen on each census day in March, April and May. The chart shows a steady background increase in species from early March to late April, followed by a decline towards the end of May. This background trend is as expected for spring migration in Hong Kong.

Small fluctuations in daily numbers can be considered random. However, there are sudden increases in species at regular intervals through the period, representing influxes of new migrants. If an influx is defined as a day when

5 or more species are seen above the count on the previous day (see Appendix 7 for more detail), influxes occurred on the following dates

March – 5th, 24th, 26th

April – 3rd, 9th, 10th, 18th, 25th

May – 1st, 13th, 21st

4.2 Weather Conditions on Influx Dates for Land Birds

4.2.1 Significance of cold fronts/depressions

For a definition of a cold front and a depression, see Appendix 8.

Of the 11 influx dates above, 9 are the day after the passage of a cold front or depression through Hong Kong. As an example, the Weather Charts for the two main influx dates, 3rd and 25th April, are attached in Appendix 10.

This result is statistically very significant (chi-squared test, $p < 0.0001$ that the events of cold front passage and influx occurrence are unrelated) and shows that spring influxes occur with the passage of a cold front through Hong Kong. (see Appendix 7)

Only 3 cold fronts passing through Hong Kong in the March to May period did not cause an influx of birds (as defined above), those passing through on 17th March, 27th March and 17th May. As no visit was made to Po Toi on the day following the cold front of 17th March, an influx may have been missed on 18th. The absence of an influx on 28th March was probably because migrant numbers were already high following influxes on 24th and 26th March and consequently no significant increase was registered on 28th. On 17th May, the wind direction in Hong Kong was not suitable for migrants to arrive (for data on weather conditions on this date, see Table 2 below). Other factors such as the lateness of the season may also be involved.

The coincidence of cold front/depression passage and influxes of spring migrants is an established pattern from 2006 and, as noted earlier, is reported in Lam and Williams (1993).

The way influxes occur suddenly on the day after a cold front and then species numbers decline in the following days is a strong indication that Po Toi is a first arrival point for migrants, the point at which they first make landfall after a migration flight. This is confirmed by visual observation of migrants arriving on influx days.

4.2.2 Weather conditions across the South China Sea on Influx Dates

An analysis of weather conditions in the South China Sea area, Hong Kong, North Philippines and Hainan on these influx dates, ordered by influx size, can be seen from Table 2. Weather data is taken from the Hong Kong Observatory weather maps and weather reports for that date.

Table 2: Weather conditions over the South China Sea on influx dates

	Size of Influx	Cold Front/ Depression day before	Hong Kong			North Philippines		Hainan	
			Wind Direction	Wind Force	Rain mm Day Before	Wind Direction	Wind Force	Wind Direction	Wind Force
Major Influxes									
3.4.07	16	Yes	N	5	24.2		1	SW	4
25.4.07	15	Yes	N	3	64.4	S	2	SE	2
10.4.07	13	Yes	NE	4	0.0	SE	3	E	2
21.5.07	11	Yes	E	4	81.6	SE	2	SW	4
Minor influxes									
5.3.07	8	Yes	E	4	0.1	S	2	E	3
26.3.07	8	Yes	S	4	0.0	E	4	SE	4
13.5.07	8	No	E	3	0.0	E	3	E	2
9.4.07	6	Yes	E	4	0.3	NE	4	E	3
18.4.07	6	Yes	N	4	6.6	SW	3	SE	3
1.5.07	6	Yes	N	2	1.8	S	2	NE	3
24.3.07	5	Yes	E	2	0.0	SE	3	E	3
No Influx									
28.3.07	2	Yes	NE	4	3.9	SE	2	E	3
17.5.07	-2	Yes	W	2	0.1	SE	2	SW	2

For a definition of Wind Force, please see Appendix 9.

4.2.3 The Effect of Rain

Significant amounts of rain (over 10mm) occurred in Hong Kong on the same day or the day before three of the four major influxes. Either would have an effect, because under both conditions the migrant would encounter rain while on its migration flight over the sea.

The effect of rain is to bring the migrants down to ground on the first land they reach, Po Toi and its surrounding islands. Without the rain they may continue their migration and over-fly the coastal areas. Rainfall itself is not the cause of the influx (influxes can occur when there is little rain) but can increase the size of the influx.

4.3 Where do the Migrants come from?

Given its geographical location on the coast of south China with the South China Sea to the south, the possible sources of spring land bird migrants in Hong Kong are the Philippines and eastern South East Asia (Vietnam and Hainan). A long sea crossing from Borneo is possible but unlikely.

Favourable conditions for migrants to begin a migration are a light to moderate following wind with fair weather. The favourable wind direction for birds from the Philippines (moving north to north west) is from the South East quadrant, and for birds from East Vietnam/Hainan (moving north east) is from the South West quadrant.

From the above table, the wind conditions in North Philippines on the dates of influxes are favourable for migrants from the Philippines on all days except 9th April, whereas the wind conditions in Hainan are unfavourable for migrants from there on all days except 3rd April and 21st May.

This indicates that the influx birds are most likely to have come from the Philippines on all influxes except 3rd April and 21st May when they may have come from both Philippines and East Vietnam/Hainan.

4.4 Why do Cold Fronts/Depressions cause Influxes?

Cold fronts/depressions occur frequently in Hong Kong in the March to May period, the transition period between winter and summer. This timing also coincides with the main spring migration period for birds flying north across and around the South China Sea.

Cold fronts usually cross Hong Kong in a north to south direction. In front of the cold front, the weather is quiet with light southerly winds. Behind the cold front, the wind is usually strong from the North East. The cold front itself carries turbulent cloud and often rain. Depressions in May can create similar weather conditions (see Appendix 8).

Appendix 11 shows the Hong Kong Observatory Satellite Photos for 8pm on 2 April and 8am on 3 April, the largest influx day. On the evening of 2 April, migrants can leave the Philippines in conditions which appear ideal (clear skies and light southerly winds) but overnight encounter a sudden change to unfavourable conditions of wind and rain when over the Bashi Channel. If the winds are too strong to fly into, their only recourse is to be carried west by the winds and come down on the first land reached. The location of Po Toi and the Dangan Islands off the coast and north west of the Philippines make this their first landing point if they arrive in the Hong Kong area.

These conditions only apply in the usually short time that the front is over the Bashi Channel. Before it arrives, the migrants can make their correct destination safely. After it has passed through, the wind conditions in North Philippines are northerly and unsuitable for migrants to start their migration (see Hong Kong Observatory Satellite Photo for 8am on 4 April, Appendix 11).

The ideal conditions will usually only last for one day, which is why influxes occur on specific days and are not prolonged. However, in 2006, cold fronts remained stationary over the Bashi Channel on two occasions, causing an extended period of influx on Po Toi.

4.5 Land Bird Influx Species

Species occurring most frequently in influxes are

Egrets, Intermediate, Little, Cattle, Pond and Striated Heron (mostly April and May)

Bitterns, Yellow, Schrenck's and Black (late May)

Waders (April)

Raptors, Grey-faced Buzzard and Chinese Goshawk (late March and April)

Cuckoos, Cuculus, Plaintive and Koel (late March and April)

Hirundines, Silver-backed Needletail (March), Pacific, Little Swift, Barn Swallow and Asian House Martin (March and April)

Dollarbird (April)

Wagtails, Yellow, Grey (April and May)

Pipits, Richards, Pechora and Olive-backed (April and early May)

Minivets, Ashy and Swinhoe's (April)

Brown Shrike (late April and May)

Flycatchers, Grey-streaked, Asian Brown, Ferruginous, Narcissus and Blue & White (April and May)

Eurasian Tree Sparrow (April and May)

Starling, Chestnut-cheeked and White-cheeked (April)

Japanese Yellow Bunting (April)

It seems likely that many of these species have wintered in the Philippines or pass through the Philippines on their spring migration. This conclusion is supported by the fact that many of the species seen are known to winter mostly or exclusively in the Philippines, e.g. Pechora Pipit, Grey-streaked, Ferruginous and Narcissus Flycatchers, Chestnut-cheeked Starling and Japanese Yellow Bunting. Others are known to be regular spring migrants between the Philippines and Taiwan e.g. Grey-faced Buzzard, Chinese Goshawk and Brown Shrike.

These conclusions support the suggestions made by Lam and Williams (1993), and provide an explanation for the earlier 'mysteries' of spring migration in Hong Kong. Spring influxes in Hong Kong are caused by migrants flying north from the Philippines towards Taiwan and Eastern China affected by the passage of cold fronts prevalent in spring and diverted westwards into Hong Kong. No such weather systems occur in autumn, and therefore Philippine wintering species will usually only be seen in Hong Kong on spring migration. This explains both the relative abundance of

spring migrants over autumn migrants in Hong Kong, and the fact that some species seen in spring are never seen or are very rare in autumn.

4.6 Sea Bird Influxes

The majority of sea birds seen from Po Toi are actually on migration, flying past Po Toi in a north easterly direction. This is quite different to land birds seen on Po Toi, which have finished a migration flight and are resting. It is also different to sea birds seen from a boat which is cruising around Hong Kong waters, when both birds resting and migrating may be seen. This difference is evident when looking at optimum weather conditions for sea bird influxes to be seen from Po Toi.

The second chart in Appendix 6 shows the number of sea birds seen on each sea watching session (sometimes more than one per day). Influxes occur in three periods, mid-March, late April and the first half of May. These timings are related to the migration periods of three different types of sea birds, gulls, skuas and terns.

4.7 Weather Conditions on Influx Dates for Sea Birds

If an influx date for sea birds is defined as a day when four or more species are seen, the weather conditions on influx dates of sea birds were as follows

Table 3: Weather conditions on sea bird influx dates

Influx Dates	Number of Species seen	Morning/ Evening seawatch	Wind Direction	Wind Force
14.3.07	4	pm	E	3
15.3.07	4	pm	E	2
16.4.07	4	pm	SW	3
22.4.07	6	am	S	4
23.4.07	4	am	SW	4
30.4.07	6	am	E	3
2.5.07	5	pm	SE	2
12.5.07	7	pm	E	3
13.5.07	8	am	E	2
14.5.07	8	am	E	3
14.5.07	8	pm	E	3
15.5.07	8	pm	E	2
21.5.07	6	am	E	4

4.7.1 Optimum Weather Conditions for Sea Bird Influxes

Although sea birds which spend their life at sea such as shearwaters are probably little affected by weather on migration, other birds such as gulls and terns will tend to migrate with favourable wind conditions. As with 2006 (see Appendix 1 for the summary of the results in 2006), it appears the optimum conditions are a light wind (force 3 or less) or a wind with a

southerly element, which is as expected for a migrant leaving Hong Kong and flying north east. These conditions often occur in the days just before a cold front passes through Hong Kong.

4.8 Sea Bird Influx Species

The key dates by species group appear to be

Mid March – gulls (particularly Heuglin's), Ancient Murrelet and Red-necked Phalarope

Late April – skuas and early terns, Red-necked Phalarope

First half of May – the main Short-tailed Shearwater and tern migration period, also some late skuas.

5. Conclusions

- a. Po Toi is the premier location in Hong Kong for the study of spring migration of both land and sea birds.
- b. Because Po Toi is the first arrival point for many of the land bird migrants, it is possible to study both the timing of migration by individual species and the weather conditions under which these migrants arrive in Hong Kong
- c. Influxes of land bird migrants usually occur on the day after the passage of a cold front in March, April and May, or a depression in May.
- d. Larger influxes usually occur when a significant amount of rain comes with the cold front/depression.
- e. The weather conditions associated with cold front/depression passage indicate that most of the land birds arriving in these influxes have their origin in the Philippines and have been migrating overnight from there.
- f. Influxes of spring sea bird migrants are usually seen from Po Toi with light winds or winds from the south quadrant, conditions which often occur just before the passage of a cold front.
- g. Certain land birds which are considered resident on Hong Kong are at least partial migrants and their migration can be observed on Po Toi.

6. Recommendations

The main recommendation is to continue the detailed recording of spring migration on Po Toi in future years, in the knowledge that this will yield more interesting observations of importance to our understanding of spring bird migration in the South China area. This requires an individual dedicated

throughout the period March to May, staying on Po Toi Island for at least 4 days in each week.

It is also recommended that detailed recording of autumn migration on Po Toi is also continued in 2007, to follow the observations made in 2006 which showed that Po Toi is an important site for autumn land bird migration.

7. Acknowledgement

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8. References

Chalmers, M.L. 1986 *Annotated Checklist of the Birds of Hong Kong*. China Alliance Press.

Hong Kong Bird Watching Society and Welch, G.T. 2006. *2006 Po Toi Records*. Hong Kong Bird Watching Society Internet website and other unpublished records.

Lam, C.Y. and Williams, M. 1993. *Weather and Bird Migration in Hong Kong*. Hong Kong Bird Watching Society 1993 Bird Report, pages 139-169.

Leader, P.J. 1997. *Po Toi Bird Survey, Nov 96 – Nov 97*. Unpublished.

McClure, H. E. 1998. *Migration and Survival of the Birds of Asia*. White Lotus Press.

Vaughan, R.E. and Jones, K.H. 1913. *The Birds of Hong Kong, Macao and the West River*. Ibis 10:17-76.

Zallis, J.I. and Bildstein, K.L. 2000. *Raptor Watch: a global directory of raptor migration sites*. Bird Life International.

9. Appendices

Appendix 1 Conclusions from 2006 Spring Migration Survey on Po Toi

A preliminary bird survey was conducted in 2006 spring. Some tentative conclusions drawn from the 2006 season were:

- a. The percentages for the different status of land bird species seen on Po Toi in spring 2006 were

Residents	13%
Spring Migrants	76%
Winter Visitors	9%
Summer Visitors	2%

The very high percentage of migrants allows the study of migration without the confusion of birds wintering or summering. For example, the dates of arrival and departure of migrant species can be much more easily identified.

- b. Po Toi is a prime location for spring bird migration. In spring 2006, four potential first records for Hong Kong were seen (Orange-breasted Green Pigeon, Owston's Flycatcher, Sulphur-breasted Warbler, Ruddy Kingfisher) and many earliest, latest or largest number records were set.
- c. Influxes of spring migrants, including migrant raptors, were seen during prolonged periods of NE winds following the passage of a cold front from late March through to end May. These birds will move on with the onset of SW winds. The differences in number of migrant species seen between days with NE and SW winds were statistically significant.
- d. At least 14 species which are considered resident in Hong Kong, such as Tree Sparrow and Large-billed Crow, are migrant on Po Toi, which adds a new dimension to the knowledge of these species.

Source : Hong Kong Bird Watching Society and Welch, G.T., 2006 records

Appendix 2: Survey Hours per Day

Land Birds

Day	February 2007	March 2007	April 2007	May 2007
1		6am-2pm	11am-7pm	6am-7pm
2			6am-7pm	6am-7pm
3			6am-7pm	6am-2pm
4		11am-7pm	6am-7pm	
5		6am-7pm	6am-2pm	
6		6am-2pm		
7				11am-2pm
8		11am-2pm	11am-7pm	
9			6am-7pm	6am-7pm
10			6am-7pm	6am-2pm
11			6am-7pm	
12			6am-2pm	11am-7pm
13	11am-7pm	11am-7pm		6am-7pm
14	6am-7pm	6am-7pm		6am-7pm
15	6am-2pm	6am-7pm		6am-2pm
16		6am-7pm	11am-7pm	
17		6am-2pm	6am-7pm	6am-7pm
18			6am-7pm	6am-2pm
19			6am-2pm	
20	11am-7pm	11am-2pm		
21	6am-7pm			11am-7pm
22	6am-2pm	11am-7pm		6am-7pm
23		6am-7pm	11am-7pm	6am-2pm
24		6am-7pm	6am-7pm	
25		6am-7pm	6am-7pm	
26		6am-7pm	6am-2pm	11am-7pm
27	11am-7pm	6am-7pm		6am-7pm
28	6am-7pm	6am-2pm		6am-7pm
29			11am-7pm	6am-2pm
30			6am-7pm	
31				11am-7pm
Total Days	8	18	20	20

Land Bird count times (dependant on ferry arrival and departure times, 11am and 2pm respectively)

11am-7pm	first count 11am to 1pm second count 2pm to 4pm
6am-7pm	first count 10am to 12am second count 2pm to 4pm
6am-2pm	first count 10am to 12am second count 12am to 2pm

11am-2pm one count from 11am to 2pm, area1, area2 (out and back)
then area 1 again

Slightly different timings on different days would not materially affect the results.

Experience shows that counts of migrant land birds on Po Toi are best done in the late morning/early afternoon, for two reasons

1. To allow time for birds to arrive on the island during the morning, either direct or from the surrounding islands and then relocate to the central area.
2. Migrants are most active feeding at this time and therefore easier to see.

Sea Birds

Day	February	March	April	May
1		am only	pm only	am only
2			am only	am,pm
3			am only	am only
4		none	am only	
5		am,pm	am only	
6		am only		
7				none
8		none	pm only	
9			am,pm	none
10			am only	none
11			am,pm	
12			pm only	pm only
13	pm only	pm only		am,pm
14	am,pm	am,pm		am,pm
15	am only	am,pm		am only
16		am,pm	pm only	
17		am only	am only	pm only
18			am only	none
19			am only	am only
20	pm only	none		
21	am only			none
22	am only	pm only		none
23		am only	pm only	none
24		am only	am,pm	
25		am only	am only	
26		am,pm	am only	none
27	pm only	am only		none
28	am,pm	none		am only
29			pm only	none
30			am,pm	
31				none

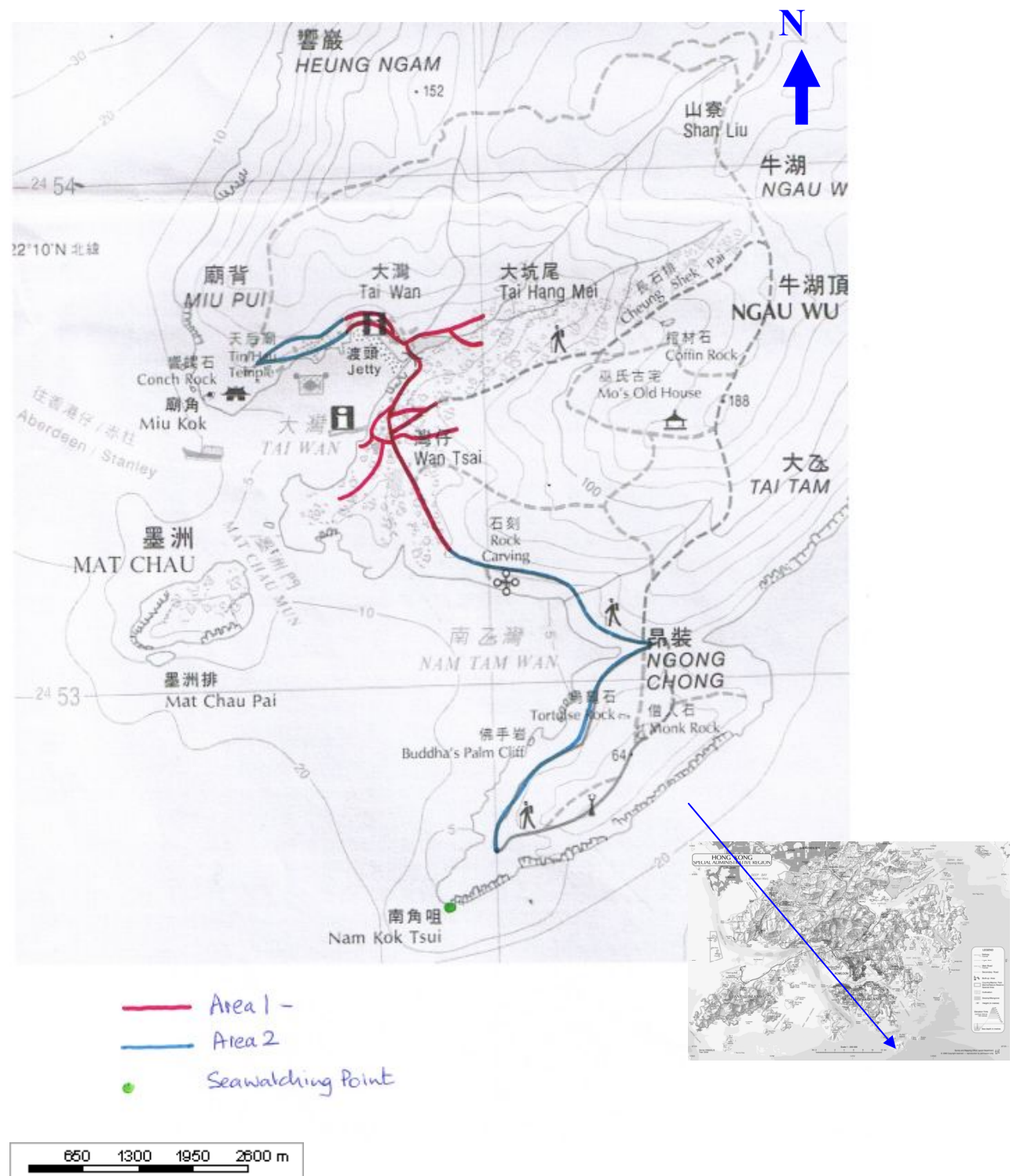
Sea bird count times (approx)

am 6.30am to 8.30am

pm 4pm to 6pm

Sea birds, which were on migration passing Po Toi, were seen mostly in the early morning, with some in the late evening. Very few were seen during the day and only summer residents after 19th May.

Appendix 3: Po Toi Map showing Census Area



Appendix 4: Frequency of Species Seen

Land Birds		w = winter visitor/spring migrant blank = spring migrant only	Area 1 Number of Days seen	Area 2 Numb er of Days seen	Visible Migrant Number of Days seen	Total Number of Days seen March to May (Total = 58)	%
Barn Swallow	<i>Hirundo rustica</i>		56	50	10	57	98
Grey Wagtail	<i>Motacilla cinerea</i>		43	13	1	43	74
Pacific Swift	<i>Apus pacificus</i>		34	28	4	42	72
Black-faced Bunting	<i>Emberiza spodocephala</i>	w	42	10		42	72
Chinese Pond Heron	<i>Ardeola bacchus</i>		38	6	4	38	66
Yellow-browed Warbler	<i>Phylloscopus inornatus</i>	w	38	4		38	66
Blue Rock Thrush	<i>Monticola solitarius</i>	w		35		35	60
Dusky Warbler	<i>Phylloscopus fuscatus</i>	w	35	21		35	60
Cattle Egret	<i>Bubulcus ibis</i>		27	9	8	32	55
White Wagtail	<i>Motacilla alba</i>	w	32	21		32	55
Little Egret	<i>Egretta garzetta</i>		23	5	7	30	52
Indian Cuckoo	<i>Cuculus micropterus</i>		30			30	52
Black Drongo	<i>Dicrurus macrocercus</i>		29	23	2	29	50
Common Kingfisher	<i>Alcedo atthis</i>		25	6		26	45
Eurasian Tree Sparrow	<i>Passer montanus</i>		23	13		26	45
Japanese Bush Warbler	<i>Cettia diphone</i>	w	23	4		23	40
Asian Brown Flycatcher	<i>Muscicapa dauurica</i>		23	1		23	40
Pallas's Leaf Warbler	<i>Phylloscopus proregulus</i>	w	22	3		22	38
Brown Shrike	<i>Lanius cristatus</i>		18	17	1	21	36
Little Swift	<i>Apus affinis</i>		18	7	2	20	34
Chestnut Bulbul	<i>Hypsipetes castanonotus</i>	w	20			20	34
Arctic Warbler	<i>Phylloscopus borealis</i>		20	4		20	34
Yellow Wagtail	<i>Motacilla flava</i>		5	19	8	19	33
Grey-streaked Flycatcher	<i>Muscicapa griseisticta</i>		18			18	31
Little Bunting	<i>Emberiza pusilla</i>		18	1		18	31
Hair-crested Drongo	<i>Dicrurus hottentottus</i>		17		2	18	31
Striated Heron	<i>Butorides striatus</i>		15		1	15	26
Red-billed Starling	<i>Sturnus sericeus</i>		13			14	24
White-shouldered Starling	<i>Sturnus sinensis</i>		14	2		14	24
Chinese Goshawk	<i>Accipiter soloensis</i>		13		2	13	22
White-throated Kingfisher	<i>Halcyon smyrnensis</i>	w	13			13	22
Blue-and-white Flycatcher	<i>Cyanoptila cyanomelana</i>		13			13	22
Common Kestrel	<i>Falco tinnunculus</i>	w	2	12		12	21

Ashy Minivet	<i>Pericrocotus divaricatus</i>		12		1	12	21
Grey-headed Flycatcher	<i>Culicicapa ceylonensis</i>	w	12			12	21
Rufous-tailed Robin	<i>Luscinia sibilans</i>	w	11			11	19
Grey Heron	<i>Ardea cinerea</i>		10			10	17
Great Egret	<i>Egretta alba</i>		5	1	8	10	17
Daurian Redstart	<i>Phoenicurus aureus</i>	w	10	7		10	17
Scaly Thrush	<i>Zoothera dauma</i>	w	10			10	17
Common Blackbird	<i>Turdus merula</i>		10			10	17
Richard's Pipit	<i>Anthus richardi</i>	w		9	3	9	16
Olive-backed Pipit	<i>Anthus hodgsoni</i>		6	3	3	9	16
Siberian Rubythroat	<i>Luscinia calliope</i>	w	1	8		9	16
Japanese Thrush	<i>Turdus cardis</i>	w	9	1		9	16
Pale Thrush	<i>Turdus pallidus</i>	w	9			9	16
Common Myna	<i>Acridotheres tristis</i>		8	1		9	16
Yellow Bittern	<i>Ixobrychus sinensis</i>		8	4		8	14
Japanese White-eye migrant	<i>Zosterops japonicus</i>				8	8	14
Schrenck's Bittern	<i>Ixobrychus eurhythmus</i>		6	1		7	12
Black-capped Kingfisher	<i>Halcyon pileata</i>		7			7	12
Red-throated Pipit	<i>Anthus cervinus</i>		2	5	2	7	12
Red-flanked Bluetail	<i>Tarsiger cyanurus</i>	w	7			7	12
Asian Stubtail Warbler	<i>Urosphena squameiceps</i>	w	7			7	12
Plain Prinia	<i>Prinia inornata</i>		7	1		7	12
Mugimaki Flycatcher	<i>Ficedula mugimaki</i>		7			7	12
Intermediate Egret	<i>Egretta intermedia</i>		6			6	10
Plaintive Cuckoo	<i>Cacomantis merulinus</i>		6			6	10
Koel	<i>Eudynamys scolopacea</i>		5			6	10
Collared Scops Owl	<i>Otus bakkamoena</i>		6			6	10
Brown Hawk Owl	<i>Ninox scutulata</i>		5		1	6	10
Oriental Reed Warbler	<i>Acrocephalus orientalis</i>		4	2		6	10
Ferruginous Flycatcher	<i>Muscicapa ferruginea</i>		6			6	10
Black-crowned Night Heron mig	<i>Nycticorax nycticorax</i>		4		1	5	9
Black Bittern	<i>Dupetor flavicollis</i>		5			5	9
Red Turtle Dove	<i>Streptopelia tranquebarica</i>		5	1		5	9
Dollarbird	<i>Eurystomus orientalis</i>		5			5	9
Pechora Pipit	<i>Anthus gustavi</i>		5			5	9
Chinese Bulbul migrant	<i>Pycnonotus sinensis</i>				5	5	9
Common Stonechat	<i>Saxicola torquata</i>		1	4		5	9
Eye-browed Thrush	<i>Turdus obscurus</i>		5			5	9
Pale-legged Leaf Warbler	<i>Phylloscopus tenellipes</i>		5			5	9

Red-throated/breasted Flycatcher	<i>Ficedula albicilla</i>		5			5	9
White-cheeked Starling	<i>Sturnus cineraceus</i>		5			5	9
Large-billed Crow migrant	<i>Corvus macrorhynchos</i>		4	4		5	9
Grey-faced Buzzard	<i>Butastur indicus</i>		4			4	7
Swinhoe's Minivet	<i>Pericrocotus cantonensis</i>		4			4	7
Narcissus Flycatcher	<i>Ficedula narcissina</i>		4			4	7
Chestnut Bunting	<i>Emberiza rutila</i>		4			4	7
Yellow-fronted Canary	<i>Serinus mozambicus</i>		4			4	7
Cinnamon Bittern	<i>Ixobrychus cinnamomeus</i>		3			3	5
Black Kite migrant	<i>Milvus migrans</i>				3	3	5
Common Buzzard	<i>Buteo buteo</i>	w	3	2		3	5
White-breasted Waterhen	<i>Amaurornis phoenicurus</i>		1	2		3	5
Chestnut-winged Cuckoo	<i>Clamator coromandus</i>		3			3	5
Silver-backed Needletail	<i>Hirundapus cochinchinensis</i>		2		1	3	5
Asian House Martin	<i>Delichon dasypus</i>		2	1		3	5
Fork-tailed Sunbird	<i>Aethopyga christinae</i>	w	3			3	5
Crested Myna migrant	<i>Acridotheres cristatellus</i>				3	3	5
Black-naped Oriole	<i>Oriolus chinensis</i>		3			3	5
Pacific Reef Egret mig	<i>Egretta sacra</i>				2	2	3
Malayan Night Heron	<i>Gorsachius melanolophus</i>		2			2	3
Crested Goshawk	<i>Accipiter trivirgatus</i>		2			2	3
Japanese Sparrowhawk	<i>Accipiter gularis</i>		1	1		2	3
Besra	<i>Accipiter virgatus</i>		2			2	3
Oriental Turtle Dove	<i>Streptopelia orientalis</i>			2		2	3
Grey-backed Thrush	<i>Turdus hortulorum</i>	w	2			2	3
Eastern Crowned Warbler	<i>Phylloscopus coronatus</i>		2			2	3
Japanese Paradise Flycatcher	<i>Terpsiphone atrocaudata</i>		2			2	3
Yellow-browed Bunting	<i>Emberiza chrysophrys</i>		2			2	3
Yellow-breasted Bunting	<i>Emberiza aureola</i>		1	1		2	3
Japanese Yellow Bunting	<i>Emberiza sulphurata</i>		2			2	3
Chestnut-cheeked Starling	<i>Sturnus philippensis</i>		1	1		2	3
Purple-backed Starling	<i>Sturnus sturninus</i>		2			2	3
Swinhoe's Egret	<i>Egretta eulophotes</i>				1	1	2
Garganey	<i>Anas querquedula</i>				1	1	2

Osprey	<i>Pandion haliaetus</i>			1		1	2
Peregrine migrant	<i>Falco peregrinus</i>				1	1	2
Crake sp (Brown?)	<i>Amaurornis akool</i>		1			1	2
Hodgson's Hawk Cuckoo	<i>Hierococcyx fugax</i>		1			1	2
Common Cuckoo	<i>Cuculus canorus</i>		1			1	2
Oriental Cuckoo	<i>Cuculus saturatus</i>		1			1	2
Drongo Cuckoo	<i>Surniculus lagubris</i>		1			1	2
Blue-tailed Bee-eater	<i>Merops philippinus</i>		1			1	2
Eurasian Hoopoe	<i>Upupa epops</i>		1			1	2
Red-rumped Swallow	<i>Hirundo daurica</i>		1			1	2
Buff-bellied Pipit	<i>Anthus rubescens</i>				1	1	2
Siberian Blue Robin	<i>Luscinia cyane</i>		1			1	2
Dusky Thrush	<i>Turdus naumanni</i>		1			1	2
Russet Bush Warbler	<i>Bradypterus seebohmii</i>		1			1	2
Lanceolated Warbler	<i>Locustella lanceolata</i>			1		1	2
Thick-billed Warbler	<i>Acrocephalus aedon</i>			1		1	2
Buff-bellied Flowerpecker	<i>Dicaeum ignipectus</i>		1			1	2
Tristram's Bunting	<i>Emberiza tristrami</i>		1			1	2
Number of winter visitors		23					
Waders							
Common Sandpiper	<i>Actitis hypoleucos</i>		19	20		31	53
Pintail Snipe	<i>Gallinago stenura</i>		5	1		5	9
Common Snipe	<i>Gallinago gallinago</i>		5			5	9
Eurasian Curlew	<i>Numenius arquata</i>				4	4	7
Oriental Pratincole	<i>Glareola maldivarum</i>		1		2	3	5
Wood Sandpiper	<i>Tringa glareola</i>		3			3	5
Bar-tailed Godwit	<i>Limosa lapponica</i>				2	2	3
Whimbrel	<i>Numenius phaeopus</i>				2	2	3
Ruddy Turnstone	<i>Arenaria interpres</i>			1		2	3
Red-necked Stint	<i>Calidris ruficollis</i>			2		2	3
Grey-headed Lapwing	<i>Vanellus cinereus</i>				1	1	2
Greater Sand Plover	<i>Charadrius leschenaultii</i>		1			1	2
Far Eastern Curlew	<i>Numenius madagascariensis</i>				1	1	2
Common Redshank	<i>Tringa totanus</i>				1	1	2
Green Sandpiper	<i>Tringa ochropus</i>		1			1	2
Grey-tailed Tattler	<i>Heteroscelus brevipes</i>		1			1	2
Red Knot	<i>Calidris canutus</i>				1	1	2

Sea Birds seen in land area							
Black-naped Tern	<i>Sterna sumatrana</i>		11	2		11	19
Red-necked Phalarope	<i>Phalaropus lobatus</i>		2	1		2	3

Sea Birds		Number of Seawatches seen (Total = 74)	%
Red-necked Phalarope	<i>Phalaropus lobatus</i>	34	46
Heuglin's Gull	<i>Larus heuglini</i>	14	19
Common Tern	<i>Sterna hirundo</i>	11	15
Whiskered Tern	<i>Chlidonias hybridus</i>	10	14
Bridled Tern	<i>Sterna anaethetus</i>	10	14
Short-tailed Shearwater	<i>Puffinus tenuirostris</i>	8	11
Aleutian Tern	<i>Sterna aleutica</i>	8	11
White-winged Tern	<i>Chlidonias leucopterus</i>	7	9
Greater Crested Tern	<i>Sterna bergii</i>	7	9
Pomarine Skua	<i>Stercorarius pomarinus</i>	4	5
Black-naped Tern	<i>Sterna sumatrana</i>	4	5
Ancient Murrelet	<i>Synthliboramphus antiquus</i>	4	5
Arctic Skua	<i>Stercorarius parasiticus</i>	3	4
Long-tailed Skua	<i>Stercorarius longicaudus</i>	3	4
Black-tailed Gull	<i>Larus crassirostris</i>	3	4
Gull-billed Tern	<i>Sterna nilotica</i>	3	4
Caspian Tern	<i>Sterna caspia</i>	2	3
Roseate Tern	<i>Sterna dougallii</i>	2	3
Little Tern	<i>Sterna albifrons</i>	2	3
Streaked Shearwater	<i>Calonectris leucomelas</i>	1	1
Bulwer's Petrel	<i>Bulweria bulwerii</i>	1	1
Red-breasted Merganser	<i>Mergus serrator</i>	1	1
Yellow-legged Gull	<i>Larus cachinnans</i>	1	1

Appendix 5: Weekly Sequence of Species Seen

Land birds

		Mar wk1	Mar wk2	Mar wk3	Mar wk4	Apr wk1	Apr wk2	Apr wk3	Apr wk4	May wk1	May wk2	May wk3	May wk4
Winter Visitors													
Common Buzzard	<i>Buteo buteo</i>	x		x	x								
Common Kestrel	<i>Falco tinnunculus</i>	x	x	x	x	x			x				
White-throated Kingfisher	<i>Halcyon smyrnensis</i>												
White Wagtail	<i>Motacilla alba</i>	x	x	x	x	x	x		x				x
Richard's Pipit	<i>Anthus richardi</i>			x	x	x	x	x	x			x	
Chestnut Bulbul	<i>Hypsipetes castanonotus</i>	x	x	x	x	x							
Rufous-tailed Robin	<i>Luscinia sibilans</i>	x	x	x	x	x	x	x	x				
Siberian Rubythroat	<i>Luscinia calliope</i>	x	x	x		x	x		x				
Red-flanked Bluetail	<i>Tarsiger cyanurus</i>	x	x	x									
Daurian Redstart	<i>Phoenicurus aureus</i>	x	x	x		x	x						
Blue Rock Thrush	<i>Monticola solitarius</i>	x	x	x	x	x	x	x	x	x			
Scaly Thrush	<i>Zoothera dauma</i>		x	x	x	x	x						
Japanese Thrush	<i>Turdus cardis</i>		x	x	x		x						
Grey-backed Thrush	<i>Turdus hortulorum</i>		x	x									
Pale Thrush	<i>Turdus pallidus</i>	x	x	x	x		x						
Asian Stubtail Warbler	<i>Urosphena squameiceps</i>		x	x	x								
Japanese Bush Warbler	<i>Cettia diphone</i>	x	x	x	x	x	x						
Dusky Warbler	<i>Phylloscopus fuscatus</i>	x	x	x	x	x	x	x	x	x		x	
Pallas's Leaf Warbler	<i>Phylloscopus proregulus</i>	x	x	x	x	x				x			
Yellow-browed Warbler	<i>Phylloscopus inornatus</i>	x	x	x	x	x	x	x	x			x	
Grey-headed Flycatcher	<i>Culicicapa ceylonensis</i>	x	x	x									
Fork-tailed Sunbird	<i>Aethopyga christinae</i>	x		x									
Black-faced Bunting	<i>Emberiza spodocephala</i>	x	x	x	x	x	x	x	x		x	x	x
Spring Migrants													
Grey Heron	<i>Ardea cinerea</i>			x	x	x							
Great Egret	<i>Egretta alba</i>	x	x			x	x	x					
Intermediate Egret	<i>Egretta intermedia</i>								x			x	
Little Egret	<i>Egretta garzetta</i>	x	x	x	x	x	x	x	x		x	x	x

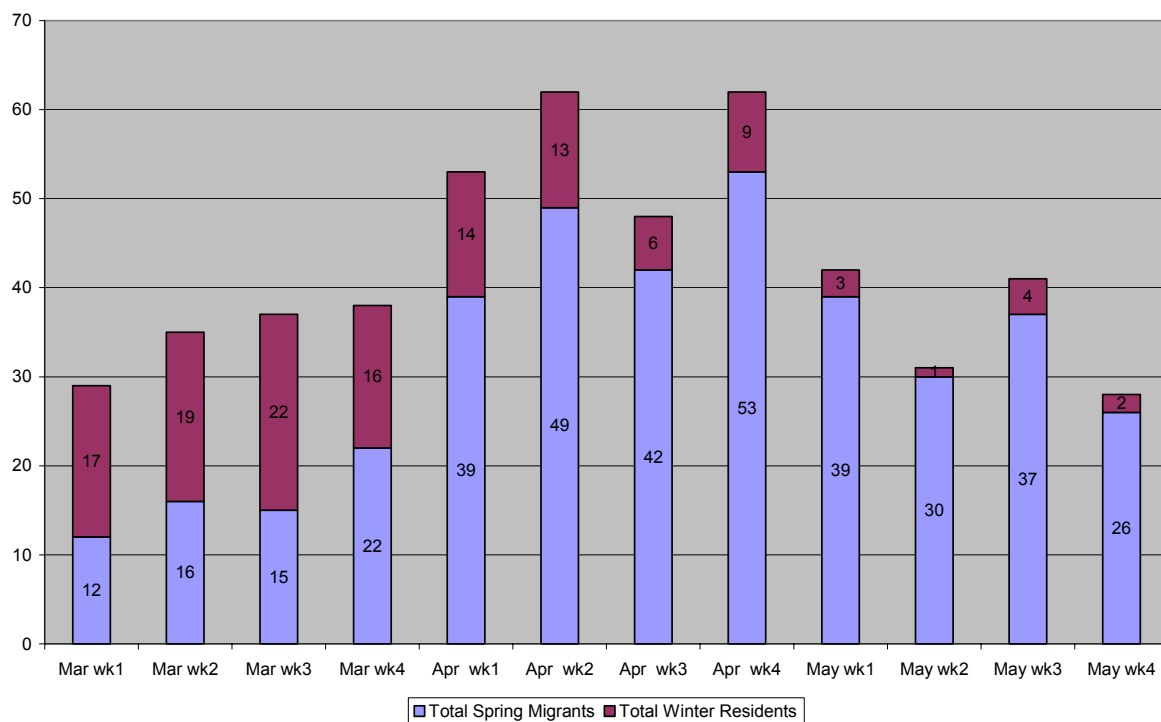
Swinhoe's Egret	<i>Egretta eulophotes</i>							x					
Pacific Reef Egret migrant	<i>Egretta sacra</i>	x							x				
Cattle Egret	<i>Bubulcus ibis</i>				x	x	x	x	x	x	x	x	x
Pond Heron	<i>Ardeola bacchus</i>					x	x	x	x	x	x	x	x
Striated Heron	<i>Butorides striatus</i>								x	x	x	x	x
Black-crowned Night Heron mig	<i>Nycticorax nycticorax</i>					x	x					x	
Malayan Night Heron	<i>Gorsachius melanolophus</i>								x	x			
Yellow Bittern	<i>Ixobrychus sinensis</i>											x	x
Schrenck's Bittern	<i>Ixobrychus eurhythmus</i>											x	x
Cinnamon Bittern	<i>Ixobrychus cinnamomeus</i>							x				x	x
Black Bittern	<i>Dupetor flavicollis</i>											x	x
Garganey	<i>Anas querquedula</i>			x									
Osprey	<i>Pandion haliaetus</i>								x				
Black Kite migrant	<i>Milvus migrans</i>	x		x									
Grey-faced Buzzard	<i>Butastur indicus</i>		x				x		x				
Crested Goshawk	<i>Accipiter trivirgatus</i>								x				
Chinese Goshawk	<i>Accipiter soloensis</i>						x		x	x	x		
Japanese Sparrowhawk	<i>Accipiter gularis</i>						x						
Besra	<i>Accipiter virgatus</i>			x									
Peregrine migrant	<i>Falco peregrinus</i>		x										
Crake sp (Brown?)	<i>Amaurornis akool</i>												x
White-breasted Waterhen	<i>Amaurornis phoenicurus</i>										x	x	
Oriental Pratincole	<i>Glareola maldivarum</i>				x				x				
Grey-headed Lapwing	<i>Vanellus cinereus</i>										x		
Greater Sand Plover	<i>Charadrius leschenaultii</i>					x							
Bar-tailed Godwit	<i>Limosa lapponica</i>						x		x				
Whimbrel	<i>Numenius phaeopus</i>							x	x				
Eurasian Curlew	<i>Numenius arquata</i>								x	x			
Far Eastern Curlew	<i>Numenius madagascariensis</i>							x					
Common Redshank	<i>Tringa totanus</i>						x						
Green Sandpiper	<i>Tringa ochropus</i>						x						
Wood Sandpiper	<i>Tringa glareola</i>					x		x					
Common Sandpiper	<i>Actitis hypoleucos</i>	x			x	x	x	x	x	x	x	x	
Grey-tailed Tattler	<i>Heteroscelus brevipes</i>							x					
Ruddy Turnstone	<i>Arenaria interpres</i>									x			

Red-necked Phalarope	<i>Gallinago stenura</i>					x							
Pintail Snipe	<i>Gallinago gallinago</i>					x	x						
Common Snipe	<i>Calidris canutus</i>	x	x		x								
Red-necked Stint	<i>Calidris ruficollis</i>								x				
Black-naped Tern	<i>Sterna sumatrana</i>									x	x	x	x
Oriental Turtle Dove	<i>Streptopelia orientalis</i>								x	x			
Red Turtle Dove	<i>Streptopelia tranquebarica</i>												x
Chestnut-winged Cuckoo	<i>Clamator coromandus</i>					x	x						
Hodgson's Hawk Cuckoo	<i>Hierococyx fugax</i>							x					
Indian Cuckoo	<i>Cuculus micropterus</i>							x	x	x	x	x	x
Common Cuckoo	<i>Cuculus canorus</i>					x							
Oriental Cuckoo	<i>Cuculus saturatus</i>						x						
Cuculus Cuckoo hepatic						x	x						
Plaintive Cuckoo	<i>Cacomantis merulinus</i>			x		x					x		
Koel	<i>Eudynamys scolopacea</i>							x	x		x		x
Drongo Cuckoo	<i>Surniculus lagubris</i>							x					
Collared Scops Owl	<i>Otus bakkamoena</i>		x	x	x								
Brown Hawk Owl	<i>Ninox scutulata</i>					x	x	x					
Silver-backed Needletail	<i>Hirundapus cochinchinensis</i>		x		x								
Pacific Swift	<i>Apus pacificus</i>	x	x	x	x	x	x	x	x	x	x	x	x
Little Swift	<i>Apus affinis</i>	x				x	x	x	x	x	x		x
Common Kingfisher	<i>Alcedo atthis</i>	x	x	x	x	x	x	x	x			x	
Black-capped Kingfisher	<i>Halcyon pileata</i>							x	x			x	
Blue-tailed Bee-eater	<i>Merops philippinus</i>									x			
Dollarbird	<i>Eurystomus orientalis</i>					x		x	x				
Hoopoe	<i>Upupa epops</i>		x										
Barn Swallow	<i>Hirundo rustica</i>	x	x	x	x	x	x	x	x	x	x	x	x
Red-rumped Swallow	<i>Hirundo daurica</i>			x									
Asian House Martin	<i>Delichon dasypus</i>	x				x	x						
Yellow Wagtail	<i>Motacilla flava</i>								x	x	x	x	x
Grey Wagtail	<i>Motacilla cinerea</i>		x	x	x	x	x	x	x	x	x	x	
Olive-backed Pipit	<i>Anthus hodgsoni</i>					x	x		x	x			
Red-throated Pipit	<i>Anthus cervinus</i>						x	x	x	x			
Pechora Pipit	<i>Anthus gustavi</i>						x		x				
Buff-bellied Pipit	<i>Anthus rubescens</i>				x								

Swinhoe's Minivet	<i>Pericrocotus cantonensis</i>					x	x					x	
Ashy Minivet	<i>Pericrocotus divaricatus</i>				x	x	x	x	x				
Chinese Bulbul migrant	<i>Pycnonotus sinensis</i>								x	x	x	x	x
Brown Shrike	<i>Lanius cristatus</i>						x		x	x	x	x	x
Siberian Blue Robin	<i>Luscinia cyane</i>						x						
Common Stonechat	<i>Tarsiger cyanurus</i>		x				x	x		x			
Common Blackbird	<i>Turdus merula</i>		x	x			x		x				
Eye-browed Thrush	<i>Turdus hortulorum</i>							x	x				
Dusky Thrush	<i>Turdus naumanni</i>						x						
Russet Bush Warbler	<i>Bradypterus seebohi</i>	x											
Lanceolated Warbler	<i>Locustella lanceolata</i>											x	
Oriental Reed Warbler	<i>Acrocephalus orientalis</i>									x		x	x
Thick-billed Warbler	<i>Acrocephalus aedon</i>											x	
Plain Prinia	<i>Prinia inornata</i>									x		x	x
Arctic Warbler	<i>Phylloscopus borealis</i>								x	x	x	x	x
Pale-legged Leaf Warbler	<i>Phylloscopus tenellipes</i>						x		x				
Eastern Crowned Warbler	<i>Phylloscopus coronatus</i>					x				x			
Grey-streaked Flycatcher	<i>Muscicapa griseisticta</i>							x	x	x	x	x	
Asian Brown Flycatcher	<i>Muscicapa dauurica</i>				x	x	x	x	x	x	x	x	
Ferruginous Flycatcher	<i>Muscicapa ferruginea</i>					x	x		x				
Narcissus Flycatcher	<i>Ficedula narcissina</i>					x	x	x					
Mugimaki Flycatcher	<i>Ficedula mugimaki</i>				x	x	x	x					
Red-throated/breasted Flycatcher	<i>Ficedula albicilla</i>				x	x	x						
Blue-and-white Flycatcher	<i>Cyanoptila cyanomelana</i>				x	x	x	x	x				
Japanese Paradise Flycatcher	<i>Terpsiphone atrocaudata</i>						x	x					
Buff-bellied Flowerpecker	<i>Dicaeum ignipectus</i>					x							
Japanese White-eye migrant	<i>Zosterops japonicus</i>						x	x	x	x	x		
Tristram's Bunting	<i>Emberiza tristrami</i>							x					
Little Bunting	<i>Emberiza chrysophrys</i>			x	x	x	x	x	x	x			

Yellow-browed Bunting	<i>Emberiza aureola</i>								x	x			
Yellow-breasted Bunting	<i>Emberiza rutila</i>								x	x			
Chestnut Bunting	<i>Emberiza sulphurata</i>							x	x				
Japanese Yellow Bunting	<i>Emberiza spodocephala</i>						x						
Eurasian Tree Sparrow	<i>Passer montanus</i>					x	x	x	x	x	x	x	x
Red-billed Starling	<i>Sturnus sericeus</i>		x	x		x	x	x					
Chestnut-cheeked Starling	<i>Sturnus philippensis</i>					x	x						
Purple-backed Starling	<i>Sturnus sturninus</i>				x				x				
White-cheeked Starling	<i>Sturnus cineraceus</i>						x				x	x	
White-shouldered Starling	<i>Sturnus sinensis</i>		x		x		x	x	x	x	x		
Common Myna	<i>Acridotheres tristis</i>									x	x	x	x
Crested Myna migrant	<i>Acridotheres cristatellus</i>									x		x	
Black-naped Oriole	<i>Oriolus chinensis</i>								x	x			
Black Drongo	<i>Dicrurus macrocercus</i>							x	x	x	x	x	x
Hair-crested Drongo	<i>Dicrurus hottentottus</i>							x	x	x	x	x	x
Large-billed Crow migrant	<i>Corvus macrorhynchos</i>				x	x							
Yellow-fronted Canary	<i>Serinus mozambicus</i>										x	x	
Total Spring Migrants		12	16	15	22	39	49	42	53	39	30	37	26
Total Winter Residents		17	19	22	16	14	13	6	9	3	1	4	2
Total Non-resident Species		29	35	37	38	53	62	48	62	42	31	41	28

Number of Species by Week for Land Birds and Waders

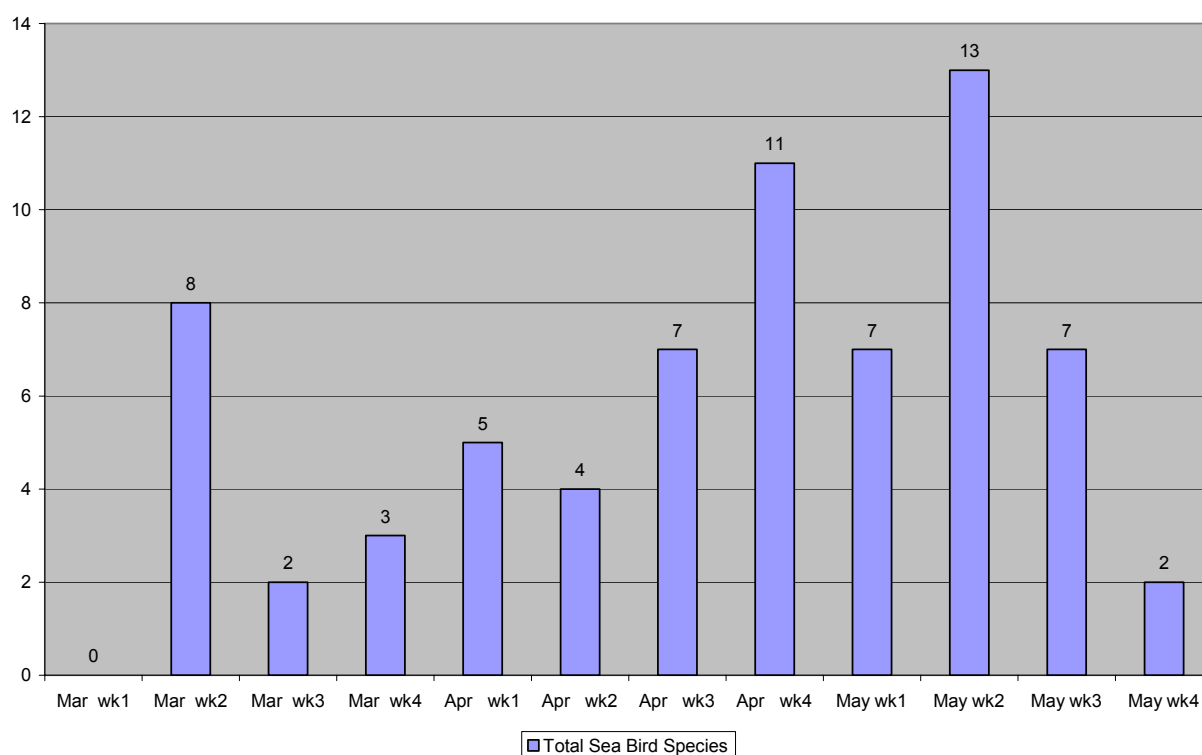


Sea Birds

		Mar wk1	Mar wk2	Mar wk3	Mar wk4	Apr wk1	Apr wk2	Apr wk3	Apr wk4	May wk1	May wk2	May wk3	May wk4
Streaked Shearwater	<i>Calonectris leucomelas</i>		x										
Short-tailed Shearwater	<i>Puffinus tenuirostris</i>								x		x	x	x
Bulwer's Petrel	<i>Bulweria bulwerii</i>										x		
Red-breasted Merganser	<i>Mergus serrator</i>		x										
Red-necked Phalarope	<i>Phalaropus lobatus</i>		x	x	x	x	x	x	x	x	x		
Pomarine Skua/Skua sp	<i>Stercorarius pomarinus</i>		x						x		x		
Arctic Skua	<i>Stercorarius parasiticus</i>								x		x		
Long-tailed Skua	<i>Stercorarius longicaudus</i>					x		x	x				
Black-tailed Gull	<i>Larus crassirostris</i>		x							x	x		
Heuglin's Gull	<i>Larus heuglini</i>		x	x	x	x							
Yellow-legged Gull	<i>Larus cachinnans</i>		x										
Whiskered Tern	<i>Chlidonias hybridus</i>								x	x	x	x	x
White-winged Tern	<i>Chlidonias leucopterus</i>										x	x	
Gull-billed Tern	<i>Sterna nilotica</i>							x			x		
Caspian Tern	<i>Sterna caspia</i>						x			x			

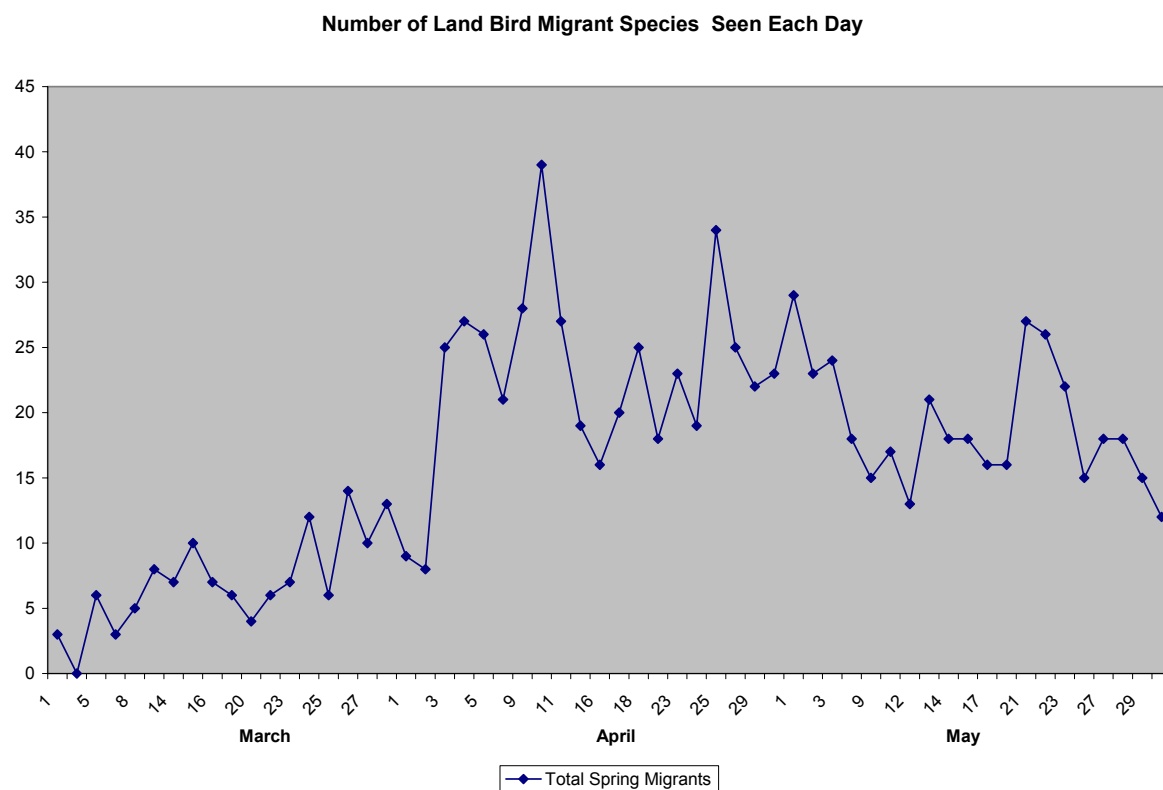
Common Tern/Tern sp	<i>Sterna hirundo</i>					x	x	x	x	x	x		
Roseate Tern	<i>Sterna dougallii</i>											x	
Black-naped Tern	<i>Sterna sumatrana</i>							x	x	x	x		
Aleutian Tern	<i>Sterna aleutica</i>							x	x	x		x	
Bridled Tern	<i>Sterna anaethetus</i>							x	x		x	x	
Little Tern	<i>Sterna albifrons</i>						x					x	
Greater Crested Tern	<i>Sterna bergii</i>					x			x		x		
Ancient Murrelet	<i>Synthliboramphus antiquus</i>		x		x								
Total Sea Bird Species		0	8	2	3	5	4	7	11	7	13	7	2

Numbers of Species by Week for Sea Birds

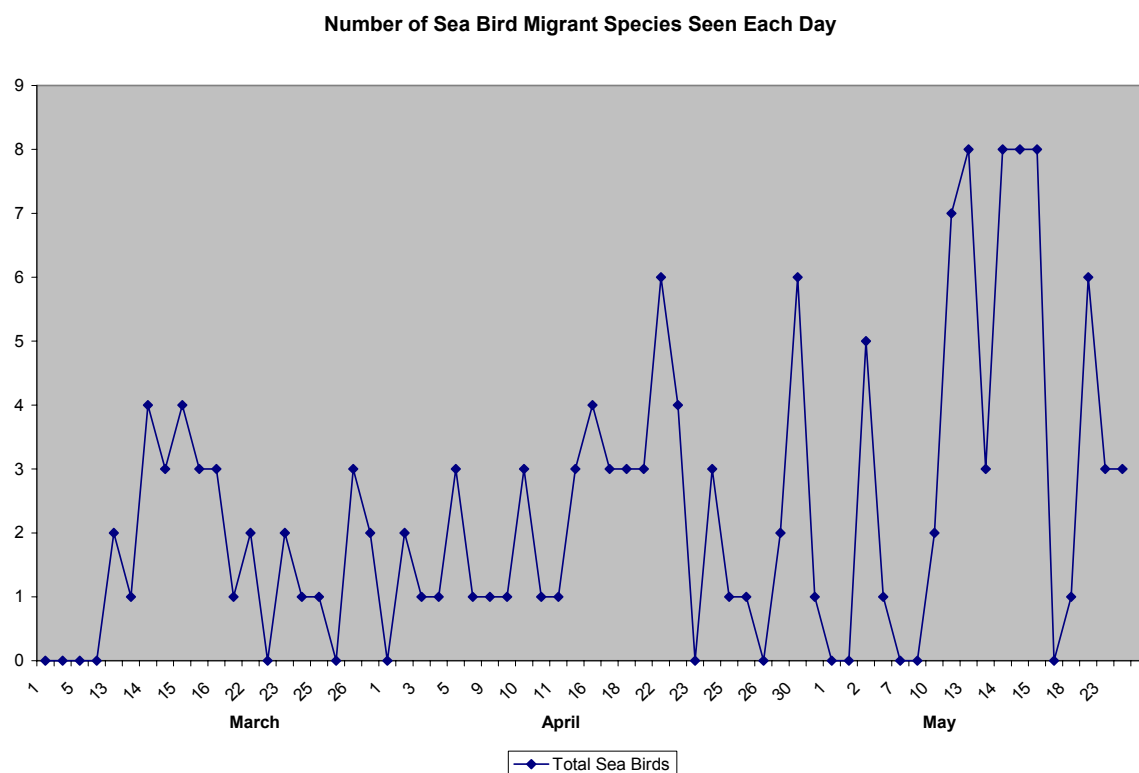


Appendix 6: Charts of the Number of Migrant Species Seen Each Day

Land Bird Species Chart



Sea Bird Species Chart



Appendix 7: Definition of Influx and the use of Chi-squared Test

Land Birds

An influx is a significant increase in the number of birds over a short period of time, usually one day. There is no established convention as to exactly what this is. The definition used here, ‘an increase of 5 species over the previous day’, was chosen for the following reasons

- a. ‘number of species’ was chosen rather than ‘number of birds’ to avoid bias towards a few species such as Pacific Swift and Barn Swallow which occur in large numbers and would overwhelm all other species numbers. An influx should be representative across a variety of species and not just of a single species.
- b. ‘5’ was chosen by considering what number of species would represent a significant increase. We estimate that a number lower than 5 might have occurred by chance whereas a number greater than 5 probably could not have occurred by chance.

Sea Birds

The definition used here for sea birds, ‘4 or more species seen on that day’, was chosen for the following reasons

- a. ‘number of species’ was chosen rather than ‘number of birds’ for the same reason as land birds above
- b. ‘increase in number of species over the previous day’ is not a useful statistic when only 23 species in total are involved. It was therefore decided to use the absolute number of species seen on an individual day. ‘4 or more species’ was chosen by inspection of the Sea Bird Species Chart in Appendix 5 as a distinct separator between days which also highlighted the key migration weeks for sea birds, week 2 of March, week 4 of April and week 2 of May.

Chi-squared Test

Of the 58 days recorded, 12 were days after a cold front passage and 46 were not.

Of the 11 days with influxes, 9 were days after a cold front passage and 2 were not.

Chi-squared Test was used to compare these two sets with the null hypothesis that ‘the events of cold front passage and influx occurrence are unrelated’.

The chi-square value is 42.837 with 1 degree of freedom, giving a probability that the null hypothesis is true of $5.95\text{E-}7$ or <0.0001 . Therefore, the converse is true with a very high degree of probability, namely that ‘the events of cold front passage and influx occurrence are related’.

Appendix 8: Definition of Cold Front and Depression.

A **cold front** is defined as the leading edge of a cooler and drier mass of air. The air with greater density wedges under the less dense warmer air, lifting it, which can cause the formation of a narrow line of showers and thunderstorms when enough moisture is present.

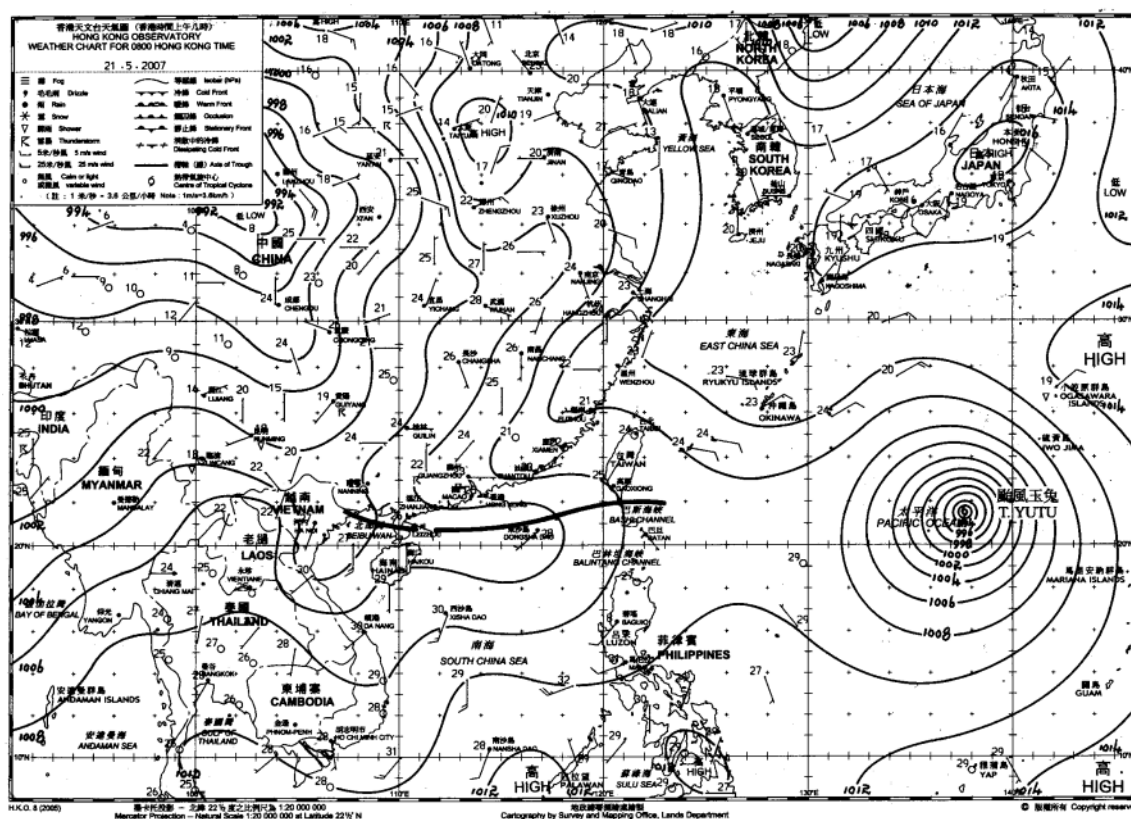
In Hong Kong, cold fronts typically appear at regular intervals in winter and spring and are caused by a mass of cold high pressure air moving south from the China land mass and meeting warmer lower pressure air in the south.

On weather maps, the surface position of the cold front is marked with a line of triangles pointing in the direction of travel.

A **depression** is an area of low pressure air.

In Hong Kong, depressions can form over the South China Sea in late spring as the sea warms up. The junction between the warm wet air of a depression and the cold dry air further north can produce a line of thunderstorms, similar in effect to a cold front.

On weather maps, the junction may be marked as a line without symbols. Here is the weather chart for 21st May.



Appendix 9: Wind Force and the Beaufort Scale

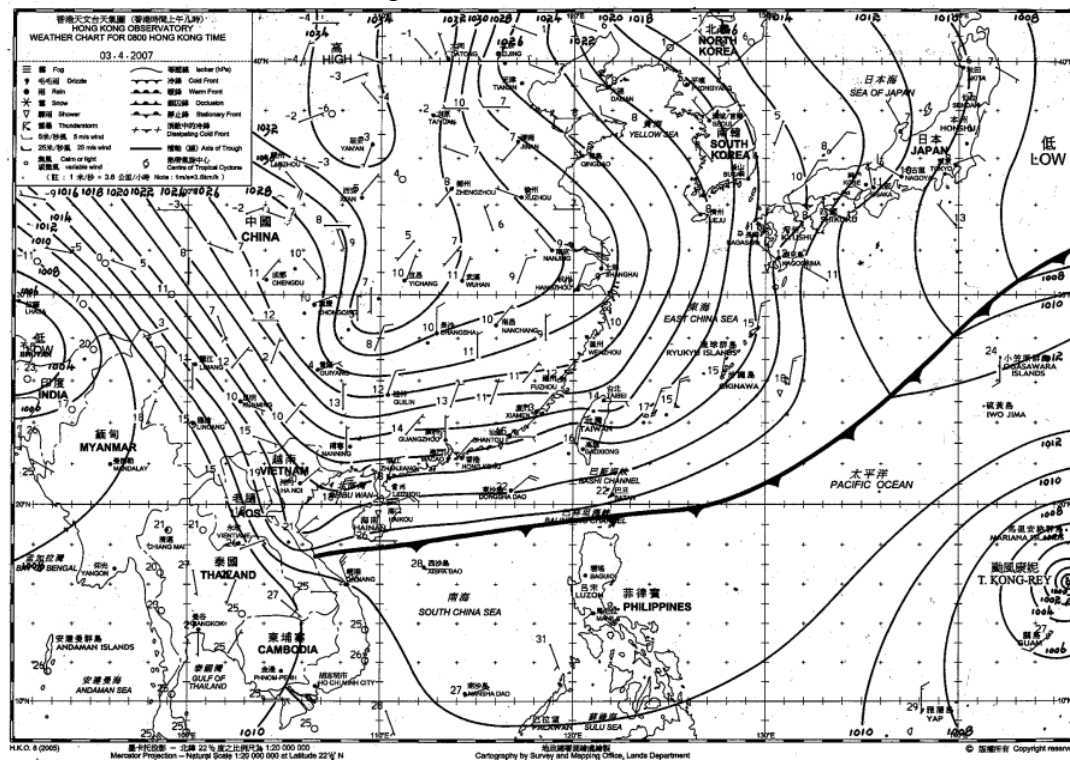
Wind Force measures wind speed and effect according to the Beaufort Scale

BEAUFORT SCALE: Specifications and equivalent speeds for use on land

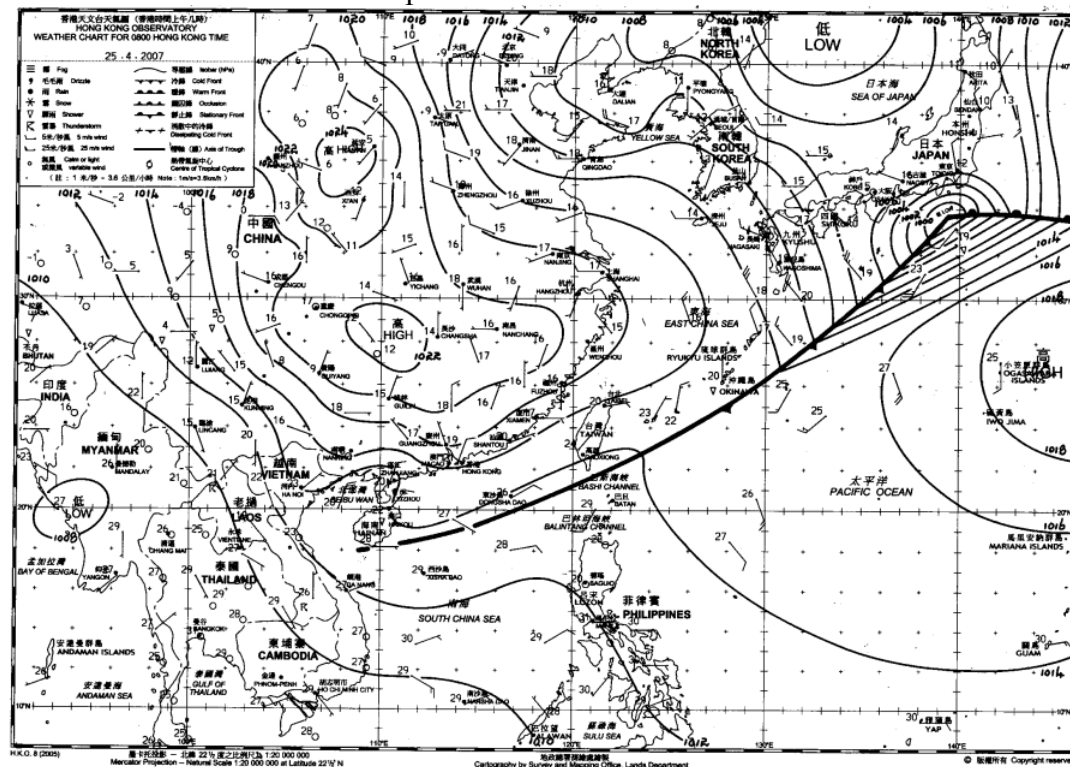
FORCE	EQUIVALENT SPEED		DESCRIPTION	SPECIFICATIONS
	miles/hour	knots		
0	0-1	0-1	Calm	Calm; smoke rises vertically.
1	1-3	1-3	Light air	Direction of wind shown by smoke drift, but not by wind vanes.
2	4-7	4-6	Light Breeze	Wind felt on face; leaves rustle; ordinary vanes moved by wind.
3	8-12	7-10	Gentle Breeze	Leaves and small twigs in constant motion; wind extends light flag.
4	13-18	11-16	Moderate Breeze	Raises dust and loose paper; small branches are moved.
5	19-24	17-21	Fresh Breeze	Small trees in leaf begin to sway; crested wavelets form
6	25-31	22-27	Strong Breeze	Large branches in motion; whistling heard in telegraph wires; umbrellas used with difficulty.
7	32-38	28-33	Near Gale	Whole trees in motion; inconvenience felt when walking against the wind.
8	39-46	34-40	Gale	Breaks twigs off trees; generally impedes progress.
9	47-54	41-47	Severe Gale	Slight structural damage occurs (chimney-pots removed).
10	55-63	48-55	Storm	Seldom experienced inland; trees uprooted; considerable structural damage occurs.
11	64-72	56-63	Violent Storm	Very rarely experienced; wide-spread damage.
12	73-83	64-71	Hurricane	

Appendix 10: Hong Kong Observatory Weather Charts for Two Largest Influx Dates

Weather chart for 8am on 3 April 2007

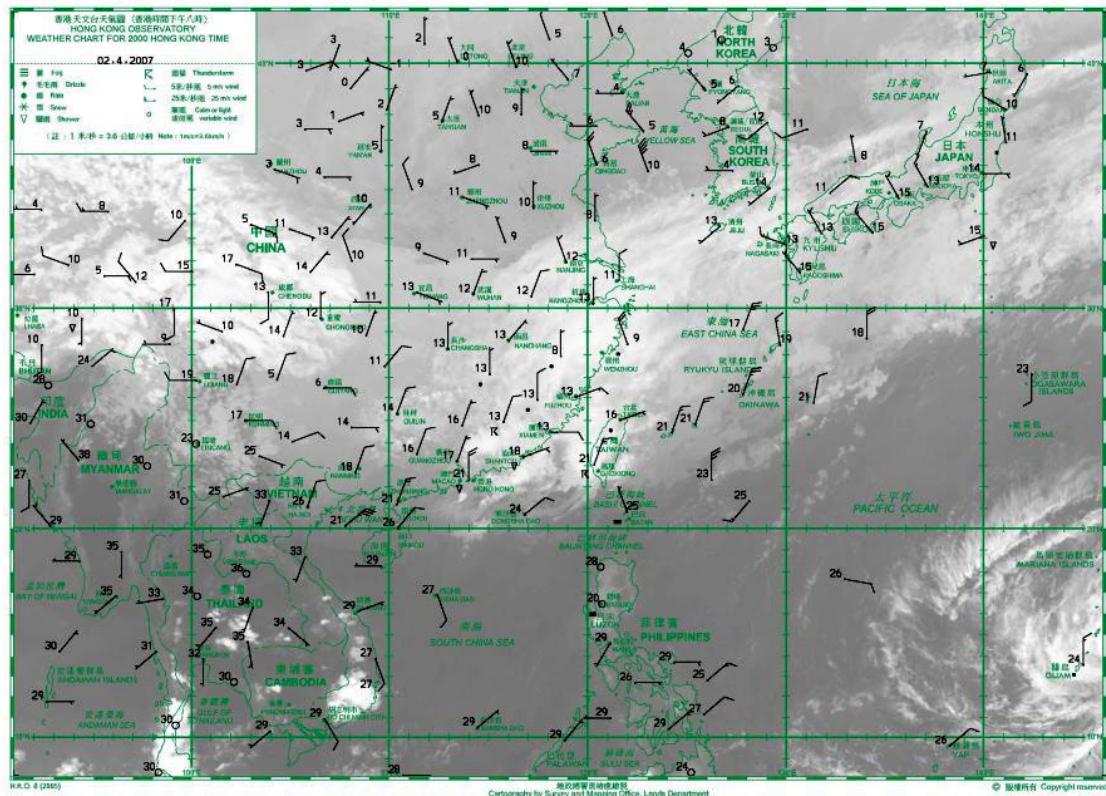


Weather chart for 8am on 25 April 2007

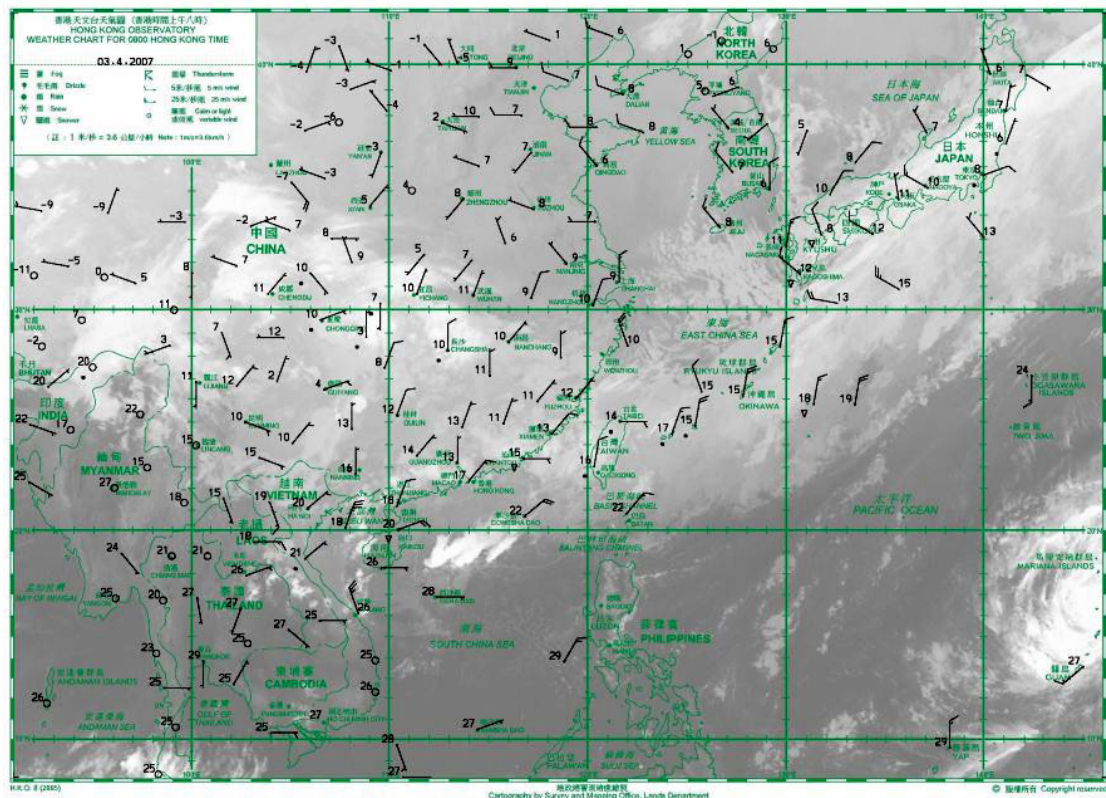


Appendix 11: Hong Kong Observatory Satellite Photographs for 2, 3 and 4 April 2007

8pm on 2 April – migrants leave Philippines in clear skies with light winds



8am on 3 April – migrants meet cold front with NE winds over Bashi Channel



香港天文台天氣圖 (香港時間上午八時)
HONG KONG OBSERVATORY
WEATHER CHART FOR 0000 HONG KONG TIME

04.4.2007

圖例 Legend

☁ 霧 Fog
☂ 毛毛雨 Drizzle
☔ 雨 Rain
❄ 雪 Snow
☂☔ 雨夾雪 Sleet

☁ 5 英里 5 mi
☂ 25 英里 25 mi
☔ 25 英里 25 mi
☂☔ 25 英里 25 mi

☁ 5 英里 5 mi
☂ 25 英里 25 mi
☔ 25 英里 25 mi
☂☔ 25 英里 25 mi

(註: 1. 和 1.5 為 0.5 倍 2. 和 2.5 為 1 倍)

香港天文台天氣圖 (香港時間上午八時)
HONG KONG OBSERVATORY
WEATHER CHART FOR 0000 HONG KONG TIME

04.4.2007

圖例 Legend

☁ 霧 Fog
☂ 毛毛雨 Drizzle
☔ 雨 Rain
❄ 雪 Snow
☂☔ 雨夾雪 Sleet

☁ 5 英里 5 mi
☂ 25 英里 25 mi
☔ 25 英里 25 mi
☂☔ 25 英里 25 mi

(註: 1. 和 1.5 為 0.5 倍 2. 和 2.5 為 1 倍)

Dark areas are clear skies

Arrows give wind direction and force at that position, numbers are temperature in deg C

Arrows give wind direction and force at that position, numbers are temperature in deg C