SEABIRD MIGRATION SURVEY IN SOUTHERN AND SOUTH-EASTERN HONG KONG WATERS, SPRING 2006

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Seabird migration survey in southern and south-eastern Hong Kong waters, spring 2006 (ECF Project 2005-10)

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Cover photo: (from up left (clockwise) Short-tailed Shearwater, Sooty Tern, Aleutian Tern, Red-necked Phalarope, Common Tern and Great Crested Tern in South Hong Kong waters (photo by: John and Jemi Holmes, Kwan Tze-hoi (Red-necked Phalarope))

Seabird migration survey in southern and south-eastern Hong Kong waters, spring 2006

EXECUTIVE SUMMARY

The Hong Kong Bird Watching Society, with support from the Environmental and Conservation Fund, undertook a survey of seabird migration in southern and south-eastern Hong Kong waters in spring 2006. A total of 22 survey trips were completed in the period from 17 March to 18 May and a total of 8,750 individual of seabirds of 23 species were recorded. The largest group comprised Red-necked Phalaropes *Phalaropus lobatus* with 6,618 individuals (76%), followed by 1,727 individuals of terns (family Sternidae) of 12 species. This study showed that high numbers of seabirds passed through Hong Kong in the spring and the actual number could well be more than this present figure. More Red-necked Phalaropes occurred in the south-eastern waters (i.e. area near the Ninepins), while more terns occurred in the southern waters (i.e. between Po Toi and Lamma Island). Hence, any future development plans in these areas need to consider their adverse impacts on these seabirds. Knowledge of seabirds in Hong Kong is still far from complete. Further studies, such as autumn migration of seabirds, are strongly recommended.

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1. Introduction

Seabirds, or marine birds, are defined as those living in and making their living in a marine environment. They include many groups of birds in different orders, including Sphenisciformes (Penguins), Procellariiformes (albatrosses, petrels, storm-petrels, fulmars, shearwaters), Pelecaniformes (pelicans, frigatebirds, gannets, boobies, cormorants) and Charadriiformes (skuas, jaegers, gulls, terns, skimmers, auks, guilliemots, puffins) (Schreiber and Burger 2002). Hong Kong locates on the northern edge of the South China Sea in the western Pacific region. A total of 39 species of seabirds have been recorded in Hong Kong so far (Carey *et al*. 2001). Some seabirds like gulls and terns occur regularly in Hong Kong but others such as boobies, frigatebirds, shearwaters and jaegers (also called skuas) were only recorded sporadically under certain rare circumstances such as approaches of tropical cyclones (Carey *et al*. 2001).

In the past, Hong Kong Bird Watching Society members have attempted to fill the information gap on seabird distribution in South China Sea. The most intriguing and important discovery is the finding of Aleutian Terns *Sterna aleutica* in southern Hong Kong waters during autumn 1992. This represented the first confirmed record of this species in China and on the Asian continent south of the breeding range. Before this, this species was only known from its breeding grounds in Alaska, Aleutian Islands, Kamchatka, Sakhalin and northeast Siberia and a handful records from Japan and the Philippines (Kennerley *et al*. 1993). This discovery led to more interest in the distribution of seabirds in this region, and it has only recently been found that this species winters in Southeast Asia.

On 17 April 2005, an exceptionally large number of jaegers and shearwaters were recorded by Hong Kong Bird Watching Society near Po Toi (HKBWS database). This suggests that the actual number of seabirds occurring in Hong Kong may be higher than what has been documented. Further evidence was provided by seabird observations in the South China Sea just outside the Hong Kong waters in the past (e.g. Chalmers 1978, 1979, Hopkin 1990, Lamont 1990, 1994).

With this background, it seems worthwhile to conduct a systematic survey to reveal the abundance and occurrence patterns of seabirds in Hong Kong waters. This would fill up the information gap that is essential to the protection of seabirds in Hong Kong and also in China. In this project, we will also try to assess the effect of weather that may affect the occurrence of these seabirds.

Hong Kong is well known to be one of the busiest ports in the world. Many vessels arrive to and depart from Hong Kong. Marine traffic is expected to increase continually in the future. A proposal for the construction of Container Terminal 10 is now under preparation to cope with the predicted expansion of marine traffic. In addition, there were recently proposals to build offshore windfarms to generate electricity in a renewable and cleaner way. Increase of marine traffic and site selection of the windfarms might have serious impacts on seabirds in Hong Kong waters. We believe that impacts from these projects could be better assessed if good baseline data is available. The main objective of this project is to fill up information gap in seabirds, by collecting information on the abundance and distribution of seabirds in Hong Kong waters during spring migration period.

2. Methods

2.1. Study area

This study is to record seabirds in the southern and south-eastern Hong Kong waters. The study area covered from the eastern part of West Lamma Channel, south of Lamma Island, waters between Lamma Island and Po Toi, Tathong Channel and between Po Toi to the East Ninepins. Survey transect was standardised and each survey trip started at Shau Kei Wan Typhoon Shelter. Survey boat went southeast through Tathong Channel, turned east after passing Tung Lung Chau towards the Ninepins. From the East Ninepins the survey boat changed to southwest direction and headed to Waglan Island and then to Po Toi. After taking a short break in Po Toi, the survey boat sailed westward to the south of Lamma Island and then turned north at the middle of the West Lamma Channel and finally entered the Victoria Harbour where the survey ended. A map showing the survey trip is shown in figure 1.

2.2. Study period

Study period was from late March to mid May 2006. Based on observations in the past, this period is thought to be the main passage period for seabirds. Survey frequency was scheduled to be once every three days in order to recording as many migratory seabirds as possible and the actual survey dates were:

2006 March: 21, 24, 27 and 30;
2006 April: 2, 5, 8, 11, 14, 17, 20, 23, 26, and 29;
2006 May: 2, 5, 8 and 11

A total of 18 regular survey trips were conducted and each survey trip started at 0830h and finished at 1630h. In addition, four supplementary survey trips were also made this spring which were aimed to provide extra information on the duration of the seabird's passage in Hong Kong. These supplementary survey trips were conducted on 17 March, 6 April, 4 May and 18 May. Totally 22 survey trips were carried out in this spring.

2.3. Counting method

Two surveyors with good seabird identification skill and bird counting skills carried out the surveys. The surveyors watched both sides of the boat to maximize the coverage of the survey. All the seabirds encountered during the survey were identified when possible and their corresponding numbers recorded. It is almost impossible to avoid double-counting completely because birds are in the air from time to time. Information such as direction of movement, flock size, special plumage features were noted and used to identify birds that were already counted.

2.4. Weather condition

Weather condition was believed to affect to seabird migration (Spear and Ainley 1997, Schreiber and Burger 2002). We have collected data on them so that a preliminary analysis can be carried out. During each survey, we recorded weather information at 0900h and 1500h. These represented the typical weather condition in the morning and the afternoon respectively. Weather condition was classified as four classes: sunny (<10% cloud), fine (10-50% cloud), cloudy (50-90% cloud) and overcast (>90% cloud). This classification of weather condition is slightly modified in the percentage of cloud from a similar one used by the Hong Kong Observatory (http://www.hko.gov.hk/wxinfo/currwx/flw_desecription/flw_e.htm). Such modification could make recording of weather condition easier and faster in the field. Rain was recorded as drizzle, rain or shower. Wind force was recorded in Beaufort scale (Appendix 1). Information of wind direction and tidal regime during the survey were collected from the Hong Kong observatory webpage (http://www.hko.hk) and information from the Waglan Island station is used because this station is situated well within the study area.

2.5. Data analysis

Since numbers of seabirds from all survey days are highly variable, percentage is used for data analysis. Analysis is focused on three main groups of seabirds: Red-necked Phalarope, Jaegers and Shearwater, and Terns, because they are main targets of this study and they have larger sample sizes. Arcsine square root transformation is applied to normalise the data. Parametric tests such as t-test and one-way ANOVA are used for the normally distributed data after transformation. Still, data of the Jaegers and Shearwaters could not be normalised and non-parametric tests of Mann-Whitney Rank Sum Test and Kruskal-Wallis one-way ANOVA are used to analyse the differences in different conditions. Two-way ANOVA is also applied to check any interaction between different factors. This method can only be applied to time and tide successfully since the data set is not large enough. The effect of other physical factors such as wind direction and force cannot be evaluated confidently.

3. Results and discussion

3.1. DIVERSITY OF SEABIRD

A total of 8,750 seabird individuals in 23 species were recorded on 22 survey days. Red-necked Phalaropes *Phalaropus lobatus* comprised the largest group of seabirds in this survey at 6,618 individuals (76%). Terns (family Sternidae) were the second largest group at 1,727 individuals (20%) in 12 species. These two largest groups are followed by Gulls (family Laridae) at 171 individuals (2%) of four species, Jaegers (family Stercorariidae) at 161 individuals (2%) of three species, Shearwaters (family Procellariidae) at 70 individuals (0.8%) of two species and auk (family alcidae) at three individuals (0.03%) of one species. Further details are listed in table 1.

The highest daily count of seabird was 969 individuals recorded on 24 March, followed by 925 seabirds on 5 May, while the lowest count was 61 birds on 30 March. Figure 2 shows changes of numbers over the study period and numbers of seabird recorded in each survey day are highly varied. High numbers of seabirds appeared in the third week of March, early April, late April and early May, while low numbers showed up in late March, mid April and mid May. These peak numbers of seabirds at different times reflect the main passage of different groups of seabirds: Red-necked Phalarope in March, early and late April and Terns in early May. The highest number of seabird species was 13 recorded on both 29 April and 5 May. Number of seabird species was relatively low in the beginning and became higher towards May. The higher numbers of seabirds species in late April and May is dominated by the occurrence of more tern species in late spring (Figure 3).

Red-necked Phalarope was the dominant species in this survey. Figure 4 shows the numbers of Red-necked Phalarope recorded in this survey and its pattern is largely similar to figure 2. Large numbers of this species were recorded in the third week of March, early April, late April and early May. In Figure 2, the patterns of occurrence of other seabird groups cannot be seen clearly because they were largely hidden behind the high phalarope numbers.

In contrast, terns showed a clear occurrence pattern. They were mostly absent in the beginning of this survey. Their number increased from mid-April and rose drastically in late April and remained high in early May. Numbers dropped toward mid-May. Details are referred to Figure 5.

Gulls also showed a clear pattern. All, except two individuals, were recorded before early

April. Their number peaked at 58 individuals on 27 March, showing that migrating gulls passed through Hong Kong in March to early April (Figure 6).

Only three species of Jaegers have been recorded in Hong Kong, namely Pomarine *Stercorarius pomarinus*, Parasitic *S. parasiticus* and Long-tailed *S. longicaudus* Jaegers and all of these were recorded during the survey. These Jaegers were recorded in higher number in early April but some could also show up in late March, late April and early May (Figure 7). Although the trend is less clear, these records suggest that Jaegers are far more common than has been documented in the past.

Shearwaters were also thought to be rare in Hong Kong waters and there were only a few positively identified records, which occurred during the approach of tropical cyclones. In this study, higher number were recorded in late April and early May and smaller numbers were also present from late March to early May (Figure 8). Similar to the situation for Jaegers mentioned above, this study suggests that shearwaters, including Streaked *Calonectris leucomelas* and Short-tailed *Puffinus tenuirostris* are regular visitors in Hong Kong waters.

Ancient Murrelet *Synthliboramphus antiquus* is the only species of Family Alcidae (Auks) that is known to be a regular visitor to Hong Kong (Carey *et al*. 2001). Only three individuals were recorded during this survey. They might have been under-counted in this survey.

3.2. SPATIAL AND TEMPORAL DISTRIBUTION OF SEABIRDS

As our survey trips were conducted using a standard transect, some details of the seabird distribution could be shown from the result. The south-eastern Hong Kong waters, including area around Ninepins, between Waglan and Ninepins and east of Po Toi, was surveyed in the morning, while the southern waters, including area between Po Toi and Lamma Island, south of Lamma and West Lamma Channel, was covered in the afternoon. Although average percentages of all seabirds recorded in the morning and the afternoon were similar (t-test, t_{40} = 1.99, P = 0.053, N.S. Table 2), different groups of seabirds showed preference to different locations and different time. More Red-necked Phalaropes were recorded in the eastern waters in the morning (t-test, t_{40} = 4.18, P <0.001, Table 2), while terns were recorded in higher number in the southern waters in the afternoon (Mann-Whitney Rank Sum Test, T = 285.500, P <0.001, Table 2). Although higher percentages of jaegers and shearwaters were recorded in the southern area in the afternoon, the difference is not highly significant (Mann-Whitney Rank Sum Test, T = 406.00, P = 0.257, N.S. Table 2). If confirmed, this result is of particular value for conservation in Hong Kong. The lack of detailed information in the past has not helped to answer this point.

3.3. WEATHER CONDITION AND TIDE

An attempt was made in this study to find out the relation of seabird occurrence and weather condition. Weather information thought to be linked to occurrence or migration of seabirds was recorded during the surveys. This includes cloud coverage, wind direction, wind force and tidal movement. We found that under different tidal condition, there was no significant relation in the occurrence of all seabirds (t-test, t_{40} = -0.538, P = 0.594, N.S.), nor Red-necked Phalarope (t-test, t_{40} = -1.224, P = 0.228, N.S.), Jaegers & Shearwaters (Mann-Whitney Rank Sum Test, T = 344.00, P = 0.279, N.S.) and Terns (t-test, t_{40} = 1.078, P = 0.287, N.S.). We also found no interaction between time and tide on the occurrence of seabirds (Two Way ANOVA, $F_{1,41}$ = 0.108, P = 0.744, N.S.). No significant relation was found between cloud coverage to the occurrence of all seabirds (One Way ANOVA, $F_{2,39}$ = 0.898, P = 0.46, N.S.), nor in Red-necked Phalarope (One Way ANOVA, $F_{2,39}$ = 1.240, P = 0.301, N.S.), Jaegers & Shearwaters (Kruskal-Wallis One Way ANOVA, H = 3.035, P = 0.219, N.S.) and Terns (One Way ANOVA, $F_{2,39}$ = 1.858, P = 0.17, N.S.).

Wind direction was also not significantly related to the occurrence of all seabirds (One Way ANOVA, $F_{6,34}$ = 0.476, P = 0.821, N.S.), nor to Red-necked Phalarope (One Way ANOVA, $F_{6,34}$ = 0.866, P = 0.530, N.S.), Jaegers & Shearwaters (Kruskal-Wallis One Way ANOVA, H = 8.063, P = 0.327, N.S.) and Terns (One Way ANOVA, $F_{6,34}$ = 0.927, P = 0.488, N.S.). Finally, different scales of wind force were also not significantly related to the occurrence of any seabirds groups (All seabirds: One Way ANOVA, $F_{2,39}$ = 0.898, P = 0.46, N.S.; Red-necked Phalarope: One Way ANOVA, $F_{2,39}$ = 1.240, P = 0.301, N.S.; Jaegers & Shearwaters: Kruskal-Wallis One Way ANOVA, H = 3.035, P = 0.219, N.S. and Terns: One Way ANOVA, $F_{2,39}$ = 1.858, P = 0.17, N.S.).

The above results are based on statistical analysis of the percentage of seabird. If the actual number of seabird is used for analysis, the present data set could not show any significant relation to the occurrence of seabirds. Sample size of data is perhaps insufficient. Details are referred to table 2.

3.4. ADDITIONAL SURVEYS

Four additional surveys were conducted to collect better information on the occurrence pattern of the migratory seabirds, These survey trips were scheduled on 17 March, 6 April, 4 May and 18 May. Some data, especially seabird numbers and weather condition, from these additional surveys was included in the data analysis to increase the sample size.

17 March 2006

The seabird survey was initially scheduled on 21 March. On 12 March, some HKBWS members found several seabirds including Pormarine and Long-tailed Jaegers which had not been recorded in this early date before, indicating that seabirds might already start their migration. This additional survey trip was carried out in order not to miss any significant data. Some gulls and Red-necked Phalaropes were recorded in this survey.

6 April 2006

One aim of this project is to find out passage duration of migratory seabirds. On 5 April, a large number of seabirds was recorded, including a total of 74 Pormarine and Long-tailed Jaegers that is also the highest count of Jaegers in spring. Hence, additional survey was arranged immediately on 6 April and the result included a total of only nine Jaegers and fewer numbers of other seabirds such as Red-necked Phalaropes. Weather condition was not same on these days, 5 April was a hot, fine and calm day while on 6 April weather was still fine in the morning but changed to windy and overcast in the afternoon. The following regular survey trip was then conducted on 8 April and total numbers of seabirds were fewer than those in 5 and 6 April but the number of Jaegers on 8 April increased to 21 birds. From observations on these two consecutive days, seabird numbers quickly dissipated and we also saw many seabirds especially terns, jaegers and shearwaters flew without stopping from the west to the east on 6 April. Therefore, we judged that migrating seabirds would stay in Hong Kong waters for only a very short period of time.

4 May 2006

The additional survey trip on 4 May was aimed to find out more on jaegers and shearwaters, From data up to early May, most sightings of jaegers and shearwaters seemed to concentrate in southern waters in the afternoon. This additional survey was to find out whether jaegers and shearwaters would come to southern waters in the evening to remain overnight. The survey took place till dusk. During this survey trip the wind was very strong in the afternoon and only one shearwater could be observed.

18 May 2006

Past experiences and information show that occurrence of seabirds in Hong Kong are related to the approach of tropical cyclones. While all regular survey trips were completed by 11 May, the approach of a tropical cyclone Chanchu on 15-17 May sparked hope that some useful information could be collected. Therefore, one additional survey was arranged on 18 May. By this time, Chanchu had just left Hong Kong. We totally recorded 516 terns but no other seabirds. This number was the highest count of terns during this study. This result indicates that some seabirds, in particular terns, would occur in Hong Kong in high numbers after the passage of a tropical cyclone.

4. Conclusion and recommendations

4.1. Abundance and occurrence of seabirds

This survey recorded high numbers of seabirds during the spring migration period. Occasional high counts of some species were also recorded in the past, especially during approaches of typhoons, but this study proves that many rare seabird species could occur in Hong Kong over a substantial period of time in spring. This suggests that they may even pass through Hong Kong regularly in significant numbers during the migration season. We have not noted any particular individuals or groups of seabirds which would stay for a long time. On the contrary, species and numbers varied greatly from day to day. This strongly suggests that different flocks of seabirds pass through Hong Kong everyday. Within 22 survey trips that are conducted once every three day, a total of 8,750 individuals were recorded in this spring. Therefore, it could be reasonably assumed that the number of seabirds passing through Hong Kong during the whole spring migration period could well be over 10,000 individuals and such high number is of local conservation importance.

Most of the seabirds recorded in this survey are long-distance migrants, i.e. species which breed at high latitudes and undertake long distance migration to winter in areas around the equator or further south. This reflects that Hong Kong waters and even the nearby South China Sea area are on their migration route. In contrast, other seabird species such as Frigatebirds *Fregata spp.* and Boobies *Sula spp.* have not been recorded in this survey. These birds are tropical breeders and their migration patterns are not as regular as high latitude breeders. Passage period of these tropical breeders in Hong Kong from existing records is also unclear. Therefore, these species might not be easily recorded from the regular surveys. Previous records of these birds also tend to relate to drastic weather condition, such as approaches of tropical cyclones and in the El Nino year.

4.2. Seabird hotspot

The dominant species in this survey is the Red-necked Phalarope which were higher number in the eastern area in the morning (Table 2), but results also suggested that the area between Po Toi and Lamma Island is also good for watching migratory seabirds where some seabird species could be observed, in particular shearwaters and jaegers which were thought to be rare in Hong Kong in the past (Figure 1).

In southern Hong Kong waters, marine traffic is very busy as it is the main navigation channel for container carriers and many other vessels. Red-necked Phalaropes usually spend their time floating on the water surface. Therefore, they are more susceptible to disturbances from ships moving, and also from high waves created by these ships. In contrast, seabirds such as jaegers, shearwaters and terns would be less affected by ships because they normally spend much more time in the air. This study shows that numbers (or percentages) of these seabirds in the southern areas is higher than in the south-eastern areas. The reason for this is far from understood. We suspect that water depth and salinity of water may be relevant. Many scattered small islands to the south of Hong Kong may also play an important role. Perhaps these seabirds may like to follow certain kind of ships, e.g. fishing vessels.

4.3. Weather and Seabirds

Seabird movement or migration is always thought to be related to the climate condition because birds choose the routes of least energy expenditure by taking advantage of prevailing winds (Schreiber and Burger 2002). This present study could not establish any relation between weather conditions and occurrences of seabirds. In the past, Lam and Williams (1994) suggested that spring movements of terns and jaegers are relate to the easterly phase of surges. During a strong easterly surge, seabirds might be forced to seek inshore waters. In addition, Spear and Ainley (1997) also suggested that many seabirds avoid flying with a tailwind (i.e. wind direction is same as flight direction.) and flight direction most often taken by Gulls was headwind (i.e. wind direction in 180 degree difference to flight direction.), while Jaegers and Terns often flew across the headwind (i.e. wind direction in between 30 to 60 degree difference to flight direction) and cross wind (i.e. wind direction in 90 degree to flight direction) and Shearwaters also preferred cross wind. These behaviours would relate to the weather condition and appearance of seabirds in Hong Kong. However, our present data could not support these ideas and more observations are needed to clarify this.

4.4. Threats to seabirds in Hong Kong

This study has not identified any immediate threats to seabirds in southern and south-eastern Hong Kong waters. The study area is one of the best water quality areas in Hong Kong and we also did not observe any significant pollution in the area. Red tide has been uncommon in the area. Even the presence of the red tide might not have a direct impact on the migratory seabirds. As discussed above, disturbances could become a major threat to seabirds because Hong Kong is one of the busiest ports in the world. Marine traffic is expected to expand in the near future after the completion of the new Container Terminal 10. In addition, the new proposed off-shore wind farm might have adverse impacts on seabirds by causing disturbance and possibly water pollution during the construction stage and also inducing bird collisions during the operation stage. Therefore, seabirds may face some considerable threats in Hong Kong in near future.

4.5. Recommendations

As mentioned above, many aspects of the relation between seabirds and the Hong Kong marine environment are still unclear. Relation of weather condition and seabird occurrence would only be found by conducting a long term study in a larger geographical scale. Disturbances to seabirds are not addressed in this study but it could become a major issue when the marine traffic increases after the completion of more new Container Terminals. The construction and operation of turbines for the off-shore wind farm projects might create disturbances. It is important to collect baseline data immediately in order to assess impacts of these developments on the seabirds in Hong Kong in the near future.

We recommend more surveys or studies of seabirds in Hong Kong because the result of this study shows that seabirds are present in Hong Kong in significant numbers but they are still poorly known. An accurate pattern of abundance and migration cannot be concluded by one year or one season observation. Long-term monitoring is the best way to offer satisfactory answers to these questions.

This survey also found high number of seabirds passing through Hong Kong in spring, but apparently no detailed or systematic records of seabirds is available for autumn migration or winter. Migration patterns could be different in spring and autumn and high numbers of seabirds were occasionally recorded in autumn in the past, e.g. about 200 Aleutian Terns in autumn 1992 (Kennerley *et al*. 1993). Therefore, it is a reasonably good guess to assume that seabirds could also pass through Hong Kong in significant numbers in autumn and some may stay in Hong Kong in the winter. Together with the data in spring, the year-round abundance of migratory seabird could then be estimated. This sort of baseline data is important not only for the conservation of the seabird, but also the Hong Kong marine environment as a whole.

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Seabird migration survey in southern and south-eastern Hong Kong waters, spring 2006

Tables

The Hong Kong Bird Watching Society Limited

Environment and Conservation Fund

Table 1. Number of seabirds recorded in spring 2006. Families are placed with a descending order of numbers and species within family are placed according to the order in Carey *et al*. (2001).

Seabirds		Number (percentage)
Family Scolopacidae (Sandpipers)		
Red-necked Phalarope *Phalaropus labotus*		6618 (75.63)
	Sub-total	6618 (75.63)
Family Sternidae (Terns)		
Whiskered Tern *Chlidonias hybridus*		6 (0.07)
White-winged Tern *Chlidonias leucopterus*		754 (8.61)
Gull-billed Tern *Sterna nilotica*		5 (0.06)
Caspian Tern *Sterna caspia*		4 (0.05)
Common Tern *Sterna hirundo*		212 (2.42)
Roseate Tern *Sterna dougallii*		2 (0.02)
Black-naped Tern *Sterna sumatrana*		258 (2.95)
Aleutian Tern *Sterna aleutica*		200 (2.28)
Bridled Tern *Sterna anaethetus*		55 (0.63)
*Sooty Tern *Sterna fuscata*		1 (0.01)
Little Tern *Sterna albifrons*		1 (0.01)
Greater Crested Tern *Sterna bergii*		10 (0.11)
Unidentified Tern *Chlidonias/Sterna sp.*		219 (2.50)
	Sub-total	1727 (19.73)
Family Laridae (Gulls)		
Black-tailed Gull *Larus crossirostris*		2 (0.02)
Heuglin's Gull *Larus heuglini*		158 (1.81)
Yellow-legged Gull *Larus cachinnans*		2 (0.02)
Slaty-backed Gull *Larus schistisagus*		1 (0.01)
Unidentified Gull *Larus sp.*		8 (0.09)
	Sub-total	171 (1.95)
Family Stercorariidae (Jaegers and Skuas)		
Pomarine Jaeger *Stercorarius pomarinus*		17 (0.19)
Parasitic Jaeger *Stercorarius parasiticus*		13 (0.15)
Long-tailed Jaeger *Stercorarius longicaudus*		113 (1.29)
Unidentified Jaeger *Stercorarius sp.*		18 (0.21)
	Sub-total	161 (1.84)

Family Procellariidae (Shearwaters)	
Streaked Shearwater *Calonectris leucomelas*	52 (0.59)
*Short-tailed Shearwater *Puffinus tenuirostris*	15 (0.17)
Unidentified Shearwater *Puffinus sp.*	3 (0.03)
Sub-total	70 (0.80)
Family alcidae (Auks)	
Ancient Murrelet *Synthliboramphus antiquus*	3 (0.03)
Sub-total	3 (0.03)
Total	8750 (100)

Species with asterisk (*) which are very rare in Hong Kong need further review by the Hong Kong Bird Watching Society's Record Committee for final acceptance of these records.

Table 2. Mean percentages, SD and sample size of all seabirds and different groups of seabirds. Percentages of jaegers and shearwaters are combined for this analysis.

			All seabirds		Red-necked Phalarope		Jaegers & Shearwaters		Terns	
		N	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Time	AM	21	0.62	0.27	0.64	0.30	0.23	0.39	0.14	0.19
	PM	21	0.47	0.24	0.26	0.22	0.44	0.47	0.72	0.35
			t = 1.99, df = 40, P = 0.053, N.S.		t = 4.180, df = 40, P < 0.001		T = 406.00, P = 0.257, N.S.		T = 285.500, P < 0.001	
Tide	Ebb	18	0.48	0.20	0.37	0.30	0.28	0.42	0.51	0.40
	Flood	24	0.52	0.22	0.51	0.33	0.38	0.45	0.37	0.40
			t = -0.538, df = 40, P = 0.594, N.S.		t = -1.224, df = 40, P = 0.228, N.S.		T = 344.00, P = 0.279, N.S.		t = 1.078, df = 40, P = 0.287, N.S.	
Interaction	Time x Tide (all seabirds)		F = 0.108, P = 0.744, N.S.							
Weather	Overcast	22	0.45	0.20	0.48	0.31	0.41	0.43	0.33	0.40
	Cloudy	10	0.55	0.19	0.50	0.34	0.20	0.42	0.46	0.40
	Fine & Sunny	10	0.54	0.25	0.33	0.35	0.30	0.48	0.62	0.36
			$F_{2, 39}$ = 0.898, P = 0.46, N.S.		$F_{2, 39}$ = 1.240, P = 0.301, N.S.		H = 3.035, df = 2, P = 0.219, N.S.		$F_{2, 39}$ = 1.858, P = 0.17, N.S.	

Table 2 (continued). Mean percentages, SD and sample size of all seabirds and different groups of seabirds. Percentages of jaegers and shearwaters are combined for this analysis.

			All seabirds		Red-necked Phalarope		Jaegers & Shearwaters		Terns	
		N	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Wind direction	North	3	0.49	0.22	0.47	0.25	0.61	0.40	0.46	0.51
	East	6	0.47	0.26	0.27	0.31	0.39	0.49	0.58	0.38
	South	5	0.47	0.22	0.52	0.37	0.18	0.42	0.53	0.39
	West	3	0.65	0.14	0.68	0.16	0.00	-	0.25	0.43
	Northeast	14	0.47	0.20	0.48	0.27	0.33	0.44	0.32	0.42
	Southeast	3	0.61	0.33	0.63	0.55	0.09	0.12	0.14	0.14
	Southwest	7	0.47	0.21	0.37	0.37	0.57	0.53	0.60	0.41
	Northwest	1	0.73	-	0.00	-	0.00	-	0.73	-
			$F_{6, 34} = 0.476$, P = 0.821, N.S.		$F_{6, 34} = 0.866$, P = 0.530, N.S.		H = 8.063, df = 7, P = 0.327, N.S.		$F_{6, 34} = 0.927$, P = 0.488, N.S.	
Wind force	Scale 1	12	0.50	0.22	0.59	0.33	0.35	0.48	0.31	0.37
	Scale 2	8	0.46	0.22	0.43	0.35	0.05	0.13	0.48	0.38
	Scale 3	18	0.53	0.21	0.38	0.32	0.47	0.44	0.46	0.41
	Scale >3	4	0.44	0.24	0.43	0.24	0.25	0.50	0.51	0.56
			$F_{3, 38} = 0.245$, P = 0.865, N.S.		$F_{3, 38} = 1.114$, P = 0.356, N.S.		H = 5.930, df = 3, P = 0.115, N.S.		$F_{3, 38} = 0.490$, P = 0.691, N.S.	

Seabird migration survey in southern and south-eastern Hong Kong waters, spring 2006

Figures

The Hong Kong Bird Watching Society Limited

Environment and Conservation Fund

Figure 1. Standard transect of the regular survey in spring 2006.

Black arrows show the transect. Area shaded with red is the area with higher abundance of Red-necked Phalarope. Area shaded with yellow is the area with higher abundance of jaegers, shearwaters and terns.

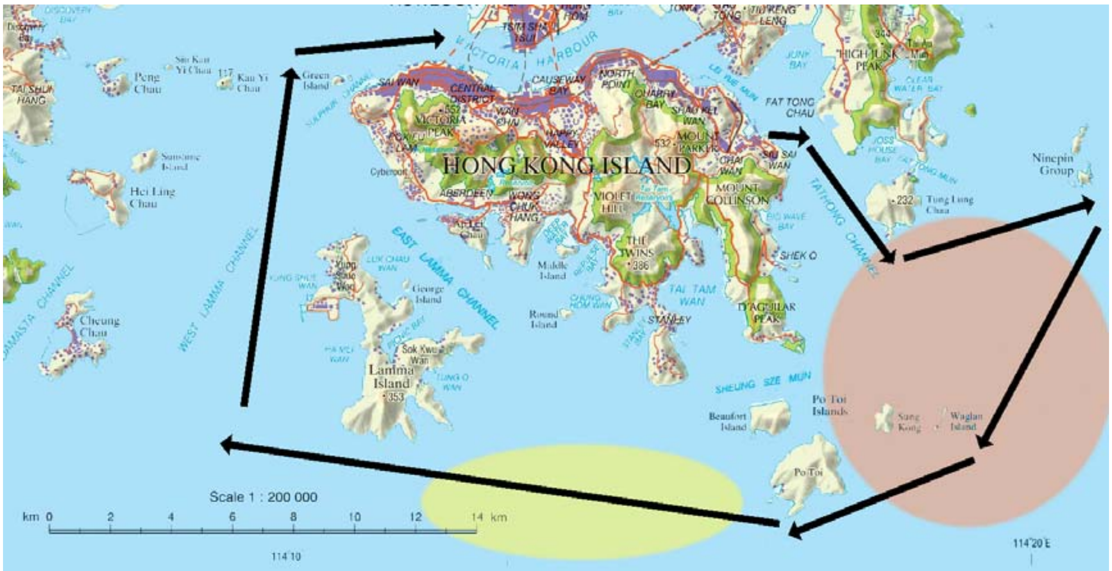


Figure 2. Number of seabird individuals recorded during the regular surveys in spring 2006.

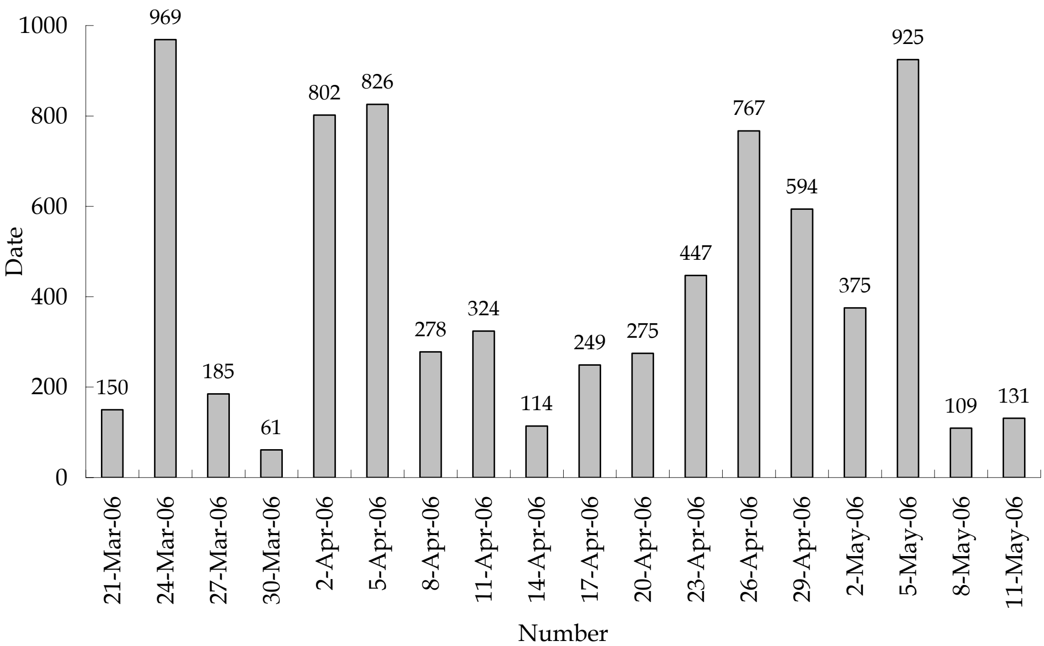


Figure 3. Number of seabird species recorded during the regular survey in spring 2006.

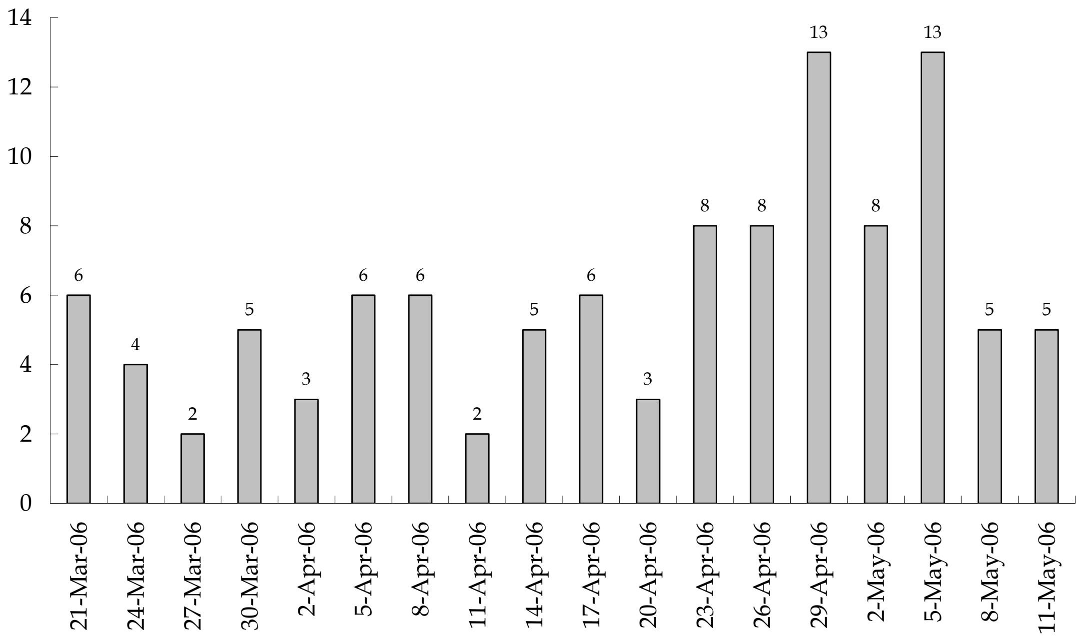


Figure 4. Numbers of Red-necked Phalarope during the regular survey, spring 2006.

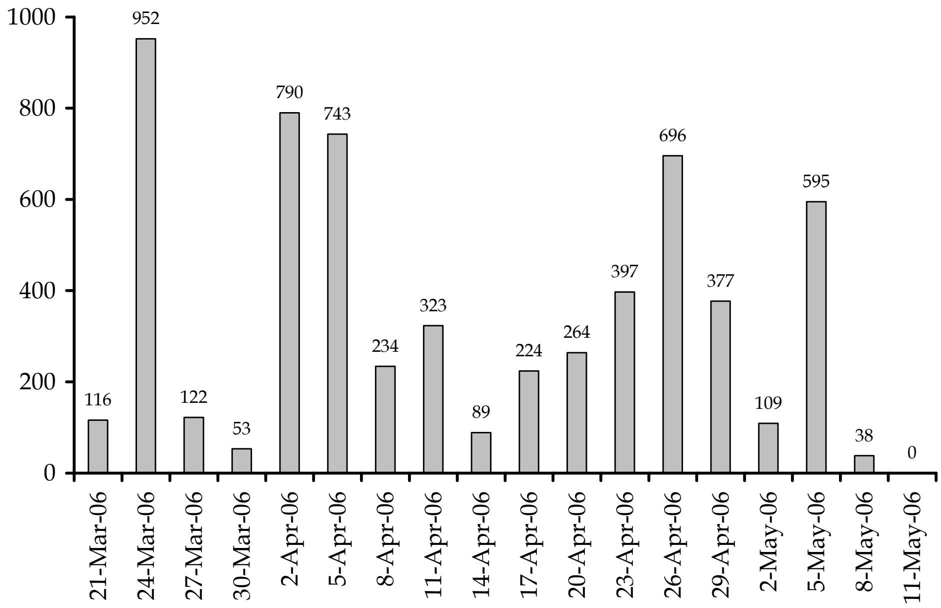


Figure 5. Numbers of terns during the regular survey, spring 2006.

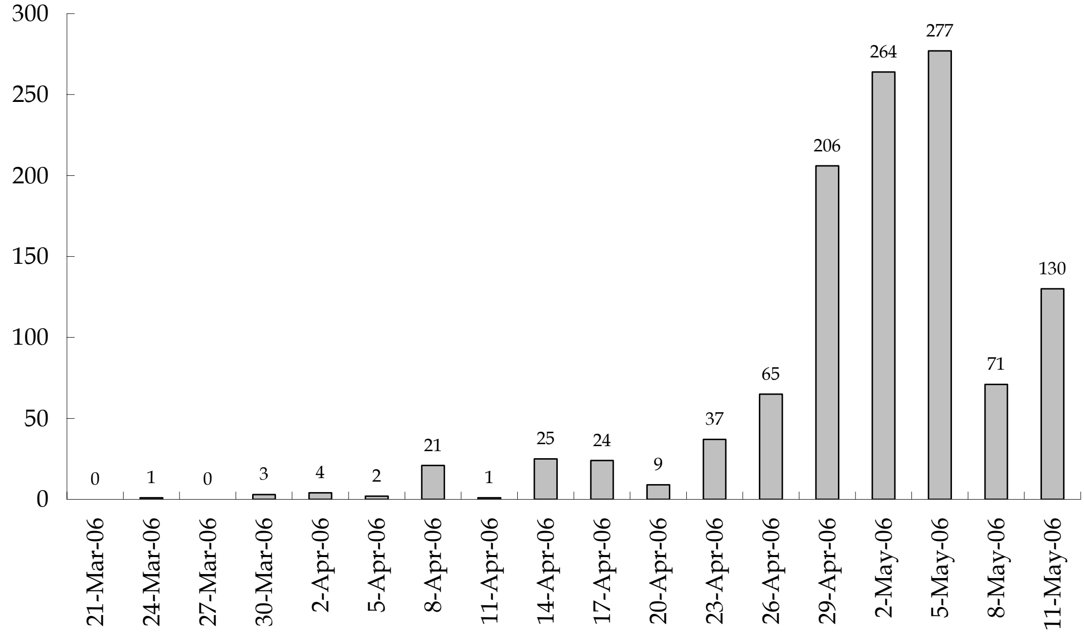


Figure 6. Numbers of gulls during the regular survey, spring 2006.

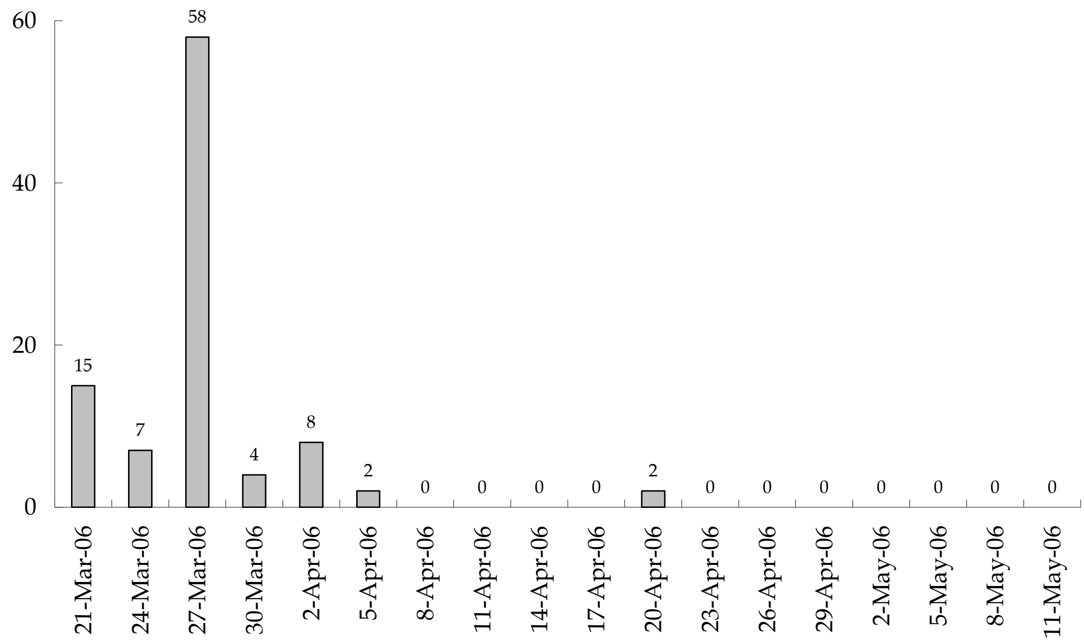


Figure 7. Numbers of jaegers during the regular survey, spring 2006.

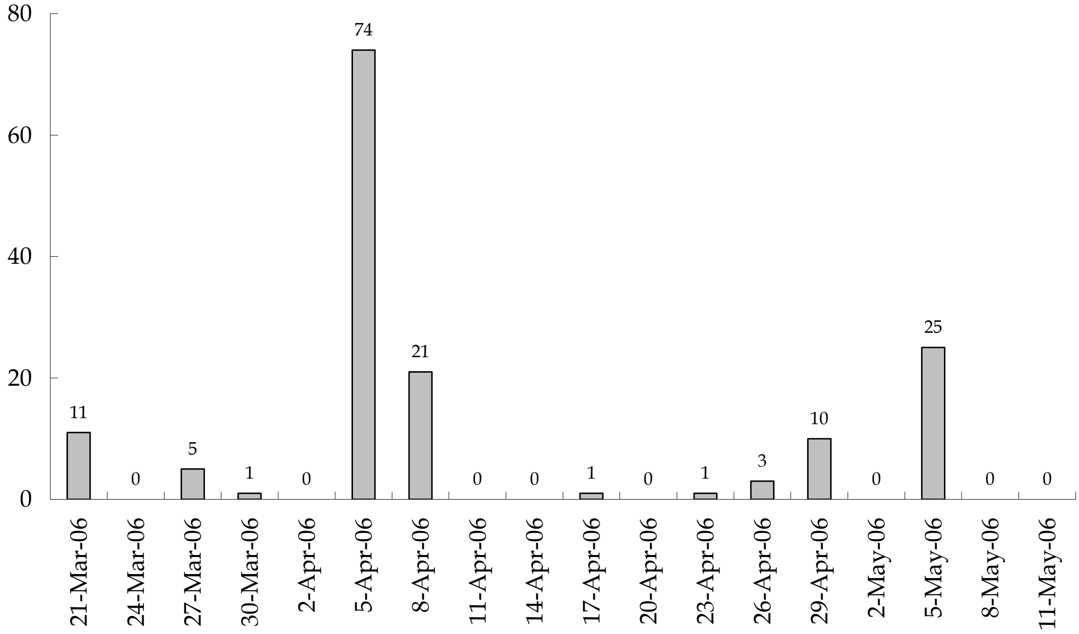
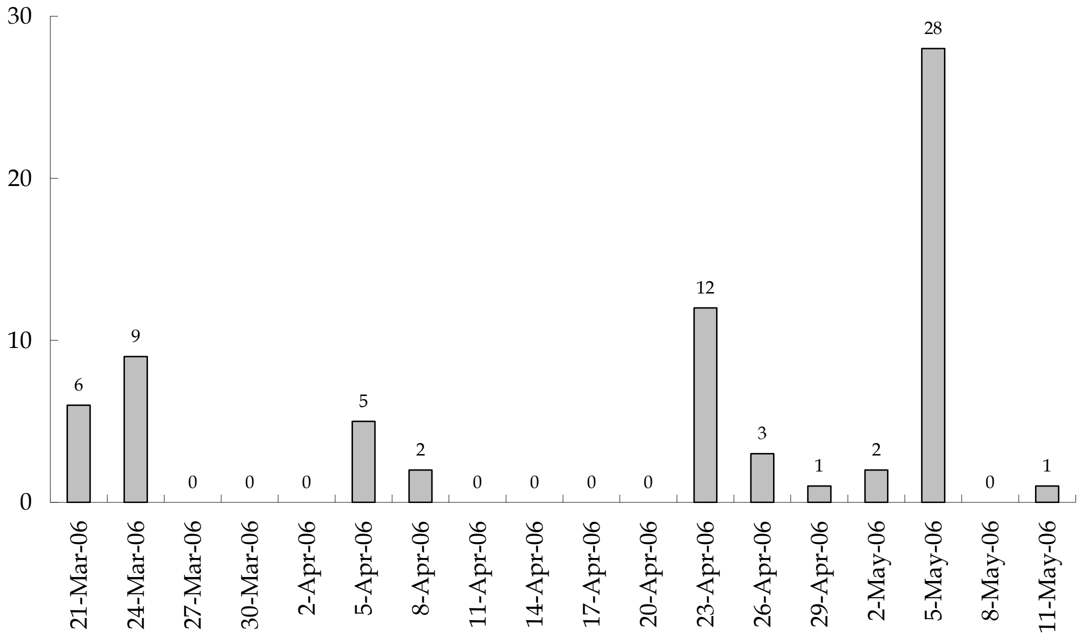


Figure 8. Number of shearwaters during the regular survey, spring 2006.



Seabird migration survey in southern and south-eastern Hong Kong waters, spring 2006

Appendix

Beaufort scale

The Hong Kong Bird Watching Society Limited

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Appendix 1. Beaufort scale for wind force by sea criterion (from the Hong Kong Observatory, http://www.hko.gov.hk/wservice/tsheet/pms/beaufort_e.htm?menu=services)

Descriptive term	**Beaufort scale number**	**Mean velocity in knots**	**Mean velocity in metre per second**	**Sea criterion**	**Probable height of waves in metres**	**Probable maximum height of waves in metres**
Calm	0	<1	<0.5	Sea like a mirror.	-	-
Light	1	1-3	0.5-1.5	Ripples with the appearance of scales are formed but without foam crests.	0.1	0.1
Light	2	4-6	2-3	Small wavelets, still short but more pronounced; crests have a glassy appearance and do not break.	0.2	0.3
Moderate	3	7-10	3.5-5	Large wavelets; crests begin to break; foam of glassy appearance; perhaps scattered white horses.	0.6	1
Moderate	4	11-16	5.5-8	Small waves, becoming longer; fairly frequent white horses.	1	1.5
Fresh	5	17-21	8.5-11	Moderate waves, taking a more pronounced long form; many white horses are formed (chance of some spray).	2	2.5
Strong	6	22-27	11.5-14	Large waves begin to form; the white foam crests are more extensive everywhere (probably some spray).	3	4
Strong	7	28-33	14.5-17	Sea heaps up and white foam from breaking waves begins to be blown in streaks along the direction of the wind.	4	55

Gale	8	34-40	17.5-20.5	Moderately high waves of greater length; edges of crests begin to break into spindrift; the foam is blown in well-marked streaks along the direction of the wind.	5.5	7.5
Gale	9	41-47	21-24	High waves; dense streaks of foam along the direction of the wind; crests of waves begin to topple, tumble and roll over; spray may affect visibility.	7	10
Storm	10	48-55	24.5-28.5	Very high waves with long overhanging crests; the resulting foam, in great patches, is blown in dense white streaks along the direction of the wind; on the whole, the surface of the sea takes on a white appearance; the tumbling of the sea becomes heavy and shocklike, visibility affected.	9	12.5
Storm	11	56-63	29-32.5	Exceptionally high waves (small and medium-sized ships might be for a time lost to view behind the waves); the sea is completely covered with long white patches of foam lying along the direction of the wind; everywhere the edges of the wave crests are blown into froth, visibility affected	11.5	16
Hurricane	12	64 and over	33 and over	The air is filled with foam and spray; sea completely white with driving spray; visibility very seriously affected.	14 or over	-

Appendix 2. List of Seabird in Hong Kong from Carey *et al*. 2001

1	Streaked Shearwater	*Calonectris leucomelas*
2	Red-footed Booby	*Sula sula*
3	Brown Booby	*Sula leucogaster*
4	Christmas Island Frigatebird	*Fregata andrewsi*
5	Great Frigatebird	*Fregata minor*
6	Lesser Frigatebird	*Fregata ariel*
7	Red-necked Phalarope	*Phalaropus lobatus*
8	Red Phalarope	*Phalaropus fulicarius*
9	Pomarine Jaeger	*Stercorarius pomarinus*
10	Parasitic Jaeger	*Stercorarius parasiticus*
11	Long-tailed Jaeger	*Stercorarius longicaudus*
12	Black-tailed Gull	*Larus crassirostris*
13	Mew Gull	*Larus canus*
14	Heuglin’s Gull	*Larus heuglini*
15	Yellow-legged Gull	*Larus cachinnans*
16	Slaty-backed Gull	*Larus schistisagus*
17	Glaucous-winged Gull	*Larus glaucescens*
18	Glaucous Gull	*Larus hyperboreus*
19	Pallas’s Gull	*Larus ichthyaetus*
20	Brown-headed Gull	*Larus brunnicephalus*
21	Relict Gull	*Larus relictus*
22	Black-headed Gull	*Larus ridibundus*
23	Slender-billed Gull	*Larus genei*
24	Little Gull	*Larus minutus*
25	Saunders’s Gull	*Larus saundersi*
26	Black-legged Kittiwake	*Rissa tridactyla*
27	Whiskered Tern	*Chlidonias hybridus*
28	White-winged Tern	*Chlidonias leucopterus*
29	Gull-billed Tern	*Sterna nilotica*
30	Caspian Tern	*Sterna caspia*
31	Common Tern	*Sterna hirundo*
32	Roseate Tern	*Sterna dougallii*
33	Black-naped Tern	*Sterna sumatrana*
34	Aleutian Tern	*Sterna aleutica*
35	Bridled Tern	*Sterna anaethetus*
36	Sooty Tern	*Sterna fuscata*
37	Little Tern	*Sterna albifrons*
38	Greater Crested Tern	*Sterna bergii*
39	Ancient Murrelet	*Synthliboramphus antiquus*