8. MARINE ECOLOGY

8.1 Background

Extensive ecological assessments have been carried out for previous studies of the Lantau Port which have concluded that the impacts will be largely within acceptable limits. The scope of the present study has been restricted to assessing the impacts on ecology from the changes in water quality.

Dredging operations, whether for sources of fill or for marine mud prior to formation of land, could have adverse impacts on both marine water quality and ecology unless otherwise controlled. Potential impacts relating to water quality are as follows:

(a) removal of habitat;
(b) entrainment of organisms during dredging;
(c) increased suspended sediments;
(d) increased levels of nutrients;
(e) increased turbidity; and
(f) depletion of dissolved oxygen.

In addition there could be physical impacts from the dredgers and other marine equipment and from changes in water circulation and water quality during and after construction of the reclamations.

The nature and extent of these potential impacts are described in this Chapter in connection with the marine species which have been catalogued through previous studies as being present in the study area.

8.2 Species Present in Study Area

The Chinese White Dolphin is listed in the Bonn Convention on the Convention of Migratory Species and is protected in Hong Kong under the Wild Animals Protection Ordinance. A study is currently being undertaken through the Swire Institute of Marine Science in conjunction with AFD to assess the population dynamics and foraging strategies of the Chinese White Dolphins in Hong Kong's territorial waters. These studies are mostly confined to Lantau Coastal Waters and research is at an early stage. A 21 day survey has been carried out as part of this Consultancy to ascertain the importance of the study area to the Chinese White Dolphin. Results are presented later in this Chapter.

Green turtles occasionally nest on Lamma Island and as these are listed under the Convention on the Trading in Endangered Species of Wild Fauna and Flora (CITES) thus are protected in Hong Kong.

8.2.1 Fisheries

Capture Fisheries

The western harbour fish catchment area can be divided into three sub-areas, northern, south-western and south-eastern. During 1989-90 adult fish caught in these areas by small craft (less than 15m) totalled 4,140 tonnes, worth approximately HK$60M, plus 3,587,000 fish fry valued at HK$6.4M. The greatest tonnage of adult fish was caught in the northern sub-area, while the greatest number of fish fry came from the south - eastern sub-area (Table 8.1).

Table 8.1 : 1989-90 Estimated Fisheries Production by Small Craft

Fishing Sub-Area	Adult Fish		Fish fry	
	Quantity (tonnes)	Value ('000HK$)	Quantity ('000No.)	Value ('000HK$)
Northern	2181	30,821	1,313	2,741
South-western	782	14,342	262	758
South-eastern	1,177	15,218	2,012	2,933
Total	4,140	60,381	3,587	6,432

Rocky substrates within the study area provide important areas for sheltering fish and support a grouper fishery primarily around Ma Wan and the west coast of Tsing Yi. Fishing for fry is carried out in sheltered bays between March and April, sometimes extending into June, for supply to the fish culture industry. Although it is unlikely that the port development will have any significant impact on the fish nursery and spawning grounds when viewed in isolation, the cumulative impacts to these areas of all the large scale infrastructure projects currently planned in Hong Kong may be significant. The possibility of this is increased by the similar planning times for these projects.

Fish Culture Zones (FCZ's)

The fish culture industry in Hong Kong is a significant source of seafood. The estimated production in 1989 was 3,860 tonnes, valued at HK$233M. Gazetted areas in the vicinity of the Study Area include those at Ma Wan and Cheung Sha Wan off Lantau Island, in addition to which there are two zones on eastern Lamma Island (Sok Kwu Wan and Lo Tik Wan). AFD data suggests that the estimated total area of cage nets in each of these areas is as follows : Ma Wan, 11,000m^2; Cheung Sha Wan, 20,000m^2; Sok Kwu Wan, 24,000m^2, and Lo Tik Wan, 25,000m^2. In each case relatively minor areas are devoted to fish holding.

8.3 Intertidal Habitats

Four main shore types are found within the study area.

- sandy (exposed) shore
- deeper embayment/sheltered shores (where the substrata consists of finer mud/sand sediment)
- rocky shores
- reclaimed shores

Sandy (exposed) shore

In the smaller, shallower embayments within the study area, the increased degree of exposure to wave action has resulted in the substratum consisting of well sorted, medium grained sands. The mobility of this type of substrate limits faunal diversity and prohibits the growth of intertidal macroalgae, although microscopic interstitial species may be present. The upper beach typically is home to burrowing Ocypodid crabs, and clams (Donax spp.) are found in the surf zone of the lower beach. Where human disturbance is low, sandy shores are often used by a number of wading birds (plovers and sandpipers) that feed on shoals of fish fry on the incoming tide. (see Appendix G3.1 for species list)

Sheltered shore

The reduced exposure and substrate mobility of sheltered shores provides habitats for a greater diversity of epifauna and infauna than exposed shores, comprising mainly annelids, worms, molluscs and crustaceans. Gobiid fish are common of such areas, and a number of wading birds feed on the infaunal invertebrates. While the unconsolidated substrate surface offers little anchorage for macroalgae, several species of green (*Enteromorpha, Cladophora*) and blue-green (*Cyanophaceae*) algae occur, along with diatoms.(Species lists are presented in Appendices G3.2 and G3.3).

Rocky shore

Sheltered and moderately exposed rocky shores are the most common shore type in the area. High-zoned organisms include gastropods (*Nodolittorina* spp.) and sea-slaters (*Ligia exotica*). The species occurring at the mid/low intertidal depends on the level of exposure of any particular stretch of coastline. Moderately sheltered shoreline will support large numbers of mobile gastropods such as *Monodonta australis* and *Lunella coronata*, with a band of rock oysters (*Saccostrea cucullata*) occupying the lower eulittoral. Lower still will appear a scatter of barnacles (*Tetraclita squamosa*), and stalked barnacles (*Pollicipes mitella*) occupy crevices as high as the mid-eulittoral. (Species lists are presented in Appendices G3.2 and G3.3)

Reclaimed shores

The biota of reclaimed shorelines depends very much on the nature of the substrate, degree of exposure and the age of the structure. Studies elsewhere in Hong Kong have shown the fauna of man-made shores to be impoverished and of little ecological value, normally as a result of low microhabitat availability.

8.4 Benthic Fauna

Polychaetes were by far the most abundant organisms, both in terms of species and individuals. The species composition was similar to other soft sediment faunal studies in Hong Kong waters. However, the species diversity and richness reported in the LAPH Environmental Survey were relatively lower than previous records in the same sampling area. Species counts for all sampling stations varied seasonally from twenty one species in December to nine species in June. All the frequently occurring species (Table 8.2) had been reported from elsewhere in Hong Kong.

Table 8.2 : **Frequently Occurring Benthic Species in the Study Area**

Species	% occurrence	Max. No. individuals m^{-2}
Dec. 1991.		
Notomastus latericeus	73	46
Paraprionospio pinata	73	40
Glycera chiori	60	13
Terebelllides stroemi	47	20
Aglaophamus lyrochaeta	40	13
June1992		
Notomastus latericeus	93	53
Aglaophamus lyrochaeta	46	13
Lumbrineris sp	40	13
Nemertea sp.	33	6
Praprionospio pinnata	26	13

In comparison with the rest of Hong Kong, there is little of a particularly unique nature in either the intertidal or subtidal communities of the study area.

8.5 Dolphin Survey

Methodology

A 21 day survey of an extended area around the proposed site for CT10 and 11 was conducted to obtain an indication of the importance of this area to the Chinese White Dolphins. A boat-based survey was conducted in the area marked in Figure 9.1. Reference can be made to Appendix G.2 for the complete report of the survey.

The objectives of the survey were to observe, report and photograph any dolphins and to record temperature and salinity profiles within the survey area. Consultation was made with Hong Kong marine mammal experts from Ocean Park and Swire Institute of Marine Science both in preparation and conduct of the methodology and analysis of the results.

The survey vessel was steered along pre-determined survey lines. The positioning of the survey vessel was determined and recorded in real time by a DGPS Positioning system. The actual route of the vessel was recorded by computer and has been plotted for each day of the survey period (see Appendix G2). The plots of the vessel route for each day show that the vessel travelled close to the transects, except where it had to avoid islands along the transects. Therefore, all transects can be considered as "on" transects.

Three experienced marine surveyors were employed to scan the waters for dolphins. Dolphins were sometimes sighted by more than one observer at the same time. No observer bias was reported. For each dolphin group sighting, the coordinates of the survey vessel were recorded. The angle between the transect and the sight line of the dolphins was measured and the distance of the dolphins away from the survey vessel was

estimated by the use of binoculars. By knowing the coordinates of the vessel, and the angle and distance from transect, the coordinates of each dolphin group were calculated. All time on board the survey vessel was spent in dolphin observations, except for the following occasions: lunch (approximately 45 minutes), and carrying out the temperature and salinity profiles (approximately 5 minutes per profile).

Temperature and salinity profiles were recorded at the start and the end of most of the survey lines. Most of the measured temperature profiles were around 27°C, and the salinity profiles around 32 ppt. The 1992 to 1994 water quality of Southern WCZ, Lantau Island East, monitoring station SM10 registered surface water temperatures of 15.4 to 29.2°C and salinity of 21.5 to 33.1 ppt.[1] The measured temperature and salinity profiles for this study were within the upper range of normal values found in the study area.

A standardised survey sheet was filled out for each sighting to describe the group size, behaviour, colour, body length and coordinates of the dolphin group. A group of dolphins was defined to be a number of dolphins that were in close proximity to each other at the time of the sighting.

Limitations of the Survey

Due to the very brief time frame of this survey and the tight programme for conducting the study, there are a number of limitations which should be taken into account when reviewing the conclusions.

(i) the marine surveyors recording the observations were not experienced marine mammal observers and therefore sighting frequency could be reduced and observations regarding activities of the dolphins may not be as accurate as those of trained dolphin observers who can more easily distinguish between feeding and socialising or playing.

(ii) the method for determining distance of the dolphins from the boat in this survey differs from the method used in the SWIMS study and this makes accurate comparison of survey information with the SWIMS data difficult.

(iii) the small number of dolphin sightings does not allow for a statistically valid treatment of the data, so a statistical calculation of the density of the dolphin sightings is not appropriate for this study.

(iv) the dolphin survey was conducted in one three week period in 1994. Since no sample was taken from other times of the year, caution should be exercised when comparing the data in this study with data from other studies.

Results

In total, thirteen groups of dolphins were sighted. The sightings were distributed mainly off the shores of the northeast end of the Lantau Island, in a stretch between Discovery Bay and Ma Wan (Figure 8.2). Since twenty one surveys were conducted within the survey period, the mean number of sightings per survey was 0.6. The distribution of the number of dolphin group sightings per survey have been plotted on Figure 8.3.

[1] Unpublished Data from EPD, Hong Kong Government, 1994.

The largest group size observed had twelve to fourteen dolphins, while the smallest had one. Most of the dolphin groups consisted of three to five dolphins per group. For most of the sightings, the dolphins were observed to be interacting socially. Some of the dolphins were one to two metres in length, but most were two to three metres long. Most dolphin groups had a mixture of white, pink, and grey dolphins. The total distance travelled for each day during the survey period has been calculated. A summary of the survey date, distance travelled for the day, number of groups sighted per day, size of group, and description of group has been detailed in Table 8.3.

Table 8.3 Total Distance Travelled Each Day

Date (October)	#	Description		Total Distance Travelled for the Day (km)
		Colour	Activity	
05	-	-	-	22
06	-	-	-	47
07	-	-	-	44
08	2	pink	social	47
09	-	-	-	42
10	-	-	-	55
11	-	-	-	54
12	1	white	jump	56
	5	white	social	-
	5	grey	social	-
	5	white/grey	social	-
13	-	-	-	49
14	-	-	-	55
15	-	-	-	55
16	2	white/grey	n/a	38
	2	white/grey	n/a	-
17	5	white/grey	social	54
	13	white/grey	social	
18	-	-	-	47
19	-	-	-	50
20	-	-	-	51
21	-	-	-	57
22	-	-	-	54
23	4	pink/grey	social	47
	4	pink/grey	social	-
	4	pink/grey	dive	-
	4	pink/grey	social	-
24	-	-	-	47
25	-	-	-	52

The measured temperature and salinity profiles had a narrow range of values. Therefore, no statements could be made about whether or not dolphin distributions were correlated with salinity and temperature. It was suspected that the number of individuals, species and diversity might decline in the winter time, with the controlling factor being the colder water temperature in winter. However, research in Hong Kong waters has not found a clear decline in species number and diversity in the winter time, and this may be due to the relatively high winter temperatures prevailing in Hong Kong waters.[2]

A pooled distribution of perpendicular sighting distances has been calculated (Figure 8.4). One of the assumptions of the line transect theory of counting dolphin populations was that the animals were not disturbed by the survey technique. The distribution of the perpendicular sighting distances showed that there were many more sightings close to the survey vessel than farther away. This result demonstrated that the dolphins were not trying to avoid the survey vessel.

A pooled herd size distribution has also been calculated (Figure 8.5).[3] The plot of the pooled herd size distribution showed that most of the herds were small, with five or less dolphins per herd. The mean herd size was four.

The WWF (World Wild Fund for Nature/Hong Kong) has been collecting dolphin sighting data up until December of 1993. Since then, intensive work has been initiated and carried out by the Dolphin Research Group at the Swire Institute of Marine Science (SWIMS) of the University of Hong Kong (HKU). A total of twenty eight dolphin surveys have been conducted by SWIMS from 09 Jan, 1994 to 28 September, 1994.[4] Dolphin surveys have mostly been carried out near the north, west, and south sides of the Lantau Island. By using photo-identification techniques, 52 dolphins have been judged by their distinctive colour, shape, and scarring to have been identified on more than two occasions. Seven of the 52 identified dolphins were calves. New dolphins were being added to the dolphin catalogue. However, the rate of increase in dolphin identification was tailing off, suggesting that the upper limit of the population was nearing.

The SWIMS data showed that dolphins were reliably seen either resting, feeding or socializing close to the Lung Kwu Chau and Sha Chau areas. The area between Tai O and Sha Lo Wan, and the area between Fan Lau and Soko Islands were also frequented sporadically. The Brothers were sometimes visited in the Spring. The distribution of the number of sightings per survey for the SWIM data has been plotted (Figure 8.6). The average number of sightings per survey was 2.6.[5]

Since August of 1994, an increasing number of dolphins has been sighted to the north

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[2] Richards and Wu. Inshore Fish Community Structure in a Subtropical Estuary.

[3] A herd size distribution can be calculated for each day. However, due to the small number of sightings for each day, the resultant distributions will not be meaningful.

[4] Ms. Lindsay J. Porter. Progress Report: Chinese White Dolphin Project. Swire Institute of Marine Science, 1994.

[5] It should be noted that 2 survey trips were abandoned due to poor weather conditions. These surveys were not counted in the data analysis.

Since August of 1994, an increasing number of dolphins has been sighted to the north and east of Lantau Island. The sudden change coincided with the summer season, which caused an increase in the flow of storm water from the Pearl River. During these episodes of increased water flow, the salinity of the water decreases. Therefore, the Dolphin Research Group has postulated that decreasing salinity concentrations in the marine waters was correlated with an increase in the dolphin population residing in the study area. The reverse logic of this postulate was that an increase in salinity levels would be correlated with a decrease in dolphin populations. However, this postulate has to be tested by SWIMS by conducting further dolphin surveys around the Lantau Island in the next few years.

The average number of sightings per survey to the northeast of the Lantau Island is 0.6. This number is much smaller than the average number of 2.6 for the north, west, and south areas of Island. The survey for this study was carried out at a time when the salinities of the waters were close to their highest in the entire year. If dolphins were sensitive to salinity changes, as postulated by SWIMS, then the much lower rate of dolphin sightings reported by the data collected in this study may have been caused by the high salinity concentrations in the marine waters. The visibility and the roughness of the sea was about equal for the SWIMS surveys and these surveys.

Conclusion

The limitations of the survey should be recognised. It is therefore important to continue monitoring prior to the commencement of the works.

Small numbers of Chinese White Dolphins were found in the study area around Penny's Bay. However, the area is less utilised by the dolphins compared to the northern Lantau waters. The study area, therefore, does not appear to be an area of major significance to the dolphins.

8.6 Impacts to Marine Ecology and the Fishing Industry

Loss of Marine Habitats

Table 8.4 shows the estimated loss of intertidal and subtidal habitats due to construction of CT10 and 11.

Table 8.4 : Habitat Loss due to Construction of CT10 and CT11

Habitat	Length or Area
Mobile sand beach	0
Sheltered beach	0
Rocky shore	3.5 km
Reclaimed shore	500m
Sub-tidal	27 ha

Approximately 3.5 km of intertidal habitat along the south coast of Tsing Chau Tsai (TCT) peninsula will be lost during construction of this project. The intertidal habitats include rock outcrops, boulders and stretches of sand and cobble. The subtidal area covered by the reclamations will also be lost and the seabed which will be dredged for the access channel will be seriously disturbed.

Many of the organisms in the top 1m of the substrate are not able to tolerate the disturbance experienced during the dredging process. Sessile organisms will be most adversely affected by the dredging works as, unlike mobile species they cannot migrate from the site when dredging commences.

Some researchers have identified that some soft bodied organisms may actually be able to survive the disturbance caused by dredging and can be reintroduced to the marine environment at the disposal site. This naturally depends upon the species involved, the method of dredging adopted and the length of time between the removal and recolonisation process. At a higher trophic level, reduction in the numbers of sessile benthic biota in an area can have an adverse impact on other forms of marine life due to the depletion in food supply.

Socio-economic Impacts to the Fishing Industry

The commercial fishing industry in the Western Harbour area is of significant economic value. It is anticipated that fishing will be disrupted to some extent during both construction and operational phases of the port development.

The northern sub-area of the fishing grounds, accounting for approximately 50% of the fish caught and profits gained, will be most affected by the development. This is due principally to the sea-area required for the port and associated reclamations, the increase in marine traffic in the vicinity and associated marine pollution. No significant impacts are anticipated on fishing activities in the southern sub-areas. However, given that many of the small fishing craft fish the combined areas in the Western Harbour, there is a potential for overfishing to occur in the southern sub-areas as a result of the decline in the northern sub-area fisheries.

It is important in this situation that the Government amasses sufficient statistics on the existing fisheries in the study area to be in a position to adequately address the potential impact on the fishing industry.

Impacts from Construction

Dredging and Reclamation

Increased water turbidity resulting from dredging and reclamation may also have indirect impacts on the local fishing industry through the disruption of marine food webs. For example, primary production by phtyoplankton may be reduced due to reduced light penetration into the water column, thus affecting the amount of energy available to higher trophic levels, including locally caught fish species.

The physical removal of benthic organisms within dredged mud is not considered to be of major significance due to the impoverished nature of the fauna. The types of organism found in the sediment are opportunistic species, and as such will quickly recolonise a disturbed area.

Increased algal productivity may result if significant quantities of nutrients are released into the water column during dredging. In severe cases this may lead to dinoflagellate blooms, or "red tides". These would have a negative impact on the fisheries within the study area, and may pose a threat to public health through the bioaccumulation of algal toxins by locally consumed species such as bivalve molluscs. Alternatively, the release of significant amounts of trace metals or other trace contaminants could threaten the fisheries industry through their uptake by species of commercial importance, possibly causing these to infringe public health limits for such contaminants laid down in the relevant Hong Kong legislation. While such problems are conceivable, it appears from studies elsewhere that they are unlikely to exert major impacts upon the receiving waters of the study area. No evidence exists to link algal blooms in Hong Kong to previous dredging works.

Construction impacts relate not only to potential injury or necrosis of pelagic fish and cetaceans through increased marine traffic and operations in the area influenced by dredging activities, but also as a result of increased suspended solids levels (and the potential release of pollutants/nutrients to the water column) and a depletion in dissolved oxygen in the receiving waters.

Organisms presently existing in the study area are frequently exposed (both seasonally and diurnally) to wide variations in suspended solids. Within this area, and further afield, many organisms have adapted to accomodate such changes in their environment. For example polychaetes have developed a specific tolerance to increases in suspended solids concentrations and movement in the seabed (for example the wave action on the seabed during typhoon conditions).

Although some pelagic species will experience trauma and necrosis through abrasion and clogging of the gills, many species not only show a wide range of tolerance to temporary variations in suspended solids levels but also to dissolved oxygen concentrations. Furthermore many of the reported cases of stress or necrosis due to elevated levels of suspended solids are due to concentrations which would rarely be found except in the immediate vicinity of the dredger head, where fish are more likely to die from injuries received.

The levels of suspended solids within the study area naturally fluctuate with variations easily reaching 50 - 70 mg/l during the wet season. Although in the vicinity of the dredgers levels of suspended solids concentrations could be double this figure, research has shown that death rates in fish in water containing 100 mg/l or more of suspended solids are very similar to those in "clean water".

It should also be noted that fish have relatively good vision and can identify hostile conditions and migrate from the area. Whether they return once conditions improve is a matter of much debate. Bearing in mind the increases in suspended solids levels are confined to a relatively small part of the natural habitat and that this can be further reduced through mitigation measures, the impacts of the works on non-capture fisheries should not be significant.

Following their initial resuspension, sediments in the water column will either be conveyed off-site or redeposited. In the sections of this report pertaining to potential sediment transport, it has been identified that the majority of deposition will take place in the first hour of release. Potential for off-site transport is limited.

Ecology and Fisheries

It is unlikely that any sediment plume released during the flood tide will be conveyed to the fish culture zone at Ma Wan due to distance and current velocities which will combine to dissipate the sediments.

The increases is suspended sediment loads are small (generally less than 5ppm) in comparison with natural levels of suspended solids and there is not likely to be any noticeable impact on fisheries.

It is unlikely that there will be impacts on the dolphins from suspended sediment loads since the dolphins are known to use waters further north in the Pearl River Estuary where suspended sediment loads are much higher.

There may be some impact on the dolphins should any stressful activities take place as a result of major underwater noise contributors, eg percussive piling. It is understood that there will be no underwater blasting for this project.

Operational Impacts

Pollution

Impacts to the fisheries and marine ecology of the study area will arise from the day to day operations of the container terminals, due to small spillages of pollutants, mostly hydrocarbon based fuels and oils. The uptake of hydrocarbons by primary producers and invertebrates can give rise to tainting of seafood and other detrimental effects. More severe, acute impacts may result from larger pollution incidents that may occur as a result of accidents at the proposed facilities.

This was considered in the LAPH study and it was concluded that the development will not contribute a significant threat to public health in this respect.

8.7 Monitoring Requirements

Water quality monitoring is proposed for the duration of all marine works and operations associated with this project. AFD have provided the guidelines shown in Table 8.5.

It is recommended that the Contractor monitors and records all sightings of dolphins in the area where he is conducting his operations. The date, time and number of dolphins should be recorded and provided to the Agriculture and Fisheries Department for their records.

Table 8.5 The Trigger, Action and Target Levels requirements for suspended solids at monitoring stations adjacent to Fish Culture Zones

	Trigger Level	Action Level	Target Level
Water Quality Criteria	50mg/l suspended solids less allowance for errors involved from estimating SS from turbidity measurements.	50mg/l suspended solids.	80mg/l suspended solids.
Actions on Exceedance	Increase monitoring to more than twice per day until compliance achieved.	Increase monitoring to high frequency level at least six times per day until compliance achieved. Alternatively 24 hour turbidity monitoring equipment would be acceptable.	Increase monitoring to high frequency level preferably at least six times per day until compliance achieved. Alternatively 24 hour turbidity monitoring equipment would be acceptable.
	Inform contractor who should undertake remedial action(s) if necessary.	Inform contractor who should undertake remedial action(s) if necessary. Inform AFD if exceedance confirmed from SS determination within 48 hours.	Inform contractor who should undertake remedial action(s) including stop work if necessary. Inform AFD if exceedance confirmed from SS determination within 48 hours.

Note : The requirements are for suspended solids levels at surface level and mid depth.

8.8 Conclusions

The conclusions for marine ecology are as follows:

(a) the number of dolphins sighted in the study area was small and the area appears to be less utilised by the dolphins than the waters to the north of Lantau Island. The area does not appear to be of major significance to the dolphins;

(b) it is unlikely that there will be impacts on the dolphins from suspended sediment loads since the dolphins frequent the waters in the Pearl River Estuary where suspended sediment loads are much higher;

(c) should any stressful activities take place contributing to major underwater noise, there may be an impact on the dolphins;

(d) the fish fulture zone at Ma Wan is unlikely to be affected by sediment plumes released during floodtide, as distance and current velocities should combine to dissipate the sediments;

(e) there is not likely to be any noticeable impact of suspended sediment loads on fisheries as the increases are small in comparison with natural levels; and

(f) fishing will be disrupted to some extent during both construction and operation of the port development, due to loss of fishing grounds and fish fry nuseries as a result of reclamation, increased marine traffic and associated marine pollution.

8.9 Recommendations

Recommendations to minimise water quality impacts from the construction works are outlined in Chapter 7 of this report.

Specific measures which are recommended for the protection of Chinese White Dolphins are as follow:

(a) the Contractors should be required to undertake dolphin spotting throughout the works;

(b) the Contractors should be required to provide a 500m buffer/safety zone for the dolphins during stressful construction activities (eg. percussive piling) should they take place;

(c) the Contractors should be required to use predefined and regular routes, especially when disposing of spoil, as these will become known to dolphins and porpoises using these waters;

(d) the Contractors should be required to minimise the impacts of his works on water quality particulary with respect to dissolved oxygen and turbidity;

(e) the Contractor should be required to control and manage all effluent from vessels and worksites as described under the water quality recommendations in Chapter 7 of this report.

It is also recommended that a monitoring programme be included to observe the impact of the works on the Chinese White Dolphins. It is important that this be statistically viable, scientifically sound and adequate.

The two major aspects of the survey should include

(a) a boat survey

This would continue along the same transects used in the 21 day survey for this report and the same methodology would be adopted. Sufficient time would need to be allowed to provide further baseline information and should continue throughout the construction period for the advance works. A post construction period should also be surveyed, the length of time should be determined at a later date dependent upon the review process to be adopted during the survey period. Data obtain during the survey should be reviewed every three months to assess any changes and the need for continued monitoring.

(b) helicopter surveys

The purpose of conducting these surveys would be to determine the location of the displaced dolphins and should be run to complement the boat survey. They should be conducted as close as possible to the time of the boat surveys (weather and other conditions permitting).

Data would again be reviewed in conjunction with the boat survey information.

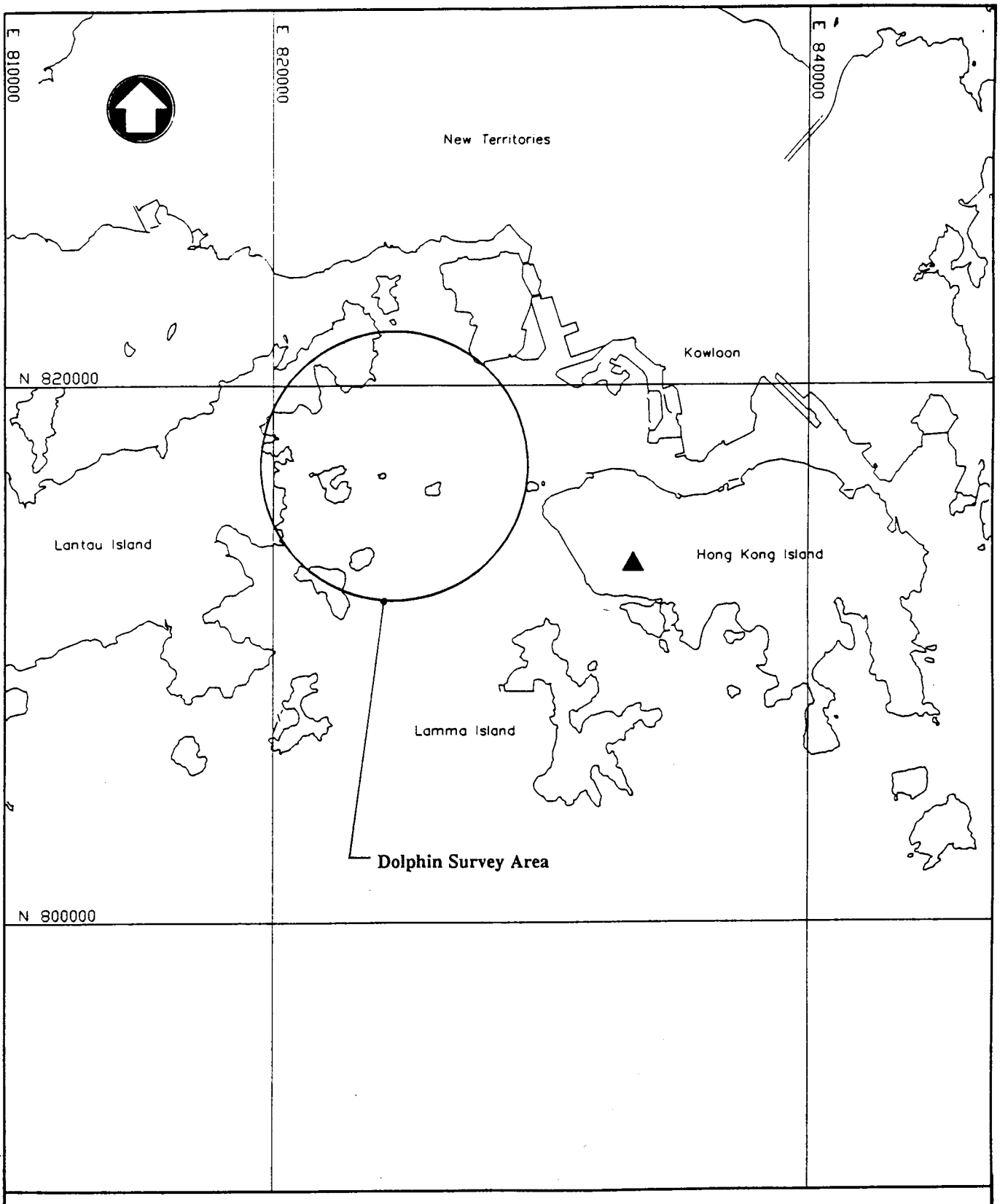
While it is neither practical nor viable to directly compensate for the loss of inter-tidal and sub tidal zones through the construction of CT10 and 11, it is recommended that consideration is given to enhancement of fisheries and provision of new nursery areas within the Study Area. Methods to achieve this include the creation of artificial rock

reefs which could be accomplished through the rubble seawall recommended for construction of CT10 and 11.

It is also noted that AFD are currently proposing a policy of off-site remedial measures to counterbalance the losses incurred through other projects in Hong Kong. Amelioration of existing, and often degraded, sub-tidal and inter-tidal reefs at certain locations throughout the territory should be considered in the context of environmental mitigation measures and audit for this project. Restoration of degraded tidal areas is an emerging technology which has been successfully applied to areas which have been affected by dredging, reclamation or from pollution sources in North America and Asia. Consideration needs to be given, at a strategic level, to defining the priority for areas to be restored and protected from encroaching development.

Government should amass statistics on the existing fisheries in the study area to assess the potential impacts on the fishing industry.

Figure 8.1
Dolphin Survey Area



Legend :

▲ Differential GPS Transmitter
(Matilda Hospital)

0 5 10 15 Km

Figure 8.2
Location of Survey Lines and Dolphin Sightings

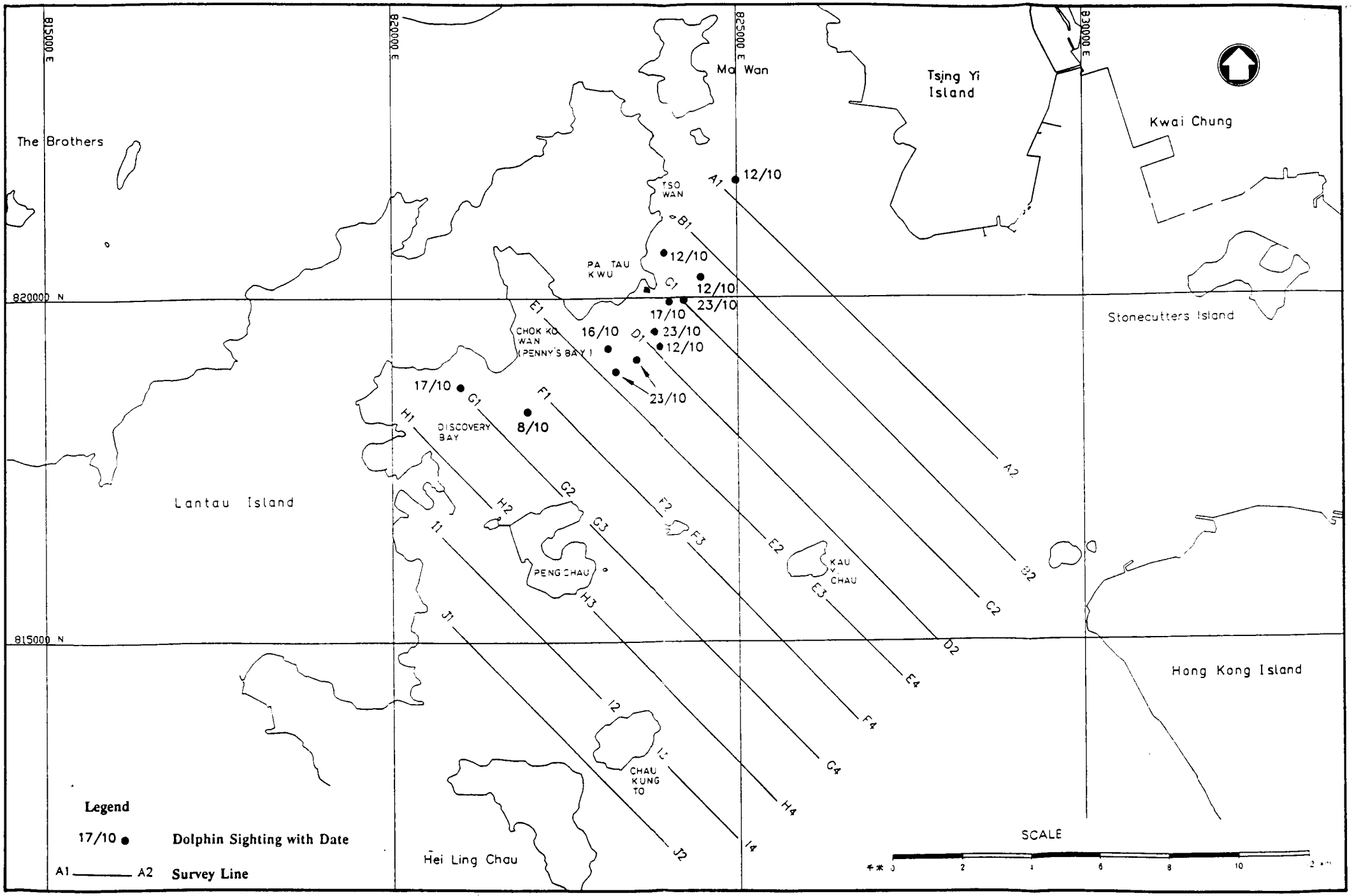


Figure 8.3
Distribution of Number of Sightings per Survey

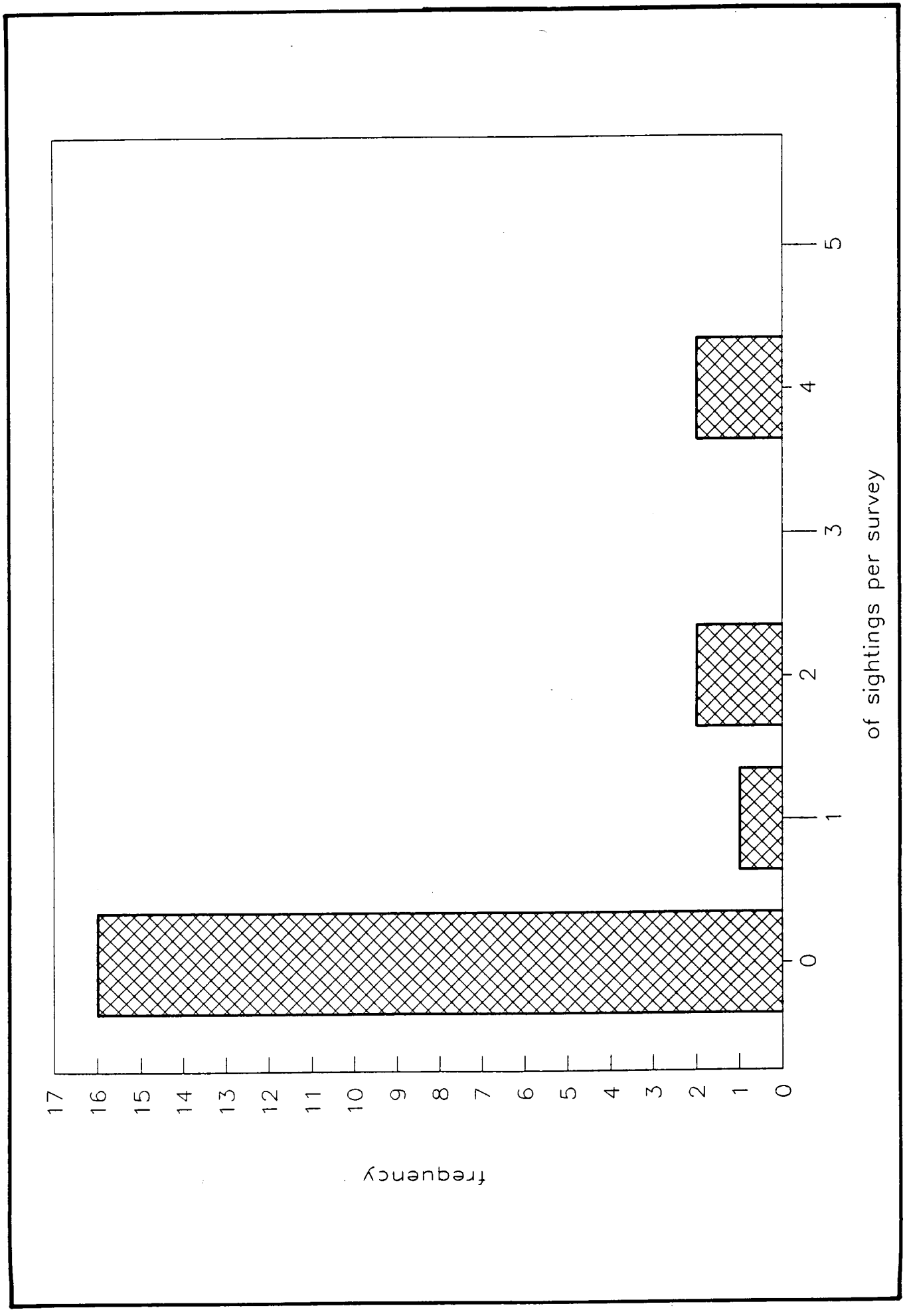


Figure 8.4
Perpendicular Sighting Distribution (Pooled)

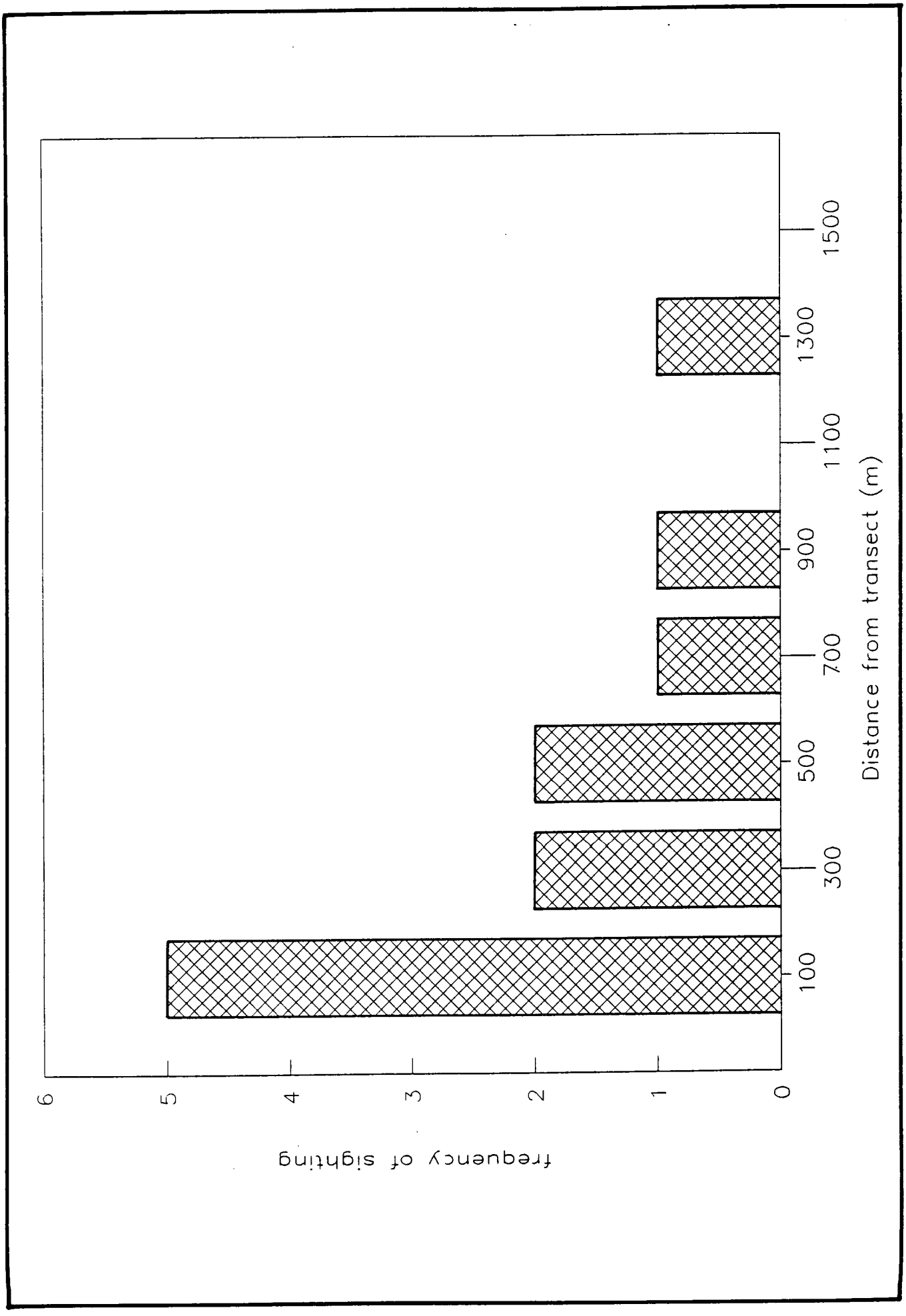


Figure 8.5
Herd Size Distribution (Pooled)

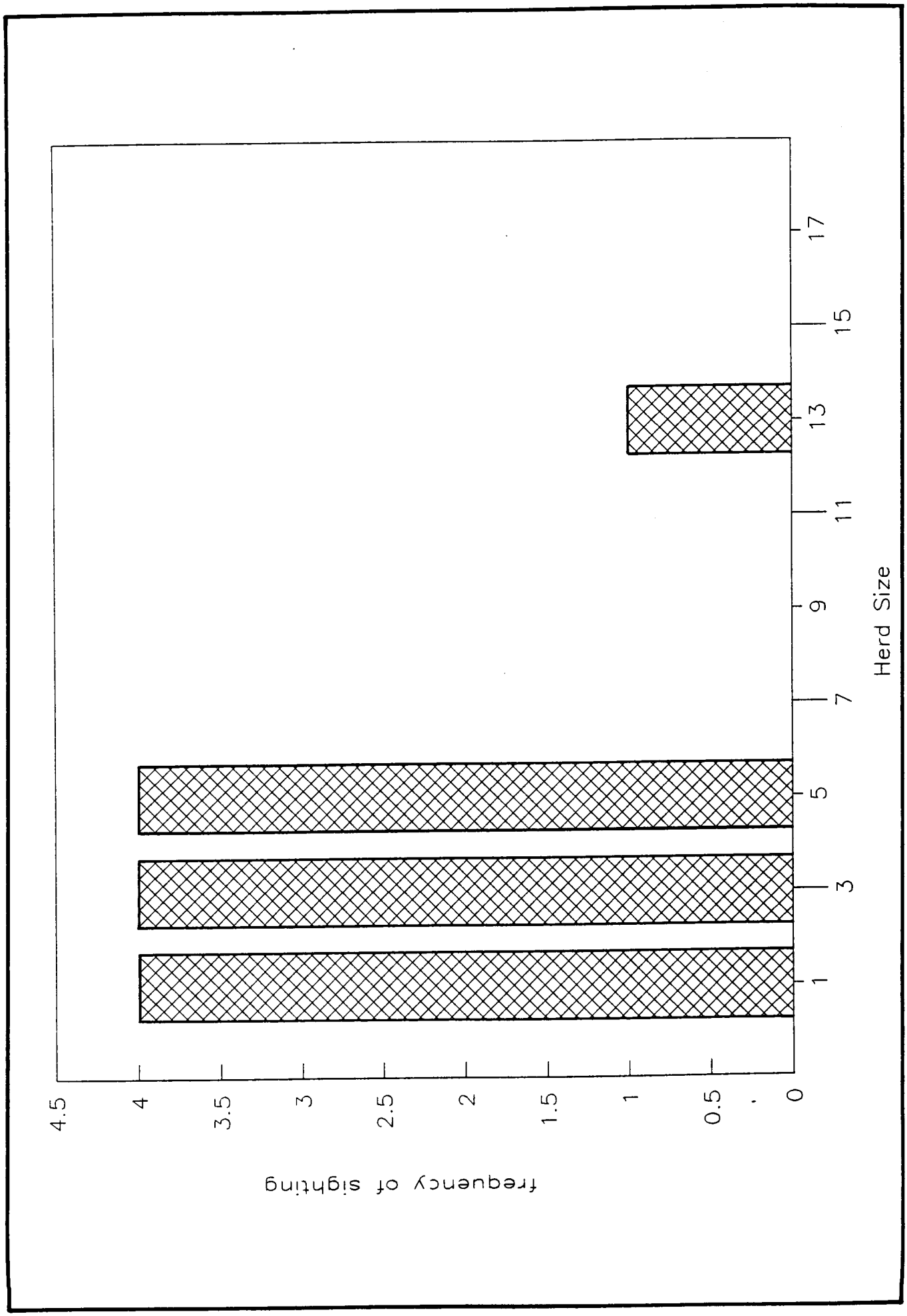


Figure 8.6
Data from SWIM
Distribution of Number of Sightings per Survey