Dorset County Council, Planning Department
Poole Harbour Commissioners
Atlantis Project

Aerial Survey of Water Borne Craft

"Harbouring Information"

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SUMMARY

Poole Harbour is one the world's largest natural harbours. Its size, location, and relatively shallow waters, make it one of England's most important sites for recreational water sports, whilst its extensive areas of mudflats are of substantial ecological significance for the bird and aquatic life they sustain. Poole is also a major base for commercial marine activities.

An Aquatic Management Plan was launched in the summer of 1994, and has been monitored during its first summer season via a series of surveys to establish not only its instant effectiveness, but also to provide benchmark data on birds, recreational craft and their interaction, as well as the views of users.

A crucial element of collecting baseline data is to establish the number of craft using the Harbour. Accordingly, the Environmental Research Group Oxford (ERGO) was commissioned by Dorset County Council to carry out a series of surveys of the number and distribution of water borne craft within the Harbour and adjacent areas of the sea. This study was carried out using low level aerial survey techniques, and is the first of its kind to be undertaken in Europe. It has been conducted in close collaboration with Dorset County Council and the Poole Harbour Commissioners (PHC), who have been co-ordinating this work with concurrent and complimentary ecological and sociological surveys.

Surveys were conducted during the May and August Bank Holiday weekends, when recreational activity in the Harbour was likely to be at its highest, as well as on a number of intervening dates when harbour usage was thought to be lower. Seven categories of water borne craft were assessed: yachts, motorboats, commercial craft, personal water craft (jetskis), waterskis, windsurfers, canoes and rigid inflatables. A distinction was made between moving and static vessels. Craft at wet berths in marinas were also assessed.

A mean of approximately 2400 craft were estimated to be on the water, with 1200 in the wet berths provided by the major marinas. On average, approximately 300 additional vessels were recorded in Poole Bay, most of which were thought to have originated from the Harbour. At peak periods, the total reached some 4200, of which about a third were in the marinas. These figures are substantially lower than those previously available, which may indicate that current Harbour usage is lower than in the past.

In the region of 90% of the craft are yachts and motorboats. Windsurfers, commercial craft and inflatables account for a further 6%. Mean numbers of waterskiers, canoes and jetskis in the Harbour are very low, ranging between 9 and 15 craft.

The numbers of vessels recorded the May surevys were all very similar, and only varied slightly with time and date. The July and August figures, whilst somewhat higher than the May ones, were also remarkably constant with respect to both time of day, and date. The numbers of motor boats rise slowly during the summer, whilst yacht numbers show no such trend.

On average, about 11% of the craft present in the Harbour are moving, rather than moored, berthed or at anchor. More vessels were moving (and thus active) on Holidays, and Sundays than other days, though the difference was, in numerical terms, small. Little evidence was found that levels of movement increase over the summer, or vary consistently during the day

The existing activity zoning, put in place by the Aquatic Management Plan, whilst not ignored, is not strictly observed by any of the craft in the Harbour. A substantial proportion of both waterskiers and jetskiers are found outside their allotted areas, and the commercial channel is used regularly by all craft types.

Between 90 and 95% of motorised craft present in the Harbour remain outside the grids that contain shellfish beds, or those adjacent to major bird roosting sites, and are unlikely to cause serious disturbance to either. Some damage to the harbour floor, caused by motorised craft, especially in shallow water, was observed in a number of areas.

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ACKNOWLEDGEMENTS

This study has pioneered a new technique. As a result, some adjustments and adaptations to the original plans have been inevitable, and would have been difficult or impossible without the full co-operation of all concerned with the project. ERGO would particularly like to extend its thanks and appreciation to: Phil Sterling and Rhona Fairgrieve who have been helpful beyond the call of duty when presented with unforeseen questions requiring an immediate solution; and to the pilots and engineers at A & G Aviation who cheerfully did all the unlikely things they were asked to do to their aircraft. Our thanks are also due to Mr R. Appleton who raised valuable points during the early stages of the project; and to the proprietors of the Grovefield Hotel in Poole who were always accommodating at very short notice.

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UNITS AND ACRONYMS

agl	Above Ground Level
APM	Aquatic Management Plan
ERGO	Environmental Research Group Oxford
ft	feet
GPS	Global Positioning System
km	kilometre
m	meter
PHC	Poole Harbour Commissioners
RIM	Resource Inventory and Management
SCUBA	Self Contained Underwater Breathing Apparatus
SE	Standard Error
SPSS	Statistical Package for the Social Sciences

MAIN REPORT

1. BACKGROUND, OBJECTIVES, AND SURVEY PROGRAMME.

1.1. Background

Poole Harbour is one the world's largest natural harbours. Its size, location, and relatively shallow waters, make it one of England's most important sites for recreational water sports, whilst its extensive areas of mudflats are of substantial ecological significance for the bird and aquatic life they sustain. Poole is also a major base for commercial marine activities (Poole Harbour Steering Group, 1994[1]).

Over the last 15 years, recreational use of the Harbour has increased significantly, and has reached the level where there is real potential for conflict between recreational, commercial and ecological interests. Such conflicts are particularly likely during the summer months, when the number of visitors, and their impact on the environment, is at its peak. There is also anecdotal evidence of increasing friction between the various recreational groups, for example sailors and jetskiers, whose activities are largely incompatible when occurring in the same area.

The interaction of commercial, recreational and environmental interests necessitated the production of overall management policies for the Harbour in 1988 (amended in 1991[2]). They sere designed to integrate the differing responsibilities for land-use planning at the margins of the Harbour. As an important follow-up to the policies, the Aquatic Management Plan was launched in the summer of 1994. This Plan covered the management of recreation on the open water by zoning the Harbour into areas for specific activities.

The Plan has been monitored during its first summer season via a series of surveys to establish not only its instant effectiveness, but also to provide benchmark data on birds, recreational craft and their interaction, and the views of users.

A crucial element of collecting baseline data is to establish the number of craft using the Harbour. Estimates of the numbers of such craft have been made in the past, although the accuracy of these estimates is uncertain, and prior to the present study no detailed examination had been made of temporal or geographic patterns in the distribution of the craft. Such information is critical to effective management, especially in consideration of the need to establish how many craft the Harbour can sustain, and there was thus a pressing need to obtain accurate data.

Accordingly, the Environmental Research Group Oxford (ERGO) was commissioned by Dorset County Council to carry out a series of surveys of the number and distribution of water borne craft within the Harbour and adjacent areas of the sea. This study is the first of its kind to be undertaken in Europe, and has been conducted in close collaboration with Dorset County Council and the Poole Harbour Commissioners (PHC), who have been co-ordinating this work with concurrent and complimentary ecological and sociological surveys.

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[1] Poole Harbour Steering Group (1994): Poole Harbour Aquatic Management Plan, Consultation Draft.
[2] Poole Harbour Steering Group (1991): Poole Harbour Management Policies.

1.2. Objectives

Prior to starting the work, the primary objectives of the study were as follows (See Specifications in Appendix 1):

- to assess the numbers of seven categories of water borne craft in Poole Harbour and Studland Bay, namely yachts, motorboats, commercial craft, windsurfers, jetskis, waterskis, canoes, and inflatables;
- to examine the variation in craft numbers at different times of day;
- to examine the variation in numbers of craft on days that were assumed to be 'busy' (bank holidays and weekends) and 'not busy' (other days);
- to establish the distribution of the various categories of craft in relation to the proposed or existing zonation within the harbour;
- to assess the distribution of craft in relation to their potential impact on wildlife, and other activities such as SCUBA diving, bait digging and shell fishing.

1.3. Survey Programme

To provide this information, and after a number of trial surveys were carried out, a preliminary survey schedule was defined as detailed in Appendix 1. This was designed to provide adequate sampling of morning and afternoon craft distribution, and to assess the variation in craft numbers on days assumed to be 'busy' (Sundays and Bank Holidays) and 'not busy' (other days).

Seven categories of water borne craft were assessed, as shown in Table 1, below. All floating craft were counted unless attached to a jetty or beached at high water. Craft in marinas were also assessed but only if floating - those in dry storage on land were excluded.

Table 1: Types of Craft Assessed

Category	Craft Included, and Comments
Yachts	Yachts, dinghies, catamarans
Motor Boats	Recreational motorboats, cruisers, not rowing boats with outboards
Commercial Craft	Ferries, fishing craft, military craft, cargo vessels, tour craft
Windsurfers	Moving and static (i.e. fallen over)
Jetskis	
Waterskis	Anything towed behind a motorboat - skiers, tyres, banana boats
Canoes	Canoes, not rowing boats
Inflatables	Rigid inflatables, but not whilst towed as tenders

As the survey progressed, a number of revisions to the original specifications were agreed and implemented (see Appendix 1).

It became increasingly evident that the distinction between moving craft and those in marinas, and at swinging moorings, was an important one, and that diurnal variation in craft numbers was relatively minor. The number of sorties per day was thus reduced to two, one in the morning and one in the afternoon, timed to avoid low water conditions.

From late July onwards, the surveys were extended to incorporate an element designed to assess the proportion of craft that were moving, as opposed to moored or anchored (Section 3.3).

2. METHODS

2.1. Data Collection Methods

There are three methods that could be used to count the number of water borne craft in a specific body of water: aerial photography; low level aerial survey; and ground counts. Each have their advantages and disadvantages.

Aerial photography, which is perhaps the most obvious possibility, provides a permanent record in the form of photographs, which can be interpreted at leisure after they have been acquired. It is, however, comparatively expensive, and requires considerable effort and time to interpret. If vertical photography is used, and the number of photographs is to be kept to manageable levels, the aircraft has to fly at several thousand feet above ground (or sea) level. This imposes severe restrictions upon the weather conditions in which photographs can be taken, and so precludes a fixed operating schedule - if the cloud base is below a certain level (3000-4000 ft), then the surveys cannot be carried out.

Because vertical photographs are taken from a distance of up to a mile, it can also be difficult if not impossible to distinguish between, for example, yachts and motorboats, or the various types of small craft. It is possible to use obliquely mounted cameras, which not only makes the differentiation of the various craft categories easier, but also means that the aircraft can fly closer to the ground, and therefore be less dependent on fine weather. Oblique photography, however, requires the use of extremely costly gyroscopically stabilised camera platforms, and it is a complex process to define the area covered by each photograph accurately.

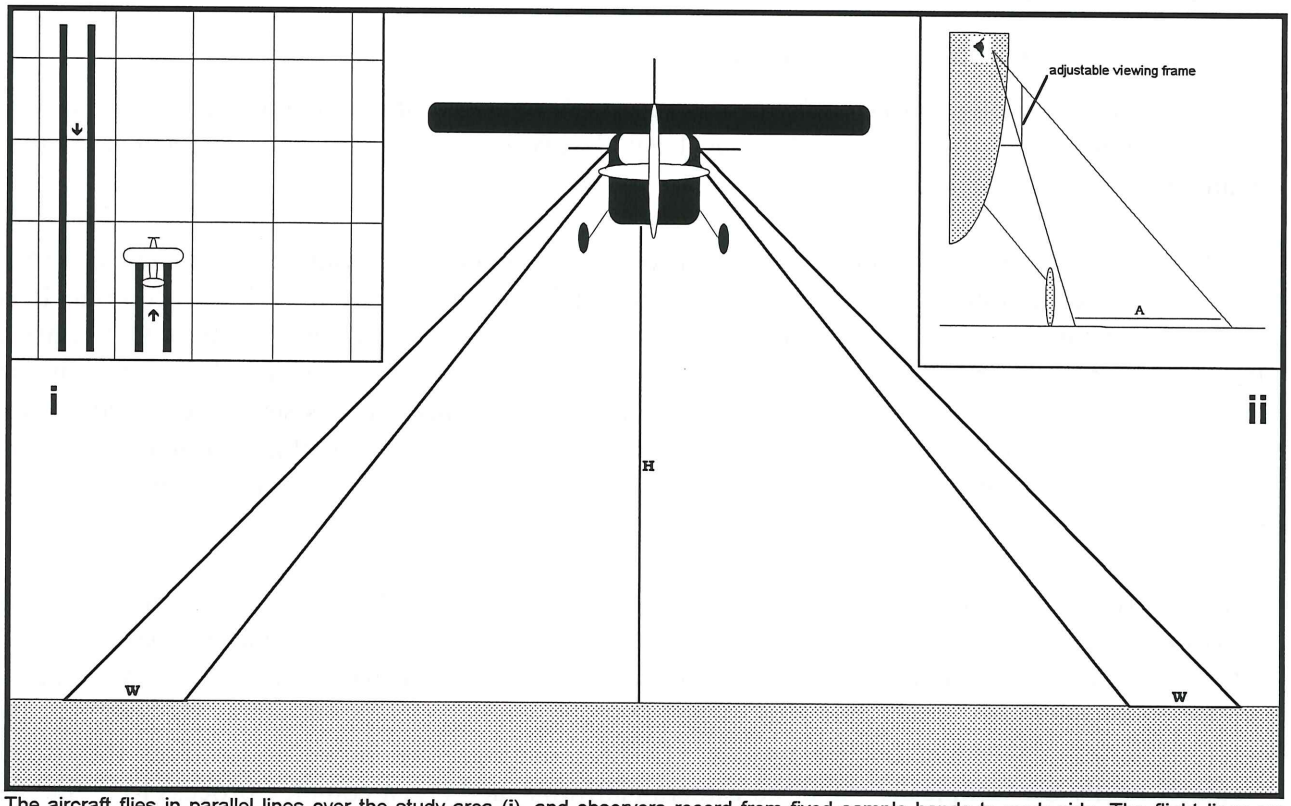
Ground surveys have the advantage that identification of the types of craft is relatively simple and reliable, do not require the use of expensive equipment, or the services of trained personnel. They do however, rely on co-ordinating the efforts of a large number of enumerators, some on land, and some on the water, particularly if surveys are to be completed quickly so that several can be carried out in a day. If surveys are to be undertaken on several consecutive days, then accommodation and subsistence costs are also substantial. In addition, ground surveys which are precisely repeatable from one count to the next are notoriously complicated to design.

A third alternative is to use low level aerial survey techniques which were originally developed to assess the numbers of human habitations and livestock in remote parts of Africa, but are applicable to any objects that can be seen and counted from the air. The technique is illustrated in Figure 1, and relies on visual counts of the targets made from aircraft flying between 400 and 1500 (125 - 500m) feet above ground level.

The air crew consists of a co-ordinator/navigator, pilot, and two rear-seat observers. Counts are made by the rear-seat observers of all craft observed within a fixed band to either side of the aircraft and delineated by a frame fixed to the windows. A series of parallel flight lines are flown and divided into equal sectors, to create a grid cell lattice (Figures 1 and 2), by which each record is located. The counts obtained are thus taken from a sample of each grid cell which, in this study, was set a nominal 50% of grid cells measuring half a kilometre square.

With survey grids only 500 metres across, precise navigation is essential. This is accomplished using a Global Positioning System (GPS) augmenting the standard equipment. GPS is a relatively recent innovation, relying on satellite triangulation, is accurate to 20 metres or less, and provides position updates every second. Without this equipment, the survey would not have been possible.

Figure 1: Aerial Survey Sampling



The aircraft flies in parallel lines over the study area (**i**), and observers record from fixed sample bands to each side. The flight lines are divided into equal sectors, to create a grid cell lattice, by which each record is located. Only those objects which pass through the observation strips are counted. The strip width (**W**) is directly proportional to the flying height above ground (**H**) and is defined by externally mounted viewing frames (**ii**) which are adjusted to delineate a band on the ground (**A**) which corresponds to the desired sample band width W at the nominal flying height. Typically, **W** ranges from 100 - 500m at 800 ft above ground level (agl) or 200 - 1000m at 1,600ft agl.

Because the technique is based on a sample, rather than a complete count, the results are estimates rather than absolute counts, and the data should not be used to assess the numbers of craft in each individual grid cell, but rather within a number of grid cells. However, this technique usually employs a sampling intensity of between 5 and 16%, which generally results in an error of between 2 and 10%. As the sample intensity for this survey was set at 50%, it can be confidently assumed that the sampling errors of the population estimates derived from any one sortie is substantially reduced, and that those for the mean estimates calculated from a number of sorties is decreased yet further.

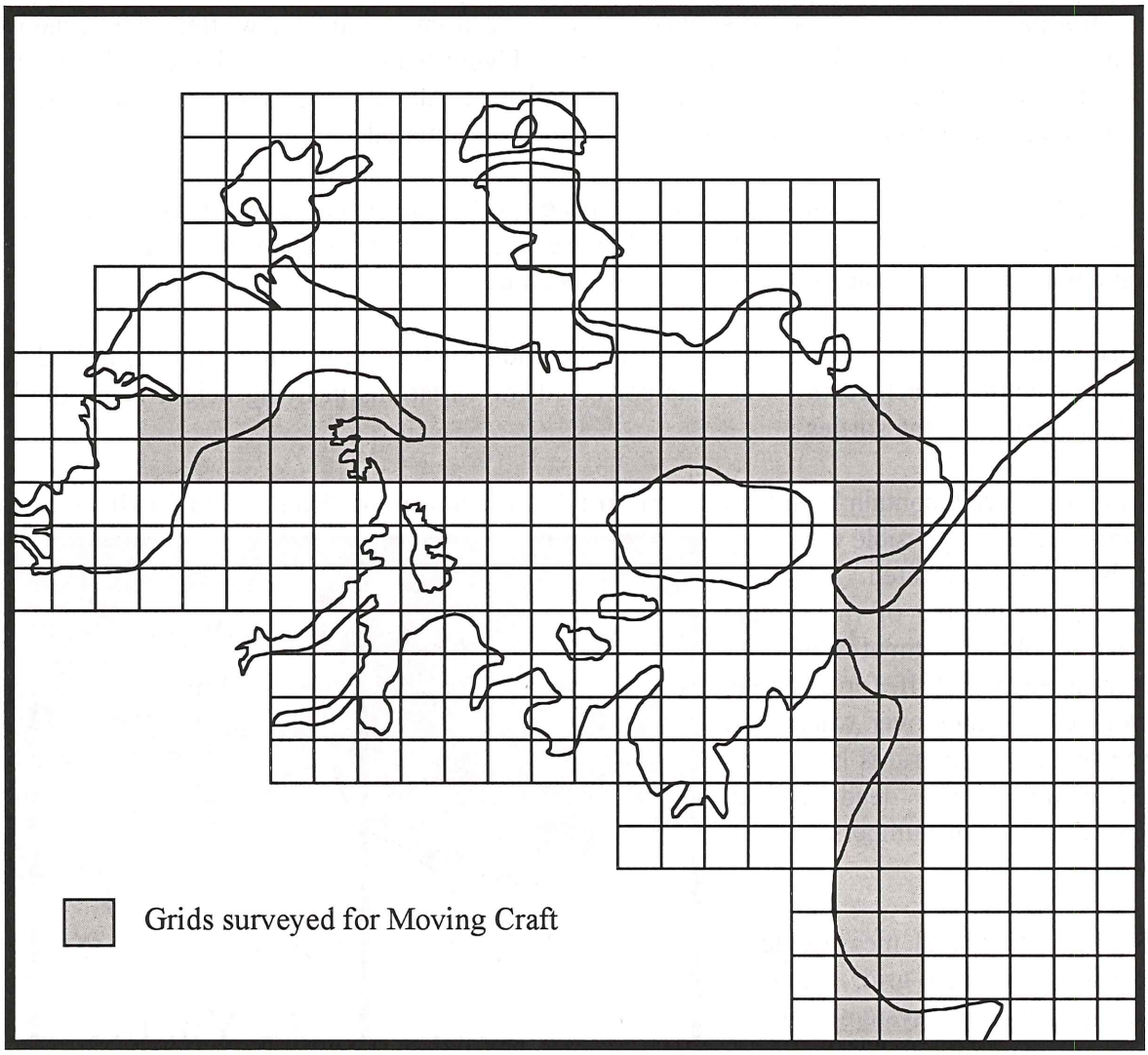
The main advantage of low level aerial survey in the current context is that, unlike aerial photography, it is essentially independent of weather conditions because the variations in flying height are recorded by the front seat navigator and compensated for during the data processing and analyses. Consequently the surveys can be flown in all but the worst weather conditions, which are infrequent during the summer. As a result, a fixed schedule could be adhered to, allowing surveys on specific dates, such as Bank Holidays, or less busy weekdays.

There are other advantages of this technique:

- identification of the various types of craft is readily achieved, because the observations are made from a relatively short distance (less than 500 metres);
- the surveys are precisely repeatable, because they are based on a fixed series of flight lines using satellite navigation equipment accurate to approximately 20m;
- the surveys take relatively little time (approximately one hour), which keeps aircraft hire costs per sortie low, but allows that several sorties to be flown in a single day if required;

- the number of survey personnel required is limited to three plus a pilot, thus reducing staff and subsistence costs.

Figure 2: Aerial Survey Grids



2.2. Marinas

Poole Harbour contains three large marinas which contain sufficient craft to make visual counting problematic Substantial numbers of craft are also to be found in the river Frome and associated marinas. At the end of each sortie, the three largest marinas, (at Holes Bay, Lower Hamworthy and Lilliput), and Frome River as far as South Bridge at Wareham, were therefore photographed, and the number of each type of craft counted from the photographs. The smaller marinas in the harbour were either included within the standard survey, or photographed when the opportunity arose, to obtain an indication of the number of craft therein.

2.3. Moving Craft

As the survey programme progressed, it became apparent that it was important to distinguish between those craft that were at fixed moorings (marinas), at swinging moorings, or were actually being used (i.e. moving). Accordingly, from July 31st onwards, additional flight lines were flown immediately after each main sortie was finished, to sample those grids with a high density of craft (Figure 2). Only moving craft were recorded, and a comparison with the total estimated numbers obtained during the main sorties used to calculate an estimate of the proportion of moving craft

within the areas that contained substantial numbers of swinging moorings, and those that did not. Further details of the calculations involved are given in Appendix 2.

2.4. Data Entry, Processing, and Analysis

For each separate flight each observer record was entered into a custom written Dbase data entry programme produced specifically for aerial surveys. Flying heights, recorded for each grid by the front seat observer, were entered into an Excel spreadsheet. All data entry was checked for accuracy, and corrected where necessary before data processing was initiated.

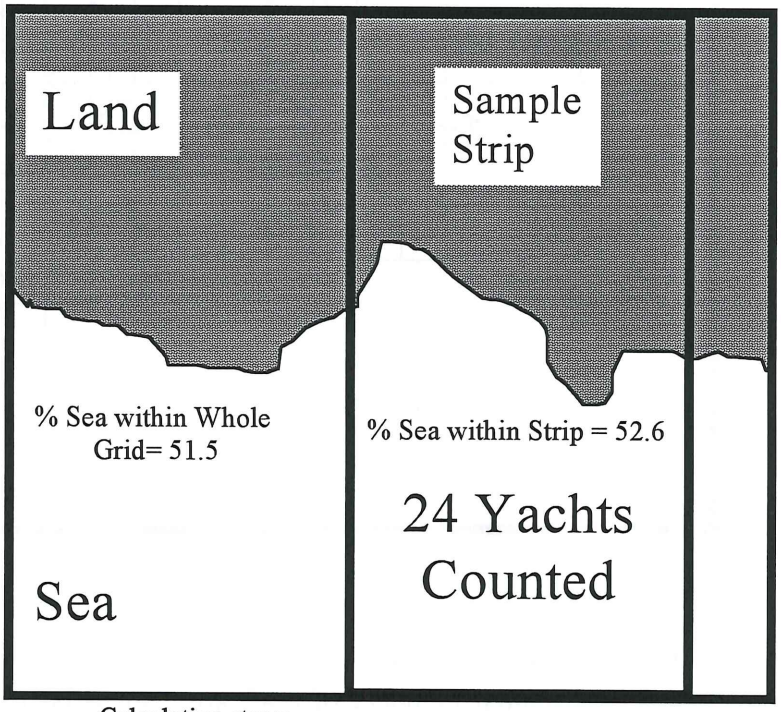
All data processing and analysis was achieved using the Statistical Package for the Social Sciences (SPSS), into which the raw data were imported. Several processing steps were required to produce the data in a form from which estimates of numbers could be made.

Because flying height varied from grid to grid, the width of the observation strip delineated on the ground also varied. Each record was thus corrected for variations in flying height using the height records made during the sorties.

Because some grids contain both land and water, it is not possible to merely multiply the corrected observer counts by the inverse of the sample intensity to obtain estimates of craft numbers in each grid. If, for example, the sample strip falls over water, and the remainder of the grid is land, such a procedure would lead to an overestimate of the numbers in each grid.

Accordingly, two area measurements were made for each grid, using an image processing system on a digitised map of the survey area: the area of water within the grids, and the area of water within a nominal strip width of 250m (i.e. the area actually sampled).

Figure 3: Calculation of Numbers of Craft in a Grid



Calculation steps:
Area of sea in strip = (0.25x0.5) x 0.526 = 0.0658 km^2
Density of yachts in strip = 24/0.0658 = 364.74 / km^2
Area of sea in grid = (0.5x0.5) x 0.515 = 0.129 km^2
Estimated number of yachts in grid = 364.74x0.129 = 47.05

Assumes no correction for variation in flying height required

The height corrected counts and the area sampled are then used to calculate the density of each type of craft within the sampled area of each grid. This, in turn is combined with the area of water within each grid to produce an estimate of the number of craft within the entire grid (Figure 3).

Estimates of the total number of craft within the survey area were then calculated by simple addition of the individual grid cell estimates. The statistical errors of these estimates are discussed in Appendix 7.

Estimates of the numbers of craft within various geographical strata (e.g. the Harbour and Poole Bay) were also required. These were obtained by coding each grid cell for a series of spatial categories, and extracting the data for the grid cells that fell within them. The categories defined in this way are shown in Table 2 below:

Table 2: Spatial Categories Used in Analyses

Category Type	Individual Strata
Geographical	Harbour, Poole Bay, Whitley Bay
Mooring	Swinging Moorings, the Rest
Activity Zones	Sub Aqua, Quiet, Enforceable Speed Limit, Jetski, Waterski, Windsurfing, Commercial and Recreational Channels
Other	Grids next to Roosting Sites, Grids with Shellfish Beds

2.5. Mapping and Reporting

A simple geographical information system, MAPICS, was used to generate all the site and distribution maps found in this report: the text maps are direct output, whilst the colour maps are MAPICS output, converted and recoloured with Powerpoint, Paintshop Pro and PhotoFinish. The data are all held in MAPICS format, from which a menu driven display of distribution maps of all craft types for each sorties can be produced on any IBM compatible PC. Diagrams and graphs were produced using Excel and Powerpoint. All reporting and presentation was accomplished using Word for Windows.

3. RESULTS AND DISCUSSION

The following section presents the survey results in several parts. First, a general overview of mean numbers and distributions of craft types is given, which is intended to provide a summarised account of the main features emerging from the data. This is followed by a more detailed treatment of several aspects of the results that are considered to be of more specialist interest. These include: the variation in craft numbers over time (Section 3.2); the changes in the numbers of moving craft over time (Section 3.3); the distribution of various categories of craft in relation to the established zonation of different activities within the Harbour (Section 3.4); and a brief examination of the data available in relation to the possible environmental impact of water-borne craft (Section 3.5).

The summary tables and illustrative graphs presented in these sections are extracted from the more detailed data tables presented in Appendix 3, to which readers requiring the full numerical results are referred. In this context, the complete computerised data set has been lodged with Dorset County Council Planning Department, in Microsoft Excel Format (See Appendix 6), and copies are held in the ERGO data archives. The colour distribution maps are contained in the wallet bound at the end of this volume.

3.1. Overall Craft Numbers and Distributions

Recent assessments, quoted in the Consultation Draft of the Poole Harbour Aquatic Management Plan, suggest that the Harbour supports a total of 7,600 craft through wet and dry berths, and swinging moorings, excluding visiting craft. At peak periods, it has been estimated that up to 4000 craft could potentially be on the water. A maximum of approximately 380 windsurfers and 160 jetskiers are thought to use the Harbours at peak periods. These figures should be compared to the estimates produced by the current survey which imply a mean of approximately 2400 craft on the water, and a further 1200 in the wet berths provided by the major marinas (Table 3). If it is assumed that most of the craft in Poole Bay originate from the Harbour, then the total number of craft, excluding those in dry berths, rises to about 3800.

Table 3: Mean Numbers of Craft, All Survey Dates

Type of Craft	Harbour				
	Marinas	Static	Moving	Total	Sea
Yachts	593	1329	119	2041	125
Motorboats	585	548	106	1239	138
Commercial	n/a	27	52	80	14
Jet Skis	n/a	0	9	9	3
Windsurfers	n/a	0	73	73	11
Waterskis	n/a	0	8	8	8
Canoes	n/a	0	15	15	5
Inflatables	16	27	9	52	17
Total	**1194**	**1931**	**391**	**3516**	**321**

Unless, therefore, there are a further 3,800 craft in dry berths, which seems unlikely, these estimates clearly diverge from those previously available. The number of craft on the water, in the Harbour, is estimated at approximately 2,400, rather than 4,000, and the number of vessels counted in marinas is also substantially lower than has been assumed.

However, an important issue is not one of absolute numbers of craft, as static vessels occupy little space and have no more than a passing influence upon the environment. The issue is rather related to the carrying capacity of the harbour in terms of active craft.

Activity can be gauged in a number of ways - either as the number of moving craft in the Harbour as a whole; as the number of craft which have left the Harbour, which is probably related to the numbers of craft in Poole Bay (see also Appendix 2); or as the traffic levels within the various dedicated channels. The present data provide estimates of the first two of these possible measures of usage, and suggest that, on average, about 11% of the Harbour's craft are moving at any one time (see also Table 6), and a roughly equivalent number are in Poole Bay.

Whilst it seems reasonable to assume that the smaller categories, namely windsurfers, jetskis, canoes, and waterskis are largely 'resident', (i.e. within the Harbour), the same cannot be said of moving yachts, motor boats and commercial craft, as many may be leaving or returning to their moorings and wet berths. Further, as it is not known for how long each craft is moving, these data cannot be used to estimate the total number of craft that are active (moving) in one day.

Such information can only be obtained by continuous observation at fixed monitoring points, and at particular traffic bottlenecks such as the Harbour Entrance. Accordingly, recommendations were made to the Harbour Project Officer that craft movements through the Harbour entrance be monitored. These recommendations were implemented during the August Bank Holiday weekend.

Table 3 shows that most of the craft in the Harbour are either yachts or motorboats, which together account for 93% of the total. Of these, only 6.9% are moving, the remainder being tied to swinging moorings or wet-berthed at the major marinas. The distribution maps for all craft, yachts and motor boats (Colour Maps 1,2,3) all show a marked concentration of these craft in Whitley Bay, along the northern shoreline, and in Holes Bay, with relatively few recorded on a regular basis elsewhere.

Of the less numerous categories, commercial craft, and windsurfers (Colour Maps 4 and 5) are the most common, each constituting somewhat over 2% of the total. The former are found at low densities throughout all but the western and southern extremities of the Harbour, with the highest numbers at the entrance of the channel to and within Holes Bay - i.e. at or near the docks.

Windsurfers are more patchily distributed, with a focus in their assigned Zone in the east of Whitley Bay. Elsewhere they are widely dispersed throughout the northern and eastern sectors of the Harbour, but do not exceed an average abundance of two per survey grid.

There are an average of just over 50 rigid inflatables in the Harbour at any one time, about a third of which are to be found tied up in the major Marinas. Like windsurfers, they are widely dispersed throughout the northern and eastern portions of the survey area, but rarely exceed a density of two per grid.

Personal water craft (jetskis), waterskis and canoes are all comparatively rare within the Harbour, with mean total numbers ranging between 8 and 15 per survey. Jetskis are largely restricted to the area around Brownsea Island, and Poole Bay outside the Harbour, though some were occasionally seen on its western edges. The highest mean numbers per grid (1.95) were recorded, not in the assigned activity zone (see Section 3.4), but rather adjacent to the public slipway at the western edge of Parkstone Bay, and south towards Brownsea Island.

Waterskis were most frequently recorded in the north west, either in or adjacent to their assigned Zone. A few, however, were observed to the north and south of Brownsea Island, and, in relative terms, a reasonable proportion of the total were found in Poole Bay. The third and last of the categories - canoes - are not only rare, but are distributed in no readily discernible pattern.

These mean numbers are useful for management purposes, and to give a general idea of the relative abundance and distributions of each type of craft. They may, however, be misleading when trying to determine peak levels of activity within the Harbour, when any potential conflict between different activities, or a more general limitation of resources, becomes more likely. Tables 4 and 5 below, show the results of individual surveys at two of the possible peaks of activity - when most moving craft were recorded, and when the highest number of craft were recorded.

The general patterns indicated by both sets of figures are similar to those implied by the mean estimates, in that yachts and motor boats are consistently the most numerous craft. On both occasions, however, the number of windsurfers on the water was very substantially higher than average, and the proportion of moving craft reached 15 to 20%. The numbers of craft in Poole Bay were also higher than average.

Table 4: Numbers of Craft on Date with Most Moving (14 Aug, pm)

Type of Craft	Harbour				Sea
	Marinas	Static	Moving	Total	
Yachts	492	1141	152	1785	251
Motorboats	560	506	204	1270	454
Commercial	n/a	0	76	76	14
Jet Skis	n/a	0	24	24	3
Windsurfers	n/a	0	191	191	23
Waterskis	n/a	0	15	25	28
Canoes	n/a	0	20	20	7
Inflatables	17	7	0	24	2
Total	**1069**	**1654**	**682**	**3405**	**782**

Table 5: Numbers of Craft on Date with Highest Number (28 Aug, pm)

Type of Craft	Harbour				
	Marinas	Static	Moving	Total	Sea
Yachts	661	1354	121	2136	107
Motorboats	644	775	97	1516	170
Commercial	n/a	52	19	71	18
Jet Skis	n/a	0	33	33	10
Windsurfers	n/a	0	354	354	39
Waterskis	n/a	0	9	9	0
Canoes	n/a	0	4	4	8
Inflatables	25	32	0	57	27
Total	**1330**	**2213**	**637**	**4180**	**385**

The maximum number of craft recorded, whilst 19% higher than the mean figure, did not, however, reach the peak levels suggested by the earlier published estimates. There are a number of possible explanations for this apparent contrast:

- Many of the swinging moorings and Marina berths were empty throughout the survey period, which suggests that there is existing capacity within the Harbour to accommodate more craft;
- On days of peak activity, it is likely that substantial numbers of craft leave the Harbour, thus reducing the number remaining;
- The weather during the August Bank Holiday, when an exceptionally large influx of craft might have been be expected, was not particularly good. It was both cloudy, rather windy and there were occasional heavy showers;
- The last few years have seen a severe economic recession, which may have adversely affected the use of recreational craft.

3.2. Variation in Craft Numbers over Time

Figures 4, 5 and 6, below, show the estimates of craft numbers from each survey flight, and provide an illustration of the changes in craft numbers over time. The data for putatively busy days - Sundays and Bank Holidays - are represented by filled symbols, and those for the other days - Saturdays and normal Mondays - by open symbols.

Perhaps the most notable characteristic of the data, best depicted in Figure 4, is their relative consistency (See also Appendix 3, Tables 8 to 10). As might be expected, given their temporal proximity, the May figures are all very similar, with little evident variability with either time or date. The July and August figures, whilst somewhat higher than the May ones, are also remarkably constant with respect to both time of day, and date. There is, however, some indication that total craft numbers are slightly lower on 'busy' days than the others, presumably because a number of boats leave the Harbour on 'busy' days, and have returned to their fixed moorings and berths at other times. Statistical analysis does not, however, show these differences to be significant.

There is also a suggestion that the numbers of motor boats rise slowly during the summer, whilst yacht numbers show no such trend. This pattern is made clearer if the craft in the major marinas are excluded (Appendix 3, Table 10): in May, between 290-680 motor boats were estimated to be in the Harbour; in July, between 520-720; and, in August, between 690-960. Equivalent figures for yachts are 1110-1610, 1530-1730 and 1290-1540 for May, July and August respectively.

Figure 4: Numbers of Major Types of Craft in Harbour

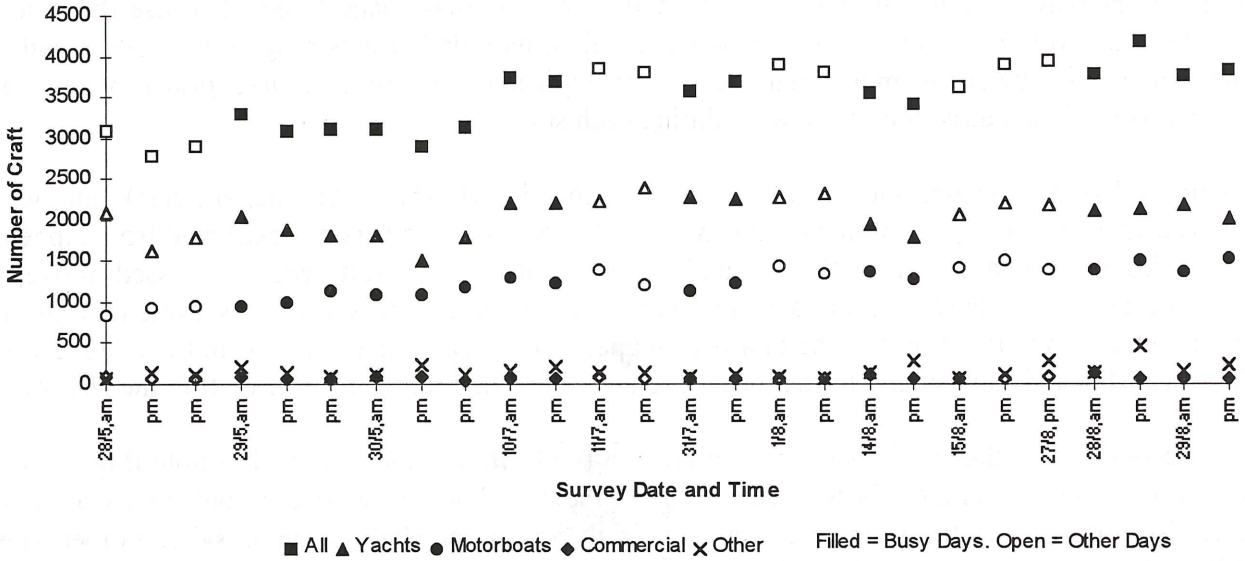


Figure 5: Numbers of Minor Craft in Harbour

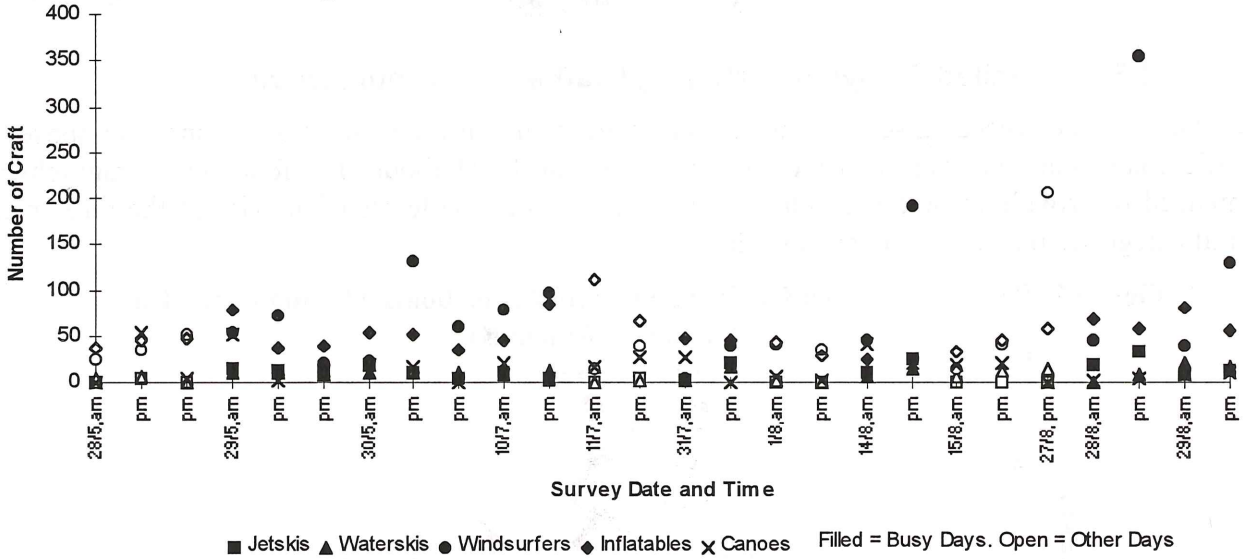


Figure 6: Numbers of Craft Recorded During Each Survey

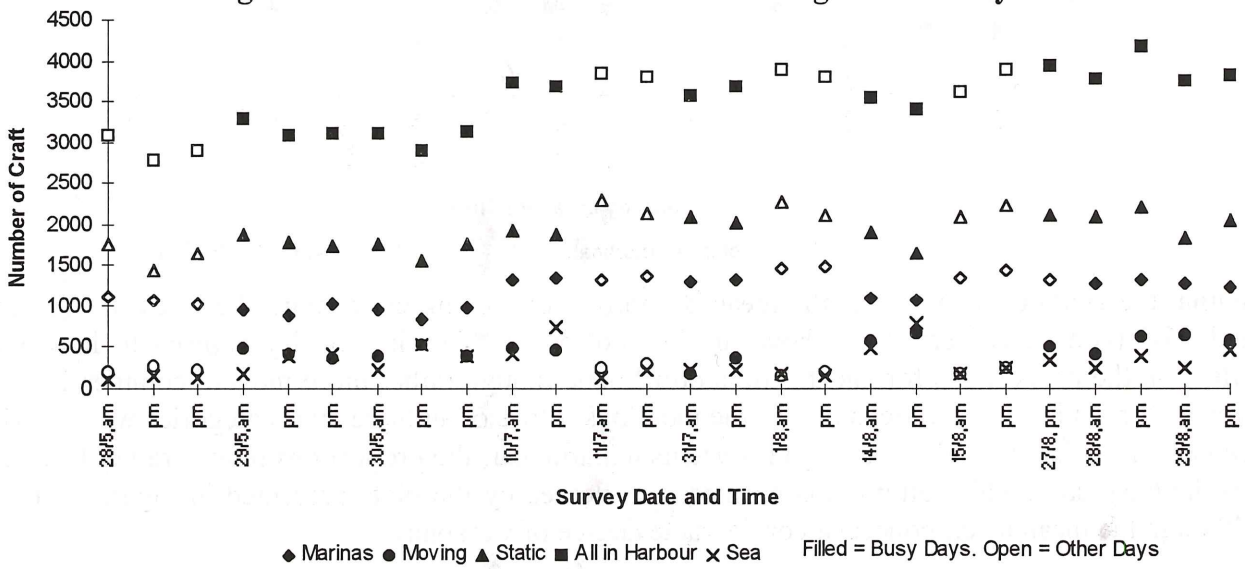


Figure 5 shows the numbers of the less numerous craft categories estimated during each survey. Little in the way of temporal pattern can be extracted from these data, largely because the absolute numbers are so low. An exception is that windsurfers, with daily totals ranging between 5 and 350 are, numerically, by far the most volatile category. Their numbers are, of course, primarily dependent on the strength and direction of the wind during each survey.

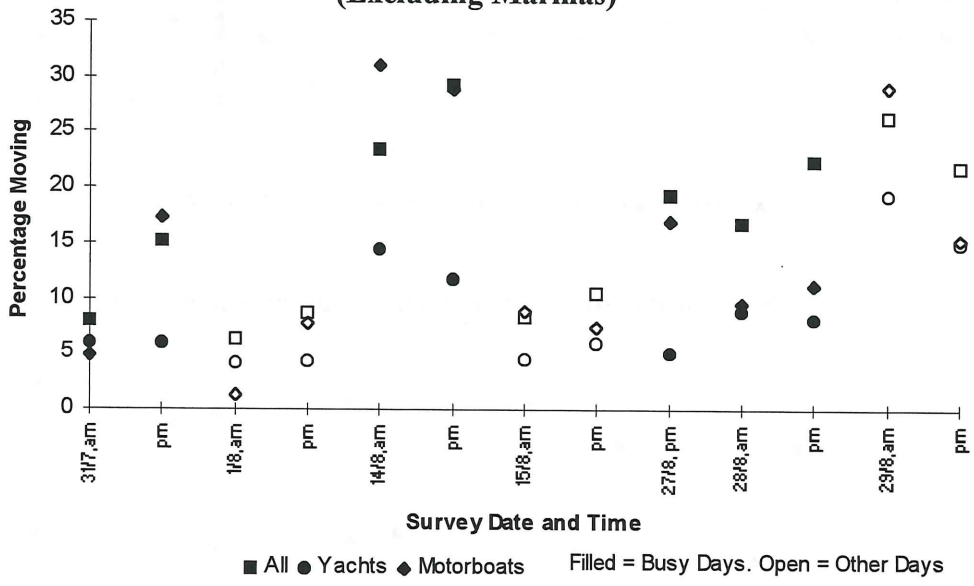
Figure 6 divides the data, not by craft type, but by location (Harbour, Marina, and Sea), and, within the Harbour, by the degree of movement (Moving and Static). The data are extracted from Appendix 3, Tables 8, 11 and 12. As with the numbers of the individual craft types, discussed above, the consistency of the figures is more striking than the differences from survey to survey, though there are two trends worthy of note. The first is a stepped rise in the number of craft in the major marinas between May and July, similar to that discussed above for the total number of craft in the Harbour.

The second is that the numbers of moving craft in the Harbour, and of craft in Poole Bay, is higher on all 'busy' days than the others, except for the 31st July, when heavy rain curtailed normal activity (see also following section). The mean number of all craft in the Harbour on 'busy' and other days is 476 and 256 respectively, and, in the surveyed parts of Poole Bay, is 399 and 195 (Appendix 3, Table 8). Given the total number of craft in the Harbour, these differences are remarkably small in absolute terms, and indeed given the subjective visual impact of moving craft when activity is high.

3.3. Detailed Analysis of Moving Craft and Harbour Activity

Throughout the preceding sections, it has been suggested that the number of moving, as opposed to static boats is an important indicator of activity within the Harbour. The following paragraphs are intended to provide some more detailed information about the levels of activity of the three major craft categories than has been given so far.

Figure 7: Percentage of All Craft, Yachts and Motorboats Moving in the Harbour (Excluding Marinas)



Within the Harbour as a whole, the mean proportion of moving craft ranges between 8% (yachts) and 66% (commercial craft), as shown in Table 6, below. The time of day appears to have little effect on the proportions for yachts and motor boats, though rather more moving commercial craft were recorded in the afternoons than in the mornings. More of all three craft categories were moving on busy days than the others, though for yachts in particular, the proportions remain rather low even on the busy days. This pattern is confirmed to a degree by the plots presented in Figure 7 above, although the mean levels conceal a considerable degree of variability.

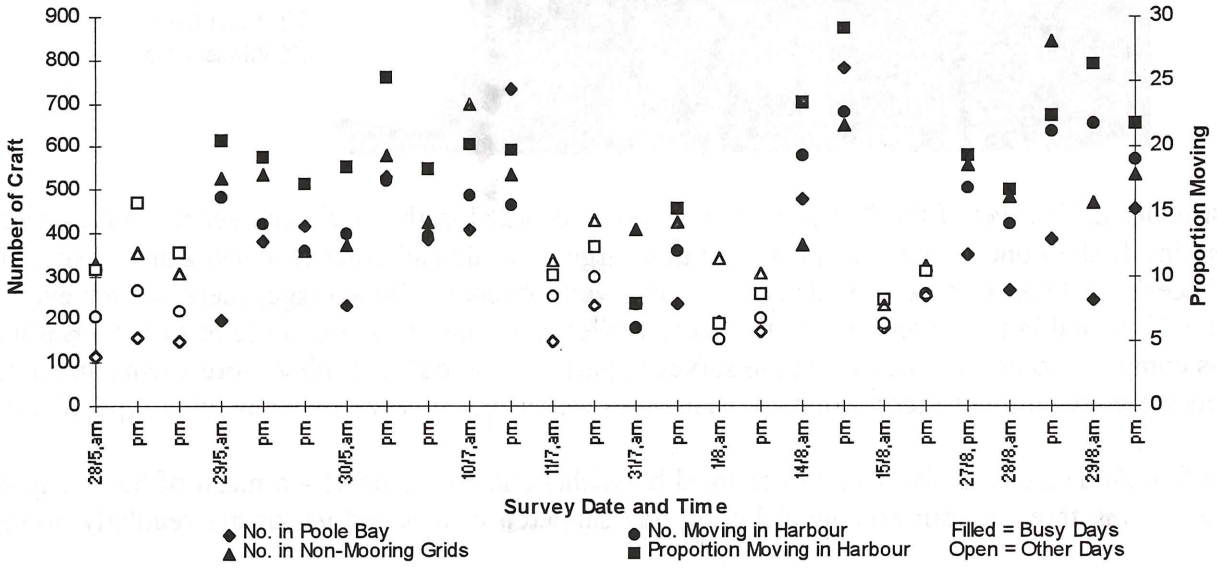
The majority of craft in the Harbour are found in the survey grids which contain fixed moorings or anchorages (see Appendix 3, Table 8 and Appendix 2, Map 3). The proportion of the yachts and motorboats in these areas that is moving at any one time is rather lower than in the harbour as a whole, largely because most of the moored craft belong to these two categories. Conversely, a significant percentage of the commercial craft in the mooring areas are moving.

In the grids without moorings or anchorages, a rather higher fraction of the yachts and motorboats is moving, particularly the latter, though a substantial fraction are static - presumably at anchor. Casual observation of these stationary craft during the course of the aerial surveys suggest that many of the yachts and motor boats were being used for picnics and the like, implying that the number of moving craft alone may be an underestimate of the recreational activity levels in the Harbour, and that the number of craft recorded in the grids without moorings may also provide an indication of Harbour usage.

Table 6: Mean Percentage of Moving Craft in Harbour

Area or Time	Yachts	Motorboats	Commercial
In the Harbour			
Morning Flights	9	16	58
Afternoon Flights	8	17	73
Busy Days	10	19	73
Not Busy Days	5	11	53
Total	**8**	**16**	**66**
In Grids with Moorings			
Morning Flights	8	9	51
Afternoon Flights	5	10	85
Busy Days	8	12	92
Not Busy Days	3	5	68
Total	**6**	**9**	**71**
In Grids without Moorings			
Morning Flights	13	79	50
Afternoon Flights	19	43	68
Busy Days	16	53	91
Not Busy Days	12	74	31
Total	**16**	**53**	**61**

Figure 8: Different Measures of Craft Activity



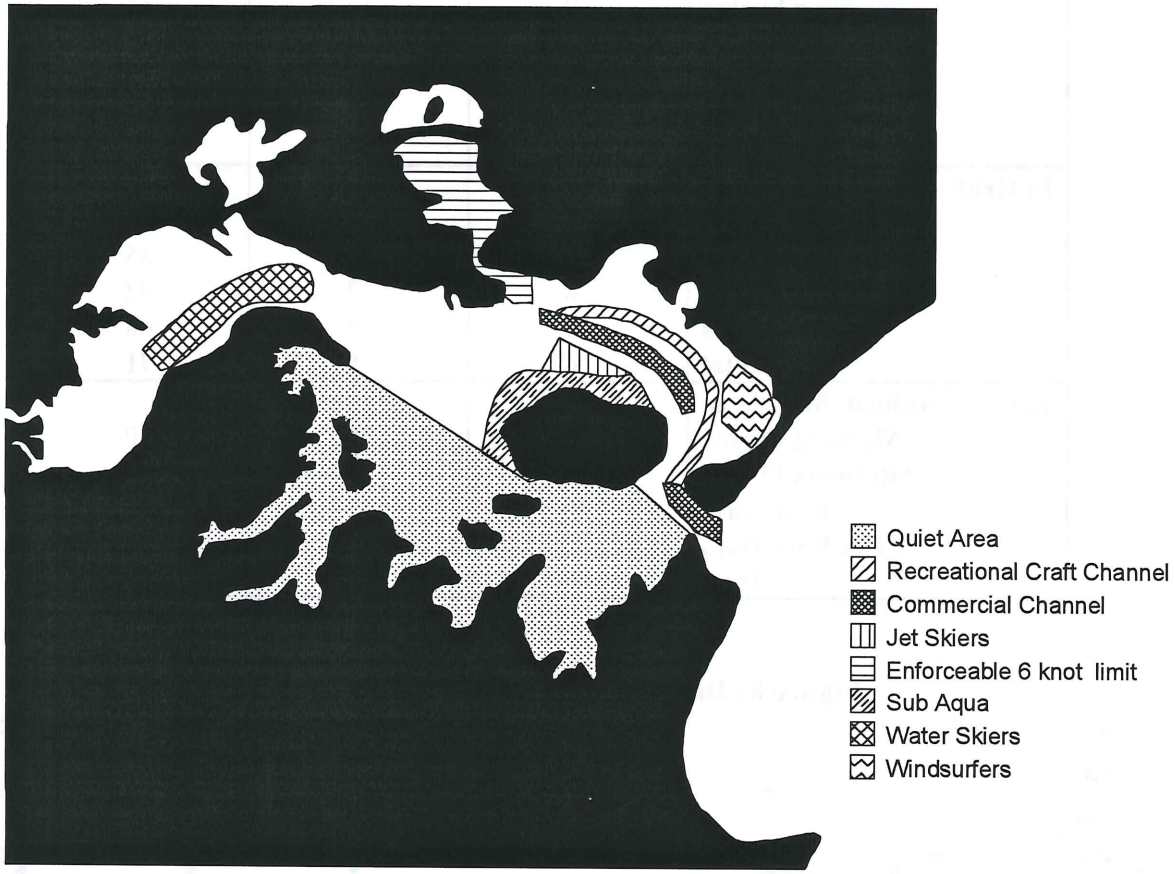
If so, the present data provide four possible indicators of Harbour activity: the numbers and proportions of moving craft in the Harbour; the numbers of moving and static craft in the grids without moorings or anchorages; and the numbers of craft in Poole Bay. These are plotted for each survey date on Figure 8 above.

All the measures show a similar pattern: there is more activity on 'busy days', except when the weather is bad (as on July 31st), but little evidence that levels of activity increase over the summer, or vary consistently during the day.

3.4. Harbour Zonation and Craft Distributions

Map 1 shows the location of the main Activity Zones within in the Harbour, as defined at the time of writing. Given the geo-referenced nature of the survey data, it is possible to estimate the numbers of various craft categories inside and outside the various zones, and so provide an indication of whether the defined Zones are being observed by Harbour users. These data are provided in Appendix 3, Table 16, and are summarised briefly below.

Map 1: Zonation in Poole Harbour



Just under half (43%) of the 200 or more waterskis recorded in the Harbour over the survey period were inside the Zone assigned to them, and they largely avoided all other assigned Zones, except the enforceable 6 knot limit, where 13% of the total were observed. On average, therefore for every, 4 waterskis found in their Zone, 1 is in the speed limited area, and three are in the rest of the Harbour. This compares to an average of 8 in the surveyed parts of Poole Bay. Rather more yachts and motor boats were seen in the waterki Zone - a mean of 43 vessels per survey - than any other type of craft.

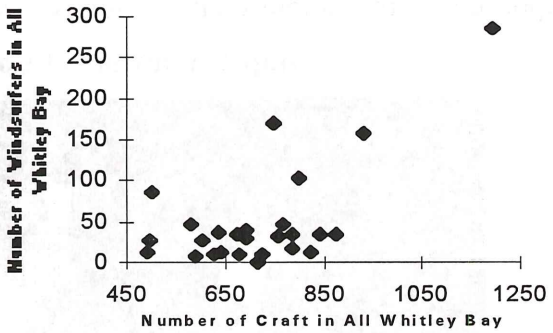
The Sub Aqua Zone is also largely occupied by yachts and motor boats - a mean of 55 at any one time, though three or four commercial craft, and singleton canoes and jetskis are regularly present.

The Zone does not appear to be a focus of distribution for the inflatables which are often used for diving as only 4% (approximately 3 per survey) of these craft were found there. Three times as many were recorded in the Quiet Zone to the south.

A mean of two thirds of the windsurfers are found within the Zone assigned to novices, the highest level of adherence to the existing zonation recorded. A significant proportion (11%) are also found in the Quiet Zone, south of Brownsea Island.

This concentration within the novices Zone is even more marked when there are very high numbers of windsurfers in the Harbour, at which times between two and three hundred windsurfers may be found within the Zone boundaries. Despite the fact that they have the freedom of the Harbour, there is no evidence that windsurfers spread outside Whitley Bay when it is especially busy. Indeed there are some indications that the converse is generally true - as shown in Figure 9, to the right.

Figure 9: Windsurfer Numbers in Whitley Bay



Over four fifths of the jetskis are outside their allotted area at any one time. Given the proximity of the Sub Aqua Zone, and the relatively restricted dimensions of the assigned Zone, a more reliable indication of intent is probably to consider the two Zones together, in which case, about a quarter of the total observe the existing limits. A further 14% are generally recorded in the Commercial Channel, much of which is also adjacent to the designated Zone.

In all, therefore, about 40% of the jetskis in the Harbour remain in or near their designated areas, from Baiter slipway and south towards Brownsea Island. This leaves the remaining 60% elsewhere - a comparable degree of adherence to the existing zonation to that shown by the waterkiers. It should, perhaps, be noted that the average number of jetskis in the Harbour is twelve, and the most recorded during a survey was 33. The relative distributions just discussed thus imply a maximum of 13 craft in or near the designated zone, and 20 in the Harbour at large.

All categories of vessel were recorded in the Commercial Channel, the most common being yachts and motor boats, with a mean combined number of 171 craft. These outnumber all other types, including commercial craft, by more than ten to one. Of the commercial craft (which include vessels other than the ferries for which the channel was mainly defined), the highest proportion was found within the enforceable 6 knot speed limit in Holes Bay and the entrance to it.

A major concern is the potential for collision between recreational and commercial craft that these data imply, particularly at the Harbour entrance. The highest risk periods are likely to be in the early morning, when there is often heavy traffic into Poole Bay, and in the late afternoon, when there many boats return to the Harbour itself. Whilst no collisions were actually observed during the surveys, some close encounters were occasionally commented upon by the observation team. These often occurred when the tidal race through the entrance was at is strongest, which presumably caused particular problems to yachts travelling against the current.

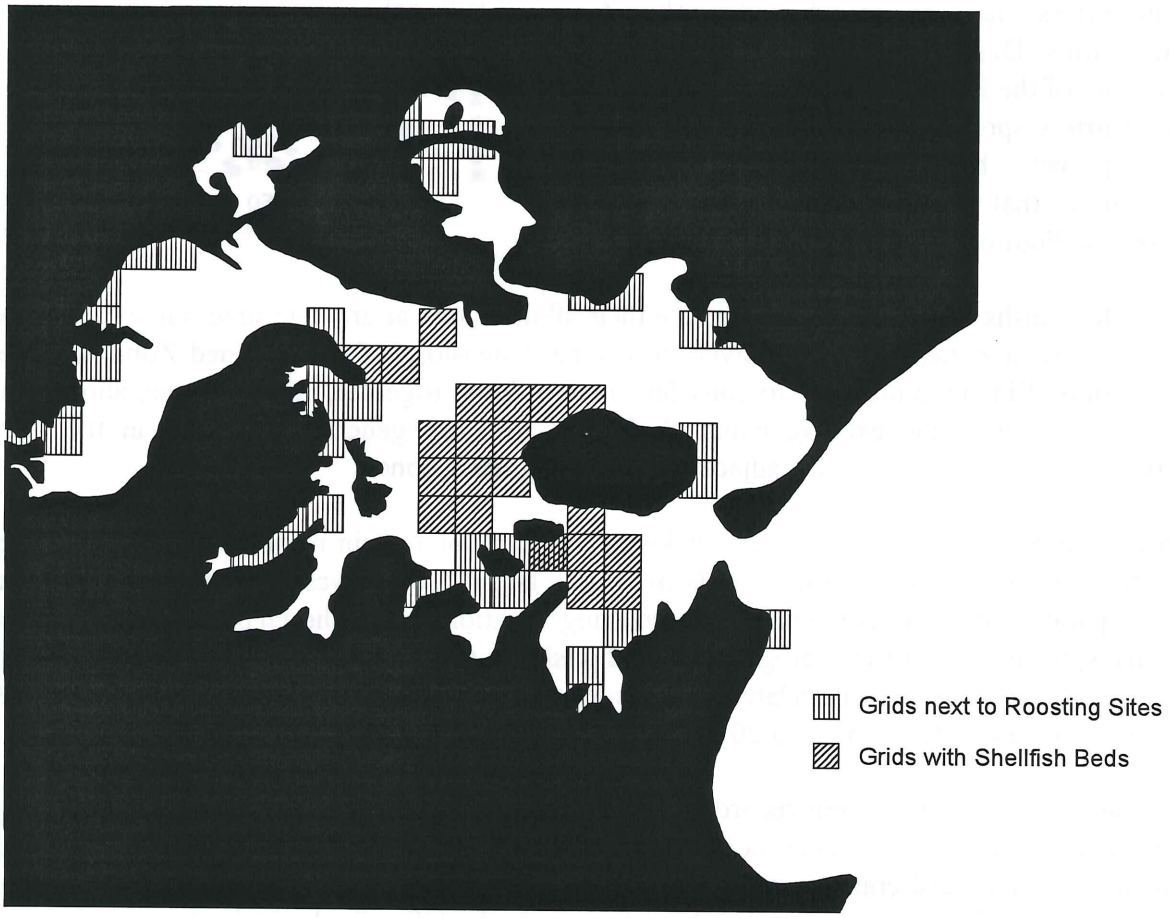
In summary, the implication of these distributions is that the existing Zonation, whilst not ignored, is not strictly observed by any of the craft in the Harbour. The available data do not permit an analysis of the types of breaches being carried out, and it is possible that many are made by craft transiting

the Harbour or moving towards (or away from) their allotted areas. The only way to ascertain the full facts is to continuously monitor craft movements.

3.5. Impact on the Environment

Of particular concern to the authorities is the impact that recreational craft may have on the Harbour's natural environment. At the client's request, two aspects of this potential problem are considered here, specifically the disturbance that craft might cause to birds and marine fauna. Map 2 below, shows the location of grid cells wherein craft might impinge on the major roosting sites for birds, as well as those which contain shellfish beds. Appendix 3, Table 16 gives the estimated mean proportions of the various craft categories inside and outside these grids.

Map 2: Location of Roosting Sites and Shellfish Beds



It is likely that the major cause of impact on bird roosting by water borne craft is noise, and that on shellfish beds is silt disturbance. Both are caused more by motorised than sail-powered craft. The available data suggest that, on average, between 90 and 95% of these craft are outside the relevant grids, and are therefore unlikely to have a seriously deleterious effect. This does leave, however, a total of 44 motorised craft within the grids that contain shellfish beds, and 68 in the grids adjacent to major bird roosting sites. The majority of these craft are in the grids along the northern margins of Brownsea Island, and along the north-east shoreline of the Harbour.

On a number of occasions, direct damage to the sea bed was observed by the aerial survey team. The majority of the marks seen appeared to be caused by bait dragging activities or motor boats, particularly in Stone Island Lake and Bramble Bush Bay, to the south east of Brownsea Island. Jetski tracks were also seen in some of the shallower areas, and in Holes Bay to the north of the rail causeway.

4. RECOMMENDATIONS FOR FUTURE SURVEYS

The present study has demonstrated that aerial survey techniques based on visual observation rather than photographic methodologies are well suited to assessing the numbers and type of water borne craft. Given the sophisticated navigation equipment now available, it has proved possible to adapt a technique originally designed to monitor large and remote areas for environmental, ecological and environmental resources, to produce useful data on recreational activity for comparatively small regions such as Poole Harbour.

Because this survey technique is based on a grid design, it is easily repeatable. This means that the surveys can be precisely duplicated in the future to allow for continuous monitoring in future years. In addition, the results obtained can readily be interpreted in relation to geographical regions, as exemplified by the zonation used in this analysis. As a consequence, the data can, if so desired, be re-analysed using different zonation schemes. The data from any one survey can therefore be integrated into future studies even if the current geographical strata are no longer relevant.

4.1. Specific Considerations of Survey Design and Implementation

Because this study is the first of its kind to be undertaken, the survey design and implementation was necessarily amended as the study progressed. Specifically, because of the unusually precise flying required to allow for 0.5 x 0.5 km grids, the pilot was unable to record variations in flying height accurately. A front seat observer was therefore needed for both this purpose, and to maintain a watch for other air traffic, allowing the pilot to concentrate on his instruments.

Once a number of sorties had been completed, and the resulting data analysed, it became evident that three flights per day were unnecessary, as there was no consistent trend in craft numbers during the day. Accordingly, from July onwards, only two flights per day were made.

The relevance of moving, as opposed to static, craft also became more apparent as the study progressed. In future surveys of this type, it may be desirable to record moving craft separately during the main sorties. If the framework of the main survey were to be unchanged this would result in eleven categories of craft for the observers to differentiate and enumerate. Experience dictates that observers can easily distinguish this number of types only if the overall numbers are comparatively low, or if each grid contains relatively few target categories.

In busy grids, eight or nine categories are considered the maximum feasible number that can be recorded. In a high density area, such as Poole Harbour, a possible solution may be either to drop the minor craft categories, or to combine them into a single group representing all craft that were not of specific interest to the particular survey. For example, canoes may be regarded as of little interest as their numbers are low and their impact upon the environment and other traffic negligible. An alternative strategy would be to maintain separate flight lines for moving craft but to increase their number and execute these counts immediately subsequent to initial sampling of the flight line. A second alternative might be to stop differentiating between the type of static craft and only categorise moving vessels. Which, if either, of these alternatives is most appropriate, will depend on the specific survey requirements.

The results obtained suggest a fairly tight link between the number of craft in the Harbour, and the number outside it, in Poole Bay. This suggests that future surveys should also record craft in the immediate vicinity of the main target area, as there is likely to be substantial traffic into and out of a particular harbour. There is also the possibility that nearby anchorages and harbours should be included within the survey areas - in this case, perhaps Christchurch Harbour - as there may well be interchange between the major harbours and satellite regions. The incremental cost of such additional

coverage is likely to be small, as the only extra charges would be for the flying itself, provided the number of days required in the field did not increase.

The present survey programme was executed during the summer months, when harbour usage is likely to be substantial. As a result, no baseline figure for the numbers of vessels in the Harbour, when activity levels are lowest, has been obtained for comparison. Such data would be a valuable addition to the information collected, but would require additional survey flights.

The present data show that more craft are found in the Harbour in late summer than during May, but that activity levels and absolute numbers do not vary consistently with time of day. It might therefore be desirable to reduce the number of flights per day designed to assess activity within a harbour to one, and, instead fly a sortie in the early morning, before the majority of recreational users were on the water. Such a schedule would have the added advantage of allowing a more precise co-ordination between survey flight times with the high tides.

In this context, it would also be desirable to gather information outside the summer season - i.e. during the winter - when the number of recreational users in the Harbour is likely to be at its lowest. This would provide a baseline datum for the calculation of the seasonal influx of craft during the year.

4.2. Further Development and Application

There seems little reason to suppose that the techniques pioneered in this study cannot be employed in any other coastal harbour or anchorage, providing aircraft and satellite coverage are available, and permissions can be obtain to fly over the areas required. It would also be possible to monitor inland water bodies if they were of sufficient size or significance. The present survey design could also be adapted to monitor blocks of coastlines or sea-lanes, provided sufficient care was taken to avoid double counting by aligning the flight lines along the major movement axes.

The present survey was based largely on visual techniques, though enhanced to a degree by the photography used to count the Marina-based craft, and to validate the observer counts. It may prove desirable in other cases to extend the use of photography to assess specific targets less amenable to rapid visual assessment. Two possible examples for the Poole Harbour area are bird nesting/roosting sites and shoreline car park occupancy.

APPENDIX 1: SURVEY SPECIFICATIONS AND SCHEDULE

1. SPECIFICATIONS FOR PILOT AERIAL MAPPING OF LEISURE ACTIVITY IN POOLE HARBOUR, SUMMER 1994

A series of low level aerial surveys will be flown in order to assess the leisure use of Poole Harbour, on the dates shown below. On each date, a number of flights will be flown, also shown on Table 1. Where three flights per day are required, overflights will be made starting at 11.00, 14.00, and 16.00; where two flights per day are scheduled, overflights will commence at 12.00 and 15.00.

Date	No. Flights
25-May	3
28-May	3
29-May	3
30-May	3
10-Jul	3
11-Jul	2
31-Jul	3
01-Aug	2
14-Aug	3
15-Aug	2
27-Aug	3
28-Aug	3
29-Aug	3
Total	36

The survey parameters have been designed to ensure as much independence from the weather as possible, and every reasonable effort will be made to fly on the specified dates. However, ERGO reserves the right to vary the survey dates if the weather compromises crew safety or compliance with air traffic regulations.

Each overflight will cover the area shown on the attached map. Flight lines will be spaced at one kilometre intervals, and observations will be made within a strip measuring 750 metres at ground level. Counts will be made of six categories of water-borne craft as follows: Commercial (including ferries, cargo ships, etc.); motorised cruisers; yachts and dinghies; jet skis; and windsurfers. On each overflight, photographs will be taken of the three marinas within the survey area, in order to assess their usage. In addition, photographs will be taken to illustrate types of harbour usage as specified by the staff responsible for the project.

As well as observer assessments of harbour use, two flights (one trial and one survey flight) will be made with fixed 35mm cameras mounted inside the aircraft to obtain oblique coverage of the harbour The resulting photographs will be catalogued and submitted to project staff so that they can be used to evaluate the use of low level aerial photography to assess harbour utilisation in the future. The cameras may also be mounted on four further occasions, should the required funding become available.

Once the flights are completed, ERGO will analyse the data collected in order to produce tables and maps describing harbour use during the summer and at different times of day. These will be

incorporated into a report describing the methods and results used. Ten copies of the report will be provided.

Dorset County Council or ERGO may revise these specifications during the course of the survey programme, providing responsible officers of both parties agree to the changes requested.

2. AGREED REVISIONS AND SURVEY SCHEDULE IMPLEMENTED:

- Grid sizes were revised to 0.5 x 0.5 kilometres, with observation strips set at 250m at the nominal flying height.
- The number of flights per day was changed to two, after the trial and may sorties were completed.
- Oblique photography was abandoned, in favour of a flight to obtain illustrative photographs for presentation.
- From the end of July onwards, additional survey lines were flown over the high density grids, in order to assess moving craft only.
- Following the malfunctioning of the satellite navigation system on the morning of August 27th the sortie for that specific time was abandoned.

The flight schedule actually carried out was therefore as shown below. As much as possible, flights were timed to avoid low water.

Date	No. Flights	Moving Craft Counts
25-May	3	
28-May	3	
29-May	3	
30-May	3	
10-Jul	2	
11-Jul	2	
31-Jul	2	
01-Aug	2	
14-Aug	2	Yes
15-Aug	2	Yes
27-Aug	1*	Yes
28-Aug	3#	Yes
29-Aug	2	Yes

*Flight aborted due to GPS satellite failure
#Addtional Photographic Flight flown

APPENDIX 2: ASSESSMENT OF MOVING CRAFT

As the survey programme progressed, it became apparent that was important to distinguish between those craft that were at fixed moorings (marinas), at swinging moorings, or were actually being used (i.e. moving). Accordingly, from July 31st onwards, additional flight lines were flown immediately after each main sortie was finished, to sample those grids with a high density of craft (Figure 2). Only moving craft were recorded, and a comparison with the total estimated numbers obtained during the main sorties used to calculate an estimate of the proportion of moving craft within the areas that contained substantial numbers of swinging moorings, and those that did not.

These proportions were then used to estimate the number of fixed and moving craft within all the grids that were known to contain significant numbers of swinging moorings (Map 3) and those that did not. All jetskis, windsurfers, canoes, and waterkiers were assumed to be moving, regardless of their location.

Map 3: Location of Swinging Moorings within Harbour

For those sorties flown before the moving craft flights were implemented, some assessment of moving craft is also desirable. Accordingly the figures available were used to calculate mean proportions of moving craft for busy and non-busy days which were then applied to the total numbers of craft estimated during the May and mid-July sorties.

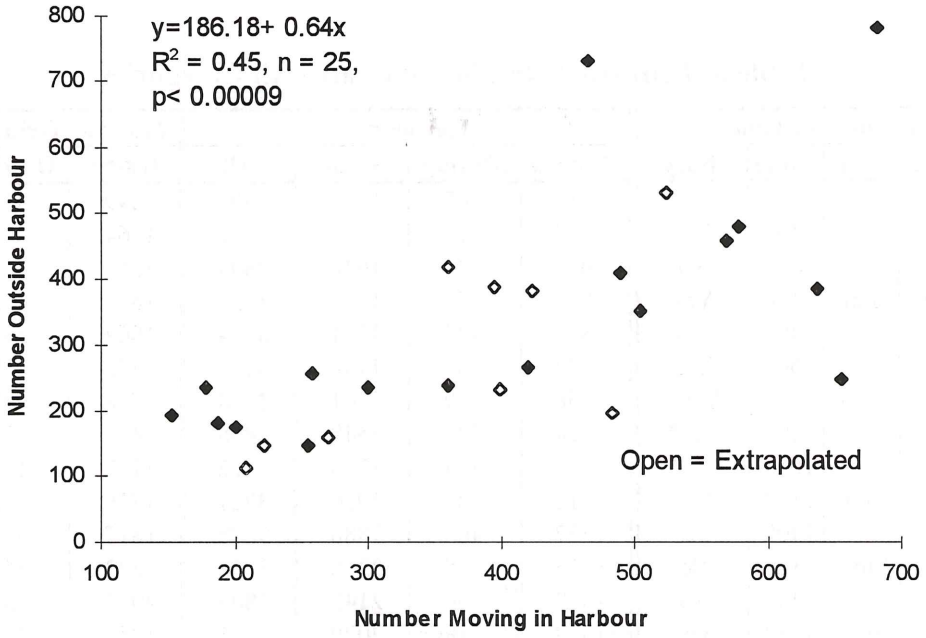
Table 7: Percentage of Moving Craft in Harbour

Survey Date and Time					Type of Craft				
Month	**Date**	**Day**	**Time**	**Busy**	**Yachts**	**Motor**	**Commercial**	**Inflatables**	**All#**
May	**28**	Sat	1100	No	4	20	56	6	**11**
	28		1400	No	5	17	54	27	**16**
	28		1600	No	5	14	58	26	**12**
	29	Sun	1100	Yes	10	21	92	31	**20**
	29		1400	Yes	10	19	92	31	**19**
	29		1600	Yes	10	17	91	30	**17**
	30	Mon	1100	Yes*	9	19	92	31	**18**
	30		1400	Yes*	10	23	92	31	**25**
	30		1600	Yes*	10	20	92	30	**18**
July	**10**	Sun	1100	Yes	11	20	92	32	**20**
	10		1400	Yes	10	20	92	31	**20**
	11	Mon	1100	No	5	10	51	30	**10**
	11		1400	No	5	17	62	29	**12**
	31	Sun	1130	Yes	6	5	33	0	**8**
	31		1430	Yes	6	17	94	30	**15**
August	**01**	Mon	1130	No	4	1	31	26	**6**
	01		1430	No	4	8	65	0	**9**
	14	Sun	1130	Yes	14	31	8	0	**23**
	14		1430	Yes	12	29	100	0	**29**
	15	Mon	1130	No	4	9	22	0	**8**
	15		1430	No	6	7	50	0	**10**
	27	Sat	1430	No	5	17	75	20	**19**
	28	Sun	1130	Yes	9	10	83	68	**17**
	28		1430	Yes	8	11	26	0	**22**
	29	Mon	1130	Yes*	19	29	72	14	**26**
	29		1430	Yes*	15	15	44	41	**22**
Mean	**All**				**8**	**16**	**66**	**26**	**17**
Mean			am		9	16	58	27	**15**
Mean			pm		8	17	73	25	**18**
Mean				Yes	10	19	73	28	**20**
Mean				No	5	11	53	22	**11**

All includes jetskis, windsurfers, canoes and waterskis. *Bank Holiday Mondays

Motor = Motor Boats; Commercial = Commercial Craft; Wksi = Waterskis; Inflatables = Rigid Inflatables.

Figure 10: Number of Moving Craft: Number Outside Harbour



Whilst these extrapolations are obviously less accurate than measurements would have been, their general validity is supported by the fairly close relationship between the estimated number of craft moving and the number present in the Bay outside the Harbour (Figure 10). Most of the craft in the Bay originate from within the Harbour. They can thus be taken as an indicator of the number of craft that have moved out of the Harbour, and by implication, of the number that were, at some stage, moving within it. As Figure 10 suggests no difference between the earlier and later dates, then the extrapolations used to calculate the number of moving craft for the earlier dates are likely to be tenable.

APPENDIX 3: TABLES OF RESULTS

Table 8: Estimated Number of Craft - All Categories

Survey Date and Time					Harbour				Mooring Grids		Poole
Month	Date	Day	Time	Busy	Marinas	Moving	Static	All	Inside	Outside	Bay
May	28	Sat	1100	No	1115	208	1770	**3093**	1649	329	114
	28		1400	No	1058	270	1448	**2776**	1364	354	159
	28		1600	No	1030	221	1648	**2899**	1560	309	148
	29	Sun	1100	Yes	942	483	1873	**3298**	1831	525	196
	29		1400	Yes	880	423	1781	**3084**	1667	537	383
	29		1600	Yes	1022	360	1734	**3116**	1735	359	418
	30	Mon	1100	Yes*	958	399	1761	**3118**	1788	372	232
	30		1400	Yes*	824	524	1548	**2896**	1493	579	531
	30		1600	Yes*	970	394	1768	**3132**	1738	424	388
July	10	Sun	1100	Yes	1312	489	1926	**3727**	1719	696	409
	10		1400	Yes	1337	465	1886	**3688**	1817	534	731
	11	Mon	1100	No	1315	255	2288	**3858**	2203	340	148
	11		1400	No	1360	300	2143	**3803**	2012	431	234
	31	Sun	1130	Yes	1308	178	2079	**3565**	1850	407	236
	31		1430	Yes	1314	360	2008	**3682**	1941	427	239
August	01	Mon	1130	No	1469	152	2268	**3889**	2076	344	192
	01		1430	No	1478	201	2121	**3800**	2013	309	173
	14	Sun	1130	Yes	1088	578	1893	**3559**	2096	375	479
	14		1430	Yes	1069	682	1654	**3405**	1685	651	782
	15	Mon	1130	No	1351	187	2087	**3625**	2043	231	179
	15		1430	No	1427	258	2216	**3901**	2147	327	255
	27	Sat	1430	No	1323	505	2115	**3943**	2064	556	352
	28	Sun	1130	Yes	1270	420	2097	**3787**	2032	485	266
	28		1430	Yes	1330	637	2213	**4180**	2006	844	385
	29	Mon	1130	Yes*	1278	654	1836	**3768**	2021	469	248
	29		1430	Yes*	1221	570	2045	**3836**	2080	535	458
Mean	**All**				**1194**	**391**	**1931**	**3516**	**1870**	**452**	**321**
Mean			am		1219	364	1989	**3572**	1937	416	245
Mean			pm		1176	411	1889	**3476**	1821	478	376
Mean				Yes	1133	476	1881	**3490**	1844	514	399
Mean				No	1293	256	2010	**3559**	1913	353	195

*Bank Holiday Mondays

Marinas = Craft in three major marinas; Moving = Moving Craft; Static = Static Craft; Inside = In Grids with Moorings or Achorages; Outside = In Grids without Moorings or Anchorages; Poole Bay = Surveyed Section of Poole Bay.

Table 9: Number of Craft in Harbour (Including Major Marinas)

Survey Date and Time					Type of Craft								
Month	**Date**	**Day**	**Time**	**Busy**	**Yachts**	**Motor**	**Comm**	**Jet**	**Wind**	**Wski**	**Canoe**	**Inflat**	**All**
May	**28**	Sat	1100	No	2096	841	90	0	25	4	0	37	**3093**
	28		1400	No	1625	939	67	4	35	7	54	46	**2776**
	28		1600	No	1776	952	66	0	52	0	5	48	**2899**
	29	Sun	1100	Yes	2049	956	84	15	53	11	52	78	**3298**
	29		1400	Yes	1879	997	72	12	73	11	2	38	**3084**
	29		1600	Yes	1818	1133	74	10	21	8	12	40	**3116**
	30	Mon	1100	Yes*	1818	1090	87	18	22	11	18	54	**3118**
	30		1400	Yes*	1500	1091	84	11	131	11	16	52	**2896**
	30		1600	Yes*	1782	1184	55	5	60	10	0	36	**3132**
July	**10**	Sun	1100	Yes	2202	1289	72	11	78	8	21	46	**3727**
	10		1400	Yes	2199	1223	67	2	96	13	4	85	**3688**
	11	Mon	1100	No	2223	1395	98	0	14	0	16	112	**3858**
	11		1400	No	2396	1202	67	5	39	2	27	65	**3803**
	31	Sun	1130	Yes	2267	1146	69	2	5	2	26	48	**3565**
	31		1430	Yes	2242	1239	80	21	39	16	0	45	**3682**
August	**01**	Mon	1130	No	2279	1440	76	0	41	3	7	43	**3889**
	01		1430	No	2315	1348	71	0	35	0	2	29	**3800**
	14	Sun	1130	Yes	1942	1373	116	11	45	6	42	24	**3559**
	14		1430	Yes	1785	1270	76	24	191	15	20	24	**3405**
	15	Mon	1130	No	2055	1421	76	0	15	6	18	34	**3625**
	15		1430	No	2205	1505	71	0	41	13	20	46	**3901**
	27	Sat	1430	No	2179	1390	95	0	207	15	0	57	**3943**
	28	Sun	1130	Yes	2113	1396	142	19	46	0	2	69	**3787**
	28		1430	Yes	2136	1516	71	33	354	9	4	57	**4180**
	29	Mon	1130	Yes*	2171	1361	78	9	40	21	8	80	**3768**
	29		1430	Yes*	2013	1527	69	13	130	17	11	56	**3836**
Mean	**All**				**2041**	**1239**	**80**	**9**	**73**	**8**	**15**	**52**	**3516**
Mean			am		2110	1246	90	8	35	7	19	57	**3572**
Mean			pm		1990	1234	72	9	100	10	12	48	**3476**
Mean				Yes	1995	1237	81	14	87	11	15	52	**3490**
Mean				No	2115	1243	78	1	50	5	15	52	**3559**

*Bank Holiday Mondays

Motor = Motor Boats; Comm = Commercial Craft; Jet = Jetskis; Wind = Windsurfers; Wksi = Waterskis; Inflat = Rigid Inflatables.

Table 10: Estimated Number of Craft in Harbour (Excluding Marinas)

Survey Date and Time					Type of Craft								
Month	**Date**	**Day**	**Time**	**Busy**	**Yachts**	**Motor**	**Comm**	**Jet**	**Wind**	**Wski**	**Canoe**	**Inflat**	**All**
May	**28**	Sat	1100	No	1546	288	90	0	25	4	0	25	**1978**
	28		1400	No	1106	410	67	4	35	7	54	35	**1718**
	28		1600	No	1313	396	66	0	52	0	5	37	**1869**
	29	Sun	1100	Yes	1612	459	84	15	53	11	52	70	**2356**
	29		1400	Yes	1476	528	72	12	73	11	2	30	**2204**
	29		1600	Yes	1339	601	74	10	21	8	12	29	**2094**
	30	Mon	1100	Yes*	1390	568	87	18	22	11	18	46	**2160**
	30		1400	Yes*	1092	683	84	11	131	11	16	44	**2072**
	30		1600	Yes*	1338	667	55	5	60	10	0	27	**2162**
July	**10**	Sun	1100	Yes	1546	647	72	11	78	8	21	32	**2415**
	10		1400	Yes	1527	575	67	2	96	13	4	67	**2351**
	11	Mon	1100	No	1598	718	98	0	14	0	16	99	**2543**
	11		1400	No	1732	519	67	5	39	2	27	52	**2443**
	31	Sun	1130	Yes	1581	539	69	2	5	2	26	33	**2257**
	31		1430	Yes	1563	626	80	21	39	16	0	23	**2368**
August	**01**	Mon	1130	No	1496	774	76	0	41	3	7	23	**2420**
	01		1430	No	1519	685	71	0	35	0	2	10	**2322**
	14	Sun	1130	Yes	1393	851	116	11	45	6	42	7	**2471**
	14		1430	Yes	1293	710	76	24	191	15	20	7	**2336**
	15	Mon	1130	No	1348	795	76	0	15	6	18	16	**2274**
	15		1430	No	1487	817	71	0	41	13	20	25	**2474**
	27	Sat	1430	No	1518	753	95	0	207	15	0	32	**2620**
	28	Sun	1130	Yes	1450	817	142	19	46	0	2	41	**2517**
	28		1430	Yes	1475	872	71	33	354	9	4	32	**2850**
	29	Mon	1130	Yes*	1538	742	78	9	40	21	8	54	**2490**
	29		1430	Yes*	1380	961	69	13	130	17	11	34	**2615**
Mean	**All**				**1448**	**654**	**80**	**9**	**73**	**8**	**15**	**36**	**2322**
Mean			am		1500	654	90	8	35	7	19	41	**2353**
Mean			pm		1411	654	72	9	100	10	12	32	**2300**
Mean				Yes	1437	678	81	14	87	11	15	36	**2357**
Mean				No	1466	616	78	1	50	5	15	35	**2266**

*Bank Holiday Mondays

Motor = Motor Boats; Comm = Commercial Craft; Jet = Jetskis; Wind = Windsurfers; Wksi = Waterskis; Inflat = Rigid Inflatables.

Table 11: Estimated Number of Moving Craft in Harbour

Survey Date and Time					Type of Craft								
Month	**Date**	**Day**	**Time**	**Busy**	**Yachts**	**Motor**	**Comm**	**Jet**	**Wind**	**Wski**	**Canoe**	**Inflat**	**All**
May	**28**	Sat	1100	No	69	58	50	0	25	4	0	2	**208**
	28		1400	No	55	69	36	4	35	7	54	9	**270**
	28		1600	No	60	56	39	0	52	0	5	10	**221**
	29	Sun	1100	Yes	159	94	77	15	53	11	52	22	**483**
	29		1400	Yes	150	100	66	12	73	11	2	9	**423**
	29		1600	Yes	130	102	68	10	21	8	12	9	**360**
	30	Mon	1100	Yes*	130	107	80	18	22	11	18	14	**399**
	30		1400	Yes*	110	154	77	11	131	11	16	14	**524**
	30		1600	Yes*	129	132	50	5	60	10	0	8	**394**
July	**10**	Sun	1100	Yes	163	132	66	11	78	8	21	10	**489**
	10		1400	Yes	151	118	61	2	96	13	4	21	**465**
	11	Mon	1100	No	72	73	50	0	14	0	16	29	**255**
	11		1400	No	80	91	41	5	39	2	27	15	**300**
	31	Sun	1130	Yes	93	27	23	2	5	2	26	0	**178**
	31		1430	Yes	93	109	75	21	39	16	0	7	**360**
August	**01**	Mon	1130	No	62	9	24	0	41	3	7	6	**152**
	01		1430	No	65	54	46	0	35	0	2	0	**201**
	14	Sun	1130	Yes	201	264	9	11	45	6	42	0	**578**
	14		1430	Yes	152	204	76	24	191	15	20	0	**682**
	15	Mon	1130	No	60	71	17	0	15	6	18	0	**187**
	15		1430	No	89	60	36	0	41	13	20	0	**258**
	27	Sat	1430	No	77	128	72	0	207	15	0	6	**505**
	28	Sun	1130	Yes	129	79	118	19	46	0	2	28	**420**
	28		1430	Yes	121	97	19	33	354	9	4	0	**637**
	29	Mon	1130	Yes*	297	216	56	9	40	21	8	8	**654**
	29		1430	Yes*	207	147	31	13	130	17	11	14	**570**
Mean	**All**				**119**	**106**	**52**	**9**	**73**	**8**	**15**	**9**	**391**
Mean			am		130	103	52	8	35	7	19	11	**364**
Mean			pm		111	108	53	9	100	10	12	8	**411**
Mean				Yes	151	130	59	14	87	11	15	10	**476**
Mean				No	69	67	41	1	50	5	15	8	**256**

*Bank Holiday Mondays

Motor = Motor Boats; Comm = Commercial Craft; Jet = Jetskis; Wind = Windsurfers; Wksi = Waterskis; Inflat = Rigid Inflatables.

Table 12: Estimated Number of Static Craft in Harbour (Excluding Marinas)

Survey Date and Time					Type of Craft								
Month	**Date**	**Day**	**Time**	**Busy**	**Yachts**	**Motor**	**Comm**	**Jet**	**Wind**	**Wski**	**Canoe**	**Inflat**	**All**
May	**28**	Sat	1100	No	1477	230	40	0	0	0	0	23	**1770**
	28		1400	No	1051	341	31	0	0	0	0	26	**1448**
	28		1600	No	1253	340	27	0	0	0	0	27	**1648**
	29	Sun	1100	Yes	1453	365	7	0	0	0	0	48	**1873**
	29		1400	Yes	1326	428	6	0	0	0	0	21	**1781**
	29		1600	Yes	1209	499	6	0	0	0	0	20	**1734**
	30	Mon	1100	Yes*	1260	461	7	0	0	0	0	32	**1761**
	30		1400	Yes*	982	529	7	0	0	0	0	30	**1548**
	30		1600	Yes*	1209	535	5	0	0	0	0	19	**1768**
July	**10**	Sun	1100	Yes	1383	515	6	0	0	0	0	22	**1926**
	10		1400	Yes	1376	457	6	0	0	0	0	46	**1886**
	11	Mon	1100	No	1526	645	48	0	0	0	0	70	**2288**
	11		1400	No	1652	428	26	0	0	0	0	37	**2143**
	31	Sun	1130	Yes	1488	512	46	0	0	0	0	33	**2079**
	31		1430	Yes	1470	517	5	0	0	0	0	16	**2008**
August	**01**	Mon	1130	No	1434	765	52	0	0	0	0	17	**2268**
	01		1430	No	1454	631	25	0	0	0	0	10	**2121**
	14	Sun	1130	Yes	1192	587	107	0	0	0	0	7	**1893**
	14		1430	Yes	1141	506	0	0	0	0	0	7	**1654**
	15	Mon	1130	No	1288	724	59	0	0	0	0	16	**2087**
	15		1430	No	1398	757	35	0	0	0	0	25	**2216**
	27	Sat	1130	No	1441	625	23	0	0	0	0	26	**2115**
	28	Sun	1130	Yes	1321	738	24	0	0	0	0	13	**2097**
	28		1430	Yes	1354	775	52	0	0	0	0	32	**2213**
	29	Mon	1130	Yes*	1241	526	22	0	0	0	0	46	**1836**
	29		1430	Yes*	1173	814	38	0	0	0	0	20	**2045**
Mean	**All**				**1329**	**548**	**27**	**0**	**0**	**0**	**0**	**27**	**1931**
Mean			am		1369	552	38	0	0	0	0	30	**1989**
Mean			pm		1299	546	20	0	0	0	0	24	**1889**
Mean				Yes	1286	548	22	0	0	0	0	26	**1881**
Mean				No	1397	549	37	0	0	0	0	28	**2010**

*Bank Holiday Mondays

Motor = Motor Boats; Comm = Commercial Craft; Jet = Jetskis; Wind = Windsurfers; Wksi = Waterskis; Inflat = Rigid Inflatables.

Table 13: Number of Craft in Major Marinas

Survey Date and Time					Number			
Month	**Date**	**Day**	**Time**	**Busy**	**Yachts**	**Motor**	**Other#**	**All**
May	**28**	Sat	1100	No	550	553	12	**1115**
	28		1400	No	519	529	11	**1058**
	28		1600	No	463	556	11	**1030**
	29	Sun	1100	Yes	437	497	8	**942**
	29		1400	Yes	403	469	8	**880**
	29		1600	Yes	479	532	11	**1022**
	30	Mon	1100	Yes*	428	522	8	**958**
	30		1400	Yes*	408	408	8	**824**
	30		1600	Yes*	444	517	9	**970**
July	**10**	Sun	1100	Yes	656	642	14	**1312**
	10		1400	Yes	672	648	18	**1337**
	11	Mon	1100	No	625	677	13	**1315**
	11		1400	No	664	683	13	**1360**
	31	Sun	1130	Yes	686	607	15	**1308**
	31		1430	Yes	679	613	22	**1314**
August	**01**	Mon	1130	No	783	666	20	**1469**
	01		1430	No	796	663	19	**1478**
	14	Sun	1130	Yes	549	522	17	**1088**
	14		1430	Yes	492	560	17	**1069**
	15	Mon	1130	No	707	626	18	**1351**
	15		1430	No	718	688	21	**1427**
	27	Sat	1430	No	661	637	25	**1323**
	28	Sun	1130	Yes	663	579	28	**1270**
	28		1430	Yes	661	644	25	**1330**
	29	Mon	1130	Yes*	633	619	26	**1278**
	29		1430	Yes*	633	566	22	**1221**
Mean	**All**				**593**	**585**	**16**	**1194**
Mean			am		611	592	16	**1219**
Mean			pm		579	581	16	**1176**
Mean				Yes	558	559	16	**1133**
Mean				No	649	628	16	**1293**

*Bank Holiday Mondays

Other = Commercial Craft and Inflatables

The marinas photographed were Cobb's Quay and Davis's Boatyard in Holes Bay, Poole Yacht Club at Lower Hamworthy, Saltern's Marina at Lilliput, and the river Frome upstream as far as South Bridge in Wareham. Sporadic photographic estimates suggest that up to 100 additional craft are contained within a number of small marinas, which are not inlcuded in these figures. The Town Quay can accomodate an additional 100 craft.

Table 14: Number of Craft in Surveyed Section of Poole Bay

Survey Date and Time					Type of Craft								
Month	**Date**	**Day**	**Time**	**Busy**	**Yachts**	**Motor**	**Comm**	**Jet**	**Wind**	**Wski**	**Canoe**	**Inflat**	All
May	**28**	Sat	1100	No	64	24	3	0	17	0	0	6	114
	28		1400	No	89	43	4	0	17	4	0	2	159
	28		1600	No	95	31	4	0	4	4	4	6	148
	29	Sun	1100	Yes	113	46	16	8	3	4	0	6	196
	29		1400	Yes	180	150	13	11	4	8	0	17	383
	29		1600	Yes	143	229	14	2	0	11	6	13	418
	30	Mon	1100	Yes*	133	71	6	0	0	0	13	9	232
	30		1400	Yes*	200	241	16	4	28	15	5	22	531
	30		1600	Yes*	110	175	19	2	2	23	22	35	388
July	**10**	Sun	1100	Yes	165	186	25	7	0	7	0	19	409
	10		1400	Yes	185	414	15	2	11	11	0	93	731
	11	Mon	1100	No	42	62	14	2	21	0	2	5	148
	11		1400	No	70	94	13	0	19	4	0	34	234
	31	Sun	1130	Yes	131	58	14	5	0	5	3	20	236
	31		1430	Yes	73	97	13	15	0	24	0	17	239
August	**01**	Mon	1130	No	110	40	9	0	2	2	10	19	192
	01		1430	No	74	44	20	0	16	0	6	13	173
	14	Sun	1130	Yes	172	233	24	9	19	12	5	5	479
	14		1430	Yes	251	454	14	3	23	28	7	2	782
	15	Mon	1130	No	64	77	9	0	19	4	6	0	179
	15		1430	No	84	114	7	0	22	9	8	11	255
	27		1430	No	108	162	33	0	13	11	13	12	352
	28	Sun	1130	Yes	116	103	13	2	3	0	4	25	266
	28		1430	Yes	107	176	18	10	39	0	8	27	385
	29	Mon	1130	Yes*	131	95	9	0	0	4	0	9	248
	29		1430	Yes*	234	160	14	5	2	19	0	24	458
Mean	All				125	138	14	3	11	8	5	17	321
Mean			am		113	90	13	3	8	3	4	11	245
Mean			pm		134	172	14	4	13	11	5	22	376
Mean				Yes	153	181	15	5	8	11	5	21	399
Mean				No	80	69	12	0	15	4	5	11	195

*Bank Holiday Mondays

Motor = Motor Boats; Comm = Commercial Craft; Jet = Jetskis; Wind = Windsurfers; Wksi = Waterskis; Inflat = Rigid Inflatables.

Table 15: Number of Craft in Survey Area (Including Major Marinas)

Survey Date and Time					Type of Craft								
Month	**Date**	**Day**	**Time**	**Busy**	**Yachts**	**Motor**	**Comm**	**Jet**	**Wind**	**Wski**	**Canoe**	**Inflat**	All
May	**28**	Sat	1100	No	2160	865	93	0	42	4	0	43	3207
	28		1400	No	1714	982	71	4	52	11	54	48	2935
	28		1600	No	1871	983	70	0	56	4	9	54	3047
	29	Sun	1100	Yes	2162	1002	100	23	56	15	52	84	3494
	29		1400	Yes	2059	1147	85	23	77	19	2	55	3467
	29		1600	Yes	1961	1362	88	12	21	19	18	53	3534
	30	Mon	1100	Yes*	1951	1161	93	18	22	11	31	63	3350
	30		1400	Yes*	1700	1332	100	15	159	26	21	74	3427
	30		1600	Yes*	1892	1359	74	7	62	33	22	71	3520
July	**10**	Sun	1100	Yes	2367	1475	97	18	78	15	21	65	4136
	10		1400	Yes	2384	1637	82	4	107	24	4	178	4419
	11	Mon	1100	No	2265	1457	112	2	35	0	18	117	4006
	11		1400	No	2466	1296	80	5	58	6	27	99	4037
	31	Sun	1130	Yes	2398	1204	83	7	5	7	29	68	3801
	31		1430	Yes	2315	1336	93	36	39	40	0	62	3921
August	**01**	Mon	1130	No	2389	1480	85	0	43	5	17	62	4081
	01		1430	No	2389	1392	91	0	51	0	8	42	3973
	14	Sun	1130	Yes	2114	1606	140	20	64	18	47	29	4038
	14		1430	Yes	2036	1724	90	27	214	43	27	26	4187
	15	Mon	1130	No	2119	1498	85	0	34	10	24	34	3804
	15		1430	No	2289	1619	78	0	63	22	28	57	4156
	27	Sat	1430	No	2287	1552	128	0	220	26	13	69	4295
	28	Sun	1130	Yes	2229	1499	155	21	49	0	6	94	4053
	28		1430	Yes	2243	1692	89	43	393	9	12	84	4565
	29	Mon	1130	Yes*	2302	1456	87	9	40	25	8	89	4016
	29		1430	Yes*	2247	1687	83	18	132	36	11	80	4294
Mean	**All**				**2166**	**1377**	**94**	**12**	**84**	**16**	**20**	**69**	**3837**
Mean			am		2223	1337	103	11	43	10	23	68	3817
Mean			pm		2123	1407	87	13	114	21	17	70	3852
Mean				Yes	2147	1417	96	19	95	21	19	73	3889
Mean				No	2195	1312	89	1	65	9	20	62	3754

*Bank Holiday Mondays

Motor = Motor Boats; Comm = Commercial Craft; Jet = Jetskis; Wind = Windsurfers; Wksi = Waterskis; Inflat = Rigid Inflatables.

Table 16: Mean Percentage of Craft in Selected Zones*

		Type of Craft										
Zone	In/Out	Yacht	Motor	Comm	Jet	Wind	Inflat	Watski	Canoe	All Motor	Recreational	All
Survey	Total No	1573.1	791.5	93.5	12.0	83.5	53.1	16.5	19.6	966.7	2549.3	2642.8
Harbour	No. In	1448.3	653.9	79.7	8.7	72.6	35.8	8.4	14.9	786.5	2242.5	2322.3
	No. Out	124.8	137.7	13.8	3.3	10.9	17.3	8.0	4.7	180.2	306.8	320.6
Watski	% In	2.3	1.5	6.1	1.0	1.3	7.3	**43.2**	3.5	2.6	2.3	2.4
	% Out	97.7	98.5	93.9	99.0	98.7	92.7	**56.8**	96.5	97.4	97.7	97.6
Aqua	% In	3.0	1.9	4.9	12.8	0.6	**3.9**	1.1	9.3	2.4	2.7	2.7
	% Out	97.0	98.1	95.1	87.2	99.4	**96.1**	98.9	90.7	97.6	97.3	97.3
Wind	% In	5.1	4.9	0.8	3.0	**66.2**	3.6	5.2	0.5	4.4	7.0	6.8
	% Out	94.9	95.1	99.2	97.0	**33.8**	96.4	94.8	99.5	95.6	93.0	93.2
Jet	% In	2.8	1.6	3.6	**12.8**	0.8	1.8	3.0	0.0	2.0	2.4	2.4
	% Out	97.2	98.4	96.4	**87.2**	99.2	98.2	97.0	100.0	98.0	97.6	97.6
Comchan	% In	9.1	6.0	**8.6**	14.1	2.9	5.5	2.1	5.0	6.3	**7.9**	7.9
	% Out	90.9	94.0	**91.4**	85.9	97.1	94.5	97.9	95.0	93.7	**92.1**	92.1
Quiet	% In	7.8	8.4	11.8	8.6	11.2	12.9	13.9	49.0	9.0	8.4	8.6
	% Out	92.2	91.6	88.2	91.4	88.8	87.1	86.1	51.0	91.0	91.6	91.4
6 knot	% In	5.1	5.9	31.0	0.0	0.5	4.3	0.0	13.2	8.2	5.2	6.1
	% Out	94.9	94.1	69.0	100.0	99.5	95.7	100.0	86.8	91.8	94.8	93.9
Shell	% In	7.0	4.6	11.1	12.8	1.7	10.5	3.4	15.0	**5.6**	6.2	6.4
	% Out	93.0	95.4	88.9	87.2	98.3	89.5	96.6	85.0	**94.4**	93.8	93.6
Bird	% In	8.0	8.4	9.3	39.9	3.6	7.1	5.0	11.5	**8.7**	8.1	8.1
	% Out	92.0	91.6	90.7	60.1	96.4	92.9	95.0	88.5	**91.3**	91.9	91.9

* Percentages are of craft within Harbour. Recreational = All but Commercial Craft.
All Motor = Motor boats + Commercial Craft + JetSkis + Water Skis + Inflatables

Zone key:

Watski	Waterskiing
Aqua	Sub Aqua
Wind	Wind Surfing
Jet	Jet Skiing
Comchan	Commercial Channel
Quiet	Quiet Zone
6 knot	Enforceable 6 knot Speed Limit
Shell	Grids with Shellfish Beds
Bird	Grids adjacent to Bird Roosting Sites

APPENDIX 4: PHOTOGRAPHIC VALIDATION OF OBSERVER ESTIMATES

The observer counts were validated in two ways:

- by a ground survey, carried out on 14th August 1994, during which the number of craft in 12 grids were counted at the same time as the afternoon sortie was being flown;

and

- by comparing the estimates derived from observer records with the number of craft counted from oblique aerial photographs of various parts of the harbour, taken at the end of the relevant sorties.

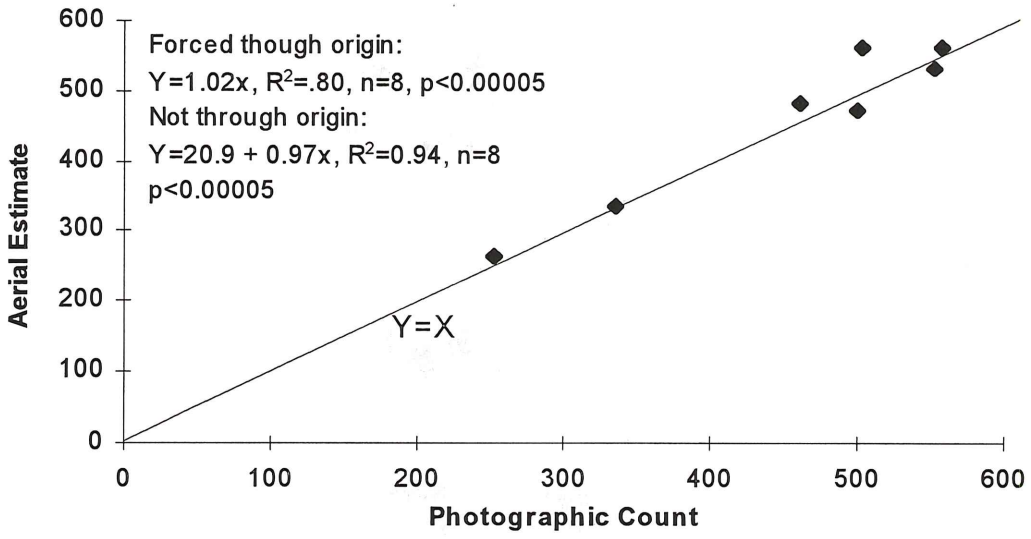
The photographs used to validate the observer counts were chosen on the basis of clarity and ease of precise location.

The results of these comparisons are shown in the following table and graph.

Table 17: Comparison of Air, Photographic and Ground Counts

Validation	Count			No. Grids Covered	Ratio Photo/Air
	Photo	Air	Ground		
Photo	557	562		13	**0.99**
Photo	253	265		5	**0.95**
Photo	500	472		5	**1.06**
Photo	336	334		5	**1.01**
Photo	504	564		9	**0.89**
Photo	552	534		9	**1.03**
Photo	461	482		5	**0.96**
Ground/Photo	327	345	303	9	**0.95**
Total	**3163**	**3213**		**60**	**0.98**

Figure 11: Comparison of Aerial and Photographic Counts



These comparisons show a close agreement between the photographic and aerial counts, which obviates the need to make any corrections to the aerial estimates. The ground count is lower than both the aerial and photographic estimates made at the on the same day. It is possible, indeed likely, that this discrepancy is caused by a minor mismatch in the precise co-ordinates of the grids used. The southern boundary of the grids surveyed on the ground coincided with a line of moored craft some 50 meters wide and over a kilometre long, which contained over a hundred craft. As both the aerial and photographic counts included approximately 40 of these boats, it may be that the three sets of estimates are more similar than it first appears.

APPENDIX 5: LIST OF COLOUR PLATES AND TRANSPARENCIES

Colour plate 1. Moored craft and Royal Yacht Club berths in North Haven Lake looking north from Sandbanks

Colour plate 2. Overview of the harbour looking north-west from off Sandbanks.

Colour plate 3. Looking north-west from Sandbanks toward Poole and Holes Bay.

Colour plate 4. The view north from Studland Heath toward Parkstone.

Colour plate 5. Brownsea Island from overhead Sandanks. Arne Bay is visible in the background, and beyond the Wareham Channel.

Colour plate 6. Looking south-west from North Haven Lake over Sandbanks toward Studland Heath.

Colour plate 7. Pergins Island in Holes Bay from the south

Colour plate 8. The rivers Piddle and Frome viewed from the south, with Ridge Wharf in the foreground

Colour plate 9. Looking north-east from Ridge across Swineham Point to the Wareham Channel.

Colour plate 10. The river Frome and its estuary looking north-west from Stoborough

Colour plate 11. The mouth of the river Frome and Swineham Point from the east.

Colour plate 12. Cobb's Quay Marina and Davis's Boatyard in Holes Bay viewed from the south-west.

Colour plate 13. Cobb's Quay Marina and Davis's Boatyard in Holes Bay viewed from the east.

Colour plate 14. Moriconium Quay, near Hamworthy, from the south-west.

Colour plate 15. Poole Yacht Club marina at Lower Hamworthy from the north.

Colour plate 16. Fisherman's Dock and Poole breakwater from the south.

Colour plate 17. Salterns marina, Lilliput, from the south-west.

Colour plate 18. Salterns marina, Lilliput, from the west.

Colour plate 19. Heavy traffic in the Harbour Entrance (between South Haven point and Sandbanks); view from the south east.

Colour plate 20. Detail of heavy traffic in the Harbour Entrance.

Colour plate 21. View of traffic crossing the chain-ferry route between South Haven point and Sandbanks, viewed from off North Haven Point.

Colour plate 22. Detail of traffic crossing the chain-ferry route, viewed from North Haven Point.

Colour plate 23. Heavy windsurfing activity in Whitley Bay.

Colour plate 24. Personal Water Craft in use between the rail causeway and Pergins Island in Holes Bay.

Colour plate 25. Personal Water Craft in use between the rail causeway and Pergins Island in Holes Bay.

Colour plate 26. Personal Water Craft tracks visible in the mud of Holes Bay after the activities shown in plates 24 & 25. Note wading birds feeding in the same site.

Colour plate 27. Bait dragging marks exposed at low water.

Colour plate 28. Disturbance of the sea bed caused by bait dragging.

Colour plate 29. Disturbance of the sea bed caused by motorised craft.

Colour plate 30. ERGO viewing frames mounted on the Cessna 172 used during the surveys. Window markings to facilitate parallax alignment are also visible.

Colour transparency 1.	Moored craft in North Haven Lake looking north from Sandbanks
Colour transparency 2.	Overview of the Harbour looking north-west from off Sandbanks.
Colour transparency 3.	The view north from Studland Heath toward Parkstone.
Colour transparency 4.	Looking north-east from Ridge across Swineham Point to the Wareham Channel.
Colour transparency 5.	The river Frome and its estuary looking north-west from Stoborough
Colour transparency 6.	The river Frome and its estuary looking north-west from Stoborough
Colour transparency 7.	The mouth of the river Frome.
Colour transparency 8.	The mouth of the river Frome and Swineham Point from the east.
Colour transparency 9.	Moriconium Quay near Hamworthy from the south-west.
Colour transparency 10.	Cobbs Quay and Davis' Boat Yard in Holes Bay viewed from the east.
Colour transparency 11.	Poole Yacht Club at Lower Hamworthy from the north.
Colour transparency 12.	Fisherman's Dock and Poole breakwater from the south.
Colour transparency 13.	Salterns marina at Lilliput from the south-west.
Colour transparency 14.	Salterns marina at Lilliput from the west.
Colour transparency 15.	View of traffic crossing the chain-ferry route between South Haven point and Sandbanks, viewed from off North Haven Point.
Colour transparency 16.	Detail of traffic crossing the chain-ferry route, viewed from North Haven Point.
Colour transparency 17.	Detail of traffic crossing the chain-ferry route at harbour entrance.
Colour transparency 18.	Traffic using recreational craft channel, off Sandbanks.
Colour transparency 19.	Heavy windsurfing activity in Whitley Bay.
Colour transparency 20.	Disturbance of the sea bed caused by bait dragging.
Colour transparency 21.	Disturbance caused by motorised vessel.
Colour transparency 22.	Cessna 172 survey plane over Sandbanks.

APPENDIX 6: DATA FILES

Survey data are provided on diskette in ***Microsoft Excel*** 2.1 format. A separate file is supplied both for each survey flight, and for the mean of all flights. For ease of storage the files are supplied in a self extracting compressed archive named **Flights.exe**.

To extract the data files using a floppy drive designated **A:**, a hard disc designated **C:**, and a data directory on the hard disk called **C:\DATA**

Make sure that there is at least 2.5 megabytes of space on the hard disc. Insert the floppy disc into the A: drive, then from prompt C:\> type:

copy a:\flights.exe c:\data*.*
cd C:\data
flights

Data are calculated numbers of craft per grid cell. Column headings in spreadsheets are the following:

EW	NS	Yachts	M'boat	W'skis	Commerc	Jetski	W'surf	Canoes	R.I.B.	Total

EW and NS are survey grid coordinates
M'boat = motorboats
W'skis = waterskis
Commerc = commercial craft
W'surf = Windsurfers.

Files for individual flights are named on a *daymonthflight* format, hence the 2nd flight (1400h) of Saturday the 27th of August is named **2782.xls**. The mean data file is named **alldates.xls**.

APPENDIX 7: NOTES

1. COLOUR MAPS.

Colour maps illustrate mean density data for a given category or categories of craft. Densities are thus based on data from the 20 individual sorties flown during the survey period. Areas marked on maps for certain craft categories correspond to the zones assigned to that craft type or activity in the consultation draft of the Aquatic Management Plan (1994). Nine separate distribution maps are provided the wallet bound at the end of this report. The tenth map, on clear acetate, shows the existing harbour zonation, which may be overlayed onto the other maps if required.

2. DATA VARIABILITY AND STANDARD ERROR CALCULATIONS

The distribution of craft in an artificial environment such as Poole Harbour is extremely patchy. Not only are zones and channels delimited which attract craft of a given purpose to certain areas, but also the location of marinas and mooring facilities lead to dense concentrations of craft.

Providing a measure of the variation in craft densities encountered during sampling is desirable, this is normally achieved by calculating population standard error values (SEs). The method of calculation of such error measures must however be carefully chosen when data are clumped, and the resulting values interpreted accordingly.

Population estimates and related standard errors can be calculated using either the Jolly Ratio Method, which uses the flight line as the sample unit, or the Marriott 4-cell Method, for which the grid cell is the sample unit. The relative advantages of each are discussed at length in Marriott and Wint (1985), and depend on the spatial integrity of the stratum selected, as well as on the distribution pattern of the population within it.

The formulae which give the population total and the variance for the Jolly SE are as follows:

Population Total: $Y = Z.R$

Population Variance: $\text{Var}(Y) = \frac{N(N - n).(s^2_y - 2.R.s_{yz} + R.s^2_z)}{n}$

Where:

Y	=	total population estimate
N	=	the potential number of sample units in the survey region
n	=	the actual number of sample units surveyed
Z	=	the area of the survey region
z	=	the area of any one sample unit
y	=	the number of crafts counted in that unit
R	=	the ratio of the craft counted to the size of the area searched

and:

s^2_y	=	the variance of animals counted between sample units
s_{yz}	=	the variance of sampled area between sample units
s^2_z	=	the covariance between counts and areas of each unit

The relevant formula for the calculation of the Marriott SE is:

$$Var(Y) = \frac{\Sigma(4y(i,j)-y(i-1,j)-y(i+1,j)-y(i,j-1)-y(i,j+1))^2}{20n^*}$$

Where:

i,j	=	co-ordinates of a grid point
y	=	number of items recorded for a given grid cell
n^*	=	number of grid points with four surrounding neighbours

The standard error (SE) is (Var(Y)/N), based on the difference between sample value (y) at point (i,j) and the average of its four neighbours, provided they all fall within the overall survey sample.

It should be emphasised that both methods are statistically conservative, and give rise to SEs which are well above the actual errors of the sampling strategies used, and which tend to increase in concert with the patchiness of the population. Moreover, although the calculated SEs may differ depending upon the method adopted and upon the underlying statistical assumptions, the size of the estimated population is *not* affected.

For a region such as Poole Harbour as a whole, the aggregations of craft found in moorings and around marinas lead to high population standard errors which merely reflect the patchiness of the data rather than the variation in counts in any given grid cell. This effect is compounded further if, as with windsurfers, few grids contain non-zero values. No tractable means exists by which the error for each individual grid cell may be visualised, as it is not possible to estimate the error inherent in a single measurement. Thus only a sample table is provided to illustrate the population variation encountered.

Table 18: Means and Standard Errors[#] of Mean Numbers of Craft

Type of Craft	All Harbour*	Mooring Grids	Sea
Yachts	1448 (10)	1194 (8)	125 (15)
Motorboats	654 (17)	565 (19)	138 (17)
Commercial	80 (13)	56 (13)	14 (12)
Jet Skis	9 (15)	7 (13)	3 (20)
Windsurfers	73 (17)	16 (9)	11 (23)
Waterskis	8 (22)	1 (19)	8 (16)
Canoes	15 (15)	9 (19)	5 (26)
Inflatables	36 (10)	22 (12)	17 (17)
Total	**2322 (11)**	**1870(10)**	**321 (15)**

[#] Standard Errors in Brackets * Excluding Marinas

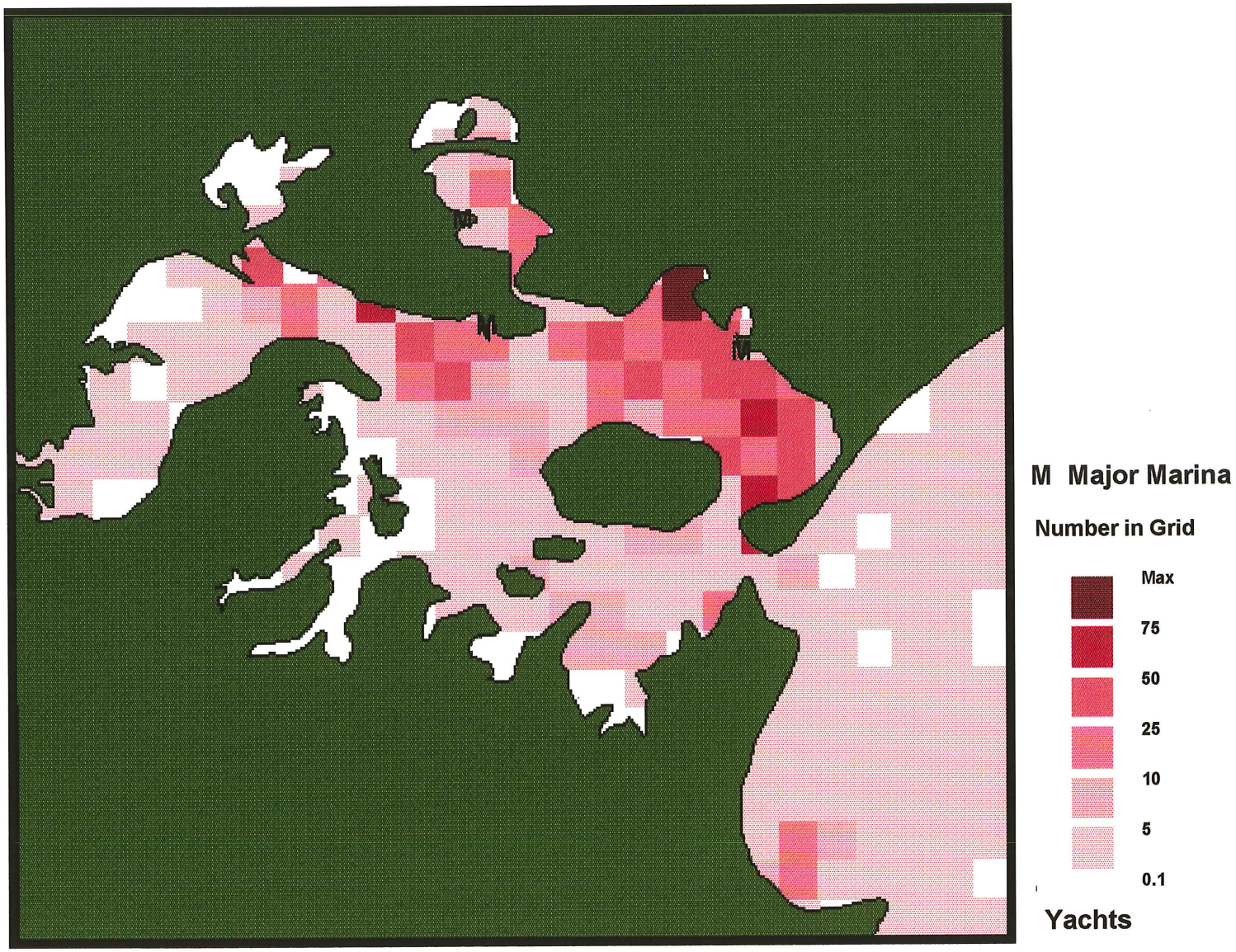
It must be stressed that the sample technique employed is highly replicable, and hence the actual errors encountered may be reduced by increasing the number of samples. Similarly, mean values for craft numbers in a given time period may be employed to calculate a more conservative error estimate independent of between-cell variation.

Poole Harbour Aerial Survey of Water Borne Craft, Summer 1994

Colour Map 1: Total Number of Craft, Mean All Surveys

Environmental Research Group, Oxford

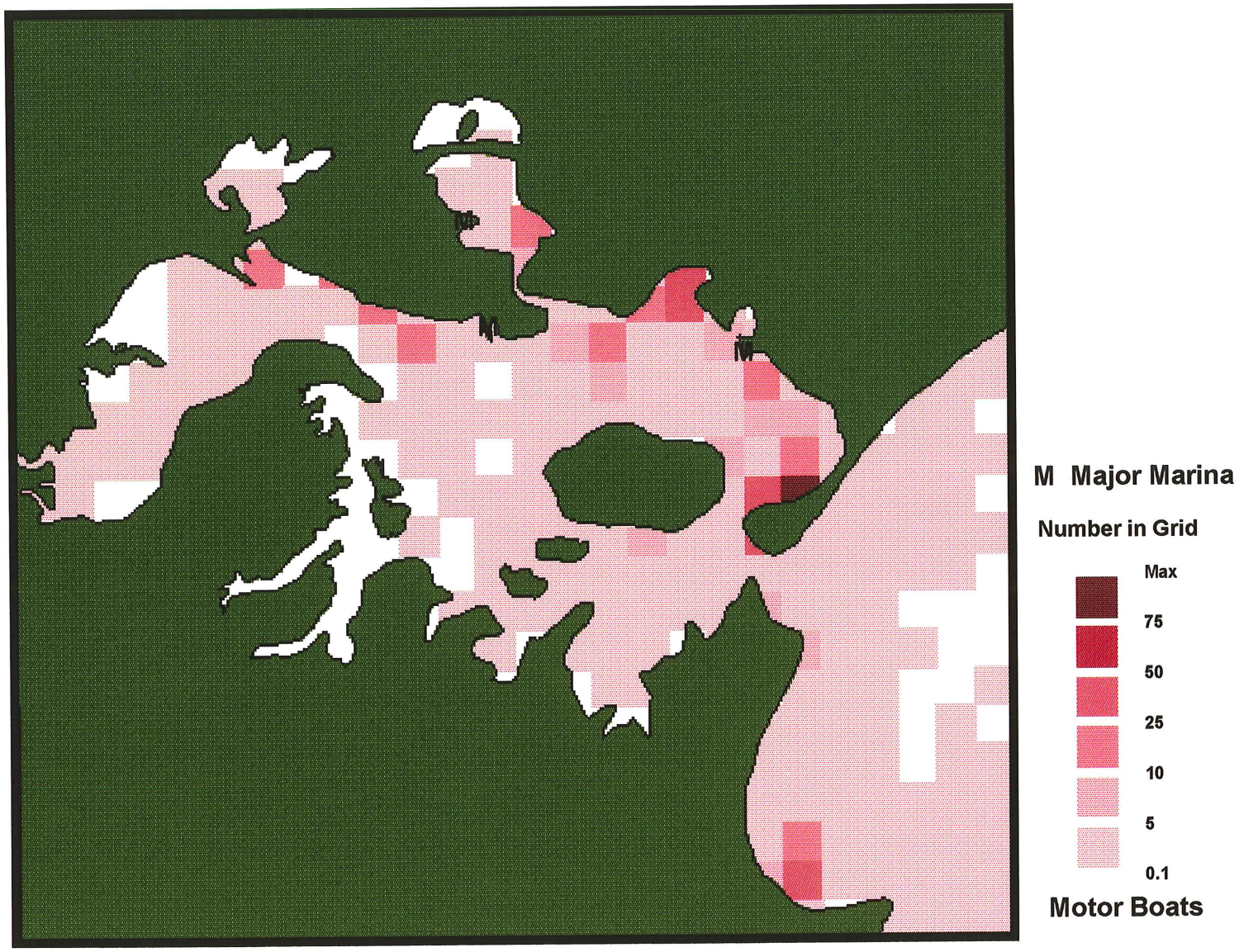
Poole Harbour Aerial Survey of Water Borne Craft, Summer 1994



Colour Map 2: Number of Yachts, Mean All Surveys

Environmental Research Group, Oxford

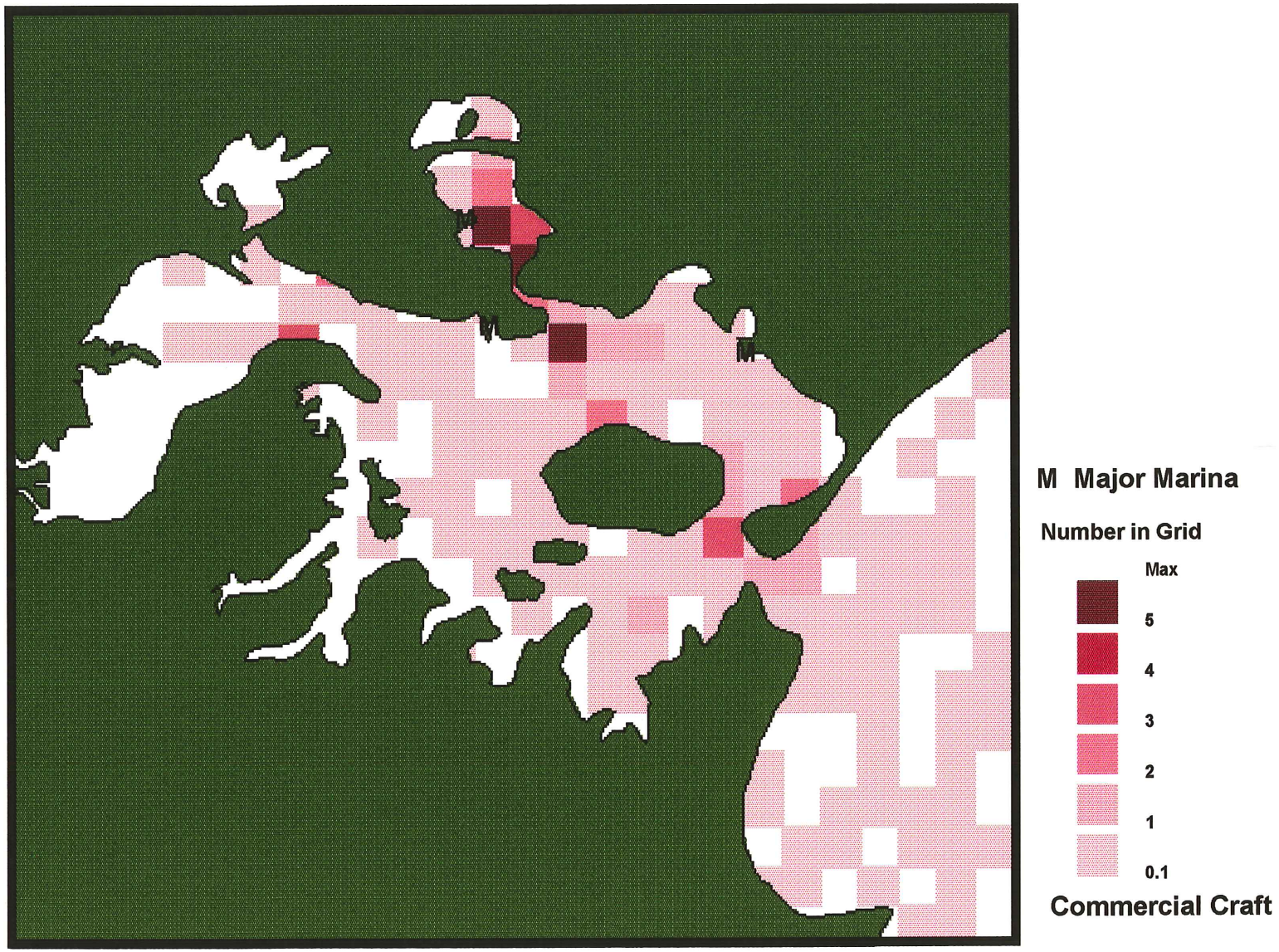
Poole Harbour Aerial Survey of Water Borne Craft, Summer 1994



Colour Map 3: Number of Motor Boats, Mean All Surveys

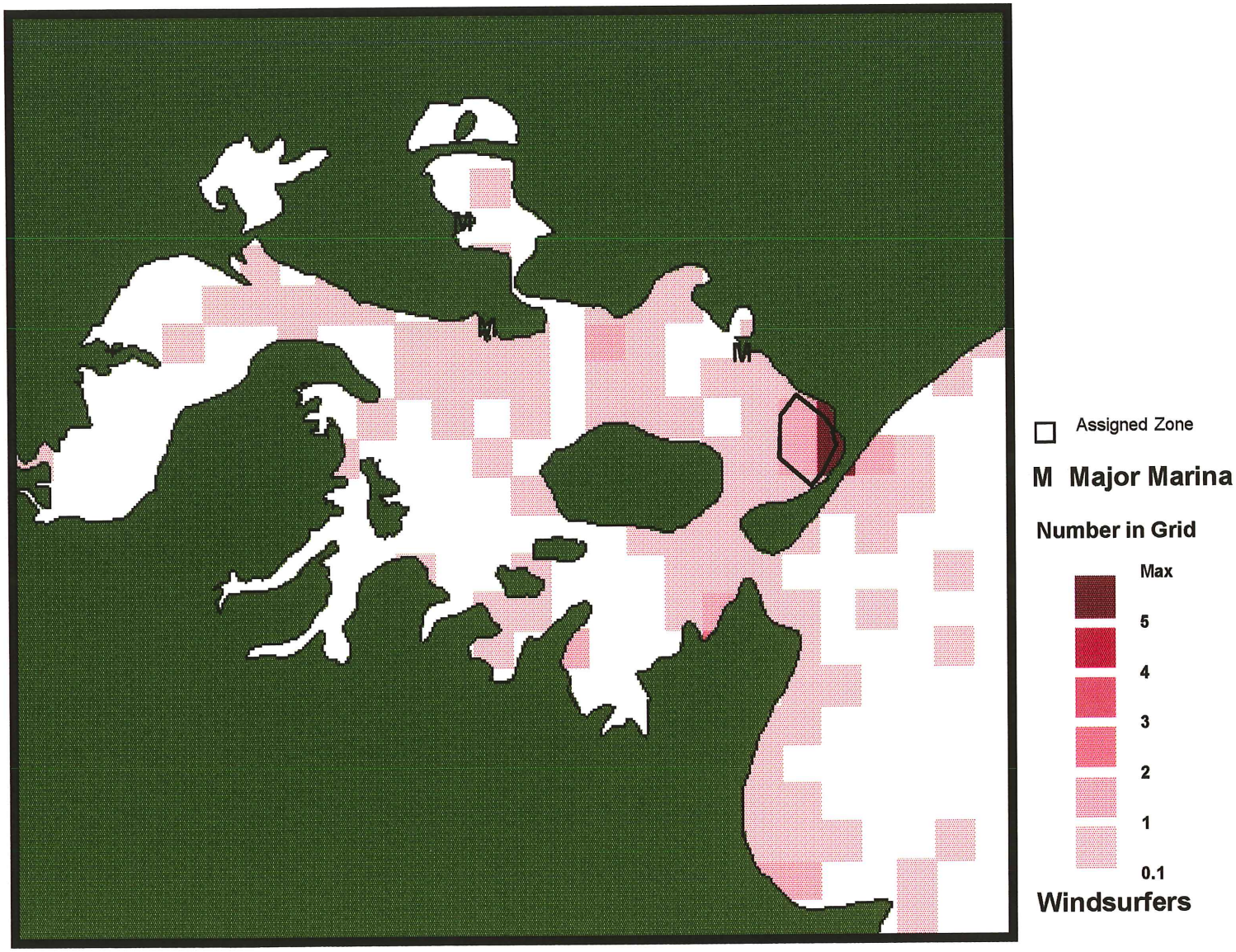
Environmental Research Group, Oxford

Poole Harbour Aerial Survey of Water Borne Craft, Summer 1994



Colour Map 4: Number of Commercial Craft, Mean All Surveys

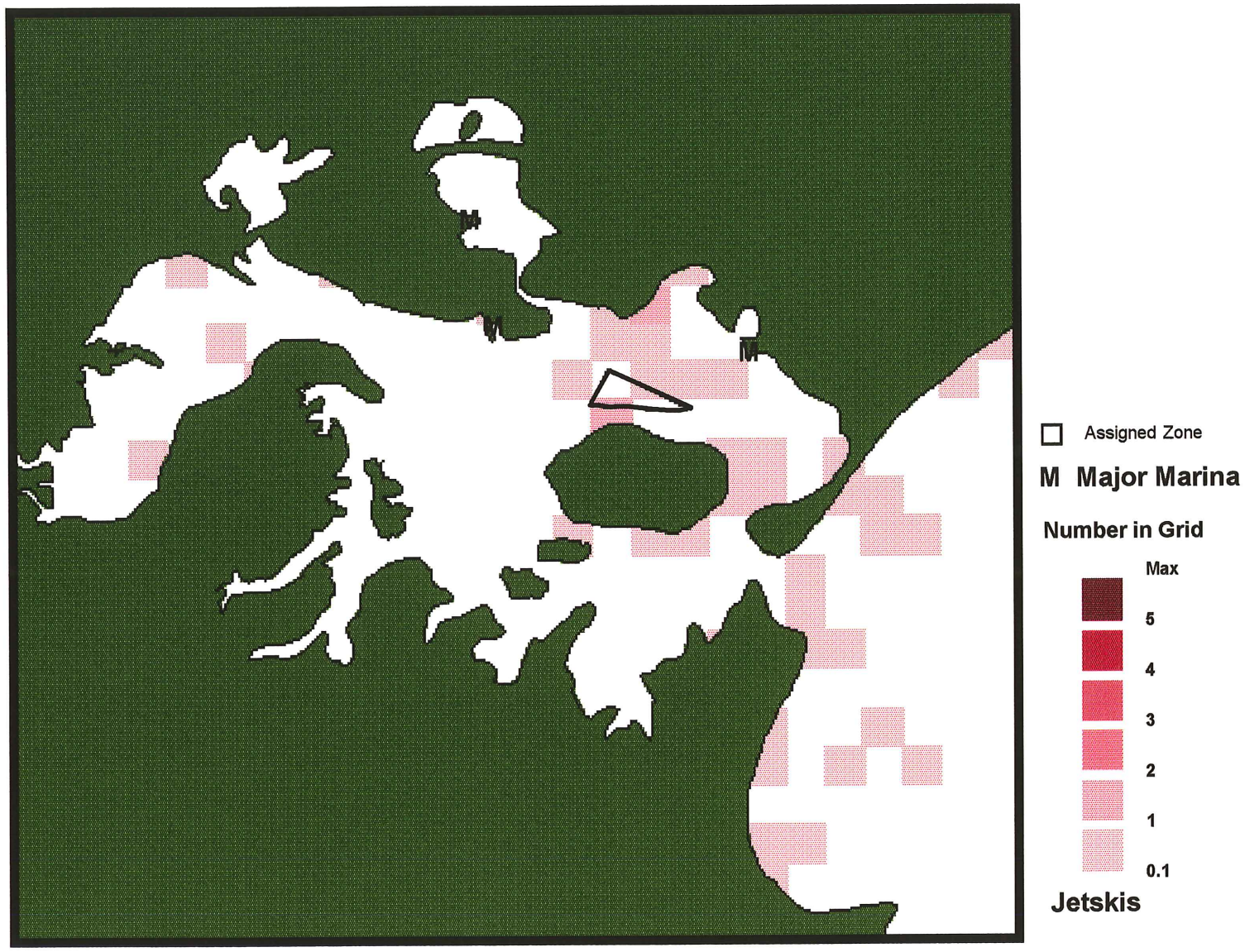
Poole Harbour Aerial Survey of Water Borne Craft, Summer 1994



Colour Map 5: Number of Windsurfers, Mean All Surveys

Environmental Research Group, Oxford

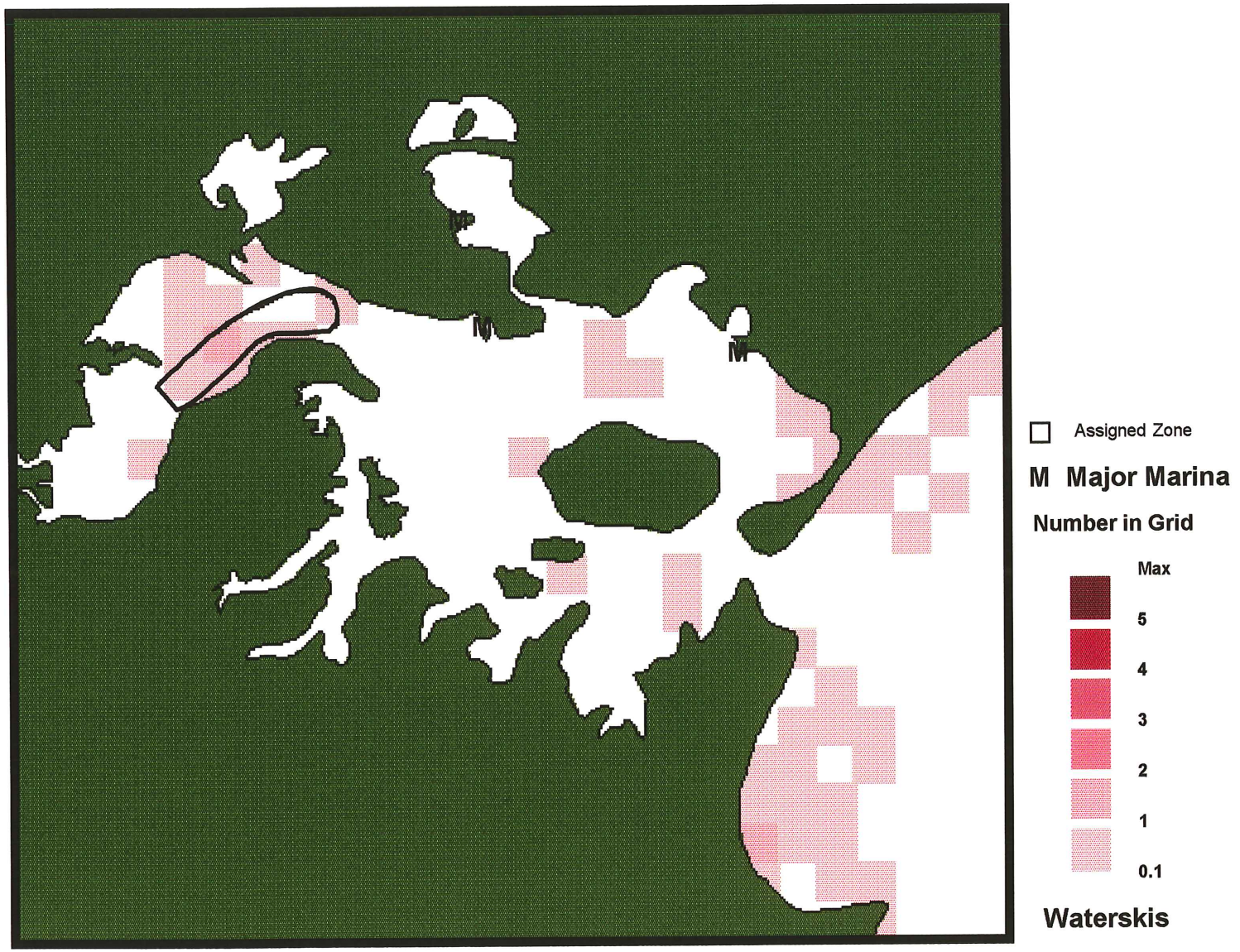
Poole Harbour Aerial Survey of Water Borne Craft, Summer 1994



Colour Map 6: Number of Jetskis, Mean All Surveys

Environmental Research Group, Oxford

Poole Harbour Aerial Survey of Water Borne Craft, Summer 1994



Colour Map 7: Number of Waterskis, Mean All Surveys

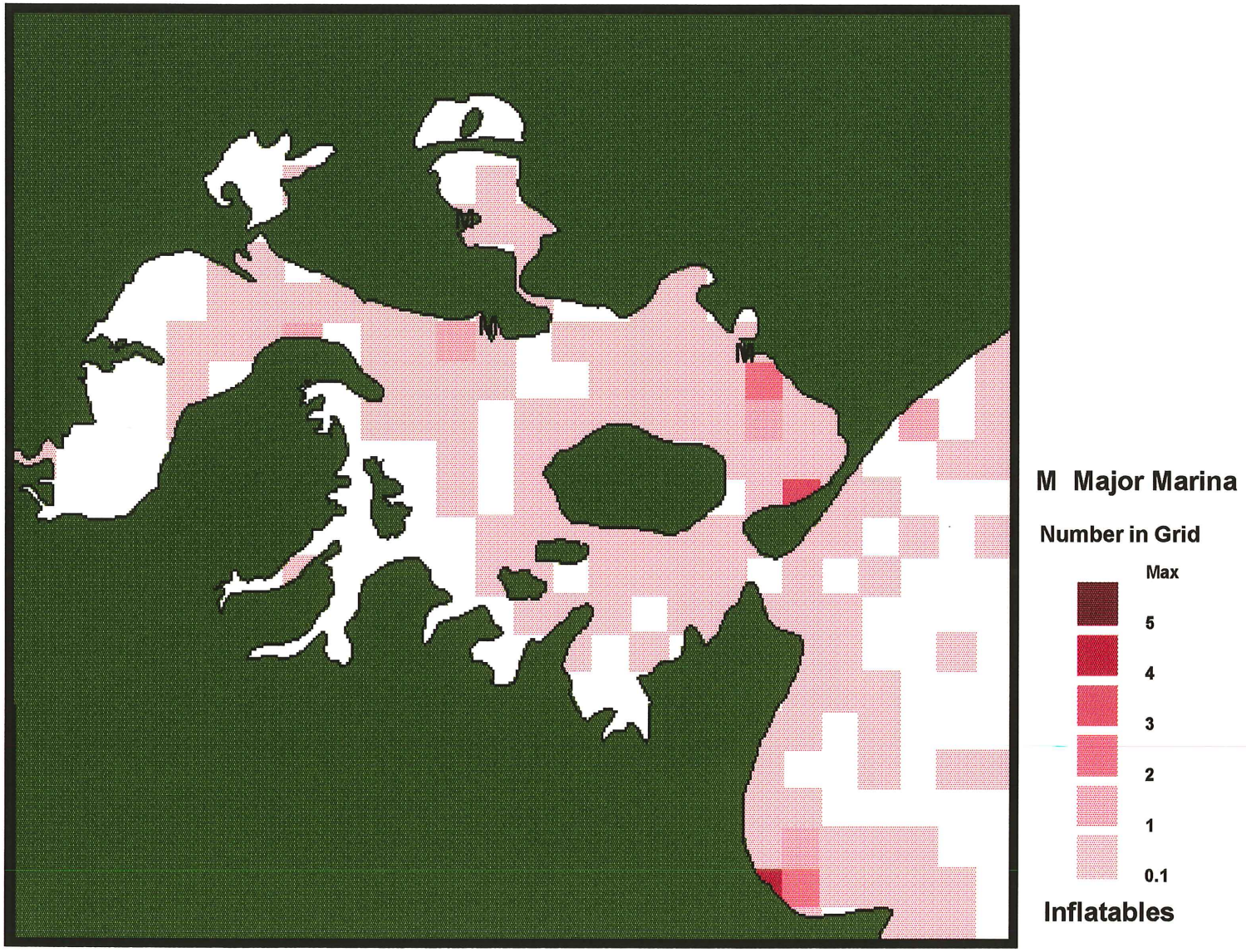
Environmental Research Group, Oxford

Poole Harbour Aerial Survey of Water Borne Craft, Summer 1994

Colour Map 8: Number of Canoes, Mean All Surveys

Environmental Research Group, Oxford

Poole Harbour Aerial Survey of Water Borne Craft, Summer 1994



Colour Map 9: Number of Rigid Inflatable Boats, Mean All Surveys

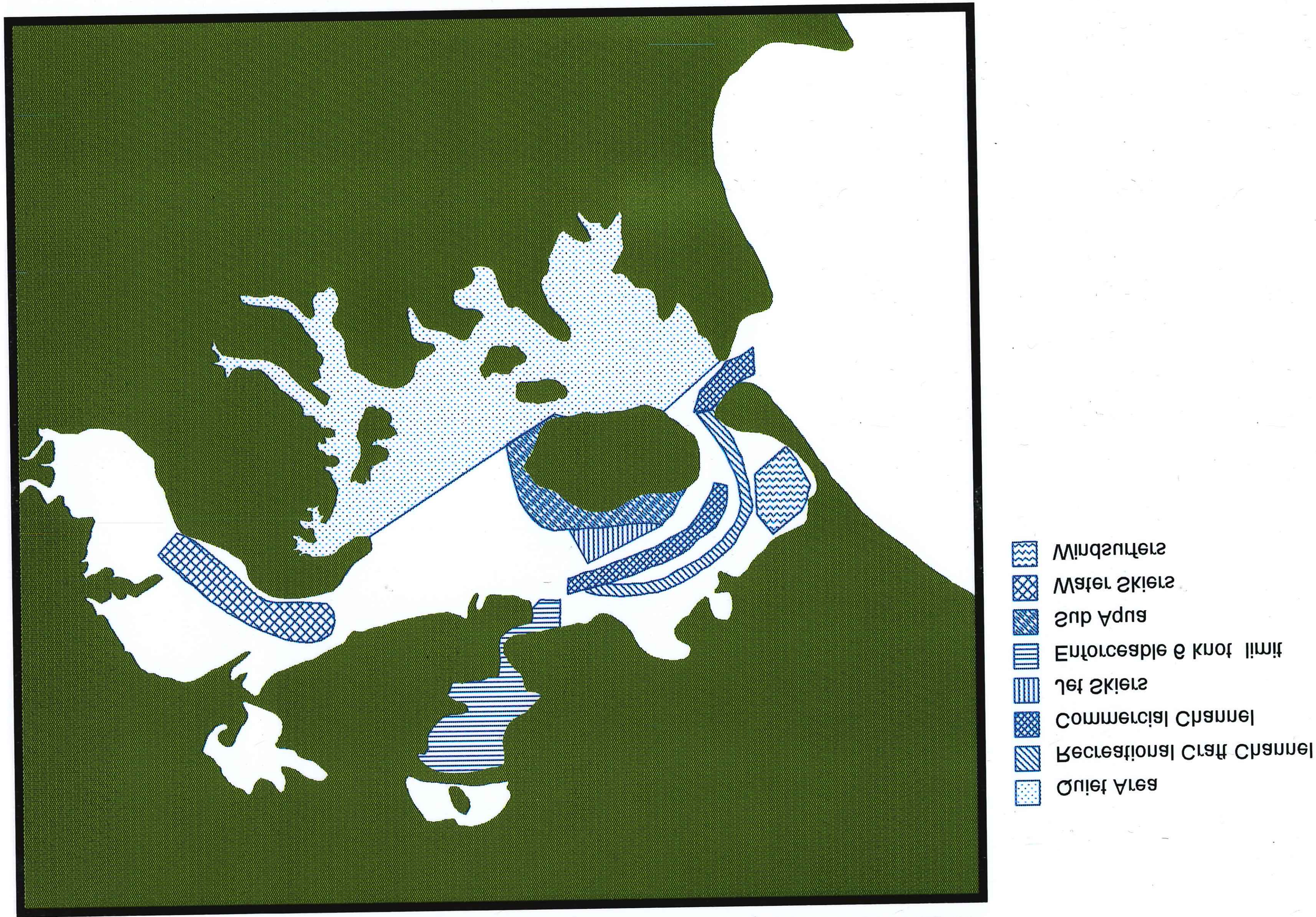
Poole Harbour Aerial Survey of Water Borne Craft, Summer 1994

Colour Map 10: Harbour Zonation

Environmental Research Group, Oxford

Colour Map 10: Harbour Zonation

Environmental Research Group, Oxford



Poole Harbour Aerial Survey of Water Borne Craft, Summer 1994