Sustainable recreation on waterways – Assessing user activity on canals and other inland waterways : a comparison of three survey methods

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Statement of Use
This project, set out to undertake the level of wildlife disturbance caused by recreational inland waterway users. Earlier work highlighted that the lack of baseline information on all user activity was a significant problem in assessing the level of disturbance. The project is intended to help all Navigation Authorities in determining proposed changes to user activities in the future and to assess current disturbance patterns to wildlife.

Keywords
Wildlife disturbance, recreational water use, survey methods

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EXECUTIVE SUMMARY

Following a previous study that the University of Liverpool undertook to investigate the level of wildlife disturbance caused by recreational inland waterway users, we highlighted that the lack of baseline information on all user activity was a significant problem in assessing the level of disturbance.

As the effective management of user activity and wildlife disturbance depends on a thorough understanding of the actual activities involved and their temporal patterns and variability, we proposed two options to counter the dearth of existing data:

1. Strategic site surveys conducted by a team of observers;
2. A remote, mobile video method that would record all activities over pre-defined time periods.

This report details the results of a study by our group during 2001, which compared two traditional observational methods (Point Sample and Walkthrough surveying) for the first of these options with the more technically advanced remote video methodology for the second.

During the first phase of the study we determined the working limits of a remote video system both in its continuous recording mode and in its mode where activity triggers the video to record via motion detectors. We then deployed the system at a number of inland, navigable waterways (low use canals, high use canals and rivers) and compared the data collected with the two observational methods.

All the methods were able to record all categories of user activity. In general, the Point Sample method was found to consistently obtain the greatest absolute number of activities, mainly those which were related to walkers. Point Sampling surveyed 100m either side of a static point, whereas the remote video surveyed in one direction with a clear picture up to 50m. The Walkthrough method covered a longer length of the waterway in one direction and was the best method for recording moored boats. Otherwise the methods all recorded comparable amounts of user activity.

The remote video demonstrated its strengths through a time-based analysis of the user activity. This showed the temporal nature of activities at a site. During multi-hour testing of 32 hours, the diurnal nature of human users from sunrise until after sunset and the nocturnal activity of domestic animals were clearly recorded.

The report discusses the results in detail and also considers the advantages and disadvantages of the methods. Finally, it recommends that future user activity surveys use a hierarchical approach to determine user activity, ie use remote video first (to characterise the activity at a site), followed by specific observer based studies to provide data on activity maxima and minima.

To obtain a realistic classification of navigable, waterway user activity we recommend:

- the application of long-term video studies to determine the initial time-based activity levels of users – with a minimum of three repeat visits per site.
- from the PIR data, identify potential sites and specific times of day where ecological bottlenecks may exist between wildlife and users.
- Deployment of observer survey teams to quantify the maximum and minimum activity of each user group at these sites and times of day – minimum of three repeat visits.

In addition, to achieve the overall aim of assessing the effects of user activity on wildlife disturbance we also recommend:

- Determination of the diversity and abundance of waterfowl and hedgerow birds (and other wildlife) at the sites and times highlighted by the user activity study.
- Comparison of wildlife diversity and abundance with user activity at sites with different activity levels to measure any relationship that exists between them.
- Application of the methodology used during the 1999/2000 project to directly measure wildlife activity and disturbance at the study sites.
- A GIS assessment of the availability of alternative habitat at the study sites.
- A predator activity survey at the study sites.

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1. INTRODUCTION

The inland navigation waterways of mainland Britain are primarily managed for multi-user recreational activities and wildlife conservation. A predicted consequence of user activity is disturbance to the wildlife, particularly the birds and mammals which inhabit these waterways. The nature, intensity, frequency and duration of any given disturbance will be the major factors involved in any disturbance. In addition, the time of day that activity occurs will be important when considering the core activity periods of the wildlife. For example, if user activity coincides with the core period of feeding activity of most aquatic birds (sunrise and sunset) then the disturbance effect may be greater than at other times of the day, owing to lower food intake rates, as demonstrated by Burger & Gochfeld (1998). This is may have implications for the allocation of energy to breeding or long term survival of the birds.

Angler activity, particularly during the early hours or over long periods during the day, has been identified as a potential threat to wildlife on the waterways. The angler issue became prominent when the Closed Season was abandoned on rivers and canals on the grounds that there was no evidence to support its continuation as a protection for fish species during their breeding season. With its cessation, the question of whether other wildlife would be affected was raised. Subsequently, it was conceded that not only could wildlife be disturbed by anglers, but also by the other users of the waterways. No information was available, however, on which to make informed management decisions regarding user disturbance of wildlife.

Therefore, during the summer of 1999-2000 we undertook a study (Gill, 1999) to assess the level of wildlife disturbance caused by recreational inland waterway users funded by British Waterways (BW), the Environment Agency (EA) and the Inland Waterway Association (IWA). Following this study, we highlighted that the lack of baseline information on all user activity was a significant problem in assessing the level of wildlife disturbance. To address this limitation we identified the need for a reliable and consistent method of collecting data on all activity along inland waterways. This activity is mainly human-related (eg. boating, angling, dog walking, jogging etc.) but can also include wildlife (eg. bird nesting, mammal movements etc.).

Current methods for determining activity levels rely on data from angler licences, voluntary person to person or postal surveys, boat counters and people counters. All of these methods provide specific information, but often this is limited, collected over poorly defined time scales and on a sub-set of waterway users.

As the effective management of user activity and wildlife disturbance depends on a thorough understanding of the actual activities involved and their temporal patterns and variability, we proposed two options to counter the dearth of existing data:

1. Strategic site surveys conducted by a team of observers;
2. A remote, mobile video method that would record all activities over pre-defined time periods.

This report, therefore, details the results of a study by our group during 2001, which compared two traditional observational methods (Point Sample and Walkthrough surveying) for the first of these options with the more technically advanced remote video methodology for the second.

The aims of the study were:

- to compare the three different methods used to collect the data, with particular reference to the advantages and disadvantages of each
- to develop guidance on the selection of the best method to determine the nature, level and timing of user movements along canals and navigable rivers over the range of circumstances encountered in waterway management.

2. METHODOLOGY

2.1 Phase 1 - Testing Remote Video Equipment

The remote video system was custom built by Tracksys Ltd, Nottingham. The system consisted of a 12v VHS video recorder, LED monitor, Video Integrated Time Code (VITC) generator, a time and battery management system, 12v batteries with chargers, an infrared sensitive camera, passive infra-red (PIR) motion detectors and infrared LED arrays. All of the equipment was housed in a secure and watertight casing with waterproof cables and connectors. The system generated real time video footage both during daylight hours and also at night using its infrared capabilities. The VITC generator ensured that when the video was downloaded into the computer software (Noldus Observer Video-Pro 4.0) for coding of user activity categories, the actual time of day was automatically registered for each occurrence.

Prior to the deployment of the equipment at the project field sites, we tested its working capabilities on the University precinct over the first month of the project. We simulated the types of users and their speed of movement to determine the clarity of the video footage and the placement of the PIR units (motion detectors).

Video footage of people walking at known distances from the camera allowed us to determine that the maximum range that would guarantee clarity of the image was approximately 50m.

We tested the sensitivity of the PIR units by using people walking or cycling past at known distances, and rolling small objects past each unit to simulate small mammals. Owing to an 11 second time lag between detection taking place and video footage being recorded it was important to determine where to place the PIR units in relation to camera view. Placement of PIR units also needed to provide video footage of all user activities from slow walkers (approx. 3mph) to cyclists (assumed maximum 14mph). In order to capture on video all canal users travelling at a variety of speeds we found that a PIR unit should be placed at 15-20 metres behind the camera and another at up to 55 metres in front of the camera.

We also tested the sensitivity of the PIR units during variable weather conditions. During blustery weather and changeable sunny to overcast conditions the PIR units sometimes detected motion without the presence of an animate trigger. This was caused by changes in air/ground temperature or brisk movement of vegetation within range of the units. We therefore had to adjust the sensitivity of the PIR units according to the manufacturers instructions.

Once all the settings had been determined we then took the equipment to sites along the Leeds-Liverpool canal to see the type of image recorded and the on site constraints that exist when using this equipment on the banks of a waterway.

We found that owing to the weight of the system in its casing the sites needed to be near to a road access point for ease of transfer of the equipment from a vehicle to the waterway site. On site, the height of the vegetation (mainly grasses) along the waterway edge was a potential problem as it could obscure the camera view and also trigger the PIR units. Therefore, the camera and the PIR units had to be positioned above the vegetation at approximately waist height. Also, to ensure that all user activity was in view of the camera we positioned it on the side of the path furthest from the waters edge. Figures 1 and 2 provide examples of the clarity and field of view recorded by the remote video system.

Figure1. Example of different user activity recorded by the remote video equipment at an urban site – 1 walker, 2 dogs, 1 boat.

Figure 2. Typical video image showing boating activity at a rural site

2.2 Phase 2 - Field data collection

For the comparative methodology phase of the project we employed three casual research workers who, working under the direction of the project Research Assistant (RA), made up a team of four personnel for a period of 10 weeks from mid July to mid September 2001. These personnel were graduate biologists recruited and trained by the same process as during the 1999/2000 project (Gill, 1999).

2.2.1 Data recording sheets

Following the initial training week, we visited canal sites near to Liverpool to assess the applicability of the 1999/2000 data recording sheet (Gill, 1999) to the new project. As we needed to record the number of occurrences of every activity during a time period, we redesigned the data sheet to include other distinct categories and to provide an easier method of recording each occurrence (Table 1, Appendix 1).

The first page of the data sheet basically described the site following the classification system used in the 1999/2000 project (Gill, 1999). This page provided the details that needed to be incorporated into the project database to ensure that the data could be sorted and accessed following an easy and unambiguous labelling system. We also recorded the type of weather during each survey period. One of these sheets was completed for every sampling period at every site.

Across the top of the second page is shown all of the main categories of user activity that were encountered. These are separated into three main groups following previous BW categorisation of user activity (Gill, 1999). Down the left hand side are numerals that were circled in sequence according to the user activity encountered. For example, if three groups of walkers were observed then 1, 2 and 3 would be circled in the walkers section of the disturbance column and in each box in the group size column the actual number of people in each of the groups would be recorded. If a group also stopped to feed the birds a tick would be entered into the 'Feeding Birds' column.

The definitions used to classify each of the user activities are shown in Table 2. It should be noted that dogs were seen with walkers, joggers or cyclists and this was noted on the data sheets.

Table 2. Categories used to define all user activity observed at a site. The occurrence of some pre-defined activities was recorded as well as the number of users.

Category	Definition
All Bank Users	
group size	number of people per disturbance/activity
sitting/standing	if people were stationary for any length of time
dog on lead	number of dogs on lead
dog off lead	number of dogs off the lead
dog swimming	if dogs swam in the waterway
feeding birds	if people fed waterfowl
with pram/cycle	if people were pushing wheeled objects
kids playing	if people included children playing noisily or running around
walking	if people were just walking
Anglers	
no. of rods	number of fishing rods
setting up/down	angler setting fishing tackle up or taking it down
landing (fish)	angler catching fish and landing it on bankside
Boats	
Moored	number of boats moored along the waterway
Moving	number of boats moving along the waterway
No. people on deck	number of people on deck as the boat passed the observer
dog on deck	number of dogs on deck as the boat passed the observer
canoes/unpowered	number of unpowered boats on waterway

2.2.2 Site Choice

Sites were selected according to their currently perceived level of activity based on experience and previous surveys by BW, EA and University of Liverpool representatives. The sites were chosen to represent low and high activity canal sites and navigable river sites (Table 3). Easy access for the survey team and equipment were also important considerations.

Following the categorisation of site by user activity, we placed greater emphasis on fulfilling the scientific requirements of experimental design and replication to take account of the variability within the data collected from each site. This meant that at least three repeat visits to a minimum of three sites within each of the representative classes of waterway were required for appropriate statistical analyses of the results. The survey team visited each of the 11 sites shown in Table 3 on three occasions at the same time of the morning and three occasions at the same time of the afternoon.

2.2.3 Field site methodology

When on site the survey team set up the remote video system and then worked in pairs collecting data, utilising the two different observational methods to survey user activity according to the following specifications:

2.2.3.1 Point Sample

The first observer method we tested was Point Sampling where a pair of observers remained stationary for a fixed period of time and recorded the type and frequency of user activity according to the categories on the data sheets (Tables 1 & 2).

User activity was only recorded if seen within 100m to either side of the observer and within 5m of the bank of the waterway. Observers were positioned next to the camera during all sample periods. Point Sample surveys took place at all sites (Table 3).

2.2.3.2 Walkthrough

The second observer surveying method that we tested with the other pair of researchers was the standard Walkthrough method. This method allows either a specific distance or a set time period to be covered. Walkthrough surveys were conducted at all but three of the sites shown in Table 3.

User activity was only recorded in the direction of walking if the observer walked past and became parallel with the activity. Observers began each Walkthrough at the camera position and walked in the direction that was out of view of the camera to ensure that they did not trigger the system adding to the data set. If the site circumstances meant that the Walkthrough was in the field of view of the camera the data set was adjusted to remove the two observers. Disturbance type and numbers of people per disturbance were recorded on the same data sheets as for the Point Sample technique (Table 1). The Walkthrough observers returned to the starting point by the camera at the end of each survey period.

2.2.3.3 Remote video System

The video system was deployed at all sites as shown in Table 3, and was set up to record either

a) continuously over a set time period or
b) only when PIR units were triggered.

Table 3. Sites visited during project. He surveys methodologies were conducted at one site in the morning and one afternoon. Point Sample, Walkthough and Continuous Video surveys took place at the same time in the morning and Point Sample, Walkthrough and PIRVideo at the same time in the afternoon.

	SITE	Canal/River	Grid Reference	Number of visits		Methodology used			
				am	pm	Point sample	Walkthrough	Continuous video	PIR video
	Low use canals								
1	Rufford	Leeds & Liverpool	SD 463 164	3	3	✓	×	✓	✓
2	Dobson's Bridge	Llangollen	SJ 493 342	3	3	✓	✓	✓	✓
3	Frankton	Montgomery	SJ 350 275	3	3	✓	✓	✓	✓
4	Salwick	Lancaster	SD 490 316	3	3	✓	✓	✓	✓
	High use canals								
5	Chester	Shropshire Union	SJ 413 667	3	3	✓	×	✓	✓
6	Froncysyllte	Llangollen Canal	SJ 274 413	3	3	✓	×	✓	✓
7	Marston	Trent & Mersey	SJ 659 758	3	3	✓	✓	✓	✓
8	Middlewich	Shropshire Union	SJ 679 648	3	3	✓	✓	✓	✓
	Navigable rivers								
9	Little Leigh	River Weaver	SJ 599 762	3	3	✓	✓	✓	✓
10	Long Eaton	River Trent	SK 492 311	3	3	✓	✓	✓	✓
11	Newark	River Trent	SK 797 542	3	3	✓	✓	✓	✓

For continuous recording we set the timer on the video recorder (and time management system) to record for the same set period as the observer surveys. For PIR recording we set the video to record for the required period, but power was only supplied to the camera and video recorder for approximately 15-25 seconds whenever the PIR units were triggered. This allowed battery reserves and videotape to be conserved when the waterway and towpath were quiet. Any category of user was able to trigger the system more than once if they remained within the 50m range of the PIR units, hence prolonging the length of the video footage.

The system was built to work remotely in different locations. In its current format we could obtain clear footage up to 50m in one direction for periods of up to 30-40 hours before the batteries needed replacing. This relatively long sample period was achieved when the PIR units were used to trigger the video recorder.

2.2.3.4 Project sample timing

Both of the observer methods were used in the morning and the afternoon surveys. Whereas, the Continuous Video was used in the morning and the PIR Video in the afternoon.

Following our arrival at a site (am: between 10:00 and 11:00h GMT; pm: around 13:30h), we set the camera up to record continuously for a one hour session at High Use Canals and two of the River sites (Long Eaton & Newark). At the Low Use Canals and L. Leigh River site a session lasted for two hours to increase the probability of recording user activity. Point Sample and Walkthrough data were collected during the 1st and 3rd quarter period of each session to allow the Walkthrough observers to return to the start by the camera for each sample period. This process was repeated in the afternoon but using the PIR motion detectors instead of continuous recording. Each method used at the river sites was over one sample period rather than two owing to the time available for the study and the distance the team had to cover between the sites.

A single sample period, therefore, lasted for 15 minutes at High Use Canals and the two River sites. At the Low Use Canals and the Little Leigh River site the sample period was 30 minutes. For the Walkthrough survey the observers moved along the canal towpath or riverside in a single direction for either 15 minutes or 30 minutes, depending on the site classification, covering a distance of approximately 230m and 460m respectively before returning to the start.

2.3 Data Handling

The data were transferred from the data sheets onto the Microsoft Access database specifically designed by the RA for the project. These data were then easily transferred into Microsoft Excel and SPSS (v10.07) statistical software for manipulation and descriptive analyses. The database was designed to allow input of all data collected by the observers, using the categories and field entry details shown in Appendix 2.

All the video footage collected was continually analysed by the RA using the existing computer facilities purchased through the 1999/2000 project and the Noldus Observer Video-Pro 4.0 software licensed to Andrew Gill at The University of Liverpool. The software codes used to analyse the user activity categories recorded by the video system are shown in Appendix 3.

2.4 Statistical tests

Owing to the small amount of data available at some sites we used mainly non-parametric analyses as they are free from the assumptions of parametric statistics which require transformation of data which is not normally distributed (Zar, 1999).

The data from the different methods were recorded during the same time periods and at the same sites. Therefore, we were able to pair the datasets and compare them using either the Wilcoxon Paired Signed Ranks test or the parametric paired t-tests on arcsine transformed proportions to normalise the data. Therefore, only data recorded during the same sample period were compared in the statistical analysis.

Any user activity category which had less than five records were omitted from all the statistical tests to meet the requirements of the standard statistical analyses (Zar, 1999).

3. PROJECT ANALYSES

3.1 Weather

We recorded information on the weather at each site, as this was a likely influence on the level and types of user activity. In the context of this project the weather was also important, as it may have influenced the motivation of observers conducting a survey. Table 4, however, shows that the weather was mainly dry for the period of the surveying.

Table 4. The type of weather recorded during each sample period at all sites morning and afternoon.

Weather	No. sample periods	% occurrence
Warm & sunny	161	39.5
Cold & sunny	11	3.0
Mainly overcast	168	41.0
Cold & wet	46	11.0
Heavy rain	22	5.5

3.2 Observer bias

As we used two observers together for both the Point Sample and Walkthrough methods we were able to assess the observer variability within each method. Hence, we compared the data collected by each observer using the same survey method to determine whether there was any consistent difference in their user activity records.

3.2.1 Point Sample

There was a small percentage difference between observers using the Point Sample method: **Low Use Canals** = 9%; **High Use Canals** = 3%; **Rivers** = 3%

This difference was statistically non-significant for all three classes of site surveyed (Table 5).

Table 5. Wilcoxon Signed Ranks test for differences between observers using the Point Sample method.

Statistic	Low Use Canals	High Use Canals	Rivers
Wilcoxon Z	-1.098	-1.342	-1.000
Number of comparisons (N)	86	63	32
Probability (p)	0.272	0.180	0.317

3.2.2 Walkthrough

There was a small percentage difference between observers using the Walkthrough method: **Low Use Canals** = 6%; **High Use Canals** = 8%; **Rivers** = 0%

This difference was statistically non-significant for all three classes of site surveyed (Table 6).

Table 6. Wilcoxon Signed Ranks test for differences between observers using the walk through method.

Statistic	Low Use Canals	High Use Canals	Rivers
Wilcoxon Z	-0.106	-0.213	-1.000
Number of comparisons (N)	95	72	32
Probability (p)	0.916	0.832	1.000

3.3 Comparison of survey methods

The first aim of the project was to compare the data collection abilities of all the survey methods. The two observer based methods were expected to yield different results as the Walkthrough covered a long length of waterway, whereas the Point Sample method surveyed one place, waiting for users to come into the predefined 100m visual zone. A comparison between these two methods was undertaken to determine the difference in the types and numbers of users encountered.

As previously noted, the Point Sample and Walkthrough surveys took place in the morning and afternoon whereas the video system was set for continuous operation only in the morning (between 10:00 and 11:00h) and PIR unit triggering only in the afternoon (approx. 13:30h).

3.3.1 Overall comparison

Tables 7a-c show the mean number and the standard deviation (±S.D.) of each pre-defined user activity category recorded per hour at each type of site for the three methods applied in the morning and the afternoon. The activity levels at all sites were comparable between each of the survey methods but quite varied as shown by the S.D. values in Tables 7a-c.

Each method recorded some level of activity in all of the pre-defined user activity categories, demonstrating that all the methods were capable of recording the data required (Table 7a-c).

Pairwise comparisons of all the data demonstrated that the only significant difference was between the Point Sample technique and the Continuous Video in the mornings (Table 8).

Table 7a. Mean number per hour of each user category at Low Use Canal sites recorded with the three survey methods applied during morning and afternoon sampling periods. An estimate of the variability in the numbers recorded in each category is shown by the standard deviation (±S.D.) of the mean.

Morning Low Use Canal	Continuous Video Mean (n=48)	S.D.	Point Sample Mean (n=52)	S.D.	Walkthrough Mean (n=30)	S.D.
Total Walkers	1.3	2.3	1.7	2.6	1.7	1.8
Lone Walkers	0.3	0.7	0.4	1.1	0.6	1.2
Groups of Walkers	0.4	0.8	0.6	1.2	0.5	0.9
Anglers	0.0	0.3	0.2	0.6	0.0	0.0
Moored Boats	0.0	0.0	0.3	0.9	2.1	1.9
Moving Boats	1.4	2.2	1.8	2.7	1.7	3.6
Dog on lead	0.1	0.5	0.3	0.8	0.3	0.7
Dog off lead	0.1	0.5	0.2	1.2	0.5	1.1
Joggers	0.3	1.2	0.4	1.4	0.1	0.7
Cyclists	0.3	1.0	0.6	1.3	0.9	1.5
Other (No. of people)	0.0	0.3	0.2	0.8	0.0	0.0

Afternoon Low Use Canal	PIR Video Mean (n=48)	S.D.	Point Sample Mean (n=54)	S.D.	Walkthrough Mean (n=28)	S.D.
Total Walkers	2.3	4.3	4.9	8.1	2.1	3.4
Lone Walkers	0.9	1.9	1.1	2.1	1.7	3.2
Groups of Walkers	0.8	1.8	1.8	2.8	0.3	1.0
Anglers	0.3	1.0	0.4	1.7	0.6	1.4
Moored Boats	0.3	1.0	0.6	1.4	4.0	3.6
Moving Boats	0.8	2.3	0.9	1.8	0.6	1.4
Dog on lead	0.5	2.1	0.5	1.9	0.4	2.3
Dog off lead	0.4	1.5	0.8	2.0	1.0	2.6
Joggers	0.0	0.0	0.0	0.0	0.0	0.0
Cyclists	0.1	0.6	0.1	0.8	0.6	1.4
Other (No. of people)	0.1	0.6	0.4	1.7	0.0	0.0

Table 7b. Mean number per hour of each user category at High Use Canal sites recorded with the three survey methods applied during morning and afternoon sampling periods. An estimate of the variability in the numbers recorded in each category is shown by the standard deviation (±S.D.) of the mean.

Morning High Use Canal	Continuous Video		Point Sample		Walkthrough	
	Mean (n=48)	S.D.	Mean (n=55)	S.D.	Mean (n=22)	S.D.
Total Walkers	27.6	44.9	35.0	53.0	3.3	8.2
Lone Walkers	13.1	22.6	11.0	19.9	0.9	1.7
Groups of Walkers	7.1	12.2	9.5	15.6	0.4	1.2
Anglers	0.0	0.0	0.7	1.5	0.0	0.0
Moored Boats	0.6	1.4	6.9	9.6	0.7	1.6
Moving Boats	6.8	7.0	7.6	5.0	8.7	5.2
Dog on lead	0.4	1.2	0.7	2.2	0.2	0.9
Dog off lead	0.5	1.6	2.0	4.3	1.3	2.6
Joggers	0.2	0.8	0.3	1.0	0.0	0.0
Cyclists	2.7	5.4	3.1	6.8	0.0	0.0
Other (No. of people)	0.1	0.6	0.4	1.2	0.0	0.0

Afternoon High Use Canal	PIR Video		Point Sample		Walkthrough	
	Mean (n=48)	S.D.	Mean (n=58)	S.D.	Mean (n=20)	S.D.
Total Walkers	35.3	54.3	39.7	66.7	2.2	2.7
Lone Walkers	17.7	31.4	19.2	35.2	1.2	1.9
Groups of Walkers	6.7	11.0	9.3	15.3	0.4	1.2
Anglers	0.1	0.6	6.8	9.0	0.2	0.9
Moored Boats	0.4	1.2	1.9	3.0	0.0	0.0
Moving Boats	4.1	3.7	7.7	8.9	7.2	3.6
Dog on lead	0.5	1.3	1.0	2.4	0.2	0.9
Dog off lead	0.7	1.7	1.5	3.4	0.8	2.1
Joggers	0.0	0.0	0.3	1.1	0.0	0.0
Cyclists	1.4	3.2	1.2	3.3	0.2	0.9
Other (No. of people)	0.0	0.0	0.1	0.6	0.0	0.0

Table 7c. Mean number per hour of each user category at River sites recorded with the three survey methods applied during morning and afternoon sampling periods. An estimate of the variability in the numbers recorded in each category is shown by the standard deviation (±S.D.) of the mean.

Morning River	Continuous Video Mean (n=24)	S.D.	Point Sample Mean (n=22)	S.D.	Walkthrough Mean (n=22)	S.D.
Total Walkers	7.9	9.1	11.9	15.1	9.0	15.9
Lone Walkers	2.9	4.3	3.6	3.6	2.5	2.7
Groups of Walkers	2.3	2.8	3.6	6.0	3.1	6.4
Anglers	0.0	0.0	0.3	0.7	0.0	0.0
Moored Boats	1.6	1.8	3.8	4.3	3.1	3.9
Moving Boats	0.3	1.0	0.9	1.6	0.8	1.6
Dog on lead	0.3	1.0	0.4	0.8	0.9	1.8
Dog off lead	1.2	1.4	1.3	1.9	0.8	1.3
Joggers	0.0	0.0	0.0	0.0	0.0	0.0
Cyclists	0.3	1.0	0.6	1.8	0.3	0.7
Other (No. of people)	1.0	1.7	0.8	1.5	1.2	1.7

Afternoon River	PIR Video Mean (n=24)	S.D.	Point Sample Mean (n=22)	S.D.	Walkthrough Mean (n=22)	S.D.
Total Walkers	2.8	4.4	6.0	6.5	4.7	5.9
Lone Walkers	1.3	1.6	2.6	2.0	2.9	4.4
Groups of Walkers	0.8	1.8	1.4	2.3	0.7	1.8
Anglers	0.0	0.0	0.2	0.6	0.0	0.0
Moored Boats	1.5	1.7	3.5	4.2	2.9	3.8
Moving Boats	0.3	0.9	1.3	3.5	0.7	2.6
Dog on lead	0.1	0.4	0.2	0.9	0.2	0.6
Dog off lead	0.8	1.4	1.2	1.6	0.5	0.9
Joggers	0.4	1.0	0.5	0.9	0.3	0.7
Cyclists	0.6	1.2	1.0	1.8	1.2	1.7
Other (No. of people)	0.3	1.0	2.0	4.2	0.6	1.4

Table 8. Paired t-test comparisons for the three survey methods at all sites in the morning and afternoon. * = statistically significant.

Technique comparison	t-statistic	d.f.	Significance (2 tailed)
Morning			
Continuous video v Point sample	-3.296	53	0.002*
Continuous video v Walkthrough	-1.881	29	0.070
Point sample v Walkthrough	-0.819	29	0.420
Afternoon			
PIR video v Point sample	-1.901	53	0.063
PIR video v Walkthrough	-1.836	27	0.077
Point sample v Walkthrough	-1.104	27	0.279

An overall test, however, does not take into account the variability in the activity occurring at each site as shown by Figures 3-8. We therefore broke down the statistical comparisons into each user activity category as long as there were more than five occurrences in that category at a site. The two video survey methods could not be directly compared as they recorded data at different times of the day.

3.3.2 Comparison between Point Sample v Walkthrough v Continuous Video

By comparing the survey methods during the same morning period of time we were able to analyse any differences in the user activity recorded by both of the observer based methods and the Continuous Video.

It should be noted that the Point Sample method surveyed from a static position 100m either side whereas the Continuous Video sampled up to 50m in one direction and the Walkthrough moved along a length of waterway in one direction during a sample period.

To determine whether there were any statistically significant differences between techniques the data were analysed in the following categories: total walkers, which included all lone and group walkers which were themselves analysed, moving boats, moored boats, dogs off and on lead and cyclists.

3.3.2.1 Low Use Canals - morning

3.3.2.1.1 Point Sample v Continuous Video

Figure 3 shows that the Point Sample recorded more total walkers than the Continuous Video (Wilcoxon Signed Ranks $Z=-2.032$, $p=0.042$). This is likely to be a consequence of walkers accessing the towpath in the opposite direction that the camera was pointing. Otherwise there were no significant differences.

3.3.2.1.2 Walkthrough v Continuous Video

The total number of walkers recorded by the Walkthrough technique was greater than the number recorded by the Continuous Video (Wilcoxon Signed Ranks $Z=-2.232$, $p=0.026$) and the number of moored boats observed was greater (Wilcoxon Signed Ranks $Z=-2.449$, $p=0.014$). We expected to record more moored boats during a Walkthrough as the likelihood of seeing them increases with the length of waterway surveyed. There were no other significant differences.

3.3.2.1.3 Point Sample v Walkthrough

Comparison of the level of user activity recorded by the Point Sample and Walkthrough technique showed that more moored boats were seen during the Walkthrough survey (Figure 3; Wilcoxon Signed Ranks $Z=-2.449$, $p=0.014$). Again, we expected more boats to be encountered by surveying over a longer length of waterway. Otherwise similar levels of activity were recorded for the other user categories by the observer-based methods.

3.3.2.2 High Use Canals - morning

3.3.2.2.1 Point Sample v Continuous Video

As there were such a large number of walkers at some of the High Use Canal sites we separated the data into walkers (Figure 4a) and all other user categories (Figure 4b). Figure 4a shows both the Point Sample and Continuous Video recorded a high number of walkers. When analysed by pairing the data records at each site and each sample period, the Point Sample recorded significantly more total walkers than the Continuous Video (Wilcoxon Signed Ranks $Z=-2.941$, $p=0.003$). This difference did not occur with lone walkers (Wilcoxon Signed Ranks $Z=-1.261$, $p=0.207$) but was attributable to the numbers of people in a group of walkers (Wilcoxon Signed Ranks $Z=-2.665$, $p=0.008$).

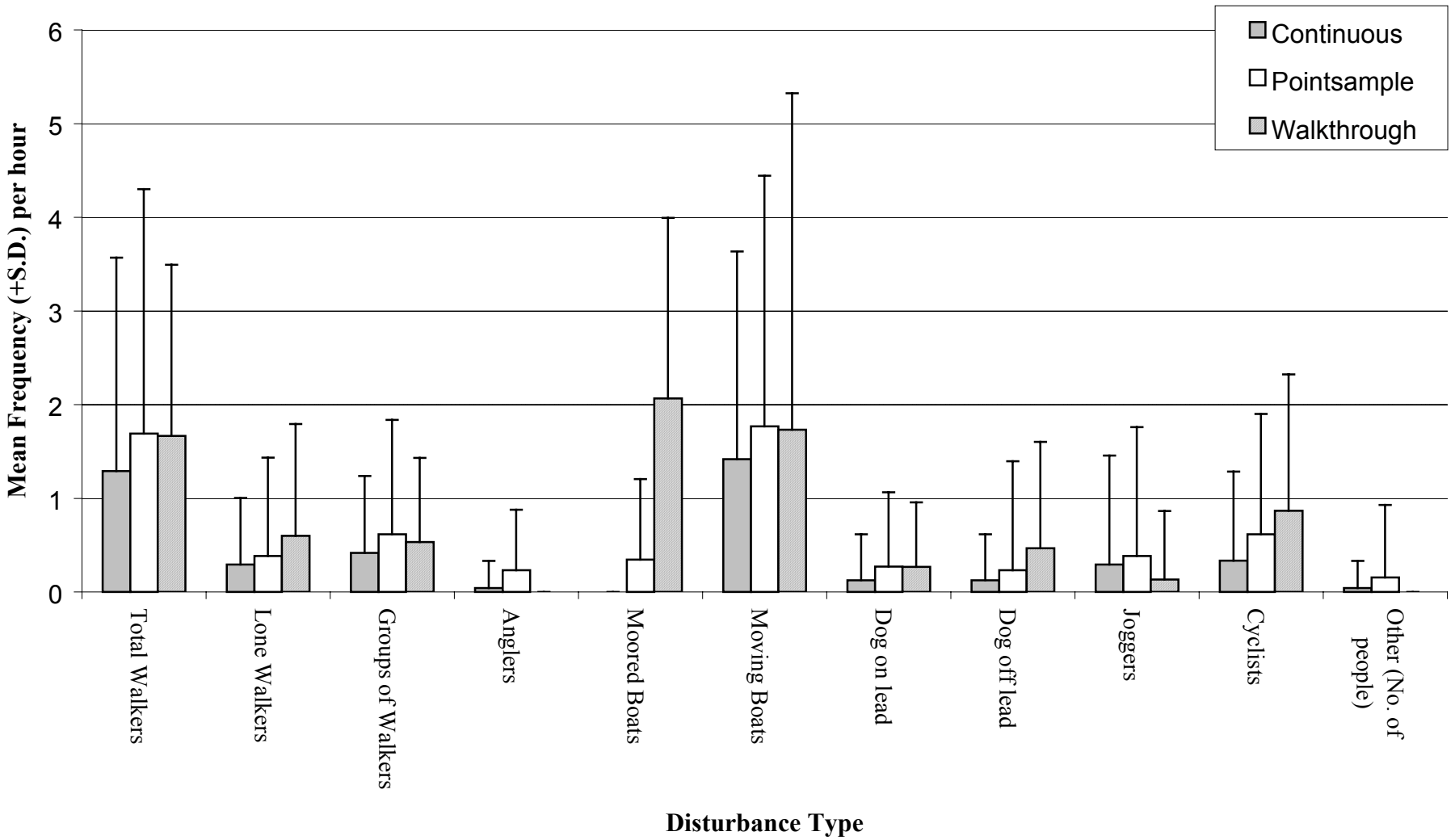

Figure 3. Mean (+S.D) frequency of user activity per hour at Low Use Canal sites in the morning. The S.D bars give an estimation of the variability in the data

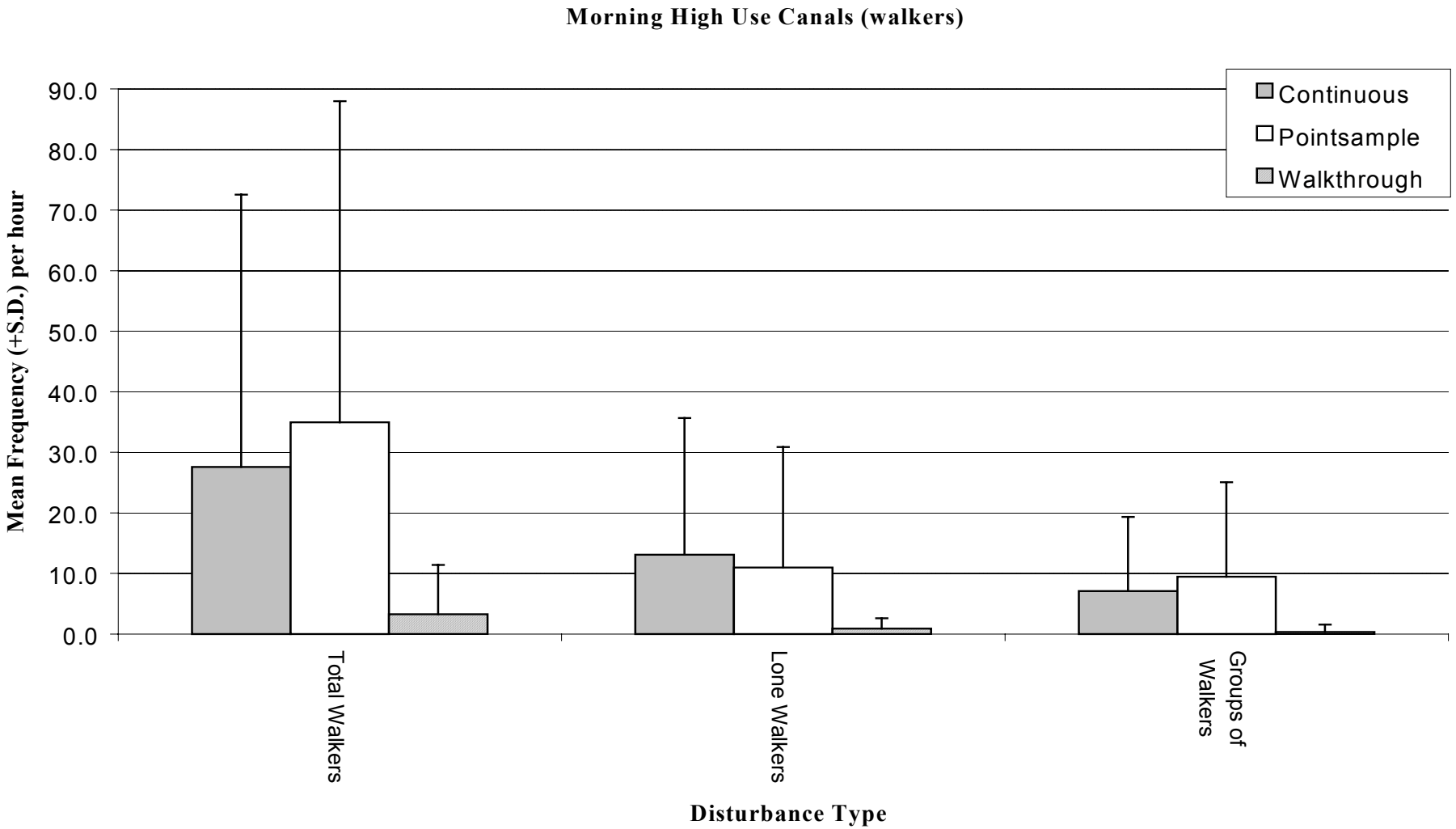

Figure 4a. Mean (+S.D) frequency of all walker activity per hour at High Use Canal sites in the morning. The S.D bars give an estimation of the variability in the data. Note: Walkthrough data came from fewer sites.

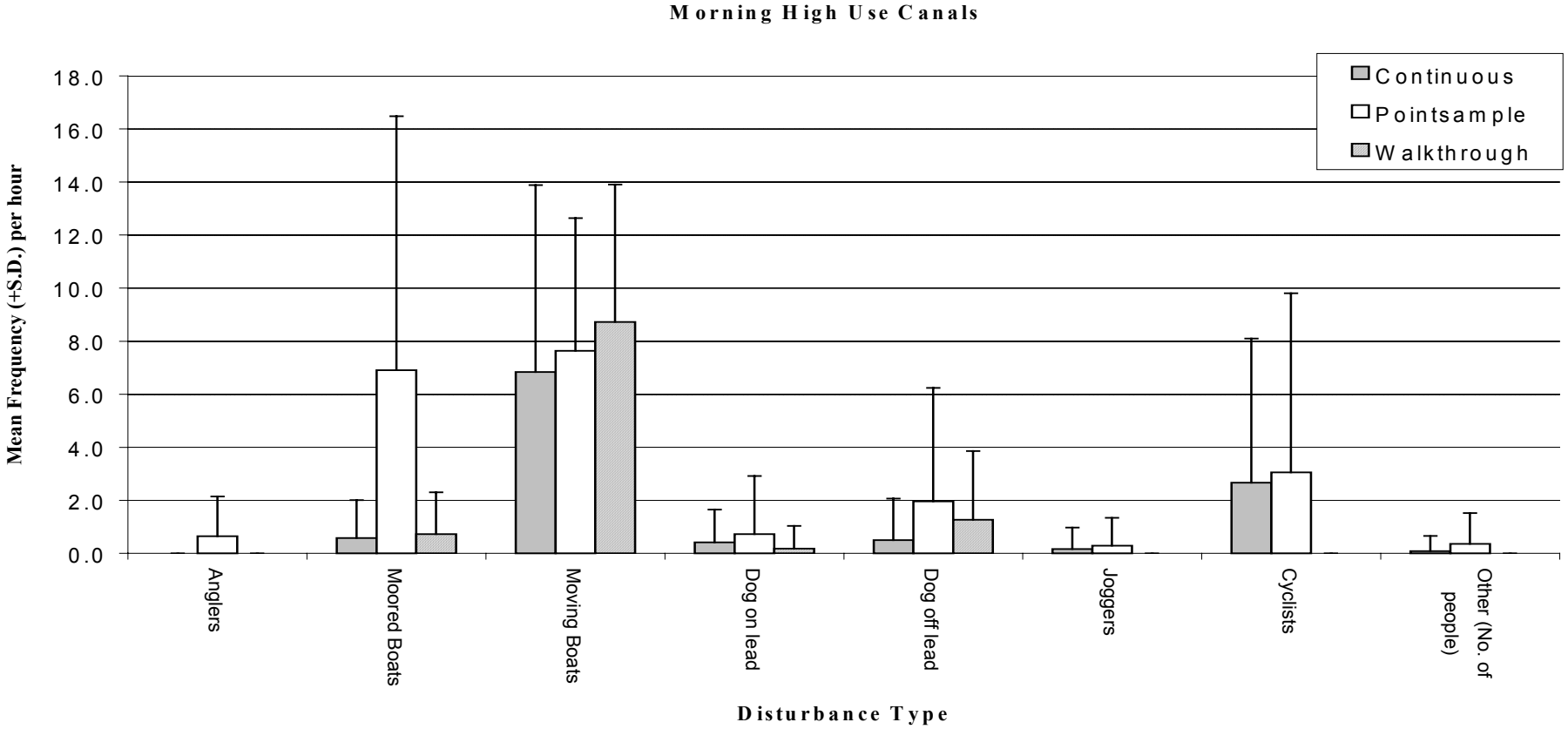

Figure 4b. **Mean (+S.D) frequency of all other user activity at High Use Canal sites in the morning. The S.D bars give an estimation of the variability in the data. Note: Walkthrough data came from fewer sites.**

At sites where groups joined the towpath more than 50m from the camera we were not always able to clearly discern the group size from the video record. However, the number of people in a group passing near to the camera was always clearly visible. There were also a greater number of moored boats recorded by the Point Sample method (Wilcoxon Signed Ranks Z=-2.449, p=0.014), when boats were moored out of view, behind the camera.

3.3.2.2.2 Walkthrough v Continuous Video

Although the total number of walkers recorded by the Walkthrough method appears to be much less than the number recorded by the Continuous Video (Figure 4a) the difference is not statistically significant. The mean value was distorted by the high walker activity at Chester where no Walkthrough surveys took place. In addition, the Walkthrough method also took the surveyors away from potential hotspots of walker activity such as access points and short cuts that people use for short stretches of some canals.

As at the Low Use Canal sites, the number of moored boats recorded by the Walkthrough method was greater than the number recorded by the Continuous Video (Wilcoxon Signed Ranks Z=-2.449, p=0.014). There were no other significant differences.

3.3.2.2.3 Point Sample v Walkthrough

Comparison of the level of user activity recorded by the Point Sample and Walkthrough methods indicated that more moored boats were seen during the Point Sample survey (Figure 4b). This difference was, however, not statistically significant. At one of the sites (Froncystylle) there were a number of boats moored behind the point where the camera was located and in the opposite direction to the Walkthrough, hence only the Point Sample method recorded their presence owing to the method collecting user activity data either side of the location point. As this occurred at just one site statistically there was no difference owing to high variability as shown in Figure 4b. Otherwise similar levels of activity were recorded for the other user categories.

3.3.2.3 Rivers - morning

3.3.2.3.1 Point Sample v Continuous Video

Figure 5 shows that the Point Sample recorded more total walkers than the Continuous Video (Wilcoxon Signed Ranks Z=-2.032, p=0.042). A result consistent with the Low and High Use Canal sites. Otherwise there were no significant differences.

3.3.2.3.2 Other comparisons

There were not enough records in the other user categories to provide sufficient data for analyses. Therefore any interpretation of Figure 5 remains unsubstantiated until further surveys are undertaken.

3.3.3 Comparison between Point sample v Walkthrough v PIR video

By comparing the survey methodologies used during the same afternoon period of time we were able to analyse any differences in the user activity recorded by both of the observer based methods and the PIR Video.

It should again be noted that the Point Sample method surveyed from a static position 100m either side whereas the PIR video sampled up to 50m in one direction and the Walkthrough moved along a length of waterway in one direction during a sample period.

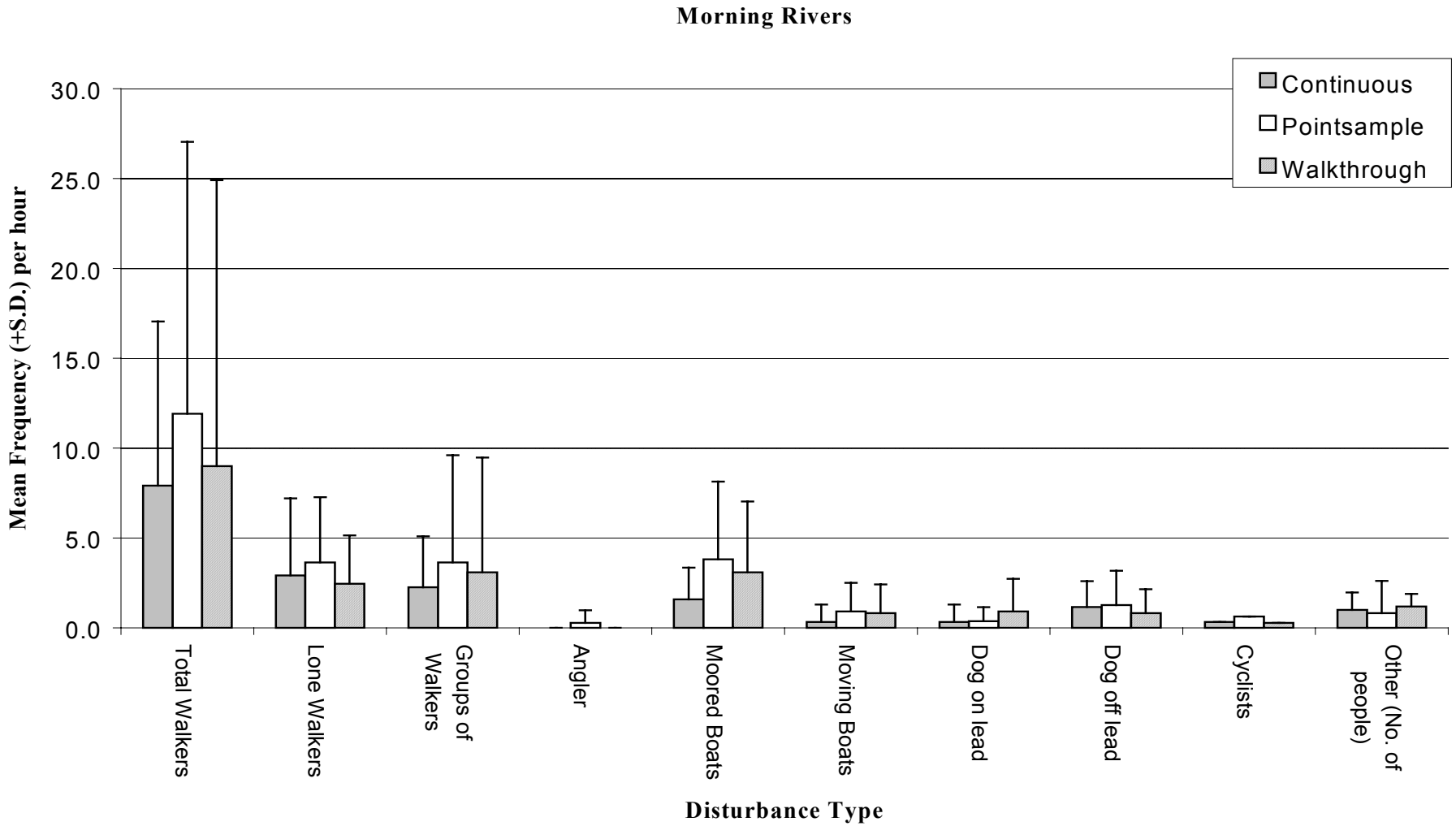

Figure 5 Mean (+S.D.) frequency of all user activity per hour at River Sites in the morning. The S.D bars give an estimation of the variability in the data

3.3.3.1 Low Use Canals – afternoon

3.3.3.1.1 Point Sample v PIR video

Figure 6 shows that the Point Sample recorded more total walkers than the PIR Video (Wilcoxon Signed Ranks Z=-1.992, p=0.046). This result is similar to our findings for Continuous Video. Otherwise there were no significant differences.

3.3.3.1.2 Walkthrough v PIR Video

The number of moored boats recorded by the Walkthrough method was greater than the PIR video (Wilcoxon Signed Ranks Z=-2.236, p=0. 025). Which is consistent with the previous Walkthrough comparisons. There were no other significant differences.

3.3.3.1.3 Point Sample v Walkthrough

Comparison of the level of user activity recorded by the Point Sample and Walkthrough method showed again that more moored boats were seen during the Walkthrough survey (Figure 6; Wilcoxon Signed Ranks Z=-2.449, p=0.014). Otherwise similar levels of activity were recorded for the other user categories.

3.3.3.2 High Use Canals - afternoon

3.3.3.2.1 Point Sample v PIR video

Figure 7a show that the Point Sample method recorded a similar number of total walkers as the PIR Video (Wilcoxon Signed Ranks Z=-1.697, p=0.090) however analysis of lone walker data showed that they were recorded more often by the Point Sample than the PIR Video (Wilcoxon Signed Ranks Z=-2.670, p=0.008). We assume that owing to the large number of people walking at Chester and the numerous access points to the towpath that the PIR units missed some lone walkers and others appeared as a group on the video record. There were also a greater number of anglers recorded with the Point Sample technique than the PIR Video (Figure 7b; Wilcoxon Signed Ranks Z=-2.588, p=0.010). Some of the anglers were positioned along the canal out of view of the camera. All other comparisons were not significantly different.

3.3.3.2.2 Walkthrough v PIR Video

Comparing the PIR Video with the Walkthrough method in Figure 7a it appears that there is a difference however this is not statistically significant. This was a consequence of the high walker activity at Chester where the Walkthrough method was not used to provide comparable data for this site.

3.3.3.2.3 Point Sample v Walkthrough

The Point Sample method and the Walkthrough also did not show any statistically significant differences although the number of walkers appears to be greater (Figure 7a). Again, Chester walkers biased the mean frequency where no Walkthrough survey was undertaken.

3.3.3.3 Rivers - afternoon

No statistical differences were determined in user activity at the river sites during the afternoon.

Figure 8 and Appendix 4c do however show that there was a large amount of variability both between methods and sites that were sampled regardless of the amount of user activity.

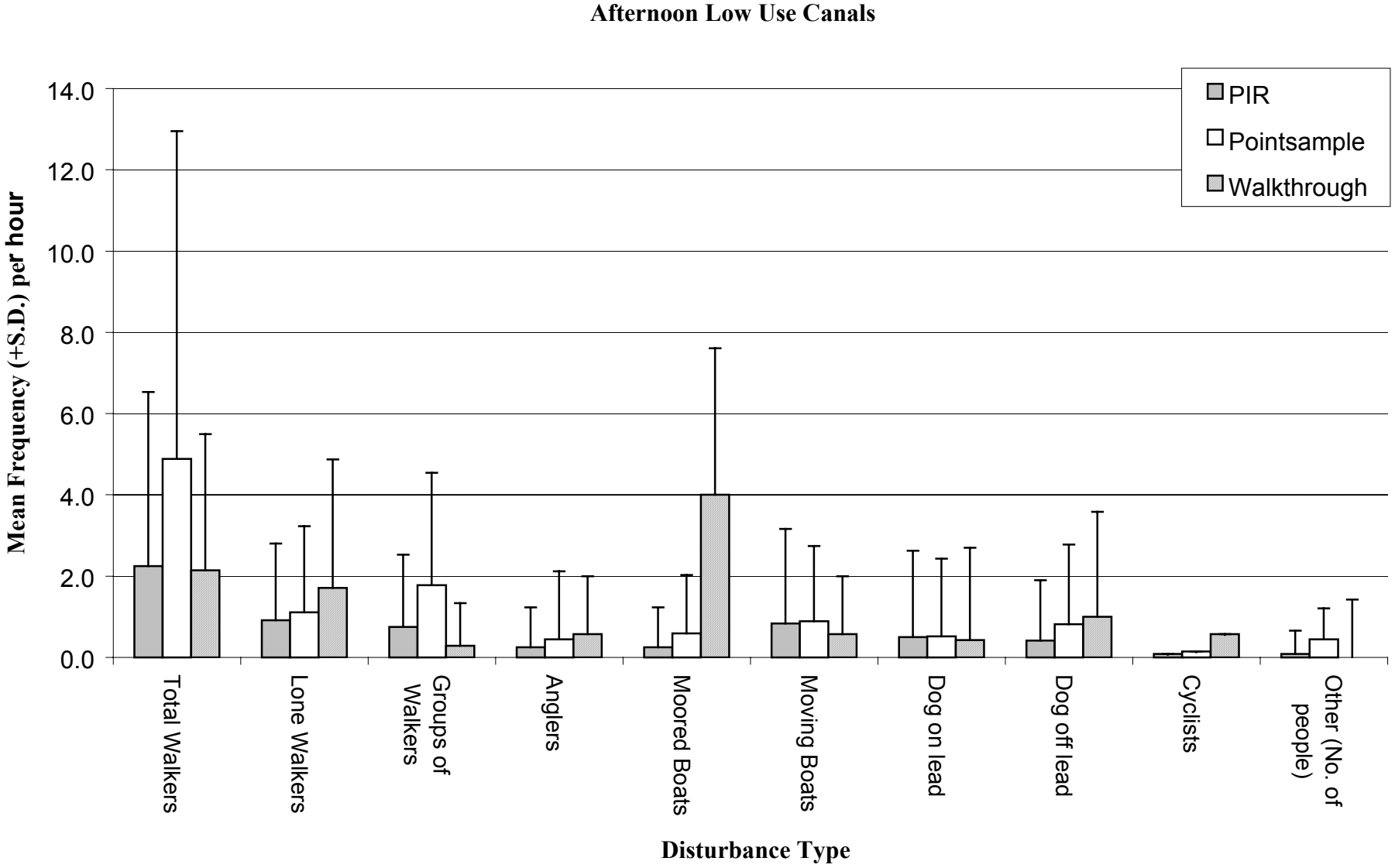

Figure 6. Mean (+S.D) frequency of all user activity per hour at low use canal sites in the afternoon. The S.D bars give an estimation of the variability in the data.

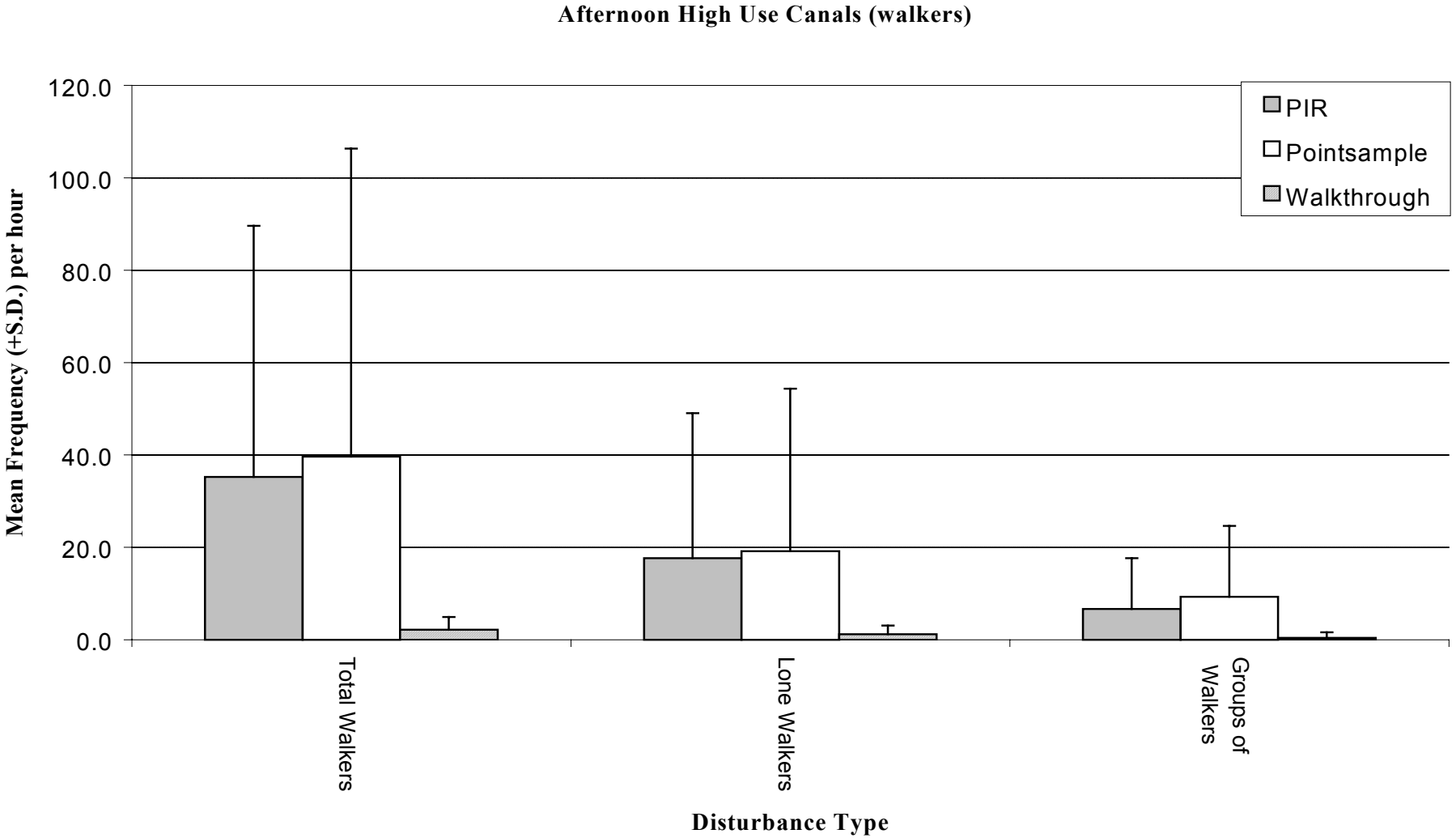

Figure 7a. **Mean (+S.D) frequency of all walker activity per hour at high use Canal Sites in the afternoon. The S.D bars give an estimation of the variability in the data. Note: Walkthrough data came from fewer sites**.

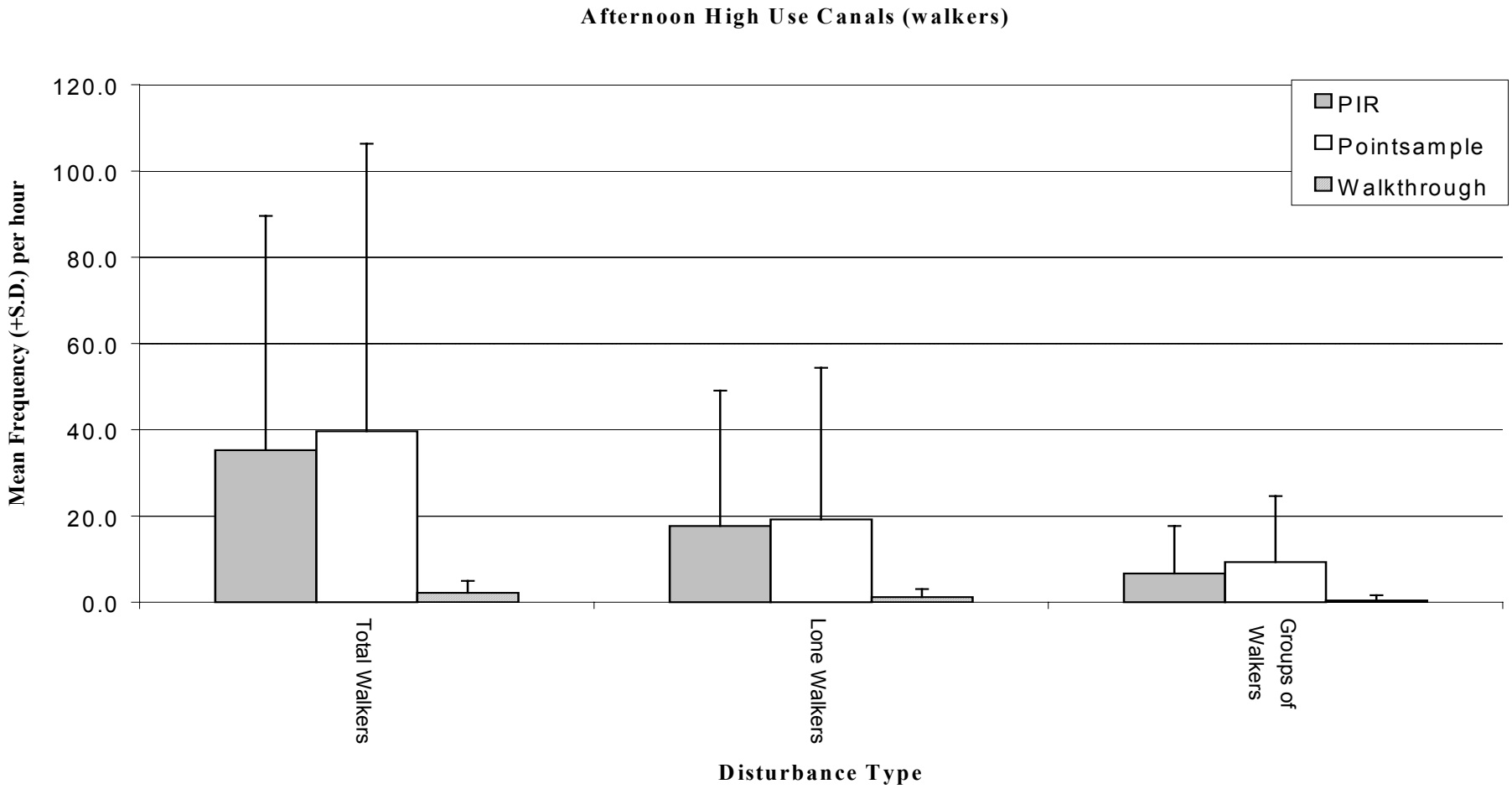

Figure 7b. **Mean (+S.D) frequency of all walker activity per hour at High Use Canal sites in the afternoon. The S.D bars give an estimation of the variability in the data.**
Note: Walkthrough data came from fewer sites

3.4 Classification of sites

It became apparent through our study that the user activity recorded at sites classified as one type (eg. Low Use Canal, High Use Canal or River) was highly variable (see Figures 3-8). This meant for example that some of the activities at a High Use Canal site appeared to fit more appropriately into the Low Use Canal site classification or vice versa. We therefore decided to analyse this aspect further as to it has consequences for the future classification of the waterways and choice of sites for surveys.

We also considered whether the user activity categorisation as well as the site classification used for the canals was appropriate for the River sites.

To simplify the analysis of site classification we have used only the Point Sample data (Table 9, Figures 9, 10 & 11) and have highlighted some of the most distinctive variability in the user activity at sites classified as the same. Note, only user activity occurring three or more times is shown. We could have used the Video or Walkthrough data (Appendix 4) in a similar manner.

3.4.1 Low Use Canals

Moving boats were recorded mainly during the morning sampling periods at all sites except Salwick (Table 9, Figure 9). However, the greatest cyclist activity was at Salwick in the morning (Figure 9). No walkers were encountered at Frankton either in the morning or afternoon in contrast to all the other sites (Table 9, Figure 9). Frankton also only had moving boats and cyclists in the morning. Dobson's Bridge was used by most user categories except anglers, joggers and cyclists (Figure 9).

3.4.2 High Use Canals

Table 9 shows that all three survey methods provided substantial data applicable to the classification of user activity at an inland waterway site. In both the morning and afternoon Chester had significantly greater numbers of people using the canal either in groups, or as lone walkers, cyclists or dog walkers (Table 9, Figure 10). However, the level of boating activity was relatively low in comparison to the other High Use Canal sites. In fact Chester is comparable with the Low Use Canal boating activity in the morning (Table 9).

In contrast, Middlewich had very little user activity except for relatively high level of boat movements both in the morning and the afternoon in comparison to the other High Use Canal sites (Figure 10). Middlewich could therefore be grouped as a Low Use Canal based on all user activity categories except boating (Table 9).

Marston was an example of a site that was used relatively heavily by all categories of user (Table 9, Figure 10).

3.4.3 Rivers

The three River sites had similar categories of user activity to the canals and also differed between themselves in their amount of user activity recorded (Table 9, Figure11). The River sites were used by all categories particularly walkers, either on their own, in groups or with dogs. Although there were a number of boats recorded as moored there were relatively few moving.

Table 9. Camparison of cumulative user activity for all sites during morning and afternoon Point Sample periods of 1 hour on each site visit.

Time	Survey Type	Site	Total Walkers	Lone Walkers	Groups of Walkers	Anglers	Moored Boats	Moving Boats	Dog on lead	Dog off lead	Joggers	Cyclists	Other (No. of people)
am	Low Use Canal	Rufford	11	1	5	2	0	5	1	4	2	2	4
	Point sample	Dobson's	3	1	1	0	7	8	0	1	0	0	0
		Frankton	0	0	0	0	0	8	0	0	0	2	0
		Salwick	3	1	1	1	0	0	1	0	3	6	0
pm	Low Use Canal	Rufford	13	2	3	0	0	0	1	2	0	0	3
	Point sample	Dobson's	12	2	5	0	2	3	2	2	0	0	0
		Frankton	0	0	0	2	2	0	0	0	0	0	0
		Salwick	4	3	1	3	0	1	0	1	0	1	0
am	High Use Canal	Chester	378	130	108	2	4	12	6	0	4	32	2
	Point sample	Froncystylle	44	8	8	4	64	28	0	6	0	6	2
		Marston	40	6	14	0	0	24	4	16	0	0	0
		Middlewich	0	0	0	0	0	26	0	0	0	2	0
pm	High Use Canal	Chester	504	248	108	4	4	10	6	0	0	16	0
	Point sample	Froncystylle	32	2	10	0	58	12	0	6	0	4	0
		Marston	44	6	16	2	2	20	2	16	0	2	0
		Middlewich	8	4	2	0	0	20	0	2	0	0	0
am	River	Newark	28	12	8	2	10	0	0	2	2	2	0
	Point sample	Long Eaton	20	6	4	0	28	2	0	2	0	4	0
		Little Leigh	13	3	3	0	0	1	3	3	0	4	6
pm	River	Newark	28	12	8	2	10	0	0	2	2	2	0
	Point sample	Long Eaton	20	6	4	0	28	2	0	2	0	4	0
		Little Leigh	14	7	3	0	0	6	2	4	1	3	11

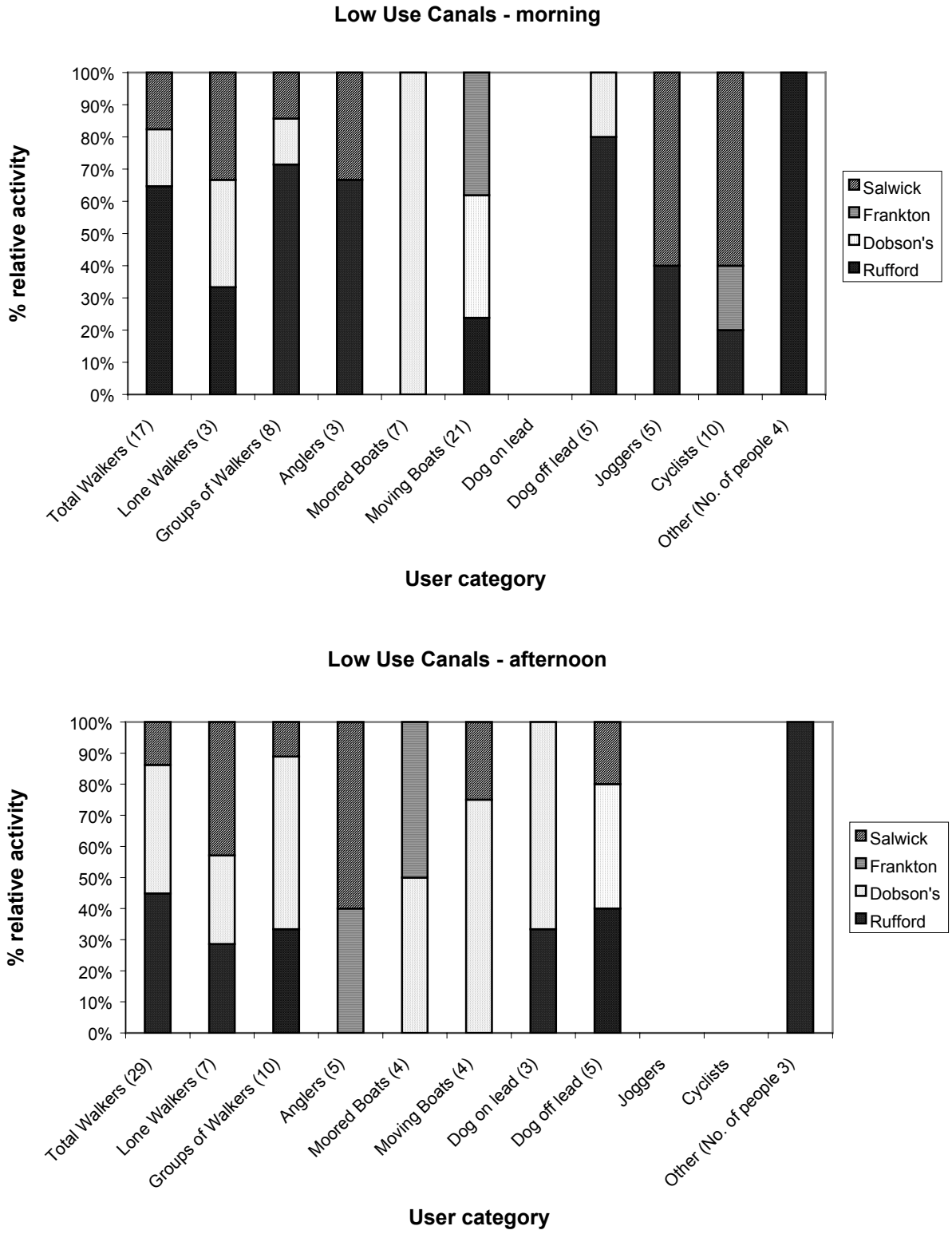

Figure 9. Relative activity of each user category at Low Use Canal sites in the morning and afternoon. The number of records in each category are shown in brackets.

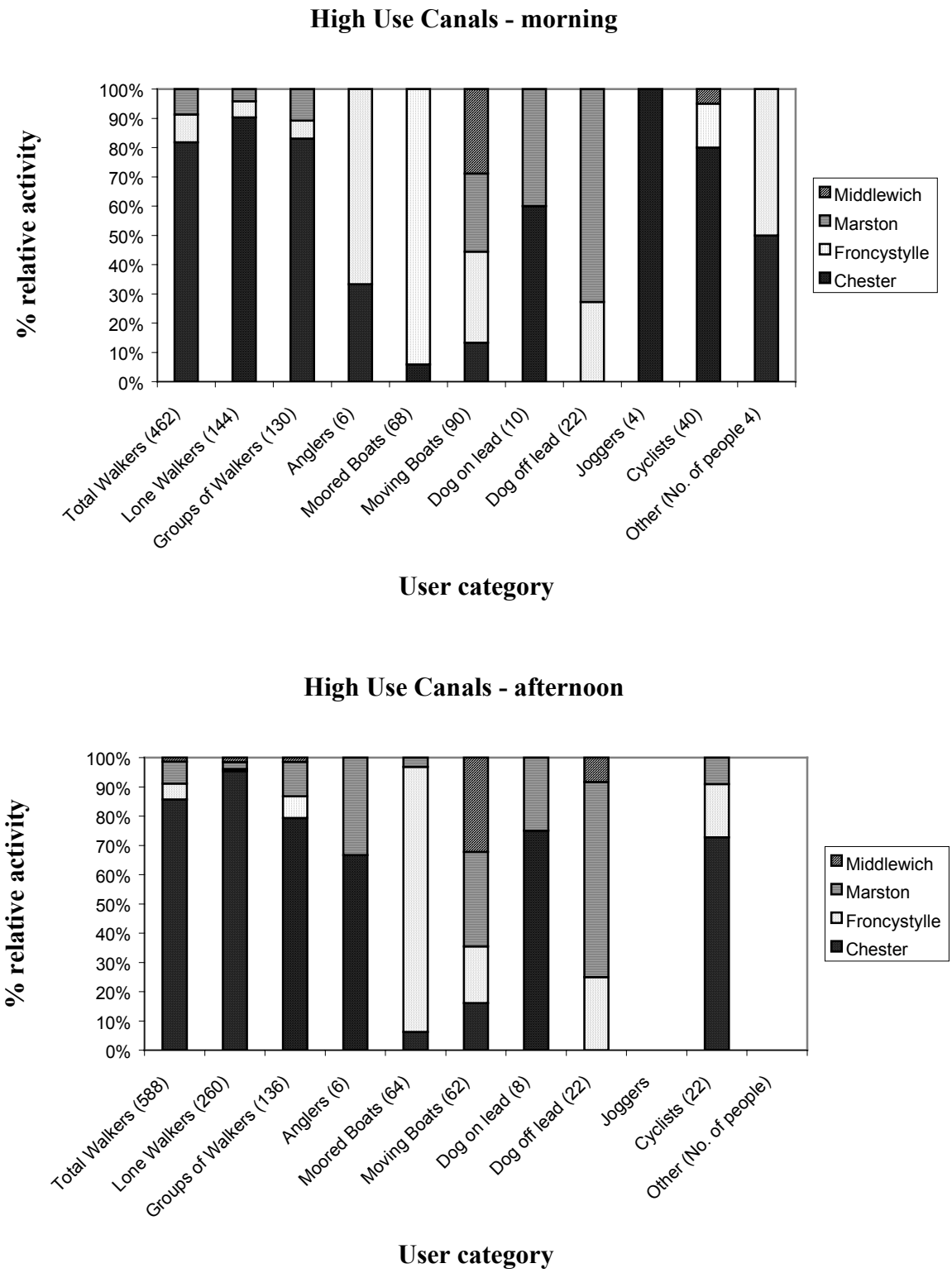

Figure 10. Relative activity of each user category at High Use Canal sites in the morning and afternoon. The number of records in each category are shown in brackets.

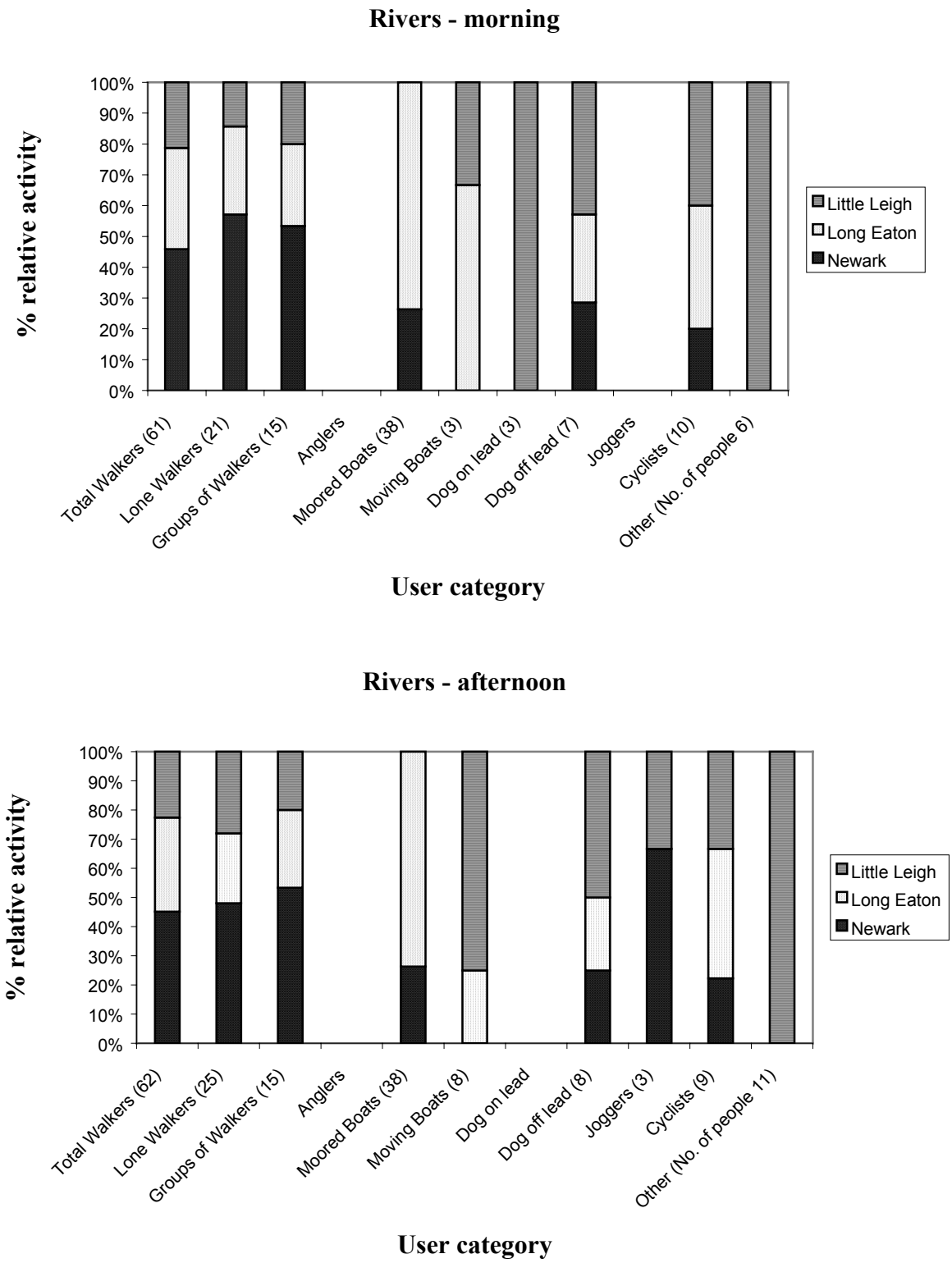

Figure 11. Relative activity of each user category at River sites in the morning and afternoon. The number of records in each category are shown in brackets.

The river sites also demonstrated that different classification could be assigned to them depending on the user category. For example, the Rivers could be placed in the same class as the three High Use Canals, Froncysyllte, Marston and Middlewich, based on the number of groups and lone walkers recorded. By contrast the level of boating activity is comparable with the Low Use Canals, however there are a noticeably higher number of moored boats at Newark and Long Eaton.

Surveys at the Rivers showed that the data collection sheet might need to be expanded for uses not previously encountered on canal sites. The 'other' category mainly related to people in cars or vans at the Little Leigh site. This may be a consequence of access to riversides often being less well determined than on canals, hence other user activity may occur that is not encountered at canal sites.

This analysis clearly shows that the nature and level of user activity of both canals and navigable rivers needs to be explicitly determined before we assign a true classification to a site.

3.5 Patterns of User Activity through time

3.5.1 Time-base analysis

The video equipment incorporated a VITC time code generator whilst the computer incorporated time code reader hardware. With this system, therefore, we were able to look at the real time activity of the users at each site. To demonstrate the usefulness of time based data collection we have put the main user categories from two of the High Use Canal sites into a similar format (Figures 12 & 13). The data shown in Figures 12 & 13 were recorded by the PIR video, meaning that these temporal patterns were obtained remotely by each user triggering the system themselves. The Figures show the main user categories at similar times of the day (13:30 to 14:30h) for the three replicate visits at Chester and Middlewich. The first user category shown is all boats (moored or moving), second is all walkers (lone and in a group), third is dogs (on or off lead) and fourth cyclists. These figures clearly show the predominance of walkers at Chester and that the main user activity at Middlewich was boats. We were able to determine these facts through our main analyses, but the time coded video added when these activities occurred. At Chester the walkers were continuously active during the sample period, whereas the cyclists appeared more grouped. Most of the boating activity at Middlewich was during the first 30-40 mins of the sample period.

3.5.2 Multi-hour Recording

To extend the time-base premise we tested the ability of the video equipment to record over long time periods at remote sites we set up the system to be triggered by the PIR units at BW Ellesmere Boat Yard (SJ 401 342) and also at Aston Locks (SJ 336 264) during November and December 2001.

To record during the night two infrared LED light arrays were used to illuminate the site providing a clear picture on the infrared compatible camera. As the system only powered up when movement triggered the PIR units, the power supply in the batteries was prolonged to provide an average recording time of 32.0 hours with a maximum of 39.0 and a minimum of 26.5 hours. When the power supply reduced to below 11volts the system stopped operating. We then replaced the batteries with another set of fully charged cells to record another multi-hour session. The system can continue to record over a much longer period of time with regular replacement of the batteries.

All the user categories defined in Appendix 2 were recorded during this section of the study. In addition, the video system was triggered to record by nocturnal animals, domestic cats and geese. The video footage was clear enough to determine that one of the cats was missing one of

its legs; the existence of a three legged cat was confirmed by its owner, the waterways manager at Aston Lock.

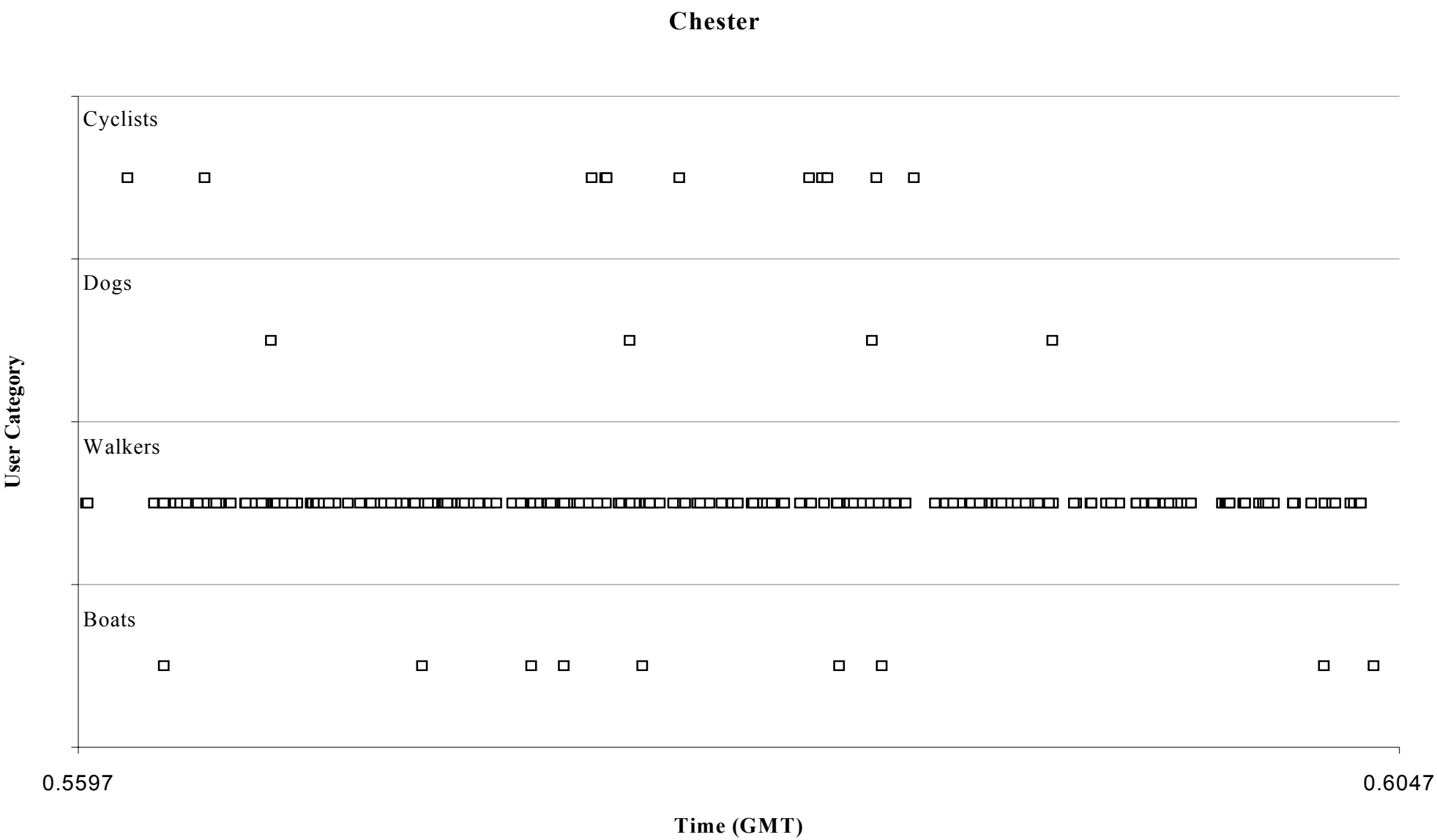

Figure 12. Real-time video data showing the main user activity during an hour long period taken from 3 site visits to Chester.

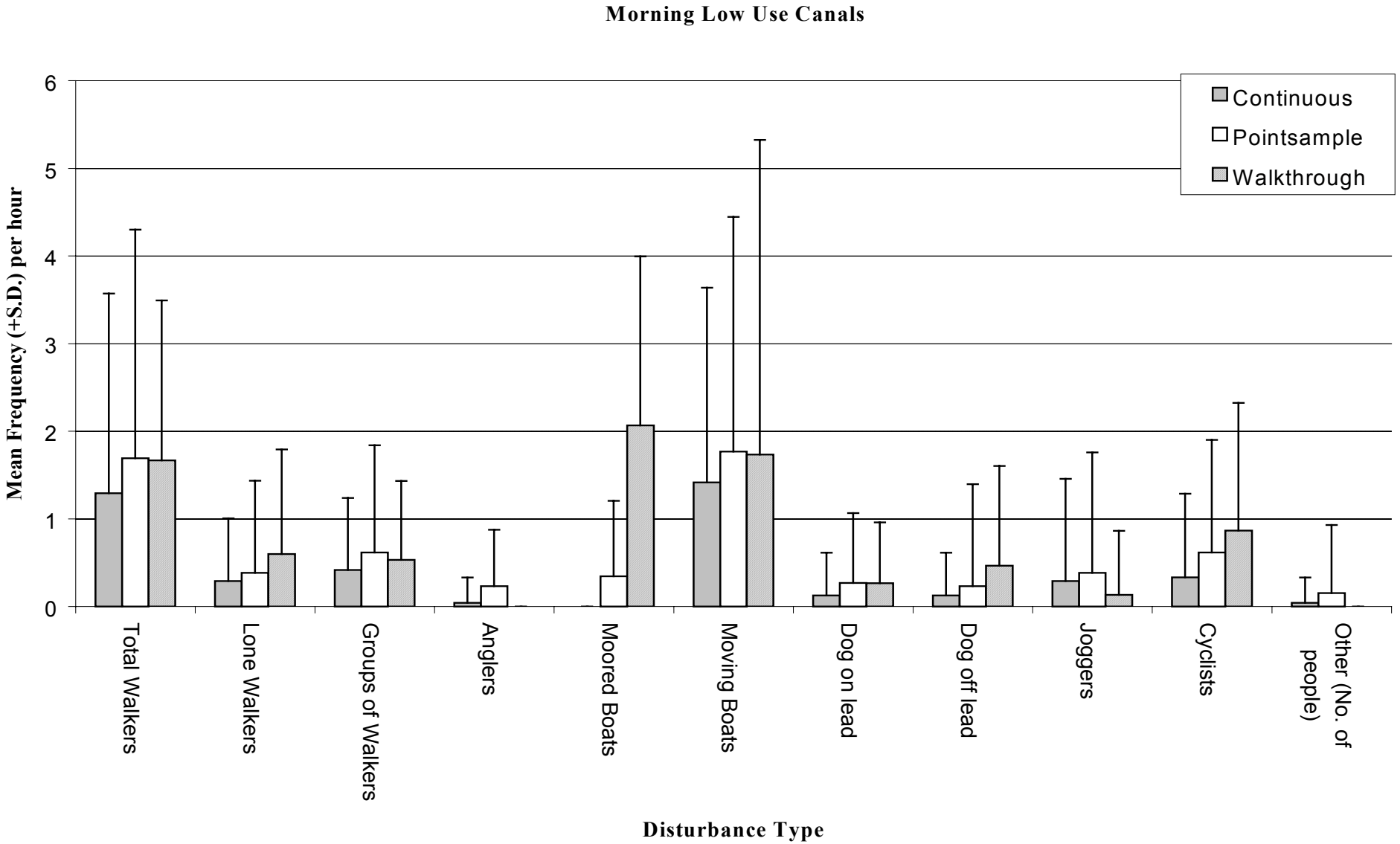

Figure13. Real-time video data showing the main user activity during an hour long period taken from 3 site visits to Middlewich.

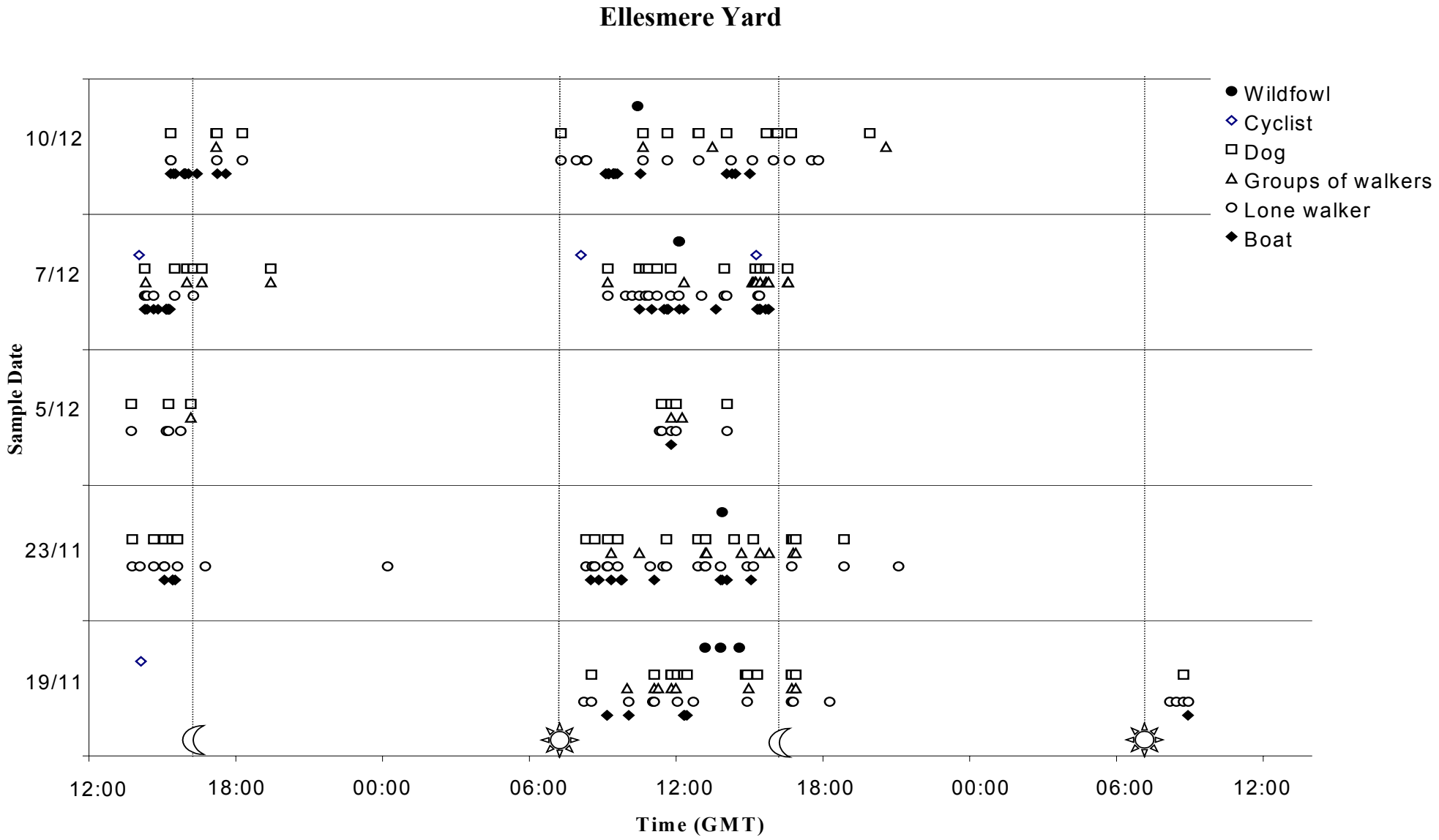

Figure 14. Multi-hour PIR Video data showing user activity throughout the day and night at BW Ellesmere yard.

Aston Lock

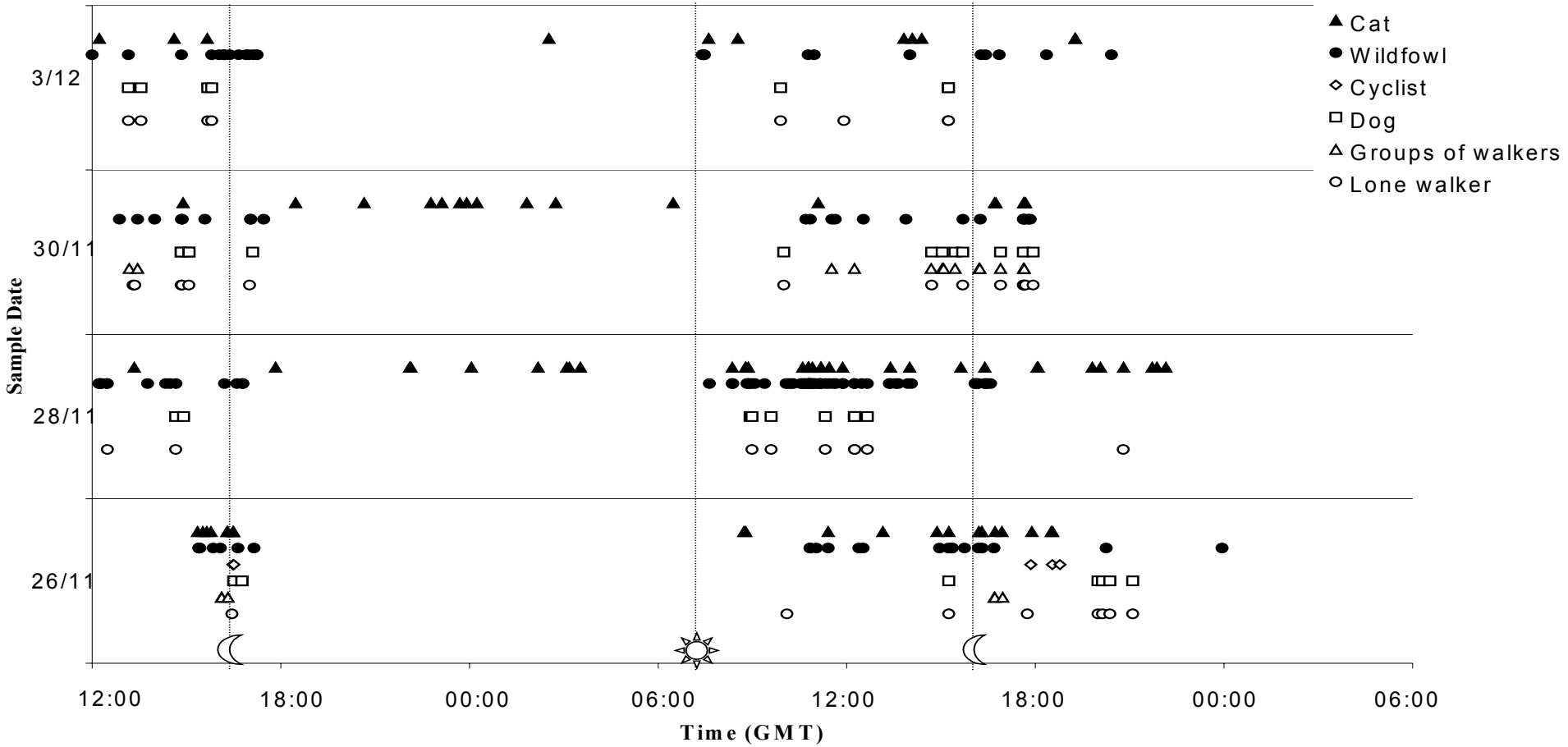

Figure 15. Multi-hour PIR Video data showing user activity throughout the day and night at Aston Locks.

Figures 14 and 15 show the variability in user activity over approximately 36 hours at both of the sample sites on different dates. It is clear that there is a daily pattern in the activity of all user categories (Figure 14 & 15). At both sites, all user groups are active during the day with walkers (lone and groups) often with dogs using the canal towpath throughout the day from sunrise to after sunset. At Aston Lock (Figure 15) the benefit of seeing temporal activity is clearly shown by the nocturnal activity of the cats and to a lesser extent the waterfowl.

Previous studies on user activity along navigable waterways have been based on at least the daily but more often weekly, monthly or annual numbers, which although useful for general understanding of the demand on the system does not provide the fine enough detail to determine if there are any similar periods of the day when users and wildlife are active. This means that to assess the potential impact of user activity on wildlife we need to know the temporal and spatial profile of the activity. If the main user activity occurs at midday when wildfowl are generally less active (Burger & Gochfeld, 1998, Owen, 1972.) then the potential for ecological conflict is reduced. However if the user activity is greatest in the morning when the waterfowl are most actively feeding (Burger & Gochfeld, 1998) and singing then further study and management efforts can be directed towards these bottleneck times of day and locations.

By increasing the amount of time that the video was deployed we saw the increased benefit of recording data whenever it occurred. The data collected during multi-hour sessions demonstrated that the remote video could be left in one place to record all categories of user activity at any time of the day for periods of days or longer if the batteries are replaced. From the main part of the study we know that the video recorded all the required user categories, although at a reduced number for groups of walkers. In its current format, the video system is self-contained and water proof and as long as it is located securely it will work in all conditions at any time of day or night and any season. In addition, the system only requires attention by personnel once every few days with the data requiring downloading from the video record to the computer at a later time.

By comparison it would be practically difficult and costly to employ observer surveyors to record data over such long sample periods and at all times of day and night. Whilst the data from the data sheets also would have to be entered into a database before analyses.

3.6 Advantages and disadvantages of methods

The primary aim of this project was to compare the three main survey methods of Point Sample, Walkthrough and Remote Video. The results showed that each of the methods recorded all the user activity categories but there was variability between them in the absolute numbers recorded for some user categories.

Overall the Point Sample method obtained the greatest amount of user activity information. A main reason for this was that the observers who were Point Sampling used a visual zone either side of the fixed point where they were located hence the method could justifiably be renamed ‘Zone Sampling’. The only problem with this is that it depends on the eyesight of the observer. In our study we restricted the observers to 100m either side to reduce the possibility of error linked to visual ability. In comparison to the video, the Point Sample method was seen to collect more data although they were positioned at the same point. The reason for this difference was that the video camera pointed only one way whereas the observers surveyed in both directions. This was particularly important in terms of moored boats and access points to the waterway. If there was an access point out of view of the camera then users could have come onto the canal towpath or riverside out of view of the camera and hence not be recorded. Therefore the siting of the camera was important. The other limitation of the camera was the clarity of the picture. We estimated that the view on the camera was clear up to 50m away and 25m at night. After

this point the camera lost definition. Better lenses would be required if distances further than 50m were to be included in the survey. The problem with clarity was demonstrated by the lower number of individual people counted in the groups of walkers. It was not always clear from the video how many people were in a group whereas the observers were able to determine the number in a group.

The camera in the PIR mode recorded each user activity clearly as the user was the trigger for the video recorder. Hence the problem with clarity and distance was not a factor.

The Walkthrough method provided some differences in the data collected as we expected, as it involved moving along a set length of waterway and recording all user activity encountered parallel to the observer. The main increase in user category was in moored boats. As the Walkthrough method only went in one direction we found that the data collected were generally not significantly different from those yielded by the Point Sample method. This was probably a consequence of the ability of the Point Sampling to obtain data in two directions. As our sample periods were relatively short (15mins or 30mins) the Walkthrough survey did not cover much of the waterway length that was not in view of the Point Sample observers. If the Walkthrough method was continued over a longer period of time and hence a longer length of waterway, then we would expect the data recorded to become increasingly different from that produced by the other static point techniques used.

A main advantage of the video method was that it recorded user activity whenever it occurred. It may have been possible for the observers to attempt to record the time that every user activity took place, but the data sheet would have had to be significantly adapted and the increase in data to be recorded could have lead to observers missing or incorrectly recording other activity whilst writing down the time, particularly at High Use sites (NB. data collection at Chester, which was the site with greatest walker activity, was often confusing). The video was analysed later and therefore represented a permanent record which could be subsequently looked at many times, whereas if direct observation had missed or incorrectly recorded some activity then it could not be checked later.

The need to consider observer bias is another aspect that is alleviated by the video equipment, as it records everything that passes the camera.

We have summarised the main advantages and disadvantages of the observer-based and remote video methodologies in Table 10.

Table 10. Summary of the advantages and disadvantages of observer based surveys and remote video surveys.

Field surveys	
Advantages	**Disadvantages**
Personnel can apply different methods	Restricted timing (unsociable hours)
Adaptability of personnel	Personnel costs (long term)
Reliability measure if two observers used	Reliability measure requires two observers to survey same site at the same time
Longer length of waterway surveyed	Data normally total per unit time
Direct data collection	Observer effect on user activity
Greater amount of data per sample period	Data input into database
Remote video	
Collect data any time of day/season	Only one direction sampled
Automatic time-based recording	Restricted view & clarity
Low variability in data collection	Tape analyses
Direct download of time based data	Computer software and coding analysis expertise required
Archive and replay	Security and mobility constraint
No effects of observers being present	Initial financial outlay
Data on species other than humans anytime	
Low long term running costs	

4. FUTURE USER ACTIVITY RESEARCH

4.1 Application of observer and video methods

The long term aim of this research is to determine the effects of user activity on inland waterways on the wildlife inhabiting those ecosystems. Through our research we have been able to ascertain the types of user activity information that can be recorded in a scientifically robust and replicable manner using currently available methods. This has allowed us to quantify the absolute amount of each user groups' activity whilst also demonstrating the extent of the variation in activity both at an individual site and also between sites. We would suggest that repeated surveys, regardless of the specific method used, are necessary to provide a true representation of the level of user activity, allowing a more realistic categorisation of a site such as multiple user high activity or single user low activity. These are important definitions in understanding the use of the waterway, its management requirements and the potential impacts of the activity.

Whilst we have shown the utility of three different methods and compared their data collecting characteristics, we advocate a hierarchical approach to user surveys such that the deployment of the remote video equipment comes first followed by an observer-based method. By applying this approach waterways managers will be able to properly characterise user activity at individual sites or lengths of waterway whilst also collecting data on a real time base. Once this has been accomplished observers could then be deployed at the sites of interest and at the times of day when the data collecting will be most applicable to the specific requirements of the study and provide the best estimate of user numbers over set periods. For instance in our study we found that at the low use sites the observers recorded only a handful of activities and stated that they found it difficult to keep motivated with so little to record. We would have been better to characterise the site activity and use the observers for surveys at specific sites (eg. access points, waterway junctions) or times of the day of greater interest (eg. sunrise or sunset).

We emphasise the remote video method to collect data for the characterisation of the user activity over time, as this aspect is crucial for any future research effort and management initiatives relating to wildlife disturbance. Most wildlife activity occurs at certain times of the day (eg. birds morning chorus) and it is imperative to know whether the user activity occurs at the same time of day. If high user activity occurs at the same time as high wildlife activity then we may have an ecological bottleneck, with direct conflict for habitat use by wildlife and humans. Direct disturbance effects on wildlife will only occur when the user groups are active at the same time. We suggest that this idea of an ecological bottleneck may be an important lesson to carry on from this research. If there is no time conflict or bottleneck then we need to look at other causes or mechanisms that may be manifest through wildlife disturbance.

4.2 The availability of alternative habitat

As an adjunct to the main research, an assessment of the availability of alternative habitat should be made at the sites specified, as it is important to understand the extent of alternative habitat available to the wildlife that may be subject to user disturbance. A hypothesis worth testing is that any effects of user activity will be greatest at sites that do not have alternative habitats available. We suggested that a Geographic Information System (GIS) analysis would be the best method to tackle this assessment. GIS facilities were not part of this project, but we re-emphasise this aspect of research here, as it could be used to select, in part, the future study sites where user activity is likely to have greatest impact on wildlife which starts to apply the methods established by the present work.

4.3 Waterfowl and hedgerow bird species diversity and abundance assessment

As previously documented, waterfowl and hedgerow birds are arguably the major wildlife interest along inland waterways, therefore, there is a requirement for a diversity and abundance assessment at sites with different levels of user activity (Gill, 1999). This type of study would provide evidence of any relationship between bird species and number at sites with different user activity and should be undertaken by acknowledged bird surveyors such as the British Trust for Ornithology (BTO) or the Royal Society for the Protection of Birds (RSPB).

It is imperative that whoever is tasked with this survey appreciates the variability in user activity that exists. The survey sites must therefore be revisited under similar conditions to provide data on the variability in the diversity and abundance of the birds. The surveys should take place at the same locales and coincide with the bottleneck times identified from the user activity studies.

Replicated bird diversity and abundance surveys should be able to highlight the vulnerable species whilst the user activity surveys can pinpoint the times of day where the birds and users are most are likely to have the greatest interaction. Further studies can then be undertaken to determine the actual effect of user activity on the birds (or other wildlife) following the methodology developed by ourselves which is detailed in the 1999/2000 report.

4.4 Predator surveys

Anecdotal accounts by local land users around inland waterways suggests that the influence of predation on the wildlife may be great enough to override any effect caused by recreational user disturbance. Although it may be restricted to particular localities, an assessment of predator activity in the area is necessary if only to eliminate its effect. To meet this requirement a specific predator survey is recommended to be undertaken by those best equipped to collect this type of data. However, during the project reported here the remote site video equipment in the PIR sensor mode recorded nocturnal activity of domestic birds and mammals, suggesting that this equipment may indeed be useful to a predator survey if specifically deployed to collect that type of activity. Other studies have used this technique to study a number of British mammalian species such as foxes, badgers, stoats, polecats, mink and otters (http://www.tracksys.co.uk).

4.5 Recommendations

To obtain a realistic classification of navigable, waterway user activity we recommend:

- Firstly, the application of long-term PIR video studies to determine the initial time-based activity levels of users – with a minimum of three repeat visits per site.
- Identification from these data potential sites and specific times of day where ecological bottlenecks may exist between wildlife and users.
- Deployment of observer survey teams to quantify the maximum and minimum activity of each user group at these sites and times of day – minimum of three repeat visits.

In addition, to achieve the overall aim of assessing the effects of user activity on wildlife disturbance we also recommend:

- Determination of the diversity and abundance of waterfowl and hedgerow birds (and other wildlife) at the sites and times highlighted by the user activity study.
- Comparison of wildlife diversity and abundance with user activity at sites with different activity levels to measure any relationship that exists between them.
- Application of the methodology used during the 1999/2000 project to directly measure wildlife activity and disturbance at the study sites (Gill, 1999).
- A GIS assessment of the availability of alternative habitat at the study sites.
- A predator activity survey at the study sites.

5. REFERENCES

Burger, J. & Gochfeld, M. (1998). Effects of ecotourists on bird behaviour at Loxahatchee National Wildlife Refuge, Florida. Environmental Conservation, Vol. 25, No. 1, pp. 13 - 21.

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Zar, J.H. (1999). Biostatistical Analysis (4th Edition). Prentice Hall.

Owen M. (1972). Some factors affecting food intake and selection in White-fronted Geese. Journal of Animal Ecology 41, pp. 79 – 92.

http://www.tracksys.co.uk/Pages/video/video.htm

6. APPENDIX 1

Table 1. Site survey data sheet.

START TIME: CONTINUOUS / PIR NAME OF RECORDER:

TAPE NO.: SESSION LENGTH: SHEET NO.:

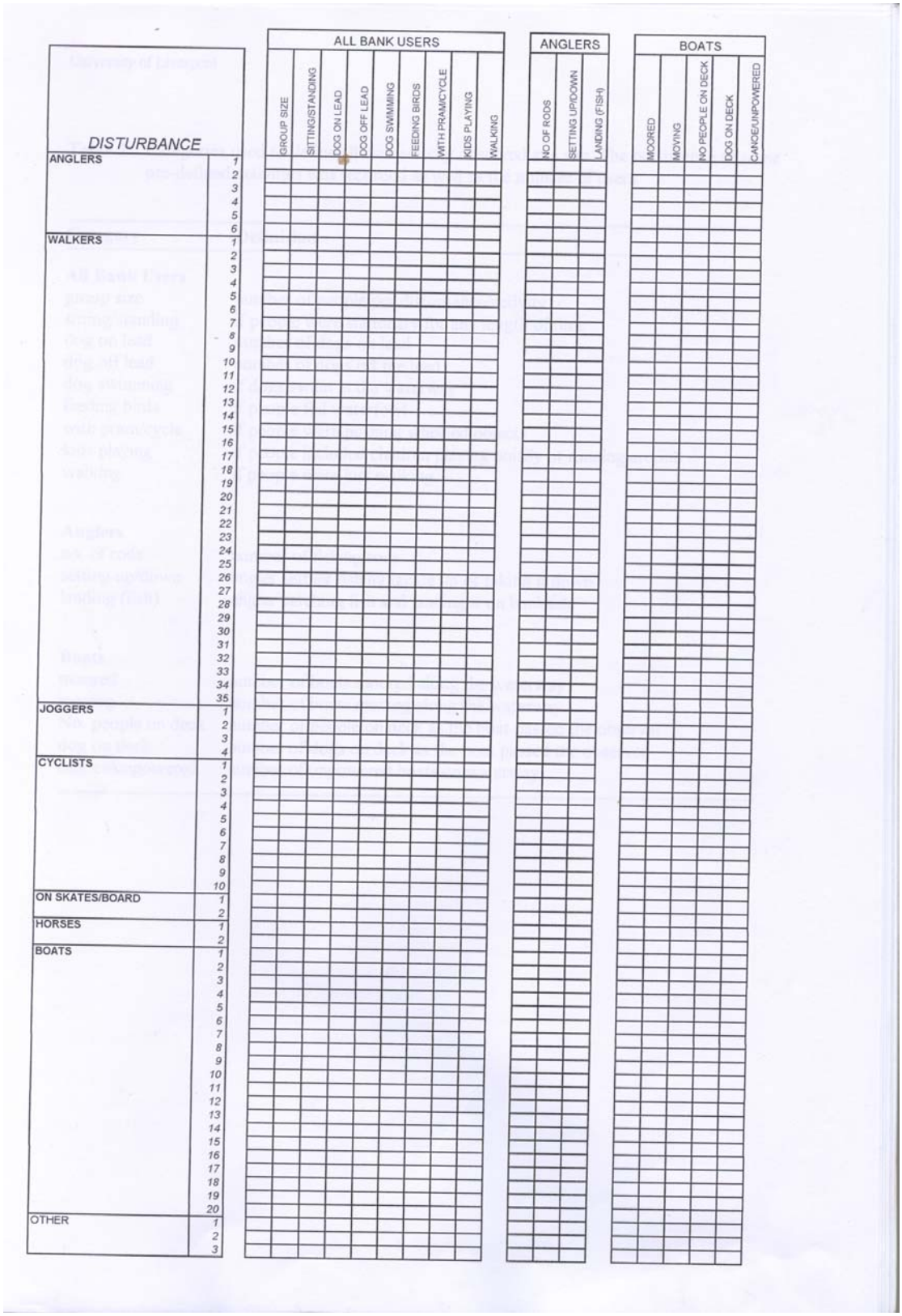
USE: HIGH / LOW / MEDIUM

		Both Sides	Tow path	Off-side
SURROUNDING HABITAT	Improved grassland			
	Rough pasture			
	Arable land			
	Hedgerows			
	Woodland			
	Marshland			
	Houses or parking			
	Factories			
	Major roads			
	Railway			
	Rock and Scree			
BANK TYPE	Concrete sides			
	Metal sides			
	Brick sides			
	Stone sides			
	Wooden sides			
	Natural bank			
BANK VEGETATION	Reed beds			
	Scrub			
	Trees			
	Hedgerows			
	Overhanging			

SITE DETAILS		
SITE No.		
SITE NAME		
CANAL		
MAP/GUIDENo.		
O/S MAP REF.		
DATE		
WEATHER:	WARM + SUNNY	
	MAINLY OVERCAST	
	COLD + WET	
	HEAVY RAIN	

Table 1. Canal wildlife disturbance project - site survey data sheet.

Table 1 continued. Site survey data sheet.



7. APPENDIX 2

<u>Access Database</u>: 'Use of waterways'. Separated into 6 categories

1.Anglers

Number of People Angling	total number of individuals associated with angling activities.
Number of Lone Anglers	number of anglers unaccompanied
Groups of Anglers	number of groups of people associated with angling
Dogs On Lead	total number of dogs on lead seen with anglers
Dogs Off Lead	total number of dogs off lead seen with anglers
Anglers Setting Up/Down	noted in instances i.e. a group counts as 1 instance
Anglers Sitting/Standing	as above
Pushing Wheeled Object	number of trolleys/bicycles etc pushed along by anglers
Walking to/from Fishing	instances of anglers walking along the canal side i.e. a group would count as 1 instance.

2.Walkers

Total People	total number of individuals walking along the canal side
Lone Walkers	number of walkers unaccompanied
Groups of Walkers	number of groups of walkers seen
Sitting/Standing	walker stationary for substantial length of time, noted in instances so groups count as 1.
Dogs on lead	total number of dogs on lead seen with walkers
Dogs off lead	total number of dogs off lead seen with walkers
Pushing Pram/Cycle	number of wheeled objects pushed along by bank users
Children Playing	number of children playing noisily and running around

3.Joggers

People Jogging	total number of individuals jogging along canal side
Lone Joggers	number of people jogging unaccompanied
Groups of Joggers	number of groups of people jogging

4.Cyclists

People Cycling	total number of individuals cycling along canal side
Lone Cyclists	number of unaccompanied cyclists
Groups of Cyclists	number of groups of cyclists
Dogs off lead	number of dogs running alongside cyclists

5.Boats

Number Moored	number of boats tethered to canal side
Number Moving	does not include unpowered boats
People on Decks	total number of people seen on boat decks
Canoes/Unpowered	number of boats without engine

6.Other

Other (Number of People)	total number of individual bank users who do not fit into any of the above categories e.g. cars, canal workers
Lone Other	number of unaccompanied individuals who do not fit into predefined category
Groups of Other	number of groups of people not in predefined category

8. APPENDIX 3

Observer Codes: key codes used to code the video footage using the Observer software.

Class: Walker

1walking = lw; lone person walking (within 5m of canal bank)
group w = gw; group of people walking, number of people in group is in notes
1station = ls; lone person sitting/standing
group s = gs; group of people sitting/standing
1feed = lf; lone person feeding birds
group f = gf; group of people feeding the birds
1push = lp; lone walker pushing a pram/cycle/wheelchair
group p = gp; group of walkers with pram/cycle/wheelchair

Class: Dogs

dog on = dn; dog on lead
dog off = df; dog off lead

Class: Anglers

anwalk = aw; lone angler walking with 5m of canal bank
angroup = rw; group of anglers walking within 5m of canal bank
anstat = as; lone angler sitting/standing
ganstat = rs; group of angler sitting/standing

Class: Boats

movboat = mb; boat moving along canal/river
staboat = sb; boat moored
unpboat = ub; canoe/unpowered boat

Class: Cyclists

1cyclist = lc; lone cyclist
group c = gc; group of cyclist

Class: Joggers

1jogger = lj; lone jogger
group j = gj; group of joggers

Class: Other

1other = lo; lone disturbance that does not fit into predefined category
group o = go; group of people/disturbances that does not fit into a predefined category
Note: For all 'group' categories the number of people per group is in the notes for the observer file.

9. APPENDIX 4

Cumulative counts of each user activity category for each survey method presented on a site-by-site basis. Note: see methods Table 2 for an explanation of the categories.

Site	Time	Survey Type	Total Walkers	Lone Walkers	Groups of Walkers	Anglers	Moored Boats	Moving Boats	Dog on lead	Dog off lead	Joggers	Cyclists	Other (No. of people)
Rufford	am	Continuous	6	0	3	0	0	5	1	0	2	0	0
		Point sample	11	1	5	2	0	5	1	4	2	2	4
Dobson's	am	Continuous	1	1	0	0	0	6	1	0	0	0	
		Point sample	3	1	1	0	7	8	0	1	0	0	0
		Walk through	1	1	0	0	3	3	0	1	0	0	0
Frankton	am	Continuous	0	0	0	0	0	8	0	0	0	0	0
		Point sample	0	0	0	0	0	8	0	0	0	2	0
		Walk through	4	2	1	0	0	9	1	3	0	1	0
Salwick	am	Continuous	2	0	1	0	0	0	0	0	3	5	0
		Point sample	3	1	1	1	0	0	1	0	3	6	0
		Walk through	8	2	3	0	12	0	1	0	2	6	0
Rufford	pm	PIR	0	0	0	0	0	0	0	0	0	0	0
		Point sample	13	2	3	0	0	0	1	2	0	0	3
Dobson's	pm	PIR	10	2	4	0	0	2	3	1	0	0	0
		Point sample	12	2	5	0	2	3	2	2	0	0	0
Frankton	pm	PIR	0	0	0	0	1	0	0	0	0	0	0
		Point sample	0	0	0	2	2	0	0	0	0	0	0
		Walk through	0	0	1	0	2	0	0	0	0	0	0
Salwick	pm	PIR	3	1	1	1	0	1	0	0	0	0	0
		Point sample	4	3	1	3	0	1	0	1	0	1	0
		Walk through	7	5	1	2	10	1	3	1	0	2	0

Note: Cumulative total for 6 half hour periods, all data unconverted to allow comparison with High Use Canal and River sites.

Appendix 4a. Cumulative total counts of each pre-defined user category for each survey method at all Low Use Canal sites.

Site	Time	Survey Type	Total Walkers	Lone Walkers	Groups of Walkers	Anglers	Moored Boats	Moving Boats	Dog on lead	Dog off lead	Joggers
Chester	am	Continuous	304	130	76	0	4	10	4	0	2
		Point sample	378	130	108	2	4	12	6	0	4
Froncystylle	am	Continuous	18	6	4	0	4	18	2	0	0
		Point sample	44	8	8	4	64	28	0	6	0
Marston	am	Continuous	12	4	4	0	0	18	0	4	0
		Point sample	40	6	14	0	0	24	4	16	0
		Walk through	18	6	2	0	4	16	2	6	0
Middlewich	am	Continuous	0	0	0	0	0	24	0	0	0
		Point sample	0	0	0	0	0	26	0	0	0
		Walk through	0	0	0	0	0	32	0	0	0
Chester	pm	PIR	380	206	80	0	4	8	4	2	0
		Point sample	504	248	108	4	4	10	6	0	0
Froncyst	pm	PIR	18	2	4	0	0	12	0	4	0
		Point sample	32	2	10	0	58	12	0	6	0
Marston	pm	PIR	12	2	4	2	0	18	2	2	0
		Point sample	44	6	16	2	2	20	2	16	0
		Walk through	4	2	0	0	0	18	0	0	0
Middlewich	pm	PIR	2	2	1	0	0	16	0	2	0
		Point sample	8	4	2	0	0	20	0	2	0
		Walk through	8	4	2	0	0	18	0	2	0

Note: Cumulative total for 6 half hour periods, all data x 2 converted to allow comparison with Low Use Canal and River sites.

Appendix 4b. Cumulative total counts of each pre-defined user category for each survey method at all High Use sites.

Site	Time	Survey Type	Total Walkers	Lone Walkers	Groups of Walkers	Anglers	Moored Boats	Moving Boats	Dog on lead	Dog off lead	Joggers	Cyclists	Other (No. of people)
Newark	am	Continuous	0	0	0	0	0	0	0	0	0	0	0
		Point sample	0	0	0	0	0	0	0	0	0	0	0
		Walk through	0	0	0	0	0	0	0	0	0	0	0
Long Eaton	am	Continuous	0	0	0	0	0	0	0	0	0	0	0
		Point sample	0	0	0	0	0	0	0	0	0	0	0
		Walk through	0	0	0	0	0	0	0	0	0	0	0
Little Leigh	am	Continuous	12	2	3	0	0	1	2	4	0	3	7
		Point sample	13	3	3	0	0	1	3	3	0	4	6
		Walk through	6	2	2	0	0	1	4	2	0	2	6
Newark	pm	PIR	0	0	0	0	0	0	0	0	0	0	0
		Point sample	0	0	0	0	0	0	0	0	0	0	0
		Walk through	0	0	0	0	0	0	0	0	0	0	0
Long Eaton	pm	PIR	0	0	0	0	0	0	0	0	0	0	0
		Point sample	0	0	0	0	0	0	0	0	0	0	0
		Walk through	0	0	0	0	0	0	0	0	0	0	0
Little Leigh	pm	PIR	12	6	3	0	0	0	1	5	0	2	4
		Point sample	14	7	3	0	0	6	2	4	1	3	11
		Walk through	8	1	3	0	0	6	1	1	1	3	5

Note: Cumulative total for 6 half hour periods, Newark and Long Eaton values x 2, Little Leigh unconverted to allow comparison with Low and High Use Canal sites.

Appendix 4c. Cumulative total counts of each pre-defined user category for each survey method at all River sites.