Ongoing monitoring of human uses of Cheetham Wetlands: evaluation of the use of sand pads as a survey technique.

Background

A major component of Birds Australia's Cheetham Wetlands Project (Antos *et al.* 2005) involved the monitoring of human activities and disturbances. This was undertaken because human disturbance has been recognised as a major causal agent of wetland habitat degradation and it has been shown to have significant negative impacts on shorebirds world wide (Thomas *et al.* 2003; Lafferty 2001; Grayson *et al.* 1999; Lord *et al.* 1997).

As well as conducting direct observations of human activities in the wetland, sand pads were also used as a supplementary survey technique. This technique involves the spreading of sand over tracks and strategic access points (Fig. 1.) and then recoding the number, type and intensity of prints present at regular time intervals.

Figure 1. Installing sand pads at the Cheetham Wetlands.

A total of seven sand pads were installed at the Cheetham wetlands and these were monitored at weekly intervals over a period of 13 weeks. Nine different types of tracks were identified from sand pads. The levels of prints on sand pads varied significantly with pads located at access points at the wetland margin having more prints than those located further inside the wetland. The number and intensity of prints recorded on sand pads peaked during Christmas and Easter holiday periods (Antos *et al.* 2005).

During the course of the study, it became apparent that sand pads are an effective tool to measure levels of human use of wetlands. A number of advantages and disadvantages of this method were identified and are summarized below.

Advantages

- Wetlands can be effectively monitored 24 hours a day
- Low impact monitoring strategy
- User friendly requiring no specialist skills
- Subjects are generally unaware they are being monitored

Disadvantages

- Cost and labour intensive as sand requires replacing
- Limited to areas of easy vehicular access
- Effects of weather and print latency remain poorly known
- Susceptible to vandalism
- Potential to offer misleading results
- Information may be lost due to extreme weather events

We conducted a series of controlled experiments in order to gain a better understanding of how sand pads are affected by weather and how long prints will persist. We quantify whether the results obtained from sand pads are representative of actual observed levels of human use. This information will be of key importance to further refine and understand this innovative monitoring tool which has the potential to be employed on all wetlands around Australia.

Methods

1. *Effects of weather and exposure*

1.1 Aims

To determine how long sand pads can be exposed to various weather conditions before prints become difficult to identify or new prints become difficult to be imprinted.

1.2 Rationale

An understanding of print latency and the impact of different conditions and exposure times on sand is essential to determine how frequently sand pads should be checked, raked and topped up.

1.3 Method

Pale brick layers sand will be used in all instances. Brick layers sand will be used because it has greater binding qualities and is less likely to be blown away by the wind when dry. Ordinary sand is generally unsuitable for this reason and would require topping up more frequently.

We have chosen to use pale brick layers sand because it blends in with the natural soil cover at the Cheetham Wetlands. It is important to match sand colour to local conditions as otherwise the sand pad becomes obvious and may be deliberately avoided by people.

Two experimental sand pads were established and subjected to two separate treatments. One treatment was a control with the pad located outside but under cover from rain while the other treatment approximated natural conditions and was exposed to the elements. The covered pad was located under raised transparent plastic sheeting so that it was still exposed to sunlight and wind. Rainfall was measured daily with a rain gauge placed near the sand pads.

Each sand pad was divided into 5 sections and had a standard human footprint (Weight 70 kg) imposed on each section. This was done to give an indication of how prints wear in time. Standard human footprints were determined by walking over a sand pad and measuring the mean depth of eight prints. Mean print depth was established to be 28.6 mm. This was marked on a boot which was then imprinted onto the sand to the required depth.

Sand pads were located in controlled environments where humans and animals had no access. All pads were examined once daily and the maximum depth of prints was measured. Photographs were taken of sand pads at regular intervals. Sand hardening was measured by dropping a 75 mm long nail weighing 6.5 grams into the sand from a height of 30 cm and measuring its degree of penetration over time. This was carried out in an area deliberately set aside adjacent to each print. It soon became apparent that the sand became too hard for the nail to effectively penetrate it so a steel hole punch was used to measure sand hardness as well as the nail.

2. Calibration of sand pads

2.1 Aims

To determine whether the levels of recorded prints on sand pads represent actual levels of use.

2.2. Rationale

It is essential to be able to calibrate actual levels of use with markings on sand pads so that they can be accurately interpreted.

2.3 Methods

A controlled Sand pad was established along a heavily used section of pathway shared by cyclists and pedestrians (path to the 100 Steps to Federation lookout). The number and types of crossings of the sand pad were observed from a distant vantage point where observers were inconspicuous. This allowed the sand pads to be examined after a known number of passes.

A person other than the observer and counter of passes, who was unaware of the number and type of passes, then examined the sand pad. A visual estimate of the percentage cover of different prints on pads was made. Prints were categorised into bike tracks, human footprints and dog prints. The number of discernible individual prints within each category was also made. A measure of the distribution of prints over the width of the pad was taken.

The behaviour of people at sand pads was also noted. Passes were categorised in terms of activity (e.g. cycling, walking) and into one of four categories: proceeded over sand pad without hesitating or looking at sand, proceeded over sand pad without hesitating but looking at the sand, proceeded after hesitating, avoided sand pad.

Results

Effects of weather and exposure on print latency

The latency of five sets of prints in the covered and exposed sand pads was monitored over a period of one month. A substantial increase in the depth of prints was recorded within the period of the first day in both of the treatments. This increase of depth was in the order of around 10% in both cases and is likely to have been caused by the subsiding of the sand within the print during the first 24 hour period. From the third day of measurement onwards, the prints in both the covered and uncovered treatments did not show any major changes in their depth. More variation was detected between the depth of prints located in the exposed pad than in the sheltered pad. The discrepancy of the depths between the covered and exposed pads was a result of the differences in the depth of the initial prints that were made. This difference was generally in the order of 10% and it remained constant through out the duration of monitoring up until the last few days of the experiment (Fig. 1). A significant rainfall event of 39mm occurred during a period when daily print depth could not be taken. This resulted in the only substantial reduction of print depth to be observed during the month that the experiment ran for. It resulted in a decrease in depth of around 4mm or 10% (Fig. 1).

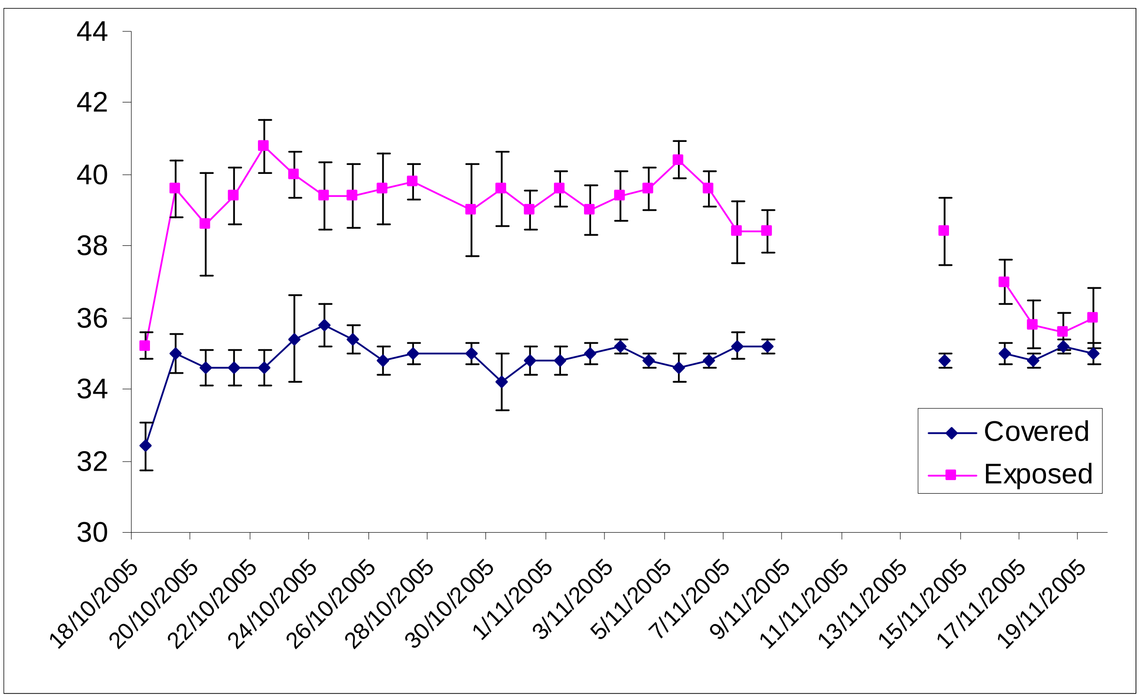

Figure 1. Mean depth (mm) of five prints (± SE) in covered and exposed sand pads measured over one month.

The hardness of both the covered and exposed pads increased by over 80% within the first 24 hour monitoring period. However, while the sand in the covered pad stayed relatively firm throughout the entire monitoring period, the hardness of the sand in the exposed pad was quite variable, showing up to 60% in variation (Fig. 2). Much of this variation can be attributed to rainfall events which generally served to soften the surface of the sand. There was a correlation between rainfall and sand softness (Fig. 3). At the conclusion of the experiment, the sand pad that was kept under cover had become so hard that walking across it did not create an indentation, although the outline of foot prints was visible.

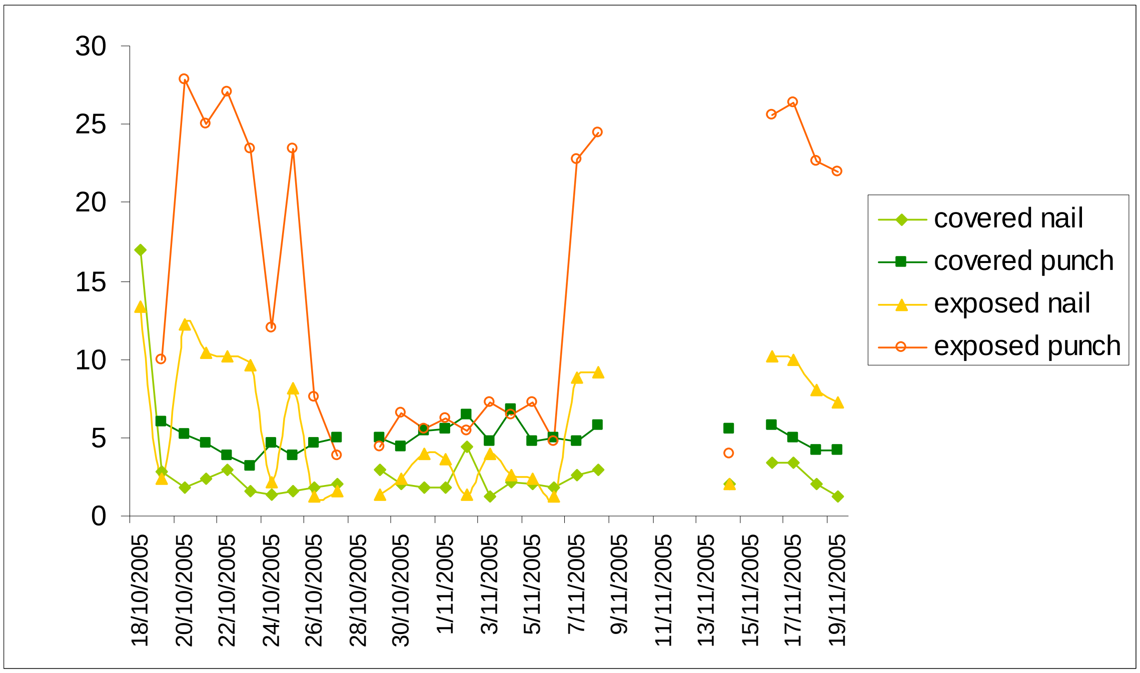

Figure 2. Mean penetration depth (mm) of a nail and steel punch dropped into covered and exposed sand pads from a height of 30 cm.

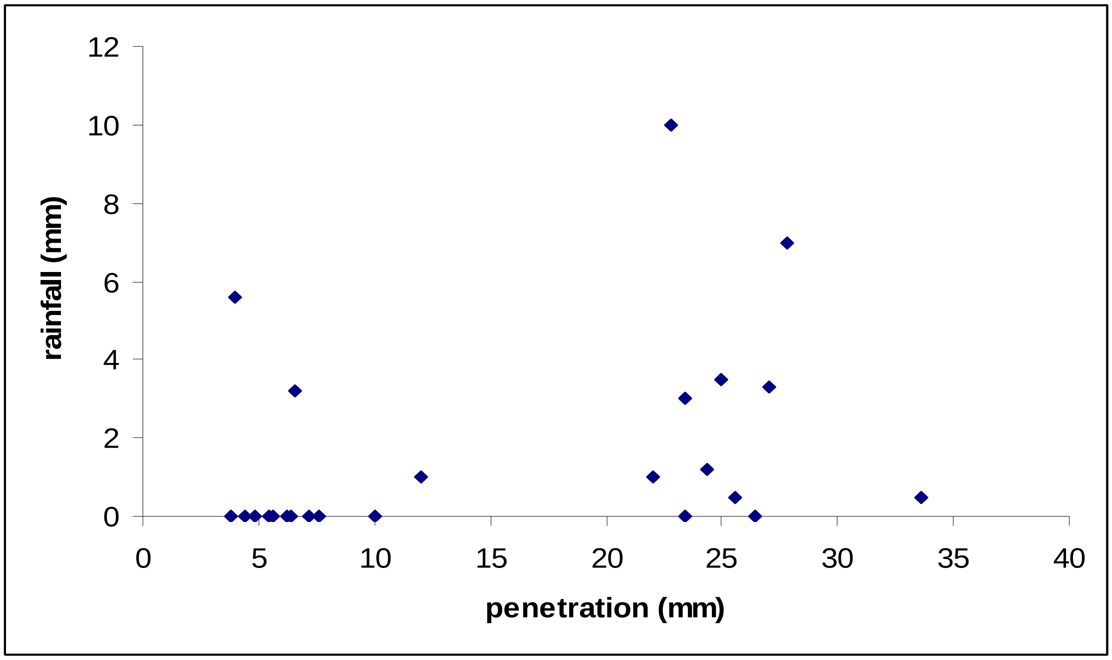

Figure 3. Mean penetration depth of steel punch dropped from 30cm and daily rainfall recorded at the exposed sand pad.

Sand pad calibration

Counts of discernable prints on the sand pad were generally well calibrated with the actual number of passes (Fig. 4). The predictions of bike tracks were the most accurate, while the counts of footprints were generally underestimated by nearly 50%. The overall number of all prints counted corresponded well with the number of actual passes. In most cases, there was a consistent relationship between the number of passes and the estimated percentage cover of prints on the sand pad (Fig. 5). There were only a few instances where a low percentage cover of prints value was obtained after a high number of passes. This was generally associated with multiple passes of bicycles which, by their nature, do not leave a large print impression (i.e. a narrow line), compared with footprints which are broader and each pass results in multiple prints.

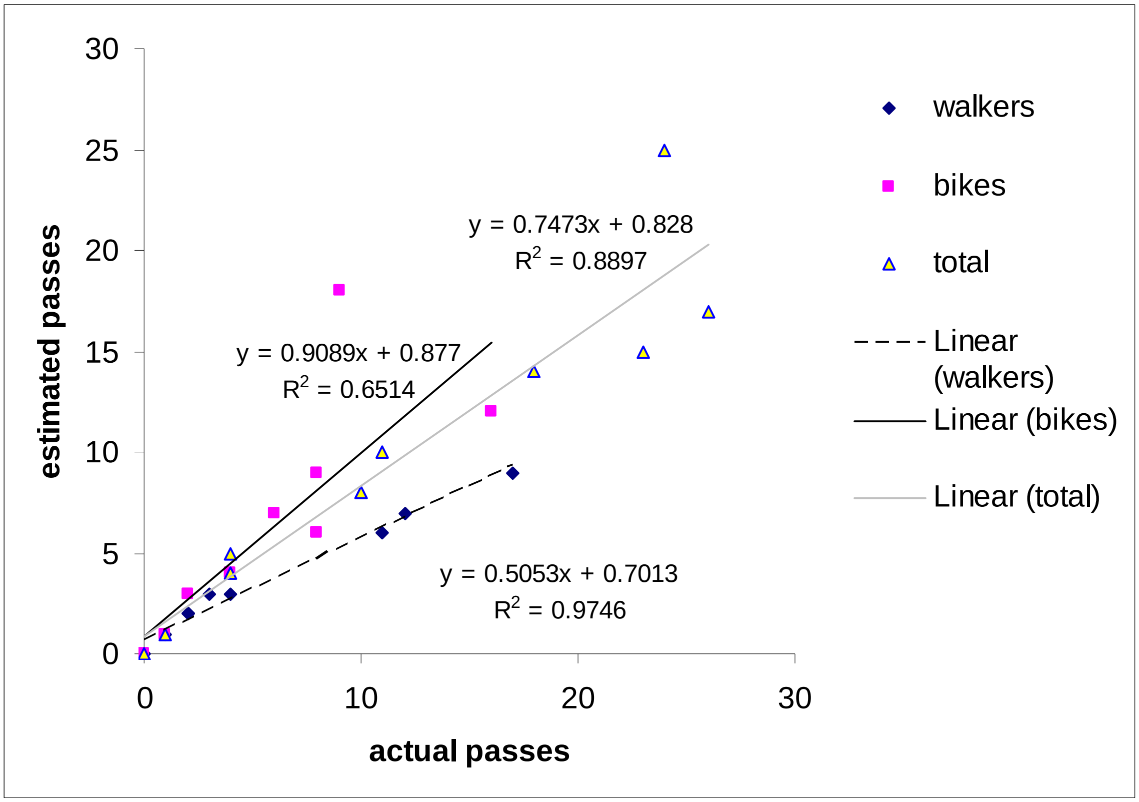

Figure 4. Relationships between the actual number of passes and estimated passes over sand pad. Lines of best fit are shown for all categories along with regression equations and R^2 values.

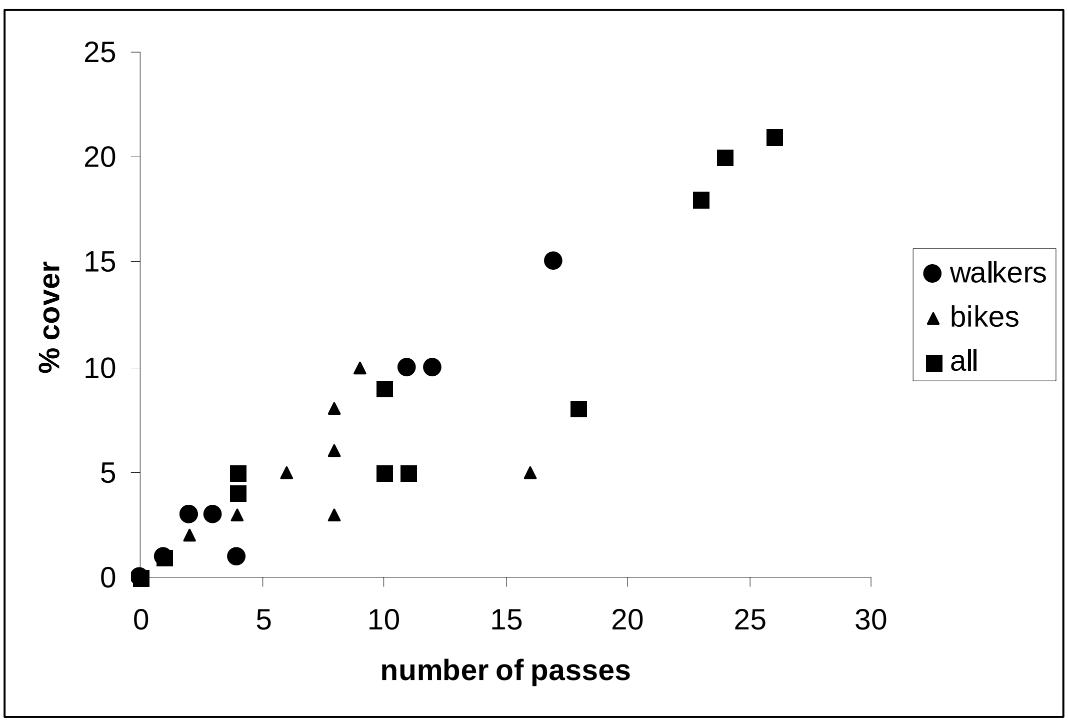

Figure 5. The relationship between the actual number of passes and estimated percentage cover of prints on sand pad.

Generally, a large proportion of the 3500mm width of the sand pad was used by people passing over it (Fig. 6). Rather than tending to follow a singular line of passage, users tended to cross the pad over nearly its entire breadth. As a rule, over 50% of the available breadth of the sand pad was used in nearly every instance. This was even true when small numbers of people (<5) had crossed the pad. Once over 20 people had crossed the pad, as much as 90% of its width was used. This pattern of usage suggests that walking in single file or along a preferred line, and thereby obliterating existing prints, is unlikely to be a major problem at pads as long as they are checked before very high numbers (>30) of users cross them.

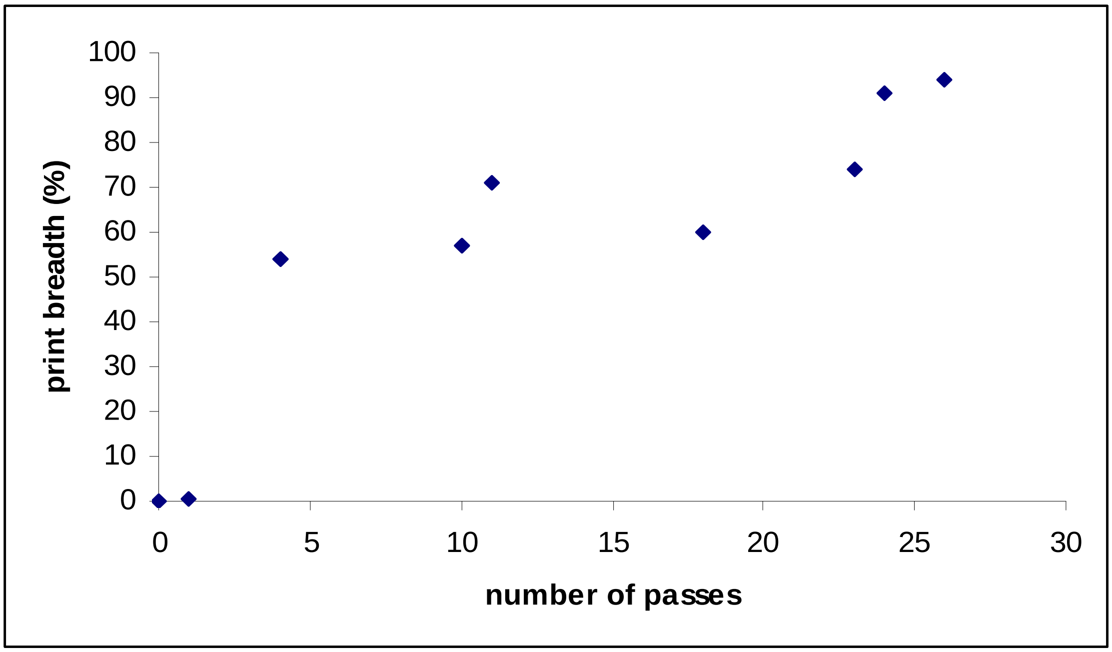

Figure 6. The relationship between print breadth (percentage width of the sand pad covered by prints) and the number of passes.

The behaviour of people at sand pads was very similar, irrespective of their activity (Fig. 7). Over half of all people crossing the pad remained unaware of its existence and did not even glance at it. Approximately 35% of people crossing the pad noticed it but continued to cross without any hesitation. Only a very small number of people hesitated before crossing the pad and levels of pad avoidance were very low (<4% in both cases). This indicates that a high degree of confidence can be placed in sand pads as an accurate tool for detecting human passes.

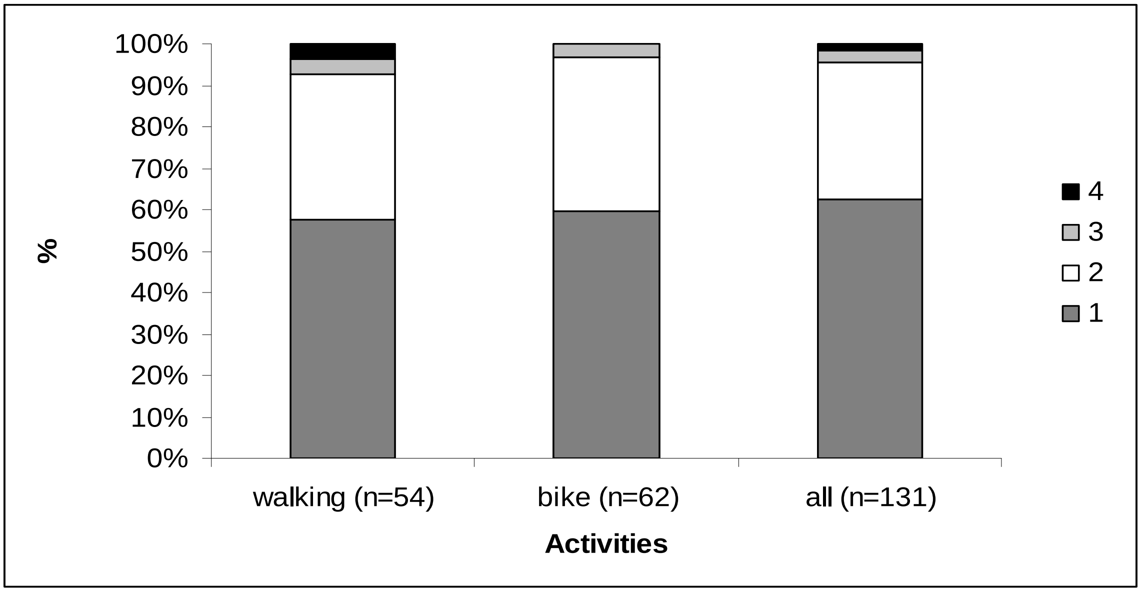

Figure 7. Behaviour of people at sand pads. 1) crossed without hesitation and without looking at pad, 2) crossed without hesitation but glanced at pad, 3) crossed after hesitation, 4) avoided pad.

Discussion

Our results have indicated that human footprints have a very long period of latency within sand pads. They are generally not affected by weather and managed to retain their depth and shape over a period of one month. These findings indicate that information will not be lost from pads if they are not checked frequently. For instance, a checking interval of a week will be sufficient as no prints will be lost.

There is however a tendency for pads to develop a hard crust with time, especially during dry conditions. Our results indicated that this occurred in as little as 24 hours. Although this reduces the penetrability of the sand surface, it does not compromise its ability to record prints. Human prints will still be easily imprinted albeit to a lower depth, provided that the sand receives some moisture. In our experiment, it was very difficult to make an imprint on a sand pad which had not been exposed to rain for over four weeks.

One serious issue with the use of sand pads is their inability to accurately record high levels of usage. While they are a very efficient tool at recording activity at sites with low human traffic (often under circumstances where direct observation is inefficient), they may be less reliable at sites with high volumes of traffic. Difficulties arise with the interpretation of sand pads where heavy use results in the overlapping and potential obliteration of pre-existing prints. This is a particular problem where visitors are likely to take the same path over the sand pad, thus leaving the majority of it blank while a small section is exposed to intense imprinting. However, our trials have indicated that this is unlikely to be a problem provided that the pad is sufficiently wide. People will generally tend to use the entire width of the pad, thus reducing the risk of print overlap, in the short tem at least.

In low traffic situations it is possible to accurately count the number of prints and therefore determine the number of people to have crossed a pad. Measures of percentage print cover are also likely to accurately reflect the intensity of passes. Because the majority of people do not notice sand pads and only a very small proportion avoid them, confidence can be placed in their efficacy and accuracy in recording actual levels of use.

This study has demonstrated that sand pads can be used effectively to monitor human activity at wetlands and other natural areas, especially where there are low levels of visitation and direct observation would prove to be inefficient. The frequency at which sand pads need to be checked and reset by raking will be influenced by the levels of visitation to a site rather than the latency of prints. Given that prints remain well preserved in sand pads over a one month period under a range conditions, inspection at areas of low use can be infrequent.

The findings of this experiment were obtained under controlled conditions. It is likely that in field situations other considerations will need to be acknowledged when determining checking frequencies for sand pads. For instance, our trials at the Cheetham Wetlands revealed that animals such as rabbits would often dig around in the sand pads, potentially destroying prints and reducing the life of the sand pad. Other considerations could include the need to keep pads topped up with fresh sand, especially in particularly exposed situations or on sloping ground where sand loss over time is an issue.

Recommendations

Which areas are most suitable for sand pads?
Sand pads can be used to monitor human activity in any natural or recreational area that receives low levels of usage. It is a cost and time effective way of surveying human visitation to these areas. Where levels of visitation are high, sand pads may not be effective as existing prints may become overlapped and obscured by new prints. In such instances, pads may need to be checked very frequently or another survey method, such as direct observation, may need to be employed.

Where should sand pads be sited?
Sand pads are best sites on unsealed tracks where they will blend in with the surrounding surfaces. Placing the pad on level ground will reduce the erosion of sand and increase the life of the pad. Try to place the pad on a section of track that has tall shrubs or other obstacles on either side of it. This will make it more difficult for people to go around it and will also protect the sand from wind erosion. The pad should be placed across a relatively wide section of track as multiple sets of prints will show up more clearly. If the pad is narrow then people are likely to walk through it along the same line and obliterate existing prints.

How often do sand pads need to be checked?
This will largely depend on the weather conditions and the amount of traffic at the areas being surveyed. In very low use areas with relatively frequent rainfall, footprints will remain discernible for over one month. In low use areas a checking interval of one week will be suitable as no prints are likely to be lost to weathering in this time. In very dry climates, pads may need to be checked and raked every few days. Dry conditions cause the sand to harden and it may reduce its ability to record all prints. If the goal of the

surveys is to record presence of visitors rather than to estimate numbers, pads can be left unchecked for longer.

What sort of sand should be used?
The most important consideration is to choose a sand colour that will blend in with its surrounds. For example, few people may be willing to walk through bright orange sand if it is located on a pale-colored path. Bricklayers sand is probably the best to use. It comes in a variety of colours and has a quality which helps it to bind together. This reduces loss of sand from the pad through wild erosion but also makes the sand develop a hard crust in dry conditions, making it difficult for further prints to be imprinted. Therefore, frequent raking may be required in dry climates.

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