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Overwintering waterbirds and waterskiing at Dosthill Lake

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EXECUTIVE SUMMARY

1. Waterskiing is a popular sport, with an expanding public interest. Much waterskiing activity occurs on inland waterbodies, which can also serve as important sites for waterbirds, particularly in winter.

2. In relation to a planning application at Dosthill Lake, Staffs., this report has three principal aims: (i) identify the questions remaining unanswered from the RPS Ecoscope (2004) report; (ii) review the published scientific literature, reporting on issues pertaining to waterbirds and waterskiing (plus related recreational pursuits); (iii) analyse Wetland Bird Survey (WeBS) data to assess the likelihood of trends at Dosthill Lake reflecting wider waterbird trends.

3. A number of points are raised regarding the RPS Ecoscope (2004) report, including the definition of terms, the treatment and selection of count data, the basis for conclusions and various other miscellaneous issues. The Conservation Management Plan (Carter Ecological Ltd. 2004) seems ultimately well produced, although there are issues to consider, particularly over the baseline data used.

4. A comprehensive and objective literature review documents many instances of waterbird reaction to water-based recreation. The ecological and energetic processes involved are highlighted, as are the indirect consequences of water-based recreation.

5. The construction of indices for nine species using standard WeBS methodology showed that over the period 1995-2002, two species increased, four species remained stable, and three species declined at Dosthill Lake.

6. In an attempt to assess ‘local’ importance, the proportion of birds held by Dosthill Lake in relation to various site consolidations was examined. Of the nine species studied, Dosthill Lake was predicted to hold an average of at least 1% of the regional total for six waterbird species.

7. This report is designed to assist and inform decisions regarding winter waterskiing at Dosthill Lake, based as it is on objective analysis of the WeBS data, and a comprehensive literature search. Targeted experimentation would be necessary to explore more closely site-specific factors.

1. INTRODUCTION

Waterskiing is a popular sport in the UK, and the number of participants is expanding. Current estimates of participants stand at around 200,000, and 54% of water ski clubs are thought to operate on enclosed inland waterbodies (Elson 1998). Many such manmade waterbodies are also important wintering sites for waterbirds (ducks, geese, waders, grebes, herons, rails and other aquatic avian species); Ward (1990) estimates that over 40% of seven waterbird species occurs on manmade waterbodies. Therefore there are likely to be many situations where human activity and waterbird interests overlap.

In 1998, the Planning Inspectorate granted conditional use of Dosthill Lake, near Tamworth, Staffs, for waterskiing in the summer months (March-September). Planning permission was conditional on the dual management of the site for both waterskiing and nature conservation. The lake is utilised during the winter by non-breeding waterbirds, which use it as a feeding and roosting site.

A recent planning application to North Warwickshire Borough Council aimed to vary the condition prohibiting winter waterskiing. In order to examine reports drafted in support of the applicant, and to bring to light previous studies that may assist the process of reaching a decision regarding winter waterskiing at Dosthill Lake, this report sought to fulfil the following aims;

1. Identify the questions remaining unanswered from the consultant's report (RPS Ecoscope 2004) in support of winter waterskiing, and highlight any problems raised.

2. Review the published scientific literature, reporting objectively on issues pertaining to waterbirds and waterskiing (plus related recreational pursuits). Additionally, discover published definitions of contentious terms relating to waterbirds and human activity.

3. Analyse Wetland Bird Survey (WeBS) data for Dosthill Lake, Dosthill Lakes, Kingsbury Water Park (KWP) & Dosthill Lakes, Middle Tame Valley Gravel Pits (MTVGPs) and the Environment Agency (EA) Midlands Region to assess the likelihood of trends at Dosthill Lake reflecting wider and/or regional trends.

2. QUESTIONS REMAINING FROM ECOLOGICAL ASSESSMENT/CONSERVATION MANAGEMENT PLAN

2.1 RPS Ecoscope Ecological Assessment

This section is a critical appraisal of the RPS Ecoscope Ecological Assessment for Dosthill Lake (RPS Ecoscope 2004). The aim is to identify questions that remain to be answered following the report, and to highlight vagaries and areas subject to interpretation.

2.1.1 Data analysis and collection

A crucial part of the RPS Ecoscope report is the species accounts under section 7: "Evaluation of Dosthill Lake as a Site of Importance for Winter Waterfowl" (sections 7.9 – 7.50). This section evaluates the "importance" of various waterbirds. Whilst the presentation of graphs is satisfactory (note that figure legends are muddled, however), it is unclear how the data have been analysed and there is no indication by what means quantification of the 'population' has been arrived at.

It is standard practice in conservation designation to base the numbers of birds held by a site on the five-year peak means of species- that is the average of the peak counts for each of the past five winters. It does not seem that this practice was employed by RPS Ecoscope, and could be easily done using Wetland Bird Survey (WeBS) data.

Another related issue concerns exactly which data are treated in analyses. Using all available data allows analysis of the year-round use of Dosthill Lake. However, under the indexing scheme used by WeBS to highlight relative changes in bird numbers, species are indexed only on the months in which their wintering populations are thought to be stable (*e.g.* Austin *et al*. 2004). Some species, such as Great-crested Grebe *Podiceps cristatus* and Little Grebe *Tachybaptus ruficola*, have their indices based on data collected in September and October. Therefore the data collected by RPS Ecoscope may be incomplete, in that important months for some species are not surveyed.

Similarly, it is unclear how the data at Dosthill Lake were collected by RPS Ecoscope. Section 3.5 states that "counts were made at each viewpoint. Maximum counts from each viewpoint were compared and the highest number used as the peak count". Without presentation of figures, it is not evident whether the 'maximum count' was the summed count across all species, or whether counts were compared species by species. It is also unclear whether observers were consistent between counts.

- *Future reports should outline clearly the calculations behind quantification of the population of birds present, and RPS Ecoscope may wish to consider extending their survey period to include those months in which some species populations are deemed most stable by WeBS.*

2.1.2 Impact, Local and National importance

Frequent reference is made to thresholds of local and national importance, whilst the conclusions refer to the 'impact' of winter waterskiing on waterbirds. These terms are defined in section 3.13, but there appear to be some inaccuracies.

'Impact' is defined as the "reduction of the numbers of specific species in the Tame Valley, as a direct result of the activity of winter water-skiing". This definition overlooks a number of factors. Firstly, no objective measurement of the magnitude of reduction is offered. Therefore, might a decline of one individual be treated as a 'reduction'? Secondly, no time scale is proposed over which to measure such change. Many waterbird populations show fluctuation in population size, therefore it should be specified over what time period the reduction occurs. Thirdly, it may be worth referring to published definitions of 'impact' for added emphasis (e.g. Robinson & Cranswick 2003; see section 3.1).

Finally, the direct causal attribution of waterbird declines to winter waterskiing is not possible without proper structured experimentation, comparing before and after the event counts.

The report offers a definition of 'Local Importance', as being "over the threshold of 0.5% of the national population". It claims this is a recognized criterion for designation as a Site of Importance for Nature Conservation (SINC). However, the criteria used to designate SINCs in Warwickshire includes no such category. Indeed, it seems strange to use a blanket figure such as 0.5% without taking into account local factors. For instance, certain sites may hold key populations of locally declining species, or may harbour species included in local conservation management plans (such as Local Biodiversity Action Plan species). Therefore when assessing 'local importance' it would seem sensible to analyse Dosthill Lake in the context of a unit such as the MTVGPs. This series of nearby man-made waterbodies appears to be a biologically relevant complex, where one might expect birds to move between component lakes. It may also be worthwhile to compare bird numbers at Dosthill with those present in the county or 'region' as a whole. This is perhaps not of such high biological relevance, but for the benefits of statutory bodies may prove useful.

The definition of National Importance given is objective and accurately stated.

- *As 'impact' is an emotive term apparently lacking a standard definition in terms of the effects on waterbirds, its use should be carefully treated. Defining quantifiable and measurable effects of 'impact' would allow all parties to agree on semantics. Reference to the published literature should also be made where possible. The use of a 0.5% of national population threshold to determine 'local importance' is questionable. As there appears to be no standard definition of this term, its usage would appear to be contentious and open to interpretation.*

2.1.3 WeBS analyses

On a number of occasions, the report makes reference to Schedule 1 of the Wildlife & Countryside Act, Annex 1 of the EU Birds Directive and the Birds of Conservation Concern Red List (Gregory *et al.* 2002). These three sources refer to breeding birds, and therefore their applicability to wintering waterbirds is lessened (though not worthless). It may be more appropriate to refer to species identified as declining by the WeBS Alerts system (Austin *et al.* 2004), or at least to make reference to wintering waterbird trends issued in the annual WeBS reports (the latest being Pollitt *et al*. 2003). The Alerts procedure analyses wintering waterbird trends on an annual basis, and in the case of rapid declines, provides an 'early warning system'. It should be noted that the only species found at Dosthill and currently subject to an Alert is Mallard (Medium Alert over 10 and 25 years in England; Austin *et al*. 2004).

Further methodology devised by the WeBS partners to analyse WeBS data can also be applied to the count data from Dosthill. Models have been developed that allow site-specific trends to be assessed in the context of regional and national trends (Banks & Austin 2004). These models are applied later in this report (section 4.1.2).

- *Advanced WeBS techniques should be applied to WeBS count data to objectively assess trends at Dosthill Lake in the context of changes at the wider scale. This will allow quantification of numbers at the site as a proportion of local, regional and, if necessary, national numbers.*

2.1.4 Ecological issues of bird displacement

One mitigating factor cited in the RPS Ecoscope report is the presence of nearby waterbodies, which could potentially be utilised by any waterbirds displaced by waterskiing activities at Dosthill Lake. However, this claim does not take into account a number of factors that could affect local populations in a negative manner.

Firstly, there may be costs imposed if birds become stressed in response to human activity (Platteeuw & Henkens 1997a). Secondly, for a bird to move to another waterbody, it must expend a certain amount of energy it would otherwise have not incurred if undisturbed, and additionally feeding time is lost as a new site is searched for. There is no guarantee that birds will fly to the nearest available site if displaced; there may be issues of site selection that mean birds must fly longer distances to find suitable replacement habitat, as ecological characteristics should be similar to the original site (Ward & Andrews 1993).

Additionally, there will be an effect on whichever waterbody the birds decide to relocate to. If there are already other birds feeding at the site, there will immediately be increased competition for food resources. It is possible that with an influx of birds to the displacement site, this second site could degrade in quality. The carrying capacity of the site would then become reduced, which could affect populations at a local level. Similarly, Dosthill Lake may represent a high quality feeding site, as RPS found that most birds surveyed were feeding (section 6.1.9). Displacement to inferior quality feeding sites could affect the energy budget of foraging waterbirds. According to some sources, any disturbance produced to essential behaviours such as foraging will lead to a likely population decline (Knight & Cole 1991; 1995), though the population scale is not defined.

There is also an issue with the temporal aspect of displacement. Although RPS are keen to stress that the level of water skiing would be restricted to 10 hours per week (and therefore that approximately only 6% of the total hours per week would be taken up with waterskiing), they implicitly assume that birds will return to Dosthill immediately after waterskiing terminates (quote: "Therefore the lake will be available for waterfowl feeding and roosting on average 22.5 hours a day/night"). This may not be the case, as birds can take some time to return after displacement (the so-called 'recuperation time'; Platteeuw & Henkens 1997a), as observed by Hume (1976). At other sites, however, birds were reported to "readily return to the reservoir" after disturbance (Parr 1974).

- *Consideration of displacement of waterbirds must take into account the energetic costs of stress and dispersal. Ecological processes affecting the carrying capacities of refuges should also be taken into account. Similarly, the behavioural responses of waterbirds should not be overlooked, particularly in respect to the timing of return to a site from which displaced.*

2.1.5 Effectiveness of mitigation measures

A number of measures have been proposed or already introduced to attempt to ameliorate any effects that winter waterskiing may have on non-breeding waterbirds. The most prominent of these is the sub-division of Dosthill Lake by constructing bunds along the length of the lake.

RPS state that this division preserves a large area of open water "available on which affected waterfowl may take refuge and continue to feed and roost", and also that "water-skiing activities will be screened from the area remaining available to the waterfowl, by the bund". However, these statements overlook the fact that waterbirds may respond to human activities at distances of up to 700 m (Hume 1976), and also that visual screening of activity is unlikely to fully exclude aural cues. There is likely to be substantial noise generated by motorboats used to tow waterskiiers, and this may be enough alone to affect waterbirds (Dahlgren & Korschgen 1992; cited in DeLong 2002). This effect may be reduced at Dosthill, as according to Knight & Cole (1991), animals elicit a milder response to noise if there is a visual buffer. However, the only evidence for this (Singer 1978) is not from the bird literature, so we cannot be sure of waterbird responses to sound created by powerboats.

Similarly, RPS stress that disturbance will be minimised by the launch location and path of the boat. However, it is reported that some waterbirds (in this case, Goldeneye *Bucephela clangula*) will respond adversely to even the presence of boats (Hume 1976), and Platteeuw & Henkens (1997b) found motorboats to be perceived as more threatening than other vessels by waterbirds.

- *The RPS Ecoscope report does not appear to recognise aural cues created by motorboats as a disturbing factor. Similarly, there is no reference to the scientific literature regarding waterbird responses to human activity. Therefore, the claim that "the overall impact on the wintering population of waterfowl at Dosthill Lake and local vicinity is expected to be insignificant" would appear to be unsubstantiated.*

2.1.6 Miscellaneous comments

Section 5.4: this section states that winter water-skiing "is unlikely to consist of an even 1.5 hours per day per week, but would vary from day to day and week to week depending on suitable weather conditions". There is some suggestion that waterbirds may be greater affected by this type of unpredictable activity than they would be by activity that occurs at regular intervals (Platteeuw & Henkens 1997a and references therein). This is likely to be an effect of a lack of habituation to the source of activity.

Section 6.3.2: although only an occasional record, the presence of a single Smew *Mergellus albellus* in March 2004 technically invalidates the claim that none of the waterbirds recorded were listed under Schedule 1 of the Wildlife & Countryside Act or Annex 1 of the EU Birds Directive.

Section 6.3.7: this section appears to highlight the importance of the open areas of the lake during spells of cold weather. If the variation of the condition prohibiting winter waterskiing is granted, it may be worth considering that a cold weather ban be enforced to prevent unnecessary energy expenditure to energetically vulnerable birds. Davidson & Rothwell (1993) state that mortality can occur within one week of the onset of cold weather, even without the extra costs of response to disturbance.

Section 7.2: The use of Wetland Bird Survey (WeBS) data must be correctly acknowledged under condition 4 of the legally binding WeBS Conditions of Use, namely:

"Data were supplied by the Wetland Bird Survey (WeBS), a joint scheme of the British Trust for Ornithology, The Wildfowl & Wetlands Trust, Royal Society for the Protection of Birds and Joint Nature Conservation Committee (the last on behalf of the Countryside Council for Wales, Department of the Environment Northern Ireland, English Nature and Scottish Natural Heritage)."

At no point is this acknowledgment made.

Section 7.8: this section rather speculatively highlights the potentially negative eutrophic effects of a recently established gull roost at Dosthill Lake, without reference to any scientific literature that supports or contradicts the hypothesis. Some sources in fact claim that most waterbird species prefer eutrophic conditions (Ward & Andrews 1993). Also, there is no recognition that this sizeable gull roost of at least 1,000 birds could be displaced by waterskiing in the same way that waterbirds could, as Section 5.5 states that the lake will "be open from dawn to dusk", potentially coinciding with the presence of roosting gulls. Note, though, that Burger (1981) concluded gulls were likely to return to the place from which they were disturbed when responding to certain types of human activity (albeit not including water skiing). Numbers of wintering Black-headed, Common and Herring Gulls (*Larus ridibundus, L. canus* and *L. argentatus* respectively) are thought to be declining in the Midlands, despite general increases at inland sites (Burton *et al.* 2003a). Any definition of site 'local importance' should therefore factor in numbers of gulls at Dosthill in the context of declining regional numbers.

Also, whilst the potentially negative effects of gulls on the macrophyte community are highlighted, there is again no reference to any published literature, which would support the case. For instance, Burton *et al.* (2003a) mention the risk of gulls acting as salmonella vectors between feeding sites and waterbodies used as roost sites.

Although sites currently tend not to be designated as SSSIs or SPAs on the basis of their wintering gull populations, the results of the 2003/04-2005/06 Winter Gull Roost Survey will be interesting to see if 1% thresholds of national or international population estimates are achieved for any gull species at Dosthill Lake.

Section 9.8: this section is factually inaccurate and vaguely worded. The statement “[f]ollowing regional and national trends the waterfowl populations at Dosthill Lake and the surrounding area are showing signs of decline” is not supported by any reference to data. Indeed, national trends for many of the species involved are stable or increasing (Austin *et al.* 2004). Also the term ‘regional’ is not defined and could relate to any number of spatial scales.

Table 9.1: it is not apparent how the “susceptibility to disturbance from the proposed winter water-skiing activities” is calculated. Certainly there are no references to published estimates of species susceptibility, and thus this category must be considered as speculative only.

2.2 Carter Ecological Conservation Management Plan (CMP)

This section offers opinion on the CMP produced by Carter Ecological Limited (Carter Ecological Limited 2004). We have commented only on those issues pertaining to waterbirds, as we are not in a position of expertise to consider any parts of the plan relating to vegetation or animals other than birds (except where there are obvious and immediate waterbird relationships).

The report seems comprehensive, detailed and well written. There also seems to be flexibility in refining and evaluating targets and management prescriptions. However, there are a number of points that require attention, clarification or review. Some of these will be largely the same as those raised by the RPS (2004) report, as it is referenced extensively.

2.2.1 Waterskiing and waterbirds

Under the General Objectives (section 4.2) stated by Carter Ecological (2004), one is “to maintain the interest of the site for birds, in particular during the winter”. Similarly, the objectives stated for Key Feature 1 (Open Water) (section 4.3.2) include “to maintain levels of disturbance from human activity at levels that will not lead to bird population changes beyond ALoCs [Accepted Levels of Change]”. Both of these objectives would seem contrary to any planned winter waterskiing. The current management prescription (section 5.3.1) states that “waterskiing will be allowed within the prescribed times” (i.e. not between October and March). The proposed CMP would need careful revision to include new ALoCs and management prescriptions, should any proposed winter waterskiing take place.

Under section 5.2, General Management Prescriptions, Prescription G3 proposes the formulation of a Visitor Management Strategy. Although care is taken to reduce disturbance from many visitor activities, including birdwatching and dog walking, no reference is made to management in relation to waterskiing.

2.2.2 Baseline conditions

It is unclear why Carter Ecological (2004) chose to use sporadic bird counts by RPS, instead of the long-running WeBS data that is readily available. Use of the WeBS data would have allowed the calculation of a five year peak mean; this is perhaps a better baseline measure, as any ‘anomalous’ years (e.g. if counts were especially high due to cold weather) would have been averaged out. This can have profound consequences. For example, the five year peak mean count for Shoveler *Anas clypeta* (according to WeBS data from 1998/99 to 2002/03) is 36, compared to a one year peak of 2 birds from RPS Ecoscope. The ‘Favourable Status’ referred to in section 3.2 should perhaps be based on WeBS five year peak means, or the value of the site for waterbirds may be undervalued.

Section 2.2.1 lists all waterbirds identified as the principal species at the site, as surveyed by RPS Ecoscope (2004). Each species is treated in terms of susceptibility to disturbance, and local and national importance. As considered in 2.1.2, none of these terms is referenced or defined in any standard manner (with the exception of national importance). Similarly, there is no reference to wintering waterbird trends (e.g. WeBS Alerts, Austin *et al*. 2004).

2.2.3 Acceptable Levels of Change

Section 4.3.7 outlines what Carter Ecological Ltd consider to be ‘Acceptable Levels of Change (ALoCs)’ to waterbirds. They state that “Decrease in populations of individual waterfowl species that can be attributed to on-site causes…would be unacceptable if they exceed 30% of 2003 levels”. Aside from the issue over baseline data, and the difficulty with assigning cause and effect in bird declines, it is also not clear how this figure is arrived at. Similarly, there is no time frame suggested over which to measure such declines. Finally, should this criteria be applied in a blanket fashion to all species? Should a decline of three birds from a total of ten over the course of a winter be considered ‘unacceptable’? Tighter definition may assist here.

One additional point is that the statement that “most changes are likely to be attributable to national trends in species populations and to land-use changes in the district” is speculative, and overlooks the importance of site-specific factors. Such statements would only be defensible after analysis in the context of wider species trends, preferably using agreed WeBS methodology (e.g. Austin *et al*. 2004, Banks & Austin 2004).

2.2.4 Miscellaneous comments

Section 2.1.2: The area of Dosthill Lake is referred to as 27 ha. This differs from the figure of 54 ha cited by RPS Ecoscope (2004).

Table 9.1: the list of bird species presented, and in particularly the numbers displayed, is potentially misleading, as the survey was conducted in March: the largest concentrations of waterbirds are likely to occur earlier in the winter than this date.

3. LITERATURE REVIEW

A comprehensive search of the scientific literature was conducted, to find any studies that had investigated the relationship between wildlife and recreational activities such as waterskiing and motor boating (the latter vessels often employed to tow water skiers).

The aim of this review is to summarise objectively the scientific literature on the relationship between wintering waterbirds and water-based recreational activity. Some definitions of contentious terms such as ‘disturbance’, ‘impact’, and ‘effect’ will be presented as outlined in the literature. Also, studies of waterbird responses to aquatic recreation will be critically discussed.

3.1 Definitions

Unfortunately, there are no accepted-as-standard definitions for many emotive terms associated with issues where conservation and recreation pursuits overlap. Thus, terms such as ‘disturbance’, ‘impact’, and ‘effect’ can hold different contexts for different parties, and planning decisions can be based on subjective interpretation of disturbance problems as a result (Hockin *et al*. 1992).

3.1.1 Disturbance

- “Any relatively discrete event in time that disrupts ecosystem, community, or population structure and changes resources, substrate availability or the physical environment” (White & Pickett 1985; Cayford 1993)
- “Disturbance is the immediate effect of interference, for example redistribution” (Ward 1990).
- “[A]ny deviation from normal behaviour in response to unexpected occurrences in the vicinity of a bird” (Platteeuw & Henkens 1997a).
- “[H]uman presence or noise which can at critical times redistribute local populations or affect breeding success with possible reductions in the size of bird populations” (Sidaway 1998).
- “Short-term effect on feeding and distribution” (Harbinson & Selwyn 1998).
- “[A]ny intentional or unintentional anthropogenic action that elicits a metabolic or behavioural response” (Morton 1995, quoted in DeLong 2002).

3.1.2 Effects

- “[an effect is] an observed response, i.e. a movement of birds (that may only be a temporary displacement) away from a site in response to some stimuli…birds may be able to use alternative sites during periods of high disturbance at the original site without any negative effects on their energy budget” (Robinson & Cranswick 2003).

3.1.3 Impact

- “[impacts] imply a reduction in survival of individuals, which may cause declines in population size. Impacts depend largely on whether alternative sites are available and the energetic costs of displacement” (Robinson & Cranswick 2003).
- “…impact may be considered as the long-term effect on survival and breeding success” (Ward 1990; Harbinson & Selwyn 1998).
- “Any overall reduction in energy intake…is the impact of disturbance on energy budgets and hence survival” (Davidson & Rothwell 1993).

3.2 Bird distribution, behaviour and human activity

Various factors are likely to determine the response of waterbirds to human activity (Platteeuw & Henkens 1997a). Firstly, response intensity will increase with decreasing distance between the bird and the source of activity. Secondly, species differ in their tolerance to disturbance and the distance at which they will react. According to Platteeuw & Henkens (1997a), Coot *Fulica atra* and Great Crested Grebe are least sensitive to disturbance, with Tufted Duck *Aythya fuligula*, Goldeneye and Shoveler at the opposite end of the spectrum. Thirdly, the predictability of the disturbance will be important, with birds habituating to regular activity but not to unpredictable events. Fourthly, the higher the food supply, the more likely a bird is to remain undisturbed, and finally, the size and species composition of flocks can be an influence in determining behavioural responses to recreation. Larger flocks are more prone to disturbance, with the 'shyest' species (as described above) governing the response of the flock. Ward (1990) adds distance from alternative sites as another factor.

Under Dahlgren & Korschgen's (1992; cited in DeLong 2002) classification scheme, human activities involving 'rapid overwater movement and loud noise' were considered to cause highest amounts of 'disturbance' to waterbirds, water skiing listed as one such activity. Tuite *et al*. (1983) likewise weighted water-based activities involving "noise and movement" as being likely to induce most disturbance. Hockin *et al.* (1992) considered power boating to represent 'active high-level disturbance', which displaces all but the most tolerant species.

Furthermore, powerboats used to tow water skiers, and other rapid and often unpredictably moving sources of disturbance, are frequently perceived by waterbirds as more 'threatening' than slow and steady vehicles (Platteeuw & Henkens 1997b). Birds may also react to them at greater distances than they would for slow-moving objects (Ward & Andrews 1993). Indeed, Hume (1976) noted 'virtually instantaneous flight' of Goldeneye in response to the appearance of a powerboat on the water at Cannock Reservoir, Staffs. Goldeneye flushed from the water at distances of between 550 m and 700 m, appeared to show no habituation, and often did not return to the original site in numbers formerly present. Additionally, Parr (1974) noted a halving of the numbers of non-breeding Teal after the introduction of winter sailing on a Surrey reservoir; however, concurrent increases were apparent on surrounding waterbodies.

Tuite *et al*. (1983), in a rare pseudo-experimental study, found a correlational link between recreational intensity and bird distribution. They showed that 7 of 8 species of waterbird surveyed were significantly excluded from their preferred areas of Llangorse Lake, in response to increasing human activity on the water. In a wider study, Tuite *et al*. (1984) examined further the relationship between recreational activity and bird distribution at inland waters. Although they found no evidence of lower than predicted bird counts on sites with waterskiing or power boating, they concluded this owed more to the (then) restricted numbers of sites supporting such pursuits, combined with the seasonal pattern of activity.

The redistribution of birds in response to human activity is an important factor in considering avian responses to recreation. The main issue at Dosthill Lake appears to be to what extent birds potentially displaced by recreational activity will re-disperse, and what effect this will have on the wider trends of the relevant species. In their literature review, Harbinson & Selwyn (1998) concluded that waterskiing appeared to have "a disturbing impact", with responses of waterbirds including redistribution around the site, or deserting the site completely. However, as often seems the case, no conclusions are reached regarding the combined effects of local impacts.

In other studies, Armitage *et al*. (2001) discovered that areas of high activity on Hickling Broad were avoided by waterbirds. This distribution pattern was considered to be partially an effect of direct disturbance from boats and wind-surfers, and partly due to reduced vegetation in the areas where activity occurred. Edington (1986) reported larger scale re-dispersal of waterbirds in two sites in South Wales. Ducks appeared to arrive at two apparent refuge sites after sailing began on their main waterbodies. However, it is crucial that such refuges are of an adequate size and include the habitat necessary to allow birds to resume their 'normal' behaviours (Harbinson & Selwyn 1998).

Waterbirds may respond to the aural as well as visual component of human activity. Evidently where motorboats are used instead of cable towing, some noise will be produced. Harbinson & Selwyn (1998) reviewed noise-monitoring tests, and found that waterski boats generally produce a noise level of 65-71 dBA. This is within the advised limits of the Noise Advisory Council, and is therefore not considered a nuisance, at least to humans. However, Marsden (2000) found that Pochard and Tufted Duck at an inland dock were more likely to desert the site and fly to a refuge in response to machinery and boats then to pedestrians. It is likely that some aural cues were involved in eliciting this behavioural response. The effect on waterbirds is not clear, although in her extensive treatment of the effects of noise on wildlife, including many examples of (negative) waterbird responses to noise, Bowles (1995) considers the effects of disturbance in response to noise to go undetected at the ‘population’ level (although the meaning of this term is slightly ambiguous).

From a literature review, national levels of waterskiing were judged by Harbinson & Selwyn (1998) to have the ‘least overall impact’ on waterbird numbers in comparison to other recreational activities, partially due to the small number of sites involved. One of the other reasons cited for this difference was the “seasonal nature of waterskiing” (i.e. restriction to the summer months). Evidently, this conclusion could not be extended to the case of Dosthill Lake if winter waterskiing was permitted. Additionally, the authors stress that their conclusion is for ‘national’, and, by implication, not ‘local’, effects.

3.3 Energy budgets, refuges and carrying capacities

Given that most sources seem to agree that some degree of waterbird re-distribution will result from waterskiing activities, the next step is to predict where the birds will move to, and whether this movement will prove detrimental. Hill *et al.* (1997) judged that displacement of over-wintering birds inevitably led to at least one of three outcomes. Firstly, there would be increased bird density on sites already used at the same intensity as the site from which birds were displaced; secondly, a larger proportion of birds would be obligated to forage at sub-optimal feeding areas; thirdly, in the event of a lack of replacement sites, mortality would result. All three factors, in isolation or combination, are negative for wintering waterbirds. Similarly, there may be direct stress placed on waterbirds when faced with human activity. Data presented in Platteeuw & Henkens (1997a) suggest a captive Tufted Duck will undergo approximately a doubling of heart-rate in response to ‘human disturbance’. However, without specific definition of the type of disturbance, and without a larger sample size, it is hard to generalise from this result. Further insight, though not apparently experimental, comes from Gabrielsen & Smith (1995), who list Tufted Duck and Pochard amongst the animals known to exhibit the ‘passive defence response’ in response to human activity. This physiological response involves a reduction in many physiological rates, including heart rate, blood flow and respiration rate, and a general inhibition of activity. Although this inhibitive process is likely to be within the normal physiological repertoire, there are implications of inducing the response- for instance, where birds enter the passive defence response, normal behaviour, such as foraging may be interrupted.

Where birds are forced to cease foraging and either move to another part of a waterbody, or desert a waterbody completely, energy expenditure will increase. Gannets *Sula bassana* undergo a twofold increase in metabolic rate when flying in comparison with surface swimming (Brit-Friesen *et al.* 1989), whilst other measurements place the cost of flight as 12 times the basal metabolic rate (Tucker 1971). The longer the birds fly, the greater the expenditure will be. Food intake or foraging rate must increase to compensate for energy expenditure made in response to displacement by human activity (Platteeuw & Henkens 1997a). Anderson (1995) raises the issue of compensatory energy intake at migratory periods. Flushing birds prior to spring migration could lead to unsuccessful migration or future reproductive problems if insufficient replacement feeding time is found. A reduction of 390 Kcal/day more than doubles the time estimated is necessary to replace lost fat reserves (Anderson 1995).

There is also the possibility that movement to alternative feeding sites could lead to increased competition with other birds already foraging at the second site. This could provoke aggressive interactions and further diminish foraging time (Platteuuw & Henkens 1997a). These density-dependent foraging dynamics could lead to a decrease in energy intake of the local population.

Platteuuw & Henkens (1997a) and Robinson & Cranswick (2003) offer lucid explanations of how frequent disturbance to waterbirds can lead to a decrease in the carrying capacity of a site, and consequently the gradual decline of the population. Compared to an undisturbed site, energy requirements will be greater at a site undergoing frequent disturbance, as birds must compensate for loss of foraging time. This could be either by increasing their foraging rate when re-settling on the original site, or flying to an alternative site where other birds may already be present (leading to increased food depletion and/or competition for food). Therefore the availability of total food resources will decrease and individual food intake will decline, thus reducing the carrying capacity. Where waterbirds are unable to compensate for extra energy loss, a direct degradation in body condition will occur. Tuite *et al*. (1983) provided some direct evidence, concluding that recreation limited the carrying capacity of Llangorse Lake for waterbirds.

The importance of refuges for waterbirds that move in response to human activity is well established. Tuite *et al*. (1983) refer to two (unobtainable) studies suggesting that bird numbers were not adversely affected by human activity if effective refuges existed, and highlighted the need to treat cases on individual merits. The effectiveness of substitute feeding sites, however, will depend largely on the species involved and the characteristics of the refuge sites. Specifically, the level of food competition will determine the level of density dependent mortality. Disturbance that forces birds to avoid sites and forage at alternative sites, already supporting waterbirds and thus experiencing strong food competition and high density-dependent mortality, will lead to a decrease in the total population (Gill *et al*. 1998). However, Tuite *et al*. (1984) note that "most inland wildfowl are mobile and adaptable enough to move out of areas of intensive recreational use temporarily, and return when the pressure is lessened"; furthermore, the same authors also suggest that daytime restrictions on site use may be compensated by nocturnal or crepuscular feeding. Nocturnal feeding was observed in Pochard & Tufted Duck that deserted an inland dock in response to human disturbance (Marsden 2000), allowing compensation for lost feeding time. Ward & Andrews (1993) add that "[p]rovision of refuges is a most effective way of reducing the effects of recreation". However, they also stress that refuges need to have a carrying capacity proportional to that of the original site, and that they must contain good feeding and loafing areas (rather than just remaining clear of disturbance *per se*).

Few researchers have provided evidence of the efficacy of refuges for displaced waterbirds, though in discussing the effects of sailing on wintering waterbirds, Edington (1986) suggests that refuges do compensate the effects of disturbance, but that the total carrying capacity of the main water body is likely to be reduced.

In a study of the effects of sailing on waterbirds at Brent Reservoir, Batten (1977) discovered that some species of waterbirds continued to use the reservoir despite increasing sailing activity. This was made possible by an undisturbed area of the reservoir which provided a refuge. Although Brent Reservoir is comparable in size to Dosthill Lake (51 ha *vs*. 54 ha respectively), Batten's (1977) study focused on sailing dinghies, which tend to be slower moving and less noisy than boats involved with waterskiing. Therefore bird responses to the two activities are unlikely to be the same.

When considering likely waterbird disturbance and refuges for Dosthill Lake, Bélanger & Bédard's (1995) assertion about the effects of disturbance should be considered. If energy intake is reduced so much that compensation is not possible by either feeding at an increased rate during undisturbed periods, feeding during the night, or by using a temporary, ecologically similar, nearby area of habitat, then disturbance can be considered "detrimental".

3.4 Indirect consequences of human activity

As well as the direct, observable changes in bird numbers that may result from winter waterskiing, a number of other processes may occur at a less noticeable level. Waterskiing, and specifically fast-moving motorboats used in the sport, potentially can affect the hydrological and geomorphogical characteristics of a waterbody, which in turn may affect the food web at any trophic level. Any effects will depend on factors such as the morphology of the shore, the intensity of boating, water depth and the type of craft used. Also, the speed of the boat is important. Maximum wakes are produced at boat speeds of 6-8 knots (Harbinson & Selwyn 1998).

Bank erosion may occur with wave formation created by motorboats, whilst the propeller could increase water turbidity (Sidaway 1998) or cut though plant material (Liddle & Scorgie 1980). The latter action could reduce available food resources, whilst the former could also in turn adversely affect plant life. Energy exchange between trophic levels may be reduced by increased turbidity (Blindow & Hargeby 2000), and the re-suspension of sediment may influence light levels reaching primary producers such as macrophytic communities (Harbinson & Selwyn 1998), though the British Water-ski Federation have observed that there is no sediment disturbance by water ski boats in water areas where the depth is greater than two metres, though no source is provided for this claim (from website: http://www.ukmarinesac.org.uk/activities/recreation/r06_05_2.htm). The visibility for diving ducks could be reduced by turbidity increases, though zoning of the waterbody may ameliorate this potential problem at Dosthill Lake. Conversely, aeration of the water could prove beneficial, though Harbinson & Selwyn concluded that waterskiing is likely to make a negligible contribution to the total volume of dissolved oxygen.

Sidaway (1998) identifies pollution ("the deposit of alien material, such as oil, gas, litter or excreta, which contaminates soils, surface or ground water") as a particular potential problem of water sports, though Harbinson & Selwyn (1998) concluded that waterskiing contributed an 'insignificant' amount to hydrocarbon contamination, in relation to other sources of pollution. This factor was even less of a concern in one test where propane-powered boats were used; 400 ppm of carbon monoxide less were recorded than from a petrol/oil-powered boat.

However, the same authors discovered some evidence of toxicity to fish stocks from discharges and emissions, if in 'sufficiently large concentrations'. Unfortunately, the source material is not referenced, and therefore quantification of such emissions is not possible. It is possible that inland waterbodies, which are not flushed by river water, may accrue build-up of discharges, although this cannot be claimed with conviction without further research. The truth is probably that the effects of chemical changes, induced by compounds emitted in oil and petrol, in relation to aquatic organisms is unclear (Cole & Landres 1995).

Liddle & Scorgie (1980), and references therein, describe the literature on the effects of recreation to wider aquatic organisms. Topics covered include the effects of wash and turbidity created by boats, propeller action and pollution. Although they outline the requirement for further research, they do conclude that higher intensity disturbance is likely to lead to decreased richness of plant and animal life.

3.5 Summary

Various studies have shown that short-term redistribution or desertion of sites is likely to result from human activity, depending on the source of disturbance and the species involved. Given that powerboats used in waterskiing are thought to represent 'active high level disturbance' (Hockin *et al*. 1992), it seems likely that such activity will displace wintering waterbirds.

Repeated disturbance during overwintering can have a "dramatic effect on a bird's energy balance" (Hockin *et al*. 1992), and this review has highlighted the potentially deleterious effects of waterbird displacement, in terms of extra energy expenditure and loss of foraging time incurred. However, the mitigating effects of nearby, ecologically similar refuges have been illustrated, although density-dependent population dynamics may be a factor. Gill *et al*. (1998) go so far as to speculate that disturbance to unthreatened species may be permissible: "for species which are not threatened and whose populations are either stable or increasing, the sensible approach is likely to be that even if human activities are altering the distribution of the birds and possibly even restricting their use of particular areas, there may be no need to alter the *status quo*".

However, if Robinson & Cranswick's (2003) assertion that disturbance can be equated to habitat loss (due to the reduction of site carrying capacity) holds true, then reduced survival rates and consequently population declines could result from enforced long-term displacement. Burton *et al*. (2003b) demonstrated that following habitat loss at Cardiff Bay, displaced adult Redshank *Tringa totanus* were subsequently significantly lighter than those originally found at the refuge site, and also experienced depressed winter survival rates compared to their pre-displacement survival rate.

What is clear from the literature is that there are still substantial gaps in knowledge about the long-term effects of water-based recreational activity on waterbirds. It is not possible to judge, for instance, whether energy losses are sufficient enough to lead to bird declines, or whether pollution from powerboats alters the relevant ecosystem. However, the point is made by Hill *et al*. (1997) that individual cases should perhaps not be treated in isolation, as there may be combined effects when considering other ventures ("there may be many more developments which are of less obvious individual importance for birds but which may have a significant cumulative impact").

4. ANALYSIS OF WeBS DATA IN CONTEXT OF WIDER TRENDS

4.1 Methods

4.1.1 Data and Site Structure

4.1.1.1 WeBS data

Data from the Wetland Bird Survey (WeBS) were used in the analysis. WeBS is a long-term waterbird monitoring scheme, relying on the monthly counts of thousands of volunteers across the UK. WeBS Core Counts were used for all site and site consolidation comparisons, for which data were available during the period 1994/95 (hereafter 1994) to 2002/03 (hereafter 2002).

WeBS annual indices are calculated using count data collected between September and March. Within this period, the months for which the numbers of a given species are at their most stable are those used for producing the index, and these months differ between species (Austin *et al*. 2004). The species identified by RPS Ecoscope (2004) were analysed in this report, using data from standard indexing months (Table 4.1.1.1). A consequence of adopting the standard WeBS indexing months is that, in addition to the breeding season, the passage period is also excluded from analysis, thereby guarding against large transitory fluctuations in numbers.

Species	Code	Great Britain
Great Crested Grebe (*Podiceps cristatus*)	GG	SON
Wigeon (*Anas penelope*)	WN	J
Gadwall (*Anas strepera*)	GA	SONDJFM
Teal (*Anas crecca*)	T.	D
Mallard (*Anas platyrhynchos*)	MA	DJF
Pochard (*Aythya ferina*)	PO	NDJ
Tufted Duck (*Aythya fuligula*)	TU	NDJF
Goldeneye (*Bucephala clangula*)	GN	F
Coot (*Fulica atra*)	CO	SONDJ

Table 4.1.1.1 Standard indexing months used in WeBS analyses (e.g. Austin *et al.* 2004) for the predominant species recorded at Dosthill Lake.

4.1.1.2 Site consolidations

Analyses were performed at various spatial scales. Smoothed indices were produced for all species at the site level, stored in the WeBS database as Dosthill Lake (WeBS code #41706). Also, trends were created for the same species at three other levels of consolidation; Dosthill Lakes (WeBS code #41249), Kingsbury Water Park (KWP) & Dosthill Lakes (WeBS code #41251) and Middle Tame Valley Gravel Pits (WeBS code #41751). Figure 1 and Tables 1 and 2 (in the appendix) show the component waterbodies for these consolidations.

To compare site trends with regional trends, counts made on WeBS sectors across the Environment Agency (EA) Midland region were used. The boundaries of this region are discernible from the EA website (http://www.environmentagency.gov.uk/regions/midlands/?lang=_e), and are based on water catchment area.

4.1.2 Analysis

Full details pertaining to the use of Generalized Additive Models (GAMs; Hastie & Tibshirani 1990) for the calculation of annual waterbird indices and the fitting of smoothed trend curves (*e.g.* by the

WeBS Alert System) are available elsewhere (Atkinson *et al*. 2001; Leech et al. 2002). An overview is given here.

4.1.2.1 Annual indices

The index value for a particular winter is the number of birds present in that winter (summed monthly counts) expressed relative to the number of birds present in the base winter, which is arbitrarily set at 100. The base winter is assigned to be the most recent winter in the data being analysed.

4.1.2.2 Smoothed GAM trends

Natural temporary fluctuations in numbers, for example those caused by variation in the severity of conditions over the winter period, can differ in size and / or direction from longer-term trends, hindering their interpretation. Extreme values may trigger false 'Alerts' (in terms of >25% declines using WeBS methodology) due to misinterpretation of temporary, short-term declines as longer-term trends. Alternatively, long-term trends that may have led to Alerts being flagged could be obscured by short-term fluctuations. In order to avoid such misinterpretations and misidentifications when calculating Alerts, the Alerts System uses GAMs to fit a smoothed trend curve to the annual indices, and this technique is adopted here. This it does by a reduction in the number of degrees of freedom available to the GAMs. As the number of degrees of freedom is decreased from (n-1) the trend becomes increasingly smooth until ultimately with one degree of freedom the smoothed curve becomes a linear fit. The WeBS Alert System adopts a standard (n/3) degrees of freedom to produce a level of smoothing that, while removing temporary fluctuations not likely to be representative of long term trends capture those aspects of the trends that may be considered to be important.

Changes in numbers calculated using values from a smoothed GAM trend are less likely to be due to the effects of temporary fluctuations in numbers, or to errors when sampling, than results produced were annual index values to be used. Thus, using GAMs reduces the probability that a decline from a short-lived unsustainable peak in numbers would be misinterpreted as a noteworthy decline.

4.1.2.3 Regional and local comparisons

To compare trends at the site level (*i.e.* Dosthill Lake) with those for the same species at wider spatial scales, additional statistical procedures recently developed for WeBS Alerts (Banks & Austin 2004) were employed. Generalized Linear Models (GLMs; McCullagh & Nelder 1989) were used to assess the relative proportion of the complex total (*i.e*. Dosthill Lakes, KWP & Dosthill Lakes or Middle Tame Valley Gravel Pits) held by the target consolidation (*i.e*. Dosthill Lake). This procedure was also used to investigate the proportion of the regional totals supported by the site.

The proportion, i.e. the number of birds counted at Dosthill Lake per year divided by the total for each complex or regional number for the year, was modelled by logistic regression. The models were binomial and specified a logit link function. Count values were only included in analysis where coverage was complete. Counts flagged as 'poor quality' were not included for analysis.

Output plots were generated for each species / site combination. In this way, the proportion of the region's birds occurring at a given site could be calculated across years. The 95% confidence limits obtained represent the confidence in the calculation of the predicted proportion as it varies with the total number of birds in the complex or region, and the between-month variation in the average proportion a site holds in a given winter.

Changes in waterbird numbers are reflected in three possible proportional trends; positive, negative and stable.

Where numbers on a site undergo expansion, and regional trends decline or remain stable, a proportional increase is seen at the site under review. The trend is for estimates to increase with time, with largely non-overlapping confidence limits.

Negative trends in the proportional estimate suggest one of three scenarios, and consideration of species' regional and site trends can determine which applies. Firstly, the site trend could be in decline while the regional trend increases or remains stable. Thus the proportion at the site becomes smaller as the two trends diverge. Secondly, the site trend could be stable whilst the regional trend increases. Thirdly, both trends may increase, but at different rates. If regional counts were formerly low, a particular site may have held a relatively high proportion of the regional total. If the species in question then expands across the region but remains stable at the site, the relative proportion at the site will decrease.

Plots can also be produced that suggest a species is relatively stable in numbers in comparison to the region, typically where a horizontal line can be drawn between the ranges of all confidence limits. These plots do not signify in which direction the site and regional trends are heading (i.e. increasing, decreasing or stable), merely that they remain consistent to each other.

4.1.3 Results

Nine graphs are displayed for each of nine species. These species were chosen for consistency with RPS Ecoscope (2004), though as very small numbers of Shoveler were recorded on their standard indexing months of September and October, this species could not be analysed. The five graphs in the left-most columns (4.1.3.1-4.1.3.9 (a)) show the smoothed GAM trends for Dosthill Lake, Dosthill Lakes, KWP & Dosthill Lakes, MTVGPs and the EA Midlands region. The four graphs in the right-most columns (4.1.3.1-4.1.3.9 (b)) show the proportion of birds Dosthill Lake holds in relation to Dosthill Lakes, KWP & Dosthill Lakes, MTVGPs and the EA Midlands region. Confidence limits are also shown.

4.1.3.1 Great-crested Grebe

At Dosthill Lake, the Great-crested Grebe trend has been to increase in a near-linear fashion since 1995. This pattern is very similar when the gavel pits in the immediate vicinity are also considered, within the complex of Dosthill Lakes. The MTVGPs show a U-shaped function, with three years of elevated counts (1998-2000), which may be as a result of trends at KWP; at this consolidation, the trend does not match that at Dosthill Lakes, therefore it is likely that bird numbers at KWP contribute to the undulating nature of the trend for Great-crested Grebe.

As the trends at Dosthill Lake and in the EA Midlands Region are so alike, it is unsurprising that the regional proportion of Great-crested Grebes held by Dosthill Lake remains consistent, as reflected by the graph of predicted proportion. This proportion is also consistently low, never rising above 1%. The proportions of birds on the MTVGPs and KWP & Dosthill Lakes change in similar patterns, with the proportion lower during the three years of high counts on the latter sites, as Dosthill Lake itself did not show such peaks. Dosthill Lake was rarely predicted to have held greater than 20% of the Great-crested Grebes present on the MTVGPs. In relation to the Dosthill Lakes complex, Dosthill Lake itself has held a steady proportion of Great-crested Grebes, predicted to be around 40%. As both KWP and MTVGPs show declines in recent years, whilst Dosthill Lake(s) show increases, it may be that Dosthill Lake assumes increased 'local' importance in future years.

4.1.3.2 Wigeon

Wigeon trends within the MTVGPs in general have declined since 1997, after two winters of increases. This trend can be seen for Dosthill Lake, Dosthill Lakes, KWP & Dosthill Lakes and the MTVGPs. The rates of decline at Dosthill Lakes and KWP & Dosthill Lakes appear particularly steep. The regional trend shows a different pattern, with a sharp increase counterbalanced by a recent decrease, leading to little relative change over the period of analysis.

The predictions from the binomial models show that Dosthill Lake sometimes holds a large proportion of the regional total of Wigeon. In five of the eight years of analysis, upwards of 6% of the regional total were held by Dosthill Lake, and in 1996 this figure was as high as 10%. Three of the four latest years of analysis have shown a decrease in the proportion of the Midlands total held by Dosthill Lake, suggesting that either numbers in the wider region increased whilst those at Dosthill Lake remained stable, or that declines at Dosthill Lake were greater than those in the region. The latter would appear more likely from the trend graphs.

Similarly, the predicted proportion of Wigeon supported by Dosthill Lake in relation to all other spatial scales analysed remained between 40% and 100% in all years barring 1999 and 2000. It would therefore seem likely that counts at Dosthill Lake were low in these years, whilst on other sites, numbers increased. Dosthill Lake would seem the preferred site in the context of Dosthill Lakes, predicted to hold nearly 100% of Wigeon in most of the years of analysis, and above 80% of the Wigeon supported by KWP & Dosthill Lakes in the same years. Even at the MTVGP level, upwards of 60% of the total numbers of Wigeon are often predicted to occur at Dosthill Lake.

One caveat is that Wigeon are only indexed using data from January counts. Any changes happening outside of this month, for instance a localised change in the phenology of migration, will not be detected.

4.1.3.3 Gadwall

On a national basis, Gadwall trends are steadily upward (Austin *et al*. 2004), and this pattern is repeated for the Midlands as a region. The index for the MTVGPs has undulated somewhat, but is now showing a similar rate of increase as regionally. However, quite the opposite trend is evident at the KWP & Dosthill Lakes comples, with an almost linear decline since 1995. The reason for this decline would appear to be due to changes at KWP, as the trend at Dosthill Lakes has been stable for a number of years, and the index shows an overall increase since 1995. However, this stability cannot be attributed to numbers at Dosthill Lake, as a decline is apparent from a peak in 1997, though the overall trend is of no appreciable change since 1995.

The importance of Dosthill Lake in relation to other site consolidations appears to be diminishing. During the period of increase between 1995 and 1998, predicted proportions of Gadwall at the Dosthill Lakes complex were around 90% for Dosthill Lake. This figure has declined to a stable proportion of around 40% in recent years (though note the wide confidence intervals). The pattern of decreasing and then stabilising proportions of totals held at Dosthill Lake is the same for KWP & Dosthill Lakes, MTVGPs and the region as a whole. For the latter, around 1% of the regional total is now found at Dosthill Lake, declining from a prediction of approximately 4%. It seems as though sites other than Dosthill Lake are absorbing the majority of the regional increase.

4.1.3.4 Teal

Trends in the index for Teal differ depending on the spatial scale examined. At the largest scale, the Midlands region, continual declines are evident since 1995, and this pattern is replicated on the MTVGPs. This suggests that the MTVGPs may contribute greatly to the regional total of Teal. However, at the finer levels of analysis, periods of decline have only begun in recent years, with relative stability or increase prior to the late 1990s. As numbers at Dosthill Lake appear stable in comparison to the wider spatial scale trends, this suggests that Dosthill Lake is a preferred site at the local level.

The proportion of wintering Teal supported by Dosthill Lake changes between years. In relation to the complex of Dosthil Lakes, and KWP & Dosthill Lakes, Dosthill Lake itself sometimes held 100% of the Teal, and sometimes held none. In the years where Teal were recorded at Dosthill Lake, these tended to represent around 10% of the total on the MTVGPs, with a larger proportion predicted in 2000. This peak in 2000 is reflected in the smoothed trend, and was enough to exceed 2% of the regional total of Teal. In other years Dosthill Lake held only a fractional proportion of this total.

4.1.3.5 Mallard

Mallard trends are increasing at Dosthill Lake, and also in the wider Dosthill Lakes complex; realistically, however, numbers are fairly small. These trends are against those in the Midlands region and the MTVGPs, which have shown steep declines since 1995. In spite of these trends, Dosthill Lake has supported a consistently low proportion of the regional total, and between 0 and 30% of the MTVGPs total.

However, in the past four years, the proportion of Mallard at Dosthill has decreased compared with Dosthill Lakes. As the trends are very similar, this implies the gravel pits surrounding Dosthill Lake are supporting numbers of mallards at a greater rate of increase than at Dosthill Lake itself. However, Dosthill Lake is of increasing importance within the overall complex of KWP & Dosthill Lakes. The trend for the latter complex has been for declines in the last four years, in opposition to Dosthill Lake. Therefore Dosthill Lake(s) hold a rising proportion of local Mallards, and show positive trends in contrast to wider population changes.

4.1.3.6 Pochard

At all spatial scales analysed, Pochard indices show declines, contrary to the trend for England which is stable (Austin *et al.* 2004). The patterns of declines are not identical, as the MTVGPs index showed stability before a drop-off in 2002. It is possible that this may be a temporary anomaly and that the index will recover in future years. However, over the period 1995-2002, severe declines were evident in all cases.

Dosthill Lake usually holds a high proportion of the Pochard counted within Dosthill Lakes, and within KWP & Dosthill Lakes, though in some years the confidence limits suggest caution. A consistent proportion of the Pochard held within the MTVGPs and the Midlands region were counted at Dosthill Lake. This suggests that trends have been roughly similar and bird number changes comparable to each other. Within the MTVGPs, most estimates of the proportion held by Dosthill Lake are just under 10%, with large upper confidence limits. Within the Midlands region, a predicted proportion of around 2% is supported at Dosthill Lake (again, with large upper confidence limits, suggesting the true proportion may be higher).

4.1.3.7 Tufted Duck

The declining trend at Dosthill Lake (and the two consolidations containing Dosthill Lake) would appear to be influenced by two years of high counts in 1995 and 1997, since when numbers have remained largely stable. The trend at the MTVGPs closely resembles that for Pochard (4.1.3.6) with a sharp decline in 2002. It is not clear why this should be, although it is possible that one or more important waterbodies (outside of the KWP & Dosthill Lakes complex) became unsuitable for such species. The regional trend for Tufted Duck shows steady declines since the late 1990s, so with the exception of 2002, the MTVGPs have not reflected the wider pattern.

Although Dosthill Lake seems to now support a fairly stable proportion of Tufted Duck wintering at Dosthill Lakes, its importance in the context of KWP & Dosthill Lakes is increasing. It seems likely from the trend graphs that numbers are declining more rapidly at this wider level than at Dosthill Lake, thus meaning that a greater proportion of this total is recorded at the latter site alone.

Dosthill Lake continues to hold a consistent proportion of the Tufted Duck within the MTVGPs, which tends to be between 5% and 13%. The regional proportion supported also seems fairly consistent, despite the different patterns in the smoothed trends; this is probably an effect of dilution, as the regional numbers are very large. In five of the eight years of analysis, the proportion of Midlands region Tufted Duck held at Dosthill Lake exceeded 1%.

4.1.3.8 Goldeneye

Goldeneye trends at Dosthill Lake and two of the consolidations analysed (Dosthill Lakes and KWP & Dosthill Lakes) are remarkable similar, showing relative stability over the time period assessed. It is perhaps then unsurprising that Dosthill Lake consistently held a large proportion of the total numbers of Goldeneye found at these sites. Predictions for Dosthill Lakes indicate that between 60% and 80% of the total for this species were counted on Dosthill Lake. A similarly high figure is predicted to occur at the next level of analysis, KWP & Dosthill Lakes. Therefore Dosthill Lake would seem highly contributory to the Goldeneye total within this context.

Within the MTVGPs, Dosthill Lake is acquiring an increasing proportion of this species, as the site level trend remains stable in relation to the wider trend. Over the period of analysis, Goldeneye in the Midlands region have undergone no overall change, but this masks a large increase followed by an equivalent decrease. In spite of this trend, the regional proportion of Goldeneye counted at Dosthill Lake has remained largely unchanged, tending to represent just under 4%. If numbers remain stable at Dosthill Lake and regional numbers continue to decrease, the lake will assume a greater importance in the context of regional numbers of this species.

4.1.3.9 Coot

In the Midlands region as a whole, Coot trends have risen in the last few years, leading to an overall increase over the period of analysis. Trends for the other four spatial scales examined have not exhibited the same pattern, usually showing shallow declines or stability. Trends are similar to those for Gadwall (4.1.3.3), which is to be expected, as these species are commonly associated with each other.

Dosthill Lake holds a similar proportion of the Coot found at both Dosthill Lakes and KWP& Dosthill Lakes. This perhaps indicates that the majority of Coot are usually found within the Dosthill Lakes complex, and that relatively few Coot are supported by the other waterbodies in KWP. The actual proportion held fluctuates between years, and confidence limits are wide suggesting there may be much between-month variation.

At the level of MTVGPs and the Midlands region, the proportions held by Dosthill Lake have remained fairly level, with the exception of a greater proportion present in 1996, this reflected an isloated high count. At least 1% of the regional total is predicted to occur on Dosthill Lake in six of the eight years studied.

4.1.3.10 Regional proportions

Table 4.1.3.10 shows the mean predicted proportion of birds, averaged over the period 1995-2002, held by Dosthill Lake in relation to the EA Midlands region as a whole. The trend of the proportion held by Dosthill Lake is also displayed. Where the proportion is increasing, Dosthill Lake is increasingly important for that species on a regional basis. Where the proportion is decreasing, it is likely that numbers at Dosthill Lake are declining or stable, whereas regionally numbers are increasing. Where the proportion appears to remain stable, trends at Dosthill Lake and within the region are likely to be similar. Variable proportions are referred to where there is no discernible trend, and proportions fluctuate between years.

	Mean predicted proportion	>1% Regional total	Proportional trend
Great-crested Grebe	0.003896	NO	Stable
Wigeon	0.051914	YES	Variable
Gadwall	0.013441	YES	Decreasing
Teal	0.004772	NO	Stable
Mallard	0.003009	NO	Increasing
Pochard	0.012545	YES	Stable
Tufted Duck	0.015548	YES	Decreasing
Goldeneye	0.026963	YES	Stable
Coot	0.016506	YES	Stable

Table 4.1.3.10 Averaged predicted proportion and trend of proportion of birds held by Dosthill Lake, in relation to regional bird numbers, over the period 1995-2002.

The table shows that six species found at Dosthill Lake occur in an average proportion of greater than 1% of the regional total. Of these, Gadwall and Tufted Duck tend to be decreasing in their proportional trends; conversely, Mallard, which currently averages 0.03% of the regional total at Dosthill Lake, seems to be increasing in proportion to the region.

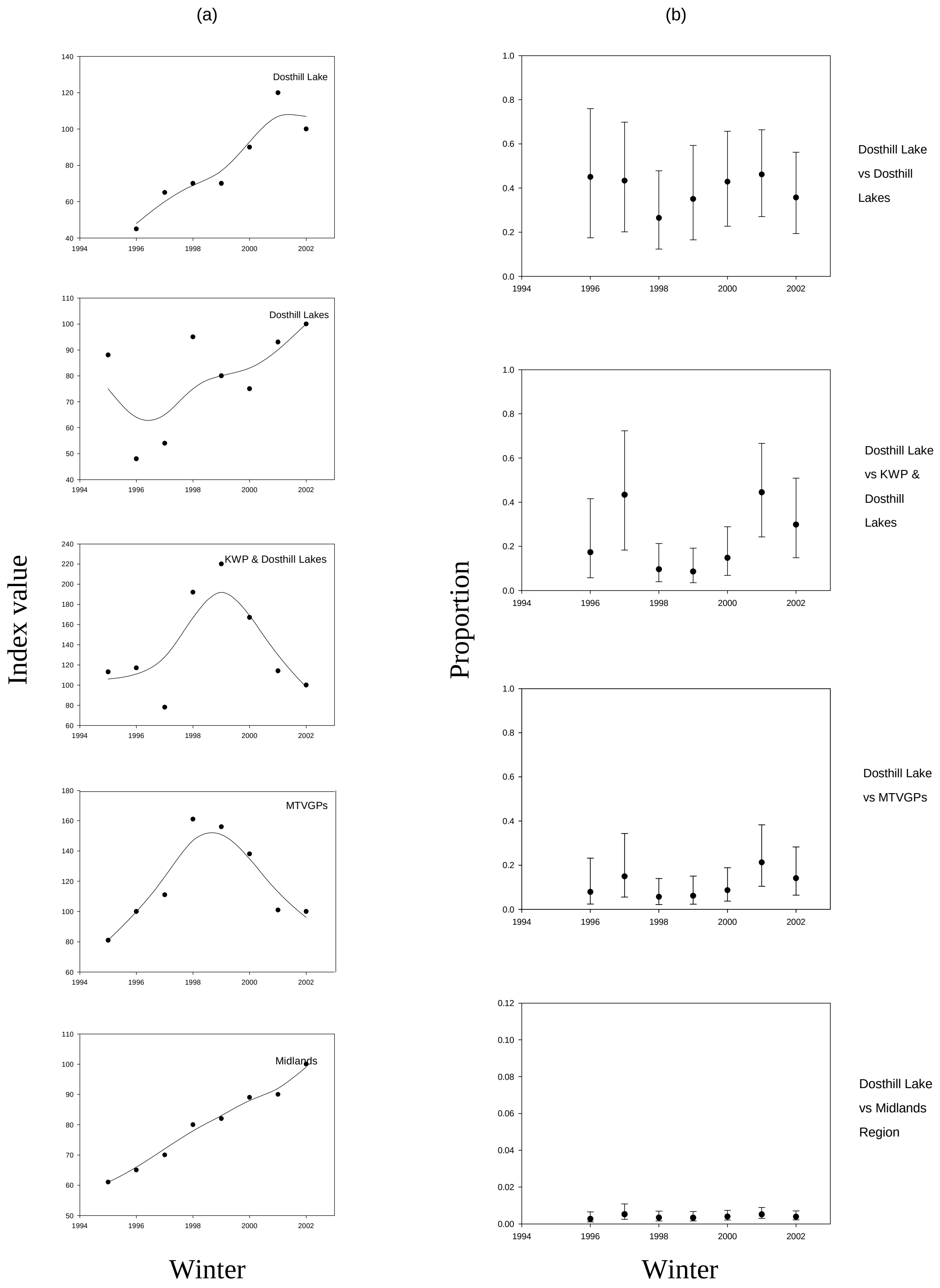

Figure 4.1.3.1 (a) Smoothed GAM trends for Great-crested Grebe. (b) Predicted proportion of Great-crested Grebe at Dosthill Lake in relation to various spatial scales.

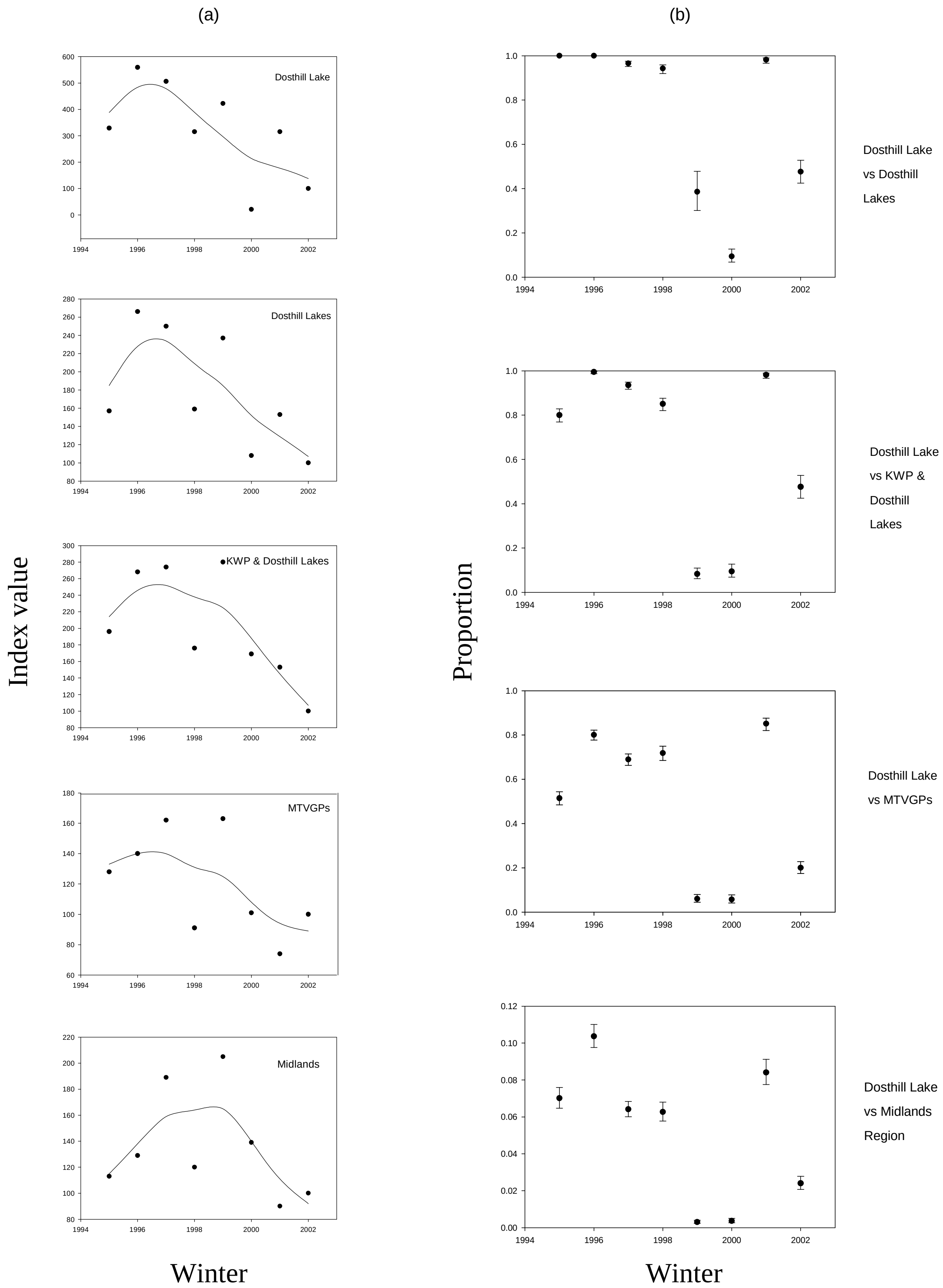

Figure 4.1.3.2 (a) Smoothed GAM trends for Wigeon. (b) Predicted proportion of Wigeon at Dosthill Lake in relation to various spatial scales.

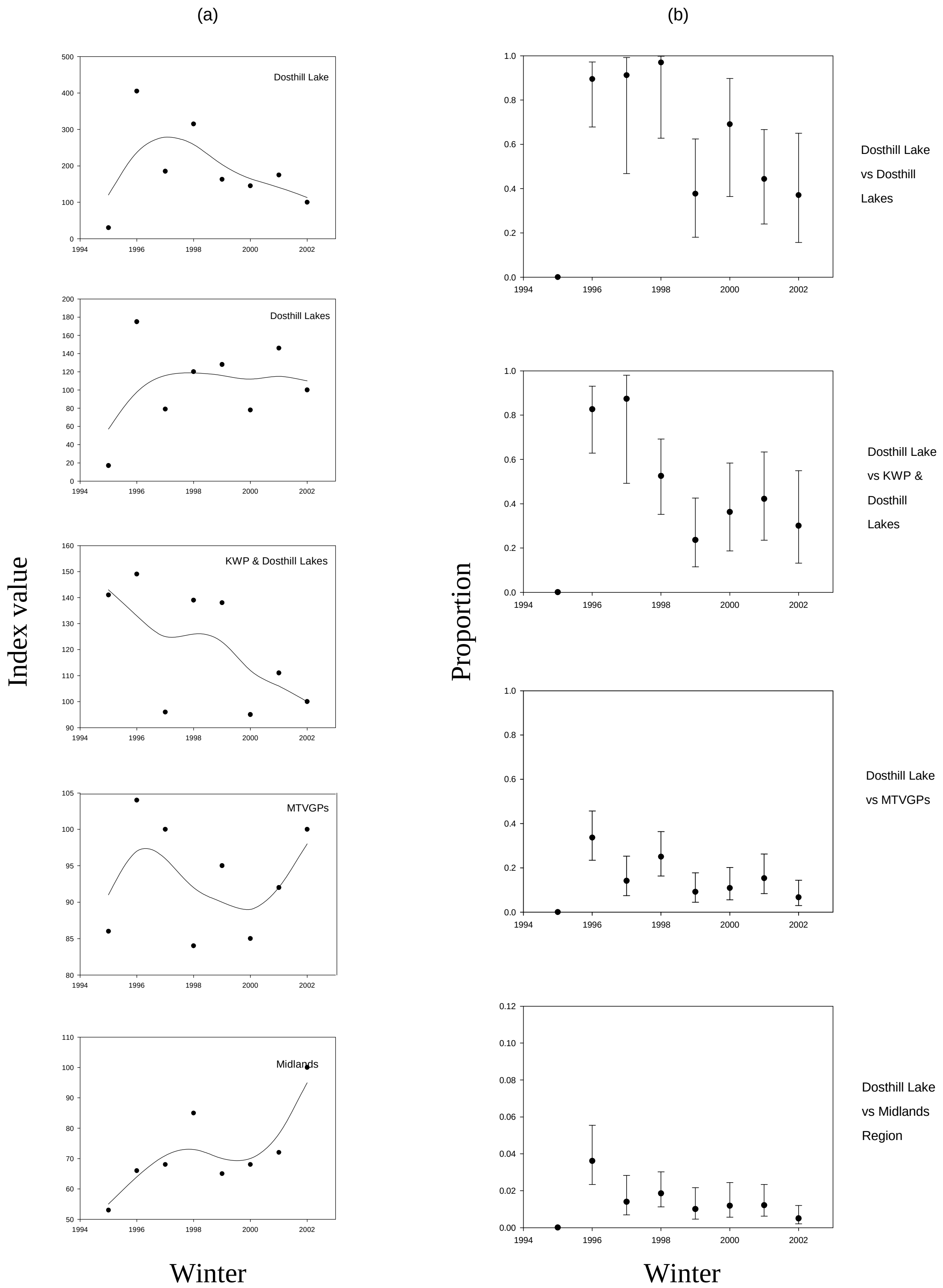

Figure 4.1.3.3 (a) Smoothed GAM trends for Gadwall. (b) Predicted proportion of Gadwall at Dosthill Lake in relation to various spatial scales.

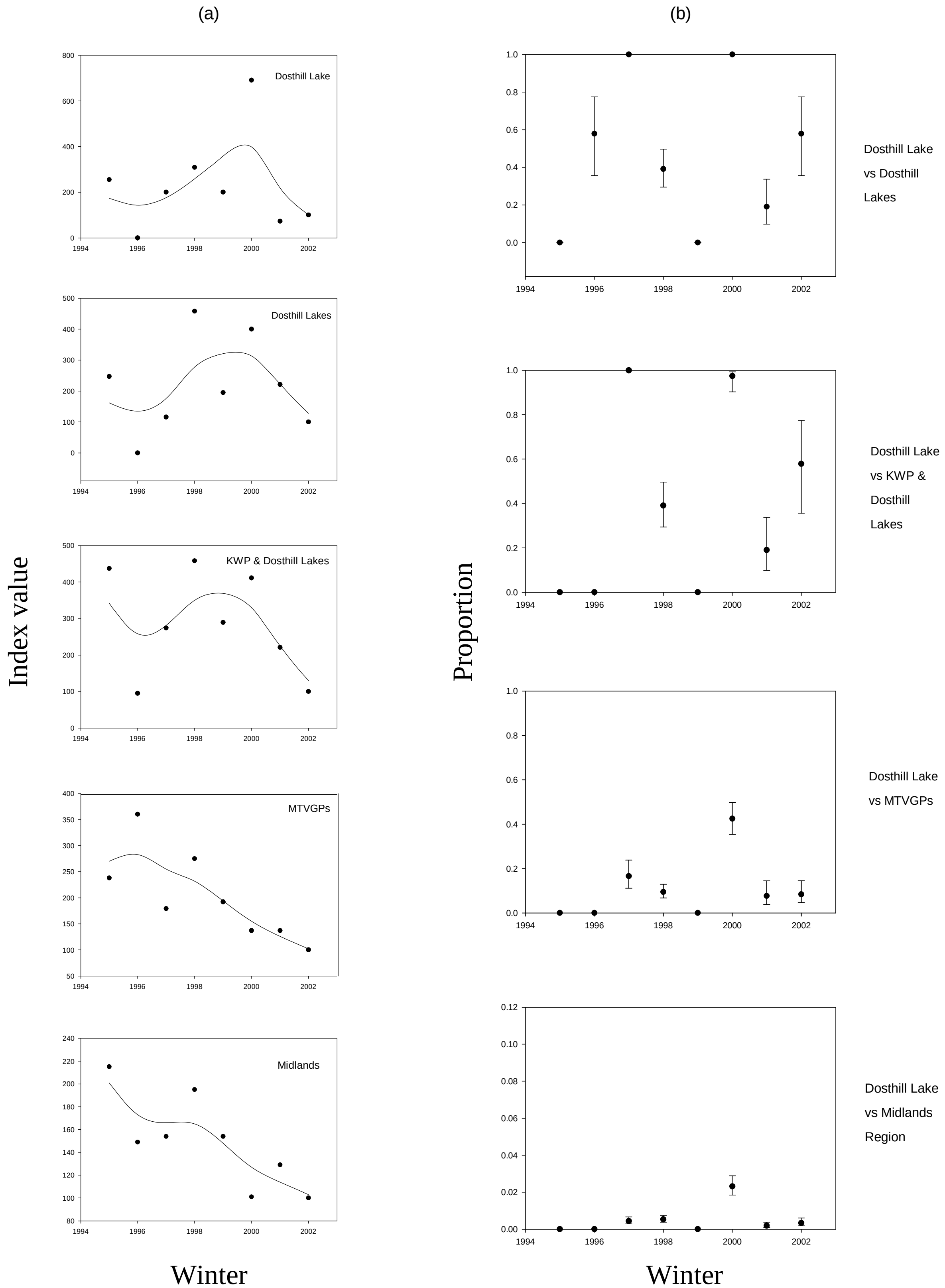

Figure 4.1.3.4 (a) Smoothed GAM trends for Teal. (b) Predicted proportion of Teal at Dosthill Lake in relation to various spatial scales.

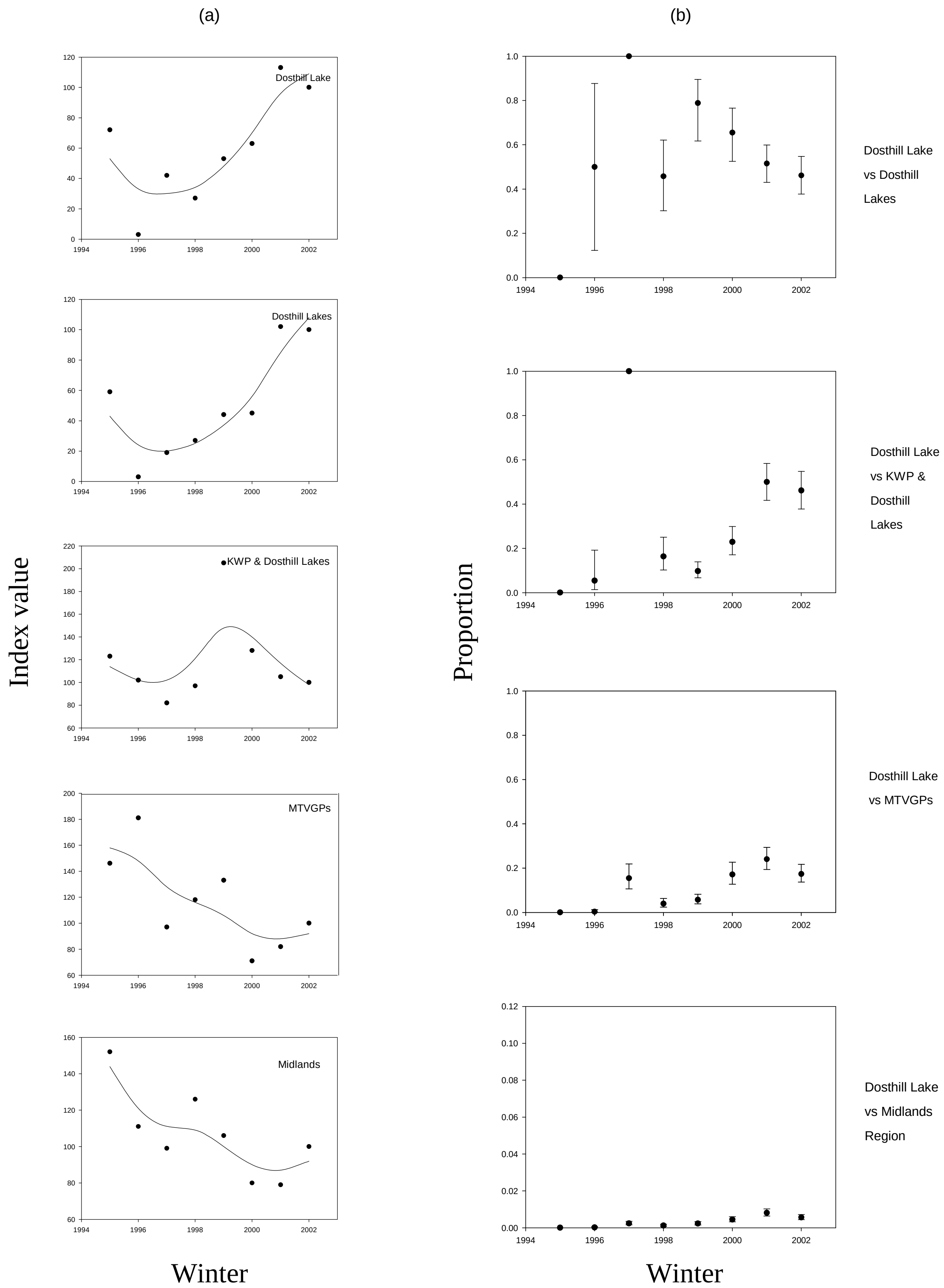

Figure 4.1.3.5 (a) Smoothed GAM trends for Mallard. (b) Predicted proportion of Mallard at Dosthill Lake in relation to various spatial scales.

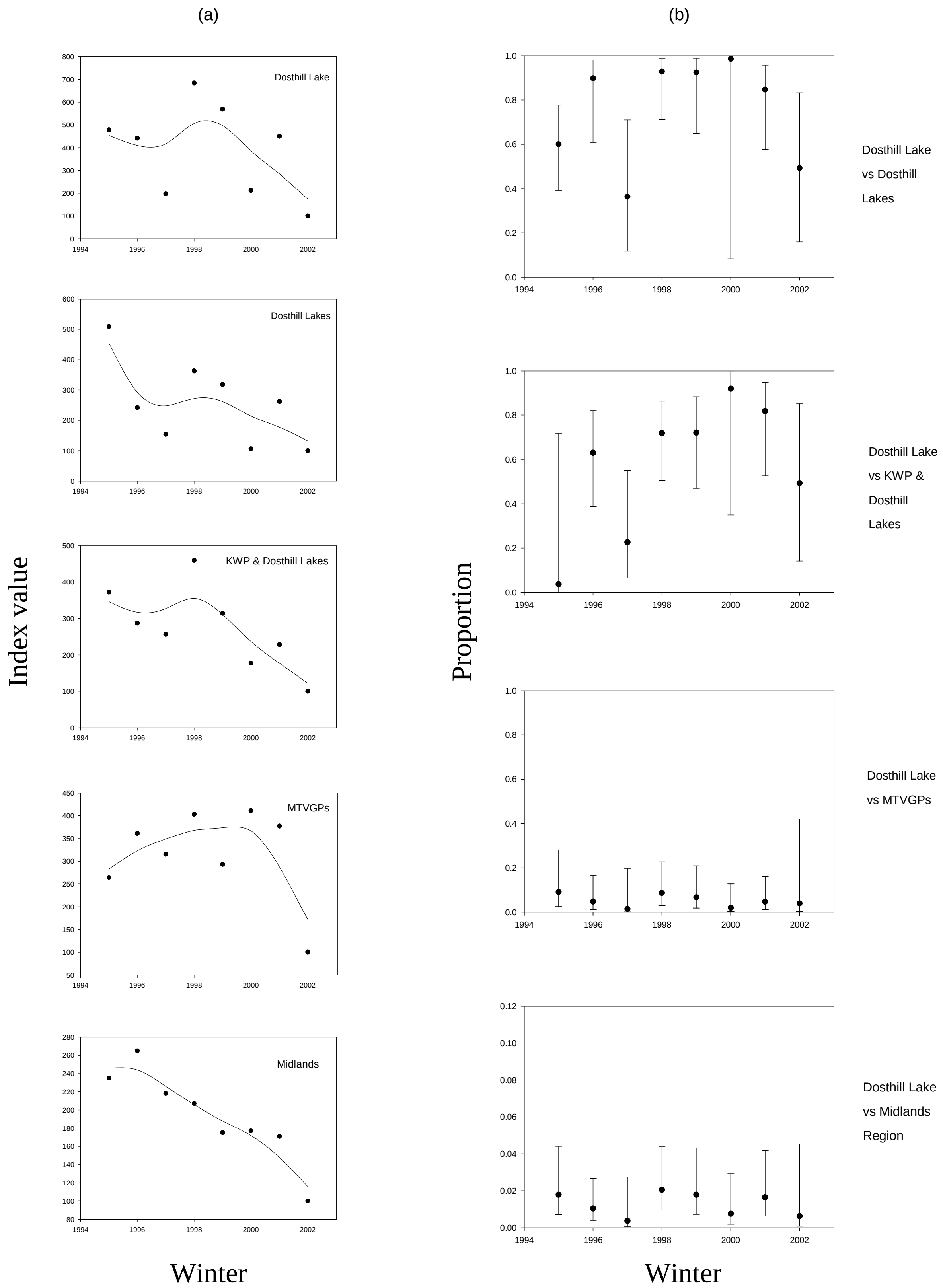

Figure 4.1.3.6 (a) Smoothed GAM trends for Pochard. (b) Predicted proportion of Pochard at Dosthill Lake in relation to various spatial scales.

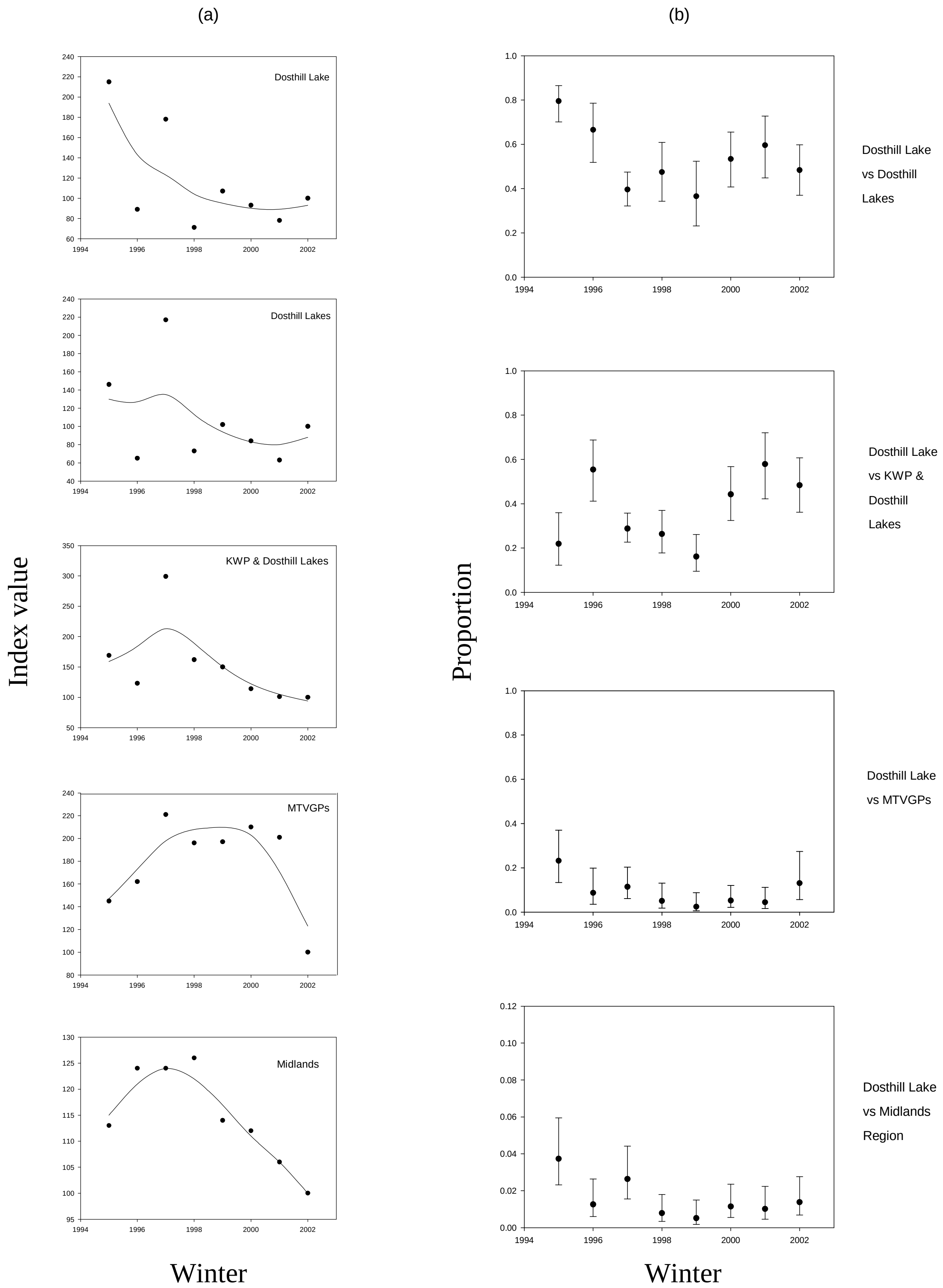

Figure 4.1.3.7 (a) Smoothed GAM trends for Tufted Duck. (b) Predicted proportion of Tufted Duck at Dosthill Lake in relation to various spatial scales.

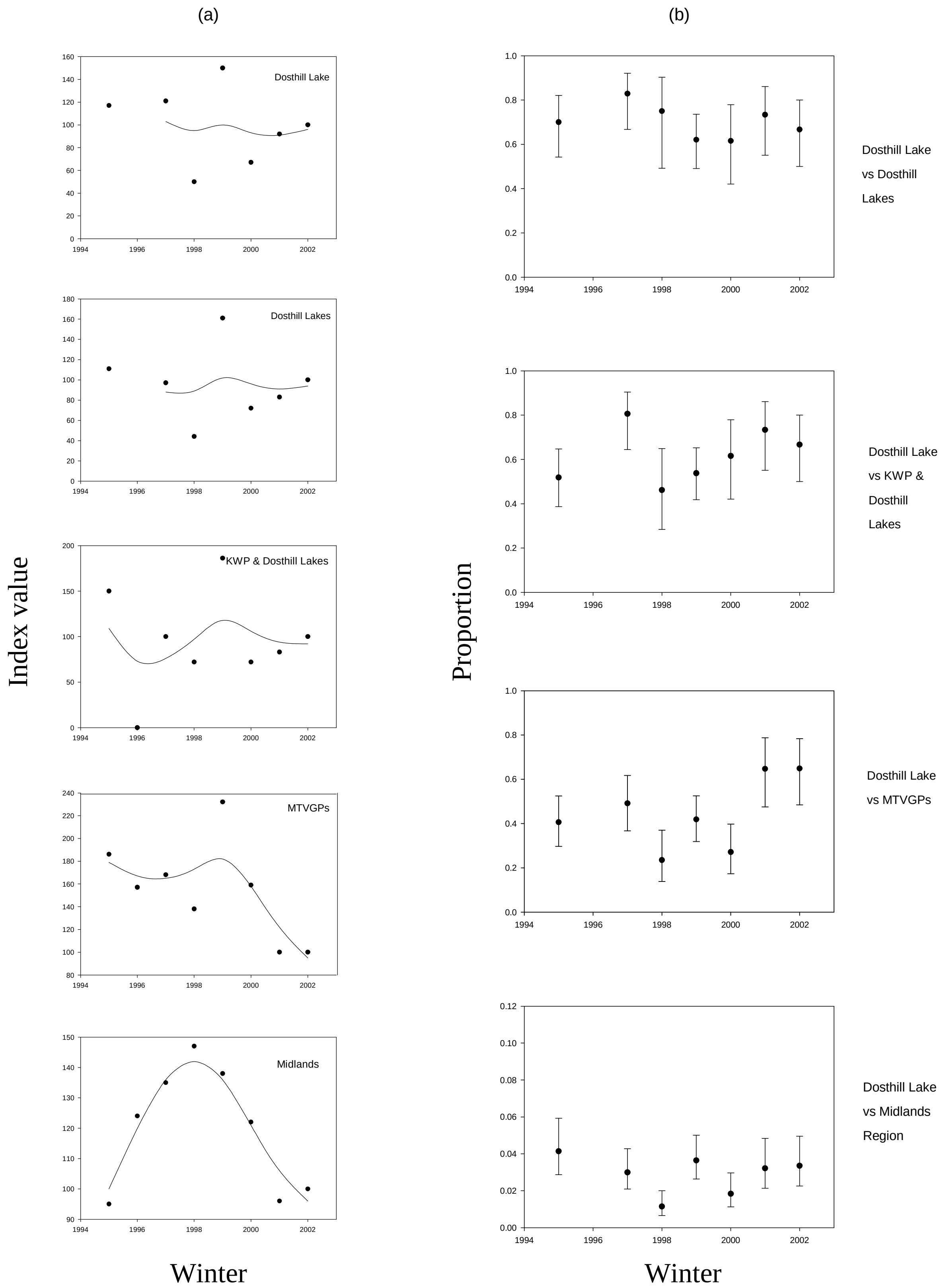

Figure 4.1.3.8 (a) Smoothed GAM trends for Goldeneye. (b) Predicted proportion of Goldeneye at Dosthill Lake in relation to various spatial scales.

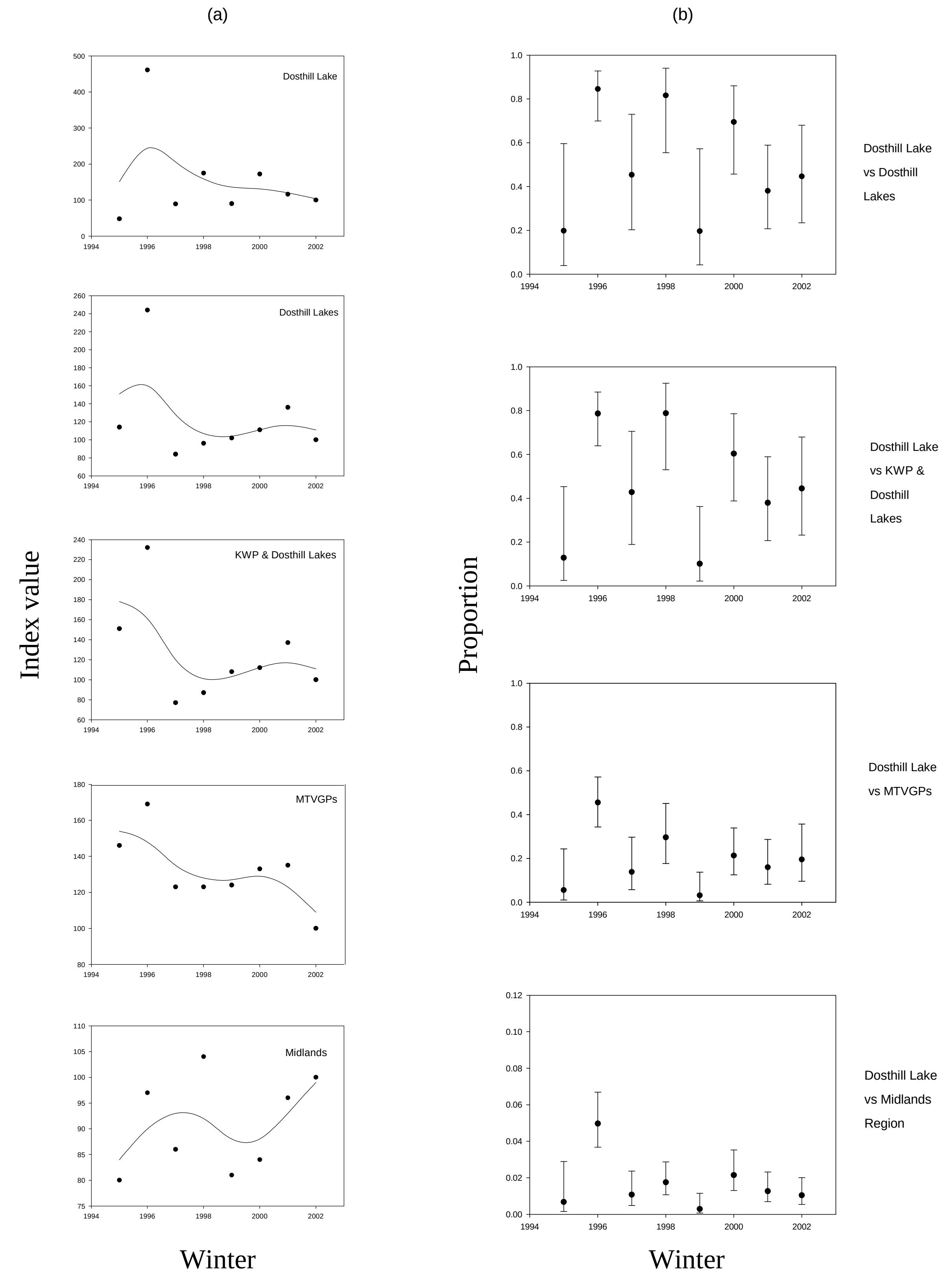

Figure 4.1.3.9 (a) Smoothed GAM trends for Coot. (b) Predicted proportion of Coot at Dosthill Lake in relation to various spatial scales.

5. CONCLUSIONS

There can be little argument with the view that "planning applications which would have significant impacts on bird populations through disturbance must be carefully weighed before being passed" (Hockin *et al*. 1992). This report attempts to inform any planning decision by (i) addressing some of the perceived problems with previous consultants reports (RPS Ecoscope 2004); (ii) reviewing the published literature regarding wintering waterbirds and water-based human activity; and (iii) contextualising WeBS counts at Dosthill Lake in relation to numbers and trends at wider spatial scales, including the EA Midlands region as a whole. The first two aims are intended as stand-alone sections and require little exploration, but their key points are referred to in the general discussion (section 5.2).

5.1 Discussion of WeBS analysis

Of the nine species analysed at Dosthill Lake, two showed an increasing trend, these being Great-crested Grebe and Mallard. In the former case, this corresponds with the regional trend; the latter case contrasts to the trend in the Midlands region. Neither of these species were proportionally found at greater than 1% of the regional total at Dosthill Lake, and it remains to be seen whether further increases could alter this. Such a scenario is perhaps more likely for Mallard, as the regional trend is in decline, meaning that under current trends Dosthill Lake would assume greater relative importance. Great-crested Grebe increases could be in response to the development of fish stocks as the lake matures.

A further four species showed a stable trend at Dosthill Lake over the eight years analysed (Gadwall, Teal, Goldeneye and Coot). In the case of Teal, this is notable as the regional trend is of a roughly linear decrease; Dosthill Lake is therefore likely to be a preferred site for small numbers of this species, as birds do not appear to be re-filling sites rendered vacant by regional declines. At present, Teal is the only one of these species where Dosthill Lake does not currently hold an average of at least 1% of the regional species total. Further regional declines could mean that Dosthill Lake will hold this figure in future.

The remaining three species analysed, Wigeon, Pochard and Tufted Duck, all showed declines at Dosthill Lake over the period investigated. The latter two species are in step with regional trends, and so local declines probably reflect changes in the wider population. Wigeon have declined sharply over the past three years in the Midlands region, but at all other spatial scales investigated, declines have proved more prolonged. In spite of these trends, Dosthill Lake still supports a relatively high proportion of the regional total for the species.

It does not seem likely that such declines could reflect general responses to changes in nutrients and food supply at Dosthill Lake, even though waterbird trends at other gravel pits have shown peaks in numbers following inundation (Milne 1974; Giles 1992). The pattern tends to be that succession leads to a change in species composition, with a decline in species of dabbling ducks (*e.g.* Mallard, Teal, Shoveler) and an increase in diving ducks feeding on submerged macrophytes (*e.g.* Coot, Gadwall: Milne 1974; Giles 1992; Phillips 1992) This is not generally evident at Dosthill Lake. Of the species in decline at Dosthill Lake, at a similar set of gravel pits (Great Linford) Wigeon numbers significantly increased in the ten years post-flooding, and Pochard and Tufted Duck showed no significant changes (Giles 1992). Total bird numbers were similar at Great Linford in the period after inundation and ten years later at maturation, though totals could increase as the waterbody matures, as generally productivity of flooded pits increases with age (Giles 1992).

In terms of potential refuges for birds that could be displaced from Dosthill Lake, it is revealing to look at trends at KWP & Dosthill Lakes and the MTVGPs complex. Here the species held by Dosthill Lake that currently average at least 1% of the regional total will be discussed.

Wigeon, Pochard and Tufted Duck trends at Dosthill Lake are similar to those at KWP & Dosthill Lakes and the MTVGPs. This would suggest that any potential refuges within the area would not be subject to increased species-specific density-dependent competition (*i.e.* competition for food resources depending on quantities of birds already present) if birds were displaced from Dosthill Lake, as numbers are falling elsewhere. However, the GB trends for these species are increasing or stable, and so there are potential problems for these species in general in the Midlands region.

Gadwall numbers are largely stable according to the Dosthill Lake index. However, trends at Dosthill Lakes and within the MTVGPs are increasing. This suggests that many nearby waterbodies are undergoing expansion in the numbers of Gadwall, although there was a severe decline within KWP & Dosthill Lakes, possibly because more profitable feeding sites were found nearby. As the proportions of Gadwall numbers held within all other spatial scales examined are decreasing, the suggestion is that other sites are absorbing local increases. Therefore any Gadwall displaced from Dosthill Lakes may experience heightened competition for food.

At Dosthill Lake(s) and KWP & Dosthill Lake, Goldeneye trends are stable since 1995. However, declines in the past three years are evident at the MTVGPs. An increasing proportion of the total for this consolidation is held at Dosthill Lake, implying it is a refuge for the species. It is not clear what effects displacement would have on this sensitive species (Hume 1976), but wider declines in Goldeneye numbers perhaps suggest this stable population should be safeguarded.

Declines in Coot have been shallower at Dosthill Lake than elsewhere studied, resulting in an index showing little overall change since 1995. The patterns of decline have been steeper within the remainder of the MTVGPs complex, although there was evidence of increases between 1997 and 2001. In a similar fashion to the patterns in Goldeneye trends, stability in the context of wider declines should perhaps be encouraged, though it is difficult to assess the true importance of Dosthill Lake for Coot with such wide confidence limits on the proportional predictions.

5.2 Overall findings and application to Dosthill Lake

Many issues are raised by the comprehensive literature review presented. Various authors consider motor boating and waterskiing to be of high disturbance to waterbirds (Tuite *et al*. 1983; Dahlgren & Korschgen 1992; Hockin *et al*. 1992). Waterbirds have been observed to respond to boats by re-dispersing (Parr 1974; Hume 1976; Tuite *et al*. 1983; Edington 1986), and the potentially detrimental effects of such re-dispersal are highlighted (Platteuuw & Henkens 1997a; Robinson & Cranswick 2003). Indirect effects of water-based activity on waterbirds, including pollution and effects of wake, are also considered (Liddle & Scorgie 1980). These studies should all be regarded in trying to predict the effects of winter waterskiing on waterbirds, though site specific factors involved in such issues should be borne in mind (Harbinson & Selwyn 1998).

The WeBS data analysis examined the context of Dosthill Lake in terms of the Middle Tame Valley Gravel Pits and the EA Midlands region. It is suggested that either of these large-scale consolidations could be considered within which to assess ‘local importance’. For example, the definition of national importance is when bird numbers at a site reach the 1% threshold of the national total for the species. Perhaps one definition of local importance could be to use the 1% threshold of the regional species total. Under this criterion, initial calculations suggest that as many as six species could qualify as ‘locally important’.

Species such as Goldeneye, are particularly sensitive to disturbance (Hume 1976). As Dosthill Lake is increasingly important for this species, especially within the MTVGPs as a whole, it is perhaps a species that requires careful consideration when reaching decisions regarding winter waterskiing at the lake.

5.3 Future considerations

The difficulty of extending general findings about disturbance of waterbirds to individual cases is emphasised by Harbinson & Selwyn (1998). They stress that impact must be observed at the site in question, as a number of variables will tend to differ between locations. This view is reinforced by Tuite *et al.* (1983): “so much depends on…the local situation that it is difficult to come to general conclusions except, perhaps, that where refuges are available to birds the deleterious impact is not serious”.

The effects that winter waterskiing might have on waterbirds can only be inferred at this stage, though greater inference could be made after an investigation of the WeBS database. If sufficient sites supporting waterskiing were counted by WeBS (*e.g.* Whisby Gravel Pits), comparisons could be made with ‘control’ sites, that could be matched on the basis of size, location, habitat and so on. Similarly, if data exist on the timing and intensity of waterskiing, it could also be possible to examine whether trends in bird numbers, at a variety of spatial scales, are temporally coincident. However, Hill *et al.* (1997) recommend that the best approach to ascertain local scale processes is to conduct targeted research:

“Before-and-after experiments should be conducted at a range of sites, for activities perceived to be significant in terms of their effect (such as power-boating or sailing), using a control site counted at the same time. The return of birds following the cessation of disturbance should be monitored. Neighbouring sites should also be surveyed and at the same frequency. Activity patterns and temporal and spatial variation in distributions should be recorded systematically” (Hill *et al.* 1997).

Therefore, it would seem likely that we will only ever be able to make informed predictions about the effects of winter waterskiing on waterbirds, unless a dedicated program of research, including controlled experimentation, is undertaken to examine the short and long-term effects. Realistically, this is an unlikely scenario.

5.4 Final conclusions

- We have identified various areas for consideration from the RPS Ecoscope (2004) report. In particular, the transparent treatment of data and reliance on contentious definitions of terms are highlighted.
- The literature review documents many direct and indirect effects of water-based recreation on waterbirds. However, the site-specific nature of disturbance should be considered before generalisation to individual cases.
- Analysis of the WeBS data shows that three species (Wigeon, Pochard, Tufted Duck) showed declines at Dosthill Lake over the period of analysis, two increased (Great-crested Grebe, Mallard) and the remaining four species were largely stable.
- Average predicted proportions of six of the nine species analysed for Dosthill Lake were in excess of 1% of the total for the EA Midlands region. This is suggested as a possible yardstick for assessment of ‘local importance’, in line with measurements of national importance.
- Further insight could be gained from an investigation of the WeBS database. If sufficient counts have been made on waterbodies where waterskiing currently takes place, trends could either be compared with ‘similar’ waterbodies, or trends could be examined with regard to temporal changes in waterskiing intensity.
- It is hoped that this report will inform the decision on whether to permit winter waterskiing at Dosthill Lake, though the only accurate way to truly assess waterbird responses to this activity is to conduct long running controlled before-and-after-event experiments.

Acknowledgments

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Appendix 1

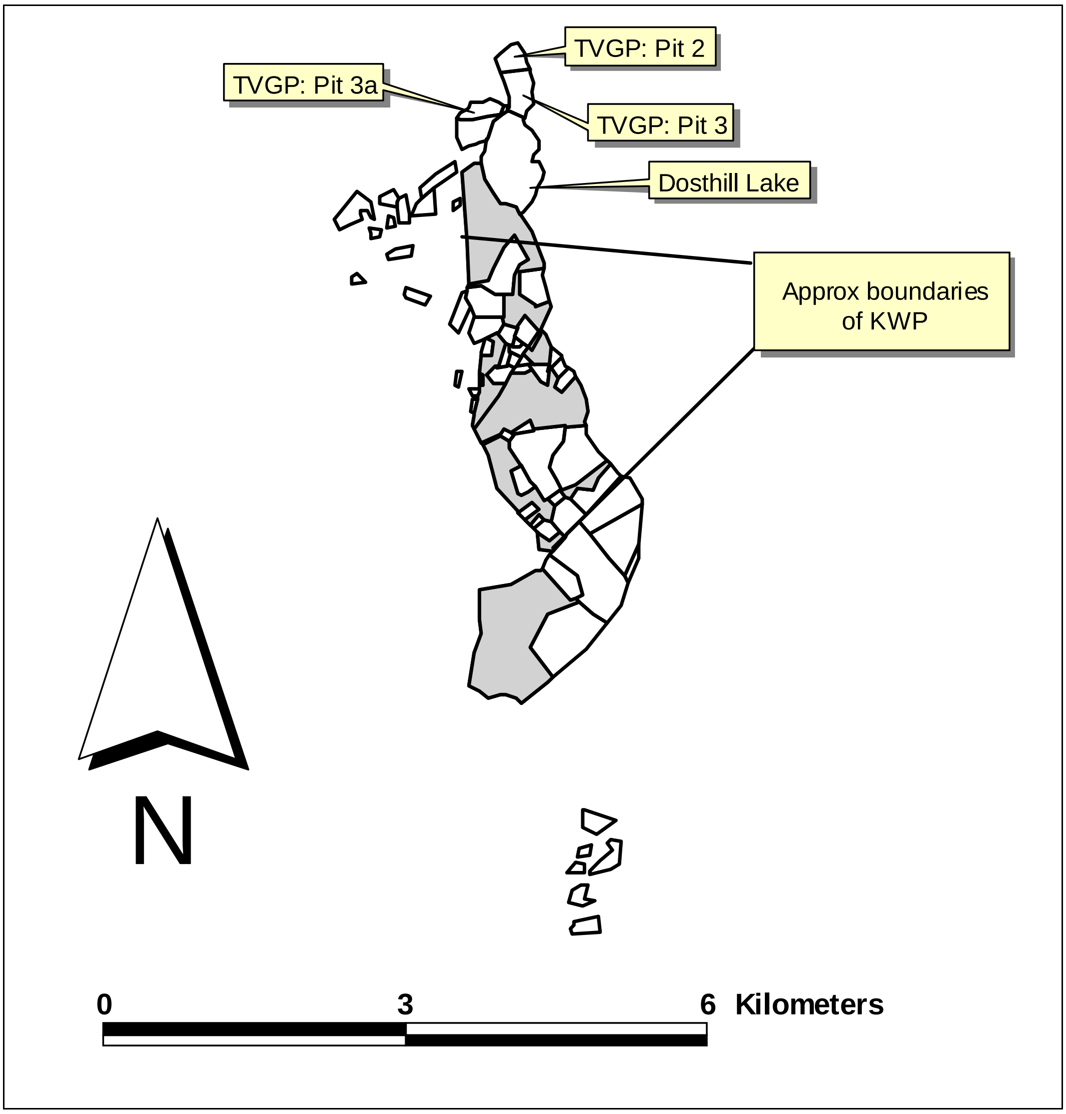

Figure A1 Map of Middle Tame Valley Gravel Pits complex, showing position of Dosthill Lake(s) and approximate location of Kingsbury Water Park. Grey areas indicate terrestrial habitat, unfilled areas indicate waterbodies.

Bodymoor Heath Water
Borrow Pit
Broomey Croft Pool
Canal Pool
Cliff Pool
Cliff Pool South
Heath House Pool
Hemlingford Water
Pine Pool
Swann Pool
Tame Valley Gravel Pits: Pit 21
Tame Valley Gravel Pits: Pit 24
Tame Valley Gravel Pits: Pit 25
Tame Valley Gravel Pits: Pit 26
Tame Valley Gravel Pits: Pit 27
Tame Valley Gravel Pits: Pit 34
Tame Valley Gravel Pits: Pit 43
Tame Valley Gravel Pits: Pit 44
Tame Valley Gravel Pits: Pit 45
Tame Valley Gravel Pits: Pit 47
Tame Valley Gravel Pits: Pit 49
Tame Valley Gravel Pits: Pits 28 to 33 and Mill Pool
Willows Pool

Table A1 Component waterbodies of Kingsbury Water Park (added to Dosthill Lakes to make consolidation #41251)

Ladywalk Nature Reserve (Hams Hall)
Marina Pool
Middleton Hall Pool
Tame Valley Gravel Pits: Eastern Pits
Tame Valley Gravel Pits: Pit 1
Tame Valley Gravel Pits: Pit 11
Tame Valley Gravel Pits: Pit 12
Tame Valley Gravel Pits: Pit 13
Tame Valley Gravel Pits: Pit 14
Tame Valley Gravel Pits: Pit 15
Tame Valley Gravel Pits: Pit 23
Tame Valley Gravel Pits: Pit 35
Tame Valley Gravel Pits: Pit 36
Tame Valley Gravel Pits: Pit 37
Tame Valley Gravel Pits: Pit 38
Tame Valley Gravel Pits: Pit 3b
Tame Valley Gravel Pits: Pit 3c-3h
Tame Valley Gravel Pits: Pit 5
Tame Valley Gravel Pits: Pit 50
Tame Valley Gravel Pits: Pit 51
Tame Valley Gravel Pits: Pit 53
Tame Valley Gravel Pits: Pit 56
Tame Valley Gravel Pits: Pit 57
Tame Valley Gravel Pits: Pit 58
Tame Valley Gravel Pits: Pit 59
Tame Valley Gravel Pits: Pit 6
Tame Valley Gravel Pits: Pit 60
Tame Valley Gravel Pits: Pit 61
Tame Valley Gravel Pits: Pit 62
Tame Valley Gravel Pits: Pit 63
Tame Valley Gravel Pits: Pit 64
Tame Valley Gravel Pits: Pit 7
Tame Valley Gravel Pits: Pit 8
Tame Valley Gravel Pits: Pit 9
Tame Valley Gravel Pits: Pits 54 and 55
Tame Valley Gravel Pits: Pits E and F
Whitacre Waterworks Pool

Table A2 Additional waterbodies in the MTVGPs complex, excluding those comprising Dosthill Lakes and Kingsbury Water Park (WeBS code #41251).