Biodiversity and Conservation **14:** 1627–1639, 2005.
DOI 10.1007/s10531-004-0534-1

Breeding waterbirds in relation to artificial pond attributes: implications for the design of irrigation facilities

J.A. SÁNCHEZ-ZAPATA*, J.D. ANADÓN, M. CARRETE, A. GIMÉNEZ, J. NAVARRO, C. VILLACORTA and F. BOTELLA
*Area de Ecología, Departamento de Biología Aplicada, Universidad Miguel Hernández de Elche, Ctra. Beniel, km 3,2, E-03312 Orihuela, Alicante, Spain; *Author for correspondence (e-mail: toni@umh.es; fax +34-966749619)*

Received 15 May 2003; accepted in revised form 26 January 2004

Key words: Agriculture, Conservation, Habitat, Waterbirds

Abstract. The growth of inter-basin water transfers and the development of new irrigation facilities in southeastern Spain are responsible for a variety of ecological impacts. In spite of this, the construction of artificial ponds to keep water for intensive agriculture may also provide new habitats for breeding waterbirds. We counted waterbirds during the breeding season in artificial ponds that had been built up using different materials and measured their abiotic and biotic attributes. We found that ponds were used as breeding and foraging habitat by 22 different waterbird species and breeding numbers of a few of them seemed to be larger in these artificial facilities than in nearby natural and semi-natural wetlands. Abundance and richness of breeding waterbirds was influenced by construction materials. Ponds constructed with low density polyethylene and covered with sand and stones held more species and their numbers were higher than those constructed with other plastic materials. The presence of emergent and submerged vegetation as well as abiotic attributes, such as pond size, accounted for most of the deviance when modelling richness and species abundance.

Introduction

The transfer of water from basins of surplus supply to those in deficit has become an increasingly common answer to the redistribution of water. This is especially so in arid and semi-arid areas where human activities largely rely on such water supplies (Davies et al. 1992). The ecological impacts of such inter-basin water transfers include the introduction of exotic species, the loss of biogeographical integrity, and the alteration of hydrological regimes, including marine and estuarine processes and water quality, among others (Ward and Stanford 1979; Davies et al. 1992). Some of these impacts have been documented for the water transfer between Tajo and Segura Rivers from central to southeastern Spain, including the transformation of about 200,000 ha of extensive agriculture into intensive irrigation crops (Peiró et al. 1996). In spite of such impacts, new irrigation areas required the construction of different facilities, including thousands of private artificial ponds to keep water for drip irrigation of citrics (orange and lemon trees) and vegetables (mostly melon, artichoke and lettuce). These ponds were constructed since the early 1980s and provide valuable habitat for breeding, wintering and migrating waterbirds in a semi-arid environment. Artificial wetlands and impoundments have been widely built or restored to increase waterbirds habitat elsewhere (McKinstry and Anderson 2002, 1994; Hortsman et al. 1998). Besides, different water facilities for agricultural use are known to provide habitat for vertebrates such as waterbirds, amphibians and fish (Hazell et al. 2001; Tourenq et al. 2001) as well as for invertebrates (Gastropoda, Odonata, Coleoptera) and aquatic plants (Oertli et al. 2002) and may be important for biodiversity conservation. Bird assemblages may be used as bio-indicators of water management (Paillison et al. 2002) and waterbirds may also play an important role as mobile links in the conservation of the biodiversity of wetlands (Green et al. 2002; Lundberg and Moberg 2003).

Some of the studies mentioned above point out the relationships between pond attributes and the abundance and diversity of different organisms. Thus, as new irrigation facilities seem to be growing and Common Agriculture Policies need to be updated to conceal agriculture funds with biodiversity conservation (Beaufoy 1998), and considering that studies on the value of artificial ponds in Spain are lacking, the following questions were addressed:

1. What species of waterbird make use of artificial ponds in southeastern Spain?
2. Are there pond attributes that explain the abundance and diversity of waterbirds?
3. Is there an optimal engineering design to conceal irrigation use and waterbird conservation?

The answer to these questions may provide a new insight into species–habitat relationships and identify those characteristics influencing abundance and richness of waterbirds. Such information is needed to make recommendations for the construction of new ponds and the restoration of old ones.

Materials and methods

Study area

The study was carried out in the Vega Baja Valley, in southeastern Spain (Figure 1). Artificial ponds are distributed all over an area of 95,840 ha, although the density is lower along the Segura River where traditional irrigation systems of the flooded plain remain since Arab times and in the close proximity of the coast line that is mostly occupied by tourist villages and bungalows. Here the climate is Mediterranean semi-arid with little annual rainfall (300 mm) and warm mean annual temperatures (18 °C). The landscape is dominated by intensive agriculture (citrics and vegetables), palm trees (*Phoenix dactylifera*), towns and sparse houses. Small amounts of extensive crops such as almond (*Prunus amygdala*), olive (*Olea europea v. oleaster*) and cob trees (*Ceratonia siliqua*) still remain, as well as remnants of natural

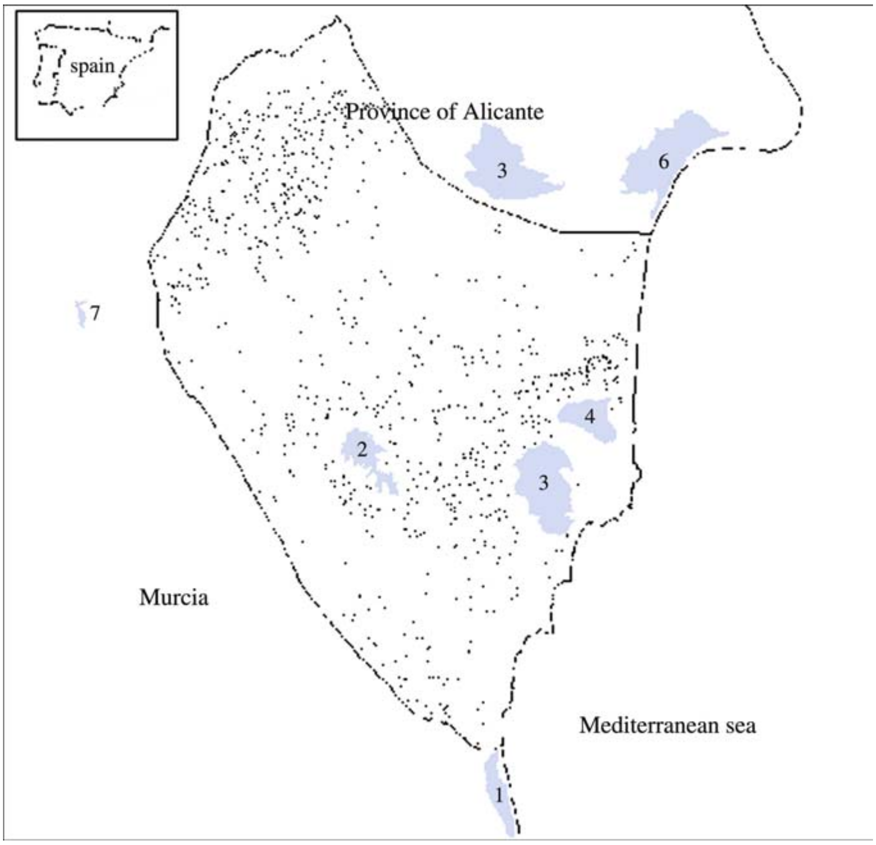

Figure 1. Study area and pond distribution (black dots). Semi-natural wetlands: (1) San Pedro del Pinatar Salines, (2) La Pedrera Reservoir, (3) Torrevieja Saline, (4) La Mata Saline, (5) El Hondo Reservoir, (6) Santa Pola Salines, (7) Santomera Reservoir.

vegetation such as Mediterranean shrubs (*Pistacea lentiscus*, *Rosmarinus offcinalis*, *Rhamnus lycioides*, *Chamaerops humilis*, *Thymus* spp). and pine trees (*Pinus halepensis* and *pinea*). Relief is plain with small hills close to the sea (Sierra Escalona; 300 m.a.s.l.) and small rocky mountains in the vicinity of the Segura River (Sierra de Orihuela; 600 m.a.s.l.) and in the north of the study area (Sierra de Crevillente; 800 m.a.s.l.). But artificial ponds remain at the lowest altitude ranging from the sea level to 300 m.a.s.l.

Apart from the ponds, there are several natural or semi-natural wetlands as well as large artificial water reservoirs and traditional salines. Some of these places (El Hondo, Salinas de Santa Pola, Salinas de La Mata and Torrevieja, Salinas de San Pedro) enjoy regional environmental protection (as Natural Parks or Protected Places) as well as international status of SPAs and RAMSAR sites because of their importance for waterbirds (http://ramsar.org/sitelist.doc). These wetlands hold the most important populations in Europe for waterfowl species such as the marbled teal (*Marmaronetta angustirostris*) and the white-headed duck (*Oxyura leucocephala*) as well as significant breeding populations of herons (*F. Ardeidae*), terns (*F. Sternidae*) and waders (*F. Charadriidae*, *F. Recurvirostridae*).

Census methods

Waterbirds were censused by ground counts during June and July 2002 using binoculars and scopes (Koskimies and Väisänen 1991). These dates match the breeding period of most of the waterbirds that nest in the study area (Peiró et al. 1996). All the species were easily detected, as the amount of emergent vegetation cover is small (mostly under 5% and frequently lacking) and the size of the ponds (0.025–6.1 ha) allows a complete survey of shores and water surface in a few minutes, thus reducing census errors of even the more elusive species (Dawson 1985; Gutiérrez and Figuerola 1997). Each pond was censused once during the breeding season and waterbirds were considered breeders when nests or chicks were detected.

Pond attributes

For each pond we measured a number of abiotic and biotic characteristics:

Abiotic characteristics. We classified ponds in two categories depending on their construction materials. On one hand, those constructed with low density polyethylene (LDP) and covered with sand and stones to prevent them from solar damage, and those constructed with other plastic materials such as PVC and high density polyethylene (HDP) without any 'natural' cover. The area (ha) was measured in the field for small and regular sized ponds and using digitalised aerial photographs (http://www.mapya.es) and a geographic information system (GRASS) for big and/or irregular sized ponds. We estimated visually the slope (%) of the beaches ranging from flat (0% = 0°) to vertical (100% = 90 °). The shore width (m) was considered to be the length between the top of the construction and the water level. We also measured the distance of each pond to the closest natural or semi-natural wetland.

Biotic characteristics. We assessed the presence or absence of shore vegetation (*Tamarix* spp., *Scirpus* spp.), emergent vegetation such as reeds (*Phragmites communis*), submerged vegetation (*Potamogeton* spp., *Cladophora* spp., *Chara* spp.) and microscopic algae during the field surveys.

Analytical procedures

We performed non-parametric Mann–Whitney *U*-tests to compare pond attributes and waterfowl abundance, richness and diversity between gravel and bare ponds. Diversity was measured by means of the Shannon–Wiener index (Begon et al. 1988).

We used Generalized Linear Models (GLMs) (Dobson 1983; McCullagh and Nelder 1989) to construct models of abundance, richness and diversity of waterfowl in gravel ponds. These models allow for a wider range of relationships between the response and explanatory variables and the use of error formulations when the normal error for a traditional regression is not applicable. For density response variables the Poisson distribution is an adequate error function (Vincent and Haworth 1983). We fitted each explanatory variable to the observed data and chose a 1% level of significance (Nicholls 1989; Sánchez-Zapata and Calvo 1999). For regression analyses we used the program STATISTIX (Analytical Software 1992).

Results

Pond attributes

We censused 219 (101 LDP and 118 HDP) ponds selected at random among the minimum of 2700 ponds existing in the study area. This is a minimum guess because most ponds were localised using aerial photographs dating back from 1998 and an unknown number of new irrigation facilities have been constructed since then.

LDP ponds were significantly larger in size, had wider shores and smaller slope, and were closer to wetlands than HDP ponds (Table 1). The frequency of ponds holding shore, submerged and emergent vegetation as well as other algae was also significantly higher in LDP ponds (Table 1).

Waterfowl

We censused 1139 waterbirds belonging to 22 different species (Appendix 1). The most abundant and frequent species were black-winged stilts (*Himantopus himantopus*), little grebes (*Tachybaptus ruficollis*) and little-ringed plover (*Charadrius dubius)* and we confirmed breeding for these, as well as for mallards (*Anas platyrrinchos*), shelducks (*Tadorna tadorna*), coots (*Fulica atra*) and moorhens (*Gallinula chloropus*). Fifteen other species, including herons (five species), wild and domestic ducks (three species), waders (*F. Scolopacidae*; two species), terns (three species) and seagulls (*F. Laridae*; two species), were observed using the ponds for feeding and/or resting.

Waterbird breeding populations in these artificial ponds seemed to be stable during short (3 years) inter-annual periods (authors, unpublished results).

Abundance, richness and diversity of waterbirds was higher in LDP ponds (Table 1). The abundance of breeding waterbirds was higher in LDP ponds for all the species except the shelduck.

Table 1. Comparison of pond attributes and breeding waterbirds in high density polyethylene (HDP) and low density polyethylene (LDP) ponds.

	HDP (118)	LDP (101)	*U*	*p*
Waterbird community				
Abundance	2.27 ± 5.21 (268)	9.18 ± 17.14 (927)	2974.0	0.000
Richness	0.64 ± 1.03	2.15 ± 1.79	2866.5	0.000
Diversity	0.06 ± 0.14	0.27 ± 0.23	2998.0	0.000
Breeding waterbirds (*n*)				
Little grebe	0.38 ± 1.54 (45)	1.60 ± 4.19 (162)	4421.5	0.000
Black-winged stilt	0.59 ± 1.03 (70)	2.26 ± 3.56 (228)	3706.5	0.000
Moorhen	0.01 ± 0.09 (1)	0.50 ± 2.67 (51)	5357.5	0.001
Mallard	0.06 ± 0.64 (7)	0.41 ± 1.28 (41)	5248.5	0.000
Shelduck	0.24 ± 1.63 (28)	0.35 ± 1.19 (35)	5923.0	0.813
Coot	0	0.54 ± 2.33 (55)	5546.0	0.004
Little-ringed plover	0.32 ± 1.16 (38)	0.58 ± 1.29 (59)	5148.0	0.010
Pond attributes				
Nearest wetland (m)	8358.5 ± 4158.0	4868.3 ± 2986.8	3072.0	0.000
Area (ha)	0.46 ± 0.62	0.86 ± 0.94	2991.0	0.000
Slope (%)	47.99 ± 7.82	30.54 ± 8.33	663.5	0.000
Shore width (m)	2.49 ± 3.03	4.13 ± 2.81	3074.5	0.000
Shore vegetation (%)	11	36	4426.0	0.000
Submerged vegetation (%)	8	33	4453.0	0.000
Algae (%)	78	91	5131.0	0.009
Emergent vegetation (%)	2	24	4104.0	0.000

Mean ± SD are shown. Absolute values are given in brackets. *p* values after Mann–Whitney *U*-tests.

Logistic models

The area was the best variable to describe the richness and abundance of waterbirds breeding in LDP ponds (Table 2). The relationship between area and richness followed an s-shaped function, whereas the relationship between area and abundance followed a bell-shaped function (Figures 2 and 3). The area was also the best variable to describe breeding densities of black-winged stilts and shelducks (Table 3). The presence of emerged vegetation (reeds and cattails) was the best variable to describe breeding densities of coots, moorhens and mallards, and distance to nearest wetland and shore-width were the best variables to predict the abundance of little-ringed plovers (Table 3).

Discussion

Artificial ponds for irrigation purposes held breeding populations of at least seven species out of the 30 waterbird species that regularly breed in natural and semi-natural wetlands throughout the study area (SEO/Birdlife 2002). This is a relatively small percentage of the overall richness of breeding waterbirds in the surrounding wetlands, but the breeding populations of certain species in

Table 2. Generalized linear models of waterbird abundance and richness in relation to pond attributes.

	Coefficient	SD	*p*
Abundance			
Constant	1.922	0.056	***
Log area	0.958	0.092	***
(Log area)^2	−0.720	0.106	***
Submerged vegetation	0.623	0.072	***
% Deviance change = 25.8%			
Richness			
Constant	0.655	0.098	***
Log (area)	0.578	0.180	***
Submerged vegetation	0.473	0.147	***
% Deviance change = 26.5%			

***$p < 0.01$

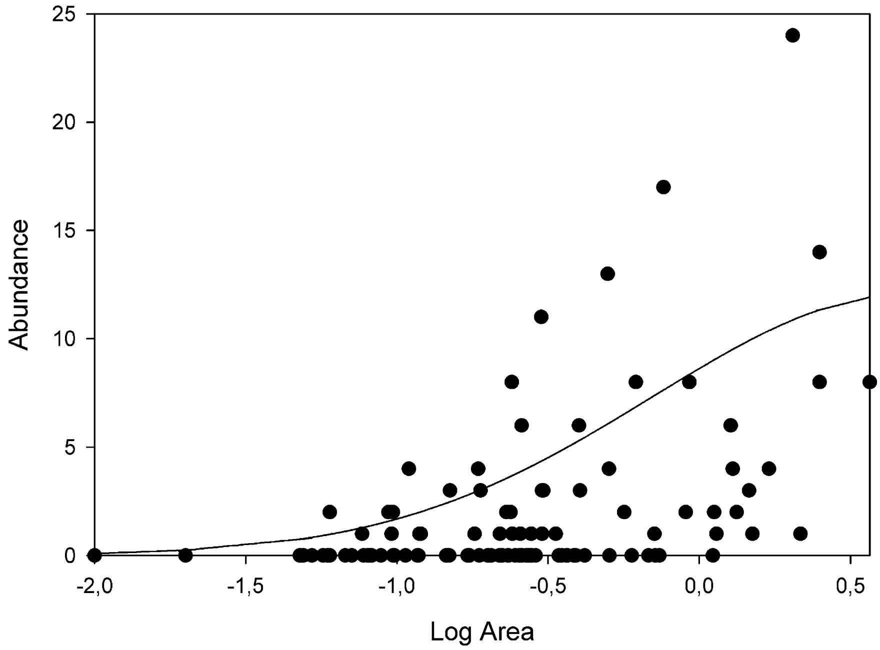

Figure 2. Abundance of waterbirds in relation to pond area.

artificial ponds may be important. In fact, the populations of salt-winged stilts, little grebes and little-ringed plovers seem to be larger in these artificial ponds than in the surrounding wetlands and although we cannot offer a precise guess of these populations because a complete survey of the 2700-plus ponds is not available yet, their breeding populations may number thousands of individuals. Besides, the high values of standard deviations did not allow us to accurately

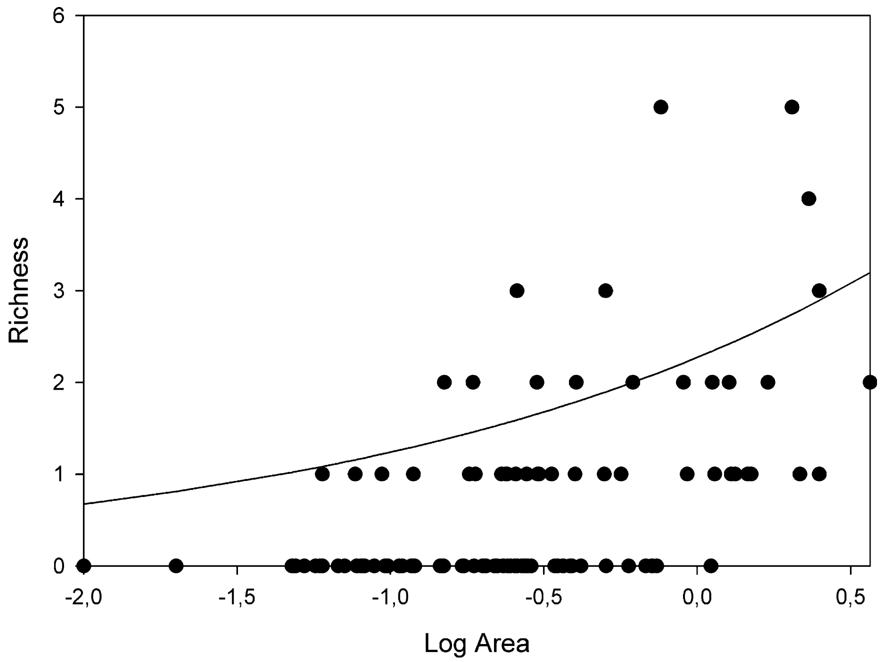

Figure 3. Richness of waterbirds in relation to pond area.

estimate breeding populations of these species. Numbers of shelducks may also be relevant, as the species is scarce (max. 50 pp) in the study area and elsewhere in Spain (125–150 pp; Martí and Del Moral 2003). On the other hand, coots, mallards and moorhens (hundreds) were scarce in relation to their abundance (thousands) in nearby wetlands (SEO/Birdlife 2002). The close vicinity of ponds to semi-natural wetlands and the high dispersal capacity of aquatic organisms (Amezaga et al. 2002; De Meester et al. 2002) may have favoured a quick colonisation by waterbirds.

Ponds did not provide valuable nesting habitat for different waterbird groups such as herons, terns or gulls, although they were frequently used for feeding and/or resting during the breeding season. Thus, the ecological value of ponds for these groups remains unknown.

Similar results of lower richness and abundance of waterbirds in artificial versus natural wetlands have been found when comparing ricefields and natural marshes in southern France (Tourenq et al. 2001). Nevertheless artificial habitats as well as other semi-natural wetlands such as traditional salines and ricefields have been found to provide valuable habitat if they are properly managed (Ferrer 1986; Elphick 2000; Múrias et al. 2002; Masero 2003). Besides, ponds may be favouring connectivity among wetlands within the study area (Amezaga et al. 2002).

Table 3. Response of water fowl to pond attributes.

	Slope	Log area	Submerged vegetation	Emergent vegetation	Algae	Shore width	Shore vegetation	Distance
Black-winged stilt (*Himantopus himantopus*)	ns	**28**+	12+	ns	6+	18+	2–	17++
Little-ringed plover (*Charadrius dobius*)	ns	ns	ns	ns	ns	5+	6–	**8**–
Little grebe (*Tachybaptus ruficollis*)	ns	ns	**26**+	10+	3+	3+	ns	10–
Moorhen (*Gallinula chloropus*)	ns	22+	15+	**77**+	ns	ns	ns	ns
Mallard (*Anas platyrrincos*)	ns	ns	10+	26+	ns	ns	ns	ns
Coot (*Fulica atra*)	ns	6+	2+	**55+**	3+	ns	3+	ns
Shelduck (*Tadorna tadorna*)	ns	**30**+	11+	ns	ns	ns	ns	18++

ns, not significant; $p > 0.01$; +, positive s-shaped function; ++, quadratic function; –, negative s-shaped function.

LDP ponds were much better than HDP ponds for waterbirds. LDP ponds had smaller slopes, which is an important feature for waterbirds (Mckinstry and Anderson 2001). Besides, the absence of gravel and stones on the shores prevented the growth of emergent vegetation, which is needed for different bird species such as coots, mallards and moorhens, to build their nests (del Hoyo et al. 1992). Shelducks were the only species that did not show significant differences between HDP and LDP ponds, perhaps because they do not breed in the ponds but in rabbit (*Oryctolagus cuniculus*) burrows and use the ponds to feed and rear their youngs (Uríos et al. 1991).

Once we eliminated HDP ponds whose attributes were significantly different from LDP ponds, GLMs showed that richness and abundance were related to the size of the ponds. Thus, in spite of the small size of the ponds, larger ponds held more breeding species and their numbers were higher, as predicted by the island biogeography theory (MacArthur and Wilson 1967; Lomolino and Weiser 2001) and similar studies of species-area relationships in wetlands (Oertli et al. 2002). Besides, overall density decreased in larger ponds, as predicted by density–area relationship (Nee and Cotgreave 2002).

Distance to the nearest wetland did not enter the multivariate models, perhaps because all artificial ponds were within a short distance of any of the wetlands of the study area.

Specific models showed that the abundance of certain species such as black-winged stilts and shelducks in LDP was area-dependent. Other species showed their relation with food resources, such as the relationship between little grebes, that feeds on invertebrates by diving (del Hoyo et al. 1992), and submerged vegetation that may be related to the abundance of prey. Other species such as coots, moorhens and mallards depended on the presence of emerged vegetation where they build their nests (del Hoyo et al. 1992) as described above. In contrast, the negative relationship between breeding waders and emerged vegetation may be related to the need of this species for open shores for feeding (del Hoyo et al. 1996).

This way, although size was important, other habitat attributes such as the presence of submerged and emergent vegetation may be favourable for certain species and detrimental for others.

Our results have shown that the material used for the construction was a key factor for waterbird use and that large ponds were richer than small ones. But there are limiting factors for materials and size. During the early 1980s to mid 1990s, most ponds were constructed using LDP but the use of this material is decreasing and actually most ponds under construction use HDP or PVC materials without any gravel cover. One of the main reasons is that the price of the land in southeastern Spain has increased 10-fold during the last years. Thus, actually one of the main limiting factors is the amount of land needed to construct the ponds. LDP ponds need a larger amount of land than HDP ponds to hold the same volume of water, as they require smaller slopes.

Waterbird use was also related to other pond attributes such as the presence of emerged and submerged vegetation, but these features are also more intensively managed actually to prevent the breaking of plastic materials and the growth of algae which may obstruct irrigation tubes. Physical treatments such as reed cutting as well as different chemical treatments to control algae growth may affect waterbird breeding populations and ponds could become an ecological trap for species breeding in nearby wetlands (Pringle 2001; Schlaepfer et al. 2002). Further research on the effects of pond management (e.g. Lindegarth and Chapman 2001) is needed to set new management proposals for ponds that have already been constructed.

Acknowledgements

This study was funded by the Generalitat Valenciana through the I + D project CTIDIB/2002/142. Cesareo provided the aerial photographs. Private owners kindly facilitated the access to their properties. Andrew Green, Edward de Reus and two anonymous referees kindly revised the manuscript. To the people of Torremendo town who are in fight for the conservation of their environment.

Appendix 1. Waterbird counts in artificial ponds.

Waterbirds	HDP ponds ($n = 118$)	LDP ponds ($n = 101$)	Total
Breeding			
Tachybaptus ruficollis	45	162	207
Himantopus himantopus	70	228	298
Charadrius dubius	38	59	97
Gallinula chloropus	1	51	52
Anas platyrrincos	7	41	48
Tadorna tadorna	28	35	63
Fulica atra	0	55	55
Non-breeding			
Sterna hirundo	14	39	53
Chlidonias hybridus	1	19	20
Sterna albifrons	21	29	50
Actitis hypoleucos	0	2	2
Tringa ochropus	4	12	16
Bulbulcus ibis	2	117	119
Egretta garzeta	3	1	4
Ardea cinerea	4	2	6
Ardeola ralloides	0	2	2
Nycticorax nycticorax	8	1	9
Larus cachiinanns	0	4	4
Larus ridibundus	7	11	18
Anas strepera	0	1	1
Anser sp. v. domestica	0	1	1
Anas sp. v. domestica	5	9	14
Total	258	881	1139

References

Amezaga J.M., Santamaría L. and Green A.J. 2002. Biotic wetland connectivity supporting a new approach for wetland policy. Acta Oecologica 23: 213–222.

Analytical Software 1992. An Interactive Statistical Analysis Program for IBM PC. Analytical Sotware, St. Paul, Minnesota.

Beaufoy G. 1998. The EU habitats directive in Spain: can it contribute effectively to the conservation of extensive agro-ecosystems? Journal of Applied Ecology 35: 974–978.

Begon M., Harper J.L. and Townsend C.R. 1988. Ecología Individuos Poblaciones y Comunidades. Ed. Omega, Barcelona, Spain.

Davies B.R., Thoms M. and Meador M. 1992. An assessment of the ecological impacts of interbasin water transfers, and their threats to river basin integrity and conservation. Aquatic Conservation: Marine and Freshwater Ecosystems 2: 325–349.

Dawson D.G. 1985. A review of methods for estimating bird numbers. In: Taylor K., Fuller R.J. and Lack P.C. (eds), Bird Census and Atlas Studies. BTO, Tring, pp. 27–33.

De Meester L., Gómez A., Okamura B. and Schwenk K. 2002. The Monopolization Hypothesis and the dispersal-gene flow paradox in aquatic organisms. Acta Oecologica 43: 223–231.

Del Hoyo J., Elliot A. and Sargatal J. (eds) 1992. Handbook of the Birds of the World, Vol. 1. Lynx Edicions, Barcelona, Spain.

Del Hoyo J., Elliot A. and Sargatal J. (eds) 1996. Handbook of the Birds of the World, Vol. 3. Lynx Edicions, Barcelona, Spain.

Dobson A.J. 1983. Introduction to Statistical Modelling. Chapman and Hall, London.

Elphick C.S. 2000. Functional equivalency between ricefields and semi-natural wetland habitats. Conservation Biology 14: 181–191.

Ferrer X. 1986. Els pobalments invernals d'anátids. In: Historia Natural dels Paisos Catalans, Vol. 12. Enciclopédia Catalana, Barcelona, Spain.

Green A., Figuerola J. and Sánchez M.I. 2002. Implications of waterbird ecology for the dispersal of aquatic organisms. Acta Oecologica 23: 177–189.

Gutiérrez R. and Figuerola J. 1997. Estimating the size of Little Grebe (Tachybaptus ruficollis) breeding populations. Ardeola 22: 157–161.

Hazell D., Cunningham R., Lindenmayer D., Mackey B. and Osborne W. 2001. Use of dams as frog habitat in an Australian agricultural landscape: factors affecting species richness and distribution. Biological Conservation 102: 155–169.

Hortsman A.J., Nawrot J.R. and Woolf A. 1998. Mine-associated wetlands as avian habitat. Wetlands 18: 298–304.

Koskimies P. and Väisänen R.A. 1991. Monitoring Bird Populations. Finish Museum of Natural History, Helsinki, Finland.

Lindegarth M. and Chapman M.G. 2001. Testing hypothesis about management to enhance habitat for feeding birds in a freshwater wetland. Journal of Environmental Management 62: 375–388.

Lomolino M.V. and Weiser M.D. 2001. Towards a more general species–area relationship. Journal of Biogeography 28: 431–435.

Lundberg J., Moberg and F. 2003. Mobile link organisms and ecosystem functioning: implications for ecosystem resilience and management. Ecosystems 6: 87–98.

Martí R. and Del Moral J.C. (eds) 2003. Atlas de las Aves Reproductoras de España. Dirección General de la Conservación de la Naturaleza. SEO, Madrid, Spain.

Masero J.A. 2003. Assesing alternative anthropogenic habitats for conserving waterbirds: salines areas against the impact of natural habitat loss for shorebirds. Biodiversity and Conservation 12: 1157–1173.

McArthur R.H. and Wilson E.O. 1967. The Theory of Island Biogeography. Princeton University Press, Princeton, New Jersey.

McCullagh P. and Nelder J.A. 1989. Generalised Linear Modelling. Chapman & Hall, London.

McKinstry M.C. and Anderson S.H. 2002. Creating wetlands for waterfowl in Wyoming. Ecological Engineering 18: 293–304.

Múrias T., Cabral J.A., Lopes R., Marquess J.C. and Goss-Custard J. 2002. Use of traditional salines by waders in thr Mondego estuary (Portugal): a conservation perspective. Ardeola 49: 223–240.

Nee S. and Cotgreave P. 2002. Does the species/area relationship account for the density/area relationship. Oikos 99: 545–551.

Nicholls A.O. 1989. How to make biological surveys go further with generalised linear models. Biological Conservation 50: 51–75.

Oertli B., Joye D.A., Castella E., Juge R., Cambin D. and Lachavanne J.-B. 2002. Does size matter? The relationship between pond area and biodiversity Biological Conservation 104: 59–70.

Paillison J.M., Reeber S. and Marion L. 2002. Bird assemblages as bio-indicators of water regime management and hunting pressure in natural wet grasslands. Biological Conservation 106: 115–127.

Peiró V., Sánchez-Zapata J.A., Ferrández T. and Martínez M. 1996. La comunidad de aves acuáticas de embalse y zonas colindantes del sur de la provincia de Alicante. Instituto de Estudios Juan Gil-Albert, Universidad de Alicante, Spain.

Pringle C.M. 2001. Hydrobiologic connectivity and the management of biological reserves: a global perspective. Ecological Applications 11: 981–998.

Sánchez-Zapata J.A. and Calvo J.F. 1999. Raptor distribution in relation to landscape composition semi-arid Mediterranean habitats. Journal of Applied Ecology 36: 254–262.

Schlaepfer M.A., Runge M.C. and Sherman P.W. 2002. Ecological and evolutionary traps. Trends Ecology and Evolution 17: 474–480.

SEO/Birdlife Alicante 2002. Las aves en Alicante. Anuario Ornitológico 2000. Alicante, Spain.

Tourenq C., Bennets R.E., Kowalski H., Vialet E., Licchesi J.-L., Kayser Y. and Isenmann. 2001. Are rice fields a good alternative to natural marshes for waterbird communities in the Camargue, southern France? Biological Conservation 100: 335–343.

Uríos V., Escobar J.V., Pardo R. and Gómez J.A. 1991. Atlas de aves nidificantes de la Comunidad Valenciana. Consellería de Agricultura y Pesca, Valencia, Spain.

Vincent P.J. and Haworth J.M. 1983. Poisson regression models of species abundance. Journal of Biogeography 10: 153–160.

Ward J.V. and Stanford J.A. 1979. Ecology of Regulated Streams. Plenum Press, New York.