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Waterfowl population survey of the Marcali reservoir (2007–2008)

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Kovács, Gy., Nagy, Á. & Winkler, D.: *Waterfowl population survey of the Marcali reservoir (2007–2008).*
Abstract: This study has shown that the Marcali reservoir is an important waterbird wetland habitat especially during the migration period. Based on our findings early springtime season proved to be the most important season concerning bird activities on the reservoir. The reservoir and its surroundings are not specifically important as breeding areas; although, some strictly protected species can be found among the breeding species. It is noteworthy to mention the strong disturbance (waterfolw hunting, intensive fishing, poaching) in the area that can have a negative impact on the breeding success of bird species. The results of similarity measures showed remarkable differences between the bird communities of different seasons. Waterbird communities of the spring season and summer season showed the highest similarity, since part of the species observed during the spring surveys were most probably breeding species that remained in the reservoir area for the summer. Comparison based on bird species diversity showed significant differences between communities of the different seasons. Diversity was higher both in the breeding and the migration season compared with the winter period characterized by the lowest species richness and number of individuals. Water level has proved to be an important determining factor of waterbird species richness.

Keywords: artificial wetland, bird monitoring, bird communities, breeding waterbird population

Introduction

In Hungary, in addition to natural wetland habitats, there are also a number of man-made (artificial) water bodies such as fishponds and reservoirs created for various use. Extensive fishpond construction work began as early as the beginning of the 19th century and continued until the Second World War. From the 1950's construction restarted and fishponds were established at a rapid rate. In the Transdanubia region alone, we can find a great number (more than 50) of water bodies that are larger than 50 ha in size. Most of these are artificially created while only 6 of these are natural or semi-natural water bodies.

There have been a number of ornithological studies conducted at the southern shore of Lake Balaton and surrounding fishponds, these publication include: Homonnay (1939a, 1939b, 1940), Keve (1973, 1975, 1978), Havranek et al. (1995) Havranek (1996) and Havranek & Szabó (1997). Since the turn of the 21st century the South Balaton Nature Conservation Group regularly surveys the area (Kovács 2008a, 2008b, 2008c, 2009).

Since the establishment of the Marcali reservoir starting in the 1990's research focused solely on the hydrobiology of the area; while research examining the natural treasures of the reservoir such as its fauna has largely been non-existent. Some occasional faunistical observations were made but these findings were never published while long-term monitoring researches were not conducted at all. This paper presents the results of a yearlong long study in the study area.

Material and Methods

Study area

The Marcali reservoir, located 10 km from the southern shore of Lake Balaton and 3 km from the city Marcali, was constructed in 1983. Its main function is to store the nutrient elements and alluvium coming from the catchment. Along with other reservoirs, the Marcali reservoir maintains the steady water supply of Lake Balaton. In addition to these functions, the Marcali reservoir also plays an important role in sewage storage and biological water cleaning. Apart from the apparent fish farming utilization, hunting utilization is also significant with a yearly harvest of 500–1000 waterfowl bag. The influent streams are the Sári and Boronkai streams, while the effluent water arrives to Lake Balaton through the „Nyugati-övcsatorna" canal. The Marcali reservoir covers 400 ha with an average depth of 2 m. It is a typical barrage lake which consists of multiple sections. The surface area of the anterior settling ponds are 27 and 29 hectares, respectively, with average depths of 0.4–0.8 m. On the Eastern side two posterior settling ponds of 8 and 4 hectares can be found with an average depth of 0.5 m (DOBRAI 1985).

The Marcali reservoir is located within the area of the Danube-Dráva National Park; it is part of the EU Natura 2000 Network as Special Protection Area (SPA) and Important Bird Areas (IBA).

Survey methods

Bird surveys were carried out from April 2007 to March 2008 (for a total of 19 field days). This research examines and analyses the data set of a yearlong long study period. The survey method used corresponds to the internationally approved waterbird counting technique. Surveys were conducted mostly biweekly and sometimes monthly due to hunting and other activities in the area. Considering the size and shape of the reservoir, four survey points were set out (Fig. 1) to ensure proper observability due to the relatively long distances. Round counts (KAUPINNEN et al. 1991) were carried out during the morning hours, starting at the southern part of the reservoir at 7.30 am. Bird census continued from the points of the western, northern and lastly from the eastern survey points. Observations were made by the aid of a 10x50 binocular and a 30x monocular spotting scope.

The applied survey method was suitable to detect the species of Gaviiformes, Podicipediformes, Pelecaniformes, Anseriformes, Ciconiiformes and Charadriiformes.

Data analysis

Breeding population was estimated by providing a minimum and a maximum value for the breeding pairs.

The minimum value, which provides a minimum accurate estimate of population size, is based on the count of pairs observed during breeding season with or without young birds. The maximum value reflects the total number of individuals observed of a certain species.

Fig. 1: Survey points around the Marcali reservoir

The attributes of bird communities are presented via comparison of number of individuals, density, species richness, ecological composition, dominance structure, constancy, Shannon diversity index ($H = -\sum pi\ ln\ pi$) and equitability ($J = H / ln\ S$ - where S is species richness).

Community structure comparison between different seasons was estimated using single linkage cluster analysis based on Jaccard's similarity index.

Further comparison was made by Hutcheson's diversity t-test (HUTCHESON 1970) and by Rényi diversity profiles (TÓTHMÉRÉSZ 1997).

Rényi diversity profiles allow for partial ranking of ecological communities based on diversity: a community of higher diversity than a second community will have a diversity profile that is consistently above the profile of the second community. In case the diversity profiles cross each other, the communities are not comparable.

Linear regression analysis was used to relate bird species ricnhess and number of individuals to the water level.

All statistical calculations and tests were prepared using PAST software (HAMMER et al. 2001).

Results and Discussion

Observed species

A total of 58 waterbird species were recorded during the study period. Based on the constancy results, 11 of them were common species (C>50%), 32 accessory (C=50–10%) and 15 rare (C<10%) species (Table 1.).

Table 1: Observed bird species on the Marcali reservoir (2007–2008)

(Av - average number of individuals per observation, N - total number of individuals, Do - dominance, De - density, C - constancy; Status: B - breeding species, C - common species, A – accessory species, R - rare species)

Species	Av	N	Do	De (ind./ha)	C	Status
Tachybaptus ruficollis	2.2	42	0.2%	0.0	47%	B, A
Podiceps cristatus	5.1	96	0.5%	0.0	74%	B, C
Podiceps nigricollis	0.1	1	0.0%	0.0	5%	R
Phalacrocorax carbo	170.1	3232	18.0%	0.4	95%	C
Phalacrocorax pygmeus	3.7	71	0.4%	0.0	32%	A
Nycticorax nycticorax	6.2	117	0.6%	0.0	26%	B, C
Egretta alba	36.7	697	3.9%	0.1	100%	C
Egretta garzetta	0.3	5	0.0%	0.0	16%	A
Ardea cinerea	48.4	920	5.1%	0.1	100%	C
Ardea purpurea	1.5	28	0.2%	0.0	37%	A
Ixobriychus minutus	0.1	2	0.0%	0.0	11%	B, A
Botaurus stellaris	0.7	13	0.1%	0.0	37%	B, A
Platalea leucorodia	0.5	10	0.1%	0.0	21%	A
Cygnus olor	8.6	163	0.9%	0.0	100%	B, C
Anser fabalis	11.7	223	1.2%	0.0	11%	A
Anser anser	46.4	882	4.9%	0.1	68%	B, C
Branta leucopsis	0.2	4	0.0%	0.0	5%	R
Branta ruficollis	0.1	1	0.0%	0.0	5%	R
Anser albifrons	193.1	3668	20.4%	0.5	32%	A
Tadorna tadorna	0.2	3	0.0%	0.0	5%	R
Anas penelope	0.3	5	0.0%	0.0	11%	A
Anas strepera	1.6	31	0.2%	0.0	16%	A
Anas crecca	32.9	626	3.5%	0.1	42%	A
Anas platyrhynchos	121.8	2314	12.9%	0.3	100%	B, C
Anas acuta	0.2	3	0.0%	0.0	11%	A
Anas querquedula	2.5	47	0.3%	0.0	16%	A
Anas clypeata	2.5	48	0.3%	0.0	21%	A
Aythya ferina	2.2	42	0.2%	0.0	42%	B, A
Aythya nyroca	8.1	154	0.9%	0.0	47%	B, A
Aythya fuligula	0.3	5	0.0%	0.0	11%	A
Aythya marila	0.1	2	0.0%	0.0	11%	A
Bucephala clangula	0.2	4	0.0%	0.0	5%	R
Gallinula chloropus	0.5	9	0.0%	0.0	32%	B, A
Fulica atra	33	627	3.5%	0.1	63%	B, A
Rallus aquaticus	0.2	4	0.0%	0.0	5%	B, R
Porzana porzana	0.1	2	0.0%	0.0	5%	B, R
Recurviristra avosetta	0.1	1	0.0%	0.0	5%	R

Table 1. continued

Species	Av	N	Do	De (ind./ha)	C	Status
Charadrius dubius	0.7	13	0.1%	0.0	5%	R
Charadrius hiaticula	0.9	17	0.1%	0.0	16%	A
Pluvialis squatarola	2.7	52	0.3%	0.0	11%	A
Vanellus vanellus	38.3	727	4.0%	0.1	53%	C
Calidris ferruginea	0.3	6	0.0%	0.0	5%	R
Gallinago gallinago	3.8	72	0.4%	0.0	32%	A
Lymnocryptes minimus	0.7	13	0.1%	0.0	5%	R
Philomachus pugnax	1.1	20	0.1%	0.0	5%	R
Tringa erythropus	8.1	154	0.9%	0.0	26%	A
Tringa totanus	1.3	25	0.1%	0.0	16%	A
Tringa stagnatilis	0.1	2	0.0%	0.0	5%	R
Tringa ochropus	1.3	24	0.1%	0.0	16%	A
Tringa glareola	0.9	17	0.1%	0.0	16%	A
Actitis hypoleucos	0.8	16	0.1%	0.0	37%	A
Limosa limosa	0.2	3	0.0%	0.0	5%	R
Larus ridibundus	105.7	2009	11.2%	0.3	89%	C
Larus canus	1.5	29	0.2%	0.0	26%	A
Larus cachinnans	33.4	635	3.5%	0.1	84%	C
Sterna hirundo	1.4	26	0.1%	0.0	26%	A
Chlidonias hybridus	2.2	41	0.2%	0.0	21%	A
Chlidonias niger	0.1	1	0.0%	0.0	5%	R

Breeding species

The most appropriate nest sites for waterbird species can be found primarily on the anterior settling ponds as well as in the reed edges of the reservoir. The anterior settling ponds have been siltated almost completely since the establishment. Hence a habitat patch mosaic structure is characteristic for this part of the study area with a vegetation consisting of sedge and reed species. The open water area is limited to 3-4 hectares; however, a significant portion of the breeding species is found in this 50 hectare habitat. While estimating the number of breeding pairs, it has to be taken into account that certain species remain hidden during such observation based surveys.

These kind of „hidden species" would be the Water Rail, the Common Gallinule and the Spotted Crake. Breeding population of the other species may be estimated with fairly high accuracy.

On the Marcali reservoir a total of 14 breeding species were recorded (Table 2), 4 of them are strictly protected, 7 protected, 4 are threatened Europe-wide (SPEC 2, 3), while the Ferruginous Duck is listed threatened worldwide (SPEC 1) (BirdLife International, 2004).

Population dynamics, density, dominance-structure

The number of individuals was notably high (3867 ind.) at the end of January. Other months with high number of birds observed (1100-1800 ind.) were March, April, July

Table 2: Estimated breeding population of waterbird species on the Marcali reservoir (2007)
(P - protected, SP - strictly protected, SPEC - Species of European Conservation Concern)

Breeding species	Breeding pairs	National legal protection status	SPEC categories
Tachybaptus ruficollis	2–4	P	Non-SPEC
Podiceps cristatus	2–7	P	Non-SPEC
Botaurus stellaris	1–2	SP	SPEC 3
Ixobrychus minutus	1	SP	SPEC 3
Nycticorax nycticorax	8–20	SP	SPEC 3
Cygnus olor	1	–	Non-SPEC
Anser anser	3	P	Non-SPEC
Anas plathyrynchos	4–5	–	Non-SPEC
Aythya ferina	1–2	P	SPEC 2
Aythya nyroca	1–3	SP	SPEC 1
Rallus aquaticus	2–10	P	Non-SPEC
Porzana porzana	1–?	P	Non-SPEC
Gallinula chloropus	1–?	P	Non-SPEC
Fulica atra	6–20	–	Non-SPEC

and October (Fig. 1). Number of birds was significantly less (~200 ind.) at the beginning of summer and at the end of December. In regards to seasonal evaluation, average number of individuals was the highest (1721 ind.) in the early spring period while total number of individuals was the highest (6406 ind.) in the winter period (Fig. 2). Measures of density follow the dynamics of number of individuals, which generally had a low value (on certain observation days 0.5-9.6 ind./ha) averaging at 2.4 ind./ha (Fig. 3).

According to the dominance structure, the Cormorant was the only species dominant (50%) in all seasons. Apart from the winter period, the Black-headed Gull also occurred with significant number of individuals. Considering the entire study period, the absolute dominant species (Do=20.4%) of all was the Greater White-fronted Goose appearing in huge flocks in winter.

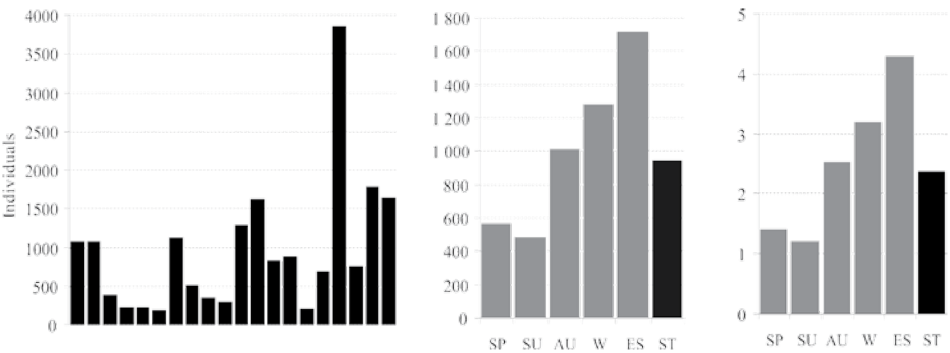


Fig. 2: Number of individuals observed on the Marcali reservoir during the 07.04.2007–03. 26. 2008 period; Fig. 3: Seasonal average of number of individuals; Fig. 4: Seasonal density (ind./ha)
(SP - spring, SU - summer, AU - autumn, W - winter, ES - early spring, ST - study period average)

Table 3: Dominant species (Do>5%) in different seasons

	Spring	Summer	Autumn	Winter	Early Spring	Study period
Phalacrocorax carbo	24.0%	23.4%	8.3%	8.2%	40.7%	18.0%
Egretta alba	6.5%	9.2%			6.3%	
Ardea cinerea		12.3%	5.9%			5.1%
Anser albifrons				56.5%		20.4%
Anser anser			13.6%			
Anas crecca					10.8%	
Anas platyrhynchos			27.5%	14.3%		12.9%
Fulica atra	12.5%	15.8%				
Vanellus vanellus			11.1%		7.5%	
Larus ridibundus	32.3%	12.1%	11.0%		14.9%	11.2%

Species richness, similarity and diversity

Species richness was the highest (32) at the end of March, while the lowest value (10) was recorded at the end of December and in February (Fig. 5). Highest average species richness (25) was found in early spring (Fig. 6), while total species richness was the highest (36) in spring period (Fig. 7). Average species richness and total species richness were both the lowest in the winter period, 12 and 23, respectively. Average species richness for the whole study period was 17, while total species richness was 58.

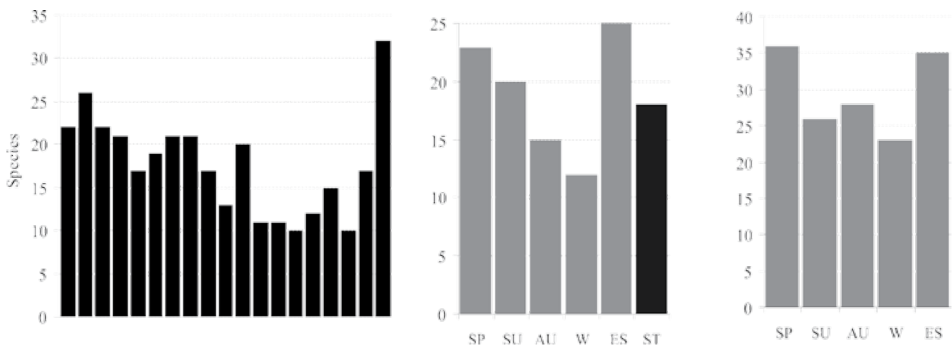


Fig. 5: Species richness on the Marcali reservoir during the 07.04.2007–03.26.2008 period
Fig. 6: Seasonal average of species richness; Fig. 7: Seasonal total species richness
(SP - spring, SU - summer, AU - autumn, W - winter, ES - early spring, ST - study period average)

Jaccard index showed the highest similarity between communities of the spring and summer seasons (Table 4), since the species observed during the spring period are mostly species that breed on the reservoir and stay there during the summer. The weakest similarity was observed between communities of the winter and spring periods. This clearly reflects the difference between the winter waterbird community, rich in migratory species, and the spring community which mostly consists of breeding species.

Table 4: Values of Jaccard similarity index between seasons (%)

Season	Summer	Autumn	Winter	Early Spring
Spring	55.00	48.84	28.26	51.06
Summer		42.11	28.95	41.86
Autumn			41.67	46.51
Winter				34.88

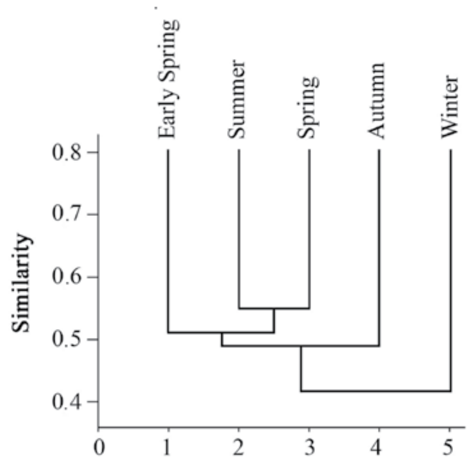


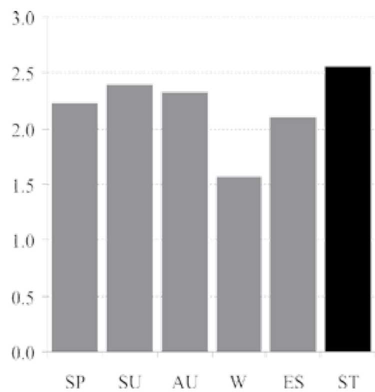
Fig. 8: Dendrogram based on cluster analysis using Jaccard's coefficient of similarity on the waterbird communities of different seasons

Hierarchical cluster analysis separated the sampled habitats into two main groups (Fig. 8). The dendrogram well emphasises the complete separation of the winterbird community. In the second main group, the community of the autumn period clearly separates from the early spring, spring and summer communities, while species composition of the spring and summer communities showed the highest similarity.

Shannon diversity and equitability were highest in the summer period and lowest in the winter period (Fig. 9, 10).

The comparison of bird community diversities (Hutcheson's test) of different seasons yielded significant differences at p=0.01 level (Table 5).

Rényi diversity profiles were used to rank the seasons according to diversity. The results show that some profiles, namely spring-winter, spring-early spring, summer-winter, autumn-winter, summer-early spring, autumn-early spring cross each other; therefore, these communities cannot be ranked. Notwithstanding, the other compared



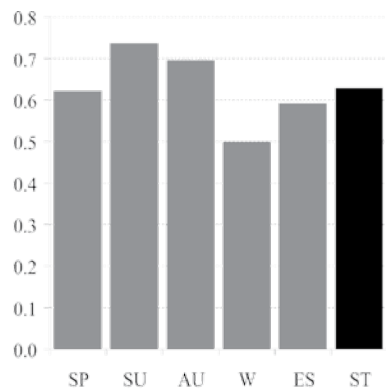


Fig. 9: Shannon diversity in the different seasons; Fig. 10: Equitability in the different seasons
(SP - spring, SU - summer, AU - autumn, W - winter, ES - early spring, ST - study period)

Table 5: Comparison of Shannon diversities (t-values, **P=0.01; *P=0.05)

t	Summer	Autumn	Winter	Early spring
Spring	4.4738**	2.7195**	17.501**	2.9135**
Summer		2.9427**	31.5140**	9.5445**
Autumn			33.5150**	7.9096**
Winter				18.9540**

airs confirmed the results of the Hutcheson probe and showed markedly and significant differences between diversities. It can also be observed that the diversity profiles of the early spring and spring communities are very close to each other (Fig. 11).

Bird community response to water level changes

Results show that the effect of water level alteration to bird community structure is not indifferent and species richness positively correlated with increased water levels (R^2=0.66, p<0.001) (Fig. 12). Very low water levels was detected from October to February. While species richness was average at medium-low water levels during the frostless period, it significantly decreased in the frost period starting in November.

Similar trend can be observed in relation to the correlation of water levels and the number of individuals of diving duck species. At higher water levels more individuals of Aythya species were observed (R^2=0.62, p<0.01) (Fig. 13).

Regarding the Mute Swan (Fig. 14) and shorebirds (Fig. 15), the relationship was just the opposite. The number of individuals of Mute Swan and shorebird species was negatively correlated with water levels (R^2=0.49, p<0.01 and R^2=0.87, p<0.001, respectively). The diet of mute swans consists mostly of submerged aquatic vegetation. The optimal diving depth is up to 1 m. The shore gradient of the reservoir on reedless parts are discontinuous, it deepens abruptly; therefore, this zone can only be optimally used for feeding at low or medium water levels. In regards to shorebirds, the strong negative correlation of their numbers with water levels can be explained with their feeding habits, since they prefer feeding areas which include shallow water depths of up to three inches.

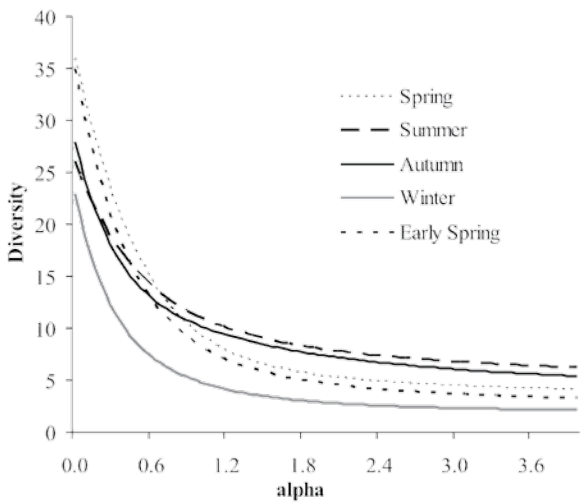
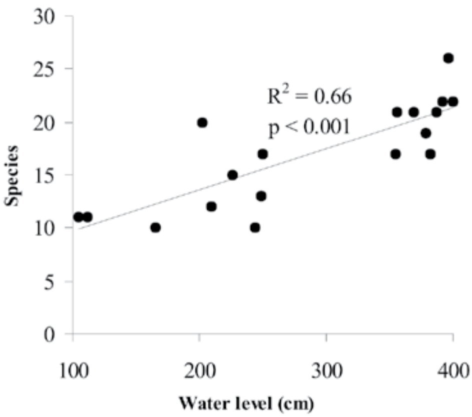


Fig. 11: Diversity profiles of bird communities



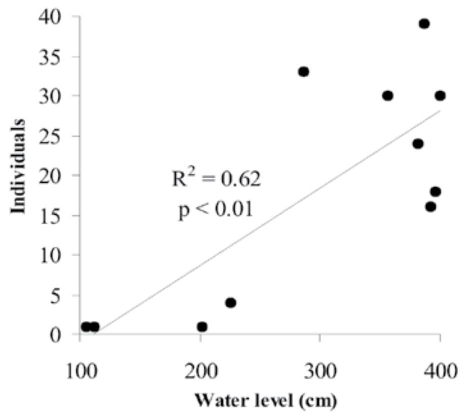
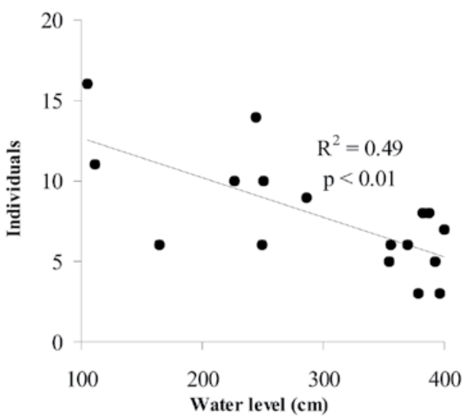


Fig. 12: Relationship between water levels and species richness
Fig. 13: Relationship between water levels and number of individulals of the diving duck species

High number of shorebird individuals can be detected only at low water levels when the waterbody is lowered to enable intensive fishing, which in turn facilitates the formation of optimal feeding habitats.



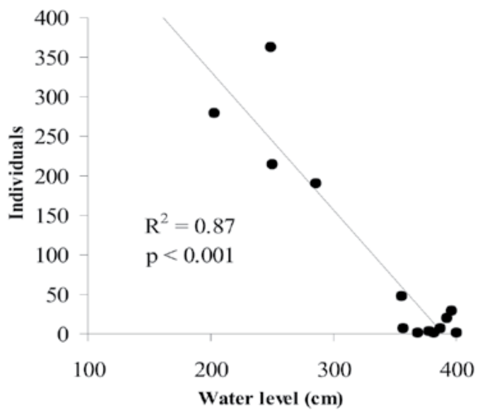


Fig. 14: Relationship between water levels and number of Mute Swan individuals
Fig. 15: Relationship between water levels and number of shorebird individuals

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