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M. MONTAGNA, G.C. LOZZIA, C. ANDREIS, A. GIORGI & J. BAUMGÄRTNER

The Beetle (Coleoptera) and True bug (Heteroptera) species pool of the alpine "Pian di Gembro" wetland (Villa di Tirano, Italy) and its conservation

Abstract - The Coleoptera and Heteroptera species pool was investigated in the "Pian di Gembro" wetland (Villa di Tirano, Sondrio, Italy). The wetland consists of a bog and its surroundings, referred to as wetland components, that are both subjected to a diversified intermediate management regime (DIMR). The application of the DIMR for plant species conservation resulted in the establishment of 11 wetland zones with a characteristic vegetation. In a three year sampling program, 997 Coleoptera and Heteroptera representing 141 species from 14 families were collected. Among these species, 64 species share both wetland components, 11 are restricted to the bog and 63 were found in the surroundings only. Among the species pool there were 23 tyrphophile taxa and only one tyrphobiont. With the exception of one zone, all zones are inhabited by zone-specific species. By taking into account both the general species pool and the pool of species of particular interest to conservationists, only one zone can be considered as redundant since it is inhabited by species that occur also in other zones. Hence, all the zones, with one exception, are effective for species pool conservation. The existing DIMR implemented for plant species conservation is also effective for conserving the species pool of Coleoptera and Heteroptera.

Riassunto - Nel presente studio sono state indagate le specie di Coleotteri ed Eterotteri presenti nell'area umida di Pian di Gembro (Villa di Tirano, Sondrio, Italia), costituita da una componente di torbiera e da ambienti ecotonali circostanti sottoposti entrambi ad un regime di gestione intermedia diversificata (DIMR). L'applicazione di strategie DIMR nella gestione e conservazione delle specie vegetali ha portato alla determinazione di 11 zone umide con vegetazione caratteristica, all'interno delle quali si sono svolti i campionamenti. Il programma di campionamento, della durata di tre anni, ha permesso di raccogliere 997 campioni di Coleotteri ed Eterotteri appartenenti a 141 specie e 14 famiglie. Tra queste specie, 64 sono state censite in entrambe le componenti della zona umida, 11 sono ristrette alla torbiera e 63 agli ecotoni circostanti. Nel gruppo di specie censite sono presenti 23 taxa tirfofili e uno solo tirfobionte. Tutte le stazioni di raccolta, eccetto una, presentano specie uniche. Considerando quelle di interesse conservazionistico, solo una zona può dirsi ridondante, in quanto le specie censitevi sono presenti in altre zone. Concludendo, 10 delle 11 zone che compongono la zona umida di Pian di Gembro sono utili nella conservazione dello “species pool”. La strategia di gestione DIMR, utilizzata per la conservazione delle specie vegetali risulta essere funzionale alla conservazione delle specie di Coleotteri ed Eterotteri presenti.

Key words - bog, insect coenoses, species pool, conservation categories.

INTRODUCTION

Wetlands are ecologically sensitive adaptive systems and much attention has been given to the design and implementation of adequate management strategies (Turner *et al*. 2000). Because of their capacity to conserve species of conservation interest and to provide ecosystem services, wetlands are considered as natural capital and often assigned protected status (Spitzer & Danks, 2006; Fisher *et al*., 2009).

The term “protected area” refers to any area of land or sea managed for the persistence of biodiversity and other natural processes, achieved through constraints on incompatible land uses (Possingham *et al*., 2006). Despite high levels of protection and adequate management within their borders, many protected areas are not functioning as originally envisioned. Agriculture, settlements, and other human land uses in the unprotected part of the ecosystem, as well as the lack of any management, may alter the flow of energy, material and organisms across the ecosystems in ways that change ecological functioning within protected areas (Hansen & DeFries, 2007). Wetlands are areas whose soil is saturated with moisture either permanently or seasonally. Nevertheless, the importance of the surroundings for the integrity of the bog and the interest in conservation measures motivated us to apply the term ‘wetland’ to a bog and its surroundings and refer to them as ‘wetland components’.

In the wetland under study, both the bog and its surroundings are subjected to diversified management procedures whose frequency and intensity change through time in different zones. Importantly, the diversification of these practices falls into range that maintains the integrity of the wetland and prevents it from shifting into an irreversible late successional state where the desirable wetland characteristics are lost (Andreis & Rodondi, 1982). Ecological theory predicts that species diversity is highest under intermediate disturbance (Smith & Smith, 2001). A combination of diversified and intermediate management regimes (DIMR) holds to promise to conserve both the species pool and a high species diversity (Guo, 2003). Specific adaptations may restrict species to either the bog or its surroundings or limit their distribution to particular zones resulting from the application of the DIMR to the two wetland components. While detailed information is available for northern wetlands (Spitzer & Danks, 2006), little is known on the diversity and the pool of species inhabiting Alpine wetlands. The limited information is restricted to specific taxa such as Odonata (Marcuzzi, 1948; Balestrazzi *et al*. 1983), Heteroptera (Rampazzi & Dethier, 1997; Montagna *et al*., 2008), Coleoptera (Focarile, 1957) and Trichoptera (Cianficconi *et al*., 2005).

A DIMR is applied for plant species conservation to the ‘Pian di Gembro’ wetland in the northern Italian Alps (Andreis & Rodondi, 1982; Andreis & Rodondi, 2005).

The application of the DIMR produced 11 different ecological zones corresponding to habitat typologies (Carta Habitat Natura 2000 IT2040025). This work deals with Beetles (Coleopera) and True bugs (Heteroptera) as important elements of the insect species pool.

MATERIAL AND METHODS

Study site

The 'Pian di Gembro' wetland is located north of the Aprica Pass at 1350 m above sea level in Villa di Tirano, Sondrio (Italy) (Fig. 1). With other alpine wetlands, it shares the features of raised and blanket bogs characterized by a mosaic of plant associations (Andreis & Rodondi, 1982). Since 1988, the wetland and the surrounding area has become a Regional Reserve and Site of Community Importance (SCI IT2040025) under the Habitat Directive Act (92/43/EEC). The protected area covers 126.5 ha, and the major and minor diameters measure 2000 m and 300 m, respectively. Coniferous forests, deciduous trees and shrubs, as well as pastures and meadows, surround the bog. Though no synthetic fertilizers are applied in the wetland, it receives nitrogen and sulphur from the atmosphere (Krupa, 2003; Erisman *et al*., 2005).

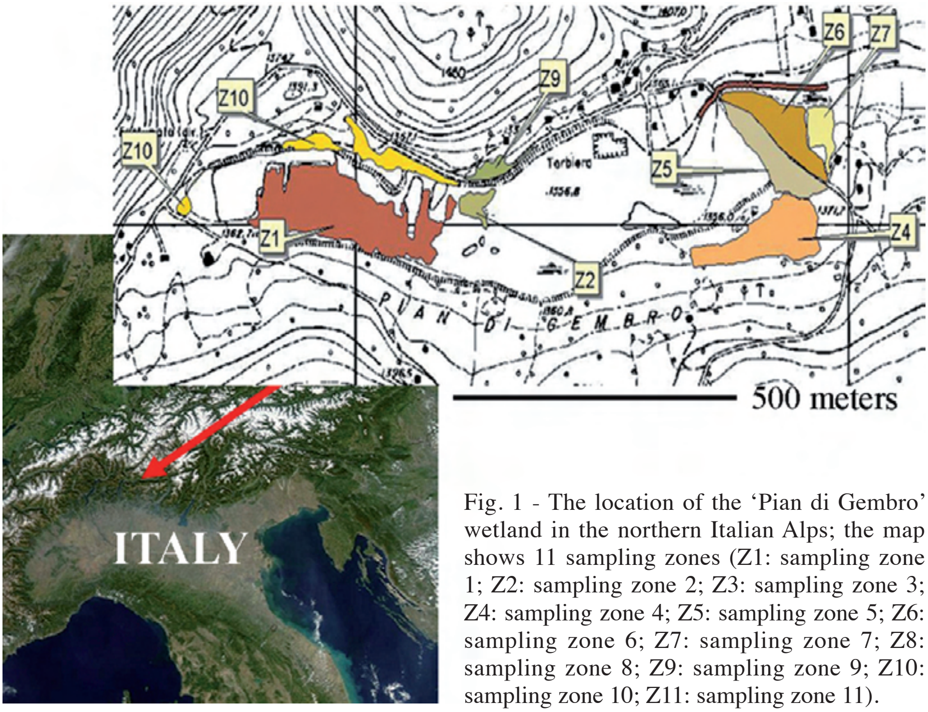

Fig. 1 - The location of the 'Pian di Gembro' wetland in the northern Italian Alps; the map shows 11 sampling zones (Z1: sampling zone 1; Z2: sampling zone 2; Z3: sampling zone 3; Z4: sampling zone 4; Z5: sampling zone 5; Z6: sampling zone 6; Z7: sampling zone 7; Z8: sampling zone 8; Z9: sampling zone 9; Z10: sampling zone 10; Z11: sampling zone 11).

Sampling

The sampling program started in 2005 and continued until 2007. It was restricted to the snow-free periods lasting from March to October. Sampling was carried out in the different zones corresponding to the habitat typologies specified in the Habitat Directive 92/43/EEC part. I and identified by a numeric code. For the protected wetland, the Carta Habitat Natura 2000 IT2040025 establishes habitat typologies and allows the identification of 11 zones (Table 1).

During 2005, one standard pitfall trap (Mason *et al*., 2002; Liu *et al*., 2007; Uys *et al*., 2010) was deployed in each zone (Table 1); to improve the sampling coverage, an additional trap was put into each of the larger sampling zones 1, 2 and 4. The pitfall traps were baited with different types of attractants such as meat, fish, beer, banana and a water solution of NaCl (Mason *et al*., 2002). A total of 19 traps were deployed in the wetland and visited every 10 days for 7 months per year. To improve the sampling efficiency, the pitfall trap technique was complemented by other sampling techniques including the use of sweep nets and entomological umbrellas (Mason *et al*., 2002), sieves, and direct observations of specimens in specific micro-habitats (e.g. tree trunks, underneath stones, and at the bottom of *Carex* spp.).

Table 1 - The sampling zones located within the "Pian di Gembro" wetland components, the description of the vegetation and the habitat code (Carta Habitat Natura 2000 IT2040025) (Z1: sampling zone 1; Z2: sampling zone 2; Z3: sampling zone 3; Z4: sampling zone 4; Z5: sampling zone 5; Z6: sampling zone 6; Z7: sampling zone 7; Z8: sampling zone 8; Z9: sampling zone 9; Z10: sampling zone 10; Z11: sampling zone 11).

Wetland components	Zones	Description of the vegetation	Habitat code
Bog	Z1	Pools with *Utricularia* spp. community	3160
	Z2	Patch vegetation with *Trichophorum* spp. and *Molinia* spp.	7140 and 7150
	Z3	*Carex lasiocarpae* community	7140
	Z4	*Trichophorum caespitosum* community	7140
Surroundings	Z5	*Calluna* dry heaths	4030
	Z6	*Calluna* dry heaths	4030
	Z7	Mountain hay meadows	6520
Drainage channel	Z8	Drainage channel vegetation	
Surroundings	Z9	Managed *Calluna* dry heaths	4030
	Z10	*Calluna* dry heaths	4030
	Z11	Mountain hay meadows	6520

Species pool and species of particular conservation interest

The collected specimens were brought to the laboratory for identification at the species level. The individuals were assigned to different families and sent to specialists who identified the species.

First, the insects were grouped into three main coenoses: *i*) species occurring in the bog, *ii*) species inhabiting the surroundings, and *iii*) species distributed over both the bog and the surroundings. Thereafter, species and families were listed according to the different zones in which they were captured. Subsequently, the species specific to a zone were separated from the ones found in more than one zone. Second, we assessed the species pool by selecting species of particular interest to conservationists. The scientific literature and experts were consulted to establish the categories of interest: a) species of humid biotopes (tyrphophiles); b) bioindicator species; c) endemic alpine taxa; d) species with boreo-alpine distribution; e) species of mountainous environments; f) species of lowland environments; g) species with wide ecological tolerance to the effect of abiotic factors.

RESULTS

Species pool

The sampling program made available 997 individuals representing 141 species from 11 families of Heteroptera (Anthocoridae, Nabidae, Miridae, Reduviidae, Coreidae, Rhopalidae, Lygaeidae, Acanthosomatidae, Pentatomidae, Scutellaridae, Thyreocoridae) and three families of Coleoptera (Carabidae, Chrysomelidae *sensu latu*, Curculionidae *sensu latu*). Table 2 lists the 141 collected species, the number of specimens and the sampling zones in which the specimens were collected.

Species grouping

The insects listed in Table 2 belong to three main coenoses. The first coenosis is composed of species exclusively found in the bog (zones 1, 2 or 3, Table 3) and consists of 11 species including 5 species of Heteroptera, 2 species of Carabidae, 3 species of Chrysomelidae and 1 species of Curculionidae. Of note, the tyrphophiles *Donacia obscura*, *Limnobaris dolorosa* and *Platysma oenotrium* are members of this coenosis. The second coenosis consists of 63 species exclusively found in the surroundings (zones 5, 6, 7, 8, 9 or 10, Table 3). These insects belong to 21 species of Heteroptera, 9 species of Carabidae, 21 of Chrysomelidae and 12 of Curculionidae. The most interesting species of this coenosis are the four endemic alpine taxa *Cryptocephalus sericeus* sp. *zambanellus*, *Otiorhynchus scaber*, *O. frigidus* and *Pterostichus dissimilis* that are of conservation interest (Osella *et al*., 2005). The third coenosis is composed of 64 species that are found in both the bog and the surroundings (Table 4).

The highest number of species specific to one zone were found in zones 10 (23

Table 2 - Species list of Beetles (Coleoptera) and True bugs (Heteroptera) sampled in the "Pian di Gembro" wetland. The number of indiviaduls is given for each sampling zone (Z1: sampling zone 1; Z2: sampling zone 2; Z3: sampling zone 3; Z4: sampling zone 4; Z5: sampling zone 5; Z6: sampling zone 6; Z7: sampling zone 7; Z8: sampling zone 8; Z9: sampling zone 9; Z10: sampling zone 10; Z11: sampling zone 11).

Species	**Z1**	**Z2**	**Z3**	**Z4**	**Z5**	**Z6**	**Z7**	**Z8**	**Z9**	**Z10**	**Z11**
Temnostethus pusillus (Herrich-Schäffer 1835)	0	0	0	0	1	0	0	0	0	0	0
Tetraphleps bicuspis (Herrich-Schäffer 1835)	2	0	0	0	0	0	1	0	0	0	0
Nabis flavomarginatus Scholz 1847	0	0	0	0	0	0	0	0	0	0	1
Nabis rugosus (Linnaeus 1758)	0	0	0	0	4	0	0	0	0	6	0
Alloeotomus gothicus (Fallén 1807)	0	0	0	0	0	0	1	0	0	0	0
Deraeocoris ruber (Linnaeus 1758)	1	0	0	0	0	0	0	0	0	1	0
Halticus apterus (Linnaeus 1761)	1	0	0	0	0	0	1	0	0	2	0
Adelphocoris seticornis (Fabricius 1775)	0	0	0	0	1	0	1	0	0	0	0
Camptozygum aequale (Villers 1789)	2	0	0	0	0	0	0	0	0	0	0
Capsus ater (Linnaeus 1758)	2	0	0	0	2	0	0	1	0	3	0
Charagochilus gyllenhalii (Fallén 1807)	0	0	0	0	0	0	0	0	0	1	0
Leptopterna dolabrata (Linnaeus 1758)	0	0	0	0	2	0	1	0	2	2	2
Lygus pratensis (Linnaeus 1758)	0	0	0	0	1	6	0	0	0	3	0
Lygus wagneri Remane 1955	0	0	0	0	1	0	0	0	0	1	0
Megaloceroea recticornis (Geoffroy 1785)	0	0	0	0	0	0	0	0	1	1	0
Notostira elongata (Geoffroy 1785)	0	0	0	0	0	0	1	0	0	0	0
Polymerus palustris (Reuter 1905)	0	0	0	0	1	0	0	0	0	3	0
Stenodema calcarata (Fallén 1807)	2	2	0	0	0	0	0	0	0	4	0
Stenodema holsata (Fabricius 1787)	1	0	0	0	4	0	0	0	0	7	0
Stenodema laevigata (Linnaeus 1758)	0	0	0	0	0	0	0	0	0	1	0
Heterocordylus genistae (Scopoli 1763)	0	0	0	0	0	0	0	0	5	0	0
Chlamydatus pulicarius (Fallén 1807)	0	0	0	0	2	0	1	0	0	3	0
Plagiognathus arbustorum (Fabricius 1794)	0	0	0	0	0	0	0	0	0	1	0
Plagiognathus chrysanthemi (Wolff 1864)	0	0	0	0	2	0	0	0	0	0	0
Coranus subapterus (De Geer 1773)	0	3	0	0	0	0	0	0	0	0	0
Rhynocoris annulatus (Linnaeus 1758)	1	0	0	0	0	0	0	0	0	0	0
Coreus marginatus (Linnaeus 1758)	0	0	0	0	0	1	0	0	0	1	0
Corizus hyoscyami (Linnaeus 1758)	0	0	0	0	0	0	0	0	1	0	0
Myrmus miriformis (Fallén 1807)	22	22	0	1	6	0	0	2	1	5	0
Rhopalus maculatus (Fieber 1837)	0	1	2	0	3	1	1	0	1	6	0
Rhopalus parumpuncactus Schilling 1829	0	0	0	0	0	0	1	0	0	2	0
Stictopleurus punctatonervosus (Goeze 1778)	5	3	0	0	9	2	0	0	2	10	0
Kleidocerys resedae (Panzer 1797)	0	0	0	0	0	0	1	0	1	1	0
Nithecus jacobaeae (Schilling 1829)	2	0	0	0	13	1	2	0	1	8	0
Eremocoris plebejus plebejus (Fallén 1807)	1	0	0	0	0	0	0	0	0	0	0

Gastrodes abietum Bergroth 1914	0	0	0	0	0	0	3	0	3	0	1
Pachybrachius luridus Hahn 1826	0	0	0	0	0	0	0	0	0	1	0
Peritrechus geniculatus (Hahn 1832)	1	2	0	0	0	1	0	0	0	0	0
Pterotmetus staphyliniformis (Schilling 1829)	0	0	0	0	0	0	3	0	0	2	0
Rhyparochromus pini (Linnaeus 1758)	2	0	0	0	0	0	1	0	0	0	1
Stygnocoris pygmaeus R.F. Sahlberg 1848	0	0	1	0	0	0	0	0	0	0	0
Stygnocoris sabulosus (Schilling 1829)	0	0	0	0	8	0	1	0	1	11	0
Trapezonotus desertus Seidenstücker 1951	0	0	0	0	1	0	0	0	0	0	0
Trapsonotus dispar Stål 1872	0	0	0	0	0	0	2	0	0	0	0
Cyphostethus tristriatus (Fabricius 1787)	0	0	0	0	0	0	3	0	0	0	0
Elasmostethus interstinctus (Linnaeus 1758)	0	0	0	0	1	0	0	0	1	1	0
Elasmucha grisea (Linnaeus 1758)	0	0	0	0	1	0	0	0	1	0	0
Picromerus bidens (Linnaeus 1758)	0	0	0	0	0	0	0	0	0	1	0
Zicrona caerulea (Linnaeus 1758)	0	0	0	0	0	0	0	0	0	1	0
Aelia acuminata (Linnaeus 1758)	0	0	0	0	1	0	0	0	3	6	0
Carpocoris purpureipennis (De Geer 1773)	0	0	0	0	3	0	0	0	0	4	0
Dolycoris baccarum (Linnaeus 1758)	2	0	0	0	2	0	1	0	0	4	0
Eurydema oleracea (Linnaeus 1758)	0	0	0	0	0	0	0	0	0	5	0
Holcostethus vernalis (Wolff 1804)	0	0	0	0	3	0	0	0	0	0	0
Neottiglossa bifida (A. Costa 1847)	0	0	0	0	0	0	0	0	0	1	0
Palomena prasina (Linnaeus 1761)	0	0	0	0	0	0	0	0	0	2	0
Pentatoma rufipes (Linnaeus 1758)	0	0	0	1	1	0	0	0	0	1	0
Eurygaster maura (Linnaeus 1758)	0	0	0	0	0	0	0	0	1	0	0
Eurygaster testudinaria (Geoffroy 1785)	0	0	0	0	0	1	0	0	0	2	0
Thyreocoris scarabaeoides (Linnaeus 1758)	0	0	0	0	0	0	2	0	0	2	0
Carabus germarii Sturm 1815	0	0	0	0	0	0	1	0	0	0	0
Agonum sexpunctatum (Linne 1758)	0	0	0	0	2	0	0	0	0	0	0
Platysma oenotrium (Ravizza 1975)	0	2	0	0	0	0	0	0	0	0	0
Pterostichus dissimilis (A. Villa & G.B. Villa 1833)	0	0	0	0	0	0	0	0	3	0	0
Poecilus versicolor (Sturm 1824)	0	0	0	0	1	0	0	0	0	0	0
Phonias diligens (Sturm 1824)	0	59	0	3	0	0	0	0	0	0	0
Bothriopterus oblongopunctatus (Fabricius 1787)	1	0	0	0	0	0	0	0	0	0	0
Amara eurynota (Panzer 1797)	0	0	0	0	2	0	0	0	0	0	0
Amara lucida (Duftschmid 1812)	0	0	0	0	0	0	0	0	1	0	0
Amara cursitans (Zimmermann 1832)	0	0	0	0	0	0	0	0	1	0	0
Anisodactylus binotatus (Fabricius 1787)	0	0	0	0	1	0	0	0	0	0	0
Acupalpus flavicollis (Sturm 1825)	0	0	0	0	0	0	0	0	0	1	0
Lamprias cyanocephalus (Linne 1758)	0	0	0	0	0	0	0	0	2	0	0
Zeugophora flavicollis (Marsham 1802)	0	0	0	0	1	0	0	0	0	0	0
Donacia obscura Gyllenhal 1813	2	0	0	0	0	0	0	0	0	0	0

Gonioctena decemnotata (Marsham 1802)	3	2	0	0	1	0	0	0	35	0	0
Gonioctena quinquepunctata (Fabricius 1787)	4	14	0	0	4	0	0	0	7	6	0
Chrysolina fastuosa (Scopoli 1763)	0	0	0	0	0	0	0	0	0	3	0
Chrysolina marginata (Linnaeus 1758)	0	0	0	0	0	0	0	0	0	3	0
Chrysolina geminata (Paykull 1799)	0	0	0	0	0	2	0	0	0	8	0
Chrysomela populi Linnaeus 1758	0	0	0	0	13	0	0	0	0	0	0
Chrysomela tremulae Fabricius 1787	0	0	0	0	59	0	0	0	0	0	0
Chrysomela vigintipunctata Scopoli 1763	0	0	0	0	1	0	0	0	0	0	0
Lochmaea caprea (Linnaeus 1758)	14	6	0	0	0	0	5	0	0	0	0
Galeruca pomonae (Scopoli 1763)	0	0	0	0	1	0	0	0	0	0	0
Galeruca tanaceti (Linnaeus 1758)	0	0	0	0	1	0	1	0	0	0	0
Luperus flavipes (Linnaeus 1767)	0	1	0	0	9	0	0	0	1	0	0
Luperus longicornis (Fabricius 1781)	0	0	0	0	0	0	0	0	1	0	0
Luperus viridipennis Germar 1824	0	0	0	0	22	0	1	4	2	0	0
Aphthona herbigrada (Curtis 1837)	0	0	0	0	0	0	0	1	2	0	0
Aphthona venustula (Kutschera 1861)	0	0	0	0	6	0	0	1	6	47	0
Longitarsus lewisii (Baly 1874)	0	0	0	0	0	0	0	0	1	0	0
Longitarsus luridus (Scopoli 1763)	0	0	0	0	0	0	1	0	0	3	0
Longitarsus melanocephalus (De Geer 1775)	0	0	0	0	0	0	0	0	4	0	0
Longitarsus pratensis (Panzer 1794)	0	0	0	0	0	0	0	0	2	0	0
Altica oleracea (Linnaeus 1758)	3	6	0	0	8	1	0	0	4	22	0
Bathophila rubi (Paykull 1799)	0	0	0	0	0	0	0	0	0	1	0
Neocrepidodera peirolerii (Kutschera 1860)	0	0	0	0	0	0	0	2	0	1	0
Crepidodera lamina (Bedel 1901)	0	0	0	0	1	0	0	0	0	0	0
Chaetocnema concinna (Marsham 1802)	0	0	0	0	0	0	0	0	0	2	0
Chaetocnema picipes Stephens 1831	0	0	0	0	0	0	0	0	0	1	0
Chaetocnema hortensis (Geoffroy 1758)	0	0	0	0	0	1	0	0	0	2	0
Chaetocnema sahlbergi (Gyllenhal 1827)	1	2	0	0	0	1	0	0	0	0	0
Smaragdina affinis (Illiger 1794)	3	4	0	0	0	0	0	0	7	0	0
Smaragdina salicina (Scopoli 1763)	0	0	0	0	2	1	0	0	0	0	0
Cryptocephalus elegantulus Gravenhorst 1807	1	0	0	0	0	0	0	0	0	0	0
Cryptocephalus labiatus Linnaeus 1761	1	0	0	0	1	0	2	0	4	0	0
Cryptocephalus vittula Suffrian 1848	0	0	0	0	0	0	0	0	0	1	0
Cryptocephalus bipunctatus (Linnaeus 1758)	1	0	0	0	0	0	0	0	0	0	0
Cryptocephalus flavipes Fabricius 1781	0	0	0	0	0	1	0	0	0	0	0
Cryptocephalus moraei (Linnaeus 1758)	0	0	0	0	0	4	0	0	0	0	0
Cryptocephalus nitidus (Linnaeus 1758)	0	0	0	0	1	0	0	0	1	0	0
Cryptocephalus quadripustulatus Gyllenhal 1813	0	0	0	0	0	0	0	0	0	1	0
Cryptocephalus sericeus Marseul 1875	0	0	0	0	0	2	0	0	0	0	0
Cryptocephalus transiens Franz 1949	0	0	0	0	0	9	0	0	6	1	0

Bromius obscurus (Linnaeus 1758)	0	0	0	0	6	0	0	0	6	11	0
Cassida sanguinolenta O.F. Müller 1776	0	0	0	0	0	0	0	0	1	0	0
Otiorhynchus armadillo (Rossi 1792)	0	0	0	0	0	0	0	0	0	2	0
Otiorhynchus scaber (Linnaeus 1758)	0	0	0	0	3	0	0	0	0	0	0
Otiorhynchus frigidus (Mulsant 1859)	0	0	0	0	1	0	0	0	0	0	0
Otiorhynchus anthracinus (Scopoli 1763)	0	0	0	0	0	0	0	0	0	1	0
Phyllobius viridicollis (Fabricius 1792)	0	0	0	0	1	0	0	0	0	0	0
Phyllobius arborator (Herbst 1797)	1	0	0	0	1	0	0	0	0	0	0
Phyllobius pyri (Linnaeus 1758)	0	1	0	0	0	0	0	0	1	1	0
Polydrusus marginatus Stephens 1831	0	0	0	0	0	0	0	0	0	1	0
Polydrusus cervinus (Linnaeus 1758)	0	0	0	0	0	0	0	1	0	0	0
Sciaphilus asperatus (Bonsdorff 1785)	0	0	0	0	3	0	0	0	0	1	0
Strophosoma melanogrammum (Forster 1771)	0	0	0	0	17	0	0	0	0	0	0
Sitona nigriclavis Stephens 1829	0	0	0	0	0	0	1	0	1	0	0
SItona sulcifrons (Gyllenhal 1834)	0	0	0	0	2	0	9	0	37	8	0
Lepyrus capucinus (Schaller 1783)	0	0	0	0	0	0	0	0	0	1	0
Hylobius abietis (Linnaeus 1758)	0	0	0	0	0	0	0	0	1	0	0
Magdalis memnonia (Gyllenhal 1832)	0	0	0	0	1	0	0	0	1	0	0
Ceutorhynchus erysimi (Fabricius 1787)	0	0	0	0	1	0	0	0	2	1	0
Nedyus quadrimaculatus (Linnaeus 1758)	0	0	0	0	0	0	0	0	0	1	0
Limnobaris dolorosa (Goeze 1777)	0	1	0	0	0	0	0	0	0	0	0
Limnobaris t-album (Linnaeus 1758)	0	0	0	0	0	0	0	0	0	2	0
Anthonomus rubi (Herbst 1795)	0	0	0	0	0	0	4	0	0	0	0
Tachyerges salicis (Linnaeus 1758)	0	0	0	0	0	0	0	0	3	1	0
Tachyerges stigma (Germar 1821)	0	0	0	0	0	0	0	0	0	1	0
Miarus campanulae Linnaeus 1767	0	0	0	0	1	0	0	0	2	3	0

species) and 5 (19 species). The zone specificity could be explained by the presence of particular host plants and abiotic ecological requirements that are present in a particular zone. It is worth noting that there were no species specific to zone 4. All the other zones, however, had a number of specific species ranging from 1 (zone 3, 8) to 18 (zone 5). In general, there were more exclusive species in the surroundings (zones 5, 9, 10) than in the bog area (zones 1, 2, 3, 8), with the exception of zone 1 which had 7 exclusive species. From the systematic point of view, both Heteroptera and Coleoptera recorded in this study are characterized by exclusive species, but the highest number of exclusive species belongs to the Heteroptera suborder (27 species) and to the Chrysomelidae family (24 species). In zone 6, we found exclusively Chrysomelidae, while the 3 species found in zone 2 belong to three different taxa. Some of the species listed in table 2, such as the aforementioned *O. scaber* and *O. frigidus,* have a restricted geographical distribution, while others such as *Anthonomus rubi* (Osella *et al*., 2005) and *Longitarsus pratensis* are common species with a wide geographical distribution (Biondi, 2005).

Table 3 - Species exclusively found in one component of the "Pian di Gembro" wetland (Lombardy, Italy): black squares show species exclusively found in the bog; grey squares show species exclusively found in the surroundings (H: Heteroptera; C: Carabidae; Ch: Chrysomelidae; Cu: Curculionidae sensu lato; Z1: sampling zone 1; Z2: sampling zone 2; Z3: sampling zone 3; Z4: sampling zone 4; Z5: sampling zone 5; Z6: sampling zone 6; Z7: sampling zone 7; Z8: sampling zone 8; Z9: sampling zone 9; Z10: sampling zone 10; Z11: sampling zone 11).

	H			**C**	**Ch**			**H**	**C**	**Cu**	**H**	**H**					**C**			**Ch**					
ZONE/SPECIES	*Rhynocoris annulatus*	*Camptozygum aequale*	*Eremocoris plebejus*	*Bothriopterus oblungopunctatus*	*Donacia obscura*	*Cryptocephalus elegantulus*	*Cryptocephalus bipunctatus*	*Coranus subapterus*	*Pterostichus oenotrium*	*Limnobaris dolorosa*	*Stygnocoris pygmaeus*	*Temnostethus pusillus*	*Plagiognathus chrysanthemi*	*Trapezonotus desertus*	*Holcostethus vernalis*	*Anisodactylus binotatus*	*Agonum sexpunctatum*	*Poecilus versicolor*	*Amara eurynota*	*Zeugofora flavicollis*	*Chrysomela populi*	*Chrysomela trenulae*	*Chrysomela vigintipunctata*	*Galeruca pomonae*	*Crepidodera lamina*
Z1	■	■	■	■	■	■	■																		
Z2								■	■	■															
Z3											■	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒
Z5																									

	Cu				**Ch**			**H**					**C**	**Cu**	**H**			**C**				**Ch**			
ZONE/SPECIES	*Otiorhynchus scaber*	*Otiorhynchus frigidus*	*Phyllobius viridicollis*	*Straphosoma melanogrammum*	*Cryptocephalus flavipes*	*Cryptocephalus moraei*	*Cryptocephalus sericeus*	*Cyphostethus tristriatus*	*Anthonomus rubi*	*Alloeotomus gothicus*	*Notostira elongata*	*Trapezonotus dispar*	*Carabus germari*	*Polydrusus cervinus*	*Corizus hyoscyami*	*Eurygaster maura*	*Heterocordylus genistae*	*Pterostichus dissimilis*	*Amara lucida*	*Amara cursitans*	*Lamprias cyanocephala*	*Luperus longicornis*	*Longitarsus lewisii*	*Longitarsus melanocephalus*	*Longitarsus pratensis*
Z5	▒	▒	▒	▒																					
Z6					▒	▒	▒																		
Z7								▒	▒	▒	▒	▒	▒												
Z8														▒											
Z9															▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒

	Ch	**Cu**	**H**								**C**	**Ch**							**Cu**						
ZONE/SPECIES	*Cassida sanguinolenta*	*Hylobius abietis*	*Charagochilus gyllenhalii*	*Stenodema laevigatum*	*Pachybrachius luridus*	*Picromerus bidens*	*Zicrona caerulea*	*Eurydema oleracea*	*Neottiglossa bifida*	*Palomena prasina*	*Aucupalpus flavicollis*	*Bathophila rubi*	*Chaetocnema picipes*	*Chaetocnema concinna*	*Chrysolina marginata*	*Chrysolina fastuosa*	*Cryptocephalus quadripustulatus*	*Cryptocephalus vittula*	*Limnobaris t-album*	*Rhyncaenus stigma*	*Otiorhinchus anthracinus*	*Polydrusus marginatus*	*Otiorhinchus armadillo*	*Lepyrus capucinus*	*Nedyus quadrimaculatus*
Z9	▒	▒																							
Z10			▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒

Table 4 - Species found in at least two zones of Pian di Gembro wetland (Lombardy, Italy). Grey squares show species widespread across surrounding zones (group A); black squares show species widespread across both the surrounding and the bog zones (group B) (Z1: sampling zone 1; Z2: sampling zone 2; Z3: sampling zone 3; Z4: sampling zone 4; Z5: sampling zone 5; Z6: sampling zone 6; Z7: sampling zone 7; Z8: sampling zone 8; Z9: sampling zone 9; Z10: sampling zone 10; Z11: sampling zone 11).

ZONE/SPECIES	*Smaragdina salicina*	*Sciaphilus asperatus*	*Luperus viridipennis*	*Lygus wagneri*	*Carpocoris pupureipennis*	*Lygus pratensis*	*Nabis rugosus*	*Stygnocoris sabulosus*	*Polymerus palustris*	*Coreus marginatus*	*Chlamydatus pulicarius*	*Elasmucha grisea*	*Cryptocephalus nitidus*	*Magdalis memnonia*	*Eurygaster testudinaria*	*Chaetocnema hortensis*	*Elasmostethus interstinctus*	*Chrysolina geminata*	*Bromius obscurus*	*Galeruca tanaceti*	*Adelphocoris seticornis*
Z5	▒	▒	▒	▒	▒	▒	▒	▒	▒		▒	▒	▒	▒			▒		▒	▒	▒
Z6	▒		▒			▒				▒					▒	▒		▒			
Z7			▒					▒			▒									▒	▒
Z8			▒																		
Z9			▒					▒				▒	▒	▒			▒		▒		
Z10		▒		▒	▒	▒	▒	▒	▒	▒	▒				▒	▒	▒	▒	▒		

ZONE/SPECIES	*Aphtona venustula*	*Cryptocephalus sericeus*	*Miarus campanulae*	*Ceutorhynchus erysimi*	*Aelia acuminata*	*Leptopterna dolobrata*	*Longitarsus luridus*	*Rhopalus parumpuncatus*	*Neocrepidodera peiroleri*	*Megaloceroea recticornis*	*Thyreocoris scarabaeoides*	*Polydrusus cervinus*	*Rhyncaenus salicis*	*Kleidocerys resedae*	*Pterotmetus staphyliniformis*	*Sitona sulcifrons*	*Aphtona herbigrada*	*Gastrodes abietum*	*Sitona nicriclavis*	*Luperus flavipes*	*Nithecus jacobaeae*
Z1																					■
Z2																				■	
Z3																					
Z4																					
Z5	▒		▒	▒	▒	▒										▒				■	■
Z6		▒																			■
Z7						▒	▒	▒			▒			▒	▒	▒		▒	▒		■
Z8	▒								▒			▒					▒				
Z9	▒	▒	▒	▒	▒	▒				▒			▒	▒		▒	▒	▒	▒	■	■
Z10	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒		▒	▒	▒	▒					■
Z11						▒												▒			

ZONE/SPECIES	*Rhopalus maculatus*	*Stenodema holsatum*	*Capsus ater*	*Dolycoris baccarum*	*Cryptocephalus labiatus*	*Altica oleracea*	*Stictopleurus punctatonervosus*	*Gonioctena decemnotata*	*Halticus apterus*	*Phyllobius arborator*	*Pentatoma rufipes*	*Deraeocoris ruber*	*Phyllobius pyri pyri*	*Stenodema calcaratum*	*Tetraphleps bicuspis*	*Smaragdina affinis*	*Gonioctena quinquepunctata*	*Myrmus miriformis*	*Lochmaea capreae*	*Peritrechus geniculatus*	*Chaetocnema sahlbergi*	*Phonias diligens*
Z1		■	■	■	■	■	■	■	■	■		■		■	■	■	■	■	■	■	■	
Z2	■					■	■	■					■	■		■	■	■	■	■	■	■
Z3	■																					
Z4											■							■				■
Z5	■	■	■	■	■	■	■	■		■	■						■	■				
Z6	■		■			■	■													■	■	
Z7	■			■	■				■						■				■			
Z8			■															■				
Z9	■				■	■	■	■					■			■	■	■				
Z10	■	■	■	■		■	■		■		■	■	■	■			■	■				

The 64 species (45% of species pool) that occur in more than one zone could be considered as “generalists”, with a wider ecological tolerance than species found in one zone only (Table 3 and 4). We split these species into two groups: group A contains “generalist” species widespread in surrounding zones, while group B contains “generalist” species widespread in both surrounding and bog zones. As expected, the outflow zone 8 is inhabited by species occurring in the bog and in the surrounding zones. In group A, there are species of conservation interest and species with a wide geographical distribution such as *Lygus pratensis* and *Galeruca tanaceti,* which has also been found in nearby commercial yarrow fields (Limonta *et al*., 2003; Sassi, 2007) where Penata Gama *et al*. (2010) studied the dynamics of aphid populations. Within group B, there are species of conservation interest and species with a wide geographical distribution, such as *Gonioctena decemnotata* and *Altica oleracea* (Sassi, 2007; Montagna, 2009).

Species of particular conservation interest

We found 39 species (28% of the species pool) of conservation interest (Table 5). *Pachybrachius luridus* is the only species that could be considered a obligate bog or tyrphobiont species linked to *Sphagnum* spp. and other bog plants (e.g. *Carex* spp., *Rhynchospora* sp., *Trichophorum* sp. and *Eriophorum* sp.) (Montagna *et al*., 2008). There were 23 species considered tyrphophiles, including *Donacia obscura* and *Chaetocnema sahlbergi* that prefer humid biotopes or microenvironments with high humidity (Doguet, 1994; Montagna, 2009). Five species, including *D. obscura* and *Pterostichus dissimilis*, are considered bioindicators of natural environments (Giaccalone *et al*., 2002; Casale *et al*., 2005; Sassi, 2005; Montagna *et al*., 2008; Montagna, 2009). *Othiorrynchus scaber, O. frigidus*, *C. sericerus* sp. *zambanellus* and *P. dissimilis* (2.8% of species pool) are taxa endemic to the Italian alpine region (Casale *et al*., 2005; Osella *et al*., 2005; Sassi, 2005). Three species of Heteroptera (2.1% of species pool), including *Trapezonotus desertus*, show a boreo-alpine distribution (Pericart, 1987; Pericart, 1998a, 1998b, 1998c). Nine species of the ‘Pian di Gembro’ species pool are typical of mountainous regions (e.g. *C. sericeus* and *Amara cursitans* are typical alpine taxa), and three are typical of lowland environments (Magistretti, 1965; Biondi, 2005; Casale *et al*., 2005; Cianficconi, 2005; Sassi, 2005; Montagna *et al*., 2008). Four species exhibit a wide ecological tolerance (Casale *et al*., 2005; Montagna *et al*., 2008). It should also be noted that even at the altitude of 1350 m above sea level and in the heart of Alps, 2% of the species are lowland species.

Among the 39 species of conservation interest, there are 25 species that occur in one zone only, 8 in two zones and 6 in more than 2 zones (Table 5).

DISCUSSION

The insect species pool of ‘Pian di Gembro’ wetland consists of 141 species collected during three years of sampling. The evaluation of the species pool is difficult because studies on alpine wetland insects are rare and usually restricted to particular taxa. Boyse (2004) studied the insect fauna of acid mires in England and found only 24 species

Table 5 - Species of Pian di Gembro wetland (Lombardy, Italy) that are considered of conservation interest.

SPECIES	Zones	Species of humid biotope	Biondicator	Alpine endemic species	Boreo-Alpine distribution	Mountaineous species	Lowland species	Wide ecological tolerance	SPECIES	Zones	Species of humid biotope	Biondicator	Alpine endemic species	Boreo-Alpine distribution	Mountaineous species	Lowland species	Wide ecological tolerance
Donacia obscura	1	■	■						*Limnobaris t-album*	10	■					■	
Rhynocoris annulatus	1					■			*Cryptocephalus quadripustulatus*	10		■					
Coranus subapterus	2					■			*Rhyncaenus stigma*	10	■						
Platysma oenotrium	2	■							*Lepyrus capucinus*	10	■					■	
Limnobaris dolorosa	2	■							*Nabis flavomarginatus*	11	■			■			
Trapezonotus desertus	5				■				*Phonias diligens*	2, 4	■	■					
Agonum sexpunctatum	5	■				■			*Neocrepidodera peiroleri*	8, 9					■		
Anisodactylus binotatus	5	■					■		*Sciaphilus asperatus*	5, 10	■						
Chrysomela vigintipunctata	5	■							*Polymerus palustris*	5, 10	■	■					
Crepidodera lamina	5	■							*Eurygaster testudinaria*	6, 10	■						
Otiorhynchus scaber	5			■		■			*Rhopalus parumpuncatus*	7, 10							■
Otiorhinchus frigidus	5			■					*Megaloceroea recticornis*	9, 10					■		
Cryptocephalus sericeus ssp. Zambanellus	6			■		■			*Rhyncaenus salicis*	9, 10	■						
Anthonomus rubi	7	■							*Chaetocnema sahlbergi*	1, 2, 6	■						
Pterostichus dissimilis	9		■	■					*Stenodema calcaratum*	1, 2, 10	■				■	■	
Amara cursitans	9					■			*Phyllobius pyri pyri*	2, 9, 10	■				■	■	
Longitarsus lewisii	9					■			*Sitona sulcifrons argutulus*	5, 7, 9, 10					■	■	■
Pachybrachius luridus	10	■				■	■	■	*Nithecus jacobaeae*	1, 5, 6, 7, 9, 10				■			■
Picromerus bidens	10	■							*Rhopalus maculatus*	2, 3, 5, 6, 7, 9, 10	■						
Aucupalpus flavicollis	10	■															

belonging to Coleoptera (Carabidae, Chrysomelidae *sensu latu*, Curculionidae *sensu latu*) and Heteroptera. Rampazzi & Dethier (1997) found 105 species of Heteroptera in a bog located in southern Switzerland, and in the Zehlau Bog in the western Russia entomologists collected 38 species of Coleoptera (Carabidae) (Främbs *et al.*, 2002). The results confirm the important contribution of Coleoptera and Heteroptera to the wetland inhabiting insect fauna. Moreover, the studies indicate that the results depend on sampling techniques and sampling efforts. This confirms the importance of building the sampling program on different techniques and justifies their implementation over an extended period of three years.

The collected species grouped into three main coenoses show that 64 species share both wetland components. Nevertheless, the 11 species restricted to the bog and the 63 species found in the surroundings show that a clear difference should be made between the bog and the surroundings. We found 23 tyrphophile insects, which exhibit preferences for boggy areas, but the only obligate bog (tyrphobiont) species found was *Pachybrachius luridus*. With the exception of zone 4, all zones are inhabited by zone-specific species (Table 1). Hence, all zones except zone 4 are important in efforts aiming at conserving the general pool of Coleoptera and Heteroptera species. From the standpoint of conserving species of particular interest (Table 5), 24 species are found in at least one out of 8 zones. In the remaining zones, zone 4 and zone 8 share a single species with zone 2 and zone 9, respectively, while only zone 3 shares the same species with 7 other zones. Hence, the zones 3, 4, 8 could be considered as redundant in efforts to conserve the pool of species of particular interest. By taking into account both the general species pool (Table 1) and the pool of species of particular interest to conservationists (Table 2), only zone 4 can be considered as redundant since it is inhabited by species that occur also in other zones.

In conclusion, with one exception, all the zones are important for conserving the general species pool and the pool of particular interest in conservation programs. As previously described, these zones result from the application of a DIMR aiming at wetland plant species conservation. From the standpoint of conserving the insect species pool, the existing DIMR is also effective for Coleoptera and Heteroptera.

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Matteo Montagna, Dipartimento di Patologia Animale, Igiene e Sanità Pubblica Veterinaria, Università degli Studi di Milano, Milano, Italy; Dipartimento di Protezione dei Sistemi Agroalimentare e Urbano e Valorizzazione delle Biodiversità, Università degli Studi di Milano, Milano, Italy. e-mail: matteo.montagna@unimi.it.

Giuseppe Carlo Lozzia, Johann Baumgärtner, Dipartimento di Protezione dei Sistemi Agroalimentare e Urbano e Valorizzazione delle Biodiversità, Università degli Studi di Milano, Milano.

Carlo Andreis, Dipartimento di Biologia, sezione di Botanica Sistematica e Geobotanica, Università degli Studi di Milano, Milan, Italy.

Anna Giorgi, GeSDiMont, Centro di studi applicati per la gestione sostenibile della montagna. Università degli Studi di Milano, Edolo, Italy.

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