Tree farming and biodiversity

Bird communities as indicators of polycyclic tree farms positive role

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Polycyclic tree farms can offer important environmental benefits, both compared to traditional tree farming and, above all, to intensive poplar cultivation. The present work compares the ability to support bird communities in polycyclic tree farms and in conventional poplar plantations.

Tree farms have a generally positive role for the environment and for "ecosystem services"; however the effectiveness and the entity of any positive effects on biodiversity are conditioned by tree farm characteristics, by the context in which it is located and by the type of environment that tree farm "replaces" (Carnus *et al.*, 2006). In Italy tree farming is mainly represented by traditional intensive poplar plantations and by medium-long cycle tree farms (also mixed tree farms, with or without accessory plants). Here, the most critical environmental issues are related to the negative impact of soil tillage, to the use of pesticides, fertilizers and water for irrigation (mainly affecting poplar cultivation), as well as the abrupt reset of the habitat at the end of the production cycle (Mori 2015). Polycyclic tree farms (Buresti Lattes and Mori 2009) can offer a possible solution to these problems. Within the LIFE InBioWood project (***www.inbiowood.eu***) it has been compared the avifauna of temporary polycyclic tree farms and traditional poplar plantations, with the aim of testing whether polycyclic tree farms are more frequented by birds than traditional poplar plantations. The birds presence (whose effectiveness as indicators is now well-established, particularly in forest environments) is useful to evaluate if polycyclic tree farms can offer an effective contribution to biodiversity.

Study area

The study was carried out in San Matteo delle Chiaviche (Viadana, MN) in temporary polycyclic tree farms and in a traditional poplar plantations, located in a 2 km radius area, at the confluence between Oglio and Po rivers. Temporary polycyclic tree farms were split into two lots and the distance between plants was 5x2.5 m. One of the temporary polycyclic tree farm lots (about 25 hectares), located in Oglio flood plain and historically cultivated with poplar, has been planted in 2003, using walnuts, hybrid walnuts, common ash, wild service tree, peduncolate oak and european wild pear as main trees; four poplar clones (Lena, Villafranca, I214 and Neva) as dual role plants; black alder, hazel and elderberry as accessory plants. The other temporary polycyclic tree farm lot (about 24 ha), outside Oglio flood plain, previously cultivated with arable land, has been planted in 2004, using walnut, linden, peduncolate oak, european wild pear and wild service tree as main trees; poplar of a single clone (Neva) as a dual role plant; black alder, hazel and elaeagnus spp. as accessory

plants. Soil tillage was performed only during the first four years with decreasing intensity; no fertilizations and irrigations were carried out and just a single pesticides treatment was made at the poplar trees, solely at the trunk, in the lot outside the flood plain. The traditional poplar plantation (about 50 ha), located in open flood plain, was totally cultivated with I214 clone and the distance between plants was 6.5 x 6.5 m. Poplars were between 9 and 12 years old. The poplar plantation owners conduct intensive cultivation techniques, with soil tillage, fertilization, irrigation, pruning and pesticide treatments.

Methods

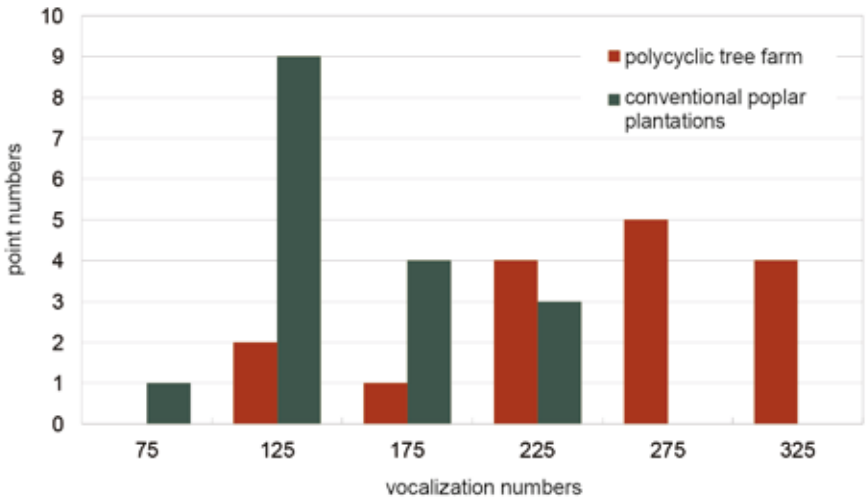
Birds were surveyed with a digital recorder equipped with a panoramic stereo microphone (ZOOM model H2), positioned on an easel at 1.2 m height. Recordings were made on 17 and 18 of May 2014, between 5:45 and 9: 30, on 16 different points inside polycyclic tree farms and 17 points inside poplar plantation, at a minimum distance of 190 m one from the other. A specific software (Audacity 2.0.5) was used to analyse 10 mins of recording for each point. From vocalization analyses, it has been derived the list of the bird species present in every plantation and, for each species, a "utilization index" given by the number of vocalizations. Generalized linear models (GLM) were used to verify the hypothesis of a significant difference between polycyclic tree farms and poplar plantation. For this purpose population structure parameters (species richness, diversity expressed by Shannon index), overall levels of activity, and activity of the single species (only for species with, at least, 50 vocalizations) were compared. Verifying the residual distributions, it has been chosen to use GLM "classical" form to test populations structure parameters. On the other side, it has been chosen to use "mixed GLM", specifically the "hurdle" models, for testing species activities. This choice allows to treat dependent variables with an excess of zeroes, versus any error distribution. Analysis also included the minimum distance from diversification elements, potentially relevant in homogeneous environments such as the studied ones. These elements are defined as any surface not affected by arboriculture exceeding 1,000 m^2 or, if mainly extended in length, wider than 20 m. Even recording time is an important element, because bird activity is strongly conditioned by this factor. All the analyses were carried out with the R package (R Core Team 2016).

Results and discussion

In total, 30 bird species were detected, 25 species inside polycyclic tree farms and 24 inside poplar plantations. The common species were 19. 11 species were detected only in one or in the other plantation, each and every with very low frequency. Some of these 11 bird species live in marginal environments (for example herons, mallard, Eurasian collared dove, common kingfisher, common moorhen) or are exclusively migratory birds (such as western Bonelli's warbler or common grasshopper warbler) with the exception of European turtle dove and magpie (only found in polycyclic tree farms) and of green woodpecker and spotted flycatcher (found only in the poplar plantation). The analysis have shown that there is no difference, in terms of bird species richness or diversity, between traditional poplar plantation and polycyclic plants, because these factors substantially depend on marginal environment proximity (Table 1). Substantially, the two areas have the same nesting birdlife and the results are similar to the ones outlined in other studies about Po Valley poplar plantations (Bogliani 1988). As far as activity levels are concerned, the difference is significant and very much in favour of polycyclic tree farms where the number of vocalizations is 40% higher (Table 1, Chart 1); moreover, taking into consideration the 14 species that could be analysed individually, for seven species the vocalization activity was significantly higher in polycyclic tree farms, while only for one species it was higher in poplar plantation (Table 2).

	Polycyclic tree farms		Conventional poplar plantations		Polycyclic tree farms effect	Other variables effect	
	Average value	IC (95%)	Average value	IC (95%)		Distance	Time
Wealth in species for every recording point	10,00	(9,50-10,50)	9,65	(8,84-10,45)	**n.s.**	-(**)	n.s.
Diversity (indice di Shannon)	1,758	(1,701-1,815)	1,776	(1,660-1,892)	**n.s.**	-(***)	n.s.
Total vocalizations	250,3	(229,4-271,2)	152,4	(137,7-167,1)	**+(***)**	-(*)	-(**)

Table 1 - Results for total plantations. The data collected, the sign and the variables significance are reported. The "+" sign indicates, for the three tested effects, that values are significantly higher in polycyclic tree farms compared to poplar plantation, as distance increases and time progresses. The "-" sign indicates the opposite effect. The significance levels are (*) p <0.05; (**) p <0.01; (***) p <0.001; n.s indicates that no significant effect was found.



Graph 1 - Distribution of vocalizations total number according to points number in each plantation type. It is clear that points with greatest activity are largely located in polycyclic tree farms.

Species		vocalization numbers/10'		Polycyclic tree farms effect	Other variables significance levels	
		Polycyclic tree farms	Conventional poplar plantations		Distance	Time
Hooded Crow	*Corvus cornix*	49.4	26.6	+(*)	*n.s.*	*n.s.*
Common Nightingale	*Luscinia megarhynchos*	40.6	12.2	+(*)	*n.s.*	*n.s.*
Eurasian Golden Oriole	*Oriolus oriolus*	27.1	21.2	***n.s.***	*n.s.*	*n.s.*
Common Chaffinch	*Fringilla coelebs*	7.0	35.8	-(**)	+(*)	*n.s.*
Great Tit	*Parus major*	30.3	8.5	+(*)	-(*)	*n.s.*
Eurasian Blackcap	*Sylvia atricapilla*	24.6	11.4	+(*)	-(*)	*n.s.*
Great Spotted Woodpecker	*Dendrocopos major*	17.4	8.5	+(*)	*n.s.*	*n.s.*
Common Pheasant	*Phasianus colchicus*	15.3	9.9	***n.s.***	*n.s.*	-(***)
Common Blackbird	*Turdus merula*	18.9	1.1	+(*)	*n.s.*	-(***)
Common Starling	*Sturnus vulgaris*	3.7	8.9	***n.s.***	*n.s.*	*n.s.*
Common Cuckoo	*Cuculus canorus*	4.6	2.0	***n.s.***	*n.s.*	-(**)
Common Wood Pigeon	*Columba palumbus*	4.3	0.4	+(*)	-(*)	-(*)
Long-tailed Tit	*Aegithalos caudatus*	3.4	0.5	***n.s.***	*n.s.*	*n.s.*
Eurasian Blue Tit	*Cyanistes caeruleus*	0.6	2.6	***n.s.***	-(*)	+(**)
Eurasian Jay	*Garrulus glandarius*	0.2	0.7			
Spotted Flycatcher	*Muscicapa striata*		0.8			
Eurasian Collared Dove	*Streptopelia decaocto*	0.9				
Grey Heron	*Ardea cinerea*	0.6	0.1			
Eurasian Magpie	*Pica pica*	0.7				
Common Moorhen	*Gallinula chloropus*	0.2	0.3			
Common Kestrel	*Falco tinnunculus*	0.3	0.2			
Black-crowned Night Heron	*Nycticorax nycticorax*	0.3	0.1			
Green Woodpecker	*Picus viridis*		0.4			
Common Whitethroat	*Sylvia communis*		0.2			
Western Bonelli's Warbler	*Phylloscopus bonelli*		0.1			
Common Kingfisher	*Alcedo atthis*		0.1			
Common Grasshopper Warbler	*Locustella naevia*	0.1				
Mallard	*Anas platyrhynchos*	0.1				
Common Swift	*Apus apus*		0.1			
European Turtle Dove	*Streptopelia turtur*	0.1				

Table 2 - Results for individual species. The data collected, the sign and the significance of the variables are reported. The "+" sign indicates, for the three tested effects, that birds activity is significantly higher in polycyclic tree farm, compared to poplar plantation, as distance increases and time progresses. The "-" sign indicates the opposite effect. The significance levels are (*) p <0.05; (**) p <0.01; (***) p <0.001; n.s indicates that no significant effect was found.

Conclusions

The higher bird activity levels recorded in polycyclic tree farms, compared to traditional poplar trees, shows their greater "ecological carrying capability". It means that polycyclic tree farms have greater resource availability for birdlife. Although the sample studied was very small (about 50 hectares of polycyclic tree farms, surrounded by intensive agriculture and intensive poplar farming) and the bird community was very similar between the compared plantations, the differences about bird activities are very evident. Compared to traditional plantations, where bird density is generally very low (Riffell *et al.* 2011), polycyclic tree farms show a greater "ecological carrying capability" which means the ability to "surrogate" natural or semi-natural forest formations (Martín-García *et al.* 2013). Wherever forests are greatly reduced or completely disappeared, as in Mediterranean region plains, polycyclic plantations can be very important. This type of tree farm could replace in part the intensive poplar plantations, whose effectiveness in terms of biodiversity support is rather low (Martín-García *et al.* 2016).

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Parole chiave: *Arboricoltura da legno, avifauna, piantagioni policicliche, pioppicoltura tradizionale, biodiversità, InBioWood.*

Abstract: ***Arboricolture and biodiversity. Avifauna as an indicator of the positive role of polycyclic plantations.*** *Birds show greater song activity in polycyclic plantations compared with poplar plantations, that means higher "carrying capacity" in polycyclic plantations. Polycyclic plantations could be used as better surrogates for native forests than poplar plantations, helping to keep higher level of biodiversity, expecially in mediterranean plains that are very poor in natural woods.*

Keywords: *Wood plantation, avifauna, polycyclic plantations, poplar plantations, biodiversity, InBioWood.*

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