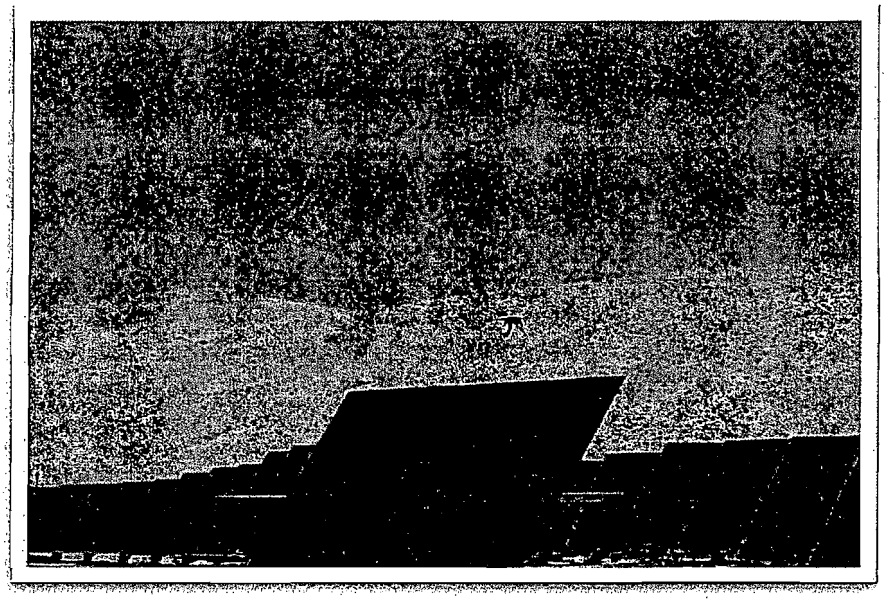
ASSESSMENT OF POTENTIAL IMPACTS TO BIRDS FROM A SOLAR THERMAL POWER PLANT, DIMONA, ISRAEL

Interim Report- Spring Survey, 2012



Tristram's Grackle flying over solor heliostat panels, Dimona, Israel (photo: Liron Ziv)

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1. Introduction

BrightSource Industries is operating a demonstration plant, SEDC (Solar Energy Development Center) near Dimona, Israel (31° 1'22.75"N, 35° 5'20.95"E). This desert region of the northern Negev is located approximately 10 miles west of the African-Syrian Rift Valley, which supports one of the largest and most concentrated bird migration flyway in the world. The plant is located within a small business park and is bordered by the Dimona Nature Reserve and closed military lands.

This plant has approximately 1600 heliostats (rotating mirrors, mostly single mirror LH-1 design), with an 60-m high central tower (excluding the boiler), 75 meter total, covering a total of 13,000 m^2. The boiler produces superheated steam, with high flux concentration on the panels. The boiler receiver panels are at 400C and 600C temperature as a pilot same as for the large tower power plants, smaller surfaces but same temperature and same fluxes intensities. SEDC began operation in June 2008. The system uses tracking mirrors (heliostats) to directly concentrate sunlight onto a boiler filled with water that sits atop a tower. When the sunlight hits the boiler, the water inside is heated and creates high temperature steam. Once produced, the steam is used either in a conventional turbine to produce electricity or in industrial process applications, such as thermal enhanced oil recovery (EOR).

1.1 Aims

This project aims to assess the potential impact to birds from the solar thermal plant activities. Bird use of the area includes resident, breeding, wintering and migrating individuals, and therefore it is important to employ a variety of methods over the course of a full year.

2. Methods

The methodology involves three main types of surveys aimed at assessing a wide range of bird use and potential impacts over the course of the year. All surveys were conducted by experienced bird watchers Liron Ziv and Tuvia Kahn.

2.1 Flight Behavior and Migration Survey

During migration periods (spring and autumn) surveys are conducted 5 days per week (Friday and Saturday the site is closed) from 12 March – 15 May (spring) and 15 August – 15 October (autumn). During summer and winter surveys will be conducted during 10 visits, 5 per month for 2 months.

Methods are based on surveys the SPNI conducts annually for monitoring migrating soaring birds during autumn (Alon et al 2004) with modifications used for assessing flight behavior within proposed wind turbine farms. The observer was stationed in a location where the entire project area is visible (Figure 1). All birds flying over the site and larger soaring birds up to 2 kilometers from the site were recorded. Data include species, number, minimum height above ground (0=ground, 1=1-60m, 2= 61-100m, 3=101-150m, 4= 151-200m, 5=201-500, 6=>500), nearest location relative to the tower, flight direction, weather variables and time of passage. Birds that remained in the immediate area for extended periods, including residents, are noted inn comments. Surveys hours were restricted to 07:30 to 16:30 due to the site's working hours; however, this period covers the peak hours of activity for most diurnal migrant birds.

2.2 General Bird Community Survey

Three transects were laid out along the perimeter of the main plant, which allowed for the detection of birds found both inside and outside the power plant area (Figure 1). The outer area is mostly natural desert habitats and contrasts greatly with the developed area inside. Transect survey method follows Bibby et al. (1993) and involves walking a given transect and recording all bird species detected according to distance from transect (<50m, >50m, flying), habitat type, survey time for each 100m section, and weather variables. Transect counts were conducted during early morning hours from sunrise to 1000, earlier if temperatures are high (based on bird activity) from April (4 times) and May (3 times) for a total of 7 complete surveys. Transects are not conducted during heavy winds, rain or stormy weather.

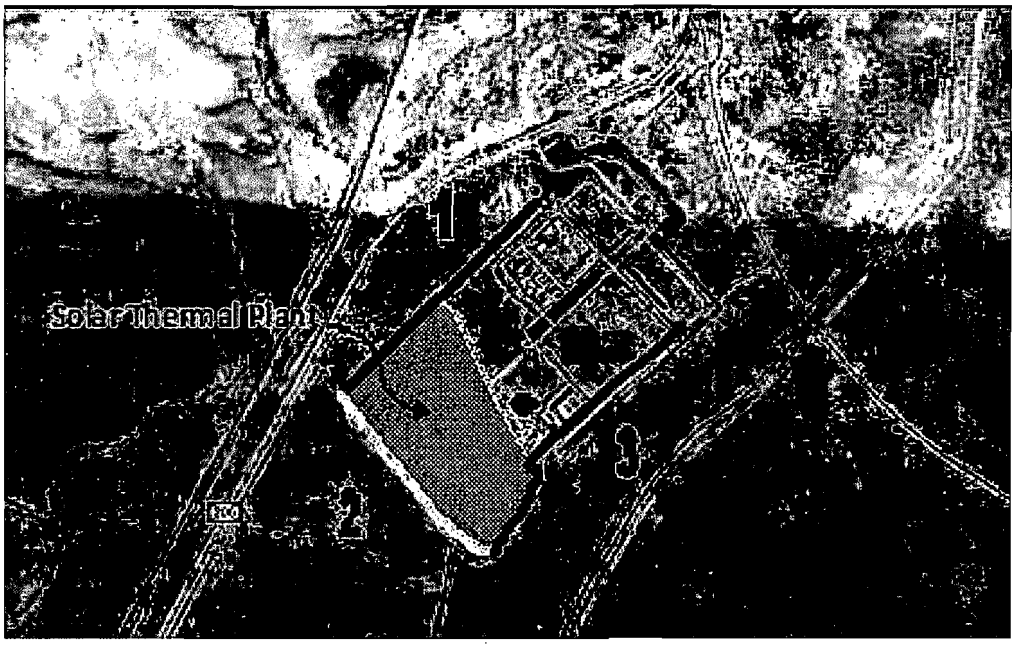

Figure 1. Study area showing Solar Thermal Plant (light blue), transects (red, yellow and blue), and location of observer for flight behavior survey (red circle).

2.3 Dead or Injured Bird Search

At least four times per week, a thorough search was made through the plant area during the morning hours beginning at 07:30. A search consists of slowly walking the paths between the heliostats, alternating between starting at the tower and working outward and visa-versa. The paths are approximately 20m apart. Carcasses should be easy to detect given the sparse vegetation and relatively flat sandy soils Areas outside of the Heliostat field could not be searched due to military restrictions. A data Form was filled out for each search even if no dead birds were found. The dead birds were collected but were not saved. For future searches we plan on leaving the carcasses in place in order to assess delectability and scavenger removal rates according to methodology of United States Fish and Wildlife Service (2011).

3. Results

During 41 days of surveys a total of 62 species were observed. The majority of the species were migrants (40),10 species breed in the area and 22 species are resident year round (Table 1).

Table 1. All species observed during the spring season listed according to survey type, distribution status, and threatened listing status (regional and global; definitions described in Appendix 1).

Species		Survey			Distribution		Status	
Latin	English	Migration	Transect	Resident	Breeding	Migrant	Israel	Global
Accipiter brevipes	Levant Sparrowhawk	x				x		LC
Alectoris chukar	Chukar		x	x			NT	
Apus apus	Common Swift	x	x		x	x		
Aquila nipalensis	Steppe Eagle	x				x		LC
Aquila pomarina	Lesser Spotted Eagle	x				x		LC
Buteo buteo vulpinus	Steppe Buzzard	x	x			x	VU*	LC
Buteo rufinus	Long-legged Buzzard	x			x	x		LC
Cercomela melanura	Blackstart		x	x				
Ciconia ciconia	White Stork	x				x	NT	LC
Ciconia nigra	Black Stork	x				x		LC
Circaetus gallicus	Short-toed Eagle	x			x	x		LC
Circus aeruginosus	Marsh Harrier	x	x			x	RE	LC
Circus macrourus	Pallid Harrier	x				x		NT
Circus pygargus	Montagu's Harrier	x				x		LC
Circus sp.	Harrier sp.	x				x		
Columba livia	Rock Pigeon	x		x				
Corvus corone	Hooded Crow	x		x				
Corvus monedula	Eurasian Jackdaw	x		x				
Corvus ruficollis	Brown-necked	x	x	x				

Species		Survey		Distribution			Status	
Latin	English	Migration	Transect	Resident	Breeding	Migrant	Israel	Global
	Raven							
Delichon urbica	Northern House-Martin	x	x			x		
Emberiza hortulana	Ortolan Bunting		x			x		
Falco biarmicus	Lanner Falcon	x		x			VU	
Falco eleonorae	Eleonora's Falcon	x				x		
Falco naumanni	Lesser Kestrel	x			x	x	EN	VU
Falco pelegrinoides	Barbary Falcon	x		x			NT	
Falco tinnunculus	Common Kestrel	x		x				LC
Galerida cristata	Crested Lark		x	x				
Grus grus	Common Crane	x				x	LC	LC
Gyps fulvus	Eurasian Griffon Vulture	x		x			EN	LC
Hieraaetus pennatus	Booted Eagle	x				x		LC
Hippolais pallida	Olivaceous Warbler		x		x	x		
Hirundo daurica	Red-rumped Swallow		x		x	x	LC	
Hirundo fuligula/obsoleta	Pale-Crag Rock Martin	x		x			LC	
Hirundo rustica	Barn Swallow	x	x		x	x	LC	LC
Lanius collurio	Red-backed Shrike		x			x	NT	
Lanius meridionalis	Southern Grey Shrike		x	x			LC	
Lanius nubicus	Masked Shrike		x			x	NT	
Merops apiaster	European Bee-eater	x	x		x	x	VU*	
Merops orientalis	Little Green Bee-eater	x		x			LC	
Milvus migrans	Black Kite	x				x	RE	LC
Motacilla flava	Yellow Wagtail		x			x	CR*	
Muscicapa striata	Spotted Flycatcher		x			x		
Nectarinia osea	Palestine Sunbird		x	x				
Neophron percnopterus	Egyptian Vulture	x			x	x	EN	EN
Onychognathus tristramii	Tristram's Starling	x	x	x				
Pandion haliaetus	Osprey	x				x		LC
Passer domesticus	House Sparrow	x	x	x				
Pernis apivorus	European Honey-buzzard	x				x		LC
Phylloscopus trochilus	Willow Warbler		x			x		
Phylloscopus collybita	Chiffchaff					x		

Species		Survey		Distribution			Status	
Latin	English	Migration	Transect	Resident	Breeding	Migrant	Israel	Global
Pterocles orientalis	Black-bellied Sandgrouse	x		x			NT	
Pycnonotus xanthopygos	White-spectacled Bulbul	x	x	x				
Rhodopechys obsoleta	Desert Finch		x	x			LC	
Riparia riparia	Sand Martin		x			x		
Streptopelia senegalensis	Laughing Dove		x	x				
Streptopelia turtur	European Turtle-Dove		x		x	x	NT	LC
Sylvia atricapilla	Blackcap		x			x		
Sylvia borin	Garden Warbler		x			x		
Sylvia communis	Common Whitethroat		x			x		
Sylvia curruca	Lesser Whitethroat		x			x		
Sylvia hortensis	Western Orphean Warbler		x			x		
Vanellus spinosus	Spur-winged Lapwing		x	x				
Total	61	38	33	22	10	39	23	22

3.1 Flight Behavior and Migration Survey

During this survey period we observed 8,540 individual birds of 38 species. Given that many migrant birds fly in flocks the actual number of observations is only 427. The most common species is Steppe Buzzard (5.330) and then the European Honey-buzzard (1,431).

During this period the numbers of migrants vary greatly on a daily basis. There appeared to be at least 2 peak periods of relatively heavy movement (Figure 2). The first peak (primarily Steppe Buzzards) occurred during the second half of March and the second peak occurred at the end of April and the first week of May and consisted primarily of European Honey-buzzards. Figure 3 shows that most migration occurred during April in absolute numbers and daily averages.

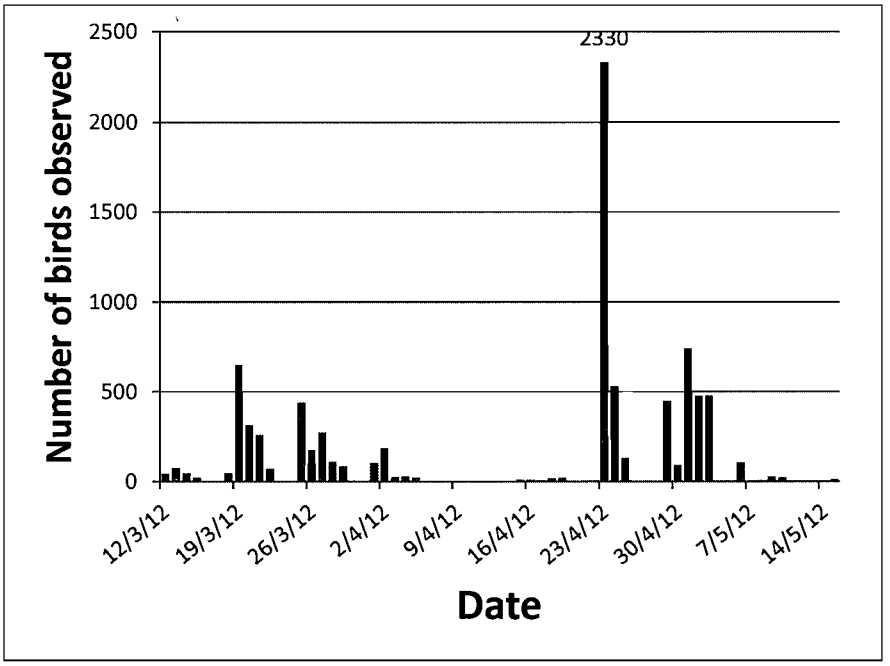

Figure 2. Number of individual birds observed during the flight behavior and migration survey.

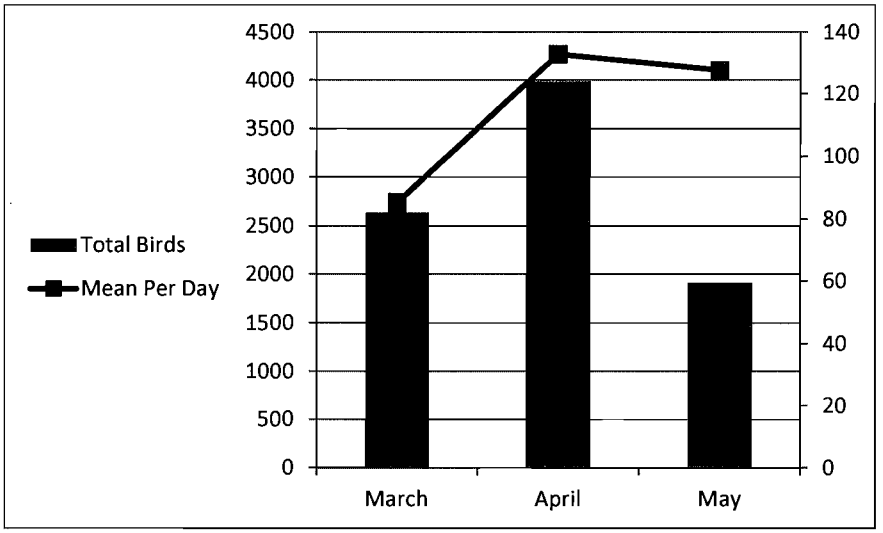

Figure 3. Total number of individuals and daily means according to month.

The general movement of birds during the day also varies greatly with a peak of activity usually occurring between 09:00 and 11:00 in the morning (Figure 4). It is important to note that the survey hours were limited due to restrictions at the site and thus some migrant birds went unobserved. However, most diurnal, soaring migrants are known to pass during this period of the day (Alon et al. 2004).

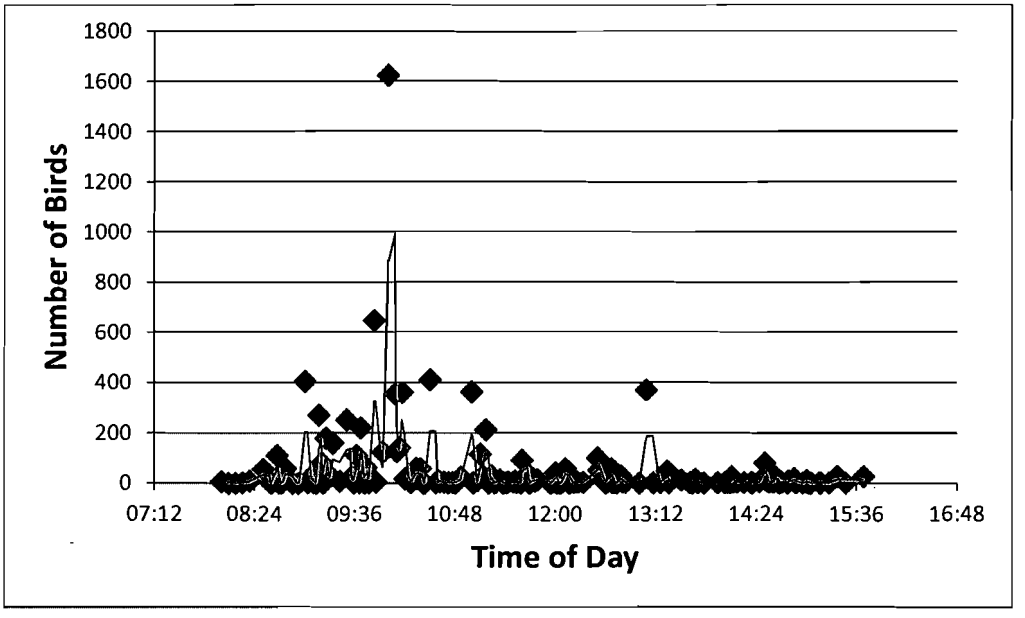

Figure 4. The total number of birds observed according to time of passage during spring migration.

An analysis of flight direction shows that most birds were headed in a northerly direction as would be expected for spring migrants (Figure 5). A minimum number of birds were observed flying in other directions and most likely represent resident birds or migrants searching for food or rest areas.

We also looked at flight behavior in terms of spatial movement relative to the solar plant. During the survey 87% of the birds observed were flying above 100m and therefore above the tower (75m) that could cause collisions (Figure 6).

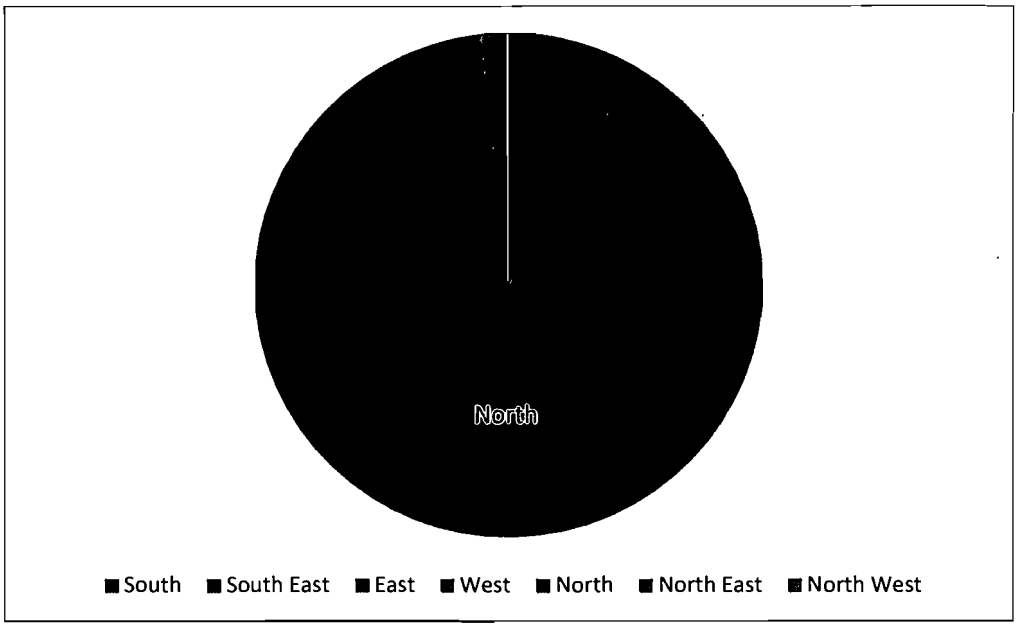

Figure 5. Flight direction of birds passing through the project area during spring.

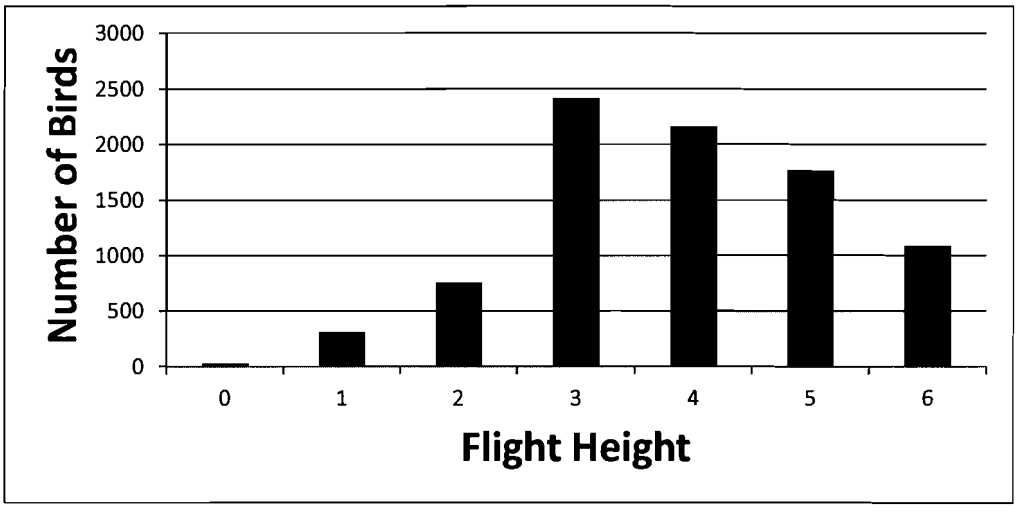

Figure 6. Number of birds observed according to flight height above the ground during spring (0=ground, 1=1-60m, 2= 61-100m, 3=101-150m, 4= 151-200m, 5=201-500, 6=>500).

In addition to flight height, we also examined distance and direction of each flying bird from the solar thermal tower. In general, most birds flew over 300m from the tower (Figure 7). Minimum distance data per species is presented in Appendix 2. Flight distance varied greatly between species even within migrating soaring birds such as European Honey-buzzard (farthest) compared to White Storks that flew on average within a few 100's of meters from the tower. Resident species showed much less variation in flight distance. Most birds passed to the east of the plant (4,401) and approximately half that number passed to the west (2,430; Figure 8).

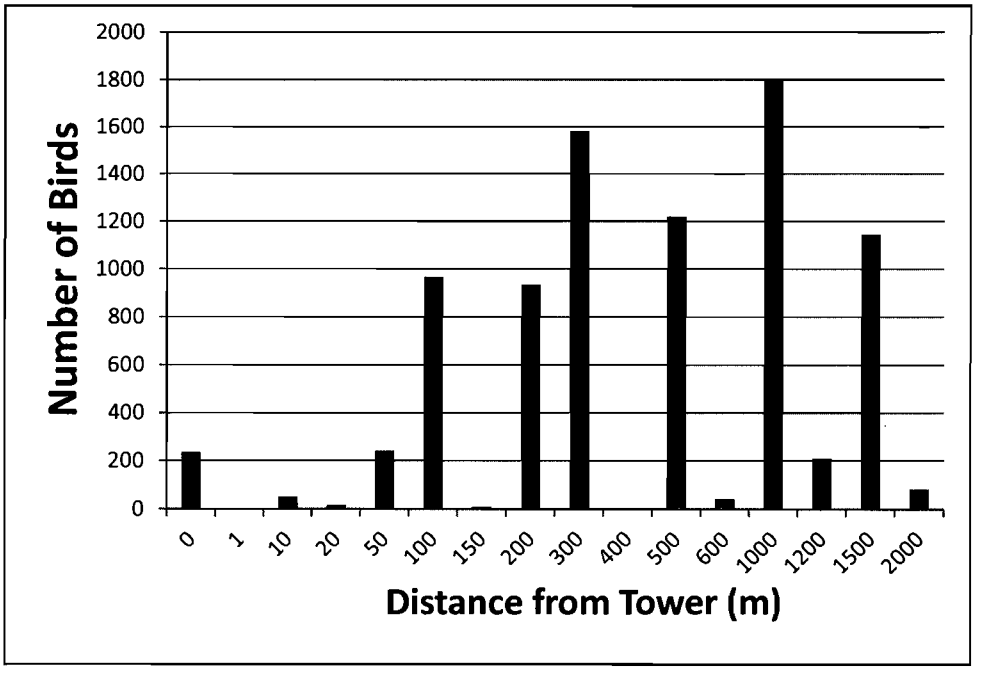

Figure 7. Number of birds observed according to distance from solar thermal tower.

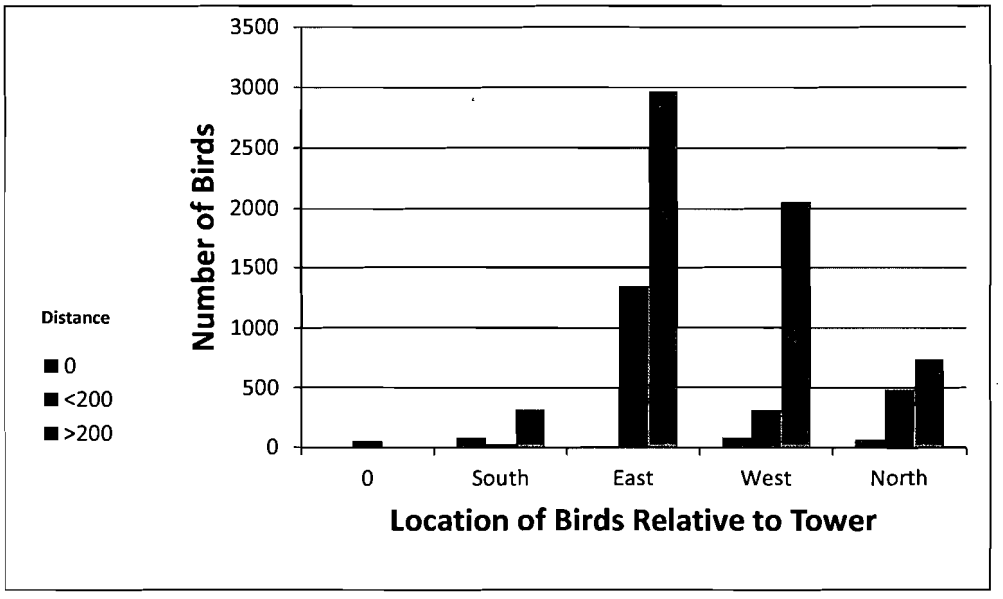

Figure 8. Location of flying birds in relation to the solar thermal tower divided into 3 distance categories.

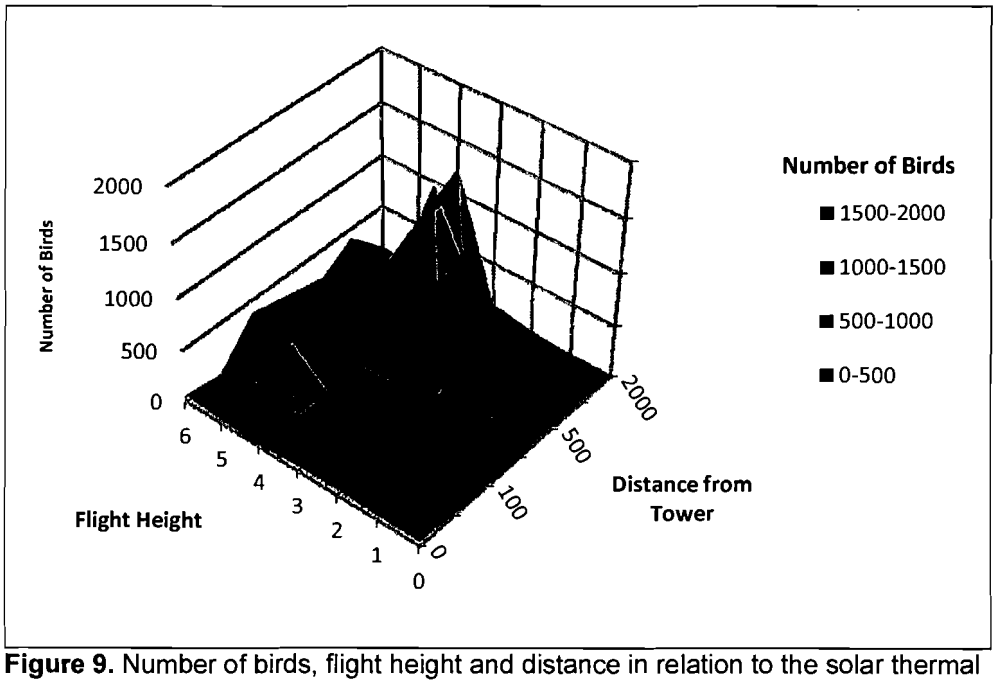

Figure 9. Number of birds, flight height and distance in relation to the solar thermal tower.

Although a full assessment of the impacts of the solar thermal plant will be dealt with only in the final report, we assume that impacts will be related to the proportion of birds flying directly over the plant and their flight height. The overall mirror surface area is approximately 13,000 m^2 (roughly 450m x 300m; see Figure 1). A total of 2.351 birds flew over the actual plant area; of these, 853 individuals of 30 species were flying relatively low (under 200m; Table 2). Six of the low-flying species are listed as Threatened regionally and/or globally.

Table 2. Total number of individuals that flew low (less than 200m) over the project area according to flight height.

Species		Flight Height (m)					
		0	1	2	3	4	Total
Accipiter brevipes	Levant Sparrowhawk		1		2	5	8
Apus apus	Common Swift		3				3
Aquila nipalensis	Steppe Eagle	1		1	1		3
Aquila pomarina	Lesser Spotted Eagle			23	34		57
Buteo buteo vulpinus	Steppe Buzzard		18	222	71	4	315
Buteo rufinus	Long-legged Buzzard		3	2	1		6
Ciconia ciconia	White Stork			30			30
Circaetus gallicus	Short-toed Eagle		1	2	3		6
Circus aeruginosus	Marsh Harrier		1	1			2
Circus pygargus	Montagu's Harrier		2				2
Columba livia	Rock Pigeon	20	52	6			78
Corvus corone	Hooded Crow		2	2			4
Corvus monedula	Eurasian Jackdaw		2				2
Corvus ruficollis	Brown-necked Raven		31	7	2		40
Delichon urbica	Northern House-Martin		10				10
Falco biarmicus	Lanner Falcon			2			2
Falco pelegrinoides	Barbary Falcon		1	1	1		3
Falco tinnunculus	Common Kestrel	9	12	4			25
Grus grus	Common Crane	0					0
Gyps fulvus	Eurasian Griffon Vulture				1	1	2
Hieraaetus pennatus	Booted Eagle			1	1		2
Hirundo fuligula/obsoleta	Rock Martin		5				5
Merops apiaster	European Bee-eater		32				32
Milvus migrans	Black Kite		26	87	1		114
Neophron percnopterus	Egyptian Vulture			1	4	1	6
Onychognathus tristramii	Tristram's Starling	2	49	25			76

Species		Flight Height (m)					
		0	1	2	3	4	Total
Passer domesticus	House Sparrow		10				10
Pernis apivorus	European Honey-buzzard		1	6	1		8
Pterocles orientalis	Black-bellied Sandgrouse			1			1
Pycnonotus xanthopygos	White-spectacled Bulbul		1				1
		32	263	424	123	11	853

3.2 General Bird Community Survey

Considering the arid conditions, the results of the general bird surveys (transects) show that the project area supports a relatively diverse avifauna. A total of 265 individuals of 32 species were observed during 7 transect visits (Table 3). The majority of these species are migrant passerines.

Restricting the data to birds observed within 50m of the transect allows a higher degree of certainty and statistical robustness (Bibby et al. 1993). The overall relative abundance per survey visit is 18.57 (SE= 3.96) and species richness is 9 (SE= 2.07). Relative abundance and species richness varied greatly between transects (Figure 10). Species richness and relative abundance was greatest along transect 1 (18 species and 7.43 birds; respectively); and lowest along transect 2 (12 species and 4.57 birds; respectively). Given the limited number of surveys and the high number of migrants, a thorough analysis will be possible only at the completion of the project.

Table 3. Maximum number of birds observed during the transect survey presented by transect number and distance from transect (< and > 50m).

Species		1		2		3	
		Total Count	50m>	Total Count	50m>	Total Count	50m>
Alectoris chukar	Chukar	4	4	3			
Apus apus	Common Swift					4	0

Species		1 Total Count	1 50m>	2 Total Count	2 50m>	3 Total Count	3 50m>
Buteo buteo vulpinus	Steppe Buzzard			3		4	0
Cercomela melanura	Blackstart			2			2
Circus aeruginosus	Marsh Harrier	1					
Corvus ruficollis	Brown-necked Raven	3	2	3	2	2	1
Delichon urbica	Northern House-Martin					2	0
Emberiza hortulana	Ortolan Bunting	2	1				
Galerida cristata	Crested Lark	2	1	2	2		
Hippolais pallida	Olivaceous Warbler	1	1				
Hirundo daurica	Red-rumped Swallow			5	4		
Hirundo rustica	Barn Swallow	6	5	4	0	5	4
Lanius collurio	Red-backed Shrike			1	1		
Lanius meridionalis	Southern Grey Shrike	1				2	1
Lanius nubicus	Masked Shrike			1			
Merops apiaster	European Bee-eater			6		7	
Motacilla flava	Yellow Wagtail	2	1				
Muscicapa striata	Spotted Flycatcher	1	1	1	1		
Nectarinia osea	Palestine Sunbird	1					
Onychognathus tristramii	Tristram's Starling	4		3			
Passer domesticus	House Sparrow	4	3	6	2	5	5
Phylloscopus trochilus	Willow Warbler	1	1	1	1		
Pycnonotus xanthopygos	White-spectacled Bulbul	3	3			1	1
Rhodopechys obsoleta	Desert Finch	2		2	1	2	0
Riparia riparia	Sand Martin	3	2				
Streptopelia senegalensis	Laughing Dove					3	
Streptopelia turtur	European Turtle-Dove	2	1				6
Sylvia atricapilla	Blackcap	3	3	1	1	3	2
Sylvia borin	Garden Warbler	1	1				
Sylvia communis	Common Whitethroat			1	1		
Sylvia curruca	Lesser Whitethroat	5	4	2	1	2	2
Sylvia hortensis	Western Orphean Warbler	2	1			2	2

Species		1 Total Count	1 50m>	2 Total Count	2 50m>	3 Total Count	3 50m>
Vanellus spinosus	Spur-winged Lapwing	2	2	2		3	0
Relative Abundance (mean individuals per survey)		16.29	**7.43**	10.14	**4.57**	11.43	**4.57**
Species Richness		23	**18**	19	**12**	15	**15**

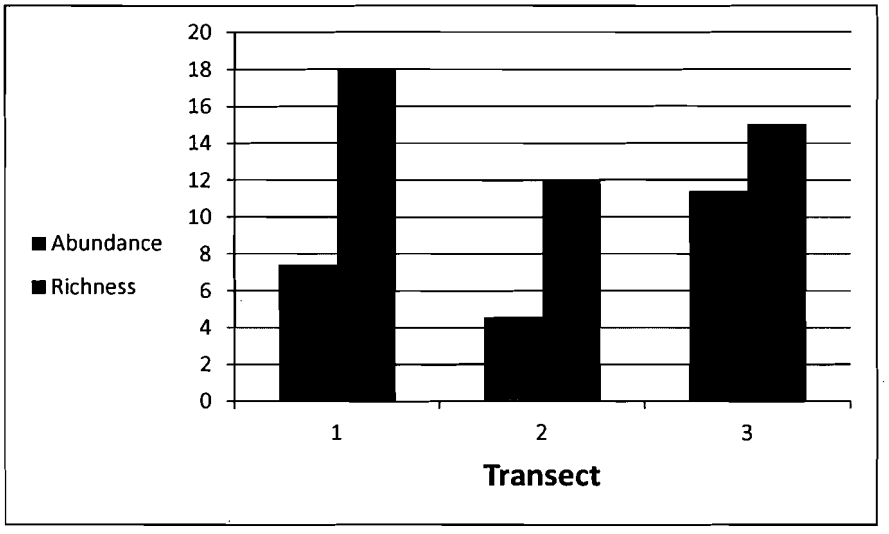

Figure 10. Relative abundance (mean number of individuals) and species richness (total number of species) according to transect. Data are maximum numbers observed within 50m of the transects.

3.3 Dead or Injured Bird Search

We found 3 dead birds within the study area during the spring period (Figure 11):

-Chiffchaff found approximately 350m northwest of the tower between heliostats on 28 March;

-Blackcap found near a heliostat approximately 200m northeast of the tower on 24 April;

-Tristram's Grackle nestling found at the base of the tower, (apparently fell from its nest) on 25 April.

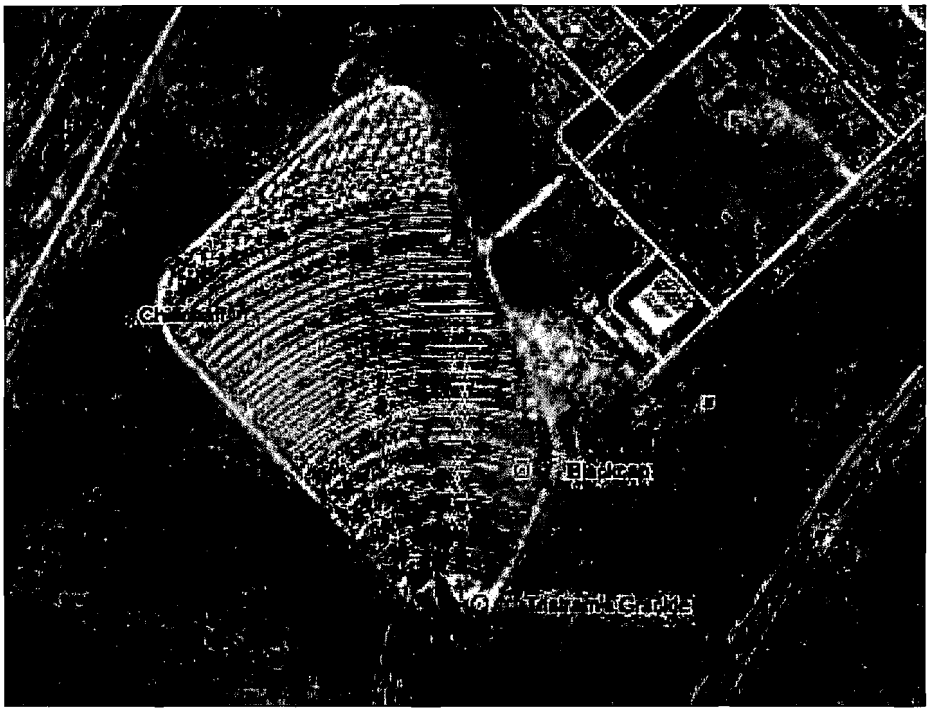

Figure 11. Locations of the three bird carcasses found during spring surveys.

None of the birds showed any visual signs for cause of death (broken appendages or burnt feathers). Results of this survey will be analyzed only at the completion of the project using Mark-capture software for estimating delectability and extrapolating total potential bird deaths at the site.

4. Discussion

The overall avifauna found at the project site during spring is relatively diverse considering the arid desert conditions. A total of 62 species were observed, of which the majority were migrants (40), then residents (22) and additional 10 species that are migrants which also potentially breed in the area.

The project area and general surroundings appear to be situated within an intermediate migration flyway relative to the major flyways known for this region. During the spring survey period we observed 8,540 birds of 38 species composed primarily of diurnal migrants. The most common species was the Steppe buzzard (5,330) and then the European Honey-buzzard (1,431). The majority of these migrants (47%) passed through the project area during April.

The majority of birds flew over the area at relatively low heights with 87% of the birds flying below 500m and 41% flew over lower than 200m. Flight direction was primarily northerly (90%) and to the east of the solar plant (50%).

The general bird community was assessed through a set of 3 transects surveyed 7 times. A total of 265 birds of 32 species were observed, the majority of which were passerine migrants. Relative abundance and species richness varied between transects with transect 1 supporting the highest overall diversity. Given the limited number of surveys and the high number of migrants, a thorough analysis will be possible only at the completion of the project.

Discerning the behavior and population demographics of resident species and species that spend a significant amount of time in the study area is critical to assessing impacts of the plant given the higher exposure rates. Certain species such as Lesser Kestrel and Long-legged Buzzard are difficult to determine whether individuals are migrants or local breeders. A total 22 species (34%) are resident and another 10 species breed in the area. It is important to note that determining the absolute number of these species is difficult at best since individuals will be observed multiple times and therefore oversampled. This bias will be dealt with more thoroughly in the final report.

We observed birds in all areas of the plant. Some species such as pigeons and House Sparrows regularly fly around the mirrors, around and in the tower and around the equipment. We found 3 dead birds during this period: Chiffchaff, Blackcap and nestling Tristram's grackle that appeared to have fallen from its nest on the solar thermal tower. The Chiffchaff and Blackcap are small migrant passerines that did not

show any evidence of broken bones or burnt feathers. As mortality rates are known to be high for migrant passerines it is impossible to determine the cause of death.

Assessing the potential impacts from the solar thermal plant on birds is complex. A full assessment will be dealt with in the final report and will be based on a combination of extrapolative data from found carcasses, overall exposure to the site and a comparison of bird population and flight behavior factors in relation to actual mortality estimates. The number of birds flying low directly over the plant would be assumed to have the highest exposure to any negative effects of the plant. We found 2,351 birds of 34 species flew directly over the site (27% of the total birds observed) and 853 birds of 30 species that flew over the site lower than 200m. Although this is relatively a small proportion of the total observed, it is important to note that 6 of these species are listed as Threatened regionally and/or globally: Lesser Kestrel, Lanner Falcon, Griffon Vulture, Egyptian Vulture, Lesser Spotted Eagle and Black-bellied Sandgrouse.

5. Acknowledgements

Meidad Goren, Director of the Negev Bird Center (SPNI) coordinated the field team and logistics. Liron Ziv conducted most of the surveys and entered the data into our data base. The BrightSource team at the plant was very helpful and assisted our field workers when needed.

6. Literature

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Appendix 1. Explanation for the Threatened species listings (Meyrose and Alon 2002).

EXTINCT (EX): A taxon is Extinct when there is no reasonable doubt that the last individual has died.

REGIONALLY EXTINCT (RE): A taxon is Regionally Extinct when there is no reasonable doubt that the last individual potentially capable of reproduction within the region has died or disappeared from the region.

CRITICALLY ENDANGERED (CR): A taxon is Critically Endangered when it is facing an **extremely high** risk of extinction in the wild in the immediate future (the population is expected to decrease by ≥80% within the next decade), as defined by any of the criteria (A to E) as described below.

ENDANGERED (EN): A taxon is Endangered when it is not Critically Endangered but is facing a **very high** risk of extinction in the wild in the near future (the population is expected to decrease by ≥50% within the next decade), as defined by any of the criteria (A to E) as described below. **VULNERABLE (VU)**: A taxon is Vulnerable when it is not Critically Endangered or Endangered but is facing a high risk of extinction in the wild in the medium-term future (the population is expected to decrease by ≥30% within the next decade), as defined by any of the criteria (A to E) as described below.

NEAR THREATENED (NT): A taxon is Near Threatened when it is not Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for Vulnerable, as defined by any of the criteria (A to E) as described below.

LEAST CONCERN (LC): A taxon is Least Concern when it is not Critically Endangered, Endangered, Vulnerable, but may qualify for Near Threatened in the near future.

DATA DEFICIENT (DD): A taxon is Data Deficient when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status.

NOT EVALUATED (NE): A taxon is Not Evaluated when information regarding its distribution and abundance is unavailable, making it impossible to assess its risk of extinction or to evaluate it against the criteria.

Appendix 2. Number of birds observed according to species and minimum distance from solar thermal tower during the spring survey.

Species		Distance from Tower (m)							Total
		0	1-50	50-100	100-200	200-500	>500	Undefined	
Accipiter brevipes	Levant Sparrowhawk	1	5			2			8
Apus apus	Common Swift				3	30			33
Aquila nipalensis	Steppe Eagle			1	4	2	17	2	26
Aquila pomarina	Lesser Spotted Eagle	4			30	60	22	3	119
Buteo buteo vulpinus	Steppe Buzzard	2		42	732	1663	2761	130	5330
Buteo rufinus	Long-legged Buzzard			1	2	3	9		15
Ciconia ciconia	White Stork		30	150			247		427
Ciconia nigra	Black Stork						25		25
Circaetus gallicus	Short-toed Eagle		1		3	15	21	1	41
Circus aeruginosus	Marsh Harrier			1	1	3	1		6
Circus macrourus	Pallid Harrier					3	2		5
Circus pygargus	Montagu's Harrier							2	2
Circus sp.	Harrier sp.					1			1
Columba livia	Rock Pigeon	15	13	17	2			31	78
Corvus corone	Hooded Crow			3				1	4
Corvus monedula	Eurasian Jackdaw			2					2
Corvus ruficollis	Brown-necked Raven		3	8	26	10	2		49
Delichon urbica	Northern House-Martin		10				14		24
Falco biarmicus	Lanner Falcon			2					2
Falco eleonorae	Eleonora's Falcon						1		1
Falco naumanni	Lesser Kestrel			1			1		2
Falco pelegrinoides	Barbary Falcon			2	1	3	3		9
Falco tinnunculus	Common Kestrel	3	1	5	6	1	1	12	29
Grus grus	Common Crane						403	0	403
Gyps fulvus	Eurasian Griffon Vulture	1			1	2	4	1	9
Hieraaetus pennatus	Booted Eagle			1	2		2		5
Hirundo fuligula/obsoleta	Rock Martin				5				5
Hirundo rustica	Barn Swallow					2			2
Merops apiaster	European Bee-eater				15	17			32
Merops orientalis	Little Green Bee-eater						2		2

Species		Distance from Tower (m)							Total
		0	1-50	50-100	100-200	200-500	>500	Undefined	
Milvus migrans	Black Kite	2	1		25	88	167		283
Neophron percnopterus	Egyptian Vulture				4	3	18	5	30
Onychognathus tristramii	Tristram's Starling		9	4	53	10		11	87
Pandion haliaetus	Osprey						1		1
Passer domesticus	House Sparrow				10				10
Pernis apivorus	European Honey-buzzard				51	601	771	8	1431
Pterocles orientalis	Black-bellied Sandgrouse	1							1
Pycnonotus xanthopygos	White-spectacled Bulbul				1				1
		29	73	240	977	2519	4495	207	8540

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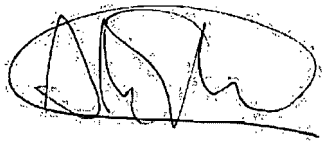
REPORT:

ENVIRONMENTAL IMPACT OF THE GEMASOLAR THERMOSOLAR PLANT ON THE BIRD COMMUNITY IN THE MONCLOVA SURROUNDING AREA (Fuentes de Andalucía, Seville, Spain)

Juan M Pleguezuelos

Granada, 08-23-2012



Education and professional experience

- Juan M Pleguezuelos, Personal ID 24859221Q, BS (1979) and PhD (1985) in Biology from the University of Granada (Spain).
- Instructor and researcher in Zoology (Vertebrates and Conservation Biology) since 1979; Professor in the Department of Zoology, School of Science, at the same university since 2009 .
- President of the Spanish Herpetology Association (2010-).
- Coordinator of the RNM-254 research group, "Biology and Conservation of Mediterranean Vertebrates," of the Regional Government of Andalucía since 1991, and collaborator with the BIODESERT group, Porto University, Portugal.
- Current lines of research: Biology of Reptile Conservation, Biology of the Conservation of diurnal birds of prey, Biology and Ecology of reptiles (mainly snakes).
- I have received 25 Grants; participated in 35 international and national research projects, some subsidized by private companies; I have directed five doctoral theses, plus four that are in process; I have published 67 articles in journals appearing on the ISI-Thompson list; 30 articles in other scientific journals; 8 books (one with three editions); 66 chapters in books, by invitation; 72 electronic scientific publications, (most on the IUCN Web page, by invitation); 32 popular articles; 95 speeches for International Congresses (some are plenary lectures); referee for 39 scientific journals; I have been a member of 25 expert commissions on environmental issues affecting vertebrates; I have carried out 12 environmental impact assessments requested by the public administration and private companies; I am currently (2008-2014) monitoring the impact of the GEMASOLAR (southern Spain) thermosolar plant on the bird community in the area.

My detailed professional experience is in an attachment to this report.

II. Environmental impact study of the GEMASOLAR thermosolar plant

a) *Purpose of the work.*

In the last decade, private initiative has promoted the construction of a large thermosolar power plant (GEMASOLAR, 2600 heliostats) inside the municipal borders of Fuentes de Andalucía, province of Seville, southern Spain. The obligatory declaration of environmental impact (prepared by a specialized company) makes monitoring mandatory with respect to the effect of the plant on avifauna during the construction phase (approximately two years) and the first three years of the operations phase. The administration with environmental authority in the study area (Environmental Department, Regional Government of Andalucía), makes a request of the promoter company, Torresolenergy, that the monitoring be done by an independent entity with expertise in the regional avifauna, and which has previously collaborated on environment subjects with the Regional Administration.

b) *Origin of the commissioning of this study from the undersigning party*

At the request of the Regional Administration, in mid-2008, Torresolenergy contacted me in my capacity as Professor of the Zoology Department of the Universidad de Granada and with expertise in regional vertebrates and Conservation Biology, asking me to design and monitor the impact the thermosolar plant will have on the area's avifauna.

Based on this request, I designed the protocol that would be used to monitor the impact of the thermosolar plant on the avifauna, which was approved by Torresolenergy. During the four years I have been carrying out the study and generating reports, the regional administration has not requested changes in my monitoring protocol. Towards the end of 2008, a contract was drawn up and signed by GEMASOLAR and the Fundación Empresa-Universidad (Universidad de Granada) to carry out this study. I am acting as the principal researcher in this Project with the participation of Dr. Mónica Feriche, a collaborator of the research group.

c) *Methodology used in the study of the avifauna of the GEMASOLAR plant*

We performed a prior survey of the landscape and of the terrain in the study area using Google Earth, which allowed us to become acquainted with the dominant habitats. We adapted the bird census in the study area to the availability of tracks within those habitats. Three censuses itineraries were selected for the avifauna:

i) "Circle," which traverses the thermosolar plant and extends for 1.6 km (from 37° 33' 19.3" N/5° 19' 42.1" W to 37° 34' 10.7" N/5° 19' 51.7" W). This census is the one that most precisely reflects the level of impact of the plant on the bird community (maximum focus).

ii) "North circle," point of departure NW of the plant (37° 34' 32.9" N/5° 20' 45.8" W) and then 2.2 km later reaches the NE part of the plant (37° 34' 18.0" N/5° 19' 18.9" W). It passes at a distance ranging from 400-1000 m from the plant, and its purpose is to show the possible impact of the plant on the bird community in its proximity (average focus). It reflects the level of involvement of the operations area in the community of steppe birds.

iii) "Carril del Marqués," follows the lane with the same name from the northern edge of the circle (37° 34' 10.7" N/5° 19' 51.7" W), and continues along 2 km (up to 37° 35' 14.4" N/5° 20' 10.5" W). This itinerary has been selected to obtain a third level of perception of the possible impact of the thermosolar plant on the bird community in the region within a radius of up to 3000 m from the center of the plant (low focus). This census, unlike the previous ones, not only traverses the habitat occupied by the plant (grain crops), but also skirts the edge of a meadow (grove, wood) that is used for cattle ranching. With this, the aim is to extend the scope of the bird community studied to include forest and shrub species.

In total, the three itineraries add up to approximately 6000 m; censuses that repeated monthly throughout the year, and every two weeks over the four central reproduction months (April, May, June, July), contribute a volume of data sufficient for the interannual comparison of the possible impact of the plant on the bird community in the study area.

The censuses are carried out by one sole researcher (JMP), on foot, in the early morning, with back to the sun, at a speed of approximately 2 km/hour. All the birds seen or heard are recorded on a digital recorder (OLYMPUS VN7600), as well as the distance for the sighting (when possible by means of the BUSHNELL sport 850 digital rangefinder), and that the angle the sighting forms with respect to the line of progression (using a compass). Although this methodology, with DISTANCE software, would allow calculating the absolute density of birds, to date all the data has been furnished in the form of the number

of individuals/km of census (Kilometric Abundance Index, KAI), following the recommendation of academic circles dedicated to Conservation Biology.

d) *Timeframe of study execution*

- Winter 2008-2009: study prior to the plant construction phase to know the avifauna in the study area before activity; three visits.
- 2009-June 2011: study during the plant construction phase; one visit per month during the avifauna breeding season (April-July) each year.
- July 2011-to date: study during the plant operations phase of the plant; two visits every month during the bird breeding season (April-July) and one visit each month the rest of the year.

Because of the novelty of the environmental impact study of this recent production system (thermosolar plant) and the elevated richness and value of the bird community in the study area (La Monclova farm), this study generated special interest for me as a naturalist. Thus, besides the previously indicated censuses on which the reports delivered to Torresolenergy were based, I have done parallel censuses on the same and on other different dates, for the same purpose and in the same study area. The data in this report comes from those parallel censuses, and in this way I do not violate the data previously furnished by me to Torresolenergy, as is established in the confidentiality agreement signed between this company and the Fundación Empresa-Universidad.

e) *Outputs related with this study.*

To date, I have generated five reports that have been delivered to Torresolenergy and which this company has, in turn, transmitted to the environmental authority: i) establishing the study protocol; ii) avifauna in the winter of 2008-2009; iii) breeding avifauna during 2009; iv) breeding avifauna during 2010, and v) avifauna during all of 2011. When I complete the study and with the prior approval of Torresolenergy, I would like to publish the results of this study in a scientific journal.

f) *Personal participation in the project.*

All the bird censuses have been carried out by me and I have written the major portion of the reports. I have had the assistance of Dr. Mónica Feriche with respect to logistics during field sampling and in the subsequent analysis of data.

III. **Results of the research at Gemasolar.**

a. *Bird species in the vicinity of the GEMASOLAR plant*

During the operations period of the GEMASOLAR thermosolar plant (July 2011-August 2012), and specifically during the bird breeding period (the months of April-July), 73 species of birds have been identified (Table 1) in the vicinity of the plant (radius of 3 km around the plant's tower). We used only the data obtained on birds during the time of reproduction, because it is the best studied phenological community of birds and the one that is principally considered in the environmental impact studies in Mediterranean terrestrial habitats.

In the same period, 53 species of birds were observed utilizing the interior of the plant space (approximate radius of 850 m around the plant tower) (Table 1). Of these, only 8 species have nested inside the plant premises, with most making two other types of use of the area: trophic (searching for food) or as a crossing point (they have crossed the installation during their daily movement) (Table 1). Of these 53 species, 12 are species of conservation concern according to the criteria and categories of the International Union for Conservation of Nature (IUCN), applied on a regional scale to Spain (see: Libro Rojo de las Aves de España (Red Book of the Birds of Spain), A. Madroño, C. González y J.C. Atienza, Eds., Ministry of the Environment and SEO; Madrid 2004). Five of these species appear within the NT (Near Threatened) category: *Burrhinus oedicnemus, Elanus caeruleus, Lanius meridionalis, Oenanthe hispanica, Milvus migrans*; seven appear within the VU (Vulnerable) category: *Calandrella brachydactyla, Circus pygargus, Falco naumanni, Glareola pratincola, Pterocles orientalis, Streptopelia turtur, Tetrax tetrax* (Table 1).

b. *Frequency with which those species fly between the heliostats and plant tower.*

During the thermosolar plant operations phase in 2011 and 2012, we logged a total of 12 and 14 hours, respectively (total 26 hours), observing the behavior of the birds that use the interior area of the plant. The observations were carried out from prominent sites outside the plant, with good visibility and quality optics (Carl Zeiss binoculars, 10 x 40). We observed 14 species of birds that have crossed the field between the heliostats and the tower (between parentheses, the number of times for each species): *Anas platyrrhynchos* (n = 1), *Apus apus* (n =18), *Ardea cinerea* (n = 1), *Bubulcus ibis* (n = 32), *Buteo buteo* (n = 2), *Calandrella brachydactyla* (n = 1), *Corvus corax* (n = 3), *Corvus monedula* (n = 2), *Egretta garzetta* (n = 2), *Falco tinnunculus* (n = 5), *Hirundo rustica* (n = 5), *Merops apiaster* (n = 11), *Milvus migrans* (n = 2), *Sturnus unicolor* (n = 7). The rest of the species observed inside the plant were on the outside the area covered by the heliostats, or below the level of these.

Of the 14 species observed in flight between the heliostats and the collection tower of the thermosolar plant, only six have been observed, at any given time, to have crossed the beam of solar radiation reflected by the heliostats toward the tower (between parentheses, the number of times for each species): *Apus apus* (n = 2), *Ardea cinerea* (n = 1), *Bubulcus ibis* (n = 5), *Buteo buteo* (n = 1), *Egretta garzetta* (n = 1), *Hirundo rustica* (n = 2). This phenomenon is easily detectable, even in full daylight, because the birds are intensely illuminated for an instant. Birds have never been observed crossing the segment of the beam reflected closer to the tower (the nearest half), where it is assumed that the solar radiation is more intense than in the segment further from the tower and nearer the heliostats. The high frequency with which one of the species, *Bubulcus ibis*, appears in this data is because it is easily detectable in the distance (white plumage), has a certain body size (48-53 cm), and is abundant in the vicinity of the plant. It also nests in a reservoir on the La Monclova farm, and from there frequently crosses the plant in its numerous daily trips in search of food. It is probable that the frequency with which small size birds cross the beam reflected towards the tower is greater than shown here. In any event, it is easy to detect bird carcasses on the ground in the study area. Inside the plant area, most of the soil is bare due to treatment with herbicides, and outside it is flat and clear, particularly after the grain crops have been harvested.

c. *Harm to or death of birds in the plant area.*

In our visits to the study area during the thermosolar plant operations phase, we have not detected bird cadavers in its immediate vicinity that would lead us to think they died from the radiation transmitted by the heliostats to the collection tower. Our visits lasted one to two days, once or twice a month, between July 2011-August 2012. Having consulted the two gamekeepers of the La Moncolva farm who are on the land where the plant is located on a daily basis, they are of the same opinion. Our excursions (two in 2011 and two in 2012) in search of bird cadavers inside the plant area generated the same results (these are not detailed because they are the property of Torresolenergy). Various cases of birds having been run over and killed (and medium sized mammals) have been observed along the access road to the plant.

d. *Conclusions regarding the risk of harm to or death of birds due to the operations phase of the GEMASOLAR thermosolar plant*

As part of my studies, I have observed the 73 species of birds described in Table 1 in the vicinity of the plant during the breeding season; 53 of these species have used the plant space to an extent; 14 of these species have been observed flying between the heliostats and the tower that collects reflected sunlight; and six have been observed crossing the flow of rays in the half that is closest to the heliostats. To date, I have not seen dead or injured birds in the plant or surrounding areas, nor have I seen evidence of injury to birds caused by the rays reflected by the heliostats. Other persons working on the farm (La Monclova) where the plant is located and which is home to a diverse community of birds, coincide with this observation.

Table 1. Species of birds during the breeding period (four months, April-July), during 2011-2012 (years of the thermosolar plant production phase) in the vicinity of the GEMOSOLAR plant (within a circle with a 3 km radius; La Monclova farm, Fuentes de Andalucía municipality, province of Seville, Spain), use that they make of the thermosolar plant (inside a circle with a radius of approximately 850 m around the tower), and risk of extinction category (IUCN criterion applied on the regional scale of Spain) for each species. Many species in the area do not use the plant (use made of its surface area is not indicated). We have eliminated those species that appeared in the March and April censuses, but which were wintering there or migrating through the area.
[1]: NID, nesting; TROF, place for feeding; PAS, passing through.
[2]: DD, Data Deficient; LC, Less Concern; NT Near Threatened; VU, Vulnerable (IUCN Criteria and Categories).

Species Common Name	Species Scientific name	Use made of the circle of the plant [1]	Extinction risk category [2]
Common sandpiper	*Actitis hypoleucos*	PAS	LC
Red-legged partridge	*Alectoris rufa*	NID	DD
Mallard	*Anas platirrhynchos*	TROF	LC
Common swift	*Apus apus*	TROF	LC
Spanish imperial eagle	*Aquila adalberti*		EN
Grey heron	*Ardea cinerea*	PAS	LC
Little owl	*Athene noctua*	TROF	LC
Cattle egret	*Bubulcus ibis*	PAS	LC
Stone curlew	*Burhinus oedicnemus*	NID	NT
Common buzzard	*Buteo buteo*	TROF	LC
Short-toed lark	*Calandrella brachydactyla*	NID	VU
Red-necked nightjar	*Caprimulgus ruficollis*	PAS	LC
Linnet	*Carduelis cannabina*	PAS	LC
European goldfinch	*Carduelis carduelis*	PAS	LC
European greenfinch	*Carduelis chloris*		LC
Little ringed plover	*Charadrius dubius*	NID	LC
Short-toed treecreeper	*Certhia brachydactyla*		LC
White stork	*Ciconia ciconia*	TROF	LC
Short-toed eagle	*Circaetus gallicus*	TROF	LC
Western Marsh-harrier	*Circus aeruginosus*	PAS	LC
Montagu's harrier	*Circus pygargus*	TROF	VU
Fan-tailed warbler	*Cisticola juncidis*	TROF	LC
Great Spotted Cuckoo	*Clamator glandarius*		LC
Common Wood-pigeon	*Columba palumbus*	PAS	LC
Common Raven	*Corvus corax*	TROF	LC
Jackdaw	*Corvus monedula*	PAS	LC
Common Quail	*Coturnix coturnix*		DD
Blue tit	*Cyanistes caeruleus*		LC
House martin	*Delichon urbica*	PAS	LC
Little egret	*Egretta garzetta*	PAS	LC
Black-shouldered kite	*Elanus caeruleus*	TROF	NT
Lesser Kestrel	*Falco naumanni*	TROF	VU
Common Kestrel	*Falco tinnunculus*	TROF	LC
Eurasian Chaffinch	*Fringilla coelebs*		LC

Crested Lark	*Galerida cristata*	NID	LC
Collared Pratincole	*Glareola pratincola*	PAS	VU
Black-winged Stilt	*Himantopus himantopus*		LC
Melodious Warbler	*Hippolais polyglotta*		LC
Red-rumped Swallow	*Hirundo daurica*	TROF	LC
Barn Swallow	*Hirundo rustica*	TROF	LC
Southern Grey Shrike	*Lanius meridionalis*	TROF	NT
Woodchat Shrike	*Lanius senator*		NT
Common Nightingale	*Luscinia megarhynchos*		LC
Calandra Lark	*Melanocorypha calandra*	TROF	LC
European Bee-eater	*Merops apiaster*	TROF	LC
Corn bunting	*Milaria calandra*	NID	LC
Black Kite	*Milvus migrans*	TROF	NT
White Wagtail	*Motacilla alba*		LC
Yellow Wagtail	*Motacilla flava*	PAS	LC
Spotted Flycatcher	*Muscicapa striata*		LC
Black-crowned Night-heron	*Nycticorax nycticorax*	PAS	LC
Black-eared Wheatear	*Oenanthe hispanica*	TROF	NT
Great Bustard	*Otis tarda*		VU
Scops-owl	*Otus scops*		LC
Great Tit	*Parus major*		LC
European House sparrow	*Passer domesticus*	NID	LC
Spanish Sparrow	*Passer hispaniolensis*	TROF	LC
Eurasian Tree Sparrow	*Passer montanus*		LC
Black-billed Magpie	*Pica pica*	TROF	LC
Black-bellied Sandgrouse	*Pterocles orientalis*	PAS	VU
Stonechat	*Saxicola torquata*	TROF	LC
European Serin	*Serinus serinus*	PAS	LC
Collared dove	*Streptopelia decaoto*	PAS	LC
European Turtle-dove	*Streptopelia turtur*	PAS	VU
Spotless Starling	*Sturnus unicolor*	NID	LC
Blackcap	*Sylvia atricapilla*		LC
Spectacled Warbler	*Sylvia conspicillata*	TROF	LC
Sardinian Warbler	*Sylvia melanocephala*		LC
Little Bustard	*Tetrax tetrax*	PAS	VU
Eurasian Blackbird	*Turdus merula*		LC
Barn Owl	*Tyto alba*	PAS	LC
Eurasian Hoopoe	*Upupa epops*	PAS	LC
Lapwing	*Vanellus vanellus*	PAS	LC

University of Granada

Impact of the GEMASOLAR Solar Power Plant (La Monclova, Fuentes de Andalucía, Province of Seville) on the Bird Population

Report 4 (September 2010): Nesting avifauna in the study area during the plant construction phase (March-July 2009-2010).

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September 10, 2010

Introduction

The records for solar thermal power plants in Spain are still anecdotal. The presence of these kinds of facilities in the rest of the world is also scant. The potential impacts that these kinds of plants might have on avifauna are still unknown. Thus, monitoring and assessing the impact of construction and operation of the Gemasolar plant on this group of vertebrates is a challenge for conservation studies.

Solar thermal power is a strategy to get power without exacerbating the current effects of climate change. However, like most great engineering projects undertaken by mankind, the construction and operation of solar thermal power plants – and their eventual dismantling – have an impact on the environment. In view of the future growth in this energy sector, it is necessary to establish a bird monitoring study protocol for these kinds of plants in Spain, so that its future development and exploitation will have the least possible impact on birds.

Listed below are the potential impacts of a solar thermal plant on birds during the construction and operating phases, and thus those that must be addressed in an environmental monitoring project such as this one:

Noise: probably the most significant noise occurs during the construction phase, caused by the traffic of heavy machinery, the assembly of structures, etc. This will affect all sizes of bird species.

Landscape impact: this kind of impact is not significant for birds, although it is significant for humans. The receiving tower for the reflected rays, which in this case is over 120 m in height, has a strong impact because it is a totally artificial structure

in a natural landscape. This is among the most noticeable impacts for the general public.

Land degradation: the surface on which the plant is built is totally degraded for use as a habitat by most bird species that previously inhabited the zone. Degradation of the land is not limited to the circle where the plant is located. It also exists in the nearby electricity transformation and distribution stations, water collection and cooling plants, access roads, etc.

Direct impact on avifauna: during the construction phase, the most direct impact is the loss of habitat in the entire surface area where the plant is located, in addition to buildings and other related structures. Loss of habitat affects birds throughout the year for most phenological categories (sedentary, oversummering, overwintering). Fortunately, the Gemasolar plant does not seem to be in a defined bird migration route. Because of the narrow profile of the collector tower, the impact from collisions or as a barrier is not expected to be significant. Impact from collisions may be observed during bad weather, such as days with heavy fog and during the night. It is likely that impact from collisions will be greater for the population of birds in migration than for the resident population. This will have to be watched during the operating phase, where there is a likely impact due to blinding of birds as they approach the reflected rays, or even death from heat stroke.

But to date we have not found in the scientific literature any quantification of the impact of solar thermal power plants on birds. Again, this absence makes the study that we are conducting at the Gemasolar plant all the more valuable.

Questions raised before undertaking an avifauna monitoring project at a solar thermal plant

These questions have been adapted from the Guide for Conducting Environmental Impact Assessment at Wind Farms, prepared by SEO/BirdLife International:

- Does the solar thermal plant represent a significant impact for members of endangered or prioritized species?
- Is significant bird mortality expected to occur during the construction or operating phases? Which species would be involved? What would be its magnitude?
- Is there intensive use by birds of the plant facilities area? By which species? What is their conservation status?
- Would the construction of the solar thermal plant make it easier for humans to access an area that is currently difficult to reach? Would this increase human traffic in the zone? Are there species that could be disturbed by this increased traffic in the area of influence of the solar thermal plant?
- Are there other solar thermal plants or solar thermal plant projects in the zone that could have an impact on the same species or habitats? What would be their collective impact?
- Are there plans or the possibility that the same developer would expand the solar thermal plant in the next 10 years?
- Are there species especially sensitive to collision with power lines? What is their conservation and protection status?
- Are there other infrastructures or projects in the zone that could attract birds and increase the risk of collision (dung heaps, garbage dumps, etc.)?
- Are there other infrastructures established or in development in the zone that could have an impact on the same species or habitats?

These questions were asked by researchers before designing the avifauna monitoring plan during the construction phase (and for the subsequent operating phase) of the Gemasolar plant. The design of the monitoring protocol sought to take into account all these factors, to allow an accurate answer to the ultimate question: "Has the construction phase of the Gemasolar plant affected avifauna in the zone?"

The Avifauna Monitoring Project in the Environment of the Gemasolar Plant, La Monclova, Province of Seville

The document "DIA Avifauna Conditions" for the Gemasolar solar power plant, in paragraph 1.1.1 (detection of unforeseen impacts on avifauna), establishes that avifauna should be monitored during the construction phase of the said plant, for *Detection of Impacts on Avifauna not considered in the Environmental Impact Study.*

This report concerns avifauna surveys conducted in the area of influence of the Gemasolar plant, La Monclova property, t.m. Fuentes de Andalucía, Seville, during March to June, in 2009 and 2010, coinciding with the mating season in bird phenology. It relates to the final report on the plant construction phase and attempts to define the impact that construction of the Gemasolar plant has had on the nesting bird population in the study area during these two years. Data are compared for both years, showing that within the plant circle, at least, there was a difference in incidence from one year to the next, probably due to the different intensity of the construction work between the two years.

Surveys were carried out during spring in 2009 and 2010 in three zones of the study area, defined as the Circle, North of Circle, and Marqués Road, in decreasing order of the Gemasolar plant's potential impact (see Material and Methods). The findings from the months of March to April 2009 are prior to the intense work of the construction phase, and therefore give us some idea of the composition of nesting avifauna in the Circle zone before the potential impact of the plant. The surveys conducted during the remaining months (May to July of 2009 and the entire spring of 2010) were during the intensive work of the construction phase, and therefore

give us an idea of the plant's impact on the bird population during the rest of the construction phase. This aspect is particularly interesting because it was impossible to know in detail the nesting bird population in the area of the plant before work started (i.e., during 2008). The other zones surveyed (North of Circle, Marqués Road) are subject to a lower impact from the Gemasolar plant, even though logically the surveys were conducted during the same time-frame as those in the Circle.

Material and Methods

Landscape elements in the Gemasolar plant environment that may affect the bird population.

The composition of the avifauna in the study area will largely depend on the current habitats and their state of conservation. The Gemasolar solar power plant is geographically located in the lower valley of the Guadalquivir River, at an altitude of 150 m above sea level. It receives an average precipitation of 736 mm, and has an average annual temperature of 17.3°C. Biogeographically it belongs to the Mediterranean Region; its phytogeography corresponds to the Andalusian Province, Seville Sector, and Seville Subsector; bioclimatically it is part of the thermomediterranean basin; precipitation is a sub-humid regimen of annual rainfall. The potential vegetation of the area is a sub-humid verticicola Andalusian thermomediterranean series (black Andalusian lands or tirs) of wild olive *(Olea sylvestris): Tamo communis-Oleeto sylvestris sigmetum.* The zone's dark soils are characterized by an abundance of montmorillonitic type clays, highly polymerized humus, and an abundance of alkaline earth metals. Given the great value of these soils, their agricultural exploitation has been frequent, and these territories are dedicated to agriculture. Cereals, sunflower and cotton are produced – the latter crop primarily in hydromorphic black soils. Because of this, these lands have been subjected to intense human exploitation since prehistory, as shown by numerous Neolithic, Iberian, Roman and Arab remains in the County. However, because La Monclova, the property where the solar power plant is located, has a large area (more than 5000 hectares) and has been held by the same family for over 600 years, the landscape is not very divided and/or exploited. There are remains of climax vegetation, including the arboreal stratum, formed by the following plant species: a) in the remains of the forest, wild olive *(Olea sylvestris),* oak *(Quercus rotundifolia),* black bryony *(Tamus communis),* Italian arum *(Arum italicum),* sea holly *(Eryngium tricuspidatum);* b) in formations of dense scrubland, Kermes oak *(Quercus coccifera),* Rhamnus oleoides *(Rhamnus oleoides),* Mediterranean fan palm *(Chamaerops humilis),* and evergreen rose *(Rosa sempervirens);* c) in the

remains of degraded scrubland, purple phlomis *(Phlomis purpurea),* Ulex scaber *(Ulex scaber),* and Asperula hirsuta *(Asperula hirsuta);* and d) grasses, abundant on the property, consisting of Brachypodium ramosum *(Brachypodium ramosum),* among others.

The large size of the property, the remains of natural vegetation still present, the presence of a royal sheep trail (*cañada real)* on its western border, and its secondary use as a low-pressure (i.e., low rate on hunted species and their natural predators) hunting ground (i.e., heightened vigilance) give it high ornithological value. Preliminary surveys (classification censuses and random surveys in the winter of 2008-2009) have already shown that the La Monclova property maintains a large overwintering population of grassland birds (little bustard, stone curlew, common lark, mockingbird) and raptors (common vulture, red kite, common buzzard, black-winged kite, common kite). A geographic factor – its proximity to the Sierra Morena – favors the presence of unique species at the property, such as the said common vulture, and cranes during the winter, in their daily food-seeking activities.

Avifauna Inventory

One of the first steps in any study to monitor or evaluate environmental impact is an adequate inventory of fauna – in this case avifauna – as required by Guideline 97/11/CEE on Environmental Impact Evaluation. This objective was accomplished by carrying out this monitoring study over the two years of the construction phase. Future monitoring studies during the operational phase of the plant will allow us to also understand its impact on all the bird communities in the zone in terms of their phenology (sedentary, oversummering, overwintering, migratory). The plant is built on farmland dedicated to cereals and therefore the bird population affected is known as grassland birds.

Selecting Census Itineraries

This is a fundamental aspect of the study. Census itineraries must be chosen to help us best describe the problem we are attempting to study, the potential impact on avifauna from the solar power plant, during both construction and operating phases. The coverage of the census itineraries must be sufficient for data to be representative of the bird population to be evaluated.

We obtained a previous study of the landscape in the area from aerial photographs from the Council of Andalusia and from Google Earth. This allowed us to become familiar with the dominant habitats and dimensions of the study area. In the subsequent field study we simply had to adapt the census itineraries to the availability of roads. Three census itineraries were chosen:

1) Defined as the "Circle": it crosses the solar power plant approximately from South to North through the ancient Marqués Road. It is 1.6 km long (from 37° 33' 19.3" N/5° 19' 42.1" W to 37° 34' 10.7" N/5° 19' 51.7" W; Fig. 1). This is the shortest census itinerary among those chosen, but as it crosses practically through the middle of the future plant, we believe it will be representative of the impact of the solar power plant on the bird population. This census itinerary will most accurately reflect the level of impact of the plant on the bird population within its limits (highest focus). When the work started, we endeavored to take a census of the bird population during off-work hours to avoid potential interference from machinery and workers.

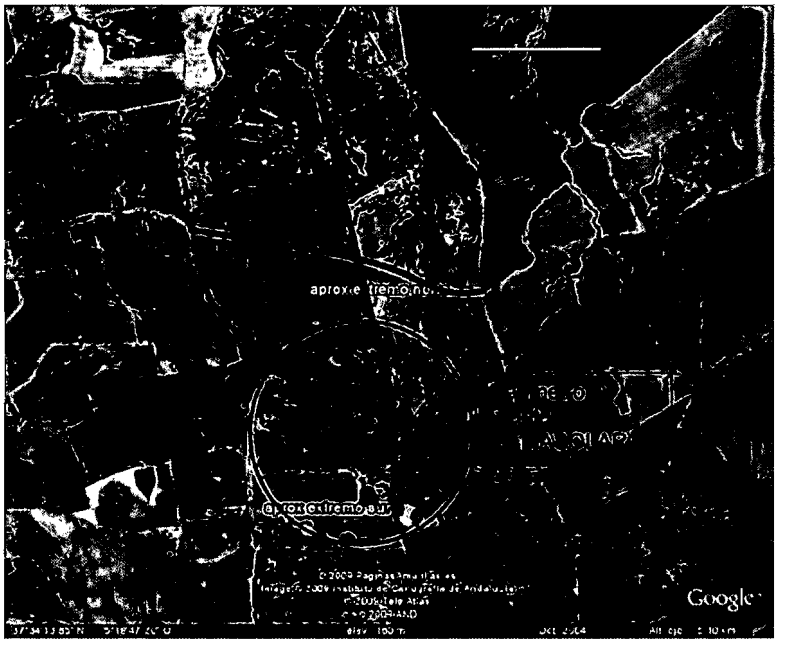
2) Defined as the "North of Circle:" part of the northwest of the plant along the edge of the Cañada Real (37° 34' 32.9" N/5° 20' 45.8" W) and after 2.2 km it reaches another road within the property at the northeast of the plant (37° 34' 18.0" N/5° 19' 18.9" W; Fig. 1). The distance from the plant ranges from 400 m to 1000 m. It attempts to reflect the possible impact of the project on nearby bird populations (medium focus). This census itinerary will not be

affected by the execution of the work over the length of the monitoring process of the bird population (years 2009 to 2014). It is designed to reflect the level of impact on the grassland bird population surrounding the plant. Also, since it is not affected by the work being performed, changes in the landscape caused by the heliostats, etc., the data obtained will be more robust for yearly comparisons.

3) Defined as the "Marqués Road": it follows its namesake road starting at the North edge of the circle (37° 34' 10.7" N/5° 19' 51.7" W), and continues within the property for 2.2 km until it reaches the zone known as the Cuarto de la Casa (37° 35' 14.4" N/5° 20' 10.5" W; Fig. 1). This itinerary was chosen to get a third level of perception on the possible impact of the plant on the bird population in the County, within a radius of up to 3000 m from the center of the plant (low focus). Unlike the others, this census itinerary not only crosses the habitat occupied by the plant (cereal crops), but also crosses a pasture (wild olive grove, oak grove) with livestock production. It attempts to expand the spectrum of the bird population studied, including forest and scrubland species. The decision for this sampling away from the plant is not an excessively conservative or protectionist approach because it is well-known that birds, as they can fly, in their search for food can travel kilometers and even dozens of kilometers every day, especially in the case of vultures.

The three itineraries total 6000 m of census area. During the construction phase (2009 to 2010), surveys have been repeated monthly for the five months during which mating takes place for most birds comprising the potential population of nesting birds in the study area (March to the end of July). They provided a volume of data sufficient for evaluating the possible impact on bird population during the construction phase of the plant. In addition, they provide information to allow year to year comparisons of the possible impact of the plant on the bird population in the study area.

Figure 1. Location of the three census itineraries established within and around the GEMASOLAR solar power plant to evaluate the possible impact of the construction phase on the nesting bird population. Green: Circle transect; blue: North of Circle transect; red: Marqués Road transect.



Spanish	English
Perímetro Planta GEMASOLAR	GEMASOLAR Plant Perimeter
aprox extremo norte	North Access
aprox extremo sur	South Access

Census Methodology

Many environmental monitoring studies conducted in Spain cannot be adequately evaluated or lack comparative data because the methodology used in the field surveys is not appropriate or well defined. Thus, the survey methodology should follow the basic principles of any scientific study – its repeatability – a characteristic that is by definition indispensable in environmental monitoring.

The likelihood that the construction phase of the Gemasolar plant will affect a specific bird species is directly proportional to the density of that bird in the zone. Therefore, in designing the avifauna monitoring protocol, we took into account the importance of evaluating to some degree the abundance of different species. As mentioned above, three census itineraries were established. The censuses are conducted by a single researcher (JMP) on foot, during the morning, facing away from the sun at an approximate speed of 2 km/h. All birds seen and heard are noted, and also the distance of the observation, when possible, using a digital laser rangefinder (BUSHNELL Yardage Pro, range 5-732 m, precision ± 1 m), and the angle between the observation and the progression line (by compass), on a digital recorder (OLYMPUS W-10).

The detailed data from these observations, showing distances and angles, as well as relative density of the species observed in each census (number of individuals per kilometer of census), were provided in the monthly partial reports. Observation distances and angles allow the calculation of the absolute density of the birds using DISTANCE software when handling a considerable volume of data. However, for comparisons within years and between years, relative density data will be used. This method assumes fewer considerations than calculating absolute densities, and therefore is more realistic for making comparisons between censuses done at the same location by the same observer and under the same conditions but at different times. There is abundant scientific bibliography supporting this statement.

During visits to the plant, the possible effect that the execution of the work was having on existing avifauna in the zone was monitored. This was carried out by using observations before, during, and after the censuses. These observations attempted to analyze habitat use by the birds, as well as factors that might attract birds to this zone (sources of food, sleeping places, mating colonies, perches, migratory routes, daily movements, etc.) and whether these factors were likely to vary between the two years of the construction phase.

It identified whether there was nesting of threatened species, as well as the dangers from the execution of the work. In order to classify the degree of threat to the species present in the study area, we used the threat score for Spanish birds that appears in the recent Red Book of the Birds of Spain [Libro Rojo de las Aves de España] (Madroño et al., eds., SEO-Ministry of the Environment, Madrid, 2004). This work follows the criteria of the IUCN [International Union for Conservation of Nature] applied at the regional level of Spain – the criteria with the greatest consensus from the scientific community for establishing the degree of threat to living creatures. It also followed the Red Book of Threatened Vertebrates of Andalusia [Libro Rojo de los Vertebrados Amenazados de Andalucía] (Rodríguez de los Santos y Franco, coord., Environmental Council, Seville, 2001), in case the level of threat to any species required adjustment according to the true geographic environment in a more restricted area than Andalusia.

One of the impacts on avifauna synergistic to the construction of the solar thermal plant is from the possible increase in accessibility to the zone by pedestrians, motorcyclists, etc. on access and maintenance roads of the facilities. This increase in people in turn increases disturbances to fauna, accidents on roads, the risk of fires, etc., and therefore the number and type of use by humans in the zone should be evaluated, as well as the future potential for this.

Findings

Wealth (number of species) of nesting birds in the environment of the solar power plant.

Table 1 and Figure 2 show the average values of the censuses for nesting bird population in the three survey locations for the study area in 2009. The wealth of the zone where the plant is located (Figure 2A) is very similar to the wealth in the zone immediately outside the plant (Mann-Whitney U-test, $Z = -0.10$, $p = 0.91$); data for 2009 are similar to 2010. This is logical, as the environments are similar and considering cumulative wealth, which for the Circle zone includes wealth before the construction phase began. The greater wealth in the Marqués Road survey is clearly owing to the inclusion of forest environment in part of the survey (comparison of Circle zone to Marqués Road, $Z = 1.98$, $p < 0.04$ in 2009). The difference in wealth is even more significant when using data from 2010, at a later phase of plant construction ($Z = -2.61$, $p < 0.009$). These data suggest that, based on this structural population parameter, the zone chosen for the installation of the plant showed the lowest nesting bird wealth compared to the environments close by and within the La Monclova property. The data coincide with those obtained for the overwintering bird population in the study area and provided by this tracking team in the first report.

The between-year comparison shows that wealth barely varied for the North of Circle and Marqués Road zones, but it varied for the Circle zone from one year to the next.

In 2010, in the North of Circle zone, the following species disappeared: *Acanthis cannabina, Anas platyrhynchos, Carduelis chloris, Circus aeruginosus, Circus pygargus, Cuculus canorus, Delichon urbica, Lanius meridionalis, Motacilla brachydactyla, Motacilla flava, Passer montanus, Picus viridis, Serinus serinus, Streptopelia turtur, Sylvia melanocephala* and *Upupa epops*. New species appearing were *Burhinus oedicnemus, Ciconia ciconia, Corvus corone, Falco naumanni, Glareola pratincola, Motacilla alba, Oenanthe hispanica, Sylvia*

conspicillata and *Vanellus vanellus.* There was no statistically significant change in wealth observed in the North of Circle zone from one year to the next (Mann Whitney U-test, Z = 0.313, p = 0.75).

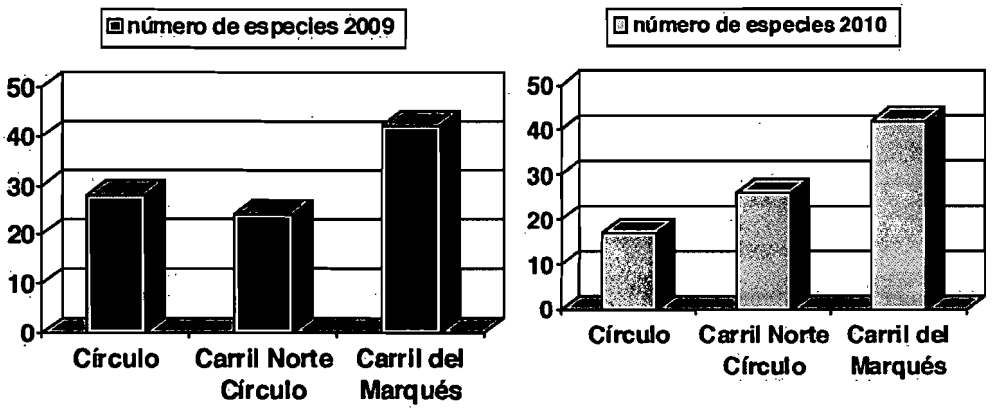
In 2010, in the Marqués Road zone, the following species disappeared: *Ciconia ciconia, Circus pygargus, Cuculus canorus, Delichon urbica, Elanus caeruleus, Gyps fulvus, Hieraaetus pennatus, Lanius meridionalis, Lanius senator, Milvus milvus, Motacilla brachydactyla, Streptopelia decaoto* and *Turdus merula.* New species appearing were *Athene noctua, Charadrius dubius, Corvus corone, Himantopus himantopus, Lullula arborea, Merops apiaster, Muscicapa striata, Parus major, Phylloscopus bonelli, Recurvirostra avoseta, Sylvia cantillans* and *Vanellus vanellus.* A comparison of the wealth of the Marqués Road zone between years showed no statistical difference (Mann-Whitney U-test, Z = 1.04, p = 0.29). The absence of change in the wealth of the other zones (North of Circle and Marqués Road) from one year to the next leads us to believe that the construction phase of the plant has not affected the avifauna in the immediate environment of the plant (between 400 and 3000 m).

However, in 2010, in the Circle zone the following species disappeared: *Actitis hypoleucos, Anas platirrhynchos, Charadrius dubius, Ciconia ciconia, Circus aeruginosus, Circus pygargus, Coturnix coturnix, Elanus caeruleus, Glareola pratincola, Motacilla flava, Passer domesticus, Passer montanus* and *Serinus serinus* as nesting birds. Newly appearing nesting species were *Motacilla alba, Oenanthe hispanica, Sylvia conspicillata* (Table 1). *Buteo buteo, Milvus migrans* and *Passer hispaniolensis* newly appeared in 2010; however, they do not nest within the Circle zone – they only use it in passing and as a feeding area. Between these two years the landscape changed significantly in the Circle zone due to the development of the construction phase of the plant, and we therefore interpret that this caused the loss of wealth in this zone. In spite of the disappearance of some species in the Circle zone in 2010 in comparison with 2009, the appearance in the 2010 surveys of some species passing through this zone, as well as the small number of degrees of freedom (5 months in each year) must be the reason for the absence of statistical significance in the comparison between years (Mann-Whitney U-test, Z = 0.313, p = 0.75). If we had considered for 2010 only data from

the nine species that are the only remaining nesting birds in 2010 in the Circle zone (see below), the differences would be significant. However, we preferred to continue taking into consideration in the study all the census species observed.

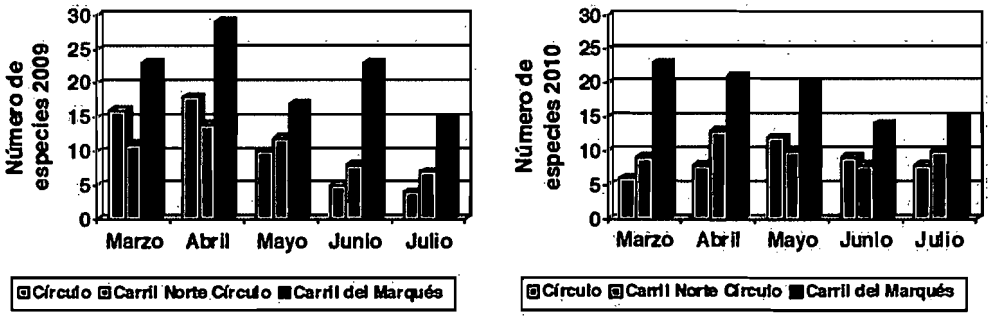
Fig. 2. Comparison of the wealth among the three zones surveyed in the La Monclova property with respect to nesting avifauna for 2009 and 2010: A, average values; B, monthly change in these values.

Fig2A



Spanish	English
número de especies 2009	Number of Species 2009
número de especies 2010	Number of Species 2010
Círculo	Circle
Carril Norte Círculo	North of Circle Road
Carril des Marqués	Marqués Road

Fig2B



Spanish	English
número de especies 2009	Number of Species 2009
número de especies 2010	Number of Species 2010
Marzo	March
Abril	April
Mayo	May
Junio	June
Julio	July
Círculo	Circle
Carril Norte Círculo	North of Circle Road
Carril des Marqués	Marqués Road

Monthly change in wealth obtained from surveys over the five months of the study (Figure 2B) in the three zones shows a peak during March to May and a decreasing trend throughout the mating season. This is a logical result of the different phenology of oversummering birds and also due to differences in detectability of most birds during the mating season. The nesting bird population is composed of sedentary and oversummering birds, and some of the latter do not arrive at the study area until April *(Coturnix coturnix, Streptopelia turtur, Cuculus canorus, Calandrella brachydactyla, Motacilla flava)*, thus increasing the wealth in that month. Although the surveys in all months are conducted by the same observer, at the same time of day and exactly the same place, the birds tend to be noisier and more active at the beginning of mating season and are least detectable toward the middle and end of it when they are incubating eggs or feeding chicks. These factors justify the need to conduct surveys during a period of the year long enough (in this case five months) to detect the nesting bird population. Furthermore, it shows us that year to year comparisons only make sense if they are based on averages for the entire mating season in each year, or else made for specific months. Especially noticeable is the loss of wealth in the Circle during the last months of the mating season in 2009 (June to July), but this is because the construction phase began in May-July, resulting in flight from the area of several bird species *(Actitis hypoleucos, Anas platirrhynchos, Charadrius dubius, Ciconia ciconia, Circus aeruginosus, Circus pygargus, Coturnix coturnix, Elanus caeruleus, Glareola pratincola, Motacilla flava, Passer domesticus, Passer montanus, Serinus serinus).*

Monthly change in avifauna wealth in 2010 shows the same pattern for the North of Circle and Marqués Road zones. However, it hardly varies for the Circle zone. Here, the site of the solar thermal plant, wealth was reduced to 17 species – the only ones apparently that are able to use this zone which was so severely transformed during the construction phase.

But only eight nesting species remain: *Alectoris rufa, Burhinus oedicnemus, Calandrella brachydactyla, Carduelis cannabina, Galerida cristata, Milaria calandra; Oenanthe hispanica, Sylvia conspicillata.* The remaining eight species only use the Circle zone to pass through *(Bubulcus ibis, Buteo buteo, Milvus migrans)* or for foraging *(Cisticola juncidis, Corvus corax, Falco tinnunculus, Melanocorypha calandra, Motacilla alba, Passer hispaniolensis).*

Again, the between-month comparison of wealth in the three zones suggests that the impact on avifauna in the study area is greatest in the Circle zone, but apparently not evident in the adjacent zones (between 400 and 3,000 meters).

Relative density of nesting birds in the environment of the solar power plant.

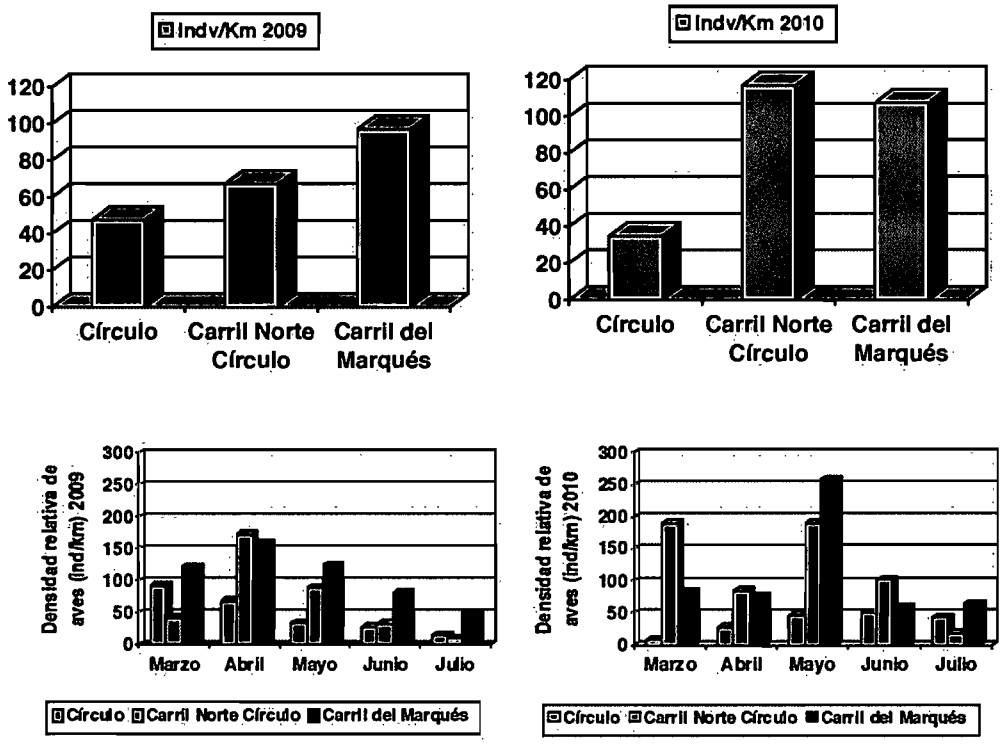
Figure 3A shows that during 2009 the average relative density of nesting birds is greater in the survey zone defined as Marqués Road (comparison between Circle and Marqués Road, $Z = -2.61$, $p < 0.009$; similar data for 2010), and very similar between the Circle and North of Circle zones (M-W U-test, $Z = 0.313$, $p = 0.75$, even though the difference approaches significance for the 2010 season). The reason for these differences is the same as for population wealth. The low values of the Circle zone are influenced by the beginning of work in this zone in May, 2009. The relative density values of birds for 2010 confirm the pattern observed in the previous year for the North of Circle and Marqués Road zones. Especially in the latter, relative density findings during 2009 and 2010 are practically identical. However, no year to year statistical differences were observed in the relative density of birds for the three zones taken separately (Mann-Whitney U-test, $p > 0.25$ in the three cases).

Figure 3B shows how the monthly trend of relative density in the three survey zones follows that found for wealth – perhaps in an even more gradual manner. Peak density is reached in April, and then decreases throughout the mating

season. The reason for this variation is the same as for wealth. In this case, the loss of density in the Circle zone after work started in May is even more pronounced. The trend observed in 2010 in the North of Circle and Marqués Road zones is similar to that observed in 2009. The strong oscillations in the North of Circle zone in 2010 are due to the appearance of flocks of *Passer hispaniolensis* in the cereal crops. However, in the Circle zone the monthly pattern of relative density stays more or less constant – and very low – as a result of the profound change in the Circle zone in 2010 during the construction phase.

Fig. 3. Comparison of relative density among the three zones surveyed in the La Monclova property with respect to nesting avifauna for 2009 and 2010: A) average values; B) monthly change in these values.

Fig. 3A



Spanish	English
Círculo	Circle
Carril Norte Círculo	North of Circle Road
Carril des Marqués	Marqués Road
Marzo	March
Abril	April
Mayo	May
Junio	June
Julio	July
Densidad relativa de aves (ind/km) 2009	Relative Bird Density (ind/km) 2009
Densidad relativa de aves (ind/km) 2010	Relative Bird Density (ind/km) 2010

Analysis of nesting bird population in the Circle zone

It is reasonable to assume that the construction phase of the Gemasolar plant will affect the nesting bird population in the Circle zone more than bird populations in the North of Circle and Marqués Road zones. The findings for the three zones in wealth and density during the mating seasons of 2009 and 2010 indicate this. Therefore, we will discuss here some of the species found in the Circle zone (Table 1), which pose some problems for conservation or suffered a significant impact due to plant construction. The phenology, habitat, conservation status in the Iberian Peninsula, and monthly trend of populations during the mating season are indicated for each of these species. A figure is included for some of the more important species showing the change in their relative density (ind/km, Y axis on the graph) during the mating season. Following previous practice for study tables provided to this point, birds are not listed in phylogenic order, but in alphabetical order.

Table 1. Bird species and their use of the Circle zone of the Gemasolar Plant, average relative density and extinction risk category (IUCN criterion applied at the regional level of Spain) for each species during the mating season (five months, March to July, in 2009 and 2010). The table includes species that do not nest within the area but that nest in adjacent areas and use the area for feeding or other purposes. Those species which appeared in the March and April censuses but which were overwintering species or passing through the zone have been eliminated from the table.
[1]: NEST, Nesting; FEED, Feeding Place; PASS, Stopover Area.
[2]: ID, Insufficient Data; LC, Low Concern; NT Nearly Threatened; VU, Vulnerable.

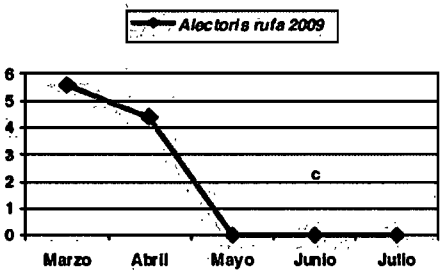
Species	Use of area[1]	Number of individuals per km 2009	Number of individuals per km 2010	Extinction risk category in Spain[2]
Actitis hypoleucos	PASS	0.12		LC
Alectoris rufa	NEST	2	2.76	ID
Anas platirrhynchos	FEED	0.5		LC
Bubulcus ibis	PASS	1.12	1.9	LC
Burhinus oedicnemus	NEST	0.37	1.3	NT
Buteo buteo	FEED		1.3	LC
Calandrella brachydactyla	NEST	6.75	17.5	VU
Carduelis cannabina	NEST	1.12	3.45	LC
Charadrius dubius	NEST	0.12		LC
Ciconia ciconia	FEED	0.12		LC
Circus aeruginosus	FEED	0.25		LC
Circus pygargus	NEST	0.37		VU
Cisticola juncidis	FEED	0.37	1.9	LC
Corvus corax	FEED	0.25	2.5	LC
Coturnix coturnix	NEST	0.25		ID
Elanus caeruleus	FEED	0.25		LC
Falco tinnunculus	FEED	0.25	0.95	LC
Galerida cristata	NEST	5	5.5	LC
Glareola pratincola	NEST	2.25		VU
Melanocorypha calandra	NEST	9.12	2.2	LC
Milaria calandra	NEST	7.87	4.07	LC
Milvus migrans			0.6	NT
Motacilla alba			0.6	LC
Motacilla flava	NEST	0.75		LC
Oenanthe hispanica			0.6	LC
Paser domesticus	FEED	0.75		LC
Passer hispaniolensis			2.73	LC
Passer montanus	NEST	5		LC
Serinus serinus	NEST	0.25		LC
Sylvia conspicillata			1.25	LC
total		45.25	51.11	

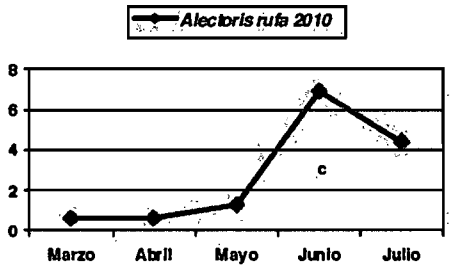
Actitis hypoleucos (Common Sandpiper)

Mainly sedentary on the Iberian Peninsula. It may nest at the reservoir within the property or by one of the streams that flank the property on the East and North, where it has frequently been observed. A record in the survey for May might pertain to a specimen in movement. It was foraging in the vernal pools formed by the rains. Plant construction starting in 2009 probably explains its disappearance from the area, because these vernal pools have disappeared.

Alectoris rufa (Red-Legged Partridge)

Sedentary and distributed throughout the Iberian Peninsula. It has been subject to a population decrease in recent decades. It has been affected by habitat alteration from agricultural intensification (loss of hedgerows, agricultural homogeneity, herbicides), among other factors. At a national level it has been classified as Insufficient Data awaiting more accurate information on population trends and distribution in Spain. In the Circle zone, the relative density was high with more than 5 individuals per kilometer, which is logical if we take into account the importance given to this species for hunting at the La Monclova property. The construction phase of the Gemasolar plant apparently has led to its disappearance beginning in April, as shown in the figure below. For this species, during the construction phase of the plant, we detected a higher level of mortality on the asphalt access road to the plant. Even though vehicle speed is limited on this stretch of road, it appears that some people do not respect the speed limit, and throughout the spring numerous adults and new chicks of this species were observed run over. When close to a vehicle, the females stay longer on the asphalt trying to get their new chicks of that year to reach roadside vegetation for protection. The result is that on some occasions not only do the new chicks die but also the females. This is an impact from the Gemasolar plant that not only affects the perimeter but also the rest of the property, and which could be easily remedied by strictly enforcing the speed limit on this road leading to the plant. During 2010, after installation of mirrors within the plant was completed, when workers and machinery no longer were present, the species reappeared in the Circle.





Spanish	English
Marzo	March
Abril	April
Mayo	May
Junio	June
Julio	July

Anas platirrhynchos (Mallard Duck)

Sedentary, the specimens observed probably reproduce at the reservoir on the La Monclova property. They were resting at vernal pools in the survey zone. It is assumed that they make intensive use of the Circle zone. The execution of the work at the plant led to the disappearance of vernal pools and of this species.

Anthus pratensis (Meadow Pipit)

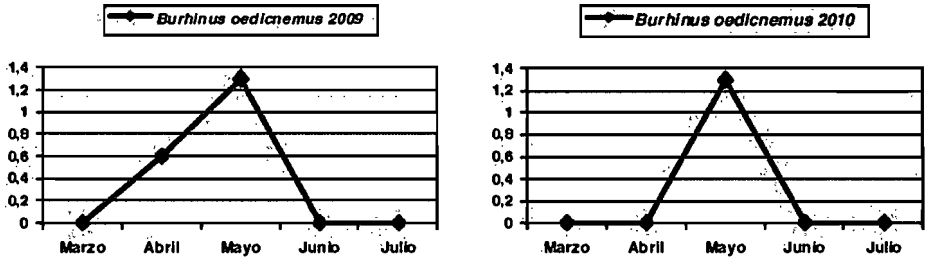
Overwintering bird in the study area. Its appearance in the censuses corresponds to the mating season because during March some overwintering birds remain in the region and there is heavy migratory traffic. During April, migrating birds heading south continued to be observed as they stopped temporarily in the pastures in the study area.

Bubulcus ibis (Cattle Egret)

Sedentary, nesting in trees, usually in corridors along large rivers and reservoir tail waters. In La Monclova there is a nesting population of 300 to 400 pairs in

continuous growth in some tamarisks that come up from the water of the reservoir on the property. They have only appeared in two of the five months in 2009 and in May of 2010, when specimens were observed passing through and resting on the way to traditional foraging places, thus their use of the Gemasolar plant area is not very intense. The species is increasing and does not show conservation problems. Also, as they live off of human activity, it is likely that their populations will require regulation by some kind of biological control. During late spring they prey on numerous chicks of partridges and other birds in the study area.

Burhinus oedicnemus



Spanish	English
Marzo	March
Abril	April
Mayo	May
Junio	June
Julio	July

The Iberian populations are sedentary, although they are increasing with the arrival of some European migrants during the winter. They occupy every kind of scrubland environment with gentle terrain and ponds or streams in the vicinity, as well as extensive crops and pastures planted with grain. The Iberian population has decreased over the past two decades because of changes in land use, such as the reduction in grazing, suppression of fallow land and hedgerows, increase in olive groves, and changes toward irrigation agriculture. Because of its twilight and nocturnal habits, the species is difficult to survey, but findings in the Circle zone suggest its presence as a nesting bird and its disappearance immediately after the start of the works because of its shy nature around disturbances. The appearance of two specimens in May 2010 when there was little activity in the edges of the Circle zone suggests that it could have returned to nest in the area. The existing landscape in this zone before the start of the work can be considered to be optimal

for this species. In the Red Book of Birds of Spain it is considered nearly threatened.

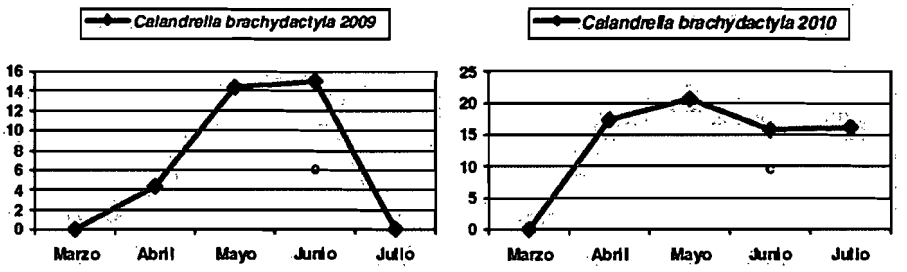
Buteo buteo (Common Buzzard)

Sedentary Iberian populations, although they are increasing with the arrival of migrants of European origin during the winter. It occupies every kind of woodland, preferring less dense formations in patchwork landscapes and pastures. It nests in the areas surrounding the solar thermal plant although we have only seen it use the Circle zone in flight for foraging and in passing through.

Calandrella brachydactyla (Greater Short-Toed Lark)

Summer bird that comes to the Iberian Peninsula between the end of March and the beginning of June, mostly in April. It lives on moors, scrubland, and dry fields left fallow after growing grains; it avoids planted cereal fields. There have been large decreases in population in the last 10 years, probably exceeding 30%. It has been established that the principal cause is the disappearance of its main habitat, long-term fallow land, caused by the overall intensification of dry cereal crops, the planting of irrigation crops, as well as orchards and crops under plastic in different counties. Because these farming trends continue in full force, along with uncertainties arising from the future of Common Farming Policy, it is thought that the situation for the species will become substantially worse in the coming years. At the regional level of Spain, it is rated as Vulnerable A2c + 3c + 4c (decrease in the population observed in the past and inferred for the future). In the Circle zone, the first migrants began to be detected in April of both years, with peak counts during May and June of 2009. Probably the initial work on land management allowed pairs to remain that were trying to mate, but the intense work of machinery and earth movement led to its total disappearance in July 2009. Thus, during the first stage of construction of the Gemasolar plant, this species was driven from the

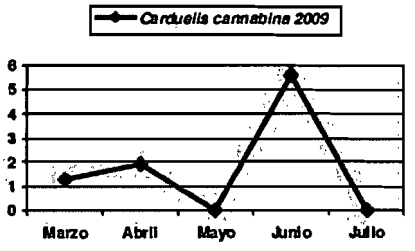
zone. In 2010, the end of the intensive work in the periphery of the Circle zone allowed the establishment of nesting pairs, and a numerous and significantly constant population was detected over months during this year. Thus in 2010 the relative density of the bird population in the Circle zone was greater than that found in 2009. This population behavior indicates a great ability by this species for adaptation to new habitats.

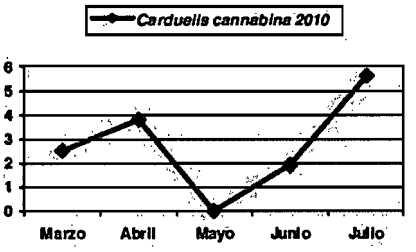


Spanish	English
Marzo	March
Abril	April
Mayo	May
Junio	June
Julio	July

Carduelis cannabina (Linnet)

On the Iberian peninsula it is basically sedentary, although overwintering specimens do come from Central and Northern Europe, and some Iberian specimens seem to migrate to Africa also during the winter. It occupies all kinds of unforested habitats, such as scrubland, moors, dry fields, and salt marshes. In the Circle area they were present throughout the year. The lack of contacts during May in both years must be due to the cautious behavior of the species when chicks are in the nest, and the peak in June and July is due to family groups observed during these months, because adults were observed together with the year's offspring. The intensity of earth moving work in the Circle area must have led to the disappearance of the species as of July 2009, although evidently the species returned to inhabit the zone in 2010.





Spanish	English
Marzo	March
Abril	April
Mayo	May
Junio	June
Julio	July

Charadrius dubius (Little Ringed Plover)

The record of this species consists of a single individual observed during spring migration that was foraging in a vernal pool in the study area. The disappearance of this type of environment in 2010 probably led to the disappearance of the species in the area.

Ciconia ciconia (European White Stork)

Basically oversummering in the Iberian Peninsula, the record of this species consist of a nesting specimen close to the study area that was using a vernal pool for foraging. The disappearance of this type of environment in 2010 probably led to the disappearance of this species in the area.

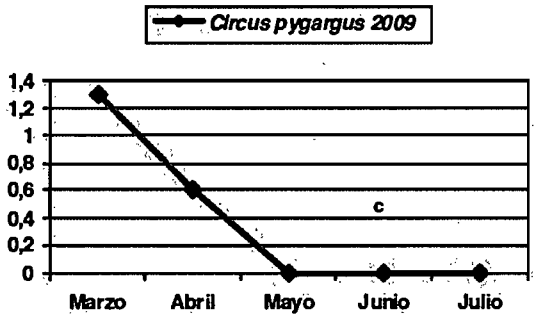
Circus aeruginosus (Western Marsh Harrier)

The Iberian population is basically sedentary, with individuals passing through and overwintering coming from central Europe. In Spain they raise families in reservoirs and artificial lakes, on the tops of the two plateaus, natural lakes, and a few pairs in grain fields. The individuals observed in the Circle area consisted of foraging movements of a pair that was nesting in the County in the vicinity of the study area and that used the vernal pools that formed in the area as a place for

foraging. The disappearance of this type of environment in 2010 probably led to the disappearance of this species in the area.

Circus pygargus (Montagu's Harrier)

On the Iberian Peninsula it migrates from across the Sahara; although rarely, some do overwinter in the Iberian south. During its stay, numbers increased due to migrants coming from central Europe. It typically nests in grain crop areas, although it also occupies pastures and uncultivated land with low scrub brush heather, gorse, and broom. The figure below shows its presence in the study area in the Circle zone from the arrival of the first migrants, but it only stayed two months because it left when work started in May of 2009.



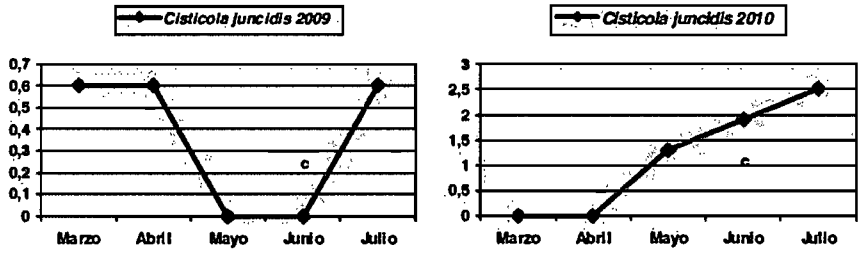
Spanish	English
Marzo	March
Abril	April
Mayo	May
Junio	June
Julio	July

During 2010 the transformation of the environment may have become so extreme for this species that it did not appear in the Circle zone. In Andalusia, the current population is estimated to be 1400 to 1500 pairs. That is the highest throughout Spain, but there seems to be a rapid decrease from the high number of unsuccessful nests each year during the harvest in grain zones and low reproductive success observed. The phenomenon of habitat disruption in the Circle zone for this species is considered one of the threat factors because of decreased available nesting area. This species has continued nesting in other zones of the study area, as we have been able to detect in the censuses of the North of Circle and Marqués Road. Thus, tentatively, we could say it has lost nesting area but has not abandoned the study zone because it is still on the La Monclova property. The Red Book of Birds of Spain considers it Vulnerable C1

(small, declining population of fewer than 10,000 individuals and continual decline greater than 10% of the population in three generations).

Cisticola juncidis (Zitting Cisticola or Streaked Fantail Warbler)

Basically sedentary in the Iberian Peninsula, although some specimens migrate in winter to the north of Africa. It nests among rushes and in developed grasslands. It was present in the Circle zone, but seems to have left when the construction phase of the plant began. The record in the July sampling consists of one specimen from outside the circle located at one of its ends. We find it hard to believe that the species remained in the area in 2009. As of May 2010, when the movement of workers and machinery ceased in the Circle areas, but far from the center, it was again observed in the circle zone, apparently foraging for food.



Spanish	English
Marzo	March
Abril	April
Mayo	May
Junio	June
Julio	July

Corvus corax (Common Raven)

Basically cliff nesting species on the Iberian Peninsula, its presence in the study area consists exclusively of specimens passing through during its extensive foraging movements.

Coturnix coturnix (Common Quail)

It migrates across the Sahara, although some individuals are overwintering, especially in the southwest of the Iberian Peninsula. It inhabits open spaces dedicated to winter grain crops and fodder, as well as in fields with adequate plant cover. It seems to be in significant decline since the second half of the twentieth century. In Spain, the change in various farming methods is its greatest threat. Because of using grain seeds with shorter and shorter biological cycles and modern harvesting machinery, this species does not have enough time to reproduce and raise its chicks. Its populations are also affected by the loss of favorable habitats for reproduction as a result of substituting grain crops with others that are not a favorable habitat, such as vineyards and olive groves. The species established itself in the Circle zone at the beginning of the mating season but left at the beginning of the construction phase of the plant and did not return to populate the zone in 2010 because of the lack of grassland. It remained on the rest of the property, as evidenced by records for this species in other samplings.

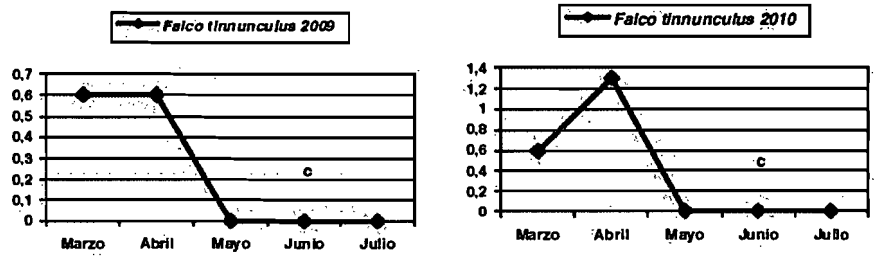
Elanus caeruleus (Black-winged Kite)

It is basically a sedentary bird. It occupies open lands with scattered trees, especially holm oaks growing in the midst of grain crops. It could be increasing in the Iberian Peninsula. On the La Monclova property, one pair was nesting, which is consistent with the observation in the Circle zone during May 2009. We assume that the dramatic change of the circle area explains why the species was not subsequently observed. In the rest of the property, it was still observed during the mating season, both in 2009 and in 2010.

Falco tinnunculus (Common Kestrel)

This is a sedentary species that, during the mating season, occupies all kinds of open land, including cropland, pasture, and uncultivated land. Within the Circle area it probably does not nest, but during the mating season it forages there, at

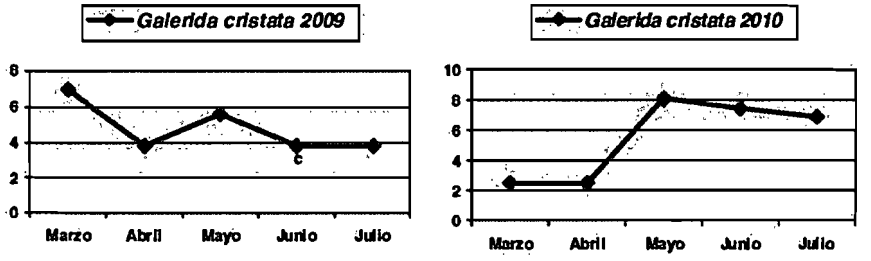
least as observed during March and April in both years. It remained on the rest of the property as shown in findings of other samplings.



Spanish	English
Marzo	March
Abril	April
Mayo	May
Junio	June
Julio	July

Galerida cristata (Crested Lark)

This sedentary bird occupies cultivated and deforested areas. An increase was observed in its numbers at higher temperatures. It is markedly anthropophilic. It is the only species that stayed constant over the five months of the census in the Circle area, both in 2009 and 2010. Also, the relative density found in both years is almost the same. Apart from bird species that live off of human activity, it is probably the best adapted bird to intensely degraded areas in Iberian Mediterranean environments.

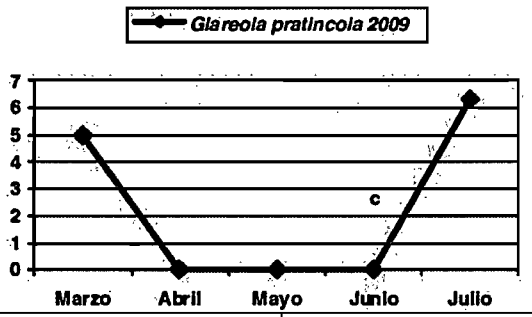


Spanish	English
Marzo	March
Abril	April
Mayo	May
Junio	June
Julio	July

Glareola pratincola (Collared Pratincole)

It oversummers in the Iberian Peninsula, with over half of the Iberian population located in the province of Seville. It reproduces in small groups spread out in areas of scant, low vegetation, such as pastures and uncultivated land. In the

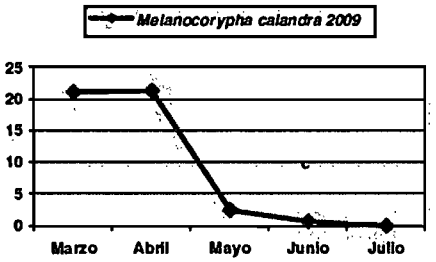
second half of the twentieth century, populations plummeted in the Iberian southwest, particularly in the lower Guadalquivir basin. It is therefore considered Threatened in the Red Book of Birds of Spain, specifically as Vulnerable A2ac C1 + 2b (small population of less than 10,000 mature individuals, that has experienced a decline of at least 10% in the last decade, and that experiences strong yearly fluctuations). The threats affecting the Iberian population are habitat loss and transformation, usually due to crop cultivation of previously uncultivated flood zones (even if the soils are saline and crop yield is poor). According to our censuses, the species arrived very early at the study area. Due to lack of contact during April and May, we doubt that mating took place within the Circle, but its presence in July suggests that it mated in the vicinity, as verified in samplings from outside the Circle; it may use the zone as a place to rest. The disappearance of flood zones in the Circle area in 2010 must have led to the disappearance of this species from the area.

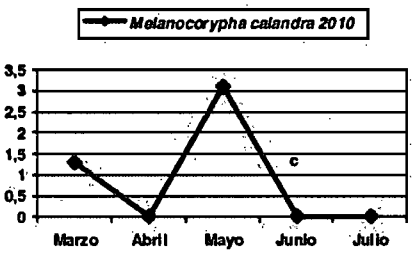


Spanish	English
Marzo	March
Abril	April
Mayo	May
Junio	June
Julio	July

Melanocorypha calandra (Calandra Lark)

This is a sedentary bird distributed in treeless areas in plains with extensive grain crops. In the circle area, records indicate that it is abundant at the beginning of the mating season, with largely similar densities during March and April. It gradually left the area as the construction phase of the Gemasolar plant progressed. In 2010 it was sporadically observed in the area, although with lower densities than in the previous year. These populations must have moved on to areas in the vicinity of the Circle area where the populations are abundant.





Spanish	English
Marzo	March
Abril	April
Mayo	May
Junio	June
Julio	July

Milvus migrans (Black Kite)

It nests in almost the entire Iberian Peninsula, with most of the population in the large western valleys. It nests in groves near scrubland, pastures, crops, and riverside meadows, as well as in fields. It migrates across the Sahara before mating between March and May and after mating in August. It only appeared in 2010, when a specimen used the area as a place to forage. It nests within La Monclova.

Sylvia conspicillata (Spectacled Warbler)

It is unevenly distributed in the Iberian Peninsula, with a greater presence in the semiarid sectors of the biological and climatic Mediterranean ecosystem. It lives in dry lands with underdeveloped shrub, such as thyme and gorse. It oversummers, traveling March to May and August to October. In the Circle zone, it did not appear until 2010 because it is one of the few species favored by the transformation of the landscape in the Circle with the construction phase (the other would be *Oenanthe hispanica,* Black-eared Wheatear). Its presence in 2010 was almost constant, which indicates nesting within the Circle, although with a very low density.

Nesting avifauna in the North of Circle and Marqués Road zones during the construction phase.

The avifauna in the North Circle zone (zone of intermediate environmental impact focus) is typical of cereal-growing areas of the southern peninsula, including species of interest such as the collared pratincole and the black-winged kite. In spite of the Gemasolar plant's proximity, it apparently has not experienced any change during the construction phase, neither in wealth nor in density.

The avifauna of the Marqués Road zone (zone of lowest environmental impact focus) is the richest of the three zones chosen for the bird monitoring plan during the construction phase. It is composed of the same typical population of cereal-growing areas mentioned above, but is enriched by forest and scrubland because it includes a field of wild olive trees. Apparently no changes have occurred in the two years of sampling in the construction phase, thus we infer that the Gemasolar plant has had little impact.

Conclusions.

- The Gemasolar plant is built in a zone of the La Monclova property that has the lowest bird population – at least when compared with two very nearby zones evaluated and monitored within the same property.

- The start of the Gemasolar plant construction work caused nesting bird species to leave the 1.7 km diameter circle where the plant is built. Some are of high conservation interest, such as the collared pratincole, Montagu's harrier, western marsh harrier and the black-winged kite. The first two probably nested in the circle zone before construction of the plant, while the latter two probably used the area as a foraging place.

- As a result, in the spring of the second year of plant construction, within its perimeter there were only eight [sic] species of nesting birds: red-legged partridge, stone curlew, greater short-toed lark, linnet, crested lark, calandra lark, corn bunting, black-eared wheatear, and the spectacled warbler.

- Except for the greater short-toed lark, the remaining nesting species in the circle area did so with very low density during the second year of construction.

- Apparently, the construction phase of the Gemasolar plant has not had a significant impact on wealth and density for avifauna in the area surrounding the circle, between 0 and 2500 m.

- The construction phase of the plant has had some impact on avifauna outside the circle, with certain species being run over, such as the red-legged partridge.

- Impact is possible on avifauna outside the circle from noise and disturbances caused by artificial lighting during the construction phase, but this has not been detected in the bird censuses.

Monthly relative density values of birds during the mating season (2010) in the sampling of the Circle of the Gemasolar solar power plant obtained from censuses at 1.6 km (one valid each month).

	March		April		May		June		July	
Species	Indiv	ind/km	Indiv	ind/km	Indiv	ind/km	Indiv	ind/km	Indiv	ind/km
Alectoris rufa	1	0.6	1	0.6	2	1.3	11	6.9	7	4.4
Bubulcus ibis					3	1.9				
Burhinus oedicnemus					2	1.3				
Buteo buteo							2	1.3		
Calandrella brachydactyla			28	17.5	33	20.6	25	15.6	26	16.3
Carduelis cannabina	4	2.5	6	3.8			3	1.9	9	5.6
Cisticola juncidis					2	1.3	3	1.9	4	2.5
Corvus corax					4	2.5				
Falco tinnunculus	1	0.6	2	1.3						
Galerida cristata	4	2.5	4	2.5	13	8.1	12	7.5	11	6.9
Melanocorypha calandra	2	1.3			5	3.1				
Milaria calandra			1	0.6	7	4.4	11	6.9	7	4.4
Milvus migrans					1	0.6				
Motacilla alba			1	0.6						
Oenanthe hispanica			1	0.6						
Passer hispaniolensis					1	0.6	10	6.3	2	1.3
Sylvia conspicillata	1	0.6			1	0.6	3	1.9	3	1.9
	13	8.1	44	27.5	74	46.3	80	50.0	69	43.1

Monthly relative density values of birds during the 2010 mating season in the North Circle sampling of the Gemasolar solar power plant obtained from censuses at 2.2 km (one valid each month).

	March		April		May		June		July	
Species	Indiv	ind/km	Indiv	ind/km	Indiv	ind/km	Indiv	ind/km	Indiv	ind/km
Alectoris rufa										
Anthus pratensis			2	0.9	25	11.4				
Bubulcus ibis	25	11.4	42	19.1						
Burhinus oedicnemus										
Buteo buteo							2	0.9	1	0.5
Calandrella brachydactyla	80	36.4	40	18.2	80	36.4	109	49.5	12	5.5
Carduelis cannabina			2	0.9						
Carduelis carduelis									4	1.8
Ciconia ciconia			1	0.5						
Cisticola juncidis										
Corvus corax	7	3.2	5	2.3	7	3.2	3	1.4	1	0.5
Corvus corone			1	0.5						
Coturnix coturnix			3	1.4					3	1.4
Elanus caeruleus					2	0.9			1	0.5
Falco naumanni	4	1.8			4	1.8				
Falco tinnunculus	1	0.5	8	3.6	1	0.5			1	0.5
Galerida cristata	11	5.0	17	7.7	11	5.0	17	7.7	8	3.6
Glareola pratincola			8	3.6			1	0.5	1	0.5
Melanocorypha calandra	50	22.7	48	21.8	50	22.7	61	27.7	9	4.1
Milaria calandra	10	4.5	7	3.2	10	4.5				
Milvus migrans										
Motacilla alba										
Oenanthe hispanica										
Passer hispaniolensis	230	104.5			230	104.5	30	13.6		
Sylvia conspicillata										
Vanellus vanellus							1	0.5		
	418	190.0	184	83.6	420	190.9	224	101.8	41	18.6

Monthly relative density values of birds during the 2010 mating season in the Marqués Road sampling of the Gemasolar solar power plant obtained from censuses at 2 km (one valid each month).

	March		April		May		June		July	
Species	Indiv	ind/km	Indiv	ind/km	Indiv	ind/km	Indiv	ind/km	Indiv	ind/km
Acanthis cannabina									15	7,5
Alectoris rufa	7	3.5	2	1	1	0.5	5	2.5	7	3.5
Anas platyrhynchos	4	2			2	1				
Anthus pratensis	7	3.5	2	1						
Athene noctua	1	0.5								
Bubulcus ibis	35	17.5	52	26	12	6	1	0.5	2	1
Burhinus oedicnemus			2	1						
Buteo buteo	1	0.5			2	1			1	0.5
Calandrella brachydactyla			16	8	10	5	23	11.5	20	10
Carduelis cannabina	4	2	4	2	2	1	19	9.5	6	3
Carduelis carduelis	2	1					6	3	16	8
Carduelis chloris	10	5	5	2.5			7	3.5		
Charadrius dubius			4	2						
Circaetus gallicus									1	0.5
Circus aeruginosus					1	0.5				
Cisticola juncidis			1	0.5	1	0.5			4	2
Corvus corax	4	2			3	1.5			4	2
Corvus corone			3	1.5						
Coturnix coturnix	1	0.5	4	2						
Falco tinnunculus			1	0.5	1	0.5	1	0.5		
Galerida cristata	22	11	20	10	16	8	17	8.5	14	7
Himantopus himantopus							1	0.5		
Lullula arborea			1	0.5						
Melanocorypha calandra	19	9.5	9	4.5	24	12	3	1.5		
Merops apiaster							1	0.5		
Milaria calandra	18	9	17	8.5	3	1.5				
Milvus migrans									2	1
Motacilla flava	3	1.5	1	0.5						
Muscicapa striata					1	0.5				
Parus major	1	0.5								
Passer hispaniolensis					420	210	28	14	36	18
Passer montanus	10	5								
Phylloscopus bonelli			2	1						
Picus viridis	2	1	1	0.5	1	0.5				
Recurvirostra avosetta					8	4				
Serinus serinus			2	1	1	0.5				
Streptopelia turtur					4	2	3	1.5	3	1.5
Sylvia atricapilla	7	3.5								
Sylvia cantillans			1	0.5						
Sylvia melanocephala	2	1					1	0.5	5	2.5
Turdus philomelos	2	1								
Upupa epops	1	0.5			2	1				
Vanellus vanellus	2	1								
	165	82.5	150	75	515	257.5	116	58	130	65

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CERTIFICATION OF ACCURACY

I CERTIFY, UNDER PENALTY OF PERJURY UNDER THE LAWS OF THE UNITED STATES OF AMERICA, THAT WE ARE COMPETENT IN **ENGLISH AND SPANISH** AND THAT THE FOLLOWING PAGES ARE, TO THE BEST OF OUR KNOWLEDGE AND BELIEF, A TRUE, CORRECT, COMPLETE AND ACCURATE TRANSLATION OF THE ORIGINAL DOCUMENT ENTITLED:

GEMASOLAR AVIFAUNA INFORME 5

I FURTHER CERTIFY THAT OUR QUALITY ASSURANCE PROCESS INCLUDES TRANSLATION BY A COMPETENT TRANSLATOR AS WELL AS REVIEW AND VERIFICATION BY A SECOND, EQUALLY COMPETENT TRANSLATOR.

February 27, 2012

JESSICA ALEXANDER
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Impact of the GEMASOLAR Solar Power Plant (La Monclova, Fuentes de Andalucia, Province of Seville) on the Bird Population

Report 5 (February 2012): Nesting Avifauna during the Final Plant Construction Phase (March – July 2011) and the First Operating Phase (August – December 2011).

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February 10, 2012

The Avifauna Monitoring Project in the Areas Surrounding of the Gemasolar Plant, La Monclova, Province of Seville

The document "DIA Avifauna Conditions" for the Gemasolar solar power plant, in paragraph 1.1.1 (detection of unforeseen impacts on avifauna), establishes that avifauna should be monitored during the construction phase of the said plant, for *Identification of Impacts on the Avifaunal Population Not Previously Considered in the Environmental Impact Study.*

This report concerns avifauna surveys conducted in the zone of influence of the Gemasolar plant, La Monclova property, municipality of Fuentes de Andalucía, Seville, from March to July 2011, which coincides, in terms of avian phenology, with the reproduction period. It corresponds to the end of the plant construction phase. It attempts to define the impact that the Gemasolar plant construction has had on the nesting bird population in the study area during this year, the last of the construction phase.

Surveys were conducted in the spring and summer of 2011 in three zones of the study area, defined as the Circle, North of Circle, and Marqués Road, in decreasing order of the potential impact of the Gemasolar plant (see Material and Methods).

The Gemasolar plant operating phase will begin in mid-July 2011. This report will therefore also consider the results of the censuses for the months of August – December 2011, intended to detect the impact of the Gemasolar plant on the avifauna during its operating phase.

Questions raised before undertaking an avifauna monitoring project at a solar thermal plant

These questions were adapted from the Guide for Conducting Environmental Impact Assessment at Wind Farms, prepared by SEO/BirdLife International. The design of the bird surveys have consistently taken these questions into account.

- Does the solar thermal plant represent a significant impact on members of endangered or prioritized species?
- Is bird mortality expected during the construction or operating phases? Which species would be involved? To what extent?
- Do the birds use the plant facilities zone intensively? Which species? What is their conservation status?
- Would the construction of the solar thermal plant make it easier for humans to access an area that is currently difficult to reach? Would this increase human traffic in the zone? Are there species that could be disturbed by this increased traffic in the area of influence of the solar thermal plant?
- Are there other solar thermal plants or solar thermal plant projects in the zone that could have an impact on the same species or habitats? What would their collective impact be?
- Are there plans or the possibility that the developer would expand the solar thermal plant in the next 10 years?
- Are there species especially sensitive to collision with power lines? What is their conservation and protection status?
- Are there other projects or infrastructure in the zone that could attract birds and increase the risk of collision (land fills, garbage dumps, etc.)?
- Are there other infrastructure projects, established or in development, in the zone that could have an impact on the same species or habitats?

During the construction phase, the most direct impact on avifauna is the loss of habitat over the entire surface area where the plant is located, in addition to buildings and other related

structures. The loss of habitat affects birds throughout the year, across all phenological categories (sedentary, summering, overwintering, in transit). Because of the narrow profile of the collector tower, the impact from collisions or as a barrier is not expected to be significant. Impact from collisions may be observed during bad weather, such as days with heavy fog and at night. It is likely that the impact of collisions will be greater for the migrating bird population than for the resident population; fortunately, it seems that the Gemasolar plant is not on a defined migratory route for birds. An impact on the avifauna in the Circle zone is expected due to the high traffic levels during the construction phase.

The same impacts as defined for the construction phase are expected during the operating phase. An impact is also possible due to the blinding of birds as they approach the reflected rays, or even death from heat stroke. Other impacts would be the loss of annual vegetation due to operations within the Circle zone and the impact of the traffic of workers entering or leaving the plant.

But to date we have not found in the scientific literature any quantification of the impact of solar thermal power plants on birds. Again, this absence makes the study that we are conducting at the Gemasolar plant all the more valuable.

The approach to the report on avifauna at the Gemasolar plant for 2011 is difficult. This year is characterized by a first half (January – mid-July) with the plant in the construction phase, and a second half (late July – December) in the operating phase. The most interesting phenological category of the avifauna, the nesting group, is recorded between March and July, that is, during the construction phase of the plant. Starting in mid-July, in the operating phase, we have various bird populations taking care of their reproduction and migratory nature, such as i) the sedentary (from late July), ii) summering plus in transit (August – October) and iii) overwintering (November – December). Since interannual comparison of bird populations with different phenologies is meaningless, we opted for:

1) Evaluating the effect of the final construction phase on the nesting avifauna, comparing the results from the start of the construction phase (2009) with the results for 2011; the data from March – July from the zone of maximum impact, the Circle, were used.
2) Describing the results of the operating phase in 2011. We did not have data for the avifauna in the study area for the months in which operations were developing (late July – December) for years prior to 2011. As an approach to the evaluation of the impact on the avifauna in the operating phase, values from inside the Circle zone were compared with those obtained in the North of Circle zone, which is very close spatially and has the same habitat as the Circle zone had prior to the construction of the Gemasolar plant.
3) Describing the results of visits inside the plant in the operating phase.
4) A general evaluation of the avifauna in 2011 on the land on which the Gemasolar plant is located.
5) Proposing possible palliative measures for the impact on the avifauna in the operating phase.

Material and Methods.

Landscape elements in the Gemasolar plant environment that may affect the bird population.

This section is reflected in Report 4.

Selection of the survey routes

This section is reflected in Report 4. But there is one variation for 2011. Because it was impossible to continue following the Circle route across the diameter of the circle of the Gemasolar plant in the construction phase (due to the continuous movement of machinery almost every day of the year), the route was set up along the border, in the part of the Circle zone closest to the surveys of the interior of the circle conducted in 2009 and 2010. When the survey was conducted across the diameter of the interior of the circle, all birds detected on both sides of the survey route were recorded, over 1.6 km; when conducting the survey in 2011 from the periphery of the circle, only the birds detected on one side of the survey route could be recorded. The length of the survey was therefore doubled to 3.2 km (but logically, recording only the birds detected inside the circle; Figure 1). Let us assume that this was the best way to maintain comparable results among the years after entry into the circle was limited.

Figure 1. Location of the three census routes established within and around the GEMASOLAR solar power plant to evaluate the possible impact of the construction and operating phases on the nesting bird population in 2011. Black: Perimeter of the Gemasolar plant; green: Circle transect; blue: North of Circle transect; red: Marqués Road transect.

Census Methodology

No change from the previous report. But starting in July 2011 when the operating phase began and following the guidelines of the DIA on avifauna, we made several visits inside the circle to detect the existence of dead birds. These surveys implied the creation of several radii of the circle, both on foot and in a plant maintenance service vehicle. Special attention was paid to the area under the central tower.

Findings

1) Evaluation of the effect of the Gemasolar plant final construction phase on nesting avifauna.

In the Circle zone between March and July 2009, at the start of the construction phase, 27 species of birds were detected between those who nested there and those who used the site for foraging. In the same months in 2011, in the final construction phase, only 14 species were detected, or practically half the specific richness. The relatively density also showed a reduction in the same period of nearly 50% (see Report 3 and Table 1). Birds linked with the vernal pools that still remained in 2009 (Common Sandpiper, Mallard duck, Cattle Egret, Little Ringed Plover, White Stork, Western Marsh-harrier, Collared Pratincole, White Wagtail, Yellow Wagtail) and some that take refuge or hunt in the vegetation that still remained before the earthmoving works (Common Quail, Black-winged Kite) disappeared from the Circle in the course of the construction.

In relation to one of the objectives of the environmental impact study on the Gemasolar plant regarding birds, it is obvious that the construction phase caused a gradual reduction in the structural parameters of this population (richness, density) in the Circle zone. Nonetheless, no changes during the construction phase were observed in the richness of the avifauna in the other two zones surveyed, the North of Circle zone and the Marqués Road zone; there was only a reduction in the relative density of individuals (comparative data not shown, but can be obtained from Figure 1, the data in the appendix to this report and Report 3).

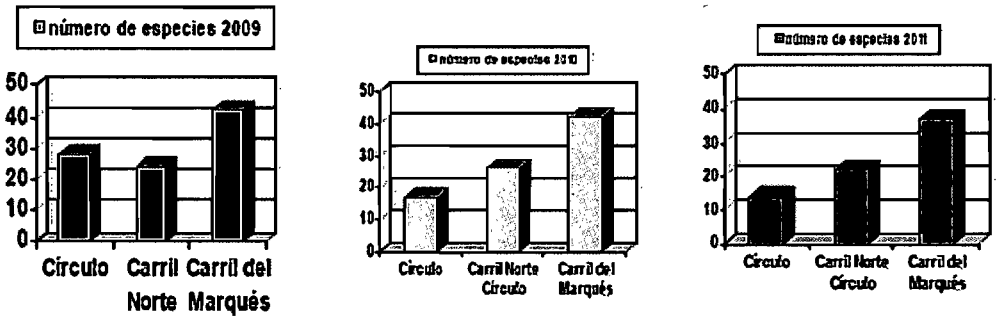
Table 1. Composition and relative abundance (ind/km) of the nesting bird population in the Gemasolar Circle zone in 2009 (A) and 2011 (B). Mean values for the five months from March to July. The late overwintering birds were not included.

Círculo mar-jul 2009 (A)	número individuos	indiv/ km
Actitis hypoleucos	1	0,125
Alectoris rufa	16	2
Anas platirrhynchos	4	0,5
Bubulcus ibis	9	1,125
Burhinus oedicnemus	3	0,375
Calandrella brachydactyla	54	6,75
Carduelis cannabina	9	1,125
Charadrius dubius	1	0,125
Ciconia ciconia	1	0,125
Circus aeruginosus	2	0,25
Circus pygargus	3	0,375
Cisticola juncidis	3	0,375
Corvus corax	2	0,25
Coturnix coturnix	2	0,25
Elanus caeruleus	2	0,25
Falco tinnunculus	2	0,25
Fringilla coelebs	1	0,125
Galerida cristata	40	5
Glareola pratincola	18	2,25
Melanocorypha calandra	73	9,125
Milaria calandra	63	7,875
Motacilla alba	3	0,375
Motacilla cinerea	3	0,375
Motacilla flava	6	0,75
Passer domesticus	6	0,75
Passer montanus	40	5
Serinus serinus	2	0,25
total 27 especies	369	46,125

círculo mar-jul 2011 (B)	número individuos	ind/km
Alectoris rufa	17	2,00
Burrhinus oedicnemus	5	0,59
Calandrella bhachydactyla	24	2,82
Circus pygargus	1	0,12
Cisticola juncidis	6	0,71
Emberiza calandra	12	1,41
Falco tinnunculus	5	0,59
Galerida cristata	18	2,12
Lanius senator	4	0,47
Milvus migrans	4	0,47
Passer domesticus	30	3,53
Passer montanus	80	9,41
Sturnus unicolor	7	0,82
Sylvia conspicillata	11	1,29
total 14 especies	224	26,35

Spanish	English
Círculo mar-jul 2009 (A)	Circle, March – July 2009 (A)
número individuos	Number of individuals
indiv/km	ind/km
total 27 especies	Total 27 species
círculo mar-jul 2011 (B)	Circle, March – July 2011 (B)
número individuos	Number of individuals
ind/km	ind/km
total 14 especies	Total 14 species
[All numbers decimal commas are equivalent to decimal points.]	

Figure 1. Richness of nesting avifauna in the Gemasolar plant (Circle) and the adjacent two zones (North of Circle and Marqués Road) in 2009, 2010 and 2011.



Spanish	English
número de especies	Number of species
Círculo	Circle
Carril Norte Círculo	North of Circle Road
Carril desl Marquéz	Number of species

2) Avifauna in the study area in the operating phase (July – December 2011).

Richness of Species and Abundance of Individuals

With 17 bird species in the 2011 operating phase (late July – December), the Circle where the Gemasolar plant was installed presents much less richness than the North of Circle zone (30 species) and the Marqués Road zone (42 species; Table 2). With 15 ind/km in the Circle area, compared to 45 ind/km in the North of Circle area and 144 ind/km in the Marqués Road area, the data on abundance of individuals further clarify the difference in avifauna colonizing the Circle compared to the other areas (Table 2). Furthermore, dominance is increasing in the bird population since half of all contacts with birds are with a single species, the Crested Lark. That means that the bird population has obviously been simplifying in the Circle zone with the tendency for it to be inhabited by a few species, such as the Crested Lark, a bird that adapts best to changes in flat Mediterranean agricultural areas. The differences are so obvious that they were not compared with statistical tools; in addition, we have very few degrees of freedom for the comparison (independent data is available for five months in each of the areas under study).

Changes in the composition of the bird population in the Circle zone

When environmental impact studies do not have data about the natural milieu before the destabilizing factor, one solution used is to compare the current results with those from a zone near the study area, with the same habitat, that was not affected by the destabilizing factor. Based on our visits to the study area in 2008, before the Gemasolar plant construction phase and based on consultation of aerial photographs, we verified that the land in the Circle zone is the same as that currently in the North of Circle zone. Comparing the results of the avifauna census between the two zones during the operating phase, we can deduce in greater detail the changes in the composition in the bird population that occurred in the 227 hectares of the Circle.

At least in the period from August to December 2011, the following disappeared from the Circle:

- Three species adapted to the grasslands, the Common Skylark (overwintering), the Lesser Short-toed Lark (overwintering) and the Chock-browed Mockingbird (sedentary).
- Six raptor species, some of whom use the study area for nesting, taking advantage of the scarce trees in the landscape, the Black-winged Kite (sedentary), the Common Buzzard (sedentary), Short-toed Snake Eagle (summering), or on the ground, Montagu's Harrier (summering) and two others who use this habitat for foraging, the Hen Harrier (overwintering) and the Western Marsh Harrier (sedentary).
- Birds suited to vernal pools or wet ground, both situations that are no longer observed in the Circle zone, the Cattle Egret (sedentary), the Northern Lapwing, Little Ringed Plover (summering), White Wagtail (sedentary), and the Yellow Wagtail (summering).

In the same period, we observed the presence in the Circle of three species that were not detected in the North of Circle zone, the Little Owl, Woodchat Shrike and the Southern Grey Shrike, although with a very low density. These are species that hunt from roosts, so they take advantage of the numerous structures now offered inside the Circle zone for this purpose.

Does the Gemasolar plant impact the composition of bird populations outside the Circle zone?

The differences in richness between the North of Circle zone and the Marqués Road zone are obvious, in the sense that the latter hosts more species and much higher densities than the former (Table 2). Since the North of Circle zone is closer to the Circle zone than the Marqués Road zone is, these differences in bird population may be thought to be the result of the greater impact of the Gemasolar plant's operating. However, the differences in richness come from the woodland birds, which are well represented in the Marqués Road zone due to the presence of the remains of the native forest on the site (see Report 4). These woodland birds are the Spanish Imperial Eagle, Red Kite, European Green Woodpecker, European Turtle Dove, Common

Blackbird, Song Thrush, Blackcap, Chiffchaff, Spotted Flycatcher, and the European Robin (Table 2). In addition, the richness of the nesting bird populations in the North of Circle zone and the Marqués Road zone have held practically constant over the three years in which these populations were surveyed (2009 – 2011; Figure 1).

Therefore, in view of the results we found, we cannot say that the plant has a direct effect on the composition of the bird populations outside the Circle.

Table 2. Results of the surveys of avifauna at the Gemasolar plant (Circle; 8 km), its immediate environment (North of Circle, 11 km) and its more distant environment (Marqués Road, 10 km) in the operating phase (August – December 2011). The relative abundance of each species is indicated by the Kilometric Abundance Index (KAI).

carril marques ago-dic 2011	número	ind/km	N circulo ago-dic 2011	número	ind/km	circulo ago-dic 2011	número	ind/km
Alauda arvensis	6	0,60	*Alauda arvensis*	82	7,45	*Alectoris rufa*	2	0,25
Alectoris rufa	26	2,60	*Alectoris rufa*	24	2,18	*Anthus pratensis*	3	0,38
Anas platyrhynchos	1	0,10	*Anthus pratensis*	27	2,45	*Athene noctua*	2	0,25
Anthus pratensis	35	3,50	*Bubulcus ibis*	16	1,45	*Calandrella brachydactyla*	2	0,25
Aquila adalberti	1	0,10	*Buteo buteo*	2	0,18	*Carduelis cannabina*	28	3,5
Bubulcus ibis	17	1,70	*Calandrella brachydactyla*	46	4,18	*Cisticola juncidis*	3	0,38
Burhinus oedicnemus	23	2,30	*Calandrella rufescens*	27	2,45	*Corvus corax*	5	0,63
Buteo buteo	2	0,20	*Circaetus gallicus*	1	0,09	*Emberiza calandra*	3	0,38
Calandrella brachydactyla	35	3,50	*Circus aeruginosus*	1	0,09	*Falco tinnunculus*	2	0,25
Calandrella rufescens	2	0,20	*Circus cyaneus*	1	0,09	*Galerida cristata*	54	6,75
Carduelis cannabina	39	3,90	*Circus pygargus*	1	0,09	*Lanius excubitor*	1	0,13
Carduelis chloris	1	0,10	*Cisticola juncidis*	14	1,27	*Lanius meridionalis*	1	0,13
Circus pygargus	2	0,20	*Corvus corax*	11	1,00	*Oenanthe hispanica*	2	0,25
Cisticola juncidis	4	0,40	*Coturnix coturnix*	2	0,18	*Phoenicurus ochruros*	1	0,13
Corvus corax	9	0,90	*Charadrius dubius*	1	0,09	*Phylloscopus collybita*	5	0,63
Coturnix coturnix	1	0,10	*Elanus caeruleus*	2	0,18	*Saxicola rubetra*	1	0,13
Elanus caeruleus	2	0,20	*Emberiza calandra*	155	14,09	*Saxicola torquata*	4	0,5
Emberiza calandra	231	23,10	*Falco tinnunculus*	6	0,55			
Erithacus rubecula	7	0,70	*Galerida cristata*	80	7,27			
Galerida cristata	136	13,60	*Melanocorypha calandra*	30	2,73			
Lanius excubitor	1	0,10	*Motacilla alba*	7	0,64			
Lanius meridionalis	3	0,30	*Motacilla flava*	6	0,55			
Melanocorypha calandra	107	10,70	*Oenanthe oenanthe*	9	0,82			
Milvus milvus	3	0,30	*Phoenicurus ochruros*	1	0,09			
Motacilla alba	14	1,40	*Phylloscopus collybita*	3	0,27			
Motacilla flava	25	2,50	*Saxicola rubetra*	1	0,09			

Spanish	English
Carril marques ago-dic 2011	Marques Road, Aug. – Dec. 2011
número	Number
ind/km	ind/km
N circulo ago-dic 2011	North of Cirde, Aug. – Dec. 2011
circulo ago-dic 2011	Circle, Aug. – Dec. 2011
[All numbers decimal commas are equivalent to decimal points.]	

Muscicapa striata		1	0,10	*Saxicola torquata*		5	0,45				
Oenanthe oenanthe		3	0,30	*Serinus serinus*		10	0,91				
Parus major		3	0,30	*Sturnus unicolor*		16	1,45				
Passer montanus		168	16,80	*Vanellus vanellus*		25	2,27				
Phylloscopus bonelli		1	0,10								
Picus viridis		3	0,30								
Serinus serinus		10	1,00								
Sylvia melanocephala		17	1,70								
Streptopelia turtur		3	0,30								
Sturnus unicolor		448	44,80								
Sylvia atricapilla		30	3,00								
Tetrax tetrax		3	0,30								
Turdus merula		1	0,10								
Turdus philomelos		1	0,10								
Upupa epops		5	0,50								
Vanellus vanellus		9	0,90								
Valores totales	42	1439	144		30	612	55,64		17	119	14,9

Spanish	English
Valores totales	Total Values
[All numbers decimal commas are equivalent to decimal points.]	

Practically all species occupying the Circle zone in the operating phase are birds that inhabit open spaces (i.e., Crested Lark, Linnet). The zone is colonized by very few insectivore individuals that, during their stay, hunt from roosts, since they take advantage of the fence structures or the mirrors themselves for such perches (African Stonechat, Whinchat, Black-eared Wheatear, Black Redstart). The low density of individuals in the Circle zone is related to the practical absence of natural vegetation. Although the results are not shown for months (they can be observed in the data in the appendix), it is still obvious when the decline in richness and density of species present in the Circle is verified after completing the process of elimination of the ruderal vegetation to reduce the risk of fire.

3) Results of Visits inside the Plant in the Operating Phase.

We had access to the interior of the Circle in July (28) and August (26) for purposes of our visits.

In July, from the second ring of mirrors onward (counting from the tower), we saw a few Northern Wheatears (*Oenanthe oenanthe*) settled down during their stay; they were also present in the rest of the radii out to the perimeter of the plant. Starting from ring 27, we saw European Bee-eaters (*Merops apiaster*); from the 29th, the Crested Lark, and from the 31st ring, Red-legged Partridges. We saw Common Swifts (*Apus apus*) flying, although they did not approach the collector tower (from ring 15 toward the outside). No bird cadavers were discovered by two people searching for 90 minutes. The search was particularly painstaking in the vicinity of the collector tower.

In August, we observed the Crested Lark starting from ring 4, the Northern Wheatear from ring 7, the Black-eared Wheatear from ring 19, the Linnet from ring 20, the Common Kestrel from ring 25, the Greater Short-toed Lark from ring 28, the Red-legged Partridge from ring 30 and the European Bee-eater from ring 40. Careful prospecting by two people for 60 minutes did not discover any bird cadavers during their search. Again, the search focused on the vicinity of the collector tower.

The results were also negative when we questioned several operators during the two visits about the presence of dead birds in the Circle.

Apparently, no birds that use the Circle for foraging and resting, or those that cross the Circle in their daily travels, have died of heat stroke (caused by the rays reflected by the mirrors). We recognize that this conclusion is nonetheless based on a very small sample.

4) **General evaluation of the avifauna in 2011 of the land on which the Gemasolar plant is located.**

We used the *Libro Rojo de las Aves de España* [Red List of Spanish Birds] to determine the conservation status of the species. This, in turn, follows the IUCN (International Union for the Conservation of Nature) criteria for categorizing the risk of extinction of the species, but applied to the regional scale of Spain.

In the operating phase, in the Circle zone, we found only one species catalogued as Vulnerable, the Greater Short-toed Lark. But since it appears with such a low density (0.25 ind/km) and it has an adequate habitat on the rest of the La Monclova land, we do not think measures have to be taken to maintain or reinforce the population of this species within the Circle. The rest of the species that have used the interior of the Circle in the operating phase are not endangered and have adequate grounds for their habitat outside the Circle.

Surveys of the North of Circle zone in fact detected the presence of two species catalogued as Vulnerable and two as Nearly Threatened. Among the Vulnerable populations, one is a dense population of Greater Short-toed Larks (4.8 ind/km) and the other is that of the Montagu's Harrier.

Following the above-mentioned Red List, the data on population and distribution area trends for the Greater Short-toed Lark in Spain have been declining significantly, at a rate probably greater than 30% over a period of 10 years. The disappearance of its principal habitat, the long-term fallowing of land due to the intensification of dryland farming, the establishment of irrigation and the proliferation of new tree crops are the main causes of this decline. The reasons why the Montagu's Harrier share in this classification are the same as for the Greater Short-toed Lark, together with the establishment of short-cycle grains that are harvested before the chicks have had time to leave the nest.

Among the Nearly Threatened species, one is a relatively dense population of Lesser Short-toed Larks (2.45 ind/km) that overwinters in the zone, and another is a pair of Black-winged Kites that nest in the zone and remain there year-round. The Lesser Short-toed Lark nests mostly in littoral areas, this distribution area is continually decreasing and, consequently, the peninsular populations are small and declining. The population of Black-winged Kites is still small on the Iberian Peninsula and is losing habitat due to changes in agricultural practices.

In the Marqués Road zone, in addition to the four species mentioned above, we find two categorized as Endangered, the Spanish Imperial Eagle and the Red Kite, one Vulnerable, the Little Bustard, and one Nearly Threatened, the Eurasian Stone Curlew.

The Imperial Eagle is endangered due to its reduced population, the decline of its primary prey (rabbits) and the presence of electrical wires. The Red Kite is jeopardized by the disappearance of garbage dumps and the use of poison; its population has declined by 50% in little more than one generation of the species. The population of Little Bustards is dropping sharply throughout Europe, including the Iberian Peninsula, due to changes in agriculture. The Eurasian Stone Curlew is affected by the loss of fallow, uncultivated land and the switch to irrigation from the old dryland agricultural practices.

In addition to the surveys, we observed the birds outside the census areas. This was useful to pinpoint how other species use the North of Circle and Marqués Road zones. In the former, a pair of Bustards was seen in the first few months of the year and a large settled flock of cranes was observed in January.

According to the property security, the pair of Bustards bred this year since he saw the female on various occasions accompanied by five fledglings from the year. In the census of Bustards conducted between 2000 and 2005, a survey of the guards produced positive results, but no leks were detected and in general, neither was the reproduction of the species in La Monclova (Alonso (ed.) 2007; *La avutarda común en Andalucía*, ed. Gypaetus). These data indicate a new

nesting zone for this threatened species in Andalusia located between the Arahal-Carmona-Paradas flock (to the east) and the Gerena-Olivares flock (to the west). Around 2009, a population of 441 individuals was estimated in Andalusia and the Bustard is considered a priority species in the conservation of biodiversity in this region. Consolidation of this nucleus of reproduction would be important to the recovery of the species in Andalusia.

Although the Imperial Eagle was detected in only one of the censuses, we observed an immature individual outside the census throughout the year around the Gemasolar plant. This suggests it has settled in this zone for its long pre-adult stage (4 years). Conservation of the areas of dispersion for immature large raptors is emerging as one of the keys to conservation of these species. Andalusia hosts 71 of the 278 pairs of this species in Spain and our country, in turn, hosts practically the entire world population of the Spanish Imperial Eagle; the sensitivity of this species to conservation efforts is therefore obvious.

The existence of various species of endangered birds on the La Monclova land, some as significant as the Bustard or the Spanish Imperial Eagle, implies strict observation of any activity deriving from the Gemasolar plant that could affect them negatively. Similarly, if these species and their populations remain steady or increase on the land over the years, it could suggest that the Gemasolar plant would be compatible with the maintenance of avian biodiversity in its proximity (La Monclova land).

5) Possible palliative measures for the impact on the avifauna during the operating phase.

In the Circle zone:

a. A pair of Common Kestrels is using the structure of one of the mirrors to nest. We suggest that the nest not be removed because we believe that this species' simple nest will not interfere with the functioning of the mirrors.

b. Numerous pairs of an opportunistic bird, the Spotless Starling, are using the cavities in the mirror structures to nest. If this becomes a problem for the efficiency of the plant, we could seek dissuasive measures against this species' nesting, but that would not affect the nesting of others, such as the one cited above.
c. The vegetation has been removed from the approximately 227 hectares of the Circle, as the plant operators have informed us, to reduce the possibility of fire. If this vegetation were maintained, if only to a height of 50 cm, it would increase the number of species and, above all else, the density of the population using the interior of the Circle. That is, the loss of habitat for species currently represented in the Circle would be palliated in part.
d. To the south of the Circle, a pool of approximately 3 hectares in area has been built to store water for the plant. This is being used timidly by some aquatic species, such as the Grey Heron and Common Sandpiper, and only as a place to rest. If some floating platforms (e.g., 3 x 3 m) were placed in the pond, aquatic birds could use it as a nesting site. One or more of the following species could potentially benefit from this: the Black-winged Stilt, Avocet, Collared Pratincole, Little Ringed Plover, Kentish Plover, Common Sandpiper, Gull-billed Tern, and the Little Tern. It would not represent a higher degree of eutrophication of the water and would scarcely contribute any solid matter to the water source since the majority of these species would use the floating platforms only as a site for their nests, feeding in the surrounding areas.

Outside the Circle zone.

e. It is important to maintain the speed bumps on the plant access road to keep traffic from speeding. High speeds increase the risk of collisions with fauna.
f. Repopulation with indigenous plant species suited to riverbanks along the artificial stream built on the outside northern border of the Gemasolar plant; this would promote its use as a place for more species of birds to rest and feed.

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APPENDIX. RESULTS OF THE BIRD CENSUSES IN LA MONCLOVA DURING THE 2011 REPRODUCTION PERIOD

círculo marzo 2011	número	ind/km
Alectoris rufa	6	3,53
Burrhinus oedicnemus	1	0,59
Calandrella bhachydactyla	15	8,82
Emberiza calandra	7	4,12
Galerida cristata	6	3,53
Lanius senator	2	1,18
Passer montanus	80	47,06
Sturnus unicolor	5	2,94
Sylvia conspicillata	2	1,18
	124	72,94
N círculo marzo 2011	número	ind/km
Anthus pratensis	4	1,82
Calandrella bhachydactyla	12	5,45
Cisticola juncidis	12	5,45
Coturnix coturnix	2	0,91
Emberiza calandra	29	13,18
galerida cristata	4	1,82
Melanocorypha calandra	46	20,91
Motacilla flava	10	4,55
	119	54,09
carril marqués marzo 2011	contactos	ind/km
Acanthis cannabina	6	3
Alectoris rufa	1	0,5
Anas platyrrhinchos	2	1
Anthus pratensis	5	2,5
Ardea cinerea	2	1
Bubulcus ibis	6	3
Buteo buteo	1	0,5
Calandrella brachydactyla	6	3
Carduelis carduelis	2	1
Carduelis chloris	4	2
Cisticola juncidis	2	1
Columba palumbus	1	0,5
Corvus corax	1	0,5
Coturnix coturnix	6	3
Emberiza calandra	14	7
Falco tinnunculus	1	0,5
Galerida cristata	22	11
Lanius senator	1	0,5
Melanocorypha calandra	35	17,5
Parus major	1	0,5
Passer montanus	14	7
Picus viridis	2	1
Serinus serinus	7	3,5
Sylvia atricapilla	8	4
Sylvia melanocephala	1	0,5
Upupa epops	1	0,5
	152	76

Spanish	English
círculo marzo 2011	Circle, March 2011
número	Number
ind/km	ind/km
N círculo marzo 2011	North of Circle, March 2011
Carril marqués marzo 2011	Marqués Road, March 2011
contactos	Contacts
[All numbers decimal commas are equivalent to decimal points.]	

circulo abril 2011	número	ind/km
Alectoris rufa	5	2,94
Burrhinus oedicnemus	4	2,35
Calandrella cinerea	5	2,94
Cisticola juncidis	2	1,18
Emberiza calandra	1	0,59
Falco tinnunculus	2	1,18
Galerida cristata	3	1,76
Milvus migrans	1	0,59
Oenanthe hispanica	1	0,59
Passer domesticus	10	5,88
Sylvia conspicillata	3	1,76
	37	21,76

N circulo abril 2011	número	ind/km
Alectoris rufa	2	0,91
Anas platyrhynchos	3	1,36
Buteo buteo	1	0,45
Calandrella bhachydactyla	10	4,55
Circus pygargus	2	0,91
Cisticola juncidis	3	1,36
Corvus corax	1	0,45
Coturnix coturnix	3	1,36
Elanus caeruleus	1	0,45
Emberiza calandra	34	15,45
Galerida cristata	8	3,64
Melanocorypha calandra	30	13,64
Motacilla flava	1	0,45
Streptopelia deacaoto	1	0,45
	100	45,45

carril marqués abril 2011	número	ind/km
Alectoris rufa	7	3,5
Anas platyrrhinchos	4	2
Bubulcus ibis	10	5
Burrhinus oedicnemus	2	1
Calandrella brachydactyla	14	7
Carduelis carduelis	2	1
Circus aeruginosus	2	1
Cisticola juncidis	3	1,5
Corvus corax	2	1
Coturnix coturnix	4	2
Elanus caeruleus	1	0,5
Emberiza calandra	14	7
Galerida cristata	20	10
Melanocorypha calandra	33	16,5
Milvus migrans	20	10
Picus viridis	1	0,5
Serinus serinus	1	0,5
Upupa epops	1	0,5
	141	70,5

Spanish	English
circulo abril 2011	Circle, April 2011
número	Number
ind/km	ind/km
N circulo abril 2011	North of Circle, April 2011
carril marqués abril 2011	Marqués Road, April 2011
[All numbers decimal commas are equivalent to decimal points.]	

circulo mayo 2011	número	densidad
Alectoris rufa	5	3,13
Calandrella cinerea	2	1,25
Cisticola juncidis	1	0,63
Emberiza calandra	1	0,63
Falco tinnunculus	1	0,63
Galerida cristata	1	0,63
Passer domesticus	10	6,25
Sylvia conspicillata	3	1,88
	24	

n circulo mayo 2011	número	densidad
Burrhinus oedicnemus	2	0,91
Buteo buteo	1	0,45
Calandrella cinerea	34	15,45
Carduelis cannabina	2	0,91
Corvus corax	1	0,45
Coturnix coturnix	11	5
Emberiza calandra	11	5
Falco tinnunculus	1	0,45
Galerida cristata	4	1,82
Melanocorypha calandra	20	9,09
Merops apiaster	4	1,82
Motacilla flava	8	3,64
Sturnus unicolor	30	13,64
	129	

carril marqués mayo 2011	número	densidad
Alectoris rufa	2	1
Bubulcus ibis	4	2
Calandrella cinerea	20	10
Carduelis carduelis	8	4
Cisticola juncidis	1	0,5
Coturnix coturnix	1	0,5
Elanus caeruleus	1	0,5
Emberiza calandra	27	13,5
Falco tinnunculus	2	1
Galerida cristata	11	5,5
Hieraaetus pennatus	1	0,5
Melanocorypha calandra	19	9,5
Motacilla flava	5	2,5
Serinus serinus	2	1
Streptopelia turtur	1	0,5
Upupa epops	3	1,5
	108	54

Spanish	English
circulo mayo 2011	Circle, May 2011
número	Number
densidad	Density
n circulo mayo 2011	North of Circle, May 2011
carril marqués mayo 2011	Marqués Road, May 2011
[All numbers decimal commas are equivalent to decimal points.]	

circulo junio 2011	número	ind/km
Calandrella brachydactyla	2	1,18
Cisticola juncidis	1	0,59
Emberiza calandra	1	0,59
Falco tinnunculus	1	0,59
Galerida cristata	5	2,94
Oenanthe hispanica	2	1,18
Passer domesticus	10	5,88
Sturnus unicolor	2	1,18
Sylvia conspicillata	3	1,76
	27	15,88
N circulo junio 2011	número	ind/km
Burrhinus oedicnemus	4	1,82
Buteo buteo	2	0,91
Calandrella brachydactyla	113	51,36
Corvus corax	3	1,36
Coturnix coturnix	2	0,91
Galerida cristata	17	7,73
Gareola pratincola	2	0,91
Melanocorypha calandra	61	27,73
Motacilla flava	6	2,73
Passer hispaniolensis	14	6,36
Vanellus vanellus	3	1,36
	227	103,18
carril marqués junio 2011	número	ind/km
Sylvia melanocephala	1	0,50
Alectoris rufa	3	1,50
Bubulcus ibis	1	0,50
Calandrella brachydactyla	23	11,50
Carduelis cannabina	14	7,00
Carduelis carduelis	4	2,00
Carduelis carduelis	2	1,00
Carduelis chloris	7	3,50
Coturnix coturnix	1	0,50
Elanus caeruleus	2	1,00
Falco tinnunculus	1	0,50
Galerida cristata	17	8,50
Himantopus himantopus	1	0,50
Melanocorypha calandra	3	1,50
Passer hispaniolensis	41	20,50
Streptopelia turtur	3	1,50
Upupa epops	1	0,50
	125	62,50

Spanish	English
circulo junio 2011	Circle, June 2011
número	Number
ind/km	ind/km
N circulo junio 2011	North of Circle, June 2011
carril marqués junio 2011	Marqués Road, June 2011
[All numbers decimal commas are equivalent to decimal points.]	

circulo julio 2011	número	ind/km
Alectoris rufa	1	0,59
Circus pygargus	1	0,59
Cisticola juncidis	2	1,18
Emberiza calandra	2	1,18
Falco tinnunculus	1	0,59
Galerida cristata	3	1,76
Lanius senator	2	1,18
	12	7,06
n circulo julio 2011	número	ind/km
Calandrella brachydactyla	3	1,36
Falco tinnunculus	1	0,45
Galerida cristata	12	5,45
	16	7,27
carril marqués julio 2011	número	ind/km
Bubulcus ibis	4	2,00
Calandrella brachydactyla	39	19,50
Carduelis carduelis	6	3,00
Elanus caeruleus	2	1,00
Emberiza calandra	6	3,00
Galerida cristata	24	12,00
Melanocorypha calandra	6	3,00
Milvus migrans	2	1,00
Petronia petronia	1	0,50
	90	45

Spanish	English
circulo julio 2011	Circle, July 2011
número	Number
ind/km	ind/km
N circulo julio 2011	North of Circle, July 2011
carril marqués julio 2011	Marqués Road, July 2011
[All numbers decimal commas are equivalent to decimal points.]	

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Incidencia de la planta de energía solar, GEMASOLAR (La Monclova, Fuentes de Andalucía, prov. Sevilla), sobre la comunidad de aves

Informe 5 (febrero 2012): Avifauna nidificante durante la última fase de construcción de la planta (marzo-julio 2011) y la primera de explotación (agosto-diciembre 2011).

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El proyecto de seguimiento de la avifauna en el entorno de la planta de Gemasolar, La Monclova, provincia de Sevilla

Según el documento "Condiciones DIA avifauna" para la planta de energía solar GEMASOLAR, en su apartado 1.1.1 (detección de impactos no previstos sobre la avifauna), se establece que deberá haber un seguimiento sobre la avifauna en la fase de construcción de la citada planta, cuyo objetivo será *Detección de impactos sobre la avifauna no contemplados en el estudio de impacto ambiental.*

Este informe corresponde a los muestreos sobre avifauna realizados en el área de influencia de la planta Gemasolar, finca La Monclova, t.m. Fuentes de Andalucía, Sevilla, durante los meses de marzo a julio de 2011, por lo que en fenología de aves coincide con el periodo de reproducción. Corresponde al final de la fase de construcción de la planta. Pretende definir el impacto que la construcción de la planta Gemasolar ha producido en la comunidad de aves nidificantes del área de estudio durante este año, último de la fase de construcción.

Estos muestreos son realizados durante la primavera y verano de 2011, en tres zonas del área de estudio, definidas como Círculo, Norte de Círculo y Carril del Marqués, ordenados en orden decreciente del potencial impacto que tendrá la planta de Gemasolar (ver Material y Métodos).

Hacia mediados de julio de 2011 comienza la fase de explotación de la planta de Gemasolar. Por ello, este informe también contempla los resultados de los censos para los meses de agosto-diciembre de 2011, que tienen como objeto el detectar el impacto sobre la avifauna de la planta de Gemasolar durante la fase de explotación.

Preguntas planteadas antes de la realización de un proyecto de monitorización de avifauna en una planta termosolar

Han sido adaptadas a partir de la Guía para la realización de EIA en Parques Eólicos, realizada por SEO-Bird Life International. Estas preguntas han sido en todo momento consideradas durante el diseño de los muestreos de aves.

– ¿La planta termosolar supondría una afección significativa para especies amenazadas o prioritarias?
– ¿Es esperable que se produzca mortalidad de aves durante las fases de construcción o explotación? ¿De qué especies se trataría? ¿Cuál sería su magnitud?
– ¿Existe un uso intensivo por parte de aves de la zona de instalación de la planta? ¿De qué especies? ¿Cuál es su estado de conservación?
– ¿La construcción la planta termosolar supondría facilitar el paso a un área de difícil acceso actualmente para los seres humanos? ¿Esto supondría una mayor frecuentación de la zona por personas? ¿Existen especies que pueden verse molestadas por esta mayor frecuentación del área de influencia de la planta termosolar?
– ¿Existen otras plantas termosolares o proyectos de plantas termosolares en la zona que puedan producir impacto sobre las mismas especies o hábitats? ¿Cuál será su impacto acumulado?
– ¿Existen planes o la posibilidad de que el promotor amplíe la planta termosolar en los próximos 10 años?
– ¿Hay especies especialmente sensibles a la colisión con tendidos eléctricos? ¿Cuáles y cuál es su estado de conservación y protección?
– ¿Existen en la zona otras infraestructuras o proyectos que puedan atraer a las aves y aumentar el riesgo de colisión (muladares, basureros, etc.)?
– ¿Existen en la zona otras infraestructuras, construidas o en proyecto, que puedan producir impacto sobre las mismas especies o hábitats?

Durante la fase de construcción, el impacto más directo sobre la avifauna es la pérdida de hábitat de la superficie donde se instala la planta, así como de los edificios y otras estructuras anexas. La pérdida de hábitat afecta a las aves durante todo el año, por tanto de todas las categorías fenológicas (sedentarias, estivales,

invernantes, en paso). Debido a la delgadez de la torre de captación, no se espera un significativo impacto por colisión o por efecto barrera; el impacto por colisión podría observarse en días de climatología adversa, como los días de fuerte niebla y durante la noche. Es probable que el impacto por colisión sea superior para la comunidad de aves en migración con respecto a la comunidad residente; afortunadamente, parece que la planta de Gemasolar no se encuentra en una definida ruta migratoria de aves. Se espera incidencia sobre la avifauna del entorno del Círculo por el elevado tránsito de vehículos durante la fase de construcción.

Durante la fase de explotación es esperable se produzcan los mismos impactos definidos para la fase de construcción. Es también posible un impacto a causa de ceguera de las aves que se aproximen a los rayos reflejados, incluso muerte por choque de calor. Otros impactos serían la pérdida de vegetación anual por manejos del medio dentro del área Círculo y los derivados del tránsito de los trabajadores en su acceso o salida de la planta.

Pero hasta el presente, no hemos localizado en la literatura científica cuantificación del impacto de las plantas de energía termosolar sobre las aves. Esta carencia, de nuevo, le da valor añadido al estudio que estamos realizando en la planta de Gemasolar.

El informe sobre la avifauna en la planta de Gemasolar para el año 2011 es de difícil enfoque. Este año se caracterizó por una primera mitad (enero-mediados de julio) con la planta en fase de construcción, y una segunda mitad (finales de julio-diciembre) en fase de explotación. Fenológicamente, la porción más interesante de la avifauna, la nidificante, se censa entre marzo-julio, luego queda dentro de la fase de construcción de la planta. A partir de mediados de julio, durante la fase de explotación, tenemos varias comunidades de avifauna atendiendo a su reproducción y carácter migratorio, como la i) sedentaria (desde finales de julio), ii) estival más paso (agosto-octubre), iii) invernante (noviembre-diciembre). Como no tiene sentido la comparación interanual de comunidades de avifauna de fenología distinta, optamos por:

1) evaluar el efecto de la fase final de construcción sobre la avifauna nidificante, comparando los resultados del inicio de la fase de construcción (año 2009) con los resultados para 2011; se utilizan los datos de los meses marzo-julio para la zona de máximo impacto, el Círculo.
2) describir los resultados de la fase de explotación durante 2011. No disponemos de datos de avifauna en el área de estudio para los meses en los que se ha desarrollado la explotación (finales de julio-diciembre), de años anteriores a 2011. Como aproximación a la evaluación del impacto sobre la avifauna de la fase de explotación, se comparan los valores dentro de la zona Círculo con los obtenidos en la zona Norte Círculo, espacialmente muy próxima y con el mismo hábitat que tenía la zona Círculo antes de la construcción de la planta de Gemasolar.
3) Describir los resultados de visitas al interior de la planta durante la fase de explotación.
4) Valoración general de la avifauna durante 2011 en la finca donde se encuentra la planta de Gemasolar.
5) Proponer posibles medidas paliativas al impacto sobre la avifauna en la fase de explotación.

Material y métodos.

Elementos del paisaje en el entorno de la planta Gemasolar que puedan condicionar la comunidad de aves.

Este apartado queda reflejado en el Informe 4.

Elección de los itinerarios de censo

Este apartado queda reflejado en el Informe 4. Pero existe una variación para el año 2011. Debido a la imposibilidad de seguir realizando el itinerario Círculo durante la fase de construcción a través de un diámetro del círculo de la planta de Gemasolar (por el continuo movimiento de maquinaria casi todos los días del año), se pasó a realizarlo desde el borde, en la zona del Círculo más próxima a los censos del interior del círculo realizados durante los años 2009 y 2010. Cuando se realizó el censo a través de un diámetro del interior del círculo, se anotaron todas las aves detectadas a ambos lados del itinerario de censo, en 1.6 km; al realizar durante el año 2011 el censo desde el borde del círculo, solo se podía anotar las aves detectadas a un lado del itinerario del censo; por ello, se duplicó la longitud del censo a 3,2 km (pero lógicamente, solo anotando las aves detectadas en el interior del círculo; Figura 1). Asumimos que es la mejor manera de mantener los resultados comparables entre años, después de la limitación a la entrada dentro del círculo.

Figura 1. Ubicación de los tres itinerarios de censo establecidos para el interior y alrededores de la planta de energía solar GEMASOLAR para evaluar el posible impacto de la fase de construcción y explotación sobre la comunidad de aves nidificantes durante 2011. Negro, perímetro de la planta de Gemasolar; verde, transecto Círculo; azul, transecto Norte círculo; rojo, transecto Carril del Marqués.

Metodología de censo

No varía sobre el informe anterior. Pero a partir de julio de 2011, cuando comienza la fase de explotación, y siguiendo las directrices de la DIA sobre la avifauna, hemos realizado varias visitas al interior del círculo con el objeto de detectar la existencia de aves muertas. Estos muestreos han implicado la realización de varios radios del círculo, tanto a pie como en vehículo del servicio de mantenimiento de la planta. Especial atención se prestó a la zona bajo la torre central.

Resultados

1) **Evaluación del efecto de la fase final de construcción de la planta de Gemasolar sobre la avifauna nidificante.**

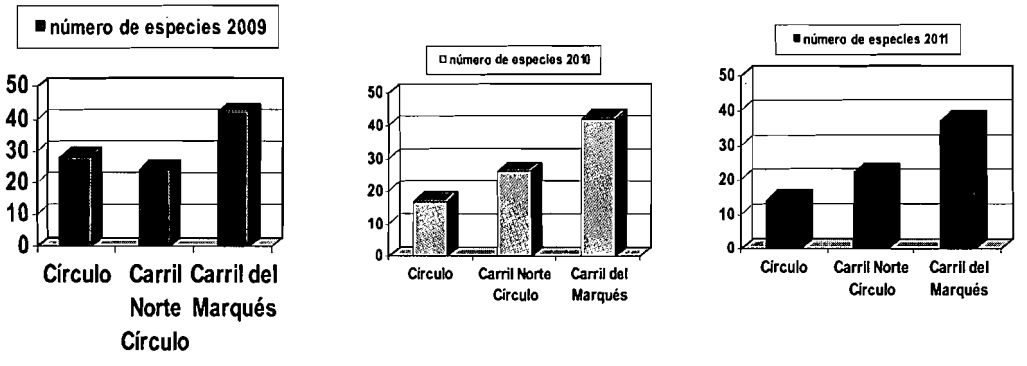
En la zona Círculo, entre los meses de marzo-julio de 2009, al inicio de la fase de construcción, se detectaron 27 especies de aves, entre las que nidificaban y las que usaban el lugar para forrajeo. Entre los mismos meses pero de 2011, en la fase final de construcción, se detectan solo 14 especies, lo que representa prácticamente la mitad de la riqueza específica. La densidad relativa también muestra una reducción en el mismo periodo próxima al 50% (ver Informe 3 y Tabla 1). Han desaparecido en la zona Círculo durante el desarrollo de la construcción las aves ligadas a los encharcamientos que aún quedaban en 2009 (andarríos chico, ánade real, garcilla bueyera, chorlitejo chico, cigüeña blanca, aguilucho lagunero, canastera común, lavandera blanca, lavandera boyera) y algunas que se refugiaban o cazaban en la vegetación que aún quedaba antes de los movimientos de tierra (codorniz, elanio azul).

En relación a uno de los objetivos del estudio del impacto ambiental de la planta de Gemasolar sobre las aves, resulta evidente que la fase de construcción ha implicado una paulatina reducción de los parámetros estructurales de esta comunidad (riqueza, densidad) dentro de la zona Círculo. Sin embargo, no se han apreciado cambios durante la fase de construcción en la riqueza de avifauna de las otras dos zonas sometidas a muestreo, la zona Norte Círculo y la zona Carril del Marqués; tan solo una reducción en la densidad relativa de individuos (datos comparativos no mostrados, pero pueden obtenerse a partir de la figura 1, de los aportados en el anexo de este informe y en el Informe 3).

Tabla 1. Composición y abundancia relativa (ind/km) de la comunidad nidificante de aves en zona Círculo de Gemasolar durante 2009 (A) y 2011 (B). Valores medios para los cinco meses marzo-julio. Se han eliminado los invernantes de presencia tardía.

Círculo mar-jul 2009 (A)	número individuos	indiv/ km	círculo mar-jul 2011 (B)	número individuos	ind/km
Actitis hypoleucos	1	0,125	*Alectoris rufa*	17	2,00
Alectoris rufa	16	2	*Burrhinus oedicnemus*	5	0,59
Anas platirrhynchos	4	0,5	*Calandrella bhachydactyla*	24	2,82
Bubulcus ibis	9	1,125	*Circus pygargus*	1	0,12
Burhinus oedicnemus	3	0,375	*Cisticola juncidis*	6	0,71
Calandrella brachydactyla	54	6,75	*Emberiza calandra*	12	1,41
Carduelis cannabina	9	1,125	*Falco tinnunculus*	5	0,59
Charadrius dubius	1	0,125	*Galerida cristata*	18	2,12
Ciconia ciconia	1	0,125	*Lanius senator*	4	0,47
Circus aeruginosus	2	0,25	*Milvus migrans*	4	0,47
Circus pygargus	3	0,375	*Passer domesticus*	30	3,53
Cisticola juncidis	3	0,375	*Passer montanus*	80	9,41
Corvus corax	2	0,25	*Sturnus unicolor*	7	0,82
Coturnix coturnix	2	0,25	*Sylvia conspicillata*	11	1,29
Elanus caeruleus	2	0,25	total 14 especies	224	26,35
Falco tinnunculus	2	0,25			
Fringilla coelebs	1	0,125			
Galerida cristata	40	5			
Glareola pratincola	18	2,25			
Melanocorypha calandra	73	9,125			
Milaria calandra	63	7,875			
Motacilla alba	3	0,375			
Motacilla cinerea	3	0,375			
Motacilla flava	6	0,75			
Passer domesticus	6	0,75			
Passer montanus	40	5			
Serinus serinus	2	0,25			
total 27 especies	369	46,125			

Figura 1. Riqueza de la avifauna nidificante en la planta de Gemasolar (Círculo) y dos zonas próximas (N Círculo y Carril del Marqués) durante 2009, 2010 y 2011.



2) Avifauna en el área de estudio durante la fase de explotación (julio-diciembre 2011).

Riqueza de especies y abundancia de individuos

Con 17 especies de aves durante la fase de explotación de 2011 (finales julio-diciembre), el Círculo donde se ha instalado la planta de Gemasolar presenta mucha menos riqueza que la zona Norte Círculo (30 especies) y la zona Carril del Marqués (42 especies; Tabla 2). Con 15 ind/km en la zona Círculo, frente a 45 ind/km en la zona Norte Círculo, y 144 ind/km en la zona Carril del Marqués, los datos de abundancia de individuos aún dejan más claro la diferencia de la avifauna que coloniza el Círculo frente a las otras zonas (Tabla 2). Además, en la zona Círculo aumenta la dominancia en la comunidad de aves, pues una sola especie, la cogujada común, representa la mitad de todos los contactos de aves. Es decir, que se ha simplificado manifiestamente la comunidad de aves dentro de la zona Círculo, con la tendencia a que esté habitada por pocas especies, como la cogujada común, el ave que mejor se adapta a los cambios en los paisajes agrícolas mediterráneos de topografía llana. Las diferencias son tan evidentes, que no son comparadas mediante herramientas estadísticas; además, poseemos muy pocos grados de libertad para la comparación (solo se dispone de datos independientes de cinco meses en cada una de las zonas de estudio).

Cambios en la composición de la comunidad de aves en la zona Círculo

Cuando en los estudios de impacto ambiental no se dispone de datos sobre el medio natural antes que ocurriera el factor perturbador, una solución a la que se recurre es comparar los resultados actuales con los de una zona próxima al área de estudio, con el mismo hábitat, y no afectada por el factor perturbador. A partir de las visitas que realizamos al área de estudio durante 2008, antes de la fase de construcción de la planta de Gemasolar, y a partir de la consulta de fotografías aéreas, comprobamos que el paisaje en la zona Círculo era igual al que existe actualmente en la zona N Círculo. Comparando los resultados de los censos de avifauna entre ambas zonas durante la fase explotación, podemos deducir con más detalle los

cambios en la composición de la comunidad de aves que han ocurrido dentro del las aproximadamente 227 ha del Círculo.

Al menos para el periodo agosto-diciembre de 2011, en la zona Círculo han desaparecido:

- Tres especies adaptadas a las estepas cerealistas, alondra común (invernante), terrera marismeña (inv), calandria común (sedentaria).
- Seis especies de rapaces, unas que utilizaban el área de estudio como lugar de nidificación, aprovechando los árboles dispersos en el paisaje, elanio azul (sed), ratonero común (sed), águila culebrera (estival), o en el suelo, aguilucho cenizo (est), y otras dos que utilizan este hábitat como lugar de forrajeo, aguilucho pálido (inv), aguilucho lagunero (sed).
- Aves propias de encharcamientos o de suelos húmedos, circunstancias ambas que ya no se observan en la zona círculo, garcilla bueyera (sed), avefría (sed), chorlitejo chico (est), lavandera blanca (sed), lavandera boyera (est).

Durante el mismo periodo de tiempo, hemos observado la presencia dentro del recinto del Círculo de tres especies que no fueron detectadas en la zona Norte Círculo, mochuelo común, alcaudón común y alcaudón meridional, aunque con densidad muy baja. Son especies que cazan desde posaderos, por lo que aprovechan para ella las numerosas estructuras que ahora le ofrece el interior de la zona Círculo.

¿Hay incidencia de la planta de Gemasolar sobre la composición de las comunidades de aves fuera de la zona Círculo?

Son manifiestas las diferencias en riqueza entre la zona Norte Círculo y el Carril del Marqués, en el sentido que este último alberga más especies y mucha mayor densidad que el anterior (Tabla 2). Se podría pensar que, al estar la zona Norte Círculo más próxima a la zona Círculo de lo que está el Carril del Marqués, estas diferencias en la comunidad de aves son el resultado de un impacto mayor de la

explotación de la central Gemasolar. Sin embargo, las diferencias en riqueza las aportan las aves forestales, bien representadas en la zona Carril del Marqués por la presencia de restos del bosque autóctono en el lugar (ver informe 4). Estas aves forestales son águila imperial ibérica, milano real, pito real, tórtola común, mirlo común, zorzal común, curruca capirotada, mosquitero común, papamoscas gris, petirrojo (Tabla 2). Además, la riqueza de las comunidades de aves nidificantes en la zona Norte Círculo y Carril del Marqués, prácticamente se han mantenido constantes a lo largo de los tres años en los que se han muestreado estas comunidades (2009-2011; figura 1).

Por tanto, a la luz de los resultados que manejamos, no podemos afirmar que exista un efecto directo de la planta sobre la composición de las comunidades de aves en el exterior del Círculo.

Tabla 2. Resultados de los censos de avifauna en la planta de Gemasolar (Círculo; 8 km), su entorno inmediato (Norte Círculo, 11 km) y su entorno más alejado (Carril del Marqués, 10 km) durante la fase de explotación (agosto-diciembre 2011). Se indica la abundancia relativa de cada especie con el Índice Kilométrico de Abundancia (IKA).

carril marques ago-dic 2011	número	ind/km	N circulo ago-dic 2011	número	ind/km	círculo ago-dic 2011	número	ind/km
Alauda arvensis	6	0,60	*Alauda arvensis*	82	7,45	*Alectoris rufa*	2	0,25
Alectoris rufa	26	2,60	*Alectoris rufa*	24	2,18	*Anthus pratensis*	3	0,38
Anas platyrhynchos	1	0,10	*Anthus pratensis*	27	2,45	*Athene noctua*	2	0,25
Anthus pratensis	35	3,50	*Bubulcus ibis*	16	1,45	*Calandrella brachydactyla*	2	0,25
Aquila adalberti	1	0,10	*Buteo buteo*	2	0,18	*Carduelis cannabina*	28	3,5
Bubulcus ibis	17	1,70	*Calandrella brachydactyla*	46	4,18	*Cisticola juncidis*	3	0,38
Burhinus oedicnemus	23	2,30	*Calandrella rufescens*	27	2,45	*Corvus corax*	5	0,63
Buteo buteo	2	0,20	*Circaetus gallicus*	1	0,09	*Emberiza calandra*	3	0,38
Calandrella brachydactyla	35	3,50	*Circus aeruginosus*	1	0,09	*Falco tinnunculus*	2	0,25
Calandrella rufescens	2	0,20	*Circus cyaneus*	1	0,09	*Galerida cristata*	54	6,75
Carduelis cannabina	39	3,90	*Circus pygargus*	1	0,09	*Lanius excubitor*	1	0,13
Carduelis chloris	1	0,10	*Cisticola juncidis*	14	1,27	*Lanius meridionalis*	1	0,13
Circus pygargus	2	0,20	*Corvus corax*	11	1,00	*Oenanthe hispanica*	2	0,25
Cisticola juncidis	4	0,40	*Coturnix coturnix*	2	0,18	*Phoenicurus ochruros*	1	0,13
Corvus corax	9	0,90	*Charadrius dubius*	1	0,09	*Phylloscopus collybita*	5	0,63
Coturnix coturnix	1	0,10	*Elanus caeruleus*	2	0,18	*Saxicola rubetra*	1	0,13
Elanus caeruleus	2	0,20	*Emberiza calandra*	155	14,09	*Saxicola torquata*	4	0,5
Emberiza calandra	231	23,10	*Falco tinnunculus*	6	0,55			
Erithacus rubecula	7	0,70	*Galerida cristata*	80	7,27			
Galerida cristata	136	13,60	*Melanocorypha calandra*	30	2,73			
Lanius excubitor	1	0,10	*Motacilla alba*	7	0,64			
Lanius meridionalis	3	0,30	*Motacilla flava*	6	0,55			
Melanocorypha calandra	107	10,70	*Oeenanthe oenanthe*	9	0,82			
Milvus milvus	3	0,30	*Phoenicurus ochruros*	1	0,09			
Motacilla alba	14	1,40	*Phylloscopus collybita*	3	0,27			
Motacilla flava	25	2,50	*Saxicola rubetra*	1	0,09			

Muscicapa striata		1	0,10	*Saxicola torquata*		5	0,45				
Oenanthe oenanthe		3	0,30	*Serinus serinus*		10	0,91				
Parus major		3	0,30	*Sturnus unicolor*		16	1,45				
Passer montanus		168	16,80	*Vanellus vanellus*		25	2,27				
Phylloscopus bonelli		1	0,10								
Picus viridis		3	0,30								
Serinus serinus		10	1,00								
Sylvia melanocephala		17	1,70								
Streptopelia turtur		3	0,30								
Sturnus unicolor		448	44,80								
Sylvia atricapilla		30	3,00								
Tetrax tetrax		3	0,30								
Turdus merula		1	0,10								
Turdus philomelos		1	0,10								
Upupa epops		5	0,50								
Vanellus vanellus		9	0,90								
Valores totales	42	1439	144		30	612	55,64		17	119	14,9

Prácticamente todas las especies que ocupan la zona Círculo durante la fase de explotación son propias de espacios abiertos (i.e., cogujada común, pardillo común). La zona es colonizada por poquísimos individuos de aves insectívoras durante los pasos que cazan desde posaderos, pues aprovechan las estructuras de vallado o los propios espejos como tales perchas (tarabilla común, tarabilla norteña, collalba rubia, colirrojo tizón). La baja densidad de individuos en la zona Círculo está en relación con la práctica ausencia de vegetación natural. Aunque no se muestran los resultados por meses (se pueden comprobar en los datos aportados en el anexo), esto queda de manifiesto cuando se comprueba la bajada en la riqueza y densidad de especies presentes en la zona Círculo después de terminar el proceso de eliminación de la vegetación ruderal para disminuir el riesgo de incendio.

3) Resultados de visitas al interior de la planta durante la fase de explotación.

Solo hemos tenido acceso al interior del Círculo con motivo de nuestras visitas los meses de julio (28) y de agosto (26).

Durante el mes de julio vimos desde el segundo anillo de espejos (contando a partir de la torre) algunas collalba gris (*Oenanthe oenanthe*) sedimentadas durante el paso, presentes en el resto de los radios hasta llegar al perímetro de la planta. A partir del anillo 27 abejaruco (*Merops apiaster*), del 29 cogujada común, del 31 perdiz común y triguero. Vencejo común (*Apus apus*) volando, aunque no se acercaban a la torre de captación (desde el anillo 15 hacia el exterior). Resultado negativo en la búsqueda de cadáveres de aves durante un periodo de 90 min, dos personas. La búsqueda fue particularmente minuciosa en la proximidad de la torre de captación.

Durante el mes de agosto, cogujada común a partir del anillo 4, collalba gris a partir del anillo 7, collalba rubia a partir del anillo 19, pardillo a partir del anillo 20, cernícalo vulgar a partir del anillo 25, terrera común a partir del anillo 28, perdiz común a partir del anillo 30, abejaruco a partir del anillo 40. Prospección detallada de dos personas durante 60 minutos aporta resultado negativo en la búsqueda de cadáveres de aves. De nuevo, la prospección se realizó con más detalle en la proximidad de la torre de captación.

Consultas a varios operarios durante las dos visitas sobre la presencia de cadáveres de aves dentro del Círculo, también dieron resultados negativos.

Aparentemente, no ocurren muertes de aves por choque de calor (producido por los rayos reflejados por los espejos) entre aquellas que utilizan el Círculo como lugar de forrajeo y descanso, o entre aquellas que cruzan el Círculo en sus desplazamientos diarios. Reconocemos que esta conclusión se basa aún en una muestra muy baja.

4) **Valoración general de la avifauna durante 2011 en la finca donde se encuentra la planta de Gemasolar.**

Para establecer el estado de conservación de las especies, seguimos el Libro Rojo de las Aves de España. Este a su vez sigue los criterios de la UICN para categorizar el riesgo de extinción de las especies, pero aplicado a la escala regional de España.

Durante la fase de explotación, dentro de la zona Círculo, solo encontramos una especie catalogada como Vulnerable, la terrera común. Pero aparece con densidad tan baja (0.25 ind/km), y tiene tanto hábitat adecuado en el resto de la finca de La Monclova, que no consideramos necesario el tomar medidas para el mantenimiento o reforzamiento de la población de esta especie dentro del Círculo. El resto de las especies que han utilizado el interior del Círculo durante la fase de explotación no están amenazadas, y disponen de hábitat adecuado en el exterior.

Los censos en la zona Norte Círculo sí detectan la presencia de dos especies catalogadas como Vulnerables y dos catalogadas Casi Amenazadas. Entre las Vulnerables, una corresponde a una población densa de terrera común (4,8 ind/km), y otra a la presencia de aguilucho cenizo.

Siguiendo el citado Libro Rojo, los datos sobre la evolución de las poblaciones y área de distribución de la terrera común en España muestran importantes descensos, probablemente superiores al 30% en un plazo de 10 años. Como causa principal de este descenso se perfila la desaparición de su hábitat principal, los barbechos a largo plazo por la intensificación del cultivo de cereal de secano, la implantación de regadíos y la proliferación de nuevos cultivos arbóreos. Las causas para que el aguilucho cenizo entre en esta clasificación son las mismas aducidas para la terrera común, unidas a la implantación de cereales de ciclo corto, sujetos a siega antes de que los pollos hayan podido abandonar el nido.

Entre las Casi Amenazadas, una corresponde a una población relativamente densa de terrera marismeña (2,45 ind/km) que inverna en la zona, y otra a una pareja de elanio azul que nidifica en la zona y permanece todo el año. La terrera marismeña tiene un área de distribución pequeña durante la nidificación, mayormente en áreas

litorales, sometida a pérdida continua de superficie, por lo que las poblaciones peninsulares son pequeñas y en declive. El elanio azul tiene aún poblaciones reducidas en la península Ibérica y está perdiendo hábitat por los cambios en las prácticas agrícolas.

En la zona Carril del Marqués, además de las cuatro especies citadas anteriormente, encontramos dos categorizadas En Peligro de Extinción, el águila imperial ibérica y el milano real, una Vulnerable, el sisón, y otra Casi Amenazada, el alcaraván.

El águila imperial se encuentra amenazada por su población reducida, el declive de su presa principal (conejo) y el efecto de los tendidos eléctricos. El milano real está amenazado por la desaparición de muladares y el uso de veneno, y ha mostrado una reducción poblacional del 50% en poco más del tiempo de una generación de la especie. El sisón común está sometido a una fuerte regresión poblacional en toda Europa, incluida la Península Ibérica, debido a los cambios en la agricultura. El alcaraván común está afectado por la pérdida de barbechos y eriales, y la transformación a regadío de la antigua agricultura de secano.

Además de los censos, hemos realizado observaciones de aves en el área de estudio fuera de censo. Han sido útiles para localizar el uso de la zona Norte Círculo y Carril del Marqués por otras especies. En la primera de las zonas, se observó en los primeros meses del año una pareja de avutardas y en enero un importante bando de grullas sedimentado.

Según el guarda de la finca, la pareja de avutardas ha criado este año, pues en varias ocasiones ha visto a la hembra acompañada de cinco jóvenes del año. En el censo de avutardas realizado entre 2000-2005, la zona dio resultados positivos en una encuesta a guardas, pero no se detectó la existencia de leks y en general, la reproducción de la especie en La Monclova (Alonso (ed.) 2007; *La avutarda común en Andalucía*, ed. Gypaetus). Este dato viene a aportar una nueva zona de nidificación para esta especie amenazada en Andalucía, situada entre el núcleo de Arahal-Carmona-Paradas (al este) y el núcleo Gerena-Olivares (al oeste). Hacia 2009, en Andalucía se estimaba una población de 441 ejemplares, y la avutarda es considerada una especie prioritaria en la conservación de la biodiversidad en esta

región. La consolidación de este núcleo de reproducción sería importante para la recuperación de la especie en Andalucía.

Aunque el águila imperial solo fue detectada en uno de los censos, un ejemplar inmaduro ha sido observado por nosotros fuera de censo durante todo el año en los alrededores de la planta de Gemasolar. Esto sugiere que el ejemplar se ha asentado en esta zona durante su larga etapa preadulta (4 años). La conservación de las áreas de dispersión de inmaduros de grandes rapaces está emergiendo como una de las claves en la conservación de estas especies. Andalucía alberga 71 de las 278 parejas de esta especie en España, y nuestro país a su vez alberga prácticamente toda la población mundial de águila imperial ibérica; luego queda de manifiesto la sensibilidad de esta especie a efectos de conservación.

La existencia en la finca La Monclova de varias especies de aves amenazadas, algunas tan significativas como la avutarda o el águila imperial ibérica, implica una observancia estricta de cualquier actividad derivada de la planta de Gemasolar que pudiera afectarles negativamente. Del mismo modo, si estas especies y sus poblaciones se mantienen o incrementan en la finca a lo largo de los años, podría sugerir que la planta de Gemasolar sería compatible con el mantenimiento de la biodiversidad aviar en sus alrededores (finca La Monclova).

5) posibles medidas paliativas al impacto sobre la avifauna en la fase de explotación.

En el Círculo:

a. una pareja de cernícalo vulgar utiliza la estructura de uno de los espejos para nidificar. Proponemos que el nido no sea removido, pues creemos que el sencillo nido de esta especie difícilmente podría afectar al funcionamiento de los espejos.
b. Muchas parejas de un ave oportunista, el estornino negro, están utilizando las oquedades de las estructuras de los espejos para nidificar. En caso que esto representara un problema para la eficiencia de la planta, podríamos buscar medidas disuasorias contra la

nidificación de esta especie, pero que no afectara a la nidificación de otras como la anteriormente citada.

c. En las aproximadamente 227 ha del Círculo se ha eliminado la vegetación, según nos dicen operarios de la planta, para disminuir la posibilidad de incendio. Si esa vegetación se mantuviera, aunque fuera solo hasta una altura de 50 cm, aumentaría el número de especies y, sobre todo, la densidad de población que utiliza el interior del Círculo. Es decir, la pérdida de hábitat para las especies que actualmente representa el Círculo, quedaría parcialmente paliada.
d. Al sur del Círculo se ha construido una balsa de aproximadamente 3 ha de superficie para el abastecimiento de agua a la planta. Está siendo tímidamente utilizada por algunas aves acuáticas, como garza real y andarríos chico, y solo como lugar de descanso. Si se colocaran en la balsa algunas plataformas flotantes (por ejemplo, de 3 x 3 m), podrían ser utilizadas como lugar de nidificación por parte de aves acuáticas. Potencialmente podrían ser beneficiarias de esta medida una o varias de las siguientes especies: cigüeñuela común, avoceta, canastera común, chorlitejo chico, chorlitejo patinegro, andarríos chico, pagaza piconegra, charrancito común. Ello no representaría un mayor grado de eutrofización del agua y apenas aporte de material sólido al vaso, pues la mayoría de estas especies solo utilizarían las plataformas flotantes como lugar para instalar sus nidos, alimentándose en los alrededores.

En el exterior del Círculo.

e. importante mantener los resaltes en el carril de acceso a la planta, para disuadir de velocidad alta en los vehículos que por él transitan. La velocidad elevada aumenta el riesgo de atropellos sobre la fauna.
f. Repoblación con especies vegetales autóctonas y propias de ribera del arroyo artificial que se ha construido en el borde exterior, norte, de la planta de Gemasolar; ello favorecería su uso como lugar de descanso y alimentación por más especies de aves.

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circulo abril 2011	número	ind/km
Alectoris rufa	5	2,94
Burrhinus oedicnemus	4	2,35
Calandrella cinerea	5	2,94
Cisticola juncidis	2	1,18
Emberiza calandra	1	0,59
Falco tinnunculus	2	1,18
Galerida cristata	3	1,76
Milvus migrans	1	0,59
Oenanthe hispanica	1	0,59
Passer domesticus	10	5,88
Sylvia conspicillata	3	1,76
	37	21,76

N circulo abril 2011	número	ind/km
Alectoris rufa	2	0,91
Anas platyrhynchos	3	1,36
Buteo buteo	1	0,45
Calandrella bhachydactyla	10	4,55
Circus pygargus	2	0,91
Cisticola juncidis	3	1,36
Corvus corax	1	0,45
Coturnix coturnix	3	1,36
Elanus caeruleus	1	0,45
Emberiza calandra	34	15,45
Galerida cristata	8	3,64
Melanocorypha calandra	30	13,64
Motacilla flava	1	0,45
Streptopelia deacaoto	1	0,45
	100	45,45

carril marqués abril 2011	número	ind/km
Alectoris rufa	7	3,5
Anas platyrrhinchos	4	2
Bubulcus ibis	10	5
Burrhinus oedicnemus	2	1
Calandrella brachydactyla	14	7
Carduelis carduelis	2	1
Circus aeruginosus	2	1
Cisticola juncidis	3	1,5
Corvus corax	2	1
Coturnix coturnix	4	2
Elanus caeruleus	1	0,5
Emberiza calandra	14	7
Galerida cristata	20	10
Melanocorypha calandra	33	16,5
Milvus migrans	20	10
Picus viridis	1	0,5
Serinus serinus	1	0,5
Upupa epops	1	0,5
	141	70,5

circulo mayo 2011	número	densidad
Alectoris rufa	5	3,13
Calandrella cinerea	2	1,25
Cisticola juncidis	1	0,63
Emberiza calandra	1	0,63
Falco tinnunculus	1	0,63
Galerida cristata	1	0,63
Passer domesticus	10	6,25
Sylvia conspicillata	3	1,88
	24	

n circulo mayo 2011	número	densidad
Burrhinus oedicnemus	2	0,91
Buteo buteo	1	0,45
Calandrella cinerea	34	15,45
Carduelis cannabina	2	0,91
Corvus corax	1	0,45
Coturnix coturnix	11	5
Emberiza calandra	11	5
Falco tinnunculus	1	0,45
Galerida cristata	4	1,82
Melanocorypha calandra	20	9,09
Merops apiaster	4	1,82
Motacilla flava	8	3,64
Sturnus unicolor	30	13,64
	129	

carril marqués mayo 2011	número	densidad
Alectoris rufa	2	1
Bubulcus ibis	4	2
Calandrella cinerea	20	10
Carduelis carduelis	8	4
Cisticola juncidis	1	0,5
Coturnix coturnix	1	0,5
Elanus caeruleus	1	0,5
Emberiza calandra	27	13,5
Falco tinnunculus	2	1
Galerida cristata	11	5,5
Hieraaetus pennatus	1	0,5
Melanocorypha calandra	19	9,5
Motacilla flava	5	2,5
Serinus serinus	2	1
Streptopelia turtur	1	0,5
Upupa epops	3	1,5
	108	54

circulo junio 2011	número	ind/km
Calandrella brachydactyla	2	1,18
Cisticola juncidis	1	0,59
Emberiza calandra	1	0,59
Falco tinnunculus	1	0,59
Galerida cristata	5	2,94
Onenathe hispanica	2	1,18
Passer domesticus	10	5,88
Sturnus unicolor	2	1,18
Sylvia conspicillata	3	1,76
	27	15,88

N circulo junio 2011	número	ind/km
Burrhinus oedicnemus	4	1,82
Buteo buteo	2	0,91
Calandrella brachydactyla	113	51,36
Corvus corax	3	1,36
Coturnix coturnix	2	0,91
Galerida cristata	17	7,73
Gareola pratincola	2	0,91
Melanocorypha calandra	61	27,73
Motacilla flava	6	2,73
Passer hispaniolensis	14	6,36
Vanellus vanellus	3	1,36
	227	103,18

carril marqués junio 2011	número	ind/km
Sylvia melanocephala	1	0,50
Alectoris rufa	3	1,50
Bubulcus ibis	1	0,50
Calandrella brachydactyla	23	11,50
Carduelis cannabina	14	7,00
Carduelis carduelis	4	2,00
Carduelis carduelis	2	1,00
Carduelis chloris	7	3,50
Coturnix coturnix	1	0,50
Elanus caeruleus	2	1,00
Falco tinnunculus	1	0,50
Galerida cristata	17	8,50
Himantopus himantopus	1	0,50
Melanocorypha calandra	3	1,50
Passer hispaniolensis	41	20,50
Streptopelia turtur	3	1,50
Upupa epops	1	0,50
	125	62,50

circulo julio 2011	número	ind/km
Alectoris rufa	1	0,59
Circus pygargus	1	0,59
Cisticola juncidis	2	1,18
Emberiza calandra	2	1,18
Falco tinnunculus	1	0,59
Galerida cristata	3	1,76
Lanius senator	2	1,18
	12	7,06

n circulo julio 2011	número	ind/km
Calandrella brachydactyla	3	1,36
Falco tinnunculus	1	0,45
Galerida cristata	12	5,45
	16	7,27

carril marqués julio 2011	número	ind/km
Bubulcus ibis	4	2,00
Calandrella brachydactyla	39	19,50
Carduelis carduelis	6	3,00
Elanus caeruleus	2	1,00
Emberiza calandra	6	3,00
Galerida cristata	24	12,00
Melanocorypha calandra	6	3,00
Milvus migrans	2	1,00
Petronia petronia	1	0,50
	90	45

ANEXO. RESULTADOS DE LOS CENSOS DE AVES EN LA MONCLOVA, DURANTE LA ÉPOCA DE REPRODUCCIÓN DE 2011

círculo marzo 2011	número	ind/km
Alectoris rufa	6	3,53
Burrhinus oedicnemus	1	0,59
Calandrella bhachydactyla	15	8,82
Emberiza calandra	7	4,12
Galerida cristata	6	3,53
Lanius senator	2	1,18
Passer montanus	80	47,06
Sturnus unicolor	5	2,94
Sylvia conspicillata	2	1,18
	124	72,94

N círculo marzo 2011	número	ind/km
Anthus pratensis	4	1,82
Calandrella bhachydactyla	12	5,45
Cisticola juncidis	12	5,45
Coturnix coturnix	2	0,91
Emberiza calandra	29	13,18
galerida cristata	4	1,82
Melanocorypha calandra	46	20,91
Motacilla flava	10	4,55
	119	54,09

carril marqués marzo 2011	contactos	ind/km
Acanthis cannabina	6	3
Alectoris rufa	1	0,5
Anas platyrrhinchos	2	1
Anthus pratensis	5	2,5
Ardea cinerea	2	1
Bubulcus ibis	6	3
Buteo buteo	1	0,5
Calandrella brachydactyla	6	3
Carduelis carduelis	2	1
Carduelis chloris	4	2
Cisticola juncidis	2	1
Columba palumbus	1	0,5
Corvus corax	1	0,5
Coturnix coturnix	6	3
Emberiza calandra	14	7
Falco tinnunculus	1	0,5
Galerida cristata	22	11
Lanius senator	1	0,5
Melanocorypha calandra	35	17,5
Parus major	1	0,5
Passer montanus	14	7
Picus viridis	2	1
Serinus serinus	7	3,5
Sylvia atricapilla	8	4
Sylvia melanocephala	1	0,5
Upupa epops	1	0,5
	152	76

BEFORE THE ENERGY RESOURCES CONSERVATION AND DEVELOPMENT COMMISSION OF THE STATE OF CALIFORNIA
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APPLICATION FOR CERTIFICATION FOR THE RIO MESA SOLAR ELECTRIC GENERATING FACILITY

DOCKET NO. 11-AFC-04
PROOF OF SERVICE
(Revised 10/16/12)

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DECLARATION OF SERVICE

I, Todd Stewart, declare that on November 1, 2012, I served and filed a copy of the attached document ____, dated _____, 2012. This document is accompanied by the most recent Proof of Service list, located on the web page for this project at: http://www.energy.ca.gov/sitingcases/riomesa/index.html.

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OR, if filing a Petition for Reconsideration of Decision or Order pursuant to Title 20, § 1720:

____ Served by delivering on this date one electronic copy by e-mail, and an original paper copy to the Chief Counsel at the following address, either personally, or for mailing with the U.S. Postal Service with first class postage thereon fully prepaid:

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I declare under penalty of perjury under the laws of the State of California that the foregoing is true and correct, that I am employed in the county where this mailing occurred, and that I am over the age of 18 years and not a party to the proceeding.

*indicates change