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Burrowing bird's decline driven by EIA over-use

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ABSTRACT

Modifications to ecosystems often lead to externalities that can be assigned an economic value and traded in ecosystem service markets. One such value may include the provisioning of nest sites for organisms that would otherwise be ousted from the surrounding cultural landscape, such as the sand martin (*Riparia riparia*), small passerine utilizing river bank rippings when available. The studied sand martin population was initially characterized as relying heavily on human activities for habitat, as extensive river regulation caused the relocation of 97% of Czech sand martins to man-made habitats, most commonly sandpits and gravel-sandpits. The socioeconomic changes and strict implementation of the EIA law had further detrimental effects on this species, which already adjusted to the human-dominated landscape, ousting it for a second time from its key nesting habitats, causing closure 86% of sandpits with only occasional quarrying and closure of 47% of those with regular small-scale regular quarrying. Meanwhile, large-scale quarries remained nearly unaffected. Conversion of any actively quarried site to that with vertical slopes present, but with quarrying absent, led to the progressive disappearance of sand martin colonies in 73% of sandpits with ceased occasional quarrying and in 87% of sandpits with ceased regular small-scale quarrying. The sharp decrease in the number of nest-sites of a bird protected by law is a gloomy result of the hypertrophied business regulation (EIA is estimated to cost € 970 million annually in the E.U. alone) aimed, paradoxically, to support the environment.

Introduction

The economic value of ecosystem services and the ability to create ecosystem service markets have gained increased attention as the landscape becomes increasingly human-dominated. Demand in ecosystem service markets should be driven by regulations that require those seeking permits to mitigate or provide offsets for their environmental impacts (Palmer, 2009), typically by Environmental Impact Assessment (EIA) and/or Strategic Environmental Assessment (SEA). However, without direct evidence for the biological and physiochemical processes that lead to the production of ecosystem services (Erskine et al., 2012), there is no way to know whether such regulations are actually leading to the delivery of services expected.

Mineral aggregates (i.e., sand, gravel and crushed rock used in construction and road building) are among the most important mining products globally and compose the largest branch of mining by production volume. The production of aggregates reached 9.8 t per capita in the United States (year 2005) and 7.1 t per capita in the European Union (year 2006). The production of aggregates is directly dependent on the course of the GDP growth cycle (Menegaki and Kaliampakos, 2010). Throughout the industrialized world, environmental regulations lead to the relocation of aggregates quarries to remote localities far from consumers. Regionally, environmental and other concerns can prevent the opening of aggregates quarries, as has happened, for example, in New Jersey (Jaeger, 2006). The transportation costs in regions with strong environmental regulations multiply and may reach values several times higher than the market value of the mineral aggregates at the quarry-gate (Jaeger, 2006).

Despite the costs of quarrying relocation are estimated to be 20 times higher than the average commercial value of high-value farmland (Erskine et al., 2012). Furthermore, applied environmental regulations may severely affect organisms that have already adjusted to human-dominated landscape. Such organisms include sand martins (*Riparia riparia*, bank swallow), small passerines which utilize river bank rippings when available. Sand martins are tightly bound to resource patches narrowly defined by soil penetrability, clay content, low incidence of parasites, and sufficient amount of aerial prey. Regular water erosion of river banks or quarrying in the sandpits is needed to retain the optimal packing density of the surface of nest sites, and to retain them in a vertical shape. When the quarrying is ceased, the sandpit slopes either collapse or are subject to formation of hardened surface crust; only rarely they remain suitable for sand martin nesting for more than a few years (Heneberg, 2012). Throughout the industrialized world, river regulations have severely depleted the nesting opportunities for these birds. This report will focus

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predominantly on data obtained in the Czech Republic (Central Europe), where the sand martin population is nearly completely reliant on man-made habitats. River bank rippings serve as nest sites for only 3% of the country's total nesting population (Heneberg, 2007), as the population has shifted primarily to aggregates quarries. The implementation of improperly designed regulations has recently led to the closure of small-scale quarrying businesses serving the local needs of the nearby villages. The costs of the newly implemented regulation are considered to be marginal for large or intermediate scale operations (Foo, 2010), but they exceed the annual income generated by the small-scale aggregates quarries. Although the regulations were aimed at supporting ecosystem services, this report provides evidence of regulation's detrimental effects on the nesting of the burrowing bird protected by law.

Utilizing long-term data obtained in sandpits and gravel-sandpits (hereinafter referred as sandpits) in the Czech Republic, we focus here on the impact of socioeconomic changes and EIA process implementation. These socioeconomic policies led to a shift in quarrying strategies, severely affecting the nearly completely human-dependent population of sand martins.

Material and methods

The data utilized in this report were obtained by direct monitoring of the sandpits known to exist throughout the studied period (1992–2012) in the Czech Republic at a latitude of 48°39′N–50°59′N and a longitude of 12°19′E–18°29′E. The sand martin counts were determined as described (Heneberg, 2007). For the purpose of this report, data from the years 1992, 2003, 2006 and 2012 were utilized. If the respective nest site was not checked in a given year, the counts obtained in the preceding or in the following year were utilized. If these data were also unavailable, the respective nest site was not included in the final count. The number of burrows in occupied colonies was included in the analyses, but the burrows in completely abandoned colonies (although still with burrows) were not included. The colonies analyzed in this report were expected to represent ~90% of all existing colonies in sandpits throughout the Czech Republic (Heneberg, 2007).

The data on the quarrying intensity were obtained chiefly by direct observation at the time of the control of each respective sandpit. The data were also supplemented and verified by comparisons with aerial photographs for each respective sandpit, which were available at www.mapy.cz (cited as 21 November 2012). The aerial photographs were available for the following three time periods: 2012, 2006 and 2003 (±1 year). Seven categories of quarrying intensity were recognized. The "vertical slopes absent" category included any sandpits where quarrying activities were recorded, but did not lead to the formation of vertical slopes (using, e.g., dredging) or where the quarrying was not performed in a given year at all. The "vertical slopes present but quarrying absent" category included any slopes that were not quarried at least since the end of the preceding calendar year. The "occasional quarrying" category included any sandpits where the quarrying was performed less than once a day. The "small-scale regular quarrying – excavators only" category included sandpits that were quarried on a daily basis but only with basic equipment, such as one or a few excavators; aggregate sorters, and where any other more advanced mechanization was absent. The "large-scale quarrying – aggregate sorters present" category included the sandpits that were intensively quarried and were typically operated by some of the large international or national aggregates suppliers. All these sites were equipped with at least one aggregates sorter and frequently with other advanced mechanization. The "sand martin post-quarrying management" category included sites where the quarrying was terminated recently or in the past, and where there were attempts to maintain the sand martin population by directed management efforts. The seventh category, "ban of quarrying due to the sand martin presence," included sandpits in which governmental authorities banned quarrying due to the presence of a sand martin colony.

We also quantified the predictive value of quarrying changes on sand martin presence at a given site in a future. For this purpose, we utilized both the immediate and delayed sand martin response. "Immediate response" indicated the sand martin mean colony size and occupancy rate linked to the quarrying activity in the same year. "Delayed response" indicated the sand martin mean colony size and occupancy rate linked to the quarrying activity in the preceding years. To calculate the delayed response, we utilized the quarrying data from years 1992, 2003 or 2006, and linked them to the sand martin occupancy rate in 2003, 2006 and 2012, respectively. We than sorted the data according to both the quarrying activity in the preceding years (termed "initial quarrying activity") and the quarrying activity in the year when each respective sand martin colony size and occupancy rate were determined (termed "new quarrying activity"). Mean sand martin colony size and occupancy rates were compared between the above groups to identify the ability of changes in quarrying rates to serve as a prognostic marker indicating the indicating the possible decrease and further disappearance of each respective sand martin colony.

Results

Substantial changes in quarrying strategies were recorded over the last two decades (Table 1). The switch from a centralized to a free-market economy was itself sufficient to prevent quarrying in 63% of the sandpits that were quarried only occasionally and in 35% of those with regular small-scale quarrying; it did not affect the number of large-scale quarries (only 9% of them were closed, which most likely corresponds to the completed excavation of

Table 1
Changes in quarrying strategies reflecting the socioeconomic changes in the Czech Republic and their association with sand martin occupancy. The changes in quarrying strategies occurring between 1992 and 2003 reflect the gradual switch from a centralized to a free-market economy. The changes occurring between 2003 and 2006 reflect the law, implemented due to entry into the E.U., which required an EIA assessment for any proposals for new quarries, for their modifications, or prolongation of the expiring permits regardless of the deposit size or quarry output. The ratio of sites occupied by sand martins is indicated.

Year: Sandpit type:	1992 Occupancy rate [%] (Occupied sandpits / Total sandpits monitored)	2003	2006	2012
Total	73 (266/344)	56 (194/345)	49 (168/346)	41 (142/343)
Vertical slopes absent	0 (0/62)	0 (0/107)	0 (0/122)	0 (0/137)
Vertical slopes present, but quarrying absent	64 (7/11)	53 (26/49)	47 (24/51)	28 (12/43)
Occasional quarrying	94 (118/126)	86 (48/56)	68 (17/25)	70 (16/23)
Small-scale regular quarrying – excavators only	96 (55/57)	85 (28/33)	74 (20/27)	71 (12/17)
Large-scale quarrying – aggregate sorters present	92 (86/93)	88 (89/101)	85 (93/109)	81 (86/106)
Sand martin post-quarrying management	N/D (0/0)	100 (3/3)	93 (13/14)	73 (16/22)
Ban of quarrying due to the sand martin presence	N/D (0/0)	N/D (0/0)	N/D (1/1)	N/D (0/1)