# Romanos, Greece: Fifteen-year Data Indicate an Increase of Nests and a Site-specific Differentiation of Incubation Durations

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Greece hosts the largest number of loggerhead nests in the Mediterranean (Casale et al. 2018). Major nesting beaches are known in Zakynthos, Kyparissia Bay, Lakonikos Bay, Rethymno, Chania, and Messaras Bay on Crete (Casale et al. 2018). However, beaches with lower nesting effort may add up to a considerable number of nests. One such area is Romanos beach and a series of nearby smaller beaches, hereafter "southern beaches", extending southwards until the Gialova lagoon in southwestern Peloponnese (Fig. 1). These beaches are included in the NATURA 2000 site "Pylos Lagoon (Divari) and Sfaktiria Island, Agios Dimitrios" (Special Area of Conservation - SAC with code GR2550004) as a single Nature Protection Zone with the aim of conserving, among others, the nesting habitat of sea turtles. ARCHELON surveyed Romanos beach in the years 1989 and 1998-2000 for an initial assessment of the nesting effort (see Margaritoulis et al. 2003) but the study did not continue due to logistical difficulties. In 2009, systematic surveys were re-instigated in Romanos and in 2011 the program encompassed the southern beaches. Nesting data for Romanos for the period 2009-2018 has been reported in Teneketzis & Margaritoulis (2019). Here, we present the results of the work in both Romanos and southern beaches for the period 2011-2025.

The main nesting beach is Romanos (2.7 km long) and the smaller successive southern beaches from north to south are Mytikas-Glyfadaki-Petrohori, hereafter called Glyfadaki (976 m), Agios Nikolaos (137 m), Almyrolakka (148 m), and Voidokilia (736 m) (Fig. 1). The entire area features moderate development, with one large hotel behind the southern part of Romanos beach. Dunes and coastal vegetation, in rather good condition, back a large part of the beaches.

Fieldwork consisted of regularly surveying the beaches to record turtle tracks and locate and protect the nests. All identified nests are protected either *in situ* (by flat metal grids anchored with bamboo stakes, against predation) or through relocation to safer parts of the beach (to avoid inundation by the sea). Relocated nests are also protected with metal grids. Protection of nests is necessary because of the high rate of egg predation by mammals (mainly jackals and foxes but also stray dogs). In the period 2018-2025, all nests were monitored until hatching, and the incubation duration (i.e., from the date of egg-laying until the date of first hatch) of the undisturbed-by-predation nests was recorded. Nests were excavated after a few days of the last hatchling emergence and contents sorted and counted as hatched eggs (from the broken eggshells in the nest), unhatched eggs (including pipped hatchlings, dead or alive) and hatchlings (dead or alive) within the nest.

We examined separately the reproductive data of Romanos beach and of all southern beaches combined. All reproductive parameters are given as a mean with standard deviation and range. Trends of annual nest numbers were checked for significance with the Mann-Kendal trend test. The significance of the difference in incubation duration mean values, between Romanos and southern beaches, was checked with the Welsh's t-test.

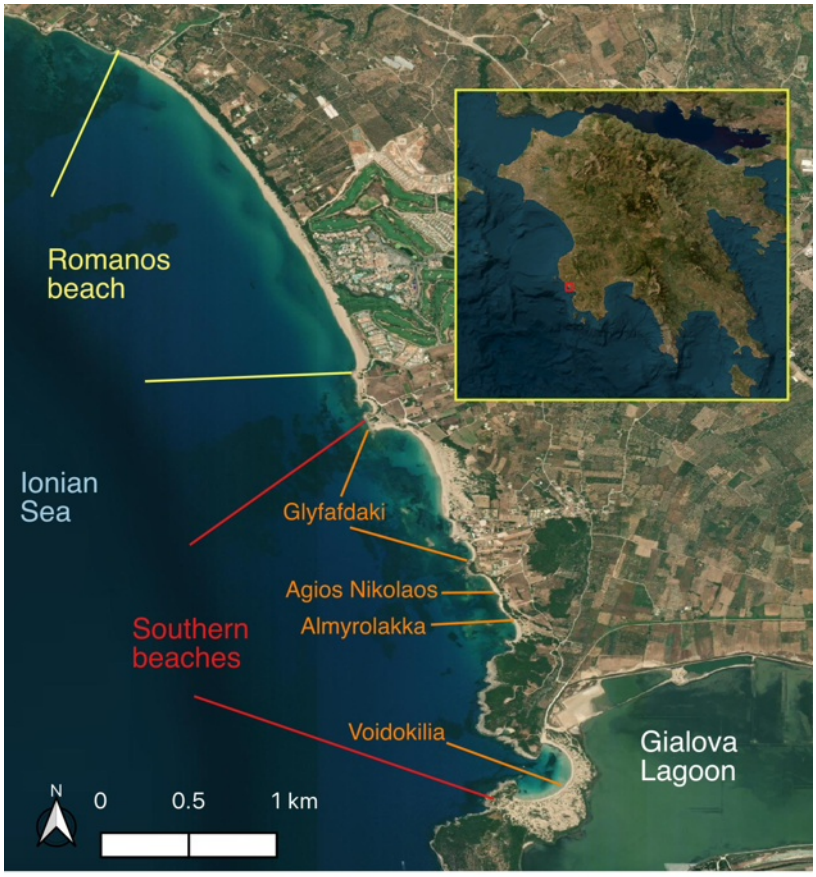


**Figure 1**. Romanos beach and the four smaller "southern beaches" that are monitored. All beaches are included in the NATURA 2000 network of protected areas.

**Table 1.** Main reproductive parameters in Romanos and southern beaches during the 8-year period 2018-2025, when full monitoring was implemented.

| Reproductive parameter | Romanos | Southern beaches |
|---|---|---|
| Clutch Size ±SD (n) | 97.8 ±24.5 (345) | 96.9 ±23.3 (163) |
| Clutch Size - range | 30-165 | 32-148 |
| Hatchling Emergence Success (n) | 70.9% (345) | 69.1% (163) |

In the 15-year period 2011-2025, we recorded 986 nests in the entire area (annual mean = 65.7 nests; range = 8-129 nests; mean density = 14 nests/km), of which 573 nests (58.1%) were laid in Romanos (nesting density = 14.1 nests/km) and 413 nests (41.9%) in the southern beaches (nest density = 13.8 nests/km). In the southern beaches, the great majority of nests were laid in Glyfadaki (310 nests, 75.1% of total nests in the southern beaches). Both sub-areas (Romanos and southern beaches) showed a significantly increasing trend (Mann-Kendall trend test; $p < 0.001$) in the annual number of nests over the years (Fig. 2).

Despite protection measures, 66 nests (11.5%) were predated in Romanos and 101 nests (24.5%) in the southern beaches. In total, 167 nests were predated (16.9% of the total). Main predators were usually red foxes (*Vulpes vulpes*) and stray dogs. Since 2023, golden jackals (*Canis aureus*) appeared first to predate nests in

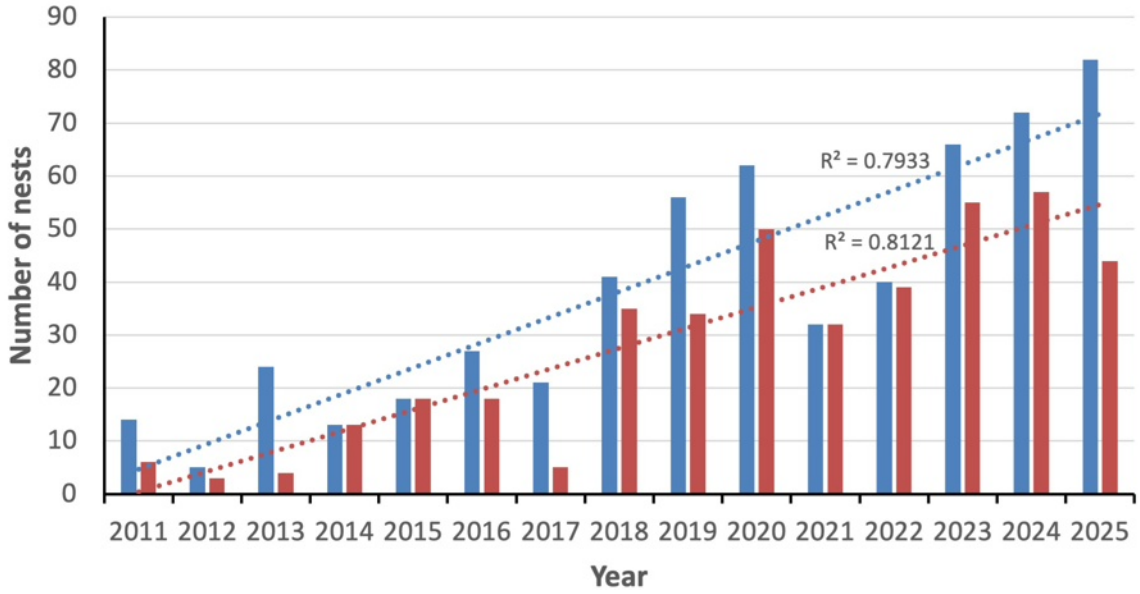


**Figure 2**. Annual number of nests in Romanos beach (blue) and in southern beaches (red) with the associated trend lines.

the area, especially in the southern beaches. Jackals proved more vigorous predators than foxes; in the period 2023-2025, from the 156 nests laid in the southern beaches, 84 (53.8%) were predated solely by jackals.

The mean clutch size and mean hatchling emergence success were similar in both sub-areas (Table 1), with the values of these metrics being 97.5 eggs and 70.3% for the entire area. Nevertheless, the mean annual incubation duration differed significantly (Welsh's t-test: t = -14.82; df = 248.8; $p$ <0.0001) between the beach of Romanos (52.2 ±4.6 days, range 44-71 d, n = 351) and the southern beaches (59.4 ±5.1 days, range 48-78 d, n = 148).

According to criteria set by Casale et al. (2018), the entire area is classified as a nesting area of "moderate-dense" nesting (i.e., 20-99 nests/year and ≥6.5 nests/km). The recorded significant upward trend in the annual number of nests follows similar trends in nearby nesting areas, like Koroni (Margaritoulis et al. 2023) and Kyparissia Bay (Margaritoulis et al. 2025). Positive trends worldwide are attributed to climate change (Laloë et al. 2014) and to long-term conservation measures (Mazaris et al. 2017). Increase of incubation temperatures (due to global warming) increase the proportion of female hatchlings and thereby increase of nests (Laloë et al. 2014). Long-term increasing nesting trends resulted in the down listing of the IUCN's Red List status of Mediterranean loggerheads to the Least Concern category (Casale 2015). However, it is widely recognized that the Least Concern status of loggerhead turtles depends on the continuation of conservation measures (Casale 2015; Casale et al. 2018).

The relatively high predation rate in the present study (16.9%), although lower than the predation rate recorded in the nearby nesting area of Koroni (23.2%; Margaritoulis et al. 2023), is attributed to the frequent predation events during the night of egg-laying, before the nest could be protected. The higher predation rate in the southern beaches, in relation to Romanos beach, was caused by the frequent occurrence of golden jackals, due to the proximity of their habitat at Gialova lagoon. The jackals often made predation attempts during the egg-laying night and they were able to penetrate protective grids more easily than foxes.

The higher incubation durations in the southern beaches, reflecting lower nest temperatures and thereby likely produce a larger proportion of male hatchlings, which

may counteract the predicted female skewed sex ratios of Romanos beach. Indeed, the mean annual incubation duration in Romanos (52.2 days) is below the pivotal incubation duration of 56.6 days, assessed for loggerheads in Greece (Mrosovsky et al. 2002). Significant differences in nest temperatures have also been noted within other nesting areas. For instance, in Zakynthos although female hatchlings represent the majority, some beaches (i.e., Marathonissi and East Laganas) produce a substantial proportion of male hatchlings (Zbinden et al. 2007; Katselidis et al. 2012). We plan to elucidate further the incubation temperature difference, between Romanos and "southern beaches", by deploying temperature loggers along both areas.

Finally, Romanos and the "southern beaches", located between the major nesting areas of Kyparissia Bay and Lakonikos Bay, may play the role of a "stepping-stone" facilitating genetic homogeneity of the loggerhead sea turtle population (Carreras et al. 2007). Thus, preservation of these beaches could be vital in maintaining population structure.

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