

Review of the occurrences of monk seals *Monachus monachus* (Hermann, 1779) on the East coast of the Adriatic Sea (Croatia and Montenegro) between 1800 and 1980

(Mammalia, Carnivora, Phocidae)

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The Mediterranean monk seal, *Monachus monachus* (Hermann, 1779) is one of the most threatened mammals in the world. Once it was widespread around the Mediterranean and the Black Sea; however, throughout the years, it became rare. There is not a previous review on the species distribution on the Croatian shores. Here we show the data collected of the occurrences from the north-eastern Adriatic Sea from the literature and information from several public collections from the period between the 1800s and 1980. We discussed the gathered occurrences one by one, and we organised them based on different aspects, and when it is possible, we also determined the minimum number of observed individuals. The locations of the observations were mapped and based on the fragmented information available, the data on maritime traffic, the number of overnight stays of tourists and fisheries statistics were presented, which could contribute to the decline of the Adriatic population of the species.

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Introduction

The Mediterranean monk seal (MMS, *Monachus monachus*, Hermann 1779) is one of the rarest marine mammals listed as endangered in the red list of the International Union for Conservation of Nature (IUCN 2022). Nowadays the species distribution is mainly concentrated along the Peninsula of Cabo Blanco and Madeira archipelago in the Atlantic and along the coast of Greece and Turkey in the Mediterranean (Karamanlidis et al. 2016, Kurt & Gücü 2021).

Once the MMS was considered common in the Adriatic Sea, an individual captured near Osor, in the southern part of the island of Cres served as the species' holotype for the first time (Hermann 1779). The number of this species later significantly decreased in the region, and it was assumed that by the middle of the 20th century, there were no more reproducing populations in the Adriatic Sea (Kryštufek 1991, Antica 1999, Gomerčić et al. 2011).

In this work, the authors analysed these processes, organised the occurrences with exact known locations and described sea traffic, the number of overnight stays of tourists and fisheries statistics from this period. To give a detailed overview of the MMS in the Adriatic region, data were collected and processed from the literature, including Hungarian sources, which have never been published in international journals.

Materials and methods

A total of 20 public collections were contacted to gather data on MMSs recovered from the East coast of the Adriatic Sea between Trieste and the Bay of Kotor. Furthermore, data were collected and analysed from the hunting and zoological literature from the beginning of the 1800s. Similarly to the methodology of another publication (Tóth et al. 2009) of ours the following journals and issues were surveyed for articles reporting on

the MMS: Acta Theriologica (1955, 1958–1973, 1975–1989, 1992–2006), Carl Hagenbecks Illustrierte Tier- und Menschenwelt (1927–1928), Carpații (1937, 1943), Das Tier und Wir (1931–1940), Erdélyi Nimród (1999–2007), Hornbill (1980–2006), Jagd und Wild (1908–1910, 1912), Kárpáti Vadász (1928–1934), Képes Vadászújság (1879 1880), Lutreola (1993), Lynx (1962–1977, 1979, 1982, 1984, 1987–1989, 1992), Magyar Vadász (1948–1968), Magyar Vadászújság (1929–1937, 1941), Mammal Review (1970–1988), Mammalia (1948–1951, 1953, 1959–2005), Nimród (1914–1918, 1920–1924, 1926–1944, 1946–1948, 1969–2006), Nimrod (Slovakian hunting journal) (1927–1931), Säugetierkundliche Mitteilungen (1954–1974, 1977–1983, 1986, 1992–1999), Székelyföldi Nimród (1998–1999), Vadász Lap (1880–1883, 1885–1920), Vadászújság (1929–1930), Vadvilág Válogatás (1993), Vertebrata Hungarica (1959–1976, 1978–1982, 1984), Waidmanns Heil (1884–1911, 1924–1931), Zeitschrift für Säugetierkunde – Mammalian Biology (1926–1942, 1952–1962, 1965–1966, 1968–2006).

The information collected was evaluated one by one according to whether it was a killed, captured or observed animal. Kills were categorised into further categories, depending on whether the specimens were placed in museums (Museum), used as food (Consumption), or there was no data about their fate (Unknown). In the case of captures, also three categories were set up: died in captivity (Death), released animals (Release), and no further information was available (Unknown). The dead animals (Death) category was broken down into two more categories, according to whether the carcasses were placed in a public collection (Museum) or their fate was unknown (Unknown); see Table 2 for an overview of the categories. For observation, two categories were used: known observer and anonymous observer. People not mentioned by name were considered known observers if it was known that they were soldiers, sailors, fishermen, and lighthouse guards.

After each case was presented, the number of animals killed, captured or observed were given; if only indirect references were available, a minimum number of individuals was used (minimum number of individuals=MNI). When no exact number was available, the MNI was established based on the expressions used in the source: two individuals were used in case the text said “rare visitor”, “not very common”, “some”, or “more”. Three individuals were used when the text mentioned “family”, “regularly observed”, or “not uncommon”. Four individuals were used when the text contained “frequent”, “often”, or “most individuals”. Six individuals were used when the text said “one to two every year”. The MNI was also presented by a twenty-year-old breakdown, showing the kills, captures and observations separately. Because some reports had inaccurate dates, the dates were listed under the principles stated in Table 1.

Table 1. Categorisation of inaccurate dates of observations in the original publications into time intervals used in this manuscript.

Date of observation – original text	Date used
Around 1900	Between 1900–1919
Before 1924	Between 1920–1939
1947 or before and the 1950–60s	Between 1940–1959

The collected data was organised into the following periods; 1800–1849, 1850–1899, 1900–1929, 1930–1959, 1960–969 and between 1970 and 1980. The reason for using periods with different lengths was that in more recent times, more data were available. The data was also mapped with QGIS Geographic Information System software (QGIS version 3.22.7; QGIS Development Team 2022). Three categories were distinguished on the maps: captured seals were marked with a black star, killed seals were marked with a black cross and observed individuals were marked with a black triangle. There may be minor differences in the location of the points on the map in cases when there were more data on the exact location, which had to be marked. Observations without precise locations were left out of the maps. When presenting the observations, coordinates of the exact sites were given. In cases when the locations were not precise, the coordinates of significant locations close to the observation site were given. Until 1920 we used the original names of the locations and also gave the currently used names in brackets.

In those descriptions where animal dimensions were given in older units, we converted them to SI units and stated them in parentheses.

In addition, we also presented statistics on vessel traffic, fishing data, and tourist nights. Since this work was often based on data older than 200 years, some statistics were incomplete or fragmented; however, they were also presented in figures and tables.

Results

The following 20 institutes were requested to provide data regarding the MMSs:

- The University of Florence – Natural History Museum, Florence, Italy
- Museo Civico di Zoologia, Roma, Italy
- Museo Civico di Storia Naturale di Trieste, Trieste, Italy
- Museo di Storia Naturale dell'Università di Pisa, Pisa, Italy
- Museum Gherdëina, Ortisei, Italy
- Sistema Museale d'Ateneo – Università degli studi di Pavia, Pavia, Italy

- Museo Regionale di Scienze Naturali, Turin, Italy
- Centro Musei delle Scienze Naturali e Fisiche, Naples, Italy
- Museo di Storia Naturale di Venezia, Venice, Italy
- Biblioteca del Museo di Storia Naturale e dell'Acquario e Civica Stazione Idrobiologica di Milano, Milan, Italy
- Museo Galileo, Istituto e Museo di Storia della Scienza Grotta, Florence, Italy
- Museo di Storia Naturale, Genova, Italy
- Museo Civico Scienze Naturali Enrico Caffi, Bergamo, Italy
- Naturhistorisches Museum, Vienna, Austria
- National Museum of Bosnia and Herzegovina, Sarajevo, Bosnia and Herzegovina
- Slovenian Museum of Natural History, Ljubljana, Slovenia
- Croatian Natural History Museum, Zagreb, Croatia
- Natural History Museum, Belgrade, Serbia
- Hungarian Natural History Museum, Budapest, Hungary

Of the institutions contacted, the Museo Galileo and the Slovenian Museum of Natural History reported that their collections do not include MMSs from the Adriatic Sea. Three museums, Museo di Storia Naturale di Venezia, Naturhistorisches Museum, Wien and National Museum of Bosnia and Herzegovina provided collectional data of their Adriatic specimens stored in their institutions. The following data were provided by these museums in the list of numbered data below:

Museo di Storia Naturale di Venezia: 6; Naturhistorisches Museum Wien: 23, 32 and 51; National Museum of Bosnia and Herzegovina: 36, 41 and 53.

Hankó (1913) and Leidenfrost (1924a) briefly mention that there is a MMS skeleton in the collection of the Hungarian National Museum; however, there is no more available information about its fate, while according to Csorba (pers. comm.), this individual was not transferred to the institution, and there is no specimen of the species in the collection up to date.

Table 2. Number of seals killed and captured between 1800 and 1980 and their further classification based on the animal's faith after death.

	Outcome	Faith of dead animal	Number of individuals
Captures	Release	-	1
	Unknown	-	14
	Death	Museum	6
	Death	Unknown	2
Kills	Death	Consumption	3
	Death	Museum	13
	Death	Unknown	22

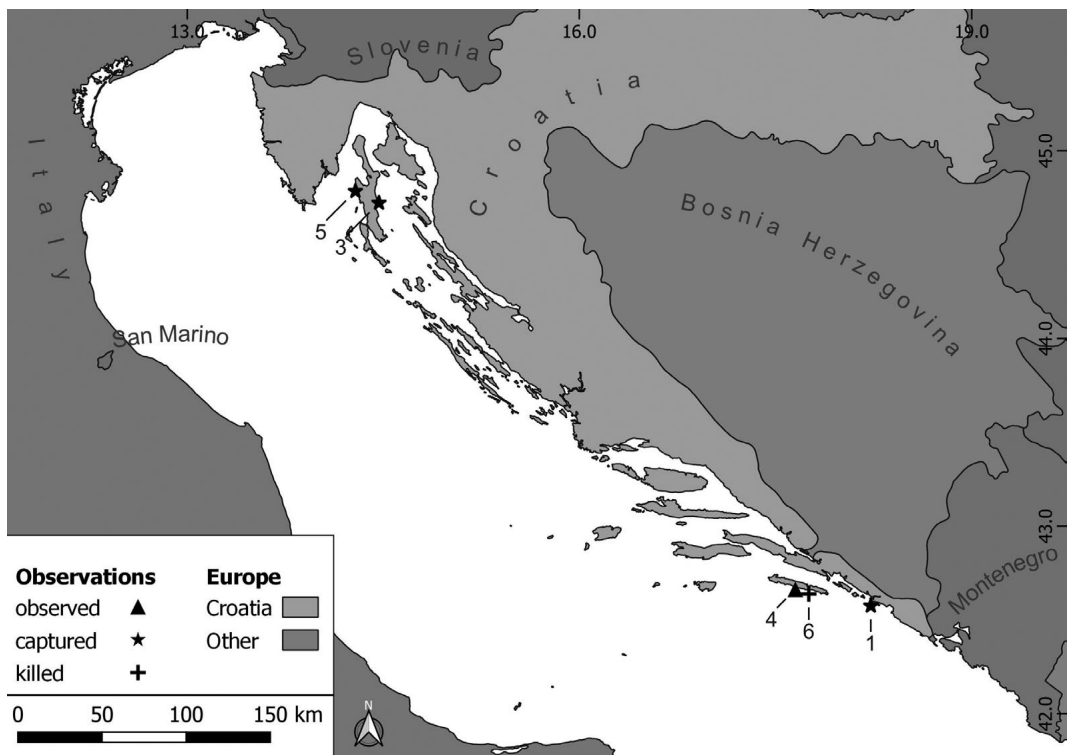


Fig. 1. Types of observations of monk seals between 1800 and 1849.

A detailed description of the observations and, when data was available, their location on the maps

Figures 1–6

1. 1809: According to the reports of Cornalia (1870), Brusina (1889), Matisz (1896), Garády (1908, 1926), Johnson (2004), Klinger & Perco (2011), and Leidenfrost (n.d.) a MMS was captured in the area around Raguza (Dubrovnik; Coordinates (subsequent abbreviated C): 42°39.4'N, 18°06.1'E), which was transported to Turin alive. The animal died there in 1810; the dermoplasty and skeleton of it were displayed in the Turin Museum. The preparations were sent to Paris in 1822 and exchanged for other preparations. The case is also mentioned by Hankó (1913). (Capture → Death → Museum Placement; MNI: 1, Fig. 1)
2. 1811: In Dalmatia, a sub-adult female MMS was caught in an unspecified location, reported by Cuvier (1813), Hamilton (1839), Brusina (1889), Matisz (1896), Garády (1908, 1926), Johnson (2004), Klinger (2010), Klinger & Perco (2011) and Leidenfrost (n.d.). According to the news, the animal was 8 feet long (about 2.2–2.4 m) and was held in captivity for about two years before it died in rather bad conditions. (Capture → Death → No data; MNI: 1)
3. 1815: Fitzinger (1860), Brusina (1889), Matisz (1896), Garády (1908, 1926), Hankó (1913), Županović (1966), Johnson (2004), Klinger (2010), Klinger & Perco (2011), and Leidenfrost (n.d.) briefly reported, that in the year of 1815 a MMS was captured around Cres (C: 44°57.6'N, 14°24.8'E) and it was shipped to Germany and displayed for money there. (Capture → No Data; MNI: 1, Fig. 1)
4. The first half of the 1820s: Partsch (1826) mentioned in his work that the MMS occasionally had appeared on the rocky shores of the island of Meleda (Mljet, C: 42°44.3'N, 17°34.5'E). Johnson (2004) and Klinger & Perco (2011) referred to this data. (Observation → Anonymous Observer; MNI: 2, Fig. 1)
5. 1830: In Cherso (Cres, C: 44°57.6'N, 14°24.8'E), fishermen captured a living seal with their net, which was 10 feet (approximately 2.8–3.0 m)

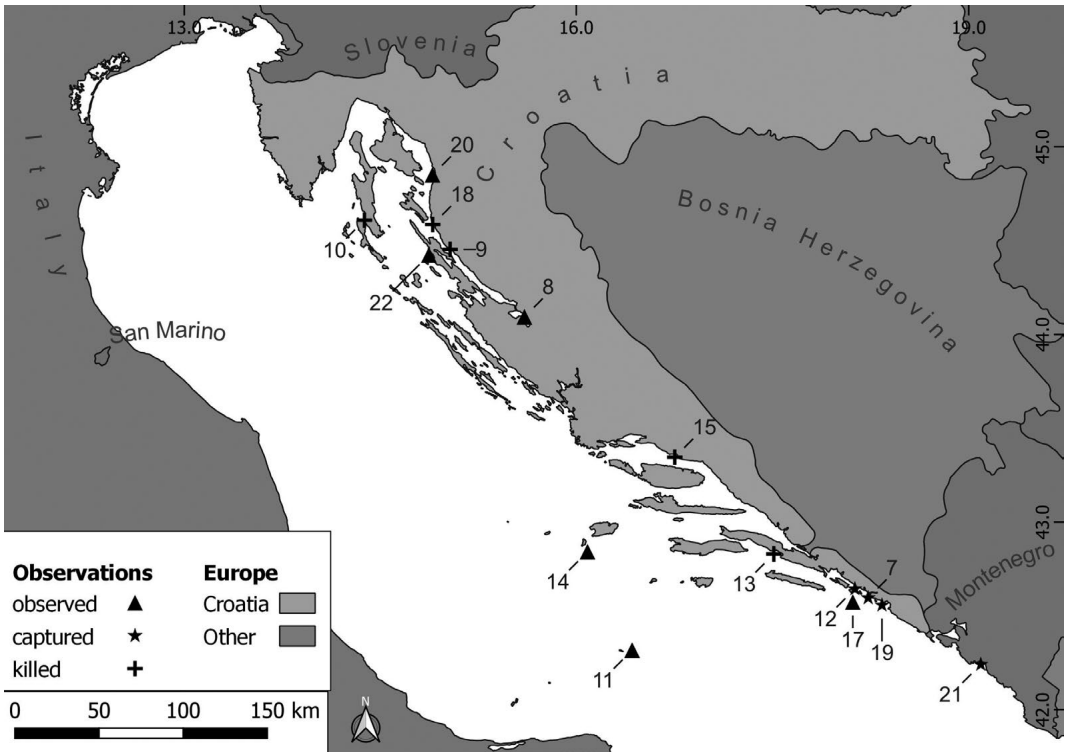


Fig. 2. Types of observations of monk seals between 1850 and 1899.

long by 5 feet (1.4–1.5 m) thick and weighed 350 pounds (about 166 kg in German pounds) in 1830 which was brought to Germany and displayed for money (Fitzinger 1860, Brusina 1889, Matisz 1896, Garády 1908, Hankó 1913, Klinger & Perco 2011, and Leidenfrost n.d). (Capture → No Data; MNI: 1, Fig. 1)

6. 1847 or earlier: According to the data of Silvia Zampieri (pers. obs.), a skull of a MMS is preserved at the Venetian Museum of Natural History from the indicated time. The animal was captured by an unknown collector from Meleda (Mljet, C: 42°44.3'N, 17°34.5' E). The data is also mentioned by Contarini (1847), Cornalia (1870), Ninni (1881) and Dal Piaz (1929). (Kill → Museum placement; MNI: 1, Fig. 1)
7. 1857 and earlier: Petter (1857) reported that in the area around Ragusa (Dubrovnik, C: 42°39.4'N, 18°06.1' E), fishermen usually caught one or two seals a year, which according to locals, caused great damage in the Ombla bay (C: 42°40.4' N, 18°06.2' E), where the animals

consumed young shoots of vines. Faber (1883), Brusina (1889), Matisz (1896), Garády (1908, 1926), Johnson (2004), Klinger (2010) and Klinger & Perco (2011) also took over the same news. (Capture → No Data; MNI: 6, Fig. 2)

8. 1857 and before: Petter (1857) stated that during storms, it was observed that seals often fled into the Velebitski kanal (Velebit channel), Karinsko bay (C: 44°08.8'N, 15°36.9' E). The same statement was also cited by Faber (1883), Matisz (1896), Hankó (1913), Garády (1926), Johnson (2004), Klinger (2010) and Klinger & Perco (2011). (Observation → Anonymous Observer; MNI: 2, Fig. 2)
9. 1864: According to Brusina (1889), in May of the indicated year, a 16-foot (about 4.4–4.9 m) long and 4.5 hundredweight seal was killed on the beach of Carlopago (Karlobag, C: 44°31.8'N, 15°04.2' E), in front of the island of Pag (C: 44°26.9' N, 15°04.4' E). The case was also mentioned by Bruno (1976). (Kill → No Data; MNI: 1, Fig. 2)

10. 1870 or earlier: Cornalia (1870) and Dal Piaz (1929) mentioned that the Trieste Museum of Natural Science had an adult specimen from Cres (C: 44°57.6'N, 14°24.8'E). It originated from the island's south side, from Osor (C: 44°41.7'N, 14°23.5'E). The data was also mentioned by Bruno (1976) and Klinger & Perco (2011). (Kill → Museum placement; MNI: 1, Fig. 2)
11. The 1870s: De Marchesetti (1876) reported that this marine mammal was frequently observed around the island of Pelagosa (Vela Palagruža, C: 42°23.6'N, 16°15.5'E). The same statement was adopted by Garády (1908, 1926), Hankó (1913), Klinger (2010) and Klinger & Perco (2011). (Observation → Anonymous Observer; MNI: 4, Fig. 2)
12. 1871: Brusina (1889), referring to the report of Kosić (pers. comm.), reported that in 1871 a seal was caught on the island of Koločep (C: 42°40.5'N, 18°00.4'E), which was subsequently displayed in Dubrovnik. Later, the animal was purchased by a certain Casagrande (pers. comm.), who showed it for money while travelling around Dalmatia. Shortly afterwards, the animal died, and the owner returned to Dubrovnik with its nearly 1.5-meter skin, and the skin was exhibited at the Dubrovnik Museum of Natural History. The case was mentioned by Matisz (1896), Johnson (2004) and Klinger & Perco (2011). In contrast with the other authors, Johnson (2004) dated the capture to 1876. (Capture → Death → Museum placement; MNI: 1, Fig. 2)
13. 1874: According to Brusina (1889), there were a 267 cm long adult seal, and a 152 cm long and a 151 cm long young female in the Trieste Natural History Museum, which were captured in Dalmatia. The data was mentioned by Klinger & Perco (2011), who stated that one specimen was collected in the spring of 1874 near Trstenik (Pelješac Peninsula, C: 42°55.0'N, 17°24.3'E). (Kill → Museum placement; MNI: 3, Fig. 2)
14. 1875 or earlier: Bruno (1976), referring to the work of Renouet (1875, as cited in Bruno, 1966), mentioned that a seal was usually seen in a ca. 150 m long sea cave on the island of Busi (Biševo, C: 42°58.5'N, 16°00.6'E), however, Bruno (1976) did not provide details of the cited work in his bibliography. (Observation → Anonymous Observer; MNI: 1, Fig. 2)
15. 1878 or 1879: Brusina (1889) reported from the work of Kosić (pers. comm.) that three seals were shot around Rat (Dugi Rat, C: 43°26.8'N, 16°37.8'E), one of which there was no information about, one was pregnant, and the size of the third animal reached two meters. The latter was prepared with negligence and exhibited at the Dubrovnik Museum of Natural History. Miličić (Kosić, pers. comm.) stated that they were most often seen around Rat and were also known by local fishermen. The case was also mentioned by Johnson (2004) and Klinger & Perco (2011). (Kill → Museum placement; MNI: 1. Capture → No data; ME: 2, Fig. 2)
16. 1878-79: Matisz (1896), Garády (1908, 1926), Hankó (1913), Bruno (1976), and Leidenfrost (n.d.) referred to an unspecified publication of Milicich (or Millicich or Miličić), according to which two large seals were shot between Trstenik (C: 44°40.1'N, 14°34.7'E) and Sipnje (Hrid Sip, C: 44°25.1'N, 14°45.2'E) in the years in question. According to Garády (1908, 1926), the site was located in Kvarnero, while Županović (1966), who also reported the incident, stated the location of the capture to the waters between the island of Šipan (C: 42°43.7'N, 17°52.7'E) and the town of Trstenik on the Pelješac Peninsula (C: 42°55.1'N, 17°24.1'E). Based on the available data, it was impossible to determine the capture's location. (Kill → No Data; MNI: 2, Fig. 2)
17. The 1880s: According to Brusina (1889), the famous hunter I. Bini shot a specimen on the waters between the island of Daksa (C: 42°40.1'N, 18°03.4'E) and Lapad Peninsula (C: 42°39.4'N, 18°04.4'E), but the animal disappeared without a trace. The case was also mentioned by Županović (1966) and Klinger & Perco (2011). (Observation → Known Observer; MNI: 1, Fig. 2)
18. 1885: On the 10th of May, fisherman Gjuretić (or Juretics or Giuretics) killed a 3.5 m long seal at the bay of Veliki Vranjāk (Vratnik or Vranjak, C: 44°40.0'N, 14°55.7'E) in the vicinity of Jablanac (Brusina 1889, Matisz 1896, Garády 1908, 1926, Hankó 1913, Županović 1966, Bruno 1976, Klinger & Perco 2011, Leidenfrost (n.d.)). According to Brusina (1889), Bruno (1976) and Leidenfrost (n.d.), this specimen was only 2.5 m long. (Kill → No Data; MNI: 1, Fig. 2)

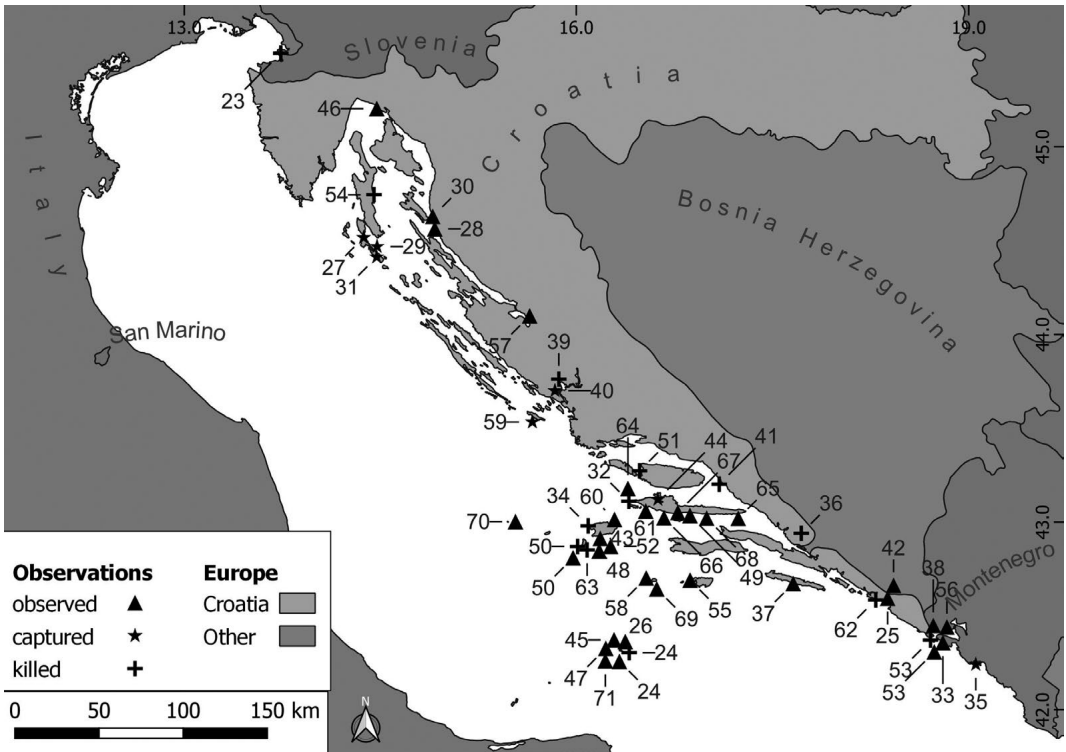


Fig. 3. Types of observations of monk seals between 1900 and 1929.

19. Before 1889: According to the report of Brusina (1889), several years before the publication of his book, the locals around Župa dubrovačka (C: 42°38.9'N, 18°05.5' E) captured a seal, but the fate of the animal is unknown. The case was also mentioned by Johnson (2004). (Capture → No Data; MNI: 1, Fig. 2)
20. 1894: According to Matisz (1896), Novák, a teacher from Zengg (Senj) and his brother saw two large seals resting on the beach near Kvarnero, San Giorgio (Sveti Juraj, C: 44°45.1'N, 14°46.0' E) in September. The animals fled into the water from the observers. The case was also mentioned by Garády (1908, 1926), Hankó (1913), Klinger & Perco (2011) and Leidenfrost (n. d.). (Observation → Known Observer; MNI: 2, Fig. 2)
21. round 1898: Anonymus (1898) reported that fishermen caught a 120 cm seal sleeping on a shore in St. Stefano (Sveti Stefan, C: 42°15.4'N, 18°53.7' E) in southern Dalmatia. This case was also mentioned by Galvagni (1902) and Kühn (1930), who know that the specimen in question was captured by Stenta (pers. comm.). Galvagni also mentioned in this work that the animal in question was kept alive for 3-4 years in the Museo di Storie Naturale of Trieste collection. After its death, the remains were placed there too. (Capture → Death → Museum Placement; MNI: 1, Fig. 2)
22. 1898: Two seals were observed on the eastern shore of Pago (Pag, C: 44°26.6'N, 15°03.6' E) by a crew member of the Croatian-Hungarian-Steamboat Company (Garády 1908, 1926, Hankó 1913, Leidenfrost n. d.). (Observation → Known Observer; MNI: 2, Fig. 2)
23. Around 1900: According to Galvagni (1902), the Vienna Museum of Natural Science received a young seal from Trieste (Trieste, C: 45°38.7'N, 13°46.5' E), but according to Hertzog (pers. comm.), this specimen was no longer found in the register of mammalian collections. (Kill → Museum placement; MNI: 1, Fig. 3)

24. The early 1900s: According to Leidenfrost (n. d., 1924a), at an unspecified date, several MMSs were observed near Pelagosa Island (Vela Palagruža, C: 42°23.6'N, 16°15.5'E) by Götzinger and Schiller (pers. comm.), and the lighthouse guard said the island's caves at that time were home to a seal family of a dozen individuals. The guard also showed a piece of leather to Schiller, which came from one of the seals killed there. (Observation → Known Observer; ME: 12. Kill → No Data; MNI: 1, Fig. 3)
25. The early 1900s: Garády (1908, 1926), referring to the observations of Roediger (pers. comm.), the harbour master of Rijeka, who could hear the seal's voice near Gravosa (Gruž, now part of Dubrovnik, C: 42°39.9'N, 18°05.5'E) every night when he was still a naval officer. (Observation → Known Observer; MNI: 2, Fig. 3)
26. 1901: At the turn of May and June of the indicated year, Galvagni (1902) and his assistant, Ginzberger (pers. comm.), on the island of Pelagosa piccola (Mala Palagruža, C: 42°23.3'N, 16°16.3'E) observed a MMS from the lighthouse pedestal. According to the author, the tower's guard, Coda (pers. comm.) informed him that the animal was constantly in the vicinity. He also mentioned that the bay where the seal was seen was known to fishermen as the "Medvjedina", the bay of the seals. (Observation → Known Observer; MNI: 1, Fig. 3)
27. 1902: According to Leidenfrost (n. d.), a flesh-coloured seal was displayed in Fiume, while Garády (1926) also mentioned that the animal had been captured on Lussin (Lošinj, C: 44°35.0'N, 14°24.0'E) and was eventually transported to Germany. (Capture → No Data; MNI: 1, Fig. 3)
28. 1903: Garády (1908, 1926) observed two specimens of the species in March, in the vicinity of Jablanac (Jablanac), not far from Bacvica Bay (Bačvica, C: 44°38.6'N, 14°56.5'E), from the steamer Klotild about 100 m away. The author estimated the larger specimen on the shore to be 3.5 m, while the other was slightly smaller. The case was also mentioned by Hankó (1913) and Leidenfrost (n. d.). (Observation → Known Observer; MNI: 2, Fig. 3)
29. 1904: According to Leidenfrost (n. d.), a flesh-coloured seal was displayed in Fiume in that year, while Garády (1926) also mentioned that the animal was captured on Lussin (Lošinj, C: 44°35.0'N, 14°24.0'E) and was eventually transported to Vienna. (Capture → No Data; MNI: 1, Fig. 3)
30. 1905: Garády (1908, 1926) heard the sound of a seal nearby one night in July with a steamer named Klotild near the island of Arbe (Rab, C: 44°45.5'N, 14°46.1'E) with its shores called Jablanacz (C: 44°42.3'N, 14°53.9'E). (Observation → Known Observer; MNI: 1, Fig. 3)
31. 1905: Garády (1908) mentioned, without specifying a site, that fishermen of Lussin grande (Veli Lošinj, C: 44°31.3'N, 14°30.1'E) had caught a seal that was displayed in Rijeka during the year. The animal eventually entered the Zagreb Museum's inventory. The case was also mentioned by Hankó (1913) and Leidenfrost (n. d.). (Capture → Death → Museum Placement; MNI: 1, Fig. 3)
32. 1905: A female specimen in the Vienna Museum of Natural History was collected near Hvar island near the Spalmatori Islands (Pakleni otoci; Sveti Klement, C: 43°09.8'N, 16°22.4'E) on the 3rd of October in 1905 (Hertzig pers. comm.). The data was also mentioned by Kühn (1930), but while this author was aware of two young specimens from the site, Reiser (1912) mentioned only one specimen in the brief description of the case. This information was also referred to by Bruno (1976). (Kill → Museum placement; MNI: 1, Fig. 3)
33. 1906: Reiser (1912) reported that he had spoken to only one trusted person (Pracher, from Sarajevo, pers. comm.) who could provide credible information on the presence of seals in the Adriatic. According to this, the said gentleman had seen seals on the coast not far from Zelenika (C: 42°26.8'N, 18°34.9'E) several times. The case was also reported by Johnson (2004). (Observation → Known Observer; MNI: 2, Fig. 3)
34. Around 1906: Galvagni (1911) reported that during his frequent visits to the island of Vis, Comisa (Komiža, C: 43°02.8'N, 16°05.5'E), he had seen several times selling seal meat on the market. Kühn (1930) and Johnson (2004) also referred to this report. (Kill → Consume; MNI: 2, Fig. 3)
35. 1906: Leidenfrost (n. d.) was informed by a captain of the monarchy that according to the report of earl Berchtold (pers. comm.), a seal pup was put ashore by the waves and was found by peasant children at Budva

- (C: 42°16.9'N, 18°49.6' E). The animal was then taken to the earl but died two days later. (Capture → Death → No Data; MNI: 1, Fig. 3)
36. 1906: According to the reports of Reiser (1912), Leidenfrost (1924a), Kühn (1930) and Johnson (2004) at the mouth of Neretva (Narenta) in the saltwater Modric lake (Jezero Modrič, C: 43°01.5' N, 17°28.9' E), around Fort Opus (Opuzen, C: 43°01.0' N, 17°33.7' E), a peasant boy shot an old female seal with a shotgun in shallow water in October. The specimen was 230 cm long and weighed 140 kg. The killed seal arrived at the National Museum of Bosnia and Herzegovina (Sarajevo) on the 29th of October, where Edmund Zelebor (pers. comm.) prepared a dermoplasty and a skeleton. According to Kotrošan (pers. comm.), the specimen was still in the museum's collection. (Kill → Museum placement; MNI: 1, Fig. 3)
 37. 1906: Klaptocz (1911) states that he heard the sound of a seal during spring at Meleda (Mljet, C: 42°44.3' N, 17°34.5' E). The case is also mentioned by Kühn (1930). (Observation → Known Observer; MNI: 1, Fig. 3)
 38. 1907: Leidenfrost (n.d.) was informed by a captain of the monarchy that a smaller group of soldiers went to a cave to hunt for white pigeons, near the Bocche di Cattaro (Boka Kotorska), near the Punta d'Arza (Rt Arza, C: 42°23.5' N, 18°34.4' E) 3–4 km to South. When the soldiers entered to an approximately 8.0 m long cavern with their boats, they startled a resting MMS. (Observation → Known Observer; MNI: 1, Fig. 3)
 39. 1907 or 1908: Garády (1908, 1926), Županović (1966), and Klinger & Perco (2011), referring to Županović (1966), and Katurić (2010, as cited in Klinger & Perco, 2011), reported that fishermen caught a female MMS which was 180 cm long and weighed 130 kg near Sebenico (Šibenik, C: 43°44.2' N, 15°53.7' E) in the Zaton village (C: 43°47.2' N, 15°49.4' E) in a tonnara, which was later consumed. The case was also mentioned by Leidenfrost (n.d., 1924a) (Kill → Consume; MNI: 1, Fig. 3)
 40. 1908: Garády (1908, 1926) reported that fishermen caught a male animal around Sebenico (C: 43°44.2' N, 15°53.7' E). It was taken to Rijeka to be sold. The captured specimen was displayed in a tent in the square in front of the fish hall. When they did not find any buyers, the animal was taken to Zagreb, but its further fate was unknown. Probably Garády (1908, 1926) made a mistake with his location; other authors mentioned Zadar instead of Zagreb (Županović 1966, Klinger & Perco 2011). According to Županović (1966), the animal was caught near the village of Zaton (C: 43°47.2' N, 15°49.4' E) and was 2.0 m long, weighed about 180 kg. The fishermen did not want to sell it to a museum but rather transferred it to Zadar, where it was displayed for money. The case was also mentioned by Leidenfrost (n.d., 1924a) and Klinger & Perco (2011). (Capture → No Data; MNI: 1, Fig. 3)
 41. 1908: According to Županović (1966) and Klinger & Perco (2011), in the autumn, a seal was killed around Makarska (C: 43°17.7' N, 17°00.8' E), which was sold to the National Museum of Bosnia and Herzegovina (Sarajevo). Kotrosan (pers. comm.) reported that the male animal was still in the museum's collection. (Kill → Museum placement; MNI: 1, Fig. 3)
 42. Around 1908: according to Garády (1908), most seals were seen in the Ombla (Rijeka) river valley (C: 42°40.4' N, 18°06.2' E). (Observation → Anonymous Observer; MNI: 4, Fig. 3)
 43. Around 1910: Anonymus (1910) mentioned that a seal was seen near Lissa (Vis, C: 43°02.7' N, 16°09.6' E). (Observation → Anonymous Observer; MNI: 1, Fig. 3)
 44. Around 1910: Herczeg (n.d.) saw a seal pup in August, caught around Cittavecchia (Stari Grad, C: 43°11.2' N, 16°35.2' E) and was displayed in Bol. The owner wanted to sell the animal for 100 HUF at first, but eventually, he would have sold it for 15 HUF, but Herczeg did not buy it. Leidenfrost (n.d.) also mentioned the case. (Capture → No Data; MNI: 1, Fig. 3)
 45. Around 1910: Koch (1914) mentioned that lighthouse personnel claimed that a couple of seals lodged themselves among the rocks around the lighthouse on the island of Pelagosa piccola (Mala Palagruža, C: 42°23.3' N, 16°16.3' E). (Observation → Known Observer; MNI: 2, Fig. 3)
 46. 1910: Anonymus (1910) reported that, according to a letter from Fiume (Rijeka), on a rock near the restaurant of the Klotild bath in Pecine (C: 45°18.8' N, 14°28.4' E) in Rijeka a pup seal was seen. (Observation → Known Observer; MNI: 1, Fig. 3)

47. 1911 or before: Ginzberger (1911) stated that he had seen a seal on the island of Pelagosa Grande (Vela Palagruža, C: 42°23.6' N, 16°15.5' E). This case was also mentioned by Kühn (1930). (Observation → Known Observer; MNI: 1, Fig. 3)
48. 1912: According to Hankó (1913), lieutenant Rodinis (pers. comm.) reported that he had seen several 2.0–3.0 m long seals in the seal cave of Busi Island (Biševo, C: 42°58.5' N, 16°00.6' E) when he had entered with his boat. (Observation → Known Observer; MNI: 2, Fig. 3)
49. 1913 or before: According to Hankó (1913), on the southern side of the island of Lesina (Hvar, C: 43°08.5' N, 16°45.5' E), unknown people saw more young MMSs in a cave. (Observation → Anonymous Observer; MNI: 2, Fig. 3)
50. 1913: Kormos (1914), Leidenfrost (1914, 1924a, 1924b, n.d.) and Garády (1926) stated that during the first Hungarian Adriatic expedition on the island of Busi (Biševo, C: 42°58.5' N, 16°00.6' E) the researchers had visited the “seal cave” of which Lieutenant Rodinis (pers. comm.) informed them, as well as members of the Austrian expedition in August. Hungarian researchers found six specimens in the cave, two of which were shot, but both animals were submerged in the water and could not be found. Hankó (1913) also reports that in addition to hunting, Lieutenant Margelik, Lieutenant Prinz, and Tivadar Kormos (pers. comm.) attended, and according to the author, there were only five seals in the cave at the designated time. (Kill → No Data; ME: 2. Observation → Known Observer; MNI: 3, Fig. 3)
51. 1914: The Natural History Museum of Vienna owns a female specimen collected on the 1st of February, 1914, on the west coast of the island of Brač between the area of Bobovisca (Bobovišće, C: 43°21.0' N, 16°27.3' E) and Milna (C: 43°19.8' N, 16°26.6' E) (Hertzig pers. comm.). The specimen was also mentioned by Kühn (1930). (Kill → Museum placement; MNI: 1, Fig. 3)
52. 1914: According to the report of Leidenfrost (1924a, 1924b, n.d.), during the second Hungarian Adriatic expedition, the participants observed two MMSs in front of the cave of Busi (Biševo, C: 42°58.5' N, 16°00.6' E), who were sunbathing on the coastal cliffs, but submerged as the ship approached. (Observation → Known Observer; MNI: 2, Fig. 3)
53. 1914: Leidenfrost (n.d.) reported that two seals had lodged themselves at the caves near the entrance of Cattaro Bay (Boka kotorska), below the cliffs of Punta d'Ostro (Rt Ostra, C: 42°23.6' N, 18°31.9' E), and a lieutenant had been hunting on them for two weeks before he could kill one. According to the author, the animal had been taken to the Sarajevo Museum, but according to Kotrošan (pers. comm.), the specimen is no longer found in the collection. (Drop → Museum Placement; ME: 1. Observation → Known Observer; MNI: 1, Fig. 3)
54. 1914: Klinger & Perco (2011), citing data from Bressi (pers. comm.), reported that a seal had been killed in Kvarnero. The photograph of the animal was published from the island of Cres (C: 44°57.6' N, 14°24.8' E). (Kill → No Data; MNI: 1, Fig. 3)
55. 1914: Županović (1966) briefly mentioned that an individual had been observed near Sveti Rafael (C: 42°45.6' N, 16°49.1' E) near the island of Lastovo. (Observation → Known Observer; MNI: 1, Fig. 3)
56. Between 1914–1918: Leidenfrost (n.d.) referring to an article of Captain's Corps, Poeckh (pers. comm.) published in an unnamed Viennese newspaper in 1935, announced that one night he had observed a MMS from his torpedo boat near the Bay of Cattaro (Boka kotorska, C: 42°28.5' N, 18°44.8' E). (Observation → Known Observer; MNI: 1, Fig. 3)
57. 1916: According to Garády (1926) and Leidenfrost (n.d.), Peterdy (pers. comm.), head of the St. Stephen Adriatic steamboat, had seen a few seals bathing on the beach at the Zermanja estuary (Zrmanja, C: 44°12.6' N, 15°35.4' E) several times in the indicated year. (Observation → Known Observer; MNI: 2, Fig. 3)
58. Before 1924: Leidenfrost (1924a) reported that according to the lighthouse guard, there had still been MMSs on the island of Cazza (Sušac, C: 42°46.0' N, 16°30.8' E). (Observation → Known Observer; MNI: 2, Fig. 3)
59. 1926: According to Županović (1966), Bruno (1976) and Klinger & Perco (2011), a juvenile 1 m long individual weighing 30 kg was caught on the island of Žirje (C: 43°39.0' N, 15°39.7' E). (Capture → No Data; MNI: 1, Fig. 3)
60. 1927: Kühn (1930) reported that on the 7th of November, he had seen a MMS off the north coast of Vis Island (C: 43°02.7' N, 16°09.6' E) west of the lighthouse. The observation is also

- referred to by Bruno (1976). (Observation → Known Observer; MNI: 1, Fig. 3)
61. 1927: In November, Kühn (1930) observed the species on the west coast of the island of Hvar (C: 43°08.5'N, 16°45.5'E). The data was also referred to by Bruno (1976) who, contrary to the above, believed that the observation was made in the southern part of the island. (Observation → Known Observer; MNI: 1, Fig. 3)
 62. 1928: Županović (1966), Bruno (1976) and Klinger & Perco (2011) reported that a MMS had been killed around the mouth of the Ombla River near Mokošica (C: 42°40.4' N, 18°05.6' E) in October. (Kill → No Data; MNI: 1, Fig. 3)
 63. 1928: In a cave on the island of Biševo (C: 42°58.5'N, 16°00.6'E), an approximately 3.0 m long and 300 kg seal was killed, which was handed over to the Museum of Natural History in Split (Županović 1966, Bruno 1976, Klinger & Perco 2011). (Kill → Museum placement; MNI: 1, Fig. 3)
 64. 1928: At Easter, Kühn (1930) observed a MMS on the Spalmdor Islands (Pakleni otoci; Sveti Klement, C: 43°09.8'N, 16°22.4'E). The case was also mentioned by Bruno (1976). (Observation → Known Observer; MNI: 1, Fig. 3)
 65. 1928: Kühn (1930) detected the presence of the species on the southeastern side of Hvar Island (C: 43°08.5'N, 16°45.5'E) in August. Observations were also reported by Bruno (1976). (Observation → Known Observer; MNI: 1, Fig. 3)
 66. 1928: Kühn (1930) mentioned from the statement of Machiedo (pers. comm.) that he had repeatedly seen and caught seals on the south side of the island of Hvar (C: 43°08.5'N, 16°45.5'E). According to the informant, the species was not uncommon in the western part of the island. (Observation → Known Observer; MNI: 5; Observation → Anonymous Observer; ME: 2, Fig. 3)
 67. 1929: Kühn (1930) mentioned a letter from Werner (pers. comm.) in which the zoologist reported that he had heard about sightings of a seal on the island of Hvar, near Pitavske Blaze (C: 43°08.1'N, 16°40.9'E). This information was also referred to by Bruno (1976). (Observation → Anonymous Observer; MNI: 1, Fig. 3)
 68. Before 1930: Kühn (1930), referring to a letter from a local doctor, Machiedo (pers. comm.), stated that the doctor had seen several MMSs on the south side of Hvar Island (C: 43°08.5'N, 16°45.5'E). The data was also referred to by Bruno (1976). (Observation → Known Observer; MNI: 2, Fig. 3)
 69. Before 1930: Kühn (1930), referring to Schiller (pers. comm.), states that he had seen a MMS on the island of Sušac (C: 42°46.0'N, 16°30.8'E). The case was also reported by Bruno (1976). (Observation → Known Observer; MNI: 1, Fig. 3)
 70. Before 1930: Kühn (1930), referring to a letter from Cori (pers. comm.), informed that he had observed the species on Pomo Island (C: 43°05.6'N, 15°27.6'E). The observation was also referred to by Bruno (1976). (Observation → Known Observer; MNI: 1, Fig. 3)
 71. Before 1930: Kühn (1930) referred to Schiller (pers. comm.) without a date, who had observed the species at Pelagosa Island (Vela Palagruža, C: 42°23.6'N, 16°15.5'E). (Observation → Known Observer; MNI: 1, Fig. 3)
 72. 1930: Dathe (1934), based on the data of Priemel and Girometta (pers. comm.) and the photos of Priemel (pers. comm.), reported that some fishermen had caught a 90 cm long and 26 kg female MMS at a cave near the south coast of Pelješac Peninsula (C: 42°53.4'N, 17°29.2'E) on the 19th of September. The animal had been wounded in the abdominal region. On the 22nd of September, they wanted to transport the seal to Marjanberg Zoo and then to Frankfurt Main Zoo, but it died on the way. The body was prepared at the Marjan Museum. The case was also referred to by Bruno (1976). (Capture → Death → Museum Placement; MNI: 1, Fig. 4)
 73. 1930: Županović (1966), Bruno (1976) and Klinger & Perco (2011) mention that a 130 cm long female was caught in Sabioncello (Orebić, C: 42°58.5'N, 17°10.8'E), which was handed over to Split Museum of Natural Science. It should be noted that according to the first two authors, the length of the animal was 120 cm. (Capture → Death → Museum Placement; MNI: 1, Fig. 4)
 74. 1931: Johnson (2004) published a photograph of Antalović (pers. comm.) with a MMS killed by fishermen in the commune of Komiža on the island of Vis (C: 43°02.8'N, 16°05.5'E). (Kill → No Data; MNI: 1, Fig. 4)

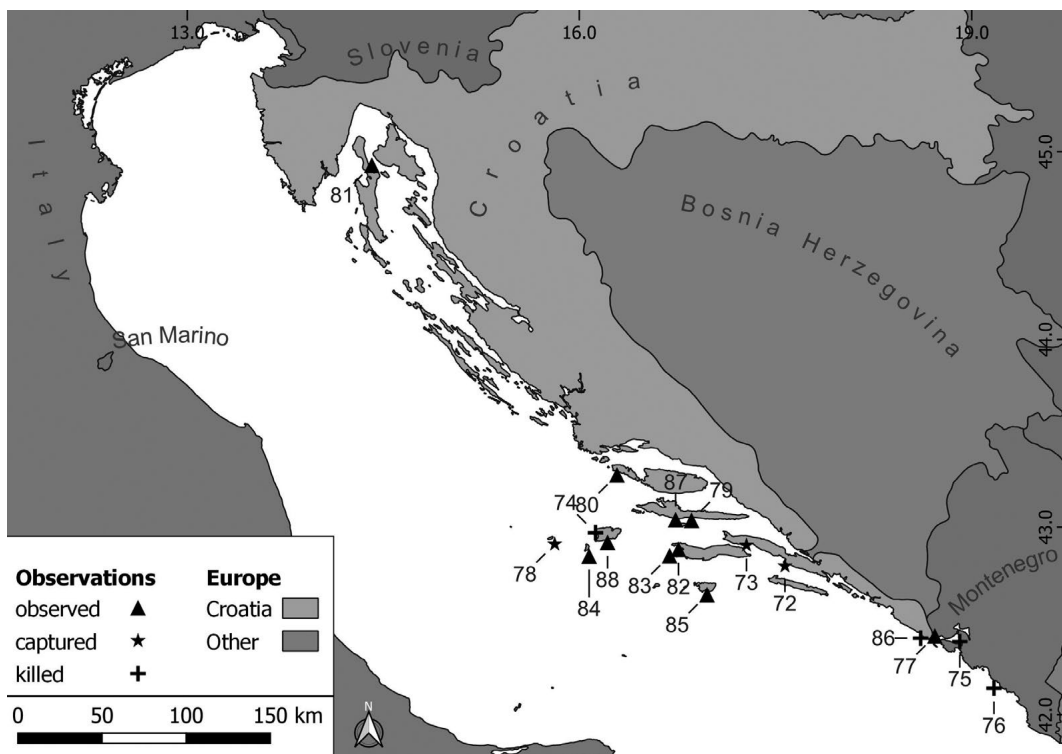


Fig. 4. Types of observations of monk seals between 1930 and 1959.

75. 1933: Dathe (1934) once bought a postcard in Kotor depicting a very poorly stuffed MMS, which was caught in the Bay of Kotor in April (Boka kotorska, C: 42°28.5'N, 18°44.8'E). The data were mentioned by Županović (1966), Bruno (1976) and Klinger & Perco (2011), but they dated the case to March. (Kill → No Data; MNI: 1, Fig. 4)
76. 1934: According to Županović (1966), Bruno (1976) and Klinger & Perco (2011) in Montenegro, on the island of Katić (C: 42°11.8'N, 18°56.1'E) between Budva and Antivari (Bar) a 260 cm long and 340 kg specimen was killed, although the first two authors reported the weight of the animal as 360 kg. (Kill → No Data; MNI: 1, Fig. 4)
77. 1938-1940: Županović (1966) and Bruno (1976) pointed out that possibly a MMS had been observed several times a week at the indicated time in the Bay of Kotor (Boka kotorska) near Herceg Novi, around the Rt Kobila (C: 42°25.4'N, 18°31.7'E). (Observation → Anonymous Observer; MNI: 1, Fig. 4)
78. 1940: Županović (1966) and Klinger & Perco (2011) briefly mentioned that a specimen more than 2.0 m long and weighing about 200-250 kg had been caught on the island of Sveti Andrija (Svetac, C: 43°01.5'N, 15°44.9'E). The animal was transported to Split, where it was released in 1940. (Capture → Release; MNI: 1, Fig. 4)
79. 1943: Županović (1966) and Bruno (1976) stated that the species had been observed in the reported year on the southern coast of the island of Hvar (C: 43°08.5'N, 16°45.5'E). (Observation → Anonymous Observer; MNI: 1, Fig. 4)
80. After 1945: Županović (1966) and Bruno (1976) stated that after World War II fishermen had repeatedly observed a seal off Lučica, off the southwest coast of Solta Island (C: 43°23.1'N, 16°12.7'E). It should be noted that the name "Lučica" is a Croatian port and not the name of a municipality, so it is impossible to pinpoint the exact location of the observation. (Observation → Known Observer; MNI: 1, Fig. 4)

81. The 1950s-1960s: Klinger & Perco (2011) mentioned that a fisherman living in Beli, Cres, had stated on a voice recording that he had seen a MMS in the vicinity of Predošćica (C: 45°02.4'N, 14°22.5'E) in the water sometime around the 1950s and 1960s. (Observation → Known Observer; MNI: 1, Fig. 4)
82. 1950: Županović (1966) and Bruno (1976) stated that a specimen of the species had been observed on the island of Ošjak (C: 42°57.6'N, 16°40.7'E). (Observation → Anonymous Observer; MNI: 1, Fig. 4)
83. 1951: Županović (1966) and Bruno (1976) stated that a specimen of the species had been observed at the indicated time on the island of Ošjak (C: 42°57.6'N, 16°40.7'E) in the Vela Luka Bay (island of Korčula). (Observation → Anonymous Observer; MNI: 1, Fig. 4)
84. 1952: Županović (1966) and Bruno (1976) reported that fishermen had found traces of the seal in the Medvjedina Cave of Biševo Island (C: 42°58.5'N, 16°00.6'E) in June. (Observation → Known Observer; MNI: 1, Fig. 4)
85. 1952: Županović (1966) and Bruno (1976) reported that fishermen had found traces of a seal in the Medvjedina Cave of Lastovo Island (C: 42°45.1'N, 16°52.3'E). (Observation → Known Observer; MNI: 1, Fig. 4)
86. 1955: Županović (1966), Bruno (1976) and Klinger & Perco (2011) stated that in December, a MMS had been entangled in the fishermen's net near Molunat (C: 42°26.9'N, 18°26.5'E), which had been killed despite the protection of the law. (Kill → No Data; MNI: 1, Fig. 4)
87. 1958: Županović (1966) and Bruno (1976) stated that fishermen often had seen seals on the south coast of the island of Hvar (C: 43°08.5'N, 16°45.5'E), near the village Ivan Dolac (C: 43°07.5'N, around 16°39.7'E) and at one time two adult specimens had been observed along with some young individuals in the Medvidin bay (Medvidina Zaljev), in the Medvid cave (Spilja Medvid). (Observation → Known Observer; MNI: 4, Fig. 4)
88. 1959: Di Turo (1984) reported that a seal colony of approximately 1012 individuals had lived around the island of Vis (C: 43°02.7'N, 16°09.6'E). The data is also mentioned by Klinger & Perco (2011). (Observation → Anonymous Observer; MNI: 10, Fig. 4)
89. 1960: Županović (1966) and Bruno (1976) reported that a seal had been observed in the lakes of the island of Mljet (C: 42°44.3'N, 17°34.5'E), which was quite rare. (Observation → Anonymous Observer; MNI: 1, Fig. 5)
90. 1961: A survey among fishermen taken by Antolović (1998) found that three fishermen had seen a total of eight MMSs around the island of Biševo (C: 42°58.5'N, 16°00.6'E). (Observation → Known Observer; MNI: 8, Fig. 5)
91. 1962 or before: Igalffy (1962) mentioned that a MMS had been seen several times on the island of Susak (C: 44°30.6'N, 14°18.0'E), and at dawn, the author had heard splashing on the southern shore of the island, which had indicated the presence of the seal. The data is also referred to by Bruno (1976). (Observation → Anonymous Observer; MNI: 1, Fig. 5)
92. 1962: Županović (1966) mentioned that, according to eyewitness accounts, an adult animal had been killed in the Medvidina cave on the island of Biševo (C: 42°58.5'N, 16°00.6'E) by the locals. The case is also mentioned by Klinger & Perco (2011). (Kill → No Data; MNI: 1, Fig. 5)
93. 1962: Bruno (1976) stated, without further reference, that in June J. Bakič biologist (pers. comm.) had observed a seal approximately 70.0 m off from the northern shores of the island of Svetac (C: 43°01.5'N, 15°44.9'E). Local fishermen had reported that seals lived in a submarine cave called Mevjedovina on the island's north coast. (Observation → Known Observer; MNI: 2, Fig. 5)
94. 1962: Bruno (1976) stated without reference that the species had been observed on the island of Šćedro (C: 43°05.2'N, 16°42.0'E) in Podspila bay. (Observation → Anonymous Observer; MNI: 1, Fig. 5)
95. 1962: Bruno (1976) stated without reference that fishermen had observed some seals in the Kornati archipelago on the south coast of the island of Mana (C: 43°48.1'N, 15°16.3'E). (Observation → Known Observer; MNI: 2, Fig. 5)
96. 1963: Županović (1966) briefly mentioned that on the island of Biševo (C: 42°58.5'N, 16°00.6'E), a MMS had been killed in August, which had been believed to be the last killing of the species on the Adriatic. The case was mentioned by Bruno (1976) and Klinger & Perco (2011), and the former author also reported that the

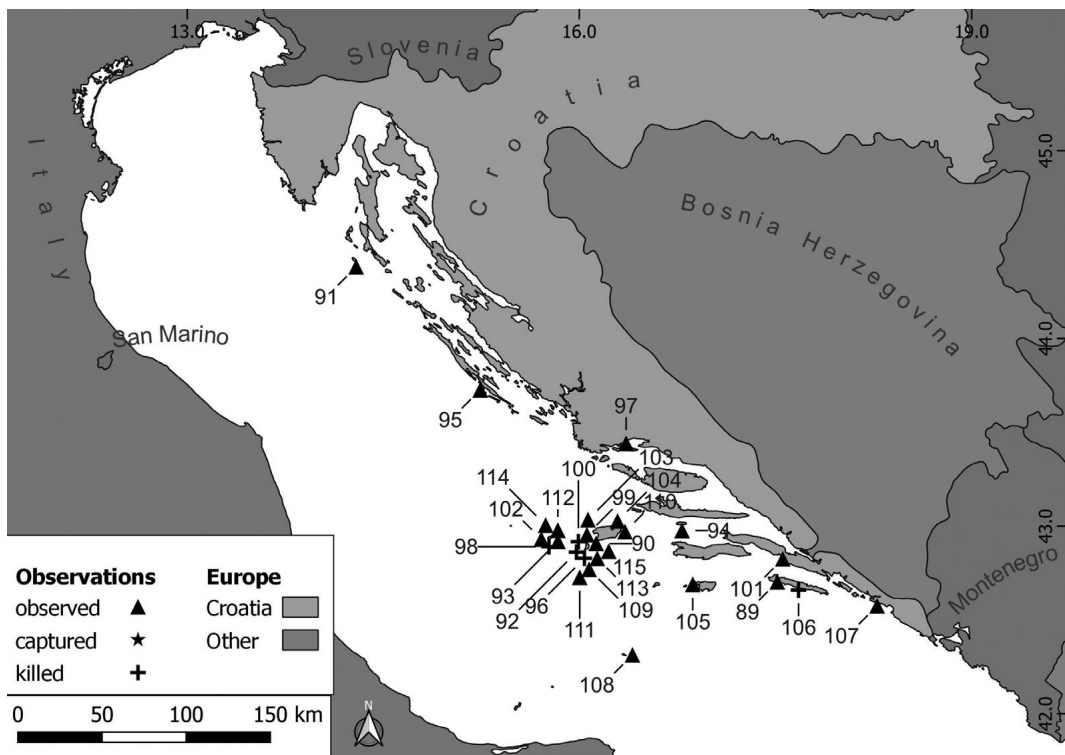


Fig. 5. Types of observations of monk seals between 1960 and 1969.

- animal had been caught in the Medvjedina Cave and had weighed 400 kg. (Kill → No Data; MNI: 1, Fig. 5)
97. 1963: Bruno (1976) stated without reference that on the northern coast of the island of Čiovo (C: 43°30.0' N, 16°17.3' E), approximately 150.0 m from the village of Slatine, seals had been observed. (Observation → Anonymous Observer; MNI: 1, Fig. 5)
98. 1963: Bruno (1976) stated without reference that fishermen had killed two female seals during the winter in Svetac (C: 43°01.5' N, 15°44.9' E) and Kamik (C: 43°01.2' N, 15°42.7' E). Both animals were reported to weigh approximately 200 kg. (Kill → No Data; MNI: 2, Fig. 5)
99. 1964: Jezovšek (pers. comm.) from Ljubljana saw two MMSs on the island of Biševo (C: 42°58.5' N, 16°00.6' E) in the Mesoparat Bay (Županović 1966, Klinger & Perco 2011). (Observation → Known Observer; MNI: 2, Fig. 5)
100. 1964: Gomerčić et al. (2009) reported that a fisherman had been suspected of killing an adult MMS near the island of Biševo (C: 42°58.5' N, 16°00.7' E), which had gone to the Department of Anatomy, Histology and Embryology, Faculty of Veterinary Science, University of Zagreb, and the skull of which the author presented in detail with a photograph. The case was also discussed by Cafuk et al. (2009). (Kill → No data; MNI: 1, Fig. 5)
101. 1964: According to Jezovšek (pers. comm.) from Ljubljana, a seal family lived in the Sabioncello Peninsula, in the gulf of Žuljana (C: 42°53.5' N, 17°27.1' E). (Županović 1966, Klinger & Perco 2011) (Observation → Known Observer; MNI: 3, Fig. 5)
102. 1965: A survey among fishermen conducted by Antolović (1998) found that a fisherman had observed three specimens around the island of Svetac (C: 43°01.5' N, 15°44.9' E). (Observation → Known Observer; MNI: 3, Fig. 5)

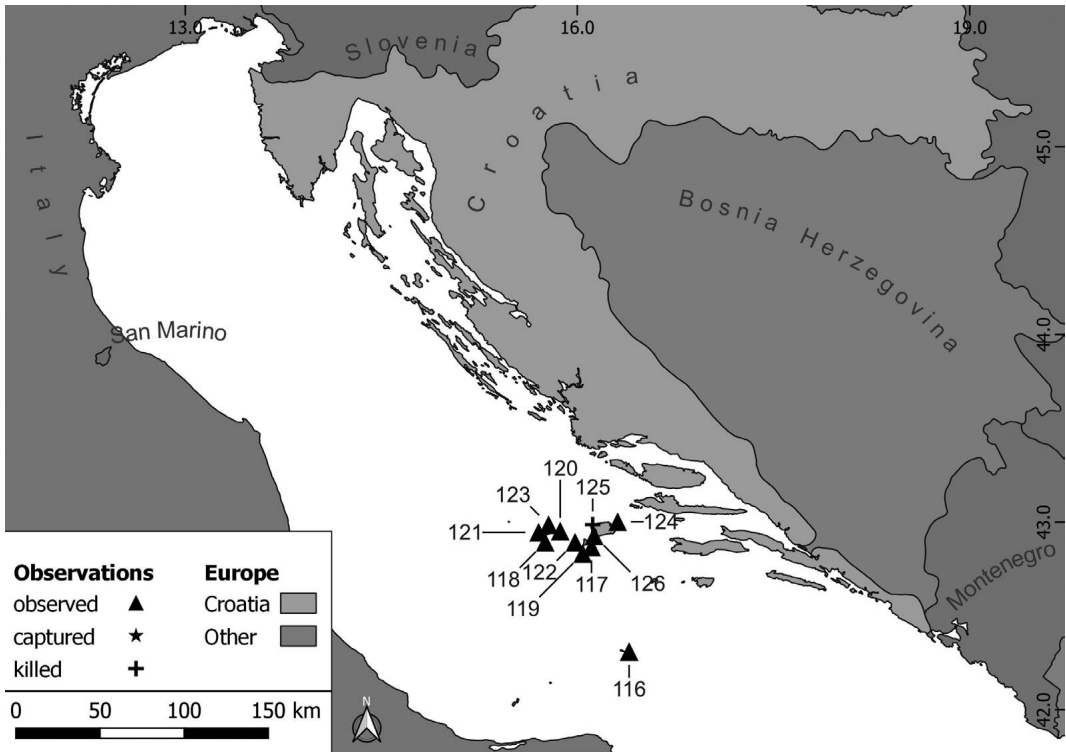


Fig. 6. Types of observations of monk seals between 1970 and 1980.

103. 1965: A survey among fishermen conducted by Antolović (1998) found that two fishermen had seen two individuals around the island of Biševo (C: 42°58.5' N, 16°00.6' E). (Observation → Known Observer; MNI: 2, Fig. 5)
104. 1965: A survey among fishermen conducted by Antolović (1998) found that a fisherman had observed a seal near Vis (C: 43°02.7' N, 16°09.6' E). (Observation → Known Observer; MNI: 1, Fig. 5)
105. 1965: According to Županović (1966) and Klinger & Perco (2011), the inhabitants of Lastovo saw a MMS (C: 42°45.2' N, 16°43.3' E) on the southeast coast of Kopište Island near Lastovo. (Observation → Known Observer; MNI: 1, Fig. 5)
106. 1965: Županović (1966) and Klinger & Perco (2011) reported that fishermen had found a skull of a MMS with a hole on it caused by a pistol on the island of Mljet (C: 42°44.3' N, 17°34.5' E). (Kill → No Data; MNI: 1, Fig. 5)
107. 1965: Županović (1966) reported that according to the observation of fishermen on the island of Mljet, a MMS had been seen several times between Cavta (C: 42°34.8' N, 18°13.2' E) and Moluna (C: 42°26.9' N, 18°26.5' E). (Observation → Known Observer; MNI: 1, Fig. 5)
108. 1966: A survey among fishermen conducted by Antolović (1998) found that a seal had been observed by a fisherman around the Palagruža Islands (Vela Palagruža, C: 42°23.6' N, 16°15.5' E). (Observation → Known Observer; MNI: 1, Fig. 5)
109. 1966: A survey among fishermen conducted by Antolović (1998) found that two fishermen had observed three individuals near the island of Biševo (C: 42°58.5' N, 16°00.6' E). (Observation → Known Observer; MNI: 3, Fig. 5)
110. 1966: A survey among fishermen conducted by Antolović (1998) found that a fisherman had seen a specimen around the island of Vis (C: 43°02.7' N, 16°09.6' E). (Observation → Known Observer; MNI: 1, Fig. 5)

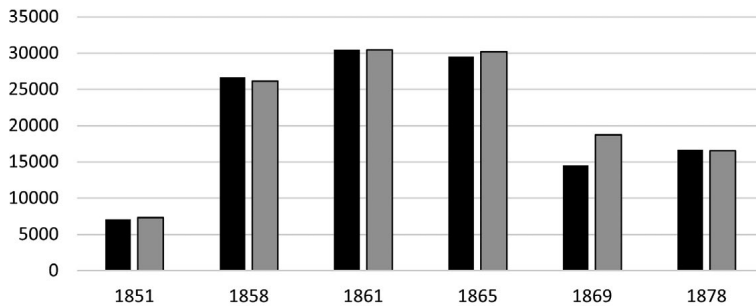


Fig. 7. Traffic of the ports of Dalmatia between 1851–1878 (after Pejdo 2007). ■, number of incoming ships; ■, number of outgoing ships.

111. 1967: A survey among fishermen conducted by Antolović (1998) found that three fishermen had seen a total of three seals around the island of Biševo (C: 42°58.5' N, 16°00.6' E). (Observation → Known Observer; MNI: 3, Fig. 5)
112. 1968: A survey among fishermen conducted by Antolović (1998) found that a fisherman had seen a MMS near the island of Svetac (C: 43°01.5' N, 15°44.9' E). (Observation → Known Observer; MNI: 1, Fig. 5)
113. 1968: A survey among fishermen conducted by Antolović (1998) found that three fishermen had observed four seals in the area of Biševo (C: 42°58.5' N, 16°00.6' E). (Observation → Known Observer; MNI: 4, Fig. 5)
114. 1969: A survey among fishermen conducted by Antolović (1998) found that on two separate occasions, one-one fisherman had seen one-one individual close to the island of Svetac (C: 43°01.5' N, 15°44.9' E). (Observation → Known Observer; MNI: 4, Fig. 5)
115. 1969: A survey among fishermen conducted by Antolović (1998) found that a fisherman had observed three MMSs in the area of the island of Biševo (C: 42°58.5' N, 16°00.6' E). (Observation → Known Observer; MNI: 3, Fig. 5)
116. 1970: A survey among fishermen conducted by Antolović (1998) found that a fisherman in the Palagruža Archipelago (Vela Palagruža, C: 42°23.6' N, 16°15.5' E) had seen two MMSs. (Observation → Known Observer; MNI: 2, Fig. 6)
117. 1970: A survey among fishermen conducted by Antolović (1998) found that three fishermen had observed three MMSs in the area of the island of Biševo (C: 42°58.5' N, 16°00.6' E). (Observation → Known Observer; MNI: 3, Fig. 6)
118. 1971: A survey among fishermen conducted by Antolović (1998) found that a fisherman had observed one MMS around the island of Svetac (C: 43°01.5' N, 15°44.9' E). (Observation → Known Observer; MNI: 1, Fig. 6)
119. 1971: A survey among fishermen conducted by Antolović (1998) found that a fisherman had observed two seals in the area of Biševo (C: 42°58.5' N, 16°00.6' E). (Observation → Known Observer; MNI: 2, Fig. 6)
120. 1974: A survey among fishermen conducted by Antolović (1998) found that one fisherman had seen two MMS, another fisherman observed one MMS, and one-one fishermen observed two-two individuals around the island of Svetac (C: 43°01.5' N, 15°44.9' E). (Observation → Known Observer; MNI: 8, Fig. 6)
121. 1975: A survey among fishermen conducted by Antolović (1998) found that a fisherman had seen three MMSs around Svetac Island (C: 43°01.5' N, 15°44.9' E). (Observation → Known Observer; MNI: 3, Fig. 6)
122. 1975: A survey among fishermen conducted by Antolović (1998) found that a fisherman had seen four seals around the island of Biševo (C: 42°58.5' N, 16°00.6' E). (Observation → Known Observer; MNI: 4, Fig. 6)
123. 1976: A survey among fishermen conducted by Antolović (1998) found that a fisherman had observed two seals on the island of Svetac (C: 43°01.5' N, 15°44.9' E). (Observation → Known Observer; MNI: 2, Fig. 6)
124. 1977: A survey among fishermen conducted by Antolović (1998) found that a fisherman had seen an individual on the island of Vis (C: 43°02.7' N, 16°09.6' E). (Observation → Known Observer; MNI: 1, Fig. 6)

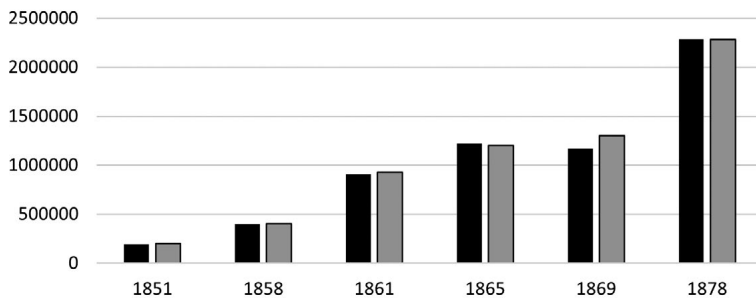


Fig. 8. Trading goods in tonnes of the ports of Dalmatia between 1851–1878 (after Pejdo 2007). ■, amount of incoming goods (t); ■, amount of outgoing goods (t).

125. 1979: Gomerčić & Huber (1989) reported about the skull of an adult seal placed at the Komiža tourist service on the island of Vis, which, according to the authors, had been killed around the island of Vis during the reported year. (Kill → No Data; MNI: 1, Fig. 6)
126. 1980: A survey among fishermen conducted by Antolović (1998) found that two fishermen had observed six seals around the island of Biševo (C: 42°58.5' N, 16°00.6' E). (Observation → Known Observer; MNI: 6, Fig. 6)

According to our calculations, the data presented above recorded at least 242 killed, captured or observed animals between 1800 and 1980 (Table 3). This data shows that in the period mentioned above, at least 38 individuals were killed within the region, including those in museum collections. In the processed 180 years, the literature reported a total of 23 captured seals. In the case of captured animals, we know that at least seven individuals died during captivity, and many others presumably died too, whereas only one seal is known for being released back into the wild. In addition, there were observation data on at least 181 individuals in the reports mentioned above (Table 3), of which, in the case of 144 animals, there was some information about the observer, while in the case of the observation of 37 individuals, the observer could not be identified.

Anthropogenic effects

The turnover of the port of Fiume (today Rijeka) in Croatia in 1927 amounted to a net tonnage of 2016000, while Yugoslavia's world trade fleet held 261000 gross tons in mid-1928 (Cholnoky 1929). The country's world trade fleet in 1955–1966 held the following amounts: 0.3; 0.83; 0.97; 0.99, and 1.08 million gross tonnages in 1955, 1961, 1964, 1965 and 1966 respectively (Radó et al. 1968).

Another component of possible negative anthropogenic effects is the increase in vessel traffic regarding which we found some data from the second half of the 19th century presented in Fig. 7. Although these data do not show a continuous increase in vessel traffic. On the other hand, the tonnes of trading goods increased over the same period (Fig 8).

Regarding fisheries data, catches in the region increased to more than double within 16 years, from 1922 to 1938 (Bašić 2005, see Fig. 9).

Concerning the development of tourism, according to Caltagirone (1995), tourism in the Dalmatian archipelago (Figs 10–11) significantly reduced the habitat of seals. Data of the Croatian National Tourist Board (2022) shows, that more than 13 million tourists and more than 83 million guest nights were spent in the country until November 2021, of which 95% of them are concentrated in the coastal regions (Rácz 2016).

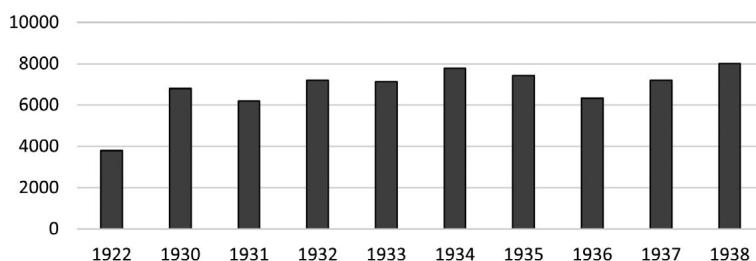


Fig. 9. Fisheries statistics of the former Yugoslavia (included fish, crustaceans, shellfish) between 1922–1938 (after Bašić 2005). ■, amount of catch in tonnes.

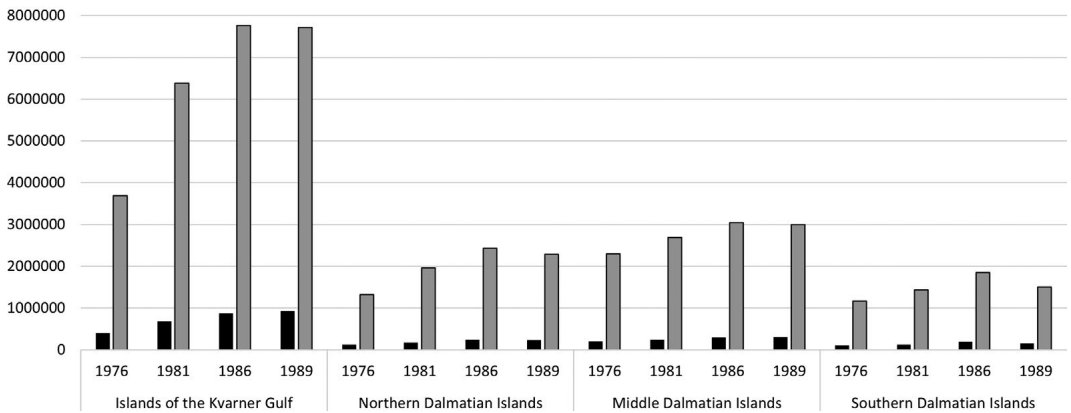


Fig. 10. Development of tourism on the Croatian Islands between 1976–1989 (after Mikačić 1994). ■, number of tourists; ■, number of overnight stays.

The number of tourists and overnight stays on the Adriatic islands of Croatia, the Kvarner islands and the North Dalmatian Islands had doubled in the 13 years between 1976 and 1989, while in the Central and South Dalmatian islands, this number increased to approximately one and a half times (Mikačić 1994, see Fig. 10).

In the former Yugoslavia, the number of tourists increased by more than 13 times during ~40 years between 1948 and 1987 (Škara 2016), and coastal areas could also significantly contribute to this growth (Fig. 11).

Discussion

The first information about MMSs from the area emerged in the 19th century. However, various authors often reported controversial data about the size of the Adriatic populations of the species. Menis (1848) stated that the MMS was not very common in the Adriatic; nevertheless, locals still caught them regularly to display these wild animals to gain some income as they were easy to tame. Garády (1908) believed that the species were once widespread in the Kvarner area, and it occurred in large numbers, particularly in the Morla Canal. According to Hankó (1913), the guards of the lighthouses of the outer islands of the Adriatic often saw MMSs; however, the author did not disclose the sites of most observations for conservation reasons, as he expressed. Nonetheless, the above-mentioned authors stated that there could be hundreds of specimens in the Adriatic Sea in the 19th century. Leidenfrost (1924a) referring to Morgan's data indicated that seals occurred in small numbers only in the vicinity of Lesina (Hvar), Lissa (Vis), Busi (Biševo), Cazza

(Sušac) and Sveti Andrea (Sveti Andrija). In this period, we also know from Kormos (1914) that several seals were displayed in the hunting section of the 1913 Vienna Adriatic Exhibition, presumably from the Adriatic.

According to Gomerčić et al. (2011), the species was extinct from the Adriatic by the second half of the 20th century, and only a few occasional observations in the region came to light. However, according to Di Turo (1984), the population size of MMSs was more than 20 individuals at the Yugoslavian coast in 1955, while in 1959 the estimated number was about 30 individuals.

Županović (1966) stated a similar headcount; where a total of 15–20 specimens could have been living across the Adriatic Sea, although the author also considered the Apulian shores within this area. Gomerčić et al. (2011) believed that the last observations of seals in the area of the outer islands of the Adriatic Sea could be in the 1970s, around Vis and Lastovo. Bruno (1976), on the other hand, claimed that his data collected from locals in the summer of 1974 showed that the species occurred around Svetac, Biševo, Sušac and Mljet too, and the seals were breeding on the shores of the two former islands. According to the author, probably 14–16 adult individuals lived in the region. According to Antica (1999), observations of the seal became very rare after 1970, and the sightings were mostly limited to the outer islands. He believed that after 1980, the seals living on the Croatian Adriatic were not permanent residents, and only some individuals appeared from time to time in the region. Likewise, Kryštufek (1991) believed that by 1991 the populations of the species completely vanished around the Slovenian coast. However, Caltagirone (1995) claimed that in the 1990s, about 20 individuals appeared in the

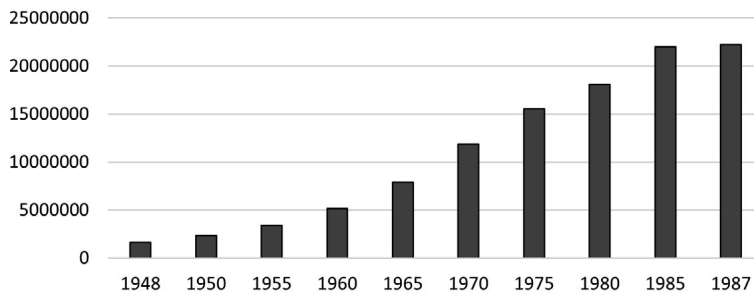


Fig. 11. Development of tourism of the former Yugoslavia between 1948–1987 (after Škara 2016). ■, number of tourists.

Adriatic. He stated that the growing observations over the past few years suggest that a small group of 5–6 seals could survive in the northern part of the region, off the coast of the island of Pag. According to Klinger & Perco (2011), since the turn of the millennium, more and more observations have been occurring on the eastern Adriatic coast. According to Gomerčić et al. (2005), two possible causes exist for the recent, more frequent observations in the Dalmatian waters. One explanation is that the species is extinct in the area, and only specimens from southern regions are occasionally detected. The other possibility is that there is a smaller group of 20 individuals in the area. Around the turn of the millennium, further growth of the Adriatic population was assumed, which was also referred to by more frequent observations of MMSs (Antolović 1998, Antolović 2005, Anonymus 2000, Gomerčić et al. 2005, Gomerčić et al. 2006, Gomerčić et al. 2011, Antolović et al. 2007, Radošević 2008). Draganović (1994a, 1994b) and Caltagirone (1995) reported that a nature conservation law protected the MMS in the former Yugoslavia under the Nature Conservation Act of 1960, adopted in 1964. After this, the deliberate killing, hunting and capture of animals were strictly prohibited, and these activities were not allowed for scientific purposes either. The authors also stated that under the Nature Conservation Act of 1976, in 1985, the Croatian Nature Conservation Council published the conservation value of protected species, among which the highest fee was established for killing seals. Antica et al. (1994) explain that the protection was not enough to recover populations in the area.

Anthropogenic effects

Experts mention human activity growth primarily increased vessel traffic (after Pjedo 2007, Figs 7 and 8), overfishing (after Bašić 2005, Fig. 9), and tourism growth (after Mikačić 1994, Škara 2016, Figs 10–11).

Since trading increased in tonnes but vessel traffic peaked and decreased, we could assume that even though the number of vessels did not increase they started building larger vessels that could support the increase in trade (Figs 7 and 8).

Various authors make human activities and their effects responsible for the decline of the species in the Adriatic region (Hankó, 1913, Kühn 1930, Klinger & Perco 2011). The disappearance of the species from the Adriatic Sea was probably due, at least in part, to the ongoing persecution, as already mentioned by Antica (1999).

Observation points on the maps (Figs 1–6) showed that data indicating MMS presence in the 19th century were proportionally distributed with a northern and a southern Adriatic hub. In contrast, from the 20th century, they became rare and later completely eradicated in the region's northern areas and became restricted to the southern areas. It is noteworthy that during the period under investigation, we have hardly found any data in the central Adriatic, but this may also be due to the low population density of the surrounding small islands. It is also clear from the map data that MMS sightings were predominantly from the islands, and much fewer data were reported from the coast (Figs 1–6).

Although, according to Antica et al. (1994), MMSs have been protected in the former Yugoslavia since 1935, the issued and renewed conservation laws helped the species to be reinforced and effectively protected in the 1960s and 1970s. Regarding the killing of individuals, Županović (1966) believed that the last killing of MMSs on the Adriatic took place in 1963, but it was clear from the above reports that one in 1964, two in 1965 and one in 1979 were still killed. Thus, the above data suggest that, until the 1960s, killings by sport hunters and fishermen could cause significant damage to the numbers of MMSs, but following this, such activity could hardly or no longer threaten these pinnipeds. Similarly,

Antica (1999) states that people's attitudes towards seal killing have improved significantly, which has helped MMSs to return to the area.

Reports suggested that the capture of individuals was primarily to sell the animals or show them to tourists for money, so this activity of fishermen was mainly motivated by financial profit (Brusina 1889, Fitzinger 1860, Garády 1908, Garády 1926, Hankó 1913, Herczeg n.d., Johnson 2004, Klinger 2010, Klinger & Perco 2011, Leidenfrost n.d., Matisz 1896, Županović 1966). However, following the declaration of MMSs as 'protected' in 1935, such activities could easily have come to the attention of the authorities. After that date, there was only one case of capturing an individual (Županović 1966, Klinger & Perco 2011). That seal was released within the same year, which was not a common practice with animals captured earlier (Table 2). In contrast, reports of seal sightings in the area have increased significantly and, in about three-quarters of the cases, the identity of observers has become known (Table 3).

According to Ka (1930) the increase of marine vessel traffic and the scarcity of fish around the area were the reasons for decreasing the number of MMSs in the Adriatic region. Other authors (Draganović 1994b, Caltagirone 1995) indicated that rare occasions of fishing with dynamite and the level of overfishing cannot cause such food shortage, which could have reduced the population size.

Antica (1999) named fishermen capturing seals as the primary reason for the decreased number of the species.

According to shipping data, from 1851 to 1878 the number of ships arriving and leaving the Dalmatian ports doubled over 17 years (Pjedo 2007), while the freight volume, on the other hand, became ten times higher (Figs 7–8). This was probably accompanied by larger motorised vessels with a greater cargo hold. The development was possibly significant in later years too, as in 1927, the port of Rijeka alone had a freight volume of approximately 50% of the entire Dalmatian trade 50 years earlier (Cholnoky 1929, Pjedo 2007). The development of Yugoslavia's world trade fleet capacity was interesting too, as its gross registered tonnage was not much less than 27 years

later, but this stagnation was possibly due to the devastation caused by the Second World War and the subsequent shortage in the economy (Cholnoky 1929, Radó et al. 1968). A significant development happened from 1955 to the next ten years, as the capacity of the country's merchant ships more than tripled (Radó et al. 1968). It is worth mentioning that tourism increased significantly after the Second World War (Mikačić 1994, Škara 2016), and technological development increased the number and traffic of various watercraft too, not just commercial ships. Although the increase of maritime traffic could disturb seals, and this development is probably still ongoing, the species reappeared in the Croatian section of the Adriatic Sea at the end of the 20th century (Caltagirone 1995, Klinger & Perco 2011). According to Gomeric et al. (2005) it was doubtful whether there were individuals permanently staying in the area however, a more recent research mentions numerous sightings along the coast of Croatia (Panou et al. 2023).

Regarding fisheries data (Bašić 2005, see Fig. 9) such increase was likely to continue to climb after the reported period, but no indication was found regarding the significant and persistent overexploitation of fish, crustaceans and mussels. However, according to Hadjichristophorou & Demetropoulos (1994), following the fisheries regulation introduced on the island of Cyprus in 1981, seals could only be observed in waters when trawling was not carried out. It is believed that this method may have contributed to the population degradation in Adriatic waters. As Johnson & Lavigne (1999) indicate trawling might not directly killed MMSs but it is possible that after its introduction fish stocks got depleted and the MMSs travelled to other waters for food. In addition, Dendrinis (1994) and Androukaki et al. (1999) pointed out that the most important cause of mortality in Greek waters was the deliberate killing of seals associated with fishing and the accidental loss caused by entangling in fishing nets.

As Figures 10 and 11 show tourism likely contributed to the MMS' habitat disappearance. In this context, Draganović (1994b) also considers tourism to be the leading cause of endangering of this species in

Table 3. The number of individuals killed, captured and observed and their sum, shown in 20 years periods from between 1800 and 1980.

	1800– 1820	1820– 1840	1840– 1860	1860– 1880	1880– 1900	1900– 1920	1920– 1940	1940– 1960	1960– 1980	Sum
Kills	–	–	1	10	1	13	5	1	7	38
Captures	3	1	6	1	2	6	3	1	–	23
Observations	–	2	2	5	5	45	20	21	81	181

recent decades, as holidaymakers visit those remote and deserted beaches, waters and caves where the MMSs live and hide and thus disturb the animals. The difference in growth between the archipelagos in Fig. 10 may also have been because while the Kvarner region and the North Dalmatian Islands were more easily accessible by motorways to tourists, the other archipelagos were more challenging to reach due to their more remote location at that time. Therefore, they were probably visited less often. In just 40 years there was also a massive increase in the number of tourists in the former Yugoslavia (Fig. 11) and such an increase in tourism and its effects were likely to have had a negative impact on the number of seals in the area. A standardised monitoring program on tourism and fisheries could help to better understand why the MMS sighting are extremely low in the area.

Conclusion

The goal of gathering the large amount of information, which until now was only available in Hungarian, and making it accessible to professionals in this article was successfully achieved. For such a rare species, we were able to collect a very significant amount of detection data in a relatively small area, which greatly contributes to getting a clearer picture of the history and population changes of the Mediterranean harbour seal. The map representation of the collected data clearly shows that there were sightings throughout the examined area, so the species occurred there indeed. It is also clear from the map representations that the populations probably crumbled first in the northern and southern basins of the Adriatic Sea, since sightings first decreased or ceased in these regions. According to the available information, it seems that the species was able to survive the longest in the central area (or islands) of the Adriatic Sea.

The collected data show that even the gradually strengthening protection measures could not prevent the disappearance of the MMS in the Adriatic Sea. Examining the reasons for the population decline, a number of factors were revealed that could have played a part in the species' disappearance. We were able to explore these factors, which can primarily be traced back to human influences, only partially in the present work, which can be traced back to the lack of data.

On one hand the authors think it is important to further investigate the causes of extinction in the future, so that a more accurate picture of the causes of extinction and the distribution of extinction factors can be obtained. At the same time, it would also be important to enter the observation data of

the expected seal return into a central register. Such information could be of significant help to nature conservation professionals and authorities.

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