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Back-to-back Meeting of the Ecosystem Approach Correspondence Groups on Monitoring (CORMON) Biodiversity and Fisheries and Economic and Social Analysis (COR ESA)

Videoconference, 10-11 June 2026

Agenda Item 3: Updated Guidance Factsheets for biodiversity (EO1)

3.3. Reptiles – Sea turtles (OE 1: Common Indicator 3 – species distributional range, Common Indicator 4 – species population abundance, and Common Indicator 5: population demographic characteristics).

Draft updated IMAP Common Indicator 3, 4 and 5 factsheets related to marine turtles

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Note by the Secretariat

In 2008, the Contracting Parties to the Barcelona Convention, through COP 15 Decision IG.17/6, committed to progressively applying the Ecosystem Approach (EcAp) to the management of human activities affecting the Mediterranean marine and coastal environment. This approach aims to promote sustainable development and achieve Good Environmental Status (GES) of the Mediterranean Sea and its coasts.

A key component of the Ecosystem Approach is the monitoring and assessment of the marine and coastal environment. To support a coherent regional implementation framework, the Contracting Parties adopted the Integrated Monitoring and Assessment Programme of the Mediterranean Sea and Coast and Related Assessment Criteria (IMAP) through COP 19 Decision IG.22/7 in 2016.

To support harmonized and consistent monitoring across the Mediterranean region, Guidance Factsheets were developed for each IMAP Common Indicator. These factsheets define common monitoring and assessment approaches and serve as key technical references for Contracting Parties in the development, revision, and implementation of their national monitoring programmes. Their overall objective is to strengthen the implementation of the Ecosystem Approach and support the achievement of Good Environmental Status (GES).

The first version of the Guidance Factsheets was reviewed by the Meeting of the Correspondence Group on Monitoring (CORMON) on Biodiversity and Non-Indigenous Species (Madrid, Spain, 28 February–1 March 2017) and by the Meeting of the SPA/RAC Focal Points (Alexandria, Egypt, 9–12 May 2017). The outcomes of these reviews were reflected in document UNEP(DEPI)/MED WG.444/6/Rev.1 presented at the 6th Meeting of the Ecosystem Approach Coordination Group (Athens, Greece, 11 September 2017).

Building on the experience gained through national IMAP implementation and the findings of the 2023 Mediterranean Quality Status Report (MED QSR), the Contracting Parties initiated the revision of the Ecosystem Approach (EcAp) policy and the update of IMAP, in line with the mandate provided at COP 23. This process aims to strengthen monitoring and assessment capacities, improve data quality, and ensure more robust and reliable regional assessments.

As outlined in the SPA/RAC work programme, the update of the IMAP Common Indicator Guidance Factsheets is scheduled to be carried out during the 2024–2025 and 2026–2027 biennia. SPA/RAC has updated the Guidance Factsheets of the IMAP Common Indicators for Ecological Objective 1 (EO1: Biodiversity), with the support of the Biodiversity Online Working Group (OWG), with the objectives to:

- incorporate climate change considerations into the updated Guidance Factsheets. As one of the most significant threats to biodiversity in the Mediterranean Sea, climate change requires further clarification within the Guidance Factsheets and GES definitions. Climate change impacts should be integrated into existing indicators and methodologies, particularly in the establishment of baseline and threshold values;
- take into consideration the development of Monitoring and Assessment Scales, Assessment Criteria, Thresholds, and Baseline Values for IMAP Common Indicators 3 (Species distributional range), 4 (Population abundance), and 5 (Population demographic characteristics) related to marine turtles; and
- integrate the latest scientific knowledge and methodological developments in marine biodiversity research, ecological monitoring, and climate change impacts to support more accurate assessments and effective conservation measures.

In this context, SPA/RAC has prepared draft updated IMAP Common Indicator 3, 4 and 5 Factsheets related to marine turtles, with a view to supporting the Contracting Parties in updating their national IMAP monitoring programmes and facilitating data collection and assessment for the third IMAP assessment cycle.

This proposal was developed with the support of the Biodiversity Online Working Group (OWG) on marine turtles. The Meeting is expected to review the document and provide guidance with a view to its submission to the SPA/RAC Focal Points Meeting (scheduled for May 2027) and the EcAp Coordination Group Meeting (scheduled for September 2027).

1. Common Indicator 3: Distribution range

Indicator Title	<i>Common indicator 3: Species distributional range – Reptiles</i>	
Relevant GES definition	Related Operational Objective	Proposed Target(s)
<p>The species continues to occur in all its natural range in the Mediterranean, including nesting, mating, feeding and wintering and developmental (where different to those of adults) areas.</p>	<p>Species distribution is maintained</p>	<p>State</p> <p>Turtle distribution is not significantly affected by human activities</p> <p>Turtles continue to nest in all known nesting sites</p> <p>Pressure/Response</p> <p>Protection of known nesting, mating, foraging, wintering and developmental turtle areas.</p> <p>Human activities¹ having the potential to exclude marine turtles from their range area are regulated and controlled.</p> <p>The potential impact of climate change is assessed</p>
Rationale		
<p>Justification for indicator selection</p> <p>In biology, the range of a given species is the geographical area in which that occurs (i.e. the maximum extent). A commonly used representation of the range of a species is a range map (sometimes with dispersion being shown by variation in local population densities within that range). Therefore, the objective of this indicator is to determine the species range of loggerhead (<i>Caretta caretta</i>) and green (<i>Chelonia mydas</i>) sea turtles that breed in the Mediterranean region. Loggerhead turtles are ubiquitous across the Mediterranean, making them an ideal species to determine conditions throughout the region, whereas green turtle distribution is more restricted and it may act as a clear indicator for the presence and health of certain types of habitats including thermal niche limitations. Green turtles are primarily herbivores, whereas loggerheads are omnivores, resulting in them representing important constituents of the food web; thus, changes to the status of sea turtles, will likely reflect perturbation in the whole food web.</p> <p>The extent of knowledge on the occurrence, distribution, abundance and conservation status of Mediterranean marine species is uneven. In general, the Mediterranean states have lists of species, but knowledge about the locations used by these species is not always complete, with major gaps existing for other associated information relevant to species conservation. It is therefore necessary to establish minimum information standards to reflect the known distribution of all selected species.</p> <p>Species distribution ranges can be gauged at local (i.e. within a defined area like a national park) or regional (i.e. across the entire Mediterranean basin) scales using a variety of approaches.</p> <p>Given the breadth of the Mediterranean, it is not feasible to obtain adequate information about the entire region, so it is necessary to choose sampling methods that facilitate suitable knowledge acquisition of the distribution range of each species. Such sampling involves high effort for areas that have not been fully surveyed to date. Monitoring effort should be long-term and should cover all seasons to ensure that the information obtained is as complete as possible.</p>		

¹ Uncontrolled use of turtle nesting sites, fishing, maritime traffic, etc.

Indicator Title	<i>Common indicator 3: Species distributional range – Reptiles</i>
Scientific References	
<p>Broderick, A.C., Türkozan, O., Demetropoulos, S., Mastrogiacomo, A., Demetropoulos, A., Levy, Y. & Leader, N. 2024. <i>Chelonia mydas (Mediterranean subpopulation)</i> (amended version of 2023 assessment). <i>The IUCN Red List of Threatened Species 2024</i>: e.T4616A259027885. https://doi.org/10.2305/IUCN.UK.2024-1.RLTS.T4616A259027885.en. Accessed on 16 December 2025.</p>	
<p>Casale P., Margaritoulis D. (Eds.) 2010. <i>Sea Turtles in the Mediterranean: Distribution, Threats and Conservation Priorities</i>. IUCN/SSC Marine Turtle Specialist Group. Gland, Switzerland: IUCN, 294 pp. http://iucn-mtsg.org/publications/med-report/</p>	
<p>Casale, P. 2015. <i>Caretta caretta (Mediterranean subpopulation)</i>. <i>The IUCN Red List of Threatened Species 2015</i>: e.T83644804A83646294. https://doi.org/10.2305/IUCN.UK.2015-4.RLTS.T83644804A83646294.en. Accessed on 16 December 2025.</p>	
<p>Casale P, Broderick AC, Camiñas JA, Cardona L, Carreras C, Demetropoulos A, Fuller WJ, Godley BJ, Hochscheid S, Kaska Y, Lazar B, Margaritoulis D, Panagopoulou A, Rees AF, Tomás J, Türkozan O. 2018. Mediterranean sea turtles: current knowledge and priorities for conservation and research. <i>Endangered Species Research</i> 36: 229-267. https://doi.org/10.3354/esr00901</p>	
<p>Casale P., Hochscheid S., Kaska Y., Panagopoulou A. (Eds.) (2020). <i>Sea Turtles in the Mediterranean Region: MTSG Annual Regional Report 2020</i>. Report of the IUCN-SSC Marine Turtle Specialist Group, 2020. https://www.iucn-mtsg.org/s/MTSG-Regional-Report_Mediterranean_2020.pdf</p>	
<p>Demography Working Group of the Conference. Demography of marine turtles nesting in the Mediterranean Sea: a gap analysis and research priorities - 5th Mediterranean Conference on Marine Turtles, Dalaman, Turkey, 19-23 April 2015. Document T-PVS/Inf(2015)15E Presented at the Convention on the conservation of European wildlife and natural habitats - 35th meeting of the Standing Committee - Strasbourg, 1 - 4 December 2015 (2015) https://rm.coe.int/168074686d</p>	
<p>DiMatteo A, Cañadas A, Roberts J, Sparks L, Panigada S, Boisseau O, Moscrop A, Fortuna CM, Lauriano G, Holcer D, Peltier H, Ridoux V, Raga JA, Tomás J, Broderick AC, Godley BJ, Haywood J, March D, Snape R, Sagarminaga R and Hochscheid S (2022) Basin-wide estimates of loggerhead turtle abundance in the Mediterranean Sea derived from line transect surveys. <i>Frontiers in Marine Science</i> 9: 930412. https://doi.org/10.3389/fmars.2022.930412</p>	
<p>Wallace BP, Posnik ZA, Hurley BJ, DiMatteo AD, Bandimere A, Rodriguez I, Maxwell SM, Meyer L, Brenner H, Jensen MP, LaCasella E, Shamblin BM, Abreu-Grobois FA, Stewart KR, Dutton PH, Barrios-Garrido H, Dalleau M, Dell'Amico F, Eckert KL, FitzSimmons NN, Garcia-Cruz M, Hays GC, Kelez S, Lagueux CJ, Madden Hof CA, Marco A, Martins SLT, Mobaraki A, Mortimer JA, Nel R, Phillott AD, Pilcher NJ, Putman NF, Rees AF, Rguez-Baron JM, Seminoff JA, Swaminathan A, Türkozan O, Vargas SM, Vernet PD, Vilaça S, Whiting SD, Hutchinson BJ, Casale P, Mast RB (2023) Marine turtle regional management units 2.0: an updated framework for conservation and research of wide-ranging megafauna species. <i>Endangered Species Research</i> 52: 209-223 https://doi.org/10.3354/esr01243</p>	
Policy Context and targets (other than IMAP)	
Policy context description	
<p>Similar to the Ecosystem Approach, the EU adopted the European Union Marine Strategy Framework Directive (MSFD) on 17 June 2008, which includes GES definitions, Descriptors, Criteria, Indicators and Targets. In the Mediterranean region, the MSFD applies only to EU member</p>	

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<p>states. The aim of the MSFD is to protect more effectively the marine environment across Europe. In order to achieve GES by 2020, each EU Member State was required to develop a strategy for its marine waters (or Marine Strategy). In addition, because the Directive follows an adaptive management approach, the Marine Strategies must be kept up-to-date and reviewed every 6 years.</p> <p>The MSFD includes Descriptor 1: Biodiversity: “The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions.” Assessment is required at several ecological levels: ecosystems, habitats and species. Among selected species are marine turtles and within this framework, each Member State that is within a marine turtle range, has submitted GES criteria, indicators, targets and a program to monitor them.</p> <p>The MSFD will be complementary to, and provide the overarching framework for, a number of other key Directives and legislation at the European level. Also it calls to regional cooperation meaning “cooperation and coordination of activities between Member States and, whenever possible, third countries sharing the same marine region or subregion, for the purpose of developing and implementing marine strategies” [...] “thereby facilitating achievement of good environmental status in the marine region or subregion concerned”.</p> <p>From the MSFD, Descriptor 1, Criterion 4 (D1C4) approximates to the CI3 of IMAP, relating to a population’s distributional range.</p> <p>Additionally, the EU Habitats Directive stipulates criteria for assessment of species range.</p> <p>Council Directive 92/43/EEC, Article 1 (i)</p> <p>“<i>conservation status of a species</i> means the sum of the influences acting on the species concerned that may affect the long-term distribution and abundance of its populations within the territory referred to in Article 2;</p> <p style="padding-left: 40px;">The <i>conservation status</i> will be taken as ‘favourable’ when:</p> <ul style="list-style-type: none"> • population dynamics data on the species concerned indicate that it is maintaining itself on a long-term basis as a viable component of its natural habitats, and • the natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future, and • there is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis; 	
<p>Indicator/Targets</p> <p>Commission Decision 2010/477/EU sets out the MSFD’s criteria and methodological standards and under Descriptor 1 includes criteria “1.1.Species distribution” and indicators “Distributional range (1.1.1)”, “Distributional pattern within the latter, where appropriate (1.1.2)”, and ”Area covered by the species (for sessile/benthic species) (1.1.3)”.</p> <p>Girard et al. (2022) state:</p> <p><i>Commission Decision (EU) 2017/848 indicates that good status for criterion DIC4 is achieved when “The species distributional range and, where relevant, pattern is in line with prevailing physiographic, geographic and climatic conditions”</i></p> <p><i>The observed distributional range of the species can be estimated using data collected through monitoring programs at sea and at nesting sites. In the case of nesting sites, beach monitoring provides the data required for the assessment of distributional range on land. At sea, aerial and shipboard (including opportunistic platforms such as ferries) distance sampling surveys represent the best source of data for the estimation of the species distributional range. Additionally, observations recorded by stranding networks and citizen science programs ... can complement aerial and shipboard surveys.</i></p>	

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<p>And the assessment is made such that <i>GES is achieved when the distributional range remains stable between reporting cycles. Nevertheless, a better understanding of environmental and anthropogenic drivers of marine turtle distribution will be necessary to finalize assessment approaches.</i></p>	
<p>Policy documents</p> <p>http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32010D0477(01)</p> <p>http://ec.europa.eu/environment/marine/good-environmental-status/descriptor-1/index_en.htm</p> <p>http://ec.europa.eu/environment/marine/eu-coast-and-marine-policy/implementation/reports_en.htm</p> <p>http://ec.europa.eu/environment/marine/pdf/1-Task-group-1-Report-on-Biological-Diversity.pdf</p> <p>http://ec.europa.eu/environment/marine/pdf/9-Task-Group-10.pdf</p> <p>Girard F, Girard A, Monsinjon J, Arcangeli A, Belda E, Cardona L, Casale P, Catteau S, David L, Dell'Amico F, Gambaiani D, Girondot M, Jribi I, Lauriano G, Luschi P, March D, Mazaris AD, Miaud C, Palialexis A, Sacchi J, Sagarminaga R, Tepsich P, Tomás J, Vandeperre F and Claro F. 2022. Toward a common approach for assessing the conservation status of marine turtle species within the European marine strategy framework directive. <i>Frontiers in Marine Science</i> 9: 790733. https://doi.org/10.3389/fmars.2022.790733</p>	
Indicator analysis methods	
Indicator Definition	
<p>Variation in the total area (trends in the number of occupied grid cells) occupied by the selected species for breeding and foraging grounds; foraging grounds being divided into nearshore, offshore neritic and offshore oceanic.</p> <p>The distributional range of a species is an important indicator that may be obtained through the georeferencing species observations, assuming objective techniques are used. To determine the distribution range of a species, it is necessary to know where individuals of the species are located from sampling information. It is therefore necessary to establish minimum information standards to reflect the known distribution of both species. Species distribution ranges can be gauged at local (i.e. within a small area like a national park) or regional (i.e. across the entire Mediterranean basin) scales using a variety of approaches. Long-term monitoring of these areas provides information on the temporal evolution in species distributions. For loggerheads the distribution range should be assumed as all known breeding sites and the entire marine area. For green turtles the distribution range should include all known breeding sites and the marine area as indicated by Wallace et al. (2023).</p>	
Methodology for indicator calculation	
<p>The European (ETRS) 10x10km² grid is used for mapping the distribution and range, accounting each known location along the Mediterranean coast. Three different maps (grids) should be produced yearly for each species, based on index site monitoring and every six years for nationwide assessments. Information should be gathered on presence/absence at breeding sites, nearshore sites and offshore sites at species level. Additional information should be obtained for migratory pathways and interesting habitats which are known to be the areas of most seasonally restricted occupancy.</p> <p>For both species information on spatial distribution within the assessment would be transferred in a 10 × 10 km (or finer for small countries, 1 x 1 km or 5 x 5 km) grid; filled cells show presence of the species. The distribution area is the sum of area of the cells where the species is “present”.</p> <p>For the reporting on the range of a species, considering that it is a suitable parameter for assessing the spatial aspects of GES, and to describe and detect changes in the extent of the distribution, a tool to calculate the range size from the map of the actual breeding (or in-water) distribution is required (i.e. occurrences). The Range Tool software and algorithm will provide a standardised process that will</p>	

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<p>help to ensure repeatability of the range calculation in different reporting rounds. After automated calculation of the range it is possible to correct the gaps to obtain a complete overview of the data following a standardised protocol. The resulting range map will then be a combination of the automated procedure completed by expert judgement.</p>	
<p><i>Indicator units</i></p> <p>Number of 10 x 10 km cells (presence/absence) occupied for breeding or wintering or feeding/developmental areas along the Mediterranean (or subregional) coast and in all pelagic marine areas. These are to be assessed:</p> <p>Annually – Total number of lost locations (breeding, in-water) at index areas; total number of 10 x 10 km lost cells</p> <p>Periodically (six-year reporting period) – Total number of new and lost locations (breeding and in-water) nationally; total number of 10 x 10 km cells</p>	
<p>Selection of guidance documents and protocols available</p> <p>Eckert, K. L., Bjorndal, K. A., Abreu-Grobois, F. A. and Donnelly, M. (Eds.) 1999. Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group Publication No. 4. Washington, DC: 235 pp. https://mtsg.files.wordpress.com/2010/11/techniques-manual-full-en.pdf</p> <p>Gerosa, G. (1996). Manual on Marine Turtle Tagging in the Mediterranean. – Mediterranean Action Plan - UNEP, RAC/SPA, Tunis, 48 pp.</p> <p>McClellan DB. 1996. Aerial surveys for sea turtles, marine mammals and vessel activity along the south east Florida coast 1992-1996. NOAA Technical Memorandum NMFS-SEFSC-390 42pp. https://repository.library.noaa.gov/view/noaa/8463/noaa_8463_DS1.pdf</p> <p>Pilcher NJ, 2023. The SPREP Sea Turtle Monitoring Manual - A guide to selecting the best tools for sea turtle research and monitoring. Secretariat of the Pacific Regional Environment Programme, Apia, Samoa. 96 pp. https://library.sprep.org/index.php/content/sea-turtle-monitoring-manual-guide-selecting-appropriate-tools-basic-sea-turtle-research</p> <p>Rees AF. 2020. Marine Turtles in MPAs: a monitoring and management guide. MedPAN Collection. 68 pp. https://medpan.org/en/resource-center/marine-turtles-mpas-monitoring-and-management-guide</p> <p>SWOT Scientific Advisory Board. 2011. The State of the World’s Sea Turtles (SWOT) Minimum Data Standards for Nesting Beach Monitoring, version 1.0. Handbook, 28 pp. https://www.seaturtlestatus.org/minimum-data-standards</p>	
<p>Data Confidence and uncertainties</p> <p>Presence/absence information is used only, because the different methods used to detect the presence/absence of turtles range from coarse to highly accurate (within metres), along with heavy sighting/detection bias to certain key regions/sites. Turtles should be assumed present in an area of previously established presence, unless proven absent through monitoring.</p>	
<p>Methodology for monitoring, temporal and spatial scope</p>	
<p><i>Available Methodologies and Monitoring Protocols</i></p>	

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<p>Monitoring effort should be long-term and consistent at index sites covering all seasons to ensure that the information obtained is as complete as possible. Periodic national assessments need to be rigorous and repeatable.</p> <ol style="list-style-type: none"> 1. Aerial surveys (planes): transects in terrestrial and marine areas (presence/potential absence at broad scales, requiring local confirmation of absence). Data obtained also contribute to CI4. 2. Aerial surveys (drones): transects (presence/potential absence at small scales, requiring local confirmation of absence). Data obtained also contribute to CI4 and CI5. 3. Boat surveys: ship-based transects (presence/potential absence at broad scales, requiring local confirmation of absence). Data obtained also contribute to CI4. 4. In-water surveys: Diving/snorkelling transects, capture-mark-recapture (nearshore presence/absence, but at very localized scales). Data obtained also contribute to CI4 and CI5. 5. Ground based surveys: Nesting monitoring (breeding areas) - Detection of nesting tracks of turtles on beaches, and stranding monitoring (coastal areas) (confirmed presence/absence, but only where monitoring is conducted). Data obtained also contribute to CI4 and CI5. 6. Bycatch data from fisheries records and onboard researchers, are invaluable for obtaining data in deep/offshore waters (presence/absence, but in focused areas). Data obtained also contribute to CI4 and CI5. 7. Telemetry, generally in the form of satellite tracking: Provides detailed information about the movements, and hence presence, of small numbers of individuals within a population. Tracking devices can be used on turtles from juvenile to adult size classes. Even tracking individuals can provide interesting and useful information, but appropriate sample sizes need to be used to make population-level inferences on movement/dispersal/distribution patterns. (confirmed presence/absence, but limited to small numbers of individuals). Data obtained also contribute to CI4 and CI5. <p>Axillary data collection methods:</p> <ol style="list-style-type: none"> 8. Beached and stranded specimen monitoring: with dedicated stranding networks already existing for sea turtles in many Mediterranean countries, and stranding information being confirmed to reflect distribution patterns based on satellite telemetry studies (supplemental presence data). Data obtained also contribute to CI4 and CI5. 9. Opportunistic data, on non-dedicated platforms (ferries, merchant marine ships or amateurs/yachts, use of citizen science), by-catch data (where dedicated research programs do not exist) (supplemental presence, requiring validation from dedicated surveys) 10. Use of high-resolution remote sensing satellite imagery to detect the presence/absence of tracks on difficult to access areas (i.e. due to distance from roads or lack of national security) may be particularly useful for green turtles with wider tracks and deeper body pits. (confirmed presence/absence over broad scales but possibly limited temporally) 	
<p><i>Available data sources for baselines</i></p> <p>Broderick, A.C., Türkozan, O., Demetropoulos, S., Mastrogiacomo, A., Demetropoulos, A., Levy, Y. & Leader, N. 2024. <i>Chelonia mydas (Mediterranean subpopulation)</i> (amended version of 2023 assessment). <i>The IUCN Red List of Threatened Species 2024</i>: e.T4616A259027885. https://doi.org/10.2305/IUCN.UK.2024-1.RLTS.T4616A259027885.en. Accessed on 16 December 2025.</p> <p>Casale P., Margaritoulis D. (Eds.) 2010. <i>Sea Turtles in the Mediterranean: Distribution, Threats and Conservation Priorities</i>. IUCN/SSC Marine Turtle Specialist Group. Gland, Switzerland: IUCN, 294 pp. http://iucn-mtsg.org/publications/med-report/</p>	

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	<p>Casale, P. 2015. <i>Caretta caretta (Mediterranean subpopulation)</i>. <i>The IUCN Red List of Threatened Species</i> 2015: e.T83644804A83646294. https://doi.org/10.2305/IUCN.UK.2015-4.RLTS.T83644804A83646294.en. Accessed on 16 December 2025.</p> <p>Casale P, Broderick AC, Camiñas JA, Cardona L, Carreras C, Demetropoulos A, Fuller WJ, Godley BJ, Hochscheid S, Kaska Y, Lazar B, Margaritoulis D, Panagopoulou A, Rees AF, Tomás J, Türkozan O. 2018. Mediterranean sea turtles: current knowledge and priorities for conservation and research. <i>Endangered Species Research</i> 36: 229-267. https://doi.org/10.3354/esr00901</p> <p>Casale P., Hochscheid S., Kaska Y., Panagopoulou A. (Eds.) (2020). <i>Sea Turtles in the Mediterranean Region: MTSG Annual Regional Report 2020</i>. Report of the IUCN-SSC Marine Turtle Specialist Group, 2020. https://www.iucn-mtsg.org/s/MTSG-Regional-Report_Mediterranean_2020.pdf</p> <p>DiMatteo A, Cañadas A, Roberts J, Sparks L, Panigada S, Boisseau O, Moscrop A, Fortuna CM, Lauriano G, Holcer D, Peltier H, Ridoux V, Raga JA, Tomás J, Broderick AC, Godley BJ, Haywood J, March D, Snape R, Sagarminaga R and Hochscheid S (2022) Basin-wide estimates of loggerhead turtle abundance in the Mediterranean Sea derived from line transect surveys. <i>Frontiers in Marine Science</i> 9: 930412. https://doi.org/10.3389/fmars.2022.930412</p> <p>Halpin, P.N., Read, A.J., Fujioka, E., et al., 2009. OBIS-SEAMAP the world data center for marine mammal, sea bird, and sea turtle distributions. <i>Oceanography</i> 22, 104–115.</p> <p>Hochscheid S, Maffucci F, Abella E, Nejmeddine Bradai M, Camedda A, Carreras C, Claro F, de Lucia GA, Jribi I, Mancusi C, Marco A, Marrone N, Papetti L, Revuelta O, Urso S, Tomás J. 2022. Nesting range expansion of loggerhead turtles in the Mediterranean: Phenology, spatial distribution, and conservation implications. <i>Global Ecology and Conservation</i> 38: e02194. https://doi.org/10.1016/j.gecco.2022.e02194</p> <p>Margaritoulis, D., Argano, R., Baran, I., Bentivegna, F., Bradai, M.N., Caminas, J.A., Casale, P., Metrio, G.D., Demetropoulos, A., Gerosa, G., Godley, B.J., Haddoud, D.A., Houghton, J., Laurent, L. & Lazar, B. (2003) <i>Loggerhead turtles in the Mediterranean Sea: present knowledge and conservation perspectives</i>. <i>Loggerhead sea turtles</i> (ed. by B.E. Witherington), pp. 175–198. Smithsonian Institution, Washington</p> <p>The state of the World’s Sea Turtles online database: data provided by the SWOT team and hosted on OBIS-SEAMAP (Ocean Biogeographic Information System Spatial Ecological Analysis of Megavertebrate Populations). In: Oceanic Society, Conservation International, IUCN Marine Turtle Specialist Group (MTSG), and Marine Geospatial Ecology Lab, Duke University. http://seamap.env.duke.edu/swot</p> <p>UNEP/MAP-RAC/SPA projects and publications http://www.rac-spa.org/publications</p>
	<p><i>Spatial scope guidance and selection of monitoring stations</i></p> <p>The presence of the two species should be periodically monitored all along the Mediterranean coast and in the known breeding, foraging/developmental areas.</p> <p>The spatial basis for assessment should be according to the Mediterranean biogeographical sub-areas to reflect changes in the distribution of sea turtles in each habitat type across the Mediterranean and its sub-regions.</p> <p>Each Contracting Party should periodically assess all marine (nearshore and offshore) and beach habitats across their national maritime waters. However, it is recommended that annual monitoring is carried out at key index sites distributed across the country in a range of habitat types.</p>

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<p><i>Temporal Scope guidance</i></p> <p>Yearly for each of the species and areas (breeding, foraging and developmental). Precise seasonality to be determined by the local experts as i.e. breeding season can vary along and across the Mediterranean. The widest known range for nesting is April/May to August/September, with the hatching period extending 45 to around 70 days after this (depending on sand composition and temperature).</p> <p>Quarterly or biannual surveying/monitoring of index marine areas should be undertaken with additional data gathered from stranding networks and bycatch monitoring programs gathered year-round.</p>	
<p>Data analysis and assessment outputs</p>	
<p><i>Statistical analysis and basis for aggregation</i></p> <p>The assessment should focus on whether the total area of a species distribution range is maintained or not, i.e. are populations in GES or not. The assessment should be grounded on a baseline condition from 1992, or to the oldest data recorded for the site. To assess the variation in breeding, foraging/developmental ranges, annual comparisons should be made with an emphasis on disappearing areas of use, expressing the range trends over the grids. Periodic analyses will include the potential for there to be emerging locations of turtle presence where none were previously reported. This would mainly refer to new nesting sites being established for either species or wider distribution for green turtles at sea.</p> <p>This objective requires the use of different but widely available GIS geoprocessing techniques and geodatabases tools (e.g. ArcGIS, QGIS, R platform, etc). Data for this CI lend themselves to expression in map form showing presence and absence data and changes from one condition to the other.</p> <p>The trends in the number of occupied cells or area occupied is a basic and immediate parameter for which the significance may be statistically assessed.</p>	
<p><i>Expected assessments outputs</i></p> <p>Temporal trends in distributional range.</p> <p>Maps showing the evolution of the distributional range for the two species at different scales.</p> <p><u>Methodologies for reporting</u></p> <p>Submission of all distribution range data and metadata in a standardized form to the IMAP INFO/RAC System (https://www.info-rac.org/).</p>	
<p><i>Known gaps and uncertainties in the Mediterranean</i></p> <p>Data gaps</p> <ul style="list-style-type: none"> • Location of all breeding/nesting sites (nearing completion) • Location of all foraging and developmental sites (assume turtles present in all range) • Connectivity among the various sites across the Mediterranean (useful for determining resilience and regional threat impacts to different breeding aggregations) <p>Assessment gaps</p> <ul style="list-style-type: none"> • Identify possible baselines and index sites. 	

Indicator Title	<i>Common indicator 3: Species distributional range – Reptiles</i>	
<ul style="list-style-type: none"> • Generate or update databases and maps of known nesting, foraging and development habitats in each Contracting Party, in the context of turtle presence being assumed within the defined species range. • Identify techniques to monitor and assess the impacts of climate change in marine habitats. • Vulnerability/resilience of identified sites in relation to physical pressures and analysis of pressure/impact relationships at these sites to predict potential changes to GES status. • Criteria for the risk-based approach to monitoring and develop harmonized sampling instructions where appropriate. • GES baselines for sites that cannot be inferred from contemporary records of pressure or construction. 		
Information management		
<ul style="list-style-type: none"> • Identify monitoring capacities and gaps for each Contracting Party • Common computing methodologies and data collection instructions, specifying the accuracy (spatial resolution or grid) of the determination of extent (area) a priori. • Harmonised sampling, cartographic, data collation and GIS protocols and standardized data flows for spatial pressure data. • Develop a guidance manual to support the monitoring programme, which will provide more detailed information, tools, and advice on survey design, monitoring methodology and techniques that are most cost-effective and applicable to each of the selected sea turtle species, in order to ultimately ensure standardised monitoring, comparable data sets, reliable estimates and trend information. 		
Synergies with other monitoring frameworks		
<ul style="list-style-type: none"> • Develop monitoring synergies in collaboration with GFCM for- EO3 (Harvest of commercially exploited fish and shellfish), to collect data on sea turtle presence in bycatch • Investigate monitoring synergies with other relevant EOs that will include coast-based fieldwork, in relation to monitoring of new/unknown sea turtle nesting beaches, and of beached/stranded animals, to obtain more widespread information • Discuss and align CI3 requirements with D1C4 of the MSFD 		
Contacts and version Date		
Key contacts within UNEP for further information		
Version No	Date	Author
V.1	20/7/2016	SPA/RAC
V.2	14/04/2017	SPA/RAC
V3	11/05/2026	SPA/RAC

2. Common Indicator 4: Population abundance

Indicator Title	<i>Common Indicator 4: Population abundance (Reptiles)</i>	
Relevant GES definition	Related Operational Objective	Proposed Target(s)
The population size allows to achieve and maintain a favorable conservation status taking into account all life stages of the population	Population size of selected species is maintained	<p>State</p> <p>No human induced decrease in population abundance</p> <p>Population recovers towards natural levels where depleted</p>
Rationale		
<p>Justification for indicator selection</p> <p>Measurements of biological diversity are often used as indicators of ecosystem functioning, as several components of biological diversity define ecosystem functioning, including richness and variety, distribution and abundance. Abundance is a parameter of population demographics and is critical for determining the growth or decline of a population. The objective of this indicator is to determine the population status of loggerhead and green sea turtles through medium- to long-term monitoring, which will establish population trends for these species. This objective requires a census to be conducted in breeding, foraging and developmental areas.</p>		
Scientific References		
<p>Broderick, A.C., F. Glen, B.J. Godley BJ, G.C. Hays. 2002. Estimating the number of green and loggerhead turtles nesting annually in the Mediterranean. <i>Oryx</i> 36:227-235.</p> <p>Broderick, A.C., Türkozan, O., Demetropoulos, S., Mastrogiacomo, A., Demetropoulos, A., Levy, Y. & Leader, N. 2024. <i>Chelonia mydas (Mediterranean subpopulation)</i> (amended version of 2023 assessment). <i>The IUCN Red List of Threatened Species</i> 2024: e.T4616A259027885. https://doi.org/10.2305/IUCN.UK.2024-1.RLTS.T4616A259027885.en. Accessed on 16 December 2025.</p> <p>Casale P., Margaritoulis D. (Eds.) 2010. <i>Sea Turtles in the Mediterranean: Distribution, Threats and Conservation Priorities</i>. IUCN/SSC Marine Turtle Specialist Group. Gland, Switzerland: IUCN, 294 pp. http://iucn-mtsg.org/publications/med-report/</p> <p>Casale P, Broderick AC, Camiñas JA, Cardona L, Carreras C, Demetropoulos A, Fuller WJ, Godley BJ, Hochscheid S, Kaska Y, Lazar B, Margaritoulis D, Panagopoulou A, Rees AF, Tomás J, Türkozan O. 2018. Mediterranean sea turtles: current knowledge and priorities for conservation and research. <i>Endangered Species Research</i> 36: 229-267. https://doi.org/10.3354/esr00901</p> <p>Casale P., Hochscheid S., Kaska Y., Panagopoulou A. (Eds.) (2020). <i>Sea Turtles in the Mediterranean Region: MTSG Annual Regional Report 2020</i>. Report of the IUCN-SSC Marine Turtle Specialist Group, 2020. https://www.iucn-mtsg.org/s/MTSG-Regional-Report_Mediterranean_2020.pdf</p> <p>Casale, P. 2015. <i>Caretta caretta (Mediterranean subpopulation)</i>. <i>The IUCN Red List of Threatened Species</i> 2015: e.T83644804A83646294. https://doi.org/10.2305/IUCN.UK.2015-4.RLTS.T83644804A83646294.en. Accessed on 16 December 2025.</p> <p>Demography Working Group of the Conference. Demography of marine turtles nesting in the Mediterranean Sea: a gap analysis and research priorities - 5th Mediterranean Conference on Marine Turtles, Dalaman, Turkey, 19-23 April 2015. Document T-PVS/Inf(2015)15E Presented at the Convention on the conservation of European wildlife and natural habitats - 35th meeting of the Standing Committee - Strasbourg, 1 - 4 December 2015 (2015) https://rm.coe.int/168074686d</p>		

Indicator Title	<i>Common Indicator 4: Population abundance (Reptiles)</i>
<p>DiMatteo A, Cañadas A, Roberts J, Sparks L, Panigada S, Boisseau O, Moscrop A, Fortuna CM, Lauriano G, Holcer D, Peltier H, Ridoux V, Raga JA, Tomás J, Broderick AC, Godley BJ, Haywood J, March D, Snape R, Sagarminaga R and Hochscheid S (2022) Basin-wide estimates of loggerhead turtle abundance in the Mediterranean Sea derived from line transect surveys. <i>Frontiers in Marine Science</i> 9: 930412. https://doi.org/10.3389/fmars.2022.930412</p>	
Policy Context and targets (other than IMAP)	
<p><i>Policy context description</i></p> <p>Similar to the Ecosystem Approach, the EU adopted the European Union Marine Strategy Framework Directive (MSFD) on 17 June 2008, which includes GES definitions, Descriptors, Criteria, Indicators and Targets. In the Mediterranean region, the MSFD applies only to EU member states. The aim of the MSFD is to protect more effectively the marine environment across Europe. In order to achieve GES by 2020, each EU Member State was required to develop a strategy for its marine waters (or Marine Strategy). In addition, because the Directive follows an adaptive management approach, the Marine Strategies must be kept up-to-date and reviewed every 6 years.</p> <p>The MSFD includes Descriptor 1: Biodiversity: “The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions.” Assessment is required at several ecological levels: ecosystems, habitats and species. Among selected species are marine turtles and within this framework, each Member State that is within a marine turtle range, has submitted GES criteria, indicators, targets and a program to monitor them.</p> <p>The MSFD will be complementary to, and provide the overarching framework for, a number of other key Directives and legislation at the European level. Also it calls to regional cooperation meaning “cooperation and coordination of activities between Member States and, whenever possible, third countries sharing the same marine region or subregion, for the purpose of developing and implementing marine strategies” [...] “thereby facilitating achievement of good environmental status in the marine region or subregion concerned”.</p> <p>From the MSFD, Descriptor 1, Criterion 2 (D1C2) approximates to the CI4 of IMAP, relating to a population’s abundance.</p>	
Indicator/Targets	
<p>Commission Decision 2010/477/EU sets out the MSFD’s criteria and methodological standards and under Descriptor 1 includes criteria 1.2. Population size and indicator “Population abundance and/or biomass, as appropriate (1.2.1)”.</p> <p>Girard et al. (2022) state:</p> <p><i>The definition of GES for DIC2 states that “The population abundance of the species is not adversely affected due to anthropogenic pressures, such that its long-term viability is ensured ... Accordingly, criterion DIC2 should be assessed based on two parameters: the temporal trends in population abundance at sea and at nesting sites.”</i></p> <p><i>Historically, population abundances have been estimated from counts of nesting females or clutches on land. Because monitoring animals on land is cheaper and logistically easier than in the ocean, long time series of nesting activity data have been collected through beach monitoring programs worldwide.</i></p> <p><i>Population abundance at sea can be estimated using distance sampling methods based on aerial and shipboard survey data, or a combination of the two. In these methods, the number of animals recorded along pre-defined transect lines is used to estimate total surface abundances and densities within the whole survey area. Aerial surveys have been one of the most powerful and commonly used tools to estimate fauna abundance at sea ... and have been suggested as one of the most robust</i></p>	

Indicator Title	<i>Common Indicator 4: Population abundance (Reptiles)</i>
<p><i>approaches to gather information on marine turtle abundance and density as they allow estimations over large areas and provide robust estimates.</i></p> <p><i>Due to high interannual variability in abundance estimates ... the longest time series available should be used for the assessment. While such long time series are available for nesting sites, observation effort at sea has usually been less constant, limiting the length and number of time series that can be used for assessment. Therefore, until longer time series become available, trends in abundance at sea should be characterized over the 6-year MSFD reporting period.</i></p>	
<p>Policy documents</p> <p>http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32010D0477(01)</p> <p>http://ec.europa.eu/environment/marine/good-environmental-status/descriptor-1/index_en.htm</p> <p>http://ec.europa.eu/environment/marine/eu-coast-and-marine-policy/implementation/reports_en.htm</p> <p>http://ec.europa.eu/environment/marine/pdf/1-Task-group-1-Report-on-Biological-Diversity.pdf</p> <p>http://ec.europa.eu/environment/marine/pdf/9-Task-Group-10.pdf</p> <p>Girard F, Girard A, Monsinjon J, Arcangeli A, Belda E, Cardona L, Casale P, Catteau S, David L, Dell'Amico F, Gambaiani D, Girondot M, Jribi I, Lauriano G, Luschi P, March D, Mazaris AD, Miaud C, Palialexis A, Sacchi J, Sagarminaga R, Tepsich P, Tomás J, Vandeperre F and Claro F. 2022. Toward a common approach for assessing the conservation status of marine turtle species within the European marine strategy framework directive. <i>Frontiers in Marine Science</i> 9: 790733. https://doi.org/10.3389/fmars.2022.790733</p>	
Indicator analysis methods	
<p><i>Indicator Definition</i></p> <p>The index of population abundance reflects the variation over time of the total population size (counted or estimated) for loggerhead and green sea turtles. This CI builds on CI3 in that not only is presence/absence of turtles noted for a given location but the number of individuals in that location is also assessed.</p> <p>Population size:</p> <p>The number of individuals present in a species specific animal aggregation within a designated geographical range that can be arbitrarily defined or be based on genetic population structuring.</p> <p>Index of population abundance:</p> <p>The index of population abundance is a single species indicator that reflects the temporal variation in the breeding or the non-breeding (foraging/developmental) population of selected species compared to a base year (or reference level). This indicator can be added into multi-species indices to reflect the variation over time of functional groups of species.</p>	
<p><i>Methodology for indicator calculation</i></p> <p>The choice of the most appropriate methodology to calculate the index of population abundance will depend on the temporal pattern of the available data. The methods to obtain the data used in the calculations are described in the monitoring methods below.</p> <p>For data available on an annual basis, site and year, specific counts of individuals of the two species can be related to site and year effects (factors). Abundance is then measured against an historical baseline value or recent trend in values depending on the length of the timeseries data that exist. Periodic assessments equal the IMAP reporting timeframe.</p>	

Indicator Title	<i>Common Indicator 4: Population abundance (Reptiles)</i>
<p><i>Indicator units</i></p> <p>The index of population abundance is a numerical value of species population abundance relative to the population size at a defined base time. The average population size during the previous six-year timeframe is used with baseline threshold levels set at from 1992 era data.</p> <p>Acknowledging that the breeding population in a given year excludes non-breeding adults and all juveniles and that turtles may shift away from index in-water sites, only overarching and obvious data trends should be used in conclusive determination in change to GES status.</p> <p>For the base data used to calculate the index of population abundance, the following units are suggested:</p> <p>Annual data gathered from index sites:</p> <ul style="list-style-type: none"> • for population size at breeding sites, use the <u>number of females (using capture-mark-recapture) or number of nests</u>, with appropriate modelling to extrapolate population numbers depending on the method used • for total number of index nesting sites, <u>number of sites</u> (n) • for non-breeding animals at foraging and developmental sites, <u>number of individuals</u> (n) with appropriate modelling to extrapolate population numbers taking into account individuals that are not observed due to low surfacing frequency in the marine environment (observation bias). <p>Periodic data gathered nationally</p> <ul style="list-style-type: none"> • Number of nests estimated nationally across the coastline • Number of turtles at sea observed and / or modelled from large scale national surveying of nearshore and offshore waters. 	
<p><i>List of Guidance documents and protocols available</i></p> <p>Agabiti C, Baldi G, Moscoloni G, Pandocchi GAA, Gonzalez-Bernando E, Casale P. 2025. High sea turtle density in a Mediterranean foraging ground revealed by UAV surveys and machine learning. <i>Endangered Species Research</i> 58: 241-256 https://doi.org/10.3354/esr01450</p> <p>Eckert, K. L., Bjorndal, K. A., Abreu-Grobois, F. A. and Donnelly, M. (Eds.) 1999. <i>Research and Management Techniques for the Conservation of Sea Turtles</i>. IUCN/SSC Marine Turtle Specialist Group Publication No. 4. Washington, DC: 235 pp. https://mtsg.files.wordpress.com/2010/11/techniques-manual-full-en.pdf</p> <p>Fuentes MMPB, Bell I, Hagihara R, Hamann M, Hazel J, Huth A, Seminoff JA, Sobtzick S, Marsh H. 2015. Improving in-water estimates of marine turtle abundance by adjusting aerial survey counts for perception and availability biases. <i>Journal of Experimental Marine Biology and Ecology</i> 471: 77-83. https://doi.org/10.1016/j.jembe.2015.05.003</p> <p>Gerosa, G. (1996). <i>Manual on Marine Turtle Tagging in the Mediterranean</i>. – Mediterranean Action Plan - UNEP, RAC/SPA, Tunis, 48 pp.</p> <p>McClellan DB. 1996. <i>Aerial surveys for sea turtles, marine mammals and vessel activity along the south east Florida coast 1992-1996</i>. NOAA Technical Memorandum NMFS-SEFSC-390 42pp. https://repository.library.noaa.gov/view/noaa/8463/noaa_8463_DS1.pdf</p> <p>Pilcher NJ, 2023. <i>The SPREP Sea Turtle Monitoring Manual - A guide to selecting the best tools for sea turtle research and monitoring</i>. Secretariat of the Pacific Regional Environment Programme, Apia, Samoa. 96 pp. https://library.sprep.org/index.php/content/sea-turtle-monitoring-manual-guide-selecting-appropriate-tools-basic-sea-turtle-research</p>	

Indicator Title	<i>Common Indicator 4: Population abundance (Reptiles)</i>
<p>Rees AF. 2020. Marine Turtles in MPAs: a monitoring and management guide. MedPAN Collection. 68 pp. https://medpan.org/en/resource-center/marine-turtles-mpas-monitoring-and-management-guide</p> <p>SWOT Scientific Advisory Board. 2011. The State of the World's Sea Turtles (SWOT) Minimum Data Standards for Nesting Beach Monitoring, version 1.0. Handbook, 28 pp. https://www.seaturtlestatus.org/minimum-data-standards</p>	
<p><i>Data Confidence and uncertainties</i></p> <p>Reliable index population abundance requires good census data, obtained regularly over a pre-defined spatial scale that is maintained through time. Index calculation methods allow for some gaps in the data series, but it is important to maintain the spatial scale so that data can be comparable across years. The calculation methods provide a confidence interval which, in turn, is dependent on the level of confidence of the original census data.</p> <p><i>Marine surveys (nearshore and offshore habitats)</i></p> <p>It is not possible to count all individuals in a given habitat/population. Transects survey data must be corrected for the likelihood of observing surfacing animals, i.e. analyses must account for observer and availability biases.</p> <p><i>Terrestrial surveys (nesting beaches)</i></p> <p>It is practically impossible to count all females that nest in a nesting area, as some may emerge before the onset of monitoring or may emerge on beaches that are not monitored. Thus, the most practical way to estimate nesting population is to document the number of nests, taking care to not double count nests on repeated surveys.</p> <p>Extrapolating female numbers from track/nest counts must be treated with caution. Various conversion factors exist to estimate this value. However, to avoid potentially erroneous conversions, nest numbers should be used as a proxy for nester abundance.</p>	
Methodology for monitoring, temporal and spatial scope	
<p><i>Available Methodologies for Monitoring and Monitoring Protocols</i></p> <p>Monitoring effort should be long-term and consistent at index sites covering all seasons to ensure that the information obtained is as complete as possible. Periodic national assessments need to be rigorous and repeatable.</p> <ol style="list-style-type: none"> 1. Aerial surveys (planes): transects in terrestrial and marine areas (Quantifying presence at broad scales, requiring local ground truthing, especially for terrestrial areas). Data building on those collected for CI3. 2. Aerial surveys (drones): transects (Quantifying presence at small scales, requiring local ground truthing, especially for terrestrial areas). Data building on those collected for CI3. 3. Boat surveys: ship-based transects (Quantifying presence at broad scales). Data building on those collected for CI3. 4. In-water surveys: Diving/snorkelling transects, capture-mark-recapture (nearshore abundance estimates, but at very localized scales Data building on those collected for CI3 and can contribute to CI5. 5. Ground based surveys: Nesting monitoring (breeding areas) - Detection of tracks of turtles on beaches, and stranding monitoring (coastal areas) (Quantifying presence, but only where monitoring is conducted). Data obtained build on those contributing to CI3 and are useful for CI5. 	

Indicator Title	<i>Common Indicator 4: Population abundance (Reptiles)</i>
	<p>6. Bycatch data from fisheries records and onboard researchers, are invaluable for obtaining data in deep/offshore waters (Relative abundance estimates possible in focused areas but only to be used as an adjunct to other more reliable data types). Data obtained build on those contributing to CI3 and are useful for CI5.</p> <p>7. Telemetry, generally in the form of satellite tracking: Provides detailed information about the movements, and hence presence, of small numbers of individuals within a population. Tracking devices can be used on turtles from juvenile to adult size classes. Even tracking individuals can provide interesting and useful information, that can be used as indicators of potential turtle hotspots, with high abundances. (confirmed presence and potentially indicators of preferred locations but limited to small numbers of individuals). Data obtained also contribute to CI3 and CI5.</p> <p>Axillary data collection methods:</p> <p>8. Beached and stranded specimen monitoring: with dedicated stranding networks already existing for sea turtles in many Mediterranean countries, and stranding information being confirmed to reflect distribution patterns based on satellite telemetry studies (supplemental abundance data). Data obtained also contribute to CI3 and CI5.</p> <p>9. Opportunistic data, on non-dedicated platforms (ferries, merchant marine ships or amateurs/yachts, use of citizen science), by-catch data (where dedicated research programs do not exist) (supplemental abundance data, requiring validation from dedicated surveys)</p> <p>10. Use of high-resolution remote sensing satellite imagery to detect the presence/absence of tracks on difficult to access areas (i.e. due to distance from roads or lack of national security) may be particularly useful for green turtles with wider tracks and deeper body pits. (confirmed abundance over broad scales but possibly limited temporally)</p>
	<p><i>Available data sources for baselines</i></p> <p>Broderick, A.C., Türkozan, O., Demetropoulos, S., Mastrogiacomo, A., Demetropoulos, A., Levy, Y. & Leader, N. 2024. <i>Chelonia mydas (Mediterranean subpopulation)</i> (amended version of 2023 assessment). <i>The IUCN Red List of Threatened Species</i> 2024: e.T4616A259027885. https://doi.org/10.2305/IUCN.UK.2024-1.RLTS.T4616A259027885.en. Accessed on 16 December 2025.</p> <p>Casale P., Margaritoulis D. (Eds.) 2010. <i>Sea Turtles in the Mediterranean: Distribution, Threats and Conservation Priorities</i>. IUCN/SSC Marine Turtle Specialist Group. Gland, Switzerland: IUCN, 294 pp. http://iucn-mtsg.org/publications/med-report/</p> <p>Casale, P. 2015. <i>Caretta caretta (Mediterranean subpopulation)</i>. <i>The IUCN Red List of Threatened Species</i> 2015: e.T83644804A83646294. https://doi.org/10.2305/IUCN.UK.2015-4.RLTS.T83644804A83646294.en. Accessed on 16 December 2025.</p> <p>Casale P, Broderick AC, Camiñas JA, Cardona L, Carreras C, Demetropoulos A, Fuller WJ, Godley BJ, Hochscheid S, Kaska Y, Lazar B, Margaritoulis D, Panagopoulou A, Rees AF, Tomás J, Türkozan O. 2018. Mediterranean sea turtles: current knowledge and priorities for conservation and research. <i>Endangered Species Research</i> 36: 229-267. https://doi.org/10.3354/esr00901</p> <p>Casale P., Hochscheid S., Kaska Y., Panagopoulou A. (Eds.) (2020). <i>Sea Turtles in the Mediterranean Region: MTSG Annual Regional Report 2020</i>. Report of the IUCN-SSC Marine Turtle Specialist Group, 2020. https://www.iucn-mtsg.org/s/MTSG-Regional-Report_Mediterranean_2020.pdf</p> <p>DiMatteo A, Cañadas A, Roberts J, Sparks L, Panigada S, Boisseau O, Moscrop A, Fortuna CM, Lauriano G, Holcer D, Peltier H, Ridoux V, Raga JA, Tomás J, Broderick AC, Godley BJ,</p>

Indicator Title	<i>Common Indicator 4: Population abundance (Reptiles)</i>
	<p>Haywood J, March D, Snape R, Sagarminaga R and Hochscheid S (2022) Basin-wide estimates of loggerhead turtle abundance in the Mediterranean Sea derived from line transect surveys. <i>Frontiers in Marine Science</i> 9: 930412. https://doi.org/10.3389/fmars.2022.930412</p> <p>Halpin, P.N., Read, A.J., Fujioka, E., et al., 2009. OBIS-SEAMAP the world data center for marine mammal, sea bird, and sea turtle distributions. <i>Oceanography</i> 22, 104–115.</p> <p>Hochscheid S, Maffucci F, Abella E, Nejmeddine Bradai M, Camedda A, Carreras C, Claro F, de Lucia GA, Jribi I, Mancusi C, Marco A, Marrone N, Papetti L, Revuelta O, Urso S, Tomás J. 2022. Nesting range expansion of loggerhead turtles in the Mediterranean: Phenology, spatial distribution, and conservation implications. <i>Global Ecology and Conservation</i> 38: e02194. https://doi.org/10.1016/j.gecco.2022.e02194</p> <p>Margaritoulis, D., Argano, R., Baran, I., Bentivegna, F., Bradai, M.N., Caminas, J.A., Casale, P., Metrio, G.D., Demetropoulos, A., Gerosa, G., Godley, B.J., Haddoud, D.A., Houghton, J., Laurent, L. & Lazar, B. (2003) Loggerhead turtles in the Mediterranean Sea: present knowledge and conservation perspectives. <i>Loggerhead sea turtles</i> (ed. by B.E. Witherington), pp. 175–198. Smithsonian Institution, Washington</p> <p>The state of the World’s Sea Turtles online database: data provided by the SWOT team and hosted on OBIS-SEAMAP (Ocean Biogeographic Information System Spatial Ecological Analysis of Megavertebate Populations). In: Oceanic Society, Conservation International, IUCN Marine Turtle Specialist Group (MTSG), and Marine Geospatial Ecology Lab, Duke University. http://seamap.env.duke.edu/swot</p> <p>UNEP/MAP-RAC/SPA projects and publications http://www.rac-spa.org/publications</p>
	<p><i>Spatial scope guidance and selection of monitoring stations</i></p> <p>The abundance of the two species should be periodically monitored all along the Mediterranean coast and in the known breeding, foraging/developmental areas.</p> <p>The spatial basis for assessment should be according to the Mediterranean biogeographical sub-areas to reflect changes in the distribution of sea turtles in each habitat type across the Mediterranean and its sub-regions.</p> <p>Each Contracting Party should periodically assess all marine (nearshore and offshore) and beach habitats across their national maritime waters. However, it is recommended that annual monitoring is carried out at key index sites distributed across the country in a range of habitat types.</p>
	<p><i>Temporal Scope guidance</i></p> <p>Yearly for each of the species and areas (breeding, foraging and developmental). Precise seasonality to be determined by the local experts as i.e. breeding season can vary along and across the Mediterranean. The widest known range for nesting is April/May to August/September, with the hatching period extending 45 to around 70 days after this (depending on sand composition and temperature).</p> <p>Quarterly or biannual surveying/monitoring of index marine areas should be undertaken with additional data gathered from stranding networks and bycatch monitoring programs gathered year-round.</p>
Data analysis and assessment outputs	
	<p><i>Statistical analysis and basis for aggregation</i></p> <p>It is not possible to survey all individuals in a turtle population either through in-water or beach-based surveys thus, various models may be established and validated for the different targets (breeding, foraging and developmental sites). That said trends in annual abundance values from index sites and differences between wider scale periodic national datasets can be combined and used to infer GES per Contracting Party and subsequently sub-regionally and regionally.</p>

Indicator Title	<i>Common Indicator 4: Population abundance (Reptiles)</i>
<p>Several analyses exist to infer population size based on the metric being counted, e.g. on nesting beaches, different groups count female numbers, nest numbers or track numbers from which population size is inferred. In the water, turtles do not surface regularly, so some individuals are always missed from population surveys. The statistics used depend on the monitoring method used and, especially in the case of marine habitats, the environmental conditions during surveying.</p> <p>To be clear, the abundance values do not need to be estimates for the entire population, but they do need to represent a considerable proportion of the population and be generated with scientific rigour from data collected in standardised and repeatable ways so that one year's estimate and each periodic estimate is comparable to previous estimates.</p>	
<p><i>Expected assessments outputs</i></p> <p>This indicator will be largely built on establishing counts of nests on beaches and sea turtles in breeding, foraging and developmental habitats. The main output of the monitoring will be therefore:</p> <ul style="list-style-type: none"> • Modelled estimates of abundance annually in index areas where turtle presence is detected and periodically over larger spatial scales • Changes (trends) in the number of individuals in each location and habitat over time <p>In addition to national or subregional indices, trends can be computed to indicate whether long term changes in turtle populations indicate GES is met, not met or undetermined and if this is different to the previous assessment.</p> <p><u>Methodologies for reporting</u></p> <p>Submission of all distribution range data and metadata in a standardized form to the IMAP INFO/RAC System (https://www.info-rac.org/).</p>	
<p><i>Known gaps and uncertainties in the Mediterranean</i></p> <p>Data gaps</p> <ul style="list-style-type: none"> • Generate or update databases and maps of known nesting, feeding, wintering habitats in each Contracting Party • Number of turtles frequenting nearshore and offshore sites, along with how numbers vary across the season as individuals enter and leave different sites. • Identify possible baselines and index sites, especially for marine habitats as nesting beaches are increasingly well documented. • Vulnerability/resilience of identified sites in relation to physical pressures and analysis of pressure/impact relationships at these sites to predict potential changes to GES status. <p>Assessment gaps</p> <ul style="list-style-type: none"> • Criteria for the risk-based approach to monitoring and develop harmonized sampling instructions where appropriate. • Identify techniques to monitor and assess the impacts of climate change in marine habitats. • GES baselines for sites that cannot be inferred from contemporary records of pressure or construction. • Identify monitoring capacities and gaps in each Contracting Party. <p>Information management</p> <ul style="list-style-type: none"> • Common computing methodologies and data collection instructions, specifying the accuracy (spatial resolution or grid) of the determination of extent (area) a priori. 	

Indicator Title	<i>Common Indicator 4: Population abundance (Reptiles)</i>	
<ul style="list-style-type: none"> • Harmonised sampling, cartographic, data collation and GIS protocols and standardized data flows for spatial pressure data • Develop a guidance manual to support the monitoring programme, which will provide more detailed information, tools, and advice on survey design, monitoring methodology and techniques that are most cost-effective and applicable to each of the selected sea turtle species, in order to ultimately ensure standardised monitoring, comparable data sets, reliable estimates and trend information. 		
Synergies with other monitoring frameworks		
<ul style="list-style-type: none"> • Develop monitoring synergies in collaboration with GFCM for- EO3 (Harvest of commercially exploited fish and shellfish), to collect data via sea turtle bycatch. • Investigate monitoring synergies with other relevant EOs that will include coast-based fieldwork, in relation to monitoring of new/unknown sea turtle nesting beaches, and of beached/stranded animals, to obtain more widespread information • Discuss and align CI4 requirements with D1C2 of the MSFD. 		
Contacts and version Date		
Key contacts within UNEP for further information		
Version No	Date	Author
V.1	20/7/2016	SPA/RAC
V.2	14/04/2017	SPA/RAC
V.3	11/05/2006	SPA/RAC

3. Common Indicator 5: Population demographic characteristics

Indicator Title		
<i>Common indicator 5: Population demographic characteristics (Reptiles)</i>		
Relevant GES definition	Related Operational Objective	Proposed Target(s)
Low mortality induced by incidental catch, Favorable sex ratio and no decline in hatching rate	Population condition of selected species is maintained	Response Measures to mitigate incidental catches in turtles implemented Viable sex ratios and high hatchling emergence success produced at nesting beaches
Rationale		
<p>Justification for indicator selection</p> <p>Demography is used in ecology (particularly population and evolutionary ecology) as the basis for population studies. Demography information:</p> <ul style="list-style-type: none"> • helps to identify the stage(s) in the life cycle that most affect(s) population stability and growth. • may be used to inform the most effective conservation/exploitation practices (e.g. fisheries management). • Can inform the health status of a population, and alert to potential impending increases or decreases in the number of breeding individuals. • may be used to assess potential competitive abilities, colonization. • may be used as a basis for understanding the evolution of life history traits. • may be used to indicate fitness with respect to the surrounding environment. 		
Scientific References		
<p>Casale, P., D. Freggi, R. Basso, R. Argano. 2005. Size at male maturity, sexing methods and adult sex ratio in loggerhead turtles (<i>Caretta caretta</i>) from Italian waters investigated through tail measurements. <i>Journal of Herpetology</i> 15: 145-148.</p> <p>Casale P., Margaritoulis D. (Eds.) 2010. <i>Sea Turtles in the Mediterranean: Distribution, Threats and Conservation Priorities</i>. IUCN/SSC Marine Turtle Specialist Group. Gland, Switzerland: IUCN, 294 pp. http://iucn-mtsg.org/publications/med-report/</p> <p>Casale P. 2011. Sea turtle by-catch in the Mediterranean. <i>Fish and Fisheries</i> 12: 299-316. https://doi.org/10.1111/j.1467-2979.2010.00394.x</p> <p>Casale P, Broderick AC, Camiñas JA, Cardona L, Carreras C, Demetropoulos A, Fuller WJ, Godley BJ, Hochscheid S, Kaska Y, Lazar B, Margaritoulis D, Panagopoulou A, Rees AF, Tomás J, Türkozan O. 2018. Mediterranean sea turtles: current knowledge and priorities for conservation and research. <i>Endangered Species Research</i> 36: 229-267. https://doi.org/10.3354/esr00901</p> <p>Casale P., Hochscheid S., Kaska Y., Panagopoulou A. (Eds.) (2020). <i>Sea Turtles in the Mediterranean Region: MTSG Annual Regional Report 2020</i>. Report of the IUCN-SSC Marine Turtle Specialist Group, 2020. https://www.iucn-mtsg.org/s/MTSG-Regional-Report_Mediterranean_2020.pdf</p> <p>Demography Working Group of the Conference. Demography of marine turtles nesting in the Mediterranean Sea: a gap analysis and research priorities - 5th Mediterranean Conference on Marine Turtles, Dalaman, Turkey, 19-23 April 2015. Document T-PVS/Inf(2015)15E Presented at the Convention on the conservation of European wildlife and natural habitats - 35th meeting of the Standing Committee - Strasbourg, 1 - 4 December 2015 (2015). https://rm.coe.int/168074686d</p> <p>Eckert, K. L., Bjorndal, K. A., Abreu-Grobois, F. A. and Donnelly, M. (Eds.) 1999. <i>Research and Management Techniques for the Conservation of Sea Turtles</i>. IUCN/SSC Marine Turtle Specialist</p>		

Indicator Title	<i>Common indicator 5: Population demographic characteristics (Reptiles)</i>
<p>Group Publication No. 4. Washington, DC: 235 pp. https://mtsg.files.wordpress.com/2010/11/techniques-manual-full-en.pdf</p> <p>Gerosa, G. and P. Casale. 1999. Interaction of marine turtles with fisheries in the Mediterranean. UNEP/MAP, RAC/SPA: Tunis, Tunisia. 59pp</p> <p>Girondot, M., Mourrain, B., Chevallier, D., and Godfrey, M. H. 2021. Maturity of a giant: age and size reaction norm for sexual maturity for Atlantic leatherback turtles. <i>Marine Ecology</i> 42: e12631. https://doi.org/10.1111/maec.12631</p> <p>Hays GC, Mazaris AD, Schofield G. 2014. Different male versus female breeding periodicity helps mitigate offspring sex ratio skews in sea turtles. <i>Frontiers in Marine Science</i> 1: 43. https://doi.org/10.3389/fmars.2014.00043</p> <p>Laurent, L., E. M. Abd El-Mawla, M. N. Bradai, F. Demirayak, A. Oruc. 1996. Reducing sea turtle mortality induced by Mediterranean fisheries. Trawling activity in Egypt, Tunisia and Turkey. Report for the WWF International Mediterranean Program. WWF project 9E0103.</p> <p>Omeyer, L.C.M., Stokes, K.L., Beton, D., Çiçek, B.A., Davey, S., Fuller, W.J., Godley, B.J., Sherley, R.B., Snape, R.T.E. and Broderick, A.C. 2021. Investigating differences in population recovery rates of two sympatrically nesting sea turtle species. <i>Animal Conservation</i> 24: 832-846. https://doi.org/10.1111/acv.12689</p> <p>Omeyer LCM, McKinley TJ, Bréheret N, Bal G, Petchell Balchin G, Bitsindou A, Chauvet E, Collins T, Curran BK, Formia A, Girard A, Girondot M, Godley BJ, Mavoungou J-G, Poli L, Tilley D, VanLeeuwe H and Metcalfe K. 2022. Missing data in sea turtle population monitoring: A Bayesian statistical framework accounting for incomplete sampling. <i>Frontiers in Marine Science</i> 9: 817014. https://doi.org/10.3389/fmars.2022.817014</p> <p>Pilcher NJ, 2023. The SPREP Sea Turtle Monitoring Manual - A guide to selecting the best tools for sea turtle research and monitoring. Secretariat of the Pacific Regional Environment Programme, Apia, Samoa. 96 pp. https://library.sprep.org/index.php/content/sea-turtle-monitoring-manual-guide-selecting-appropriate-tools-basic-sea-turtle-research</p> <p>Rees, A.F., D. Margaritoulis, R. Newman, T.E. Riggall, P. Tsaros, J.A. Zbinden, B.J Godley. 2013. Ecology of loggerhead marine turtles <i>Caretta caretta</i> in a neritic foraging habitat: movements, sex ratios and growth rates. <i>Marine Biology</i> 160: 519-529. https://doi.org/10.1007/s00227-012-2107-2</p> <p>Rees AF. 2020. Marine Turtles in MPAs: a monitoring and management guide. MedPAN Collection. 68 pp. https://medpan.org/en/resource-center/marine-turtles-mpas-monitoring-and-management-guide</p> <p>Schofield G, Katselidis KA, Lilley MKS, Reina RD, Hays GC. Detecting elusive aspects of wildlife ecology using drones: New insights on the mating dynamics and operational sex ratios of sea turtles. <i>Functional Ecology</i> 31: 2310–2319. https://doi.org/10.1111/1365-2435.12930</p> <p>SWOT Scientific Advisory Board. 2011. The State of the World’s Sea Turtles (SWOT) Minimum Data Standards for Nesting Beach Monitoring, version 1.0. Handbook, 28 pp. https://www.seaturtlestatus.org/minimum-data-standards</p>	
Policy Context and targets (other than IMAP)	
<p>Policy context description</p> <p>Similar to the Ecosystem Approach, the EU adopted the European Union Marine Strategy Framework Directive (MSFD) on 17 June 2008, which includes GES definitions, Descriptors, Criteria, Indicators and Targets. In the Mediterranean region, the MSFD applies only to EU member states. The aim of the MSFD</p>	

<p>Indicator Title</p>	<p><i>Common indicator 5: Population demographic characteristics (Reptiles)</i></p>
<p>is to protect more effectively the marine environment across Europe. In order to achieve GES by 2020, each EU Member State was required to develop a strategy for its marine waters (or Marine Strategy). In addition, because the Directive follows an adaptive management approach, the Marine Strategies must be kept up-to-date and reviewed every 6 years.</p> <p>The MSFD includes Descriptor 1: Biodiversity: “The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions.” Assessment is required at several ecological levels: ecosystems, habitats and species. Among selected species are marine turtles and within this framework, each Member State that is within a marine turtle range, has submitted GES criteria, indicators, targets and a program to monitor them.</p> <p>The MSFD will be complementary to, and provide the overarching framework for, a number of other key Directives and legislation at the European level. Also it calls to regional cooperation meaning “cooperation and coordination of activities between Member States and, whenever possible, third countries sharing the same marine region or subregion, for the purpose of developing and implementing marine strategies” [...] “thereby facilitating achievement of good environmental status in the marine region or subregion concerned”.</p> <p>From the MSFD, Descriptor 1, Criterion 3 (D1C3) approximates to the CI5 of IMAP, relating to a population’s demographic parameters.</p>	
<p>Indicator/Targets</p> <p>Commission Decision 2010/477/EU sets out the MSFD’s criteria and methodological standards and under Descriptor 1 includes criteria “1.3. Population condition” and indicators “Population demographic characteristics (e.g. body size or age class structure, sex ratio, fecundity rates, survival/mortality rates) (1.3.1)” and “Population genetic structure, where appropriate (1.3.2)”.</p> <p>Girard et al. (2022) state:</p> <p><i>In this case, the status of D1C3 will be considered as good when “The population demographic characteristics (e.g. body size or age class structure, sex ratio, fecundity, and survival rates) of the species are indicative of a healthy population that is not adversely affected due to anthropogenic pressures”. Although considered as secondary in the GES Decision, D1C3 is in fact a key criterion. ... the proper estimation of demographic parameters such as fecundity or survival rates is essential to the development of demographic models, and thus central to the assessments of primary criteria D1C1 and D1C2...</i></p> <p><i>While further work is needed to effectively assess criterion D1C3, approaches relying on field data, genetic studies and modelling were discussed. Specifically, an approach based on the evaluation of the adult/juvenile ratio, estimated from size distribution data (“reaction norm of the size of sexual maturity” method; Girondot et al., 2021) was considered as particularly promising and is currently under development.</i></p> <p>It is clear from the above that determination of GES for D1C3 is not fully elaborated under the MSFD framework.</p>	
<p>Policy documents</p> <p>http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32010D0477(01)</p> <p>http://ec.europa.eu/environment/marine/good-environmental-status/descriptor-1/index_en.htm</p> <p>http://ec.europa.eu/environment/marine/eu-coast-and-marine-policy/implementation/reports_en.htm</p> <p>http://ec.europa.eu/environment/marine/pdf/1-Task-group-1-Report-on-Biological-Diversity.pdf</p> <p>http://ec.europa.eu/environment/marine/pdf/9-Task-Group-10.pdf</p>	

Indicator Title	<i>Common indicator 5: Population demographic characteristics (Reptiles)</i>
<p>Girard F, Girard A, Monsinjon J, Arcangeli A, Belda E, Cardona L, Casale P, Catteau S, David L, Dell'Amico F, Gambaiani D, Girondot M, Jribi I, Lauriano G, Luschi P, March D, Mazaris AD, Miaud C, Palialexis A, Sacchi J, Sagarminaga R, Tepsich P, Tomás J, Vandeperre F and Claro F. 2022. Toward a common approach for assessing the conservation status of marine turtle species within the European marine strategy framework directive. <i>Frontiers in Marine Science</i> 9: 790733. https://doi.org/10.3389/fmars.2022.790733</p>	
Indicator analysis methods	
<p>Indicator Definition</p> <p>Demography is the study of various population parameters. Demography provides a mathematical description of how such parameters may change over time. Demographics may include any statistical factors that influence population growth or decline, but several parameters are particularly important: population size, density, age structure, fecundity/recruitment (birth rates), mortality (death rates), and sex ratio, which is especially important in species with temperature dependent sex determination, such as sea turtles.</p>	
<p>Methodology for indicator calculation</p> <p>Methods to acquire data for this CI in part build on those gathered for CI3 and CI4 but also involve a range of dedicated monitoring methods. For example, monitoring methods used to determine presence absence of turtles for distribution (CI3) when identifying the numbers of individuals present can be used for abundance estimates (CI4) and if those individuals can be sexed or assigned to size/age classes they can be used for demographic purposes (CI5).</p> <p>Additional data required to assess demography, such as age at sexual maturity, growth rate and age structure, fecundity (clutch size and numbers of hatchlings that emerge from nests and then reach the sea), mortality (death rates, and notably from bycatch) for each stage/age class, and sex ratios (in turtles: hatchling, juveniles, and adults).</p> <p>The choice of the most appropriate methodology to calculate the different types of demographic information will depend on the temporal pattern of the available data. The methods to obtain the data used in the calculations are described in the monitoring methods below.</p> <p>Due to the complex nature of some of the data requirements for demographic assessments not all contracting parties need to determine their own national factor values, such as age at sexual maturity. Instead, values generated elsewhere across the region, by other contracting parties with more turtles and resources, can be used.</p>	
<p>Indicator units</p> <ul style="list-style-type: none"> • A variety of population demography values will be compiled for different components of the populations of the two species. Trend analyses should be based on at least six years' of information as the base level to align with reporting requirements and reflecting the minimum timeframe relevant to sea turtle life-histories. • Indicator units are a mixture of those factors that simply indicate population status, but cannot be affected by conservation actions, such as number of eggs per clutch, and those factors that can be influenced by conservation and management, such as hatchling emergence success and population-level bycatch impacts. <p>Units to be monitored</p> <ul style="list-style-type: none"> • Number of individuals in relation to population estimates per population range or management unit, per year, per size class and per sex. 	

Indicator Title	<i>Common indicator 5: Population demographic characteristics (Reptiles)</i>
<ul style="list-style-type: none"> • Breeding success/failure (Emergence success rate for hatchlings from each annual cohort of nests, the average number of eggs per clutch and number of clutches laid) • Sex ratio of turtles of all age/size classes from hatchlings to adults at breeding, foraging and developmental sites. • Mortality/Survival rates, per age class, determined from capture-mark-recapture programs, bycatch levels and stranding records at index sites in different habitats. <p>Additional monitoring units to inform possible future changes in GES</p> <ul style="list-style-type: none"> • Physical health indicators of turtles from juveniles to adults • Numbers of individuals, of different size classes and where possible identified by sex, killed through non-natural causes. 	
<p><i>List of Guidance documents and protocols available</i></p> <p>Bellier, E., Monestiez, P., and Guinet, C. 2009. Geostatistical modelling of wildlife populations: A non-stationary hierarchical model for count data. In <i>GeoENV VII – Geostatistics for Environmental Applications</i>. Eds. P. M. Atkinson and C. D. Lloyd (Dordrecht: Springer Netherlands), 1–12. https://doi.org/10.1007/978-90-481-2322-3_1</p> <p>Bentley, B. P., Kearney, M. R., Whiting, S. D., and Mitchell, N. J. 2020. Microclimate modelling of beach sand temperatures reveals high spatial and temporal variation at sea turtle rookeries. <i>Journal of Thermal Biology</i> 88: 102522. https://doi.org/10.1016/j.jtherbio.2020.102522</p> <p>Bjorndal, K. A., Bowen, B. W., Chaloupka, M., Crowder, L. B., Heppell, S. S., Al, E. 2010. <i>Assessment of sea-turtle status and trends: integrating demography and abundance</i>. Washington National Academic Press. 174pp. https://doi.org/10.17226/12889</p> <p>Casale, P., Heppell, S. S. 2016. How much sea turtle bycatch is too much? a stationary age distribution model for simulating population abundance and potential biological removal in the Mediterranean. <i>Endangered Species Research</i> 29: 239-254. https://doi.org/10.3354/esr00714</p> <p>Casale P, Broderick AC, Camiñas JA, Cardona L, Carreras C, Demetropoulos A, Fuller WJ, Godley BJ, Hochscheid S, Kaska Y, Lazar B, Margaritoulis D, Panagopoulou A, Rees AF, Tomás J, Türkozan O. 2018. Mediterranean sea turtles: current knowledge and priorities for conservation and research. <i>Endangered Species Research</i> 36: 229-267. https://doi.org/10.3354/esr00901</p> <p>Casale P., Hochscheid S., Kaska Y., Panagopoulou A. (Eds.). 2020. <i>Sea Turtles in the Mediterranean Region: MTSG Annual Regional Report 2020</i>. Report of the IUCN-SSC Marine Turtle Specialist Group, 2020. https://www.iucn-mtsg.org/s/MTSG-Regional-Report_Mediterranean_2020.pdf</p> <p>Crouse, D. T., Crowder, L. B., and Caswell, H. 1987. A stage-based population model for loggerhead sea turtles and implications for conservation. <i>Ecology</i> 68: 1412-1423. https://doi.org/10.2307/1939225</p> <p>Dickson LCD, Tugwell H, Katselidis KA and Schofield G. 2022. Aerial drones reveal the dynamic structuring of sea turtle breeding aggregations and minimum survey effort required to capture climatic and sex-specific effects. <i>Frontiers in Marine Science</i> 9: 864694. https://doi.org/10.3389/fmars.2022.864694</p> <p>Dimitriadis, C., Mazaris, A. D., Katsanevakis, S., Iosifakis, A., Spinou, E., Kalli, E., et al. 2022. Stranding records and cumulative pressures for sea turtles as tools to delineate risk hot spots across different marine habitats. <i>Ocean and Coastal Management</i> 217: 106017. https://doi.org/10.1016/j.ocecoaman.2021.106017</p>	

Indicator Title	<i>Common indicator 5: Population demographic characteristics (Reptiles)</i>
<p>Eckert, K. L., Bjørndal, K. A., Abreu-Grobois, F. A. and Donnelly, M. (Eds.) 1999. Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group Publication No. 4. Washington, DC: 235 pp. https://mtsg.files.wordpress.com/2010/11/techniques-manual-full-en.pdf</p> <p>Fuentes, M. M. P. B., and Porter, W. P. 2013. Using a microclimate model to evaluate impacts of climate change on sea turtles. <i>Ecological Modelling</i> 251: 150–157. https://doi.org/10.1016/j.ecolmodel.2012.12.020</p> <p>Gerosa, G. (1996). Manual on Marine Turtle Tagging in the Mediterranean. –Mediterranean Action Plan - UNEP, RAC/SPA, Tunis, 48 pp.</p> <p>Gerosa, G. and M. Aureggi. 2001. Sea Turtle Handling Guidebook for Fishermen. UNEP Mediterranean Action Plan, Regional Activity Centre for Specially Protected Areas. Tunis. http://www.rac-spa.org</p> <p>Mazaris AD, Dimitriadis C, Papazekou M, Schofield G, Doxa A, Chatzimentor A, Turkozan O, Katsanevakis S, Lioliou A, et al. 2023. Priorities for Mediterranean marine turtle conservation and management in the face of climate change. <i>Journal of Environmental Management</i> 339: 117805. https://doi.org/10.1016/j.jenvman.2023.117805</p> <p>McClellan DB. 1996. Aerial surveys for sea turtles, marine mammals and vessel activity along the south east Florida coast 1992-1996. NOAA Technical Memorandum NMFS-SEFSC-390 42pp. https://repository.library.noaa.gov/view/noaa/8463/noaa_8463_DS1.pdf</p> <p>Omeyer, L.C.M., Casale, P., Fuller, W.J., Godley, B.J., Holmes, K.E.K.E., Snape, R.T.E. & Broderick, A.C. 2019. The importance of passive integrated transponder (PIT) tags for measuring life-history traits of sea turtles. <i>Biological Conservation</i> 240: 108248. https://doi.org/10.1016/j.biocon.2019.108248</p> <p>Patricio A., Hawkes L. A., Monsinjon J., Godley B. J., Fuentes M.M.P.B. 2021. Climate change and marine turtles: recent advances and future directions. <i>Endangered Species Research</i> 44: 363-395. https://doi.org/10.3354/esr01110</p> <p>Phelan S. M, Eckert K.L. 2006. Marine Turtle Trauma Response Procedures: A Field Guide. Wider Caribbean Sea Turtle Conservation Network (WIDECAST) Technical Report No. 4. Beaufort, North Carolina. 71 pp. https://www.widecast.org/Resources/Docs/Phelan_and_Eckert_2006_Sea_Turtle_Trauma_Response_Field_Guide.pdf</p> <p>Schofield, G., K.A. Katselidis, P. Dimopoulos, J.D. Pantis. 2008. Investigating the viability of photo-identification as an objective tool to study endangered sea turtle populations. <i>Journal of Experimental Marine Biology & Ecology</i> 360: 103-108. https://doi.org/10.1016/j.jembe.2008.04.005</p> <p>Stokes, K. L., Fuller, W. J., Glen, F., Godley, B. J., Hodgson, D. J., Rhodes, K. A., et al. 2014. Detecting green shoots of recovery: The importance of long-term individual-based monitoring of marine turtles. <i>Animal Conservation</i> 17: 593-602. https://doi.org/10.1111/acv.12128</p> <p>SWOT Scientific Advisory Board. 2011. The State of the World’s Sea Turtles (SWOT) Minimum Data Standards for Nesting Beach Monitoring, version 1.0. Handbook, 28 pp. https://www.seaturtlestatus.org/minimum-data-standards</p> <p>Wallace BP, Bandimere AN, Abreu-Grobois A, Acosta H, Akiti J, Akomedi M, Alfaro-Shigueto J, Allen CD, et al. 2025. Updated global conservation status and priorities for marine turtles. <i>Endangered Species Research</i> 56: 247-276. https://doi.org/10.3354/esr01385</p>	
<i>Data Confidence and uncertainties</i>	

Indicator Title	<i>Common indicator 5: Population demographic characteristics (Reptiles)</i>
<p>Life history studies and demographic analyses need extensive and, often, long-term data accumulation from either carcass collection or capture-mark-recapture (tagging or photo-id) histories, or a combination of several different techniques. In general, these studies may be implemented by different research teams that use different sampling and analysing processes. However, demographic parameters must be collected in a standard way among different research groups. Well-established complex demographic parameters determined by well-resourced Contracting Parties, such as age and size at sexual maturity, can be used in place of specific values for each contracting Party.</p>	
Methodology for monitoring, temporal and spatial scope	
<p><i>Available Methodologies for Monitoring and Monitoring Protocols</i></p> <p>Monitoring effort should be long-term and consistent at index sites covering all seasons to ensure that the information obtained is as complete as possible. Periodic national assessments need to be rigorous and repeatable.</p> <ol style="list-style-type: none"> 1. Aerial surveys (drones): transects (abundance of different size classes of turtles and sex of mature individuals at small scales). Data obtained also contribute to CI3 and CI4. 2. In-water surveys: Diving/snorkelling transects, capture-mark-recapture (nearshore abundance of different size classes of turtles and sex of mature individuals, but at very localized scales). Data obtained also contribute to CI3 and CI4. 3. Ground based surveys: Nesting monitoring (breeding areas) - Assessment of nesting activity on beaches, and stranding monitoring (coastal areas) (reproductive output, recruitment and hatchling sex ratios estimated, sex ratios determined from strandings, but only where monitoring is conducted). Data obtained also contribute to CI3 and CI4. 4. Bycatch data from fisheries records and onboard researchers, are invaluable for obtaining data in deep/offshore waters (Catch per unit effort, mortality rates, size class distribution and sex ratios but in focused areas). Data obtained also contribute to CI3 and CI4. 5. Telemetry, generally in the form of satellite tracking: Provides detailed information about the movements, and hence presence, of small numbers of individuals within a population. Tracking devices can be used on turtles from juvenile to adult size classes. Even tracking individuals can provide interesting and useful information, such as clutch frequency, but appropriate sample sizes need to be used to make population-level inferences on behaviour and survivorship rates. (confirmed behaviours and survival but limited to small numbers of individuals). Data obtained also contribute to CI3 and CI4. <p>Axillary data collection methods:</p> <ol style="list-style-type: none"> 6. Beached and stranded specimen monitoring: with dedicated stranding networks already existing for sea turtles in many Mediterranean countries, and stranding information provide threat data as well as size class distributions and sex ratios (these are supplemental data to at-sea monitoring). Data obtained also contribute to CI3 and CI4. 7. Opportunistic data, on non-dedicated platforms (ferries, merchant marine ships or amateurs/yachts, use of citizen science), by-catch data (where dedicated research programs do not exist) (supplemental threat, size class and sex ratio data, requiring validation from dedicated surveys). 8. Genetic sampling encountered individuals for identification of structuring within the metapopulation. <p><i>Data to collect:</i></p> <p>Turtle body size (carapace length): indicative of the age structure of populations. From capture-mark-recapture and stranding studies.</p>	

Indicator Title	<i>Common indicator 5: Population demographic characteristics (Reptiles)</i>
<p>Turtle sex: from tail length for adult and pubescent sea turtles. Laparoscopy could be used by qualified individuals to sex non-adult turtles from capture-mark-recapture and stranding studies.</p> <p>Turtle weight: used in combination with body size to define health. From capture-mark-recapture studies.</p> <p>Turtle genetic sequences: for population structure studies. From capture-mark-recapture and stranding studies.</p> <p>Turtle contaminant levels: to assess health. From capture-mark-recapture and stranding studies.</p> <p>Turtle age: using skeletochronology and/or age-size correlation sea turtles for stranded and capture-mark-recapture individuals.</p> <p>Clutch size (number of eggs per clutch): from post-hatch nest excavation, to determine reproductive output</p> <p>Hatchling emergence success rate (Proportion of eggs that produce hatchlings that make it to the beach surface): from post-hatch nest excavation to determined population recruitment.</p> <p>Hatchling sex ratios (estimated %female hatchlings produced): rough estimates derived from proxies such as nest or beach temperature or incubation duration.</p> <p>Clutch frequency (number of clutches deposited by a female in a season): derived from telemetry or capture-mark-recapture, to determine reproductive output per individual and estimate number of nesters per season.</p> <p>Remigration interval (period in years between successive nesting season): derived from telemetry or capture-mark-recapture, to determine reproductive output per individual</p> <p>Mortality (death rates): from telemetry, bycatch and to some degree strandings records. Indication of cause of death useful for quantifying pressures facing populations in different locations and habitats.</p> <p>Turtle identity (from tagging or photoID): to determine longevity and other individual-based life history traits.</p>	
<p><i>Available data sources</i></p> <p>Casale P, Broderick AC, Camiñas JA, Cardona L, Carreras C, Demetropoulos A, Fuller WJ, Godley BJ, Hochscheid S, Kaska Y, Lazar B, Margaritoulis D, Panagopoulou A, Rees AF, Tomás J, Türkozan O. 2018. Mediterranean sea turtles: current knowledge and priorities for conservation and research. <i>Endangered Species Research</i> 36: 229-267. https://doi.org/10.3354/esr00901</p> <p>Casale P., Hochscheid S., Kaska Y., Panagopoulou A. (Eds.). 2020. <i>Sea Turtles in the Mediterranean Region: MTSG Annual Regional Report 2020</i>. Report of the IUCN-SSC Marine Turtle Specialist Group, 2020. https://www.iucn-mtsg.org/s/MTSG-Regional-Report_Mediterranean_2020.pdf</p> <p>Halpin, P.N., Read, A.J., Fujioka, E., et al., 2009. OBIS-SEAMAP the world data center for marine mammal, sea bird, and sea turtle distributions. <i>Oceanography</i> 22: 104-115.</p> <p>The state of the World's Sea Turtles online database: data provided by the SWOT team and hosted on OBIS-SEAMAP (Ocean Biogeographic Information System Spatial Ecological Analysis of Megavertebrate Populations). In: Oceanic Society, Conservation International, IUCN Marine Turtle Specialist Group (MTSG), and Marine Geospatial Ecology Lab, Duke University. http://seamap.env.duke.edu</p> <p>Margaritoulis, D., Argano, R., Baran, I., Bentivegna, F., Bradai, M.N., Caminas, J.A., Casale, P., Metrio, G.D., Demetropoulos, A., Gerosa, G., Godley, B.J., Haddoud, D.A., Houghton, J., Laurent, L. & Lazar, B. (2003) Loggerhead turtles in the Mediterranean Sea: present knowledge and conservation perspectives. <i>Loggerhead Sea Turtles</i> (ed. by B.E. Witherington), pp. 175–198. Smithsonian Institution, Washington</p>	

Indicator Title	<i>Common indicator 5: Population demographic characteristics (Reptiles)</i>
<p>Margaritoulis D., Dean C.J., Lourenco G, Michalidis T, Papafitsoros K, Rees A.F., Riggall, T.E. 2023. <i>Caretta caretta</i> (loggerhead sea turtle). Reproductive longevity. <i>Herpetological Review</i> 54(4): 639-640.</p> <p>Omeyer, L.C.M., Stokes, K.L., Beton, D., Çiçek, B.A., Davey, S., Fuller, W.J., Godley, B.J., Sherley, R.B., Snape, R.T.E. and Broderick, A.C. 2021. Investigating differences in population recovery rates of two sympatrically nesting sea turtle species. <i>Animal Conservation</i> 24: 832-846. https://doi.org/10.1111/acv.12689</p> <p>Omeyer LCM, McKinley TJ, Bréheret N, Bal G, Petchell Balchin G, Bitsindou A, Chauvet E, Collins T, Curran BK, Formia A, Girard A, Girondot M, Godley BJ, Mavoungou J-G, Poli L, Tilley D, VanLeeuwe H and Metcalfe K. 2022. Missing data in sea turtle population monitoring: A Bayesian statistical framework accounting for incomplete sampling. <i>Frontiers in Marine Science</i> 9: 817014. https://doi.org/10.3389/fmars.2022.817014</p> <p>Seaturtle.org – Global Sea Turtle Network. Sea turtle tracking. http://www.seaturtle.org/tracking/http://www.seaturtle.org/</p> <p>Sea Turtle Tag Inventory. Archie Carr Center for Sea Turtle Research, University of Florida https://accstr.ufl.edu/resources/tag-inventory</p> <p>Marine Turtle DNA Sequences Database. Archie Carr Center for Sea Turtle Research, University of Florida. https://accstr.ufl.edu/resources/mtdna-sequencesThe Reptile Database: Location of juvenile loggerheads and greens in the Eastern Mediterranean. http://reptile-database.reptarium.cz/species?genus=Caretta&species=caretta</p> <p>Mediterranean marine research centres, NGOs, universities and institutions, local and national sea turtle monitoring projects. Governmental Ministries and IUCN specialists (MTSG)</p>	
<p><i>Spatial scope guidance and selection of monitoring stations</i></p> <p>A number of index sites should be selected that represent a sufficiently large proportion of the subregional or national population for demographic data to be collected (reflecting the breeding, foraging and developmental populations that are representative of the nation and across the region). the greatest accumulation of different breeding populations), as well as those that support single breeding populations, which may be of equal importanceMonitoring should be carried out at such an intensity that suitable sample sizes for all data types can be collected and used in the assessment of GES either directly as individual units or meaningfully combined for regional assessment..</p> <p>Opportunistic data should be collected from all possible sources, wherever possible, and compiled into a single database, which might be used to provide an overview of the entire area.</p>	
<p><i>Temporal Scope guidance</i></p> <p>Annual data on breeding surveys at selected sites to determine adult male and female sex ratios (operational sex ratios), recruitment, mortality and longevity of breeding, as well as genetic structure and physical health indices (April-July). In parallel, data on reproductive output and offspring should also be collected (July to October), to determine the number of individuals and sex ratio of offspring entering the population. Data used as proxies for hatchling sex ratio (sand/nest temperature and incubation durations should be collected (June to September).</p> <p>Annual data on foraging/developmental surveys at selected sites to estimate the age/size class, sex ratio of adults, recruitment and dispersal of individuals, as well as genetic structure and physical health indices (expect mixing of turtles from different breeding populations) of individuals (seasonally, January to December).</p>	
<p>Data analysis and assessment outputs</p>	

Indicator Title	<i>Common indicator 5: Population demographic characteristics (Reptiles)</i>
<i>Statistical analysis and basis for aggregation</i>	
<p>At present, many specific demographic parameters are not regularly assessed to a similar level of female/nest counts, due to the data intensive nature of this component. Many programs assess the hatchling emergence success rate and determine average clutch size; however, these represent a small component of the topic. Research on hatchling sex ratios, juvenile sex ratios, adult (operational) sex ratios is intermittent and based on different fieldwork approaches/methods and analytical techniques depending on the objective (usually, aiming towards a journal publication). Set analyses need to be established that are applicable within and/or across the different habitat types to allow comparison at the Mediterranean level.</p>	
<i>Expected assessments outputs</i>	
<p>Knowledge about the sex ratios and genetic structure of the metapopulation and different populations needs to be reported together with recruitment and mortality rates within different parts of the population (both spatially and in terms of life stage). This information is important to understand whether there are sex-specific mortality risks at different age/size classes, which is important towards aiding population recovery. Also, knowledge on the physical health status of group of individuals will indicate the capacity for resilience to human activities, including climate change.</p> <p>It is difficult for GES to be categorically established using all components of CI5 monitoring, but hatchling emergence success rate, estimated hatchling sex ratios and bycatch levels are factors that can be influenced by conservation measures and hence should be assessed and specifically reported on at national sub-regional and regional levels.</p>	
<u>Methodologies for reporting</u>	
<p>Submission of all distribution range data and metadata in a standardized form to the IMAP INFO/RAC System (https://www.info-rac.org/).</p>	
<i>Known gaps and uncertainties in the Mediterranean</i>	
Data gaps	
<ul style="list-style-type: none"> • Knowledge of sex ratio of different life stages (hatchlings, oceanic juveniles, neritic juveniles, subadults and adults) and abundance of these age classes from the metapopulation to national levels. • Knowledge of reproductive output and recruitment rate per index site, contracting party. • Knowledge about the physical health status of these groups. • Vulnerability/resilience of these populations/sub-populations in relation to physical pressures. 	
Assessment gaps	
<ul style="list-style-type: none"> • Identify possible baselines and index sites. • Analysis of pressure/impact relationships for populations/sub-populations and definition of qualitative GES. • Criteria for the risk-based approach to monitoring and develop harmonized sampling instructions where appropriate. • GES baselines for sites that cannot be inferred from contemporary records of pressure or construction. • Identify techniques to monitor and assess the impacts of climate change. 	
Information management	
<ul style="list-style-type: none"> • Identify monitoring capacities and gaps in each Contracting Party • Common computing methodologies and data collection instructions, specifying the accuracy (spatial resolution or grid) of the determination of extent (area) a priori. 	

Indicator Title	<i>Common indicator 5: Population demographic characteristics (Reptiles)</i>	
<ul style="list-style-type: none"> • Harmonised sampling, cartographic, data collation and GIS protocols and standardized data flows for spatial pressure data. • Develop a guidance manual to support the monitoring programme, which will provide more detailed information, tools, and advice on survey design, monitoring methodology and techniques that are most cost-effective and applicable to each of the selected sea turtle species, in order to ultimately ensure standardised monitoring, comparable data sets, reliable estimates and trend information. 		
Synergies with other monitoring frameworks		
<ul style="list-style-type: none"> • Develop monitoring synergies in collaboration with GFCM for- EO3 (Harvest of commercially exploited fish and shellfish), to collect data via sea turtle by-catch • Investigate monitoring synergies with other relevant EOs that will include coast-based fieldwork, in relation to monitoring of new/unknown sea turtle nesting beaches, and of beached/stranded animals, to obtain more widespread information • Discuss and align CI5 requirements with D1C3 of the MSFD 		
Contacts and version Date		
Key contacts within UNEP for further information		
Version No	Date	Author
V.1	20/7/2016	SPA/RAC
V.2	14/04/2017	SPA/RAC
V3	11/05/2026	SPA/RAC

