UNITED NATIONS

EP

UNEP/MED WG.502/16 Rev.1.Appendix C. Rev.1

UNITED NATIONS
ENVIRONMENT PROGRAMME
MEDITERRANEAN ACTION PLAN

21 June 2021
Original: English

Fifteenth Meeting of SPA/BD Focal Points

Videoconference, 23-25 June 2021

Agenda Item 7: Status of implementation of the Ecosystem Approach (EcAp) Roadmap

7.1. Implementation of the second phase (2019-2021) of the Integrated Monitoring and Assessment Programme (IMAP - Biodiversity and non-indigenous species) in the framework of the EcAp Roadmap

Implementation of the second phase (2019-2021) of the Integrated Monitoring and Assessment Programme (IMAP- Biodiversity and non-indigenous species) in the framework of the EcAp Roadmap

Appendix C Rev.1: Monitoring and Assessment Scales, Assessment Criteria, Thresholds and Baseline Values for the IMAP Common Indicators 3, 4 and 5 related to Marine Turtles

UNEP/MAP
SPA/RAC-Tunis, 2021

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Acknowledgment

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Executive Summary

Two necessarily overlapping sympatric assessment systems have been established covering marine habitats and species within the Mediterranean. On one hand, you have 2 European Union (EU) Directives the EU Marine Strategy Framework Directive (MSFD- Directive 2008/56/EC) and the EU Habitats directive (92/43/EC) both of which apply only to EU Member States (MSs) and the second is the Ecosystem Approach (EcAp) & Integrated Monitoring and Assessment Programme (IMAP) process of the Barcelona Convention (UNEP/MAP 2016; UNEP(DEPI)/MED IG.22/Inf.7) that apply to all Contracting Parties (CPs) of the Mediterranean, noting that all are parties to this Regional Sea Convention, this means *all* the 21 riparian countries that border the Mediterranean Sea and including the European Union.

In terms of certain marine species and in this case, sea turtles, both systems intend to report on their conservation status and that of populations with reference to Good Environmental Status (GES), which is determined through elaboration of certain criteria/indicators. Predefined scales of monitoring and assessment are required for these criteria/indicators and findings need to be compared to either baseline or threshold values (whichever is most appropriate) to confirm GES is met, and/or to determine if trends are improving or worsening.

Elaboration of three specific EcAp/IMAP Common Indicators (CI) for marine turtles in the Mediterranean are the subject of this report namely:

CI 3 – Species distribution range

> Existing GES definition: "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) sites"

CI 4 – Population abundance

> Existing GES definition: "The population size allows to achieve and maintain a favourable conservation status taking into account all life stages of the population"

CI 5 – Population demographic characteristics

> Existing GES definition: "Low mortality induced by incidental catch and favourable sex ratio and no decline in hatching rate"

This report presents information, perspectives and recommendations on 1) revising the existing scales of monitoring, 2) establishing suitable scales of assessment and appropriate assessment criteria, and 3) establishing appropriate baseline and threshold values on which to base GES.

In order to stimulate progress towards realisation of workable regional assessments for sea turtles, proposals contained herein provide a pragmatic approach to establishing baselines and thresholds using conceptually simple methods for determination and assessment of populations in terms of GES. Given time and increased capacity, following the acceptance of the initial scales and thresholds/baselines determined by the current process, it is foreseen that some adjustment may be required, especially for the threshold and baseline components, to reflect more robust scientific determination of GES, however no adjustment would be expected for the remainder of the current and subsequent IMAP six-year assessment periods.

The following tables provide summaries of the existing status of the elaboration of the three subject CIs together with proposed updates and clarifications that are made within the main body of this report.

Agreed EcAp Common Indicators, Ecological Objectives, GES definitions and GES target					**STEP 1** **Refining <u>scales of monitoring</u>, by revising the existing IMAP/EcAp proposals and identifying adequate scales for the most relevant species in the Mediterranean context.**		**STEP 2** **Developing <u>scales of assessment</u>**		**STEP 3** **Developing <u>assessment criteria</u>**		**STEP 4** **Develop <u>threshold and baseline values</u>**	
Common Indicator	**Operational Objective**	**GES definition**	**GES target**	**Comments, suggestions**	**Existing context**	**Proposed changes**	**Existing context**	**Proposals**	**Existing context**	**Proposals**	**Existing context**	**Proposals**
CI3: Species distributiona l range [1]	Species distribution is maintained	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) sites	State • Turtles continue to nest in all known nesting sites • Turtle distribution is not significantly affected by human activities Pressure/Response • Protection of known nesting, mating, foraging, wintering and developmental turtle sites. • Human activities having the potential to exclude marine turtles from their range area are regulated and controlled. • The potential impact of climate change is assessed		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.	Revise mapping requirements to two maps; one for <u>nesting areas</u> and one for <u>marine areas</u>. <u>Nesting areas monitoring</u> • Geographic scale: ○ (sub-)National. Up to 7 established sites or 75% of national nesting activity (index areas) • Method: ○ standard nesting beach surveys. • Frequency: ○ Minimum = June/July annually for index areas. ○ six-yearly national scale. <u>Nearshore monitoring</u> • Geographic scale: ○ (sub-)National. Up to 4 sites. • Method: ○ systematic regular monitoring index areas. ○ bycatch/stranding data. • Frequency: ○ biannual monitoring index areas. ○ year-round bycatch/stranding recording. ○ six-yearly national scale. <u>Offshore monitoring</u> • Geographic scale: ○ (sub-)National/regional. • Method: ○ Aerial surveys ○ Boat surveys ○ Bycatch recording. ○ Opportunistic boat surveying. • Frequency: ○ Yearly for aerial and boat surveys ○ Year-round for bycatch records ○ *Ad hoc* boat surveying. ○ six-yearly national scale.	The European (ETRS) 10x10km grid is used for mapping the distribution and range…, Three different maps (grids) are produced yearly for each species accounting for breeding sites, wintering sites and feeding/developmental sites. Number of 10x10 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.	<u>Nesting areas</u> National and Subdivisional level GES assessments based on maintenance of distribution of all nesting sites. <u>Marine areas</u> Subregional GES assessments.	Turtles continue to nest in all known nesting sites. Turtle distribution is not significantly affected by human activities.	<u>Nesting areas</u> Turtles remain present in all parts of annually monitored nesting sites and at all established sites during periodic surveys. <u>Marine areas</u> Turtles remain present in all annually monitored, CP defined, hotspot areas and no evidence of definitive absences in any other area withing the RMU distribution.	None	<u>Nesting areas</u> Baselines centred on 1992 to be used for established nesting sites. More recent data to be modelled to 1992 era levels for these sites. New and emerging sites to use maximum existing 6-year average as baseline. <u>Marine areas</u> All areas assumed to have turtle presence (in line with updated IUCN-MTSG RMU boundaries) unless proven otherwise.

[1] https://www.medqsr.org/common-indicator-3-species-distributional-range-marine-turtles

Agreed EcAp Common Indicators, Ecological Objectives, GES definitions and GES target					**STEP 1** **Refining scales of monitoring, by revising the existing IMAP/EcAp proposals and identifying adequate scales for the most relevant species in the Mediterranean context.**		**STEP 2** **Developing scales of assessment**		**STEP 3** **Developing assessment criteria**		**STEP 4** **Develop threshold and baseline values**	
Common Indicator	**Operational Objective**	**GES definition**	**GES target**	**Comments, suggestions**	**Existing context**	**Proposed changes**	**Existing context**	**Proposals**	**Existing context**	**Proposals**	**Existing context**	**Proposals**
CI4: Population abundance of selected species [2]	Population size of selected species is maintained	The population size allows to achieve and maintain a favourable conservation status taking into account all life stages of the population	State • No human induced decrease in population abundance • Population recovers towards natural levels where depleted		For counts carried out on an annual basis, a number of sites should be selected that represent a sufficiently large proportion of the subregional or national population, with criteria being delineated by expert groups. The "Demography Working Group[3]" suggests that comprehensive surveys should be carried out every 5 years, with the aim of covering all breeding, foraging, wintering and developmental sites. However, here, it is recommended that the whole coastal and marine area is covered on a national or subregional scale to take into account changes in population distribution (and hence counts) in relation to climate change.	Nesting areas monitoring • Geographic scale: ○ (sub-)National. Up to 7 sites or 75% of national nesting activity (index areas) • Method: ○ standard nest count surveys. • Frequency: ○ Minimum = June/July annually for index areas. ○ six-yearly national scale. Nearshore monitoring • Geographic scale: ○ (sub-)National. Up to 4 sites. • Method: ○ systematic regular monitoring index areas. ○ bycatch/stranding data. • Frequency: ○ biannual monitoring index areas. ○ year-round bycatch/stranding recording. ○ six-yearly national scale. Offshore monitoring • Geographic scale: ○ (sub-)National. • Method: ○ Aerial surveys ○ Boat surveys using standardised protocols • Frequency: ○ Yearly organised aerial/boat surveys ○ six-yearly national scale.	For counts carried out on an annual basis, a number of sites should be selected that represent a sufficiently large proportion of the subregional or national population, with criteria being delineated by expert groups. The "Demography Working Group" suggests that comprehensive surveys should be carried out every 5 years, with the aim of covering all breeding, foraging, wintering and developmental sites. However, here, it is recommended that the whole coastal and marine area is covered on a national or subregional scale to take into account changes in population distribution (and hence counts) in relation to climate change.	Nesting areas National and Subdivisional level GES assessments based on maintenance of nesting abundance at all sites. Marine areas Subregional GES assessments based on relevant population segments present in each area.	Nesting areas The average breeding population size during at least a decade is suggested as the base level (based on International Union for Conservation of Nature Red List minimal criteria for sea turtles) Marine areas for non-breeding animals at wintering / foraging / developmental sites, number of individuals (n) with appropriate modelling to extrapolate population numbers	Nesting areas Rolling average of previous six years' data to count in the annual assessment. To coincide with the six-yearly regionwide GES assessments. Marine areas Rolling average of previous six years' data to count in the annual assessment. To coincide with the six-yearly regionwide GES assessments. Observations on numbers of turtles in different life-stages and sex ratios to be considered for indications of perturbations in population structure (see CI 5)	None.	Nesting areas Baselines centred on 1992 to be used for established nesting sites. More recent data to be modelled to 1992 era levels for these sites. New and emerging sites to use maximum existing 6-year average as baseline. Marine areas GES baseline taken as annual abundance derived from existing modelled abundances[4] or first year of monitoring which should begin ASAP across the Mediterranean. Where historic (post 1992) data showing larger populations exist, they can be used to amend the baseline of specific countries. For both areas a decrease in population abundance of 10% over a six-year reporting period should trigger increased conservation actions to prevent further decreases and populations falling out of GES

[2] https://www.medqsr.org/common-indicator-4-population-abundance-selected-species-marine-reptiles

[3] Cardona L, *et al.* (2015) Demography of marine turtles nesting in the Mediterranean Sea: a gap analysis and research priorities. Demography Working Group of the 5th Mediterranean Conference on Sea Turtles. 37pp. Bern Convention, T-PVS/Inf (2015) 15

[4] Sparks LM & DiMatteo AD (2020) Loggerhead sea turtle density in the Mediterranean Sea. NUWC-NPT Tech Rep 12360. 77pp.

Agreed EcAp Common Indicators, Ecological Objectives, GES definitions and GES target					**STEP 1** **Refining scales of monitoring, by revising the existing IMAP/EcAp proposals and identifying adequate scales for the most relevant species in the Mediterranean context.**		**STEP 2** **Developing scales of assessment**		**STEP 3** **Developing assessment criteria**		**STEP 4** **Develop threshold and baseline values**	
Common Indicator	**Operational Objective**	**GES definition**	**GES target**	**Comments, suggestions**	**Existing context**	**Proposed changes**	**Existing context**	**Proposals**	**Existing context**	**Proposals**	**Existing context**	**Proposals**
CI5: Population demographic characteristic [5]	Population condition of selected species is maintained	Low mortality induced by incidental catch. Favourable sex ratio and no decline in hatching rates.	Response • Measures to mitigate incidental captures in turtles implemented	Reformulate GES definitions for CI5 based on factors that can be influenced by intervention but gather data on wider demographic parameters.	A number of 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, wintering, foraging and developmental populations that are representative of the region).*** If possible, populations should be selected where animals have been tracked with a sufficient number of units (i.e., >50 individuals), from which the connectivity among these different habitat types can be established.	Nesting areas monitoring • Geographic scale: ○ (sub-)National. Up to 7 established sites or 75% of national nesting levels • Methods: ○ Standard: hatchling emergence success (HES) and nest temperature data. ○ Additional: Sex ratio adults • Frequency: ○ Annually, Minimum: August/September for index area HES and May-September for temperature data. April-May for adult sex ratios. ○ six-yearly national scale. Nearshore monitoring • Geographic scale: ○ (sub-)National. Up to 4 index hotspot sites. • Method: ○ systematic regular monitoring index areas. ○ bycatch/stranding data. • Frequency: ○ biannual monitoring index areas. ○ year-round bycatch/stranding recording. ○ six-yearly national scale. Offshore monitoring • Geographic scale: ○ (sub-)National. • Method: ○ Bycatch recording. ○ Opportunistic boat surveying. • Frequency: ○ Year-round bycatch records ○ *Ad hoc* boat surveying. ○ six-yearly national scale.	The selected breeding sites should aim to be genetically diverse, so as this diversity can be detected at foraging/ wintering/ developmental grounds where different populations diverge. This will facilitate the selection of marine areas for protection that support the highest genetic diversity (i.e., the greatest accumulation of different breeding populations), as well as those that support single breeding populations, which may be of equal importance. 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. Knowledge about the sex, health and genetic structure of the different populations/subpopulations will be obtained, by understanding recruitment and mortality within different parts of a population and across populations. 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 and genetic health of populations will be obtained, which will indicate the capacity for resilience to human activities, including climate change.	Nesting areas National and Subdivisional level GES assessments. Marine areas Subregional GES assessments.	At present, 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 clutch success (i.e., the number of eggs that hatch from a clutch); however, this represents a small component. Research on offspring 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). Most studies that do exist are focused on the breeding areas; thus, greater focus is required at foraging, wintering and developmental areas, with in-water limitations needing to be accounted for in analyses. Therefore, set analyses need to be established that are applicable within and/or across the different habitat types to allow comparison at the Mediterranean level.	Nesting areas Maintenance of suitable hatchling sex ratios and high hatchling emergence success. Marine areas Quantification of bycatch and calculation of bycatch mortality rates. Observations on numbers of turtles in different life-stages and sex ratios to be considered for indications of perturbations in population structure.	No threshold and baseline values have been consistently defined and applied to date.	Nesting Areas 'Good' HES values can be taken from published literature and taken as thresholds with a buffer zone for improved conservation measures. Nest temperature records to be monitored with estimations of over 95% female production as an upper threshold. Marine areas Human-induced mortality as a component of longevity and survivorship is the one factor that can be measured and affected by conservation actions and hence can be considered as an actionable indicator for GES. Numbers of deaths should be used as the indicator with a stable or declining trend in numbers indicating GES.

[5] https://www.medqsr.org/common-indicator-5-population-demographic-characteristics-marine-reptiles

Preamble

Briefly, the Terms of Reference for the consultant undertaking the current contracted activity covered the following four topics:

1 *Revise the existing scale of monitoring* and further work on developing adequate scales of monitoring for the Integrated Monitoring and Assessment Programme of the Mediterranean Sea and Coast and Related Assessment Criteria (IMAP) Common Indicators (CIs) 3 (Distribution), 4 (Abundance) and 5 (Demography) related to marine turtles;

2 *Establish scales of assessment* and

3 *Establish assessment criteria* for the IMAP CIs 3, 4 and 5 related to marine turtles;

4 *Establish baseline and threshold values* for Ecological Objective 1 related to marine turtles;

Three Deliverables were initially anticipated to be submitted.

D1 Document detailing the consultant's workplan and timetable (completed; August 2020) and;

D2 Document covering topics 1 to 3 above;

D3 Document covering topic 4 above.

However, it was agreed between SPA/RAC and the consultant that D2 and D3 can be combined into a single deliverable document. This report represents that document of the two combined deliverables.

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I. Introduction

1. Two necessarily overlapping sympatric assessment systems have been established covering marine habitats and species within the Mediterranean. On one hand, you have 2 European Union (EU) Directives the EU Marine Strategy Framework Directive (MSFD- Directive 2008/56/EC) and the EU Habitats directive (92/43/EC) both of which apply only to EU Member States (MSs) and the second is the Ecosystem Approach (EcAp) & Integrated Monitoring and Assessment Programme (IMAP) process of the Barcelona Convention (UNEP/MAP 2016; UNEP(DEPI)/MED IG.22/Inf.7) that apply to all Contracting Parties (CPs) of the Mediterranean, noting that all are parties to this Regional Sea Convention, this means *all* the 21 riparian countries that border the Mediterranean Sea and including the European Union.

2. In terms of certain marine species and in this case, sea turtles, both systems intend to report on their conservation status and that of populations with reference to Good Environmental Status (GES), which is determined through elaboration of certain criteria/indicators. Predefined scales of monitoring and assessment are required for these criteria/indicators and findings need to be compared to either baseline or threshold values (whichever is most appropriate) to confirm GES is met, and/or to determine if trends are improving or worsening. EcAp Common Indicators (CI) and their corresponding MSFD Criteria are presented in Table 1.1 below. Both, especially the EcAp definitions, are presented as very simplistic overviews of the Theme, whereas data recording to meet the requirements of each are varied and complex.

Table 1.1 EcAp/IMAP Common Indicators subject to this assessment and their MSFD equivalents.

Theme	**Barcelona Convention EcAp /IMAP** Ecological Objective 1 Common Indicator # UNEP(DEPI)/MED WG.444/6/Rev.1 (marine turtle specific excerpts)	**EU MSFD** Descriptor 1 Criterion # Commission Decision (EU) 2017/848 of 17/05/17
Distribution	**CI 3** Turtle distribution is not significantly affected by human activities *and* turtles continue to nest in all known nesting sites	**D1C4** The species *distributional range* and where relevant, pattern, is in line with prevailing physiographic geographic and climatic conditions
Abundance	**CI 4** No human induced decrease in population abundance	**D1C2** The *population abundance* of the species is not adversely affected due to anthropogenic pressures, such that its long-term viability is ensured
Demography	**CI 5** Low mortality induced by incidental catch. Favourable sex ratio and no decline in hatching rate	**D1C3** 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 which is not adversely affected due to anthropogenic pressures.

3. Guidance for Common Indicators, including specific sections for marine turtles, has been published (UNEP(DEPI)/MEDWG.444/6/Rev.1) and links the EcAp /IMAP process with that of the MSFD. It is clear from the document that there is a need for a coherent regionwide set of assessment standards that apply to all CPs, as each CP currently has defined their own disjointed targets.

4. GES can be assessed in several ways that may combine both baseline and trend-based approaches. A solely baseline approach based on a predetermined threshold value does not permit normalisation of an expanding/improving situation within the indicator, leading to indicators in decline remaining in GES.

5. Conversely a solely trend-based approach does not permit any decrease in an indicator, no matter how much it exceeds the initial level when GES status may have been indicated. Combined baseline and trend-based approaches includes thresholds that evolve in response to improving conditions, hence recognising the new state as GES, and permit small-scale variation in conditions to not immediately throw an improved indicator out of GES (Figure 1.1).

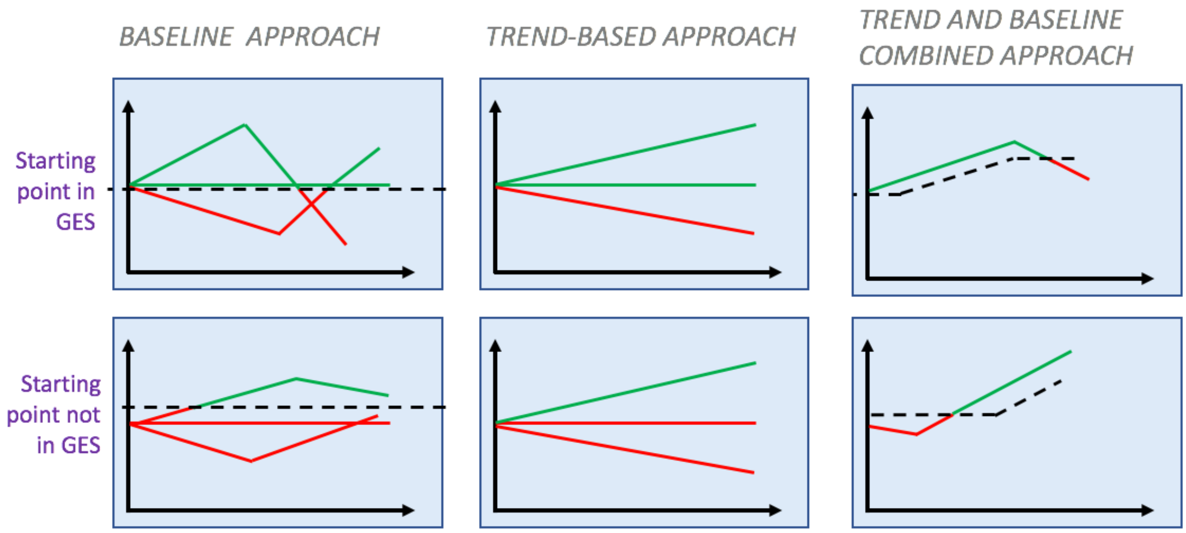

Figure 1.1. Approaches to determination of GES. Green line - GES met. Red line - GES not met. Dashed line - threshold values.

6. The setting of threshold values for an indicator is a complex and imprecise process, that requires detailed understanding of historic or past reference values and their interplay with contemporaneous pressures. An idealised situation equates to reference values being known from a period with no anthropogenic pressures acting upon indicator. Given it is unlikely that data are available from this pristine situation, alternative methods of determining acceptable thresholds are used. These alternative methods have been discussed at length within the EU MSFD context (Palialexis et al. 2019) and yet no single method has been adopted as standard either across the European member states or in any particular EU region or subregion. This is partly to do with lack of compatible monitoring regimes and hence absence of suitable data and partly to do with the differing levels of feasibility of each method.

7. Additionally, though there are likely precise theoretical threshold values that may be adopted, in practice these values can neither be definitively stated nor can data acquired be sufficiently robust to precisely determine which side of a single point threshold the indicator sits. Instead of the hard threshold it is more practical to have a threshold value range that covers the uncertainty of GES assignment. Thus, an indicator falling in this buffer zone will trigger additional measures to improve clarity in the assignment and precautionary-principal conservation measures (Figure 1.2).

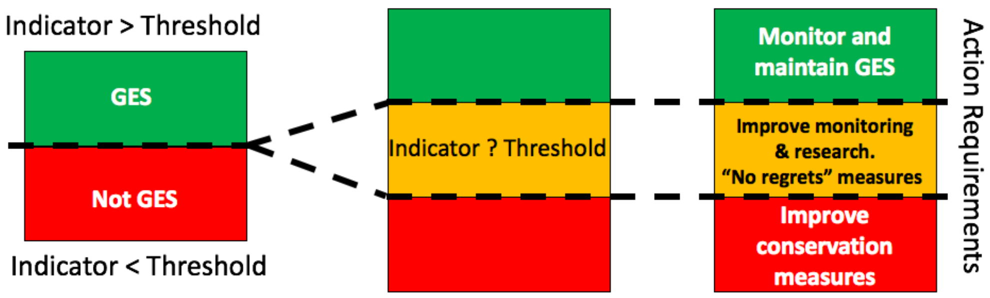

Figure 1.2. Threshold level setting incorporating uncertainty.

8. In order to stimulate progress towards realisation of workable regional assessments for sea turtles, proposals contained herein provide a pragmatic approach to establishing baselines and thresholds using conceptually simple methods for determination and assessment of populations in terms of GES. Given time and increased capacity, following the acceptance of the initial scales and thresholds/baselines determined by the current process, it is foreseen that some adjustment may be required, especially for the threshold and baseline components, to reflect more robust scientific determination of GES, however no adjustment would be expected for the remainder of the current and subsequent IMAP six-year assessment periods.

9. Unlike the situation for sea birds and marine mammals, there are a very limited number of marine turtle species that need to be assessed in the EcAp process. Of the seven species of marine turtle that inhabit the world's oceans only two have established resident breeding populations in the Mediterranean and require assessment. These are the loggerhead turtle (*Caretta caretta*; IUCN (regionally) Least Concern) and green turtle (*Chelonia mydas*; IUCN (globally) Endangered). Loggerheads in the Mediterranean are from two-possibly three globally defined Regional Management Units (RMUs) defined in Wallace et al. 2010. These are the most populous 'endemic' Mediterranean RMU supplemented with fewer turtles that have migrated into the area from the North West Atlantic and possibly the North East Atlantic Ocean RMUs. Loggerhead presence is so widespread across the Mediterranean, shown through tracking, at-sea surveys and stranding records, that they have been chosen to be used by the EU as a bio-indicator species for monitoring marine litter distribution and abundance[6]. Green turtles in the Mediterranean contrast with loggerhead turtles in that they are almost exclusively from the 'endemic' Mediterranean RMU and the vast majority of them remain in the eastern Mediterranean (Figure 1.3). With regard to breeding sites, loggerhead turtle nesting areas are currently concentrated along the shores of the eastern Mediterranean, though new and increased nesting is occurring in the western Mediterranean. Green turtles breed almost exclusively in the north eastern part of the eastern Mediterranean, except for one nest recorded in Tunisia and two recorded on the Island of Crete in Greece (Figure 1.4).

10. It is clear from the differing distributions of the two marine turtle species that each CP will have a distinct subset of the population segments to monitor and assess, with both requiring their own independent assessments of GES that will inform a taxon-wide GES status.

[6] https://indicit-europa.eu/

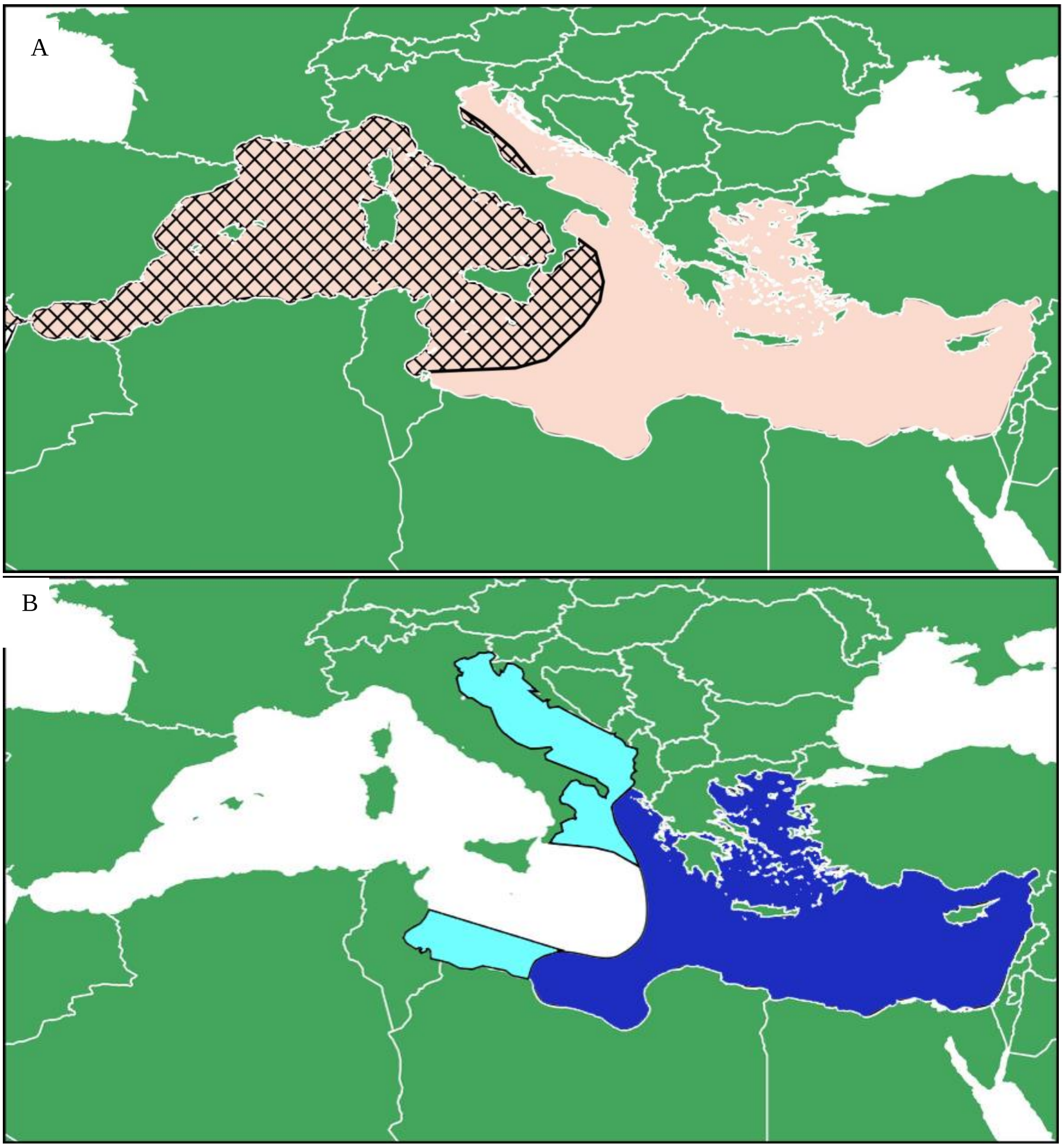

Figure 1.3. Marine turtle RMU limits in the Mediterranean. (A) Loggerhead distribution in the Mediterranean. Beige = Mediterranean RMU, crosshatch = Atlantic RMU. From RMU distribution presented in Wallace et al. (2010). (B) Green turtle distribution in the Mediterranean. Dark blue = established RMU distribution (Wallace et al. 2010). Pale blue (lower polygon) = extension of the distribution confirmed by sat tracking (Stokes et al. 2015) and a single nesting event in Tunisia. Pale blue (upper polygon) = recent records of green turtle captures (Piroli et al. 2020, Bentivegna et al. 2011, Lazar et al. 2004)

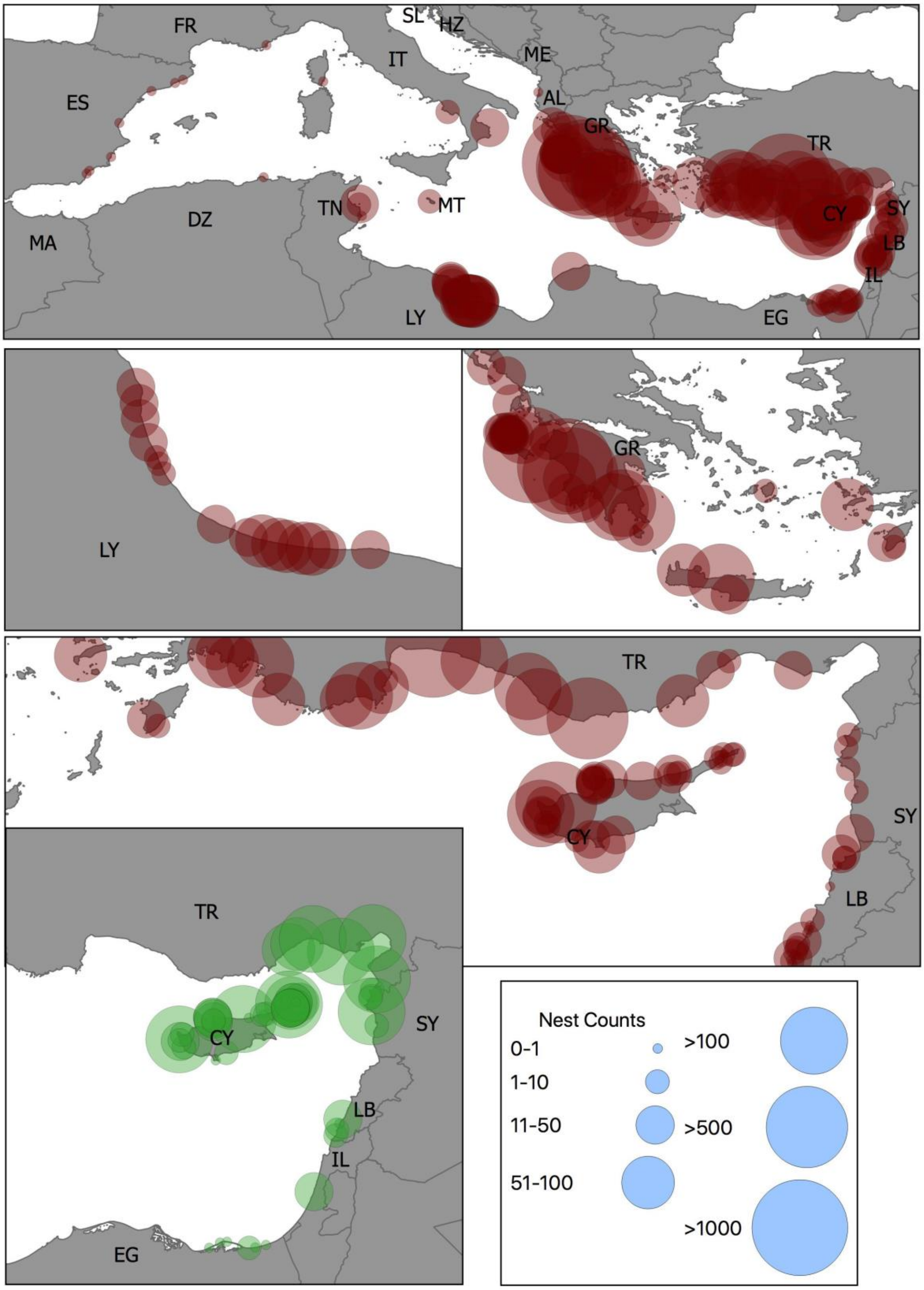

Figure 1.4. Overview of marine turtle nesting across the Mediterranean region. Note that nesting site information from Italy, Israel and Egypt are only available at sub-national levels and are summed and *presented at generalised locations*. Additionally, not all nesting beaches in Libya are represented due to lack of precise beach coordinates. Red circles – Loggerhead nesting sites. Green circles – Green turtle nesting sites. (Reproduced from SPA/RAC-UNEP/MAP 2020)

II. Scales of monitoring

11. Sea turtles occupy three main marine zones and one terrestrial zone during their life cycle. The breeding adults of both sexes congregate **nearshore at *breeding areas*** at predictable periods of time before migrating away to their ‘foraging grounds’[7]. Clutches of eggs incubate on **sandy beach *breeding areas*** which are selected by the adult females. The hatchling and early-years turtles move to **deeper epipelagic *offshore habitats*** (>5km[8] from shore) for a number of years before they leave this developmental habitat and, frequently, undergo an ontogenetic shift to **neritic and often *nearshore habitats*** (<5km from shore).
There is a strong need for representation in monitoring data from across the region and from a suitable number of representative sites per habitat type per Contracting Party. Each requirement is elaborated in turn below.

Breeding areas

12. Assessment of nesting levels and distribution around the Mediterranean has progressed well in recent years, at a time when the range of loggerhead nesting areas is expanding. Accordingly, most Contracting Parties can be assigned to one of four categories relating to nesting activity that is independent for both endemic sea turtle species. Nesting prevalence ranges from established and high level to no or only sporadic nesting. The four categories of prevalence are presented in Table 2.1 together with the associated Contracting Parties.

Table 2.1. Classification of nesting status of countries per sea turtle species in 2020

Loggerhead turtles (*Caretta caretta*)	**Green turtles (*Chelonia mydas*)**
Category 1 - Established: common / dense	
Greece, Turkey, Cyprus, Israel, Libya,	Turkey, Cyprus, Syria
Category 2 - Established: limited / sparse	
Italy, Syria, Lebanon, Egypt, Tunisia	Lebanon, Israel, Egypt
Category 3 - New: emerging / low level	
Spain	NA
Category 4 - Absent: No / sporadic* nesting	
France*, Slovenia, Croatia, Bosnia and Herzegovina, Montenegro, Albania*, Malta*, Algeria*, Morocco	Spain, France, Italy, Slovenia, Croatia, Bosnia and Herzegovina, Montenegro, Albania, Greece*, Libya, Malta, Tunisia*, Algeria, Morocco

Spatial Scope

13. Countries in which nesting is now well established and plentiful (Category 1 countries) are subject to annual minimum monitoring to record 75% of the nation’s nesting per species, or top 7 nesting areas, whichever is achieved first. In the case of extensive single nesting beaches, core areas of approximately 10km may be defined and used as index of nesting at that key site. Countries with established but low-level nesting (Category 2 countries) should identify a minimum of up to 4 index sites recording or recording 50% of the nation’s nests (per species), whichever comes first, to monitor annually. Countries with new and emerging nesting (Category 3) should continue dedicated coast monitoring and citizen science monitoring projects to record any nesting across the country. Countries with no sites where regular nesting occurs should incorporate any observations, or lack thereof, from other coastal based actions (e.g., summer beach stranding monitoring), including citizen science reports, as negative results for nesting.

[7] The term ‘foraging grounds’ is used to cover the location(s) inhabited by sea turtles away from their nesting areas, which is where they reside for the majority of the time.
[8] 5km range distance is indicated as this is the range that can be monitored by drone from the shore and hence separates the marine habitat into two areas of differing simplicity of access for assessment. The offshore zone may still contain demersal/benthic turtle habitats as well as epipelagic ones.

14. All countries should undertake periodic broadscale coastal assessments for nesting to facilitate adaptive monitoring practices that meet the conservation needs of the species at country level. If new nesting areas arise that warrant monitoring, as they contain nationally important nesting levels, the new location should be added to monitoring effort undertaken at all the original index beaches, as long-term datasets provide a better understanding of variation and trends in turtle nesting habits.

Temporal Scope

15. Loggerhead turtles migrate to their breeding areas a month or more prior to the onset of nesting. Male loggerheads depart the nesting areas early in the nesting season when females are no longer receptive (Schofield et al. 2017, 2020), and it is assumed to be the same for green turtles. Female turtles depart the breeding areas after depositing their quota of eggs - normally in one to five clutches. The nesting season in the Mediterranean generally lasts from late May to early August with peak nesting occurring in June and July. Consequently, monitoring in breeding habitats should take place during April/May for at-sea turtle surveys and from late May to August for nest count surveys. Nest monitoring should continue until the end of September to record the fate of the majority of incubating nests and assess annual hatchling production. The broadscale coastal assessments for nesting should be carried out or reviewed every six years to facilitate adaptive monitoring practices that meet the conservation needs of the species at country level.

Data analysis and outputs

16. Monitoring at the index nesting beaches should ideally be undertaken such that nest counts are accurate to within 10% of the actual number of nests and no worse than 20% modelled accuracy. See SWOT (2011) for monitoring methods that can achieve the required level of accuracy of nest monitoring. At sea surveys should be repeated three times over a period of a week in the pre-nesting period to be able to generate confidence limits to numbers of turtles that are present. Ideally the at-sea surveys should produce data in which male and female turtles can be distinguished. See Schofield et al. (2017) for example methodology. Data should be compiled into annual GIS map summaries that facilitate determination of trends in distribution and abundance of nests, for CI 3 and CI 4 respectively, and sex ratios of adults for CI 5.

Nearshore demersal/benthic foraging habitats

17. Data on nearshore habitats used by sea turtles, away from their seasonal use before and during the breeding season, is patchy and based mainly on data from stranding records with very few coastal hotspots recognised in the literature. Examples of known nearshore turtle hotspots are Amvrakikos Gulf, Greece (Rees et al. 2013, 2017), Drini Bay, Albania (White et al. 2013, Piroli et al. 2020), Fethiye Bay (Turkozan & Durmus 2000; Baskale et al. 2018), Iskenderun Bay (Oruç 2001; Turkozan et al. 2013) and Lake Bardawil, Egypt (Rabia & Attum 2020) in which many turtles are located in waters less than 3m deep and some form of capture-mark-recapture study have taken place.

Spatial Scope

18. Given turtles are present in waters of all countries bordering the Mediterranean, each country should establish, as a minimum, a national stranding network to report and record the majority of turtles that strand along the vast majority of the country’s shoreline, as indicate in the updated Mediterranean Action Plan for marine turtles conservation (UNEP/MED IG.24/22 2019). It should be noted that debilitated and dead turtles may drift considerable distances before they strand, and interpretation of their origins needs to be accepted with caution (Santos et al. 2018). This network need not conduct systematic surveys in people-frequented areas, but seasonal surveys remote areas would improve coverage at a national level. Additionally, effort-adjusted turtle bycatch rates should be reported per fishery as well as its fishing effort at several key areas around the country to help quantify presence of turtles at sea and also evaluate the threat that these fisheries present. The General Fisheries Commission for the Mediterranean (GFCM) are encouraging the documenting

of marine turtle and other bycatch in regional fisheries (FAO 2020) and successful implementation of this initiative will contribute greatly to our understanding of the threats that sea turtles are facing.

19. Various datasets such as stranding records, fisheries records, results from local stakeholder questionnaires and tracking data should be used to identify nearshore marine hotspots around the country, with each Contracting Party determining its own criteria to identify hotspots. Up to 4 of these nearshore hotspots (per species) per country should be included in an in-water monitoring program and, if logistically feasible, at least one of these hotspots should also be the location of a capture-mark-recapture study to acquire data relevant to CI 5.

20. All countries are to undertake more broadscale review of turtle presence in neritic waters every six years to facilitate adaptive monitoring practices that meet the conservation needs of the species at country level. If new, important, foraging areas arise, or are discovered, that warrant monitoring, the new location should be added to monitoring effort undertaken at all the original hotspots, as long-term datasets provide a better understanding of variation and trends in turtle numbers.

Temporal Scope

21. Stranding networks and fishery bycatch record taking should operate year-round whilst the in-water hotspot monitoring programme surveys should be carried out in winter and summer with a set of repeated surveys in each season to provide confidence intervals on the number of turtles that are present.

Data analysis and outputs

22. Year-round, national data should be normalised for observer effort, and summarised by month or quarterly to identify seasonal trends and annually to generate year-on-year comparative data. Data should be mapped to the specified grid system in GIS software to standardize presentation in space and over time. The bi-annual hotspot monitoring data should be internally assessed separately to identify trends and combined into an annual summary that is mapped as for year-round data.

Offshore habitats

23. Offshore habitats are the most spatially extensive and logistically challenging to monitor zone in which turtles reside, and the difficulty to monitor turtles there is further exacerbated through the generally lower densities of turtles that are present. However, these habitats are where the majority of turtles reside given a population structure that includes multi-decadal lifespans and a far greater number of juveniles than adults. Given the widespread distribution of loggerhead turtles that entirely overlaps that of green turtles in the Mediterranean, all Contracting Parties should adopt measures to monitor the presence of sea turtles in oceanic habitats.

Spatial Scope

24. One way of monitoring offshore turtle presence *and* quantify threat levels to turtles is to employ national fisheries bycatch reporting mechanisms (see FAO 2020 and FAO, 2019) that incorporate a *sufficient proportion of vessels per area and per fishing gear*. However robust scientific data should be recorded from aerial and boat surveys. To extend coverage and establish regular distance surveys, these dedicated aerial and boat surveys can be supplemented with sightings utilising ferries or tourist boats as survey vessels (e.g., Zampollo et al. 2018, Casale et al. 2020). Effort should be made to identify turtles by species where possible, however outside of breeding migrations it can be assumed that any turtle over 40cm in length observed in offshore habitats will be a loggerhead as almost all green turtles have switched to benthic nearshore foraging habitats by that size class.

Temporal Scope

25. At a minimum periodic basis, such as every six years to match the IMAP cycle, collaborative subregional aerial surveys (e.g., ACCOBAMS Survey Initiative[9]) can be organised to assess turtle and other marine megafauna presence at sea, thus supplying broadscale quantitative data that can contribute to CI 3 and especially CI 4. Until there are repeated validated data from aerial surveys to form a strong baseline these aerial surveys should be carried out more frequently than every six years. Bycatch records and transect survey data should be collected year-round to establish seasonality in turtle presence and abundance etc.

Data analysis and outputs

26. As for nearshore data, year-round, national data should be summarised by month or quarterly to identify seasonal trends and annually to generate year-on-year comparative data. Data should be mapped to the specified grid system in GIS software to standardize presentation in space and over time. This mapping of gridded data also applies to any periodic, national and sub-regional aerial surveys that are performed.

Know Gaps and Uncertainties

27. Gaps and uncertainties for successful assessment of GES occur in both data types held and acquired and in the process for determining GES itself. These were previously listed in UNEP(DEPI)/MED WG.444/6/Rev.1. Here below the list was revised, selecting, with minor revision, those items determined to be the most important for having sufficient data to use in GES assessments, with reference to a recent Gap analysis on the conservation of marine turtles in the Mediterranean (SPA/RAC-UNEP/MAP 2020). Those items that referred to the process of determining GES have been removed as they are being resolved with the acceptance, after review, of proposals presented in this document.

Population distribution data gaps

- Location of all important wintering/feeding and developmental sites of juvenile and adult turtles
- Connectivity among the various sites in the Mediterranean
- Identify possible baselines and index sites
- Generate or update databases and maps of known nesting, feeding, wintering habitats in each Contracting Party.

Population demographic data gaps

- Number of males and females frequenting all breeding/nesting sites each year (operational sex ratio), and the total number of individuals in the breeding populations
- Number of adults and juveniles frequenting wintering/feeding and developmental sites, along with how numbers vary across the season as individuals enter and leave different sites
- *Knowledge on recruitment levels at representative index breeding areas from each relevant contracting party*
- Knowledge on the sex ratios within different components (breeding, *recruiting*, *maturing*, wintering/feeding), overall and across populations.

Pressure data

- Analysis of pressure/impact relationships for these sites, *with special attention to fishing pressure and mortality rates*
- Criteria for a risk-based approach to monitoring and develop harmonized sampling instructions where appropriate.

Data acquisition

- Identify monitoring capacities and gaps in each Contracting Party
- Develop monitoring synergies in collaboration with GFCM for- EO3 (Harvest of commercially exploited fish and shellfish), to collect data on sea turtle by-catch

[9] https://accobams.org/main-activites/accobams-survey-initiative-2/asi-preliminary-results/

• 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.

III. Scales of Assessment

28. Each country should look at its own data to determine national GES assessments. The **Contracting Party assessment** would take into account data on the CI 3, CI 4 and CI 5 that are obtained through monitoring at selected index nesting and nearshore foraging areas and through national offshore monitoring. In this level of assessment, data will inform the respective country if and where additional conservation measures are required to move towards GES if it is not met, or flag locations where indicators are suggesting worsening situations, whilst GES based on threshold values is still achieved.

29. Each Contracting Party assessment should feed into a **subdivisional scale assessment** in terms of reproductive distribution for two reasons. 1) genetic analyses have indicated several sub-RMU population clades exist for both loggerheads and green turtles (Figure 3.1); and 2) loggerhead turtles are undergoing a range expansion throughout the Mediterranean, probably driven by climate change, which renders a universal threshold value obsolete. Possible emergent regular nesting sites need to be treated differently to long-established major and minor nesting sites (see Section 2). For turtles in their other habitats (nearshore and offshore foraging zones) Contracting Party assessments should feed into subregional assessments. Contracting party assignation to specific subdivisions and subregions is provided in Table 3.1 and Figure 3.2.

30. **Subregional assessment** level is the most suitable scale for turtles in marine habitats for a number of demographically defensible reasons. The western Mediterranean which is the only sub-region to have large numbers of Atlantic loggerheads residing and to a *very* small degree breeding there, with only low-level emergent nesting taking place. The Adriatic Sea has little to no nesting taking place, but a large number of turtles present at sea that are potentially facing high threats from intensive fishing that takes place in the sub-region. The remaining two areas (Central Mediterranean/Ionian and the Aegean/Levant) cover the main nesting sites for both endemic species of sea turtle and the vast majority of the spatial distribution of green turtles with only very low numbers of that species being found in the Adriatic Sea. The Central Mediterranean/Ionian region also hosts important demersal and epipelagic feeding grounds for loggerheads and the Levant contains important migratory corridors for both species.

31. Because of the borders established in the current subdivision / subregion structure, data from several countries, especially Italy, Greece, Turkey and Libya will need to contribute multiple transnational segments. It is possible therefore that a country may not be in GES at national level, but subdivision and subregion areas to which the Contracting Party can be in GES depending on the subnational part of the Contracting Party's assessment, i.e., non-achievement of GES by a Contracting Party does not automatically result in non-achievement of GES of all of the subdivisions and subregions in which that party is situated (Figure 3.3).
Due to the intensity of work required, it is likely that not all Contracting Parties will be able to determine values for all relevant components that combine to make up CI 5. In these cases, demographic values from proximate Contracting Parties, or from any regional Contracting Party where data are scarce, can be used in calculating related demographic values. For example, accurate clutch frequency data (CF; the average number of clutches of eggs laid by a turtle during a single nesting season) are hard to acquire as they necessitate intensive nocturnal fieldwork programs, smaller scale but expensive tracking projects or large scale, technically complex and expensive sampling and genetic studies. Thus, species-specific CF values can be adopted by Contracting Parties from one of the few locations that they have been established in the region (e.g., Broderick et al. 2002, Rees et al. 2020).

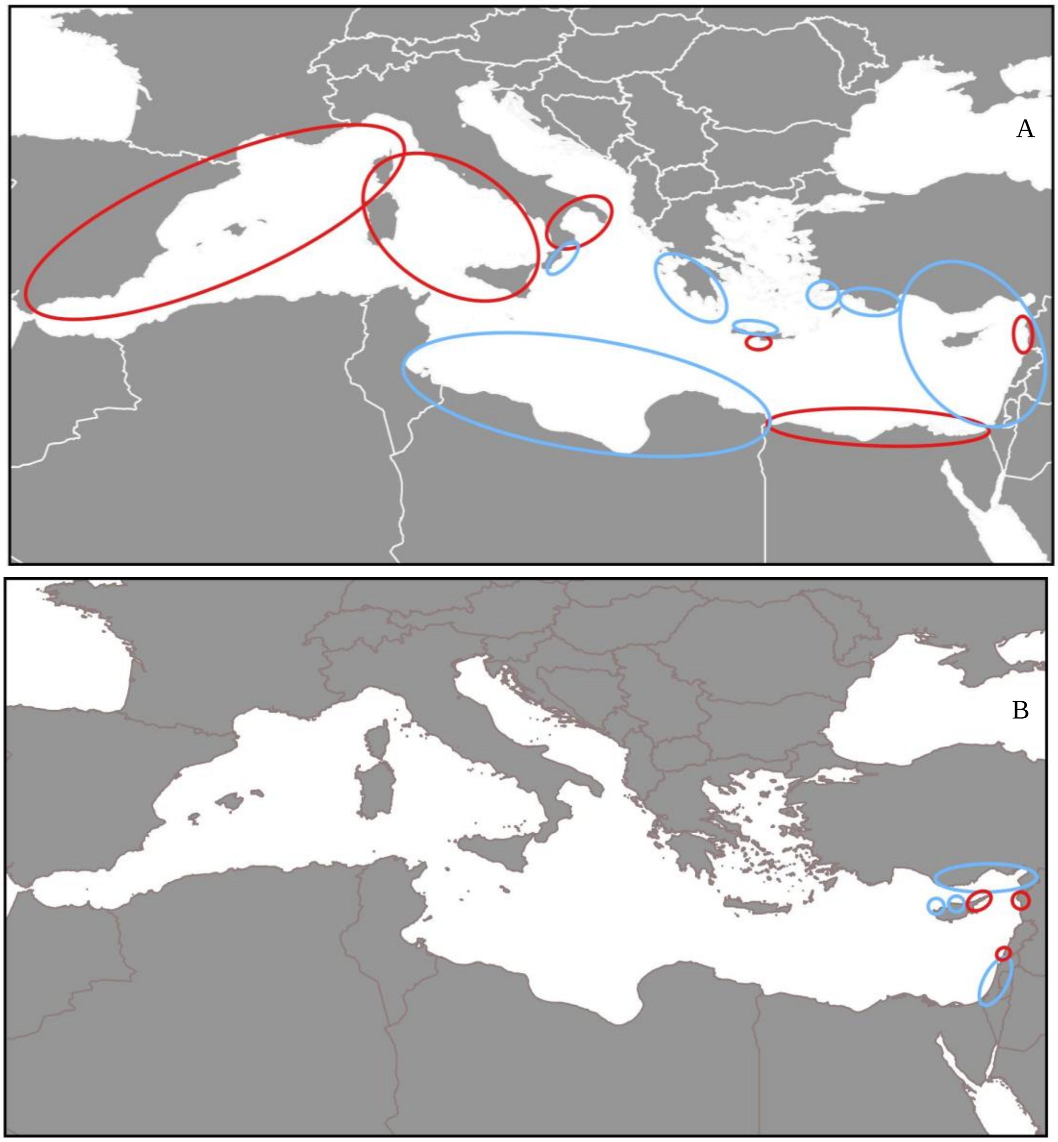

Figure 3.1. Genetic clusters for marine turtles breeding in the Mediterranean. (A) Loggerhead mtDNA genetic clusters (Based on Shamblin et al. 2014) (B) Green turtle mtDNA STR genetic clusters (Based on Tikochinski et al. 2018). Cluster colour codes: blue = defined, red = not processed / unsampled

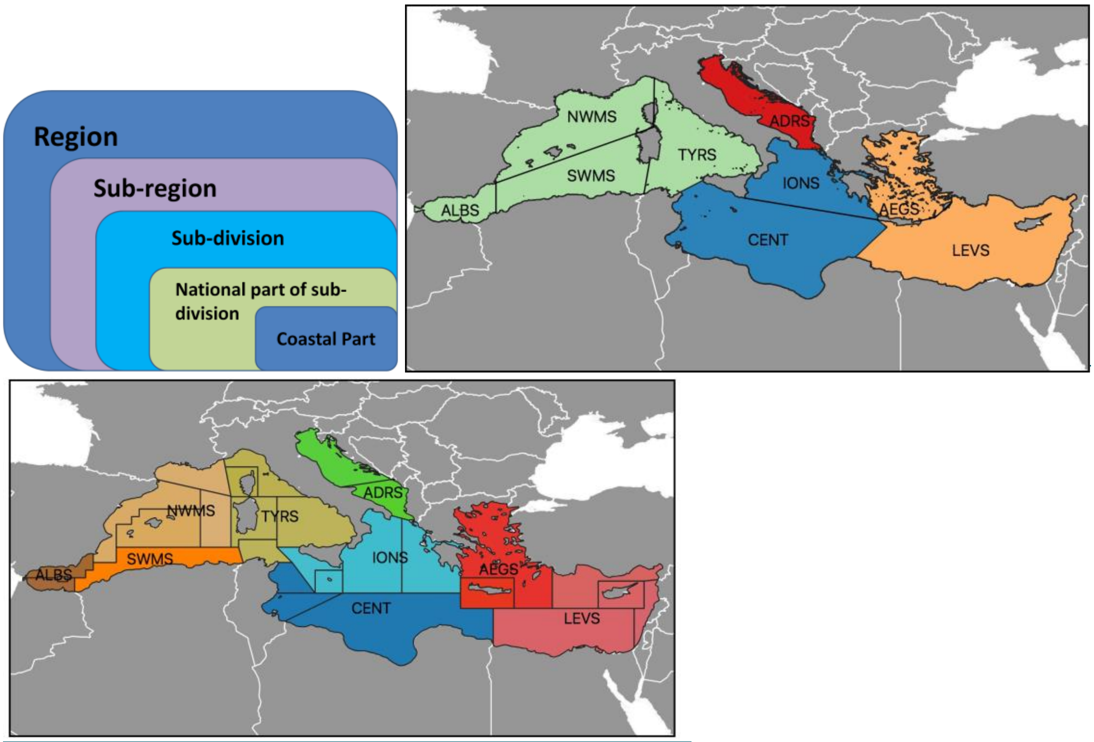

Figure 3.2. The established approximate four Sub-regions (coloured ~~areas~~ clades on map) and *draft suggested*, nested, nine Sub-division segments of the Mediterranean Sea, based on GFCM boundaries, for marine and nesting area assessment scales respectively. *(See also Table 3.1*)

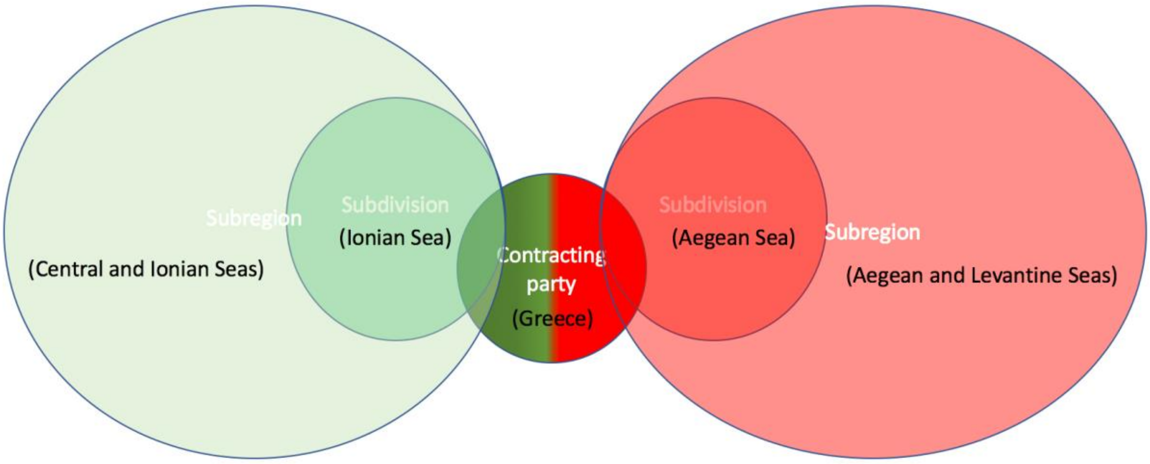

Figure 3.3. A Contracting Party that only partly achieves GES for any specific CI has a non-achieving status but may contribute both positively (GES achieved; green) and negatively (GES not achieved; red) to *draft subdivision* and subregion status based on the relevant prevailing condition at the sub-national level, with the example given of Greece.

Table 3.1. Suggested placement of Contracting Parties into four Subregional & 9 *draft* Subdivisional segmentation of the Mediterranean Sea for marine and nesting area assessment scales respectively. CPs in parenthesis contribute only a small portion of their coast towards the relevant *draft* sub-division. *(See also Figure 3.2*)

Sub-Region	Sub-Division	Contracting Party
	North Western (NWMS)	Spain, France~~, Italy~~

Western Mediterranean Sea	Alboran Sea (ALBS)	Spain, ~~(Algeria,)~~ Morocco
	Tyrrhenian Sea (TYRS)	Italy, Tunisia (France)
	South Western (SWMS)	~~(Spain),~~ Algeria~~, (Italy)~~
Adriatic Sea	Adriatic Sea (ADRS)	Italy, Slovenia, Croatia, Bosnia and Herzegovina, Montenegro, Albania
Central and Ionian Seas	Central (CENT)	~~Italy,~~ Libya, ~~Malta,~~ Tunisia (Italy)
	Ionian Sea (IONS)	Italy, Greece, Malta
Aegean and Levantine Seas	Aegean Sea (AEGS)	Greece, Turkey
	Levantine (LEVS)	Turkey, Cyprus, Syria, Lebanon, Israel, Egypt~~, (Libya)~~

IV. Assessment Criteria

CI 3 Distribution

32. The distribution criterion is a Boolean characteristic assessed over a predefined spatial grid of occurrence. Turtles are either recorded as present or absent, for nesting on sandy beaches or foraging at in-water locations with a predefined 10km square grid. For the well-defined somewhat one-dimensional nesting beach turtle focal areas their predictable presence at certain times of the year makes the distribution assessment relatively straightforward compared to the expansive two-dimensional marine realm. Nevertheless, with temporally and spatially sufficient monitoring taking place, as defined above, assessment towards GES can be made across the Mediterranean region in all habitats. Table 4.1 lists the various factors that need to be considered to understand sea turtle distribution together with the broad-strokes methods used and what data is to be collected.

Table 4.1. Topics and data gathering requirements for CI 3: turtle distribution per species.

Terrestrial habitat (nesting beach)		
Necessary information	**Methods**	**Data collected**
Actual nesting activity distribution	Foot patrols UAV surveys Plane surveys (Genetics)	Extent of each nesting site. Nesting activity locations. (Haplotyping adults)
Potential nest site distribution (minor / emerging nesting beaches)	Foot patrols UAV surveys Plane surveys	Extent of each potential nesting site. Confirmation of nesting/no nesting every 6 years.
Marine habitat		
Necessary information	**Methods**	**Data collected**
Offshore foraging areas	Plane surveys Telemetry Bycatch Boat surveys UAV surveys (boat based) (Genetics)	Location of turtles Seasonality of presence (Mixed stock analysis)
Nearshore foraging areas	Boat surveys UAV surveys Plane surveys Telemetry Bycatch Strandings (Genetics)	Location of turtles Seasonality of presence (Mixed stock analysis)
Migratory pathways	Telemetry Bycatch	Location of turtles Seasonality of presence
Internesting areas	Telemetry UAV surveys Boat surveys	Location of turtles

Breeding area

33. Each stretch of coast should be classified as nesting beach or not, in 10km blocks following a presence/absence criterion based on both historic and most recent data on the knowledge of nesting locations. From the annual nest count surveys that cover a high proportion of a country's nesting, based on country category defined in Table 2.1, the spatial distribution of nesting can be determined per year. Every six years, this national situation should be revisited and at least a sample of previously known nesting areas and other potential nesting areas need to be re-assessed. GES should be declared when all monitored index sites are fully maintained as nesting sites and there is little or no degradation of other known sites, that may be monitored to a lesser degree and are not included as index sites.

Nearshore / Offshore habitats

34. Validation of the distribution of turtles in both nearshore and offshore habitats should come from changes in results from monitoring methods described in Section 2. The ubiquitous presence of loggerhead turtles across the entire Mediterranean Sea and current and anticipated patchiness of distribution data mean that their potential presence should be assumed unless persistent absence can be confirmed (e.g., through persistent lack of turtle bycatch records in a fishery and area which previously reported them, or where a monitored nearshore hotspot no longer has turtles). The predefined 10km grid squares should be used for monitored hotspot areas. Other locations should present amalgamated and interpolated distribution data that show a combination of assumed and confirmed at-sea presence. Similar assertions should be made for green turtles within their more restricted eastern Mediterranean range. Given the stipulated existence of monitoring at several key nearshore foraging sites and sufficient reporting of bycatch data per Contracting Party, GES can be argued from persistence of turtles recorded in all areas. Periodic subregional aerial or other survey data can be used to support these assumptions for both turtle species.

CI 4 Abundance

35. The measure of abundance per species of turtle per grid cell covers a scale that includes zeros but is quantified as some measure of density, such as numbers of nests or turtles per 10 km cell. The difficulty in acquiring robust monitoring data from marine habitats highlights the necessary investment of effort and resources required by Contracting Parties in order to properly assess this CI for turtles, and the benefit from maximising data acquisition for multiple taxa from single surveying efforts. Table 4.2 lists the various factors that need to be considered to understand sea turtle abundance together with the broad-strokes methods used and what data these methods collect.

Table 4.2. Topics and data gathering requirements for CI 4: turtle abundance.

Nesting beach		
Necessary information	**Methods**	**Data collected**
Actual nest site locations	Foot patrols UAV surveys Plane surveys	Number of nests/tracks per season per index beach.
Potential nest site locations (minor / emerging nesting beaches)	Foot patrols UAV surveys Plane surveys	Quantification of nesting / no nesting every 6 years.

Marine habitat		
Necessary information	**Methods**	**Data collected**
Offshore foraging areas	Plane surveys Boat surveys UAV surveys Telemetry (Genetics)	Number of turtles (seasonal considerations) Location of turtles (seasonal considerations) (Mixed stock analysis)
Nearshore foraging areas	Boat surveys UAV surveys Telemetry Stranding Plane surveys (Genetics)	Number of turtles (seasonal considerations) Location of turtles (seasonal considerations) (Mixed stock analysis)
Migratory pathways	Telemetry (Genetics)	Number of turtles (seasonal considerations) (Mixed stock analysis)
Internesting areas	Telemetry UAV surveys	Number of turtles (seasonal considerations) Density of turtles

Breeding area

36. As suggested above, abundance of turtles present at a breeding site, in its most basic form, can be inferred from the numbers of nests deposited on the monitored index nesting beaches and subsequently divided by the number of 10 km cells to provide a density value, when required. However, nest numbers do not provide an irrefutable direct indication of the number of adults breeding annually in a population. This is because adult female turtles deposit between one and five clutches in a given breeding season, and successive breeding seasons may be two or more years apart for the nesting turtles. Additionally, given the temperature-determined sex differentiation in sea turtles, sex ratios of populations may significantly differ from 1:1 and furthermore, male turtles are reported to return to breed more frequently than females, often annually. Given these facts, deriving adult population size (abundance) from a nest count from a single year is likely to produce widely erroneous results. Nevertheless, the use of nest count trend data is generally accepted as the most practical way of determining population abundance, e.g., it is this metric used in the IUCN MTSG to determine red list status of regional and global assessments. The underlying demographic factors (assessed in CI 5) need to be incorporated in any determination of adult turtle abundance associated with monitored nest numbers. Additionally, to avoid misinterpretation caused by interannual variation, a time series of at least six years of nest count data should be used.

Nearshore

37. Nearshore abundance data should be collected from the monitored index coastal hotspots (see Section 2) which will give a six-monthly assessment. The two seasonal surveys can be combined to give an annual assessment on abundance per location and the various coastal hotspots combined to give a national value (for monitored index hotspots). Bycatch and stranding records should be analysed annually to identify any locations with increasing rate occurrence (bycatch values adjusted for fishing effort) which may mean increasing populations, or for areas where regular turtle reports are reducing or no longer occurring which may indicate local reduction in population size. However, the main robust and defensible data to contribute to the abundance assessment should come from standardised repeated surveys in the hotspots. The nearshore zone is also utilised by both species of turtle as migratory thoroughfares at regular times of the year (pre- and post- breeding season) and this may affect abundance estimates determined during certain time periods, so monitoring and analysis need to account for this seasonality.

Offshore

38. This region is the one that is hardest or most expensive to survey and produce spatially explicit abundance values. That said, as indicated in Section 2, there are several ways to monitor the presence of- and derive abundance values for- sea turtles in the open seas. Abundance values from dedicated annual or periodic regional or subregional aerial surveys should be used for definitive assessments and to validate opportunistic survey results and can be used to cover gaps in data collection from contracting parties unable to generate their own national abundance data. Sighting data from ferry routes, or touristic boats can additionally contribute to the abundance estimates, if collected systematically over a long period (Zampollo et al. 2018, Casale et al. 2020). These data can be more accurately spatially grouped to provide quantitative turtle abundance estimates along the ferry route. Variability in these data can be investigated to determine what level of sightings are required to identify real increases and decreases in population abundance. The offshore zone is also utilised by both species of turtle as migratory thoroughfares at regular and predictable times of the year (pre- and post-breeding season) and this may affect abundance estimates determined during certain time periods, so monitoring and analysis need to account for this seasonality.

CI 5 Demography

39. Understanding the demography of sea turtle metapopulations helps to identify which pressures may most impact on population stability and which conservation measures are likely to have greatest effect in stabilising or recovering population levels. The basic principle being that the number of turtles recruiting to the population each year needs to be sufficient to sustain the level of reproductive adults in the population given the differing mortality rates affecting the population at each ontogenetic stage / age class. To adequately assess this basic principle requires data on numerous aspects of the sea turtles' life cycle including fecundity rates and their interplay with threats to the turtles' environment and the turtles themselves, for example through fisheries bycatch. Table 4.3 lists the various factors that need to be considered to understand sea turtle demography together with the broad-strokes methods used and what data these methods collect. Data on certain aspects of demography may take decades to acquire and not all Contracting Parties have the capacity to determine them unilaterally. This especially applies for topics such as age at sexual maturity, and longevity etc. In these cases, a Contracting Party can adopt values produced by other Contracting Parties or regional collaborations as proxies for their own populations. However, each nation is strongly encouraged to gather data relating to reproductive output and population recruitment through targeted monitoring of index nesting beaches.

Breeding area

40. The focus on data gathering at nesting sites is on individual and population level reproductive output, population recruitment, sex ratios of hatchlings and adults and adult longevity. Output, recruitment and hatchling sex ratios are relatively simple to determine and should be undertaken at the monitored index beaches that have been selected by each Contracting Party. The other data topics require intensive monitoring regimes to be carried over the well-defined summer breeding season and should carried out where possible.

Nearshore neritic

41. This zone is generally occupied by larger juvenile (>45cm CCL) through to adult loggerhead sea turtles and by small juvenile (>30cm CCL) through to adult green turtles – though green turtles may shift through a series of size-class specific habitats/locations. Data required from this habitat focus on size class distribution, growth rates, sex ratios, survivorship (which can include bycatch and mortality rates) and age at maturity. Several of these topics require intensive and specialised, invasive, research methods, such as determining age at maturity and sex ratio of juvenile turtles, and data from other Contracting Parties or collaborative efforts can be used for these topics, but each Contracting Party should acquire its own data where feasible in terms of expertise and resources.

Offshore oceanic

42. This zone is most commonly inhabited by hatchlings and early-years juvenile turtles, <30cm for both species, though loggerheads of larger size classes – including a large proportion of adults – may remain in the oceanic zone year-round. Data acquisition here broadly follows that for neritic stage turtles, such as size class distribution, growth rates, survivorship (which can include bycatch and mortality rates) and sex ratios with little or no opportunity for direct data on age and size at sexual maturity. Again, if necessary, collaborative data or data from other Contracting Parties can be used where an individual Contracting Party is unable to acquire its own data.

Table 4.3. Topics and data gathering requirements for CI 5: turtle demography. **factors that can be *improved* by direct conservation measures. *factors that can be *improved* by indirect conservation measures.

Breeding areas			
Necessary information	**Methods**	**Data collected**	**Refs.**
Clutch size	Nest excavation	Number of eggs per clutch	1, 12, 14
Incubation duration (ID)	Regular Foot patrols Temperature loggers	Laying/hatching dates Incubation temperature profile	12
**Hatchling emergence hatching success	Nest excavation	Percentage of eggs that produced a hatchling that escaped the nest (considering predation and inundation etc.)	1, 14
Internesting Interval	Telemetry Night patrols (Genetics)	Nesting events identified from movements Nesting events identified by observation of turtle (Nesting events confirmed by individual-specific DNA analysis)	9, 14
Remigration Interval	Telemetry Night patrols (Genetics)	Presence in nesting area confirmed through observation of individual or from tracking	13, 14
Clutch frequency	Telemetry Night patrols (Genetics)	Number of clutches per individual identified from movements Number of clutches per individual identified by observation of turtle (Number of clutches per individual confirmed by individual-specific DNA analysis)	2, 3, 14
**Sex ratio Hatchlings	Regular Foot patrols Temperature loggers (Biochemical analysis -hatchlings)	Derived from laying and hatching dates (ID) Derived from nest/beach temperatures (Assessed from blood sampling / hormone assay)	10, 14
(operational) Sex ratio adults	UAV survey Plane survey Boat survey (Genetics - hatchlings)	Proportion of sexes observed during the pre-nesting season gathering at sea near the nest site (Determined by identification of males from genetic characteristics and inferred from multi-paternity in clutches)	15, 16
Longevity	Foot patrols Capture-Mark-Recapture (CMR)	Reproductive longevity and output of females and repeat presence of males	17, 18

Marine habitat			
Necessary information	**Methods**	**Data collected**	**Refs.**
Oceanic foraging area: size classes / Sex ratio	Boat surveys UAV / Plane surveys Bycatch	Abundance and distribution data separated by size and sex (where sexing individuals is only possible for sub-adult and adult size classes from external morphology)	11, 14
Neritic foraging area: size classes / Sex ratio	Boat surveys UAV / Plane surveys Bycatch / Strandings	Abundance and distribution data separated by size and sex (where sexing individuals is only possible for sub-adult and adult size classes from external morphology)	4, 7, 11, 14
**Oceanic foraging area: threats and survivorship	Bycatch Telemetry CMR	Incidence of bycatch and resulting mortality rates Mortality rate of identifiable individuals	8, 14, 24
**Neritic foraging area: threats and survivorship	Bycatch / strandings CMR Telemetry	Incidence of bycatch and resulting mortality rates Mortality rate of identifiable individuals	8, 14, 24
*Oceanic foraging area: health index	Bycatch CMR	Size/weight Pollutants	20, 25
*Neritic foraging area: health index	CMR Bycatch / strandings	Size/weight Pollutants	19, 20, 21, 22, 23,
Growth rates	Bycatch Strandings CMR	Size at capture	6, 14
Age and size at sexual maturity	Bycatch/ Strandings , CMR	Age (skeletochronology) Maturity (necropsy/ laparoscopy) When mature (from CMR).	5, 8, 12, 14

V. Baseline and Threshold Values for IMAP/EcAp CIs

CI 3 Distribution

Breeding area

43. The most appropriate measure to establish distribution of nesting areas is through accepting a baseline reference year. Baseline spatial distribution to be used should be that recorded in 1992 with the year chosen to align with historic threshold data adopted at the onset of the EU Habitats directive, with this applying to all riparian countries of the Mediterranean, not only those in the EU. Where data are not available for this period the oldest records dated after 1990 can be used. All long-term studies have shown that nesting areas that were present in 1992 are still valid nesting areas today. Using the data from annual monitoring at index nesting sites covering the majority of nesting in each Contracting Party, reduction of the number of 10km blocks with nesting can be identified. This is to be supplemented every six-year cycle with more widespread national reassessments of nesting distribution for a more complete national and regional view.

44. Loggerhead turtles are currently undergoing a relatively rapid expansion of breeding site distribution with new regular nesting sites occurring in Italy and increased number of sporadic nesting in Spain, Albania and Malta. Many of these sites are already heavily developed and are not ideal nesting grounds for turtles, leading to successful establishment of breeding populations likely to be entirely conservation dependent. National programs currently underway to monitor nesting in these countries should be maintained. Green turtles are not yet demonstrated to be undergoing a range expansion in terms of nesting sites, with only three anomalous nesting events recorded as taking place since 2007, namely two nests at widely different locations on Crete, in Greece, and one nest in Tunisia. However, should range expansion been shown, baseline values can be treated in the same way as for loggerheads in emerging nesting sites.
National programs currently underway to monitor nesting in countries with emerging nesting populations should be maintained with the aim to confirm the establishment of these areas as regular nesting sites and implementation of necessary conservation measures.

45. GES can be accepted per Contracting Party for Category 1 and 2 countries (Table 2.1 and Breeding Areas; Fig 1.4), when annual monitoring confirms that nesting is taking place at all the selected index sites. Years without nesting at all established index sites are indicative that GES is not achieved and that reasons for the lack of nesting should be investigated and remedial action, to minimize threats, taken to facilitate return of nesting activity. For Category 3 countries, GES can be assumed if nesting is continuing at a national level for sporadic nesting, but GES is not achieved where no nesting is recorded over six years at a low-level but regular nesting site.

Nearshore

46. Because of the paucity of data and understood general low density of turtle presence in coastal waters, it can be assumed that turtles are still currently distributed in all their natural ranges across the Mediterranean Sea. For loggerheads, this means the entire coastal waters are accepted as part of their baseline distribution (Figure 1.3A). However, green turtle baseline distribution is restricted to the eastern Mediterranean, generally as depicted in the Mediterranean green turtle RMU in Wallace et al. (2010) article but with the south western extent of occurrence of the species reaching to the south of Tunisia as shown by satellite tracking adult turtles (Figure 1.3B).

47. GES status for this part of the Indicator can be lost if monitored nearshore hotspots are shown to no longer have turtles present at any time of the year or if bycatch and stranding (when a turtle washes ashore dead, injured or debilitated) data reveal no more turtles are being recorded in a certain region. The hotspot monitoring presence should be indicated in the relevant blocks of the regional 10km grid, but the stranding

and bycatch data should be applied at sub-national level as the amount of data collected and spatial accuracy of presence records are low.

Offshore

48. There is a greater paucity of data and lower density of turtles present in offshore neritic and oceanic habitats than in nearshore habitats, hence the accurate assessment of turtle distribution in terms of presence/absence is even more difficult to determine. Consequently, effort made to assess turtles in the offshore zone should focus on data collection towards CI 4 and CI 5 as presented in Sparks and DiMatteo (2020). The baseline distribution of loggerhead and green turtles should be accepted as depicted in Figure 1.3.

CI 4 Abundance

49. Determination of abundance baselines and thresholds is more involved than for CI 3 (distribution), with the main issues being: (a) how to set a baseline (e.g., based on a certain historic data or modelled values)?, (b) how to acquire sufficient suitable data that will be used in abundance assessments?, and based on the precautionary principle, (c) how much of a buffer of uncertainty should be assigned to ensure that increased conservation measures are put in place before populations collapse?

50. Setting these values and acquiring relevant requires differing methods and levels of effort and based on the turtle habitat under examination. Assessments based at the nesting areas are simplest as they are restricted spatially and temporally, nearshore habitats are next most accessible for monitoring and offshore oceanic habitats are the most difficult and expensive to assess though have been carried out with notable success of the ASI project of ACCOBAMS in 2018[10].

51. For both species of turtle breeding in the Mediterranean, prior to the potential of GES not being achieved, negative population trends should be used to raise concern and drive increased conservation actions, with a recommended trigger of a greater than estimated 10% decrease in population size over a six-year reporting period.

Breeding areas

52. Baseline values rather than thresholds are suggested to be used for loggerheads to aid determination of GES, with values derived from the average of five years of nest count data centred on 1992. The year is chosen to align with historic threshold data adopted with the establishment of the EU Habitats directive, and five years of data (1990-1994) to determine historical level are shown to be very similar to an average of all nesting data between 1984-1991 – the longest and hence most historic published time series of data from two of the most important loggerhead nesting areas in the Mediterranean (Margaritoulis and Rees 2001, Margaritoulis 2005). Adoption of this timeframe can be further validated with other long-term datasets for Mediterranean loggerhead nesting, if they exist. Where data are not available for this period the oldest records can be used and modelled against other contemporary datasets, as seasonal inter-seasonal variation in nest numbers shows rough correlation across the region, to establish baseline data for those sites extrapolated back to 1992, or a trend-based approach using rolling 6-year datasets and baseline value from start of monitoring dataset. Many loggerhead nesting sites across the eastern Mediterranean in the latter 2010s through to 2020 are showing increased numbers of nests (Pers. Obs.), which may suggest updating baseline values to more recent averages, however it is not known if these increases are part of a multidecadal cycle, as demonstrated for loggerheads in the NW Atlantic (Ceriani et al. 2019) which will include a forthcoming decline in nest numbers not resulting from any specific anthropogenic worsening of habitat conditions and/or effects of climate change and adaptations of turtles to such changes. Consequently, 1992 average or modelled baseline data for long-term datasets should currently be maintained (for at least one more six-year IMAP reporting

[10] https://accobams.org/main-activites/accobams-survey-initiative-2/asi-preliminary-results/

cycle) until the increases in nest numbers is confirmed as a positive trend in population size. National programs currently underway to monitor nesting in countries with new and emerging nesting populations should be maintained and baseline values should be assumed as individual nests. Baselines in these areas should be revised upwards (using a trend-based approach) with every six-year cycle to ensure that spatially stable nest sites with increasing numbers of nest are represented in their best condition and a return to zero is not acceptable.

53. No such historic time-series nest count data exist for Mediterranean green turtles, with only one published dataset originating from late 1989 (Lara-Cyprus) and two from 1993 (Alagadi-Cyprus and Israel). Five- and ten-year rolling average values for these three locations indicate a general increase in nest numbers over time, indicating that adoption of the most historic five-years of data for a given nesting site is a suitable baseline value. It should be noted that these three sites have been subject to long-term nest management and protection measures and are therefore likely to be in better condition, with more positive nest trends, than other sites where conservation actions have not been, or have more recently been put in place. However, the lack of certainty over historic nesting levels at green turtle nesting sites suggests that adoption of the most historic 5 years' worth of data, with periodic trend-based increases, remains most valid.

54. No nesting areas are currently considered at carrying capacity, and hence have the potential to host increased numbers of nests over time. However, no nesting area is known to ever have been at theoretical carrying capacity so that threshold should not be taken into account for determining GES.

Nearshore neritic

55. Abundance estimates in nearshore habitats will mainly be generated through annual hotspot monitoring for both species. It is not anticipated that historic abundance values will be available or calculable, so data from the first monitoring year should be accepted as baseline. Monitoring through the year should be conducted so that the actual number of turtles present with an estimate of variance can be calculated. The sites can then be considered achieving GES if the annual estimate is above baseline minus 1 standard error and all sites need to be in this condition, so that GES at a large site cannot compensate for lack of GES at a lesser site. Lastly, periodic aerial surveys can be used to generate data at subregional scale timed to take place prior to the six-yearly assessment period. It is unlikely that the aerial surveys will cover the same locations as the nearshore hotspot monitoring so both datasets would need to be taken into account in the periodic assessment, together with stranding data if obtained in sufficient levels. Given that across the Mediterranean both species of sea turtle are tentatively regarded as displaying an upward trend in population size (based on increased nest numbers), current levels of turtle abundance in nearshore neritic waters are likely to represent a positive state for GES determination and future assessments that fluctuate above this baseline value should all be considered GES.

Offshore oceanic

56. Where historic records for offshore presence and abundances of sea turtles exist, these can be used as baselines. Such data is lacking and improbable to be accurately modelled for the majority of contracting parties and hence the first year's data collected should act as baseline. Due to the low densities and high motility of turtles in the oceanic realm abundance values should be determined at large subnational or national scales. Broad-scale abundance values derived from sightings data from non-dedicated observation platforms such as systematic observations from ferries/platforms can be used. Ideally this data should be robust enough to allow abundance values with estimates of variance to be calculated. Periodic sub-regional aerial surveys can provide a snapshot of abundance used to calibrate national findings. GES can be accepted unless measurable decreases in abundance below threshold (abundance baseline, minus one standard error) are detected at national level.

CI 5 Demographics

57. Demographic characteristics of populations need to be assessed for accurate modelling of population structure and anticipated resilience to anthropogenic and other stressors. For conservation purposes, these characteristics are better evaluated using threshold values rather than baselines. The values should be constant over time, irrespective of population size, and set at levels that are sufficiently conservative to ensure that positive outcomes result from summary assessments of complex data types.

58. Not all sought-after data are equal in terms of ease of attainment, both in terms of timescales and effort required for their determination. For example, estimations of *clutch size* and *hatchling emergence success* can be obtained from one week's fieldwork whereas determination of longevity or survival of breeding adults requires decades of intense nocturnal fieldwork over several months per year. Consequently, hard to acquire demographic values generated by monitoring and research efforts by one Contracting Party can be used by another Party until they have their own equivalent data. Indeed, in some cases, for example for small nesting populations, the effort required to determine certain values, such as *clutch frequency* and *remigration intervals*, far outweigh the utility of determining Contracting Party-specific data points and other subregional values can be adopted in the Party's national assessment.

59. Certain demographic metrics are useful for understanding population resilience but cannot be affected by conservation measures, e.g., *clutch size*, whereas other metrics can be used to understand population resilience and can be positively affected by conservation measures, e.g., *hatchling emergence success*. It is those metrics that can be manipulated that should be used as main criteria for determining GES relating to CI5.

60. A full list of metrics to understand sea turtle demography, which metrics can be improved through conservation measures and what data need collecting is presented in Table 4.3. Each metric is discussed in turn, below, with regard to established values and the need for Contracting Parties to determine local, up-to-date data values.

Metrics obtained from Breeding Areas

Clutch Size (CS)

61. This is a commonly collected metric obtained from post-hatch excavation of nests or from egg counts during relocation of clutches soon after egg-laying. CS is needed to be able to determine *Hatching Success* and *Hatchling Emergence Success* (see below) and is part of the data that contributes to understanding sea turtle fecundity. Typical CS for loggerheads ranges from 70 to 110 and for green turtles the range is 100 to 115 (Casale et al. 2018). It is not a measure that can be manipulated for conservation purposes, but it should be assessed by each individual Contracting Party.

Incubation Duration (ID)

62. Precise laying and hatching dates are required to calculate an accurate ID. IDs are negatively correlated with nest temperature and hence can be used to produce a rough estimate of the *Sex Ratio of Hatchlings* produced by the nest. This sex ratio feeds into demographic models that predict sex ratios at later life stages which in turn can affect population resilience. It is not a measure that should be directly manipulated, though if there is strong evidence that beach temperatures are frequently exceeding the thermal tolerance of embryos (see *Hatchling Emergence Success*) then management measures such as nest shading can be adopted to reduce the temperature to tolerable levels. ID should be assessed by each individual Contracting Party at each index nesting site.

Hatchling Emergence Success (HES)

63. This is a frequently collected metric and is a measure that combines both egg fertility and suitability of nest conditions that result in a certain percentage of eggs that will successfully develop to produce hatchlings that emerge from the nest. HES may be reduced if the nest is inundated by sea water, when sand infiltrates the air spaces between the eggs, if incubation temperatures lie outside the thermal tolerance range for embryo development, if the nests are plundered by predators or if nests are crushed or trampled by heavy machinery etc., or if the sand conditions are not conducive to successful incubation. Reported HES for loggerheads in the Mediterranean varies greatly and ranges from around 20 to 80% (Casale et al. 2018) and for green turtles it averages around 75% (Casale et al. 2018). The green turtle value (75%) can be accepted as a threshold level for this species in the region and 65% is a suitable target value for loggerhead turtles. This is a measure for which conservation actions can be carried out and as such it is a suitable candidate to have target thresholds assigned, however as HES is only determined at the end of a nest's incubation, conservation measures need to be put in place for the following seasons. For example, if many nests are inundated by storm waves, nest relocation measures can be adopted and if nests are being depredated then nest protection measures or predator management measures can be put in place. To balance out inter-nest variation, all nests should be treated as one single clutch. For example, if HES was averaged across the season per nest then a nest with 30 eggs of which 7 produced hatchlings that emerged (23%) and a nest of 140 eggs with 122 emerged hatchlings (87%) would give a HES of 55% (not meeting GES), whereas if all nests were treated as a single clutch 129 eggs from 170 eggs would be recorded as producing emerged hatchlings with a resulting HES of 76%, which reflects the actual beach-level HES, and GES is met. Obviously, the effect of HES from small clutches reduces as sample size increases, but it may skew results in small samples sizes and should be avoided through treating all nests as a single clutch. Additionally, to assess HES across the beach then stratified sampling of nests needs to be undertaken combining at least three different nest incubation conditions, namely, *in situ* / relocated nests, inundated / non-inundated nests and depredated / non-depredated nests. As not all eggs can be found for depredated nests, the CS for non-predated nests should be used for these nests to standardize their contribution to the final HES value. Exceeding threshold values for HES should be targeted per monitored nesting area per year. Absolute thresholds should be set at 10% lower than average trigger no GES, with a buffer extending from average to this -10% mark indicating additional conservation measures are indicated. This equates to non-achievement of GES threshold values of 55% for loggerheads and 65% for green turtles. HES should be assessed by each individual Contracting Party at each index nesting site.

Internesting Interval (II)

64. This is the elapsed time in days between clutch deposition and the next time the turtle emerges onto the beach to nest- whether successfully or not. Determining II requires intensive night work on a capture-mark-recapture project during the nesting season that needs to be carried out by trained personnel to avoid disturbance to the nesting turtles. II, used together with *Clutch Frequency* (see below) can indicate how long a turtle will be resident in the breeding area, post onset of nesting, however the daily trend in nest numbers is a better indicator of how many turtles may still be in the breeding area. Normal values are from 10 to 20 days (loggerheads; Margaritoulis et al. 2013, green turtles; Broderick et al. 2002). It negatively correlates with sea temperature (Hays et al. 2002) and is not a metric that can or needs to be affected by conservation measures. There is no requirement for a Contracting party to obtain data for II as part of a basic monitoring program.

Remigration Interval (RI)

65. The number of years between successive breeding seasons is known as the Remigration Interval. It ranges from one to five years or more but is commonly two or three years. RI is related to the conditions in foraging grounds experienced by the adult turtles that influence the rate at which the turtles can replenish body condition and build up enough reserves to see them through a breeding period season. Male turtles, requiring fewer biological resources pre breeding season, are thought to have shorter RIs than females, as has been

documented for loggerhead turtles breeding on Zakynthos Island, Greece (Schofield et al. 2020). Accurate determination of RI is important for population modelling (Casale & Ceriani 2020).

Clutch Frequency (CF)

66. This is the average number of clutches deposited by a turtle during a single breeding period. Each clutch is separated by an *Internesting Interval*, during which time the subsequent clutch is ovulated, fertilised and the shells formed on the eggs. CF output of individual females is derived from capture-mark-recapture data (Broderick et al. 2002), tracking studies (Rees et al. 2020) or genetic studies (Shamblin et al. 2017). Knowing CF contributes to the estimations of number of breeding females in a given season. There is limited data on clutch frequency for Mediterranean turtles. The only data for green turtles comes from Cyprus where CF of 2.9 – 3.1 has been estimated (Broderick et al. 2002). Similarly, a CF of 1.8 – 2.2 has been estimated loggerhead turtles nesting on Cyprus, but more recently a value of 3.8 ± 0.7(SD) was calculated from Greece. CF is not a metric that can be affected by conservation measures. Given the difficulty in obtaining accurate population level CF values, published data can be used across the Mediterranean for determining demographic metrics.

Sex Ratio of Hatchlings (SR-H)

67. Sex ratio of hatchlings is roughly obtained from interpreting IDs, nest or beach temperatures or, more accurately, from sampling hatchlings (e.g., Mrosovsky et al. 2002, Tezak et al. 2020). Methods involving hatchling sampling are invasive and is best only carried out on larger populations. Sex ratios feed into the demographic assessment of a population such as higher ratios of females facilitating faster population recoveries or extreme lack of males possibly leading to unsuccessful breeding seasons for individual females. Sex ratios published to date in the Mediterranean are typically female skewed for both loggerheads and green turtles (Casale et al. 2018). However different areas and times of the season may produce closer to 50% ratio or even be male biased (e.g., Katselidis et al. 2012). SR-H is not a metric that should be manipulated, except for the most extreme cases where and HES is consistently being compromised due to thermal extremes. Estimates for SR-H should be assessed by each individual Contracting Party at each index nesting site to understand that sufficient male turtles are still being produced under the influence of climate change. A female threshold of no more than 95% per country can be used, as research has indicated that only a low percentage of male hatchlings are required to maintain populations and there is equal concern over reduced *hatchling emergence success* (Hays et al. 2017) which is also to be monitored and can be mitigated against.

Sex Ratio of Breeding Adults (SR-BA)

68. SR-BA can be determined from surveys of the nearshore marine habitat for approximately one month prior to the onset of the nesting season until nesting begins, i.e., from mid-April to mid-to-late-May. The number of adult male and female turtles observed during the survey produce the season’s operational sex ratio (OSR), but this can be taken further to produce functional-OSR when timing of the surveys is taken into account (Schofield et al. 2017). OSR can also be determine through in-depth genetic studies of paternity in multiple nests from a population (Wright et al. 2012). SR-BA is used for demographic analyses and provide insights into any persistence and effects of skewed SR-H. OSR (male:female) for loggerheads is 1:2.7 at Zakynthos, Greece (Schofield et al. 2017) 3:1 for green turtles in Turkey (Turkozan et al. 2019) and 1.4:1 for green turtles in Cyprus (Wright et al. 2012). No other data exist for Mediterranean turtles. SR-BA is not a measure that can be manipulated for conservation purposes but should be assessed periodically by each individual Contracting Party.

Longevity

69. Longevity is best determined from intensive capture-mark-recapture projects, carried out at nesting areas. Understanding how long animals may live provides insight on lifetime reproductive output for adult female turtles that contribute towards population modelling. Current maximum reproductive longevity for

adult female loggerheads in Greece was recently published at 33 years (Margaritoulis et al. 2020). Longevity was analysed for loggerheads and green turtles in Cyprus (Omeyer et al. 2019) with loggerheads breeding up to 25 years and green turtles 24 years. No other data have been published for the Mediterranean. Biological longevity are not metrics that can be manipulated for conservation purposes, but reduction of threats, both marine and terrestrial will aid turtles' abilities to live to reach their natural lifespans and hence their reproductive potential. Due to the length of time required to measure these traits they need not be ascertained for all nesting populations, though they can be an aspirational goal for nascent turtle monitoring projects at index nesting areas per Contracting Party.

Metrics from other marine habitats

Size classes / sex ratios in offshore foraging areas

70. These data are gathered from dedicated surveys, surveys from regular boat traffic, such as ferries, aerial surveys and bycatch records (See Casale et al. 2006). They give an understanding of the population structure in the open seas including data on abundance, distribution and threats. Turtles found in the open seas may range from yearlings to adults for loggerheads and yearlings to around 30cm for green turtles. There will likely be bias in observations as bigger turtles will be easier to spot. In subadult and adult sizes that are observed close-up as with bycaught turtles, sex of individuals can be inferred from tail length. Size classes and sex ratios are not metrics that can be manipulated for conservation purposes, but they should be assessed by each individual Contracting Party for CI 3 & CI 4.

Size classes / sex ratios in nearshore foraging areas

71. Similar to the offshore zone, these data are gathered from dedicated surveys, surveys from regular boat traffic, such as ferries, aerial surveys and bycatch records (e.g., Casale et al. 2014), but additional data can be obtained from strandings (e.g., Maffucci et al. 2013). They give an understanding of the population structure in the nearshore seas including data on abundance, distribution and threats. Turtles found nearshore may generally range from 45cm-juveniles to adults for loggerheads and 30cm-juveniles to adults for green turtles. There will likely be bias in observations as bigger turtles will be easier to spot. In subadult and adult sizes, that are observed close-up as with bycaught turtles or low-flying drones, sex of individuals can be inferred from tail length. Size classes and sex ratios are not metrics that can be manipulated for conservation purposes, but they could be assessed by each individual Contracting Party for CI 4.

Threats and survivorship in offshore foraging areas

72. Data on these metrics are obtained from fisheries bycatch, telemetry and capture-mark-recapture (CMR) studies, with the latter utilising bycaught turtles. Threats are classified as catch per unit effort per fishery that also records direct mortality rates resulting from the bycatch event. Telemetry data can reveal probable mortality events as demonstrated by Snape et al. (2016), which is useful to assess post-bycaught indirect mortality, but sample sizes need to be large to derive population level inferences. Threats and survivorship are metrics that can be influenced for conservation purposes. Efforts to reduce levels of bycatch (through bycatch reduction devices or revised fishing practices) or improve the condition of bycaught turtles (through better handling and release protocols, e.g., Gerosa & Aureggi 2001, FAO & ACCOBAMS 2018) can create positive outcomes at population level. Threat levels and survivorship should be assessed by each Contracting Party and conservation measures put in place as a precautionary measure irrespective of trend in mortality. At national level, each Contracting Party should aim to acquire robust bycatch data that will hopefully show a reduction in mortality, over time, and at the very least to not let the trend in anthropogenic mortality worsen. A stable (from first year of data collection) or negative trend for mortality levels would be required for this metric to not impact achievement of GES. Only when all populations are recovered and turtle numbers are improved should mortality rate be considered as a metric for GES assessment, as even with low mortality rates if the bycatch level is high mortality levels may impact population trends.

Threats and survivorship in nearshore foraging areas

73. Data on these metrics are obtained from fisheries bycatch, strandings, telemetry and capture-mark-recapture (CMR) studies, with the latter utilising both bycaught turtles and those observed during nearshore hotspot monitoring. Threats are classified as catch per unit effort per fishery that also records direct mortality rates resulting from the bycatch event. A more detailed assessment of threats and survivorship can be made with the nearshore hotspot CMR projects, where turtles may be observed over extended periods in which they may be impacted and potentially subsequently recover from local threats such as boat strikes, hooking, entanglement and directed trauma. Telemetry data can reveal probable mortality events as demonstrated by Snape et al. (2016), which is useful to assess post-bycaught indirect mortality, but sample sizes need to be large to derive population-level inferences. Threats and survivorship are metrics that can be manipulated for conservation purposes. Efforts to reduce levels of bycatch (through bycatch reduction devices or revised fishing practices) or improve the condition of bycaught turtles (through better handling and release protocols, e.g., Gerosa & Aureggi 2001, FAO & ACCOBAMS 2018) can create positive outcomes at population level. Threat levels and survivorship should be assessed by each Contracting Party and conservation measures put in place as a precautionary measure irrespective of trend in mortality. At national level, each Contracting Party should aim to acquire robust bycatch data that will hopefully show a reduction in mortality, over time, and at the very least to not let the trend in anthropogenic mortality worsen. A stable (from first year of data collection) or negative trend for mortality levels would be required for this metric to not impact achievement of GES. Only when all populations are recovered and turtle numbers are improved should mortality rate be considered as a metric for GES assessment, as even with low mortality rates if the bycatch level is high mortality levels may impact population trends.

Health index in offshore foraging areas

74. Sea turtles to assess and sample for health assessments may be obtained through bycatch and CMR studies. They are measured and weighed, and injuries recorded. Dead turtles can additionally have various organs sampled and assessed for pollutant load and their gastro-intestinal tract examined for debris ingestion (as required for CI 18 of EO10). Although not currently incorporated in demographic modelling, indices of health status are useful indicators for general state of the environment, with loggerhead turtles specifically chosen as indicators for prevalence of marine litter across the Mediterranean. Health indices are not something that can be improved at population level through direct conservation but lessening the amount of plastic pollution that reaches the sea plays a part in improving the situation. However, conservation actions may contribute directly on individuals through rehabilitation projects. Each Contracting Party should obtain data on animal health, specifically those that may contribute to pan-Mediterranean initiatives such as monitoring debris ingestion (CI 18).

Health index in nearshore foraging areas

75. See Health index in offshore foraging areas, above.

Growth rates

76. Growth rates are determined from repeat measuring of individual turtles over an extended period of time, i.e., from months to years. This involves some form of CMR project, that can be nocturnal monitoring of nesting beaches (though adults do not grow very much; Omeyer 2018) or more helpfully from in-water CMR studies that should be carried out at nearshore turtle hotspots (e.g., Rees et al. 2013) and, to a lesser extent, from repeat captures of bycaught turtles (e.g., Casale et al. 2009). Growth rates are useful for determining general age-at-size and age at maturity values and for understanding how long turtles remain in specific ontogenetic categories such as epipelagic juveniles and demersal/benthic juveniles etc. These data are vital to successful stage-based sea turtle life-history models. Growth cannot be manipulated for conservation

purposes, but each Contracting Party should strive to obtain relevant local data on this topic. However, values from other locations across the region may be used in modelling where local data are lacking.

Age and size at sexual maturity

77. These data points require detailed laboratory studies (necropsy and skeletochronology; Casale et al. 2011, Guarino et al. 2020) or invasive surgical techniques (laparoscopy) for individuals obtained as bycatch or strandings, or long-term CMR projects (Casale et al. 2009) incorporating both foraging and breeding areas to elucidate values for individuals that contribute to wider studies. Values for age and size at sexual maturity contribute to stage- and age- based demographic models which are used to assess a population's resilience to threats and stressors (Casale & Heppell 2016) and identify where targeted conservation can be most efficacious. Reaching sexual maturity cannot be manipulated for conservation purposes, but each Contracting party should strive to obtain relevant local data on this topic, especially as regional variation at size of sexual maturity has been demonstrated (Margaritoulis et al. 2003). However, values from other proximate locations may be used in modelling where local data are lacking.

VI. References

Table 4.3 References

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