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Updated global conservation status and priorities for marine turtles

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ABSTRACT: Assessing conservation status and pursuing applicable management priorities for marine megafauna across multiple scales pose significant challenges. Because marine turtles exemplify these challenges, the IUCN Marine Turtle Specialist Group (MTSG) developed the 'conservation priorities portfolio' (CPP) framework in 2011 to evaluate population risk and threats for regional management units (RMUs). Here, the MTSG has updated the 2011 CPP framework through an inclusive assessment process. Expert elicitation results involving 145 individuals from 50 countries suggests that marine turtle conservation status appears to be improving, but significant challenges remain. Since the previous assessment, long-term abundance trends increased on average, and threat impact scores improved for nearly twice as many RMUs (53%) as worsened (28%) (≥10% threshold for changes in numeric scores). While expert-assessed threat impacts have generally decreased, fisheries bycatch remains the highest scored threat across regions and species. Risk—threat staus improved for most (54%) RMUs. Over 40% of RMUs were scored as low risk—low threats, of which 8 were green turtles *Chelonia mydas* RMUs. Less than 20% of RMUs were scored as high risk—high threats, of which 4 were leatherback turtles *Dermochelys coriacea*. Most high risk—high threats RMUs were in the Pacific Ocean, while most low risk—low threats RMUs were in the Atlantic Ocean. Eleven RMUs were evaluated as having critical data needs. Our results — also provided through an interactive data dashboard — underscore the importance of context-specific planning to effectively target limited conservation resources. Future assessments should further prioritize inclusion of under-represented topics, researchers, and regions to better address multifaceted conservation challenges.

KEY WORDS: Status assessments · Threat impacts · IUCN Red List · Conservation priority-setting · Endangered species · Marine megafauna

1. INTRODUCTION

For widely distributed, long-lived taxa, establishing conservation and research priorities at biologically appropriate population scales can pose significant challenges (Boyd et al. 2008, Klein et al. 2017). Reflecting these challenges, different frameworks are used at national, regional, and global scales to assess conservation status and inform priority-setting. In turn, this can create inconsistencies in conclusions and prioritization of limited conservation resources. Further, there is a persistent need for status or threat assessment frameworks to be recognized by entities that share management responsibility for highly migratory taxa that cross geopolitical boundaries (NMFS et al. 2011, Department of Environment and Science 2021).

Marine turtles embody the challenges of assessing conservation status and pursuing broadly applicable management priorities for marine megafauna (e.g. elasmobranchs, marine mammals, seabirds) across multiple scales. Despite including only 7 species, marine turtles inhabit nearly all oceans from temperate to tropical latitudes, occupy diverse marine and coastal habitats, and present intra-specific variation in abundance, trends, reproduction, and demography (Bolten 2003, Bolten et al. 2011, Wallace et al. 2023). Similarly, variation in impacts of threats and environmental conditions can manifest in differential life histories and population dynamics across geographic ranges (Bolten et al. 2011, Seminoff & Wallace 2012, NMFS & USFWS 2020, Hays et al. 2022). Further, marine turtle population dynamics are complex, with multiple overlapping generations, vast dispersal, and variable mortality of juveniles from natal sites (nesting beaches) to and among successive developmental habitats that often host individuals originating from different nesting rookeries, long-distance migrations of adults between feeding and breeding areas, polygyny and polyandry, and multi-decadal lifespans distributed across multi-geopolitical land- and seascapes (Bolten 2003, Bowen & Karl 2007). Therefore, identifying the appropriate demographic unit and framework for conservation assessments is challenging.

1.1. Shortcomings of existing assessment frameworks

Marine turtles are present on various threatened species lists for differing conservation, management, or protection purposes at national (including subnational) (e.g. US Endangered Species Act, Wild Life Protection Act 1972 of India) and international scales (e.g. Protocol concerning Specially Protected Areas and Wildlife in the Wider Caribbean, IUCN Red List of Threatened Species [hereafter IUCN Red List], Convention for International Trade of Endangered Species [CITES], Convention on Migratory Species [CMS]). Their presence on threatened species lists typically implies that these species should receive various levels of conservation priority, legal protection, and public attention (Possingham et al. 2002, Klein et al. 2017, Valdivia et al. 2019). However, threatened species lists typically only denote extinction risk, focus on abundance of adults, and conflate various types of conservation priorities depending on the full suite of relevant status and threat criteria (e.g. Possingham et al. 2002).

For example, the IUCN Red List, the most widely recognized global extinction risk framework, represents a comprehensive information source on the global conservation status of animal, fungi, and plant species (IUCN 2019). However, only 44 000 (~28%) of the approximately 157 000 species assessed on the IUCN Red List are classified in a threatened status category (Critically Endangered, Endangered, or Vulnerable; www.iucnredlist.org). Thus, because its focus is to identify species (or subpopulations) at imminent risk of global extinction, the Red List does not address the wide variation in conservation status of the remaining >70% of assessed species, nor does it provide prescriptive conservation guidance for any species. Further, while the IUCN Red List permits assessment of subpopulations below the species level (IUCN 2019), its evaluation criteria do not adequately characterize variation at any population scale in status, trends, and threats to marine megafauna species to inform sound, actionable conservation strategies (Mrosovsky 2003, Fowler et al. 2005, Godfrey & Godley 2008, Seminoff & Shanker 2008, Lascelles et al. 2014).

Beyond the frameworks themselves, it is imperative to synthesize available knowledge and information from diverse researchers and backgrounds to produce robust, comprehensive conservation status assessment prioritization for taxa like marine turtles (Mazaris et al. 2018). However, doing so is extremely challenging in practice (Tomasini 2018, Robinson et al. 2022, 2023). Fortunately, knowledge gained from research on marine turtles has increased greatly in recent decades with the expanded geographic scales and enhanced complexity of international research collaboration networks (Mazaris et al. 2018). These phenomena have produced comprehensive information on certain topics (e.g. nesting ecology and monitoring), species (e.g. green turtles *Chelonia mydas* and loggerhead turtles *Caretta caretta*), life stages (e.g. adult females, eggs, hatchlings), and threats at bioregional scales (e.g. leatherback turtles *Dermochelys coriacea*; Eckert & Hart 2021), while simultaneously revealing the persistence of several important research gaps among other life stages, habitats, sexes, and species (Wildermann et al. 2018, Fuentes et al. 2023, Robinson et al. 2023). Also evident is a persistent, disproportionately high representation of researchers and research topics from the Global North (e.g. North America, Europe; Robinson et al. 2022, Shanker et al. 2023). For these reasons, inclusive initiatives designed to collect and synthesize knowledge from diverse sources and geographies would result in more comprehensive assessments and conservation priorities (Tomasini 2018).

1.2. The IUCN Marine Turtle Specialist Group 'Burning Issues' initiative

To address these shortcomings in existing status assessments, the IUCN Species Survival Commission's Marine Turtle Specialist Group (MTSG) launched the 'Burning Issues' (MTSG-BI) workshop series in 2003 to direct on-the-ground conservation actions toward the highest priorities. The goal of MTSG-BI is to cultivate a collaborative space where MTSG members and an inclusive array of experts contribute their expertise and unique perspectives to generate freely available products that inform and advance conservation strategies.

To address the issue of defining appropriate biological scales for marine turtle assessments, the MTSG-BI developed the concept of the marine turtle 'regional management unit' (RMU) in 2010 (Wallace et al. 2010) and updated it in 2023 (Wallace et al. 2023). As described by Wallace et al. (2023), the globally consistent and biologically relevant RMU framework defines assemblages of marine turtles below the level of species but above the level of genetic stocks ('management units' or MUs, sensu Moritz 1994) that share areas critical to life history requirements such as breeding, foraging, and juvenile development. Turtles within RMUs are exposed to similar drivers of population dynamics (e.g. environmental factors, threats) across their overlapping geographic distributions, which places them on similar demographic and potentially evolutionary trajectories. RMUs were intended to support holistic conservation assessments and strategies to reduce threats to all life stages across geographic scales as well as to provide the MTSG with a consistent, globally applicable framework of appropriate targets for Red List assessments (i.e. subpopulations) (Wallace et al. 2010, Havice et al. 2018).

Because of aforementioned issues raised by MTSG members and Red List assessors about the efficacy of Red List criteria and categories to adequately characterize marine turtle conservation status (Mrosovsky 1997, 2003, Godfrey & Godley 2008, Seminoff & Shanker 2008, Campbell 2012), the MTSG-BI also developed a second framework to evaluate the conservation status of all marine turtle RMUs using taxonomically appropriate criteria and information: the 'conservation priorities portfolio' (CPP) (Wallace et al. 2011). This CPP framework is based on standardized criteria defined by MTSG-BI experts to evaluate risk as well as threat impacts at the RMU scale as complementary suites of relevant criteria. The resulting portfolio provided a globally comprehensive view of status and data needs for all marine turtle RMUs, allowing for finer-scale prioritization exercises that focus on the relative impacts and feasibility of specific conservation actions (e.g. Klein et al. 2017).

Since the initial publication of the CPP was in 2011, new information has become available about marine turtle status and trends (e.g. Seminoff et al. 2015, Gaos et al. 2017, Mazaris et al. 2017, Pilcher 2021, López-Castro et al. 2022), conservation capacity (Barrios-Garrido et al. 2020), and relative impacts of various threats including fisheries bycatch (e.g. Wallace et al. 2013, Clarke et al. 2014, Lewison et al. 2014), direct take (e.g. Humber et al. 2014, Senko et al. 2022), coastal development (e.g. Dimitriadis et al. 2018, Nelson Sella & Fuentes 2019, Hirsch et al. 2022), pollution (including marine debris, e.g. Schuyler et al. 2016, Stelfox et al. 2016, Senko et al. 2020; inorganic contaminants, e.g. Cortés-Gómez et al. 2017, Leusch et al. 2021; oil spills, e.g. Wallace et al. 2020), and climate change (including habitat loss, e.g. Fuentes et al. 2013, Lettrich et al. 2020, Patricio et al. 2021). In addition, comprehensive reviews have highlighted advances as well as gaps in research and monitoring tools and efforts to support marine turtle conservation around the world (Rees et al. 2016, Casale et al. 2018, Mazaris et al. 2018, Wildermann et al. 2018, Patricio et al. 2021, Robinson et al. 2022, 2023, Fuentes et al. 2023). Thus, given that more than a decade has passed since the initial CPP assessments, the results and implications for conservation require updates that reflect new information and conservation efforts.

1.3. Goal and objectives of MTSG-BI7

In 2020, the MTSG convened the seventh BI initiative (MTSG-BI7), a collaborative, inclusive, and science-based initiative designed to improve and update past outputs. MTSG-BI7 objectives and products included: (1) guidelines and criteria for delineating Important Marine Turtle Areas (IMTAs), which consider not only areas of biological significance to marine turtles but also culturally significant areas within RMUs (IMTA Working Group 2021); (2) an update of RMUs and genetic stocks that incorporated information from >1000 sources published since 2009 (Wallace et al. 2023); and (3) an update of the CPP, including the original risk and threat criteria (Wallace et al. 2011), along with new criteria such as conservation dependence and conservation capacity.

This paper describes how the CPP framework was updated through MTSG-BI7 to generate a contemporary 'portfolio' of marine turtle conservation status and priorities using the refined RMUs (Wallace et al. 2023) as the basis for assessment. The specific objectives were to:

(1) Provide a robust, global-level assessment that integrates standardized methodological rigor including synthesis of inputs from experts worldwide;

(2) Use the CPP framework to describe patterns of RMU-level risk, threats, and conservation capacity by species and region;

(3) Describe the global-level variation in conservation status and priorities for RMUs, species, and regions to highlight context-specific conservation and research needs; and

(4) Compare current results with those from the previous assessment (Wallace et al. 2011) to describe changes in conservation status and identify specific criteria that influence observed changes within and among RMUs.

2. METHODS

The original plan for updating the CPP framework was to convene an in-person workshop in 2020 of the MTSG-BI7 working group to efficiently generate and incorporate revisions, similar to the process used to develop RMUs and the CPP initially (Wallace et al. 2011). When the COVID-19 pandemic rendered such in-person meetings impossible, the MTSG-BI7 organizers (co-authors A. N. Bandimere, P. Casale, A. DiMatteo, B. J. Hurley, B. J. Hutchinson, R. B. Mast, S. M. Maxwell, Z. A. Posnik, I. Rodríguez, B. P. Wallace) developed a fully online process to engage experts from around the world in a prolonged, inclusive assessment. Participants who contributed to the assessment were invited to be co-authors of the present paper.

2.1. Initial assessment process

The original 2011 CPP framework was structured into 2 groups, or 'matrices', of criteria: (1) risk, i.e. demographic viability (e.g. abundance, short- and long-term trends, rookery vulnerability, and genetic diversity); and (2) threats, i.e. population-level impacts of various threats (e.g. fisheries bycatch, direct take, coastal development, pollution, and climate change) (Table S1 in Supplement 1 at www.int-res.com/articles/suppl/n056p247_supp1.pdf; all table, text, and figure call-outs). Thus, the CPP provided the relative risk and threat status for each RMU and highlighted data needs (Wallace et al. 2011).

As a first step toward updating the CPP, MTSG-BI7 organizers distributed an initial online survey to all MTSG members (~300 individuals from >100 countries) in March 2020 about how to improve and update RMUs and the CPP, requesting general suggestions and ideas with an emphasis on applications to conservation and research efforts (for details about the RMU update process and results, see Wallace et al. 2023). A later survey (September–October 2022) focused on how to improve the CPP framework by adjusting, adding, or eliminating criteria. MTSG-BI7 organizers then incorporated feedback from survey respondents and distributed suggested updates to criteria for further comments from October to December 2022. Based on MTSG member recommendations and inspired by the Conservation and Enforcement Capacity index (CECi; Barrios-Garrido et al. 2020), a third set of criteria to complement risk and threats, namely 'conservation capacity' (see Section 2.2.3 for criteria definitions), was developed to evaluate existing capacity for implementing conservation actions within the geographic range of each RMU. Updated criteria definitions are provided in detail in the following sections and in Text S1 and Table S1.

To ensure prompt and focused feedback on each step of the assessment process, the MTSG-BI organizers engaged a small group of co-authors (H. Barrios-Garrido, K. A. Bjorndal, S. A. Ceriani, M. M. Early Capistrán, A. D. Phillott, N. J. Pilcher). These advisors participated in all steps described below as full participants but also provided detailed advice about procedures (e.g. authorship guidelines, structure of and process for assessment forms) and edits to materials shared with the broader group.

2.2. Criteria definitions

The updated CPP framework includes the same 5 risk and 5 threat criteria as the 2011 version, as well as the new conservation capacity criteria (all criteria described in detail below and in Table S1). All criteria were evaluated on a semi-quantitative numeric scale from 1 to 3 (with increments of 0.5), where 1 corresponds to 'best' conditions, i.e. low risk, low threats, and high conservation capacity, and 3 corresponds to 'worst' conditions, i.e. high risk, high threats, and low conservation capacity. To visually summarize criteria scores on this 1 to 3 scale, we defined 'low' $\leqslant 1.8$, 'moderate' $\geqslant 1.8$ to < 2.2 and 'high' > 2.2 (Figs S1–S3 in Supplement 1). If insufficient information was available to provide a numeric score for a given criterion, it was scored as data deficient (DD). For complete criteria definitions and instructions to assessors, see Table S1.

2.2.1. Risk criteria

Risk criteria evaluated indices of demographic viability that affect the resilience of a RMU to negative impacts. For example, RMUs with high abundance, increasing abundance trends, and high genetic diversity would be more resilient to impacts of threats than RMUs with low abundance and negative trends. Risk criteria and definitions were as follows:

- Abundance: annual average number of nesting females, according to species-specific abundance bins (Table S1). Differences in abundance bins reflect variation among species in relative abundance, such as the enormous mass nesting rookeries of *Lepidochelys* spp. (Wallace et al. 2011). Where multiple nesting rookeries were included within RMUs, we summed available abundance values and assigned the RMU a score based on the cumulative abundance
- Short-term trend: abundance trend over the last ≥10 yr (consistent with time-series data sets used in marine turtle Red List assessments). For a trend to be considered increasing or decreasing, confidence intervals (if available) around trend estimates could not include zero
- Long-term trend: abundance trend for at least 1 generation but could include historical abundance values >1 generation in the past. Generation length was defined according to IUCN Red List guidelines (IUCN 2019) as the average age of adults of the current cohort of newborn individuals of the assessed population, which, for marine turtles, is generally ≥30 yr. For a trend to be considered increasing or decreasing, confidence intervals (if available) around trend estimates could not include zero
- Rookery vulnerability: the likelihood of loss of functional rookeries (nesting sites) that would pre-

vent recovery based on the number and distribution of rookeries within a RMU

- Genetic diversity: the number of known or inferred genetic stocks from species-specific patterns of genetic distinctiveness among rookeries based on analyses of mitochondrial DNA (i.e. MUs sensu Moritz 1994) within a RMU.

2.2.2. Threat impact scores

Threat impact criteria evaluated the relative impacts of threats in terms of the magnitude of mortality relative to overall RMU abundance in terms of adult equivalents (sensu Conant et al. 2009). Thus, higher impacts were assigned to threats that result in mortality of more late-stage than early-stage individuals (and vice versa). Quantitative analyses (e.g. matrix population modeling) were not used to derive numerical conversions between adult equivalents and non-adult life stages because data required for such analyses are typically unavailable for most RMUs, but this concept was to be considered when evaluating the relative magnitude of the impacts of each threat category. Assessors were instructed to evaluate each threat category separately, but threat scores were made consistent across threat categories within each RMU. That is, if fisheries bycatch and pollution were each scored 'high' impact, that would mean that both bycatch and pollution caused mortality of similar magnitude in the numbers of turtles and life stages affected. In the absence of rigorously quantified threat impacts, assessors were encouraged to provide a score based on their expert understanding of impacts (with appropriate justification and citations). Although sublethal effects of threats are important, mortality was used as the metric because it was more straightforward to evaluate and compare relative impacts within and among threats at RMU scales. It is important to note that threat impacts were assessed based on expert perceptions, not direct quantification or numerical estimates of mortality.

For each threat not scored as 'high', assessors evaluated 'conservation dependence', which describes the extent to which threat impacts are reduced due to conservation efforts, such that if conservation efforts were reduced or eliminated, the threat impact would increase. Conservation dependence was not required to be evaluated for threat criteria scored as 'high' because enhanced conservation actions are self-evidently needed to reduce impacts. Conservation dependence was a new addition to the updated CPP framework based on MTSG member feedback.

Threat criteria and definitions, at the RMU level, were as follows (see Table S1 for more details):

- Fishery bycatch interactions: mortality caused by incidental capture (bycatch) in fishing gears
- Direct take: mortality caused by legal and illegal take, including direct utilization of turtles, eggs, or other derived products for human use (e.g. consumption, trade, commercial products)
- Coastal development: mortality caused by human-induced alteration of coastal environments such as construction, dredging, beach modification, artificial lighting, vessel traffic, etc.
- Pollution: mortality caused by marine pollution and debris that affect marine turtles through ingestion or entanglement, adverse toxicological/physiological effects, or other mechanism(s)
- Climate change: mortality caused by climate change effects on marine turtles and their habitats, including but not limited to impacts on nesting beaches (e.g. increasing sand temperatures on nesting beaches affecting hatchling production, embryonic death, hatching success, and hatchling sex ratios; loss or inundation of nesting habitat due to sea level rise and increased frequency of high intensity storms). Assessors focused on evidence of ongoing climate-related impacts, with preference for empirical observations over projected, predicted, or inferred impacts
- Other: mortality caused by other threats not listed above, such as indirect human actions (e.g. feral or introduced animal predation on turtles, eggs, or hatchlings), disease and health risks (e.g. toxins produced by harmful algal blooms and/or cyanobacteria, fibropapillomatosis), and loss of offshore juvenile development habitats (e.g. sargassum harvesting). Because no threat from this category was scored as 'high' impacts for any RMU, we do not summarize these results herein. However, the complete assessment results are included in Supplement 2 at www.int-res.com/articles/suppl/n056p247_supp2.xlsx.

2.2.3. Conservation capacity

Conservation capacity evaluates status of enabling conditions for and/or obstacles to marine turtle conservation. These criteria were evaluated qualitatively through the lens of on-the-ground, in-country capacity to implement conservation actions.

Conservation capacity criteria and definitions are summarized as follows:

- Socio-economic indicators: based on the CECi framework (Barrios-Garrido et al. 2020), this criterion combined the United Nations Development Programme's Human Development Index (UNDP HDI, https://hdr.undp.org/data-center/human-development-index) and the Global Economic Index (United Nations 2023), rescaled to the same 1 to 3 scale as other criteria in this study. This was calculated by the MTSG-BI7 organizers for the updated RMUs

- Enforcement capacity of formalized protection framework: legal protections afforded by national and/or international laws, treaties, conventions, and other instruments, or community-based protection/management of marine turtles
- Resource availability: extent to which resources are available and stable to support conservation of marine turtles and habitats. Primarily refers to funding, but also materials and equipment to implement conservation actions
- Coordination capacity: degree to which government, non-governmental organizations, academia, private sector, communities, and other actors participate in functioning network(s) and are working together toward shared conservation goals
- Expertise/technical capacity: individuals and organizations present and capable of providing expert-level knowledge and information — not limited to Western scientific knowledge generation and communication — and included/engaged appropriately by decision-makers.

2.2.4. Data uncertainty index

Data uncertainty scores were calculated for risk and threat criteria following Wallace et al. (2011) by combining data quality scores and number of criteria scored as DD. Data uncertainty was not evaluated for conservation capacity criteria because these were evaluated qualitatively by assessors. Assessors were asked to score 'data quality' by evaluating the amount and type of information available to score each risk and threat impact criterion. The overall data uncertainty score was the sum of (1) the data quality score (0 to 1 scale) and (2) the number of DD scores divided by the total number of criteria (0 to 1 scale). Thus, the data uncertainty score could be between 0 (lowest uncertainty) and 2 (highest uncertainty). Following the previous CPP (Wallace et al. 2011), the numeric scale used for data uncertainty translated to relative size of error bars around scores. Thus, a lower data uncertainty value would be represented by narrower error bars. RMUs were classified as 'critical data needs' in 3 different ways: (1) >1 data uncertainty score, (2) ≥2 risk criteria scored DD, or (3) ≥3 threat criteria scored DD. Sources used to score criteria in this process are included in the bibliography (Text S2). Data quality scores and definitions were as follows:

- 0 (high quality): extensive publications and other resources (e.g. peer-reviewed publications, some grey literature sources such as government-issued technical reports, end-project reports, International Sea Turtle Symposium and other conference abstracts, State of the World's Sea Turtles Reports [www.seaturtlestatus.org/reports]) covering >50% of RMU population abundance, on both long-term monitoring of nesting populations and some in-water work (e.g. mark—recapture studies, satellite telemetry)
- 0.5 (medium quality): combination of grey literature sources and some peer-reviewed publications (i.e. <50% of RMU population abundance covered; incomplete spatiotemporal coverage of RMU), at a minimum monitoring of nesting populations
- 1 (low quality): grey literature, unpublished data/personal communications; no peer-reviewed publications specifically providing information on the criterion in question;
- DD: not enough information to assign a score.

2.3. Assessment process based on expert elicitation

With criteria defined, the MTSG-BI7 organizers developed a fillable, online form to facilitate assessments by experts. Participants then evaluated the updated 2023 RMUs with which they were most familiar. We first sent the online form in December 2022 to a subset of ~80 MTSG members and other experts who (1) had participated in the previous CPP assessments, (2) had been actively involved in MTSG efforts (e.g. Red List assessments, MTSG Regional Reports, previous MTSG-BI initiatives), (3) were MTSG regional vice-chairs, or (4) had specialized expertise relevant for specific criteria. Subsequently, additional experts were then invited by MTSG-BI7 organizers and assessors to provide assessments or join assessment teams to ensure comprehensive regional and subject-matter coverage across all assessments and RMUs. In this way, the process remained open for participation, regardless of whether individuals had been invited originally by MTSG-BI7 organizers. We also provided the assessment form as a PDF and accompanying Excel spreadsheet to facilitate the completion of assessments by assessors who preferred that format or who had unreliable internet connections. We also shared with assessors a 'frequently asked questions' document to clarify instructions and key points about the assessment, authorship guidelines, and a bibliography of publications that supported criteria evaluation (Text S2).

Our target was to receive at least 1 assessment for all RMUs for all species except for the flatback turtle *Natator depressus*, which was not assessed here because new RMUs were not developed for this species (see Wallace et al. 2023 for details) (updated RMUs are presented in Table S2). To accomplish this, the prolonged assessment period was extended from April to October 2023. Initially, we expected assessments to be completed by individuals filling out the online form (or the Excel version). However, because some assessors preferred to form groups to ensure comprehensive, collective expertise among criteria within an assessment, group assessments were also accepted. The experts who participated in assessments were generally biologists whose technical expertise about specific data types, species, and regions aligned with the goal of evaluating the risk, threats, and conservation capacity criteria defined above. Thus, each expert's input was weighted equally. Overall, our methods were similar to expert elicitation or key informant approaches (Martin et al. 2012, Crandall et al. 2018, Wildermann et al. 2018).

Overall, 145 individuals participated in this initiative and are listed as co-authors; 133 individuals contributed to at least 1 assessment or to analyses, and the remainder contributed to developing the manuscript or as MTSG-BI7 organizers, providing overall coordination and technical expertise. Participants represented 50 different countries and territories, and 46% of participants were from countries classified as Very High on the HDI. For comparison, at the time of this initiative, there were 319 MTSG members representing 108 different countries and territories, and 51% of members were from countries classified as Very High HDI countries (Table 1). We acknowledge that, despite substantial efforts to make the review as inclusive and accessible as possible through regular email reminders inviting participation, open invitations for assessors to invite other colleagues, allowing multiple methods for performing assessments, and an extended assessment period, the pool of experts who ultimately provided input (see author list and acknowledgements) may not comprehensively reflect the diverse technical, cultural, or geographical expertise among the full MTSG membership (see https://www.iucn-mtsg.org/members) and the broader marine turtle conservation community. This could have resulted in disproportionate contributions of expertise from some regions and countries.

2.4. Consistency review

Once all assessments were submitted, subject-matter experts among the co-authors volunteered to review individual criteria across all RMUs to ensure consistency in how criteria were assessed and to highlight discrepancies among assessments for each RMU and criterion. Although some variation in scoring among assessments of the same RMU was expected, reflecting differences among assessors, this step was intended to ensure consistency of methods used across all assessments. Participants with specialized expertise reviewed scores within a specific criterion (all scores for fisheries bycatch, or all scores for genetic diversity, etc.) with the following aims: (1) to highlight any factual errors (e.g. incorrect number of genetic stocks, under- or over-estimate of threat impacts); (2) to identify cases, particularly for RMUs with multiple assessments, where assessors might have interpreted and evaluated criteria differently

Table 1. Representation among participants (co-authors) of the present assessment in terms of country of primary affiliation, compared with representation among members of the IUCN Marine Turtle Specialist Group. Countries were classified by the United Nations Development Programme's Human Development Index (UNDP HDI; https://hdr.undp.org/data-center/human-development-index). NA: countries for which HDI could not be calculated, or dependent territories that are part of a sovereign country (e.g. French Overseas Territories, Caribbean Netherlands)

UNDP HDI Category	Present assessment			IUCN Marine Turtle Specialist Group		
	Number of countries represented	Number of participants	% of participants	Number of countries represented	Number of members	% of members
Very High	20	67	46.2	33	161	50.5
High	12	38	26.2	25	66	20.7
Medium	9	15	10.3	19	50	15.7
Low	6	14	9.7	10	11	3.4
NA	3	11	7.6	21	31	9.7
Sum	50	145	100.0	108	319	100.0

when scoring the same criterion; and (3) to ensure consistency in how relative impacts of threats were evaluated. Reviewers were also asked to review references associated with individual scores and suggest additional references that would result in a score change.

After the consistency review, comments were compiled and shared with assessors for potential revisions of scores. If assessors agreed with a proposed change, the change was made. If assessors disagreed with any proposed changes, MTSG-BI7 organizers facilitated discussions between assessors and reviewers to make a group decision about how to proceed. If assessors did not respond, MTSG-BI7 organizers made a final decision about whether to change a score based on reviewer comments and references provided. This consistency review process, including resolution of issues highlighted by reviewers, occurred between August and December 2023, after which the data set was considered finalized.

When different scores were provided for the same criterion for the same RMU, including at least one DD score, the DD score was not counted in the overall numerical score for that RMU + criterion combination. In this case, an additional score of 1 was added to the calculation of the data quality score for each DD criterion. If only DD scores were assessed for a given RMU + criterion, the data quality score was also DD.

Overall, 16.8% of risk and threat criteria scores and 8.7% of data quality scores required adjustment (see Supplement 2). Scores often required adjustments because they failed to include all available documentation, thus creating discrepancies with assessments that more thoroughly reviewed available information. More risk criteria scores (26.0%) required adjustment than threat criteria scores (7.5%), likely because risk criteria were defined using more quantitative thresholds (e.g. abundance bins, number of genetic stocks) toward which scores supported by insufficient references could be adjusted. In several cases, for example, assessments for a given RMU that had been performed by individual assessors all required adjustments toward a 'correct' score.

2.5. Data analyses

The updated CPP assessment process evaluated marine turtle risk criteria and population-level impacts of threats, first separately and then together as complementary suites of relevant criteria, along with considerations of existing conservation capacity. This approach generated a comprehensive view of the status of all RMUs globally, with no particular status results receiving *a priori* emphasis (Fig. 1).

We calculated single, average values for each criterion for a given RMU by weighting criteria scores by the number of assessors contributing to each assessment (Supplement 2). This approach assumed that scores on group assessments reflected the consensus opinion shared by all group members. In this way, a criterion score from an assessment by 5 assessors was weighted 5 times more than an assessment by a single assessor.

To facilitate comparisons in conservation status between the 2011 CPP assessment (Wallace et al. 2011) and the current assessment, we averaged the 2011 scores for each of the previous RMUs now represented by the updated RMUs (Wallace et al. 2023), where necessary. The exception to this re-calculation was for abundance, for which we either retained the highest abundance category among the previous RMUs in the new, combined RMUs, or, where necessary, adjusted the abundance bin to reflect the higher, combined abundance. In Section 3, we highlight criteria values as 'improved' or 'worsened' since the first assessment if the score increased or decreased by >10%. Following Wallace et al. (2011), we then plotted the average of scores for threat criteria against the average of scores for risk criteria for each RMU, where each axis was on a scale of low to high (1 to 3). Scores fell within 1 of 4 quadrants that corresponded to 4 portfolio categories: (1) high risk—high threats; (2) high risk—low threats; (3) low risk—low threats; (4) low risk—high threats (Fig. 1). If an RMU fell on the border between 2 categories (moderate score = 2), we applied a precautionary approach and assigned it to the higher-risk or higher-threat category.

2.6. User-friendly data dashboard

To facilitate the ability of users to focus on results and priorities most relevant to the scale of their conservation and research activities, we developed a dynamic data dashboard (https://www.seaturtlestatus.org/cpp-dashboard) that allows users to interact with the CPP results and produce customized views of results. For example, users can generate region-specific, species-specific, or criteria-specific views of the CPP results, depending on their needs and intended audiences. The data dashboard is intended to provide a wide range of stakeholders with an intuitive, easily accessible platform to interact with CPP results. With respect to the data dashboard

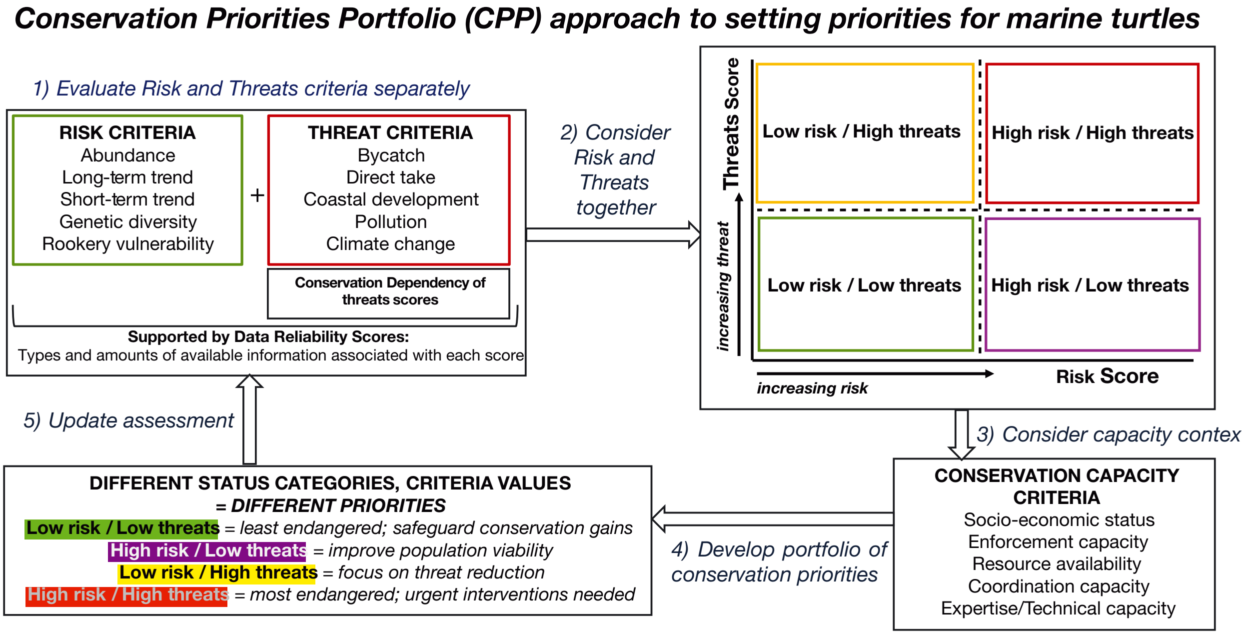

Fig. 1. Process (steps numbered and in blue font) for conservation priority portfolio (CPP) assessments that consider (1) biological (demographic risk or viability) criteria and (2) threat impacts, as well as (3) conservation capacity criteria, to generate a 'portfolio' of conservation priorities for marine turtle regional management units (RMUs). This process allows identification of individual criteria as well as characterization of general status categories that warrant development of targeted conservation efforts to address 'population'-specific priorities

and the results overall, within-RMU variation in the criteria assessed are not necessarily reflected in RMU-scale criteria scores.

2.7. Caveats when comparing the 2011 and 2024 assessment results

By updating the existing CPP framework, we hoped to facilitate comparisons between results of the 2011 assessment and the present assessment, performed more than a decade apart. However, we acknowledge some important differences between previous and present assessments that warrant consideration when comparing results. For example, because the COVID-19 pandemic prevented us from convening an in-person workshop to discuss and achieve consensus about criteria definitions and scores in real-time as in the previous assessment (Wallace et al. 2011), MTSG-BI7 organizers invested extensive efforts in (1) developing, disseminating, and emphasizing clear criteria definitions (see Section 2.3); and (2) providing a dedicated review period to ensure consistency in how criteria were defined and scored within and among RMUs (see Section 2.5).

To further promote consistency and thus facilitate comparisons between the results of the 2011 CPP assessment and the present assessment, colleagues who participated in the development of the original CPP framework were invited to participate in this update. However, the difference in assessment formats led to unavoidable differences in the 2 groups of participants in the respective assessments. For example, while 31 individuals (representing 13 countries) participated in the 2011 CPP assessment, 17 of whom also participated in the present assessment, 128 individuals contributed only to the present CPP assessment (n = 145 total participants representing 50 countries and territories). Despite this discrepancy, we consider the substantial increase in participation and representation to be a clear benefit to the present assessment.

There are other reasons why comparisons between 2011 and 2024 assessments have merit despite the methodological differences. First, while long-term monitoring of marine turtle populations typically relies on standard data collection protocols to promote consistency over time, there are inevitable variations in such projects, including changes in data collection tools and techniques, and, of course, in the people performing the monitoring. This issue is certainly true for Red List assessments that rely on calculating a percent change between 'past' and 'present' abundance estimates, which typically span several decades (IUCN 2019), during which people and protocols typically change (Seminoff & Shanker 2008). Second, updates to the criteria in the present assessment did not substantially change the criteria themselves in general, nor the information used to interpret them, with the possible exceptions of rookery vulnerability and genetic diversity (Table S1 provides a comparison of criteria definitions from the 2011 and present assessments). Instead, the more detailed criteria definitions provided in the present assessment added clarity to a completely virtual/remote assessment team that was made in real-time, in-person during the 2011 assessment. Thus, we are confident that comparisons of results between the previous and current assessments are valid, but they should be interpreted with these caveats in mind.

3. RESULTS

All 48 RMUs were assessed at least once and by at least 1 assessor. On average, 4 assessors contributed to each assessment (range: 1–13 assessors), and each RMU had 2 assessments (range 1–9 assessments) with 7 assessors contributing (range: 1–28 assessors). Overall, 133 individuals contributed to a total of 103 assessments (Supplement 2).

3.1. Risk, threat, and conservation capacity scores among species and RMUs

Across all RMUs, average risk, threat, and conservation capacity scores were ≤2 (moderate or lower) (Table 2; Table S3, Figs. S1–S3). The sole Kemp's ridley *Lepidochelys kempii* RMU had the highest species-level risk score, while risk and threat scores for leatherbacks were the highest among species with multiple RMUs. Further, leatherbacks had the highest combined scores across all 3 categories and were the only species with scores > 2 for 2 sets of criteria (risk and conservation capacity) and nearly had the highest scores for the third set of criteria (threats) (Table 2; Table S3). Data uncertainty scores were generally higher for threat criteria than for risk criteria.

3.1.1. Individual criteria scores among species and RMUs

Across all species, the criterion with the lowest risk score was abundance, while the highest risk score was for rookery vulnerability. The threat with the lowest expert-assessed impact score overall was pollution, and the highest was bycatch. The highest conservation capacity (lowest numeric score) was for expertise/technical capacity, while the lowest capacity score (highest numeric score) was for socio-economic status. The only criteria scored >2 were rookery vulnerability for risk, bycatch for threats, and socio-economic status for conservation capacity (Table 3).

All species except olive ridleys *L. olivacea* had at least 1 risk criterion >2, while leatherbacks were the only species with all risk scores >2. Similarly, all species had at least 1 threat score >2, and the highest threat score overall was bycatch for leatherbacks. As with risk and threats, all species had at least 1 conservation capacity score ≥2, and leatherbacks and hawksbills *Eretmochelys imbricata* had 3 scores each ≥2 (Table 3). Pollution (n = 14) and climate change (n = 13) were scored DD for more RMUs than any other criterion (Table 3; Table S3).

Across RMUs, there were no statistically significant relationships (Kendall's Tau-b, $p > 0.05$) between overall average threat scores and their corresponding average conservation dependence scores. However,

Table 2. Summary of risk, threat, and conservation capacity scores by species (1 = best, 3 = worst). Data uncertainty scores (in parentheses) for risk and threat criteria ranged from 0 (low) to 2 (high). Conservation capacity criteria were evaluated qualitatively, without documenting references, and thus did not have data uncertainty scores. RMUs: regional management units

Species	Number of RMUs	Risk score (uncertainty)	Threat score (uncertainty)	Conservation capacity score
Caretta caretta	10	2.05 (0.37)	1.75 (0.70)	1.82
Chelonia mydas	11	1.66 (0.30)	1.72 (0.62)	1.81
Dermochelys coriacea	7	2.29 (0.29)	1.90 (0.85)	2.07
Eretmochelys imbricata	13	2.06 (0.59)	1.65 (0.87)	1.91
Lepidochelys kempii	1	2.56 (0.26)	1.67 (0.43)	1.56
Lepidochelys olivacea	6	1.71 (0.54)	1.92 (0.88)	1.99
Overall average score		1.96 (0.42)	1.76 (0.77)	1.89

Table 3. Risk, threats, and conservation capacity scores by species and averaged across all regional management units (RMUs) (1 = best, 3 = worst). Conservation dependence describes the extent to which threat impacts are reduced due to conservation efforts, such that if conservation efforts were reduced or eliminated, the threat impact would increase

Species	Risk (3 = high risk)						Threats (3 = high impact)					Conservation capacity (3 = low capacity)				
	Number of RMUs	Abundance	Short-term trend	Long-term trend	Rookery vulnerability	Genetic diversity	Bycatch	Take	Coastal development	Pollution	Climate change	Socio-economic status	Enforcement capacity	Resource availability	Coordination capacity	Expertise/ technical capacity
Caretta caretta	10	1.78	2.00	1.94	2.40	1.89	2.29	1.50	1.64	1.58	1.54	2.06	1.86	1.97	1.54	1.37
Chelonia mydas	11	1.55	1.82	1.63	2.03	1.27	2.13	1.77	1.42	1.33	1.75	2.11	1.89	2.00	1.67	1.35
Dermochelys coriacea	7	2.21	2.29	2.42	2.14	2.43	2.56	1.69	1.85	1.52	1.52	2.27	2.25	2.38	1.68	1.79
Eretmochelys imbricata	13	2.12	1.91	2.06	2.07	2.00	1.47	1.81	1.22	1.31	2.04	2.15	2.00	2.10	1.74	1.57
Lepidochelys kempii	1	1.79	2.00	3.00	3.00	3.00	2.13	1.21	1.92	1.50	1.58	1.00	1.82	2.00	2.00	1.00
Lepidochelys olivacea	6	1.50	1.67	1.70	1.84	1.90	2.43	1.30	1.93	2.02	1.78	2.44	1.95	2.21	1.77	1.61
Overall average		1.85	1.93	1.95	2.13	1.87	2.16	1.65	1.54	1.51	1.73	2.16	1.99	2.11	1.70	1.52
Conservation dependence							1.84	2.49	2.00	1.04	1.45					
Number of RMUs scored	48	45	40	48	42	44	46	43	34	25	48	48	48	48	48	

climate change threat scores increased significantly (Kendall's Tau-b = 0.33, p = 0.03) with their corresponding conservation dependence scores, perhaps indicating that assessors evaluated dependence as increasing with perceived impacts of threats. There were no other statistically significant correlations between conservation dependence and any other individual threat score among RMUs.

3.1.2. Risk—threat categories

Twenty-four RMUs were scored as high risk (Fig. S1), while 14 were scored as high threats (i.e. threat score ≥ 2) (Fig. S2). There was no significant relationship between risk—threat category and conservation capacity, although average conservation capacity scores (>2) were poorer for high threat RMUs than those of low threat RMUs (<1.9) (Table S4).

Nineteen of 48 RMUs were scored low risk—low threats, 5 as low risk—high threats, 14 as high risk—low threats, and 9 as high risk—high threats (Figs. 2 & 3, Table 4; Fig. S4, Table S5). One RMU, northeast Indian Ocean hawksbills, was not placed in a risk—threat category due to ≥3 threats scored as DD.

Of the high risk—high threats RMUs, 4 were leatherbacks, 3 loggerheads, 1 green turtle, and 1 hawksbill (Table 4). Among the 19 low risk—low threats RMUs, 8 were green turtles, 4 loggerheads, 4 hawksbills, and 3 olive ridleys (Fig. 3; Tables S4 & S5). No leatherback RMUs were scored low risk—low threats. Nine RMUs had risk and threats scores <1.75, indicating especially high demographic viability and relatively low threats impacts (Table 4). Of these especially low risk—low threats RMUs, 3 were green turtles, 3 were hawksbills, 2 were loggerheads, and 1 was an olive ridley.

Eleven RMUs were classified as having 'critical data needs' due to ≥2 DDs for risk and/or ≥3 DDs for threat criteria and/or high data uncertainty scores (Fig. 2, Table 4; Table S6).

3.2. Regional comparisons

Pacific RMUs had the highest average risk and threats scores and the poorest conservation capacity scores (Table 5; Tables S7—S9, Figs. S1—S3). Atlantic RMUs had the lowest (highest confidence) data uncertainty scores, and Indian Ocean RMUs had the highest (lowest confidence) data uncertainty scores. Overall and by ocean basin, data uncertainty associated with risk criteria was higher than data uncertainty associated with threat scores (Table 5; Tables S7—S9).

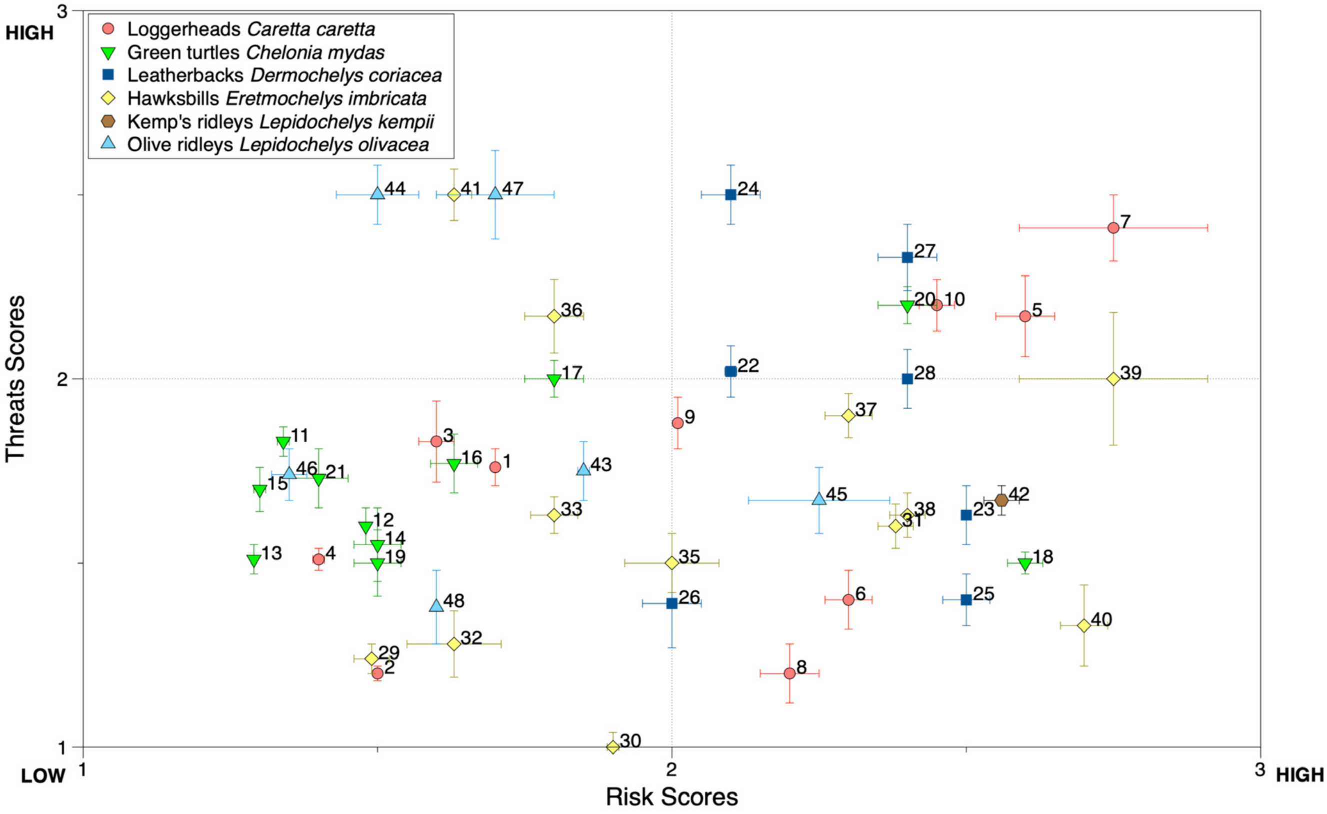

Fig. 2. Risk versus threat scores (data uncertainty scores for risk scores and threat scores shown as horizontal and vertical bars, respectively; rescaled to visualize on the same scale as risk and threat scores) by species, 2024 (1 = best, 3 = worst). See Figs. 3 & 4 for comparison with 2011 status for all regional management units (RMUs). Loggerhead *Caretta caretta* RMUs: 1 — Northwest Atlantic, 2 — Southwest Atlantic, 3 — Northeast Atlantic, 4 — Mediterranean, 5 — Northwest Indian, 6 — Southwest Indian, 7 — Northeast Indian (assumed), 8 — Southeast Indian, 9 — North Pacific, 10 — South Pacific; green turtle *Chelonia mydas* RMUs: 11 — North Atlantic, 12 — South Atlantic, 13 — Mediterranean, 14 — Northwest Indian, 15 — Southwest Indian, 16 — East Indian and Southeast Asia, 17 — Southwest Pacific, 18 — North Central Pacific, 19 — West Central Pacific, 20 — South Central Pacific, 21 — East Pacific; leatherback *Dermochelys coriacea* RMUs: 22 — Northwest Atlantic, 23 — Southwest Atlantic, 24 — Southeast Atlantic, 25 — Southwest Indian, 26 — Northeast Indian, 27 — West Pacific, 28 — East Pacific; hawksbill *Eretmochelys imbricata* RMUs: 29 — Northwest Atlantic, 30 — Southwest Atlantic, 31 — East Atlantic, 32 — Northwest Indian (assumed), 33 — Southwest Indian, 34 — Northeast Indian (assumed), 35 — Southeast Indian (assumed), 36 — Southeast Asia, 37 — Southwest Pacific, 38 — North Central Pacific, 39 — West Central Pacific, 40 — South Central Pacific, 41 — East Pacific; Kemp's ridley *Lepidochelys kempii* RMU: 42 — Northwest Atlantic; olive ridley *L. olivacea* RMUs: 43 — West Atlantic, 44 — East Atlantic, 45 — West Indian, 46 — Northeast Indian, 47 — West Pacific, 48 — East Pacific

3.2.1. Individual risk, threats, and conservation capacity scores by region

Average abundance scores were moderate or low risk (≤2) across ocean basins (Table S7). Average long-term trends (2.10) and short-term trends (2.18) were declining overall for Pacific Ocean RMUs; long-term trends were declining (2.13), while short-term trends were increasing (1.93) among Indian Ocean RMUs; and both long-term (1.60) and short-term (1.78) trends were increasing among Atlantic Ocean RMUs. Rookery vulnerability was high risk among RMUs in the Atlantic (2.17) and Pacific Oceans (2.47), and lower risk (1.76) in the Indian Ocean. Genetic diversity scores — representing numbers of genetic stocks — were higher risk for Indian Ocean RMUs (2.25) than Atlantic (1.64) and Pacific Ocean RMUs (1.80) (Table S7). A lack of genetic information from the Indian Ocean RMUs may explain the comparatively low genetic diversity scores.

Threat scores were highest for Pacific Ocean RMUs, and lowest for Atlantic Ocean RMUs (Table S8). Across all regions, bycatch scores indicated moderate to high impacts (2.16) while direct take and coastal development scores reflected moderate to low impacts (1.65 and 1.54, respectively). Pollution (2.08) and climate change (2.37) were moderate to high impacts for Pacific Ocean RMUs, but moderate to low for Atlantic (pol-

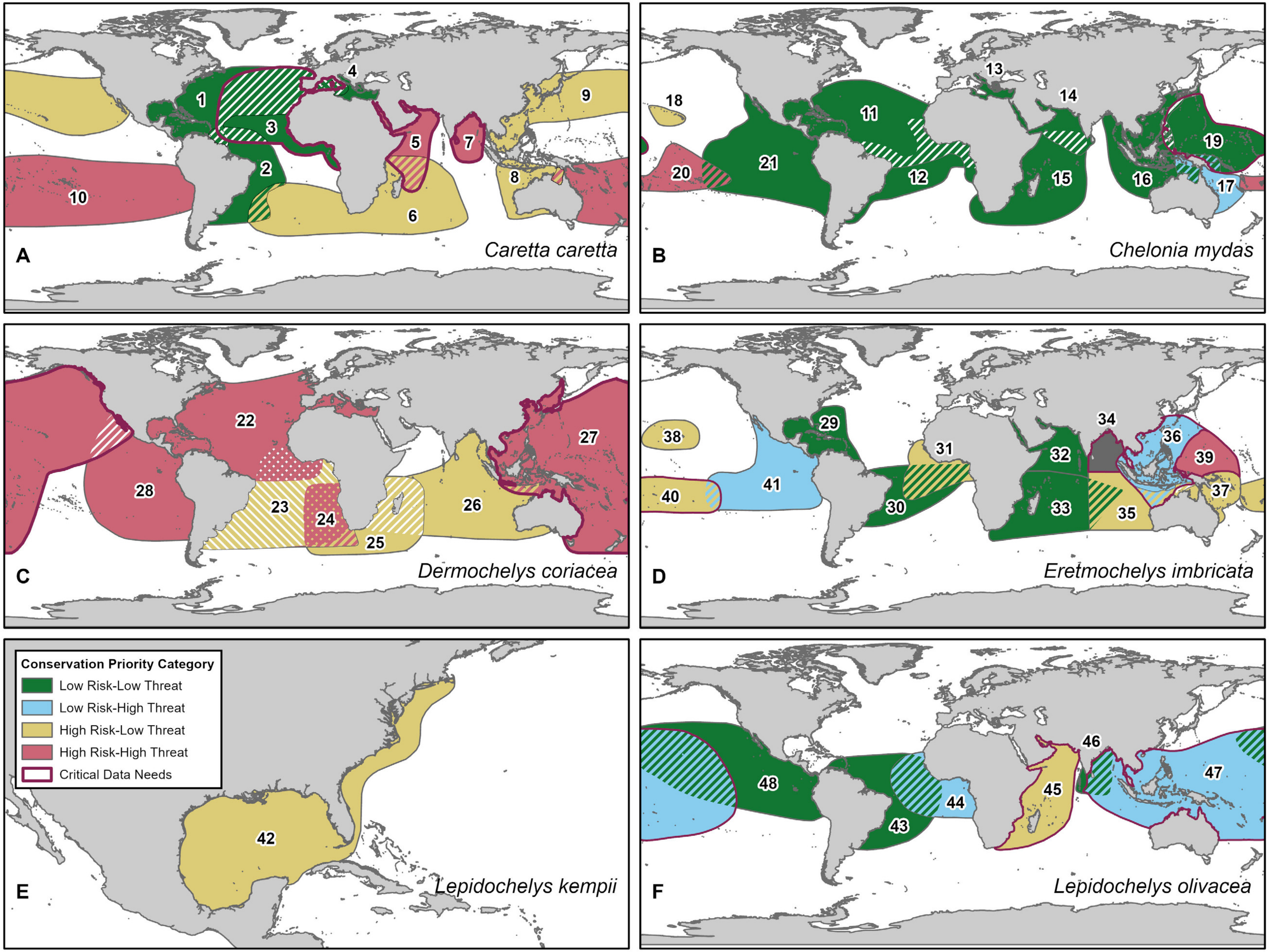

Fig. 3. Conservation priority portfolio categories for regional management units (RMUs) of each marine turtle species: (A) loggerhead, (B) green turtle, (C) leatherback, (D) hawksbill, (E) Kemp's ridley, (F) olive ridley. See Fig. 2 for RMUs. RMUs were classified as critical data needs if the data uncertainty indices for both risk and threats were ≥1 (denoting high uncertainty) and are outlined in red. Hatched areas represent spatial overlaps between RMUs. The dark grey area in panel D represents the hawksbill Northeast Indian Ocean RMU (RMU 34), which had excessive data deficient scores and was not included in overall calculations and categorization

Table 4. Regional management units (RMUs) with highest and lowest risk and threat scores and those with critical data needs in 2024

High risk—high threats RMUs (both risk and threats >2)	Low risk—low threats RMUs (both risk and threat scores <1.75, sum ≤3)	Critical data needs RMUs
Caretta caretta, Northwest Indian	*Caretta caretta*, Southwest Atlantic	*Caretta caretta*, Northeast Atlantic
Caretta caretta, Northeast Indian	*Caretta caretta*, Mediterranean Sea	*Caretta caretta*, Northeast Indian
Caretta caretta, South Pacific	*Chelonia mydas*, Mediterranean Sea	*Caretta caretta*, Northwest Indian
Chelonia mydas, Central South Pacific	*Chelonia mydas*, Southwest Indian	*Chelonia mydas,* Central West Pacific
Dermochelys coriacea, Northwest Atlantic	*Chelonia mydas,* West Central Pacific	*Dermochelys coriacea*, West Pacific
Dermochelys coriacea, Southeast Atlantic	*Eretmochelys imbricata*, Northwest	*Eretmochelys imbricata*, Northeast Indian
Dermochelys coriacea, West Pacific	*Eretmochelys imbricata*, Southwest Atlantic	*Eretmochelys imbricata*, East Indian/ West Pacific
Dermochelys coriacea, East Pacific	*Eretmochelys imbricata*, Northwest Indian Atlantic	*Eretmochelys imbricata*, Central West Pacific
Eretmochelys imbricata, Central West Pacific	*Lepidochelys olivacea*, East Pacific	*Eretmochelys imbricata*, Central South Pacific
		Lepidochelys olivacea, West Indian
		Lepidochelys olivacea, West Pacific

lution = 1.25, climate change = 1.32) and Indian Ocean RMUs (pollution = 1.56, climate change = 1.41). Similar to the previous assessment, pollution and climate change were scored DD across RMUs within ocean basins (Table S8).

Conservation dependence scores were highest for Pacific Ocean RMUs, and lowest for Indian Ocean RMUs. The highest conservation dependence score was for climate change among Pacific Ocean RMUs (2.74), while the lowest was pollution among Indian Ocean RMUs (0.86).

Average overall conservation capacity scores were similar across ocean basins, with high variation among regions within each ocean basin (Table S9). Socio-economic status and resource availability had the worst capacity scores overall (both >2.1), while expertise/technical capacity had the best overall capacity score (1.52). Values for individual conservation capacity criteria varied widely within ocean basins and overall (Table S9), showing the variation among countries within RMU boundaries within the same ocean basin (Fig. S3).

Table 5. Overall risk, threat, and conservation capacity scores (1 = best, 3 = worst) and data uncertainty scores (0 = low, 2 = high) averaged across regional management units (RMUs) by ocean basin and region

Ocean basin and region	Number of RMUs	Average risk score (data uncertainty)	Average threat score (data uncertainty)	Average conservation capacity score
Atlantic	16	1.79 (0.19)	1.70 (0.59)	1.89
East	2	1.94 (0.51)	2.05 (0.71)	2.50
Mediterranean	2	1.35 (0.07)	1.51 (0.33)	1.45
North	1	1.34 (0.13)	1.83 (0.43)	1.97
Northeast	1	1.60 (0.30)	1.83 (1.07)	1.89
Northwest	4	1.96 (0.17)	1.67 (0.51)	1.75
South	1	1.48 (0.00)	1.60 (0.73)	1.78
Southeast	1	2.10 (0.50)	2.50 (0.83)	2.52
Southwest	3	1.97 (0.03)	1.28 (0.48)	1.75
West	1	1.85 (0.09)	1.75 (0.76)	1.90
Indian	16	1.98 (0.64)	1.66 (0.90)	1.89
Northeast	4	2.03 (0.94)	1.85 (1.19)	2.11
Northwest	3	1.91 (0.56)	1.67 (0.97)	1.95
Southeast	4	1.91 (0.57)	1.66 (0.84)	1.73
Southwest	4	1.98 (0.33)	1.53 (0.64)	1.93
West	1	2.25 (1.20)	1.67 (0.90)	1.28
Pacific	16	2.13 (0.44)	1.91 (0.81)	1.91
East	4	1.76 (0.21)	1.90 (0.83)	1.56
North	1	2.01 (0.00)	1.88 (0.66)	2.24
North Central	2	2.50 (0.32)	1.56 (0.45)	1.17
South	1	2.45 (0.30)	2.20 (0.65)	2.31
South Central	2	2.55 (0.45)	1.77 (0.78)	2.20
Southwest	2	2.05 (0.45)	1.95 (0.55)	1.74
West	2	2.05 (0.75)	2.42 (1.05)	2.29
West Central	2	2.13 (1.00)	1.75 (1.35)	2.45
Overall	48	1.96 (0.42)	1.76 (0.77)	1.89

Table 6. Risk, threat, and associated data uncertainty scores (0 = low, 2 = high) from 2011 versus 2024 averaged across regional management units (RMUs) by species

Species	Number of RMUs	Risk 2011 Criteria score	Risk 2011 Data uncertainty score	Risk 2024 Criteria score	Risk 2024 Data uncertainty score	Threats 2011 Criteria score	Threats 2011 Data uncertainty score	Threats 2024 Criteria score	Threats 2024 Data uncertainty score
Caretta caretta	10	1.95	0.60	2.05	0.37	2.16	0.74	1.75[a]	0.70
Chelonia mydas	11	1.63	0.32	1.66	0.30	1.92	0.78	1.72[a]	0.60
Dermochelys coriacea	7	2.16	0.30	2.29	0.29	1.80	0.81	1.90	0.85
Eretmochelys imbricata	13	2.09	0.85	2.06	0.59	2.14	0.99	1.65[a]	0.87
Lepidochelys kempii	1	2.40	0.00	2.56	0.26	1.80	0.20	1.67	0.43
Lepidochelys olivacea	6	1.83	0.12	1.71	0.54	2.17	0.59	1.92[a]	0.88
Overall	Avg	1.94	0.49	1.96	0.42	2.04	0.80	1.76[a]	0.76

[a] Scores improved by ≥10% from 2011 to 2024 (1 = best, 3 = worst)

3.2.2. Risk–threat categories

Of the 9 high risk–high threats RMUs, a majority (5 of 9) were in the Pacific Ocean, while a majority (10 of 19) of low risk–low threats RMUs were in the Atlantic Ocean (Fig. 3, Table 4; Tables S4 & S5). Six of the critical data needs RMUs were in the Pacific Ocean, and 4 were in the Indian Ocean (Table 4). Northeast Indian and West Central Pacific hawksbill RMUs were classified as critical data needs by all criteria used (Table S6).

3.3. Changes in status between past (2011) and present (2024) CPP assessments

3.3.1. Changes in status and data uncertainty

Risk scores did not increase ≥10% for any species (Table 6). In contrast, threat impact scores decreased by an average of 11% for all species except leatherbacks and Kemp's ridleys. Data uncertainty scores in 2024 were similar to those in 2011 for both risk and threats for all species.

3.3.2. Changes in individual risk and threat criteria scores

On average among all RMUs, individual risk and threat criteria scores either improved or stayed the same (Table 7; Fig. S4, Table S10). The number of RMUs scored as DD across risk criteria decreased by 37% (27 to 17) and across threat criteria decreased by 42% (65 to 38) from 2011 to 2024 (Table 7; Table S10).

Risk scores in 2024 were similar to those from 2011 (Table 7; Table S10). Nineteen RMUs that had been scored DD for short-term and long-term trends in 2011 had enough data to be scored in 2024, while the number of RMUs scored as DD increased for genetic diversity. Long-term trend scores improved overall, while short-term trend scores worsened for half of the RMUs (Table 7; Table S10). In contrast to long-term trends, rookery vulnerability scores worsened between 2011 and 2024 (Table 7).

Average threat scores improved from 2011 to 2024 (Table 7; Table S10). Scores for individual threat criteria improved ≥10% for all threats except bycatch, which remained the highest-impact threat and was the only threat that scored >2 overall in the present assessment. Scores for coastal development and pollution improved for a majority of RMUs (Table 7; Table S10). The number of RMUs

Table 7. Summary of risk and threat scores (1 = best, 3 = worst) averaged across regional management units (RMUs) by criterion 2011 vs. 2024, with associated data quality scores (i.e. amount and quality of available information; 0 = high, 1 = low) and number of RMUs scored data deficient (DD) for each criterion

	2011			2024		
	Score	Data quality	Number of DD RMUs	Score	Data quality	Number of DD RMUs
Risk criteria						
Abundance	1.97	0.36	0	1.85	0.35	0
Short-term trend	1.80	0.25	12	1.93	0.41	3
Long-term trend	2.53	0.28	15	1.95[a]	0.35	8
Rookery vulnerability	1.73	0.34	0	2.13[b]	0.32	0
Genetic diversity	1.88	0.35	0	1.87	0.20	6
Overall	1.94	0.37	27	1.96	0.42	17
Threats						
Bycatch	2.23	0.41	2	2.16	0.48	4
Take	1.99	0.46	1	1.65[a]	0.64	2
Coastal development	1.95	0.50	4	1.54[a]	0.62	5
Pollution	1.75	0.65	28	1.51[a]	0.57	14
Climate change	2.33	0.80	30	1.75[a]	0.66	13
Overall	2.04	0.80	65	1.76[a]	0.80	38

[a]Scores improved by ≥10% from 2011 to 2024, [b]scores worsened by ≥10% from 2011 to 2024

scored as DD for pollution and climate change decreased significantly (≥50%), although ~27% of RMUs were still DD for these threats (Table 7; Table S10).

3.3.3. Changes in risk and threat criteria scores at regional scales

Although risk scores in 2024 were similar to those in 2011 among ocean basins, threat impact scores improved most for Atlantic Ocean RMUs, and least for Pacific Ocean RMUs (Table S11). However, change in pollution impacts over time was not calculated for the Pacific Ocean, because every Pacific RMU was DD either in 2011, 2024, or both. Similarly, only 1 Indian Ocean RMU was scored for climate change in both 2011 and 2024.

3.4. Changes in risk–threat categories

Risk–threat categories improved for a majority (54%, n = 26) of RMUs and worsened for 15% (n = 7) of RMUs from 2011 to 2024 (Fig. 4, Table 8; Fig. S4). The proportion of high risk RMUs (scores >2) remained the same between 2011 (28 of 57; 49%) and 2024 (24 of 48; 50%), while the proportion of high threat RMUs (scores >2) declined from 63% (36 of 57) in 2011 to 30% (14 of 47) in 2024 (Wallace et al. 2011; Fig. 4).

3.4.1. Changes by species and RMUs

Of 19 low risk–low threats RMUs, 14 (~74%) had both improved risk and threat scores relative to 2011; of these, 4 were loggerhead and 6 were green turtle RMUs (Table 8; Fig. S4). In contrast, risk and threat scores worsened since 2011 for 5 of 9 (55%) of high risk–high threats RMUs, 3 of which were leatherbacks (Table 8; Fig. S4).

Seven of 13 (54%) hawksbill RMUs and 4 of 9 (44%) loggerhead RMUs had improved risk–threat categories compared to 2011, while categories of 3 of 7 (43%) leatherback RMUs and 2 of 13 (15%) hawksbill RMUs worsened (Fig. 4).

3.4.2. Changes by ocean basin and region

By ocean basin, 69% of Atlantic Ocean RMUs improved for both risk and threats, whereas only 25% of Pacific Ocean RMUs improved for both. Half of the RMUs whose risk and threat scores worsened were in the Pacific Ocean.

3.5. Low risk–low threats RMUs and high risk–high threats RMUs

Of 11 RMUs identified as high risk–high threats in 2011, all had improved risk scores, threat scores, or both, and 7 had improved risk–threat categories in

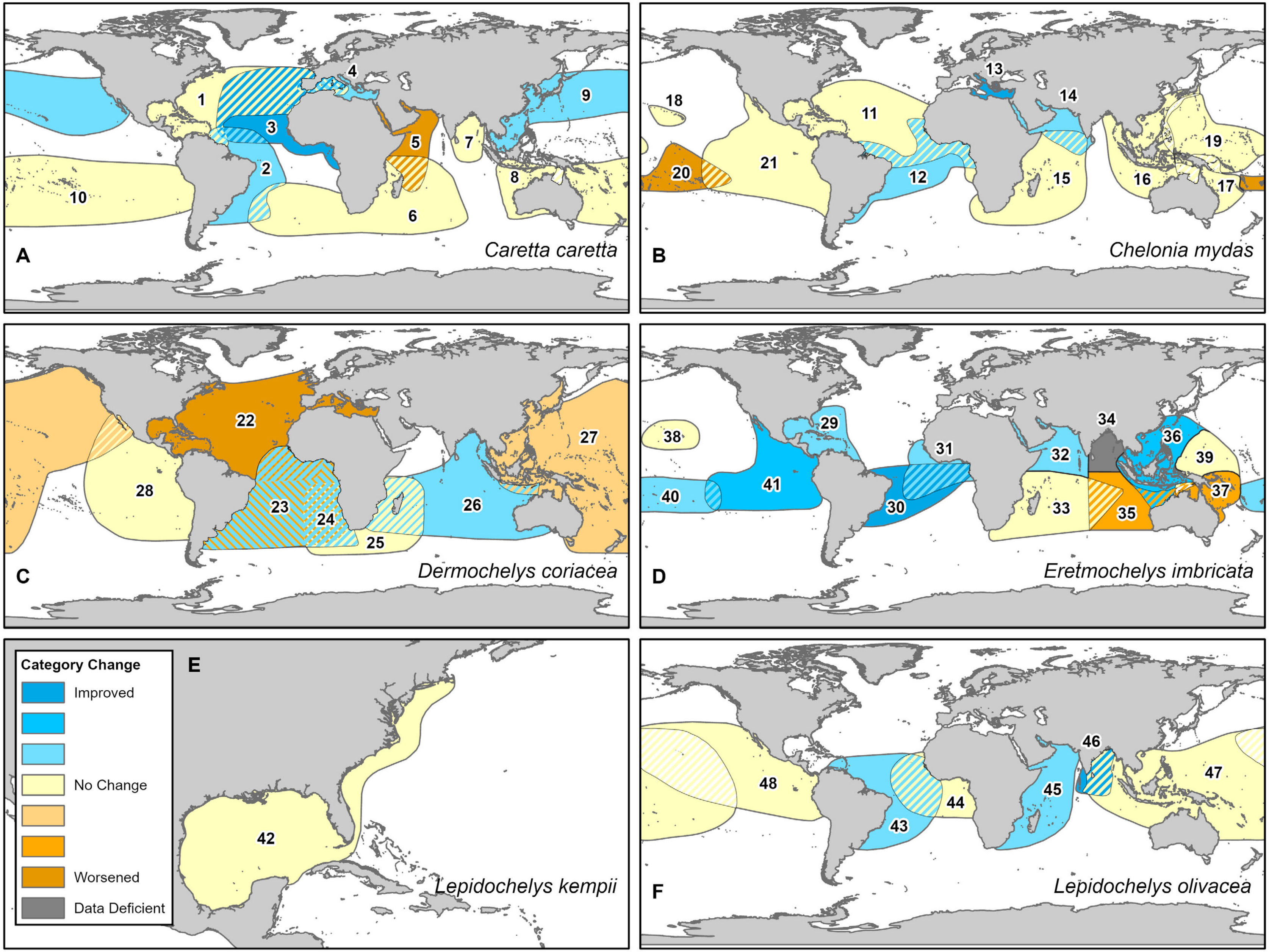

Fig. 4. Relative changes in overall risk–threat categories among marine turtle regional management units (RMUs) between 2011 and 2024 assessments (categories: low risk–low threats, low risk–high threats, high risk–low threats, high risk–high threats). Color gradient indicates the number of categories an RMU changed (maximum = 3), either showing an improved or a worsened status. (A) loggerhead, (B) green turtle, (C) leatherback, (D) hawksbill, (E) Kemp's ridley, (F) olive ridley. See Fig. 2 for RMUs. Other details as in Fig. 3

Table 8. Relative values of risk and threat scores for regional management units (RMUs) by species in 2024 and how they changed between the 2011 and 2024 assessments. Color scale is similar to Fig. 4; blue indicates low (best) scores (≤1.8), beige indicates moderate (1.9–2.2), and orange indicates high (worst) scores (≥2.2). Cells that contain plus signs indicate scores that improved ≥10%, while minus signs indicate scores that worsened ≥10%. RMU IDs are presented in Fig. 2 and in Table S2. ATL: Atlantic Ocean; MED: Mediterranean Sea; IND: Indian Ocean; PAC: Pacific Ocean; SEA: Southeast Asia (East Indian/West Pacific)

Species	RMU ID	Risk Scores	Threats Scores
Loggerheads *Caretta caretta*	CC_01_ATL_NW	🟦	🟦 +
	CC_02_ATL_SW	🟦	🟦 +
	CC_03_ATL_NE	🟦 +	🟨 +
	CC_04_MED	🟦 +	🟦 +
	CC_05_IND_NW	🟧 -	🟨 -
	CC_06_IND_SW	🟧	🟦
	CC_07_IND_NE	🟧 -	🟧 +
	CC_08_IND_SE	🟨	🟦 +
	CC_09_PAC_N	🟨	🟨 +
	CC_10_PAC_S	🟧	🟧
Green turtles *Chelonia mydas*	CM_11_ATL_N	🟦	🟨
	CM_12_ATL_S	🟦	🟦 +
	CM_13_MED	🟦 +	🟦 +
	CM_14_IND_NW	🟦 -	🟦 +
	CM_15_IND_SW	🟦	🟦
	CM_16_IND_E_SEA	🟦	🟦 -
	CM_17_PAC_SW	🟨 -	🟨 +
	CM_18_PAC_NC	🟧	🟦 -
	CM_19_PAC_WC	🟦 +	🟦 +
	CM_20_PAC_SC	🟧 -	🟧 -
	CM_21_PAC_E	🟦 +	🟦
Leatherbacks *Dermochelys coriacea*	DC_22_ATL_NW	🟨 -	🟨 -
	DC_23_ATL_SW	🟧	🟦 +
	DC_24_ATL_SE	🟨 -	🟧 -
	DC_25_IND_SW	🟧	🟦 -
	DC_26_IND_NE	🟨 +	🟦 +
	DC_27_PAC_W	🟧	🟧 -
	DC_28_PAC_E	🟧	🟨 +
Hawksbills *Eretmochelys imbricata*	EI_29_ATL_NW	🟦	🟦 +
	EI_30_ATL_SW	🟨 +	🟦 +
	EI_31_ATL_E	🟧	🟦 +
	EI_32_IND_NW	🟦 -	🟦 +
	EI_33_IND_SW	🟨	🟦 +
	EI_34_IND_NE	🟨 +	🟧 -
	EI_35_IND_SE	🟨 -	🟦 -
	EI_36_PAC_SEA	🟨 +	🟨 +
	EI_37_PAC_SW	🟧 -	🟨 -
	EI_38_PAC_NC	🟧 +	🟦 -
	EI_39_PAC_WC	🟧 -	🟨 +
	EI_40_PAC_SC	🟧 -	🟦 +
	EI_41_PAC_E	🟦 +	🟧 -
Kemp's ridleys, *Lepidochelys kempii*	LK_42_ATL_NW	🟧	🟦
Olive ridleys *Lepidochelys olivacea*	LO_43_ATL_W	🟨 -	🟦 +
	LO_44_ATL_E	🟦	🟧
	LO_45_IND_W	🟧 +	🟦 +
	LO_46_IND_NE	🟦 +	🟦 +
	LO_47_PAC_W	🟦	🟧 -
	LO_48_PAC_E	🟦	🟦
	Average Scores	**1.96**	**1.76 (+)**

2024 (Table S12). However, of the 11 RMUs identified as low risk–low threats in 2011, 8 RMUs had worse risk and threat scores, and 6 were classified in worse risk–threat categories. Two RMUs (East Pacific olive ridleys and West Central Pacific green turtles) remained among the low risk–low threats RMUs, while 3 (East Pacific leatherbacks, West Central Pacific hawksbills, and Northeast Indian loggerheads) remained among the high risk–high threats RMUs (Table S12).

4. DISCUSSION

The MTSG-BI7 developed a comprehensive, expert elicitation-based framework that assessed risk criteria, threat impacts, and conservation capacity to enable the identification of RMU-specific conservation priorities. CPP results not only highlight overall risk–threat categories for all RMUs, but also allow criteria-specific diagnoses of status results within and among RMUs, species, and ocean basins that can inform conservation planning at finer geographic scales.

The present CPP results demonstrate the apparent efficacy of many existing conservation strategies (Mazaris et al. 2017, Hays et al. 2024), highlighting several cases of favorable — and improving — conservation status at the RMU scale (Figs. 2–4, Table 8; Fig. S4). For example, 40% of RMUs were classified as low risk–low threats, which means that these RMUs are characterized by relatively high abundance, stable or increasing abundance trends, and relatively low population-level impacts of threats. Overall, threat scores were generally moderate to low (Table 3), improved from the 2011 assessment (Tables 6 & 7), and the proportion of high threat RMUs decreased from nearly two-thirds to less than one-third of all RMUs (Table S11). Further, three-quarters of RMUs showed improved status for risk, threats, or both (Table 8; Table S11). While the assessment highlighted capacity needs for successful conservation efforts, namely for enforcement of formalized protection measures and availability of critical resources, existing capacity for coordinating conservation efforts and for expertise and technical capacity appear strong overall (Table 3). At the same time, CPP results showed that there are several marine turtle RMUs in need of urgent conservation interventions. Nine RMUs were classified as high risk–high threats, 4 of which were leatherbacks (Figs. 2 & 3, Table 4), and fisheries bycatch remains the highest threat among RMUs. Eleven RMUs were classified as having critical data needs, highlighting important research priorities (Table 4). Overall, our results highlight both the diversity of conservation status and priorities as well as the need for national governments and international collaborations and policy instruments to develop and coordinate national and multinational approaches to address specific risk, threat, and conservation capacity criteria, as well as information gaps for each RMU.

4.1. Changes in risk and threat scores and data uncertainty

While changes in risk and threat criteria generally indicate true changes over time, some changes could still be caused by methodological differences between past and present assessments. For example, long-term trend scores among RMUs have improved (Table 7), possibly because long-term trends were scored as DD for many RMUs in 2011, and additional RMUs could be scored in 2024 with more years of monitoring data (Table S10). However, when considering only the RMUs that were scored both in 2011 and 2024, 17 showed improved long-term trends, while only 4 showed worsened long-term trends (Table S10). Further, the 2024 definitions and scoring thresholds for the trend criteria were intended to identify changes in abundance over time (different from zero), which should have made scores for trends more conservative in the absence of true increases or decreases. Indeed, short-term trends worsened slightly (1.81 to 1.93) overall, but long-term trends nonetheless improved. We conclude that this pattern reflects improvements in long-term trends for many marine turtle RMUs, in agreement with patterns suggested by rookery-level trend analyses (Mazaris et al. 2017, López-Castro et al. 2022, Hays et al. 2024), regional assessments (Pilcher 2021), and recent RMU (i.e. IUCN subpopulation)-scale Red List assessments (e.g. East Pacific green turtles, Seminoff 2023; Southwest Indian green turtles, Bourjea & Dalleau 2023; Mediterranean green turtles, Broderick et al. 2023; Kemp's ridley, Wibbels & Bevan 2019; Central South Pacific green turtles, Allen et al. 2023).

Other risk criteria showed important changes between the past and present assessments that were likely due to differences in the 2011 versus 2024 assessments themselves. Rookery vulnerability worsened significantly, but this change was likely due to the updated definition of this criterion being more threshold-driven than the previous definition (see Section 2, and Table S1). Similarly, the number of RMUs scored as DD paradoxically increased for genetic diversity, probably because this criterion was defined in the present assessment using only published genetic stocks, while in the 2011 assessment it could also be inferred based on known geographic distances among documented genetic stocks (Table S1). These factors and the caveats described in Section 2.7 merit consideration when interpreting comparisons between 2011 and 2024 results for these criteria.

Threat impact scores (based on expert perception) improved significantly for a majority of RMUs, and individual threat scores (except for bycatch) improved ≥10% across RMUs (Tables 6–8). Although overall bycatch scores improved slightly, they remained >2 and the highest threat, highlighting the persistent importance of fisheries bycatch for marine turtles globally (Wallace et al. 2011, 2013, Lewison et al. 2014). Direct take and coastal development impact scores showed greater improvements than did bycatch between 2011 and 2024. In addition, direct take, coastal development, and bycatch had the highest conservation dependence scores (Table 3). Direct take and coastal development are perhaps more tractable threats to marine turtles than bycatch, because bycatch in legal fisheries is by definition incidental or indirect. This might imply that conservation actions to reduce threats like direct take and coastal development can be more targeted to the specific threat dynamic. However, bycatch is perhaps less tractable because it accidentally and often unpredictably affects turtles under circumstances that are difficult to measure (Peckham et al. 2007, Alfaro-Shigueto et al. 2011, Wallace et al. 2013, Clarke et al. 2014), particularly in the case of illegal, unreported, and unregulated fisheries (Leforestier 2024). Indeed, monitoring and reporting of bycatch and enforcement of existing regulations are largely lacking at national and regional scales (Wallace et al. 2013, Eckert & Hart 2021, Leforestier 2024). This suggests that direct take has been more effectively reduced in recent years than has bycatch (Lewison et al. 2014, Senko et al. 2022), though it remains an important threat in various regions for many RMUs (van de Geer et al. 2022).

Research on potential and inferred impacts of climate change on marine turtles has increased in recent years (e.g. Lettrich et al. 2020, Patricio et al. 2021, Robinson et al. 2023), in agreement with the improved data availability and quality revealed by our assessment. However, data deficiencies remain highest for climate change and pollution among all threats (Table 7; Table S10). Thus, increased production and dissemination of marine turtle research (sensu Mazaris et al. 2018, Robinson et al. 2023) improved the depth and breadth of the information available for the present CPP assessment, but persistent data gaps remain and warrant attention (Fuentes et al. 2023). For example, there remains a general lack of information about trends in the abundance of male and immature turtles, which is concerning because males are predicted to become scarcer with climate warming (e.g. Jensen et al. 2018), with ensuing negative consequences for population viability. Since immatures represent the bulk of marine turtle populations, monitoring their numbers would likely reveal population trends much earlier than assessing only nesting adult females, the most commonly monitored population unit (Wildermann et al. 2018). For some threats, such as pollution and disease, the body of literature on these topics continues to grow, but the cryptic and transboundary nature of such threats, particularly pollution, hinders its detectability resulting in challenges assessing population level impacts (Senko et al. 2020).

Data availability has improved since the 2011 assessment as shown by the ~30% decrease in risk and threat criteria scored as DD (Table 7; Table S10). However, 11 RMUs, including 6 in the Pacific Ocean and 4 in the Indian Ocean, were identified as having critical data needs (defined in Section 2.2.4), due to multiple criteria scored DD and/or high data uncertainty scores (Table 4; Table S6). Further, data uncertainty scores for both risk and threat criteria were lowest for Atlantic Ocean RMUs and highest for Indian Ocean RMUs. These geographic patterns reflect findings of a global review of marine turtle research over the past 30+ years, which revealed significant and persistent bias toward research on the Atlantic Ocean RMUs — specifically those in the North Atlantic Ocean and Mediterranean Sea — and a converse underrepresentation from South Atlantic Ocean, Indian Ocean, and Pacific Ocean RMUs (Robinson et al. 2023).

4.2. Conservation capacity

Expert assessment suggested that conservation capacity is not generally hindered by expertise or technical capacity, nor coordination capacity, but rather by resource availability and socio-economic status. This aligns with observed increases in research output and the diversity of researchers' countries of origin within the marine turtle biology and conservation community in recent decades (Mazaris et al. 2018, Robinson et al. 2022, 2023). However, these capacities are not uniformly distributed among regions or topics (Robinson et al. 2023), and these research advances tend to over-represent high income countries and regions (Robinson et al. 2022). Indeed, resource availability and socio-economic status of countries within RMU borders were scored as the lowest capacity criteria overall by species and by region, which relates to relatively low overall capacity for enforcement of established protection frameworks as well (Table 3; Table S9).

The present assessment represents a first attempt to evaluate the conservation capacity concept and criteria; we acknowledge that they are inter-connected and their status and influence on conservation status is complex and often non-linear. As such, these criteria deserve a much more detailed definition and evaluation, particularly the connections between criteria and how they vary across geographies and governance regimes. Thus, future work should further analyze the conservation capacity concept and its constituent criteria. Regardless, identifying capacity weaknesses is critical to effective implementation of conservation priorities within regions and organizations.

4.3. Changes in risk–threat categories

Changes in risk–threat categories among RMUs since 2011 showed some encouraging trends (e.g. Fig. 4, Table 8), but patterns of status changes varied within and among species and regions. For example, following significant changes from the previous assessment (Fig. 4, Table 8; Fig. S4), nearly three-quarters of green turtle RMUs were low risk–low threats, whereas all leatherback RMUs were high risk and 4 of 9 were high risk–high threats (Figs. 2 & 3, Table 4; Fig. S4). These results agree broadly with global and RMU-scale status assessments published since 2011 (e.g. Seminoff et al. 2015, NMFS & USFWS 2020). For example, leatherback RMUs around the world are exhibiting declining abundance trends (e.g. West and East Pacific, Northwest and Southeast Atlantic) or exhibit low abundance and geographic range restrictions (e.g. Southwest Indian, Southwest Atlantic) (Northwest Atlantic Leatherback Working Group 2018, Laúd OPO Network 2020, NMFS & USFWS 2020, van de Geer et al. 2022). Northwest Atlantic leatherbacks were previously considered to be abundant and stable or increasing with relatively low threats (Wallace et al. 2011). However, more recent assessments revealed that annual nest abundance had decreased significantly at regional, genetic stock, and site levels over multiple time scales, likely related to persistent bycatch mortality in small- and industrial-scale fisheries (Northwest Atlantic Leatherback Working Group 2018) as well as illegal, unregulated, and unreported fishing activities (Leforestier 2024). This change in status resulted in an update in the official Red List status for this RMU (or 'subpopulation', in IUCN parlance; IUCN 2019) from 'Least Concern' to 'Endangered' (Northwest Atlantic Leatherback Working Group 2019).

In contrast, several green turtle RMUs appear to be recovering to various degrees (Figs. 2–4; Figs. S2 & S4), likely due to enhanced conservation efforts, especially focused on reducing direct take (Seminoff et al. 2015, Senko et al. 2022). For example, owing largely to the prohibition since 1990 of a legal green turtle harvest in Mexico — home to the largest nesting rookeries and nearly continuous, high-quality foraging areas — the East Pacific green turtle RMU has been steadily increasing over the past 2 decades and is currently approaching abundance levels last reported over 50 yr ago (Delgado Trejo & Alvarado Díaz 2012, Seminoff 2023). Differences in species-specific recovery patterns, especially among sympatric species, might also reflect variation in foraging strategies, demographic rates, and other biological factors that result in higher resilience to impacts of threats (Seminoff & Wallace 2012, Omeyer & Stokes et al. 2021, Hays et al. 2022).

In summary, threat scores have generally improved, while risk scores have remained largely the same. These changes, however, vary between species and RMUs and so highlight the need for RMU-specific conservation strategies to effectively address persistent threats and risk factors. Further, because RMU-level status does not necessarily reflect variation in status of individual rookeries or genetic stocks within RMUs, conservation initiatives often must be tailored to finer geographic scales to effectively address impediments to marine turtle recovery.

4.4. Conclusions and recommendations

Our CPP approach represents a flexible, comprehensive framework that evaluates multiple relevant, complementary criteria by synthesizing information and expert judgment to generate a robust, multi-faceted assessment of marine turtle conservation status. Further, conservation priorities that emerge from the results reflect the wide variation in conservation status, risk factors, impacts of threats, data quality and availability, and enabling capacity conditions that provide a basis for conservation strategies that target specific needs. The data dashboard (see Section 2.6) accompanying this paper can be used to visualize results at multiple scales for all criteria scored.

4.4.1. Current and future applications of the CPP

Our analysis underscores the importance of coherent conservation strategies that reflect the multinational, multi-jurisdictional nature of marine turtle population dynamics and conservation status. International collaborations and conservation strategies are crucial for ensuring the recovery of globally distributed species such as marine turtles. For example, various international policy instruments and goals (e.g. Global Biodiversity Framework, CITES, CMS), as well as marine turtle-specific conventions (e.g. Memorandum of Understanding on the Conservation and Management of Marine Turtles and their Habitats of the Indian Ocean and South-East Asia [IOSEA Marine Turtle MoU], Inter-American Convention on the Protection and Conservation of Sea Turtles) represent tangible targets toward which CPP results and priorities could be focused to influence implementation strategies. The CPP results, shared via this paper and the data dashboard, provide ample opportunities to identify population-level and threat-specific priorities at regional scales via RMUs that align well with such international frameworks. We emphasize that initiatives aimed at influencing such policy frameworks must include appropriate engagement with local communities to ensure that recommended conservation priorities and approaches incorporate their knowledge and perspectives.

We also recommend continued examination of the extent to which reported threat impact scores are dependent upon conservation actions, particularly for low risk–low threats RMUs whose apparently favorable conservation status could be dependent on the persistence of conservation investment and actions. The goal should be to avoid mistakenly responding to low risk and threat status by reducing or eliminating vital conservation interventions on which that status ultimately depends.

Conservation capacity criteria — individually and collectively — are more complex than risk and threat criteria. Therefore, we reiterate recommendations made by other authors (e.g. Rees et al. 2016, Fuentes et al. 2023) for robust qualitative, social science-informed approaches to assess these criteria and interactions between them with greater nuance and precision than in the present assessment. Along these lines, we further recommend a more detailed investigation of conservation capacity criteria to better articulate conservation priorities that focus on enhancing specific aspects of local capacity that can either bolster or hinder conservation success, depending on their status. This will require careful, well-planned, and appropriate engagement of local conservation groups and communities to empower them to develop and implement locally suitable conservation strategies.

The CPP framework, as well as RMUs, should be updated regularly (every ~10 yr) to accommodate growing knowledge and changes in criteria status. These updates will depend on generating, sharing, and synthesizing new information, which should prioritize filling the data gaps identified above such as several threat criteria (e.g. pollution and climate change), and multiple criteria for several Pacific and Indian Ocean RMUs (Table 4, Fig. 3).

4.4.2. Toward more inclusive international collaborations and networks

The development and updates of frameworks like RMUs and the CPP through the MTSG-BI initiative represent sincere efforts to include as many people and their expertise as possible, albeit via mostly remote communications platforms. This is critical to ensuring that resulting products might be as comprehensive as possible, and thus widely applicable to supporting efforts to set and implement conservation priorities by many actors across multiple scales. Fortunately, increased scale and complexity of generating and transferring knowledge has expanded substantially in the international marine turtle research community in the past 50+ yr (Mazaris et al. 2018, Hamann et al. 2021, Robinson et al. 2022, Madden Hof et al. 2023). Mazaris et al. (2018) speculated that these enhanced networks might partially underlie improving status and conservation gains being reported for many marine turtle nesting rookeries around the world (Mazaris et al. 2017, Hays et al. 2024), and this trend could be relevant to many results highlighted in this paper. Increased diversity in origins, genders, and professional backgrounds among collaborators is certainly a positive and necessary trend, reflecting improved inclusivity in what should be globally representative marine turtle research and conservation initiatives (Robinson et al. 2022, Shanker et al. 2022).

Persistent data gaps and disproportionate representation of Global North countries among assessments, assessors, and available data (Tables 1, 4, 5, Fig. 3) — phenomena rooted in neo-colonialist legacies — underscore the need for continued efforts to improve representation (Robinson et al. 2022, 2023, Shanker et al. 2022, 2023). Despite substantial efforts to include as many willing participants as possible from around the world, our co-authorship (145 individuals) was still skewed toward Very High and High

HDI countries, although these proportions were similar to the distribution of the overall MTSG membership (Table 1). Factors contributing to these patterns likely include language barriers, limited access to resources (including reliable internet connections) and conservation networks or research groups, lack of relevance of such synthesis initiatives to local activities, and the deep-rooted dynamic in which most researchers — especially those presenting research at international symposia and publishing in peer-reviewed scientific journals — are from, reside in, and receive their training in Global North (mainly Very High HDI) countries (Robinson et al. 2022, Shanker et al. 2023). To achieve truly global representation in international conservation and research networks, and the downstream conservation efforts that emerge from such networks, the marine turtle community must sincerely and steadfastly strive to improve inclusion of underrepresented people and their perspectives into future global status assessments and conservation priority-setting exercises. This is especially important because these individuals typically hail from countries that are true epicenters for marine turtle conservation — and biodiversity conservation broadly.

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LITERATURE CITED

Alfaro-Shigueto J, Mangel JC, Bernedo F, Dutton PH, Seminoff JA, Godley BJ (2011) Small-scale fisheries of Peru: a major sink for marine turtles in the Pacific. J Appl Ecol 48:1432–1440

Allen CD, Martin SL, Jones TT (2023) Green turtle *Chelonia mydas* (Central South Pacific subpopulation). The IUCN Red List of Threatened Species 2023: e.T220353080A220353155. https://dx.doi.org/10.2305/IUCN.UK.2023-1.RLTS.T220353080A220353155.en (accessed 9 Aug 2024)

Barrios-Garrido H, Shimada T, Diedrich A, Hamann M (2020) Conservation and enforcement capacity index (CECi): integrating human development, economy, and marine turtle status. J Environ Manage 262:110311

Bolten AB (2003) Variation in sea turtle life history patterns: neritic vs. oceanic developmental stages. In: Lutz PL, Musick J, Wyneken J (eds) The biology of sea turtles, Vol II. CRC Press, Boca Raton, FL, p 243–257

Bolten AB, Crowder LB, Dodd MG, MacPherson AL and others (2011) Quantifying multiple threats to endangered species: an example from loggerhead sea turtles. Front Ecol Environ 9:295–301

Bourjea J, Dalleau M (2023) Green turtle *Chelonia mydas* (Southwest Indian Ocean subpopulation). The IUCN Red List of Threatened Species 2023: e.T220970396A220970430. https://dx.doi.org/10.2305/IUCN.UK.2023-1.RLTS.T220970396A220970430.en (accessed 17 May 2024)

Bowen BW, Karl SA (2007) Population genetics and phylogeography of sea turtles. Mol Ecol 16:4886–4907

Boyd C, Brooks TM, Butchart SHM, Edgar GJ and others (2008) Spatial scale and the conservation of threatened species. Conserv Lett 1:37–43

Broderick AC, Türkozan O, Demetropoulos S, Mastrogiacomo A, Demetropoulos A, Levy Y, Leader N (2023) Green turtle *Chelonia mydas* (Mediterranean subpopulation). The IUCN Red List of Threatened Species 2023: e.T4616A83319449. https://dx.doi.org/10.2305/IUCN.UK.2023-1.RLTS.T4616A83319449.en (accessed 17 May 2024)

Campbell LM (2012) Seeing red: inside the science and politics of the IUCN Red List. Conserv Soc 10:367–380

Casale P, Broderick AC, Camiñas JA, Cardona L and others (2018) Mediterranean sea turtles: current knowledge and priorities for conservation and research. Endang Species Res 36:229–267

Clarke S, Sato M, Small C, Sullivan B, Inoue Y, Ochi D (2014) Bycatch in longline fisheries for tuna and tuna-like species: a global review of status and mitigation measures. FAO Fish Aquacult Tech Pap No. 588. FAO, Rome

Conant TA, Dutton PH, Eguchi T, Epperly SP and others (2009) Loggerhead sea turtle (*Caretta caretta*) 2009 status review under the US Endangered Species Act. Report of the Loggerhead Biological Review Team to the National Marine Fisheries Service, August 2009. https://repository.library.noaa.gov/view/noaa/16204

Cortés-Gómez AA, Romero D, Girondot M (2017) The current situation of inorganic elements in marine turtles: a general review and meta-analysis. Environ Pollut 229: 567–585

Crandall SF, Ohayon JL, de Wit LA, Hammond JE and others (2018) Best practices: social research methods to inform biological conservation. Australas J Environ Manage 25: 6–23

Delgado Trejo C, Alvarado Díaz J (2012) Current conservation status of the black sea turtle in Michoacán, México. In: Seminoff JA, Wallace BP (eds) Sea turtles of the Eastern Pacific: advances in research and conservation. University of Arizona Press, Tucson, AZ, p 263–278

Department of Environment and Science (2021) Queensland Marine Turtle Conservation Strategy (2021–2031). Queensland Government, Brisbane

Dimitriadis C, Fournari-Konstantinidou I, Sourbès L, Koutsoubas D, Mazaris AD (2018) Reduction of sea turtle population recruitment caused by nightlight: evidence from the Mediterranean region. Ocean Coast Manage 153: 108–115

Eckert K, Hart K (2021) Threat assessment: Northwest Atlantic leatherback sea turtles, *Dermochelys coriacea*, with special emphasis on Trinidad & Tobago and the Guianas. Tech Rep 21. WIDECAST, Godfrey, IL

Fowler SL, Cavanagh RD, Camhi M, Burgess GH and others (2005) Sharks, rays and chimaeras: the status of the chondrichthyan fishes. Status survey. IUCN/SSC Shark Specialist Group, IUCN, Gland

Fuentes MMPB, Pike DA, DiMatteo A, Wallace BP (2013) Resilience of marine turtle regional management units to climate change. Glob Change Biol 19:1399−1406

Fuentes MMPB, McMichael E, Kot CY, Silver-Georges I and others (2023) Key issues in assessing threats to sea turtles: knowledge gaps and future directions. Endang Species Res 52:303−341

Gaos AR, Liles MJ, Gadea V, Peña de Niz A and others (2017) Living on the edge: hawksbill turtle nesting and conservation along the Eastern Pacific Rim. Lat Am J Aquat Res 45:572−584

Godfrey MH, Godley BJ (2008) Seeing past the red: flawed IUCN global listings for sea turtles. Endang Species Res 6:155−159

Hamann M, Flavell F, Frazier J, Limpus C, Miller J, Mortimer J (2021) Assessment of the hawksbill turtles in the Indian Ocean and South-East Asia Region. IOSEA Marine Turtle MOU, CMS, Bonn

Havice E, Campbell LM, Braun A (2018) Science, scale and the frontier of governing mobile marine species. Int Soc Sci J 68:273−289

Hays GC, Mazaris AD, Schofield G (2022) Inter-annual variability in breeding census data across species and regions. Mar Biol 169:54

Hays GC, Schofield G, Papazekou M, Chatzimentor A, Katsanevakis S, Mazaris AD (2024) A pulse check for trends in sea turtle numbers across the globe. iScience 27:109071

Hirsch SE, Toonder M, Reilly JD, Hoover SR, Perrault JR (2022) Responses of three nesting sea turtle species to hard-armoring structures. Front Mar Sci 9:980715

Humber F, Godley BJ, Broderick AC (2014) So excellent a fishe: a global overview of legal marine turtle fisheries. Divers Distrib 20:579−590

IMTA (Important Marine Turtle Area) Working Group (2021) Important marine turtle areas. Guidelines 1.0 (August 2021). Prepared for the 7th Burning Issues Workshop (BI-7). IUCN-SSC Marine Turtle Specialist Group. https://static1.squarespace.com/static/5e4c290978d00820618e0944/t/61e0557f9c2cdd4c4bec8037/1642091906570/IMTA+Guidelines+1.0.pdf

IUCN (2019) Guidelines for using the IUCN Red List categories and criteria. Version 14. Prepared by the Standards and Petitions Subcommittee. www.iucnredlist.org/technical-documents/red-list-documents

Jensen MP, Allen CD, Eguchi T, Bell IP and others (2018) Environmental warming and feminization of one of the largest sea turtle populations in the world. Curr Biol 28:154−159

Klein CJ, Beher J, Chaloupka M, Hamann M, Limpus C, Possingham HP (2017) Prioritization of marine turtle management projects: a protocol that accounts for threats to different life history stages. Conserv Lett 10:547−554

Lascelles B, Notarbartolo Di Sciara G, Agardy T, Cuttelod A and others (2014) Migratory marine species: their status, threats and conservation management needs. Aquat Conserv 24:111−127

Laúd OPO Network (2020) Enhanced, coordinated conservation efforts required to avoid extinction of critically endangered Eastern Pacific leatherbacks. Sci Rep 10:4772

Leforestier S (2024) Estimate of illegal foreign fishing in French Guyana. Tech Rep to CRPMEM Guyane, WWF-French Guiana, and IFREMER. https://www.wwf.fr/sites/default/files/doc-2024-09/Rapport_Scientifique_Peche_INN_VF.pdf

Lettrich MD, Dick DM, Fahy CC, Griffis RB and others (2020) A method for assessing the vulnerability of sea turtles to a changing climate. NOAA Tech Memo NMFS-F/SPO-211. https://repository.library.noaa.gov/view/noaa/30910

Leusch FDL, Hollert H, Holmes G (2021) Editorial — Virtual special issue (VSI) green turtles as silent sentinels of pollution in the Great Barrier Reef — Rivers to Reef to Turtles project. Sci Total Environ 757:144188

Lewison RL, Crowder LB, Wallace BP, Moore JE and others (2014) Global patterns of marine mammal, seabird, and sea turtle bycatch reveal taxa-specific and cumulative megafauna hotspots. Proc Natl Acad Sci USA 111:5271−5276

López-Castro MC, Cuevas E, Guzmán Hernández V, Raymundo Sánchez Á, Martínez-Portugal RC, Reyes DJL, Chio JÁB (2022) Trends in reproductive indicators of green and hawksbill sea turtles over a 30-year monitoring period in the southern Gulf of Mexico and their conservation implications. Animals 12:3280

Madden Hof CA, Desbiens AA, Kinch J, Fitzsimmons NN and others (2023) From rookeries to foraging grounds: understanding regional connectivity and genetic diversity in hawksbill turtles. Front Mar Sci 10:1201009

Martin TG, Burgman MA, Fidler F, Kuhnert PM, Low-Choy S, McBride M, Mengersen K (2012) Eliciting expert knowledge in conservation science. Conserv Biol 26:29−38

Mazaris AD, Schofield G, Gkazinou C, Almpanidou V, Hays GC (2017) Global sea turtle conservation successes. Sci Adv 3:e1600730

Mazaris AD, Gkazinou C, Almpanidou V, Balazs G (2018) The sociology of sea turtle research: evidence on a global expansion of co-authorship networks. Biodivers Conserv 27:1503−1516

Moritz C (1994) Defining 'evolutionary significant units' for conservation. Trends Ecol Evol 9:373−375

Mrosovsky N (1997) IUCN's credibility critically endangered. Nature 389:436

Mrosovsky N (2003) Predicting extinction: fundamental flaws in IUCN's Red List system, exemplified by the case of sea turtles. http://www.seaturtle.org/members/mrosovsky/extinct.pdf

Nelson Sella KA, Fuentes MMPB (2019) Exposure of marine turtle nesting grounds to coastal modifications: implications for management. Ocean Coast Manage 169:182−190

NMFS, USFWS (National Marine Fisheries Service, US Fish and Wildlife Service) (2020) Endangered Species Act status review of the leatherback turtle (*Dermochelys coriacea*). Report to the National Marine Fisheries Service Office of Protected Resources and US Fish and Wildlife Service. https://repository.library.noaa.gov/view/noaa/25629

NMFS, USFWS, SEMARNAT (Secretaría de Medio Ambiente y Recursos Naturales) (2011) Bi-national recovery plan for the Kemp's ridley sea turtle (*Lepidochelys kempii*), 2nd rev. National Marine Fisheries Service, Silver Spring, MD

Northwest Atlantic Leatherback Working Group (2018) Northwest Atlantic Leatherback Turtle (*Dermochelys coriacea*) Status Assessment. WIDECAST Tech Rep 16.

Conservation Science Partners and the Wider Caribbean Sea Turtle Conservation Network (WIDECAST), Godfrey, IL

Northwest Atlantic Leatherback Working Group (2019) Leatherback *Dermochelys coriacea* (Northwest Atlantic Ocean subpopulation) (errata version published in 2020). The IUCN Red List of Threatened Species 2019: e.T46967827A184748440. https://dx.doi.org/10.2305/IUCN.UK.2019-2.RLTS.T46967827A184748440.en (accessed 17 May 2024)

Omeyer LCM, Stokes KL, Beton D, Çiçek BA and others (2021) Investigating differences in population recovery rates of two sympatrically nesting sea turtle species. Anim Conserv 24:832–846

Patricio AR, Hawkes LA, Monsinjon JR, Godley BJ, Fuentes MMPB (2021) Climate change and marine turtles: recent advances and future directions. Endang Species Res 44: 363–395

Peckham SH, Maldonado Diaz D, Walli A, Ruiz G, Crowder LB, Nichols WJ (2007) Small-scale fisheries bycatch jeopardizes endangered Pacific loggerhead turtles. PLOS ONE 2:e1041

Pilcher NJ (2021) Review of the status of sea turtles in the Pacific Ocean 2021. Secretariat of the Pacific Regional Environment Programme, Apia

Possingham HP, Andelman SJ, Burgman MA, Medellín RA, Master LL, Keith DA (2002) Limits to the use of threatened species lists. Trends Ecol Evol 17:503–507

Rees AF, Alfaro-Shigueto J, Barata PCR, Bjorndal KA and others (2016) Are we working towards global research priorities for management and conservation of sea turtles? Endang Species Res 31:337–382

Robinson NJ, Mills S, St.Andrews L, Sundstrom A, Thibodeau J, Yaney-Keller A, Gatto CR (2022) Representation in sea turtle science: slow progress towards gender equity and globalization revealed from thirty years of symposium abstracts. Front Mar Sci 9:943056

Robinson NJ, Aguzzi J, Arias S, Gatto C and others (2023) Global trends in sea turtle research and conservation: using symposium abstracts to assess past biases and future opportunities. Glob Ecol Conserv 47:e02587

Schuyler QA, Wilcox C, Townsend KA, Wedemeyer-Strombel KR, Balazs G, Van Sebille E, Hardesty BD (2016) Risk analysis reveals global hotspots for marine debris ingestion by sea turtles. Glob Change Biol 22:567–576

Seminoff JA (2023) *Chelonia mydas* (East Pacific subpopulation). The IUCN Red List of Threatened Species 2023: e.T220970302A220970304. https://dx.doi.org/10.2305/IUCN.UK.2023-1.RLTS.T220970302A220970304.en (accessed 17 May 2024)

Seminoff JA, Shanker K (2008) Marine turtles and IUCN Red Listing: a review of the process, the pitfalls, and novel assessment approaches. J Exp Mar Biol Ecol 356:52–68

Seminoff JA, Wallace BP (2012) Sea turtles of the Eastern Pacific: advances in research and conservation. University of Arizona Press, Tucson, AZ

Seminoff JA, Allen CD, Balazs GH, Dutton PH and others (2015) Status review of the green turtle (*Chelonia mydas*) under the US Endangered Species Act. NOAA Tech Memo NOAA-NMFS-SWFSC-539

Senko JF, Nelms SE, Reavis JL, Witherington B, Godley BJ, Wallace BP (2020) Understanding individual and population-level effects of plastic pollution on marine megafauna. Endang Species Res 43:234–252

Senko JF, Burgher KM, del Mar Mancha-Cisneros M, Godley BJ and others (2022) Global patterns of illegal marine turtle exploitation. Glob Change Biol 28:6509–6523

Shanker K, Early Capistrán MM, Urteaga J, Mohd Jani J, Wallace BP (2022) Moving beyond parachute science in the sea turtle community. The State of the World's Sea Turtles (SWOT) Report 17. https://www.seaturtlestatus.org/articles/moving-beyond-parachute-science-in-the-sea-turtle-community?rq=parachute

Shanker K, Early Capistrán MM, Urteaga J, Mohd Jani J, Barrios-Garrido H, Wallace BP (2023) Decolonizing sea turtle conservation. SWOT Report 18. https://www.seaturtlestatus.org/articles/decolonizing-sea-turtle-conservation

Stelfox M, Hudgins J, Sweet M (2016) A review of ghost gear entanglement amongst marine mammals, reptiles and elasmobranchs. Mar Pollut Bull 111:6–17

Tomasini S (2018) Unpacking the Red List: use (and misuse?) of expertise, knowledge, and power. Conserv Soc 16: 505–517

United Nations (2023) World economic situation and prospects 2023. https://www.un.org/development/desa/dpad/publication/world-economic-situation-and-prospects-2023/

Valdivia A, Wolf S, Suckling K (2019) Marine mammals and sea turtles listed under the US Endangered Species Act are recovering. PLOS ONE 14:e0210164

van de Geer CH, Bourjea J, Broderick AC, Dalleau M and others (2022) Marine turtles of the African east coast: current knowledge and priorities for conservation and research. Endang Species Res 47:297–331

Wallace BP, DiMatteo AD, Hurley BJ, Finkbeiner EM and others (2010) Regional Management Units for marine turtles: a novel framework for prioritizing conservation and research across multiple scales. PLOS ONE 5:e15465

Wallace BP, DiMatteo AD, Bolten AB, Chaloupka MY and others (2011) Global conservation priorities for marine turtles. PLOS ONE 6:e24510

Wallace BP, Kot CY, DiMatteo AD, Lee T, Crowder LB, Lewison RL (2013) Impacts of fisheries bycatch on marine turtle populations worldwide: toward conservation and research priorities. Ecosphere 4:40

Wallace BP, Stacy BA, Cuevas E, Holyoake C and others (2020) Oil spills and sea turtles: documented effects and considerations for response and assessment efforts. Endang Species Res 41:17–37

Wallace BP, Posnik ZA, Hurley BJ, DiMatteo AD and others (2023) Marine turtle regional management units 2.0: an updated framework for conservation and research of wide-ranging megafauna species. Endang Species Res 52:209–223

Wibbels T, Bevan E (2019) Kemp's ridley *Lepidochelys kempii* (errata version published in 2019). The IUCN Red List of Threatened Species 2019: e.T11533A155057916. https://dx.doi.org/10.2305/IUCN.UK.2019-2.RLTS.T11533A155057916.en (accessed 17 May 2024)

Wildermann NE, Gredzens C, Avens L, Barrios-Garrido H and others (2018) Informing research priorities for immature sea turtles through expert elicitation. Endang Species Res 37:55–76

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