

Diversity, life history patterns and status

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University of Primorska

Testudines
Turtles

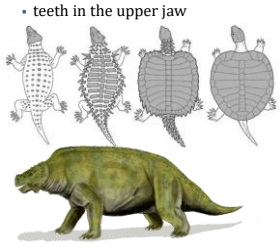
- Shell: modified ribcage
- Oviparous: they lay eggs in a nest
- K-strategists
- Among the longest living reptiles
  - often >50 yrs
  - large terrestrial species >100 yrs.
- Cosmopolitan distribution
  - in terrestrial, freshwater and marine habitats





Evolution of shell

- First fossil finding: *Proganochelys quenstedti* (Germany)
  - lived before 204-206 Mya
  - whole, massive shell
  - spikes on tail and neck spine
  - teeth in the upper jaw



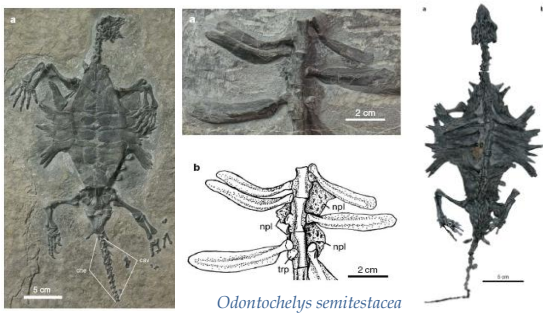


- Turtles: related to *Pareiasaurus*
- ***Out side → in*** origin of shell
- Evolution of shell on land

Vol 456|27 November 2008|doi:10.1038/nature07533 nature

An ancestral turtle from the Late Triassic of southwestern China

Chun Li[1], Xiao-Chun Wu[2], Olivier Rieppel[3], Li-Ting Wang[4] & Li-Jun Zhao[5]



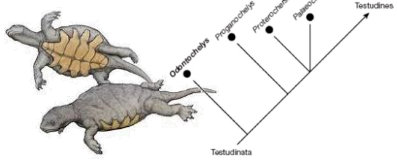
Odontochelys semitestacea

Vol 456|27 November 2008|doi:10.1038/nature07533 nature

An ancestral turtle from the Late Triassic of southwestern China

Chun Li[1], Xiao-Chun Wu[2], Olivier Rieppel[3], Li-Ting Wang[4] & Li-Jun Zhao[5]

- Fossil finding of *Odontochelys semitestacea* (SW Chi
  - lived before ≈ 220 MYA (upper Triassic)
  - 40 cm in length, inhabited shallow seas
- *Missing link:* early stage in shell evolution
- Osteology and DNA: related to Diapsids
- ***Inside → out*** evolution of shell



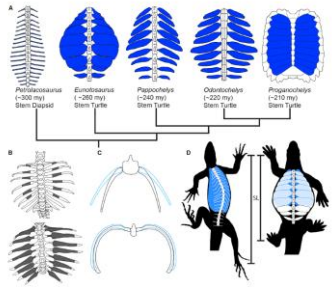
Current Biology (2016), http://dx.doi.org/10.1016/j.cub.2016.05.020

Current Biology Report CellPress

Fossorial Origin of the Turtle Shell

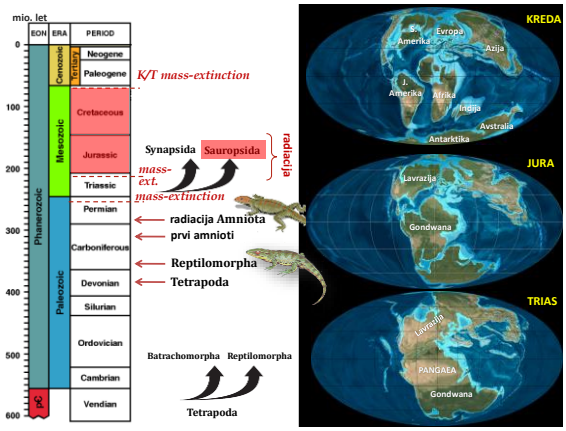
Tyler R. Lyson,[1,2,*] Bruce S. Rubidge,[3] Torsten M. Scheyer,[3] Kevin de Queiroz,[4] Emma R. Schachner,[5] Roger M.H. Smith,[6,7] Jennifer Botha-Brink,[7,8] and G.S. Bever[4,9,10]

Fossorial animal: **žival, ki živi pod zemljo (iz latinskega *fossor* 'kopalec'), je tista, ki je prilagojena kopanju in živi pretežno (vendar ne izključno) pod zemljo.**





Microanatomy of the stem-turtle *Pappochelys rosinae* indicates a predominantly fossorial mode of life and clarifies early steps in the evolution of the shell



Sea turtles: Reptiles

- Ectotherms: Activity and distribution dependant upon environmental temperature
  - Temperature dependant sex determination (TDS)
- Secondary aquatic – breath air
- Skin covered with scales and scutes (keratinous layer of epidermis)



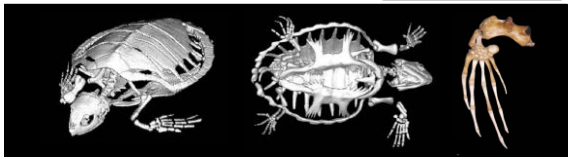


Adaptations
to marine environment





- Shell: hydrodynamic shape, reduced
- Front and hind legs → flippers
- Can't contract/hide in the shell
- Salt glands ("turtle tears")



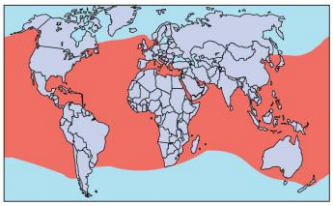
Systematic of sea turtles

Two living families:

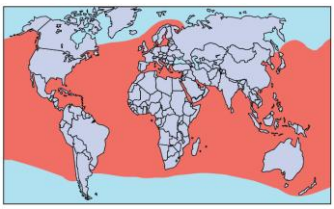
1. fam. Dermochelyidae
   - single species: leatherback turtle (*Dermochelys coriacea*)
   - shell covered with dark skin, with 7 longitudinal ridges
   - mosaic of small dermal bones
2. fam. Cheloniidae
   - 6 species
   - shell covered with keratinous scutes



fam. Cheloniidae



fam. Dermochelyidae



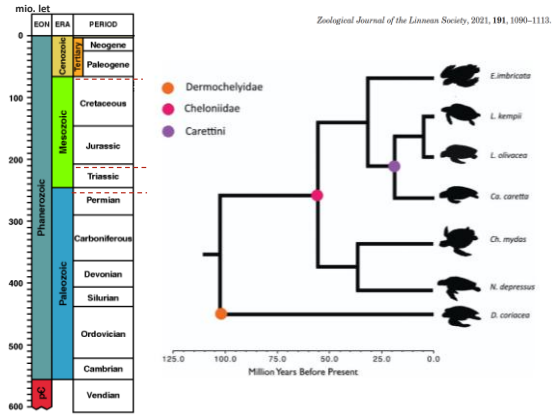
Sea Turtles
Diversity

Family / Species
fam. Cheloniidae
Loggerhead turtle (*Caretta caretta*)
Green turtle (*Chelonia mydas*)
Hawksbill turtle (*Eretmochelys imbricata*)
Kemps ridley (*Lepidochelys kempii*)
Olive ridley (*Lepidochelys olivacea*)
Flatback turtle (*Natator depressus*)
fam. Dermochelyidae
Leatherback turtle (*Dermochelys coriacea*)



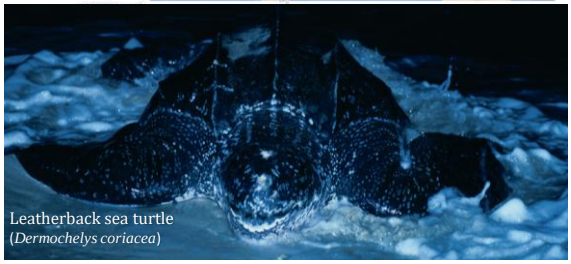


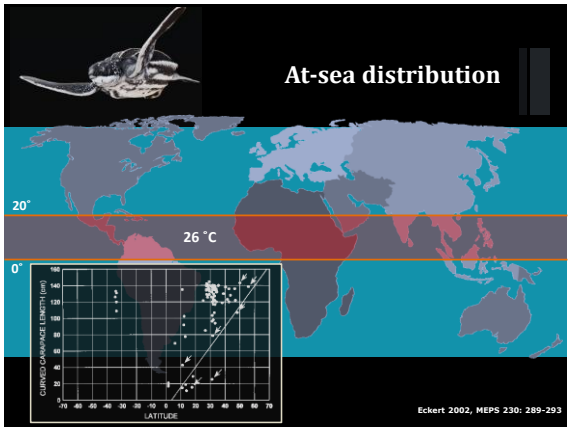


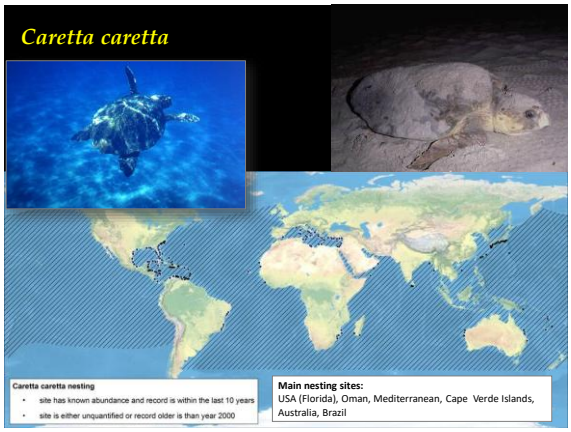



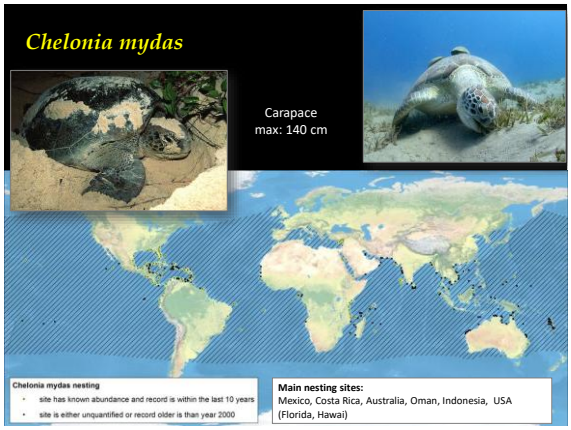


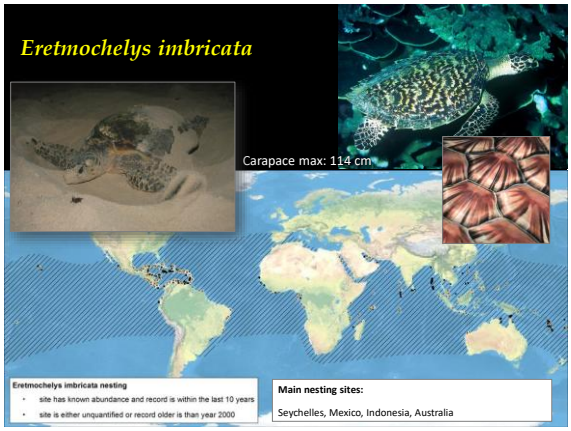
Dermochelys coriacea





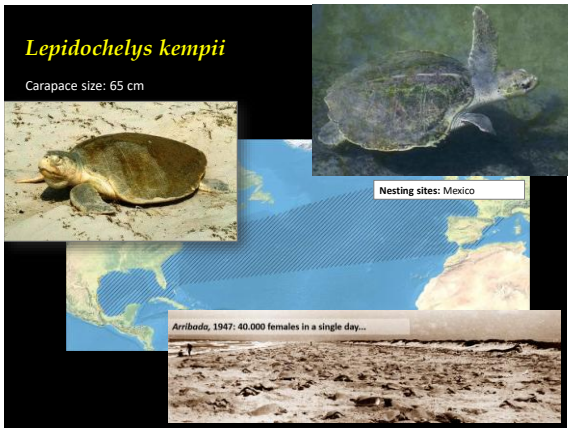

Caretta caretta
Caretta caretta nesting
site has known abundance and record is within the last 10 years
site is either unquantified or record older is than year 2000
Main nesting sites:
USA (Florida), Oman, Mediterranean, Cape Verde Islands, Australia, Brazil


Chelonia mydas
Carapace max: 140 cm
Chelonia mydas nesting
site has known abundance and record is within the last 10 years
site is either unquantified or record older is than year 2000
Main nesting sites:
Mexico, Costa Rica, Australia, Oman, Indonesia, USA (Florida, Hawai)


Eretmochelys imbricata
Carapace max: 114 cm
Eretmochelys imbricata nesting
site has known abundance and record is within the last 10 years
site is either unquantified or record older is than year 2000
Main nesting sites:
Seychelles, Mexico, Indonesia, Australia

Lepidochelys kempii

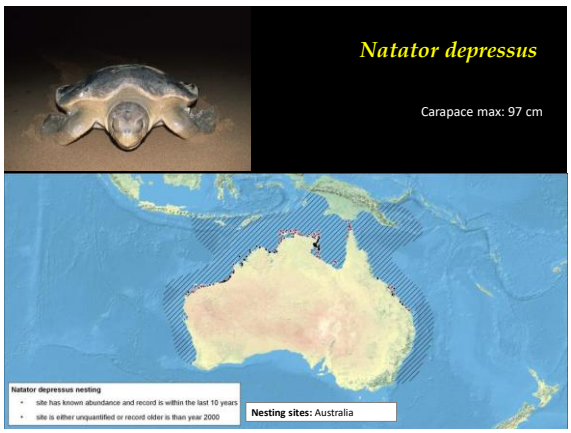
Carapace size: 65 cm



Lepidochelys olivacea



Natator depressus



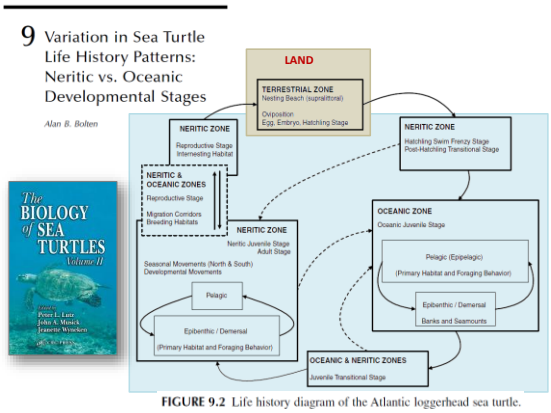


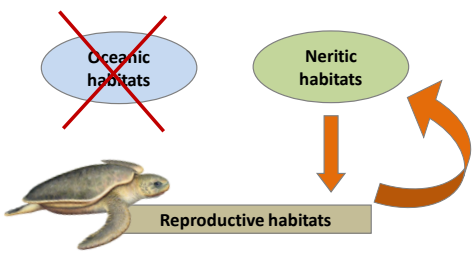
FIGURE 9.2 Life history diagram of the Atlantic loggerhead sea turtle.

Life history patterns

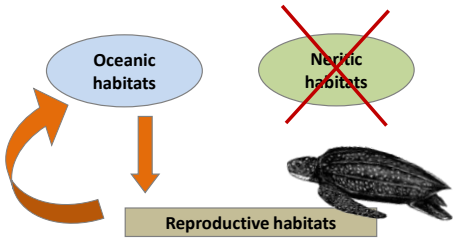


- The neritic developmental pattern
  - *Natator depressus*
- The oceanic developmental pattern
  - *Dermochelys coriacea*
  - *Lepidochelys olivacea* (E Pacific populations)
- The oceanic-neritic developmental pattern
  - all other sea turtle species

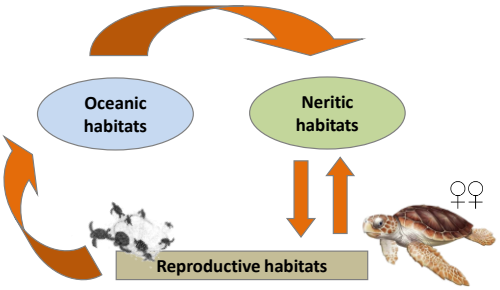
Neritic developmental pattern



Oceanic developmental pattern

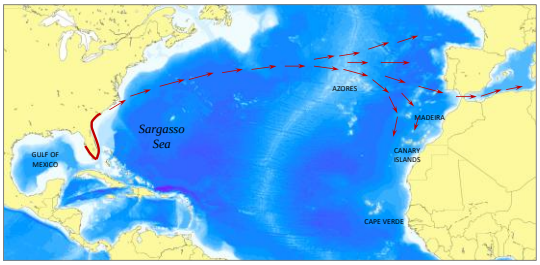


Oceanic-neritic developmental pattern



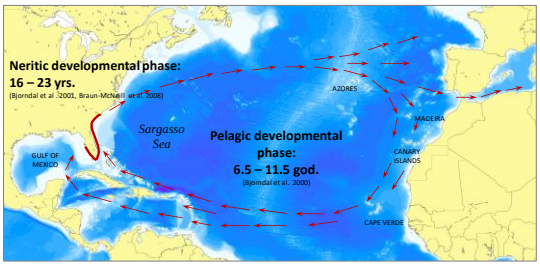
Trans-Atlantic developmental migrations

(Carr 1987. Conserv. Biol.)



Trans-Atlantic developmental migrations

(Carr 1987. Conserv. Biol.)



Loggerhead turtle

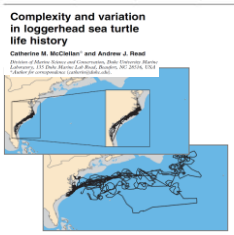
Ecological plasticity…


Proceedings, 25th Symposium on Sea Turtle Biology and Conservation NOAA Tech. Memo. NMFS-SEC

FEEDING ECOLOGY OF "PELAGIC" LOGGERHEAD SEA TURTLES, *CARETTA CARETTA*, IN THE NORTHERN ADRIATIC SEA: PROOF OF AN EARLY ONTOGENETIC HABITAT SHIFT

Bojan Lazar[1,2], Romana Gracan[1], Dusan Zavodnik[3] and Nikola Tvrtkovic[2]

[1] Department of Zoology, Croatian Natural History Museum, Zagreb, Croatia
[2] Blue World Institute of Marine Research and Conservation, Veli Losinj, Croatia
[3] Centre for Marine Research, Ruđer Bošković Institute, Rovinj, Croatia


Complexity and variation in loggerhead sea turtle life history

Catherine M. McClellan* and Andrew J. Read

Division of Marine Science and Conservation, Duke University Marine Laboratory, 135 Duke Marine Lab Road, Beaufort, NC 28516, USA
*Author for correspondence (cathermc@duke.edu).

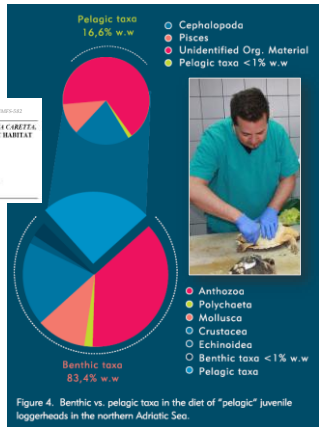
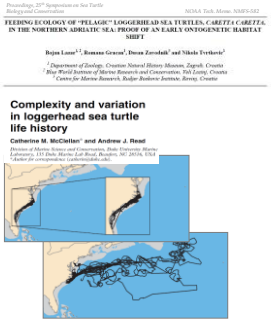


Figure 4. Benthic vs. pelagic taxa in the diet of "pelagic" juvenile loggerheads in the northern Adriatic Sea.

Loggerhead turtle

Relaxed life history model


Proceedings, 25th Symposium on Sea Turtle Biology and Conservation NOAA Tech. Memo. NMFS-SEC

FEEDING ECOLOGY OF "PELAGIC" LOGGERHEAD SEA TURTLES, *CARETTA CARETTA*, IN THE NORTHERN ADRIATIC SEA: PROOF OF AN EARLY ONTOGENETIC HABITAT SHIFT

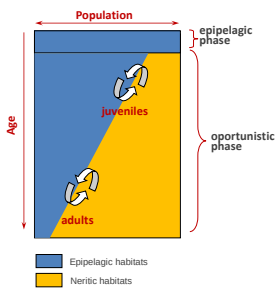
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Complexity and variation in loggerhead sea turtle life history

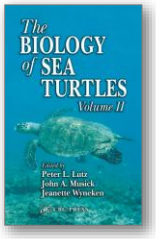
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Division of Marine Science and Conservation, Duke University Marine Laboratory, 135 Duke Marine Lab Road, Beaufort, NC 28516, USA
*Author for correspondence (cathermc@duke.edu).



Readings

Bolten A.B. 2003. Chapter 9: Variation in sea turtle life history patterns: Neritic vs. oceanic developmental stages. In: Lutz P.L., Musick J. A., Wyneken J. (Eds) *The Biology of Sea Turtles, Vol. 2.* CRC Press, Boca Raton.

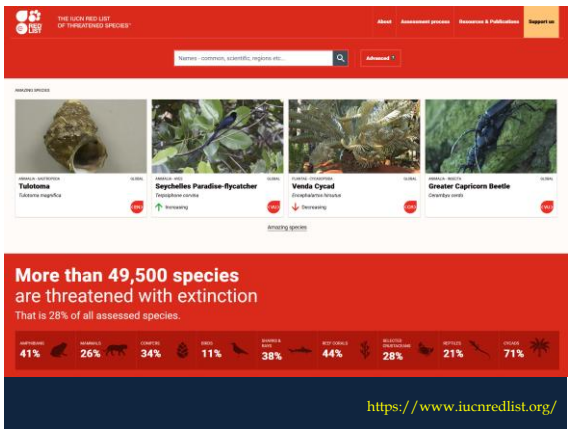


Evaluating species status…

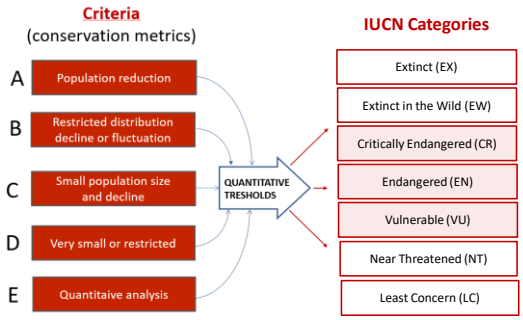
- Status: evaluation of populations relative to some standard/goal
  - the *size* or general *health* of a population relative to some management standard
- Typically related either to harvest or to conservation objectives
  - *harvest objectives*: population size/level that would support sustainable yield/catch
  - *conservation objectives*: ranging from preventing the extinction of species to returning populations to their "natural" /carrying capacity level

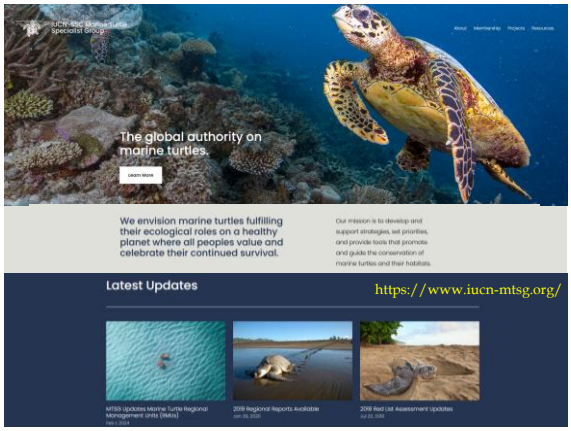
Conservation Status Metrics, *e.g.*

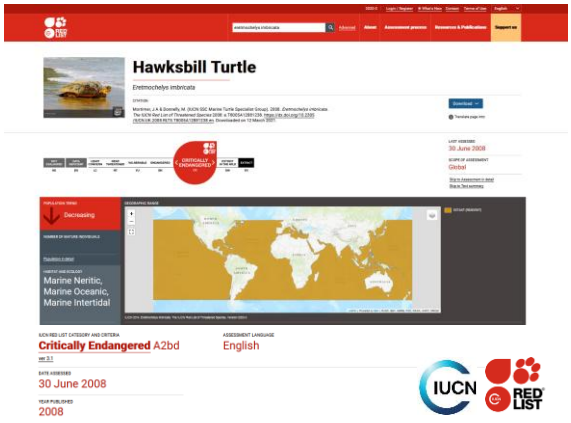
- Population trend: the rate at which a population grows or declines over some time period
- Probability of extinction (within some time period): for small or rapidly declining populations



Quantification of Conservation Status







Sea Turtles
Global Conservation Status

Family / Species	IUCN status	Assesment yr.
fam. Cheloniidae		
Loggerhead turtle (*Caretta caretta*)	VU A2b ↓	2017
Green turtle (*Chelonia mydas*)	LC A2bd ↓	2024
Hawksbill turtle (*Eretmochelys imbricata*)	CR A2bd	2008
Kemps ridley (*Lepidochelys kempii*)	CR A2bd	2019
Olive ridley (*Lepidochelys olivacea*)	VU A2bd ↓	2008
Flatback turtle (*Natator depressus*)	DD	1996
fam. Dermochelyidae		
Leatherback turtle (*Dermochelys coriacea*)	VU A2bd ↓	2013



Criterion A2*bd*



A. Reduction in population size:

- **2.** An observed, estimated, inferred or suspected ***population size reduction*** over the last 10 years or three generations, whichever is the longer, where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (*a*) – (*e*).

CR: ≥80% **EN**: ≥50% **VU**: ≥30%

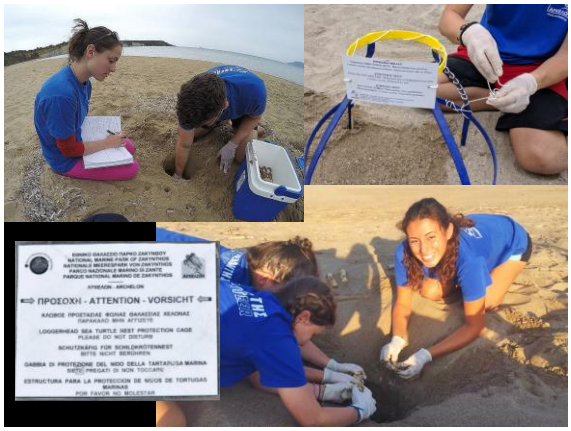
(*a*) direct observation
(*b*) an *index of abundance* appropriate to the taxon
(*c*) a decline in area of occupancy, extent of occurrence and/or quality of habitat
(*d*) actual or potential *levels of exploitation*
(*e*) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites

Conservation Status of Sea Turtles

- Listing against Criterion A**:** change in population size (*no.of mature individuals*) over the 3-generation period
- Index of abundance: nest counts



- **Index beaches** – conditions:
  - Time series of nesting data (> 10 yrs of data)
  - Constant research effort over time/space
  - Constant methodology
- Trend of individual populations weighted against its population size

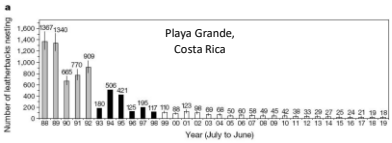


NATURE | VOL 405 | 1 JUNE 2000 | www.nature.com

Pacific leatherback turtles face extinction

Fisheries can help avert the alarming decline in population of these ancient reptiles.

James R. Spotila*, Richard D. Reina*, Anthony C. Steyermark*, Pamela T. Plotkin†, Frank V. Paladino‡



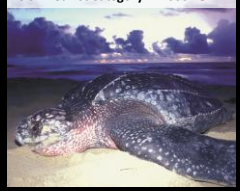
Population in the E Pacific:

1980: ≈ 4600 nesting females
2009: ≈ 900 nesting females

Sustainable bycatch
(1% antropogenic mortality/yr):

≈35 adult females/ yr

IUCN RedList Category in 2000: CR



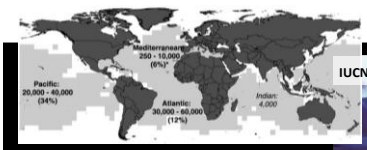
Ecology Letters, (2004) 7: 221–231 doi: 10.1111/j.1461-0248.2004.00573.x

REPORT

Quantifying the effects of fisheries on threatened species: the impact of pelagic longlines on loggerhead and leatherback sea turtles

Rebecca L. Lewison ✉, Sloan A. Freeman, Larry B. Crowder

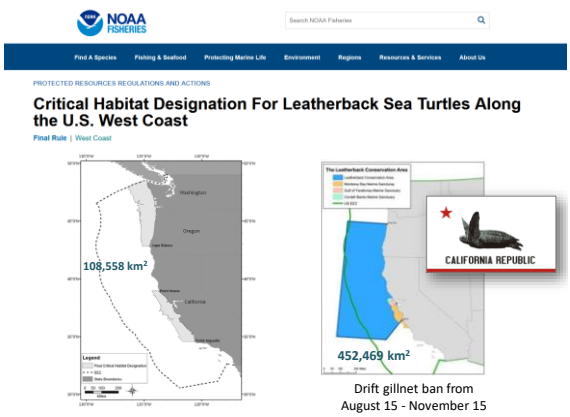




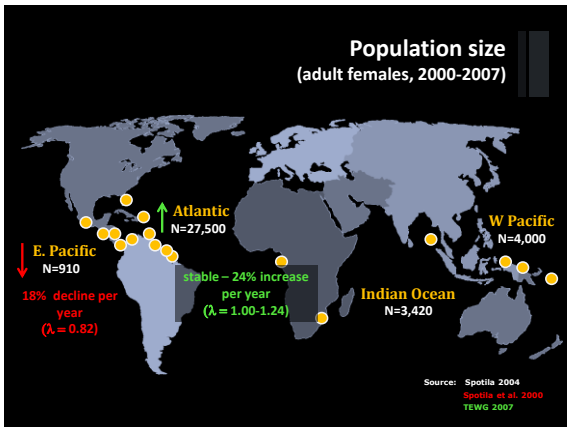
IUCN RedList Category in 2000: CR



Bycatch estimate in Pacific in 2000:
20.000 – 40.000/yr (!)



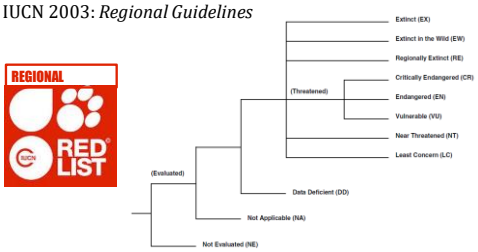
Drift gillnet ban from
August 15 - November 15



Conservation status

Shifting Conservation Targets…

- IUCN Red List Assessments: going *regional*…..
  - IUCN 2003: *Regional Guidelines*



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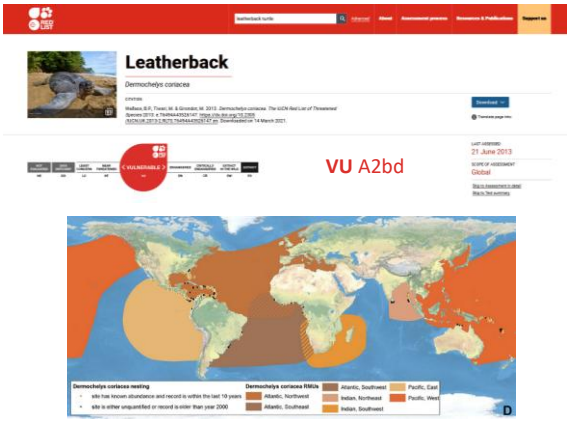
Regional Management Units for Marine Turtles: A Novel Framework for Prioritizing Conservation and Research across Multiple Scales

Bryan P. Wallace[1,2,3]*, Andrew D. DiMatteo[1,4], Brendan J. Hurley[1,2], Elena M. Finkbeiner[1,5], Alan B. Bolten[1,6], Milani Y. Chaloupka[1,6], Brian J. Hutchinson[1,2], F. Alberto Abreu-Grobois[1,7], Diego Amorocho[1,8], Karen A. Bjorndal[1,6], Jerome Bourjea[1,9], Brian W. Bowen[1,10], Raquel Briseño Dueñas[1,11], Paolo Casale[1,12,13], B. C. Choudhury[1,14], Alice Costa[1,15], Peter H. Dutton[1,16], Alejandro Fallabrino[1,17], Alexandra Girard[1,18], Marc Girondot[1,19], Matthew H. Godfrey[1,20], Mark Hamann[1,21], Milagros López-Mendilaharsu[1,22,23], Maria Angela Marcovaldi[1,24], Jeanne A. Mortimer[1,25], John A. Musick[1,26], Ronel Nel[1,27], Nicolas J. Pilcher[1,28], Jeffrey A. Seminoff[1,29], Sebastian Troëng[1,2,30,31], Blair Witherington[1,32], Rod

Table 1. Summary of number of nesting sites, genetic stocks, and RMUs identified for all marine turtle species.

species	no. nesting sites	no. mtDNA stocks	no. nDNA stocks	no. RMUs (no. putative RMUs)
Caretta caretta	626	15	8	10 (1)
Chelonia mydas	935	33	9	17
Dermochelys coriacea	652	9	6	7
Eretmochelys imbricata	1,337	19	2	13 (7)
Lepidochelys kempii	30	1*	1*	1
Lepidochelys olivacea	426	6	2	8 (1)
Natator depressus	287	4	ND	2
TOTAL	4,293	87	28	58 (9)

ND: no data. Putative RMUs were described for regions with available nesting data but no associated data on genetics or distributions. (
*denotes that although nesting sites have not been sampled for genetics, all *L. kempii* individuals are presumed to belong to same stock and a single RMU.)
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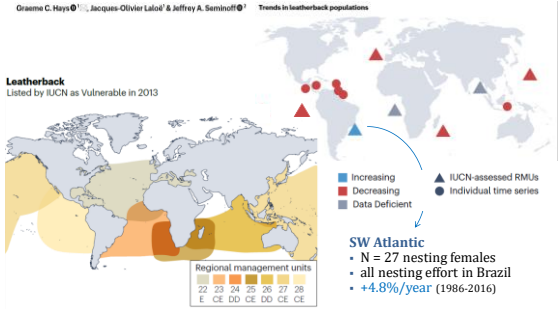
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27 January 2025

Status, trends and conservation of global sea turtle populations

Graeme C. Hays[1], Jacques-Olivier Laloë[1] & Jeffrey A. Seminoff[2]

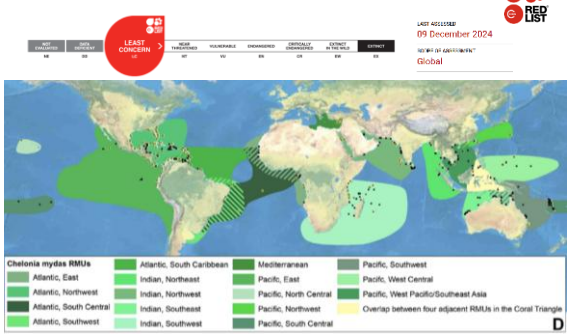


SW Atlantic
- N = 27 nesting females
- all nesting effort in Brazil
- +4.8%/year (1986-2016)

Green Sea Turtle (*Chelonia mydas*)

Regional Managemen Units (RMUs)

Wallace et al. 2010. PlosONE 5(12)

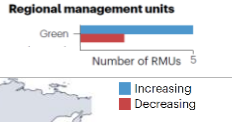


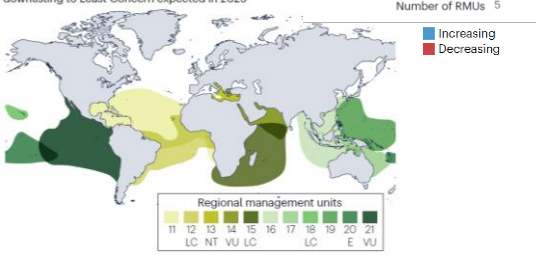
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Green
Listed by IUCN as Endangered in 2004; downlisting to Least Concern expected in 2025

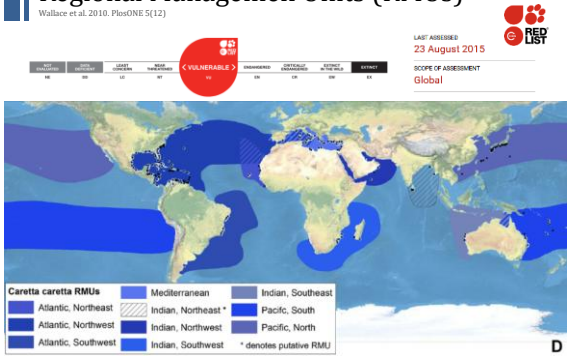




Loggerhead sea turtle (*Caretta caretta*)

Regional Managemen Units (RMUs)

Wallace et al. 2010. PlosONE 5(12)

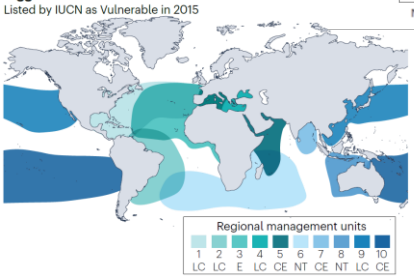


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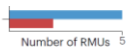
Status, trends and conservation of global sea turtle populations

Graeme C. Hays[1]✉, Jacques-Olivier Laloë[1] & Jeffrey A. Seminoff[2]

Loggerhead
Listed by IUCN as Vulnerable in 2015



Regional management units





MARINE CONSERVATION

Global sea turtle conservation successes

Antonios D. Mazaris,[1] Gail Schofield,[1,2] Chrysoula Gkazinou,[1] Vasiliki Almpanidou,[1] Graeme C. Hays[2]*

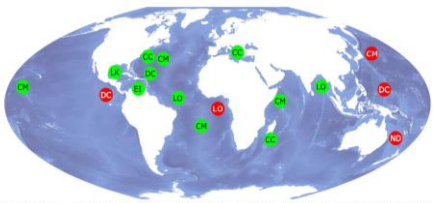


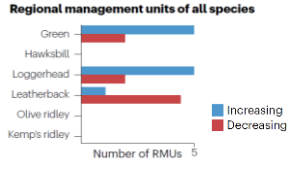
Fig. 2. Trends in the nesting abundance of sea turtles integrated within RMUs. Plot symbols reflect species, colors reflect upward (green) or downward (red) trends, and symbol size represents mean growth rate. CC, *C. caretta* (loggerhead turtle); CM, *C. mydas* (green turtle); DC, *D. coriacea* (leatherback sea turtle); EI, *E. imbricata* (hawksbill turtle); LK, *L. kempii* (Kemp's ridley); LO, *L. olivacea* (olive ridley); ND, *N. depressus* (flatback turtle).

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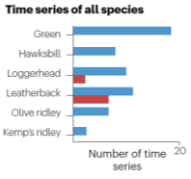
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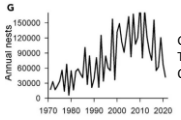
Graeme C. Hays[1]✉, Jacques-Olivier Laloë[1] & Jeffrey A. Seminoff[2]

Regional management units of all species

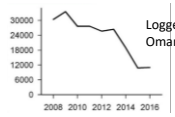


Time series of all species





Green turtles
Tortuguero,
Costa Rica



Loggerheads
Oman

CellPress
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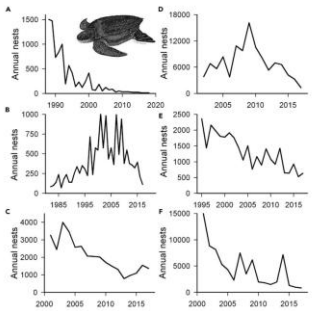
A pulse check for trends in sea turtle numbers across the globe

Graeme C. Hays,[1,4,*] Gail Schofield,[2] Maria Papazekou,[3] Anastasia Chatzimentor,[3] Stelios Katsanevakis,[3,4] and Antonios D. Mazaris[3]

Costa Rica, Pacific coast

St Croix, Caribbean US Virgin Islands

Indonesia western Pacific

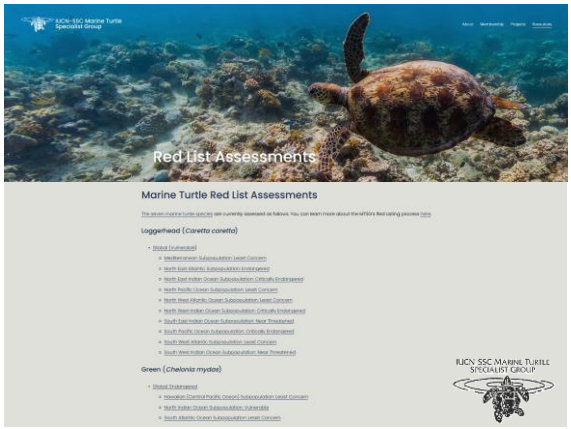


French Guiana Atlantic

Costa Rica Caribbean

Suriname Atlantic

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Published November 16

Marine turtle regional management units 2.0: an updated framework for conservation and research of wide-ranging megafauna species

Brian P. Wallace[1,2,*], Zachary A. Wendt[3,4], Brendan J. Hayes[5], Andrew D. Dittmeier[6], Ashleigh MacKinnon[7], Isabel Rodriguez[8,9], Sara M. Maxwell[10], Lucy Hiwot[11], Hannah Bruner[12], Michael D. Jensen[13,14], Erin LaCasella[15], Brian M. Shamblin[16], P. Alberto Abreu-Grobois[17], Ana Rebeca Alfaro-Shigueto[18,19], Rita Alkhoury[20], Ali Al-Kiyumi[21], Ibrahim Baidas[22], Ebrahim Baldawi[23], Thomas Barnett[24], Florence Bell-Lemire[25], Karen L. Bjorndal[26], Nancy N. Fietkiewicz[27], Marco Garcia Cruz[28,29], Graeme C. Hays[30], Gabriela Ketos[31], Cynthia J. Lagueux[32], Christine A. Madden Hof[33], Jeffrey A. Mangel[34], Jesús Alfonso Mariscal-Loza[35], Jeffrey A. Miller[36], Kelly R. Moncada[37], Andrea D. Phillott[38], Nicolas J. Pilcher[39], Nathan F. Putman[40], Evan R. Rees[41], Juan D. Rguez-Baron[42,43], Jeffrey A. Seminoff[44], Adhith Sivasundaram[45], Ogen Tackeyan[46], Sarah H. Vaeqer[47], Robin D. Vaeqer[48,49], Mihelle Vilaça[50], Scott D. Whiting[51], Brian A. Hutchinson[1], Paolo Casale[52], Andrew B. Shaw[1]