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COMMENTARY

Hawksbill sea turtles: can phylogenetics inform harvesting?

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In their recent articles, Mortimer *et al*. (2007) and Bowen *et al*. (2007) imply that historical declines in hawksbill sea turtle (*Eretmochelys imbricata*) populations in the Caribbean together with new phylogenetic data provide solid evidence that hawksbills cannot be harvested on a sustainable level. We suggest that broad inferences on the impacts of harvesting based on phylogenetic data alone are insufficient as an argument against sustainable use of sea turtles. Rather, we recommend that the merits of harvesting schemes should be assessed on a case-by-case basis, which should enable beneficial and sustainable projects to proceed and also discourage unsustainable ones.

As reported by Mortimer *et al*. (2007), recent data on mtDNA haplotype diversity show that rookeries and foraging areas in the Caribbean are connected, with juveniles moving across national boundaries from natal beaches to foraging grounds, and back again to natal beaches as adults (Bowen *et al*. 2007). Based on these associations, Bowen *et al*. (2007) suggest that 'harvest [of hawksbills] in the Caribbean foraging areas will deplete nesting populations across multiple jurisdictions', while Mortimer *et al*. (2007) state that any harvest on nesting beaches or feeding grounds could negatively impact hawksbill populations throughout the Caribbean region. We suggest that these claims are not necessarily true in all situations. A case in point is the current harvesting of hawksbills in Cuban waters (Carrillo *et al*. 1999) and the ongoing increase of the nearby nesting population of hawksbills in the Yucatán Peninsula (Garduño-Andrade *et al*. 1999). Published phylogenetic studies have reported that a significant source rookery for turtles harvested in Cuba is the Yucátan Peninsula (Díaz-Fernández *et al*. 1999; Bowen *et al*. 2007). A second example is the hawksbill rookery in Antigua. Phylogenetic data show that hawksbills from Antigua contribute significantly to foraging grounds in Cuba (Bass 1999; Díaz-Fernández *et al*. 1999; Bowen *et al*. 2007). And yet, numbers of nesting females in Antigua have been increasing over the last decade, despite the ongoing harvest of hawksbills in Cuba (Richardson *et al*. 2006a). Clearly, the situation regarding harvesting and its impacts on regional nesting populations is more complex than presented in Mortimer *et al*. (2007) and Bowen *et al*. (2007).

A primary principle of wildlife management is that a target population can be kept at a level below its carrying capacity, through harvesting or culling, without causing a decline in the population, due to density-dependent rates of growth (Getz & Haight 1989). That is to say, harvesting individuals in a population does not lead a priori to population decline. As has been suggested for at least one sea turtle population, there is an inverse relationship between rates of growth and turtle density (Bjorndal *et al*. 2000). Again, this suggests that harvest of juvenile or adult hawksbills may not cause population declines in source (rookery) populations in some cases. Indeed, harvest was followed by an increase in population density for some wild reptile populations (Velasco *et al*. 2003). Although the new phylogenetic data provided by Bowen *et al*. (2007) illuminate hawksbill migratory behaviour, they do not specifically inform us about sustainable levels of mortality of sea turtle populations. In the Caribbean, there are currently legal harvesting projects of hawksbills in several islands (e.g. Cuba, various islands in the UK Overseas Territories — see Richardson *et al*. 2006b, etc.). Simultaneously, there are nesting populations that are growing (see above). Rather than dismiss possible sustainable use out of hand based on phylogenetic data, we urge our colleagues to engage in active dialogue that considers the possibility of harvesting in specific cases where the harvesting is sustainable. We recognize that some hawksbill nesting populations are not growing, such as Costa Rica (Troëng *et al*. 2005) and Panama (Meylan & Donnelly 1999), the latter decline presumably caused by unsustainable rates of harvest of adult females. Nevertheless, in certain circumstances, sustainable use is an effective conservation technique, as exemplified by management schemes for some other endangered mammals, reptiles and marine species (e.g. Ross 1998; Foster & Vincent 2005; Leader-Williams *et al*. 2005).

A second aspect of the arguments against all harvesting of hawksbill turtles used by Mortimer *et al*. (2007) and

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Bowen *et al*. (2007) is this species' conservation classification as 'Critically Endangered.' The Red List status of the hawksbill has been the subject of much debate, including whether it meets the World Conservation Union (IUCN) criteria for 'Critically Endangered' (Meylan 1998; Mrosovsky 2000, 2003; S&PS 2001). Most of the arguments have focused on the rate and timing of historical declines of hawksbill populations (e.g. Meylan & Donnelly 1999; Mrosovsky 2003). Often overlooked in debates about classifications of species is that the Red List status, while policy relevant, is not policy prescriptive (Seminoff 2004). The conservation and management regimes designed for particular populations of specific species do not hinge on whether the species is listed as Threatened, Endangered, or even Critically Endangered. Although often presented as mutually exclusive ideas, sustainable use and protected species management can go hand in hand, and have been considered useful tools with seahorses, marine mammals, crocodilians, etc. (Harwood & Smith 2002; Webb 2002; Foster & Vincent 2005). Indeed, sustainable use is considered to be part of the principal IUCN strategy (IUCN 1980).

The IUCN Marine Turtle Specialist Group's Global Strategy for the Conservation of Marine Turtles (1995) identified the promotion of environmental sustainability as a priority issue in turtle conservation. Yet, there has been reluctance by sea turtle biologists, managers and conservationists to consider sustainable use as a potential conservation tool (Campbell 2002). Arguments against use have largely taken one of two forms: (i) that it is unnecessary because other nonconsumptive methods are at least as successful or more successful (e.g. Pritchard 2000; Troëng & Drews 2004); (ii) species such as the hawksbill cannot support consumptive take (e.g. Bowen & Bass 1997; Bowen *et al*. 2007). And yet, harvest of sea turtles and their eggs continue to this day in different parts of the world (e.g. Campbell 2003; Martin *et al*. 2005), and some of these programs are beneficial not only for turtles but also for the local human inhabitants (e.g. Campbell 1998). Although we do not suggest that all marine turtles everywhere should be subject to harvesting, we argue that some populations can support a managed harvest. We urge all our colleagues to move towards deeper discussions on all types of conservation methods including harvesting that benefit both sea turtles and local human populations.

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References

Bass AL (1999) Genetic analysis to elucidate the natural history and behavior of hawksbill turtles (*Eretmochelys imbricata*) in the wider Caribbean: a review and re-analysis. *Chelonian Conservation and Biology*, **3**, 195–199.

Bjorndal KA, Bolten AB, Chaloupka MY (2000) Green turtle somatic growth model: evidence for density dependence. *Ecological Applications*, **10**, 269–282.

Bowen BW, Bass AL (1997) Movement of hawksbill turtles: what scale is relevant to conservation and what scale is resolvable with mtDNA data? *Chelonian Conservation and Biology*, **2**, 440–442.

Bowen BW, Grant WS, Hillis-Starr Z *et al*. (2007) Mixed-stock analysis reveals the migrations of juvenile hawksbill turtles (*Eretmochelys imbricata*) in the Caribbean Sea. *Molecular Ecology*, **16**, 49–60.

Campbell LM (1998) Use them or lose them? Conservation and the consumptive use of marine turtles at Ostional, Costa Rica. *Environmental Conservation*, **25**, 305–319.

Campbell LM (2002) Science and sustainable use: views of marine turtle conservation experts. *Ecological Applications*, **12**, 1229–1246.

Campbell LM (2003) Contemporary culture, use, and conservation of sea turtles. In: *Biology of Sea Turtles*, Vol. II (eds Lutz PL, Musick JA, Wyneken J), pp. 307–338. CRC Press, Boca Raton, Florida.

Carrillo E, Webb GJW, Manolis SC (1999) Hawksbill turtles (*Eretmochelys imbricata*) in Cuba: an assessment of the historical harvest and its impacts. *Chelonian Conservation and Biology*, **3**, 264–280.

Díaz-Fernández R, Okayama T, Uchiyama T *et al*. (1999) Genetic sourcing for the hawksbill turtle, *Eretmochelys imbricata*, in the northern Caribbean region. *Chelonian Conservation and Biology*, **3**, 296–300.

Foster SJ, Vincent ACJ (2005) Enhancing sustainability of the international trade in seahorses with a single minimum size limit. *Conservation Biology*, **19**, 1044–1050.

Garduño-Andrade M, Guzmán V, Miranda E, Briseño-Dueñas R, Abreu-Grobois FA (1999) Increases in hawksbill turtle (*Eretmochelys imbricata*) nestings in the Yucatán Peninsula, Mexico, 1977–1996: data in support of successful conservation? *Chelonian Conservation and Biology*, **3**, 286–295.

Getz WM, Haight RG (1989) *Population Harvesting: Demographic Models of Fish, Forest and Animal Resources*. Princeton University Press, Princeton, New Jersey.

Harwood LA, Smith TG (2002) Whales of the Inuvialuit Settlement Region in Canada's Western Arctic: an overview and outlook. *Arctic*, **55**, 77–93.

International Union for the Conservation of Nature (IUCN) (1980) *The World Conservation Strategy*. IUCN, Gland, Switzerland.

Leader-Williams M, Milledge S, Adcock K *et al*. (2005) Trophy hunting of black rhino *Diceros bicornis*: proposals to ensure its future sustainability. *Journal of International Wildlife Law and Policy*, **8**, 1–11.

Marine Turtle Specialist Group (1995) *Global Strategy for the Conservation of Marine Turtles*. IUCN, Gland, Switzerland.

Martin CS, Jeffers J, Godley BJ (2005) The status of marine turtles in Montserrat (Eastern Caribbean). *Animal Biodiversity and Conservation*, **28**, 159–168.

Meylan A (1998) Hawksbill still endangered. *Nature*, **391**, 117.

Meylan AB, Donnelly M (1999) Status justification for listing the hawksbill turtle (*Eretmochelys imbricata*) as critically endangered on the 1996 IUCN Red List of Threatened Animals. *Chelonian Conservation and Biology*, **3**, 200–224.

Mortimer JA, Meylan PA, Donnelly M (2007) Whose turtles are they, anyway? *Molecular Ecology*, **16**, 17–18.

Mrosovsky N (2000) *Sustainable Use of Hawksbill Turtles: Contemporary Issues in Conservation*. Key Centre for Tropical Wildlife Management, Northern Territory University, Darwin, NT, Australia.

Mrosovsky N (2003) *Predicting Extinction: Fundamental Flaws in IUCN's Red List System, Exemplified by the Case of Sea Turtles*. Available at URL: http://members.seaturtle.org/mrosovsky.

Pritchard PCH (2000) A response to Nicholas Mrosovsky's Sustainable Use of Hawksbill Turtles: Contemporary Issues in Conservation. *Chelonian Conservation and Biology*, **3**, 761–767.

Richardson JI, Hall DB, Mason PA *et al*. (2006a) Eighteen years of saturation tagging data reveal a significant increase in nesting hawksbill sea turtles (*Eretmochelys imbricata*) on Long Island, Antigua. *Animal Conservation*, **9**, 302–307.

Richardson PB, Broderick AC, Campbell LM, Godley BJ, Ranger S (2006b) Marine turtle fisheries in the UK Overseas Territories of the Caribbean: domestic legislation and the requirements of multilateral agreements. *Journal of International Wildlife Law and Policy*, **9**, 223–246.

Ross JP (1998) *Crocodiles: Status Survey and Conservation Action Plan*, 2nd edn. IUCN/SSC Crocodile Specialist Group, IUCN, Gland, Switzerland and Cambridge, UK. Available at URL: www.flmnh.ufl.edu/natsci/herpetology/act-plan/plan1998a.htm.

Seminoff JA (2004) Sea turtles, Red Listing, and the need for regional assessments. *Marine Turtle Newsletter*, **106**, 4–6.

Standards and Petitions Subcommittee (S&PS) (2001) Red List petitions results. *Species*, **36**, 31–34.

Troëng S, Drews C (2004) *Money Talks: Economic Aspects of Marine Turtle Use and Conservation*. WWF-International, Gland, Switzerland.

Troëng S, Dutton PH, Evans D (2005) Migration of hawksbill turtles *Eretmochelys imbricata* from Tortuguero, Costa Rica. *Ecography*, **28**, 394–402.

Velasco A, Colomine G, De Sola R, Villarroel G (2003) Effects of sustained harvests on wild populations of caiman *Crocodilus crocodilus* in Venezuela. *Interciencia*, **28**, 544–548.

Webb GJW (2002) Conservation and sustainable use of wildlife: an evolving concept. *Pacific Conservation Biology*, **8**, 12–26.

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