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Series Editors: Umberto Albarella, Keith Dobney and Peter Rowley-Conwy

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# The Future from the Past

*Archaeozoology in wildlife conservation  
and heritage management*

Edited by

Roel C. G. M. Lauwerier and Ina Plug

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## 10. Marine Turtles of the Past: A Vision for the Future?

*Jack Frazier*

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*Marine turtles and humans have interacted for millennia: the evidence is abundant and diverse. Zooarchaeological remains from the Middle East date back over 7,000 years; there are also numerous records from the Americas and the Pacific. Relatively large numbers of remains have been recovered from several sites, and cultural modifications to bones and shell are not uncommon. In numerous cases interment of turtles seems to have had special cultural significance. Cultural manifestations of turtles are common in many cultures. Ancient historic records also show the diversity and antiquity of human-turtle interactions. Possibly, marine turtles provided a critical resource base for the development of certain human populations or institutions. Some workers suggest that prehistoric exploitation by humans decimated turtle populations. However, zooarchaeological information is generally inadequate to understand the ecology of human-turtle interactions. Protocols and methods for collecting, analysing, and reporting data need careful attention, as do some basic assumptions that frame zoological and zooarchaeological research. Only when zooarchaeological information is more robust and standardised will it be possible to make detailed interpretations on how past human-turtle interactions affected the reptiles, insights that are essential for guiding future human actions, to promote the long-term prosperity of both turtles and humans.*

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### **Introduction**

There are seven living species of marine turtles: loggerhead (*Caretta caretta*), green (*Chelonia mydas*), leatherback (*Dermochelys coriacea*), hawksbill (*Eretmochelys imbricata*), Kemp's ridley (*Lepidochelys kempii*), olive ridley (*Lepidochelys olivacea*), and Australian flatback (*Natator depressus*). These are remarkable animals from many standpoints. Evolutionarily their ancestors date back over 100 million years, to before the dinosaurs. Their natural history is complex in the extreme: during the course of a normal life cycle an individual marine turtle depends on both terrestrial environments (high beach), as well as on the open ocean and near shore environments. They are slow-maturing, taking a decade or more to reach reproductive maturity, and long-lived with the potential to live for more than half a century. Marine turtles lay over a hundred eggs in a single clutch, producing as many as a dozen clutches in a single season, and potentially nesting, usually every two or three years, for more than a decade. This results in a 'deceptive fecundity' in which a female turtle, producing thousands of eggs during her

lifetime, appears to be able to reproduce without limits (for general reviews see J. Miller 1997; Frazier 2001).

In addition, marine turtles are remarkable for social and political reasons. They are large, attractive, and charismatic, while at the same time they are valued traditionally in many societies for a wide variety of reasons: they even occupy a central role in many coastal cultures. Hence, these are 'flagship species', animals that can be used as symbols or icons, to raise public awareness about conservation issues and promote interest and action by resource users, the general public, and decision-makers (B. Miller *et al.* 1999). This is an invaluable attribute for biological conservation, because actions and initiatives taken in favour of marine turtles can have wider repercussions for a variety of environments and species. The purpose of this paper is to explore the relationship between zooarchaeology and marine turtle conservation, and to suggest both practical and theoretical considerations that could greatly improve the value of future studies. Based on a defensible understanding of past human-turtle interactions, zooarchaeology has the

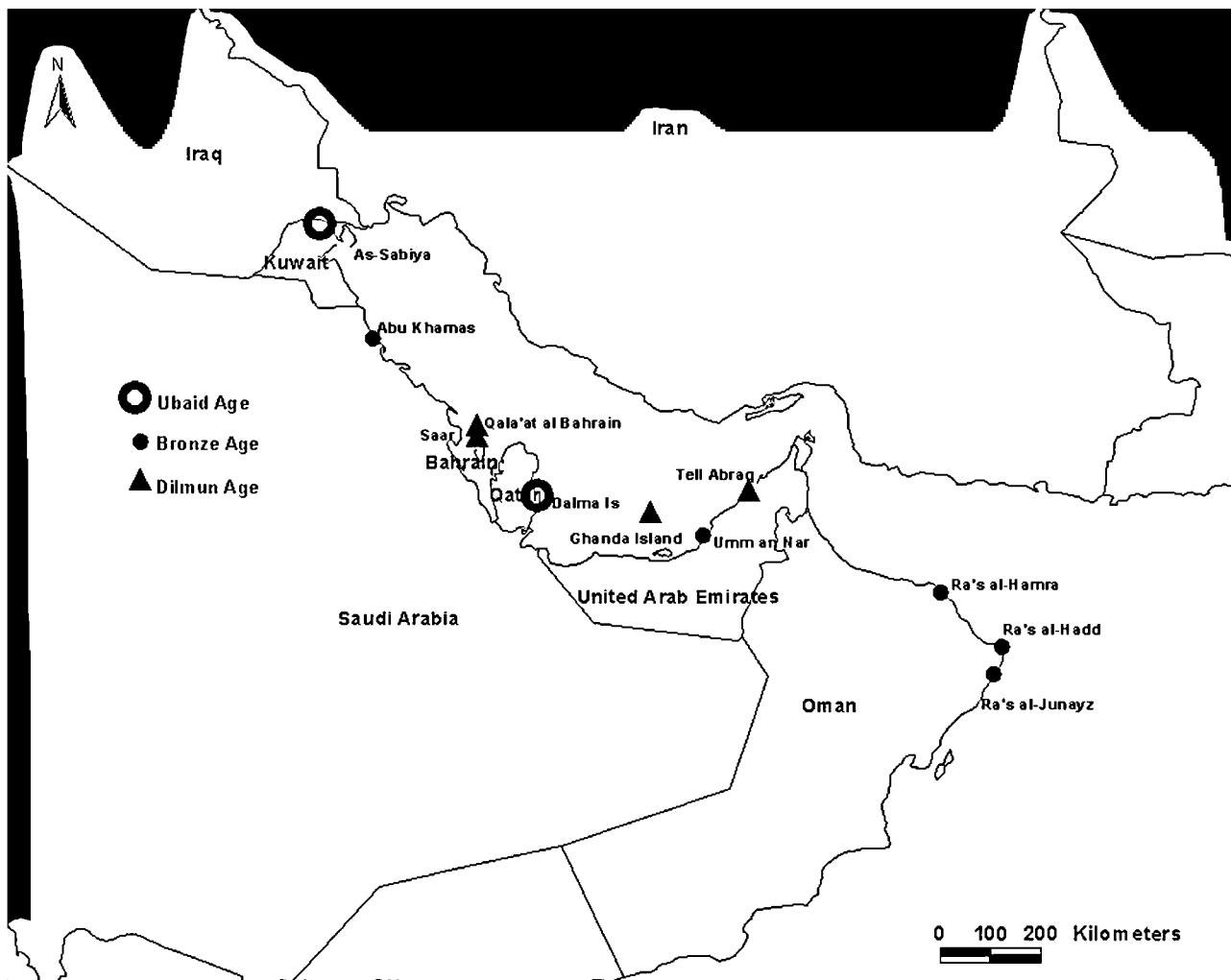


Fig. 1. Partial record of archaeological sites on the eastern shores of the Arabian Peninsula, from where marine turtle remains have been reported; Ubaid (5500–4000 BC), Bronze Age (after 4000 BC), and Dilmun (2150–1000 BC) are distinguished (summarised from data compiled in Frazier 2003, Table 1.1).

potential to provide unique insights into how future conservations initiatives could be most effective.

#### Zooarchaeological and Other Evidence

A preliminary survey of the literature shows that there is extensive zooarchaeological evidence for marine turtles in various parts of the world (see Frazier 2003 for details). The Middle East, particularly the western shores of the Arabian (or Persian) Gulf, has records from numerous sites (Fig. 1), including at least two Ubaid (5500–4000 BC), six Bronze Age (after 4000 BC; four of which involve large collections of turtle bones), and four Dilmun (2150–1000 BC; one of which involves a large collection of turtle bones). Additional records from the region include a Bronze Age site in Israel, and a 9th century AD site in the Comores (Frazier 2003). Zooarchaeological remains of marine turtles in the Americas are also numerous, with

more than 40 sites in south-eastern USA, more than 30 in the Caribbean (excluding Florida), and more than 13 sites in the Maya area (the Yucatán Peninsula and Belize). In contrast to the Arabian sites, very few of these New World sites date to before the Christian Era, and only about five out of the scores of sites have large collections (Fig. 2; Frazier 2003). There are additional sites in Brazil, Ecuador, Peru and Chile (Frazier and Bonavia 2000; in prep.). There are also scores of archaeological sites with marine turtles on Pacific islands (T. Hunt *in litt.* 4 December 2002; Frazier in prep.). The actual numbers and locations of archaeological sites with marine turtle remains in the above-mentioned regions are surely far more than what is described herein, or reported in the literature, and further investigation is certain to show wide and diverse occurrence of marine turtle remains in many tropical and subtropical coastal regions around the world.

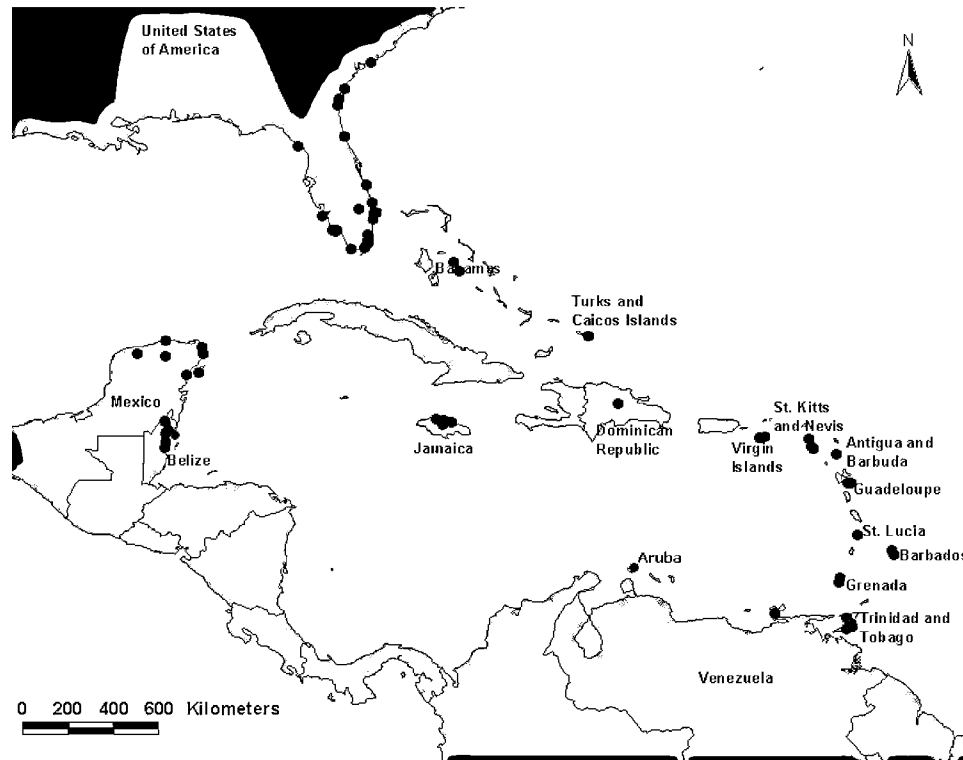


Fig. 2. Partial record of archaeological sites in the Caribbean basin, from where marine turtle remains have been reported (summarised from data compiled in Frazier 2003, Tables 1.2–1.4).

In addition to archaeological remains, there are diverse records of cultural artefacts representing marine turtles. In the Middle East these include Early Dilmun seals and engraved cylinders, particularly from Saar, Bahrain, as well as Mesopotamian stamps and wall reliefs, for example at Sennacherib's Palace at Nineveh and at Sargon's Palace at Khorsabad. Until recently, pearl-divers in the Gulf used nose clips made of tortoiseshell. (Nowadays the term 'tortoiseshell', or 'tortoise-shell' or 'tortoise shell', usually refers to the keratinous, or epidermal, scutes of the hawksbill sea turtle. Its shell is used as a raw material for various crafts. There is, however, evidence in ancient Classical Greek texts that the keratinous scutes of land tortoises [family Testudinidae], and perhaps even scutes from fresh water turtles [family Emydidae], were also used in certain crafts [see Casson 1989, 102, 168]).

Coins, ceramics, and statues from ancient Greece include depictions of marine turtles. Cultural artefacts from the Americas include a wide diversity of items, such as turtle effigies, masks, tortoiseshell pins, tortoiseshell fishhooks, and much more from the Caribbean, including ceramics. Between 100 BC and 400 AD tortoiseshell artefacts found their way into Hopewell sites, in the interior of North America, over 500 km from the nearest subtropical shores. Turtles were of great importance to the Maya, who represented these reptiles in diverse media, including ceramics, carved figurines, stone alters, stucco, parchment, limestone cliffs, and so on. The Mayan

representations take on central importance, including the rebirth of the all-important maize God through a turtle shell; the God *Pauhtun* (the sky-bearer or world-bearer) who wears a turtle shell; the constellation *ak ek'* seen as a great turtle in the sky; the *K'an* cross on the celestial turtle shell, which is interpreted as the precise site where creation began; earth platforms and central altars; the physical form of the *k'atun* wheel, representing a unique and central unit of time – 20 years; and singular architectural elements in the roofs of various sorts of buildings. While not all of these representations clearly depict marine turtles, some of them do. In South America marine turtles are represented in ceramics, petroglyphs, and other items (Frazier 2003).

A third line of evidence involves ancient historic accounts. Cuneiform tablets from the Late Uruk (3500–3000 BC) as well as from Ur III (2100–2000 BC) have information about turtles, possibly marine species.

Agatharchides of Cnidus, writing in 300 BC, clearly describes the hunting and use of marine turtles by different peoples, apparently in the southern Red Sea. One of the most impressive sources documenting the wide-ranging trade in marine turtles is the *Periplus Maris Erythrae*, written about 50 AD. This, and other sources, shows that a well-established network for international trade in tortoiseshell was highly organised and very active throughout the Indian Ocean by the beginning of the Christian Era. Additionally, there are diverse 10th century

AD accounts in both Arabic and Chinese, again showing the importance of tortoiseshell in international trade, from East Africa to China (Frazier 2003).

### The Implications of Past Human-turtle Interactions

Based on three lines of evidence: zooarchaeological remains, cultural artefacts, and ancient historic accounts, it is clear that marine turtles and humans have been interacting for many millennia. These reptiles have provided nutritional, economic, and spiritual sustenance to human societies around the globe, and in many coastal communities they are an important part of the cultural fabric. There is no doubt that human societies and cultures have been impacted by marine turtles. In some cases one is prompted to ask: Did marine turtles provide crucial resources for human survival? For instance, on remote shores of arid lands (such as the coast of the Arabian Peninsula), or remote islands (such as the Caribbean and Pacific), marine turtles could provide a bountiful and relatively long-lasting source of meat and oil (and possibly even emergency sources of fluids in times of dehydration), sufficient to sustain human populations that had limited resource bases: this could have made the difference between survival and starvation, and allowed certain human groups to pass through difficult times, to finally prosper. For example, there are accounts of Polynesian sailors being stranded on remote, uninhabited islands, and surviving by eating turtles (McCoy 1974, 210 fn 2).

Did marine turtles provide critical resources for the development of human institutions? Casson (1989, 17) explained that '[t]ortoise shell receives more mention in the *Periplus* than any other object of trade'; and there are numerous other accounts that show that marine turtles or their products were important commodities, as items of trade and exchange. Given the degree to which ancient trade networks had developed, and the vast distances over which these products - tortoiseshell in particular - were transported for commerce in the Indian Ocean as well as in North America, it is evident that marine turtles provided the raw materials on which certain human institutions were sustained, if not founded. Similar arguments could be offered regarding the massive exploitation of green turtles from ex-British colonies to supply markets in growing colonial centres as well as the motherland and elsewhere in the former empire (Jackson *et al.* 2001). Hence, although marine turtle products may no longer be significant as major items of international trade today, during prehistoric, ancient, and colonial times they may have supported the establishment of institutional precedents that continue to this day. Clearly, at different times and at different places marine turtles have enriched the human body and soul in many ways; it remains for archaeologists, historians, and economists to describe and evaluate these issues more fully. (The use of the term 'economist' is meant to refer to those specialists

who deal with economies in the broad sense of the word, not those who masquerade under this name with the pretence that the flow and accumulation of dollars, euros, gold, yen, and other currencies, is all there is to economy).

On the other side of the human-turtle interaction, and central to the topic of this paper, is the question of how marine turtles have been impacted by humans. It is well established that many turtle populations have been so intensely exploited that their populations have declined dramatically, or even disappeared (*e.g.* Pritchard and Plotkin 1995; TEWG 1998; Meylan and Donnelly 1999; Spotila *et al.* 2000; Seminoff 2002; Bolton and Witherington 2003). In a word, these animals have been subject to intense overexploitation, globally and historically: as with other living marine resources (*e.g.* Ganter, 1994; Jackson *et al.* 2001), there is a long history of marine turtle fisheries that have gone from boom to bust. In addition to direct exploitation, other human activities have also resulted in significant threats to marine turtles, such as habitat perturbation and degradation, pollution, and more recently, incidental capture by industrialised fisheries. As a result of the dramatic, worldwide declines in their populations, these animals are recognised under special conservation categories such as 'endangered', and 'critically endangered' (Hilton-Taylor 2000; S&PS 2001; the Australian Flatback is categorized as 'data deficient' in the IUCN Red List of Threatened Species); and as a consequence, marine turtles are provided legal protection by both national and international legislation (Frazier 2002).

In this arena, zooarchaeology offers singular tools for evaluating the question of how humans have affected marine turtles in the past, and from that vantage point, providing insights on how humans might conduct themselves in the future for the long-term prosperity of both people and turtles. By providing a clearer understanding of the past, zooarchaeology enhances our vision of the future; as Zayed bin Sultan al Nahyan explained: '[a] nation without a past has neither a present nor a future.' (DTA 198-)

### Basic Considerations for the Greatest Application of Zooarchaeological Information Toward Biological Conservation

For this approach to be most effective, it is essential to provide solid answers to a number of basic biological questions. As Reitz and Scarry (1985, 9) pointed out: '[t]he full potential of subsistence studies cannot be realized unless the processes by which biological materials enter the archaeological record and the effects of the methods employed to recover and study them are taken into account before excavation begins.' They, as well as Reitz and Wing (1999) and O'Connor (2002) devote substantial space to reviewing and explaining in considerable detail critical factors that must be taken into



consideration when designing, conducting, analysing, and reporting zooarchaeological investigations. 'Biases are unavoidable but should be the result of choice rather than chance.' (Reitz and Scarry 1985, 12); it is imperative to understand that '[d]eceptively simple decisions made in the field or laboratory affect all subsequent results.' (Reitz *et al.* 1996, 11).

These considerations follow the thoughtful reflections made by Gilmore, from more than a half century ago (1946; 1947), so in many ways there is nothing new about this discussion. However, despite the above-mentioned, and other valuable descriptions of the conceptual and procedural underpinnings of environmental archaeology, particularly zooarchaeology, a great amount of the zooarchaeological information on marine turtles is much less useful than it could be. Because these studies are potentially unique sources of information which could illuminate some pressing questions about biological conservation, it is necessary to discuss some of the major points that require careful consideration, in the hope that future studies will be able to provide information of enhanced value. The questions that follow are those of a biologist, eager to employ the zooarchaeological information as fully as possible, in an effort to have a clearer vision about the development, implementation, and evaluation of conservation activities.

What species were taken? Seven species of living marine turtle are recognised; all but one of them are hard-shelled turtles, in the taxonomic family Cheloniidae. The osteological specimens available to zooarchaeologists are frequently fragmented, small and extremely difficult – if at all possible – to identify to species (*e.g.* Carr 1989b; Uerpmann and Uerpmann 1994; Reitz *in litt.* 18 December 2002; pers. obs.). As a consequence, some authors have assumed a species identity on the basis of present-day geographic distributions (*e.g.* Hoch 1979; Kirch 1988; Bökönyi 1992; Mosseri-Marlio 1998; 2000). Although this may be an effective way to round out an account of what might have gone on in the past, an assumption about species identity is only a supposition, and there is a grave danger that in the retelling of an account about a site, the assumption will be transformed into an 'established truth'.

In fact, to be able to understand human impacts on marine turtles one needs to know not only the species, but also the population that is affected (known also as the 'stock' or 'management unit'); for it is a population – and not an entire species – that bears the direct effects of human exploitation and other environmental effects; and this biological entity must be evaluated against these 'selective pressures'. Clearly, it is difficult enough to determine species, much less populations, from archaeological specimens, but it is fundamental that zooarchaeologists be aware of the kind of basic information needed by biologists to enable them to realistically evaluate how certain animal populations have responded to certain types of human actions. This is true whether the

anthropogenic impacts are through direct exploitation or through indirect effects, such as habitat perturbation, food chain modification, impacts on predators, and so on.

Molecular genetics – ancient DNA analysis – could be used to help in the species identification of troublesome specimens, and perhaps one day even to illuminate populations of origin for zooarchaeological specimens of marine turtles (*e.g.* see Pennisi 2002). Isotope ratios of common elements in food (particularly carbon and nitrogen) might also be useful in helping to determine not only the relative contributions of terrestrial and marine foods in prehistoric diets (*e.g.* Keegan and Deniro 1988), but possibly also populations/areas of origin for certain items in archaeological diets, such as marine turtles. However, these are not techniques that have been tested and proven for these questions, and a substantial amount of development and verification will be required before they can be put into practice with reliable results.

In this light, there are other basic questions that biologists will press for. What individuals were 'captured'? To understand the dynamics of how populations are impacted by humans it is important to know what segment(s) of the population were most affected: for example, was exploitation focused on the young, the old, the reproductively active, males, females, or feeding animals? Information on the size-classes and/or age classes, sex, reproductive condition, and physical condition of the individuals found in the archaeological remains is critical in this respect. It is also essential to be able to determine if zooarchaeological specimens derive from animals actually captured and killed by humans, for turtles can die from other causes and their parts can be opportunistically scavenged by people for a variety of reasons, and then deposited in archaeological sites. Clearly, the relationship between humans and turtles is very different if the people are not actually capturing the animals directly, but simply taking advantage of some other predator or phenomenon. Hence, some evidence – physical or cultural – of a capture technology, or better even, the effect of a capture tool (such as physical damage resulting from a hunting implement, or even the remains of such an implement) together with the zooarchaeological specimen would be ideal. For example, it was suggested that round holes in carapace bones from Coraile, Grand Turk, Turks and Caicos (Bahamas Archipelago, about 8th century AD), were made by harpoons (Carlson, 1999).

In effect, two sequels to the last question are: What capture methods were used? Under what conditions were the animals taken? The answers to these last questions may lie more in the field of cultural anthropology than zooarchaeology, but a thorough analysis of zooarchaeological material should contemplate issues of capture and butchery techniques and implements.

Straight-forward morphometric data may be invaluable in helping to answer these questions. Marine turtle remains at Coraile, Grand Turk, were not only identified to species, but also to size-class, and it was shown that

85% of the remains were from animals smaller than adult size. Indeed, remains from two animals of hatchling size were also recovered (Carlson 1999, 128), and remains of hatchlings were also reported from a late Prehistoric Lucayan site on Middle Caicos Island (O'Day 2002a). Bones smaller than adult size indicate that the animals were captured at sea, for today only nesting females crawl out onto beaches in the Caribbean. The presence of hatchling remains is evidence that eggs were taken, evidently from nesting beaches in the vicinity of the respective site. At Paradise Point, Jamaica, remains of both adult size and smaller were recovered, and together with a specimen identified as an adult male because of the large pollex claw, this was again evidence for at least some turtles being captured at sea (O'Day 2001).

What transport methods were involved? Any careful evaluation of zooarchaeological materials should include a cautionary note explaining that what can be reported is what can be found and identified: that no evidence is not negative evidence. One major challenge when investigating the remains of animals of large body size (like marine turtles) is the '*schlepp effect*' – that is, 'the larger the animal and the farther from the point of consumption it is killed, the fewer of its bones will get "schlepped" back to camp, village, or other area' (Daly 1969, 149). Moreover, one animal might be divided and shared between various people, and the remains deposited in a variety of locations. Hence, an archaeological sample most likely does not represent what was captured and utilized, but rather what was transported and deposited into a certain site. Such a sample could have little direct relevance to what was actually captured; and the zooarchaeological sample would be an unreliable measure of human impact on the prey population.

Evaluating the question of transport practices requires information from a variety of sources, particularly anatomical aspects of the prey species, cultural aspects of the society in question, and especially the means to compare between different sites. For example, Carr (1989a, b) studied some 4,000 osteological remains from Isla Cerritos, a Maya site off the north coast of Yucatán that had a peak in human population coinciding with the height of development at Chichén Itzá, approximately 900–1200 AD. At the island there were large numbers of fish bones, including cranial elements, but although marine fish bones occurred at the large inland ceremonial site, cranial elements were nearly absent. This led her to suggest that Isla Cerritos served as a fish-exporting site. Because there were also large numbers of marine turtle bones at the Island, but virtually none at Chichén Itzá, it was also proposed that marine turtle meat, without bones, was transported from the Island to the Chichén Itzá. Likewise, Saar, a Dilmun (2150–1900 BC) settlement, has remarkably few marine turtle bones, while at the contemporaneous site of Qala'at al Bahrain, only about 7 km to the northeast but on the coast, marine turtle bones are common. This led Uerpmann and Uerpmann (1999,

639) to suggest that the turtles were slaughtered on the coast and just the meat was taken inland to Saar. In a similar light, a predominance of forelimb bones at Paradise Point, Jamaica, led to a suggestion that the hind limbs were less desirable, and hence they were not utilized (O'Day 2001).

On the other hand, 'pushing' the data too far can result in conclusions that are untenable. For example, it is rare to find cranial material of marine turtles in archaeological deposits; in her detailed evaluation of tens of thousands of green turtle bones, Carlson (1999, Table 8) found a great paucity of skull bones. This phenomenon has led at least three archaeologists (Versteeg and Effert, 1987, 11, 18; Carr 1989b, 10; Mosseri-Marlio 2000, 33) to propose that these reptiles were decapitated by prehistoric peoples. However, in contemporary times, even with iron knives, this practice is rare at best, probably because of the size and strength of the cervical vertebrae. Although Rolett (1986, 85) claims that green turtles were beheaded for some Polynesian ceremonies, there is little evidence for this practice in contemporary or historic societies. Hence, although decapitation may seem like a perfectly logical explanation for the lack of cranial elements in archaeological remains, it is not consistent with what is known of most contemporary practices or the anatomy of the animals; and this attempt to use a preparation/transport practice to explain incomplete anatomical material may be inappropriate. Another, contrary, example comes from El Meco, a Maya site north of Cancún, Mexico, where it was suggested that crania of marine turtles were used as containers (Andrews 1986, 69); there is no evidence, either cultural or historic, for this, not to mention that the cranium of a marine turtle is unsuited to serve as a vessel or container.

These problems of 'cultural filters' have greatly complicated the advance of zooarchaeological research (Reitz and Wing 1999, 6). In this respect, cultural anthropology can provide valuable insights by documenting how contemporary societies obtain, prepare, distribute, and transport turtle products (*e.g.* Nietschmann 1973; 1979; McCoy 1974, 211–214; O'Dea 1991, 238; Bliege Bird and Bird 1997; Bliege Bird *et al.* 2001), how they regulate the exploitation of turtles and their eggs (*e.g.* McCoy 1974; Johannes 1978, 352, 354; 1981; Zann 1985, 66, 69, 70; Rolett 1986, 86), and how they dispose of the remains (*e.g.* Rolett 1986, 85). For example, some authors claim that a mechanistic, optimum foraging strategy can be used to explain prehistoric hunting activities (*e.g.* Kay and Simmons 2002a), but studies of contemporary societies clearly show that human beings are much more complex, and the objective of hunting may not always be to maximise immediate protein and food procurement rates, but rather to gain prestige and social status. These considerations, that are distinctly 'cultural' and inconsistent with mechanistic explanations (Bliege Bird and Bird 1997; Bliege Bird *et al.* 2001), would be 'invisible' to the archaeological record.

What was the rate of exploitation? What is at the foundation of many of the above questions is an attempt to estimate, with some form of standardised units, the degree to which humans impacted the animal populations with which they were interacting. Ideally one would like to have some idea of what proportion of a respective population segment was exploited and how intense in time and space this extraction was. For example, what proportion of nesting females were slaughtered each nesting season. Clearly, this is a tall order even for contemporary conditions, and zooarchaeology has limited means to estimate rates of exploitation, at least with the current techniques available. However, it is a goal that zooarchaeologists must work toward if their results are going to have the greatest relevance to biological conservation. In the end, the question that the conservationist is groping with is: What effect did prehistoric capture and environmental modification have on past populations of turtles?

At least four Pacific island sites have been reported to have had reductions in abundance of marine turtle remains, occurring shortly after prehistoric colonisation: Tahuata, Marquesas; Tikopia, Solomon Islands; Niuaotupapu and Tongatapu, Tonga (Kirch and Yen, 1982; Kirch, 1988; Burley *et al.*, 2001; Woodrom-Luna *in press*; Steadman *in litt.* 28 Jan. 2003). Kirch and Yen (1982) and Kirch (1988) argue repeatedly that marine turtles, together with molluscs, fishes and marine birds, were depleted at Tikopia and Niuaotupapu, as well as at other Pacific islands, after the first wave of human colonisation. Although this resource depletion has been shown with other marine animals in the region (*e.g.* Spennemann, 1987; Smith 1989), and there is abundant evidence that the terrestrial faunas of numerous Pacific islands were depleted shortly after prehistoric human colonization (Steadman *et al.*, 2002 and references therein), the data for marine turtles generally do not enable an unequivocal interpretation of overexploitation. For example, Weisler (2001, 124, 126, 127, 130) concluded that over a millennium of human impacts on Utrök Atoll, Marshall Islands, had 'little noticeable impact on the marine ecosystem' with no evidence of a decline in turtle remains.

At least two authors have contended that there was overkill of marine turtles during prehistoric times along the eastern shores of the Arabian Peninsula, with resulting extirpation of local populations (Hoch 1979; 1995; Mosseri-Marlio 2000). Hoch (1995, 250) even argued that the local nesting population of turtles at Umm an-Nar, a site on a small island off the coast of Abu Dhabi that is estimated to date back as late as 2700 BC, may have been overexploited, resulting in 'a decline in health and prosperity for man, then a collapse of town life with the abandonment of the island as a consequence'. Because even species identifications for the turtles at these sites are uncertain, more elaborate conclusions about population declines are not easily sustained by the data.

Two sites at Tobago, one preceramic and one ceramic, both had significant numbers of marine turtle bones, but species identifications were not made, so little could be concluded about trends (Steadman and Stokes, 2002; Steadman, *in litt.* 28 Jan. 2003). Convincing cases of change in prehistoric availability and/or use of marine turtles were made at Coralie, Grand Turk, (Carlson 1999) and also for two neighbouring sites at Paradise Point, Jamaica (O'Day 2001). It was concluded that 'the vast majority of meat consumed at [Grand Turk] was from sea turtle', and *Chelonia mydas* was the 'primary faunal deposit in the site' (Carlson 1999, 59). Remarkably, the earliest sites at Coralie provided both the largest individuals and relatively more turtle remains; over the period 700 to 1100 AD there was a decline in the proportion of minimum number of individuals (MNI) that were marine turtles. Moreover, the recovery of hatchling-sized bones from a site that has no historic records of nesting turtles indicates that there was a nesting beach there during prehistoric times (Carlson 1999, 128, 129, 140, 141). On Jamaica, the earlier, Ostionan site (about 850 AD) was only about 250 m from a later Meillacan site (about 1430 AD). Remains of both *Caretta caretta* and *Chelonia mydas* were identified at the Ostionan site, and there was evidence of burning and butchery on other turtle remains that were not identified to species. Although marine turtle remains contributed the largest portion of vertebrate NISP (number of identified specimens per taxon) at the Ostionan site, there was no evidence for them at the Meillacan site (O'Day 2001). While the reasons for the differences in turtle remains, abundance at earlier sites and absence or reduced abundance at the later sites, is unknown, the unmistakable differences indicate a clear change in human-turtle interactions; and the likely explanation is that the resource was less accessible as it became depleted.

Changes over time in presence-absence or relative abundance of a species' remains are direct indications of population changes in prey animals. However, other parameters may be equally valuable, such as trends in size composition of individual animals. For example, body size of spur-thighed tortoises (*Testudo graeca*) around the Mediterranean (Israel and Italy) was shown to have decreased in the Middle and Upper Paleolithic, and this was interpreted to be the tortoises' demographic response to intensified predation by Paleolithic human bands (Stiner *et al.* 1999; 2000). Trends in shell size of Pacific molluscs show clear declines over time (Spennemann 1987). But, adequate data are rarely available to make such interpretations, and it is essential that factors other than direct human predation, such as cultural filters and environmental change, be carefully considered. Ideally, one would like a relatively long series of well-dated sites, each analysed with procedures that allow rigorous comparisons between sites (see below) as well as an analysis of diverse faunal elements – large and small – to show comparable – or contrasting – trends in more than one species.

Additional evidence linking the trends in zooarchaeological remains to subsequent changes in the human populations also helps to strengthen the case.

The issue of species identification is not trivial. In many cases, turtle remains are too fragmentary to allow for unequivocal identification of species based on morphological comparisons; and in these cases the lowest taxon recognizable is genus or even family (*e.g.* O'Day 2001; Reitz and Sandweiss 2001; Wing 2001a; 2001b). Comparisons of a taxon's representation over time and space assume that the species composition of that taxon remains constant. If this assumption is unfounded, then trends established by the comparisons will be indefensible. For example, if genus 'X' comprises species 'A', 'B', and 'C', the fact that the value for 'X' increases does not mean that 'A', 'B', and 'C' have all increased by the same proportion. Indeed, the increase in 'X' could be produced by an extraordinary increase in 'A', while 'B' and 'C' both decreased. In the latter case, a trend in 'X' would have to be interpreted with great care.

Wing (2001a, 2001b) used estimates of body size, minimum number of individuals, biomass contribution, and trophic level of animals' remains to evaluate relative abundance and dietary importance of different potential prey species from various Caribbean sites. She reported (2001a, tables 5–12; 2001b, tables 4–12) that the relative contribution of marine turtle (Cheloniidae) biomass in prehistoric diets declined markedly over time in two of the five sites that had data for making comparisons. This was consistent with her findings for other marine species for which there was much more data, particularly fishes, leading to an interpretation that non-industrial, indigenous peoples made serious impacts on the animal populations that they exploited, essentially 'fishing down the food web', a trend in taking relatively fewer select species (*e.g.* top predators) and relatively more lower trophic level species (*e.g.* herbivores), a phenomenon which has been described for modern fisheries (Pauley *et al.* 1998). Wing's findings are a clear indication of overfishing, and non-sustainable use of marine resources in preColumbian populations: yet, they are not unequivocal. The trend for marine turtles was not consistent for all sites, and the taxon being compared was the family Cheloniidae – which today comprises three species that frequent Caribbean islands, so while one species may have decreased, another could have increased. This is not to mention the unanswered questions about whether transport practices, and other cultural factors, were comparable between sites and different times. Hence, the results can only be interpreted as an indication of changes in population sizes.

### **Basic Considerations for More Robust Zooarchaeological Data**

Despite the limitations of zooarchaeological techniques

and information that are presently available, several general points can be addressed immediately with the techniques that are now at hand; and these can greatly enhance the value of zooarchaeological data and interpretations. As mentioned above, the following points have been amply discussed by leaders in the field for decades (*e.g.* Gilmore 1946; 1947; Reitz and Scarry 1985; Reitz and Wing 1999; O'Connor 2000), but because unnecessary lacunae continue to appear, it seems that the arguments need to be repeated.

First and foremost is the issue of sampling (or specimen recovery). Sampling techniques need to be carefully documented in the very least, and ideally they should be standardised. The issue of varying mesh sizes, with consequent obstacles in comparing samples from different studies that were sieved under different conditions, has been pointed out for decades: recently, Wing (2001, 115) lamented the 'lingering tradition for recovery of faunal remains with coarse (1/4 inch) gauge screen sieves.' While marine turtle bones are large, generally robust, relatively easily identifiable at least at the family level (although in some cases it may only be possible to reach the level of order [O'Day 2001; 2002a]), and they may be adequately collected by hand, without sieving, the relative importance of turtle remains cannot be correctly understood if the overall collection of zooarchaeological materials is missing the smaller bones of other species. There are limited comparisons that can be made between bones that were picked through manually with those that were extracted by sieving (*e.g.* Reitz and Scarry 1985, 12; Reitz and Wing 1999; Reitz and Sandweiss 2001, 1087). Moreover, if only large screen sizes are used, then entire categories of smaller specimens will probably be undetected (*e.g.* O'Day 2002b, 299). In some cases there is confusion about the numbers of marine turtle specimens identified from the same field study, and as there is no clarity about the sampling method used, the data have little comparative value (O'Day 2002a, 9).

Even more basic is the question of the number of sites sampled. Keegan and DeNiro (1988, 238) drew attention to the fact that there was no evidence of marine turtles from the Bahamas, suggesting that this was because of inadequate sampling. And, indeed, a decade later Carlson (1999) was able to show that at Coraile, Grand Turk, there were abundant remains, and that marine turtles were in fact the 'primary faunal deposit.'

It is also necessary to explain the amount of substrate that was sampled for each different site and strata, so that the results can be compared not only within the site, but also between different sites, studies and authors. Some authors have deliberately avoided complex statistical analysis of faunal data (*e.g.* Kirch 1988, 219) because the results can be heavily influenced by differences in sample size between sites (Grayson 1984; Reitz and Wing 1999).

Details of the 'microgeography', or context, of sampled sites need to be explained, for certain cultural and environmental contexts are likely to affect the quantity

and quality of bone deposited, as well as to provide the archaeologist with insights on how to interpret the deposit. Unfortunately, few reports of marine turtle remains provide these basic data, leaving it impossible to make quantitative comparisons between different studies.

Another problem comes from general collecting and cataloguing procedures. If animal bones show signs of cultural modification (burns, cut marks, reshaping, holes, etc.) they may well be catalogued by field staff as cultural materials, and not included in any list of zooarchaeological specimens (Wing *in litt.* 28 January 2002). Worse yet is when field staff make arbitrary decisions about which zooarchaeological specimens should be collected, or catalogued, and which should be discarded. In some cases, the large and bulky osteological specimens – despite their unique importance – were simply not shipped back after excavation (Uerpmann and Uerpmann *in prep.*). There is a great need for zooarchaeologists to educate cultural archaeologists and other co-workers about the basic needs of zooarchaeological research – and the benefits it can provide overall to an archaeological study. Reitz and Scarry (1985, 2–25), Reitz and Wing (1999, Appendix 3), and O'Connor (2000) have provided excellent advice, in clear and simple terms.

Although many zooarchaeologists are aware of the needs to understand what taphonomic processes have affected their study materials, there is very little information directly relevant to many species, and in the specific case of marine turtles what there is (Meyer 1991), is of limited relevance for archaeological work. Clearly, several considerations about the conditions under which turtle remains were deposited are of obvious relevance. Were they on the surface or interred; in/on sandy beach (*i.e.* in basic conditions) or in/on humus-laden soil (*i.e.* in acidic conditions); *etc.*? In addition, the way the carcass was treated before being deposited in an archaeological site will affect what is available for the zooarchaeologist. Basic questions include if it was butchered and then cooked or cooked whole with little if any dismemberment; were just soft tissues utilised as food or were bones (and keratinous shell) used for some cultural/technical purpose; was the catch used only locally or used in a trade/exchange system? To date, the relatively poor quality of marine turtle specimens have made answers to these basic questions difficult, if not impossible, to provide.

Reporting procedures are no less important than the methods used in sampling, data collection, and analysis. A large amount of information on marine turtle remains is available only in unpublished, preliminary reports, often obtainable exclusively through the kindness of the head archaeologist of the relevant project; indeed, this is a general problem for archaeological studies in general (Kirch 1988, viii). Even when it is published in more widely available literature, the information may be so abbreviated that it is close to impossible to understand basic points, such as where the specimens were in relation to different strata, and their relative ages; how the

#### **Standardised basic data for zooarchaeological reports**

Names of excavator(s), cataloguer(s), restorer(s), and project director(s)  
 Addresses of key contacts  
 Date of excavation and/or find  
 Site name, country, province/state/department, Municipality, distance from nearest town  
 Latitude, longitude, elevation  
 Substrate type  
 Depth of find  
 Contemporary environmental context  
 Cultural context  
 Key associated pieces in same strata  
 Culture of site  
 Date estimates  
 Basis and materials for date estimates

Area of substrate sampled  
 Volume of substrate sampled  
 Mesh sizes employed  
 Quantity of substrate separated by flotation

Where specimens are deposited

*Fig. 3. Suggestions for standardised basic data for zooarchaeological reports.*

specimens were identified to species; how conclusions on biological interpretations (*e.g.* size-class and other physical conditions) were derived; how conclusions on cultural interpretations (*e.g.* various forms of cultural modification, capture and transport practices) were derived; where the specimens have been deposited in case there is a need for subsequent re-examination; and even basics of the sampling and cataloguing procedures used in the study are routinely absent from reports (*e.g.* Byrd 1996). In some cases authors have been discouraged or even prevented from presenting detailed data, as editors and publishers look for ways to cut publication costs (Hamlin *pers. com.*). Some specialists have been very outspoken when evaluating the shortcomings of studies in this field: Moorey (1994, iv) minced no words when he concluded that ‘many references are either misleading or so imprecise as to be merely irritating’.

Clearly, the value of data – and particularly the ability to defend interpretations – will be dependent on the robustness of the conceptual and procedural aspects on which they were based, and it should not be the readers’ responsibility to guess at these, or have to make exhaustive research and enquiries to obtain basic information on the conditions of the study. To facilitate the reporting of fundamental information it would be useful to develop a list of basic values and parameters that must be reported, together with a standardised order and reporting procedure (*i.e.* a standard protocol for reporting basic information for every site and study resulting from that site, see Fig. 3 for a preliminary example).

Zooarchaeologists have obvious needs to interact effectively with various disciplines, including archaeologists, anatomists, anthropologists, biologists, chemists, cultural anthropologists, ecologists, geologists, ocean-

ographers, palaeontologists, and sedimentologists, among others (Reitz *et al.* 1996; Reitz and Wing 1999; O'Connor 2000). It is therefore essential that their work be easily 'translated' between disciplines: in other words the technical jargon should be kept to a minimum and always carefully defined. (This is not to mention the diverse conceptual, terminological, and other barriers that have come to exist in the various sub-disciplines of environmental archaeology [Bailey *et al.* 2000a]). At the same time, there is a need to be realistic about the limits and capabilities of different disciplines, and their respective practitioners. As Morrey (1994, 18) so candidly explained: '[a]t first archaeologists tended to expect miracles from natural scientists, with consequent frustration and irritation when expectations were rarely, if ever, satisfied.'

### **The Pristine Myth, 'Wild' Animals, and the Implications of Humans As Agents of Environmental Change**

Beyond these procedural matters is an issue of considerable theoretical enormity. So far, the understanding of human impacts on marine turtles has been focused on overexploitation and population declines. We need to question seriously if human effects on these animals have gone beyond these well-known problems, and been much more profound. Have humans affected the biology of marine turtles? Have millennia of human exploitation on nesting turtles, feeding turtles, nests, and other life phases – as well as perturbations to their terrestrial and marine habitats and the organisms that live in them – resulted in changes to the biology of the reptiles? It does not take much to imagine that the turtles that have survived countless generations of anthropogenic mortality and environmental modification have adapted to humans. Mating behaviour, nesting behaviour, and sunning behaviour are obvious candidates for human-induced changes, for these are activities that put marine turtles at extraordinary risk before human hunters. Changes in behaviour may in turn provoke changes in other aspects of the biology of the animals, such as reproductive physiology, digestive physiology, and perhaps even morphology, colouration, and migratory habits. As a result, characteristics other than behavioural traits may have been affected by humans, for example through selective predation on turtles of a certain size or colouration, or on turtles in a certain habitat, or during a certain season. In this light, there is accumulating evidence that in only a few decades modern fisheries have significantly diminished the genetic diversity of several stocks of marine fishes, even though there are millions of individuals in the respective populations (Hauser *et al.* 2002). Clearly, if such large populations can be subjected to genetic effects in such a relatively short period of time, a wide variety of phenotypic modifications are possible for animals subjected to millennia of impacts by humans.

A broader sequel to this question would be: Is zoological study deceived by the 'pristine myth'? In other words, is research on 'wild' animals in 'natural environments' part of a convenient myth, constructed by western scientists? In the main, biologists have been trained to remove *Homo sapiens* from the equation and deal with 'natural' systems, typically understood as being free from impacts by humans. In the present context it is important to appreciate that as a consequence, zooarchaeologists follow the same line of reasoning, at least when interpreting 'wild' animals in 'natural' environments. Would it not be more realistic, objective, and honest if zoological and ecological questions were viewed through the lens of millennia of selective pressures, direct and indirect, caused by *Homo sapiens* on countless species and environments? There is tremendous evidence from many disciplines that the romantic concept of pristine environments, unaffected by people – at least until European technologies arrived, is but a myth. The breadth and depth of impacts that humans have had on diverse species and environments are truly tremendous (*e.g.* Lewis 1980; Hughes 1985, 302 ff., Diamond 1986; Kirch 1988; Chapman *et al.* 1989; Bowden 1992; Denevan 1992; 1996; Turner and Butzer 1992; Wilson 1992; McDonnell and Pickett 1993; Edwards *et al.* 1994; Flannery 1994; Kay 1995; Hames 1996; Hunter 1996; G. H. Miller *et al.* 1999; Bailey *et al.* 2000b; Endfield *et al.*, 2000; Nicholson and O'Connor 2000; Kay and Simmons 2002b). Even while this recognition has grown for terrestrial species and environments, it has not been until relatively recently that there has been a wider recognition that marine species are subject to extinction (*e.g.* Roberts and Hawkins 1999) and that coastal marine environments are far from 'pristine' (*e.g.* Jackson 2001; Jackson *et al.* 2001). In summarising the 'dynamic environment' at Niuaotupapu in Polynesia, Kirch (1988, 247, 250) concluded that 'there is little that could be said to represent a 'natural' environment'; 'we now recognize that entire island ecosystems must be understood as the consequences of human actions.'

In some cases the myth of pristine environments has been constructed for more than emotional reasons, for it has been a convenient means of obtaining 'legal' access to vast areas and resources. Perhaps without consciously, or carefully, evaluating the issue, many ecologists, field biologists, and conservation biologists – not to mention zooarchaeologists – have relied on, and supported, certain fundamental elements of the pristine myth. (On the other hand, there are those who, aware that significant human impacts on the environment are prehistoric, advocate for setting conservation benchmarks 'without human influence' [Hunter 1996], a goal that seems naïve at best.)

Moreover, few practitioners seem to appreciate, or admit – much less talk openly about – the fact that scientific concepts and underlying assumptions are constructed by societies, and modern science is permeated with politics. Science and its constructs are not the exclusive property of deities (*e.g.* Nader 1996; Demeritt

2001; Schneider 2001). 'Science is a human invention and a cultural artifact' (Caldwell, 1992, 5).

In this respect it is useful to consider the implications of O'Connor's (1997) critique of archaeology's much-used, and disputed, term 'domestication'. As he points out, not only is the term used to describe a wide variety of different types of relationships between humans and other animal species, but it is often assumed to represent a phenomenon unique to *Homo sapiens*, and to have come about because of human ingenuity and intelligence. However, the many different types of inter-species relationships to which the term 'domestication' (or 'domestic') is routinely applied (e.g. alpaca-human, bee-human, camel-human, cat-human; cow-human, dog-human, elephant-human, goat/sheep-human, guinea pig-human, horse-human, llama-human, pigeon-human, sparrow-human) renders the term ambiguous, and of little analytical use. Moreover, many types of the same inter-species relationships as those involving people and other animal species are not unique to humans, and do not depend on some socio-economic attribute of humans, nor is the process of domestication necessarily one-sided, and solely of human initiation. Inter-species relationships, including those that involve *Homo sapiens*, include variations from mutualism (where there is benefit to both species for associating with each other) to competition (where there is a mutual detriment in the association). Diverse types of inter-species associations that might have been the precursors to the conventional notion of 'domestication' are widespread in the animal kingdom. Hence 'domestication' is more accurately envisaged as a form of behavioural co-evolution. When referring to interactions between humans with other animals, some authors have suggested using 'animal husbandry' as it is more flexible. In the end, O'Connor makes a case for avoiding the extreme terms of 'domestic' and 'wild' and the artificial dichotomy that they establish.

Put another way, and considering the effects that millennia of human interactions have had on marine turtles, together with countless other species that are conventionally considered to be 'wild', one could ask: Are these animals in the process of being 'domesticated'? Certainly, their population statuses, demography, and life histories have been substantially modified by humans. More broadly, the question could be: Given the diversity, intensity, and extent of human impacts on this planet, is 'domestication' the norm, and not the exception? For example, Carr (1996) explores the question of whether or not deer were 'managed' by Precolombian Maya, providing suggestions of how zooarchaeologists might evaluate the evidence.

For both scientific curiosity and conservation pragmatism, it would be invaluable to be able to design research to test these questions. However, as Broughton (2002, 68–70) explained, there is no single 'original state of nature' or benchmark for which modern conservationists can set clear targets for biological conservation. The environment

– despite the constant hype from the sustainable development and sustainable use bandwagons – is in constant change (Frazier 1997; Jackson 2001, 5416).

Zooarchaeologists must not fall into these pitfalls, and must be cautious in the use of even the most fashionable of terms. In this way the discipline can most effectively provide unique information that can inform conservation practices. Clearly, there are enormous challenges for zooarchaeology to provide robust information by which conservation initiatives can be guided. Although the situation may be frustrating, even daunting, practitioners should be of stout heart, for the information that they supply can provide unique insights, even though it may not be perfect.

As Johannes (1998) explained, we will never have adequate scientific information (not to mention political will, see Ludwig *et al.* 1993) to be able to manage marine fisheries for optimal yields: there is simply too much to know, and the systems – both human-dominated and otherwise – are far too complex, dynamic and unpredictable. Yet, sub-optimal management, as deficient as it may be, is still better (or less-worse) than no management at all. Hence, he explains the fundamental need for data-less (or data-poor) management: 'that is, management carried out in the absence of the data required for the parameterization and verification of models that predict effects of various management actions with useful statistical confidence limits.' And while '[m]anagement not preceded by conventional research or followed by scientific monitoring may verge, to some people, on heresy', there really are no realistic options: 'science' for all the sacred, God-like qualities attributed to it, will never have enough information. The need for the precautionary approach could not be clearer. 'Data-less and data-poor management are, under the circumstances, not just valid alternatives. They are an imperative.'

Zooarchaeological information – as with any other scientific pursuit – may never be perfect, especially with animals as complex as marine turtles. Yet, a clearer understanding of the past should provide unique insights that are unavailable from any other discipline. The more robust these data are, the clearer the vision for the future.

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