Editorial:

Conceptual Problems with the IUCN Red Listing Assessment for the Green Turtle: Move Over Raine Island

N. Mrosovsky

Department of Zoology, University of Toronto, Toronto, Ontario, Canada, M5S 3G5 (E-mail: mro@zoo.utoronto.ca)

The IUCN Red Listing of the green sea turtle, *Chelonia mydas*, in the Endangered category has recently been re-affirmed, along with supporting documentation (Seminoff 2004). The criterion invoked as qualifying the species for this category is a >50% decline in 3 generations (see IUCN 2001). An Endangered species is "considered to be facing a very high risk of extinction in the wild" (IUCN 2001).

Three generations ago is thought to be 1853-1895 (mostly 1873), depending on the population. The assessment provides tables about the data from which changes over 3 generations are inferred. This is an improvement over the 1966 listing of the green turtle, which provided no supporting documentation! Nevertheless, because reliable or even unreliable data going so far back are scarce, the assessment has to depend on extrapolations from present trends into the past. In some cases the available information is so slender as to place this procedure between the dubious and the worthless. But it is not the intent here to pick over such details for each population, but rather to draw attention to two general problems.

Use of average numbers nesting per year.

One of the outcomes of the appeal process against the 1996 red listing was the ruling that assessments should not be based on the number of geopolitical units showing such declines or gains, but be weighted according to the size of populations (Standards & Petitions Subcommittee of IUCN 2001).

The largest green turtle population - or so I along with many others thought - is that nesting at Raine Island and nearby islands, Australia. This impression is confirmed by estimates given in Limpus *et al.* (2003): in very high density nesting years, there are thought to be about 80,000 females in the inter-nesting habitat of Raine Island, based on re-sighting of marked turtles. And then there is Moutler Cay, some 14.5 km from Raine Island itself. Neither Moutler Cay nor Raine Island turtles have suffered sustained heavy exploitation of nesting turtles; they are likely to be the genetically similar. According to Limpus *et al.* (2003), in very high density seasons the total annual nesting population for Raine Island and Moulter Cay would approximate 131,000 nesting females.

However, if one goes to the assessment for the green turtle, one discovers a remarkable thing. The most important population, so the one that contributes most weight to the totals from which population changes are calculated, is that at Tortuguero, Costa Rica, not Raine Island. The present average per year for Tortuguero is given in Table 5 of Seminoff (2004), in round figures, as 27,000: that at Raine Island comes in at about 18,000. How can Tortuguero be allowed to contribute so much more to an assessment of changes in world numbers than the huge population at Raine Island?

This can be understood by working through a hypothetical example, deliberately made extreme to illustrate the principle involved. Suppose there are two populations (Table 1). The first has 100,000 adult females, but they only nest once every 10 years. When they do nest, virtually all the population nests, with negligible numbers in between. The average per year will then be 10,000. But this average per year represents only 10% of the total number of adult females.

The second hypothetical population is only 40,000 mature females. But it breeds every 2 years, with negligible numbers in the intervening years. So the average per year comes out to 20,000, which is 50% of the total number of adult females. This example shows that with the type of situation occurring at Raine Island (occasional mass nestings, with a long inter-nesting interval, maybe in order of 5 years) using the average per year will underestimate the population relative to other populations without these characteristics.

There is no cogent evidence that numbers at Raine Island have declined. Indeed, the assessment gives some increase there. If the Raine Island population were allowed to contribute in proportion to its numerical eminence, then a number of 80,000 or so in the present column of the balance sheet, and another large value on the past column, would promote stability. Larger absolute numbers in stable or increasing populations make it harder to obtain declines of 50% in totals for the whole world.

But then some other changes would also be needed. The Tortuguero population would be greater than 27,000. The inter-seasonal nesting interval for Tortuguero is probably in the 2.5-3 years range (S. Troeng, pers. comm. 2004). Multiplying 27,000 by a value in the 2.5-3 range could give a population size for Tortuguero approximately equal to or close to the 80,000 for Raine Island, but still less than the 131,000 for the Great Northern Barrier Reef complex of Raine Island and Moulter Cay.

Of course, that is in a good year. In some years only a few thousand turtles nest, and in others fewer still. But if one wants to know the number of turtles that exist in a population, one must pay special attention to the number in a good year. These turtles are not, it is presumed, suddenly gone from the seas in a subsequent year when few come to nest. Likewise, the many turtles nesting on nearby Moulter Cay should not be left out of the picture. They exist and there is nothing to indicate that numbers there have changed differently over the last 3 generations than those on nearby Raine Island.

The potential argument that the assessment used a 2001 cut-off, and the Limpus *et al.* estimates were published in 2003 may be discounted. Some figures were obtainable before. Even without some of the recent details, the Raine Island population should not have been downgraded by using the annual averages. With values in the literature of greater than 14,000 turtles on Raine Island in a single night (Jessop *et al.* 1999), it is surely likely that 18,000 per year leaves out something important about the size of this population. Be that as it may, the point stands: for estimating numbers and changes in numbers of animals, there is a general problem in using annual averages. The differing biology of populations has to be taken into account.

Inter-nesting interval (yrs) (negligible nesting in intervals)	Total breeding females in pop	Mean females per year	Mean/year as % of total
10	100,000	10,000	10%
2	40,000	20,000	50%

Table 1. Two hypothetical turtle populations.

Constraints on extrapolating into the past.

The scarcity of data on turtle numbers for the 1800s requires extrapolation to estimate values for 3 generations ago. The assessment makes use of both linear and exponential extrapolations. The justification for exponential extrapolation is a topic that could be debated in itself. It does not make allowance for density-dependent effects on population change. And the matter of extrapolating back over many years from two points that may be separated by relatively few years is also debatable. But it is a less immediately obvious matter that I wish to raise.

In the tables there are columns giving Past and Present raw data for 32 index sites (as a matter of explanation, not one of criticism, Present does not necessarily mean 2004, or even 2001, but refers to a time when some data could be found for a period later than that for the Past value). Comparing the numbers in the Past and Present columns for each index site (tables 4-6 in Seminoff 2004), one finds that 18 have Present values that are lower than the Past values, i.e., show declines; 10 have Present values that are higher than the Past values, i.e., show increases; and 3 have values that are equal, i.e., no change (not included in this tally is Sabah where the changes do not fit readily into these categories). Nearly all the Past values are not for the 1800s but more recent ones, so it is still necessary to project back to obtain some numbers for 3 generations ago. Now comes the telling part: of the 18 sites with declines, 12 are projected back to give some value for a time earlier than the Past value, but for the 10 sites with increases, only one is projected back earlier than the value in the Past column, and for that site only one or two years extrapolation appear to be involved.

Extrapolating declining populations into the past will boost the estimates for numbers existing 3 generations ago and so favour finding declines >50% from those numbers. Not extrapolating backward for increasing populations will exclude the possibility that some populations were smaller 3 generations ago than indicated in the Past column. For example, for Ascension Island surveys indicated 2670 nesting females for the 1977/78 season and 3709 per season for the 1998-2001 period. The 3 generations ago value was also taken as 2670 rather than some lower value that would be derived from extrapolations backward to the late 1800s.

Doubtless, it will be argued that it is unlikely that any turtle population was lower in the late 1800s than it is now and that therefore backward extrapolation of increasing populations should be disallowed. I disagree. We do not know enough about stochastic variables, diseases, fluctuations in availability of food, the dynamic nature of certain beaches, movements of turtles from one beach to another, the impact of predators (sharks were probably more abundant formerly), the effects of a run of thermally different years in unbalancing sex ratio, and turtle demography in general to adopt a biased procedure. Using extrapolations back over long periods from presently declining populations results in still higher numbers 3 generations ago. Virtually excluding extrapolation backward for populations that have risen more recently prevents the possibility of there being smaller numbers 3 generations ago. The procedure is inherently biased in favour of finding declines from 3 generations ago, and so meeting IUCN decline thresholds. I drew attention to this problem in comments on a draft assessment but without avail. The text of the final assessment does not even mention this constraint.

The validity of this constraint depends quite heavily on the frequent use of "no change" in the tables. If no change occurred for years prior to the Past value, then no further backward projection would be appropriate. But these liberally used assumptions of no change need examination. To discover numbers for particular years in the past is often hard enough. To establish that there have been no major changes over spans of decades without quasi-regular surveys and records of those surveys, is far fetched. For example, for the Yucatan Peninsula, Table 5 gives no change for the years 1879-1982 citing Parsons (1962). Note the publication date - prescient person, this Parsons. In any case, the scant information in the sections of his book on the Yucatan is too flimsy a basis for assuming level numbers over this period.

A number of the "no change" comments in Table 5 have no associated reference at all. Some of these refer to periods of more than 100 years. This softness of these "no change" designations is a further reason for wondering about assumptions underlying the decision not to project increasing numbers back to dates earlier than the Past data point. Note: it is not suggested that it would be valid, say, to extrapolate back exponentially from the present increasing populations of Tortuguero to 1895. It is suggested that the present procedures are biased in favour of finding declines.

The next step and assessing the assessment.

One could go on tinkering with the assessment, trying to improve it, bringing in adjustments for inter-seasonal nesting intervals in different populations. The presentation could be more transparent. Despite efforts to lay out the basis of calculations, it is not always easy to understand over what periods projections have been made. Graphs for each site would enable one to see this at glance. Such graphs should include the Past and Present data points and their trend lines, and dotted lines for any projections (linear, exponential, forward, backward). To make things completely explicit and easy to grasp, the important dates should be on the x axis. Graphs would show more saliently how greatly the assessment depends on extrapolation, and they would promote transparency. But is it worth the extra work?

Another response to the general problems mentioned above - as well as to all the doubts that arise if one follows up on references for particular populations and finds how tenuous the information given often is - would be to stop wasting more time on this flawed and fruitless endeavor. It is hard enough to estimate how many turtles there are today, let alone how many there might have been in 1873! The requisite information to come up with meaningful numbers is just not there; for declines over 3 generations it is a case of Data Deficient. Moreover, it may be asked to what extent is a greater than 50% loss over 3 generations for a long-lived species a good indication that it faces a very high risk of extinction in the wild. There are demonstrated instances of the ability of sea turtles to rebound from low numbers (for greens, see Balazs & Chaloupka 2004; Hays 2004).

Numbers, tables, and projections may look objective and scientific, but when one starts to delve into the details it turns out that much depends on subjective judgments. In some cases one type of projection gives an impossible or outrageous value, for example a population for 2001 of zero when this is known not to be so. In such cases the assessor has substituted another type of projection. But what of all the other projections that were not changed in this way? Just because they do not give an impossible answer is no guarantee of their worth. This is not an argument against making qualitative and subjective judgments: it is protest against any pretense that this exercise is an objective scientific process whose bottom line has much quantitative meaning.

The scarcity of data for 3 generations ago is not the only problem about applying the IUCN criteria to the green turtle. This is a widespread pantropical species. If it is recovering and doing well in some places, but doing badly or even wiped out in others, does that mean the species is soon going extinct, that no green turtles will exist in the wild? This type of contradiction would be avoided by regional listing with a de-emphasis on global listing for widespread species.

Regional or population based listing would also enable more attention to be devoted to local problems, as opposed to trying to force into a uniform scheme populations that differ in important characteristics such as inter-seasonal nesting interval. Regional red listing by IUCN might inform and promote local initiatives. After all, green turtles are not managed on a global basis; what happens to them depends on what happens in the various regions. Even populations that are doing well by IUCN numerical criteria, as far as one can tell, may need attention and exhibit regional specific problems that need to be brought out. For instance, flooding in recent years on Raine Island has reduced the amount of recruitment. This and decreasing size of nesting turtles may be of some concern (Limpus *et al.* 2003), even if not fitting neatly into IUCN's numerical system - or they may represent natural fluctuations in habitat with which the Great Barrier Reef turtles are adapted to cope. In either case, monitoring and thought are needed. Focussing on such local matters, which may differ from region to region, may be more worthwhile than spending more time on dubious historical global tallies. It is, therefore, a pity that IUCN has demanded that the present green turtle listing be a global one, rather than a number of regional listings. Regional listing could also ameliorate the problems arising from lack of data for the past. Those populations for which data are really just too scarce could be listed as Data Deficient, without preventing assigning threat categories to populations for which more data exist.

Further details, problems, and inconsistencies in the Red Lists for sea turtles, together with an account of the history of these listings, and of how the Crocodile Specialist Group (CSG) has dealt with similar questions, are available in Mrosovsky (2003). The assessment makes no reference to the existence of such contrary opinions.

In summary:

1. The assessment diminishes the contribution of the huge Raine Island green turtle population by using average nesting numbers per year.
2. It contains inherent biases in favour of finding declines by excluding the possibility that some populations might have been smaller 3 generations ago.
3. Trying to estimate green turtle numbers in 1873 and use changes from those levels as a basis for predicting extinction is an exercise in futility and fantasy, because appropriate data are not available. And even if adequate data were available, and a decline of >50% were demonstrated, for a long-lived species this value may have little relevance to predicting extinction risk in the future. Current trends and circumstances are more important.
4. For a widespread animal, IUCN's insistence that a global listing for the species as a whole be their priority, rather than making listings for different regions, leads to contradictions. If a species is stable or increasing in a number of areas, some with major populations, how can it be facing a very high risk of global extinction?
5. Much time has been spent on this assessment. That IUCN should promote this ridiculous exercise, and that the MTSG should abjectly go along with it, distracts from focussing on more important conservation issues.

BALAZS, G.H. & CHALOUPKA, M. 2004. Thirty-year recovery trend in the once depleted Hawaiian green sea turtle stock. Biological Conservation 117:491-498.

HAYS, G.C. 2004. Good news for sea turtles. Trends in Ecology and Evolution 19:349-351.

JESSOP, T.S., LIMPUS, C.J. & WHITTIER, J.M. 1999. Plasma steroid interactions during high-density green turtle nesting and associated disturbance. General and Comparative Endocrinology 115:90-100.

LIMPUS, C.J., MILLER, J.D., PARMENTER, C.J. & LIMPUS, D.J. 2003. The green turtle, *Chelonia mydas*, population of Raine Island and the northern Great Barrier Reef: 1843-2001. Memoirs of the Queensland Museum 49:349-440.

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

PARSONS, J.J. 1962. The Green Turtle and Man. University of Florida Press, Gainesville.

SEMINOFF, J. 2004. Green turtle (*Chelonia mydas*) Red List assessment. http://www.iucn-mtsf.org/

STANDARDS AND PETITIONS SUBCOMMITTEE of IUCN 2001. 2001. Red List Petitions Results. Species 36:31-34.