The status of olive ridley sea turtles in the West Atlantic

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INTRODUCTION

The olive ridley (*Lepidochelys olivacea*) is considered both the most numerous species of sea turtle in the world (Pritchard 1997) and also the least abundant marine turtle in the Western Atlantic region (Marcovaldi 2001a). Colonization of the West Atlantic by olive ridleys is hypothesized to have proceeded from the Indo-Pacific by way of the Cape of Good Hope (Bowen et al. 1998). In the West Atlantic, olive ridleys have been observed at sea as far north as Florida, USA and as far south as Uruguay, encompassing a range between 34ºS and 24ºN (Fretey 1999, Foley et al. 2003), but regular observations of this species are confined to the waters of Venezuela, Trinidad, the Guianas, and Brazil (Reichart 1993). Confirmed olive ridley nests fall between 20°S and 10°N (Fretey 1999), but only two principal rookeries are known in the West Atlantic: one spanning eastern Suriname/French Guiana and one in the state of Sergipe, Brazil (Figure 1). Interestingly, there is little geographic overlap in both nesting and feeding ranges of the olive ridley and the closely related Kemp's ridley sea turtle (*Lepidochelys kempii*), the latter of which is largely found north of 19 ºN in the Gulf of Mexico and Northern Atlantic (Fretey 1999). This geographic segregation could be the result of interspecific competition (Fretey 1999). In any case, the exact biogeography of the two species in the West Atlantic was a mystery up until the 1960s, when nesting areas for both species were positively confirmed (Schulz 1975).

Figure 1 : The 2 principal nesting populations of olive ridleys in the West Atlantic are indicated by the star symbols. Abbreviations: TT = Trinidad and Tobago, VE = Venezuela, GU = Guyana, SU = Suriname, FG = French Guiana, SE = Sergipe, Brazil, UR = Uruguay.

The goal of this report is to assess the population status of the olive ridley in the West Atlantic. The olive ridley species is distributed globally. As is the case with other marine turtle species (Bowen, 1997), there appears to be regional segregation of discret nesting olive ridley population, including a major phylogeographic division between the Atlantic and Indo-Pacific ocean basins (Bowen *et al.* 1998). Regional segregation of olive ridleys appears to be driven by female natal phylopatry, based on studies of differentiation of matrilineally inherited mtDNA across different populations around the globe (Bowen *et al.* 1998). At the current time, no data are available on male mediated gene flow for this species. Hence it is still possible that males may be moving among different regional populations, thereby facilitating gene flow between separate rookeries.

Within the Atlantic, the lack of haplotypic diversity among the rookeries of South America and Africa found to date (Bowen et al. 1998) makes it difficult to draw conclusions, although the existence of a unique mtDNA haplotype found only in olive ridleys in Suriname suggests that there may be some rookery isolation. Tagging records support this hypothesis, as to date no tagged females from Suriname or Brazil have been observed nesting on beaches in Western Africa, for example in São Tomé (Fretey 2001). Overall, more genetic research and tagging studies are needed to clarify the possible genetic exchanges among the different Atlantic olive ridley populations (including the possibility of transatlantic male-mediated gene flow). Nevertheless, based on the data available at the current time, we believe that the West Atlantic regional population is isolated from the East African population.

I – WEST ATLANTIC OLIVE RIDLEY POPULATIONS TRENDS

Outside of the two main rookeries of Suriname/French Guiana and Sergipe, Brazil, confirmed nesting is rather scarce. No confirmed nests of olive ridleys have been recorded in Venezuela, although future surveys in the eastern extreme of the coast, near Guyana, may reveal some nests (H. Guada, pers. comm.). In the last decade, there has been one reported but unconfirmed olive ridley nest in Trinidad and Tobago (D. Sammy, pers. comm.). A maximum of 14 nests/year have been recorded in Guyana, although not all potential nesting beaches are monitored (A. Arjoon, pers. comm.). This limited number of nests probably represents a maximum of about 10 females/year, which could be stray females from the Suriname/French Guiana population. Occasional olive ridley nests are seen in the states of Bahia and Espírito Santo in Brazil (Marcovaldi and Laurent 1996). Note that northern Brazil, from the mouth of the Amazon to the border with French Guiana, has not been carefully surveyed for sea turtle nests since the early 1980s, so it is possible that olive ridleys nest there. If olive rildey turtles do nest in this area, they are more likely to be related to the Suriname/French Guiana population, given the geographic proximity (Montjoly-Remire beach in Cayenne is less than 150 km from the border with Brazil). No other major olive ridley nesting beach in South America, outside of Suriname/French Guiana and Sergipe, Brazil, has ever been reported or discussed in the published literature. Therefore, this status review will be focused on the two main rookeries of Suriname/French Guiana and Sergipe, Brazil.

Several pieces of evidence suggest that rookeries in Suriname/French Guiana and Sergipe, Brazil are distinct:

- No females have ever been observed shifting between these 2 rookeries.
- The nesting seasons of Suriname/French Guiana and Sergipe are inversed, suggesting that each separate population has adapted to local conditions over a long period.

- There appears to be a segregation of females from the two populations on feeding grounds. Recaptures of tagged turtles at sea showed that almost all of the females from Suriname were recaptured in waters ranging from Trinidad to Amapa (in northern Brazil) (Reichart 1993), while recoveries of tagged females from Sergipe were restricted from Sergipe southwards to Santa Catarina (in southern Brazil) (Marcovaldi *et al.* 2002).
- Initial surveys in 1980 and 1981 revealed that Sergipe already had many olive ridley nests, while annual nest totals at Eilanti beach remained between 1000-1500 for about 15 years from 1970-1985.

Until future genetic surveys are available that include increased sample sizes and investigate specifically male-mediated gene flow, at the current time and with the currently available information, we assume that the two nesting populations in the West Atlantic are isolated.

A – Status of the Suriname/French Guiana population

The coastline of French Guiana and Suriname is characterized by successive westward movements of banks of sand and mud, at the rate of ca. 2 km/year (Schulz 1975). Hence, nesting beaches are continually being formed and destroyed, through a constant process of accretion and erosion. Faced with a dynamically changing environment, nesting sea turtles in Suriname/French Guiana tend to move between different nesting areas, both intra- and inter-annually, depending on accessibility. Movement of olive ridley females across the Maroni/Marowijne River has been noted for some time. Based on interviews with Amerindians on the western coast of French Guiana and his own observations, Schulz (1971) reported that some olive ridley turtles from Eilanti, Suriname moved east to other nesting beaches near Organabo, French Guiana, when Eilanti was inaccessible to turtles due to the presence of a mud flat. Limited recoveries of olive ridley females in French Guiana with tags from Eilanti are consistent with this (Schulz 1975). Hence, due to the extensive movement among beaches, the olive ridley sea turtles nesting in Suriname and French Guiana are considered to comprise one larger population.

Effective monitoring of sea turtles in Suriname and French Guiana has been challenging for several reasons, including the following :

- The dynamic processes that cause beaches to erode and accrete makes it nearly impossible to effectively plan ahead, because there is no clear indication where suitable nesting habitat will occur from one year to the next.
- The typical nesting beaches for olive ridleys are often isolated and difficult to access.

In addition, there have been variable differences in monitoring effort of olive ridley sea turtles in the two countries, ranging from complete coverage in some years in Suriname to no coverage in French Guiana in others. For simplicity, we now differentiate between data collected in Suriname and those collected in French Guiana, although olive ridleys nesting in both countries are considered to be part of the same larger nesting population.

1 – Suriname data

To date, the majority of information on olive ridleys in the West Atlantic comes from Suriname, which has sponsored sea turtle monitoring since the 1960s (Schulz

1975). There was regular monitoring of all nesting beaches from the mid-1960s until the start of civil war in 1986. Since then, monitoring effort has been variable, at times being focused only on larger nesting beaches such as Galibi, Krofajapasi/Matapica, and Braamspunt, due to budgetary and other constraints. Additionally, tensions between the federal government and Amerindian community of Galibi about control of marine turtle resources led to incomplete information on the number of nests laid per year on the beaches within the Galibi Natural Reserve, particularly in the early 1990s (Reichart and Fretey 1993). In the last 5 years, greater effort has been made to survey the nesting beaches, but to date it has been logistically impossible to record all nests on all beaches (B. de Dijn, pers. comm.). Hence, data from Suriname are considered to be nearly complete for years 1967 to the 1980s, and incomplete since then (see Appendix I for details on the sources of data).

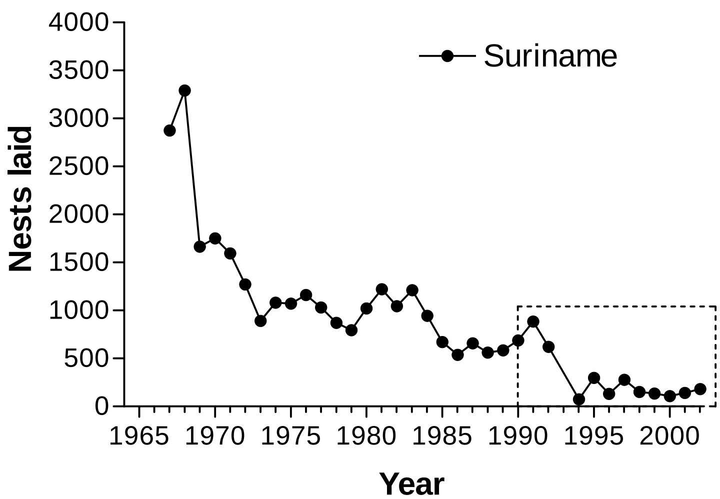

Figure 2 : Annual totals of nests laid by olive ridley sea turtles in Suriname. For years encompassed by the box, data are missing or incomplete (Sources: Marcovaldi 2001a; Reichart and Fretey 1993; Bart De Dijn/STINASU pers. comm.; Maartje Hilterman/BIOTOPIC pers. comm.; see Appendix I for more information).

Note that from the late 1980s onwards, there was <100% coverage of all nesting beaches. Nevertheless, there have been no reports of large nesting aggregations of olive ridleys from fishermen or wildlife rangers that often visit different beaches along the coast. For these reasons, we assume that the total numbers of nests from 1990 onwards, as presented in Fig. 2, represent at least 50 % of the country-wide total. In this situation, even taking into account the variable survey effort, it is possible to distinguish a clear downward trend over the past 40 years.

On a larger time scale, the decline is probably greater. According to Geijskes (1945, cited in Reichart and Fretey 1993), from 1933 to 1940 about 1500 nesting females were taken per year on Eilanti beach. To convert these annual harvest values to annual number of nests laid, we assumed that between 15% and 50% of all nesting females were harvested per year (see Appendix III for more detail). Based on the observation that each female produces on average 1.5 nests per year (Reichart 1993), the range of possible harvest rates translates into a range of 4500 and 15000 nests laid per year in Eilanti in 1933-1940. Therefore, on a 70-year time scale, it is likely that the annual number of nests laid in Suriname has drastically declined from 4500 – 15000 nests to <500 nests.

2 - French Guiana data

In French Guiana, although sea turtle monitoring has been conducted for more than 20 years, most of the effort was aimed at leatherback sea turtles. Thus few data on olive ridleys have been collected because the peak of nesting for olive ridleys is delayed relative to that of leatherbacks, and also olive ridleys seem to prefer nesting on more isolated (and hence less monitored) beaches. The only published data dealing with olive ridleys in French Guiana before the 1990s are the following:

- Pritchard (1973a) tagged sea turtles in western French Guiana from 1969 to 1973. Annual tagging effort was concentrated, ranging from 2 weeks to one month, with 5 to 18 olive ridleys tagged per year.
- During their survey on the western nesting beaches of French Guiana, Fretey and Lescure (1979) observed 20 olive ridley nests in 1977, 102 nests in 1978 and 93 nests in 1979.
- Fretey (1989) recorded 452 olive ridley nests in western French Guiana (from Malmonoury to the border with Suriname) during1987.

The variation in survey effort, both temporally and geographically, makes it difficult to discern any clear trends in this limited dataset.

More recently, efforts have been made to monitor nesting of olive ridleys on the urban beaches in Cayenne and Kourou, in the eastern half of coastal French Guiana. Data collected in the last four seasons show that several hundred nests are laid per year on the urban beaches, with indications of an increase reproductive effort (Table 1).

Table 1 : Number of olive ridley nests encountered in Montjoly/Kourou beaches on the eastern coast of French Guiana (source: Benoit Thoisy/Kwata, unpublished data).

Year	Observed nests
1999	204
2000	546
2001	689
2002	>1000

There is a lack of information on nesting activity of olive ridley turtles on isolated beaches in the western half of the French Guiana coast in the last 10-15 years. In 2002, surveys of nesting beaches of this zone were conducted by WWF-France. Estimates based on preliminary results from this monitoring program suggest 600-1000 olive ridley nests were laid on the western beaches of French Guiana in 2002 (L. Kelle, pers. comm. – *these data cannot be used for any other purpose without permission*). Although the lack of complete historical records makes it difficult to discern clear trends, it appears that totals of olive ridley nests in French Guiana are increasing. The few historical data available (see above) suggest that in the late 1960s no more than 500 nests were laid per year in the western part of French Guiana. If we assume a similar number of nests were laid in the eastern half, the overall total is close to 1000 nests laid per year, with some annual fluctuations due in part to emigration to and immigration from the beaches in Suriname and possibly northern Brazil. In recent years, the total number of nests has increased to about 2000 or possibly more, since not all beaches in the western half have been surveyed.

For the larger Suriname/French Guiana region then, the status of the olive ridley is difficult to discern because survey effort has been very variable. There has not been full monitoring of all potential nesting beaches in Suriname since the late 1980s (Reichart and Fretey 1993, B. De Dijn and M. Hiltermaan, pers. comm.), and in French Guiana, occasional monitoring was historically conducted in specific years (e.g. Fretey 1987), while only recently have data begun to be collected on annual basis. Nevertheless, the *arribada* events of Eilanti, Suriname that were common prior to the 1970s (Schulz 1975) have never been seen again, and no new mass-nesting populations have been observed or reported by fishermen, airplane pilots, or enforcement authorities that regularly visit the various sections of the coasts of Suriname and French Guiana. Whether we assume that the nesting by olive ridleys in French Guiana has remained relatively stable or has increased over the past several decades, the disappearance of the *arribada* colony in Suriname nevertheless represents a large loss for the regional population as a whole. Furthermore, based on historical records that suggest the *arribada* in western Suriname was composed of around 4500 – 15000 nests in the 1930s (Appendix III), the current level of nesting in Suriname/French Guiana has been severely reduced relative to the 1930s and somewhat reduced relative to the 1960s. In the last 20-30 years, there is not enough available evidence to discern clear trends in nesting numbers.

B – Status of the Brazil population

In the case of Brazil, there are very few historical data available concerning sea turtle abundance, and only since the early1980s has there been annual monitoring of sea turtle activities. In 1980 and 1981, a countrywide coastal survey revealed concentrated nesting of olive ridleys on Pirambu beach in Sergipe, Brazil, and hence a research/conservation station was established there by Projeto TAMAR (Marcovaldi and Marcovaldi 1999). Protocols for monitoring and beach management were standardized in Brazil in the late 1980s, and patrols for nesting activity were expanded to cover all nesting beaches in the state of Sergipe. Regular night patrols to intercept and tag nesting females were halted in 1996/1997, because of the small amount of data collected relative to the enormous amount of resources expended to undertake such patrols. Daily morning nest counts are usually conducted throughout the nesting season, with post-emergence nest excavations used to verify species (loggerhead turtles also nest in Sergipe).

Although ideally all beach monitoring is close to 100% effective, in some years economic and/or logistic restraints reduced the beach coverage, for example in 1998/99 only about 20% of the nesting season had daily nest counts. Each season, the species identification for some nests was unknown. The seasonal total of olive ridley nests was calculated by summing known olive ridley nests together with a percentage of nests laid by an unknown species, the percentage being determined by the relative numbers of known olive ridley and loggerhead nests laid that season. Based on this methodology, and despite changes in monitoring effort across years, there is an upward trend in numbers of olive ridley turtle nests laid each year for the past 10 years (Figure 3). This upward trend is also paralleled by an increase in the relative number of olive ridley nests as compared to loggerhead nests laid per season, from 48% of all known nests in 1990/91 to 87% in 2000/01 (Projeto TAMAR-IBAMA, unpublished data).

It is unclear if olive ridleys were ever historically abundant in Sergipe, or if there had been arribadas there in the past. Interestingly, there was no specific common name for olive ridleys in Brazil when monitoring was began, as there were for other species, which suggests they were never very plentiful. Note that some olive ridley nests are laid on Brazilian beaches located to the south of Sergipe (e.g. Marcovaldi and Laurent 1996), but these are relatively rare occurrences. In all, the lack of historical information on olive ridleys in Brazil makes it impossible to elucidate any clear trends beyond the last decade or so.

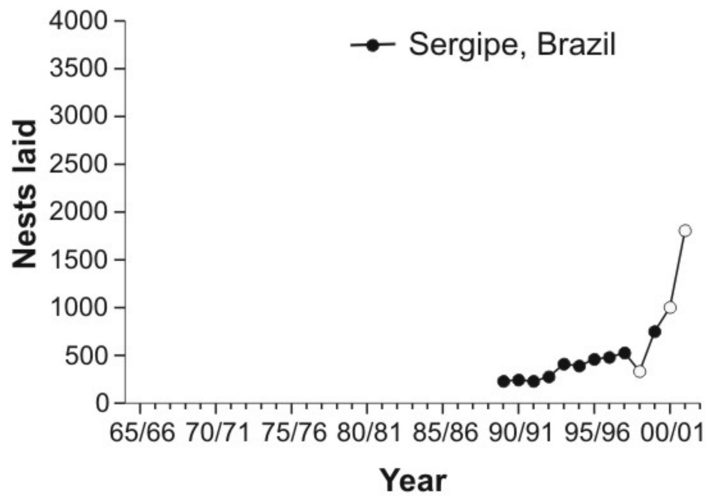

Figure 3 : Seasonal number of nests laid on beaches in Sergipe, Brazil. Note that final values include some unverified nests that were estimated to be laid by olive ridley. Open circles represent seasonal totals where >50% of the values were unverified but assumed to be laid by olive ridleys (source: Projeto TAMAR-IBAMA, unpublished data).

II – THREATS FACED BY WEST ATLANTIC OLIVE RIDLEY POPULATIONS

As with marine turtle populations everywhere, olive ridleys in the West Atlantic are subject to a variety of pressures, including habitat destruction, egg harvesting, accidental and directed capture of adult females, etc. Taking into consideration the historical context of changes of the threats faced by the nesting sea turtle populations in the West Atlantic, we can make a basic division between historical threats and those more relevant in the last few decades or so.

A - Historical threats

In Brazil, there exists no historical information on land-based threats facing olive ridleys in Sergipe before 1980. Informal surveys with local fishermen and villagers in the early 1980s revealed that marine turtles were hunted and their eggs collected for consumption, but usually only as supplementary sources of food or income, and there was no organized sea turtle fishery (Marcovaldi and Marcovaldi 1999).

For Suriname/French Guiana, there are some historical accounts of the collection of olive ridley females and their eggs. For instance, Geijskes (1945, cited in Reichart and Fretey 1993) estimated that 1500 adult female olive ridleys were harvested on Eilanti beach each year between 1933-1940. Additionally, olive ridley eggs have likely been consumed locally in perpetuity, although few data exist prior to the last 4 decades. The egg harvest apparently intensified in the 1960s: Schulz (1975) reported that egg harvest of olive ridleys from Galibi beaches was close to 90% of all nests laid in 1967. This prompted the establishment of a moratorium on legal egg collection from olive ridley nests in 1970, which remains in effect today (Mohadin 2000), although enforcement may not be always effective.

In terms of historical in-water threats faced by olive ridleys, there are few records available to evaluate them in either Sergipe or Suriname/French Guiana. More than 30 years ago, Pritchard (1969) reported that in French Guiana "fair numbers of turtles, probably mainly ridleys, are caught at sea by shrimp trawlers." The pressure from the shrimp fishery in this region developed only in the second half of the 20^{th} century. The discovery of the shrimp resource in the Guianas around 1945 was followed by the development of shrimp-directed fisheries around 1960. Fishing effort grew until the 1970s, after which the effort was stabilized because the fishery was thought to be sustainable.

B - Present day threats

For the Suriname/French Guiana population, the decrease in intensity of land-based threats faced by olive ridleys seems to been matched or overtaken by an increase in oceanic threats. Shrimp overfishing since the 1970s has forced trawlers to expand their efforts, and now many are working closer to the coast (Dintheer *et al.* 1989), where they may be more likely to catch olive ridley sea turtles. Reichart and Fretey (1993) suggested that accidental capture of olive ridley turtles at sea was the largest unaddressed problem facing this species in the region. Fisheries targeting shrimp occur throughout the normal range of olive ridleys that nest in Suriname and French Guiana: from Trinidad and Venezuela down to Amapa, Brazil. Olive ridleys appear to be the most common sea turtle species being accidentally captured and killed in trawling nets in the region (Tambiah 1994; Gueguen 2000). Shrimp boats appear to catch olive ridleys in all months during the year, but it is unclear if captures are more frequent at certain times of year. Pritchard (1973b) reported that 39 olive ridley tag returns that were from shrimp trawlers were distributed throughout the year with a slight peak from July to September, while Tambiah (1994) suggested accidental captures were greatest from January to March. Interestingly, 23% (9/39) of all captures by shrimp trawlers reported by Pritchard (1973b) occurred in Venezuelan waters, while a recent survey of turtles captured by at least part of the Venezuelan shrimping fleet revealed few if any captures of olive ridleys (Guada 2001).

Turtle Excluder Devices (TEDs) are not required on shrimp trawlers registered in French Guiana, but they are obligatory for countries such as Suriname, Guyana and Trinidad & Tobago who wish to export their shrimp catch to the US. However, verification and enforcement of TEDs use by trawlers is typically challenging and usually done in a limited manner, in all countries. To date, there is no real estimate of total turtle mortality related to shrimping boats in the region, but it has been suggested that about 1600 marine turtles were killed each year by the Suriname shrimp fleet in the early 1990s (Tambiah 1994). Gueguen (2000) conducted interviews with shrimp fishermen in French Guiana and estimated about 12 olive ridleys are accidentally captured per boat per year. Extrapolating this value to the entire fleet of registered shrimp boats in French Guiana, Gueguen (2000) suggested that about 1000 turtles are captured each year. Expanded and updated information is greatly needed to fully understand the extent of this threat facing olive ridleys and other species in the region.

A new beach threat to olive ridleys has been identified on the urban beach of Montjoly, in Cayenne, French Guiana. Stray dogs have killed as many as 42 nesting females in 2002 alone (Kwata, unpub. data), although control measures are now being organized.

Until recently, studies of the Brazilian olive ridley population failed to identifity any important threat either on land or at sea. For example, studies of accidental captures by fishing weirs on the Northeastern coast and by long line fleets in the south do not report that olive ridleys are often caught in these types of fishing gear in these areas (Marcovaldi *et al.* 2001b ; Kotas *et al,* 2004). The recent observations dead adult olive ridleys found on the nesting beaches in Sergipe each year (Thome et al. 2003), including more than 20 dead stranded olive ridleys in Sergipe during the 2003/2004 nesting season (Marcovaldi, *pers. comm*.) raises the possibility of a previously unknown and/or possible increase of the fisheries bycatch of this species. This underlines the importance of wide-ranging studies of sea turtle bycatch planned in Brazil in the near future (Marcovaldi *et al.* 2002).

C – Synthesis

Overall there is little documented evidence of specific direct threats to olive ridleys in Brazil, either in the past or present day (although they still suffer from general threats faced by all marine turtle species in Brazil). The recent observation of dead stranded adult olive ridleys in Sergipe may indicate a recent increase in mortality due to bycatch. For the Suriname/French Guiana population, major threats have been identified and include direct capture of nesting females at least in the 1930s, overharvest of eggs until the 1970s, and adult mortality due to accidental capture by shrimp fishing boats since the 1960s.

III – STATUS OF THE OLIVE RIDLEY SEA TURTLES OF THE WEST ATLANTIC

A clear understanding of the status of olive ridleys in the West Atlantic is complicated by various factors :

- First, although some data exist supporting the idea that the two main nesting populations of Suriname/French Guiana and Brazil are distinct in terms of female philopatry, they are not conclusive and also the lack of information about male migratory and reproductive behavior makes it impossible ascertain if these populations are genetically isolated, or even what their relationship is with the olive ridley populations in the East Atlantic (see section I). However, information on the relatedness of these two populations between themselves and with respect to others in the East Atlantic is extremely important in the overall assessment of population status. Grouping the populations together for a single assessment may mask the gravity of the threats being faced by two genetically isolated small populations. As the data available do not clearly confirm the presence of two genetically isolated populations of olive ridleys in the West Atlantic, in this document we consider the status of the larger West Atlantic population as a whole. In addition, since the global status was recently reviewed

(Species Survival Commission 2001), a logical progression is to assess the species on regional levels, including the Western Atlantic. Nevertheless, we strongly urge more studies (tagging, DNA analysis, and behavioral monitoring) on the relatedness of not only these two rookeries, but also all others in the Atlantic, as it is an important parameter in the assessment of the extinction risk of the West Atlantic olive ridley population.

- Second, the lack of a long term dataset for the nesting population in Brazil and the continued lack of standardized monitoring effort in French Guiana and Suriname make it difficult to apply the IUCN criteria for assessing regional population status. For threat classification according to the criteria of the IUCN Red list, it is necessary to compare trends over the last 3 generations of olive ridleys in the region (45-60 years, A. Abreu-Grobois, pers. comm.). Given the data available, the annual number of nests laid appears to be the only useful index to assess trends in the size of the population in this region. We assume that nest production is an adequate proxy for population abundance, although this implies that average reproductive output has not changed significantly over the past 3 generations. Given that data are missing for many years over the past three generations, many assumptions and inferences are necessary to determine the overall regional population trend. A simple strategy that minimizes the number of inferences necessary is to compare current abundance with abundance 45-60 years ago. The following section elaborates the calculations used to realize this strategy.

A - Current population abundance

According to Schulz (1975), the majority of olive ridleys in Suriname return to nest in successive years, with the average interval between nesting seasons being 1.4 years. Therefore the average number of nesting females per year based on 3 or 4 years of data would be a better index of abundance than the only a single year of data, particularly given the fluctuation of annual number of nesting for sea turtles (cf. Hays 2000). The lack of a comprehensive database on nesting activities allowed us to use only the average number of nests laid in the past 2 years (2001 and 2002) as an index of the approximate abundance of reproductive females in the population. These estimates were generated by summing annual estimates for each country:

- For Suriname the mean annual number of nests for 2001 and 2002 on the monitored beaches was 161 (see Appendix I). The number of nests laid annually on unmonitored beaches has been estimated to be 200-300, which translates into an annual average between 361 and 461 nests for this period.
- For French Guiana the mean annual number of nests for 2001 and 2002 on the eastern beaches was 844. The number of nests laid in 2002 on the western beaches was estimated to be 600-1000 (L. Kelle, pers. comm. – *these data cannot be used for any other purpose without permission*). Therefore the average annual number of nests for 2001-2002 in all of French Guiana was between 1444 and 1844.
- For Brazil the nesting season spans September – March. For our purposes, the mean annual number of nests for 2001 and 2002 is based on the Sept. 2000-March 2001 and Sept. 2001-March 2002 seasons. The mean number of nests was 1456.

Thus, the average number of nests laid per year in the West Atlantic, based on data from 2001 and 2002, is 3261-3761. Note that these values may still be underestimates, as large parts of northern Brazil near the French Guiana border remain un-surveyed but could host olive ridley nests.

B - Historical population abundance 3 generations ago (45-60 yrs)

The lack of precise details regarding the age of maturity and reproductive lifespan of olive ridleys in the West Atlantic and elsewhere makes it necessary to assume a range of values (45-60 years) as an approximation of 3 generations of 15-20 years each (A. Abreu-Grobois, pers. comm.). For simplicity, we will compare current status with the estimated status 45 years ago (i.e. 1957) and 60 years ago (1942), specifically the upper and lower bounds of the range.

No records exist of the numbers of nests laid per year in 1957 or 1942. However, some anecdotal information in the literature does facilitate the estimation of nesting output in these years. For Suriname, the two earliest annual totals available are for 1967 and 1968, with an average of 3082 nests laid per year at this time (Appendix II). From historical records of Geijskes (1945, cited in Reichart and Fretey 1993), about 1500 females were harvested per year from Eilanti beach from 1933-1940. We estimate that these values correspond to 4500 – 15000 nests laid per year in 1940 (see Appendix III for details). Thus, by fitting a simple line between the datapoints from 1940 and 1967/68, we estimated that there were between 3607-7496 nests in 1957 and between 4395-14117 nests in 1942 (see Appendix III for details). These data are for Suriname only. For French Guiana, we assumed that in the past only 1000 nests maximum were laid per year (see section "*French Guiana data*" above). For Brazil, there is no indication that levels were high in Sergipe (see section "*Status of Brazil population*" above), hence we assume that only 250 nests were laid there annually in 1957 and 1942. The sum of these values is 4857-8746 nests for 1957 and 5645-15367 nests for 1942, for the whole of the West Atlantic.

C – Population trend for the last 3 generations (45-60 yrs)

The lack of precise historical data creates uncertainty in the estimates of historical population size, and this is reflected in the ranges given for 45 and 60 years ago. Comparisons of the estimates of abundance in 2002 with those from 1957 and 1945 show a concomitant wide range of declines, anywhere from 0% to 76.9%, depending on which year and which extreme of the range is selected (Figure 4). Again, it should be recalled that there are many uncertainties associated with these estimates. In particular our assumptions for past abundance in French Guiana and Brazil may be vastly underestimated, but from current available evidence, there is no reason to infer larger populations in either area 3 generations ago.

According to the above information on decline and the IUCN criteria for Redlist Categories (version 3.1), olive ridleys in the West Atlantic can potentially be classified in several different categories: Endangered (EN), Vulnerable (VU), Near Threatened (NR) and Least Concern (LC). Based on the population change during the upper limit of time for 3 generations (i.e. from 1942 to 2002), the appropriate redlist categories include ENA1bd, VUA1bd and LC. For the lower limit of time for three generations (i.e. from 1957 to 2002), the changes in nest abundance imply that the olive ridley qualifies for the following Redlist categories: ENA1bd, VUA1bd and LC.

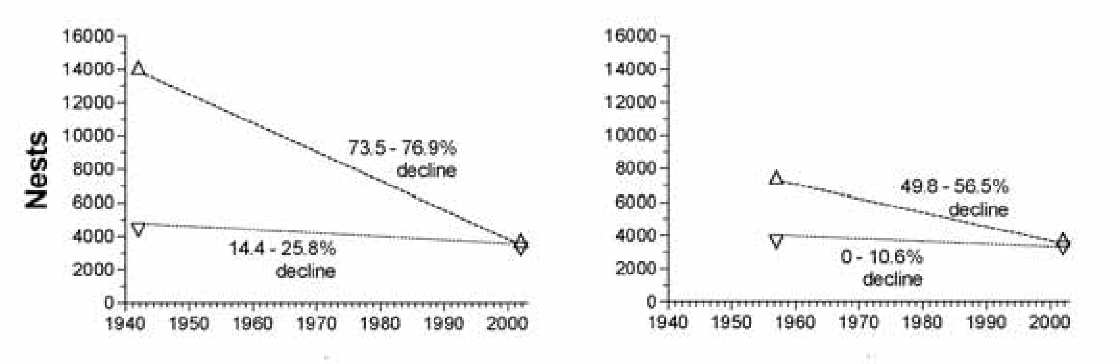

Figure 4. Upper and lower limits of decline of annual number of olive ridley nests laid in the West Atlantic, from 1957 or 1942 (corresponding to 45 and 60 years ago, which encompass the possible range of years covering 3 generations of olive ridleys; see text for more details).

D – Regional listing proposition

According to the IUCN Red list criteria, in the case of several appropriate categories, the assessors have the option to suggest the most appropriate, based on their interpretation of the data. Therefore, to help define which category is most appropriate, we provide the following points to help give place the West Atlantic olive ridley population in context.

1 - Ongoing pressures faced by the olive ridleys in the West Atlantic

- The number of olive ridley nesting females in the Western Atlantic is small. Based on the average number of nests for 2001-2002 (3261-3761), the data on the mean annual number of nests laid per female (1.5 nests per female, according to Schulz 1975) and the interval between two nesting seasons for a female (1.4 years, according to Reichart 1993), the West Atlantic olive ridley rookery is estimated to be comprised of 3043-3510 nesting females. Small populations such as these are more susceptible to collapse than larger populations, due to the Allee effect (Courchamp et al. 1999).
- The Western Atlantic olive ridley population is probably composed of two isolated populations (at least in terms of nesting animals) that are estimated (using the same calculations as above) to 1685-2150 adult nesting females for Suriname/French Guiana and about 1358 adult nesting females for Brazil. The probable segregation of this small population into two smaller populations increases further their susceptibility to collapse.
- Mortality related to accidental capture by shrimp trawlers is a major hazard and will continue unless actions are taken to reduce this threat, either by enacting a moratorium or enforcing use of TEDs and/or shorter trawl times. Given the reduced size of the population, mortality related to shrimping probably has a major negative impact on population growth. For instance, based on the estimates of Gueguen (2000) and Tambiah (1994), roughly 2000 olive ridleys are accidentally captured per year by shrimp trawlers operating in waters off of Suriname and

French Guiana, while the total nesting population size in those two countries is thought to be <2500 adult females. The economic importance of shrimping in the region, plus the difficulty associated with enforcement near international borders, makes it unlikely that accidental capture in trawlers will be stopped in the near future.

- The impact of smaller pressures, such as predation by stray dogs, may not be fully recognized or known, particularly on isolated beaches in Suriname/French Guiana.

2 - Positive features regarding olive ridleys in the West Atlantic

- The apparent increase in annual numbers of nests laid in Brazil.
- The recently discovered nesting population in eastern French Guiana, which is relatively large and apparently increasing.
- The increase in interest in this species in French Guiana, which should lead to greater effort to monitoring olive ridleys throughout the coast and more focus on reducing or eliminating accidental capture by shrimp boats.

Therefore, taking into account the analyses on population trends together with the above points, we suggest that the population olive ridleys in the West Atlantic be placed in the Endangered (EN) category (Table 2).

Table 2. Regional Red List classification for olive ridleys in the West Atlantic Ocean.

Taxon name	Breeder/Visitor	Regional RL category	Global RL category	Proportion (%) of global population
Lepidochelys olivacea (Eschscholtz, 1829) olive ridley sea turtle	Breeder	ENA1bd	ENA1bd	<1%

E - Perspectives

It is hoped that recognition of the endangered status of the olive ridley in the West Atlantic will lead to improved conservation, will help to underscore the need for improved and widespread population monitoring, and will lead to studies of genetic interchange among rookeries. Such information is vital for future, updated reviews on the status of this species in the region, particularly since the present review was hampered by lack of detailed data.

The IUCN Red List of Threatened Species "is designed to determine the relative risk of extinction, and the main purpose of the IUCN Red List is to catalogue and highlight those taxa that are facing a higher risk of global extinction"[1]. The IUCN through the Species Survival Commission "remains firmly committed to providing the world with the most objective, scientifically based information on the current status of globally threatened biodiversity".[1] Moving beyond the global level, the global Red List criteria can be applied to regional populations in order to assess the risk of extinction for a regional population of a species (IUCN 2003).

[1] www.redlist.org/info/introduction.html

For this regional status review, the lack of accurate long-term data on the West Atlantic olive ridley population resulted in classifying this regional population in several different categories, depending on the range of the data available. Based on the IUCN Red list criteria, we had the option to suggest the most appropriate, based on our interpretation of the data. We have tried to be as objective as possible, and based on the contextual information in Section D, we have concluded that the Endangered category (ENA1bd) for the West Atlantic olive ridley population is the most appropriate and the most conservative estimate.

Within the Atlantic basin, the olive ridley with EN classification appears to be under a lesser threat of extinction than hawksbills, leatherbacks and Kemp's ridleys (all classified as CR). The other two species, loggerheads and green turtles, are classified as EN. And yet, relative to the other species in the Atlantic the West Atlantic population of olive ridleys is likely one of the most endangered sea turtle species in the ocean basin, given its small population size, population trends, severity of current threats, and lack of definitive reduction of these threats in the near future. Therefore, an important outcome of this analysis of olive ridleys in the West Atlantic is that the IUCN Red List criteria to date have not been used to produce an adequate ranking of marine turtle species based on extinction risk, at least in the West Atlantic.

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Appendix I : Sources of data for olive ridley nests laid on beaches in Suriname, 1968-2002

Table A : Annual number of olive ridley nests laid in Suriname.

YEAR	NESTS	SOURCE
1967	2,875	Schulz 1975
1968	3,290	Schulz 1975
1969	1,665	Schulz 1975
1970	1,750	Schulz 1975
1971	1,595	Schulz 1975
1972	1,270	Schulz 1975
1973	890	Schulz 1975
1974	1,080	Schulz 1975
1975	1,070	Schulz 1975
1976	1,160	Reichart & Fretey. 1993
1977	1,030	Reichart & Fretey. 1993
1978	870	Reichart & Fretey. 1993
1979	795	Reichart & Fretey. 1993
1980	1,020	Reichart & Fretey. 1993
1981	1,220	Reichart & Fretey. 1993
1982	1,045	Reichart & Fretey. 1993
1983	1,212	Reichart & Fretey. 1993
1984	944	Reichart & Fretey. 1993
1985	670	Reichart & Fretey. 1993
1986	537	Reichart & Fretey. 1993
1987	659	Reichart & Fretey. 1993
1988	563	Reichart & Fretey. 1993
1989	585	Reichart & Fretey. 1993
1990	*688*	Estimated from Reichart & Fretey. 1993
1991	*884*	Estimated from Reichart & Fretey. 1993
1992	*621*	Estimated from Reichart & Fretey. 1993
1993	????	-----
1994	75*	Marcovaldi 2001a
1995	297*	Marcovaldi 2001a
1996	132*	Marcovaldi 2001a
1997	277*	Marcovaldi 2001a
1998	151*	Marcovaldi 2001a
1999	136*	Marcovaldi 2001a
2000	109*	STINASU; Biotopic pers. comm.
2001	140*	STINASU, pers comm
2002	182*	STINASU, pers comm

Note : Data in italics are based on estimates (see Appendix II). Data with asterisks (*) are based on incomplete surveys of all nesting beaches.

Appendix II : Calculation of olive ridley nestslaid in Suriname for the years 1990-1992

Reichart and Fretey (1993) provide annual nest totals for all beaches in Suriname from 1990-1993, excluding the beaches within the Galibi Nature Reserve. However, for the years 1984-1989, they provide annual totals of olive ridley nests for both beaches in the Galibi Nature Reserve and for all of Suriname. Using these latter data, it is possible to estimate the average contribution of nests laid outside the Galibi Nature Reserve to the annual total for Suriname:

Table B : Olive ridley nests laid in Suriname, from Reichart and Fretey (1993)

Year	Nests outside Galibi Reserve	Nests inside Galibi Reserve	Suriname total	% of nests laid outside the Galibi Nature Reserve
1984	212	732	944	22.46
1985	255	415	670	38.06
1986	116	421	537	21.60
1987	112	547	659	17.00
1988	151	412	563	26.82
1989	161	424	585	27.52
TOTAL	**1007**	**2951**	**3958**	**25.44**

Table C : Nest totals for 1990-1993 for beaches outside of the Galibi Nature Reserve

Year	Nests outside the Galibi Nature Reserve	Estimated total (assuming 25.44% of all nests per year laid outside of the Galibi Nature Reserve)
1990	175	688
1991	225	884
1992	158	621

Note that Schulz (1975) also gave data on numbers of nests laid inside and outside the Galibi Nature Reserve for the years 1968-1975. According to those data, 17% of all olive ridley nests were laid outside of the Galibi Nature Reserve. However, given the dynamic nature of the coast, and the migration of sand and mud, it is unlikely that this relationship remains constant over long periods of time. For this reason, we did not include these data in the estimates of annual number of nests laid per year for all of Suriname, from 1990-1992.

Appendix III : Calculations to arrive at total reproductive output in Suriname three generations ago (45-60 years or 1957 and 1942)

The oldest data for seasonal totals of olive ridley nests laid in Suriname are 1967 and 1968 = annual mean 3082 nests (Schulz 1975). Records from Geijskes (1945, cited in Reichart and Fretey 1993) indicate that 1500 olive ridley turtles were taken each year from Eilanti beach, Suriname, from 1933 to 1940. It is difficult to transform this harvest information into number nesting females per year during this time. Rather than seek a definitive estimate, we instead sought to find a range of reasonable estimates. Given that olive ridleys in Suriname nest on average every 1.4 years (Reichart 1993), it is unlikely that the harvest of 1500 females was close to 100% of all females encountered, otherwise it would have been impossible to continue the harvest during 8 years. Nevertheless, it could be the case that although the harvest remained constant, the population declined substantially during the whole period. This dichotomy of possible scenarios helps define the range of estimates for nesting females during 1933-1940. To calculate the minimum value of females present per year, we assumed that the annual harvest was around 50% of all females, at least towards the end of this period. Any greater harvest would have likely been unsustainable over 8 years. To calculate the maximum value of females, we assume that the harvest and the nesting population were relatively constant during this period. In such a case the low impact of the harvest would have been a consequence of the number of females caught per year being a low percentage of the total annual number of nesting females. For this calculation we assume that the annual harvest could have been as low as 15% of all females arriving on the beach. This translates to 10000 females arriving per year during 1933-1940, or 15000 nests (based on 1.5 nests laid per female each season, from Schulz 1975).

Therefore, for 1940, we calculated that the possible range of total olive ridley nests laid in Suriname was 4500-15000 (Figure A).

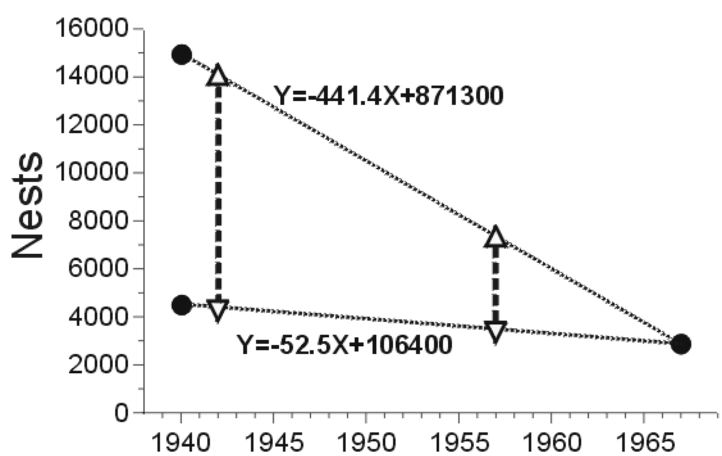

Figure A : Straight line used to estimate the annual total of nests laid in Suriname in 1942 and 1957. Closed dots represent the years in which historical data are available.

Three generations of olive ridley sea turtles is estimated to be 45-60 years (A. Abreu-Grobois, pers. comm.). To arrive at annual nest totals for Suriname 45-60 years ago, it is necessary to interpolate between the 1967 datum (Schulz 1975) and the range of values estimated for 1940 (above). To do this, we calculated the formulae for two simple straight lines connecting the values from 1967 to the upper and lower values for 1940 (Figure A). Using these formulae, we estimated the range of possible values for 3 generations ago: 3607-7496 nests for 45 years ago, 4395-14117 nests for 60 years ago.

Note that there are many assumptions inherent in these calculations, including the value of nests in 1940 and the constant rate of decline of the population from 1940 to 1967. However, in absence of alternative sources of information, these simple approximations are a best-guess attempt at inferring historical population levels.