"Salmon Spirit" of the Pacific Northwest Coast by Roxana Leask

Volume II, Number 2

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AUTUMN
99

Currents - A Publication of the Oceanic Resource Foundation Dedicated to the Protection of the Marine Environment

Community Turtle Conservation at Río Oro on the Pacific Coast of Costa Rica

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The local community (population *ca.* 150) at Río Oro on the Osa Peninsula, Costa Rica, is currently taking steps to manage marine turtles through the Asociación de Desarrollo y Conservación de Río Oro (Río Oro Development and Conservation Association or ADECORO) which has 40 members. This organisation was formed following a four year programme of marine turtle monitoring carried out by local residents (1992-1996). A major part of the work is the study and management of the marine turtles which nest on the 5.9 km beach situated near the main hamlet. Drake (1993) published a partial analysis of the first results of this programme.

Members of ADECORO monitor turtle nesting and nest predation. Daily patrols are carried out at first light and data are collected regarding species (from track morphology), nest location and any nest destruction events (mainly by dogs and humans). Further details are provided in Drake (1993) and Govan and ADECORO (1996).

Four species of turtle are thought to nest on the Pacific coast of Costa Rica (Cornelius 1995). These are the olive ridley (*Lepidochelys olivacea*), Pacific green (*Chelonia mydas agassizi*), leatherback (*Dermochelys coriacea*) and hawksbill (*Eretmochelys imbricata*) turtles. At Río Oro, a minimum of 2,860 nests were laid in 1994 and species identification was possible in 2,423 cases (Table 1). In 1996, a total of 3,162 were laid. Most nesting is by olive ridley turtles, with relatively low numbers of green turtles and leatherback turtles. Hawksbill turtles are reported to occur by local inhabitants but none were positively identified at Rio Oro in 1994 or 1996.

Although nesting is recorded in all months of the year, each of the species recorded have a seasonal peak of activity (Table 1). Nesting levels show marked spatial variation and in some 100m stretches, densities reach an equivalent of 840 nests/km/year.

The Pacific coast of Costa Rica hosts some of the most spectacular mass nesting phenomena in the world during which hundreds of thousands of olive ridley turtles participate in "arribadas" on the beaches of Nancite and Ostional (Cornelius 1986, 1995). However, hatching success of these nests can be very low (<10%). The hatching success rate at solitary or medium intensity nesting beaches, such as Río Oro, can be much higher (Castro 1986; this study). These observations may lend some support to the hypothesis that it is the solitary or medium intensity nesting beaches that maintain population levels of olive ridley turtles (Castro 1986), possibly increasing the biological importance of nesting beaches such as Rio Oro.

Table 2 shows the monthly total of nests destroyed by dogs in both 1994 and 1996. In June 1996, ADECORO started community-based management of the beach which involved both the participation of community members in

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Table 1. **Breakdown of marine turtle nests recorded in 1994, with an indication of the peak of nesting for each species.**

Species	*No. nests*	*Peak Nesting season*
Olive ridley	2370	July-Oct.
Pacific green	46	Nov.-Dec.
Leatherback	7	Oct.-Dec.
Not identified	437	-
Total	2860	-

Grupo Tortuguero de Baja California

Second Annual Meeting of Baja Sea Turtle Group in Loreto Advances Goals for Marine Conservation in Baja California

The second annual Grupo Tortueguero meeting has been set for January 28-30, 2000 and will again be held in Loreto, Baja California. This coalition of fishermen, grassroots community NGOs, and researchers is attempting to develop a base of information about the five species of threatened sea turtles that inhabit the coastal waters of Baja California and develop community-based strategies to save these animals. More importantly—these groups form the basis of stakeholder action groups at the most biologically important coastal sites in the region. It is estimated that thousands of turtles are still being killed annually in Baja Pacific coast and the Sea of Cortez waters, primarily through shrimp trawling and fishery bycatch.

Last year about fifty fishermen, researchers and NGO representatives from all over the peninsula attended the Loreto meeting. This year members of the Seri Nation engaged in sea turtle conservation efforts in the Midriff Islands region have also been invited.

The 2000 meeting is being supported by the Oceanic Resource Foundation (ORF), the Chelonia Research Foundation, the University of Arizona, and other private donors. The meeting will be be hosted by the Grupo Ecologista Antares and ORF.

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controlling movements of their animals, and the removal of feral dogs which was carried out in conjunction with local authorities. A marked reduction can be seen in predation levels subsequent to the commencement of this initiative. It is almost certain that the reduction of dog predation is the result of a combination of the activities of the beach patrols and general increasing awareness in the community. This increased awareness is likely to have contributed to the decrease in the activities of human egg collectors. The number of nests collected by humans fell from 344 (12%) in 1994 to 122 (4%) in 1996.

Recently, a more serious threat has come to light in the form of proposed plans for a hotel and tourism development of the coastal strip. Developments are proposed to be implemented within a year. It is recommended that a degree of legal protection should be given to the coastal strip at Río Oro and this area should be managed by, or in very close collaboration with, the local community through a local association such as ADECORO. The coastal strip could then serve as a buffer zone between developments and the nesting beach. Developments affecting the nesting beach should take into account both the vulnerability of the resource and the need of the local community for sustainable alternative livelihoods. The community could then benefit from their management actions through a variety of sustainable activities, particularly eco-tourism. ADECORO is currently negotiating with the Ministry of the Environment and other interested parties in order to achieve these aims.

Table 2. **Turtle nests destroyed by dogs in 1994 (of 2,860 nests) and 1996 (of 3,162 nests) (*=subsequent to dog control programme)**

	Jan.	*Feb.*	*March*	*April*	*May*	*June*	*July*	*Aug.*	*Sept.*	*Oct.*	*Nov.*	*Dec.*	*Total Predated*	*% Predated*
1994	70	52	31	24	10	15	37	35	32	51	42	18	417	**15%**
1996	89	48	46	41	16	14	**1***	**4***	**6***	**5***	**16***	**6***	292	**9%**

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El Niño Related Coral Bleaching in Palau, Western Caroline Islands

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Complete references for this article are found on pages 17 and 18 of the online version at www.orf.org/CURRENTS/autumn99.pdf

Introduction

Coral reefs throughout the world are currently experiencing unprecedented degradation (Wilkinson 1992, Sebens 1994). The changes generally comprise reduced coral cover, fish abundance, and overall species diversity (Wilkinson 1992, Hughes 1994, Edmunds and Bruno 1996, Jackson 1997). Although there are certainly many causal factors (e.g. overfishing, outbreaks of coral diseases and predators, sedimentation and nutrient inputs; Sebens 1994, Jackson 1997), coral bleaching is currently viewed as a major agent of change in coral reef communities (Brown 1997). Bleaching refers to the loss of symbiotic dinoflagellates (zooxanthellae), from the host tissue of scleractinians and other cnidarians, a reduction in zooxanthellae pigmentation, or both (Hoegh-Guldberg & Smith 1989). Bleaching is considered to be a response to environmental stresses including elevated sea water temperature (Hoegh-Guldberg & Smith 1989, Gates *et al*. 1992, Jokiel & Coles 1990), high irradiance (Lessor *et al*. 1990, Gleason & Wellington 1993), calm weather (Jaap 1979), and decreased salinity (Goreau 1964). Effects on coral populations range from total recovery in one or two months to mortality rates of nearly 100 % (Glynn 1984, 1990, Harriott 1985, Fitt *et al*. 1993). On a scale of months to years such high mortality rates may not affect many other reef inhabitants since the dead coral skeletons remain in place and should continue to provide spatial refuge. However, prolonged recovery and subsequent bioerosion can result in habitat loss with cascading effects on numerous fish and invertebrate species (Glynn 1993, Sebens 1994).

Although biologists have been aware of localized bleaching for over a century (Glynn 1993), mass bleaching episodes that result in large-scale coral mortality were first recorded in the early 1980's (Glynn 1984). Since then there have been several similar bleaching events on reefs around the world (e.g. Roberts 1987, Lang *et al*. 1992, Hoegh-Guldburg & Salvatt 1995, Brown 1997) and there is evidence that the frequency and severity of bleaching has increased (Glynn 1991, 1993, Goreau 1992, Hoegh-Guldburg & Salvatt 1995, Brown 1997, Winter *et al*. 1998). This view has been reinforced by wide-spread bleaching in association with 1997/1998 El Niño Southern Oscillation event which resulted in sea surface temperatures 1 - 4°C above normal summer highs over a broad geographic range and by some measures was the strongest El Niño on record (McPhaden 1999). Coincident mild to catastrophic bleaching has been reported from many locations world-wide including the Caribbean, Indian Ocean, east Africa, southeast and east Asia, and the eastern and western Pacific (Baird & Marshall 1998, Wilkinson 1998, see report at: http://coral.aoml.noaa.gov/gcrmn/mass-bleach.html, Berkelmans & Oliver 1999).

The purpose of this study was to document wide-spread coral bleaching in the Republic of Palau, western Caroline Islands that was associated with the 1997/1998 El Niño. We documented the 1998 bleaching event in Palau by several methods including line transects at numerous sites and qualitative in situ and aerial surveys over a larger area. We quantified the percentage of living coral cover that was bleached at one or two depths (3 - 5 m and 10 - 12 m) at nine sites to determine the spatial extent of the bleaching across sites, depths, and habitats. A variety of habitat types were sampled including highly protected lagoon and fringing reefs, vertical reef walls, exposed barrier reefs, as well as reefs with both high and low tidal current

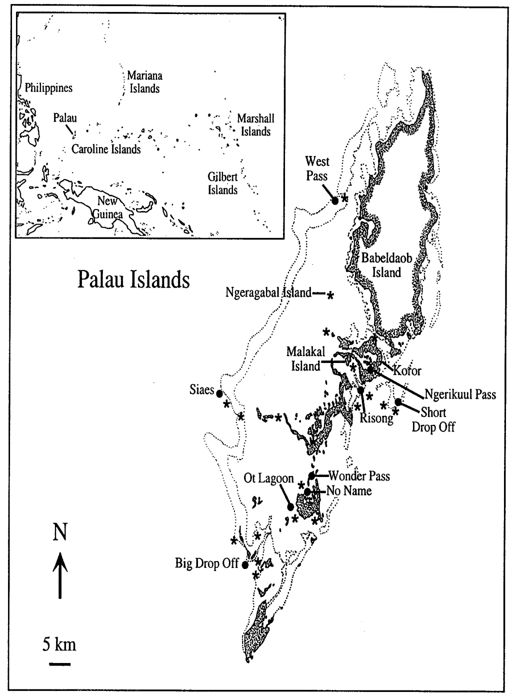

Fig. 1 Map of study sites in Palau

velocities. We also surveyed numerous (964) colonies from five sites and twenty coral taxa to determine how general the bleaching was within the Scleractinia.

Initial Qualitative Observations

The first indications of coral bleaching in Palau were seen in late June 1998, as small portion of healthy coral colonies became light in color. By mid-July it was evident that numerous species were starting to bleach and through August the extent of bleaching increased markedly. In

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September 1998 aerial surveys undertaken to assess the geographic extent of bleaching indicated that bleaching was evident throughout the Palau archipelago. Bleaching of large colonies, particularly *Porites lutea* and *P. lobata*, could be seen from 2,500 m altitude. Qualitative observations suggested that bleaching intensity peaked during September and October, with large numbers of colonies and species totally bleached or already dead. In situ surveys using SCUBA in lagoonal areas indicated bleaching was common to depths of at least 35 - 40 m. On outer reef drop offs, bleaching was observed to depths of 55 - 60 m, the lower limits of most colonial scleractinians in Palau (P. Colin unpublished data). Many other coral reef organisms were bleached including a majority of colonies of common Alcyoniid soft corals such as *Sarcophyton* spp. and *Lobophyton* spp. and a number of giant clams (*Tridacna gigas*).

Methods

Study Location and Sites

The Palau archipelago in the western Pacific (07ºN, 134ºE) is a group of hundreds of small and large islands and lagoons surrounded by an extensive barrier reef. Palau has the highest shallow water marine species diversity found in Micronesia, with over 350 species of scleractinian corals reported (Veron 1986, 1995, Maragos et al. 1994), plus approximately 200 species of other anthozoans.

Six of the nine sites that were sampled quantitatively (Fig. 1, Table 1; Risong Lagoon, Ot Lagoon, No Name, Ngerikuul Pass, Wonder Pass, and Big Drop Off) were located in the southern rock island region of Palau which consists of hundreds of small limestone islands that are often surrounded by a narrow (5 - 30 m), shallow (1 - 5 m depth) shelf/fringing reef that ends at a near vertical drop off or wall that usually extends down to 20 - 30 m in depth. The rock island sites are all protected from open ocean swells, but experience a range of local tidal flow conditions (J. Witman unpublished data). The other three sites (West Pass, Siaes Reef, and Short Drop Off) were located on the 120 km long, exposed outer barrier reef.

Quantitative Survey Techniques

The spatial extent of scleractinian bleaching was quantified in November, 1998 using the point-intercept technique (Lang *et al*. 1992) at two depths: at 3 - 5 m on the horizontal fringing reefs or reef crests at eight sites and at 10 - 12 m depth on vertical rock and reef walls at six sites. Three horizontal 20 m transect lines were haphazardly placed at each sampled depth/site combination. The sessile organisms and substrate directly beneath each 10 cm increment was characterized as one of four categories: healthy coral (coral tissue with apparently "normal" coloration), bleached coral (coral tissue that was obviously pale or white in appearance), recently dead coral (corals that had apparently died in the last few weeks - this category includes both the "just dead" and "recently dead" categories of Lang *et al*. 1992), and other (which included bare substrate, dead coral skeletons, and space occupied by other organisms). Means and standard errors were calculated from the three replicate transects at each depth/site combination. We examined variation in bleaching at the colony level within and among coral taxa in five 1 x 30 m video band transects placed along the 10 - 12 m depth contour (one per site at five sites: West Pass, Ot Lagoon, No Name, Siaes, and Ngerikuul Pass). Video transects were analyzed in the laboratory by scoring each coral colony (or individual coral polyp in the case of solitary corals) that fell within the bands as healthy, partially bleached or totally bleached (> 90 % of the coral tissue was pale or white). These data were pooled across sites for analysis.

Temperature Measurements

Sea Surface Temperature (SST) was measured biweekly at an offshore reef area (Short Drop Off) using a hand-held mercury thermometer, beginning > 1year prior to the bleaching event. We also utilized large-scale SST anomaly images that were provided by the United States National Oceanic and Atmospheric Administration and are available on the world wide web at: http://manati.wwb.noaa.gov/orad/sub/noaarsrc.html. These images are based on multi-channel SST satellite imagery data interpolated to a resolution of 50 km and represent elevations over the long-term (1984 - 1993) monthly mean SST.

Results and Discussion

The results of our surveys indicate that the 1998 coral bleaching in Palau was relatively severe and widespread across depths, sites, habitats, and coral taxa. The mean percent cover of bleached scleractinian corals was 18.88 ± 1.45 (mean ± 1 SE) and the cover of healthy corals was only 15.64 ± 1.99 (when pooled across sites and depths). The overall percentage of living scleractinian coral tissue that was bleached (termed bleaching severity) was 53.4 ± 6.2 (range of site

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Table 1. Coordinates and descriptions of sites used in quantitative bleaching surveys in Palau. Flow data (Whitman unpublished) obtained using the dissolution block technique (Thompson and Glenn 1994).

Site	*Coordinates*	*Characteristics*
Big Drop Off	07º 06.32'N, 134º 15.25'E	rock island, med flow
Ngerikuul Pass	07º 19.26'N, 134º 29.78'E	rock island, high flow
Ot Lagoon	07º 09.48'N, 134º 20.53'E	rock island, low flow
Raisong Bay	07º 18.45'N, 134º 28.85'E	rock island, low flow
Short Drop Off	07º 16.47'N, 134º 31.50'E	barrier reef, med flow
West Pass	07º 32.52'N, 134º 28.25'E	barrier reef, high flow
Wonder Pass	07º 10.88'N, 134º 21.65'E	rock island, high flow
No Name	07º 14.80'N, 134º 23.02'E	rock island, low flow
Siaes	07º 18.79'N, 134º 13.43'E	barrier reef, high flow

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means = 32.3 - 79.3) at 3 - 5 m and 68.9 ± 6.2 (45.7 - 91.7) at 10 - 12 m and did not differ significantly between depths (Fig. 2; t = 1.741; df = 1,12; P > 0.05). Although this parameter varied significantly among sites (3-5 m, $F_{7,15} = 6.28$, $P < 0.01$; 10 - 12 m, $F_{5,12} = 3.25$, $P < 0.05$), the lowest recorded percentage at any site/depth combination was 32.3 ± 4.8 (Fig. 2). Among-site variation in the degree of bleaching could have been due to variability in the susceptibility of locally dominant species to thermal stress and might explain why bleaching intensity did not correspond to any obvious site characteristics. For example, bleaching severity did not vary significantly between fringing reef and rock island sites (Kruskal-Wallis test of 3 - 5 m transect data: $X^2 = 0.022$, df = 1, P = 0.88; fringing reef mean ± 1 SE = 18.9 ± 4.9; rock island = 17.6 ± 3.8).

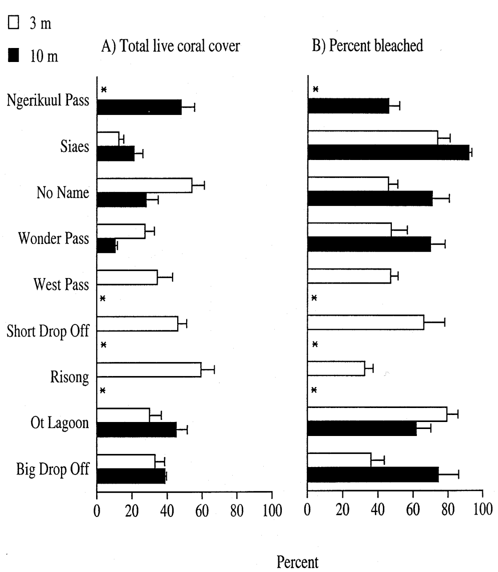

Fig.2 Percentage of the substratum that was covered by (A) live scleractinian corals, and (B) the percentage of that live coral that was "bleached."

The percent cover of recently dead scleractinians ranged from 0 - 6.6 among sites. Our point-intercept sampling took place 12 - 16 weeks after the beginning of severe bleaching and it is possible that many coral colonies died and were overgrown weeks before we quantified the occurrence of recently dead corals.

For example, dead skeletons of tabular Acroporids (e.g. *A. tenuis* and *A. hyacinthus*), still in growth position, were very common at depths of 1 - 10 m at many of the sites we surveyed. However, Palau was affected by a poorly documented infestation of *Acanthaster planci* during the 1970's which impacted a number of reef areas and a subsequent, perhaps smaller, outbreak lasting from the mid 1990's to the present which caused near total coral mortality at some sites (P. Colin personal observations). Because plating species of *Acropora* are a preferred prey of *A. planci* (Birkeland 1982, Colgan 1987), it is unclear if predation or bleaching (or some other factor) was the source of mortality for these normally common species.

Nearly half (48 %) of the 946 colonies surveyed in the video transects (pooled across twenty taxa) were totally bleached, and 15 % were partially bleached (Table 2). However, there was considerable variation among taxa and a few (e.g. *Goniopora* spp. and *Montipora* spp.) displayed much lower bleaching frequencies. Such taxa specific bleaching susceptibility could result in a major shift in species composition on reefs that have been severely or repeatedly bleached (Glynn 1993). Interestingly, at the generic level, the relative bleaching frequencies we recorded in the quantitative surveys do not correspond to the order of susceptibility reported from previous Pacific bleaching episodes in which *Acropora* spp. was the most susceptible and *Porites* spp. was the least susceptible taxa (Gleason 1993, Hoegh-Guldberg & Salvat 1995). However, variation within genera may account for the discrepancies between our results and previous reports. For example, qualitative surveys indicated considerable variation in bleaching susceptibility among Acroporid species as some had apparently experienced nearly 100% mortality (e.g. *A. echinata, A. hyacinthus*), while other species appeared unaffected (e.g. *corymbose Acroporids*). Despite strong variation among taxa, gross colony morphology was not strongly related to bleaching as some species with massive (e.g. *Porites lutea*), branching (e.g. *Acropora formosa*), tabular (e.g. *Acropora hyacinthus*), plating (e.g. *Pachyseris speciosa*), and free-living (e.g. *Fungia fungites*) morphologies all exhibited high frequencies of bleaching (Table 2).

The direct causes of coral bleaching have proved difficult to elucidate (Brown 1987, Edmunds 1994). Nonetheless, a number of experimental laboratory studies have demonstrated the importance of increased water temperature (Hoegh-Guldberg & Smith 1989, Glynn and D+Croz 1990, Gates et al. 1992, review in Brown 1997) and many past mass-bleaching episodes were correlated with sea surface temperatures 1-4º C above normal summer highs (Glynn 1984, Gates 1990, Hoegh-Guldberg & Salvat 1995, Brown *et al*. 1996, Winter *et al.* 1998). For example, the 1983/1983 El Niño caused 2 - 3º C SST increases and was related to especially severe bleaching and high rates of coral mortality in the Eastern Pacific (Glynn 1983, 1984, 1990). It is generally thought that SST increases of 3 - 4º C for 1 - 2 days or 1 - 2º C for several weeks are required to cause severe thermal bleaching (Glynn 1993).

Local temperature records indicate that water temperatures in Palau were 31º C for a period of at least 30 days, during the late summer of 1998 (Fig. 3A), when El Niño related increases in SST peaked in the western Pacific (McPhaden 1999). SSTs at Short Drop Off reef were > 1.5º C higher in 1998 than the previous year (Fig. 3A). Furthermore, satellite-based SST measurements for the Palau region indicate that during the late summer of 1998 SST was 1.0 - 1.25 greater than the long-term monthly mean (Fig. 3B). Additional daily SST measurements taken in Malakal Harbor on the island of Malakal (Fig. 1), during and after the bleaching event, indicated that SST was generally 0.5º C higher in this protected lagoon than at Short Drop Off which is an offshore reef. During normal conditions on the outer reefs there are two moderate (1 - 3º C) thermoclines between the surface and 100 m depth, however during the period of bleaching, none occurred and the water

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column was isothermal. These data suggest that El Niño related STT increases are likely the cause of the 1998 bleaching in Palau. However, El Niño/La Niña events can also be associated with unusually calm periods that can enhance shallow subtidal irradiance levels (Lesser *et al*. 1990, Gleason & Wellington 1993). Thus, increases in irradiance may have contributed to this bleaching event.

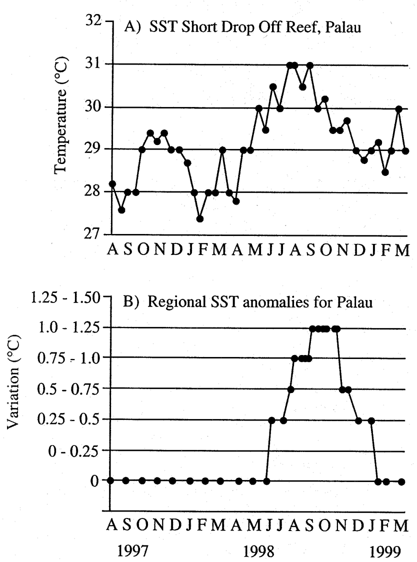

Fig.3 Local SSTs (A) and regional SST anomalies (B) for the Palau region.

The effects of the 1998 bleaching in Palau are difficult to asses in more detail because of the lack of quantitative baseline data. A qualitative rapid ecological assessment of Palau's reefs in 1992 reported that "coral reefs in Palau are in excellent condition supporting diverse and abundant coral reef, seagrass, mangrove and lagoon ecosystems" and "only a few coral reef areas have been subjected to anthropogenic impacts" (Maragos & Cook 1995). Ultimately, the affects of the 1998 bleaching will be determined by rates of coral recovery and mortality and subsequent regrowth and recruitment. Moderate to severe mortality of corals that were bleached in 1998 could reduce coral cover to < 10 - 20 % at a number of rock island and barrier reef sites. As of May 1999, there appears to have been very little recovery of bleached corals following the return of SST to normal levels (P. Colin personal observations). Preliminary estimates of mortality based on reefs that were originally sampled with low altitude (300 m or less) aerial photographs and resampled using SCUBA indicate that bleaching related mortality was relatively high for some massive reef-building species. For example, at one patch reef in the central lagoon near the small island of Ngeragabal (Fig. 1), in nearly all cases, colonies of *Porites* spp. that were bleached in September were dead by December (n = 100 colonies). However, not all *Porites* spp. colonies on this reef bleached. Non-bleached colonies were not evident in the aerial photographs and of 491 *Porites* spp. colonies surveyed at this site, 40% were found to be alive, 30% were heavily damaged by bleaching but a portion was still alive, and 30% were completely dead. These results are concordant with qualitative observations at numerous other sites during early 1999, which suggested that bleaching related mortality although variable, was high for some species.

Reef-building corals have inhabited shallow tropical waters for > 200 million years (Stanley 1981). However, they only generated coral reef habitats intermittently during periods when water temperature and ocean chemistry were favorable to high calcification rates (Veron 1995). During numerous periods of non-optimal environmental conditions, scleractinians experienced high extinction rates, were largely restricted to habitat refuges, and generally did not create large structures (Veron 1995). If climatic phenomena such as El Niño become more frequent or severe or act in conjunction with anthropogenic sources of stress, reef-building corals may not be able to maintain their current role as habitat providers to numerous reef-dependent taxa (Sebens 1994, Brown 1997). Because of the critical importance of coral reefs to tropical marine species diversity and human economic interests, their fate should be regarded as a pressing scientific, conservation, and social issue.

Table 2. Percentage of colonies of each scleractinian taxa that displayed normal or health coloration, and those that were partially or totally bleached. Data pooled from 5 sites.

Taxa	*% Healthy*	*% Bleached*	*% Part. Blch.*	*Number*
Acropora sp.	62	32	6	47
Astreopora sp.	41	50	9	22
Favia sp.	16	71	13	80
Favites sp.	23	61	17	168
Fungia sp.	28	51	21	121
Galaxea sp.	60	20	20	5
Goniopora sp.	95	0	5	20
Heliofungia actiniformis	100	0	0	11
Lobophyllia sp.	8	83	9	88
Montipora sp.	92	5	4	83
Pachyseris speciosa	17	58	25	12
Pavona sp.	65	10	25	20
Pectinia paeonia	18	53	29	17
Physogyra lichtensteini	14	86	0	7
Platygyra sp.	41	55	5	22
Pocillopora sp.	60	20	20	25
Porites sp.	35	42	23	168
Psammocora contigua	0	100	0	25
Scolymia sp.	88	13	0	8
Turbinaria sp.	47	13	40	15
TOTALS	37	48	15	964

On The Coast of Pulau Banyak, Indonesia

By Thomas Stringell
Environment Programme Pulau Banyak

Straddling the Equator, Indonesia stretches about 5,000km across four time zones (6ºN to 10ºS and 95ºE to 142ºE), and is one of the most biologically diverse regions on the planet. Indonesia is the world's biggest archipelago consisting of 17,508 islands, and some of these islands are excellent examples of 'island biogeography' yielding many endemic species. Pulau Banyak (97º 05'E, 02º 03'N) is a small archipelago off the west coast of Sumatra. It is abound with fantastic beaches, coral reefs and pristine forests that represent some of Indonesia's impressive biodiversity.

Indonesia's Coastal Ecosystems

Indonesia has an interesting geological and zoo-geographical history which contributes to the archipelago being inhabited by many of the worlds most productive ecological communities. For example, the maze of islands yields a complex pattern of currents and shallow fertile seas in which coral reefs thrive. It has been estimated that two-thirds of the Indonesian coastline is protected by coral reefs. This is possibly an overestimate, however, Indonesia is close to the centre of coral diversity with 350 species from 75 genera of hard corals recorded (Soegiarto, 1997). Scientists have also reported a high diversity of reef fish, with 268 species in East Indonesia and 179 in West Indonesia (Chou, 1998). Mangrove forests also add to the region's productivity and diversity and can be found extensively throughout Indonesia with large stands on the east coast of Sumatra. Altogether, Indonesia, with 81,000 km of coastline, is undoubtedly one of the, if not the, richest areas of marine life in the Indo-Pacific.

The Habitats of Sumatra

Sumatra, which lies on the Sunda shelf with Borneo, Java and Bali, comprises representatives of the entire range of Indonesian habitats: swampy wetlands and extensive mangrove forests on the eastern coast, the lowland rainforests of central Sumatra, the upland and alpine forests of the Bukit Barisan mountains

Fig. 1 Location of Pulau Banyak

along the entire west coast, and the jungle beaches of the Indian Ocean fringes. The famous Sea Gardens of Pulau Weh on the northernmost tip of Sumatra demonstrate that coral reefs have not been left out of the Sumatran habitat list.

Introducing Pulau Banyak

Pulau Banyak lies between the islands of Simeulue to the north-west and Nias to the south-east, off the west coast of Aceh, Sumatra's north-westernmost province (Fig. 1). It is a remote series of islands with a population of less than 5,000.

As its name suggests ("many islands" in Indonesian), this small archipelago officially consists of 99 islands. The land area covers approximately 15,000 ha, while the sea within the Pulau Banyak District (Kecematan Pulau Banyak) covers about 212,000 ha. Its tropical positioning provides a hot humid climate with a wet season between June and November, the 'Western Season' or southwest monsoon, and a dry season between November and May, the 'Eastern Season' or northeast monsoon. The 'Western Season' is characterized by strong winds from the west making the western and northern coasts prone to very large waves.

Coastal Communities

Like Sumatra, Pulau Banyak (Fig. 2) also has a healthy array of habitats and wildlife. The following outlines the region's coastal environment. A more comprehensive species list is found at http://www.bart.nl/~edcolijn/sumatra.html.

Coastal Forests, Rivers and Beaches

The two largest islands, Tuangku and Bangkaru, are covered by dense, pristine lowland rainforest with many tree ferns, strangler fig trees (*Ficus* sp.) and many epiphytes such as the birds-nest fern. The interior of these islands and much of the coastal areas away from settlements are uncharted. The forests of Tuangku are rarely visited by humans as access is made difficult due to the dense jungle surrounding the periphery of the rainforest. Tuangku is home to the only monkeys found in Pulau Banyak, the macaques and leaf monkeys (silvered and banded).

Near the coasts, the lowland forest gives way to a community of mostly screw pines (*Pandanus* sp.), rattan palms and nipa palms (*Nypa fruticans*) along river edges. Most resident animal species are representatives from the nearby forest, not far from the coasts and rivers.

Fig. 2 The habitats of Pulau Banyak

Examples of these include the lesser mousedeer, plantain squirrels, hill mynah (*Gracula religiosa*), flocking magpies (*Platysmurus leucopterus*) and treepies (*Dendrocitta occipitalis*), occasional island flying foxes (*Pteropus*

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hypomelanus) and numerous land crabs (*Gecarcinidae* sp.). More specifically around rivers, the blue-eared and storkbilled kingfishers (*Alcedo* sp. and *Pelargopsis capensis*), white bellied sea-eagles (*Haliaeetus leucogaster*), Brahminy kite (*Haliastur indus*), water monitor lizards (*Varanus salvator*), and edible mud crabs (*Potamonidae* sp.) are frequently observed. A few estuarine or saltwater crocodiles (*Crocodylus porosus*) also reportedly exist on and around Bangkaru and Tuangku islands.

Fig. 3 Turtle beach 'Amandangan' on Pulau Bangkaru

Along the beach, only coconut palms, Pandanus pines, thick waxy-leafed woody and ground covering shrubs can withstand the well-drained, sandy, salty and exposed environment. The invertebrates here are mostly marine scavengers luding ghost crabs (*Ocypode* sp) and hermit crabs (*Coenobita* sp).

On Pulau Bangkaru, forest and river species forage on the beaches due to the bountiful supply of turtle eggs. Amandangan beach (Fig. 3) is the main green turtle (*Chelonia mydas*) rookery that also has sporadic nesting of leatherback (*Dermochelys coriacea*) and hawksbill (*Eretmochelys imbricata*) turtles. Green turtle nesting densities are high; between 3 and 15 nests are laid each night throughout the year on the 1.3km beach. Monitor lizards and ghost crabs are the main egg predators. Whilst on the beach, emerging hatchlings, are prone to both previous egg predators and on occasional early morning emergences, the white bellied sea eagle and Brahminy kite arrive to feed almost instantly. Numerous reef fish, particularly snappers (lutjanids and lethrinids) and groupers (serranids) await the hatchlings in the sea.

Mangrove Forests

The mangrove thickets lie in a narrow strip along the sheltered eastern side of Pulau Tuangku. They are ideal nursery grounds for neritic fish species and shrimps, and probably one of the reasons why Pulau Banyak has some of the richest fish stocks in Aceh. The communities are based around *Sonneratia* and *Rhizopora* sp. mangroves, nipa palms and screw pines. The typical fauna found includes grapsid mangrove crabs, fiddler crabs (*Uca* sp.), mangrove oysters (*Isognomon* sp.), mudskippers (*Periophthalamus chrysospilos*) and numerous birds including egrets and previously mentioned raptors. The state of the mangrove forests in Pulau Banyak is unknown as no formal studies have been carried out, but the exploitation of mangroves is thought to be negligible due to local and traditional protective laws. Clear-felling the mangroves for woodchip production was once a potential threat, but permits were refused owing to the efforts of a locally living Swedish conservationist, Mahmud Bangkaru.

Rocky Coasts

Most of the coastal areas, not covered by mangroves, are sandy beaches. However on the exposed western coasts, rocky outcrops and tide pools are present. Some of the typical species exposed to severe wave action include encrusting lichens; corraline algal turfs in the sublittoral zone; balanomorpha barnacles, mytelid mussels, limpets (*Patelloida saccharina*), echinoids including *Heterocentrotus* sp., the armour plated *Colobocentrotus* sp., and less frequently sea urchins (*Diadema setosum*) in the eulittoral zone. In the eulittoral, grapsid crabs are frequently found on the intertidal rocks and can be observed exploring the winkle-dominated littoral zone.

Shallow Seas

Scattered sea grass beds exist in the shallow seas and are thought to be feeding grounds for the resident dugongs (*Dugong dugon*). The population size of dugongs is unknown, but they can occasionally be viewed at night in these sea grass beds. Dugongs are present in small numbers throughout the western Acehnese islands from south Simeulue to north Nias, and possibly beyond these distributions.

Turtle grass offers good grazing for many fish and a possible feeding ground for green turtles, although this has not been observed. The sea grass beds are not extensive but the potential for growth is good. In fact, seaweed cultivation (*Eucheuma* sp.) has been proposed as an alternative source of income to fishing.

Of note are the frequently observed pan-tropical spotted dolphins (*Stenella attenuata*).

Coral Reefs

The most complete fringing coral reefs are found around the many islands in the shallow seas between Tuangku and Balai (Fig. 4) and fringing reefs surround the

Fig. 4 Aerial view of the fringing reefs around some of Pulau Banyaks' islands

three main islands. Most observations have been made of reefs close to main human settlements or tourist areas, which have generally been subjected to a certain degree of damage from coral collection, fishing and anchor use. Thorough surveys have not been carried out in Pulau Banyak, but presumably around its more remote islands, coral reefs would be

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more healthy, with diverse fish and invertebrate communities. Pulau Banyak has been previously noted for its important reef invertebrate resources (UNEP/IUCN, 1988). These remote island reefs may still not be remote enough to hinder destructive fishing practices particularly with the use of bombs. However, this type of fishing is hated and forbidden by most of the resident traditional fishermen.

The fringing reefs are typical of Indo-Pacific coral reefs. Rounded colonies of honeycomb coral (*Favites* sp.) are found in the shallows and ramified *Acropora* sp. coral and brain coral (*Platygyra* sp.) are common in the outer reef margin. The following list indicates some of fish and invertebrate species observed on the reefs of Pulau Banyak: blacktip reef shark (*Carcharinus melanopterus*), honeycomb stingray (*Himantura uarnak*), yellow margin triggerfish (*Pseudoballistes flavimarginatus*), coral grouper (*Cephalopholis miniata*), parrotfish (*Scarus* sp.), blue surgeonfish (*Acanthurus leucosternon*), trumpetfish (*Aulostomus chinensis*), indian turkeyfish (*Pterois miles*), unicornfish (*Naso* sp.), blackspotted pufferfish (*Arothron stellatus*), butterflyfish (*Chaetodon* sp.), christmas tree worm (*Spirobranchus giganteus*), and from shells washed up on the beach, the tiger cowrie (*Cypraeae tigris*), topshells (*Trochus* sp. and *Clanculus* sp.) and the beautiful nautilus (*Nautilus pompilius*).

The Yayasan Pulau Banyak
The Environmental Program

Pulau Banyak is a remote, undeveloped and poor region that may benefit from sustainable development based around the conservation of its wildlife and natural habitats. A long term environmental conservation and community development project, the Environmental Program Pulau Banyak (EPPB), has been set up, implemented and controlled by the Yayasan Pulau Banyak (YPB - Pulau Banyak Foundation).

The programme aims to study, conserve, preserve, and to increase the awareness of various aspects of the island's anthropological and biological diversity. Achieving the objectives is being accomplished by implementing community-based conservation measures. For example, setting up independent community groups that are supported and advised by the Yayasan has improved access to educational resources, and confirmed community ownership of the land and shore habitats, an important step in initiating habitat and species conservation. Detailed plans are outlined in the EPPB's overview of management and activities available from the project's directors.

Threats to Marine Habitats

Waste disposal from islands, with very limited infrastructure, is primitive and a potential health hazard for localised areas around the two main villages of Haloban and Balai. Its influence on the marine life of these specific areas has not been studied, although it is probable that some degree of eutrophication occurs particularly in sheltered harbour areas, and an increase in sedimentation on nearby coral reefs is likely. In Pulau Banyak, coral is extensively used as a traditional building material, adding further destructive pressure to the reefs.

Ninety percent of the local community's work force are fishermen who work alone or in small groups. The majority of fishing activity relies on coral reef fish communities. Coral reef destruction is a problem in Pulau Banyak, as dynamite, bomb and poison fishing by resident and outside fishermen does occur and could potentially outcompete traditional artisanal fishing practices. Parts of the archipelago's reefs have been exploited in this way and the extent of the damage is visible, yet has not been assessed so far. By lack of clear fishery guidelines, statistics and quotas, the region's fish stocks remain dangerously unmonitored. The population levels and fish communities are poorly understood and it is therefore impossible to know whether even lightly exploitative fishing has any lasting detrimental effect on the reef communities.

In principal, foreign ships are forbidden to enter the waters of Pulau Banyak unless carrying necessary permits, and large fishing trawlers have been banned by a presidential decree. In reality, non-resident fishermen (including large foreign ships reportedly from Taiwan) frequent the waters and, due to no implementation of exclusive fishing zones (or law enforcement should they be in place), the productive shallow seas surrounding the islands are viewed as common grounds, to the aggravation of local fishermen. As these seas are not held in common management and are essentially open to everyone, the situation is a part of the 'Tragedy of Open Access' and coral reef destruction is therefore likely to increase. The EPPB is developing proposals to tackle such fishery problems such as setting up a Fishermen's Alliance and introducing exclusive fishing rights for resident fishermen. The benefits and disadvantages of such proposals are reviewed in Steeman (1997) available from the project directors.

Incidental catch of sea turtles and dugongs is probably more significant offshore, where large fishing boats net for fish, than inshore where most resident fishermen predominate. Local fishermen seldom use nets inshore and rely on line and hook. Incidents of sea turtle and dugong catches are unlikely to be logged and the fate of the animal purely speculative, although they would probably not be kept for food. Turtles are considered 'macro' by the Muslims of Aceh, which in terms of religion, means that turtles can be eaten but are not recommended. Turtle eggs however, can be eaten. In the neighbouring island of Nias, neither turtle meat nor turtle eggs can be consumed. Here, an animal living in 'two worlds' is a forbidden food. The religious status of dugong meat is unknown by the author, but they were once hunted in Pulau Banyak. It seems that dugong hunting has now stopped for reasons unknown.

The nesting green turtle population of

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Pulau Banyak, Indonesia

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Amandangan beach on the uninhabited island of Pulau Bangkaru, has been known for at least 30 years. Anecdotal evidence suggests that about 10 years ago egg poaching was a profitable and organised venture that was given written concession by the Regency of Aceh. The number of eggs that were taken over this period is unknown, but over-harvesting was likely, since the profits from egg sales funded the development of parts of Pulau Banyak, the building of fishing boats and were used to pay government charges. Currently, poaching is thought to be of low intensity, although quantitative information is not available, since the beach is not constantly monitored. The present day turtle project seems to have reduced poaching to a very low opportunistic level.

Litter is relatively abundant on Amandangan beach and to a lesser extent on more sheltered beaches. Plastic bottles for example, are washed in from the Indian Ocean, their origin being wide-ranging, not only from Indonesia, highlighting this global problem.

The Future of Pulau Banyak

Pulau Banyak is a very poor region. Identifying potential sources of income to develop the region's economy and encourage conservation, is a major drive of the EPPB. Anthropologically, the archipelago has a very interesting history with an influence of many regional cultures, five distinct languages, a strong tradition of spiritualism yielding many 'Pawang' (spiritual guides or shamens) and of course the diversity of habitats and wildlife. Traditional medicines from forest plants have not been fully replaced by modern equivalents. Many of the animal species in Pulau Banyak have a superstitious importance, for example, the coastal oriental magpie-robin (*Copsychus saularis*). Its regular song perch is often found beside a local resident's home and if their colourful song is followed by flight in a particular direction, it indicates that the resident will be receiving a visitor shortly. Not surprisingly, tourism has increased in the last five years from a handful to approximately 1,000 visitors per year. Much of the income generated by tourism goes towards the sustainable development programme of the EPPB and to partly fund the green turtle monitoring project. Future plans aim to provide an assessment of coral reef damage, a reef species inventory, a thorough habitat map and the status of dugong, crocodile and green turtle populations.

Protection Status

In 1996 the protection status of Pulau Banyak was upgraded from a Wildlife Reserve (Suaka Margasatwa) to a Protected Nature Tourism Park (Taman Wisata Alam). This upgraded legislative protection from the administration of regional government to that of central government, but with this, the Wildlife Reserve status was removed. How this declared status can assist the protection of Pulau Banyak's vulnerable marine habitats is questionable. The boundaries of the Nature Tourism Park are not demarcated in the field, and as such provide no basis for enforcing the park laws.

Even if the park's boundaries were defined, fish, sea turtles and dugongs would still roam areas beyond these boundaries. Enforcing protective legislation via civilian jurisdiction would be very hard to achieve in a strong community and traditional law based archipelago; such remote areas are far from the influence of civil law and central government. A quid pro quo approach would be necessary with defined obligations and incentives; only then could protective legislation and enforcement be effective.

The future of Pulau Banyak's protection status, laws and the conservation efforts of the EPPB remain to be seen. The large green turtle population, extensive coral reefs, and presence of dugongs and saltwater crocodiles add weight to the region's importance. The need for sustainable development based around fisheries, agriculture and ecological conservation can only be achieved with further funding. The EPPB was previously funded by generous grants from Jakarta's Biodiversity Foundation and the Social Foundation Chevron and Texaco from PT Caltex Pacific Indonesia. These have since been exhausted and the programme currently relies on donations by tourists visiting the turtle project base on Bangkaru. The logistic cost of running the turtle project alone is prohibitive and if no further funds can be found EPPB will not be able to conserve this beautiful, remote tropical archipelago.

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The Black Sea - New Challenges

Complex Socio-Economic and Ecological Problems and Solutions

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Introduction

Almost one third of the entire land area of continental Europe drains into the Black Sea. It is an area which includes major parts of seventeen countries, thirteen capital cities and some 160 million people. The second, third and fourth major European rivers, the Danube, Dneper and Don, discharge into this sea, but its only connection to the world's oceans is the narrow Bosphorus Chanel. The Bosporus is as little as 70 meters deep and 700 meters wide, but the depth of the Black Sea itself, exceeds two kilometers in places.

The large natural river supply of phosphorus and nitrogen, essential nutrients for marine plants and algae, has always made the Black Sea very fertile. The tiny floating marine plants known as phytoplankton, which form the base of the marine food chain, are either eaten or die and gradually fall to deeper waters where bacteria decompose them, almost completely. Replenishment of the bottom waters of sea with new seawater from the Mediterranean takes hundreds of years. The bacteria in the bottom waters quickly consume all the oxygen and the sea is virtually dead below a depth of about 180 meters. The Black Sea is the biggest natural anoxic basin in the world.

Hydrogen Sulphide in the Black Sea

As the result past of geological events, its morphometry and specific water balance, nearly 87% of the Black Sea water volume is anoxic and contains high levels of hydrogen sulphide. The 13% of volume that contains oxygen consists of the shallow surface water and the waters from the shelves. The recent eutrophication of the sea has placed even this 13% under severe stress. The introduction of excess nutrient loads has been accompanied by massive phytoplankton blooms (especially flagellates), whose death in turn depletes even the shallow shelf waters of oxygen as the oxidation of organic materials consumes valuable oxygen resources. Up to 40,000 square km of the north-west shelf of Black Sea is now subject to hypoxia. The high levels of hydrogen sulphide, both naturally occurring and exacerbated by anthropogenic factors, have considerable socio-economical and ecological implications.

Most hydrogen sulphide production is due to redox process that occurs in the water column. There is little evidence of hydrogen sulphide production by geothermal or other crustal processes. A single source of hydrogen sulphide was observed during bottom sampling on the north-western shelf, analogous to a "black smoker," but the volumes produced by such geothermal sources are negligible compared with the redox process.

Despite the relatively stable hydrogen sulphide distribution over the last 7,500 years, the level of the interface separating the oxygenated water from the oxygen-deprived lower waters has fluctuated according to the physical oceanography of the region. The hydrogen sulphide layer lies some 100-200 meters below the surface. There are also seasonal and annual fluctuations in the level at which hydrogen sulphide is first encountered. Seasonal atmospheric variations produce considerable variations in circulation (Oguz *et.al*.,1995). The hydrogen sulphide boundary is usually deepest in summer and shallowest in spring. Human use of the Black Sea drainage basin has also had a profound impact on the ecology and oceanography of the Black Sea (Aubrey *et. al*., 1996a).

Eutrophication has risen as the nutrient load has increased, leading to hypoxia and occasional anoxia, particularly on the north-west shelf. This anoxia also leads to the formation of hydrogen sulphide in the shelf zones. Garkavaya (unpublished date) recently recorded hydrogen sulphide concentrations of 1.5 to 2.25 ml/l in the lower water column on the north-western shelf at depths of 10-30 meters. This hydrogen sulphide only became apparent in the 1970's as a consequence of increased levels of eutrophication. Yet hydrogen sulphide on the shelf is still transistory, occurring primarily in summer and autumn, as intense water column mixing during winter and spring reoxygenates the bottom waters. Never the less, the zones of hypoxia have definitely expanded in recent years. From 1973 to 1990, the bottom area affected by hypoxia increased from 3,500 square km to 40,000 square km (Zaitsev, 1993). This undoubtedly led to increases in hydrogen sulphide in the bottom waters, although measurements of hydrogen sulphide are

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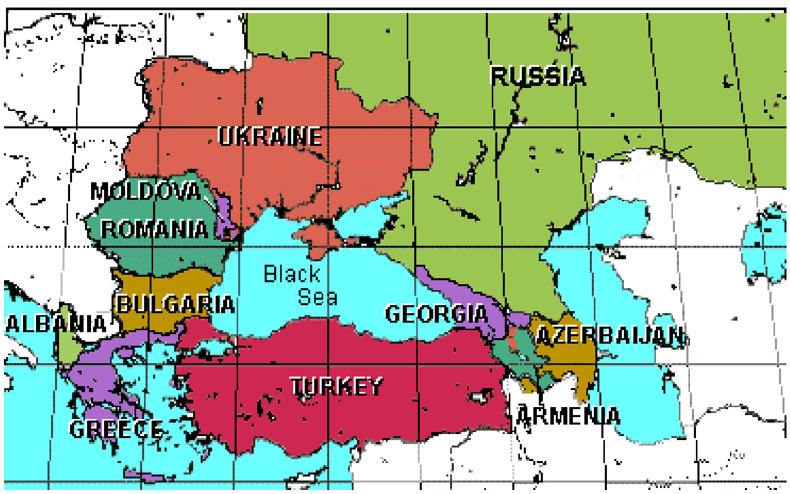
much less abundant than measurements of oxygen levels. Since the north-western shelf is only 64,000square km (limited by the 100 m isobath), the hypoxia has now extended to a significant proportion of the shelf area.

What will happen to the hydrogen sulphide levels in the Black Sea in the future? On the north-western shelf, hydrogen sulphide concentrations may decline as measures are implemented to reduce the nutrient loading. But the improvement in the ecosystem will not be immediate. The sequestering of nutrients in bottom sediments will continue to provide a source of nutrients through benthic fluxes. No reliable data is currently available on nutrient levels in the sediments or the rates of nitrification and denitrification. Additional research on nutrient sequestering on the shelf and on benthic regeneration is required in order to make an accurate assessment of future levels of eutrophication on the shelf once nutrient input from the rivers has been reduced to acceptable levels (Aubrey *et. al*., 1996 b).



But what of the deep hydrogen sulphide in the Black Sea? Will the hydrogen sulphide boundary rise? Fortunately, existing data indicate that this boundary is relatively constant. There is no evidence that the average hydrogen sulphide boundary is shoaling over the basin or that it will do so at a future date.

It is clear that the aggressive reduction of nutrient inputs from river and atmospheric sources will have a positive effect on the ecosystem and reduce the spread of the hydrogen sulphide across the shelf. But the sequestering of nutrients in bottom sediments means that it is still not possible to predict the response time of the ecosystem. In the deep Black Sea the hydrogen sulphide layer appears relatively stable, but large changes in fresh water inflow or physical mixing processes may produce changes in the hydrogen sulphide boundary, which may have a negative impact on the ecosystem as a whole (Aubrey *et al*., 1996 b).

The Black Sea in Crisis

In a period of only three decades, the Black Sea has suffered the catastrophic degradation of a major part of its natural resources. Increased loads of nutrients from rivers caused an overproduction of tiny phytoplankton, which in turn blocked the light reaching the sea grasses and algae, essential components of the sensitive ecosystem of the shelf; the entire ecosystem began to collapse. This problem, coupled with pollution and irrational exploitation of fish stocks, started a sharp decline in fishery resources. To make matters worse, in the mid-1980's, a jellyfish-like species (*Mnemiopsis leidyi*), was accidentally introduced to the Black Sea. Its diet included fish larvae and the tiny animals small fish feed upon. It quickly reached a total mass of 900 million tons (ten times the annual fish harvest of the entire world). Though declining, *Mnemiopsis* continues to plague to Black Sea, but this is not the only problem. Poor planning has destroyed much of the aesthetic resources of the coastlines. Uncontrolled sewage pollution has led to frequent beach closures and considerable losses in the tourist industry. In some places solid waste is being dumped directly in the sea or on valuable wetlands. Tanker accidents and operational discharges have often caused oil pollution. All of this came at a time when five of the Black Sea countries were facing an economic and social transition and were unable to take the necessary urgent remedial actions.

It does not require much insight to appreciate that the exploitation of the Black Sea's resources in the past few decades has been unsustainable. The environment of the Black Sea has deteriorated dramatically in terms of its biodiversity, habitats, fishery resources, aesthetic and recreational value, and water quality. The Black Sea has many uses, ranging from fishing, tourism and mineral extraction on one hand, to its use as a cheap transport route and as a convenient place to dump solid and liquid waste on the other. Many of these uses have an additional economic cost through their impact on the environment. The present environmental crisis has been precipitated largely by ignoring these hidden costs. Like so many environmental issues, by paying little or no attention to these costs, they have been conveniently transferred from one generation to the next.

Industrial Waste Management

During the Soviet period, a huge multi-sectoral industrial machine was operating in Georgia. Recent transitional processes resulted in the almost complete collapse of country's economy. Most industrial enterprises are in a stand-still or operating on a very limited basis. Centralized control of industrial sectors was based on so called "high effectively" approaches, which basically meant unreasonably high

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rates of production. "High effectively" has never meant the integrated consideration of environmental, social and economic issues.

Separate agencies were responsible for the management of generated industrial waste within the sector and the decision-making has also been exercised within the authority of the respective agency. Naturally this has resulted in a widespread practice of disposing of the industrial waste on the territories of the industrial enterprises. Frequently the industrial waste was disposed of on community waste landfill sites without any reference to its toxicity and environmental impact. Disposal to specialized landfills was organized only under exceptional circumstances (e. g, radioactive waste disposal).

Decision-making in the field used to be a unilateral process; public participation had never been practiced and there was no sharing of responsibilities. The waste management system has never been fully operational, nor the unified legislation in place.

Today the conditions are even worse. Apparently, the economic recovery will inevitably lead to increased production of industrial waste and simultaneous growth in the volumes and spectrum of community waste in favor of non-recyclable wastes, such as plastic packaging, bottles, and disposable consumer goods.

Due to over-filled old landfill sites and disintegrated systems of waste management, several uncontrolled and illegal landfill sites are emerging in large cities. Near villages and other settlements, disposal sites are located near the water bodies as a rule. For years, the generated industrial waste has been disposed of near the site of origin under the open air, easily susceptible to atmospheric precipitation.

The Need for International Action

The resources of Black Sea, and its problems, are shared by six coastal countries: Bulgaria, Georgia, Romania, Russia, Turkey and Ukraine. Management of the Black Sea's shared resources is the responsibility of these countries, but part of the responsibility for controlling aquatic and airborne pollution should also be shared amongst the other eleven countries which have a major part of their territory in the Black Sea basin. Protection of the Black Sea cannot be achieved on a unilateral basis. Almost every use of the sea and coastal areas has the potential for affecting the well-being of neighboring countries. Even pollution restricted to the vicinity of an industrial plant may affect the economic development of another country by killing juvenile fish which would have otherwise migrated to its coastal seas. On the other hand, countries may wish to over exploit their part of a migrating resource in order to deny access (and advantage) to the neighbors. Joint management and protection of shared marine living resources is one of the few available options to countries bordering the Black Sea. In this manner, a better sense of ownership of the Sea's resources can be attained as "owners" tend to protect their property more than those enjoying a free service. There is a strong need for harmonizing legal and policy objectives and for developing common strategies for investment in the control of pollution. Use of the "common" space must be carefully regulated so that one "user" does not deprive another of his or her rights. Furthermore, only joint international action can hope to do anything to protect the biological diversity of the Black Sea.

Integrated Coastal Zone Management in Georgia

In April, 1992, the governments of Georgia and five other Black Sea coastal nations (Bulgaria, Romania, Russia, Ukraine and Turkey) signed the Convention for the Protection of the Black Sea Against Pollution. The Convention was rapidly ratified by all six countries. The signing of the Convention was followed by the joint Ministrial Declaration on the Protection of the Black Sea (April, 1993, Odessa, Ukraine).

The Odessa Declaration specifically mentions the need for integrated Coastal Zone Management (ICZM), stating that countries should "elaborate and implement national ICZM policies, including legislative measures and economic instruments, in order to ensure sustainable development in the spirit of Agenda 21," thus stressing the importance of developing ICZM practices on the national level.

ICZM activities in Georgia are catalyzed and supported by international donor assistance, particularly within the framework of the regional Black Sea Environmental Program (BSEP), supported by the World Bank, UNDP and UNEP. Currently there are three inter-related programs under way to apply ICZM methodology for managing the Georgian Black Sea coast:

1) BSEP ICZM activities (implemented through the designated Focal point in the country), which has contributed significantly into the development of the country's ICZM network of institutions and produced the comprehensive National ICZM Report (Dzneladze, 1996).

2) BSEP ICZM Pilot Project (due to be initiated soon and implemented by the private consulting company ARCI Studio) will attempt to translate the general management principles into detailed instructions and regulations for both central and local coastal authorities, as well as to develop technical tools such as Geographic Information Systems (GIS) in support of the decision-making process.

3) The World Bank/GEF funded Georgia ICZM Program, initiated after the stimulating national ICZM workshop in April, 1995.

BSEP ICZM Focal Point is coordinating all these efforts to guarantee coherent implementation and to avoid duplication.

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The Black Sea-Ecological Problems and Solutions

Regardless of the collective and individual attempts of many states, ecological conditions of the Black Sea are becoming worse because of the increasing anthropogenic influence. Launching of the TRASECA and Oil Transit projects in the near future will increase cargo ship traffic in the eastern part of the Black Sea, particularly in the economic zone of Georgia. In this situation, if special precautions are not taken, not only will general conditions become worse, but the real danger of a major ecological disaster will occur.

Transport lanes, which are not arranged well ecologically are the very reason for the heavy and irreversible processes in the environment; These are: a) anthropogenic changes in the climate; b) increasing pollution of the world's ocean; and c) degradation of the ecological system.

One of the most significant (powerful) instruments for protection of the environmental balance is modern international law, which generally has coordinating character. In this regard one of the most efficient measures is the UNO Convention on Marine Law, which has been in effect since 1982 and is called "Overall Constitution of the World Ocean." The International Marine Organization (IMO) with its Convention provides regulations and control of ecological diversions and environmental disasters caused by ships.

Projected cargo circulation of the TRASECA and Oil transit Project equals to 30-40 tones per annum. Over half of this cargo will be oil. To provide transportation of this volume 1,300-1,500 ships of 30-50 tones displacement are necessary. This implies that the Batumi-Supsa-Poti section of Georgian coast will sustain the most ecological pressure, and this region has the highest recreation value which can provide $200 million US annually.

Establishment of coastal monitoring for the Georgian economic zone should be exercised according to the ALARA (As low as reasonable) principle. According to this concept, transport technology should be created which will provide the least damage to the environment. The operation of the transport systems should be implemented in such a way that will not endanger the existing ecosystem and losses of species affected by system should not exceed 5%.

The ecological monitoring system should include an immediate reaction unit (Ecological Patrol), the main task of which would be the immediate identification of pollution sources, their origin and liquidation. The monitoring network should be introduced in two areas: a) environmental units operating on the ships in the open sea; and b) complex facilities on the shore. The ecological patrol unit, together with the rescue coordination center, is also responsible for monitoring of pollution levels at ports and within the limits of sea routes, corresponding to the transport system.

According to the convention by the IMO, SOLAS 74/78/88 (Safe of Life at Sea), Chapter 5, regulation 8(b), the State is responsible to provide the organization of the Traffic Separation Schemes with radio location centers in the exclusive economic zones where there is extensive traffic. This system should be arranged at the Batumi-Supsa-Poti ports, to provide regulation and control of the ship flow in order to avoid vessels collisions.

To avoid duplication, the monitoring system shall operate together with a meteorological center. This coordinated system with a powerful communication network will provide constant monitoring of the open seas and coastal zones. The main components of this system are: a) high frequency mobile net in the open seas and coastal zones; b) immediate response patrol; c) analytic center with communication facilities; d) comprehensive marine legislation with regard to marine pollution.

Unfortunately, Georgia is currently unable to finance the necessary research and then implement the results. Donations and investments are being sought to realize the dream of creating a comprehensive marine monitoring system in Georgia.

PCBs in Pacific Orcas

Seattle, WA

High concentrations of the toxic chemical polychlorinated biphenyls (PCB) have been found in the Pacific killer whale (*Orcinus orca*) population off the coast of the Pacific Northwest, as reported in a recent article by lead author Dr. Peter Ross of the Institute of Ocean Sciences in Sidney, B.C. These killer whales are now considered among the most contaminated marine mammals in the world.

Researchers collected blubber samples from 47 orcas in the coastal populations that swim the waters around Washington and British Columbia. Tissue samples were collected with 6.4 mm pneumatic darts. The most contaminated were the high-seas transients and the Washington "J," "K," and "L" pods. PCB levels in transient males averaged 251 ppm

The researchers are concerned over the population's survival as PCBs are known to weaken the animals' immune system and the population could be wiped out by a virus. The chemical may cause birth defects by passing through the females' placenta, and is also transmitted to the calves through the mothers' high-fat milk.

Recommended Reading

Due out January 2000

Saving the Gray Whale: People, Politics and Conservation in Baja California
Serge Dedina, Ph.D.
University of Arizona

In this book, Serge Dedina takes us on a journey into the gray whale lagoons of Baja California, an in-depth look at the conservation of Mexico's marine animal superstar and the battle to protect Laguna San Ignacio. Serge's book is a must-read for all who think saving gray whales is a simple issue. Look for this book on the ORF website soon!

Postcards from the Field

Conservation Volunteer Work in SE Asia – Barbara Strnadova

I was really hoping that my trip to Asia would include some volunteer work while I was going to be abroad for 5 months. I tried with great enthusiasm to line up a job or two working with any turtle or coral conservation group in South East Asia. I proceeded to send a ton of e-mails to anyone remotely related to this kind of work in that part of the world. To my dismay I slowly realized that parts of Asia are extremely disorganized and quite behind us in conservation organizations.

The only organizations with a set agenda, were through more elite western-based companies which charge an arm and a leg for "vacationers" to help scientists do research. So, due to my traveling on a shoestring budget, I was unable to set up any serious volunteering from the US.

So I flew off to Bangkok, traveled through Thailand, Cambodia, Malaysia, and finally landed in Indonesia. On the Island of Bali while searching for a reputable dive shop, I found a scuba center called "Reef Seen Aquatics" who ran a Green Sea Turtle rehabilitation center on the north shore of western Bali in the town of Pemuteran. I was so excited and impressed for Bali to have a haven of such caliber. Bali is the only Hindu based island in the center of the giant Muslim based archipelago of Indonesia. The Balinese-Hindu culture slaughters close to 10,000 giant green sea turtles each year for their meat and shells. Only about 6000 are actually sacrificed for holy events such as cremations ceremonies. It was too late in my trip to volunteer for I was leaving in a few days. So I donated some money in hopes of continuing to support their turtle project, which in Balinese is called "Proyek Penyu". They have a hatchery and have developed holding tanks for random turtles as well as turtle whom are confiscated from people or animal markets. There are laws in Indonesia to protect endangered turtles, which are not often enforced due to corruption in their current governmental system.

Well maybe someday Asia will become more unified and be able to fully protect their underwater Garden of Eden from all the unpatrolled fishing. Until then organizations like "Proyek Penyu" could surly use donations. Even $10 US goes such a long way with the weak exchange rates in these struggling countries.

Barbara Strnadova has worked with the ASPCA (American Society for the Prevention of Cruelty for Animals) for 2 years as a Photo Editor and Photographer for their publications department. She is currently establishing herself as a wildlife, animal welfare and fire art photographer. She recently returned from a 5-month trek through South East Asia.

Vision Paper is a small, innovative company that has taken a clearly unique approach to paper. Their mission is to make the most environmentally positive products possible. Vision Paper works with U.S. farmers to grow an annual row crop called kenaf. This crop is used as their raw material instead of trees. Vision manufactures paper, without using any chlorine compounds. ORF is proud to use Re:Vision 100% recycled rrocessed chlorine-free, 50% kenaf - 50% PCW paper for this newsletter. For information about this paper contact Vision Paper, PO Box 20399, Albuquerque, NM 87154, Phone (505) 294-0293 or visit their website at www.visionpaper.com.

Acknowledgements!

The Oceanic Resource Foundation extends our appreciation to the David and Lucile Packard Foundation for a research grant of $25,000 for a long term loggerhead sea turtle satellite tagging project being conducted by Wallace J. Nichols. This grant is expected to substantially fund the Baja California project during the 2000 season.

We would also like to thank the Alan and CC Blank Enviro-Mental Foundation for a contribution of $1,250 in support of the Loreto Grupo Tortuguero Meeting 2000.

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Palau Bleaching

We would like to thank the staff of the Coral Reef Research Foundation laboratory in Palau for their support and also A. Strong and the National Oceanic and Atmosphere Administration/National Environmental Satellite, Data, and Information Service for providing large-scale SST data. This research was funded in part by a National Science Foundation grant (#OCE-9730647) to Jon D.Witman and a National Science Foundation dissertation improvement award to John F. Bruno.

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Indonesia Conservation

Our thanks to Thomas Stringell, Mahmud Bangkaru, Arnoud Steeman, Lynn Bateman and all the YPB and the Environmental Programme Pulau Banyak staff and volunteers

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Costa Rica Turtles

ADECORO would like to thank the following organisations for financial support: The Chelonia Institute, US Fish and Wildlife Service through the Aquatic Resources Conservation Group, Secretaria de Estado para la Cooperación Internacional y para Iberoamérica, Ministerio de Asuntos Exteriores de España (SECIPI) through the Asociación para el Estudio y Defensa de los Ecosistemas Marinos (AEDMAR). We also wish to acknowledge the invaluable work of Tierras Unidas Vecinales para el Ambiente (TUVA) and numerous local participants and foreign volunteers.

ORF needs your support. Become a member today!

Support the Baja Sea Turtle Group with a donation today and receive a free t-shirt.

The Oceanic Resource Foundation is restoring sea turtles and conducting coral reef research in the ocean waters off the Baja California peninsula. Patrolling remote beaches, tagging and monitoring adult turtles, and conducting underwater coral reef surveys and fish population counts require the participation of volunteers and sustaining contributions from environmentally concerned supporters.

Become an ORF member. Help us protect Baja's Vizcaino Biosphere Reserve (a UN World Heritage Site), Laguna San Ignacio and Bahia Magdalena, Cabo Pulmo National Marine Park, Loreto National Marine Park, and over 100 kilometers of turtle nesting beaches at Los Cabos.

ORF is a 501(c)(3) tax-exempt organization.

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KUDOS

ORF gratefully acknowledges contributions to this and upcoming issues of *Currents* by Houg Govan, ADECORO; John F. Bruno, Brown University; Thomas B. Stringell, EPPB; Shota Kunchulia, Batumi Marine Academy; Kakhaber Bilashvili, Irakli Khomeriki, Parmen Margvelashvili, Giorgi Metreveli, & Zurab Savaneli, Tbilisi State University (Republic of Abkhazia); Wallace J. Nichols, University of Arizona; Michelle Kinzel, ORF; Barbara Strnadova; James Tucker Jr., Graphic Design (Tortuguero logo); and Vision Paper. Thanks from the editor! GLC

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Printed on Re:Vision 50/50 Kenaf / Recycled Paper

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