or rarity. Catching a fish larger than 12 inches (30.5 cm) from the small size group will do no harm, as the members of this group reach maturity at a length of about 6 inches (15 cm). The extra-large group contains one very rare species that is not caught in commercial fisheries. These two size restrictions are expected to result in about 80 per cent of commercial and potentially commercial grouper species being caught after they have spawned at least once in their life.

Review statistics collection

To implement most of the recommended measures effectively, catch-and-effort and export data are required. Therefore, it is important to review the present system of collecting grouper statistics to improve the quality of data.

Aquaculture

Experiments in grouper aquaculture should be done with the long-term aim of increasing grouper production through cultured stocks and sea ranching. The Marine Research Section of MOFA has already initiated such experiments.

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Destructive fishing methods in and around Komodo National Park

by Jos Pet [1]

Introduction

Interviews and surveys in and around Komodo National Park (KNP) have resulted in the description of eight different categories of destructive fishing, which are described below. Almost all the information is anecdotal, since documented material is not available. Informants are reluctant to give details on destructive fishing practices and it is therefore most difficult to obtain detailed information on the history of destructive fishing, especially when it comes to locations and time periods of occurrence of certain practices.

Some data on frequency of occurrence (Figures 1 and 2) and locations (Figure 3) of destructive fishing methods (mainly fish bombing) have been available at the National Park Authorities since 1988. The park authorities have started documenting detailed information on fishing activities—resource utilisation patterns, described by locations, dates, type of activity, yield, etc.—only since 1996. The local fisheries service cannot provide any such data. It is therefore not possible to come up with detailed historical data on temporal and spatial patterns in destructive fishing effort.

A lot of the information on spatial and temporal differentiation within the KNP area has to be obtained by monitoring the present status of the reef. The Komodo Field Office of the Nature Conservancy (KFO) has therefore started a coral reef survey in which 192 locations are surveyed at three different depths: 0–5 m (manta tow), 5–15 m (diver) and 10–15 m (diver). The status of the reefs is recorded in terms of percentages of 1) live hard coral, 2) dead hard coral standing, 3) coral rubble, 4) soft coral, 5) sand, 6) algae & weeds, 7) rock, and 8) others. This survey will be completed by the end of 1996 and a good picture of

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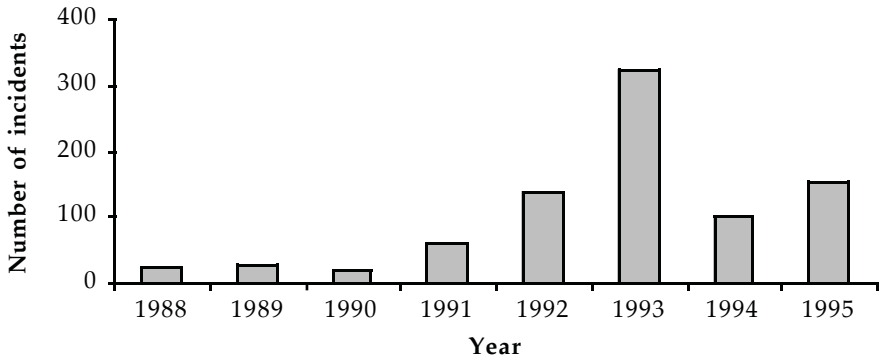

Figure 1: Number of fish-bombing incidents recorded annually in Komodo National Park

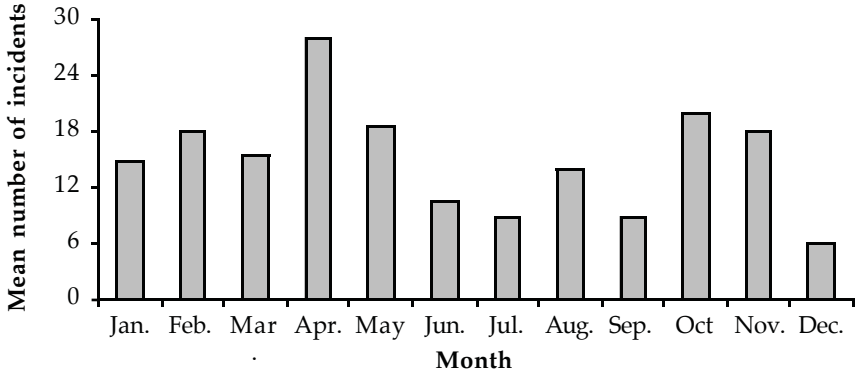

Figure 2: Mean number of fish-bombing incidents per month in Komodo National Park, 1992–1995

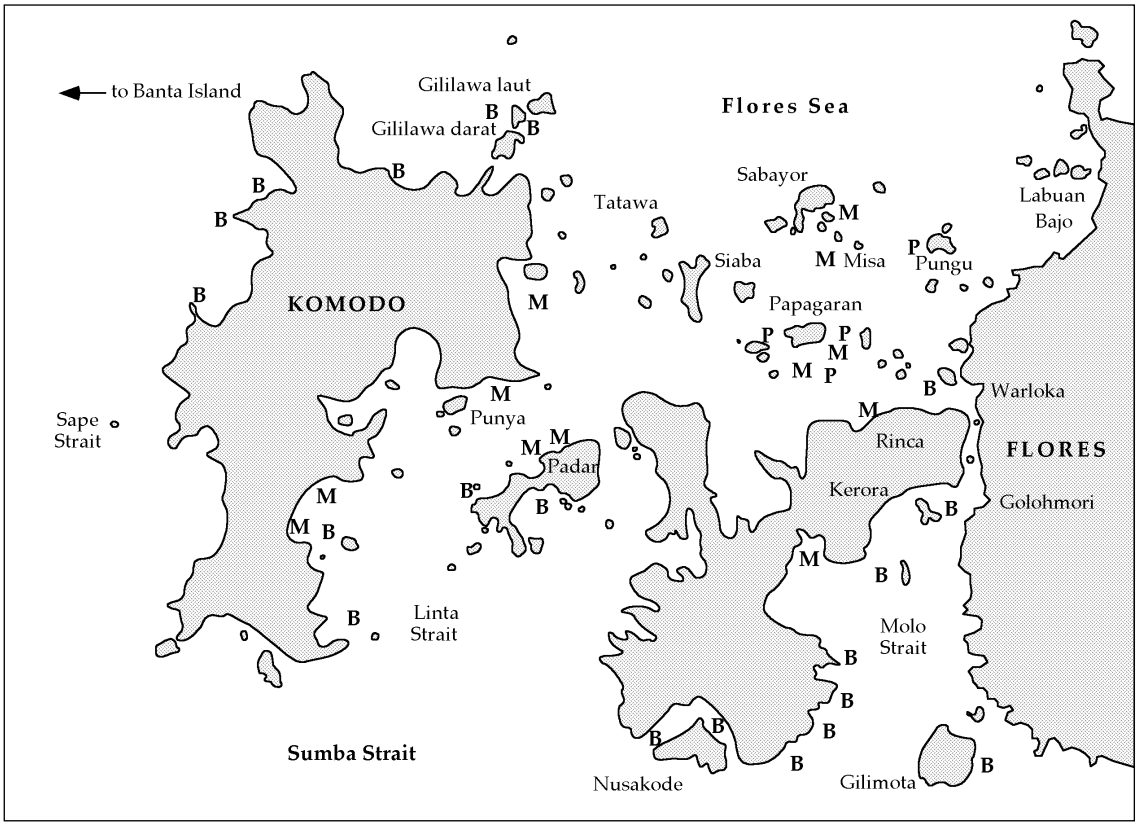

Figure 3: Locations of destructive fishing methods
B: Bombing — **M:** 'Meting' — **P:** Poisoning

the status of the reefs should result. Preliminary results show the following overall mean percentages (for 72 locations at the north side of the park): 1) 15% live hard coral, 2) 15% dead coral standing, 3) 35% coral rubble; 4) 15% soft coral, 5) 15% sand, and 6,7,8) 5 % algae, weeds, rock and others.

The variation between locations seems to be high. The areas of coral rubble that are overgrown with soft corals were probably destroyed earlier than the areas which consist of large percentages of pure (white) coral rubble. Coral rubble with a thick layer of algae may form an intermediate stage.

Categories of destructive fishing

1. Fish Bombing

'Modern' fish bombs are usually made from glass bottles filled with fertilizer (urea) which has been mixed with diesel or kerosene. Dynamite is sometimes added. Bombs with a burning fuse are thrown from the boat when 'shallow-water bombing' (0–10 m). When 'deep-water bombing' (more than 5–10 m), the bomb, which is connected to an electric ignition cable, is brought down to a good position by a diver when a fish aggregation is spotted. This bomb is then detonated from the boat by the use of batteries. In choosing an area for fish bombing the fishermen do not look for a particular type of habitat, although the water depth should preferably be less than 10 m for boats without compressors and less than 25 m even for boats with compressors (diving fishermen).

Fish bombers look for fish aggregations, using face masks, snorkelling around areas where fish are expected. When no fish aggregations are encountered they are sometimes 'created' by chumming a reef area with small fish or chopped-up larger bait A typical bombing operation takes around one week at sea and yields around 500 to 1000 kg of dried fish.

In general it can be said that all reefs, rocks, seamounts and bays are potential bombing areas (and have been in fact bombed in the case of KNP). Figure 3 shows confirmed bombing locations as recorded by National Park Authorities. Places which are less affected (and still have good coral) are usually small seamounts in the middle of the straits (very heavy current) where it is difficult for fish bombers to operate successfully. A potential bombing area should preferably not be too close to any village or ranger station, although several hard-core bombers have been known to operate in full sight of the park rangers (defending themselves with bombs if arrests are attempted).

Fish bombing in the KNP area is said to have already started on a very small scale before the second world war. During the war the Japanese soldiers introduced fish bombing on a much larger scale and local fishermen adopted the method, using different kinds of ammunition and grenades. Since that time it has apparently been very easy for fishermen to obtain or make explosives, and bombing has been practised throughout the area on a very large scale since the early 1950s.

No regulations or enforcement limited fish bombing until the early 1980s when the National Park was established. Virtually all fishing communities in and around KNP were involved in fish bombing between roughly 1950 and 1980. No detailed and/or documented material is available for this period. KNP data show an increase in the number of recorded fish bombings between 1988 and 1993 (Figure 1) but it is unclear whether this represents an actual increase in occurrence. Increased law-enforcement effectiveness (fast boats; sufficient funds for operations; cooperation of KNP, the police and the army; use of firearms) have resulted in a decreasing occurrence of fish bombing since 1993 and this occurrence has become very low since early 1996 when the Park Authorities implemented a weekly marine patrol which investigates all fishing activities in the park. A number of bombing crews were arrested in 1996, including one of the leading figures who unfortunately died when he tried to throw a bomb at the patrol boat.

At present (August 1996) it is said that fishing communities in and around KNP are no longer involved in fish bombing, Only a small group of 10 local persons from Bajo Pulau, Sape (a former hard-core bombing community) is said to be still involved in bombing. Outside bombers from Pulau Palue, Maumere and Ende still visit the area but the frequency has become very low. Many former dynamite fishermen say they have stopped bombing because enforcement has become too effective for them to take the risk. Accidents with fish bombings have also played a role, but there are no signs of much 'increased awareness' of the effects on the habitat and the resource itself.

The fish bombers are most active in the periods between the monsoons (April – May and October – November, see Figure 2), when there is little wind and their work is therefore easier (the north-west monsoon peaks in January – February, the south-east monsoon peaks in July – August).

2. Cyanide fishing for aquarium fish

Cyanide fishing for aquarium fish is said to have been widespread around 5–10 years ago, but is now rarely observed in the KNP area. Fishermen from Madura (East Java) were traditionally involved in this practice and are still visiting the area regularly in search of sea cucumber, anemones and other species. Lombok fishermen are also said to have been involved in the aquarium-fish trade. The aquarium-fish catchers usually operated in the area just north of the National Park where many coral reefs are found (now largely destroyed). Main locations were Pulau Kanawa (up to five years ago, now protected by the owner who used to be heavily involved in cyanide fisheries but now has a tourist operation on the island) and Pulau Seraya (still visited occasionally by aquarium-fish collectors).

The solutions which are used in this fishery vary but are usually around 1 tablet (ca. 13 grams) per litre of water. Cyanide tablets are dissolved in water in half-litre squirt bottles or battery-water bottles and the solution is squirted around individual fish or small aggregations.

Aquarium-fish collectors are said to work a specific area (reef) for about three days, after which they will move to a next location. A typical trip takes around two weeks and covers four locations. These fishermen are said not to return to a specific location for a second time, since the reefs where they worked would be empty of target species for long periods. However, different groups have been observed to work on the same location at intervals of several weeks to several months. An important reason not to return to any specific location is the fear of law enforcement, local fishermen often inform the authorities of outside intruders.

3. Cyanide fishing for live groupers and Napoleon wrasse

Informants from the KNP area (former cyanide fishermen and divers who used to work for the Hong Kong-based operation) were reportedly always supplied with ready-to-use solution of cyanide in water and they did not know the concentration. Informants from other areas (Bima, Ujung Pandang) confirmed the use of tablets dissolved in water (1 tablet of about 13 grams per litre of water), in the same concentration as was mentioned for aquarium fish.

This type of fishery has only been active for a few years and virtually disappeared after 1995 (leaving behind one of the Hong Kong built motherships which is still lying abandoned in the harbour of Labuan Hajo), reportedly since enforcement and public awareness became too much of a problem. Former employees of the Hong Kong-based operation say that catches were still good and declining yields were not the reason for stopping the operation. Handlining for groupers still continues, mainly in areas north of the park where numerous holding cages contain live groupers which are supposedly caught by hook and line.

Former employees/divers of the Hong Kong traders say that the main area of operation for the live reef food-fish traders was the southern part of Rinca Island and its bays. This is a rocky area where barramundi cod *(Cromileptis altivelis,* a valuable species) is still abundant (pers. obs.). The former divers say they worked mainly at depths of 10 to 20 m.

They reportedly moved continuously from one location to the next, never returning to locations which they had fished out. Other sources say that a lot of cyanide fishing for grouper and wrasse also took place around the coral reefs north of the National Park. This is also where most of the holding cages were (and are) situated and where there is still an active hook-and-line fishery for live grouper.

4. Cyanide fishing for lobster

Fishermen from Bajo Pulau, Sape, East Sumbawa, have started fishing intensively for lobster in Komodo National Park since around 1990. They reportedly use cyanide to stun the lobsters before taking them (undamaged) from holes. This fishery is mostly concentrated around the rocky southern shores of Komodo, Padar and Rinca. There are also coral reefs in these areas which are undoubtedly affected by this fishery. The lobster fishery is very profitable and it is therefore still growing. Around 40 boats, equipped with compressors, are presently active in this fishery. The number of active units is said to be still increasing.

The total amount of cyanide used by this type of fishery is probably much higher than the accumulated amounts of all other types of cyanide fisheries presently operating in the area. Law enforcers and park rangers are not yet checking lobster boats for the presence or use of cyanide, so they can work freely inside the park. The lobsters are transported to Bali where they are sold in the hotels and restaurants. The concentration of the cyanide solution used in this fishery is again reported to be 1 tablet (13 grams) per litre of water.

5. Cyanide fishing for consumption fish

Fishermen from the area between Komodo and Labuan Bajo are reported to have used cyanide also to catch fish for local consumption, although this method has apparently not been used in the area for a few years. Fishermen used fishbait (small fish or chopped-up larger fish) mixed in drums with cyanide solution and then spread out over reef flats and crests. The fish that ate the chum died or were stunned and were then collected. Local fishermen seem to have switched to other types of poison to be used with this same method (see Sections 6 and 7 below).

6. Fishing with natural poisons for consumption fish

A traditional fish poison which is used on the coral reefs of Komodo National Park is called **tuba**. It is a powder made from the seeds of trees. Tree species which were mentioned are *Croton argyratus, Croton tiglium* and *Anamirta cocculus,* but this has not yet been confirmed. The powder of the ground seeds is mixed with water which is then spread out mainly over sea-grass beds to catch rabbitfish (Siganidae). The fish are reportedly only stunned by the poison and do not die of it. Stunned fish are collected for local consumption and dried for sale on local markets. Reefs around northern Rinca and Papagaran were mentioned as main target areas. This method is reportedly widespread and about 60 per cent of all fishermen in the area use **tuba** every now and then. Since this natural poison is difficult to obtain and not very effective (not 'strong' enough), fishermen are starting to introduce chemicals like herbicides and pesticides that they still call **tuba**. This can be confusing in interviews.

7. Fishing with herbicides and pesticides

Whereas fishing with natural poisons has long been used in the KNP area, mostly over sea-grass beds in search of rabbitflsh, agricultural poisons have been introduced recently to fish for small groupers, emperors and snappers over the coral reefs. Fishermen from the area between Komodo and Labuan Bajo are reported to use several types of poisons for this purpose.

Two readily available cheap, and therefore popular, poisons are 'Teodal' (a herbicide/fungicide) and 'Endrin' (a pesticide) which are used to catch a variety of small reef fish for consumption. Both poisons are mixed with drums full of sand which is then dumped over the reef flats and crests. Everything dies. Fishermen say that the sand–poison mixture remains active for three days, so they can keep on collecting fish which pass over the reefs which they have poisoned. Fishermen also report that they do not encounter any fishes over a poisoned reef for at least one week after the operation. They do not fish these reefs for a long period after they have poisoned them.

Teodal is reportedly only used in the sand–poison-mixture-method but Endrin is also used as a replacement for cyanide in the mentioned earlier method (see Section 5), in which the poison is mixed with bait to kill fish eating the chum. Teodal is sold in 0.25 l cans which cost only Rp 12.000 each. Endrin is sold per litre from large drums. A single can of Teodal or 0.25 litre of Endrin is mixed with a large bucket of sand (about 30–40 kg) and this mixture is enough to poison an area of 50 x 50 m of reef. Poisoning the reefs is therefore as cheap as Rp 48,000 or US$ 20 per hectare.

The fish caught with poison are dried and sold at low prices on local markets. This method of using herbicides and pesticides is said to have been introduced in 1993 and is rapidly expanding since it is a 'cheap, easy and effective' method. It also seems to be extremely lethal to the coral reefs and deserves immediate attention from park authorities.

The potential group of users—those who are used to fishing with **tuba**—is very large (60 per cent of all local fishermen). Fishermen from Papagaran (KNP buffer zone, reefs in very bad condition) have been mentioned as users of Teodal and Endrin. Outsiders from Longos at the north coast of Flores are also reported to enter the area and fish with these poisons. It is unclear what percentage of **tuba** fishermen are presently already using Teodal and/or Endrin. It is also unclear whether this method is used in other parts of Indonesia.

Some fishermen say they are opposed to this method, and there have been cases where local fishermen were caught by their fellow community members and fined as much as Rp 100,000 by 40 village leaders. Other reports say, however, that these fishermen were caught only because they poisoned the reefs and collected the fish before their colleagues could get a piece of the pie.

Apparently poisoning operations are collectively planned by larger groups and fixed locations and dates for the operation are decided upon. If one fishermen decides to go out and work over the particular reef before the rest of the group does, he will get a good catch, whereas the people following him will be left empty handed. Such 'private enterprise' is not appreciated by the rest of the community.

8. Fishing for abalone by breaking corals ('meting')

The fishery for abalone (**mata tuju**) has recently (1995–1996) destroyed more coral reefs in the area than any other destructive fishing method. While dynamite and cyanide fishing are becoming less important (on the coral reefs), many fishermen are digging through the reefs, using compressors and steel bar tools (the method is called **meting**), in search of abalone and other invertebrates.

The fishermen break and turn over all the corals (which are also trampled by them in the process) and leave behind them fields of near 100 per cent dead coral rubble. Some of the worst affected reefs are found around the northern islands between Komodo and Labuan Bajo, but also in bays further to the south.

Collecting invertebrates from the reef flat is a traditional activity which was usually focused on sea cucumber and carried out during very low tides. The high price for abalone (Rp 15,000 per kg) and the availability of dive gear (hookah compressors) since 1995 have resulted in a marked increase in this activity. The application of steel tools to break is causing major damage. The most important groups involved in this practice are fishermen from Komodo (inside KNP) and Pulau Misa (just north of KNP).

The fishermen from Komodo do not have compressors. Since early 1995, around 5 boats go out each low tide from Komodo, bringing around 75 people to search for abalone. From Pulau Misa, around 25 boats with compressors have worked the reefs during 1995 and 1996. These fishermen reported that there is now hardly any more abalone to be found in the area and they have now switched to the collection of whip corals (**tali arus**), sold around Rp 3,000 to Rp 4,000 per kg, for which there is apparently a market in Ujung Pandang, South Sulawesi. The whip corals are mostly collected from reef slopes and drop offs in areas of strong currents.