



Protein mining the world's oceans: Australasia as an example of illegal expansion-and-displacement fishing

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Abstract

Illegal, unreported and unregulated (IUU) fishing can lead to irreversible ecosystem changes; however, it is also one of the most difficult forms of fishing to manage and deter. In northern Australia over the past decade there has been a large increase in small-scale IUU fishing. We suggest that this small-scale fishing has arisen because of long-term fisheries over-exploitation in South East Asia. This IUU fishing forms part of the expansion-and-displacement cycle that can rapidly reduce biomass and alter the trophic structure of local ecosystems. With increasing human populations in the region, the pressure to fish illegally is likely to increase. Regional responses are required to deter and monitor the illegal over-exploitation of fisheries resources, which is critical to secure ecosystem stability as climate change and other destructive human activities threaten food security.

Keywords Ecosystem change, food security, illegal unreported and unregulated fishing, sharks, Southeast Asia

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The spatial extent of anthropogenic threats to global marine biodiversity and ecosystem stability (Ludwig *et al.* 1993; Halpern *et al.* 2008) is ever-increasing and threatens the livelihoods and services on which humanity depends (Worm *et al.* 2006). Among current impacts, one of the greatest threats to many marine ecosystems is over-fishing. This may lead to ecosystem changes or states that require many decades to reverse (Jennings and Kaiser 1998; Hutchings and Reynolds 2004; Pauly *et al.* 2005; Reynolds *et al.* 2005; Essington *et al.* 2006; Stobutzki *et al.* 2006a).

Illegal, unreported and unregulated (IUU) fishing plays a major role in over-exploitation of fisheries resources (Pitcher *et al.* 2002; Sumaila *et al.* 2006).

It is also one of the most difficult and expensive types of harvest to quantify (Stobutzki *et al.* 2006b). Nevertheless, current estimates suggest that landed catch from IUU fishing is worth between US\$9–\$23 billion year⁻¹ (Agnew *et al.* 2008), or possibly up to \$41 billion year⁻¹ (Pauly *et al.* 2002). There have been successes in mitigation of IUU fishing by large industrial vessels through measures such as port or point-of-entry monitoring and catch certification (Le Gallic 2008). Such measures, however, require strong governance, infrastructure and enforcement capabilities (FAO 2002) not often available in developing countries. This lack of action against IUU fishing has led to an increase in both industrial and small-scale IUU operations in such countries

(Williams 2007). Where this has occurred, sanctioned or industrial IUU may also displace local artisanal fishers and so may stimulate small-scale IUU. Small-scale fisheries play an important role in providing rural resource and economic needs, and their catches have tended to be higher than those reported in official catch statistics (Zeller *et al.* 2006, 2007). However, these high demands and displaced fisheries leading to small-scale IUU may become a more pervasive problem (Hauck and Kroese 2006; Putt and Anderson 2008). Impacts of IUU fishing are therefore not only limited to countries undergoing rapid increases in effort, they also spread out to surrounding areas, with insidious ecological and economic consequences.

Since the 1960s, over-fishing has had large socio-economic consequences in the Asia-Pacific region (Christensen *et al.* 2003) and has led to disputes over resources and jurisdictional boundaries (Pomeroy *et al.* 2007; Vince 2007). Over-exploitation from IUU fishing has followed a predictable pattern of southward progression from an initial focus on the South China Sea and Gulf of Thailand. Unsustainable harvest has occurred across a range of habitats (coral reef and pelagic ecosystems) and resulted in a decline in the mean trophic level of landings (*sensu* Pauly *et al.* 1998) such that there has been a gradual replacement in catches of large, long-lived fishes [e.g. sharks, groupers (Serranidae) and snappers (Lutjanidae)] by species that are small and short-lived (often described as 'trashfish'; Christensen *et al.* 2003; Suvapepun 1991).

This reduction and change in catch composition has displaced fishing effort for larger and more valuable species to surrounding areas, further spreading the IUU problem. For example, in the Raja Ampat Archipelago of Eastern Indonesia (Ainsworth *et al.* 2008), a region renowned for exceptional coral reef biodiversity (McKenna *et al.* 2002), declines in the catches and abundance of marine resources targeted by commercial and artisanal fisheries were first recognized in the 1970s. These declines continued with biomass of larger species targeted by fisheries now reduced by as much as an order of magnitude (Ainsworth *et al.* 2008). This pattern of over-fishing has continually moved southward (Pomeroy *et al.* 2007; Ainsworth *et al.* 2008). Such movement initially involves small, traditional vessels that are unable to compete with large and efficient industrial operations. Driven out to new areas, they are again displaced by the industrial fleets once resources at their point of

origin have been depleted (Pomeroy *et al.* 2007). This pattern of displacement of effort has been termed 'vacuuming' of resources (analogous to exploitative mining) and leaves depauperate ecosystems and socio-economic hardship in its wake (Pomeroy *et al.* 2007). Furthermore, in areas depleted of fish stocks, destructive fishing practices (i.e. cyanide, explosives) are used to extract and to gather the few resources that remain (McManus 1997).

The continual southward displacement of fishing effort that began in the South China Sea and Gulf of Thailand some decades ago reached the waters of northern Australia in the late 1990s (Fig. 1; Vince 2007; Pomeroy *et al.* 2007). IUU fishers of mainly Indonesian origin target high-value stocks [shark fin, trepang (Holothuroidea), trochus (Trochidae), snappers] in north Australian waters, with predictable consequences. Surveys of the heavily fished Ashmore, Scott and Cartier Reefs in 2003–2004 (inside the Australian-Indonesian Memorandum of Understanding Fishing Box – MoU74) revealed that some shark species have been completely removed from near-reef waters (Fig. 2). In deeper (40–70 m) reef areas, large sharks were 2–4 times less abundant than at unfished reefs just to the south (the Rowley Shoals, north-western Australia). Some species, including silvertip (*Carcharhinus albimarginatus*, Carcharhinidae) and tiger (*Galeocerdo cuvier*, Carcharhinidae) sharks, were completely absent from fished reefs, and some hammerhead sharks (*Sphyrna* spp., Sphyrnidae) were rare (Meekan *et al.* 2006). Stocks of trochus and trepang reveal the same pattern of almost total removal from fished reefs (Rees *et al.* 2003).

There are few data representing the historical levels of IUU fishing in North Australian waters. However, after 2001 there was a large increase in the number of sightings of IUU vessels in north Australian waters by Australian Customs patrol flights (Fig. 1), with a peak occurring in late 2005 and early 2006. Over 4000 small traditional vessels (10–16 m in length) were recorded in aerial surveys during 2006 (average 22 day⁻¹), representing a fleet of between 220 and 600 vessels and a total fishing effort of over 1600 days month⁻¹ (Salini *et al.* 2007). Initially, IUU fishing concentrated on harvesting sharks and trepang, but since 2007, larger steel vessels and trawlers of Chinese origin that target reef-associated and demersal species such as snappers have been sighted (Williams 2007). Indonesian IUU fishers have also begun to

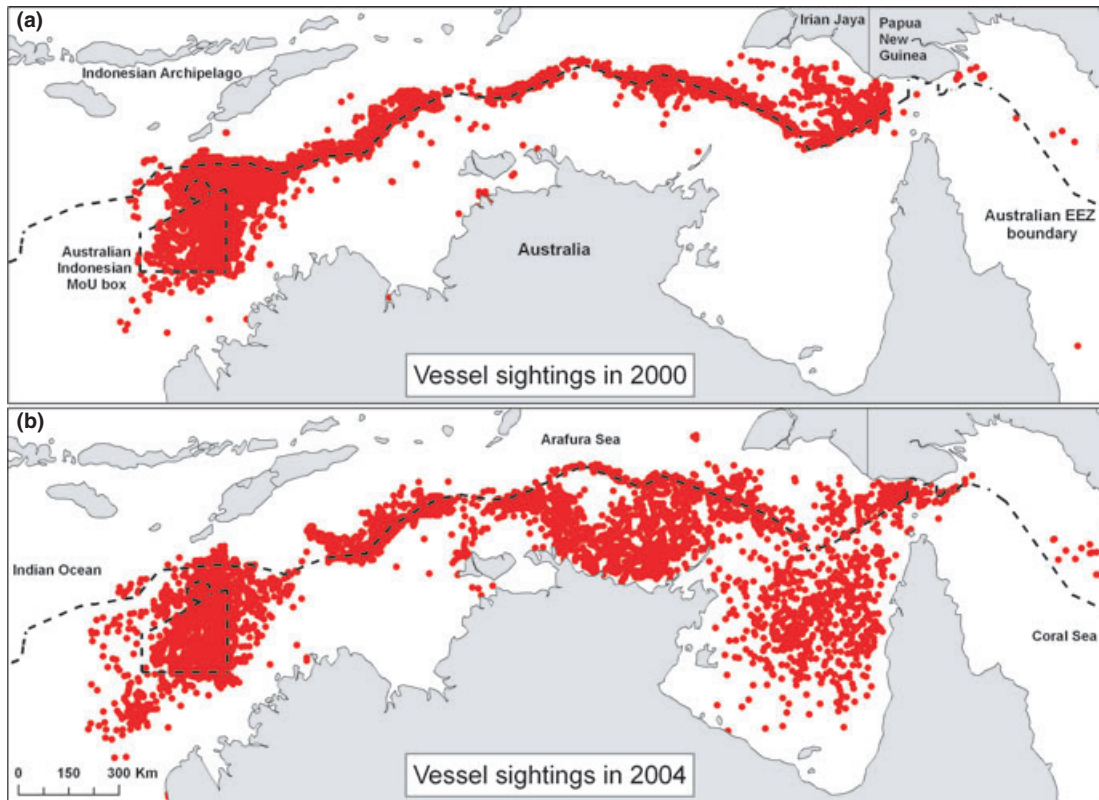


Figure 1 Coastwatch sightings (Banks 2005) of foreign fishing vessels bordering and within the Australian Economic Exclusive Zone (EEZ) in 2000 and 2004 (a and b respectively), showing the southward progression of illegal, unreported and unregulated (IUU) fishing effort.

explore new techniques: for example, harvesting deeper reefs using diving gear (ABC News 2008).

The rapid rise in incursions prompted a compensatory build-up in border security by the Australian Government and two major surveillance and border enforcement operations (Operation 'Clearwater' and 'Breakwater') that resulted in over 454 apprehensions from January 2005 to June 2006 (Salini *et al.* 2007). While this has been argued to be the main driver for a decline in IUU fishing since 2006 (Salini *et al.* 2007), a combination of other factors cannot be ruled out, including international government agreements and domestic policies (Vince 2007), sharp increases in the global price of fuel (Sumaila *et al.* 2008), and reduction in abundance of target species. Although the relative contribution of each is difficult to determine, changes in size and vessel types, gear and target species and resource surveys suggest that exhaustion of stocks in easily accessible regions near the edge of the Australian Exclusive Economic Zone (EEZ) (Fig. 1), particularly for shark

and trepang, may be largely responsible for the reduction of IUU fishing and considered an indication of fishing down the food web (Pauly *et al.* 1998; Pauly 2007).

The invasion of Australian waters by small-scale IUU fishermen has occurred as fleets of large, industrial IUU fishing vessels of mainly Chinese and Taiwanese origin have become common in Indonesian waters (Tonny Wagey, Agency for Marine and Fisheries Research, Indonesia, unpublished data). Some of these large-vessel fleets may be operating in part legally, but with additional vessels fishing under forged licenses or a under joint ventures of dubious legality (Williams 2007). The displacement of small-scale fishers caused by this activity occurs not only to the south, but also to the east of Indonesia into the waters of neighbouring countries such as Papua New Guinea and others in and surrounding the Coral Sea (Williams 2007). Such incursions involve far less risk of apprehension for fishers than voyages into the Australian EEZ,

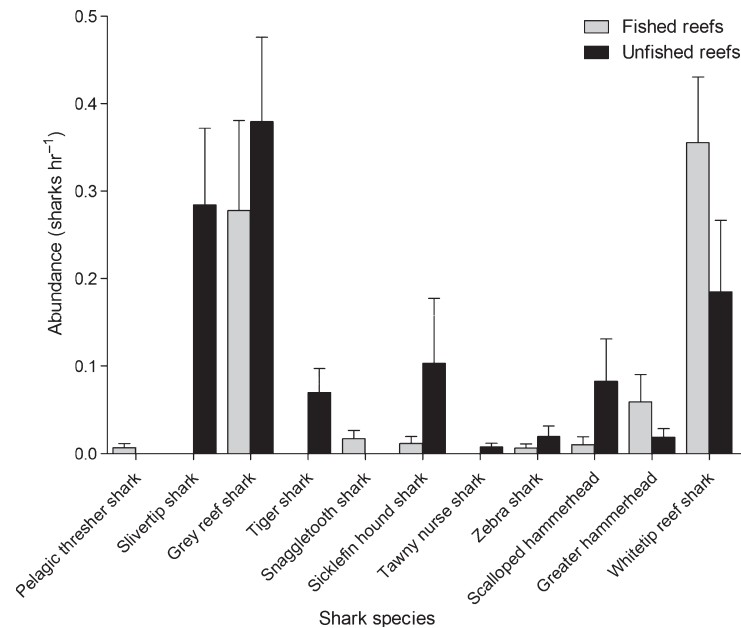


Figure 2 The difference in abundance (mean \pm SE) of pelagic thresher sharks (*Alopias pelagicus*, Alopiidae), slivertip sharks (*Carcharhinus albigmarginatus*, Carcharhinidae), grey reef sharks (*C. amblyrhynchus*, Carcharhinidae), tiger sharks (*G. cuvier*, Carcharhinidae), snaggletooth sharks (*Hemipritys elongate*, Hemigaleidae), sicklefin hound sharks (*Hemitriakis falcate*, Triakidae), tawny nurse sharks (*Nebrius ferrugineus*, Ginglymostomatidae), zebra sharks (*Stegostoma fasciatum*, Stegostomatidae), scalloped hammerhead sharks (*Sphyrna lewini*, Sphyrnidae), greater hammerhead sharks (*S. mokarran*, Sphyrnidae), and whitetip reef sharks (*Triaenodon obesus*, Carcharhinidae) at fished reefs and at the Rowley Shoals prior to fishing (dark grey) and within the Memorandum of Understanding (MoU74) Box (light grey; Meekan *et al.* 2006) measured using baited remote underwater video systems (BRUVS).

and far greater socio-economic consequences for these developing nations whose populace relies heavily on coastal resources to sustain livelihoods (Pomeroy *et al.* 2007). In 2004, the value of the catch by small-scale Indonesian IUU fishers in Papua New Guinean waters was estimated to be 14% of the value of the total legal catch (Williams 2007).

Concerns over IUU fishing often focus on large-scale industrial fisheries. Throughout much of Southeast Asia, these fishers are only part of a larger, more complex problem that involves both large- and small-scale fisheries and the displacement of activity as marine resources are exhausted by successive waves of vessels. As the Australian experience shows, even relatively rich, developed countries may incur substantial loss of sovereign resources and have great difficulty in deterring these invading fishers. This cannot be achieved without substantial investment in border protection. The continued pressure of expanding human populations worldwide (U.S. Census Bureau, 2008), poor or inadequate governance of resource exploitation

in international waters (Ludwig *et al.* 1993; Maguire *et al.* 2006), and potentially catastrophic climate change impacts (Parmesan and Yohe 2003; Harley *et al.* 2006) mean that the most well-managed national marine resources will be under serious threat of ecosystem collapse and loss of food security. This is a regional and global problem that is operating beyond national jurisdictional boundaries. Responses need to be of a similar scale, with coordinated action implemented by regional approaches to shared resources and fisheries.

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