Sustainable Use of Marine Resources Focus Group

Final Report Submitted to the Marine Biodiversity Working Group

21 Sept 2014

A) Introduction to the Focus Group

Aim / objective

To examine the sustainability of the current and predicted use of marine resources in Hong Kong, and make recommendations for improvement and/or areas of further study.

Scope

All uses of the sub-tidal coast and sea within Hong Kong that use biodiversity as an important component of the activity (this excludes activities that simply impact biodiversity such as reclamation and shipping).

Relevant Aichi Targets and Articles

Target 6. By 2020 all fish and invertebrate stocks and aquatic plants are managed and harvested sustainably, legally and applying ecosystem based approaches, so that overfishing is avoided, recovery plans and measures are in place for all depleted species, fisheries have no significant adverse impacts on threatened species and vulnerable ecosystems and the impacts of fisheries on stocks, species and ecosystems are within safe ecological limits.

Target 4. By 2020, at the latest, Governments, business and stakeholders at all levels have taken steps to achieve or have implemented plans for sustainable production and consumption and have kept the impacts of use of natural resources well within safe ecological limits.

Target 7. By 2020 areas under agriculture, aquaculture and forestry are managed sustainably, ensuring conservation of biodiversity.

Target 14. By 2020, ecosystems that provide essential services, including services related to water, and contribute to health, livelihoods and well-being, are restored and safeguarded, taking into account the needs of women, indigenous and local communities, and the poor and vulnerable.

The relevant CBD Articles are listed in Appendix A.

Focus Group Members

The Focus Group was convened by Dr. Andy Cornish and had around 20 members, including AFCD, academics, NGOs, industry and interested stakeholders. Combined expertise covers marine biodiversity and conservation, commercial and recreational

fisheries, mariculture, diving and snorkeling industry, yachting, tourism, and marine education.

A list of members is provided in Appendix D.

B) Introduction to Marine Uses of Biodiversity in Hong Kong

Twenty-two uses of the marine environment were identified, all of which involved the use of marine biodiversity as an important part of the activity. In the case of some of the yachting activities involving vessels, marine biodiversity, while not a key focus of the activity, was believed to enhance the experience and, therefore, less vessel use would occur if there were little marine biodiversity present.

The uses were broadly divided up into i) Fisheries and Mariculture and ii) Recreational, Scientific and Educational Uses

i. Fisheries and Mariculture (including recreational fishing)

- Spearfishing and other underwater harvesting (whether diving or snorkeling)
- Squid jigging (recreational)
- Purse seine fishing
- Gill net fishing
- Trap fishing (including fish cage traps, and crab traps)
- Hook and line fishing (including trolling but excluding longline)
- Longline fishing
- Hand collection of sea urchins and other invertebrates using surface supplied air
- Collection of small reef fishes for the aquarium trade
- Deployment of Artificial Reefs
- Floating cage culture
- Oyster culture

ii. Recreational, Scientific and Educational uses

- Recreational Yachting: Leisure boating (sailing and motoring)
- Commercial day trips: Ferries of all kinds traveling between piers
- Commercial day trips: “Party boats” making day trips to scenic areas
- Dolphin watching
- Educational tours (Including vessel trips to Geo-Parks, guided visits along the coastline)
- Recreational use of beaches and other coastal areas
- Gleaning (hand collection of marine life along the shoreline)
- Scientific research (including by academic institutions, government, environmental consultants and students)
- Recreational diving
- Snorkeling

Methodology (see Appendix D for a more detailed account)

All the uses were examined in terms of Scope, Impact and Irreversibility on marine biodiversity, and scored across each of these criteria (see Box 2, WWF 2007). The combined scores were summed to produce a total score and a ranking of all the uses.

The ranking exercise was intended to reduce subjectivity in assessing impacts to biodiversity, but not to provide a definitive assessment. Members of the group used the scores and their own knowledge to select the uses thought to have the highest impact on marine biodiversity for more detailed assessment as follows (and in rough order of highest perceived negative impact to biodiversity).

- Gill net fishing
- Hook and line fishing (including trolling but excluding longline)
- Spearfishing and other underwater harvesting (whether diving or snorkeling)
- Recreational diving
- Trap fishing (including fish cage traps, and crab traps)
- *Commercial day trips: Ferries of all kinds traveling between piers

*It was decided to combine Commercial day trips: Ferries of all kinds traveling between piers for sightseeing, Commercial day trips: "Party boats" making day trips to scenic areas, Dolphin watching and Recreational Yachting: Leisure boating (sailing and motoring) into a single category of "Recreational Use of Vessels" as the types of impacts were similar.

Artificial reefs were also assessed in more detail as their impact on, and implications for, biodiversity could not be initially assessed with confidence by the group. The detailed assessments for the seven main uses can be found in Appendix B.

The initial assessments of those marine uses not assessed in detail, can be found in Appendix C.

C) FISHERIES USES

i) Introduction to Fishing

What are the main fishing and harvesting techniques used in recent years?

Hong Kong's first inhabitants in the Neolithic period were coastal, and fishing was one of the main subsistence activities. Bronze fish hooks have been excavated dating back to the second millennium BC in Hong Kong, and at one site were found with pebble net weights and several thousand bones of Smooth-headed catfish (*Plicofollis nella* – reported as *Arius leiotetocephus*, a synonym) (Meacham 1995).

The number of fishing vessels in Hong Kong grew rapidly after the Second World War. In the early 1960s, the number of fishing vessels grew to 10,000, most of which were not mechanised. Subsequently, mechanisation was actively pursued, and the number of fishing vessels gradually decreased to around 4,000 at present (excluding non-fishing vessels). On the other hand, the overall engine power of the fishing vessels increased from 400,000 kilowatts in 1985 to 770,000 kilowatts in 2008 (Committee for Sustainable Fisheries, 2010).

As a result of mechanisation and growth of the local fishing fleet, Hong Kong's annual capture fisheries production increased from around 100,000 tonnes in 1965 to 230,000 tonnes in 1989. Afterwards, due to declining fisheries resources and competition from the Mainland fishermen, annual production of the local fishing fleet decreased to 160,000 tonnes. Likewise, a similar downward trend in production value was observed. The average annual production per vessel of the Hong Kong fishing fleet also decreased along with capture production since 1989, with a rebound from

2000 mainly due to the decrease in the number of fishing vessels starting from 2000 (the decrease was mainly among the smaller, low power vessels). Although there were less fishing vessels, their overall engine power continued to increase. The catch per unit of effort (CPUE) (i.e. catch per kilowatt of vessel power) still decreased, reflecting a reduction in fishing efficiency. The fisheries resources in the traditional fishing grounds (the South China Sea and Hong Kong waters) of the Hong Kong fishing fleet exhibited a continual decline due to ovefishing, marine pollution and marine development projects (Committee for Sustainable Fisheries, 2010).

Legislation banning trawling activities in Hong Kong waters came into force on the 31st December 2012, and is discussed further below. The remaining fishing vessels which numbered just under 3,000 in 2012, are mainly small sampans, gill netters, long liners, hand liners and purse seiners, engaged in fishing potentially inside and outside Hong Kong waters.

Estimated number of fishing vessels by type in 2012 – 2013

Gill Netter	202
Long Liner	113
Hand Liner	55
Purse Seiner	90
Fishing Sampan (mixed gear)	2,372

The current numbers of fishing vessels by type is not known, as the registration of fishing vessels was ongoing at the time of finalising this report (Sept 2014).

Which fish and invertebrate stocks and aquatic plants are harvested?

The Hong Kong marine capture fishery is a mixed-species fishery targeting more than 100 species of fish and invertebrates (a small amount of seaweed harvesting also occurs but is not considered further). A definitive list of those species that are harvested by the current (i.e post-trawl ban) Hong Kong fleet, whether intentionally or not, is not readily available, although records of more than 50 major families/species noted by fisherman as being caught in the Port Survey 2006 can be found at www.afcd.gov.hk/english/fisheries/fish_cap/fish_cap_latest/fish_cap_latest_species.html. Around 1,000 species of marine fishes alone have been recorded in local waters, including more than 325 reef associated species (Sadovy and Cornish 2000, To et al. 2013), and as most species are retained unless poisonous or very small, the total number of harvested fish species likely numbers several hundred.

It does not appear that there has been any previous attempt in Hong Kong to define those species or species assemblages that are the target catch, as opposed to the incidental or discarded catch (see definitions in Alverson et al. 1994 – but see Chau and Sadovy 2005 for a survey of 'trash' – non-target fish taken in HK and used as fish feed). Indeed, while it seems likely that at least some of the fishing community targets certain species/species groups at certain times and places – as fishers targeting fry or croakers during spawning seasons did in the past – very little information is available on the degree to which the targeting of specific species occurs.

It will be important to gain more clarity on the most "important" species and species groups for the fishery moving forwards, so that the expectations of the fishing community are married with those of fisheries managers, and to enable management interventions and monitoring to be prioritized. Importance could be determined in

different ways, e.g. for people as well as for the ecosystem, such as herbivores in reef systems.

What are the management objectives for the marine capture fishery?

Recommendations of the Committee on Sustainable Fisheries

The Government policy on fisheries is to conserve the fisheries resources in local waters and promote the sustainable development of the fisheries industry, with a view to maintaining a steady supply of fresh fish to local consumers. Capture fisheries are regulated under Fisheries Protection Ordinance (Cap.171).

The Government established the Committee for Sustainable Fisheries (the CSF) in 2006 to study the long-term direction and goals, as well as feasible options and strategy for the sustainable development of the local fisheries industry.

A key finding of the CSF was that according to a study conducted by the South China Sea Fisheries Research Institute of the Chinese Academy of Fisheries Sciences in 2006 , the maximum sustainable yield (MSY) of Hong Kong waters was estimated to be about 20,500 tonnes, and the fishing effort in terms of engine power should be kept below 140,000 kilowatts. According to statistics in 2006, the fisheries production of Hong Kong waters was around 26,700 tonnes, while the overall engine power of fishing vessels was around 270,000 kilowatts (Committee for Sustainable Fisheries, 2010).

As such, it was concluded that the fisheries production and fishing effort had far exceeded the estimated MSY and the optimum fishing effort. “In view of the continual deterioration of the fisheries resources in Hong Kong waters, it is necessary to further reduce the overall engine power and fisheries production in Hong Kong waters to the level of maximum economic yield in order to accelerate and enhance the recovery of fisheries resources and maximize the economic gains of the fishing vessels operating in Hong Kong waters. If this level is attained, fishermen can have maximum returns at optimal fishing effort, their operations will be the most cost-effective, and fisheries resources will be sustainable” (Committee for Sustainable Fisheries, 2010).

In order to control the fishing effort of local capture fisheries, the Committee proposed to:

. (1) Maintain an appropriate number of fishing vessels;

. (2) Prohibit fishing by non-local vessels in Hong Kong waters;

. (3) Ban trawling in Hong Kong waters;

. (4) Assist trawler fishermen to switch to other operations; and

. (5) Strengthen fisheries management and law enforcement.

The Committee also proposes certain measures to protect important marine and fisheries ecosystems, such as fish spawning and nursery grounds, and to promote the rehabilitation and growth of fisheries resources in Hong Kong waters. The measures included:

. (1) Strengthen regulation of coastal and marine development projects;

. (2) Designate fisheries protection areas (FPAs); and

. (3) Prohibit commercial fishing in marine parks

Recommendations from the Committee, accepted by the Government in 2010, set out the policy blueprint for the sustainable development of fisheries in Hong Kong. To achieve the goals of the sustainable development of the fisheries industry, the Committee formulated two directions for promoting the industry's sustainable development:

> (1) To assist fishermen to develop or switch to modernised and sustainable modes of operation; and
> (2) To protect, conserve and rehabilitate the marine ecosystem and fisheries resources.

The Committee proposed the following measures to promote the sustainable development of the local fisheries industry:

> (I) Promote modernisation of the fisheries industry and sustainable modes of operation;
> (II) Control fishing effort of capture fisheries; and
> (III) Conserve and enhance fisheries resources.

For further information on fisheries management measures, please see "Sustainable Development of Fisheries in Hong Kong" of Marine Biodiversity Working Group (MBWG Paper 03/2013). Additionally, Sumaila et al. (2007) provides socio-economic valuations of the fisheries and societal benefits of various fisheries management measures including a trawling ban and ban on fishing in marine parks.

Current Fisheries Management Measures

To bring the fishing industry back to a sustainable path, the Government amended the Fisheries Protection Ordinance (Cap. 171) to implement a series of fisheries management measures to control the fishing effort in Hong Kong waters and protect important fish spawning and nursery grounds.

One of the key measures taken to help recover the depleted fisheries resources to an ecologically sustainable level was the banning of trawling activities in Hong Kong waters since 31 December 2012, adding it to a category of other banned destructive fishing activities (such as the use of explosives, toxic substances, electricity, dredging and suction devices). The trawling ban removed a destructive fishing method and major fishing pressure (trawlers operating wholly and partly in Hong Kong waters accounted for roughly 80% of the total engine power of the fishing fleet operating in Hong Kong waters) from Hong Kong waters. The remaining fishing vessels are mainly sampans and other small vessels.

The Agriculture, Fisheries and Conservation Department (AFCD) are monitoring the fisheries resources in Hong Kong waters through trawling surveys with a view to assessing the effectiveness of the ban and other complimentary fisheries management measures.

To complement the trawling ban, the Fisheries Protection Ordinance (Cap 171) was

also amended in 2012 for the establishment of a registration system for the local fishing vessels, limiting new entrants to maintain an appropriate level of fishing effort, restricting fishing activities of local non-fishing vessels and prohibiting fishing activities aided by non-local vessels in Hong Kong waters. The Director will issue a Certificate of Registration of Local Fishing Vessel to the owner of a registered vessel. Any person who engages in fishing in Hong Kong waters with the use or aid of the registered vessel (or any of its ancillary vessels) shall carry out fishing activities in accordance with the particulars and conditions specified in the certificate in terms of engine power, maximum number of ancillary vessels, fishing methods, fishing gears, fishing area and fishing period. The registration will remain valid throughout the life span of the vessel and no renewal of registration will be required. An application for replacement of a registered vessel by a new one may be approved, provided that the engine power of the vessel does not exceed that of the replaced vessels.

The objective of these measures is to control the fishing effort (through capping fishing vessel numbers and their horsepower at an appropriate level) in Hong Kong waters, and hence the pressure on all the fisheries resources holistically. The measures do not address or focus on particular species or particular gears (other than trawling).

Fisheries management measures are intended to put the development of the fisheries industry on a sustainable track. AFCD considers that, in the short to medium term, priority should be given to implementing recommendations of the CSF, e.g. establishment of Fisheries Protection Areas (FPAs) to protect important spawning and nursery grounds, conducting fisheries resources enhancement programmes, and assessing the effectiveness of the trawl ban.

No direct fisheries subsidies are in place, although fishermen may benefit from low interest loans.

In addition, the Government has in place various measures to protect the marine environment and reduce the impact of development works and water pollution. These include designation of marine parks and a marine reserve, enforcing the legislation governing environmental impact assessments, water pollution control, and implementing schemes to strengthen control of pollution sources and sewage treatment.

At the time of finalizing this report, there were four marine parks, and one marine reserve, covering around 2% of Hong Kong waters. Three more marine parks have been proposed to extend protection for the Chinese white dolphin, at the Brother's Islands, South West Lantau, the Soko Islands, as well as an expansion of the existing Sha Chau Lung Kwu Chau Marine Park. The coverage of all the current and proposed marine parks is around 5% of local waters.

ii) Main Findings on Fishing

Detailed assessments of Gill net, Cage trap, Hook and line and Spearfishing can be found in Appendix B.

Prior to the trawling ban on the 31st December 2012, a consultancy study carried out by the Agriculture, Fisheries and Conservation Department (AFCD) in 1998, found that due to high fishing pressure, and impacts from marine development projects (such as reclamation, sand dredging and mud dumping) and marine pollution, on

inshore resources and fishing grounds local catch composition had shifted from mainly large, slow-growing and high-value species to small, fast-growing and low-value species including rabbitfishes (Siganidae) and mullets (Mugilidae) (Pitcher et al., 1998; Situ & Sadovy, 2004; Buchary et al., 2003 Cheung & Sadovy 2005). Some species assemblages such as sharks which were still widespread and common in Hong Kong year round in the 1940s (Lin 1940) have become functionally extinct (Lam 2009), while others such as the Chinese bahaba (*Bahaba taipingensis)* have become critically endangered (Wang et al. 2005).

While trawling - which comprised around 80% of the fishing effort, was indiscriminate in the size and species taken, and destroyed living habitat - was most probably the biggest contributor of the fishery to declining stocks, fishing using other gear types will also have played, and continues to play, a part. The ban on trawling activities is intended to enable the marine ecosystem to rehabilitate to an ecologically sustainable level. Species with commercial value should increase in number in local waters and ecologically important sessile species such as corals should also benefit from a less disturbed and healthier marine environment. Restoration of the habitats of marine fauna will in turn promote the diversity of marine life and help safeguard the ecological integrity of the local marine environment.

At the time of writing (Sept. 2014) the status of the fishery, and the sustainability of current fishing operations is not known following the trawling ban and implementation of other measures under the Fisheries Protection Ordinance. These measures were designed to have long-term benefits to the development of sustainable fisheries, and are being monitored by AFCD and other institutes to determine what changes have occurred to fisheries resources such as demersal fishes and invertebrates since the trawling ban. The results of such surveys are not yet available, nor have any determinations of sustainability (e.g. through stock assessments) been made.

Some cases of illegal trawling have occurred since the trawling ban, but this is not thought to be widespread. There were 14 and 5 cases of illegal fishing activity using prohibited dredging device that were successfully prosecuted in 2011 and 2012, respectively. Since the trawl ban, 13 cases of illegal fishing activity using the prohibited trawling gear were successfully prosecuted in 2013. Fishing with banned explosives, and poisons seems to be less prevalent than it has been in the past.

The biggest difficulty in assessing the impacts and sustainability of any of the remaining fishing gears, is separating their impacts from those of other fishing gears, both past and present and future. The effectiveness and selectivity of the remaining fishing gears after trawling ban have not been studied. However, from the data available and summarized in this report, gill nets take a wider range of fish species than hook and line, which in turn are capable of catching and, therefore impacting, a wider range of species than cage traps.

At a stage when some but not all of the recommendations of the 2010 CSF report have been implemented, and are currently being evaluated, this report aims to describe the current fisheries and management against the Aichi targets, and to build on the existing recommendations.

The most recent study to analyse the Hong Kong fishery, and which recommended the ban on trawling and on fishing in marine parks concluded “we want to emphasize that the projected net benefits, both to fishers and to society, are based on the strong assumption that Hong Kong’s fishery resources will be managed efficiently after the implementation of the new management scenarios. That is, there will be no growth in capacity (i.e. the ability to fish) and over-fishing of the stocks thereafter. This means

that an effective licensing, monitoring, control and surveillance system, together with an incentive scheme for fishers to ensure sustainable and efficient fishing by the remaining Hong Kong fleet, will have to be put in place" (Sumaila et al. 2007).

In other words, while the trawling ban commendably removed 80% of fishing effort by vessel power, and elimination of the most destructive legal fishing type, the fishing effort by the current, remaining fleet needs to be maintained at an appropriate level, or this could slow or even prevent the recovery of fish stocks, the ecosystem and biodiversity. Capping the size and horsepower of the remaining fleet – as recent changes to the Fisheries Protection Ordinance has done – was fundamental to achieving this, and a major step in the right direction.

Vigilance is needed to watch for possible shifts in fishing activity as a response to the trawl ban (such as increases in other gear types), which commonly occur after major changes in fishery regulations, and changes in overall fishing effort.

Additionally, the large recreational fishery (notably hook and line but also spearfishing) is not capped nor managed, and it should be anticipated that effort would increase if fish and invertebrate stocks start to recover, as this would provide an incentive to fish more. While recreational fisheries globally are typified by high effort and low catchability and typically harvest less than commercial fisheries, in some areas the reverse is true. Furthermore recreational fishing like commercial fishing has the potential to negatively impact fish, fisheries and aquatic habitats in parallel with commercial fisheries (see Cooke and Cowx 2006).

Hong Kong waters encompass many habitat types, but some commercially important fishes including species of croakers, sea breams and thread fin breams are known to undertake onshore-offshore seasonal movements as adults that would very likely take them into mainland waters. Species whose movements and stocks straddle the waters of Hong Kong will need effective cross-boundary management to be truly effective (see Marine Fish Sub Group report).

The approach to date by Government has been to adopt a holistic ecosystem-based approach to monitor the fishing effort by restricting certain fishing methods or fishing time or location, together with other resources protection and enhancement measures, to promote sustainable fisheries in Hong Kong. AFCD conducts fisheries resource surveys with a view to monitoring the local fisheries resources upon the implementation of the trawl ban and other management measures. Based on the information collected, AFCD will be able to evaluate the fisheries resource situation.

The impact of fishing on species has been disproportionate, with certain species depleted more than others and some under serious risk of extinction (see Marine Fish Focus Group report). All species of marine fishes and invertebrates are currently excluded from protected species status (Whitfort et al. 2013), and there are no species recovery plans in place, nor other measures intended to restore particular depleted species.

Moving forwards, the overarching recommendations of this report are to build on the ongoing management framework and pursue a parallel, synergistic approach, consistent with the precautionary principle. Fisheries management is not an exact science, and the key to success is having access to key up-to-date information, so that science-based adaptive management can be employed.

i) Taking further measures to prevent an increase in or redirection of fishing effort in the near future, through an expansion of areas where fishing is not

permitted or greatly reduced, and to put in place measures to encourage sustainable fishing.

ii) Pro-actively conducting research to fill the highest priority data gaps and implementing increased and ongoing monitoring of the fishery, to indicate whether/where additional management measures may be necessary.

The most appropriate way to encourage sustainable fishing in the mid-to-long term within the fishing community will need detailed discussions with this community, and other key stakeholders. The CBD notes “quotas, allocation of rights to harvester, communities, or other appropriate units, fishing gear restrictions, spatial measures including marine protected areas, catch reductions, partial or full fishery closures, license buybacks” as options.

The commercial fishery is no longer open-access, but limited to existing participants. This opens the door to changing the mind-set of the fishing community to where they see themselves as custodians of the local fishery, and work together to protect and increase the productivity of the fishery for the benefit of all.

Stakeholders could be divided into i) those individuals/communities whose livelihoods depend on the health of marine resources, such as commercial fishers, the recreational fishing industry, businesses supplying goods and services to the fisheries sector, the diving and snorkeling industry, yachting clubs and ii) those who buy local seafood products or enjoy marine biodiversity recreationally or academically and non-governmental organisations with an interest in marine conservation etc. iii) others whose stake in marine resources is less direct.

iii) Data and Other Gaps

When changes to the Fisheries Protection Ordinance (including a ban on trawling) were debated in the Legislative Council in 2010, the Food and Health Bureau stated that it would monitor the remaining commercial and recreational fisheries in the following years to determine whether additional management measures were necessary. While AFCD and the University of Hong Kong have been monitoring the impacts of the trawling ban with “before and after” scientific trawling surveys, the status of pelagic species, and fish and invertebrate stocks inhabiting reefs is, however, not being assessed (either independently, or through the monitoring of commercial catches using gears such as hook and line). In addition, there is no ongoing fisheries monitoring programme, and stock assessments have not been carried out for any species, while the vulnerability of harvested species to extinction has only started to be undertaken as part of the formulation of this BSAP. The last comprehensive trawl survey is > 15 years out of date.

Additionally, the annual harvest of the recreational hook and line fishery, and spearfishing have never been quantified, making it impossible to determine the scale of the annual recreational vs. commercial catch.

The Port Surveys, which are the primary source of fisheries data for AFCD (and for Environmental Impact Assessments), along with baseline studies of fisheries resources conducted by various consultants, have been conducted in 1996/7, 2001/2 and 2006, and collect data through interviews with fishers. These need to be upgraded as i) they are undertaken too sporadically to be able to allow fisheries managers to adjust management to rapid changes “in the water” ii) they do not collect data by species, nor record other crucial information for stock assessments such as the size of individuals caught iii) the way that data has been available to

researchers does not permit direct comparisons over time and iv) they rely on interviews and it seems likely that the resulting production figures for Hong Kong are over-estimates (Sumaila et al. 2007, p77).

While the onus is on Government to conduct ongoing fisheries monitoring programmes to assess the effectiveness of the fisheries management measures, it is also remarkable that local academic institutions conduct so little fisheries related research. Those academic studies that have been made on individual species, and their biology and ecology, provide useful insights. An even greater emphasis on research to inform the sustainability of fisheries management moving forwards would be beneficial. Involving commercial fishers in fisheries studies has worked quite well in Australia for example, and is worthy of consideration.

Overall, data are not currently being collected that would enable the use of fisheries science to determine i) whether fish and invertebrate stocks outside trawling grounds (e.g. on reefs) are recovering following the trawling ban in December 2012 and other complimentary fisheries management measures, ii) the relative impacts of different fishing gears on fish and invertebrate stocks and biodiversity including vulnerable species, iii) the scale and impacts of recreational fishing using hook and line and spearfishing and ultimately iv) whether the current and potential future fishing effort by all gear types are being redirected, or will allow recovery of depleted fish and invertebrate stocks, and the development of a healthy and sustainable fishery.

It is also has not been defined how the effectiveness of measures to achieve the objective of “rehabilitating the marine ecosystem” will be determined, or how ‘rehabilitating’ is defined.

More information is also needed to understand the life-histories and movements of more mobile fish and invertebrate species, who may not be resident in Hong Kong throughout their lives, and/or seasonally, particularly those species important for the fishery, and conservation. Information on spawning and nursery areas are largely lacking or from studies conducted more than a decade ago and in need of updating, while identifying key habitat and food resources for different life stages of important commercial and recreational species also needed.

iv) Recommendations

Taking measures to prevent an increase in fishing effort in the near future, and to put in place measures to encourage sustainable fishing while pro-actively conducting research to fill the highest priority data gaps and implementing increased and ongoing monitoring of the fishery are the overarching recommendations, and consistent with CBD’s precautionary principle.

Furthermore, a number of studies have found that many of the fish taken by local commercial and recreational fisheries are juveniles (e.g. Lau 2005, To and Sadovy 2009). Allowing juvenile fish and invertebrates to reach sexual maturation, and then protecting the adult fish, and particularly the largest individuals of the most important fishery species is critical to facilitating recovery of the fishery and ecosystem. Research has demonstrated that older individuals of some fish species produce larvae that have better potential to survive, as the larvae grow faster and can survive starvation several times better than those from smaller females. In addition, the older fishes are more experienced and successful at spawning, and may have a longer spawning season (Berkeley 2004, Berkeley *et al.* 2004, Bobko & Berkeley 2004). These findings indicate that older/larger individuals may be crucial in the maintenance of exploited stocks, and that they should be maintained through

networks of no-take zones (Birkeland & Dayton 2005).

Fisheries Management Recommendations (in order of priority)

1. The most practical way to prevent a potential expansion of fishing effort from reducing the rate of recovery and sustainability of the fishery is to expand the coverage of marine parks, in order to allow slow growing long-lived fishery species across a range of habitats to have an opportunity to grow and reproduce undisturbed. Therefore, the coverage of marine parks should be expanded to include habitats and species not afforded protection by existing marine parks.

2. An Advisory Committee for the Sustainable Use of Marine Resources consisting of management authorities, fisheries and other scientists, representatives of the commercial and recreational fishing communities, relevant NGOs, and representatives of the marine recreational community should be established under AFCD as soon as possible to advise government.

3. Building on Recommendation 1, the recommendation of the CSF to ban commercial fishing in marine parks, and announced by government in the 2008 policy address, should be executed without further delay. This will also fully protect the existing artificial reefs deployed within the parks. Continued resistance to this initiative by some potentially affected fishers will need to be resolved.

4. Rehabilitating the marine ecosystem and establishing a sustainable fishery will require management actions that prioritise rebuilding those stocks of ecologically important species/species groups that have suffered major declines, and are the most important fishery species, respectively. Different management measures will benefit different species differently if at all, for example a change in fish cage mesh size will have no impact on tuna. As it would not be possible nor desirable to undertake a multitude of different management measures simultaneously, the most important species/species groups for the fishery should be determined in consultation with Advisory Committee and other stakeholders, and management objectives established for the various species/species groups. Subsequent management decisions should be designed to i) enhance stocks and the sustainable utilization of these important species ii) rebuild the ecosystem and iii) protect vulnerable species according to ecosystem-based fisheries management principles.

5. Fisheries Protection Areas should be introduced in the near future to protect spawning and nursery areas for important species, and potentially vulnerable species. The appropriate management measures to provide a high-level of protection could potentially encompass no-take zones, closed seasons, and other restrictions, and should be decided through consultation with stakeholders.

6. Species level management measures should be introduced for the most threatened, and depleted species (e.g. the Chinese Bahaba, which is Critically Endangered globally and locally according to the draft Regional Red List assessment, and protected in Mainland China). Species of special conservation concern such as Whale sharks (*Rhincodon typus*) should be

fully protected from fishing as they are in many countries through amendments to existing legislation, notably the Fisheries Protection Ordinance, and provisions made to allow for unintended interactions (see Marine Fish Sub-Group report and Whitfort et al. 2013).

7. The marine park programme should adopt fisheries management as an appropriate objective (in addition to conservation and recreation), and new marine parks should be established to encompass key habitat types not yet included within existing marine parks. This will serve to increase the variety of species receiving some level of protection, the total area protected, and facilitate recovery of the ecosystem and surrounding fisheries through spillover and recruitment effects (Russ 2002).

8. Increased resources will be required for monitoring and enforcement of new management measures.

9. Catch and release should be encouraged amongst commercial and recreational fishers, particularly for juveniles of commercially important species. Education on catch and release, ages of maturity for different species, should be undertaken, such as through recreational fishing magazines, fishing clubs etc. The types of hooks used can also make a difference to the survival rates post release.

10. Move towards shared stock fisheries research and management under the Framework Agreement with Guangdong authorities.

Fisheries Research Recommendations (in order of priority)

1) The rapid introduction of an ongoing fisheries monitoring programme, that directly quantifies fish catches and collects information that can be used for stock assessments (e.g. gear used, locality, season, species, number and size of individuals taken) is needed. The methodologies used should be sufficiently robust and remain similar over time to the degree that direct comparisons of different years can be made, and include the recreational fishery. Far greater resolution on fishing effort using different gears is required for more than 2,300 mixed-use “sampans”, as this category includes the majority of fishing vessels, and according to the 2006 Port Survey the highest total catches of the remaining i.e. non-trawl fleet except for purse seiners which also have high catches in some areas. This is in line with the recommendation by Sumaila et al. 2007 which relied primarily on Port Survey data and noted “It is also likely that the current method for recording catches will need to be revised so that accurate fisheries data is available to inform future fisheries management decisions.” The use of onboard observers and the use of log-books are options that can be considered, along with a dedicated fisheries research vessel.

2) Surveys of the different fishing gears should be used to determine the species that are most commonly caught in the commercial fishery, and their relative abundance for each gear type in Hong Kong. Interviews of fishers should be conducted to learn whether and how they target specific species/species groups using different gears, and their expectations for future catch composition under a sustainable fisheries management regime.

3) The slow recovery of major exploited stocks following a ban on trawling and ban on commercial fishing in marine parks as predicted by fisheries modeling

highlights the importance of protecting local spawning and nursery grounds (Sumaila et al. 2007). This study notes “Protecting these areas from all fishing activity should facilitate the recovery of depleted stocks,” and that Fisheries Protection Areas are intended to be used for this purpose. At present the spawning and nursery grounds of most commercially important species are not well-known, apart from some areas identified by studies more than a decade ago. More targeted research is urgently required. Such research can also be used to inform EIAs and reduce the likelihood of these grounds being lost or degraded by reclamation and other developments.

4) Formal stock assessments should be undertaken for a small number of commercially important species (both species that were important in the past and present) that are broadly representative of the commercial fishery. These assessments will determine the health of these stocks and the sustainability of fishing on them, and can be used to inform management of the fishery, and should be built on through repeat assessments and the extension to a greater range of species over time.

5) The analysis and release of existing government fisheries data. Data collected prior to the trawling ban is extremely valuable for determining baselines, yet much was not available for this review. For example, only very limited data collected through the three Port Surveys on the catches of different families by different gear types is available, and analysis interpreting changes over time is not available. It is also known, for example, that fishing surveys at the Cape d’Aguilar Marine Reserve were conducted by AFCD over many years before and after the establishment of the Reserve in 1995, but no data or summary report have been released. Establishment of an online database with fisheries related studies and data should be established to inform and facilitate fisheries research.

6) A much better understanding of the recreational fishery is required. Given the small size of local waters, and large size of the recreational fishing community (hundreds of thousands to millions of individuals), it is vitally important that the current and potential economics, motivation to grow, and structure are documented, along with the spearfishing (and underwater harvesting) fishery.

7) The formation of the Sustainable Fisheries Development Fund offers an excellent opportunity to fill data gaps, including those identified here. Research institutes could then apply to the Fund for funding to carry out the research. A mechanism by which the Advisory Committee for the Sustainable Use of Marine Resources could share recommendations on the research it considers most urgent with the Advisory Committee for the Sustainable Fisheries Development Fund, in order to facilitate such research from being undertaken, should be put into place.

8) The proposed FPAs offer an opportunity to trial new, and mixed-management regimes, such as controlling mesh sizes for different gears. These can be decided on following consultations with an array of stakeholders. FPAs with no-take zones should also be designated around the existing artificial reefs such as in Outer Port Shelter, to fully protect them from fishing, and eliminate the risk that they may be contributing to overfishing.

9) The 2010 Framework Agreement on Hong Kong/ Guangdong Co-operation covers fisheries, and allows for collaborations to improve the marine ecological environment, protecting rare marine wild fauna and flora, to start

joint law enforcement actions in respect of marine fisheries including cross-boundary illegal fishing, to make joint efforts in fisheries resources conservation, and to regulate fishery production. The sharing of fisheries data with Guangdong fisheries authorities should be enhanced, with a view to facilitating the joint-management of shared stocks in the foreseeable future.

10) Use of the "Marine Trophic Index", an indicator accepted by the CBD for use in measuring progress against Aichi Target 6 (http://www.bipindicators.net/mti) should be explored for applicability, and the availability of suitable data, in measuring rehabilitation of the marine ecosystem in Hong Kong.

11) Little research has been conducted on the sources of larvae of commercially important fish and invertebrate species that recruit to Hong Kong, although it seems likely given the size of Hong Kong waters, circumstantial information, and what is known on larval duration etc. from elsewhere, that some sources are local, and some are external. Identifying and protecting such sources is critical to the long-term sustainability of the fishery, and the creation of a network of protected areas that extends beyond Hong Kong along the coast of mainland China where needed would be a worthy long-term goal.

12) Hold an expert workshop to review the experience of deploying ARs, and the available information from HK and elsewhere on their effectiveness before deploying any more.

Fisheries Education and Awareness Raising Recommendations (in order of priority)

1. Enhancing understanding within the fishing community of best-practice fisheries management, and gaining a common understanding of the direction that needs to be taken, and why specific management measures are being adopted, are important complementary measures.

2. Government should periodically release public updates on the status and recovery of the marine ecosystem, and fisheries. Summaries from trawl and other fisheries surveys could be released every 1-2 years to inform interested stakeholders of the status of the recovery of the fishery, and progress towards management objectives.

3. Enhancing understanding within other communities that use the sea (e.g. yachting community, diving community, companies offering vessels for hire) on measures underway to achieve a sustainable fisheries, in order to build community support for sustainable fisheries management, is also fundamental.

D) RECREATIONAL, SCIENTIFIC AND EDUCATIONAL USES

i) Introduction to Recreational, Scientific and Educational Uses

What are the main uses in HK?

There is a wide range of primarily recreational activities, but also educational and

scientific research conducted along the coastline and waters of Hong Kong that have marine biodiversity as an important component. These include diving, snorkeling, day trips to scenic areas, swimming at beaches, the hiring of vessels for transport to remote areas, dolphin watching, school field-trips to study and learn about marine life, and scientific research.

Detailed assessments of Recreational Diving and Recreational Use of Vessels can be found in Appendix B.

What kinds of marine biodiversity are impacted in general by these uses in HK?

Marine biodiversity identified as being negatively impacted includes hard coral communities (from diving, snorkeling, and anchor damage) and Chinese white dolphins (*Sousa chinensis*), from dolphin watching. The impacts of pollutants originating from vessels supporting recreational activities, educational and scientific research will likely be impacting a greater range of biodiversity, but examining the impacts of pollution was beyond the expertise of this Focus Group.

Are there any management objectives related to biodiversity and these uses?

Some management measures designed to reduce the negative impacts of some of the recreational, educational and scientific uses are in place, notably in marine parks. These measures include the designation of anchoring areas, use of speed limits, and controls on gleaning. Other measures are focused on protecting hard coral communities through core areas, and codes of conduct for diving/snorkeling in coral areas, and dolphin watching. The areas in which these measures are in place are limited.

Main Findings on Recreational, Scientific and Educational Uses

Most of the negative impacts to biodiversity from these uses are unintentional, and likely to result in damage to the health of marine organisms, rather than direct mortality. However, direct mortality may occur from some kinds of scientific research.

The impacts from individual and multiple types of non-fishing uses are not spread evenly across local waters, and some uses are concentrated in specific areas e.g. close to coral communities in eastern waters where multiple impacts may be occurring. As such, a site-based rather than threat-based approach to managing impacts is likely to be the most effective.

Of the ten non-fishing uses identified, only dolphin watching, and to a partial extent, diver damage to coral communities, have had their impacts to biodiversity studied. Overall, the sustainability of the non-fishing uses individually and collectively is not clear, but impacts will likely be less than fishing, which by its nature causes direct mortality. Illegal activity was not identified as a contributing factor.

More study is needed to ascertain whether existing management measures are sufficient in ensuring these activities are sustainable, and will remain so. Recreational use of the sea and coastlines is undoubtedly on the increase, as evidenced by a nearly 50% increase in the number of licensed leisure craft from 2006 to 2013 (Marine Department figures). The increasingly high concentrations of these vessels, and associated recreational activities at popular bays, is some cause for concern.

Leisure craft at Tai Long Sai Wan, Sai Kung. Aug 2014 (pic. Andy Cornish)

Data and Other Gaps

- No information is available on the current size, trends and dynamics of the recreational diving community active in Hong Kong.
- It is not known whether coral communities can recover from diver damage faster than it occurs and, therefore, whether recreational diving in coral areas is sustainable. This is particularly important to understand in the most intensively dived sites, notably in Port Shelter.
- The full extent of gleaning, in terms of species harvested, areas targeted and impact on marine biodiversity is not known, and has rarely been the subject of scientific study.

Recreational, Scientific and Educational Use Management Recommendations (in order of priority)
1. Dolphin-watching activities could be more tightly regulated in areas of high dolphin densities. Options include regulating dolphin-watching operations through a licensing system, which has been done in some other countries, or establishing marine parks in these areas. 2. Installation of mooring buoys for vessels supporting diving and snorkeling operations around coral communities should be explored by AFCD in consultation with the diving community. This is common practice in many locations in Asia and beyond. 3. Based on the findings of the research studies, additional management measures can be considered.
Recreational, Scientific and Educational Use Research Recommendations (in order of priority)

1. Conduct a study in collaboration with the local diving industry to quantify recreational diving in Hong Kong, e.g. numbers of active divers, preferred sites, motivations for diving, seasonality, knowledge of codes of conduct etc. 2. Conduct further research to understand the susceptibility and rates of recovery of different coral species to diver damage. 3. Use information from the two studies above to look at the carrying capacity of some of the most intensively dived coral communities in Hong Kong, to gain a better understanding of the likely broader impacts of recreational diving. 4. The extent of gleaning, in terms of species harvested, areas targeted, impact on marine biodiversity and sustainability needs to be studied. The study should also clarify whether such activities are recreational and/or artisanal/ commercial.
Recreational, Scientific and Educational Use, Education and Awareness Raising Recommendations
1. Increased activities by government to increase knowledge and buy-in of the Code of Conduct for diving and snorkeling by the diving community would be a worthwhile preventative measure.

E) Overall Recommendations

While not specifically examined by the Focus Group, there is a recognition that the benefits to Hong Kong from achieving the sustainable use of marine resources are wide and varied, and include maintaining the rich cultural heritage of the fishing community, increased access to quality, locally produced seafood, enhanced quality of life for urban dwellers through access to a diverse range of recreational activities, to the economic benefits of businesses that support and are associated with uses of the marine environment. The importance of achieving sustainability, therefore, in the many uses of the marine environment identified here, goes well beyond the conservation of the living marine resources, extending into food, livelihoods, culture and well-being.

Objectives for the Sustainable Use of Marine Resources

i) Fisheries and Mariculture

The recommendations provided within this report, build on the current management objectives and measures for the capture marine fishery (p. 5-6) in a way that increase consistency with the FAO guidance, and the Aichi targets. It is recommended that the highest priority research, management and education recommendations outlined in this report are initiated by the end of 2017.

More detailed management objectives will be required moving forwards, in order to guide and prioritise research and effectively manage development of a sustainable

fishery, and it is recommended that the general FAO guidance for setting management objectives for responsible fisheries (below) be specifically adopted for Hong Kong.

The FAO Code of Conduct for Responsible Fisheries (http://www.fao.org/docrep/005/v9878e/v9878e00.htm#7) provides the following guidance on establishing management objectives.

"7.2 Management objectives

7.2.1 Recognizing that long-term sustainable use of fisheries resources is the overriding objective of conservation and management, States and subregional or regional fisheries management organizations and arrangements should, inter alia, adopt appropriate measures, based on the best scientific evidence available, which are designed to maintain or restore stocks at levels capable of producing maximum sustainable yield, as qualified by relevant environmental and economic factors, including the special requirements of developing countries. □□

7.2.2 Such measures should provide inter alia that: □

a) excess fishing capacity is avoided and exploitation of the stocks remains economically viable;
b) the economic conditions under which fishing industries operate promote responsible fisheries;
c) the interests of fishers, including those engaged in subsistence, small-scale and artisanal fisheries, are taken into account;
d) biodiversity of aquatic habitats and ecosystems is conserved and endangered species are protected;
e) depleted stocks are allowed to recover or, where appropriate, are actively restored;
f) adverse environmental impacts on the resources from human activities are assessed and, where appropriate, corrected; and
g) pollution, waste, discards, catch by lost or abandoned gear, catch of non-target species, both fish and non- fish species, and impacts on associated or dependent species are minimized, through measures including, to the extent practicable, the development and use of selective, environmentally safe and cost-effective fishing gear and techniques.

7.2.3 States should assess the impacts of environmental factors on target stocks and species belonging to the same ecosystem or associated with or dependent upon the target stocks, and assess the relationship among the populations in the ecosystem."

ii) Recreation, Educational and Scientific Uses

An appropriate objective for the recreational, educational and scientific uses of the marine environment identified here, should be that they are all conducted in a sustainable manner.

Given that recreational use of the sea, at least by vessels is increasing considerably over time, this objective should be formally adopted as soon as possible, and a strategy based on research adopted to prevent potential issues requiring reactive management.

F) Implementation (estimated resources)

Calculating the estimated resources for the management, research and awareness raising recommendations is a major exercise, and was not a feasible task for the Focus Group

G) Evaluation and monitoring

Potential Fishing Indicators (from the Aichi Target 6 guidance)

• Trends in proportion of depleted species with recovery plans

• Trends in area, frequency, and/or intensity of destructive fishing practices

• Trends in catch per unit effort

• Trends in extinction risk of important and other aquatic species

• Trends in fishing effort capacity

• Trends in population of important aquatic species

• Trends in proportion of utilized stocks outside safe biological limits

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APPENDIX A Relevant CBD Articles

Article 7. Identification and Monitoring

Each Contracting Party shall, as far as possible and as appropriate, in particular for the purposes of Articles 8 to 10:

(a) Identify components of biological diversity important for its conservation and **sustainable use** having regard to the indicative list of categories set down in Annex I:

(b) Monitor, through sampling and other techniques, the components of biological diversity identified pursuant to subparagraph (a) above, paying particular attention to those requiring urgent conservation measures and those which **offer the greatest potential for sustainable use;**

(c) Identify processes and categories of activities which have or are likely to have significant adverse impacts on the conservation and **sustainable use** of biological diversity, and monitor their effects through sampling and other techniques; and

(d) Maintain and organize, by any mechanism data, derived from identification and monitoring activities pursuant to subparagraphs (a), (b) and (c) above.

Article 8. In-situ Conservation

Each Contracting Party shall, as far as possible and as appropriate:

(a) Establish a system of protected areas or areas where special measures need to be taken to conserve biological diversity:

(b) Develop, where necessary, guidelines for the selection, establishment and management of protected areas or areas where special measures need to be taken to conserve biological diversity:

(c) Regulate or manage biological resources important for the conservation of biological diversity whether within or outside protected areas, with a view to ensuring their conservation and **sustainable use**;

(d) Promote the protection of ecosystems, natural habitats and the maintenance of viable populations of species in natural surroundings:

(e) Promote environmentally sound and sustainable development in areas adjacent to protected areas with a view to furthering protection of these areas:

(i) Endeavour to provide the conditions needed for compatibility between present uses and the conservation of biological diversity and the **sustainable use** of its components:

(j) Subject to its national legislation, respect, preserve and maintain knowledge, innovations and practices of indigenous and local communities embodying traditional lifestyles relevant for the
conservation and sustainable use of biological diversity and promote their wider application with the approval and involvement of the holders of such knowledge, innovations and practices and encourage the equitable sharing of the benefits arising from the utilization of such knowledge,

innovations and practices:

Article 10. Sustainable Use of Components of Biological Diversity Each Contracting Party shall, as far as possible and as appropriate:

(a) Integrate consideration of the conservation and **sustainable use** of biological resources into national decision-making;

(b) Adopt measures relating to the use of biological resources to avoid or minimize adverse impacts on biological diversity;

(c) Protect and encourage customary use of biological resources in accordance with traditional cultural practices that are compatible with conservation or sustainable use requirements;

(d) Support local populations to develop and implement remedial action in degraded areas where biological diversity has been reduced; and

(e) Encourage cooperation between its governmental authorities and its private sector in developing methods for sustainable use of biological resources

Annex I. Identification and Monitoring

(1). Ecosystems and habitats:
- containing high diversity,
- large numbers of endemic or threatened species, or
- wilderness;
- required by migratory species;
- of social, economic, cultural or scientific importance; or,
- which are representative, unique or associated with key evolutionary or other biological processes;

(2). Species and communities which are:
- threatened;
- wild relatives of domesticated or cultivated species;
- of medicinal, agricultural or other economic value; or social, scientific or cultural importance; or
- importance for research into the conservation and sustainable use of biological diversity, such as indicator species

(3). Described genomes and genes of social, scientific or economic importance.

APPENDIX B Assessment of Higher Impact Marine Uses

ii) Assessments of Individual Fisheries Gears

1. Gill net fishing

i) What is the status of this fishing gear?

Gill netting in Hong Kong normally operates with a rectangular net anchored at both ends. The upper end is buoyed with floats while the lower end is weighed down in the water column, to form a vertical net wall in the water to entangle and catch fish that it. Trammel nets employing three panels with two different sized meshes are employed by some fishers. About 200 fishing vessels operate mainly in gill netting, but they spent the majority of the time fishing outside Hong Kong waters. For those operating in Hong Kong waters, gill netting is operated by hand in coastal waters on family basis. Production figures of the Port Survey (2006) from the gill netters were of range 0-200 kg per hectare annually in coastal waters. Production was highest south of Cheung Chau and around the Po Toi group of islands. The catch may include croakers and scads.

Gill nets can be used by some 2000 sampans of largely 5-6 m in length, which are engaged in small-scale, seasonal and mixed gear fishing (currently, some 70% sampans registered gill nets as one of the fishing gears). The numbers of fishing vessels engaged in gillnetting has been quite stable in the past decade.

ii) What management measures are already in place?

Amendments to the Fisheries Protection Ordinance (Cap. 171) in 2012

The amendments to the Fisheries Protection Ordinance in 2012 included the establishment of a registration system for local fishing vessels, limiting new entrants to maintain an appropriate level of fishing effort, restricting fishing activities of local non-fishing vessels and prohibiting fishing activities of non-local fishing vessels in Hong Kong waters, and designation of fisheries protection areas. The use of gill nets is not permitted on local fishing vessels if this gear type is not specified in the conditions of registration.

Restriction of fishing activities in Marine Reserves and Parks

Limited number of fishing permits, including to use gill nets, have been issued by AFCD to bona fide fishermen or persons who ordinarily reside near marine parks. All fishing activities are prohibited inside the core areas within Tung Ping Chau Marine Park and within the Marine Reserve.

Clearance of ghost nets

Upon report of ghost nets at the major coral areas, AFCD will execute investigation and net clearance exercise as appropriate to minimize the damage to coral communities. Sources of ghost net reports mainly come from the Reef Check coordinated by AFCD which has covered the major coral areas in Hong Kong, while ad hoc reports are also received occasionally. With the contribution in information provision from divers and AFCD action in net clearance, so far there have been no

reports of devastating impact on the major coral areas resulting from ghost nets.

iii) What effect is the gear (or type of fishing) having on vulnerable species and ecosystems?

No formal assessment has been made of the sustainability of the gill net fishery, including impacts to vulnerable species, although some data is available and is summarized below.

One study found that of the 123 fish species recorded from 3 coral communities, 58 were caught by gill nets (more than hook and line and traps) (Cornish 2000). Another multi-year study at Hoi Ha collected 55 of the total 137 fish species by gill net, and the most common species were scad, filefish, cardinalfish, rabbitfish, ponyfish and biddy (Leung et al. 1997). Gill nets proved to be less selective than cage traps and hook and line in both studies. The catch is still dependent on the mesh size, but sizes used in Hong Kong will take juveniles and adults of many fish species (from fast-growing species such as damselfish and ponyfishes, to groupers, snapper, parrotfish and croakers), as well as shrimp (in Deep Bay) crabs, lobster, horseshoe crabs (*C. rotundicauda*, and *T. tridentatus*), also squid and cuttlefish. The catch includes commercially valuable and low-to-no value species.

Ghost nets have an impact in terms of catching fish initially, and then crabs primarily later. Ghost nets also lost in coral communities can smother and kill patches of corals. Ghost nets tend to get caught in branching corals (rather than brain corals such as *Porites*), and may kill parts of the colony. Branching corals are faster growing species but may still take years to recover.

Recommendations

Research

- A comprehensive review of existing reports/data to categorise the gill net fishery in terms of gears deployed, habitats targeted, species and sizes taken, the relative abundance of species seasonality etc. would provide valuable information to inform management decisions.

- The current fishing effort using gill (and trammel) net across all vessel types also needs to be determined.

- Gill nets are also deployed from shore, but this method of fishing is limited to very shallow areas, and appears to be small scale and sporadic, so is not a high priority to investigate at this time.

Management

- An increase in areas, and types of habitat where gill netting is not permitted, including marine parks and potential FPAs, will act to conserve biodiversity and facilitate recovery of fish stocks and the marine ecosystem.

- Ghost nets increase mortality in the fishery, with no benefit. Finding ways to reduce the loss of ghost nets, and then to further reduce the impacts once they are lost additional to the current ghost net clearing exercises could be a “low-hanging fruit”. Positive incentives that could be provided to fishers to encourage them take measures that make it less likely that the nets will be

lost in the first place should be examined, and will require understanding local fishers attitudes towards lost nets. Overseas examples are likely to be instructive and should be researched.

- Increased clearances of ghost nets in problem areas would be a worthwhile activity, particularly when combined with measures aimed at decreasing the loss of gill nets (above). A mechanism for all members of the community to report loss of net and discovery of ghost net should be established and publicized for gathering relevant statistics to fill in the current data gap as well as to increase the possibility of taking timely clearance actions.

- Gill nets have the least gear selectivity (i.e. they will take the greatest range of species) compared with the other main gear types still employed in Hong Kong. This will be exacerbated by the use of trammel nets which have less selectivity than gill nets (http://www.fao.org/fishery/geartype/223/en), and the wide range of mesh sizes employed locally. Fisheries management typically aims to increase the productivity of the fishery by targeting certain size classes of important species, and placing controls on mesh sizes, such as within potential FPAs, should be considered in the future in line with management objectives for important species. This will need to be done with consideration of those gear types/mesh sizes available to local fishers, and may need to be done in conjunction with a ban on possession of non-permitted gears/mesh sizes in order to be effective.

2. Trap fishing (including fish cage traps, and crab traps)

i) What is the status of this fishing gear?

Cage traps are designed to encourage the entry of marine organisms, which are then prevented from escaping either by particular aspects of their behaviour and/or by the design of the trap itself. The most common trap used by Hong Kong fishermen are baited metal cage traps. The operation of baited traps is that animals are attracted to the bait, and enter the trap through tapered openings from which it is difficult to escape. The catch may include rabbit fish and crabs. About 50 fishing vessels operate mainly in cage trapping, but they spent the majority of the time fishing outside Hong Kong waters. The numbers of fishing vessels engaged in cage trapping has remained quite stable in the past decade.

Cage traps can be used by some 2,000 sampans of largely 5-6 m in length, which are engaged in small-scale seasonal and mixed gear fishing. Currently, some 40% sampans have registered cage traps as one of their fishing gears. The Port Survey surveys do not provide information on catches by cage traps as a distinct gear type.

ii) What management measures are already in place?

Amendments to the Fisheries Protection Ordinance (Cap. 171) in 2012

The amendments to the Fisheries Protection Ordinance in 2012 included the establishment of a registration system for local fishing vessels, limiting new entrants to maintain an appropriate level of fishing effort, restricting fishing activities of local non-fishing vessels and prohibiting fishing activities of non-local fishing vessels in Hong Kong waters, and designation of fisheries protection areas. The use of cage traps is not permitted on local fishing vessels if this gear type is not specified in the

conditions of registration.

Restriction of fishing activities in Marine Reserves and Parks

Limited number of fishing permits, including to use cage traps, have been issued by AFCD to the bona fide fishermen or persons who ordinarily reside near marine parks. All fishing activities are prohibited inside the core areas within Tung Ping Chau Marine Park and within Marine Reserve.

iii) What effect is the gear (or type of fishing) having on vulnerable species and ecosystems?

No formal assessment has been made of the sustainability of the cage trap fishery, including impacts to vulnerable species, although some data is available and is summarized below.

A 3 year study at Hoi Ha Wan found that only 14 of the 137 fish species that were recorded, were caught in cage traps. Damselfish, blennies, rabbitfish, wrasse small grouper and monocle bream were the most common species taken (Leung et al 1997). Another study found that of 123 species found at 3 coral communities, 40 were taken by traps (Cornish 2000). Rabbitfish are commonly taken, also commercial and non-commercial species including groupers, butterflyfish, damselfish, parrotfishes, octopus, crabs and starfish. Juveniles of commercially important species are taken, and occasionally fishers will attempt to grow these to market size in floating mariculture cages.

Some specialised traps, including larger cages for cuttlefish, and plastic cylindrical traps for moray eels are employed. Crab traps deployed in the intertidal zone will take horseshoe crabs at spawning events (in June) in western waters.

Lost traps will still catch fish until the cage door falls open or the traps disintegrates, termed “ghost” fishing. Damage to habitat from cage traps appears minimal although hard coral colonies are occasionally overturned or damaged when traps are retrieved from coral areas, if the leader line or trap becomes trapped in the coral framework.

Recommendations

Research

- Production figures for cage trap fishing are not currently available, and need to be collected.

- A comprehensive review of existing reports/data to categorise the cage trap fishery in terms of gears deployed, habitats targeted, species and sizes taken, the relative abundance of species seasonality etc. would provide valuable information to inform management decisions.

- The current fishing effort using cage traps across all vessel types also needs to be determined.

Management

- An increase in areas, and types of habitat where cage traps are not permitted,

including marine parks and potential FPAs, will act to conserve biodiversity and facilitate recovery of fish stocks and the marine ecosystem.

- The introduction of "degradable panels" to greatly reduce the possibility of a trap continuing to fish for long after it is lost should be investigated through a study referencing overseas jurisdictions where the technology is quite mature, e.g. Texas (www.tpwd.state.tx.us/regulations/outdoor-annual/fishing/shellfish-regulations/crab-and-ghost-shrimp-legal-devices-and-restrictions).

- As with gill nets, controlling the mesh size in the cage and other traps will have an impact on the size range of fish and invertebrates taken. The mesh of some traps employed at present is small enough to catch juveniles of commercially important species such as small groupers of 15 cm. Unless fishers can be encouraged to release these fish, having a minimum mesh size can be considered to increase the productivity of the fishery, in line with management strategies.

3. Hook and line (excluding long-line and squid-jigging)

i) What is the status of this fishing gear?

Fishing with hook and line in recent decades has usually been undertaken from a boat or the shore using a handline, and weights to take the baited hook to the seabed. This method is commonly used by commercial and recreational fishers. Floats are also sometime used, and lures are sometimes pulled behind boats (trolling). Fishing from rocky coastlines and islands using more sophisticated rods and reels, fishing lures and techniques such as chumming the water to attract fish which emulate Japanese practices have also become popular amongst recreational fishers, who hire boats to transport them to remote locations only accessible by sea.

Fishing using hook and line is most concentrated on the shoreline and on boats close to shore but occurs everywhere, including Victoria Harbour and over deep-water rocky and soft-bottom habitats. It is estimated that there were 55 hand liners engaged in fishing inside (and possibly outside) Hong Kong waters in 2012/13, while many of the 2,372 mixed-use sampans probably employ hand lines occasionally. As any vessel other than non-local vessels may fish with hook and line, and not register the gear with AFCD, the total number of vessels that fish using hook and line (whether commercially or recreationally) is not known, but it is believed to be the most common fishing gear employed.

The Port Survey (2006) indicates that hand liners primarily fish at the Soko Islands, around Hong Kong and Lamma Islands, in Port Shelter and Tai Long Wan (Sai Kung), with the greatest intensity being around the Ninepin and Po Toi Island groups. Production figures from the hand liners were in the region of 0-50 kg per hectare annually for all these areas, and less elsewhere. Unfortunately, data collected during this survey on production by family, is not available.

A public survey commissioned by WWF in 2008 found that 54% of the local Chinese speaking public fished recreationally at least once a year. Some 46% of those fished from at least once per 1-2 months, to at least once per week. The most popular areas were Port Shelter (31% of the fishers fished there) and the Outer Islands (32%). Separately, the AFCD reported in 2004 that there were around 500,000 recreational fishers who fish around one to four times a year (AFCD 2004).

Recreational fishing using hook and line was not included within estimates of local fishing effort used to derive a level of sustainable fishing effort by fishing vessel horsepower (see p. 5).

ii) What management measures are already in place?

Under Schedule 2 of the Fisheries Protection Ordinance, fishing permitted with the use or aid of vessels other than non-local fishing vessels includes “Fishing by means of a line (without any branch line) with one or more hooks or jigs operated by hand.” As such fishing, hook and line fishing is conducted by i) registered fishing vessels, ii) other vessels and iii) from the shoreline. Only fishing effort of the first is controlled, through the numbers of vessels registered to use hand lines.

All recreational fishing is prohibited in Marine Reserves and Parks, which cover around 2% of local waters, except for a designated recreation fishing area on shore for hook and line fishing in the Tung Ping Chau Marine Park. Small numbers of indigenous villagers are permitted to use hook and line in the Marine Parks, while commercial fishing with hook and line is undertaken in Marine Parks by license holders. Hook and line fishing for scientific research is only permitted in the Marine Reserve and requires a research permit issued by AFCD.

iii) What effect is the gear (or type of fishing) having on vulnerable species and ecosystems?

No formal assessment has been made of the sustainability of the hook and line fishery, including impacts to vulnerable species, although some data is available and is summarized below. Indeed, the seasonality, effectiveness and selectivity of hook and line activities have not been studied. Any impacts on ecosystems are likely to be the result of the direct mortality of fishes caught, or indirect cascading effects, rather than the loss or degradation of habitat, as hook and line has minimal impacts to habitat. In general hook and line can take a wide size range of fishes from gobies to large sharks, depending on the hook size, and line strength, bait used etc.

A wide range of primarily fish species is taken by hook and line. Some invertebrates such as crabs will also occasionally be taken. The diversity of fishes that can be taken by hook and line (termed “gear selectivity”) appears higher than for cage traps, but less than gill net (see Leung *et al.* 1997, Cornish 2000). For example, a three year study at Hoi Ha Wan found that 49 of the 137 species recorded were done so by being caught on hook and line. Cardinalfish, small grouper, biddy, wrasse, pufferfish and goby were the most commonly take (Leung *et al.* 1997). Another study found that of 123 fish species found at three coral communities in eastern waters, 45 could be caught by hook and line (Cornish 2000).

A study interviewing recreational fishers employing hook and line along the coastline or returning from vessel fishing trips in winter months found that 64 fish species were taken from Aberdeen, and Victoria Harbour to Sai Kung (Lau 2005). While recreational fishers fishing from natural and artificial shorelines mostly caught small species such as rabbitfish, rockfish, wrasse, cardinalfish, pufferfish, gobies and small groupers, those returning from vessel fishing trips mostly caught larger commercially valuable species: croaker, snapper, groupers, seabream, sweetlips. The most commonly used hook size was a size 2 (about 1 cm in length), suggesting that mostly small-medium sized fish were being targeted. The Catch Per Unit Effort (CPUE) per fishing trip was often lower than 0.1 kg/hr, but ranged as high as 0.3

kg/hr (with one outlier of 0.6 kg due to a single fishing event with a particularly good catch). Interestingly, the length of fish caught generally ranged from 5.5 – 10.5 cm at four shoreline sites, but the majority of fish caught at two offshore sites was greater at 15.5 – 20.5 cm. Unsurprisingly given the small sizes of fishes caught, the majority of fishes caught by the recreational anglers were juveniles.

No data is available on the catches from trolling, but experienced fishers report that limited trolling is conducted primarily around outer islands such as Ninepins, and targets pelagic or semi-pelagic, larger predatory species such as jacks, barracuda and tuna.

One associated issue is that catch and release does not appear to be common amongst recreational and commercial fishers. Even juvenile fish < 5 cm may be retained, or discarded dead at the end of the fishing trip. This wasteful practise will contribute to overall mortality, and decrease the productivity of the fishery. There also seems to be some targeting of spawning aggregations, which could be quite damaging to the species concerned.

In comparison with other fishing gears, production by hand liners is far higher. While the AFCD Port Survey 2006 data available online does not provide total production by gear type, the production by area figures are mostly 0-50 kg, with areas to the south 50-100 kg, and one cell 100- 200 kg. Figures for hand liners in most areas are 0 kg (presumably as the hand liners are not fishing in these areas, rather than their annual catch there is zero), with the highest areas 0-50 kg.

Catches by mixed-use sampans, which comprise by far the majority of the fleet and which includes hook and line fishing, are substantially higher than handliners alone with production of 100-200 kg annually in some areas, and even two areas where 200-400 kg was recorded. The component of this production attributable solely to hook and line is not available.

Data and other gaps

There is no ongoing fisheries monitoring programme, the last Port Survey was conducted in 2006 and does not contain species-level information, and stock assessments have not been carried out for any species, while the vulnerability of harvested species to extinction has only started to be undertaken as part of the formulation of this BSAP. Additionally, the catch taken by mixed-gear sampans using hook and line is not quantified, and the annual harvest of the recreational hook and line fishery has never been quantified, making it impossible to determine the scale of the annual recreational vs. commercial catch.

Recommendations

Research

- A much better understanding of the recreational fishery is required. Given the small size of local waters, and huge size of the recreational fishing community (hundreds of thousands to millions of individuals), it is vitally important that the current and potential economics, motivation to fish, and structure are well understood, in addition to information on species and sizes taken, relative abundance, species, areas and habitats targeted, seasonality, and overall fishing effort

- A comprehensive review of existing reports/data to categorise the commercial

hook and line fishery in terms of gears deployed, habitats targeted, species and sizes taken, the relative abundance of species seasonality etc. would provide valuable information to inform management decisions.

- The current fishing effort using hook and line across all vessel types, including mixed-gear sampans needs to be determined.

- The catch taken by mixed-gear sampans using hook and line should be recorded in future fisheries monitoring programmes.

Management

- The large recreational fishery is not capped nor managed, and fishing effort might rise if fish stocks start to recover, as this would provide an incentive to fish more. Studying the recreational fishery is an essential prerequisite to determining if active management is required, and what form it should take.

- Catch and release should be encouraged, amongst recreational fishers, particularly for juveniles of commercially important species. Education on catch and release, ages of maturity for different species, should be undertaken, such as through recreational fishing magazines, fishing clubs etc. The types of hooks used can also make a difference to the survival rates post release.

4. Spearfishing and other underwater harvesting (whether diving or snorkeling)

i) What is the status of this fishing gear?

Spearfishing has occurred in Hong Kong for decades, and is generally undertaken by recreational divers using scuba (and even rebreathing equipment), rather than by freedivers. Spearfishing is not known to be undertaken commercially, only being undertaken by several hundred individuals who typically eat or share their catch.

A license from the Hong Kong Police Force is required for the possession of a spear gun (under the Firearms and Ammunition Ordinance), although small spear apparatus such as “Hawaiian slings” may not require a license. The police supplied the following figures on the numbers of spear gun licences for the past five years.

Year	No. of licences
2009	672
2010	659
2011	667
2012	660
2013	663
2014 (as at 31 June 2014)	675

Under current policy, two spear guns are allowed to be registered under one licence.

For the number of spear guns under licence for possession, please refer the following table

Year	No. of spear guns
2009	1142
2010	1123
2011	1142
2012	1130
2013	1138
2014 (as of 31 June 2014)	1164

Spearfishing is known to be undertaken during the day and night, across all of eastern waters, down to at least 30 m, and as far west as Lamma, Cheung Chau and possibly Lantau. Hong Kong waters are small enough that any reef can be accessed in a few hours from a major port, and spearfishers are primarily inhibited only by rough seas and low underwater visibility (the latter being why they are less active in western waters).

Spearfishers primarily target large reef fishes, spiny lobster, squid, cuttlefish, and sometimes octopus and crabs. They may also take other demersal and pelagic fishes if they are seen. Photographs of the catches of local spearfishers, informal conversations with them, and information from Sadovy and Cornish (2000), indicate that the main species targeted are large groupers (particularly *Epinephelus* species and Leopard coral trout *Plectropomus leopardus*), Parrotfishes (Scaridae), Wrasse (few large species occur locally but Blackspot tuskfish *Choerodon schoenleinii* is highly prized), Jacks (Carangidae), Snappers (Lutjanidae), Emperor (Lethrinidae), Sweetlips (Haemulidae), Sea bream (Sparidae), Sea chub (Kyphosidae), Japanese sea perch (*Lateolabrax japonicus*), and Spottedtail morwong (*Cheilodactylus zonatus*). Large individuals of other reef food fishes such as Barracuda (Sphyraenidae), Filefish (Moncanthideae), Mullet (Mugilidae), Knifejaws (Oplegnathidae), and Goatfish (Mullidae) may also be taken if encountered.

Some spearfishers are also known to shoot smaller fishes as target practice, these may not be retained.

Very little information on other kinds of underwater harvesting is available, but is known that diving events are organized where the primary focus is the collecting of marine life for consumption.

ii) What management measures are already in place?

Spearfishing has received little attention up until now, and was not included within estimates of local fishing effort used to derive a level of sustainable fishing effort by fishing vessel horsepower (see p. 5). There are very few management measures in place to control spearfishing e.g. there are no limits to the sizes of marine life, or species that can be taken, apart from a few protected species of cetacean and marine turtle. The number of licences issued is not known to be limited by the police, and if were limited, would not be for reasons of sustainability. Spearfishing is however, prohibited in Marine Reserves and Parks, which cover around 2% of local

waters.

According to AFCD's records, there were six cases of illegal spearfishing occurred in marine parks between 1999 to 2004 and all cases were successfully prosecuted. No illegal spearfishing cases have been reported in marine parks / reserve since 2004.

iii) What effect is the gear (or type of fishing) having on vulnerable species and ecosystems?

There has never been any academic study into spearfishing in Hong Kong, and the lack of basic catch data (e.g. on species, quantities, sizes, temporal and spatial differences) prevents any formal assessment of sustainability.

While the numbers of spearfishers appears to have been quite stable in the past five years (from the numbers of licenses issued) and is quite low, there are reasons to be concerned about the impacts of spearfishing additional to all other kinds of fishing, some of which are far larger in scale.

As the marine capture fishery in Hong Kong moves towards sustainability, including those types that target reefs (e.g. by capping the number of licensed vessels that can fish), the largest individuals of the large slow growing reef fishes will be particularly important in replenishing stocks of species that have become depleted (see p. 11).

However, these large individuals are typically the ones targeted by spearfishers, many of who are remarkable in their ability to effectively locate and spear individuals of sizes and species that are rarely seen in the catches of commercial fishers. Spearfishing can have rapid and substantial negative effects on reef fish populations, even when moderate size- and catch-limits apply (Frisch 2012), and particularly impact the reproductive potential of long lived and slow growing species with low reproductive potential (Lloret et al. 2008). While such impacts have yet to be examined locally, the risk is evident.

The concern, therefore, is that spearfishing may be having a significant impact on the replenishment and potential recovery of certain species of large important reef food fishes (and possibly also spiny lobsters and other invertebrates that may be depleted). The spearfishing impacts on non-reef species are likely to be far less (as most spearfishing occurs on or around reefs).

Furthermore, a major study that modeled a variety of possible fishery management measures (Sumaila et al. 2007), predicted that the recovery of medium and large reef fishes (both in terms of biomass and catches of them) would be very slow even following the implementation of a trawling ban and the banning of fishing within existing marine parks. Little recovery of medium and large reef fishes was predicted five and 10 years after implementation, but major recovery was anticipated after 25 years. Spearfishing (along with other kinds of fishing targeting reef fishes, and large-scale disturbances to reefs) therefore has the potential to slow recovery down even further. There are also likely to be cascading effects on the ecosystem from continued low levels of top-level predators, that we barely understand at present.

In some cases, spearfishing may actually be driving certain species towards extinction. For example, the draft Red List local assessment for the Knobsnout parrotfish (*Scarus ovifrons*) categorized it as being Endangered, with spearfishing believed to be a contributing factor in its decline.

These concerns are amplified as there are currently no controls on the amount of

fishing being undertaken by spearfishing, both by each license holder and the number of license holders. It should be no surprise if more people were to actively spearfish if fish stocks start to increase following the trawling ban and other management measures. It is also conceivable that commercial spearfishing (which occurs in many Pacific Islands for instance) could become economically viable if commercially important food fishes and invertebrates become abundant. There is no evidence that increases in spearfishing have occurred to date following the trawling ban, and there is an opportunity to prevent these potential problems being realized.

Recommendations

Research

- A study is urgently needed to gather basic information on spearfishing (e.g. on species, quantities, relative abundances of different species, sizes, temporal and spatial differences. The study should also aim to capture information on the behavior of spearfishers, e.g. what species are primarily targeted, which habitats are targeted, and during day or night time. Ultimately the study should aim to understand the sustainability of the spear fishery in the context of other fishing activities. This study could then evolve into an ongoing monitoring programme.

- More information is required on all aspects of recreational, non-spearfishing underwater harvesting.

Management

- In order to reduce the impacts of spearfishing and better protect, conserve and rehabilitate the reef ecosystems, the coverage of MPAs where spearfishing is prohibited (e.g. marine parks, reserves or FPAs) should be expanded. These should include areas of deeper rocky reefs as these are where the largest individuals of large reef species are typically found (see Sadovy & Cornish 2000), such as at offshore islands.

- If research shows that spearfishing is, or has the potential to significantly impact the recovery and sustainable management of the marine fishery, then it will need to be managed using sustainability criteria. This would not be possible under current legislation.

- Should research show that important species (from fishery, ecological or cultural perspectives) are being threatened with extinction, with overharvesting by spearfishing being a major factor, consideration should be given to giving these species protected status. Any protection of individual species under existing Ordinances would greatly reduce the impacts of spearfishing on individual species, but increased resources would be needed for enforcement.

- The small size of HK waters needs to be considered in any management measures. It means that spearfishers have great freedom to access any areas they like, but also makes monitoring and enforcement across the territory easier.

Education

- Ideally, the spearfishing community should be informed of moves to transform the fishery towards sustainability to gain their support, encouraged to restrain their behavior and spearfish in moderation, and perhaps to move to shooting with a camera, rather than a spear.

5. Artificial Reefs

i) What is the status of this fishing gear?

In Phase 1 of the Artificial Reef Programme, AFCD deployed 28,040 m^3 of artificial reefs in Hoi Ha and Yan Chau Tong Marine Parks, in 1998 – 99. In Phase 2 136,270 m^3 of artificial reefs were deployed during 2002-9 in Outer Port Shelter and Long Harbour. Additionally, 9,180 m^3 artificial reefs of were deployed in the Airport Exclusion Zones, and Sha Chau and Lung Kwu Chau Marine Park as dolphin feeding stations in 2000, and 3,530 m^3 of biofilters were deployed in various fish culture zones from 2002-8, and 1,910 m^3 of artificial reefs were deployed during 2006-8 in the Tung Ping Chau Marine Park, and a further 200 m^3 off Kat O.

The total volume of artificial reefs and biofilters deployed in Hong Kong to date is 179,130 m^3 (see http://www.artificial-reef.net/main2.htm#).The ARs within marine parks may only be fished by license holders for the parks, while those outside the parks and fish culture zones are open access.

What effect are artificial reefs (ARs) having on vulnerable species and ecosystems?

Two differing viewpoints exist, as follows.

VIEWPOINT 1. ARs IN HK ENHANCE BIODIVERSITY.

Underwater monitoring surveys indicated that ARs in HK increase habitat complexity, in particular when deployed in simple habitats like soft muddy / sandy bottom by providing hard surface habitats which support more marine invertebrates and fish. ARs deployed on mud bottom support significantly higher numbers and species than substrates comprised of bare mud. ARs support higher number of high and medium value commercial fish than natural rocky shores and mud bottom control sites. ARs provide an important habitat for many commercial fishes including adult and juvenile snapper, grunt, sweetlip and seabreams. In addition, ARs are used by some commercial fish species as spawning grounds. e.g. Leopard coral trout. Different fish species demonstrate different degree of affinity to ARs, e.g. the less mobile species (groupers) were observed in the ARs quite a long period of time after release. According to Gao et al 2008, ARs deployed in Fish Culture Zones improve marine environment in the zones. The filter feeders attached to the biofilters deployed in fish culture zones can improve the benthic abiotic environment and biotic conditions beneath fish rafts.

VIEWPOINT 2. ARs IN HK MAY BE REDUCING BIODIVERSITY.

There is no evidence that ARs in HK (as with many other parts of the world) enhance overall production and biodiversity through the creation of additional habitat, as opposed to aggregating marine life from surrounding areas. It appears that production in HK is limited by the scale of larval recruitment, rather than being limited by habitat, as local waters have plenty of natural rocky reefs and coral communities that appear to have supported more diverse communities with higher biomass in the

past. ARs in HK should be considered experimental at this stage. ARs can negatively impact biodiversity if they are fished, by concentrating fish and invertebrates to the benefit of fishers. Many of the ARs in HK are not protected from fishing, and are known to be fished. Those deployed in Outer Port Shelter were originally intended by government to be protected from fishing but this did not occur.

Recommendations

Research

- Hold an expert workshop to review the experience of deploying ARs, and the available information from HK and elsewhere on their effectiveness before deploying any more ARs.

Management

1. Ban commercial fishing in those marine parks where ARs are already deployed, to fully protect the ARs and eliminate the risk that they may be contributing to overfishing.

2. ii) Create FPAs with no-take zones around all the other ARs such as in Outer Port Shelter, to fully protect those ARs from fishing, and eliminate the risk that they may be contributing to overfishing.

ii) Assessments of Individual Recreational, Educational and Scientific Uses

6. Recreational Diving

What is the status of this use?

Recreational diving occurs mostly to the east but primarily north-east from Port Shelter northwards. Hong Kong waters are generally less than 30 m in depth and within recreational diving depths, and only a few areas have strong currents, so most areas are accessible to divers, visibility permitting. Coral communities in Port Shelter, notably at Sharp, Shelter and Bluff Islands are popular areas for learner divers.

Most recreational diving takes place in the summer months when the water is warmer. The numbers of divers actively diving in Hong Kong is believed to be in the order of thousands to tens of thousands, but has never been quantified (Steve Chan pers. comm.).

What effect is this use having on vulnerable species and ecosystems?

The full range of potential impacts of recreational diving to marine life has not been formally studied, but the greatest impacts are likely to be to hard coral communities, which are popular areas to dive, and specifically to branching, plating corals. Two main kinds of impact, direct contact with corals which can result in breakage, permanent damage, or full recovery, or indirect impact by stirring up silt which may smother creatures, including corals, are known (Chung et al., 2013).

The greatest impacts are to branching corals, and it seems that diving pressure may have influenced the proportions of different coral types over time, and there is a

correlation between the numbers of divers visiting a site, and numbers of recently broken corals (Au et al. 2014)

From the overseas literature, many corals should be able to recover from minor diver damage but it is not clear whether this necessarily true in Hong Kong as corals which may be stressed by other factors, including natural temperature fluctuations, and anthropogenic pollutants. There may also be indirect cascade effects to the ecosystem resulting from impacts to the corals e.g. changes to coral composition may impact certain species of butterflyfishes that rely on specific coral species (see Cornish and Sadovy 2000).

Other possible impacts which are probably occurring but to an unknown degree include the impacts of personal care products on corals, such as sun screen which can cause rapid coral bleaching even at low concentrations (Danovaro et al. 2008). It may also be that divers may accidentally cause physical damage to benthic organisms such as feather stars and soft corals, or stress animals by harassing them.

The recreational diving community does have a positive impact on the marine environment through operations to remove ghost nets and trash, and the freeing of fish and invertebrates from abandoned/lost fishing gear and debris.

The impacts of vessels supporting diving operations is covered elsewhere, under Recreational Use of Vessels.

What management measures are already in place?

There is no policy or management plan intended to manage the overall impacts of recreational divers on the marine environment, but there are some measures in place.

AFCD installed No-Anchoring Zones demarcated by coral marker buoys around the main coral communities at Port Island, Sharp Island and Bluff Island (Ung Kong Wan) from 2002-2004, and has issued guidance materials for these areas that note "Novice SCUBA divers who do not have good buoyancy control should avoid diving at coral sites." AFCD has also produced guidance to "Visiting coral areas – Codes for SCUBA divers and snorkelers."

Within Marine Parks, specific anchoring areas are designated to reduce direct damage on coral habitats by anchor such as in Hoi Ha Wan Marine Park, Tung Ping Chau Marine Park and Yan Chau Tong Marine Park. Inboard vessels are also prohibited from entering some of the coral-rich areas within Hoi Ha Wan Marine Park, to protect corals in the shallow waters from vessels running aground on them (www.afcd.gov.hk/english/aboutus/abt_adv/files/WP_CMPB_11_2013.pdf) .

Recreational diving is not permitted in marine reserves, but is permitted without restrictions (apart from a ban on spearfishing) in marine parks.

What monitoring and enforcement is in place?

All corals and organisms in Marine Parks and Marine Reserve are protected under Marine Park Ordinance (Cap. 476). No fishing, spear-fishing and collection of marine life is allowed in the parks and reserve, unless a permit is granted by the Country and Marine Parks Authority.

The status of coral communities of Hong Kong is actively monitored through annual "Reef Check". Results of the Reef Check are publicised to raise public awareness of

the current status of the marine environment and to seek the public's cooperation in protecting our biodiverse marine resources.

Are there data gaps for this particular use?

No information is available on the current size, trends and dynamics of the recreational diving community active in Hong Kong.

It is not known whether coral communities can recover from diver damage faster than it occurs and, therefore, whether recreational diving in coral areas is sustainable. This is particularly important to understand in the most intensively dived sites, notably in Port Shelter.

Recommendations

Research

1. Conduct a study in collaboration with the local diving industry to quantify recreational diving in Hong Kong, e.g. numbers of active divers, preferred sites, motivations for diving, seasonality, knowledge of codes of conduct etc.

2. Conduct further research to understand the susceptibility and rates of recovery of different coral species to diver damage.

3. Use information from the two studies above to look at the carrying capacity of some of the most intensively dived coral communities in Hong Kong, to gain a better understanding of the likely broader impacts of recreational diving.

Management

- Based on the findings of the research studies, additional management measures can be considered.

Education and Awareness Raising

- Increased activities by government to increase knowledge and buy-in of the Code of Conduct for diving and snorkeling by the diving community would be a worthwhile preventative measure.

7. Recreational Use of Vessels

What is the status of this use?

Recreational Use of Vessels includes ferries visiting natural areas for sightseeing, and private or hired leisure vessels, whether motor, wind-powered or self-propelled, traveling through local waters, and making day trips to beaches and other natural areas of coastline. Dolphin watching in the waters around Lantau is another specific use. Boating occurs over most of local waters, and mostly affects surface waters except for toilet flushing, the intended or unintended release of oil and other pollutants, and when anchoring. Most day-trip activity appears to be concentrated within a few hours sailing from the major harbours/ pick-up points of Aberdeen, Victoria Harbour, Sai Kung town and Hebe Haven.

According to the Marine Department, here were some 8,491 licensed leisure craft in

2013 (Class IV), up from 5,714 in 2006.

Dolphin watching occurs primarily to the north and west of Lantau, including the Brother's Islands and Sha Chau / Lung Kwu Chau Marine Park. Currently, there are three main types of dolphin-watching activities in HK: 1) speedboats that take tourists out from Tai O fishing village, which may not adhere to the dolphin-watching code-of-conduct and which have caused a lot of disturbance to the dolphins because of their high speed and close proximity to the dolphins; 2) professional operators who follow the dolphin-watching code-of-conduct and likely cause very little disturbance to the dolphins; 3) general hire or company owned vessels that are occasionally used for dolphin watching, which are quite variable in terms of adherence to the code-of-conduct.

What effect is this use having on vulnerable species and ecosystems?

The main impacts from the Recreational Use of Vessels are likely to be

i) Indirect impacts of organic pollution from flushing toilets (most of which discharge immediately into the surrounding seas)

ii) Indirect impacts of litter lost overboard

iii) Indirect effects of pollution from oil, anti-fouling paint and other chemicals discharged when clearing the bilges etc.

iv) Direct impacts of vessel strikes on marine life

v) Anchor damage to hard corals and other benthic marine life and habitats

vi) Disturbance to Chinese white dolphins

vii) Underwater acoustic disturbance generated by vessels may impact marine life including dolphins

While more research is needed on the impacts of pollutants originating from vessels on marine biodiversity, most impacts i) to v) are probably quite diffuse except in areas like Long Ke Wan where there are coral communities in < 10 m depth in areas where boats congregate, and where anchor damage and toilet paper have been observed damaging/on corals. Large table corals in the outer islands including the Ninepin Islands are also vulnerable to anchor damage, and some with shattered plates consistent with anchor damage have been observed (Cornish pers. obs.).

There may also be some impacts from anchors to Amphioxus (see Status, Trends and Recommendations on Protection of Selected Marine Invertebrates – Hong Kong's "Living Fossils").

Normally, the disturbance on dolphins by dolphin-watching activities is relatively short-term. The impact of dolphin-watching may be irreversible if a unless a vessel hits a dolphin directly in causing physical harm. However, this a very rare event based on past research (Samuel Hung pers. comm.). Dolphin watching occurs throughout the range of the Chinese white dolphins in local waters, but occurs more intensively in areas of high abundance such as adjacent to Tai O. Initial research suggests that suggest that short-term changes in dolphin movement occur in the presence of different vessel types in Hong Kong waters, and that this may be heightened for fast moving dolphin watching vessels but more information is needed

for rigorous statistical analyses (Piwetz et al. 2012). The potential for a bigger impact can be seen back in the days of SARS when 20-30 boats would go out looking for dolphins on any given day (Samuel Hung pers. comm.)..

What management measures are already in place?

AFCD installed No-Anchoring Zones demarcated by coral marker buoys to protect the main coral communities at Port Island, Sharp Island and Bluff Island (Ung Kong Wan) from anchor damage from 2002-2004. Anchoring areas have also been put in place at Hoi Ha Wan, Yan Chau Tong and Tung Ping Chau Marine Parks, and vessels are only allowed to anchor in these special anchoring zones (located away from coral areas) in the Marine Parks.

The Wild Animals Protection Ordinance prohibits any harassment to dolphins, although in practice enforcement is difficult.

Additionally, AFCD has produced a voluntary Code-of-Conduct for Dolphin Watching. AFCD conducts regular meetings with walawala operators at Tai O to ensure that they understand the code–of-conduct and that we are monitoring the situation.

What monitoring and enforcement is in place?

AFCD patrols waters around Tai O to ensure that nobody is violating the Wild Animals Protection Ordinance. No one has been found violating the law.

Are there data gaps for this particular use?

No studies appear to have examined the impacts of vessels used for recreational on marine biodiversity, and habitats, apart from on the Chinese white dolphin.

Recommendations

Research

- Marine pollution experts should be consulted to determine if non-organic pollutants from vessels are likely to be impacting marine biodiversity significantly, and whether additional research is required.

- A study should be conducted in conjunction with Marine Department to find solutions to prevent the sewage from leisure craft from being dispelled in environmentally sensitive areas, and more broadly to address related human health issues, and to start to implement them.

- Under the Clean Shorelines programme (www.epd.gov.hk/epd/clean_shorelines/), the Environmental Protection Department has employed a consultant to conduct research on the types and sources of marine litter in Hong Kong, which should provide useful information on the scale of marine litter originating on vessels being used for recreation. Information gathered by this study could be used to guide management actions.

- ReefCheck has been conducted in Hong Kong since 1997, and teams are encouraged to record diver damage. The dataset should be examined to look for trends and potential problem areas. New research could also be conducted as part of the research into the carrying capacity of different coral

areas to recreational diving (see Recreational Diving recommendations)

Management

- Dolphin-watching activities could be more tightly regulated in areas of high dolphin densities. Options include regulating dolphin-watching operations through a licensing system, which has been done in some other countries, or establishing marine parks in these areas.

- Installation of mooring buoys for vessels supporting diving and snorkeling operations around coral communities should be explored by AFCD in consultation with the diving community. This is common practice in many locations in Asia and beyond. Reef Check sites would be a logical place to start.

Education

- Conduct awareness raising activities to vessel owners on areas where coral communities are found and where anchors should be deployed with caution, or not at all.

APPENDIX C. Marine Uses Not Examined In Detail

Use	Scope	Impact
Fisheries and Mariculture (including recreational fishing)		
Purse seine	There are about 90 registered purse seiners (with dinghies with the lights on them). They tend to focus in shallower areas, and they operate in the top of the water column	Mostly fishing at night for a small number of target species e.g. squid and small pelagics (sardines, anchovies). A 3.5 year study at Hoi Ha collected 54 of the total 137 fish species by purse seine, and the most common species were sardines, anchovies, herring, hairtail ponyfish and scad (Leung et at al 1997). These target species tend to be fast growing and reproduce at a low age. There are no restrictions on mesh size. Little or no impact on habitats.
Longline (demersal).	Not widely used in HK but in eastern and western waters. About 110 longliners in 2012 partly fishing in HK.	A 3 year study at Hoi Ha found that only 21 of the 137 species were recorded by demersal longline, the most common species were snake and pike eels, scorpion and tigerfish, sillago, moray eels, cardinalfish, sea bream, monocle and threadfin bream (Leung et at al 1997). There may be some impact to coral communities and other benthic life from lost monofilament lines, but it is believed to far less than from gill nets. Pelagic longlines are not known to be used in HK waters.
Hand collection of sea urchins and invertebrates	Primarily in southern and eastern waters, and almost entirely on rocky reefs	1-4 divers operate using air from compressors aboard small vessels in shall waters. Only 2 (?) species of urchins are targeted, while divers may also opportunistically take invertebrates such as crabs that they encounter.
Collection of small reef fishes for the aquarium trade	Collection not been directly observed happening, but most likely occurs in eastern waters	Fishes observed at the Mong Kok aquarium fish shops that appear very likely to have been collected in HK waters include Clark's anemone fish, and several common cardinalfishes. Collection by handnets, small cages and hook and line are all possible. The collection of aquarium fishes in Hong Kong appears to be small scale, and probably low-impact at present

Floating cage culture	Marine fish culture is currently limited to 26 Fish Culture Zones covering roughly 2 million sq. m, but as of May 2012, only 292,000 sq. m was licensed for use (LC Paper No. CB(2)1284/12-13(05)). On grounds of environmental impact, there has been a general moratorium since 1990 on the issue of new fish culture licences and raft area extensions in existing fish culture zones (FCZs) and designation of new FCZs. With a view to utilising the surplus carrying capacity, and at the same time encouraging advances in technology and best practices in the industry, AFCD plans, to issue new marine fish culture licences on a trial basis at a small scale. Environmental management measures, including water modelling and controlled use of trash fish, will be employed to ensure sustainability. Please refer to LC Paper No. CB(2)1284/12-13(05) for details.	A review of mariculture in Hong Kong noted a number of issues facing floating cage culture, of which three relate to sustainable use/ impacts on biodiversity: serious organic and nutrient enrichment in the bottom sediments under the cages, use of locally caught mixed fish as fish feed, and by-catch problems associated with fry inputs using small- meshed nets (Chan 2005). In 2013, the Food and Health Bureau and AFCD completed an environmental assessment using a computer modelling and found that "if the then existing fish farms would operate in line with their recommendations (including reduction in standing stock and raft area; improved husbandry practices; replacement of trash fish by pellet feed; reduction of pollutant input from garbage and cleaning of cages; prohibition of dwellings on rafts and periodic movement of rafts for sediment recovery), most of these existing fish farms were or would be environmentally acceptable" (LC Paper No. CB(2)1284/12-13(05)). The impact on biodiversity is mainly confined to the benthic environment directly under the sea cages. There are measures to effectively manage the possible impact (e.g. carrying capacity modelling, biofilters). The trawling ban has further reduced the use of trash fish. Still planning for some new FCZs in the coming years but will have to do EIA and avoid the most sensitive areas The impacts of escaped exotic species are covered by the Marine Impact Assesment FG
Oyster culture	Oyster culture on mud-flat has been practised along the intertidal mud flat of Deep Bay in north western corner of Hong Kong for at least 200 years. The area of Oyster Bed in Deep Bay is about 1,304 hectares. This culture practice is indeed fading out gradually in the last few decades due to the lack of production efficiency. For raft-culture, currently, there are about 5,000 oyster rafts mooring at Deep Bay. The impact of oyster raft culture on biodiversity is relatively small. Since feeding is not required, the oyster culture in Deep Bay is indeed harvesting	Overall oyster farming should have little negative impact on the environment, although mangrove planting can reduce available habitat for horseshoe crabs and other mudflat grazers. Mangrove planting by oyster farmers is limited. The Coastal Community Working Group of AFCD conducts surveys on the distribution of seagrass in Hong Kong since 2002. H. beccari seagrass beds have been recorded at 7 sites including Sheung Pak Nai, Ha Pak Nai, Pak Nai, Sha Kong Tsuen, Nam Chung Yeung Uk, Sham Wat and Tai O Salt Pan. According to AFCD data, the largest piece of H. beccari seagrass bed was recorded at Pak Nai in 2011 with an area of 3.6ha, yet mangrove planting by oyster farmers is limited to the mouth of the Sheung Pak Nai stream only. Pak Nai was designated as a SSSI in 1980 and thus the habitat gains certain protection. Apart from this, all established seagrass beds are considered important habitats

	biomass from the eutrophicated Deep Bay.	under the Environmental Impact Assessment Ordinance. Any proposed development that may affect this habitat has to undergo the ecological impact assessment process, so as to avoid / minimize the threats to the seagrass communities. As for horseshoe crabs, an ECF project was conducted in 2003-2007 to assess their juvenile distribution in Hong Kong (Shin et al. 2007). The study documented the presence of juvenile horseshoe crabs not only at Pak Nai but also Lantau Island, including Shui Hau Wan, San Tau, Sham Wat, Yi O and Tung Chung, and Tsim Bei Tsui at Northwestern New Territories.
Recreational, Scientific and Educational uses		
Educational Tours (geo-park, AFCD alt. livelihood scheme, geo-park)	Mostly limited to geo-park and marine parks	Largest impacts probably from vessel use, and even these are probably relatively low impact including engine noise/petrol/bilge pumping/toilet flushing.
Other: Beach and recreational activities	Scope includes all beaches and rocky shorelines below the high-tide mark, but little impact on the sea beyond	litter/disturbance of nesting grounds/turtles (although many beaches that provide habitat for turtles are relatively inaccessible and the main green turtle beach at Sham Wan on Lamma is off-limits in the egg-laying season). Continued disturbance of burrowing animals e.g. ghost crabs at gazetted beaches in particular.
Squid jigging (listed under recreational as squid jigging only occurs as a recreational pursuit)	There is a seasonal fishery operating at night in Port Shelter in summer (which) months. Recreational only.	Squid jigging targets squid, and may take a small catch of fishes attracted to the lights and accidently snagged
Gleaning	Mudflats/beach/rocky shore	Known to include harvesting by individuals and small groups of mussels, clams, polychaete worms (as fishing bait) and starfish (as fertilizer). While the species targeted seem to be relatively common, it seems likely that localised depletions could occur if gleaning occurs regularly. No research on the impacts of gleaning in HK is known - may be difficult to ascertain scope and severity of impacts since no license required for this type of harvesting (including potentially commercial harvesting). There are believed to be impacts on juvenile horseshoe crab foraging grounds

		around Lantau
Snorkeling	Snorkeling primarily north east from Port Shelter and further north, and generally water in < 5 m	Greatest impacts to hard coral communities. Impacts to very shallow coral communities may be greater than from diving, with snorkelers occasionally observed standing on corals in very shallow water e.g. at Hoi Ha Wan Marine Park and Sharp Island. There is less scope for releasing marine life, removing ghost nets etc. than through diving. Awareness raising on appropriate codes of conduct for snorkelers in coral communities in particular, is needed
Scientific research (including by academic institutions, government, environmental consultants and students)	From both degraded and man-made habitats, to the least disturbed areas, from coastlines to the seabed. A wide scope, even if the intensity in most areas is probably low	Most scientific research probably is not too severe at a local population level, and may be purely observational, although removing and killing of animals/plants for study is still commonplace. A permit from AFCD is required for research trawling activities. The impact of research trawling on the fisheries habitats and resources would likely to be may not be significant overall owing to the low frequency, small swept area, short tow time and small sample size, but will have a high impact in the areas directly trawled (although most sea bed communities will still be degraded due to intensive commercial trawling in the past). Currently, several parties are conducting research trawling

APPENDIX D. Focus Group Members and Methodology

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Methodology

1. The Focus Group first identified the types of use of marine biodiversity in Hong Kong waters that it will include in its deliberations.

   Note that in following Article 2 on sustainable use, the sectors/activities to be included should involve the use of biological diversity, not merely pose threats to it.

2. Information was collated relevant to three criteria to assess the potential impact of that use on biodiversity (scope, severity and irreversibility) which was then used to assess the (negative and positive) impacts to local marine biodiversity from each type of use. Scoring ranged from 1 (Low) to 4 (Very High). Use + scores for positive impacts, and – scores for negative impacts.

   - **Scope** refers to the proportion of the target (area for ecosystems, population for species) that is likely to be affected within 10 years under current circumstances.
   - **Severity** attempts to categorize the level of damage to the biodiversity target expected within that particular scope and in the specified time frame.

- **Irreversibility** is the degree to which the effects of a given threat can be undone and the targets affected by the threat restored, if the threat is stopped.

3. The FG divided into four sub-groups based on expertise and interest in particular types of use of marine biodiversity, and provided a written account of the anticipated impact of that type of use on biodiversity (genetic, species and/or ecosystem) based on available knowledge and the expertise of the group, against each criteria.

   A. *Fisheries and mariculture*
   B. *Below water recreation*
   C. *Above water recreation*
   D. *Scientific research*

   The guidance provided to the sub-groups noted "Some kind of uses may have quite different impacts to specific species vs. habitats or ecosystems – these should be captured. The information should focus on current use, but take account of any changes in use that are anticipated with a strong degree of certainty before 2020. Note that the sub-group should NOT score each criteria as a sub-group, but should be prepared to recommend to the full focus group a score for discussion. Sub-groups should also note where additional research in certain areas would be particularly valuable in years to come.

   When scoring "Irreversibility" please note if reversing the impact will take a long time, or if by waiting for some time to act, it will be more difficult to reverse the impact."

   Both positive and negative impacts should be recorded by + and – scores.

Level of impact	Score
None	0
Low	1
Moderate	2
High	3
Very High	4

4. The Focus Group then collectively agreed the score for each use/criteria for each type of use, and the score were summed across each use to rank the impact on biodiversity. The ranking exercise was intended to reduce subjectivity in assessing impacts to biodiversity, but not to provide a definitive assessment. Members of the group used the scores and their own knowledge to select the uses thought to have the highest impact on marine biodiversity for more detailed assessment as follows (and in rough order of highest perceived negative impact to biodiversity).

   - Gill net fishing
   - Hook and line fishing (including trolling but excluding longline)
   - Spearfishing and other underwater harvesting (whether diving or snorkeling)

- Recreational diving
- Trap fishing (including fish cage traps, and crab traps)
- *Commercial day trips: Ferries of all kinds traveling between piers

*It was decided to combine Commercial day trips: Ferries of all kinds traveling between piers for sightseeing, Commercial day trips: “Party boats” making day trips to scenic areas, Dolphin watching and Recreational Yachting: Leisure boating (sailing and motoring) into a single category of “Recreational Use of Vessels” as the types of impacts were similar.

Artificial reefs were also assessed in more detail as their impact on, and implications for, biodiversity could not be initially assessed with confidence by the group.

5. Detailed assessments were drafted for seven marine uses by several members of the FG, against questions adapted from the Quick Guide to Aichi Target 6. These were improved through email and meetings, and then collated and expanded on by the convenor, and refined through several rounds of email and a meeting to produce the final report.