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LIVE REEF FOOD FISH WET MARKET SURVEY
LIVE REEF FOOD FISH GUIDE

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Introduction

Live reef food fish (LRFF) are a staple of every Hong Kong family's dinner table. Whether in daily meals or celebration banquets, the dish of fish is omnipresent as a key source of protein and a sign of a wholesome meal. On average, each Hong Kong person consumes 65.5 kg of seafood every year, putting Hong Kong in rank as the 2nd largest per capita consumer of seafood in Asia, and 8th largest in the world (WWF-Hong Kong, 2017).

Most of the live reef food fish retailed in Hong Kong today are imported. This however, was not always the case. Prior to the1980s, Hong Kong's live reef food fish market was mostly supplied by local catches (Johannes & Reipen, 1995). As popular species became increasingly overfished in local and adjacent waters, Hong Kong began importing more of its live reef fish from other countries/territories, including Indonesia, Maldives, Australia and the western Pacific (Lee & Sadovy, 1998). By the mid-1990s, about 15,000 t of Hong Kong's live reef food fish were imported, rising from only 2,000 t in the late 1980s (Lee & Sadovy, 1998). Furthermore, as stocks in the exporting countries are depleted, the trade shifts to exploit other regions around the world (Sadovy et al., 2003). Records from the Census and Statistics Department of the Government of Hong Kong SAR (CED) show that Hong Kong currently imports LRFF from over 40 countries/territories globally.

Previous research showed a historical local fondness for groupers over other LRFF species groups. A study by Lee & Sadovy (1998) showed a strong preference for groupers in the 1990s' LRFF market of Hong Kong. In the mid-1990s, more than 80% of the total abundance of the LRFF market in the restaurant trade was imported groupers (Lee & Sadovy, 1998). A decade later, in mid-2000s, a market survey found over 80% of live groupers sold in two of Hong Kong's main live fish wet markets were juveniles (To & Sadovy de Mitcheson, 2009). The same study showed that catch of juvenile groupers was increasing as a trend in Hong Kong for 50 years. Such high consumer demand has put heavy fishing pressures on groupers (Sadovy et al., 2003).

Today, in both wet markets and restaurants of Hong Kong, a variety of snappers, pompanos and wrasses can be found alongside groupers among the LRFF selection. Hybrid grouper species, especially the Sabah grouper (*Epinephelus fuscoguttatus x E. lanceolatus*: a cross-breed between the tiger grouper and giant grouper), seems also to be found in abundance. The Sabah grouper was introduced to the Hong Kong market in the late 2000s, and in Lam's study in 2013, this hybrid species was found to have replaced the parent species' importance in both the restaurant and wet market trades. It was also speculated that other forms of hybrid grouper species may also have been introduced into the local market since (pers. Comm. Stan Shea).

Evidently, Hong Kong's LRFF market has undergone many changes in species composition and sourcing origins in the past few decades. The situation today, however, is yet unstudied and therefore unknown. Since To & Sadovy de Mitcheson's (2009) study of wet markets in the mid-2000s, Lee & Sadovy's (1998) study of restaurants in the 1990s and Lam's unpublished study in 2013, there have not been any further detailed and comprehensive surveys to understand the composition of LRFF found in Hong Kong's wet markets and restaurants. It is hence not possible to accurately describe what changes may have occurred in the 10 – 15 years since the previous surveys.

The current study seeks to provide this very update, to understand how the wet market trade has changed with respect to their provisions of live reef food fish. More specifically, it aims to study and update the species diversity and abundance in local fish markets. The significance of Sabah grouper

and potential presence of other hybrid species will also be noted. Conservation implications for the results will also be discussed.

About the Live Reef Food Fish Guide

The Live Reef Food Fish Guide is a companion to this study.

Many consumers rely on labels provided by markets to know what species of fishes they are buying. However, these labels may not always be available, or when available, may not always be accurate. Recent studies conducted by the WWF-HK (2016a,b) have discovered the mislabeling of LRFF in many local supermarkets. One study showed that some species were misidentified on supermarket labels as more expensive species, effectively allowing consumers to be overcharged. Another study showed the presence of threatened and endangered species in local supermarkets, as well as species associated with human rights issues. Such cases have also been observed in local wet markets (pers. Comm. Stan Shea).

While markets and supermarkets must take responsibility for the accurate identification of the fishes they sell, consumers can also gear up by enhancing their knowledge and ability to recognise different species of LRFF. Most live fishes found at markets and restaurants are possible to identify simply based on their appearances.

In 2000, the *Identification Guide to Fishes in the Live Seafood Trade of the Asia-Pacific Region* (Lau & Li, 2000) was published, in a joint project between WWF and the Agriculture, Fisheries and Conservation Department of the Government of Hong Kong SAR (AFCD). The document was made in response to recommendations proposed in the 1997 Asia-Pacific Economic Cooperation (APEC) Workshop on the Impacts of Destructive Fishing Practices on the Marine Environment. The goal was to produce a user-friendly guide and identification aid for live fish species commonly encountered in the market, accessible to members of the general public and encouraged for use among customs and fisheries officers, traders, retailers and fishermen alike. While composition of fishes in markets may have changed since the guide's publication over a decade ago, there have not been any updates to the document.

The 2017 guide will offer an update to the 2000 publication. In this guide, each species of LRFF is presented with common names, scientific name, conservation statuses, general descriptions, and photographs of live specimens as encountered in the market.

Through this resource, it is hoped that understanding for the types of LRFF that are being consumed, and the surrounding conservation issues, may be enhanced among all users.

Wet Market Survey Methodology

Study sites

In this study, two local wet markets were chosen for market surveys to update the conditions of live marine fishes in local retail markets. Of the 180+ local seafood retail markets in Hong Kong, only seven wet markets have more than 40 fish stalls (Goods Market, 2017; Lam, 2013). Tai Po Market

and Yeung Uk Road Market were selected among the seven, given these two markets' relatively high abundance and species diversity of live marine fishes (Lam, 2013) and comparability with previous studies.

Market	Total number of fish stalls	Stalls selling live marine fishes
Tai Po Market	65	21
Yeung Uk Road	66	22

Table. 1. Total numbers of fish stalls and the number of those selling live marine fishes in the two wet markets studied (FEHD, 2017)

Sampling protocol

The study period was from January to June 2017. Each market was visited twice a week at three- to four- day intervals, except during festive days when local fishermen rested and fish stalls closed, such as during Chinese New Year.

According to Lam (2013), sellers revealed that turnover rates of the fish was about 50% in three days. Visits to the same market on consecutive days were hence avoided to minimise double counting. Surveys were conducted either in the morning from 0900 to 1000 or in the early afternoon from 1400 to 1500, so as to meet the peak times of fish arrivals and avoid times with highest customer flows.

During surveys, information on diversity and numbers of all live reef fishes on sale in each stall were collected. All live reef fishes were identified on site or photographed for identification ex-situ to species level if possible, or otherwise to the genus level, and then recorded according to their lowest level of identification i.e. species or genus. Origins and sources of the fishes were investigated through conversations with fish retailers.

Note that surveyed species are restricted to LRFF species only and excludes all freshwater species. Species that cannot easily be identified on site are noted. Live flatfishes, for instance, can mostly be identified to genus-level only due to the extreme similarity in appearance between different species. However, as most flatfish species come from fish farms, they are of a relatively lower conservation concern in comparison to other species in this study.

Data analysis

Species diversity and relative abundance

Yeung Uk Road: A total of 123 live fish and hybrid species were found in the Yeung Uk Road wet market. The total number of individuals counted was 55,148.

Four species took up more than 5% of the total abundance. These were *E. fuscoguttatus x E. lanceolatus* (hybrid), *Trachinotus blochii*, *Siganus canaliculatus*, and *Lutjanus argentimaculatus*. The *E. fuscoguttatus x E. lanceolatus* (hybrid), was by far the most abundant, accounting for over 20% of the total abundance during the sampling period.

The most frequently encountered species, for which the frequency of encounter was 50% or above, is presented in table 2. Groupers are the most frequently encountered fish group.

	Species (Scientific name)	Fish group (based on FishBase.org

		definitions)
1	*Plectropomus areolatus*	Grouper
2	*Plectropomus leopardus*	Grouper
3	*Trachinotus blochii*	Pompano
4	*Lutjanus argentimaculatus*	Snapper
5	*Lutjanus malabaricus*	Snapper
6	*Epinephelus fuscoguttatus*	Grouper
7	*Epinephelus fuscoguttatus x Epinephelus lanceolatus*	Hybrid Grouper
8	*Lates calcarifer*	Lates perch
9	*Lutjanus stellatus*	Snapper
10	*Plectorhinchus cinctus*	Grunt
11	*Siganus punctatus*	Rabbitfish
12	*Siganus canaliculatus*	Rabbitfish
13	*Oplegnathus punctatus*	Knifejaw
14	*Epinephelus coioides*	Grouper
15	*Plectropomus maculatus*	Grouper
16	*Larimichthys crocea*	Croaker
17	*Acanthopagrus schlegeli*	Sea Bream
18	*Cephalopholis sonnerati*	Grouper
19	*Acanthopagrus latus*	Sea Bream
20	*Cromileptes altivelis*	Grouper
21	*Epinephelus polyphekadion*	Grouper
22	*Sparus aurata*	Sea Bream
23	*Lateolabrax japonicus*	Asian Seaperch
24	*Epinephelus bleekeri*	Grouper
25	*Hapalogenys nitens*	Barbeled Grunter
26	*Scatophagus argus*	Scat
27	*Epinephelus corallicola*	Grouper
28	*Epinephelus maculatus*	Grouper

Table 2. Most frequently encountered species (50% or above frequency of encounter) in Yeung Uk Road

Tai Po Market: A total of 160 live fish and hybrid species were found in the Tai Po Road wet market. The total number of individuals counted was 63,351.

Four species took up more than 5% of the total abundance. These were *Sebasticus marmoratus*, *Siganus canaliculatus*, *E. fuscoguttatus x E. lanceolatus* (Hybrid), and *Trachinotus blochii*. The *S. marmoratus* accounted for over 15% of the total abundance during the sampling period.

The most frequently encountered species, for which the frequency of encounter was 50% or above, is presented in table 3. Groupers are also the most frequently encountered fish group in this market.

	Species (Scientific name)	**Fish group (based on FishBase.org definitions)**
1	*Sebastiscus marmoratus*	Rockfish
2	*Lutjanus stellatus*	Snapper
3	*Epinephelus coioides*	Grouper
4	*Trachinotus blochii*	Pompano

5	*Lutjanus malabaricus*	Snapper
6	*Epinephelus fuscoguttatus*	Grouper
7	*Plectropomus leopardus*	Grouper
8	*Siganus canaliculatus*	Rabbitfish
9	*Epinephelus fuscoguttatus x Epinephelus lanceolatus*	Hybrid Grouper
10	*Oplegnathus punctatus*	Knifejaw
11	*Scorpaenopsis cf. cirrosa*	Scorpionfish
12	*Cephalopholis boenak*	Grouper
13	*Siganus punctatus*	Rabbitfish
14	*Acanthopagrus schlegeli*	Sea Bream
15	*Lates calcarifer*	Lates perch
16	*Scatophagus argus*	Scat
17	*Epinephelus polyphekadion*	Grouper
18	*Plectorhinchus cinctus*	Grunt
19	*Cromileptes altivelis*	Grouper
20	*Epinephelus bleekeri*	Grouper
21	*Lutjanus argentimaculatus*	Snapper
22	*Cephalopholis sonnerati*	Grouper
23	*Mugil* spp.	Mullet
24	*Plectropomus maculatus*	Grouper
25	*Epinephelus awoara*	Grouper
26	*Epinephelus corallicola*	Grouper
27	*Larimichthys crocea*	Croaker
28	*Plectropomus areolatus*	Grouper
29	*Acanthopagrus latus*	Sea Bream
30	*Terapon jarbua*	Tigerfish
31	*Epinephelus maculatus*	Grouper
32	*Hapalogenys analis*	Barbeled Grunter
33	*Monacanthus chinensis*	Filefish
34	*Epinephelus quoyanus*	Grouper
35	*Stephanolepis cirrhifer*	Filefish
36	*Epinephelus akaara*	Grouper
37	*Aethaloperca rogaa*	Grouper
38	*Gymnothorax reevesii*	Moray Eel
39	*Pagrus major*	Sea Bream
40	*Scarus ghobban*	Parrotfish
41	*Girella punctata*	Sea Chub

Table 3. Most frequently encountered species (50% or above frequency of encounter) in Tai Po Market

Overall between both markets: Overall, within the survey period, more than 180 live fish and hybrid species comprising 118,499 individuals were counted in both wet markets combined. The full list of species encountered can be found in Appendix B.

E. fuscoguttatus x E. lancolatus (hybrid), was the most abundant species in both markets, accounting for over 15% of total abundance in the entire survey.

The most frequently encountered species, for which the frequency of encounter was 50% or above, is presented in table 4. Groupers are the most frequently encountered fish group in both markets.

	Species (Scientific name)	Fish group (based on FishBase.org definitions)
1	*Plectropomus leopardus*	Grouper
2	*Trachinotus blochii*	Pompano
3	*Lutjanus malabaricus*	Snapper
4	*Epinephelus fuscoguttatus*	Grouper
5	*Epinephelus fuscoguttatus x Epinephelus lanceolatus*	Hybrid Grouper
6	*Lutjanus stellatus*	Snapper
7	*Siganus canaliculatus*	Rabbitfish
8	*Epinephelus coioides*	Grouper
9	*Siganus punctatus*	Rabbitfish
10	*Lates calcarifer*	Lates Perch
11	*Lutjanus argentimaculatus*	Snapper
12	*Oplegnathus punctatus*	Knifejaw
13	*Plectorhinchus cinctus*	Grunt
14	*Plectropomus areolatus*	Grouper
15	*Acanthopagrus schlegeli*	Sea Bream
16	*Plectropomus maculatus*	Grouper
17	*Epinephelus polyphekadion*	Grouper
18	*Cephalopholis sonnerati*	Grouper
19	*Cromileptes altivelis*	Grouper
20	*Larimichthys crocea*	Croaker
21	*Epinephelus bleekeri*	Grouper
22	*Sebastiscus marmoratus*	Rockfish
23	*Scatophagus argus*	Scat
24	*Acanthopagrus latus*	Sea Bream
25	*Scorpaenopsis cf. cirrosa*	Scorpionfish/Rockfish
26	*Epinephelus corallicola*	Grouper
27	*Hapalogenys nitens*	Barbeled Grunters
28	*Epinephelus maculatus*	Grouper
29	*Mugil cephalus*	Mullet
30	*Cephalopholis boenak*	Grouper
31	*Gymnothorax reevesii*	Moral Eel

Table 4. Most frequently encountered species (50% or above frequency of encounter) in both markets

*Near Threatened and threatened species as defined by the IUCN **Red** List of Threatened Species*

A total of 17 species listed as Near Threatened (NT) or threatened under the IUCN Red List of Threatened Species were counted from both markets. This comprised of 10 Near Threatened (NT) species, 5 Vulnerable (VU) species, and 2 Endangered (EN) species, and included groupers, wrasses and a species of shark. These are shown in table 5 below.

The results reveal the prevalence of threatened species in Hong Kong's wet markets and indicate a need for conservation action.

	Species (Scientific name)	IUCN Red List Conservation Status	Fish group (based on FishBase.org definitions)
1	*Plectropomus areolatus*	VU	Grouper
2	*Cromileptes altivelis*	VU	Grouper
3	*Epinephelus bruneus*	VU	Grouper
4	*Epinephelus akaara*	EN	Grouper
5	*Epinephelus lanceolatus*	VU	Grouper
6	*Plectropomus laevis*	VU	Grouper
7	*Cheilinus undulatus*	EN	Wrasse
8	*Epinephelus coioides*	NT	Grouper
9	*Plectropomus leopardus*	NT	Grouper
10	*Epinephelus fuscoguttatus*	NT	Grouper
11	*Epinephelus bleekeri*	NT	Grouper
12	*Epinephelus polyphekadion*	NT	Grouper
13	*Plectropomus oligacanthus*	NT	Grouper
14	*Epinephelus malabaricus*	NT	Grouper
15	*Choerodon schoenleinii*	NT	Wrasse
16	*Plectropomus pessuliferus*	NT	Grouper
17	*Chiloscyllium plagiosum*	NT	Shark

Table 5. Species recorded in the survey that are categorized as Near Threatened (NT) or threatened under the IUCN Red List of Threatened species

Discussion

To compare or not to compare: species composition through the years

Table 6 shows a historical overview of studies related to LRFF provision in Hong Kong. It intends to summarize, at a glance, the results of studies related to Hong Kong's commercial provision of live reef fishes through the years to give an idea of species composition recorded in different years of survey. The table does not offer a direct comparison, as the captioned surveys employ different methodologies, which would potentially yield incomparable results. Note that, while this study followed the methodology used in Lam (2013), Lam's study focused only on groupers.

A direct comparison of researches may not currently be possible, but table 6 brings out the importance of consistent monitoring of the market to understand effects of the LRFF trade on individual species and their wild populations. Changes in the species composition of live reef fish provision over time can be influenced by many factors, such as changes in consumer demand and availability of natural stocks.

The need for continued and comparable LRFF market studies is evident. Current data monitoring for the LRFF trade is not sufficient to draw temporal comparisons. Despite the incomparability of research, it appears from table 6 that some species have, through time, disappeared from the local markets. It is important to investigate the reasons for their disappearance or any implications for those species and the marine ecology to achieve a deeper understanding through research.

Apart from market surveys, interviews with traders, fishermen and market stall owners can also shed light on how provision of certain species have changed from source countries/territories. On the other hand, sociological surveys conducted locally can help to reveal preferences in consumer demand, giving hints at whether or not changing preferences might have influenced the disappearance and replacement of species in the market.

It is suggested for the relevant local governmental departments, perhaps in partnership with academics and NGOs, to take charge of conducting studies to monitor the market and the status of the trade. This includes market surveys and trader interviews. For market surveys, time and budget constraints have proved to be challenges in this study. With additional resources, it is recommended that the market surveys be conducted throughout the year to investigate seasonal or festive influences in trends. Surveys should also follow a consistent research protocol and methodologies, such as those applied in the current study, to ensure comparability of results of studies conducted through time.

Resource	Lee & Sadovy (1998)	Lau & Parry-Jones (1999)	McGilvray & Chan (2001)	To (2009)	Lam (2013)	Current study (2017)
Survey method	Restaurant surveys	Trader interviews	Trade data & fish cage surveys	Local wet market surveys	Local wet market surveys	Local wet market surveys
Target fish groups	Reef fishes	Reef fishes	Reef fishes	Groupers Only	Groupers Only	Reef fishes
Notes	Fish observed at least 10 occasions during survey			Observed more than 5% of total abundance	Observed more than 2% of relative abundance (> 500 individuals)	
Trachinotus spp.	Y		Y			
Lates calcarifer	Y					
Psammoperca waigiensis	Y					
Plectrohinchus cintus	Y		Y			
Cheilinus undulatus	Y	Y	Y			
Choerodon anchorago	Y					
C. azurio	Y					
C. schoenleinii	Y					
Gymnocranius griseus	Y					
Lutjanus argentimaculatus	Y	Y	Y			
L. bohar	Y					
L. malabaricus			Y			
L. johnii	Y		Y			
L. rivulatus	Y					
L. russellii	Y		Y			
L. sebae	Y					
L. stellatus	Y		Y			
Symphorus nematophorus	Y					
Scatophagus argus						
Scarus forsteni	Y					
S. ghobban	Y					
Synanceia verrucosa	Y					
Siganus canaliculatus			Y			
Acanthopagrus berda			Y			
A. latus	Y		Y			
A. schlegeli	Y					
Rhabdosargus sarba	Y		Y			
Pomadasys kaakan			Y			
Parapristipoma trilinatum			Y			
Lethrinus haematopterus			Y			
Rachycentron canadum			Y			

Sciaenops ocellatus			Y			
Seriola dumerili			Y			
Epinephelus fuscoguttatus x Epinephelus lanceolatus (hybrid)					Y	Y
Aethaloperca rogaa	Y					
Anyperodon leucogrammicus	Y					
Cephalopholis args	Y					
C. boenak				Y	Y	Y
C. sonnerati	Y				Y	Y
Cromileptes altivelis	Y	Y	Y			Y
Epinephelus akaara	Y	Y	Y			
E. areolatus	Y	Y	Y			
E. awoara	Y			Y	Y	
E. bleekeri	Y	Y	Y	Y		Y
E. bruneus				Y	Y	
E. caeruleopunctatus	Y					
E. coioides	Y	Y	Y	Y	Y	Y
E. corallicola					Y	
E. cyanopodus	Y					
E. fasciatomaculosus				Y		
E. fuscoguttatus	Y	Y	Y	Y	Y	Y
E. howlandi	Y					
E. lanceolatus	Y	Y	Y			
E. maculatus	Y					
E. malabaricus	Y					
E. merra	Y			Y	Y	Y
E. polylepis	Y					
E. polyphekadion	Y	Y	Y		Y	Y
E. quoyanus				Y		
E. tauvina	Y					
E. tukula	Y					
Plectropomus areolatus	Y	Y	Y		Y	Y
P. laevis	Y					
P. leopardus	Y	Y	Y		Y	Y
P. maculatus	Y				Y	Y
P. oligacanthus	Y					
P. pessuliferus	Y					
Variola louti	Y					Y

Table 6. Summary of research relating to commercial reef fish provision in Hong Kong

Dominant species and the Sabah grouper

Past research indicated that the grouper species *E. aerolatus*, *E. polypheadion*, and *E. lanceolatus* were important species in the market and was abundant in the wet market and/or restaurant trades (Lee & Sadovy, 1998; Lau & Parry-Jones, 1999). Their importance at the time had led to an inclusion of new HS Codes for those species in Hong Kong, so as to provide more data for analysis and increase capacity for monitoring their trades.

The current study found a relatively low abundance of the three grouper species, and instead, a high predominance of the Sabah grouper (*E. fuscoguttatus x E. lanceolatus*) hybrid, was recorded.

Notably, while both *E. polypheadion*, and *E. lanceolatus* were recorded to have a low abundance in the market in this study, both species were documented in Hong Kong's import data to have high import volumes (CSD, 2017). It is a common understanding that the difference between import and re-export volumes would indicated domestic consumption. Hong Kong had imported 192 metric tons and 1,335 metric tons of *E. polypheadion*, and *E. lanceolatus* respectively in the year 2016, with no re-exports (CSD, 2017). With the relatively low abundance of the species in wet markets, it raises the question of where the remainder of the groupers imports had gone. It may be speculated that those groupers were either consumed in restaurants, or that cases of underreporting in re-exports to other destination countries/territories had resulted in the lack of re-export reports. Further investigation is recommended to gain a deeper understanding of the trade in these species.

On the other hand, the prevalence of the Sabah grouper also raises concern. The Sabah grouper is a hybrid grouper, bred and preferred for its high growth and survival rates, resistance to disease, low production cost and reportedly better taste (pers. comm. Stan Shea). The species emerged in the LRFF market in the late 2000s and since then, it's importance in the local market has grown quickly and sustained (Lam, 2013). Today, the Sabah grouper can easily be found in any wet market or restaurant and has evidently replaced its parent species' importance in the markets. Their potential escape into the wild may pose problems for the local ecology.

In recent years, there have already been media reports (AppleDaily, 2017) of Sabah groupers found swimming freely in Hong Kong waters. How the individuals might have been introduced into the wild is unknown, but speculations have been made. Upon arriving Hong Kong, fish may temporarily be stored in fish farms before being delivered to restaurants, wet markets or supermarkets. In this time there is a possibility for escape, although it is yet unknown for certain whether or not storage of the fish in these "fish hotels" have had a role to play in introducing Sabah groupers into the wild. Religious fish releases which often purchase fish from wet markets may also have facilitated the release of Sabah grouper into the wild (AppleDaily, 2017).

A further word on introduced species

Apart from the Sabah grouper, it is worth noting that the *Sparus aurata*, a species not native to Hong Kong, is also found in this study to have moderate importance in local wet markets. For both species, there is a need to investigate their potential effects to local fish populations as invasive species.

Threatened species in the local market

Results of the study confirm the ongoing trade of LRFF species that are listed as Near Threatened (NT) or threatened under the IUCN Red List. These species are known to enter the local market through

both international imports and local catches, indicating an opportunity to enhance regulations and enforcement efforts on their international trades and local landings by the local government.

Currently in Hong Kong, the only protection that internationally traded marine fishes may potentially enjoy is provided by CITES, however only one species, *Cheilinus undulatus*, is listed under CITES. Other species are freely traded without regulations to help their survival. The *E. lanceolatus*, for instance, is not listed under CITES and was recognized in the past as one of the most traded species of Hong Kong (Lee & Sadovy, 1998; Lau & Parry-Jones, 1999; McGilvray & Chan, 2001). Since 1996 however, the species has become listed as Vulnerable (VU) under the IUCN Red List (Shuk Man & Ng, 2006) and its importance in the trade has been replaced by other species, including the hybrid Sabah grouper.

For species in the LRFF trade that, like *E. lanceolatus*, are becoming or have become threatened, there is a need to understand the influence of the trade on the species. Although some of these species will come from farmed sources, certain farming practices such as collection of fish fry from the wild continue to influence wild populations.

Locally, the government may explore strategies to more effectively manage the trade and fisheries of threatened species. Currently, only species listed under CITES are protected under Hong Kong's Cap. 586. Taking a step forward, local regulations may be amended to also regulate trades of threatened species. Such measures may include:

1. Species-specific HS codes for threatened species: updating HS codes to include species information for at least the threatened species, so that a clearer picture of Hong Kong's trade in those species may be derived from the trade data. This should be done regularly to keep up with updates to LRFF species' conservation statuses.
2. Labelling of fish species at retail markets: mandating the species name to be clearly and accurately stated in retail markets (including at least wet markets, supermarkets and restaurants) facilitates data collection for research, and helps to inform customers at purchase.
3. Species-specific HS codes for heavily traded species: species that are not necessarily threatened but are a dominant species in local markets should also be more closely monitored. The *Cephalopholis sonnerati*, for instance, was one of the most frequently encountered species in this study, but the level of trade is unknown as the species does not have its own HS code. As with point 1 above, such updates in HS codes should be done regularly to keep up with changes in species dominance in the market.
4. Footprint monitoring measures: improving monitoring capacity so that a holistic understanding of Hong Kong's footprint on LRFF consumption maybe achieved. In particular for the LRFF trade, for which most of the trade comes from imports, impacts are not only local but also internationally from source countries. Given Hong Kong's commitment to the Convention on Biological Diversity (CBD), Hong Kong has a responsibility to monitor it's LRFF footprint both for locally and globally.
5. A stepwise approach to go beyond CITES: the government may work towards giving the trade in species that are not currently listed on CITES but are considered threatened under the IUCN Red List similar to CITES-level status in the local legislation. Given Hong Kong's position as a key trader of some of these species, their policies should also reflect a responsibility towards species at risk of extinction and impacted by the trade.

For local catches, CITES-listed species that are caught in local waters and kept live at stores will require possession licenses. Dead individuals and all non-CITES-listed species are not currently

protected. There is also currently no legislation in Hong Kong to protect local marine fish species in the wild. However, as mentioned above, several Near Threatened (NT) and threatened species have been recorded to appear in local waters and caught locally by fishermen. Given the need for wild populations of threatened species to be protected globally, the local government may devise enforceable regulations to protect marine fish populations found in Hong Kong. Regulations should consider not only how those species are traded and sold, but also how catches may be managed to avoid overharvesting and protect wild populations.

Fulfilment of CBD and BSAP Actions

This study and the new Live Reef Food Fish Guide fulfils at least the following Actions in Hong Kong's Biodiversity Strategy and Action Plan (BSAP):

- **Action 5** Step up enforcement against wildlife crime
- **Action 16** Improve sharing of knowledge
- **Action 20** Promote biodiversity awareness
- **Action 22** Promote sustainable consumption

Further recommendations for the future

Size study. This study was unable to collect individual fish size information, given limited resources. However, as size of fish can be an indication of the shifting baseline effect, it is worthwhile to conduct such a study. Sizes of fish found in the market today can then be compared to that of the past as indicated in existing literature to investigate signs of a shifting baseline.

Restaurant study. It is known that at least one restaurant study for LRFF has been conducted in the past. Continued study of the restaurant market for LRFF for a comprehensive analysis of fish abundance, species composition and frequency of encounter for species over time.

Market abundance of threatened species. Market studies to focus on threatened species is found needed to understand their prevalence in the trade and possible influences that the trade may have on wild populations. In particular, information source countries/territories of fish are challenging to obtain, given the lack of labelling. Imports of LRFF also do not include species information, which increases the challenge of locating the sources of LRFF imported. Such information is needed to identify species needing regulation in the trade, and to lobby for their inclusion in CITES and other local and international measures for managing wildlife resources.

Conclusion

There is an urgent need for more regular monitoring of the local LRFF market, whether in wet markets or in restaurants. This study has shown that at least 180 marine fish species are involved in this market, some of which are threatened with extinction. For a market of this scale, the existing efforts to monitor and regulate trades must be increased. The Hong Kong government is encouraged to take the lead in initiating better management of the local LRFF trade and market, stepping up as one of the biggest consumer markets of the region as a supporter of responsible trade.

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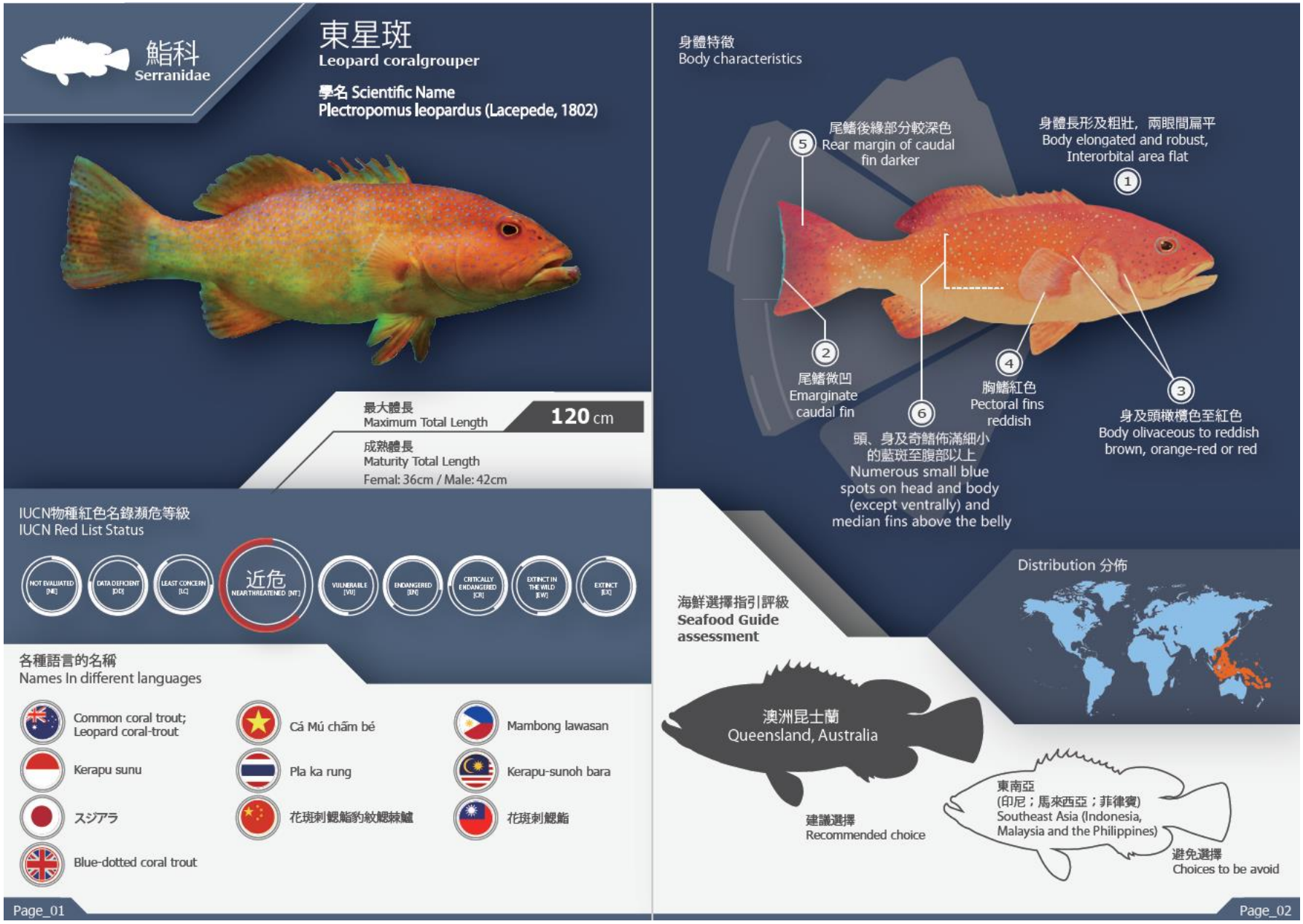
Appendix A – Sample page of the *Live Reef Food Fish Guide*



Appendix B – Full list of species recorded in the study period

No.	Species
1	*Abudefduf bengalensis*
2	*Abudefduf vaigiensis*
3	*Acanthopagrus australis*
4	*Acanthopagrus berda*
5	*Acanthopagrus latus*
6	*Acanthopagrus schlegeli*
7	*Aethaloperca rogaa*
8	*Aluterus monocero*
9	*Aluterus scriptus*
10	*Amphiprion clarkii*
11	*Anguilla* spp.
12	*Anyperodon leucogrammicus*
13	*Apogon doederleini*
14	*Apogonichthyoides niger*
15	*Apogonichthyoides sialis*
16	*Arius* spp.
17	*Boleophthalmus pectinirostris*
18	*Brachirus* spp.
19	*Calotomus carolinus*
20	*Cephalopholis argus*
21	*Cephalopholis boenak*
22	*Cephalopholis formosa*
23	*Cephalopholis miniata*
24	*Cephalopholis sonnerati*
25	*Cephalopholis urodeta*
26	*Chaetodon wiebeli*
27	*Cheilinus trilobatus*
28	*Cheilinus undulatus*
29	*Cheilodactylus zonatus*
30	*Chiloscyllium plagiosum*
31	*Chlorurus microrhinos*
32	*Chlorurus sordidus*
33	*Choerodon anchorago*
34	*Choerodon azurio*
35	*Choerodon schoenleinii*
36	*Chromis notata*
37	*Cirrhitichthys aureus*
38	*Cromileptes altivelis*
39	*Cynoglossus* spp.
40	*Cynoglossus spp.*
41	*Dactyloptena orientalis*
42	*Dasyatis akajei*
43	*Diagramma pictum*
44	*Drepane punctata*

45	*Echeneis naucrates*
46	*Eleutheronema* spp.
47	*Epillephelus fasciatus*
48	*Epinephelus akaara*
49	*Epinephelus areolatus*
50	*Epinephelus awoara*
51	*Epinephelus bleekeri*
52	*Epinephelus bruneus*
53	*Epinephelus caeruleopunctatus*
54	*Epinephelus chlorostigma*
55	*Epinephelus coioides*
56	*Epinephelus corallicola*
57	*Epinephelus erythrurus*
58	*Epinephelus fasciatomaculosus*
59	*Epinephelus fasciatus*
60	*Epinephelus fuscoguttatus*
61	*Epinephelus hexagonatus*
62	*Epinephelus kohleri*
63	*Epinephelus lanceolatus*
64	*Epinephelus lanceolatus x Epinephelus fuscoguttatus*
65	*Epinephelus latifasciatus*
66	*Epinephelus maculatus*
67	*Epinephelus malabaricus*
68	*Epinephelus merra*
69	*Epinephelus moara*
70	*Epinephelus ongus*
71	*Epinephelus polyphekadion*
72	*Epinephelus polyphekadion* x *Epinephelus fuscoguttatus*
73	*Epinephelus quoyanus*
74	*Epinephelus spilotoceps*
75	*Epinephelus trimaculatus*
76	*Epinephelus tukula*
77	*Epinephelus undulosus*
78	*Girella punctata*
79	*Gracila albomarginata*
80	*Gymnothorax favagineus*
81	*Gymnothorax flavimarginatus*
82	*Gymnothorax isingteena*
83	*Gymnothorax kidako*
84	*Gymnothorax reevesii*
85	*Halichoeres dussumieri*
86	*Hapalogenys nigripinnis*
87	*Hemigymnus melapterus*
88	*Hemiscyllium plagiosum*
89	Hybrid Grouper other than Sabah Grouper
90	*Kyphosus cinerascens*

91	*Larimichthys crocea*
92	*Lateolabrax japonicus*
93	*Lates calcarifer*
94	*Lethrinus erythracanthus*
95	*Lethrinus haematopterus*
96	*Lethrinus lentjan*
97	*Lethrinus nebulosus*
98	*Lipocheilus carnolabrum*
99	*Lutjanus argentimaculatus*
100	*Lutjanus bohar*
101	*Lutjanus gibbus*
102	*Lutjanus johnii*
103	*Lutjanus kasmira*
104	*Lutjanus malabaricus*
105	*Lutjanus quinquelineatus*
106	*Lutjanus russellii*
107	*Lutjanus sebae*
108	*Lutjanus stellatus*
109	*Lutjanus vitta*
110	*Microcanthus strigatus*
111	*Monacanthus chinensis*
112	*Mugil* spp.
113	*Muraenesox* spp.
114	*Nemipterus japonicus*
115	*Nibea albiflora*
116	*Oplegnathus punctatus*
117	*Ostorhinchus fasciatus*
118	*Ostorhinchus fleurieu*
119	*Otolithes ruber*
120	*Oxycheilnus digrammus*
121	*Pagrus major*
122	*Pampus chinensis*
123	*Paracentropogon* spp.
124	*Paralichthys* spp.
125	*Paralichthys* spp.
126	*Parapristipoma trilineatum*
127	*Parupeneus biaculeatus*
128	*Parupeneus chrysopleuron*
129	*Parupeneus cyclostomus*
130	*Periophthalmus modestus*
131	*Platax teira*
132	*Platycephalus indicus*
133	*Plectorhinchus chaetodonoides*
134	*Plectorhinchus cinctus*
135	*Plectorhinchus flavomaculatus*
136	*Plectropomus areolatus*

137	*Plectropomus laevis*
138	*Plectropomus leopardus*
139	*Plectropomus maculatus*
140	*Plectropomus oligacanthus*
141	*Plectropomus pessuliferus*
142	*Pleuronichthys* spp.
143	*Plotosus lineatus*
144	*Pomadasys kaakan*
145	*Psammoperca waigiensis*
146	*Pseudorhombus* spp.
147	*Rachycentron canadum*
148	*Rhabdosargus sarba*
149	*Rhynchopelates oxyrhynchus*
150	*Sargocentron rubrum*
151	*Sargocentron spiniferum*
152	*Scarus forsteni*
153	*Scarus ghobban*
154	*Scarus rivulatus*
155	*Scatophagus argus*
156	*Sciaenops ocellatus*
157	*Scolopsis monogramma*
158	*Scophthalmus* spp.
159	*Scorpaenopsis* cf. *cirrosa*
160	*Sebastiscus marmoratus*
161	*Seriola dumerili*
162	*Siganus argenteus*
163	*Siganus canaliculatus*
164	*Siganus labyrinthodes*
165	*Siganus puellus*
166	*Siganus punctatus*
167	*Solea spp.*
168	*Sparus aurata*
169	*Stephanolepis cirrhifer*
170	*Synanceia verrucosa*
171	*Takifugu alboplumbeus*
172	*Terapon jarbua*
173	*Terapon theraps*
174	*Thalassoma lunare*
175	*Trachinotus blochii*
176	*Triso dermopterus*
177	*Variola albimarginata*
178	*Variola louti*
179	*Xyrichtys dea*
180	*Zanclus cornutus*
181	*Zebrias zebra*