

CONVENTION ON INTERNATIONAL TRADE IN ENDANGERED SPECIES  
OF WILD FAUNA AND FLORA



Thirty-second meeting of the Animals Committee  
Geneva (Switzerland), 19 – 23 June 2023

Regulation of trade

Exemptions and special trade provisions

Review of CITES provisions related to trade  
in specimens of animals and plants not of wild source

CONSIDERATIONS AND RECOMMENDATIONS FOR RANCHING OF MARINE SPECIES

1. This document has been submitted by the United States of America.\*
2. At its 19th meeting (CoP19; Panama, 2022), the Conference of the Parties adopted Decisions 19.179 and 19.180 on *Review of CITES provisions related to trade in specimens of animals and plants not of wild source*.
3. Decision 19.179 includes an instruction directing the Standing Committee, in consultation with the Animals and Plants Committees to:
  - c) *review issues and challenges in the application of the Convention for trade in non-wild specimens of both CITES-listed animal and plant species, in particular key elements that may contribute to the uneven application of Article VII, paragraphs 4 and 5, and consider the scientific advice and guidance from the Animals and Plants Committees on the need for implementing these Articles differently for either animal specimens from species bred in captivity or plant specimens that are artificially propagated; and*
  - d) *make recommendations for addressing these issues and challenges, including amendments to existing Resolutions or development of a new Resolution or Decisions to address these issues and challenges, for consideration at the 20th meeting of the Conference of the Parties.*
4. In support of the Standing Committee's implementation of Decision 19.179, Decision 19.180 directs the Animals and Plants Committees, separately and together in their joint session to: c) provide any other scientific advice and guidance on CITES provisions concerning trade in non-wild specimens of CITES-listed animal and plant species to the Standing Committee upon request and as appropriate.
5. Among the source codes used for trade in specimens of animals not of wild source (source code W) is source code R (Ranching), which the Conference of the Parties has defined as: "specimens of animals reared in a controlled environment, taken as eggs or juveniles from the wild, where they would otherwise have had a very low probability of surviving to adulthood" (See Resolution Conf. 12.3 (Rev. CoP19))."
6. Ranching was originally introduced for application to crocodylians transferred from Appendix I to Appendix II (See Resolution Conf. 11.16 (Rev. CoP15); Resolution Conf. 9.24 (Rev. CoP17) Annex 4). Among other requirements, the original purposes of the term include, ensuring the ranching program must be primarily beneficial to the conservation of the local population (i.e., where applicable, contribute to its increase in the

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\* *The geographical designations employed in this document do not imply the expression of any opinion whatsoever on the part of the CITES Secretariat (or the United Nations Environment Programme) concerning the legal status of any country, territory, or area, or concerning the delimitation of its frontiers or boundaries. The responsibility for the contents of the document rests exclusively with its author.*

wild or promote protection of the species' habitat while maintaining a stable population); the program must have in place appropriate inventories, harvest-level controls and mechanisms to monitor the wild populations; there must be sufficient safeguards established in the program to ensure that adequate numbers of animals are returned to the wild if necessary and where appropriate; evidence must be provided that the taking from the wild will have no significant detrimental impact on wild populations; and documented evidence must be provided to demonstrate that the program is beneficial to the wild population through reintroduction or in other ways. Even so, source code R has been increasingly used for export permits for taxa included in Appendix II, without an assessment of the suitability of its application or potential for subsequent negative impacts on the species' conservation status. This raises cause for concern given the unique circumstances under which this source code as originally defined should be applied, particularly as these specimens are taken from the wild.

7. An intersessional working group of the joint AC/PC (AC23/PC17) examined the application of source code R for countries and species that had regularly used this source code in the prior 15 years. The working group concluded, based on six comprehensive responses out of 13 countries that replied to the questionnaire, that source code R had been used erroneously in several countries and there were several indications that the conservation benefits of ranching may be absent, unknown or questionable (see Document CoP15 Doc. 29).
8. Marine species are among the taxa for which source code R has been used, and for which application may not be appropriate. The application of ranching to European eel (*Anguilla anguilla*) was considered by the Animals Committee in fulfillment of paragraph c) of Decision 18.200 on *Eels* (*Anguilla spp.*), which directed the Animals Committee, *inter alia*, to consider the potential use of source code R (ranching) for specimens of *A. anguilla* from aquaculture production systems and provide advice and make recommendations to the Parties and the Standing Committee as appropriate. The Animals Committee was unable to develop recommendations for European eels from aquaculture production since the question of whether the glass eel (fingerling) life stage has a "low probability of surviving to adulthood" was determined to be complex and inconclusive based on a lack of data to calculate the natural mortality of juvenile eels. The Animals Committee agreed to reconsider the issue of the potential use of source code R for specimens of European eel from aquaculture production systems at its first meeting following CoP19 (see Document SC74 Doc. 64.2).
9. Ranching is currently applied to other CITES-listed marine species including humphead wrasse (*Cheilinus undulatus*), arapaima (*Arapaima gigas*), arowana (*Scleropages formosus*), and some sturgeon species. As illustrated in a recent publication ("Mortality and management matter: Case study on use and misuse of 'ranching' for a CITES Appendix II-listed fish, humphead wrasse (*Cheilinus undulatus*)"), there is growing concern that the source code R is being misapplied to such species, which could be negatively affecting wild populations of these species (see Annex 1). To illustrate, if specimens of animals are taken from the wild for ranching at the inappropriate life stage, their conservation status may be negatively affected, and their survival in the wild may be jeopardized.
10. Using humphead wrasse as a case study, the article discusses how fish are being harvested after settlement when mortality rates in the wild are relatively low, which is contrary to the definition of ranching and may not be biologically sustainable.
11. Other concerns regarding the ranching of marine species are the lack of sufficient monitoring and assessment of its impacts on the conservation status of populations. As discussed in the report included in the Annex to the present document, humphead wrasse specimens have been exported using source code R in significant quantities in the absence of a scientifically based non-detriment finding (NDF) or consideration of mortality rates in captivity. While ranched specimens may be traded using source code R, rather than source code W, the provisions of Articles III, IV and V of the Convention continue to apply, in particular including requirements for making NDFs under Articles III and IV to ensure that the trade will not be detrimental to the survival of the species in the wild. As relevant to Appendix-II species, the requirements of Article IV must be met to authorize trade in ranched specimens.
12. An additional concern associated with ranching of marine species is the inability to visually distinguish specimens sourced from the wild from specimens sourced from ranching operations, with the possibility of wild specimens (source code "W") being falsely identified as ranched specimens.

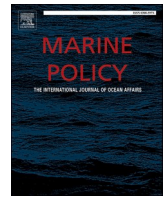
### Recommendations

13. The Animals Committee is requested to consider the publication in Annex 1 and the recommendations contained therein.

14. Recognizing the definition of ranching in Res. Conf. 12.3 (Rev. CoP19) requiring that the specimens harvested would otherwise have had a very low probability of surviving to adulthood, and the Convention's requirements *inter alia* in Article IV that the trade of specimens of Appendix-II-listed species traded under source code "R" must be accompanied by a valid NDF demonstrating that the proposed trade will not be detrimental to the survival of the species in the wild, the Animals Committee is requested to consider recommending that:
  - a) guidelines for the making of NDFs for specimens of marine species sourced from ranching operations are needed; and
  - b) the making of NDFs for specimens of marine species sourced from ranching operations be considered at the upcoming global CITES Expert workshop on NDFs and any recommendations put forward for the Animals Committee's consideration.
15. Based on results of the global CITES Expert NDF workshop referenced above, the Animals Committee is asked to recommend the Standing Committee put forward draft decisions for consideration by the 20th meeting of the Conference of the Parties that include calling for development of guidance for the ranching of marine species that would define the appropriate life stage or stages at which various commercially important marine species may qualify for ranching, and other factors that may affect a determination that a specimen qualifies as source code R, taking into consideration the definition of ranching under Res. Conf. 12.3 (Rev. CoP19) and the original purposes of the term.

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## Mortality and management matter: Case study on use and misuse of ‘ranching’ for a CITES Appendix II-listed fish, humphead wrasse (*Cheilinus undulatus*)

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### ABSTRACT

CITES is the most important international instrument for managing threatened or potentially threatened wildlife trade. If listed organisms are removed from the wild at stages of highest natural mortality and held in captivity to increase survivorship and hence make more organisms available for trade without impact on wild populations, this form of production is termed ‘ranching’ (coded ‘R’ under CITES). To gain benefits for livelihoods and species, ranching must be managed effectively and wild capture conducted sustainably. CITES-listed species are increasingly being ranched, yet in many cases key information on natural and captive mortality and implications for trade controls of introducing ranching is lacking. Endangered (IUCN Red List) fish humphead wrasse (*Cheilinus undulatus*) was traded in wild (W-code) form after its CITES App II-listing in 2004, with ranching subsequently introduced in 2018. This well-studied species is used as a case study to examine the outcomes and implications of uncontrolled ranching (capture and grow-out) operations. For humphead wrasse, ranching is currently unjustifiable according to CITES provisions and poses a further potential threat to the species. Fourteen recommendations call for action by CITES as well as along much of the trade chain. CITES must review and define when ranching can be applied and operate sustainably. Exporting countries must ensure sustainable catches accounting for mortality levels at capture and during ranching, and conduct an appropriate non-detriment finding, while import destinations need to effectively distinguish and control the trade in W- and R-coded fish. A Review of Significant Trade, assessment of legal acquisition and communications between Parties are recommended.

### 1. Introduction

The estimated worth of international wildlife trade is between USD 2.9–4.4 trillion for the period 1997–2016 and involves hundreds of millions of plants and animals [1]. Categories of wildlife trade range from furniture and fashion, to food, medicines, pets and ornaments, among other products. The high profitability of many wildlife products is a major source of income for local communities and highly lucrative for traders in many countries [2].

Legal frameworks to manage wildlife trade range from national and regional measures and instruments to, most importantly for international trade, the Convention on International Trade in Endangered Species of Flora and Fauna (CITES). CITES entered into force in 1975 and recognizes the importance of cooperation among member countries (Parties) to ensure that international trade in wild animals and plants

does not threaten the survival of CITES-listed species [3]. CITES today provides various levels of protection to about 39,000 species listed in one of its three Appendices (I to III) which apply differing levels of trade control. Appendix II contains about 97% of the species listed and includes those that, while not necessarily threatened with extinction, may become so if international trade is not regulated to within the biological limits of the species. Also sometimes included in listings are species which resemble species of conservation concern.

Several challenges to implementing the Convention persist which leave certain species at risk. Limited management and oversight mean that illegal and unregulated capture/collection and trade of CITES-listed wildlife may continue to threaten many species [4] while controls on different modes of production (e.g. wild-capture, ranching, captive breeding) may not be sufficiently controlled to safeguard certain species. Such shortcomings may result in trade that is legal yet unsustainable and

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unmonitored thereby undermining the intent of CITES controls [1]. In the last two decades, a growing number of commercially important marine species has been added to CITES App II, mainly due to over-exploitation [5,6]. On CITES Appendices, 2392 species were considered to be marine, of which 2176 species were on Appendix II [6].

### 1.1. TRADE UNDER CITES OF APP II LISTED SPECIES

Under CITES App II international trade in plants and animals is subject to export, re-export and import controls and permits, and all trade conducted according to a set of trade codes ('Source' codes). The ten CITES source codes indicate the form of the plant or animal being traded (live, body part, eggs, etc.), its provenance (country), management/production system (captive-bred, wild-caught, etc.), destination, and the purpose of trade (commercial, food, display), etc., and trade must be reported to CITES annually according to the relevant code. To implement CITES each Party typically has a Management Authority (MA) responsible for implementing the Convention, while scientific guidance is usually provided by a Scientific Authority (SA).

For all species (or their parts/products) taken from the wild (as opposed to captive-bred, for example) for international trade under CITES a non-detriment finding (NDF)<sup>1</sup> is needed from source exporting countries. The purpose of an NDF is to determine the biologically appropriate level or conditions of trade that should ensure that exports are not detrimental to the species. In other words, it considers biological sustainability to be a fundamental condition for export of wild-caught animals and plants. NDFs can use information on population status and trends, catches and trade, biological and ecological factors although there are no specified requirements [7].

### 1.2. Use of CITES source code 'R' (Ranching)

One of the eleven trade codes under CITES,<sup>2</sup> R (Ranching), is the focus of this study because its use is increasing and, if misapplied, poses potential threats to certain species or populations. Challenges to its correct application arise from ambiguity, or lack of clarity, in the CITES provisions for its designation, and loopholes thereby created for illegal and unsustainable trade. Ranching, under CITES provisions, involves the capture of wild animals and their subsequent '*rearing in a controlled environment of animals taken as eggs or juveniles from the wild, where they would otherwise have had a very low probability of surviving to adulthood*' due to high natural mortality from predation, disease, environmental factors, etc.; a controlled environment is one that provides conditions necessary for the growth and well-being of the species, such as adequate shelter, food, veterinary care, etc. (CITES Resolution Conf. 11.16 Rev. CoP15). To ensure adequate control of trade there is need for a uniform marking system such that animals from ranching operations are identifiable [8] and ranched animals can be distinguished from those taken directly from the wild.

Ranching was originally introduced for crocodylians transferred from App I to App II over two decades ago and has been extensively applied to reptilians [9,10]. Benefits to both people and species from ranching can occur if the collection of the young, high natural mortality, life-stages is sustainable and effectively managed, and if loopholes are not created that allow wild animals to be laundered as ranched. Some ranching operations successfully support livelihoods as well as provide economic

<sup>1</sup> Non-detriment findings: a conclusion by a Scientific Authority that the export of specimens of a particular species will not impact negatively on the survival of that species in the wild.

<sup>2</sup> 'Source' codes under CITES: A (artificially-propagated plants), C (captive-bred animals), D (Appendix-I animals bred in captivity for commercial purposes), F (animals born in captivity), I (confiscated/seized), O (pre-Convention), R (ranched animals), U (unknown source), W (wild-caught), X (marine specimens from high seas), Y (plants from "assisted production")

incentives for conservation [10]. However, problems in the application of R are widespread, and its use for some species in certain countries is a matter of concern and may further threaten species when wild removals are not managed and trade oversight is insufficient [9, 10, CITES CoP15 Doc. 29, CITES Resolution Conf. 11.16 (Rev. CoP15)].

The ball python, *Python regius*, is listed on App II and provides an example of some of the challenges because its use and trade are relatively well-documented [11]. The species is heavily traded and plays an important role in local livelihoods for rural and urban communities in West Africa. Most international trade of the species is reported to CITES as ranched. Ranching includes the collection of several important life stages (i.e. eggs, neonates and gravid females). Wild gravid females are kept captive until their eggs are laid and these are artificially incubated. After laying, the females and some of the neonates are supposed to be re-released back into the wild, according to the ranching system developed for the species. In some locations, however, the collected gravid females are not returned to the wild but sold locally and consumed as bushmeat. In addition, some capture methods can cause the destruction to or damage of female oviposition sites. Hence, there is some concern for negative impacts on the species associated with ranching of this species for export due lack of effective oversight and controls of ranching-related operations.

Ranching has been introduced for a growing diversity of taxa listed in App II and it is clear that more information is needed on the benefits and impacts of commercial ranching operations to evaluate its implications for species and to determine whether it is correctly applied according to CITES provisions [10]. In a review of ranching operations responses from 6 of the 27 countries invited to participate (CITES CoP15 Doc. 29) provided feedback. While some conservation benefits were noted, there were also indications that benefits may be variously absent, unknown or questionable as well as cases where ranching had been erroneously applied [10]. For many species, insufficient information is available with which to evaluate its pros, cons and applicability.

Ranching operations in certain fishes have proven particularly controversial and are subject to ongoing debate. Species include arapaima (*Arapaima gigas*), arowana (*Scleropages formosus*), and several sturgeons [12–15]. The proposal to use R for European eel (*Anguilla anguilla*) was recently rejected and is subject to review because natural mortality of juveniles could not be determined due to insufficient spatial and temporal data, lack of an NDF, and because the 'low probability of surviving to adulthood' criterion could not be justified (CITES SC74 Doc. 64.2; CITES Decision 18.200). There are similar concerns about applicability in the case of the reef fish humphead wrasse, for which R was introduced in 2018.

The case of the humphead wrasse is of particular interest because it provides an excellent opportunity to examine the applicability, and possible pros and cons, of ranching since the species is relatively well-studied in terms of its biology, grow-out operations and trade controls. The main issues with this species are that ranched animals are still wild-caught, but the fishery for animals destined for ranching is uncontrolled and has not been subject to an NDF that considers biological factors. Hence ranching could be having a negative impact on wild populations. Moreover the presence of both W and R-coded fish in trade undermines enforcement and has opened loopholes for laundering because the two forms are indistinguishable from each other. Moreover, since animals are not taken at their highest levels of mortality, it is not clear whether capture for ranching is biologically sustainable, or even applicable under CITES provisions.

## 2. Humphead wrasse – Biology and conservation status

The humphead wrasse is a large, widespread, coral reef fish reported to reach at least 1.6 m total length (TL) and distributed across the Indo-Pacific down to 100 m; the species is naturally uncommon [16]. Spawning occurs regularly at specific outer reef sites [17]. Fertilized eggs hatch into larvae which take 40–50 days before transitioning to the

demersal phase [18,19] living in the plankton before settling out into nursery habitat of macroalgae at about 1 cm long [18]. As they grow, juveniles inhabit shallow mangrove or algal habitats before migrating to coral reefs [19,20]. Growth is slow in this species, for a reef fish; at around six months of age the juveniles only attain 5–6 cm in total length [18]. It is unknown how far the planktonic phase moves from spawning sites but, considering the duration of the planktonic phase, propagules have the potential to remain locally or travel hundreds or thousands of km. Given lack of evidence for population sub-structuring, extensive egg/larval movement is likely to occur in many locations with single populations possibly spanning broad areas [21]. While the species can spawn in captivity, larval survival under captive conditions is extremely low and growth is slow; commercialized hatchery-based production does not occur [18,22–24].

At a global level the humphead wrasse was listed as ‘Endangered’ on the IUCN Red List in 2004 and was the first, and currently only, reef food fish to be listed on CITES App II. All animals are wild-caught, and most traded alive, internationally by sea or air, and for commercial purposes. Until 2018, the species was only traded in wild (‘W’) form but since that year, both ranched and wild forms are traded. However, the two forms are indistinguishable and illegal trade has been occurring [25,26]. Hence, it is important to consider the applicability of R to this species, in relation to CITES provisions and considering the conservation status of the species. Of particular relevance, as in the case of glass eel capture, are the size, number and capture/culture mortality levels of small fish taken for ranching grow-out in relation to natural mortality levels. In other words, does ranching occur of ‘...animals taken as eggs or juveniles from the wild, where they would otherwise have had a very low probability of surviving to adulthood’ according to the CITES provisions? To address this key question, mortality patterns in pelagic spawners in general and in humphead wrasse in particular are summarized according to current understanding.

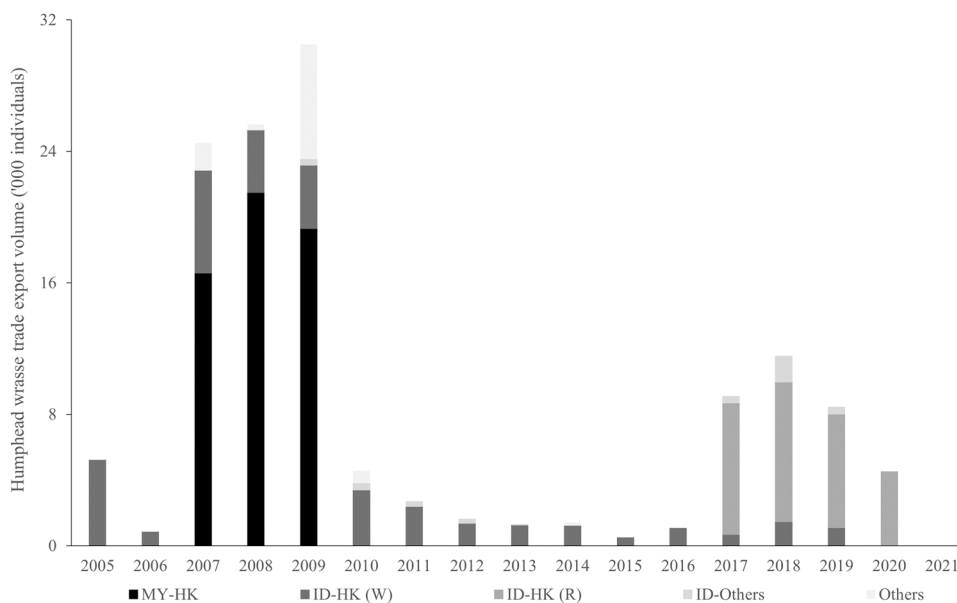
Pelagic spawners, like humphead wrasse, produce thousands to millions of eggs per spawning period but these numbers plummet by orders of magnitude between egg hatching and recruitment (i.e. settlement from pelagic to demersal habitat) which occurs weeks to months later (depending on the species) [27–29]. The pelagic (pre-settlement) phase is, therefore, the highest mortality phase for pelagic spawners, with no reason to believe that the humphead wrasse is any exception. Following the pelagic phase, larvae undergo a transition to the benthic form and shortly after settlement mortality rates of the early post-larvae rapidly decline [27,30]. Metanalyses of reef fishes show that, among a

diverse range of over 150 species, mortality rates dropped markedly within just 48 h of settlement (Fig. 1 in [31]; [32]). Note that time post-settlement rather than body size at settlement is used from the Goatley and Bellwood study [31] because settlement phase fish can vary enormously in size.

Mortality quickly drops after settlement as animals find shelter from predation and start to feed, and can be affected by factors such as density and body size [32]. In the case of the humphead wrasse, survival is about 10% (i.e. 90% of young originally produced had perished) by the time of settlement [18,24]. Settlement size for humphead wrasse in captivity is about 1 cm long [18,24] (mean=1.41 ± 1.0 cm) (Guohua Chen and Jian Luo Hainan University, personal communication). Assuming that the humphead wrasse is not dissimilar to other reef fishes studied to date, then the highest natural mortality phase occurs in the plankton with most post-settlement mortality occurring within just a few days of settlement. This information is relevant to the consideration of ranching of humphead wrasse, based on post-larval/juvenile capture, for understanding the possible implications of such capture for the conservation status of the species. The fishery is unmanaged and fish are often caught long after settlement.

### 3. Humphead wrasse - use and trade

The humphead wrasse is an iconic reef fish that recreational divers seek out (non-consumptive) and which is highly appreciated as food in some countries [22,33,34]. It is important in the local traditions of certain Pacific island countries and is a minor component of small-scale reef fisheries [22]. Large individuals are a prize catch by spearfishers and anglers. International trade started in the 1980 s, and by the late 1990 s, prior to its CITES 2004 listing, involved an estimated 790,000 fish over 7 years (1997–2003) [35]. Since about the 1980 s it is among the most expensive species in the international live seafood trade, predominantly serving demand centres in China and Chinese seafood restaurants where the fish is considered a status species to serve to family or business associates [22,36,37]. In Hong Kong and mainland China retail prices in recent years range from USD 250 to almost USD 850 per fish or kg, while preferred sizes are ‘plate-sized’ juveniles at about 700–1000 g (35–40 cm long) [25,37–42]. International trade in humphead wrasse declined markedly following the CITES App II listing in 2004 until 2017/8 when trade rebounded after the ‘R’ coded fish were traded in addition to W coded fish. Hong Kong remains the major known trade hub (importer and re-exporter to mainland China).



**Fig. 1.** Annual export volumes of live humphead wrasse (individuals) from 2005 to 2021 recorded in the CITES Trade Database (<https://trade.cites.org/>). Export volumes (individuals) of each live humphead wrasse shipment to Hong Kong, reported by the exporting country to the Database, were gathered by year. MY-HK: wild-sourced humphead wrasse from Malaysia to Hong Kong; ID-HK (W): wild-sourced humphead wrasse from Indonesia to Hong Kong; ID-HK (R): ranch-sourced humphead wrasse from Indonesia to Hong Kong; ID-Others: wild-sourced humphead wrasse from Indonesia to other countries/regions; Others: miscellaneous.

Following its CITES listing in 2004, annual international trade declined from at least 100–200 mt (about 133,000 – 266,000 individuals, assuming average size in trade is 0.75 kg) recorded in the 1990 s to about 4000 individuals in 2010 and about 1000 in 2016 (Fig. 1). Shortly after the CITES listing most countries ceased legally exporting the species, leaving, as of 2010 after zero exports were introduced by former major trader Malaysia, Indonesia as its only legal exporter. By 2016, much of the trade was legal and under control, although small numbers of illegal imports were occasionally detected in Hong Kong [25]. Indonesia, the major exporter, initially and successfully exported the species according to an annually adjusted quota of ‘W’ fish associated with an NDF tailored for the species and with regular documentation. The Philippines also exports the species but all exports are illegal [25,26,40,43].

As of late 2017/2018 numbers traded increased sharply when the first export of ranched fish took place from Indonesia (Fig. 2), with strong indications of illegally traded fish according to both the CITES Trade Database and observations in Hong Kong’s retail sector. Ranched fish quickly became the major source of humphead wrasse, raising the annual exports to more than 3000 animals since 2018, while the ‘W’ export quota fell to zero in 2020 [26,44]. In 2020/2021, while trade in live seafood, including humphead wrasse, was badly hit by the COVID-19 epidemic due to major reductions in dining, it continued. However, recorded legal trade in the species declined to zero. Regular visits to Hong Kong retail outlets during 2021 and 2022 (Y. Sadovy de Mitcheson, pers. obs.) found these to be sourcing the species on a regular basis, despite over 2 years of no legally recorded trade. Given that the estimated turnaround time in retail outlets for individual fish is less than a month and, most typically, less than two weeks [45], the fish must have been illegally imported. It is not known whether the fish observed were ranched or direct from wild capture as these cannot be distinguished. An independent report based on interviews of shop staff and managers revealed that fish are regularly entering the city from the Philippines and Indonesia [46].

On the basis of the history of trade in humphead wrasse since its CITES listing and the outcomes of multiple studies on use and in the field, it is proposed that the recent (2018) introduction of ranched exports of humphead wrasse from Indonesia is not demonstrably sustainable biologically, does not appear to be applicable under CITES provisions and may pose further risks to the species which will ultimately undermine livelihoods. This situation has also created challenges

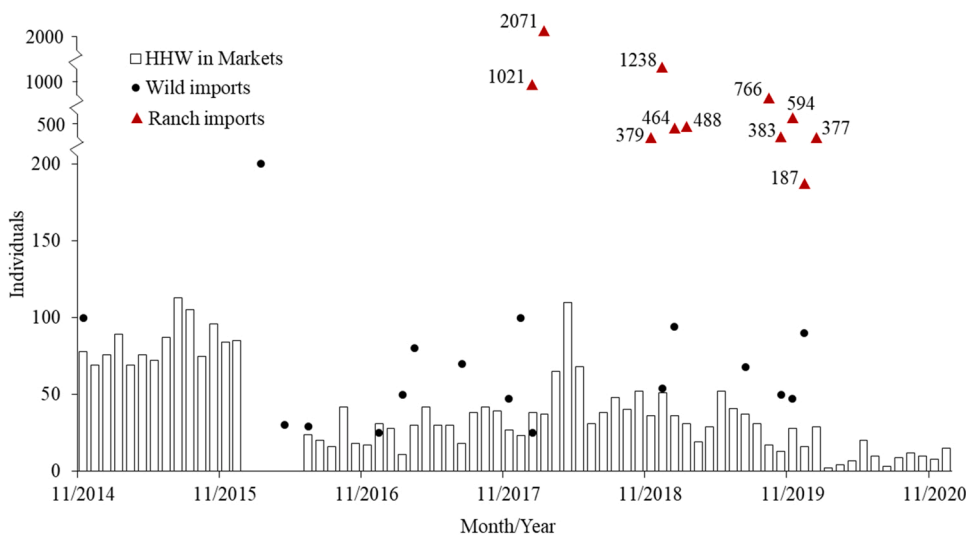
to implementing CITES because ranched (R) and wild (W) fish are subject to different levels of oversight and control in Indonesia and Hong Kong in ways that could favour laundering of R fish. These concerns are discussed in the sections on Indonesia and Hong Kong. To resolve this situation actions are called for by both trading Parties as well as by the CITES Secretariat [5,6,47]. The analysis and outcomes are also relevant to the application of ranching to other CITES App II listed species, especially pelagic-spawning fishes (CITES Doc Cop18 Inf.71).

#### 4. Exporting party controls under CITES: Indonesia

Indonesia is a particularly important range state for the humphead wrasse because of its massive reef area, favoured habitat for the species, and because since 2010 it is its sole legal exporter. It was also the first country to document export of humphead wrasse in the mid-1980 s [35]. Some communities gain substantial economic benefits from the humphead wrasse and would continue to do so if populations are sustained. How this conservation-dependent [33] species is managed in the country and how it responds is, therefore, important both for its conservation status and for its continued social and economic value.

Two measures are used to control exports of the species, numbers and sizes of animals. National legislation (since 1995) stipulates that all exported humphead wrasse must be within a 1–3 kg size range (about 38–54 cm TL) (decree of the Ministry of Marine Affairs and Fisheries No. 37; CITES Notification to Parties 2018/022). An NDF based on a fishery stock assessment tailored to the species and following consultation with traders established the total number of fish permitted for export [48]. This quota, developed for wild-caught fish (W-code), was reduced from 8000 live individuals in 2006, to 1800 in 2019, and zero W fish in 2020, with exports only permitted by air after 2007 [49]. Despite some illegal trade (trade without permits and undersize fish) detected in Hong Kong between 2013 and 2016, effective trade control was largely in place between Indonesia and Hong Kong [25,26,50].

Wild-caught fish sourced from across Indonesia were either exported shortly after capture or after brief grow-out periods, with one exception, the Anambas/Natuna islands. In this small group of islands in northwest Indonesia post-larvae and small juveniles are grown out in coastal cages for up to 5 years to reach market size, and exported by sea. This long-standing practice went undocumented until recently, yet likely accounted for a significant proportion of the country’s exports [50]. Following requests from the community in these islands, after 2017



**Fig. 2.** Annual imports of wild and ranched humphead wrasse to Hong Kong versus number of individuals recorded in monthly surveys in Hong Kong major seafood retail markets, from November 2014 to December 2020. Bars: ‘humphead wrasse in Markets’ indicated number of live humphead wrasse (individuals) observed in Hong Kong seafood restaurants and shops during monthly market surveys (except January to May 2016; [45]). From start of 2021 the COVID-19 pandemic affected imports. Despite no legal imports in 2021 and 2022, fish have continued to be on sale. Most of these are likely illegal taking into account typical turnaround times of about two weeks in the city’s retail sector. The market destination of most ranched imports is unknown since numbers in Hong Kong remain low and no re-export data are reported for possible trade into mainland China, the likely destination.

(a) The following data points were collected from AFCD official records of live humphead wrasse import volumes (individuals) by months, black dots •: wild-sourced humphead

wrasse shipments; red triangles ▲: ranch-sourced humphead wrasse shipments.

these fish were legalized under the export category of ranched fish [50]. Annual export quotas for R-coded fish were set at 40,000 fish in 2018, to clear an initial backlog of stored fish, dropping to 15,000 in 2019 and 6500 fish in 2020. In total 29,000 ranched fish were permitted for export from Indonesia during 2018–2020 (Table 1). These R quotas are considerably higher than the export quotas for W fish and were set in the absence of a biologically based NDF [51]. Actual R exports reported to CITES were less than 50% of that quota, at less than 22,000 fish for 2018–2020, likely due largely to COVID-19 which slowed trade (Fig. 1).

4.1. Potential of increased risk to the species and absence of NDF

According to CITES provisions, organisms taken from the wild for ranching should otherwise have had a very low probability of surviving to adulthood at the time of capture. This pre-supposes that, by placing them in captivity their chance of survival is higher than it would be in the wild and that, all else being equal, if their removal is not detrimental to the species or population more animals can be traded. Ranching is also proposed as a means to facilitate managing for different beneficiaries in source countries. None of these conditions can be assumed and none precludes the need for assessing and managing the number of animals removed, or for understanding the socio-economic implications of trading W versus R coded fish. As such, examination of mortality rates in both the wild and in captivity is necessary and a biologically based NDF is required for the post-recruit fishery. In the case of the humphead wrasse, the existing NDF, produced for W fish, could readily be adapted to cover R fish as well, with a total nationwide export quota allocated between W and R-coded fish. A national quota could also be assigned spatially, according to the needs of communities and provinces across the country. Since the default assumption is one of a single population (in the absence of evidence for sub-structuring [21]) then the export level permitted should consider all capture components (R+W) within a single national quota.

As currently applied, we consider that the humphead wrasse does not qualify for ranching because it is taken beyond the stages of highest, or even high, natural mortality typical of pelagic-spawning fishes. The highest mortality phase is in the plankton, dropping rapidly within just a few days of settlement on the substrate [49,52,53]. Recorded capture sizes for ranching operations range from 1 to 28 cm (most commonly up to about 8 cm), which means that animals are being captured for ranching for months or up to 2–3 years beyond settlement (Table 2). Moreover, mortality in captivity is high, with only 12–20% of the fish of 1–2 weeks old surviving in the caged environment (Table 3). This means that approximately 20–40,000 postlarvae/juveniles are needed to produce about 5000 farmed fish of 1 kg each [44,53–55]. The long grow-out period needed to attain marketable size, up to 5 years (Table 4), poses further risks of mortality in captivity [51]. Hence an NDF is needed to determine the number of fish that can be removed sustainably each year for ranching operations, factoring in the various mortality levels to which the species is exposed.

Humphead wrasse were once common across Indonesia’s reefs, yet despite almost 2 decades since the CITES listing there is little indication

Table 1

Annual Indonesian export quota (individuals) and reported export (individuals and % of quota), in CITES Trade Database (<https://trade.cites.org/#>) for wild and ranch humphead wrasse from 2018 to 2021. Data for 2022 not available yet as of January 2023.

Year	Export quota (W fish, individuals)	Reported export (individuals) [% of W fish quota]	Export quota (R fish, individuals)	Reported export (individuals) [% of R fish quota]
2018	2000	1550 [77.5]	40,000	10,000 [25]
2019	2000	1552 [77.6]	15,000	6900 [46]
2020	0	0	6500	4500 [69.2]
2021	No data	No data	No data	No data

Table 2

Capture sizes of humphead wrasse for ranching at the Anambas and Natuna Islands. Conversion from weight measurements to length were conducted with a length–weight conversion for the species,  $W = 0.0123TL^{3.115}$  (weight W in g and TL in cm) [58].

Area	Capture size	Reference
Anambas Islands	3.4–5.6 cm	[52]
	< 1–6 cm	[51]
	Juvenile to < 0.4 kg (~28.09 cm)	[56]
	0.35–3 in. (0.9–7.62 cm); most common in 2–2.5 in. (5.08–6.35 cm)	[57]
Natuna Islands	2–2.5 cm	[51]

Table 3

Mortality rate of humphead wrasse in the wild and in captivity at different sizes. Conversion from weight measurements to length were conducted with a length–weight conversion for the species,  $W = 0.0123TL^{3.115}$  (weight W in g and TL in cm) [58].

Captivity/Wild	Size (cm)	Mortality rate	Reference
Wild (lightly fished population)	N/A	0.10–0.14/year	[59]
Captivity	N/A	0.134/year	[48]
	4.7–8.8	11%/grow-out period	[52]
	< 1	60–70%/grow-out period	[51]
	5	15–30%/grow-out period	[51]
	~22.48–25.61 (200–300 g)	5%/grow-out period	[51]
	N/A	12–20%/grow-out period	[55]

Table 4

Body lengths of humphead wrasse in wild and captivity from age 0.5–5 years old. Wild fish lengths were measured in fork length (cm FL) [59]. Captive fish lengths were measured in total length (cm TL) [51]. In humphead wrasse, FL and TL of the same individual are similar. Common market size of humphead wrasse is about 35–40 cm long [25,37–42].

Age in wild/captivity (years)	Wild (cm FL)	Captivity (cm TL)
0.5	8	
1	12	21 – 25
2	23	25
3	31	30
4	38	35
5	42	40

of recovery where the species continues to be fished, including the Anambas Islands [54,56]. This suggests that fishing continues to be pose a threat to the species. Where fished and surveyed, adults are few, densities are much below those of unfished populations and many fish are removed in their juvenile phase [54]. If too few juveniles mature to become females, and too few females reproduce and survive to become males (the species is hermaphroditic and changes from female to male over time) then reproduction and population viability are compromised. In addition to catch or export volume controls, size limits help to safeguard juveniles and ensure that sufficient adults survive to reproduce.

4.2. Weakened controls over international trade

Since 2007 W fish could only be exported by air (CoP15 Doc. 51, CoP15 Com. II Rec. 11 (Rev. 1)), while exports of R fish are only permitted by sea (Decree of the Ministry of Marine Affairs and Fisheries No. 37; CITES Notification to Parties 2018/022). However, the control of foreign live seafood carrier vessels, mainly Hong Kong-based, that transport this species and other reef fish, is extremely weak [25,26,37].



In Indonesia fewer than a dozen vessels are the major means of exporting live seafood from Indonesia to Hong Kong, including ranched humphead wrasse [26]. Such was the concern about illegal activities by these vessels in Indonesia that a Ministerial Decree of Marine and Fisheries Affairs (Republic of Indonesia No. 56/2014 - Moratorium of Licensing of Fisheries Business) was enacted which temporarily prohibited foreign vessels from entering Indonesian waters [44,51]. This regulation substantially reduced trade in humphead wrasse to Hong Kong from 2015 to 2017, when the moratorium ended. However, vessels are the only practical means of exporting the species from the Anambas/Natuna islands, due to lack of air links, and have conducted trade illegally (Fig. 3). Hence, stronger controls of their activities are needed both within Indonesia at export and in Hong Kong at import [60].

Finally, since W and R fish cannot be readily distinguished other than, perhaps, by farmers [51] (neither 'form' is marked in any way), there is a considerable loophole for laundering W as R fish or for marketing R as W (after export). This is because of (a) the very different export quotas for R and W, and (b) the difference in value (retail) of the two forms with 'wild' fish being more highly valued. Once the fish have entered trade there is no reliable way to distinguish between the two forms. This has created problems at import (see below), while consumers may be charged wild prices for ranched fish [41].

##### 5. Importing party controls under CITES: Hong Kong

Hong Kong and mainland China are the major importers of the humphead wrasse with imports to Hong Kong regularly recorded on CITES records, but re-exports and import data to the mainland for the species largely lacking [45]; trade in endangered species between Hong Kong SAR and the mainland should be controlled and re-export from Hong Kong to the mainland requires a licence (CAP 586). After import to Hong Kong, fish are either taken to wholesale areas or to retail outlets (shops or restaurants) where they are displayed live for consumers to select for cooking and immediate consumption. They may also be available from restaurants to order on request. An unknown proportion of fish entering Hong Kong is trans-shipped, mainly smuggled by sea, into mainland China [25]. Some fish may be stored briefly in Hong Kong in tanks on land or floating cages at sea, although the latter does not seem to be common practice and imported fish typically enter the retail sector directly [25,46]. In the mainland, humphead wrasse were regularly viewed on sale in markets like Guangzhou, Shanghai and Beijing [61], sold on Hainan Island (Jan 12–14, 2022, Anon, pers. comm.) and regularly advertised online, despite sparse records of legal trade into the mainland China since the CITES listing (in China the fish is a Class II protected species since 2019, the only reef food fish so protected, and it should not be sold) [25,45].

CITES is implemented in Hong Kong through specific legislation, known as CAP 586 (Protection of Endangered Species of Animals and Plants Ordinance: <https://www.elegislation.gov.hk/hk/cap586>) which purpose is to give effect to CITES to regulate the import, 'introduction from the sea',<sup>3</sup> export, re-export, and possession of certain endangered species, and potentially provides additional and very positive support to the Convention. The legislation is implemented under the responsibility of the Agriculture, Fisheries and Conservation Department (AFCD) which is the Hong Kong CITES management authority (MA). It is an important piece of legislation given Hong Kong's heavy role in the international wildlife trade of a wide range of plants and animals.

In addition to the general trade (import, export and re-export) permit requirements under CITES that AFCD is responsible for overseeing, a Licence to Possess (PL) system is implemented in the city under CAP 586 for further control of trade within the city. A PL is required for any shops

or individuals 'to possess an Appendix I species, or a live animal or plant of Appendix II species of wild origin for commercial purposes in Hong Kong' (AFCD Endangered Species Advisory Leaflet AF CON 07/37). The PL specifies the maximum number of live individuals of listed species at any time point within a 5-year validity period that may be held on the licensed premises. All transactions (trade-in and -out) under the PL for wild-caught fish must be recorded by the receiving business premises within 3 days together with supporting documents for inspection by AFCD officers on their request.

While AFCD has been implementing CITES for humphead wrasse and has successfully prosecuted 36 cases of illegal trade from 2006 to 2021, illegal trade in the species continues and has recently increased. This is determined by numbers on sale in excess of import permits issued, absence of re-export records [25], and absence of reporting imports to Customs (the species has its own Customs code '0301 9931 Humphead Wrasse (*Cheilinus undulatus*), live' and must be reported to Customs within 14 days of entry to HK). In addition, animals are regularly seen on sale months or years after the last legal import (well in excess of turnaround times that are typically less than a few weeks) [26]. Many fish are also below the minimum legal size imposed by Indonesia for exports (1 kg) [25,45].

Three factors allow for ongoing illegal trade and undermine the ability of AFCD to fully implement CITES for humphead wrasse, among certain other CITES-listed species. These factors are (1) weakened PL regulations due to (a) classifying ranched animals as 'non-wild' (note that CAP 586 is for 'wild' origin), (b) inability to distinguish R from W and (c) duration of validity of the PL, (2) poor or absent fish carrier vessel oversight weakening effective implementation of CAP 586 for imports by sea, and (3) limited investigative capability by AFCD in the case of illegal imports.

##### 5.1. Weakened licence to possess regulations by classifying R as 'non-wild'

Regarding implementation of CAP 586, the legislation intended to give effect to CITES in Hong Kong, three issues are relevant to humphead wrasse which severely undermine effectiveness of the legislation for this, and similarly traded, species. The first is the way that CAP 586 is applied to 'ranched' fish, treating them differently from wild fish; neither 'wild' nor 'ranched' are defined under HK Law. The second is that there is currently no mechanism used, for example by tagging, to distinguish R from W fish in trade. The third is that the validity period for the PL is far too long for the trade dynamics (i.e. short turnaround times) of the species.

For the first issue, while CAP 586 applies the PL to 'Appendix II species of wild origin', inexplicably CAP 586 does not consider ranched fish to be of 'wild origin'. Instead, they are considered under the law to be 'non-wild'. This interpretation of wild-caught ranched fish being 'non-wild' appears to have been an internal government decision, the justification for which could not be determined as it is nowhere indicated that ranching does not refer to wild-caught animals. Because of this interpretation, however, the PL is not used to limit and monitor the number of ranched humphead wrasse traded within and through Hong Kong.

The problem that arises in relation to the PL system as can be found in the following wording and circularity in use of terms: 'no licence is required for possession of a live animal or plant of Appendix II species of non-wild origin if it can be proved by documentary evidence of its non-wild origin' [62]. In this case it is the R-code used in CITES documents that the Hong Kong government is considering as 'documentary evidence' for 'non-wild' origin. Yet, all ranched humphead wrasse are sourced from the wild. Moreover, since CITES does not consider 'R' fish as non-wild, there is in fact no 'documentary evidence' of non-wild origin. This 'non-wild' interpretation of fish which are, in reality, sourced from the wild (and hence of interest from the aspect of sustainable use) is a serious and unexplained shortcoming in the interpretation of the HK law. It also runs

<sup>3</sup> Introduction from Sea: Transportation into a State of specimens of any species which were taken in the marine environment not under the jurisdiction of any State.



**Fig. 3.** (Left) Humphead wrasse grow-out pens in coastal areas of Anambas Islands, Indonesia where fish are kept for several years at low density in the sea to reach marketable size (about 30–45 cm). (Right) Fisherman/trader transferring live humphead wrasse from farming pens onto a Hong Kong vessel (Cheung Kam Wah) as part an illegal sea shipment to Hong Kong. Photos: Y. J. Sadovy (2013).

counter to the spirit of CAP 586 to give effect to CITES.

For the second issue, since R and W coded fish cannot be distinguished this has created a loophole for laundering W as R fish, which can be more easily traded and have a much higher export quota, and hence seriously undermines controls of W fish in Hong Kong. To address this issue, a method is needed to reliably distinguish R from W fish. Conventionally this might involve tagging but there are animal welfare considerations when physically marking live animals, and possible safety considerations for consumers [26]. For humphead wrasse, a novel facial identification method was successfully developed and could be applied by enforcement officers to trace individual fish [26]. A practical approach would for this species is to apply facial marking to W fish, which are imported in smaller numbers than R fish and subject to greater controls, so that these can be identified, tracked from import and traced within the retail sector [26,45].

For the third issue, PL validity, the PL system has a validity of 5 years for all live CITES App II listed species but is far too long for the humphead wrasse. The PL specifies the maximum number of animals that can be held on the premises at any one time. In the case of humphead wrasse this is much longer than the typical (or even maximum) holding (i.e. turnaround) time in retail outlets and hence represents a massive loophole for laundering, in the absence of other controls such as individual tagging or facial recognition. In practice, there is nothing to stop businesses replacing legally imported animals with those acquired illegally as long as their premises never hold more than the number indicated in the PL.

Studies of the retail market, trader experience and expert aquarist opinions clearly show that humphead wrasse held in typical retail and trader holding tank facilities with other fish typically survive up to a couple of weeks, maximum of about a month. This is due to water quality conditions, typically high fish densities, and the sensitivity of the species to bacterial infections and stress in captivity (Fig. 4; 45). The documented median turnaround of live humphead wrasse individuals in tanks of the retail markets in Hong Kong was 4.25 days (mean  $\pm$  SD: 5.5  $\pm$  4.8) [26]. The maximum recorded holding time in our studies is 19 days, more than a week is rare and traders themselves say that a week or so is typical [46]. Professional aquarists specify that the species is sensitive to water quality and conditions which need to be carefully controlled for this species. In Hong Kong imported animals are sometimes held briefly in coastal net cages at sea before being moved to the



**Fig. 4.** Large numbers of live humphead wrasse kept in a tank openly displayed to visitors in a seafood restaurant, Hong Kong, in 2019. High density of fish in the tank, much higher than in natural habitats or ranching pens, is highly stressful to the fish and unfavourable for survival of the humphead wrasse in such tanks. Note that the mouths of many fish are already damaged which could quickly lead to bacterial infection.

retail sector or re-exported to mainland China. However, coastal water temperatures in Hong Kong drop to 16 °C, sometimes dipping to 12 °C in winter, far lower than both W and R fish are used to in Indonesia, where minimum temperatures in net cage conditions are above 28 °C [52]. Hence, net cage holding in Hong Kong is only possible briefly.

Notwithstanding the short turnaround times recorded, some traders currently with fish but no valid permit claim that they have kept the species for one to two years in captivity in their holding tanks, which are not designed for long-term holding. In addition to the maintenance challenges, keeping such species for long periods in captivity also makes little business sense because this high value species has high risk of mortality and financial loss. Hence, traders seek to sell animals as quickly as possible after import ([46]; Chair, of the Hong Kong Chamber of Seafood Merchants Ltd., personal communication). For more than two years (since end 2020–2022) live humphead wrasse individuals were regularly seen on sale in local markets of Hong Kong (until end 2022) despite no legal imports of the species after January 2020 ([45]; AFCDC, personal communication). Again, without individual fish identification

methods in place, detection and tracing of laundered (i.e. illegal import replacing a legal import) fish is impossible as long as the number of fish in tanks is kept within the PL quotas. This loophole for humphead wrasse has been exploited extensively, as identified in government audits, but without resolution to date [25,63]. Unfortunately, the AFCD, in-line with its trader-centred approach to commerce, appears to accept trader claims of extended keeping times, without requiring evidence, with the view to facilitating trade and despite having limited investigation capacity.

### 5.2. Poor or absent fish carrier vessel oversight

Regarding vessels used to transport live marine fish from Indonesia to Hong Kong, inadequate government oversight of the small number of Hong Kong fish carrier vessels involved allows for ongoing illegal imports of humphead wrasse. While these vessels are required under the law (since 2009), as cargo vessels (Marine Department Class III(a)), to declare their cargo manifests to Customs they consistently have not done so despite the fact they regularly import the species according to CITES records [26]. Since vessels were the main source of humphead wrasse imports to Hong Kong prior to the CITES listing, regularly (pre-COVID-19) collected the species from Anambas/Natuna (Anon., personal communication), and are the only legal means of transporting ranched fish, they are clearly implicated in some illegal trade (Fig. 3). Due to the Hong Kong Marine Department Director's executive decision, these vessels have been exempted from reporting their exit/entry to Hong Kong waters by the Marine Department which makes tracing their movements and ad hoc inspections of their cargo by Customs impossible. Moreover, despite a request and a good import census system the CS&D department could not confirm that these vessels are reporting any imports [64]. Few of the vessels appear to use Automatic Identification System (AIS), even the larger vessels (>300 gross tonnage) which should be doing so for international movements and for safety considerations ([37]; Global Fishing Watch, personal communication). Nor are they required to do so by the Hong Kong government, unlike other cargo vessels [64]. This issue of poor oversight on fish carrier vessels was discussed in the Hong Kong Legislative Council in 2018 but no improvement measures identified or implemented and there remains little control of fishery-related vessels by the government [64].

### 5.3. Limited investigative capability of AFCD

Until recently, for CITES-related cases the investigative capacity of AFCD was solely dependent on the limited power and resources granted to the department under CAP 586. Recent positive changes have potential to improve this for wildlife investigations. In 2021, wildlife crime was included within the scope of the Hong Kong Law CAP 455 the Organized and Serious Crimes Ordinance (OSCO). This increased the heaviest possible penalties for violations of wildlife related regulations and opened the possibility to involve cross-departmental and multi-disciplinary intelligence in investigations of wildlife-related cases if there is evidence of trans-national and organized crime. This is a positive step that recognizes the seriousness and complexity of wildlife crime [2, 65,66], and gives better capacity to the authorities to investigate and deter wildlife crime, including the investigation of financial matters. However, it is reliant on the AFCD in Hong Kong to refer cases to OSCO and the department has yet to do so for any wildlife crime.

## 6. Conclusion and recommendations

As a result of the introduction of the R code for the humphead wrasse by Indonesia in 2018 international trade in the species (numbers of animals) increased while controls weakened in the major trading partners for this species, with a resulting increase in illegal trade. In Indonesia export quotas for ranched fish are not assigned on a biological basis, while in HK controls on ranched fish are weaker than those for

'wild-caught' fish, undermining the city's ability to implement CAP 586. Oversight of fish carrier vessels permitted to transport ranched (but not wild) fish is weak in both Indonesia and Hong Kong. Since the two forms, W and R, cannot be distinguished there is now ample opportunity for laundering.

Partly as a result of the apparent misapplication of ranching to the humphead wrasse and the resulting weakened control on its international trade, threats to the species in the wild in Indonesia have likely grown. This is further to the fact that its condition in the wild is not yet showing recovery in Indonesia following the 2004 CITES listing which suggests that exploitation levels continue to be too high. Our assessment also highlights shortcomings in CITES provisions related to the definition and application of the R-Code for App II listed species more broadly. Several of the same issues are, or may become, relevant to other fishes using the R code, with some of the concerns identified being already relevant to other, non-fish, taxa. To address the concerns raised, there are fourteen recommendations.

1. The CITES Secretariat should clarify the provisions for 'ranched' animals in relation to their conservation status and reaffirm the need for a biologically determined NDF for R-coded animals.
2. A Review of Significant Trade (RST) under CITES should be conducted for both W and R humphead wrasse to evaluate current management measures (export, import, re-export), including the NDF, and to identify actions to be taken by Parties involved to reduce illegal trade and address enforcement loopholes.
3. An assessment of "legal acquisition" for trading parties should be conducted to determine whether individuals are (a) obtained in accordance with the provisions of national laws of the exporting Party for the protection of wildlife and plants and (b) traded internationally in accordance with the provisions of CITES.
4. All humphead wrasse should be coded as W by exporting Parties until/unless they demonstrably qualify for R coding. Benefits to and impacts on the species from ranching operations should be evaluated. R coding should not be used in any species without sufficient biological information and a biologically based NDF which assesses and accounts for mortality levels in nature and captivity.
5. Apply the existing stock assessment model [48], used for W fish, to R-coded humphead wrasse to determine export quotas of all fish (R & W); quotas can be allocated between the two forms and among provinces, as needed for social and economic aims.
6. The current grow-out practice in Anambas is more correctly termed 'capture-based aquaculture' which needs to be managed as capture fisheries for both its wild-capture and culture components [67]. Several lobster fisheries, which take both post-settlement and adult animals, indicate how such fisheries can be conducted<sup>4</sup>. Humphead wrasse grow-out aquaculture could similarly be managed for both its wild-capture and culture components [67].
7. For any species traded in both R and W forms between the same trade partners, a robust system to distinguish the two forms at all stages of trade is needed (e.g. tagging that considers animal welfare, storage locations, molecular means, facial recognition of individual fish etc.). This is particularly important if legal export quotas, or other regulatory matters, differ between W and R-coded fish (as for humphead wrasse) in the same country.
8. Implementation effectiveness of CITES should not be compromised by the application of W and R coding in trade.

<sup>4</sup> An example of managing a fishery that takes both adult fish and settlement-stage (puerulus) animals (followed by grow-out) and incorporates puerulus recruitment levels into assessment, is the lobster, *Panulirus cygnus*, fishery of western Australia [68]. Other examples are lobster fisheries in Vietnam and Indonesia [69].

9. International cooperation is essential for the protection of certain species of wild animals and plants under CITES to combat threats to species; hence Management Authorities should collaborate/communicate among Parties; for the humphead wrasse two major areas which could benefit from cooperation are the activities of live fish trading vessels and legal export sizes (CITES Decisions 15.86, 16.139).
10. The Indonesian Management Authority needs mechanisms to verify that only R fish are transported by sea and that both W and R exports comply with assigned quotas and permitted export fish size slots.
11. The Philippines should address its illegal exports of humphead wrasse either by better enforcement, or conduct and apply an NDF for the species which allows for legal exports.
12. In Hong Kong, three improvements are needed for the Possession Licence (PL) system. (a) The duration of the PL validity of 5 years is inappropriately long for the short turnaround rate (less than 2 weeks) of the humphead wrasse. Instead, a species-appropriate and administratively practical, period of 6 months PL validity is suggested. (b) The PL is linked to a premise and not to the species. The PL condition should apply to the actual number of fish that can legally held on the premises (according to import permits) and not the maximum number of fish that can be held at any one time. (c) Ranched fish should be treated as 'wild' instead of 'non-wild' under this system to better enable CAP 586 to fulfil its mandate.
13. Individual identification methods for humphead wrasse should be implemented in Hong Kong, at least to record and monitor the imports and trade flow of W fish from arrival port to the retail sector.
14. Hong Kong should improve its oversight on live seafood carrier vessels and should (a) lift the exemption for reporting their movements into the city a (b) ensure they are submitting declarations and manifests to Customs. AIS should be required on vessels > 300 GT, as per international practice, and used on all live fish carrier vessels moving internationally. Indonesia should improve oversight of these vessels in its waters.

### CRediT authorship contribution statement

**Hau, C. Y.:** Conceptualization, Methodology, Validation, Formal analysis, Investigation, Resources, Data curation, Writing – original draft, Writing – review & editing, Visualization. **Sadovy de Mitcheson, Y. J.:** Methodology, Validation, Formal analysis, Investigation, Resources, Supervision, Project administration, Writing – original draft, Writing – review & editing.

### Data Availability

The data that has been used is confidential.

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