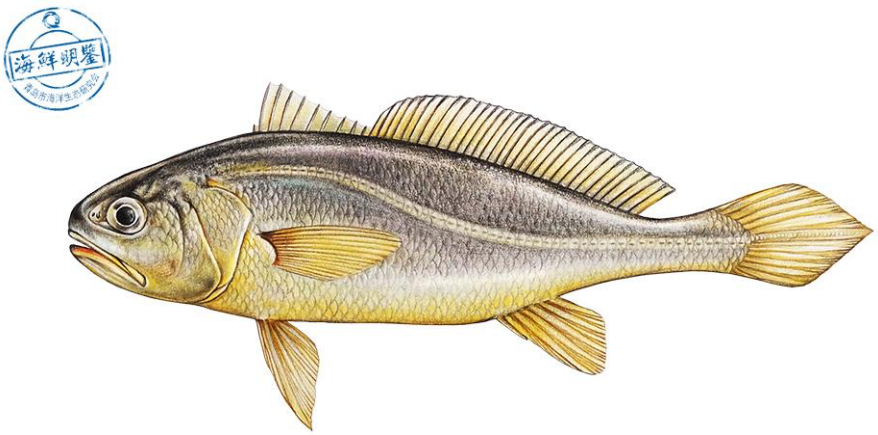
China Sustainable Seafood Assessment (CSSA)

Fishery



Small Yellow Croaker (*Larimichthys polyactis*)
Offshore Fisheries

CSSA Team

December 2023

Statement

In the assessment of all species, the China Sustainable Seafood Assessment (CSSA) team will strictly follow the assessment criteria and refer to the latest, impartial and objective scientific data. Common sources of reference for evaluation data include literature review, official materials, objective and unbiased media reports, data obtained from field research, and expert interviews. Inevitably, many fisheries face the problem of lacking robust data, and some data are not publicly available, which may affect the assessment results to some extent. The CSSA team is committed to carrying out the assessment and evaluation of the species objectively and impartially, basing on respecting objective facts, making maximum use of open data, and relying on rigorous scrutiny of experts. The results of the species assessment do not represent the opinion of any particular expert, scholar, etc.. The CSSA team has the right to the final interpretation of the assessment results.

Content

Introduction

China is the world's largest fishing country, and also has a large consumer market for aquatic products. The food choices we make determine the present and future of our marine and freshwater ecosystems. In order to cultivate a new generation of responsible seafood foodies, Qingdao Marine Conservation Society (QMCS) has launched the China Sustainable Seafood Assessment (CSSA) project to customize scientific and interesting sustainable seafood consumption guides for domestic consumers. We hope that by raising public awareness and promoting changes in consumer behavior, we can use the power of the market to force industrial transformation and make a lasting contribution to the continuous improvement of the health of China's marine and freshwater ecosystem.

Executive Summary

The small yellow croaker (*Larimichthys polyactis*) is widely distributed throughout the Bohai Sea, Yellow Sea, East China Sea, and along the western coast of the Korean Peninsula. It is a warm-temperate, bottom-dwelling schooling fish. Within China's coastal waters, there are three small yellow croaker populations: the northern Yellow Sea-Bohai Sea, southern Yellow Sea, and East China Sea populations.

Extensive research has been conducted on the population dynamics of the small yellow croaker. The small yellow croaker resource has undergone a prolonged decline over time. With the implementation of measures such as closed seasons and spawning ground protection, as well as the influence of external factors like changes in the marine environment and climate, recent years there are some signs of recovery in its resources. However, challenges such as individual size reduction and early maturity persist. Key resource indicators like average length and reproductive capacity have not returned to historical levels, suggesting that the resource status has not fully recovered. China's annual catch of small yellow croaker has hovered around 300,000 tons in recent years, with several stocks facing high fishing pressure, indicating overexploitation.

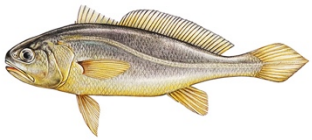
In the small yellow croaker fishery, common bycatch species include lantern fish (*Benthosema pterotum*), Bombay duck (*Harpadon nehereus*), yellow goosefish (*Lophius litulon*), mantis shrimp (*Oratosquilla oratoria*), hairtail (*Trichiurus japonicus*), black mouth croaker (*Atrobuccanibe*), Japanese butterfish (*Psenopsis anomala*), silver pomfret (*Pampus argenteus*), *Solenocera crassicornis*, and gazami swimming crab (*Portunus trituberculatus*). While species like scalloped hammerhead (*Sphyrna lewini*) are occasionally incidentally caught, the impact remains minor.

Primary fishing methods for small yellow croaker include bottom trawling and gillnetting. However, bottom trawling has detrimental effects on seabed habitats and lacks selectivity, while gillnets may contribute to overfishing of economically important species' juveniles, hindering resource recovery. Small yellow croakers primarily feed on zooplankton, such as North Pacific krill (*Euphausia pacifica*). Fluctuations in the abundance of these low trophic level species also influence the health of small yellow croaker populations, necessitating a comprehensive assessment of the prey-predator

relationship among these species for effective fishery management.

China has implemented control measures such as closed seasons, non-trawling zones, aquatic germplasm reserves and spawning ground protected areas, as well as setting up the minimum catch size of small yellow croaker. While these regulations have yielded some positive effects, implementation shortcomings persist.

In conclusion, CSSA's assessment indicates that the small yellow croaker's resource status has not fully recovered. Issues such as high fishing pressure, inadequate gear selectivity, and enforcement of management measures remain challenges. Therefore, CSSA rates China's coastal small yellow croaker fishery as Yellow – overall sustainability is fair, but there is room for improvement.



Small Yellow Croaker

Larimichthys polyactis

Think Twice

Species Profile

The small yellow croaker (*Larimichthys polyactis*), classified under the class Osteichthyes, order Perciformes, family Sciaenidae, and genus *Larimichthys*. It is widely distributed in the Bohai Sea, Yellow Sea, East China Sea, and along the western coast of the Korean Peninsula, thriving as a warm-temperate demersal schooling fish. Regarding spawning and overwintering migrations, small yellow croaker populations in China's coastal waters can be categorized into three primary populations: the northern Yellow Sea-Bohai Sea, the southern Yellow Sea, and the East China Sea populations, with the size of southern Yellow Sea population being the largest.[19] The spawning season for the northern Yellow Sea-Bohai Sea and southern Yellow Sea populations spans from April to late May, primarily occurring along the coast of the Bohai Sea and the Lvsi fishing ground in the southern Yellow Sea. The Lvsi fishing ground is the largest spawning ground for small yellow croaker in China. Spawning grounds typically exhibit water temperatures ranging from 11 to 15°C, with salinity levels ranging from 24‰ to 33‰.

Two migratory populations of small yellow croaker exist along the Chinese coast. The Bohai-Yellow Sea population overwinters in the central Yellow Sea near 36°00'N, 123°00'E, migrating to the Bohai Sea and along the coast of the northern Yellow Sea and Haizhou Bay for spawning in June. Those inhabiting the Bohai Sea forage in the central Bohai Sea between September and November before migrating past Chengshantou toward the wintering grounds. The East China Sea population, influenced by warm currents, spends the winter months from December to February in the southwestern area of Jeju Island and the central-southern regions of the East China Sea. In March, they migrate to spawning grounds, entering the Zhoushan fishing ground by late March. They merge with the spawning population migrating northward from the southern East China Sea. Some of them

spawn locally, while others migrate northward and enter the Lvsi fishing ground in April. From May to June, after spawning, adult and juvenile fish gather, later moving to the Dasha fishing ground for foraging between July and September. Come October, most croakers migrate to offshore wintering grounds, while some journey south to return to central-southern regions of the East China Sea. Moreover, some individuals from the wintering population in the central-southern East China Sea may migrate to nearby bays and estuaries for spawning and foraging, and returning to nearby wintering grounds during the winter season.[18]

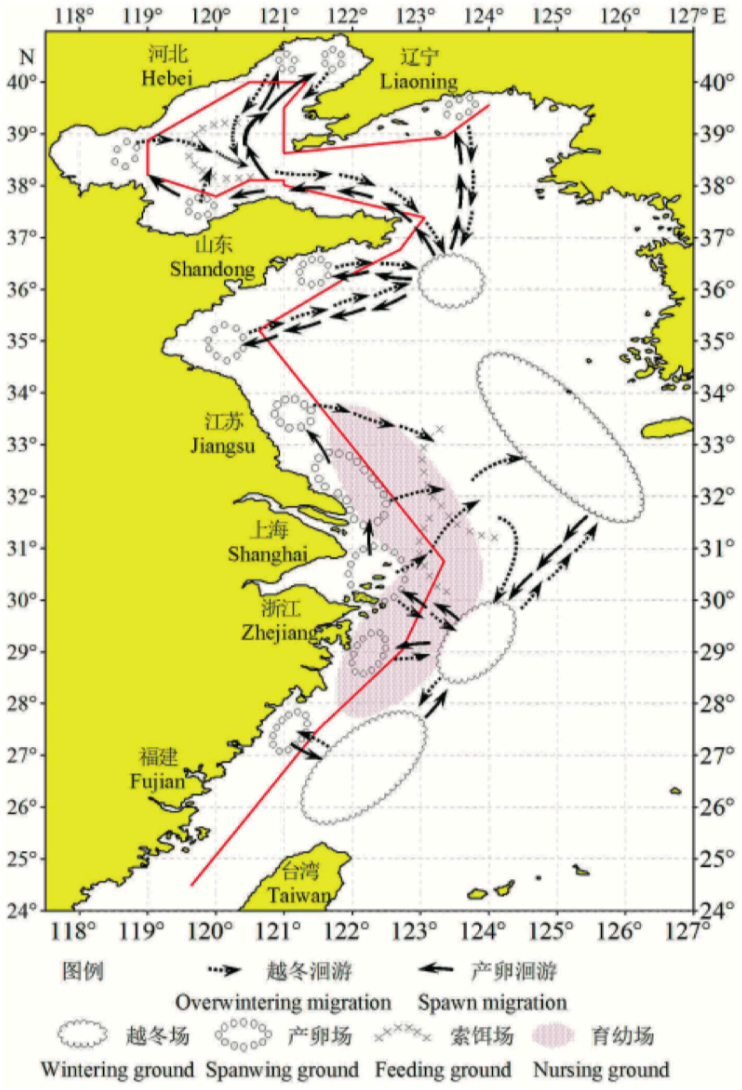


Figure 1. Migratory routine of L. polyactis (Red solid line means fishing close line)[18]

FULL ASSESSMENT

Criterion 1: Impact on Target Species

Status of resources

Over the years, extensive research has been conducted in China on the quantity and population characteristics of small yellow croaker resources. Numerous studies have explored the population dynamics of small yellow croaker. Ni et al.'s study observed that the biomass of small yellow croaker

in the Zhoushan fishing ground reached its lowest point in the 1980s, gradually recovering in the 1990s, albeit with a trend toward smaller sizes.[8] Liu et al. compared the biological parameters of small yellow croaker stock in Liaodong Bay waters between 2012-2013 and 2000, discovering a significant decrease in asymptotic length, indicating concerning trends toward juvenility and smaller sizes.[7] Lin's research highlighted severe overfishing of the East China Sea small yellow croaker population in 2002.[6] A study by Xia et al. assessed the status of small yellow croaker stock in Haizhou Bay using the length-based spawning potential ratio (LB-SPR) method. The study indicated that the SPR reference point for small yellow croaker in Haizhou Bay averaged at 0.22, showing a declining trend. This value falls below the commonly accepted target reference point of SPR=0.4 and is nearing the minimum limit reference point of SPR=0.2. These findings suggest that the small yellow croaker population in Haizhou Bay has been subject to intense overfishing, resulting in a relatively diminished reproductive potential for the population.[17] In the study conducted by Yan et al. on the abundance of small yellow croaker in the southern Yellow Sea, it was found that the maximum age of the population decreased from 23 years in 1961 to 12 years. The age composition sequence of the population shortened. At the same time, the study estimated that the asymptotic length of small yellow croaker was less than that of the 1960s, approaching that of the 1980s, but greater than that of the 1990s and the 2000s. The asymptotic length showed a trend of initial decline followed by an increase, reflecting some degree of recovery in small yellow croaker resources in recent years.[19] Wang et al.'s research revealed an increase in small yellow croaker resource density in the Zhoushan fishing ground in recent years, albeit with persistent issues of smaller-sized individuals.[15] Studies in 2022 demonstrated a significant downsizing trend in the spawning population of small yellow croaker in the Zhoushan fishing ground compared to the historical data in 2002 and 2016, accompanied by early sexual maturation and decreased minimum maturation length. In terms of absolute fecundity, there is a decreasing trend compared to historical data from 2000. However, the difference between the study's findings and those of 2007 is not significant.[14]

Overall, recent studies indicate that China's small yellow croaker resources have rebounded to some extent after experiencing a period of decline. However, under the multiple influences of management protection measures such as closed seasons and spawning ground protection areas, as well as marine environment and climate change, the density of resources has increased, but trends such as smaller-sized individuals and earlier sexual maturity have not changed significantly. Moreover, indicators such as asymptotic length and fecundity have not returned to historical levels, indicating that the resource has not effectively recovered.

Fishing level

Before the 1990s, the small yellow croaker was a primary target fishery species in China, Japan, and South Korea. Presently, China and South Korea are the main countries engaged in its harvesting. According to statistics, the combined catch of small yellow croaker by China and South Korea surged from 51,968 tons in 1991 to a historical peak of 458,688 tons in 2011. From 1996 to 2018, China's share of the catch ranged from 85.65% to 97.10%.[19]In mainland China, annual production of small yellow croaker reached 163,000 tons in 1957. Subsequently, it experienced fluctuations but generally declined, dropping to 17,000 tons by 1989. Production began to recover in 1990, reaching 153,000 tons by 1995 and peaking at 401,000 tons in 2010. In recent years, China's annual catch of small yellow croaker has remained relatively stable at 300,000 to 400,000 tons, with the highest annual catch reaching 400,000 tons.

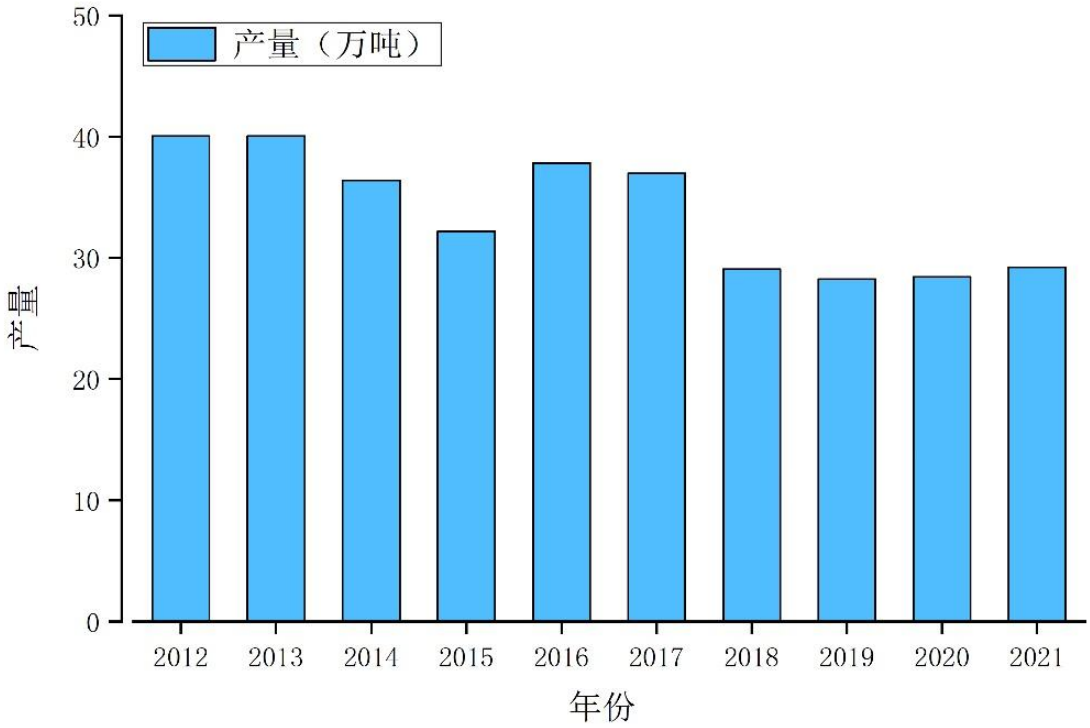


Figure 2 The annual catch of small yellow croaker in China [12]

The catch of small yellow croaker varies among coastal provinces and cities. In 2021, Zhejiang had the highest production, reaching 126,000 tons, accounting for nearly half of the national total. Following Zhejiang are provinces such as Liaoning, Shandong, and Jiangsu.

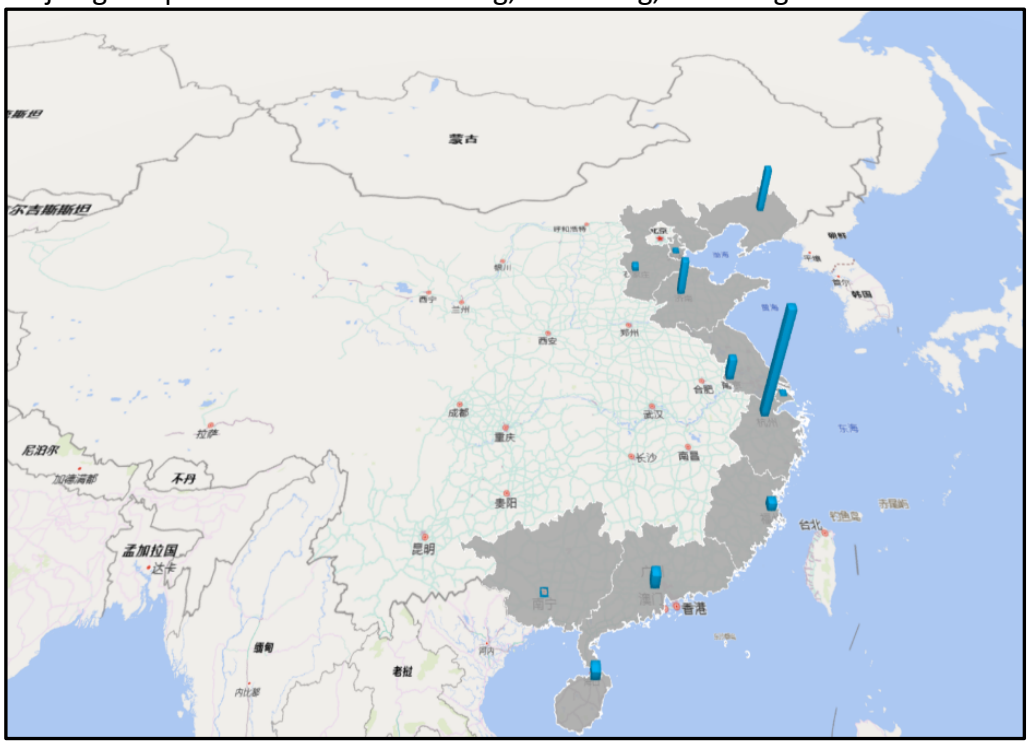


Figure 3 The catch of small yellow croaker in each coastal province in 2021 [12]

Xia et al. estimated the fishing pressure on the yellow croaker population in Haizhou Bay and found that the F/M average value was 2.46. Over the survey years, it showed a trend of first decreasing and

then increasing, far exceeding the reference point value of 0.87, which is deemed appropriate for achieving maximum sustainable yield. This indicates that the yellow croaker population in Haizhou Bay is under significant fishing pressure.[17] Yan et al. estimated the current fishery exploitation rate (E = 0.82) of the yellow croaker population in the southern Yellow Sea, which exceeded the estimated biological reference point (Emax = 0.67). This confirms that the yellow croaker population in the southern Yellow Sea exceeds the optimal fishing level and is in a state of overexploitation. [19]

Criterion 2: Impact on Non-target Species

Bycatch of other concurrently harvested species and Threatened, Endangered, Protected (ETP) species

When employing bottom trawls, gillnets, and stow nets for fishing, various species of fish, cephalopods, and crustaceans are caught besides the small yellow croaker. In the East China Sea, small yellow croaker maintain a significant presence throughout both winter and summer seasons, while lantern fish (*Benthosema pterotum*) and Bombay duck (*Harpadon nehereus*) are also dominant species year-round in the southern coastal waters of Zhejiang. Moreover, during winter, species like yellow goosefish (*Lophius litulon*), mantis shrimp (*Oratosquilla oratoria*) are dominant economically valuable species, while hairtail (*Trichiurus japonicus*), black mouth croaker (*Atrobuccanibe*), Japanese butterfish (*Psenopsis anomala*), silver pomfret (*Pampus argenteus*), *Solenocera crassicornis*, and gazami swimming crab (*Portunus trituberculatus*) are prevalent during the summer months.[13]

In the small yellow croaker fishery, data for endangered, threatened and protected species encounters are limited. Occasionally, a few shark species are incidentally caught, but in minimal quantities. For instance, in a study conducted by Li et al. on the gear selectivity of silver pomfret gill nets in the East China Sea, scalloped hammerhead (*Sphyrna lewini*) was found in the catch.[4]Scalloped hammerhead is categorized as critically endangered (CR) by IUCN and is found in the South China Sea, East China Sea, and Yellow Sea in China, primarily encountered in the Xisha, Nansha, and Zhongsha areas in longline fishing.[1] The incidental catch of scalloped hammerhead in gillnet fishery is considered having limited impact on its population. Additionally, in gillnet fisheries, there may be occurrences of large yellow croaker (*Larimichthys crocea*) (IUCN— CR). Although not classified as an endangered species in China, its wild populations remain threatened by fishing activities. Furthermore, Bombay duck (*Harpadon nehereus*), IUCN rated near threatened NT species, it's a economically valuable species in the East China Sea, and has substantial production in China. Moreover, species like Spadenose shark (*Scoliodon laticaudus*) (IUCN—near threatened NT) may occasionally be encountered in nearshore fisheries in the East China Sea. In the future fishery management, efforts should be taken on reporting and releasing these bycatch ETP species, while improving gear selectivity to mitigate the risk of bycatch.

Criterion 3: Control Impact on Ecosystem

The effect of fishing gear

The yellow croaker is a warm-temperate bottom-dwelling species. Primary methods for catching yellow croaker include bottom trawling and gillnetting. Trawling is towing fishing gear along the seabed or through the water column with the movement of vessels. The fish, shrimp, and crabs can be pushed into the net by water pressure. Trawling not only significantly impacts fishery resources

but also poses harm to the marine ecological environment, particularly through bottom trawling. In the last decade, advancements and innovations in bottom trawlers have led to traditional nylon trawl nets being more robust, allowing for easier operation in complex bottom environments, leading to more extensive impacts on benthic habitats. Bottom trawling typically involves a codend made of traditional diamond-shaped mesh netting. With the tension during trawling, the meshes are semi-open, gradually closing as trawling speed increases, making it challenging for juvenile fish to escape.

Gillnetting is a traditional and efficient fishing method primarily used to catch migratory fish species. It involves suspending vertical nets in the water, where passing fish become entangled in the mesh. This type of gear does not require towing but rather relies on the fish swimming into the net and becoming trapped. Gillnets come in various forms. Single-layer gillnets offer a relatively high degree of selectivity. However, in recent years, the length of gillnets has increased significantly, with some extending for tens or even hundreds of kilometers. Developments have progressed from using single-layer net panels to employing double or triple-layered ones, with mesh sizes generally small and some even featuring codends. Many gillnets are placed across the migratory routes of marine species, causing significant harm to the fishery resources while obstructing their migration to spawning grounds for reproduction. As a result, the fishing intensity for adults and juveniles is high. Therefore, multi-layer gillnets have become a highly destructive fishing gear for fisheries resources. Currently, the use of gillnets has been prohibited in key areas of the Yangtze River Basin in China. [11]

Furthermore, in some regions, stow nets represent a significant method for capturing small yellow croakers. Investigations indicate that during the autumn season, stow nets, commonly referred to as "pot nets," in the Haizhou Bay area primarily target small yellow croakers, constituting up to 71.31% of the total catch. Pot nets are a type of stow nets characterized as passive fishing gear, relying on water currents to guide the catch into the net. Stow net operations incur relatively low production costs and require minimal labor, making them one of the primary fishing gears utilized in China's coastal fisheries, extensively deployed in the Yellow Sea, Bohai Sea, and East China Sea. The impact of pot net fishing on the seabed substrate is deemed insignificant. However, the adverse effect on fishery resources stems from the relatively high proportion of juveniles in the catch. When mesh sizes are small, the escape rate of juveniles is low, leading to the depletion of fishery resources.[3]

Ecosystem-based fisheries management

Based on the principles of ecosystem-based fisheries management, it is imperative to not only focus on the target species but also consider the broader components and functions of the ecosystem in fisheries management practices.[2] Ecosystem-based fisheries management represents a more comprehensive approach to resource management. However, in China, fisheries management predominantly relies on total catch and input controls, with limited implementation of measures for conserving and managing fisheries resources at the ecosystem level. While marine protected areas have been established for small yellow croaker to safeguard and replenish fishery resources, the planning and design of these protected areas have yet to fully integrate their ecological roles and impacts on the ecosystem into the fisheries management framework.

Small yellow croakers' diet primarily rely on zooplankton, constituting 61.8% of their total prey.[16]Studies have confirmed that small yellow croakers in the central Yellow Sea predominantly feed on North Pacific krill (*Euphausia pacifica*).[5]Zooplankton species like krill, which occupy lower trophic levels in the marine ecosystem, play a pivotal role. They not only influence the biomass of

marine plankton but also support the population of numerous economically valuable species, including small yellow croakers. Therefore, in managing fisheries for such species, it is crucial to adopt a holistic perspective and incorporate the dynamics of species interactions into management frameworks. Consequently, CSSA advocates for the comprehensive consideration of various factors, including the management of prey resources, when developing management plans for small yellow croaker fisheries. This approach facilitates the maintenance of marine ecosystem balance and the achievement of management objectives aimed at restoring fishery resources.

Criterion 4: Management and Implementation

Fishery management plans for target species

In 1955, the State Council issued the "Order on the Prohibition of Trawling in the Bohai Sea, Yellow Sea, and East China Sea by Motorized Trawlers," which established a non-trawling zone line consisting of 17 reference points. It stipulated that motorized trawlers equipped with propellers and fishing gear intended for bottom-dwelling aquatic animals (excluding sailboat fishing vessels) were not allowed to operate within the non-trawling zone line. The zone line was extended in 1957 and 1980, resulting in the national non-trawling zone line for motorized trawling fishing vessels comprising 40 reference points. Starting in 1981, all motorized bottom trawling fishing vessels were prohibited from operating within the aforementioned non-trawling zone line.

Since 1995, to conserve the spawning fisheries resources in summer, the East China Sea region has implemented a comprehensive fishing ban on trawling and canvas stow nets in July and August, gradually extending to the entire Chinese coastline. Currently, the summer fishing ban has become one of the fundamental fisheries management measures in China, covering major fishing operations and adjusting the timing, types, and scope of fishing bans according to the actual situation each year.

In 2011, the Ministry of Agriculture merged the nationally designated aquatic germplasm reserve established on the inner side of the non-trawling zone line in the Lvsi Sea area of Jiangsu Province with the Lvsi Fishing Ground Small Yellow Croaker and Silver Pomfret National Aquatic Germplasm Reserve designated by the Ministry of Agriculture. This Reserve, located in the southern Yellow Sea Lvsi Fishing Ground, primarily protects spawning individuals and juveniles of small yellow croakers and silver pomfrets, as well as other economically important fish species. The total area of the protection zone is 1.66 million hectares, with a core area of 0.87 million hectares and an experimental area of 0.78 million hectares. The special protection period is from May 1st to July 1st.[9]

To more effectively promote the conservation of fisheries resources, Zhejiang Province implemented the Zhejiang Fishing Ground Restoration and Revitalization Action in 2017, establishing 10 spawning ground protection zones in the nearshore waters of Zhejiang. In addition to the national summer fishing moratorium, fishing is completely banned in April within the protection zones, and corresponding resource conservation measures such as patrolling and ecological restoration are implemented. The Zhoushan Fishing Ground Spawning Ground Protection Zone is one of the ten major spawning ground protection zones, primarily protecting species such as hairtail, small yellow croaker, silver pomfret, and cuttlefish.

Regarding the minimum catchable size of small yellow croakers, relevant management regulations already exist. In 2015, Zhejiang Province issued a Notice on the Implementation of the Minimum

Catch Size and Juvenile Proportion Management System for Key Marine Fishery Species, setting the minimum catch size of small yellow croakers at a weight of 50 grams or a length of 145 mm.[20]In 2016, according to the Decision of the Standing Committee of the Zhejiang Provincial People's Congress on Strengthening the Protection of Marine Juvenile Resources to Promote the Restoration and Revitalization of Zhejiang Fishing Ground, Zhejiang Province began implementing a transitional minimum catch size management system for six key marine fishery species, including hairtail, large yellow croaker, small yellow croaker, silver pomfret, chub mackerel, and gazami swimming crab.[22]In February 2017, the Zhejiang Provincial Bureau of Ocean and Fisheries issued a Notice on the Transitional Minimum Catch Size of Key Marine Fishery Species, setting the minimum catch size of small yellow croaker at a weight of 30 grams, effective from March 24, 2017.[21] To effectively protect juvenile fish resources and promote the recovery and sustainable utilization of marine fishery resources, starting in 2018, the minimum catch size standards and juvenile catch proportion management regulations for 15 important economic fish species were implemented in accordance with the requirements of the Ministry of Agriculture and Rural Affairs. The minimum catch size for small yellow croakers is set at a length of ≥150 mm.[10]

However, it cannot be ignored that, despite the various management measures in place for small yellow croakers, the actual implementation effectiveness remains to be evaluated and verified. In field surveys, it has been observed that the enforcement of the minimum catch size for small yellow croakers is not adequate, and a large number of individuals below the catchable size are present in the catch. Due to continued fishing pressure and inadequate improvements in fishing selectivity, the recovery of small yellow croaker resources remains difficult.

Fisheries management system

China's current fisheries management primarily relies on measures such as summer fishing moratorium, non-trawling zone lines, and aquatic germplasm reserves to control fishing intensity and alleviate fishing pressure. While these initiatives have yielded some initial outcomes, they have not effectively addressed the overarching goal of resource recovery. China's fisheries management system faces several key deficiencies:

1. Inadequate data reporting and monitoring of fishery catches, leading to a lack of fishery-dependent species biomass assessment and monitoring.
2. Low gear selectivity resulting in a high proportion of non-target species and economically valuable species' juveniles in the catch, with limited information available to evaluate associated impacts.
3. The substantial catch of low trophic level species may have significant ecosystem impacts, but relevant information for assessing these impacts is lacking.
4. Absence of specific management plans tailored to individual species, beyond general measures like summer fishing moratorium and non-trawling zones.

Moreover, China's nearshore areas typically feature mixed fisheries involving multiple species. Challenges in designing and implementing quota-based fishing management systems arise due to incomplete regulations, lack of vessel and catch volume data, and the absence of an effective fisheries monitoring system.

To address these challenges, it is imperative to not only reinforce enforcement of existing management measures but also to:

- Strictly limit the use of destructive fishing gear and practices.
- Crack down on three-no fishing vessels (fishing vessels without licenses, vessel names or proof of being on a port registry).
- Improve gear selectivity to reduce bycatch.
- Strictly implement minimum mesh sizes and minimum catch sizes to protect juveniles.

Additionally, there is a pressing need to develop comprehensive fish catch monitoring systems, design and implement ecosystem-based management approaches, and integrate species-specific fishing management plannings into the existing management framework. These efforts are crucial for establishing a robust and effective fisheries management system in China.

Acknowledgement

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Reference

[1] 陈丕茂,李永振,袁蔚文.路氏双髻鲨的种群统计分析[J].南方水产科学, 2006, 2(2).DOI:10.3969/j.issn.2095-0780.2006.02.003. Pi-mao, C., Yong-zhen, L., Wei-wen, Y. Demographic analysis of scalloped hammerhead, Sphyrna lewini[J]. South China Fisheries Science, 2006, 2(2): 15-19.

[2] 褚晓琳.基于生态系统的东海渔业管理研究[J].资源科学, 2010(4):6.DOI:CNKI:SUN:ZRZY.0.2010-04-006. Xiao-lin, C. (2010). Ecosystem-Based Management of Fishery Resources in the East China Sea. Resources Science.

[3] 黄六一, 杨意馨, 许庆昌, & 尤鑫星. (2023). 菱形与方形网目网囊的坛子网对小黄鱼选择性的比较研究. 渔业现代化, 50(1), 80-88. HUANG Liuyi, YANG Yixin, XU Qingchang , YOU Xinxing. Selectivity of diamond and square mesh cod-ends in the stow nets for Larimichthys Polyactis . Fishery Modernization. 2023, 50(1): 80

[4] 李灵智，黄洪亮，王磊，冯春雷，许永久，张禹.东黄海区银鲳流刺网网目尺寸选择性研究[J].海洋渔业, 2010, 032(001):89-94. Ling-zhi, L., Hong-liang, H., Lei, W., Chun-lei, F., Yong-jiu, X., Yu, Z. (2010). The mesh size selectivity research of silvery pomfret gillnet in Yellow and East China Sea.

[5] 李子东, 王燕平, 仲霞铭, 杨家新, 葛慧, & 施金金, et al. (2023). 江苏海域小黄鱼时空分布及生物学特征研究. 海洋渔业, 45(1), 73-null. LI Zidong，et al. (2023). Spatio-temporal and spatial distribution and biological characteristics of Larimichthys polyactis in Jiangsu sea area. Marine Fisheries. 45(1), 73-null.

[6] 林龙山. 东海区小黄鱼现存资源量分析 [J]. 海洋渔业，2004, 26 (1):18-23. Long-shan, L. (2004). Analysis on extant abundance of small yellow croaker Pseudosciaena polyactis in the East China Sea.

[7] 刘修泽, 郭栋, 王爱勇, 董婧, 王小林, & 段妍等. (2018). 辽东湾水域小黄鱼的生长特征. 海洋渔业, 40(2), 8. Xiu-ze, L. et al. (2018). Growth characteristics of small yellow croaker Larimichthys polyactis in the Liaodong Bay. Marine Fisheries. 40(2), 8.

[8] 倪海儿，陆杰华. 舟山渔场主要渔业资源利用现状［J］应用生态学报，2003，14(14):569-572. Ni H, Lu J. [Present utilization situation of main fishery resources in Zhoushan fishing ground]. Ying Yong Sheng Tai Xue Bao. 2003 Apr;14(4):569-72. Chinese. PMID: 12920904.

[9] 农业部, 农业部办公厅关于调整吕泗渔场小黄鱼银鲳鱼和东海带鱼两个国家级水产种质资源保护区面积范围和功能分区的通知, 2011 https://www.moa.gov.cn/govpublic/YYJ/201112/t20111213_2434798.htm#:~:text=. Ministry of Agriculture. (2011). Circular of the General Office of the Ministry of Agriculture on the Adjustment of the Area Scope and Functional Sub-area of the Two State-level Aquatic Germplasm Resource Protection Areas for the Small Yellow Croaker Silver Pomfret and the East China Sea Striped Bass in Lvsi Fishing Ground

[10] 农业部，农业部关于实施带鱼等 15 种重要经济鱼类最小可捕标准及幼鱼比例管理规定的通告,2018 https://www.moa.gov.cn/nybgb/2018/201803/201805/t20180528_6143239.htm. Ministry of Agriculture. (2018). Circular of the Ministry of Agriculture and Rural Affairs on the Implementation of the Minimum Allowable Catch Standard for Fifteen Important Economically Important Fish Species and Provisions on Management of the Proportion of Juvenile Fish in the Catch.
[11] 农业农村部, 农业农村部关于发布长江流域重点水域禁用渔具名录的通告, 2021. Ministry of Agriculture and Rural Affairs. (2021). Circular of the Ministry of Agriculture and Rural Development on the Release of the List of Prohibited Fishing Gear in Key Waters of the Yangtze River Basin. https://www.moa.gov.cn/govpublic/CJB/202110/P020211015553933959387.pdf.
[12] 农业农村部渔业渔政管理局, 全国水产技术推广总站, 中国水产学会. 2022 中国渔业统计年鉴 [M]. 中国农业出版社, 2022. China Agriculture Press. (2022). 2022 Chinese Fishery Statistical Yearbook.
[13] 沈恺华. （2022）.浙江南部近海渔业资源群落结构及资源概况. 上海海洋大学. Kai-hua, L. (2022). Community Structure and General Situation of Fishery Resources in Coastal Waters of Southern Zhejiang. Shanghai Ocean University.
[14] 王雅丽, 胡翠林, 徐开达, 周永东, 蒋日进, & 李振华等. (2022). 2020—2021 年舟山渔场及邻近海域小黄鱼繁殖力现状. 海洋开发与管理, 39(5), 5. WANG Yali,HU Cuilin,XU Kaid,ZHOU Yongdong,JIANG Rijin,LI Zhenhu,LI Xiafang.Reproductive Status of Larimichthys polyactis in Zhoushan Fishing Ground and Adjacent Waters from 2020 to 2021[J].Ocean Development and Management,2022,39(5):53-57.
[15] 王雅丽,胡翠林,李振华,蒋日进,周永东,张琳琳,张洪亮,徐开达,熊瑛.舟山渔场产卵场保护区春季小黄鱼群体结构及资源动态[J].应用生态学报,2021,32(9):3349-3356. Wang YL, Hu CL, Li ZH, Jiang RJ, Zhou YD, Zhang LL, Zhang HL, Xu KD, Xiong Y. Population structure and resource change of Larimichthys polyactis in spring in Zhoushan fishery spawning ground protection area, China. Ying Yong Sheng Tai Xue Bao. 2021 Sep;32(9):3349-3356. Chinese. doi: 10.13287/j.1001-9332.202109.036. PMID: 34658222.
[16] 王雅丽,王晶,周永东,徐开达,蒋日进,李振华,朱海晨,王静,崔国辰.基于 two-stageGAM 的舟山渔场及邻近海域小黄鱼时空分布特征[J].中国水产科学,2022,29(4):633-641. WANG Yali, WANG Jing, ZHOU Yongdong, XU Kaida, JIANG Rijin, LI Zhenhua, ZHU Haichen, WANG Jing, CUI Guochen. Spatial and temporal distribution characteristics of Larimichthys polyactis in Zhoushan fishing ground and the adjacent waters based on two-stage GAM[J]. Journal of Fishery Sciences of China,2022,29(4):633-641
[17] 夏恒睿，王琨，董秀强，刘逸文，张崇良，纪毓鹏，任一平. (2022). 基于体长-繁殖潜力比方法的海州湾小黄鱼资源状态评估. 中国海洋大学学报:自然科学版, 52(12), 25-32. Heng-rui, X. et al. (2022). Evaluating stock status of small yellow croaker (Larimichthys polyactis) in Haizhou Bay based on body length/spawning potential ratio method[J]. Periodical of Ocean University of China. 52(12), 25-32.
[18] 徐兆礼, & 陈佳杰. (2009). 小黄鱼洄游路线分析. 中国水产科学, 16(6), 10. Zhao, X. (2009). Analysis on migratory routine of Larimichthy polyactis. Journal of fishery sciences of China.
[19] 严利平, 刘尊雷, 金艳, 程家骅, 熊瑛, & 胡翠林. (2022). 黄海南部小黄鱼种群动态和开发模式. 中国水产科学(007), 029. Li-ping, Y. et al. (2022). Population dynamics and exploitation patterns of small yellow croaker (Larimichthys polyactis) in the Southern Yellow Sea.
[20] 浙江省海洋与渔业局，关于实施海洋渔业资源重点保护品种可捕规格及幼鱼比例制度的通告， 2015 https://www.zj.gov.cn/art/2021/8/18/art_1229278041_2322439.html. Zhejiang Provincial Bureau of Ocean and Fisheries. (2015). Notice on the Implementation of the Minimum Catch Size and Juvenile Proportion Management System for Key Marine Fishery Species.
[21] 浙江省海洋与渔业局，浙江省海洋与渔业局关于海洋渔业资源重点保护品种最小可捕过渡性规格的通告，2017 https://www.zj.gov.cn/art/2021/8/18/art_1229278041_2322506.html. Zhejiang Provincial Bureau of Ocean and Fisheries. (2017). Notice on the Transitional Minimum Catch Size of Key Marine Fishery Species
[22] 浙江省人大常委会关于加强海洋幼鱼资源保护促进浙江渔场修复振兴的决定，2016 http://www.daishan.gov.cn/art/2017/1/5/art_1229683988_13240353.html. Decision of the Standing Committee of the Zhejiang Provincial People's Congress on Strengthening the Protection of Marine Juvenile Resources to Promote the Restoration and Revitalization of Zhejiang Fishing Ground. (2016).