

Review Articles

Present situation of fisheries in Henan province, China

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Henan province possesses abundant fishery resources and is recognized as a typical representative region for inland fisheries in China. However, no comprehensive literature has been reported on its current status of the fishery industry. This review summarized the current situation of Henan fishery industry and found that its fishery production expanded at an average annual growth rate of 8.6% from 1978 to 2022. Aquaculture was the primary source of fish production in the province. Fish dominated aquaculture production, followed by crustaceans and molluscs. The two main aquaculture environments in Henan were ponds and reservoirs. Currently, the fishery industry faces challenges including scarce freshwater resources and the presence of saline-alkali water, low market value of farmed species, a lack of professional talent, inadequate standardization and industrialization, disease outbreaks, and stringent provincial policy requirements. Possible solutions were proposed to address these issues. The statistics presented in this review can provide a theoretical basis for the healthy development of Henan's fishery industry.

INTRODUCTION

Henan province, located in central and eastern China within the middle and lower sections of the Yellow River, covers an area of 167 thousand square kilometers. It is the only province encompassing the Yellow River, Huai River, Yangtze River, and Hai River. Over 1500 rivers crisscross its territory, with 1030 watercourses having drainage areas exceeding 50 square kilometers. The province also contains 2651 reservoirs with a total storage capacity of 42.3 billion cubic meters. Henan possesses abundant fishery resources, hosting 129 fish species, including over 60 commercially valuable key species.¹ Due to its average economic and aquaculture development, Henan is regarded as a representative inland region of China.² However, no comprehensive literature has been published recently on the current status of Henan's fishery production. This review therefore summarized the fishery production in Henan province from capture and aquaculture, providing information that could form a solid foundation for the sustainable development of the province's fishery industry.

1. CURRENT STATUS OF FISHERY PRODUCTION IN HENAN PROVINCE

Fishery production in Henan province increased at an average annual growth rate of 8.6% from 1978 to 2022. Production rose from only 24.7 thousand tons in 1978 to 942.5 thousand tons in 2022 ([Fig. 1A](#)), peaking at 1023.4 thousand tons in 2015 ([Fig. 1A](#)). Concurrently, the gross output value of fishery grew rapidly at an annual growth rate of 16.3%, increasing from 19 million RMB in 1978 to 14.7 billion RMB in 2022 ([Fig. 1B](#)). According to the Fisheries Bureau of the Ministry of Agriculture of the People's Republic of China (FBMA),³ China's average freshwater fishery production and gross output value per province in 2022 were 1098.8 thousand tons and 26.3 billion RMB, respectively. Given Henan's production level is close to the national provincial average, the province serves as a representative case for China's inland fishery production.

As fishery production comprises both capture and aquaculture sectors,⁴ these components are detailed below.

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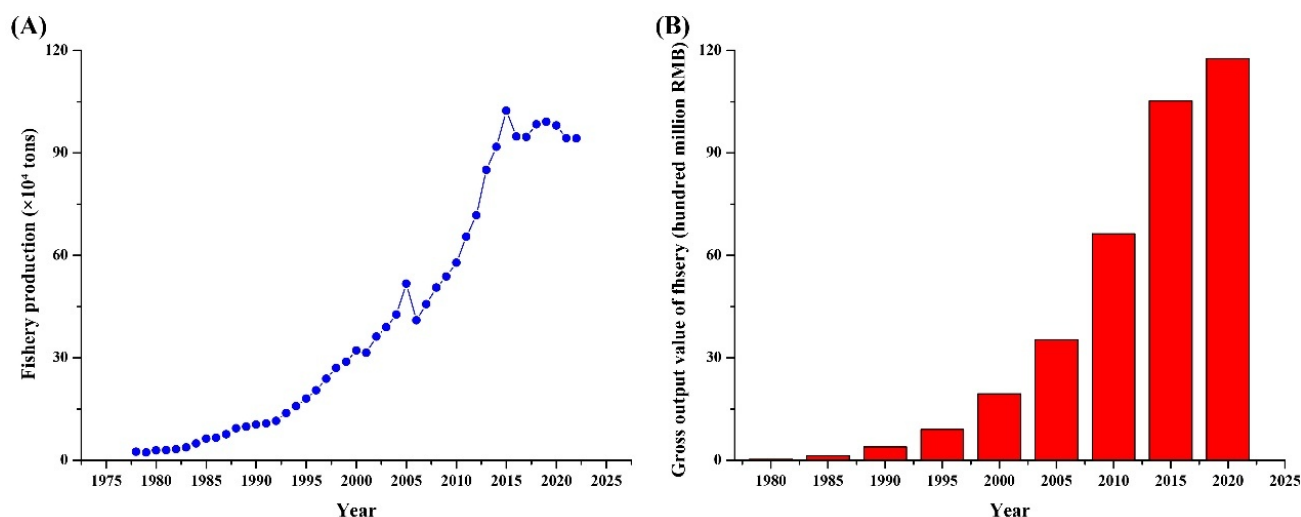


Figure 1. Fishery production (A) and gross-out value (B) in Henan province.

1.1. CAPTURE PRODUCTION

Henan province comprises 18 cities, with capture production concentrated in those possessing abundant natural water resources. Zhumadian, Nanyang, Xinyang, and Pingdingshan collectively accounted for 71.8% of the province's total capture production (Fig. 2A). From 2010 to 2022, capture production climbed from 32.4 thousand tons to 110.9 thousand tons (Fig. 2B). In 2022, freshwater capture production in Henan (110.9 thousand tons) exceeded China's provincial average (37.6 thousand tons). Capture production consists of fish, crustaceans, molluscs, and others. Fish dominated 2022 yields, followed by crustaceans and molluscs (Fig. 2C).

1.2. AQUACULTURE PRODUCTION

Aquaculture production was dominated by the cities of Xinyang, Nanyang, Zhumadian, and Kaifeng, which collectively accounted for 60.2% of total production (Fig. 3A). Aquaculture production in Henan province increased from 546.2 thousand tons in 2010 to 831.5 thousand tons in 2022 (Fig. 3B). In 2022, China's average freshwater aquaculture production per province (1061.2 thousand tons) exceeded Henan's output. Aquaculture species comprise four categories: fish, crustaceans, molluscs, and others. Fish dominated, followed by crustaceans and molluscs (Fig. 3C).

At present, aquaculture dominates Henan's fishery production. According to a recent survey released by the Department of Agriculture and Rural Affairs of Henan Province, aquaculture accounted for 88.2% of the province's total fishery production in 2022. As a result, the following sections focused on aquaculture production when detailing fish species output.

1.2.1. AQUACULTURE PRODUCTION BY SPECIES

Table 1 showed the production of the top reported fish species in 2022. Silver carp (*Hypophthalmichthys molitrix*), common carp (*Cyprinus carpio*), grass carp (*Ctenopharyn-*

godon idella), and bighead carp (*Hypophthalmichthys nobilis*) were the four largest producers, collectively comprising 80.4% of total fish aquaculture production. From 2003 to 2022, channel catfish (*Ictalurus punctatus*), largemouth bass (*Micropterus salmoides*), weather loach (*Misgurnus anguillicaudatus*), and sturgeon exhibited higher annual percentage rates (APRs) ranging from 12.62% to 37.21% (Table 1). Among sixteen cultured fish species, only silver carp, bighead carp, common carp, and channel catfish exceeded the national provincial average yield. The largest producers of fed fish species were Xinyang, Nanyang, and Zhumadian, which contributed 28.3%, 11.1%, and 10.4% of total fish production in 2022, respectively. Primary producers varied by species. Xinyang dominated production of silver carp, common carp, grass carp, bighead carp, *Carassius* sp., *Parabramis* and *Megalobrama*, ricefield eel (*Monopterus albus*), yellow catfish (*Pelteobagrus fulvidraco*), and snakehead (*Channa striatus*); Puyang led in *Silurus* sp., weather loach, and tilapia; and Zhengzhou, Zhumadian, and Anyang were primary producers of channel catfish, largemouth bass, and sturgeon, respectively.

Crustacean farming involved only five species (Table 2). Red swamp crayfish (*Procambarus clarkii*) accounted for 88.9% of total crustacean production, while giant freshwater prawn (*Macrobrachium rosenbergii*) represented the smallest share (1.1%) (Table 2). Red swamp crayfish and whiteleg shrimp (*Litopenaeus vannamei*) showed the highest APR (2003 to 2022). Unlike farmed fish, all crustacean species in Henan yielded below the national provincial average. According to FBMA,³ Xinyang was the main producer of red swamp crayfish, oriental river prawn (*Macrobrachium nipponense*), and giant freshwater prawn. Zhumadian was the primary producer of Chinese mitten crab (*Eriocheir sinensis*) and giant freshwater prawn. Puyang, Shangqiu, and Kaifeng were the main producers of whiteleg shrimp.

Mollusc production totaled 362 tons, comprising mussels (63.5%), snails (30.9%), and clams (5.5%) (Table 3). From 2003 to 2022, mussel and clam aquaculture grew rapidly, while snail production increased slowly (Table 3). Similar to crustaceans, all mollusc species in Henan

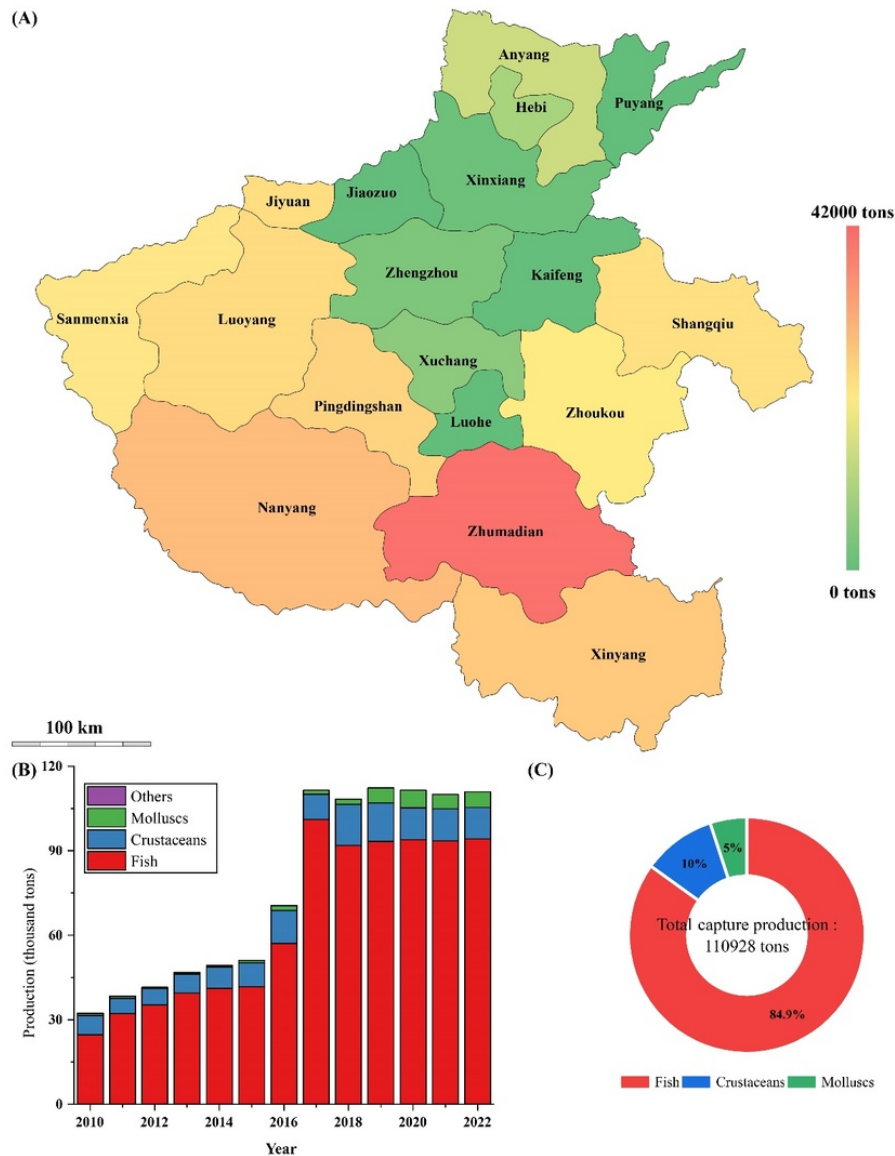


Figure 2. Current status of capture production in Henan province. A. Heat map of capture production distribution in 2022 for Henan Province; B. Aquaculture production from 2010 to 2022. C. Capture production divided by species in 2022.

province had yields below the national average per province. According to FBMA (2023), Zhumadian was the sole producer of mussels and clams and accounted for 91.9% of the total production of snails.

Additional aquatic animal production included soft-shelled turtles, frogs, and turtles (Table 4). Soft-shelled turtle output in 2022 was the highest (Table 4), which was primarily distributed in the cities of Xinyang, Kaifeng, and Nanyang. Turtle production declined since 2003 (Table 4) and concentrated in Xinyang, Zhumadian, and Nanyang. The production of all species was below the national average per province.

1.2.2. PRODUCTION ENVIRONMENTS AND SYSTEMS

Aquaculture environments in Henan include ponds, lakes, reservoirs, diked areas, and other types. From 1986 to 2022, all four primary areas expanded and then fell (Fig. 4). Ponds

and reservoirs were the two principal aquaculture production environments in Henan, accounting for 78% and 17% of the total aquaculture area in 2022, respectively. Ponds, on the other hand, produce the most, accounting for 80% of Henan's aquaculture production in 2022. Pond aquaculture remains the primary method of fish production in China.⁵ According to government statistics, pond aquaculture in China represents 52% and 73% of total freshwater area and production, respectively.³ From these aspects, Henan province's pond aquaculture production efficiency is lower than the national average.

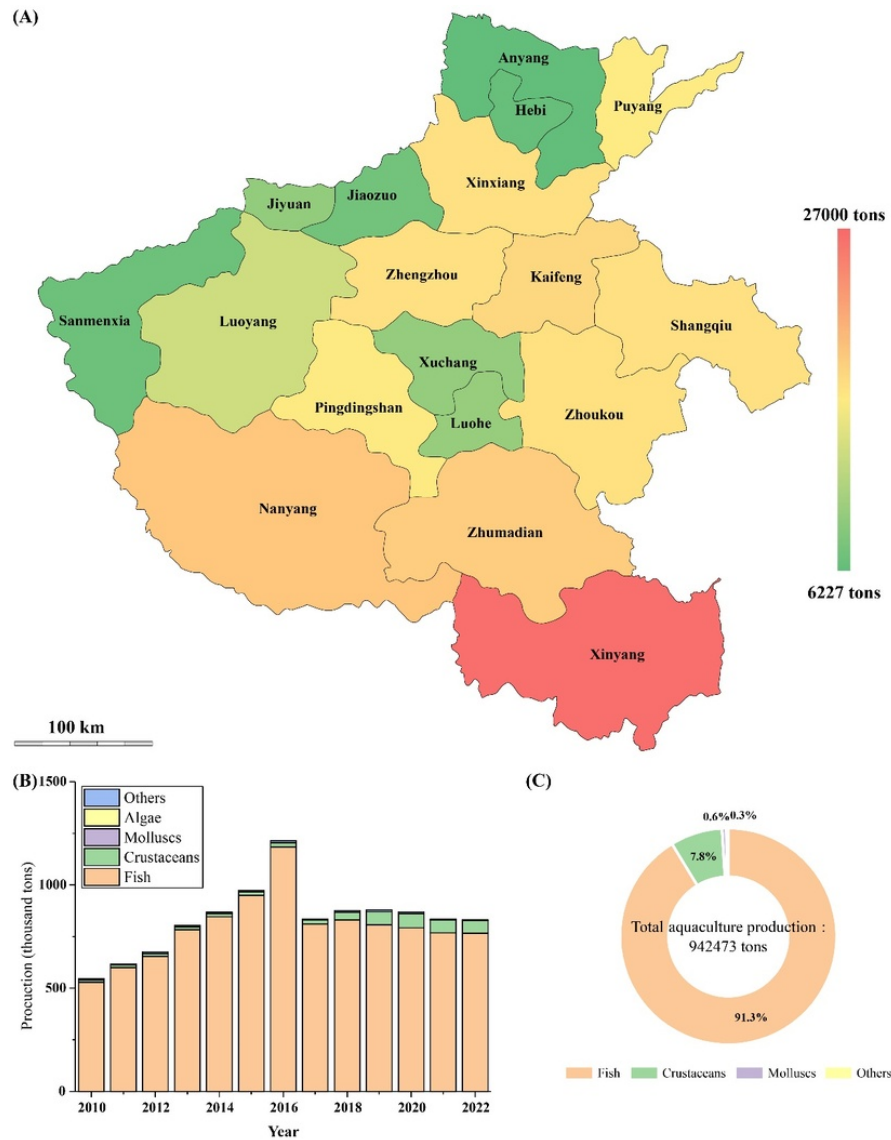


Figure 3. Current status of aquaculture production in Henan province. A. Heat map of aquaculture production distribution in 2022 for Henan Province; B. Aquaculture production from 2010 to 2022. C. Aquaculture production divided by species in 2022.

2. EXISTING PROBLEMS AND PROSPECTS FOR HENAN'S FISHERY SECTOR

2.1. LIMITED FRESHWATER RESOURCES AND ABUNDANT SALINE-ALKALI WATER

Henan province faces freshwater scarcity, with per capita water resources $\leq 400 \text{ m}^3$.^{6,7} Conversely, it possesses extensive saline-alkaline resources exceeding 3.5 billion tons.⁸ Situated in the middle and lower reaches of the Yellow River, the region contains vast saline-alkaline water bodies characterized by high salinity, alkalinity, pH, and complex water quality.^{8,9} Developing these resources represents an urgent challenge. Furthermore, traditional aquaculture methods (e.g., cages) and industrial effluent pollution exacerbate water quality degradation, damaging aquatic ecosystems.¹⁰⁻¹² Consequently, aquaculture area decreased by 51% from 2013 to 2022. The implementation of ecological

and environmental protection planning in the Yellow River basin has also caused a large reduction in aquaculture area.^{3,13,14} Introducing saline-alkaline-tolerant species is critical for utilizing these marginal resources and boosting aquaculture production. Some species have been shown to survive in saline water environments, such as tilapia (*Oreochromis niloticus*)¹⁵ and crucian carp (*Carassius auratus*).¹⁶

2.2. LOW MARKET VALUE OF AQUACULTURE SPECIES

Henan's aquaculture sector remains dominated by conventional species, particularly the "Four Major Chinese Carps (i.e., bighead carp, grass carp, silver carp, and black carp)" and common carp. As demonstrated in [Table 1](#), these species collectively accounted for 76% of total aquaculture production. While crucial for food security and animal protein provision,¹⁷ their market value remains low (\$0.50-\$1.50/kg).¹⁸ In addition, rising living standards have

increased consumer demand for high-quality aquatic products that conventional species cannot satisfy.¹⁹ Accelerating the introduction of high-value fish species is therefore essential. Although some high-value commercial fish species like largemouth bass have been introduced into Henan, their current production remains low. Additional measures are required to expand their cultivation scale and production.

2.3. SHORTAGE OF PROFESSIONAL EXPERTISE

Currently, Henan province possesses a substantial fishery workforce, but the general population is undereducated and unprofessional. According to the official statistics, the workforce in Henan province's fishery industry was about 434 thousand individuals in 2022, with only 144 thousand comprising professional practitioners who specialize in capture and aquaculture. Addressing this requires implementing comprehensive training programs for aquaculture technicians and modern fishermen, actively recruiting specialized fisheries professionals, and increasing financial investment in fishery technology extension services.

2.4. UNDERDEVELOPED ENTERPRISES AND LIMITED INDUSTRIAL STANDARDIZATION

Aquatic enterprises in Henan province exhibit small operational scales, low profitability, limited industrialization, and underdeveloped industrial integration mechanisms. At present, most aquatic products undergo primary processing with minimal value addition. According to a recent survey, Henan's freshwater aquaculture competitiveness falls below China's median level.²⁰ Strengthening scientific innovation and actively developing aquatic consumer markets is crucial for addressing intensifying market competition. The government should continue to enhance support for cultivating leading enterprises, give full play to the leading role of leading enterprises, actively introduce advanced technology and professional personnel, promote standardized production systems, and facilitate enterprises' scale expansion.

Table 1. Top reported fish aquaculture in 2022 in Henan province

Fish species	Thousand tons (2022)	APR%/year 2003-2022	Nation average per province in 2022 (thousand tons)	Main producers (2022)
Silver carp	181.91	3.08	125.15	Xinyang (38%), Nanyang (18%), Zhumadian (13%)
Common carp	150.62	1.66	91.71	Xinxiang (16%), Zhengzhou (14%), Shangqiu (12%)
Grass carp	145.31	4.88	190.48	Xinyang (19%), Kaifeng (16%), Nanyang (11%)
Bighead carp	138.13	9.79	105.44	Xinyang (46 %), Nanyang (13%), Zhumadian (13%)
<i>Carassius. sp</i>	52.81	0.66	91.92	Xinyang (56%), Nanyang (12%), Zhumadian (8%)
Channel catfish	43.99	24.98	13.43	Zhengzhou (45%), Kaifeng (38%), Luoyang (3%)
Black carp	14.49	9.45	24.13	Xinyang (31%), Zhumadian (30%), Kaifeng (13%)
Largemouth bass	10.07	37.21	25.90	Zhumadian (38%), Jiaozuo (19%), Zhengzhou (17%)
<i>Parabramis and Megalobrama</i>	8.59	0.40	24.75	Xinyang (55%), Nanyang (15%), Zhumadian (13%)
<i>Silurus sp.</i>	6.53	1.56	10.50	Puyang (45%), Shangqiu (18%), Hebi (13%)
Weather loach	6.05	12.62	12.10	Puyang (43%), Shangqiu (16%), Xinyang (14%)
Ricefield eel	2.42	4.70	10.78	Xinyang (89%), Zhumadian (7%), Nanyang (4%)
Yellow catfish	1.64	4.51	19.35	Xinyang (48%), Zhengzhou (10%), Nanyang (9%)
Sturgeon	1.26	23.31	4.22	Anyang (41%), Luoyang (40%), Jiyuan (8%)
Snakehead	1.18	4.78	17.85	Xinyang (57%), Nanyang (13%), Sanmenxia (13%)
Tilapia	0.48	-5.04	56.10	Puyang (50%), Pingdingshan (28%), Hebi (8%)

Table 2. Top reported crustacean aquaculture in 2022 in Henan province

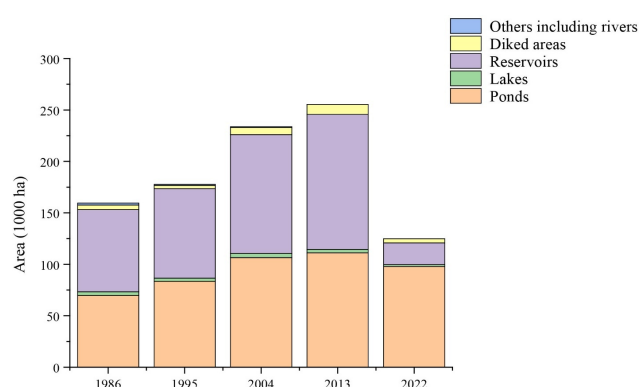
Top crustacean species	Tons (2022)	APR% 2003-2022	Nation average per province in 2022 (tons)	Main producers (2022)
Red swamp crayfish	53338	21.40	93248	Xinyang (75%), Nanyang (17%), Puyang (5%)
Oriental river prawn	4477	1.43	7300	Zhoukou (53%), Xinyang (26%), Shangqiu (8%)
Chinese mitten crab	2060	2.75	26301	Zhumadian (29%), Shangqiu (28%), Nanyang (18%)
Whiteleg shrimp	1489	22.20	24463	Puyang (29%), Shangqiu (19%), Kaifeng (18%)
Giant freshwater prawn	645	1.23	573	Zhumadian (86%), Shangqiu (9%), Xinyang (5%)

Table 3. Top reported molluscs aquaculture in 2022 in Henan province

Top molluscs species	Tons (2022)	APR%/year 2003-2022	Nation average per province in 2022 (tons)	Main producers (2022)
Mussels	230	6.05	1685	Zhumadian (100%)
Snails	112	0.32	3054	Zhumadian (91%), Xinyang (9%)
Clams	20	2.59	695	Zhumadian (100%)

Table 4. Top reported other aquatic animals in 2022 in Henan province

Top species	Tons (2022)	APR%/year 2003-2022	Nation average per province in 2022 (tons)	Main producers (2022)
Soft-shelled turtles	1812	0.23	12055	Xinyang (77%), Kaifeng (11%), Nanyang (7%)
Frogs	922	7.24	6938	Zhumadian (83%), Luohe (5%), Nanyang (5%)
Turtles	25	-2.68	1739	Xinyang (84%), Zhumadian (12%), Nanyang (4%)

**Figure 4. Aquaculture area by culture environment in Henan province (1986-2022)**

2.5. DISEASE OUTBREAKS

Disease outbreaks currently threaten the healthy development of the Henan fishery industry. For example, the carp edema virus, with clinical signs of acute gill rot, is a great

threat to carp and koi farming and causes losses of approximately 50-100 million RMB per year in Henan province.^{21, 22} *Vibrio metschnikovii* has induced a high mortality rate of hybrid sturgeon (*Acipenser baerii* ♀ × *Acipenser schrenckii* ♂) in Zhengzhou.²³ *Shewanella putrefaciens* has led to mass mortality at a low temperature (10 °C) in Henan province.²⁴ According to the Henan fishery statistics, in 2022, fish disease afflicted 1063 ha of aquaculture operations, causing losses of 713 tons of aquatic products and 7.56 million RMB in economic damage.³ Preventive strategies such as vaccines, probiotics, prebiotics, and medicinal plants could mitigate these impacts.^{25,26}

2.6. STRICT PROVINCIAL POLICY REQUIREMENTS

Henan's fisheries development operates within China's national framework for agricultural modernization and ecological conservation, notably guided by the Ministry of Agriculture's Green Aquaculture Development Initiatives. Responding to acute environmental pressures in the Yellow River Basin and chronic water scarcity, the province has en-

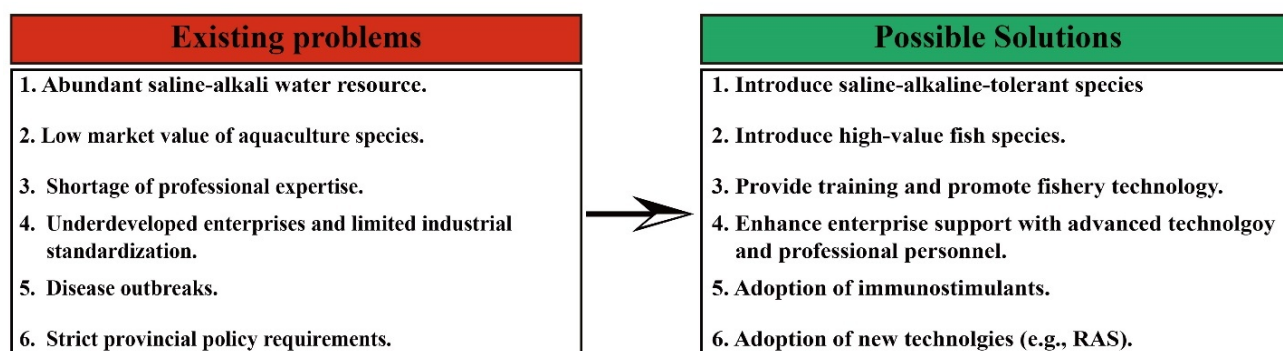


Figure 5. Existing problems and possible solutions of Henan fishery industry

acted stringent regulations: (1) The “14th Five-Year Plan for Ecological Protection” (2022) mandates environmental surveys, promotes large-waterbody ecological aquaculture, and enforces wastewater treatment; (2) Provincial discharge standards (DB41/2575-2024) impose strict limits on nitrogen (TN: 8–15 mg/L) and phosphorus (TP: 0.5–1 mg/L) based on recipient water sensitivity; (3) The Three-Year Action Plan (2024–2026) accelerates the transition toward facility-based, integrated systems, targeting 1.05 million tons of output, >50% fry self-sufficiency, and 22000 RMB fishermen income by 2026.

Henan province lacks freshwater resources and is characterized by a temperate continental climate.² These features compress the effective production time of pond aquaculture to less than 180 days, seriously limiting the development of the Henan fisheries industry. Under strict provincial policy mandates and constraints of freshwater resources and climate, adopting recirculating aquaculture systems (RAS) has become an essential pathway. This technology can achieve year-round production under idealized aquaculture conditions and significantly reduce water consumption and the discharge of aquaculture tailwater.²⁷

3. CONCLUSION

At present, aquaculture has dominated fishery production in Henan province. In aquaculture, fish dominated, followed by crustaceans and molluscs. The fishery production in Henan province was limited by scarce freshwater resources and the presence of saline-alkali water, the low market value of aquaculture species, a shortage of professional expertise, underdeveloped enterprises and limited industrial standardization, disease outbreaks, and strict provincial policy requirements. Possible solutions can be used to solve these problems, such as introducing fish species acclimated to saline-alkali water and special fish with great value, increasing financial investment to introduce advanced technology and professional personnel, using vaccines and medicinal plants, and adopting new aquaculture technology (e.g., RAS) (Fig. 5).

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AUTHORS' CONTRIBUTION

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COMPETING INTEREST – COPE

No competing interests were disclosed.

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All authors and institutions have confirmed this manuscript for publication.

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All are available upon reasonable request.

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REFERENCES

1. Ji G, Sun G. Basic situation, existing problems and development ideas of Henan fishery. *Henan Fisheries*. Published online 2004.
2. Pemsil DE, Bose ML. *Recommendation Domains for Pond Aquaculture. Country Case Study: Development and Status of Freshwater Aquaculture in Henan Province, China*. The WorldFish Center; 2008.
3. FBMA (Fisheries Bureau of the Ministry of Agriculture of the People's Republic of China). *China Fishery Statistical Yearbook*. China Agriculture Press; 2023.
4. Thilsted SH, Thorne-Lyman A, Webb P, et al. Sustaining healthy diets: The role of capture fisheries and aquaculture for improving nutrition in the post-2015 era. *Food Policy*. 2016;61:126-131. doi:[10.1016/j.foodpol.2016.02.005](https://doi.org/10.1016/j.foodpol.2016.02.005)
5. Zhang M, Dong J, Gao Y, et al. Patterns of phytoplankton community structure and diversity in aquaculture ponds, Henan, China. *Aquaculture*. 2021;544:737078. doi:[10.1016/j.aquaculture.2021.737078](https://doi.org/10.1016/j.aquaculture.2021.737078)
6. Jia Y, Shen J, Wang H, Dong G, Sun F. Evaluation of the spatiotemporal variation of sustainable utilization of water resources: case study from Henan province (China). *Water*. 2018;10:554. doi:[10.3390/w10050554](https://doi.org/10.3390/w10050554)
7. Wu Z, Zhang Y, Hua Y, Ye Q, Xu L, Wang S. An improved system dynamics model to evaluate regional water scarcity from a virtual water perspective: a case study of Henan province, China. *Sustainability*. 2020;12:7517. doi:[10.3390/su12187517](https://doi.org/10.3390/su12187517)
8. Zhang Y. Introduction to salt and alkali resources in Henan province. *China Salt Industry*. 2023;6:41-46. doi:[10.19396/j.cnki.issn1004-9169.2023.06.012](https://doi.org/10.19396/j.cnki.issn1004-9169.2023.06.012)
9. Shaoli W, Xiugui W, Brown LC, Xingye Q. Current status and prospects of agricultural drainage in China. *Irrigation and Drainage*. 2007;56:S47-S58. doi:[10.1002/ird.374](https://doi.org/10.1002/ird.374)
10. Duan Y, Liu L, Tang R, et al. Assessing changes in China's pond water quality from 1989 to 2020: implications for green development in aquaculture. *Reviews in Aquaculture*. 2025;17:e12997. doi:[10.1111/raq.12997](https://doi.org/10.1111/raq.12997)
11. Li K, Jiang R, Qiu J, et al. How to control pollution from tailwater in large scale aquaculture in China: A review. *Aquaculture*. 2024;590:741085. doi:[10.1016/j.aquaculture.2024.741085](https://doi.org/10.1016/j.aquaculture.2024.741085)
12. Liu X, Wang Y, Liu H, et al. A systematic review on aquaculture wastewater: Pollutants, impacts, and treatment technology. *Environmental Research*. 2024;262:119793. doi:[10.1016/j.envres.2024.119793](https://doi.org/10.1016/j.envres.2024.119793)
13. Department of Agriculture and Rural Affairs of Henan Province. *Henan Fishery Statistical Yearbook*. Department of Agriculture and Rural Affairs of Henan Province; 2023.
14. Qu Y, Zong H, Su D, Ping Z, Guan M. Land use change and its impact on landscape ecological risk in typical areas of the Yellow River basin in China. *International Journal of Environmental Research and Public Health*. 2021;18:11301. doi:[10.3390/ijerph182111301](https://doi.org/10.3390/ijerph182111301)
15. Song L, Zhao Y, Song Y, Zhao L, Ma C, Zhao J. Effects of saline-alkaline water on growth performance, nutritional processing, and immunity in Nile tilapia (*Oreochromis niloticus*). *Aquaculture*. 2021;544:737036. doi:[10.1016/j.aquaculture.2021.737036](https://doi.org/10.1016/j.aquaculture.2021.737036)
16. Ding L, Liu Y, Wei X, et al. Effects of saline-alkaline stress on metabolome, biochemical parameters, and histopathology in the kidney of crucian carp (*Carassius auratus*). *Metabolites*. 2023;13:159. doi:[10.3390/metabo13020159](https://doi.org/10.3390/metabo13020159)
17. Zhao Y, Hu H, Jiang G, Ge X. Current status and development trend on national conventional freshwater fishery industry. *Chinese Fisheries Economics*. 2012;30:91-99.
18. Miao W, Yuan X. The carp farming industry in China - an overview. In: *Species and System Selection for Sustainable Aquaculture*. Blackwell Publishing; 2007:373-388. doi:[10.1002/9780470277867.ch25](https://doi.org/10.1002/9780470277867.ch25)
19. Kang B, Vitule JRS, Li S, et al. Introduction of non-native fish for aquaculture in China: A systematic review. *Reviews in Aquaculture*. 2023;15:676-703. doi:[10.1111/raq.12751](https://doi.org/10.1111/raq.12751)
20. Zhu Z, Wu D, Jiang Q. Chinese freshwater aquaculture: A comparative analysis of the competitiveness on regional aquaculture industries. *Aquaculture and Fisheries*. 2024;9:860-870. doi:[10.1016/j.aaf.2022.11.001](https://doi.org/10.1016/j.aaf.2022.11.001)
21. Wang X, Liang H, Jia T, Yang Z, Zhang Y. Investigation on acute gill rot disease of common carp in Henan province along the Yellow River. *Animals Breeding and Feed*. 2016;2:55-58.

22. Zhang J, Huiling Q, Wen Z, et al. Carp edema virus, a great threat for carp and koi farming in Henan, China. *Aquaculture*. 2023;576:739869. doi:[10.1016/j.aquaculture.2023.739869](https://doi.org/10.1016/j.aquaculture.2023.739869)
23. Xiao Z, Li X, Xue M, et al. *Vibrio metschnikovii*, a potential pathogen in freshwater-cultured hybrid sturgeon. *Animals*. 2022;12:1101. doi:[10.3390/ani12091101](https://doi.org/10.3390/ani12091101)
24. Jiang X, Wang X, Li L, et al. Identification of *Shewanella putrefaciens* as a novel pathogen of the largemouth bass (*Micropterus salmoides*) and histopathological analysis of diseased fish. *Frontiers in Cellular and Infection Microbiology*. 2022;12:1042977. doi:[10.3389/fcimb.2022.1042977](https://doi.org/10.3389/fcimb.2022.1042977)
25. Assefa A, Abunna F. Maintenance of fish health in aquaculture: review of epidemiological approaches for prevention and control of infectious disease of fish. *Veterinary Medicine International*. 2018;2018:5432497. doi:[10.1155/2018/5432497](https://doi.org/10.1155/2018/5432497)
26. Zhang W, Zhao J, Ma Y, Li J, Chen X. The effective components of herbal medicines used for prevention and control of fish diseases. *Fish & Shellfish Immunology*. 2022;126:73-83. doi:[10.1016/j.fsi.2022.05.036](https://doi.org/10.1016/j.fsi.2022.05.036)
27. Chen W, Gao S. Current status of industrialized aquaculture in China: a review. *Environmental Science and Pollution Research*. 2023;30:32278-32287. doi:[10.1007/s11356-023-25601-9](https://doi.org/10.1007/s11356-023-25601-9)