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An Updated Checklist of Freshwater and Estuarine Fishes of Kinmen, with New Records of Invasive Freshwater Fishes from Mainland China via Transnational Water Diversion

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ABSTRACT

A series of field surveys were undertaken from 2013 to 2025 to investigate the inland water fish fauna in Kinmen and Lieyu Islands, with a total of 181 established sampling sites. An updated checklist of freshwater and estuarine fish species of Kinmen is presented in this study based on the results of these field surveys. A total of 61 inland water fish species were recorded from Kinmen and Lieyu Islands. Among them, 10 species were newly recorded in Kinmen, comprising six native species (*Hemiculter leucisculus, Rhodeus ocellatus, Mesopristes argenteus, Oxuderces dentatus, Pseudogobius taijiangensis, and Anabas testudineus*) and five alien species (*Chanodichthys erythropterus, Toxabramis houdemeri, Sarotherodon galilaeus, Clarias gariepinus,* and *Micropterus salmoides*). Notably, since the transnational water diversion from mainland China to Kinmen Island started to deliver water in 2018, seven fish species from mainland China were recorded to have invaded Kinmen's water via this diversion route. These species include *Chanodichthys erythropterus, Toxabramis houdemeri, Rhodeus ocellatus, Pseudorasbora parva, Sarotherodon galilaeus, Rhinogobius similis,* and *Coptodon zillii.* All these invasive species or alien populations from China were detected in the retention pond, with some species subsequently invading the rivers and reservoirs in eastern Kinmen. Based on the findings of the present study, an updated list of threatened inland water fish species in Kinmen is provided. *Puntius snyderi* and *Cobitis* sp. have possibly gone extinct from Kinmen, *Macropodus opercularis* is possibly extinct in the wild from Kinmen, five native species (*Misgurnus anguillicaudatus, Metzia mesembrinum, Rhodeus ocellatus, Anabas testudineus,* and *Hemiculter leucisculus*) are classified as threatened in Kinmen inland waters.

Keywords: Kinmen, fish fauna, inland water, new record, invasive species.

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1 INTRODUCTION

Kinmen County in Taiwan, consists of 12 islands located off the southeastern coast of mainland China. Among these islands, Kinmen and Lieyu are the largest and second-largest, respectively. However, only a few surveys and studies on Kinmen's inland water fish fauna have been published so far. The first report was published by Cheng (1960), with a total of 13 species from 9 families inhabiting freshwater and estuarine water recorded and only one invasive fish species (*Gambusia affinis*) included. Based on the results from surveys carried out at 14 rivers and lakes in Kinmen and Lieyu Islands, Chen et al. (2002) recorded 48 inland water fish species and two invasive fish species (*Gambusia affinis* and *Oreochromis* sp.). In 2013, 50 inland water fish species were recorded by Chen, Weng, et al. (2013) and three invasive fish species (*Gambusia affinis, Coptodon zillii,* and *Oreochromis* sp.) were included. These findings indicate an increase in the number of invasive fish species in Kinmen over time.

Since the publication of Chen et al.'s Kinmen freshwater and brackish water fish checklist in 2013, the authors of the present study have carried out several field surveys from 2013 to 2025 to investigate Kinmen's inland water fish fauna. Several fish species collected from freshwater and brackish water were recorded as newly recorded local species. In order to better understand the inland water fish fauna of Kinmen, it is necessary to update this checklist.

To resolve the water shortage problem in Kinmen, a transnational water diversion route from mainland China to Kinmen Island was built (Figure 1). The project was initiated in 2015 and completed in 2018 with water starting to flow to Kinmen on August 5, 2018. The water is sourced from the Shanmei Reservoir in Quanzhou City, Fujian, China, delivered to the Longhu Reservoir via the Jinjiang Basin (Jin River), and finally delivered to a retention pond (Figure 2) in eastern Kinmen Island via a 16 km-long submarine pipeline. The retention pond supplies water to a total of eight reservoirs and artificial lakes in Kinmen, including Tianbu Reservoir, Yangming Lake (Yangminghu Reservoir), Tai Lake (Taihu Reservoir), Shanxi Reservoir, Rong Lake (Ronghu Reservoir), Jinsha Reservoir, Lan Lake (Lanhu Reservoir), and Qionglin Reservoir.

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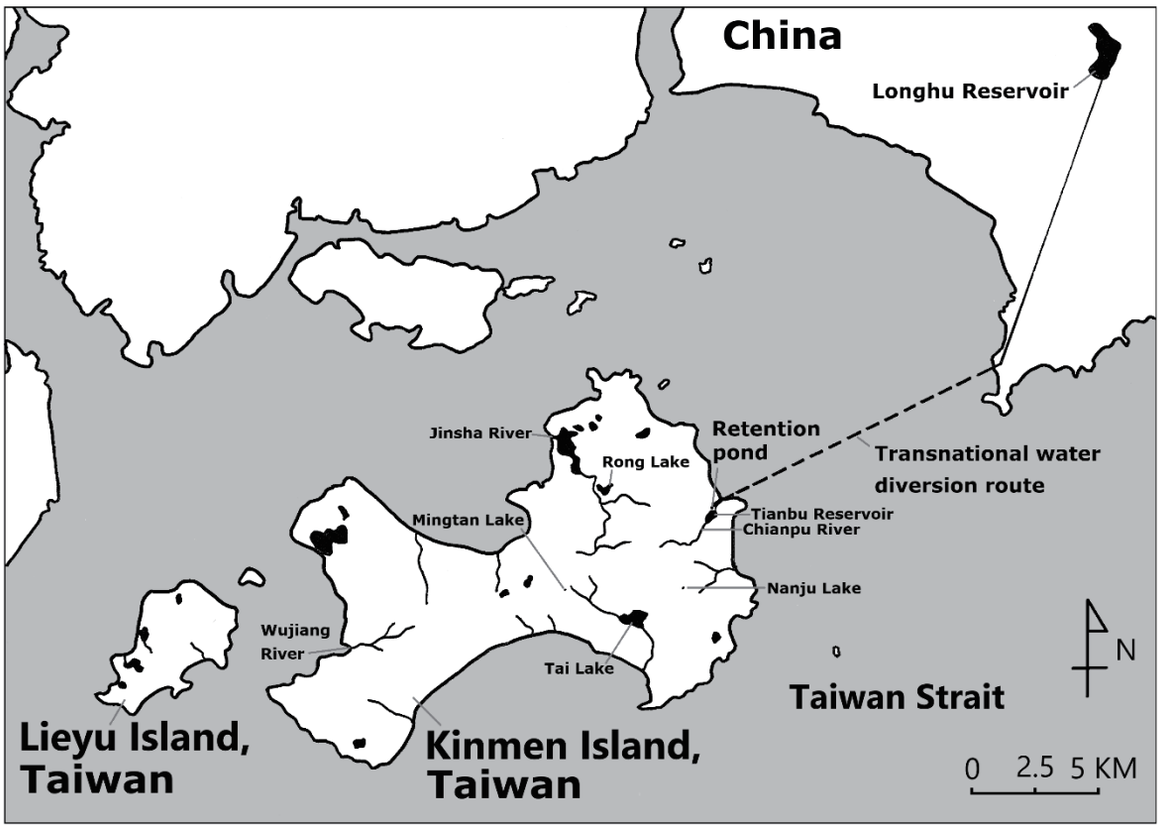

Figure 1. The locations of Longhu Reservoir, retention pond, and localities where newly recorded fish species have been found. The dotted line indicates the submarine pipeline. The pipeline route shown is only a schematic diagram.

In 2022, one predatory carp, *Chanodichthys erythropterus* (Basilewsky, 1855), was unexpectedly captured during a field survey in the Jinsha River Basin, which is connected to Jinsha Reservoir. Additional fish specimens of the predatory carp were also collected at the retention pond that year. Giving that the isolated retention pond was artificially built to only receive pipeline water from mainland China, it is likely that these newly discovered predatory carps in the retention pond originated from the pipeline water from mainland China after August 5, 2018.

The recent discovery of non-native fish species and a span of 12 years since the last inventory of fish fauna was conducted make it imperative to update the checklist of Kinmen's inland water fish fauna. This study catalogs all newly collected native and non-native species from Kinmen and Lieyu Islands between 2013 and 2025. The study also lists the invasive fish species that were likely introduced via the pipeline water from China. An updated checklist of Kinmen's inland water fish species is provided herein, along with a discussion of the current status of Kinmen's native species.

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Figure 2. The retention pond is located in eastern Kinmen Island.

2 RESEARCH METHODS

2.1 Sample Collections

From 2013 to 2025, fish specimens were collected from all major river basins, ditches, reservoirs, lakes and ponds in Kinmen and Lieyu Islands. There were 143 sampling sites in Kinmen Island and 38 sites in Lieyu Island. All the specimens were captured using hand nets, cast nets, traps, and pole fishing. No live specimens were cultured and used for experiment in this study; therefore, no IACUC protocol was applied.

2.2 Species Identification

Most fish specimens were recorded and identified in the field, and then released back in situ. Some individuals were transported back to the laboratory for further species identification. All fish listed in this study were identified to the species level. Some specimens were fixed in a 5% formalin solution and then transferred to 70% ethanol for long-term preservation. The specimens examined were deposited at the Biodiversity Research Museum, Biodiversity Research Center, Academia Sinica, Taipei (ASIZP). Abbreviated names of institution codes followed Fricke and Eschmeyer (2025). All length measurements shown in this study refer to standard length (SL).

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3 RESULTS AND DISCUSSION

3.1 Newly Recorded Local Native Fish Species in Kinmen (Figure 3)

- *Hemiculter* leucisculus (Basilewsky, 1855)

Geographic range in Kinmen: Known only from three small ponds in southeastern Lieyu Island. This species was initially recorded on May 21, 2021.

- *Rhodeus ocellatus* (Kner, 1866)

Geographic range in Kinmen: Known only from the Chianpu River in eastern Kinmen Island. This species was initially recorded on June 10, 2016.

- *Mesopristes argenteus* (Cuvier & Valenciennes, 1829)

Geographic range in Kinmen: Known only from the estuary of the Chianpu River in eastern Kinmen Island. To date, only one specimen was recorded on November 17, 2021.

- *Oxuderces dentatus* (Eydoux & Souleyet, 1850)

Geographic range in Kinmen: Known only from the estuary of the Wujiang River in western Kinmen Island. To date, only one specimen was recorded on November 17, 2021.

- *Pseudogobius taijiangensis* (Chen, Huang & Huang, 2013)

Geographic range in Kinmen: Known only from the brackish waters of western Lieyu Island. This species was initially recorded on May 19, 2021.

- *Anabas testudineus* (Bloch, 1792)

Geographic range in Kinmen: Known only from several ponds in western Lieyu Island. This species was initially recorded on May 19, 2021.

Rhodeus ocellatus was discovered in Kinmen before 2018. In addition, *Hemiculter leucisculus* was only found in Lieyu Island, which does not receive the pipeline water from mainland China, thus these two species were treated as native species to Kinmen.

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Figure 3. Photographs of six newly recorded native fish species and two alien fish species collected from Kinmen. (A) *Hemiculter leucisculus*, ASIZP0082648, 140.0 mm SL, Lieyu Island, 05/21/2021; (B) *Rhodeus ocellatus*, ASIZP0082643, 53.2 mm SL, 06/10/2016; (C) *Mesopristes argenteus*, ASIZP0082662, 28.8 mm SL, estuary of the Chianpu River, Kinmen Island, 11/17/2021; (D) *Oxuderces dentatus*, ASIZP0082663, 36.5 mm SL, estuary of the Wujiang River, Kinmen Island, 11/17/2021; (E) *Pseudogobius taijiangensis*, ASIZP0082639, 28.1 mm SL, Lieyu Island, 05/19/2021; (F) *Anabas testudineus*, ASIZP0081628, 86.7 mm SL, Lieyu Island, 05/19/2021; (G) *Clarias gariepinus*, Nanju Lake, Kinmen Island, 07/27/2022; (H) *Micropterus salmoides*, Mingtan Lake, Kinmen Island, 06/04/2022.

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3.2 Newly Recorded Alien Species (Not Caused by the Pipeline Water Diversion) in Kinmen (Figure 3)

- *Clarias gariepinus* (Burchell, 1822)

Geographic range in Kinmen: Known only from the Nanju Lake (Nanjuhu) in eastern Kinmen Island. This species was initially recorded on July 27, 2022. However, this species was not found in the retention pond and was only found in an isolated lake that does not receive the pipeline water.

- *Micropterus salmoides* (Lacepède, 1802)

Geographic range in Kinmen: Known only from the Mingtan Lake (Mingtanhu) in southeastern Kinmen Island. This species was initially recorded on June 4, 2022. However, the fish was not found in the retention pond and was only found in an isolated lake that does not receive the pipeline water.

3.3 Invasive Species or Populations Introduced from Mainland China via Pipeline Water (Figure 4)

- *Chanodichthys erythropterus* (Basilewsky, 1855)

Geographic range in Kinmen: Currently known only from the retention pond, Tai Lake (Taihu Reservoir), and Jinsha River in northeastern and eastern Kinmen Island.

- *Toxabramis houdemeri* (Pellegrin, 1932)

Geographic range in Kinmen: Currently known only from the retention pond, Rong Lake (Ronghu Reservoir), and Jinsha River in northeastern and eastern Kinmen Island.

- *Rhodeus ocellatus* (Kner, 1866)

Geographic range in Kinmen: Currently known only from the retention pond in eastern Kinmen Island.

- *Pseudorasbora parva* (Temminck & Schlegel, 1846)

Geographic range in Kinmen: Alien population found in the retention pond in eastern Kinmen Island. However, the native local population is widespread in Kinmen and Lieyu Islands.

- *Rhinogobius similis* (Gill, 1859)

Geographic range in Kinmen: Alien population found in the retention pond in eastern Kinmen Island. However, the native local population is widespread in Kinmen and Lieyu Islands.

- *Coptodon zillii* (Gervais, 1848)

Geographic range in Kinmen: Currently found in the retention pond in eastern Kinmen Island. However, this species is widespread in Kinmen and Lieyu Islands as an alien species.

- *Sarotherodon galilaeus* (Linnaeus, 1758)

Geographic range in Kinmen: Currently known only from the retention pond in eastern Kinmen Island.

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Figure 4. Photographs of seven fish species from mainland China via transnational water diversion. (A) *Chanodichthys erythropterus*, ASIZP0082644, 145.0 mm SL, 06/15/2021; (B) *Toxabramis houdemeri*, ASIZP0082654, 61.3 mm SL, 11/30/2022; (C) *Rhodeus ocellatus*, 09/06/2024; (D) *Pseudorasbora parva*, ASIZP0082658, 54.0 mm SL, 11/30/2022; (E) *Rhinogobius similis*, ASIZP0082659, 46.2 mm SL, 11/30/2022; (F) *Coptodon zillii*, ASIZP0082657, 58.5 mm SL, 11/30/2022; (G) *Sarotherodon galilaeus*, 11/30/2022. Fish A was collected from the Jinsha River, Kinmen Island; fishes B-G were collected from the retention pond, Kinmen Island.

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3.4 Updated Checklist of Freshwater and Estuarine Fish of Kinmen (Table 1)

A total of 61 fish species were recorded from the inland waters of Kinmen and Lieyu Islands during surveys conducted from 2013 to 2025. Among these, 11 were newly recorded in the two islands, including *Chanodichthys erythropterus, Hemiculter leucisculus, Rhodeus ocellatus, Toxabramis houdemeri, Clarias gariepinus, Micropterus salmoides, Sarotherodon galilaeus, Mesopristes argenteus, Oxuderces dentatus, Pseudogobius taijiangensis,* and *Anabas testudineus.*

This study also recorded eight alien fish species, including *Chanodichthys erythropterus, Toxabramis houdemeri, Clarias gariepinus, Gambusia affinis, Micropterus salmoides, Coptodon zillii, Oreochromis niloticus,* and *Sarotherodon galilaeus.* These findings represent a historic increase in the number of alien fish species in Kinmen (eight species versus one, two, and three species recorded in Cheng 1960, Chen et al. 2002, and Chen, Weng, et al. 2013, respectively).

3.5 Comments on the Threatened Status of Several Inland Water Fish Species in Kinmen

Based on surveys conducted at 181 sampling sites, the authors believe that two primary freshwater fish species (*Puntius snyderi* and *Cobitis* sp.) are possibly extinct from Kinmen and Lieyu Islands. Chen et al. (2002) reported the presence of *Macropodus opercularis* in two rivers (Wujiang River and Chianpu River). However, the present study revealed that this species has likely gone extinct in the wild on Kinmen since 2015, with only one restored population remaining at a local restoration center.

Five other species inhabit only a few habitats. Although Chen et al. (2002) reported the presence of *Misgurnus anguillicaudatus* in the Chianpu River of Kinmen Island, this study revealed that this species may now be extinct from Kinmen Island and was only found in one sampling site in Lieyu Island. Similarly, the native population of *Rhodeus ocellatus* was only found in one sampling site in eastern Kinmen Island while *Anabas testudineus* was only found in two sampling sites in Lieyu Island.

Metzia mesembrinum is the only species among all the inland water fish species of Kinmen listed as a protected species (Protected Species Category: III, Other Conservation-Deserving Wildlife) by Taiwan's Ministry of Agriculture in 2009 (Shao, 2025). Although Chen et al. (2002) reported the presence of this species in three rivers of Kinmen Island (Jinsha River, Chianpu River, and Xiahu basin), the present study indicated that the fish may have disappeared from the Chianpu River and Xiahu basin, and it is currently found only in three sampling sites of the Jinsha River. The threaten status of these species, as suggested in this study, is provided in Table 1.

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Table 1. Inland water fish species recorded in Kinmen, Taiwan.

		Previous studies			This study				
Family	Species	Cheng (1960)	Chen et al. (2002)	Chen, Weng, et al. (2013)	Recorded in this study	Newly recorded native species in Kinmen	Newly recorded alien species (not caused by water diversion)	Invasive species or population from China via pipeline water	Status of native local population*
Elopidae	*Elops machnata*		V		V				
Anguillidae	*Anguilla japonica*	V	V	V	V				
	Muraenesox bagio			V	V				
Clupeidae	*Konosirus punctatus*		V						
	Sardinella lemuru			V	V				
Cyprinidae	*Carassius auratus*	V	V	V	V				
	Chanodichthys erythropterus				V			V	
	Cyprinus carpio	V	V		V				
	Hemiculter leucisculus				V	V		V	Vulnerable
	Metzia mesembrinum	V	V	V	V				Endangered
	Pseudorasbora parva		V	V	V			V	
	Puntius snyderi	V	V						Possibly Extinct
	Rhodeus ocellatus				V	V		V	Endangered
	Toxabramis houdemeri				V			V	
Clariidae	*Clarias gariepinus*				V		V		
Cobitidae	*Cobitis* sp.	V							Possibly Extinct
	Misgurnus anguillicaudatus	V	V		V				Critically Endangered
Mugilidae	*Planiliza lauvergnii*		V	V					
	Planiliza haematocheilus		V						
	Planiliza macrolepis		V	V	V				
	Planiliza subviridis		V						
	Mugil cephalus		V	V	V				
Poeciliidae	*Gambusia affinis*	V	V	V	V				
Syngnathidae	*Parasyngnathus pencillus*		V						
Synbranchidae	*Monopterus albus*	V	V	V	V				
Ambassidae	*Ambassis urotaenia*		V	V	V				
Percichthyidae	*Lateolabrax japonicus*	V	V	V	V				
Centrarchidae	*Micropterus salmoides*				V		V		
Leiognathidae	*Leiognathus nuchalis*		V						
Lutjanidae	*Lutjanus argentimaculatus*		V	V	V				
	Lutjanus russelli		V						
Gerreidae	*Gerres erythrourus*		V	V					

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		Previous studies			This study				
Family	**Species**	**Cheng (1960)**	**Chen et al. (2002)**	**Chen, Weng, et al. (2013)**	**Recorded in this study**	**Newly recorded native species in Kinmen**	**Newly recorded alien species (not caused by water diversion)**	**Invasive species or population from China via pipeline water**	**Status of native local population***
Sparidae	*Acanthopagrus latus*		V		V				
	Acanthopagrus schlegelii			V	V				
Terapontidae	*Mesopristes argenteus*				V	V			
	Pelates quadrilineatus			V					
	Terapon jarbua		V	V	V				
Cichlidae	*Coptodon zillii*			V	V			V	
	Oreochromis niloticus			V	V				
	Oreochromis sp.		V	V					
	Sarotherodon galilaeus				V			V	
Labridae	*Halichoeres dussumieri*		V		V				
Blenniidae	*Omobranchus punctatus*		V						
	Praealticus striatus		V						
Eleotridae	*Bostrychus sinensis*			V	V				
	Butis koilomatodon		V						
	Butis melanostigma		V	V	V				
	Eleotris oxycephala		V	V					
Gobiidae	*Acanthogobius hasta*		V	V	V				
	Acentrogobius viridipunctatus		V	V	V				
	Acentrogobius brevirostris			V	V				
	Apocryptodon punctatus			V	V				
	Boleophthalmus pectinirostris			V	V				
	Glossogobius olivaceus		V	V	V				
	Hemigobius crassa			V	V				
	Luciogobius sp.			V					
	Mugilogobius abei		V	V	V				
	Mugilogobius chulae		V	V	V				
	Mugilogobius myxodermus		V	V	V				
	Oxuderces dentatus				V	V			
	Oxyurichthys ophthalmonema			V	V				
	Papillogobius reichei			V	V				
	Periophthalmus modestus	V	V	V	V				
	Psammogobius biocellatus			V	V				
	Pseudogobius javanicus			V	V				
	Pseudogobius masago		V	V	V				

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		Previous studies			This study				
Family	**Species**	**Cheng (1960)**	**Chen et al. (2002)**	**Chen, Weng, et al. (2013)**	**Recorded in this study**	**Newly recorded native species in Kinmen**	**Newly recorded alien species (not caused by water diversion)**	**Invasive species or population from China via pipeline water**	**Status of native local population***
Gobiidae	*Pseudogobius taijiangensis*				V	V			
	Rhinogobius similis	V	V	V	V			V	
	Scartelaos histophorus			V	V				
	Tridentiger barbatus		V						
	Tridentiger bifasciatus		V	V	V				
	Wuhanlinigobius polylepis			V	V				
	Yongeichthys caninus			V	V				
Scatophagidae	*Scatophagus argus*		V		V				
Siganidae	*Siganus fuscescens*		V	V	V				
Osphronemidae	*Macropodus opercularis*	V	V	V	V				Possibly Extinct in the Wild
Anabantidae	*Anabas testudineus*				V	V			Endangered
Channidae	*Channa maculata*		V	V	V				
Tetraodontidae	*Takifugu niphobles*		V	V	V				

*: Non-native local populations are not included.

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4 CONCLUSIONS

In this study, a total of 61 inland water fish species were found in Kinmen and Lieyu Islands. Eleven of them were newly recorded in Kinmen, including six newly recorded native species (*Hemiculter leucisculus, Rhodeus ocellatus, Mesopristes argenteus, Oxuderces dentatus, Pseudogobius taijiangensis,* and *Anabas testudineus*), two newly recorded alien species (*Clarias gariepinus* and *Micropterus salmoides*), and three newly recorded alien species from mainland China via transnational water diversion (*Chanodichthys erythropterus, Toxabramis houdemeri* and *Sarotherodon galilaeus*).

A total of eight species from mainland China via the diversion route were recorded, including *Chanodichthys erythropterus, Hemiculter leucisculus, Rhodeus ocellatus, Pseudorasbora parva, Toxabramis houdemeri, Sarotherodon galilaeus, Rhinogobius similis,* and *Coptodon zillii.* All these invasive species or alien populations from China were found in the retention pond with some species subsequently invading the rivers and reservoirs in eastern Kinmen.

Among all inland water fishes recorded in Kinmen, two species (*Puntius snyderi* and *Cobitis* sp.) have possibly gone extinct from Kinmen. One species (*Macropodus opercularis*) is possibly extinct in the wild from Kinmen. Five other native species (*Misgurnus anguillicaudatus, Metzia mesembrinum, Rhodeus ocellatus, Anabas testudineus,* and *Hemiculter leucisculus*) are listed as threatened in Kinmen's inland waters.

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