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Fish diversity at Hirm Wetland and conservation concerns across four understudied wetlands in the Persis basin, southern Iran

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Abstract

Wetlands are valuable aquatic ecosystems, yet many small wetlands in Iran remain poorly studied and receive limited conservation attention. This is particularly concerning in arid and semi-arid regions, where drought, water extraction, and land-use change can rapidly alter aquatic habitats. We assessed fish diversity and potential conservation concerns in four understudied wetlands—Hirm, Hood, Harm, and Karian—in the Persis basin of southern Fars Province, Iran. Field surveys were conducted in 2017 and 2018, followed by a qualitative visit on 5 October 2026. Surveys used hand nets, direct observations, and searches of springs, reed margins, shallow pools, and connecting channels. Habitat conditions, hydrology, aquatic vegetation, and visible anthropogenic pressures were also recorded. Three fish species were recorded at Hirm Wetland: the tooth-carp *Aphaniops stoliczkanus* (Day, 1872) and the two alien species, eastern mosquitofish *Gambusia holbrooki* Girard, 1859, and Nile tilapia *Oreochromis niloticus* (Linnaeus, 1758). No fish or aquatic reptiles were detected at Hood, Harm, or Karian during the surveys; however, these non-detections do not establish permanent absence. Observed and potential pressures included drought, reduced water availability, water extraction, land-use change, riparian and wetland-vegetation degradation, livestock grazing, reed burning, possible pollution, and alien fishes. In October 2026, dead Nile tilapia were observed along wetland margins, and *A. stoliczkanus* was observed farther from the permanent spring. Because sampling was qualitative and water chemistry was not measured, these observations do not establish the cause of mortality or demonstrate competition among species. The permanent spring at Hirm appears to provide an important local refuge for freshwater biodiversity. Conservation priorities include protecting the spring (Howba) and surrounding habitats, maintaining environmental water availability and seasonal hydrology, preventing further introductions of alien fishes, and establishing long-term monitoring.

Key words: *Aphaniops stoliczkanus*, ichthyofauna, Persis basin, non-native fishes, seasonal wetlands

Introduction

Wetlands are among the most productive and ecologically important ecosystems, supporting diverse aquatic and terrestrial communities and providing a wide range of ecosystem services. Freshwater ecosystems contain disproportionately high biodiversity relative to their area, yet they have experienced substantial losses

and degradation due to water extraction, habitat modification, pollution, biological invasions, and other anthropogenic pressures (Dudgeon et al., 2006; Davidson, 2014; Reid et al., 2019). Wetland degradation is therefore a major component of the global biodiversity crisis, with consequences for ecosystem functioning and human well-being (Gaston and Spicer, 2004; Convention on Wetlands, 2021).

Wetlands are especially sensitive to changes in water quantity, timing, and persistence (Kingsford et al., 2016). Seasonal wetlands in arid and semi-arid landscapes are particularly vulnerable because relatively small changes in precipitation and water availability can determine whether aquatic habitats persist long enough to support aquatic communities (Williams, 2006). Climatic variability and human demand for water can further reduce the duration and extent of inundation, potentially eliminating aquatic habitats during critical periods (IPCC, 2023).

Iran is predominantly located in arid and semi-arid climatic zones, and its freshwater ecosystems are affected by recurrent drought, variable precipitation, water extraction, agricultural development, habitat alteration, and the introduction of alien species (Esmaeili et al., 2017, 2018; Jouladeh-Roudbar et al., 2020; Eagderi et al., 2022). These pressures are important for Iranian freshwater fishes because many species have restricted distributions and occur in small drainage systems or isolated springs. Local habitat degradation may therefore have disproportionate effects on their populations and conservation status.

Fars Province supports diverse freshwater fishes (about 55 species) and encompasses several biogeographically distinct drainage systems, including the Kor, Maharlu Lake, Persis, Hormuz, and Tigris basins (Esmaeili et al., 2010, 2015, 2017; Eagderi et al., 2022; Sayyadzadeh and Esmaeili, 2024). Although major wetlands and lakes in Fars Province–including Bakhtegan, Tashk, Kamjan, Parishan, Maharlu Lake, and Arjan–have received scientific attention, many smaller wetlands and spring-fed habitats remain poorly documented. Previous investigations have linked wetland loss and habitat degradation in Fars Province with reduced fish diversity and the contraction or disappearance of local populations (Gholamifard, 2018, 2021; Gholamifard and DeMilio, 2024). Regional checklists improve understanding of fish composition and distribution but do not necessarily document species occurrence or habitat condition at individual wetlands (Jouladeh-Roudbar et al., 2020; Eagderi et al., 2022). Shatoei Gharenjeh et al. (2026) surveyed rivers in the Persis and Hormuz basins and recorded 48 fish species from 16 families and 34 genera. *Capoeta saadii* was the most widely recorded species, occurring at 73 stations, whereas 10 species were recorded at only one station. These findings provide a recent regional overview of riverine fish diversity and indicate that some taxa have highly localized records. Sayyadzadeh (2026) provides an updated national inventory of Iran's endemic freshwater fishes and their conservation status.

The Persis basin is biogeographically important because it supports a distinctive assemblage of freshwater and brackish-water fishes. Esmaeili et al. (2015) listed 44 confirmed freshwater fish species from the Persis region, including 11 endemic and 10 non-native species. The description of *A. furcatus* and subsequent morphological, osteological, and molecular studies illustrate the taxonomic diversity of aphaniid tooth-carps (Teimori et al., 2014; Charmpila et al., 2020; Esmaeili et al., 2020; Freyhof and Yoğurtçuoğlu, 2020). The more recent river survey by Shatoei Gharenjeh et al. (2026) documented spatial variation in beta diversity across the Persis and Hormuz basins. Total beta diversity and the richness-related (nestedness) component were highest in the western part of the study area, particularly in the Persis basin. The spatial patterns of the richness-related component, species turnover, and total beta diversity across individual sampling sites are presented in Figures 2–4, respectively. Although species turnover also reached its highest values in the Persis basin, it contributed relatively little to total beta diversity overall, indicating that differences in species richness were the predominant component of the observed beta-diversity patterns (Shatoei Gharenjeh et al., 2026).

These findings highlight regional variation in riverine fish communities but do not directly characterize fish assemblages in the four wetlands examined here, which were not included in that river survey. Small spring-fed and wetland habitats may provide important refuges for freshwater fishes in arid regions because they can retain water as surrounding seasonal habitats contract. Assessing the conservation significance of a local population requires reliable species identification, distributional evidence, and site-specific information on habitat condition. The present study therefore documents fish occurrence and observed pressures at four wetlands to use direct observations to infer potential ecological explanations. Non-native fishes are an additional concern for Iranian freshwater ecosystems. *Gambusia holbrooki*, has been introduced widely and can affect native aquatic communities through predation on eggs and larvae, competition for food and habitat, and interference with the recruitment of native fishes (Pyke, 2008; Cucherousset and Olden, 2011; Esmaeili et al., 2014). Non-native cichlids and other fishes have also been introduced into southern Iranian waters, sometimes in association with aquaculture and fish translocations (Teimori et al., 2017; Jouladeh-Roudbar et al., 2020; Gholamifard and DeMilio, 2024). Such introductions may be of conservation concern in small, isolated wetlands where native species have limited opportunities to disperse. However, the presence of a non-native species alone does not demonstrate an adverse effect on a co-occurring native fish; evidence of population-level effects requires direct observations or appropriate ecological data.

This study provides a baseline assessment of fish fauna and ecological condition in four understudied wetlands—Hirm, Hood, Harm, and Karian—in the

Persis basin of southern Fars Province. The objectives were to (1) document fish species recorded during surveys, (2) distinguish native and non-native taxa, (3) describe the conservation relevance of the recorded fishes, and (4) identify major hydrological, habitat, and anthropogenic pressures that may explain fish diversity. In addition to field surveys conducted in 2017 and 2018, qualitative observations from 5 October 2026 provided supplementary information on habitat conditions and fish occurrence; however, they are not treated as a standardized population assessment.

Material and Methods

Study area

Fieldwork was conducted in four wetlands in Fars Province during 2017 and 2018. Hirm, Hood, Harm, and Karian were selected because these wetlands have received relatively little scientific attention and remain poorly studied. Supplementary qualitative observations were made on 5 October 2026 to update descriptions of habitat conditions and fish occurrence. These later observations were not part of a standardized, repeated sampling design.

Hirm Wetland is located in southern Fars Province at approximately 27°57′ N, 53°52′ E, about 60 km northeast of Lar city and adjacent to Hirm village (Figs. 1 and 2). The wetland covers an area of approximately 8,000 ha and is located in the southern Zagros Mountains (Joulaei and Ebrahimi Karnami, 2014). A permanent spring in the northern part of the wetland provides a relatively persistent aquatic habitat, whereas other areas receive seasonal runoff. Reed beds and shallow-water habitats occur around parts of the spring and along the wetland margins.

Hood Wetland is approximately 5 km from Hood village, west of Hirm Wetland. It is predominantly seasonal and fills following rainfall and surface runoff. Aquatic and wetland vegetation may develop during wetter years, whereas much of the wetland dries during the warm season (Fig. 3A).

Harm and Karian form a seasonal wetland system at approximately 28°13′ N, 53°30′ E (Fig. 3B). The system extends for approximately 30 km and has been estimated to cover about 10,000 ha (Joulaei and Ebrahimi Karnami, 2014). Surface runoff from the Ahmad-Mahmoudi highlands and the Harm drainage contributes to the system. Water availability depends strongly on precipitation; the wetlands may retain water for several months in relatively wet years but may dry extensively or completely during prolonged droughts (Joulaei and Ebrahimi Karnami, 2014; Gholamifard, 2018).

Field sampling and specimen identification

The original field surveys were conducted in 2017 and 2018. Fish were sampled using hand nets, and additional records were obtained through direct visual observations. Active searches were conducted in springs, reed margins, shallow pools, and channels connecting aquatic habitats. A limited number of fish specimens was collected under authorization from the Fars Provincial Department of Environment. Specimens were preserved, identified using published taxonomic references (Abdoli, 2016; Esmaeili and Teimori, 2016; Jouladeh-Roudbar et al., 2020) and other relevant literature, and deposited in the Lorestan University Zoological Museum (LUZM). Observations of amphibians and reptiles were also recorded.

At each wetland, habitat characteristics, hydrological conditions, aquatic and riparian vegetation, and visible anthropogenic disturbances were documented. Observations focused on water extraction, drought-related habitat contraction, agricultural activity, grazing, reed burning, visible signs of potential pollution, road and infrastructure development, and other habitat alterations. Salinity, other water-quality variables, and pollutant concentrations were not measured; therefore, field observations were not used to establish causal links between water quality and fish mortality.

During the supplementary visit on 5 October 2026, qualitative observations of fish occurrence and habitat use were made around the permanent spring, wetland margins, and reed-covered areas. Observations included the occurrence of *G. holbrooki* and *O. niloticus* and the locations where *A. stoliczkanus* was observed (Fig. 4). Because the visit did not follow a standardized quantitative protocol, observations were used only to describe conditions on that date and were not interpreted as estimates of abundance, population trends, competitive interactions, or causal effects of salinity.

Data analysis

Because this study was designed as a baseline field assessment and the number of collected specimens was limited, analyses were qualitative. Species were categorized by native or alien status, conservation relevance, habitat association, and occurrence among the four wetlands. Potential threats were distinguished from directly observed conditions. Non-detection during a survey was not treated as proof of absence, and the presence of a non-native fish was not considered, by itself, evidence of ecological impact.



Figure 1: Panoramic view of Hirm Wetland looking south (A) and Hirm Spring (Howba), a permanent water source for the wetland (B). Photographs by the first author, April 2017 (A) and August 2017 (B).



Figure 2: Satellite images of Hirm Wetland during summer, showing (A) the spring in the northern part of the wetland and the seasonal Hood Wetland to the west, and (B) the spring area on 5 October 2026. Image source: Google Earth (2018; panel A).

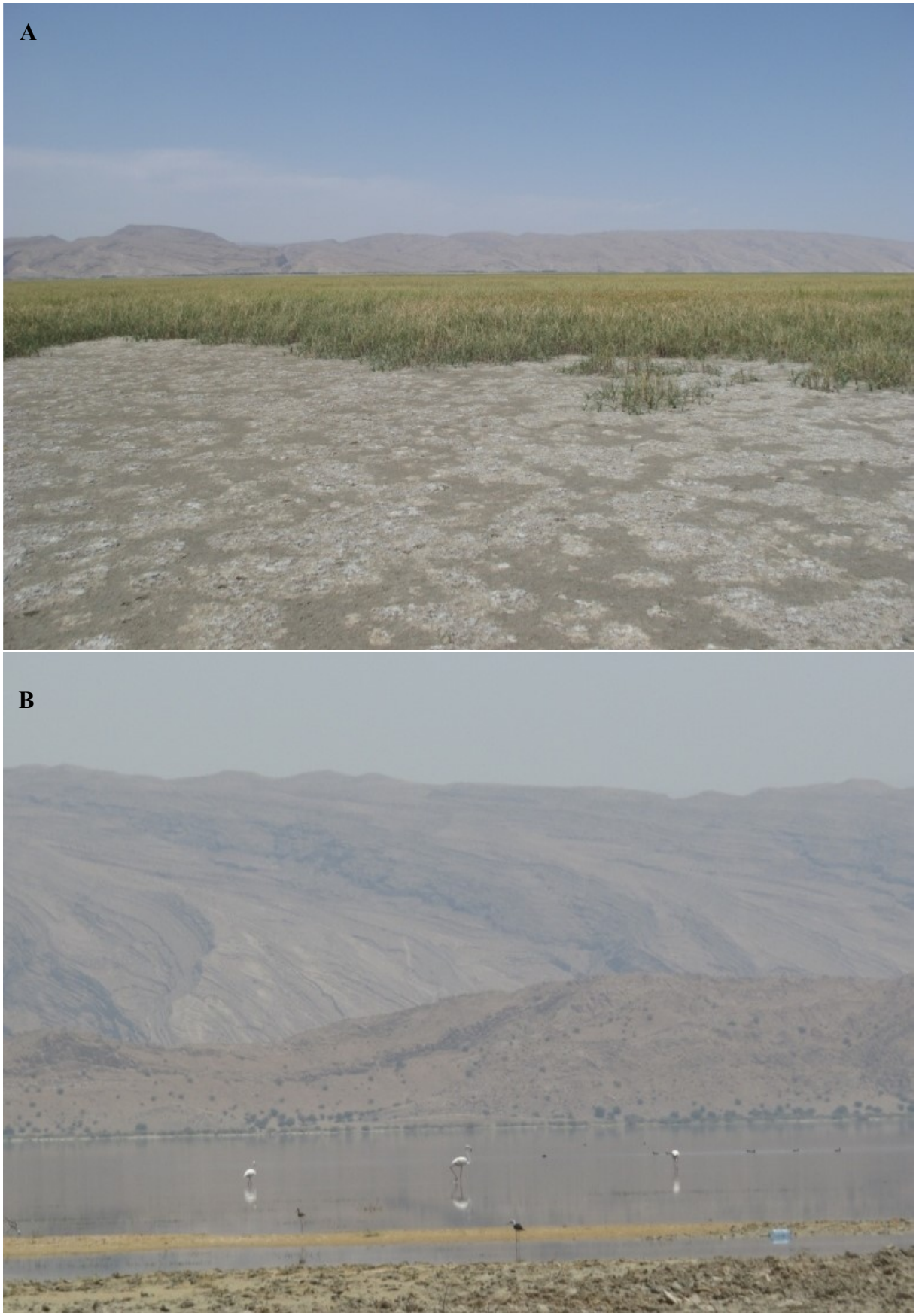


Figure 3: Moist substrate and vegetation in the seasonal Hood Wetland, viewed northward from the western part of Hirm Wetland during the dry season (A), and flamingos and other waterbirds at the seasonal Harm and Karian wetlands (B). Photographs by the first author, August 2017.

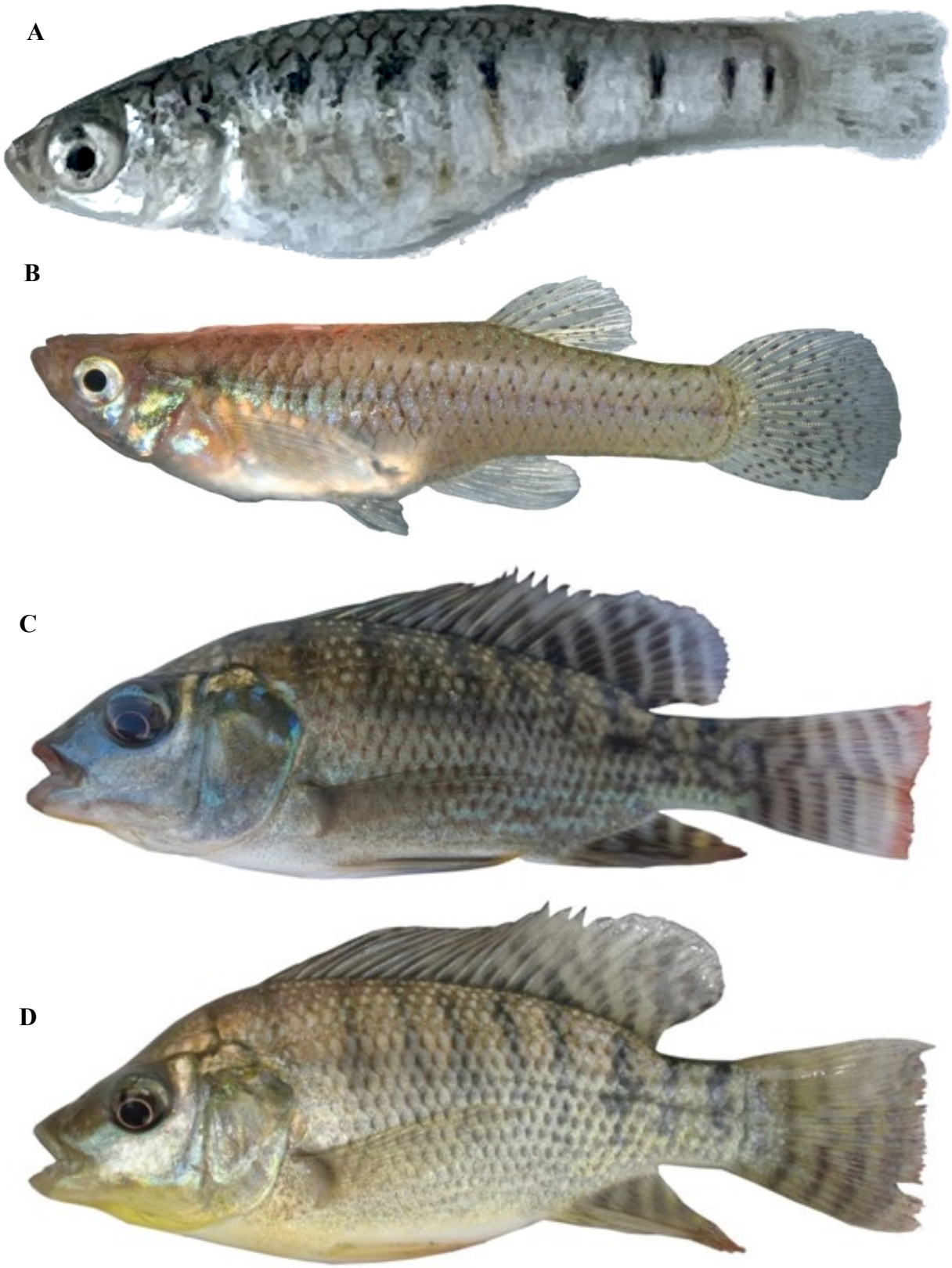


Figure 4: *Aphaniops stoliczkanus* (A), the alien *Gambusia holbrooki* (B), and male (C) and female (D) *Oreochromis niloticus*, an alien species, from Hirm Wetland, Peris basin. Photographs by the first author, August 2017 and October 2026 (A).

Results

Fish diversity

Three fish species were recorded at Hirm Wetland: *Aphaniops stoliczkanus* (Day, 1872) (Aphaniidae), *Gambusia holbrooki* Girard, 1859 (Poeciliidae), and *Oreochromis niloticus* (Linnaeus, 1758) (Cichlidae) (Fig. 4). *Aphaniops stoliczkanus* (Fig. 4A) was observed in shallow vegetated habitats associated with the Hirm spring (locally called Howba) and reed margins. *Gambusia holbrooki* (Fig. 4B) and *O. niloticus* (Fig. 4C-D), were observed mainly in the spring and in portions of Hirm Wetland and its margins where the water appeared less saline (Fig. 5). These habitat observations were not based on quantitative salinity or abundance measurements.

During the supplementary visit on 5 October 2026, fish were less conspicuous near the permanent spring. *Gambusia holbrooki* was observed more frequently than *O. niloticus* in the immediate spring area and the latter was observed in deeper, reed-covered habitat that could not be surveyed fully. *Aphaniops stoliczkanus* was observed farther away along wetland margins; *G. holbrooki* was not observed in those particular marginal areas during this visit. The endemic *Cyprinion tenuiradius* Heckel, 1847 was observed in water-transfer channels and surface flows adjacent to Harm and Karian (Fig. 6), but it was not recorded in the wetlands themselves. Therefore, this species is not included among the fish fauna documented from the four wetlands.

Drought and declining water availability were among the most evident pressures at Hirm Wetland (Fig. 7A-B). As water levels declined, available aquatic habitat contracted, and fish were concentrated in the remaining spring-fed and shallow-water areas (Fig. 7B). Some wetland margins appeared saline, and dead *O. niloticus* and *A. stoliczkanus* were observed along these margins, including during the supplementary visit in October 2026 (Fig. 7A, C). Salinity was not measured quantitatively, and the cause of mortality could not be established from field observations alone.

Additional anthropogenic pressures around Hirm Wetland included reed burning, livestock grazing, visible habitat disturbance, possible pollution, road and infrastructure development, and recreational activities around the spring (Fig. 7D). No quantitative pollution measurements were available, so the presence and ecological effects of specific chemical contaminants could not be determined.

Threats to Hood, Harm, and Karian wetlands

No fish or aquatic reptiles were recorded at Hood, Harm, and Karian during the surveys. Anthropogenic pressures were nevertheless documented in these wetlands, including land-use change, agricultural expansion, drainage and leveling, road construction, livestock grazing, water extraction, and degradation of wetland vegetation (Figs. 6–8). Agricultural activity was particularly evident around Harm and Karian. Artificial channels and physical disturbance were also observed in these areas (Figs. 6 and 7E, F).



Figure 5: Hirm spring in the Persis basin, southern Iran, showing populations of the alien fishes *Oreochromis niloticus* and *Gambusia holbrooki*. Photographs by the first author, September 2017.



Figure 6: South-facing view of a water-transfer channel excavated to supply agricultural wells from the Harm and Karian wetland system, showing the habitat of *Cyprinion tenuiradus* during the wet (A) and dry (B) seasons. Photographs by the first author, August 2017 (A) and April 2018 (B).



Figure 7: Extensive drying of Hirm Wetland and fish mortality under high-salinity conditions (A, B); biological and chemical pollution entering the wetland, associated with mortality of *Aphaniops stoliczkanus* (C); recreational swimming by members of local communities in the Hirm spring (D); and pollution, habitat degradation, and amphibian mortality associated with agricultural activities around the Harm and Karian wetland system (E, F). Photographs by the first author, August 2017.

Discussion

Fars Province supports a diverse freshwater fish fauna distributed among several distinct drainage systems, many of which have undergone substantial hydrological and anthropogenic change (Esmaeili et al., 2010, 2015, 2017; Gholamifard, 2021; Eagderi et al., 2022; Gholamifard and DeMilio, 2024; Sayyadzadeh and Esmaeili, 2024). The present study adds site-level observations from four relatively understudied wetlands in southern Fars Province: Hirm, Hood, Harm, and Karian. Esmaeili et al. (2015) reported 44 confirmed freshwater fish species from the Persis region, including 11 endemic and 10 alien species, providing a regional baseline against which localized wetland records can be considered. The regional river survey by Shatoei Gharenjeh et al. (2026) recorded 48 species in 16 families and 34 genera and found that total beta diversity and the richness-difference component were highest in Persis and lowest in Hormuz, whereas turnover made a

comparatively small contribution to total beta diversity. Their spatial analyses showed that total beta diversity and the richness-related (nestedness) component were highest in the western part of the study area, particularly in the Persis basin. Although species turnover, another component of beta diversity, also reached its highest values in the Persis basin, it contributed relatively little to total beta diversity overall. Thus, the overall spatial pattern of beta diversity was driven primarily by the richness-related component rather than by species replacement. These basin-scale patterns highlight spatial variation in fish-community composition at the basin scale, but they are not direct evidence of fish diversity within the four wetlands studied here because that survey sampled rivers rather than these wetlands.

Our observations are consistent with previous reports of wetland degradation in Fars Province. Drought, declining water availability, water extraction, and land-use change have contributed to the deterioration or drying of several major wetlands, with negative consequences for aquatic biodiversity (Joulaei and Ebrahimi Karnami, 2014; Gholamifard, 2018, 2021; Gholamifard and DeMilio, 2024). In the Cheshmeh Gomban wetlands, changes in hydrological conditions were identified as threats to fish biodiversity and habitat persistence (Gholamifard, 2021). Research in the Maharlu Lake basin likewise documented concerns associated with wetland drying and non-native fish farming (Gholamifard and DeMilio, 2024). The pressures observed at Hirm and the surrounding seasonal wetlands therefore reflect broader freshwater-conservation challenges in Fars Province.

Hirm was the only studied wetland where fish were recorded. This difference may primarily reflect hydrological persistence: its permanent spring likely provides a comparatively persistent aquatic refuge, whereas Hood, Harm, and Karian depend much more strongly on precipitation and seasonal surface runoff. Temporary wetlands can support diverse aquatic communities when inundated, but their ecological functioning depends on the duration, frequency, and timing of inundation (Williams, 2006). Prolonged drought or increased water extraction may shorten hydroperiods and reduce the time available for aquatic organisms to persist or reproduce. Because surveys were qualitative and detection probability was not estimated, however, the non-detection of fish at Hood, Harm, and Karian does not establish that these wetlands are permanently without fish. Seasonal drying or limited detectability may explain the lack of records, but these possibilities remain untested.

The record of the tooth-carp identified as *A. stoliczkanus* at Hirm is noteworthy because it was the only native fish species recorded in the wetland. Although *A. stoliczkanus* has a broad geographic distribution, its occurrence at Hirm documents its presence in a wetland subject to hydrological fluctuations and local habitat degradation. During the supplementary visit, the species was observed in remaining aquatic habitats, while parts of the wetland showed signs of drying and salinization. Maintaining the Hirm spring and its associated shallow-water and reed habitats is therefore a reasonable conservation priority. Further surveys across seasons and years are needed to confirm the identification and assess the local population status and the site's conservation significance. The co-occurrence of *A. stoliczkanus*, *G. holbrooki*, and *O. niloticus* raises a potential conservation concern. Non-native freshwater fishes can affect native communities through predation, competition for food and habitat, alteration of aquatic vegetation, and pathogen transmission (Cucherousset and Olden, 2011). *Gambusia holbrooki*, is well known for its broad ecological tolerance and ability to establish populations in modified aquatic habitats (Pyke, 2008). In Iran, it is a widespread non-native component of freshwater fish assemblages (Esmaeili et al., 2014). However, this study did not measure ecological interactions among the three species.

The occurrence of *O. niloticus* at Hirm Wetland deserves particular attention. *Oreochromis niloticus* is native to Africa and has been introduced into parts of Iran for aquaculture; tilapias can persist in suitable warm-water environments following intentional or accidental release (Jouladeh-Roudbar et al., 2020). Repeated observations may be consistent with establishment at Hirm, but this qualitative survey cannot determine population persistence, recruitment, or the introduction history of the species. Intentional stocking, accidental release, or other human-mediated introductions are plausible pathways, but none was verified in this study.

The occurrence of *O. niloticus* should be considered in the context of previous reports of non-native fish introductions in the Hirm–Hobaw system. Teimori et al. (2017) documented *Coptodon zillii* at Hobaw Spring, the water source feeding Hirm Wetland, and reported other non-native fishes, including *G. holbrooki*, *Carassius auratus*, *Cyprinus carpio*, and *Sander lucioperca*, from Hobaw Spring and Hirm Wetland. They also reported temporal changes in the fish assemblage of Hobaw Spring: *Aphaniops dispar* was abundant during earlier sampling occasions but was not observed or captured in later surveys, whereas *C. zillii* and *G. holbrooki* were abundant during the later sampling period (Teimori et al., 2017). These records indicate changes in the reported fish assemblage but do not establish local extinction of *A. dispar* or identify a single cause. They highlight the potential role of fish introductions and translocations in shaping the contemporary community. The historical non-detection of *A. dispar* in later surveys does not, by itself, establish local extinction or demonstrate that non-native fishes caused its apparent decline, but it is suggestive that there may be a link between the two.

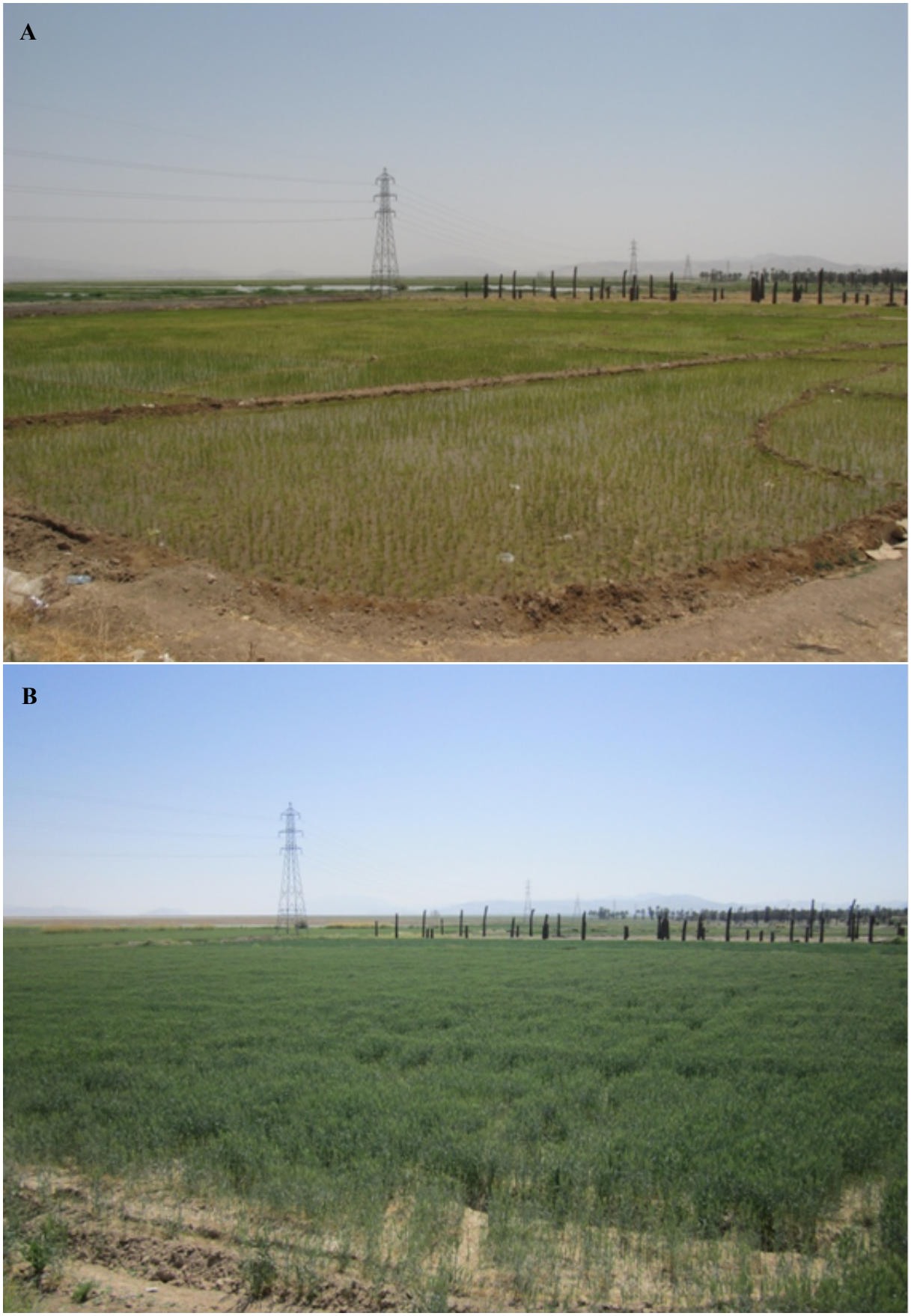


Figure 8: Rice (A) and wheat (B) cultivation along the southern margin of the seasonal Harm and Karian wetland system, using water from the wetland during the wet and dry seasons, respectively. Photographs by the first author, August 2017 (A) and April 2018 (B).

Potential pathways for the occurrence and establishment of non-native fishes in the Hirm–Hobaw system include intentional stocking, unauthorized or accidental release, transfer with commercially valuable fishes, and subsequent dispersal through hydrological connections among springs, wetlands, and associated water bodies. Teimori et al. (2017) suggested that *C. zillii* may have been accidentally transferred to Hobaw Spring together with commercially valuable fishes from other habitats. The presence of several non-native species in the Hirm–Hobaw system, together with the record of *O. niloticus* in the present study, is consistent with repeated human-mediated fish movements rather than a single introduction event. This interpretation remains hypothetical because introduction pathways and chronology have not been directly investigated.

The present study did not directly assess ecological interactions among *O. niloticus*, *G. holbrooki*, and *A. stoliczkanus*; therefore, ecological effects should not be inferred from co-occurrence alone. During the supplementary visit on 5 October 2026, *G. holbrooki* was observed mainly near the permanent spring, whereas the tooth-carp was observed farther away along the wetland margins, where *G. holbrooki* was not observed during that visit. *Oreochromis niloticus* was also observed in deeper, reed-covered habitat that could not be surveyed fully. These qualitative observations indicate spatial differences in fish detections on that date, but they do not demonstrate competition, habitat exclusion, or a causal effect of non-native fishes on the tooth-carp. Future research should examine abundance, reproduction, recruitment, diet, habitat use, and overlap, together with seasonal variation in population structure, to determine whether and how these species interact with one another and with native fish communities. Particular attention should also be given to the apparent decline or later non-detection of *A. dispar* reported by Teimori et al. (2017). Comparative surveys of Hobaw Spring and Hirm Wetland, supported by historical records and targeted monitoring, could help clarify introduction pathways, establishment, dispersal, and the potential ecological consequences of non-native fishes in this system.

The occurrence of *Cyprinion tenuiradius* in channels and surface flows adjacent to the Harm and Karian wetlands highlights the potential importance of hydrological connectivity. The species has been recorded from southern Iranian drainage systems, including the Dalaki, Qarah Aghaj, and Mond basins (Jouladeh-Roudbar et al., 2020). Although it was not detected within the wetlands during this study, its occurrence in adjacent flowing waters suggests that wetland–river connections may become relevant to aquatic communities when seasonal inundation creates temporary connections. Maintaining natural or semi-natural connectivity may therefore support aquatic-community resilience and organism movement during wet periods (Amezaga et al., 2002; Williams, 2006). However, the extent, timing, and frequency of such connections were not quantified, and movement of *C. tenuiradius* into the wetlands was not demonstrated.

The threats observed at Hirm, Hood, Harm, and Karian are consistent with broader pressures affecting wetlands in arid and semi-arid regions. Agricultural expansion and infrastructure development may alter drainage patterns or water availability and reduce connectivity among aquatic habitats. These effects may be particularly serious in small wetlands, where ecological conditions can change rapidly in response to shifts in water availability. Although saline-looking conditions and dead *O. niloticus* were observed along wetland margins, neither salinity nor other water-quality variables were measured. The cause of the observed fish mortality therefore remains unknown, and these observations identify a need for future monitoring of water chemistry, hydrology, and fish health.

The conservation value of these wetlands should not be assessed solely on the basis of the number of fish species detected during a survey. Seasonal wetlands may provide important ecological functions even when temporarily without fish, including habitat for aquatic invertebrates, amphibians, reptiles, migratory organisms, and terrestrial species associated with wetland vegetation (Gaston and Spicer, 2004; Williams, 2006; Convention on Wetlands, 2021). For some amphibian species, wetlands without fish may provide suitable breeding habitats because predatory fish can reduce the survival of amphibian larvae (Kats et al., 1988). Temporary hydrological connections may also contribute to regional biodiversity and facilitate dispersal during favorable periods.

At Hirm Wetland, conservation should prioritize maintaining the permanent spring and protecting the surrounding shallow-water and reed habitats from further degradation. Management should focus on maintaining adequate environmental water availability, controlling excessive extraction, reducing physical disturbance and potential sources of pollution, protecting spring and reed habitats, and preventing further intentional or accidental introductions of non-native fishes.

At Hood, Harm, and Karian, conservation should emphasize maintaining natural hydroperiods and wetland connectivity. Agricultural development, drainage, leveling, and excessive water extraction should be carefully managed because these activities may permanently alter the seasonal hydrology and water quality of these ecosystems. Long-term monitoring is needed to determine whether fish colonization occurs during exceptionally wet years and whether seasonal connections with adjacent streams permit native species to move among habitats.

Community participation will also be important. Livestock grazing, reed burning, water use, agricultural expansion, and recreational activities are influenced in part by local land-use practices. Conservation measures that account for local water use and livelihood requirements alongside wetland-protection needs are likely to be more sustainable than measures focused exclusively on individual species.

This study shows that small, understudied wetlands in southern Fars Province may retain conservation value despite substantial hydrological and anthropogenic pressures. Hirm Wetland is notable because it supports a tooth-carp identified here as *A. stoliczkanus* alongside alien fishes, whereas Hood, Harm, and Karian provide seasonal wetland habitats whose aquatic fauna may vary strongly with hydrological conditions. Surveys across wet and dry years, together with monitoring of fish populations, water quality, salinity, hydroperiod, and alien species are needed to provide a stronger basis for conservation planning in the Persis basin.

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Author contributions

A. G.: Conceptualization, methodology, field investigation, specimen collection, data curation, data analysis and interpretation, and writing—original draft. S. K.: Writing—review and editing, and project administration. Both authors reviewed and approved the final version of the manuscript.

Conflicts of interest

The authors declare that there are no conflicting issues related to this research article.

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