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Assessment of trophic status and dominant aquatic macrophyte in Hasanloo dam lake, West Azarbaijan, Iran

Masoud Seidgar

National Artemia Research Center, Iranian Fisheries Science Research Institute, Agricultural Research, Education and Extension Organization, Urmia, Iran
seidgar21007@yahoo.com

Fereydoon Mohebbi*

mohebbi44@gmail.com

Forest and Rangeland Department, West Azarbaijan Agricultural and Natural Resources Research and Education Center, Agricultural Research, Education and Extension Organization, Urmia, Iran

Zhaleh Alizadeh osaloo

National Artemia Research Center, Iranian Fisheries Science Research Institute, Agricultural Research, Education and Extension Organization, Urmia, Iran
alizadeh.zhaleh@yahoo.com

Abstract

Hasanloo Wetland is one of the natural landscapes of West Azerbaijan Province. It has been registered in the Ramsar Convention on the list of international wetlands. Hasanloo Dam has a high capacity for the excessive growth of nuisance aquatic plant species. Therefore, field collection of plant species and water from this lake was carried out to identify dominant species and determine the trophic status of the water. The results of this study showed the presence of five dominant plant species, including *Stuckenia pectinata*, *Potamogeton crispus*, *P. perfoliatus*, *Myriophyllum spicatum*, and *Najas marina*. Calculations based on Carlson's trophic index showed that the water of this lake is hypereutrophic. The cause of this problem can be attributed to agricultural runoff containing fertilizer and livestock waste. The results showed that the establishment and dominance of these plants in the lake were related not only to its high eutrophic status, but also to high electrical conductivity (EC), increased water temperature, and the transformation of the wetland into a dam lake due to water demand associated with climate change. It should be noted that all these factors have their roots in human interference in natural ecosystems. To eliminate these unwanted plants and control their populations, it is recommended to use combined control methods, including physical, mechanical, ecological, and chemical methods.

Keywords: Trophic status, Hasanloo Lake, dominant, aquatic plant, *Myriophyllum spicatum*

Introduction

Located twenty kilometers from the city of Naqdeh, Hasanloo wetland with an area of about 1,100 hectares, is one of the natural landscapes of West Azarbaijan Province, Iran ([Asalpishe & Manaf Far, 2017](#)). This lagoon is located west of the Mahabad-Urumiyah highway, which makes it easy to access. The lagoon, which has an altitude of 1308 meters above sea level ([Asalpishe & Manaf Far, 2017](#)), enjoys a very beautiful appearance and is a habitat for many birds throughout the year. The lagoon was initially very shallow,

*Corresponding author

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with salty water. The boiling springs, the runoff waters, the snowfall and rain also provide the water needs of the lagoon. The Hasanloo Lagoon (Shurgol) along with several other lagoons is on the list of international wetlands registered and protected by the Ramsar Convention (The Convention on Wetlands, 1975). Over time, in recent years, a dam has been built across the outlet of this lagoon, which has changed its condition. The construction of this dam has caused the Hasanloo lagoon to become deeper with fresher water. Now, this lagoon has become more of a lake behind the dam. The lake's ecosystem has also undergone significant changes, and new conditions have taken hold. The lush green pastures around the lake are also a local grazing ground for livestock in the region. The water from this dam is used to irrigate agricultural lands in the surrounding areas. The construction of the Hasanloo Dam, located on the border of the Gedar River and Lake Urmia, began outside the riverbed in 1996 and was put into operation in 2000. The maximum and regulation volume of the reservoir are 99 and 93 million cubic meters, respectively (Akbari & Mousavi, 2023). The Hasanloo Dam is supplied with water by diverting water from the Naqadeh diversion dam on the Gedar River and transferring water through the feeder canal with a capacity of 15 cubic meters per second. This dam was primarily constructed to store water from the Gedar River and to provide full water for 8,000 hectares of the Hasanloo highlands and supplementary water needed during the months of maximum consumption for 8,800 hectares of the Naqadeh plain (Akbari & Mousavi, 2023) (Figure 1). In Figure 1, the left and right-side images show the situation of Hasanloo lake with Urmia lake and the general view of the Hasanloo lake, respectively. The bidirectional relationship between plant species richness and community biomass is often variable and poorly resolved in natural grassland ecosystems, impeding progress in predicting impacts of environmental changes. Zhang et al. (2025) found that community biomass provides little predictive ability for community richness, consistent with previous findings. By contrast, the relative abundance of dominant species quantitatively predicts species richness, whereas their absolute abundance quantitatively predicts community biomass under both ambient and altered environmental conditions, as expected mathematically. Their model predicted community richness and biomass under ambient and anthropogenically altered conditions. Ohlert et al. (2025) studied the effects of removing dominant species on community composition, diversity, and aboveground net primary production (ANPP) over a 23-year period. Their results showed that dominant grasses suppressed both richness and abundance of subordinate species. These results have important implications for ecosystem management and conservation, highlighting the potential impact of losing dominant species on subordinate species and community dynamics. Studies have shown that biodiversity–ecosystem functioning (BEF) relationships are influenced by functional community structure through two mutually non-exclusive mechanisms: (1) the dominance effect (which relates to the traits of the dominant species); and (2) the niche partitioning effect [which relates to functional diversity (FD)]. Engel et al. (2023) evaluated dominance and niche partitioning effects simultaneously in grassland systems world-wide. Their analysis provides empirical evidence that plant functional community structure and global patterns in primary productivity are linked through the resource economics and size traits of the dominant species. This is an important test of the hypotheses underlying BEF relationships at the global scale. A study of the lake's water quality after its impoundment in 2002 showed that the lake had 24.6 million cubic meters of water in an area of 1,111 hectares with a depth of 0.8–3.3 meters (Babai et al., 2008). Re-evaluations in 2004 and 2005 showed that the higher depth has a direct effect on the quality of the lake water in terms of available salts, as well as an indirect effect on nutrient levels and biological activity. The levels of anions and cations showed a significant decrease after several years of water abstraction and the introduction of freshwater from the Gedar River (Babai et al., 2008). The alkalinity of the water, as well as the high levels of nitrogen and phosphorus, indicated the lake's high capacity for increased biological activity and higher production (Babai et al., 2008). Currently, the flourishing and excessive growth of aquatic plants has caused numerous problems, including reduced water quality, damage to local fishermen's motorboats, and damage to the tourist attractions of Hasanloo Dam. The present study was conducted with the aim of identifying nuisance aquatic plants and providing solutions for their control.

Materials and methods

Hasanloo Dam Lake is located in West Azarbaijan Province, between 37°02'–37°06' N, 45°44'–45°50' E. The situation of this lake relative to Lake Urmia is shown in Figure 1. On November 2, 2025, after visiting the Hasanloo Dam, visual inspections were conducted by boat through the dam lake, and samples of nuisance plants and water were collected for identification and analysis. The herbarium specimens of these plants were identified by flora references (Dinarvand, 2017; Davis, 1985) and deposited in the West Azarbaijan Agriculture and Natural Resources Education and Research Center's Herbarium (WESTA). Water samples were transferred to the Water Chemistry Laboratory (Urummyeh) to determine the amount of phosphorus and nitrogen. Total Nitrogen (TN) was measured by spectrophotometer using TNT Persulfate Digestion Method 10071 (Hach, 2024) and Total Phosphorus (TP) was measured by EPA Persulfate Digestion Method (HACH Method 8190, Hach, 2024). To measure the amounts of nitrate, ammonia, phosphate and nitrite, water samples were first fixed in situ with 98% sulfuric acid (Merck) and then they were transferred to the laboratory in ice freezers at a temperature of 3–4°C. The physical and chemical parameters of water that were measured at the sampling sites (Franson, 2005) included: Dissolved Oxygen (DO): by the membrane electrode method with Multi 3410 WTW multimeter, pH: by electrometry with portable pH meter model 340 i WTW, nitrate (NO_3^-): by ultraviolet spectrophotometry with T +80 spectrophotometer, nitrite (NO_2^-): by colorimetric method with spectrophotometer model + 80 T, phosphate (PO_4^{3-}): by tin chloride method with spectrophotometer model + 80 T, ammonia (NH_3): by Nessler method (Franson, 2005) with spectrophotometer + 80 T model, total suspended solids (TSS): by drying method at 103°C (Franson, 2005).



Figure 1. Location of Hasanloo Dam.

Results

In this study, 5 invasive species of aquatic plants were identified, whose scientific names, herbarium codes along with their growth forms are presented in Table 1. Totally, these five plants covered about 70% of the Hasanloo dam lake surface with long branches growing into the lake depth. Images of these plants are shown in Figure 2. The scientific names, life forms and herbarium codes of plant species are indicated in Table 1. The total nitrogen and phosphorus content of Hasanloo Dam water is also shown in Table 3.



Figure 2. Images of dominant plants identified from Hasanloo Dam: upper left, *Stuckenia pectinata*; upper center, *Potamogeton crispus*; upper right, *Myriophyllum spicatum*; lower left, *Potamogeton perfoliatus*; lower right, *Najas marina*.



Figure 3. Sampling campaign of aquatic plants from Hasanloo Dam Lake. The plant species in the right-hand image is *Potamogeton crispus*.

Table 1. Classification, life forms, and herbarium codes of nuisance plants identified in Hasanloo Dam.

No.	Species	Family	Order	Class	Life form	Herbarium code
1	<i>Potamogeton perfoliatus</i> L.	Potamogetonaceae	Alismatales	Liliopsida	Submerged	11115
2	<i>Myriophyllum spicatum</i> L.	Haloragaceae	Saxifragales	Magnoliopsida	Submerged	11117
3	<i>Potamogeton crispus</i> L.	Potamogetonaceae	Alismatales	Liliopsida	Submerged	11124
4	<i>Najas marina</i> L.	Hydrocharitaceae	Alismatales	Liliopsida	Submerged	11114
5	<i>Stuckenia pectinata</i> (L.) Börner (Syn.: <i>Potamogeton pectinatus</i> L.)	Potamogetonaceae	Alismatales	Liliopsida	Submerged	11116

Table 2. Some physical and chemical parameter levels in Hasanloo Dam water on November 2, 2025.

No.	Parameter	Sampling point 1	Sampling point 2	Sampling point 3
1	Water temperature (°C)	13.7	13.9	13.6
2	pH	8.5	8.6	8.7
3	DO (mg/L)	7.5	8.5	10.8
4	O ₂ (%)	84	75	120
5	N-NO ₃ ⁻ (mg/L)	3	1	3
6	NO ₃ ⁻ (mg/L)	10	4	12
7	N-NO ₂ ⁻ (mg/L)	0.008	0.001	0.004
8	NO ₂ ⁻ (mg/L)	0.04	0.02	0.01

According to the information in Table 5, the water of Hasanloo Dam on the sampling date (2nd of November 2025) was hypereutrophic in terms of trophic index. The trophic state of Hasanloo Wetland during 2017–2018 is shown in Table 4. In this previous study, two sampling points in the east and west of the wetland were selected. Sampling was performed seasonally. Trophic state and Carlson's trophic state index were calculated in this study. TSI was calculated according to the formula (Carlson, 1977) and is presented in Table 5. It was found that the water of Hasanloo Dam Lake was hypereutrophic.

Table 3. Results of sampling in Hasanloo Wetland in 2017–2018.

Parameter	Hasanloo (east) Spring 2018	Hasanloo (east) Winter 2018	Hasanloo (east) Autumn 2018	Hasanloo (east) Summer 2018	Hasanloo (west) Spring 2018	Hasanloo (west) Winter 2017	Hasanloo (west) Autumn 2017	Hasanloo (west) Summer 2017
Temperature (°C)	4/11	6/6	3/10	3/27	11	7/6	2/10	1/28
pH	14/7	37/7	9/7	9/8	15/7	42/7	8/7	23/9
EC (μS/cm)	575	558	602	693	553	562	601	694
Transparency (m)	1	1	9/0	35/0	2/1	2/1	1/1	1
TDS (mg/L)	386	258	297	443	372	261	295	444
TP (mg/L)	256/0	12/0	144/0	385/0	452/0	11/0	122/0	392/0
TN (mg/L)	45/3	751/0	674/0	61/2	297/3	778/0	743/0	71/2
TKN (mg/L)	732/2	26/0	25/0	6/0	576/2	26/0	26/0	7/0
DO (mg/L)	87/9	1/15	45/8	59/7	72/9	15	50/8	14/8
O ₂ (%)	9/102	1/145	2/91	118	9/101	3/144	92	1/120
N–NO ₂ (mg/L)	005/0	006/0	007/0	01/0	003/0	006/0	004/0	01/0
NO ₂ (mg/L)	016/0	021/0	023/0	03/0	009/0	019/0	013/0	03/0
N–NO ₃ (mg/L)	713/0	485/0	417/0	7/1	718/0	512/0	479/0	2/2
NO ₃ (mg/L)	157/3	15/2	84/1	52/7	179/3	26/2	12/2	74/9
N–NH ₃ (mg/L)	26/0	02/0	0	04/0	0	022/0	02/0	1/0
NH ₃ (mg/L)	312/0	025/0	0	05/0	0	027/0	024/0	12/0

Table 4. Trophic status of Hasanloo Wetland stations based on TP and Secchi disc depth in 2017–2018.

Parameter	Hasanloo (east) Spring 2018	Hasanloo (east) Winter 2018	Hasanloo (east) Autumn 2018	Hasanloo (east) Summer 2018	Hasanloo (west) Spring 2018	Hasanloo (west) Winter 2017	Hasanloo (west) Autumn 2017	Hasanloo (west) Summer 2017
TSI (TP)	11/84	18/73	8/75	99/89	3/92	9/71	42/73	25/90
Trophic status	Hypereutrophic	Hypereutrophic	Hypereutrophic	Hypereutrophic	Hypereutrophic	Hypereutrophic	Hypereutrophic	Hypereutrophic
TSI (SD)	60	60	5/61	1/75	37/57	37/57	6/58	60
Trophic status	Eutrophic	Eutrophic	Hypereutrophic	Hypereutrophic	Eutrophic	Eutrophic	Eutrophic	Eutrophic
TSI	72.06	66.6	68.65	82.54	74.8	64.6	66	75.1
Trophic status	Hypereutrophic	Hypereutrophic	Hypereutrophic	Hypereutrophic	Hypereutrophic	Hypereutrophic	Hypereutrophic	Hypereutrophic

Table 5. Trophic status of Hasanloo Lake on November 2, 2025.

Parameter	Sampling point 1	Sampling point 2	Sampling point 3
TP (mg/L)	0.13	0.132	0.212
TP (μg/L)	130	132	212
TSI (P)	74.37	74.52	81.44
Trophic status	Hypereutrophic	Hypereutrophic	Hypereutrophic

Discussion

Being eutrophic indicates an increase in the amount of one or more factors effective in photosynthesis such as light, carbon dioxide, or nutrients such as phosphorus in the water (Chislock et al., 2013). The hypereutrophication of the water of Hasanloo Lake can be attributed to the washing away of agricultural runoff containing fertilizer and waste from livestock grazing around the lake. This has led to an increase in the amount of phosphorus entering the lake. The high phosphorus acts like a fertilizer and causes excessive growth of dominant plants. Images of the excessive growth of these plants are presented in Figure 3. Comparing the data of the present study with that of Mohebbi (2019) indicates a significant increase in TN concentration in 2025. This is due to water level reduction and agricultural run-off water containing high levels of nitrogenous fertilizers flowing into the lake. Considering the conditions prevailing in the Hasanloo Dam and the constant influx of sewage and agricultural runoff, and the large presence of livestock around it, it can be



said that eutrophic conditions have dominated it throughout the years from 2017 to 2025 (Mohebbi, 2019). However, eutrophication cannot be considered the only factor in the occurrence of dominant aquatic plants in the dam. Factors other than phosphorus and nitrogen have affected the establishment and growth of these plants. By comparing the physical and chemical parameters of the dam water between two dates, 2017 and 2025, some of these parameters can be identified. One of them is the electrical conductivity (EC) of water, which was recorded at an average of 600 microsiemens/cm in the fall of 2017, while in 2025 this variable increased to an average of 930 microsiemens/cm. Zarkami et al. (2021) showed that the invasive plant water hyacinth (*Eichhornia crassipes* Mart.) has become dominant in some wetlands of Guilan not only due to high eutrophication, but also due to high electrical conductivity, changes in water flow velocity, turbidity, and bicarbonate. This finding is consistent with our study in terms of the effect of electrical conductivity on the dominance of aquatic plants in Hasanloo. However, it does not seem to agree with our study in terms of other factors. Another variable is water temperature, which in the fall of 2017 was 10.25 degrees Celsius, but in 2025 it increased to 13.7, which can play a major role in the establishment of invasive plants in the cold season. Other factors also show changes in these two time periods. One of these is TDS, which increased from 296 in 2017 to 462 in 2025. This can increase the turbidity of the water, which acts as a facilitator for the dominance of aquatic plant species. Also, the amount of dissolved oxygen has decreased slightly between these two periods. However, it seems that this is a consequence of the presence of aquatic plants in the dam rather than the cause of their occurrence. Rahel and Olden (2008) reviewed the effect of climate change on aquatic invasive plants. They found that climate change can impose adverse consequences on aquatic ecosystems such as higher water temperatures, altered stream flow patterns, increased salinization (EC) and increased needs for water storage. These findings are consistent with our study, which indicated increased water temperature and higher EC values. (Hellman et al., 2008) has encouraged the dominant plant species overgrowth. Establishment of aquatic plants mainly entered by fishing facilities and facilitating the spread of plants during floods was mentioned by Lawler (2009) which is in accordance in our study in which expanding fish-culture facilities in Hasanloo dam entered the new species into its water. Climate change influence riverside vegetation in some different manner, but with the same consequences (reduced species diversity). This was indicated by Mohebbi (2025) who studied the effects of river dredging on riverside vegetation diversity. Eliminating cold temperatures in winter hypoxia (Rahel & Olden, 2008), due to climate change acted as a facilitator for invasive species survival in Hasanloo wetland that acted as a center for dominant plants in the region. Kernan (2015) studied the consequences of human impact on aquatic ecosystems. He declared that multiple stresses impact aquatic ecosystems globally and adversely affect physical, chemical and ecological water status and changing in species composition and biodiversity. This study is consistent with our study in that five plant species dominated Hasanloo wetland as invasive species and influenced water properties. Hasanloo wetland has been converted to a dam (Mohebbi & Zarehzadeh, 2024). This has resulted in new physical, chemical and ecological conditions that dominated the ecosystem. Furthermore, they attributed the invasive plant species to the eutrophy of the water due to agricultural runoff waters and livestock waste material entering the water (Mohebbi & Zarehzadeh, 2024). This study is consistent with our study in that it links the nuisance plants to eutrophy. However, our study indicated that other factors in addition to eutrophy influence plant dominance in the dam. These included increased water temperature, EC, TDS, expansion of the wetland into a dam lake, and changes in water flow, all of which are anthropogenic. Mirzajani et al. (۲۰۲۰) studied the water hyacinth (*Eichhornia crassipes* Mart.) in Anzali lagoon between 2015 and 2018. They concluded that high water temperatures and salinity are two main drivers of this plant invasion which is in accordance with our study. This plant was present annually even at latitudes much higher than northern Iran, such as the upper reaches of the Illinois River; although it did not occur at high densities, it can pose acute risks and the seeds did not germinate. The failure of the seeds to germinate has been interpreted as being due to inappropriate environmental conditions (humidity, depth, and temperature) and their non-viability as being due to late production (prematurity) (VonBank et al., 2018). Laboratory studies by VonBank et al. (2018) showed the vigor of the hyacinth plant in the upper reaches of the Illinois River and, accordingly, warned that if current climate change continues, conditions for plant growth and development will become more favorable. Deslippe and Veenendaal (2025) synthesized how climate change influences plant invasions across ecological scales. Climate change interacts with invasive species traits—such as high genetic and phenotypic plasticity, rapid reproduction, and generalist interactions—to facilitate invader transport, establishment, and spread, enabling them to outcompete native plants. Together, climate change and plant invasions destabilize ecological networks, reduce biodiversity, and trigger cascading effects on socio-ecological systems. Addressing these challenges requires inclusive, integrative approaches that prioritize emission reductions, biosecurity, conservation, and ecological restoration. Tokasi et al. (2018) evaluated the risk of two invasive aquatic plants *Eichhornia crassipes* and *Ambrosia psilostachya* in Guilan province (north of Iran). They concluded that both posed a high risk to aquatic ecosystems and their expansion should be prevented. West Azerbaijan Province is considered one of the important landscapes of the country in terms of its water resources, which are suitable for aquaculture. In this province, 10 lakes behind dams and several dams and reservoirs are used for fishing. In this regard, thousands of fishing families are engaged in fishing in these water resources. Hasanloo Dam Lake is one of the important water resources of West Azerbaijan Province, where nearly 80 tons of fish are caught annually. This includes the Sarin Soolar Fishing Cooperative, which consists of 30 families and generates a steady income from this place during about 8.5 months a year. Any factor that threatens aquatic life, including dominant aquatic plants, can also have a significant economic impact. The results obtained from the collected data indicate that the water level in Hasanloo Dam is high and invasive plant species are growing in it. The lack of control of these aquatic species has negative effects on aquatic ecosystems, as they prevent oxygen from reaching fish and other aquatic life, cause the blockage of waterways, and pose a serious threat to native plant species that act as food and habitat for fish and aquatic life (Clayton, 1996). Dominant plant species also create breeding grounds for mosquitoes and increase the risk of diseases such as viral diseases. They can even affect the sex composition of fish eggs by shading them and reducing the temperature of the eggs. In general, the natural system of the aquatic ecosystem and its ecological balance will be disrupted by the growth of invasive plants; therefore, measures must be taken to prevent and control these aquatic species. The first strategy to combat these dominant species is prevention. For this purpose, it is recommended to prevent the entry of sewage and agricultural runoff into the dam and to prevent the water from rising. In addition, integrated management should be implemented to control invasive plants. To control invasive plants, physical, mechanical, biological and chemical control methods can be used. Physical methods include the physical manipulation of the habitat

through methods such as hand pulling, aeration, etc. Mechanical removal is costly and does not eliminate the plants. This method also causes the disappearance of native plants in the ecosystem. Another disadvantage of this method is the spread of invasive plants by leaving plant fragments that later invade other parts of the water body. In the biological method, a living organism is usually added to the environment to control the population of the target plant. Biological methods can be used after considering the target plant, habitat, and management objectives. Aquatic herbicides, including chemical and mechanical methods, are effective, efficient, and common for controlling invasive aquatic plants. Unlike other methods, herbicides can be used both pointwise and broadly (DiTomaso et al., 2013). Aquatic invasive plants have different forms and are controlled by different methods. Among the important forms of aquatic species, we can mention submerged, floating, and emerging forms, each of which has a different method of reproduction (Dinarvand et al., 2022); some are propagated by transferring seeds from one point to another, and some are propagated by cuttings, in which a piece of the cut plant becomes a complete plant. Submerged plants have roots below the water surface, with some parts of them emerging above the water surface. Since many of these plants reproduce by cuttings, they are often eliminated by root-cutting herbicides. The invasive weed introduced in the present study from the Hasanloo Dam is the water-striped watercress (*Stuckenia pectinata*). Physical, biological, and chemical management strategies are used to combat this weed. One of the dangers of chemical control methods or the use of herbicides is the potential for oxygen depletion, which results from the decomposition of dead plant material and can cause fish kills (DiTomaso et al., 2013). The fringed watercress (*Potamogeton perfoliatus*) is another invasive species that was collected and identified from Hasanloo Dam. Cutting back the watercress (*P. perfoliatus*) in the spring will be able to control it to some extent in the coming seasons. However, the most effective control method is the use of low doses of endothal in the spring (McComas et al., 2015). It is important to note that the lack of continuous and long-term treatment of the plant will result in a reduction in plant density (McComas et al., 2015). The lack of control of this invasive plant and its resulting natural death in mid-summer leads to the release of high levels of phosphorus into the water (James et al., 2002) and leads to increased trophic status of the water.

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