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Biological Invasions
Research Article

Aquatic Invasive Alien Species in Lake Ohrid: Horizon Scanning and Assessment with Aquatic Species Invasiveness Screening Kit

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Abstract: The study comprises the horizon scanning of the aquatic invasive and alien species (IAS) in the region of Lake Ohrid as a risk assessment area (RA). It included three already established species and their possibility of further spreading (*Elodea canadensis, Physella acuta* and *Lepomis gibbosus*) and three IAS present in the surroundings but not yet detected in the region of Lake Ohrid (*Eichornia crassipes*, *Corbicula fluminea* and *Dikerogammarus villosus*). The selection of the potential IAS for assessment has been done based on the following three criteria: an elevated level of invasiveness and impact on a global scale, presence in the geographical proximity (horizon countries) and climate similarity between the horizon area and the RA area. The latest available data point out the positive trend in the distribution of the established species, which, in the last 60 years since its introduction (such as *E. canadensis*), have increased their distribution along the whole littoral zone of the lake and coastal waters. With the application of Aquatic Species Invasiveness Screening Kit (AS-ISK), all the six species were assessed and their scores of invasiveness were calculated. The results from the screening indicate a high level of invasiveness and impact for all six species, whereby, the highest expected is the impact on the native biodiversity of the RA area. The fact that biodiversity, enhanced endemism and relic species give the Lake Ohrid a status of increased scientific importance, uniqueness and peculiarity, enacting management and eradication measures towards protection from the IAS is more than appealing and urgent.

Key words: invasive species, Lake Ohrid, AS-ISK, impact

Introduction

The Global Assessment of the Intergovernmental Science – Policy Platform on Biodiversity and Ecosystem Services in 2019 identified invasive alien species (IAS) as those introduced by humans and otherwise into regions beyond their natural distributions. According to Seebens et al. (2017), the IAS are one of the five top direct drivers of biodiversity loss. Despite there being some cases where the impact of the IAS is neutralised through positive adaptations of the introduction, IAS are regarded as a hard threat to local ecosystems, wildlife, human health and overall wellbeing. Once

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established, according to Booy et al. (2020), the eradication measures to be undertaken are always too expensive and may raise public health and ethical concerns due to the possible effects of the measures on the environment and human livelihoods (e.g., usage of chemical control or biocontrol agents for eradication purposes).

The issue of IAS in the last few decades come to be a world problem and it has been spread throughout the Globe. Regardless of their development, all countries in the world have been affected by the IAS somehow. North Macedonia is not an exception (Trajanovski et al. 2020). Moreover, it is especially worrisome when the IAS are detected in or near protected areas that are characterised by endemic or endangered species they are safeguarding. Lake Ohrid, for instance, is a superlative natural phenomenon, providing refuge for numerous endemic and relict freshwater species of flora and fauna dating from the tertiary period (Albrecht et al. 2014). As a deep and ancient lake of tectonic origin, Lake Ohrid has existed continuously for around two and a half million years. Its oligotrophic waters conserve over two hundred endemic species of plants and animals, including algae, turbellarians, snails, crustaceans and 17 endemic species of fish, including two species of trout, as well as a rich birdlife (Albrecht & Wilke 2008). According to the same authors, this makes Lake Ohrid a freshwater ecosystem with the highest number of endemic species per unit squared. This uniqueness and richness of the flora and fauna, especially with endemic and relict forms, which have an almost uniform distribution throughout the lake ecosystem was one of the reasons why the region has been proclaimed a site of mixed natural and cultural values inscribed on the list of UNESCO in 1979/1980, and in 2019 the Albanian side has been included (Natural and Cultural Heritage of the Ohrid region 2022). Likewise, the area is included in the Transboundary Biosphere Reserve Ohrid-Prespa, established in 2014 (Ohrid-Prespa Transboundary Biosphere Reserve, Albania/ North Macedonia 2022). This additionally raises the importance of integral and long-term protection through cross-border conservation which is an essential step that should be undertaken in all regards, including the issue of IAS.

The importance of the IAS issue has been also stressed by the Reactive Monitoring Mission of UNESCO (Decision of the Committee for the worlds heritage of UNESCO 41-COM 7B.34) in their report on the state of the natural and cultural heritage of the Ohrid region for 2020. It emphasised the problem with "invasive non-native species" as a serious problem that requires a systematic approach to monitoring and undertaking measures for controlling and mitigating the consequences of the possible presence of invasive species in the lake.

However, within the national framework, IAS extent and impact have not been extensively studied, especially not in the region of the Lake Ohrid. There are a few exceptions of implemented projects, which provide some information on the state of the IAS in the region. Likewise, there is a lack of legislation regarding the IAS on a national level and a lack of implementation of the existing laws, which would mitigate the possible negative effects of the IAS in the region or their introduction (Piria et al. 2021).

This study comprises findings obtained during the implementation of the Project: "Follow up measures and activities towards effective invasive and non-native species management in the Natural and Cultural Heritage of the Ohrid Region", which has been financed by UNESCO and is dealing with the current IAS detected in the Lake Ohrid. An important task of the project was to undertake horizon scanning of possible IAS that have been detected in the neighbouring countries and may occur in the Lake Ohrid region. Furthermore, it the frames of the project, we analysed the pathways and vectors of introduction of IAS to the Lake Ohrid area as a Risk Assessment (RA) area and provided conclusions and recommendations for measures that would decrease the risk of introduction.

Materials and Methods

The information on the IAS, which are present in the region of the Lake Ohrid, has been collected based on literature data and published papers on records of the alien species in the area. Most of the results included in the analysis of this study were generated within the implementation of the research in the project for IAS funded by UNESCO from the 2018-2019 Participation Programme. This project yielded valuable outputs, significantly contributing towards the foundations of comprehensive and long-term planning of activities involving all stakeholders relevant to the successful management of IAS. In this project, all the IAS data from all previous research were combined and synthesised for the first time. A cross-section of the situation with the current IAS and their distribution as well as the threats associated with them was developed.

The potential invaders were selected based on the literature data about their presence in neighbouring countries and their biological and

ecological ability to establish in the region of Lake Ohrid due to favourable environmental conditions, climate aspects, etc.

Horizon scanning has historically included extensive literature reviews to ascertain species of concern and (not always) some form of risk assessment. However, the importance of risk assessment tools is increasingly recognised as a component of approaches to identify potential IAS not already present within a region (Essl et al. 2016). Risk assessment tools based on a specified set of criteria have been developed for several countries. Many of these are used to prioritise alien species already present according to their impact (Randall et al. 2008). In addition, their potential for identifying future IAS (not yet present) is also recognized (Roy et al. 2014, Peyton et al. 2020).

A way to predict and prevent the introduction of IAS is to study the invasiveness records of these species in different areas, especially in neighbouring areas. In this context, it is pivotal to assess their risk of entering new environments and not limiting surveys and monitoring efforts to specified geographical or national borders. However, in general, the first step for defining the risk level of an invasion of a species is to perform a risk assessment of the invaders. A risk assessment is generally carried out to (a) evaluate the likelihood of the introduction of invasive species in natural ecosystems, (b) gain insights into the main pathways and conveyances prior to the establishment to guide decisions on prevention measures, and (c) support decision-making concerning allocation of resources for monitoring, control and/or eradication of established populations, including common actions between countries to mitigate impacts on the environment or human health. This has been done regarding the potential invaders of the Lake Ohrid region with the application of the Aquatic Species Invasiveness Screening Kit (AS-ISK). This approach was used in our study that aimed to identify potentially invasive, non-native aquatic species. It is based on Excel® using Visual Basic for Applications® (VBA) code from the original Weed Risk Assessment (WRA) toolkit (Pheloung et al. 1999). The AS-ISK tool is composed of forty-nine questions that examine the impact of an alien species from a biogeographical, biological and economic point of view. The combination of these three types of impact produces a Basic Risk Assessment (BRA) score. Further six questions ask the user to define the Climate Change Assessment (CCA) of the species, describing the potential effects of future climate change on the risk of the species' introduction, establishment, dispersal and socio-economic impacts. Moreover, for each question, a brief guide with an explanation of its aim is provided. The final BRA and BRA + CCA scores vary from −20 to 68 and from −32 to 80, respectively, and the combination of the BRA with the CCA scores gives the species the final level of invasiveness. AS-ISK scores higher than one indicate an IAS that may have a medium or elevated risk of invasiveness. On the contrary, species with scores lower than one are not considered to be invasive in the RA (Risk Assessment area). The boundaries between a medium and prominent level of invasiveness depend on the threshold value that is used. When using a small dataset, it is possible to borrow these values from other studies. In our case, we have used the values as proposed by Vilizzi et al. (2021).

Results

The study comprises the horizon scanning of the aquatic IAS in the region of Lake Ohrid, including three already established species and their possibility of further development and three IAS present in the surroundings but not yet detected in the region of Lake Ohrid. Each of the established IAS belongs to a different systematic group: fish – *Lepomis gibbosus* Linnaeus, 1758, macroinvertebrate – *Physella acuta* Draparnaud, 1805 and macrophyte – *Elodea canadensis* Michx. The assessment has been undertaken to check the possibility of their further spreading under the present conditions, i.e., without any applied measures for their management and eradication. To assess the possibility of the IAS present in the region entering the RA area, three other IAS have been considered, also representing different systematic groups: amphipod – *Dikerogammarus villosus* Sowinsky, 1894 (killer shrimp), bivalve – *Corbicula fluminea* O. F. Müller, 1774 (Asian clam), and the macrophyte – *Eichornia crassipes* Mart. (water hyacinth). The selection of the potential IAS for assessment has been done based on the following three criteria:

- Elevated level of invasiveness and impact (global scale).
- Presence in the geographical proximity.
- Climate similarity between the area of their presence (horizon countries) and the RA area.

Table 1 depicts the status of the established species in Lake Ohrid and its coastal waters. Based on the data available, all three established species (Trajanovski et al. 2013, 2015, 2019, Trajanovski 2020) are on the National List of Invasive and Non-native Species of North Macedonia (National

Table 1. Established invasive alien species in Lake Ohrid area

Group, species name	Common name	Distribution in RA	First record	Pathways and vectors	Trend	Impact assessment in RA		
						B	H	E
Macrophytes								
Elodea canadensis Michx., 1803	Canadian pondweed	Y	1957	Ornamental trade	Positive	NA	NA	NA
Gastropods								
Physella acuta Draparnaud, 1805	Bladder snail	Y	2009	Ornamental trade	Positive	NA	NA	NA
Fish								
Lepomis gibbosus L., 1758	Pumpkin seed	Y	~1990	Stocking material	Positive	NA	NA	NA

Biodiversity Strategy with Action Plan 2018).

Elodea canadensis is the earliest introduced non-native species in Lake Ohrid. It has been introduced in 1957, either during the ornamental plant trading or with the fish stocking material (Kostoski et al. 2010). The latest available data (Trajanovski et al. 2019, Trajanovski 2020) point out the positive trend in the distribution of this species, which, in the last 60 years since its introduction, has increased its distribution along the whole littoral zone of the lake and coastal waters (Trajnovski 2022, unpublished).

Physella acuta is an invasive snail that was recorded in Lake Ohrid for the first time in 2009. The possible pathways and vectors include an aquarium and ornamental plant trade (Albrecht et al. 2009). Since its introduction, this species, similarly to *E. Canadensis*, has spread from the initial two localities to eight, mostly in the northern part of Lake Ohrid and its tributaries (Trajanovski 2020).

Lepomis gibbosus has been introduced in the second half of the 1990s, probably with the fish stocking material (Spirkovski et al. 2017). Although there are no precise data for its distribution, based on the latest findings (Spirkovski, personal communication), it has become a regular part of fish catch, especially in the northern part of the lake.

As for the horizon species, none of them is on the national list of invasive and non-native species of North Macedonia (Table 2). *Eichornia crassipes* is both in List of Invasive Alien Species of Union concern (2020) and the IUCN List of 100 Most Invasive Species (Luque et al. 2014). This species has not been yet registered in any of the horizon countries (Albania, Bulgaria, Greece and Serbia). Italy is the closest country to the RA where this species started spreading intensely in the last few decades, being proclaimed as local invasive species due to its limited distribution in some places in Sicily and Sardinia only (Celesti-Grapow et al. 2009). The local impact of this species in Italy has not been performed yet but globally it has been found that due to its intensive reproduction and growing up to 60 kg/m^2 wet weight (Julien & Orapa 1999) can cause a high impact on the local biodiversity (Babu 2003, Wilson et al. 2005), economy (Center et al. 2005) and humans (National Geographic 2004). The main pathway for the introduction of this invasive plant includes horticultural suppliers for ornamental gardens or aquaria in both Italy and Europe (Brunel 2010)

The Asian clam is not present only in Albania out of the four horizon countries. Earliest, it has been registered in Serbia, in 1998, in the Danube River (Paunovic et al. 2005). In Bulgaria, the species has been registered in 2001 in the Danube River, at three localities (Kenderov 2009). In Greece, the first record was in 2018 (Karaouzas et al. 2020) in the river Erythropotamos. The negative impact of this species in the horizon countries is not assessed yet but it is well known that the species spreading has been either with the ballast water or passively with the water currents (Karaouzas et al. 2020). The general impact of the Asian clam is well known and it is high on the aquatic biodiversity and the economy and high on human health (Sousa et al. 2008a, 2008b).

The first records of *Dikerogammarus villosus* in Serbia date from 2001 where it has become the dominant amphipod along the Danube River (Zoric et al. 2020). In Bulgaria, the species has been first recorded in 2011, and then again in 2016 in a reservoir 30 km far from the Danube River (www.esenias.org). The spread of *D. villosus* in the Danube River occurred by active movement and drift or because of ship transport (Paunovic et al. 2015). No impact assessment in the horizon countries has been done so far. However, in all the European aquatic

Table 2. Potential invasive alien species for Lake Ohrid area

Group, species name	Common name	Distribution in RA	Distribution in neighbouring countries/Year of introduction				Pathways and vectors	Impact assessment		
			AL	BG	GR	SRB		Biod.	Hum.	Econ.
Macrophytes										
Eichornia crassipes (Marts.) Solms	Common water hyacinth	N	N	N	N	N	Ornamental trade	High	Med.	High
Bivalves										
Corbicula fluminea Muller, 1774	Asian clamp	N	N	Y/2001	Y/2018	Y/1998	Ballast water	High	Med.	High
Amphipods										
Dikerogammarus villosus Sowinsky, 1894	Killer shrimp	N	N	Y/2001	N	Y/2001	Migration / vessels	High	Low	Low

Table 3. AS-ISK assessment of established and potential invasive alien species in Lake Ohrid area

Species	Sector affected			Score partitions			Level of risk		Thresholds		Risk	
	Commercial	Environment	Species traits	Biogeographical / Historical	Biological / Ecological	Climate change	BRA	BRA + CCA	BRA	BRA + CCA	BRA	BRA + CCA
Elodea canadensis	21	12	25	27	21	10	43	53	24.5	12.5	High	High
Eichornia crassipes	20	12	31	23	24	12	47	59	24.5	12.5	High	High
Physella acuta	17	17	41	13	36	10	50	60	13.25	25.75	High	High
Corbicula fluminea	12	17	31	15	29	12	44	56	13.25	25.75	High	High
Dikerogammarus villosus	16	17	28	19	26	12	45	47	13.25	25.75	High	High
Lepomis gibbosus	21	17	28	24	19	10	51	61	114.7	17.7	High	High

systems where it has become established, *D. villosus* has replaced both indigenous and exotic amphipod species (Kelleher et al. 1999, Dick & Platvoet 2000, Whitfield 2000, Dick et al. 2002, Kley & Maier 2003), thus affecting the native biodiversity. Less is known about its impact on human health and the economy.

Thus, six species have been the subject of assessment to check the trend in the future distribution of the already established invasive species and to find the probability or invasive potential of three horizon species to get introduced and established in the RA. Pretty equivalent results for the assessed alien species were obtained using the BRA + CCA (Fig. 1). The scores varied in the range from 41 to 61. Thus, according to the BRA and BRA+CCA thresholds for the freshwater species (Vilizzi et al. 2021), all six species have been assessed as species with high invasiveness potential.

The highest BRA and BRA+CCA score has been recorded for *L. gibbosus* and *P. acuta,* both already established in Lake Ohrid. This points us to the conclusion that these two species will successfully continue their invasion of RA under the current conditions without any IAS management measures. Lower are the scores for the other species but, however, as mentioned, they are all far above the invasiveness thresholds for the freshwater species. Out of the horizon species, *C. fluminea* has the highest invasive potential based on the BRA and BRA+BCC scores. As shown in the Fig. 1, the cumulative BRA+BCC score is highest for *E. crassipes*, although it is higher at all species for 10-12 scores, indicating that climate change will have a positive influence and will further emphasise the species' invasiveness.

Table 3 depicts the detailed analysis of the sector affected, score partition and the level of risk, given as BRA and BRA+CCA scoring. Regarding the commercial impact, the least score is obtained for *C. fluminea*, while the other scores vary within the values from sixteen for *D. villosus* to twenty-

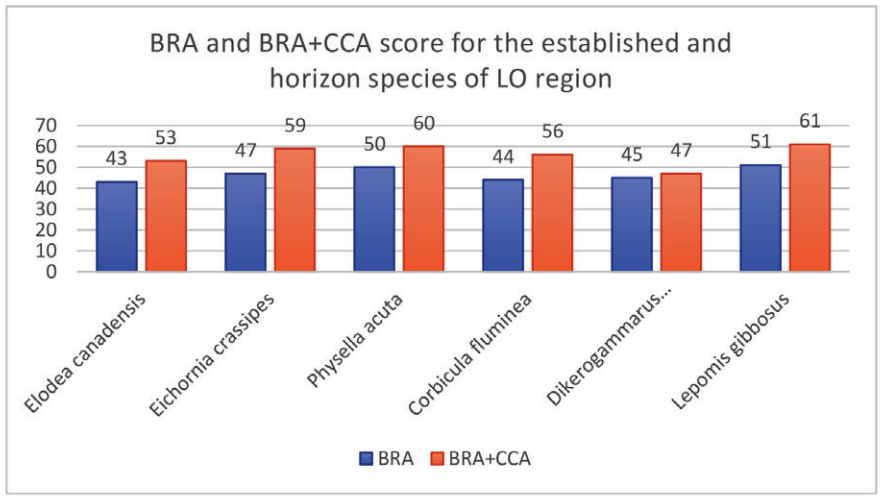

Fig. 1. Aquatic Species Invasiveness Screening Kit (AS-ISK) assessment of Lake Ohrid using Basic Risk Assessment (BRA) and Climate Change Assessment (CCA) scores for the established and horizon species.

one for *E. canadensis* and *L. gibbosus*. As for the environmental impact, the species are grouped into two groups: species with lower impact (12 scores) and species with higher impact (score 17). The highest is the impact on the species' diversity, whereby three species are scored with the same value 31 (*E. crassipes*, *P. acuta* and *C. fluminea*). The lower is the impact of the *D. villosus* and *L. gibbosus*, while the lowest expected impact on the native species will have *E. canadensis* with a score of 15.

As for the score partition values, the higher are scores for Biology/Ecology than the scores for Biogeography/Historical. The highest score for the Biology/Ecology partition is obtained for *P. acuta*. The climate change score is similar for all assessed species, and it is in the boundaries from 10 to 12, indicating that climate change will doubtfully contribute towards increasing the species' invasiveness.

As shown in Table 3, the threshold values are quite lower than the obtained values indicating the high invasiveness of all species, as stated in the last column of the table.

Discussion

Invasive species have a particularly negative impact on freshwater ecosystems. Due to the nature of their habitat (surrounded by land), their native biota is characterised by high rates of endemism. As a result, freshwater biodiversity is particularly threatened by anthropogenic impacts like habitat alteration, pollution and overexploitation of the water resource. In this situation, intentionally or accidentally introducing non-native species can fill several vacant niches and accelerate the biological homogenization of these ecosystems (Paganelli 2021).

The identification of horizon species using a risk screening tool is a parsimonious undertaking (Parrott et al. 2009, Gallardo et al. 2016, Bayón & Vilà 2019) that is best achieved through a formal horizon scanning exercise (Roy et al. 2018). The results obtained by the application of AS-ISK as a tool for environmental risk assessment have clearly shown that all six assessed species have been characterised by high invasiveness, which makes their introduction, establishment and spreading highly probable to Lake Ohrid and its coastal waters.

Out of the group of established species in the RA, two species have been scored with the highest BRA and BRA+CCA scores. These are *L. gibbosus*, which is enlisted in the species of EU concern, and *Physella acuta*, an invasive species from the National List of IAS. Although the score for *Elodea canadensis* in the RA is lower, it still points to the high invasiveness of this species. All three species have increased their distribution range, whereby, the earliest introduced *Elodea canadensis*, yet in low abundance, have managed to occupy the whole littoral (Imeri et al. 2013) and reach the south part of the lake, including the springs St. Naum (Trajanovski 2022, unpublished data). All three species are present in the northern part of the lake and along the tributaries, whereby their highest abundance is recorded in highly altered habitats, either in tributaries` mouths or bigger settlements (Trajanovski et al. 2015).

Dikerogammarus villosus is a freshwater amphipod of Ponto-Caspian origin that has already colonised several freshwater ecosystems in Europe

due to its high adaptability to environmental conditions (Rewics et al. 2015). Based on the results of BRA and BRA+BCC score, it is highly possible for this species to get introduced into Lake Ohrid. Its presence in the near geographical proximity and the similar hydrometeorological conditions between the RA and the horizon counties increase the probability of its introduction. Having in mind its predatory and aggressive behaviour (Haas et al. 2002, Grabowski et al. 2007), the impact of this species on the native and endemic amphipods that inhabit Lake Ohrid would be devastating. Based on the data of its rapid spreading across European waters from its appearance in the Danube delta (1989) reaching the Austro-German border by 1992 (Nesemann et al. 1995) and on its high invasiveness score, this species would be of special concern for the RA.

Eichornia crassipes is not present in the horizon yet. However, its ecophysiological characteristics followed by extreme biomass production and spreading by mostly vegetative reproduction (Julien & Orapa 1999) point to its high invasiveness potential (Table 3). The highest impact of this species is on the native biodiversity (score 31), which was also pointed out by many other authors (Babu 2003, Wilson et al. 2005). Although the species is not yet present in the horizon countries, by modelling in MAXENT regarding its future distribution, the southeastern parts of the Balkan Peninsula, including North Macedonia, have been assessed as an acute geographical area for the future invasion of *E. crassipes* (Cordeiro et al. 2020). This is closely related to the prognosis of the increasing average annual temperature in this region, which would beneficially affect the further introduction and spreading of this species.

Corbicula fluminea has been already recorded in three out of the four horizon countries. The general impact of the Asian clam is well known and it is high on the aquatic biodiversity and the economy and high on human health (Sousa et al. 2008a, 2008b). In our assessment, the score for the impact on local diversity is 31 and it is significantly higher than the impact on the economy and environment.

The main vectors for the introduction of all six species could be divided into two groups: intentional and accidental. In the group of intentional vectors of the invasive species are the aquarium and ornamental trade: the introduction of both established and one "horizon" species *P. acuta, E. canadensis* (Albrecht et al. 2009) and *E. crassipes* is related with this activity (Brunel 2010). The introduction of the third established species (*L. gibbosus*) is related to unintentional stocking material as well as intentional aquarium release (Spirkovski et al. 2017). Accidental introductions such as transport with boats, ballast water and equipment are the most probable vectors of introduction for the *D. villosus*. However, it is well-known and documented that the active migration of this species along the water bodies in inland waters (Panov et al. 2009) is an important factor in the introduction of this species. Having in mind the connection of Lake Ohrid with Lake Skadar via the hydrographical connection by Drin River, this way of introduction could have consideration.

Based on the above-mentioned, it is evident that management of the IAS should be a high priority due to the vast effects these species have on the ecosystems and humans. However, short-term management is only dealing with the symptoms and problems caused by the species. The long-term management of IAS, on the other hand, is a loosely defined practice and its meaning and implications can be best understood by examining the objectives and interventions proposed in policies and strategies. At the global level, the UN Sustainable Development Goal 15, concerned with life on land (Division for Sustainable Development Goals, United Nations), states its target 15.8 to "reduce the impact of invasive alien species on land and water ecosystems and control or eradicate the priority species." The indicator for the accomplishment of this target is the "proportion of countries adopting relevant national legislation and adequately resourcing the prevention or control of IAS." This means that addressing IAS impacts is the objective, but progress is tracked through species-based population control. IAS population control is the ongoing suppression of IAS abundance or population size (Robertson et al. 2020). This includes control to maintain current abundance levels and to reduce the current IAS abundance (Mack et al. 2000, Kopf et al. 2017, Robertson et al. 2020). Transnational entities have created policies and strategies along the same lines. Long-term management policies and strategies to address IAS impacts should be based on the tenets of adaptive management and policymaking cycles (Conroy & Peterson 2013, Dunn 2017). From a policy and strategy perspective, deciding on interventions for the impact-based long-term management of IAS should be guided by six criteria: how widespread the IAS is; the time of residency of the IAS in the recipient region; the uncertainty about the impacts produced by the IAS; the range of interventions that are available and socially, economically, and technically feasible; the risks of potential negative and unintended consequences

of the proposed interventions (Kopf et al. 2017); and the capital and recurring costs and benefits associated with the impacts and interventions.

Conclusions

Considering all the environmental challenges that freshwater ecosystems may encounter in the future, biological invasions will surely be pervasive and highly diffused one, highly likely to increase in the next decades, aided also by climate change (Nunes et al. 2015). The AS-ISK screening results for the three established and three horizon species have shown a high level of invasiveness, hereafter, a high probability for these species to continue their spreading (for the established species) or get introduced and start their invasion (for the horizon species) in the RA area, without any management and eradication measures being enacted. Therefore, there is an urgent need for the implementation of efficient and realistic policy and management measures that minimise the likelihood of species entry through the main pathways of introduction especially in protected areas. However, as these main pathways are associated with strong economic activities that benefit millions worldwide, an inevitable conflict between economic interests and the need to control or halt the introduction of new IAS arises and should be considered when taking management and political decisions (Gherardi et al. 2009, Gozlan et al. 2010, cited after Nunes et al. 2015). Since a clear policy for the prevention, containment and monitoring of invasive alien species is finally available in Europe, adequate measures tackling priority pathways and gateways of introductions in Europe are expected to be implemented soon across all EU countries including the candidate ones, such as North Macedonia.

Finally, we should keep in mind that the present state regarding the absence of any active IAS management in the RA area outcomes from low institutional and public awareness and a lack of basic knowledge about the IAS, the biodiversity of the region in general, and the importance of Lake Ohrid and the region as a UNESCO heritage. In order not to leave a burden on future generations but also to avoid the continuous remarks of the Reactive Mission in the future, or even more important, to preserve this unique ecosystem, it is necessary to implement school programs at the regional level, or even better, at the national level, a new curriculum or specific teaching chapter regarding the IAS, their impact and management policy towards protection of Lake Ohrid from the increasing and jeopardizing potential of the IAS.

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