EUROPEAN
COMMISSION

Brussels, 13.12.2024
SWD(2024) 281 final

COMMISSION STAFF WORKING DOCUMENT

Implementing the Strategic Guidelines on EU Aquaculture
Access to space and water for freshwater and land-based aquaculture

CONTENTS

DISCLAIMER: This document reflects only the views of the Commission services and is not legally binding. It has been prepared according to the methodology described in Annex II. It rests with the EU Court of Justice to provide a definitive interpretation of relevant EU legislation.

LIST OF ABBREVIATIONS

Term	Description
AAC	Aquaculture Advisory Council
AAM	Aquaculture Assistance Mechanism
AMA	Aquaculture Management Area
AZA	Allocated Zone for Aquaculture
EC	European Commission
EAA	Ecosystem Approach to Aquaculture
EIA	Environmental Impact Assessment
EMFAF	European Maritime, Fisheries and Aquaculture Fund
EMFF	European Maritime and Fisheries Fund
EU	European Union
FAO	Food and Agriculture Organisation of the United Nations
GIAHS	Globally Important Agricultural Heritage System
GIS	Geographic Information System
IMTA	Integrated Multi-Trophic Aquaculture
MNSPA	Multiannual National Strategic Plan for Aquaculture
RAMPS	Recirculating Aquaculture Multi-trophic Pond systems
RAS	Recirculating Aquaculture System
RBMPs	River Basin Management Plans
TAPAS	Tools for the Assessment and Planning of Aquaculture Sustainability
UK	United Kingdom
WFD	Water Framework Directive

1 INTRODUCTION

In May 2021, the European Commission (EC) adopted the European Union's (EU) 'Strategic Guidelines for a more sustainable and competitive EU aquaculture for the period 2021 to 2030' ([1]) (hereinafter the 'Strategic Guidelines'). These guidelines set the vision for EU aquaculture to grow into an even more competitive and resilient sector and become a global reference for sustainability by 2030. They are the result of extensive consultation with EU Member State experts on aquaculture and with the Aquaculture Advisory Council (AAC), as well as a public consultation.

The Strategic Guidelines identify a wide range of areas where further action is needed, including access to space and water for aquaculture. These guidelines note that 'coordinated spatial planning, with the early involvement of relevant stakeholders, is essential' to 'ensure the allocation of space and water among different activities, while preserving ecosystems'. They provide some recommendations and call on the Commission to 'develop a more detailed guidance document on the planning for space and access to water for marine, freshwater and land-based aquaculture' (Annex 2.1.1.).

This document aims to provide relevant authorities in EU Member States and other policymakers with potential solutions to the challenges of planning freshwater and land-based aquaculture. Marine aquaculture planning is addressed separately in a dedicated Staff Working Document (SWD) ([2]). It elaborates further on the key recommendations on good practices outlined in the Strategic Guidelines to address the access to space and water for freshwater and land-based aquaculture.

It aims to support public authorities in promoting coordinated efforts to encourage coexistences and synergies, reduce conflicts, and optimise the use of space and water resources. This document illustrates consolidated good practices and tools for aquaculture planning with concrete examples from EU and non-EU countries, such as Norway and the UK. Stakeholders can also draw inspiration from these good practices. The annex outlines the methodology followed for its preparation.

As explained in the SWD 'Regulatory and Administrative Framework for Aquaculture' ([3]), the EU legislative framework for aquaculture is a complex one. Aside from legislation on animal health ([4]), food safety ([5]) and markets ([6]), most EU legislation applicable to aquaculture is not specific to the sector. Applicable EU environmental legislation consists of a wide range of EU Directives such as the EU Water Framework Directive (WFD)([7]),

([1]) Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions – Strategic guidelines for a more sustainable and competitive EU aquaculture for the period 2021 to 2030 (COM/2021/236).
([2]) SWD_2024_Space marine aquaculture.pdf (europa.eu)
([3]) SWD 2024 on Regulatory and administrative framework for aquaculture (europa.eu)
([4]) Regulation (EU) 2016/429 of the European Parliament and of the Council of 9 March 2016 on transmissible animal diseases and amending and repealing certain acts in the area of animal health (Animal Health Law).
([5]) Regulation (EC) No 178/2002 of the European Parliament and of the Council of 28 January 2002 laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety.
([6]) Regulation (EU) No 1379/2013 of the European Parliament and of the Council of 11 December 2013 on the common organisation of the markets in fishery and aquaculture products, amending Council Regulations (EC) No 1184/2006 and (EC) No 1224/2009 and repealing Council Regulation (EC) No 104/2000.
([7]) Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy. This directive is complemented by two

the Birds Directive ([8]), the Habitats Directive ([9]), and the Environmental Impact Assessment (EIA) Directive ([10]), which Member States have to transpose into national, regional, and local regulations applicable to the sector. Consequently, much of the regulatory and institutional framework is decided at national, regional or local level.

For example, to comply with the WFD, Member States have to put in place the River Basin Management Plans (RBMPs). These plans have to:

- identify the current status of all water bodies within the identified River Basin Districts,
- assess pressures and impacts affecting these water bodies, and
- set out measures to ensure that the status of water bodies does not deteriorate and they achieve or maintain good status.

It is important that RBMPs integrate objectives and measures to promote aquaculture production areas, so that the possible impact (positive or negative) of the sector and its future needs can be considered at river basin level ([11]).

The 'Nature Restoration Law' ([12]) also sets biodiversity and restoration targets to be met by Member States, which will affect existing legislation on habitats such as wetlands, rivers and lakes. The impact of its application on aquaculture is unknown at the time of writing.

It is worth noting that the scientific literature and good practices for spatial planning in freshwater and land-based aquaculture are not as advanced as those for marine aquaculture. However, some of the good practices established for marine aquaculture ([2]) can be adapted to guide the planning of space for freshwater and land-based aquaculture.

For the purposes of this document, freshwater and land-based aquaculture means the production of aquatic organisms in freshwater ecosystems and land-based facilities. Within this scope, this document covers:

'daughter' directives setting further requirements in relation to the chemical status of surface water (Directive 2008/105/EC of the European Parliament and of the Council of 16 December 2008 on environmental quality standards in the field of water policy, and Directive 2006/118/EC of the European Parliament and of the Council of 12 December 2006 on the protection of groundwater against pollution and deterioration).

([8]) Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds..

([9]) Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora.

([10]) Directive 2011/92/EU of the European Parliament and of the Council of 13 December 2011 on the assessment of the effects of certain public and private projects on the environment.

([11]) For example, in Spain the River Ebro RBMP (which views fish farming as a pressure) reports data on freshwater and land-based aquaculture in its annexes. Although aquaculture occupies only the 5th position, the River Ebro RBMP considers aquaculture as an economic activity and reports 30 freshwater and land-based aquaculture establishments in the river Ebro basin. It notes that in 2019 freshwater and land-based aquaculture production amounted to 5 754 tonnes, with a value of EUR 28 753 243, considerably more than Spain's other river basins. The farms account for approximately 20% of the freshwater and land-based aquaculture facilities in Spain. These mainly produce rainbow trout and, to a lesser extent, native trout for fish restocking, as well as sturgeon for caviar. This document also describes the impact of the sector on the local community, noting that aquaculture employs 233 people.

([12]) Regulation (EU) 2024/1991 of the European Parliament and of the Council of 24 June 2024 on nature restoration and amending Regulation (EU) 2022/869.

- **Pond systems** Fishponds are artificial constructions that maintain significant manufactured wetland habitats in Europe. Although a pond is an artificial system, its nutrient cycling processes are identical to natural semi-static wetlands. It is generally an extensive (or semi-intensive) farming technology that uses natural food sources (mainly zooplankton), often complemented with cereals.

- **Enclosures** are areas of a water body (in shallow coastal lagoons or lakes or reservoirs) that are fenced in using artificial structures permitting free water exchange. In coastal lagoons, artificial enclosures capture fish migrating with the natural lagoon currents. Lagoon or coastal wetland production is generally at low (stocking) density.

- **Net pens** are used in lakes and ponds.

- **Flow-through/raceways** are artificial units capable of holding and interchanging water. Generally built above ground level and taking water from rivers or wells, in many European countries they are associated with the traditional culture of rainbow trout.

- **Recirculating Aquaculture Systems (RAS)** ([13]) are water-efficient and highly productive systems which recycle and reuse water after mechanical and biological filtration. RAS systems are typically indoor and recirculate almost all of the incoming water and act as almost completely closed circuits. However, all systems that are improved to use less water and to treat used water, are effectively 'recirculation' or 'partial recirculation' systems.

- **Aquaponics** ([14]) is a form of RAS which uses nutrient-rich effluents from fish farming to produce aquatic animals and plants, without any soil. It can be performed in both rural and urban environments.

- **Recirculating Aquaculture Multi-trophic Pond Systems** (**RAMPS**) are innovative freshwater integrated multi-trophic aquaculture (IMTA) systems combining RAS, IMTA and pond farming techniques and producing complementary species from different levels of the food chain ([15]).

This document offers a direct link between problem and solution, providing (to the extent possible) a tailored approach to solving a specific problem related to the planning of freshwater and land-based aquaculture as identified in the Strategic Guidelines. Chapter 2 sets out the key topics and their main challenges. Chapter 3 illustrates good practices and

---

([13]) According to EUMOFA (https://aquaculture.ec.europa.eu/knowledge-base/reports/recirculating-aquaculture-systems), RAS facilities are generally sophisticated closed systems (equipped with filters, aeration, etc.) that reuse water at high rates. Conventionally, fully recirculating RAS are typically defined as systems that recycle over 90% of their water. Furthermore, there is a strong connection between freshwater RAS and marine aquaculture. Atlantic salmon juveniles (known as smolt) are bred and reared in freshwater RAS and then translated to net pens.
([14]) Aquaponics is the combination of aquaculture and hydroponics culture.
([15]) In IMTA, the uneaten feed, waste, nutrients and by-products of one species are recaptured and converted into fertiliser, feed and energy, for the growth of the other species.

examples implemented by EU and non-EU countries (Norway and the UK) through seven factsheets.

Aquaculture is a sector subject to continuous innovation and technological development to better meet existing and emerging challenges. The good practices in this staff working document will be updated via the EU Aquaculture Assistance Mechanism website ([16]) as progress is made in this area.

Note that the hyperlinks in this document are valid at the time of its publication. Updates to these hyperlinks might be necessary in the future and will also be made via the EU Aquaculture Assistance Mechanism website.

([16]) https://aquaculture.ec.europa.eu/

2 KEY TOPICS ADDRESSED

Classifying the diverse constraints on access to space and water for freshwater and land-based aquaculture is difficult. However, for the purpose of structuring the information in this document, they have been grouped into **six main categories**: i) legal issues, ii) site availability, iii) scarcity of water resources, iv) coherence with other legislation (such as environmental management), v) public concerns about aquaculture sites, and vi) innovative aquaculture.

A detailed analysis of these six **main issues** identified several **key topics** and related **challenges.** To address these, the document proposes **good practices** that Member States could adopt to improve planning or access to space and water for freshwater and land-based aquaculture.

Table 1. Areas, main issues, key topics, challenges and good practices presented in this staff working document.

#	Areas	Main issues	Key topics	Challenges	Good Practices
2.1	**Access to space**	Legal issues	Licensing process	Multiple levels of authorities	See the Staff Working Document on the regulatory and administrative framework for aquaculture ([3])
		Site availability	Integrated spatial planning	Conflicts with other activities	Promoting synergies with other economic activities / symbiosis centres (see 3.1.1)
			Allocated Zones for Aquaculture (AZAs) & Aquaculture Management Areas	Designation of areas suitable for aquaculture	See the Staff Working Document on the planning of space and access to water for

#	Areas	Main issues	Key topics	Challenges	Good Practices
			(AMAs)		marine aquaculture ([2]) (where relevant)
			Site selection	Lack of data or outdated or poor quality data	Developing GIS-based models and tools for spatial planning (see 3.1.2)
				Cost of space	Restoring abandoned facilities (see 3.1.3)
			Nature Protection	Conditions imposed on the aquaculture companies in protected areas	Reinforcing positive interactions within protected areas (see 3.1.4)
2.2	**Access to water**	Scarcity of water	Water quality and availability	Water rights and licences, application of the WFD and RBMPs	Establishing tools with current information on water quality and availability (see 3.2.1)
				Adaptation to climate change	See the Staff Working Document on climate-change adaptation in the aquaculture sector ([17])

([17]) SWD (2024) 282 – Implementing the Strategic Guidelines on EU Aquaculture. Climate-change adaptation in the aquaculture sector.

#	Areas	Main issues	Key topics	Challenges	Good Practices
2.3	**Other cross-cutting issues related to access to space and water**	Coherence with other legislation (e.g. environmental protection)	Ponds and manmade wetlands' habitat conservation	Extensive aquaculture sector's competitiveness	Valorising aquaculture that has low or positive impact on the environment (see 3.3.1)
		Public concerns about aquaculture sites	Raising awareness and training	Lack of social acceptance	Promoting synergies with other economic activities / symbiosis centres. (see 3.1.1) Valorising aquaculture that has low or positive impact on the environment (see 3.3.1)
		Innovative aquaculture	Integrated and circular approaches	Use of space not suitable for conventional aquaculture	Promoting circular and integrated approaches to save space and water (see 3.3.2)

2.1. Access to space

Licensing process

Countries may have **multiple authorities** managing administrative procedures related to the licensing of freshwater and land-based aquaculture. This poses a challenge for spatial planning, especially when various activities coexist in the same ecosystem.

The particular challenges related to the licensing process for EU aquaculture are addressed in the Staff Working Document on ‘Regulatory and administrative framework for aquaculture’ ([3]), which also gives examples of related good practices developed by Member States.

Further factors relevant for the licensing process are set out in the Water Framework Directive. Under Article 11(3)(e), Member States must set controls over the abstraction and impoundment of fresh surface water. Under Article 11(3)(i), Member States must set controls in relation to any (other) significant adverse impacts on the status of water. These controls shall be periodically reviewed and, where necessary, updated, to avoid deterioration of the status of water bodies and ensure achievement of good status.

Integrated spatial planning

In this document ‘integrated spatial planning’ refers to a comprehensive, data-driven development approach that takes into account spatial or geographical considerations and in which policymakers identify, plan, and implement various policies, with a particular focus on nature conservation and local communities’ needs ([18]).

Public authorities often overlook freshwater and land-based aquaculture in integrated spatial planning and fail to specify suitable production methods for each zone. Consequently, most Member States lack dedicated areas for these types of aquaculture, leading to conflicts with other economic activities such as agriculture, fisheries, energy production (such as floating solar panels), and tourism. Additionally, Member States generally do not take into consideration that the aquaculture sector needs not only the physical space for facilities but also the environmental space to release its emissions if any.

Spatial planning can serve as a valuable tool for water management in the RBMPs. It should be noted that the WFD requires Member States to identify pressures and related impacts on surface waters, including those from aquaculture (Article 5), and to implement measures to address pollution and alteration of surface waters in national and international river basin districts (Article 11).

To ensure that freshwater and land-based aquaculture sector are included in integrated spatial planning, there is a need to **strengthen coordination** among stakeholders and **consider the concerns of local communities**, among others, to avoid conflicts (Cavallo et al., 2021).

In expanding or establishing space for the sector, public authorities should **promote the integration and the coexistence** of freshwater and land-based aquaculture with various economic activities, such as aquatic food processing plants, waste management companies, feed manufacturers, agriculture, markets, etc.

([18]) Further information regarding integrated spatial planning can be found here: https://www.undp.org/publications/integrated-spatial-planning-workbook.

This integration allows freshwater and land-based aquaculture sector to benefit from proximity to both service providers and customers, while promoting water saving, waste reuse, energy efficiency, and circularity, among others. This approach is particularly beneficial for production systems like Recirculating Aquaculture Systems (RAS).

This document highlights synergies between different economic activities and showcases examples of symbiosis and industrial synergies as good practices (see good practice 3.1.1).

Allocated Zones for Aquaculture (AZAs) and Aquaculture Management Areas (AMAs)

As stated in the SWD on 'access to space and water for marine aquaculture'([2]), spatial planning should be based on the **designation of areas suitable for aquaculture** or 'allocated zones for aquaculture' (AZAs).

A good practice is to develop 'aquaculture management areas' (AMAs). **AMAs** are zones where different farms coexist and share resources such as water supply. Established by the relevant authorities or identified by stakeholder groups, they make it easier to open new facilities and maintain existing ones, as problems (such as diseases) in the AMA can be managed more efficiently collectively than individually. An AZA may have one or more AMAs.

Although specific good practices or examples of implementing AZAs and/or AMAs for freshwater and land-based facilities have not yet been identified at the time of drafting this document, it is still pertinent to address the factors to consider when selecting locations for these aquaculture facilities in Member States (see section below).

Site selection

The site selection for the establishment of an aquaculture facility should be based on the **Ecosystem Approach to Aquaculture (EAA)**, which integrates aquaculture into the wider ecosystem. Based on governance and environmental and socio-economic principles, it emphasises the importance of minimising negative impacts and maximising benefits for society, involving all stakeholders in decision-making, and integrating with other sectors ([19]). Ecosystem-based management therefore presents a transition from traditional sector-by-sector planning and decision-making to the broader approach of integrated natural resource management at different scales and for ecosystems that cross administrative boundaries.

The Ecosystem Approach to Aquaculture involves performing **carrying capacity studies.** In the aquaculture sector these studies cannot be any longer based solely on production. There should be a comprehensive study including four dimensions: i) physical condition, ii) production, iii) ecological and iv) social carrying capacity.

Appropriate data sets are therefore crucial for site selection. Since data will vary based on local policy priorities and circumstances, key environmental, social, and economic

([19]) 'Apply EAA as the key strategy for planning and management for aquaculture, and specifically: take account of the landscape/seascape approach with a full range of ecosystem products, functions and services, including biodiversity, and not threaten the sustained delivery of these to society or lead to their degradation beyond their capacity to regenerate; support the improvement of human well-being with equity for all stakeholders; consider the linkages and interactions across freshwater, brackish and marine environments, as appropriate; and, take account of the policies and goals of other relevant sectors, as appropriate' Committee on Fisheries. Thirty-sixth session, 8-12 July 2024. Guidelines for Sustainable Aquaculture (fao.org).

parameters for freshwater and land-based facilities must be established locally. A **lack of data, outdated or poor quality data** is a major challenge for site selection.

Using inadequate (outdated or poor quality) data to assess the location for the site selection may lead to unreliable results. For example, in some countries, water-related data for some freshwater lakes ([20]) are based on monitoring from several decades ago. Depth is a very important factor for aquaculture in lakes, so if the information is from a time when the effects of climate change were not as severe, the data may not fully reflect the reality of the ecosystem, therefore compromising the site selection for the allocation of the aquaculture facility (such as, net pens).

In areas without specific aquaculture zones, the challenge is not just a lack of data but also the need to assess the location of water bodies and their interconnection, if any. Site availability and suitability assessments should consider the whole water system to gather key environmental and social data.

The collection of updated and high-quality data is the basis for the development of decision support systems such as the **geographic information systems (GIS),** which show great potential for planning freshwater and land-based aquaculture. GIS are extensively covered in the staff working document 'Planning of space and access to water for marine aquaculture' ([2]). This document will only focus on GIS tools developed at national level and GIS-based models as good practices for freshwater and land-based aquaculture spatial planning (see good practice 3.1.2).

Another challenge in selecting a site for a new aquaculture facility is the **cost of space**. Exploring access to space in line with the Strategic Guidelines could also reveal opportunities to restore abandoned aquaculture sites (such as old ponds or industrial facilities) or to combine the restoration of wetlands with adequate freshwater aquaculture activities. A good practice is to repurpose abandoned industrial land and rehabilitate closed aquaculture facilities (see good practices 3.1.3).

Nature protection

Many suitable sites for freshwater and land-based aquaculture fall within protected zones. This could be considered a challenge given the **requirements placed on aquaculture companies in protected areas** (for example, with regard to pond drainage, flora cutting and bird control ([21])). Conversely, it could also be considered an opportunity as it ensures high water quality for aquaculture. The WFD rules on protected areas for the protection of economically significant aquatic species oblige Member States to introduce additional water quality objectives where necessary.

Authorities are encouraged to consider natural reserves as areas that can be used for aquaculture. Positively balancing aquatic food production with environmental objectives in these protected areas could contribute to biodiversity conservation while reaching aquaculture production goals (see good practice 3.1.4).

The guidance document on 'Sustainable aquaculture activities in the context of the Natura 2000 Network' ([22]), promotes sustainable aquaculture practices that align with the

---

([20]) Lakes are important for freshwater and land-based aquaculture in Poland, Scotland, and Sweden.
([21]) The Background Paper on Good Husbandry Practices addresses solutions regarding how to protect the stock from predators.
([22])Guidance on aquaculture and Natura 2000 - Publications Office of the EU

conservation objectives of Natura 2000 sites. It recognises aquaculture as a valuable economic activity when conducted sustainably and provides guidance for preventing, minimising and mitigating the impacts of aquaculture activities.

Moreover, the Nature Restoration Law ([12]) aims to restore ecosystems, habitats and species across the EU's land and sea areas. Therefore, it offers a significant opportunity to combine sustainable aquaculture practices with wetland restoration efforts.

2.2. Access to water

Water quality and availability

Regarding access to water, **water rights and licences** are one of the biggest challenges for the sector to grow. As explained in the SWD 'Regulatory and administrative framework for aquaculture' ([3]), the licence process can prove lengthy and costly and, in some countries, they are only granted for a short period of time.

Fees that aquaculture producers pay for the water they consume vary from region to region even within the same country (for example, in Italy it can be up to five times more between one region and another). This also affects profitability when considering establishing freshwater and land-based aquaculture farms.

To reach the good ecological and chemical status required by the WFD Member State authorities work to reduce nutrient and pollution levels in water bodies. This makes it challenging to find sites for new or expanded aquaculture farms which might increase nutrient emissions.

In general, there is a need to recognise that aquaculture is not a (surface) water consuming activity when compared to other activities ([23]). As a food production activity, it has both negative and positive impacts. The environment and water resources can be affected as a result of excess nutrients levels and the use of various chemical substances (such as pharmaceuticals), but certain types of aquaculture such as extensive pond aquaculture ([24]), also provide ecosystem services. In this context, the aquaculture sector claim that there is no level playing field between aquaculture and agriculture in terms of environmental requirements and incentives linked to environmental services or in terms of access to water resources and impacts.

Public authorities often lack up-to-date data to accurately calculate the water available for various economic activities, including maintaining minimum ecological flows. In some cases, the data used date back to the 1980s and 1990s, a period when climate change had not yet significantly impacted river systems. This outdated data influences how water is distributed among activities, some of which consume a lot of water and some, like aquaculture, not that much. Therefore, it is crucial for public authorities to have accurate and current data on water availability to make informed decisions about its allocation.

Accurate data is also essential for planning in other water bodies, such as lakes, where understanding depth and other characteristics is necessary for activities like installing net pens.

([23]) The only exception to this is RAS. Once RAS tanks are filled, they keep the water and send only a little back to the recipient water body.

([24]) Ponds and wetlands can play an important role in water retention and biodiversity conservation.

In Member States where water is scarce, **water balances** ([25]) should be established and maintained to take stock of the available water resources and water use to regularly review whether water abstractions lead to overexploitation. Water balances constitute a proper knowledge basis for the establishment and implementation of any water allocation mechanisms ([26]). Member States are responsible for setting a priority list for allocating water among activities in periods of scarcity. In this regard, aquaculture, despite not being a water consuming activity, competes with multiple other activities.

Finally, **climate change** challenges to the sector require the implementation of climate **adaptation** plans to minimise the effects on the aquaculture production of water scarcity, water quality deterioration, extreme water levels, and droughts.

A separate Staff Working Document on climate-change adaptation in the aquaculture sector includes recommendations and good practices ([17]). This document will therefore include only good practices and examples related to climate-change adaptation specifically concerning access to water for freshwater and land-based aquaculture to complement the former and avoid overlaps (see good practices 3.2.1).

2.3. Other cross-cutting issues relevant to access to space and water for freshwater and land-based aquaculture

Artificial wetlands – habitat conservation

Although extensive and semi-extensive aquaculture in artificial ponds and wetlands can be an important ecosystem services provider ([27]), which preserves both space and water and contributes to habitat maintenance and water management, according to the sector ([28]), they face profitability issues due to environmental restrictions, which compromise their competitiveness.

As wetlands for extensive aquaculture are artificial, if the aquaculture activity lacks economic viability, the producers will abandon the activity, and therefore the biodiversity associated to the wetland ([29]) will be lost and the ecosystem will degrade.

However, if the benefits of the extensive and semi-extensive farming are recognised and integrated into the overall value chain of the industry, the feasibility of the freshwater and land-based aquaculture industry can be improved, avoiding the abandonment of the wetlands by producers (see good practices 3.3.1).

([25]) A water balance is – in simplified terms - a calculation of the water quantity available during a specific time period (such as a month or a year) in a river basin, considering water abstraction, use and consumption. This calculation can be used to maintain sufficient water levels in water bodies, to ensure their good status/potential, to allocate water to the different users, to avoid overexploitation of natural water resources, and to build resilience against climate change.

([26]) To support the development of water balances, an EU guidance document was adopted in 2015 - European Commission, Directorate-General for Environment (2015): Guidance document on the application of water balances for supporting the implementation of the WFD: final: version 6.1 – 18/05/2015, Publications Office, 2015, https://data.europa.eu/doi/10.2779/352735.

([27]) The Commission is currently drafting a document that will include aquaculture practices with lower environmental impact and nature-based solutions. Therefore, Chapter 3 of this document will only include good practices and examples of access to water for freshwater and land-based aquaculture in a way that can complement the former and avoid any overlaps.

([28]) https://aac-europe.org/en/publication/aac-recommendation-on-freshwater-aquaculture-and-wildlife/

([29]) https://aac-europe.org/en/publication/aac-recommendation-on-ecosystem-services/

Need for awareness raising and training

Freshwater and land-based aquaculture also face lack of awareness and knowledge among the general public and, in certain cases, lack of political will to develop new projects too. Both factors challenge the sector compromising its **social acceptance**. The SWD on 'Regulatory and Administrative Procedures in Aquaculture' ([3]) reviews the challenges related to the social acceptance faced by the aquaculture sector and provides good practices and examples to address this issue.

Lack of **social acceptance** is especially significant for drinking water reservoirs. As aquaculture is sometimes perceived as a source of contamination, this perception can lead to conflicts and local opposition, making it nearly impossible to use these water bodies for sustainable aquatic food production.

In some countries, there is also a need for **training** aimed at developing synergies between aquaculture and other businesses, notably agriculture but also tourism. For instance, the integration of freshwater and land-based aquaculture operations into the activities of companies running agriculture — which could play an important role in reducing the conflicts between these two food production systems — fails when agriculture operators are not well-prepared to face this new scenario.

Integrated and circular approaches

Closed and semi-closed systems are commonly used ([30]) in those spaces or areas that are not suitable for 'conventional aquaculture'. This is the case, for example, in areas that do not have direct access to water bodies that meet the needs of marketable species, either due to droughts or due to the absence of marine water in landlocked countries that demand aquatic food.

Closed or semi-closed sophisticated land-based facilities, which require pumps, filters, aerations and strict control of the water quality to ensure fish welfare, can bring aquatic food production almost everywhere, even in combination with edible plants. The biggest challenge is their **need for continuous energy supply**. Good practices for this topic have been gathered in Section 3.3.2.

([30]) Following the description provided in Chapter 1- Introduction, 'conventional aquaculture' refers to all types of aquaculture but RAS, aquaponic and RAMPs.

3 GOOD PRACTICES

This chapter presents the seven good practices on how some of the challenges mentioned in Chapter 2 are faced.

Table 2. Good practices summary table

#	Area	Good Practices
3.1	**Access to space**	3.1.1. Promoting synergies with other economic activities / symbiosis centres. 3.1.2. Developing GIS tools & models for spatial planning. 3.1.3. Restoring abandoned facilities. 3.1.4. Reinforcing positive interactions within protected areas.
3.2	**Access to water**	3.2.1 Establishing tools with current information on water quality and availability.
3.3	**Other cross-cutting issues related to access to space and water**	3.3.1. Valorising aquaculture that has low or positive impact on the environment. 3.3.2 Promoting circular and integrated approaches to save space and water.

3.1 Access to space

3.1.1 Promoting synergies with other economic activities / symbiosis centres.

Access to space
Promoting synergies with other economic activities / symbiosis centres
In some Member States, space for freshwater and land-based aquaculture has been optimised by creating synergies with other activities, saving space and avoiding/minimising conflicts between economic sectors. Integrating freshwater and land-based aquaculture with other activities promotes synergies, business diversification and growth of aquaculture. This can easily happen in 'symbiosis centres', which are industrial areas where multiple activities coexist and benefit the local community. Symbiosis can occur on a small scale, where two different companies share the same space for different activities, or on a larger scale, through dedicated areas for more ambitious projects.
Key factors for the development of a symbiosis centre
• Working with the private sector and academia to implement innovations to achieve the desired symbiosis, integrate the necessary technical skills in the centre and develop a network of relevant actors. • Fostering cooperation between local companies which face common challenges and/or which can be integrated in a circular economy approach (using each other's waste streams) (e.g. water treatment, by-product valorisation, waste heat

Access to space
Promoting synergies with other economic activities / symbiosis centres

generation).

- Offering training and educational programs for citizens and stakeholders involved in aquaculture and its potential integration with other economic activities.

Examples of application

Germany	The Federal Ministry of Education and Research is supporting the SektoRAS [1] project plan to operate a trout farm near a hydrogen and methane production plant in Lübesse [2] in Mecklenburg-Western Pomerania. The energy conversion processes will supply fish production with thermal energy and the oxygen emitted during hydrogen production.
	A private company is operating a warm-water shrimp RAS farm in Glückstadt, Northern Germany. This small-scale facility recirculates 99% of the water and uses residual heat from a neighbouring paper mill plant to heat its systems, minimising their ecological footprint [3]. This is an example of an agreement among two companies, where the role of the administration was limited to the approval of the agreement/symbiosis. The permits already held by the paper mill eased the process for starting the new activity.
Sweden	A private company has developed a RAS farm system that breeds catfish and tilapia, recycling 95% of fish tank residues and using nutrient-rich water for agriculture. In 2013 it launched a franchising model to replicate the system on other farms, building facilities, securing permits and certificates, leasing equipment, and offer 24-hour maintenance. The company focuses on converting abandoned agricultural facilities, like barns, into RAS aquaculture farms [4]. The company received public funding from the Swedish food strategy (approx. SEK 2 million) and the European Maritime and Fisheries Fund (EMFF) to develop this land-based aquaculture concept.

Access to space	
Promoting synergies with other economic activities / symbiosis centres	
	The municipality of Sotenäs has established a symbiosis centre to connect industries, allowing them to utilise each other's waste products. The centre acts as a catalyst for food producers (terrestrial and aquatic). There is a waste and biogas plant that returns 'waste' heat and nutrients, and a recycling centre that repairs, reuses and recycles plastics and old fishing gear. It will also include a large-scale fish production facility, small- and medium-scale aquaculture, a flexible zone for external systems and a biorefinery to increase the value of raw materials [5]. The project's development planning has been funded by the Swedish Agency for Innovation Systems.
Further information	
1. Blue bioeconomic https://www.naturwind.de/naturwind-untersucht-synergien-der-sektorenkopplung-mit-der-aquakultur/ and https://blaue-biooekonomie.de/de/projekte/sektoras 2. Synergy in aquaculture https://www.naturwind.de/naturwind-untersucht-synergien-der-sektorenkopplung-mit-der-aquakultur/ 3. Sustainable prawn farming https://hansegarnelen.de/ 4. Sustainable practices and techniques in Sweden https://www.gardsfisk.se/projekt 5. Symbiosis around fishing gear and marine waste http://www.symbioscentrum.se/symbiosisdevelopment.4.63823e331859e02e4ce1b618.html	

3.1.2 Developing GIS-based tools and models for spatial planning.

Access to space
Developing GIS-based tools & models for spatial planning
Online Geographical Information Systems (GIS) offer stakeholders (investors, private companies, researchers) and the public access to information on the locations of freshwater and land-based aquaculture facilities through websites or applications (apps). A GIS for freshwater and land-based aquaculture could include information on: - economic and social factors (e.g. infrastructure, public spaces for recreational uses of space and water), - the environment (e.g. hydrographic information, including the ecological status of the water body and protected areas), These **GIS tools can also include information** on other aspects specifically relevant for aquaculture such as - the technology employed on the farms,

- the species that are farmed in the facilities,
- available sites for new facilities,
- facilities that have been closed or abandoned and the socio-economic or environmental reasons why.

These models **can be supported by carrying capacity assessments which make them very practical** for assessing new sites for freshwater and land-based aquaculture facilities.

A GIS system can be developed at national level or at local level, and can be presented as a catalogue for investors, entrepreneurs, farmers, etc.

Not all GIS need to be fully fledged to be useful. Smaller GIS projects can be prepared *ad hoc* for a specific case study or project, providing enriched maps with relevant data for freshwater and land-based aquaculture (hydrographic information, water quality, location of other activities, and results from stakeholders' consultation) and **alternative scenarios for aquaculture.**

Relevant aspects for developing GIS-based tools & models for freshwater and land-based aquaculture [1]

1. **Identifying project requirements**

   For a GIS project to thrive, it is essential to develop a common understanding of both the project's goals and the GIS functionalities required by the project's final users.

2. **Identifying data sources and gathering information**

   Data described above as relevant for GIS for freshwater and land-based aquaculture can be gathered from satellites, administrative authorities, and/or in the field (e.g. through sampling, inspections).

Examples of Application

Austria	In the AQUAZOOM project [2], developed by the Institute of Hydrobiology and Water Management at the University of Natural Resources and Life Sciences (Vienna), 17 land-based and 17 water-based spatial criteria were identified for assessing suitability for trout production. These criteria were combined using an integrative GIS-based modelling approach, resulting in a zoning of suitable areas for aquaculture. Out of a total of 8 113 sub-catchment areas with a mean size of 10 km^2, 1 295 were classified as suitable. This approach will be converted into an online tool to support the decision-making needed to avoid conflicts with other activities.
Greece	The geoportal WFDGIS.YPEKA provides data on protected areas for economically important aquatic species, as part of the implementation of River Basin Management Plans in Greece. This includes information on river basin

	districts, river basins, water bodies, water classification and water body status. The data is available via View, Download, and Discovery services, and was developed using Open Geospatial Consortium open standards, such as Web Map Services, Web Feature Services and Catalogue Services for the Web. The public can access information on the status of every water system in the country through thematic maps and structured databases [3].
Hungary	The AquaSpace project [4] combined a multi-layer GIS study and multiple stakeholder feedback surveys in Békés County. The overlap between different land uses, public use and the opinions of the general population highlighted the importance of consultation and participatory processes for different stakeholder groups (face-to-face meetings). This example shows that communication can eliminate false assumptions and increase awareness of aquaculture industry efforts.
Norway	Online GIS app Kart i Fiskeridirektoratet [5] maps facilities in freshwater areas. The data uploaded to the system comes from the municipalities, which play a crucial role in spatial planning in Norway. Abandoned or closed facilities can also be identified in this app.
United Kingdom	In Scotland, the Loch Shin study from the tools for assessment and planning of aquaculture sustainability (TAPAS) Project [6] carried out site selection to grow juvenile Atlantic salmon in cages. The whole freshwater system of this lake was considered by the development of an integrated loch-catchment model. A carrying capacity assessment was also performed using predictive models. This is an example of how to approach access to space for aquaculture in lakes or water reservoirs.
Spain	The online GIS app Acuivisor [7] maps existing freshwater aquaculture facilities. It also includes a tool for identifying new sites for the development of the sector. It shows 61 aquaculture facilities in Natura 2000 areas.

Further information

1. Applications of geographical information systems (GIS) for spatial decision support in aquaculture https://doi.org/10.1016/S0144-8609(00)00051-0
2. *AquaZoom – eine integrative Methode zur Bewertung des Fischzuchtpotenzials entlang österreichischer Fließgewässer* [AquaZoom – an integrative method for assessing the aquaculture potential alongside Austrian rivers and streams] https://link.springer.com/article/10.1007/s00506-022-00894-1
3. Visualisation of cartographic characteristics in Greece http://wfdgis.ypeka.gr/
4. Aquaspace 2020 http://www.aquaspace-h2020.eu/ Deliverable 2.1
5. Fish directory https://open-data-fiskeridirektoratet-fiskeridir.hub.arcgis.com/
6. Results from project TAPAS https://tapas-h2020.eu/results/ Deliverables 5.6 and 5.8
7. Aquaculture facilities in Spain https://www.mapa.gob.es/es/pesca/temas/acuicultura/visor-de-instalaciones/

3.1.3 Restoring abandoned facilities

Access to space

Restoring abandoned facilities

Restoring abandoned ponds revitalises degraded wetlands and promotes biodiversity recovery.

Restoring and repurposing old industrial facilities creates new sites suitable for aquaculture. This practice of land revaluation can rehabilitate industrial areas that are no longer in use or use land that is not suitable for agriculture, helping also to prevent conflicts between these two sectors. Member States could develop projects aimed at identifying available spaces and creating a catalogue to share this information with citizens (see GIS study in good practice 3.1.2). These projects should also include promoting the opportunities offered by these spaces.

Main steps for developing a strategy to support the restoration of abandoned facilities [1]

- Identify and assess freshwater and land-based abandoned facilities to determine their status and potential for restoration. This may involve conducting site visits, reviewing historical records, consulting experts, and assessing the status (quality and availability) of water resources in the zone.
- Address administrative, legal, and environmental issues related to permits, property ownership disputes or environmental concerns that may be hindering restoration efforts.
- Develop a restoration plan that includes specific measures to be taken, timelines and funding sources. The plan should be based on the assessment of the abandoned facility and should consider environmental and regulatory requirements.
- Identify funding opportunities to help investors implement the restoration plan and put the facility back into operation.

Examples of application

Czechia	Over the last three decades, Czechia has invested in the creation,

	revitalisation, and restoration of ponds. These initiatives are rooted in a long history of fishpond farming in the country, which has been developed since the 14th century. Support for these initiatives, particularly those aimed at strengthening the sustainability and resilience of the aquaculture sector, comes from public programmes including EC funding (EFF/EMFF/EMFAF), and from the Czech Ministry of Agriculture [2, 3]. The support focuses on investments such as the construction and restoration of small ponds and the purchase of new equipment. The Ministry also supports intensive aquaculture systems and provides compensation for non-productive pond functions (e.g. ecosystem and habitat preservation). Two of the most important aspects include using military maps to identify historic pond areas and determining how they are connected to the watercourses revitalisation and restoration projects underway since 1992 [2]. The 40-hectare Vajgar fishpond in South Bohemia is a good example of a pond restoration project. Here, 330 000 m^3 of black sediment were pumped out and moved to settling ponds 2.5 km away. Another 40 000 m^3 of eutrophic sediment were directly used in an agricultural field, while sediment containing oil products was decontaminated using a biocatalyst and bacterial culture [4].
Spain	The land-locked Autonomous Community of Extremadura has been developing projects to support freshwater aquaculture in the region. One of these projects, supported by the EMFF [5], focused on identifying new sites for aquaculture facilities by analysing available water resources and minimising environmental impacts. This was achieved by repurposing abandoned farms and old gravel pits. Additionally, the project included training programmes to educate potential investors and entrepreneurs on freshwater management in the region and the administrative procedures required to establish new aquaculture companies in Extremadura. In this context it is worth highlighting a tench production farm built in a former gravel mine. The company operating this farm breeds fingerlings for authorised sport fishing restocking and also has two ponds on this farm offering recreational fishing activities. The production method used is semi-extensive, consisting of nineteen production ponds, each measuring 20x10 meters and covered with nets. In total, the farm produces 1 million larvae, of which 200 000 reach the minimum saleable size of 15 cm [6].

Further information

1. Characterisation of closed continental aquaculture establishments: https://www.observatorio-acuicultura.es/recursos/publicaciones/caracterizacion-de-establecimientos-cerrados-de-acuicultura-continental
2. Operational Programme Fisheries 2021-2027

https://eagri.cz/public/portal/mze/dotace/operacni-program-rybarstvi-na-obdobi-2021-2027

3. Subsidies in water management https://eagri.cz/public/portal/mze/dotace/narodni-dotace/dotace-ve-vodnim-hospodarstvi
4. The restoration of fishponds in agricultural landscapes https://doi.org/10.1016/S0925-8574(02)00020-4
5. *La acuicultura en la economía verde y circular, el agua como sistema productivo en Extremadura. Junta de Extremadura. Consejería de Agricultura, Desarrollo Rural, Población y Territorio. Nº expediente: 1953SE1FP374* [Aquaculture in the green and circular economy: water as a productive system in Extremadura. Regional government of Extremadura. Department of agriculture, rural development, population and territory. File No 1953SE1FP374]
6. Private aquaculture farms: http://pescayrios.juntaextremadura.es/pescayrios/web/guest/explotaciones-privadas

3.1.4 Reinforcing positive interaction within protected areas.

Access to space

Reinforcing positive interactions within protected areas

The guidance document on 'Sustainable aquaculture activities in the context of the Natura 2000 Network' [1] outlines the procedure for opening aquaculture facilities in Natura 2000 sites, and provides guidance for Member States that currently prohibit aquaculture in Natura 2000 areas or other natural reserves, aiming to support the development of suitable aquaculture in these areas.

Aimed at helping Member States understand how suitable freshwater and land-based aquaculture can be supported in protected areas, natural parks, and nature reserves, it allows and encourages Member States to use these spaces for food production while simultaneously protecting the environment.

Key considerations for Member States in establishing freshwater and land-based aquaculture in protected areas.

- Consider that belonging to a protected area is not always a reason to prohibit aquaculture activities.
- Provide an online catalogue or public GIS tool ([31]) to display suitable sites for freshwater and land-based aquaculture in protected areas.
- Offer guidance on restrictions in suitable sites within protected areas and how freshwater and land-based aquaculture can align with them.
- Conduct environmental assessments according to the space and the technology that will be used in the aquaculture project.

Examples of application

([31]) See examples under good practice 3.1.2 above.

Access to space	
Reinforcing positive interactions within protected areas	
Czechia	The Nesyt fishpond [2] in the Natura 2000 site 'Lednice fishponds', which hosts fish farming activities, has integrated summer drainage as a management measure to create optimal environmental conditions for halophilous vegetation on exposed pond substrates and to support certain threatened wetland birds.
France	The Natural Park of La Brenne [3, 4] comprises nearly 4 000 man-made ponds created since the High Middle Ages. Today, these ponds play a crucial role in preserving flora and fauna, especially for waterfowl nesting and migratory birds. In the park, environmental measures are applied to fishponds with the aim of developing aquaculture production methods that enhance environmental quality and preserve nature. Some of these measures focus on recreating and maintaining favourable conditions for insects, amphibians, birds, and fish. They include maintaining vegetation belts, avoiding fertilisation, and using filters, shooting and trapping to manage alien species such as coypu, muskrats, and crayfish. The primary species reared in these ponds are carp, roach, and pike and more recent additions like black bass and pikeperch.
Italy	Some of the best-preserved freshwater wetlands in the Friuli Venezia Giulia region [1] have survived the simplification of the hydrographic network and drainage that impacted the Friuli plain over the last century, thanks to fish farming activities. In some aquaculture ponds in the Veneto Plain, the largest wintering colony of cormorants and one of the last colonies of yellow belly toads are found near existing aquaculture areas. Aquaculture in the wetlands of Friuli Venezia Giulia includes both freshwater species such as carp, tench, and northern pike, and brackish water species like mullets, seabass, seabream, and eels [5].
Slovakia	A common practice in some farms [1] is to prevent the removal of aquatic vegetation, resulting in patches of Typha and Phragmites across a significant part of the fishpond system. These ponds serve as breeding sites for heron-like birds (purple heron, spoonbill, night heron), marsh harriers, bitterns, little Bitterns, red-necked grebes,

Access to space	
Reinforcing positive interactions within protected areas	
	black-necked grebes (now rare) and ferruginous ducks.

Further information

1. Guidance on Aquaculture and Natura 2000: Guidance on aquaculture and Natura 2000 - Publications Office of the EU
2. The summer drainage of Nesyt Fishpond in 2007: a successful conservation measure or ecological catastrophe?: https://www.semanticscholar.org/paper/The-summer-drainage-of-Nesyt-Fishpond-in-2007%3A-a-or-Sychra-Danihelka/bfa52217280c9033319e555d32dd6e84e5b9827c
3. *«Cahiers d'habitats » Natura 2000. Connaissance et gestion des habitats et des espèces d'intérêt Communautaire* [Habitat notebooks. Natura 2000. Knowledge and management of habitat and species of Community interest]: https://inpn.mnhn.fr/docs/cahab/tome3.pdf
4. Fauna in the Natural Park of Brenne https://www.parc-naturel-brenne.fr/le-territoire/nature/faune
5. *Acquacoltura - Le produzioni ittiche in Triveneto* [Aquaculture – Fishing production in Triveneto]: https://www.izsvenezie.it/documenti/comunicazione/materiale-editoriale/1-comunicazione-scientifica/appunti-scienza/acquacoltura.pdf

3.2 Access to water

3.2.1 Establishing tools with current information on water quality and availability.

Access to water
Establishing tools with current information on water quality and availability
Ecological flows are essential for maintaining river ecosystems and the communities that rely on them, by ensuring adequate water quantity, quality and distribution. Therefore, it is key to integrate ecological considerations into water management practices. Water allocation mechanisms are crucial for maintaining ecological flows [1] as per the WFD, and broader biodiversity goals. **Water quality and availability** are critical criteria for establishing freshwater and land-based aquaculture facilities, especially given the impacts of climate change. Establishing **national-level public websites that provide current data on water quality and quantity** can significantly empower authorities, companies, entrepreneurs and the public to take decisions on providing access to water for aquaculture. These websites would offer reliable and crucial information for decision-making when setting up new facilities and managing existing aquaculture operations. Additionally, the internet can serve as a platform for disseminating water treatment solutions. Public websites can educate producers on water recycling methods and alternative water sources, promoting sustainable practices in aquaculture. Having these tools available is considered a good practice as they help protect rivers so that they can continue providing resources for the dependent activities. Aquaculture should be considered one more activity that depends on the river water for their use of water and their consumption. These tools should also consider that the values of use and consumption by aquaculture are not the same as much of the water that is used goes back to the river flow.
Key steps for dynamic and flexible national surface water management
• Develop a network of sensors that can measure water indicators in real-time (e.g. acidity, salinity and temperature). • Carefully select sensor locations, consider streams, canals, rivers, etc. including the subsoil near sewerage and water treatment plants. • Use self-learning algorithms to analyse the data from the sensors and combine it with other sources of information (e.g. measurement from other networks aimed at environmental control). • Use the outputs to produce hydrological models that support freshwater and land-based aquaculture, as well as all kinds of water-related decisions. • Promote communication between public authorities and the private sector, by creating working groups where the data are shared and discussed for decision-making.

Access to water	
Establishing tools with current information on water quality and availability	
Examples of Application	
Belgium 	The Internet of Water [2] is a public website from Flanders that provides real-time water monitoring through an extensive network of sensors. It can help aquaculture producers find available water sources and information on discharge conditions.
	The Inagro Water Knowledge Centre [3] offers the public a website which provides information to farmers who choose 'alternative' water (e.g. rainwater, surface water and recovery water for their facilities in Flanders). The website indicates appropriate water treatments to make these alternative water sources suitable for farming.
	The HaLAVla project [4] examined using alternative sources of water, such as industrial waste streams, for aquaculture. It identified 10 new feasible sites for land-based aquaculture in Flanders, focusing on waste stream quality and logistical possibilities, and also addressed legal framework issues.
Greece 	Greece's National Water Monitoring Network [5] is an essential information system for systematically monitoring the quality and quantity of surface and groundwater bodies. This system operates through River Basin Management Plans. Through its interactive website, the programme shares detailed monitoring results, providing public access to comprehensive water system data via subject-based maps and structured databases.
Italy 	In Friuli Venezia Giulia, integrated water management involves collaboration among three key stakeholders: regional government authorities, aquaculture producers, and managers from the wastewater treatment sector [6]. Their collaboration ensures comprehensive oversight and sustainable practices in water management across the region.
Spain	The status and quality of freshwater and land-based aquaculture waters must be updated annually in the NABIA information system that was set up in 2015 [7], based on the WFD criteria for monitoring and assessing

Access to water
Establishing tools with current information on water quality and availability

waters and environmental quality standards.

NABIA is mainly used to monitor the obligation to obtain good status of water bodies. It was designed to integrate data on the quality and status of surface water and groundwater from the different water administrations (including the regional administrations) into a single database.

The Directorate General for Water of the Ministry of Ecological Transition of Spain carries out quality assurance and coordination tasks across the data collection processes within NABIA. The system performs calculations to evaluate water body status and generates reports in line with WFD requirements.

The **Water Cycle Observatory** [8] aims to enhance water management and transparency through a web portal that gathers, analyses, and disseminates hydrological data and information on water uses and users across the country. The portal has dynamic sections for visualising real-time and static hydrological data, providing valuable decision-making support for the freshwater and land-based aquaculture sector. It promotes adaptive strategies for climate change and facilitates public engagement in water resource management.

Both NABIA and the Spanish Water Observatory offer essential data-driven tools to facilitate informed decision-making regarding water quality and availability for freshwater and land-based aquaculture companies and entrepreneurs.

The Ministry for the Ecological Transition and the Demographic Challenge, through the Hydrographic Confederations, has sole responsibility for water management.

The General Secretariat for Fisheries established a **technical working group on access to space for freshwater and land-based aquaculture** and on water quality, to inform Spain's contribution to the strategic guidelines for a more sustainable and competitive EU aquaculture in 2021-2030.

The group includes participants from the ministry's water management units, regional governments, and the aquaculture sector. One of its key objectives is to communicate aquaculture-related issues regarding space and water access to the ministry, enabling more informed decision-making.

Access to water
Establishing tools with current information on water quality and availability
Further information
1. Ecological flows in the implementation of the Water Framework Directive. https://circabc.europa.eu/sd/a/4063d635-957b-4b6f-bfd4-b51b0acb2570/Guidance%20No%2031%20-%20Ecological%20flows%20%28final%20version%29.pdf 2. Internet of Water https://www.internetofwater.be/ 3. Watertool (Water Knowledge Centre) https://www.watertool.be/interface/index.aspx 4. Land-based aquaculture in Belgium https://lv.vlaanderen.be/sites/default/files/attachments/haalbaarheidsstudie_landbased_aquacultuur_vlaanderen.pdf 5. Greek National Water Monitoring Network Home | National Monitoring Water Network (ypeka.gr) 6. *FVG Delibera della Giunta regionale n. 529 del 1 aprile 2021 - Decreto No 150/DGEN del 19/04/2021* [Friuli Venezia Giulia Resolution of the Regional Council No 529 of 1 April 2021 – Decree No 150/DGEN of 19 April 2021] 7. Information system on the status and quality of freshwater and land-based aquaculture waters https://acrobat.adobe.com/link/track?uri=urn%3Aaaid%3Ascds%3AUS%3Af8c1ac1e-ecb3-4d18-8731-c6b3173de8ec 8. *Observatorio del Ciclo del Agua en España* [Spanish Water Cycle Observatory]

3.3 Other cross-cutting issues related to access to space and water for freshwater and land-based aquaculture.

3.3.1 Valorising aquaculture that has low or positive impact on the environment.

Other cross-cutting issues related to access to space and water for freshwater and land-based aquaculture
Valorising aquaculture that has a low or positive impact on the environment
The strategic guidelines recommend valorising aquaculture that has positive impacts or a low negative impact on the environment. This can increase acceptance by authorities and communities and facilitate access to space. Awareness needs to be increased that environmental protection can be effectively combined with freshwater and land-based aquaculture by providing space for types of aquaculture that have lower negative or positive impacts on nature. The potential of these types of aquaculture as a tool for restoring natural habitats, as demonstrated in good practice 3.1.3., also needs to be stressed. Member States are invited to promote the implementation of **data-driven practices** in the freshwater sector to disseminate knowledge about the **environmental benefits of aquaculture in ponds and wetlands.**

Other cross-cutting issues related to access to space and water for freshwater and land-based aquaculture

Valorising aquaculture that has a low or positive impact on the environment

Data analysis can provide valuable insights into farm performance, enabling authorities to offer **targeted support to farms that implement best practice and achieve the best results**. Additionally, data-driven practices can improve **the development of local branding, public certification, technical standards and codes of conduct**. Farms adopting these practices can demonstrate their commitment to sustainability and best practice, further promoting these methods.

Some benefits of pond farming

Most freshwater facilities in ponds apply extensive (<500 kg/ha) or semi-intensive (<2 000 kg/ha) technologies and are developed in harmony with nature [1].

Artificial wetlands for pond farming and extensive aquaculture are among the most ecologically valuable and species-rich cultural landscapes, due to their sustainable and nature-friendly management. Developed over long periods of time, they have led to very stable ecosystems without the need for any major alterations and help improve water management and preserve biodiversity.

Ponds play a role in water retention, groundwater regulation, flood control and other ecosystem services that ensure the good status of water bodies and the conservation of wetlands. Managing them appropriately prevents the deterioration of this valuable asset.

Examples of application

Austria	Carp pond farming in the Waldviertel Region has been recently proposed as a Globally Important Agricultural Heritage System (GIAHS) [2] to safeguard and support its agricultural heritage. This FAO recognition promotes an integrated approach to sustainable aquaculture and rural development and promotes public understanding of the services that these systems provide for the environment and local communities [3].
Germany	Fish from regions such as Northern Bavaria have been granted the EU 'Protected Geographical Indication' to safeguard and support their agricultural heritage and Bavarian carp pond farming (*Bayerische Karpfenteichwirtschaft*) has been listed as an example of UNESCO 'Intangible Cultural Heritage' since 2021 [4]. Extensive and organic production in ponds can benefit from a special funding scheme to compensate farmers for this particularly eco-friendly and resource-saving management of carp ponds.

Other cross-cutting issues related to access to space and water for freshwater and land-based aquaculture

Valorising aquaculture that has a low or positive impact on the environment

Hungary	Hungary has established measures to help improve water management for pond fish farming. Fees for using water resources are limited (there are no fees below 25 000 m^3/ha), as are fees for the water supply (no more than 1 500 HUF/ha). However, no fees are paid for water supply during drought periods.
Italy	An extensive aquaculture company in Friuli Venezia Giulia [5] received support for pond restoration and the creation of bird habitats [6] from the European Agricultural Fund for Rural Development . The company produces European seabass in lagoons that benefit from sea intakes certified under European organic standards.
Poland	Many Polish salmonid farmers contribute to improving the environmental conditions in rivers by, for example, adopting water purification systems at both inflows and outflows. In recognition, the Polish Trout Breeders Association introduced the ‘Our Trout’ certification, with rules for basic and extended certification for breeders and feed suppliers. They also established training for operators of trout fish farms [7]. The certification, included in the producers organisation’s marketing plans funded by the EMFF 2014-2020, allows consumers to identify trout that meets verified quality standards. ‘Our trout’ has also been promoted through campaigns, including the ‘Second nationwide promotional campaign for trout’ (2021-2023), with over PLN 8 million of funding, in collaboration with the Ministry of Agriculture and Rural Development.

Further information

1. Aquaspace 2020 (Deliverable 2.1) http://www.aquaspace-h2020.eu/
2. UNESCO agriculture heritage sites in Europe and Central Asia https://www.fao.org/giahs/giahsaroundtheworld/designated-sites/europe-and-central-asia/en/
3. Fishponds in Austria https://info.bml.gv.at/themen/landwirtschaft/landwirtschaft-in-oesterreich/tierische-produktion/fischzucht-oe/sonderrichtlinieteichwirtschaft.html
4. UNESCO Biosphere Reserve Upper Lausitz Heath and Pond Landscape https://www.unesco.de/en/node/2392 https://karpfenteichwirtschaft-bayern.de/
5. Valle Pantani agricultural society https://vallepantani.it/
6. European Agricultural Fund for Rural Development - European Commission (europa.eu)

Other cross-cutting issues related to access to space and water for freshwater and land-based aquaculture

Valorising aquaculture that has a low or positive impact on the environment

7. Trout quality and certification http://naszpstrag.pl/jakosc-i-certyfikacja/nasz-pstrag

3.3.2 Promoting circular and integrated approaches to save space and water

Other issues relevant to space & water conservation

Promoting circular and integrated approaches to save space and water

As noted in Chapter 1, **recirculating aquaculture systems (RAS) can be run almost anywhere, regardless of local conditions.** If run with freshwater and brackish water, their effluents can be directed from hydroponics systems into an **aquaponic system**.

Aquaponics allows both fish and edible plants to be produced in the same facility, occupying the same space and water and reducing the conflicts between aquaculture and agriculture in their competition for water and soil. Currently, there are even projects that assess space availability for this type of aquaculture in cities [1].

Due to the energy requirements and operating costs of both RAS and aquaponics, public authorities that want to provide space for this kind of aquaculture should promote the **integration of renewable energies in projects** and foster industrial symbiosis (good practice 3.1.1).

Freshwater integrated multi-trophic aquaculture (IMTA), such as aquaponics, uses nutrients generated by fish and is gaining popularity on land, enabling food production in spaces that are not suitable for agricultural activities.

Both RAS and IMTA can provide different kinds of products using the same space and water. This is especially relevant for landlocked countries that can produce aquatic food along with vegetables and therefore become more self-sufficient.

How can public authorities support this?

- **By designating suitable areas for RAS**: identifying and designating commercial areas with good transport links, particularly for feed delivery, that are well-suited for recirculating aquaculture systems.

- **By offering special support conditions**: providing favourable conditions, such as reduced requirements for projects that will produce less than 1 000 metric tonnes per year.

Examples of application

Ireland 	Recirculating Aquaculture Multi-trophic Pond systems combine RAS, IMTA and pond-farming techniques. They are used to combine fish, plant and algae production on marginalised agricultural land and cutaway peatlands. The resulting paludiculture includes trout and perch rearing

Other issues relevant to space & water conservation	
Promoting circular and integrated approaches to save space and water	
	ponds and algae and duckweed canals for effluent remediation. The system is already being commercially exploited for both fish species and there have been no discharges for 9 months [2].
Spain	In the landlocked region of Castilla y León in Spain there is a privately-operated marine RAS producing shrimps for local markets [3].
	The NewTechAqua marine aquaponics project funded by the EU Horizon 2020 programme received the FAO's MedFish4Ever award. In its first phase, the project grew 90 kg of lettuce in fewer than 3 months during the winter, achieving a productivity of 4-5 kg/m², without heating or fertilisers. The second phase focused on Salicornia, an edible plant that grows in marshlands, yielding 250 kg in 18 m². This aquaponics system can be adapted to various fish and vegetable models, optimising the space-productivity ratio for several species of plants and fish, such as Salicornia, lettuce, tomatoes, grey mullet, trout, and seabass [4].
Spain and Egypt	A Spanish private company collaborated with the El-Kanater El-Khayria Fish Research Station of Egypt's National Institute of Oceanography and Fisheries on an international study funded under the HortiMed H2020 PRIMA project. The study, presented at the first International Electronic Conference of Horticulture, was on a combination of IMTA with hydroponic horticultural production. Nutrients from cultured tilapia, mullets, crayfish, clams and silver carp were successfully used to produce green leaf lettuce, chilli and bell peppers, cucumber, eggplant, mallow, watercress and celery. A total system biomass (crop and aquatic species) of 1 017.30 kg was produced [5].

Further information

1. City or hinterland –potential sites for upscaled aquaponics in a Berlin case study: https://doi.org/10.1038/s42949-022-00072-y
2. Effects of climate and environmental variance on the performance of a novel peatland-based integrated multi-trophic aquaculture (IMTA) system: Implications and opportunities for advancing research and disruptive innovation, post COVID-19 https://doi.org/10.1016/j.scitotenv.2022.153073
3. Climate change-aware shrimp-farming optimisation technology https://norayseafood.es/en/technology/

Other issues relevant to space & water conservation
Promoting circular and integrated approaches to save space and water
4. Saltwater aquaponics systems in MedFish4Ever https://www.fao.org/gfcm/meetings/MedFish4Ever/awards/irta-saltwater-aquaponicsystem 5. Integrated multi-trophic aquaponics - a promising strategy for cycling plant nutrients and minimising water consumption https://doi.org/10.3390/IECHo2022-12493

ANNEX I: METHODOLOGY

This document was developed with support from the EU Aquaculture Assistance Mechanism (EU AAM) ([32]). It includes data from various data collection activities aimed at gathering updated information on challenges, solutions, and good practices for accessing space and water for freshwater and land-based aquaculture.

Data collection and sources

- **Literature review and desk research:** This document is based on various documents and studies, including guidelines from the European Commission, FAO handbooks, peer-reviewed scientific publications, EU-funded project deliverables, recommendations from the Aquaculture Advisory Council (AAC), EU Member States' Multiannual National Strategic Plans for Aquaculture (MNSPAs) and EU River Basin Management Plans (RBMPs).

- **EU-funded projects:** Essential insights on various aquaculture issues came from projects such as the 'ecosystem approach to making space for aquaculture' (Aquaspace) ([33]), which offered key information on challenges regarding access to space, and the 'Tools for the Assessment and Planning of Aquaculture Sustainability' (TAPAS) ([34]), which provided information on site selection.

- **Online EU survey** (April 2023): This survey gathered insights from 13 respondents, namely public authorities, and policymakers responsible for aquaculture in Member States, and officials from spatial planning and environmental departments who were invited to participate given the cross-cutting nature of freshwater and land-based aquaculture planning.

The survey's main goal was to identify key challenges and solutions related to space and water access for freshwater and land-based aquaculture in Europe. It also collected information on the phases and key elements of planning for these types of aquaculture.

- **Consultations with experts and associations:** National experts, scientists and representatives from the TAPAS and AquaSpace projects were interviewed by e-mail or in bilateral meetings to address gaps identified from the survey responses.

The 'APROMAR' Spanish farmers association was also consulted on RBMPs and on the implementation of the Water Framework Directive in Spain, while the Hungarian Aquaculture Technology and Innovation Platform provided insights on freshwater and land-based aquaculture techniques with a low or positive impact on the environment. These interviews were crucial for validating good practices.

Finally, this document was presented and discussed at a workshop organised by the European Commission in Brussels in October 2023. Participants received the paper in advance to facilitate informed discussions. Following the workshop, the document was revised to incorporate valuable input from the Member States, representatives of the freshwater and land-based aquaculture sector and other experts.

([32]) EU Aquaculture Assistance Mechanism

([33]) Aquaspace – Making space for Aquaculture

([34]) TAPAS project .