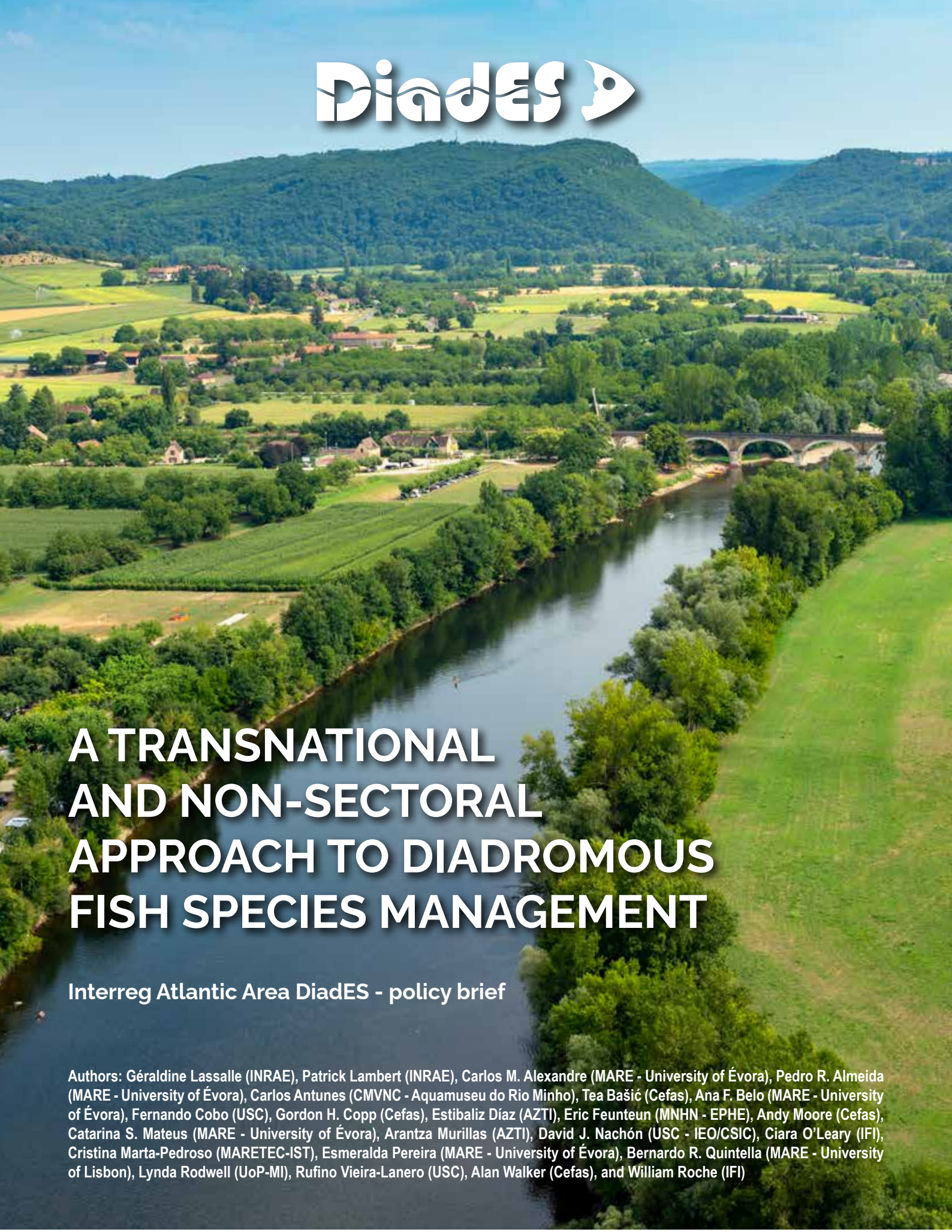

A TRANSNATIONAL AND NON-SECTORAL APPROACH TO DIADROMOUS FISH SPECIES MANAGEMENT

Interreg Atlantic Area DiadES - policy brief

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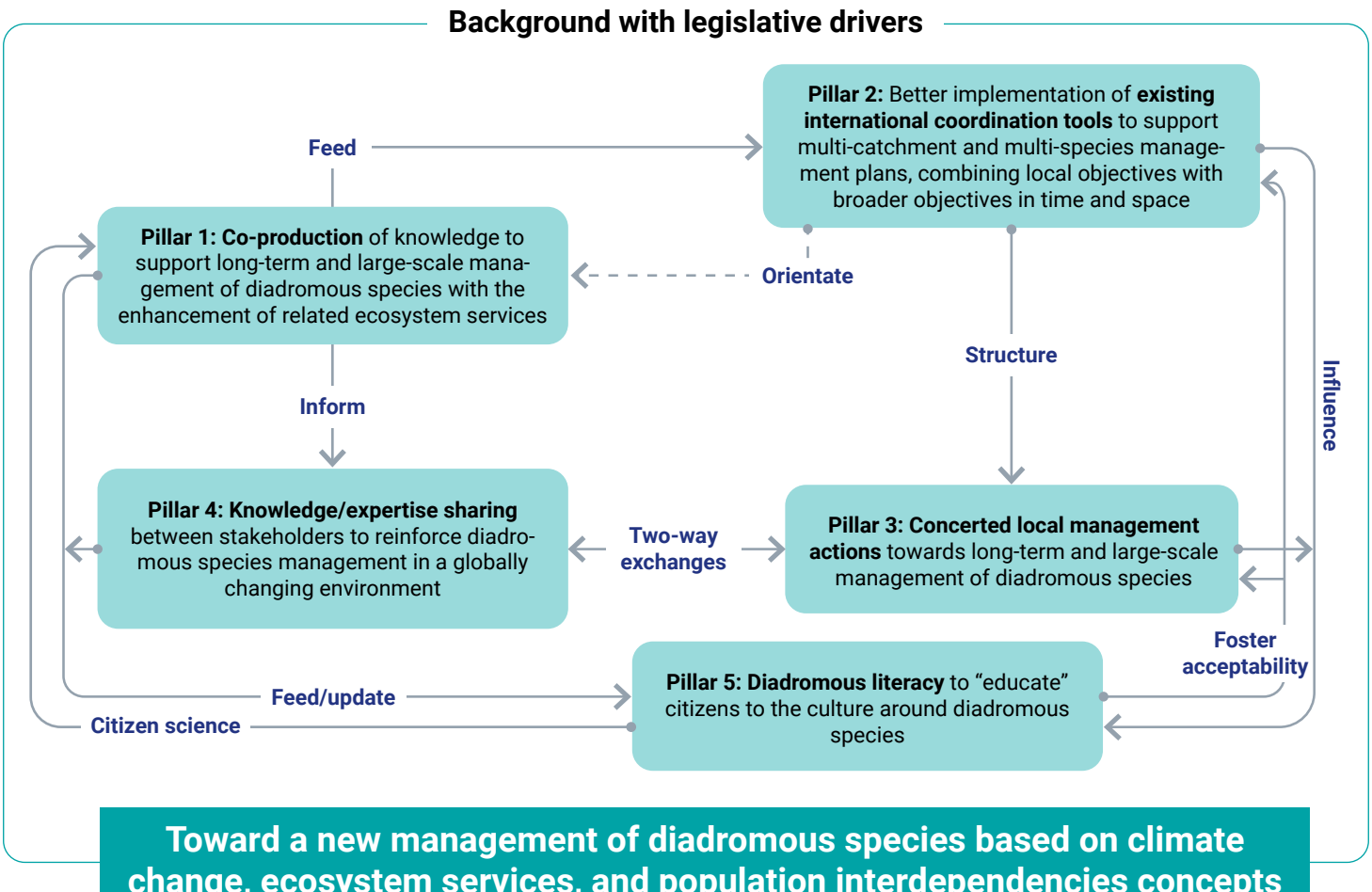
Diadromous fishes are migratory species connecting rivers and seas across international boundaries/borders. In that sense, these species' stocks are shared across countries and they provide multiple societal benefits. However, they are in a generalised decline due to numerous human and environmental pressures. Management actions have been species-specific, carried out at the local scale, during a short period of time, with limited knowledge on the biology of many of the target species and without consideration of their full economic value. Positive outcomes to date have not been sufficient to ensure the viability of diadromous species in the long term. Climate change is compounding the main threats, acting as a driver of changes in species distributions that could lead to new territorial interconnections and opportunities.

The DiadES project came about by recognising that an urgent shift in the paradigm of diadromous species management was needed. It proposes a collective agreement for which global/international objectives are now needed, which have to be delivered primarily by concerted local actions, in order to tackle fish population interdependencies and climate change impacts more effectively. Local management should focus on an ecosystem level and multi-species approach, spanning several generations of the target species, while acknowledging different pressures, species interdependencies, and status within species across countries. We provide a roadmap of five guidance pillars that rely on existing international frameworks (such as UN Sustainable Development Goals, EU Green Deal with the Biodiversity Strategy for 2030, Water Framework Directive and Birds and Habitats Directives) and on the promotion of better implementation of those legislative frameworks to achieve more sustainable population and biodiversity levels. This will, at the same time, also create or enhance sustainable economic development opportunities associated with diadromous species. This policy brief addresses the management of diadromous species in the long term and at large spatial scales.



PILLAR 1

Co-production of knowledge to support long-term and large-scale management of diadromous species with the enhancement of related ecosystem services

Successful management and conservation of diadromous species requires robust and proactive knowledge that underpins the advice provided to managers and policymakers. However, we do not need to know everything to provide relevant advice. Consistent approaches, applied in a network of pilot case studies, would facilitate the transfer and integration of results into global management recommendations. The DiadES project identified the following critical research needs to improve management outcomes. This is particularly true for data-poor species such as smelt, shads, lampreys, mullet and/or flounder.

1. Land-sea continuum research

Although some life stages of diadromous species are more vulnerable to changes in environmental conditions, maintenance of all life stages is essential for population persistence. Integrated knowledge of the interrelationships between the different aquatic environments (i.e., freshwater, estuarine and marine) inhabited by diadromous species and their varying pressures (such as bycatch in the marine environment) will serve to inform decisions on the sustainable management of these resources. This is particularly true for the marine environment where there is still a general lack of knowledge about critical aspects of the species life cycle.

2. Ecosystem services research

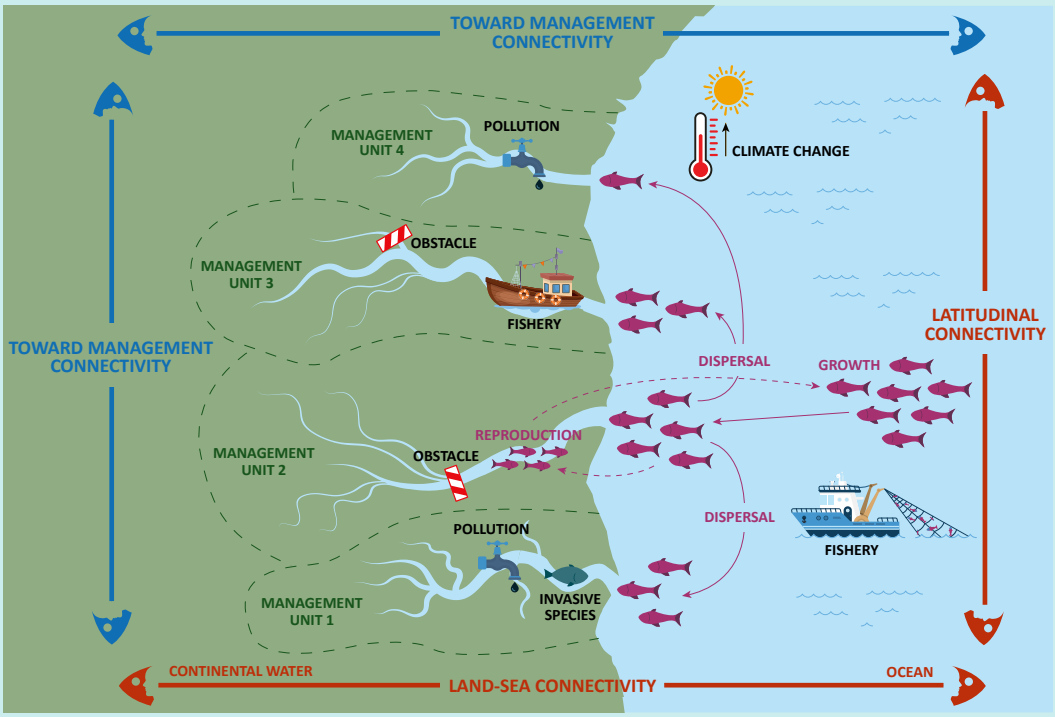
Priority should be given to ecosystem services quantification in a climate-change scenario as a tool to support management actions and enhance restoration, as it highlights the full array of benefits and risks that are normally hidden and not considered in decision-making. Policy and management may be able to aid capital input and support for access to benefits, such as new fisheries, as a result of the availability of new species in regions due to climate change. Societal demands for ecosystem services and acceptance of newly exploited services should be closely monitored.

3. Pressures' inter-dependencies research

Studies along river catchments and between river catchments should be framed in climate-change scenarios. Improved assessments to predict the capability of species to surpass barriers will identify those structures where effort should be focused to enhance connectivity and thereby maximise the benefits to diadromous species under future climate-change scenarios. Reduced precipitation patterns and increased temperatures may create new conditions that are not adequate for diadromous species to negotiate in-river barriers while migrating either upstream or downstream. This is particularly important for rivers more vulnerable to contamination by organic and metallic pollutants that are produced by agriculture, industry and medicine.

SIDE BOX 1

Diadromous species complex life cycle requires specific management measures



PILLAR 2

Better implementation of existing international coordination tools to support multi-catchment and multi-species management plans, combining local objectives with broader objectives in time and space

The EU and third countries request advice for the sustainable use of living marine resources from intergovernmental organizations such as ICES (International Council for the Exploration for the Sea) and NASCO (North Atlantic Salmon Conservation Organization). These organisations encourage, promote and facilitate coordinated and collaborative scientific data collection at the international level to improve the assessment of available resources and help managers set and meet objectives.
The priority work programme suggested by DiadES includes the definition of stocks by assessing the levels of population interdependencies, a climate vulnerability analysis across the species, and an economic valuation of ecosystem services associated with diadromous species. The DiadES consortium suggested that there be greater focus on data-poor diadromous species (such as smelt, shads, lampreys, mullet and/or flounder). This would enable the definition of emerging sustainable management of these sensitive species.
Finally, the priority work programme may also consider the potential benefits of other international regulations (e.g., the emerging Nature Restoration Law, the Birds and Habitats Directives, the Water Framework Directive, the Marine Strategy Framework Directive, the Eel Regulation) on diadromous species to highlight the benefits and importance of fully implementing these existing mechanisms to ensure Good Ecological and Environmental Status in all types of water body. The ultimate implementation goal is towards new applications of these tools for greater benefit for diadromous species. The increase of sampling areas or the adaptation of standardized methodologies are easy targets to better assess the presence of diadromous species.

PILLAR 3

Concerted local management actions towards long-term and large-scale management of diadromous species

Diadromous species are impacted by both human activities and associated environmental changes on land, in rivers, in estuaries and in the ocean. These impacts of concern to management include degradation and loss of habitats and their connectivity, overfishing, pollution, climate change, and invasive species. To tackle these threats, managers generally implement measures locally and in the short term without consideration of the interdependencies between fish populations and territories.
In the context of on-going environmental change, local managers should define their objectives in the context of the provisioning, cultural and regulating ecosystem services that were listed in the DiadES project along with the more traditional abundance approach. This could be achieved by implementing the following guidelines:

- Introduce more precautionary targets in terms of species abundance and mortality to take into account climate change uncertainty;
- Set long-term targets (10-50 years) and a range of long- and short-term (< 5 years) management measures to anticipate and consider the changes that may occur under the different climate change scenarios;
- Implement adaptive management with revision of 'recovery' targets following unforeseen issues corresponding to changes in environmental and social conditions;
- Take into account measures from neighbouring management units as diadromous species are a mobile and transboundary resource;
- Take an holistic approach with measures targeting habitat quality and quantity and multiple species since the community of diadromous species will develop under a changing climate. Only integrated management plans that identify and act simultaneously on keystone pressures are relevant.

These measures will improve the ability of managers of diadromous species to reach and adjust conservation and exploitation targets in the face of climate-change impacts.

PILLAR 4

Knowledge/expertise sharing between stakeholders to reinforce diadromous species management in a globally changing environment

A key objective of the information/knowledge sharing pillar is to inform and 'educate' all interested parties of the potential for new opportunities associated with the management and protection of diadromous species, and related ecosystem services, in the context of a globally changing environment. Achieving this goal will require improvements in communication between and among catchment managers and stakeholders at regional/national and international levels.

Individual catchment management will more efficiently use resources when benefiting from others' experiences. Exchange of management strategies (e.g. fishery management, stock restoration, barrier removal, reduction of organic and metallic contaminants) and population status or monitoring data will help to coordinate and offer joint solutions to common problems. Managers should be invited to share successes and failures of actions/management measures with neighbouring catchments or regions. This would be particularly beneficial in the case of data-poor diadromous species.

In a changing environment, shared experiences could help raise awareness of future impacts (e.g. population disappearances) and opportunities (e.g. arrival of a new species with climate change), related-ecosystem modifications, or the potential introduction of new fish viruses and pathogens along with alien predatory species. Understanding distribution shifts as a consequence of climate and oceanographic changes, rather than local human interference, is necessary to achieve optimal outcomes in terms of management.

Delivering on these recommended objectives will need the creation of new exchange arenas at regional, national, transboundary and international levels. In the meantime, the Interactive Web Atlas produced under DiadES could host shared information that will facilitate regular meetings to cross-pollinate successes but also failures and non-significant results. This effort can be linked to others internationally over time to create a larger set of learning opportunities.

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SIDE BOX 2

Ecosystem services associated with diadromous species

Ecosystem services are the marketed and non-marketed benefits that well-functioning ecosystems provide to society. For diadromous species, they are of three types:

- **Provisioning services:** Supplying protein and other products, in the form of fish, is a primary ecosystem service provided by diadromous species. They can be exploited in marine, estuarine or riverine fisheries, and, for some species, such as the Atlantic salmon, successfully farmed for aquaculture production.
- **Regulating services:** Diadromous species can be described as the link between the river and the sea from an ecological functioning point of view: these species serve as a major source of food in marine food webs, and they bring nutrients of marine origin into riverine ecosystems through their spawning activity and from any in-river adult mortalities.
- **Cultural services:** Several diadromous species enjoy an elevated cultural heritage associated with celebrations, culinary specialties, arts and folklores across their range. Diadromous species are also highly valued as angling sport fish with associated activities like international fishing competitions and leisure angling in fishing hotspots.

PILLAR 5

Diadromous literacy to 'educate' citizens about the culture around diadromous species

Education is a crucial lever of action in reversing the generalized decline of diadromous species, particularly what could be called 'diadromous literacy'.

Raising awareness of the wide range of ecosystem services provided by these migratory species identified in DiadES, providing education on the key concepts surrounding diadromy, and encouraging people to be proactive in enhancing their knowledge may promote increased responsibility among citizens and managers. Better-informed and concerned citizens could increase the onus on managers to balance the competing socio-economic and environmental issues towards improved conservation.

Diadromous species are highly sensitive to human pressures and should be presented as 'indicator and umbrella species'. Diadromous species have different life history strategies, including short and long lived and occupy multiple habitats, thus they provide information on the status of the whole ecosystem, or key processes such as in-river connectivity, water quality (including contaminants) and conservation measures applied will be beneficial to other species.

Raising awareness in citizens of all ages and promoting diadromous literacy could take various forms to bridge the gap between science and society, such as on-site information boards, exhibitions, comics, and storytelling. In the DiadES consortium, we designed a serious game to explore alternatives in diadromous species management in the context of climate change.

In order to attain better results, the five pillars should be addressed simultaneously because they are interconnected with numerous back-loops between them.

SIDE BOX 3

Key concepts mobilized in defining new rules for diadromous species management

The *precautionary approach* supports action to anticipate and avert environmental harm in advance of, or without, a clear demonstration that such action is necessary. In relation with climate change impacts and diadromous species, operational measures can be on setting both short-term and long-term targets locally and promoting a network of management units sharing objectives as further described under Pillar 3.

Ecosystem-Based Management (EBM) is defined as an integrated approach that incorporates the entire ecosystem, including humans, into resource management decisions. In the context of diadromous species management, knowing more about the ecosystem services they provide is part of the process along with considering the links operated by diadromous species across interconnected habitats.

Adaptive management is defined as an intentional approach to making decisions and adjustments in response to new information and changes in context. Concerning diadromous species management, collecting and sharing new co-produced insights and management outcomes in a structured way is key.

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