Assessing and enhancing ecosystem services provided by diadromous fish in a climate change context

Executive report.

Deliverable title: The full list of ecosystem services provided by diadromous fish

Deliverable reference: WP 4 – Action nr.1

Contributors and affiliations:

Arantza Murillas (AZTI); Matthew Ashley (Plymouth university); Cristina Marta-Pedroso (MARETEC/IST-UL); Angela Muench (Cefas); Lynda Rodwell (Plymouth university); Sian Rees (Plymouth university); Tea Basic (Cefas); Estibaliz Díaz (AZTI); Patrick Lambert (Irstea); Lassalle Geraldine (Irstea); Catarina Mateus (Univ. Evora), Pedro R. Almeida (Univ. Evora), David J. Nachon (USC), Fernando G. Cobo (USC), Rufino Vieira (USC), Aitor Lecuona (Diputación Foral de Gipuzkoa), Gordon H. Copp. (CEFAS), James King (Inland Fisheries Ireland), William Roche (Inland Fisheries Ireland), Carlos Antunes (CMVNC), Thomas Trancart (MNHN), Eric Feunteun (MNHN)

This project is co-financed by the Interreg Atlantic Area Programme through the European Regional Development Fund.

Abstract

The rivers in the EU Atlantic Area´s (AA´s) support diadromous fish populations which provide numerous benefits to society known as ecosystem services (ES). These benefits include provisional values such as food, but also values of intrinsic (e.g. maintaining resources for future generations) and cultural importance (e.g. heritage). In this study, developed under the framework of the INTERREG AA´s DiadES Project, ES linked to diadromous fishes were identified through extensive literature review and by consulting local stakeholders from case study rivers across the AA´s (from Gipuzkoa rivers in Spain, Loire and Mondego rivers in France and Portugal, to Rivers Tamar, Frome and Taff in UK). The ES identified as relevant to diadromous fish populations include food provision (provisioning service), nutrient exchanges between coastal and inland habitats (regulating service) and recreational fishing and tourism linked to the societal interest for diadromous fishes (cultural service). Contribution of diadromous species to supporting gastronomic festivals and knowledge systems (environmental education and research) also relates to cultural ES. Potential trade-offs are identified between services provided by diadromous fish populations and other services provided in AA´s rivers, that support alternative benefits (i.e. flood control; electricity production; agricultural pollution; sand extraction).

Introduction

The knowledge and awareness of ecosystem services (ES) provided by the environment is developing rapidly through increased publications either at European level but also at national policy. However, although the ecosystem service concept, the classification system and the economic quantification framework have been widely covered in a growing number of case-based research papers, an operational framework for assessing the ES provided by diadromous fishes in river ecosystems has not been adequately employed in the EU Atlantic Area (AA). Only a few research papers so far focus specifically on ES provided from diadromous fishes in the AA, and the majority mention individual ES but do not directly assess level of provision. This research aims to summarise the evidence base for contribution of diadromous fish species to ecosystem service provision in the European AA and assess knowledge gaps through a systematically undertaken scoping evidence review of peer-reviewed studies and grey literature. We also gather stakeholder expert knowledge in case study estuary and river systems across the Atlantic AA, from scientists and conservation and fisheries management professionals in each region, of ES benefits perceived to be provided by diadromous species in each case study. The stakeholders in case study locations were provided a set of well-defined questions: (i) Which diadromous fishes are providing ES in the AA´s? (ii) Which ES are provided by diadromous fishes in the AA´s? (iii) Which ES are identified in the literature versus the ES provided by diadromous fishes according to the empirical knowledge? (iv) What are the knowledge gaps (identified from review of current research and empirical knowledge)? (v) How is an integrative ES-based knowledge needed to manage the natural resource? The combination of a systematic evidence review and research conducted to critically assess current evidence in existing literature, in relation to local stakeholder ecological knowledge (LEK), provides the first detailed review and assessment of contribution of diadromous species to ecosystem service provision across the EU Atlantic Area.

Scoping Evidence Review

Which ES are provided by diadromous fish?

Evidence of provision of cultural services, especially recreational angling, related to the CICES class '*Physical and experiential interactions with natural environment - Physical use of land/seascapes in different environmental settings'* was highly supported by the literature (50 of 92 papers). Studies assessing cultural ES focused on salmon and/or sea trout. Provisioning services (support for commercial fisheries related to the CICES class: '*Biomass - wild animals and their outputs')* received the second most research attention (31 papers of 92

This project is co-financed by the Interreg Atlantic Area Programme through the European Regional Development Fund.

reviewed). Evidence for provision of regulating services by diadromous species, in particular those relating to the transfer of nutrients from marine to river and terrestrial systems, relating to the CICES group - *Regulation of physical, chemical, biological conditions,* was also well supported (23 papers of 92 reviewed). Supporting services such as biological diversity, primary production and larval/gamete supply were identified to be provided by all species, although this was often not the focus of the study. In all studies a reduction in abundance of diadromous fish caused a reduction in the level of provision of ES associated with the species, while presence or increased abundance provided an increase in provision of ES. Only in relation to lamprey presence was there an associated negative impact, as, although lamprey enhance provision of 'biological control' benefits (regulating ES), there is an associated negative impact on the host species (trout) in elevated water temperatures (Cline et al., 2014).

Studies in the European AA´s identify a decline in abundance, leading to a decline in the commercial fisheries supported by diadromous species. Overall, there was a focus on salmonids in the literature; diadromous species other than salmonids were only considered in a small number of studies. Reducing the macro-benthic species diversity resulted in a decrease of 8.88% in the number of adult salmon, thereby reducing Chinook salmon catch from 8,18kt to 8,14kt per year (Daniels et al., 2018). In addition to demand, climate change has been identified as a threat to maintaining delivery of provisioning services from diadromous species in Europe AA´s and globally for over a decade (Graham and Harrod, 2009, Cheung et al., 2012). A positive change in abundance is shown in studies to increase level of contribution to regulation and maintenance ESs, and likewise a decrease in abundance to limit provision of the ES within a river catchment. Transport of marine-derived nutrients to rivers and streams (and riparian vegetation) relating to: Regulation of physical, chemical, biological conditions – and decomposition and fixing processes and their effect on soil quality received the most research attention. Marine-derived carbon and nutrients are delivered to river systems through fish excretion, production of gametes as well as through decomposition of carcasses of fish dying post-spawning (Bottom et al., 2009, Dudgeon, 2010, Field and Reynolds, 2011, Gende et al., 2002, Graham and Harrod, 2009, Hammerschlag et al., 2019, Holmlund and Hammer, 1999, Kappel, 2005, Limburg and Waldman, 2009, Morton et al., 2017). In relation to: Physical and experiential interactions with natural environment - Physical use of land/seascapes in different environmental settings', recreational angling was the dominant cultural activity. The high historical contribution of diadromous fish populations to provisioning services, is reported to have shifted to a higher contribution to cultural services in recent years (Drouineau et al., 2018). For example, Haro et al. (2009) highlights the shift in economic contribution from commercial to recreational fishing in the Baltic region of Sweden, due to decreasing abundance of diadromous fish resources. From the results of the literature search, the largest contribution from diadromous fish populations to ES categories under CICES are likely to be to the cultural services category.

Classification of ES integrating the local empirical knowledge (LEK) and community values

One of the main outcomes when following the bottom-up approach is the observed gap between the potential ES which diadromous fish might provide to people and, the empirically identified ES which may not cover neither all ES nor all species for each region. LEK reflected the findings of the ER, with regards to the provisioning ES (biomass) provided by diadromous fishes, as salmon species and sea trout were the most prominent species relating to this ES in the ER and LEK. However, LEK responses also mentioned the commercial fisheries of European flounder, smelt and sturgeon across the AA´s case studies as important provisioning ES. However, as can be seen, in all the case studies there are not necessarily commercial fisheries and therefore the nutrient/biomass supply in these areas has been drastically reduced to zero. Thus, it is worth mentioning the case study that looks at the Gipuzcoan Rivers, where there are no commercial fisheries linked to these species. In addition, fisheries are not expected to recover in the future, pushing option values on biomass towards zero. However, other option values might include molecules or leathers as identified by stakeholders, but molecule or leather provision not currently identified as ES related to diadromous species in the literature reviewed in the ER, potentially being overlooked as ES related to diadromous fish.

This project is co-financed by the Interreg Atlantic Area Programme through the European Regional Development Fund.

Although in theory, all diadromous fish could be providers of food/biomass, approximately only one thirds (30%) of the potential commercial fisheries (nine diadromous fish are present in nine case studies) were identified to be providing this service according to LEK. Hence, only relying on the evidence in the scoping ER, of literature identifying ES provision from diadromous species within temperate northern hemisphere locations, might be misleading, as it provides a generalisation and gives provisional ES of food a higher importance then it has within individual estuary and river systems. However, it should be noted that, for example, some of these fisheries are non-existent currently due to fishing legislation which prohibits commercial fishing due to the past overexploitation of the stock resulting in currently low stock size. In contrast, in the LEK approach, local stakeholders pointed out the increasing relevance and the evidence of future leather and molecules provision, especially from sea lamprey for which no evidence was found in the scoping ER. However, there appears limited empirical knowledge or documentation of provision of these ES despite their identification in LEK responses.

The evidence provided by the scoping ER with regards to regulatory services results are more abundant than derived by the LEK approach. Stakeholders remarked that there is a lack of general evidence on these, although LEK responses recognized their existence and crucial relevance in supporting other ES. The ER results and LEK responses suggested that diadromous fish provide cultural ES with regards to recreational fishing. Evidence provided by the scoping ER suggested that recreational angling was mainly focused on salmon and/or sea trout. In contrast, in the LEK approach, the high spectrum of target species in the recreational fisheries across case studies in the AA included other diadromous species. In relation to other cultural ES, the scoping ER provided more evidence than the LEK approach, these included the importance and relevance of *Intellectual and representative interactions with natural environment - education and scientific knowledge.* However, in the LEK approach more emphasis was given to *Intellectual and representative interactions with natural environment - Gastronomy around species and emotional brotherhood, gastronomic events, art, and folklore*. The latter were mainly identified for Allis shad, Sea lamprey, European eel, and the Atlantic salmon. The Atlantic salmon was also the most frequent species to be identified with regards to providing cultural ES.

From evidence of ES provision to enhancing and integrating knowledge to aid management of natural resources

Understanding the value of diadromous fish species and the wider benefits they provide allows us to identify the relative cost and benefit of wider natural resources that support the species (other species, rivers, coastal areas etc.) and costs and benefits of management strategies. The ES identified in relation to diadromous species may provide complex interactions within natural systems as well as complex interactions between exploitation of ES benefits and the health of the natural resource providing the ES, such as a species population. For instance, Butler (2011) shows the example of salmon and seal populations, where a stand-off between beneficiaries of ES from two species occurs. Salmon fishery stakeholders see the seal population as a threat to the abundance of salmon available to the fishery, whereas marine mammal conservation groups and wildlife watchers oppose control of the seal population for the sake of the fishery, due to the existence value, wildlife watching and tourism benefits the seal population in northeast Scotland provides. Thereby, supply of certain cultural ES and beneficiaries (i.e. cultural: wildlife tourists/wildlife watching) may increase at the expense of the ES benefits provided by the salmon to commercial and recreational fishery stakeholders (i.e. cultural: anglers, ghillies, fishery owners, public; provisioning: netters, consumers). Auerbach et al. (2014) extend the previous example to consider not only interactions between species, but also, a higher-level of interactions that might occur in a natural system. For instance, social benefits derived from rivers might include ES benefits related to diadromous species but in current management contexts, other ES benefits are often considered with more emphasis, such as, floodplain, agriculture and cultural significance of the riverine biodiversity. In developing, for instance, river-water infrastructures (dams, levees, canals) and related management strategies, all activities within the

This project is co-financed by the Interreg Atlantic Area Programme through the European Regional Development Fund.

ecosystem are required to be considered (e.g. hydropower generation, thermoelectric cooling, transportation of people and materials, recreation, pollutant removal etc.). However, trade-offs often occur, with certain benefits prioritized (energy production, flood prevention, agriculture) or not fully assessed against costs and benefits to ES benefits provided by the river system, and particularly, in the scope of this review, diadromous fish. Decision makers should at least understand the nature and volume of these trade-offs (i.e. dams alter sediment regimes and disrupt reproductive cues and migrations fundamentals for diadromous fish). Current management is not completely foreign to the identification of ES related to diadromous fish, but as Morton et al (2017) suggest for Columbia Rivers, sometimes the current management might consider a re-prioritization of the hydropower production which is pushing a loss of net economic benefits from diadromous ES (fishing, angling, nutrient cycling etc.). More general, Pope et al. (2016) remark that if wider ecosystem costs and benefits are initially undetected, the complete loss of certain ES might result if an ecosystem-based management is not adopted. These authors identified the decision of introducing a fish ladder on the Landsburg Dam at Rock Creek, USA, to recolonize the salmon in the area, provided additional provisional and cultural (via angling) ES. The work of Semmens et al. (2011) is key for showing the relevance of establishing ecological linkages between multiple areas that diadromous fishes utilize as essential habitats. Quantifying ES that diadromous fish species contribute to multiple areas will allow for a development of the integrated spatial management. Local benefits may also depend on provision of ES in other areas, when provision and use of the ES are not located at the same area. This cross-border nature of flow of ES benefits (listed and quantified) related to highly migratory fish species should also be acknowledged and relevant policy and regulations adopted by policymakers.

Finally, an even more important than the lack of monetary assessments is the challenge of empirical knowledge integration in decision-making processes. Almost none of the reviewed papers involved stakeholders in ES identification and monetary assessments. Hattan et al. (2015) remarks that not all experts are familiar with the ES terminology, which implies the necessity of making an additional effort when involving them. By combining review of evidence of ES provision from diadromous species in existing literature with stakeholder LEK, and guided critical review of ES identified in existing literature with stakeholders, greater awareness of the ES benefits provided by diadromous species and the ES frameworks applied by scientists has been shared.

This project is co-financed by the Interreg Atlantic Area Programme through the European Regional Development Fund.

Table 1. Level of contribution of diadromous species to provision of ES (within categories)

Section	CICES 5.1 Division/group/class	Anadromous (see Table 1)								Catadromous (see Table 1)		
		Salmon	Brown / sea trout	Sturgeon	Smelt	Allis Shad	Twaite Shad	Sea Lamprey	River Lamprey	Eel	Flounder	Mullet
Provisioning	**Biomass** (wild animals and their outputs)	3	3	3	3	3	3	3	3	3	3	3
Regulation and Maintenance	Transformation of biochemical or physical inputs to ecosystems – **Bioremediation by micro-organisms, algae, plants, and animals**	3	1									
	Regulation of physical, chemical, biological conditions – **regulation of the chemical composition of freshwaters by living processes**	3	3	3	3	3	3	1	1	1	1	1
	Regulation of physical, chemical, biological conditions – **nutrient cycling (marine to terrestrial)**	3	3	3	3	3	3	3	3	3	3	3
	Decomposition and fixing processes and their effect on soil quality	3	3	3	3	3	3			1		
	Maintaining nursery populations and habitats (including gene pool protection)	3	3	3	3	3	3	3	3			
Cultural	Physical and experiential interactions with natural environment - **Physical use of land/seascapes in different environmental settings**	3	3	3	3	3	3	3	3	3	3	3
	Intellectual and representative interactions with natural environment – Characteristics of living systems that enable **scientific investigation or the creation of traditional ecological knowledge**	3	2	2	2	2	2	2	2	2	2	2
	Intellectual and representative interactions with natural environment – Characteristics of living systems that enable **education and training**	1	1	1	1	1	1	1	1	1	1	1
	Intellectual and representative interactions with natural environment – Characteristics of living systems that are resonant in terms of **culture or heritage**	3	3	3		3	3	3	3	3		
	Intellectual and representative interactions with natural environment – Characteristics of living systems that enable **aesthetic experiences**	3	3							3		
	Intellectual and representative interactions with natural environment – Elements of living systems that have **symbolic meaning**	3										
	Intellectual and representative interactions with natural environment – Elements of living systems that have **sacred or religious meaning**	3										

This project is co-financed by the Interreg Atlantic Area Programme through the European Regional Development Fund.

Section	CICES 5.1 Division/group/class	Anadromous (see Table 1)								Catadromous (see Table 1)		
		Salmon	Brown / sea trout	Sturgeon	Smelt	Allis Shad	Twaite Shad	Sea Lamprey	River Lamprey	Eel	Flounder	Mullet
	Intellectual and representative interactions with natural environment – Characteristics or features of living systems that have an **existence value**	3	3	1	1	1	1	1	1	1	1	1
	Intellectual and representative interactions with natural environment – Characteristics or features of living systems that have an option or **bequest value**	3	3	1	1	1	1	1	1	1	1	1
Other Supporting services **Other Regulating services**	**Primary production**	3	3	1	1	1	1	1	1	1	1	1
	Biological diversity	3	3	3	3	3	3	3	3	3	3	3
	Biological control							3	3			
	Larval /Gamete supply	1	1	1	1	1	1	1	1	1	1	1

Scale of ecosystem service supplied relative to other features		Confidence in evidence	
#	Significant contribution	3	AA´s relevant - Peer-reviewed literature
#	Moderate contribution	2	Grey literature or evidence from outside AA´s sites
#	Low contribution	1	Expert opinion
#	No or negligible ecosystem service provision		Not assessed
	Not assessed		

This project is co-financed by the Interreg Atlantic Area Programme through the European Regional Development Fund.

Table 2. ES provided by diadromous fish according to the expert knowledge (following MEA classification)

ES identification				Species		Case Studies Atlantic Area								
MEA classification	**CICES 5.1 Division/group/class**	**ES (expert knowledge)**	**Nb.**	**Diadromous fish**	**Nb.**	**Ulla catchment**	**Gipuzcoan rivers**	**Minho catchment**	**Mondego catchment**	**Gironde/Garonne/ Dordogne system**	**Loire catchment**	**Normand-Breton Bay/Gulf**	**Tamar (T), Frome (F) and Taff (Ta) rivers**	**Waterford harbour and the three sisters' rivers**
						8	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**9**
Provisioning services	**Biomass** (wild animals and their outputs)	**Food provision**	1	Allis shad	1a			X	X		X			
				Twaite shad	1b			X		X	X			
				Sea lamprey	2a	X		X	X	X	X			
				River lamprey	2b						X			
				European eel	3	X		X	X	X	X		X (T, F, Ta)	X
				Atlantic salmon	4			X					X (T, F)*	X
				Sea trout	5								X (T,F)*	
				European sturgeon	6									
				Thin lipped grey mullet	7			X	X		X		X (F)	
				European smelt	8									
				European flounder	9	X		X		X				
				Thin lipped grey mullet	7						X	X		
		Option value (Leather provision)	3											
		Option value (molecules provision)	4	Sea lamprey	2a	X**								
	Physical and experiential interactions with natural environment **Intellectual and representative interactions with natural environment**	**Recreation sport fishing**	5	Allis shad	1a			X	X			X		
				Twaite shad	1b	X		X	X	X				X
				Sea lamprey	2a				X					
				River lamprey	2b				X					
				European eel	3		X							
				Atlantic salmon	4	X		X					X (T, F, Ta)	X
				Sea trout	5	X	X	X					X (T, F, Ta)	X
				European sturgeon	6									
				Thin lipped grey mullet	7	X	X	X					X (T, F, Ta)	
				European flounder	9		X	X					X (T, F, Ta)	X
				Other species	---									X
		Sport fishing competitions	6	Atlantic salmon	4	X							X(Ta)	

This project is co-financed by the Interreg Atlantic Area Programme through the European Regional Development Fund.

ES identification				Species		Case Studies Atlantic Area								
MEA classification	CICES 5.1 Division/group/class	ES (expert knowledge)	Nb.	Diadromous fish	Nb.	Ulla catchment	Gipuzcoan rivers	Minho catchment	Mondego catchment	Gironde/Garonne/ Dordogne system	Loire catchment	Normand-Breton Bay/Gulf	Tamar (T), Frome (F) and Taff (Ta) rivers	Waterford harbour and the three sisters' rivers
Cultural services				Sea trout	5				X				X(Ta)	
		Option value (fishing competitions)	7	European flounder	9								X(T, F)	X
				Twaite shad	1b									X
	Spiritual, symbolic, and other interactions with natural environment	Spiritual experience (including emotional benefits	8	European eel	3		X							
	Intellectual and representative interactions with natural environment – Characteristics of living systems that are resonant in terms of culture or heritage	Gastronomy around species and emotional brotherhood	9	Allis shad	1a			X	X					
				Twaite shad	1b	X		X						
				Sea lamprey	2a	X		X	X	X				
				River lamprey	2b									
				European eel	3	X	X	X	X					
				Atlantic salmon	4	X								
		Gastronomic festival or events	10	Allis shad	1a			X	X	X				
				Twaite shad	1b			X		X				
				Sea lamprey	2a	X		X	X	X				
				European eel	3	X		X	X					
				European flounder	9	X		X						
		Art and folklore	11	Allis shad	1a								X(T)	
				Sea lamprey	2a	X								
				Atlantic salmon	4	X								X
				European Smelt	8								X(T)	
		Local identity art benefits (songs, literature, painting, city emblems…)	12	Allis shad	1a									
				Twaite shad	1b									
				Atlantic salmon	4					X				
				Sea lamprey	2a	X			X					
				European sturgeon	6					X				
		Traditional know-how,	13	Sea lamprey	2a	X			X		X			
				European eel	3	X	X		X	X				
				Atlantic salmon	4								X(T, F)	

This project is co-financed by the Interreg Atlantic Area Programme through the European Regional Development Fund.

ES identification				Species		Case Studies Atlantic Area								
MEA classification	CICES 5.1 Division/group/class	ES (expert knowledge)	Nb.	Diadromous fish	Nb.	Ulla catchment	Gipuzcoan rivers	Minho catchment	Mondego catchment	Gironde/Garonne/ Dordogne system	Loire catchment	Normand-Breton Bay/Gulf	Tamar (T), Frome (F) and Taff (Ta) rivers	Waterford harbour and the three sisters' rivers
Cultural services				Sea trout	5								X(F)	
				Diadromous fish	--					X				
	Characteristics or features of living systems that have an existence value	Natural heritage and natural diversity – the existence value	14	Allis shad	1a				X					
				Twaite shad	1b				X					X
				Sea lamprey	2a				X					
				European eel	33				X					X
				Thin lipped grey mullet	7				X					
				All species (full assemblage of fishes)	----					X			X (T,F,Ta)	
	Characteristics of living systems that enable scientific investigation or the creation of traditional ecological knowledge Characteristics of living systems that enable education and training	The potential for environmental education and research	15	Allis shad	1a				X				X (T)	
				Twaite shad	1b	X			X					X
				Sea lamprey	2a				X					
				European eel	3	X	X		X		X		X (T,F,Ta)	X
				Atlantic salmon	4	X	X	X					X (T,F,Ta)	X
				Sea trout	5								X (T,F)	
				Thin lipped grey mullet	7				X					X
Regulating and Supporting services	Food web control		16	European eel	3								X (T,F,Ta)	
				Atlantic salmon	4								X (T,F,Ta)	
	Redistribution of fluxes, nutrient regulation (i.e. energy and matter, upstream, downstream inputs,)		17	Allis shad	1a	X	X	X	X	X	X	X	X (T)	
				Twaite shad	1b				X	X				X
				Sea lamprey	2a				X				X (T,F,Ta)	X
				European eel	3				X				X (T,F,Ta)	X
				Atlantic salmon	4								X (T,F,Ta)	X
				Sea trout	5								X (T,F,Ta)	X
				Thin lipped Grey mullet	7				X					X
				European smelt	8								X(T)	X
	Biological cycle (i.e. other species biological cycle participation)		18	Allis shad	1a								X(T)	
				Twaite shad	1b									

This project is co-financed by the Interreg Atlantic Area Programme through the European Regional Development Fund.

ES identification				Species		Case Studies Atlantic Area								
MEA classification	CICES 5.1 Division/group/class	ES (expert knowledge)	Nb.	Diadromous fish	Nb.	Ulla catchment	Gipuzcoan rivers	Minho catchment	Mondego catchment	Gironde/Garonne/ Dordogne system	Loire catchment	Normand-Breton Bay/Gulf	Tamar (T), Frome (F) and Taff (Ta) rivers	Waterford harbour and the three sisters' rivers
				Sea Lamprey	2a								X (T,F,Ta)	X
				European eel	3								X (T,F,Ta)	X
				Atlantic salmon	4								X (T,F,Ta)	X
				Sea trout	5								X (T,F,Ta)	
				Thin lipped grey mullet	7				X					
				European Smelt	8								X(T)	
	Sediment turnover and formation		19	Sea lamprey	2a								X (T,F,Ta)	X
				River lamprey	2b								X (T,F,Ta)	X
				Atlantic salmon	4								X (T,F,Ta)	X
				Sea trout	5								X (T,F,Ta)	X

(*) Salmon or sea trout catches from commercial fisheries allowed until 2018, so no more provisional services from 2019.

(**) To potentially explore this unknown current value in some Atlantic case studies.

This project is co-financed by the Interreg Atlantic Area Programme through the European Regional Development Fund.