

## Marine Institute Job Description

<b>Position</b>	<b>Temporary Post-Doctoral Researcher – DiadSea (Interreg) Project</b>
<b>Grade &amp; Contract</b>	<b>Specified purpose contract (Post-Doctoral Researcher) for a maximum duration of 29 months up to end October 2026 (Interreg Atlantic Area DiadSea Project).</b>
<b>Service Group</b>	<b>Fisheries &amp; Ecosystems Advisory Services</b>
<b>Location</b>	<b>Marine Institute, Newport, Co. Mayo, Ireland The Marine Institute has a Blended Working Policy in Place</b>

### Who will you Work With and What Will The Role Involve?

The Post-Doctoral Researcher (PDR) will work with scientists specialising in migratory diadromous fish and in ocean and climate modelling. The role will be part of a wider consortium of scientists and stakeholders from Portugal, Spain, France and Ireland undertaking the Interreg funded DiadSea project.

DiadSea will build transnational marine management and conservation strategies for diadromous fish (DF) in the Atlantic Area (AA). DF occur in two different habitats (fresh and marine) presenting significant management, conservation and societal challenges. They occur along the AA but there is a lack of joint solutions to mitigate common threats exacerbated by climate change. DiadSea will complement the work from a previous project, DiadES, which focused on freshwater habitats, by focusing on the marine environment where there are serious knowledge gaps and where fewer management and conservation actions directed to DF take place. DiadSea will map the distribution of DF at sea and identify important areas for these species, apply the latest ocean and climate models to predict the future of these stocks, create a large-scale DF Observatory, and conduct related dissemination actions. By protecting biodiversity, DiadSea will bring socioeconomic and cultural benefits for local communities.

The Marine Institute, supported by this post-doctoral researcher (PDR), will participate in all five work packages in the project, but our main focus will be on Work Package 1 (Biological Data Collection) and Work Package 2 (Innovative Methods to fill Gaps in Data-poor species).

WP1 will aim to fill various data gaps in distribution and abundance and in parameters required for other work packages such as presence/absence, genetics and growth. The MI will mine various international fisheries databases and will also provide an information sheet to fisheries fleet and bycatch observers, and scientists on fisheries independent surveys in the hope to broaden the collection of information. You will work with scientists in our fisheries group to collate data on diadromous fish observations in fisheries catch data, and in fisheries independent surveys such as the Irish Ground Fish Survey. Other data gaps, such as

fish growth extracted from fish scales and the supply of samples and eDNA to other partners will also be part of the role.

In WP2, The Marine Institute will carry out an Irish case study with a collaboration between the MI Ocean Services and Climate Change Group and the diadromous fish group in FEAS based in Newport Co. Mayo (see full description in the Annex). This case study will involve longterm datasets (fish and environmental) collected in Newport (Burrishoole) and oceanographic modelling capacity in Galway to examine the environmental drivers in freshwater and marine that may be influencing salmon and sea trout growth and survival. Future climate scenario modelling will be a key output from this WP. WP2 will be the main responsibility of the PDR and will be in full collaboration with researchers in the MI OCIS group based in Galway.

This position requires a background in marine, or a related science, good mathematical ability and previous experience in ecological and environmental/climatological modelling, statistics, good organizational skills, and a willingness to undertake both desk based study and field and coastal boat work.

DiadSea Workpackages:

1	Biological Data Collection	01/10/2023	31/05/2026
2	Innovative Methods to fill Gaps in Data-poor Species	01/10/2023	30/09/2026
3	Assessment of Priority Areas for Conservation	01/03/2024	30/09/2026
4	Transnational Management of Diadromous Fishes	01/11/2023	30/09/2026
5	Tools for Capacitation and Capitalization towards DF Sustainability	01/03/2024	30/09/2026

## What Will You Be Doing Every Day?

### Principal Tasks:

The PDR will be involved in all of the project's 5 work packages:

#### WP1

- Co-ordinate and collate data on occurrences of diadromous fish in commercial and recreational fisheries
- Provide Marine Institute data, where relevant, into the DiadSea databases
- Provide sample material for the development of an international sea trout genetic database

#### WP2

- Provide eel samples to the MNHN partner for determination of eel maternal origin and panmixia hypothesis.
- Lead the WP2 A2.4 Case Study on Dynamic Salmonid Ocean Climate Modelling – see annex
- Oversee and download CTD sensors located in Clew Bay and carryout regular (~every 3 months) temperature, salinity and oxygen profiles at set locations in Clew Bay

- Assist in QC and management of the Clew Bay environmental data
- Work with fish biologists in the Burrishoole River, Newport, Ireland and the Bresle and Oir Rivers, France, to identify, parameterise and develop possible migration timing and impact models for salmon and sea trout. Longterm data for migrations of upstream returning adult salmon and trout, and downstream outgoing juvenile salmon and trout smolts will be used to examine interannual variability and possible impacts of size and frequency of extreme events.
- Analyse physical ocean and coastal sea parameters such as incoming freshwater and sea surface temperatures, salinity, coastal currents and retention zones and utilise in a new hydrographic model for the Clew Bay area (Nagy et al. 2023), to examine sea conditions pre- and during the smolt run and post-smolt periods.
- Utilise data from the Copernicus Marine Environmental Monitoring service (CMEMS) (1993-2021) will be used to examine changes in physical oceanographic and biogeochemical conditions in the Atlantic area of importance to DF.
- Contribute to and utilise data held in the international SalHub database to yield insights into environmental drivers of importance to DF, at least for salmon but the parameters in SalHub would have relevance for other DF such as sea trout.
- Deliver a forecast model of fish dynamics and ocean climate change along with the operational hydrodynamic model of the Clew Bay area to enable additional scenario testing and process studies.
- Deliver a forecast model of fish dynamics and ocean climate change along with the operational hydrodynamic model of the Clew Bay area to enable additional scenario testing and process studies.
- Produce a report with all the Team: Report on variability of salmon and sea trout migrations to and from the sea
- Produce a report with all the Team: Report on factors influencing DF performance in the sea
- Take note of Project outputs listed in D10 – see Annex

#### **Other Tasks**

- Provide inputs to WPS 3-5 as required.
- Prepare reports, publications, and other relevant project outputs.
- Attend project meetings as required.
- Assist with management of the timesheets and finances, supporting the project leads and the research project finance officer.
- Day to day coordination of the project to ensure the deliverables and milestones are achieved.

### **What do You Need to Have Done to Apply for This role? (Education, Professional or Technical Qualifications, Knowledge, Skills, Aptitudes, Experience and Training)**

#### **Essential / Important:**

- A PhD in either mathematics, environmental science, ecological modelling or similar related discipline.
- Previous relevant experience in ecological modelling and environmental climate research
- Excellent numerical and literacy skills.
- The ability to be well organised and work to deadlines identifying priorities and managing time effectively.
- A high level of computer literacy and computer programming (R, MATLAB, PYTHON, QGIS).

- Experience in the application of statistical modelling techniques to ecological data
- Familiarity with collaborative programming tools (e.g. GITLAB)
- The ability to communicate effectively in English, both written and verbally.
- The ability to work unsupervised and to work well with others.
- Willingness and ability to work at sea
- Full clean driving licence.

#### **Ideally Nice to Have / Desirable:**

- Experience in delivering related fisheries or environmental research projects especially with focus on impact and time series modelling.
- Track record in preparing technical reports and scientific publications.

#### **What else do you need to know?**

##### **(Special personal attributes required for the role)**

- An analytical approach to problem solving.
- An ability to work in an organised manner and progress work independently.
- Self-starter, dynamic and reliable.
- Self-sufficiency, while being a good team player.
- Good interpersonal skills.
- Ability to effectively communicate results of teamwork in written and audio-visual formats.

#### **Description of Service Groups: Fisheries Ecosystems Advisory Services (FEAS) and Ocean Climate Information Services (OCIS) – The Wider Team**

##### **Fisheries Ecosystem Advisory Services - FEAS**

The Fisheries Advisory Ecosystems Services (FEAS) mission is “to assess research and advise on the sustainable exploitation of marine fisheries resources. The Service group operates a significant part of their services from the headquarters in Oranmore, Co. Galway with additional port based facilities and a major research facility at Newport, Co Mayo. FEAS staff spend a considerable amount of time at sea. A key element of FEAS work is the provision of scientific support for the Irish government (principally the Department of Agriculture, Food and the Marine – DAFM) Aquaculture and on marine fisheries ecosystems related issues and an important output of FEAS is the annual Stock Book and the annual Shellfisheries Stock Book. These provide the latest assessment and scientific advice for the resources exploited by Irish vessels and is a key reference for the Governments annual sustainability assessment. FEAS also publish much of its work in peer reviewed scientific journals.

FEAS staff actively participate at many meetings of the International Council for the Exploration of the Seas (ICES). ICES organises many Expert Groups, Study Groups and co-ordination Groups related to provision of scientific advice on marine ecosystems. ICES is focused on advancing scientific understanding of marine ecosystems, providing information, knowledge and advice on the sustainable management of human activities affecting and affected by marine ecosystems. ICES is a key forum for scientific co-ordination of data collection and the provision of independent scientific advice.

FEAS also participate at other international fora including STECF (Scientific, Technical and Economic Committee for Fisheries), NEAFC (North East Atlantic Fisheries Commission) and NASCO (North Atlantic Salmon Commission). FEAS provide scientific support for DAFM at various EU meetings (e.g. the EU Norway

Agreements and the EU Council of Fisheries Ministers). In addition, FEAS is responsible for the salmon National Coded Wire Tagging and Tag Recovery programme and working closely with [IFI](#) (Inland Fisheries Ireland) on the Technical Expert Group on Salmon and the Technical Expert Group on Eel.

**Burrishoole Newport Co. Mayo:** The Marine Institute operates a research facility in the Burrishoole catchment, Co. Mayo, which is one of the few index sites for diadromous fish in the North Atlantic region. Burrishoole is a small (100 km<sup>2</sup>) upland catchment in the west of Ireland (53° 56' N, 9° 35' W) draining into the North-east Atlantic through Clew Bay. The region experiences a temperate, oceanic climate with frequent episodic events driven by Atlantic depressions. Declines of the Burrishoole's native diadromous fish (Atlantic salmon *Salmo salar*, anadromous brown trout *Salmo trutta*. and European Eel *Anguilla anguilla*) have been noted in recent years, and evidence is mounting that part of these declines are linked with oceanic climate change. In Burrishoole, climate impacts on the freshwater stages of diadromous fish populations are also apparent. In order to supplement the fisheries data, the Burrishoole site has a well-established environmental monitoring programme to continuously monitor essential climate and aquatic variables. A combination of the fisheries data, environmental monitoring and the genetic resources provide the opportunity to add significant value to the advisory capacity on diadromous fish populations. This is an area which is crucial for the conservation of these stocks, and the management of the catchments and waterbodies which they populate and for the future culture opportunity for salmon and trout.

#### **Ocean Climate and Information Services – OCIS**

Oceans, Climate and Information Services provide support for national and international marine monitoring and research and development as well as Information Technology infrastructure and information management. The mission of OCIS is *“To provide scientific, operational and analytical support and services to strategic RTDI and statutory monitoring programmes (at national and international level) to promote and support the sustainable development of Ireland’s marine resources”*

Ocean Science and Information Services incorporates:

- Information Services & Development
- Advanced Mapping Services
- RV Operations
- Oceanographic and Climate Services
- Marine Research Infrastructures

Oceanographic and Climate Services provide comprehensive oceanographic services, within the Marine Institute and externally to industry, third level partners and the public. The team are responsible for the operation and maintenance of the National Weather Buoy Network, consisting of five buoys around the Irish coast. The team also manages and supports the Irish tide gauge network, ocean modelling, satellite remote sensing, coastal buoys, oceanographic equipment pool and oceanographic support of diverse seagoing research programmes related to marine fisheries and environment.

A number of hydrodynamic and ecosystem models are run at the Marine Institute to produce short range forecasts and to build up a database of modelled data to support marine research. This modelling underpins a wide variety of activities such as support for aquaculture site planning and monitoring, assisting the police in marine-related incidents, and the production of maps of environmental indices such as seabed kinetic energy. The team also carries out modelling within the context of EU projects to address areas such as oil spill forecasting, shellfish growth and pathogen contamination, and harmful algal bloom warnings.

### Who Will You Report to / Who will Manage and Support You?:

The successful candidate will be based at the Marine Institute in Newport, Mayo and will directly report to the Marine Institute's project lead on DiadSea, Dr. Russell Poole.

### What we offer

We value our staff, and we value their contribution to the work of the Marine Institute. In return for this, we provide benefits that promote a healthy work-life balance and which we hope will help them to develop professionally. These include personal and career development, work/life balance policies, an employee assistance programme, "Bike to Work" Scheme, staff medicals and annual flu vaccination.

#### **Training**

A full range of training will be provided as required, on the job and through appropriate courses. Training needs will be identified through the MI Performance Management Development System (PMDS).

### Contacts:

The candidate will have close interactions with the MI based Project Team in FEAS Newport and OCIS Galway. The candidate will be based within the MI's FEAS group in Newport and will interact with other staff working in Burrishoole and the wider MI. Much of the ocean modelling work will take place under the supervision of OCIS team in Galway. The candidate will also interact considerably with the DiadSea project team including; the Project Leads for WP1 Dr. Ciara O'Leary IFI, WP2 Dr. Bernardo S Quintella FCUL and WP3, Dr. Clarisse Boulenger INRAE

#### **Within the Marine Institute:**

FEAS staff in Newport, DiadSea SM Russell Poole, STO Elvira de Eyto

OCIS staff in Galway, DiadSea SM Glenn Nolan, STO Tomasz Dabrowski

Corporate Services and Finance and staff of the Marine Institute.

#### **External:**

DiadSea project Team

Inland Fisheries Ireland

Stakeholders to the DiadSea project

Fisheries Stakeholders for data collection

### Salary:

Remuneration is in accordance with the Public Sector, Department of Finance approved Salary Scale for a Post-Doctoral Researcher, with a full time salary scale running from €44,347-€50,805 per annum, pro-rated with time worked. You will become a member of the Single Public Service Pension Scheme unless you are currently or have worked in the Public Sector in the past 6 months and are a member of another Public Sector Scheme.

## Annual Leave:

Annual leave entitlement for a Post-Doctorate Researcher Grade is 24 working days per annum pro-rated to reflect time worked. Annual leave entitlements are exclusive of Public Holidays. All leave must be approved in advance in line with Marine Institute leave policies and using time and leave management system in place, by your manager or their authorized representative

## Duration of Contract:

This temporary specific purpose contract of employment will be for a maximum 29 month period up to the 31<sup>st</sup> October 2026. The successful candidate will be on probation for the first six months of this contract.

## Who is the Marine Institute?

The Marine Institute is a non-commercial semi-state body, which was formally established by statute (Marine Institute Act, 1991) in October 1992.

Under the Act, the Marine Institute was given the responsibility:

*“to undertake, to co-ordinate, to promote and to assist in marine research and development and to provide such services related to marine research and development, that in the opinion of the Institute will promote economic development and create employment and protect the marine environment”.*

The Marine Institute is the national agency responsible for marine research, technology, development and innovation (RTDI). The Marine Institute seeks to assess and realise the economic potential of Ireland’s 220-million-acre marine resource; promote the sustainable development of marine industry through strategic funding programmes and scientific services; and safeguard the marine environment through research and environmental monitoring. The Institute works in conjunction with the Department of Agriculture, Food and Marine (DAFM) and a network of other Government Departments, semi-state agencies, national and international marine partners.

***Our vision - The Marine Institute, as a global leader in ocean knowledge, empowering Ireland and its people to safeguard and harness ocean wealth.***

***Our Mission - The Marine Institute, provides government, public agencies and the maritime industry with a range of scientific, advisory and economic development services that inform policy-making, regulation and the sustainable management and growth of Ireland’s marine resources. The Institute undertakes, coordinates and promotes marine research and development, which is essential to achieving a sustainable ocean economy, protecting ecosystems and inspiring a shared understanding of the ocean.***

In order to achieve this vision, the MI have six service areas; (1) Ocean, Climate and Information Services, (2) Marine Environment & Food Safety Services, (3) Fisheries Ecosystems Advisory Services, (4) Irish Maritime Development Office, (5) *Policy, Innovation and Research Services* and (6) Corporate Services.

The Marine Institute 5 Year Strategic Plan (2023 to 2027) is available [Here](#)

## How to Apply:

A C.V. and letter of application, summarising experience and skill set applicable to the position should be emailed to [recruitment@marine.ie](mailto:recruitment@marine.ie) or posted to Human Resources at the Marine Institute, Rinville, Oranmore, Galway. All correspondence for this post should quote reference **FEAS/PDR/INTERREG/JUN24**

### **Closing date for Applications:**

All applications for this post should be received by the Marine Institute in advance of **12 noon, Wednesday 19<sup>th</sup> of June 2024**. Unfortunately, late applications cannot be accepted.

**Use of Data** - all personal data and the information submitted for this application will be used solely for the purpose of this campaign, after which it will be deleted in line with our General Data Protection Regulation Policy and data retention schedule. All information will be treated with the strictest confidence and accessed only by those involved directly in the campaign.

**The Marine Institute is an organisation that champions Diversity, Inclusion & Equality for all. We encourage and welcome applications from anyone interested in this role. Please do advise if there are any special accommodations required for the recruitment process. We are here to help you access opportunities with us.**

### **Annex: WorkPackage 2: Dynamic Salmonid Ocean Climate Modelling**

This activity will be divided in 2 tasks, as described below:

**Task a (Freshwater):** The Burrishoole catchment (western Ireland) is a long-term index river for the daily counting and measuring of salmonids (*e.g.*, Cotter et al., 2022; Poole et al., 2006). This task will examine the long-term census datasets collected over a 50+ year period for salmon and sea trout leaving and returning to the Burrishoole River along with the environmental conditions (*e.g.*, temperature, salinity, river flow, tidal currents, local weather) in both freshwater and in the sea prior to and during their sojourn in each habitat and their transition from one to the other.

Studies have indicated changes are occurring in migration timing both as downstream migrating smolt (juveniles migrating to sea to start the oceanic feeding stage), but more dramatically as adults returning from the sea to spawn in rivers (de Eyto et al., 2022). This task will examine the inter-annual variability of juvenile smolt migration timing of salmon and sea trout, fish size and annual marine survival and will analyse these in a multi-species model. Outputs of this model will be used, along with other information on age, growth and survival, in the hindcast/forecast projections. Daily data on water temperature, water level (river flow) and meteorological parameters (*e.g.*, rainfall, air temperature, barometric pressure, sunshine hours) will be tested against this multi-species model of migration in order to select the main drivers of variability in run timing, growth and survival.

Sea trout scales collected in the fish traps in Burrishoole and held in the scale archive (Tray et al. 2020) will be used in the calculation of growth rates. Scales are available for most decades since the 1950s, these will be digitised and used to calculate smolt growth and post-smolt sea growth. This task has synergies with task 1.3a2.

**Task b (Marine):** In this task physical ocean and coastal sea parameters such as incoming freshwater and sea surface temperatures, salinity, coastal currents and retention zones will be analysed and utilise in a new hydrographic model for the Clew Bay area (Nagy et al. 2023), to examine sea conditions pre- and during the smolt run and post-smolt periods.

Significant changes in both the Atlantic salmon and the sea trout stocks have taken place in the Burrishoole, often indicative of changes occurring throughout the species range. The sea trout stock collapsed in the late 1980s, with the spawning stock dropping from 1000s to only 224 fish in 1989. The stock has failed to recover and is currently at an all-time low. The stock collapse in Burrishoole, and many rivers in the west of Ireland, Scotland and Norway, was associated with a collapse in marine survival due to sea lice infestation (Gargan et al., 2006), an external parasite emanating from salmon farms and possibly exacerbated in warmer years. This illustrates the potential for changes in climate to create cumulative effects, which can strongly impact on the resilience of populations already under pressure. Using the 50+ years of trout and salmon migration data, a hind-cast model of factors likely to be influencing migration phenology, growth and survival of salmonids in the greater Clew Bay area will be developed. Data from freshwater including temperature and water level and from local synoptic weather stations will also be incorporated into the modelling, especially with a view to analysing the impact of adverse or extreme events on the migrations and survival of smolt and post-smolt in the sea (Data: e.g., Dillane et al. 2018; <http://www.marine.ie/site-area/data-services/real-time-observations/integrated-marine-observations>). This hind-cast model could be a gateway into future projects on the impact of climate and ocean change on the success of these DF stocks. ISIMIP/CMIP climate projections will be used and locally downscaled data will facilitate dynamic modelling (Nagy et al., 2021). Findings could potentially be transferred to other species throughout the project timeframe.

Data from the Copernicus Marine Environmental Monitoring service (CMEMS) (1993-2021) will be used to examine changes in physical oceanographic and biogeochemical conditions in the Atlantic area of importance to DF. Data would include gridded time series of temperature, salinity, currents and net primary productivity. Data sets such as ChlA (phytoplankton), inshore phytoplankton data (e.g., MI toxic algae monitoring), and offshore zooplankton data (<https://www.cprsurvey.org/>) will be incorporated into the models where possible.

MI will also contribute to and utilise data held in the international SalHub database to yield insights into environmental drivers of importance to DF, at least for salmon but the parameters in SalHub would have relevance for other DF such as sea trout.

The MI (P4) has overall responsibility for this action, and plans collaboration between MI fisheries and ocean climate groups and between other partners within the project consortium, such as INRAE, where expertise and data exist. It is planned to incorporate data or research outputs from other Partners such as for the River Bresle in France (INRAE, task 1.3a2) in order to assess with wider applicability of the results outside of the Burrishoole, West of Ireland area.

### **Output - Forecast model of fish dynamics and ocean climate change for sea trout and Atlantic salmon.**

This activity will deliver a forecast model of fish dynamics and ocean climate change along with the operational hydrodynamic model of the Clew Bay area to enable additional scenario testing and process studies. It will consist of a description and analysis of the long-term population metrics (run timing, size, age, growth rate, survival) of the west of Ireland sea trout, and salmon, it will fill a data gap on sea trout behaviour and growth in the sea (already studied in the area for salmon) and will produce a dynamic model analysing the possible environmental variables in freshwater and the sea which might influence the performance of those stocks, especially under the added pressures of climate and ocean change.

This model will also identify a suite of environmental data sets, weather, freshwater and marine identified as potential drivers of variability and this information will be fed into a hindcast/forecast model for projections on how a changing ocean might be expected to influence these DF into the future.

#### **D10 - Analysis reports and projections composed by:**

- Report on variability of salmon and sea trout migrations to and from the sea: An analysis of the daily run timing of juvenile and adult salmon and sea trout in the Burrishoole and a number of other rivers (if data are available), including inter-species and inter-annual variability. This will examine the environmental variables, such as water flow, water temperature, moon phase, time of year and their influence on the timing of fish movement. This will set the baselines for the marine modelling work
- Report on factors influencing DF performance in the sea: An analysis of physical ocean and coastal sea parameters such as incoming freshwater and sea surface temperatures, salinity, coastal currents and retention zones, and utilise a new hydrographic model for the Clew Bay area to examine sea conditions pre- and during the smolt run and post-smolt periods.
- Projections on the possible future under different ocean/climate scenarios: The data and information from Output O8 will be combined with local weather and future climate and ocean scenarios to examine the impact of extreme events/years on migration and performance of diadromous fish (salmon, sea trout), and to inform possible future scenarios for DF at sea. The hind-cast models could be a gateway into future projections on the impact of climate and ocean change on the success of these DF stocks. ISIMIP/CMIP climate projections will be used and locally

downscaled data will facilitate dynamic modelling. Findings could potentially be transferred to other species throughout the project range.

## References

Cotter D., Vaughan L., Bond N., Dillane M., Duncan R., Poole R., et al. (2022). Long-term changes and effects of significant fishery closures on marine survival and biological characteristics of wild and hatchery-reared Atlantic salmon *Salmo salar*. *Journal of Fish Biology*, 101, 128–143.

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Gargan P., Poole W.R. & Forde G. (2006). A review of the status of Irish Sea trout stocks. In: *Sea Trout: Biology, Conservation and Management*. (Ed. N.M. Graeme Harris), pp. 25–44. Blackwell, Oxford.

Poole W.R., Dillane M., de Eyto E., Rogan G., McGinnity P. & Whelan K. (2006). Characteristics of the Burrishoole Sea Trout Population: Census, Marine Survival, Enhancement and Stock-Recruitment Relationship, 1971-2003. In: *Sea Trout: Biology, Conservation and Management*. (Eds G. Harris & N. Milner), pp. 279–306. Blackwell, Oxford.

Nagy H., Mamoutos I., Nolan G., Wilkes R. & Dabrowski T. (2023). High-Resolution Model of Clew Bay—Model Set-Up and Validation Results. *Journal of Marine Science and Engineering* 11, 362.

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Tray E., Leadbetter A., Meaney W., Conway A., Kelly C., Maoiléidigh N.Ó., et al. (2020). An open-source database model and collections management system for fish scale and otolith archives. *Ecological Informatics*, 59, 101115.

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