ICFT2023

6th INTERNATIONAL CONFERENCE ON FISH TELEMETRY   SÈTE - FRANCE

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INTERACTIVE PROGRAM AND ABSTRACT BOOK

marbec
marine biodiversity
exploitation & conservation

ICFT2023

Information for Delegates

Dear participants,

It is with great pleasure that the organizing committee extends a warm welcome to all of you attending the 6th International Conference on Fish Telemetry at the Ifremer Station in Sète (France).

We are thrilled to have such a diverse and distinguished group of scientists and industry professionals gathered here to exchange knowledge and insights on the fascinating field of fish telemetry. Four years after the last event in Norway, this conference provides a unique opportunity for us to explore the latest advancements, discuss cutting-edge research, and foster collaborations that will contribute to the conservation and understanding of aquatic ecosystems.

We have prepared an engaging program filled with keynote speeches, oral and poster presentations, as well as workshops. But we also identified many moments of break or extra-scientific activities in order to have time to meet, to know each other and to exchange freely. This conference will allow us to explore various aspects of fish telemetry, including tracking technologies, data analysis methods, migration patterns, behavior studies, and more. We encourage you to actively participate, share your expertise, and engage in thought-provoking discussions that will shape the future of this field. We would like to pay particular attention to inter-generational exchanges, which are characteristic of previous conferences, but which are even more necessary after the COVID crisis that we have all experienced.

Furthermore, we encourage you to take full advantage of this conference to network and build connections with fellow attendees. The diverse range of backgrounds, expertise, field environments, species and techniques represented here presents an exceptional opportunity for new collaborations and the exchange of ideas.

Also called "l'île singulière" because of its insular location between the Mediterranean Sea, the Etang de Thau and the canals that criss-cross the city center, Sète is known for being the first French fishing port in the Mediterranean. We hope you find the time to visit this beautiful coastal city and its surrounding area, without forgetting to taste its great wines and culinary specialties.

Lastly, we would like to express our gratitude to all the sponsors and partners who have made this event possible. Your support and dedication are invaluable, and we extend our heartfelt thanks to each and every one of you.

Once again, welcome to the 6th International Conference on Fish Telemetry. May this conference be a memorable and enriching experience for all of us. We look forward to fruitful discussions, meaningful collaborations, and the advancement of fish telemetry research.

Best regards,

Laurent Dagorn

The organizing committee (Marc Soria, Marie-Laure Begout, Johann Mourier, Fabien Forget, Sylvie Pounhet, Laurent Dagorn)

Information for Delegates

International Conference on Fish Telemetry

International Organizing Committee

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Pedro Almeida, University of Évora, Portugal
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Conference Venue

IFREMER Station
87 Av. Jean Monnet,
34200 Sète
France

Information for Delegates

Information for ICFT Delegates

Program Sections

Except with special authorization, access by car to the IFREMER marine station is not allowed. The station is open every day except weekends, between 7:30 a.m. and 7:45 p.m.

Workshop Info

Special Events

AFTERNOON

2:00 **ETN Workshop 2:00-5:00 p.m**

Maison Régionale de la mer (Regional Sea House) Quai Louis Pasteur.

The European Tracking Network (ETN), is organizing a side meeting (2-3 hours) on Sunday afternoon to present their work, an update on compatibility general introduction on ETN data-management and next things to tackle with the community. The provisional program with the speakers planned for the moment are indicated in the link below :
https://docs.google.com/document/d/1UHz Nsl_mResiKTg2_lw8sis5aSVyz6-R46EMLSR3Rh4/edit

AFTERNOON

5:00 **Registration Open 5:00-7:00 p.m**

Maison Régionale de la mer (Regional Sea House) Quai Louis Pasteur.

7:00 **Welcome cocktail 6:00-8:00 p.m**

Maison Régionale de la mer (Regional Sea House) Quai Louis Pasteur

Information for Delegates

SITE MAP

IFREMER Station views

CELIMER Building Plan

Exhibition room for sponsors

Auditorium

Hall Celimer for poster exhibition

Registration desk

Conference Village

Barnums for buffet lunches and Coffee breaks
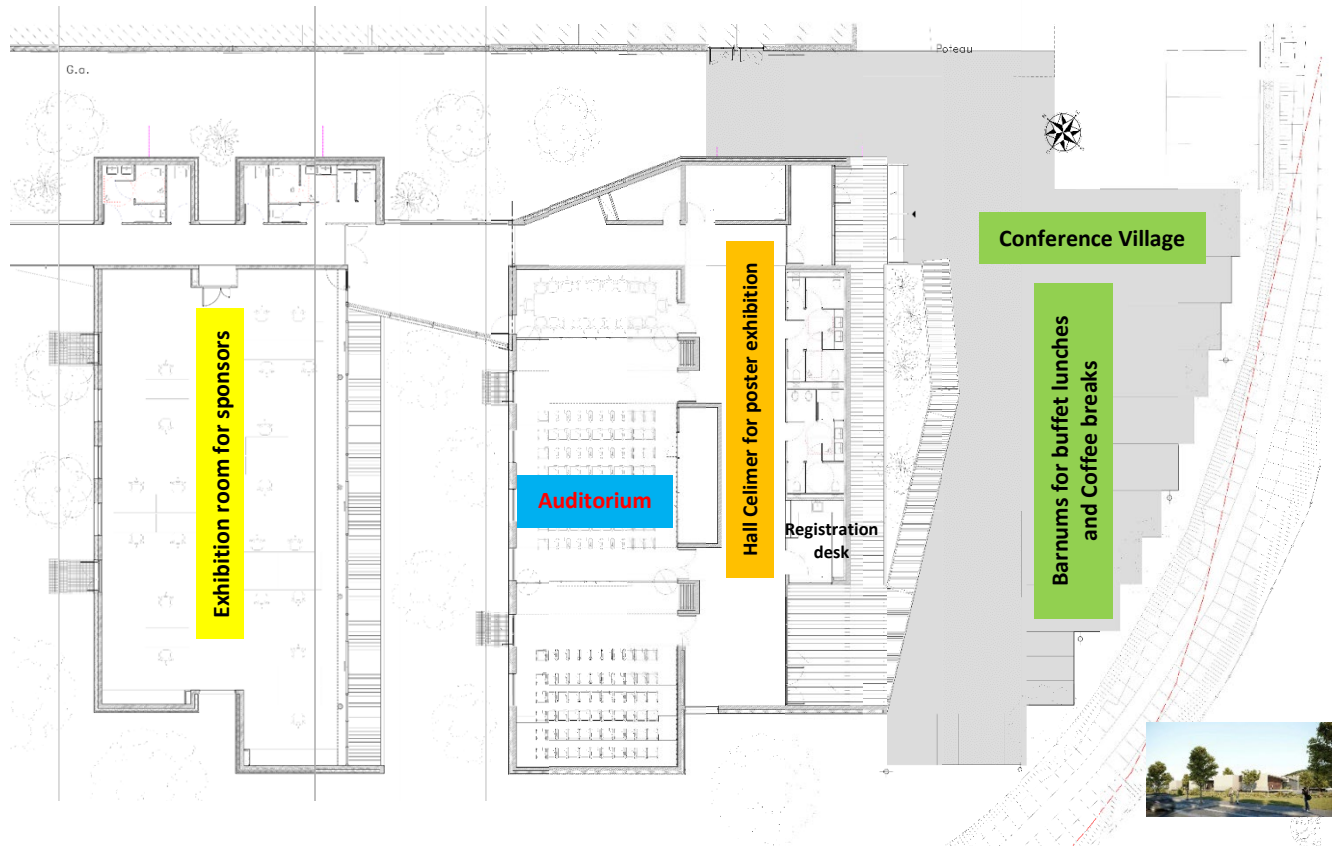
[Information for Delegates](#)

6th International Conference on Fish Telemetry

MORNING

7:45 **Registration, Hall CELIMER**

8:15 **Opening ICFT2023 Auditorium**

8:45 **PLENARY: Rachel Graham**

The vertiginous highs and abject lows in biologging: sharing lessons learned from a quarter-century in the field

9:30 **Taryn Murray**
Do Marine Protected Areas really protect mobile aquatic animals?

9:45 **Mark Royer**
"Breath holding" as a thermoregulation strategy in a deep-diving tropical ectothermic shark

10:00 **Chantel Elston**
From small fry to the big leagues: a national telemetry array reveals novel fine- and large-scale insights into the movements of rays

10:10 **Coffee Break**

11:00 **Michael Stokesbury**
Acoustic tagging in the Gulf of St. Lawrence determines fidelity, survivorship, spatial habitat and migration timing of Atlantic Bluefin Tuna

11:15 **Jessica Rudd**
Multiple tag-types reveal longer-term behavioural responses of Atlantic bluefin tuna to catch and release angling

11:30 **Martin Cabello**
Taking steps towards understanding the life cycle of a challenging species in the North Atlantic: Albacore tuna

11:38 **Fabrice Jaine**
The role of acoustic telemetry networks to monitor priority species and inform management in a changing ocean

11:53 **Jordan Matley**
Global trends in aquatic animal tracking with acoustic telemetry

12:10 **Steven Kessel**
Global distribution of aquatic telemetry effort: hotspots, gaps, and influencing factors

12:25 **Pierluigi Carbonara**
Spatial distribution, vertical movement and migration of the blue shark (Prionace glauca L.) assessed by pop-up satellite tagging in Central Mediterranean

12:30 **Lunch time**

AFTERNOON

2:00 **Ryan Daly**
Contrasting drivers of home range size for endangered and iconic reef fishes with implications for conservation

2:15 **Molly Scott**
Combining telemetry and local ecological knowledge to identify strategies to reduce mortality to threatened shark species in small scale fisheries across the main Hawaiian Islands

2:30 **Philippe Sabarros**
Epi- vs. mesopelagic: contrasted behaviour and habitat preferences of tropical tunas (yellowfin and bigeye tuna) in the southwestern Indian Ocean

2:45 **Emy Cottrant**
Movement patterns and social structure of the spotted gully shark *Triakis megalopterus* in the Western Cape, South Africa

2:53 **Belinda Goddard**
Movement, connectivity and behaviour of Australian Yellowtail Kingfish (Seriola lalandi) informed by conventional and satellite tagging

3:00 **Robert Lennox**
Studying predation with electronic tags to reveal species interactions and address human-wildlife conflicts

3:15 **Leanne Currey-Randall**
Elucidating broad-scale movements of marine species using a state-wide acoustic telemetry array

3:30 **Tea Break**

4:15 **David Moreno**
Using animal-borne acoustic tags to explore the vulnerability of the endangered Maugean skate to habitat degradation

4:30 **Pierre Labourgade**
Multi spatial-scales approach in acoustic telemetry reveals intraspecific variability in habitat use and behaviour of the undulate ray (Raja undulata) within an estuary

4:45 **Alina Hillinger**
Movement strategies and individual variation in spatial behavioral traits in Raja undulata

5:00 **POSTER SESSION**
Hall Célimer

5:00 **Workshop Kingfisher Marine Research and Wildlife Computers**
Salle Saint-Clair

Kingfisher Marine Research and Wildlife Computers are offering a workshop on methods for fish geolocation using satellite tag data. Potential topics include a detailed discussion of light-based geolocation and general aspects of using open-source hidden Markov models as well as Wildlife Computers GPE3 location processing.

Information for Delegates

MORNING

8:30 **PLENARY: Pablo Arechavala**

🇪🇸 **Tracking fish in aquaculture environments**

9:15 **Joseph Bottoms**

🇨🇦 Applying spatial capture-recapture models to acoustic telemetry data collected in river networks

9:30 **Jordanna Bergman**

🇨🇦 An Interdisciplinary Evaluation of Multi-Species Fish Connectivity in Canada's Historic Rideau Canal Waterway

9:45 **Michael Williamson**

🇬🇧 Timing, stability and purpose of non-spawning aggregations in adult anguillid eel

9:53 **Michaël Ovidio (Withdrawal)**

🇧🇪 Movement behaviour and fishway performance for endemic and exotic species in a large anthropized river

10:00 **Coffee Break**

10:45 **Amaël Dupaix**

🇫🇷 Quantifying the impact of habitat modifications on species behavior and mortality: case-study on floating objects and tropical tuna

11:00 **Paige Wernli**

🇺🇸 Fine-scale analysis of acoustically tagged tiger shark (Galeocerdo cuvier) seasonal movements around Maui Nui, Hawaii

11:15 **Antonia Kloecker**

🇳🇴 On the edge – Deciphering movement patterns of pelagic sharks in the Arctic

11:23 **Christopher Vandergoot**

🇺🇸 Great Lakes Acoustic Telemetry Observation System: Transitioning from Project-specific to Lake-wide Infrastructure

11:30 **Richard Kraus**

🇺🇸 Fish have tales! Can Patterns of Lake Whitefish Migration and Habitat Use Inform Research and Management in Laurentian Great Lakes?

11:45 **Steven Cooke**

🇨🇦 Animal welfare considerations for fish tracking studies

12:00 **Saron Berhe**

🇳🇴 Monitoring the restoration effects on the biodiversity of the city fjord in Bergen

12:08 **Chloé Blandino**

🇺🇸 Habitat partinioning in sympatric sharks at French Frigate shoals atoll

12:15 **Lunch time**

AFTERNOON

2:00 **Karl Gjelland**

🇳🇴 Fin-scale behaviour of Atlantic cod Gadus morhua ecotypes

2:15 **Jessica Garcia**

🇫🇷 Comparison of the spatio-temporal behaviour of two predators in a marine protected area in Corsica

2:30 **Inge Van der Knaap**

🇳🇱 Impact of two human-made impulsive sounds on free-ranging cod in the North Sea

2:45 **Alison Frey**

🇺🇸 Informing management of fisheries and offshore wind development using acoustic telemetry of spawning cod

2:53 **Marine Gonse**

🇫🇷 Combining acoustic telemetry with archival tagging to investigate the spatial dynamic of the understudied pollack, *Pollachius pollachius*

3:10 **Benoit Berges**

🇳🇱 Behavior and seasonal stay of Atlantic cod around artificial reefs in an offshore wind farm

3:25 **Tea Break**

4:10 **Pieterjan Verhelst**

🇧🇪 Mapping silver eel migration routes and behaviour in the North Sea and the Channel

4:25 **Marie Prchalova**

🇨🇿 Behaviours and strategies of top fish predators in three different lentic systems

4:40 **Devon Smith**

🇨🇦 Habitat use by white sturgeon varies across seasons and hydrological conditions

5:00 **POSTER SESSION**

Hall CELIMER

19:30 **Conference Dinner**

Restaurant La Ola

La Ola is a small guinguette on the beach of Sète which will prepare a meal for you in the form of lunch with, just for us, a whole set of delicious starters and dishes such as Houmous, razor clams en persillade, tartare of red tuna, as well as vegetarian meals.
Don't forget to bring your music scores for the song contest!...
Address:
La Ola - 201, Promenade du Lido - 34200 SETE
04 67 53 07 14 - 06 86 74 12 34
https://www.tourisme-sete.com/la-ola-sete.html

Information for Delegates

8:15 Breakfast

8:45 Davide Thambithurai
Applying network methods to quantify the movement dynamics of gilt-head bream (Sparus aurata) across the Gulf of Lions

9:00 Sébastien Alfonso
Insights on the use of telemetry sensors as a tool for health and welfare monitoring of gilt-head sea bream (Sparus aurata) in aquaculture

9:15 Thomas TinHan
Introducing the Pacific Islands Region Acoustic Telemetry (PIRAT) Network

9:22 Andrea Sauviat
Designing a miniature electronic tag for jellyfish tracking

9:30 Sarah Larocque
Development of telemetry-based fish habitat models to inform environmental restoration

9:45 Silviya Ivanova
Fish biodiversity hotspots in a large lake: an ecosystem-wide data synthesis

10:15 Tour 1 and 2 bus depart

Time	Tour 1	Tour 2	Tour 3	Tour 4
	Ostreïcole farm	**Valmagne Abbey**	**Petanque tournament**	**Ferme Marine des Aresquiers**
10:15 AM	Bus **DEPART** Station Ifremer to Loupian (1/2 hour bus ride)	Bus **DEPART** Station Ifremer to Villeveyrac (45 mn bus ride)		
11:00 AM	START visit (2 hours for visit and degustation)			
1:30 PM	**RETURN** to Sète (downtown)	**RETURN** to Sète (downtown)		
4:30 PM			Bus **DEPART** Train Station Sète (1/2 hour bus ride) to Frontignan	
5:00 PM			START Tournament	
6:30 PM			Bus **DEPART** Frontignan to the Marine Farm of Aresquiers	Bus **DEPART** Train Station Sète to the Marine Farm of Aresquiers
7:00 PM			Brasucade and concert	
9:00 PM			**RETURN** to Sète (downtown)	
10:30 AM			**RETURN** to Sète (downtown)	

Information for Delegates

11:00 a.m: visit of the Abbey of Valmagne Villeveyrac

7:00 p.m: dinner Brasucade. The Aresquiers marine farm

11:00 a.m: visit of the Oyster farm Loupian

5:00 p.m: Petanque Tournament Frontignan
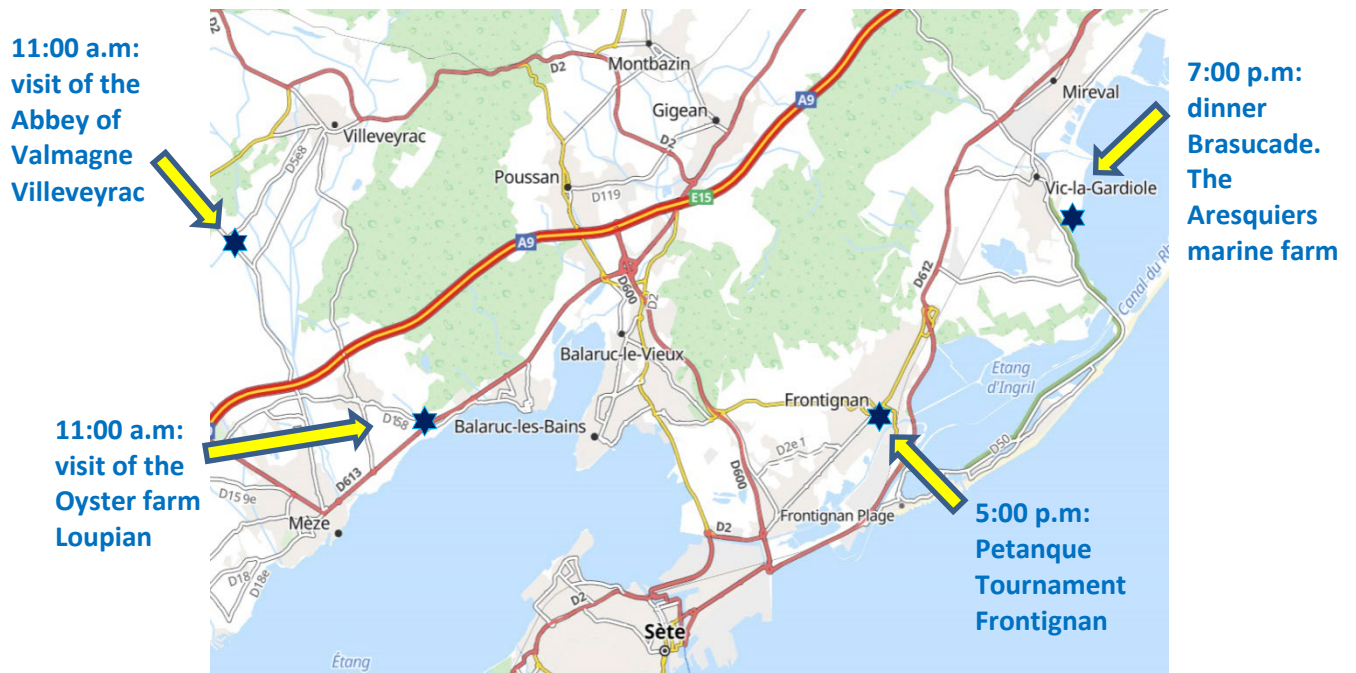
6th ICFT Social events

In the Wednesday morning, two choices:
- a visit to Guy Sanchez's oyster farm in Loupian with an oyster tasting accompanied by white wine (https://guysanchez-huitres.fr/en)
- a visit to the Valmagne Abbey in Villeveyrac followed by a tasting of the abbey's wines (https://en.wikipedia.org/wiki/Valmagne_Abbey)

In the afternoon, a first departure will be made from the train station of Sète, around 4:00 p.m to join the boulodrome of Frontignan, where the organizers of the petanque tournament (for a maximum of 50 people) are waiting for you.

In the evening, around 7:00 p.m, another departure is planned from the Sète train station to the Ferme Marine des Aresquiers (https://www.lafermemarinedesaresquiers.fr/) where a Brasucade of mussels with regional white wine (Muscat of Frontignan) will be served in a rural and musical atmosphere. Vegetarian meals are also available.

Reservations for the different activities will be made one week before the conference or during registration. The number of places is limited to 100 people for each morning activity and 50 for the petanque tournament.

Information for Delegates

MORNING

8:30 PLENARY: Pedro Afonso
To track or not to track

9:15 Mathieu Woillez
Fish don't have borders – Towards integrating fish spatial ecology into ecosystem-based fisheries management using a large scale acoustic telemetry network (FISH INTEL)

9:30 Bernat Hereu
Integrating fish movescapes, habitat use and connectivity to implement effective ecosystem-based management in a transboundary MPA network

9:45 Caroline Bousquet
First insights of the Angelsharks (*Squatina squatina*) behavior in Corsica

9:53 Lydie Couturier
Monitoring the habitat use and movements of mobile species in a context of offshore wind energy development

10:00 Coffee Break

10:45 Jayne Gardiner
Effects of climate change on migratory movements of juvenile blacktip sharks, *Carcharhinus limbatus*

11:00 Haley Dolton
New biologging method to assess the physiology of basking sharks

11:15 Lotte Pohl
Using Acoustic Data Storage Tags (ADST) to assess seasonal movements of the starry smooth-hound shark in the North Sea

11:23 Natalie Klinard
Making the most of aquatic animal tracking: the use of complementary methods to bolster acoustic telemetry research

11:30 Yuri Niella
Using machine learning to predict risk of shark bites along the coast of New South Wales, Australia

11:45 Thomas Horton
Tracking bluefin tuna from the United Kingdom & Channel Islands: a re-established seasonal hotspot in the northeast Atlantic

12:00 Josep Alos
Toward a decade of ocean science for sustainable development through acoustic animal tracking

12:08 Charlie Huveneers
The curious case of Norfolk Island and its challenging waste disposal — is tiger shark space use impacted by dumping cow offal?

12:15 Lunch time

AFTERNOON

2:00 Jan Davidsen
Can detailed knowledge about sea trout's marine feeding migration improve coastal zone planning?

2:15 Aaron Fisk
Lake trout site fidelity in Lake Ontario during periods of spawning

2:30 Johan Coeck
Passage efficiency, survival and downstream migration behavior of salmon smolt at the Anundsjö hydropower plant (River Moälven, Sweden)

2:45 Samuel Shry
Benefits of Dam Removal for Atlantic Salmon (*Salmo salar*) Smolt Migration and Identified Challenges in Downstream Passage of Fragmented Reaches

2:53 Rosie Smith
Dead until proven living: A simple framework for conservatively identifying mortalities and tag expulsion in non-overlapping acoustic arrays

3:00 Jelger Elings
Discovering behavioral patterns with high-throughput telemetry

3:15 Kandace Griffin
Swimming a fine line: How migrating sea lamprey navigate through complex and risky habitats

3:30 Tea Break

4:15 Evgeny Romanov
Habitat and movements of the swordfish Xiphias gladius, in the waters of southern Indian Ocean oligotrophic gyre and beyond

4:30 Henrik Baktoft
Tagging giant Atlantic bluefin tuna back in Nordic waters – five years on

4:45 Amber-Robyn Childs
Impact of exploitation on resident reef fish activity in a thermally variable environment

5:00 POSTER SESSION
Hall CELIMER

5:30 Innovasea Update Presentation
Salle Saint-Clair

Join Innovasea team in the Saint-Clair Room at Ifremer for a presentation on the latest developments in acoustic telemetry from Innovasea followed by an informal social gathering outside in the lunch area.
5:30-6:30 What's New from Innovasea, Saint-Clair Room
6:30-7:30 Informal Social, Outside (hors d'oeuvres and beverages provided). Space is limited to 40 participants so please RSVP to nancy.edwards@innovasea.com by June 2.
You can also signup up by adding your information to this form:
https://docs.google.com/document/d/13JJjooM388ON5oZx0biFHpIl7dCtDFcuYeb8wUjM3So/edit

Information for Delegates

MORNING

8:30 **PLENARY: Christophe Guinet**

How elephant seals help us to observe the Ocean while investigating their foraging ecology

9:15 **Bernardo Quintella**

Using an acceleration tag to assess the activity and tridimensional space use of the European catfish

9:30 **David Abecasis**

Multidisciplinary estimates of connectivity suggest the use of multiple units for the conservation and management of meagre, Argyrosomus regius

9:45 **Aina Pons Salom**

Social networks revealed by high-throughput tracking correlate with gut microbiome in marine fish

9:53 **Brittany Evans**

Meta analysis of Giant Trevally (*Caranx ignobilis*) Movement Patterns and Home Range Sizes in Hawaiian Waters

10:00 **Coffee Break**

10:45 **Knut Vollset**

Building a telemetry Network in the Nordhordland UNESCO Biosphere: Bergen Telemetry Network

11:00 **Julie Nielsen**

Is your fish out of water? Modifications to a hidden Markov model for reconstructing fish movement pathways in study areas with island topography or convoluted shorelines

11:15 **Tea Bašic**

Estuarine and in-river survival and migratory behaviour of adult salmonids

11:23 **Jorge Fontes**

The advantages and challenges of non-invasive towed PILOT tags for free-ranging deep-diving megafauna

11:30 **Eneko Aspillaga**

Interoperability and performance of the new Open Protocol for acoustic tracking: results from field tests in European waters

11:45 **Ana Filipa Silva**

An acclimatization period in a fish farm cage promotes site fidelity of released hatchery-reared dusky groupers

12:00 **Scott Colborne**

Estimating internal and external tag retention by Walleye (*Sander vitreus*) over multiple years after release in the Laurentian Great Lakes

12:08 **Sindre Eldøy**

Does pathogen burden affect the temperature preference of salmonids?

12:15 **Lunch time**

AFTERNOON

2:00 **Jena Edwards**

Transcending boundaries in fish movement ecology through the European Tracking Network

2:15 **Jessica Robichaud**

Using acoustic telemetry to identify critical habitat functions for spatial planning

2:30 **Morgan Piczak**

Spatial ecology of non-native common carp (*Cyprinus carpio*) in Lake Ontario with implications for management

2:38 **Fanny Alix**

The use of acoustic and RFID tags to study the behaviour of twaite shads at a fish pass (Hérault, France)

2:45 **Matthew Acre**

Pulling the plug: Space use and movement of fishes prior to removal of a large dam

3:00 **Ana Rato**

Homing and movement patterns of Iberian barbel (*Luciobarbus bocagei*) following translocation in a highly impounded river

3:15 **Coffee Break**

4:00 **Kim Holland**

Near Real-Time Ocean Profiles from Animal-Borne Platforms; Sharks as a Case Study

4:20 **Colin Simpfendorfer**

Using multiple telemetry and biologging methods to study juvenile sharks and rays in very shallow coastal habitats

4:40 **Jan Reubens**

The European aquatic animal tracking network (ETN) – a timely initiative for the animal tracking community in Europe

5:00 **POSTER SESSION**

Hall CELIMER

Information for Delegates

8:30 **PLENARY: Rachel Graham**

The vertiginous highs and abject lows in biologging: sharing lessons learned from a quarter-century in the field

Belize

The vertiginous highs and abject lows in biologging: sharing lessons learned from a quarter-century in the field

9:30 **Taryn Murray**
Do Marine Protected Areas really protect mobile aquatic animals?

Movements in ecology

South Africa

Do Marine Protected Areas really protect mobile aquatic animals?

Taryn Murray[1], Chantel Elston [1], Matthew Parkinson

[1] South African Institute for Aquatic Biodiversity (SAIAB) – Private Bag 1015 Grahamstown, 6140 South Africa, South Africa

Economic growth and environmental sustainability are the two cornerstones of the African Blue Economy. Sustainably-managed fisheries along the African continent will contribute to, and benefit, both cornerstones. A popular tool to achieve such sustainability is through the use of spatial management, which requires information on the habitat use of a species, especially since animal movements shape ecosystems by structuring spatio-temporal interactions with other animals (including humans). Acoustic telemetry is now the primary tool used worldwide to study fish movements and habitat use, and through its popularity, has led to the development of largescale acoustic telemetry networks around the globe, including South Africa's Acoustic Tracking Array Platform. Not only can the data collected by these networks answer a plethora of research questions about complex migratory movements, predator-prey interactions and post-release behaviour, but by placing receivers strategically within biologically significant or protected areas, one can gain a better understanding of the relative importance of these areas to both resident and migratory species. This presentation will explore and showcase some of the important telemetry work taking place in Marine Protected Areas (MPAs) along the South African coastline, for example, teleosts (*Argyrosomus japonicus* and *Lithognathus lithognathus*) and sharks (*Triakis megalopterus*, *Sphyrna zygaena*, *Carcharhinus brachyurus*) in the De Hoop MPA; migratory species transitioning through the Greater Addo Elephant National Park MPA; and the movements of both resident (e.g. *Mycteroperca andersoni*) and migratory (e.g. *Carcharhinus leucas* and *Caranx ignobilis*) species remaining in, or passing through the network of MPAs along South Africa's east coast, crossing the border into southern Mozambique. The importance of understanding the relative connectivity between protected areas in order to assess the efficacy of these MPAs will be highlighted, which will in turn be able to inform future protected area designations or amendments to existing MPAs.

Keywords: acoustic telemetry, Acoustic Tracking Array Platform, transboundary movements, residency, site fidelity, migration

"Breath holding" as a thermoregulation strategy in a deep-diving tropical ectothermic shark

Mark Royer[1], Carl Meyer[1], John Royer[2], Kelsey Maloney[1], Edward Cardona[1], Chloe' Blandino[1], Guilherma Silva[3], Kate Whittingham, Kim Holland

[1] Hawaii Institute of Marine Biology – United States
[2] The University of Edinburgh – United Kingdom
[3] University of Hawai'i at Mānoa – United States
[4] Whitman College – United States

Fish moving between different thermal environments experience heat exchange through conduction across the body wall and convection from blood flow across the gills. Here we report a novel strategy of preventing convective heat loss at the gills during excursions into cold water by the scalloped hammerhead shark (*Sphryna lewini*). Adult scalloped hammerhead sharks dive rapidly and repeatedly from warm (~26ºC) surface waters to depths exceeding 800 meters and temperatures as low as 5◦C. Biologgers attached to adult sharks revealed that warm muscle temperatures were maintained throughout the deepest portion of each dive and cooling only occurred during the latter stages of the ascent phase. Once initiated, cooling was rapid. Heat transfer coefficient modeling indicates convective heat transfer is suspended, probably by suppressing gill function during deep dives. This strategy has never been observed in fishes and has broad similarities to marine mammal "breath hold" diving.

Keywords: scalloped hammerhead shark, accelerometers, body temperature, thermoregulation, deep, diving, bio, logging

10:00 **Chantel Elston**

From small fry to the big leagues: a national telemetry array reveals
novel fine- and large-scale insights into the movements of rays

**Movements in ecology
South Africa**

From small fry to the big leagues: a national telemetry array reveals novel fine- and large-scale insights into the movements of rays

Chantel Elston[1], Taryn Murray [1], Matthew Parkinson [1], John Filmalter [1], Paul Cowley

[1] South African Institute for Aquatic Biodiversity (SAIAB) – Private Bag 1015 Grahamstown, 6140 South Africa, South Africa

To understand the ecological roles of, and best management practices for, a species, insights into their ecology over multiple scales is required, in particular, quantifying when and where they move over both fine and large spatial scales. Large-scale insights into animal movement ecology have traditionally been hampered by small acoustic telemetry arrays. However, the movement to large collaborative networks of receivers is beginning to overcome this. In particular, South Africa's nation-wide Acoustic Tracking Array Platform (ATAP) has allowed for the investigation into both small-scale (i.e. bay or estuary use) and large-scale (national migrations) movements of South African rays for the first time. In addition to having important national ramifications in terms of management, insights gained into ray ecology have been novel and relevant on a global scale. Two examples will be used to illustrate this. In the first, telemetry data from 27 blue stingrays *Dasyatis chrysonota* collected over 4.5 years showed that, while individuals dis- played site fidelity to specific areas along the coastline, important movement corridors between different habitats were present. Individuals were also found to travel up to 450 km from their tagging locations, the furthest recorded distance for a benthic undulatory ray. This challenges preconceived global notions that this faunal group is incapable of traveling far distances, and highlights that they may be more important in connecting different habitats than previously thought. In the second example, 33 diamond rays *Gymnura natalensis* and 25 bull rays *Aetomylaeus bovinus* were tagged and monitored for up to 6 years. Given their semi-pelagic nature they were recorded to migrate significant distances, over 1 000 kms, on a seasonal basis. However, in this instance, what was surprising were the fine-scale insights gained. A small portion of these tagged individuals (n = 6, all female) displayed philopatric behaviours to estuaries, returning to specific estuaries (after making winter migrations) for up to six consecutive years. This is the first time estuary use by rays has been quantified in South Africa, and it highlights that this is an important habitat type to a sub-population of these species. Globally, it was the first time that this divergent habitat use pattern has been identified, with some individuals highly seasonally resident to estuaries, and other individuals not recorded in this habitat type at all. Both of these examples illustrate that it is only through combining both small- and large-scale insights into movement ecology that a more holistic understanding into animal ecology can be gained.

Keywords: Rays, South Africa, ATAP, migration, site fidelity, movement ecology

Information for Delegates

11:00 **Michael Stokesbury**

Acoustic tagging in the Gulf of St. Lawrence determines fidelity, survivorship, spatial habitat and migration timing of Atlantic Bluefin Tuna

Movements in ecology

Canada

Acoustic tagging in the Gulf of St. Lawrence determines fidelity, survivorship, spatial habitat and migration timing of Atlantic Bluefin Tuna

Michael Stokesbury [1], Becky Whitlock [2], Robbie Schallert [2], Mike Castleton [2], Barbara Block [2]

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Atlantic Bluefin Tuna, *Thunnus thynnus,* are the largest tuna of the genus *Thunnus,* and utilize a spatial range throughout the North Atlantic and adjacent seas. These fish support commercial and charter fisheries throughout their migratory range and are managed by the International Commission for the Conservation of Atlantic Tunas. In the Tag-A-Giant program run by Stanford University over 2000 electronic tags have been deployed on bluefin including archival, pop-up satellite archival and acoustic tags. Acoustic tags were first deployed in 2009 and over fifteen years have logged > 115,000 detections on 1500 receivers in North American and European waters. Receiver infrastructure is primarily provided by the Ocean Tracking Network, as well as independent receivers from collaborators along the North American coastline and in Europe. This research provides the highest spatial coverage in the Canadian Maritime Provinces where large acoustic lines act like gates across the entrance to the Gulf of St. Lawrence. The spatial and arrival and departure data provides precise information on how and where bluefin enter and exit the Gulf of St. Lawrence and specific information on movements on the Scotian Shelf and in the Gulf of Maine. Receiver arrays provide detection information from the migratory paths of the bluefin as they move to, and then return from, spawning grounds. Time series of detections along with information from other tagging technologies, over multiple years, provides information on spawning and feeding site fidelity, natural survivorship, and stock structure that informs management of these iconic fish.

Keywords: Atlantic Bluefin Tuna, Acoustic Tags, Movement, Migration, Survival, Stock Structure

Multiple tag-types reveal longer-term behavioural responses of Atlantic bluefin tuna to catch and release angling

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Catch and release sport fishing is increasingly popular, and particularly so for large pelagic species such as sharks and tuna. In UK and other waters in northern Europe, catch and release fishing programmes for Atlantic bluefin tuna (*Thunnus thynnus*) have been introduced following a significant increase in sightings and encounters over the last decade. However, little is known about the effects of angling and handling on the post-release behaviour of captured fish. We used eight high-resolution Cefas G6 tags (depth & temperature at 1 Hz and triaxial acceleration at 20 Hz) deployed for 21 - 94 hours and 12 additional fish tagged with Wildlife Computers MiniPATs (depth, temperature, light and triaxial acceleration, each at 0.2 Hz) deployed for 110 - 366 days to compare initial behavioural responses of tuna after capture with long-term trends. Immediately post-release, fish (n=20) displayed a long (8 - 175 min) deep dive (15 - 75 m, mean bathymetry: 63 m) that increased significantly in duration with fight time (range 10 - 30 min). In common with previously published billfish studies, activity (VeDBA g), tailbeat amplitude (∘.s-1) and frequency (Hz) were greater (2.5, 3.6 and 1.4 times respectively) within the first hour post-release than the subsequent 48 hours, stabilising at lower levels within 6 - 8 hours. The long-term deployments of MiniPATs revealed that fish maintained this reduced activity for an average of 6 days (max. 21 days), with fish allocating less than 1% of each day to putative feeding activities, determined from burst energy events. By day 15, fish regained higher activity levels, resumed diel vertical migration and were significantly more active during daylight hours than at night. By day 21, the time allocated to burst energy events was comparable to foraging behaviour recorded at similar geographic locations a year later. This work highlights that the impacts of capture and tagging on Atlantic bluefin tuna behaviour are lasting and complex. Longer-term tag deployments for catch-and-release studies are necessary to understand how target species respond to fishing and tagging practices.

Keywords: bluefin tuna, Thunnus thynnus, accelerometer, catch, and, release, biologging

Information for Delegates

11:30   **Martin Cabello**

Taking steps towards understanding the life cycle of a
challenging species in the North Atlantic: Albacore tuna

Behavioral ecology
Spain

Taking steps towards understanding the life cycle of a challenging species in the North Atlantic: Albacore tuna

Martin Cabello De Los Cobos Labarquilla [1], Haritz Arrizabalaga [1],
Iñigo Onandia [1], Igor Arregi [1], Francisco J. Abascal [2], Victoria Ortiz
De Zarate [2], Rosa Delgado [2]

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The North Atlantic Albacore, *Thunnus alalunga*, is a temperate tuna stock that annually performs variable trophic and spawning migrations during its life cycle. Since the 1960s, there have been several conventional tagging studies that have given us some idea of these migrations. However, basic life cycle assumptions are yet based mostly on fisheries data and conventional tagging data (which is also fisheries dependent). Electronic tagging of North Atlantic albacore proved challenging, given their relatively small size for pop-up deployment, their vulnerability to the tagging process, their soft flesh and their elusive behaviour. In this presentation we show the results of a recent electronic tagging study where we deployed more than 30 PSATs and 89 internal archival tags in both juvenile and adult individuals throughout the Northeast Atlantic, shedding light to previously unknown behaviours of the stock, as well as covering, for the first time, a whole year cycle of a juvenile individual in the North Atlantic. We discuss the methodologies and practices in order to further improve retention times, survival rates and data recovery in the future.

Keywords: albacore, tuna, tagging, popup, pop, up, migrations, challenge, Atlantic, stock

Information for Delegates

11:38 **Fabrice Jaine**

The role of acoustic telemetry networks to monitor priority
species and inform management in a changing ocean

Movements in ecology
Australia

The role of acoustic telemetry networks to monitor priority species and inform management in a changing ocean

Fabrice Jaine [1,2], Rob Harcourt [1,2], Emma Bowen [1], Adam Barnett [3], Leanne Currey [4], Paul Butcher [5], Ross Dwyer [6], Adrian Gleiss [7], Charlie Huveneers [8], Daniel Ierodiaconou [9], Stephen Newman [10], Colin Simpfendorfer [11], Matt Taylor [5], Vinay Udyawer [12], Michelle Heupel [11]

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Globally, the world's oceans are facing rapid change and increasing pressures in the Anthropocene. Under the influence of unprecedented global warming, ocean circulation patterns and sea temperatures are shifting with cascading effects on marine ecosystems and animal populations. Broad-scale permanent animal tracking networks offer an opportunity to monitor movements and distributions of aquatic species in response to these changes. Over the past 16 years, the Animal Tracking Facility of Australia's Integrated Marine Observing System (IMOS) has collected over 130 million records of the movements and presence of commercially and recreationally important aquatic species as well as species of conservation concern, using a continental collaborative acoustic telemetry network. In recent years, the IMOS Animal Tracking Facility has focused on 1) optimising the continental infrastructure network to increase relevance to resource managers, 2) developing tools to facilitate data management, visualisation, analysis and integration with oceanographic observations, and 3) integrating with other data providers such as the Atlas of Living Australia and the EcoCommons online species distribution modelling platform to facilitate uptake of data by decision makers. As aquatic environments continue to change, documenting the occurrence and range shifts of species and animal populations, monitoring the physical properties of habitats and making the associated data available to decision makers, will be crucial to effective and sustainable management.

Keywords: acoustic tracking, telemetry networks, IMOS, priority species, data uptake, fisheries management, conservation

11:53 **Jordan Matley**
Global trends in aquatic animal tracking
with acoustic telemetry

Global approach of Telemetry studies

Canada

Global trends in aquatic animal tracking with acoustic telemetry

Ana Barbosa Martins [1], Jordan Matley, Natalie Klinard, Kim Aarestrup, Eneko Aspillaga , Steven Cooke , Paul Cowley , Michelle Heupel , Christopher Lowe, Susan Lowerre-Barbieri, Hiromichi Mitamura, Jean-Sébastien Moore, Colin Simpfendorfer, Michael Stokesbury, Matthew Taylor, Eva Thorstad, Christopher Vandergoot, Aaron Fisk

[1] Dalhousie University – Canada

Acoustic telemetry (AT) is a rapidly evolving technique used to track the movements of aquatic animals. As the capacity of AT research expands it is important to optimize its relevance to management while still pursuing key ecological questions. A global review of AT literature revealed region-specific research priorities underscoring the breadth of how AT is applied, but collectively demonstrated a lack of management-driven objectives, particularly relating to fisheries, climate change, and protection of species. In addition to the need for more research with direct pertinence to management, AT research should prioritize ongoing efforts to create collaborative opportunities, establish long-term and ecosystembased monitoring, and utilize technological advancements to bolster aquatic policy and ecological understanding worldwide.

Keywords: Acoustic telemetry, Management

12:10 **Steven Kessel**
Global distribution of aquatic telemetry effort:
hotspots, gaps, and influencing factors

Global approach of Telemetry studies

USA

Global distribution of aquatic telemetry effort: hotspots, gaps, and influencing factors

Steven Kessel [1], Marie Auger-Méthé [2], Steven Cooke [3], Aaron Fisk [4], Michelle Heupel [5], Natalie Klinard [6], Ana Martins [6], Jordan Matley [7], Nigel Hussey [8]

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Aquatic telemetry studies (both acoustic and satellite) have been conducted across diverse global aquatic systems since their emergence in the late 1980s. Despite this global distribution, there are still important regions that have been left under or unstudied. To examine the factors influencing the past global distribution of telemetry studies, the number of acoustic and satellite telemetry studies published by country were modelled with the following explanatory covariates: mean political score (based on the Fragile States Index's 11 group political stability scale, with 1 the most stable and 11 the least), mean total conservation spending, mean population size, total number of scientific documents produced, combined length of the freshwater and marine coastlines, and whether English was the nation's first language. The most important variables that had influenced the distribution of telemetry studies/publications were: political score, conservation spending, and English as a first language. Acoustic telemetry studies were conducted in nations from political groups 1 to 8 and satellite telemetry studies from groups 1 to 10. Collectively, 77% of aquatic telemetry studies were conducted in nations from groups 1 to 3, increasing to 86% when normalised by number of nations per group. Only 7% fell within the boundaries of global fisheries conservation hotspots. The fire-and-forget nature of satellite telemetry increases feasibility of deployment in unstable nations, relative to acoustic telemetry where equipment typically must be maintained and recovered. Despite the associated difficulties of working in politically unstable regions, without focused effort a more complete understanding of global aquatic ecosystem connectivity will not be possible.

Keywords: acoustic telemetry, ecosystem connectivity, political instability, satellite telemetry, spatial ecology

Information for Delegates

12:25   **Pierluigi Carbonara**

Spatial distribution, vertical movement and migration of the blue shark (*Prionace glauca* L.) assessed by pop-up satellite tagging in Central Mediterranean

Movements in ecology

Italia

Spatial distribution, vertical movement and migration of the blue shark (*Prionace glauca* L.) assessed by pop-up satellite tagging in Central Mediterranean

Pierluigi Carbonara [1], Giulia Prato [2], Simone Niedermüller [3], Walter Zupa [1], Sébastien Alfonso [1], Cosmidano Neglia [1], Maria Spedicato [1], Giuseppe Lembo [1]

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By-catch is the catch fraction "unintentionally" captured during a fishing operation, in addition to the target species, including incidental catches of endangered, vulnerable or rare species (e.g. sea turtles, chondrichthyans, marine mammals). In the Mediterranean basin, pelagic sharks are caught as by-catch in longline fisheries (PLL) targeting swordfish and tunas. PLL showing higher by-catch rate than other commercial fishing gears. The most catch/landed pelagic shark species in Mediterranean is the blue shark (*Prionace glauca*, L. 1758), classified as "critically endangered" (IUCN) mainly due to fishing mortality. Understanding behavior of non-targeted species such as blue shark is of primary interest to better avoid by-catch and maintain good status of wild populations. In this context, a fishery monitoring and satellite tagging (pop-up) programs were both carried out on blue shark in south Adriatic Sea. A total of 32 blue sharks were tagged with satellite pop-up tag from 2019 to 2022 to assess its spatial behavior, measuring vertical and horizontal positions over time (~1-6 months). The depth data obtained from pop-up tag allowed us to model (generalized additive model) the vertical movement of blue shark in correlation to several environmental parameters (e.g., temperature, currents, moon phases). Moreover, a seasonal migration pattern has been described for the first time in the Mediterranean. Finally, the blue shark catch data collected, during the fishing-trip monitored, allowed us to model (maximum entropy model) the distribution pattern of blue shark during the summer (bulk season for PLL) in south Adriatic Sea. The position data of blue shark, collected by pop-up satellite, were used to validate the distribution map assessed by catch data. Overall, all such results elucidate the biological/ecological features of blue shark in Adriatic Sea, and will help to implement successful management strategies to mitigate the by-catch on this species catch by PLL targeting swordfish.

Keywords: bycatch, blue shark, pop, up satellite tag, spatial distribution, vertical movement, migration

Strategy for conservation
South Africa

Contrasting drivers of home range size for endangered and iconic reef fishes with implications for conservation

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Defining the home range of vulnerable species is critical for designing effective spatial management strategies. However, animal home ranges often change with ontogeny, and quantifying the associated drivers of the temporal and spatial changes is particularly challenging for mobile marine species. Here, we investigated how the space use of two co-occurring vulnerable and ecologically important top predatory coral reef-associated fish species, the giant trevally (*Caranx ignobilis*) and humphead wrasse (*Cheilinus undulatus*) change with ontogeny and investigate the contrasting drivers of such change. Fish were tagged with acoustic transmitters and passively tracked for > 3 years at a tropical island and atoll in the Republic of Seychelles. Tagged humphead wrasse (n = 20) exhibited persistent (> 500 d) site fidelity, with low dispersal distances (6.44 ± 4.0 km) and restricted home ranges (0.91 km2). In contrast, giant trevally (n = 17) exhibited dispersal distances of up to 35.29 km (± 31.18) and a home range from 77.32 km2 (small adults) to 209.74 km2(large adults). Furthermore, tagged giant trevally took up to 34 months (mean = 18.54) to utilize the full extent of their home range. When considering the implementation of a spatial management plan, the establishment of a proposed no-take marine protected area at the study site would encompass the core home range area of all tagged humphead wrasse. However, the same marine protected area may only offer protection for giant trevally as juveniles. This highlights the importance of understanding the habitat use of species over time to assess how effective a spatial management might be for each species.

Keywords: passive acoustic telemetry, coral reef fish, home range, spatial

[Information for Delegates](#)

02:15 **Molly Scott**

Combining telemetry and local ecological knowledge to identify strategies to reduce mortality to threatened shark species in small scale fisheries across the main Hawaiian Islands

Fisheries management
USA

Combining telemetry and local ecological knowledge to identify strategies to reduce mortality to threatened shark species in small scale fisheries across the main Hawaiian Islands

Molly Scott [1], Melanie Hutchinson [1]

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Fish aggregating devices (FADs) are a critical fisheries enhancement tool for tropical commercial (i.e., purse seine fisheries) and small-scale fisheries throughout the world. Oceanic whitetip (*Carcharhinus longimanus*) and silky (*Carcharhinus falciformis*) sharks as well as many other species of pelagic shark are temporally resident at anchored FADs around the main Hawaiian Islands. Both species are often captured incidentally by recreational and commercial fishers targeting tuna and billfish around the Hawai'i FAD array. As such, these species have been implicated as major contributors to shark depredation rates and are considered a nuisance by local fishermen. A result of these interactions is that fishermen may harm sharks captured in their gear or if they appear to be 'scaring tuna away'. This study describes the results from the Hawaii Community Tagging Program (HCTP), a citizen-science initiative established in 2016 that works directly with local fishers to tag incidentally captured sharks and establish methods of reducing shark interactions. To date, the HCTP has tagged a total of 303 pelagic and coastal sharks (n=125 C.longimanus ; n=67 C.falciformis) with acoustic, satellite and conventional identification tags. Data generated from this collaborative project has increased understanding of species-specific FAD associative behavior and elucidated potential spatial and temporal hotspots including areas of biological significance for shark populations, including the threatened oceanic whitetip shark, around Hawaii.

Keywords: Bycatch mitigation strategies, oceanic whitetip shark, telemetry, fish aggregating de- vices, silky shark

Information for Delegates

02:30 **Philippe Sabarros**

Epi- vs. mesopelagic: contrasted behaviour and habitat preferences of
tropical tunas (yellowfin and bigeye tuna) in the southwestern Indian Ocean

Behavioral ecology

France

Epi- vs. mesopelagic: contrasted behaviour and habitat preferences of tropical tunas (yellowfin and bigeye tuna) in the southwestern Indian Ocean

Philippe S. Sabarros [1], Evgeny Romanov [2], Pascal Bach[1]

[1] MARBEC – Institut de recherche pour le développement [IRD] – France
[2] CITEB – Centre technique d'appui à la pêche réunionnaise (CAP RUN - CITEB) [France] – France

Habitat and migratory movements of the yellowfin tuna and the bigeye tuna in the Indian Ocean are still poorly known despite decades of research and dedicated large-scale tagging programs. Past tagging efforts mostly based on conventional tags only provided a broad idea on the scale of dispersion across the western Indian Ocean. Here we present results of the first large-scale tagging efforts using Pop-Up Satellite Archival Tags (PSATs) focused on two highly exploited tuna species in the Indian Ocean: the yellowfin tuna (YFT) and the bigeye tuna (BET). In the framework of EU-funded project PROSPER 2, a total of 40 PSATs were deployed on YFT (26) and BET (14) between November 2014 and December 2015. PSAT deployments took place within different zones of the western Indian Ocean (off Reunion Island, west border of the Saya-de-Malha Bank, and off the east coast of Madagascar). A total of 36 PSATs surfaced and reported data. Here we show that during relatively short deployment periods (104 days max at liberty) all species perform large-scale movements throughout the western Indian Ocean reaching South African waters southward and equatorial waters northward. BET demonstrates lower dispersion than YFT suggesting a certain site-fidelity in short-term scale while overall distances covered by BET were greater than those of YFT due to better tag retention rates and hence longer deployments. With few exceptions YFT occupies the epipelagic environment (0-200 m) irrespectively of the time of the day limiting its movements to the upper mixed layer during the night. BET follows a similar pattern during the night but stays in colder and deeper layers down to 350-600 m during the day. Deep-dives (below 500 m depth) is a usual pattern for BET that spends most of daytime below 200 m depth suggesting that mesopelagic environment is its preferential habitat in the western Indian Ocean. BET is also capable of exploring the bathyal environment below 1000 m depth, however, the current generation of electronic tags is not well adapted for bathyal dives due to pressure resistance limitations (2000 m). Our results provide first insights on the high rates of individuals' dispersion of both YFT and BET in the western Indian Ocean with contrasted habitat uses between the two species. A potential link of bathyal dives with deep-water prey resources availability will be discussed.

Keywords: Habitat, Vertical behavior, PSAT, Tropical tunas, Indian Ocean

Information for Delegates

02:45 **Emy Cottrant**

Movement patterns and social structure of the spotted gully shark
Triakis megalopterus in the Western Cape, South Africa

Behavioral ecology
South Africa

Movement patterns and social structure of the spotted gully shark *Triakis megalopterus* in the Western Cape, South Africa

Emy Cottrant [1,2], Natalia Drobniewska [1], Thomas Johnson [1], Leslie Underhill [2,3], Taryn Murray [4], Neil Hammerschlag [5], Patricia Albano [5,6], Meaghen Mccord [1], Paul Cowley [4], Chris Fallows [7], Timothy Paulet [1]

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[2] University of Cape Town (UCT) – South Africa
[3] Biodiversity and development institute (BDI) – South Africa
[4] South African Institute for Aquatic Biodiversity (SAIAB) – South Africa
[5] Rosentiel school of marine, atmospheric, and earth sciences – United States
[6] National Marine Sanctuary Foundation – United States
[7] Apex Shark Expeditions – South Africa

Acoustic telemetry is traditionally used to study individual movements of species within a designated area, with receiver arrays designed specifically for this purpose. However, recent studies have used telemetry data to explore species behaviour, especially social preferences, in the marine environment. The spotted gully shark *Triakis megalopterus,* is a species endemic to southern Africa and is listed as "Least Concern" by the IUCN. Few studies have investigated their ecology and behaviour to date, to address this, acoustic telemetry was used to investigate the behaviour and movements of this species around the Western Cape coastline in South Africa. Through spatial and social network analyses, the randomness of movements and associations between individuals, the presence of sexual segregation in the population, and the effectiveness of marine protected areas (MPAs) were investigated. The research revealed that spotted gully sharks exhibited non-random movements, although associations between individuals remained random ($p = 0.681$). This highlighted a potential lack of social structure for this species, but could also be a result of the small sample size. Sexual segregation was observed using spatial network analysis while social networks revealed no such behaviour. Male individuals used protected areas to a greater extent than females, which were principally found in exploited areas. Movements and residency of tagged spotted gully sharks were not predominant within existing MPA boundaries, indicating the requirement to extend these areas or to create new ones if there are population decreases in the future. This study is a first step towards understanding the behaviour of this species, but a larger sample size is needed to confirm these results. Future assessment of spotted gully sharks would benefit from a combination of acoustic telemetry, mark-recapture and baited remote underwater video data.

Keywords: acoustic tagging, aggregation, chondrichthyans, endemic, marine protected area, network analysis

Information for Delegates

2:53 **Belinda Goddard**

Movement, connectivity and behaviour of Australian Yellowtail Kingfish (Seriola lalandi) informed by conventional and satellite tagging

Movements in ecology

Australia

Movement, connectivity and behaviour of Australian Yellowtail Kingfish (*Seriola lalandi*) informed by conventional and satellite tagging

Belinda Goddard [1,2], Tristan Guillemin [1,2], Hayden Schilling [3], Julian Hughes [4], Stephanie Brodie [5], Corey Green [6], Charlie Huveneers [7], Dan Ierodiaconou [8], Sean Tracey [9], Matt Taylor [3], Rob Harcourt [1], Iain Suthers [10], Fabrice Jaine [1,2]

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Yellowtail Kingfish (*Seriola lalandi*) are a large, pelagic, highly mobile species of considerable commercial and recreational importance in Australia. Within Australia there are two recognised genetically distinct stocks, the "Western" and "Eastern Australia" stock, however empirical movement data to inform stock structure over ecologically-relevant time scales are currently limited. In this study, we describe movement and connectivity patterns of kingfish in Australia and New Zealand (NZ) using over 40,000 tagged individuals and 3,000 subsequent recaptures spanning 1973-2022 as part of the New South Wales (NSW) Game Fish Tagging Program, the world's longest-lived, citizen-science saltwater recreational tagging program. Network analysis of kingfish recaptures revealed extensive connectivity across fisheries jurisdictions as well as five main bioregions in coastal and offshore southern and eastern Australia, as well as NZ, suggesting that co-management of the stock may be needed. However, there was evidence of potential "partial migration" within the Eastern Australian stock, with most kingfish recaptures occurring within 11km of release locations, but distances of up to 2835 km were recorded. To build upon our understanding of the drivers of movement and connectivity of kingfish, 13 large, sexually mature kingfish (> 83 cm fork length) have been satellite tagged (MiniPAT, Wildlife Computers) for up to 96 days. The resulting high-resolution information has provided unique insights into the depth and temperature habitat use of kingfish, alongside their horizontal movements over a three-month period. The high resolution data has also afforded insights into previously unknown spawning sites of the stock. Our findings provide important new insights into the structure, connectivity and behaviours of the Eastern Australian kingfish stock and highlight the need for multiple fisheries jurisdictions to collaborate in managing this stock.

Keywords: movement, stock structure, citizen science, satellite telemetry, habitat use

3:00 **Robert Lennox**
Studying predation with electronic tags to reveal species interactions and address human-wildlife conflicts

Innovation in fish telemetry
Canada

Studying predation with electronic tags to reveal species interactions and address human-wildlife conflicts

Robert Lennox [1,2], Cecilie Nilsen [3], Lotte Dahlmo [3], Saron Berhe [3], Lene Sortland [4], Erlend Hanssen [3], Marius Kambestad [3], Knut Vollset [3]

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[4] DTU Aqua – Denmark

The fate of wild animals is one of the most challenging aspects of biological research and for fisheries this is the rate of natural mortality, which drives many fisheries models. Predation is a major component of natural mortality, but predation may drive compensatory or additive mortality depending on the condition of animals that are eaten. Recent advances in telemetry have opened new avenues to study the fate of animals in higher resolution, including novel predation sensors that can detect predation events and confirm the fates of fish with tools including acid- or tilt-based sensors. Using Atlantic salmon, as a focal species, we demonstrate how novel insights can be revealed about the nature of predators and their prey in aquatic ecosystems using aquatic telemetry and some of the new tools available for tracking. We additionally provide an overview of considerations for designing predation studies using electronic tags and illustrate how these data can contribute to defining and resolving conflicts between people and predators.

Keywords: Atlantic salmon, Eurasian otter, sea, run brown

Elucidating broad-scale movements of marine species using a state-wide acoustic telemetry array

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Over the past three decades acoustic telemetry has become a standard tool in the marine ecologist and fisheries scientist's toolbox. Acoustic receiver array designs have evolved from relatively small, localised arrays to large continental-scale arrays covering thousands of kilometres. These arrays can act as collaborative networks through coordinated efforts and data sharing. Maintaining such broad-scale arrays is costly and time consuming, often requiring multiple collaborating agencies with differing needs and priorities. With broad-scale arrays, movements can be detected in greater detail and greater scales, enabling researchers to address questions about species connectivity, stock structure, and drivers of movement and migration. In 2020, the Integrated Marine Observing System (IMOS) Queensland Acoustic Telemetry Array was set up along the Queensland coast in Australia in response to a need from state government to better understand species relevant to management. This collaborative infrastructure involving 20 organisations enhances the continental IMOS Acoustic Tracking Network by 345 receivers, with data hosted in a central database maintained by the IMOS Animal Tracking Facility. Since its inception, the new telemetry array has recorded over 2.5 million detections at 224 sites across Queensland waters, from over 920 animals and 40 marine species of management importance. Here, we showcase the benefit of this new array in capturing detailed, Queensland-wide, multi-project and multi-species movement data. We highlight examples of movements that reveal a broader spatial resolution that would remain unknown without such an extensive network, and record movements of some species greater than previously recorded on the east coast of Australia. Data generated by this program demonstrate the ability for broad-scale, single receiver, telemetry arrays to provide important information on connectivity, critical for spatial management of marine species and ecosystems.

Keywords: broad, scale movement, management, collaborative network

Information for Delegates

Using animal-borne acoustic tags to explore the vulnerability of the endangered Maugean skate to habitat degradation

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Maugean Skate (*Zearaja maugeana*) have perhaps the most restricted distribution of any elasmobranch, as they are now thought to be confined to a single remote estuary (Macquarie Harbour) in Tasmania, Australia. Conditions in the system have changed markedly since Euro- pean settlement, influenced by anthropogenic activities in and around the estuary (e.g., mining, hydro-electricity generation, and marine farming operations). Of recent concern, has been a sig- nificant and ongoing decline in dissolved oxygen (DO) levels in the water column. It is critical for the conservation of the species to understand the current and future effects of these changes in their last known habitat. 25 adult Maugean Skate were externally tagged with novel multi-sensor acoustic tags continuously transmitting information on depth, temperature and dissolved oxygen concentrations experienced over a 12-month period. Results show an intricate link between movement of the Maugean Skate and environmental conditions in Macquarie Harbour. The species appear to behaviourally modulate the impacts of environmental stressors through movement, balancing optimal habitat requirements against the energetic cost of chronic hypoxia in deeper waters and increased thermal and osmoregulatory stress at shallow sites. Two multi-stressor events (3 and 6 months into the tracking period) resulted in several mortalities (50 %) and elicited a behavioural response from all remaining individuals. This suggests that recent changes in the environmental health of the system (especially dissolved oxygen levels), coupled with the consequences of climate change (including occurrence of extreme weather events), may already be challenging the skate's capacity to cope with the environmental conditions in Macquarie Harbour. This study represents the first use of animal-borne acoustic sensors to monitor long-term dissolved oxygen conditions experienced by a coastal elasmobranch and how these relate to behaviour and physiology. Results from this work coupled with recent documented declines in the population highlight the significant extinction risk for this micro-endemic species and the need for urgent conservation action.

Keywords: hypoxia, microendemic, extinction risk

Information for Delegates

4:30   **Pierre Labourgade**

Multi spatial-scales approach in acoustic telemetry reveals intraspecific variability in habitat use and behaviour of the undulate ray (*Raja undulata*) within an estuary

Movements in ecology

France

Multi spatial-scales approach in acoustic telemetry reveals intraspecific variability in habitat use and behaviour of the undulate ray (*Raja undulata*) within an estuary

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The undulate ray, *Raja undulata*, is an elasmobranch species belonging to the Rajidae family found in coastal and estuarine areas of metropolitan France. As a result of overfishing, habitat loss and other anthropogenic impacts, this species is listed as Endangered on the IUCN red list and showed a significant decline in stocks in recent years. The large-scale development of off- shore wind farms adds anthropogenic pressures to this electrosensitive species. In particular, the installation of submarine power cables will generate electromagnetic fields which may impact on *R. undulata* behaviour. Those effects are difficult to assess as baseline knowledge on the species'behavioural ecology is still lacking at fine and large spatial scales. Here, we present a preliminary study to improve knowledge on the behaviour and habitat use of this species. We used passive acoustic telemetry to study the behaviour and habitat use of *R. undulata* both at the scale of an estuary and at a finer scale within the estuary. The Rance estuary in French Brittany was equipped with 51 receivers over a distance of 16 kilometres from upstream to downstream. At 4 km from the river mouth, where *R. undulata* aggregation has been observed, a total of 27 receivers, separated by an average of 200 metres, were deployed to study the fine-scale behaviour and habitat use of the individuals (HD zone). This enabled a sub-metric detection of the position of the individuals in time that could be calculated based on the Time Difference of Arrival (TDOA). A total of 40 rays were equipped with acoustic tags (23 males; 17 females). The fine-scale analyses of the HD zone identified global habitat features of R. undulate as well as differences in the habitat selection between individuals. Mature individuals tended to explore more their environment and showed a larger home range than immature ones. At the large spatial scale, we observed a tendency for spatial and temporal segregation between mature males and females. Females tended to display larger regular upstream and downstream move- ments than males and immature individuals. Our study improves knowledge on behavioural variation and home range of R. undulata. This will contribute to better identify impacts of anthropogenic activities on the species. In particular, we highlight that our multiscale methodological approach is applicable to FISHOWF project aiming to analyse the effects of electromagnetic fields on behavioural responses of elasmobranchs (as planned in the FISHOWF project).

Keywords: Raja undulata, multispatial, scales, TDOA, habitat selction, movements, acoustic telemetry

[Information for Delegates](#)

Movement strategies and individual variation in spatial behavioral traits in *Raja undulata*

Alina Hillinger [1], David Villegas-Rios [1], Christopher Monk [2], Gonzalo Mucientes [1], Kenn Papadopoulo [1], Alexandre Alonso-Fernández [1]

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Individual variation in almost any trait is a common feature of aquatic species. Despite being crucial to understand both ecological (e.g. demographic change) and evolutionary processes (e.g. fishing-induced evolution), individual variation in behavior remains understudied, and often overlooked in fish conservation and ecology studies. Here, we investigated the existence and covariation of spatial behavioral traits at multiple levels within a population of the endangered undulate skate, *Raja undulata*, in a small marine protected area in Galicia, NW Spain. We used tracking data of 197 individuals across four years to explore long-term movement strategies (e.g. seasonal residents, continuous residents and individuals expressing site fidelity) based on presence/absence patterns in the study area, and fine-scale behavioral patterns (e.g. activity, space use) based on high-resolution positions. Then, we used Bayesian multivariate mixed-effects models to investigate consistency at the individual level in spatial behavior, and covariation between long-term movement strategies and short term behavioral traits. We show that multiple movement strategies coexist in the studied population. In our preliminary analysis, 45.5% of individuals were seasonal residents, followed by individuals expressing site fidelity, and thus returning to the site after an extended absence (28.9%). Continuous residents were the least common (25.6%). Furthermore, we found consistent individual variation in fine-scale spatial behavior which reinforces the idea that individual variation in behavior may be common in aquatic species. Our results suggest that in order to enhance the resilience of the species, the conservation of different behavioral types should be taken into account when designing and managing marine protected areas.

Keywords: individual behavior, covariation, acoustic telemetry, elasmobranch

Information for Delegates

8:30 **PLENARY: PLENARY: Pablo Arechavala**

Tracking fish in aquaculture environments

Welfare and aquaculture

Spain

Tracking fish in aquaculture environments

Aquaculture is a worldwide industry experiencing a rapid growth during the last decades. Fish farm facilities can be found nowadays all over the world, where diverse fish species are reared in different environments, from open-sea cages to coastal lagoons or on-land facilities. Under these scenarios, the great advance of animal tracking technologies such as acoustic telemetry and biosensors can provide great insights on sustainable and responsible aquaculture management. On the one hand, the interest on behaviour and welfare of farmed fish has rapidly increased during last years. The fast development of the industry and the increased social concern about the welfare of fish in captivity have led to several studies monitoring behavioural parameters, such as swimming activity and daily patterns, spatial use and distribution, feeding, or aggressiveness, among others. A better knowledge on farmed fish behaviour can help farmers to improve feeding strategies and other routinely procedures, ensuring better captive conditions and a more sustainable activity. In addition, escape events of farmed fish can eventually occur, which may provoke serious ecological and socio-economic impacts. Monitoring escaped fish using acoustic telemetry techniques can be crucial for a proper aquaculture management in terms of escapees. For instance, studying the residence time and dispersion of escapees, or the connectivity with other fish-farming areas, fishing grounds or coastal/protected areas. On the other hand, coastal and off-shore on-growing facilities can act as fish aggregation devices (FADs) or ecological traps, attracting a wide number of wild fish looking for food and/or shelter. In this sense, tracking farm-aggregated fish population through telemetry can help to develop a more sustainable aquaculture activity, shedding light on the ecological and socio-economic effects of this activity on wild fish populations and fisheries. In this talk, I will compile information from existing fish tracking studies under these scenarios, highlighting the applicability, utility and limitations of acoustic telemetry and biosensors as management tools in aquaculture environments.

Combined approach in telemetry

Canada

Applying spatial capture-recapture models to acoustic telemetry data collected in river networks

Joseph Bottoms [1], Bryce O'connor [1], Marie Auger-Méthé [2], Mark Shrimpton [3],
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Spatial capture-recapture (SCR) models are a relatively recent extension of classical capture-recapture models which have been a cornerstone of animal ecology for decades. SCR models have greatly expanded the analytical potential of capture-recapture models by accommodating the inclusion of georeferenced covariates and animal locations and have been widely applied in terrestrial study systems. Fewer studies have extended their use into the aquatic environment; those that have were applied mostly in lentic systems where 2D movements are more easily determined, and fewer yet have applied SCR to the riverine environment. When applied in river systems, these models take on a 1D form where movements are restricted to either the upstream or downstream vector. However, applying SCR to branching (dendritic) river networks, where movements in the state-space are neither purely 1D or 2D, has proven challenging and hampered the application of SCR to data collected beyond single streams. The development of the R package secrlinear (Efford 2021) has provided functionality for this obstacle to be overcome. This research explores how SCR can be applied to a telemetry datasets collected in river networks. We illustrate the application of SCR to acoustic telemetry data collected on a migratory population of Arctic grayling as they complete their life history stages entirely within a dendritic river network. By allowing for branches within a river network, this approach provides aquatic ecologists with a new, quantitative tool for assessing population movements at the watershed scale. Through the integration of statistical rigor to a framework which often relies on simple descriptions of an organism's detection history, this application can be used as part of predictive conservation planning workflows.

Keywords: acoustic telemetry, spatial capture, recapture, migratory species, arctic grayling

Information for Delegates

9:30 **Jordanna Bergman**

An Interdisciplinary Evaluation of Multi-Species Fish Connectivity
in Canada's Historic Rideau Canal Waterway

**Strategy for conservation
Canada**

An Interdisciplinary Evaluation of Multi-Species Fish Connectivity in Canada's Historic Rideau Canal Waterway

Jordanna Bergman[1], Joseph Bennett , Valerie Minelga , Chantal Vis , Aaron Fisk , Steven Cooke

[1] Carleton University – Canada

Interconnected freshwater systems, like artificial waterways, are now pervasive globally and have facilitated countless invasions. Most waterways are linked by barriers (e.g., lockstations), providing an opportunity to selectively restrict invasive species without negating connectivity to native species. However, the ecological connectedness across a waterway is often unknown, make it difficult to apply selective fragmentation efforts. Here, we blended acoustic telemetry (native largemouth bass ($M.\ salmoides$) & northern pike ($E.\ lucius$), and invasive common carp ($C.\ carpio$); N=225) and mark-recapture (15 species; N=9563) data with management consultations, ecohydraulics, and environmental information to evaluate barrier passability at ten lockstations over five years (2018-2023) in the Rideau Canal Waterway. This 202-km navigable route is interconnected by 23 operating lockstations, and is internationally significant as a UNESCO World Heritage Site and as a hydrological link between the Ottawa River and the Laurentian Great Lake Ontario. Our results suggest barriers minimize, but not entirely restrict, connectivity. We documented 36 passage events by 26 native fishes at nine lockstations, mostly in the spring. No common carp passages were detected; movements indicated carp favoured high-flow areas downstream of dams, regions with no pathway upstream. Passages were recorded in all years, except 2020 – the year of global COVID-19 lockdowns – implying potential "anthropause" effects. We discuss consequences of season-, direction-, and species-specific passages, and other fish interactions with infrastructure. Our work informs evidence-based management planning to support freshwater biodiversity conservation and invasion prevention in North American waterways and beyond.

Keywords: invasive species, selective fragmentation, fish passage, connectivity, navigation lock, ecohydraulics

Timing, stability and purpose of non-spawning aggregations in adult anguillid eel

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Many life stages of anguillid eels possess a strong tendency to aggregate and can be highly gregarious. This can occur en masse within a specific waterbody leading to silver eel, pre-spawning aggregations. Environmental cues, such as precipitation and lunar phase, are thought to play an important role in instigating downstream spawning migrations in mature silver eels. As well as changes in environmental conditions, social cues may play an important role in aggregation and movement with silver eels triggered to migrate by other conspecifics. However, what structure these aggregations take or to what extent they are maintained by social interactions between individuals is unknown, largely because it is so difficult to obtain sufficient data on migrating silver eel behaviour. In this paper, we used the VEMCO VR2W Positioning System (VPS) to track the movements of 36 and 68 European eels in Hanningfield reservoir, UK in 2015 and 2016, respectively. Social network sampling, null modelling and sensitivity analyses were used to define the temporal and spatial conditions of aggregations, and whether aggregations in lentic water bodies are socially or environmentally driven. There is a paucity of ecological knowledge on European eel aggregations. Since aggregations often occur at specific times and locations, aggregations can be vulnerable to anthropogenic pressure. As such, this study pro- vides important information on the behavioural ecology of the critically endangered European eel. Spatio-temporal information of aggregations can be vital for vulnerable species, such as European eel, as they can inform protection measures like protected areas and no-take zones, as well as conservation and management protocols, such as monitoring and trap and transport.

Keywords: aggregation, eel, movement, telemetry, VPS

10:00 **Michaël Ovidio**

Movement behaviour and fishway performance for endemic and exotic species in a large anthropized river

Movements in ecology

Belgium

Movement behaviour and fishway performance for endemic and exotic species in a large anthropized river

Michaël Ovidio [1], Arnaud Dierckx [1], Jean Philippe Benitez [1]

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Studies of fishway performance, at the multi-species level in large rivers, are scarce and this raises the question of the passage success of both endemic and exotic species in anthropised environments. The study was conducted in the downstream part of the River Meuse (average annual discharge = 400 m3.s-1) on a 13 km transect between two successive fishways (M0 and M1). From 2015 to 2021, a total of 1065 adult individuals, representing 14 large potamodromous (including asp *Aspius aspius* and catfish *Silurus glanis* as exotics) and diadromous species, were captured at the trap of the Lixhe fishway (M0), individually tagged (using biocompatible RFID tags-Radio Frequency Identification), and released upstream of M0. To analyse the performance of the M1 vertical slot fishway using standardised metrics, a RFID detection station was placed with one antenna at the entrance and one antenna at the most upstream pool of the M1 fishway (5.7 m height 18 pools). With 456 individuals detected in the M1 fishway, the ascending rate from M0 to M1 was 42.8% (the common bream, *Abramis brama* achieving 85.7%); the exotic species (catfish and asp) reached 21.5% and 30.5%, respectively. The adjusted passage performance was the best for the exotic asp (94.9%) followed by the trout, *Salmo trutta* (90.0%). The median time to cross the M1 fishway was shorter for the trout (median = 01h08) and longer for the eel *Anguilla anguilla* (median = 21h17); the exotic asp was also very fast (median = 1h31). The hourly passage time at M1 was variable, with some species migrating during daylight, dark periods or the entire 24h cycle. The multispecies vertical slot fishway studied presented the best performance, in terms of passage success, at an international level, associated with good transit times It also allows the passage of exotic species, which will increase their expansion area.

Keywords: telemetry, ecological continuity, migration, dam, river restoration

Quantifying the impact of habitat modifications on species behavior and mortality: case-study on floating objects and tropical tuna

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Ecosystems and biodiversity across most of the world are being altered by human activities. Habitat modification and degradation is among the most important drivers of biodiversity loss. These modifications can have an impact on species behavior, which can in turn impact their mortality. The use of Drifting Fish Aggregating Devices (DFADs) by purse seine fisheries is a major concern and offers a good case study to assess the impact of habitat modifications on species behavior and mortality. Because several pelagic fish species, such as tuna, associate with floating objects, fishers have started deploying their own floating objects – DFADs – in the early 1990s to increase tuna catchability. The massive deployment of DFADs has modified tuna habitat, by increasing the density of floating objects, with potential consequences on tuna associative behavior. In this study we use an individual-based model, based on a correlated random walk calibrated on passive acoustic tagging data, to determine a general relationship between FAD density and the time tuna spend between two associations with a FAD. Using this general relationship and fisheries data in the Indian Ocean (IO), we predict that, as DFAD density increases, tuna spend a higher percentage of their time associated in the area where most of the purse seine sets on floating objects occur. Hence, purse seine fisheries modify tuna habitat by increasing DFAD density which in turn can impact tuna mortality, through a modification of their associative behavior. As DFAD density is linked to tuna fishing mortality, there is an urgent need to continue regulation efforts on DFAD deployments.

Keywords: global change, purse, seine fisheries, Fish Aggregating Device, individual, based model, associative behavior

Information for Delegates

Fine-scale analysis of acoustically tagged tiger shark (*Galeocerdo cuvier*) seasonal movements around Maui Nui, Hawai'i

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Maui (Hawaiian Islands) waters experience a seasonal influx of tiger sharks (*Galeocerdo cuvier*) during the winter months. The drivers of this seasonal migration are unknown but the timing overlaps both tiger shark mating season (January/February) and peak humpback whale (*Megaptera novaeangliae*) abundance in Maui waters. Thus, tiger sharks may be attracted to Maui during winter by mating opportunities and/or possible enhanced foraging opportunities associated with whales such as sick/injured individuals and placental falls. We are using a combination of acoustic monitoring, accelerometer-camera deployments, drone surveys, modeling, stable isotope analyses and DNA metabarcoding of cloacal DNA swabs to evaluate whether tiger sharks visit Maui during winter for mating, foraging on whales, or both. Preliminary analyses of an existing long-term (2013-2019) acoustic monitoring data set suggests possible tiger shark aggregation behavior at a specific location off the west coast of Maui with multiple sexually mature individuals detected during the same day or hour during the core winter months of January and February. This combined approach is providing new insights into the ecological role played by tiger sharks in Hawaii coastal habitats and the importance of Maui Nui waters and humpback whales to tiger shark ecology in Hawaii.

Keywords: acoustic telemetry, biologging, coastal ecology

Information for Delegates

11:15 **Antonia Kloecker**
On the edge – Deciphering movement patterns of pelagic
sharks in the Arctic

Movements in ecology
Norway

On the edge – Deciphering movement patterns of pelagic sharks in the Arctic

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The North East Atlantic is home to several species of pelagic sharks, including the porbeagle shark (*Lamna nasus*) and the basking shark (*Cetorhinus maximus*), which are critical components in the region's ecosystem. Despite their importance, the movement behaviour and population dynamics of these species, particularly at the northern edge of their distributions, remain poorly understood. In this talk, latest results from the "Sharks on the Move" project will be presented, in which we shed light on the movement patterns of porbeagle and basking sharks in northern Norway and beyond. By utilising a combination of long- and short-term deployments with Smart Position and Temperature (SPOT) Transmitting tags and pop-off satellite archival transmitter (PSAT) tags, we investigate the movement dynamics of both species at different spatiotemporal scales. Thereby, we aim to close key knowledge gaps regarding the large-scale migration and connectivity patterns as well as the effects of environmental gradients, such as temperature fronts and prey availability, on the space-use of these "edge" individuals. First results hint at individuals undertaking large scale migrations spanning across almost 40◦ in latitude and exploiting wide depth and temperature ranges. In conjunction with identified hotspots based on static data from fisheries and citizen science, these tracking data contribute to a spatiotemporally integrated view the overlap between human activities and the shark's space-use. By investigating these data in the context of existing knowledge from individuals at the core of their distributions, we will further be able to assess the potential impacts of climate change on respective populations. With climate change set to alter environmental conditions in the North East Atlantic, and particularly the high latitudes, this knowledge will be crucial in assessing the potential impacts and in informing the development of effective management strategies in the region.

Keywords: PSAT, SPOT, large, scale migration, climate change, high latitudes, distribution edge

[Information for Delegates](#)

Strategy for conservation
USA

Great Lakes Acoustic Telemetry Observation System: Transitioning from Project-specific to Lake-wide Infrastructure

Christopher Vandergoot [1] and Christopher Holbrook [2]

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[2]United States Geological Survey (USGS) – États-Unis

The Great Lakes Acoustic Telemetry Observation System (GLATOS) formed out of four research projects that demonstrated the utility and value of using acoustic telemetry to track native and invasive fishes across broad geographic scales. During its first 10 years, efforts focused primarily on supporting individual research projects and the minimum functions needed to meet their individual and collective objectives. Since then, long-term funding commitments and increased appetite for fish movement data from research and management communities have fostered transition of focus from individual projects to foundational infrastructure that supports multiple projects. For example, currently three of the five Great Lakes (Ontario, Erie and Huron) are "wired" with uniformly spaced receiver grids to monitor broad-scale movement of ecologically and economically significant species. Continued growth of the network is expected due to existence of strong collaborative partnerships and a data policy and data system that respects privacy of tag owners while affording efficient data transfer among members. We highlight successes from the first 10 years of GLATOS along with new directions, opportunities, and key challenges as the network moves further into its next phase.

Keywords: telemetry, networks, fish, great lakes

11:30 **Richard Kraus**

Fish have tales! Can Patterns of Lake Whitefish Migration and Habitat Use Inform Research and Management in Laurentian Great Lakes?

Fisheries management

USA

Fish have tales! Can Patterns of Lake Whitefish Migration and Habitat Use Inform Research and Management in Laurentian Great Lakes?

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Lake whitefish (*Coregonus clupeaformis*) populations in the Laurentian Great Lakes are impacted by multiple stressors such as historical overfishing, eutrophication, invasive species, and climate change. Currently, reduced recruitment and low population abundance are fueling management concerns about future sustainability of these iconic fisheries. Here, we use novel data generated in Lake Erie as an example to illustrate how telemetry can advance our understanding of critical knowledge gaps and inform fisheries management. Specifically, our results test key assumptions about spatial uniformity in distribution, catchability by different fisheries, and differential stock mixing. Further, telemetry has revealed behavioral responses to habitat degradation and allowed fisheries-independent estimates of mortality to improve stock assessments.

Keywords: Great Lakes, Lake Erie, Coregonus, Habitat Use, Fishery Management

Information for Delegates

11:45 **Steven Cooke**

Animal welfare considerations for fish tracking studies

Animal welfare
Canada

Animal welfare considerations for fish tracking studies

Steven Cooke [1]

[1] Carleton University – Canada

Before fish tracking studies commence it is necessary to determine best practices for tagging that attempt to maintain the welfare status of fish. That information is used to develop protocols that are assessed by institutional animal care committees or other permitting bodies. Increasingly, those practices are also critiqued at the peer review stage. It has long been known that if the tagging process (spanning capture, handling, tagging, post tagging retention, etc) or burden of a device impact the behaviour, health, condition or fate of a tagged animal that resultant data will fail to be representative of the broader untagged population. Moreover, there is growing public attention and concern for fish welfare necessitating more efforts to study and mitigate welfare issues related to fish tracking studies. Here I will provide a candid overview of the current state of fish welfare as it related to fish tracking. Topics covered will include the importance of pre and post operative care, use of electro-immobilization tools, analgesia, antibiotics, and more generally what is needed to maintain the social licence to tag fish. I will reflect on the evidence base (or lack thereof) and what we need to do as a community to ensure that our methods are ethical, responsible and legal. The perspective provided emerges from my recent stint serving as Chair of the Fish Care Guideline Revision for the Canadian Council on Animal Care and my experiences as a fish pain skeptic and fish welfare advocate working in the fish tagging and tracking realm.

Keywords: Fish welfare

12:00 **Saron Berhe**

Monitoring the restoration effects on the biodiversity of the city fjord in Bergen

Strategy for conservation

Norway

Monitoring the restoration effects on the biodiversity of the city fjord in Bergen

Saron Berhe [1], Robert Lennox, Knut Vollset, Cecilie Nilsen, Lotte Dahlmo

[1] NORCE Norwegian Research Centre – Norway

The sea bottom in and around the city fjord in Bergen, Norway is polluted due historic dumping of waste and discharges from industry, in addition to runoff from urban areas and roads. The municipality of Bergen has initiated a plan for establishing a new and clean seafloor of the inner parts of the Bergen city fjord to improve the sea bottom conditions, and in doing so, enhance the habitat available to fish and delivery of ecosystem services from the city fjord to the local society. The project has used four coastal species: European lobster, Atlantic cod, ballan wrasse, and corkwing wrasse to investigate the habitat use before and after capping of the polluted substrate in the restoration program. This project aims to deliver actionable advice to the municipality about the costs and benefits of restoration in terms of fish habitat, ascertained from the movement data in the acoustic tracking project. In addition, we aim to better understand the restoration process and guide future efforts working to restore coastal marine habitats.

Keywords: Acoustic telemetry, restoration, restoration effects, European Lobster, Ballan wrasse, Corkwing wrasse, Atlantic cod

Information for Delegates

12:08 **Chloé Blandino**

Habitat partinioning in sympatric sharks at French Frigate
shoals atoll

Behavioral ecology

USA

Habitat partinioning in sympatric sharks at French Frigate shoals atoll

Chloé Blandino [1]

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Competition and predation are important ecological mechanisms shaping resource utilization patterns in sympatric species. Determining how mobile marine predators partition resources is extremely challenging because of the concealing nature of the ocean, hence most studies of resource partitioning in sharks have focused on diet which can be gleaned from examining the stomach contents of dead individuals or stable isotope analyses of shark tissues. Far less is known about how sympatric sharks partition habitat because of the difficulties associated with quantifying their use of habitat over time. To overcome this challenge, I used passive acoustic monitoring to quantify space and habitat use by sympatric shark species at a remote, protected atoll (French Frigate Shoals: FFS) with near-pristine ecology. I analyzed the movements of 149 individuals over a 2-year period to determine whether and how sympatric sharks partition habitat. The observed patterns of shark habitat use at FFS were consistent with preferred prey distribution, resource partitioning/competitive exclusion and predator avoidance. Some sympatric shark species partitioned habitat along spatial and temporal (seasonal and diel) dimensions, whereas others overlapped possibly by exploiting different prey. Tiger sharks may occupy a keystone role in the shark assemblage at FFS, with their habitat use and prey preferences shaping those of other shark species. For example, a tiger shark preference for foraging on fledging birds and other prey found concentrated in shallow lagoon habitats may restrict grey reef shark use of these habitats because these smaller sharks are potential prey for tiger sharks. This study reveals how apex predators can modify the behavior of subordinate species, leading to the structuring of marine ecosystems.

Keywords: resource partitioning, habitat use, movements

Information for Delegates

Fin-scale behaviour of Atlantic cod *Gadus morhua* ecotypes

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Different ecotypes of a species often display different movement ecology. Atlantic cod *Gadus morhua* has several ecotypes, among which the Northeast Arctic cod ecotype is known to make foraging migrations far into the Barents Sea. The Norwegian coastal cod ecotype is more sta- tionary within fjords but may make smaller regional migrations. However, both these ecotypes have spatiotemporal overlapping spawning in coastal areas during spring and may potentially interact during the spawning season. Moreover, the juvenile progeny of both ecotypes may to some extent grow up in the same area for some time. Although the large-scale movement ecology of these two ecotypes is known, the knowledge about fine scale behaviour is still very limited. We address this by tracking cod of both ecotypes by 3D acoustic telemetry year-round in a subarctic fjord (20 km2). The fish tracks were combined with bathymetric maps and bottom substrate classification maps to assess high-resolution habitat use. Ecotype and sex were de- termined by genetic analyses. The probability of being in different behavioural states (resting vs moving states) was assessed by Hidden Markov Modelling. We show how the behavioural patterns changes with ontogeny and contrasts between sex and ecotypes. Finally, we discuss how the behavioural parameters can be used to investigate behavioural changes following some external impact factors such as aquaculture and fishing.

Keywords: Aquaculture interactions, movement ecology, *Gadus morhua*, YAPS, 3D telemetry

Comparison of the spatio-temporal behaviour of two predators in a marine protected area in Corsica

Jessica Garcia [1], Caroline Bousquet, Romain Bastien, Salomé Ducos, Mikaël Demolliens, Johann Mourier, Antoine Aiello, Eric D. H. Durieux

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Marine reserves are efficient tools for the conservation and protection of vulnerable species. In Corsica, movements of two vulnerable fish species (*Epinephelus marginatus* and *Dentex dentex*) were monitored in a marine protected area (MPA) using acoustic telemetry. In this study, we compared the spatio-temporal variations at different temporal scales (day, month, and year) between these two top-predators. From July 2018 to December 2021, 10 *Dentex dentex* and 16 *Epinephelus marginatus* were studied in a Corsican no-take zone (Nonza) using 40 passive acoustic receivers (Thelmabiotel, TRB700). Both species had home range of similar size but their spatio-temporal use of habitats were very different. Indeed, *D. dentex* performs diel migrations between the surface and deeper areas and stayed close to coastal areas. *E. marginatus* stayed at the same depth for several days and explored a larger area. The larger individuals resided in deeper habitats, and age and/or sex could influence fish behaviour. For both species, the thermocline appeared to influence the preferred area of residency. Our results showed the importance to take into account spatio-temporal movements of fish in marine reserves for conservation and management. The MPA of Nonza appears to be an efficient marine conservation tool, at least for these two vulnerable species.

Keywords: marine reserve, spatio, temporal variations, mediterranean fish, diel migrations

Information for Delegates

02:30 **Inge Van der Knaap**

Impact of two human-made impulsive sounds on free-ranging
cod in the North Sea

Strategy for conservation

Netherlands

Impact of two human-made impulsive sounds on free-ranging cod in the North Sea

Inge Van Der Knaap * [1], Hans Slabbekoorn [2], Erwin Winter [3], Tom Moens [4], Michael Ainslie [5], Jeroen Hubert [6], Len Thomas [7], Jan Reubens [8]

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Sound is everywhere in the marine environment and hearing is therefore a very important for stimuli for fish. They use sound for orientation, communication, during migration, aggregation and spawning, but also for detection of prey and predators. Understanding how fish are effected by human-made sound has become increasingly important in light of the increasing contribution of noise produced by human activity at sea. Over the past years, we investigated the effects of two anthropogenic sound sources in relation to the movement behaviour of free-swimming Atlantic cod (*Gadus morhua*) in the North Sea: seismic surveying for the exploration of the seabed and pile driving during the construction of offshore windfarms. Results from the two sound exposure studies demonstrated that both seismic and piling sound effect the behaviour and activiy of cod. Exposure to a seismic survey resulted in alterations in the diurnal pattern, reduced activity, and fish leaving the area earlier in the year. Piling did not result in leaving but did cause cod to move closer to the hard bottom structures. Ultimately, these insights will bring us one step closer towards recognising the effects of anthropogenic noise on the behaviour of individual marine fish and the potential consequences this may have at population level.

Keywords: Atlantic cod, Anthopogenic noise, Acoustic telemetry, HMM, Behaviour, Seismic survey, Piling, Wind energy

Information for Delegates

02:45 **Alison Frey**

Informing management of fisheries and offshore wind
development using acoustic telemetry of spawning cod

Fisheries management

USA

Informing management of fisheries and offshore wind development using acoustic telemetry of spawning cod

Alison Frey [1], Sofie Van Parijs, Steve Cadrin

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Atlantic cod is an ecologically, economically, and culturally important fishery resource in the North Atlantic Ocean. This species was historically overexploited, and New England stocks remain well below rebuilding targets due to overfishing and climate effects. Cod in southern New England were recently identified as a discrete population for stock assessment and fishery management, but spawning dynamics are relatively uncertain in the southernmost extent of their range. Offshore wind development is planned on cod spawning grounds in southern New England. Spawning aggregations are highly sensitive to human disturbance, and cod may be impacted by offshore wind development through alteration of habitat and disruption of spawn- ing behavior. We mapped the spatiotemporal distribution of cod spawning in the region as a pre-construction baseline for characterizing interactions with offshore wind development. In collaboration with commercial and recreational fishermen as well as offshore wind developers, we tagged spawning cod with acoustic transmitters and deployed an array with ten moored receivers on the primary spawning ground. Simultaneously, an autonomous glider surveyed an extended region for telemetry detections and passive acoustic detections of sound production by cod during spawning activities. Data from four subsequent seasons was used to quantify residence, straying, and site fidelity to the primary spawning ground as well as thermal preferences throughout the year. Results indicate that spawning occurs from November to March, with high residence on the spawning ground, some regional distribution beyond the primary spawning ground, and multi-year, annual spawning site fidelity. These findings will help to inform the stock structure of cod and successful management for the coexistence of offshore wind energy and fisheries.

Keywords: acoustic telemetry, autonomous glider, passive acoustics, Atlantic cod (*Gadus morhua*), spawning dynamics, offshore wind development

Information for Delegates

02:53 **Marine Gonse**

Combining acoustic telemetry with archival tagging to investigate the spatial dynamic of the understudied pollack, *Pollachius pollachius*

Combined approach in telemetry

France

Combining acoustic telemetry with archival tagging to investigate the spatial dynamic of the understudied pollack, *Pollachius pollachius*

Marine Gonse [1], Martial Laurans, Mickael Drogou [1], Justus Magin [2], Tina Odaka[2], Stéphane Martin[1], François Garren[1], Thomas Stamp [3], Mathieu Woillez[1]

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For the understudied pollack of the Northeast Atlantic, *Pollachius pollachius*, knowledge of population structure, habitat use, connectivity between essential habitats, and movement behavior are critically lacking while the stock appears to be declining, given the drop in landings and fishing yields. Here, we present a first attempt to assess the amenability of pollack for tagging, their habitat use and movement behavior by tracking fish using acoustic telemetry and data storage tags (DSTs). In 2022, a wide network of acoustic receivers has been deployed in the Channel along the French, English and Belgian coasts (FISHINTEL project). 83 pollack were tagged with acoustic transmitters, among which 70 were double tagged with DSTs. Each acoustic tag is associated with a unique identifier that pings every 3 minutes for 5 years. The detections were correlated to environmental conditions to characterize the habitat use of pollack. In January 2023, 19 pollack were detected by the network, mostly on rocky substrates. Complementarily, DSTs provide temperature and depth profiles every 90 seconds for 2 years. By combining the acoustic detections with the temperature and depth timeseries in a geolocation model, we were able to qualify the model performance and reconstruct the trajectories of 6 recaptured pollack, among which 4 were detected by the network. The trajectories last summer suggested a high degree of fidelity, for instance for the Iroise Sea as a potential feeding ground. As data accumulates, the combination of innovative tracking methods will continue to bring new insights into the ecology of the understudied pollack.

Keywords: Hidden Markov Model, geolocation model, Pollock, movement ecology

Information for Delegates

03:00 **Benoit Berges**

Behavior and seasonal stay of Atlantic cod around artificial reefs in an offshore wind farm

Strategy for conservation
Netherlands

Behavior and seasonal stay of Atlantic cod around artificial reefs in an offshore wind farm

Benoit Berges [1], Erwin Winter [2], Olvin Van Keeken [1]

[1] Wageningen Marine Research – Netherlands; [2] Wageningen Marine Reseach – Netherlands

Following European targets for renewable energy, it is expected that the number of Offshore Wind Farms (OWF) in the southern North Sea will increase substantially in the coming years. This will complement the already large base of OWFs operating in the North Sea. The impact of OWF on marine wildlife is a mixture of beneficiary and detrimental effects. A potential beneficiary effect of OWF is the provision of new habitats, protected from fisheries. Such a positive impact can be further developed through artificial enhancement of the marine habitat with artificial reefs. In that context, fish telemetry has a role to play to investigate at fine temporal and spatial scales the impact of OWFs and the implementation of artificial structures. Along the Dutch coast, four artificial reefs were deployed in an operational OWF, in the vicinity of a wind turbine. In order to investigate the behavioral pattern near the structures but also the seasonal stays, a network of 16 acoustic telemetry receivers was used, coupled with 64 individually tagged Atlantic cod (*Gadus morhua*). The monitoring was ran for 18 months across 2 consecutive summer seasons. Through the collected fish telemetry data, fine scale positioning at location was performed for each individual fish, providing detailed information on behavior, area utilization and attachment to structures. Results show an overall strong attachment (high fidelity) to the artificial reef with few individuals exemplifying over-winter stays. These results suggest a clear beneficial impact of the deployed artificial structures.

Keywords: offshore wind farm, fine schle positioning, artificial reefs

[Information for Delegates](#)

Mapping silver eel migration routes and behaviour in the North Sea and the Channel

Pieterjan Verhelst [1] , Håkan Westerberg, Johan Coeck, Tom Moens, Jan Reubens, Janek Simon, Jeroen Van Wichelen, Klaus Wysujack, David Righton

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Recent developments in tracking technology have helped to map the large-scale oceanic spawning migration routes of the European eel (*Anguilla anguilla*). However, despite the connectivity of many large European rivers with the North Sea, the migration routes across the NE Atlantic continental shelf have rarely been studied. Here, we present the most comprehensive map to date of migration routes used by silver European eels (n=54) as they migrate to the ocean after being tagged in Belgium and Germany. Tagged eels either moved directly west, enabling us to document successful migration through the Manche/Channel for the first time, or moved north to exit the North Sea at is border with the Norwegian Sea and Atlantic Ocean. The use of each route was independent of the catchment that the eels originated from. We observed a wide range of daily migration speeds (between 6.8 – 45.2 km day-1) as eels moved between different sea areas; overall, eels migrating through the Channel achieved a greater average migration speed. Although eels migrating over the shelf did not exhibit the ubiquitous large diel vertical migrations (DVM) observed of eels migrating in the open ocean, there was a strong diel effect on behaviour, with (typically) higher vertical movement range and position at night compared to daytime. Furthermore, vertical movements were also influenced by tidal currents, with eels moving away from the seabed and higher into the water column when the direction of current was favourable (selective tidal stream transport, or STST). We hypothesize that the migratory and vertical movement tactics that we observed are driven by navigation, bio-energetic efficiency or predator avoidance.

Keywords: Anguilla, migration, telemetry, archival tags, data storage tags, North Sea, Manche, Channel, diadromy, selective tidal stream transport, diel vertical migration, circadian

Information for Delegates

Behavioral ecology

Czech Republic

Behaviours and strategies of top fish predators in three different lentic systems

Milan Říha [1], Ruben Rabaneda-Bueno [1], Ivan Jarić [1,2], Marie Prchalová [3], Karl Øystein Gjelland [4], Lukáš Vejřík [1], Jiří Peterka [1]

[1] Biology Centre CAS, Institute of Hydrobiology – Czech Republic; [2] Université Paris-Saclay, CNRS, AgroParisTech, Ecologie Systématique Evolution – Université Paris-Saclay – France; [3] Biology Centre CAS, Institute of Hydrobiology – Czech Republic; [4] Norwegian Institute for Nature Research (NINA) – Norway

Behaviours and strategies of acoustically-tagged predators (N) – northern pike *Esox lucius* (47), wels catfish *Silurus glanis* (45), and pikeperch *Sander lucioperca* (20) – were studied using autonomous fine-scale positioning system in three lentic systems in the Czech Republic. The systems studied – two post mining lakes, and a deep-valley reservoir with rocky shores – contrasted in littoral structural complexity and prey abundance, which enabled us to follow differences in predators' behavioural patterns. Comparison of lakes with differing macrophyte coverage showed that pike displayed increased activity, space use, individual growth, and behavioural differentiation, as well as longer residence in pelagic habitat in the lake with low structural complexity. In the lake with lower prey abundance, catfish activity lacked typical strong differentiation between circadian activity levels, resulting in high overall movement throughout the day, while activity remained mainly nocturnal in the prey-rich reservoir. Within one reservoir with pronounced trophic gradient we observed that pike consistently used the same sections of the reservoir, while pikeperch and catfish frequently visited the tributary during the warm season, and moved closer to the dam during the cold season. Longitudinal activity of pike was highest in the cold season, of pikeperch in the warm season, while catfish activity peaked in both seasons. Overlap in the depth use among species was higher in the warm season, when all species used the upper layer of the water column, and lower in the cold season, when pikeperch and catfish used deeper areas. Analysis of the effect of internal seiche on predators in one lake revealed that pike and catfish strongly react to upward seiche, resulting in reduced space use. Such effects were manifested only during the strongest seiche events, and only during the day. Our research revealed how predators mediate their strategies in coexistence with other predatory species, and as a response to differing structural complexity, prey abundance and hydrology of the system.

Keywords: pike, pikeperch, wels catfish, lake, reservoir, movement, activity, depth use

04:40 **Devon Smith**
Habitat use by white sturgeon varies across seasons
and hydrological conditions

Habitat use by white sturgeon varies across seasons and hydrological conditions

Devon Smith [1], James Crossman [2], Eduardo Martins [1]

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Endangered white sturgeon (*Acipenser transmontanus*) residing within the Transboundary Reach of the Upper Columbia River (Canada and USA) have been impacted by extensive anthropogenic alterations of the aquatic environment. While the movement and habitat use of white sturgeon throughout the Canadian portion of the Columbia River has been defined, longer-term relationships describing how environmental variables influence the use of critical habitats and the movements between habitats have not been thoroughly evaluated but are needed to inform conservation efforts. This research aimed to determine how river regulation and environmental covariates influence habitat-specific residence and the movement between such habitats by white sturgeon. We analyzed a 10-year acoustic telemetry dataset initially with the Actel R package and then further with a generalized linear mixed-effects model (GLMM). On average, we found that white sturgeon moved across river sections between 07:00 and 11:30 in the morning. Additionally, they were nearly absent from lower sections of the study area during the winter but present across all sections during spring, summer, and fall. Most sturgeon resided in the upper sections of the Columbia River system across all four seasons, and residence was not related to an individual's sex. Knowing when and where sturgeon reside during different periods of the year will benefit future conservation actions, such as habitat restoration, hatchery supplementation, and population monitoring.

Keywords: white sturgeon, residence analysis, acoustic telemetry, habitat use, Canada, movement ecology

Applying network methods to quantify the movement dynamics of gilt-head bream (*Sparus aurata*) across the Gulf of Lions

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The Gulf of Lion, situated in the north-western Mediterranean, is characterized by a series of highly productive estuarine lagoons connected to the sea via canals, which act as nursery and foraging sites for many fishes in the region. Gilt-head seabream (Sparus aurata) are known to use these lagoons as well as offshore waters during their yearly migrations between feeding and spawning areas. Yet, knowledge on the spatial ecology of this species is fragmentary, and key gaps in our understanding of their movement remain to successfully manage the population. Here, we used 3 years of acoustic telemetry data together with network analysis to determine the space use of over 200 gilt-head bream within an acoustic network of more than 100 receivers deployed in the Gulf of Lion. We assessed movement globally, but also as a function of where fish originated (i.e. different lagoons). Analyses indicated that there are clear patterns in seasonal movements, with fish displaying highest regional activity between October and February, whilst being more resident during warmer periods of the year. Fish size influenced spatial network metrics, with larger fish undertaking more protracted, long-ranging movement. Emigration to sea from different lagoons was found to be relatively synchronous; whilst aggregations of fish identified within the Parc National des Calanques, suggest that spawning individuals originate from across the Gulf of Lion. Together, these data present a new window into the spatial ecology of gilt-head sea bream in the Mediterranean.

Keywords: Fisheries management, Spatial ecology, Spatial network analysis, Ecology, Behaviour

Information for Delegates

8:45 **Sébastien Alfonso**

Insights on the use of telemetry sensors as a tool for health and welfare
monitoring of gilt-head sea bream (Sparus aurata) in aquaculture

Animal welfare

Italy

Insights on the use of telemetry sensors as a tool for health and welfare monitoring of gilt-head sea bream (*Sparus aurata*) in aquaculture

Sébastien Alfonso [1], Walter Zupa [1], Maria Teresa Spedicato [1],
Giuseppe Lembo [1], Pierluigi Carbonara [1]

[1] Fondazione COISPA ETS – Italy

The real-time monitoring technologies are gaining use in aquaculture farming to improve production and to monitor the health and welfare of farmed fish. In that sense, accelerometer tags have been proved to be sensitive remote monitoring tools to asses fish response to various rearing practices (e.g., stocking density, vaccination, water quality). Aims of this study are to present (1) the effect of tag implantation on swimming performance and physiology of the gilt-head sea bream (*Sparus aurata*), a key species of the European marine aquaculture, and to present (2) some insights gathered from several studies on how the use of such tags would help to remotely assess fish welfare in aquaculture environments. To do so, we calibrated acceleration recorded by accelerometer tag with the oxygen consumption rate (MO2) and the activity of white and red muscle of sea bream during swimming trials in controlled conditions. Such calibration of the acceleration with the physiological endpoints (MO2, muscle activity) is needed to use the acceleration recorded by the tag as a remote proxy of energetic expenditure in free-swimming fish. In addition, we investigated and found no potential deleterious effects of such tagging on swimming performance as well as the physiological stress profile and growth rate of fish following the implantation of such sensors at medium-term, overall ensuring that tagging does not impair its behavior and welfare. Finally, using acceleration as a proxy of energy expenditure, we showed some examples of the sea bream responses to different rearing conditions (e.g., high stocking density, vaccination and diet regimes) and according on its coping style. Overall, this study provides valuable insights on the use of telemetry sensors, especially accelerometer tags as tools for remotely monitoring welfare of sea bream in aquaculture environments.

Keywords: gilt, head sea bream, Sparus aurata, welfare, accelerometer tag, MO2, sensor, aquaculture

Information for Delegates

9:00 **Thomas TinHan**

Introducing the Pacific Islands Region Acoustic Telemetry (PIRAT) Network

Global approach of Telemetry studies

USA

Introducing the Pacific Islands Region Acoustic Telemetry (PIRAT) Network

Thomas Tinhan [1], Melanie Hutchinson [2], Molly Scott [2], Melissa Iwamoto [1]

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Since 2010, over 160 telemetry studies have been conducted within the eastern and western Central Pacific. However, with the exception of a small number of telemetry networks at the eastern and westernmost extents of the Pacific Ocean (e.g., IMOS, MigraMar), data sharing for the identification of external detections across the region has been done largely on an *ad hoc* or within-institution basis. In May of 2022, the Pacific Islands Region Acoustic Telemetry (PIRAT) Network was established with the intent of providing researchers across the Pacific Islands with a system of organizing and archiving acoustic telemetry data, as well as a framework for the fair exchange of those data that encourages collaboration within the region. Here we give a brief overview of the PIRAT Network, and some of the telemetry projects it currently supports.

Keywords: regional networks

Designing a miniature electronic tag for jellyfish tracking

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Rhizostoma pulmo is one of the most abundant jellyfish in the Mediterranean Sea. Its out- breaks have undeniable negative socio-economic and ecological impacts. To date, there are very few measurements of jellyfish growth rates in the literature, and no measurement of individual growth and sexual differentiation processes in situ, as this requires the ability to recapture the same individual in the environment. Some jellyfish species realize their entire life cycle in Mediterranean lagoons. For example, Bages-Sigean lagoon harbors a perennial population of R. pulmo since 2014 unabling the study of this jellyfish growth in the natural environment. We plan to collect and tag individuals, and to carry out repeated biometric measurements on these organisms (umbrella size, wet weight, gonad maturity index). For subsequent recapture and further measurements on those same individuals, we have developed a tag that allows the jellyfish to be sporadically geolocated. Data are transmitted via the LoRa-WAN network. Numerous technical issues need to be taken into account for this development: in particular the volume and weight of the tag to limit the impact on the animal, the hanging technique, a reliable geolocation and transmission system, a maximum energy autonomy for a minimum volume. Our approach is structured along two lines: firstly, we plan to estimate and understand the impact of our brand on the jellyfish displacement, and secondly, to carry out deployments lasting for several days. Some preliminary experiments indicate that there is no impact on the movement of the tagged jellyfish. The methodology for real-time tracking of jellyfish involves the use of GPS tags attached to the individual, which transmit their position via the LoRa network. To validate the effectiveness of our tracking system, we have also simultaneously deployed control tags and tagged jellyfish to determine the direction of movement between the jellyfish and the tag. In our experiments, the size of the tags varied to assess their impact on the swimming behavior of the jellyfish. Additionally, different sizes of jellyfish were chosen (from 22 cm to 38 cm) to determine the impact of the floats on their swimming behavior. Preliminary results from our float size studies suggest that there is no significant impact of the float on jellyfish movement. In addition, we observed a period of readaptation in tagged jellyfish after tagging, corresponding to the resumption of normal activity. Further experiments are needed to fully characterize this phenomenon and our previous results. In 2023, we plan to expand our experiments by using a wider range of jellyfish sizes, recording the movements of tagged and untagged jellyfish through drone video and deploying tags for longer periods. This will allow us to make more robust conclusions about the impact of our tagging methodology on jellyfish behavior and to study individual movements and growth.

Keywords: Jellyfish Tracking, Marine IoT, Bio, Measurements

9:30 **Sarah Larocque**

Development of telemetry-based fish habitat models to inform
environmental restoration

**Strategy for conservation
Canada**

Development of telemetry-based fish habitat models to inform environmental restoration

Sarah Larocque [1], Jake Brownscombe [1], Paul Bzonek [1], Jill Brooks [2],
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Fish habitat associations and selection can vary seasonally and by life stage, and in turn can impact the effectiveness of fish habitat management and environmental restoration. Acoustic telemetry data combined with habitat and environmental variables can be used in resource selection functions to model fish habitat associations. Using a 6-year acoustic telemetry dataset, we generated seasonal habitat selection models of four adult fish species in an urban freshwater coastal embayment, Hamilton Harbour, Lake Ontario. We used both dynamic (e.g., water temperature) and static (e.g., substrate) habitat and environmental variables in random forest algorithms to determine seasonal habitat associations for each fish species. Comparing the main habitat associations to the measured availability of that habitat feature can reveal if it is limiting within Hamilton Harbour and can influence the design of fish habitat and environmental restoration projects. How these associations compare to the literature may also reveal a lack of suitable habitat in the area for certain life history stages (e.g., spawning). Overall, using telemetry to develop spatial-temporal habitat models will help determine critical habitat for fishes and can be used to guide habitat management and environmental restoration.

Keywords: habitat, machine learning, restoration, freshwater

Fish biodiversity hotspots in a large lake: an ecosystem-wide data synthesis

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Large lakes are complex ecosystems that carry unique challenges for scientific study and management as they span hundreds of square kilometers and may cross international boundaries. As a result, there is a need for multi-species, ecosystem-wide perspective studies and broader-scale knowledge of biodiversity hot spots. To address this gap and improve understanding of the function of the fish community and the entire ecosystem, in this first-of-its-kind study in the Laurentian Great Lakes of North America, we aggregated data from ~ 95% of the leading acoustic telemetry researchers and scientists in Lake Ontario. The resulting dataset spans data between 2010 and 2021, includes 19 out of 22 fish species tagged and over 950 individuals. The objective of this study was to identify fish biodiversity hotspots and characterize the associated environmental envelope. The results from this study provide valuable insights of the span of essential fish habitat across Lake Ontario including commonalities and differences within the fish community.

Keywords: biodiversity, multi species, synthesis studies, ecosystem modelling, environmental envelope, essential fish habitat, fish community

8:30 **PLENARY: Pedro Afonso**

To track or not to track

Portugal

To track or not to track

Biotelemetry offers an ever growing palette of exciting and innovative avenues in marine research, from animal ecology to expanded ocean observation. Yet, it also comes with a number of challenges and limitations, including costs, technological, ethical and inherent data characteristics. What goals can we achieve in using biotelemetry as a research tool that we couldn't otherwise? How much does one need to balance its inevitable costs with the foreseeable gains? How can simple and frequently disregarded details (e.g. tag attachment, animal handling, experimental design) make the difference in increasing a study's success rate? And what difference can it really make in applied science actually supporting improved management, e.g. ecosystems approach to fisheries and conservation? I'll attempt to discuss these 'existentialist' topics of a fish telemetrist real life under the lens of our research group's experience applying various types of telemetry (from acoustic to satellite and high-res multisensory tracking) in different study species (from whale shark to eel) around the Azores, mid-north Atlantic ridge.

9:15 **Mathieu Woillez**

Fish don't have borders – Towards integrating fish spatial ecology into ecosystem-based fisheries management using a large scale acoustic telemetry network (FISH INTEL)

**Fisheries management
France**

Fish don't have borders – Towards integrating fish spatial ecology into ecosystem-based fisheries management using a large scale acoustic telemetry network (FISH INTEL)

Mathieu Woillez [1], Thomas Stamp [2], Carlota Muniz [3], Eider Graner [4], Lydie Couturier [5], Thomas Horton [6], Silvana Birchenough [7], Marine Gonse [1], Alice Hall [2], Jan Reubens [3], Katia Frangoudes [4], Lucy Hawkes [6], Martial Laurans [1], Peter Davies [2], Matthew Witt [6], Emma Sheehan [2]

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We present the FISH INTEL project (INTERREG EU Channel/Manche 2021-2023), which is an international collaborative initiative undertaken to track several marine species at both large and small spatial scales. The project main objective was to deploy an acoustic telemetry network in the Channel/Manche across seven pilot sites in three countries (UK, France, Belgium) to track movements and habitat use of five target species: European bass (*Dicentrarchus labrax*), Pollack (*Pollachius pollachius*), Bluefin Tuna (*Thunnus thynnus*), Black bream (*Spondyliosoma cantharus*) and Crawfish (*Palinurus elephas*). Interviews or meetings with local stakeholders (e.g. fishers, IFCA) were conducted to gather empirical ecological knowledge on each species, as well as consider their input on the design of the acoustic telemetry network. In 2022, a compatible acoustic telemetry network with more than 200 receivers was deployed across three countries, while 852 marine animals were tagged with acoustic transmitters. Data collection is ongoing, however preliminary results highlight previously unknown/undocumented movements and habitat use patterns. These data sets will be actively incorporated into fisheries management plans and these new information will contribute towards achieving Ecosystem-Based Fisheries Management. Here we provide a broadscale overview of the project, including lessons learnt and key findings, such as site residency and fidelity and migrations patterns.

Keywords: behaviour, movements, essential fish habitats, fishing strategies, *Dicentrarchus labrax, Pollachius pollachius, Thunnus thynnus, Spondyliosoma cantharus, Palinurus elephas*

Information for Delegates

9:30 **Bernat Hereu**

Integrating fish movescapes, habitat use and connectivity to implement effective ecosystem-based management in a transboundary MPA network

Strategy for conservation

Spain

Integrating fish movescapes, habitat use and connectivity to implement effective ecosystem-based management in a transboundary MPA network

Bernat Hereu [1,2], Philippe Lenfant [3], Eneko Aspillaga [4], David Casals [1,2], Gilles Saragoni [3], Joan Lluis Riera [1,2], Meryl Zimmermann [3], Martin Desmalades [3], Nicolas Lucchini [3], Irene Rojo [1], Julia Ortega [1,2], Graciel·la Rovira [1,2], Jerôme Bourjea [5]

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A current challenge for marine conservation is incorporating connectivity into fisheries management plans. Movement range and habitat use vary from species to species, as part of their life history, and their management is likely to require different approaches based on an understanding of the areas they use and the level of connectivity across the extent of their geographic range. Although Marine Protected Areas (MPA) have been successful in the recovery of some species, they often have not been efficient in preventing the overfishing of others. Moreover, the efficacy of MPA networks is unclear because sound evidence for connectivity is still lacking. Therefore, it is necessary to understand the spatial and habitat use of the different species with different life histories and connectivity patterns to combine efficient fisheries and spatial measures for a better conservation of marine ecosystems and to ensure the sustainable exploitation of the oceans. The European project Poctefa RESMED was developed along the marine coastline of the Eastern Pyrenees (NW Mediterranean Sea) with the objective of understanding the movement and habitat use of species with different life histories to evaluate and design new management measures on a regional transboundary scale. Through an acoustic telemetry study, a network of more than 100 receivers was deployed along a coastline of more than 100 linear km on both sides of the Spanish and French border, which included three MPAs with alternating rocky and estu- arine habitats. A total of 300 individuals of 25 different species belonging to 10 different families were tagged, including benthic and bento-pelagic species, and their movement was studied using a detailed mapping of the marine habitats of this area. The results showed several movement strategies of species related to their life history, ranging from sedentary patterns to displacements of hundreds of kilometers. In addition, we identified feeding and breeding areas for some species and habitats used as migratory corridors, such as estuarine seagrass beds. Furthermore, we demonstrated the effective connectivity between the MPAs along the Spanish and French coasts. Several individuals of 6 different species were also detected by the neighboring CONNECTMED receiver network, some recording movements of hundreds of kilometers along the coast. Our results show a mismatch between the scales of spatial management (MPAs of a few kilo- meters across) and the scales of the real ecological functioning in the study area (across tens of kilometers). Thus, we should combine spatial management with fisheries measures integrating ecological connectivity into management programs, increase the spatial scales at which management operates, and consider this large area as an ecological unit and an effective MPA network. These measures should be unified and agreed upon between different MPAs, open fishing areas, and transboundary countries.

Keywords: movescapes, connectivity, habitat use, MPA network, transboundary movements, spatial management, fisheries management

9:45 **Caroline Bousquet**
First insights of the Angelsharks (*Squatina squatina*)
behavior in Corsica

Movements in ecology
France

First insights of the Angelsharks (*Squatina squatina*) behavior in Corsica

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Antoine Aiello [1], Jessica Dijoux [3], Eric D. H. Durieux [1,4]

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The Angelshark (*Squatina squatina*) belongs to the 100 most threatened species worldwide. The ecology of this Critically Endangered species was poorly understood until the start of the Angel Shark Project in the 2010s in the Canary Islands. The project has now expanded throughout the North-East Atlantic and the Mediterranean, revealing important areas for the species' conservation. Corsica (Western Mediterranean) is one of these important areas, where the low fishing pressure and a good ecological state of marine habitats have allowed Angelsharks to survive. Besides working on local ecological knowledge and mark-recapture to understand the population dynamic in Corsica, the main objective focuses on the species' behavior using passive acoustic telemetry. The two aims of this study are to (i) understand the residency and estimate home range of Angelsharks through the year according to sex and sexual maturity of the sharks and (ii) appreciate the daily activity using environmental variables such as daylight, moonlight, depth and temperature. To do so, 24 sharks were tagged with acoustic transmitters recording depth, activity and temperature on the Eastern coast of Corsica. Overall, 4 males and 20 females were tagged through 15 fishing campaigns between July and September 2022, suggesting a 1:5 sex ratio in summer. Preliminary results of the first 4 months of tracking indicate sharks can spend up to a few days in very shallow waters (< 15 meters) around estuaries and move to deeper waters (40 – 60 meters with the deepest record being 184 meters). These results could provide key aspects of the Angelsharks' spatio-temporal dynamic in Corsica to mitigate fishers and sharks interaction by identifying "Angelsharks hotspot" along the Eastern coast of Corsica. Understanding spatio-temporal dynamic would in the end, brings insight to improve the conservation of this Critically Endangered species.

Keywords: Shark, Corsica island, behavior, habitat use, diel patterns

9:53 **Lydie Couturier**

Monitoring the habitat use and movements of mobile
species in a context of offshore wind energy development

Monitoring the habitat use and movements of mobile species in a context of offshore wind energy development

Lydie Couturier [1], Pierre Labourgade [2,3], Thomas Trancart [3], Jérôme Bourjea [4], Eric Stéphan [5], Marine Gonse [6], Martial Laurans [6], Mathieu Woillez [6], Jan Reubens [7], Philippe Lenfant [8]

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In France, offshore wind energy development is rapidly expending with over 13 projects of offshore windfarms (OWF) currently in progress. OWFs can act as artificial reefs for certain fish communities with species exhibiting high residency patterns for these new habitats. In addition, underwater power cables within OWFs generate electromagnetic fields that can affect the behaviour of electro- and magneto-sensitive species (e.g. sharks and rays). Considering the ecological functions and socio-economic importance of fish communities, these effects need to be assessed through comprehensive and long-term monitoring. Currently, empirical evidence is sparse as the sampling design of traditional surveys used in OWF regulatory impact assessment is not usually sufficient or adapted to detect and quantify these effects. The collaborative FISHOWF project uses acoustic telemetry to identify how mobile fish species use and connect different habitats across OWF development areas in the Channel, Atlantic and Mediterranean sea. This project relies on dedicated receiver arrays deployed within OWF, combined with the region-wide acoustic telemetry networks FISHINTEL (Channel), CONNECT-MED & RESMED (Mediterranean) to monitor occupancy patterns and movements of over 400 fish/crustaceans (including sea bass, pollack, lobster, sharks and rays). Here we will present 1) the specific goals of the FISHOWF project, 2) the challenges encountered for the deployment of our acoustic arrays within OWF and, 3) our preliminary results on fish occupancy and movement patterns within OWF (in construction and operational). Results will be used to better assess the effect of habitat modifications induced by OWF implantation from the seafloor to the surface.

Keywords: Offshore wind energy, Acoustic telemetry, Habitat use, Movement patterns

Information for Delegates

10:00 **Jayne Gardiner**

Effects of climate change on migratory movements
of juvenile blacktip sharks, *Carcharhinus limbatus*

Climate change and spatial movements

USA

Effects of climate change on migratory movements of juvenile blacktip sharks, *Carcharhinus limbatus*

Jayne Gardiner [1], Victoria Goldner [1], Tonya Wiley [2]

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Animal migration is thought to be an adaptive response to specific environmental conditions, and seasonal temperature changes are a key driver of migratory movements in many marine taxa, including sharks. Climate-driven increased ocean temperatures have been correlated with spatial and temporal range shifts in several shark species, but a causal relationship between climate change and altered migration phenology has yet to be established. The blacktip shark is a circumglobally distributed species found in tropical to warm-temperate waters. Like many large coastal sharks, they use estuaries as nursery habitat. Terra Ceia Bay, on the Gulf of Mexico coast of Florida, is arguably the best studied blacktip shark nursery and patterns of habitat use here are well established, due to extensive research conducted 20 years ago. Pups born in early summer reside in the nursery for the first six months of life, then migrate south to winter feeding grounds. Nursery departures occurred in October to November coincident with rapid decreases in water temperature associated with seasonal cold fronts, with the last shark departing by late November. Some individuals return to their natal nursery the following year, arriving beginning in April to May. Recently, we have observed blacktip sharks remaining in the nursery much longer than in the past. From 2016 to 2022, departure dates for acoustically-tagged juvenile blacktip sharks were precisely determined using a directionally-gated acoustic receiver array. Using mixed effects models, we examined the effects of temperature, change in temperature, and day length on the timing of migration. We found that temperature is the key driver of migration and because the temperature threshold is reached later compared with 20 years ago, juvenile blacktip sharks are consistently departing the nursery later, with some individuals remaining well into February. Returns to the nursery were also observed to begin earlier, with the first individuals arriving in February. These results have implications for management of this globally-exploited species, as well as ecosystem ecology, as changes in species overlap alter predator-prey dynamics.

Keywords: shark, climate change, migration, temperature

New biologging method to assess the physiology of basking sharks

Haley Dolton [1], Andrew Jackson [1], Robert Deaville [2], Jackie Hall [3], Graham Hall [3], Gavin Mcmanus [1], Matthew Perkins [2], Rebecca Rolfe [1], Edward Snelling [4], Houghton Jonathan [5], David Sims [6], Nicholas Payne [1]

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Abstract text removed on demand of the authors.

Keywords: regional endothermy, basking shark, ectotherm, physiology, anatomy, biologging

Using Acoustic Data Storage Tags (ADST) to assess seasonal movements of the starry smooth-hound shark in the North Sea

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To successfully manage fish populations, knowledge on distribution and movements is necessary. Acoustic telemetry investigates animal movements within the spatial range of acoustic receivers, while archival Data Storage Tags (DSTs) continuously log temperature and pressure allowing to infer animal trajectories through geolocation modelling. Recently, these two tech- nologies were merged into a single tag: the Acoustic Data Storage Tag (ADST), which combines the benefits of both technologies. Elasmobranchs are especially vulnerable to threats from climate change and anthropogenic pres- sure due to late sexual maturity and low fecundity. This makes them a high priority group for conducting movement ecology studies. The starry smooth-hound shark Mustelus asterias (Cloquet 1819) is a widely distributed elasmobranch in the Northeast Atlantic Ocean. Its population is currently stable but fishing pressure on the species might increase following the protection of the spiny dogfish Squalus acanthias. Crucial habitats for mating or pupping are not clearly identified yet, and previous studies on Mustelus asterias suggest a difference in circannual migration patterns dependent on sex and life stage. During 2018 and 2019, 30 individuals of M. asterias were tagged with ADSTs in the Scheldt estuary (Dutch Southern North Sea). Acoustic detections were obtained from the permanent network of acoustic receivers deployed in the Belgian Part of the North Sea and the Westerscheldt as part of LifeWatch. Twenty individuals were detected in the acoustic network, and 8 of the tags were recovered. Three of the recovered tags were detected by acoustic receivers. Two of the recovered tags logged information for > 1 year, one of which was in a female, and the other in a male Mustelus asterias. Their modelled trajectories show a sex bias in winter habitat with the male migrating north into the Southern North Sea, and the female migrating south into the English Channel which goes in line with previous studies. Pressure and temperature data (where available, i.e., the tags have been recovered) will be used in combination with the acoustic detections to infer differences between sex and life stages in habitat use and location. Relevant environmental variables such as temperature and food avail- ability, and anthropogenic sea use such as through Offshore Wind Farms and fishing vessels will be consulted to infer explanations for potential differences found. Further results on movements within the Southern North Sea will be discussed.

Keywords: movement ecology, starry smooth hound, acoustic telemetry, data storage tags, acoustic data storage tags

11:23 **Natalie Klinard**
Making the most of aquatic animal tracking: the use of
complementary methods to bolster acoustic telemetry research

**Combined approach in telemetry
Canada**

Making the most of aquatic animal tracking: the use of complementary methods to bolster acoustic telemetry research

Natalie Klinard [1], Jordan Matley [2], Ana Barbosa Martins [1], Sarah Larocque [3], Montana Mclean [4], Jake Brownscombe [3], Graham Raby [5], Vivian Nguyen [6]

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[3] Fisheries and Oceans Canada Great Lakes Laboratory for Fisheries and Aquatic Sciences – Canada; [4] Acadia University – Canada; [5] Trent University – Canada; [6] Carleton University – Canada

Tracking the movements of aquatic animals is a primary means of understanding movement ecology and the effects of and interactions with human activities. Despite the diverse spatiotemporal scales that underwater tracking tools such as acoustic telemetry enable, there are still limitations associated with their application and ability to address the complex and assorted factors that influence movement patterns. To optimize the data that can be collected in a study or overcome such limitations, supplementary methods are often used to complement tracking approaches. We evaluated the different types of complementary methods used in acoustic telemetry research over the past decade, categorizing both broad and specific methods as well as the objectives connected to different multi-method approaches. In addition to highlighting how complementary methods have been used to bolster acoustic telemetry research, we demonstrate how a combination of methods can be used in future research to address specific objectives within the fields of population biology, reproduction, trophic ecology, health and survival, and physiology, and provide movement ecologists with practical resources to aid in planning future research. As the field of movement ecology continues to grow and contribute to management decisions, it becomes increasingly important to optimize data collection and bolster multidisciplinary research to address diverse questions.

Keywords: Methods, methodology, complementary approaches, multidisciplinary, sampling

11:30 **Yuri Niella**

Using machine learning to predict risk of shark bites along the coast of New South Wales, Australia

Combined approach in telemetry

Australia

Using machine learning to predict risk of shark bites along the coast of New South Wales, Australia

Yuri Niella [1], Paul Butcher [2], Amy Smoothey [2], Victor Peddemors [2], Maxime Marin [3], Salomé Hussein [3], Robert Harcourt [1]

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Human-wildlife conflicts arise when people and animals are forced to interact and share resources, which may result in wildlife posing direct and recurrent hazards to people. This may then lead to persecution of the animals involved. While the frequency of shark bites is rare, bites have a high profile as well as being one of the most widespread of all human-wildlife conflicts, occurring in all major oceans. Of the > 500 shark species described, only three (white, tiger and bull sharks) account for more than half of the incidents globally. A long-term government monitoring program tracked 1,437 sharks from these three species (white = 960, tiger = 312, bull = 165) off the coast of New South Wales (NSW), Australia, between 2009 and 2022, using both acoustic and satellite transmitters. To help NSW government stakeholders reduce risk from shark bites, and to provide ocean users of potential shark bite risk where and when they enter the water, we developed a machine learning model. Outputs from a high resolution (5-m triangular mesh) hydrodynamic model, forced by remote sensing data (Integrated Marine Observing System) and a re-analysis model (Bluelink CSIRO), were used to obtain environmental conditions known to influence shark movements. These model outputs were extracted at daily resolution for the entire coast of NSW (~1,090 km). Pseudo-absences were derived using simulated tracks (satellite tags), and random selection of acoustic receivers without detections for the days when sharks were detected. A Generalised Additive Mixed model was constructed to predict occurrence of each species, with the variables 'year' and 'day' included as random factors to account for temporal variability in shark movements. Model skill was evaluated based on predictive accuracy in identifying daily core habitats for each species, and efficacy in predicting previous shark-human interactions (n = 73) within the NSW coast during the study period. Our research applies machine learning tools to predict risk of shark bites with the aim of improving beach safety and allowing people to better co-exist in harmony with some of the ocean's greatest predators.

Keywords: acoustic telemetry, hydrodynamic modelling, machine learning, satellite telemetry, shark, human interactions

Information for Delegates

11:45 Thomas Horton

Tracking bluefin tuna from the United Kingdom & Channel Islands:
a re-established seasonal hotspot in the northeast Atlantic

Movements in ecology

UK

Tracking bluefin tuna from the United Kingdom & Channel Islands: a re-established seasonal hotspot in the northeast Atlantic

Thomas Horton * [1,2], Francis Binney [3], Samantha Birch [4], Barbara Block [5], Alex Plaster [3], David Righton [4], Jeroen Van Der Kooij [4], Matthew Witt [1,6], Lucy Hawkes [1]

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Since 2014, Atlantic bluefin tuna (*Thunnus thynnus,* ABT) have been observed with increasing frequency in waters of the northeast Atlantic. However, detailed information about the spatial ecology of these individuals has been lacking. Here we report on the electronic tag- ging of 63 ABT (153 to 242 cm curved fork length, CFL) on foraging grounds off the UK & CI between 2018 and 2021, resulting in 46 tracks between 21 and 708 days long (mean $\pm$ 1 Standard Deviation = 277 $\pm$ 129 days) totalling 12,759 tracking days. After tagging in late summer, ABT remained within UK & CI waters for between 4 and 179 days before dispersing west into the High Seas or south-west to French or Spanish sovereign waters between December and April. Beyond this, we were able to describe the annual migratory cycle of 28 ABT with tags that remained attached for > 300 days (including two tags that remained attached for 481 and 708 days). In May and June, larger ABT (n=16, 213 $\pm$ 19 cm CFL) made a rapid migration into the Mediterranean Sea, presumably to spawn, and occupied Spanish, Algerian or Libyan waters. Smaller individuals (n=12, mean size $\pm$ 1 Standard Deviation 179 $\pm$ 21 cm CFL) occupied Spanish and French waters of the south-east Bay of Biscay. After June, all ABT returned to sovereign waters of the UK and CI, at latest by the 31st of August. Our findings highlight the fidelity of foraging ABT to sovereign waters of the UK & CI during late summer and early autumn. We also show that other eastern Atlantic habitats, such as the Bay of Biscay and the High Seas, play an important role in the annual migratory cycle of ABT that have readopted more northerly foraging areas.

Keywords: Atlantic bluefin tuna, northeast Atlantic, pop up satellite archival tags, migration

Information for Delegates

12:00 **Josep Alos**

Toward a decade of ocean science for sustainable development through acoustic animal tracking

Fisheries management

Spain

Toward a decade of ocean science for sustainable development through acoustic animal tracking

Josep Alos [1], Kim Aarestrup [2], David Abecasis [3], Pedro Afonso [4], Alexandre Alonso-Fernández [5], Eneko Aspillaga [1], Margarida Barcelo-Serra [1], Jonathan Bolland [6], Miguel Cabanellas-Reboredo [7], Robert Lennox [8], Ross Macgill [9], Aytaç Özgül [10], Jan Reubens [11], David Villegas-Rios [5]

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The ocean is a key component of the Earth's dynamics, providing a great variety of ecosys- tem services to humans. Yet, human activities are globally changing its structure and major components, including marine biodiversity. In this context, the United Nations has proclaimed a Decade of Ocean Science for Sustainable Development to tackle the scientific challenges necessary for a sustainable use of the ocean by means of the Sustainable Development Goal 14 (SDG14). Here, we review how Acoustic animal Tracking, a widely distributed methodology of tracking marine biodiversity with electronic devices, can provide a roadmap for implementing the major Actions to achieve the SDG14. We show that acoustic tracking can be used to reduce and monitor the effects of marine pollution including noise, light, and plastic pollution. Acoustic tracking can be effectively used to monitor the responses of marine biodiversity to human-made infrastructures and habitat restoration, as well as to determine the effects of hypoxia, ocean warming, and acidification. Acoustic tracking has been historically used to inform fisheries man- agement, the design of marine protected areas, and the detection of essential habitats, rendering this technique particularly attractive to achieve the sustainable fishing and spatial protection target goals of the SDG14. Finally, acoustic tracking can contribute to end illegal, unreported, and unregulated fishing by providing tools to monitor marine biodiversity against poachers and promote the development of Small Islands Developing States and developing countries. To fully benefit from acoustic tracking supporting the SDG14 Targets, trans-boundary collaborative efforts through tracking networks are required to promote ocean information sharing and ocean literacy. We therefore propose acoustic tracking and tracking networks as relevant contributors to tackle the scientific challenges that are necessary for a sustainable use of the ocean promoted by the United Nations.

Keywords: Acoustic tracking, movement, climate change, sustainable development, fisheries, marine pollution, ocean monitoring, networks, telemetry

Information for Delegates

12:08 **Charlie Huveneers**

The curious case of Norfolk Island and its challenging waste disposal
— is tiger shark space use impacted by dumping cow offal?

Movements in ecology

Australia

The curious case of Norfolk Island and its challenging waste disposal - is tiger shark space use impacted by dumping cow offal?

Charlie Huveneers [1], Lauren Meyer , Adam Barnett , Elizabeth Dinsdale , Michael Doane , Lisa Hoopes , Mark Scott , David Harasti , Jordan Matley

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Norfolk Marine Park is the most remote Australian marine park, located 750 nm east of mainland Australia, which is creating logistical challenges to manage the island's waste as conventional solutions are not feasible. As a result, some of Norfolk Island's waste is disposed of into the marine park. The need to reach zero dumping has led to several changes in the management of waste, but 30% of the organic waste (butcher's waste and offal) continues to be dumped into the ocean at Headstone Bay. Rather than ignoring the rule, dumping is being conducted as concerns remain amongst the local community that the complete cessation of offal dumping would lead to increased risk of shark bite from the large tiger sharks that frequent the dumping site potentially looking for alternative food sources. We used a combination of satellite (n = 35) and acoustic (n = 42) tracking to monitor the fine- and large-scale movements of tiger sharks (size 3.2 – 4.55 m; mean = 3.7 m total length) for 3.5 years. All tiger sharks seasonally left Norfolk Island between June and October with ˜85% of the sharks spending extended amount of their time off southeast New Caledonia, suggesting that these sharks are not reliant on the organic waste being disposed of in the water. Besides the Norfolk Island and New Caledonia aggregations, shark movements were extremely variable with some sharks going to Fiji, Vanuatu, New Zealand, or Australia. While in Norfolk Island, 16 acoustic receivers deployed around the island showed that sharks spent more time at the dumping site than other locations but were also detected for extended periods around the entire island. These findings will help marine park managers and the island's local council to develop a plan to reduce waste disposal in the marine park while addressing the community's concerns related to human safety.

Keywords: tiger shark, anthropogenic activity, Marine Park

2:00 **Jan Davidsen**
Can detailed knowledge about sea trout's marine feeding
migration improve coastal zone planning?

**Strategy for conservation
Norway**

Can detailed knowledge about sea trout's marine feeding migration improve coastal zone planning?

Jan Davidsen [1], Sindre Eldøy

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Conflicts between nature conservation and anthropogenic interactions like urbanization, aquaculture, fisheries and recreation in coastal marine ecosystems are common and divisive for communities. E.g., in Europe, the increasing use of near-coastal areas for sea cage aquaculture may negatively influence anadromous brown trout (*Salmo trutta*; a.k.a. sea trout). Sea trout provide important social and ecosystem services in many countries, including Norway. However, during the last 10-20 years, the abundance of sea trout has declined markedly in many regions. For example, catches in Norwegian rivers have declined by 23%–70% during the last two decades, excluding the southern and northernmost areas. Knowledge about the biology, ecology and habitat use of sea trout is limited and insufficient for successfully planning sustainable coastal developments. "*The secret life of sea trout*" research program is using acoustic telemetry linked with physiology, stable isotopes and genomics to document marine migrations and habitat use of anadromous brown trout from several Norwegian fjords. The findings show that sea trout exhibits diverse marine behavior in time and space depending on nutritional state, sex and morphology of the home watercourse. Thus, potential negative impacts from coastal developments like open net pen aquaculture may vary among individuals and watercourses. Acoustic telemetry has also been used in several estuaries in Norway to document potential conflicts with human influences such as different infrastructure and land reclamation. At the same time, habitat use of sea trout has been studied in undisturbed and pristine estuaries at Kerguelen Island to serve as a reference. Results show that estuaries are important transition zones, especially for younger individuals, between the nursery areas in freshwater and feeding grounds at sea. Additionally, during certain times of the year, estuaries may act as an important longer-term habitat, with fish residing there for weeks to months, and sometimes for the whole duration of the summer feeding migration. A consequence of longer-term residency in estuaries is an increased risk of disturbance from boat traffic, industrial development, harbours, local pollution, gravel extraction, and other physical developments that are often located in estuaries. The findings are used by stakeholders when decisions are made regarding locations of new fish farms and development of infrastructure in coastal areas. The participation of the public in the research project through community consultations has provided educational opportunities for the local communities, especially their youth, and has allowed for exchange of local and scientific knowledge, enriching both communities.

Keywords: Acoustic telemetry, Sea trout, Compensatory measures, Estuaries, Aqua culture, Impact asessment

Information for Delegates

Behavioral ecology

Canada

Lake trout site fidelity in Lake Ontario during periods of spawning

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Site fidelity identifies areas of high importance for animals and thus is a valuable tool for species restoration and management. Throughout the Laurentian Great Lakes, and specifically in Lake Ontario, lake trout populations collapsed by the 1950s due to sea lamprey predation, pollution, and overfishing. Rehabilitation efforts intensified in the early 1970s and although adult populations are stable, recruitment success is < 1 percent. The goal of this study was to quantify site fidelity of lake trout during November, the month of peak spawning activity, using acoustic telemetry data from 2016 to 2020, 80 tagged individuals, and 23 locations (15 historically known spawning areas and 8 random) in eastern Lake Ontario. Approximately 30% of the fish showed medium ($> 50\%$ of time spent at < 4 sites) and high ($> 75\%$ of time spent at < 3 sites) fidelity across all 4 years, while 41% showed low (no sites were visited for long or consistent periods of time) fidelity. Four of the 15 known spawning sites accounted for all the high fidelity fish visits and nine for medium fidelity, suggesting these locations are currently being used for spawning by lake trout. None of the 8 random sites showed any significant fidelity during the study period. Although spawning has not been confirmed, and the sex of the fish is unknown, this study provides important insights on the site fidelity of a species under long-term rehabilitation. It also provides guidance for future efforts to confirm spawning activity and assess spawning site habitat characteristics to help identify recruitment barriers for this native top predator.

Keywords: freshwater, fish, Great Lakes, lake trout, Lake Ontario, spawning

2:30 **Johan Coeck**

Passage efficiency, survival and downstream migration behavior of salmon smolt at the Anundsjö hydropower plant (River Moälven, Sweden)

Strategy for conservation

Belgium

Passage efficiency, survival and downstream migration behavior of salmon smolt at the Anundsjö hydropower plant (River Moälven, Sweden)

Johan Coeck [1], Raf Baeyens , Ine Pauwels , Pieterjan Verhelst , David Buysse , Kordula Schwartzwälder , Angela Odelberg

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As with many Baltic rivers, the River Moälven once had a self-sustaining salmon population that is now extinct. A salmon restoration program was set up with the reintroduction of hatchery smolt and a new fish pass facility at the Anundsjö hydropower plant (HPP; head 61 m, 10m^3/s) in Bredbyn (Örnsköldsvik Municipality, Sweden). In this study, we investigated the passage efficiency, survival and downstream migration behavior of salmon smolt at the HPP. The HPP is located at the downstream side of a lake that is fed by the River Moälven. A floating trunk that functions as a debris catcher in the middle of the lake prevents woody debris from entering the HPP, whereas a fish guidance screen downstream of the floating trunk should guide smolts towards the inflow of a fish pass that connect the lake with the residual. We performed 1D and 2D acoustic tracking of 60 downstream migrating salmon smolts from the nearby hatchery. VEMCO VR2W 180 kHz receivers were placed in the river up- and downstream the lake for 1D tracking. VEMCO HR2 180 kHz receivers were fixed in an array in the lake for 2D tracking of smolt movement in the area around the debris catcher, the smolt guidance screen, the inlet of the HPP and the entrance of the fish pass. 10 smolts were tagged with V5 predations tags (VEMCO) to evaluate predation. The tracks were used to study the efficiency and success of smolt downstream migration passed the HPP and through the 4 km residual flow downstream. Besides, we investigated the efficiency of the smolt guidance screen in the lake. None of the tagged smolts were able to find the entance of the fish pass to bypass the HPP through the fish pass. Passage success of smolt in the residual was only 50%. None of the smolt with acoustic tags reached the sea. During the study, the smolt guidance structure in the lake did not prevent smolts from approaching the hydropower plant and finally entering it. The predation tags proved that searching smolt in the lake were eaten by pike. Hence, the results of this study show that supporting the salmon population by introduction of hatched smolts in lake Anundsjo is highly inefficient as long as safe smolt passage at the HPP is not guaranteed. Therefore, the findings of this study are used to develop adaptive management of the hydropower plant and to design a more efficient smolt guidance structure and bypass facility. This research is was carried out as part of the EU H2020 FITHydro project.

Keywords: acoustic telemetry, salmon, smolt, behavior, hydropower, fish bypass

Information for Delegates

2:45 **Samuel Shry**

Benefits of Dam Removal for Atlantic Salmon (*Salmo salar*) Smolt Migration and Identified Challenges in Downstream Passage of Fragmented Reaches

Strategy for conservation
Sweden

Benefits of Dam Removal for Atlantic Salmon (*Salmo salar*) Smolt Migration and Identified Challenges in Downstream Passage of Fragmented Reaches

Samuel Shry [1], Hanna Forsberg [1], Andrew Harbicht [2], Anders Nilsson [3], Martin Österling [1], Gustav Hellström [4], Olle Calles [1]

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In many fish species, migration is imperative to survival and population sustainability. Additionally, river connectivity is essential in facilitating these migrations and river functionality as a whole, transporting matter and organisms throughout. River fragmentation, such as dams, compromise this connectivity and can displace fish populations or interrupt their migrations. In order to restore connectivity, dam removal is considered one of the most effective fish passage solutions. To evaluate the impacts of river fragmentation and dam removal, we investigated Atlantic salmon (*Salmo salar*) smolt migration past two hydroelectric power stations equipped with partial downstream bypass solutions and past one recently removed hydroelectric power station to the river mouth (> 25 km). We implanted 120 acoustic transmitters in wild smolts to evaluate dam impacts, releasing 40 individuals at three different locations, one control group in free-flowing river, one group passing one dam, and one group passing two dams. Smolt passage probabilities were found to be similar for the two studied dams (86.5 & 87.3 %), but displayed variation in path choice, delay times, and mortality vectors. Several factors influenced survival, such as total length, diel period, trapping location, water temperature, and total discharge. Cumulative survival to the river mouth (59.2%) varied between release groups and number of dams passed. Within the restored river sections, passage efficiency and speeds were significantly higher than all other sections of river, with the highest in-river survival (98.8%). Our findings provide valuable information on the benefits of dam removal restoration and outline the need for further restoration measures in the upriver reaches, where barriers still affect downstream passage. Overall, this study advances our understanding of smolt migrations in fragmented rivers and the importance of river restoration in mitigating our effect on wild populations.

Keywords: Atlantic salmon, Salmo salar, smolt, migration, dam removal, fish passage, river fragmentation, river barrier

Information for Delegates

2:53 **Rosie Smith**

Dead until proven living: A simple framework for conservatively identifying
mortalities and tag expulsion in non-overlapping acoustic arrays

Innovation in fish telemetry

Canada

Dead until proven living: A simple framework for conservatively identifying mortalities and tag expulsion in non-overlapping acoustic arrays

Rosie Smith [1], Tracey Loewen [2], Heidi Swanson [1,3]

[1] University of Waterloo [Waterloo] – 200 University Avenue West, Waterloo, ON, Canada N2L 3G1, Canada
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Potential mortalities or expelled tags are addressed in fewer than half of published ecological and behavioural studies that use aquatic acoustic telemetry, and may lead to misinterpretation of data. Detecting mortalities or expelled tags is especially challenging in arrays where receivers have non-overlapping detection radii, as precise positioning of tagged individuals over time is unknown. While methods such as Bayesian state-space modeling have been successfully used to identify mortalities, there is a need for simple, easily reproduced methods that can be consistently applied by diverse practitioners. We present a framework to identify potential mortalities and tag expulsions for acoustic telemetry data from non-overlapping receivers in ecological and behavioural studies. Tools within this framework can be used in quality control processes, and were initially developed using telemetry data from anadromous Arctic Char (*Salvelinus alpinus*), which exhibit substantial seasonal differences in mobility. Our method involves identification of mortalities based on thresholds established from the dataset itself; thus, functions are easily adapted to other species, regions, and seasonal behaviour patterns of interest. Application of this method to data from a relatively sedentary, slow-moving species (Greenland cod, *Gadus ogac*) in the same telemetry array reveals potential impacts on analysis and interpretation that can result when mortalities are not considered, and aids in assessing the suitability of array design to answer research questions. We believe that our framework and associated tools will help other researchers reduce potential bias and encourage more reproducible research in aquatic acoustic telemetry.

Keywords: acoustic telemetry, nonoverlapping receivers, mortality, tag expulsion, methods, R package

Behavioural ecology

Belgium

Discovering behavioral patterns with high-throughput telemetry

Jelger Elings [1], Stijn Bruneel [1], Matthias Schneider [2], Ine Pauwels [3], Rachel Mawer [1], Peter Goethals [1]

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[2] SJE Ecohydraulics GmbH – Germany
[3] Research Institute for Nature and Forest (INBO) – Instituut Natuur- en BosonderzoekBrussels, Belgium

Freshwater fish communities have declined by 83% since the 1970s. The reasons for this decline are plentiful, ranging from water pollution to overexploitation. One of the major con- tributors behind this decline is the construction of dams for flow regulation and hydropower. The construction of dams effectively blocks fish migration and thereby putting pressure on the spawning success of many fish species. Fishways have been developed to mitigate this issue but have also been shown not to be effective enough. Fish pass efficiency can be divided into two components: the attraction efficiency and the passage efficiency. A common claim surrounding upstream fish migration is that fish orient themselves by aligning themselves with flow patterns, termed positive rheotaxis. This has been shown in flume experiments, but in field experiments the focus on this research has mainly been directed to downstream migration. In this study we have used data from fish observations in the river Iller river near the hydropower facility of Altusried in Southern Germany. Thirty nine fish, grayling and barbel, have been tracked between April and August 2018 in a 70x400m river stretch covered by 16 HR2 180 kHz receivers (VEMCO/INNOVASEA). By having near-continuous tracking we are able to define fine-scale behavioural changes with the development of a Hidden Markov Model suitable to fine- scale telemetry data. Applying hidden Markov models to fine-scale telemetry data was done by including movement parameters common in other movement analyses, but unusual in hidden Markov modelling. Linking the fine-scale behavioural model to a high-resolution computational fluid dynamic model allows us to associate behaviour and behavioural changes to different flow parameters, thereby assessing the effect of the fishway attraction flow on fish behaviour.

Keywords: fine, scale telemetry, hydropower facilities, fishway entrance, attraction flow

3:15 **Kandace Griffin**

Swimming a fine line: How migrating sea lamprey navigate through complex and risky habitats

Movements in ecology

USA

Swimming a fine line: How migrating sea lamprey navigate through complex and risky habitats

Kandace Griffin [1], C. Michael Wagner [1], Daniel Zielinski [2], Christopher Holbrook [3], Peter Hrodey [4], Trevor Meckley [5], Brandon Mcelroy [6]

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Animals that undertake long-distance reproductive migrations must balance efficient navigation with managing the risk of predation in unfamiliar environments to preserve sufficient energy for successful reproduction. The sea lamprey (*Petromyzon marinus*), a parasitic fish, begins a solitary, nocturnal spawning migration when it detaches from its host in open waters (lake or ocean) and enters a coastal river. At the coastal transition lie estuaries – shallow regions of complex hydrology and geomorphology that are challenging to navigate and occupied by high densities of predators, including nocturnally hunting shoreline mammals. We used fine-scale acoustic telemetry (Innovasea VPS) to track 58 sea lamprey as they moved through an 'estuarine' reach of the White River, a tributary to Lake Michigan, USA. Using a computational fluid dynamics (CFD) model and bathymetry, we constructed cost functions for movement paths related to high navigational efficiency (e.g., thalweg following behavior), least energetic cost (swimming expenditure), or greatest safety (depth and distance from shore). We then contrasted observed movement paths to reasonable hypothetical paths (e.g., correlated random walk with persistent upstream movement) to determine which of these functions best predict the paths chosen by migrating sea lamprey. We will discuss implications of the findings for understanding the sea lamprey migratory strategy and the construction of effective conservation and management tactics that exploit movement tendencies.

Keywords: finescale, lamprey, cost function, ecology, navigation, predation, spawning

4:15 **Evgeny Romanov**
Habitat and movements of the swordfish *Xiphias gladius*, in the
waters of southern Indian Ocean oligotrophic gyre and beyond

Movements in ecology

France

Habitat and movements of the swordfish Xiphias gladius, in the waters of southern Indian Ocean oligotrophic gyre and beyond

Evgeny Romanov [1], Philippe Sabarros [2,3], Nicolas Guillon [4], Loïc Le Foulgoc [5], Pascal Bach [2,6], Francis Marsac [2,6]

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Habitat and migratory movements of swordfish in the Indian Ocean are still poorly known despite decades of research. Past tagging efforts were limited in time and space both due to a low survival rate of tagged swordfish and high cost of electronic tags. The limited number of swordfish tagged with conventional tags has provided a broad idea on the scale of horizontal displacements and tagging experiments using Pop-Up Satellite Archival Tags (PSATs) off South Africa have shown apparent site fidelity of swordfish in that area. Yet, the overall knowledge of the vertical habitat, dispersion rates and migratory patterns at the scale of the western Indian Ocean are still poorly known. Here we present results of swordfish tagging experiments using PSATs in the southwestern Indian Ocean that were carried out in the framework of EU-funded project PESCARUN where a total of 7 PSATs were deployed on swordfish between September 2021 and December 2022 and further 5 PSATs expected to be deployed in January 2023. We also used data from two swordfish tagged with PSATs in November 2012 and in December 2015 in the framework of the SWIOFP and PELICAN projects, respectively. All tagging operations took place within southwestern Indian Ocean oligotrophic gyre (in proximity with Reunion Island). To date, a total of 8 PSATs surfaced and reported data. During relatively short deployment periods (100 days max at liberty) swordfish performed large-scale movements throughout the western Indian Ocean reaching the Mozambique Channel in the west and equatorial waters in the north. Some individuals, however, showed 'homing' movements around Reunion Island circling back to the tagging place. All tagged individuals showed a similar vertical habitat occupation pattern: upper mixed layer/thermocline during the night and deeper hence colder mesopelagic layers around 500-900 m during daytime. Swordfish spent most of daytime (~80%) below 200 m depth suggesting that mesopelagic environment is its principal habitat in the western Indian Ocean. Diving behaviour along the northward migratory tracks showed habitat compression towards equatorial waters apparently rather driven by temperature limitations than dissolved O2 concentrations. Our results provide the first insights on the high rates of swordfish individuals' dispersion at ocean-scale level.

Keywords: tracking, migrations, vertical habitat, habitat compression, miniPATs

Information for Delegates

4:30 **Henrik Baktoft**

Tagging giant Atlantic bluefin tuna back in Nordic waters – five years on

Movements in ecology

Denmark

Tagging giant Atlantic bluefin tuna back in Nordic waters – five years on

Henrik Baktoft [1], Kim Birnie-Gauvin [1], Tomas Brodin [2], Gustav Hellström [2], Kristi Kallo [1], Anders Koed [1], Brian Mackenzie [3], Einar Eg Nielsen [1], Lene Klubben Sortland [1], Andreas Sundeløf [4], Kim Aarestrup [1]

[1] DTU Aqua, National Institute of Aquatic Resources – Silkeborg, Denmark
[2] Swedish University of Agricultural Sciences (SLU) – Umeå, Sweden
[3] DTU Aqua, National Institute of Aquatic Resources – Kgs. Lyngby, Denmark
[4] Swedish University of Agricultural Sciences (SLU) – Lysekil, Sweden

Large Atlantic bluefin tuna (*Thunnus thynnus*) recently returned to Nordic waters after several decades of absence. They disappeared from Nordic waters in the early 1960s potentially due to overfishing of prey fish and the tuna themselves. Aside from sporadic bycatches, tunas were absent from Nordic waters up until the early 2010s after which sightings and bycatches increased. The tunas reaching Nordic waters are among the largest individuals recorded in recent years, suggesting that they constitute an important part of the population. Consequently, we launched an annual tagging programme in 2017 targeting bluefin tuna in Nordic waters to increase our knowledge and understanding of this potentially important part of the population. From 2017 through 2022, more than 180 tunas were tagged with pop-up satellite archival tags (PSATs) and more than 400 tagged with long-life acoustic transmitters. Results from the first five years will be presented.

Keywords: bluefin tuna, Thunnus thynnus, PSAT, acoustic, Nordic waters, oceanic migrations

4:45 **Amber-Robyn Childs**

Impact of exploitation on resident reef fish activity in a thermally variable environment

Climate change and spatial movements

South africa

Impact of exploitation on resident reef fish activity in a thermally variable environment

Amber-Robyn Childs [1], Michael Skeeles , Nonhle Mlotshwa , Alex Winkler , Murray Duncan , Cuen Muller , Kyle Smith , Warren Potts

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The persistence of harvested fish populations in the Anthropocene will largely be determined by their response to the interacting effects of climate change and exploitation. The response of fishes to climate stressors is underpinned by their physiological capacity and behavioural plasticity, which through the process of fisheries-induced evolution may change under varying exploitation levels. The aim of this study was to determine the effect of $in\ situ$ temperature and exploitation on the activity and behavioural patterns of a resident coastal fishery species. Forty individuals were caught from exploited and unexploited populations and tagged with acoustic accelerometer and depth transmitters. Fish were monitored using a series of fine-scale telemetry arrays deployed in marine protected areas (MPAs) and highly exploited environments during periods of intense thermal variability. Linear mixed effects models and 3D kernel utilisation distributions indicated that the activity of fish from exploited populations appeared to be more constrained at thermal extremes when compared to individuals from unfished populations. The results highlight the critical role of MPAs in conserving and harnessing physiological and behavioural phenotypic diversity, and the emergent research opportunities provided by biologging technologies.

Keywords: phenotypic diversity, fisheries exploitation, climate change, acceleration, home range, activity

8:30 **PLENARY: Christophe Guinet**

How elephant seals help us to observe the Ocean while investigating their foraging ecology

France

How elephant seals help us to observe the Ocean while investigating their foraging ecology

Over the last twenty years deployment of satellite data relayed logger collecting both behavioral and environmental data had an increasing contribution in the observation of the Ocean. One of the best example of how marine animal could contribute to the observation of the Ocean is provided by the program Southern Elephant Seals as Oceanographic Samplers initiated in 2004 and representing today a major contribution on the observation of the Southern Ocean in complement to other observational approaches (oceanographic vessels, Argo floats, satellite observations…).

The development and incorporation of new sensors in biologgers deployed on these wide-ranging deep diving predators, allows the monitoring of an increasing number of oceanographic parameters critically important to address numerous oceanographic questions and assess how quickly the Southern Ocean Is changing but also investigate the at-sea ecology of this marine predator in relation to the oceanographic context. Historically measurements were restricted to the assessment of physical parameters: temperature, salinity, light level, wind/sea-state, completed, in a second stage, by the monitoring of biogeochemical parameters such as chlorophyll-a and dissolved oxygen. Currently, instrumental developments effort focusses on the characterization of the biological compartment of the Southern Ocean and in particular of the poorly known but essential mid-trophic level compartment. In this talk, I will review the list of monitored oceanographic parameters with a special focus on the new approaches we are developing and implementing to improve our knowledge on zooplankton and micronekton within the Southern Ocean and how this influence the foraging performances of these seals. These technologies rely on the development of a miniature echo sounder along new imaging technics deployed on seals.

9:15 **Bernardo Quintella**

Using an acceleration tag to assess the activity and tridimensional space use of the European catfish

Combined approach in telemetry

Portugal

Using an acceleration tag to assess the activity and tridimensional space use of the European catfish

Bernardo Quintella [1,2], Gil Santos [3], Esmeralda Pereira [4], Ana Filipa Silva [5], Pedro Almeida [6,7], Diogo Ribeiro [5,8], Filipe Ribeiro [5]

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The European catfish (*Silurus glanis*) is the 10th largest freshwater fish in the world, being an invasive species in western European countries, such as Portugal. Considering its large size, high fecundity rates, long longevity and voracious predatory behaviour, the impact of *S. glanis* on native freshwater fish communities is considered disturbing. Although there are some studies regarding the movement patterns of the *S. glanis*, many of them are restricted to its native range and do not describe the circadian and annual variability of this species' behaviour in detail. Considering these knowledge gaps, this study resorts to acoustic biotelemetry to track 10 adults in a Tagus River reservoir (Belver dam, Portugal), through an array of passive acoustic biotelemetry receivers. The fish were tagged with transmitters equipped with 3D-accelerometer and pressure sensors, obtaining information on movement patterns, activity and depth use for over a year. The results show that, contrarily to observations made at higher latitudes, *S. glanis* is active throughout the year but with increased activity levels in summer and minimal in autumn, and with a crepuscular and nocturnal rise in activity. On what concerns habitat use, the *S. glanis* occupied shallower depths in spring/summer, and roam at relatively deeper waters in autumn/winter. Circadian vertical movement patterns were identified, associated with seasonal variability. Possible migration to a spawning site, where adult aggregations were previously detected, was identified. These findings will support the development of more effective control measures by maximizing the efficiency of mass removal actions of this invasive fish.

Keywords: Silurus glanis, Invasive species, Habitat use, Movement patterns, Vertical habitat use, Acoustic biotelemetry.

Information for Delegates

9:30 **David Abecasis**

Multidisciplinary estimates of connectivity suggest the use of multiple units for the conservation and management of meagre, *Argyrosomus regius*

Combined approach in telemetry

Portugal

Multidisciplinary estimates of connectivity suggest the use of multiple units for the conservation and management of meagre, *Argyrosomus regius*

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Information on the population connectivity of targeted fish species is key to the proper management and implementation of spatial conservation measures. We used a combination of genomics, biophysical modelling, and biotelemetry to infer the population structure and connectivity of the Atlantic meagre, an important fishery resource throughout its distribution. Genetic samples from previously identified Atlantic spawning locations (Gironde, Tejo, Guadalquivir, Banc D'Arguin) and two additional regions (Algarve and Senegal) were analysed using genome- wide SNP-genotyping and mitochondrial DNA analyses. Biophysical models were used to investigate larval dispersal and connectivity from the known Atlantic spawning locations whereas biotelemetry was used to assess the movement patterns and connectivity of adult individuals. This multidisciplinary approach provided a robust overview of the meagre population structure and connectivity in the Atlantic. Our results showed a clear differentiation between European and African populations and significant isolation of the few known Atlantic spawning sites. The limited level of connectivity between these subpopulations is potentially driven by adults, capable of wide-ranging movements and connecting sites 500 km apart, as evidenced by biotelemetry, while larval dispersal inferred by modelling is much more limited. Our results show sufficient evidence of the population structure, particularly between Africa and Europe, but also within Europe, for the meagre to be managed as separate stocks.

Keywords: fisheries management, migration, spatial conservation planning, gene flow

Information for Delegates

9:45 **Aina Pons Salom**

Social networks revealed by high-throughput tracking correlate
with gut microbiome in marine fish

Behavioral ecology
Spain

Social networks revealed by high-throughput tracking correlate with gut microbiome in marine fish

Aina Pons Salom [1], Ignacio Catalán‡ [1], Eneko Aspillaga§ [1], Ramon Rosselló-Mora¶ [1], Tomeu Viver[1], Robert Arlinghaus** [2], Martina Martorell-Barceló†† [1], Margarida Barcelo-Serra‡‡ [1], Josep Alos [1]

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The animal gut hosts diverse bacterial communities that can affect their behavior, physiology and metabolism. However, the relationship between an individual's microbiome and its social behavior in the wild is poorly understood. We re-constructed the social network of a marine fish (*Xyrichtys novacula*) in their natural environment. Relying on high-resolution acoustic telemetry, we first obtained a high-quality positioning data-set composed of 7,930 one-day long trajectories from 232 individuals (153 females and 79 males). From these data, we computed the associations between paired individuals and found a harem-like social structure. Territories were formed by one male and several females, and males displayed agonistic behaviors towards their neighbors to defend territories. Subsequently, a sample of the social network was captured, and the diversity of the gut microbiome was quantified using operational phylogenetic units (OPUs) based on the analysis of 16S rRNA gene amplicons using Illumina high throughput sequencing. The social network properties were intimately linked to the microbiome. Individual microbiome samples of fish from the same harem (including from different sex) were more similar to each other, while differences to other harems were strong. The use of similar local microhabitats, including food resources, as well as local social contact can both provide key transmission pathways for gut symbionts that shape gut microbiota, structuring the microbiome along social networks in aquatic animals. This work is among the first to show a relationship of social structure and the microbiome in a fish in the wild. Further work will reveal cause-and-effect relationships into whether the social network shapes the microbiome or the microbiome and the resulting metabolites shape certain behaviors that in turn create the network structure.

Keywords: social networks, gut microbiome, tracking, behavior, 16S rRNA gene, marine fish

Information for Delegates

9:53 **Brittany Evans**

Meta analysis of Giant Trevally (*Caranx ignobilis*) Movement
Patterns and Home Range Sizes in Hawaiian Waters

Movements in ecology

USA

Meta analysis of Giant Trevally (*Caranx ignobilis*) Movement Patterns and Home Range Sizes in Hawaiian Waters

Brittany Evans [1], Carl Meyer [1]

[1] Hawai'i Institute of Marine Biology (HIMB) – 46-007 Lilipuna Rd, Kaneohe, HI 96744, United States

Giant trevally ("ulua", *Caranx ignobilis*) are large, mobile mesopredators found in coral reefs ecosystems across the Indo-Pacific. Despite their cultural significance, popularity in recreational fisheries, and likely importance in coral reef ecosystems, we lack key basic knowledge about ulua home range sizes, habitat preferences, and movement patterns. I analyzed a long-term (14 year) acoustic monitoring dataset of 169 ulua tagged at 8 Hawaiian islands to characterize ulua movement patterns, site fidelity, and space and habitat requirements across the Hawaiian Archipelago. Ulua showed moderate to high fidelity to relatively small (< 5 km maximum linear dimension) home ranges with occasional forays into larger familiar areas ultimately constrained by the size of their 'home' islands. There was no evidence of ulua moving across deep ocean channels between adjacent islands. Ulua movement patterns and habitat use were generally consistent with those of other coral reef fishes, albeit on a larger spatial scale. Understanding these patterns of space and habitat use enables us to design more effective management strategies for these heavily targeted fishes.

Keywords: Trevally, Movements, Habitat Use, *Caranx ignobilis*

10:45 **Knut Vollset**

Building a telemetry Network in the Nordhordland UNESCO
Biosphere: Bergen Telemetry Network

Strategy for conservation

Norway

Building a telemetry Network in the Nordhordland UNESCO Biosphere: Bergen Telemetry Network

Knut Vollset [1], Cecilie Nilsen , Lotte Dahlmo , Saron Berhe , Eirik Normann ,
Yngve Landro , Torgeir Bjørn , Kari Natland , Robert Lennoc

[1] NORCE Norwegian Research Centre – Norway

UNESCO Biosphere Reserves were established to provide immersive learning opportunities in nature. In western Norway, the Nordhordland Biosphere Reserve was established in 2019 with a goal of being a learning for sustainable development. The marine and freshwater region of the biosphere stretches from the one national salmon river in the inner part (Vosso) through some of the deepest fjords in the world to archipelagos stretching out towards the continental shelf and the deep Norwegian trench where the Norwegian Sea starts. Covering the southern part of the Biosphere, our telemetry network has established a network of receivers currently tracking salmonids, sharks, gadoids, wrasses, and lobsters. The region is unique in its habitats but also in its presence of active industrial development such as fish farms and hydropower as well as marine and terrestrial anthropogenic infrastructure. Despite this, the fjords of western Norway are still viewed as relatively pristine with functional aquatic ecosystems. In this presentation, we will present the Bergen Telemetry Network's ongoing initiatives and strategy towards using telemetry systems to inform conservation and restoration.

Keywords: UNESCO Biosphere, salmon, shark, wrasse, trout, lobster

11:00 **Julie Nielsen**

Is your fish out of water? Modifications to a hidden Markov model for reconstructing fish movement pathways in study areas with island topography or convoluted

Innovation in fish telemetry

USA

Is your fish out of water? Modifications to a hidden Markov model for reconstructing fish movement pathways in study areas with island topography or convoluted shorelines

Julie Nielsen [1], David Bryan , Kimberly Rand , Martin Arostegui , Camrin Braun , Ben Galuardi , Susanne Mcdermott

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Data from electronic archival tags can be used to reconstruct movement pathways of tagged fish with state-space geolocation models. Such models typically estimate locations (along with associated location error) of tagged fish at regular intervals throughout the period of tag de- ployment. Reconstructed pathways provide valuable insights into fish movement patterns over large scales of space and time. However, the presence of land in the study areas can complicate the process of reconstructing pathways for nearshore fishes, as location probability can "leap over" land barriers and point locations can be placed on land. We present two modifications to a hidden Markov model (HMM) that together result in more realistic reconstructed pathways in study areas with island topography or convoluted shorelines. The first modification is to the movement model, where successive smaller movement model updates are applied (with land removed at each update) prior to the data likelihood model update at each model time step. This provides a movement kernel that moves around, instead of over, land masses. The second modification is to the method for estimating point locations, where the Viterbi algorithm is used to find the most probable pathway through the posterior daily probabilities provided by the HMM. This results in a pathway that has locations in high-probability areas at each time step and is compatible with spatial error estimates output by the model. We describe these modifications and demonstrate their utility using satellite tag data from Pacific cod in Alaskan waters as well as simulated trajectories. The modifications to the HMM presented here will benefit research on nearshore fish species that occupy areas with convoluted shorelines or island chain topography and will be included in a revised version of the HMMoce R package.

Keywords: Geolocation, hidden Markov model, fish migration, satellite tags, Pop, up Satellite Archival Transmitting tags, Viterbi algorithm, reflecting boundary

Information for Delegates

Estuarine and in-river survival and migratory behaviour of adult salmonids

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Marine mortality has been highlighted as an important contributory factor regulating salmonid populations. The assessment of marine mortality is generally based on the percentage of emigrating smolts that survive to return as adults to rivers to reproduce. While the focus of most studies has been on assessing key survival bottlenecks during the downstream seaward migration of smolts, little consideration has been given to the survival of adults in the estuary, prior to entry into fresh water, where salmonids can spend a considerable amount of time awaiting the arrival of suitable environmental conditions. Thus, a telemetry study was undertaken to describe the behaviour and survival of adult Atlantic salmon (*Salmo salar* L.) and sea trout (*Salmo trutta* L.) in the estuarine and riverine environments of the River Tyne, England. Fifty salmon and twenty-five sea trout caught by commercial fishers at the mouth of the estuary were tagged with a coded acoustic transmitter incorporating a temperature sensor and tracked using strategically positioned acoustic receivers across the estuary and the river catchment. Twenty-three of the tagged salmon entered fresh water of which 16 reached spawning grounds and three returned to outer estuary/sea as kelts. In contrast, just six sea trout entered fresh water of which three were presumed to have spawned, but none of them returned to the outer estuary/sea as kelts. There was evidence of seal predation of salmon and sea trout throughout the estuary and in fresh water, with inferred mortality considered to be high for both species, which might have substantial effects on regulation of their populations. The implications of these outcomes for the assessment of salmonid populations and future studies are discussed.

Keywords: salmon, sea trout, spawning migration, survival, predation

11:23 **Jorge Fontes**
The advantages and challenges of non-invasive towed PILOT tags
for free-ranging deep-diving megafauna

Combined approach in telemetry

Portugal

The advantages and challenges of non-invasive towed PILOT tags for free-ranging deep-diving megafauna

Jorge Fontes [1]

[1] Okeanos - Institute of Marine Research (Okeanos- UAc) – Rua Porfessor Doutror Frederico Machado 2 9900-862, Portugal

Biologging technologies have yielded new insights into the ecology and behaviour of elasmo-branchs, but to date, most studies involve animal capture and restraint to attach tags. Capturing animals usually results in a period of atypical behaviour after release and is undesirable or simply not possible for large and vulnerable elasmobranchs such as mobulas and whale sharks. To avoid animal capture and restraint, we developed and tested two non-invasive multisensor towed tags. The use of towed packages creates additional data analytical challenges relative to fixed packages because towed devices wobble independently of animal movements. We present five examples, two mobulas (reef manta and sicklefin devil ray) and three sharks (blue, tiger and whale shark), to illustrate the advantages and challenges of this approach. We used animal-borne video to validate behavioural data derived from accelerometers and conducted an experiment to compare accelerometer data from attached and towed tags simultaneously deployed on a shark.We used fluid dynamic models to calculate the added drag of towed devices on target species. We found that drag impact is acceptable for short-term tagging of large mobulas, but the drag penalty associated with the current camera tag design is greater than 5% for most mature blue sharks. Despite wobble effects, swimming behaviour (tail-beat and wing-stroke frequency) captured by towed accelerometers was consistent with those attached directly to the animal and with data from animal-borne video. Global Positioning System (GPS) sensors recorded up to 28 and 9 geolocations per hour of surface swimming by sicklefin devil ray and blue sharks, respectively. Towed tags with non-invasive attachments provide an effective alternative for acquiring high- resolution behaviour and environmental data without capturing and handling animals. This tool yields great potential to advance current knowledge of mobula ecology and behaviour without capture or invasive tagging

Keywords: Non-invasive, Bio-loggers, Sharks, Mobulas, Swimming behaviour

11:30   **Eneko Aspillaga**

Interoperability and performance of the new Open Protocol for acoustic tracking: results from field tests in European waters

Innovation in fish telemetry
Spain

Interoperability and performance of the new Open Protocol for acoustic tracking: results from field tests in European waters

Eneko Aspillaga [1], Stijn Bruneel [2], Josep Alos [1], Pieterjan Verhelst [3], David Abecasis [4], Kim Aarestrup [5], Jolien Goosens [6,7], Kim Birnie-Gauvin [8], Pedro Afonso [9], Miquel Palmer [1], Jan Reubens [7]

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The lack of compatibility between equipment from different manufacturers has been a pri- mary obstacle to consolidating large collaborative acoustic telemetry networks. Especially, undisclosed encrypted signal coding protocols used by some companies hamper detections and collab- oration between research groups with equipment from different manufacturers. This seriously limits the potential of acoustic telemetry to study animal movements over large spatial and transboundary scales, reduces competition among manufacturers, and stifles innovation. The European Tracking Network, in collaboration with some acoustic telemetry manufacturers, has worked to develop a new protocol for acoustic tracking. The result is an energy-efficient trans- mission protocol, open and accessible to all researchers and manufacturers, where ID allocation relies on an industry-independent third party (the Flanders Marine Institute, Belgium). Today, the Open Protocol (OP) is already available to manufacturers agreeing to a memorandum of understanding, and the first transmitters and receivers implementing it are already available on the market. The main objective of this study was to conduct the first extensive field tests of the OP to confirm the compatibility between devices, characterise the acoustic range of each transmitter-receiver manufacturer combination, compare the detection efficiency to the stan- dard code set used at present, and assess its robustness against spurious detections. A large international collaborative effort was made to conduct long-term (˜2 weeks) range tests in four main aquatic habitats: a river, a coastal lagoon, nearshore habitat, and the open sea. At each location, sets of receivers and transmitters from different manufacturers were deployed at increasing distances between them using the same experimental design. The decay of detection probability with distance was modelled for each transmitter-receiver manufacturer combination by applying logistic regression using a Bayesian approach. Moreover, we made a direct field comparison between smolts groups tagged with OP tags and R64K tags, respectively, tracking their migration to the sea. Our results confirmed full compatibility between the tested devices. We observed negligible differences in the measured acoustic ranges between manufacturers, with habitat type being the main cause of variability. The OP was also found to be robust against spurious detections, and the field comparison between OP and R64K showed equal performance. We hope that our novel insights will encourage international research groups to foster OP-based studies to ensure compatibility and maximise the benefits of acoustic telemetry networks.

Keywords: open protocol, coding systems, acoustic range, compatibility, European Tracking Network

Information for Delegates

Fisheries management

Portugal

An acclimatization period in a fish farm cage promotes site fidelity of released hatchery-reared dusky groupers

Ana Filipa Silva [1], João J. Castro [2,3,4], Esmeralda Pereira [2], João Pedro Marques [1], Teresa Silva [2,3], Pedro G. Lino [5], Ana Candeias-Mendes [5], Pedro Pousão-Ferreira [5], José L. Costa [1,6], Pedro Raposo De Almeida [2,4], Bernardo Ruivo Quintella [1,6]

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The dusky grouper *(Epinephelus marginatus)* is one of the most emblematic species of the Mediterranean and Northeast Atlantic Marine Protected Areas (MPAs). This endangered species has been protected from fishing (including spearfishing) in the last decades in several Mediterranean MPAs and there is supporting evidence of their positive reserve effect, particularly in highly protected areas. In the Northeast Atlantic, in mainland Portugal, there is a great lack of scientific knowledge on this species' population dynamics. However, despite the establishment of no-take areas and the prohibition of catching dusky groupers in a southwestern Portuguese MPA (SACVMP - 'Sudoeste Alentejano' and 'Costa Vicentina' Marine Park) since 2011, reports of sightings by scuba divers in the marine park and catches by fishers in the surroundings continue to be rare. By using acoustic biotelemetry, this work aimed to evaluate the feasibility of restocking hatchery-reared adult dusky groupers in protected areas of the 'Sudoeste Alentejano' coast. In 2019, twenty young adult groupers tagged with acoustic transmitters were released inside a no-take area of the SACVMP, with no previous acclimatization. None of the fish settled down in the no-take area, some individuals displayed extended movements of more than a hundred kilometers along the Portuguese coast which was rarely reported for this species. Considering these results, a second trial was initiated in 2021 with the release of two sets of young adult dusky groupers in the Sines harbor (adjacent to SACVMP, and where fishing is also highly restricted), on the same day, but with different acclimatization conditions. After three weeks of recovery from tagging procedures, eight groupers were translocated from the tagging site to a fish farm cage in the release site, where they remained for five weeks with food (live prey) and shelter provided. The other seven groupers remained in the tagging site until the release, with no previous *in situ* acclimatization. About 50% of the acclimatized groupers were still detected in the Sines harbor ten months after, and 25% remained in the vicinities of the fish farm cages. The other seven groupers (non acclimatized) did not remain in the monitored area for more than five days. This study highlights the importance of the acclimatization and progressive release of the hatchery-reared dusky groupers in the wild, seeking the promotion of site attachment and fidelity. This is apparently crucial to the success of large-scale restocking programs in MPAs, such as the one designated in the southwestern Portuguese mainland coast.

Keywords: *Epinephelus marginatus*, acoustic biotelemetry, restocking trials, acclimation, MPAs, Portuguese southwest coast

Information for Delegates

12:00 Scott Colborne

Estimating internal and external tag retention by Walleye (*Sander vitreus*) over multiple years after release in the Laurentian Great Lakes

Methodology

USA

Estimating internal and external tag retention by Walleye (*Sander vitreus*) over multiple years after release in the Laurentian Great Lakes

Scott Colborne [1], Matt Faust [2], Travis Brenden [1], Todd Hayden [3], Jason Robinson [4], Thomas Macdougall [5], Andrew Cook [5], Daniel Isermann [3], Mark Haffley [6], Christopher Vandergoot [1]

[1] Michigan State University (MSU) – United States; [2] Ohio Department of Natural Resources (ODNR) – United States; [3] United States Geological Survey (USGS) – United States; [4] New York State Department of Environmental Conservation (NYDEC) – United States; [5] Ontario Ministry of Natural Resources and Forestry (OMNRF) – Canada; [6] Pennsylvania Fish and Boat Commission – United States

Tagging fish has been used for over a century with the types of tags and tagging methods diversifying with technological and material advances. Tags now range from simple external markers anchored under the skin to electronic tags that are surgically implanted. Multiple tag types can be used simultaneously, for example, pairing an external reward tag with an internal transmitter tag to facilitate reporting of harvested fish. A common assumption is that tags will have high retention rates and, in the case of electronic tags, low premature failure rates. Here, we used recapture data (2011 – 2021) of Walleye (*Sander vitreus*) from three Laurentian Great Lakes to evaluate multiple tag types. To be considered, a fish had at least one external tag (T- bar, cinch, or internal anchor tags) and an acoustic transmitter (V13 or V16 model, InnovaSea Ltd.). A total of 1,125 Walleye with acoustic transmitters were recovered, with no confirmed cases of a transmitter being shed following release. A total of 11 recovered acoustic transmitters failed before the end of their estimated battery life, but only one of these transmitters was never detected after release. Fish recovered with external T-bar tags placed anterior and posterior of the dorsal fin showed differences between the two placements after one year (anterior 73%, posterior 59%), but by four years retention was < 25% for both locations. Internal anchor tags had a one-year retention of 88%, declining to 81% after four years. Cinch tags had the highest one-year retention (98%) but were similiar to T-bar tags after four years (31%). High transmitter retention and low battery premature failure was consistent with over a decade of developing surgical practices for Walleye and product development for these particular transmitter models. External tags varied in retention, such that T-bar and cinch tags were likely to be effective markers for fish recaptured within 1-2 years, whereas anchor tag retention was more stable across time. The use of internal transmitters and external markings is likely to continue, but understanding tag retention characteristics can inform study design, be considered in model parameters (e.g., estimating mortality rates), and, ultimately, improve inferences made using tagged animals.

Keywords: tag retention, tag failure, external marking, surgical procedures

Information for Delegates

12:08 **Sindre Eldøy**

Does pathogen burden affect the temperature preference of
salmonids?

Does pathogen burden affect the temperature preference of salmonids?

Sindre Eldøy [1], Robert Lennox [2], Jan Davidsen , Kristi Miller [3], Angela Schulze [3], Knut Vollset [2]

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[2] NORCE Norwegian Research Center – Norway
[3] Fisheries and Oceans Canada (DFO) – Canada

Fever is a physiological response observed in a range of endotherm species, where the animals internal body temperature is increased as an immunological response in order to enhance the capacity of the immune system to tackle viral disease. For ectotherms which are not able to internally regulate their body temperature, thermoregulatory behavior has been seen for a range of taxa. The thermoregulatory behavior of ectotherms plays crucial roles in phycological processes such as locomotive capacity, digestion, growth, hibernation and reproductive maturation. Moreover, behavioral thermoregulation to stimulate immunological responses, often referred to as behavioural fever, has been recorded for a range of taxa including reptiles, amphibians and fish. In this study, we explore whether anadromous sea trout *Salmo trutta* display behavioral fever using acoustic telemetry to track the behavior and body temperature, combined with genetical analyses to map the pathogen burden and gene expression of inflammation and viral disease markers. More specifically, we hypothesize that individuals with high loads of pathogens and gene expression indicating inflammation and viral disease will display higher body temperatures than individuals with low pathogen loads and gene signatures on their return from the sea to the river.

Keywords: *Salmo trutta*, sea trout, salmonid, pathogens, disease, behavioural fever

Transcending boundaries in fish movement ecology through the European Tracking Network

Jena Edwards [1], David Abecasis , Hendrik Winter , Aytaç Özgül , David Villegas-Rios , Kim Aarestrup , Kim Birnie-Gauvin , Tomas Brodin , Bruno Macena , Claudia Meneses , Pieterjan Verhelst , Josep Alos , Eneko Aspillaga , Marija Smederevac-Lalic , Inge Van Der Knaap , Pablo Arechavala-Lopez , Einar Kärgenberg

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In the marine realm, few barriers exist to limit the extent of animal migrations. As a result, mobile marine animals can occupy vast home ranges and undertake migrations that span across entire ocean basins. These large-scale movements can in turn, complicate both research and management occurring at local or regional scales. Advances in aquatic telemetry are continuing to allow researchers to monitor marine animal movements across greater distances and with increasing resolutions. However, for acoustic telemetry studies that typically use an array of fixed receivers to detect presence of tagged animals moving within a defined region, the spatial scale of acquired movement data is often restricted to regions delimited by invisible geographic or jurisdictional boundaries. To overcome this limitation, acoustic telemetry networks such as the European Tracking Network have been established to facilitate collaboration among movement ecologists and to house archives of detection data for more efficient data sharing. By combining the detections of individual tagged animals recorded across multiple discrete arrays, the extent of monitoring can be greatly expanded to reflect more ecologically-relevant spatial and temporal scales. To exemplify the benefit of the acoustic telemetry networks for large-scale collaboration and fundamental research on migratory fish, we have compiled examples of movement trajectories collected by an international group of researchers using multiple acoustic arrays and spanning national or international boundaries. From basin-wide migrations to cross-continental displacements, this diverse dataset demonstrates how connectivity between acoustic telemetry arrays and research institutes can lead to novel insights in movement ecology for a range of fish species.

Keywords: Acoustic telemetry, telemetry network, transboundary movement, movement ecology, fish migration

Using acoustic telemetry to identify critical habitat functions for spatial planning

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Aquatic ecosystems are complex, and there is a wide range of options for spatial management measures to achieve conservation endpoints and generate social and economic value. To these ends, fish tracking can produce valuable insights into how fishes use aquatic ecosystems to guide management approaches. We have been using acoustic telemetry combined with stable isotopes and accelerometry to characterize critical habitat functions for Permit (*Trachinotus falcatus*) in coastal regions of the Florida Keys. Permit rely on a diversity of habitat types, from offshore reefs to nearshore seagrass flats for spawning and foraging, and concomitantly, support two different fisheries with varied conservation impacts. The combination of technologies has aided in discovering these habitat functions, for example, accelerometry helped to identify early evening spawning aggregation behaviour at certain sites. Layering habitat function with conservation threats provides directions for nuanced spatial management including smaller-scale seasonal no- fishing areas around critical spawning locations. Ongoing work aims to continue to refine spatial management efficacy through understanding multi-species responses to management measures.

Keywords: spatial planning, habitat function, acoustic telemetry, biologging, fisheries management

2:30 **Morgan Piczak**

Spatial ecology of non-native common carp (*Cyprinus carpio*) in Lake Ontario with implications for management

Movements in ecology

Canada

Spatial ecology of non-native common carp (*Cyprinus carpio*) in Lake Ontario with implications for management

Morgan Piczak [1], Jill Brooks [1], Christine Boston [2], Susan Doka [2], Rick Portiss [3], Nicolas Lapointe [4], Jon Midwood [2], Steven Cooke [1]

[1] Carleton University – Canada
[2] Fisheries and Oceans Canada – Canada
[3] Toronto and Region Conservation Authority – Canada
[4] Canadian Wildlife Federation – Canada

Common carp, Cyprinus carpio, are a non-native species that established within the Lauren- tian Great Lakes more than a century ago and are abundant in some locations. Common carp have negatively impacted freshwater ecosystems, including in the Great Lakes, by increasing turbidity and uprooting vegetation through foraging and/or spawning activities. Knowledge of spatial ecology is necessary to effectively manage non-native species and aid in the development of remediation strategies. The aim of this study was to examine the spatial ecology of com- mon carp across multiple spatial scales within Lake Ontario using passive acoustic telemetry. First, Residency Index (RI), as a metric for habitat preference, was calculated for common carp in Toronto Harbour (TH) and Hamilton Harbour (HH). Linear mixed modelling revealed that season, as well as the interaction between season and physical habitat conditions significantly affected RI. Specifically, during spring and summer common carp had significantly higher RI at sites with increased submerged aquatic vegetation, which could be associated with spawning activities. All common carp tagged in HH were resident, compared to half of individuals tagged in TH. Larger individuals tagged in TH were more likely to be absent from the array during summer. Non-resident common carp tagged at TH made extensive movements in spring and summer along the nearshore of Lake Ontario and were detected throughout the entire basin. Knowledge of spawning habitat could inform efforts to exclude common carp from these specific locations. Based on our findings, common carp should be managed at a regional level, as opposed to single sites, owing to their extensive movements.

Keywords: Movement, Management, Invasive species, Control, Fish, Spawning

2:38 **Fanny Alix**
The use of acoustic and RFID tags to study the behaviour of twaite shads at a fish pass (Hérault, France)

Strategy for conservation

France

The use of acoustic and RFID tags to study the behaviour of twaite shads at a fish pass (Hérault, France)

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The Mediterranean twaite shad (Alosa agone, Scopoli 1786) is a highly sensitive migratory specie. Since 2021, Migrateurs Rhône Méditerranée Association develops a new protocol to catch and handle shads properly for tagging, the aim being to better understand the behaviour associated with fish-pass use by twaite shads during the final stage of upstream migration. To do so, MRM installed HTI devices downstream the dam of Bladier-Ricard, located in the Hérault river, directly connected to the Mediterranean Sea. In 2021, 50 shads were tagged with Pit-Tag (RFID-HDX). Among them, 10 were detected at the entrance of the fish-pass, and only 2 completely crossed the device. This first result stirred up 2 mains interrogations: Does the catch/surgery affect fishes behaviour? Is the fish-pass ineffective for shads? To answer these questions, additional experiments have been launched in 2022, using more sophisticated tags, based on acoustic technology (V3-307kHz), in addition of RFID tags. In 2022, 29 shads were captured and equipped with both RFID and acoustic tags. The results obtained after the migration period showed that shads often reach the entrance of the fish-pass, but mostly failed to get through it, despite several attempts (spaced from a few hours to a few days). This result matches direct observations from fishermen and scientists (made above the dam with drones) and revealed selectivity of the dam of Bladier-Ricard. In order to increase the efficiency of the fish-pass, solutions are currently discussed to optimize its attractivity using sluice gate management. Finally, the Hydrophone located a few kilometers downstream identifies a downstream period for tagged shads, that look to be slowed above the Chaussée d'Agde, because of low water levels. This last point is essential in the current context of global warning and climate change, and lead to preoccupations about the possibility for shads to succeed their downstream migration in future low water conditions. Beyond the local impacts of these investigations on dam management, this monitoring experiment on Bladier-Ricard brings additional elements, to validate telemetry's relevance in monitoring aquatic wildlife behaviour in one hand, but also in transposing this experiment to areas with similars problematics.

Keywords: twaite shad, Telemetry, RFID, dam management, Hérault

2:45 **Matthew Acre**

Pulling the plug: Space use and movement of fishes
prior to removal of a large dam

Strategy for conservation

USA

Pulling the plug: Space use and movement of fishes prior to removal of a large dam

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Fragmented aquatic systems are ubiquitous across the globe. Dams and other water control structures represent significant barriers to fish passage. In many countries, these structures represent ageing infrastructure which no longer serve their original function prompting an ac- celerated dam removal period. In the U.S., nearly 1200 dams have been removed in the last two decades and additional dams are slated to be removed. These removals offer an opportu- nity to inform conservation science and community recovery in reconnected systems. One such dam removal is underway on the Cuyahoga River in northeast Ohio and is expected to be fully removed in 2025. The Ohio Edison Dam was constructed in 1913 and is the last remaining dam in the lower 92 km of the river. To empirically assess fish behavior pre-dam removal, we tagged 117 fish in May (n = 45), June (n = 20), and October (n = 52) of 2022 with acoustic telemetry tags in three distinct river segments: downstream of the reservoir (DS), within the reservoir (RE), and upstream of the reservoir (US). Tags were implanted in Northern Pike *Esox lucius*, Smallmouth Bass *Micropterus dolomieu*, Northern Hogsucker *Hypentelium nigricans*, and White Sucker *Catostomus commersonii*. We deployed 19 acoustic receivers along 22 river kilometers spaced approximately every km. To-date we have collected 1.1 million unique detections and 99% of the detections represent fish never leaving the detection field of the same receiver (no movement). The remaining 1% of detections represent small movements (n = 11,006; i.e., moving in and out of the same receiver's detection field) and state changes between two unique receivers (n = 1,999). Fish of the same species in US and DS segments were more likely to exhibit directional movements and greater dispersal than in RE segment. However, fish in the RE segment exhibited greater cumulative distance moved but nearly zero net dispersal. Overall fish in the RE segment moved more often and faster than their counterparts in the US and DS segments, likely a product of limited habitat in the isolated system they currently occupy. This phenomenon has been recorded in other systems and is indicative of poor-quality habitat as fish move more frequently over greater distances to access necessary resources. No movements between the three primary segments have been identified. These baseline behavior data are critical to evaluate effectiveness of small and large restoration projects such as dam removals.

Keywords: Dam removal, river, movement ecology

3:00　**Ana Rato**

Homing and movement patterns of Iberian barbel (*Luciobarbus bocagei*)
following translocation in a highly impounded river

Strategy for conservation

Portugal

Homing and movement patterns of Iberian barbel (*Luciobarbus bocagei*) following translocation in a highly impounded river

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The Iberian barbel (*Luciobarbus bocagei* Steindachner, 1864) is a highly plastic potamodromous species, that exhibits adult upstream movements, in the spring, associated to the repro- ductive period, followed by adult and juvenile downstream migration, in the autumn, to feed in more productive river stretches. However, increasing river fragmentation and impoundment, due to dam construction and operation, with the consequent loss of suitable habitat, can fully disrupt the naturally expected behaviour. In River Tua (a tributary from River Douro, Northeast Portugal) a large hydroelectric dam (Foz Tua dam, 108 meters height) was recently built (i.e., 2017) only 1.1 km from the river mouth, leaving completely inaccessible a previously common spawning ground for this species in the highly impounded Douro river basin. To evaluate the behavioural response of the target species to this impact, a passive acoustic array was deployed in the study area and, between 2018 and 2021, the movements of 120 tagged fish were moni- tored. Within the tagged fish, two different behavioural profiles were found, as both migratory and resident individuals were observed in the same population. During the four-year study period, 63% of the fish captured and released immediately downstream Foz Tua dam, showed a typically migratory behaviour, 6.7% maintained residency in the release site and 13.3% switched between both profiles. During the study, 90 fish were translocated to an alternative tributary (20 km away from Rive Tua), from which 63% remained in the releasing stretch, whilst 25% made continuous return attempts to the capture location (i.e., River Tua). Out of the migratory portion (i.e., 25%), 42% of those individuals maintained the migratory behaviour in the follow- ing years. Generalized Linear Models were performed for each of the two behavioural profiles observed in this study, to identify which environmental variables attracted the tagged barbels to downstream Foz Tua dam. Ecological flow, temperature, photoperiod, and day period were the most important variables influencing the use of the regulated stretch below the dam. This study updates the available information regarding this specie movement patterns and specific site fidelity responses, contributing to enhance management and conservation programs focused on the protection of potamodromous species, such as the Iberian barbel, in highly impounded and fragmented habitats.

Keywords: Potamodromy, Site fidelity, River fragmentation, Acoustic telemetry

Near Real-Time Ocean Profiles from Animal-Borne Platforms; Sharks as a Case Study

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Much of the world's oceans remains undersampled in terms of both biology and oceanography. This is particulary true in regions such as coastal boundary currents and remote areas such as high latitudes. These environments are critical habitat for many species and are also among those showing the most rapid changes. Recently developed animal-borne telemetry devices can acquire and transmit vital information about ocean stucture (such as oxygen, salinity and temperature strata) from regions that are otherwise difficult to monitor. These devices are being deployed on a range of taxa including marine mammals, turtles and fishes. Increased satellite coverage and the deployment of land-based receivers now allow these data to be acquired in near real-time. This presetation will detail how ocean temperature-depth profiles are generated and transmitted by shark-borne transmitters deployed in Hawaiian waters and how these data are being used to improve ocean models. Possible future directions will be discussed.

Keywords: animal, borne oceanographic sensors, ocean profiles, near real, time, sharks

4:20 **Colin Simpfendorfer**
Using multiple telemetry and biologging methods to study juvenile
sharks and rays in very shallow coastal habitats

Combined approach in telemetry

Australia

Using multiple telemetry and biologging methods to study juvenile sharks and rays in very shallow coastal habitats

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Juvenile sharks and rays often use shallow coastal waters as nursery areas, but we have little detailed understanding of how and why they use these habitats. Over a period of more than 10 years, and with at least six students, we set out to explore the spatial ecology of two species of stingray (mangrove whipray *Urogymnus granulatus*, broad cowtail ray *Pastinachus ater*) and one species of shark (blacktip reef sharks *Carcharhinus melanopterus*) in a tropical bay including coral reef, reef flat and mangrove habitats using a range of telemetry and biologging approaches. Methods deployed included manual acoustic telemetry, broad scale acoustic monitoring, fine scale acoustic monitoring focused within mangrove habitats, GPS logging, temperature logging, and archival tagging. Deployment of multiple approaches enabled a wide range of ecological questions to be investigated, some more successfully than others. Each species uses the available habitats differently, but with a focus on avoiding predation by larger sharks that frequent the bay on rising and high tides. There is also evidence that behavioural thermoregulation drives the behaviour of at least one species of stingray. This talk will provide an overview of the outcomes of this work, and how each of the methodological approaches helped to understand the spatial ecology of the focal species.

Keywords: acoustic telemetry, biologging, shark, stingray

The European aquatic animal tracking network (ETN) – a timely initiative for the animal tracking community in Europe

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The European aquatic animal Tracking Network (ETN) is an initiative to integrate the aquatic animal tracking community in Europe with the mission to track aquatic animals to better understand, protect and manage them. It is a timely initiative that fits within the Ocean Decade: the EU Mission Ocean that aims to restore our Ocean and waters, and to provide significant contributions to EU directives. ETN started as an idea in 2017 and from 2019 is supported by the COST Action (European Cooperation in Science and Technology) for four years but will persist as a long-term platform for the European biotelemetry community. ETN is a dynamic organization focusing on four main pillars: 1) centralizing and sharing tracking data using FAIR principles; 2) working on technological advancements in the sector with a focus on inter-applicability and compatibility across instruments; 3) establishing telemetry infrastructure and research cooperation in key areas across Europe and initiate excellence in science, and ; 4) providing continuous training and knowledge dissemination. To achieve our goals, we organize collaborative workshops, training courses, events and scientific missions, widening knowledge and cooperation. So far, this has been achieved by bringing together scientists from all over Europe and beyond, who work with marine and freshwater telemetry. In addition, we collectively seek funding for new initiatives such as the new STRAITS project to track fish across major egress points in Europe's seas.In this talk we will showcase the benefits of large-scale telemetry initiatives by highlighting some case studies on each of the pillars and providing some insights in the challenges ETN aims to tackle.

Keywords: tracking network, ETN, management, conservation

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A radio telemetry study of the Atlantic salmon (*Salmo salar* L.) spawning migration behavior in the Salaca river

Janis Bajinskis [1], Jānis Aizups [1], Edmunds Bērziņš [1], Jānis Dumpis [1], Elīna Ellere [1], Ričards Kaupužs [1], Jānis Kolangs [1], Oskars Kozinda [2], Ruta Medne [1,2], Jurģis Pētersons [1], Raimonds Rezevskis [1], Amanda Tropa [1], Toms Zalāns [1]

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Salaca River is the most productive wild salmon river in the Latvia as well as in the southern part of the Baltic Sea. Although regular surveys of salmon populations have been conducted since the 1960s, there is still a lack of some fundamental knowledge about the migration behavior of salmon in the river. The main objective of this study was to obtain more knowledge about salmon movement in the Salaca river during spawning and post–spawning period as well as post–spawning survival, spawning site selection and the use of habitats above the remains of Staicele paper mill dam. It was also attempted to assess how catch–and–release (C&R) angling affects the post release behavior and survival of salmon and upstream migration success through the VAKI counter installed in the lower part of the river. In total 39 ascending salmon were tagged by surgically implanting radio transmitters. 25 salmon were tagged as control group caught with fyke net in the rivermouth of Salaca River and 14 salmon were caught and tagged in C&R angling in the lower reaches of the river below VAKI counter. Both groups were predominant with one sea winter fish. The timing of salmon entry into the river did not play a significant role in the distance covered to the spawning sites which most likely is related to the overall spawning grounds distribution in the river. Salmon caught and tagged in C&R angling performed a significantly shorter spawning migration than the control group which may be directly related to stress experienced during the pull-out fight. Three major patterns of behavior were observed during the post–spawning period: descend migration to the sea right after spawning; descend to deeper, calmer waters before overwinter- ing; overwintering near spawning grounds. Majority of tagged salmon descended 3–7 km prior to overwintering 64% of them being female. Only five salmon left river right after spawning, majority of them being male caught in C&R angling.

Keywords: behavior, radio telemetry, Salmo salar, Salaca River, spawning migration

Acoustic tracking of Western North Atlantic fishes using enhanced drifting surface buoys

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Successful acoustic tracking of marine animals depends on having sufficient networks of acoustic receivers positioned in the ocean. Due to cost and operational concerns many places in the ocean lack receivers. Working with MetOcean Telematics and InnovaSea, we incorporated acoustic tracking capability into iSVP (Iridium Surface Velocity Program) surface drifting buoys which are currently widely used in global ocean monitoring. This created a mobile receiver ca- pability to detect and position acoustically tagged animals. We then conducted a field test to see if the system could be targeted to detect tagged animals in the open ocean. On June 8, 2022, 10 iSVP buoys equipped with acoustic receivers and spaced ≈1 km apart were launched in a line perpendicular to the coast of northern Newfoundland (Carmanville; 30km off Fogo Island) to drift within a probable migration corridor for acoustically tagged Atlantic salmon migrating towards summer feeding areas in the Labrador Sea. True drift patterns of the buoys were com- pared against those predicted from simulations derived from daily ocean surface current output from the Regional Ice Ocean Prediction System (RIOPS). Overall, the drift patterns reasonably tracked those predicted by the current model, although the accuracy of the predictions declined with time after launch. The buoys carried out many unpredicted erratic movements, likely reflecting the relatively coarse spatial and temporal resolution of the model compared to the precise, higher-resolution positioning data provided by the floats. Many acoustically tagged an- imals of different species including cod and salmon were detected and reported in near-real time by the buoys, indicating that the buoys and the drifting-line strategy have great potential to provide valuable detection data and reliably covered planned target areas. National authorities could greatly increase acoustic tracking capabilities if they included acoustic telemetry options in their annual purchases of drifter buoys.

Keywords: Acoustic telemetry, surface drifters, mobile receivers, cod, salmon

Atlantic cod body size links with individual spatial behaviour and stable isotopes in a no-take marine reserve

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Foraging is a behavioural process and, therefore, individual behaviour and diet should co- vary. However, few comparisons of individual behaviour type and diet exist in the wild. We tested whether behaviour type, diet and body size covary in a population of Atlantic cod, *Gadus morhua.* Working in a no-take marine reserve, we could collect data on natural behavioural variation and diet choice with minimal anthropogenic disturbance. We measured behaviour us- ing acoustic telemetry and diet with δ13C and δ15N stable isotopes. We further investigated whether behaviour and diet could have survival costs. We found more active cod consumed resources with a higher contribution from pelagic primary production and cod with shorter diel vertical migration (dvm) distances fed at higher trophic levels. Cod δ13C and δ15N scaled posi- tively with body size and larger cod had shorter dvms suggesting dvm may act as a behavioural link between diet and body size in coastal cod populations. Neither behaviour nor diet pre- dicted survival, indicating phenotypic diversity is maintained without survival costs for cod in a protected ecosystem. Our findings emphasize that, along with body size, individual behavior indeed plays a role in trophic interactions, and the effect of individual behavioural composition on community dynamics requires research attention.

Keywords: VPS, Atlantic cod, diet specialization, marine reserves, stable isotopes

Can acoustic telemetry be used inside mangrove habitats?

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Acoustic telemetry has been used to monitor the movement of sharks and rays in a broad range of aquatic environments. Despite their importance, mangrove habitats are understudied for spatial ecology of elasmobranchs, with acoustic telemetry rarely used inside mangrove habi- tats. One reasons may be a general assumption that acoustic signal would not be able to get detected by the receivers in such shallow water, structurally complex, environments. This study tested whether acoustic receivers can be used in mangrove habitats to track the movement of sharks and rays. 38 receivers were deployed in a mangrove system in Pioneer Bay, Orpheus Island, Great Barrier Reef, including inside mangroves, mangrove edges and adjacent reef flat areas. The detection range and receiver performance metrics, such as code detection efficiency, rejection coefficient and noise quotient were examined and tested among habitats. Results high- lighted that the signal from transmitters were successfully detected inside mangrove habitats as well as on the adjacent reef flat. The detection range to get at least 50% of detection was up to 20 m inside mangroves and up to 120 m outside mangroves. The performance metrics of acoustic receiver in mangrove habitat was characterised by low background noise, low rejection rates and reasonably high code detection efficiency. Furthermore, this study tested application of this method on juvenile sharks and rays and demonstrated that it can be used to successfully track animals inside mangrove habitat. This novel method could reveal further information on how sharks and rays are using mangrove habitats.

Keywords: acoustic telemetry, VR2W, mangrove systems, range test, sharks, rays

Comparing Common Snook Hurricane Response Behaviors Across Multiple Disturbance Events with Long-Term Acoustic Telemetry Tracking

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Hurricane frequency and intensity is expected to increase as climate change raises mean global sea-surface temperatures, which provides additional energy for storm formation. Extreme climatic events, such as hurricanes, are known to influence fish movement and distribution patterns, but the extent to which shifts in disturbance regimes will alter fish behavior, and subsequently ecosystem processes, is unknown. This gap primarily stems from difficulties in quantifying fish response behaviors to disturbances and a lack of long-term movement data capable of comparing multiple disturbance events. In the Florida Coastal Everglades Long- Term Ecological Research site an acoustic telemetry array has actively tracked fish movements throughout Everglades National Park since 2008. In 2011 the project expanded to include acoustic tracking of common snook (*Centropomus undecimalis*) an important euryhaline fisheries species that seasonally traverses between marine and riverine ecosystems. With this array, researchers evaluated snook movement responses to Hurricane Irma in 2017 and found that 73% of detected fish moved down river with some fish potentially leaving the system entirely. We detected similar movement responses during hurricane Ian in 2022. Here we provide preliminary results for the first ever comparative analysis of hurricane disturbance responses in common snook using environmental cues outlined the initial Irma study. Our results will refine our understanding of environmental drivers that influence snook movement patterns and provide insight on how shifts in disturbance regimes will alter Everglades ecosystems. Furthermore, our study emphasizes the need for consistent long-term monitoring efforts to study animal movement patterns under shifting climatic conditions.

Keywords: Disturbance regimes, hurricanes, common snook

Connectivity, Movement and Distribution of Fish in Offshore Wind Farm Areas

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To meet the growing demand for renewable energy, there is rapid development of large- scale offshore wind farms, often in areas that are important fishing grounds. Wind turbines built on foundations in the seabed introduce hard substrate into an environment that is often composed of soft sediment. These structures extend from the seabed to the surface, provid- ing a complex three-dimensional habitat that will likely introduce marine growth and impact ecosystem structure. We are using passive acoustic telemetry in combination with optical and acoustic imaging to determine the impact of turbines on three commercially and recreationally important fish species: black sea bass (*Centropristis striata*), striped bass (*Morone saxatilis*), and summer flounder (*Paralichthys dentatus*) around the Block Island Wind Farm off Rhode Island, USA. The objectives of the project are to understand: 1) connectivity for fish between turbines and resulting additive effect on fish from multiple turbine structures, 2) the vertical reef effect of turbines which may enhance local or regional marine fish and invertebrate pro- ductivity, and 3) fish distribution near the turbines in the horizontal spatial scale. This study is valuable for stakeholders (i.e., fishermen, fisheries management, windfarm operators) as it will determine individual and additive impacts of multiple wind turbine structures, providing better understanding of the benefits or impacts of offshore wind farms on fisheries resources and ecosystems.

Keywords: Fisheries, ecosystem, artificial reef, anthropogenic development, telemetry

Downstream migration and survival of juvenile Baltic sturgeon (*Acipenser oxyrinchus*) in rivers with dams

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The Baltic sturgeon *Acipenser oxyrinchus* is an anadromous migratory fish spending most of its life in marine waters while returning to its native river for reproduction. Populations of the species have dramatically decreased during the last centuries. Subsequently, the species became extinct in the Baltic range states during second half of the 20th century. Besides anthropogenic changes to rivers such as channelizations, the construction of river dams, and pollution, overharvest has been identified to be the key impact that caused the dramatic decline of the populations throughout the Baltic. The aim of our study was to assess the impacts of hydroelectric plants (HEPs) on downstream migration hatchery-reared juvenile *A. oxyrinchus*. The fate of telemetry-tagged hatchery-reared juvenile Baltic sturgeon was investigated in the Narew and Vistula rivers during 2 years. Individually identifiable Vemco V9 and V7 acoustic tags (batery life 104-126 days) were surgically implanted into the abdominal cavities of sturgeon. Sixteen and 30 sturgeon were tagged and released in May 2012 and during late May 2013, respectively. Out of the total of 46 juvenile sturgeon, only six in the first year of study and only one in second year were recorded to leave the Wloclawek *HEP* and enter the Vistula River estuary. Juvenile sturgeon had a 3-25% migration success along the entire 440 km long rivers reach, that is, 75-97% were lost. *This research was supported by the statutory project no. Z-003 of the National Inland Fisheries Research Institute*

Keywords: Acipenserids, acoustic telemetry, dispersal, hydroelectric plants, movement

Drivers of behaviour and spatial ecology of the small spotted catshark (*Scyliorhinus canicula*)

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Shark populations have suffered dramatic declines across the world as a result of overfish- ing. Marine protected areas (MPAs) can help restore overfished populations; however, their effectiveness largely relies on understanding the ecology of the targeted species. This study investigated the spatial ecology of the intensely harvested but understudied small spotted cat- shark (*Scyliorhinus canicula*) through acoustic telemetry in the Cíes Islands, a small MPA in the northwest of the Iberian Peninsula. There were significant effects of diel, seasonal cycles, biotic (sex and total length) and abiotic (bottom sea temperature) variables on the spatial ecology of *S. canicula*. The mean residency index was low (0.27) and movement patterns suggested a strong connection with inshore waters. While the probability of presence in the study area was mainly driven by sex (i.e. greater for females), a drastic increase in activity was observed at night (compared to day hours). Activity space decreased with larger body sizes. Warmer waters were related to higher activity levels and larger activity spaces. This study offers an essential foundation for comprehending key aspects of the behaviour *of S. canicula*, with significant im- plications for the conservation and management of this species. The present findings suggest the failure of small MPAs to efficiently protect the whole range of movements of *S. canicula*, however, they show their ability to offer protection for part of the population (i.e. females). Finally, this work reveals temporal instances when *S. canicula* are at its maximum vulnerability and the conservation benefits that this species could gain from the implementation of temporal fishing restrictions. To be effective for *S. canicula* conservation, MPAs should be appropriately sized and designed for the ranging behaviour of the target species for total protection. Temporal restrictions of fishing at night time mirroring the peak activity pattern of *S. canicula* could be implemented to limit the probability of its capture.

Keywords: acoustic telemetry, diel patterns, elasmobranch, marine protected area, Scyliorhinus canicula, sharks, spatial ecology

Environmental variability affects species behaviour and overlap across multiple timescales

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Fluctuating environmental conditions in space and time are ubiquitous in nature and widely perceived as a regulator of species behaviour. In response to environmental variability, an organism can alter when it is active during a day, month, and year and where it resides in space. These changing behaviours can also shift how competing organisms overlap with one another in space and time. Climate change has increased interest in understanding the effects of changing environmental conditions on species' behaviour and their overlap. Unfortunately, many of these studies limit natural context through fixed laboratory conditions, fall short in acknowledging the importance of environmental variability across multiple timescales, or do not consider biological scales above that of an individual or its population. Here, we explore how fluctuating conditions in nature drive changes in the timing of activity and space use across multiple timescales and species. By examining how daily, monthly, and seasonal variation shape the spatiotemporal overlap of three predatory freshwater fish species, this research sheds new light on the impor- tance of environmental change for species interactions and the maintenance of coexistence. A VEMCO Positioning System (VPS), with 86 acoustic receivers and complete lake coverage, was used to collect high-resolution position and acceleration data for three freshwater fish species (lake trout, smallmouth bass, and burbot) in Algonquin Provincial Park, Ontario, Canada. En- vironmental conditions, including temperature, light, and dissolved oxygen profiles, were mea- sured continuously to determine their effect on species behaviour and interactions at multiple time scales. Preliminary results demonstrate species-specific activity patterns across a daily cycle, under- pinned by differences in biology. Specifically, burbot adopted a nocturnal foraging strategy, which may limit competition with lake trout and smallmouth bass that opted for diurnal activ- ity. At a monthly scale, species may converge in their activity timing, whereby species increase nocturnal activity as the percentage of lunar illumination increases. On a seasonal scale, lake trout and burbot maintained higher acceleration than smallmouth bass during cold winter pe- riods, reflective of underlying differences in thermal preference. Despite both belonging to the cold-water thermal guild, Lake trout and burbot tended to occupy different depths. Species that converged in the timing of their activity at one scale may therefore diverge in the timing of their activity at alternative timescales (i.e., days vs. seasons), diverge in their spatial niche use (i.e., depth partitioning) or a combination of each. Our work is uncovering how environmental varia- tion at multiple scales shapes the activity and space use of multiple species within a community simultaneously, with important consequences for understanding the role of spatiotemporal niche divergence for the maintenance of coexistence.

Keywords: Community, Coexistence, Interactions, Freshwater, Behaviour, Accelerometry, Activity, Timing, Environment, Spatiotemporal, Niche

Extraordinary fish movements in coastal marine fishes: interest in MPA management and evolutionary population dynamics

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The marine environment is a dispersive environment where scientists have often presented the fish larval phase as almost the only pathway of connectivity between populations. For decades, many studies of population genetics have explained the differentiation or the absence of genetic structuring across populations by the role of offspring and currents. Along with this observation, fish species are described in the literature by a number of life history traits, including their behavior regarding their essential daily habitats. The range of behaviors goes from sedentariness (benthic species such as blennies, gobies, etc.) to strong migratory behaviors, such as those exhibited by certain pelagic fish (e.g. tuna). In the latter case, the adult phase potentially generates as much connectivity as the larval phase. But between these two extremes there is a set of demersal species that have potential movements over areas of a few square kilometers. This is the case for emblematic protected species such as the grouper, the brown meagre or large seabream. The literature abounds with reports on their behavior, which tends towards a sedentary lifestyle with often limited home ranges. Acoustic telemetry makes it possible to inform and supplement this ecological information when the deployment of hydrophones and implanted tags is sufficiently large and the battery life of tags allows monitoring over at least a full year. Thanks to the European project Poctefa RESMED, coordinated by the University of Barcelona and of which the University of Perpignan is a partner, a network of more than 100 hydrophones has been deployed on both sides of the Franco-Spanish boundary in the Mediterranean Sea, also covering marine protected area (MPA) networks present in both countries. With 25 species tagged simultaneously, we were able to confirm home ranges and distances traveled at different time scales. At the same time, for several species that are mostly sedentary, we have observed movements that can be considered extraordinary given the distance traveled (30 to 100 km) and the very short time used to cover those distances (a few days). These movements also showed a close link with the presence of the various MPAs. Our results show a possibility of exchange between populations by the adult phase, which suggests potentially important roles from an evolutionary point of view: maintenance of genetic diversity, founder effect, etc. In the context of climate change, it is crucial to understand the importance of this type of movements in shaping future fish communities.

Keywords: marine protected area, connectivity, movement, management, network

Factor influencing presence, space use and activity in grey reef sharks in the south channel ofFakarava, French Polynesia.

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Knowledge of the spatial ecology and movement of animals contributes to our understanding of intra- and inter-specific interactions and ecosystem dynamics, and can inform conservation actions. Activity patterns are a key component of animal fitness shaped by endogenous and exogenous factors that dictate behaviour and determine species movement patterns. Here we assessed the space use and activity levels of a marine predator, the grey reef shark (*Carcharhinus amblyrhynchos*), in the south channel of Fakarava, French Polynesia, over a year using acoustic telemetry. Thirty-eight adult sharks were tagged with acoustic transmitters (equipped with pressure and accelerometer sensors). We studied the temporal patterns of presence of sharks in the channel as well as how biotic (sex and size) and abiotic (tide and moon phases, time of year and time of day) factors influence their spatial utilisation and level of activity. Tagged sharks were very resident as 76% of them were detected on more than 95% of days of the monitoring period. Space use was variable according to individuals and was influenced by tide. Peaks of activity occurred in early morning and early night. Activity also increased during full and new moon. This study provides a unique opportunity to understand the patterns of activity of a dense population of reef sharks that rest and hunt in a highly dynamic environment.

Keywords: shark, movement, acoustic telemetry, kernel utilisation density, activity, tide

First insights into the movement ecology of the Western Atlantic Pygmy Devil Ray using passive acoustic telemetry

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The Western Atlantic pygmy devil ray, *Mobula hypostoma*, is currently listed as "Endan- gered" on the IUCN Red List based on reduced observations throughout its range. Although increased sightings have been reported on the southeast coast of the U.S. over the last 20 years, most of the species' biology and ecology remains unknown, including the distribution and sea- sonality throughout *M. hypostoma's* range. Since 2013, Mote Marine Laboratory's Sharks and Rays Conservation Research Program (SRCRP) has been opportunistically collecting data on *M. hypostoma* off of Sarasota, on the central west coast of Florida. Between 2019 and 2023, eighteen devil rays were internally tagged with Innovasea V13 (90 or 120 seconds of nominal delay) acoustic transmitters, including juveniles on the central west coast of Florida (N=7), juveniles off the Florida Panhandle (N=7) and adults on the central east coast of Florida (N=4). Preliminary acoustic detection data provided through iTAG and FACT collaborative networks revealed seasonal migrations between the central west coast of Florida (summer and fall) and the Florida Panhandle (fall and winter), a pattern at the opposite of another ray species (*Ae- tobatus narinari*) studied in the same region. The longest documented return migration was of a juvenile male tagged off Sarasota in August 2020, detected by the Mississippi River mouth (Louisiana, 691 km from tagging location) in October 2021, and detected back in Sarasota in July 2022. Future research efforts include additional collaborative tagging of *M. hypostoma* in the Gulf of Mexico and the east coast of the United States to examine the consistency in observed movements. Passive acoustic telemetry data together with citizen observations and fisheries-dependent data, will also be used to build an ecological niche model for the species in the Western Central Atlantic region. This study hopes to fill critical knowledge gaps in *Mob- ula hypostoma*'s ecology to inform management and conservation strategies of this endangered species.

Keywords: devil ray, passive acoustic telemetry, movement, distribution, seasonality

From Ireland and beyond - Environmental drivers of Atlantic Bluefin Tuna migrations

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Management of highly-mobile species is notoriously difficult. Spatial and temporal data for such species is usually limited, and often relies on expensive electronic satellite tags to deci- pher their movements. Furthermore, such technology only produces 'presence' data e.g. the tagged individual was at 'LatLong' on 'DateTime'. Subsequently, limited numbers of satellite tracks are not robust enough to make appropriate management decisions without further analy- sis to understand why individuals moved through their environment in the direction detected by tags. Atlantic bluefin tuna (ABFT) are a highly important species politically, economically, and ecologically. However, due to their large migrations across multiple jurisdictions, effective man- agement is challenging and depends on our ability to interpret how populations are distributed. Much of our understanding comes from ABFT tagged over the past few decades, yet only a small proportion of these originate in the North East Atlantic. To expand on our existing knowledge of ABFT migrations, we combine 'presence' only tracking data from fish tagged in Ireland with satellite derived environmental data to understand the drivers behind their movements. A switching state-based model was applied to 49 ABFT tracks from 2016-2021. Erroneous data was then removed, resulting in 4,216 'presence' locations. For each of these locations, 100 'pseudo absence' locations were simulated using correlated random walk modelling. Data for a variety of environmental variables was then extracted for both daily 'presence' and 'pseudo absence' locations. Finally, generalized additive mixed models were used to interpret the role of each variable on ABFT movements. Preliminary results suggest sea surface temperature (IQR: 13.4 - 17.1◦C), eddy kinetic energy (IQR: -1.8 to -2.7 m2s-1), mixed layer depth (IQR: 22.7 - 113.4 m) and rugosity (72.7 - 382.3 m) play an important role in ABFT space use. Identifying important oceanic attributes through the combination of tracking and 'pseudo absence' data is extremely advantageous when producing species distribution models used to predict future distributions. The applications of these findings are therefore particularly pertinent given our changing climate and need for adaptive management.

Keywords: Atlantic bluefin tuna, satellite tagging, species distribution model, generalized additive mixed models

Habitat-Dependent Bioenergetic Costs for a Wild Cold-Water Fish

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For fish, water temperature is the largest driver of biological processes as it influences phys- iological mechanisms dictating movement and behaviour, growth, reproduction, and survival. Thermal habitats that fish rely on are being altered by climate change which synergistically interacts with anthropogenic stressors. Bioenergetic models have assisted in understanding how energy moves through fish. Lake trout (*Salvelinus namaycush*) are culturally and economi- cally important cold-water fish within northern North America and occupy lakes that are likely affected by climate change. Therefore, we evaluated how changes in thermal habitats in a multibasin lake influence activity metabolism. Activity corresponded to seasonal changes and were basin specific, suggesting that thermal habitats dictate energetic costs for lake trout. As thermal habitats are reduced, lake trout will reduce their energetic costs resulting in negative consequence. However, our findings show that even when thermal habitats are limiting, the species can adjust its energetics costs allowing for its persistence.

Keywords: Thermal Habitats, Lake Trout, Metabolism, Acoustic Telemetry

How a VEMCO 180 kHz high residency receiver array speaks and listens in a fast flowing river: evaluating array performance and precision in relation to its environment

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Recent technological advancements in acoustic telemetry have enabled 2D or 3D positioning of mobile aquatic animals in receiver arrays with overlapping detections. The resulting sub-meter scale precision and near-continuous, accurate positioning data has allowed new research questions to be tackled. However, generating sufficiently precise and accurate data to answer fine-scale (e.g. within several meters) questions remains a challenge. Both precision and accuracy depend on the characteristics of the positioning system and its environment. In this study we evaluate the effect of external factors such as ambient noise, the flow velocity, temperature and depth on the detection probability. We also investigate the relation between the detection probability and the spatial and temporal variation in precision of PPM and HR based positions of six reference tags. The setup consisted of 16 HR2 180 kHz receivers (VEMCO/INNOVASEA), covering an area of 400 x 70 m river directly downstream of a hydropower plant (Iller River, Altusried, Germany). Data were collected between March and August 2018. Discharge ranged from 30 to 100 m^3s-1, with flow velocities ranging from 0 to 1.6 ms-1, and the receivers were deployed at depths of 1-4 m. Gravel and cobbles characterise the substrate in the study area and the banks surrounding the receiver array are a mixture of natural (gravel, tree roots and sediment) over semi-natural (fortified with rocks) to artificial (concrete banks of the hydropower plant) banks. Knowledge on the performance of this setup and its anomalies is valuable for researchers planning fine scale tracking of migrating fish near barriers and fish passes in natural and semi- natural fast-flowing rivers. Despite the increasing number of studies on the performance of acoustic receiver arrays for fine scale 2D and 3D tracking, a knowledge gap still exists in how system performance, accuracy and precision are affected by external factors and are therefore habitat and site-specific. Such knowledge will help researchers with important considerations about telemetry system and array design in relation to the study site, and how to evaluate system performance when designing future fine scale aquatic tracking studies.

Keywords: Fine scale tracking, Positioning system performance, Detection probability, Position precision

Impact of hydropower on lake behaviour of anadromous brown trout (*Salmo trutta*)

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Many Norwegian rivers and lakes are regulated for hydropower, which affects freshwater ecosystems and anadromous fish species. To investigate this, we tagged 30 adult sea trout (*Salmo trutta*) with acoustic tags instrumented with acceleration, depth, and temperature sensors in summer 2021. Our results indicate that there was a large prevalence of sea trout in the lake during the spawning migration, and that sea trout were less active in the lake compared to the riverine habitats. The increase in activity of sea trout in the lake during autumn might indicate that sea trout spawn in the lake. However, the discharge from the high-head storage plant into the lake had a minimal effect on the activity of sea trout in the lake, and did not affect their depth use. In conclusion, our results could not find evidence of a large impact of the discharge on the behaviour of sea trout in the lake.

Keywords: salmo trutta, hydropower, lake ecology, acoustic telemetry

Interactive software to rapidly visualize high-resolution aquatic animal movement in three dimensions

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Animal movement in the wild is increasingly collected by high-resolution, machine-sensed, reality-mining approaches, such as fine-scale acoustic telemetry or GPS, leading to a revolution from a data-poor to a data-rich discipline. However, our ability to convert machine-sensed trajectories into meaningful observations of animal behaviour has not followed the pace of our ability to collect data. We therefore need new tools and approaches to efficiently analyze the wealth of animal movement data. One solution is to use immersive analytics approaches, to reconstruct the physical and biological environments *in silico* into an immersive and interactive environment, in which animal movement can be observed directly. We have developed software using the Unity 3D Engine, for interactively visualizing 3D fine-scale movement data. The software can be used to visualize the movement multiple individuals simultaneously through a database connection and the provision of a terrain/bathymetric map. Additional environmental data, such as wind speed and direction, temperature or thermocline position, as well as individual metadata can be added and displayed for the integration of multiple data streams. This fully open-source software will be freely accessible and available for community contributions. We anticipate that this software will not only stimulate the generation of new hypotheses based on observing animal interactions from the wild in high-resolution, but will also act as a medium for public outreach

Keywords: visualization, fine, scale telemetry, immersive analytics, open, source software

Investigating post-release mortality of coho salmon in a Canadian marine recreational fishery

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Although many recreationally caught Pacific salmon are harvested in Canada, a substantial number of salmon are released after capture. Released fish are often assumed to survive; how- ever, actual catch-and-release mortality rates are largely unknown for Pacific salmon, a popular sportfish in Canada. As a result, published mortality rates likely underestimate reality, com- plicating the ability to develop biologically meaningful management measures for wild salmon populations. This study examines the capture and handling factors influencing post-release mortality of coho salmon (*Oncorhynchus kisutch*) in a marine recreational fishery in British Columbia, Canada. Over two years, adult coho were angled in the marine environment, affixed with acoustic transmitters, and tracked using an existing network of acoustic receivers located at multiple locations frequented by coho along their return migration to their natal spawning streams. We found mortality to the first point of detection was 33% (median = 3.5 days after release), and mortality was higher among coho with injuries such as scale loss, eye damage, and bleeding. Quantifying post-release mortality rates and understanding how capture and handling factors influence behaviour and mortality will provide information vital to developing management tools and fishing best practices to increase survival of wild fish.

Keywords: migration, fisheries management, injury, catch and release

Is being conservative crucial in spatial network analysis? An alternative approach applied to acoustic tracking data of large sharks in French Polynesia

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Network analyses have been a growing technic for analyzing habitat connectivity and move- ment patterns across the animal kingdom and are especially suited for data obtained using acoustic telemetry. However, although different approaches have been proposed to assess the connectivity of various locations, the consideration of detection timing might often be over- looked in spatial network analyses, which may then bias the results obtained by overestimating the degree of connectivity across locations. Here, we propose a conservative approach involving a dummy acoustic station and a classification method to consider detection timing and distance across receivers and refine our understanding of animal movements. Based on a case study us- ing acoustic telemetry to investigate the movement patterns of two large shark species around the islands of Tahiti and Moorea, French Polynesia, we aimed to assess the relevance of this approach in comparison with a more traditional method for spatial network analyses applied to acoustic telemetry data.

Keywords: acoustic telemetry, network analysis, graph theory, detection gap

Large-scale collaborative telemetry networks reveal stock structure and seasonal site fidelity of cobia Rachycentron canadum on the U.S. east coast

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Understanding temporal and spatial patterns of animal movement is critical for their assess- ment, management and conservation. We used acoustic telemetry to evaluate the placement of the current management boundary between U.S. Atlantic and Gulf of Mexico stocks of cobia and to investigate metapopulation structure within the Atlantic stock. From 2016 to 2020, 406 cobia were tagged from Virginia to Florida, U.S. as part of multiple complimentary research projects. After removing false detections, 389,845 detections from 360 fish were collected from 61 acoustic receiver arrays. While nearly 78% of detections were generated from FACT Net- work partners, the project benefited with detections from neighboring networks including OTN, ACT, and iTAG. Network analysis revealed regional structure within the Atlantic stock during spawning months and seasonal site fidelity to specific regions across years. The results suggest a biological boundary south of the current management boundary and regional structure within the Atlantic stock should be considered for management. Our study demonstrates how collab- orative telemetry networks may be utilized to elucidate annual migratory pathways and reveal metapopulation structure within marine fish stocks.

Keywords: FACT network, network analysis, collaborative telemetry networks, stock structure, seasonal site fidelity, fisheries management, recreational fishery, marine fishery

Living the Bream: Application of fine-scale acoustic telemetry to inform spatial-temporal management of a temperate Marine Conservation Zone

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Fish spawning aggregations can be highly vulnerable to overexploitation, resulting in severe ecological, social and economic consequences. Effective conservation of transient fish spawn- ing aggregations, including spatial management, requires knowledge of the space use and tem- poral residency patterns of individuals at key spawning sites. In the UK, angling for black bream *Spondyliosoma cantharus* is subject to spatial and temporal catch restrictions during the spawning season in the Kingmere Rocks Marine Conservation Zone (KRMCZ). However, little is known about bream space use and residency patterns during their spawning season, and thus the appropriateness of current and future conservation measures. This presentation will provide results from the first year of a multi-year, fine-scale acoustic telemetry study on black bream conducted in the KRMCZ. Acoustic tagged black bream ($n = 25$) displayed diurnal patterns of activity, as well as strong fidelity to apparent nocturnal roosting sites. Detection patterns indicated that residency within the KRMCZ was highly transient, confirmed by the cessation of residency of most tagged fish in late May, and subsequent detection of fish on receivers outside of the KRMCZ. Findings from the study are discussed in the context of the ongoing development spatial and temporal management plans for the species.

Keywords: management, finescale telemetry

Long way with limited success. The potential eel migration from Masurian Lake District, northern Poland

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The Masurian Lake District is part of the eastern Baltic lake district complex and covers an area of 13,000 km2. The network of lakes is largely connected by a system of rivers and canals. The basin of the Masurian lakes is drained by the two large rivers, the Narew and the Vistula. European eels, during their catadromic migration to the Baltic Sea, must not only travel several hundred kilometers but also overcome two large hydroelectric power plants and their reservoirs: Debe on the Narew River and Wloclawek on the Vistula River. In this work, the possibility and rate of silver eel runoff through both dams and along the entire section to the sea were investigated using acoustic telemetry. A total of 90 silver eels were tagged during the two research seasons. Eel runoff times on individual river sections were calculated and potential mortality was determined. The results showed that a significant proportion of eels did not choose to migrate through hydropower plants: 40% in 2012 and 32% in 2013. Among the eels that overcame the power plant in Debe, no mortality was recorded. In the first season of research, 28% of fish reached Wloclawek, and in 2013, it was 36%. Only 12% of the eels tagged in 2013 managed to swim to the Baltic Sea. *This research was supported by the statutory project no. Z-001 and Z-003 of the National Inland Fisheries Research Institute, Poland.*

Keywords: silver eel, lake complex, large dams, acoustic telemetry

Long-distance migrations and seasonal movements of large coastal predator (meagre, *Argyrosomus regius*) along the Iberian Peninsula coast

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The meagre, *Argyrosomus regius* (Asso 1801), is a coastal predatory fish inhabiting waters from the Eastern Atlantic to the Mediterranean Sea, being one of the most targeted species in small-scale commercial and recreational fisheries across its range. Despite being amongst the world's largest marine teleosts, its spatial ecology and migratory behavior remain poorly documented. In this study, we used a combination of acoustic telemetry and pop-up satellite archival tags to investigate the movements of adult meagre (22 individuals, 70-143 cm TL) along the Southwestern coast of the Iberian Peninsula. Our results clearly dismiss the hypothesis of restricted adult dispersal as a factor for the previously reported genetic differentiation, revealing instead some of the longest migrations ever recorded for a coastal teleost (with a single individual travelling > 2000 km in less than a year). Moreover, regional movement patterns suggest that natal philopatry could be one of the factors behind meagre's population structure and corroborate the existence of a marked seasonal behavioral shift, with individuals being less active and moving to deeper waters during winter months. Finally, we identified putative aggregation areas that may harbour important feeding/overwintering grounds, and that may be of particular importance for the conservation and management of this species.

Keywords: movement ecology, satellite archival telemetry, acoustic telemetry, predator, seasonal migration, philopatry

Marine predators' traits and their selection for Lagrangian features

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The capacity to predict where marine predators are located is important for both conser- vation and fisheries management. To that end, a lot of effort has been put into understanding how marine predators interact and select for specific environmental conditions. Most studies of pelagic predators have focused on ocean conditions coincident in time and space with the animal (Eulerian or state predictors), without consideration of the dynamic history of the water parcel occupied by the predator. Such Eulerian predictors track changes in water characteristics (temperature, chlorophyll, etc.) at a given location. In contrast, Lagrangian predictors follow the evolution of a water parcel along its trajectory, providing a critical complement to the Eulerian viewpoint. The Lagrangian framework, thus, can capture along-trajectory processes such as accumulation of biomass that cannot easily be extracted from Eulerian fields. In addition, analyses of movement tracks of some marine organisms (including elephant seals, frigatebirds, penguins) hints that marine predators may select for Lagrangian features that aggregate planktonic biomass. But to our knowledge, no study has systematically explored the use of Lagrangian features by marine predators. Further, relating the use of Lagrangian features to animal traits (such as size, trophic level, endothermy) would enable drawing general predictions regarding the importance of Lagrangian features and their use by different animals at the ecosystem level. Here, we present a method that tests for the selection for Lagrangian features in marine predators. Using the TOPP (Tracking of Pacific Predators) dataset, we assess the selection of Lagrangian features by 42 different species of marine predators, ranging from sea turtles to sharks, elephant seals, and whales. We then relate the selection of the different organisms to their size, energy requirements, and trophic level, to infer relationships between marine predator traits and selection for Lagrangian features.

Keywords: environmental selection, Lagrangian features, SPOT tags, biologging

Marine reserve use by the migratory coastal shark, *Carcharias taurus*

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Networks of small no-take marine protected areas (MPAs) are a popular approach to protect mobile marine species at key sites along their migration routes. Understanding how individuals vary in their use of these sites is needed to ensure MPA networks are optimised to offer maxi- mum protection benefits. Using diver-led surveys, coded acoustic tags and a continental-scale collaborative network of acoustic receivers, we investigated variation in the use of three Aus- tralian MPAs by aggregating grey nurse sharks, *Carcharias taurus*. The Wolf Rock MPA was used year-round by *C. taurus* and as a gestation site, with females spending up to 254 d at the site with 2.2–3.7 year absences between residencies. In contrast, Flat Rock and Cherubs Cave-Henderson Rock MPAs were used as a transitory aggregation site with males and females occurring at the site for 30 min – 59 d intervals between June–January, only. Migratory move- ments ranged up to 1,500 km along the coastline, intersected 18 MPAs and/or recognised *C. taurus* aggregation sites, and connected temperate waters at Montague Island (36.25∘ S) with that of the southern Great Barrier Reef (23.40∘ S). Our study demonstrates how local receiver arrays and national collaborative acoustic telemetry networks are powerful tools to reveal use, fidelity and connectivity of MPA networks by marine migratory species. As the east Australian *C. taurus* population is critically endangered and at particular risk of anthropogenic threats, on- going monitoring of the species' movement behaviour and complementary management outside protected area boundaries is warranted to assist its protection.

Keywords: shark, MPA connectivity, threatened species, acoustic telemetry, sand tiger, grey nurse

Monitoring commercially relevant shark species by acoustic telemetry in the northern Adriatic Sea to contribute to the fishery management plans

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Elasmobranch in the Mediterranean Sea are facing a worsening conservation status compared to the ones in other oceans, because of fishing overexploitation and vulnerability due to their life-history traits (Walls & Dulvy, 2021). Among Mediterranean subbasins, the highest fishing pressures is present in the Adriatic Sea (Russo et al., 2019). The smooth-hounds (*Mustelus* spp.) and the spiny dogfish (*Squalus acanthias*) are among the most common commercially relevant shark species in the north-central Adriatic Sea (Barausse et al., 2014), being either by-catch or seasonal target. Within the EU Marine Strategy project, we aim at evaluating the post-release survival of these two species through acoustic telemetry. Together with the at-vessel vitality condition, these results can contribute to the fishing mortality estimation under management scenarios that can include the juveniles release (minimum retainable size), quotas or ban. Res- idency and inter-annual site fidelity in high fishing pressure area are assessed as well. Since summer 2022, 11 acoustic receivers were deployed (VRT2x, InnovaSea) in the fishing ground of Chioggia's fishing fleet. During fishing vessel boarding on bottom trawlers and gillnetter, 10 *Mustelus* spp. and 19 *S. acanthias* were externally tagged with either V9 or V13 acoustic tags (Innovasea). The number of tagged smooth-hounds was equal between fishing gears. while spiny dogfish were mostly tagged on gillnetters. Preliminary results highlighted the detection of 4 individuals of *Mustelus* spp. (60%) and 4 of *S. acanthias* (20%) and the persistence in the area until the 77th day after release of smooth-hounds and until the 43rd of spiny dogfish. Further tagging and data collection is planned from Spring 2023.

Keywords: elasmobranch, fishery, conservation, Mediterranean Sea, managment

Monitoring whitespotted eagle ray behavior in shellfish restoration sites in Sarasota Bay, Florida USA

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Several species of durophagous rays have been implicated in shellfish aquaculture depredation in regions around the world. In Florida USA, shellfish aquaculture is a multi-million-dollar industry with ongoing shellfish restoration efforts to improve water quality, larval recruitment, and habitats. Since 2019, over one million hard clams (*Mercenaria sp.*) have been released in Sarasota Bay, FL with the primary goals of monitoring growth, survival, and suitability of habitats for further restoration efforts. Sarasota Coast Acoustic Network (SCAN), a multi- institution collaborative group with more than 70 acoustic receivers in Sarasota Bay and along the coast of central west Florida, placed Innovasea VRTx and VR2W acoustic receivers at these clam restoration sites (N=4) to monitor presence of tagged species of rays, sharks, fish and invertebrates. Since 2016, 88 whitespotted eagle rays (*Aetobatus narinari*) were tagged within the study area with acoustic transmitters (Innovasea V9, V13 and V16 depending on body size). Of these rays, 14 were detected at the clam sites. Diurnal patterns of visitation by tagged rays varied between the sites. Additionally, a subset of these sites (N=2), were monitored with passive acoustic monitoring devices (Loggerhead Instruments: SNAP recorder (equipped with a HTI96 hydrophone) and LHC Cyclops (equipped with a video camera and HTI96 hydrophone) which captured predation sounds by whitespotted eagle rays. Further understanding of the use of these clam restoration sites, particularly by durophagous predators, is important in helping inform best practices for shellfish aquaculture areas. Tagging and tracking these species through a coordinated network such as SCAN can provided important information regarding predators preferred habitats helping to pinpoint more successful restoration efforts in the future.

Keywords: shellfish aquaculture, shellfish restoration, whitespotted eagle ray, predation, passive acoustic monitoring, acoustic telemetry, diurnal behavior

Multi-scale Habitat Selection of Spotted Seatrout in an area of Seagrass Recovery

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A recent call to arms in the field of fish telemetry is to apply the data collected to investi- gate habitat selection to inform management. In south Florida, the Everglades and specifically Florida Bay have experienced continuous degredation over the past several decades due to anthropogenic activities. In particular, major reductions in freshwater inflows have led to 2 large- scale seagrass die-offs in Florida Bay, resulting in a reconfiguration of the seagrass seascape in the northcentral region. Using machine learning and resource selection functions, we investigated the habitat selection of Spotted Seatrout within this recovering northcentral region of Florida Bay at multiple scales within 2 Basins following different recovery trajectories. Preliminary results indicate that Spotted Seatrout prefer areas of high seascape complexity characterized by more edge habitat regardless of the within-patch characteristics of the SAV (Submerged Aquatic Vegetation). These results indicate that spatially-complex beds, a target of Everglades restora- tion and management, could have a positive influence on Spotted Seatrout occurrence in Florida Bay.

Keywords: Habitat Selection, Machine Learning, Spotted Seatrout

Released captive fish seems to return to their wild behaviour after a period of adaptation

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Marine biodiversity is threatened in the Mediterranean Sea mainly due to human activities such as pollution, intensive fishing and coastal habitat destruction. Restocking programs are interested in helping to maintain the fish stocks targeted by the fishery. In Corsica, 5 mature *Dentex dentex* were captured and maintained in large tank during 5 years for breeding and then released into the wild. The spatio-temporal movement patterns of these 5 captive and 10 other wild dentex have been investigated in the Nonza no-take zones (NTZ) using a network of 40 passive acoustic receivers. All fish were released inside the NTZ, close to their capture location for the wild ones. In this study, we compared the behavior of fish kept in captivity to that of wild fish and investigated the ability of captive fish to recover to their originated wild behaviour. We observed that wild dentex took refuge as soon as they were release at depth (15 to 30 m) and stay for several months around their release points in NTZ. Morever, after release all 5 captive fish remained in shallow areas (< 5 m), corresponding to the depth of the tanks. After a few days (3-5 days), all captive individuals left the reserve and moved long distances (> 10 km). Two individuals returned to the NTZ several months after their release and seemed to have settled nearby. Two individuals were caught after more than 4 months of freedom. Our results showed that captive fish survive during several months after their release and have the ability to return to their original wild behaviour after a period of adaptation. These results give highlights in terms of management for fish release originating from breeding or aquarium program.

Keywords: Common dentex, captive, wild, marine fish, coastal, MPA, No take zone

Remediation solutions to enhance post release survival of sharks caught on pelagic longline

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Sharks are often considered as the less valuable bycatch for many global fisheries. However they represent an essential source of food security in many coastal countries and their fins and meat have commercial value in global markets. While fishing pressure on sharks remains im- portant due to the continued demand for seafood, their landings have declined over the past 50 years. Over the last two decades, tuna regional fishery management organizations have signifi- cantly improved conservation measures targeting sharks, such as retention bans and restriction on the international trade. However, fishing limits are inadequate and the effectiveness of the implementation of conservation measures is not strong enough to curb overfishing. Manage- ment measures controlling input factors in fisheries such as fishing effort, are challenging to set up. Therefore reducing the interactions between fishing gears and bycaught species can be achieved by adopting a four-step mitigation hierarchy process: 1 – Avoidance (spatio-temporal exclusion from fishing), 2 – Minimization (fishing technologies to reduce contact between gears and unwanted resources), 3 – Remediation (devices or handling practices aiming to provide a safe release to sea of an unwanted capture and thus enhance the post release survival) and 4 – Offsetting (eradication of predators impacting the demography of the unwanted population). Here, we present the results of tagged discarded sharks conducted within the framework of both POREMO and ASUR EU projects aimed at developing a remediation solution. We analysed the depth time series collected by electronic tags (MiniPAT and sPAT from Wildlife Computers) of released sharks to produce indicators to characterise the post-release mortality and to interpret the drivers of tag detachment. At the date when we are writing this abstract, 9 oceanic white tip sharks were tagged between latitudes -32.75 ◦S and -20.5 ◦S (average of -21.8 ◦S) and between longitudes 34.9 ◦ E and 54 ◦E (average of 52.2 ◦E.) Considering a fork length of 157 cm as the size of 50% of maturity, the tagged individuals were mostly juveniles, 5 individuals out of 9. Days at liberty of tagged individuals ranged from 9 to 185 days with an average of 58 days. Among the 9 individuals, no post release mortality was observed. These encouraging results are a source of motivation to develop a technology dedicated to pelagic longline fisheries aiming at promptly releasing release promptly a shark into the water while securing fishers.

Keywords: pelagic longline fisheries, bycatch, ban retention, post release survival, innovation

Residency patterns of the blue-spotted ribbontail ray, Taeniura lymma, in the Red Sea

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Stingrays play a significant role in maintaining the health of coral reef ecosystems but are vulnerable to the cumulative impacts of human activities and climate change. The blue-spotted ribbontail stingray (*Taeniura lymma*) is a demersal species common to coral reef habitats across the Indo-West Pacific and can be found on most reefs in the Red Sea. Despite facing similar pressures to other species of stingray, the ribbontail ray is one of the few reef-associated species showing an increasing population trend, though little remains known about the species' movement patterns. To better understand the residency patterns, habitat use, and connectivity of the ribbontail ray, 25 individuals were tracked using acoustic telemetry in a lagoonal system in the eastern central Red Sea (Thuwal, Saudi Arabia) between August 2019 and August 2020. Stingrays were present year-round in the lagoon system and typically remained within 500m of their original tagging location. Females were found to visit a higher number of stations and to make longer-distance movements more frequently than males, but there was no clear effect of seasonality observed on the number of detections for either sex. This study provides new insights into the residency patterns and movement ecology of the blue-spotted ribbontail ray, which are valuable for understanding the potential impacts of population changes on coral reef ecosystems and in designing conservation measures. The limited movement patterns exhibited by the blue-spotted ribbontail ray indicate a vulnerability to localized overfishing and impacts from habitat loss due to a likely low rate of replacement of individuals from nearby reefs.

Keywords: Dasyatidae, Coral reefs, Acoustic telemetry, Residency, Habitat connectivity

Revealing the migration behaviour and survival of Atlantic salmon and sea trout smolts using acoustic telemetry

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The smolt migration from freshwater to sea is a critical stage of anadromous salmonid's lifecycle, during which smolts can experience high mortality from multiple sources. Although Atlantic salmon (*Salmo salar*) and sea trout (*Salmo trutta*) constitute two of the most well- researched salmonids, few studies simultaneously compare the downstream migration of these two species within the same river and marine habitat. This study investigated the migratory behaviour and survival of salmon and trout smolts during their seaward migration using acoustic telemetry in the spring of 2021. A total of 75 hatchery salmon smolts, 75 hatchery trout smolts, and 150 wild trout smolts were tagged with acoustic transmitters and released into River Gudenaa, Denmark. The downstream movements of tagged fish were monitored using acoustic receivers deployed in the river and fjord. The findings shed light on the extent to which species and rearing history (i.e., wild or hatchery) influence the migration behaviour and survival of smolts, with the end-goal of informing species-specific management actions to aid population recoveries.

Keywords: Acoustic, telemetry, salmon, trout, smolt, migration

Shark movements and connectivity between separate coral reefs in the northeast Caribbean

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World-wide most reef-associated shark populations have strongly declined, mainly due to fisheries and habitat degradation. In large parts of the Caribbean, status and movement ecology of shark species that use coral reefs during at least one life stage still remain largely unknown. This lack of baseline knowledge hampers the evaluation of measures taken to protect coral reefs, such as marine protected areas and fisheries regulations, on reef associated shark populations. This study focuses on tracking individual behaviour of reef-associated sharks by using acoustic telemetry to help understand their movement ecology at different spatio-temporal scales. A network of 34 acoustic receivers (VR2W, InnovaSea) was deployed on the reefs around Saba, St Eustatius, St Maarten and on the Saba Bank in the northeast Caribbean. Small marine parks are present around Saba, St Eustatius and St Maarten. The large "Yarari" marine mammal and shark sanctuary encompasses the reefs around Saba Bank, Saba, St Eustatius and the pelagic waters in between these reefs. Since 2015, in total 81 sharks were implanted with acoustic transmitters (V16 and V16p, InnovaSea): 49 Caribbean Reef Shark *Carcharhinus perezi*, 15 Silky Shark *Carcharhinus falciformis*, 11 Nurse Shark *Ginglymostoma cirratum* and 5 Tiger Shark *Galeocerdo cuvier*. Juvenile and adult Caribbean reef sharks, juvenile silky sharks and juvenile nurse sharks showed strong residency to relatively small home ranges (a few km) on all four reef systems studied. Individual sharks stayed within the borders of the marine parks for long periods. Adult nurse sharks and juvenile tiger sharks showed higher mobility and shorter lasting residency. Larger scale movements between reefs that were separated by deep pelagic waters (> 500m depth) were observed in adult Caribbean Reef sharks, often short lasting directed back and forth movements, juvenile silky sharks, adult nurse sharks and juvenile tiger sharks. Implications of the results for management will be discussed.

Keywords: Movement ecology, connectivity, coral reef, sharks, marine reserves, acoustic telemetry

Small coastal marine protected areas offer limited, seasonal protection to the common stingray (*Dasyatis pastinaca*)

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Marine protected areas (MPAs) are a useful conservation tool to provide spatial protection to marine species. However, elasmobranchs are generally not the primary target to protect when establishing MPAs, and how the latter benefit these species remains to be better understood. In the Luís Saldanha Marine Park, a temperate coastal protected area in Portugal, acoustic telemetry was used to study the residency and space use of common stingrays, classified as vulnerable by the IUCN, and the results used to propose improvements to their protection. Thirty-one individuals were tagged and monitored for an average of 625 days per individual. Their presence was markedly seasonal, correlating with the day of the year, and the overall residency low. Yet, while in the marine park, their space use areas were not larger than the fully protected area. Higher presence of stingrays was seen during the colder months, which in turn were virtually absent during warmer months. During these absences, most individuals were detected in the nearby Sado estuary, likely for reproductive purposes. These results show common stingrays present site fidelity to the marine park yet are not protected year-round. Improvements to their protection could be achieved by establishing a protected corridor between the marine park and the Sado estuary.

Keywords: Residency, site fidelity, migration, Dasyaidae

Spatial Ecology of Sympatric Juvenile Atlantic Cod and Saithe at Nursery Grounds

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Structured habitats in Iceland's coastal waters provide important nursery areas for juvenile Atlantic cod (*Gadus morhua*) and saithe (*Pollachius virens*). Environmental conditions such as temperature, as well as seasonal change in the photoperiod and habitat associations are likely to have strong effects on juvenile distribution and migration from nurseries. Furthermore, dif- ferences in the small scale movement between species, size-classes and individuals can unveil adaptations which allow closely related species, such as the sympatric cod and saithe juveniles to coexist. In this study we used acoustic telemetry to measure inter- and intraspecific differences in move- ment of age-group 1 and 2 Atlantic cod and saithe in near-shore nursery grounds. Specifically, we measured between receiver movement as a proxy for activity, number of receivers as an esti- mate of mobility and included the mean water depth at receiver position to distinguish between different habitats within the study area. Each movement metric was examined for differences between species, size classes and diel variation. We further examined the effect of temperature on juvenile movement and early winter migration. The movement of 53 juvenile cod and 33 juvenile saithe was studied in an array of 33 receivers positioned in 6 gates across a small fjord in the Icelandic Westfjords. The study period extended from late summer until early winter in 2020 and 2021. Habitat divergence between cod and saithe increased with increasing body size, as larger cod juveniles moved into deeper waters. Saithe of all size classes occupied the shallow water habitats (< 20m) throughout the study period. Both activity and mobility increased in juvenile cod with increasing body size. The majority of juveniles left the fjord during the study period, with larger juveniles being more likely to leave the fjord. The results indicated that juveniles respond to both colder and warmer temperatures by migrating to deeper waters. Different effects of temperature between years suggest that temperature may not be the sole driver of "early winter migration" in juvenile gadoids.

Keywords: nearshore, nursery grounds, juvenile gadoids, Atlantic cod, temperature, early winter migration

Sticking with it: a multi-sensor tag to reveal the foraging ecology and fine-scale behavior of elusive durophagous stingrays

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Large, durophagous (shell-crushing) rays are hypothesized to play a pivotal role in marine food webs, yet information on their fine-scale behavioral ecology is limited due to their elusive nature and challenges with tagging these morphologically unique animals. Using a novel, mini- mally invasive tagging approach we are able to investigate the movements, behaviors, and ecolog- ical interactions of these understudied species. Our multi-sensor device includes a CATS-CAM (Customized Animal Tracking Solutions, Ltd.) equipped with a hydrophone (HTI 96-min), an Innovasea V-9 coded acoustic transmitter, and a Wildlife Computers satellite transmitter (363- C). Fully assembled, the package is approximately 2.8 x 7.6 x 5.1 cm, and weighs 430 g in air. The units are attached to the dorsal cephalic region of the rays via two or three silicone suction cups, which are placed along a recessed area between ridges of the chondrocranium. Through captive trials (N=27) at Mote Marine Aquarium in Sarasota, Florida and field trials (N=3) in Harrington Sound, Bermuda, retention times on whitespotted eagle rays (*Aetobatus narinari*) have ranged from minutes to over 13 hours with an average retention time of 4.4 hours. Data from the IMU portion of the tag suggest postural and pitching motions related to feeding, while video and audio data appear capable of revealing prey identity and capturing shell fracture acoustics (i.e., predation). Field recordings have thus far documented the benthopelagic behav- ior of rays including interactions with bottom substrate habitat and other conspecifics. With further refinements to our package and extended retention times (> 24 h), we expect this tool to be capable of revealing in situ behaviors of multiple species of benthopelagic rays, particularly in areas with suitable acoustic telemetry infrastructure.

Keywords: batoid, telemetry, ray, elasmobranch, biologging, acoustics

The movement ecology of bull sharks determined by network analyses in Reunion Island, Indian Ocean

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Knowledge of the spatial ecology and movement of animals contributes to our understanding of ecosystem dynamics and can inform conservation actions. In addition, animal movements are typically influenced by multiple environmental factors simultaneously and individuals vary in their response to this environmental heterogeneity. Therefore, understanding how environmental aspects, including biotic, abiotic and anthropogenic factors, influence the movements of wild animals is an important focus of wildlife research and conservation. Acoustic telemetry and network analyses were used to investigate the spatial ecology of bull sharks in Reunion Island. We found that the west coast of the island was not used uniformly by all individuals, with size predicting the movements of sharks along the coast. Node-based centrality metrics revealed that smaller sharks primarily used the south-west coast while larger individuals spent most of their time in the northern region with regular visits to multiple areas along the coast. We also applied exponential random graph models (ERGMs) to analyze the movement networks of bull sharks and identify the effects of environment or other types of covariates on their movements. This revealed that intra- and interspecific factors often had stronger effects on movements than environmental variables. Network analyses of movements made it possible to identify core areas and explain the main factors affecting movements in bull sharks on the west coast of Reunion Island. Such findings provide important information for our understanding of population dynamics of these coastal predators and for management of human-predator conflicts.

Keywords: shark, movement, acoustic telemetry, network analyses, centrality, ERGM

The Ocean Tracking Network: 15 years of collaborative aquatic animal tracking across the globe

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Since 2008, the Ocean Tracking Network (OTN) has been monitoring the movements, habitat use, and survival of aquatic animals in the context of changing environments. A global community of researchers is using OTN's infrastructure and analytical tools to track keystone, commercially and culturally important, and endangered species around the world. OTN connects an international community of researchers, teaches open-source data analysis tools, and contributes to the development of global data standards. By building partnerships with regional telemetry groups and providing compatible infrastructure and data support, OTN has strategically connected affiliated networks, or 'nodes', and facilitated data sharing across geographic boundaries. This approach enables the matching of 'mystery' detections, expands receiver cov- erage for individual researchers, and supports the application of FAIR principles for data storage and analysis. OTN also has a pool of receiver units available for loan to academic institutions, industry, non-governmental and other organizations. This equipment assists in fostering high- quality telemetry science and expanding OTN's global network coverage. OTN's core funding has been renewed through 2029, enabling the expansion of its operations and capabilities. OTN will continue forming partnerships with researchers and leveraging its infrastructure and exper- tise in support of management and conservation priorities at local, national, and international levels.

Keywords: telemetry networks, movement ecology, international collaboration, data management, conservation

The use of predator tags to identify unusual movement patterns in Atlantic salmon smolts

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Acoustic telemetry is commonly used to assess survival rates of Atlantic salmon smolts (*Salmo salar*) on their outward migration to the sea. In general, salmon smolts are thought to make a unidirectional migration from freshwater to the sea, on a mission driven by changes in their physiology and as part of their life history. However, unusual movement patterns are often difficult to identify as movement made by the tagged individuals or a potential predator. Over three years, 217 salmon smolts (55 wild and 162 hatchery-reared, from here on called ranched) were acoustically tagged and released into an embayment on the west coast of Ireland. In 2020, returning behaviour of ranched smolts between a saline lagoon and its estuary were no- ticed. Initially, these reversals were thought to be fish acclimatising to saline conditions for the first time in their lives or reacting to environmental cues to find their way out of the embayment to the sea. In 2021, to fully determine whether this movement were salmon smolts or predation, predator tags with a digestive sensor were used. In 2022, the addition of a temperature sensor was used to determine the potential type of predator causing the returning movement. Of the 25 ranched smolts tagged with predator tags 50% and 46% respectively were triggered or eaten, after which they displayed the returning behaviour.To identify wh ether smolts without the extra predator sensors could also be linked to predation events, two types of machine learning were tested. Ten variables were used in both cluster and random forest analysis. Upon comparison of the two types of machine learning techniques, no difference was found in the overall results and both identified 16% of ranched smolts in 2020, 34% in 2021 and 16% in 2022 as having the same behaviour as those confirmed to be predated upon. A mammalian predator was identified and results showed that predominantly ranched smolts were predated upon in either the lake or the estuary. Over the course of the study, only one wild fish was identified as predated upon by the same type of predator using these two methods. The quality control of detection data is an important step in correctly reporting target species numbers, helping to prevent a predator-bias. The use of predator tags is recommended to help identify predation events, improving the overall validation of survival estimates of salmon smolts in an area or study.

Keywords: Atlantic salmon, Predator tags, Machine learning

TrackdAT: An acoustic telemetry metadata portal to integrate global fish and shark tracking research

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Movement ecology research continues to expand, not only in the amount of studies being conducted but also the breadth of its application to address complex ecological questions. In- creasingly, there are calls to bridge science from fish and shark tracking to effective policy and management spurred by global efforts to increase ocean monitoring, data storage and sharing, and multifaceted collaborations. Here, we introduce a new online open-source metadata portal designed to address a significant gap for researchers and managers in finding and evaluating published acoustic telemetry research. The main database forms the culmination of three years of extracting informative metrics from thousands of peer-reviewed articles. Our main objective is to make acoustic telemetry research accessible, providing the tools to inform scientists and relevant stakeholders about ways to optimize and apply movement ecology research. This pre- sentation will demonstrate the various tools built into the web interface including the database itself and affiliated components such as a global study map, interactive visualizations, and re- search networks, among others. Recent research that has used components of the database will also be discussed to show different ways the metadata portal can be utilized. As the field of movement ecology continues to grow it is vital that the information garnered from research be organized, catalogued, and readily accessible to the global community.

Keywords: Database, acoustic telemetry, literature review, global catalogue

Turning the tide, understanding estuarine detection range variability via structural equation models

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Insight into the detection range of acoustic telemetry systems is crucial for both sampling design and data interpretation. The detection range is highly dependent on the environmental conditions and can consequently be substantially different among aquatic systems. Also within systems temporal variability can be significant. The number of studies to assess the detection range in different systems has been growing, though there remains a knowledge gap in estuarine habitats. In this study, a two-month experimental set-up was used to assess the detection range variability and affecting environmental factors of an estuary. Given the expected complex interplay of different factors and the difficulties it entails for interpretation, a structural equation modelling approach is proposed. The detection range of this study was relatively low and variable (average 50% detectability of 106 meters and ranging between 71 and 229 meters) compared to studies of riverine and marine systems. The structural equation models revealed a clear, yet complex, tidal pattern in detection range variability which was mainly affected by water velocity, via ambient noise and tilt of the receivers, water depth and wind speed. The negative effect of ambient noise and positive effect of water depth became more pronounced at larger distances. Ambient noise was not only affected by water velocity, but also by water depth, precipitation, tilt angle and wind speed. Although the tilt was affected by water velocity, water depth and wind speed, most of the variability could be traced back to the receivers themselves. Similarly, the receivers themselves seemed to explain a considerable portion of the detection range variability. It was however not possible to find the actual origin of this variability due to the small number of receivers, variable distances between receivers, and limited spatial resolution and scale of the environmental measurements. Shortening the study period and redirecting some of the sampling effort towards more spatially extensive measurements could have been more effective. Especially since retrospective power analyses indicated that for most factors only a minor gain in explanatory power was achieved after more than two days of data collecting. Since the low and variable detection range in estuaries can seriously hamper ecological inferences, range tests with sound sampling designs and appropriate modelling techniques are paramount.

Keywords: detection range, estuary, structural equation models, power analysis

Understanding the impacts of exploitation and fragmentation on the upstream migrating, adult river lamprey (*Lampetra fluviatilis*) using telemetry techniques

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Globally, freshwater ecosystems are heavily impacted by anthropogenic pressures. However, the impact of these pressure on anadromous fish species is rarely quantified. Consequently, this study aimed to improve our understanding of the impact of exploitation and fragmentation by low-head barriers on the upstream spawning migration of river lamprey (*Lampetra fluviatilis*) in the Yorkshire Ouse, one of the UKs largest river lamprey populations and home to the main English lamprey fishery. Acoustic (n = 180 and 172) and passive integrated transponder (PIT; n = 1499 and 1113) telemetry studies were performed across two consecutive years with highly contrasting annual flows (2018/19 = dry and 2019/20 = wet). Acoustic-tagged river lamprey were tracked using 64 strategically located, fixed position, omnidirectional acoustic receivers to study three objectives: 1) quantify interactions with the commercial fishery, 2) assess the impact of man-made barriers and hydrology on catchment-wide migration, and 3) translocate fish to reveal the impact of man-made barriers on onward migration. For Objective 1, the movements of acoustic-tagged lamprey were used to refine mark-recapture rates of PIT-tagged lamprey and run size estimates were reduced by over 100,000 individuals in both study years. Capture susceptibility was mainly dependent on environmental conditions and the number of trap line encounters were exacerbated during retreat from a man-made weir upstream of the exploited reach. For Objective 2, significantly more lamprey reached spawning habitat (76% vs 39%) and penetrated significantly further upstream (median (km) from release, 53.9 vs 16.8) in the wet year than the dry year. Passage at weirs was almost exclusively during elevated river level, which directly and collectively influenced catchment-wide distribution, especially in the dry year. For Objective 3, delay at barriers did not impact the onward migratory capability of individuals which ascended these barriers, but median catchment penetration increased with consecutive release upstream. The study highlights how acoustic and PIT telemetry can provide essential knowledge to inform fishery management, catchment-scale restoration of connectivity and a true understanding of barrier impacts to inform management of threatened anadromous species.

Keywords: Exploitation, fish passage, fishery management, hydrology, longitudinal connectivity, mark recapture, movement ecology, river fragmentation

Unraveling movement patterns and spawning behavior of dusky grouper (*Epinephelus marginatus*) within three MPAs in the NW Mediterranean Sea: implications for management

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In order to protect and ensure the long-term viability of fish stocks, it is important to understand the movement patterns of different species when designing effective marine pro- tected areas (MPAs). This is particularly important for apex predator species, such as the dusky grouper (*Epinephelus marginatus*), which play a crucial role in maintaining the balance of marine ecosystems. This study aimed to investigate the movement patterns and reproductive behavior of dusky grouper within three well-enforced MPAs in the NW Mediterranean sea. Adult dusky grouper individuals were monitored using passive acoustic telemetry for different time periods, with more than 4 years of consecutive data to get a clearer view of all types of movements, including vertical and horizontal movement linked to circadian rhythms, breeding patterns, and spawning aggregation areas. Results showed sedentary patterns and high territoriality, although some extraordinary long journeys have been detected in a few individuals. Groupers also exhibited vertical and horizontal movement patterns linked to circadian rhythms, with individuals remaining in deeper waters during the day and moving to shallower waters at night. Breeding patterns and spawning aggregation areas were also found to be linked to the formation of the thermocline, with individuals congregating in specific areas during the breeding season. The study advances our understanding of the effectiveness of three established MPAs to protect dusky groupers populations and provides new insights into the ecology and reproductive biology of this species. These results suggest that fish behavior, such as movement patterns and reproductive behavior, are crucial factors to consider when designing and managing marine protected areas. This information can be used to improve the effectiveness of MPAs in protecting and conserving dusky grouper populations and the broader Mediterranean marine ecosystem.

Keywords: Dusky grouper, Acoustic telemetry, Mediterranean MPAs, Movement ecology, Spawning behavior, MPA management

Unveiling the 3D movements of porbeagle sharks (*Lamna nasus*) by coupling data with heterogeneous spatio-temporal resolutions

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Porbeagle shark (*Lamna nasus*, Bonnaterre 1788) is a widely distributed in temperate and cool waters in the Atlantic and Southern Pacific Oceans. The main knowledge on seasonal and vertical distribution of porbeagle sharks is based on fisheries data, especially catches and landings. Those data provided evidences of seasonal movements, sex segregation and vertical occupancy. More informative studies on movements in space and time of porbeagle sharks have been enabled by advances in tracking technologies, unveiling potential pupping and mating grounds as well as fidelity behaviour towards the continental shelf. In the North-eastern Atlantic Ocean, studies have been focused on major former fishing grounds along the continental slope of Bay of Biscay, the coastal area of Bristol Channel and off Northwest Ireland. Since 2012, a narrow area of French shoreline in the English Channel has raised local attention following an increase of reported observations to the French Association APECS. In order to understand the connection in space and time between the porbeagle sharks frequenting these coastal wa- ters and those exploiting the diverse areas previously mentioned, we deployed pop-up satellite archival tags (Wildlife Computers Inc.) on 19 individuals. Despite an expected unbalanced sampling related deployment-related risks, we unravelled a consistent diel vertical behaviour amongst tagged individuals in line with daily experienced bathymetric features. Besides, the monthly distribution of individuals is strongly related to the English Channel and its shallow waters. Therefore, when upscaling from daily vertical use of the water column to monthly moves, the vertical behaviour pattern does neither rely on spatial areas, nor on horizontal behaviours (travel/residence). This behavioural consistency is a key information for conservation of this species.

Keywords: telemetry, lamnid, shark, vertical behaviour, movement

Use of acoustic telemetry to management of fisheries in the artificial reefs: Edremit Bay Artificial Reefs Area

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Artificial reefs have been used for habitat protection and restoration purposes in many coun- tries and regions across the world. It is also used to improve traditional fisheries by enhancing local fish populations, especially in the Mediterranean. The interaction between fish and arti- ficial reefs are extremely important for the management of fisheries. So, understanding home ranges and residency is essential for the improve of effective conservation and resource manage- ment strategies. The aim of this study is to contribute to the management of the artificial reefs area by determining the habitat parameters and residences of important reef species. The study was carried out in Edremit Bay Artificial Reef Area between December 2013 and November 2015. Within the scope of fisheries management, small-scale fishing is allowed in 4 subareas, while all fishing activity is prohibited in 3 subareas. 14 *Scorpaena porcus*, 7 *Scorpaena scrofa*, 23 *Sciaena umbra*, 5 *Diplodus puntozzo*, 5 *Diplodus vulgaris*, 14 *Sparus aurata* and 12 *Pomatomus saltatrix* individuals were examine the fine-scale movement patterns and residency by the Vemco VR2W positioning system (VPS). All tagged species demonstrated high site fidelity throughout the tracking period. The residence index was calculated as 0.88 for *S. porcus*, 0.95 for *S. scrofa*, 0.75 for *S. umbra*, 0.98 for *S. aurata*, 0.88 for *D. vulgaris*, and 0.96 for *D. puntozzo*.This study can be offer valuable approach to decision makers in the field of sustainable fisheries in artificial reefs. It also provides valuable information for decision-makers on the temporal and spatial scale of fishing bans to be implemented in the artificial reefs area.

Keywords: Acoustic telemetry, Fisheries Management, Artificial Reefs, Small, scale Fisheries

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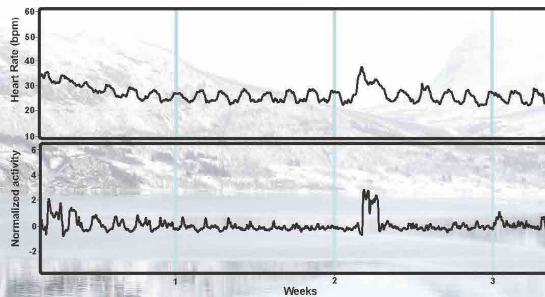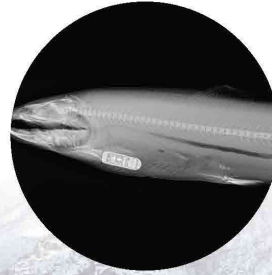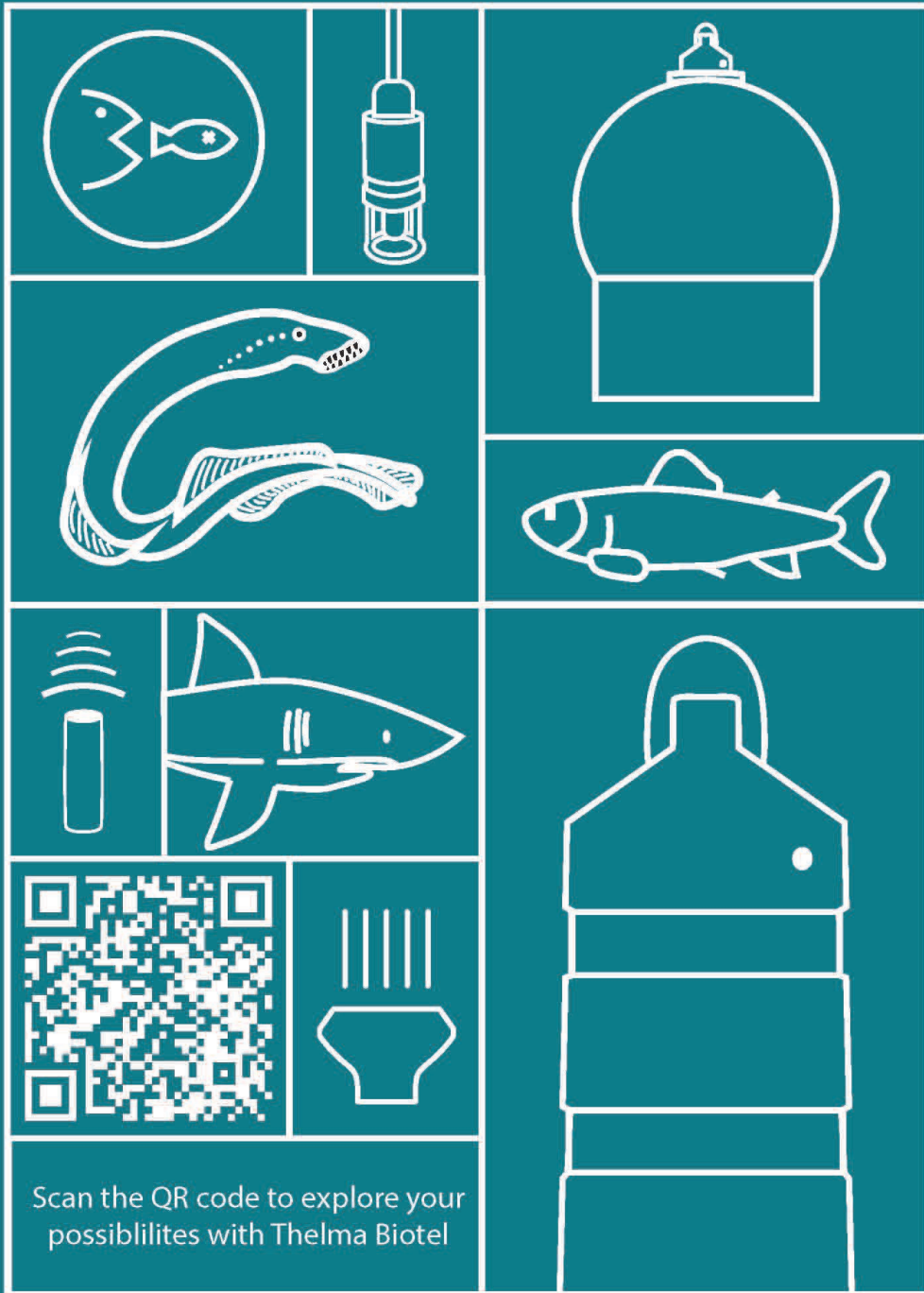
Scan the QR code to explore your possiblilites with Thelma Biotel

Information for Delegates

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LoggLaw CAM Hydrophone Integrated Video Logger

Overview :

- Capable of recording video data at up to 30fps in Full HD, up to 60fps in HD, and up to 120fps in VGA.
- The standard size has a recording time of approximately 5-6 hours at VGA 30fps and approximately 3 hours at Full HD 30fps.
- Can be equipped with a hydrophone, depth, temperature, 3 axis-acceleration, and 3 axis-geomagnetic sensors, enabling recording at the same time as the video logger.
- Can be equipped with a function to start video recording triggered by pressure or acceleration sensors.
- Since the power supply for the sensors (depth, temperature, 3 axis-acceleration, and 3 axis-geomagnetic sensors) is separate, it is possible to continue measuring sensor data even if the video runs out of battery.

Size : W30✕H32.5×L58mm〜

Weight in Air : 96g〜

Depth Range: 〜1,000m

BIOLOGGING SOLUTIONS INC.

Contact :

Biologging Solutions Inc.

Room409, YSGarden, 2-1-8, Nakano-ku, Tokyo, 164-0012, Japan

E-mail : contact@biologging-solutions.com

TEL : 03-6885-3725

HP : http://www.biologging-solutions.com/en

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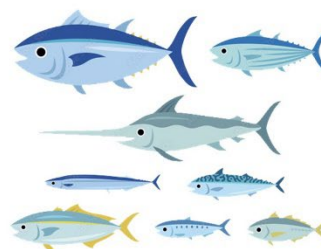
GLASS TAGS AND READERS

Glass tags in bulk, glass tags with injectors (sterile blisters), development of customized applications and readers.
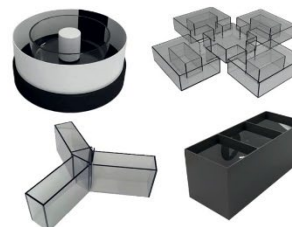
TAG TAM-S
Ø 1.25 x 7mm

TAG TAM-M
Ø 1.40 x 8mm

TAG TAM-L
Ø 2.12 x 12mm

WATER MAZES

A wide variety of water mazes for research with different species (octopus, zebrafish,...)

ICFT2023
6th INTERNATIONAL CONFERENCE ON
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Information for Delegates

Call for Papers

Advances in telemetry approaches and technologies applied to fish ecology and management

Submission deadline: 31 October 2023

Telemetry has been a key tool in fish ecology for several decades and helped uncover several mysteries in fish ecology such as migrations, behaviour, activity and space use, intra and interspecific interactions or human impacts. The technology has dramatically improved since its first application allowing to monitor fish at smaller size and for longer periods among other technological improvements allowing to measure internal and external properties of the tagged fish. In addition, the analytical tools and approaches to infer fish movement and behaviour derived from telemetry data has considerably advanced.

The 6th International Conference on Fish Telemetry will take place in Sète, France, from 11-16 June 2023. This conference aggregates an international community of fish scientists using telemetry in freshwater and marine environments. This conference is the opportunity to put together the latest advances in telemetry approaches and technologies applied to fish ecology and management. Whether your work was presented, inspired by, or just relevant to the conference, we encourage you to consider submitting your fish tracking research to this special issue.

The Journal of Fish Biology invites original and novel manuscripts that address the general theme of movement ecology, spatial ecology, and behaviour of freshwater and marine fish using telemetry and biologging. We will accept several formats including: Original Research Article, Brief Communication, Review Article, and Opinion Piece.

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Topics for this call for papers include, but not restricted to:

- Movement ecology in freshwater and marine fish
- Behavioural ecology of fish
- New technologies in telemetry and biologging
- New analytical approaches in movement ecology
- Ethical issues related to telemetry procedures and fish welfare

Editors:
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Dr. Kim Birnie-Gauvin, *Post-Doctoral fellow, Section for Freshwater Fisheries and Ecology, Technical University of Denmark, Silkeborg, Denmark*
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Keywords: Telemetry; biologging; fish; methodology; experimental design; fish behaviour; movement ecology

Link : https://onlinelibrary.wiley.com/page/journal/10958649/homepage/call-for-papers/si-2023-000563

Submission Guidelines/Instructions

Please note: This issue was born from the organisation of the International Conference on Fish Telemetry 2023 conference in Sète, France – June 11-16. However, both conference attendees and external authors are welcome to submit their work if they are corresponding to the topics listed above. Any general enquiries should be directed to Johann Mourier at **johann.mourier@umontpellier.fr**.

Please submit your manuscript to: **http://jfb.edmgr.com/** and in the Additional Information" step of the submission process please answer the question: "Is this submission for a Special Issue?" by selecting the Special Issue title from the drop-down list. Please refer to the **author guidelines** to prepare your manuscript.

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