

Intergovernmental Oceanographic Commission

Workshop Report No. 282



IOCC/OBIS-Event-Data workshop on animal tagging and tracking (ATT)

Ostend, Belgium

23–26 April 2018

UNESCO

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on animal tagging and tracking
(ATT)**

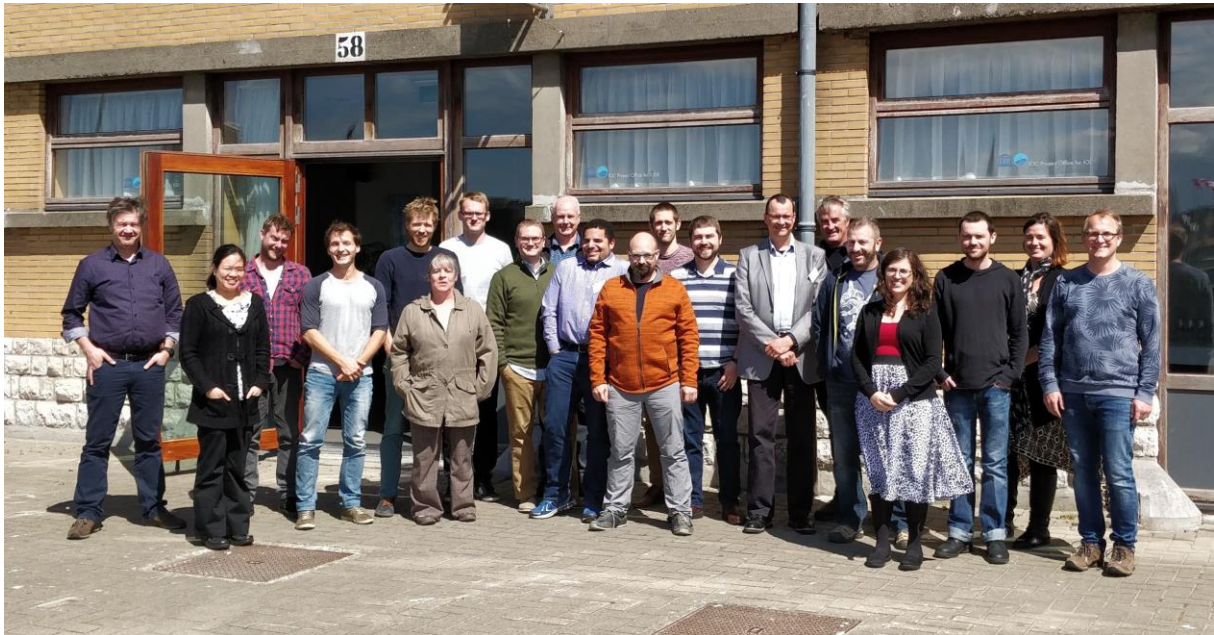
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From left to right: Francisco Hernandez, Connie Kot, Andre Steckenreuter, Xavier Hoenner, Jan Reubens, Lenore Bajona, Pieter Provoost, Kyle Wilcox, Peter Walsh, Brian Jones, Anton Van de Putte, Peter Desmet, Jon Pye, Holger Dettki, Paul Cowley, Robert Harcourt, Abby Benson, Daphnis De Pooter, Peggy Newman, Ward Appeltans (on a walk Samuel Bosch).

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Executive Summary

The International Oceanographic Data and Information Exchange (IODE) project office of the Intergovernmental Oceanographic Commission (IOC) held the IODE/OBIS-Event-Data workshop on animal tagging and tracking (ATT) from 23 to 26 April 2018 in Ostend, Belgium, to test the [OBIS-ENV-DATA](#) standard through the development of data products for scientific applications. This workshop was attended by 22 participants from 8 countries representing the major animal telemetry networks in Africa, Antarctica, Australia, Canada, Europe and the USA.

The participants agreed to use the OBIS-ENV-DATA [Darwin Core](#) standard to exchange and publish detection data through [OBIS](#) (both acoustic and satellite) and work with OBIS and the scientific community to develop data products for the Essential Ocean Variables (EOV) of the Global Ocean Observing System (GOOS), in particular the “Marine turtles, birds, mammals abundance and distribution EOV” and the “Fish abundance and distribution EOV”.

The guidelines for the implementation of the OBIS-ENV-DATA standard for tracking data (acoustic and satellite detections) were agreed upon and will be further refined and documented in collaboration with the data standardization working group of the International Bio-logging Society as well as the Biodiversity Information Standards ([TDWG](#)) community which oversees development of Darwin Core.

In collaboration with several scientists involved in animal tracking, the OBIS Secretariat is developing a data aggregation tool (which will be available as an R package) to calculate home ranges, migration pathways and movement patterns based on the tracking data in OBIS. It is expected that new public tracking data will be made available to OBIS before mid-2018 and the first products be available early 2019. It was felt important that OBIS provides access to the relevant (aggregated) data used to calculate the scientific products and provide links back to the original (raw) data sources to ensure proper data provenance and allow reproducibility.

This was the first workshop of the IODE pilot project entitled OBIS-Event-Data, which aims at seeking early adopters of the OBIS-ENV-DATA standard and develop data products and scientific applications in particular to support the work of the Biological and Ecosystem EOVs of GOOS and the Marine Biodiversity Observation Network of the Group on Earth Observations ([GEOBON MBON](#)).

1 OPENING OF THE MEETING

1.1 INTRODUCTION AND MEETING OBJECTIVES

Mr Francisco Hernandez, Head of the data centre of the Flanders Marine Institute ([VLIZ](#)), opened the meeting and welcomed the participants. He summarized the meeting objectives as follows: How can tracking data fit into a global biodiversity data system like OBIS? Currently, the tracking data in OBIS vary; some only provide release data, while others provide GPS data captured every minute. Furthermore, how can we capture scientifically relevant data into the Ocean Biogeographic Information System (OBIS), as well as into the Global Biodiversity Information Facility (GBIF)?

The animal tracking networks attending this workshop will have an opportunity to present on their work and show the scientific applications and data products they build. The workshop will discuss how tracking data can fit in the OBIS-ENV-DATA format and what is relevant to store in OBIS. We will then identify different data products which we will try to create together.

1.2 INTRODUCTION TO IODE/OBIS

Mr Ward Appeltans, project manager of the Ocean Biogeographic Information System (OBIS), provided an introduction to OBIS. Currently OBIS serves over 50 million records from 120,000 marine species integrated from over 2,500 datasets provided by over 600 institutions via the 30 OBIS nodes.

He mentioned the work currently undertaken to re-engineer the OBIS platform (OBIS2.0), which will be a powerful upgrade of the current system, allowing for near real-time data integration of species occurrences and environmental data, including advanced QC services, and well-performing data access and visualization tools. Currently OBIS holds 832,700 records of 282 tracking datasets provided through 5 OBIS nodes ([AntOBIS](#), [OBIS Australia](#), OBIS-SEAMAP, OBIS-Canada/OTN, SWP-OBIS).

The role for OBIS to support various international processes including delivering on the biological and ecosystem Essential Ocean Variables of the Global Ocean Observing System (GOOS) puts OBIS in a key position for brokering regional biodiversity observing networks, of which the animal telemetry community could be one. This meeting should provide an answer as to what OBIS can mean for the animal tracking networks and vice versa. One of the elements to work on is supporting the development of a community-wide data standard for the exchange of tracking data, preferably modeled around the OBIS-ENV-DATA standard. In addition, a system that monitors the status of the animal tracking system, globally, in (near) real-time would be a strong asset for GOOS and would show the maturity of the tracking technology. OBIS, through IODE's [OceanTeacher Global Academy](#) can also support the community with capacity building through training courses, both online, classroom as well as blended online and classroom training.

OBIS has set up an open collaborative work space for the meeting on GitHub: <https://github.com/iobis/tracking-data>

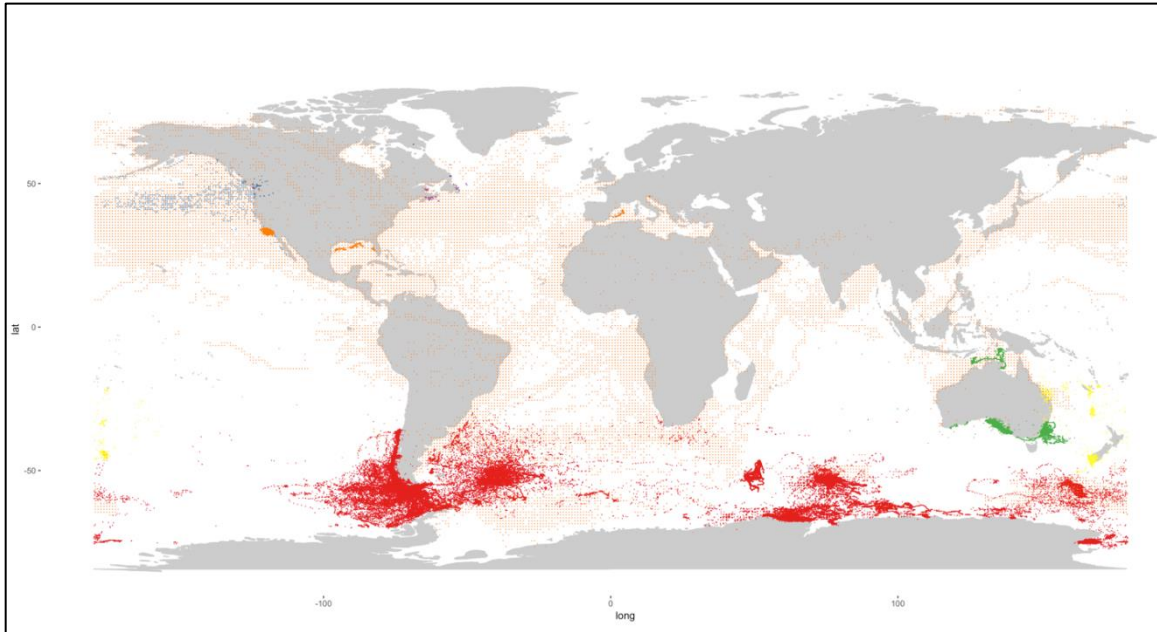


Figure 1. Global map showing the positions of the 282 tracking datasets currently in OBIS. Color coded by OBIS node (red = Antarctic OBIS, green = OBIS Australia, purple = OBIS Canada/OTN, orange = OBIS-SEAMAP, yellow = South Western Pacific OBIS, bleu = no OBIS node affiliation).

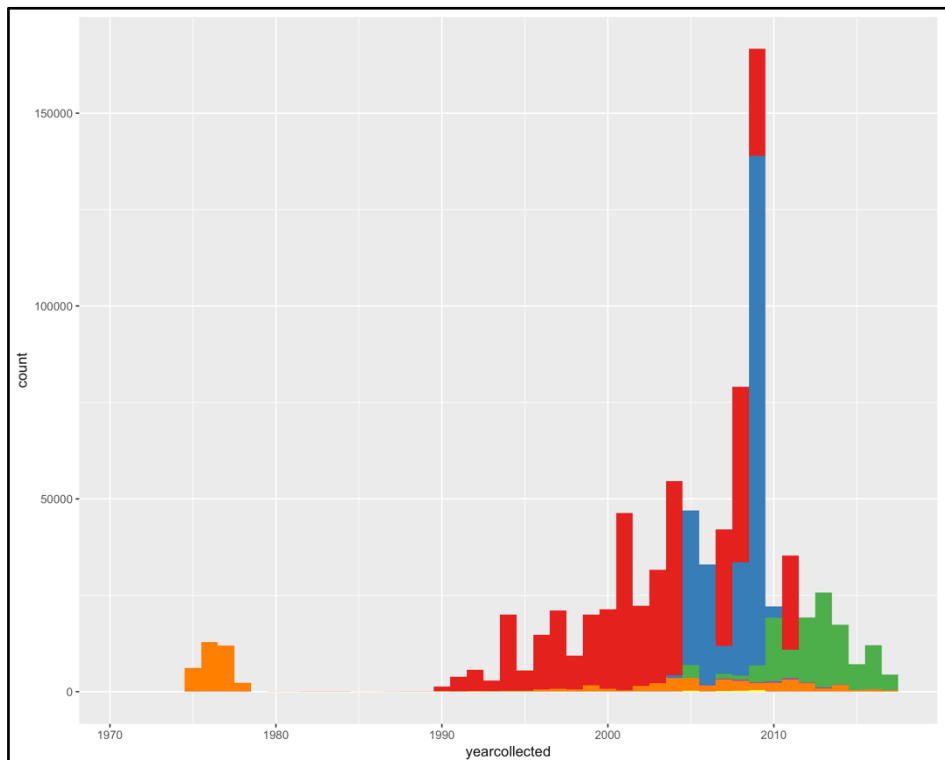


Figure 2. Bar plot showing the number of occurrences from the 282 tracking datasets per year and color code by OBIS node (See Figure 1).

1.3 INTRODUCTION TO EACH OF THE OBSERVING NETWORKS, INCLUDING DESCRIPTION OF DATA FLOWS

1.3.1 Ocean Tracking Network (OTN)

Mr Jonathan Pye, Assistant Director of Data Management of the Ocean Tracking Network ([OTN](#)), introduced us to OTN. OTN is a global aquatic animal tracking, data management, and partnership platform headquartered at Dalhousie University in Canada. OTN and its partners are using electronic tags to track many keystone, commercially important, and endangered species at an international scale, across all ocean regions. The OTN Data Centre (OTNDC) is responsible for the collection, aggregation, cross-referencing, and dissemination (both public and private) of acoustic and satellite animal detection data. OTNDC (<https://members.oceantrack.org>) also maintains data linkages to sibling telemetry data centres and external data partners around the world, and has designed publication pathways for providing curated datasets to global biogeographical information systems such as OBIS.

Mr Pye gave a status update on OTN's goals as a Major Science Initiative of the Canadian Foundation for Innovation, described the general concepts that allow OTN and OTN-affiliated databases to share data, as well as OTN's ongoing efforts to share expertise, equipment and data management practices with established and emergent communities of marine animal telemetry researchers.

In response to a question whether OTN will provide detection data, and not only the releases, Mr Pye replied that OTN will provide datasets with detection data to OBIS in the format agreed as one of the outcomes of this workshop. At the moment, there are >19,000 individuals representing >35 million detections waiting to be published to OBIS.

1.3.2 Integrated Marine Observing System (IMOS) Animal Tracking Facility

Dr Xavier Hoenner, Data Scientist of the Integrated Marine Observing System ([IMOS](#)) animal tracking facility, presented the Animal Tracking Facility, one of eleven facilities of the Integrated Marine Observing System (IMOS). It represents the higher biological monitoring of the marine environment for the IMOS program. Currently the [Animal Tracking Facility](#) uses acoustic technology and CTD satellite trackers to monitor coastal and oceanic movements of marine animals from the Australian mainland to the sub-Antarctic islands and as far south as the Antarctic continent. The Animal Tracking Facility is set up to collect data over a long period of time. This sustained approach will enable researchers to assess the effects of climate change, ocean acidification and other physical changes that affect animals within the marine environment. Currently, a large range of fish, sharks and mammals are collecting a wide range of data. This includes behavioural and physical data such as depth, temperature, salinity and movement effort of individual marine animals. All observations collected are subsequently made freely available through the Australian Ocean Data Network portal (AODN: <https://portal.aodn.org.au/>), the primary national repository for marine and climate science data. Dr Hoenner gave a brief overview of the IMOS programme, presented the work carried by the Animal Tracking Facility, and described how biologging data flows to the AODN portal and to biodiversity databases.

1.3.3 US-IOOS Animal Telemetry Network (ATN)

Mr Kyle Wilcox, Software Architect at Axiom Data Science, represented the U.S. Integrated Ocean Observing System ([US-IOOS](#)) Animal Telemetry Network ([ATN](#)). Detailed observations of animal movements and behaviour in relation to critical habitats in their marine environment have significantly improved our understanding of ecosystem function and dynamics. Through a combination of position technology, a wide spectrum of tag sensors, and variety of data

recovery options, marine animal telemetry provides a tremendous capacity to investigate how animals use their three-dimensional world to quantify important physical and biological aspects of their environments and begin to elucidate their ecosystem functions.

Although a substantial telemetry infrastructure exists in the U.S. these assets are currently operated independently by multiple agencies and institutions. Many existing programs have the capability to provide live updates on animal movements, behaviour, and oceanographic environment data but not all do. Some of the programmes are organized within regional networks but connections are limited between the regions. Thus, data display, quality control, and availability of data can vary across the current infrastructure.

The multi-agency U.S. National Animal Telemetry Network (ATN), hosted at the U.S. IOOS Program Office, provides a mechanism to facilitate and empower an alliance to coordinate marine animal telemetry infrastructures and operations within the U.S. Top priorities of the ATN are to facilitate and support baseline observations of marine species movement and behaviour, to maintain/enhance the existing U.S. animal telemetry infrastructure and to implement a centralized operational Data Assembly Center (DAC) that will receive data from multiple regional sources and enable/promote data availability and sharing among the global community.

This presentation outlines the vision, the programme components/activities and approach of the U.S. ATN and provides a high-level view of the data flow into and out of the ATN Data Assembly Center.

1.3.4 OBIS Spatial Ecological Analysis of Megavertebrate Populations (OBIS SEAMAP)

Mrs Connie Y. Kot, Researcher at Marine Geospatial Ecology Lab ([MGEL](#)), Nicholas School of the Environment, Duke University, represented [OBIS SEAMAP](#), the global thematic OBIS node for marine mammals, seabirds, sea turtles, sharks and rays. The science needed to understand that highly migratory marine mammal, sea bird, sea turtle, shark and ray species is not adequately addressed by individual data collections developed for a single region or single time period. These data must be brought together into a common, global map based on a coherent, interoperable, and openly accessible information system. Initiated in 2002 and still highly active, the OBIS SEAMAP information system continues to bring together georeferenced distribution, abundance, and telemetry data with tools to query and assess these species in a dynamic and searchable environment. Currently, the OBIS SEAMAP system remains an important world data-centre for marine mammal, sea bird, sea turtle, shark, and ray information, archiving and serving more than 5.7 million records from over 400 contributors, spanning centuries (1525–Present). Telemetry data within the OBIS SEAMAP database include satellite, passive acoustic, and geolocation tags and can be contributed to OBIS SEAMAP directly or through established data repositories. Expanded capability and applications beyond visual survey observations and telemetry data locations involve new technologies and data types, such as providing a platform for density models, passive acoustic monitoring data layers, animal photo-ID catalogs, easier integration of citizen science data, and providing marine science educational materials. All of these data and information are provided by a growing international network of individual and institutional data providers, made available for the public to discover and explore.

1.3.5 Acoustic Tracking Array Platform (ATAP)

Dr Paul Cowley, Principal Scientist at the South African Institute for Aquatic Biodiversity ([SAIAB](#)) and Manager of the Acoustic Tracking Array Platform ([ATAP](#)) presented on ATAP. ATAP is a marine science programme hosted by the South African Institute for Aquatic Biodiversity (SAIAB) that monitors the movements and migrations of inshore marine animals

along the Southern tip of the African continent. The ATAP is a partner of the Canadian-based global Ocean Tracking Network (OTN) that has provided financial support for capital equipment, together with the National Research Foundation ([NRF](#)) of South Africa. The ATAP network of moored acoustic receivers spans 2,200 km of continental coastline from Cape Point in the West to the South Africa-Mozambique border in the East. Since its inception in 2011, the ATAP has achieved outstanding progress in terms of the number of animals and the diversity of species tagged. To date, the ATAP has yielded multiple million detections from more than 750 acoustically tagged animals, representing over 25 different species, including fishery-at-risk species, IUCN ([International Union for Conservation of Nature](#)) data deficient species and iconic elasmobranchs, such as the white shark *Carcharodon carcharias*. Over the years, refinement of the receiver network was required and it currently focuses on tracking the movements of nearshore coastal (<50m depth) and estuary-associated species. The platform supports research conducted by approximately 30 researchers; however, it presents unprecedented opportunities for broader international collaborations to study aquatic animal movements in a biodiversity rich region and a climate change hotspot. The ATAP will undoubtedly yield new discoveries and provide a greater understanding of the movement patterns and migrations of a wide variety of inshore marine and estuary-associated species.

1.3.6 Wireless Remote Animal Monitoring (WRAM) e-Infrastructure

Dr Holger Dettki, Director of [Swedish LifeWatch](#) and Coordinator of the Wireless Remote Animal Monitoring (WRAM) e-Infrastructure, presented WRAM. New biotelemetry technologies have become available to ecologists, allowing remote real-time data capture from an increasing number of taxa, species and animals. To realize the potential of the data, researchers must be able to receive, handle, and share data in order to collaborate with the global research community. The Wireless Remote Animal Monitoring (WRAM) e-Infrastructure, started in 2003, contains more than 209 million records from real-time biotelemetry sensors and is used to date by more than 37 user groups from 8 countries, monitoring more than 24 species and 3,747 individual animals. The infrastructure represents the Swedish national data node and data sharing portal for real-time biotelemetry sensor data from animals. WRAM, as part of Swedish LifeWatch (SLW), publishes aggregated tracking data as 'occurrence data' to SLW and is cooperating with several other international bio-logging database initiatives. The infrastructure consists of 2 main parts: (i) The WRAM Data Warehouse (WDW) is a high-performance data warehouse for automatic reception and storage of real-time 'big data' as position, acceleration, or heartbeat data from fish and wildlife. The use of modern 'key-value-pair' database technics enable any type of current or future sensor data to be stored without any change to the underlying database or table structures. (ii) The WRAM Data Broker (WDB) is the single-sign-on web interface federating the WDW with other similar database systems around the world as Movebank, EuroDeer, or CAnMove to enable seamless real-time querying across systems and easy data sharing between data owners, while honoring local authentication and authorization settings. Query results are also accessible through Open Database Connectivity (ODBC) in a temporary database, enabling users to use local analysis tools for further analyses. Here, we give an overview over the different parts of the e-infrastructure, including automated data capture tools, database models, data sharing approaches, and web-based visualization tools.

1.3.7 GPS tracking network for large birds

Dr Peter Desmet, Research Institute for Nature and Forest ([INBO](#)), presented on the GPS tracking network for large birds. Since 1999, INBO studies migration and site/mate fidelity of large gulls using observer sightings of colour-ringed individuals. Using similar methods, the INBO started studying the ecology of the Western Marsh Harrier in 2011, an Appendix I species of the European Birds Directive which Belgian population is in decline. Although the database holds an extensive amount of resighting records, emerging habitat use, and migration patterns are strongly biased towards more populated areas and locations where the

rings can easily be read. In the framework of the Flemish contributions to the LifeWatch infrastructure, a high-tech sensor network was installed (<http://www.lifewatch.be/en/gps-tracking-network-large-birds>, starting May 2013) to better monitor the habitat use and migration patterns of the Herring Gull (*Larus argentatus* Pontoppidan, 1736), Lesser Black-backed Gull (*Larus fuscus* Linnaeus, 1758) and Western Marsh Harrier (*Circus aeruginosus* (Linnaeus, 1758)). The birds are tracked with the University of Amsterdam Bird Tracking System (UvA-BiTS, <http://www.uva-bits.nl>), described in Bouten et al. (2013, <https://doi.org/10.1007/s10336-012-0908-1>). The lightweight, solar powered GPS trackers periodically record the 3D position and air temperature, and can be configured to collect body movements with the built-in tri-axial accelerometer as well. The data are stored on the tracker, until these can be transmitted automatically and wirelessly to a base station. Data cannot be retrieved from birds that do not return to the colony/base stations, which are located along the southern North Sea Coast. At present (May 2013 - March 2018), over 10 million GPS fixes have been collected for 48 Herring Gulls, 134 Lesser Black-backed Gulls and 7 Western Marsh Harriers. The research is led by INBO researchers Eric Stienen (gulls) and Anny Anselin (Western Marsh Harrier) in collaboration with the Terrestrial Ecology Unit (TEREC) at the University of Ghent, and the University of Amsterdam (UvA). The Flanders Marine Institute (VLIZ) is responsible for the installation, maintenance and data flows of the sensor network, while the INBO periodically publishes the data as open data (Stienen et al. (2013), <https://doi.org/10.3897/zookeys.555.6173>), which are accessible through GBIF (<https://doi.org/10.15468/02omly> and <https://doi.org/10.15468/rbquhj>).

1.3.8 The European Tracking Network (ETN)

Dr Jan Reubens, Research Assistant at the Flanders Marine Institute (VLIZ), presented the European Tracking Network (ETN). ETN is a data and partnership platform for aquatic animal telemetry in Europe. ETN aims to develop an integrated, sustainable telemetry network to deliver high-quality and cross-bordering data that, in turn, may contribute to policy and management needs and foster technological innovations. The data management platform, hosted by the Flanders Marine Institute, is the central data portal of ETN and provides an interface to manage and explore the (meta) data. ETN will capture all types of aquatic animal telemetry data (currently acoustic telemetry is captured) as it aims at being all-inclusive.

Dr Reubens gave a brief overview on how ETN was established, how the database looks like and described the data flow and data policy.

1.3.9 The Atlas of Living Australia (ALA) and ZoaTrack

Mrs Peggy Newman, IT Advisor of the Atlas of Living Australia ([ALA](#)), introduced us to ALA and its ZoaTrack. The Atlas of Living Australia (ALA) is a national biodiversity database founded on the principles of data sharing and reuse. Supported by Australia's National Collaborative Research Infrastructure Strategy and the Commonwealth Scientific and Industrial Research Organisation ([CSIRO](#)), as the Australian node of the Global Biodiversity Information Facility (GBIF), the ALA aggregates species and environment data from many sources to answer two key questions: where a species occurs, and what species occur in a given area. Eleven portals based on the open source ALA infrastructure have been launched in countries and institutions outside of Australia creating the Living Atlases international community. More recently ALA has been looking beyond species occurrence data to enhance the biodiversity record, investing in exploration and development of other data sources: field data collection, citizen science, genomics and traits. ZoaTrack is ALA's bio-logging web platform and holds 4 million detections from 9,500 deployments across 450 marine and terrestrial projects.

ZoaTrack is a web-based platform for the management and analysis of animal movement data. Hosted by the Atlas of Living Australia (ALA), it sits within its own container outside of

the core infrastructure. With a relational data model based on animal identifiers, timestamps and locations, ZoaTrack handles mostly satellite or GPS based movement data provided via direct file uploads or automated feeds from Argos. Users can publish data with a DOI and although an open data policy is encouraged as per ALA the option is available to annually embargo projects. Exploratory analysis is encouraged in ZoaTrack's spatial interface using temporal charts and point and click access to R based home range estimation tools, animations, and environmental spatial layers.

Movement data from ZoaTrack is discoverable through the ALA when users search by species or location. ALA typically ingests data in Simple Darwin Core, a flat file format which accommodates simple occurrence data well. ZoaTrack records are summarized into this format by representing a track as an occurrence record with a summary footprint over a date range. An implementation like this as a metadata catalogue not only allows tracking data to be discoverable via Living Atlas infrastructure, but also opens possibilities for API development and machine interoperability between other external systems and users. In short, bio-logging systems and practitioners could be able to easily discover relevant studies by searching by location and/or species.

1.3.10 Movebank

Ms Sarah C. Davidson, Data Curator and Research Engineer at the Max Planck Institute for Ornithology and the Ohio State University, introduced us to Movebank (movebank.org), which is an online resource for working with animal tracking and bio-logged data open to any species, region or method. Movebank provides tools for researchers, institutions and the public to collect, manage, analyze, archive and reuse data. As of April 2018, Movebank has over 18,000 registered users, and the database contains over 700 million locations and 1.2 billion other sensor measurements stored in 4,600 user-created studies, owned by thousands of contributors and representing 778 taxa. Users retain ownership of their data and control access to the public and other users through study- and animal-specific sharing settings. Data collected by deployed satellite, GSM and Iridium data can be automatically transferred to Movebank through data feeds for over 10 manufacturers, and users can add existing data through a flexible import interface. The API and Animal Tracker Application offer ways to share up-to-date animal movements. Once data are in Movebank, owners can manage deployment information and flag outliers manually and with Argos-specific and general-purpose filters. Imported data can be downloaded in a variety of common formats or pulled directly by R and other user-created applications for further analysis. The Environmental Data Automated Track Annotation System (Env-DATA) System allows users to browse and select from hundreds of environmental parameters from global remote sensing products and weather re-analyses to have annotated to animal movement data or related time-location records. Completed datasets can be reviewed and published in the Movebank Data Repository, providing public domain licenses, DOIs and formal citations to enable persistent access and reuse. The Repository currently contains 98 datasets describing movements and other bio-logged sensor measurements of over 4,000 animals that underlie 125 peer-reviewed papers published in 54 journals by 372 authors. To enhance discoverability and collaboration across other bio-logging and biodiversity databases, Movebank is working with representatives from many of these groups and with the International Bio-Logging Society's new Data Standardization Working Group to pursue opportunities for standardization. We are particularly interested in shared tools and best practices for maintaining machine-readable vocabularies, creating Darwin Core instances for discoverability in biodiversity data aggregators, and exploring ideas for a standard API or export format that could be shared across systems with differing database structures and data terms. Movebank is hosted by the Max Planck Institute for Ornithology and has past and current funding from the German Aerospace Center ([DLR](http://www.dlr.de)), German Science Foundation ([DFG](http://www.dfg.de)), Max Planck Society ([MPG](http://www.mpg.de)), US National Science Foundation ([NSF](http://www.nsf.gov)), National Aeronautics and Space Administration ([NASA](http://www.nasa.gov)) and the [University of Konstanz](http://www.uni-konstanz.de).

2 IDENTIFICATION AND SELECTION OF ATT DATA PRODUCTS AND APPLICATIONS

During this session participants were asked to present existing use cases, (scientific) applications and studies (papers) describing the process from collection, to data storage, pre- and post-data processing, including expertise and data needs and which parameters were derived from the raw data.

2.1 UGHENT CASE STUDIES

Dr Jan Reubens, Research Assistant at the Flanders Marine Institute (VLIZ), with input from Inge van der Knaap and Pieterjan Verhelst, presented on two studies using acoustic telemetry to track movement behaviour of European eel (*Anguilla anguilla*) and Atlantic cod (*Gadus morhua*), respectively. Although both studies use acoustic telemetry (Vemco Ltd); the setup, objectives and data collected are very different. The use case on eel was performed in an estuary, gathering presence-absence data. Detections were linked to environmental data (tidal information) to infer selective tidal stream transport. The other study was performed in an offshore wind farm, gathering presence-absence data, triangulated positions and sensor data (i.e. depth and acceleration) to investigate the effect of seismic surveys on the movement behaviour of cod.

The use cases highlight that, depending on the research objectives, very different approaches are used. This results in different types of data collection and the need for different protocols for data processing/analysis.

With Absence/Presence records of eels the following questions can be addressed:

- When do they leave the area?
- Which routes do they take?
- Migration barriers present?
- What is the average migration speed in the system?
- Which environmental factors influence movement?
- Percentage reaching the sea?

For cod tracking records the following questions were addressed:

- Fish move out of the detection array (presence/absence),
- Behavioural change (acceleration, residencies),
- Physiological change.

Take home message:

This study only dealt with acoustic studies which already created different data types (presence/absence, positions, sensor data, trajectories) depending on the objectives and setup. In addition, there is data storage, PIT, satellite. Is there one OBIS answer to all?

2.2 MIGRATORY CONNECTIVITY IN THE OCEAN (MICO)

Dr Connie Y. Kot (Marine Geospatial Ecology Lab, Nicholas School of the Environment, Duke University) presented on the project Migratory Connectivity in the Ocean ([MICO](#)). Highly migratory and long-lived marine species experience a variety of anthropogenic threats over their annual cycles. Combined with management strategies that do not adequately address the importance of maintaining connectivity among different habitats and regions over their full

annual cycle, these threats can continue to contribute to global population declines. Therefore, data on connectivity is vital for marine spatial planning initiatives, especially within areas beyond national jurisdiction (ABNJ) where information is lacking and not easily available for conservation planning purposes. To address this need, the Migratory Connectivity in the Ocean initiative seeks to synthesize information and data about important sites/nodes, the routes/corridors among sites/nodes, and the network connections for marine mammal, seabird, sea turtle, and fish species utilizing ABNJ. The MiCO initiative involves a systematic literature review of relevant information derived from telemetry, mark/recapture, passive acoustic, stable isotope, and genetic studies on over 200 species. In addition, telemetry data for seven seabird and seven sea turtle species that have been directly contributed by collaborating partners will be further used to examine methods for aggregating to higher-level features, including nodes (aggregations of sites), corridors (aggregations of routes), and connections (aggregation of connected features). Developed geospatial products will be made accessible within the MiCO system, an online geospatial database and application that will facilitate the analyses of migratory corridors and connections, identification of current knowledge gaps, and transfer of information among researchers and organizations involved in ongoing processes to develop sound international marine policy, such as the Convention on Biological Diversity ([CBD](#)), United Nations Educational, Scientific and Cultural Organization ([UNESCO](#)), regional fisheries management organizations, and the International Seabed Authority ([ISA](#)).

2.3 MOVEMENT ECOLOGY ON TEMPERATE REEF FISHES: AN ATT DATA COLLABORATION

Dr Andre Steckenreuter, with input from David Abecasis, Jorge Fontes, Karim Erzini, Pedro Afonso, presented on an animal tagging and tracking (ATT) data collaboration effort studying the movement ecology of temperate reef fishes in the Azores. Despite the growing number of biotelemetric studies on the spatial ecology of marine fishes, there has not been any formal attempt to test some of the fundamental hypothesis regarding their behavioral ecology. For example, many assumptions regarding reef fishes' space use being dependent on a species' trophic level, ecological niche or reproductive mode/season remain untested beyond the results of a particular species and study.

In this study we use a multi-specific, multi-study approach to test several hypotheses regarding the influence of life history and social status on the movement ecology of temperate reef fishes, namely that space use is affected by their (i) ecological niche (habitat), (ii) trophic level, (iii) individual size and (iv) reproductive status. We use published and unpublished acoustic telemetry data from mainland Portugal and the Azores covering contrasting environments (continental shelf coast, oceanic island coast, deep sea) and life histories (nine species) to estimate home range areas (core and activity), maximum ranges and residency indexes to test these hypotheses. Our results demonstrate that pelagic species have larger home range areas than benthic-pelagic and benthic species but that site attachment between these species types is more similar than previously thought. Regarding the reproductive status significant differences were found in the residency, maximum distance and home range size for some of the species. These results offer some conclusions that contribute to the discussion and understanding of the behavioural ecology of reef fishes in temperate regions. Furthermore, they can be used as surrogates in support of management based in data-poor systems whenever fishes' spatial ecology is to be used as criteria to design spatial measures such as MPAs. The data collaboration of animal tagging and tracking (ATT) data serves as an example of how the emerging European Tracking Network ([ETN](#)) could foster these collaborations even further in the future.

2.4 IMOS ANIMAL TRACKING FACILITY

Prof. Rob Harcourt, Facility Leader, IMOS Animal Tracking Facility (ATF), introduced us to the IMOS Animal Tracking Facility. ATF consists of two streams: Acoustic Telemetry and Satellite

Tagging. Acoustic telemetry is a principle tool for observing aquatic animals, but coverage over large spatial scales remains a challenge. Australia has implemented the Integrated Marine Observing System's Animal Tracking Facility - Acoustic which comprises a continental-scale hydrophone array and coordinated data repository. This national acoustic network connects localized projects, enabling simultaneous monitoring of multiple species over scales ranging from 100 s of metres to 1000 s of kilometres. There have been 7,574 receiver deployments and 7,582 animals tagged across 137 species over the 11 years of the network. Data is classified as Open, Embargoed or Protected but over the 10 years of the network there has been a decline in the use of Embargoes and only a single species has been classified as Protected, the White Shark. We evaluate the utility of this national network for monitoring animal movement ecology, and to identify the spatial scales that the network effectively operates over. In a new Scientific Reports paper lead by Dr Steph Brodie, we undertook network analyses to assess the utility and redundancy of each component of the national network, revealing multiple spatial scales of connectivity influenced by the geographic positioning of acoustic receivers. We then used cluster analyses to assess movements and residency of 2,181 individuals from 92 species and identified four functional movement classes apparent only through aggregating data across the entire national network (Irruptor, Resident, Occasional and Roamers). These functional movement classes described movement metrics of individuals rather than species and highlighted the plasticity of movement patterns across and within populations and species. He also present the [Acoustic Tracking Toolbox](#) being developed by Dr Vinay Udyawer which provides standardised metrics that can; (i) be directly compared between multiple species monitored at multiple sites, (ii) be compared between multiple species tagged at a single study site, and (iii) assess changes in activity space metrics over time. The IMOS ATF Satellite Tagging stream has been deploying Conductivity-Temperature Depth Satellite Relay Data Loggers ([CTD SRDLs](#)) on seals since 2008 and all the data is available on the [AODN](#) web portal. IMOS is a major partner in the Marine Mammals Exploring Pole to Pole ([MEOP](#)) collaboration providing over 107,000 CTD casts in the Southern Ocean. IMOS seal data has also been provided to the Marine Megafauna Movement Analytical Program (MMMAP) and is a major contributor to the recent PNAS (Proceedings of the National Academy of Sciences) paper led by Dr Ana Sequeira. IMOS seal data is also in the forthcoming Reanalysis of Antarctic Animal Tracking Data (RAATD).

2.5 THE RETROSPECTIVE ANALYSIS OF ANTARCTIC TRACKING DATA (RAATD)

Dr Anton Van de Putte presented on "The Retrospective analysis of Antarctic Tracking Data (RAATD)" (a presentation from Mark Hindell). RAATD is a multi-species assessment of Antarctic top predators to identify Areas of Ecological Significance (AES) - regions that are important range of predators and which have high diversity and abundance of lower trophic levels. It is an international effort with 79 data contributors from 46 institutions that is coordinated by the Scientific Committee on Antarctic Research ([SCAR](#)) Expert group on Birds and Marine Mammals.

The project will provide: (i) a greater understanding of fundamental ecosystem processes in the Southern Ocean, (ii) facilitate future projections of predator distributions under varying climate regimes, and (iii) provide input into spatial management planning decisions for management authorities such as the Commission for the Conservation of Antarctic Marine Living Resources ([CCAMLR](#)). The data includes 4,060 tracks from 2,965,926 location fixes (before filtering).

The approach is to (i) develop a Habitat Utilisation Models (HUM) for each species, (ii) use that HUM to make global predictions of habitat use based on colony locations (where appropriate), and (iii) combine these to indicate Areas of Ecological Significance.

To make the HUMs, all tracks are filtered, then “pseudo-tracks” are generated to assess regions that are potentially available – but not used by that animal, and the environmental conditions in the areas that were used are compared to those potentially available using a statistical model.

3 PRESENTATION AND DISCUSSION ON DATA STANDARDS AND FORMATS, BASED ON OBIS-ENV-DATA EXAMPLES

During this session, participants were asked to share experience and examples of encoding tracking datasets into the OBIS-ENV-DATA standard.

3.1 OBIS-ENV-DATA EXAMPLES FROM ETN

Mr Daphnis De Pooter (VLIZ/EurOBIS) said that while there is a need for grouping the automated detections when downloading occurrence/sample data from the OBIS Portal, OBIS still needs the automated detections to develop data products. The question is: Does this grouping need to be carried out by the provider (e.g. ETN) or can this be done by the aggregator (OBIS)? In the IODE/OBIS-ENV-DATA pilot project (2015-2017), we assumed expert judgement is needed and the grouping, therefore, needs to be done by the provider. So, OBIS-ENV-DATA worked out a format to allow exchange of both the detailed detections and of grouped occurrences. Mr De Pooter presented this format using a bird tracking demo dataset (<http://ipt.iobis.org/obis-env/resource?r=gulltracking>, which was a pilot dataset of the OBIS-ENV-data project) and a fish tag demo dataset (<https://tinyurl.com/OBIStelemetry>). Mr De Pooter also presented a proposal for exchanging the ETN CPOD data (passive acoustics).

3.2 OBIS-ENV-DATA EXAMPLE FROM ATN

Mrs Abigail Benson ([OBIS-USA/USGS](#)) walked us through her R code to convert a tracking dataset from the US-IOOS Animal Telemetry Network (ATN) into the OBIS-ENV-DATA scheme. The dataset represents a use case wherein an elephant seal is collecting animal borne sensor data.

3.3 OBIS-ENV-DATA EXAMPLE WITH STATION DATA FROM OTN

Mr Jon Pye (Ocean Tracking Network) presented a provisional acoustic telemetry OBIS-ENV-DATA fileset with a few thoughts about approaches for other various tagging cases, some minor proposed updates to the URN guidance on unique fields in DwC to help ensure uniqueness for tracking datasets, and posed a few philosophical questions for the future: https://drive.google.com/file/d/1KMupd0zq58DYw9b87MdmqZQHzc5_UGJS/view?usp=sharing

3.4 UPDATES FROM THE IBLS DATA STANDARDIZATION WORKING GROUP

Mrs Peggy Newman and Dr Holger Dettki described the development of the IBLS Data Standardization Working Group, and some of the activities and considerations of the organizing committee. Bio-logging experts and manufacturers from around the world joined the 6th International Bio-Logging Science Symposium entitled “A future for a common bio-logging language? Discussions about data standards and interoperability in the bio-logging world” held in September 2017. In preparation for this workshop, a 10-person organizing committee identified and invited ~130 domain experts and surveyed bio-logging manufacturers and biodiversity data experts to assess current workflows, knowledge, and preferences. Over 50 people attended the workshop, representing bio-logging equipment

manufacturers, bio-logging database and biodiversity data initiatives, bio-logging scientists, analysis tool developers, conservation groups, and students. Attendees came from all over the world and represented diverse taxonomic and methodological expertise. The outcome of this workshop has been the formation of a Working Group on data standardisation, supported by the [International Bio-logging Society](#).

4 SELECTION OF DATA PRODUCTS OR APPLICATION(S) TO WORK ON TOGETHER

Before we started the discussion on which output we would like to see from this collaboration, the group discussed a data flow model ([Figure 3](#)) and agreed to:

- Encode the detections into the OBIS-ENV-DATA following the guidelines defined during the workshop (see below),
- Publish the detections via an IPT (Integrated Publishing Toolkit),
- Allow OBIS to harvest and aggregate the data,
- Allow OBIS to visualize and distribute the aggregated data through its web portal, API and R package and point to the original data at the data providers IPT or portal.

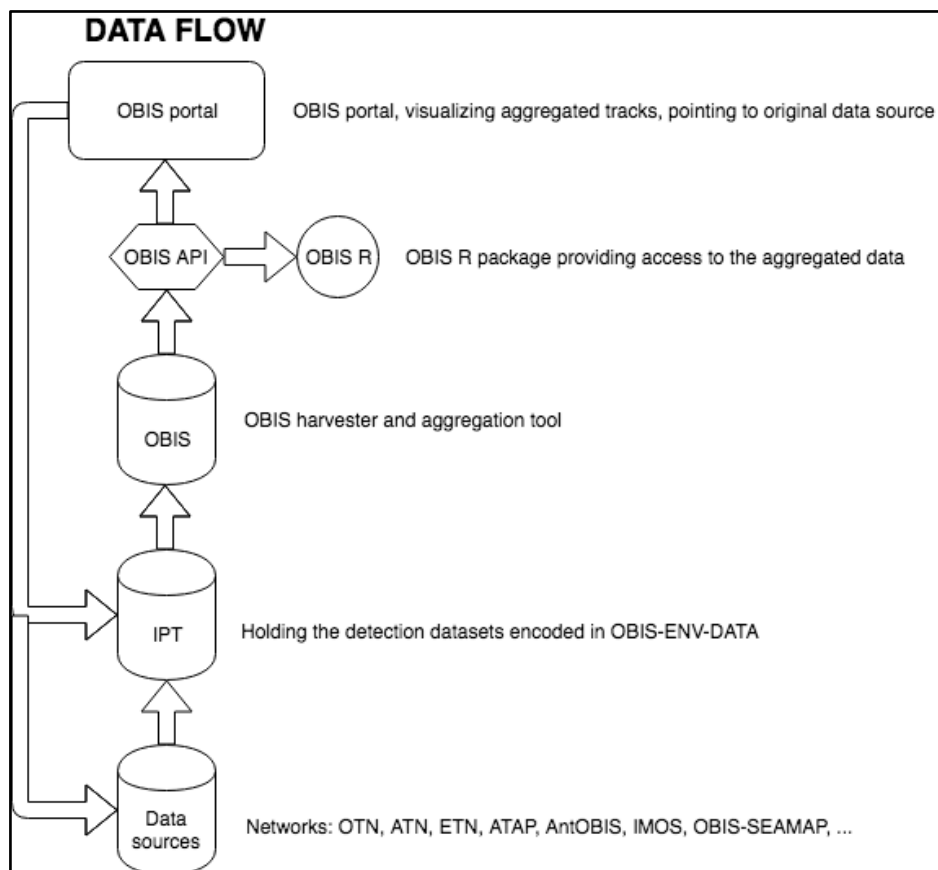


Figure 3. Schematic overview of the data flow agreed by the tracking networks present at the workshop.

Currently, OBIS's main output is "which marine species lives where, when and how many". However, with tracking data there is an opportunity to also provide information on species

behaviour (species traits). This can include calculations such as average/max migration speed, distance travelled, length/weight measurements, which would be a valuable resource for quality control, and will complement information published in the literature and the World Register of Marine Species ([WoRMS](#)).

The group supported the idea that the tracking community could work through OBIS to support the Global Ocean Observing System (GOOS) by providing access to global data, but also organize/facilitate product development with the scientific community. The group looked at the derived products listed in the specification sheets of the Essential Ocean Variables (EOVs) of GOOS, in particular those of the "[Marine turtles, birds, mammals abundance and distribution](#)" and "Fish abundance and distribution" (see <http://www.goosocean.org/eov>). Those are:

- Density
- Hotspots
- Home range*
- Utilization distribution (relative occupation of home range)*
- Movement patterns*
- Migration pathways
- Habitat maps
- Population status (increasing, decreasing stable).

5 DEVELOPMENT OF ATT DATA PRODUCTS AND APPLICATIONS BUILDING ON OBIS-ENV-DATA

The meeting decided to split into two break-out groups. Group 1 was tasked to look into the most efficient way to exchange data using the OBIS-ENV-DATA and the Ecological Metadata Language (EML) standard, while Group 2 looked into how "raw" detection data could be aggregated to calculate meaningful biodiversity parameters (usable by the larger biodiversity community).

Results from Group 1

The group began by agreeing to a few general principles, to structure the schema in such a way that Occurrence entries could stand alone as a plain record of where animals were observed, and to avoid data duplication within DwC terms, especially regarding location and date fields. The full-length date columns would be preferred as an expression of date, time, and date time ranges, and so all other partial or derived expressions of date and time could safely be omitted.

Group 1 then discussed the OBIS-ENV-DATA scheme for satellite GPS tracking ([case 1](#)) and acoustic telemetry ([case 2](#)) data and developed guidelines on the Darwin Core and EML implementation which are documented on the TDWG GitHub wiki: <https://github.com/tdwg/dwc-for-biologging/wiki>.

Case 1–GPS tracking

GPS-based tracking is characterized by tagging the animal with a device that can periodically record its geographical location using the Global Positioning System (GPS). The recorded data can either be transmitted via satellite or short-range transmission or stored on-board the device until it is later retrieved and downloaded. Systems vary in characteristics of the attached trackers (sometimes referred to as “tags”), including what type of additional measurements these can take (temperature, altitude, body movements by accelerometer), and sampling interval settings. A track session starts when the animal is captured and tagged (and often biometrics are taken) and lasts until the animal is found/assumed dead or the tracker is detached/removed/replaced or ceases to function. A track session represents a relation between the individual ID and the tracker ID and allows - together with the tracking start and end date - to assign recorded occurrences (sometimes referred to as “GPS fixes”) to an individual.

In keeping with our group’s agreed-upon philosophy that the occurrences should stand as an independent dataset to the greatest degree possible, we characterize each GPS fix (referred to as detection in [Figure 4](#)) as Machine Observation Occurrence of that individual, with the individual being identified using a globally-unique organism ID. As these occurrences differ substantially in date time and coordinates, we saw little value in creating separate event records for these occurrences. A track can be identified in the occurrence data by filtering on organism ID and ordering the data chronologically on event Date. Measurements taken when a GPS fix is made (e.g. temperature) can be expressed in the ExtendedMeasurementOrFact extension, with a link to the relevant occurrence.

The other type of Occurrence we identified is the capture/tagging (and optionally also release) event. This is recorded as a Human Observation, and all additional details about the individual, weights, lengths, gender and life stage information, can be attached to this occurrence via the ExtendedMeasurementOrFact extension. If the release of the animal took place at a separate time and/or location, an additional Human Observation should be created.

Machine Observation Occurrences can optionally be grouped in Events (using a common event ID) identifying track sessions (referred to as animal deployment in [Figure 4](#)). This is especially useful if characteristics about the tracker (“tag”) and its sensors are known (e.g. tracker ID, attachment type, default sampling interval settings) which can then be shared in the ExtendedMeasurementOrFact extension. If such an Event core is used, the capture/tagging HumanObservation should have its own Event, and the optionally separate release HumanObservation should be in the track session Event.

For more details on how to complete the various required and recommended fields for GPS tracking Occurrences and Events, see the [guidelines and demonstration dataset](#) for an ongoing gull tracking project near the southern North Sea coast, in Belgium and the Netherlands (Stienen et al. <https://doi.org/10.3897/zookeys.555.6173> and <https://doi.org/10.15468/02omly>).

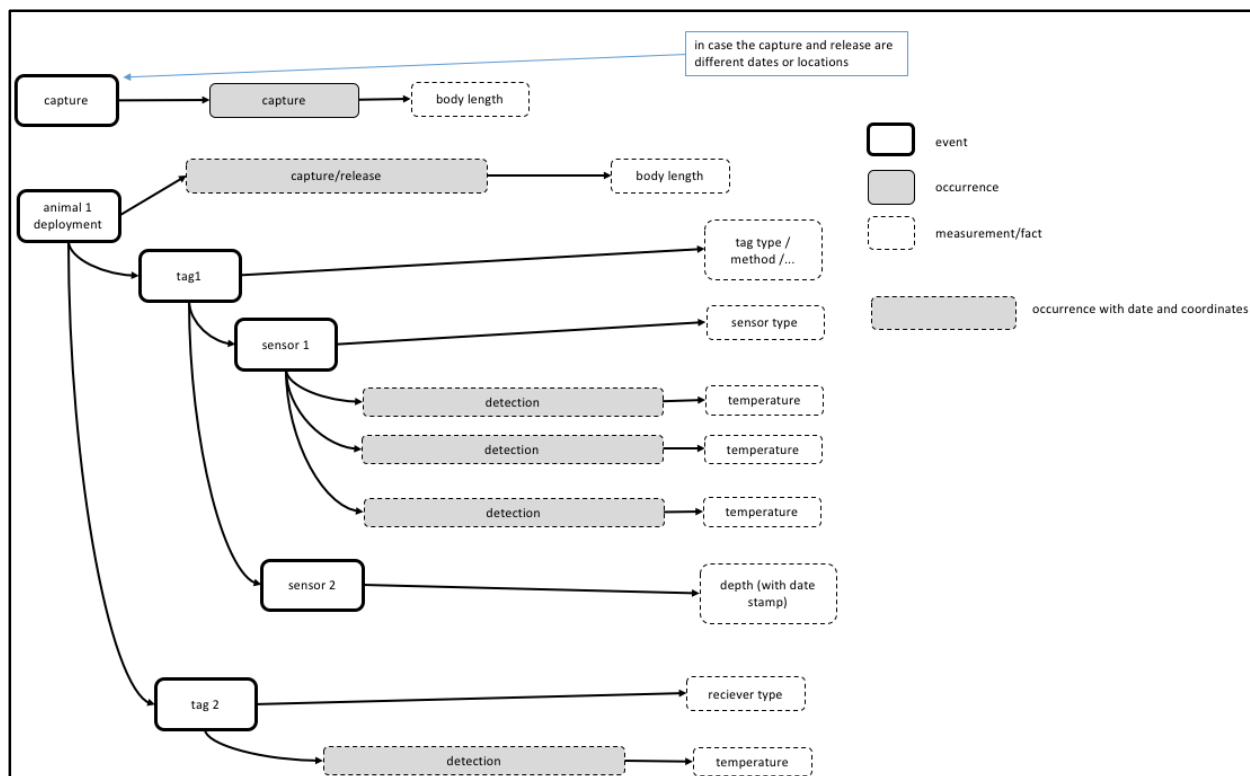


Figure 4. Proposed OBIS-ENV-DATA scheme for GPS tracking data.

Case 2 – Acoustic Telemetry

Acoustic tracking is characterized by the pairing of one or many listening devices (stationary or mobile) with acoustic pingers attached to individuals of the tracked species. These pingers emit complex codes that can (with some external information) be used to associate a detection event recorded by a listening station back to an individual animal. The attachment methods, characteristics of the attached tags, and configuration of the listening stations may vary, but observation events in acoustic tracking, generally known as detections, result from the combination of a pinger and a listening device in close enough proximity to capture and record the distinct pinger code, and then the subsequent identification of that code to the prior capture, tagging and release of the individual animal.

As a starting point, we reviewed the method prescribed for telemetry data in [De Pooter et al. \(2017\)](#), specifically Case 6, and resolved to make a few adjustments to fit the data sources and parameters of acoustic telemetry studies. In keeping with our group’s agreed-upon philosophy that the occurrences should stand as an independent dataset to the greatest degree possible, we characterized the detection events as Machine Observation Occurrences of that individual. The individual is identified using a globally-unique organism ID, and without any other knowledge about animal location, the location of the listening station is used to locate the occurrence geographically.

The other type of Occurrence generated by acoustic telemetry studies is common to all tagging studies, the capture event. This is recorded as a HumanObservation, and all additional details about the individual, weights, lengths, gender and life stage information, can be attached to this occurrence via the ExtendedMeasurementOrFact (EMOF) extension. An organismID for the individual will also be assigned at capture time and attached by the data aggregator (OTN, ATAP, IMOS-ATF, ETN, ATN) to subsequent confirmed detections. An Event may be associated with the capture Occurrence to help encapsulate multiple captures, as well as any other activities that might have been undertaken concurrently to the capture of the individual.

There are a few different categories of Event entries for acoustic telemetry studies. For the release of instrumented individual animals (referred to as the 'platform' in [Figure 5](#)), we record a deployment Event. This deployment Event can have a number of child Events corresponding to each instrument attached to the animal. These Events can subsequently be associated with EMOF entries corresponding to information about the programming, provenance, and unique characteristics of each tag. Tracking an acoustic pinger's ID code, its pinging rate and signal strength, what sensor information it collects, all of this information can be captured as EMOFs for the individual instrument. This design also caters well to dual-tagging studies or multi-tagging studies.

The deployment of a listening station is also to be characterized as an Event, with an eventDate representing the range of time that the platform was deployed and able to detect tags. The eventID schema proposed is a URN that matches closely with the current advice on populating eventID, with a 'database' provision added to keep the various telemetry data aggregators from assigning the same eventID. Similar to tag deployments, the EMOF extension can be used to capture individual information about the listening instrument itself, as well as any time-series information that might be captured by the instrument.

For detection events of tags with environmental sensors which record data only during detection events (e.g. Vemco TP tags), an EMOF with measurement values and units could be associated with both the animal Occurrence and receiver deployment Event that generated it. For longer time-series datasets that are stored on the tag/instrument, an approach similar to Case 1 can be used to capture the time series and associate it with the tagging Event.

For more details on how to complete the various required and recommended fields for acoustic telemetry Occurrences and Events, see the [guidelines and demonstration dataset](#) for an ongoing blue shark tagging project based near Nova Scotia, Canada (*Whoriskey, F., Davis, B. 2013. Ocean Tracking Network : Nova Scotia Blue Shark Tracking*).

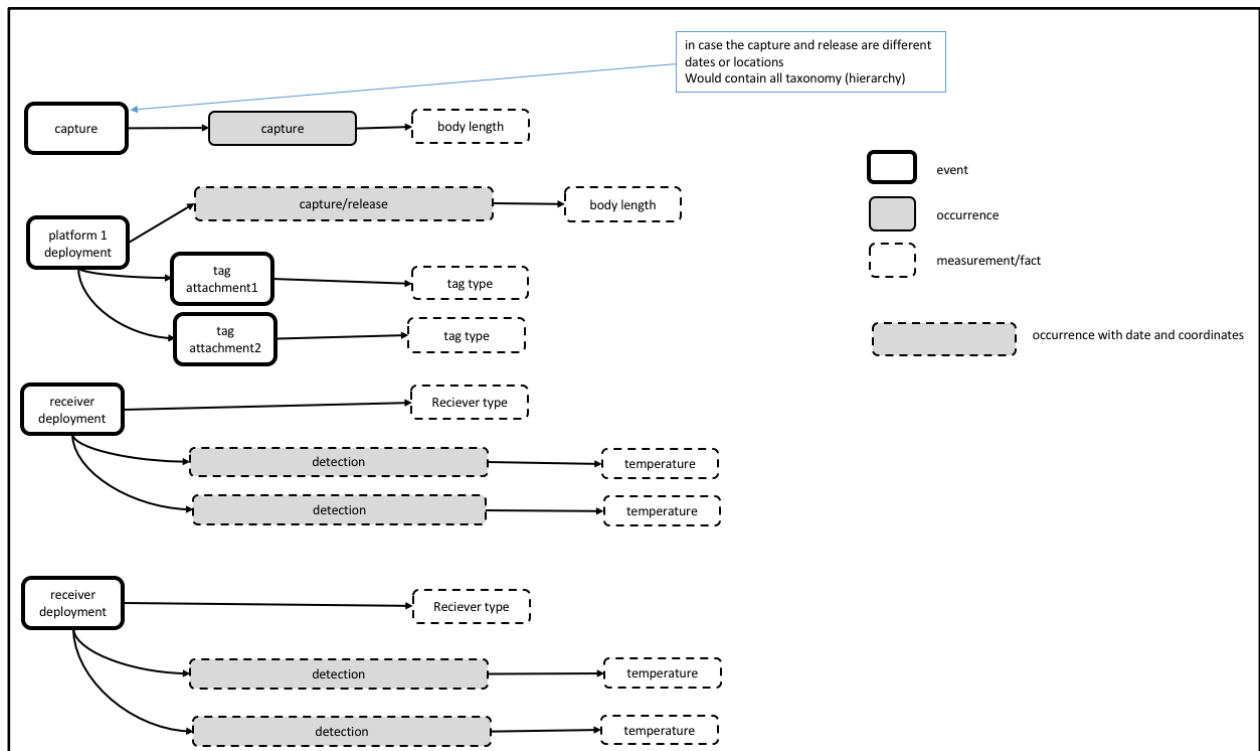


Figure 5. Proposed OBIS-ENV-DATA scheme for acoustic receiver data.

The group agreed to work on three test cases and encode the following datasets into one of the above OBIS-ENV-DATA schemes:

- [GPS tracking of large birds](#) (ETN dataset)
- [Acoustic and Sensor enabled tagging of blue sharks](#) (OTN dataset)
- [GPS/Argos tracking of saltwater crocodiles](#) (ZoaTrack dataset)

The scripts used to transform these datasets will be shared on <https://github.com/iobis/tracking-data/tree/master/scripts>.

Results from Group 2

This group proposed that the raw data be aggregated (binned) based on a space-time gridding with a spatial resolution of 1km² and a temporal resolution of 1 week. This means a new occurrence record should be created when an observed organism moves from one spatiotemporal cell to another. The arrival and departure date from this spatiotemporal cell will be saved as part of the aggregation. With respect to abiotic parameters, such as temperature, recorded together with the observations, the start and end values will be saved. This aggregation will be implemented in a new R package called ziptrack (<https://github.com/iobis/ziptrack>).

Based on this aggregated data, we'll investigate if and how we can calculate minimum convex polygons, brownian bridge home ranges and migration paths, dispersal distances and bearings using the Acoustic Tracking Toolbox developed by Vinay Udyawer at AIMS with support from IMOS, and which will be incorporated within the [V-Track R package](#), see also <https://github.com/vinayudyawer/Acoustic-Tracking-Toolbox>.

ANNEX I

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ANNEX II

LIST OF ACRONYMS

ABNJ	Areas beyond national jurisdiction
AES	Areas of Ecological Significance
ALA	Atlas of Living Australia
AODN	Australian Ocean Data Network
ATAP	Acoustic Tracking Array Platform
ATN	Animal Telemetry Network
ATT	Animal Tagging and Tracking
CBD	Convention on Biological Diversity
CCAMLR	Commission for the Conservation of Antarctic Marine Living Resources
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CTD SRDLs	Conductivity-Temperature Depth Satellite Relay Data Loggers
DAC	Data Assembly Center
DFG	German Science Foundation
DLR	German Aerospace Center
EML	Ecological Metadata Language
Env-DATA	Environmental Data Automated Track Annotation System
ETN	European Tracking Network
GBIF	Global Biodiversity Information Facility
GPS	Global Positioning System
HUM	Habitat Utilisation Models
IMOS	Integrated Marine Observing System
INBO	Research Institute for Nature and Forest
IOC	Intergovernmental Oceanographic Commission of UNESCO
IODE	International Oceanographic Data and Information Exchange
IPT	Integrated Publishing Toolkit

ISA	International Seabed Authority
IUCN	International Union for Conservation of Nature
MEOP	Marine Mammals Exploring Pole to Pole
MGEL	Marine Geospatial Ecology Lab
MiCO	Migratory Connectivity in the Ocean
MMMAP	Marine Megafauna Movement Analytical Program
MPG	Max Planck Society
NASA	National Aeronautics and Space Administration
NRF	National Research Foundation
NSF	US National Science Foundation
OBIS	Ocean Biogeographic Information System
OBIS SEAMAP	OBIS Spatial Ecological Analysis of Megavertebrate Populations
OTN	Ocean Tracking Network
OTNDC	Ocean Tracking Network Data Centre
RAATD	Reanalysis of Antarctic Animal Tracking Data
SAIAB	South African Institute for Aquatic Biodiversity
SCAR	Scientific Committee on Antarctic Research
SLW	Swedish LifeWatch
US-IOOS	US Integrated Ocean Observing System
UvA-BiT	University of Amsterdam Bird Tracking System
VLIZ	Flanders Marine Institute
WDB	WRAM Data Broker
WDW	WRAM Data Warehouse
WRAM	Wireless Remote Animal Monitoring

IOC Workshop Reports

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1, rue Miollis, 75732 Paris Cedex 15, France

No.	Title	Languages	No.	Title	Languages	No.	Title	Languages
1	CCOP-IOC, 1974, Metallogenesis, Hydrocarbons and Tectonic Patterns in Eastern Asia (Report of the IDOE Workshop on); Bangkok, Thailand, 24-29 September 1973 UNDP (CCOP).	E (out of stock)		5-9 June 1978 (UNESCO reports in marine sciences, No. 5, published by the Division of Marine Sciences, UNESCO).		40	24-29 September 1985. IOC Workshop on the Technical Aspects of Tsunami Analysis, Prediction and Communications; Sidney, B.C., Canada, 29-31 July 1985.	E
2	CICAR Ichthyoplankton Workshop, Mexico City, 16-27 July 1974 (UNESCO Technical Paper in Marine Sciences, No. 20).	E (out of stock) S (out of stock)	20	Second CCOP-IOC Workshop on IDOE Studies of East Asia Tectonics and Resources; Bandung, Indonesia, 17-21 October 1978	E	40	First International Tsunami Workshop on Tsunami Analysis, Prediction and Communications, Submitted Papers; Sidney, B.C., Canada, 29 July-1 August 1985.	E
3	Report of the IOC/GFCM/ICSEM International Workshop on Marine Pollution in the Mediterranean; Monte Carlo, 9-14 September 1974.	E, F E (out of stock)	21	Second IDOE Symposium on Turbulence in the Ocean; Liège, Belgium, 7-18 May 1979.	E, F, S, R	41	First Workshop of Participants in the Joint FAO/WHO/IAEA/UNEP Project on Monitoring of Pollution in the Marine Environment of the West and Central African Region (WACAF/2); Dakar, Senegal, 28 October-1 November 1985.	E
4	Report of the Workshop on the Phenomenon known as 'El Niño'; Guayaquil, Ecuador, 4-12 December 1974.	E (out of stock) S (out of stock)	22	Third IOC/WMO Workshop on Marine Pollution Monitoring; New Delhi, 11-15 February 1980.	E, F, S, R	43	IOC Workshop on the Results of MEDALPEX and Future Oceanographic Programmes in the Western Mediterranean; Venice, Italy, 23-25 October 1985.	E
5	IDOE International Workshop on Marine Geology and Geophysics of the Caribbean Region and its Resources; Kingston, Jamaica, 17-22 February 1975	E (out of stock) S	23	WESTPAC Workshop on the Marine Geology and Geophysics of the North-West Pacific; Tokyo, 27-31 March 1980.	E, R	44	IOC-FAO Workshop on Recruitment in Tropical Coastal Demersal Communities; Ciudad del Carmen, Campeche, Mexico, 21-25 April 1986.	E (out of stock) S
6	Report of the CCOP/SOPAC-IOC IDOE International Workshop on Geology, Mineral Resources and Geophysics of the South Pacific; Suva, Fiji, 1-6 September 1975.	E	24	Workshop on the Inter-calibration of Sampling Procedures of the IOC/WMO/UNEP Pilot Project on Monitoring Background Levels of Selected Pollutants in Open-Ocean Waters; Bermuda, 11-26 January 1980.	E (out of stock)	44	IOC-FAO Workshop on Recruitment in Tropical Coastal Demersal Communities, Submitted Papers; Ciudad del Carmen, Campeche, Mexico, 21-25 April 1986.	E
7	Report of the Scientific Workshop to Initiate Planning for a Co-operative Investigation in the North and Central Western Indian Ocean, organized within the IDOE under the sponsorship of IOC/FAO (IOFC)/UNESCO/ EAC; Nairobi, Kenya, 25 March-2 April 1976.	E, F, S, R	25	IOC Workshop on Coastal Area Management in the Caribbean Region; Mexico City, 24 September- 5 October 1979.	E, S	44	IOC-FAO Workshop on Recruitment in Tropical Coastal Demersal Communities, Submitted Papers; Ciudad del Carmen, Campeche, Mexico, 21-25 April 1986.	E
8	Joint IOC/FAO (IPFC)/UNEP International Workshop on Marine Pollution in East Asian Waters; Penang, 7-13 April 1976	E (out of stock)	26	CCOP/SOPAC-IOC Second International Workshop on Geology, Mineral Resources and Geophysics of the South Pacific; Noumea, New Caledonia, 9-15 October 1980.	E	45	IOC-FAO Workshop on Physical Oceanography and Climate; Cartagena, Colombia, 19-22 August 1986.	E
9	IOC/CMG/SCOR Second International Workshop on Marine Geoscience; Mauritius 9-13 August 1976.	E, F, S, R	27	FAO/IOC Workshop on the effects of environmental variation on the survival of larval pelagic fishes. Lima, 20 April-5 May 1980.	E	46	Reunión de Trabajo para Desarrollo del Programa "Ciencia Oceánica en Relación a los Recursos No Vivos en la Región del Atlántico Sud-occidental"; Porto Alegre, Brasil, 7-11 de abril de 1986.	S
10	IOC/WMO Second Workshop on Marine Pollution (Petroleum) Monitoring; Monaco, 14-18 June 1976	E, F E (out of stock) R	28	WESTPAC Workshop on Marine Biological Methodology; Tokyo, 9-14 February 1981.	E	47	IOC Symposium on Marine Science in the Western Pacific: The Indo-Pacific Convergence; Townsville, 1-6 December 1966	E
11	Report of the IOC/FAO/UNEP International Workshop on Marine Pollution in the Caribbean and Adjacent Regions; Port of Spain, Trinidad, 13-17 December 1976.	E, S (out of stock)	29	International Workshop on Marine Pollution in the South-West Atlantic; Montevideo, 10-14 November 1980.	E (out of stock) S	48	IOCARIBE Mini-Symposium for the Regional Development of the IOC-UN (OETB) Programme on 'Ocean Science in Relation to Non-Living Resources (OSNLR)'; Havana, Cuba, 4-7 December 1986.	E, S
11	Collected contributions of invited lecturers and authors to the IOC/FAO/UNEP International Workshop on Marine Pollution in the Caribbean and Adjacent Regions; Port of Spain, Trinidad, 13-17 December 1976	E (out of stock), S	30	Third International Workshop on Marine Geoscience; Heidelberg, 19-24 July 1982.	E, F, S	49	AGU-IOC-WMO-CPNS Chapman Conference: An International Symposium on 'El Niño'; Guayaquil, Ecuador, 27-31 October 1986.	E
12	Report of the IOC/FAO/UNEP Interdisciplinary Workshop on Scientific Programmes in Support of Fisheries Projects; Fort-de-France, Martinique, 28 November-2 December 1977.	E, F, S	31	UNU/IOC/UNESCO Workshop on International Co-operation in the Development of Marine Science and the Transfer of Technology in the context of the New Ocean Regime; Paris, France, 27 September-1 October 1982.	E, F, S	50	CCALR-IOC Scientific Seminar on Antarctic Ocean Variability and its Influence on Marine Living Resources, particularly Krill (organized in collaboration with SCAR and SCOR); Paris, France, 2-6 June 1987.	E
13	Report of the IOC/FAO/UNEP Workshop on Environmental Geology of the Caribbean Coastal Area; Port of Spain, Trinidad, 16-18 January 1978.	E, S	32	CCOP/SOPAC-IOC-UNU Workshop on Basic Geo-scientific Marine Research Required for Assessment of Minerals and Hydrocarbons in the South Pacific; Suva, Fiji, 3-7 October 1983.	E	51	CCOP/SOPAC-IOC Workshop on Coastal Processes in the South Pacific Island Nations; Lae, Papua-New Guinea, 1-8 October 1987.	E
14	IOC/FAO/WHO/UNEP International Workshop on Marine Pollution in the Gulf of Guinea and Adjacent Areas; Abidjan, Côte d'Ivoire, 2-9 May 1978	E, F	33	Workshop on the IREP Component of the IOC Programme on Ocean Science in Relation to Living Resources (OSLR); Halifax, 26-30 September 1983.	E	52	SCOR-IOC-UNESCO Symposium on Vertical Motion in the Equatorial Upper Ocean and its Effects upon Living Resources and the Atmosphere; Paris, France, 6-10 May 1985.	E
15	CCPS/FAO/IOC/UNEP International Workshop on Marine Pollution in the South-East Pacific; Santiago de Chile, 6-10 November 1978.	E (out of stock)	34	IOC Workshop on Regional Co-operation in Marine Science in the Central Eastern Atlantic (Western Africa); Tenerife, 12-17 December, 1963.	E, F, S	53	IOC Workshop on the Biological Effects of Pollutants; Oslo, 11-29 August 1986.	E
16	Workshop on the Western Pacific, Tokyo, 19-20 February 1979.	E, F, R	35	CCOP/SOPAC-IOC-UNU Workshop on Basic Geo-scientific Marine Research Required for Assessment of Minerals and Hydrocarbons in the South Pacific; Suva, Fiji, 3-7 October 1983.	E	54	Workshop on Sea-Level Measurements in Hostile Conditions; Bidston, UK, 28-31 March 1988.	E
17	Joint IOC/WMO Workshop on Oceanographic Products and the IGOS Data Processing and Services System (IDPSS); Moscow, 9-11 April 1979.	E, F, R	36	IOC/FAO Workshop on the Improved Uses of Research Vessels; Lisbon, Portugal, 28 May-2 June 1984.	E	55	IBCCA Workshop on Data Sources and Compilation, Boulder, Colorado, 18-19 July 1988.	E
17	Papers submitted to the Joint IOC/WMO Seminar on Oceanographic Products and the IGOS Data Processing and Services System; Moscow, 2-6 April 1979.	E	36	Papers submitted to the IOC/FAO Workshop on the Improved Uses of Research Vessels; Lisbon, 28 May-2 June 1984	E	56	IOC-FAO Workshop on Recruitment of Penaeid Prawns in the Indo-West Pacific Region (PREP); Cleveland, Australia, 24-30 July 1988.	E
18	IOC/UNESCO Workshop on Syllabus for Training Marine Technicians; Miami, U.S.A., 22-26 May 1978 (UNESCO reports in marine sciences, No. 4 published by the Division of Marine Sciences, UNESCO).	E (out of stock), F, S (out of stock), R	37	IOC/UNESCO Workshop on Regional Co-operation in Marine Science in the Central Indian Ocean and Adjacent Seas and Gulfs; Colombo, 8-13 July 1985.	E	57	IOC Workshop on International Co-operation in the Study of Red Tides and Ocean Blooms; Takamatsu, Japan, 16-17 November 1987.	E
19	IOC Workshop on Marine Science Syllabus for Secondary Schools; Llantwit Major, Wales, U.K.,	E (out of stock), S, R, Ar	38	IOC/ROPME/UNEP Symposium on Fate and Fluxes of Oil Pollutants in the Kuwait Action Plan Region; Basrah, Iraq, 8-12 January 1984.	E	58	International Workshop on the Technical Aspects of the Tsunami Warning System; Novosibirsk, USSR, 4-5 August 1989.	E
			39	CCOP (SOPAC)-IOC-IFREMER-ORSTOM Workshop on the Uses of Submersibles and Remotely Operated Vehicles in the South Pacific; Suva, Fiji,	E	58	Second International Workshop on the Technical Aspects of Tsunami Warning Systems, Tsunami Analysis, Preparedness,	E

No.	Title	Languages	No.	Title	Languages	No.	Title	Languages
59	Observation and Instrumentation. Submitted Papers; Novosibirsk, USSR, 4-5 August 1989.	E, F, S		Meeting for the Organization of an International Conference on Coastal Change; Bordeaux, France, 30 September-2 October 1992.		103	Liège, Belgium, 5-9 May 1994.	E
	IOC-UNEP Regional Workshop to Review Priorities for Marine Pollution Monitoring Research, Control and Abatement in the Wider Caribbean; San José, Costa Rica, 24-30 August 1989.		83	IOC Workshop on Donor Collaboration in the Development of Marine Scientific Research Capabilities in the Western Indian Ocean Region; Brussels, Belgium, 12-13 October 1992.	E	104	IOC Workshop on GIS Applications in the Coastal Zone Management of Small Island Developing States; Barbados, 20-22 April 1994.	E
60	IOC Workshop to Define IOCARIBE-TRODERP proposals; Caracas, Venezuela, 12-16 September 1989.	E		International Workshop on the Black Sea; Varna, Bulgaria, 30 September - 4 October 1991		105	Workshop on Integrated Coastal Management; Dartmouth, Canada, 19-20 September 1994.	E
61	Second IOC Workshop on the Biological Effects of Pollutants; Bermuda, 10 September-2 October 1988.	E	84	Workshop on Atlantic Ocean Climate Variability; Moscow, Russian Federation, 13-17 July 1992	E	105 Suppl.	BORDOMER 95: Conference on Coastal Change; Bordeaux, France, 6-10 February 1995.	E
62	Second Workshop of Participants in the Joint FAO-IOC-WHO-IAEA-UNEP Project on Monitoring of Pollution in the Marine Environment of the West and Central African Region; Accra, Ghana, 13-17 June 1988.	E	85	IOC Workshop on Coastal Oceanography in Relation to Integrated Coastal Zone Management; Kona, Hawaii, 1-5 June 1992.	E	106	Conference on Coastal Change: Proceedings; Bordeaux, France, 6-10 February 1995	E
63	IOC/WESTPAC Workshop on Co-operative Study of the Continental Shelf Circulation in the Western Pacific; Bangkok, Thailand, 31 October-3 November 1989.	E	86	International Workshop on the Black Sea; Varna, Bulgaria, 30 September - 4 October 1991	E	107	IOC/WESTPAC Workshop on the Paleographic Map; Bali, Indonesia, 20-21 October 1994.	E
64	Second IOC-FAO Workshop on Recruitment of Penaeid Prawns in the Indo-West Pacific Region (PREP); Phuket, Thailand, 25-31 September 1989.	E	87	Taller de trabajo sobre efectos biológicos del fenómeno «El Niño» en ecosistemas costeros del Pacífico Sudeste; Santa Cruz, Galápagos, Ecuador, 5-14 de octubre de 1989.	S only (summary in E, F, S)	108	IOC-ICSU-NIO-NOAA Regional Workshop for Member States of the Indian Ocean - GODAR-III; Dona Paula, Goa, India, 6-9 December 1994.	E
65	Second IOC Workshop on Sardine/Anchovy Recruitment Project (SARP) in the Southwest Atlantic; Montevideo, Uruguay, 21-23 August 1989.	E	88	IOC-CEC-ICSU-ICES Regional Workshop for Member States of Eastern and Northern Europe (GODAR Project); Obninsk, Russia, 17-20 May 1993.	E	108 Suppl.	UNESCO-IHP-IOC-IAEA Workshop on Sea-Level Rise and the Multidisciplinary Studies of Environmental Processes in the Caspian Sea Region; Paris, France, 9-12 May 1995.	E
66	IOC ad hoc Expert Consultation on Sardine/Anchovy Recruitment Programme; La Jolla, California, U.S.A., 1989	E	89	IOC-ICSEM Workshop on Ocean Sciences in Non-Living Resources; Perpignan, France, 15-20 October 1990.	E	109	UNESCO-IHP-IOC-IAEA Workshop on Sea-Level Rise and the Multidisciplinary Studies of Environmental Processes in the Caspian Sea Region; Submitted Papers; Paris, France, 9-12 May 1995	E
67	Interdisciplinary Seminar on Research Problems in the IOCARIBE Region; Caracas, Venezuela, 28 November-1 December 1989.	E (out of stock)	90	IOC Seminar on Integrated Coastal Management; New Orleans, U.S.A., 17-18 July 1993.	E	110	First IOC-UNEP CEPPOP Symposium; San José, Costa Rica, 14-15 April 1993.	E
68	International Workshop on Marine Acoustics; Beijing, China, 26-30 March 1990.	E	91	IOC-UNEP Workshop on Training Requirements in the Field of Eutrophication in Semi-enclosed Seas and Harmful Algal Blooms, Bremerhaven, Germany, 29 September-3 October 1992.	E		IOC-ICSU-CEC regional Workshop for Member States of the Mediterranean - GODAR-IV (Global Oceanographic Data Archeology and Rescue Project) Foundation for International Studies, University of Malta, Valletta, Malta, 25-28 April 1995.	E
69	IOC-SCAR Workshop on Sea-Level Measurements in the Antarctica; Leningrad, USSR, 28-31 May 1990.	E	92	SAREC-IOC Workshop on Donor Collaboration in the Development of Marine Scientific Research Capabilities in the Western Indian Ocean Region; Brussels, Belgium, 23-25 November 1993.	E	111	Chapman Conference on the Circulation of the Intra-Americas Sea; La Parguera, Puerto Rico, 22-26 January 1995.	E
69 Suppl.	IOC-SCAR Workshop on Sea-Level Measurements in the Antarctica; Submitted Papers; Leningrad, USSR, 28-31 May 1990.	E	93	IOC-UNEP Workshop on Impacts of Sea-Level Rise due to Global Warming; Dhaka, Bangladesh, 16-19 November 1992.	E	112	IOC-IAEA-UNEP Group of Experts on Standards and Reference Materials (GESREM) Workshop; Miami, U.S.A., 7-8 December 1993.	E
70	IOC-SAREC-UNEP-FAO-IAEA-WHO Workshop on Regional Aspects of Marine Pollution; Mauritius, 29 October - 9 November 1990.	E	94	BMTC-IOC-POLARMAR International Workshop on Training Requirements in the Field of Eutrophication in Semi-enclosed Seas and Harmful Algal Blooms, Bremerhaven, Germany, 29 September-3 October 1992.	E	113	IOC-IAEA-UNEP Group of Experts on Standards and Reference Materials (GESREM) Workshop; Miami, U.S.A., 7-8 December 1993.	E
71	IOC-FAO Workshop on the Identification of Penaeid Prawn Larvae and Postlarvae; Cleveland, Australia, 23-28 September 1990.	E	95	SAREC-IOC Workshop on Donor Collaboration in the Development of Marine Scientific Research Capabilities in the Western Indian Ocean Region; Brussels, Belgium, 23-25 November 1993.	E	114	IOC Regional Workshop on Marine Debris and Waste Management in the Gulf of Guinea; Lagos, Nigeria, 14-16 December 1994.	E
72	IOC/WESTPAC Scientific Steering Group Meeting on Co-Operative Study of the Continental Shelf Circulation in the Western Pacific; Kuala Lumpur, Malaysia, 9-11 October 1990.	E	96	IOC-UNEP-WMO-SAREC Planning Workshop on an Integrated Approach to Coastal Erosion, Sea Level Changes and their Impacts; Submitted Papers	E	115	International Workshop on Integrated Coastal Zone Management (ICZM) Karachi, Pakistan; 10-14 October 1994.	E
73	Expert Consultation for the IOC Programme on Coastal Ocean Advanced Science and Technology Study; Liège, Belgium, 11-13 May 1991.	E	96 Suppl.	IOC-UNEP-WMO-SAREC Planning Workshop on an Integrated Approach to Coastal Erosion, Sea Level Changes and their Impacts; Submitted Papers	E	115	IOC/GLOSS-IAPSO Workshop on Sea Level Variability and Southern Ocean Dynamics; Bordeaux, France, 31 January 1995	E
74	IOC-UNEP Review Meeting on Oceanographic Processes of Transport and Distribution of Pollutants in the Sea; Zagreb, Yugoslavia, 15-18 May 1989.	E	97	IOC-UNEP-WMO-SAREC Planning Workshop on an Integrated Approach to Coastal Erosion, Sea Level Changes and their Impacts; Submitted Papers	E	116	IOC/WESTPAC International Scientific Symposium on Sustainability of Marine Environment: Review of the WESTPAC Programme, with Particular Reference to ICAM, Bali, Indonesia, 22-26 November 1994.	E
75	IOC-SCOR Workshop on Global Ocean Ecosystem Dynamics; Solomons, Maryland, U.S.A., 29 April-2 May 1991.	E	97 Suppl.	IOC-UNEP-WMO-SAREC Planning Workshop on an Integrated Approach to Coastal Erosion, Sea Level Changes and their Impacts; Submitted Papers	E	117	IOC-UNEP-NOAA-Sea Grant Fourth Caribbean Marine Debris Workshop; La Romana, Santo Domingo, 21-24 August 1995.	E
76	IOC/WESTPAC Scientific Symposium on Marine Science and Management of Marine Areas of the Western Pacific; Penang, Malaysia, 2-6 December 1991.	E	98	IOC-UNEP-WMO-SAREC Planning Workshop on an Integrated Approach to Coastal Erosion, Sea Level Changes and their Impacts; Submitted Papers	E	118	IOC Workshop on Ocean Colour Data Requirements and Utilization; Sydney B.C., Canada, 21-22 September 1995.	E
77	IOC-SAREC-KMFRI Regional Workshop on Causes and Consequences of Sea-Level Changes on the Western Indian Ocean Coasts and Islands; Mombasa, Kenya, 24-28 June 1991.	E	99	IOC-UNEP-WMO-SAREC Planning Workshop on an Integrated Approach to Coastal Erosion, Sea Level Changes and their Impacts; Submitted Papers	E	119	IOC-UNEP-NOAA-Sea Grant Fourth Caribbean Marine Debris Workshop; La Romana, Santo Domingo, 21-24 August 1995.	E
78	IOC-CEC-ICES-WMO-ICSU Ocean Climate Data Workshop Goddard Space Flight Center, Greenbelt, Maryland, U.S.A., 18-21 February 1992.	E	99	IOC-UNEP-WMO-SAREC Planning Workshop on an Integrated Approach to Coastal Erosion, Sea Level Changes and their Impacts; Submitted Papers	E	120	IOC Workshop on Ocean Colour Data Requirements and Utilization; Sydney B.C., Canada, 21-22 September 1995.	E
79	IOC/WESTPAC Workshop on River Inputs of Nutrients to the Marine Environment in the WESTPAC Region; Penang, Malaysia, 26-29 November 1991.	E	100	IOC-UNEP-WMO-SAREC Planning Workshop on an Integrated Approach to Coastal Erosion, Sea Level Changes and their Impacts; Submitted Papers	E	121	IOC Workshop on Ocean Colour Data Requirements and Utilization; Sydney B.C., Canada, 21-22 September 1995.	E
80	IOC-SCOR Workshop on Programme Development for Harmful Algae Blooms; Newport, U.S.A., 2-3 November 1991.	E	101	IOC-UNEP-WMO-SAREC Planning Workshop on an Integrated Approach to Coastal Erosion, Sea Level Changes and their Impacts; Submitted Papers	E	122	International Training Workshop on Integrated Coastal Management; Tampa, Florida, U.S.A., 15-17 July 1995.	E
81	Joint IAPSO-IOC Workshop on Sea Level Measurements and Quality Control; Paris, France, 12-13 October 1992.	E	101	IOC-UNEP-WMO-SAREC Planning Workshop on an Integrated Approach to Coastal Erosion, Sea Level Changes and their Impacts; Submitted Papers	E	123	Atelier régional IOC-CERESCOR sur la gestion intégrée des zones littorales (ICAM), Conakry, Guinée, 18-22 décembre 1995	F
82	BORDOMER 92: International Convention on Rational Use of Coastal Zones. A Preparatory	E	102	IOC-UNEP-WMO-SAREC Planning Workshop on an Integrated Approach to Coastal Erosion, Sea Level Changes and their Impacts; Submitted Papers	E	124	IOC-EU-BSH-NOAA-(WDC-A) International Workshop on Oceanographic Biological and Chemical Data Management; Hamburg, Germany, 20-23 May 1996	E
				IOC-UNEP-WMO-SAREC Planning Workshop on an Integrated Approach to Coastal Erosion, Sea Level Changes and their Impacts; Submitted Papers	E	125	Second IOC Regional Science Planning Workshop on Harmful Algal Blooms in South America; Mar del Plata, Argentina, 30 October-1 November 1995.	E, S
				IOC-UNEP-WMO-SAREC Planning Workshop on an Integrated Approach to Coastal Erosion, Sea Level Changes and their Impacts; Submitted Papers	E		GLOBEC-IOC-SAHFOS-MBA Workshop on the Analysis of Time Series with Particular Reference to the Continuous Plankton Recorder Survey; Plymouth, U.K., 4-7 May 1993.	E
				IOC-UNEP-WMO-SAREC Planning Workshop on an Integrated Approach to Coastal Erosion, Sea Level Changes and their Impacts; Submitted Papers	E		Atelier sous-régional de la COI sur les ressources marines vivantes du Golfe de Guinée; Cotonou, Bénin, 1-4 juillet 1996.	E

No.	Title	Languages	No.	Title	Languages	No.	Title	Languages
126	IOC-UNEP-PERSGA-ACOPS-IUCN Workshop on Oceanographic Input to Integrated Coastal Zone Management in the Red Sea and Gulf of Aden. Jeddah, Saudi Arabia, 8 October 1995.	E	127	IOC Regional Workshop for Member States of the Caribbean and South America GODAR-V (Global Oceanographic Data Archeology and Rescue Project); Cartagena de Indias, Colombia, 8-11 October 1996.	E	128	Atelier IOC-Banque Mondiale-Sida/SAREC-ONE sur la Gestion Intégrée des Zones Côtières ; Nosy Bé, Madagascar, 14-18 octobre 1996.	E
129	Gas and Fluids in Marine Sediments, Amsterdam, the Netherlands; 27-29 January 1997.	E	130	Atelier régional de la COI sur l'océanographie côtière et la gestion de la zone côtière ; Moroni, RFI des Comores, 16-19 décembre 1996.	E	131	GOOS Coastal Module Planning Workshop; Miami, USA, 24-28 February 1997	E
132	Third IOC-FANSA Workshop; Punta-Arenas, Chile, 28-30 July 1997	S/E	133	Joint IOC-CIESM Training Workshop on Sea-level Observations and Analysis for the Countries of the Mediterranean and Black Seas; Birkenhead, U.K., 16-27 June 1997.	E	134	IOC/WESTPAC-CCOP Workshop on Paleogeographic Mapping (Holocene Optimum); Shanghai, China, 27-29 May 1997.	E
135	Regional Workshop on Integrated Coastal Zone Management; Chabahar, Iran; February 1996.	E	136	IOC Regional Workshop for Member States of Western Africa (GODAR-VI); Accra, Ghana, 22-25 April 1997.	E	137	GOOS Planning Workshop for Living Marine Resources, Dartmouth, USA; 1-5 March 1996.	E
138	Gestión de Sistemas Oceanográficos del Pacífico Oriental; Concepcion, Chile, 9-16 de abril de 1996.	S	139	Sistemas Oceanográficos del Atlántico Sudoccidental, Taller, TEMA; Furg, Rio Grande, Brasil, 3-11 de noviembre de 1997	S	140	IOC Workshop on GOOS Capacity Building for the Mediterranean Region; Valletta, Malta, 26-29 November 1997.	E
141	IOC/WESTPAC Workshop on Co-operative Study in the Gulf of Thailand: A Science Plan; Bangkok, Thailand, 25-28 February 1997.	E	142	Pelagic Biogeography ICoPB II. Proceedings of the 2nd International Conference. Final Report of SCOR/IOC Working Group 93; Noordwijkhout, The Netherlands, 9-14 July 1995.	E	143	Geosphere-biosphere coupling: Carbonate Mud Mounds and Cold Water Reefs; Gent, Belgium, 7-11 February 1998.	E
144	IOC-SOPAC Workshop Report on Pacific Regional Global Ocean Observing Systems; Suva, Fiji, 13-17 February 1998.	E	145	IOC-Black Sea Regional Committee Workshop: 'Black Sea Fluxes' Istanbul, Turkey, 10-12 June 1997.	E	146	Taller Internacional sobre Formación de Capacidades para el Manejo de las Costas y los Océanos en el Gran Caribe. La Habana, - Cuba, 7-10 de Julio de 1998/ International Workshop on Management Capacity-Building for Coasts and Oceans in the Wider Caribbean, Havana, Cuba, 7-10 July 1998	S/E
147	IOC-SOA International Training Workshop on the Integration of Marine Sciences into the Process of Integrated Coastal Management, Dalian, China, 19-24 May 1997.	E	148	IOC/WESTPAC International Scientific Symposium - Role of Ocean Sciences for Sustainable Development Okinawa, Japan, 2-7 February 1998.	E	149	Workshops on Marine Debris & Waste Management in the Gulf of Guinea, 1995-97.	E
150	Primera Sesión del Grupo de Trabajo COI sobre Algas Nocivas en el Caribe y Regiones Adyacentes (IOCARIBE-ANCA)/First Meeting of the IOC Working Group on Harmful Algae in the Caribbean and Adjacent Region (IOCARIBE-ANCA), 29 June - 1 July 1998, Havana, Cuba.	S/E (electronic copy only)	151	Taller Pluridisciplinario TEMA sobre Redes del Gran Caribe en Gestión Integrada de Áreas Costeras Cartagena de Indias, Colombia, 7-12 de septiembre de 1998.	S	152	Workshop on Data for Sustainable Integrated Coastal Management (SICOM) Maputo, Mozambique, 18-22 July 1998	E
			153	IOC/WESTPAC-Sida (SAREC) Workshop on Atmospheric Inputs of Pollutants to the Marine Environment Qingdao, China, 24-26 June 1998	E	154	IOC-Sida-Flanders-SFRI Workshop on Ocean Data Management in the IOCINCWIO Region (ODINEA project) Capetown, South Africa, 30 November-11 December 1998.	E
			155	Science of the Mediterranean Sea and its applications UNESCO, Paris 29-31 July 1997	E	156	IOC-LUC-KMFRI Workshop on RECOSCIX-WIO in the Year 2000 and Beyond, Mombasa, Kenya, 12-16 April 1999	E
			157	'98 IOC-KMI International Workshop on Integrated Coastal Management (ICM), Seoul, Republic of Korea 16-18 April 1998	E	158	The IOCARIBE Users and the Global Ocean Observing System (GOOS) Capacity Building Workshop, San José, Costa Rica, 22-24 April 1999	E
			159	Oceanic Fronts and Related Phenomena (Konstantin Fedorov Memorial Symposium) - Proceedings, Pushkin, Russian Federation, 18-22 May 1998	E	160	Under preparation	
			161	Under preparation		162	Workshop report on the Transports and Linkages of the Intra-americas Sea (IAS), Cozumel, Mexico, 1-5 November 1997	E
			163	Under preparation		164	IOC-Sida-Flanders-MCM Third Workshop on Ocean Data Management in the IOCINCWIO Region (ODINEA Project), Cape Town, South Africa, 29 November - 11 December 1999	E
			165	An African Conference on Sustainable Integrated Management; Proceedings of the Workshops, An Integrated Approach, (PACSIKOM), Maputo, Mozambique, 18 - 25 July 1998	E, F	166	IOC-SOA International Workshop on Coastal Megacities: Challenges of Growing Urbanization of the World's Coastal Areas; Hangzhou, P.R. China, 27 - 30 September 1999	E
			167	IOC-Flanders First ODINAFRICA-II Planning Workshop, Dakar, Senegal, 2-4 May 2000	E	168	Geological Processes on European Continental Margins: International Conference and Eight Post-cruise Meeting of the Training-Through-Research Programme, Granada, Spain, 31 January - 3 February 2000	E
			169	International Conference on the International Oceanographic Data & Information Exchange in the Western Pacific (IODE-WESTPAC) 1999, ICWIP '99, Langkawi, Malaysia, 1-4 November 1999	E	170	IOCARIBE-GODAR-I Cartagena, Colombia, February 2000	(electronic copy only) under preparation
			171	Ocean Circulation Science derived from the Atlantic, Indian and Arctic Sea Level Networks, Toulouse, France, 10-11 May 1999	E	172	(Under preparation)	
			173	The Benefits of the Implementation of the GOOS in the Mediterranean Region, Rabat, Morocco, 1-3 November 1999	E, F	174	IOC-SOPAC Regional Workshop on Coastal Global Ocean Observing System (GOOS) for the Pacific Region, Apia, Samoa, 16-17 August 2000	E
			175	Geological Processes on Deep-water European Margins, Moscow-Mozhenka, 28 Jan.-2 Feb. 2001	E	176	MedGLOSS Workshop and Coordination Meeting for the Pilot Monitoring Network System of Systematic Sea Level Measurements in the Mediterranean and Black Seas, Haifa, Israel, 15-17 May 2000	E
			177	(Under preparation)		178	(Under preparation)	
			179	(Under preparation)		180	Abstracts of Presentations at Workshops during the 7th session of the IOC Group of Experts on the Global Sea Level Observing System (GLOSS), Honolulu, USA, 23-27 April 2001	E
			181	(Under preparation)		182	(Under preparation)	
			183	Geosphere/Biosphere/Hydrosphere Coupling Process, Fluid Escape Structures and Tectonics at Continental Margins and Ocean Ridges, International Conference & Tenth Post-cruise Meeting of the Training-through-Research	E	184	Programme, Aveiro, Portugal, 30 January-2 February 2002	
						185	(Under preparation)	
						186	(Under preparation)	
						187	(Under preparation)	
						188	Geological and Biological Processes at deep-sea European Margins and Oceanic Basins, Bologna, Italy, 2-6 February 2003	E
						189	Proceedings of 'The Ocean Colour Data' Symposium, Brussels, Belgium, 25-27 November 2002	E
							Workshop for the Formulation of a Draft Project on Integrated Coastal Management (ICM) in Latin America and the Caribbean (LAC), Cartagena, Colombia, 23-25 October 2003	E F (electronic copy only)
							Taller de Formulación de un Anteproyecto de Manejo Costero Integrado (MCI) en América Latina y el Caribe (ALC), Cartagena, Colombia, 23-25 de Octubre de 2003	
						190	First ODINCARSA Planning Workshop for Caribbean Islands, Christchurch, Barbados, 15-18 December 2003	E (electronic copy only)
						191	North Atlantic and Labrador Sea Margin Architecture and Sedimentary Processes - International Conference and Twelfth Post-cruise Meeting of the Training-through-research Programme, Copenhagen, Denmark, 29-31 January 2004	E
						192	Regional Workshop on Coral Reefs Monitoring and Management in the ROPME Sea Area, Iran I.R., 14-17 December 2003	E (under preparation)
						193	Workshop on New Technical Developments in Sea and Land Level Observing Systems, Paris, France, 14-16 October 2003	E (electronic copy only)
						194	IOC/ROPME Planning Meeting for the Ocean Data and Information Network for the Central Indian Ocean Region	(under preparation)
						195	Workshop on Indicators of Stress in the Marine Benthos, Torregrande-Oristano, Italy, 8-9 October 2004	E
						196	International Coordination Meeting for the Development of a Tsunami Warning and Mitigation System for the Indian Ocean within a Global Framework, Paris, France, 3-8 March 2005	E
						197	Geosphere-Biosphere Coupling Processes: The TTR Interdisciplinary Approach Towards Studies of the European and North African Margins; International Conference and Post-cruise Meeting of the Training-Through-Research Programme, Morocco, 2-5 February 2005	E
						198	Second International Coordination Meeting for the Development of a Tsunami Warning and Mitigation System for the Indian Ocean, Grand Baie, Mauritius, 14-16 April 2005	E
						199	International Conference for the Establishment of a Tsunami and Coastal Hazards Warning System for the Caribbean and Adjacent Regions, Mexico, 1-3 June 2005	E
						200	Lagoons and Coastal Wetlands in the Global Change Context: Impacts and Management Issues - Proceedings of the International Conference, Venice, 26-28 April 2004 (ICAM Dossier N° 3)	E
						201	Geological processes on deep-water European margins - International Conference and 15th Anniversary Post-cruise Meeting of the Training-Through-Research Programme, Moscow/Zvenigorod, Russian Federation, 29 January-4 February 2006	E
						202	Proceedings of 'Ocean Biodiversity Informatics': an international conference on marine biodiversity data management Hamburg, Germany, 29 November-1 December 2004	E
						203	IOC-Flanders Planning Workshop for the formulation of a regional Pilot Project on Integrated Coastal Area Management in Latin America, Cartagena de Indias, Colombia, 16-18 January 2007	E (electronic copy only)
						204	Geo-marine Research along European Continental Margins, International Conference and Post-cruise Meeting of the Training-through-research Programme, Bremen, Germany, 29 January-1 February 2007	E
						205	IODE/ICAM Workshop on the development of the Caribbean marine atlas (CMA), United Nations House, Bridgetown, Barbados, 8-10 October 2007	E (electronic copy only)
						206	IODE/JCOMM Forum on Oceanographic Data Management and Exchange Standards, Ostend, Belgium, 21-25 January 2008	(Under preparation)
						207	SCOR/IODE Workshop on Data Publishing, Ostend, Belgium, 17-18 June 2008	(Under preparation)

No.	Title	Languages	No.	Title	Languages	No.	Title	Languages
208	JCOMM Technical Workshop on Wave Measurements from Buoys, New York, USA, 2–3 October 2008 (IOC-WMO publication)	(Under preparation)	233	2010 Meeting of the Joint IODE-JCOMM Steering Group on the Global Temperature-Salinity Profile Programme	E (electronic copy only)	263	International Coastal Atlas Network Workshop 6: Expanding Participation in Coastal Web Atlas Development and Use, 16–17 June 2013, University of Victoria, British Columbia, Canada	E (electronic copy only)
209	Collaboration between IOC and OBIS towards the Long-term Management Archival and Accessibility of Ocean Biogeographic Data, Ostend, Belgium, 24–26 November 2008	(Under preparation)	234	Ocean CO ₂ Atlas (SOCAT) Workshop, CSIRO Marine Laboratories, Hobart, Tasmania 16–18 June 2010	E (electronic copy only)	264	9th WESTPAC International Scientific Symposium, Research Directors' Forum: A Healthy and Safe Ocean for Prosperity in the Indo-Pacific region, Nha Trang, Viet Nam, 22 April 2014	E (electronic copy only)
210	Ocean Carbon Observations from Ships of Opportunity and Repeat Hydrographic Sections (IOCCP Reports, 1), Paris, France, 13–15 January 2003	E (electronic copy only)	235	The Caribbean Marine Atlas (CMA) Review and Planning Workshop and Saint Lucia National Coastal Atlas Stakeholder Event, Bay Gardens Inn, Rodney Bay, Saint Lucia, 2–6 August 2010	E (electronic copy only)	265	Electoral Group 1 Consultation on the Future of the IOC, Utrecht, The Netherlands, 26–27 May 2014	E (electronic copy only)
211	Ocean Surface pCO ₂ Data Integration and Database Development (IOCCP Reports, 2), Tsukuba, Japan, 14–17 January 2004	E (electronic copy only)	236	First Session of the IODE Steering Group for the IODE OceanDataPortal (SG-ODP-I), 20–22 September 2010, Ostend, Belgium	E (electronic copy only)	266	IOC-UNESCO-ISESCO workshop on Improving Tsunami Warning and Emergency Response in the North-Eastern Atlantic, Mediterranean and connected seas Rabat, 23–24 September 2014	A/E/F (electronic copy only)
212	International Ocean Carbon Stakeholders' Meeting, Paris, France, 6–7 December 2004	E (electronic copy only)	237	Ad hoc meeting of the IODE Steering Group for OBIS, Ostend, Belgium 18–19 November 2010	E (electronic copy only)	267	Proceedings of the First IOCAFRIKA Ocean Forecasting workshop for the Western Indian Ocean region, Nairobi, Kenya, 11–15 August 2014	E (electronic copy only)
213	International Repeat Hydrography and Carbon Workshop (IOCCP Reports, 4), Shonan Village, Japan, 14–16 November 2005	E (electronic copy only)	238	Implementing Adaptation to Climate Change in Western and Eastern Africa, Nairobi, Kenya, 3–5 November 2010	E (electronic copy only)	268	Proceedings of the African Summer School on Application of Ocean Data and Modelling Products, Ghana, Kenya, April–September 2014	E (electronic copy only)
214	Initial Atlantic Ocean Carbon Synthesis Meeting (IOCCP Reports, 5), Laugavátn, Iceland, 28–30 June 2006	E (electronic copy only)	239	2nd Advisory Workshop on enhancing forecasting capabilities for North Indian Ocean Storm Surges, 11–15 February 2011, New Delhi, India	E (electronic copy only)	269	Forum on Sustained Ocean Observations and Services in IOC Group V (Africa and Arab countries)	Under preparation
215	Surface Ocean Variability and Vulnerability Workshop (IOCCP Reports, 7), Paris, France, 11–14 April 2007	E (electronic copy only)	240	Ocean Biogeographic Information System (OBIS) Infrastructure Meeting, INCOIS, Hyderabad, India, 2–4 March 2011	E (electronic copy only)	270	Second China-Africa Forum on Marine Science and Technology, 9–10 April 2015, Nairobi, Kenya	Under preparation
216	Surface Ocean CO ₂ Atlas Project (SOCAT) 2nd Technical Meeting Report (IOCCP Reports, 9), Paris, France, 16–17 June 2008	E (electronic copy only)	241	Best Practice on Tsunami and Coastal Hazards Community Preparedness and Readiness in Central America and the Caribbean, 11–13 August 2008, Panama City, Panama	E (electronic copy only)	271	WESTPAC Workshop on Research and Monitoring of the Ecological Impacts of Ocean Acidification on Coral Reef Ecosystems, Phuket, Thailand, 19–21 January 2015	E (electronic copy only)
217	Changing Times: An International Ocean Biogeochemical Time-Series Workshop (IOCCP Reports, 11), La Jolla, California, USA, 5–7 November 2008	E (electronic copy only)	242	Integrated Coastal Area Management (ICAM) Training Workshop for the English Speaking Caribbean States, 16–18 March 2011, Bridgetown, Barbados	E (electronic copy only)	272	Second IOCAFRIKA Planning Meeting for the Second International Indian Ocean Expedition (IIOE-2), 6–8 October 2015, Catembe, Mozambique	E (electronic copy only)
218	Second Joint GOSUD/SAMOS Workshop, Seattle, Washington, USA, 10–12 June 2008	E (electronic copy only)	243	Cancelled		273		
219	International Conference on Marine Data management and Information Systems (IMDIS), Athens, Greece, 31 March–2 April 2008	E	244	SCOR/IODE/MBLWHOI Library Workshop on Data Publication, 4 th Session, British Oceanographic Data Centre, Liverpool, United Kingdom, 3–4 November 2011	E (electronic copy only)	274		
220	Geo-marine Research on the Mediterranean and European-Atlantic Margins. International Conference and TTR-17 Post-cruise Meeting of the Training-through-research Programme, Granada, Spain, 2–5 February 2009	E (electronic copy only)	245	Cancelled		275		
221	Surface Ocean CO ₂ Atlas Project Pacific Regional Workshop, Tsukuba, Japan, 18–20 March, 2009 (IOCCP Report Number 12)	E (electronic copy only)	246	NEAMTIC/ICAM Workshop on Coastal Management Approaches for Sea-Level Related Hazards, Paris, UNESCO, 5–7 December 2011	E (electronic copy only)	276	Sources of Tsunamis in the Caribbean with Possibility to Impact the Southern Coast of the Dominican Republic, Santo Domingo, Dominican Republic, 6–7 May 2016	E & S
222	Surface Ocean CO ₂ Atlas Project Atlantic and Southern Oceans Regional Meeting, Norwich, UK, 25–26 June, 2009 (IOCCP Report Number 13)	E (electronic copy only)	247	Technical Workshop on the IODE OceanDataPortal, IOC Project Office for IODE, Ostend, Belgium, 27–29 February 2012	E (electronic copy only)	277	VI IOC Regional Science Planning Workshop on Harmful Algae in the Caribbean and Adjacent Regions, Santo Domingo, Dominican Republic, 26–30 October 2015 / COI – VI Taller Regional de Planificación Científica sobre Algas Nocivas en el Caribe y Regiones Adyacentes, Santo Domingo, República Dominicana, 26–30 Octubre 2015	E/S
223	Advisory Workshop on enhancing forecasting capabilities for North Indian Ocean Storm Surges, Indian Institute of Technology (IIT), New Delhi, India, 14–17 July 2009	E (electronic copy only)	248	Inter-sessional working group for updating the IOC Strategic Plan for Oceanographic Data and Information Exchange (2012–2015), Ostend, Belgium, 1–2 March 2012	E (electronic copy only)	278	Tsunami Hazard in Central America: Historical Events and Potential Sources. Meeting of Experts, San José, Costa Rica, 23–24 June 2016	E
224	2009 International Nutrients Scale System (INSS) Workshop Report, Paris, France, 10–12 February 2009	E (electronic copy only)	249	Operational Oceanography of IOC (for Group II Member States), 20–22 March 2012 Paris, UNESCO (Advisory Workshop)	E (electronic copy only)	279	2nd International Conference on Marine/Maritime Spatial Planning, 15–17 March 2017, UNESCO, Paris	E
225	Reunión subregional de planificación de ODINCARSA (Red de Datos e Información Oceanográficos para las Regiones del Caribe y América del Sur)/ODINCARSA (Ocean Data and Information Network for the Caribbean and South America region) Latin America sub-regional Planning Meeting, Universidad Autónoma de Baja California (UABC), Ensenada (México), 7–10 December 2009, 2010	E/S (electronic copy only)	250	Advisory Workshop on The Future of IOC towards next ten years and its Implications for Member States, Varna, Bulgaria, 19 March 2012	E (electronic copy only)	280	Information Meeting on North-Eastern Atlantic, the Mediterranean and Connected Seas Tsunami Early Warning and Mitigation System (NEAMTWS) and NEAMWave 17 Tsunami Exercise: Summary Recommendations, Tunis, Tunisia, 13–14 September 2017	E/F/Ar
226	OBIS (Ocean Biogeographic Information System) Strategy and Work plan Meeting, IOC Project Office for IODE, Ostend, Belgium, 18–20 November 2009	E (electronic copy only)	251	Second Technical Meeting of Ocean Biogeographic Information System (OBIS), Ostend, Belgium, 21–22 June 2012	E (electronic copy only)	281	Workshop on Sea-Level Measurements in Hostile Conditions, Moscow, Russian Federation, 13–15 March 2018	E/R
227	ODINAFRICA-IV Project Steering Committee, First Session, Ostend, Belgium, 20–22 January 2010, 2010	E (electronic copy only)	252	SCOR/IODE/MBLWHOI Library Workshop on Data Publication, 5 th Session, Woods Hole Oceanographic Institution, Woods Hole, USA, 9–10 October 2012	E (electronic copy only)	282	IODE/OBIS-Event-Data workshop on animal tagging and tracking, Ostend, Belgium, 23–26 April 2018	E
228	First IODE Workshop on Quality Control of Chemical Oceanographic Data Collections, Ostend, Belgium, 8–11 February 2010, 2010	E (electronic copy only)	253	Second IODE Workshop on Quality Control of Chemical and Biological Oceanographic Data Collections, 22–24 October 2012, IOC Project Office for IODE, Ostend, Belgium	E (electronic copy only)	283	Sixth International XBT Science Workshop, Ostend, Belgium, 18–20 April 2018	E
229	Surface Ocean CO ₂ Atlas Project Equatorial Pacific, North Pacific, and Indian Ocean Regional Workshop, Tokyo, Japan, 8–11 February 2010, 2010 (IOCCP Report Number 18)	E (electronic copy only)	254	Consultation on Scientific and Technical Aspects of Sustained Ocean Observations and Services, 5 th March, 2013, Rio de Janeiro, Brazil	E (electronic copy only)			
230	SCOR/IODE/MBLWHOI Library Workshop on Data Publication, Paris, France, 2 April 2010	E (electronic copy only)	255	Earthquake and tsunami hazard in Northern Haiti: Historical events and potential sources (Meeting of experts)	E (electronic copy only)			
231	First ODINAFRICA Coastal and Marine Atlases Planning Meeting, Ostend, Belgium, 12–14 October 2009	E (electronic copy only)	256	Sexto Taller Regional de Planificación Científica sobre Floraciones de Algas Nocivas en Sudamérica, Guayaquil, Ecuador, 22–24 Octubre 2003	S (electronic copy only)			
232	Eleventh International Workshop on Wave Hindcasting and Forecasting and Second Coastal Hazard Symposium, Halifax, Canada, 18–23 October 2009	E (electronic copy only)	257	(Under preparation)				
			258	(Under preparation)				
			259	Noveno Taller Regional-COI de Planificación Científica sobre Florecimientos de Algas Nocivas en Sudamérica, 11–13 enero 2011, Puerto Varas, Chile	S (electronic copy only) (Summary in E)			
			260	Caribbean Marine Atlas Review and Planning Meeting, Miami, USA, 10–13 December 2013				
			261	Indo-Pacific Ocean Forum on "Charting the Future of Sustained Ocean Observations and Services", Bangkok, Thailand, 25–28 Nov. 2013	E (electronic copy only)			
			262	First Planning Workshop For The Ocean Data And Information Network For The Westpac Region (ODINWESTPAC), Tianjin, China, 4–7 March 2014				