

Special Technical Specifications (STS)

Supply Contract

Supply of archival tagging and marine acoustic telemetry equipments

N° 261000115

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1. Object

1.1. Object of the contract

The purpose of this document is to describe and define the terms and conditions for the supply of archival tagging and marine acoustic telemetry equipments and their accessories. The objective of this contract is to enable Ifremer to study the behaviour and movement of species of fishery interest at different spatio-temporal scales and to understand changes in space occupancy as a function of variations in environmental conditions (inter- and intra-annual variability, climate change) or anthropogenic pressures (e.g. fishing, OWF).

1.2. Background

To follow the trajectory of fish or crustaceans in space and time (the term fish will be used later in the document), it is not possible to use conventional technologies such as GPS. It is therefore necessary to implement alternative approaches and we have identified the following ones:

- A tracking method using acoustic telemetry. Its principle consists of communication between a transmitting tag (implanted in a fish) and a receiving device (hydrophone or receivers) by means of an acoustic signal to determine the location of the tag (i.e., fish). The electronic tags to be acquired transmit unique global identification and sensor data (e.g., temperature) via acoustic signals at fixed time intervals. The position and behaviour of the fish, as well as the conditions of the water it encounters, will therefore be known when it is within range of the acoustic telemetry network. High-resolution tracking is possible either within a dense acoustic telemetry network by triangulation or by active tracking using a directional hydrophone used from a small boat.
- A tracking method using a geolocation model. Its principle consists in estimating the position of the fish from the high-resolution time series of temperature and depth recorded by an archival tag (or DST; data storage tag) using a geolocation model based on a hidden Markov model. The archival tags to be acquired will record environmental data (e.g. temperature and depth) or behavioural data (e.g. acceleration, predation, mortality) at fixed time intervals. The position of the fish will be inferred using a specific geolocation model when it is outside the acoustic telemetry network.
- A combination of these two tracking methods.

The acoustic and/or archival tags sought will most often be surgically implanted in fish. The tags will be deployed on demersal fish, e.g. sea bass (*Dicentrarchus labrax*), pollack (*Pollachius pollachius*), and large crustaceans, e.g. spiny lobster (*Palinurus elephas*) and spider crab (*Maja brachydactyla*). We will try to recover the tags either to use the recorded data (temperature and depth), or to redeploy them if they allow it (battery and memory still good). The specific geolocation technology used in the last two approaches is only of interest to fish that make movements on continental shelves and that have a high probability of being recaptured by fishing (professional or recreational) or whose tags have a high probability of being found on beaches (dead fish by predation). A flotation device around the electronic tag is therefore necessary for the implementation of this technique.

The deployment of this acoustic telemetry equipment in a network is part of a national and international scientific collaboration effort on the tracking of marine species at the scale of the North-East Atlantic continental shelf. It is therefore important that the equipment from different suppliers is compatible so that tagged fish can be detected beyond the network that will be deployed by Ifremer as part of this public procurement. The network deployed will also have to be able to detect fish tagged outside the provider acquired under this public procurement. The deployed acoustic telemetry network will be part

of the European Tracking Network and will follow its compatibility recommendations (<http://www.europeantrackingnetwork.org/open-protocol>).

2. Technical specifications of the procurement

The contract includes 2 lots:

- Lot 1: Acoustic tags and receivers (and necessary accessories)
- Lot 2: Archival tags equipped with floats (and accessories needed)

2.1. Lot 1: Acoustic tags and receivers

This batch concerns acoustic tags (i.e. not archiving additional data), acoustic receivers and accessories necessary for the deployment of an acoustic telemetry network for the monitoring of tagged marine fish.

2.1.1. Acoustic tags

Acoustic tags must have the following characteristics:

- Transmission rates must be programmable;
- A (globally) unique identifier must be defined for each acoustic tag;
- Tags may have the option to include sensors, e.g. depth, temperature, activity, tilt, mortality, predation, acceleration (non-exhaustive list);
- The sensor data will be transmitted directly by acoustics;
- Open protocol (OPI/OPs) will be required, as recommended by the ETN;
- The activation of the tags must be clear and direct (leaving no room for interpretation).

Different tag models and accessories can therefore be offered. The offer will have to specify the accessories necessary for the proper use of its tags and their deployment. For example, the characteristics of a trademark programming interface software can be detailed. The tags will either be surgically implanted in the inner cavity of fish or attached to the outside of individuals (especially for crustaceans). Examples of external fasteners can be offered for illustration. A minimum warranty of 2 years is required. The conditions for replacing the tags in the event of a malfunction must be indicated (e.g. lead times, spare parts, price). The tags to be acquired will have to be robust, qualified to withstand depths of 200 m. The acoustic transmission power must be as high as possible to allow the greatest possible detection range by the receivers in ambient conditions of sometimes high noises related to tidal current and wave conditions.

Three types of acoustic tags will be sought in particular:

- a 6 mm diameter tag for tagging small individuals (with optional sensors indicating whether the animal is dead or alive and activity sensors, or pressure/depth sensor),
- a 9 mm diameter tag with either additional temperature sensor, pressure sensor or an extra battery and high power.
- a 13 mm diameter tag with either additional temperature sensor, pressure sensor or an extra battery and high power.

Required options must be offered for each of these acoustic tags.

Here are the desired specifications for the first acoustic tag:

First acoustic tag	
Model	Specify
Name	Specify

Diameter	≤ 6 mm
Length	< 17 mm
Weight in Water	Less than 0.8g
Emission rate	Adjustable but 60-90s preferably
Power	Low power
Communication protocol	Open protocol
Emission frequency	69kHz
Duration	> 100 days
Depth usage	Up to ca. 50 m
Options required	Mortality sensor and/or activity sensor and/or additional battery and/or depth sensor

Here are the desired specifications for the second acoustic tag:

Second acoustic tag	
Model	Specify
Name	Specify
Diameter	≤ 9 mm
Length	less than 37 mm
Weight in Water	Less than 3.2g
Extra battery	Specify
Emission rate	On demand, but 60s for comparison purpose
Power	Medium or High power
Communication protocol	Open protocol
Emission frequency	69kHz
Duration	365 days at least
Depth usage	For depth up to ca. 200 m
Options required	temperature sensor and/or depth sensor and/or additional battery

Here are the desired specifications for the third acoustic tag:

Third acoustic tag	
Model	Specify
Name	Specify
Diameter	≤ 13 mm
Length	less than 34 mm
Weight in Water	Less than 7.3g
Extra battery	Specify
Emission rate	On demand, but 60s for comparison purpose
Power	Medium or High power
Communication protocol	Open protocol
Emission frequency	69kHz
Duration	1000 days at least
Depth usage	For depth up to ca. 200 m
Options required	depth sensor and/or temperature sensor and/or additional battery

2.1.2. Acoustic Receivers

Acoustic receivers must have the following basic characteristics (see table below):

- Robust design that can be deployed up to a depth of 200m;
- Downloading of data (fish ID and environmental and behavioral variables recorded at the time of transmission) with a bluetooth communication system;
- Large data storage capacity (> 1 million detections);
- Autonomy of more than 20 months allowing long deployments at sea;
- Interface software to query receivers, download data while allowing them to be visualized;
- Open protocol required, as recommended by the ETN;
- Ability to operate at 69kHz and other nearby frequencies (e.g. 67kHz, 68kHz, 70kHz, 71kHz);
- With acoustic release and its optional anchoring system.

Detailed specifications	
Model	specify
Dimension	specify
Weight	specify
Power supply	specify
Detection	provide range test
Battery Life	> 20 months
Maximum depth	200 m
Receive frequency	67kHz, 68kHz, 69kHz, 70kHz, 71kHz
Buoyancy	specify
Data storage / Capacity	specify; > millions of detection
Acoustic communication from surface	Yes (e.g. distance, released or not, tilt)
Ambient Temperature	yes
Attachment	specify
Transmitters	logs and decodes all transmitters
Code Maps	Open protocols required
Option required	Acoustic release

The offer must specify the characteristics of the proposed programming interface (software). Similarly, the offer must detail all the accessories necessary for the deployment of an acoustic telemetry network, for example, directional hydrophones (and their communication case, etc.) adapted to communicate from the surface with the receivers or to actively track from a small boat.

Different models of acoustic receivers (and accessories) may be offered in connection with particular specificities making them more suitable for the conditions of installation. For example, it may be:

- a cabled receiver for installation on a buoy that is already instrumented and self-sufficient in energy;
- a simple receiver with batteries for attachment to an easily accessible navigation buoy or structure at sea;
- a receiver with acoustic release for immersion on the bottom and easy recovery.

A minimum warranty of 2 years is required. The conditions for replacing the receivers in the event of a malfunction must be indicated (e.g. deadlines, spare parts, price). The reliability of the acoustic release must be specified.

Orders must be able to be placed on the anchoring system associated with the acoustic receiver with acoustic release in spare parts. It is requested that the available spare parts be included in the BPU-

DQE. We are thinking specifically about the central part, ie. the central leg of the rope canister for instance. We would like also to have the choice to order or not the rope within the rope canister.

2.2. Lot 2: Archival tags equipped with floats

This lot mainly concerns archive tags (or DST, data storage tags), their individual floats and accessories needed to track tagged fish from a high-resolution temperature and depth time series using a geolocation model based on a hidden Markov model. However, sensors other than temperature and pressure may be proposed.

Archival tags must have the following characteristics:

- Acquisition rates must be programmable;
- Archival tags can have different sizes (size of the tag to be adapted according to the size of the fish), however tag diameter must be below or equal 13 mm and tag length must be below or equal 45 mm;
- Archival tags must be equipped with floats, perfectly adjusted (to the diameter of the tag). There should be no exceeding pieces likely to injure the internal organs of the fish. It is required to provide technical information about theoretical weights, in air and seawater, of the archival tag, the float and the combination of the two, as well as their densities.
- Software(s) to program the tags and retrieve data stored must be provided without additional cost (with a user interface in either English or French). No geolocation software is expected and thus should not be included in the present market.
- Tags must at least integrate pressure and temperature sensors. In addition, tags can also incorporate other sensors, e.g. activity, accelerometry, magnetic steering/compass. However, tags must not include light sensors. The tags must be intern (within the fish) and no pieces or sensors should be outside of the fish.
- Sensor data will be archived; the battery and internal memory must ideally allow for more than 2 years of data, temperature and pressure, archived every 90s;

Here are the specificities sought for the base tag with pressure and temperature:

General specifications	
Diameter	Less than 13 mm
Length	Less than 45 mm
Weight in Water	< 7 g
Flash Memory	2 MB at least
Data resolution	12-bit
Time series data point s	Specify number
Battery life	24 months at least. Preferably beyond at 90s interval.
Data retention (provided by the manufacturer)	10 years at least
Supporting standard freezing (-20 °C) without failure	preferable
Depth sensor	
Max Depth	ca. 200 m
Absolute Max depth	Please specify
Accuracy	±1% Full Scale or better
Resolution	Better than 0.05% full scale
Temperature compensated?	Specify
Max depth before failure	Specify

Temperature sensor	
Temperature range	0-40°C
Accuracy	Better than that. $\pm 0.1^{\circ}\text{C}$
Resolution	Better than 0.05°C
Response time	specify
Temperature range before failure	specify
Additional specifications	
Clock	specify
Programmable logging	required
Summary Log	preferable
Rate of tag failure	Specify
Disinfection method prior insertion into the intracoelomic cavity	Specify
Float specifications	
Floating collar	For depth up to ca. 200 m
Float coating	Inert and biocompatible, ideally a medical grade silicon.
Dimension with floating collar	Perfectly adjusted to the diameter and length of the archival tag. The diameter of the whole device, i.e. the tag equipped with the float, should not exceed 21 mm. The length of the tag equipped with the float should not exceed 45 mm.
Weight in air and in water for the tag and the tag associated with the float	Specify
A label where something can be written	At least 4 lines with a tag number, a phone number, an email address and two lines detailing the reward amount.

In addition to the « base model » described above, we are looking for additional tags, providing the ability to adapt to fish size (additional tag 1) or to incorporate additional sensors, i.e. accelerometer or magnetism (additional tags 2 & 3). Here are their specificities:

Tags	Specifications
Additional tag 1	Archival tag <30mm in length with pressure and temperature sensors, and float
Base tag	Archival tag <35mm in length with pressure and temperature sensors, and float
Additional tag 2	Archival tag <40mm in length with sensors of pressure, temperature, magnetometry and accelerometry, and float
Additional tag 3	Archival tag <45mm in length with sensors of pressure, temperature, magnetometry and accelerometry, and float

3. Details on delivery terms

⇒ **Delivery location**

The equipment will be delivered to Ifremer stations in mainland France. The material to be sent to each site will be specified in each purchase order.

⇒ **Provisional delivery schedule**

The delivery dates will correspond to the deployment surveys.

The supplier will have to indicate delivery times in order to adjust the order date to the desired delivery dates.

⇒ **Specific delivery methods**

All the equipment listed in the BPU of each lot must be delivered in DDP (delivered duty paid) to the various Ifremer sites in mainland France. Tags and receivers must be issued within a maximum of 4 weeks after the order has been shipped.