SAS MORBIHAN HYDRO ENERGIES

- PROJECT TIGER - APPLICATION FOR CASE-BY-CASE REVIEW

APRIL 2020

Sabella

TIGER TIDAL STREAM INDUSTRY ENERGISER

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1 PROJECT TIGER

The TIGER (Tidal Stream Industry Energiser) project is an experimental European cooperation project between France and England. The project aims to demonstrate the economic viability of tidal stream energy so that it can become part of the energy mix in England and France.

Eighteen partners, industrialists, researchers, energy companies, development agencies, French and Anglo-Saxon, gathered around the British government agency ORE CATAPULT, are involved in the project.

Within the framework of this project, several potential areas of interest are identified in England (Isle of Wight), Wales (Ramsey Sound) and France (Paimpol-Bréhat, Raz-Blanchard and Golfe du Morbihan).
These areas are the test sites for the TIGER programme.

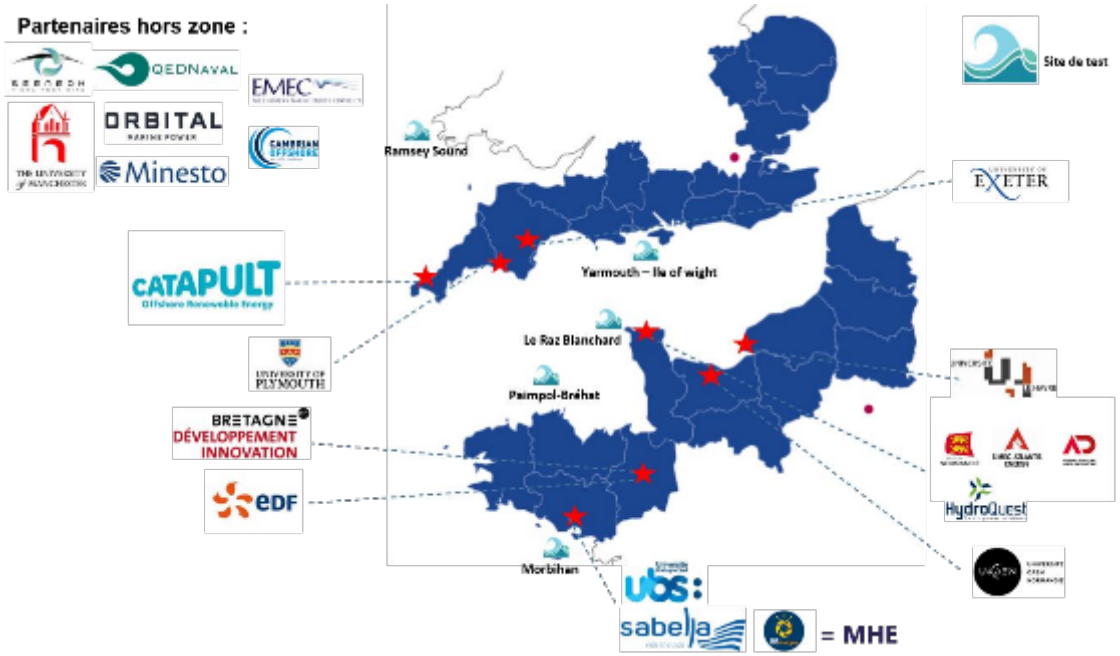


Figure 1: TIGER programme partners and test sites

The company MORBIHAN HYDRO ENERGIES (MHE), resulting from the merger of the companies SA SABELLA and SEM 56 ENERGIES, is in charge of the tests on the Golfe du Morbihan site within the framework of this experimental project.

SABELLA is a wind turbine technology developer based in Quimper and 56 ENERGIES is the semi-public company of MORBIHAN ENERGIES, the Morbihan Departmental Electricity Syndicate.

The UNIVERSITE DE BRETAGNE SUD (UBS) is also part of the European project and supports MHE in the development of the Morbihan site.

MHE and UBS have already carried out numerous environmental studies in the Gulf of Morbihan, in particular with a view to defining a site suitable for the installation of a tidal turbine. Two potential sites have been studied:

The southern site of Ile Longue; The

southern site of Ile Berder.

The synthesis of these specific studies and the field investigations (bathymetric surveys, current measurements, etc.) made it possible to identify the main issues in the study area and to favour a site for the installation of the project. Thus, the site in the south of Ile Longue was considered to be the most favourable area for the installation of two tidal turbines.

This document first presents in detail the main issues of the study area and then analyses the potential effects of the installation and operation of the wind energy project.

All of these elements must enable the Environmental Authority to judge whether or not an environmental assessment is necessary in accordance with Article R.122-2 of the Environmental Code.

The reference "TIGER project" in the document refers only to the Morbihan section of the European project.

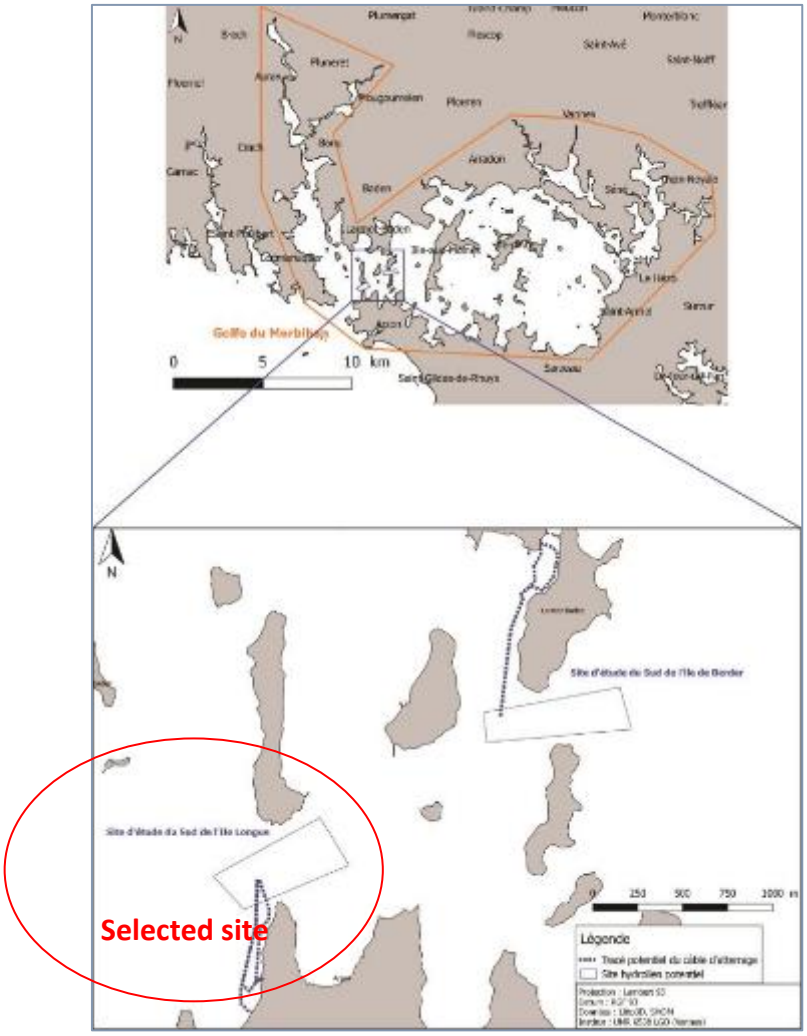


Figure 2: Sites studied for potential tidal turbine implantation (UBS, 2018)

2 THE REGULATORY CONTEXT

The TIGER project is subject to the regulations of the environment code, the general code of public property, the energy code, the local authority code and the heritage code.

2.1 Regulations under the Environmental Code

The Environmental Code contains legal texts relating to environmental law. It is composed of seven books. The TIGER project is potentially affected by the following books:

- Book I: Common provisions (general principles, environmental assessment, administrative procedure) ;
- Book II: Physical environments (water and aquatic and marine environments: installations, works and activities (IOTA)) ;
- Book III: Natural areas (nature reserves, classified sites, etc.);
- Book IV: Natural Heritage (Natura 2000 impact assessment).

2.1.1 Book I: Common provisions

The common provisions constitute Book I of the Environmental Code and set out, among other things, the framework for environmental assessment (or impact assessment), public enquiries and administrative procedures.

2.1.1.1 Environmental assessment

This assessment is defined, for its legislative part, in articles L122-1 to L122-3-4 and for its regulatory part in articles R122-1 to R122-27.

Article R122-2 sets out the criteria for identifying projects subject to environmental assessment or case-by-case review: *"Projects falling under one or more of the headings listed in the table annexed to this article shall be subject to environmental assessment, either systematically or after a case-by-case review, pursuant to II of Article L. 122-1, in accordance with the criteria and thresholds specified in this table.*

The TIGER project is concerned with the following categories:

Energy		
Project category	Projects subject to environmental assessment	Projects subject to case-by-case examination
31. Offshore energy production facility	Offshore wind turbines	All other installations

34. Other cables in the marine environment		Other cables in the marine environment installed in the public maritime domain

Table 1: Category of projects subject to environmental assessment or case-by-case review

The TIGER project is subject to a case-by-case review under project categories 31 and 34.

2.1.1.2 Public participation (public enquiry)

The legislative part of public participation is defined in Articles L123-1 to L122-19-8 and the regulatory part in Articles R123-1 to D123-46-2.

Article L123-1 states*: "I. - A public enquiry subject to the requirements of this chapter shall be held prior to their authorisation, approval or adoption:*

1° Projects for works, structures or developments carried out by public or private persons that must include an environmental assessment pursuant to Article L. 122-1 [...]".

Article R123-1 states: "*I. For the application of 1° of I of Article L. 123-2, a public enquiry subject to the requirements of this chapter shall be held for works, structures or development projects that are systematically subject to an impact study in application of II and III of Article R. 122-2 and for those that, following the case-by-case examination provided for in the same article, are subject to such a study".*

The TIGER project will be subject to a public enquiry if, after a case-by-case examination, the Environmental Authority recommends that an environmental assessment (impact study) be carried out, in which case the public enquiry will last at least one month.

It should be noted that the project may be subject to a public enquiry via other regulatory entries, particularly if the project is subject to authorisation under Book II of the EC Physical Environment (Water and aquatic and marine environments: installations, works, works and activities (IOTA)). Thus the analysis carried out in § 7.1.1.2 page 59 shows that the project will in all cases be subject to a public enquiry lasting at least fifteen days.

2.1.1.3 The administrative procedure (environmental permit)

The framework of the environmental authorisation is defined, for its legislative part, in articles L181-1 to L181-31 and for its regulatory part in articles R181-1 to R181-56.

Article L181-1 specifies**: "***Environmental authorisation, the system for which is organised by the provisions of this book and by other legislative provisions under the conditions set out in this title, is applicable to the following activities, installations, works and undertakings, when they are not of a temporary nature:*

- 1° Installations, works, works and activities mentioned in I of Article L. 214-3 [1] , including water withdrawals for irrigation in favour of a single body in application of 6° of II of Article L. 211-3[2] ;
- 2° Installations classified for the protection of the environment mentioned in Article L. 512-1[3] . »

It is also applicable to the projects mentioned in the second paragraph of II of Article L. 122-1-1[4] when the administrative authority competent to issue the authorisation is the prefect, as well as to the projects mentioned in the third paragraph of this II5.

The TIGER project will be subject to environmental authorisation if, after a case-by-case examination, it is to be subject to an environmental assessment.
It should be noted that the project may be subject to environmental authorisation via other regulatory entries, particularly if the project is subject to authorisation under Book II of the EC Physical Environment (Water and aquatic and marine environments: installations, works and activities (IOTA)). Thus the analysis carried out in § 7.1.1.2 page 59 shows that the project will in all cases be subject to environmental authorisation.

2.1.2 Book II: The physical environment

The book on physical environments defines the legislative and regulatory framework for the protection of water and aquatic environments and in particular sets out the nature of administrative applications (authorisations or declarations).

The character of administrative applications is defined, for its legislative part, in articles L.214-1 to L.214-11 and, for its regulatory part, in articles R.211-1 to R.19-17.

Article L214-2 states: *"The installations, works and activities referred to in Article L. 214-1 are defined in a nomenclature, established by decree in the Council of State after consultation with the National Water Committee, and subject to authorisation or declaration according to the dangers they present and the seriousness of their effects on water resources and aquatic ecosystems, taking into account in particular the existence of zones and perimeters established for the protection of water and aquatic environments. This decree also defines the criteria for domestic use, and in particular the volume of water below which the abstraction is considered as such*

[1] Article L214-3 I specifies: "*I. Installations, works and activities likely to present dangers for public health and safety, to harm the free flow of water, to reduce water resources, to significantly increase the risk of flooding, to seriously affect the quality or diversity of the aquatic environment, in particular fish populations, are subject to authorisation by the administrative authority. This authorisation is the environmental authorisation governed by the provisions of the single chapter of Title VIII of Book I, without prejudice to the application of the provisions of this* title. The projects concerned are therefore those subject to authorisation under the Water Act (IOTA).
[2] This article concerns water abstraction and is not relevant to the present project.
[3] Article L512-1 specifies: "*Installations that present serious dangers or inconveniences for the interests mentioned in Article L. 511-1 are subject to authorisation. The authorisation, known as an environmental authorisation, is issued under the conditions set out in the single chapter of Title VIII of Book I. "*The projects concerned are therefore those subject to authorisation under the ICPE.
[4] The second paragraph of II of Article L. 122-1-1 refers to projects subject to environmental assessment, but falling under a declaration regime. [5] The third paragraph of Article L. 122-1-1 refers to projects subject to environmental assessment that are not subject to any particular authorisation or declaration regime.

use, as well as other forms of use whose impact on the aquatic environment is too small to justify their being subject to authorisation or declaration.

Article R.214-1 presents the nomenclature of installations, works and activities subject to authorisation or declaration in application of articles L214-1 to L214-6.

The TIGER project falls under the following heading:

Table of Article R. 214-1	
Title	**Headings that could potentially concern the project**
TITLE IV - Impacts on the marine environment	4.1.2.0. Port development works and other works in contact with the marine environment and having a direct impact on this environment :
	1° Of an amount equal to or greater than EUR 1.9 million - Authorisation
	2° Of an amount equal to or greater than 160,000 euros, but less than 1.9 million euros - Declaration.

Table 2: Nomenclature of Installations, Structures, Activities and Works (IOTA)

The TIGER project, which is worth more than 1.9 million euros, will be subject to authorisation under the Installations, Works, Activities and Activities (IOTA) (e.g. Water Law). In accordance with Article L181-1 of the Environment Code, it will be subject to environmental authorisation (see § 7.1.1.1.3 page 58).

2.1.3 Book III: Natural areas

Book III of the Environmental Code sets out the legislative and regulatory framework for the areas of the conservatory, nature parks, nature reserves, listed and classified sites, the blue and green belt, Ramsar zones, etc.

The locations of the various components of the project in relation to natural areas are as follows:

- Regional Parks: the entire project will be located in the Golfe du Morbihan Regional Nature Park;
- Listed and classified sites: Several listed and classified sites are identified within the Gulf of Morbihan. The TIGER project is notably located within the listed site "Gulf of Morbihan and its surroundings".
- Biosphere reserves: the TIGER project will be located more than 10 km from the national nature reserve of the Marais de Séné.

2.1.3.1.1 Regulation of regional parks

Article R333-15 specifies: *"When projects subject to environmental assessment under Article R. 122-2 are envisaged in the territory of the park, the impact study defined in Article R. 1225 shall be submitted to it for its opinion by the authority competent to take the decision to authorise the project.*

If the project TIGER is subject to environmental assessment, the Regional Nature Park of the Gulf of Morbihan will asked for its opinion on the impact assessment.

2.1.3.1.2 Regulations on classified sites

Article L341-10 states: *"Natural monuments or classified sites may not be destroyed or modified in their state or appearance without special authorisation. »*

Article R341-10 specifies: "*When a special authorisation is requested for a project falling within the scope of Article L. 181-1*[5] *, the environmental authorisation provided for by this article replaces the authorisation required by Articles L. 341-7 and L. 341-10. The application is then examined and issued under the conditions provided for by the single chapter of Title VIII of Book I for the environmental permit and the provisions of this paragraph are not applicable.*

Article L181-2 specifies*: I. - The environmental authorisation replaces, including for the application of other legislation, the following authorisations, registrations, declarations, non-oppositions, approvals and authorisations, when the project for activities, installations, works and structures covered by Article L. 181-1 is subject to them or requires them :*

4° Special authorisation for classified sites or sites in the process of being classified in application of articles L. 341-7 and L. 341-10, except in the cases provided for by article L. 425-1 of the town planning code where one of the permits or decisions determined by this article replaces this authorisation;

The environmental permit (or single permit) holds place of special authorisation for si your classified.

2.1.3.1.3 Biosphere reserve regulations

Article 336-1 specifies: *"In application of Resolution 28C/2-4 of the United Nations Educational, Scientific and Cultural Organization conference approving the Seville Strategy and adopting a statutory framework for the World Network of Biosphere Reserves of 14 November 1995, local authorities, their groupings, all mixed syndicates within the meaning of Book VII of Part V of the General Code of Local Authorities, associations and national public establishments of an administrative nature may set up a biosphere reserve. A biosphere reserve contributes to the objective of sustainable development, within the meaning of II of Article L. 110-1 of the present code.*

[5] The TIGER project falls within the scope of this article (see page 7).

The presence of the Biosphere Reserve 10 km from the projdoes not create a constraint in terms of regulatory .

2.1.3.2 Book IV: The Natural Heritage

Book IV of the Environmental Code sets out the legislative and regulatory framework for natural heritage.

The TIGER project may be affected by the regulations of this book in relation to the conservation of natural habitats, animal or plant species and their habitats as well as the regulations relating to Natura 2000 sites.

2.1.3.2.1 Natural habitats and protected species

Article L411-1, the basis of which is derived from Law 2016-1087 of 8 August 2016 for the reconquest of biodiversity, nature and landscapes, states:

- *"I- When a particular scientific interest, the essential role in the ecosystem or the need to preserve the natural heritage justifies the conservation of sites of geological interest, natural habitats, non-domesticated animal or non-cultivated plant species and their habitats, the following are prohibited*
  - *1° The destruction or removal of eggs or nests, the mutilation, destruction, capture or removal, intentional disturbance, naturalization of animals of these species or, whether alive or dead, their transport, peddling, use, keeping, offering for sale, sale or purchase ;*
  - *2° The destruction, cutting, mutilation, uprooting, gathering or removal of plants of these species, their fruiting bodies or any other form taken by these species during their biological cycle, their transport, their peddling, their use, their offering for sale, their sale or their purchase, the possession of specimens taken from the natural environment ;*
  - *3° The destruction, alteration or degradation of these natural habitats or species habitats;*
  - *4° The destruction, alteration or degradation of sites of geological interest, in particular natural or artificial underground cavities, as well as the removal, destruction or degradation of fossils, minerals and concretions present on these sites;*
  - *5° The installation of telephone poles and posts for avalanche and flood control nets that are hollow and not plugged.*
- *II- Prohibitions on possession enacted pursuant to 1°, 2° or 4° of I shall not apply to specimens lawfully held at the time of entry into force of the prohibition relating to the species to which they belong. »*

Article L411-2 states:

- *« I. - A decree in Council of State shall determine the conditions under which: ○ 4° exemptions from the prohibitions mentioned in 1°, 2° and 3° of Article L. 4111, provided that there is no other satisfactory solution, which may be assessed by a third party expert opinion carried out, at the request of the competent authority, by an external body chosen in agreement with it, at the expense of the petitioner, and that the derogation does not harm the maintenance, in a favourable conservation status, of the populations of the species concerned in their natural range:*
  - *a/ in the interest of the protection of wild fauna and flora and the conservation of natural habitats ;*
  - *b/ to prevent significant damage to crops, livestock, forests, fisheries, water and other forms of property;*
  - *c/ in the interest of public health and safety or for other imperative reasons of overriding public interest, including those of a social or economic nature, and for reasons which would have an overriding beneficial effect on the environment;*
  - *d/ for the purposes of research and education, repopulation and reintroduction of these species and for breeding operations necessary for these purposes, including the artificial propagation of plants;*
  - *e/ to permit, under strictly controlled conditions, in a selective manner and to a limited extent, the taking or possession of a limited and specified number of certain specimens. »*

If it turns out that the TIGER project component affects protected species or their habitat, the project developer may apply for a derogation from the prohibitions mentioned in 1°, 2° and 3° of Article L. 411-1.

It should be noted that the impact studies carried out in the context of the Sabella D10 project did not show that the installation and operation of the tidal turbine demonstrator would affect protected species or their habitats.

2.1.3.2.2 Natura 2000 sites

Article L414-4 states: *"I. - When they are likely to significantly affect a Natura 2000 site, individually or because of their cumulative effects, they must be subject to an assessment of their impacts with regard to the site's conservation objectives, hereinafter referred to as the "Natura 2000 Impact Assessment": 1° Planning documents which, without themselves authorising the carrying out of activities, works, developments, works or installations, are applicable to their implementation;*
2° Programmes or projects for activities, works, developments, structures or installations;
3° Events and interventions in the natural environment or landscape. […]
III. - Subject to IVa, planning documents, programmes or projects as well as events or interventions subject to an administrative authorisation, approval or declaration regime under legislation or regulations other than Natura 2000 shall be subject to a Natura 2000 impact assessment only if they are listed :
1° or on a national list established by decree in the Council of State ;
2° or on a local list, complementary to the national list, drawn up by the competent administrative authority. »

Article R414-19 states: *"I. - The national list of planning documents, programmes or projects as well as events and interventions that must be subject to an impact assessment on one or more Natura 2000 sites pursuant to 1° of III of Article L. 414-4 is as follows [...] :*

- *3° Projects subject to environmental assessment under the table annexed to Article R. 122-2;*
- *4° installations, works and activities subject to authorisation or declaration under Articles L. 214-1 to L. 214-11.*

The project TIGER is subject to authorisation under Articles L. 214 -1 to L. 214-11 It will have to be the subject o assessment of its impact on Natura 2000 sites.

2.2 Regulations under the General Code of Public Property (CG3P)

The use of the public domain is defined, for its legislative part, in articles L2122-1 to L2125-8 and for its regulatory part in articles R2122-1 to R2125-16.

Article L2122-1 specifies that: "*no one may, without having a title authorising him to do so, occupy a public domain dependency of a public person mentioned in Article L. 1 or use it within limits exceeding the right of use which belongs to all".*

Article L2124-3 specifies that: *"For the application of Articles L. 2124-1 and L. 2124-2, concessions for the use of the public maritime domain including the maintenance of the conceded land in the public domain may be granted. A decree in the Council of State sets out the conditions for the examination and issue of these concessions".*

The ons of hydrokinetic energy production fall within the scope of Article L2124 -3 on concessions for the use of the public maritime domain. The draft TIGER is subject to a request for concession to use the Dom aine Public Maritime.

2.3 Regulations under other codes

2.3.1 Energy Code

Article L311-1 of the Energy Code specifies: "*Subject to Article L. 311-6, the operation of any new electricity production facility is subject to obtaining an administrative authorisation. Installations whose installed capacity is increased by at least 20% as well as those whose primary energy source is modified are also considered as new production installations, within the meaning of the present article".*

The project TIGER is subject to Article L311 -1 of the Energy Code. In accordance with Article L. 181-2 of the Code o
The single environmental permit replaces this permit.

2.3.2 Town Planning Code

The construction of the delivery station is subject to planning permission under the town planning code.

2.3.3 Local and regional government code

The work to bury the submarine cable that links the tidal turbine to the delivery station requires work on the road.

The project TIGER includes work on the v oirie; these works are subject to the local authority code.

3 DETAILED DESCRIPTION OF THE PROJECT

3.1 The Sabella D10 project

3.1.1 SABELLA, from Odet to Fromveur

In 2008, the SABELLA company immersed a 1/3 scale pilot tidal turbine in the Odet (29). "Sabella D03" was raised in April 2009 after two test campaigns and very promising results.

Figure 3: "Sabella D03" trials in Bénodet Bay - Final lifting in April 2009 - Exhibition on the forecourt of OCEANOPOLIS (SA SABELLA)

On the strength of this experience, SABELLA is developing the "Sabella D10" demonstrator in the Fromveur Passage. This site, located between the Molène archipelago and the island of Ouessant, was chosen for the capacity of its tidal field. After the Raz Blanchard, it is the second largest deposit in France, with an estimated 300 to 500 MW (Boyé et al., 2013). It was also chosen for its simplicity of implementation (connection: 1.5 to 2.5 km from the Ouessant coast), and for energy and environmental reasons. Not connected to the national interconnected grid, the Ponant islands of Pointe Bretagne (Ouessant, Molène, Sein) currently produce all their electricity using thermal units (oil-fired generators).

In 2015 SABELLA achieved a national first by immersing the Sabella D10 tidal turbine in the Fromveur Passage. This machine, connected to the Ushant electricity grid, is the first tidal turbine to produce and inject electricity into the national grid.

Since 2015, the Sabella D10 tidal turbine development programme has been ongoing and should be completed in 2022, to be replaced by two Sabella D12/D15 tidal turbines under the PHARES programme with AKUO Energies

3.1.2 Characteristics and implementation of the Sabella D10 wind turbine

3.1.2.1 Preamble: Operating principle of a tidal turbine

A tidal turbine is a device that uses the kinetic energy of ocean currents to convert it into electrical energy. The tidal current turns the rotor. This rotation drives a generator which produces an electric current.

A tidal turbine consists of a turbine (rotor and nacelle[6]), containing a generator and an electrical conversion and transformation chain, and a supporting structure called a base.

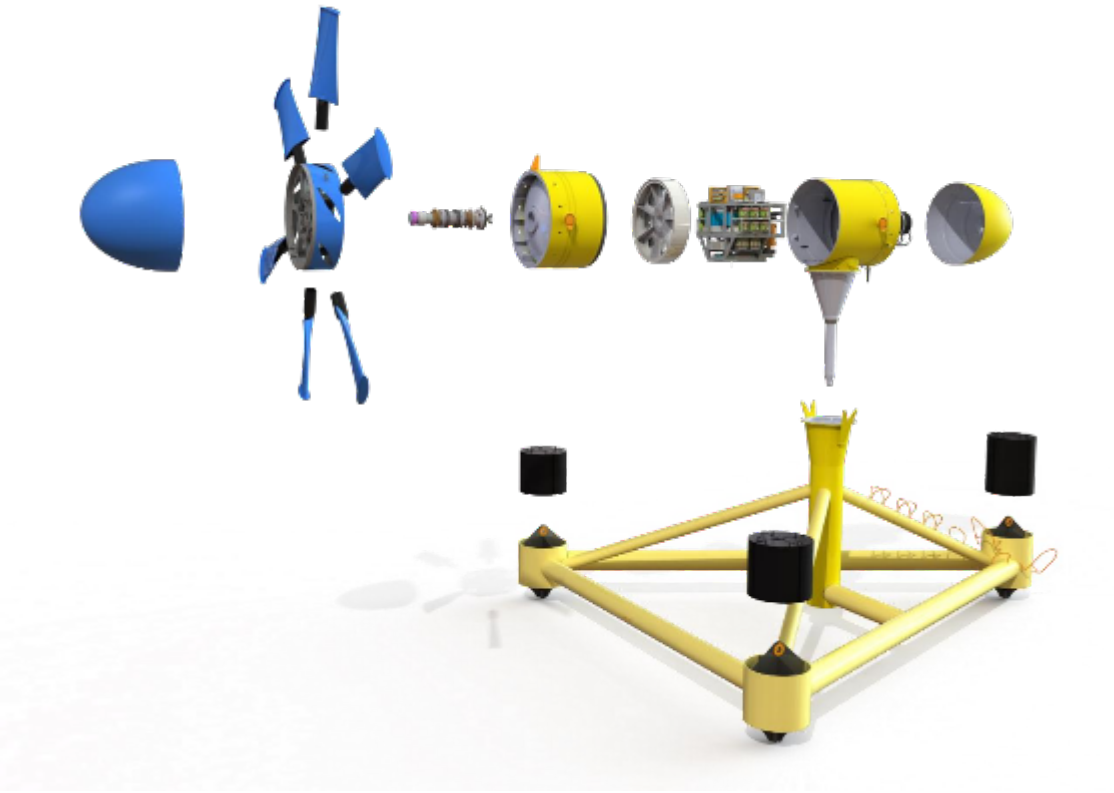


Figure 4: Representation of the sub-assemblies of the Sabella D10 tidal turbine (SABELLA)

The tidal turbine is then connected to the grid by an export cable (marine and land-based part) and possibly a delivery station8.

3.1.2.2 Presentation of the facilities

3.1.2.2.1 The turbine and its base

[6] The nacelle consists of a generator that transforms mechanical energy into electrical energy, and also contains an electrical conversion and transformation chain that allows a frequency-regulated signal to be exported to earth at 50 Hz and in voltage. [8] A unit called a delivery station delivers a signal at the voltage of the injection grid.

Sabella D10 is an axial flow water turbine with a horizontal axis and a gravity foundation as the supporting structure. The characteristics of the machine are :

- rated power: 500 kW at a site current of 3 m/s with a rotor diameter of 10 m;
- overall dimensions: length 20 m, width 20 m, height 17 m;
- weight: 400 tonnes.

Figure 5: Photo of the Sabella D10 tidal turbine (SABELLA)

Its architecture is modular, with a base that ensures the stability of the tidal turbine in the current and its anchorage to the seabed. It is composed of a tripod supporting gravity weights in each foot. The base carries in its centre a mast with a female conical socket at the top, which houses a centring finger for the turbine. The feet of the base are designed in the shape of "diamond points" to be embedded in the bedrock.

On the other hand, a turbine ensures the hydrodynamic capture *via* a rotor composed of 6 blades, and the electrical generation in a sealed nacelle integrating :

- a generator with a nominal power of 500 kW;
- a conversion chain (rectifier and chopper);
- a step-up transformer;
- data acquisition, transmission and control electronics;
- electromagnetic and mechanical brakes.

The nacelle is carried by a male conical centring pin, which is fitted by removal without fixing to the mast of the baseplate having a female embedding cone.

Figure 6: Base and turbine of the "Sabella D10" tidal turbine (SABELLA)

A 100 to 200 metre long cable umbilical attached to the turbine is connected to the export cable *via* a subsea connector.

Figure 7: Underwater connector (SABELLA)

3.1.2.2.2 The export cable

The characteristics of the export cable are :

- diameter: 6.85 cm;
- length: 2 km.

This cable consists of the following components:

- three phases for the export of electricity;
- two small auxiliary power cables, used for the control of the tidal turbine;
- eighteen optical fibres, allowing the transfer of information between the land and the tidal turbine;
- several sealing barriers and mechanical protections.

In shallow waters the cable is weighted and protected by shells and embedded (by divers) in the soft sediments; in deeper waters it is simply laid.

Figure 8: Composition of the export cable and shells installed on the cable in the hard substrate area (SABELLA)

3.1.2.2.3 The delivery station

For the delivery, two containers are necessary due to the specificity of the network on the island of Ushant:

- a twenty-foot container (dimensions 2.6 m high x 2.4 m wide x 6.1 m long) for electricity conversion;
- a "twenty-foot" container for connection to the ENEDIS network.

Figure 9: Shore-based control station (SABELLA)

3.1.2.3 Installation of the demonstrator

The installation of the demonstrator took place in several stages according to the following timeline:

Components	Date
Export cable	
At sea	From 24 to 26 May 2015
Export cable to ground and delivery station (ground operation)	
Conversion container	From 28 to 29 May 2015
Laying the export cable to earth	From 4 to 5 June 2015

Delivery container	24 September 2015
Hydro turbine and cable connection	
Installation of the tidal turbine	From 25 to 26 June 2015
Connection of the sling with the export cable	21 September 2015
Connection to the ENEDIS electricity network in Ushant	5 November 2015

Table 3: Dates of the installation operations of the different components of the tidal turbine

The two cables (ramp and export cable) were connected together on 21 September 2015. ENEDIS connected the installation to the island's grid on 5 November 2015 so that the tidal turbine could inject its first kWh into the homes of Ushant.

The demonstrator was then emerged in July 2016 and re-emerged in October 2018. A number of problems with the cooling system and the cable jumper required the turbine to be taken out of the water. It is expected to be re-launched in the summer of 2020 until September 2022 at the latest, when the two Sabella D12/D15 tidal turbines should be installed as part of the PHARES project.

3.1.2.3.1 Laying the export cable

3.1.2.3.1.1 Nautical means

The vessel used for the cable installation is the Argonaute, belonging to the BOURBON company, with a length of 69 metres and a draught of 6.5 metres. This vessel is equipped with a dynamic positioning system, which enabled it to follow the cable route indicated by SABELLA precisely. No anchors were used for the operation.

The Argonaute was assisted by a dive team operated by SCAPH'EUSSA, which also had a support vessel from the company IROISE MER (a small vessel of about 5 metres was also present). The latter was used mainly for the landing of the cable and for its ensoulment.

Finally, land-based construction equipment was mobilised on Ushant to guide the cable up the beach.

Figure 10: Naval resources mobilised, the Argonaute and the barge Iroise Mer (SABELLA)

Figure 11: Resources mobilised on land (SABELLA)

3.1.2.3.1.2 Sequence of operations

The Argonaute, positioned a few hundred metres from the beach, transferred the end of the cable to the shore team, using a messenger line transmitted by the IROISE MER barge. 200 metres of cable were then pulled onto the beach, then the cast iron protective shells were installed on a 250 m section of the cable.

Figure 12: Positioning of the Argonaut - pulling the cable onto the beach - placing the shells (SABELLA)

The remaining length of cable was then laid on the bottom by unwinding the cable as the vessel moved along the planned cable route.

At the end of the cable, the connector was placed on the bottom. In order to allow the recovery of the cable, in view of the connection between this cable and the strap attached to the tidal turbine, the end of the cable was equipped with a recovery system: a metal cable of approximately 100 metres, a floating end, a plate weighing approximately 200 kilograms equipped with two acoustic beacons. [7]

[7] These tags are used to locate the connector.

Figure 13: The submarine cable (left), the connector (middle) and the dead body with its two acoustic beacons (right) (SABELLA)

In parallel with the completion of the cable installation, on 26 May 2015, the cable was sunk by the diving team along its entire length in the sandy area, and weighted down by rocks in the intra-port area.

Figure 14: Embedding the cable in the sandy area (SABELLA)

3.1.2.3.2 Installation of the tidal turbine

3.1.2.3.2.1 Nautical means

The vessel used for the installation of the "Sabella D10" tidal turbine is the Palembang, from the German company COMBI LIFT. This 133-metre long vessel has two 450-tonne cranes for lifting the tidal turbine, which weighs around 400 tonnes.

This vessel does not have a dynamic positioning system. In order to maintain its position in the Fromveur Passage, it was anchored at two points, using its own anchors moored to the front of the vessel. To keep the vessel in the

current, three tugs were chartered. The three tugs chosen were the Gascogne, the Croisic and the Saint Denis, belonging to the company BOLUDA.

Figure 15: The Palembang and two of the three tugs used, the Gascogne and the Croisic (SABELLA)

3.1.2.3.2.2 Sequence of operations

The launch took place in two stages:

- immersion of the tidal turbine in an area slightly outside the Fromveur, with much less current (25 June 2015 in the morning), and hanging under the hull on suspension tables;
- moving to the site and placing the tidal turbine (and its cable strap) on the bottom (25 June afternoon).

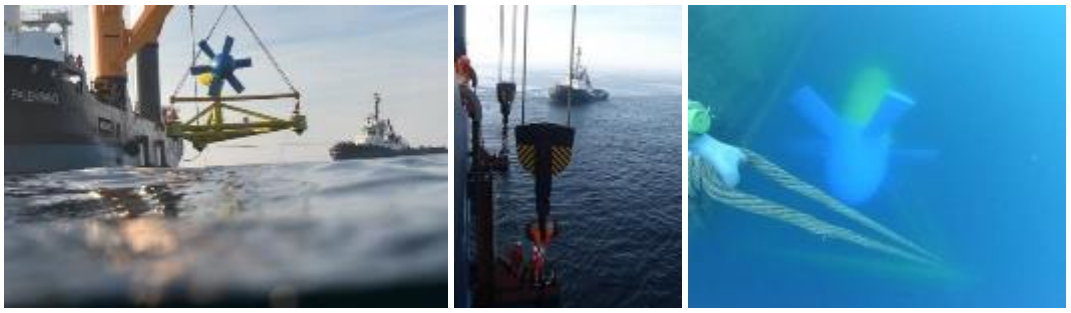


Figure 16: Launching of the tidal turbine (SABELLA)

On the evening of 25 June 2015 and the morning of 26 June 2015, the ROV[8] carried out a bottom check.

Figure 17: Submarine turbine and connector placed on the bottom (SABELLA)

3.1.2.3.3 Connecting submarine cables

[8] Remotely Operated Vehicle: underwater remotely operated vehicle

3.1.2.3.3.1 Nautical means

The connection between the cable ramp linked to the tidal turbine and the export cable of the tidal turbine was again made with the Argonaute, which had laid this cable in May. Its dynamic positioning system allows it to remain in position in the Fromveur Passage for about 2 hours around slack water during neap tides.

3.1.2.3.3.2 Sequence of operations

The operation to connect the ramp and the export cable took place on 20 and 21 September 2015. Due to the possibility of working only around slack tide, the operations were sequenced as follows:

- Bring the two connectors together by lifting the ends of the cables and placing them back in the desired position;
- The two cable ends were lifted, an arch was put in place to respect the bending radius of the cable, the two connectors were installed on a guide plate to secure and pre-align them in preparation for their subsequent connection, and the whole unit was put back in the water;
- lift the assembly, open the two half-connectors and connect, then test from the ground and lay the connected assembly on the bottom;
- ROV visual inspection of equipment on the seabed.

The connection was made on 21 September 2015 at 11 a.m., the brakes were disengaged and the rotor of the "Sabella D10" tidal turbine was able to make its first turns under water.

Figure 18: Connection of the tidal turbine to its electricity export cable - 21/09/2015 (SABELLA)

3.1.2.3.4 Laying the export cable (foreshore section) and the delivery station

3.1.2.3.4.1 The means

The means of installing the cable at the foreshore is shown in the figure below.

Figure 19: Means for installing the cable on the foreshore (SABELLA)

3.1.2.3.4.2 Sequence of operations

The cable

As mentioned earlier, when the export cable was laid, the land end was pulled by construction equipment to the car park at the top of the Porz ar Lan car park. During the laying of the onshore end of the cable (on 4 and 5 June 2015), the cable was pulled up from the beach to the road above, along the cliff, by pulling it up into the rocks just past the slipway. The cable was fixed in the rocks and covered with a signal and safety sheath. Along the cliff, a trench was dug and the cable was buried.

Figure 20: Passage of the cable past the slipway and along the cliff (SABELLA)

The containers

The conversion container (in which are also installed the control and command tools of the tidal turbine, as well as the satellite communication for remote control) was delivered and installed in Ushant on 28 and 29 May 2015. The export cable was then connected to it.

The second container for the grid connection was installed on 24 September 2015 and connected to the control container on the one hand and to the Ushantine grid on the other.

Figure 21: Installation of the conversion and control container (SABELLA SAS)

3.1.2.4 Operation of the demonstrator

The objective of the demonstrator is to validate the technology on a scale of 1. To do this, the performance of the tidal turbine and its behaviour on the site are analysed and measured by SABELLA.

The environmental footprint of the tidal turbine is studied *via* an environmental monitoring protocol

During the lifting operations, only the turbine is lifted. During the installation of the tidal turbine in June 2015, the vessel used did not have dynamic positioning and was therefore anchored to the seabed. The feedback from this operation led SABELLA to opt for dynamically positioned vessels during the lifting and release operations in July 2016, October 2018 and April 2019. This will also be the case for future immersion and emersion operations.

3.1.2.5 Dismantling the demonstrator

By September 2022 at the latest, the entire demonstrator will be raised. The turbine and the base will be raised in reverse order to the installation operation.

The cable will be lifted by a cable-laying vessel on the maritime section and then by construction equipment on the land section.

The two containers forming the delivery station will be loaded onto trucks and then transported back to the mainland.

3.1.3 The preliminary studies carried out in the context of the Sabella D10 project

Environmental studies began in 2010 on the Fromveur Passage site. These studies were part of the environmental impact assessment required by the regulations in force at the time. Thus, in this context, specific studies and field investigations were carried out mainly on the physical and biological environment:

Specific studies and investigations carried out on the physical environment					
Date of missions	Provider	Title of the study or assignment	Details		Reference
December 2010	IN VIVO	Geophysical measurements prior to the implementation of a tidal demonstrator in the passage of the Fromveur	Sediment sampling (granulometric and biological analyses) at the landing zone		In Vivo, 2011b
			Topographic survey at the landing zone		
			Sediment sampling (granulometric and biological analyses) in the area of the cable route.		
			Survey of the seabed using video towing in the area of the cable route and the installation area.		
			Multibeam bathymetry at the site		
			Side scan sonar sediment survey of the siting area		
			Current profile measurements		
March - April 2011	IN VIVO	Tidal and current analysis in the Fromveur Passage	Installation of a current meter within the siting area		In Vivo, 2011c
May 2011	IN VIVO	Geophysical measurements in the Fromveur (cable route area)	Multibeam bathymetry		In Vivo, 2013
			Side scan sonar sedimentological survey		
June 2011	ARTELIA	Hydraulic study	Phase 1: Definition of conditions hydrodynamics on the website	Step 1: Establishing an offshore swell database	Artelia, 2011a
September 2011				Step 2: Offshore wave propagation study	Artelia, 2011b
July 2012				Step 3: Construction and validation of a numerical model three-dimensional (3D) hydrodynamics	Artelia, 2012
April 2016	IFREMER	Methods used for the noise characterisation ambient	Ambient noise measurements (without the tidal turbine)		Ifremer, 2016

Table 4: Specific studies and investigations conducted on the physical environment

Specific studies and investigations carried out on the biological environment				
Date of missions	Provider	Title of the study or assignment	Details	Reference
December 2010	IN VIVO	Measures geophysical for the implementation of a tidal turbine demonstrator in the Fromveur Channel	Sediment sampling (granulometric and biological analyses) at the landing zone	In Vivo, 2011b
			Sediment sampling (granulometric and biological analysis) in the cable route area	
			Survey of the seabed using video towing in the area of the cable route and the installation area	
February 2011	CALIDRIS	Collection and analysis of the literature on the risks generated by the SABELLA D10 project on marine birds		Calidris, 2011
May 2015	SABELLA SAS	Post video monitoring installation of the cable	Post-installation video monitoring of the cable by scuba diving in shallow waters (less than 20 metres) and by means of an underwater robot (ROV) in deeper waters	SABELLA SAS, 2015

Table 5: Specific studies and investigations conducted on the biological environment

3.1.4 Environmental monitoring

The environmental impacts of the installation and operation of the Sabella D10 hydrolic demonstrator are relatively limited.

However, some impacts have been monitored in order to improve knowledge of the impacts of tidal energy production in general and to specify the impacts on the environment of the Iroise Sea in particular.

3.1.4.1 Reminder of the monitoring protocol

The monitoring programme presented in the *"New application for permission to maintain the tidal turbine demonstrator"* (Ecorivage, 2016) was as follows:

Environmental monitoring		Sub-fund(s) concerned	Acquisition methodologies
1	Acoustic measurements	Acoustic environment	Acoustic measurements before and after the installation (IFREMER)
2	Acoustic measurements	Acoustic environment	1 fixed hydrophone on the machine
3	Acoustic measurements	Marine mammals	1 specific marine mammal hydrophone (C-Pod), on the camera tripod
4	Current measurements	Courantology, turbulence	Immersion of two ADCP on the structure
5	Biofouling monitoring	Biofouling, reef effect	Delimitation of 4 x 3 quadrats (20x20cm) on the demonstrator and monitoring of colonisation by species of fixed fauna by photography, then by scraping during emersion (specific composition, biomass)
6	Monitoring of species behaviour	Marine mammals, fish, diving birds	2 fixed cameras, wide-angle, high definition and high power lighting - analysis of the risk of collision and the behaviour of species in the vicinity of the rotor

Table 6: All environmental monitoring in the new application (Ecorivage, 2016)

Article 4 of the prefectoral order of 18 May 2017 also specifies that: *"the project leader proposes a solid transport monitoring protocol in line with the demonstrator. It shall regularly inform the services of the difficulties inherent in the implementation of this type of monitoring. "*It should be remembered that the impacts of the tidal turbine on sediment transport had been considered negligible.

3.1.4.2 Progress and adaptations of the monitoring protocol

The entire monitoring protocol could not be implemented due to a technical incident during the installation of the demonstrator in June 2015. The progress of the monitoring protocol and its adaptations are presented in the following table:

Initial protocol				Acquisition and adaptation between June 2015 and July 2016	Acquisition and adaptation to From October 2018	Acquisition and adaptation to From June 2019
Follow-up		Compartment targeted	Acquisition methodologies (foreseen in the 2016 dossier)			
1	Acoustic measurements	Acoustic environment	Acoustic measurements	Before installation: Measurements carried out	-	-

			one-offs before and after the installation (IFREMER)	according to the initial protocol (Ifremer, 2015)		
				Monitoring not carried out	The analysis will be carried out as part of the preliminary studies for the project PHARES, by modelling from data measured before installation and data from the hydrophone attached to the machine	
2	Acoustic measurements	Acoustic environment	A hydrophone fixed on the machine	No acquisition following the technical incident during the of the installation	Acquisition in progress since October 2018 from the hydrophone attached to the turbine	Continuity of acquisition and campaign specific by drifting hydrophone
3	Acoustic measurements	Marine mammals	Two specific hydrophones mammals marine (C-Pod) attached to the machine	Data acquisition following the recovery of the two hydrophones by divers in May 2016	No acquisition since October 2018	August 2019: installation of a C-POD on the tripod video
4	Current measurements	Courantology, turbulence	Immersion of two ADCP on the structure	No acquisition following the technical incident during the of the installation	No acquisition since October 2018 (instruments not yet connected)	Acquisition from ADCPs fixed on 2 tripods located at a distance from tidal turbine and not attached to the structure as intended
5	Biofouling monitoring	Biofouling, reef effect	Followed by 12 plates for the effectiveness of diving paintings	Monitoring of the 12 quadrats during dives and monitoring of the colonisation on the turbine during emersion by scraping on 9 quadrats (20 x 20 cm)	Plotting 4 x 3 quadrats (20x20cm) on the demonstrator and monitoring the colonisation by fixed species - monitoring by dive	
6	Follow-up of the species behaviour	Marine mammals, fish, diving birds	2 fixed, wide-angle cameras, high definition and high power lighting	No acquisition following the technical incident during the of the installation	Since October 2018 acquisition from a fixed camera (instead of 2)	Acquisition from a fixed camera and two cameras mounted on a tripod

Carried out in accordance with the prefectural decree	Achieved or will be achieved after adaptation	Not achieved

Table 7: Current status of the monitoring protocol

Some monitoring could therefore be carried out in accordance with the protocol defined in the Order of 18 May 2017. Others could not be implemented or had to be adapted.

3.1.5 Initial results of environmental monitoring

Summaries of the first monitoring results are presented below.

3.1.5.1 Monitoring 1 - Acoustic point measurements, from the surface, carried out before the installation

3.1.5.1.1 Acoustic measurements at fixed points

The ambient noise measurement campaign in the Fromveur Passage, in fixed point acquisition mode, took place on 13 and 14 April 2015, with relatively low tidal coefficients of around 50.

The fixed-point monitoring measurements proved to be inconclusive, as the Ifremer report states*: "This fixed-point deployment in a very strong current zone (up to 4.5 to 5 knots), which was a first, went well. The local recording of acoustic data and their transmission by Wi-Fi were validated. The data acquired continuously for 6h + 12h were processed and analysed. The noise levels are very high and do not only characterise the ambient noise, due to the poor hydrodynamic behaviour of the recorder, in both configurations tested. We were aware at the outset of the complexity of the area for acoustic measurement, particularly for a fixed-point mode; these acquisitions have largely confirmed this perception. »*

3.1.5.1.2 Acoustic measurements in drift mode

The campaign took place on 19 June 2015 (acquisitions from 10:00 to 17:00), with a high tidal coefficient (85), in drifting mode. The maximum current measured during these measurements was slightly above 6 knots.

"The results show that the ambient noise reaches a maximum in the very low frequencies (< 10 Hz) of over 135 dB. In the high frequencies (10 kHz), the noise levels are between 60 and 80 dB depending on the time of acquisition and therefore on the time of the tide. »

3.1.5.2 Monitoring 2 - Acoustic measurements at the tidal turbine

For the time being, data have been collected, but not processed in such a way that they can be interpreted.
These data are to be analysed shortly and will be the subject of an interpretation report.

3.1.5.3 Monitoring 3 - Acoustic measurements - marine mammals

Two C-POD marine mammal click recorders were installed on the machine in September 2015. The instruments were recovered by divers in May 2016, after a year of immersion. As the instruments are battery operated, they stopped acquiring data after 4 to 5 months of operation, depending on the device.

The C-PODs were positioned as follows:

- Station 1: starboard support of the tidal turbine (C-POD n° 2067); Station 2: port support of the tidal turbine (C-POD n° 2068).

The photo in the following figure shows the position of the C-PODs on the machine.

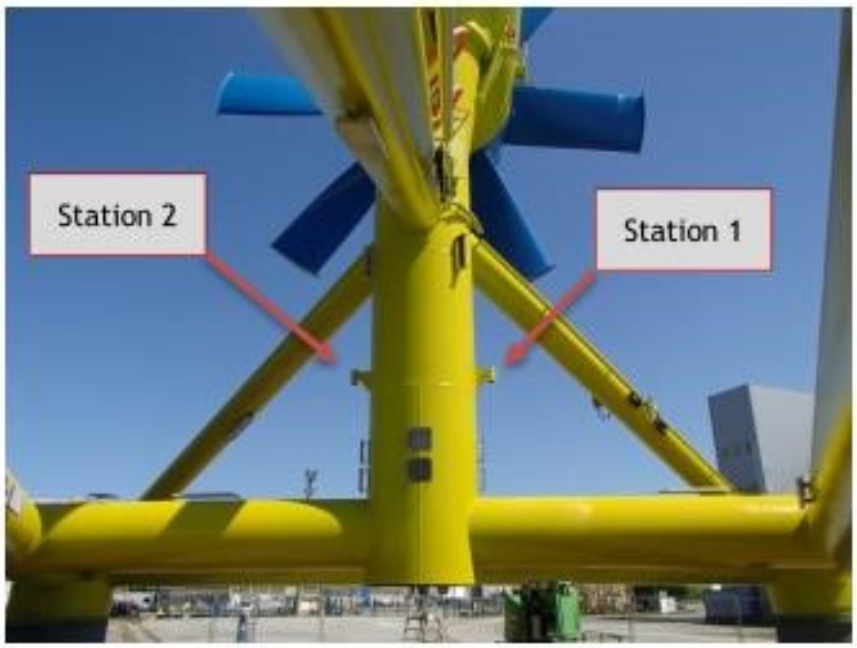


Figure 22: Position of the C-PODs (Setec in vivo)

The results of this acoustic measurement campaign dedicated to the detection of marine mammals using C-PODs provide interesting information on the frequentation of the area, particularly by dolphins.
There is a strong seasonality, which varies according to the species (porpoise or dolphin).

The conclusions of this study are as follows:

- *"Dolphin detections were more numerous than porpoise detections (ratio of 4 over the whole measurement period, for both stations). This is directly linked to the frequency of use of the area, but also to the detection range (2-3 km for dolphins against only about 300 m for porpoises). The weight of the two criteria cannot be quantified.*
- *The average presence times are homogeneous for porpoises (between 1 and 1.3 hours) and more fluctuating and more important for dolphins (between 1.5 and 3.2 hours). This tends to indicate that porpoises spend less time in the listening area, with no change during the measurement period. It is possible that this is related to the transient nature of the porpoises' presence, but this must be qualified, as the detection ranges for dolphins and porpoises are radically different.*
- *The detection periods are not concomitant. Dolphin detections were numerous in June, July and August (to be qualified for the month of June which was strongly weighted), whereas porpoise detections were important in October. This could be explained by a known antagonism between the two species.*
- *Dolphin detections occurred mainly during the day and at sunset (+/- 1 hour) throughout the measurement period, with significant detections at sunrise (+/- 1 hour) in July and August. Porpoise detections were high at sunset and during the night. These results are consistent with previous studies carried out by Setec in vivo at other sites.*
- *No relationship could be established between the detections and the tide (height, amount/loss and coefficient).*
- *Dolphin detections, but no porpoise detections, were recorded during the periods of rotation of the tidal turbine. However, given the low number of operating hours, the absence of control CPODs outside the*

potential nuisance perimeter of the operating tidal turbine, and the unknown distance of the dolphin detections from the rotating tidal turbine, no reliable trend can be identified. "(Setec In Vivo).

If the monitoring of marine mammals yields initial results, it could be maintained in order to estimate the actual impact of the tidal turbine operation on marine mammals.

3.1.5.4 Monitoring 4 - Current measurements

Data were collected by SABELLA (current measurements by ADCP on independent tripods in autonomous operation) during two measurement campaigns carried out between the summer of 2016 and the spring of 2017, while the turbine was out of the water. These measurements could be compared with the current prediction model developed by SABELLA, but did not make it possible to analyse the impact of the tidal turbine on the currentology. These measurements will be continued after re-immersion of the turbine in summer 2020 and connection of the two ADCPs to the machine.

3.1.5.5Monitoring 5 - Biofouling monitoring (diving and emersion)

A biofouling study was carried out in October 2017 and is based on more than one year of immersion of the tidal turbine (June 2015 to July 2016). This study is based on the following data:

- video footage taken by diver (at the plates) during technical visits in August, September and October 2015 and April and May 2016;
- photographs taken during the lifting of the machine (turbine) on 13 July 2016 and also during the cleaning of the machine on 19 and 20 July 2016;
- samples taken from the turbine on 13 July 2016.

The conclusions of this study are as follows:
"Macro-biofouling or colonisation by sessile fauna (in view of the depth of the site) develops in 4 main stages which are :

- *Recruitment phase (0-16 months) or initial transitional stage, depending mainly on the immersion period and only on physical factors, mainly temperature;*
- *predominance stage (12 to 24 months), depending mainly on the combination of physical and biological phenomena;*
- *Predestination stage (around 16 months): biological interrelating factors have taken precedence over physical factors;*
- *Maturation stage (24 to 48 months), or qualitative climax phase: this "pre-climactic" state, reached at around two years of age, corresponds to the stage where almost all the species of the rock are represented, but where they are not in the ratio of abundance, size and population structure observed in the natural stands of the rock in place;*
- *Climax or final stage (> 48 months): this is the final phase where the stand is equivalent to a stand on a similar bedrock.*

In our case, despite a fairly high biodiversity (24 species) and very high abundances of certain species (Anomias, for example), we are still in the first phase of recruitment. The presence of the species observed was only conditioned by their presence in the plankton and in the water column during the immersion period. This assemblage of species is

therefore only due to chance, without any biological interrelationships between them. In the future, as indicated for this phase, some species will disappear in favour of other, more perennial species.

We have not yet been able to observe any significant difference between the different orientations of the machine (horizontal surfaces compared to vertical surfaces, surfaces facing the current compared to those in the current, etc.). However, a very clear difference in species was observed in the rear bulb, which was loaded with fine sediment and thus constituted a biotope favourable to the development of the scallop bivalve. This presence is very unusual and is solely due to the accumulation of silt in the bulb and the presence of scallop larvae in the water mass, the origin of which remains unknown, but which may be very distant from the Fromveur itself. "(Gaïa Terre Bleue, 2017).

3.1.5.6 Monitoring 6 - Analysis of species behaviour (installation of cameras on the turbine and on the tripod)

Under the initial protocol, two cameras were attached to the tidal turbine and the data was to be retrieved in real time. The technical incident that occurred during the installation of the tidal turbine in June 2015 did not allow the data to be recovered.

During the launching operations in October 2018, the protocol for monitoring the behaviour of the species was adapted and two cameras were installed on an independent tripod placed under the rotor as well as a camera fixed on the machine. The data is retrieved remotely via the tidal turbine's underwater cable, in the container on land. The first video captures have allowed the acquisition of numerous images, of which two examples are shown below (videos of 17 October 2018 from 16:42 and 17 October 2018 from 17:12).

Figure 23: Capture of the videos taken by the camera attached to the turbine (SABELLA SAS)

The first analyses of the images show an absence of fish when there is a current. The analyses show the occasional presence of fish in the vicinity of the tidal turbine, during slack tide. The analysis of the video images from the cameras will be continued after the turbine is re-immersed in the summer of 2020.

3.2 The TIGER project

3.2.1 General description

The TIGER project is based on two D08 type H1 and H2 tidal turbines with a diameter of approximately 8 metres and a unit power of 250 kW.

Figure 24: Artist's view of the TIGER experimental project (SABELLA)

The tidal turbines will be installed on the site known as "Ile longue", between the Pointe du Monténo (commune of Arzon) and Ile Longue (commune of Larmor-Baden).

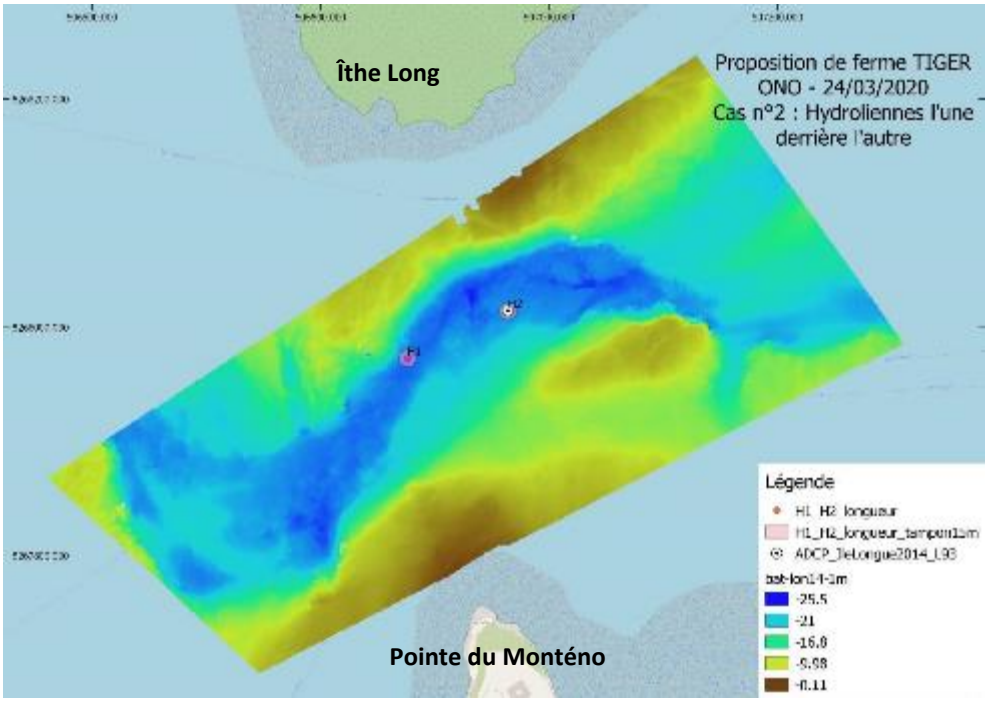


Figure 25: Installation of the two D08 tidal turbines on the Ile longue site (SABELLA)

The tidal turbines will be installed at a depth of around 22 m CM[9] .

[9] CM: Marine Chart Datum - a depth in marine chart datum is expressed in metres relative to the hydrographic datum. The latter corresponds to the chart datum for a tidal coefficient of 120.

With regard to the tests carried out on the impact of the wake[10] on the SABELLA tidal turbines, the turbines are spaced with respect to the main axis of the current:

- in the longitudinal direction of 9 diameters centre to centre, i.e. 72 m
- in the latitudinal direction of 2 diameters centre to centre, i.e. 16 m

The proposed coordinates of the rear legs of the two tidal turbines in UTM30 are as follows:

	X	Y
H1 tidal turbine	506875	5267973
H2 tidal turbine	506965	5268015

Table 8: Coordinates of the rear foot of the two TIGER tidal turbines

One underwater power cable per machine will allow the power to be exported to land.

3.2.2 Presentation of the facilities

3.2.2.1 Turbines and their bases

3.2.2.1.1 Characteristics of tidal turbines

The technical characteristics of the D08 tidal turbines envisaged in this project are presented in the table below.

Characteristics of Sabella D08 tidal turbines	
Rated power (kW)	250
Starting current speed (m.s-1) Rated current speed (m.s-1)	1 3.2 (H1) and 3.1 (H2)
Height (m) **Width (m)** **Mass (t)** **Maximum draught (m)** **Rotor diameter (m)** **Pod diameter (m)**	14 à 15 14 to 18 (base wheelbase) 350 t 7 8 2,5
Number of blades **Blade length (m)** **Blade profile** **Blade material** **Blade swept area (m²)**	3 3,5 Symmetric (H1) and asymmetric (H2) Carbon / epoxy 50

Table 9: Technical characteristics of D08 tidal turbines

3.2.2.1.2 Turbines

[10] Wake: The wake is a vortex effect that develops behind a tidal turbine. It causes a decrease in the current speed behind the turbine, resulting in a decrease in efficiency and an increase in turbulence, leading to an increase in the loads on the blades.

The D08 turbines are fixed and each consists of a nacelle and a three-bladed rotor. The mass of each turbine is 50 t.

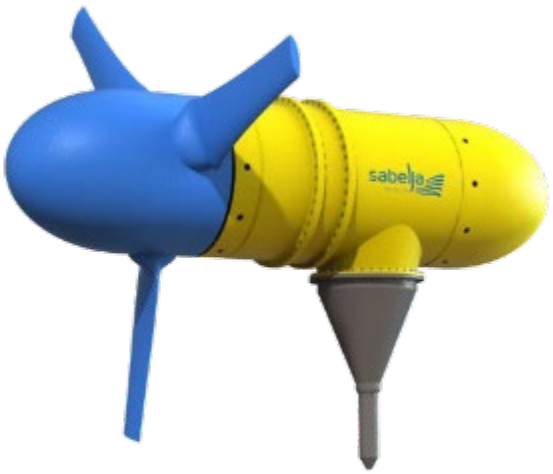


Figure 26: 3D view of the preliminary design of the D08 turbine (SABELLA)

The nacelle of the tidal turbines houses the electrical chain which groups together the functions of electrical generation, conversion and transformation of the signal before export in the submarine cable.

The nacelles are protected against corrosion by indium aluminium sacrificial anodes, fixed at various points. For each nacelle, the mass of the anodes is estimated to be around 200 kg.

The export cable is connected to the cradle with a wet-matte junction to allow underwater connection (see "Connection to the cradle").
3.2.2.2).

3.2.2.1.3 The bases

The base does not house the core of the technology, which is focused on electricity production, but it does meet the need for stability of the tidal turbine placed on the seabed in the face of hydrodynamic loads induced by tidal currents and swell.

It should be noted that it could be planned to disconnect part of the electrical conversion on the base, on at least one of the two tidal turbines.

The base planned for the D08 tidal turbines is in line with the concepts previously developed by SABELLA. It is the result of the experience acquired during the D03 and D10 projects and specific research programmes, particularly on hybrid steel-concrete bases. Its design is also based on MHE's current knowledge of the geotechnics and geophysics of the Ile Long site.

For reasons of ease of implementation, preservation of the seabed and the nature of the soil, the choice of a gravity base was made.

The basic principles of this base are as follows:

- a gravity base resting on three legs, to ensure stability and avoid any hyperstatic problems;
- Places in each foot to accommodate cast iron weights to provide sufficient weight in the water to prevent slippage and tilting of the turbines under load, while allowing for modular installation and a reasonable weight to be lifted during installation;
- a robust turbine/base interface inspired by offshore oil concepts, allowing the separation of the tidal turbine stabilisation (the base) and electricity production (the turbine) functions.

Figure 27: 3D view of the preliminary design of the D08 base (SABELLA)

The base structure is made of S355 steel. Different tube diameters and steel thicknesses are used for different sub-assemblies of the base to meet the loadings encountered. Cast iron weights are installed in dedicated locations at each leg. It is also possible that part of the base, on at least one of the two turbines, is made of concrete.

The total mass of the whole base with its weights is about 300 tons:

	Mass
Base	60 t
Front ballast	2x 70 t
Rear ballast	100 t

Table 10: Mass of the tidal turbine base for TIGER

In the same way as for the nacelle, the protection of the steel elements against the corrosion of the bases is ensured by indium aluminium sacrificial anodes, fixed at various points of the structure. The mass of the anodes for each base is estimated to be around 600 kg.

The entire design and manufacture of the base is carried out in accordance with the BUREAU VERITAS Hydropower Certification Framework.

3.2.2.1.4 Turbine base interfaces

The interface system between the turbine and the base consists of a male and a female steel cone, fixed to the turbine and the base respectively. A centring finger is added under the male cone to facilitate the approach of the turbine to the baseplate. This centring system has already been implemented on the Sabella D10 demonstrator and has been used several times at sea with great success.

3.2.2.2 Export cables and the injection point

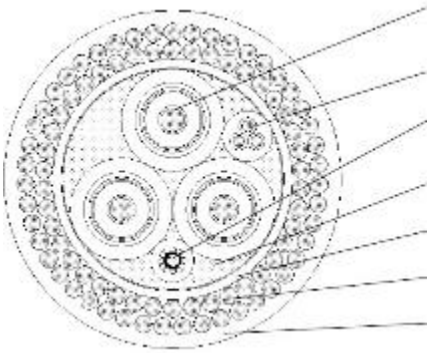
The export cables are directly connected to each turbine via a junction with passive wet mate connectors and a guide system. This connection system is watertight and does not require any specific action. The wet mate connection eliminates the need for a dry mate connector and a cable drop loop, as on the D10 demonstrator.

Figure 28: 3D view of a passive wet mate connection (SABELLA)

The two cables, with a voltage of approximately 7.5 kV, which connect the tidal turbines to the delivery point at Monténo Point, have a total length of approximately 1.2 km for H1 and 1.3 km for H2, a diameter of 70 mm and a linear mass of 12.4 kg/m. Each cable consists of :

- three copper conductors allowing the passage of a voltage of 7.5 kV and a nominal current of 50 A per phase for the transmission of electrical power;
- three copper conductors allowing the passage of a voltage of 1 kV for the supply of auxiliaries;
- eight single-mode optical fibres for communication and bi-directional transfer of information between the ground and the machines.

A diagram of this cable including its main properties is shown below.



35 mm² copper insulated 6/10(12) kV with individual lead shielding and individual LDPE shielding
3 conductors of 6 mm² copper insulated 1 kV under PE sheath
8-unit unimodal fibre optic element
Polypropylene wire packing HDPE inner cladding
Double weave galvanised steel wire
HDPE outer sheath

Figure 29: Diagram of submarine electricity export cables

These cables will be laid on the seabed and will be protected and stabilised over a large part of their length, in particular from the coast to the northern limit of the Monténo point. This stabilisation will be carried out with cast iron half-shells. These cast iron shells, with a mass of 100 kg/m, were developed in partnership with FMGC as part of the D10 demonstrator. They were implemented on the export cable still submerged in the Fromveur Passage, over a length of 200 m in the shallow water approaching the coast and on either side of the cable ramp abandonment loop. To date, no significant movement has been observed on the D10 demonstrator export cable, which has been submerged since May 2015.

In the intertidal zone, the cables will be buried for the entire length in the sandy zone to ensure the invisibility of the two submarine export cables.

The cables will arrive on the coast in the commune of Arzon, at the Tréno beach or at the Port Douar street.

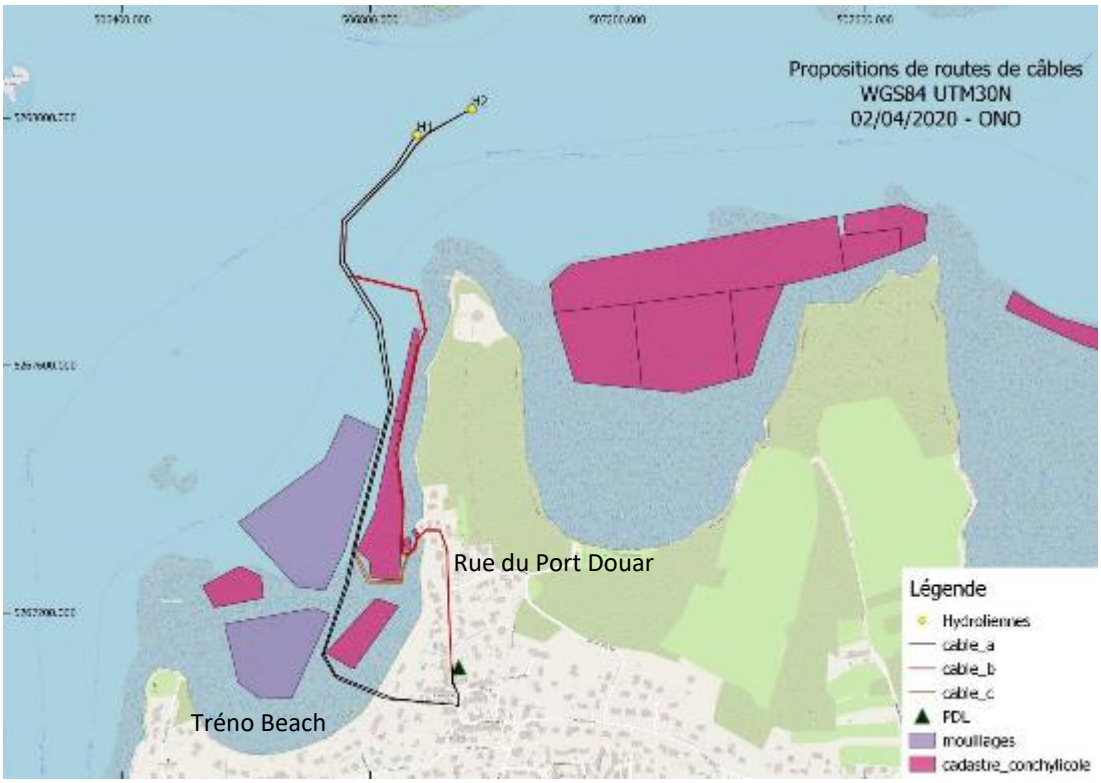


Figure 30: Cable route from the tidal turbines to the delivery point - (SABELLA)

A connection chamber will be installed to connect the submarine cables to the land cables. The land cable(s) will then be connected to the delivery point located at 12 rue du Port Douar, where the ENEDIS substation is located.

The capacity of the latter will have to be increased in order to allow the injection of all the energy produced by the tidal turbines. The terrestrial cables will be buried.

A pilot station will be set up to house the control and command tools for the D08 tidal turbines, as well as satellite communication for remote control. In the case where an arrival in Port Douar street is chosen, the pilot station could be installed near the shore. In the other case, it is likely that the pilot station will be directly integrated into the injection station. In this case, it will be installed at 12 rue du Port Douar.

In all cases, the landscape integration of these buildings will be the subject of a study carried out by a specialist firm.

3.2.3 Installation

3.2.3.1 Laying the export cable

As with the D10 demonstrator, the offshore cables will be unwound from a dynamically positioned vessel. The end of the cables will be transmitted by means of messenger lines onshore. A barge will be used to transmit these lines. The cables will be pulled from the beach by construction equipment to the connection chamber.

The remaining length of cable will be laid on the seabed by unwinding the cable as the vessel proceeds along the planned cable route.

The cable ends will be laid on the seabed at the location of the two tidal turbines.

In order to allow the recovery of these, the cable ends that accommodate the wet mate cable jointing system will be fitted with a recovery system with acoustic beacons. [11]

The cable will be sunk by the diving team along its entire length in the sandy area and by the shore teams on the foreshore. The installation of the protective shells will be done on the boat by the dedicated teams.

The terrestrial cable(s) will be buried under the road to the substation.

3.2.3.2 Installation of the tidal turbines

The installation vessel must be able to position itself accurately without the use of anchors, for environmental reasons of non-deterioration of the seabed, in order to avoid the risks associated with the lifting of anchor chains. In addition, feedback from D10 showed that the use of anchors in the passage was not easy and presented potential risks. Therefore, the installation of the machines will be carried out exclusively with dynamically positioned vessels.

It is planned to install the two tidal turbines in several separate lifting operations.

[11] These tags are used to locate the connector.

Each of the tidal turbines will be installed in five "packages":

- package 1: the base without its weights ;
- Packages 2, 3 and 4: each of the base weights (one in each foot); Package 5: the turbine.

Each of the packages will have a maximum weight of 100 tonnes. This relatively limited weight will allow the use of a dynamically positioned vessel with average lifting capacities of around 150 tonnes. These vessels are typically around 100 metres long, have an ROV (underwater working robot) and can accommodate over 100 people.

There are quite a number of vessels in the market, and many operate in relatively close areas, especially in the North Sea. Mobilisation costs are therefore relatively reasonable and the availability of these vessels is good. An example of such a vessel is shown in the figure below.

Figure 31: Far Superior, DP2 vessel used for D10 resting in October 2018 (SABELLA)

This type of vessel has several major advantages:

- safe installation and proven naval means;
- Installation methods tested and proven on D10 several times, significant feedback;
- precise installation thanks to dynamic positioning;
- respect for the environment and the seabed thanks to the absence of anchoring;
- acceptable limiting environmental conditions and leaving statistically sufficiently frequent and long installation ranges;
- qualification of a future solution that will certainly be used for future commercial farms;
- relatively low cost due to good availability;
- flexibility of these vessels, based near the installation area.

Two trips between Brest and the Ile Longue site will be necessary for this installation operation.

1. The vessel will first take on board the bases of the two tidal turbines and install them in their final position. The ship will then proceed to the installation of the wet mate connections by lifting the cables from the bottom and placing them in their dedicated position on each base.

Figure 32: 3D view of the preliminary design of the D08 sub-base with its wet mate standby system (SABELLA)

2. It will then come to Brest to load the weights of the two bases as well as the two turbines. The ballast weights and the turbines will then be placed on the bottom of the water on their respective bases. The turbines will be directly connected to the cables during the installation by means of the wet mate junction.

For each of the packages, the installation vessel will position itself in front of the installation point. The installation of each element on the seabed will then be carried out using the ship's crane. The orientation of the elements, in particular that of the bases, which must imperatively be installed perfectly facing the current, will be carried out by rotations and movements of the crane and the vessel. The ROV (underwater robot) will also be on the seabed and will be able to rotate the elements with its thrusters, if necessary.
An inertial unit and/or acoustic beacons will be placed on each of the elements, so that the position and orientation of the equipment during the descent is always available on the surface. All underwater operations will be monitored visually by the ROV.

The turbines will be installed with the help of a special tool, called the Launch and Recovery System (LARS). It consists of a metal structure that follows the shape of the nacelle on the underside and has four hydraulically activated lifting rings that close on the turbine's lifting trunnions. This tool eliminates the need for complex and time-consuming slings and greatly simplifies operations. This system was used and tested during the lifting of the D10 turbine in July 2016 and April 2019 and its re-installation in October 2018.

Figure 33: LARS used for D10 (SABELLA)

The guidance of the turbine on its base is facilitated by the centring finger located under the turbine. The procedure for placing a turbine on its base is shown below.

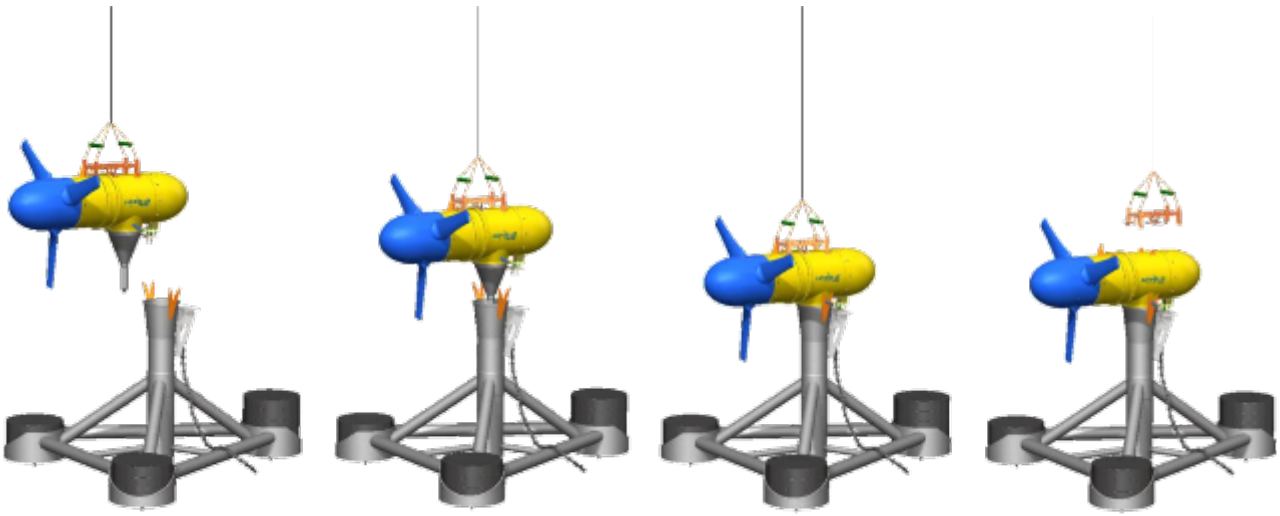


Figure 34: Procedure for installing the turbine on the base (SABELLA)

3.3 Main differences between the Sabella D10 project and the TIGER project

The TIGER project has many similarities with the Sabella D10 project. The similarities between the two projects are

- the methodology of the work ;
- the importance of the preliminary studies carried out.

The main changes between D10 and D08 tidal turbines are as follows:

- implementation of two tidal turbines instead of one
- Reduction in blade length from 10 metres to 8 metres diameter;
- changing the number of blades from six to three using a wet mate connection

4 THE MAIN CHARACTERISTICS OF THE ENVIRONMENT IN THE STUDY AREA

4.1 Defining the issues

The impact study guides, available on the Ministry's website, state: "*the analysis of the initial state constitutes the reference document for characterising the environment and assessing the consequences of the project. It aims to identify and prioritise the environmental issues in the study area. The analysis of the initial state concludes with an identification of the environmental issues*" (MEEDM, 2010).

"The issue represents for a portion of the territory, taking into account its current or foreseeable state, a value with regard to heritage, aesthetic, cultural, living environment or economic concerns. The issues are assessed in relation to criteria such as quality, rarity, originality, diversity, wealth, etc. ».

At the end of the analysis of each component analysed in the framework of the baseline, a synthesis will be presented and an issue level will be attributed for each component according to the following ranking

Very high stake
High stakes
Medium stakes
Low stakes
Null or Negligible (N) or Not Determined (ND)

Table 11: Classification of issue levels

4.2 The physical environment

The elements presented hereafter come from numerous biobibliographic data collected by the UBS (UBS, 2018), but also from specific field investigation studies implemented in the framework of this project:

Studies and investigations carried out in the framework of the TIGER project

Date of missions or study	Provider	Title of the study	Details	Reference
November 2014	UBS	Missing title - study not appended	Bathymetric survey in the channels of the Gulf of Morbihan	UBS, 2018
Missing date	UBS	Missing the title - study not implemented annex	Current measurements	Sedrati et al, 2016
2 to 20 June 2017	Quiet Oceans	Tidal turbines in the Gulf of Morbihan - Acoustic impact assessment	▶ Initial state of the acoustic environment : field measurements to analyse the ambient noise ▶ Modelling the propagation of sound levels generated by tidal turbines	Quiet Oceans, 2018

Table 12: Field investigations carried out in the TIGER project

4.2.1 Bottom morphology

The morphology of the seabed was the subject of field investigations (bathymetric survey) carried out in November 2014 by the UBS. In order to analyse the mobility and flatness of the seabed, the data acquired by the UBS was compared with data acquired by the SHOM in 2004.

4.2.1.1 Bathymetry

The following figure shows the bathymetric map of the potential siting area.

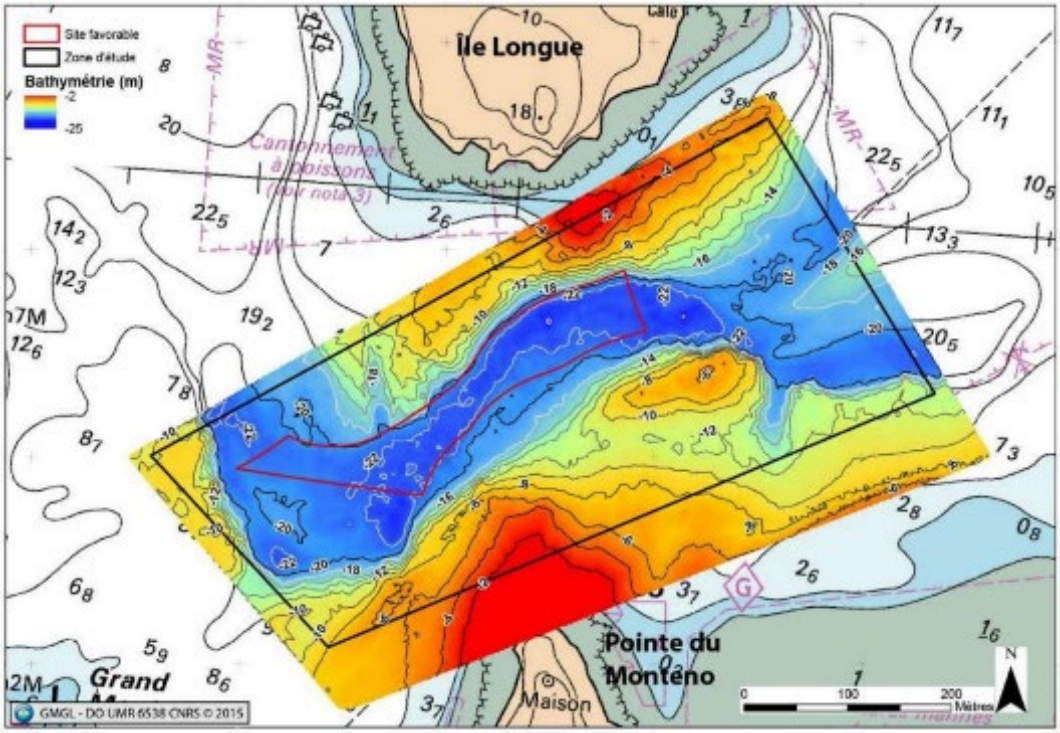


Figure 35: Interpolated Digital Terrain Model in ArcGis for the November 2014 SMF bathymetry (0.5m grid) South of Ile Longue with isobaths every 2 metres (SHOM chart base 7137) (UBS, 2018)

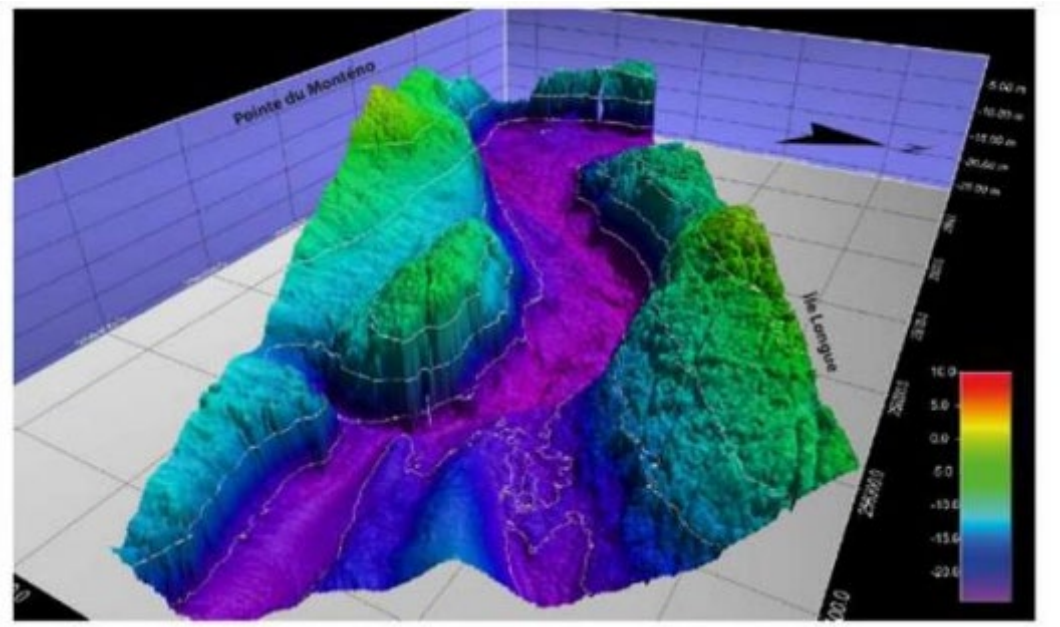


Figure 36: 3D Fledermaus morpho-bathymetric representation of the site located south of Ile Longue from the data from November 2014 (westward looking, vertical exaggeration x 5) (UBS, 2018)

The site to the south of Ile Longue is located at the entrance to the Gulf of Morbihan and it is through this channel that most of the marine exchanges between the Gulf and Quiberon Bay take place. This channel is constrained to the north by Ile Longue and to the south by the Rhuys peninsula. There are two irregular rocky flats to the north and south which are the submarine extension of the aerial structures and whose depth rarely exceeds ten metres. In the

centre there is a meandering channel, 80 to 150 metres wide. At the level of this channel, the depth increases very quickly to 20 metres and can reach 24 metres.

4.2.1.2 Slopes

The following figure shows the slopes at the bottom.

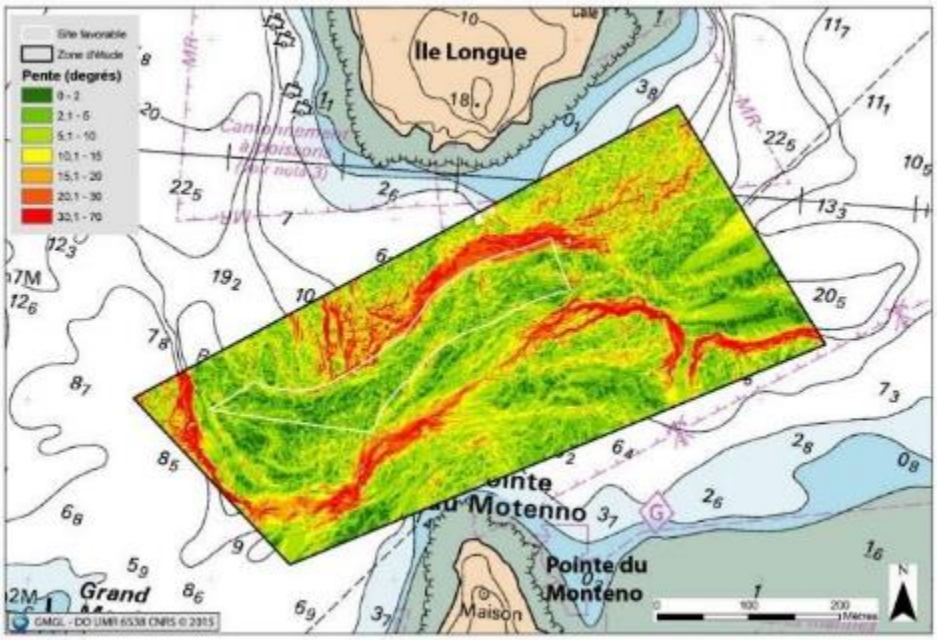


Figure 37: Slope map (degrees) from bathymetric data November 2014 gridded at 1m (SHOM chart base) 7137) (UBS, 2018)

The analysis of the slope maps confirms the existence of almost flat surfaces (slope < 5°) at the level of the preferential polygons for the potential installation of turbines. Indeed, the steepest slopes were found on the sides of the meandering channels.

4.2.1.3 Evolution of the funds

Differential Digital Terrain Models (DTMs) were produced with bathymetric data measured in 2004 by SHOM and those acquired in 2014 by UBS, in order to map the evolution of the seabed on the study site.

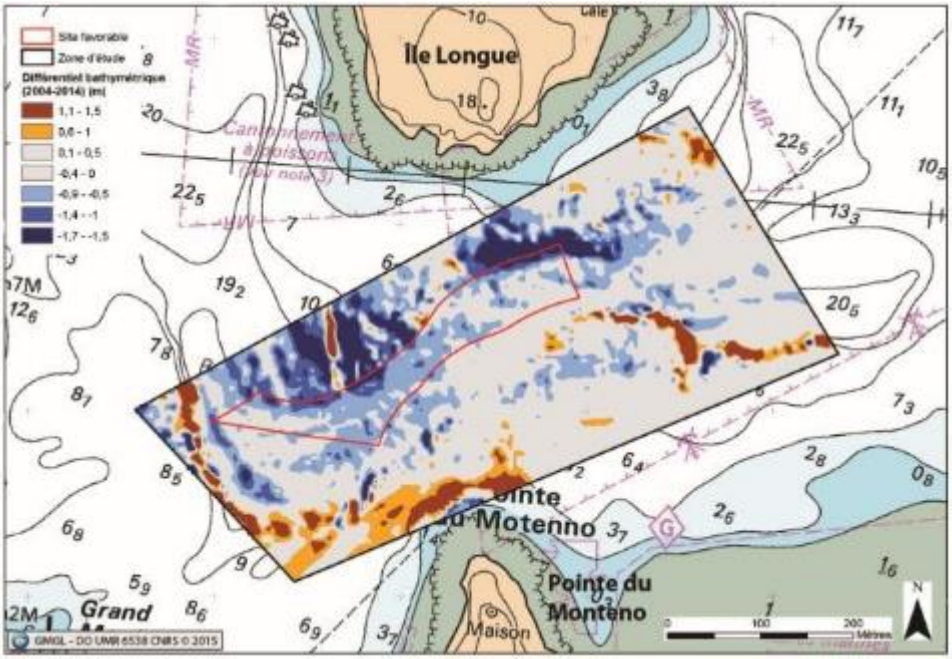


Figure 38: Bathymetric differential between 2014 and 2004 (5m grid) (SHOM 7137) (UBS, 2018)

The differential DTMs between the Litto3D® bathymetry (2003-2004S, SHOM) and November 2014 (SMF bathymetry carried out specifically for this study) showed the absence of significant seabed mobility at the study site. The very small altimetric differences observed on the differential DTMs are mainly due to the limits of the interpolation of the bathymetric data from the Litto3D® bathymetry, meshed at five metres.

The bathymetry at the site shows depths ranging from 20 to 24 m CM. The bathymetric survey shows also a no slope and no change in the bottom.

4.2.2 Hydrodynamic agents

In the Gulf of Morbihan, the main hydrodynamic agent is the tidal currents. The influence of waves (swells, wind seas) is also discussed.

4.2.2.1 Currentology

4.2.2.1.1 In the Gulf of Morbihan

At the entrance to the Gulf, south of Ile Longue, the current can reach speeds of up to 9 knots in white water. The Mare current is thus the second strongest current in Europe and makes the reputation of the Gulf of Morbihan. At each tide, the large volumes of water that enter the Gulf in strong currents through the Port-Navalo Narrows are directed to the west and south of the Ile-aux-Moines, then slowed down when they reach the shallows of the eastern part of the Gulf (Figure 39). This loss of speed leads to the deposition of sedimentary particles in suspension and explains the marked distinction between the western and eastern basins of the Gulf of Morbihan. Tidal currents are thus a major parameter in the erosion and sediment deposition processes in the Gulf (DOCOB Natura 2000 ZSC " Golfe du Morbihan, côte ouest de Rhuys " et ZPS " Golfe du Morbihan ", 2013 in UBS,

2018).

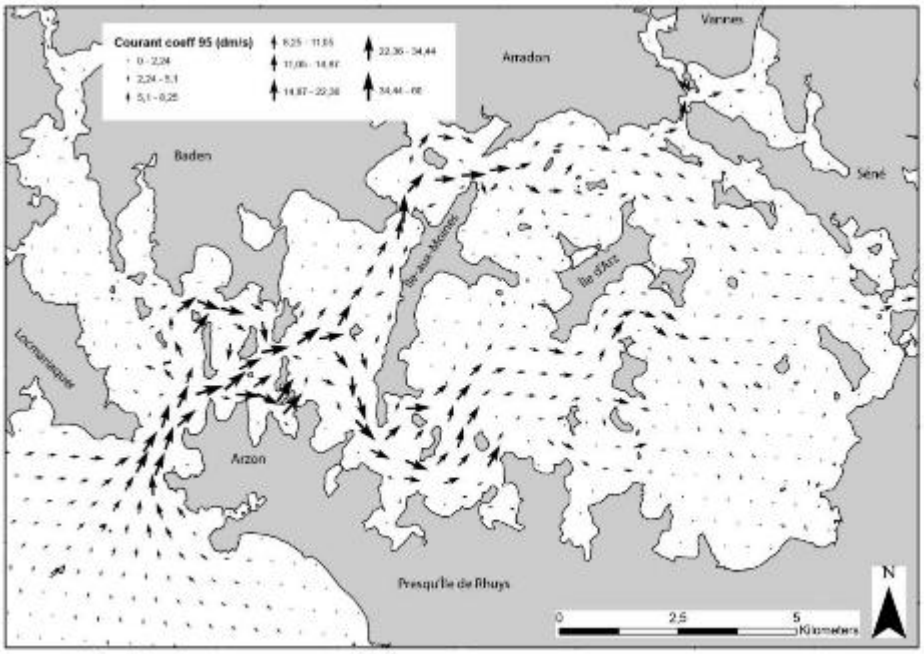


Figure 39: Map of currents in the Gulf of Morbihan at high tide for a coefficient of 95 (SHOM) (UBS, 2018)

4.2.2.1.2 At the level of the study site

In the framework of this project, current measurements were carried out. Two complementary approaches to hydrodynamic data acquisition were implemented: point measurements and current profiles (Sedrati et al., 2016). For both approaches, measurements covering a wide range of tidal conditions were carried out (two tidal cycles for point measurements and current profiles in neap and spring conditions).

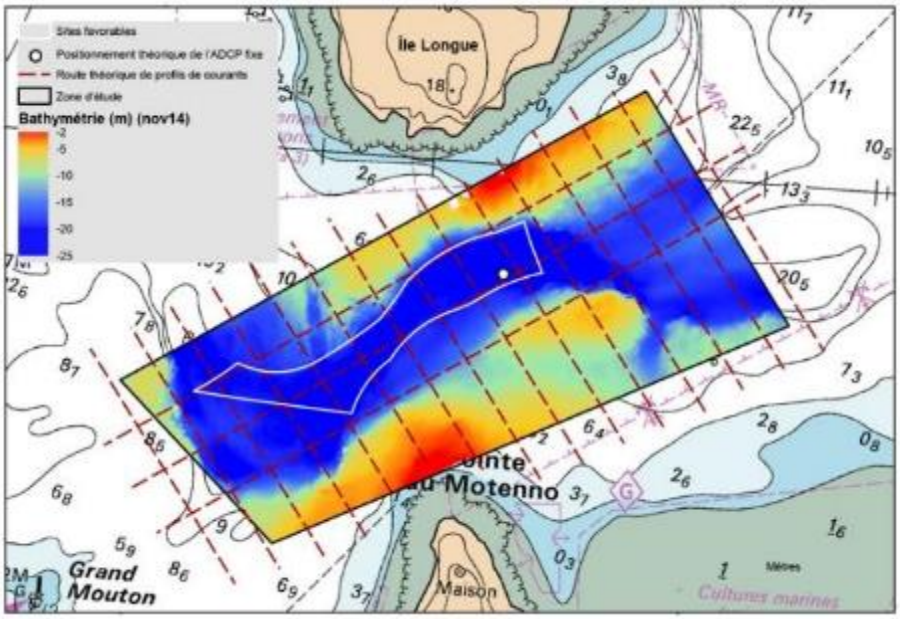


Figure 40: Current profiles and current meter deployment (Sedrati et al., 2016 in UBS, 2018)

The results of the current measurements showed that the currents were strongly correlated with the tidal coefficients. Current speeds can reach 3.5 m/s in the ebb tide. The ebb speeds can be 1.5 times the flood speeds.

Coefficient de marée	45	61	72	91	99
Marnage	2 m	2,5 m	3 m	3,75 m	4 m
Vitesse du flot	1,5 m/s	1,8 m/s	2 m/s	2,3 m/s	2,4 m/s
Direction du flot	ENE	ENE	ENE	ENE	ENE
Vitesse du jusant	2,3 m/s	2,5	2,9 m/s	3,3 m/s	3,5 m/s
Direction du jusant	OSO	OSO	OSO	OSO	OSO
Rapport jusant/flot	1,5	1,4	1,45	1,45	1,45

Figure 41: Water heights, average current velocities over the water column and average current directions at the measurement point at the southern Long Island site. (b) Evolution of tidal range, ebb and flood according to the tidal coefficient at the south of Ile Longue (Sedrati et al., 2016 in UBS, 2018)

4.2.2.2 Agitation

The Gulf of Morbihan is sheltered from the dominant south-westerly swells by Belle-Île, the Quiberon peninsula, the islands of Houat and Hoëdic, and the Rhuys peninsula. These natural barriers protect the narrow gully of Port Navalo, which allows water masses to enter the Gulf of Morbihan. Inside the Gulf, low amplitude waves can be generated by the wind (windy sea). The influence of this hydrodynamic parameter is minor in the Gulf of Morbihan.

The currents : at the level of Ile Longue, tidal current speeds e can exceed 3.5 m/s.

Unrest : the surroundings of the Ile Longue are protected from the waves.

4.2.3 The sedimentary context

4.2.3.1 In the Gulf of Morbihan

In the Gulf of Morbihan, the distribution of sediments follows a granulometric gradient, from the east of the basin towards the more external zone and the Port Navalo Narrows. This gradient is also found when moving away from the axis of the tidal channels towards the sheltered areas (Marcaillou *et al.*, 1996). This configuration is directly linked to the intensity of the tidal currents *(see 4.2.2.1.1 page 53*). Indeed, in channels with strong tidal currents, the sediment is coarser, including in the eastern Gulf. In contrast, low-energy environments, including some coves and coasts, show siltation due to the settling of fine particles (Perez Belmonte, 2008) (Figure 42).

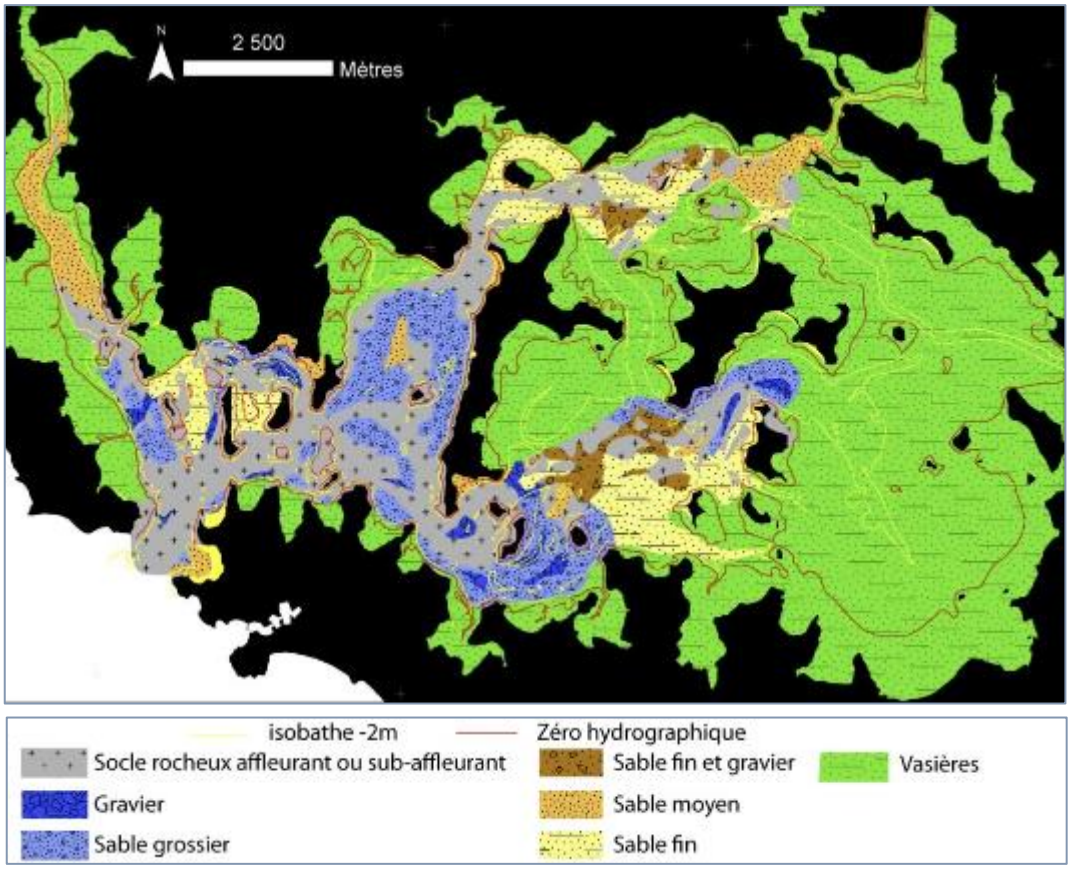


Figure 42: Sediment map of the Gulf of Morbihan. The isobath - 2 metres shows the tidal channels (from Menier and Cancouët, 2010 in UBS, 2018)

Between the south-west of the Île-aux-Moines and the Port-Navalo Narrows, the crystalline basement is exposed. It is an altered granitoid dotted with pebbles (Dubois, 2008). In the secondary channels, we find sedimentary formations made up of gravel banks and coarse sand composed of shell fragments, which form the Creïzic and Kergonan banks, as well as medium to fine sand in the most sheltered areas. In the eastern part of the basin and upstream of the rivers of Vannes, Auray and Noyalo which feed the Gulf of Morbihan, where the depths and currents are low, mudflat areas dominate.

4.2.3.2 At the study site

The Ile Longue site is located in the main channels used by the tidal currents at the entrance to the Gulf. The bedrock is predominant because the hydrodynamics are too great to allow sedimentation and the deposition of silt (Figure 43).

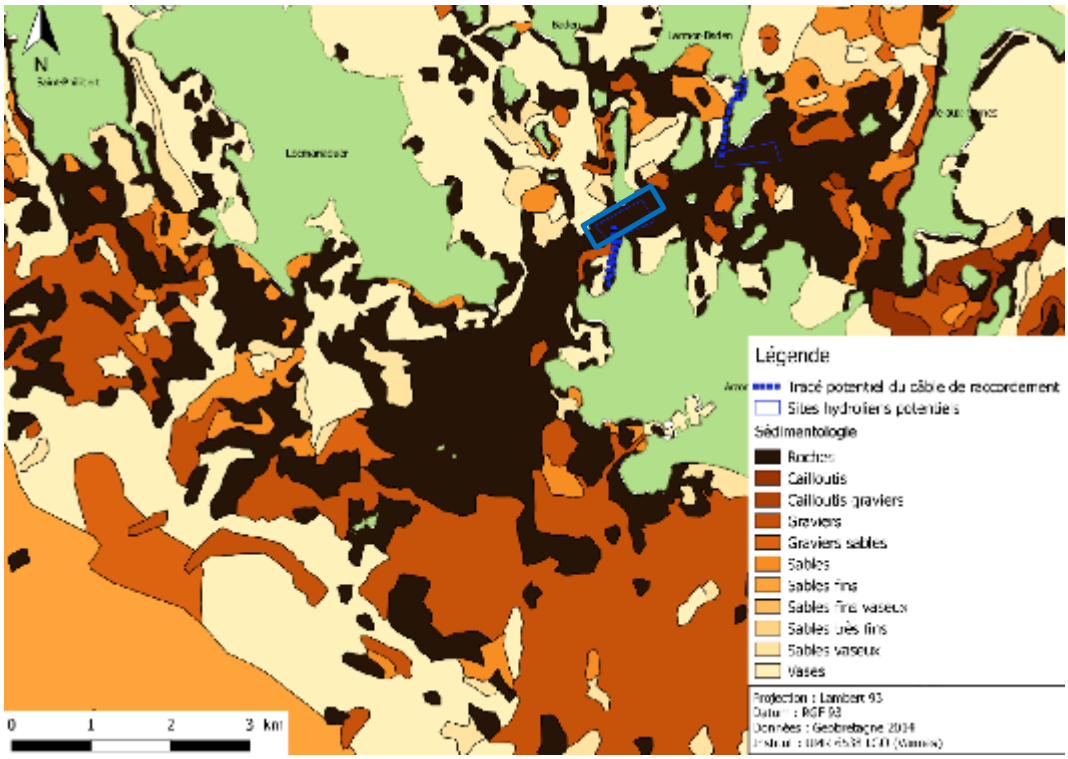


Figure 43: Sedimentary nature in the vicinity of the Ile Longue study site

In the potential area the nature of the seabed in the channels, which are highly exposed to the sun, is a ma
It is mainly made up of rocks.

4.2.4 Water quality

The waters of the Gulf of Morbihan are under the influence of the 37 communes of the catchment area, i.e. a population of approximately 135,000 permanent inhabitants, to which should be added approximately 50,000 seasonal inhabitants. The sources of urban, diffuse and industrial pollution are linked to the high population density, growing urbanisation and high tourist numbers that characterise the territory bordering the Gulf of Morbihan (sanitation, rainwater management, agricultural activities, etc.).

The quality of the water governs the maintenance of the ecological balance as well as all the professional and leisure activities that result from it. It is a major issue in the Gulf of Morbihan, for anthropic uses (swimming, shellfish farming, fishing on foot, etc.) and for sensitive natural environments (seagrass beds, natural shellfish beds, mudflats, etc.) (UBS, 2018). Numerous monitoring programmes are therefore implemented to track the quality of these waters.

The Gulf of Morbihan is particularly important for tourism and shellfish farming. Water quality is very important fo
these activities and for the natural environment; water quality must not be degraded.

4.2.5 The underwater sound environment

Within the framework of the TIGER project, a specific study on underwater acoustics was carried out by the company QUIET OCEANS (QuietOcéans, 2018). This study should make it possible, in the long term, *via* modelling, to assess the underwater sound levels generated by the tidal turbines in operation (this analysis is presented in chapter 5: impact analysis). Initially, this study analysed the ambient noise in the study area.

4.2.5.1 Underwater noise: generalities

4.2.5.1.1 Introduction

The underwater world is anything but silent and is made up of a sound chorus comprising three families of noises: natural noises (waves, seismic cracks, etc.), biological noises (marine mammals and other marine biodiversity) and anthropogenic noises (human activities, maritime traffic, etc.). The nature of these noises varies according to location, season, climatic conditions, time of day, etc. Thus, underwater noise is a physical component to be assessed in a given geographical context, and its modifications can potentially have consequences on the ecosystem and certain pressure-sensitive marine organisms. Underwater noise levels are not to be compared with airborne noise levels. Indeed, the reference level is 1 µPa in underwater acoustics, compared to 20 µPa in air. Moreover, with a density approximately 1000 times higher than air, the oceanic environment is considered to be an incompressible propagation medium unlike air. Thus, any comparison should be avoided (QuietOceans, 2020). The following figure gives, by way of illustration, a scale of typical sound levels emitted, either by human activities, by marine fauna or by environmental conditions.

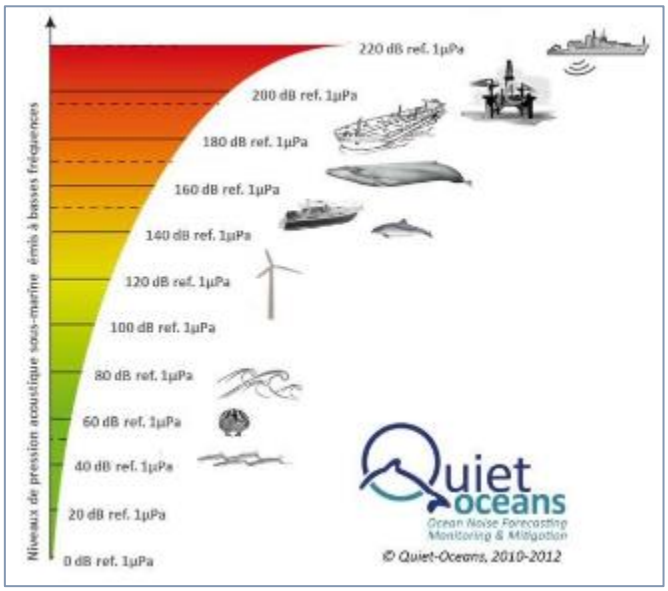


Figure 44: Qualitative scale of underwater noise levels emitted at one metre in a low frequency band from a few kHz (QuietOceans, 2018)

4.2.5.1.2 What is the underwater chorus

Underwater noise is a real sound chorus where noises of different natures and origins are mixed together:

- Natural sounds or geophony include the sounds of the earth cracking, the movement of marine sediments, the breaking of waves, precipitation, etc. ;
- Biological noise or biophony includes noise of biological origin generated by marine fauna;
- Anthropogenic noise, or anthropophony, is man-made noise generated by maritime activities.

As shown in the figure below, all these sounds interact with each other, dominating each other to form the sound context of a study area.

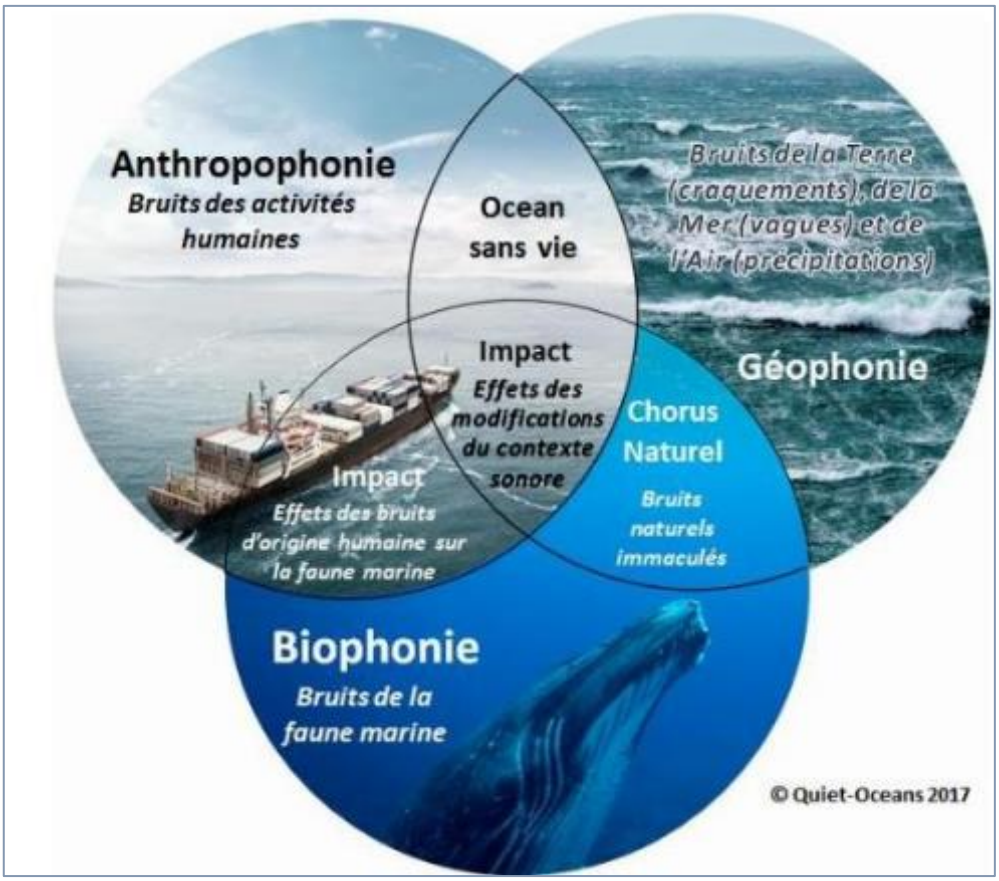


Figure 45: Composition of the underwater sound chorus (QuietOceans, 2018)

Underwater noise is produced by sounds of different natures and origins which mix together. A distinction is made between natural noise or geophony (movement of marine sediments, waves breaking, currents, etc.), biological noise or biophony (benthic populations, fish, marine mammals, etc.) and anthropogenic noise or anthropophony (ships, marine activities, etc.).

Figure 46 summarises the typical sound levels in dB ref 1µPa²/Hz according to their origin (anthropogenic, environmental or biological) and according to the frequency range. All the sound sources contribute to the ambient noise with a very variable predominance depending on the frequency, environmental conditions, human activities and the local context.

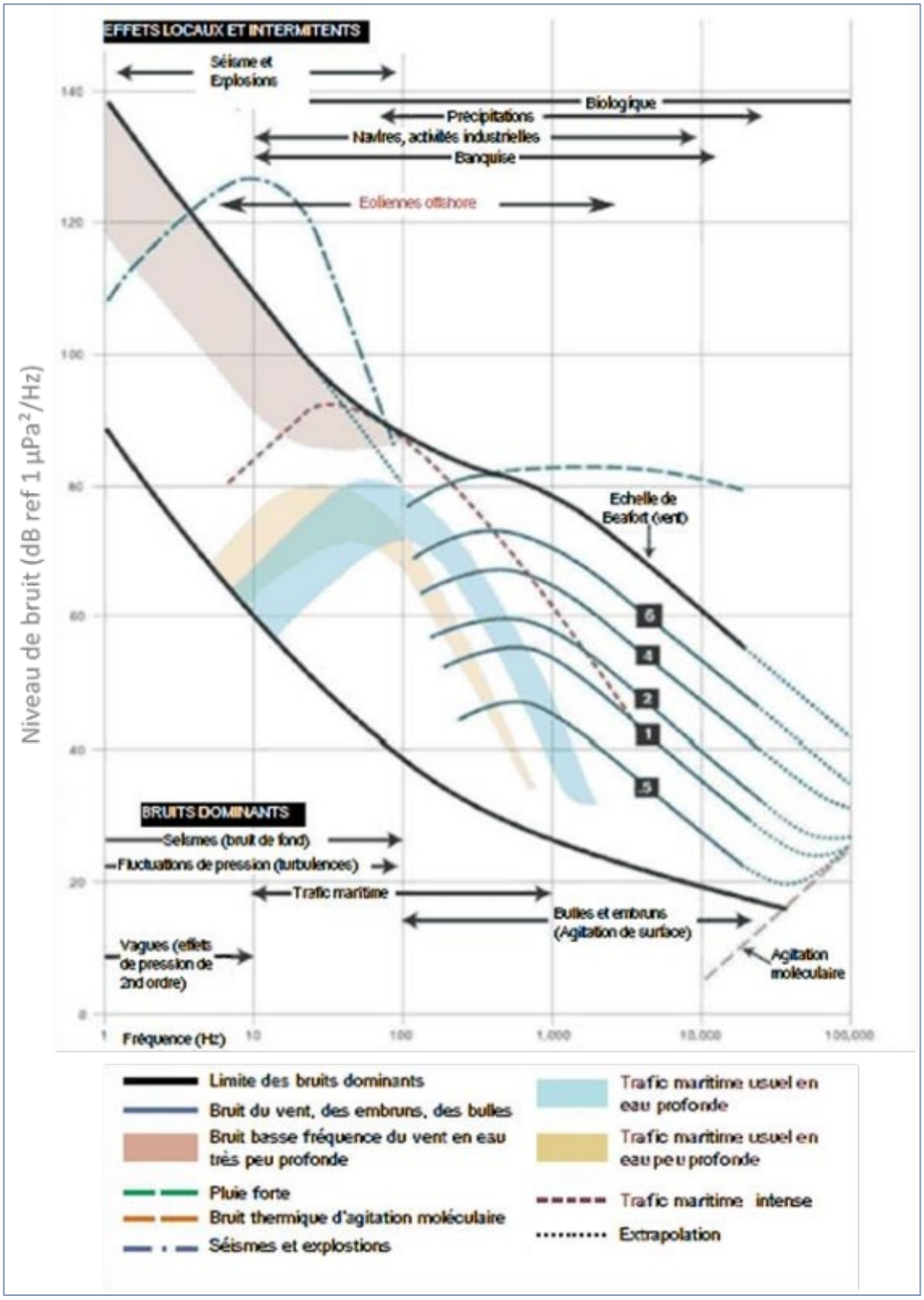


Figure 46: Summary of typical noise levels as a function of frequency and nature of the noise source

4.2.5.1.2.1 Geophony

Natural noises can be of various kinds: seismic noises in the very low frequencies (below a few tens of Hz), precipitation noises, sedimentary transport noises, sea noises generated by waves and wind, etc. (QuietOceans, 2018).

4.2.5.1.2.2 Biophony

Biophony refers to the biological noise generated by living underwater organisms. These noises are generated by marine mammals, fish, crustaceans, molluscs, etc. The sound signals emitted by these living organisms can be impulsive (clicks, slams, etc.) or transient (whistles of cetaceans, for example). The frequency ranges and levels are highly variable and largely dependent on the species and the context (QuietOceans, 2018).

4.2.5.1.2.3 Anthropophony

So-called anthropogenic noise is generated by human activities at sea, such as the noise of ships involved in maritime traffic, recreational craft at sea, maritime works, prospecting activities, etc. These noises may be masked by natural or biological noise, or on the contrary, dominate the sound chorus (QuietOceans, 2018). These noises can be masked by natural or biological noises, or on the contrary, dominate the sound chorus (QuietOceans, 2018).

4.2.5.1.3 What does the noise distribution in the marine environment depend on?

The purpose of this section is to describe the parameters that influence the noise distribution. Noise propagation and ambient noise levels are mainly determined by (Table 13):

- bathymetry ;
- the nature of the background ;
- oceanographic conditions, such as temperature and salinity, currents, tide;
- weather conditions, such as wind (and hence waves);
- maritime activities ;
- other parameters affecting propagation and noise levels, but to a lesser extent.

	Bathymétrie	Nature du fond	Température et salinité	Variation du niveau de la mer (marée)	Courant	Vent / Vague	Précipitation
Conditionne la propagation des bruits	✓	✓	✓	✓	✗	✓	✗
Génère des bruits propres	✗	✓	✗	✗	✓	✓	✓

Table 13: Effect of the physical conditions of the ocean environment on acoustic propagation and on the generation of self-noises contributing to the ambient noise resultant (QuietOceans, 2018)

The lower the water level (cumulative effect of bathymetry and tide), the greater the propagation loss. This is due to the interaction of the sound waves with the interfaces of the ocean waveguide (surface and bottom). However, the lower the water level, the more wave breaking is favoured and the contribution of wave noise to the ambient noise is important.

Propagation losses are greater the more loose and fine-grained the bottom (e.g. silt absorbs more sound waves than gravel). However, the denser the sediment, the more reverberant it is. This is because sound waves with large angles of incidence on the sediment are better reflected when the sediment is dense.

Wind helps to generate waves. Waves scatter and absorb sound waves even better in rough seas (Wenz, 1962). However, waves generate their own noise by breaking, which has the effect of raising the ambient noise level. In high sea states, natural wave noise increases when other noise sources are less well propagated.

Under the effect of the current and/or waves in shallow waters (about 10 metres), the transport of sediments and the clashing of sedimentary particles generates noise, with levels that are all the greater as the sediments are coarse and their movements are rapid.

The vertical distribution of temperature and salinity stratifies the water column. Acoustic waves are highly sensitive to this vertical stratification and, to a lesser extent, to horizontal stratification (Guiesse & Sabathié, 1964). Indeed, a negative vertical temperature/salinity gradient will refract the waves towards the bottom, making the influence of the nature of the sediments predominant. On the contrary, when no stratification is present (homogeneous medium), some acoustic paths may not interact with the interfaces (surface and/or bottom) and present larger ranges.

Precipitation has a marginal influence on underwater sound propagation, but generates noise and contributes to the increase in environmental noise (geophony).

Most of the parameters of the physical environment have cross-effects on the propagation of noise and on the level of contribution to natural background noise. It is therefore difficult to have universal dependency rules that justify the use of models.

It is important to note that when the propagation of project noise is promoted, the propagation of other existing anthropogenic noise is also promoted (e.g. noise from marine traffic, recreational boating or fishing activities), also contributing to an increase in ambient noise levels (QuietOceans, 2018).

Noise propagation and ambient noise levels are mainly conditioned by bathymetry, the nature of the seabed, oceanographic conditions (temperature - salinity - currents - tide), meteorological conditions (wind, rain) and by maritime activities.

4.2.5.2 Environmental noise analysis

The methodology proposed in this study is based on four steps:

- Step 1: Statistical mapping of pre-existing noise related to both wave and sea state and existing maritime activities. This constitutes an assessment of the initial noise situation. To this mapping, a statistical mapping of the pre-existing noise potentially maximum during the nautical event "la semaine du Golfe" is added;
- Stage 2: Establishment of a model of the acoustic source of a tidal turbine in the operational phase based on bibliographic data;
- Step 3: Assessment of the noise footprint of the entire wind farm in the operational phase;

- Step 4: Establishing sound fields of project noise in each sensitivity range of the species likely to be present.

The elements of stage 1 relating to the statistical mapping of pre-existing noise are presented below. The results of the other stages relating to the effects on the acoustic environment of the operation of the tidal turbines are presented in the chapter dealing with the potential effects of the project in the operational phase (see 5.3 page 141).

4.2.5.2.1 Measurements carried out

An in situ measurement campaign was carried out from 2 to 20 June 2017, in the immediate vicinity of the future tidal turbine installation zones. A stand-alone hydrophone placed on the seabed made it possible to continuously capture the existing noise statistics over a significant period (Figure 47).

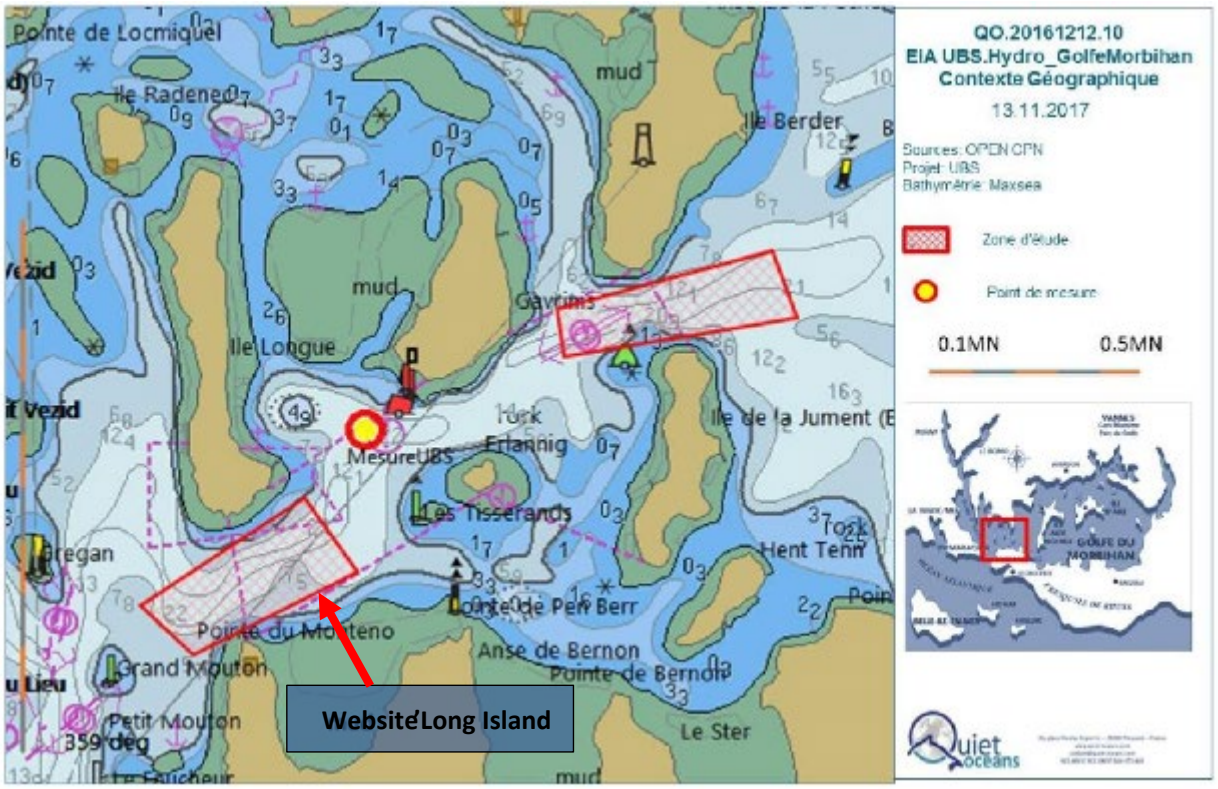


Figure 47: Location of passive acoustic measurement point deployed in June 2017 (QuietOceans, 2018)

The results of the measurements show that at this point the median ambient noise (50% of the time) is 107 dB ref1µPa², decreases by 3.5 dB at night and increases by 3 dB during the day. This difference between day and night is mainly due to the frequent passage of recreational vessels (about 106 passages per day). The noise level (or permanent noise) (percentiles from 100 to 90% or very frequent levels) is 94.8 dB ref1µPa² and offers a variability (± 5 dB) mainly due to the significant variations in current during the day. This noise level is highest at the time of maximum current velocity for the ebb flow.

En dB ref 1µPa²	Minimum	Très fréquent		Courant			Rare		Maximum
Percentile (%)	100	99	90	75	50	25	10	1	0
Toute la période	94.8	97.7	100.8	103.4	107.0	114.9	122.1	130.9	142.4
Jour	96.0	98.8	102.9	105.4	110.2	118.2	123.6	131.9	142.4
Nuit	94.8	96.8	99.1	101.0	103.5	106.4	110.0	128.5	135.6

Table 14: Probability of measuring a sound level (dB ref. 1 µPa2) greater than or equal to (QuietOceans, 2018)

4.2.5.2.2 Ambient noise mapping by modelling

The measured data are then integrated into the model (Quonops© platform) to map the ambient noise according to the characteristics of the site (nature of the seabed, bathymetry, etc.). For this mapping, two situations are presented:

- A common situation;
- An exceptional situation corresponding to the week of the gulf when many boats frequent the area (Grand Parade).

4.2.5.2.2.1 Current situation

Statistical noise levels in the 45 Hz to 71 kHz band related to marine traffic and environmental conditions are presented in Table 15 and Figure 48. The tidal turbine siting area is located in a sector already affected by noise from pleasure craft traffic, along a traffic corridor defined by the geographical context (entrance to the Gulf). Moreover, in this area with strong currents, the acoustic contribution of this hydrodynamic component is predominant. There is continuous competition as to the predominance of anthropogenic noise or noise generated by the current. Outside this singular zone, noise levels are significantly lower, due to the reduced presence of recreational vessels and the significant decrease in current speeds.

En dB ref 1µPa²	Minimum	Très fréquent		Courant			Rare		Maximum
Percentile (%)	100	99	90	75	50	25	10	1	0
Toute la période	99.0	99.1	99.7	101.7	104.8	107.7	118.3	139.9	162.8

Table 15: Summary of estimated noise levels (natural and man-made) in the project area (QietOcéans, 2018)

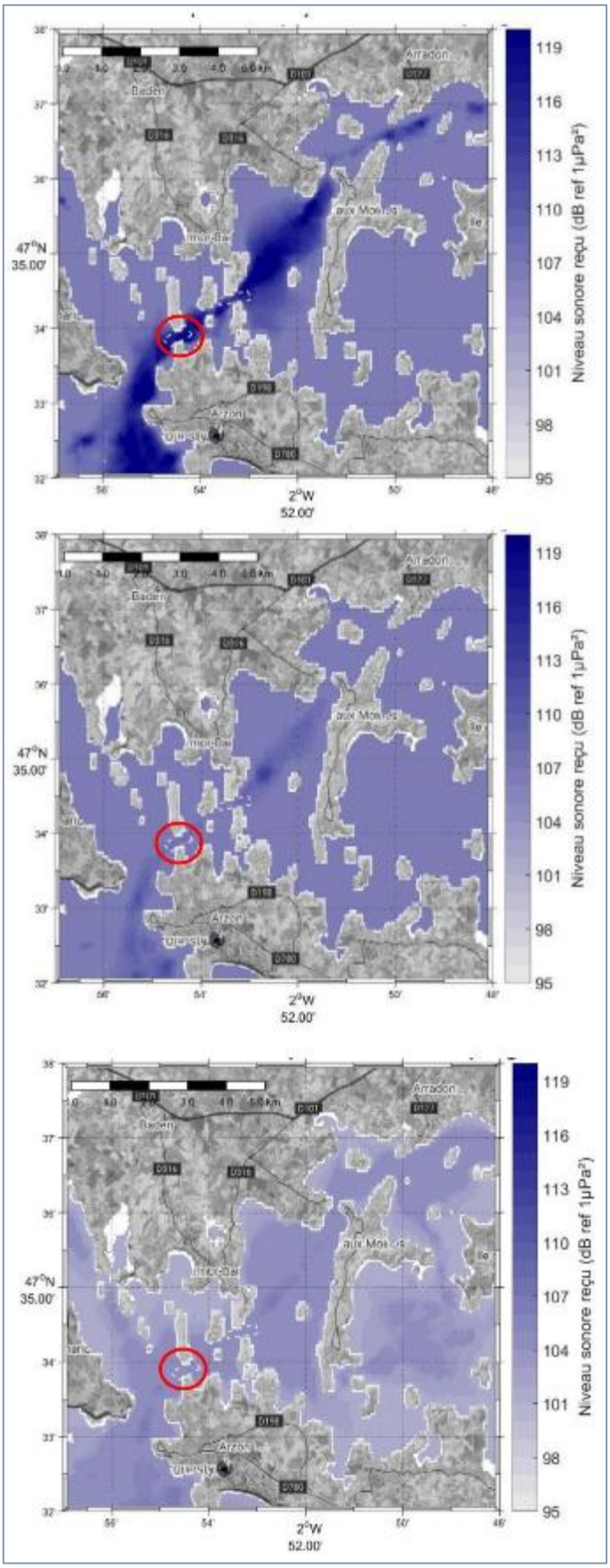

Arradon
Baden
aux Moines
Arzon
47°N
35.00'
2°W
52.00'
119
116
113
110
107
104
101
98
95
Niveau sonore reçu (dB ref 1µPa²)

Figure 48: Noise level of natural noise and pre-existing maritime traffic in the 45Hz to 70 kHz band - red circle: the site Long Island (QuietOceans, 2018)

4.2.5.2.2.2 Exceptional situation

In the case of the instantaneous situation during the Grande Parade in the Gulf of Morbihan, the concentration of ships in the traffic corridor leads to a significant increase in noise in this area in a band about 1.5 km wide. The noise level very commonly reaches 140.3 dB ref1µPa² (50% of the time), at a minimum 133 dB ref1µPa² (100% of the time) and at a maximum 155 dB ref1µPa² during ship passages in the project area. Compared to the usual noise in this area, the median increase is 35 dB ref1µPa² due to the dense use of recreational vessels (Table 16 and Figure 49).

En dB ref 1µPa²	Mini mum	Très fréquent		Courant			Rare		Maximum
Percentile (%)	100	99	90	75	50	25	10	1	0
Situation	133.9	133.9	134.3	134.9	140.3	150.0	154.8	155.4	155.4

Table 16: Summary of estimated noise levels (natural and man-made) in the project area (QuietOceans, 2018)

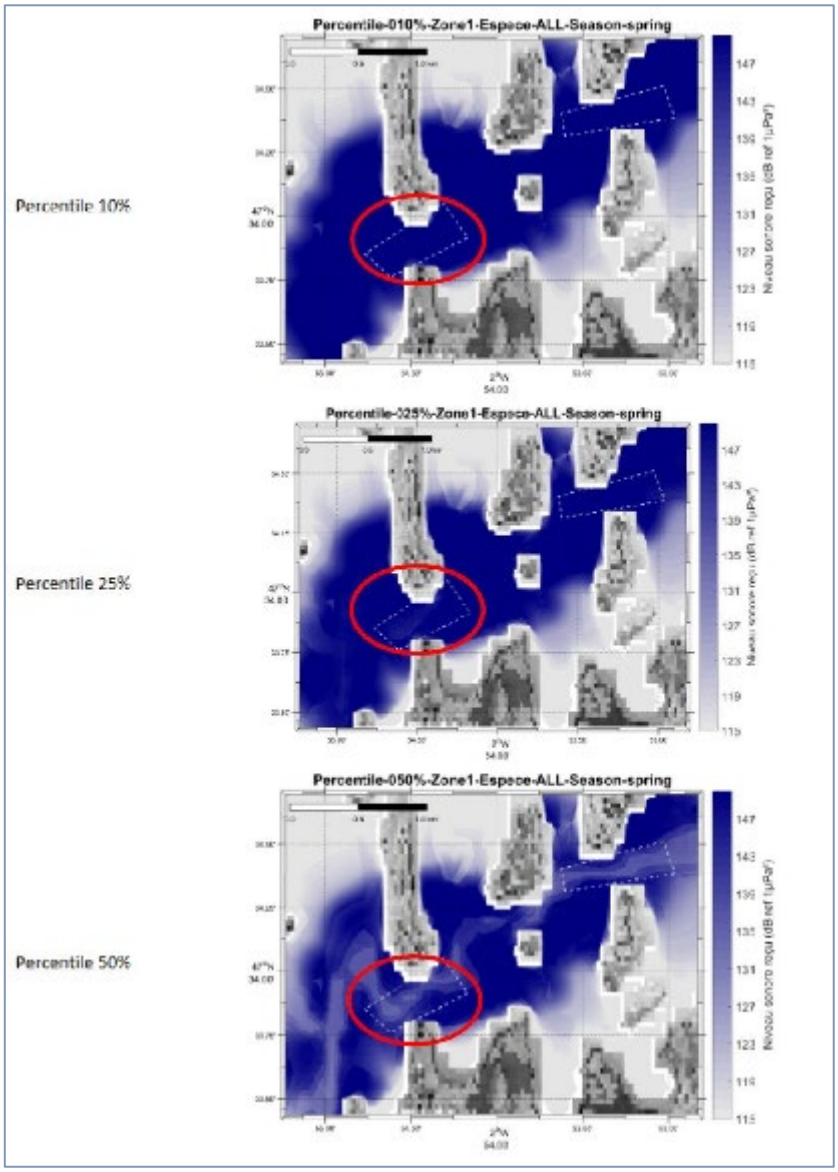


Figure 49: Mapping of natural broadband noise and pre-existing maritime traffic during a moment of the Grand Parade

The results of the ambient noise measurements show that the median noise (50% of the time) is 107 dB ref1µPa²

The results of the modelling show that a track of recreational vessel traffic crosses the location of potential wind energy sites. The acoustic signature of this regular anthropogenic activity is observable from the 25% percentile, i.e. 25% of the time the acoustic trace emerges from the natural noise. This road is located along a south/west/north/east axis and is approximately one kilometre wide. For the lower percentiles (more frequent levels), the noise in this area is dominated by environmental conditions and mainly by current-induced noise.

In the particular situation of the Grand Parade during the Gulf Week, the existing noise in the area is mainly dominated by the movement of pleasure boats in and around the regular traffic corridor. For this situation, the noise level reaches 140 dB ref1µPa² 50% of the time and thus systematically dominates the natural noise.

4.2.6 Summary of the physical environment and definition of issues

bathymetric survey also shows a lack of slope and bottom evolution.

Hydrodynamic agents :

Currentology: at the level of Ile Longue, tidal current speeds can exceed 3.5 m/s.

Agitation: the surroundings of the Ile Longue are protected from the waves.

The sedimentary context: In the potential Ile Longue siting area, the nature of the bottom of the channels, which are highly hydrodynamic, is mainly rocky.

Water quality: The Gulf of Morbihan is particularly important for tourism and shellfish farming. Water quality is very important for these activities and for the natural environment; water quality must not be degraded.

Underwater noise environment: The results of the ambient noise measurements show that the median noise (50% of the time) is 107 dB ref1µPa². The modelling results show that a recreational vessel traffic track crosses the location of the potential wind energy sites. The acoustic signature of this regular anthropogenic activity is observable from the 25% percentile i.e. 25% of the time the acoustic trace emerges from the natural noise. This road is located along a south/west/north/east axis and is approximately one kilometre wide. For the lower percentiles (more frequent levels), the noise in this area is dominated by environmental conditions and mainly by current-induced noise. In the case of the particular situation of the Grand Parade during the Gulf Week, the existing noise in the area is mainly dominated by the movement of the pleasure boats in and around the regular traffic corridor. For this situation, the noise level reaches 140 dB ref1µPa² 50% of the time and thus systematically dominates the natural noise.

The following table presents the issues of the physical environment:

Components	Features	Issue level
Bottom morphology		
Depth - slopes	These parameters constitute elements of context and definition of the project (location of cables, tidal turbines), but they do not present any particular problems. not a particular environmental issue	Not determined
Hydrodynamic agents		
The currents	Agitation and currents are an issue, particularly *through* the influence they can have on sediment dynamics	Medium

Restlessness	(modification of the coastline - disturbance of habitats...)	
The sedimentary context		
Sediment dynamics	Sediment dynamics can have an influence on habitats or the coastline. The equilibrium must not be disturbed	**Fort**
Water quality		
General water quality	Numerous water-related activities - environmental balance	**Fort**
The sound environment		
Sound environment	This parameter is an important issue for marine fauna in general and for marine mammals and fish in particular	**Fort**

Table 17: Definition of physical environment issues

4.3 The biological environment

The elements presented hereafter come from numerous biobibliographic data collected by the UBS (UBS, 2018), but also from specific field investigation studies implemented in the framework of this project:

Studies and investigations carried out in the framework of the TIGER project				
Date of missions or study	**Provider**	**Title of the study**	**Details**	**Reference**
May to November 2017	Plankton Observatory	Plankton monitoring - Summary report	Plankton sampling by bongo net - Water sampling for phytoplankton counting - Three sampling sites	Plankton observatory, 2017
Missing mission date	Integrated into the synthesis (UBS, 2018)	-	Two video-tracted transects carried out at the Ile Longue site	UBS, 2018

8 November 2017	Integrated into the summary (UBS, 2018)	-	Survey on 8 November 2017, from 1pm to 2.30pm, at low tide (stall at 2.06pm) - Coefficient of tide of 91	UBS, 2018
8 November 2017	UBS - Evelyne Goubert	Particle size analysis by sieving and studying the benthic foraminifera sample of the Gulf of Morbihan in the framework of the project "Water turbines	Four samples taken at the landing zone	Goubert, 2018
July 2018	Bretagne Vivante	Farm development tidal turbine in the Gulf of Morbihan - pre-diagnosis of avifauna	Avifauna study based on a bibliographic synthesis and on counts carried out each winter (mid-January) between 2011 and 2016.	Callard, 2018

Table 18: Field investigations carried out as part of the TIGER project

4.3.1 Natural and ecological heritage

The Gulf of Morbihan has many ecological and natural interests (mudflats, sea grass beds, etc.). In order to improve knowledge and preserve these exceptional sites, numerous management/protection zones have been set up within the Gulf. These management tools can be grouped as follows:

Knowledge tools (ZNIEFF, ZICO) ;

Regulatory and conventional protection (national or regional nature reserve, classified sites, biosphere reserve, regional nature park, marine park, etc.);

Public land protection (Conservatoire du Littoral et des Rivages Lacustres land, Espaces Naturels Sensitive, etc.).

The natural heritage management tools identified within the Gulf are presented below.

4.3.1.1 Knowledge tools

There are three types of heritage inventories within the remote study area: ZNIEFF (Natural Areas of Ecological, Faunistic and Floristic Interest); ZICO (Areas of Importance for the Conservation of Birds).

4.3.1.1.1 Natural Areas of Ecological, Faunistic and Floristic Interest (ZNIEFF)

Launched in 1982, the ZNIEFF (Zones Naturelles d'Intérêt Ecologique Faunistique et Floristique) inventory aims to identify and describe areas with high biological capacities and a good state of conservation. There are two types of ZNIEFF:

- Type I ZNIEFF: areas of great biological or ecological interest;
- Type II ZNIEFFs: large, rich and little modified natural areas with significant biological potential.

The following figure shows the location of the ZNIEFFs within the Gulf of Morbihan.

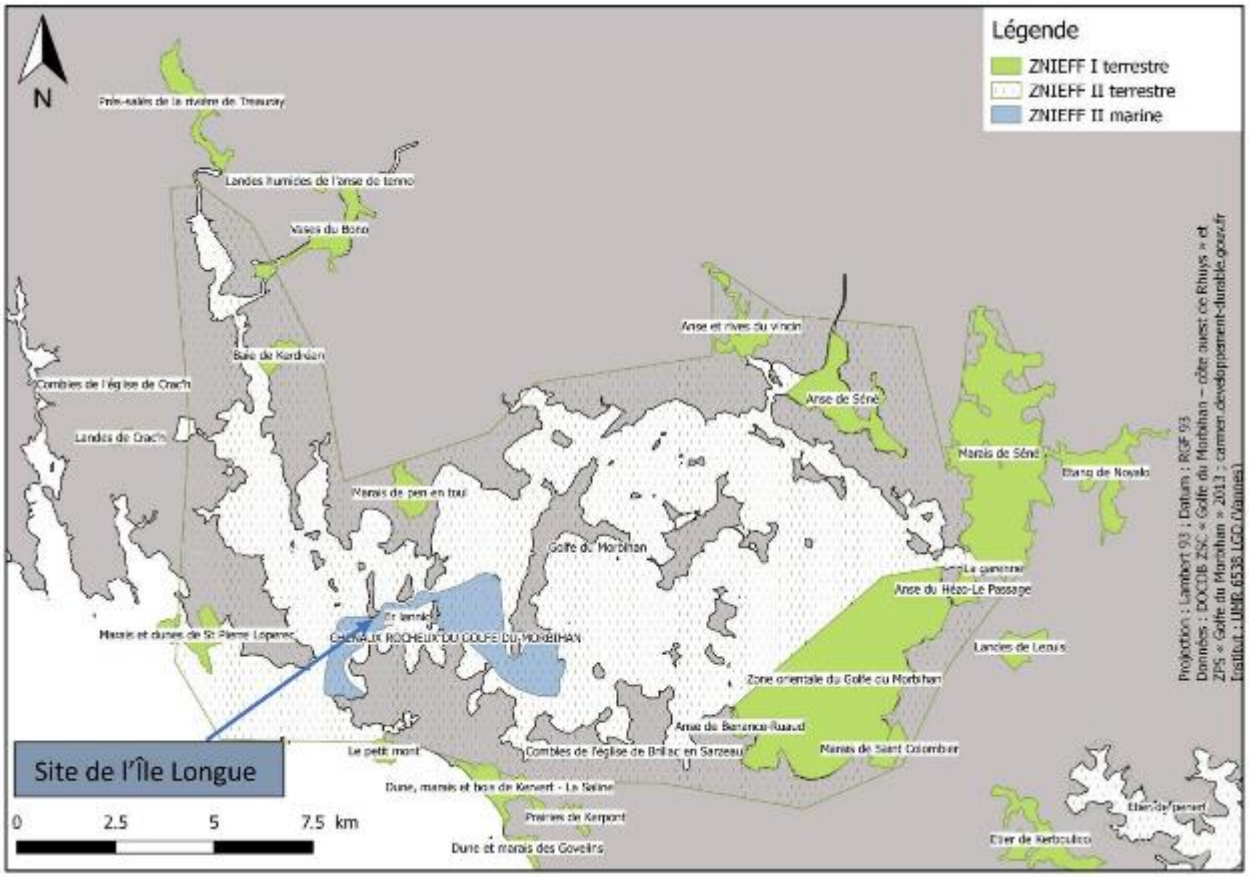


Figure 50: ZNIEFFs within the Gulf of Morbihan (UBS, 2018)

The Ile Longue site is located within the type II marine ZNIEFF "Chenaux rocheux du Golfe du Morbihan" and th type II land ZNIEFF "Golfe du Morbihan".

4.3.1.1.2 Important Bird Areas (IBAs)

IBAs, or Important Bird Areas, are sites of major interest that host wild bird populations considered to be of Community or European importance. Their inventory was established by the Ministry of the Environment following the adoption of the European directive known as the "Birds Directive". The IBAs are the basis for the proposed NATURA 2000 perimeters for the creation of Special Protection Areas (SPAs) within the framework of this same directive.

The following figure shows the location of the IBAs within the Gulf of Morbihan.

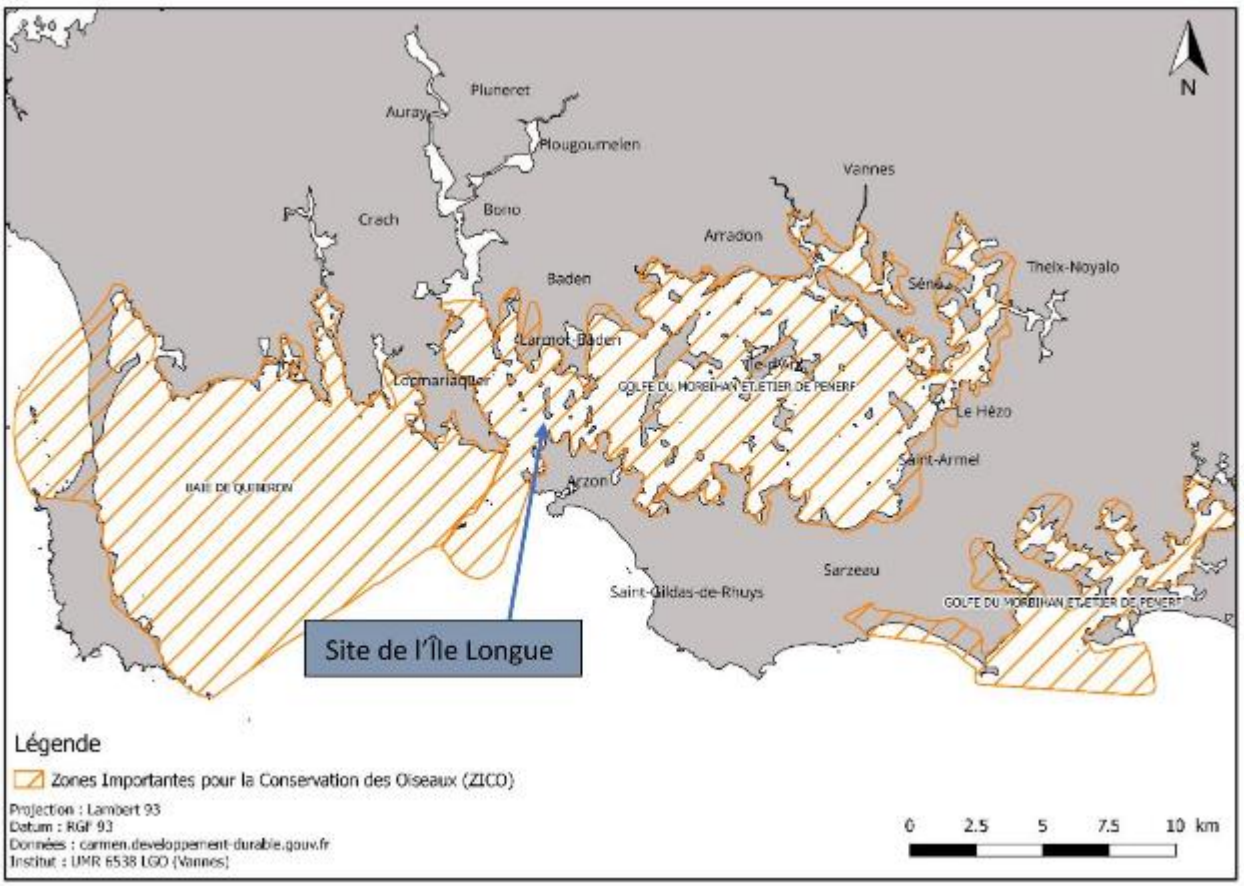


Figure 51: IBAs within the Gulf of Morbihan (UBS, 2018)

The Ile Longue site is located within the ZICO "Gulf of Morbihan and Étier de Pénerf.".

4.3.1.2 Regulatory and contractual protections

The regulatory and contractual protections identified within the Gulf of Morbihan are presented below.

4.3.1.2.1 Regional Nature Parks

Regional nature parks are created to protect and enhance large inhabited rural areas. A "Regional Nature Park" may be classified as a predominantly rural area whose landscapes, natural environments and cultural heritage are of high quality, but whose balance is fragile. A Regional Nature Park is organised around a concerted project for sustainable development, based on the protection and enhancement of its natural and cultural heritage (www.parcs-naturels-regionaux.fr).

The Regional Natural Park (PNR) of the Gulf of Morbihan was classified by decree of the Prime Minister on 2 October 2014 for a maximum period of twelve years, renewable (). It has a total surface area of more than 81,000 hectares, including approximately 17,000 hectares of maritime area of interest and 460 kilometres of coastline (Figure 261).

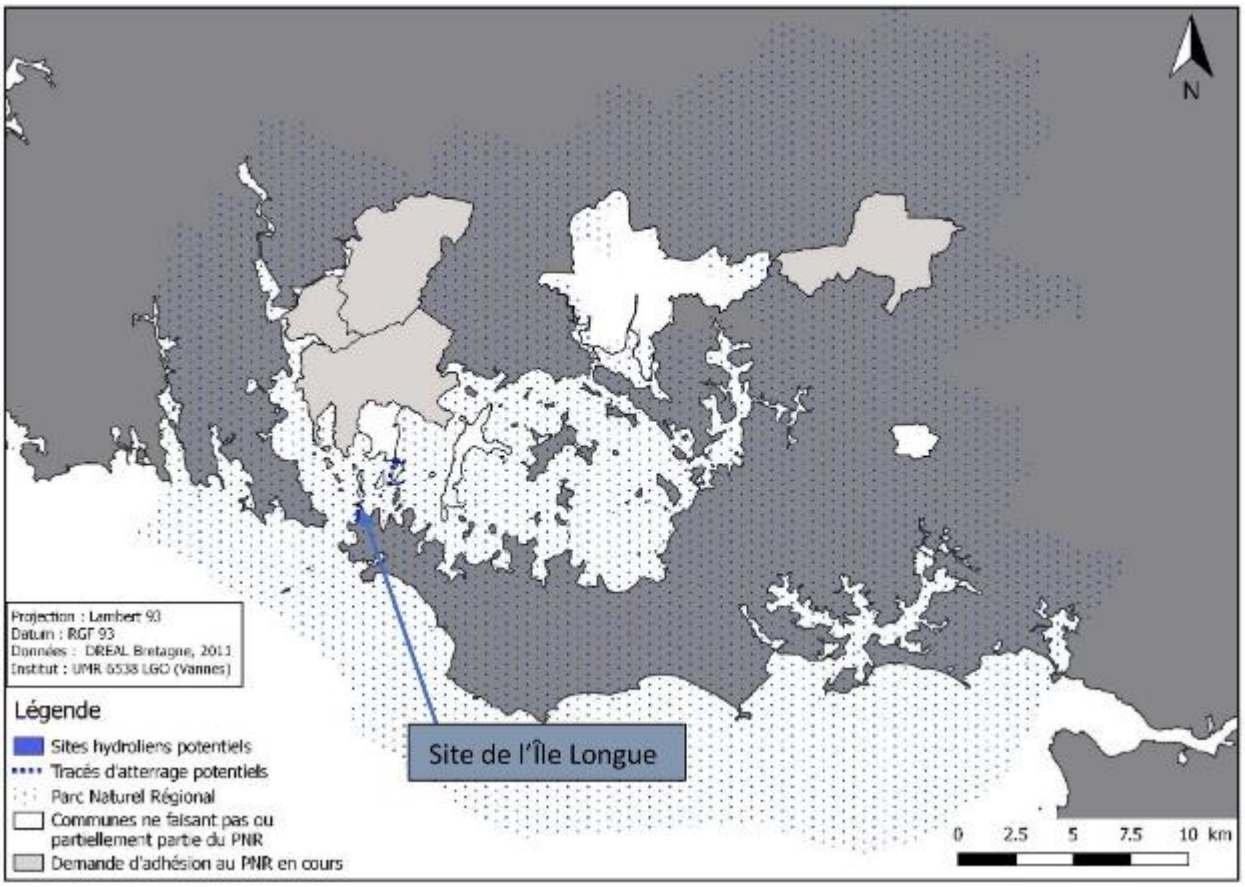


Figure 52: Location of the Golfe du Morbihan Regional Nature Park (PNR)

The The TIGER project is located in the Regional Natural Park (PNR) of the Gulf of Morbihan

4.3.1.2.2 National Nature Reserves (NNR)

National nature reserves are areas of excellence for the preservation of biological and geological diversity, both on land and at sea. They aim to provide sustainable protection for environments and species by combining regulation and active management.

Within the Gulf of Morbihan, a national nature reserve has been identified, the Marais de Séné reserve.

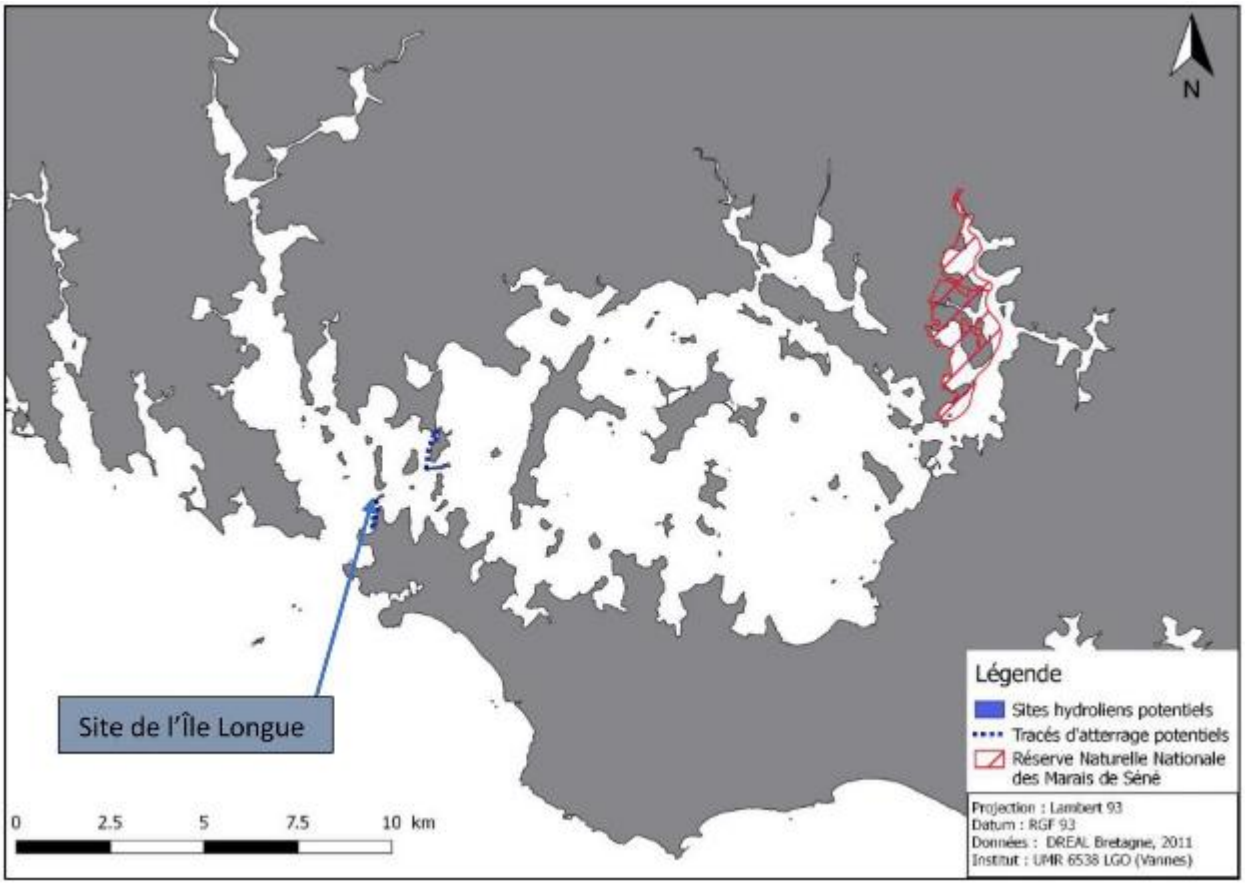


Figure 53: Location of the Marais de Séné reserve

The Ile Longue site is located more than 10 km from the reserve of the Marais de Séné

4.3.1.2.3 National Game and Wildlife Reserves (RNCFS)

The National Game and Wildlife Reserves are located along the coastline of Metropolitan France in order to protect important migration areas for waterfowl and nesting areas for seabirds from hunting. The main objectives are :

- Protect migratory bird populations in line with international commitments;
- To ensure the protection of natural environments that are essential to the safeguarding of endangered species; To promote the development of management tools for wildlife species and their habitats; To contribute to the sustainable development of hunting in rural areas.

A national hunting and wildlife reserve is located in the Gulf of Morbihan:

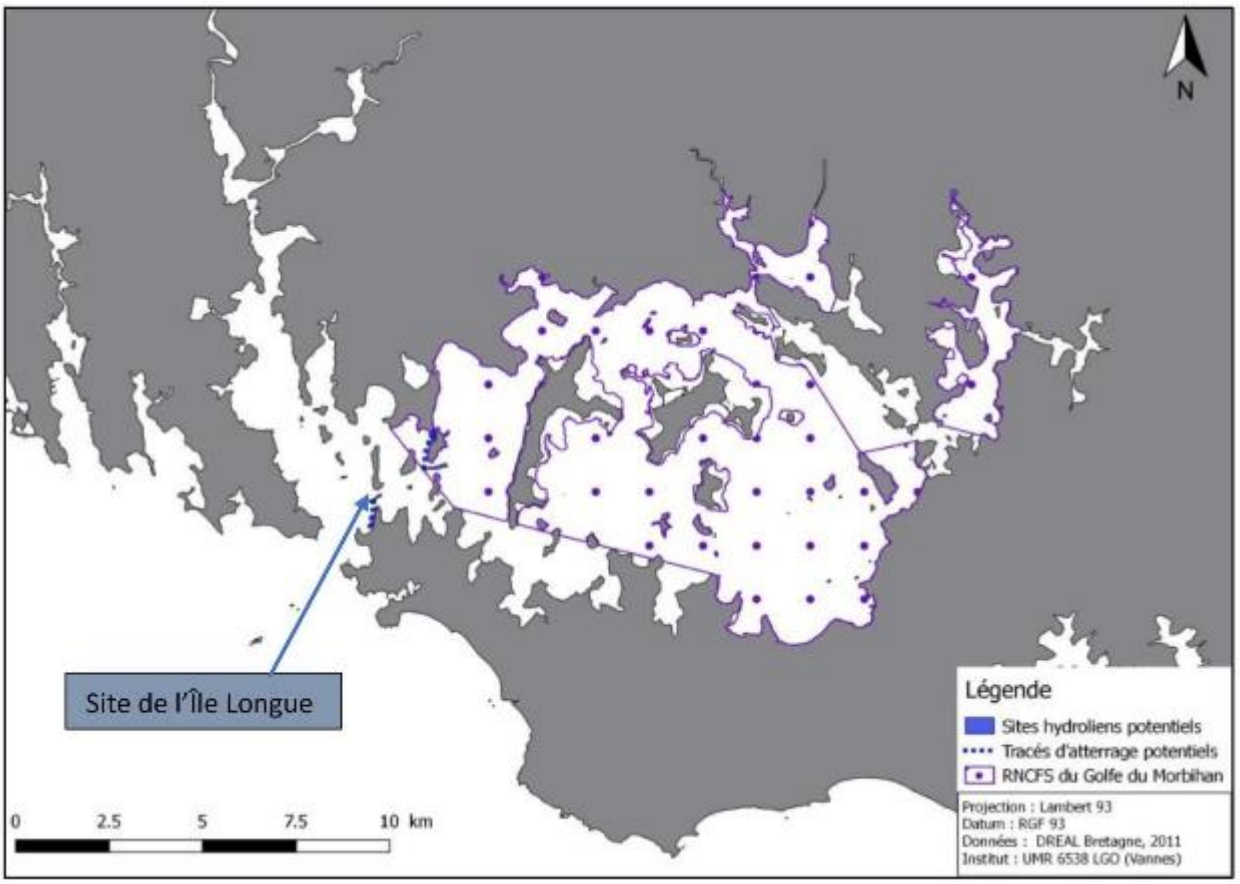


Figure 54: Location of the Gulf of Morbihan National Hunting and Wildlife Reserve

The Ile Longue site is located in the vicinity of the national hunting and wildlife reserve of Golfe du Morbihan

4.3.1.2.4 Wetlands of international importance (Ramsar Convention)

Adopted in Ramsar, Iran, in 1971, the Ramsar Convention is the only global environmental treaty that focuses on a particular ecosystem. Its mission is "the conservation and wise use of wetlands through local, regional and national actions and international cooperation, as a contribution to achieving sustainable development throughout the world". In adopting the Ramsar Convention, each State Party must designate at least one wetland as Wetland of International Importance. France has 15 wetlands of international importance counted as marine protected areas.

The Gulf of Morbihan is classified as a Ramsar site:

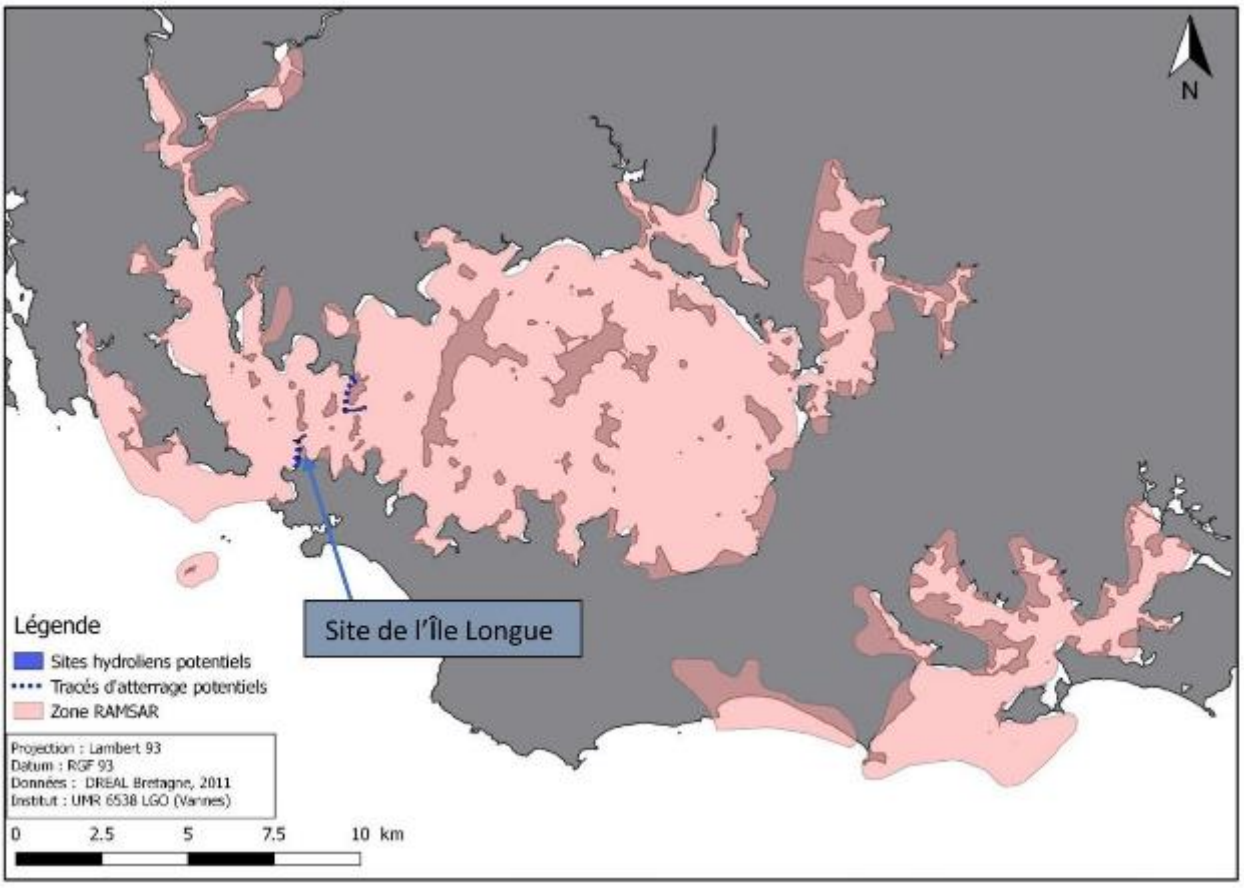


Figure 55: Location of the Gulf of Morbihan RAMSAR site

The Ile Longue site is located à proximity awithin a RAMSAR site.

4.3.1.2.5 Prefectural Biotope Protection Orders (APPB)

The protection of a species begins with the preservation of the environments essential to its survival. Thus, the safeguarding of biotopes is ensured by prefectoral decrees. The Prefectoral Biotope Protection Orders (APPB) consist of regulating certain human activities in order to preserve the natural habitats necessary for the survival of certain species and the biological balance of certain environments.

In the Gulf of Morbihan, three APPBs are in force: "Islands and islets of the Gulf of Morbihan", "Marais du Duer" and "Zone de tranquillité pour l'avifaune de l'ouest du Golfe du Morbihan" (Figure 271). The APPBs of "Combles and bell tower of the church of Crac'h" and "Combles and lower parts of the church of Brillac in Sarzeau" are also located in the Gulf of Morbihan, but are not affected by a potential wind energy project.

The APPBs of the Gulf of Morbihan are located on the figure below:

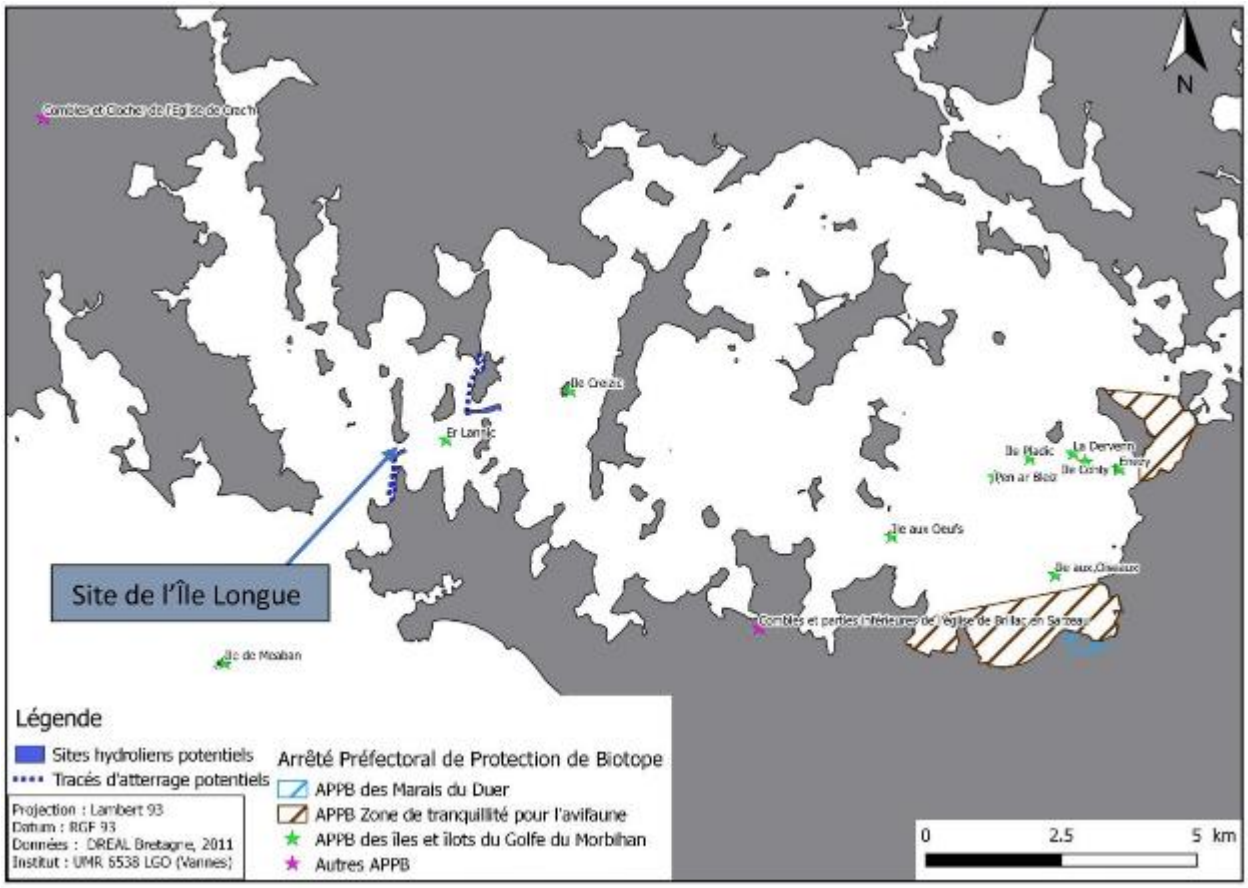


Figure 56: Location of the prefectoral orders for the protection of biotopes in the Gulf of Morbihan

In the Gulf of Morbihan, three APPBs are in force: "Islands and islets of the Gulf of Morbihan", "Marais du Duer" and "Zone de tranquillité pour l'avifaune de l'ouest du Golfe du Morbihan". The APPBs of "Combles and bell tower of the church of Crac'h" and "Combles and lower parts of the church of Brillac in Sarzeau" are also located in the Gulf of Morbihan, but are not affected by a potential wind energy project.

4.3.1.3 The Natura 2000 network

On the basis of inventories and scientific studies, the European Union has identified animal and plant species and environments on its territory that are "endangered", "vulnerable", "rare" or "endemic". Considered to be of "Community interest", they benefit from conservation measures under Natura 2000.

The founding texts are the European "Birds" (1979) and "Habitats, Fauna and Flora" (1992) directives. They establish the regulatory basis for the large European ecological network. The sites designated under these directives form the Natura 2000 network:

- Special Protection Areas (SPAs) are defined under the Birds Directive;

- Special Areas of Conservation (SACs) are defined under the Habitats Directive[12].

The Natura 2000 sites in the Gulf of Morbihan are located in the following figure:

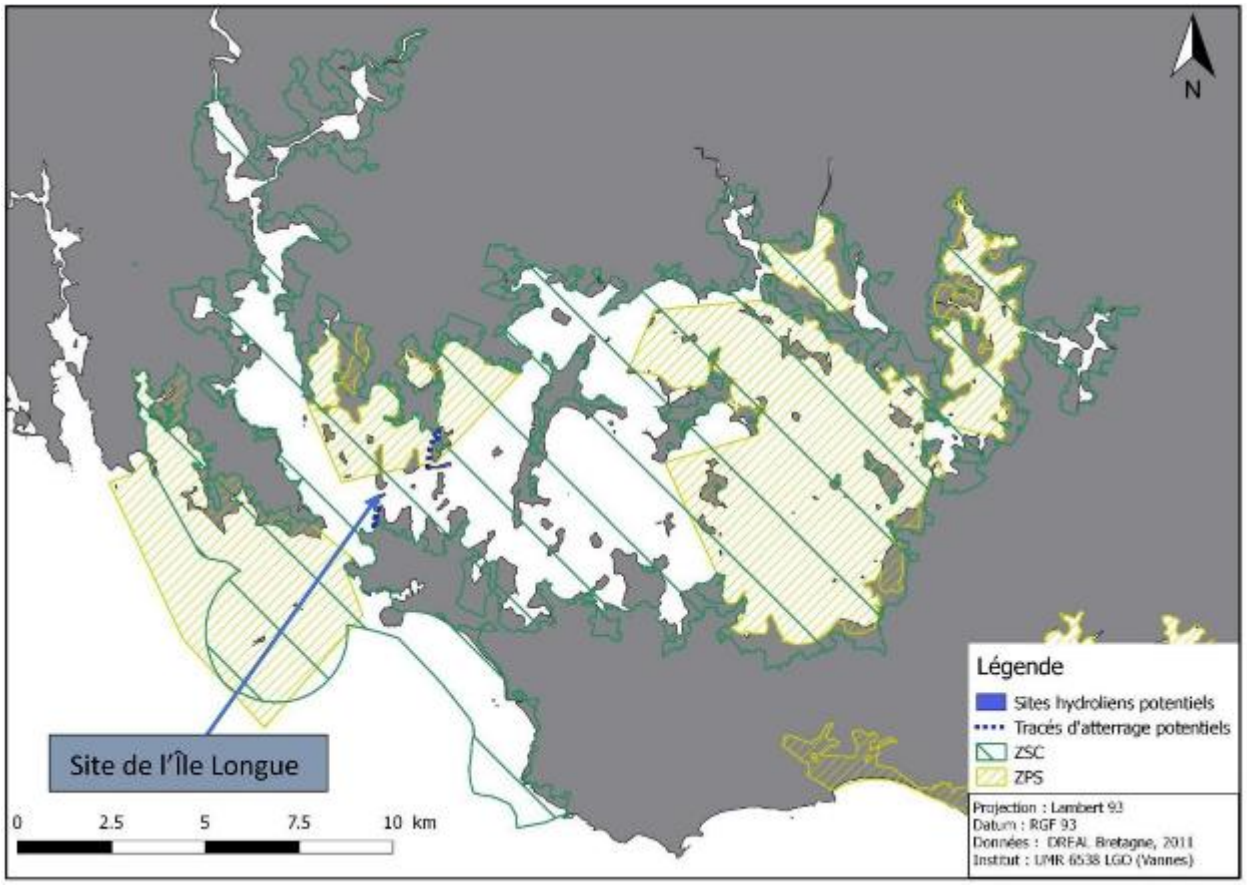


Figure 57: Location of Natura 2000 sites in the Gulf of Morbihan

Two Natura 2000 sites have been identified in the Gulf of Morbihan :
From the Special Protection Area Gulf of Morbihan » ;
FroThe ZoneSpecial Area of Conservation Golfe du Morbihan, west coast of Rhuys ».

4.3.1.3.1 Listed and classified sites

The law of 2 May 1930 on the protection of sites institutes two levels of protection, the use of which is placed under the responsibility of the DAU at the Ministry of Public Works, which also acts on behalf of the Ministry of the Environment with regard to natural sites: The classified site; The registered site.

Listed site

The Classified Site is a very strong protection, which gives rise to a public enquiry, an opinion of the Departmental and Higher Commission for Sites and a decree in the Council of State. All work likely to modify or destroy the state

[12] SACs are the end result of the designation procedure. Previously the areas were SCIPs (Proposed Sites of Community Importance) and SCIs (Sites of Community Importance).

or appearance of the site is prohibited unless expressly authorised by the Minister of Public Works or the Minister of the Environment.

Listed site

The Listed Site is a protection instituted by decree of the competent Minister, having regard to the nature of the site, after the opinion of the Departmental Commission of Sites. In the case of a listed site, owners are required to declare any work projects in advance to the Architecte des Bâtiments de France, who has four months to give his opinion.

The following figure shows the location of the listed and classified sites in the Gulf of Morbihan.

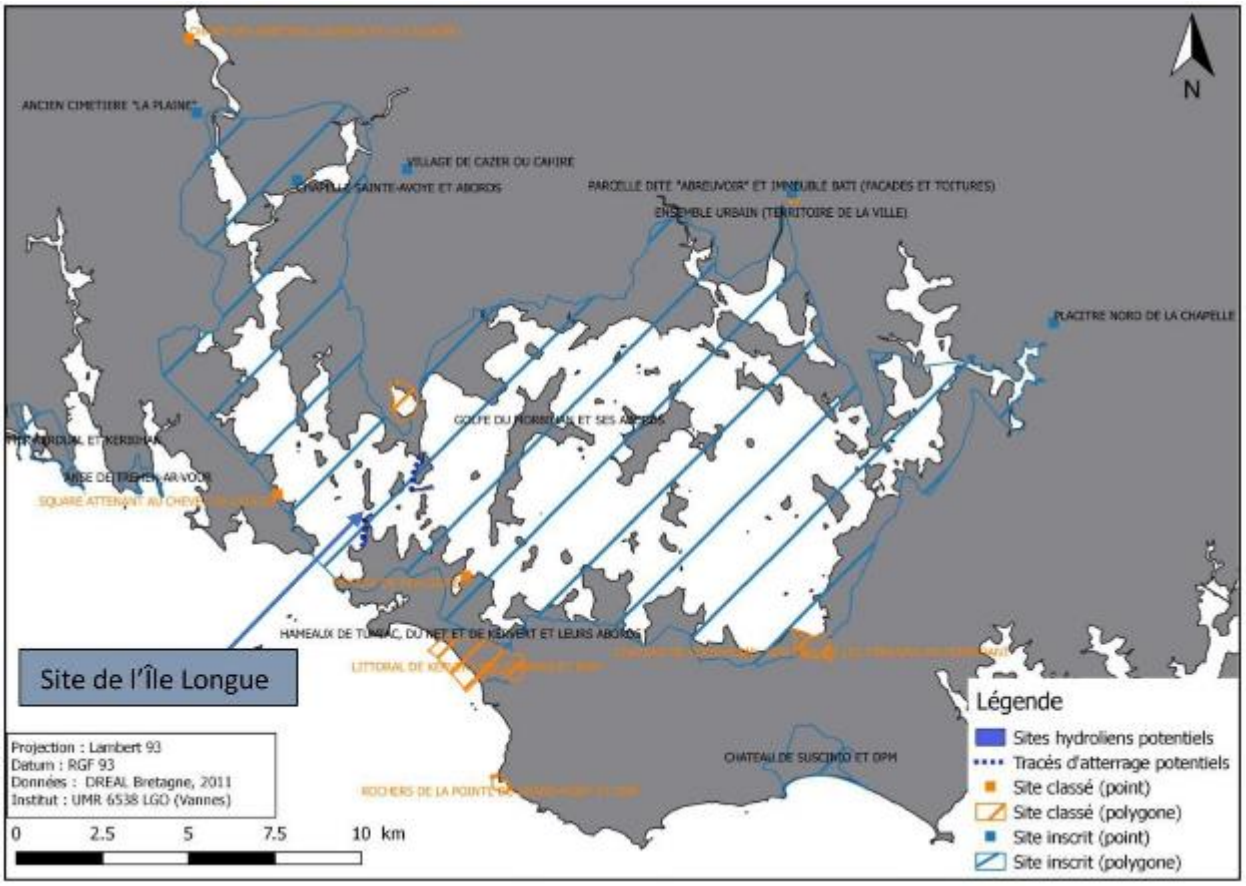


Figure 58: Location of listed and classified sites in the Gulf of Morbihan

Several listed and classified sites are identified within the Gulf of Morbihan. The Ile Longue wind energy project i located within the listed site "Gulf of Morbihan and its surroundings".

4.3.1.4 Public land protection

In France, and more particularly on the coast, various measures are being taken to preserve rare and sensitive natural areas, to manage the consumption of space and to open up these natural sites to the public. To this end, the control of development and urban planning generated by the Coastal Act is part of a sustainable development approach.

Furthermore, the protection of nature by controlling and acquiring land is used in particular in areas subject to strong dynamics of space consumption such as the coastline. Land allocated or acquired through transfers by owners becomes part of the public domain and is inalienable.

Two networks of natural areas implement this protection approach in the Gulf of Morbihan:

- The Conservatoire de l'Espace Littoral et des Rivages Lacustres (CELRL) has the task of acquiring coastal sites in order to limit the development of infrastructures on the coastline and shores;
- French departmental councils acquire, through a tax on new buildings, sensitive natural areas (ENS) intended both to preserve threatened habitats and to welcome visitors.

4.3.1.4.1 The Conservatoire de l'Espace Littoral et des Rivages Lacustres (CERL)

Aware of the ecological, social, economic and cultural value of its coastline, France has chosen to preserve a significant part of it. To this end, the Conservatoire du littoral was created in 1975 by the State with the objective of preserving natural coastal and lake areas of ecological and landscape interest and the balance of the coastline. The CERL sites in the Gulf of Morbihan are shown in the figure below:

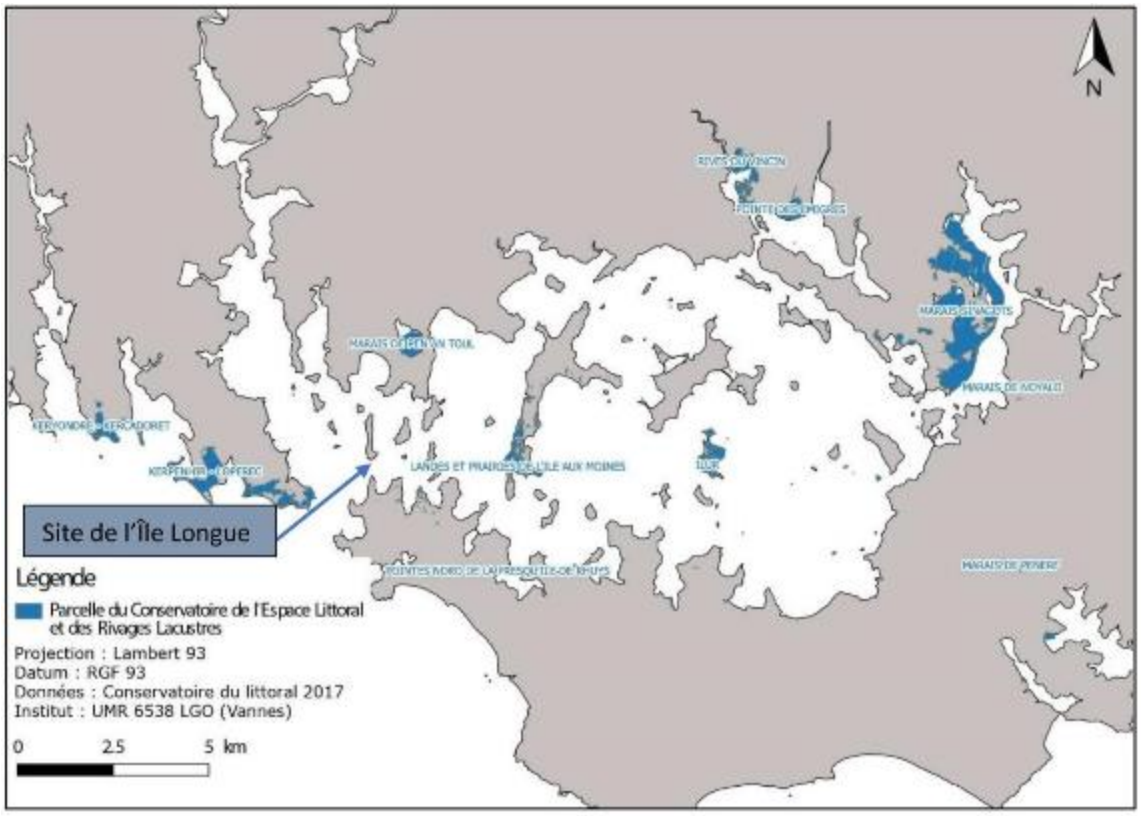


Figure 59: Location of CERL sites in the Gulf of Morbihan

Several listed and classified sites are identified within the Gulf of Morbihan. The Ile Longue wind energy project i located within the listed site "Gulf of Morbihan and its surroundings".

4.3.1.4.2 Sensitive Natural Areas

The Espaces Naturels Sensibles (ENS) are land protection measures implemented by the départements. They aim both to preserve natural environments and landscapes and to offer recreational areas to the public, when the

characteristics of the place allow it. They are a major component of the departments' land use and sustainable development policy.

The Sensitive Natural Areas identified within the Gulf of Morbihan are located on the figure below:

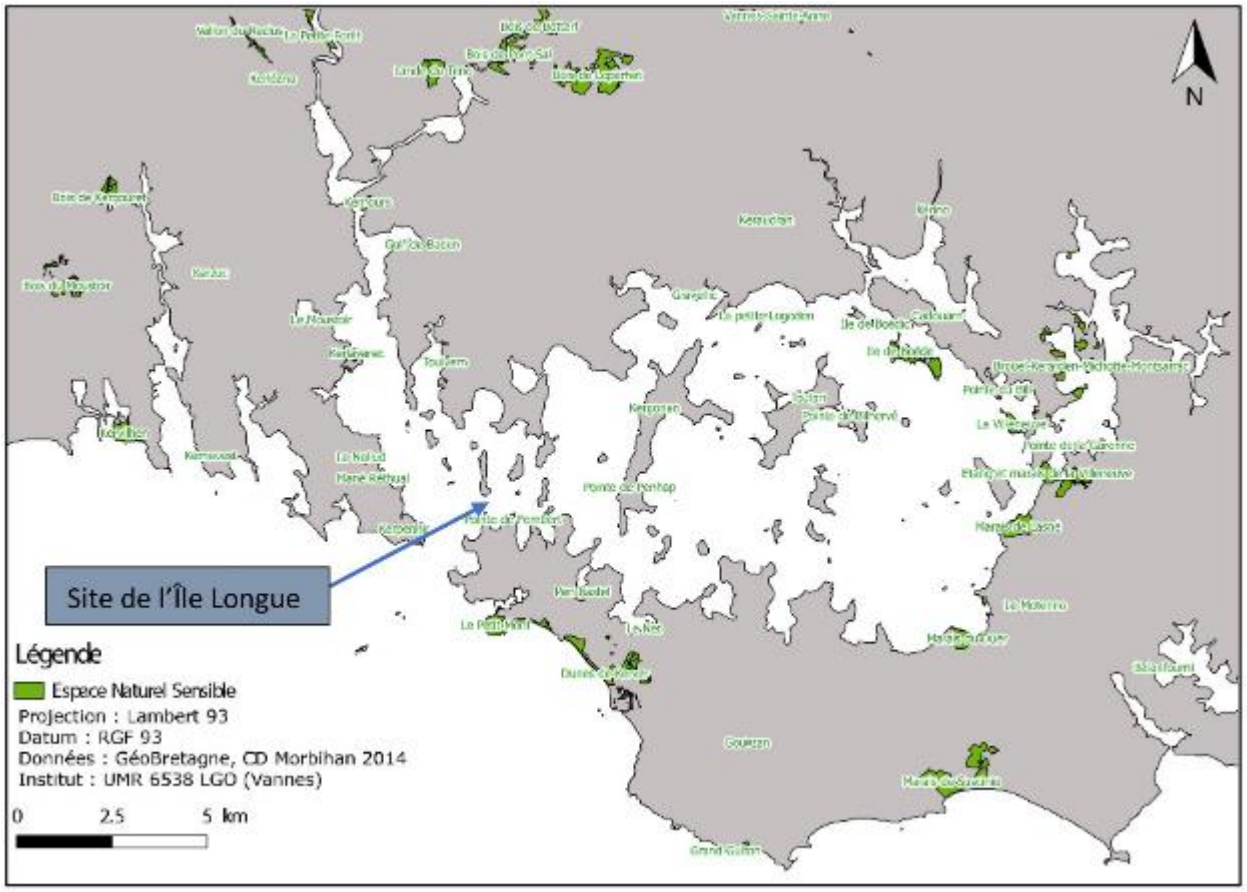


Figure 60: Location of sensitive natural areas (ENS) in the Gulf of Morbihan

Several sensitive natural areas (ENS) have been identified in the Gulf of Morbihan. In the vicinity of Ile Longue, ther is the Pointe de Pembert, which will not be directly affected by the project.

4.3.2 Planktonic biocenoses

As part of the TIGER project, a plankton analysis of the study area was carried out between May and November 2017. This study was carried out by the UBS and the Plankton Observatory.

In the framework of this study, three sites were studied

- The potential site for the installation of tidal turbines on Ile Longue, or the "Sea" site, where the extraction takes place in the drift between the south of Ile Longue and Gavrinis, in an area of strong currents and at an average depth of between 20 and 25 metres;
- the peripheral site, or "Land" site, with weaker hydrodynamic conditions and a depth of about 4 metres;
- the third site, in the eelgrass bed on the west beach of Ilur Island, at a depth of about 4 metres, has been sampled by the Gulf of Morbihan Regional Nature Park since 2015.

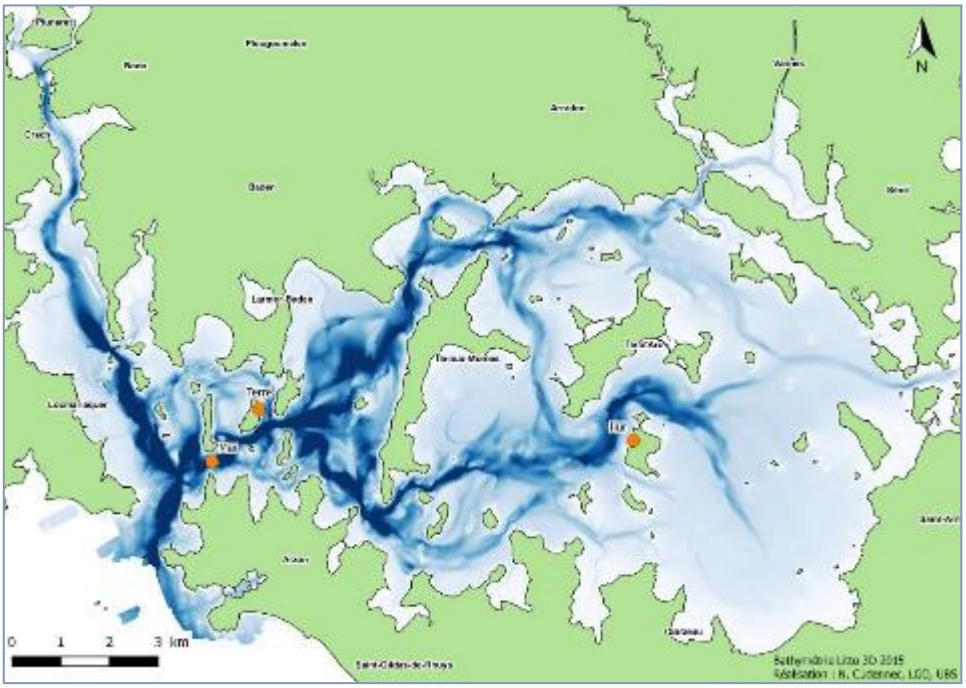


Figure 61: The three sampling points in the Gulf of Morbihan (UBS, 2018)

The sampling carried out in 2017 made it possible to acquire data and carry out an initial characterisation of the planktonic biocenoses in the vicinity of the study sites. This series of analyses made it possible to compare two morphologically different sites and to describe the variations in abundance and diversity of zooplankton and phytoplankton.

This study made it possible to highlight the alternations in planktonic communities. The most representative phytoplankton genera were identified by season and the variations in phytoplankton and zooplankton diversity described according to an alternation synonymous with a good biological response (UBS, 2018).

Within the framework of the TIGER project, phytoplankton analyses were carried out. These analyses made it possible to identify representative species. The results of the analyses also revealed a phytoplankton/zooplankton alternation showing a good biological response.

4.3.3 Benthic biocenoses

4.3.3.1 In the potential tidal turbine siting area

4.3.3.1.1 Bibliographical data: habitats

The two study sites and the potential landfall cable routes overlap several marine habitat types of Natura 2000 community interest.

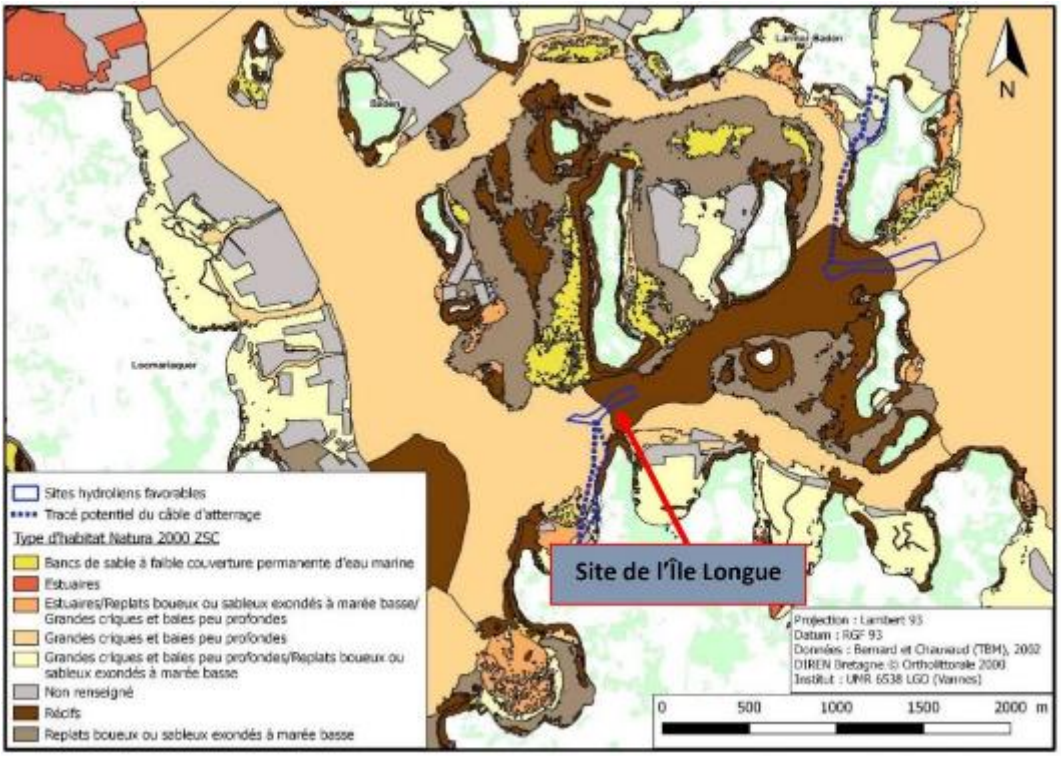


Figure 62: Marine habitats of Natura 2000 community interest in the two study sites (UBS, 2018)

The Ile Longue study site is located within two marine habitat types of Natura 2000 community interest:

- Reefs ;
- Large coves and shallow bays.

In view of the hydrodynamics and the substrate, the species richness and the number of individuals are probably very low at the sites studied. Indeed, the rocky channels are subject to strong and continuous hydrodynamics. These environmental conditions limit the number of species and individuals that can settle in the microhabitats constituted by the cracks and crevices of the rock.

4.3.3.1.2 Video-tracking investigations

In the framework of the TIGER project, video-tracting was carried out along the following transects:

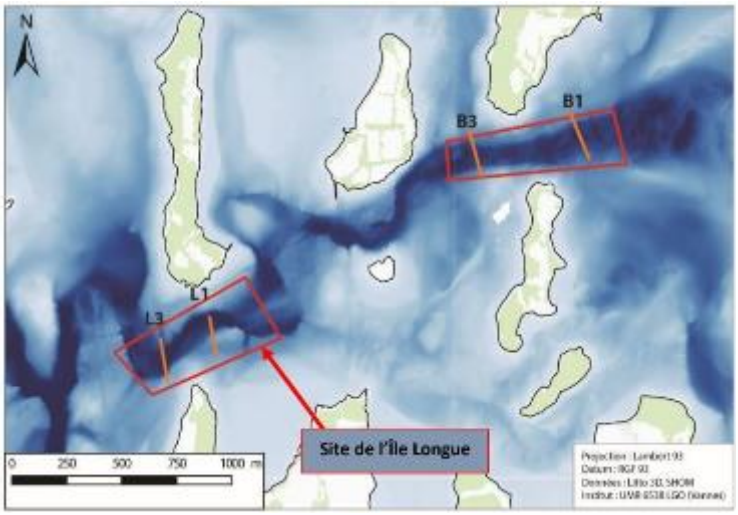
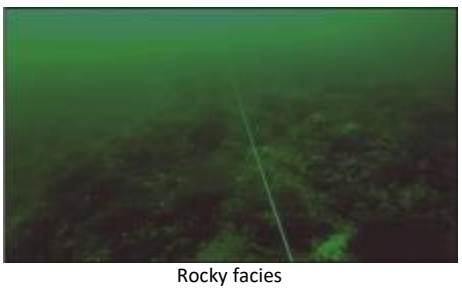


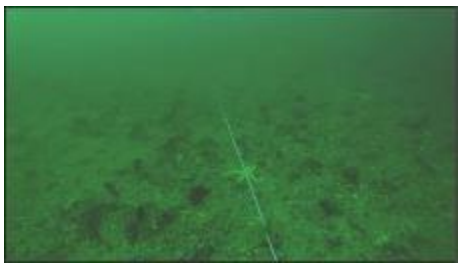
Figure 63: Positioning plan for towed video features (UBS, 2018)

The use of video towing allowed four facies to be distinguished, presented below. In view of the hydrodynamics and the substrate, the quality of the videos did not allow the identification of all the associated biocenosis, but some species could be identified:

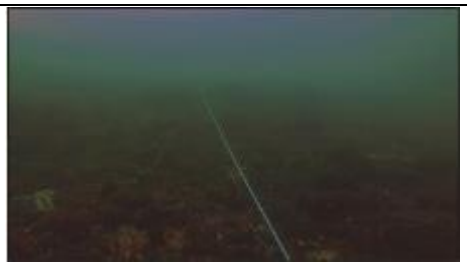
- Rocky facies ;
- Coarse sandy and gravelly facies; Rocky facies dominated by fixed fauna ;
- Medium sandy dune facies.



Rocky facies



Coarse sandy and gravelly facies



Rocky facies dominated by fixed fauna

Medium sandy dune facies

Figure 64: Photographs of facies identified by video-traction (UBS, 2018)

As part of the TIGER project, video-tracting was carried out. These investigations made it possible to identify the benthic habitats in the potential Ile Longue siting area. Four habitats were identified: rocky facies, coarse sandy and gravelly facies, rocky facies dominated by fixed fauna and medium sandy dune facies.

4.3.3.2 In the cable route area

As shown in Figure 62, the potential routes of the landing cable from the Ile Longue study site to Arzon cross four Natura 2000 marine habitat types of community interest: "Reefs", "Large inlets and shallow bays", "Estuaries / Muddy or sandy flats flooded at low tide / Large inlets and shallow bays", "Large inlets and shallow bays / Muddy or sandy flats flooded at low tide

The areas not indicated correspond to oyster farms.

4.3.3.3 At the landing zone

Within the framework of the Tiger project, the sections of the foreshore potentially crossed by the routes of the landing cables were surveyed. After a general description of the foreshore, the different algal belts were characterised and the main associated animal species identified. Sediment sampling was carried out and these samples were then processed to study the benthic foraminifera.

4.3.3.3.1 General description of the foreshore

The area (see Figure 65) was surveyed on 8 November 2017, from 13:00 to 14:30, during low tide (slack tide at 14:06), with a tidal coefficient of 91.

Figure 65: Area surveyed for cable landing (UBS, 2018)

It should be noted that after the field analysis, a variant of the cable routes was proposed, avoiding the passages in the shellfish beds (Figure 66). A lift station located at the top of the beach (Figure 67) was used as a starting point for the proposed variant.

Figure 66: Landfall cable routes and proposed variant (UBS, 2018)

Figure 67: Lift station located at the top of the Tréno beach, Arzon (UBS, 2018)

The area surveyed consists, in its upper part, of a small loose cliff two to three metres high, in some places completely vegetated and in others recently eroded. At the bottom of this cliff, produced by its alteration, there is a strip of pebbles on average five metres wide, which mixes in its lower part with a sandy area a few metres wide. The foreshore ends in mud (Figure 68).

Figure 68: Foreshore consisting of an upper pebble strand, sand and then silt (UBS, 2018)

The habitats identified within the surveyed area are

- Belt with Fucus vesiculosus and Ascophyllum nodosum ;
- Eelgrass (Zostera marina) beds ;

Figure 69: Left: Fucus belt - Right: Eelgrass beds (UBS, 2018)

Within the framework of the TIGER project, an inventory of the foreshore has been carried out. This is mainly char a belt with Fucus and eelgrass beds.

4.3.3.3.2 Benthic foraminifera analysis

Three surface sediment samples were taken from the foreshore to study foraminifera.

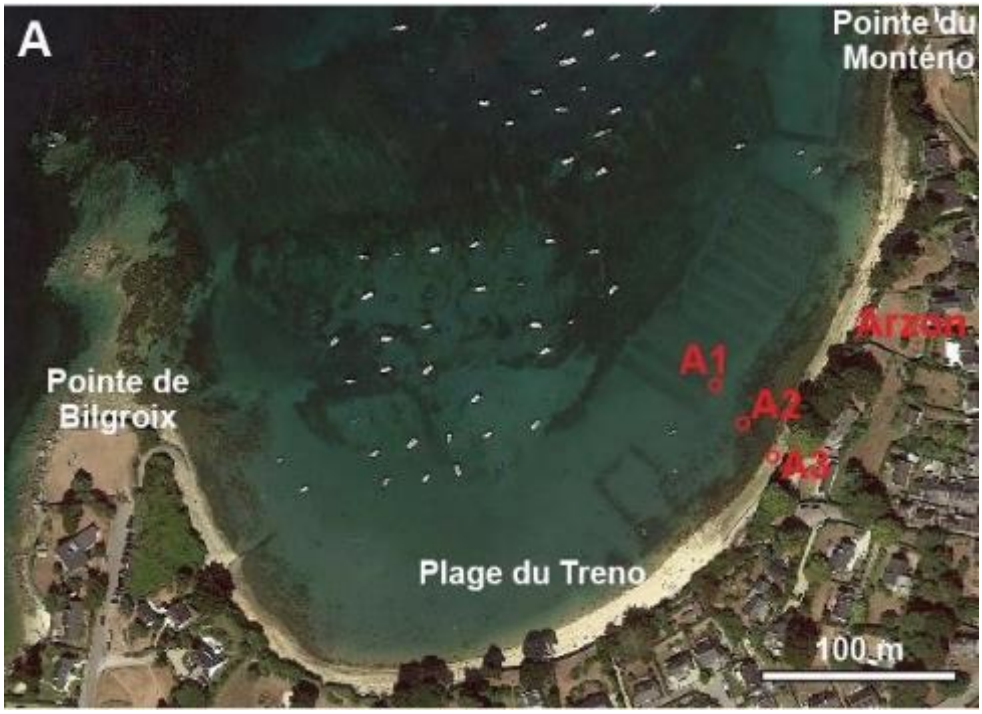


Figure 70: Sample location plan (UBS, 2018)

The results showed that sample A3 is devoid of foraminifera and the other two samples (A2 and A1) are very poor in foraminifera. The foraminifera (all dead) present in these two samples are either relics of former biocenoses or come from other nearby ecological niches. The assemblages of these samples show individuals of robust species that best withstand particle size sorting and transport.

The foreshore of the landing zone does not present any particular species, all the species found are typical not only of the Gulf of Morbihan, but above all of all temperate coastal environments with a mesotidal regime bordering all the oceans.

All the samples indicate a sandy sedimentation environment, which is very dynamic and therefore unstable for the development and long-term maintenance of benthic foraminiferal communities. It should be noted that this instability is valid for all marine benthic organisms smaller than about two millimetres. The macrofauna that can be envisaged in this type of sediment are gastropods (hydrobial type on the surface of foreshore areas), bivalves (cockles, etc.), worms and arthropods (UBS, 2018).

The foraminiferal analysis, carried out as part of the TIGER project, showed that the foreshore of the landing zone was poor in foraminifera and that no particular species was identified. The benthic fauna present is mainly made up of bivalves, worms and arthropods.

4.3.4 Fish and fisheries resources

The size of the regularly exposed mud flats, the existence of seagrass beds and the inflow of fresh and salt water make the Gulf of Morbihan a site likely to be a nursery for many species exploited in the Bay of Biscay (Guerault et al., 1996 in UBS, 2018). In order to study the coastal nurseries in the Bay of Morbihan, trawling carried out in 1995

and 1996 enabled twenty-seven species to be identified (twenty-two species of fish, including eleven commercial species, two species of commercial crustaceans and three species of commercial molluscs. Among them, nine basic species (common and constant species with an occurrence rate of over 25%) likely to use the Gulf of Morbihan as a nursery were also identified: curly ray, eel, pout, sea bass, red mullet, grey mullet, sole, curlew, common cuttlefish, as well as seven accessory species (whose occurrence is always less than 25% in the area): brown skate, pollack, whiting, flounder, pink shrimp, scallop and abalone (Guerault et al., 1996 in UBS, 2018).

It should also be noted that the Gulf of Morbihan is home to amphihaline fish, depending on the season (Sea Lamprey, Atlantic Salmon, European Eel). Two species of seahorse are also present in the Gulf of Morbihan.

Sea bream

Speckled seahorse

Atlantic salmon

Figure 71: Illustrations of some species present in the Gulf of Morbihan (UBS, 2018)

Many species of fish, crustaceans and molluscs, some of which are commercially attractive, are present in the Gulf of Morbihan. In addition, the Gulf can be a functional area (nursery, spawning ground) for many of them. We should also note the presence of species with a high heritage value: Atlantic salmon, seahorse, etc.

4.3.5 Marine mammals and marine megafauna

Off the French Atlantic coast, Mysticetes, Odontocetes and Pinnipeds are observed, whether they are residents or just passing through. Although knowledge of the presence of marine mammals in the Gulf of Morbihan remains to be improved through regular monitoring, only a few individuals of three species have been observed. Their presence is considered to be anecdotal and probably accidental, as the site is marginal given their vast home range: the Grey seal (*Halichoerus grypus*), which has been reported occasionally in the Gulf, the Calf seal (*Phoca vitulina*), whose

presence remains exceptional, and the Bottlenose dolphin (*Tursiops truncatus*), which seems to frequent the Atlantic coast of the Gulf of Morbihan and sometimes enters it.

The Gulf of Morbihan may occasionally be visited by a few species of marine mammals (Grey seal, Calf sea Bottlenose dolphin). Their presence remains anecdotal.

4.3.6 Birdlife

Within the framework of the TIGER project, a synthesis of knowledge concerning the avifauna in the Gulf of Morbihan was carried out. The following figure shows the entire study area, including all the islands, localities and communes considered for interactions with birdlife.

Figure 72: Spatial information of the study area (Callard, 2018 in UBS, 2018)

A census of diving birds wintering in the Gulf of Morbihan has been carried out by the association of the Friends of the Séné Reserve, Bretagne Vivante, the communes of Île-aux-Moines and Sarzeau, the Morbihan Hunting Federation, the Gulf of Morbihan Regional Nature Park and the ONCFS. These birds are counted in the middle of winter (mid-January). The counts are carried out by sector, presented in the species groups. The analyses are carried out by averaging the numbers over the years 2011-2016. The data also present a phenology resulting from concerted counts for wintering species. This information makes it possible to understand the periods of presence of the species.

As an example, the elements show the results for alcids.

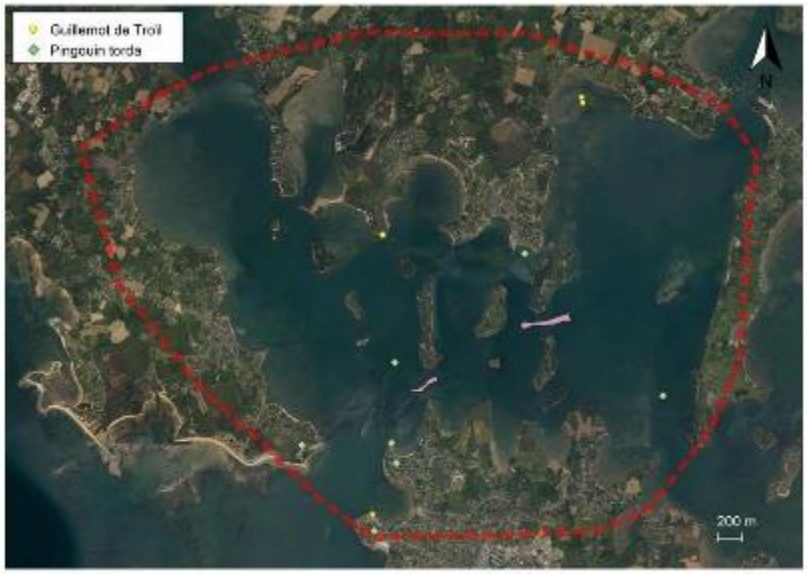


Figure 73: Distribution of Alcidae observations according to Faune Bretagne (UBS, 2018)

Figure 74: Average annual number of Alcidae in mid-January

Alcids are rather deep-sea and pelagic birds that are only occasionally present in the Gulf of Morbihan, generally during the winter period and during storm events that prompt them to seek shelter (Figure 73 and Figure 74). The two most coastal species were observed: the Common Murre and the Razorbill. These two species, which breed in Brittany, are only present in the Gulf of Morbihan in winter. Excellent divers, these species can descend to over fifty metres. There is a low risk of interaction with the project given the very low numbers (UBS, 2018).

The pre-diagnosis of the avifauna of the project of implantation in the Gulf of Morbihan allowed to put forward the knowledge on the local avifauna. The state of the art from the data available at this stage of the project was presented and an interpretation of the results was made. The results are sketchy in the absence of protocolised field data, but already allow a list of species present in the area to be drawn up, with an overall distribution based on observations and a winter presence phenology.

4.3.7 Summary of the biological environment and definition of issues

ZNIEFF : The Ile Longue site is located within the type II marine ZNIEFF "Chenaux rocheux du Golfe du Morbihan" and the type II land ZNIEFF "Golfe du Morbihan".

The IBAs: The Ile Longue site is located within the IBA "Golfe du Morbihan et étier de Pénerf".

Regional Nature Parks: The TIGER project is located within the Regional Nature Park (PNR) of the Gulf of Morbihan.

The National Nature Reserves (RNN): The Ile Longue site is located more than 10 km from the Marais de Séné reserve.

The National Hunting and Wildlife Reserves (RNCFS): The Ile Longue site is located near the national hunting and wildlife reserve of the Gulf of Morbihan.

Wetlands of international importance (Ramsar convention): The Ile Longue site is located in the vicinity of a RAMSAR site.

Prefectoral decrees for the protection of biotopes (APPB): The APPBs "islands and islets of the Gulf of Morbihan" are located near the TIGER project.

The Natura 2000 network: Two Natura 2000 sites have been identified in the Gulf of Morbihan, one SPA and one SAC.

Listed and classified sites: Several listed and classified sites are identified within the Gulf of Morbihan. The Ile Longue wind energy project is located within the listed site "Gulf of Morbihan and its surroundings".

Sensitive natural areas: Several sensitive natural areas (ENS) have been identified in the Gulf of Morbihan. In the vicinity of Ile Longue, we note the proximity of the Pointe de Pembert, but which will not be directly affected by the project.

Planktonic biocenoses: Within the framework of the TIGER project, phytoplankton analyses were carried out. These analyses made it possible to identify representative species. The results of the analyses also highlighted a phytoplankton/zooplankton alternation showing a good biological response.

Benthic biocenoses :

At the level of the potential siting area: Within the framework of the TIGER project, video-tracting was carried out. These investigations made it possible to identify the benthic habitats in the potential siting area of Ile Longue. Four habitats were identified: rocky facies, coarse sandy and gravelly facies, rocky facies dominated by fixed fauna and medium sandy dune facies.

In the cable route area: The cable route area crosses four Natura 2000 marine habitat types of community interest: "Reefs", "Large inlets and shallow bays", "Estuaries / Muddy or sandy flats exposed at low tide / Large inlets and shallow bays", "Large inlets and shallow bays / Muddy or sandy flats exposed at low tide

In the cable landing zone: As part of the TIGER project, an inventory of the foreshore was carried out. The foreshore is mainly characterised by a wrack belt and eelgrass beds. The analysis of foraminifera, carried out as part of the TIGER project, showed that the foreshore of the landing zone was poor in foraminifera and that no particular species was identified. The benthic fauna present is mainly made up of bivalves, worms and arthropods.

spawning ground) for many of them. We should also note the presence of species with a high heritage value: Atlantic salmon, seahorse, etc.

Marine mammals and marine megafauna: The Gulf of Morbihan may occasionally be visited by a few species of marine mammals (Grey seal, Calf seal, Bottlenose dolphin). Their presence remains anecdotal.

Avifauna: The pre-diagnosis of the avifauna of the project in the Gulf of Morbihan enabled knowledge of the local avifauna to be highlighted. The state of the art from the data available at this stage of the project was presented and an interpretation of the results was made. The results are sketchy in the absence of protocolised field data, but already allow a list of species present in the area to be drawn up, with an overall distribution based on observations and a winter presence phenology.

Components	Features	Issue level
Natural and ecological heritage		
The ZNIEFF	Project located in ZNEIFF. Inventory areas without regulatory scope, but showing an area of interest	Medium
IBAs	Project located in an IBA. Inventory zones without regulatory scope, but showing an area of interest	Medium
Natural parks regional	Project located in the Gulf of Morbihan Regional Nature Park	Fort
National nature reserves	The Ile Longue site is located more than 10 km from the Marais de Séné reserve.	Medium
The National Reserves of Hunting and Wildlife Wild (RNCFS)	The Ile Longue site is located near the national hunting and wildlife reserve of the Gulf of Morbihan. Preservation of species and habitats	Medium
RAMSAR site	The Ile Longue site is located nearby within a RAMSAR site. No regulatory commitment, but preservation of the environment	Medium
The prefectoral decrees of Biotope Protection (APPB)	The APPB: "islands and islets of the Gulf of Morbihan" are located in the vicinity of the TIGER project. Regulated human activities	Fort
Natura 2000 sites	Project located within a SPA and SAC	Fort
Listed sites	The Ile Longue wind energy project is located within the "Golfe du Morbihan and its surroundings" registered site.	Fort
Natural Areas Sensitive areas (ENS)	In the vicinity of Ile Longue, we note the proximity of the Pointe de Pembert, but which will not be directly affected by the project.	Fort
Planktonic biocenoses		
Phytoplankton	No special features, but base of the food chain	Fort
Zooplankton		
The benthic communities		

Location of the tidal turbines	Benthic habitats in the potential Ile Longue siting area: rocky facies, coarse sandy and gravelly facies, rocky facies dominated by fixed fauna, medium sandy dune facies. No particular features observed at this stage	Medium
In the area of the cable route	The cable route area crosses four marine habitat types of Natura 2000 community interest: "Reefs", "Large inlets and shallow bays", "Estuaries / Muddy or sandy flats flooded at low tide / Large inlets and shallow bays", "Large inlets and shallow bays / Muddy or sandy flats flooded at low tide Potential presence of eelgrass beds with high heritage value.	Fort
In the area landfall	Habitat: Fucus belt and eelgrass beds. High heritage value for the meadows.	Fort

Table 19: Definition of biological environment issues (1/2)

Components	Features	Issue level
Fish and fisheries resources		
Fish and fisheries resources	The Gulf of Morbihan is a nursery area for many species.	Fort
Components	**Features**	**Issue level**
Marine mammals and sea turtles		
Marine mammals and megafauna	Few marine mammals in the Gulf of Morbihan	Low
Components	**Features**	**Issue level**
Birdlife		
Avifauna	Presence of numerous species justifying the numerous natural protections (RNCFS - ZPS - ZICO)	Fort

Table 20: Definition of biological environment issues (2/2)

4.4 The living environment

4.4.1 The landscape

"Landscape" means a part of a territory as perceived by people, the character of which results from the action of natural and/or human factors and their interrelationships. "*Extract from the European Landscape Convention.*

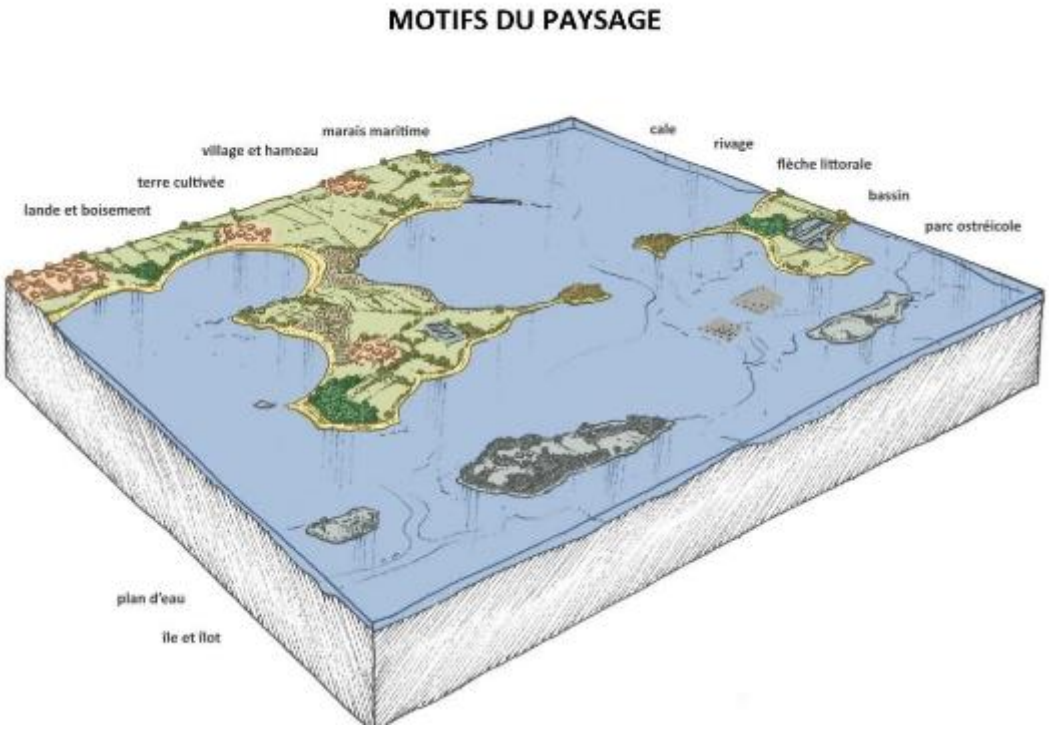


Figure 75: Landscape block "Golfe du Morbihan" (Panorama des paysages du littoral, 2017).

The landscape of the Gulf shows a great diversity of coastal forms, with a clear opposition between the western and eastern basins: rocky coasts with small cliffs in the west, coasts and muddy foreshore in the east, interspersed with small estuaries, marshes and salt meadows, sandy beaches, moors and woodlands.

Most of these remarkable sites are safeguarded by various types of protection (listed site, classified site, historic monument classification, nature reserve, biotope protection order, application of the coastal law, etc.).

A landscape entity (or landscape unit) refers to "a continuous part of territory that is coherent from a landscape point of view. This given landscape is characterised by a set of landscape structures and landscape elements that give it its uniqueness. A landscape unit is distinguished from neighbouring landscape units by boundaries that may be clear or blurred" (MEDDE, 2015).

This assembly makes it possible to set up tools for analysis and then for orientation in order to respond to problems and monitor common developments. The Gulf of Morbihan is divided into **five** main **entities** within the scope of the **SMVM** and **eleven entities** within the scope of the **NRP**.

1.3.4.1.1. The landscape within the SMVM perimeter

Schematically, five large homogeneous landscape entities have been identified by the SMVM (Étude Paysagère, SMVM, 2002), three Gulf entities and two River entities.

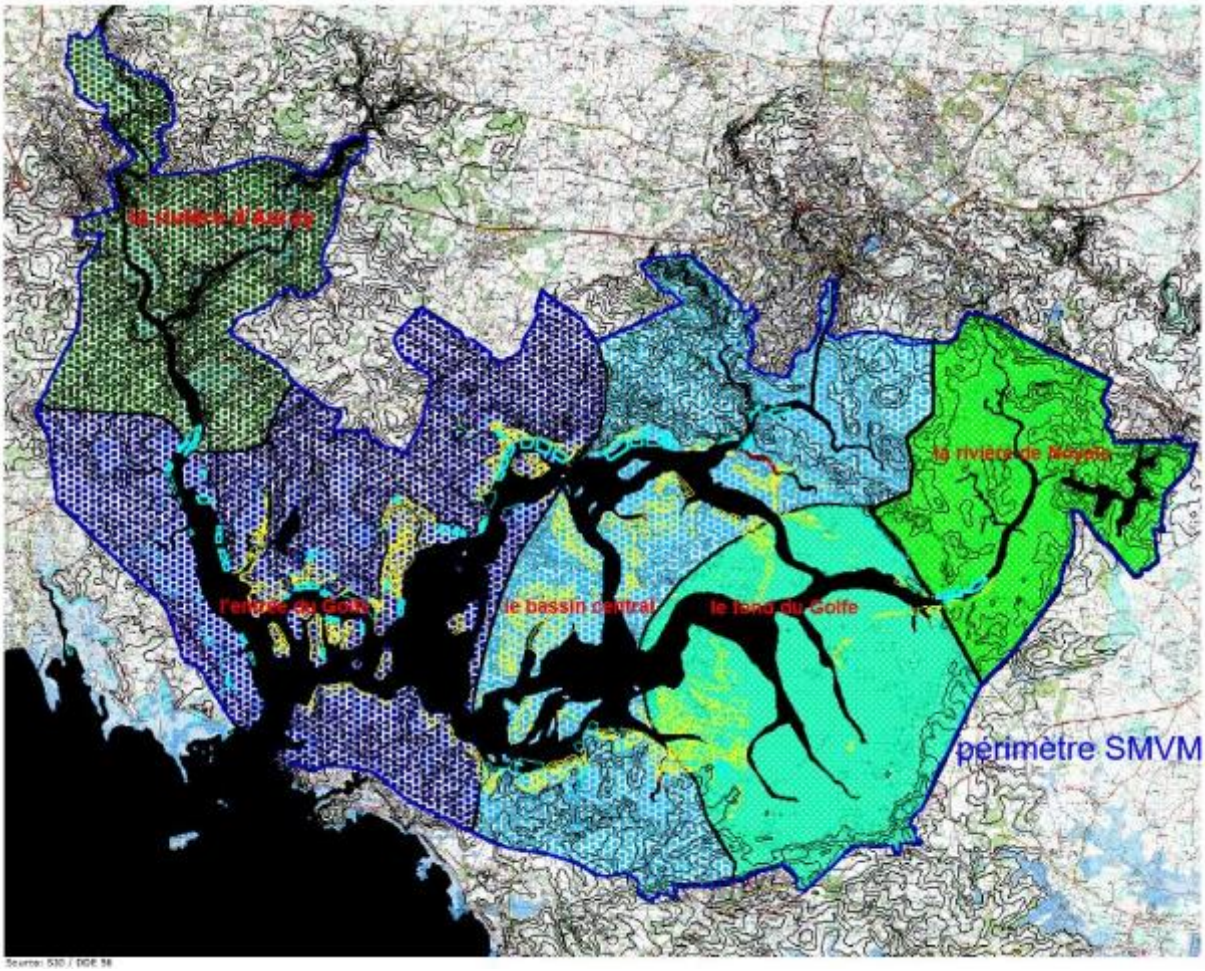
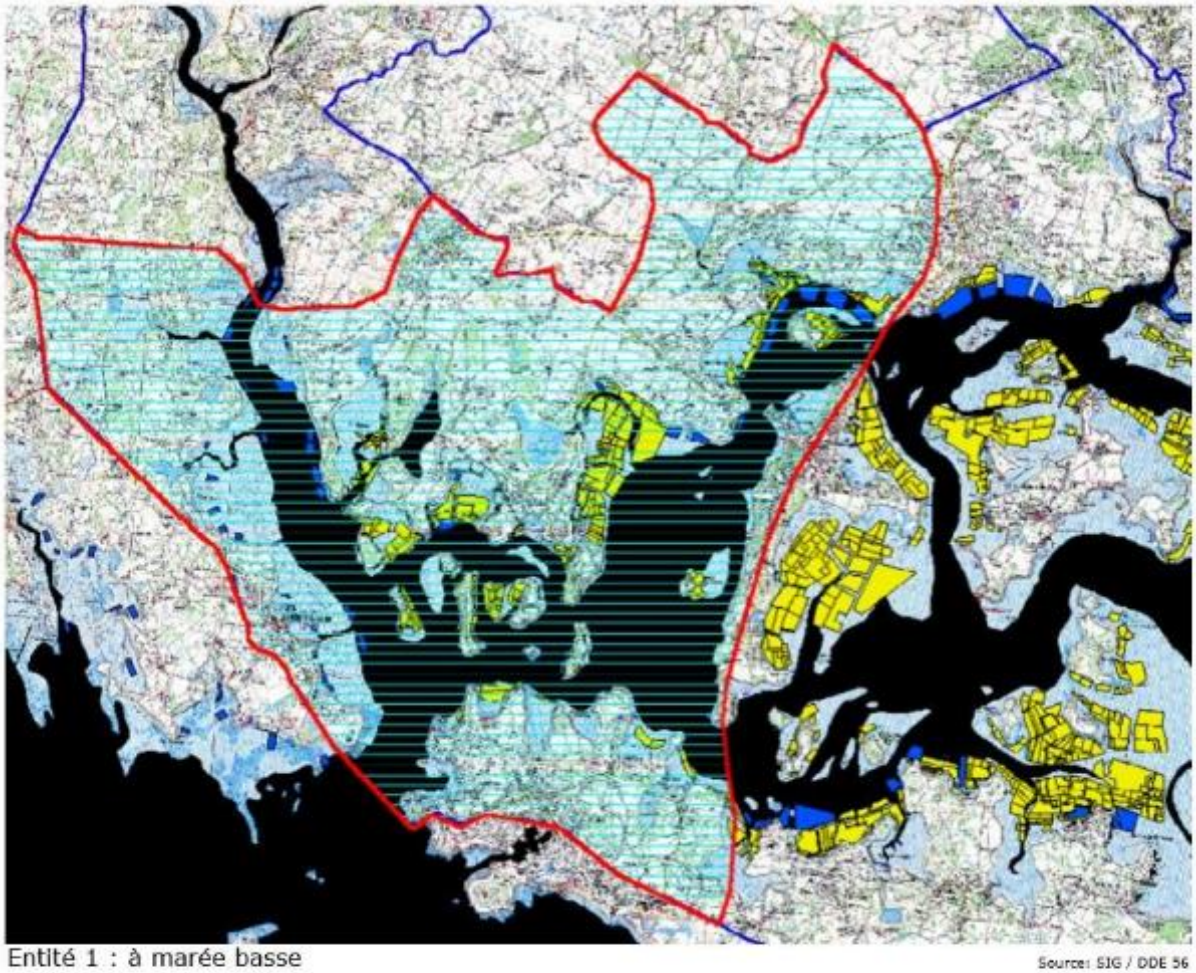


Figure 76: The five landscape entities (Landscape study, SMVM, 2002).

The entrance to the Gulf of Morbihan marked by the ocean, strong currents, a system of points and cliffs, a strong human presence, a zone of strong competition.



Entité 1 : à marée basse

Source: SIG / DDE 56

Locmariaquer : une côte architecturée par les ouvrages de soutènement et les pontons

Anse de Locmiquel : un relief doux en contrepoint aux pointes plus abruptes

1.3.4.1.2. The landscape in the NRP area

The perimeter of the Regional Natural Park of the Gulf of Morbihan corresponds to a geographical perception and use of the landscape rather than a purely administrative perimeter. The maritime imprint of the water body, its vegetation, its reliefs, its lights, and the activities that develop there mark the belonging to the same "country" (PNR, 2010). A landscape analysis has made it possible to define eleven landscape entities that have been included in the Park Plan (Briandet, 2003; NRP, 2010).

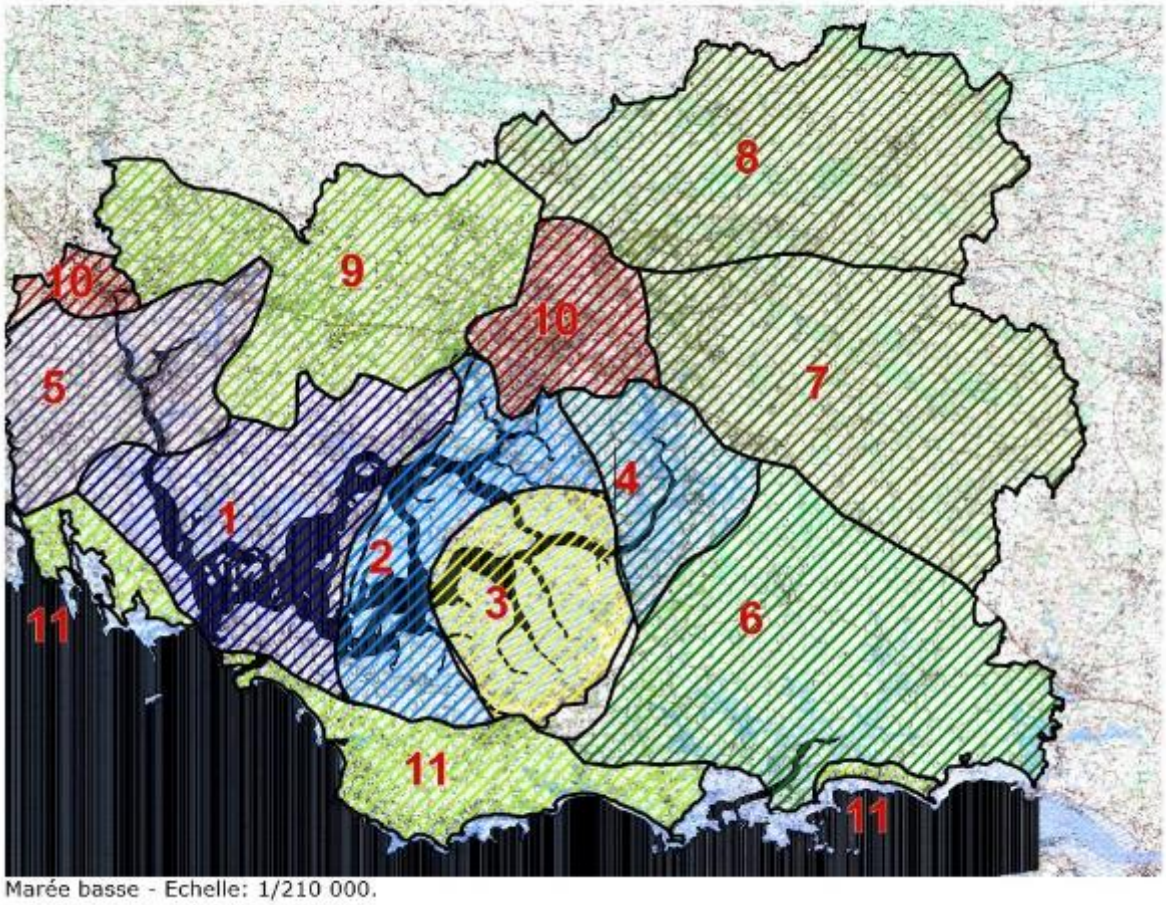


Figure 77: The eleven landscape entities (NRP, 2010).

The entrance to the Gulf is under the direct influence of the ocean, with a very strong current and a high tidal range, a topography and altitudes more marked than elsewhere at the edge of the water body, coasts and wooded islets. The strong human presence makes it an important area of competition.

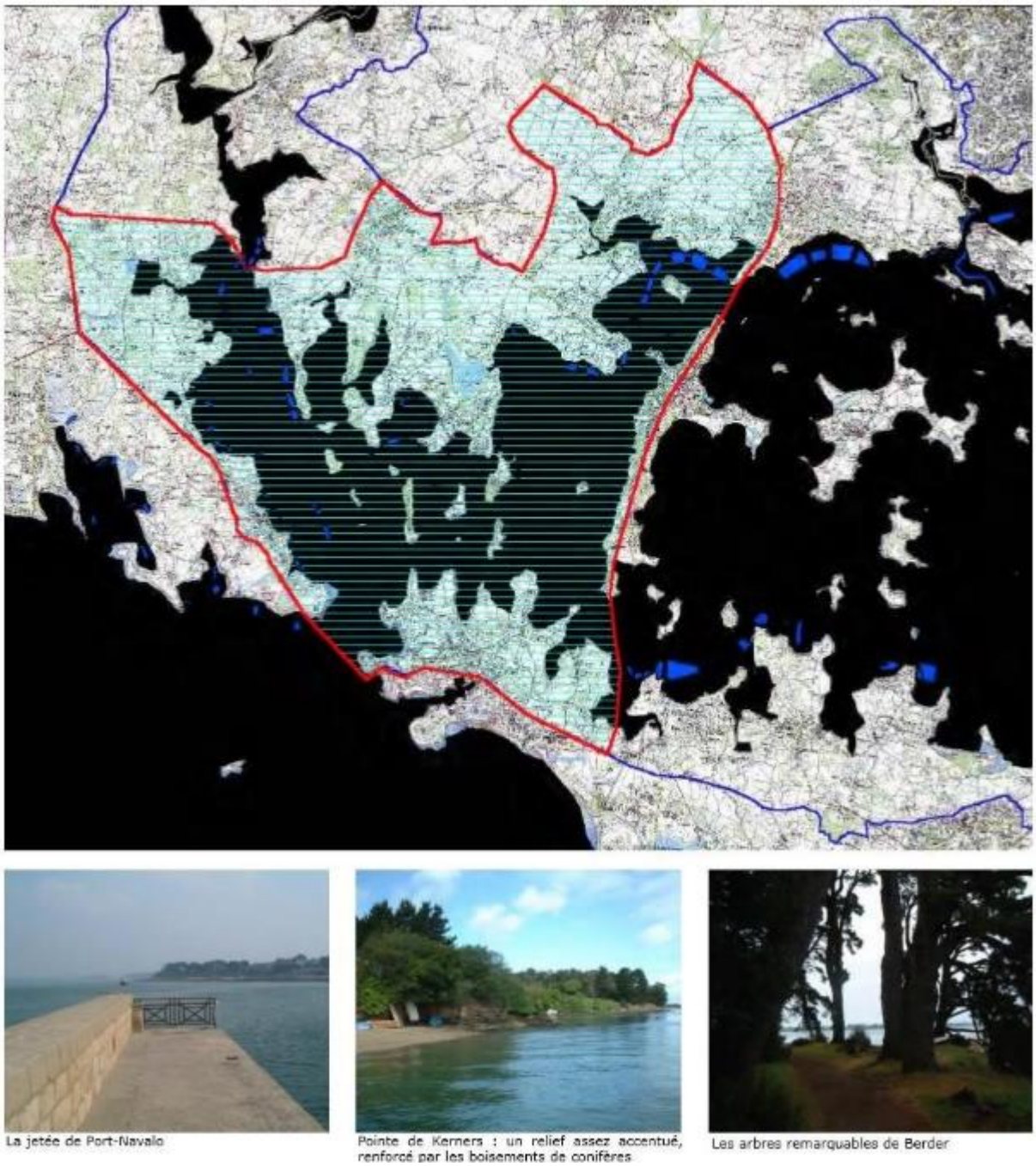


Figure 78: Feature 1 - The entrance to the Gulf (Briandet, 2003).

4.4.2 Cultural heritage

4.4.2.1 The heritage of the Gulf of Morbihan

The identification of the Gulf's heritage resources is carried out through a classification into three typologies: archaeology, ethnology and architecture, which deeply mark its cultural heritage (NRP, 2010).

The archaeological heritage is very present, particularly for the Neolithic period, represented by the number and diversity of the megaliths that still dot the landscape (Merchant's Tables, Ile Longue tumulus, Gavrinis cairn, Er Lannic

cromlech, Petit Mont cairn...). The megalithic sites in the south of Morbihan (Carnac, Quiberon and the Gulf of Morbihan) are the subject of an **application for inclusion in the UNESCO World Heritage List**.

Research into terrestrial and underwater archaeology is divided between institutions and State services, via the Direction Régionale des Affaires Culturelles de Bretagne (DRAC) and the Département des Recherches Archéologiques Subaquatiques et Sous-Marines (DRASSM), but also local associations (Paysages de Mégalithes, etc.).

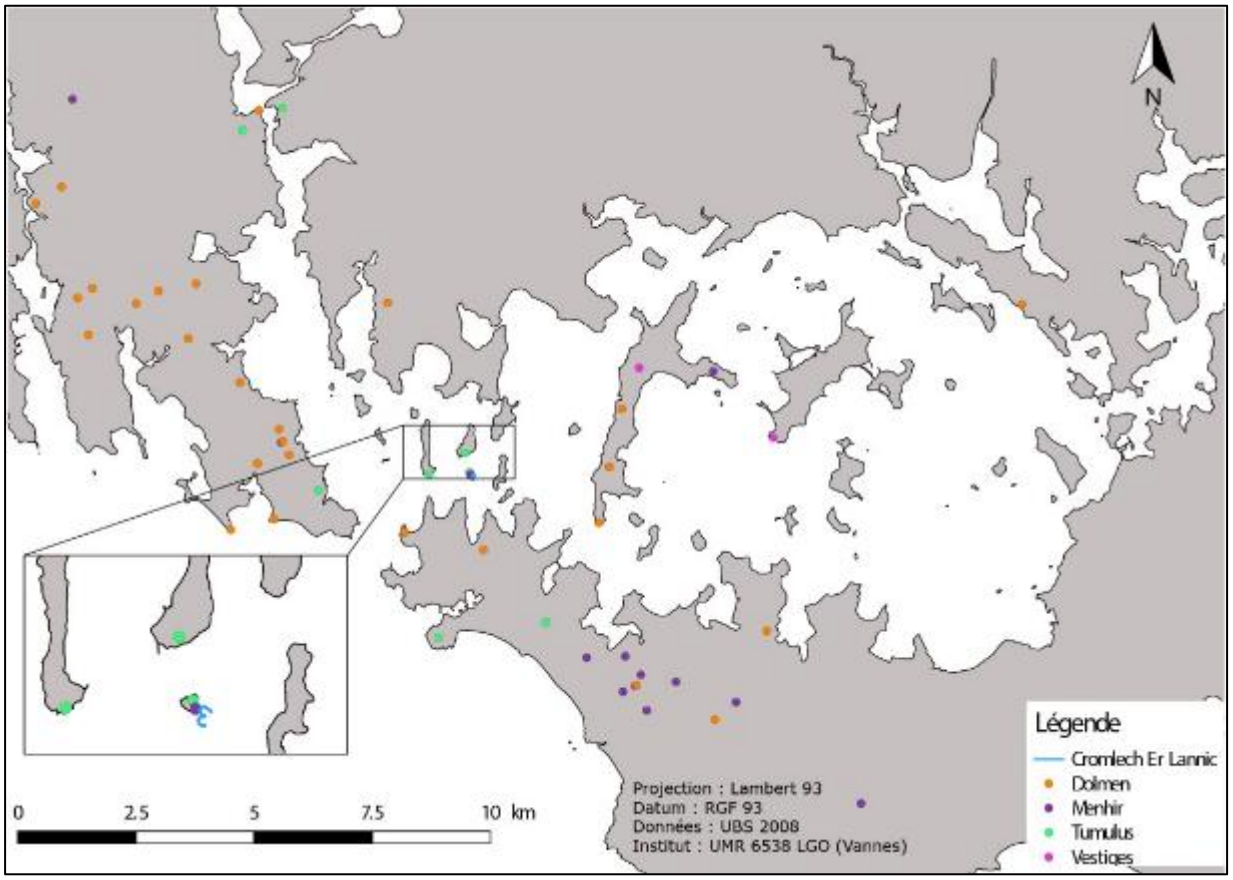


Figure 79: Inventory of megaliths in the Gulf of Morbihan (NRP, 2010)

The architectural heritage is characterised by the large number of chapels, churches, castles and manor houses as well as by the singularities of the vernacular architecture around the traditional habitat (NRP, 2010). One of the main sources of knowledge of the built heritage is the general inventory conducted by the Service Régional de l'Inventaire (SRI) attached to the DRAC. Other inventories have been carried out by associations, including the learned societies, Glad Senolf, LaLaLa, Ram'Dam, Ambon et son Histoire, Damgan et son Histoire, etc.

Ethnological heritage, which defines local cultural identity, is based on the material or immaterial traces that still exist on the territory and bear witness to aspects of life, in its lifestyles, activities, know-how, traditions, social and economic organisation, customs and languages (NRP, 2010). Regional and departmental associations such as the Cinémathèque de Bretagne, Dastum, the Institut Culturel de Bretagne, Kendalc'h..., or local associations such as Glad Senolf have been carrying out research in this field for several decades (collecting memories, images, songs, music), but the lack of protection measures concerning this type of heritage makes it difficult to recognise.

Most of the remarkable sites in the Gulf of Morbihan are currently protected by various types of protection: listed sites, sites classified as Historical Monuments, ZNIEFF, ZPS, biotope decree, RAMSAR convention, etc. Beyond the

existing protections, it is necessary to integrate this heritage in order to define a coherent territory and to highlight the human dynamics and the historical heritage of the Gulf, as well as the singularity of the natural environments.

The **built maritime heritage is** made up of oyster huts, slipways, moorings, etc. The coastline of the Gulf of Morbihan Regional Nature Park has a multitude of built maritime heritage elements. These structures bear witness to the activities of human beings and the special bond that unites them with the "little sea" (Mor Bihan) or the ocean (Mor Braz). In 2017, the NRP launched an inventory of the maritime built heritage.

4.4.2.2 Most Beautiful Bays in the World Club

The Most Beautiful Bays in the World Club is an international association, created in the 1990s, with its headquarters in Vannes. It brings together organisations, each representing a community, offering a maritime frontage on an exceptional bay of the world coastline. Today, it brings together 36 bays from 27 different countries and aims to preserve the environment of these remarkable sites. The Gulf of Morbihan and the Bay of Quiberon are part of this club, whose members must respect a number of commitments:

- Save their natural heritage,
- Preserve their identity,
- To respect the way of life and traditions of the people who live there, while at the same time aiming for economic development compatible with these commitments.

The club aims to be a place of exchange for the protection, preservation and enhancement of bays. Having the label **"One of the most beautiful bays in the world"** can have interesting tourist and financial repercussions**.**

The archaeological heritage is very present in the Gulf of Morbihan, with a large number and diversity of megaliths (Merchant's Tables, Ile Longue tumulus, Gavrinis cairn, Er Lannic cromlech, Petit Mont cairn...). The megalithic sites in the south of Morbihan (Carnac, Quiberon and the Gulf of Morbihan) are the subject of an application for inclusion in the UNESCO World Heritage List.
The Gulf of Morbihan is listed alongside Along Bay in the "Club of the most beautiful bays in the world", whose headquarters are in Vannes. This reputation is based on its undeniable landscape qualities. The image of the Gulf is also impregnated by a singular temporality, ancient on the historical time scale evoked by the numerous megaliths, but very recent on the geological time scale.

4.4.2.3 Buildings listed or classified as historical monuments

"A historic monument is a building or an area that has been classified or listed in order to protect it because of its historical or artistic interest. As such, the heritage protected as a historic monument today includes many areas such as domestic, religious or industrial heritage. Its temporal scope extends from the prehistoric period to the 20th century. ».

The legislation distinguishes between two types of protection, **classified** sites and **registered sites**:

- Historic buildings are **classified** as "buildings whose conservation is of public interest from the point of view of history or art". This is the highest level of protection.

- The following are **listed** as historical monuments: "buildings which, without justifying an immediate application for classification as historical monuments, are of sufficient historical or artistic interest to make their preservation desirable".

For listed buildings, as for registered ones, this protection can be total or partial, concerning only certain parts of a building. The distinction between listed and classified buildings can also be understood according to the extent of the building's heritage interest: classification is carried out at a national level and listing at a regional level. The law of 25 February 1943 established a 500-metre perimeter (the "approaches") around protected monuments and a system of control, by the Architecte des Bâtiments de France, of work carried out within this perimeter (Direction Régionale des Affaires Culturelles de Lorraine, February 2013). **Seven buildings listed or classified** as historical monuments are located near the study sites:

- The Cromlech of Er Lannic (Arzon, Er Lannic) was classified in 1889.
- The Graniol Dolmen (Arzon, Graniol Tal er Men Guen) was listed in 1973.
- The Dolmen of the Pointe de Bilgroix (Arzon) was classified in 1978.
- The Cromlech of Kergenan (Île-aux-Moines, Kergonan) was classified in 1862.
- The Dolmen of Pen-Hap (Île-aux-Moines, Er Golo Taul) was classified in 1979.
- The Etal-Berder Mound (Larmor-Baden, Etal-Berder) was listed in 1960.
- The Cairn of Gavrinis (Larmor-Baden, Gravinis Island) was listed in 1901.

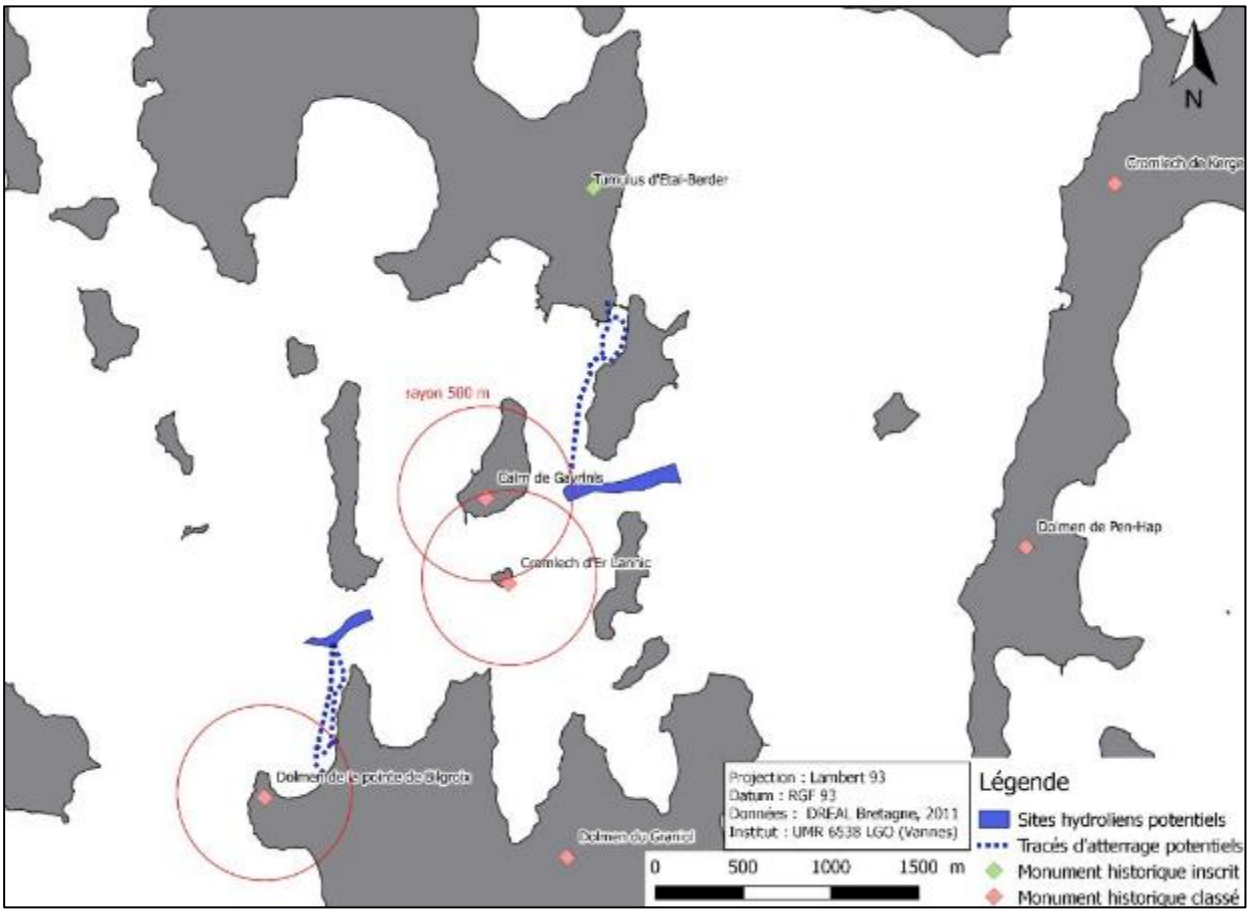


Figure 80: Listed and classified historic monuments in the vicinity of the study sites

The **Cairn de Gavrinis** and the **Dolmen de la pointe de Bilgroix are** listed buildings. They are respectively located less than 500 metres from the end of the Berder hydrolic study site and from the potential route of the landing

4.4.3 Air quality

The regional air quality network, Airbreizh (http://www.airbreizh.asso.fr), operates the measuring stations and disseminates the daily data. In the Gulf of Morbihan, there is only one UTA measuring station in the city of Vannes. It measures the following pollutants; NOx, Ozone, Fine particles (PM10 and PM2.5).

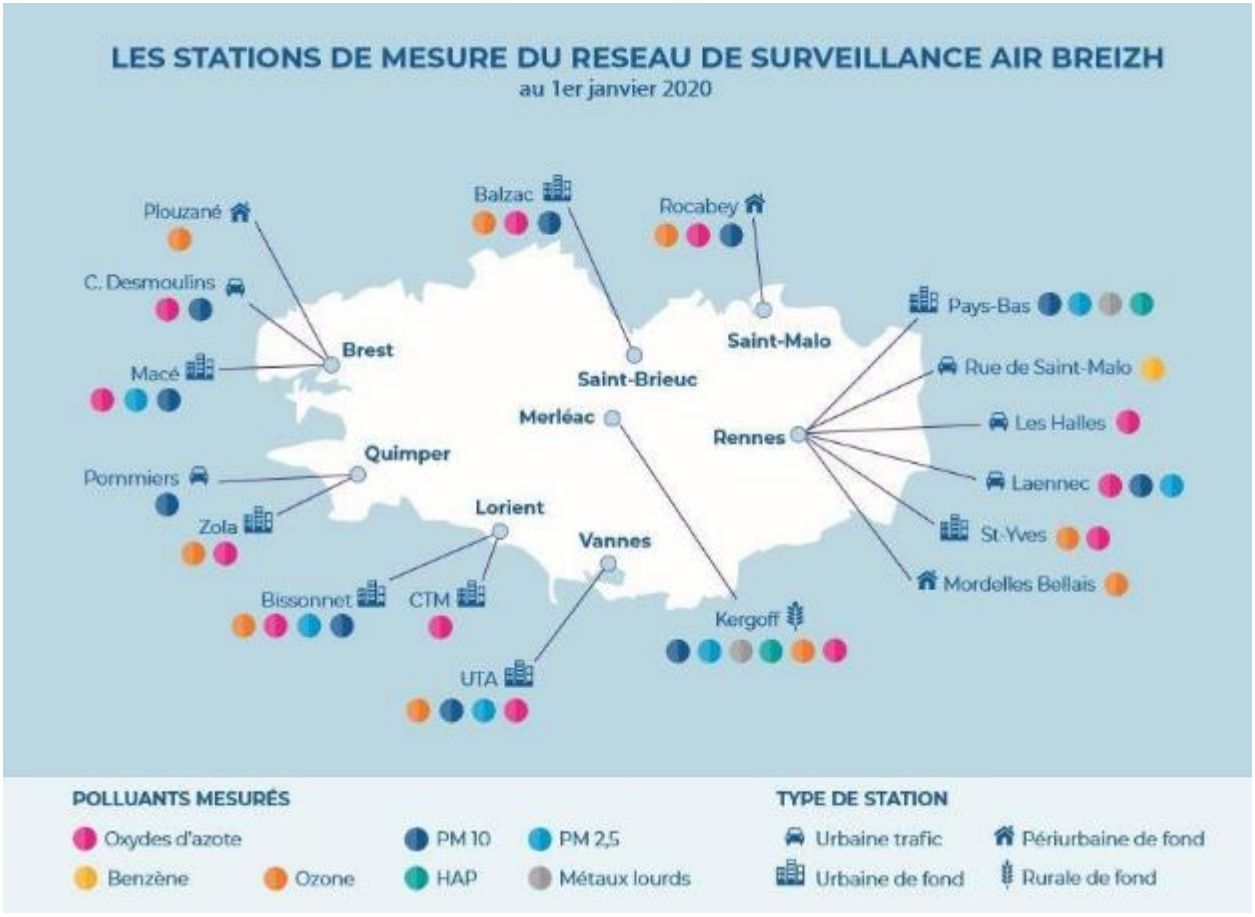


Figure 81: Network of measurement stations in Brittany (source Airbreizh)

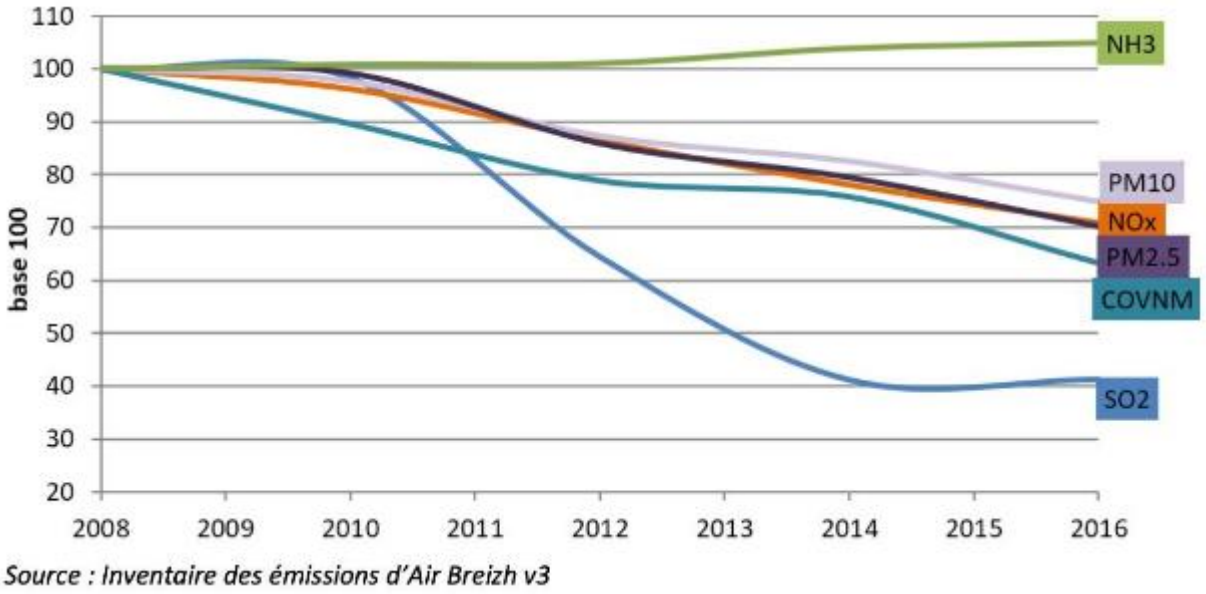


Figure 82: Evolution of emissions (source Airbreizh)

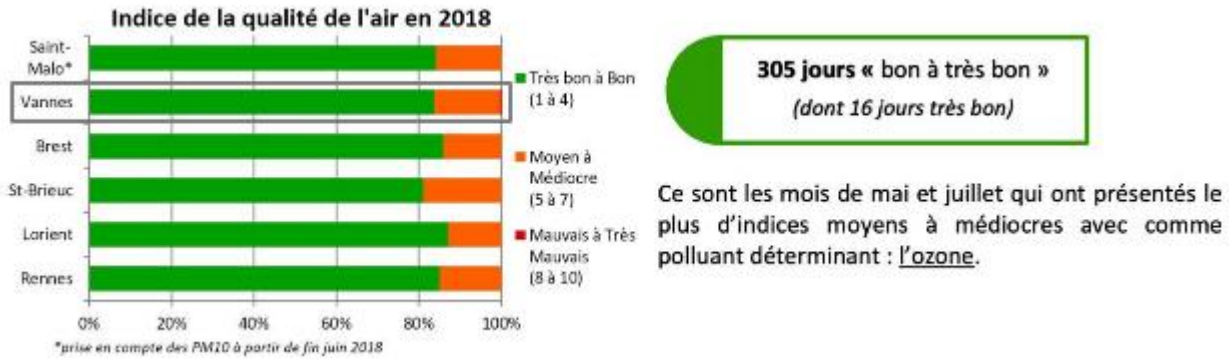


Figure 83: Air quality index of the main Breton cities (source Airbrezih)

Except for ammonia, emissions have all been decreasing over the last ten years. Air quality is good in Vannes, as in Brittany.

4.4.4 Airborne noise environment

Noise is a set of sounds produced by a vibratory phenomenon propagating mainly through the air.
In its physical dimension, noise can be characterised by a large number of parameters, in particular

- Its sound level or acoustic intensity, which is measured on a logarithmic scale in decibels (dB) ;
- Its pitch or frequency expressed in Hertz (Hz);
- Its duration ;
- Whether it is stable or impulsive, continuous or intermittent;

The main component of noise is physiological and perceptual: it is then defined as "any unpleasant or annoying auditory sensation, any acoustic phenomenon producing this sensation, any sound with a random character which has no defined component" (AFNOR definition). Taking into account this perceptual dimension leads to the

correction of the decibel measurement system by a weighting according to the sensitivity of the hearing system: the weighted decibel, dB(A), takes into account the fact that the human ear is not equally sensitive to all frequency ranges.

According to several opinion polls, Brittany is one of the regions in France where the population claiming to be bothered by noise (30 to 40%) is the lowest. However, noise is still considered as one of the main threats to the quality of life (Survey of the Interregional Policy Observatory 2001 - Source: IFEN).

4.4.4.1 Road transport, the main source of noise

In Morbihan, the main cause of airborne noise is road transport. There are prefectural decrees on noise classification imposed by articles L 571-10 and R 571-32 and following of the environment code for national and departmental roads (Decree of 1 December 2003) and communal roads in Vannes (Decree of 2 November 2004), Caudan, Larmor-Plage, Lorient, Ploërmel, Pontivy, Queven, Saint-Avé and Séné (Decree of 19 June 2009)

Figure 84: Noise classification of national and departmental roads (source CD56)

Overall, more than 4,700 people in Morbihan are likely to be exposed, due to road infrastructures, to exceeding the noise limit value prescribed by European regulations, weighted by the different periods of the day (68 dB(A)).

This number falls to an estimate of more than 2,700 people exposed to exceeding the threshold (62 dB(A)) during the night.

No educational or health establishments have been identified in these zones exposed to exceeding the noise limit values. There is no noise classification for land transport infrastructures in the Morbihan railway area to date, as traffic is less than 50 trains per day on the entire network.

4.4.4.2 Air transport

As regards air transport, the number of commercial aircraft movements more than doubled between 1993 and 2006 in Morbihan. Three infrastructures are subject to a Noise Exposure Plan in the department: Lorient-Bretagne sud airport, Vannes-Meucon and Quiberon airfields. Morbihan is one of the few departments that have not yet set up a land transport noise observatory. Defined by a decree and two circulars, it aims to identify national road and rail noise black spots and to prepare a plan to reduce these black spots. It must also become the monitoring committee for noise maps and PPBEs.

4.4.4.3 Leisure: not noise neutral

Recreational activities as a whole are also sources of noise. The example of **water sports** is particularly relevant to the departmental context: the Gulf of Morbihan is one of the busiest shipping basins in France (the most critical passage being that of Port Blanc, with flows of up to 237 boats per hour in the high season). The noise levels generated are generally well below the maximum permitted by Directive 2002/49/EC. However, in most cases they would be too high for nature parks or protected areas (CSNPSN, 2007).

Noise is a complex concept that covers different dimensions (physical, psychological, etc.) and can have extremely varied natures and sources. It is also a nuisance that is not well tolerated by the population because of its consequences on health (fatigue, stress, aggressiveness, etc.). Numerous regulatory measures therefore exist, proposing noise emission standards according to the activities concerned. However, noise also has an impact on the environment, particularly through the disturbance of wildlife. In Morbihan, there are many sources of noise and real pressures on the environment. They are mainly linked to **transport activities**.

4.4.5 Risks in the Gulf of Morbihan (source Atlas de l'environnement 56)

Risks are the result of hazard (occurrence, intensity and duration of an event) and vulnerability (level of foreseeable consequences of a phenomenon). Vulnerability may concern humans, property or the environment. So-called major risks have a low frequency but a high severity.

These risks can be :

- Natural: landslides, floods, earthquakes, forest fires, storms, etc.
- Technological: industrial, dam failure, transport of hazardous materials, etc.

4.4.5.1 Natural hazards

Since 1983, 1,038 natural disaster decrees have been published in the official journal for Morbihan, of which about 80% are the result of only 4 major events. The majority of these decrees concern storms and floods. The risks detailed below are those applicable to the Gulf of Morbihan.

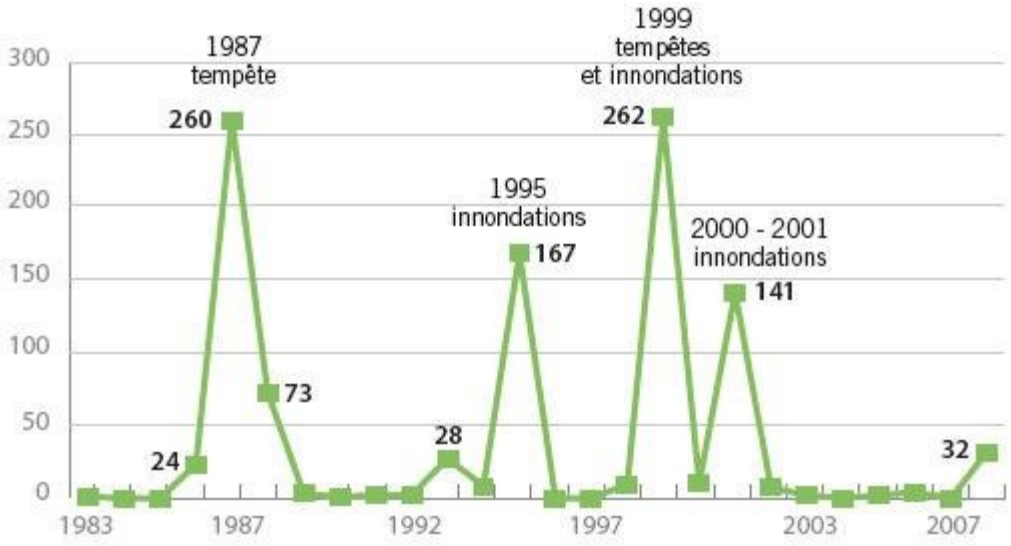


Figure 85: Evolution of the number of natural disaster decrees published (source BD Gaspar)

4.4.5.1.1 Storm risk

Morbihan is most exposed to storms. The term "storm" is used when the average winds exceed 89 km/h for 10 minutes (i.e. degree 10 on the Beaufort scale). Although this risk concerns all the communes of the department, it is the sectors closest to the coast that are the most vulnerable, especially as the strength of the winds is generally greater there. The storms of 1987, 1995, 1999 and 2008 illustrate this, with south-westerly winds reaching up to 180 km/h in the islands, 166 km/h in Lorient and 144 km/h in Ploërmel in 1987. Most storms occur during the cold season, between October and March. Some summer storms are also accompanied by strong winds. The storms originate preferentially from sectors between 220 and 320°, i.e. SW to NW (Lemasson, 1999).

4.4.5.1.2 The risk of marine submersion

Sea surges are episodic flooding of low-lying areas below the highest water level. The continental coastal fringe is then invaded by sea water. Since 1983, 32 natural disaster decrees have been registered in the official gazette for marine submersion. 30 of them are the result of the equinox storm of 9 March 2008. Indeed, marine submersion is often the result of the conjunction of an equinox tide and meteorological effects. Storms then cause an increase in the tidal range. In 2008, high tidal coefficients and winds measured at 137 km/h in Vannes led to marine submersion as far as Auray. The submersion phenomena have several possible causes:

- High amplitude waves,
- Overflow or breach of dykes,
- The break-up or destruction of dune strips.

The defence works have been listed and 26 sites sensitive to the risk of marine submersion have been defined. But 5 sites seem to have priority: the Stole cove in Ploemeur, the large beach in Gâvres, Suscinio in Sarzeau, the Grée Penvins in Sarzeau and Banaster (Tourolle, 2003).

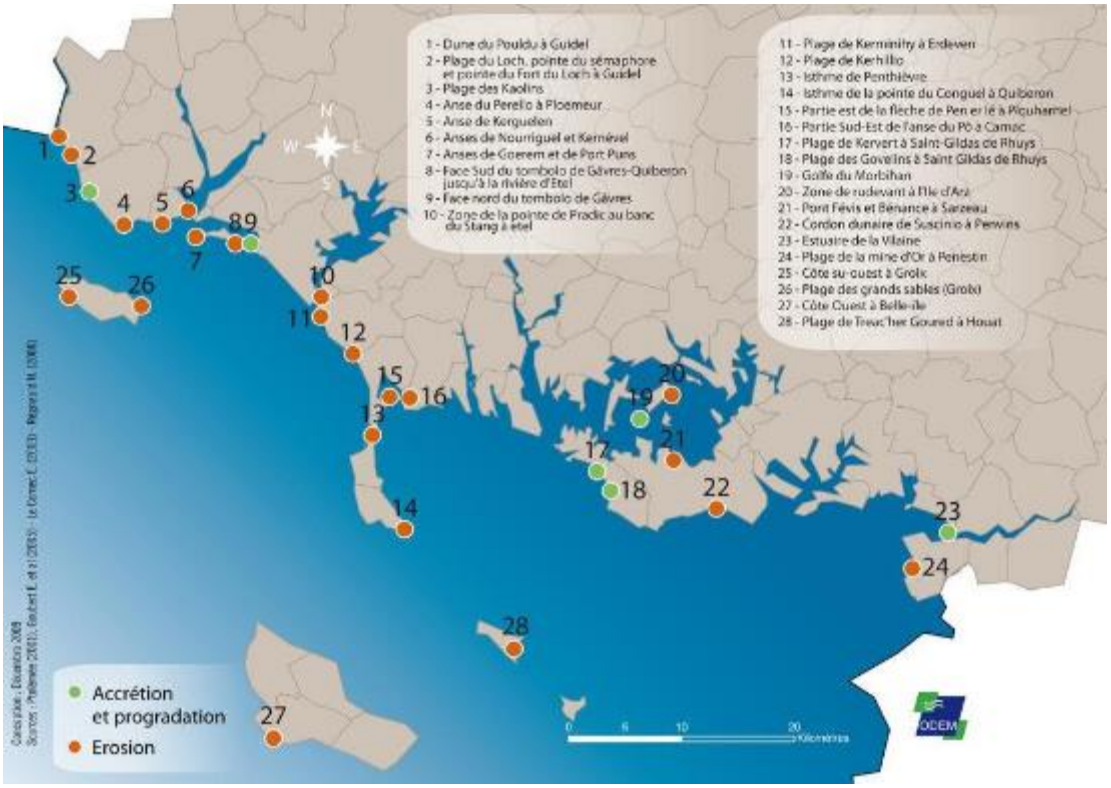


Figure 86: Sites sensitive to marine submersion in the Morbihan (source CD56)

4.4.5.1.3 The risk of coastline change

Coastal erosion is classified as a risk of land movement. Morbihan is not subject to large-scale land movements, but rather to slow land movements, such as coastal erosion. This is a discontinuous phenomenon that depends essentially on three types of factors:

- weather (precipitation, wind),
- hydrodynamics (wind, sea level, currents, swell), sedimentary movements.

The evolution of the coastline can be influenced by any anthropogenic disturbance of these two parameters, notably (Yoni & al., 2001):

- sediment extraction,
- construction/deconstruction of structures such as dykes, walls, dams or jetties,
- discharges of quarry materials,
- shellfish farming facilities, tourism.

In addition, the risks of coastal erosion and marine submersion are affected by the rise in sea level resulting from climate change. The map below shows the sites where significant changes in the coastline have been measured or observed. Most of the areas to be monitored are eroding areas.
Out of 28 sites, 22 are declining and 6 are increasing in size.

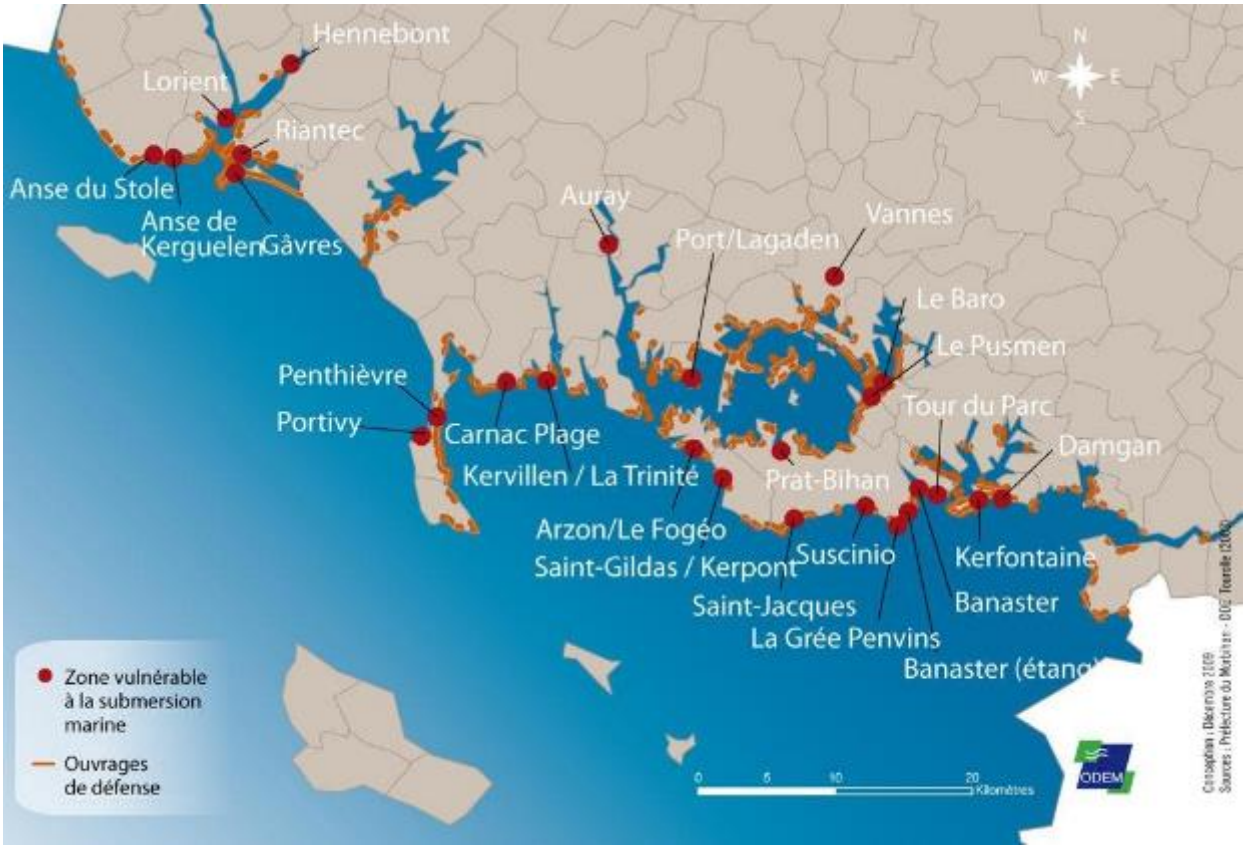


Figure 87: Areas vulnerable to changes in the coastline in Morbihan (source CD56)

4.4.5.1.4 Earthquake risk

Earthquakes are one of the manifestations of plate tectonics. Seismic activity is concentrated along faults, where friction occurs. Historically, earthquakes whose epicentre was located in Morbihan have never exceeded an epicentral intensity of 7 (9 January 1930 in Meucon) on a scale of 1 to 12. The intensity measures the damage, unlike the magnitude which measures the energy released. Most of the time, the epicentre is located along the South Armorican Shear. It is along this shear that the tremors are felt the most because of the direction of the seismic waves. For example, the earthquake of 30 September 2002, whose epicentre was located near Hennebont, was felt as far away as Poitiers. However, the damage was minor and only two communes were declared natural disasters. More rarely, earthquakes occur on small faults, but are less intense.

According to the French central seismological office, the granite bedrock is not very conducive to the local amplification of tremors, which explains why the intensities recorded are low compared to the magnitude of the earthquakes. The "seismic plan", a national seismic risk prevention programme, began on 21 November 2005. The first step was to draw up a map of seismic hazards at the municipal level. This probabilistic map was constructed taking into account return periods. Morbihan is located in a low hazard zone like the whole of Brittany. This future zoning project is being carried out by France with a view to applying the new European construction standards Eurocode 8.

4.4.5.2 Technological risks

The Analysis, Research and Information on Accidents (ARIA) database of the Bureau d'Analyse des Risques et des Pollutions Industrielles (BARPI) lists a total of 143 minor accidents of various types between 1998 and 2008, of which more than two thirds were technological fires in Morbihan.

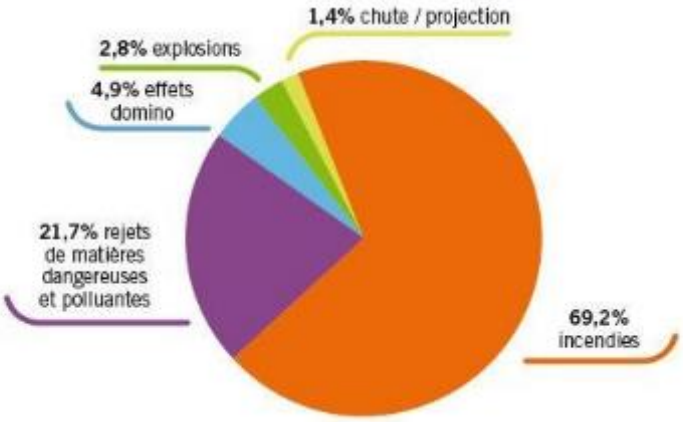


Figure 88: Distribution of the type of technological accidents 1998-2008 (source: ARIA database)

The ARIA database does not record any major technological accidents in Morbihan. In particular, it does not take into account oil spills, whereas, for example, the sinking of the Erika caused a great deal of damage, particularly to coastal ecosystems. It has been detailed below that the technological risks applicable to the Gulf of Morbihan, the industrial risks and the risks of dam breakage do not concern the Gulf.

4.4.5.2.1 The risk of transporting dangerous goods

This risk is theoretically present everywhere in the department, as it often concerns the transport of products used on a daily basis, such as fuel, gas, fertiliser, etc. Any accident has the same effects as the industrial risk: explosions, fires, toxic releases. To date, there have been no major accidents of this type in the Morbihan.

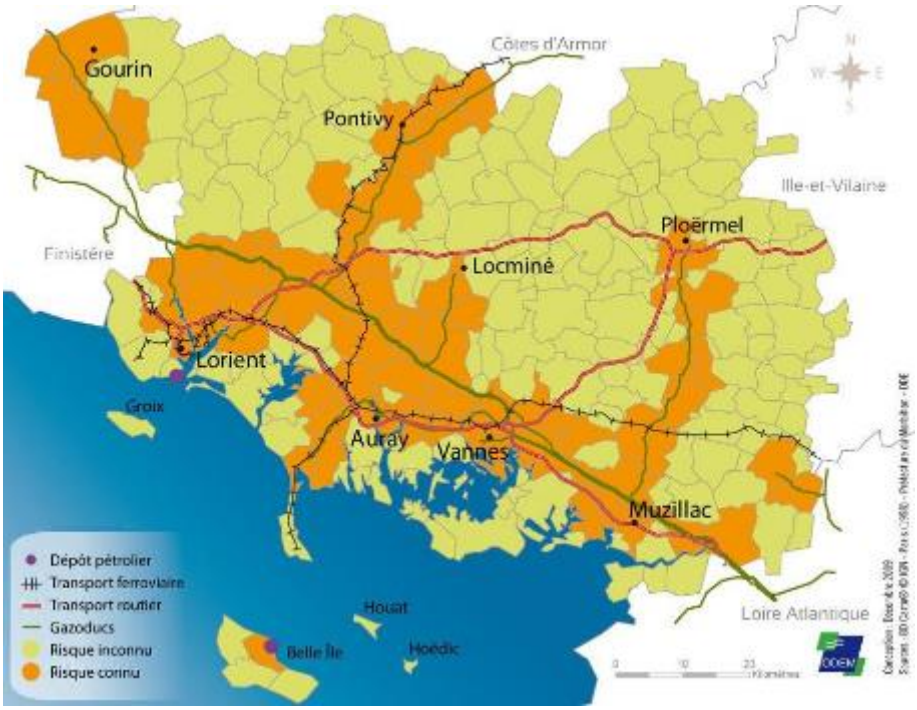


Figure 89: Main routes presenting risks of transporting materials (source CD56)

4.4.5.3 Summary of risks

Nature du risque	Nombre de communes exposées à l'aléa	Pourcentage de communes exposées à l'aléa
risque de rupture de barrage (Guerlédan)	24	9,2%
risque de mouvements de terrain (érosion littorale)	23	8,8%
risque industriel	31	11,9%
risque de transport de matières dangereuses	73	28%
risque de feu de forêt	86	33%
risque d'inondations	127	48,7%
risque de séisme	261	100%
risque de tempête	261	100%

Figure 90: Summary of risks involved (source BF Gaspar)

Like any territory, Morbihan is exposed to various risks. The most important of these are natural risks: floods, forest fires, storms, coastal erosion and marine submersion. There are many issues at stake, involving people, activities, property and the environment (changes to the landscape, destruction of natural environments or pollution, etc.).

In a given territory, vulnerability can be increased if two risks are associated. This is the case, for example, if a hazardous industrial site is built in a flood zone.
Even if the department is relatively unexposed compared to other regions, many communes are affected by potential risks (see table above).

The current challenge is to reduce the risks to which the territory is exposed. To achieve this, various solutions ar to be considered:

- Predicting the hazard by improving knowledge (zoning, intensity, return period, etc.);
- Reduce the risk by controlling land use, in particular through the use of Risk Prevention (PPR) and maintenance of protection works; Reduce vulnerability at each stage of risk management.

4.4.6 Definition of the Living Environment Issues

The following table presents the Living Environment issues in relation to the project site:

Components	Features	Issue level
The Landscape		
Landscape	The landscape at the entrance to the Gulf is in competition between "wild" natural space and urbanised space. The fact that the Gulf belongs to the Club of the most beautiful bays in the world reinforces the challenge	**Fort**

Cultural heritage		
Archaeological heritage	The presence of numerous megaliths which are also listed sites, as well as a rich maritime built heritage on the foreshores, make the issue is very strong	**Major**
Maritime built heritage		
Air quality		
Air quality	The air quality is good in the department and in the Gulf itself	**Fort**
The sound environment		
Airborne noise	The area at the entrance to the Gulf of Morbihan is subject to significant noise pollution from shipping	Medium
The risks		
Natural hazards	The natural risks at the entrance to the Gulf are essentially linked to coastal erosion and storms	**Fort**
Technological risks	They are poorly represented in the Gulf entrance area	Low

Table 21: Definition of the living environment issues in the study site

4.5 Socio-economic activities and uses

4.5.1 Maritime navigation in the Gulf of Morbihan

The **Gulf of Morbihan** is very popular for **boating** and the activities that are practised on the water are diverse. The importance of water sports constitutes a pressure whose consequences on other uses (oyster farming, environmental protection, etc.) must be controlled by specific regulations.
The latter includes certain types of gear, speed, geographical areas and anchorages.

Only information that is primarily relevant to our study site has been presented.

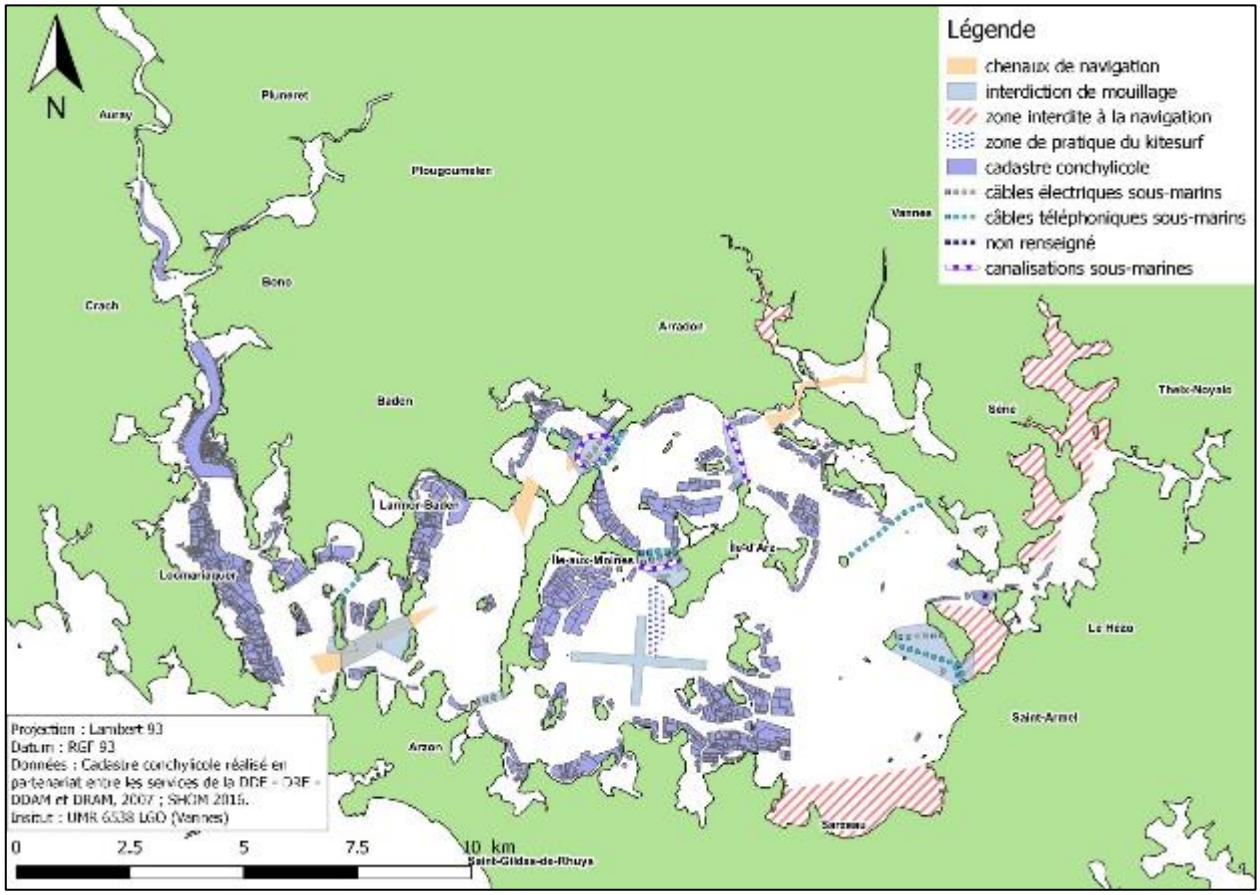


Figure 91: Regulated maritime areas in the Gulf of Morbihan (UBS 2008)

4.5.1.1 Navigation channels in the Gulf of Morbihan

Speed is limited to five knots in the 300 metre coastal strip.

The speed is limited to ten knots for vessels beyond this coastal strip (decree n°2006/40 of 29 June 2006). At low tide, this corresponds to only three areas (eastern basin, between Île-aux-Moines and Île d'Arz, between Île-aux-Moines and Larmor-Baden).

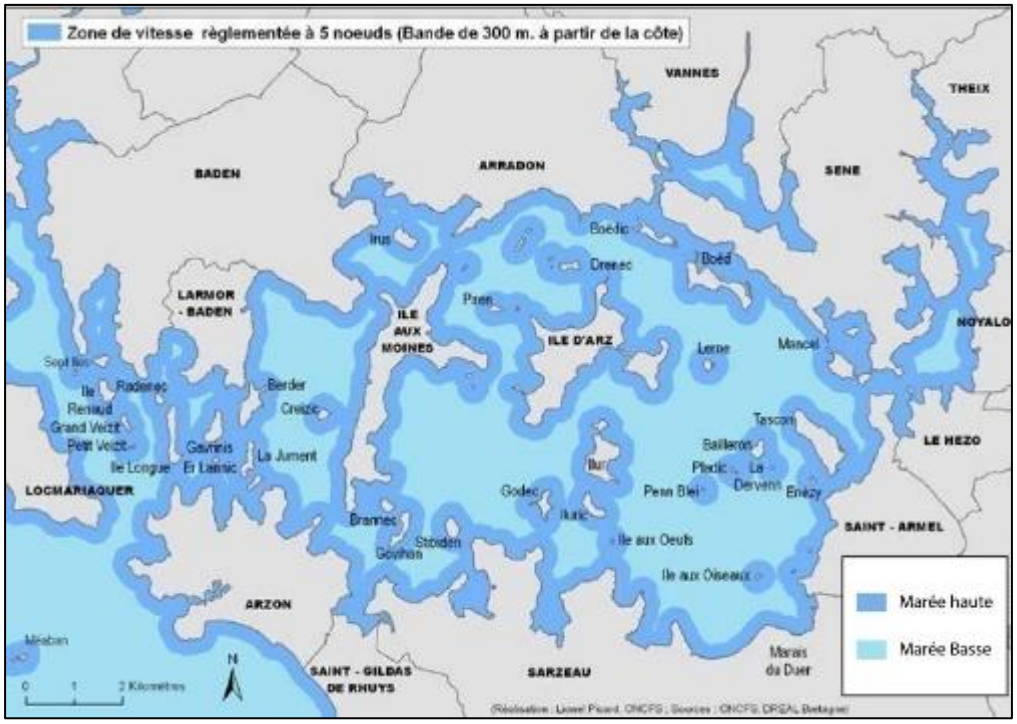


Figure 92: 300 metre zones at high and low tide (ONCFS, DREAL Bretagne).

Four specific navigation zones in the narrowest maritime areas of the Gulf of Morbihan have been defined by order n°2017/024 of 11 April 2017 in order to clarify the uses and speed limits in the narrowest and busiest passes of the Gulf of Morbihan:

- passes between the islands of Longue, Gavrinis, Er Lannic and la Jument;
- passes between Port-Blanc and Île-aux-Moines;
- passes between the Pointe d'Arradon and the Pointe du Trech; passes between the Pointe de l'île Boedic and Conleau.

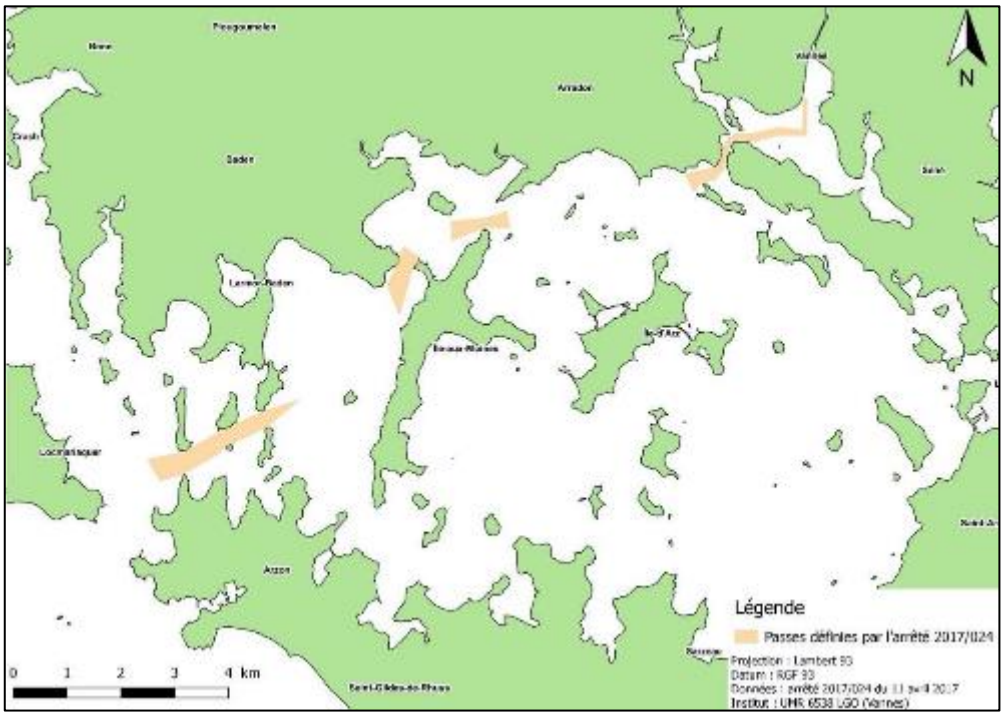


Figure 93: Special navigation zones in the narrowest maritime areas of the Gulf of Morbihan

Within the passes defined above :

- Drifting is prohibited between [1] June and 31 August, between 10:00 and 19:00, and permitted the rest of the time, provided that the ships' engines are kept running so as to maintain manoeuvring capacity in case of emergency.
- The anchoring of boats and fishing gear is prohibited.
- Vessels are authorised to navigate at a speed of up to ten knots, excluding the pass between the island of Boëdic and Conleau, in order to maintain their manoeuvring capacity and by way of derogation from the provisions of the Atlantic Maritime Prefect limiting speed to five knots in the 300 metre coastal strip.

4.5.1.2 Anchorages

In the Gulf of Morbihan, the number of moorings in the anchorage areas and in the ports must be stabilised at the threshold of 7,000 (excluding areas reserved for flat-bottomed boats and light pleasure craft of less than five metres in length and with engines of less than 10 hp, SMVM 2006). Moorings are organised within defined and administratively validated mooring zones, with or without a Temporary Occupation Authorisation (AOT): it is **forbidden to use mooring buoys** outside these zones.

Anchoring is thus prohibited by the decree of 14/06/1974 (n°12/74, protection zone for underwater cables and water pipes on the Ile-aux-Moines, Ile d'Arz, Bailleron and Arzon) in the following areas:

- Between the tip of Penboc'h and the end of the island of Arz,
- Between the tip of Arradon and the northern tip of the Ile-aux-Moines,
- Between the point of Brouel (Île-aux-Moines) and the coale de Mounienn (Île d'Arz), Between the island of Bailleron, the island Tascon and the mainland.

Anchoring is also forbidden in the bailing zone for canadairs, created in order to provide for the possibility of tanker planes bailing into the Gulf of Morbihan in order to fight possible forest fires. This zone corresponds to two 200 metre wide corridors, the first being 3,000 metres long and running East/West between Ilur and the îlot de l'Œuf, and the second 2,000 metres long and running North/South between the Pointe de l'Ours in Sarzeau and the parallel of the Pointe de Léos in the Île d'Arz (decree n°27/76 of 30/12/1976).

Anchoring is also forbidden by decree n°81/01 of 08/01/1981 for the protection of the underwater electric cable between Arzon and Ile-aux-Moines, between the Pointe de Saint-Nicolas in Arzon and the Pointe de Penhap in Ile-aux-Moines.

The parking and anchoring of vessels at the entrance to the Gulf of Morbihan are prohibited by the decree of 30/06/1989 (n°51/89) in the zone delimited by the southern points of the islands Longue, Gavrinis, Berder, the northern point of the island of the Mare, the southern points of the Mare, Er Lannig and the point of Moteno in Arzon.

Anchoring in the fishing zone created to the south of Ile Longue is prohibited by the decree of 20/12/2006 (n°2006/97), to preserve the very rich seabed in this sector. Anchoring on a dead body in this zone is prohibited except on the four dead bodies for which the AOT has been delivered to the Syndicat d'Aménagement du Golfe du Morbihan.

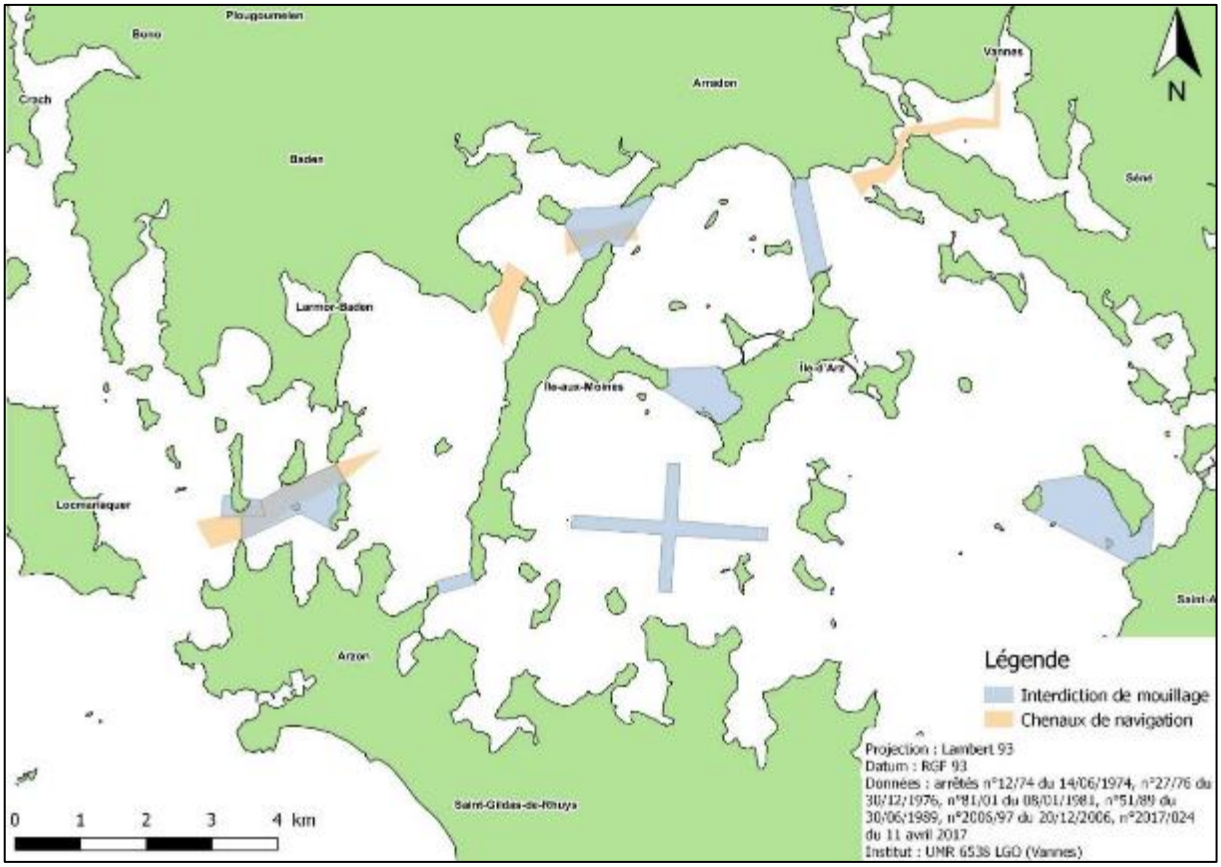


Figure 94 : No-go areas for anchoring.

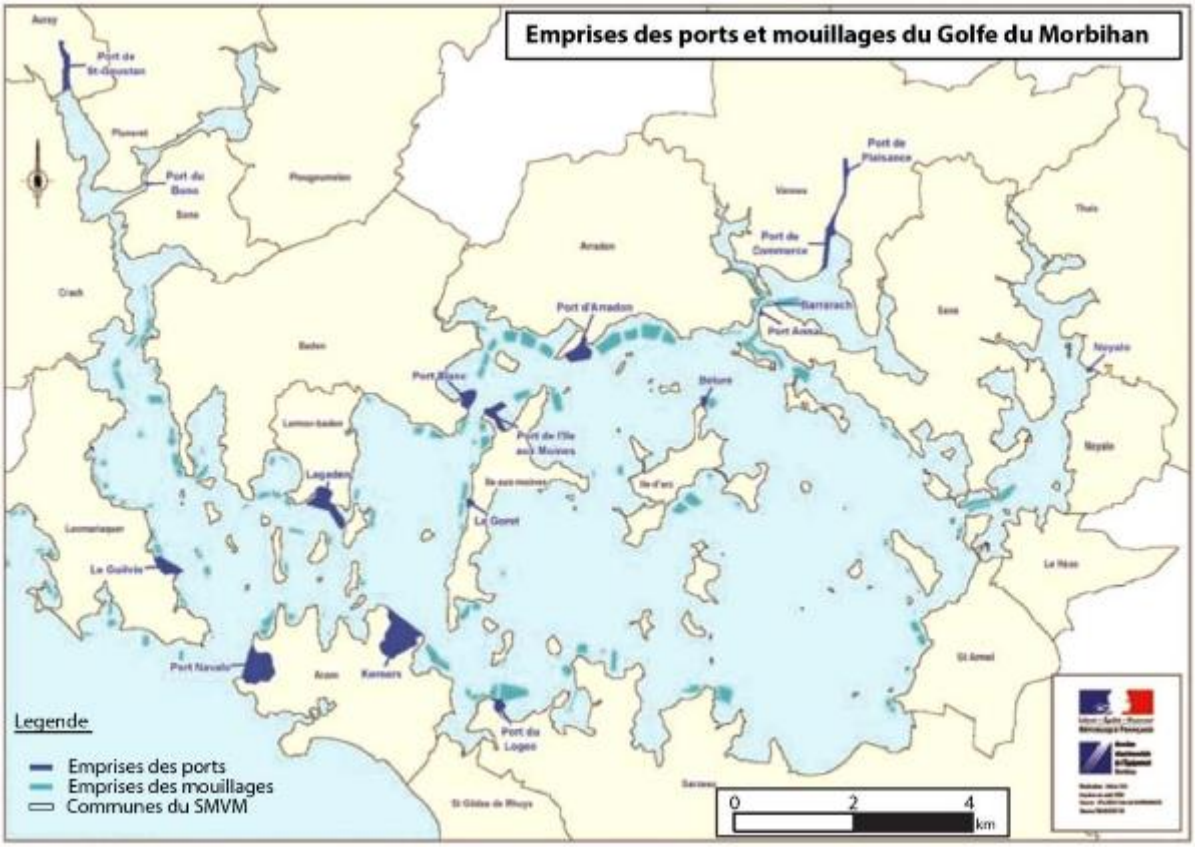


Figure 95: Ports and anchorages in the Gulf of Morbihan (from SMVM 2006).

4.5.1.3 Maritime traffic

The Gulf of Morbihan is a very popular sailing area. This passion for sailing dates back to the end of the 19th century, with the creation of the Société des Régates Vannetaise (SMVM 2006). Since then, the number of visitors to the lake has increased and it has reached saturation point. Navigation traffic can be very dense, particularly in the summer. The boats are varied (dinghies, fishing boats, kayaks, sailing boats, semi-rigid boats, passenger shuttles, cargo ships, oyster barges and professional fishing vessels) and more or less manoeuvrable depending on the conditions, which makes navigation potentially dangerous in the main channels.

4.5.1.3.1 Recreational boating

Boaters whose vessels are based in the Gulf of Morbihan mostly practice coastal sailing, within the Gulf and as far as the islands of Houat and Hoëdic. The purpose of these short trips (one day) is to fish or to go for a walk at sea. The sailing area extending as far as Belle Île is more frequented by Vannes boaters than the eastern part of the Mor Bras (Dumet, La Turballe, Piriac), which goes up the Vilaine to La Roche Bernard. Finally, half of the boaters based in Vannes sail within an area extending from the Odet and the Glénan archipelago to the Vendée islands.

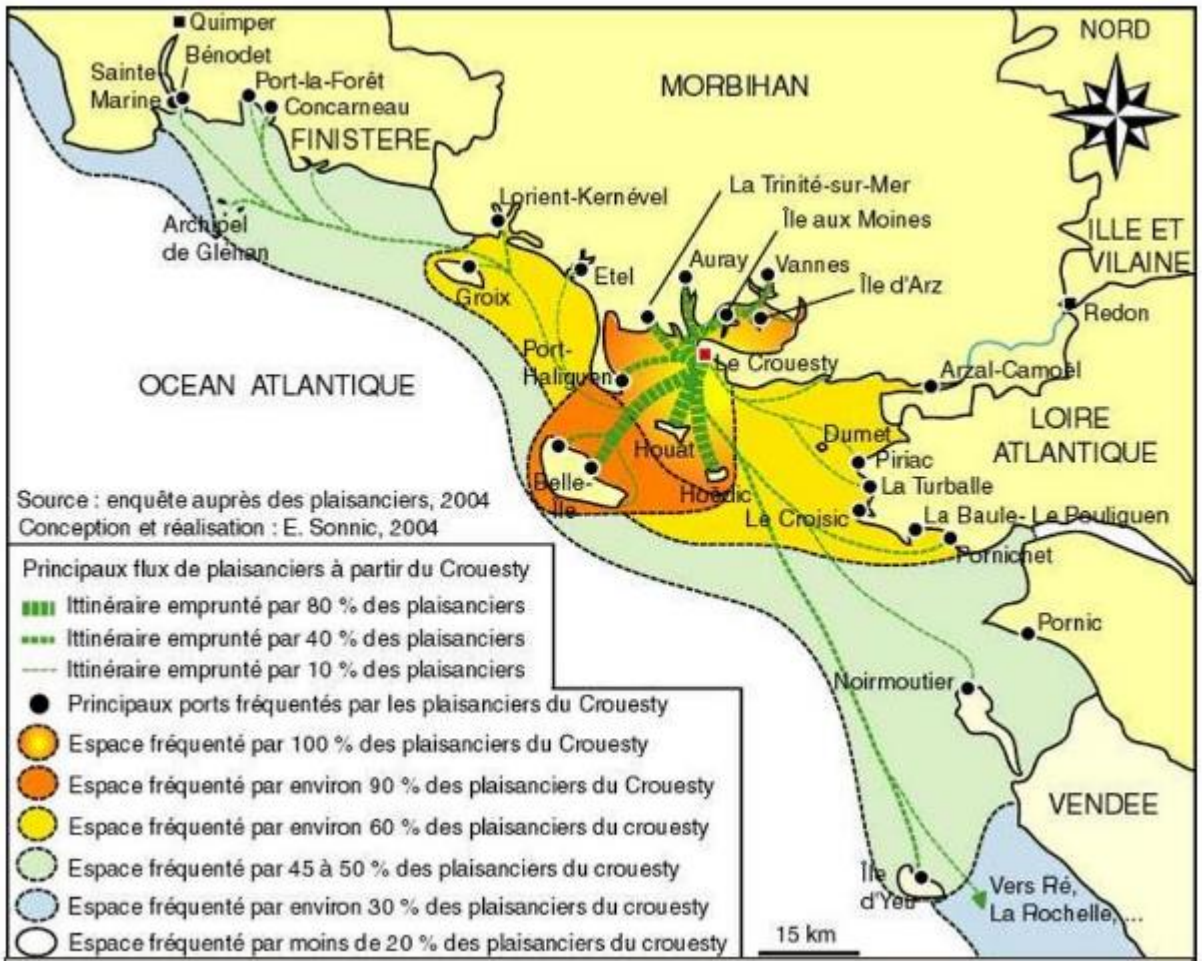


Figure 96: Pleasure boat flows from the port of Vannes (Sonnic 2006).

4.5.1.3.2 Commercial shipping

Commercial shipping in the Gulf of Morbihan mainly concerns the transport of goods for the supply of the islands. The commercial port of Vannes is under the jurisdiction of the Brittany Region. It occasionally welcomes small cargo

ships, its 75-metre long quay being able to accommodate two coasters simultaneously. A storage and handling platform, as well as an operating building occupied by the Compagnie de Transport Maritime Côtier (TMC) allow the organisation of freight services to the offshore islands. From the commercial port of Vannes, goods and construction materials (approximately 60,000 tonnes per year) are transported to Belle-Île, Yeu Island and the islands of Houat and Hoëdic mainly.

4.5.1.3.3 Passenger transport

Passenger transport is an important activity in the Gulf of Morbihan. This success is mainly due to its islands, the Ile-aux-Moines being the most attractive, followed by the Ile d'Arz (SMVM 2006). Many shipping companies provide crossings and cruises to visit the Gulf of Morbihan and its islands. Some companies serve destinations outside the Gulf such as Quiberon Bay, Houat, Hoëdic, Belle-Ile... The Ile-aux-Moines is the second most visited island in the department after Belle-Ile-en-Mer, with 423,000 passengers disembarking in 2008 (Observatoire du Tourisme en Morbihan). Passenger transport shuttles to the Ile-aux-Moines reach 52,000 passengers per month in August and remain above 10,000 passengers per month all year round. The daily peak is 5,971 landings for 115 shuttle rotations, observed on 15 August 2008 during the Festival de la Voile (Étude de la fréquentation touristique des îles du Golfe du Morbihan, SIAGM, 2009). Nearly 172,400 passengers disembarked on Arz Island in 2008 (Geomer, 2010). In August 2008, there were a maximum of 51 shuttle rotations per day, as well as six freight rotations. Thus, on 13 August 2008 there were 2,097 passengers to embark (Geomer, 2010). By December, the number of passengers had fallen to around 1,600 per month, but the share of island passengers remains constant throughout the year.

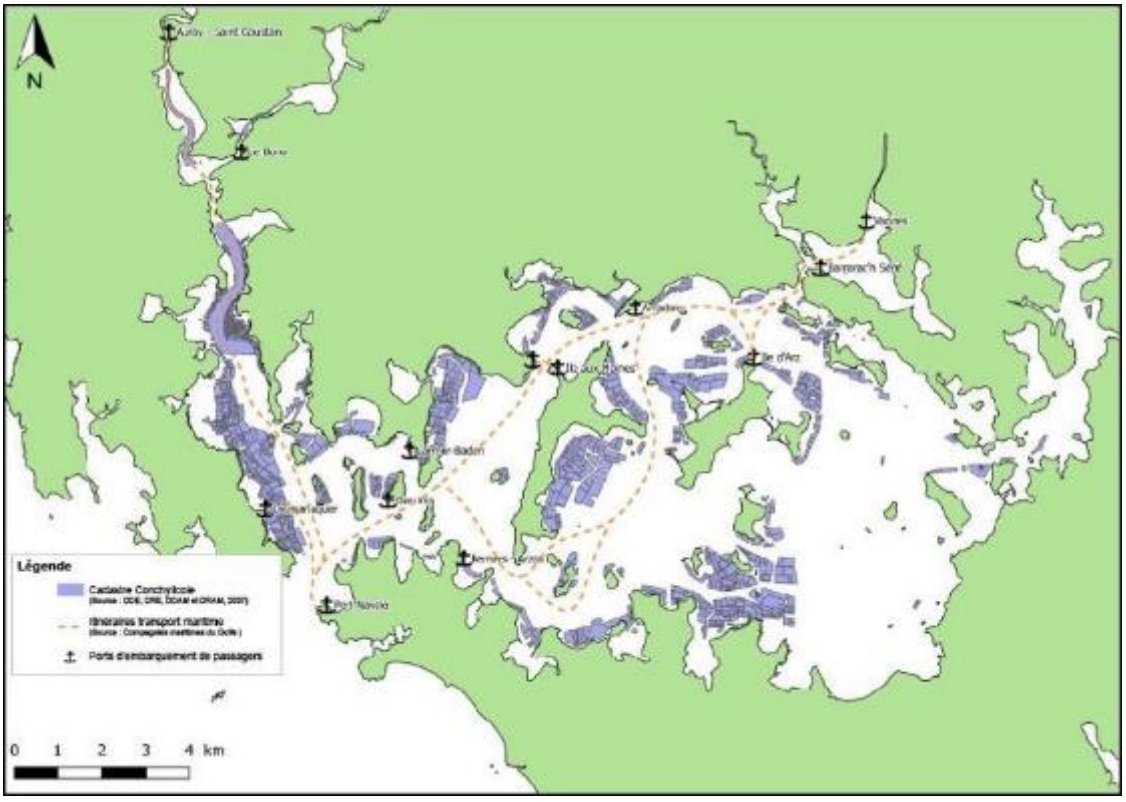


Figure 97: Main maritime transport routes in the Gulf of Morbihan.

4.5.1.4 Summary on maritime transport

The regulations relating to boating in the Gulf of Morbihan concern the types of gear, speed, geographical area, anchorages, obstacles to navigation and areas of concession or temporary occupation of the DPM. All

4.5.2 Professional fishing activities

4.5.2.1 A VALPENA-type study on 2013 data

A diagnosis of professional fishing activities in the Gulf of Morbihan was carried out by the Comité Départemental des Pêche Maritimes et des Élevages Marins du Morbihan (CDPMEM 56) as part of a feasibility study for the implementation of a tidal turbine farm in the Gulf of Morbihan. The study was based on activity data from 2013. Only vessels from the Breton maritime districts are taken into account in the diagnosis.

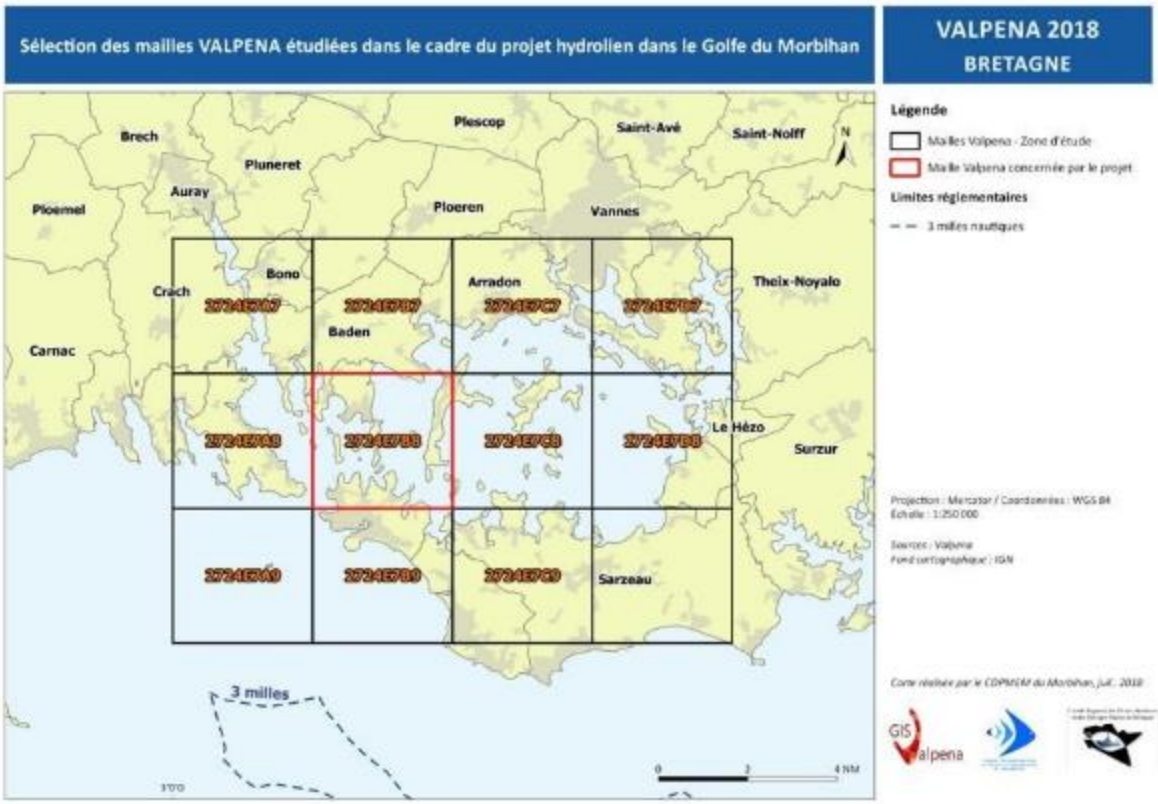


Figure 98: VALPENA meshes studied in the framework of the tidal turbine project (source CRPMEM)

4.5.2.2 Types of vessels using the study area

Vessels operating in the study area come from ports located in the Gulf of Morbihan (25 vessels) and Quiberon (20 vessels). Many of the vessels fishing in the study area come from outside the Gulf of Morbihan. All of the vessels in the study area are less than 12 metres in size, with an average size of around 9 metres. These vessels have an engine power of between 44 and 221 kW, with an average of 97 kW (approximately 130 hp). The average age of the vessels is close to 28 years, the oldest vessel in the fleet is 57 years old. Almost all the fishing vessels are classified as small-scale fisheries, only 3% are coastal fisheries (tidal range between 24 and 96 hours).

4.5.2.3 Annual attendance

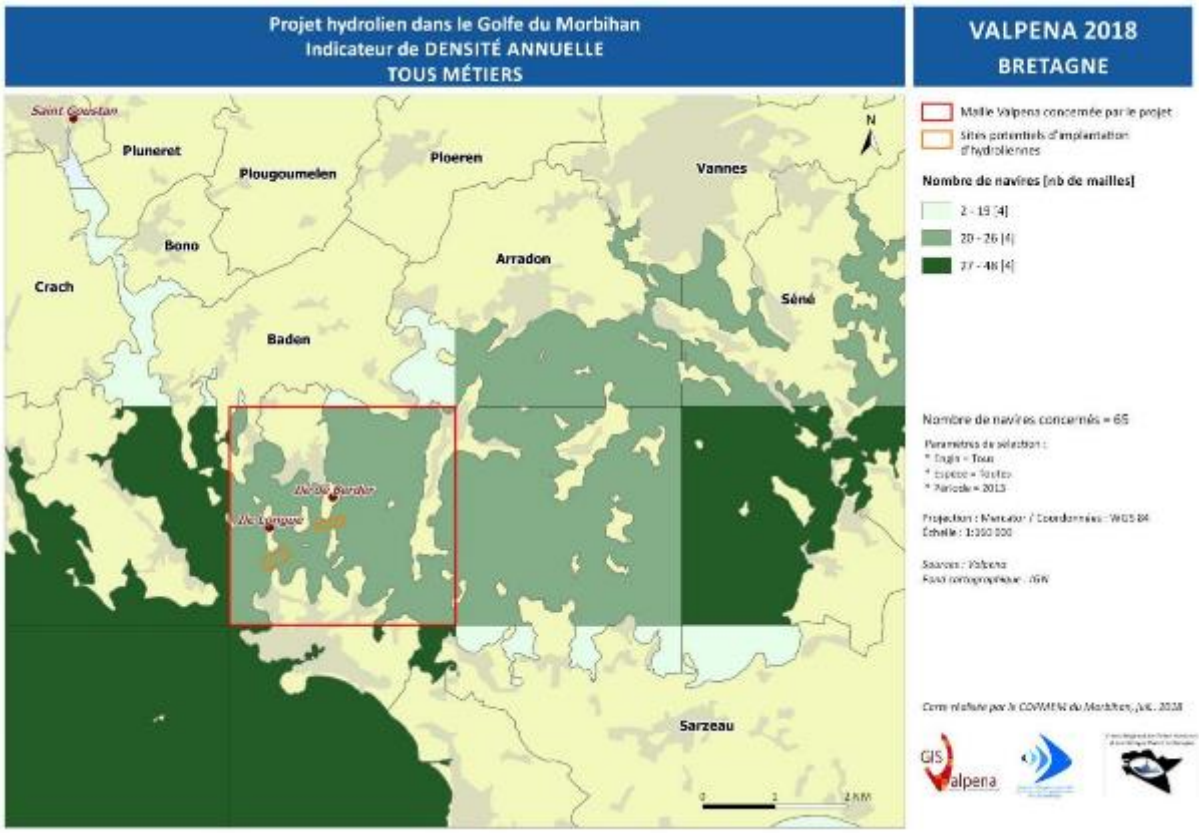


Figure 99: Annual density indicator for Breton vessels visiting the "hydrolic project" study area (source CRPMEM)

The density indicator, or frequentation, indicates the **number of vessels present** on a given mesh over a given period.

The meshes concerned by this study are frequented by 65 Breton fishing vessels. There are between 2 and 48 vessels depending on the mesh size. The least frequented mesh is located to the north of the Auray River. The most frequented meshes are located at the entrance to the Gulf and at the bottom of the Gulf, in the Tascon sector.
At least **23 vessels frequent the potential tidal turbine installation zone** (Ile Longue and Ile de Berder sectors).

4.5.2.4 Monthly attendance

The monthly density indicator shows the **number of vessels present on a given mesh in a** given **month.** Seasonality is marked in the Gulf. The monthly density varies between 1 and 36 vessels per mesh. There is an increase in activity in spring (March/April) until September. Attendance then decreases between October and January.

Figure 100: Monthly density indicator for Breton vessels visiting the "hydrolic project" study area (source CRPMEM)

4.5.2.5 Analysis of spatial dependency

The spatial dependence index expresses the number of meshes worked by the vessel in an area, in relation to the total number of meshes worked by that vessel. It reflects the importance of the area in terms of surface area of activities. For example, if a vessel has a spatial dependence index of 20%, this means that 1/5th of its activity area is located in the study area.

Quartier maritime	Taux de dépendance spatiale moyen	Classe de dépendance spatiale (nb de navires)				Nb total de navires
		[0-1[%	[1-10[%	[10-30[%	>30%	
AY	23%	0	21	8	7	36
LO	32%	1	2	0	3	6
VA	47%	0	2	5	16	23
TOTAL	**32%**	**1**	**25**	**13**	**26**	**65**

Table 22: Spatial dependence of vessels on the "Hydropower project" study area by maritime district (source CRPMEM)

The mesh concerned by the potential installation of tidal turbines represents on average 9% of the overall fishing area of the vessels (23 vessels frequent the mesh).

4.5.2.6 Time dependency analysis

The time dependency index expresses the number of months of activity declared by a vessel in an area, relative to the total number of months of activity declared by this vessel. For example, if a vessel has a time dependency rate of 50%, this means that half of its months of activity take place, in whole or in part, in the study area. The scale of knowledge for this indicator is the month, it is not possible to know the number of days spent per month in the area. The mesh is declared by the vessels as soon as they carry out an activity there at least once a month.

Quartier maritime	Taux de dépendance temporelle moyen	Classe de dépendance temporelle (nb de navires)				Nb total de navires
		[0-15[%	[15-30[%	[30-50[%	[50-100]%	
AY	54%	4	12	3	17	36
LO	68%	0	1	1	4	6
VA	71%	1	4	0	18	23
TOTAL	**61%**	**5**	**17**	**4**	**39**	**65**

Table 23: Temporal dependence of vessels on the study area by maritime district (source CRPMEM)

Of the 23 vessels surveyed that use the mesh concerned by the project, half of them carry out their activity there all year round (dependency = 100%).

4.5.2.7 Number of vessels by gear used (annual analysis)

Machines	No. of vessels declaring to use the gear in the study area	% (of the 65 ships frequenting the area)
Dredge	27	42
Locker	20	31
Net	19	29
Longline	12	18
Bottom trawl	10	15
Eel verbena	5	8
Line	3	5
TOTAL	**96**	

Table 24: Number of declarations and proposals for each fishing gear used in the study area (source CRPMEM)

The most commonly used gear in the study area is the dredge (42% of declarations). The passive arts, and in particular the trap, net and longline trades, are particularly practised in the study area. The sum of the declarations is greater than the number of vessels using the area. This highlights the versatility of the vessels. Indeed, some will use several gears in the course of a single year. In the same month, or even in the same tide.

In the mesh concerned by the potential installation of a tidal turbine, 15 vessels use traps, 8 use nets, 5 use longlines, 3 use eel fyke nets and 1 uses lines.

4.5.2.8 Targeted species

Species	Number of declarations (ships)	Percentage (of 65 ships)
Scallop	24	37%
Cuttlefish	22	34%
Common bar	13	20%
Red mullet	9	14%
Common sole	8	12%
Sea bream	7	11%

Stranglehold	7	11%
Hake	7	11%
Common bouquet (pink shrimp)	6	9%
Grey sea bream	6	9%
Various mullets	6	9%
Eel	5	8%
Various	5	8%
Whiting	5	8%
Manila clam	5	8%
Congre	4	6%
Pollock	4	6%
Green crab	3	5%
Spider crab	1	2%
Bulot	1	2%
Squid	1	2%
Lobster	1	2%

Table 25: Species targeted in the study area (source CRPMEM)

Espèce / Mois	1	2	3	4	5	6	7	8	9	10	11	12
Seiche	2	3	17	19	15	4	6	6	4	4	3	3
Bar commun	5	5	5	5	5	5	5	6	10	10	10	7
Mulets divers	4	5	6	5	5	5	5	5	5	6	5	5
Etrille	4	4	5	5	5	5	6	6	6	5	4	4
Divers	4	4	4	4	4	4	4	5	5	5	5	5
Sole commune	2	2	3	4	3	4	4	4	6	6	6	6
Rouget-barbet de roche	2	2	2	1	4	7	8	8	7	5	2	2
Dorade royale	1	1	2	3	5	5	6	6	6	3	2	2
Coquille St-Jacques										19	21	2
Bouquet commun (crevette rose)	4	5	1	2	2	2	3	4	5	5	3	3
Dorade grise	2	1	3	2	3	3	3	4	4	5	3	3
Merlu	6	5	2					1	2	3	5	5
Anguille				3	4	5	5	5	5			
Crabe vert	3	3	3	2	2	2	2	2	2	2	2	2
Merlan	5	4	2					1	1	2	4	4
Congre	3	3	3	3	1	1	1	1	1	2	2	1
Lieu jaune	4	3	1					1	1	2	3	3
Calmars ou encornets	1	1	1	1	1	1	1	1	1	1	1	1
Homard			1	1	1	1	1	1	1			
Bulot	1	1	1							1	1	1
Araignée de mer					1							

Table 26: Targeting schedule for the main species fished in the study area (in number of vessels)

4.5.2.9 Trades in the study area

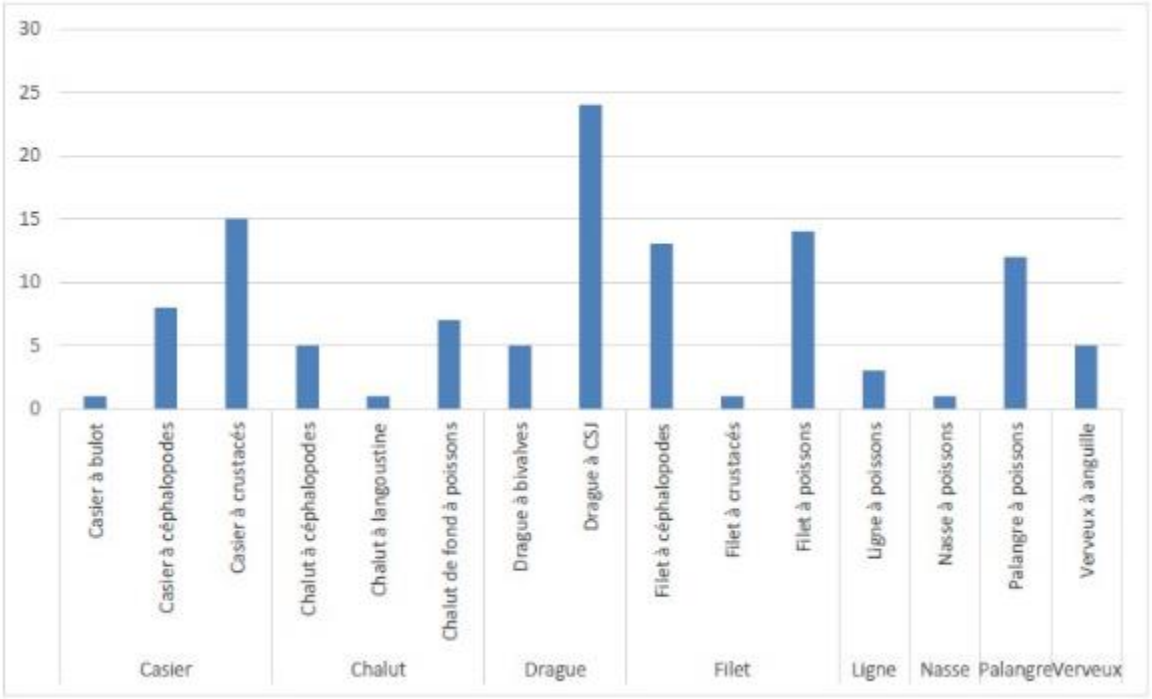


Figure 101: "Trades" practised in the study area (number of vessels) (source CRPMEM)

Trades are identified by gear/species pairs. A vessel can practice several trades, depending on the area, the season and the species targeted. There are 15 different trades in the study area, grouped into 8 families. The vessels that fish in the Gulf practice a daily artisanal and multipurpose fishery. They combine different fishing activities throughout the seasons. Thus, the vessels surveyed practice between 1 and 5 trades during the same year in the study area.

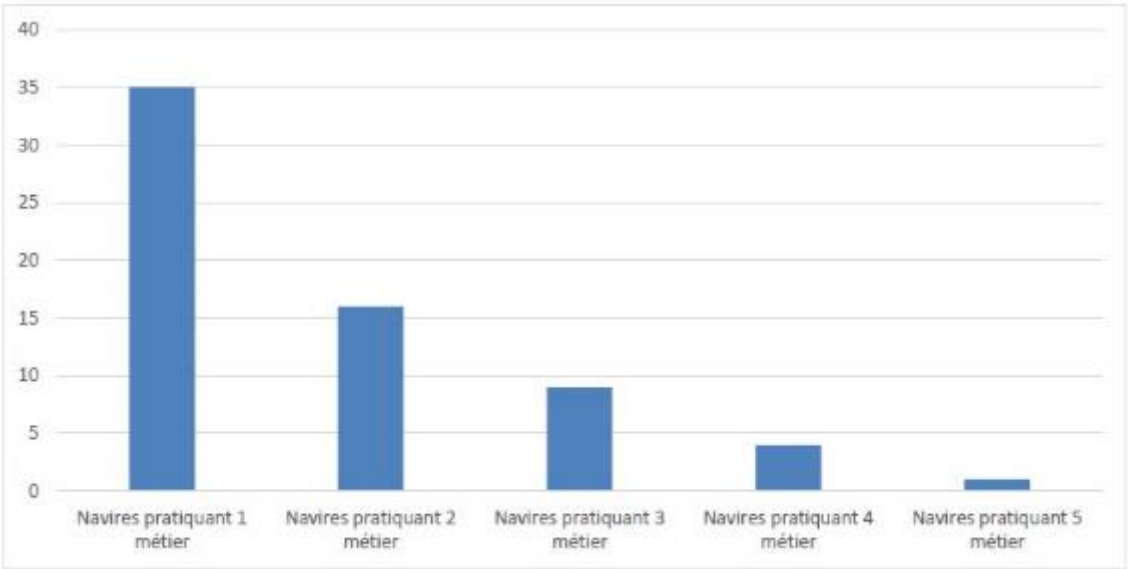


Figure 102: Number of trades practised by fishing vessels in the study area (source CRPMEM)

4.5.2.10 Shore fishing and shellfish beds

There are 3 major clam beds (Gulf, Auray, Noyalo) as well as a hand fishing bed for sea urchins. In 2013, 150 professional fishermen have the stamp to fish clams and 18 fishermen have the hand sea urchin licence. Clam fishing is actually carried out by 114 fishermen from January to December. Sea urchin fishing is actually carried out by 3 fishermen from November to February.

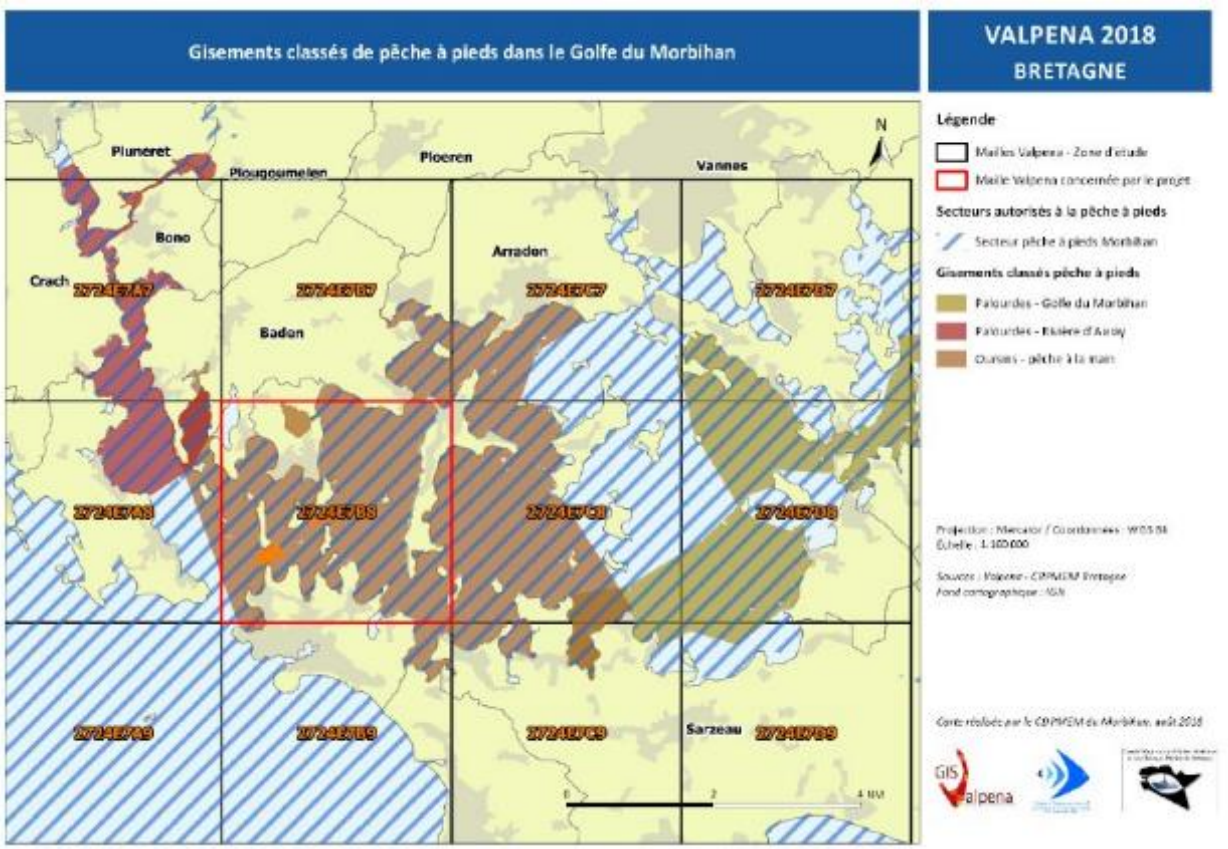


Figure 103: Sites classified for foot fishing in the Gulf of Morbihan.

4.5.2.11 Summary

- 23 Breton vessels frequent the study area.
- All the vessels are less than 12 metres in length.
- 95% of the vessels are in the "small-scale fisheries" category.
- The maximum density in 2013 is located at the entrance to the Gulf and at the bottom of the Gulf.
- A peak of activity is visible in spring and autumn.
- Vessels have a strong spatial and temporal dependence.
- 7 different machines are used in the study area.
- The Gulf of Morbihan is an important area for professional fishing

4.5.3 Marine farming

In the Gulf of Morbihan, the shellfish farming register shows different types of crops, but the majority of them are oysters. The nearest cadastral parcels are located less than 300 metres from the potential location of the tidal turbines (West of Berder).

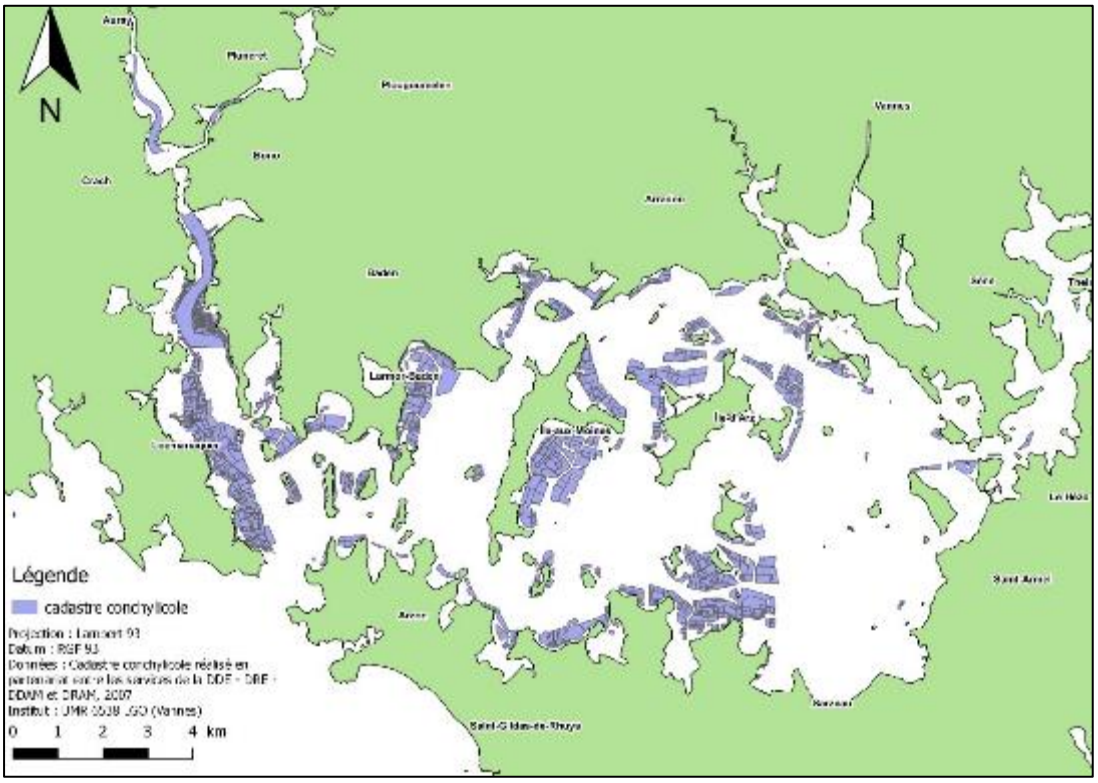


Figure 104 : Operating concession ation of marine cultures in the Gulf of Morbihan.

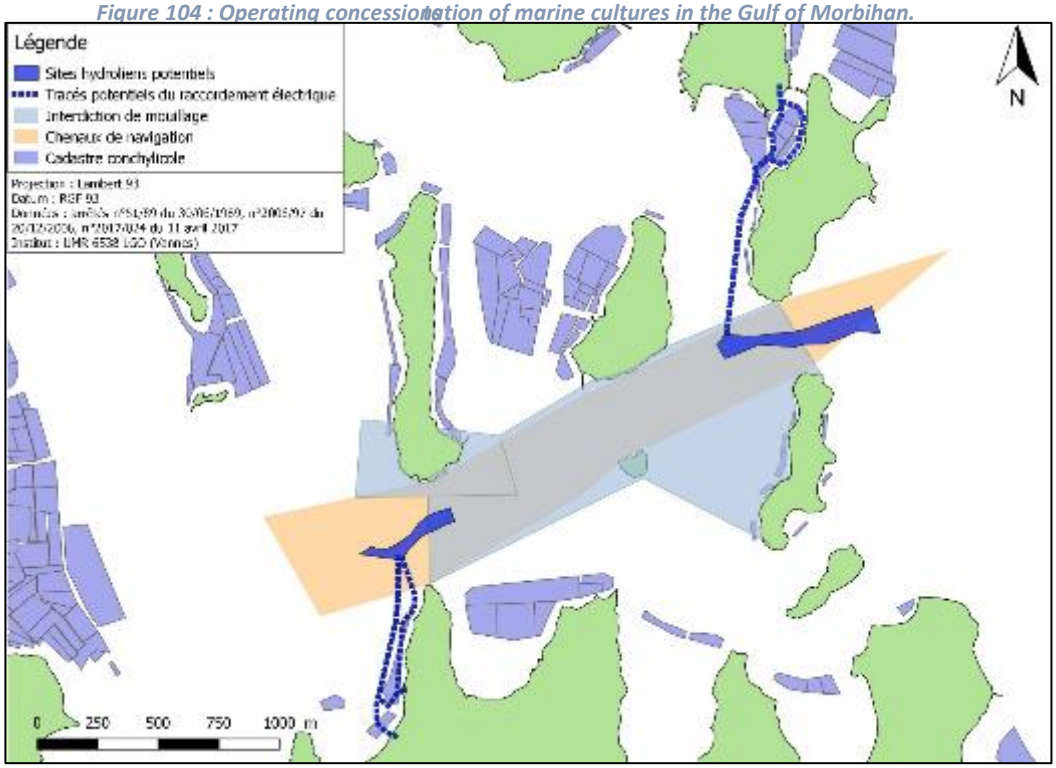


Figure 105: Existing regulations on and around potential wind energy sites in the Gulf of Morbihan

The total surface area granted for shellfish farms on the DPM in the Morbihan in 2013 was 5,250 hectares, including 1,450 hectares in the Gulf of Morbihan and the Auray River (CRCBS, 2013). In the Gulf of Morbihan, this economic

activity plays a significant role in the attractiveness of the area. The most widespread shellfish farming activity is **oyster farming,** which occupies about a quarter of the foreshore.

In 2013, there were 112 shellfish farming companies in the Gulf and River of Auray, operating 1,590 hectares of concessions, 95% of which are located in South Brittany, representing 396 jobs (322 full-time equivalents). In the Gulf and River of Auray, 1,450 hectares of shellfish farms are under concession, 63% of which are operated by the 112 companies located in the riverside municipalities (source CRCBS 2013).

Oyster farming concessions are concentrated in the western and central part of the maritime area of the Gulf of Morbihan and are almost absent in the east of the territory where mudflats predominate. Classified clam beds and the bird reserve also limit the accessibility of the foreshore for this activity. Production in the Gulf of Morbihan is mainly made up of hollow oysters and was estimated at 3,850 tonnes in 2012.

The oyster farms are located in the western and central part of the region on 1,450 ha in the Gulf of Morbihan an the Auray River for 112 companies (in 2012). In 2012, they produced 3,850 tonnes of oysters.

4.5.4 Recreational fishing

4.5.4.1 Recreational fishing

The main areas of foot fishing in the Gulf of Morbihan are located in the **Locmariaquer** sector and the **classified site of Sarzeau**. The other fishing sites mentioned in the Gulf of Morbihan are the following: Benance, Bernon, Brillac, Ile d'Arz, îles du Golfe, La Bernerie en Retz, Larmor Baden, Le Duer, Le Logeo, Le Ludré, Locmariaquer, Locmiquel, Mousterian, Rivière d'Auray, Sarzeau, Séné, St Colombier and Tour Carrée (Péronnet *et al*., 2003, Pêche de loisir).

The **difficulty of accessing the foreshore** (shellfish farms, difficult and restricted parking, dangerous travel on mudflats) limits the practice of fishing on foot in certain areas and explains why it is **more common on the Atlantic coast** than in the Gulf of Morbihan. The most popular sites are Baie de Quiberon, Damgan, Penvins, Penestin, etc. (Péronnet *et al*., 2003, Pêche de loisir).

In 2013, during the high tide of 22 August (coefficient of 108), the five most frequented communes in the Gulf of Morbihan by anglers were Baden and Larmor Baden (81 anglers counted), Arradon (152 anglers at Anse de Kerbilouët), Séné (148 anglers at the Moustérian site) and Saint Armel (148 anglers).

4.5.4.2 Recreational fishing

The species caught by boat fishermen in the Gulf of Morbihan are mainly sea bass (39% of catches), mackerel (25%) and sea bream (15%). The population of recreational fishermen on board varies according to the time of year and peaks in particular in the summer and during school holidays, with winter being the least frequented season. The average number of trips per angler on board is 36 per year. Catches are very variable and the species caught (sea bass, mackerel, sea bream, pollack, sole, conger eel, red mullet, cuttlefish) are linked to the gear used. 54% of respondents stated that they landed less than one kilogram per trip and only 4% more than ten kilograms. The average weight caught per trip was nevertheless estimated at 3.3 kg (Péronnet *et al*., 2003, Pêche de loisir).

A common fishing practice in the Gulf of Morbihan is "**drift fishing**". It is practiced in the channels, where the current is concentrated. Boaters generally turn off their engines and let themselves be carried along by the current. However, some of the channels are closed to drift fishing.

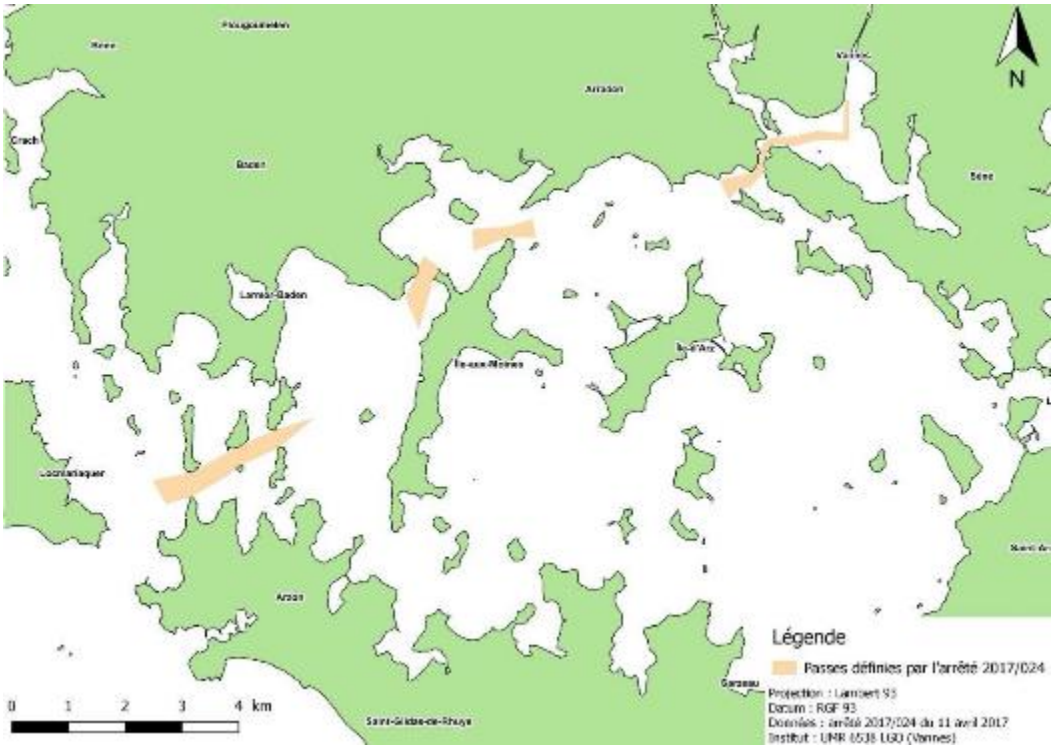


Figure 106: Passages affected by the ban on drifting between [1] June and 31 August, from 10 a.m. to 7 p.m., in the Gulf of Morbihan.

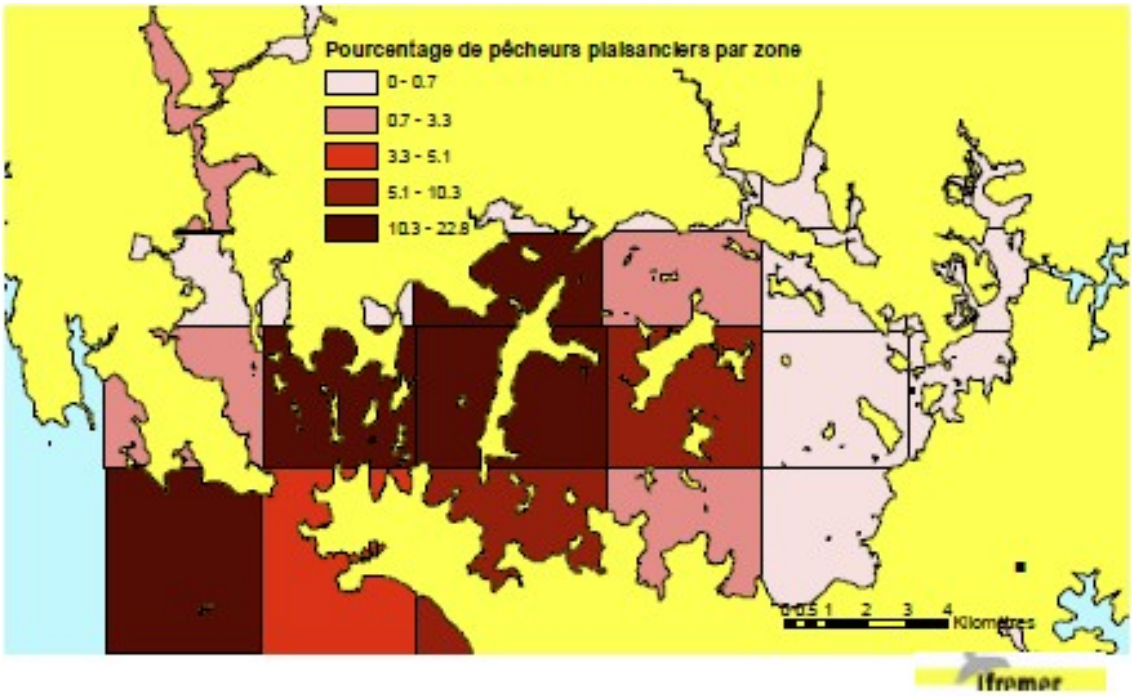


Figure 107: Fishing areas of the 272 recreational anglers surveyed (Bosser, 2001 in Péronnet et al., 2003, Pêche de loisir)

4.5.4.3 Underwater hunting

Underwater fishing is prohibited in the saltwater part of estuaries, but this rule applies well upstream in the Gulf of Morbihan. Indeed, recreational snorkelling (or underwater hunting) is prohibited "*in the entire Gulf of Morbihan (east of a line joining Port Navalo to the tip of Kerpenhirs). However, fishing is authorised up to 150 metres off the*

low water mark on the part of the west coast of the Ile-aux-Moines between the Pointe de Grigon to the north and the Pointe de Pen-Hap to the south. Within this authorised sector, fishing is however prohibited within 150 metres of the Goret hold" (Article 11 of Order n°192/97 modified by Order 88/2004 DRAM of 24/3/2004).

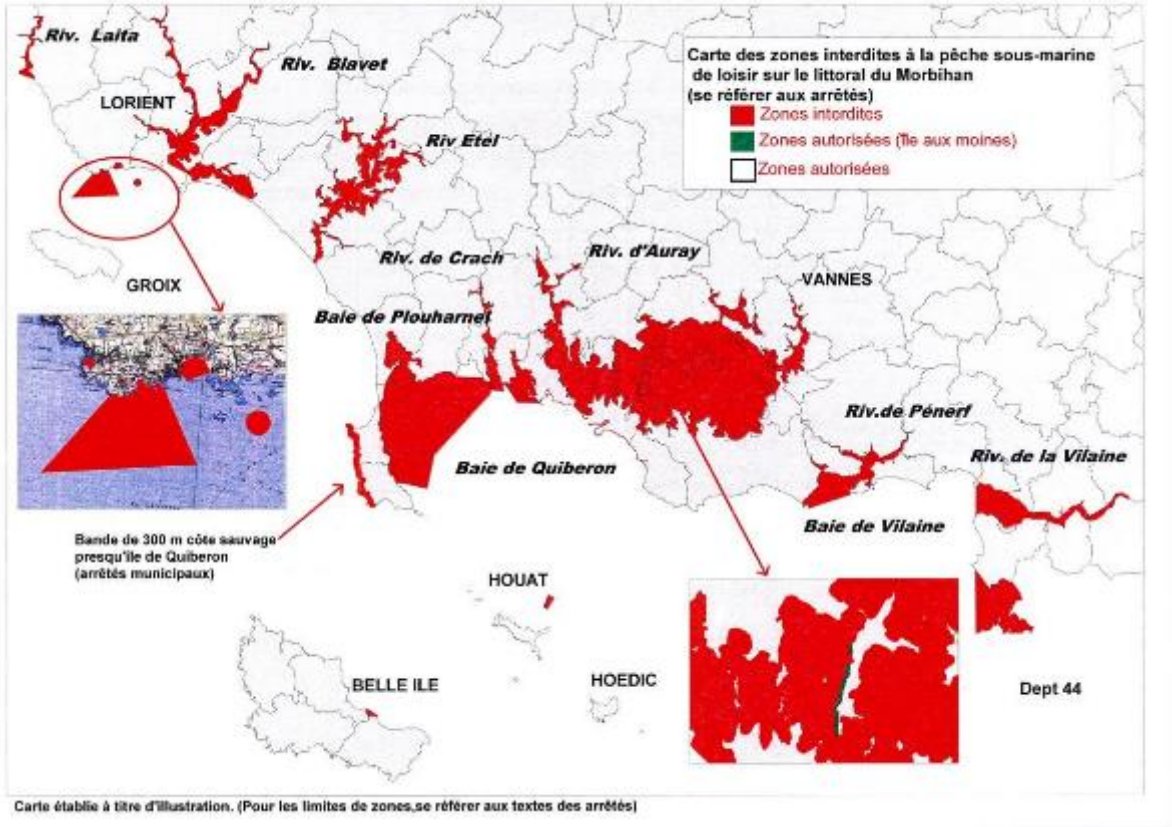


Figure 108: Zones prohibited to recreational underwater fishing on the Morbihan coast (source: Web)

4.5.4.4 Summary of recreational fishing

Fishing on foot is a leisure activity practised by a middle-aged population (over 50) and where retired people are strongly represented. It is an important activity in the Gulf of Morbihan. Recreational fishing on board is difficult to quantify. It is an activity that is practised throughout the year, but more particularly between April and November, with a peak in July and August. It is mainly carried out on board a fishing vessel. Underwater hunting is anecdotal.

4.5.5 Scuba diving

In the Gulf of Morbihan, scuba diving is mainly practised in **association clubs** or **diving centres**. This activity is also practised at **individual** level, in **apnea** or **with tanks** (rentals are possible in most of the diving centres of the Gulf of Morbihan). In addition to these local players, groups from other French regions regularly travel to dive in the Gulf of Morbihan. There are 6 main scuba diving organisations in the Gulf of Morbihan: H2JO (Joël GERNIER, Crouesty), Club Subaquatique Alréen (Luc MEDINGER, Saint Goustan), Association Subaquatique de Rhuys (Thomas ANNIC, Sarzeau), Allo plongée (Pierre-Yves CARON, Logeo), Scubaventure (Eloïse RAJ, Vannes), les Vénètes (Jean-Pierre Le Corvec, Vannes). The three clubs have about 400 members and more than 2,000 dives per year (including dives outside the Gulf). The three diving centres have nearly 6,000 dives (including dives outside the Gulf) and up to sixteen jobs in

the summer season. Although some centres are open all year round, the majority of dives take place between July and August.

The main diving sites in the Gulf of Morbihan are the rocky cliffs in the west of the Gulf. The south of Ile Longue is a very popular dive site and is well known for its underwater scenery, fauna and flora. Depending on the current, it is the sheltered side of the island that is explored ("La Cale" at high tide and "Les Gorets" at low tide). These two sites seem to be the most frequented in the Gulf of Morbihan, with about 25,000 dives per year. In the high season (end of May to beginning of June), up to twelve boats of divers can be seen on these sites simultaneously. Depending on the weather and sea conditions, the diving structures also frequent numerous sites outside the Gulf: around the islands of Groix, Houat, Belle Ile, the Quiberon peninsula, etc.

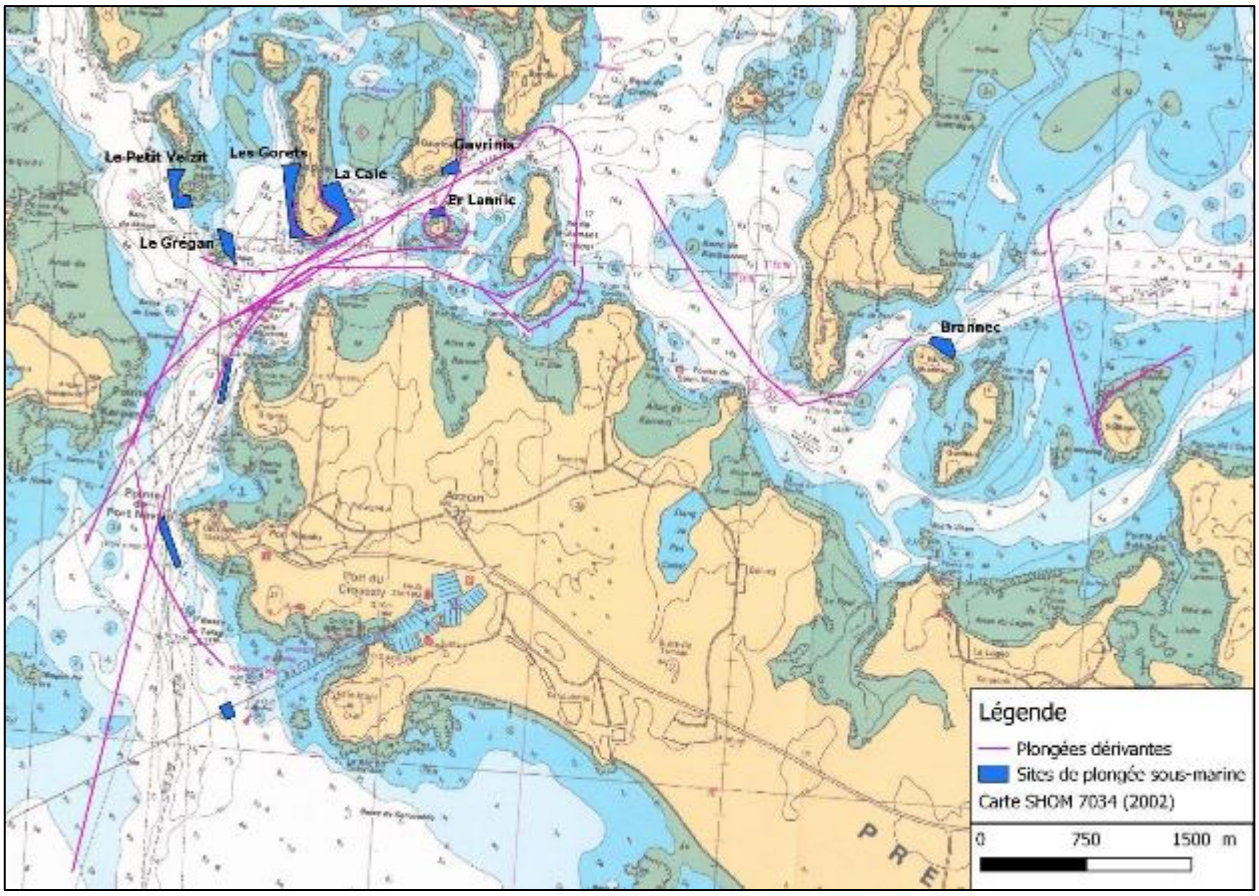


Figure 109: Main dive sites and routes used during drift dives in the Gulf of Morbihan.

Five of these anchorages were set up by the NRP between 2005 and 2008 as part of an experiment to reduce the impact of repeated anchorages on the benthos, including gorgonians (http://www.parc-golfe_morbihan.bzh/la-preservation-des-fonds-marins/). At the same time, decree n°2006/97 prohibits the use of anchorages and institutes a fishing block to the south of Ile Longue to preserve the rich seabed.

There are also **so-called drift dives**, which are practised by four of the six diving organisations we met. The drift dive itineraries of these four structures all pass through the potential hydrolic site south of Ile Longue and one through the south of Berder. These dives are carried out on rising or falling tides, mainly during low tidal coefficients. These dives are only carried out "out of season" due to the density of maritime traffic (April or October).

Scuba diving is a strong and very present activity in the Gulf of Morbihan. It is mainly organised on sites in the west of the Gulf on the drop offs to the south of the islands, such as the Ile Longue, with more than 25,000 dives per year. The majority of these dives take place in July and August. However, there is also a particularity linked to the Gulf current, which is drift diving. This diving is considered the "trademark" of the Gulf. The channel south of Ile Longue is more frequented for drift diving than the south of Berder. These dives take place in April and October.

4.5.6 Defining the issues of socio-economic activities

The following table presents the socio-economic activity issues in relation to the project site:

Components	Features	Issue level
Maritime navigation		
Recreational boating	Important in the Gulf, much of it passes through the Long Island Channel to enter or leave the Gulf	**Fort**
Commercial shipping	In the same way, coasters pass through the site on their way to the commercial port of Vannes at the bottom of the Gulf.	**Fort**
Passenger transport	There are a large number of passenger vessels in the Gulf, with significant summer activity	**Fort**
Professional fishing		
Fishing on board	23 vessels of less than 12 m are engaged in professional fishing in the area of the close study area	**Fort**
Fishing on foot	Important fishery, but on the East of the Gulf of Morbihan	**Medium**
Oyster farming	112 companies with more than 1,450 ha of production, including many sites on the western foreshore of the Gulf, particularly at the landing stage.	**Major**

Components	Features	Issue level
Recreational fishing		
On-board fishing	Mostly present in spring and summer and not allowed to drift in the main channels (including the tidal turbine site)	**Fort**
Fishing on foot	Not very present in the western Gulf	Low
Underwater hunting	Most of the Gulf is closed to hunting	Negligible
Scuba diving		

Scuba diving	6 main organisations make dives from spring to autumn with a peak in summer. 25 000 dives are organised in the area around the island Long with drift dives in April and October	**Major**

Table 27: Definition of socio-economic activity issues in the study area

5 THE POTENTIAL EFFECTS OF THE INSTALLATION, OPERATION AND DISMANTLING OF THE WIND ENERGY PROJECT

5.1 Definition of potential effects

5.1.1 Methodological source and feedback

The methodology for conducting this environmental assessment is based in particular on the following guides

- Marine renewable energy - methodological studies of environmental and socio-economic impacts (MEDDE, 2012) ;
- Guide d'évaluation des impacts sur l'environnement des parcs éoliens en mer - (MEEM, 2017) ;
- Environmental Impact Assessment Guide for Offshore Wind Energy Technologies, GHYDRO (GEF, 2013).

The evaluation also draws on feedback from Sabella :

- Immersion of the Sabella D03 in the Odet at Bénodet (20082009)
- Immersion of the Sabella D10 in the Fromveur at Ushant (2016-2017, 2019-2020)
- PHARES case file, 2019

5.1.2 Assessment of potential effects

The assessment of environmental effects consists of predicting and determining the significance of the various effects by distinguishing between: effects over time, direct or indirect effects, temporary or permanent effects, and cumulative and transboundary effects.

The effects of the project are addressed in the three phases of the project:

- effects related to the installation of tidal turbines and cables;
- effects related to the operation of tidal turbines ;
- effects related to the dismantling of the tidal turbines and cables.

The effects are analysed according to the four media defined in the baseline scenario:

- the physical environment ;
- the biological environment ;
- the living environment ;
- socio-economic activities and uses.

The effects are prioritised as follows:

- Positive or negative effects;
- Direct or indirect effects;
- Duration of effects (temporary or permanent at project scale); Degree of effects: ○ Null; ○ Negligible; ○ Weak; ○ Medium; ○ Strong.

The assessment of the effect is based on three methods:

- By analysing feedback from similar projects that have already been implemented and whose effects have been proven;
- By simulation using a model that will simplify reality, but whose equations are recognised and whose results will allow a certain prediction;
- By analogy with assessments of effects of projects in the same environment (e.g. effects of other marine renewable energy systems, port works, etc.); By expert judgement.

Five levels of effects are defined:

None
Negligible
Low
Medium
Fort

Table 28: Classification of effect levels

5.2 Potential effects during the installation phase

5.2.1 Potential effects on the physical environment

During the installation phase of the tidal turbines and cables, the main potential effects on the physical environment are based on :

- Interaction with the funds ;
- An increase in noise levels generated by vessels present at the time of installation; Disruption of water quality.

5.2.1.1 Interactions with funds

5.2.1.1.1 Installation of tidal turbines

In the case of the TIGER project, the tidal turbines are simply placed on the seabed via gravity foundations, no preparation of the seabed is necessary. The ground contact surfaces of these foundations are limited to the "diamond tip" of the bases and are a few m^2.

As stated in the France Energies Marines guide, the effects of gravity foundations are small and localised.

It should also be noted that, in the same way as for the Sabella D10 project in Ushant, the vessels operating the installation of the tidal turbines will be equipped with the dynamic positioning system, avoiding any anchoring on the seabed.

5.2.1.1.2 Cable installation

The effects of cable laying are directly related to the technique used to lay the cables:

- Laying, including cable protection ;
- Trenching or sinking, on the land section, foreshore and shallow waters; Directional drilling.

In this case, and as presented in § 3.2.3.1, the cables will be laid on the seabed and sunken on the sandy part. The cables will also be protected with cast iron shells for most of their length.

5.2.1.2 The increase in noise levels

During the installation of cables and tidal turbines, noise sources are mainly caused by the presence of vessels. The noise caused by a vessel depends on its size, drive technology, speed, etc. Most of the noise is caused by the rotation of the propellers, but also by the operation of the machinery and turbulence. Most of the noise is generated by the rotation of the propellers, but also by the operation of the machinery and the turbulence generated. Some orders of magnitude of noise levels can be provided depending on the size of the vessels:

- Small ships (< 50 m): 160-175 dB re 1µPa (at the source, i.e. 1 metre); the frequency is higher than for larger ships, generally between 1 kHz and 10 kHz;
- Medium-sized ships (50 to 100 m): 165-180 dB re 1µPa at 1 m; the frequency band is low (between 100 Hz and 1,000 Hz);
- Large ships (over 100 m long): 180-190 dB re 1µPa at 1 m; the frequency is very low (100 Hz) (MEDDE, 2012).

In view of the configuration of the Gulf of Morbihan, the vessels will be in the low end of the medium size range (around 100 metres), the noise levels produced will be of the order of 180 dB re 1µPa at 1 m.

The analysis of the initial state showed that the Ile Longue site was frequented by many ships, particularly during the Grande Parade. Thus, the noise levels produced during the works are part of an environment usually subject to such variations in noise levels.

5.2.1.3 Disruption of water quality

During the installation of the tidal turbines and cables, the water quality may be affected by :

- Resuspension of sediments;
- An input of external materials (tidal turbines themselves, cables and protection).

5.2.1.3.1 Resuspension of sediments

The resuspension of sediments leads to an increase in turbidity (or a decrease in water clarity). This phenomenon depends on the nature of the work and the level of fine particles in the sediment.

At the location of the tidal turbines the seabed is rocky, so there is no possibility of resuspension of loose sediments.

When the cables are laid, there will be a slight resuspension, but this will be very limited in time and space.

5.2.1.3.2 Input of external materials

During the installation of the tidal turbines and cables, no external material is required. Indeed, the only elements brought in are those constituting the project elements: bases, turbines, cables (and their protective shells).

5.2.1.4 Summary of potential effects on the physical environment

The following table summarises the main potential effects on the physical environment during the installation phase:

Components	Effects	
	Nature	Degree
The nature of the funds		
In terms of tidal turbines	Very light contact with the ground	Negligible
At the level of offshore cables	Slight reshuffling during ensoulment	Negligible
At the landing zone	Reshaping the bottom of the trench	Negligible
The sound environment		
In the area of the cable route and the installation of the tidal turbines	Increase in ambient noise from 70 dB re 1µPa at the source to 100 dB re 1µPa at the source	Low
Water quality		
At the landing zone	Slight resuspension	Negligible
At the level of offshore cables	Slight resuspension	Negligible
For the installation of the tidal turbines	Very slight resuspension	Negligible
Input of external materials	Treated in the operational phase	None

Table 29: Main expected effects on the physical environment in the installation phase

5.2.2 Potential effects on the biological environment

During the installation phase of the tidal turbines and cables, the main potential impacts on the biological environment are based on :

- Interaction (crushing - disturbance) of project elements (bases, cables) with benthic communities;

- An increase in noise levels generated by vessels present at the time of laying, which may disturb fish and marine mammals;
- Disturbance of avifauna by the presence of ships and construction equipment.

5.2.2.1 Effects on benthic communities

The direct destruction of benthic habitats is very localised in space and the surface area impacted depends closely on the different options for installing objects on the seabed (GEF, 2013). In the case of tidal turbines, the surface area affected theoretically corresponds to the surface area of the bases plus that of the temporary anchoring systems (GEF, 2013).

In this case, the "diamond tips" of the bases allow a very limited surface area of contact with the ground (a few ^{m2}). During the installation works, the vessels laying the tidal turbines will be equipped with the hydrodynamic positioning system, avoiding any contact with the ground.

The cable installation works will also generate interactions with the seabed which will be at least the contact area of the cables or their protection where applicable.

5.2.2.2 Effects on fish and fishery resources

The installation of tidal turbines may cause significant disturbances to the local environment. Apart from the fact that the structures (machines and cables) will remain in place (effects dealt with in the operational phase), most of the effects related to the installation are considered to be temporary (from a few weeks to a few months, with some residual effects). Stressors in this phase include noise, increased vessel traffic, habitat disturbance associated with the installation of anchors and cables (Polagye et al., 2011 in GEF, 2013).

In this case, the duration of the work is estimated at 10 days for the installation of the bases and turbines and 3 to 4 days for the installation of the offshore cables.

As mentioned above, disturbance to benthic communities and habitats will be limited (low ground contact of the platforms). The main disturbance to fish and fishery resources will therefore come from disturbance and increased noise levels.

The diversity of auditory systems in fish is greater than in marine mammals because there are different groups of species depending on their anatomical characteristics (Nedwell et al., 2004; Thomsen et al., 2006 in FEM, 2013). The literature shows that impacts on fish can be significant when pile-driving type operations are implemented: Some fish use sound to locate their feeding grounds and it is assumed that noise can interfere with this ability (Langhamer et al., 2010 in GEF, 2013). Many species use noise to communicate and to detect prey and predators. Although fish of the Gadidae family (e.g. cod, whiting, pout) respond by fleeing to airgun blasts from seismic devices, their subsequent behaviour and distribution is not affected. In these species, communication by sound is an essential component of breeding behaviour, and it is known that pile-driving or other noise pollution can disrupt this behaviour (Moura et al., 2010 in GEF, 2013). If installations require pile-driving, the use of explosives or seismic campaigns, it is likely that the surrounding noise level will exceed thresholds for fish protection (at the individual or population level) (GEF, 2013). In general the response of fish is to avoid pile-driving areas. However, juveniles and small species are likely to have more difficulty escaping than large and pelagic species (Engas et al., 1996 in GEF,

2013). According to Gill (2005) noise levels above 260 dB can cause hearing damage to some species within 100m (GEF, 2013).

In this case, the noise levels generated will be much lower than those observed during piling operations. As mentioned above, the disturbance is solely due to the presence of the vessels, the noise levels achieved will be of the order of 180 dB re 1µPa at 1 m.

5.2.2.3 *Effects on marine mammals*

In the same way as for fish, during the installation phase, the effects on marine mammals are based on disturbance and the associated noise disturbance.

It should be noted, however, that marine mammals are not very present in the Gulf of Morbihan, and their reaction to any potential presence during the works will be to flee.

5.2.2.4 *Effects on birdlife*

During the installation phase, the main effects on birdlife come from :

- At sea: from disturbance caused by the presence of ships;
- Onshore: disturbance caused by the work at the cable laying stage.

The installation of the tidal turbines will require the presence of vessels larger than those generally present in the area. The presence of these vessels may lead to changes in the flight paths of birds transiting the area, or to disturbance of birds in their feeding or resting areas, and their displacement to other potentially less favourable areas, resulting in a loss of habitat for these species (FEM, 2013). The disturbance of birdlife, through disturbance, will be limited in time and space. It should also be noted that if the vessels present are of a larger size than usual, the area is subject to significant vessel traffic.

The main effect on birds during the installation of the cables on land is disturbance and care must be taken to ensure that nesting species are not disturbed during the works.

5.2.2.5 *Summary of potential effects on the biological environment*

The following table summarises the main potential effects on the biological environment during the installation phase:

Components	Effect	
	Nature	Degree
Benthic biocenoses		
Benthic communities in the cable route area	Restricted destruction	Low
The benthic communities in the area of the tidal turbines	Very limited destruction limited to the contact surfaces of diamond tips	Low

Fish and fisheries resources		
Fish and fisheries resources	Increased noise levels	Low
Marine mammals and marine megafauna		
Marine mammals and marine megafauna	Noise pollution	Negligible
Birdlife		
Birds in the tidal turbine siting area	Disturbance	Low
Birds at the landing zone	Disturbance	Low

Table 30: Main expected impacts on the biological environment in the installation phase

5.2.3 Potential effects on the living environment

During the installation phase of the tidal turbines and cables, the main potential effects on the living environment are based on :

- The visual presence of marine works vessels in the channel for the laying works
- The release into the air of exhaust gases from the thermal engines of ships
- Airborne noise from laying vessels
- The consequences of industrial pollution in the event of an incident on board the vessels or a machine (tidal turbine or cable) breaking down during installation.

5.2.3.1 The visual presence of laying vessels

The installation of the tidal turbines and the cable will take place in late spring or early autumn and will only last about ten days. The worksite is therefore temporary and of short duration and will not alter the landscape or the protected cultural heritage in the vicinity. The work of burying the cable on the foreshore will also be temporary, as will the work of landing. However, once these are completed, there will be no visual impact, as the landscape will have been restored to its original state.

5.2.3.2 Air emissions from ships

The vessels and equipment used will emit greenhouse gases via the exhaust from the engines used (propulsion engines, generators, etc.). However, the number of construction machines and vessels is limited and the intervention period is short.

5.2.3.3 Airborne noise

The noise of the works will be mainly that of the engines of the ships and cranes used to lower the two tidal turbines. There will also be noise from the cable landing site and its passage on land (excavation...). However, the construction site is temporary, of short duration and will be carried out in a few days, at slack tide of low coefficient.

5.2.3.4 Risk of pollution in the event of an accident

Accidents can occur on any site with risks of collision, equipment breakage, cable breakage, etc. However, a risk analysis will be carried out with the marine works company that will install the tidal turbines and cables. In general, the application of safety measures in marine works is much stricter than on land, due to the aggressiveness of the marine environment. In addition, all marine works are equipped with anti-pollution kits with booms, skimmers and oil absorbers. In addition, an audit of the chosen company will be carried out to check the ship's safety documents. Finally, the company Sabella has a good experience (Odet, Fromveur) of installing and removing these tidal turbines.

5.2.3.5 Summary of potential effects on the living environment

The following table summarises the main potential effects on the living environment during the installation phase:

Components	Effects	
	Nature	Degree
Landscape and cultural heritage		
For the tidal turbines and the cable	Short-term, temporary and invisible work once completed	Negligible
Air quality		
For the tidal turbines and the cable	The number of machines is limited and the work period is short	Low
The sound environment		
For the tidal turbines and the cable	Short-term, daytime work at low tide slack water	Low
Technological risks (risk of accidental pollution)		
For the tidal turbines and the cable	Audit of the companies that are going to work, carrying out a risk analysis of the installation procedure, presence of anti-pollution kit, feedback	Negligible

Table 31: Main expected effects on the living environment in the installation phase

5.2.4 Potential effects on socio-economic activities and uses

During the installation phase of the tidal turbines and cables, the main potential effects on the living environment are based on :

- A restriction of the navigation channel, or even a ban on access during the installation work over a 200 m zone.
- Work to bury the cable at the oyster concession

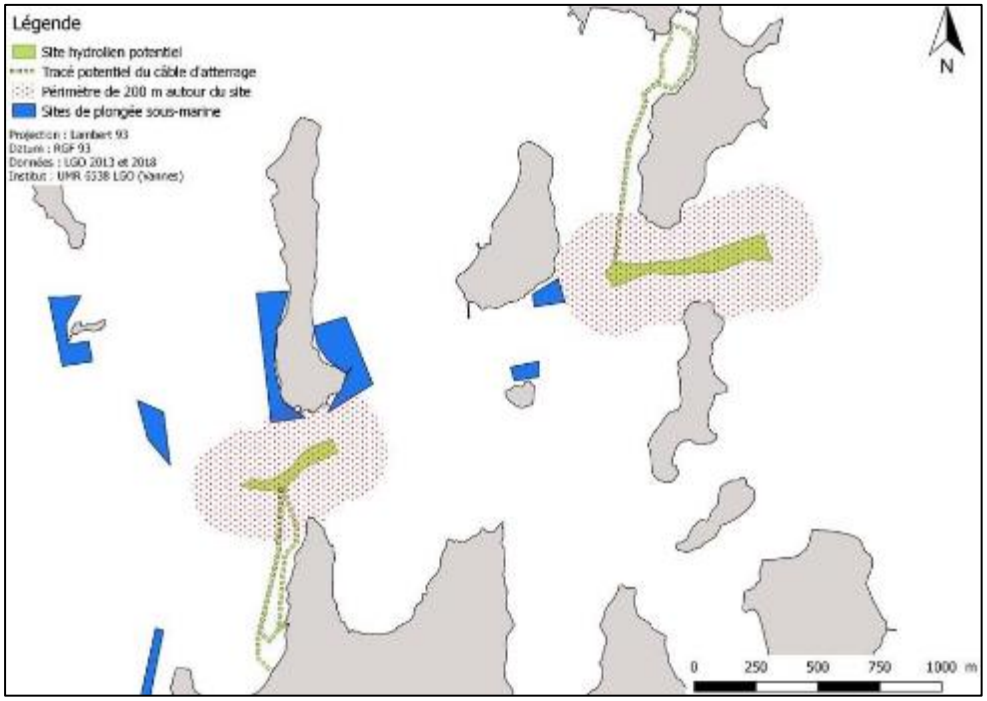


Table 32: Dive sites and 200m exclusion zones around proposed sites

5.2.4.1 A restriction of the navigation channel and a 200 m zone around the works

In general, to limit the risks of interaction with maritime users (ships, fishermen, divers), the work zone with a 200 m perimeter around it is forbidden to navigation and any maritime use. This period is temporary and will be limited to the two weeks of work. However, this ban will have a major impact on all users of the site.

5.2.4.2 Cable burial works in the middle of an oyster farm concession

The landing works, which will be carried out in the spring or autumn, but not in the summer, will cross a shellfish farming concession area. The site will therefore be directly impacted.

5.2.4.3 Summary of potential effects on socio-economic activities and uses

The following table summarises the main potential effects on socio-economic activities in the installation phase:

Components	Effects	
	Nature	Degree
Maritime navigation		
On boating	The works are short term, but will require the use of an alternative access channel for boaters	Medium
On commercial shipping	The works are short term, but will impose another access channel with important draught restrictions for this type of vessel	Fort
On passenger transport	Access through this busy channel will no longer be possible. There will therefore be a loss of use of the construction period	Fort

Professional fishing		
On ship-based fishing	The period is short, but reduces the fishing area to months (spring/autumn) when these areas are worked on	Medium
On fishing on foot	The area is little used	Low
Marine farming		
In the area of cable routing	The work crosses an oyster farm concession	Fort
Recreational fishing		
In the area	The channel is already closed to recreational drift fishing.	Negligible
Diving		
In the area	The ban may prevent drift dives from taking place and may also have an impact on sites in the south of the Long Island. However, they are short durations	Medium

Table 33: Main expected effects on socio-economic activities in the installation phase

5.3 Potential effects in the operational phase

5.3.1 Potential effects on the physical environment

The operation of tidal turbines may have effects on :

Hydrodynamic conditions and sediment dynamics; Noise environment↘

5.3.1.1 Effects on hydrodynamics and sediment dynamics

The presence of obstacles modifies the local hydrodynamic conditions, by :

- Increased turbulent flow energy due to vortex generation;
- Acceleration of the flow in the vicinity of the obstacle, by convergence of the streamlines.

The impacts on local swell and current conditions may therefore be decisive, as the "mask" effect and the "wake" effect may have repercussions on sediment dynamics, particularly by capturing part of the sediment transit (FEM, 2013). Nevertheless, as presented in § 4.2.3.2, the analysis of the sedimentary characteristics of the Ile Long site highlights a predominantly rocky base, as the hydrodynamics are too great to allow sedimentation and the deposition of silt. Furthermore, feedback from the Sabella D10 demonstrator shows that the impact of a tidal turbine on the capture of part of the sediment transit is negligible.

5.3.1.2 Effects on the noise environment

5.3.1.2.1 Methodology of the acoustic study

The analysis of the noise generated by the tidal turbines was studied by means of modelling. Thus, as presented in the initial analysis (make a reference), a model integrating the ambient noise was defined. The noise emitted by a tidal turbine is integrated into this model. Thus, in this study, the noise level emitted by a tidal turbine is estimated from the recent publication relating to an equivalent turbine model (Naval Group model) whose broadband noise level is 154.1dB ref1µPa@1m. The scenario envisaged assumes the deployment of 18 turbines on the Ile Longue site, which is largely overestimated since, as a reminder, the TIGER project only plans to install two tidal turbines. The study used the Quonops© underwater noise prediction model developed and operated by Quiet-Oceans. Quonops© takes into account the environmental parameters of the site, such as bathymetry, the nature of the sediments, the temperature and salinity conditions in the ocean, as well as the sea states.

Based on the mapping of the noise generated by the tidal turbine farm in operation and the existing noise in the area, the mapping of the noise emergence thus makes it possible to quantify the extent of the perception of this underwater activity. For the operating scenario envisaged, a comparison is made on the one hand with the existing current noise and on the other hand with the exceptional situation during the Grande Parade du Golfe. For each mapping, the blue line gives the geographical limit of the perception of the tidal turbine park in operation, and the contours inside the footprint give the absolute noise level in 5 dB steps.

5.3.1.2.2 Results

In the current situation

The figure shows the statistical noise footprint obtained after comparison with the existing statistical noise in the area.

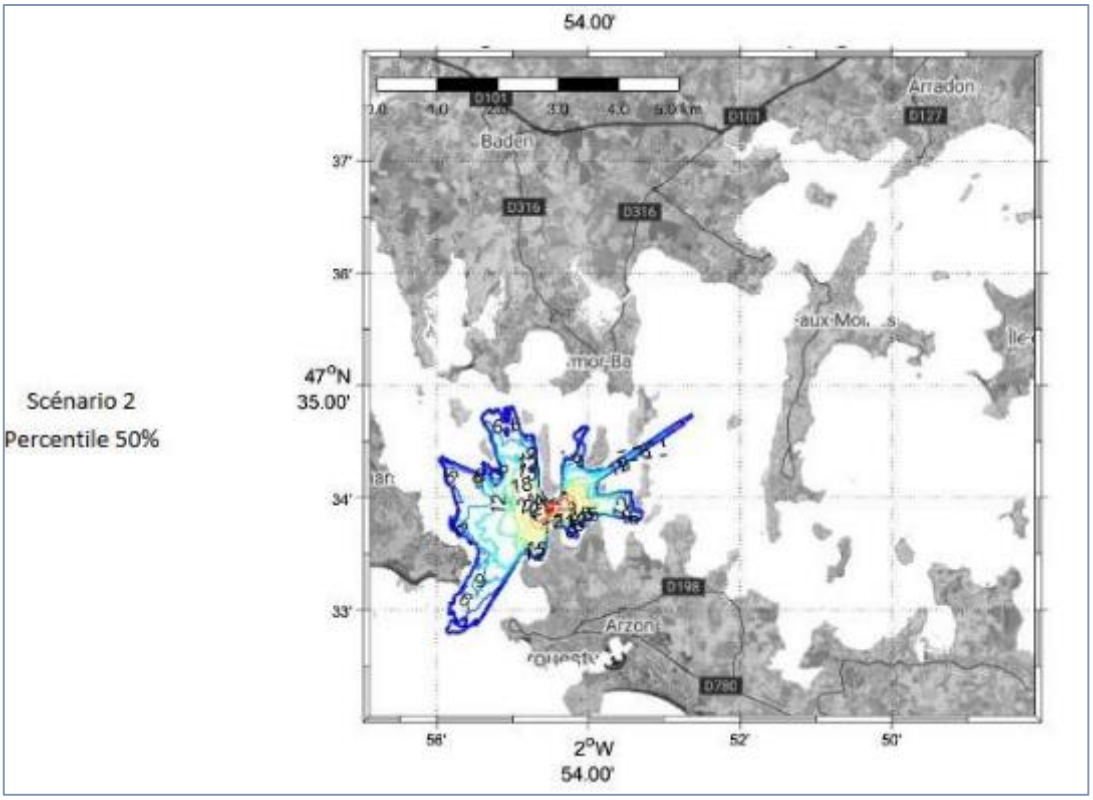


Figure 110: 50 % percentile map of the noise emergence of the tidal turbine farm compared to the ambient noise in a current situation (Quiet Oceans, 2018)

The results show that the total area of the noise footprint is 4.6 km² and extends up to two kilometres from the park in the southwest and north directions.

The analysis of noise emergence shows that the noise generated by the tidal turbines will be perceived at a distance of about two kilometres from the turbines. It should be noted, however, that the modelled scenario includes eighteen tidal turbines, whereas the TIGER project will have only two.

In situation Grand Parade

The following figure shows the statistical noise footprint obtained after comparison with the existing statistical noise in the area.

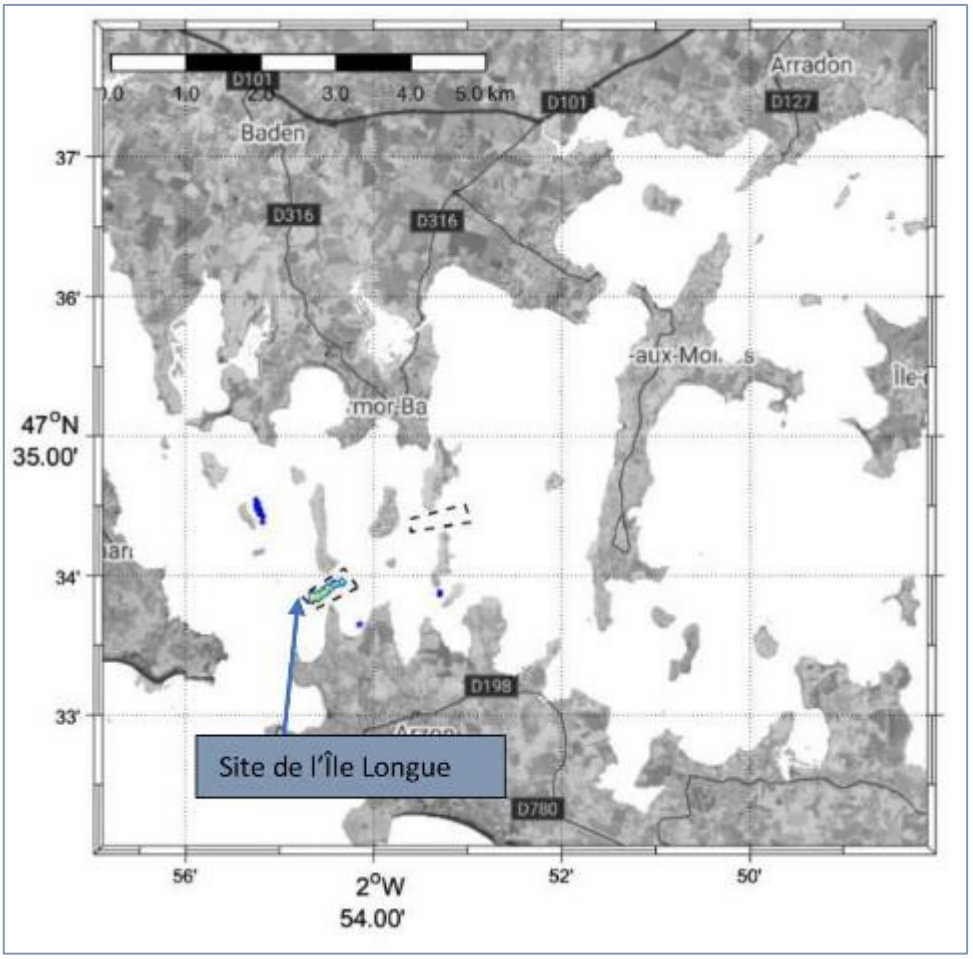


Figure 111: 10% percentile mapping of the noise emergence of the tidal turbine park during the Grande Parade in the Gulf of Morbihan (Quiet Oceans, 2018)

During the Grande Parade in the Gulf of Morbihan, the operation of the tidal turbine park results in zero (50% percentile) or reduced (10% percentile) emergence in the immediate vicinity of each tidal turbine (above), compared to the intense traffic in the area. The maximum surface area of the noise footprint of the tidal turbine farm in operation is 0.1 km².

In exceptional situations (Grande Parade), the noise of the tidal turbines is hardly noticeable.

5.3.1.3 Summary of potential effects on the physical environment

The following table summarises the main potential effects on the physical environment during the operational phase:

Components	Effect	
	Nature	Degree
Oceanographic conditions		
The currents	Current attenuation	Low [1]
Sea states	Sea state mitigation	Low [2]
Sediment dynamics		
Sediment dynamics	Capture of a part of the sediment transit	Low [3]
The sound environment		
How tidal turbines work	Increased noise levels	Low

Table 34: Main expected impacts on the physical environment in the operational phase

5.3.2 Potential effects on the biological environment

The main effects of the operation of tidal turbines can be on :

- Fish and fisheries resources from the risk of collision, noise and electromagnetic disturbance;
- Marine mammals from the risk of collision, noise and electromagnetic disturbance;
- Birds from the risk of collision.

5.3.2.1 Effects on fish and fishery resources

5.3.2.1.1 Risk of collision

The literature indicates that there is insufficient data to make a definitive statement on the impact of operating tidal turbines on fish and fish habitat (Frid, 2012 in FEM, 2013). Observations from the Roosevelt Island tidal turbine project on the East River in New York (Anon, 2008 in FEM, 2013) showed that the number of fish in and around the turbines was generally low (a range of 16 to 1400 individuals observed per day) and that the fish were predominantly small. Video footage from the site showed that there were generally no fish when the current speed was above 0.8 m/s and the turbines were running (Polagye et al., 2011 on GEF, 2013).

As presented in § 3.1.5, as part of the Sabella D10 project, one of the monitoring activities consists of analysing the behaviour of species in the vicinity of the tidal turbine using videos.

The first results of the camera monitoring show that :

- The tidal turbine is regularly used around slack water, whatever the tidal range

[1] Estimated effect level based on feedback
[2] Estimated effect level based on feedback
[3] Estimated effect level based on feedback

- The fish are mainly wrasse, with mainly olds and coquettes; one locus was observed on a record; these are bentho-demersal fish typical of rocky bottoms

- The incursions of these fish are furtive (a few tens of seconds) to take shelter from the current or to graze on some preys around the holding pole on the base; the fish never approach the rotor when it is in rotation;
- In the observations, the fish are alone, sometimes in pairs and very rarely in threes;
- Their movements are always from below or behind and remain essentially circumscribed around the side of the turbine, the anti-tilt system and the holding post on the base; when the rotor is turning driven by the tidal current, there are no fish sightings.

The first results seem to show that the Sabella D10 tidal turbine has been integrated by benthic fish in the same way as a wreck or an artificial reef.

Effects related to collision risks appear to be negligible.

5.3.2.2 Noise pollution

The analysis of the impacts of the noise generated by the tidal turbines on fish was carried out via the modelling study carried out by the company Quiet-Oceans. Thus, the mapping of the noise footprints was carried out by comparing the sound fields generated by the project with the sensitivity thresholds of the species.

For species that are significantly more receptive at the predominant frequencies (~150 Hz), the extent of the noise footprint is very close to the broadband noise footprint, i.e. an area of up to 8.5 km² (Figure below). However, the experimental study by Halvorsen (2011) demonstrated a negligible effect of extreme tidal turbine noise on the tissues of salmon-like fish in the immediate vicinity after a prolonged period of sound exposure (without taking into account the mobility of the animal).

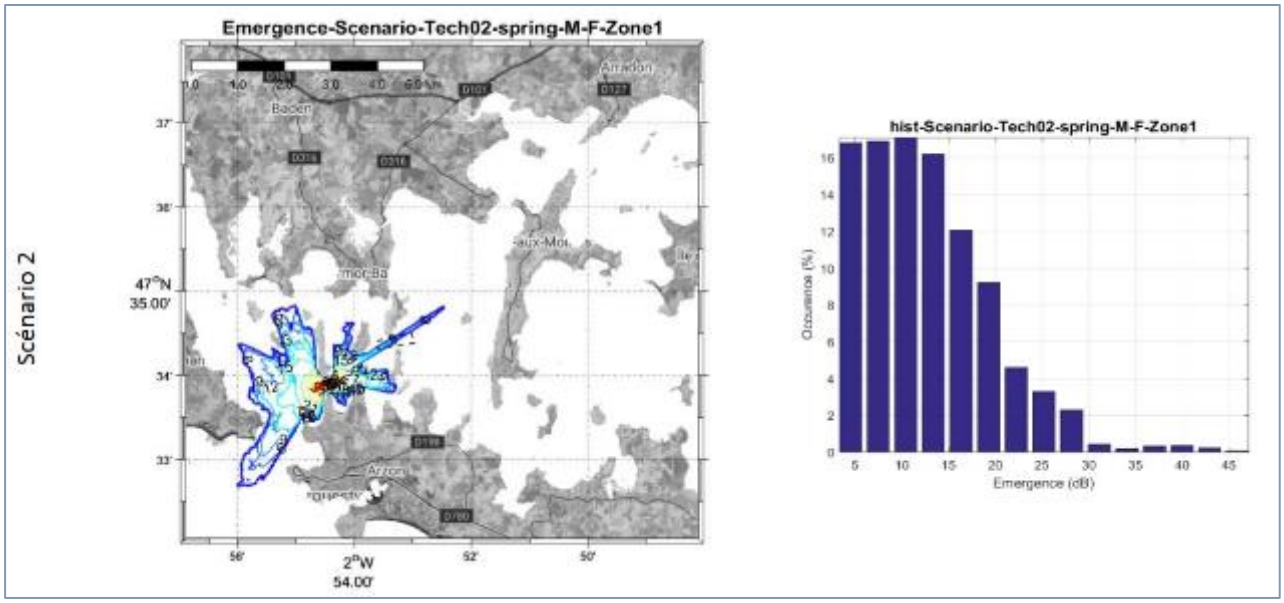


Figure 112: Sound emergence perceived by fish (left) and distribution of emergences in the sound footprint (right) (Quiet Oceans, 2020)

The noise of the tidal turbines will be perceived by fish, but no physiological risk is expected (see below).

Groupe d'espèces	Référence	Abbr.	Gamme de fréquences de perception (kHz)	Bruits continus SEL (dB réf. 1µPa²s)		Bruits impulsifs SEL (dB réf. 1µPa²s)	
				TTS	PTS	TTS	PTS
Poissons sans vessie natatoire	(Popper, et al., 2014)	F	< 1.0	186	219	186	219
Poissons ayant une vessie natatoire sans cil sensitif	(Popper, et al., 2014)	FD	< 4.0	186	207	186	207
Poissons ayant une vessie natatoire avec cils sensitifs	(Popper, et al., 2014)	FBL	< 1.0	186	210	186	210
Œufs et larves de poissons	(Popper, et al., 2014)		< 1.0	NC	210	NC	210

NC : non connu

Table 35: Species groups considered and associated sensitivity thresholds (Quiet Oceans, 2018)

5.3.2.3 Electromagnetic disturbances

Several studies suggest that the sensory system of some fish species may be influenced by natural electromagnetic fields, which they use for orientation, migration and predation. Small amounts of magnetic material can be found in all teleost groups in various parts of the body depending on the species: for example, the skull, spine and pectoral girdle for the eel (Anguilla anguilla) (Hanson et al. 1984 in Öhman et al. 2007). Elasmobranchs (sharks and rays) can analyse their environment by detecting the electromagnetic fields created by ocean currents, thanks to the electrosensitivity conferred by their Lorenzini bulbs (MEDDE, 2012).

It is now estimated that the most electrosensitive species are elasmobranchs. While teleosts are considered to exhibit behavioural disturbances at fields of 0.5 to 7.5 V/m (Poléo et al. 2001 in OSPAR, 2008), the sensitivity of elasmobranchs has been illustrated at fields up to 10 000 times lower (10 µV/cm).

Available knowledge confirms that the behaviour of electrosensitive fish can be disturbed by the fields generated by electric cables. However, this knowledge does not allow us to establish the real consequences on these species in terms of impact.

In this case, given the characteristics of the cables used in the Tiger project and the analysis of the literature, the magnetic field produced in the immediate vicinity of the cable should be less than 1 µT. The electric field should be of the order of tens of µV/m.

5.3.2.4 Effects on marine mammals

It should be remembered that the analysis of the initial state showed that marine mammals were not very present in the Gulf of Morbihan.

5.3.2.4.1 Risk of collision

The bibliographical data indicate a low risk of collision. Given the low presence of marine mammals in the Gulf of Morbihan, the risk is even lower.

5.3.2.4.2 Noise pollution

Despite the low number of marine mammals in the Gulf of Morbihan, the analysis of acoustic impacts on species was carried out using modelling.

Taking into account the auditory sensitivity (or audiogram, see Figure below) of the species likely to be present in the area, an assessment of the perceived noise emergence is made for mid-frequency cetaceans (dolphins and pilot whales), high-frequency cetaceans (porpoises) and pinnipeds (seals). For each category, each figure gives the extent of the perceived noise footprint as well as the distribution of these emergences in comparison to the seasonal noise common in that area. The noise perceived by the species is inversely proportional to the distance separating it from the tidal turbine in operation. Whatever the species, the levels perceived do not exceed the physiological damage thresholds (see table below).

Groupe d'espèces	Référence	Abbr.	Gamme de fréquences de perception (kHz)	Bruits continus SEL (dB réf. 1µPa²s)		Bruits impulsifs SEL (dB réf. 1µPa²s)	
				TTS	PTS	TTS	PTS
Cétacés basses fréquences	(NOAA, 2016)	LF	0.2-19	179	199	168	183
Cétacés moyennes fréquences	(NOAA, 2016)	MF	8.8-110	178	198	170	185
Cétacés hautes fréquences	(NOAA, 2016)	HF	12-140	153	173	140	155
Pinnipèdes	(NOAA, 2016)	P	1.9-30	186	206	170	185
Tortues marines	(Popper, et al., 2014)	T	< 0.9	175	210	175	210

Table 36: Species groups considered and associated sensitivity thresholds (Quiet Oceans, 2018)

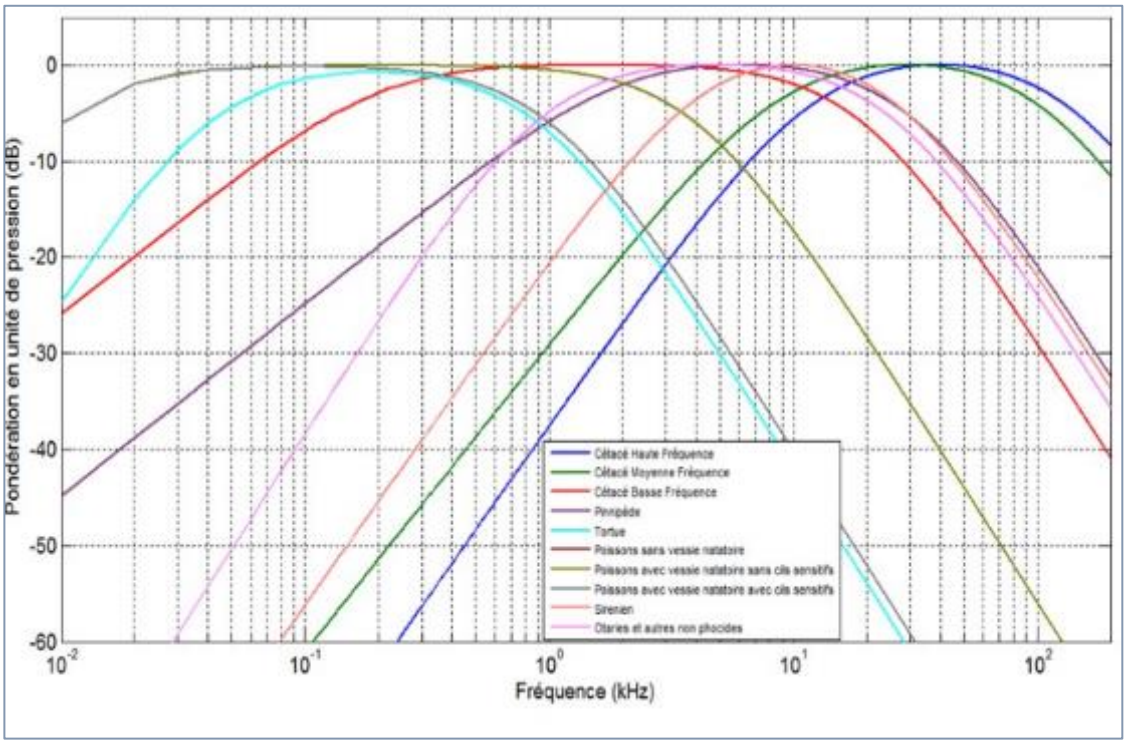


Figure 113: Auditory sensitivity function of different categories of marine mammals according to (NOAA, 2016) and fish and turtles according to (Popper, et al., 2014 in Quiet Oceans, 2018

Cetaceans of the medium frequency category

For these species, the extent of the noise footprint is limited to the immediate vicinity of the tidal turbine over an area of 0.014 km² (see following figure).

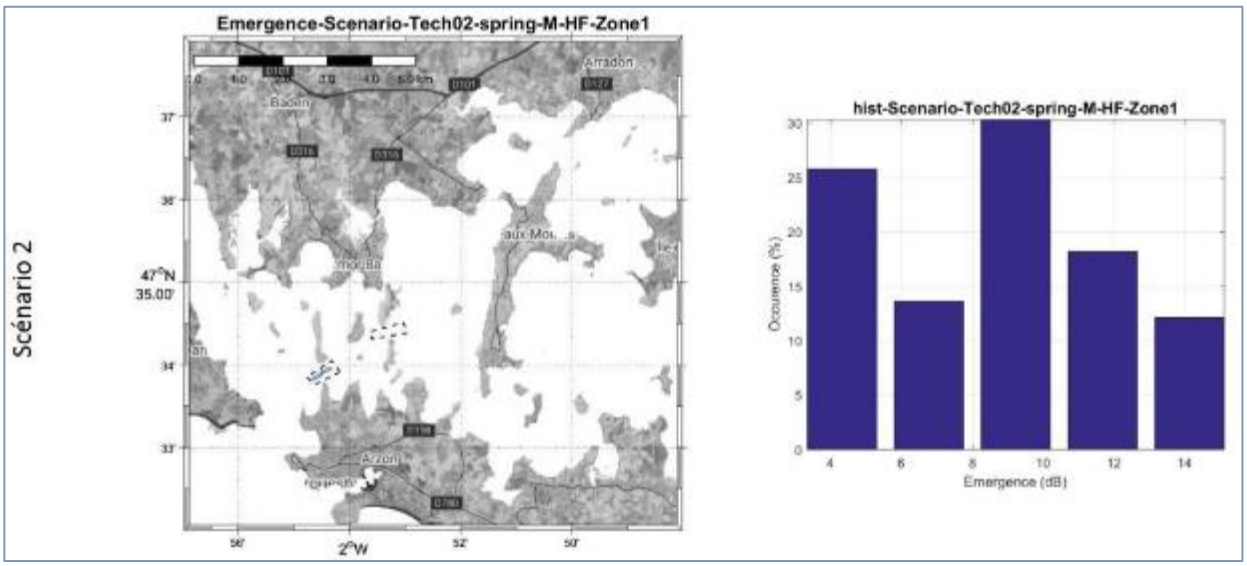


Figure 114: Sound emergence perceived by high frequency cetaceans (left) and distribution of emergences in the sound footprint (right) (Quiet Oceans, 2018)

Pinnipeds

For these species, the extent of the noise footprint is limited to an area of 0.6 km², i.e. the area of the project zone (see figure below).

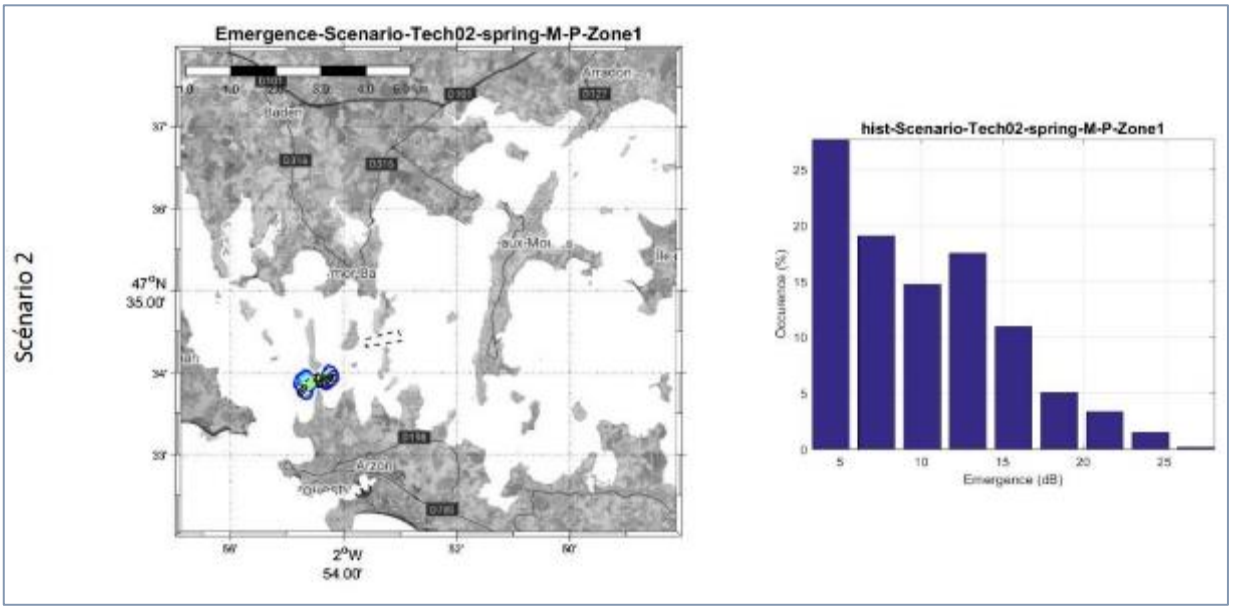


Figure 115: Sound emergence perceived by pinnipeds (left) and distribution of emergences in the footprint (right) (Quiet Oceans, 2018)

5.3.2.5 Electromagnetic disturbances

Some studies have suggested possible effects of electric fields on the movement of marine mammals (Dolman and Simmonds, 2010), but there is currently no evidence of such impacts. The effects of these electric fields are difficult to assess, as is the use of the Earth's magnetic field by cetaceans during travel (Gould, 2008).

The presence of magnetic fields can result in only one potential effect: temporary behavioural responses. Although behavioural responses by electrosensitive species (such as basking sharks) have been demonstrated, the likelihood

of basking sharks being affected by the presence of magnetic fields around cables is low. This is because basking sharks are a pelagic species and generally stay away from the seabed where cables are installed. In any case, temporary attraction or avoidance responses caused by magnetic fields are unlikely to result in much more than a small-scale loss of energy (Wilson and Wilding, 2017).

There is no evidence of electrosensitivity in marine mammals in the scientific literature (Normandeau et al., 2011). In terms of sensitivity to magnetic fields from buried cables, theoretical results suggest that changes in swimming behaviour are likely to be corrected within a few metres and that magnetic fields therefore have minimal influence on these species (Normandeau et al., 2011).

At this stage, it is therefore difficult to estimate an effect on marine mammals due to the presence of cables. It should be noted, however, that the fields produced by the TIGER project appear to be low, particularly in view of the electricity transmission cables. At this stage the effect is considered to be low.

5.3.2.6 Effects on birdlife

In the operational phase, the main effect to be studied is the risk of collision. Thus, the main risks of hydroelectric projects are related to the presence of elements that can trap diving birds (Cruz and Simas, 2012) or injure them during their movements, particularly impacts with the blades. Diving birds are the species at greatest risk during the operational phase. The main species potentially present in the study area are (groups in taxonomic order):

- The Gaviidae group (Red-throated Loon, Brilliant Loon, Arctic Loon);
- The Podicipedidae group (Great Crested Grebe, Black-necked Grebe, Horned Grebe, Great Horned Grebe) ;
- The Phalacrocoracidae group, (Great Cormorant and Crested Cormorant);
- The Anatidae group, specifically the diving marine Anatidae (Black Scoter, Common Scoter, Common Eider, Common Goldeneye, Red-breasted Merganser);
- The Alcidae group (Common Murre, Razorbill, Atlantic Puffin, Little Auk).

These groups are identified in the French and international literature (Comolet-Tirman, Hindermeyer and Siblet, 2007; France Energies Marines, 2013; Furness et al., 2012; McCluskie, Langston and Wilkinson, 2013). Within these groups, some families seem to interact more than others, especially species that spend the majority of their time on the water and whose hunting methods require deep dives, such as the Gaviidae, Phalacrocoracidae or Anatidae divers.

Further studies, in particular the inventories that will be carried out in the area where the tidal turbines will be installed, should make it possible to identify the species present in the vicinity of the future tidal turbines and thus to estimate the potential effects of the project on diving birds. It should be noted that within the framework of the PHARES project in Ushant, ornithological observations have shown the low presence of marine birds in the area of intense current veins (CEMO, unpublished).

5.3.2.7 Summary of potential effects on the biological environment

The table summarises the main potential effects on the biological environment in the operational phase:

Components	Effect	
	Nature	Degree

Fish and fisheries resources		
Noise pollution - operation of tidal turbines	Perception of the noise footprint area of 8.5 km².	Low
The risk of collision	Literature data show little presence of fish, especially when the blades are in motion	Negligible
Electromagnetic fields	Generation of low level electromagnetic fields	Low
Marine mammals and marine megafauna		
Noise pollution	Perception at 0.014 km2 for cetaceans medium frequent and 0.6 km2 for pinnipeds	Low
Risk of collision	Few marine mammals present	Negligible
Electromagnetic fields		Low
Birdlife		
Risk of collision	A priori the risk is limited, but to be validated within the framework of complementary studies	Low

Table 37: Main expected impacts on the biological environment in the operational phase

5.3.3 Potential effects on the living environment

In the operational phase, the visual effects (landscape and cultural heritage), on air quality or airborne noise will be negligible, as the tidal turbines will be submerged, the export cable will be buried in the sea and foreshore, and the land-based part will be buried, so that nothing will be visible or will be able to reach these compartments.

The only point that may be impacted by the project in operation is the technological and natural risk compartment with :

- Effect of a surge with a combination of a strong swell and a tidal current in the same direction as the wind in spring tide.
- Effect of a technical incident on one of the tidal turbines or at the delivery station

5.3.3.1 Effect of natural hazards

As we have seen above, the main natural risk linked to the project is essentially the risk linked to a strong storm (ten-year, fifty-year or one-hundred-year) of west or south-west winds which could enter in conjunction with a spring tide. This conjunction could thus create a surge and an increased stress on the tidal turbines. It is therefore important to properly dimension the project to take into account the meteorological conditions according to a return period to be defined (ten-year, fifty-year or hundred-year). The effect of the natural risk on the project can therefore be strong, with risks of blade breakage, machine tipping, cable untwisting, etc.

5.3.3.2 Effect of technological risks

The main risk is an internal risk to the project, in which a technical incident (breakage, short-circuit, fire, etc.) would lead to the partial or total destruction of a tidal turbine or its delivery station. This would result in potential water and air pollution. However, even if the risk still exists, it depends on the reliability of the machines, Sabella's experience as a manufacturer, and the probability of occurrence over the operating period.

5.3.3.3 Summary of potential effects on the living environment

The table summarises the main potential effects on the living environment in the operational phase:

Components	Effect	
	Nature	Degree
Landscape, natural heritage, air quality		
Visual risk or damage to the compartment from the operation	Unseen tidal turbines and cables	Negligible
The natural risk		
Surge effect with VE tide conjunction	Additional stress on the blades, with a risk of breakage, tilting of the turbines or scouring...	Fort
Technological risk		
Technical incident on the tidal turbines or on the delivery station	Breakage, short-circuit, fire...	Medium

Table 38: Main expected impacts on the living environment in the operational phase

5.3.4 Potential effects on socio-economic activities and uses

In the exploitation phase, the main impacts will be linked to a ban on practices around the tidal turbines (200 m radius?) which will be defined by the Préfecture maritime and the Préfecture. This ban will have a direct impact on professional fishermen and divers, who will no longer be able to drift dive through this channel, by reducing the fishing area. Other activities (recreational fishing, fishing on foot, marine cultures) will not really be impacted, as they are either not very present in the area (fishing on foot, etc.) or are not disturbed by the operation of the project (oyster farms). Maritime transport (pleasure boating, trade, passengers) will not be impacted, as the water level at the two sites is sufficient to leave a significant margin above the tidal turbines for the passage of ships.

5.3.4.1 Effect of site occupation on professional fishing

The site will be closed to all fishing, anchoring and diving activities, with a buffer zone that could be 200 m in radius around the two tidal turbines. This ban will therefore reduce part of the fishing area for professionals in the Gulf of Morbihan for the duration of the project (3 years).

5.3.4.2 Effect on diving

In the same way, it will no longer be possible to drift dive on the pass where the two tidal turbines will be located. There will therefore be a definite impact on diving activities.

5.3.4.3 Summary of potential effects on socio-economic activities and uses

The following table summarises the main potential effects on socio-economic activities in the operational phase:

Components	Effects	
	Nature	Degree
Maritime navigation		
On all types of shipping (commercial, pleasure, passenger),	there will be more than enough water above the tidal turbines not to interfere with traffic	Negligible
Professional fishing		
On ship-based fishing	A 200 m radius fishing zone around the tidal turbines will be prohibited	Fort
On fishing on foot	The tidal turbines are always submerged and the cable is buried in the water	Negligible
Marine farming		
In the area of cable routing	The cable is embedded	Negligible
Recreational fishing		
In the area	The channel is already closed to recreational drift fishing.	Negligible
Diving		
In the area	The ban may prevent drift dives from taking place and may also have an impact on the south of the long island	Fort

Table 39: Main expected effects on socio-economic activities in the operational phase

5.4 Potential effects in the decommissioning phase

There is as yet no specific feedback on Marine Renewable Energy (MRE). However, the impacts of decommissioning will be directly linked to the impacts that the installations will have had during the operational phase. Thus, many questions remain as to the damage that a return to the initial state may cause in comparison to the advantages and disadvantages of leaving certain project components in place.

In the case of the TIGER project, the colonisation of the different components (turbine, cable) of the two turbines will be limited and there is no indication that some elements should, for environmental reasons, be kept in place.

The dismantling of the facilities is relatively simple:

- Turbine and sub-base takeover
- Re-attachment of the cables, with the removal of the cable from the sediment simply by pulling it
- Opening the trench on the foreshore and near the coastline and recovering the cable
- Removal of the cable on the land side to the delivery station

The expected effects in the decommissioning phase are largely similar to the effects identified for the installation works (noise, substrate disturbance, etc.).

6 CONCLUSION

In the present case, the numerous feedbacks from Sabella D10 and D03 show that the **expected effects** of the TIGER project **are relatively limited** (in time and space) and mainly concern the aquatic environment and the uses of this environment (professional fishing and diving). At this stage of the study, the effects, which may be strong, have not been evaluated in terms of impact, i.e. the cross-referencing of sensitivity (transcription of the issue in the face of the generic impacts of tidal turbines and broken down into two criteria, such as tolerance or resistance and resilience) in relation to the effects. This cross-referencing will make it possible to characterise the potential impacts, which will then be transformed into a residual impact by applying the ERC sequence (avoidance, reduction, compensation). However, at this stage in the 'case by case' dossier, we are not yet in the process of carrying out a complete incidence or impact study.

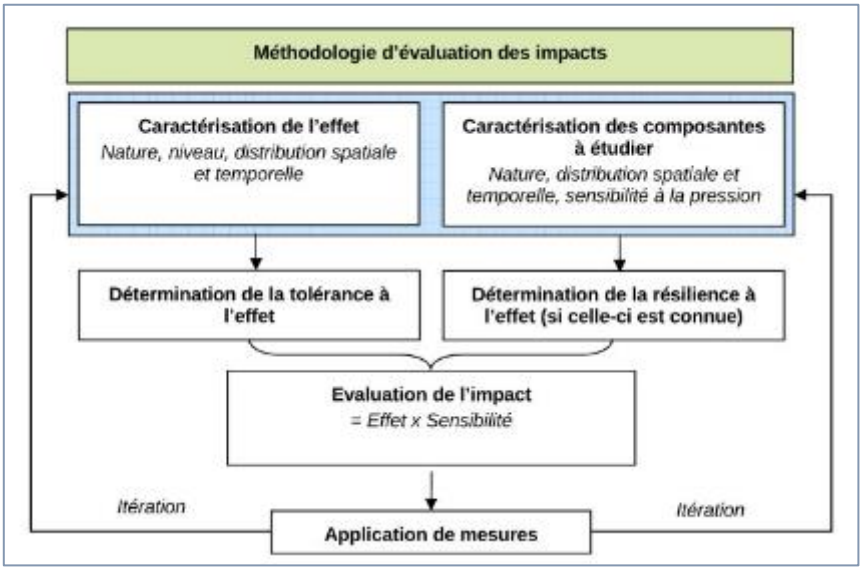


Figure 116: Impact assessment methodology (MEEM, 2017)

The assessment of local issues and potential effects should enable the administration to evaluate whether or not it is necessary to carry out a full environmental assessment. However, the project owner believes that the installation of two D08 tidal turbines could require only an environmental impact study (Article R181-14). This impact study would be appropriate for this type of innovative and experimental project, which will be subject to environmental monitoring during **its three years of operation.**

The impact study would thus include, in accordance with Article R181-14, the following elements

- 1° the current state of the site on which the project is to be carried out and its environment ;
- 2° the direct and indirect, temporary and permanent impacts of the project on the interests mentioned in Article L. 181-3, taking into account its characteristics and the sensitivity of its environment;
- 3° the measures envisaged to avoid and reduce the significant negative effects of the project on the environment and health, to compensate for them if they cannot be avoided or reduced and, if it is not possible to compensate for them, the justification for this impossibility;
- 4° follow-up measures ;
- 5° the conditions for rehabilitating the site after exploitation.

The impact assessment would also address the impact on Natura 2000 sites.

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