

## PROPOSITION DE SUJET DE THESE

Formulaire demande de financement : ARED - ISblue - ETABLISSEMENTS - ...

*pour dépôt sur le serveur <https://theses.u-bretagne.fr/sml> au format PDF**NB : ce dossier ne vous dispense pas de déposer en parallèle votre dossier à la Région***Identification du projet****Acronyme du projet** (8 caractères *maximum*) : DIVPEL**Intitulé du projet en langue française** : Diversité écologique au sein des communautés de petits poissons pélagiques des systèmes d'upwelling de bord-est et dynamiques de population**Intitulé du projet en langue anglaise** : Ecological diversity within small pelagic fish communities in Eastern-boundary upwelling systems and population dynamics**Présentation de l'établissement porteur (bénéficiaire de l'aide régionale)****Établissement porteur du projet** : Université de Bretagne OccidentaleEcole Doctorale : EDSML  SPI  ou MATHSTIC pour les projets ISblue **Identification du responsable du projet (futur directeur de thèse)****Nom du laboratoire d'accueil** : Laboratoire des Sciences de l'environnement marin - LEMAR**Code du laboratoire (U/UMR/USR/EA/JE/...)** : UMR 6539**Directeur<sup>1</sup> du Laboratoire** : Luis Tito de Morais**Nom de l'équipe de recherche** : DISCOVERY Ecologie marine : diversité, structure et dynamique des populations et des communautés

Nombre HDR dans le laboratoire : 51    Nombre de thèses en cours : 47    Nombre de post-docs en cours : 16

**Nom et prénom du directeur\* de thèse (HDR), porteur du projet** : Fred JEAN- **e-mail** : fjean@univ-brest.fr- **Téléphone** : 02 98 49 86 01- **Publications récentes du directeur de thèse** (nb total et 5 références max au cours des 5 dernières années) : **53**

- Émilien Pousse, Jonathan Flye-Sainte-Marie, Marianne Alunno-Bruscia, Hélène Hégaret, Éric Rannou, [Laure Pecquerie](#), Gonçalo M. Marques, Yoann Thomas, Justine Castrec, Caroline Fabioux, Marc Long, Malwenn Lassudrie, Ludovic Hermabessiere, Zouher Amzil, Philippe Soudant, **Fred Jean**. Modelling paralytic shellfish toxins (PST) accumulation in *Crassostrea gigas* by using Dynamic Energy Budgets (DEB). *Journal of Sea Research*, Elsevier, 2019, 143, pp.152-164. ([10.1016/j.seares.2018.09.002](https://doi.org/10.1016/j.seares.2018.09.002)). ([hal-02114653](https://hal.archives-ouvertes.fr/hal-02114653))

<sup>1</sup> Ce formulaire est rédigé en style épïcène

- Arturo Aguirre-Velarde, Laure Pecquerie, **Fred Jean**, Gérard Thouzeau, Jonathan Flye-Sainte-Marie. Predicting the energy budget of the scallop *Argopecten purpuratus* in an oxygen-limiting environment. *Journal of Sea Research*, Elsevier, 2019, 143, pp.254-261. [10.1016/j.seares.2018.09.011](https://doi.org/10.1016/j.seares.2018.09.011). [hal-02114544](https://hal.archives-ouvertes.fr/hal-02114544)

- Romain Lavaud, Eric Rannou, Jonathan Flye-Sainte-Marie, **Fred Jean**. Reconstructing physiological history from growth, a method to invert DEB models. *Journal of Sea Research*, Elsevier, 2019, 143, pp.183-192. [10.1016/j.seares.2018.07.007](https://doi.org/10.1016/j.seares.2018.07.007). [hal-02114581](https://hal.archives-ouvertes.fr/hal-02114581)

- Romain Lavaud, Aurelie Jolivet, Eric Rannou, **Fred Jean**, Oivind Strand, et al.. What can the shell tell about the scallop? Using growth trajectories along latitudinal and bathymetric gradients to reconstruct physiological history with DEB theory. *Journal of Sea Research*, Elsevier, 2019, 143, pp.193-206. [10.1016/j.seares.2018.04.001](https://doi.org/10.1016/j.seares.2018.04.001). [hal-02871386](https://hal.archives-ouvertes.fr/hal-02871386)

- Clément Le Goff, Romain Lavaud, Philippe Cugier, **Fred Jean**, Jonathan Flye-Sainte-Marie, et al.. A coupled biophysical model for the distribution of the great scallop *Pecten maximus* in the English Channel. *Journal of Marine Systems*, Elsevier, 2017, 167, pp.55-67. [10.1016/j.jmarsys.2016.10.013](https://doi.org/10.1016/j.jmarsys.2016.10.013). [hal-01394278](https://hal.archives-ouvertes.fr/hal-01394278)

#### - **Expériences d'encadrement et co-encadrement de doctorants (passées et en cours)**

(nom des doctorants dirigés et en cours et antérieurement, sur les 6 années passées : sujet, financement, date de soutenance, et situation professionnelle actuelle si connue)

- Babacar Sane. Financement : IRD. Soutenance prévue : novembre 2023
- Laure Régnier : ARED/France Filière Pêche. Soutenance prévue : octobre 2022
- Romina Barbosa. Financement : ARED/EDSML. Soutenance prévue : octobre 2021
- Rosa Cueto Vega. Financement péruvien. Soutenance prévue : octobre 2021
- Emilien Pousse. Financement ANR. Date de soutenance : 21/12/2017
- Nikolaos Alexandridis. Financement. Date de soutenance : 28/03/2017
- Arturo Aguirre-Velarde. Financement: Date de soutenance: 15/12/2016

#### **Co-directeur de thèse : Laure Pecquerie (dépôt HDR prévu en 2022)**

**Laboratoire de recherche** : UMR 6539 LEMAR

- **e-mail** : laure.pecquerie@ird.fr

- **Téléphone** : 02 90 91 55 52

- **Site web (liste publications et projets)**: [https://www-ium.univ-brest.fr/lemar/equipe/pecquerie\\_laure/](https://www-ium.univ-brest.fr/lemar/equipe/pecquerie_laure/)

#### - **Expériences d'encadrement et co-encadrement de doctorants (passées et en cours)**

(nom des doctorants dirigés et en cours et antérieurement, sur les 6 années passées : sujet, financement, date de soutenance, et situation professionnelle actuelle si connue)

- Clara Menu. *Modélisation de la dynamique de population et de l'évolution des traits biologiques de l'anchois et de la sardine du Golfe de Gascogne au travers d'une approche couplée DEB-IBM*. Financement : France Filière pêche / ARED-ISblue. Ecole Doctorale : EDSML. Encadrement 25%. Soutenance prévue : octobre 2023.
- Jorge Flores. *Modélisation dynamique des effets de la variabilité environnementale sur l'abondance des populations d'anchois (*Engraulis ringens*) et de sardines (*Sardinops sagax*) dans l'écosystème d'upwelling du Humboldt*. Financement : Bourse PDI (Programme Doctoral International), Sorbonne Université. Encadrement 40%. Soutenance prévue : avril 2022.
- Florence Mounier. *Modélisation mécaniste de la bioaccumulation de contaminants organiques (PCB et PFAS) chez les poissons dans le contexte du changement global. Application aux juvéniles de sole commune de l'estuaire de la Gironde*. Financement : Ifremer/IRSTEA. Université de Bordeaux. Encadrement 30%. Date de soutenance : 28/03/2019. Situation professionnelle : Post-Doctorat IRSTEA

#### **Nom et prénom du co-encadrant scientifique : Gonçalo Marques, <https://orcid.org/0000-0002-1693-9042>**

**Laboratoire de recherche co-encadrant** Environment and Energy at IST, engineering school of the University of Lisbon, Portugal and MARETEC (Marine Environment and technology center)

- **e-mail** : [goncalo.marques@tecnico.ulisboa.pt](mailto:goncalo.marques@tecnico.ulisboa.pt)

Le cas échéant, autres collaborations (co-encadrant et laboratoire concerné) :

- Marie Vagner, LEMAR, pour le lien avec la partie expérimentale du projet ISblue OMEGA sur la sardine (thèse qui démarre en 2021)

## Financement du projet de thèse

En cas de financement à 50 %, le cofinancement est-il déjà identifié (oui/non) : non

Si oui, préciser la nature du cofinancement (ANR, partenaire privé, Ademe, etc.) :

Si le cofinancement n'est pas encore confirmé, date prévue de réponse du cofinancier :

En cas de non-obtention du cofinancement demandé, une autre source de cofinancement est-elle identifiée (oui/non) :

Si oui, laquelle :

Sollicitez-vous un co-financement Is-Blue ( y compris ARED Is-Blue) (oui/non) ? oui

**Important :** Veillez à bien compléter les différents co financements sollicités sur le serveur Thèses en Bretagne Loire lors du dépôt de votre dossier.

## Projet de thèse en cotutelle internationale

S'agit-il d'un projet de thèse en cotutelle internationale dans le cadre d'une convention (oui/non) : non

Si oui, préciser l'établissement pressenti (et le pays de rattachement) :

Ce projet de thèse fera-t-il l'objet d'un cofinancement international (oui/non) : non

*(Rémunération du doctorant par l'établissement implanté sur le territoire régional (18 mois sur 36 mois), et l'établissement étranger, qui s'engage également à rémunérer le doctorant dans le cadre de son séjour à l'étranger, soit durant 18 mois -a minima-)*

En cas de cofinancement international, préciser -si vous en avez connaissance- l'organisation du calendrier des périodes de séjour :

Préciser quel est le stade du projet international (joindre une lettre d'engagement du partenaire)

**merci de respecter ce format maxi compatible avec extranet région**

**Résumé du projet (4000 caractères maxi espaces compris) :**

Small pelagic fish communities that make up the so-called Eastern-boundary upwelling ecosystems, which are the most productive ecosystems in the world, are only rarely compared. However, if we look at the Humboldt (Peru), Baja California (Mexico) and Benguela (South Africa) ecosystems, the most abundant species are of the same genus: e.g. *Sardinops* spp, *Engraulis* spp, *Etrumeus* spp. etc. These species are all characterized in these systems by strong variations in abundance that are difficult to predict. Characterizing the similarities and differences between these populations in terms of life history traits, diet, and reproductive strategy is an approach that has never been done before at this scale and should reveal some of the factors controlling these variations.

The thesis proposes here to characterize the ecological diversity of these species within the conceptual framework of DEB (Dynamic Energy Budget) theory and to compare ecological diversity and observed dynamics of these populations by means of DEB-IBM (Individual-Based Models) population models forced by simplified representations of the environment from existing physical-biogeochemical models of these systems. The hypothesis tested in this thesis work will be the importance of bottom-up control over these populations via a mechanistic individual and population modeling approach. This work will also provide a basis for the development of community scale models.

The data used will be the growth, reproduction and energy content monitoring data from the fisheries institutes partners of the EUR ISblue funded OMEGA project on "Effects of declining trophic availability in OMEGA 3 on global small pelagic and human populations". The differences in Omega 3 content between populations that will be established during the project will also be taken into account in the DEB modelling approach. The experiment on the effects of omega 3 deficiency on sardine (*Sardina pilchardus*) conducted in the framework of this project will also provide calibration data for the DEB models.

The objectives of the thesis will be: i) to characterize the ecological diversity of these species in terms of growth, development, energy content and reproductive strategy, ii) to develop a new method for multi-species estimation of the parameters of a DEB model applied to small pelagics, based on the phylogenetic distance between species and iii) to test the sensitivity of DEB-IBM population models to the different sets of estimated parameters. The responses obtained from the different population models will allow the formulation of hypotheses on the specific control factors of each small pelagic community.

**Présentation détaillée du projet :**

**1 - Hypothèse et questions posées, état de l'art, identification des points de blocages** scientifiques (4000 caractères maxi espaces compris)

Small pelagic fish populations represent more than 20% of the world catches. These populations are particularly abundant in the eastern coastal upwellings systems (Canary Islands, Benguela, California, Humboldt). They are an essential link between low trophic levels (phyto and zooplankton) and higher trophic levels (predatory fish, birds and marine mammals). The main hypothesis underlying the strong variations in the commercial catches of these small pelagic species is a so-called bottom-up control (forced by climate) of the environmental conditions encountered by these populations, with top-down control by predators and fishing of these species playing a secondary role. Given the ecological and economic importance of these populations, elucidating the possible responses in terms of abundance and distribution of these populations to climate change is of primary importance.

The population dynamics of small pelagic fish are the subject of numerous studies but these dynamics remain difficult to predict. The thesis therefore proposes to change scale and to compare within the same conceptual and quantitative framework the four most productive systems in the world (the Canary, Benguela, California and Humboldt currents) on a limited number of individual and population traits.

The approach considered is the Dynamic Energy Budget (DEB) type modeling approach, which makes it possible to represent the complete life cycle of an individual as a function of the temperature and food encountered by that individual and to predict the life history traits (growth, development, reproduction) of an individual, these life traits being themselves determining factors in the dynamics of a population. Currently, many works are based on this theory for the modelling of the life cycle of small pelagics. However, even if the theory is the same, a model is associated with a particular issue and this can result in different models and sets of parameters for the same species. Moreover, the estimation of the parameters of DEB models is particularly sensitive to the evaluation of the reproductive investment of an individual. However, this information is particularly difficult to access for small pelagic fish that have so-called indeterminate fecundities with de novo vitellogenesis (number of oocytes recruited for spawning depends on the conditions encountered by the individual throughout the breeding season). Comparing the same species in different habitats or close species in the same system is an approach that appears promising to limit the uncertainty around the set of estimated parameters and that will be developed in this thesis project.

Following the example of the Darwin-type modeling approach on phytoplankton communities, the objective of the thesis is to elucidate the functional traits of these populations and the characteristics of their habitats that underlie the dynamics observed within the community of small pelagic fishes (dominance of one species in a given system - e.g. anchovy in Peru, co-existence of several species with alternation of some species, e.g. in Mexico).

## **2 - Approche méthodologique et techniques envisagées :** (4000 caractères maxi espaces compris)

The objectives of the thesis in terms of modeling are the following: i) To develop a generic small pelagic life cycle model of the DEB type (larval growth and development module, feeding module, reproduction module) as simple as possible, ii) to develop an estimation method to reduce the uncertainty around the value of small pelagic model parameters, and iii) to evaluate the sensitivity of a population model to the structure of the individual model and to the different sets of estimated parameters. Achieving these three objectives will require several iterations. If the population model cannot generate different dynamics under different environmental scenarios, the individual model will be complexified to include new processes.

This thesis project will be divided into three distinct tasks:

i) A first task will consist in continuing<sup>2</sup> the synthesis of existing data (literature, FAO database, Fishbase) on the variations in abundance of small pelagic populations in the eastern upwelling systems and on their ecological diversity (life history traits, diet, reproductive strategy) in order to feed the AmP database ([https://www.bio.vu.nl/thb/deb/deblab/add\\_my\\_pet/](https://www.bio.vu.nl/thb/deb/deblab/add_my_pet/)) for the estimation of the DEB parameters of each of the populations considered.

ii) A second task will be to develop a new method for multi-species estimation of the parameters of small pelagic fish life cycle models of the DEB (Dynamic Energy Budget) type. This multi-species method will be based on the phylogenetic distance between these species in order to better constrain the number of possible sets of parameters that reproduce the diversity of life history traits established in Task 1 of the project.

iii) A third task will be to develop a simple community model of several small pelagic populations of the DEB-IBM (Individual-Based Model) type that will allow to elucidate the sensitivity of the response of the populations to the structure and parameters of the DEB life cycle model, as well as to the environmental forcing considered.

## **3 - Positionnement et environnement scientifique dans le contexte régional, national et international :**

The thesis will take place within the DISCOVERY team of LEMAR for which the question of the impact of climate change on the dynamics of populations and communities is a central issue. As the main objective of the thesis is to contribute to a better understanding of the dynamics of populations that support fisheries that are socio-economically essential for the countries of the South, it will actively participate in the work of the LEMAR South and South IUEM cross-cutting axes.

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<sup>2</sup> Master thesis (2020-2021)

Within ISblue, the thesis project will be based on collaborations with the Ifremer STH laboratory, whose expertise on anchovy and sardine populations in the Bay of Biscay is recognized. Close exchanges within the framework of C. Menu's thesis (Modelling of the population dynamics and the evolution of biological traits of anchovy and sardine in the Bay of Biscay through a coupled approach DEB-IBM, co-supervision STH/LEMAR, DEFIPEL project) are planned. The project will also rely on the expertise of LOPS researchers for the representation of the physical and biogeochemical environment of upwellings systems in the eastern part of the Bay of Biscay for these populations.

At the international level, data synthesis and analysis will be carried out within the framework of the Joint Working group ICES/PICES (Atlantic and Pacific International Councils for the Exploration of the Sea) on small pelagic fish, which brings together 24 countries and 106 researchers with expertise in small pelagic populations and their exploitation. Specific data from campaigns and experiments will also be available for the project thanks to collaborations established within the ISblue OMEGA project (South Africa, Senegal, Peru, Mexico). Finally, the methodological developments planned during the thesis, notably under the supervision of G. Marques who will co-supervise the thesis, will be communicated within the DEB community (International Symposium that takes place every two years, DEB2019 having been organized by LEMAR).

**4 - Contexte scientifique et partenarial : éléments généraux (ERC, CPER, FEDER, Breizhcop ...)** (4000 caractères maxi espaces compris)

The thesis is part of the OMEGA project "Effects of declining trophic availability of OMEGA 3 on global small pelagic and human populations : Elaboration of an interdisciplinary framework combining physical, biological, economic and sociological approaches" which is one of the emblematic projects of EUR ISblue (400 k€, 2021-2024) based on four ISblue laboratories (LEMAR, Ifremer STH, LOPS and AMURE), four partners at national level (LP3C, Audencia Business School, LOCEAN and UMMISCO) and a French socio-economic partner, the Chancerelle cannery, as well as eight foreign partners, involving for each site (Senegal, South Africa, Peru, Mexico) a university or training institute (UCAD, UCT, UPCH, CIBNOR) and a fisheries or marine biology research institute (CRODT, DAFF, IMARPE, CICIMAR).

This thesis project is fully in line with the WP(work-package) 3 of the project which aims to better understand the responses of small pelagic populations to a degradation of the quality of their food sources in the eastern coastal systems. These populations are indeed the main sources of long-chain omega 3 in terms of direct consumption in Southern countries and industrial use (flour and oil). Interactions are planned with WP1 (Observation) and WP2 (Experimentation) in order to obtain the necessary data for the modelling work. A thesis is in fact financed within the framework of the OMEGA project to elucidate the effects at the individual level of an omega 3 deficiency in the Bay of Biscay sardine (*Sardina pilchardus*). The coupling between modeling (this present subject) and experimentation (OMEGA/ISblue thesis already funded) will be one of the originalities of the project since the modeling work will allow to define part of the experimental protocol before the experimentation in order to guarantee a better exploitation of the results.

**Vous sollicitez un financement ISblue, ou une ARED ISblue :**

Précisez le lien du sujet avec les thèmes ISblue

Thème ISblue	Thème principal	Thème secondaire (si nécessaire)	Autre (si nécessaire)
la régulation du climat par l'océan			
les interactions entre la Terre et l'océan			
la durabilité des systèmes côtiers			
l'océan vivant et les services écosystémiques	x		
les systèmes d'observation à long terme			

**Expliquez/précisez en quelques lignes dans quelle mesure votre demande correspond à l'un ou plusieurs des critères ISblue ci-dessous :**

**1- Originalité, impact potentiel du projet** (4 lignes maxi)

The originality of the topic will consist in i) taking into account the phylogenetic distance between species for simultaneous multi-species estimation of the parameters of DEB models in order to improve robustness for data-poor species and ii) developing DEB models for several species of the same small pelagic community in order to analyze the variability of population-scale responses to different environmental scenarios.

**2- Positionnement international du sujet, cotutelle ou co-encadrement international** (4 lignes maxi)

This thesis topic is part of the OMEGA project which has a strong international dimension (4 main upwellings on the east coast: Senegal, South Africa, Mexico and Peru). The PhD student will participate in the work of the ICES/PICES Joint working group on small pelagic fish (106 researchers, 24 countries) and will be co-supervised by a researcher from IST, a renowned institute for engineering training, from the University of Lisbon in Portugal.

**3- Effet intégrateur entre unités de recherche et / ou interdisciplinarités** (4 lignes maxi)

Developing a comparative approach to small pelagic upwellings systems in the eastern seaboard requires strong interdisciplinarity (fisheries, physiology, oceanography) and will strengthen links with LOPS researchers working on the physical-biogeochemical modeling of these systems. The PhD student will also benefit from the development of an interdisciplinary approach on small pelagics in the Bay of Biscay by the OMEGA project.

**4- Potentiel d'insertion à un haut niveau dans la communauté académique ou non académique du docteur** (4 lignes maxi)

The participation in the work of an emblematic interdisciplinary project and a large international working group for the management of small pelagic fisheries, and the mastery of modeling tools and the publication of methodological developments in the framework of the DEB theory, which applies to a large number of disciplines and species, will guarantee the insertion potential of the future PhD.

**Le candidat**

**Profil souhaité du candidat (spécialité/discipline principale, compétences scientifiques et techniques requises) :**

- Master's degree in quantitative ecology or fisheries sciences
- - Scientific knowledge: Population dynamics, marine ecology,
- - Skills and techniques required: mathematical modeling (differential equations), statistics (parameter estimation), programming (R, Matlab or Python), scientific writing in English