



**ARQDAÇO – Recommendations of the Working  
Group on research surveys in the Ocean  
Governance in Archipelagic Regions International  
Conference**

Régis Santos, Michael Sigler, Ana Novoa-Pabon, Wendell Silva, Eduardo Isidro, Octávio Melo, Marc Larose, Maria Rosa, Joana Miodonski, Luís Rodrigues & Mário Pinho

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*Okeanos*- UAc: Instituto de Investigação em Ciências do Mar  
UNIVERSIDADE DOS AÇORES (UAc)  
Rua Prof. Dr. Frederico Machado, 4,  
9900-138 HORTA, Faial,  
PORTUGAL

Tel.: + 351 292 200 400  
[www.okeanos.uac.pt](http://www.okeanos.uac.pt)

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## **ARQDAÇO – Recommendations of the Working Group on research surveys in the Ocean Governance in Archipelagic Regions International Conference**

Régis Santos<sup>1,2,\*</sup>, Michael Sigler<sup>3</sup>, Ana Novoa-Pabon<sup>2</sup>, Wendell Silva<sup>1,2</sup>, Eduardo Isidro<sup>1,2</sup>, Octávio Melo<sup>1,2</sup>,  
Marc Larose<sup>2</sup>, Maria Rosa<sup>1,2</sup>, Joana Miodonski<sup>3</sup>, Luís Rodrigues<sup>3</sup>, Mário Pinho<sup>1,2</sup>

<sup>1</sup> IMAR Institute of Marine Research, University of the Azores, Rua Prof. Dr. Frederico Machado, 9901-862, Horta, Portugal.

<sup>2</sup> Okeanos R&D Centre, University of the Azores, Rua Prof. Dr. Frederico Machado, 9901-862, Horta, Portugal.

<sup>3</sup> Alaska Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, 17109 Point Lena Loop Rd., Juneau, AK 99801, USA. (retired).

<sup>4</sup> Regional Directorate for Fisheries, Azorean Regional Government, Rua Cônsul Dabney - Colónia Alemã, 9900-014, Horta, Portugal.

\* Corresponding author: Régis V. S. Santos, e-mail: [regis.vs.santos@uac.pt](mailto:regis.vs.santos@uac.pt), Tel: (+351) 935098870.

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## **RESUMO**

O cruzeiro de palangre de fundo para as espécies demersais de águas profundas do arquipélago dos Açores (ARQDAÇO) começou nos anos 90. Sua aplicação prática é a avaliação de stocks e recomendações para a gestão dos recursos demersais explorados comercialmente. Para isso, é fundamental que sejam identificados possíveis vieses das estimativas de abundância no desenho atual da amostragem e que sejam sugeridas soluções. Para isso, foi proposto um grupo de trabalho durante a Conferência Internacional sobre Governança dos Oceanos nas Regiões Arquipelágicas, 2019 na ilha do Faial, nos Açores. Duas questões principais foram levantadas: (1) Para quais espécies o levantamento atual do ARQDAÇO é confiável para a gestão?; (2) Quais são as prioridades para responder à pergunta anterior?. O grupo de trabalho contou com a participação de 10 investigadores nacionais e internacionais, presidido pelo Dr. Mário Pinho (Universidade dos Açores, Portugal) e teve como convidados o Dr. Michael Sigler (NOAA, EUA) e o Dr. Régis Santos (Centro I&D Okeanos-UAç, Portugal). Algumas diretrizes e recomendações importantes para trabalhos futuros foram desenvolvidas e são apresentadas neste relatório.



## **ABSTRACT**

The bottom longline survey for demersal deep-water species of the Azores archipelago (ARQDAÇO) began in the 1990s. Its practical application is stock assessment and advice for management of commercially exploited demersal species. For this, it is critical that possible biases of the estimates for the current survey design be identified and solutions proposed. To do this, a working group was proposed during the *Ocean Governance in Archipelagic Regions International Conference, 2019* in Faial island, Azores. Two main questions were raised: (1) For what species is the current ARQDAÇO survey reliable for management?; (2) What are the priorities to answer the previous question?. The working group was attended by 10 national and international researchers, was chaired by Dr. Mario Pinho (University of the Azores, Portugal) and had as invited guests Dr. Michael Sigler (NOAA, USA) and Dr. Régis Santos (Okeanos-UAc , Research Centre, Portugal). Some guidelines and key recommendations for future work were developed and are presented in this report.





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## **INTRODUCTION**

The bottom longline survey for demersal deep-water species of the Azores archipelago (ARQDAÇO) began in the 1990s and is probably the only one of its kind running in the Northeast Atlantic Ocean. The main objectives of the ARQDAÇO surveys are: (a) provide fishery independent estimates of abundance and size composition for commercially important demersal species; (b) collect information for biological studies on growth, reproduction, diet and migration; and (c) obtain information for ecological studies, such as depth distribution and community structure. Their practical application is stock assessment and advice for management of commercially exploited demersal species. For this, it is critical that possible biases of the estimates for the current survey design be identified and solutions proposed.

To discuss these aspects, the Working Group *The research surveys ARQDAÇO* occurred during the *Ocean Governance in Archipelagic Regions International Conference (OGAR Conference)*, between 7 and 10 October 2019, held at Horta (Faial island), Azores. Due to the relevance of the theme to the scientific community and policy makers, the members who participated in this working group decided to disclose the main recommendations that were made at this meeting in this report.

## **METHODOLOGY**

The working group was attended by 10 national and international researchers, was chaired by Dr. Mario Pinho (University of the Azores, Portugal) and had as invited guests Dr. Michael Sigler (NOAA, USA, retired) and Dr. Régis Santos (University of the Azores, Portugal).

Two main questions were raised: (1) “For what species is the current ARQDAÇO survey reliable for management?”, and (2) “What are the priorities to answer the previous question?”. Some guidelines and key recommendations for future work were developed and are presented in the following sections.

## RESULTS AND DISCUSSION

### 1. FOR WHAT SPECIES IS THE CURRENT ARQDAÇO SURVEY RELIABLE FOR MANAGEMENT?

The survey is reliable for management advice for 10 species, especially if the depth coverage the survey consistently extends to 800 m. These species are *Phycis phycis*, *Pagellus bogaraveo*, *Pagrus pagrus*, *Helicolenus dactylopterus*, *Conger conger*, *Mora moro*, *Beryx decadactylus*, *Raja clavata*, *Beryx splendens* and *Pontinus kuhlii*.

This recommendation is based on:

- i. The abundance trends generally are consistent over multiple years (e.g., *Phycis phycis* increased from the mid-1990s to the mid-2000s and then decreased; see Pinho et al., 2019). Some statistical smoother should be applied to the abundance estimates for providing management advice, in particular for the 9 species without an age-structured assessment (i.e., all of these species except *Pagellus bogaraveo*). A candidate smoother is the random effects model applied for Northeast Pacific Ocean stock assessments. See the “Modeling Approach” section of the Gulf of Alaska shortraker rockfish assessment <https://www.afsc.noaa.gov/REFM/Docs/2017/GOAshortraker.pdf> for an example.
- ii. The survey area covers the depth range inhabited by most (7 of 10) of these species (Pinho et al., 2019) and, therefore, likely represents the abundance trends of these populations in the survey area. For 3 species including alfonsino (*B. decadactylus*), European conger (*C. conger*) and common mora (*M. moro*), their distributions extend deeper than the surveyed area (Santos et al., 2019) and the relative abundance index may not reflect the abundance of the population occurring around the Azores. Concern over this mismatch is somewhat alleviated because the Azorean fleet mainly operates within the surveyed depths (up to 800 m; Santos et al., 2019) (i.e., the fished portion of the population is fully surveyed).
- iii. The current survey covers the islands and nearby banks, but not the Mid-Atlantic Ridge (MAR). The MAR has become an important fishing area (Diogo et al., 2015), yet is not surveyed. This lack is an important concern which is addressed in section 2.

Another issue that should be addressed is the need to understand the relationship between longline catch rate and fish density (i.e., the longline catching process) (Sigler, 2000). This issue is motivated by questions raised during the International Council for

the Exploration of the Sea (ICES) stock assessment reviews. Three factors may affect the longline catching process: gear saturation, soak time and competition for hooks, and should be understood to reliably apply longline catch rates for management advice. Experiments to understand this process are briefly described in section 2.

## 2. WHAT ARE THE PRIORITIES TO ANSWER THE PREVIOUS QUESTIONS?

Extend survey to the MAR: An extension of the current survey area is recommended to sample offshore seamounts, mainly on the MAR. For this, the working group recommended:

- i.* Identify the extension areas by comparing the distributions of commercially important demersal deep-water species with the distribution of fishing effort;
- ii.* Include stakeholders as partners during survey design;
- iii.* Apply the same rules of the random stratified design as the current survey (allocate sampling effort according to species occurrence and strata size and consider economic value in doing so).

A new survey using a new vessel prepared to operate in offshore areas should be implemented to meet the above recommendations. The time of the year for the MAR extension and the methods for combining indices with the current survey should also be developed. It is important to stress that a good survey design for the MAR extension will require access to fishery data (e.g. catch, effort, biological data by species, fishing area and other related fishing operation information) and environmental characterization (e.g., geomorphology, bathymetry) of the Azorean region.

Conduct experiments to understand the longline catching process: A series of experiments were designed to understand the effects of soak time, gear saturation and competition for hooks on the longline catching process. To study soak time, repetitively deploy longline gear at the same location, hauling back the gear after a range of soak times (2h, 4h, 6h). To study gear saturation, deploy longline gear with hooks in “clusters”, yet overall with the same number of hooks per unit of gear. To study competition for hooks, deploy a camera in a frame with a short section of longline in the camera view. All of these experiments were designed as part of a doctoral thesis project by Wendell Medeiros Leal under the supervision of Dr. Mario Pinho and Dr. Michael Sigler. These experiments require funding to be completed.

## **CONCLUSIONS**

The Working Group recommends that:

- A new research survey should be developed, financed and implemented to sample offshore seamounts (Mid-Atlantic Ridge) where the fishery has expanded.
- The new survey areas should be identified by comparing the distributions of commercially important demersal deep-water species and distribution of fishing effort.
- Detailed information on fishery (e.g. catch, effort, biological data by species, fishing area and other related fishing operation data) and environmental characterization (e.g. geomorphology, bathymetry) of the Azorean region is required for the design of the new research survey and should be made available to researchers working on fish stock assessment.
- Stakeholders should be partners during survey design.
- A new vessel prepared to operate in offshore areas should be acquired.
- Experiments designed to observe the catching process and understand the effects of soak time, gear saturation and competition for hooks should be performed.
- Project funding calls should consider these fish stock assessment issues (e.g. longline catch process studies) and include them as priority areas.
- Resources for training human resources (fellowships and grants) in fish stock assessment should be financed.

## REFERENCES

- Diogo, H., Pereira, J.G., Higgins, R.M., Canha, Â., Reis, D. (2015). History, effort distribution and landings in an artisanal bottom longline fishery: An empirical study from the North Atlantic Ocean. *Marine Policy*, 51, 75-85.
- Pinho, M.R.; Medeiros-Leal, W.M.; Sigler, M.F.; Santos, R.V.S.; Novoa-Pabon, A. M.; Menezes, G.M.; Silva, H.M. (2019). Azorean Demersal Longline Survey Abundance Estimates: Procedures and Variability. *Regional Studies in Marine Science*, under review.
- Santos, R.V.S.; Silva, W.M.M.L.; Novoa-Pabon, A.M.; Silva, H.M.; Pinho, M.R. (2019). Long term changes in the diversity, abundance and size composition of deep sea demersal teleosts from Azores assessed through surveys and commercial landings. *Aquatic Living Resources*, 32 (25), 20 pp. <https://doi.org/10.1051/alr/2019022>.
- Sigler, M.F. (2000). Abundance estimation and capture of sablefish, *Anoplopoma fimbria*, by longline gear. *Canadian Journal Fisheries & Aquatic Sciences*, 57, 1270-1283.

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## ANNEXES

### Annex 1: List of participants

Name	Institution	Country	Contact
Mário Rui Pinho	University of the Azores	Portugal	mario.rr.pinho@uac.pt
Michael F. (Mike) Sigler	National Oceanic and Atmospheric Administration (NOAA), retired	USA	mike.sigler@noaa.gov
Régis Santos	University of the Azores	Portugal	regis.vs.santos@uac.pt
Ana M. Pabon	University of the Azores	Portugal	19anita89@gmail.com
Maria Domitilia Rosa	University of the Azores	Portugal	maria.dc.rosa@uac.pt
Eduardo J. Isidro	University of the Azores	Portugal	eduardo.jl.isidro@uac.pt
Joana V. Miodonski	Regional Directorate for Sea Affairs	Portugal	joana.v.miodonski@azores.gov.pt
Luís Rodrigues	Regional Directorate for Fisheries	Portugal	luis.m.rodrigues@azores.gov.pt
Marc Larose	University of the Azores	Portugal	marc.larose@uac.pt
Octávio Melo	University of the Azores	Portugal	octavio.eb.melo@uac.pt



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Tanto quanto possível cada relatório deverá ter a seguinte organização:

1 - Capas rígidas: de cor azul para os Relatórios Internos e verde para Cruzeiros. Na capa frontal deverá ser indicada a série, a numeração e o título, podendo ainda conter uma figura ilustrativa do estudo. O verso da capa frontal deve ter informação geral, podendo conter informação adicional, relativa por exemplo à origem da ilustração da capa, arranjo gráfico ou impressão.

2 - Primeira página, sem numeração, com título, nome do(s) autor(es) e afiliação complementar quando aplicável.

3 - Resumos, em Português e Inglês (máx. 300 palavras cada)

4 - Agradecimentos (fontes de financiamento, etc.)

5 – Índices, para documentos com mais de 10 páginas;

6 – Estrutura principal:

- Introdução (com objetivos)
- Metodologias
- Resultados
- Discussão e Conclusões
- Referências
- Anexos

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Folha A4 com as seguintes margens: direita e esquerda com 2,5 cm, topo e inferior com 3,0 cm. Os documentos com mais de 12 páginas devem ser, de preferência, impressos em frente e verso.

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Páginas - A numeração da página deverá ser em arábico para a parte textual, centrada no fundo da página e iniciarse na primeira página com texto (introdução). As partes antes da introdução (pré-textuais) e depois das referências (parte pós-textual; ex. Anexos) deverão ser numeradas em romano.

Figuras e Tabelas - Numeradas também em arábico e de preferência inseridas no texto.

3 - Estilo e Fontes

De preferência deverá ser usada a fonte Georgia 12, com texto a uma coluna. O espaçamento deverá ser de 1,5. A fonte e o espaçamento poderão ser reduzidos para textos mais longos (estilo “text”).

Títulos - Deverão ser em maiúsculas, fonte Tahoma, e sem numeração. Os subtítulos deverão ter uma fonte mais pequena que os principais. De preferência devem usar-se os estilos de fontes já preparados no template (“headings”).

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Citações e referências – Utilizar o estilo APA disponível no software de gestão bibliográfica.

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Estes documentos podem ser redigidos em Português ou Inglês, cabendo esta opção aos autores.

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