

# OASIS

Oceanic Seamounts: An Integrated Study  
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## OASIS: Summary Report of Scientific Achievements and Results

Bernd Christiansen

Universität Hamburg



Contact: Dr. Bernd Christiansen [bchristiansen@uni-hamburg.de](mailto:bchristiansen@uni-hamburg.de)  
Universität Hamburg,  
Institut für Hydrobiologie und Fischereiwissenschaft  
Zeiseweg 9, D-22765 Hamburg, Germany  
Tel. +49 40 42838-6670, Fax +49 40 42838-6696

[www.rrz.uni-hamburg.de/OASIS](http://www.rrz.uni-hamburg.de/OASIS)

OASIS report

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Scientific Achievements and Results

Bernd Christiansen  
Authors' address:  
Universität Hamburg  
Institut für Hydrobiologie und Fischereiwissenschaft  
Zeiseweg 9  
22765 Hamburg, Germany

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## OASIS: Summary Report of scientific achievements and results

### Introduction

Seamounts are of great interest to science, industry and conservation because of their potential role as 'stirring rods' of the oceans, their enhanced productivity, their high local biodiversity, and the growing exploitation of their natural resources. This is accompanied by rising concern about the threats to seamount ecosystems, e.g. through over-fishing and the impact of trawling.

The OASIS project aims to describe the functioning characteristics of seamount ecosystems. OASIS' holistic approach to investigate seamount ecosystems integrates hydrographic, biogeochemical and biological information. Based on two case studies, OASIS yields an advanced understanding of seamount ecosystems, and their influence on the surrounding ocean. The scientific results, condensed in conceptual and mass balanced ecosystem models, are applied to outline a model management plan as well as site-specific management plans for the seamounts investigated.

OASIS addresses five main objectives.

Objective 1: To identify and describe the physical forcing mechanisms effecting seamount systems

Objective 2: To assess the origin, quality and dynamics of particulate organic material within the water column and surface sediment at seamounts.

Objective 3: To describe aspects of the biodiversity and the ecology of seamount biota, to assess their dynamics and the maintenance of their production.

Objective 4: Modelling the trophic ecology of seamount ecosystems.

Objective 5: Application of scientific knowledge to practical conservation.

### Scientific achievements and results

During the course of the OASIS project from 1.12.2002-30.11.2005, a total of 7 research cruises were performed using German, Portuguese and British research vessels. The cruises on R.V. *Arquipelago*, R.V. *Poseidon*, R.V. *Meteor* and R.R.S. *Discovery* aimed at physical, biogeochemical and biological sampling at different localities of the two main OASIS study sites, Sedlo Seamount and Seine Seamount. The samples and measurements included:

- bathymetric measurements
- measurements of currents, temperature, conductivity, oxygen in the water column
- samples of POC, PON, DOC, Chl. a,  $^{234}\text{Th}$  in the water column and in the sediment
- measurements of primary production and water column respiration (ETS)
- samples of phytoplankton.

- stratified zooplankton and mikronekton samples using multiple opening and closing nets
- benthopelagic fish samples using trawls and longlines
- satellite images with sea surface temperature and ocean colour data
- photographic and video transects of the seafloor
- benthic sampling with trawls, corers, grabs and dredges

The further processing of the samples and the analyses of the data were conducted in the laboratories of the participating institutions. The analyses included:

- production of bathymetric maps
- description of the water masses and the flow fields around the seamounts
- modelling of oceanographic process at the seamounts
- Calculation of production, respiration and export fluxes
- quantification and characterization of DOC, POC, sPOC
- description and quantification of the main compartments of the ecosystem: phytoplankton, zooplankton, mikronekton, fish and benthos
- characterization of habitat types
- Analyses of trophic relationships: stomach contents, lipids, stable isotops.
- conceptual and mass balanced modelling of the ecosystem
- production of generic and site-specific management plans based on scientific results.
- promotion of seamounts

The analyses revealed that Sedlo Seamount and Seine Seamount both offer highly complex hydrographical patterns. The seamounts lie within similar biogeographic provinces in the sub tropical Atlantic with similar dynamical forcing characteristics, but importantly experience a similar degree of variability in the dynamical regime due to the impact of mesoscale eddies, usually derived from a MW source. Both seamounts may receive upstream input of biologically important material or nutrients. Both seamounts have typical anti-cyclonic circulations around their summit depth regions, driven principally by the Taylor Column formation process as tidal rectification is weak at both seamounts. The detailed observations at Sedlo, however, have demonstrated that this circulation may be significantly disrupted by variable background flow forcing, especially by the interaction of MW eddies impacting the seamount region. This has significant implications for the passive material transport and retention in the vicinity of the

seamount. Process modelling to assess the influence of this dynamic variability on the bio-physical coupling and biological implications is ongoing.

ETS measurements in the water column show a large seasonal and inter-seamounts variability in the epipelagic respiration (R), with higher values in the subtropical seamount (Seine), but comparable values in the mesopelagic zone (200-1000 m) of the two seamounts. R decreased exponentially with depth. Compared to the far-field station, respiration and sedimentation were not significantly higher around the two seamounts. This suggests that local trapping of organic matter by seamounts was less important than processes at larger temporal or spatial scales. Sedimentation of particles below the epipelagic zone accounted for 15-35% of the carbon respired in the mesopelagic zone. The seasonal and spatial variability in the water-column distribution of dissolved organic carbon (DOC) and particulate organic matter (POM) suggests that suspended POC would constitute a rather stable pool throughout the year, in contrast to the sinking components of the POM pool. The contribution of dissolved organic carbon (DOC) to the apparent oxygen utilization (AOU) in the upper 1000m was significantly higher in Seine (25%) than at Sedlo (10%).

The suspended particulate organic matter (sPOM) had a strong phytoplankton signature, although there were also abundant faecal pellets and some zooplankton. At Sedlo,  $\delta^{15}\text{N}$  values of surface water sPOM is similar to that of Seine in winter, whereas in summer 2004 values were much more enriched suggesting a deeper N source possibly by phytoplankton mining at the nutricline. sPOM quality decreases with depth at both study sites.  $\delta^{15}\text{N}$  values of sPOM at Seine reflect heterotrophic reworking of OM in the water column, summer stratification and perhaps lateral advection of organic material. The results show that there is fresh, presumably nutritious suspended organic material above seamounts at depth, not necessarily only over the summits. In the light of this and the absence of convincing evidence for enhanced primary productivity closer to the surface, it is suggested that the mechanism of this organic matter enrichment may be advection of suspended labile material with depth at both sites where lipid enrichment is observed in the summer (i.e. summit and trough), a result that is also supported by the isotopic data.

Both seamounts offer a mixed habitat of soft and hard substrate. Enhanced stocks of organisms were not found; but seamount effects were observed in many ways. The zooplankton community above the seamount summits had a lower biomass concentration and smaller mean sizes than in the periphery of the seamounts and in the surrounding ocean, contradicting the hypothesis of high productivity. Similarly, the standing stock of planktivorous benthopelagic fish which comprised typical seamount and shelf species,

appeared to be low in the summit region. Density and composition of the benthic epifaunal community varied with depth and was dominated on the slopes by corals and sponges. The summit plateau (of Seine?) appeared to be nearly void of larger animals, but in places aggregations of polychaetes, sea urchins, and gastropods were observed. The macrofaunal analyses resulted in a total of 408 species for Seine Seamount and 54 species for Sedlo, where only two stations were sampled successfully. Both faunal assemblages differed markedly, with a predominance of typical Lusitanian species and even a West African influence on Seine, whereas the Sedlo communities show affinities with the mid-Atlantic ridge fauna. A total of 19 species were new to science.

The trophodynamic models of seamounts in the NE Atlantic imply that the seamounts are non-matured, early development systems. The simulations support the hypothesis that there is generally a lack of resources in the system to support large fish aggregations, meaning that these are supported from external sources. The overall study suggests that a sustainable seamount fisheries with tolerable ecosystem impacts appears to be close to the scenario found by maximizing the 'ecological' objective function.

Two OASIS reports give advice on the conservation and management of seamount ecosystems. The "Offshore MPA Toolbox- Implementing Marine Protected Areas in the North-East Atlantic Offshore: Seamounts – A Case Study" compiles experiences and advice from all over the world on designating and managing MPAs to protect seamounts and similar offshore habitats in general. It includes chapters on the legal frameworks for implementing marine protected areas in the North East Atlantic, namely Natura 2000 and OSPAR. "Toward the Conservation and Management of the Sedlo Seamount" is a site-specific draft management plan for Sedlo seamount, one of the seamounts investigated by the project consortium, and builds on the knowledge acquired in the course of OASIS.

## Overall conclusions

OASIS has completed the first seamount study which integrated results from physical oceanography, biogeochemistry and biology, and which used the scientific results gained to develop tools for the management of seamount ecosystems.

The results from the OASIS project stress the complexity and the variability of seamount ecosystems. By contrast to the common view of highly productive seamounts, indications for an enhanced productivity and high stocks of seamount-associated organisms were weak at the two seamounts studied. However, the OASIS results show clear seamount effects on the hydrography, the biogeochemistry and the biology, as

compared to the surrounding ocean. In particular, the flow regime, the particle fluxes and the distribution and composition of the benthic and pelagic fauna are strongly influenced and modified by the topographic features.

OASIS results and products have been distributed and discussed in political bodies like OSPAR, the EC Marine Experts Group and the NE Atlantic Fisheries Commission (NEAFC), and have contributed to a rising awareness of the threats to seamount ecosystems.

## OASIS main deliverables

### Reviews and reports

- Report on existing data for study sites
- Review of hydrography of seamounts and study sites
- Topographic maps of study sites
- Species seamount lists and voucher specimen/ photograph catalogue macrofauna (BIAS)
- Review of biogeochemistry of kilometre-scale seafloor topography
- State of the art report ("Seamount Report", to be finalized)

### Cruise reports

- Cruise report pilot cruise including CSR forms
- Cruise report OASIS 1 including CSR forms
- Cruise report OASIS 2 including CSR forms

### Management

- "Offshore MPA toolbox"
- Final management plan

### Public outreach

- Publication project colour brochure
- Public website
- Interactive OASIS DVD

### Data sets (not public yet)

- Common database for all project data accessible through WWW
- Photo and video database
- Complete hydrographic (CTD) dataset from all cruises
- Current-meter dataset from all cruises
- Dataset of quality and quantity of particulate material.
- Dataset of transmission/nepheloids through the watercolumn and optical
- Dataset of dissolved organic carbon across target topographic features from all cruises characterisation of BML and BNL for all cruises

- Dataset of dissolved and particulate  $^{234}\text{Th}$  across target topographic features from all cruises
- Dataset of production/respiration, remineralization rates and metabolic activities in the water column.
- Data set on abundance and biomass of pelagic BML fauna
- Taxonomic composition of DSL and BML fauna
- Dataset on biomass, abundance and distribution of DSL fauna from MOCNESS and VPR samples
- Data report on lipid / fatty acid biomarker composition, stable isotope ratios ( $\delta^{15}\text{N}$  and  $\delta^{13}\text{C}$ ),  $^{234}\text{Th}$  gut contents and ETS activity of selected species
- Project results on CD-Rom
- Internal project website

### Modelling (in progress)

- Process models
- Estimation of residence times of particulate material in different compartments of the water column at target topographic features
- Estimation of a budget of labile (nutritious) carbon at target topographic features by coupling of the whole dataset
- Graphical presentation and interpretation of DSL formation and dispersion from echosounder and ADCP data
- Estimates of potential POM utilisation by DSL and BML fauna
- Final versions of CEM and ECOPATH models
- Final synthesis reports on the fish and fisheries, the ecology of mega-benthos and the trophodynamics and energetics of seamount ecosystems
- Genetic analysis and comparisons for key species

## OASIS documents

Detailed results of the OASIS project and supplementary information are given in the following reports and papers. These papers are currently under review for publication in a special volume of Deep-Sea Research Part II.

- Arístegui, J., A. Mendonça, J.C. Vilas, M. Espino, I. Polo, M.F. Montero, A. Martins (*subm.*) Plankton metabolic balance at two north Atlantic seamounts.
- Bashmachnikov, I.L., M. White, C. Mohn, A. Martins, F. Jose, J. Pelegrí and F. Machín (*subm.*) Interaction of Mediterranean water eddies with Sedlo and Seine seamounts, Subtropical Northeast Atlantic.
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- Christiansen, B., B. Martin and S. Hirsch (*subm.*) The benthopelagic fish fauna of Seine Seamount, NE Atlantic: Composition, population structure and diets
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- Kiriakoulakis, K., J.C. Vilas, S.J. Blackbird, J. Arístegui and G. Wolff (*subm.*) Seamounts and organic matter – is there an effect? The case of Sedlo and Seine Seamounts. Part II. Composition of suspended particulate organic matter.
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- Stefanni, S., H. Knutsen and R. Bettencourt (*subm.*) Phylogeography and demographic history of the deep-sea fish, *Aphanopus carbo* (Lowe, 1839) in the NE Atlantic: vicariance followed by secondary contact or speciation?
- Vilas, J.C., J. Arístegui, K. Kiriakoulakis, G. Wolff, M. Espino, I. Polo, M.F. Montero and A. Mendonça (*subm.*) Seamounts and organic matter – is there an effect? The case of Sedlo and Seine Seamounts Part 1. Distributions of dissolved and particulate organic matter.
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