SOLSTICE

Implementation Plan

Version 4

26 March 2018

Ecosystem shifts & fishery collapse:

South African Chokka squid fishery

(South African Case Study)

Contents

Document Purpose

The purpose of the SOLSTICE Implementation Plan is to identify key contributions of SOLSTICE partners to research, capacity development and communication objectives of the project and their associated timescales, milestones and deliverables.

This document underpins Institutional Agreements between the Lead Organisation (National Oceanography Centre, UK) and the partner institutions. This document also underpins SOLSTICE Monitoring and Evaluation Plan.

The document is available to project partners and the project Advisory Panel.

SOLSTICE Implementation Plan is an evolving document and subject to regular reviews by the SOLSTICE Leadership Team. Any changes to this document must be approved by the Leadership Team and communicated to all project participants. The latest version of this document can be found on the password-protected SOLSTICE website.

Text shown in red requires updating.

SOLSTICE project outputs

SOLSTICE Logical Framework v1 (as submitted with the project proposal in May 2017) identifies the following key project outputs:

Output1: Strong and self-sustaining **scientific transdisciplinary WIO-UK network** producing high quality intensive body of knowledge on ecosystems dynamics, human dependence on them, their future trends and human responses

Output 2: **Capacity developed in WIO** to conduct interdisciplinary ecosystem research that meets the needs of ecosystem approach to fisheries (EAF), policy, industry and markets. **Capacity developed in UK** to meet the needs of official development assistance (ODA) compliant research.

Output 3: Strong body of evidence produced by the network in each **Case Study addressing societal challenges** and providing strategy options co-created with stakeholders and based on ecosystem approach

Output 4: **Transfer of cost saving technologies** underpinning ecosystem research to overcome limited investment into research infrastructure in WIO.

SOLSTICE Logical Framework and Theory of Change are evolving documents and will be revised regularly by the SOLSTICE Monitoring and Evaluation team. All changes to either of the documents (including proposed Outputs above) are subject to approval by the Project Leadership Team (appointment and Terms of Reference for the Project Leadership Team are expected by the end of January 2018).

Case Study 3 (South Africa): Ecosystem shifts & fishery collapse: South African Chokka squid fishery

1. Resource summary

Participant short name	NOC-OBE	NOC-MPOC-PHY	NOC-MPOC-RS	NOC-MSM	NOC-OTE	PML-RS	PML-SE	HWU	Rhodes	NMU-BGC	NMU-PHY	NMU-Mod-RS	BCRE
Person-mon	24	24	18	24	6	10?	10	?	20	48	24	36	12

The table above lists all SOLSTICE project partners contributing to the South African Case study with the number of months funded by SOLSTICE for this Case Study. For the partners working on multiple case studies, % of total participant time shows relative contribution of the participant to this case study. For example IMS is working on Tanzanian Case Study only (100%) while NOC-MSM is contributing equal amount of effort to each of the three Case Studies (33%). Numbers in all three tables add up to 100%. A slight adjustment of UK contribution in person-months (within 10%) is still possible until April 1st 2018. The table includes only directly funded contributions. Contributions "in kind" and studentships aligned with the project are not included into this table and are listed below. Due to the size and complexity of NOC contribution, NOC departments and groups are listed separately.

KEY

NOC – National Oceanography Centre, UK

NOC-OBE – Ocean Biogeochemistry and Ecosystems (NOC, UK)

NOC-MSM – Marine System modelling (NOC, UK)

NOC-RS – Remote Sensing (NOC, UK)

NOC-MPOC – Marine Physics and Ocean Climate (NOC, UK)

NOC-OTE – Ocean Technology and Engineering (NOC, UK)

NOC-MG – Marine Geoscience (NOC, UK)

PML – Plymouth Marine Laboratory (UK)

PML-RS – Remote Sensing (PML, UK)

PML-SE – Socio-Economics (PML, UK)

HWU – Heriot-Watt University (UK)

SAEON – South African Environmental Observation Network (SA)

Rhodes – Rhodes University (SA)

NMU – Nelson Mandela University (NMU)

Contributions "in kind" (students and staff effort only)

Nelson Mandela University will align the following MSc/ PhD students with SOLSTICE. More details of these projects can be found in the Appendix.

1. **Unnamed (PhD)** Title: "Composition, dynamics and role of Benthic Nepheloid Layers (BNLs) on the Agulhas Bank:" Start date: 2018; End date: 2020 ; Supervisors: Sanders/Painter: NOC; E. Rocke: UCT, M Noyon NMU
2. **Unnamed (PhD)** Title: "Agulhas Bank circulation and long-term variability". Supervisors: M. Roberts: NMU; D. Smeed: NOC. Start date: 2018; End date: 2020
3. **Unnamed (MSc)** Title: "SST—chlorophyll structures and variability on the Agulhas Bank using earth observations". Supervisors: M. Roberts: NMU; M.Srokosz: NOC; Start date: 2018; End date: 2019
4. **Unnamed (PhD)** Title: "Physical processes affecting the evolution and structure of the Cold Ridge". Supervisors: M. Roberts: NMU; M. Palmer: NOC; Start date: 2018; End date: 2020
5. **Unnamed (MSc/PhD)** Title: "Zooplankton dynamics of the eastern and central Agulhas Bank". Supervisors: M. Noyon: NMU; A. ; S. Painter: NOC; Start date: 2018; End date: 2020
6. **Oyama (MA)** Title: "Small scale (squid) fishers in Port Elizabeth". Supervisor: B. Snow: NMU; Start date: 2018; End date: 2019
7. **Sarah Taylor** (MA) "Assessment of marine food security in WIO and potential impacts of climate change" Supervisors: ????? NMU; B. Milligan: UCL Start date: 2018; End date: 2019

In addition to these post graduate students, selected Intern Candidates from the South African National Research Foundation (NRF) will also be accepted for training on an annual basis.

1. 2018: name to be inserted. Job description (to be updated once candidate has been chosen. Margaux is interviewing.

Rhodes University will align the following MSc/PhD students with SOLSTICE (SA case study only)

1. **Jessica Joyner (PhD)**, Start Date: Nov 2017; End date: Nov 2018; Title: Squid catch modelling (GAM): Has the position and timing of peak spawning (catches) changed from the historical analysis? W. Sauer: Rhodes; M. Roberts: NMU; J. Mwicigi: DAFF
2. **Brett Johnson (MSc/PhD)**, Start Date: Nov 2017; End date: Nov 2018; Title: "Spatial and temporal dynamics of the Bottom Nepheloid Layer (BNL) on the eastern Agulhas Bank". Supervisors: MJ Roberts, WHH Sauer, J Mwicigi, Matthew Palmer (AWAC analysis)
3. **Unnamed** (MSc) Title: "Importance of skip jack tuna along the east African coast", Supervisors: WHH Sauer (Rhodes), K.Popova (NOC), P.Shaw (Aberystwyth)

University of Cape Town will align the following PhD and MSc student with SOLSTICE

1. **Peter Mthembu (MA),** Socio-economic model of fishers; University of Cape Town; Supervisors: T. Lieman: UCT; Start Date: Nov 2017; End date: Nov 2018;
2. **Unnamed**, Socio-economics of the SA squid fishery: Consequences of the 2014-15 fishery crash; University of Cape Town; Supervisors: T. Lieman: UCT; Start Date: Nov 2017; End date: Nov 2018;

2. Case Study background

The case study will address the causes of the Chokka squid fishery collapse in 2013, believed by local fishermen to be due to environmental changes. The Chokka squid fishery has an important role as a local employer and source of protein for poor coastal communities. The squid fishery is the 4th most valuable commercial fishery in South Africa, importing foreign currency (as the entire product is exported to Europe) to one of the poorest provinces in South Africa with a high level of unemployment. Local fishermen are paid individually for their catch, with the fishery employing semi-artisanal fishermen, who in turn have >30,000 dependents. Thus, the 2013 crash had a devastating effect on the Eastern Cape. The specific reasons for the fishery collapse are unknown, with the potential for recovery unclear. Such uncertainty highlights that although South Africa is a country with exemplary fishery management structures and scientific capacity compared with the wider WIO region, it still lacks the research capabilities needed to understand ecosystem shifts that directly impact food security and the livelihoods of poor coastal communities.

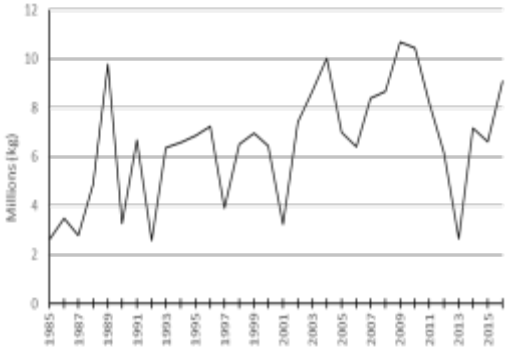


Figure 1: Annual catches of South

Although the 2013-14 crash was the largest crash of the South African squid fishery (Figure 1), there have been other times of low catches (i.e. 1992 and 2001) but this came off a 10-year period of high annual catches averaging some 8 500 tons, and had devastating socioeconomic consequences. While catch effort has crept upwards over the history of the fishery, measures such as an extra 3-month closed season (April, May, June) have been introduced, to stabilise this effort. Presently there are 2451 fishers in the fishery using 131 vessels. These fishers are artisanal in that they are 'self-employed' as are paid individually for their catch. This number is set to increase as the SA Government is set on introducing more artisanal fishers using small ski-boats to consume 25% of the TAE — overall increasing the total number of family dependents on the squid catch.

Four key hypotheses were proposed to explain the collapse:

Life cycle specific hypotheses:

H1: An increase in benthic turbidity events (Benthic Nepheloid Layer, BNL) on the inshore spawning grounds driven by an increase in primary productivity caused drastic drops in catches and the squid fishery to crash in 2013/14.

H2: An absence or less intense cold ridge upwelling resulted in low levels of zooplankton which in turn resulted in paralarvae starvation and reduced recruitment.

H3: Unusual Agulhas Current boundary dynamics (i.e. unusually large meanders, Natal pulse or successions of either) caused greater offshore (leaving the continental shelf) losses of squid paralarvae.

General hypothesis:

H4: The Agulhas Bank underwent an ecosystem 'step-change' (rapid shift) that, through processes not covered in H1-3, impacted squid biomass, distribution, and/or catches

The key questions to be investigated in this case study are:

1. What caused this catch crash — and the previous dips in catches?
2. Can these be predicted?
3. What were the true impacts (not only reported by media) on the squid fishery (industrial sector) and the artisanal fishers?
4. Are there mitigation measures that can be put in place to reduce the impact of these low catch dips on the fishery and the fishers?
5. What is the future of the South African squid fishery given the effects of Climate Change?

3. Description of work

3.1. Syntheses and Hypotheses setting

3.1.1. End-to-end literature review and formulation of key hypotheses

Deliverable: Internal project report (Month 12)

PI responsible for delivery: M.Roberts (NMU)

Participating institutions: NMU, all participants.

We will produce a comprehensive interdisciplinary literature review for the case study following the structure of the SOLSTICE WPs including main challenges and review of the key hypotheses. This review will underpin WP contributions to the case study and design of the field work. It is anticipated that this review will form an introductory paper in the SI. Preliminary hypothesis testing is anticipated by WP1a,b (Remote sensing and modelling).

3.1.2. Special Issue (SA Case Study)

Deliverable: Collection of peer-reviewed papers (Month 36)

PI responsible for delivery: M.Roberts (NMU), K.Popova (NOC)

Milestones:

M12: Full list of potential papers identified, journal agreed, guest editors assigned

M24: Full list of papers finalised

Participating institutions: SOLSTICE Directors (M.Roberts, K.Popova), all participants.

As a main deliverable for Output 3 ("Strong body of evidence"), we will produce a Special Issue (SI) in DSR II or a similar journal with a socio-economic component. The latter may well be in a complementary journal.

3.1.3. Synthesis paper(s)

Deliverable: Peer-reviewed papers (post-SI effort, Month 42)

PI responsible for delivery: M.Roberts (NMU), K.Popova (NOC)

Milestones:

M30: List of papers identified

M36: List of papers finalised and lead authors assigned.

Participating institutions: all participants.

Key end-to-end synthesis paper(s) with strong links to policy recommendations will be based on the SI collection and submitted by Month 42.

3.1.4. Final project Report for SA Case Study

Deliverable: External Project Report (Month 48)

PIs responsible for delivery: SOLSTICE directors (Roberts, Popova)

Milestones:

M31: Decision if to proceed with the report, its content and alignment with the final project reporting

Participating institutions: all participants.

This report is likely to provide key end-to-end synthesis of the project findings with strong links to policy recommendations. At this stage there is no consensus if such a report is needed/useful. This will be decided by the Project Leadership Team in April 2020, M31. No reporting guidelines have yet been received from the UK project funder (GCRF).

3.2. WP1a Remote Sensing

3.2.1. Synthesis of the satellite-derived data to identify large scale drivers of Agulhas Bank ecosystem variability

Deliverables:

- Contribution to the CS review (Month 12)
- SI paper or contribution to WP1b-led SI paper (Month 24)
- Contribution to MOOC (M30)
- Contribution to synthesis paper(s) (M40)

PI responsible for delivery: M.Srokosz (NOC)

Milestones:

M12 Preliminary results presented as internal project report (underpinning model verification)

Participating Institutions: NOC-MPOC (PI M.Srokosz), NOC-MSM, PML-RS, NMU

Analysis of temporal and spatial variability of parameters influencing ecosystem dynamics on the Agulhas Bank (i.e. the Agulhas Current [AVISO, OSCAR], chl-a, primary production, plankton functional types (PFTs), coastal altimetry). Link to large scale mechanisms of interannual and decadal variability (e.g., ENSO, SAM, IOD); Working with trends in Long-Term Underwater Temperature

(UTR) data in Section 3.5.5; working with WP1b to support model validation and hypothesis testing (with a particular focus on meander hypothesis).

3.2.2. Remote sensing analysis to support benthic turbidity (Benthic Nepheloid Layer, BNL) study

Deliverable: SI Paper (if successful, as this is a high uncertainty study)

Milestone: 12m mooring data set is delivered and is of sufficiently high quality (**M16**)

Participating Institutions: NMU, PML

PI responsible for delivery: M.Roberts (NMU), D.Raitsos (PML)

This study aims to investigate the possibility of developing a surface chlorophyll proxy (index) time series for BNL presence and intensity on the Agulhas Bank. The analysis will involve creating daily times series of 1km chl-a and SST (daily fields) for the entire Eastern Agulhas Bank (to shelf break) and then to correlate this with the turbidity data collected from the moorings (1 year data set will be available at the end of year 1). A time lag is between high levels of surface chlorophyll and the emergence of intense BNLs. This lag should correlate with the marine snow investigation. If a chl-a proxy is found, then to check if this signal also present in the 4km data. If 4km data can be used, then go back to 1997 (start of ESA ocean colour CCI global data) to reconstruct a long-term time series of the turbidity events.

3.2.3. Remote sensing analysis of the Port Alfred upwelling and Cold Ridge

Deliverable: SI Paper

PI responsible for delivery: D.Raitsos (NOC)

Participating Institutions: PML, NMU, NOC-RS, NOC-MSM (advertised NMU MSc project)

Milestones: NMU student identified (M6) or deliverable re-assigned to PML or NOC

URGENT: statistical analysis of seasonality and location of the Cold Ridge for mooring deployments M6 and ship survey booking

Analysis of 1km chl-a and SST data to identify the location of upwelling events, their frequency, intensity, distribution and seasonal and interannual variability. This includes the cold ridge. Compare with NEMO, if NEMO is capable of reproducing this scale. Can 4 km data be used for the same purpose? If 4km data can be used, then go back to 1997 to reconstruct a long-term time series of upwelling off Port Alfred and the Cold Ridge. A further question to be addressed is whether the biomass from this location is advected to produce the turbidity seen at the Eastern Agulhas Bank (linking to above study on turbidity). Link to MEDUSA 1/12˚ ecosystem model embedded in NEMO.

3.2.4. Real-time support of fieldwork and optimisation of cruise strategy

1. **Deliverable:** online data base and contribution to the cruise plan (Months 6-20)
2. **Participating Institutions:** PML-RS (PI: B.Taylor, NEODAAS)
3. This work will provide the consortium with near-real-time daily ocean colour and SST products at 1km resolution from MODIS and VIIRS satellite sensors to support field campaigns in the South Africa case study region - to cover the 1-month field campaign in February 2019 + 1 month before fieldwork start and 1 month after field-work finish.

3.2.5. On-line / off-line data access: altimetry, chl-a, SST

4. **Deliverable:** on-line /off-line database and data discovery tools (Month 12 and on-going)

Participating Institutions: NOC-IT (PI V.Byfield), NOC-RS, PML-RS

5. IT group at NOC will develop a web based system. NOC-MPOC and PML-RS will provide relevant data to populate system. Initially, this could be large-scale, low resolution, data (e.g. ESA CCI altimetry, chl-a, SST) on a ¼˚ grid and monthly for the whole WIO over the satellite era (1990s onwards). WP4 (Capacity development) will engage with the WIO partners to identify requirements for remotely sensed data and WP 1a will populate the database accordingly. Remotely sensed data used in SOLSTICE studies will also be added to the database (e.g. 1km high resolution chl-a, SST). Of particular importance is a historical 1 km resolution, daily SST and chl-a data image library for the Agulhas Bank (A legacy from SOLSTICE to promote continued research at NMU).

3.2.6. Training/capacity development for WP1a (Remote sensing)

Milestones:

- Student co-supervision and exchange visits identified (M4)
- See additional milestones related to the training courses in Section 3.7.2

PIs responsible for delivery: V.Byfiled (NOC)

A 2-week remote sensing training course will be run at IMS.

Exchange/training visits dedicated to the remote sensing applications for the SA case study up to one month duration to NOC and PML (UK) are possible if prioritised by NMU.

Co-supervision of the WIO students working on remote sensing data by UK partners is expected.

6.

3.3. WP1b Modelling

3.3.1. Model skill assessment

Deliverables:

Internal project report (M6)

Participating institution: NOC-MSM (PI E.Popova)

Aim is to assess NEMO-MEDUSA model skills in the case study area, establish model limitations, and identify most promising model applications, and range of possible projects and their costs. The key questions to investigate are: Does the model reproduce the cold ridge and Port Alfred upwelling? Does the model reproduce the westward circulation of the eastern and central Agulhas Bank? Is the

position of the Agulhas Current correct, especially the retroflection? (Compared with observed data). Do Chl-a and nutrients show sensible background values and seasonality? (Compare with observed data; see below 3.4.2). If the model skills are insufficient to test the proposed hypotheses, then a similar investigation using the regional ROMS model will be conducted.

3.3.2. Biogeochemical modelling

Deliverables:

- Contribution to the CS review (Month 12)
- Agulhas Bank dataset extracted and ready for model validation (M12)
- SI paper or contribution (Month 24)
- Contribution to MOOC (M30)
- Contribution to synthesis paper(s) (M40)

Milestones:

M6 Model skill assessment showed the model agreement with data is good enough for the hypothesis testing

M8 NMU modeller is in place, training identified

Participating institutions: **NMU** (PI Roberts), NOC-MSM (PI E.Popova), NOC-RS, NOC-OBE, PML-RS,

Description:

The NMU modeller will analyse NEMO-MEDUSA coupled physical and biogeochemical model at 1/12° (hindcast) and 1/4° (climate change projections for RCP8.5 to year 2099) to constrain the key large-scale drivers of the ecosystem variability at seasonal, decadal (ENSO, SAM, Indian Ocean Dipole) and climatically driven (RCP8.5) variability on the Agulhas Bank. The model will be validated using available climatological data, ARGO floats, remote sensing and in-situ observations if available (see below). Importantly, historical and future long term trends in ecosystem performance will be produced. The modelling package will also assist with optimisation of the fieldwork and synthesis of the observational information.

Note: Some 37 years of tri-annual surveys (April, August and November) of the Agulhas Bank are archived in the South African Centre for Oceanographic Data (SADCO) and the Department of Environmental Affairs (DEA). These data should be extracted and analysed as soon as possible by a student (i.e. PhD student #6; see advert). If no student is available, then by the NMU modeller.

3.3.3. Lagrangian modelling

Deliverables:

- SI paper (M36);
- Contribution to synthesis paper(s) (M40)

- Internal report on numerical runs conducted for a number of studies co-designed with SA scientists for a variety of applications (M30)
- Contribution to MOOC (M30)

Milestones:

M6 Model skill assessment showed the model agreement with data is good enough for the hypothesis testing

Participating institutions: NOC-MSM (PI E.Popova), NOC-RS, NMU

Description:

We will use the Lagrangian tracer approach to constrain key advective pathways on the Agulhas Bank, their variability, and potential modifications under the impact of climate change. We will investigate Lagrangian pathways between the spawning grounds and the Cold Ridge. Importantly, we will assess the variability of shelf retention of Lagrangian particles for various regimes of Agulhas Current meandering (i.e. Natal pulse, presence of Agulhas Bight eddy, transient meanders). Lagrangian data collect from satellite-tracked surface drifters deployed at the ADCP mooring sites (3 sets) can also be used to validate models results (see 3.5.2).

3.3.4. Climate change stressors and their uncertainty

Deliverables:

- SI paper (month 36)
- Contribution to synthesis paper(s) (M40)
- Contribution to MOOC (M30)

Participating institutions: NOC-MSM (PI E.Popova), NMU

We will analyse CMIP5 and CMIP6 model ensembles for the WIO, identify their predictive skills and evaluate key drivers of uncertainty in future projections of the Agulhas Bank ecosystem dynamics. If the squid collapse has been explained and linked to the environmental characteristics, we will use the forward run of NEMO-MEDUSA (1/4^{o} resolution or 1/12^{0} if available by M30) to assess variability of these characteristics under the climate change impacts and project risks of future collapse.

3.3.5. Updating the Generalised Additive Model (GAM) approach to predict future squid catches

Deliverables:

- Contribution to literature review report (M12)
- SI paper (month 36)

PIs responsible for delivery: W.Sauer, M.Roberts (supervising J.Joyner, PhD student)

Participating institutions: NMU, Rhodes, NOC

In an attempt to quickly understand the cause of the 2013 squid fishery crash, a GAM was employed in 2015-16 (MSc study) to ascribe monthly environmental variability to monthly squid catch. This was based on the well-developed understanding that catch fluctuations in squid fisheries is often

$$Catch \sim BT + VarBT + SST + VarSST + VarWS + WD + VarWD + P + VarP + ONI + Chl + MaxWS + MinWS + ModeWD + Easterlies + AAO$$

influenced by the environment. The best fit model selected was given by the formula

Where *BT* represents Bottom Temperature, *SST* represents SST data, *WS* represents Wind Speed, *WD* represents Wind Direction, *P* represents pressure, *ONI* represents Oceanic Nino Index data, *Chl* represents Chlorophyll-a data, *MaxWS* and *MinWS* represent Maximum and Minimum Wind Speed respectively, *ModeWD* represents predominant wind speed, *Easterlies* represents the number of hours of easterlies per day, and *AAO* represents the Antarctic Oscillation index data. These environmental data were then included in a Generalised Additive Model (GAM). While the analysis showed mean bottom temperature BT (UTR data) and standard deviation in SST (satellite) as the stronger drivers of catch, it failed to predict the observed catch.

The approach will be refined following results of the remote sensing analysis and NEMO-MEDUSA modelling.

3.3.6. NEMO-MEDUSA data access server

Deliverable: online data access and user manual (months 18)

Participating institution: NOC (PI H.Snaith)

We will develop a server providing access to the model output with area-extraction capability suitable for low internet bandwidth. This server will be essential for the wide use of the model by WIO researchers and will underpin Modelling training course.

3.3.7. Training/capacity development for WP1b (Modelling)

Milestones:

- Student co-supervision and exchange visits identified (M6)
- Review of the funding situation for potential training course at NMU (M12)
- See additional milestones related to the training courses in Section

PIs responsible for delivery: V.Byfiled (NOC)

A 2-week modelling training course will be run at IMS.

Exchange/training NOC (UK) visits dedicated to modelling applications for the SA case study are essential for the NMU modeller. (maximum 1 month stays)

If all NMU student positions are filled, a modelling training course at NMU should be considered (currently unfunded).

3.4. WP1c Marine Robotics and WP1d Fieldwork

3.4.1. Three Bay OBS (turbidity) moorings and BNL dynamics

Description:

This project aims to investigate the occurrence, extent and intensity of BNLs on the squid spawning grounds. Three shallow, diver operated, moorings will be deployed at a depth of 25 m in Algoa Bay, St Francis Bay and Oyster Bay to respectively collect an hourly, 12-month time series. Mooring positions will correspond to key spawning and historical measurement sites. Each will be equipped with an AWAC (currents, temperature, waves) and an OBS with wiper. This data set will underpin the remote sensing package on developing surface indicators of the BNL highlighted in Section 3.3.2.

Data collected: Time series of OBS, currents, waves, [also to collect BNL samples for marine snow project]

Participating Institutions: PI M.Roberts, NMU (Diving support and Brett Johnson, MSc student), BCRE (equipment), NOC (AWAC advice), DAFF (supervision and close season field work)

PI responsible for delivery: M.Roberts (NMU)

Milestones:

- Deployment 1 Nov 2017
- Monthly servicing and data upload
- Retrieval: 28 Feb 2019

Deliverables:

- BODC-Archived data set of 13 months' time series (M13)
- Internal project report (Analysis of wave, OBS, and temperature data, M13)
- Thesis (MSc) -TBC
- Contribution to MOOC (including filming)
- Paper #1: Research article (spatial and temporal dynamics of BNLs on EAB), drafted by student

3.4.2. Cold Ridge ADCP moorings and drifters (RV Ellen Khuzwayo, 2x 4-day cruises)

Participating institutions: PI M.Roberts, NMU (technical support & student), BCRE (equipment), NOC (supervision, D.Smeed)

Milestones:

- Deployment: May 2018 (RV Ellen Khuzwayo 4-day hire)
- Service date: August 2018 (RV Ellen Khuzwayo 4-day hire)
- Retrieve moorings (February 2019 – end of CR cruise)
- Deployment of 3 sets of SVP drifters from mooring sites

Deliverables:

- BODC archived data set (6 months data): October 2018
- Internal project report (6 months data): October 2018
- BODC archived data set (12 months data): June 2019
- Internal project report (12 months data): June 2019
- SI Paper #2 (M36): Research article (circulation around the Cold ridge): Oct 2020 (M36)

Description:

In theory, the Cold ridge will have a cyclonic circulation which will be good for retention of matter. This component tests the theory by deploying 4 x ADCP short stubby moorings (see pic) across the ridge for a period of 12 months. (NB. Mooring positions need to be informed by Remote Sensing project 3.3.3) These moorings consist of a FT float with a 300 kHz ADCP, two Benthos Acoustic releases, Argos transmitter, radio beacon, and a weight. The positions will be determined from averaged SST, Ocean Colour and (coastal) remote sensing data. Each mooring will also have a temperature array comprising 10 UTRs that will monitor the depth of the thermocline. The temperature array will terminate 15 m from the sea surface.

Moorings will be deployed and serviced after 6 months using the RV Ellen Khuzwayo. Satellite-tracked surface drifters will be deployed above each mooring at deployment, servicing and retrieval times to provide Lagrangian data on the circulation.

Possibility: Altimetry data will be analysed in conjunction with that from the moorings, and the S-ADCP data collected on the ship-glider survey to confirm clockwise, retentive, circulation pattern around this feature. These products will be compared with AVISO/OSCAR gridded data and NEMO. These circulation data will be analysis in conjunction with the long term Storms River ADCP dataset of 25 years (see 3.5.5).

Data collected: ADCP, T profiles to near-surface, Satellite-tracked drifters

3.4.3. Ellen Khuzwayo cruise (Leg1, Nepheloid layer) and small boat sampling line

Team members (8 berths): M Noyon (NMU), Brett Johnson (MSc), W Goschen (SAEON?), A.Poulton (HWU), A.N.Other (OBE), Brian Godfrey + 2 SOLSTICE students – MARS technicians?

PI Responsible for delivery: M.Noyon

Data collected: S-ADCP, CTD (T, S, O2, Fluorescence, OBS), water samples (O2 + S calibration, nutrients), phytoplankton, zooplankton, ichthyoplankton, marine snow

Milestones:

- Set up a small boat, monthly time series sampling line off NMU (May 2018)
- Secure vessel time (February 2018 – no report)
- Draft Leg 1 cruise plan
- Load vessel and execute survey (February 2019)
- data and achievement report
- Physical data worked up; water samples analysed; plankton sampled worked up
- integration of Leg 1 data with Leg 2
- S-ADCP and OBS data mapped and integrated with OBS moorings in 3.5.1
- Chl-a integrated with RS data (validation 3.3.4 and 3.3.2)
- Draft SI manuscripts

Deliverables:

- Samples from small boat monthly time series (From May 2018)
- Survey plan (Internal report, October 2018, M12)
- 7 day survey (February 2019)
- BODC archived temperature, salinity, turbidity, chlorophyll, zooplankton data set
- Cruise report (Internal project report, May 2019)
- SI Paper #3 (M36): Research article (composition and rates of BNLs on EAB)
- SI Paper #4 (M36): Research article (plankton on EAB)

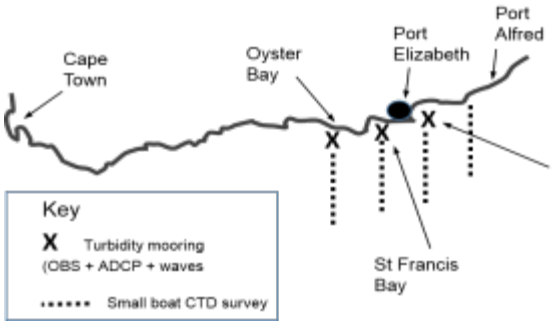
Description:

A small boat monthly sampling line (10-100 m) will be established off Port Elizabeth to collect hydrographic data and plankton. These data will provide a context for the extensive cruise in February 2019 as well Remote sensing data in 3.3.3.

This survey will be done as Leg 1 of the February 2019 RV Ellen Khuzwayo cruise. Leg 1 will start and finish in Port Elizabeth.

To contextualise the 3 x OBS moorings, a snap-shot inshore hydrographic survey will be undertaken over several days to ascertain the horizontal extent and vertical nature of the BNLs on the inshore spawning grounds. 4-5 hydrographic lines will be completed extending from 10-100 m depths (see

figure below). Stations will be between 2-5 km apart depending on proximity to the shore, and data collected using a SBE-19 CTD that has OBS and fluorescence sensors added. Water samples will be collected from a small bottle CTD rosette for nutrient analysis. Plankton will be collected using a bongo net and portable winch. The vessel has an RDI Ocean Surveyor II 150 kHz ADCP on board to measure currents.



Marine snow (this component will be undertaken on both legs, Snow Catchers loaned from NOC)**.** The aim is to define the composition of marine snow, settling rates and decomposing times so as to determine the lag between planktonic growth in the upper mixed layer and fallout to the seabed — and hence the formation and decay of the BNL. As noted, sampling will take place on both Leg 1 and Leg 2 of the February cruise using a Large Volume Water Sampler – alias 'Marine Snow Catcher'. Water samples will be collected on selected stations from the surface, mid and bottom of the water column.

3.4.4. Ellen Khuzwayo cruise (Leg2, The Cold Ridge Survey)

Participating Institutions: PI M.Roberts, NMU, NOC, HWU [TBC], DAFF [TBC]

PI responsible for delivery: M.Roberts

Team (Leg 2 only): Roberts (PI, NMU), Noyon (NMU), Poulton (HW), NOC-OBE person, Godfrey (NMU), NOC glider (MARS), Matt Palmer (NOC), + 1 NMU student

Data collected:

Ship: S-ADCP, CTD (T, S, O2, Fluorescence, OBS), water samples (O2 + S calibration, nutrients), phytoplankton, zooplankton, ichthyoplankton, marine snow

Gliders: T, S, Fluorescence, NO3, micro turbulence

Milestones

- Secure vessel time (February 2018 – no report)
- Draft Leg 2 cruise plan
- Load vessel (gliders) in PE and execute CR survey (February 2019)
- Retrieve ADCP moorings
- Deploy SVP drifters from mooring sites
- Deploy glider missions
- data and achievement report
- Physical ship data worked up; water samples analysed; plankton sampled worked up
- Snow catcher samples worked up
- Integration of Leg 1 data with Leg 2
- Chl-a integrated with RS data (validation 3.3.4 and 3.3.2)
- Glider data worked up
- Draft SI manuscripts

Deliverables:

- Produce the Cruise Plan, and submit to DAFF sailing orders (document), November 2018
- Execute cruise, February 2019
- Cruise report, May 2019
- Submit data to BODC (done once each data set has been cleaned and calibrated)
    - SI Paper #5: Research article (Subsurface structures and biogeochemistry of the CR)
    - SI Paper #8: Research article (Phytoplankton characteristics of the CR)
    - SI Paper #9: Research article (Zooplankton characteristics of the CR)
    - SI Paper #10 Research article (squid paralarvae)?

Description:

This survey will be done as Leg 2 (9 days, 7 days on survey) of the RV Ellen Khuzwayo cruise in February 2019 starting in Port Elizabeth and finishing in Cape Town.

Prior to the cruise, gliders will be readied at NMU and an operations centre set up for demo and training purposes. Together with the scientific compliment, gliders, a NOC technician, and NMU technician will be transported to Cape Town to meet the ship. The ship will sail straight to transect 4 where gliders will be deployed. The ship will stay close to the gliders for 24 hours in case of problems, then proceed to Port Elizabeth. Gliders will be retrieved at the end of the CR survey and returned to Cape Town, where upon the equipment and personnel will return to NMU.

The aim of this leg of the survey is to provide a snapshot view of the Cold Ridge which highlights the subsurface physical, biogeochemical, and biological structure of the feature. These datasets will then be used to investigate biophysical interactions at the Cold Ridge and relate these to surface signatures

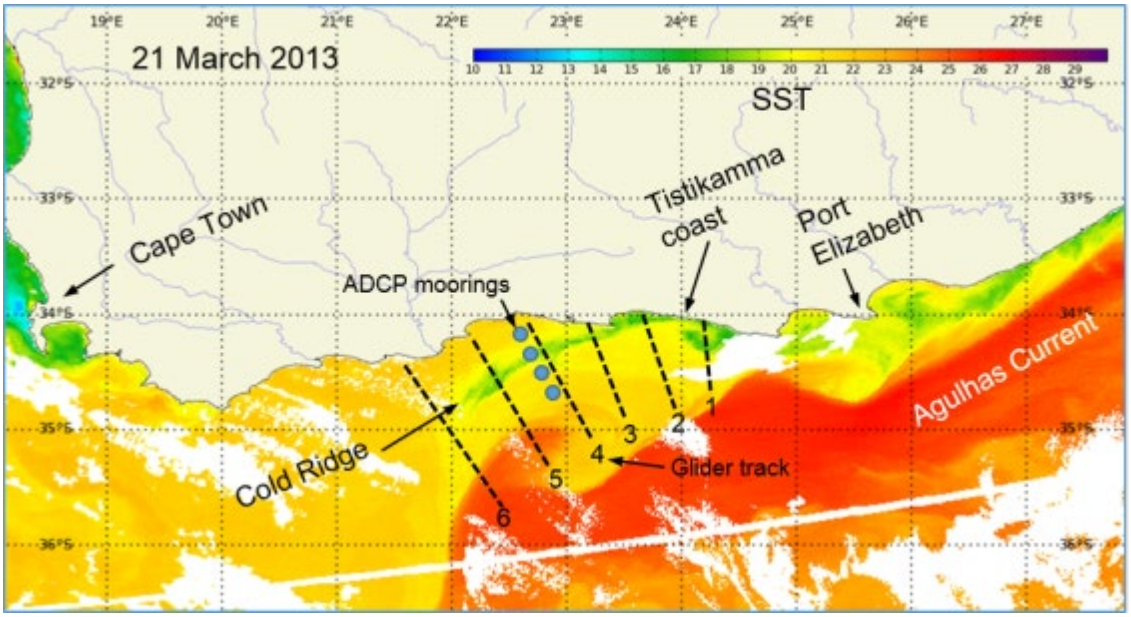
obtained from remote sensing (see 3.3.3). Emphasis will also be placed on the collection of squid paralarvae in plankton samples to better map the spatial distribution of the paralarvae which is still under discussion amongst specialist in the field.

To address the main question as to whether the cold ridge is a hotspot of productivity, phytoplankton and zooplankton production will need to be measured using 24-hour incubation experiments. Preliminary data have been shown that the cold ridge is often associated with presence of early juveniles of the zooplankton organisms, suggesting that secondary productivity might be associated with the cold ridge. However the underlying mechanisms are not well understood.

In situ sampling of the Cold ridge will be undertaken using two methods: (1) ship-based transects, and (2) gilder transects. The 38 m research vessel RV Ellen Khuzwayo, owned by the Department of Forestry Agriculture and Fisheries (DAFF), will be used to perform this survey. The survey will comprise 6 transects ranging between 40 and 60 km in length across the Cold ridge (see pic). Sampling stations will be 5 km apart and range in depth between 50 – 170 m (full depth of water column).

The exact positioning of the survey lines will be informed by recent daily remote sensing products (supplied by PML; see 3.3.3 and 3.3.4). Data collected by the ship include CTD profiles (T, S, O_2, OBS, Fl), nutrients, in situ Chl-a, zooplankton (nets), primary and secondary production and S-ADCP, acoustic (multi-beam) SIMRAD (plankton scatter).

Marine snow catcher samples will be collected at selected stations during Leg 1 and Leg 2. Gliders will carry CTD, acoustic, fluorescence and nitrate sensors and continuously operate for the full duration of the cruise.



Training/capacity development:

The following T/CD will be undertaken during field operations:

- 4 post graduate students over Leg 1 and Leg 2 will receive Safety at Sea training and data collection training using a variety of instrumentation.
- Training of NMU technician in glider operations in Liverpool (covered in SA Budget)
- Workshop/training 3-days for 10 SA people on gliders during Feb 2019 field operations room
- 2 SA students/technicians to be trained at NOC on nutrient analysis
- Training in snow catcher operations and methods (covered in SA Budget)
- Training in phytoplankton techniques and id (Alex Poulton to spend 1-2 weeks at NMU (HWU Budget)

3.4.5. Synthesis of the long term historical observations on the Agulhas Bank

Participating institutions: NMU (PI M.Noyon), NOC, PML

PI responsible for delivery: M.Noyon (NMU)

Milestones

M6 NMU Students/staff assigned to the task

Deliverables

M12 Contribution to the literature review paper with an overview of all available data

M24 Internal project report

M30 SI paper #11: Research article (Zooplankton long term trend)

Description

25 years of ADCP and UTR data collected on the Tsitsikamma coast will be analysed for regime changes. This will be augmented with remote sensing data (chl-a, SST, altimetry).

Zooplankton samples together with hydrological data have also been collected since 1988 during two different type of fisheries surveys. These two collections are still intact in formalin and some have never been analysed. The spatial distribution of the stations as well as the date of collection are quite patchy as the samples were collected as a side project during fishery surveys. Nevertheless, assessing whether these samples can contribute to the understanding of the squid fisheries is of crucial importance and will therefore be analysed prior to the in situ work.

It should be noted that some 37 years of tri-annual surveys (April, August and November) of the Agulhas Bank are archived in South African Centre for Oceanographic Data (SADCO). These data should be extracted and analysed as soon as possible and would constitute an ideal student project if can be arranged within the first year of the project. Failing that, it will be one of the first tasks for the NMU modeller.

3.5. WP2 Socio-economic studies

3.5.1. Multi species fish modelling

Deliverables:

- Contribution to the CS review (Month 12). Dependant on collected data regarding fish and fisheries.
- SI paper (Month 24 paper identified and finalised; Month 36 paper submitted to SI)
- Contribution to MOOC (Month 30). No specific Fish modelling contribution to the MOOC schedule, but will participate and help during the MOOC
- Contribution to synthesis paper(s) (Month 30, 36 paper(s) identified and finalised; Month 42 paper submitted)
- Fish model outputs (Month 15-18) made available to partners along with short description of the outputs and how to use them. Plus delivery of model outputs for further work within WP2 (specific data type and format).
- Report on the model outputs (Month 24) with case study specific aspects highlighted. Plus comparison to available data.

Milestones:

M6 Lead contacts for fish related enquiries identified by NMU.

M6 NEMO-MEDUSA data received from NOC

M7 list of main fish species of interest for the case study agreed on by case study partners.

M8 Additional data (where needed) for model parameterisation provided by partners or gathered from literature

M10-15 Data on fish catch to validate the model output

Participating institutions: PML (PI: Sévrine Sailley), NOC, NMU

Description:

The fish modelling will make use of the SS-DBEM model to obtain projections regarding possible changes of fish species distribution and potential catch within the century. The model projections will target key fish species for the case study (both in term of subsistence and economic value) and make

use of NEMO-MEDUSA model outputs to look at changes of distribution and abundance due to change in climate. There will also be additional run(s) to look at effect of fishing and different management approaches (whether the fishing is at or above the Maximum Sustainable Fishing Yield, MSFY). Model outputs will be made available to project partners, and a report will be produced to highlight the major findings regarding the sustainability of current targeted fishes and possible alternatives.

Although the model and report deliverables will be specific to this case study, the model domain and some of the fish species will overlap across all three SOLSTICE case studies (Kenya, Tanzania, and, South Africa).

3.5.2. Wider engagement with fisheries: Importance of skip jack tuna along the east African coast

Participating institutions: Rhodes (PI W Sauer), NOC, PML

Contribution "in kind" U.Aberystwyth, UK

Deliverables:

- Project progress report (M24)
- SI paper (Month 36)

Milestones:

- Rhodes student identified (M6)
- Timing of the exchange visit agreed (M6)
- Deliverables agreed (M12)
- Input into policy identified (M24)

Description:

The project will address importance of skip jack tuna along the east African coast – synthesis of current biological knowledge, understanding population structure, and potential impacts of climate change. This project was created on request of the DSFA and is aligned with projects in the University of Aberystwyth (UK, Prof. P. Shaw) and Rhodes. The project will include synthesise available biological info (desk top), understand population structure, lagrangian modelling of the ocean circulation related to tuna movement with emphasis on climate change, and provide management advice. The project will include field trips to collect genetic samples - South Africa, Tanzania (mainland, Zanzibar and Pemba Island), Kenya (skip jack, genetic tissue from different sites, 20 from each).

Capacity development:

The following exchange visit will be offered to the Rhodes student (funded from NMU budget): Visit to the UK for 4 months, 2 months to NOC (Ocean circulation models and lagrangian analysis),

Genetic analysis: - 2 month Aberystwyth (travel Southampton-Aberystwyth as well as T&S during stay in Aberystwyth will be funded by Aberystwyth).

3.5.3. Input-output tables

Deliverables:

- Contribution to the CS literature review (Month 12)
- SI paper (Month 24 paper identified and finalised; Month 36 paper submitted to SI)
- Contribution to MOOC (M30). Regionalising input-output tables and its application to fisheries under climate change scenarios
- Contribution to synthesis paper(s) (Month 30, 36 paper(s) identified and finalised; Month 42 paper(s) submitted)
- Regional input-output data table and user document made available to partners and wider community (Month 24)

Milestones:

M9: Data required for regional input-output tables identified and agreed with University of Cape Town

M30: Data collated for regional input-output table in collaboration with University of Cape Town

M18: Fish model outputs received from PML-fisheries

M18: Squid model outputs received from PML-DEB model

M33: Results of economic assessment produced and used in writing SI and synthesis papers

Participating institutions: PML (PI: E. Papathanasopoulou), UCT, DAFF, SASMIA

Description:

Regionalised input-output (RIO) tables will be produced for the case study areas. These will be developed using earlier productions of the table at a national level and scaled down by regional data available through statistical records and collected by local partners (UCT). The RIO tables will be used to estimate the direct and indirect economic impact on the local economies from changes in fisheries due to climate change using outputs from the multi-species fish model (SS-DBEM). They will also be used to carry out an assessment of the Small Scale Fisheries Policy using outputs from the DEB squid model. The direct and indirect impacts provide insight into the wider economic impact of the reliance on natural resources and can prove useful for structural regional development that aims to ensure resilience and adaptive capacity. These impacts will be estimated in revenue and employment units.

3.5.4. Chokka Squid collapse: drivers, consequences and significance of environmental factors

Participating institutions: NMU, Rhodes, UCT, NOC, PML

PI responsible for delivery: M.Roberts (NMU)

Deliverables:

- Key contribution to the CS literature review (M12)
- SI paper submitted (M 30)

Milestone: Lead author identified, contributions agreed (M18)

Description:

This is a key "foundation" study demonstrating what we know about the fishery, why its sustainable management is critically dependent on understanding of the marine environment and biophysical drivers; what are key hypotheses of the collapse and why do we expect strong sensitivity to climate change impacts. This study should result in the SI "setting the scene" paper (a compulsory requirement of the SI).

This is a "mission-critical" contribution to SOLSTICE.

3.5.5. Chokka squid modelling

Deliverables:

- Contribution to the CS review (Month 12).
- SI paper (Month 24 paper identified and finalised; Month 36 paper submitted to SI)
- Contribution to MOOC (Month 30). [TBD. It would provide a key link between WP1 and the socioeconomic analyses, but would need dedicated time]
- Contribution to synthesis paper(s) (Month 36 paper(s) identified and finalised; Month 42 paper submitted – this is post-SI effort)
- Model tools and initial outputs made available to partners along with short descriptions (Month 15-18).
- Report on the model outputs and validation results (Month 24).

Milestones:

M6 Samples of NEMO-MEDUSA output and particle trajectories received from NOC (minimum time span covered by sample output: 1 year)

M6 Identification of key aspects of Chokka life history and physiology used for parametrization of DEB model (NMU + PML)

M12 Model infrastructure complete and running

Participating institutions: PML (PI J. Bruggeman), NMU, NOC

Description

In this task we apply a process-based model to link hydrodynamics and plankton distributions (WP1) to the abundance of Chokka squid. In turn, this will feed into socioeconomic analyses of Chokka fisheries (e.g., input-output tables below). This task is based on existing, portable modelling tools (a size spectrum model for higher trophic levels, a Dynamic Energy Budget model for individual physiology) that are open source and will be made available to all partners.

First, we will run a size spectrum model (DOI: 10.1111/1365-2664.12238) for higher trophic levels (1 mg – 100 kg; large copepods to fish) to reconstruct prey available to different Chokka life stages. This size spectrum model will be driven by temperature and by the concentrations of different plankton size classes simulated by NEMO-MEDUSA. The model will be spatially explicit: it will run on the same grid as the NEMO-MEDUSA inputs.

Second, we will apply a process-based model of individual squid to track their development from hatching till adulthood. This model will be based on Dynamic Energy Budget theory (Kooijman 2010), which has previously been applied to a wide range of taxa including 9 species of cephalopod (http://www.bio.vu.nl/thb/deb/deblab/add_my_pet). The DEB model will be parametrized using a combination of prior information from other species (http://www.marine-ecosystems.org.uk/Trait_Explorer; DEB section) and specific information on Chokka life history and physiology. To describe development of the paralarvae, we will build upon the Lagrangian modelling of larval dispersal in WP1. Along the particle trajectories WP1 produces, we will reconstruct environmental conditions from NEMO-MEDUSA and prey availability from the size spectrum model. These conditions drive the squid model, and thus enable us to describe larval feeding, growth and mortality over time. When modelled squid individuals reach a size where active movement dominates over passive drift with the currents, further development and displacement of the individuals will be based on nearby availability of prey, derived from the size spectrum model.

The squid model will be driven by outputs of the NEMO-MEDUSA hindcast and its RCP8.5 forward projection. This permits direct comparison with past catches and stock assessment in order to assess model skill, and further enables forecasting of catches under climate change.

3.5.6. Considering climate change as part of resilient Marine Planning & Ecosystem Based Management for fisheries in Port Elizabeth

Participating institutions: PML (PI: A. Queirós), NMU, Rhodes & others

Note: this study will go ahead if the associated Milestone at M9 (data scoping) has a positive outcome.

Deliverables:

- Contribution to the CS review (Month 12)
- SI paper (Month 36 paper submitted to SI)

- Report geared towards policy communicating main findings of spatial analysis providing advice for resilient use of different gear fisheries & other wild capture resources, as well as conservation resources based activities in the PE, within the context of climate change and ecosystem based management. (Month 42).
- Contribution to synthesis paper(s) (Month 42 paper submitted)

Milestones:

M6: Spatial data on relevant marine sectors required co-mapping identified with NMU, Rhodes & others

M9: Data scoping: feasibility assessment of the Marine Spatial Planning study

M12: Spatial data delivered with NMU, Rhodes & others

M18: Climate modelling projections for physics, biogeochemistry and fish models received from PML-fisheries and NOC-modelling, ready for use in spatial meta-analysis.

M36: Results of spatial meta-analysis data finalised and delivered as manuscript to SI

M42: Report summarising results in less technical language and geared towards policy delivered, with input from partners.

Description:

The main outcome of this task will be to:1) highlight potential opportunities for growth and resilience for fisheries in Port Elizabeth that may result from potential changes in the distribution of living resources (multiple-species context), and/or of key areas that may support their productivity, as climate change unfolds in the region; 2) anticipate potential conflicts and opportunities for other sectors using the marine space in PE and emcompassing waters, given those changes.

The contribution of local institutes will consist of: the provision of GIS data; support in the liaison with other local partners that may hold available data(pending data availability); co-development of the work through advice in the understanding of the local blue economy context; and participation in publications & dissemination as appropriate.

We will assess the resilience (and vulnerability) of wild fisheries in PE and encompassing waters, as well as their distribution. The analysis will take into account the current distribution of activities (gear specific fishing grounds) and co-located economic sectors (e.g. spatial data on tourism, MPAs or other), as well as projected changes to their associated environment and target resources (species specific), based on modelling projections to the end of the 21st century undertaken by PML and NOC (NEMO-MEDUSA, DEB and SS-DBEM).

The completion of this activity will be dependent on the availability of spatial data for co-mapping (local partner engagement) and model projection availability.

Capacity building for this task will be achieved through the collaboration in all aspects of the work, co-design of the study and one-to-one/small team coaching on the methodology and result

interpretation. The main capacity building outcome is the analysis as a product for use by the local partners in their marine management engagement and advice to government in South Africa.

3.5.7. Economic structure of the industrial side and the fisher component of the fishery

Participating institutions: UCT, PML

PI responsible for delivery: T.Leyman

Milestones:

- (!) Ethical approval of relevant UK and SA panels are to be obtained prior to any work with the communities. Clarification on ethics to be provided by NOC by 1st March 2018 (instructions from funder are currently unclear).

Deliverables:

- Summary of data required, Methodology for Survey, Design survey/questionnaire/ structure for focus group interviews (Project report, M9)
- Contribution to the Case Study literature review (survey of existing data and literature on the squid industry in E Cape, and I/O tables and SAMs for SA and for policy in general) M12
- Run industry focus group or individual interviews (Brief project report, M12)
- Submit draft of dissertation (Peter Senzo Mthembu) (M13, 31 Oct 2018)
- Analysis of household and industry risk factors (Project report, M18) March 2019
- Evaluation of labour contracts – theoretical assessment of contractual form if appropriate (M26, November 2019)
- Contribution to the South African Case study "Foundation Paper" for SI (M30)
- Draft of fisheries based local Input/Output table or Social Accounting Matrix as a contribution to the SI I-O paper (M36 Sept 2020)
- Policy proposals for mitigation of economic risks related to squid stock declines in form of either popular document or audio-visual presentation (M42 March 2021)
- PhD dissertation (TBC, possibly after the end of the project)

Paper #: Research article (M?)

Data collected: number fishers, time fishing, income (and in-kind), dependents, abode, expenses,

Description:

The South African squid fishery is made up of a number elements: the resource (squid), resource management (DAFF and SASMIA), vessels and owners (131), fishers (2441), factories, exporters, and international markets (Europe). Each has a set of dynamics which impacts the element chain, and ultimately the performance and survival of the fishery. The aim of this research component is to collect economic data on the resource, vessel owners, factories, exporters, and international markets so as to quantitatively understand the structure and economics of the fishery, assess the overall performance, and hardships during periods of low catches.

A new element into this chain is the Small-scale fishers sector (Government policy of providing more access to marine resources) which DAFF will implement in 2018. This will have considerable implications both for the industry, squid fishers, and small-scale fishers. The introduction of the Small-scale sector must be factored into SOLSTICE.

The fisher component of the research will aim to provide a quantitative description of the fisher work force, their dependents, and livelihoods so as to assess their dependence on the squid fishery, impact of poor catches and closed seasons.

At the end of the first year the following outputs will be produced:

- Survey of existing data and literature on the squid industry in E Cape, and I/O tables and SAMs for SA
- Lit survey on use of I/O in design and evaluation of fisheries policy
- Summary of data required; Methodology for Survey, Design survey/questionnaire/ structure for focus group interviews.
- Synopsis of expected backward and forward linkages from local squid industry – this will be the basis for construction of I/O tables, or be the basis for an alternative to them (SAM).
- Run industry focus group or individual interviews: Outputs to include: a) survey of industry structure and existing contracts b) Sales Rand analysis

At the end of the first year the following outputs will be produced:

- Identify, describe and evaluate key *industry risk factors*: exchange rate / oil price / stock and other factors determining CPUE
- key *household risk factors*: Labour contracts/CPUE/regulated effort reduction/full-time or part-time employ.
- Household size & location: dependency ratio/multiple income earners?/rural or urban?

- Compare impacts of predicted seasonal closure (closed seasons midyear & oct/nov) vs stock collapse
- Evaluation of labour contracts: Does employment contract involve risk sharing (pay on fixed scale or tied to personal or vessel catch etc) – theoretical assessment of contractual form if appropriate

Year 3 and 4 outputs include:

- Draft relevant components of a fisheries based local Input/Output table or Social Accounting Matrix

- Policy proposals for mitigation of economic risks related to squid stock declines in form of either popular document or audio-visual presentation

3.6. WP3. Science into policy and wider stakeholder engagement

By contrast to the East African Case studies, fisheries in South Africa are in principle well managed but due to the complexity, different functions with different departments, ruling party political agendas and interference — the efficiency of the fisheries management structures has been comprised to a degree.

Given the loss of research capability in ecosystem functioning and the potential impacts of climate change, as well as the lack of fisheries related socio-economic understanding in DAFF — SOLSTICE is most timely and apt.

For Science to Policy WP3, SOLSTICE will engage with existing DAFF management structures via the Squid Working Group (SWG). It is important to note here that the squid fishing association, South African Squid Management Industrial Association — SASMIA, is represented on the SWG. Hence the squid fishery is co-managed. SASMIA likewise is a major beneficiary of SOLSTICE collaboration and outputs. The SWG avenue will also be used for engagement of WP 2 (and possibly WP 4 + 5).

The following pathways to engagement are currently proposed:

1. Invite DAFF to SA Case Study meetings

2. Request to DAFF that SOLSTICE be formerly represented at SWG meetings with agendarised feed-back/progress reporting (Letter of Appointment)
3. Give DAFF senior management a presentation on SOLSTICE to enable and leverage full integration of science to policy
4. Involve DAFF scientists in the SA SOLSTICE science plan, including supervision of students and participation in cruises to encourage ownership
5. DAFF representative to sit on SOLSTICE advisory board
6. Hold DAFF-SOLSTICE workshops to explore methods of using the SOLSTICE generated information to improve management of the squid fishery and fishers

3.6.1. Stakeholder engagement Action Plan

Deliverable: Project Report (Month 14)

Milestone: Science into Policy working group identified and a meeting convened in September 2018

Participating institutions: NMU, Rhodes, PML, NOC, UCT

PI responsible for delivery: M.Roberts

Description:

We will produce a report identifying key stakeholders in the following groups: policy, industry, communities, and academia. The report will contain a detailed engagement plan including plans for profiling (M&E indicators, surveys and interviews), identification of stakeholder capacity development needs/challenges, stakeholder engagement events, and links with MOOC-light.

3.6.2. Technology demonstration/stakeholder engagement event

Deliverable: Robotics operation (real time) demonstration event at NMU (Feb 2019)

Participating institutions: NOC, PML, NMU (R.Wynn, Directors, WP leads)

Description:

Aim is to promote UK robotic and technology innovation within the SA Government structures as a more efficient means for the collection of environmental data to support fisheries management. DAFF have two fisheries survey vessels (FRS Africana and FRS Ellen Khuzwayo) which are always under pressure to cater for the many fishery sectors. These technologies offer a relatively cheaper and more efficient means. As a way of engaging senior management, a robotics operations room will be set up at NMU equipped with screens showing real time robotics data as well as modelling and RS information during the February 2019 cruise operations. This room will work as a main hub and stakeholder engagement and training space in all three technologies. This is the main high profile project event where participation at the ministerial level and representation of GCRF, World Bank and the UK Scientific Innovation Network (SIN) is anticipated. Ensure that screens are budgeted in NMU.

3.6.3. Policy and practice notes

Deliverable: Policy and practice information pack (M42)

PIs responsible for delivery: M.Roberts, K.Popova, WHH Sauer

Participating institutions: NMU, Rhodes, PML, NOC, UCT

Milestones:

M9: Science into policy framework and action plan developed; Successful examples of Policy and Practice notes from previous projects reviewed (if exist).

M36: Full list and layout of Policy and practice notes identified

Description:

We will produce policy and practice notes aiming at key groups of stakeholders (Management of LMR, Policy, Businesses and Industry, Technology, Communities).

3.6.4. Final stakeholder presentation event

Deliverable: Workshop [1-2 day event following Science Synthesis Workshop M48]

PI responsible for delivery: M.Roberts

Participating institutions: NMU, UCT, Rhodes, NOC

We will run a targeted stakeholder information event on the key deliverables of SOLSTICE, its legacy, and the way forward. We will present the Policy and Practice information pack. We will also use this event for the final stakeholder related indicators for M&E profiling (interviews, surveys).

3.7. WP4. Capacity Development

3.7.1. Full capacity development plan for South Africa

Deliverable: Project report and outcome/impact indicators (M9)

Participating institutions: NOC (Byfield), WP leaders 1a,b,c and 2, NMU

We will produce a project report outlining the following:

- Institutional capacity baseline, including overview of facilities and expertise

- All project MSc/PhD studentships including UK-WIO supervisors, training needs, participation in the project events and exchange visits and contribution to the key deliverables.
- Institutional capacity development requirements in technologies (modelling, remote sensing, robotics) and field work, key outcome indicators, baseline assessment of these indicators, and capacity development plan.
- Stakeholder capacity development needs
- NOC/PML capacity development needs in application of core expertise in ODA arena
- GCRF might require additional activities on baselining of institutional capacity (TBC).
- Note request from NMU for training in productivity measurements (primary and secondary) by HWU and NOC staff for M.Noyon.

3.7.2. Training courses

Deliverable: Training courses and associated material (M12, M18, M30)

Description:

We will run three 2-week training courses: Applications of remote sensing, Applications of ocean modelling, and Science communication. This will be available to junior staff and post-graduate students at participating institutions, including at least one person from each of the supporting partners in the wider WIO. A MOOC production workshop and communication course will be run at IMS. Dr M. Noyon (NMU) and Dr J. Mwaluma (KMFRI) offers to train TAFIRI and IMS researchers, technicians and students (collaborative work with the IIOE2-SA Agulhas II cruises) on zooplankton species identification

Course 1: Applications of marine remote sensing (M12, Zanzibar)

Deliverables: Training course brochure (M8), delivery (M12); course report (M13); course lectures and tutorials available on line (M13).

Participating: NOC-RS (PI V.Byfield), IMS, TAFIRI, PML-RS, CORDIO, SAEON, Rhodes?

Milestones (main milestones for wider distribution in bold)

M8: Course brochure for publication to partner institutions,

M12: Delivery of the training course

M13: Course report with analysis of student feedback

Course 2: Modelling training course (M24, Zanzibar)

Deliverables: Training course brochure (M14), delivery (M18); course report (M19); course lectures and tutorials available on line (M21).

Participating: NOC-MSM (PI E.Popova), NMU, PML

Milestones:

M20: Course brochure for publication to partner institutions,

M24: Delivery of the training course

M25: Course report with analysis of student feedback

M28: On-line availability of course material (lectures and tutorials) on SOLSTICE web site

Course 3: Science communication& MOOC production workshop (M30)

The aim of this training workshop is to develop skills for communicating science to different audiences through participatory training exercises and produce SOLSTICE MOOC material based on the case studies.

Deliverables: Training course brochure (M25), delivery (M30); course report (M19); course lectures and tutorials available on line (M21), additional outreach resources on line (M24).

Participating: NOC-MPOC (PI V.Byfield), IMS, Imperative Space, NOC Coms, all partners

Milestones (main milestones for wider distribution in bold)

M30: Delivery of the training course;

M31: Course report with analysis of participant feedback

M23: On-line availability of communication material developed during the course and refined by participants in the following months.

Training workshop on zooplankton identification

Dr M. Noyon (NMU) in collaboration with Dr J. Mwaluma (KMFRI) offers to train TAFIRI and IMS researchers, technicians and students (collaborative work with the IIOE2-SA Agulhas II cruises) on zooplankton species identification
Milestones:
M9 Workshop content, date, location and participation agreed.

3.7.3. Fieldwork hands-on training

Fieldwork hands-on training and its scientific deliverables are described in the Fieldwork package.

Responsible: WP4 lead, Field work lead Co-PIs and main contact in each partner organisation participating in the field work

Additional deliverables

M9, M21, M30: Support for filming to provide outreach material and content for the SOLSTICE MOOC (Mentors and trainees; NOC Coms, V.Byfield supported by 2-3 volunteers to film field activities, including under-water).

M12, M30 Report on the effectiveness of the fieldwork capacity development activities based on feedback from participating mentors and 'trainees', as contribution to an M&E report.

3.7.4. MOOC

Deliverables: course content (M36) and screening (Months 37, 42, 48)

Provisional title: "Sustainable use of living marine resources: case studies from the Western Indian Ocean"

PI: V.Byfield

Description:

The MOOC will run on the Future Learn (Open University) platform. Following its first screening, an offline version will be made available for use by the partners, and other organisations in the WIO in their course activities. The MOOC will build on research activities in WPs 1, 2 and capacity development resources developed in 4.2, using examples from each of the three case studies, and from SOLSTICE stakeholder engagement activities. The content will address selected capacity development needs of partner institutions and stakeholders, as identified in the capacity development plan. It will run over 6 weeks, each week covering a major theme in SOLSTICE research and stakeholder engagement. Content related to Kenya will include:

- interviews with experts and selected stakeholders, transcript of interviews,
- video from research activities collected during training courses and workshops
- model and satellite animations,
- brief background text and figures with references to further information on the SOLSTICE web site and elsewhere on-line,
- short Q/A exercises to test student understanding,
- forum where students can discuss the topic, ask questions, and share information.

All Co-Is in the UK and WIO are expected to contribute in areas of their expertise, and encourage their students and junior scientists to engage with the MOOC development. Contributors are expected to:

- give interviews about their work and area of expertise,
- facilitate filming of research and other project activities

- provide background text and references, figures, images and/or animations for the MOOC content, related to their research and area of expertise
- follow the MOOC on-line while it runs to answer questions related to their area of expertise.

Milestones:

M9: MOOC outline agreed, all contributors identified,

M12: detailed MOOC outline developed, presenter/interviewer identified for each country (Kenya, Tanzania, South Africa, UK)

M13: MOOC promotional video produced (NOC, IMS)

M13: MOOC sample lecture produced (NOC)

M18: MOOC CS1 &2 layout finalised (following fieldwork completion)

M24: MOOC CS3 layout finalised (following fieldwork completion)

M34: MOOC outline completed and advertised on Future Learn

M35: Full MOOC content compiled

M36 – Published on FutureLearn platform

M37: MOOC Run 1 (Oct 2020)

M40: Off-line version of MOOC available on SOLSTICE web site (Jan 2021)

M42: Off-line version on Ocean Teacher

M42: MOOC Run 2 (Apr 2021)

M48: MOOC Run 3 (Sep 2021)

M39,M44, M50 Short reports with statistics on MOOC uptake and user profiles for inclusion in M&E reports

3.7.5. MOOC Light

Deliverables: M39 MOOC Light; M48 report on community testing

PI: V.Byfield

Description:

The MOOC Light will be designed for use in schools and as informal education tool to promote ocean literacy. Covering the main themes addressed by the MOOC, it comprises video, informative brochures and a selection of guided education activities to promote understanding of local habitats,

the global interconnectedness of the oceans, and of the productivity that supports larger marine animals, including species important to local fisheries. It will be available in English and Swahili.

Milestones:

M12: recommendation from Science-to-policy WGs on MOOC content received

M30: MOOC Light layout agreed (following CS 1, 2 and 3 fieldwork) and

M39: Content compiled in English and Swahili

M45: MOOC light tested with local fishing communities (KMFRI, IMS, NMU, SAEON,SASMIA, WWF, other participants involved in community engagement activities)

3.8. WP5 Communication

3.8.1. Regular channels of communication:

- Project website (external): Fully operational by 15th December 2017
- Project website (internal): Fully operational by 1st march 2018
- Project newsletter (internal): every 3 months starting 1st December 2017
- Project newsletter (external, summary for stakeholders): every 6 months, starting 1st April 2018
- Project newsletter (external, impact summary for funders): every 6 months, starting 1st April 2018

3.8.2. One-off communication material:

- SOLSTICE banners (M1)
- SOLSTICE brochure (M1)
- Notes for partners on community engagement regarding the use of robotics (in preparation for reconnaissance mission in June 2018): M4 (January 2018)
- Community engagement leaflet on the use of robotics for Tanzanian newspapers: M3 (January 2018)
- Video on robotics for Tanzanian schools / community engagement (M5)
- SOLSTICE promotional video: M9
- SOLSTICE MOOC promotional video: M12
- SOLSTICE MOOC sample lecture (video): M12
- Training course leaflets
- MOOC leaflets (M32)
- Infographics for the Case Studies (M42)
- Policy and practice notes for the Case Studies (M42)
- SOLSTICE: summary of outcomes and impacts leaflet

4. Monitoring and evaluation

4.1.1. Network profiling

Deliverables: survey and basic analysis tools **(M6)**

Participating institutions: NOC (Popova, Alexiou), PML, all partners

Milestones:

M5 questionnaire finalised

M5 survey returned

M6 methodology and indicators finalised

We will use a modified GULLS survey (social network analysis) to profile the network strength and growth parameters (baseline, midterm and end term). International transdisciplinary network is the key delivery of the GCRF Grow call, thus this survey is of extreme importance and should clearly reflect our key success indicators.

4.1.2. M&E strategy

Participating institutions: NOC (Popova), PML,UCT

Deliverables: Project Report (M6)

In consultation with GCRF we will produce a strategy document detailing a complete M&E approach including logframe, theory of change, profiling surveys and methods of qualitative information collection.

4.1.3. Monitoring and evaluation reports

Participating institutions: NOC, PML,UCT

Deliverables: Project Report (M12, M30, M51, long term impact TBD)

Milestones: M&E indicators will be collected every six months

M&E will consider four evaluation categories: i) impact of capacity development both in WIO and UK; ii) benefits, costs and practicalities of employing the new technologies and recommendations; iii) societal impact of case study outcomes; and iv) strength and impact of UK-WIO transdisciplinary networks.

Towards the end of the project we will secure additional funding for the post-project M&E when the highest impacts are expected to be achieved (GCRF additional funding, NC, national and public good are the most obvious routes).

5. Alignment with key regional programs

5.1. IIOE-II

IIOE-II (Second International Indian Ocean Expedition (IIOE-2)

Engagement: We will engage with Mika Odido from IOC sub-commission for Africa and the adjacent island states (via SOLSTICE Advisory Panel). Will also engage with Human Benefits and Impacts (Science Theme 1). Lead Dr Ben Milligan.

5.2. The Western Indian Ocean Upwelling Research Initiative (WIOURI)

WIOURI (Western Indian Ocean Upwelling Research Initiative)

WIOURI is a flagship IIOE2 project, along with EIOURI. Engagement via WIOURI PI Mike Roberts. It should be noted that the establishment of the Ocean Sciences Campus at NMU, with the strong assistance of SOLSTICE, fulfils a major aspect of the WIOURI-IIOE2 plan. SOLSTICE will be highly visible at WIOURI/IIOE2

6. Key events and workshops

April 2018, London (TBC)

- Annual Leadership team meeting
- Annual Advisory Panel meeting

May 2018, NOC

- SA science planning meeting

October 2018, PE-CT

- WP2 meeting
- Sci-Policy WG
- Stakeholder engagement

February 2019

- SA cruise and operations room

April 2019, Mombasa (TBC)

- Annual Leadership team meeting

- Annual Advisory Panel meeting

September 2019, Zanzibar (preliminary date)

- Modelling training course

November 2019, Location?

- 11th WIOMSA symposium
- SOLSTICE exhibition and special session (if WIOMSA is run in one of the SOLSTICE countries)

January 2020, PE

- SA Case Study science progress WS in preparation to SI submission

April 2020, Zanzibar (TBC)

- Annual Leadership team meeting
- Annual Advisory Panel meeting

May 2020 (preliminary date)

- Communication training course

February 2021 (PE)

- Science into Policy WG meeting (preliminary date)

April 2021, Port Elizabeth (TBC)

- Annual Leadership team meeting
- Annual Advisory Panel meeting

September 2021, PE-CT

- Synthesis, evaluation and science into policy workshops

October 2021, Location?

- 12th WIOMSA symposium
- SOLSTICE exhibition and special session (if WIOMSA is run in one of the SOLSTICE countries)

7. Institutional Contributions to the Case Study

7.1 NMU

NMU will work as a hub for the South African Case study and will provide meeting facilities for all SA project workshops and meetings.

Prof Roberts will lead delivery of the SA Case Study outcomes including all key documentation and Special Issue

Prof Roberts will lead all SA field work and its deliverables as described in this IP.

Prof Roberts will ensure smooth collaboration with BCRE in respect to all equipment.

Prof. Roberts will provide engagement with Case Study related stakeholders

Prof Roberts will serve as a member of the SOLSTICE Leadership Team reporting annually to the Advisory Panel.

Dr. M.Noyon will contribute to all SA field work organisation and coordination. She will participate in and lead some of the cruises and field work.

Dr M. Noyon will coordinate SA contribution to the literature review.

Dr M. Noyon will lead the plankton productivity work and will take a lead on publications of the results to SI. Additional training in plankton productivity will be required.

Dr M. Noyon will supervise NMU students and coordinate their work with wider SOLSTICE activities.

Mr Brian Godfrey will be part of the NMU dive team and will coordinate the deployment and service of OBS moorings as well as the other moorings activities related activities on the Agulhas Bank

Mr Brian Godfrey will get some training on the technical aspects of gliders deployment, calibration, data collection and validation. A visit to NOC Southampton or Liverpool is planned.

A modeller (to be identified) will be employed for 3 years to work on the modelling aspect of the SA project and supervise students

7.2 Rhodes

Prof. W Sauer will lead on SOLSTICE wider engagement with the WIO fisheries and DSFA (with links to tuna) in particular.

Prof. W Sauer will strongly contribute to the Science into Policy working group activities and in particular to the production of final Science into Policy briefings and material for all three Case Studies.

Prof. Sauer will serve as a member of the SOLSTICE Leadership Team reporting annually to the Advisory Panel.

5.1. 7.3. UCT

Prof T.Leiman will co-lead SA WP2 (with E. Papathanasopoulou) as described in this IP and in particular will deliver WP 3.6.5. Economic structure of the industrial side and the fisher component of the fishery.

Prof T.Leiman will serve as a member of the Science into Policy WG for SA Case Study and will contribute to project monitoring and evaluation.

7.4 PML

PML will take the lead on WP2 (Socio Economics, PI: E. Papathanasopoulou) and contribute to: the Remote Sensing component of WP1 (Remote Sensing, PI: D. Raitsos), WP3 (Science to Policy), WP4 (Capacity Development) and M&E.

PML will take a lead on the following WP2 tasks: Multi-species fish modelling; Input-Output tables; and Marine Spatial Planning. It will also strongly contribute/lead WP1 tasks: synthesis of satellite information to identify large scale drivers, local drivers, real-time support of fieldwork, on-line/off-line remote sensing access; WP3: all relevant activities; WP4: 2-week remote sensing training course and MOOCs.

PML will be involved in co-supervising master and PhD students aligned with the SA case study, particularly through the WP2 Input-output task (E. Papathanasopoulou).

E. Papathanasopoulou will serve as a member of the SOLSTICE Leadership Team reporting annually to the Advisory Panel.

7.5 NOC

NOC as a lead organisation has overall responsibility for delivering the project. NOC PI is identified in every WP with two exceptions: Social Studies 3.4.7 and 3.4.8.

Dr.Popova and Dr.Byfield will serve as members of the SOLSTICE Leadership Team reporting annually to the Advisory Panel.

8. List of abbreviations

AUV - Autonomous Underwater Vehicle

BGC - Biogeochemistry

CS – Case Study

EAF - ecosystem approach to fisheries

GCRF – Global Challenges Research Fund, UK (Project Funder)

MOOC – Massive Online Open Course

M&E – Monitoring and Evaluation

ODA - official development assistance

ROV - (Remotely Operated Vehicle)

RS – Remote Sensiong

SI – Special Issue

WG – Working Group

WP – Work Package

5.2. APPENDIX

Nelson Mandela University Ocean Science Campus

Opportunities for Post-Graduate Studies in Marine Science

2018

Opportunities to study ocean science are now available starting in February 2018 at the newly opened *Ocean Science Campus* (OSC) located at the Nelson Mandela University in Port Elizabeth, South Africa. Phase 1 of the OSC was completed in September 2017 (above pics). The regional facility embraces state-of-the-art physical oceanography work spaces, laboratories, post graduate offices, board and lecture rooms, experimental aquaria and a scientific diving and training centre — all of which support a range of disciplines including ocean physics, biogeochemistry, phytoplankton, zooplankton, trophic assemblages and ecology, and fisheries across estuaries, coastal, shelf and deep ocean waters. The OSC is a post graduate facility specialising in the impacts of climate change on western Indian Ocean (WIO) marine ecosystems. It is strongly allied with the *International Indian Ocean Expedition 2 (IIOE2)* (*http://www.iioe-2.incois.gov.in/)* initiative and the Sustained Indian Ocean Biogeochemistry and Ecosystem Research (SIBER — http://www.incois.gov.in/portal/siber/index.jsp). As the OSC is focused on regional research, post graduate students studying for MSc and PhD degrees and Post-Doctoral candidates are placed in international, multidisciplinary teams which explore and model the varying ecosystems of the WIO. This not only broadens their knowledge base in ocean science and linkages but also prepares early career scientists for the working environment where teamwork is essential to study large, complex

earth systems. Ship-based and robotic sampling forms a key component of all research projects. Research and outputs are strongly aligned with food security and science to governance.

This advert for five study positions initiates the South African part of a new, largescale, 4-year international project (2018-21) which investigates ecosystem functioning in the domains of the East African Coastal Current (Kenya and Tanzania) and the Agulhas Bank (South Africa), with reference to climate change and food security. Referred to as SOLSTICE-WIO (*Sustainable Oceans, Livelihoods and food Security Through Increased Capacity in Ecosystem research in the Western Indian Ocean* — http://solstice-wio.org/), the project aims to also build research capability in the WIO and hence student training and early career advancement is of great importance. Funding for SOLSTICE is provided by the UK Global Challenge Research Fund (GCRF) with scientific expertise from the National Oceanography Centre in Southampton, United Kingdom.

The chosen Post Graduate students will be based at the OSC but will also be required to travel to the National Oceanography Centre (NOC) in Southampton (UK) for training and co-supervision during their study period, and therefore must meet UK visa criteria. These visits will provide exposure to international standards for research. They will be part of a transdisciplinary team based between these institutes and will need to work as part of the SOLSTICE team. Students must be highly motivated and determined to succeed as the SOLSTICE team will depend on their results which will be published in peer-reviewed international journals. Scholarships from the Nelson Mandela University will be provided for the duration of study (3 years maximum).

Closing date for applications: 15 February 2018

SOLSTICE Projects and positions

The South African component of SOLSTICE, led by the Nelson Mandela University, is focused on the collapse of the squid fishery in 2013-14, and the underlying ecosystem shifts that might have been responsible. The study encompasses physical and biological oceanography (incl. biogeochemistry) as well as socio-economic aspects of the collapse of squid fishery.

The following are offered as of February 2018.

Composition, dynamics and role of Benthic Nepheloid Layers (BNLs) on the Agulhas Bank: This project aims to understand the formation and decay of the BNL on the eastern Agulhas Bank. The BNL is responsible for water clarity near the seabed which appears to play an important role in squid spawning behaviour. Suspended organic bottom particles also support bottom filter-feeders and nutrient regeneration making them key components of the ecosystem. The project will involve going to sea on large and small vessels to collect water samples containing marine snow using a "snow catcher" and analysing these for particulate organic matter (POM) composition and settling rates. Experimentation both in situ and in the laboratory will also be undertaken to determine microbial decomposition rates and products. This work will be undertaken in tandem with another PhD study that uses moorings to measure and monitor the occurrence and intensity of BNLs. Expected level of study will be a PhD with the student have strong skills in microbiology or marine biology, statistical analyses and communications (good English, written and spoken). Candidates with previous experience in experimental set-up and biological oceanography will be an advantage.

Short title: Marine snow Agulhas Bank

Start date: February 2018

[For official purposes: Student # 3]

Agulhas Bank circulation and long-term variability: This project investigates the circulation (ocean currents) on the eastern and central Agulhas Bank with special attention given to a feature known as the cold ridge. Acoustic Doppler Current Profiler (ADCP) moorings will be deployed from a ship for 12 months off the Tsitsikamma-Knynsa coast in early 2018. Moorings will be serviced after 6 months with first data uploaded. Surface satellite-tracked drifters will be released from a ship during deployment, service and recovery of the moorings. Ship collected ADCP data will augment mooring and drifter measurements. The student will be expected to go to sea to participate in all activities. Historical ADCP data as well as satellite altimetry measurements will be analysed in the first 6 months of the project. The research output will be a quantitative understanding of the circulation on the eastern and central Agulhas Bank, with insights on the formation of the Cold Ridge. This will be used to validate an ocean model. Expected level of study will be a PhD with the student have strong skills in physics or physical oceanography, programming (Matlab), excellent analytical skills, and good communications skills (written and spoken English).

Short title: Agulhas Bank circulation

Start date: February 2018

[For official purposes: Student # 4]

SST—chlorophyll structures and variability on the Agulhas Bank using earth observations: This study needs to start as soon as possible as it underpins several of the projects listed. It requires workup of historical daily composite ocean colour and SST products at 1 km resolution from MODIS, VIIRS, Envisat and Sentinel-3 satellite missions to ascertain spatial, seasonal and inter-annual trends for various regions of the Agulhas Bank, including upwelling off Port Alfred and the Cold Ridge. The

student will work closely with the SOLSTICE team at the National Oceanography Centre and the Plymouth Marine Laboratory (PML) in the UK. Emphasis will be placed on the spatial structure of these features so that mooring locations and cruises can be planned and configured. These data will link with all projects listed in this advert involving case study support, and model validation. The project will also provide near-real time products to guide cruise and glider operations to take place in February 2019. Long term data from coastal underwater temperature recorders (UTRs) will be used to validate remote sensing SST products. Expected level of study will be a MSc/PhD with the student have strong skills in physics or physical oceanography, programming (Matlab), excellent analytical skills, and good communications skills (written and spoken English).

Short title: Earth observation Agulhas Bank

Start date: February 2018

[For official purposes: Student #: 5]

Physical processes affecting the evolution and structure of the Cold Ridge: This study investigates the evolution and structure of the Cold Ridge on the Central Agulhas Bank — a feature thought to be an upwelling filament emanating from upwelling along the Tsitsikamma coast. The Cold Ridge is expected to be a major source of nutrients and therefore a stimulus for production, and hence an important feeding area for squid paralarvae. The study will include elements of modelling, remote sensing and *in situ* sampling using a ship and gliders. While acquiring skill sets in the first 10 months, the student will first investigate historical ship-collected data in preparation for a 14 day cruise. While the ship survey data will provide the subsurface structure of the Cold Ridge, the gliders will investigate sub-mesoscale processes, particularly near the feature's boundary, thought to be responsible for the observed patchiness of plankton. A prototype state-of-the-art nutrient micro-sensor will be deployed on one of the gliders for this purpose. Depending on the progress made and availability of instrumentation, microstructure turbulence may also be investigated. This project, owing to the advanced technology used, will be strongly supported by the NOC Robotics team, but the student will be expected to go on small and large vessels to assist operations. Expected level of study will be a PhD with the student have strong skills in physics or physical oceanography, programming (Matlab), excellent analytical skills and good communications skills (written and spoken English).

Short title: Cold Ridge evolution

Start date: February 2018

[For official purposes: Student # 6]

Zooplankton dynamics of the eastern and central Agulhas Bank: This project investigates the productivity of zooplankton of the eastern and central Agulhas Bank and will comprise historical sample analysis along with new ship-collected samples and experiments. Special emphasis will be

placed on the Cold Ridge and their importance in the Agulhas Bank ecosystem. The student will be expected to work in the lab using instrumentation such as a Zooscan, as well as to go to sea for sample collection and experiments using both small and large vessels. Zooplankton samples with hydrological data have been collected since 1988 on the Agulhas Bank during spring and autumn during DAFF fisheries surveys. These collections are still intact in formalin. Analysis of these will comprise assemblage composition, biomass, ecology and trends. New samples will be collected during a 14-day cruise in February 2019 updating the zooplankton data set, but also focusing on the ecology and community dynamics — the latter including experimentation. Expected level of study will be a PhD with the student have strong skills in ecology, marine biology or biological oceanography. Excellent numerical (incl. multivariate analyses) and statistical skills are required. Programming experience in Matlab or R would be a benefit.

Short title: Agulhas Bank Zooplankton

Start date: February 2018

[For official purposes: Student # 7]

Enquires and Applications

Interested students should electronically submit:

1. CV with university courses and grades

2. A letter of motivation of why you want to do the project

3. Copy of ID/passport

These should be sent to:

Dr Margaux Noyon

Ocean Science Campus

Nelson Mandela University

Email: Margaux.Noyon@mandela.ac.za