

Darwin Initiative Main Project Annual Report

Important note: To be completed with reference to the Reporting Guidance Notes for Project Leaders:

it is expected that this report will be about 10 pages in length, excluding annexes **Submission**

Deadline: 30 April

Darwin Project Information

Project Reference	21-013
Project Title	Alternative livelihood opportunities for marine protected areas fisherwomen
Host Country/ies	Sierra-Leone, UK
Contract Holder Institution	University of Stirling (UoS)
Partner institutions	Fourth Bay College, University of Sierra Leone Institute of Marine Biology and Oceanography (IMBO), Njala University (NJU), Macalister Elliot and Partners Ltd. (MEP).
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Project Leader name	Francis Murray
Project website/blog/Twitter	http://www.stir.ac.uk/aquaculture-mangrove-oyster/
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Glossary of Terms and Abbreviations

CBD	The Convention on Biological Diversity (1992)
CMA	Community Management Association
DI	Darwin Initiative
dd-RAD	Double Digest Restriction-site Associated DNA marker analysis
EJF	Environmental Justice Foundation (UK NGO)
FT	Freetown
GHI	Global Hunger Index (IFPRI)
HH	Household
IMBO	Institute of Marine Biology and Oceanography (Fourah Bay College, Freetown)
(I)RDP	(Integrated) Rural Development Program
LMC	Local Management Committee (with oversight for CMAs)
<i>Lumi</i>	A weekly (usually Sunday) open-air food market
MDG	Millenium Development Goals
MFMR	Ministry of Fisheries and Marine Resources
MPA	Marine Protected Area
NJU	Njala University
PI	Principle Investigator

SDG	Sustainable Development Goals
SSL	Sierra Leone Leones (Le: local currency)
UoS	University of Stirling

1. Project Rationale

Sierra Leone is the 4th poorest country in the world according to the IFPRI World Hunger Index. Many Sierra Leonean fisherwomen living in coastal mangrove areas are trapped in a downward spiral of environmental destruction and resource depletion. Because they are poor, lacking capital and alternative sources of income, they are compelled to harvest oysters in what has become an increasingly widespread and unregulated seasonal activity. It is a hard and dangerous life, injuries such as infected cuts from roots and shells are common. Mangrove trees are damaged by the harvesting and habitat for other species is disturbed. If the oysters are overexploited from an area one of the few options left for the women will be to cut the trees for firewood. The government is making efforts to regulate the fishing effort of artisanal fishermen; from the start of 2014, only 11,000 boats, mostly dug-out canoes (on which female oyster gatherers also depend) were registered and licensed to fish throughout the country. Agricultural and other livelihood opportunities are few in the research area; most inhabitants depend on exploitation of primary (aquatic, and forest) resources. Alternative livelihoods also need to be found for families excluded from fishing. Most of the commercial fish species in Sierra Leone also depend on the mangroves as spawning and nursery areas.

This project aims to support the work of the Marine Protected Area by providing alternative livelihoods based on carefully managed extensive culture and value-added marketing of native mangrove oysters in order to make it a financially viable income earning activity for local women whilst also protecting its sustainability for the future. A native oyster depletion and degradation problem was identified during 2006/7 by a previous Darwin Initiative project under which two reconnaissance surveys (Wadsworth 2009a & 2009b) were undertaken to consider the possibility of including the mangrove forests as a “biodiversity offset” to a commercial Rutile-mineral mining concession (NACE 2009). Subsequent research indicates that the oyster population may be more resilient to the prevailing hand-gathering methods than first anticipated (see 2017-2018 annual report), thus greater emphasis is now being placed on sustainable mangrove management linked to incentivising prudent oyster harvest and processing practices.

The primary research area and main target beneficiaries, i.e. female oyster gatherers and their households, is located in Bonthe District, Southern Province around the Sherbro River estuary, an area which includes the district administrative centre, Bonthe Town on Sherbro Island (Figs 1a-c). Sherbro Island borders the Atlantic Ocean to the west, and is separated from the African mainland by the Sherbro River in the north and by the Sherbro Strait to the east. The Sherbro Estuary is 32 miles (51 km) long and up to 15 miles (24 km) wide, covering a total area of approximately 230 square miles (600 km²). At the western extremity is Cape St Ann, and on the eastern end, is the chief port and commercial centre of Bonthe. Fig 1c shows the location of satellite-communities identified in mangrove stands around Bonthe town. This is effectively the larger target-population to which project results will be generalizable.

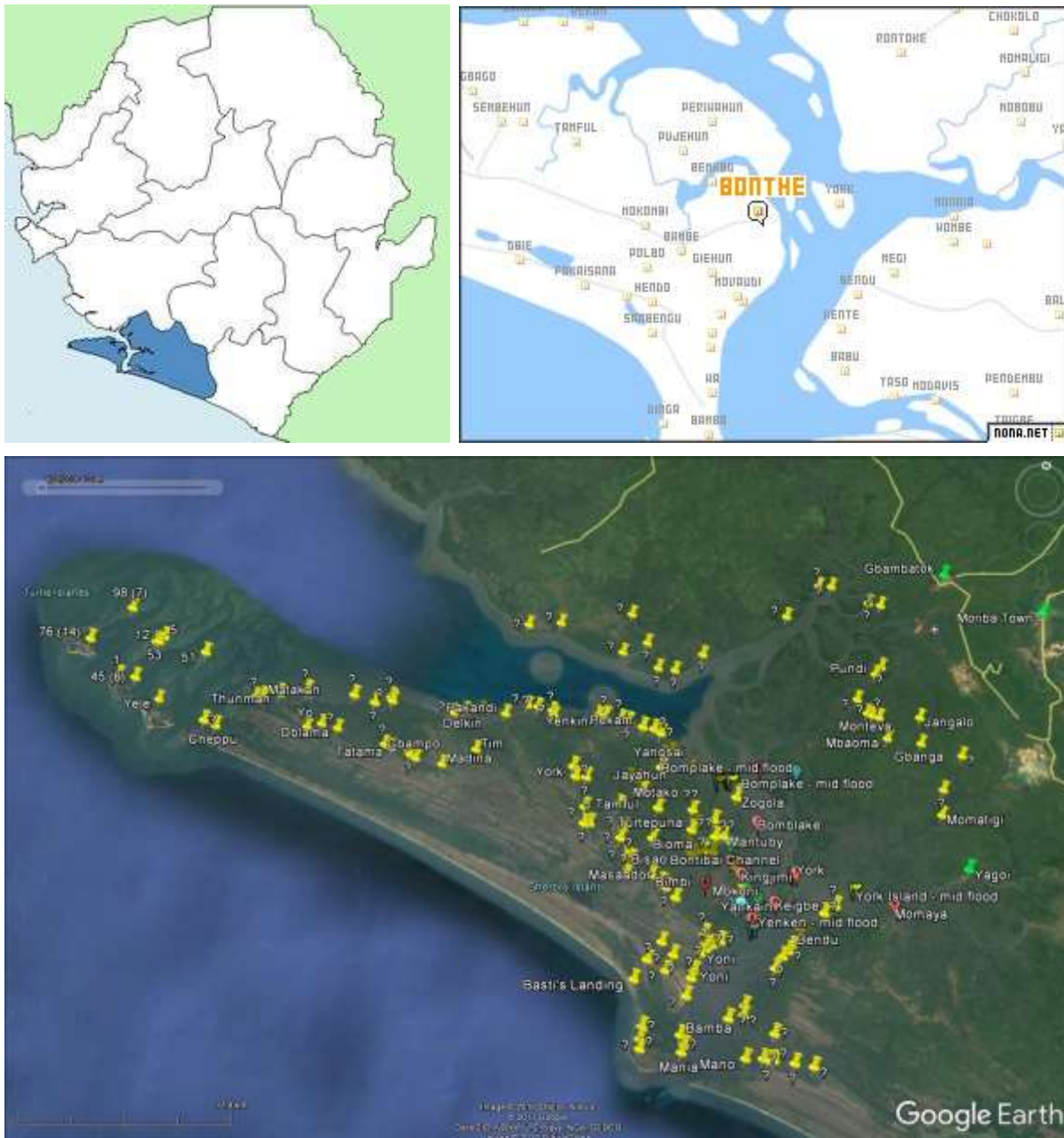


Figure 1a-c: Location of project area in the Sherbro estuary and Bonthe town. The lower map (Fig 1c) shows locations satellite mangrove communities around Bonthe town (redflags are focal research communities (Satellite image source: Google Earth 2016).

Most oyster gathering and processing is undertaken by small satellite communities located around the oldest and largest settlements of Bonthe and York on Sherbro and York Islands (Fig 1). In the absence of roads and motorised transport, oyster-gathering, fishing and most local transport is highly dependent on having access to small (1 to 3 person) dug-out canoes.

Oysters are steamed for domestic consumption and local retail in more populated areas to the south of the MPA, especially Bonthe (Pop. ~11,000) and York (Pop. ~500) towns, together constituting Bonthe Municipality. Remoter 'satellite' communities with poor access to these retail markets must first steam then smoke-preserve their oyster (and fish) surpluses to stockpile and sell in one of two weekly mainland wholesale markets (*lumis*) with motorable road connections; Yagoi on the Sherbro River to the south and Gbambatok to the north. A separate tier of female vendors then transport and market the smoked oysters in inland population centres including Bo and Kenema. Relatively low volumes appear to reach Freetown where preferential demand for steamed demands is met from adjacent mangrove fisheries.

As a euryhaline species the mangrove oyster (*Crassostrea tulipa*) targeted by artisanal fishers is phenotypically adapted to estuarine variability. In the Sherbro estuary, most oysters are

harvested from mangrove roots where their inter-tidal position results in high periodic natural mortality linked to low surface water salinity during the rainy season. Thus most harvesting pressure appears to be on single year-class cohorts capable of rapid growth under nutrient rich, warm water conditions. Despite observed increases in gathering pressure, oyster populations still appear to rebound on an annual basis due to a combination of residual breeding pools e.g. sub-tidal 'mud' oysters are more resistant to hand harvesting, high fecundity and rapid growth. Taxonomic similarities between morphotypes associated with different substrate types are being evaluated. Findings suggest that the most pressing environmental threat linked to the fishery is mangrove depletion resulting from imprudent oyster harvesting methods, especially root cutting and use of mangrove wood as fuel for oyster processing.

Consequently a revised Log-frame incorporating several major changes to the original planned intervention options has been developed following extended consultation with all project partners and the Darwin Initiative (Section 10). This includes a shift from resource intensive aquaculture and solar cold-chain options in favour of post-harvest interventions with greater economic justification for sustained adoption. The revised higher-level project impact statement (Annex 2a) is now as follows

'Improved wellbeing of local communities and reduced pressure on mangrove populations resulting from improved sustainability of mangrove-oyster harvesting and processing practices and value added marketing in the Sherbro Marine Protected Area (Bonthe District, Sierra Leone)'

2. Project Partnerships

The following project partners and affiliates collaborated on research activities in around Bonthe during the current reporting year:

1. Dr Francis Murray: Aquaculture development specialist, UoS (PI)
2. Mr William Leschen: Aquaculture development specialist, UoS
3. Dr Richard Wadsworth: environmental science specialist, Njala University, SL (PI)
4. Dr Salieu Sankoh: aquaculture and fisheries specialist, IMBO, SL (PI)
5. Mr. Richard Kapindi: Community outreach & survey expert, IMBO, SL
6. Mr James Green: Commercial oyster aquaculture specialist, Whitstable Oysters, UK
7. Mr Edward (Amara) Kalone: IUU project officer, Environmental Justice Foundation, Bonthe, SL
8. Dr Richard Quilliam: food borne pathogen analyses, UoS, UK
9. Mr Nicholas Shell: Sustainable aquaculture MSc project-student UoS.

PIs of the three principle collaborating institutions (see above) participated in a joint field mission to Bonthe District from 3rd – 11th June 2016 (following on from a similar mission in January 2016). The party was also accompanied by Dr Richard Quilliam (UoS) and Mr James Green (Whitstable Oyster Company). Objectives of the mission were: to (i) review progress and support field skills training and supervisory support for embedded staff including UoS MSc student (Mr Nick Shell; Apr-Jul 2016), (ii) to implement further primary research around oyster production, hydrography, faecal contaminants and nutrients analysis and marketing and (iii) to review and revise intervention options with consortium members and local stakeholders. This included Bonthe Municipal Council Mayor; Mr Layemin 'Joe' Sandy. Mr Kapindi (IMBO) and Mr Kalone (EFJ) remained based in Bonthe to coordinate longitudinal production, marketing and water quality survey work.

3. Project progress

Previous research outcomes (Annual report 2015/16) demonstrated flaws in assumptions on which original log-frame outputs 1 '*Sustainable production and collective management systems*' & 2 '*Supply chain enhancement*' were predicated (Annex 1). Consequently, the revised LogFrame (Annex 2a) has replaced the more resource intensive planned aquaculture and solar

cold-chain options in-favour a range of (mainly) post-harvest interventions determined to have greater adoption potential under local resource and market-conditions. The original Output 3 'Market promotion and value-addition & 4 Training and dissemination' has also been revised in accordance with these changes. Following is a summary of the revised intervention changes (see Annex 2b):

- (1) Fuel efficient cookers:** for steaming & smoking oysters to reduce operational costs and dependence on mangrove fuel: The following options will be assessed (1.1) Solar cookers – for primary (steam) processing (1.2) Fuel efficient wood-stoves for steaming and secondary (smoke) processing and reduction in water activity (Annex 7: Box A7.1)
- (2) Value-added through extension of product shelf-life:** in addition to the above technologies, we will assess potential for Low-cost evaporative cooling to extend supply catchment for daily marketing of more valuable steamed) oysters to the largest local market in Bonthe Municipality (also conferring direct food security benefits).
- (3) Other value-added processing** of smoked oysters (& possibly steamed if solar dried) (i) vacuum packing to extend niche value-added sales of branded product e.g. retail outlets in Freetown and inland cities. (ii) Ready meals - for value-added local sales in absence of coldchain (also using vacuum packaging). A recipe competition will be central part of the first Bonthe Oyster Festival (BOF: see below)
- (4) Re-use of shucked oyster shell waste for low input/output aquaculture:** (i) bottomculture thought transfer of shell-waste middens to adjacent mud banks. Note: whitewash production will not be considered as considerable amounts of mangrove wood is likely to be used in its production.
- (5) Training & Institutional capacity building:** On interventions above identified as having greatest potential (i) seek exchange around best-practice, training & institutional capacity building support from Gambia 'TRY' Women's oyster association¹. (ii) Institutional capacity building in Bonthe around centralised processing activities linked to MPA objectives where possible. Bonthe & satellite community engagement will also be built through mutually beneficial branding & promotion.
- (6) Branding & promotion:** (i) development of Sherbro logo and promotional materials (ii) Bonthe Oyster festival June 17 (with support of James Green, Whitstable Oysters UK) (iii) Media promotional coverage including local station Radio Bontico.

3.1 Progress in carrying out project Activities

Due to rainfall-linked salinity fluctuations in the Sherbro estuary, most oyster harvesting activity takes place from late Feb to Early Sept with May to July being peak months. Most field activities were timed around this cycle. Primary research outcomes for current year are summarised in Annexes 4 to 9.

These outputs contributed to improved problem-framing under-pinning the revised project design and the design of follow-on activities in the project M&E plan.

An additional 13 in-depth semi-structured interviews with oyster value-chain and institutional stakeholders in Bonthe and the Sherbro MPA were conducted during the June Mission. Results were transcribed and content thematically classified consistent with project research questions. A total of 30 such rich in-depth qualitative interviews have now been logged (6 institutional, 6 market and 18 with members of oyster communities in and around Bonthe). These interviews provided the basis for the preliminary analysis on mangrove impacts presented in Annex 4. Anonymised transcripts will be inventoried as a project output (Log-Frame Output 6).

¹ <http://oceansymposium.com/wp-content/uploads/2016/06/TRY-Oyster-Women%E2%80%99sAssociation.pdf>

Differential residual current (RC) patterns across the MPA have potential to influence: faecal contaminants concentration, mud-bank distribution primary productivity, oyster spat fall and condition index. To assess RC, hydrographic surveys were conducted at strategic locations of the estuary at different tidal states over a 12month period (Annex 7). Results can be used to predict the location of mud-banks supporting mud-oyster fisheries. This work is be conducted in conjunction with longitudinal primary productivity (PP) and oyster condition index analysis. PP levels in 'pilot' water samples collected from Bonthe waterfront were lower than anticipated emphasising the significance of residual currents to nutrient replacement rates (Annex 6).

In a second more systematic survey of oyster faecal contamination, Dr Richard Quilliam (UoS) confirmed unacceptable human health risks associated with consumption of fresh (un-steamed) oysters sampled in the Sherbro MPA (Annex 8). Although further research might have been directed at simple depuration options (e.g. solar depuration) market research indicated sufficient supplies of oysters are locally available adjacent to target-tourist beach markets near Freetown. Furthermore no contamination risk was detected in 'rock-oysters' in waters subject to full oceanic dilution near these beaches.

Samples of fresh and processed (steamed, smoked and sun-dried) mangrove oysters from Freetown and the Sherbro MPA were also subjected to proximate analysis (UoS) to determine impacts of processing on nutritional profiles (Annex 7). Results indicate a significant (21%) decrease in the crude protein levels of smoked compared to steamed oysters; being the two main commercial product forms.

A preliminary review of smoked oysters sales collected from Yagoi weekly wholesale market on the mainland (Annex 9) from Jun to Nov 2016, confirms the large catchment and primacy of this market. Female harvester-processors travel by launch from sites up to 75km distant at the northern mouth of the estuary. Prices rise significantly following the onset of the rains consistent with a reported decline in oyster condition index. Rising sales volumes recorded over the same period probably reflect a lack of discrimination between smoked oysters and cockles; the latter more likely to be collected in higher salinity waters at the northern mouth of the estuary.

The water quality analysis reported in the last annual report i.e. based on a single sample point at Bonthe Pier were extended over the same time period to give over a full year of data (data not shown). Attempts to extend the analysis to York Town and other satellite village sites were largely unsuccessful.

Mr. Nicholas Shell a UoS MSc student conducted project-related field work with these staff members between April to July 2017 contributing to submission of dissertation paper. *'Evaluating the role of mangrove oyster (Crassostrea tulipa) production and marketing on livelihoods of fisherwomen in the Sherbro River Delta, Sierra Leone; a mixed methods study'*. The thesis has been uploaded to the project website.

3.2 Progress towards project Outputs

Progress against the revised project outputs are as follows and summarised in Annex 1:

Output 1. Secondary pressure on mangroves populations reduced through more fuefficient processing: Will be assessed as party of two MSc projects (i) coordinated by Dr Richard Wadsworth (Njala University) planned for 2018 using historic satellite imagery (Annex 10) combine with supervised land-use/ impact classification (ii) an empirical survey of mangrove exploitation practices associated with oyster harvesting and processing, including fuel efficiency assessments, planned for 2017 and coordinated by Dr Richard Quilliam (UoS). These survey's will be framed around preliminary research findings on mangrove exploitation patterns summarised in Annex 4.

Output 2. Profitability of female oyster gathering increased through testing and adoption of extended product 'shelf-life' and value added processing techniques: Interventions described in Section 3 to be evaluated with local stakeholders in next research period.

Output 3. Safety and seasonality of female oyster gathering opportunities increased through localised re-use of shell-waste for low-input-output culture enhancements on mud-banks: Will be assessed as part of an MSc project planned for 2017/18 coordinated by Dr Salieu Sankoh (IMBO). Hydrographic (Annex 5), primary productivity (Annex 6) and oyster condition index analysis will be used to assess the biotechnical feasibility of suitable sites.

Output 4. Demand for value-added products created through branding and promotion. Branding: A post-graduate intern with requisite marketing skills will be recruited to support evaluation of branded products through product placement exercises in target inland markets. A prototype logo has been developed (Section 12) and radio promotion initiated (Section 12).

Output 5. Sherbro women's oyster gatherers association established based on mutually beneficial cooperation around processing and market interventions: To be initiated in the next research period (see Sections 11 & 12).

Output 6. Research outputs documented & shared with target audiences: All interim project outputs to be uploaded on the project website and interim findings to be shared with primary stakeholders at first Bonthe Oyster Festival (May 2017)/

3.3 Progress towards the project Outcome

The revised project outcome is as follows: *'Environmentally sustainable mangrove-oyster harvesting and value-added processing and marketing options for female gatherers evaluated and rolled out in the Sherbro Marine Protected Area (Bonthe District, Sierra Leone). Prudent harvesting and fuel-efficient processing also reduces pressure on mangrove populations with associated biodiversity gains'* (Annex 2a)

Associated revisions in development interventions were designed considering the following needs and risk analysis findings:

- Closer alignment with needs and capacities of the target female beneficiary group
- Reduction of unintended risks of increased resource extraction and elite-capture
- Reduction of pressure on mangroves assoc. with fuel use for primary (steaming) and secondary (smoking) oyster processing - potentially extending to reduction in use by males for smoking fish.
- Interventions accommodating very different resource & market constraints facing female gatherers in Bonthe Town and remoter satellite mangrove communities.

The efficacy of revised measurement indicators at will be assessed output and outcome level in the next research period. As the project is currently scheduled to end mid-way through a

seasonal production cycle in April 2018, a no-cost extension request has been submitted to the DI to extend the project to 31 Oct 2018.

3.4 Monitoring of assumptions

Critical monitoring of project assumptions lead to the major logical framework revisions comprehensively documented elsewhere in this report. Assumptions will continue to be monitored as part of the projects revised M&E strategy (Section 8).

3.5 Impact: achievement of positive impact on biodiversity and poverty alleviation

Potential impacts of project interventions (Activities 1.1 and 1.2) on mangrove health will be assessed through empirical trials (e.g. of fuel efficiency; Activity 1a) combined with longitudinal survey of harvesting & processing effort in project villages (Activity 1.3) over the 2017 production season, validated against a survey of smoked oysters wholesale activity in Yagoi weekly market (Activity 1.4) number & origin of vendors, type and sales volumes). Longer term trends in coverage (Activity 1b) and population settlement (Activity 1.5) will be assessed through GIS analysis of satellite images (Annex 10). The stratified sample design presented in Table 1 (Section 7) will provide the basis for assessment of livelihood impacts on the primary stakeholder of female gatherer-processors.

Genetic (dd-RAD) mapping of oyster morphotypes associated with different inter and sub-tidal substrates will be used to verify the working hypothesis that sub-tidal mud-oysters which are more resistant to prevailing hand-gathering methods could represent resilient multi-year class breeding pools.

4. Contribution to the Global Goals for Sustainable Development (SDGs)

The projects revised objectives have potential to contribute to the following SDG's:

Goal 1. End poverty in all its forms everywhere

Goal 2. End hunger, achieve food security and improved nutrition, and promote sustainable agriculture

Goal 5. Achieve gender equality and empower all women and girls

Goal 10. Reduce inequality within and among countries

Goal 12. Ensure sustainable consumption and production patterns

Goal 14. Conserve and sustainably use the oceans, seas and marine resources for sustainable development

Goal 15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss

The SDGs also emphasise improved monitoring, evaluation and accountability. In this respect, the projects longitudinal mixed-methods social and environmental survey design is highly consistent with the SDGs target by 2020 to *"increase significantly the availability of high-quality, timely and reliable data disaggregated by income, gender, age, race, ethnicity, migratory status, disability, geographic location and other characteristics relevant in national contexts."*² As the MDGs were compromised by failure of aid-flows to materialise the SDGs have put sustainable, inclusive economic development at the core of the strategy in order to enhance the ability of countries to address social challenges largely through improving their own revenue generating capabilities. This objective is reflecting in the projects exit strategy around an economically empowered women's marketing association.

² <https://advocacy.thp.org/2014/08/08/mdgs-to-sdgs/>

5. Project support to the Conventions, Treaties or Agreements

Project objectives under the Convention on Biological Diversity (CBD) are highly consistent with national objectives underpinning establishment of the Sherbro MPA. The revised project logical-framework (Annex 2a) now places increased focus on mitigating mangrove destruction through promotion of more prudent oyster harvesting and processing practices. The project remains aligned to the conventions 3 main diversity goals as follows:

1. **Conservation of biological diversity:** In the short to medium term and under prevailing environmental, market and artisanal gathering practices; oyster populations appear relatively resilient to over-exploitation. Mitigation of the negative impacts of oyster production on the health of mangrove assemblages will also have wider benefits to ecosystem health.
2. **Sustainable use of its components:** The economic rationale for investment in aquaculture appears questionable under prevailing resource conditions (further assessment is underway). The proposed shift of emphasis toward post-harvest supply chain interventions (Section 2, Annex 2a) has also been designed to limit extraction pressure and secondary impacts on mangroves.
3. **Fair and equitable sharing of benefits arising from genetic resources:** exploratory analysis (Annual Report 2015/16) identified the most resource-poor dependents on the oyster fishery in remoter satellite communities lacking land-connections to Bonthe. This and their greater population transience make such communities a challenging intervention target. Risks of centralising post-harvest options (in Bonthe for example) are well recognised and lessons will be learned from other local development projects (Section 11). Nevertheless poverty levels are universally high and interventions may be merited even if the poorest of the poor are difficult to reach. Any interventions must still consider food-security implications for these most vulnerable and a 'do-no harm' ethos is adopted to ensure there are no unintended negative impacts on these communities.

Despite repeated attempts by local partner Dr Sankoh it has not been possible to meet with the host country convention focal points in the last 12 months

6. Project support to poverty alleviation

Against a background of extreme poverty, it is noted that inhabitants of remoter satellite communities lacking land connections to Bonthe are amongst the neediest whilst also being the most difficult to reach. Consequently, processing and marketing development interventions will, as far as possible incorporate decentralised as well as centralised options (e.g. around branded packaging in Bonthe Town). This mix will be correlated with risks of 'elite-capture' assessed as partner of on-going stakeholder engagement and analysis. Direct benefits are not anticipated until the last 2 project years.

7. Project support to gender equality issues

The project explicitly targets female oyster gatherers and processors as the primary project beneficiaries. Female dominance in the profession is re-enforced by negative male attitudes of oyster gathering as 'a less serious' activity compared to fishing for example. However research has pointed to growing participation by some younger males in Bonthe Town; linked to their greater mobility in the use of dugout canoes for harvesting and lower entry costs compared to fishing requiring access to costly gears subject to theft. Further research effort will directed at assessing and quantifying this trend.

8. Monitoring and evaluation

The following research hypotheses, based analysis of qualitative data-transcripts with oyster gatherers in and around Bonthe (n = 18: Section 3.1) will be the basis for stratification of future primary stakeholder survey efforts (Annex 1) underpinning the projects M&E strategy.

Hypotheses 1: Gatherers with ready land-access or short canoe distances (up to 2-3km) have preferential access to more value-added markets for steamed oysters in Bonthe Municipality.

Hypotheses 2: Females oyster producers based in more exposed coastal locations (along the main estuary sea-channel) have lower mobility and autonomy in gathering decisions.

M&E survey efforts will be limited to eight communities in and around Bonthe Town classified according to these criteria (Table 1).

Table 1: Sample design for future stratification of community surveys based on (i) access to markets for steamed oysters (ii) female autonomy in gathering decisions linked to site exposure.

SN	Village	Code	Market Access	Female Autonomy	GPS lat/long	Description
1	Gbembeehun	GHN	Low	Lower	7°37'9.56"N 12°30'11.11"W	Islet main channel
2	Bomblake	BBK	Low	Lower	7°34'35.60"N 12°29'54.10"W	Shero Island main channel
3	Keigbe	KGB	Med	Lower	7°31'5.56"N 12°28'33.80"W	Islet main channel
4	Tokpumbu	TPB	High	Higher	7°32'57.87"N 12°33'5.89"W	Shero Island coastal creek
3	Mosakai	BTB	High	Higher	7°32'45.58"N 12°32'49.68"W	Shero Island coastal creek
5	Gbongboma	GBM	High	Higher	7°31'21.80"N 12°31'50.81"W	Shero Island inland creek
6	Yankain	YKN	High	Higher	7°30'10.86"N 12°29'28.76"W	Sheltered Islet coast
7	York	YRK	High	Higher	7°32'34.98"N 12°27'47.73"W	York Island river mouth
8	Kingjimi	KJM	High	Higher	7°32'5.37" N 12°30'15.99"W	Bonthe Town

9. Lessons learnt

Working in the remote and poorly developed Sherbro MPA requires careful contingency planning i.e. to deal with erratic electricity supplies, communications and lack all but the most basic supplies in Bonthe Town, the districts central administrative headquarters.

Assuring the quality of longitudinal research efforts out with joint field missions partner institution principle investigators (PIs) has been a challenge due to a lack of suitably trained personal embedded in the MPA over the longer term. Conditions are particularly challenging during the rainy season, also the low season for oyster gathering. In the coming year we will team MSc students from local and UK research partner institutions (IMBO and UoS) to conduct collaborative field-research over 2-3 months during the production season (May to July). We will also look to recruit a suitably qualified person to mentor local staff and coordinate research over a longer period including the 'off-season'.

10. Actions taken in response to previous reviews

The review of the last (2015/16) annual report raised no specific questions relating to the projects progress to date. However the following clarifications were requested regarding the (then) proposed significant change request (at impact, outcome and output level) to the DI:

'It would be helpful for the DI to understand how decisions for the anticipated change request will be made and how the process will be managed. The reviewer would encourage the project to work closely with the DI to ensure that the outcome and outputs are achievable within the timeframe to project end and that the project's M&E is designed in such a way that indicators are SMART and capable of monitoring cross cutting issues, including poverty alleviation, gender or capacity building'.

Having determined that the fundamental precondition of natural resource scarcity for investment in aquaculture is not met under prevailing resource and market conditions; a dialogue was initiated by the UK PI with project partners and affiliates on how best to refocus the project more explicitly on oyster supply chain development. Discussion around the following themes: Fuel efficient cookers; Extending shelf-life, Value-added processing, Re-use of shellwaste Training & Institutional capacity building, resulted in the intervention shortlist presented in Annex 2b. This internal review initiated during June 2016 field mission (Section 2) included consultations with local stakeholders including the Mayor of Bonthe Municipality. The revised logical framework was finally submitted to the DI for review later in the year and the final version agreed in Feb 2017. In this second iterative phase emphasis was placed on refinement of SMART indicators consistent with the above recommendations, resulting in the log-frame presented in Annex 2a. All revisions were circulated and agreed by the project consortium.

11. Other comments on progress not covered elsewhere

Numerous development organisations have implemented projects in the research area over recent years. However, all on-going programs are humanitarian in nature e.g. a mother and child nutrition and health care and infectious diseases programs are being implemented by Plan International and the Red Cross. Signage in and around Bonthe points to several recently terminated rural development programs (RDPs), notably by local NGO 'Green Scenery' (www.greenscenery.org/). However, most of these organisations are head quartered in Freetown with little or no permanent presence in Bonthe District, most RDPs are limited to 1-3 year project cycles and outreach limited mainly to Bonthe and York towns and more accessible neighbouring settlements. Despite a post-civil policy-trend towards more decentralised governance (Box 1), the Mayor of Bonthe, Layemin 'Joe' Sandy has complained about the growing marginalisation of Bonthe, once second only to Freetown in terms of economic importance as a coastal trading centre. Many government offices, including health and education have relocated from the Island to the main land town of Mattru Jong. The Government sponsored fisheries is cited as an egregious example of mal-development. Intended to boost the district's fishing industry through provision of preservation, exportmanufacturing and provision of youth employment *'the project structure is now eroding and its vision lost in the fog of neglect'*³

The challenge for this project then, is to support development of a representative local marketing cooperative; that is truly embedded within the local community. Further effort will be made to identify and engage local influencers, especially female around the revised project objectives.

³ <http://www.sierranetworksalone.com/home/index.php/blog/item/993-the-cry-of-bonthe-mayor-says-the-issue-ofbonthe-needs-urgent-cabinet-decision>

Box 1: Local Governance. A total of 19 local councils in Sierra Leone are governed by the Local Government Act 2004, giving councils legislative, financial and administrative powers. Bonthe is one such council. Some 149 traditional chiefdom administrations operate alongside these councils, each headed by a paramount chief elected for life from a ruling family of the chiefdom. The Chieftaincy Act 2009 specifies the functions of a paramount chief including serving as an agent of development in the chiefdom. The basic chiefdom administrative unit is the 'section', made up of a number of towns or villages headed by a section chief (aka subchief). The paramount chief, chiefdom speaker (deputy) and section chiefs form a political hierarchy along with town chiefs and village headmen. A chiefdom committee of sub-chiefs and chiefdom councillors presided over by the paramount chief serves as an executive body to the chiefdom. Bonthe district incorporates 11 such chiefdoms. Bonthe Town, the district headquarters is strategically positioned at the center of the district and was once an important economic hub. It is surrounded by the chiefdoms of Dema, Sittia, Nongobabullom, Bendu-cha and Kuamebai-Krin.

http://www.clgf.org.uk/default/assets/File/Country_profiles/Sierra_Leone.pdf

12. Sustainability and legacy

During the June 2016 mission, project aims were presented by project collaborators (Francis Murray and James Green) on Bonthe local station Radio Bontico (Section 13) during a weekly public service 'Council Hour' show. The show which deals with local development related activity was entirely dedicated to the project. It also included a Q&A session with the host and Bonthe Municipality communications officer. The 'Bonthe Oyster Festival' planned for 2016 was also publicised. Radio is recognised as the most effective means of mass communication in Sierra Leone, with over 76% of the population regularly listening to local radio⁴. The local effectiveness of this channel became apparent during subsequent visits to remoter satellite villages and mainland sites where community members evidenced clear familiarity with the project. Earlier ambiguities regarding the project objectives arising from word-of-mouth communication were also largely resolved. Ready access to (numerous) local radio stations also presents an opportunity brand-promotion which will be exploited in the projects value-added oyster marketing strategy.

Research findings indicate economic incentives are likely to be the most promising means for promoting mutually beneficial action around environmental and social-equity objectives in the absence of any effective formal or informal regulation of oyster gathering or processing practice. Accordingly, following log-frame revisions (Annex 2a), the project's exit strategy will centre on development of a women's oyster marketing (rather than production) cooperative. Post-project sustainability will be underpinned by collective economic benefits associated with development and promotion of value-added products carrying the Bonthe oyster brand and its associated marketing messages (Fig 2). Collective marketing opportunities for dried/ smoked oyster products in larger inland markets, backed by local promotion will also be explored.

In addition we will present project outputs including an audio-visual presentation chronicling the first (2017) Bonthe festival at UK oyster festivals and other events to solicit external sponsorship to support future Bonthe events. This will include the annual Whitstable Oyster Festival coordinated by project partner James Green.

The potential will also be explored to use the sale of carbon-credits to promote improved mangrove stewardship linked to prudent harvesting and processing methods reducing CO₂

⁴ <http://www.bbc.co.uk/mediaaction/where-we-work/africa/sierra-leone>

emissions (this could also be used to re-enforce marketing messages). Examples of community based initiatives along with details of audit and brokerage processes/ options are available at the following link: <http://www.planvivo.org/plan-vivo-certificates/>.



Fig 2 The pilot ‘Bonthe Oyster’ merchandising brand-logo, incorporating the DI logo (Courtesy of James Green, Whitstable Oysters).

13. Darwin identity

The project has been branded as the ‘Bonthe Oyster Project’ as part a marketing promotion strategy. The logo based on an iconic clock-tower on the water-front of Bonthe Town, has the Darwin Initiative logo embedded within it (Fig 2). Publicity materials for the forthcoming ‘Bonthe Oyster Festival’ including a poster and trade-journal article (The Grower: Annex 11) are similarly branded. All outputs on the project web-site and Facebook page carry the Darwin logo.

The Darwin Initiative was also publicised during Bonthe ‘Council Hour’ radio show hosted by local station ‘Radio Bontico’ (Section 12). The initiative was also introduced to staff and postgraduate students of the UoS Institute of Aquaculture during a project seminar given in January 2017 (Annex 11).

14. Project expenditure

Table 1: Project expenditure during the reporting period (1 April 2016 – 31 March 2017)

Project spend (indicative) since last annual report	2016/17 Grant (£)	2016/17 Total Darwin Costs (£)	Variance %	Comments (please explain significant variances)
Staff costs (see below)			0	
Consultancy costs			0	
Overhead Costs			0	
Travel and subsistence			0	

Operating Costs			0	
Capital items (see below)			0	
Others (see below)			0	
TOTAL	105,579.98	105,579.98		

Annex 1: Report of progress and achievements against Logical Framework for Financial Year 2016-2017 (revised log-frame)

Project summary	Measurable Indicators	Progress and Achievements April 2014 - March 2015	Actions required/planned for next period
<p>Impact.</p> <p>Improved wellbeing of local communities and reduced pressure on mangrove populations resulting from improved sustainability of mangrove-oyster harvesting and processing practices and value added marketing in the Sherbro Marine Protected Area (Bonthe District, Sierra Leone).</p>		<p>Preliminary findings and stakeholder consultations indicate that incentives equitable sharing of costs and benefits will be best served through formation of a women's marketing association.</p>	
<p>Outcome. Environmentally sustainable mangrove-oyster harvesting and value-added processing and marketing options for female gatherers evaluated and rolled out in the Sherbro Marine Protected Area (Bonthe District, Sierra Leone). Prudent harvesting and fuel-efficient processing also reduces pressure on mangrove populations with associated biodiversity gains.</p>	<p>(i) Income from oyster processing and marketing activity of at least 30 female gatherers in 8 communities increased by at least 10% by end of project.</p> <p>(ii) Rate of mangrove degradation (and associated botanical and invertebrate diversity) relative to overall oystergathering livelihood dependency, reduced by at least 8% across 8 study sites as a result of improved oyster (and potentially fish) harvesting, processing and collective marketing practices by end of project.</p>	<p>Implementation to commence in next project period.</p>	<p>Key actions planned for next period;</p> <p>Action research on value-added interventions with local stakeholders</p> <p>Longitudinal (i) producer, market and (ii) GIS surveys to quantify contribution of oyster harvesting and processing practices on mangrove assemblages (these constitute two proposed UoS MSc student projects). Preparatory materials are presented in Annex4 and Annex 10.</p> <p>Identification of locally embedded male and female influencers as first step formation of marketing assoc.</p>

<p>Output 1. Secondary pressure on mangroves populations reduced through more fuel-efficient processing</p>	<p>1a. Most promising technologies evaluated with stakeholders in satellite communities increase fuel-efficiency of primary and secondary processing by at least 50% and 10% respectively by project end.</p> <p>1b. Contribution to reduction in mangrove clearance rates (over last decade) associated with fuel-efficiency gains and adoption quantified; normalised against historic trends in</p>	<p>Implementation to commence in next project period</p> <p>1a. Secondary review of technologies in comparable development settings underway - resource inventory presented in Annex 2c</p> <p>1b. Fuel efficiency experiments planned as part of UoS MSc student project.</p>
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	<p>coverage and population settlement trends.</p>	
<p>Activity 1.1 Evaluate efficiency and adoptability of solar steam cooker designs for primary (steam) processing with/ by female oyster gatherers in Bonthe Town and satellite communities.</p>		<p>Implementation to commence in next project period.</p> <p>Secondary review of technologies in comparable development settings underway</p>
<p>Activity 1.2, Evaluate efficiency and adoptability of fuel efficient stove designs for primary (steam) and secondary (smoke) processing with/ by female oyster gatherers in Bonthe Town and satellite communities</p>		<p>Implementation to commence in next project period.</p> <p>Secondary review of technologies in comparable development settings underway</p>
<p>Activity 1.3 Longitudinal baseline quantitative survey of harvesting and processing effort/ practices and livelihood contribution to female oyster gatherers in satellite Sherbro Island communities over peak production months and mangrove impacts modelled</p>		<p>Implementation to commence in next project period. This will constitute a proposed MSc project.</p>
<p>Activity 1.4 Validate production estimates of smoked oysters from Activity 1.3 through assessment of smoked oyster sales at <i>Yagoi lumi</i> - a 'bottle-neck' mainland weekly retail market</p>		<p>Ongoing activity; interim results presented in Annex 9</p>
<p>Activity 1.5 Trends in population settlement and mangrove coverage assessed using satellite images</p>		<p>Implementation to commence in next project period.</p>

<p>Output 2. Profitability of female oyster gathering increased through testing and adoption of extended product 'shelf-life' and value added processing techniques</p>	<p>2a. Cost-benefit analysis indicates an increased net margin for value-added products of at least 7% on retail of 'loose' smoked oysters 'by the cup'.</p> <p>2b. Volume and/ or number of women currently capable of selling steamed oysters to the market in Bonthe increased by at least 10% by project end.</p>	<p>Implementation to commence in next project period.</p> <p>2a. A post-graduate intern with requisite marketing skills will be recruited to support evaluation of branded products through product placement exercises in target inland markets.</p>
<p>Activity 2.1. Fuel-efficient pasteurisation options evaluated in conjunction with Output 1 activities</p>		<p>Implementation to commence in next project period.</p> <p>Secondary review of technologies in comparable development settings underway</p>
<p>Activity 2.2. Evaporative cooling and solar drying designs (for steamed oysters) evaluated with female oyster gatherers in Bonthe Town and satellite communities</p>		<p>Implementation to commence in next project period.</p> <p>Secondary review of technologies in comparable development settings underway</p>
<p>2.3 Vacuum packing options designs (for smoked oysters alone and in ready meals) evaluated with female oyster gatherers in Bonthe Town and satellite communities</p>		<p>Implementation to commence in next project period. To be supported by same intern described above (Output 2)</p> <p>Resource inventory presented in Annex 2c</p>
<p>2.4 Value-added oyster ready-meal recipes developed based on locally available ingredients and potential market demand</p>		<p>A recipe competition open to contenders from the entire Bonthe District will be an integral part of the 'First Annual Bonthe Oyster Festival'. The event has already been publicised in a dedicated talk-show on local station Radio Bontico (Section 12)</p>
<p>Output 3. Safety and seasonality of female oyster gathering opportunities increased through localised re-use of shell-waste for low-input-output culture enhancements on mud-banks</p>	<p>3a. Harvests of 'mud-oysters' extended 2-3 weeks beyond the end of conventional harvests of inter-tidal oysters on mangrove roots.</p>	<p>Implementation to commence in next project period.</p> <p>To be the focus of a local (IMBO) student MSc project - project linked to hydrographic (Annex 5), primary productivity (Annex 6) and oyster condition index (CI) analysis.</p>
<p>Activity 3.1 Assess adoptability of enhanced mud-oyster fishery through placement of oyster-cultch on inter-tidal mud-banks with satellite communities</p>		<p>Implementation to commence in next project period.</p> <p>To be focus of local (IMBO) student MSc project (see above)</p>

<p>Output 4. Demand for value-added products created through branding and promotion</p>	<p>4a. Logo(s) adopted and used by local stakeholders in marketing of value-added products and recognised by consumers</p> <p>4b. At least one branded product-line placed in at least one formal retail outlet increased by project end.</p>	<p>4a. Bonthe oyster logo has been developed (Section 11, Fig 2) along with publicity materials for the Bonthe Oyster Festival (Annex 11).</p> <p>4b. Stakeholder engagement will be incorporated as part of Activity 2a (above)</p>
<p>Activity 4.1 'Sherbro' branding, logo, labelling options for value-added products developed and refined based on feed-back from local stakeholders</p>		<p>Logo will be evaluated as part of product placement research in next project period (see Output 2).</p>
<p>Activity 4.2 Demand for branded value-added products assessed through market survey and product placement with retail and food service outlets</p>		<p>To be evaluated in inland markets, including Bo, Kenema, Freetown and Gbambatok in next project period (see Output 2).</p>
<p>Output 5. Sherbro women's oyster gatherers association established based on mutually beneficial cooperation around processing and market interventions</p>	<p>5a. Formation of Sherbro Women's Oyster Association - formalised post Bonthe oyster festival (BOF Jun 2017) - incorporating best-practice adaptive learning from the Ghana TOWA model.</p> <p>5b. At least 40 local women (from Bonthe & satellite communities) attend training on sustainable and</p>	<p>Implementation to commence in next project period</p> <p>5b. Training (5b) to be embedded within two planned BOF events (see Activity 5.1).</p>
	<p>profitable oyster production and marketing during Bonthe Oyster Festival.</p> <p>5c. Training manual on sustainable/profitable oyster production and marketing utilised by Bonthe Municipal Authority Sherbro MPA, women's association, & local NGOs (e.g. Green Scenery).</p>	
<p>5.1 Plan and implement the first 'Bonthe Oyster Festival (BOF) ' in June 2017 with collaboration of local and international stakeholders (inc. representatives of the successful Try Women's Oyster Association (TOWA) in Ghana</p>		<p>Training on sanitary processing practices and review of prototype interventions to be incorporated in first BOF.</p> <p>Note: BOF date moved forward to May 2017 to fall out with the Muslim Ramadan Holy Month (26 May – 24 Jun). The 2nd 2018 BOF will be scheduled for late June (Ramadan 15 May – 14 Jun 2018).</p>

5.2 Implement training of female oyster-gatherers on learning outcomes of outputs 1-4 as part of the BOF		Training on development interventions in second annual Bonthe Oyster Festival 2018.
Output 6. Research outputs documented & shared with target audiences	6a. Journal article on project development outcomes submitted to peer-review journal & draft version uploaded to UoS open-access STORRE repository.	6a Co-authored paper(s) to be drafted in 2018 pending development outcomes. A second paper based on dd-RAD sequencing of mangrove oyster morphotypes. Samples will be collected from the Sherbro MPA and Freetown regions for analysis by UoS partners.
	6b. Gender development learningoutcomes presented to an international audience in an oral session in at least one scientific conference.	6b Problem-framing paper abstract accepted for presentation in Iceland Seafood Congress, Sep 2017 (Annex 12). Paper outline presented in UoS seminar Jan 2017 (Annex 13).
	6c. Policy brief developed and shared with local stakeholders.	6c Final project dissemination output scheduled for 2018
6.1 Policy workshop co-hosted with Bonthe Municipal Authority and Sherbro MPA		To be incorporated in second annual Bonthe Oyster Festival 2018
6.2 At least one scientific paper submitted to a peer-reviewed journal and presented at an international scientific conference		Submission of one or more draft papers scheduled for 2018 (see Output 6).

Annex 2a: Revised full- project logical framework (Feb 2017)

Project summary	Measurable Indicators	Means of verification	Important Assumptions
<p>Goal: Effective contribution in support of the implementation of the objectives of the Convention on Biological Diversity (CBD), the Convention on Trade in Endangered Species (CITES), and the Convention on the Conservation of Migratory Species (CMS), as well as related targets set by countries rich in biodiversity but constrained in resources.</p> <p>Impact: Improved wellbeing of local communities and reduced pressure on mangrove populations resulting from improved sustainability of mangrove-oyster harvesting and processing practices and value added marketing in the Sherbro Marine Protected Area (Bonthe District, Sierra Leone</p>			

<p>Outcome:</p> <p>Outcome: Environmentally sustainable mangrove-oyster harvesting and value-added processing and marketing options for female gatherers evaluated and rolled out in the Sherbro Marine Protected Area (Bonthe District, Sierra Leone). Prudent harvesting and fuel-efficient processing also reduces pressure on mangrove populations with associated biodiversity gains.</p>	<p>(i) Income from oyster processing and marketing activity of at least 30 female gatherers in 8 communities increased by at least 10% by end of project.</p> <p>(ii) Rate of mangrove degradation (and associated botanical and invertebrate diversity) relative to overall oyster-gathering livelihood dependency, reduced by at least 8% across 8 study sites as a result of improved oyster (and potentially fish) harvesting, processing and collective marketing practices by end of project.</p>	<p>(i) Household survey reports - 2017 (baseline) and 2018 (monitoring)</p> <p>(ii) Household baseline and monitoring survey reports (see MoV (i)) and analysis of satellite imagery of Sherbro MPA prior to 2017 and 2018</p>	<p>Even if disaggregate 2015 census statistics finally become available in 2017, data deficiencies likely to be associated with the remoteness of the Sherbro research area will necessitate validation efforts and/ or alternative approaches to estimating population trends (Activity 1.5). Realistic quantification of impacts at outcome level will be contingent on these estimates.</p>
<p>Outputs:</p> <p>1. Secondary pressure on mangroves populations reduced through more fuel-efficient processing</p>	<p>1a. Most promising technologies evaluated with stakeholders in satellite communities increase fuel-efficiency of primary and secondary processing by at least 50% and 10% respectively by project end.</p> <p>1b. Contribution to reduction in mangrove clearance rates (over last decade) associated with fuel-efficiency gains and adoption quantified; normalised against historic trends in coverage and population settlement trends.</p>	<p>1a. 1a. End of project technical report on iterative demonstration trials with target beneficiaries and household baseline (2017) and monitoring survey outcomes (2018) - inc. photographic evidence.</p> <p>1b. End of project technical report on survey (Activities 1.3, 1.4, 1.5) and associated modelling outcomes.</p>	<p>1a. Appropriate technologies' are adaptable to target stakeholder needs and resource constraints. Secondary processing (smoking) of oysters and fish harvested by males are often undertaken concurrently. Technology options must also reflect gender-roles and female decisionmaking autonomy around such jointactivity. There is also potential to multiply environmental benefits if the fuel efficiency of both activities can be increased with mutual benefits to females and males.</p> <p>1b. Increased fuel-efficiency does not also lead to intensified resource extraction. Note: in the absence of effective regulation (formal or informal) our working hypothesis</p>

			is that access to un-motorised dug-out canoes and safety issues around harvesting remain the first limiting production factors for most female gathers. Whilst more profitable value-added options may attract new entrants - this could ultimately be a precursor for simple oyster fishery enhancements (e.g. Activity 3) followed by more intensive aquaculture interventions.
2. Profitability of female oyster gathering increased through testing and adoption of extended product 'shelf-life' and value added processing techniques	<p>2a. Cost-benefit analysis indicates an increased net margin for value-added products of at least 7% on retail of 'loose' smoked oysters 'by the cup'.</p> <p>2b. Volume and/ or number of women currently capable of selling steamed oysters to the market in Bonthe increased by at least 10% by project end.</p> <p>2c. As result of 2b - a concomitant decrease in fuel-use for secondary processing (smoking) of at least 50% by project end.</p>	<p>2a. Technical report on cost-benefit analysis (2018).</p> <p>2b. Report (2018) on household surveys in 2017 (baseline) and 2018 (monitoring).</p> <p>2c. Report (2018) on household surveys - 2017 (baseline) and 2018 (monitoring).</p>	<p>2a. Sufficient demand exists or can be stimulated for value-added products in target markets (see Output 4). A 'do-no harm' ethos will also be adopted - acknowledging the potential risk of driving intensified resource extraction by linking local producers of low-value 'commodityproduct' to regional markets under asymmetrical bargaining relations. Opportunities and constraints for transitioning from volumetric to weightbased measures/ packaging will also be explored.</p> <p>2b. May provide greater opportunities for satellite communities with land access to Bonthe if/ where extended marketing is limited by female access to canoes and/ or safety characteristics.</p> <p>2c. Opportunity for verification of 2b and 2c is likely to be restricted to case-study documentation within remaining project duration (i.e. without no-cost extension).</p>
3. Safety and seasonality of female oyster gathering opportunities increased through localised re-use of shell-waste for lowinput-output culture enhancements on mud-banks	3a. Harvests of 'mud-oysters' extended 2-3 weeks beyond the end of conventional harvests of inter-tidal oysters on mangrove roots.	3a. Substantive yields are likely to be contingent on progressive build-up of oyster 'cultch' over successive years i.e. substantially beyond the current project life-cycle - during which it will only possible to verify initiation and preliminary	3a. Stability of mud-banks permits progressive build-up of oyster-cultch on their surface. Banks with suitable tidal characteristics & access rights in proximity of communities. Note: Preliminary findings indicates negligible opportunity-cost for

			oyster shell-waste evidence by build-up of
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		harvesting based on photographic evidence.	large shell-middens in many satellite communities
4. Demand for value-added products created through branding and promotion	<p>4a. Logo(s) adopted and used by local stakeholders in marketing of value-added products and recognised by consumers</p> <p>4b. At least one branded product-line placed in at least one formal retail outlet increased by project end.</p>	<p>4a. Opportunity for verification is likely to be restricted to case-study documentation within the remaining project duration. This will include testimonials from oyster vendors and retail outlets in target markets.</p> <p>4b. Retail and consumer testimonials and photographic evidence.</p>	<p>4a. (i) Willingness of appropriate channels to engage in promotion; especially national and local radio, TV and press (ii) increase in commercial opportunity does not result in male displacement of females in marketing (this & other elite capture risk also underpin the need for development of an effective women's association that is inclusive of and empowers the target beneficiaries)</p> <p>4b. Sufficient demand exists or can be stimulated and adequate food-safety standards can be assured (Note: there is currently no established market for any locally packaged oyster products).</p>

<p>5. Sherbro women's oyster gatherers association established based on mutually beneficial cooperation around processing and market interventions</p>	<p>5a. Formation of Sherbro Women's Oyster Association - formalised post oyster festival (Jun 2017) - incorporating best-practice adaptive learning from the Ghana TWA model.</p> <p>5b. At least 40 local women (from Bonthe & satellite communities) attend training on sustainable and profitable oyster production and marketing during Bonthe Oyster Festival.</p> <p>5c. Training manual on sustainable/ profitable oyster production and marketing utilised by Bonthe Municipal Authority Sherbro MPA, women's association, & local NGOs (e.g. Green Scenery).</p>	<p>5a. Association constitution, membership and meeting activity documented</p> <p>5b&5c. Post-training evaluation survey with target beneficiaries, training and extension staff.</p>	<p>5a. (i) Such association can increase the collective bargaining power of individual gathers to sell value-added products in local and regional markets (ii) Women in satellite communities are not excluded due to remoteness or institutional capture by centralised interest-groups in Bonthe (iii) means to incentivise prudent harvesting practices can be devised in the absence of any real existing formal or social prohibition on damaging practices.</p> <p>5b. Women from remote satellite communities are able to travel to Bonthe (efforts will be made to understand constraints and enable participation).</p>
<p>6. Research outputs documented & shared with target audiences</p>	<p>6a. Journal article on project development outcomes submitted to peer-review journal & draft version uploaded to UoS openaccess STORRE repository.</p>	<p>6a. Journal confirmation email.</p> <p>6b. Conference confirmation email, online abstract or proceedings.</p> <p>6c. Policy meeting attendance register and signed-testimonials on utility of policy brief</p>	<p>6b. Acceptance of abstract</p> <p>6c. Adequate representation of female oyster gathers (within and around Bonthe) within the MPA institutional structure.</p>
	<p>6b. Gender development learning outcomes presented to an international audience in an oral session in at least one scientific conference.</p> <p>6c. Policy brief developed and shared with local stakeholders.</p>	<p>from local (MPA and municipal authorities) and national authorities.</p>	

Activities (each activity is numbered according to the output that it will contribute towards, for example 1.1, 1.2 and 1.3 are contributing to Output 1)

- 1.1 Evaluate efficiency and adoptability of solar steam cooker designs for primary (steam) processing with/ by female oyster gatherers in Bonthe Town and satellite communities
- 1.2 Evaluate efficiency and adoptability of fuel efficient stove designs for primary (steam) and secondary (smoke) processing with/ by female oyster gatherers in Bonthe Town and satellite communities
- 1.3 Longitudinal baseline quantitative survey of harvesting and processing effort/ practices and livelihood contribution to female oyster gatherers in satellite Sherbro Island communities over peak production months and mangrove impacts modelled
- 1.4 Validate production estimates of smoked oysters from Activity 1.3 through assessment of smoked oyster sales at Yagoi lumi - a 'bottle-neck' mainland weekly retail market
- 1.5 Trends in population settlement and mangrove coverage assessed using satellite images
- 2.1 Fuel-efficient pasteurisation options evaluated in conjunction with Output 1 activities
- 2.2 Evaporative cooling and solar drying designs (for steamed oysters) evaluated with female oyster gatherers in Bonthe Town and satellite communities
- 2.3 Vacuum packing options designs (for smoked oysters alone and in ready meals) evaluated with female oyster gatherers in Bonthe Town and satellite communities
- 2.4 Value-added oyster ready-meal recipes developed based on locally available ingredients and potential market demand
- 3.1 Assess adoptability of enhanced mud-oyster fishery through placement of oyster-cultch on inter-tidal mud-banks with satellite communities
- 4.1 'Sherbro' branding, logo, labelling options for value-added products developed and refined based on feed-back from local stakeholders
- 4.2 Demand for branded value-added products assessed through market survey and product placement with retail and food service outlets
- 5.1 Plan and implement the first 'Bonthe Oyster Festival (BOF) ' in June 2017 with collaboration of local and international stakeholders (inc. representatives of the successful Try Women's Oyster Association (TWOA) in Ghana
- 5.2 Implement training of female oyster-gatherers on learning outcomes of outputs 1-4 as part of the BOF
- 5.3 Support institutional capacity building of female oyster gatherers within the Sherbro MPA centred on collective processing and marketing activities and sustainable production practices - based on adaptive learning from the TWOA model
- 5.4 Assess genotypic differentiation of oyster phenotypes associated with different substrates through DNA marker analysis
- 6.1 Policy workshop co-hosted with Bonthe Municipal Authority and Sherbro MPA
- 6.2 At least one scientific paper submitted to a peer-reviewed journal and presented at an international scientific conference

Annex 2b: Intervention Review (F. Murray, S. Sankoh, R. Wadsworth, R. Quilliam, J Green - Sep 2016)

	Theme	Intervention	Potential	Comments
1	Fuel efficient cookers	1.1 Solar steam cookers	High	Stage: Primary steam processing oysters, villages Notes: Local (Freetown) availability of thermal solar units should be determined (before importing) & adapted locally for steaming purpose

		1.2 Fuel efficient wood-stoves	High	Stage: Secondary smoke processing oysters (& fish), villages Notes: Based on materials/ capacities within Bonthe District
2	Extending shelf-life	2.1 Solar dryers	Med	Stage: Drying steamed oysters (& fish), villages &/or Bonthe Town Notes: High challenges for decentralised operation
		2.2 Evaporative cooling	High	Stage: Steamed oysters, villages Notes: Pot-in-a-pot – Lunsar country pots (RW)
3	Value-added processing	3.1 Vacuum packing	Med	Stage: Smoked oysters villages &/or Bonthe Town <ul style="list-style-type: none"> Notes: High food-safety risk (anaerobic bacteria) assoc. with vacuum packing exc. steamed oysters in absence of cold-chain Electric-powered machines limited to Bonthe (foci for institutional capacity building – see below?)
		3.2 Ready meals	Med	Stage: Smoked oysters (in absence of cold-chain), villages &/or Bonthe Notes: Food safety assurance under ambient conditions may be beyond scope of this project?
4	Re-use of shell-waste	4.1 Mud-bank culture substrate	Med	Stage: Enhanced culture, villages Notes: Year on year laying may be required to demonstrate impact
		4.2 Whitewash production	Low	Stage: Value-added co-product, villages Notes: High risk of mangrove damage assoc. with processing
5	Training & Institutional capacity building	5.1 Institutional capacity building – Sherbro Women’s Prod Assoc.	High	Stage: Centred in Bonthe (around centralised interventions)? Notes: Fostering collective action around shared provenance/ branding
		5.2 Gambia Tri-Oyster Festival Women’s association exchange	High	Stage: Bonthe Oyster Festival Notes: Best practice knowledge exchange and training
6	Branding & promotion	6.1 Develop Sherbro logo & promotional materials	High	Stage: Pre. Bonthe Oyster Festival Notes: Separate for Sherbro Brand & Bonthe Festival (JG)
		6.2 Bonthe Oyster festival June	High	<ul style="list-style-type: none"> Media: Radio Bontico support engaged - & Freetown? Training & promotional videos

Annex 2c: Fuel efficient and value-added processing; resources & references

1. **Solar steam cookers:** To potentially eliminate dependence on mangrove fuel **Examples**

http://solarcooking.wikia.com/wiki/Solar_Steamer

<http://www.ebay.co.uk/gds/All-Solar-Ovens-are-Not-Created-Equal-5-Considerations/10000000016505690/g.html>

1.2 **Fuel efficient wood-stoves:** To reduce dependence on mangrove fuel **Examples:**

<https://www.sussex.ac.uk/webteam/gateway/file.php?name=the-next-generation-ideas-workshopreport.pdf&site=25>

2. **Value-added through extension of product shelf-life:**

2.1 **Solar dryers (steamed & fresh oysters):** To reduce moisture content

<http://www.fao.org/Wairdocs/X5434E/x5434e0f.htm> FAO general shellfish Bangladesh

<http://practicalaction.org/media/preview/10715> Practical Action Kenya

<http://answers.practicalaction.org/our-resources/item/solar-dryers-in-kenya>

http://nrgtechnologists.com/Solar_Dryer_Solution/nrg_solar_dryer.html

<http://www.solare->

bruecke.org/index.php?option=com_content&view=article&id=8&Itemid=8&lang=en

<https://www.amazon.co.uk/s/?ie=UTF8&keywords=dehydrators&tag=mh0a9->

21&index=aps&hvadid=2978590465&hvqmt=p&hvbmt=bp&hvdev=c&ref=pd_sl_17khn2u3g8_p

Stacked food dehydrators

http://www.ebay.com/sch/i.html?_nkw=solar+dehydrator Solar hanging dehydrators Ebay

<http://www.rainier.com/yurts/yurt-living/living-off-the-grid/solar-food-dehydrators/> Solar food dehydrators – hand made Italy

2.2 **Low-cost evaporative cooling:** To extend supply catchment for daily marketing of more valuable 1ry processed (steamed) oysters to Bonthe Town (& possibly more distant weekly markets e.g. Yagoi, Gbambatok) **Examples:**

<http://www.wikihow.com/Make-a-Pot-in-a-Pot-Refrigerator>

<http://www.fao.org/climatechange/178500c63507f250b5a65147b7364492c4144d.pdf>

3. **Other value-added processing**

3.1 **Vacuum packing (smoked oysters & possibly steamed if solar dried?) -**

To extend niche value-added sales of branded product e.g. retail outlets in Freetown or regions. **Examples:**

https://www.amazon.co.uk/s/?ie=UTF8&keywords=foodsaver+vacuum+sealer&tag=mh0a921&index=aps&hvadid=3170594485&hvqmt=p&hvbmt=bp&hvdev=c&ref=pd_sl_1ztpsdtq1v_p

Annex 3: Standard Measures

Table 1: Project Standard Output Measures

Code No.	Description	Gender of people	Nationality of people (if relevant)	Year 2 Total	Year 3 Total	Year 4 Total	Total to date	Total planned
2	Aquaculture MSc thesis	M & F	Vietnam/ USA Sierra Leone	1	2	2	1	5
3	Aquaculture Diploma	Male	Sierra Leone			1	0	1
4c	Post graduate field skills training	Male	Sierra Leone		1		0	1
6A	Training of local enumerators in survey methods	M & F	Sierra Leone	2	6	12	2	20
6A	Training on high potential postharvest interventions extended to female gatherers during 2 Bonthe oyster festivals	M & F	Sierra Leone		40-50	40-50	0	80-100
9	Policy brief on intervention recommendations based on action research outcomes	M & F	Sierra Leone			1	0	1
11B	Papers submitted to peer reviewed journals	M & F	Sierra Leone, UK			1-2	0	1-2
12A	Excel database of abiotic, biotic, social mapping survey results - in Sherbro MPA	M & F	Sierra Leone, UK			1	0	1

Table 2: Publications

Title	Type (e.g. journals, manual, CDs)	Detail (authors, year)	Gender of Lead Author	Nationality of Lead Author	Publishers (name, city)	Available from (e.g. website link or publisher)
Evaluating the role etc ¹	MSc Thesis	Shel. N. TI	Male	Vietnamese/ American	Unpublished	Project website
² First Sherbro Oyster etc.	Trade assoc. Journal	Brown,J Murray,F Green,J	Female	UK	The Grower (ASSG)	http://assg.org.uk/the-grower/4532754744 *(Annex 11)
³ Oysters, mangroves, Ebola etc	Power point present	Murray,F	Male	UK	Unpublished	Project website *(Annex 13)

¹ Schell, N. T. 2016 'Evaluating the role of mangrove oyster (*Crassostrea tulipia*) production and marketing on livelihoods of fisherwomen in the Sherbro River Delta, Sierra Leone; a mixed methods study'. MSc Thesis, University of Stirling (Unpublished).

² Brown, J., Murray, F., Green, J. Mar-Apr 2017 *First Sherbro Oyster Festival* - 'The Grower' Assoc.

Scottish Shellfish Growers. No. 20: Photo news. <http://assg.org.uk/the-grower/4532754744> Murray, F. 2017 *Oysters, mangroves & Ebola! Development problem-framing in a data-deficient environment*; A Darwin Initiative research project in Sierra Leone. Presentation given at the University of Stirling, 18 Jan 2017 (Unpublished)

Checklist for submission

	Check
Is the report less than 10MB? If so, please email to Darwin-Projects@ltsi.co.uk putting the project number in the Subject line.	Y
Is your report more than 10MB? If so, please discuss with Darwin-Projects@ltsi.co.uk about the best way to deliver the report, putting the project number in the Subject line.	NA
Have you included means of verification? You need not submit every project document, but the main outputs and a selection of the others would strengthen the report.	Y
Do you have hard copies of material you want to submit with the report? If so, please make this clear in the covering email and ensure all material is marked with the project number.	NA
Have you involved your partners in preparation of the report and named the main contributors	Y
Have you completed the Project Expenditure table fully?	Y
Do not include claim forms or other communications with this report.	