

SERVICES & FACILITIES ANNUAL REPORT - FY April 2014 to March 2015

SERVICE NERC Facility for Scientific Diving (NFSD)	FUNDING SLA	AGREEMENT With SAMS	ESTABLISHED as S&F 2003	TERM 5+2+1y
---	-----------------------	-------------------------------	---------------------------------------	-----------------------

TYPE OF SERVICE PROVIDED:

The NERC Facility for Scientific Diving (NFSD) at SAMS provides divers, equipment, training and scientific/technical support that underpins a wide range of interdisciplinary research in the underwater environment. The primary level of service delivers practical support for diving-related underwater scientific projects through providing additional manpower for groups with limited diving experience, total project management for scientists with no diving experience and/or specialist equipment loans for groups with diving experience but limited resources. On a secondary level, the Facility undertakes to ensure proper adherence to Health and Safety legislation as applied to diving at work activities. This can be through targeted training programmes, communicating advice and guidance for senior management with legal responsibilities for diving at work, undertaking safety audits on behalf of the NERC Health and Safety management structure and facilitating a wider interactive dialogue with others in the higher education field and the Health and Safety Executive. The NFSD is the main service provider and the major supporter of research within the UK that involves scientific diving through: support and maintenance of an extensive underwater research programme; support for the UK Scientific Diving Supervisory Committee (SDSC); interactions with other diving industry bodies; ongoing diving research and evaluation programmes; and a focussed training programme for scientists and technicians involved with working underwater. In addition to diving services per se, the NFSD also provides support and training in associated small boat operations and in emergency diving medicine. The NFSD provides a diving support service for the UK National Tide Gauge Network which, in turn, contributes to outputs of the National Tidal and Sea Level Facility (NTSLF); it also has research links with the NERC Field Spectroscopy Facility.



A diver using a specially-designed hole punch for estimating kelp growth over time

The NFSD is the main service provider and the major supporter of research within the UK that involves scientific diving through: support and maintenance of an extensive underwater research programme; support for the UK Scientific Diving Supervisory Committee (SDSC); interactions with other diving industry bodies; ongoing diving research and evaluation programmes; and a focussed training programme for scientists and technicians involved with working underwater. In addition to diving services per se, the NFSD also provides support and training in associated small boat operations and in emergency diving medicine. The NFSD provides a diving support service for the UK National Tide Gauge Network which, in turn, contributes to outputs of the National Tidal and Sea Level Facility (NTSLF); it also has research links with the NERC Field Spectroscopy Facility.

ANNUAL TARGETS AND PROGRESS TOWARDS THEM

The increased number and diversity of projects supported through the NFSD continues to be maintained. This has resulted in support for a wide diversity of project areas that now contribute to all of the NERC strategic priority areas. The NFSD is the only diving facility worldwide that is supporting, either directly or indirectly, such diverse topics as sea-level measurement, water-quality assessment, underwater light measurement, functional ecology, cell biology, animal genomics, paleoclimatology, ocean acidification, biogeochemistry, eco-physiology, habitat mapping and maritime science-based archaeology. In addition, the NFSD has maintained a research presence in the fields of diving and hyperbaric medicine. The expanded capacity over the past 3-4 years has produced a consistent publication output.

SCORES AT LAST REVIEW (each out of 5)				Date of Last Review:	March 2008
Need 5.0	Uniqueness 5.0	Quality of Service 4.5	Quality of Science & Training 4.5	Average 4.8	

CAPACITY of HOST ENTITY FUNDED by S&F	Staff & Status	Next Review (March)	Contract Ends (31 March)
50 %	Dr Martin Sayer, Head of Unit, SAMS Grade 6 (50%) Dr Simon Thurston, Dive Technician, SAMS Grade 4(50%) Mr Hugh Brown, Dive Technician, SAMS Grade 4(50%) Ms Elaine Azzopardi, Dive Technician, SAMS Grade 4 (50%)		2016

FINANCIAL DETAILS: CURRENT FY						
Total Resource Allocation £k	Unit Cost £k			Capital Expend £k	Income £k	Full Cash Cost £k
	Science support 'away'; own boat	Science support 'away'; charter	Science support 'home'			
243.0	2.14	2.26	1.73	110.0		353.0
FINANCIAL COMMITMENT (by year until end of current agreement) £k						
2014-15	(243k)	2015-16	(241k)			

STEERING COMMITTEE	Independent Members	Meetings per annum	Other S&F Overseen
NFSD-SC	Eight	One; August 2014	none

APPLICATIONS: DISTRIBUTION OF GRADES (current FY — 2014/15)

	10	9	8	7	6	5	4	3	2	1	0	R*	Pilot
NERC Grant projects*													
Other academic			1	1									
Students					4								
TOTAL			1	1	4								

APPLICATIONS: DISTRIBUTION OF GRADES (per annum average previous 3 financial years —2011/2012, 2012/2013 & 2013/2014)

	10	9	8	7	6	5	4	3	2	1	0	R*	Pilot
NERC Grant projects*			0.3										
Other academic			1.0	0.3								0.6	
Students				1.3	2.0								
TOTAL			1.3	1.6	2.0							0.6	

PROJECTS COMPLETED (current FY – 2014/15)

	10 (α5)	9	8 (α4)	7	6 (α3)	5 (α2)	4	3 (α1)	2	1 (β)	0 (Reject)	Pilot
NERC Grant projects*												
Other Academic												
Students					2							

Project Funding Type (current FY – 2014/15) (select one category for each project)

Grand Total	Infrastructure						PAYG					
	Supplement to NERC Grant *		PhD Students		NERC Centre	Other	NERC Grant*	PhD Students		NERC Centre	Other	
	NERC	Other	NERC	Other			NERC	Other	NERC	Other		
17	4		3	1	3	6	0	0	0	0	0	0

Project Funding Type (per annum average previous 3 financial years - 2011/2012, 2012/2013 & 2013/2014)

Grand Total	Infrastructure						PAYG					
	Supplement to NERC Grant *		PhD Students		NERC Centre	Other	NERC Grant*	PhD Student		NERC Centre	Other	
	NERC	Other	NERC	Other			NERC	Other	NERC	Other		
15.6	3.3		3.0	2.3	3.0	4.0	0	0	0	0	0	0

User type (current FY – 2014/15) (include each person named on application form)

Academic	NERC Centre	NERC Fellows	PhD Students	Commercial
15	10	2	6	0

User type (per annum average previous 3 financial years - 2011/2012, 2012/2013 & 2013/2014)

Academic	NERC Centre	NERC Fellows	PhD Students	Commercial
15.7	12.0	1.7	6.7	0.0

OUTPUT & PERFORMANCE MEASURES (current year)

Publications (by science area & type) (calendar year 2014)*											
SBA	ES	MS	AS	TFS	EO	Polar	Grand Total	Refereed	Non-Ref/ Conf Proc	PhD Theses	
1		31				4	69	40	28	1	

Distribution of Projects (by science areas) (FY 2014/15)

Grand Total	SBA	ES	MS	AS	TFS	EO	Polar
19.5	0.8		17.0		0.7	0.5	0.5

OUTPUT & PERFORMANCE MEASURES (per annum average previous 3 years)

Publications (by science area & type) (Calendar years 2011, 2012 & 2013)*											
SBA	ES	MS	AS	TFS	EO	Polar	Grand Total	Refereed	Non-Ref/ Conf Proc	PhD Theses	
1.7		20.0				5.7	45.3	25.7	18.7	1.7	

Distribution of Projects (by science areas) (FY 2011/2012, 2012/2013 & 2013/2014)

Grand Total	SBA	ES	MS	AS	TFS	EO	Polar
17.3	0.9		14.0		0.7	0.7	1.0

Distribution of Projects by NERC strategic priority (current FY 2014/15)

Grand Total	Climate System	Biodiversity	Earth System Science	Sustainable Use of Natural Resources	Natural Hazards	Environment, Pollution & Human Health	Technologies
18.0	7.6	5.8	1.3	1.1	0.7	0.6	0.9

*some OPMs do not fit NERC science areas; e.g. diving physiology, diving medicine

*Either Discovery Science (Responsive Mode) or Strategic Science (Directed Programme) grants

NOTE: All metrics should be presented as whole or part of whole number NOT as a %

OVERVIEW & ACTIVITIES IN FINANCIAL YEAR (2014/15):

Overview: A total of 714 diving operations were completed in 2014 in support of 18 projects. The on-going projects in 2014/15 and onwards continue to demonstrate the highly interdisciplinary nature of the science being supported through diving. These projects include contributing to studies investigating sea-level measurement, water-quality assessment, underwater light measurement, functional ecology, cell biology, animal genomics, paleoclimatology, ocean acidification, biogeochemistry, eco-physiology, habitat mapping and maritime science-based archaeology. Support in 2014/15 was provided to researchers from the following universities/institutes: BAS, CEH, NOC, BGS, PML, SAMS, MBA, Aberdeen, Aberystwyth, Bangor, Bristol, Cambridge, Edinburgh, Exeter, Hull, Leeds, Liverpool, Liverpool John Moores, Natural History Museum London, St. Andrews, Southampton and the University of the Highlands and Islands.

Major projects: Support has been concentrated on two projects that both required significant time investment in 2014-15: "Assessing and mapping benthic productivity on natural and man-made structures" (Heriot Watt, SAMS) and "Extreme Climatic Events in Marine Ecosystems" (MBA Plymouth; NE/K008439/1). Diving in support of the tide gauge network was focussed on the impacts of the winter storms of 2014. A more structured programme of support is scheduled for 2015-16.

Training and Guidance: One fast-track HSE SCUBA course was run in 2014 for a BAS researcher; two RYA Level 2 boat-handling courses were also provided. The NFSD received NERC Advanced Training Course Awards in both 2014-15 and 2015-16. The courses, "Scientific diving techniques and technologies" are delivered jointly with Heriot Watt University.

Value-added research: The NFSD continues to contribute to the areas of diving safety, physiology and hyperbaric medicine. Focus has continued in 2014/15 on developing a greater understanding of how dive computers work in relation to decompression management; four related studies were published in 2014/15. Pilot studies have been carried out on transferring terrestrial stereophotogrammetry techniques to the underwater environment.

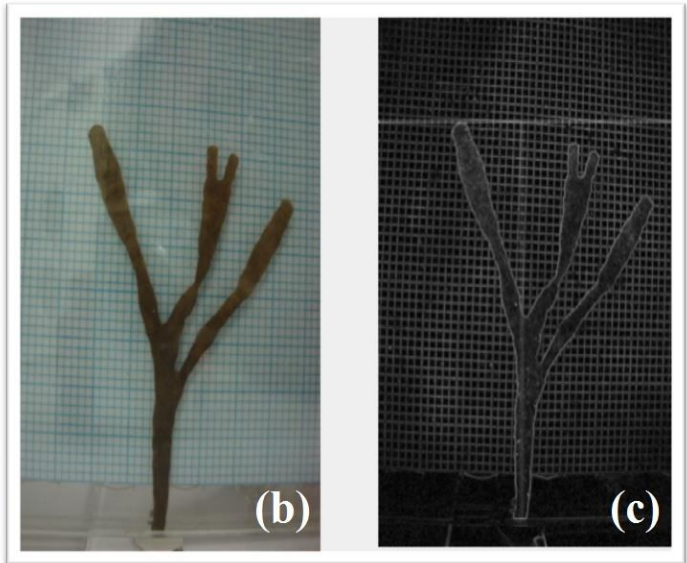
Capital spending: Capital was secured in 2014/15 and 2015/16 to upgrade the NFSD portable recompression system. In particular, the new system will consist partly of a 2.0m high chamber; the whole system will be capable of operating in environments with temperature +40°C to -40°C.

Outputs: 35 ISI-rated science papers published or in press; six diving publications and 25 abstracts, conference proceedings and edited works. One supported PhD student graduated.

SCIENCE HIGHLIGHTS.

Using transplants of *Flustra foliacea* (Bryozoa: Cheilostomata) as a tool for in-situ rapid assessment of fine-scale variations in benthic productivity: Scottish Association for Marine Science, Heriot Watt University

With increasing pressures from human activities in coastal zones there is a growing need to quantify ecosystem functioning. One of the most common measures of ecosystem function is secondary productivity of an indicator species. The feasibility of the marine bryozoan species *Flustra foliacea* as an indicator for benthic secondary productivity was assessed because its large colonial form can be split into genetically identical segments and its two dimensional growth allows productivity to be measured via multiple methods. Using diving, clones of *F. foliacea* were transplanted to a site where the species naturally occurs and is locally abundant, and a site where the species has not been observed. The growth (productivity) of the clones was measured using changes in area and buoyant weight; changes were measurable within five weeks. With this technique, it is possible to transplant a large number of replicates to natural reef surfaces, or artificial structures, and measure fine scale variations in productivity. Beyond this, clones can be deployed such that productivity can be 'mapped' as a function of abiotic variables. Ultimately, such information could be used to measure the effects of impact to the physical environment on ecosystem functioning; such impacts will have societal relevance.



F. foliacea transplants attached to an artificial reef block (a). Digitised two-dimensional growth analysis (b & c)

Using diving, clones of *F. foliacea* were transplanted to a site where the species naturally occurs and is locally abundant, and a site where the species has not been observed. The growth (productivity) of the clones was measured using changes in area and buoyant weight; changes were measurable within five weeks. With this technique, it is possible to transplant a large number of replicates to natural reef surfaces, or artificial structures, and measure fine scale variations in productivity. Beyond this, clones can be deployed such that productivity can be 'mapped' as a function of abiotic variables. Ultimately, such information could be used to measure the effects of impact to the physical environment on ecosystem functioning; such impacts will have societal relevance.

Linking environmental variables with regional-scale variability in ecological structure and carbon storage function of kelp forests in the United Kingdom: MBA, Aberystwyth

Kelp forests represent some of the most productive and diverse habitats on Earth. Understanding drivers of ecological pattern at large spatial scales is critical for effective management and conservation of marine habitats. Using diving, kelp forests dominated by *Laminaria hyperborea* were surveyed across a 9° latitude and >1000 km of coastline and key physical variables

at multiple scales were measured to link ecological structure and standing stock of carbon with the marine environment. Kelp density, biomass, morphology and age were highly variable between sites within regions, highlighting the importance of wave exposure in structuring *Laminaria hyperborea* populations. At the regional-scale, wave-exposed kelp canopies in the cooler regions (the north and west of Scotland) were greater in biomass, height and age than in warmer regions (southwest Wales and England); these patterns were strongly correlated with increased light availability and decreased temperature at higher latitudes. The range and maxima values of standing stock of carbon contained within kelp forests was greater than in historical studies, suggesting that this ecosystem service may have been previously undervalued. Compared to other vegetated marine and coastal habitats, kelp forests have been overlooked within the context of carbon cycling and storage. In the UK, however, the standing stock of carbon within kelp forests may be up to two orders of magnitude greater than seagrass meadows and one order of magnitude greater than saltmarshes. Although turnover in kelp forests is very rapid - kelps do not bury carbon in sediments and, therefore, do not function as blue carbon sinks – the extensive and productive nature of these habitats allows for significant uptake of carbon and transfer to higher trophic levels. As light availability and temperature are important drivers of kelp forest biomass, effective management of coastal human activities is necessary to maintain ecosystem functioning, while increased temperatures related to anthropogenic climate change may impact kelp forest structure and reduce the carbon storage services they provide.

A comparison of benthic foraminifera genotypes across a range of habitats: from fjords to open ocean margins:

Edinburgh, St Andrews

The foraminiferal fossil record of fjordic environments provides the opportunity for high resolution spatial and temporal palaeoclimate studies owing to their continuous and often rapid accumulation of fine sediments. In some fjordic environments this rapid lay-down of sediment is also coupled with low oxygen levels and, hence, reduced bioturbation; in some cases, minimal tidal activity generated high resolution sequences. In order to interpret the fossil record, an understanding of modern forams is necessary and, to date, small sub-unit rDNA genotyping from diving-based samples has identified morphologically cryptic species within foraminiferal assemblages. To obtain a more comprehensive understanding of the benthic foram assemblages specifically associated with fjords, it is necessary to compare their genetic profiles with those of more open-ocean margins and intertidal environments. Forams were collected by methods including diving from sites spanning five biogeographic provinces from the cold waters of the high arctic provinces, to the Lusitanian province off Portugal. Morphological examination via Scanning Electron Microscopy (SEM) and genetic characterisation have been employed to determine the relationship between the genetic characters of the benthic morphospecies distributed within fjords compared with the same morphospecies found in other environments. However, the comparison of benthic foraminiferal assemblages from different locations is hampered by the diverse regional taxonomic systems used by different workers. DNA genotyping, SEM imaging and ecological data of the more common species found off the European coasts of the Atlantic has revealed a wide range of genotypes. This extensive dataset allows the identification of cosmopolitan and endemic species within European waters and also has the potential to reveal the presence of cryptic or pseudo-cryptic species. This unique combination of genetic, morphological, biogeographic and ecological data also allows the long lasting issue of ecophenotypy to be addressed.

FUTURE DEVELOPMENTS/STRATEGIC FORWARD LOOK

The current host of the NFSD, the Scottish Association for Marine Science (SAMS), is expanding its diving-based capacity through a series of new and re-furbished infrastructure initiatives. The NFSD will remain a central component of that development and will benefit from purpose built diving-support facilities with greatly enhanced teaching capability. The unit will have a greater academic focus plus the ability to host and sustain a wider range of visiting researchers. It is likely that the unit will begin to provide a support base for diving-based early stage researchers.

NFSD OUTPUT & CITATION ANALYSES (2006-2015)

NFSD-supported research that was published in the years 2006 to 2015 was collated and grouped according to the journal *Thompson-Reuter ISI Impact Factor* (IF) for the year of publication. Citations from these publications were tracked from 2007 to July 2015 using *ISI Web of Knowledge* and presented as annual totals. Since 2006, NFSD support has generated 135 ISI-rated publications (IF median 2.48; mean 3.25); these have been cited 2078 times with a current *H-index* of 24:

