

**IMPROVING AND DEVELOPING ACCESS TO THE LAST GREAT FRONTIER -
THE DEEP SEA**

FINAL REPORT FOR THE 2015 MARINE ALLIANCE SCIENCE TECHNOLOGY SCOTLAND
(MASTS) VISITING FELLOWSHIP

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The importance of the deep sea for resource exploitation, global climate impacts, and new discoveries is increasingly recognized. Recent years have seen resurgence in scientific interests in the deep sea as illustrated by the formation of such organizations as INDEEP (<http://www.indeep-project.org/>), INCISE (<http://www.incisenet.org/home>) and a new deep-sea scientific society (<http://dsbsoc.org/>). There have also been a number of recent syntheses and reviews of deep-sea environments and issues (e.g., Levin and Dayton 2009; Dücker 2014; Thurber et al. 2014; Sweetman et al. ms in review), all of which emphasize the importance of the deep sea, the immediate need for more research, and the appalling lack of even basic data. But, ironically, access to this environment is relatively primitive and restricted compared with some other ecosystems. Access (obviously) is the key component for successful research. Unlike other ecosystems, research in the deep sea is accompanied by major challenges in even the most basic activities of simply collecting field data. In shallow waters, coral reefs may have once presented similar challenges, and the greatest strides in coral reef ecology were not made until the availability of SCUBA. This ubiquitous, relatively inexpensive tool, relevant to nearly every discipline, revolutionized data collection in difficult to sample habitats within its depth limits, putting these ecosystems within reach of almost every scientist. Because of its greater size, complexity, logistical challenges and much greater expense to visit, similar sudden advances in deep-sea access are less likely. But it is clear that when access is improved or novel technology provides access to even the deepest hadal depths, significant discoveries are forthcoming (Gallo et al. 2015).

Conceptual issues are also problematic for deep-sea scientific advancement more so than in other disciplines. Related to the lack of baseline data are the difficulties of assessing ecosystem resilience and basic condition in the deep-sea. This inhibits the formulation of concepts of exactly what constitutes healthy deep-sea ecosystems and the degrees and types of impacts they may experience. Indicators of health, such as stability and sustainability and resistance to stress (Costanza et al. 1992), are difficult to determine in the deep sea.

This MASTS deep-sea Visiting Fellowship (VF) explored an array of issues (conceptual and logistical) that impede research in the least known large ecosystem on Earth, the deep sea. To facilitate this, the Fellowship brought together experts in deep-sea research, who (guided by the VF, Dr. S.W. Ross from the United States and host universities) reviewed the current state of deep-sea research, determined major technological or conceptual limitations to deep-sea research, and began a process to address these limitations. The original Fellowship proposal suggested concentrating resources on two technological issues related to deep-sea research. Those were to improve benthic lander technology and utility and to improve analyses of underwater video. While these important topics were discussed and evaluated during the Fellowship, the VF in consultation with MASTS hosts and an expert panel determined that a more pressing and tractable need in deep-sea research was to start a process of determining how to evaluate the basic health of deep-sea ecosystems. This process likely would involve lander and video methods, but the Fellowship topic was considerably broadened from the original proposal. While it was recognized that this Deep Ocean Health Check (DOHC, first proposed by Dr. Ross in early 2015) activity could not be completed in this Fellowship period, starting the process and promoting its progression were considered to be valuable tasks.

This MASTS Fellowship was funded for a 6-month duration (August 2015 - January 2016); however, activities were begun before the official project start and are still continuing. The VF was funded to spend about seven weeks in the UK and Europe, most of which time was spent at Heriot-Watt University (Edinburgh, Scotland), the main host institution. The other time in the Fellowship

was spent mostly at the VF's home institution (Univ. of NC at Wilmington, USA). Additional funding was added to the project from outside sources to supplement MASTS support. The main components of this Fellowship final report include a timeline of the major activities accomplished and the current draft (a work in progress) of the DOHC concept (Appendix). Although the VF (Dr. Ross), Dr. Roberts, Dr. Jamieson, and Dr. Lea-Anne Henry continue to refine and consider the DOHC, it is unclear when or how this concept can be implemented. The original test cruise has not developed as expected. The intent is for the white paper (Appendix) to continue to evolve into a form that is publishable as a review or opinion topic. The authors are still working toward that goal as well as looking for field test opportunities.

MASTS Fellowship Timeline (major events)

25 February 2016 - notification of MASTS funding

5 March - VF conference call with MASTS hosts, Dr. Roberts (Heriot-Watt Univ.) and Dr. Jamieson (Aberdeen Univ.). Project timeline and initial activities established as a two phase approach (USA work phase and Scotland work phase).

30 April - Contact with committee of deep-sea experts; discussion of deep-sea issues and future meetings.

6-16 May - Travel to London and Edinburgh and return (funded by outside sources), meeting at Oxford Univ. to discuss deep-sea ocean health and meetings at Heriot-Watt Univ. with university and British Geological Survey scientists to discuss future cruises, collaborations and deep-sea exploration and research.

29 May - Conference call with Dr. Jamieson to discuss MASTS project details.

24-28 June - Travel to/from Bermuda, meetings with Bermuda deep-sea scientists (funded by outside sources). Discussed DOHC and future cruises.

6-7 August - Travel to the UK to begin overseas phase of project.

9-12 Aug - Meeting with panel of deep-sea scientists at Oxford Univ., convened and led by the MASTS VF. All issues of deep-sea research and management were discussed and the foundation of a DOHC was started. The DOHC was considered the most effective way to advance progress in deep-sea science at this time. The VF's task was to begin an outline and draft white paper (see Appendix) which could evolve into a concept that could be tested and then applied widely in deep-sea science.

13 Aug - Meetings with scientists at the National Oceanographic Center in Southampton. Travel to Edinburgh (Heriot-Watt Univ.) to set up VF base of operations.

13-29 Aug - Work at Heriot-Watt, including discussions and outline related to a DOHC.

30 August - 4 September - Travel to Aviero, Portugal to attend the International Deep-Sea Symposium and presented two papers.

7-9 September - Travel to/from Malta to evaluate undersea technology (submersibles and cameras) for use in deep-sea research (funded by outside sources).

10-29 Sep - Work at Heriot-Watt, continue work on DOHC, plans for future cruises, preparation for MASTS meeting.

30 Sep - 1 October - Attend MASTS annual meeting in Glasgow. Presented a paper reviewing the MASTS Fellowship activities to date and plans for future continuation of the project.

2 Oct - Return to the United States (Univ. of NC - Wilmington). Continue discussions and plans for developing the DOHC. Start writing initial drafts of the DOHC.

22 Oct - Conference call with Woods Hole deep-sea scientists updating them on the MASTS project and the DOHC.

8-10 December - Travel to/from Halifax, Canada (funded by outside sources) to meet with Dept. of Fisheries and Oceans scientists to discuss future cruises and implementation of tests for the DOHC.

21 December - Conference call with Dutch scientists (NIOZ) concerning future participation in DOHC cruises.

22-25 February - Travel to/from New Orleans (funded by outside sources) to attend International Ocean Sciences meeting. Continued DOHC conversations with colleagues.

21-23 March - Travel to/from Halifax, Canada (funded by outside sources) to present a deep-sea seminar and to meet with Dept. of Fisheries and Oceans scientists to discuss future cruises and implementation of tests for the DOHC.

March onward through 2016 - Continued work on future cruises and the DOHC concept, document and potential implementation.

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