



Nekton – Mission to Bermuda – 2016

Mission Report

June 5, 20196

Prepared for:

Alex Rogers, Ph.D.
Ocean Research and Conservation Group
Department of Zoology
University of Oxford
The Tinbergen Building
South Parks Road
Oxford, OX1 3PS
United Kingdom

Introduction

Global Underwater Explorers (GUE) sent a team of nine divers, including eight volunteers, to Bermuda in 2016 to support a collaborative mission engaged by *Project Baseline* and the *Nekton Foundation*. The objective of the collaboration was to document the health of the marine environment in support of the *XL Catlin Deep Ocean Survey*. The mission ran for 27 consecutive days from July 18 to August 14, 2016 during which time the GUE team were supported by the Baseline Explorer and dived in conjunction with two 2-person 1000-foot submersibles to document fish populations and benthic conditions along a series of transects at seven general depth levels at five locations around the islands. The target locations included three reefs located along the southwest, southeast and northeast sides of the island and two of the adjacent seamounts, Challenger and Argus Banks (Figure 1). This report provides a summary of the diving activities conducted by the GUE divers and the submersibles during the mission.

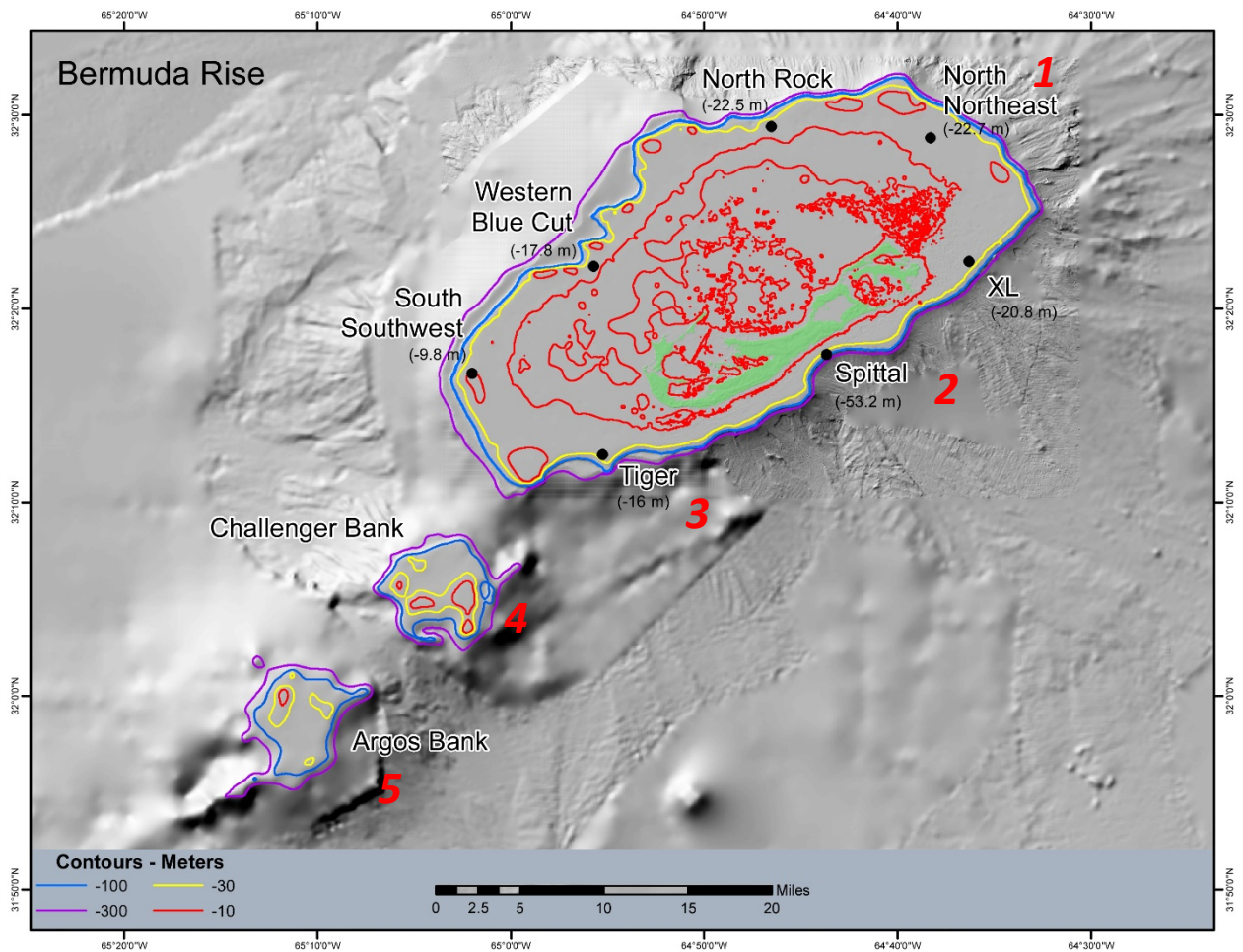


Figure 1. Map showing the location of the five target dive sites relative to a shaded relief map of the bathymetry and contour lines marking the target survey depths.

Dive Team Activities

Objectives

The primary objective for the GUE dives was to conduct a series of transect surveys at 90m, 60m, 30m, and 15m at each of the five sites. Two types of transects were performed at each depth and at each location. One was a traditional benthic survey in which a video camera and light were oriented perpendicular to the bottom and slowly carried along a 50m survey tape to record the diversity and density of life on the seafloor (benthos). The other was a stereo video survey (SVS) in which two cameras, approximately 1m apart and oriented parallel to the seafloor, were carried along the same 50m line about 1.5m off the bottom following a protocol described by Andradi-Brown (2016).

In addition to these transect surveys, the divers also collected a variety of samples and numerical data to support the development of the ocean health index including water, coral, algae, and sponge samples from deep and shallow portions of each site, as well as conductivity, temperature, depth, pH, oxygen, and oxidation-reduction potential measurements at 15-second intervals throughout the water column.

Methods

The divers used the “JJCCR” closed circuit rebreather specifically modified to conform to GUE’s standards. Dilluent gas was mixed to an appropriate trimix (11% oxygen, 75% helium, balance nitrogen) for the maximum depth of the mission dives such that it also served as the primary bailout gas. Each diver also carried sufficient decompression bailout gas to ensure that they could safely ascend to 70 feet, where they were able to receive additional gas from a surface support team. For the dives to 90m, this consisted of one 10L cylinder of trimix (21% oxygen, 35% helium, balance nitrogen) and one 5L cylinder of nitrox (50% oxygen, 50% nitrogen).

Dive team make-up typically involved three divers. One diver operated the SVS and benthic transect cameras. One diver assisted by laying out and reeling up the measuring tape, and the third diver carried a floating tracking device and documented the team activities with still and video cameras. In some cases, the team only consisted of two divers, in which case the assisting diver was required to carry the tracking device. In other cases, the team consisted of four divers, in which case the fourth diver was dedicated to video and still media collection.

Dive profiles were generally designed to result in total dive times for the team of approximately 5 hours. Each diver carried a diver propulsion vehicle (DPV) and used the DPVs to navigate to specific target sites at varying depths on each dive. Whenever possible, the divers navigated from the deepest target depth into shallow water during their decompression periods such that additional surveys and sample collection could be conducted on each dive. At the Tiger and Spittal dive sites in particular, the divers were able to navigate from 90m up to 6m following the bottom using the DPVs thereby enabling 90m, 30m, and 15m transects to be conducted on each dive. Generally speaking the 60m transects were conducted on a dedicated dive.

A surface support team of at least two divers followed the dive team at all times by way of the floating tracking buoy carried by the dive team. The support boat was equipped with two additional 10L cylinders of the trimix decompression gas, two additional 10L cylinders of the nitrox decompression gas, and two 10L cylinders of oxygen.

Results

Thirty-two (32) mission dives were conducted. Twenty-eight of those dives were conducted solely by the GUE divers. Four dives were done with two to three divers from the Nekton team. A total of 313.6 person-hours were logged underwater during the Bermuda mission. Table 1 provides a summary of the dives performed by each of the twelve participating divers.

Table 1. Summary of dives conducted during the Bermuda mission.

Name	Group	Number of Dives			Total Dive Time		
		Total	>=300	>=200	(mins)	(hrs)	hrs/dive
Todd Kincaid	GUE	16	7	9	3,302	55.0	3.4
Martin McClellan	GUE	10	6	8	2,525	42.1	4.2
Susan Bird	GUE	10	4	6	2,074	34.6	3.5
Meredith Tanguay	GUE	9	5	7	2,378	39.6	4.4
Kevin Dow	GUE	6	4	5	1,651	27.5	4.6
Graham Blackmore	GUE	8	4	5	1,731	28.9	3.6
JP Bressor	GUE	3	2	2	708	11.8	3.9
Kyungsoo Kim	GUE	8	4	5	1,957	32.6	4.1
SuEun Kim	GUE	6	2	3	1,353	22.6	3.8
Heidi Hirsh	Stanford	7	0	0	463	7.7	1.1
Catherine Head	Oxford	5	0	0	363	6.1	1.2
Melissa Price	Nekton	5	0	0	310	5.2	1.0
<i>Totals</i>		<i>93</i>	<i>38</i>	<i>50</i>	<i>18,815</i>	<i>313.6</i>	<i>3.4</i>

Seventeen of the GUE dives were conducted in which the primary purpose was to conduct SVS and benthic transects surveys. A total of 73 benthic and 67 SVS transect surveys were conducted. Sampling for coral, sponges, algae, and or water was performed on seventeen dives as well, though not necessarily the same dives as the transects. In addition to the survey dives, GUE divers also supported scientific dives conducted by some of the collaborating scientists and dives conducted for the specific purpose of filming the submersible operations. The scientific dives were primarily conducted to deploy and retrieve a monitoring station called the BEAMS (*Benthic Ecosystem Acidification Monitoring System*), which delivered important data on how the process of ocean acidification is affecting coral health in Bermuda. Tables 2-3 provide a summary of the dive team results.

Table 2. Number of SVS and Benthic transect surveys conducted at each dive site by depth.

Dive Site	Total Dives	SVS Transects					Benthic Transects				
		90m	60m	30m	15m	Total	90m	60m	30m	15m	Total
North-Northeast	5	4	4	6	6	20	4	6	8	6	24
Spittal	4	4	5	4	4	17	5	4	4	4	17
Tiger	3	4	4	4	4	16	4	4	4	4	16
Challenger Bank	0	0	0	0	0	0	0	0	2	0	2
Argus Bank	3	4	4	2	0	10	4	2	4	0	10
Wreck-Dredger	2	0	0	0	4	4	0	0	0	4	4
<i>Total</i>	<i>17</i>	<i>16</i>	<i>17</i>	<i>16</i>	<i>18</i>	<i>67</i>	<i>17</i>	<i>16</i>	<i>22</i>	<i>18</i>	<i>73</i>

Table 3. Number of dives conducted for sampling at each site by type of sample collected.

Dive Site	Total Dives	Sampling Dives			
		Water	Coral	Algae	Sponge
North-Northeast	6	6	6	4	1
Spittal	4	4	3	4	2
Tiger	3	3	3	3	2
Challenger Bank	1	1	1	1	1
Argus Bank	3	3	1	3	1
Wreck-Dredger	0	0	0	0	0
<i>Total</i>	<i>17</i>	<i>17</i>	<i>14</i>	<i>15</i>	<i>7</i>

Submersible Diving Activities

A total of 77 submersible dives were conducted during the Bermuda mission. Dive objectives primarily focused on the execution of benthic and SVS transect surveys similar in scope to those conducted by the divers. The specific protocols were adapted however to conform to the limitations of working with the equipment from inside the submersibles. The most significant of these limitations was the necessity of powering on the SVS and benthic cameras at the surface, which then limited dive times to the life of the respective batteries. A total of 65 transects were conducted in which SVS and benthic surveys were performed across a total distance of over 18 km. Tables 4 provides a summary of the transect surveys conducted at each site by depth.

Table 4. Summary of transect surveys performed by the submersibles.

Station Name	Total		120-150 m		180-210 m		210-240 m		240-270 m		270-300 m	
	#	Dis (m)	#	Dis (m)	#	Dis (m)	#	Dis (m)	#	Dis (m)	#	Dis (m)
North-Northeast	21	5,774	3	1,180	12	3,447	0	0	3	466	3	682
Argus	14	3,724	2	198	6	2,136	0	0	3	808	3	582
Spittal-North	16	5,732	7	2,597	3	967	0	0	3	1,326	3	842
Tiger	14	3,154	6	1,573	5	1,123	3	458	0	0	0	0
<i>Total</i>	<i>65</i>	<i>18,384</i>	<i>18</i>	<i>5,549</i>	<i>26</i>	<i>7,672</i>	<i>3</i>	<i>458</i>	<i>9</i>	<i>2,599</i>	<i>9</i>	<i>2,105</i>

In addition to the surveys, samples for coral, sponges, algae, and water was conducted on several of the dives. Beyond the scientific objectives, dives were also conducted to introduce media and marine policy personnel as well as project sponsors to the marine environment. Table 5 provides a summary of the submersible dives conducted by overall mission objective. Tables 6 and 7 list the organizations and the observers carried by the submersibles and the number of dives and hours conducted by each one.

Table 5. Number of submersible dives conducted by mission objective.

Dive Mission	# Dives	Duration (hours)	Minimum Depth (m)	Maximum Depth (m)
Orientation	2	2.8	45	55
Science	32	73.1	37	305
Media	15	33.3	61	305
Exploration	6	13.9	152	304
Policy	2	4.4	159	159
VIP-Promotional	18	10.9	15	248
Training	2	1.6	10	110

Table 6. List of organizations for which representatives were carried by the submersibles and statistics for the dives they conducted.

Observer Organization	# Dives	Duration (hours)	Minimum Depth (m)	Maximum Depth (m)
BBC	1	1.5	303	303
Bermuda Aquarium	3	9.2	218	305
Forbes Magazine	1	2.8	305	305
Gaurdian	1	2.1	152	152
Nekton	11	24.9	10	304
NOAA-NURP	1	1.8	154	154
Oxford Univ.	21	47.0	37	305
PBS NewsHour	1	2.8	244	244
Rockefeller Center	1	1.2	158	158
Rodenberry Entertain.	1	0.9	158	158
Sky News	2	2.6	61	62
Stanford Univ.	1	2.5	199	199
Telegraph	1	0.7	152	152
Trinity College	1	1.6	201	201
Undersea Research	1	2.7	249	249
UNESCO	2	4.4	159	159
Univ. Puerto Rico	1	1.7	167	167
Univ. Rhode Island	2	4.4	158	202
XL Catlin	16	7.9	15	15

Table 7. List of individuals carried by the submersibles and statistics for the dives they conducted.

Observer / Organization	# Dives	Duration (hours)	Minimum Depth (m)	Maximum Depth (m)
Alex Rogers / Oxford Univ.	19	41.6	37	305
Oliver Steeds / Nekton	7	14.1	10	304
Robbie Smith / Bermuda Aquarium	2	6.3	218	305
Will West / Nekton	2	6.0	200	203
John Fugelsang / Actor	1	4.4	304	304
Thea Popolizio / Univ. Rhode Island	2	4.4	158	202
Douglas Batchelor / Baird & Warner Real Estate	2	4.1	201	248
Chris Flooke / Bermuda Aquarium	1	2.9	303	303
Jim Clash / Forbes Magazine	1	2.8	305	305
Katherine Head / Oxford Univ.	1	2.8	200	200
Nsikan Akpan / PBS NewsHour	1	2.8	244	244
Joe McInnis / Undersea Research	1	2.7	249	249
Melissa Price / Nekton	1	2.7	303	303
China Mieville / Writer	1	2.6	303	303
Lucy Woodall / Oxford Univ.	1	2.6	200	200
Heidi Hirsh / Stanford Univ.	1	2.5	199	199
Gayle Batchelor / Baird & Warner Real Estate	1	2.5	248	248
Fanny Douvere / UNESCO	1	2.3	159	159
Greg Foote / Nekton	1	2.2	250	250
Philip Renaud / UNESCO	1	2.2	159	159
Oliver Millman / Gaurdian	1	2.1	152	152
Aviva Ruthkin / New Scientist	1	2.0	200	200
David Rees / Sky News	1	1.9	62	62
Karen Kohanovich / NOAA-NURP	1	1.8	154	154
Nikolaos Schizas / Univ. Puerto Rico	1	1.7	167	167
Craig Schneider / Trinity College	1	1.6	201	201
Justin Marozzi / BBC	1	1.5	303	303
Jen Hagerty / Rockefeller Center	1	1.2	158	158
Kelvin Magee / Triton	1	0.9	110	110
Rod Rodenberry / Rodenberry Entertain.	1	0.9	158	158
Chris Reeves / XL Catlin	1	0.8	15	15
India Sturges / Telegraph	1	0.7	152	152
Stephen Catlin / XL Catlin	1	0.7	15	15
Thomas Moore / Sky News	1	0.6	61	61
Paul Brand / XL Catlin	1	0.6	15	15

Observer / Organization	# Dives	Duration (hours)	Minimum Depth (m)	Maximum Depth (m)
Mike Maran / XL Catlin	1	0.6	15	15
Elliot Bundy / XL Catlin	1	0.6	15	15
Annie Sousa / XL Catlin	1	0.5	15	15
Graham Everard / XL Catlin	1	0.5	15	15
Paul Ritchie / XL Catlin	1	0.5	15	15
Pete Porrino / XL Catlin	1	0.5	15	15
Myron Hendry / XL Catlin	1	0.4	15	15
Krista Doran / XL Catlin	1	0.4	15	15
Greg Hendrick / XL Catlin	1	0.4	15	15
Tom Booth / XL Catlin	1	0.4	15	15
John Smart / XL Catlin	1	0.4	15	15
Kelly Lyles / XL Catlin	1	0.3	15	15
Mike McGavick / XL Catlin	1	0.3	15	15