

Benthic Species on the Wreck of the *Victory* (1744), Western English Channel

Neil Cunningham Dobson

Odyssey Marine Exploration, Tampa, Florida, USA

Silje-Kristin Jensen

Scottish Oceans Institute, School of Biology, University of St. Andrews, Scotland, UK

Sean A. Kingsley

Wreck Watch Int., London, UK

A marine biological survey was conducted in February 2012 across the wreck of the First Rate warship the *Victory* (site 25C) in the Western English Channel. A total area of 40,000m² was surveyed in 134 lines, which included the 2,520m² wreck mound as well as offsite zones to its north and south. Species types and densities were compared intra-site and in relation to the offsite zones to characterize and quantify the biological oasis effect.

Site 25C proved to be inhabited by a wide variety of common marine flora and fauna. The survey recorded 38 species of invertebrates and 21 species of vertebrates with a total species value in excess of 17,316. Nectobenthic species comprised 92.1% of the total and sessile 7.9%. No rare or endangered species were recorded. The overall oasis effect ratio of the central wreck mound containing hard surfaces and nutrient-rich deposits was 15:1 compared to the offsite north area and 11:1 in relation to the southern offsite zone. The 2012 survey establishes a benchmark for such research in the English Channel, where no comparable studies exist.

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1. Introduction

Odyssey Marine Exploration discovered the wreck of the *Victory* (site 25C) in April 2008 during the Atlas Shipwreck Survey Project conducted outside UK territorial waters between the Western Approaches and the Western English Channel. The site lies approximately 80km south-west of Plymouth at a depth of 75m. *Victory* was a 100-gun First Rate English warship lost en route from Gibraltar to England during a storm on 5 October 1744 (Cunningham Dobson and Kingsley, 2010).

The *HMS Victory, 1744 (Site 25C) – Project Design* required a set of varied non-disturbance activities to be performed, ranging from production of a master photo-mosaic to a side-scan sonar, magnetometer and multibeam survey and documentation by video and photography of all surface features (Seiffert *et al.*, 2013). The environmental study used a Beckman-Coulter LS-230 particle size analyser, X-Ray Fluorescence Spectrometry (XRF) and X-Ray Diffraction (XRD), as well as imaging using a Keyence VHX 2000 3D digital microscope, to characterize the site sedimentology (Prave *et al.*, 2013). The non-disturbance program was supplemented by Sub-Bottom Imaging profiling (Seiffert *et al.*, 2013).

The 2012 activities included a marine biological site assessment in accordance with the UNESCO Convention on the Protection of the Underwater Heritage protocols (Annex Rule 29). Phase 2 of the Project Design stipulated a requirement for a desk-based assessment utilizing photographic and video data to define the wreck's oasis effect. The primary data drawn from site video coverage were processed by Silje-Kristin Jensen from the Scottish Oceans Institute, School of Biology, University of St. Andrews, Scotland.

2. Site Environment

Site 25C is a discretely bounded artificial ellipsoidal mound with a 50cm elevation (72.0-72.5m depth) rising above the surrounding sea floor that is otherwise broadly flat. The wreck mound is flanked around 22m to the east by Sandwave 1 (Fig. 2), part of a continuous northeast/southwest oriented sedimentary feature extending at least 750m in length. The wreck and sandwave comprise elevated highs on an otherwise even and featureless seabed. To the west the seabed descends smoothly down to bedrock at a depth of 74.1m. To the east the seabed undulates in a gentle depression towards Sandwave 1, which reaches a localized

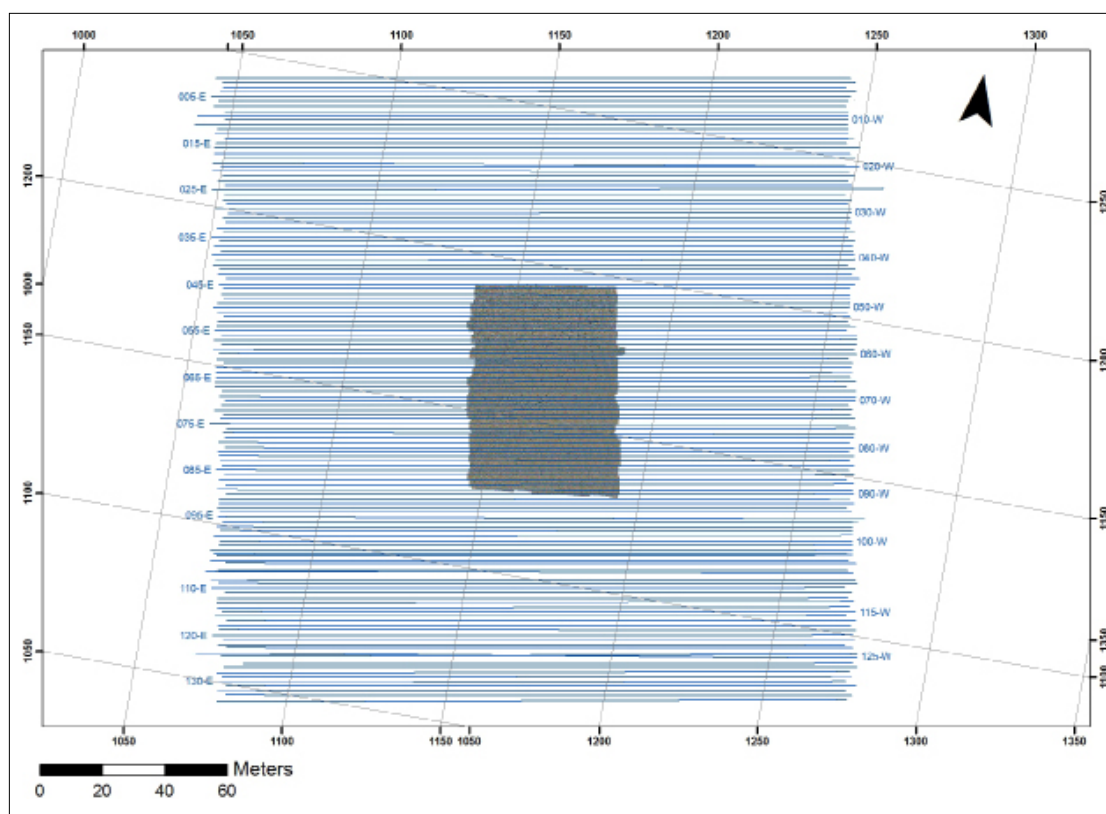


Fig. 1. Locations of lines surveyed during the Victory shipwreck marine biological site assessment.

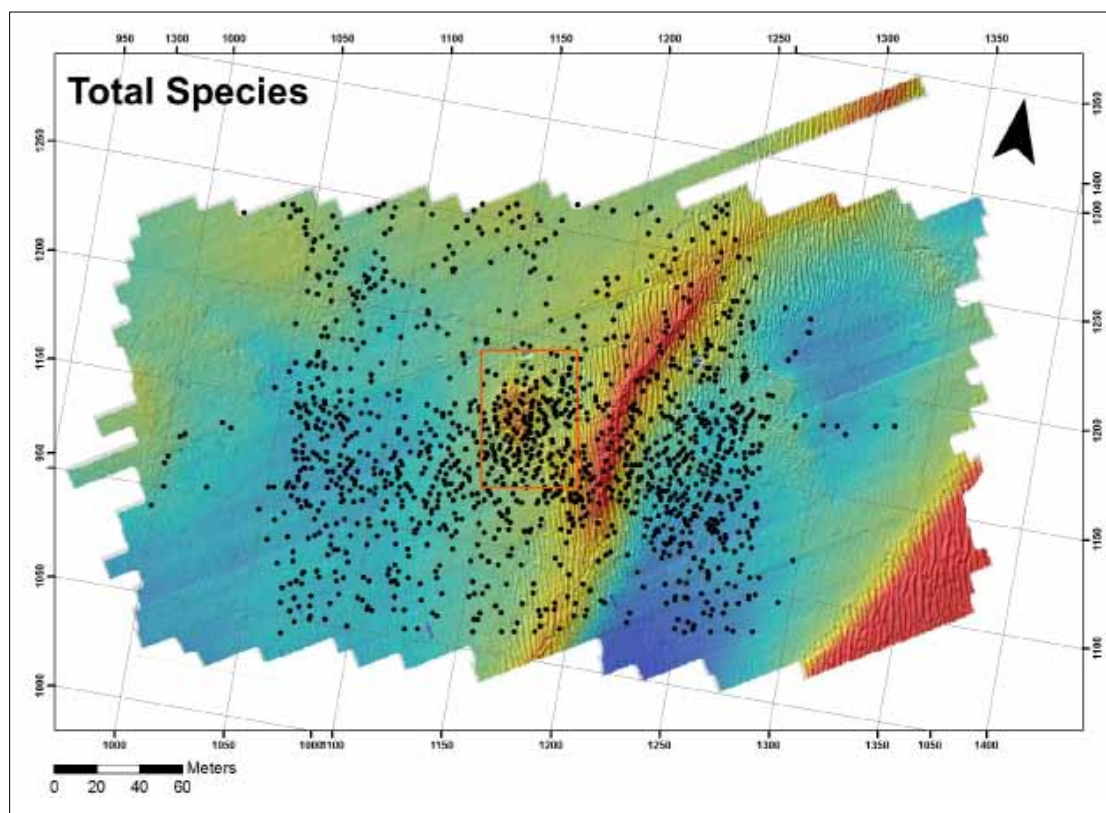


Fig. 2. Distribution of total marine species recorded during the Victory shipwreck marine biological site assessment.

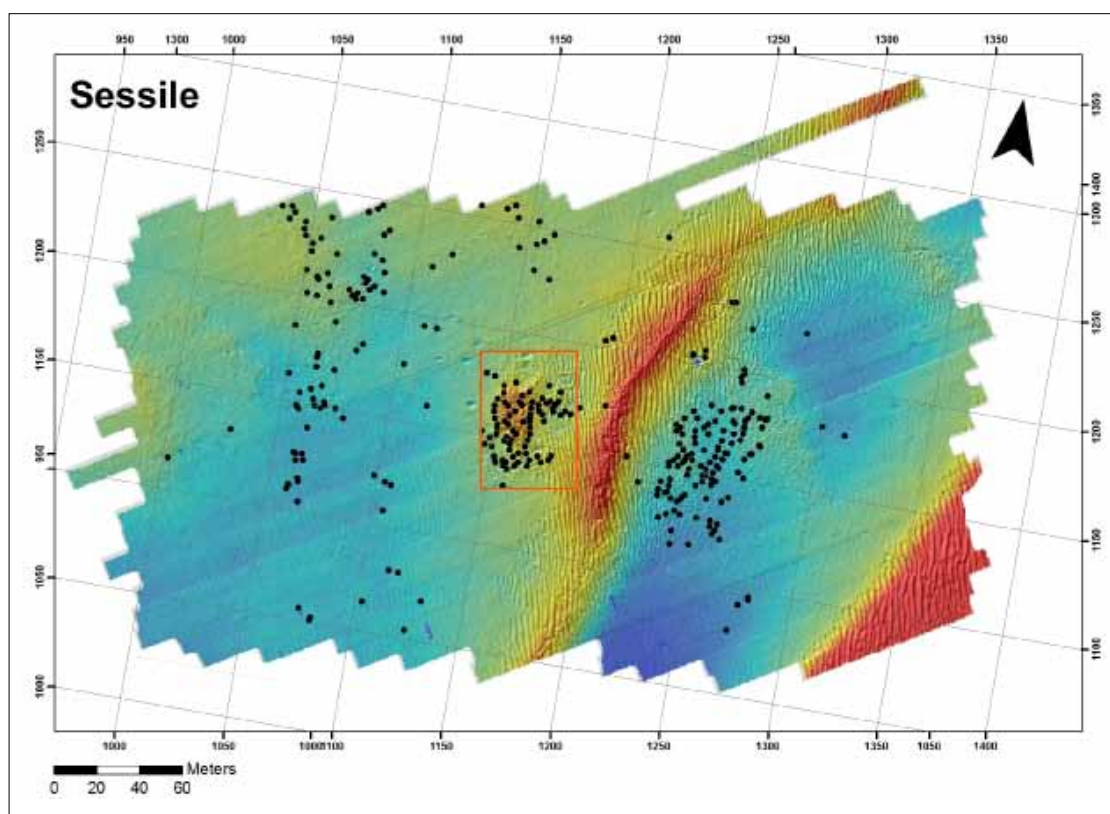


Fig. 3. Distribution of sessile species recorded during the Victory shipwreck marine biological site assessment.

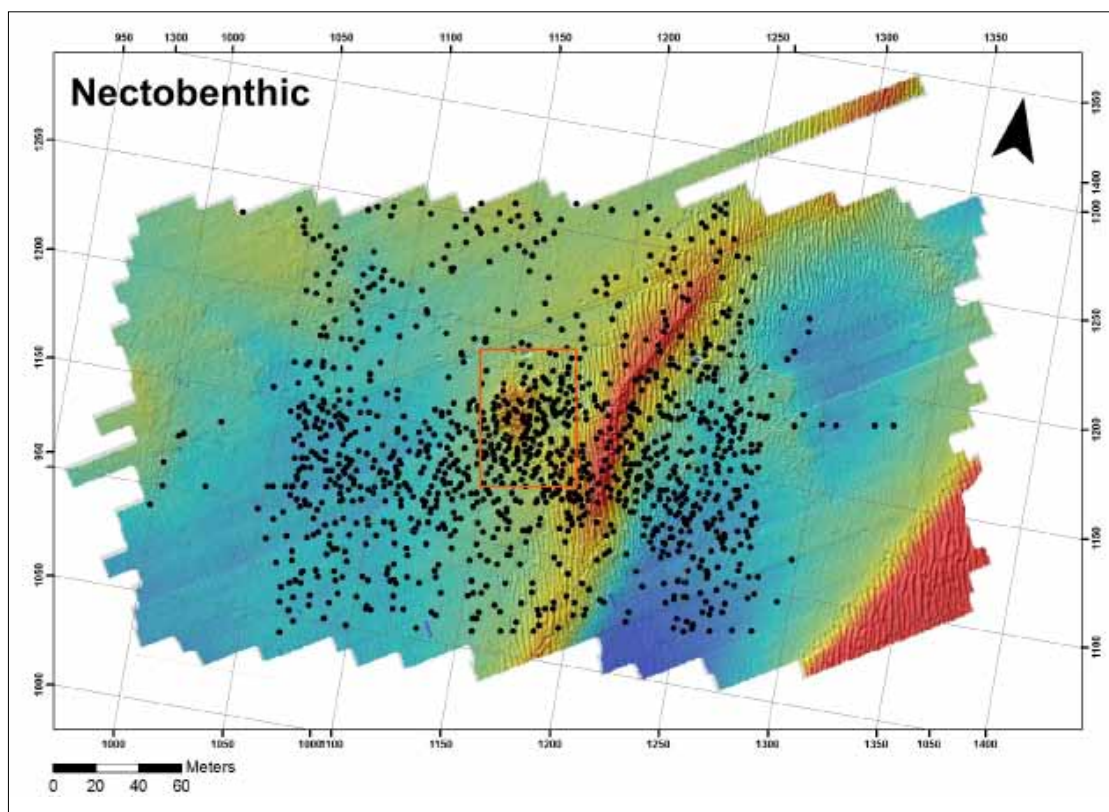


Fig. 4. Distribution of nectobenthic marine species recorded during the Victory shipwreck marine biological site assessment.

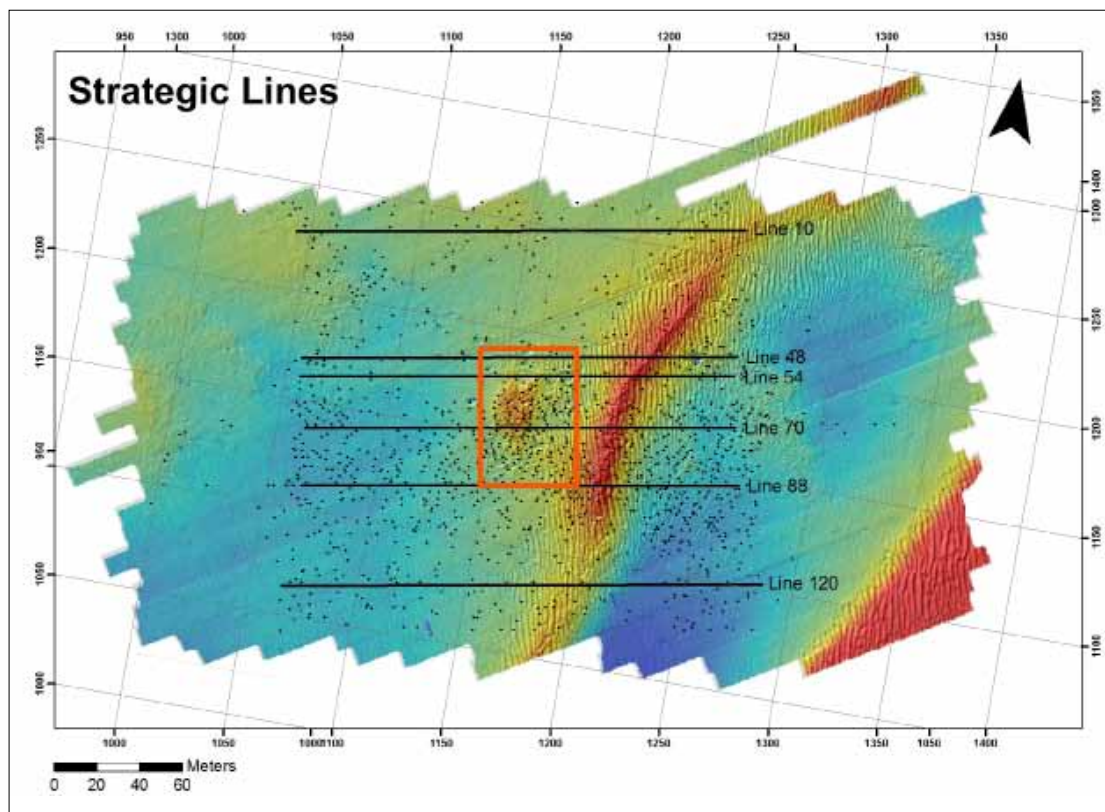


Fig. 5. Locations of strategic Lines TB-010-W, TB-048-W, TB-054-W, TB-070-W, TB-088-W and TB-120-W surveyed during the *Victory* shipwreck marine biological site assessment.

high of 68.1m before descending to a depth of 74.1m. The orientations of the sandwaves, and low-lying parallel ripples across site 25C, reflect a dominant northeast/southwest tidal current with a 180° cyclical daily rotation (Seiffert *et al.*, 2013: 3).

Sediment analyses conducted by the Centre for Earth Resources St. Andrews (CERSA) determined that finer than coarse sand comprised only around 1-2% by volume of the samples, while 38-59% by volume proved to be very coarse sand and gravel particles. Abundant material between c. 1-2mm and larger consisted of broken and abraded bioclastic fragments dominated by epifauna forms such as bivalves and bryozoans (Prave *et al.*, 2013).

The nature and size of the sediments constituting the seabed at site 25C enabled the tidal currents to configure wide mesoforms fields, which are dynamic and asymmetric straight crested 2D dunes. Their values of migration rate up to 1m h⁻¹ during spring tidal cycles. Comparative multibeam data indicate that Sandwave 1 has remained stable since at least 2005 (González and Lozano Guerra-Librero, 2013).

The wreck of the *Victory* lies on a northwest to southeast orientation with the bows directed towards the northwest. The discontinuous site boundaries extend across a total area 84m north/south (anchor A2 to the rudder) and 305m east/west (cannon C32 to C47). The continuous site boundaries defined by the central elevated wreck mound cover an area of 60m north/south and 42m east/west. The surface archaeological remains are characterized most conspicuously by 50 bronze cannon. At least three guns have been dragged offsite by 48-233m by fishing trawlers. One anchor lies to the north of the wreck in Area A, while a second is located 16m northeast of the northern termination of the wreck mound.

Remains of the wooden rudder denote the southwest site terminal. Apart from the bronze guns, significant surface artifacts include a crushed copper cooking kettle, two stone grinding stones or gunners' wheels, a concentration of rectangular iron ballast kentledge to the west (Area F), bronze rigging and a possible sprocket wheel from a chain pump. No articulated wooden hull remains were recorded on the wreck's surface. Between 2008 and February 2012,

SITE 25C - BIOLOGICAL SITE ASSESSMENT 2012					HABITAT		
Name	Taxon	Qty	Sessile	Vagile	Hard	Soft	Water Column
INVERTEBRATES							
Annelida							
Feather Duster Worm	<i>Sabellidae</i>	4	X			X	
Arthropoda							
Edible Crab	<i>Cancer pagurus</i>	14		X	X		
Crab	<i>Canceridae</i>	8		X	X		
Hermit Crab	<i>Paguridae</i>	>10,137		X	X		
Hermit Crab	<i>Paguridae</i> spp.	1386		X	X		
Cnidaria							
Sea Anemone	<i>Actinimeria</i> spp.	>363	X		X		
Sea Anemone	<i>Bolocera</i>	1	X		X		
Hydrail	<i>Caryocarpa</i> spp.	1	X			X	
Jellyfish	<i>Ephyra</i>	>107		X			X
Plumose Anemone	<i>Metridium</i> sp.	>68	X		X		
Sea Bream	<i>Nemertea</i> spp.	>164	X		X		
Soft Coral	<i>Nephthya</i>	1	X		X		
Sea Pen	<i>Paraulacina</i>	3	X			X	
Coral	<i>Zoanthids</i>	>100	X		X		
Echinodermata							
Common Starfish	<i>Crossaster pupposus</i>	1		X	X		
Sea Urchin	<i>Echinus</i> sp.	114		X	X	X	
Sea Cucumber	<i>Holothuridae</i>	2		X	X	X	
Brittle Star	<i>Ophiuroidea</i>	1		X	X		
Mollusca							
Starfish	<i>Asteroides</i>	44		X	X	X	
Cuttlefish	<i>Cephalopoda</i>	32		X	X	X	X
Octopus	<i>Octopoda</i>	4		X	X		
Mollusc	<i>Pectinidae</i>	1		X	X	X	
Scallop	<i>Pectinidae</i>	15		X	X	X	
Cuttlefish	<i>Sepiidae</i>	12		X	X	X	
Cuttlefish	<i>Sepiidae/Cephalopoda</i>	3		X	X	X	
Porifera							
Sponge	<i>Porifera</i>	671	X		X	X	
Sponge	<i>Porifera encrusting</i>	2	X		X	X	
Sponge	<i>Porifera encrusting on boulder</i>	2	X		X	X	
Total		13,361					

Table 1. Sessile and nectobenthic/vagile species on the wreck of the Victory, February 2012.

SITE 25C - BIOLOGICAL SITE ASSESSMENT 2012				HABITAT		
Name	Taxon	Qty	Vagile	Hard	Soft	Water Column
VERTEBRATES						
Pisces						
Grey Gurnard	<i>Eutrigla</i>	1	X		X	
Cod, Haddock, Whiting, Pollock	<i>Gadidae</i>	>434	X			X
Atlantic Cod	<i>Gadus Morhua</i>	1	X			X
Gurnard	<i>Aspitrigla cuculus</i>	12	X	X	X	
Sculpin	<i>Myoxocephalus</i> spp.	62	X	X	X	
Flatfish	<i>Pleuronectiformes</i>	8	X	X	X	
Unknown	<i>Sand burying fish</i>	1	X	X	X	
Dogfish/Catshark	<i>Scyliorhinidae</i>	31	X		X	
Unknown	<i>Sebastes like</i>	1	X	X		
Bib	<i>Trisopterus</i>	>344	X	X	X	
Ray-Finned Fish	<i>Teleost large (Rockfish?)</i>	>88	X	X	X	
Ray-Finned Fish	<i>Teleost Triglidae like</i>	1	X	X	X	
Ray-Finned Fish	<i>Teleostei</i>	>1614	X	X	X	
Ray-Finned Fish	<i>Teleostei large</i>	1	X	X	X	
Ray-Finned Fish	<i>Teleostei small</i>	>1303	X	X	X	
Gurnard	<i>Triglidae</i>	153	X	X	X	
Total		4055				

Table 2. Nectobenthic/vagile species on the wreck of the Victory, February 2012.

conger eels were commonly observed inhabiting cannon bores (Fig. 11), while crabs and lobsters were frequent amongst and under the iron ballast in Area F (Fig. 13A, B, D). The biological oasis effect was otherwise identified as light based on visual observations prior to the 2012 marine biological site assessment.

3. Methodology & Results

The research platform used during the 2012 project was the 76m-long, 1,431-ton *Odyssey Explorer*. This ship is comprehensively equipped to support deep-sea exploration and contains deck-mounted deployment capabilities, umbilical cable and recovery equipment suitable for the operation of a work-class ROV and side-scan sonar systems. Odyssey's ROV Zeus was configured for site surveys with all camera and lighting systems fully functional.

The biological survey data were gathered in February 2012 over a survey area of 200 x 200m focused on the wreck mound, with 2m line spacing, and consisted of 134

survey lines running alternatively east/west and west/east (TB-001-E to TB-134-E; Fig. 1). A total area of 40,000m² was surveyed, of which 2,520m² comprised the wreck mound (Lines 45-90), with the objective of characterizing species representation and comparing their densities on-site and off-site (Fig. 2). A total of 62 hours of footage was recorded for the marine biological assessment. The underwater visibility was generally poor throughout the survey's duration.

The ROV's HD camera system visually recorded the data, a copy of which was transferred to Silje-Kristin Jensen at the Scottish Oceans Institute, School of Biology, University of St. Andrews. Jensen produced a written evaluation of the video-transects for each DVD, along with a spreadsheet containing the latitude/longitude, time, date, species, value, visibility and comments specific to all the features and organisms seen on every transect. Folders were supplied from the research vessel containing screen-grabs of transects where the most frequent and infrequent species were observed.

Shipwrecks become unintended artificial biological reefs associated with concentrations of organisms. Their remains, structures, cannon and artifacts provide surfaces on which algae and hard-bottom fauna, such as kelp, sea anemones and sponges, can develop. Fish are attracted to the artificial reefs in search of food and shelter. The subsequent colonizing biofouling community can strip nutrients and suspended material from passing water and plankton, generating epibenthic production. In turn, this process attracts nectobenthic fish and thus a biological oasis is formed.

Lying within the epipelagic zone (0-200m), site 25C is inhabited by a wide variety of common marine flora and fauna (Figs. 6-18). Nectobenthic fauna comprised 92.1% of the total species and sessile flora 7.9%. The survey recorded 38 species of invertebrates and 21 species of vertebrates with a total species value in excess of 17,316 (4,055 vertebrates and 13,261 invertebrates) (Tables 1-2).

The surfaces of the bronze cannon, concreted ballast and anchor A1 were lightly covered with common organisms, such as sea beard (*Nemertesia*), sea anemones (*Actiniaria* spp.), sea urchins (*Echinus* spp.) and colonial hydrozoans (Figs. 6-8). Abundance and species diversity was highest nearer to the cannon due to the presence of fish that aggregate around these features on an otherwise flat seabed (Fig. 17A-E). Small upwellings from the currents expose buried nutrients and propel them into the water column to attract small prey on which fish can forage. An unusual feature observed in February 2012 was the large quantities of hermit crabs seemingly gathering in proximity to sand ripples (Fig. 12A-D). These animals more typically aggregate on the edge of sandwaves for ease of capturing particles within the water column.

In total, the northern offsite sector (Lines 1-44) contained a species density of over 953, of which 54% were nectobenthic and 46% sessile (Table 3). Hermit crabs were most highly represented (>173 examples), followed by sea anemones (>152), sea beard (>115), ray-finned fish (>109), coral (>100) and plumose anemones (>68). Coral (*Zoanthids*) was only attested in this zone, while the 14 scallops (*Pectinidae*) were most highly represented on site 25C. Only one example was recorded across the wreck mound and none within the offsite south zone (Tables 4-5).

The onsite sector (Lines 45-90) exhibited a species density of over 15,063, a 1,580% increase over the northern offsite area, of which 94.5% was nectobenthic (Table 4). The statistic is skewed by the massive representation of hermit crabs observed (>11,080 examples), which may have been attracted to the onsite zone by by-catch dumped onto the wreck site by French trawlers in February 2012 (Fig. 12E-F). Excluding the hermit crabs from Lines 45-90

Common Name	Taxon	Quantity
Sessile		
Cnidaria	<i>Zoanthids</i>	>100
Hydroid	<i>Corymorphidae</i>	1
Plumose Anemone	<i>Metridium</i> sp.	>68
Sea Anemone	<i>Actiniaria</i> spp.	151
Sea Anemone	<i>Bolocera</i> sp.	1
Sea Beard	<i>Nemertesia</i> spp.	>115
Sponge	<i>Porifera encrusting</i>	2
Nectobenthic		
Bib	<i>Teleost large</i>	9
Brittle Star	<i>Ophiuroidea</i>	1
Cuttlefish	<i>Cephalopoda</i>	21
Edible Crab	<i>Cancer pagurus</i>	4
Gurnard	<i>Triglidae</i>	40
Hermit Crab	<i>Paguridae</i>	>173
Jellyfish	<i>Hydrozoa</i>	>13
Ray-Finned Fish	<i>Teleostei small</i>	>107
	<i>Teleost large</i>	1
	<i>Teleost Triglidae like</i>	1
Scallop	<i>Pectinidae</i>	14
Sculpin	<i>Myoxocephalus</i> spp.	59
Starfish	<i>Asteroidea</i>	18
Sea Urchin	<i>Echinus</i> sp.	42
Dogfish/Catshark	<i>Scyliorhinidae</i>	11
Unknown	<i>Sebastes like</i>	1
Total		>953

Table 3. Sessile and nectobenthic species in Lines 1-44, offsite north, wreck of the Victory, February 2012.

generates a 3,983 sample size that still provides a 417% increase over the northern offsite sector. Compared to the northern offsite zone quantities, the 2,179 ray-finned fish represent a 1,999% increase and the 335 bib a 3,722% rise. Sea anemone densities are virtually equal, with >147 within the onsite zone. The 619 sponges reflect the presence of hard adhesive surfaces; just two were documented in the northern offsite zone. The >428 cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*), whiting (*Merlangius merlangus*) and pollock (*Pollachius pollachius*) are unattested to the north.

The offsite south sector (Lines 91-134) contained a combined species density of over 1,300, closer to the offsite north quantity of over 953, and a 1,158% drop

Common Name	Taxon	Quantity
Sessile		
Sea Anemone	<i>Actiniaria</i> spp.	>147
Sea Beard	<i>Nemertesia</i> spp.	48
Soft Coral	<i>Nephtheidae</i>	1
Sponge	<i>Porifera</i>	617
	<i>Porifera encrusting</i>	2
Nectobenthic		
Bib	<i>Trisopterus</i>	>335
Cod, Haddock, Whiting, Pollock	<i>Gadidae</i>	>428
Crab	<i>Cancridae</i>	8
Cuttlefish	<i>Cephalopoda</i>	6
	<i>Sepiidae</i>	7
Edible Crab	<i>Cancer pagurus</i>	5
Flatfish	<i>Pleuronectiformes</i>	2
Gurnard	<i>Chelidonichthys</i>	2
	<i>Cuculus</i>	
Gurnard	<i>Triglidae</i>	48
Hermit Crab	<i>Paguridae</i>	>11,080
Jellyfish	<i>Hydrozoa</i>	56
Mollusc	<i>Pectinoidea</i>	1
Ray-Finned Fish	<i>Teleostei small</i>	749
	<i>Teleost large</i>	>88
	(Rockfish?) <i>Teleostei</i>	>1342
Scallop	<i>Pectindae</i>	1
Sculpin	<i>Myoxocephalus</i> spp.	3
Starfish	<i>Asteroidea</i>	13
Sea Urchin	<i>Echinus</i> sp.	68
Dogfish/Catshark	<i>Scyliorhinidae</i>	5
Unknown	<i>Sand burying fish</i>	1
Total		>15,063

Table 4. Sessile and nectobenthic species in Lines 45-90 covering the wreck mound of the Victory, February 2012.

compared to the on-site zone (Table 5). A total of 90.2% was nectobenthic. Ray-finned fish dominate at >718 (a 303% drop from the onsite zone), followed by 279 hermit crabs (a 3,971% drop and closer to the northern off-site figure of >173), 65 sea anemone (a 226% drop) and 54 sponges (a 1,146% decrease). The cod, haddock, whiting and pollock present reduced dramatically by 7,133% to six examples. The two sea cucumbers present in the off-site south zone are the only examples documented across site 25C.

The distribution of drifting jellyfish seemed to be largely randomly represented across the three zones, with >13 present offsite north, 56 onsite and 38 offsite south. Sea urchins displayed a similar non-sedimentological specific distribution: 42 north offsite, 68 onsite and four in the offsite south area. Gurnard were relative even across all three zones (40 offsite north, 50 onsite and 68 examples offsite south), increasingly insignificantly southwards.

Six lines were selected strategically to examine species characteristics and densities further between the different site micro-zones (Fig. 5). Line TB-010-W is located off-site at the north of the study area and 55m north of the wreck mound. Line TB-048-W covers the northern end of the wreck mound. Line TB-054-W is positioned one-quarter of the way southward down the wreck mound. Line TB-070-W dissects the center of the site. Line TB-088-W extends east/west three-quarters southward down the site. Finally, line TB-120-W lies 47m offsite south of the edge of the wreck mound.

Offsite northern Line 10 contained a low quantity of >35 combined species values, 54% nectobenthic. Off-site southern Line 120 displayed a lower species value of just seven, all jellyfish, ray-finned fish and cuttlefish. The densities immediately increased on the wreck mound's borders: Line 48 exhibited a total species value of at least 297, 89.6% nectobenthic, while Line 88 had a total value of 206 of which 92.3% were nectobenthic. Both on-site Lines 54 and 70 exhibited relatively low species values, respectively 59 (95% nectobenthic) and 13 (90.2% nectobenthic).

4. Conclusion

The marine biological assessment of the wreck of the *Victory* in the Western English Channel identified a total species value in the excess of 17,316 across an area of 40,000m². Nectobenthic fauna comprised 92.1% of the total species and sessile flora 7.9% (Figs. 3-4). The on-site sector exhibited a species density of more than 15,063 (94.5% nectobenthic), the northern offsite sector over 953 (54% nectobenthic) and the offsite south sector over 1,300 (90.2% nectobenthic). With its hard surfaces attracting sessile species, the 815 examples within the central mound area represents respectively a 47% and 84.5% increase compared to the northern and southern offsite zones. The overall oasis effect ratio of the wreck mound containing nutrient-rich deposits was 15.8:1 compared to the offsite north area and 11.5:1 in relation to the offsite south zone.

All species attested on site 25C are typical to the waters of the UK and the English Channel. None are rare

or endangered. Of the 20 taxa of commercial fish attested (Table 2), plus monkfish and conger eel, with a Marine Conservation Society Rating 3 only gurnard and monkfish's Rating 4 are not currently considered sustainable.¹ Because conger eels only spawn once in their life cycle, their consumption is also considered unsustainable.

Trawlers are recorded as working over the *Victory* wreck site and potters commonly exploit the area as a resource for crab and lobster (Fig. 10E-F; Kingsley *et al.*, 2012: 6, 9-15), which are under-represented within the current survey data, but were frequently recorded between 2008 and 2012 (Figs. 13-14). Certainly conger eels (*Conger conger*) conspicuously and continuously inhabited cannon bores since 2008 (Fig. 11). Monkfish (*Lophius piscatorius*) were not attested during the current survey, but were documented in single numbers on-site in 2011 and 2012 (Fig. 18D-E). White cylindrical objects initially misidentified in 2008 as human or animal ribs (Cunningham Dobson and Tolson, 2010) are now correctly defined as marine borer calcareous tubes. They cluster around cannon deposits, presumably feeding on wooden gun carriages (Fig. 18F). No live marine borers were observed on the site's surface.

Comparative species density data for the region are not available. Based on analyses of submerged wind farm infrastructures off the Belgium coast of the North Sea (Kerckhof *et al.*, 2012: 35), it may be assumed that biofouling of the *Victory*'s wreckage was rapid. Chronological change related to site formation, specifically when three-dimensional standing hull remains were still present immediately after the warship sunk, is impossible to predict. Since elevated wreckage, such as modern steel wrecks in the Atlas Shipwreck Survey Zone, attracts far greater schools of fish for feeding and nesting (Fig. 19D-F), the current flattened wreck profile characterized by less than 50cm elevation may be envisaged to represent a far lighter oasis effect than before the hull collapsed and became inundated with sediments.

Parallel wreck studies are few. The *Victory*'s oasis effect is comparable to site 35F, the wreck of an English merchant vessel trading with West Africa in the last quarter of the 17th century sunk at a depth of 80m in the Western Approaches (Cunningham Dobson and Kingsley, 2011). The pattern of conger eel and lobsters inhabiting concealed spaces beneath ballast and iron concretions on the mid-18th century, 80m-deep *Marquise de Tourny* wreck within the same environmental zone of the Western English Channel (Cunningham Dobson, 2011), is very similar to the *Victory* (Fig. 19A-B), which otherwise exhibited greater species densities. The same overall pattern was observed on the 101m-deep site T3a35a-2, a 19th-20th century wooden ship, possible burnt, in the Atlas Shipwreck Survey Project zone (Fig. 19C).

Common Name	Taxon	Quantity
Sessile		
Feather Duster Worm	<i>Sabellidae</i>	4
Sea Anemone	<i>Actiniaria</i>	65
Sea Grass	<i>Gresstuster</i>	1
Sea Pen	<i>Pennatulacea</i>	3
Sponge	<i>Porifera</i>	52
	<i>Porifera encrusting on boulder</i>	2
Nectobenthic		
Atlantic Cod	<i>Gadus Morhua</i>	1
Cod, Haddock, Whiting, Pollock	<i>Gadidae</i>	6
Common Sunstar	<i>Crossaster papposus</i>	1
Cuttlefish	<i>Cephalopoda</i>	13
Edible Crab	<i>Cancer pagurus</i>	5
Flatfish	<i>Pleuronectiformes</i>	6
Grey Gurnard	<i>Eutrigla</i>	1
Gurnard	<i>Triglidae</i>	67
Hermit Crab	<i>Paguridae</i>	279
Jellyfish	<i>Hydrozoa</i>	38
Octopus	<i>Octopoda</i>	4
Ray-Finned Fish	<i>Teleostei small</i>	>447
	<i>Teleostei</i>	271
Sea Cucumber	<i>Holothuroidea?</i>	2
Starfish	<i>Asteroidea</i>	13
Sea Urchin	<i>Echinus irregular</i>	1
	<i>Echinus sp.</i>	3
Dogfish/Catshark	<i>Scyliorhinidae</i>	15
Total		>1,300

Table 5. Sessile and nectobenthic species in Lines 91-134, offsite south, wreck of the *Victory*, February 2012.

Beyond Odyssey's fieldwork within the Western Approaches and Western English Channel, HMS *Swift* lost off southern Argentina in 1770, and lying at a depth of 10-18m, is the closest chronological parallel. This site was found colonized by a great variety of fouling species that originated from the area's hard natural bottoms that were sufficiently dense to complicate *in situ* archaeological identification (Bastida *et al.*, 2008: 179). The same high-level biofouling is not shared by *Victory*'s micro-environment, where all surface features are readily visible. Studies of the well-preserved wooden wreck of the *Vrouw Maria*, lost in 1771 in a far more anaerobic context in the Northern Baltic Sea, determined that the site's total coverage of sessile species was 4.7% and 5.2% on the left and right

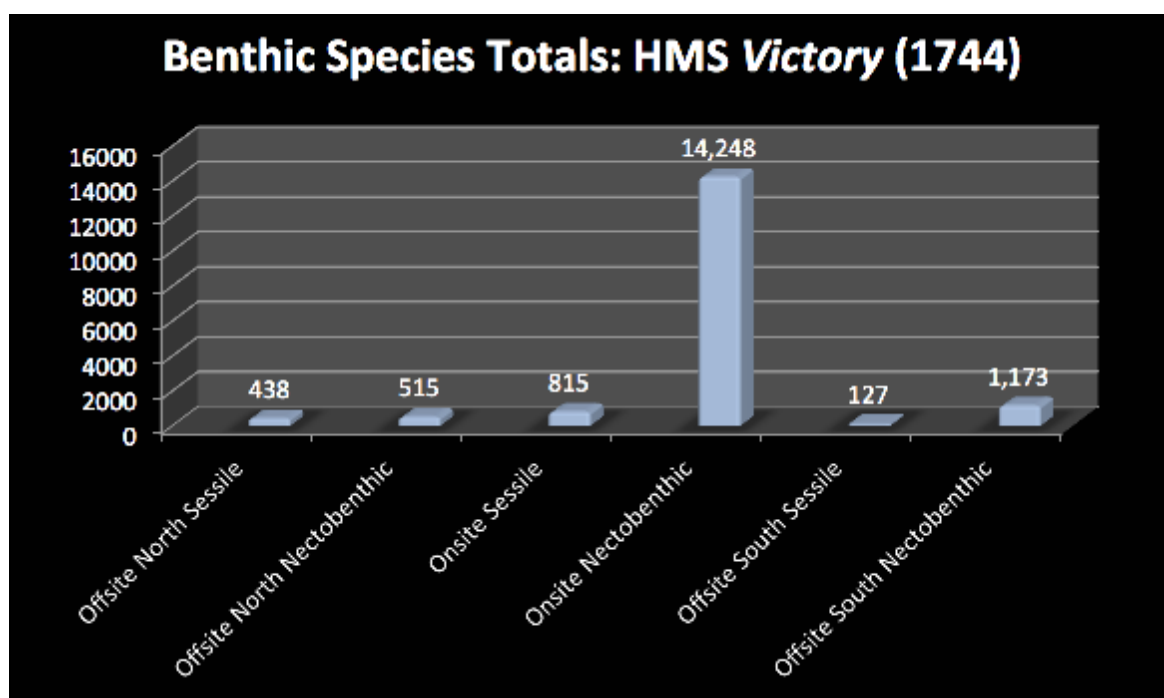


Table 6. Benthic species totals recorded on the wreck of HMS Victory (1744) in 2012.

sides respectively (Leino *et al.*, 2011: 140). Site 25C exceeds in variety and density the 12 species of fauna documented on the remains of the French frigate *La Surveillante* scuttled north of Whiddy Island, Bantry Bay, Ireland in 1797 (Wheeler, 2002: 1155).

The most extensive physical science program conducted on a deep-sea shipwreck focused on the SS *Central America*, a side-wheel steamer lost in 1857 on the Blake-Bahama Outer Ridge en route from San Francisco to New York. Lying at a depth of 2,200m, and with wreckage rising 5-7m in places accelerating currents, a conspicuous diversity of hexactinellid sponges, gorgonian corals, sea anemones, polychaetes, pholadid bivalves, benthic molluscs, isopods, decapods, amphipods, barnacles, crinoids, sea stars, holothurians and benthopelagic fishes were documented – approximately 175 taxa of macroscopic animals. Some 15,134 pteropod shells were recorded within the hull area compared to 2,686 outside the hull, which indicates an oasis effect of 5.6:1. Differing habitat preferences were documented between the water column, seabed, ship's wood, coal, and gold and leather artifacts. The project concluded that the wreck of the *Central America* fostered a deep-sea ecosystem that was quite different from the monotonous foraminiferal ooze surrounding the wreck for many kilometers (Herdendorf, 1995: 62-159).

A series of assessments of marine biofouling are emerging for shipwrecks in the Gulf of Mexico. Fish, numerous macroinvertebrates and sessile megafauna were observed on the 610m-deep Viosca Knoll wreck, a possible early

nineteenth-century wooden brig (Church *et al.*, 2008). The biological community visible on the surface of three early 19th-century shipwrecks off Monterrey is currently being mapped.

Steel and wooden wrecks create far different site formations and consequently artificial reef environments. The vast majority of studies have focused on shipwrecks dated to World War II and later. Unsurprisingly, the species varieties represented on six World War II sites, again found in the Gulf of Mexico during oil and gas surveys in water depths ranging from 87m to 1,964m, are far denser than on the *Victory*. Microbial concretions coated 30% of the *Gulfspenn's* observable surface, while the deepwater coral *Lophelia pertusa* had colonized 12-15% of the ship's surface, including a vertical wall of coral 7m long and 3.5m high along the starboard side. Brown hanging rusticles, ranging up to 2m long and 25cm wide, occupied 20% of the *Robert E. Lee's* visible areas (Church *et al.*, 2009: 54-55, 58). The effect of the *Orion* modern shipwreck off northeast Rio de Janeiro on fish assemblage distributions was extensive: 1,789 specimens were captured with a total biomass of 311kg (Barros Fagundes-Netto *et al.*, 2011: 106).

The current study of the First Rate warship *Victory's* biological oasis effect is the first initiated for a historical wooden wreck in the English Channel and establishes a benchmark for future research. The current project provides seasonal data, which are not necessarily constant all year round. Studies of marine biofouling are more commonly conducted off the UK, such as on HMS *Colossus*, and

within European waters through the Monitoring of Shipwreck Sites project (Palma, 2005; Camidge, 2009: 168-70). Future recovery of the sacrificial frames deposited to the east of site 25C will enable comparable studies to be developed for the *Victory* (Seiffert *et al.*, 2013: 13, 18, 24-26).

Acknowledgements

Many thanks are extended to the *Odyssey Explorer* team for collating the marine biological assessment primary data, and to Greg Stemm and Odyssey Marine Exploration for facilitating the project. The fieldwork was conducted under the aegis of the Maritime Heritage Foundation, owner of the *Victory* shipwreck. The enthusiastic support of its Chairman, Lord Lingfield, and its Scientific Advisory Committee, Margaret Rule, Ivor Noël Hume and John Bingham, is greatly appreciated. The maps produced in this paper were formulated by Bastian Genna and Mark Mussett, kindly facilitated by John Oppermann at Odyssey, Tampa.

Notes

1. Based on reference to www.fishonline.org.

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A



B



C



D



E



F

Fig. 6. Sea beard (*Nemertesia*) on the wreck of the *Victory*.



A



B



C



D



E



F

Fig. 7. Common sea urchins (*Echinus esculentus*), on the wreck of the Victory.



A



B



C



D



E



F

Fig. 8. Sessile and vagile species on the wreck of the Victory: plumose anemones (*Metridium senile*: A-F), common sea urchin (*Echinus esculentus*: A, E, F), sea beard (*Nemertesia* spp: A, C, D, F) and sponge (*Porifera*: F).



A



B



C



D



E



F

Fig. 9. Plumose anemones (*Metridium senile*) on the wreck of the Victory.



A



B



C



D



E



F

Fig. 10. Sessile species on the wreck of the Victory: bryozoans (*Pentapora foliacea*: A-D) and sea beard (*nemertesia* spp), sponge (Porifera) and plumose anemone (*Metridium senile*) attached to a lobster pot (E-F).



A



B



C



D



E



F

Fig. 11. *Conger eels (Conger conger) inhabiting bronze cannon bores on the wreck of the Victory.*

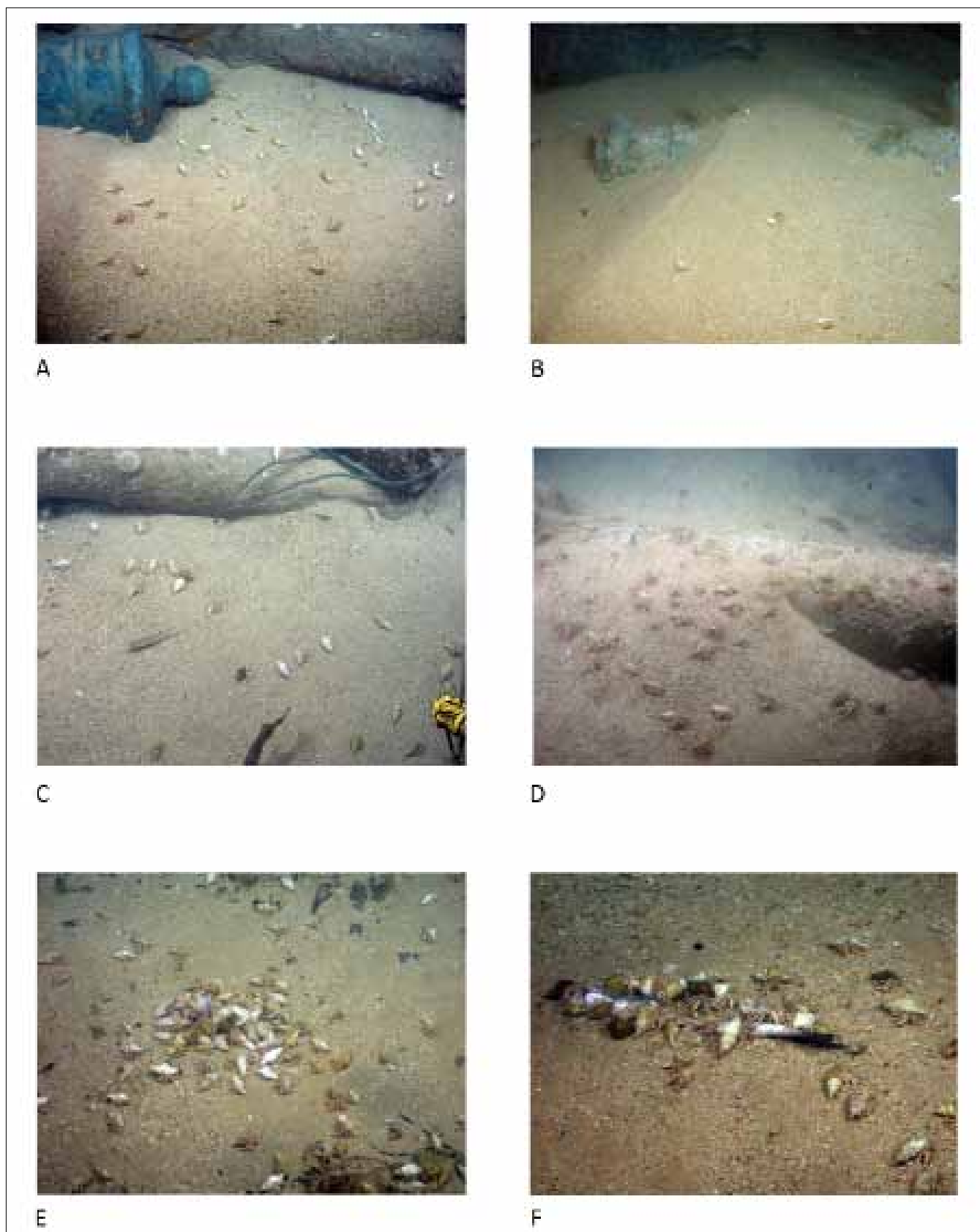


Fig. 12. Hermit crabs (Paguridea) on the open sand bottom and cannon sediment berms on the wreck of the Victory (A-D) and feasting on dumped Atlantic mackerel (*Scomber scombrus*) by-catch in Area C1 (E-F).



A



B



C



D



E



F

Fig. 13. Edible crab (*Cancer pagurus*) on the wreck of the Victory.



A



B



C



D



E



F

Fig. 14. The long-clawed squat lobster (*Munida rugosa*: A-C) and European lobster (*Homarus gammarus*: D-F) on the wreck of the *Victory*.



A



B



C



D



E



F

Fig. 15. Vagile species on the wreck of the Victory: seven-armed starfish (*Luidia ciliaris*: A), the common sunstar (*Crossaster papposus*: B), starfish (*Asteroidea*: C-E) and three-legged starfish (*Asteroidea*: F).



A



B



C



D



E



F

Fig. 16. Vagile species on the wreck of the Victory: octopus (Octopoda: A, B under the rock, C) and cuttlefish (Cephalopoda: D-F).



A



B



C



D



E



F

Fig. 17. Bib (*Trisopterus*) on the wreck of the Victory.



A



B



C



D



E



F

Fig. 18. Vagile species on the wreck of the Victory: young ray-finned fish (Teleostei: A), bib (Trisopterus: B), red gurnard (*Aspitrigla cuculus*: C), monkfish (*Lophius Piscatorius*: D-E) and a marine borer calcareous shell (F).

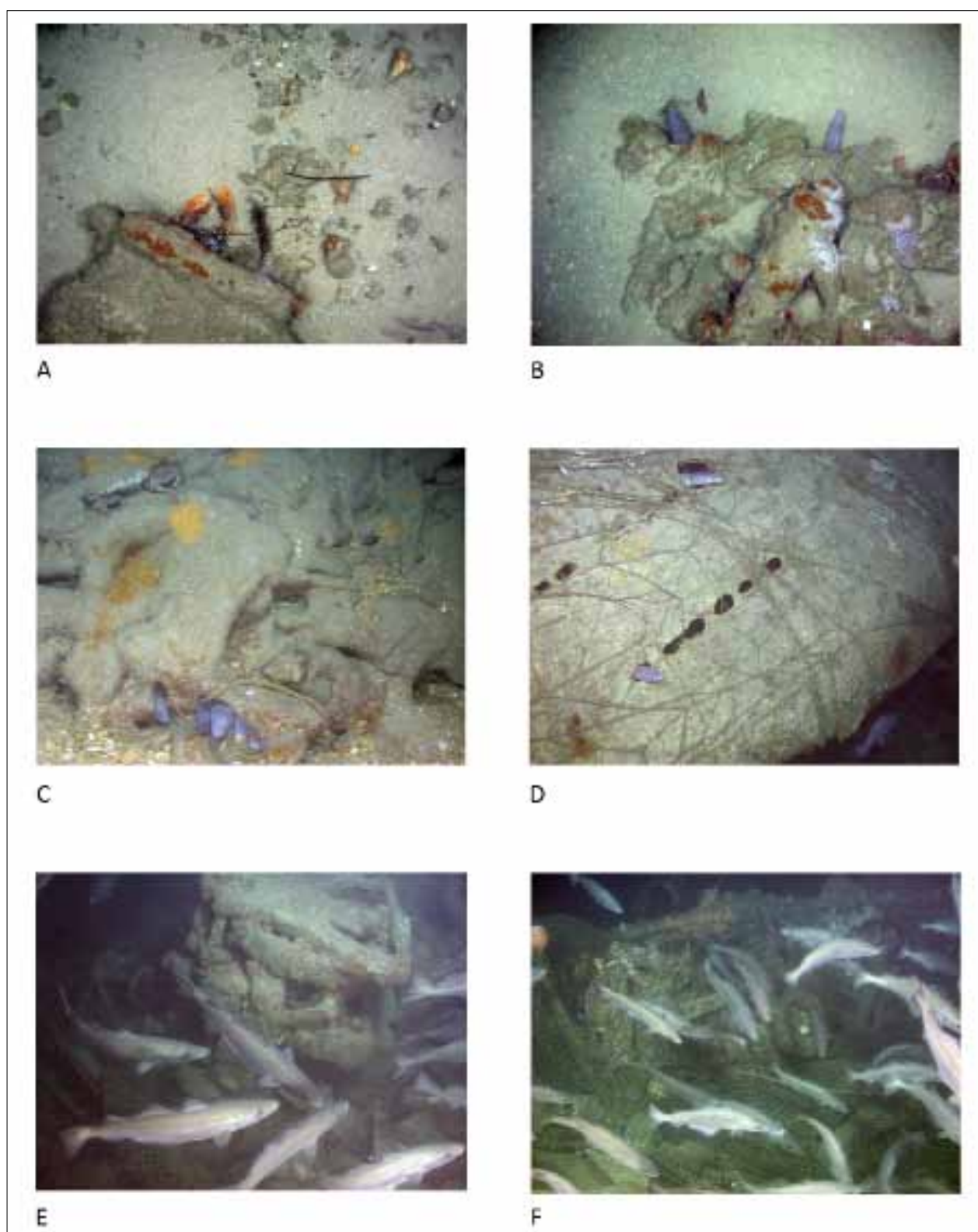


Fig. 19. Comparative shipwrecks and marine biology in the Atlas Shipwreck Survey Zone. A-B. European lobster (*Homarus gammarus*) and conger eels (*Conger conger*) on the mid-18th century wreck of the Marquise de Tourny (Site 33c), 80m depth. C. Conger eels (*Conger conger*), edible crab (*Cancer pagurus*) and the long-clawed squat lobster (*Munida rugosa*) on site T3a35a-2, a possible 19th-20th century burnt wooden ship, 101m depth. D. Conger eels (*Conger conger*) inhabiting the fishing-net snared German submarine U-326, depth 164m. E-F. Pollock (*Gadidae*) on 20th-century steel wrecks.