

# XOCEAN<sup>®</sup>

## Full Unmanned Surface Vessel (USV) 'Over Horizon' Operations



FIGURE 1: XOCEAN'S XO-450 USV AT SEA

# Full Unmanned Surface Vessel (USV) ‘Over Horizon’ Operations

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## Abstract

XOCEAN's platform is designed for the collection of ocean data using industry standard survey sensors and techniques. The sensors are mounted to an unmanned surface vessel (USV) which is controlled and monitored over a satellite internet connection by a team of trained USV pilots in XOCEAN's operations centre. This paper presents an overview of an XOCEAN mission in the Celtic Sea during June 2018 and discusses the tools and techniques used to facilitate safe navigation of the USV via satellite.

## Mission data

<b>Client</b>	Marine Institute (Ireland)
<b>Date</b>	June 2018
<b>Location</b>	Celtic Deep, Mid Celtic Sea
<b>Mobilisation location</b>	Milford Haven
<b>Peak distance from launch site</b>	100NM
<b>Total distance travelled</b>	350NM
<b>Mission duration</b>	7 days
<b>Purpose</b>	Acoustic Fisheries Survey

## Introduction

XOCEAN's mission is to deliver a step change in the cost, efficiency, environmental impact and safety of collecting ocean data through the use of our USV. To fully realise these benefits, XOCEAN's unmanned platform is designed to be operated fully over-the-horizon by a team of shore-based USV pilots, requiring no mothership presence offshore. Given this absence of a mothership, XOCEAN's system is designed to provide the USV pilots with a level of situational awareness that facilitates safe and responsible navigation achieving international regulations for preventing collisions at sea (COLREGS) compliance through equivalence with a traditional vessel.



FIGURE 2: XO-450 USV BEING PREPARED FOR LAUNCH

XOCEAN's USVs feature 18 days endurance, a 1,500 nautical mile range and are designed for extended operation offshore. The vessels are equipped with an Inmarsat FBB 250 satellite internet system for two-way data transmission. This allows for transmission of situational awareness information, vessel control, and remote desktop connection to vessel software systems as required.

In a typical mission, the XOCEAN USV is road trailed and slipway launched (Figure 2) from a convenient location. Control of the USV during launch is by way of the thrusters being operated in real-time using a radio joystick controller. The USV is then escorted by a small support vessel from the harbour type environment to clear water. At a suitable point, control of the USV is transferred to the USV Pilot in the Operations Centre who engages the autopilot and begins watchkeeping. The USV Pilot has full control to alter the course or stop the vessel at any time as necessary.

### Mission summary – Celtic Sea June 2018

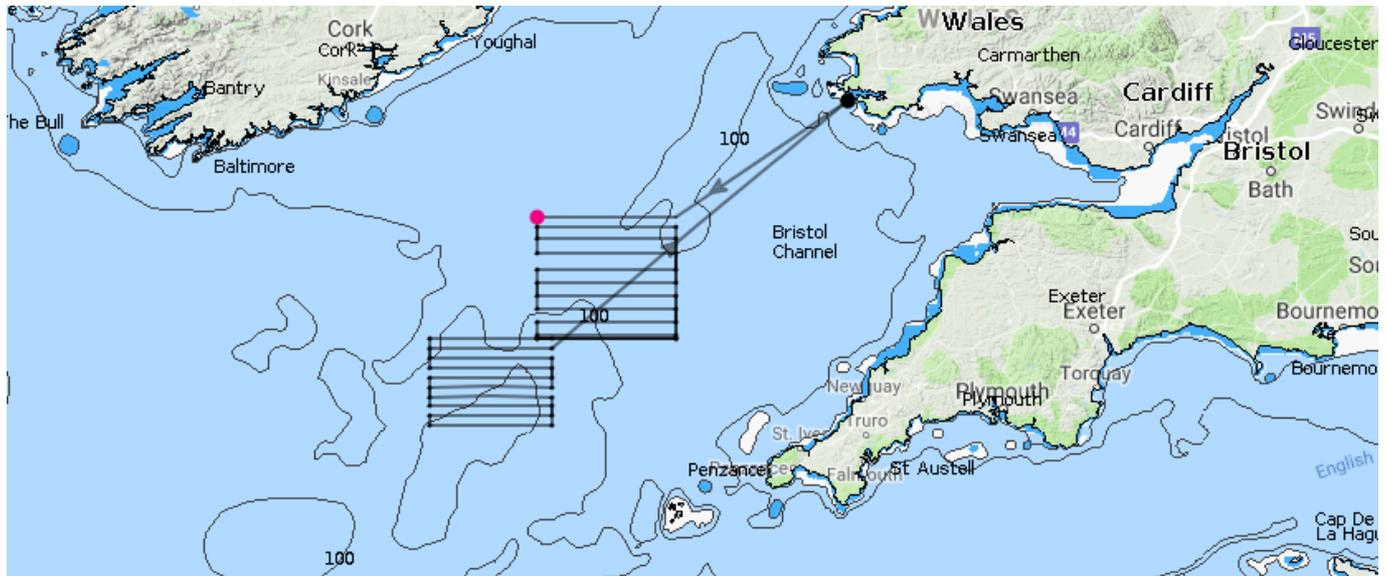


FIGURE 3: LOCATION OF JUNE 2018 FISHERIES MISSION

XOCEAN demonstrated the over-the-horizon capabilities of the USV platform in an acoustic fisheries research mission in the Celtic Sea in June 2018. The primary survey site was in the Celtic Deep, shown in Figure 3. Milford Haven was selected as the launch location. The mission began on the 17<sup>th</sup> June when the USV was escorted to Milford Haven port limit by a support RIB. From there the USV was controlled remotely by USV pilots in XOCEAN's operations centre in Ireland. The USV completed seven days of unaccompanied operation. It was then joined on site by the Marine Institute research vessel *Celtic Explorer* for a day of joint research work on 25 June. From there the USV was recovered to the deck of the *Celtic Explorer* and brought to Galway in time to participate in Ireland's *Our Ocean Wealth* summit 2018. Navigation warnings covering the various phases of the mission were issued by the United Kingdom Hydrographic Office (UKHO).



FIGURE 4: USV DEPARTING MILFORD HAVEN IN ROUGH WEATHER

The weather on the transit to site subjected the USV to rough conditions with wave heights of over 5.0m recorded (Figure 4). The satellite communication link and vessel autopilot remained highly stable throughout.

The site transit required the USV to safely navigate areas of high shipping traffic density. The XOCEAN CyberDeck system provides the USV pilot with a combination of a situational awareness moving map and real-time camera images. The moving map displays the vessel's current position, loaded waypoint list and tracks, along with AIS targets in the area. The camera viewer presents the images received from the vessel, updating in real time. The camera images are processed onboard the vessel to reduce their size and make them suitable for transmission back to the datacentre via the satellite communication system. Figure 5 provides an example of the image data provided to the USV operator. In this example a ship can be seen several miles ahead on the horizon and a second ship passing astern. Note that the same ship is seen on both the aft and port cameras due to overlaps in the camera field of view, designed to avoid blind spots.

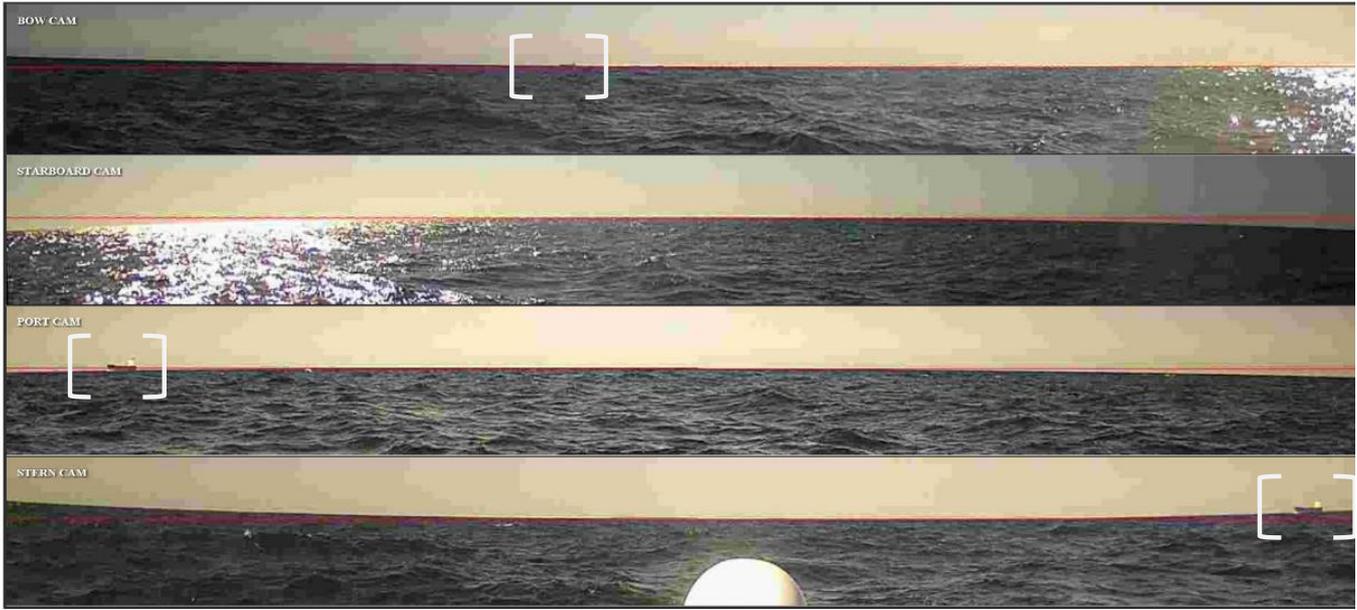


FIGURE 5 – CYBERDECK CAMERA IMAGES

Figure 6 shows the USV's position on the situational awareness moving map shortly after the USV entered international waters on the evening of the 17 June. In this example no AIS targets were in the vicinity.

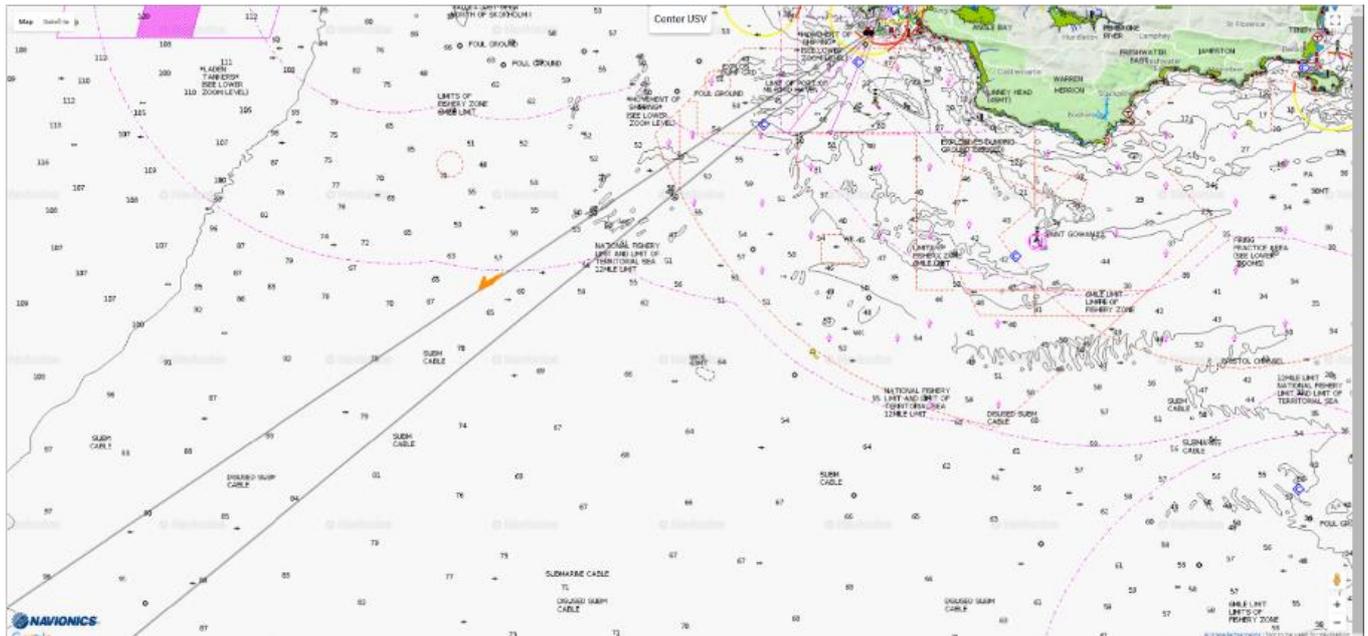


FIGURE 6: CYBERDECK SITUATIONAL AWARENESS MAP

When the operator identifies a potential collision situation, they have the same options as a manned vessel i.e. hold course and stand on, adjust course/speed or stop as appropriate considering the situation. The USV is also equipped with a number of features making it visible to other marine users including navigation lights, sound signals, an active radar target enhancer and an Automatic Identification System (AIS).

In the example shown in Figure 7 two merchant vessels were on course to cross the USV track. A fishing vessel is also present to the North. To maintain separation, the USV pilot made a clear course adjustment to starboard, ensuring the vessels would pass port-to-port, and then once at a suitable distance, re-engaged the autopilot to direct the USV to the waypoint to start the next East-West survey line.

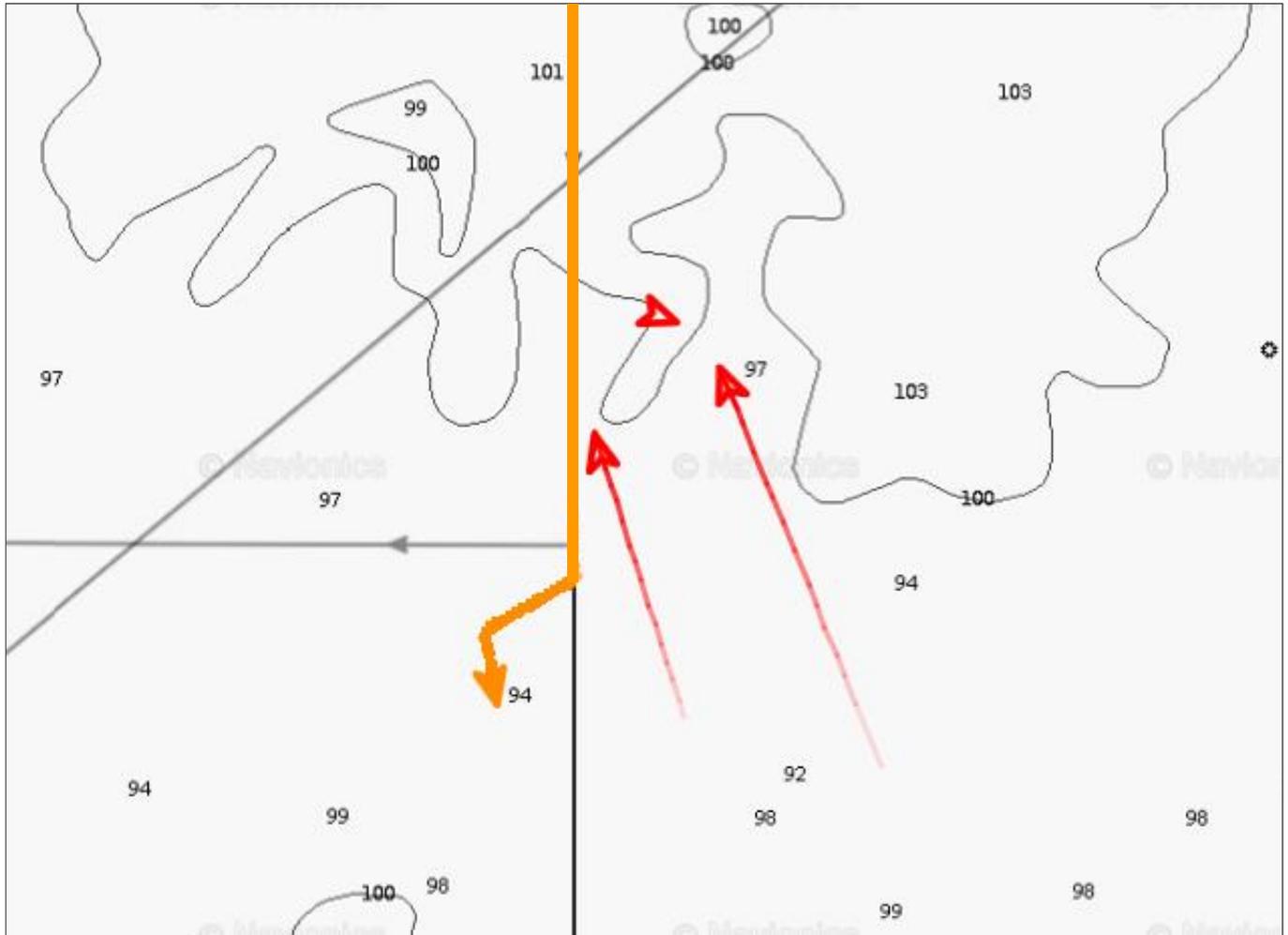


FIGURE 7: USV PILOT COURSE ADJUSTMENT

**Conclusion**

Using XOCEAN's control environment, USVs can be safely and responsibly piloted via a satellite internet connection, permitting true unmanned, over-the-horizon operation, thereby enabling the full cost, efficiency, environmental impact and safety benefits of unmanned survey operations to be realised.