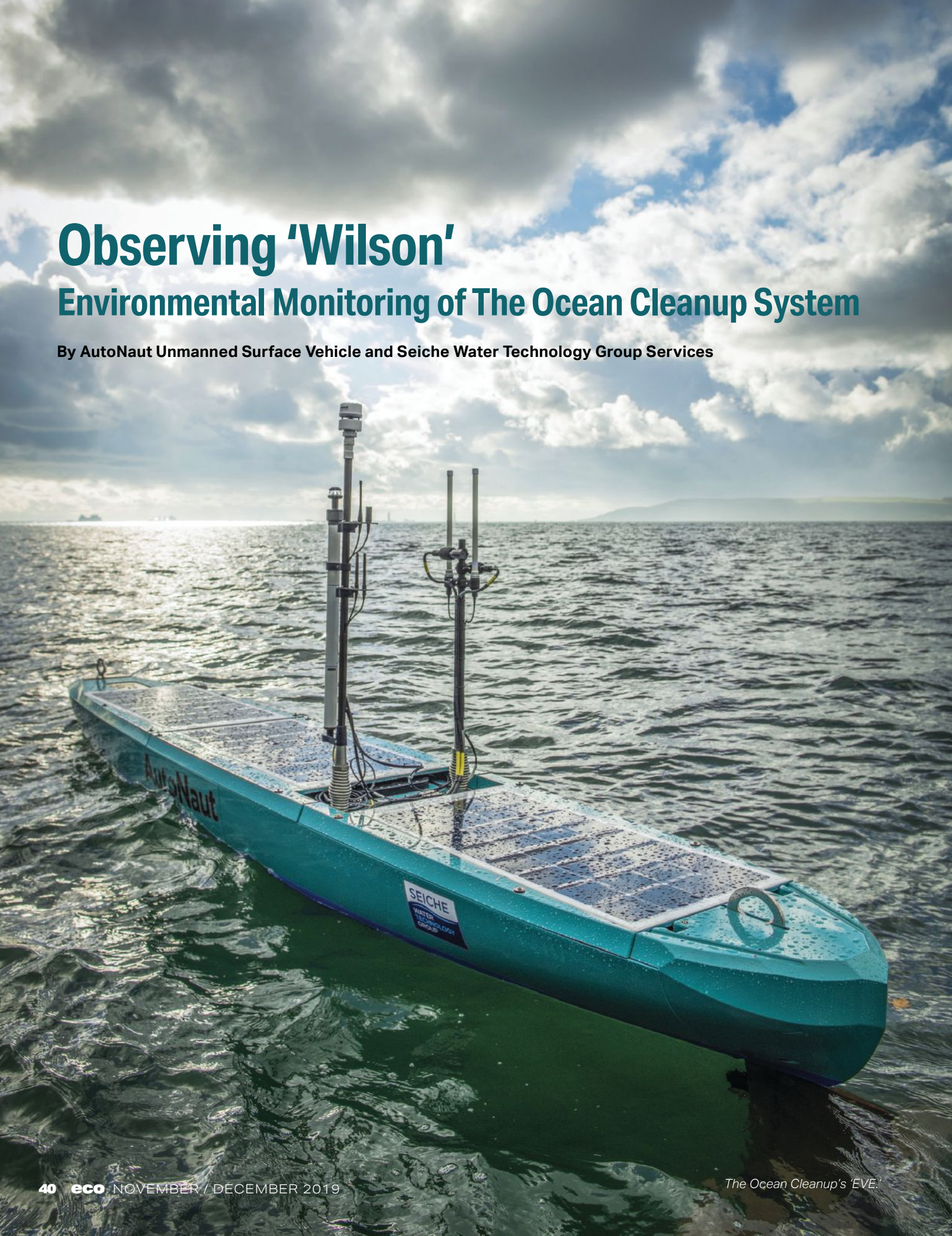
Observing 'Wilson'

Environmental Monitoring of The Ocean Cleanup System

By AutoNaut Unmanned Surface Vehicle and Seiche Water Technology Group Services



The Ocean Cleanup's 'EVE.'

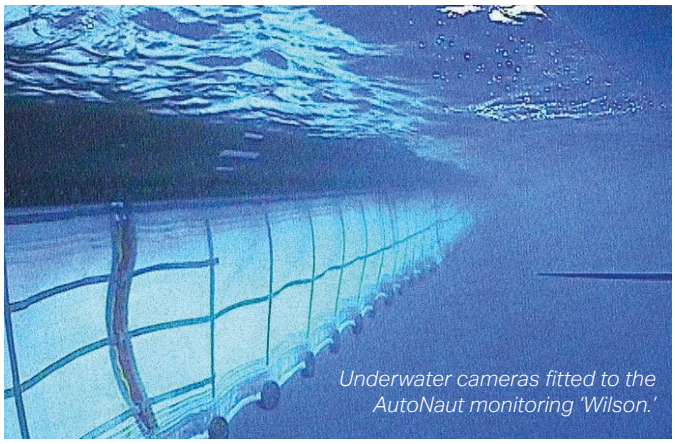
The Ocean Cleanup is an ambitious multi-national initiative developing technologies to rid the world's ocean of plastic. The ultimate aim of the non-governmental organization, founded by Boyan Slat, is to launch a full fleet of systems to clean up 50 percent of plastic in the Great Pacific Garbage Patch (GPGP) every five years. The first device of its type, System 001 or "*Wilson*", has been undergoing trials in the Pacific Ocean since November 2018. Recently, the organization also launched the "Interceptor" system for river clean ups.

Concern has been raised by some within the scientific community about the potential impact this system may have on marine life and the effectiveness at achieving this ambitious objective. However, The Ocean Cleanup has deployed a suite of technology and organizations to observe the system's performance and collect an abundance of vital data within the infamous 'plastic soup' plaguing the Pacific Ocean.

In support of the mission, an AutoNaut Unmanned Surface Vessel (USV) has been working alongside the marine plastics removing device as it navigates the GPGP. Since November 2018, a five-meter USV (www.autonautusv.com) has been involved in a series of missions of up to 50 days' duration, collecting a wealth of meteorological and oceanographic data as well as visual imagery. The AutoNaut USV is just one of a suite of technology solutions provided by Seiche Water Technology Group (www.seiche.com) who have been working as an official partner for The Ocean Cleanup. In conjunction with the USV, the UK-based Seiche Group provided drifter buoys equipped with hydrophones to acoustically monitor for whales and dolphins.

Powered using renewable sources, wave energy propels the AutoNaut USV along its course as it remains offshore for multiple weeks at a time, and solar panels power a range of sensors. Scientific sensors fitted into the autonomous vessel include; a YSI Xylem EX02 (for dissolved oxygen (DO), conductivity, temperate and depth (CTD) and pH), an Aanderaa Motus wave sensor and a Nortek Signature 1000 ADCP to measure oceanic currents. The data collected by these instruments is of particular interest given that this area of the Pacific, 1200 nautical miles out from California, is little studied. Crucially, the information gathered has supported understanding of interactions between aggregations of plastic litter and the *Wilson* barrier.

As well as acquiring data on ocean current, meteorological and oceanographic parameters, the AutoNaut was equipped with cameras both above and below the water to capture images of any marine life and plastics present, as well as for inspection of the system. Twin cameras were mounted to the mast facing ahead of the USV and a pair were affixed to the hull of the AutoNaut. To visually observe any marine life or plastics present, the cameras were set to record a snap-shot image every five minutes. A live video feed was also used, relaying imagery over Wi-Fi when the support vessel for The Ocean Cleanup system



Underwater cameras fitted to the AutoNaut monitoring 'Wilson.'

was in range. This capability proved to be of key importance for safe maneuvering of the AutoNaut during "close-pass" operations within just a few meters of *Wilson*. A further need here being for visual inspection of the system itself; checking configuration and for any potential tears in the plastics-collecting skirt suspended beneath the barrier.

Then came the task of spotting and listening for whales and dolphins. Seiche provided drifter buoys equipped with hydrophones which relayed raw acoustic signal back over Wi-Fi to a Passive Acoustic Monitoring (PAM) operator on the *Wilson*'s Maersk support vessel. Seiche personnel also worked onboard as Marine Mammal Observers (MMOs) and 1045 hours of visual and acoustic monitoring for marine life were recorded over a total of 141 days. Sightings and detections included humpback whales, sea turtles and a range of fish and seabird species both on the trials site and in transit to port. Such efforts were conducted for mitigation purposes — helping to ensure *Wilson* meets the most stringent environmental guidelines and has the lowest possible impact on marine-life.

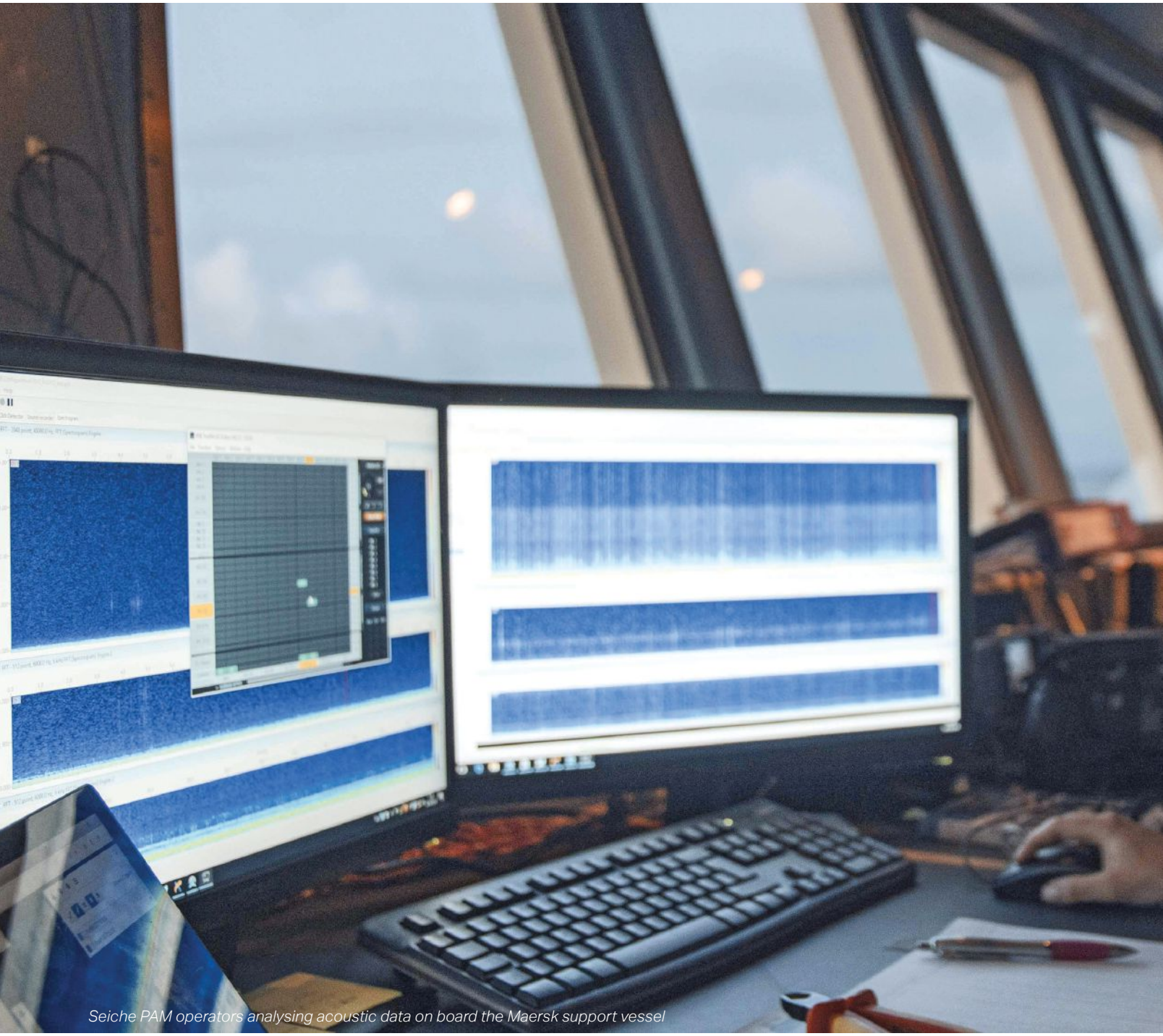
Offline analysis of this wealth of data acquired by the AutoNaut and Seiche teams has been completed, but much is ongoing. The transmission of data streams, both scientific and sensory, was a key element of the work with the USV and drifter buoys. The technology to deliver such data in near real-time can be of huge value in supporting operational decision-making in the field.

AutoNaut conducting a close pass of 'Wilson.'

But, such timely delivery of data at sea has its challenges.

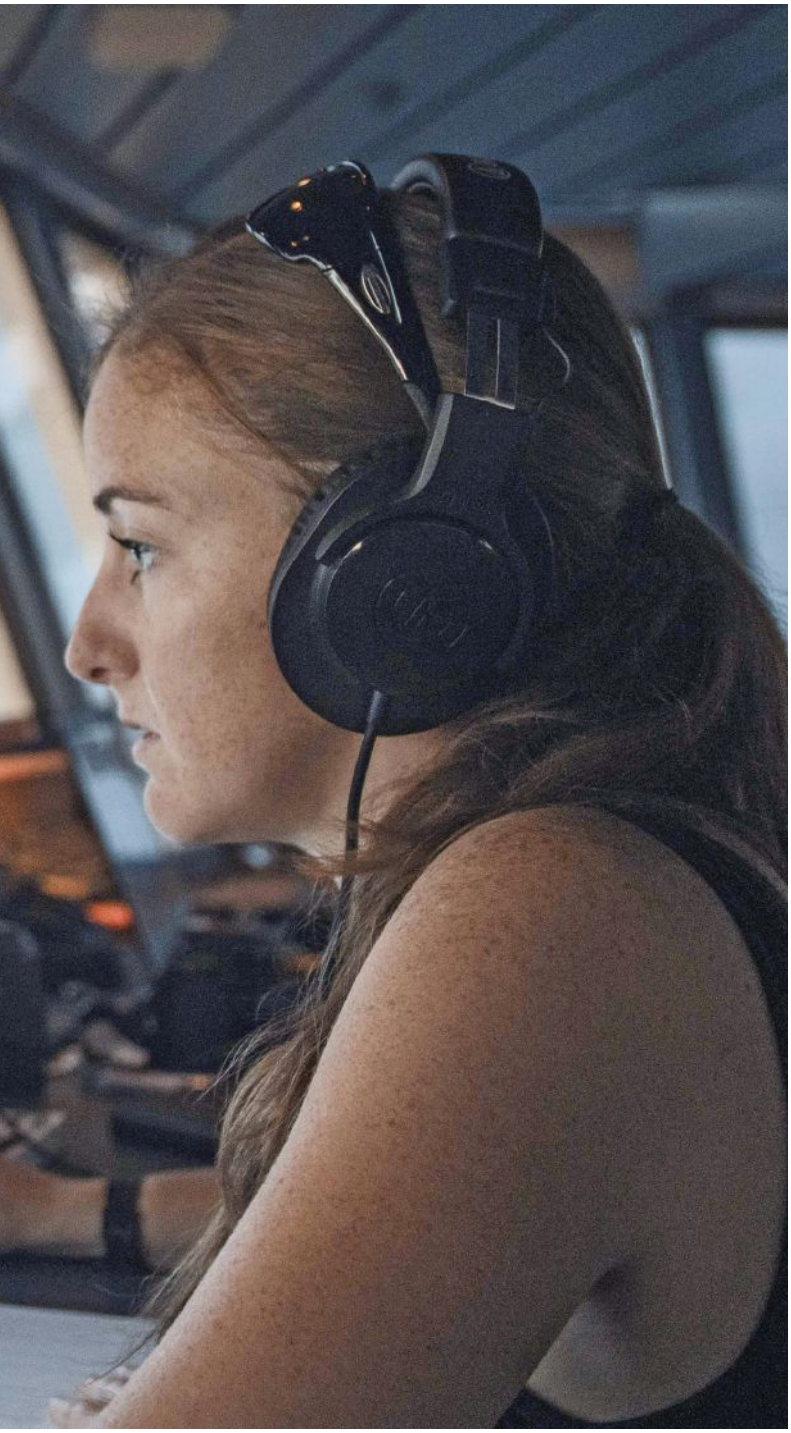
Throughout the Pacific missions, the system and accompanying environmental monitoring technology faced sea states of up to Beaufort 7, with surface currents of up to 1.5 knots and sea swells of three meters height. The drifter buoys and the USV showed real resilience in such testing oceanic conditions and data was supplied that would be prohibitively hazardous and costly to acquire by any other means.

For the work in close proximity to the *Wilson* system, consistent track-keeping and remaining within position of at least five meters accuracy was required of the wave-propelled AutoNaut USV. To get up close and personal to an offshore installation with any USV, complete reliability is essential. Not just mechanically but also of the command and control system. Working procedures are vital too; as USVs mature and take on challenging roles such as this, the Marine Autonomous System (MAS)-UK Code of Conduct has to be followed and the highest industry standards must be met.



Seiche PAM operators analysing acoustic data on board the Maersk support vessel

The confidence to operate in a demanding environment under remote supervision and in autonomous mode increased significantly throughout the missions. For close-pass maneuvers, operators on the nearby Maersk vessel (supporting the clean-up system) utilized wireless comms and kept line-of-sight to the USV in daylight hours. Whereas in hours of darkness (local time), protocols switched to data collection in the far field and were overseen by operators based onshore at AutoNaut's UK headquarters via Iridium satellite link. Safe operation at sea was, therefore, assured and the mission demands guided the development of an enhanced AIS-based autonomy system.



This innovation allows the USV to operate in a "track-and-follow" pattern, thereby maintaining a consistent and safe distance to a moving offshore installation. Which, as in the case of The Ocean Cleanup device, may not be wholly predictable and controllable. Transceivers on the system were autonomously tracked and dynamic waypoints generated onboard — meaning no necessity for human intervention. Designed chiefly as a safety measure, the system also has the ability to switch between survey modes according to behavior or direction of the offshore asset.

AutoNaut's new generation craft, named "EVE", was the first to incorporate this innovation along with other technical developments. "We are very proud of EVE" said Peter Bromley, Managing Director of AutoNautUSV, "The Ocean Cleanup were keen to adopt our very latest technology and she's the most advanced boat in our fleet. Officially launched in June, *EVE* can closely accompany The Ocean Cleanup independently — the ultimate aim being to do so on missions of many months."

The desire to clear the ocean of plastic is vital and the size of the task is huge, but the ambition of The Ocean Cleanup is clear. AutoNaut USV will be right there alongside *Wilson* and future systems as their mission continues.

System 1. Credit: The Ocean Cleanup

Seiche drifter buoys leaving San Francisco to head for the Great Pacific Garbage Patch.