Wave Gliders for Offshore Operations

What could you do with a robot in the water 24/7? Get extreme current data in real-time, measure seafloor motion with millimeter accuracy, monitor downhole pressure and temperature during well P&A, and more.

Learn how Wave Gliders help make offshore operations safer and more cost-effective.

LIQUID ROBOTICS
A Boeing Company

+1 408 636 4200 www.liquid-robotics.com info@liquid-robotics.com

Table of Contents

Executive Overview

Today, the offshore energy industry faces tremendous pressure to restructure its base costs. Over the last two years, supply chains have been severely compressed and the industry has shed a significant amount of cost. Yet, amidst these cuts, existing operations and operators still need to find cost-effective solutions. Operators are turning to autonomous systems to replace and/or augment conventional vessels and technologies that are significantly more expensive to operate.

Adoption of innovative technology allows companies to remonetize the cost of services. Remotely operated vehicles (ROVs) are an excellent example of this. Once considered fringe tools, ROVs now dominate the robotics oil and gas subsea landscape. Over the past five years, additional autonomous marine technologies have matured from novel systems to industry workhorses. From ROVs to autonomous underwater vehicles (AUVs) to unmanned surface vehicles (USVs), these systems have gone through years of sea trials and global missions and have been used to expand exploration, reduce costs and increase operational safety.

During this time, Wave Gliders have gained invaluable experience traveling over 1.4 million nautical miles at sea. Systems have operated through dynamic and sometimes brutal ocean conditions. Since 2010, Wave Gliders have been used in offshore energy for environmental monitoring, maritime security and seismic surveys.

In this white paper, you'll learn how Wave Gliders can help you:

- Increase efficiency of vessels by offloading tasks to autonomous systems
- Get more complete, real-time data sets for better insights and analysis
- Take people and high-value assets out of harm's way, especially during severe or harsh weather conditions

About the Wave Glider

The Wave Glider is the most experienced ocean surface robot on the planet.

Powered by wave and solar energy, the Wave Glider can operate 24x7 over long durations (6+ months), in fleets or individually. The combination of wave-propulsion and stored solar energy enable persistence, continuous data collection, and real-time communications capabilities.

The Wave Glider platform also offers unrivaled flexibility for sensor and payload integration, accommodating multiple sensors per mission. An optimized motion and sound isolation system makes the Wave Glider well suited for towed acoustic applications and subsea communications.

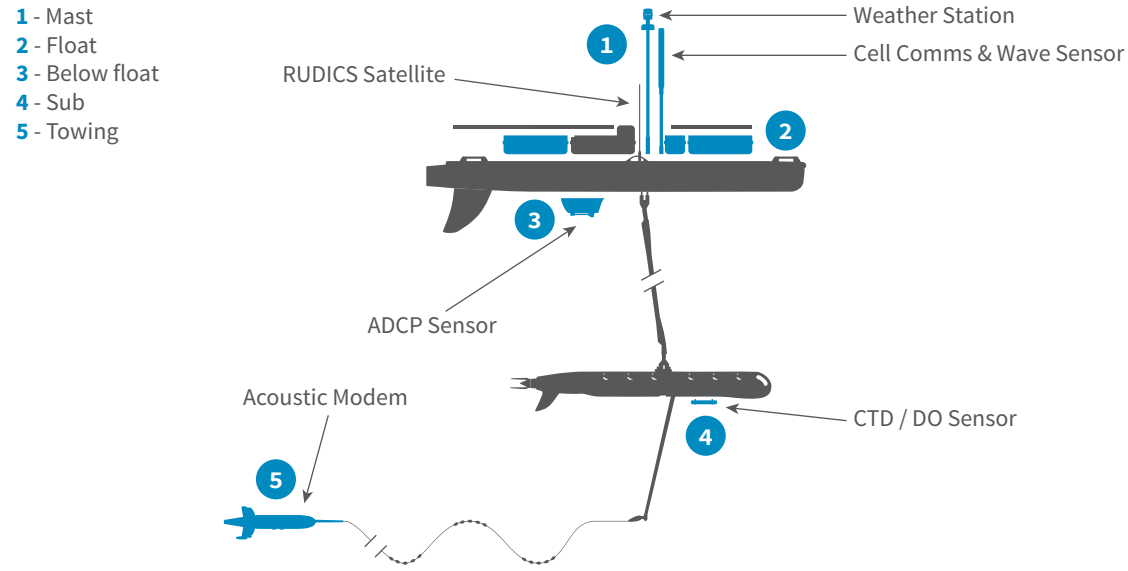

Figure 1 - Wave Glider showing areas of sensor placement

Wave Gliders can operate independently with our Mission Management Software or have command-and-control integrated into broader Common Operating Picture (COP) systems. An open platform design, development tool kit, and component testing service allow sensor and payload customization to meet unique mission needs.

Our Mission Services are designed to ensure your success from start to finish. From planning and risk assessments, to vehicle launch and recovery, to piloting and maintenance services, we're with you every step of the way.

Next, we'll take a look at what mission success can mean for offshore operations.

Wave Gliders for Offshore Operations

What could you do with a robot in the water 24/7? Get real-time information about vortex-induced vibration (VIV), track the motion of an escarpment near your development with millimeter accuracy, monitor downhole pressure and temperature during well P&A, and more.

The mobile, long-duration Wave Glider can monitor multiple facets of the oilfield: harvesting data from seafloor sensors and infrastructure, collecting and monitoring metocean data, and even monitoring dark target activity to help ensure asset security.

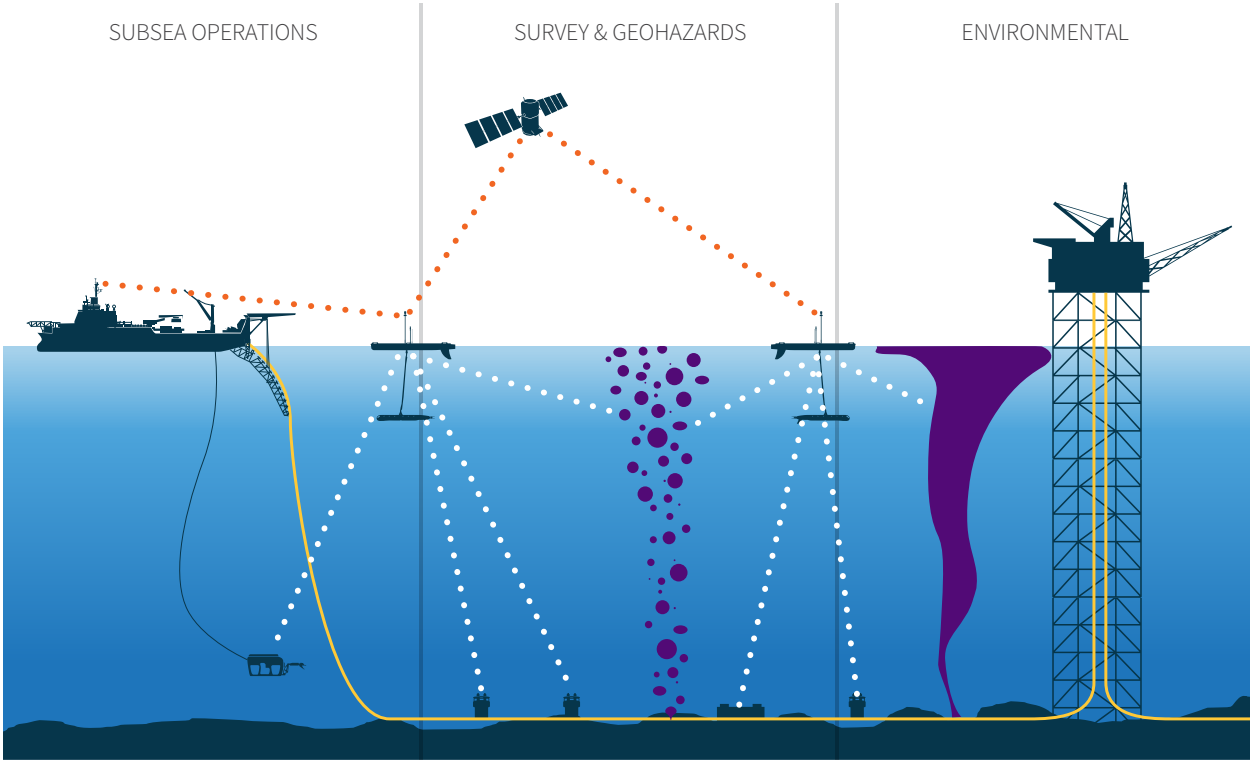

Figure 2 – Examples of tasks Wave Gliders can take on in the oilfield

Subsea Comms Gateway
- Data harvesting using acoustic modems
- Downhole pressure and temperature data retrieval
- Wireless subsea infrastructure communication
- Precise positioning of seafloor sensors
- Positioning aiding for ROV TDM

Survey & Geohazards
- Seep detection
- Monitor pipeline vibration and seafloor motion
- Communicate with AUVs and subsea infrastructure

Metocean Monitoring
- Metocean modeling / monitoring & alerting
- Buoy replacement/ complement
- Satellite record corroboration
- Environmental baseline
- Disaster response modeling
- Hydrocarbon monitoring
- Turbidity monitoring
- Oil spill response

Subsea Communications: Your Boat Has More Important Things to Do

Coordinating communication with assets above and below the water line is difficult and expensive. The Wave Glider can act as a communications gateway, enabling underwater and seafloor assets to offload data and extend the duration of your missions.

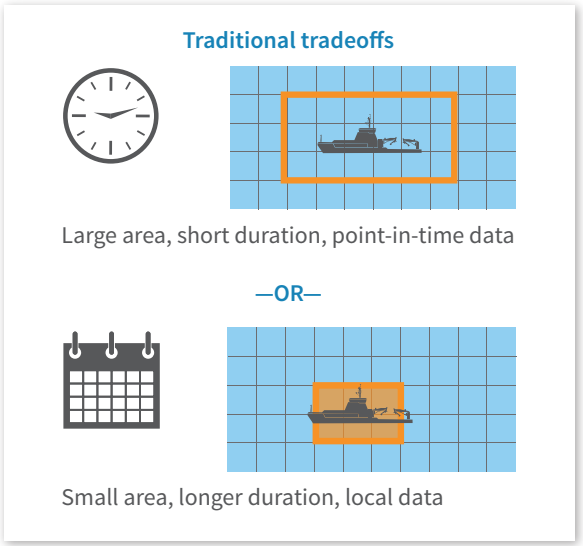

Figure 3 – Traditional approaches vs. Wave Gliders

Traditional Tradeoffs

Ships have long been the go-to choice; highly mobile platforms with extensive capacity for people and their equipment. However, they're also extremely costly to operate. Food, fuel, and personnel costs can easily exceed $50,000 per day. These high operating costs limit the frequency and duration of missions. In the best of cases, manned missions can provide useful snapshots of data over relatively short periods of time. But they are not economically suitable for collecting continuous, real-time data over long durations.

New Economics

First, forget about food, fuel, and extensive personnel costs; autonomous platforms like the Wave Glider immediately transform the operational costs of subsea communications. The wave-powered Wave Glider is ideally suited for towing an acoustic modem, and can communicate with subsea sensors & equipment, underwater vehicles and line-of-sight assets. Next, add persistence, with the ability to serve as a real-time data relay at the surface for months at a time, sending data back to shore via satellite, cell or Wi-Fi. Finally, intelligent onboard processing can help with data reduction and management.

Next, we'll cover some more specific subsea communications applications.

Precision Acoustics for Tracking Seafloor Infrastructure

When you combine GPS and precision acoustics, the result is incredibly accurate seafloor measurements—precise enough to track tectonic plate movement. The Wave Glider can help position sensors and other devices on the seafloor with millimeter accuracy, so you can measure vortex-induced vibration (VIV), monitor pipeline buckling, or track escarpment movement close to a development.

One of the latest developments is the ability to precisely position a Sonardyne seafloor transponder from a Wave Glider in up to 3,000 meters of water depth. The ability to precisely position infrastructure on the seafloor is not new; the ability to do it without requiring expensive surface vessels is.

Dr. David Chadwell of Scripps Institute of Oceanography pioneered this method. In his work, Dr Chadwell tracks plate tectonic motion using Wave Gliders equipped with a Sonardyne 6G modem, Precision GPS, and an MRU. This technology is available commercially and unlocks new and exciting capabilities in commercial industries.

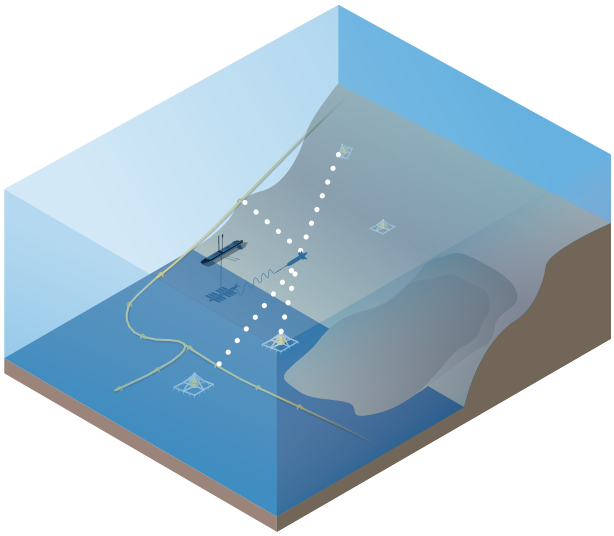

Figure 4 – A Wave Glider monitoring slope stability and seafloor subsidence

Slope stability is typically evaluated historically. Geohazards specialists find areas where mass movement has occured and analyze shallow and deep seismic data, coupled with age dating to predict the chance of slope movement. Now operators can track seabed movement over formations in near real time, using inexpensive sensors and equipment to do so, with Wave Gliders at the air/sea interface and Sonardyne sensors on the seabed. This technology can also be coupled with existing motion tracking technology to accurately determine if a pipeline is moving subsea, so you can measure and predict vortex-induced vibration (VIV) or lateral buckling—a risk mitigation technique that won't break the budget.

Well Plug & Abandonment: P&A the Unmanned Way

Wave Gliders can help monitor downhole pressure, temperature, and other variables during well plugging and abandonment without any need for wires back to the surface. And, they can offer a more cost-effective way to monitor them after the well has been abandoned.

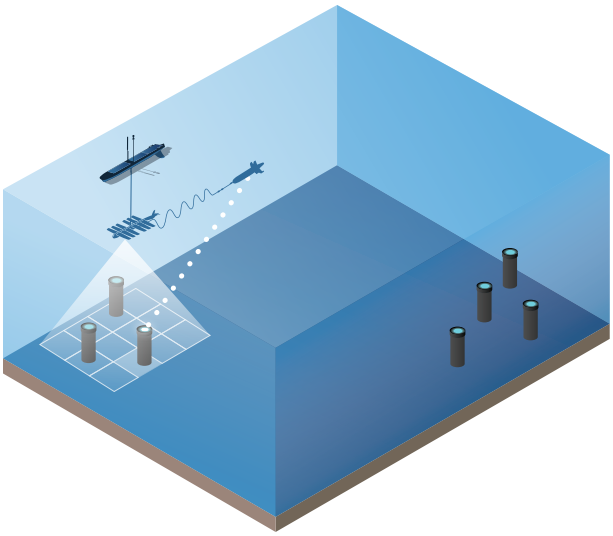

Figure 5 – A Wave Glider interrogating Sonardyne subsea transponders, down-loading temperature and pressure data from plugged and abandoned wells

Subsea infrastructure is getting older, and in many areas around the world oil companies are beginning plans to decommission fields.

So what happens after you plug and abandon (P&A) these wells? In many cases, the local regulatory body will dictate periodic monitoring of the wellhead post P&A. In some cases, internal HSEQ Oil operator regulations mandate a monitoring period to ensure the integrity of the P&A. In all of these cases, the Wave Glider is the most cost effective platform to get the data back to shore.

If wellheads are instrumented, they are most likely fitted with devices which record temperature and pressure, and other variables of concern to a regulatory body or operator.

The devices are either paired with acoustic modems so that data may be harvested at regular intervals by vessels of opportunity, or they are hard wired back to infrastructure in the field.

With Wave Gliders, you can communicate with infrastructure on the seafloor and collect data more frequently, over long durations. And with no fuel or crew required, Wave Gliders enable the operation to be cost-effective.

Metocean Monitoring

Get the metocean data you need to make more informed decisions.

The Wave Glider is an ideal platform for metocean data collection and monitoring. Increasing the quantity, quality, and timeliness of metocean data can improve the accuracy of forecasting models and provide operators in-situ measurements in near real time.

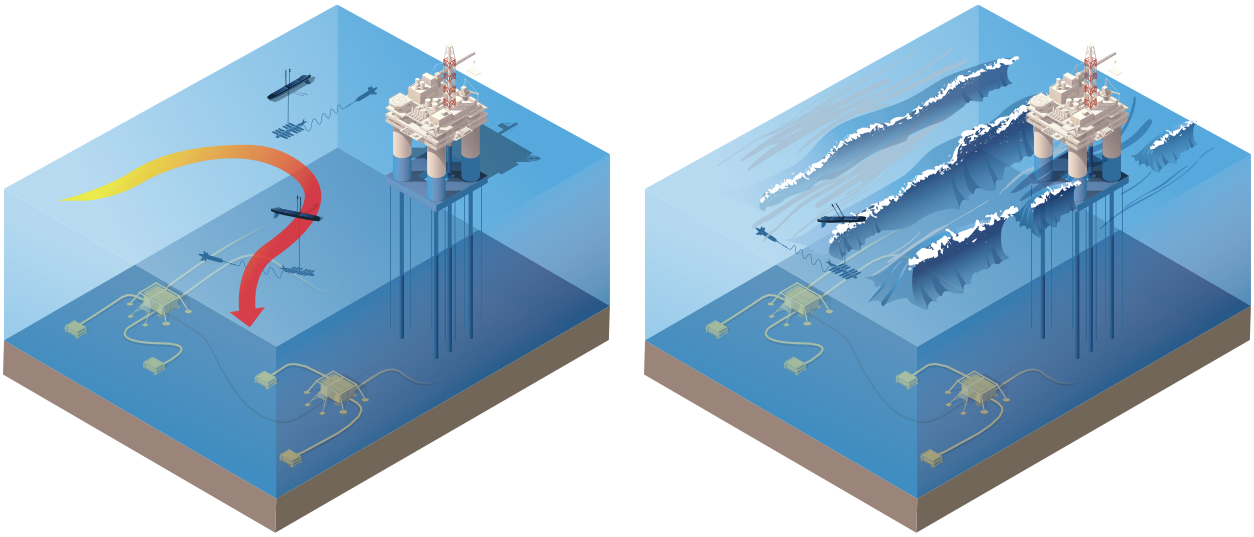

Figure 6 – Extreme condition metocean monitoring with Wave Gliders

Our platform allows customers to integrate additional sensors into their Wave Glider configurations (e.g., acoustic modem). Liquid Robotics currently supports approximately 20 different sensors, but over 50 different sensor integrations have been done by customers and partners.

For metocean monitoring, oil and gas customers have used Wave Gliders to help set environmental baselines, collecting weather data including surface and water temperature, air pressure, dew point, wave height, currents, and more. Wave Gliders have also completed successful missions monitoring hydrocarbons and helping with oil spill response efforts, capabilities that were demonstrated in the aftermath of the Deepwater Horizon disaster in the Gulf of Mexico (2011). Additional mission experience includes monitoring turbidity and providing seismic operations support.

Wave Gliders are more cost-effective and reliable than buoys, and as a mobile platform, are adaptable to evolving demands and ship operations.

Asset Security

Wave Gliders can host sensor payloads designed to detect the presence of surface vessels entering, operating within, or exiting a surveillance/protected area. Wave Glider can hold station across a suspected navigation corridor, around the perimeter of or within a surveillance area including choke points. Alternatively, mobile Wave Gliders can patrol a surveillance area or boundary.

Wave Glider provides customers with:

- A New Type of Surveillance Capability – Continuous vessel activity monitoring using a combination of sensors including passive acoustic sensors and a camera
- Record-Breaking Durability – Long duration and long range capabilities enable a new class of missions
- Lower Cost Ocean Surveillance – Deploy multiple Wave Gliders in different formations and locations to improve detection capabilities before deploying costlier assets
- Enhanced Situational Awareness – Continuous monitoring, near real-time alerts, and traffic pattern data can be integrated into a Common Operating Picture (COP)

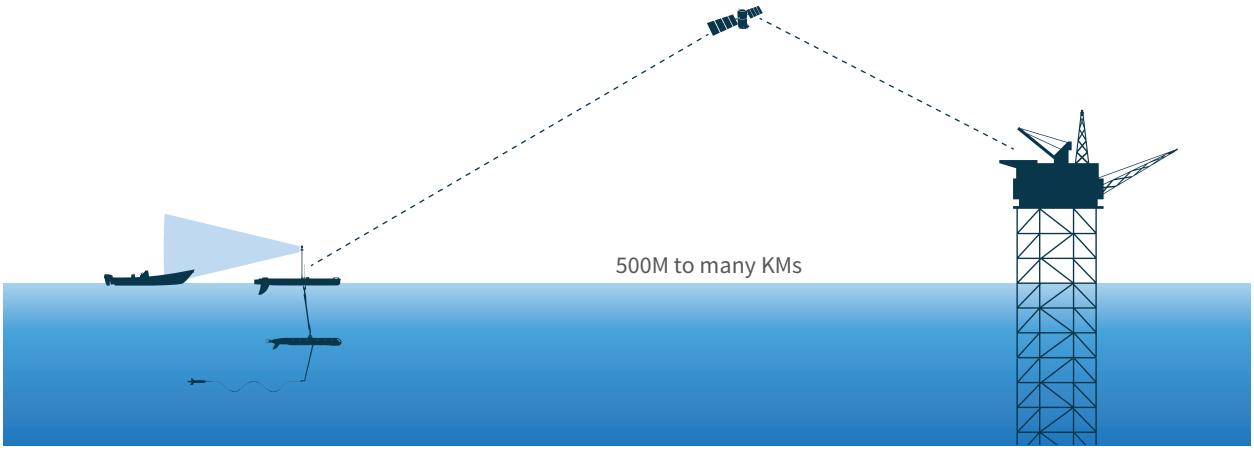

Figure 7 – Wave Gliders for Asset Security

Summary

With over 1.5 million nautical miles navigated, hundreds of missions successfully completed, and 44,200+ days at sea, Wave Gliders are a proven long duration, sensor hosting platform.

The cost advantages are clear: running a Wave Glider for an entire year costs less than running a construction vessel for 3 days. Your vessels have more important things to do than harvest data from sensors, and simply aren't cost effective or efficient when trying to constantly monitor something on the seabed for a long period of time. And, adding Wave Gliders into offshore operations adds a new level of in-situ data that can improve decision-making and decrease risks.

How can Wave Gliders help make your offshore operations safer and more cost-effective? Contact us to talk to a Wave Glider expert.