| FEATURE |

OPTIMIZING HIGH-RESOLUTION SURVEYS WITH AUVs

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TERRADEPTH

The opening of offshore wind development lease blocks on both the east and west coasts of the United States has created significant demand for marine geophysical surveys. The schedule pressures and escalating costs felt by offshore wind developers and their partner electric utilities is quite real, and increased demand for high-resolution geophysical (HRG) surveys in the oil and gas industry only place further constraints on survey asset and crew availability.

A growing emphasis on deeper projects (particularly for floating offshore wind farms) may introduce added complications such that high-accuracy, surface-based surveys lack critical resolution in depths greater than 100 msw. Expanding the adoption of AUV-based data collection can directly address resource, staffing, and data turnaround challenges to make offshore development faster, easier, and safer.

Improving the temporal and areal resolution of these surveys is also possible when leveraging the operational benefits of unmanned systems, particularly autonomous underwater vehicles (AUVs), which can provide high-quality data with lower overhead and greater operational flexibility. Surveys with AUVs can characterize the seafloor with superior resolution independent of water depth, plus provide programmatic agility to perform repeat surveys necessary to enhance the definition of seafloor dynamics that can adversely impact these offshore energy developments.

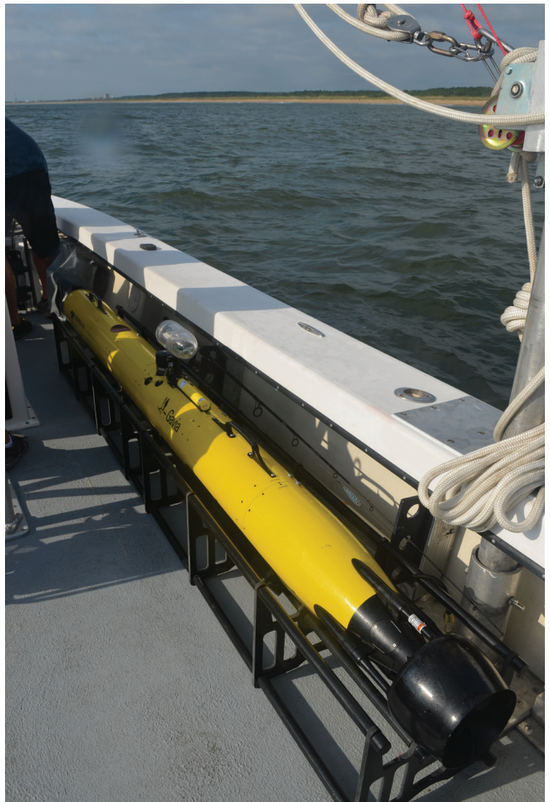
The potential to reduce costs, manage risks, and accelerate offshore renewable energy development using readily available AUV technology justifies immediate consideration by regulatory agencies and developers, especially considering the unique benefits that AUVs can provide throughout a project's timeline.

There are also two metrics by which AUVs can demonstrate superior performance: *Improved Temporal Resolution* and *Consistent Areal Resolution.*

TEMPORAL RESOLUTION

In some regions, such as the continental shelf of the eastern United States, seafloor dynamics pose significant risks to foundations and cable routes. Failure to properly characterize sediment transport dynamics during the design phase of an offshore development can lead to long-term operations and maintenance challenges and existential risks to subsea assets. For example, pipelines partially buried in an area subject to significant sediment transport—a detail easily ill-defined during the siting and design of the installation—will subsequently be at risk to exposure, scour, and potential undermining.

» *Teledyne Gavia AUV staged on deck of an 8-meter-long vessel of opportunity prior to deployment. (Photo credit: Terradepth)*



The current approach to HRG surveys that rely upon large surface vessels to execute expansive survey campaigns cannot adequately characterize these seafloor dynamics because different scales of bedforms may change over different periods of time or due to discrete metocean events with highly variable return periods. Thus, the variation of seafloor conditions must be characterized (and appreciated) on the time scale of weeks or months, as well as years and decades.

AREAL RESOLUTION

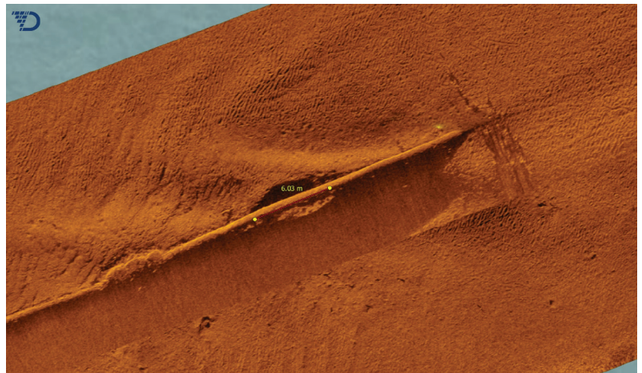
As the developments move into deeper water (such as the recently auctioned lease areas offshore California), the water depths will directly impact the actual resolution of any HRG surveys conducted from surface vessels, potentially driving the need for subsea survey assets (large towed platforms, ROVs or AUVs) to collect seafloor data with adequate resolution to assess risk of the anchoring systems, inter-array cables, and export cables. The use of such ancillary assets calls for larger surface vessels from which to deploy them, further driving up operational costs. These realities will likely jeopardize data quality, increase costs, and extend survey durations.

UTILITY OF AUV & HRG SURVEYS

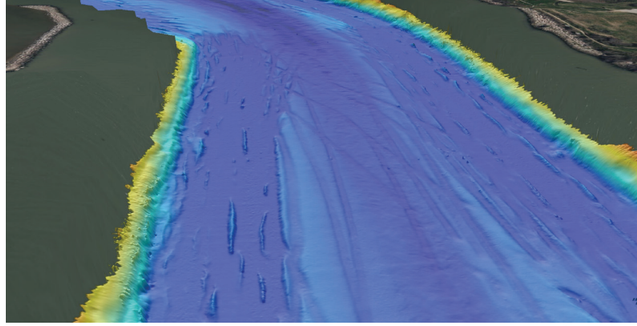
Portable AUVs carrying industry-leading geophysical sensors can support HRG surveys by providing a cost-effective alternative to traditional vessel-based operations. A full range of geophysical sensors including multibeam echosounders, sidescan sonars, sub-bottom profilers, and magnetometers are now available on commercial-off-the-shelf (COTS) AUVs.

At Terradepth, we invested in Teledyne Gavia AUVs dues to its form factor, portability, modularity and overall high performance. These AUVs can be utilized at various phases in offshore renewable energy development to provide immediate, tangible benefits to HRG survey campaigns because they support lower cost, more efficient operations by virtue of several key features, which include:

1. Lower costs of operation
2. Reduced staffing requirements
3. *One Operator-to-Many AUV* operations generate 2x or greater production rates
4. Self-contained systems and smaller form factors that grant greater support vessel flexibility
5. Reduced carbon emissions during survey operations
6. Tangible reductions in schedule to save developers significant time and money
7. Faster, easier mobilizations to support frequent, repeatable surveys = higher temporal resolution
8. Consistent, constant altitudes relative to the seafloor produce superior areal resolution



» *Sidescan sonar imagery of an exposed pipeline, collected with a Teledyne Gavia AUV. (Image credit: Terradepth)*



» *3D render of Freeport Ship Channel collected with a Reson T20 MBES onboard a Teledyne Gavia AUV. (Image credit: Terradepth)*

In addition, AUV-based HRG surveys can supply important data, *independent of total water depth,* regarding:

1. Seafloor depth and character
2. Seafloor sediments, bedrock, boulders, and bedforms
3. Presence, location, and condition of pipelines and cables
4. Periodic surveys of submarine cable routes and wind turbine generator (WTG) foundations to evaluate cable location, depth of burial, evidence of anchor drags or fishing gear trawls, scour, foundation or anchor condition
5. Condition of cable protection systems

PARADIGM SHIFT

AUV-based surveys represent a cost-effective strategy to execute broad area or targeted survey campaigns. Recent advances in the performance of AUVs—and their sensors—dramatically improved their compatibility with high-specification marine geophysical surveys, while portability and modularity promote tremendous operational flexibility.

We are already seeing broader acceptance of AUVs and ASVs as useful (even preferred) tools for seabed characterization and asset monitoring in the more mature wind farm developments in Europe. The flexibility and reliability of these platforms, when deployed as part of a deliberate campaign of repeat surveys in a specific survey footprint, can immediately help developers and project stakeholders to better understand sediment transport dynamics and human activities as a function of time with the objective of better managing risk during design, construction, and operations.

Using AUVs for HRG surveys can also supply critical, high-resolution seafloor data to detect and characterize detailed seafloor conditions that might otherwise be missed during surface surveys. In North America, we may be approaching a point where greater adoption of these unmanned assets will be necessary to manage risk and maintain project timelines.

For more information, visit: *www.terradepth.com.*