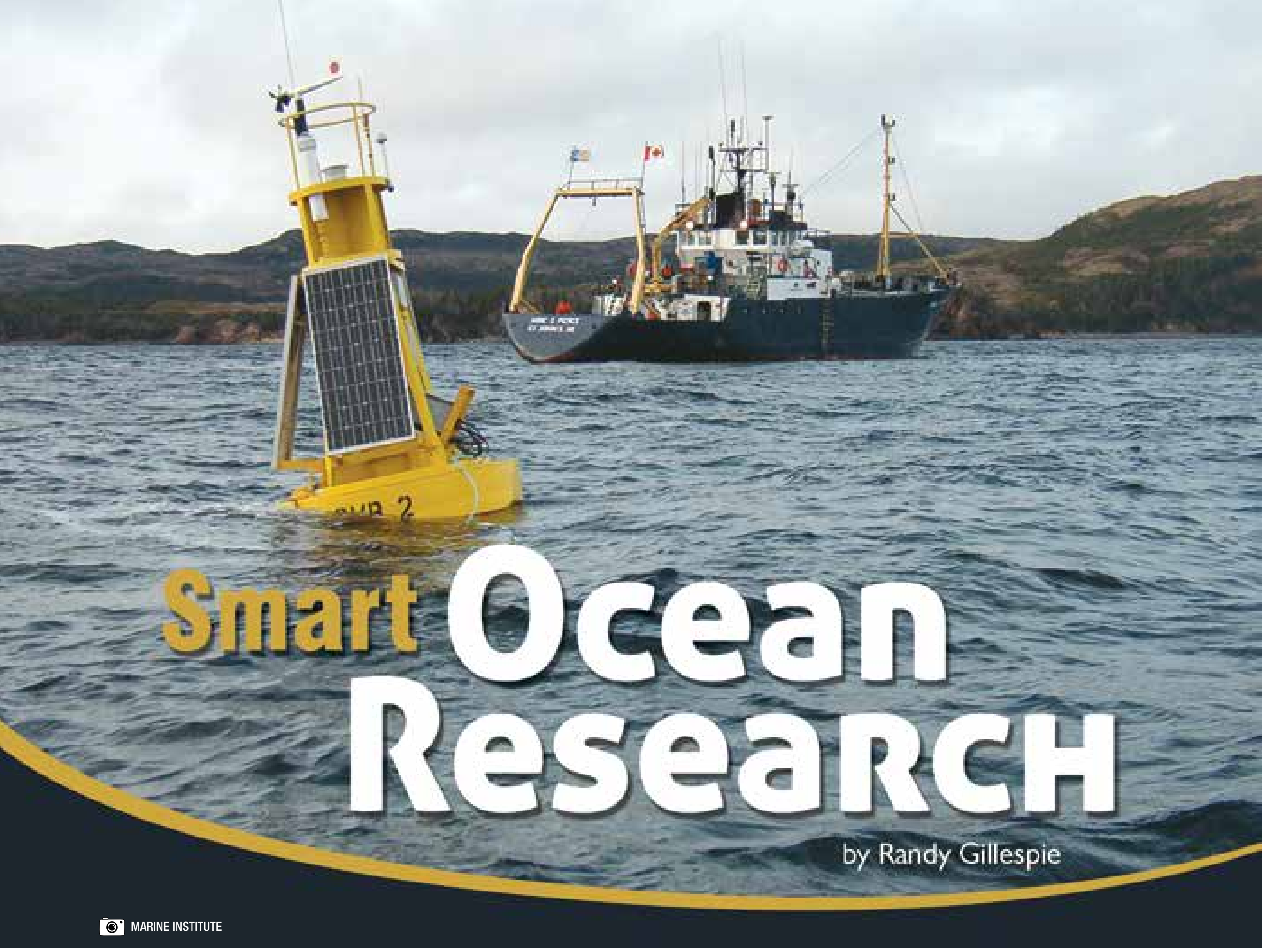
Smart Ocean Research

by Randy Gillespie



MARINE INSTITUTE

MV *Anne S. Pierce*, owned and operated by the Marine Institute, deploys a SmartBay buoy in Placentia Bay, Newfoundland.

As Dermot Loughnane points out in his article entitled “Rethinking Research Ships” (see *Homeward Bound* column in this issue), building and operating ships for the sole purpose of research is a costly proposition. As such, a ‘ship-centric’ approach to ocean research has some very real limitations both in terms of the number of ships available to carry out research, and the number of days those ships go to sea. Given that we do not yet have anywhere close to enough data to understand or manage our oceans sustainably, and given the high cost of building and operating dedicated research ships, combined with shrinking budgets for ocean research, the onus is on the ocean community to be smarter about where research ships – as bastions of floating technology – fit in the context of other ocean data collection technologies and methodologies.

By far the most pervasive and lowest cost approach to ocean monitoring is the global network of free-floating Argo drifters (numbering 3,568 as of February 2013) that gather realtime data on temperature, salinity, optical properties of the water column and other physical parameters to depths of 2,000 metres in support of meteorological and oceanographic research. According to the Argo team, organizations in 23 different countries are active participants in this important effort to understand our oceans. The advantages of this approach to ocean monitoring are the relatively low cost and sheer number of devices. The disadvantage is that we cannot dictate where the drifters will drift.

Moored ‘observatories’ such as the Integrated Ocean Observing System in the United States, or the SmartBay observatory in Placentia Bay, Newfoundland, collect meteorological and oceanographic data as part of the Global Ocean Observing System. This approach to ocean research offers the advantage of being able to place each buoy precisely where the measurements are needed. However, the cost of each station is an order of magnitude, or more, than that of drifting buoys. The number of buoys, however, in this global network of ocean observation is growing (for example, the SmartBay project, a relatively small enterprise in the grand scheme of things, will be adding four new buoys this year), and consideration is being given to outfitting conventional navigation buoys, where practical, with sensors to gather oceanic and atmospheric data, thereby ‘doubling up’ on the impact of these floating assets.

The number of organizations that operate underwater gliders is growing, and currently includes Memorial University of Newfoundland, Rutgers University and the National Oceanography Centre in Southampton, among others. These autonomous underwater vehicles use small changes in buoyancy in conjunction with wings to convert vertical motion to horizontal, and thereby propel themselves forward with very low power consumption, enabling ocean measurement and sampling missions that can run over many months and thousands of kilometres. The number of gliders in use is still relatively small, but they offer the advantage of being able to sample the entire volume of the ocean, and some control over where to sample.

While the realization of a truly autonomous research ship may be well beyond the horizon, the idea of autonomous vehicles operated from a ‘mother ship’ has been around for many years, beginning with the development of the DOLPHIN (Deep Ocean Logging Platform for Hydrographic Information) in the late 1980s. These semi-submersible vehicles were powered by diesel engines and fitted with multibeam sonars. The concept was for a school of such vehicles to carry out mapping of broad swaths of the ocean, thereby significantly enhancing the impact of the lone mother ship.

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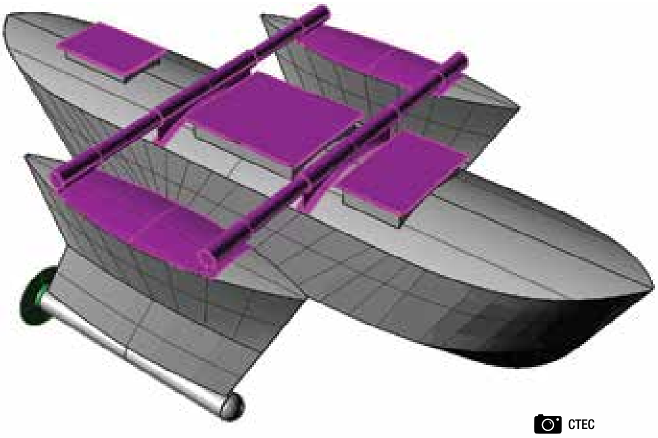
Explorer is an autonomous underwater vehicle built by International Submarine Engineering and operated by the MERLIN Lab at Memorial University.

Autonomous vehicles launched from a research ship, or from shore, also offer the potential for ocean research in high risk littoral areas. Your average ship will not, for safety reasons, venture blindly into shallow littoral waters. As a result, nearshore areas (between the shoreline and roughly 10 m water depth) remain largely uncharted because ships don't go there. Autonomous surface vehicles such as the Smart Autonomous Shallow Surveyor (SmartASS) under development by the Centre for Applied Ocean Technology (CTec) represent one response to this challenge.

The SmartASS vehicle has been fitted with a GeoSwath Plus phase measuring bathymetric sonar contributed to the research effort by Kongsberg Maritime. This system offers simultaneous swath bathymetry and side scan seabed mapping from a payload module readily integrated into any remotely operated vehicle. The GeoSwath system offers data coverage of up to 12 times water depth and, being designed specifically for installation on autonomous vehicles, has very low power consumption. The system includes a full software package for data acquisition, processing and system calibration, and can interface to the vehicle's control system and integrate all ancillary data from the vehicle sensors either in realtime over Ethernet or during post processing using time-stamped data. Autonomous operation can be achieved either by command from the vehicle mission control computer or using pre-set parameter files loaded prior to start of mission.

The vehicle itself is 'smart' in the sense that a predetermined area can be defined and the onboard guidance control system uses realtime GPS and other inputs to create a survey track. Automated feedback loops are used to keep the vessel on course and choose paths that are suitable for the underwater terrain, including avoiding any shoals that may be encountered along the survey route.

Another innovative approach to collection of ocean data that is complementary to the use of dedicated research ships is the use of 'vessels of opportunity.' There are many examples of this being done already, including the long standing Ship of Opportunity Programme spearheaded jointly by the International Oceanographic Commission and the World Meteorological Organization since 1999. This 'crowd sourcing' approach to the collection of ocean data by a fleet of industry and recreational vessels offers the potential to exponentially increase the flow of ocean data well beyond what could be imagined for research ships alone. Technology such as Olex is extending this concept to the collection of sounder data by fishing and recreational vessels, resulting in significant increases in the amount of hydrographic data in otherwise 'lightly' charted waters. In the U.S., the National Oceanic and



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Smart Autonomous Shallow Surveyor (SmartASS) concept diagram. This system offers simultaneous swath bathymetry and side scan seabed mapping from a payload module readily integrated into any remotely operated vehicle.

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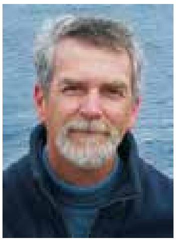
Collection of ocean data by 'vessels of opportunity,' such as fishing vessels, offers the potential to exponentially increase the flow of ocean data well beyond what could be imagined for research ships alone.

Atmospheric Administration recently announced a collaboration with fishing vessel operators who will be recording their sounder data for use by scientists in an effort to more sustainably manage Bering Sea pollock stocks.

When considered in the broader context of other means of collecting ocean data, the role and cost of the research ship can become more rational and sustainable in the face of diminishing financial capacity of the public and private sectors in tough economic times. I have outlined above just a few of the complementary data collection technologies that need to be considered when planning to build and operate a dedicated research ship. In the end, no matter how it is collected, the goals are to increase the quantity of ocean data without compromising quality; improve our understanding of our oceans and best serve the interests of the safety, efficiency and profitability of ocean enterprise; and ensure the sustainability of the ocean environment and resources.



Randy Gillespie is the Director of the Centre for Applied Ocean Technology (CTec) of the Fisheries and Marine Institute of Memorial University of Newfoundland. In this capacity, he works with a top notch group of professionals to establish world class applied research programs in ocean instrumentation, underwater vehicles, ocean mapping and ocean observing systems.