Statement of

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Before the

Subcommittee on Environment

Science, Space, and Technology Committee

U.S. House of Representatives

Hearing on

"Leading the Way:

Examining Advances in Environmental Technologies"

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Key points

- Oceans play a key role in our nation's continued economic growth, contributing an estimated $359 billion in gross domestic product.
- In-situ ocean data is critical to understanding global systems yet collecting in-situ ocean data is expensive as it relies on ships
- The commercial sector is providing cost-efficient environmental technology advances in response to this problem, an example of which is the Saildrone Unmanned Surface Vehicles (USVs), capable of missions of up to 12 months using wind power for propulsion
- USVs of this type allow for many different government applications, and service both Defense and Civilian needs
- Data quality and cost-efficiencies are key and both have been demonstrated in partnership with NOAA which has deemed the saildrones "*a platform that is ready for ocean research missions from the tropics to the Arctic*"
- NOAA's current days-at-sea shortage and ocean data gaps could be addressed by USV technology augmenting NOAA's ships.
- However, despite being an effective R&D partner, NOAA has no clear pathway or budget to move this type of technological advances from research into operations and is thus not realizing the associated cost-savings.
- We would recommend that such a pathway to operations be better defined.
- The Weather Research and Forecasting Innovation Act of 2017 stops short of defining a clear public-private partnership framework and remains ambiguous in defining the type of data it encourages NOAA to source from the private sector.
- We would recommend that these ambiguous data types be clarified to include ocean surface observations thus encouraging such public-private partnerships.

Thank you, Mr. Chairman and Members of the Environment Subcommittee, for providing an opportunity to discuss the important topic of sustaining U.S. leadership through the leveraging of advances in environmental technologies. This topic cuts across vital American commercial, economic, and national security interests in many different ways. In particular, my testimony will focus on two key areas. First, how the latest advances in environmental technologies can increase mission effectiveness of both Civilian agencies – for example, the National Oceanic and Atmospheric Administration – as well as to the U.S. Department of Defense. Second, I will make some suggestions about facilitating the transition from research to operational deployment, in order to generate positive economic impact and provide the best value to taxpayers.

My name is Sebastien de Halleux, and it is my honor to testify here today. I am the Chief Operating Officer of *Saildrone Incorporated*, a company based in Alameda, California. We have developed unmanned surface vehicle technologies, which collect ocean data with unprecedented cost-efficiencies at global scale, providing enhanced insights into systems like weather, fish stocks and marine life, surface and sub-surface maritime traffic. Our unmanned surface vehicle technologies generally make such systems more visible, predictable and actionable for the nation, with the goal to create direct positive economic impact and help protect lives and property. Our company currently employs 30 people and has operations across the US maritime sectors, from the Bering Sea to the Tropical Pacific, the Gulf of Mexico and the Atlantic.

Current Context

Oceans cover over 71 percent of the planet and represent a key domain that impacts the nation. For example, oceans are key drivers of weather patterns -- including most notably, catastrophic events such as floods, droughts and hurricanes.   Additionally, oceans provide a major source of food (the estimated U.S. per capita consumption of fish and shellfish was 15.5 pounds in 2015[1]). Oceans facilitate maritime transport, essential to the world's economy since over 90% of the world's trade is carried by sea[2]. Finally, they play an important role in the energy sector, where an estimated 30% of global oil and gas now comes from offshore.

Most importantly, the ocean economy in the US was estimated to directly contribute to 149,000 business establishments, 3.0 million employees, $117 billion in wages[3], and $359 billion in gross domestic product. Consequently, a better understanding of the ocean domain through the use of advances in environmental technologies is critical in achieving our nation's continued economic growth.

Additionally, in order to better understand our global ocean systems, several existing environmental technologies which collect ocean data, are used. Satellites successfully provide the big picture. However, spatial and temporal resolution of satellites are limited and remote sensing techniques are only capable of measuring the top surface or 'skin' of the oceans. To study the deep oceans, profilers and buoyancy gliders are used to sample salinity and temperature profiles. A key data gap remains in the surface maritime domain and specifically, the air-sea interface.

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[1] NOAA National Marine Fisheries Service, "Fisheries of the United States" report, 2015
[2] United Nations International Maritime Organization (IMO)
[3] The NOAA Fleet Plan: Building NOAA's 21st century fleet

The reason for this data gap is that collecting *in-situ* ocean data is expensive, because it relies on ships and buoys. A government research vessel costs anywhere between $100-200m to purchase and $35,000 to $60,000 a day to operate. NOAA operates a fleet of 16 research and survey ships. Yet, the U.S. Exclusive Economic Zone or EEZ is the largest in the world, containing 3.4 million square nautical miles of ocean, larger than the combined land area of all fifty states[4]. In addition of being a vast domain, the oceans are also a dangerous environment, regularly putting lives at risk.

The Commercial Sector Offers Innovative, Effective and Efficient Environmental Monitoring Technologies

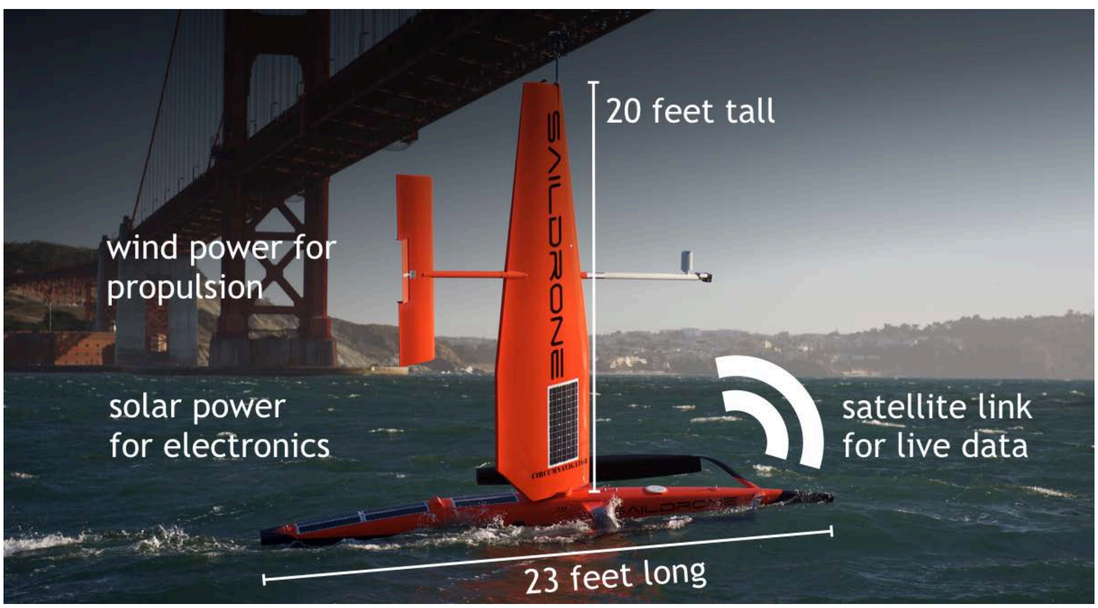

Figure 1 - a Saildrone USV on its way to a data collection mission in the Pacific

[4] source: NOAA

In response to these challenges in observation for the maritime domain, the commercial sector has developed responsive, cost-efficient and innovative environmental technologies. In particular, the solution SAILDRONE has developed to address them is an unmanned surface vehicle (or USV), which harvests all its energy from the environment it travels through. It uses wind-power for propulsion, provided by a patented wing technology, which evolved over 10 years of private sector R&D. Electricity for the onboard suite of sensors, computers and communication link is provided by photovoltaic panels.

Each USV is 23ft long, 20ft high, with a draft of 7ft and is using a persistent satellite communication link to transmit real-time data to shore. Each USV is capable of mission duration of up to 12 months in any ocean and has been extensively tested in extreme conditions in either grid survey or station-keeping mode. Additionally, each USV carries a suite of sensors monitoring key environmental variables, covering the atmospheric, surface and sub-surface domains, including wind strength and direction, humidity, temperature, solar radiation, magnetic field, sea surface temperature, wave height and period, water temperature, salinity, biogeochemistry and ocean currents. In addition, vehicles are equipped with passive acoustic sensor enabling the tracking of marine mammals and marine traffic, and with a sonar, enabling them to detect fish in the water column or take precise depth soundings.

Government applications

Our proprietary technology has been successfully deployed in the field and Saildrones have accumulated over 100,000 nautical miles of missions, demonstrating its actual capabilities in a range of extreme environments. Saildrone's capabilities allow for many different applications and service both

Defense and Civilian needs. Defense applications include the deployment of USVs for Maritime Domain Awareness. As our land borders are tightened, the flow of illegal drugs increasingly relies on offshore maritime routes, representing a detection challenge for DoD. Currently, SAILDRONE supports the DoD on drug interdiction missions, by providing persistent maritime domain awareness at sea.

Our Civilian applications – which include NOAA and NASA missions -- cover a wide range of ocean data collection from meteorological and oceanographic data collection to autonomous fish stock assessment to ground truthing satellite observations.

Data quality and Cost Efficiency are key

In any observation system, data quality is key. It is not enough to take an observation; it needs to be validated against known measurements. Such an evaluation of Saildrone's data has been performed by NOAA over the last 2 years, under a Collaborative Research and Development Agreement (CRADA), comparing data collected by Saildrone USVs with the same data collected by NOAA ships and buoys in the same location and at the same time. USV data has compared favorably with existing NOAA assets with scientists stating that: "*Outstanding correlation [was] found between Saildrone and ship calibrated measurements,"* and NOAA further stated that Saildrone USVs represent *'a platform that is ready for ocean research missions from the tropics to the Arctic"*[5]

In the past, new technologies were expensive to acquire and even more expensive

[5] "The Use of Saildrones to Examine Spring Conditions in the Bering Sea: Instrument Comparisons, Sea Ice Meltwater and Yukon River Plume Studies" Cokelet, Meining et al, IEEE, 2015

to maintain, resulting in large capital outlay, before proving any value. In contrast, Saildrone' ocean data capability is offered as a fully managed service including USV lease, operation, data management and distribution for a fixed daily price per USV (achieving cost efficiencies of the order of 90% cheaper than the daily cost of a government research vessel). In getting the private sector to pay for the expensive infrastructure and shouldering the operational risk, this public-private partnership framework provides great value to NOAA.

NOAA's days-at-sea shortage could be addressed by USV technology

NOAA states in its 'Fleet Plan' that the total internal demand for days at sea in fiscal year 2017 totaled 8,063 days-at-sea across its various missions. However, the current aging NOAA fleet can only provide 3,096 days-at sea. The shortfall is partially addressed by chartering private vessels for approximately 2,320 days-at-sea. This leaves an unaddressed gap of 3,191 days-at-sea in fiscal year 2017 alone.

Worse, NOAA further states that *"Between 2017 and 2018, eight of NOAA's [16] ships will exceed their design service life and are due to retire by 2028. The loss of these eight ships will undermine NOAA's ability to meet its mission. "*

This clearly will have consequences, which NOAA lists as: " *the total absence of mapping capabilities on the West Coast and in the United States Arctic, specifically in the Pacific Ocean, Bering Sea and Arctic Ocean; a 75 percent loss of its hydrographic survey capability on the East Coast and in the Caribbean; and the inability to conduct fishery and marine mammal stock assessments, monument and sanctuary stewardship in the Central, Southern, and Western Pacific, and trawl-based stock assessments in the Gulf of Mexico. […] Moreover, the loss of* *data used to validate and calibrate satellites and feed weather forecasting models will result in less accurate planning for emergency response, agriculture, and coastal management that will increase risk to lives and property and have negative economic impacts."*

We believe that USV technologies can cost-efficiently address this gap and augment NOAA ships, while also potentially reducing the dependencies on expensive charters.

The long tail of ocean data collection

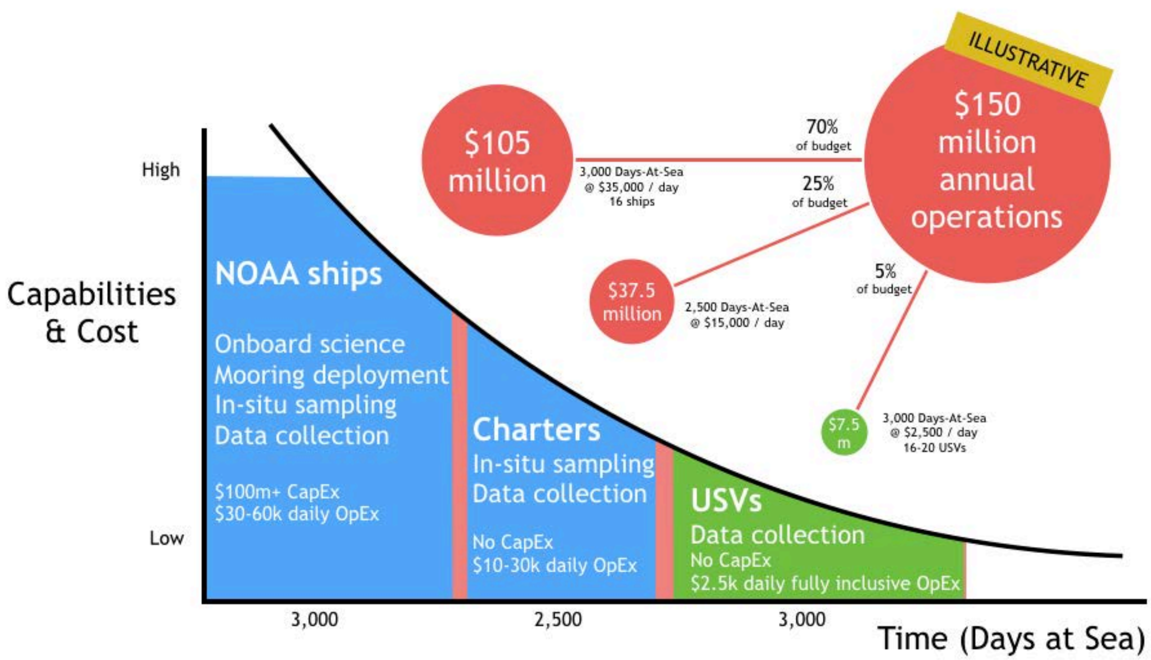

Figure 2 - The long tail of data collection

Naturally, different monitoring missions require different capabilities. Some circumstances require complex capabilities such as the ability to deploy heavy equipment, perform in-situ sampling of fish or water and perform complex onboard analyses. These uses cases clearly require a ship, which remains the bed-

rock of ocean research and a core component of NOAA's capabilities. We thus agree with NOAA's statement that *"It is a fallacy to assume that technology can replace ships"*.
However, for many missions where the capabilities only require data collection for long periods of time over large areas, USVs are uniquely qualified and could play an important role in increasing the mission effectiveness of NOAA.

The cost-efficiencies are clear: the operating cost of a government ship is approximately $35,000 to $60,000 a day, after an initial capital expense in excess of $100m. A charter costs on average $15,000 per day. In contrast, a Saildrone USV costs $2,500 per day or a 90% cost saving for those missions which only require data collection. USVs, when offered on a data-as-service basis require no upfront capital expense, and shift the burden of operation and risk to the private sector.

Yet, NOAA today has no budget dedicated to operationalizing Unmanned Surface Vehicles nor a clear pathway to move this type of environmental technological advances from research into operations.

Fisheries for example would reap short term benefits from better fish stock assessment. And NOAA's weather models would also benefit from reducing their observational data gaps, by acquiring data collected from USVs such as those offered by our company and others.

Recommendation for better transfer of technology from research to operation

The US government has been an effective R&D partner to Saildrone. For example, we believe that the Collaborative Research & Development Agreement framework (or CRADA) has enabled NOAA OAR to very efficiently work with companies like ours to assess and adapt private sector innovation to the unique needs of the agency.

However, the lack of pathways to transition technology from R&D to Operations is a known issue. This means that despite the fact that the US government recognizes the potential of emerging technologies like USVs, transitioning them to operations and realizing the associated cost-savings, has been challenging.

The **Weather Research and Forecasting Innovation Act of 2017** is meant to help, but stops short of providing a robust private-public partnership framework.

"Sec. 106) NOAA must: (1) prioritize observation data requirements necessary to ensure weather forecasting capabilities to protect life and property to the maximum extent practicable; (2) evaluate observing systems, data, and information needed to meet those requirements; (3) identify data gaps in observing capabilities; and (4) determine a range of options to address those gaps."[6]

Furthermore, the bill's authorization for the purchase of commercial weather data is ambiguous when it comes to the type of data considered, and especially its applicability to ocean surface data such as those provided by companies like ours.

TITLE III--WEATHER SATELLITE AND DATA INNOVATION

(Sec. 302) The bill permits the purchase of weather data by the federal government

[6] H.R.353 - Weather Research and Forecasting Innovation Act of 2017 - 115th Congress (2017-2018)

through contracts with commercial providers and the placement of weather satellite instruments on co-hosted government or private payloads.

We would recommend that the Data Innovation mandate be clarified to include surface observations in order to help address NOAA's recognized data gaps in this area.

We would further recommend that NOAA be encouraged to transition technology assessed by OAR to operational line offices by directing funds for that specific purpose.

Closing Remarks

In spite of the challenges mentioned here, the nation still holds a leadership position and a strategic advantage in environmental observations and the technologies that make those observations not only possible, but also reliable and accurate. Activity is taking place at an accelerated pace, given technology and market developments, including the leveraging of advances in environmental technologies in an expanding maritime ecosystem. U.S. policy and regulatory mechanisms need to reflect the current status of technology and market factors, and even anticipate more innovative technological developments with an eye toward efficient and objective addressing of mission and incentive creation for U.S. industry. The nation as a whole benefits from such an approach.

In closing, I would like to thank you for giving me the opportunity to present some of the advancements in environmental technologies and to explain how companies like SAILDRONE can cost-effectively augment existing US government capabilities to better manage our country's resources and prepare our population confronted with complex environmental challenges such as weather, fisheries and environmental monitoring.

Our company provides infrastructure to Government agencies to enable them to fulfill their mandate with a higher degree of success and higher cost efficiencies.

Such advances in USV technologies and data management provide new opportunities for public-private partnerships, as our work with NOAA and DoD have demonstrated.

I appreciate the opportunity to express my views to you today, and I invite any of the Members or staff to come visit SAILDRONE the next time you are on the West Coast.

Thank you for your attention. I am prepared to answer any questions that you may have.

For more information

- An IEEE publication by NOAA PMEL about the mission performance of the Saildrone USV performing autonomous meteorological and oceanographical data collection in the Bering Sea: https://www.pmel.noaa.gov/pubs/PDF/mein4372/mein4372.pdf
- An IEEE publication by NOAA PMEL about the instrument comparison between Saildrone USVs and NOAA ships and buoys: https://www.pmel.noaa.gov/foci/publications/2015/coke0847.pdf
- A Remote Sensing Journal publication about the performance of Saildrone USV in autonomous oil spill detection in the Gulf of Mexico: http://coaps.fsu.edu/~ddmitry/MyPapers/Asl_oilseeps_2017.pdf

Biography

Sebastien de Halleux
Chief Operating Officer
Saildrone Inc.

Sebastien de Halleux is the Chief Operating Officer of Saildrone Inc., a company designing wind and solar powered ocean drones aiming at revolutionizing data collection at sea. At the confluence of autonomous technologies and big data, Saildrone believes that improving the understanding of our oceans will help us better understand key planetary systems that affect humanity such as weather and fisheries. Formerly, Sebastien was Co-Founder and COO of Playfish, one of the largest and fastest growing social gaming companies. Sebastien helped grow the company to over 300 million players in two years before being acquired by video game giant Electronic Arts (EA) in 2009. Prior to founding Playfish, Sebastien helped launch Glu Mobile, an early pioneer in mobile games which IPO'ed in 2007.

Sebastien is the recipient of the 2012 EA Emerging Leaders Award, the 2011 Tech 100 award, the 2010 TechFellow award, and the 2003 Booz Allen Professional Excellence Award. He sits on the boards of UWC-USA, the Solar Fuel Institute, and Trusted Family.

He is passionate about helping the next generation of entrepreneurs, acting as mentor for the Founders Institute, BetaGroup and 500 Startups. Sebastien holds a Masters degree in Civil and Environmental Engineering from Imperial College London and is a member of the 2016 Class of Henry Crown Fellows and the Aspen Global Leadership Network at the Aspen Institute.