Manned Submersible Technology – Opening the Ocean to Scientific Study

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Abstract - Since creating NOAA more than 30 years ago, the nation is re-assessing its ocean policy with a focus on the next 30 years. We are finding that we know a lot about the oceans but very little about the way life systems interact and survive. All the management and policies of the world will not help unless we come to understand the functioning parameters of this vital eco-system. The desire for a bold change in policy must first translate into an attitude change in the way we study the oceans. We will not solve this colossal challenge within the confines of our research labs. We must acknowledge that there is no substitute to going out into the field. This paper proposes that not only are manned submersibles not an irrelevant technology but in fact a necessary cornerstone for future oceans discoveries to further the gathering of scientific data in support of more effective and precise management of ocean policies.

I. INTRODUCTION

The statistics are sobering, the numbers are real. They directly affect our homes, our food and our leisure. Demographers anticipate that by 2025, three-quarters of the U.S. population will reside in coastal regions. Growing coastal populations increase waste loads on coastal environments. Estuaries are most directly affected. Seafood is the fastest growing source of low cost protein worldwide, in great part due to the unprecedented technologies available for mechanical harvesting. The risk of overfishing is significant. Numbers shows that the federal government does not know the status of 75% of its managed fish species. Of the stocks where the status is known, 43% are overfished [1]. Moreover, 58% of the coastal waters (e.g. estuaries, bays, harbors) of the 48 contiguous states were under fish and/or shellfish consumption restrictions in 1998 due to high concentrations of chemical contaminants such as mercury, PCBs or dioxin. Use of our coastal zones for leisure offer equal cause for attention. Beaches are America's number one tourist destination; approximately 180 million people vacation along U.S. coasts every year [2].

II. THE OCEAN WELL SOURCE

We have come to understand and accept that the ocean is not a limitless source of food and repository for all that we do not wish to store on land. Striking a just balance between its sustainable exploitation and allowance for regeneration is the principal function of policy makers, who accept the responsibility entrusted to them as elected officials in considering the far reaching implications of their decisions.

A. The Problem

One of the biggest problems today in managing ocean policies is the burden of controversy and economic adversity created by legal decisions. The sources of such controversies almost always arise from having legislative bodies that are asked to make extremely difficult ocean policy decisions with insufficient or incomplete scientific data to guide their options. It is not realistic to expect politicians to abstain from writing legislation when faced with absence of knowledge. In the face of crisis, politicians simply cannot avoid making policy decisions. The result forces policy makers to make decisions whether they have supporting data or not. Today, the nation does not have a sufficient science base to guide political decisions in a factual manner. It is then easy to appreciate how quickly any data is absorbed and utilized in the political process, regardless of its source, bias, motive or credibility.

B. The Solution

The only solution is to ensure the availability of comprehensive scientific data, easily at hand for policy makers to find and utilize when faced with difficult Ocean policy decisions. Controversy is always an unproductive process and our ability to manage our oceans in a sustainable mode is indeed time sensitive. Controversies waste time and money, both precious resources that are always better allocated to solving the problems. Facts are the most effective tool to overcome controversy. The need for facts points to the inevitable need for a national central science base, recognized and accepted as the national repository for all scientific data. This task is monumental in many ways, starting with the acquisition of the scientific knowledge and followed by the data management. Indeed, this data management aspect presents many challenges addressed in the conclusion of two national commissions studying the ocean. Clearly, better coordination between the science and management sectors is paramount; the best policies are built on sound information. Timely access of

sufficient and recent data is key to building such a useful science base. Dissemination of this data will become increasingly important as large data sets start streaming in.

C. Ocean Policy Studies

A great deal of time and energy has been expended in the last 3 years through two independent national commissions, both tasked with finding a new bold direction to the next 30 years. The congressional “US Commission on Oceans” as well as the independent “Pew Oceans Commission” are both unanimous in their findings.

1. We need a science base to understand the oceans.
2. We need to monitor oceans with directives to re-establish ecosystems.
3. We need better information management and exchange between researchers and our government policy makers.
4. We need a higher level of public ocean awareness to support political allocation of funding for the oceans.

D. National Directive

Both commissions conclude that a national directive is necessary to impress the strategic importance of fixing our oceans. Studies can point us in the right direction but this does not usually happen without clear leadership and clear objectives. A national directive is necessary for a broad and focused mobilization of people: Its first task, the science base -- the discovery, exploration and understanding of our ecosystems.

E. Need for Discovery

A fundamental tenet of discovery, besides the luck of being in the right place at the right time, is that people solve problems, not machines. The most powerful tool we know today is the cognitive capacity of the human eye and brain to decipher and understand complex interactions. It would follow that the more people are engaged in the oceans, in-situ gathering data, the higher the chances of discovering new facts and the faster we will accumulate knowledge. Mobilizing thousands of qualified researchers into the oceans will establish the cornerstone for ocean observation, empowered data collection, greater understanding and ultimately a knowledge base of our oceans.

F. Available Resources

First, we must realize that, unique in the history of humankind, the most extraordinary resource we have at hand is our vast scientific human capital. This scientific foundation can empower us today to champion the ocean’s cause and its conscientious stewardship. Unquestionably, this is the part of the solution that takes the longest to develop, and it is at hand through thousands of institutions of higher education and research centers nation wide.

Second, in order to bring in-situ access to the human capital, we need to change our perceptions of manned submersible uses and applications. Manned submersibles remain uniquely effective at bringing human intelligence directly in the field. Nevertheless, for a wide variety of reasons manned submersibles are often overshadowed by robotic technologies and remain overlooked as a practical technology. The two major arguments against the technology are: First, exorbitant costs are used to disqualify the technology by using costs of present manned submergence expeditions, which are all focused on deep exploration. Second, when shallow depth diving is mentioned, scuba access and the cost effectiveness of divers is used to disqualify the submersibles. In reality, neither arguments are complete.

G. Cost of Scuba Diving

It is true that SCUBA diving can reach 130 feet and commercial mixed gas diving routinely works at 300 feet, but this technology does not provide universal scientific access by any stretch of the imagination. In terms of productivity, it is absolutely impossible for a team of three Scuba divers to spend 10-15 man hours per day underwater, every day for a year, at even benign depths of 100 feet. At a productivity level of approximately ½ hour per day per diver, this would require at least 30 people but more likely 50-60 people to sustain that level of effort for a year. When considering anything beyond 100 feet, the numbers quickly become even more unrealistic.

H. Cost of Deep Submergence Diving

The main obstacle keeping people from the ocean has always been cost; there is no mass transport system in place to shuttle a wide array of multi-disciplinary scientists. Deep submergence is complex and remains expensive, by necessity, and has increasingly relied on ROV and AUV technology to address the need for expanded access. The National Deep Submergence Foundation is the main source for submersible research time in the US. Cost for traditional deep manned access ranges from $10,000 to $20,000 per day. Clearly, such costs would be prohibitive for mass transit considerations and no current budget for ocean research could ever support this.

I. Light Submergence Diving

If Scuba divers cover the 0-100 foot range and Deep Submergence research the 1,000 to 20,000 foot range, there remains a clear zone of opportunity, namely the first 1,000 feet. The solution is to redefine an operating depth for manned submergence that remains within practical budgets while maintaining meaningful capability for research.

Today's light submergence vehicle technology offers cost effective means to work in nominal depths of 300-500 feet range and can provide upwards of 2000 hours of work per year at an operational cost of less than $1000 a day [3] [4]. These systems are capable of diving every day, each carrying a pilot and a researcher with an assortment of relevant instruments. These machines would not only provide universal access to all levels of researchers, but the true breakthrough is the aspect of going out in the field daily, consistently, generating new data at unprecedented rates each year. A fleet of 100 light submergence manned submersibles, distributed among the many hundreds of institutions along our coasts, could gather upwards of 200,000 hours a year. The acquisition cost of such a fleet would be equivalent to a single new deep submergence submersible. This is not to represent that the national deep submergence capability be restricted but indicates that the fiscal demands are well within the realm of practicality.

The potential of this type of technology [5] should embolden us to set a national goal, to aim for a concrete achievement that would revolutionize our understanding of the oceans: The collection of 1 million hours of manned science data within the next 10 years. To put that goal in perspective, at today's rate of manned submersible exploration, this would take 1000 years to accomplish. Doing it in 10 years would be a clear breakthrough.

J. Historical Precedent

Just as President Roosevelt directed the nation 100 years ago, establishing the first National Parks and with it the Forest Rangers, so it is time for the nation to realize we need a broad mobilization of Ocean Rangers to learn and study our Oceans. We have the capability to set up a network of Ocean Ranger Centers that deploy manned submersible expeditions every single day. Using simpler vehicles, in more places more often and involving more researchers and students, will capitalize on the existing human knowledge base and produce true discoveries. The natural evolution of this process, of the routine mobilization of multi-disciplinary science bodies committed to study the ocean, is a gradual change in attitude. Scientists and researchers will think less about the means to reach the oceans and concentrate their creative minds on expanding the level of research that needs to be done. Giving easy access to all levels of researchers is a first step in promoting the accessibility of the Oceans and making it less of an abstract science. This perception of empowerment and motivation will nurture the interest of a new generation of students that will open doors for new information and investments in Ocean Study. Public awareness will become a natural and integral part of the process as each person is enfranchised by the perception of accessibility. The perception of human access is what will give the public a sense that we can and are doing something about the ocean, and is ultimately the only way ocean sciences will gain an increasing level of political support and proportional research funding. One only needs to look back at the successful funding of NASA's space program over the past 30 years. The majority of people on the street could surely come up with some idea if asked their thoughts on the future direction of our space program. It is difficult to imagine their response to a similar question about our future Ocean Program.

III. CONCLUSION

We simply do not have sufficient knowledge of our oceans to make wise management decisions for the long term sustainability of the oceans. Among many important priorities, it starts with gathering an understanding of the living realm as an ecosystem. There are no short cuts towards that knowledge. It involves many scientists and a lot of field work. It must involve an army of Ocean Rangers dedicated to its exploration and empowered to shuttle broad multidisciplinary scientific teams throughout our coastal oceans. Manned submersible remains the most effective technology to bring the powers of human deductive reasoning to the oceans, providing that the equipment and objectives are designed for practical depth ranges, balancing functionality and cost.

Manned submersible technology is not an irrelevant option in our future study of the oceans. Many automated data gathering technologies have profound capabilities for monitoring of the oceans. However, the first problem at hand is the determination of how the eco-systems function. Only then can we effectively plan a monitoring program. The first part involves manned fieldwork; the second can be increasingly automated.

Theodore Roosevelt declared in January 1904 that, "The Forests are the Nation's Life. The most vital internal problem in the United States can only be solved by Trained Foresters". In an article in support of his National Parks vision he wrote, "I believe that there is no body of men who have it in their power today to do a greater service for their country than those engaged in the scientific study and practical application of approved methods of forestry for the preservation of the woods of the United States." These words hold true today and are equally applicable to our oceans.

We will only come to understand our oceans through the dedication of men and women that are willing to serve the cause of the ocean. In return, we must enable simple access to the work site and let human creativity do the discovering. The necessity of a dialogue or debate about the strategic importance of manned submersibles within the context of a national review of our ocean policies for the

next 25 years is important, unless the presumption is that human intervention is optional.

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