An Exploratory Study: The Use of Privately Owned Vessels as Mobile Research Platforms

Stockman, Brittany L.

UNIVERSITY OF MIAMI

AN EXPLORATORY STUDY: THE USE OF PRIVATELY OWNED VESSELS AS MOBILE RESEARCH PLATFORMS

By

Brittany L. Stockman

A THESIS

Submitted to the Faculty
of the University of Miami
in partial fulfillment of the requirements for
the degree of Master of Science

Coral Gables, Florida

December 2013

UNIVERSITY OF MIAMI

A thesis submitted in partial fulfillment of
the requirements for the degree of
Master of Science

AN EXPLORATORY STUDY: THE USE OF PRIVATELY OWNED VESSELS AS MOBILE RESEARCH PLATFORMS

Brittany L. Stockman

Approved:

_____ David Letson, Ph.D. Professor, Marine Affairs and Policy	_____ Maria Luisa Estevanez, M.S. Senior Lecturer, Marine Affairs and Policy
_____ Daniel DiResta, Ph.D. Senior Lecturer, Biology	_____ M. Brian Blake, Ph.D. Dean of the Graduate School

STOCKMAN, BRITTANY L. (M.S., Marine Affairs and Policy)

An Exploratory Study: The Use of Privately Owned Vessels As Mobile Research Platforms (December 2013)

Abstract of a thesis at the University of Miami.

Thesis supervised by Professor Maria Luisa Estevanez and Dr. David Letson.
No. of pages in text. (75)

Due to limited public funding for scientific studies and data collection, private sector entities increasingly fill the gap by facilitating research inquiries. Specifically, coastal, oceanic and marine conservation nonprofit organizations (NPOs) play a direct role in research by both funding and orchestrating research missions across the globe. Through the examination of existing organizations and vessels involved in such efforts, this study examined the practicality of a NPO managed program that provides marine scientists with suitable mobile research platforms and evaluated the overall benefits of such a program on the ocean research community. One such organization, the International SeaKeepers Society (SeaKeepers), remains the primary focus as the author was employed to design, test and implement the SeaKeepers Discovery Yachts Program (SDY). Through SDY, SeaKeepers enables the yachting community to take full advantage of their unique potential to advance marine sciences and to raise awareness about global ocean issues by making unconventional vessels, member yachts, available to the scientific community. SDY intends to augment current knowledge about the state of the oceans, rouse significant scientific

discovery, raise awareness about critical ocean issues and inspire a passion for the seas.

Acknowledgements

I would like to thank the International SeaKeepers Society, who supported the research involved in this project. I would also like to thank my thesis committee: Maria Estevanez, Dr. Daniel DiResta, and Dr. David Letson. I greatly appreciate their patience guiding a terminal procrastinator along with their continuous willingness to review and critique this endeavor. Additionally, I acknowledge the generosity of the inaugural DISCOVERY Yacht owners, whose willingness to involve themselves and support a blossoming program made it such a success. Specifically, James F. Jacoby and Captain Carl Hampp were invaluable assets in the planning and orchestration of SDY expeditions, and their leap of faith transformed SDY from a proposal into a functioning program. Finally, my largest thanks goes to my chief editor. You know who you are.

TABLE OF CONTENTS

Page

LIST OF FIGURES vi

LIST OF TABLES vii

LIST OF ABBREVIATIONS viii

Chapter

1 INTRODUCTION AND LITERATURE REVIEW 1
- 1.1 Importance of Understanding the Oceans 1
- 1.2 Major Research Questions and Future Science Needs 5
- 1.3 Critical Infrastructure for Ocean Research 9
  - 1.3.1 Mobile Platforms: Research Vessels 11
  - 1.3.2 U.S. Academic Research Fleet… 12
  - 1.3.3 Federal Oceanographic Fleet 14
  - 1.3.4 Current and Future Infrastructure Needs 15
- 1.4 The International SeaKeepers Society 19

2 GOALS AND OBJECTIVES 22

3 SIGNIFICANCE AND LIMITATIONS 25

4 METHODS 29
- 4.1 Analysis of Yachting and Boating Communities' Potential to Expand Ocean Research Efforts 29
- 4.2 Analysis of Existing Programs Providing Mobile Research Platforms 30
- 4.3 Design and Development of the International SeaKeepers Society's Discovery Yachts Program 31
  - 4.3.1 Pilot Studies Providing Proof of Concept 32
  - 4.3.2 Design and Launch of Online Interface 33

5 RESULTS 34
- 5.1 Analysis of Yachting and Boating Communities' Potential to Expand Ocean Research Efforts 34
- 5.2 Analysis of Existing Programs Using Privately Owned Vessels as Research Platforms 41
- 5.3 The Design and Development of the International SeaKeepers Society Discovery Yachts Program 46

5.3.1 Pilot Studies Providing Proof of Concept 46
5.3.2 Design and Launch of Online Interface 50
5.3.3 Protocol and Operational Framework 50

6 DISCUSSION 53
6.1 The Use of Privately Owned Vessels for Research 53
6.2 Limitations and Shortcomings 56

7 CONCLUSIONS AND RECOMMENDATIONS 57
7.1 Conclusions of Research Goals and Objectives 57
7.2 Recommendations for Future Research 58

REFERENCES 59

APPENDIX A 63

APPENDIX B 64

APPENDIX C 67

APPENDIX D 71

APPENDIX E 73

LIST OF FIGURES Page

Figure 1 - The six societal themes and associated research questions as presented in *Science for an Ocean Nation* 6

Figure 2 - Conceptual overview of the relationship between infrastructure, ocean research, knowledge, social objectives and economic benefits from *Critical Infrastructure for Ocean Research and Societal Needs in 2030* 10

Figure 3 - Rising total operating costs and associated decline in total operating days for the UNOLS Fleet 13

Figure 4 - Rising costs of select Global Class Vessels within the UNOF 15

Figure 5 - Graph depicting declining fleet capacity as a result fleet size reduction as projected in 2025 16

Figure 6 – Growth of the SuperYacht Industry 36

Figure 7 – Average Monthly Expenditure Spent on Running Costs 38

Figure 8 – Trends in SuperYacht Builds from 2007 – 2012 39

Figure 9 - Cost breakdown for Miss Phebe Dry Tortugas research mission 48

LIST OF TABLES Page

Table 1 - Six Societal Themes Highlighted in Science for An Ocean Nation: Update of the Ocean Research Priorities Plan 5

Table 2 - Research Queries Identified in *Science for an Ocean Nation* Aimed at Filling the Knowledge Gap Preventing Effective Management and Conservation of the Seas 7

Table 3 - Research Queries Identified in *Science for an Ocean Nation* Aimed at To Ensure the Future of Human Populations and their Economies 7

Table 4 - Research Queries Identified in *Science for an Ocean Nation* Aimed at To Increase Knowledge to Efficiently Manage Scarce Oceanic Resources 8

Table 5 - Research Queries Identified in *Science for an Ocean Nation* Required to Gain a Holistic Understanding of the Oceans 8

Table 6 - Distribution of Superyachts by Size 37

Table 7 – Average Value of Yachts Over Time 39

Table 8 - Comparison of Seven Private Entities Facilitating Ocean Research and Exploration 45

Table 9 - Breakdown of costs incurred by yacht owner for Miss Phebe Dry Tortugas research mission 48

Table 10 -Breakdown of costs incurred by RSMAS research team for Miss Phebe Dry Tortugas research mission 48

LIST OF ABBREVIATIONS

- BIOS - Bermuda Institute for Ocean Sciences
- CENORF - Committee on Evolution of the National Oceanographic Research Fleet
- CES – Committee of the Exploration of the Seas
- COISUSOR - Committee on an Ocean Infrastructure Strategy for Ocean Research
- DOE – Department of Energy
- EEZ – Exclusive Economic Zone
- EPA – Environmental Protection Agency
- FAU – Florida Atlantic University
- GDP- Gross Domestic Product
- IWG-Facilities – Interagency Working Group on Facilities
- LUMCON – Louisiana Universities Marine Consortium
- MY – Motor Yacht
- NAS – National Academy of Sciences
- NASA – National Aeronautics and Space Administration
- NAVOCEANO - Naval Oceanographic Office
- NOAA – National Oceanographic and Atmospheric Organization
- NOC – National Ocean Council
- NPOs - Non Profit Organizations
- NRC - National Research Council
- NSF - National Science Foundation

- NSTC - National Science and Technology Council
- OCE – Division of Ocean Sciences
- OER - Office of Ocean Exploration and Research
- OMAO - Office of Marine and Aviation Operations]
- ONR - Office of Naval Research
- RSMAS - Rosentiel School of Marine and Atmospheric Science
- RV - Research Vessel
- SDY - SeaKeepers DISCOVERY Yachts
- SeaKeepers - The International SeaKeepers Society
- SIO - Scripps Institute of Oceanography
- SOST - Subcommittee on Ocean Science and Technology
- UD - University of Delaware
- UG/SKIO - University System of Georgia/Skidaway
- UM - University of Miami
- UMD - University of Minnesota, Duluth
- UNOLS - University-National Oceanographic Laboratory Systems
- USACE – United States Army Corps of Engineers
- USAF – United States Academic Fleet
- USCG – United States Coast Guard
- USCO - United States Commission on Ocean Policy
- USGS - United States Geological Survey
- USOF - United States Oceanographic Fleet
- WHOI - Woods Hole Oceanographic Institute

CHAPTER ONE

INTRODUCTION AND LITERATURE REVIEW

The following literature review highlights the importance of ocean research and exploration in relation to human society and examines significant knowledge gaps and future research needs. The state of the US Oceanographic Fleet (USOF) and US Academic Fleet (USAF) is explored with a focus on the declining ability of public funds to facilitate needed investigations and overall limitations of the government funds. Consequently, private sector organizations, namely non-profit organizations (NPOs), which make up this shortfall in spending by the state and federal government by providing research platforms to deserving scientific needs, are introduced. The accomplishments of the International SeaKeepers Society ("SeaKeepers") are emphasized to provide sufficient introduction to the current proposed study.

1.1 Importance of Understanding the Oceans

Regarding knowledge, Isaac Newton sensibly stated, "What we know is a drop, what we don't know is an ocean." His statement remains valid to this day, particularly when assessing the world's least explored frontier: the oceans (CES & NRC, 2003). The world's oceans cover 361 million square kilometers (139.4 million square miles) and hold a volume of 1,370 million cubic kilometers (329 million cubic miles) of water (Garrison, 2007). The oceans cover 71% of our planet and house 80% of life on Earth. "The ocean drives climate and weather,

regulates temperature, absorbs much of the carbon dioxide from the atmosphere, holds 97% of Earth's water and embraces 97% of the biosphere," writes Sylvia Earle, renowned oceanographer and marine scientist in her most recent publication, *The World is Blue*: *How Our Fate and the Ocean's are One* (Earle, 2009). Equally inspiring, Joseph Allen, an astronaut in the 1990's, once pointed to the Earth while in orbit and pleaded, "There it is. Our life support system. Learn everything you can about it and do everything you can to take care of it" (Earle, 2009).

Every US citizen, regardless of her proximity to the coast, is intrinsically dependent on the resources and services the ocean supplies (USCOP, 2004). The United States' exclusive economic zone (EEZ) covers 13,000 miles of coastline and consists of approximately 3.4 million square nautical miles of ocean. With the largest EEZ in the world, the US is truly a coastal nation. The value of this asset is indefinable, though economists estimate that 58% of US gross domestic product (GDP) in 2010 was generated in coastal watershed counties and associated ocean waters (NOAA, 2012). In fact, the majority of the nation's population resides in counties with a coastline; a statistic that illustrates our love of and dependence on aquatic resources. The oceans and coasts not only feed us, provide millions of jobs and offer numerous recreational opportunities; but also their very existence naturally enhances national security (USCOP, 2004). Tourism and recreation continues to remain one of the nation's greatest and most rapidly growing sectors, which in 2009 contributed more than $61 billion to US GDP and employed nearly 2 million Americans (Chasis, 2010).

A 2011 study reported that commercial and recreational fishing industries generated over $116 and $50 billion respectively in expenditure alone and were responsible for approximately 1,320,000 jobs (Chasis, 2010). Furthermore, maritime industries and marine transportation are vital components of the US economy. Advancements in ocean science support national interests by addressing national challenges, informing national ocean policy and increasing understanding of emerging topics such as ocean acidification and climate change (SOST, 2013).

On the other hand, the ocean under US jurisdiction also poses a threat to human populations from exposure to destructive tsunamis and hurricanes, industrial accidents, like the 2010 Gulf of Mexico *Deepwater Horizon* oil spill, and devastating outbreaks of waterborne pathogens (COISUSOR, 2011). Introduced species, whether intentional or not, pressure marine community dynamics and threaten to induce irreversible ecosystem changes. Limited research, management funding and gaps in scientific knowledge exacerbate these hazards to human and marine populations (Simberloff, Parker, & Windle, 2005).

Marine research is essential for advancements in human health and medicine. For example studies reveal that sharks contain a molecule in the liver that will play a role in the treatment of brain tumors (Alexander, 2011). Sequencing the genomes of organisms with simple nervous system structure sheds light onto the origins of the complex brain and informs wide ranges of treatments for human disorders (Maxmen, 2013).

According to the Committee of Exploration of the Seas (CES) and the National Science Foundation (NSF), “only a fraction of the world’s marine species have been discovered and even fewer have been scientifically identified and named. New species are discovered on virtually every expedition that seeks to uncover them” (Census of Marine Life, 2010. CES & NRC, 2003). Improved understanding of marine systems and anthropogenic impacts on such systems will allow managers to efficiently use oceanic resources, both living and non-living, and safeguard the biodiversity teeming in the ocean. Additionally, the more we know about the oceans, the better ability we have to value and quantify ecosystem components, produces and services (Alexander, 2011). Incomplete understanding of the ocean ecosystem requires supplementation through fundamental research, which is supported entirely by ocean research infrastructure (COISUSOR, 2011).

In February 2013 the Obama Administration published a report titled *Science for an Ocean Nation: Update of the Ocean Research Priorities Plan*, which presented six themes representing significant areas of interaction between human society and the ocean. The societal themes driving future ocean research priorities are shown in Table 1 (SOST, 2013), and all depend entirely on a sustained adaptive capacity to gather ocean data. “Every societal objective implies a demand for certain information, the acquisition of which has a certain value for society” (COISUSOIR, 2011).

Table 1: Six Societal Themes Highlighted in *Science for An Ocean Nation: Update of the Ocean Research Priorities Plan*

Theme One	Stewardship of Natural and Cultural Ocean Resources
Theme Two	Increasing Resilience to Natural Hazards and Environmental Disasters
Theme Three	Maritime Operations and the Marine Environment
Theme Four	The Ocean's Role in Climate
Theme Five	Improving Ecosystem Health
Theme Six	Enhancing Human Health

1.2 Major Research Questions and Future Science Needs

The *2012 Draft National Ocean Policy Implementation Plan,* identifies the following nine priority objectives of a comprehensive national ocean policy in addition to individual actions needed for effective goal attainment (NOC, 2012). After one year, the research priorities and activities were updated in *A Science for an Ocean Nation* (See Figure 1*).*

1. Ecosystem-based management
2. Coastal and marine spatial planning
3. Inform decisions and improve understanding
4. Coordinate and support
5. Resiliency and adaption to climate change and ocean acidification
6. Regional ecosystem protection and restoration
7. Water quality and sustainable practices on land
8. Changing conditions in the Arctic
9. Ocean, coastal, and Great Lakes observations, mapping and infrastructure

Similarly, the Committee on an Ocean Infrastructure Strategy for US Ocean Research (COISUSOR) in 2030 expands on research priorities in depth, with a focus on those that are expected to be of interest in 20 years, in *Critical Infrastructure for Ocean Research and Societal Needs in 2030*. Similar to the

structure of *A Science for an Ocean Nation*, this publication organizes research questions are presented under the context of 4 key societal drivers, enabling stewardship of the environment, protecting life and property, promoting sustainable economic vitality and increasing fundamental scientific understanding (COISUSOR, 2011).

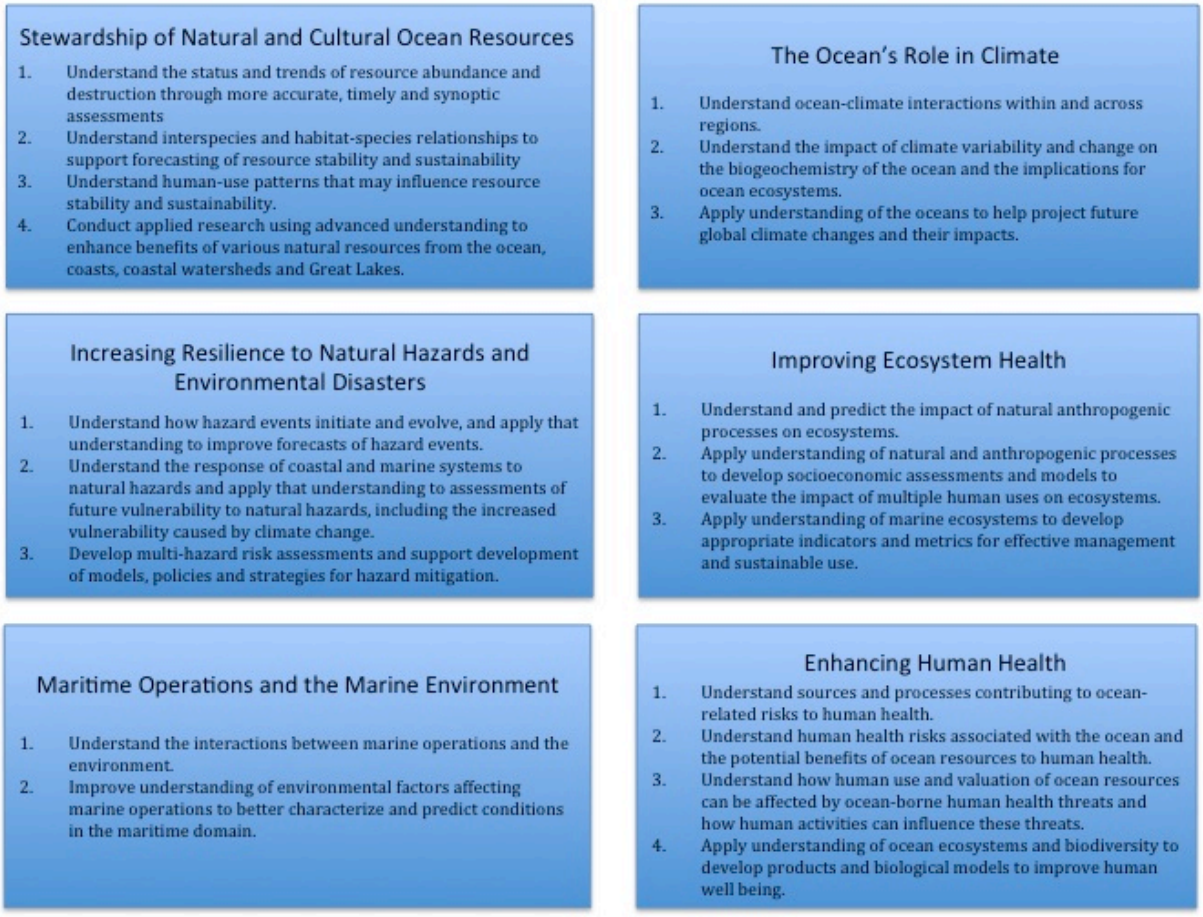


Figure 1: The Six Societal Themes and Associated Research Questions as Presented in *Science for an Ocean Nation.*

Stewardship of natural and cultural ocean resources enables society to maximize the benefits of ocean products and services for future generations. The

following questions in Table 2 intend to fill the knowledge gap preventing effective management and conservation of the seas.

Table 2: Research Queries Identified in *Science for an Ocean Nation* Aimed at Filling the Knowledge Gap Preventing Effective Management and Conservation of the Seas	
1	How will sea level change on a range of spatial and temporal scales and what are the potential impacts?
2	How will climate change influence cycles of primary production?
3	How will marine ecosystem structure, biodiversity and population dynamics be shapes by a changing ocean environment?
4	How will marine organisms and ecosystems be affected by ocean acidification?
5	How will climate change influence the distribution of chemical elements?
6	How do the distributions and fluxes of organic carbon components evolve in an altered ocean?
7	How will ocean circulation and the distribution of heat in the ocean and atmosphere respond to natural and anthropogenic drivers?
8	How will alterations in the global water cycle influence the ocean?
9	How will changes at coastal boundaries alter physical and geochemical processes?
10	How will coastal ecosystems ad communities respond to multiple stressors?
11	What are the critical interactions among ocean, ice, land, and atmosphere in polar regions and how will they influence physical and biological changes?
12	What advances will be made in predictions and mitigation of oil spills and industrial accidents in the ocean?
13	What are the potential impacts on the ocean from geoengineering (COISUSOR, 2011)?

The following questions in Table 3 are essential to ensure the welfare and future of human populations and their economies.

Table 3: Research Queries Identified in *Science for an Ocean Nation* Aimed at To Ensure the Future of Human Populations and their Economies	
1	How does strain accumulate in underwater volcanoes and offshore fault zones and what is needed for better forecasting of major events?
2	How can understanding and prediction of tsunamis be improved?
3	How can understanding and prediction of the path and intensity of severe storms be improved?
4	How will the extent and other characteristics of sea ice and icebergs change in the future, and how can the impacts of reduced sea ice be mitigated?

5	What is the role of coastal pollutants and pathogens on human and ecosystem health?
6	How do changes in the coupled ocean-climate system affect human health and welfare (COISUSOR, 2011)

The US ocean economy, as mentioned in section 1.1, is composed includes oil and gas extraction, fisheries, transportation, recreation, aquaculture, wind power and marine hydrokinetic activities. The following research questions identified in Table 4 intend to increase knowledge so as to efficiently manage the scarce resources found in the oceans.

Table 4: Research Queries Identified in *Science for an Ocean Nation* Aimed at To Increase Knowledge to Efficiently Manage Scarce Oceanic Resources	
1	How can humanity ensure sustainable food production in the ocean?
2	How can humanity maximize energy and mineral resource extraction, while minimizing adverse environmental aspects?
3	What is the ocean's potential as a source of renewable energy (COISUSOR, 2011)?

Increased fundamental knowledge of the seas has substantial value in it's own right. The following research questions in Table 5, though not directly applicable to human society, must be investigated in order to gain a holistic understanding of the oceans.

Table 5: Research Queries Identified in *Science for an Ocean Nation* Required to Gain a Holistic Understanding of the Oceans	
1	How does Earth's interior work, and how does it affect plate boundaries, hotspots and other surface manifestations?
2	What are the plausible rates and magnitudes of climate change?
3	How can the effects of ocean and atmosphere interactions be better parameterized?
4	What processes dominate mixing in the ocean and on what space and time scales?
5	How does fluid circulation within the ocean crust impact chemistry and

	biology of the subseafloor and the hydrosphere?
6	How does the deep ocean biosphere inform the origin and evolution of life?
7	What regulates the diversity and rates of molecular and biochemical evolution in the ocean?
8	What is the biodiversity of the deep-sea pelagic ecosystem?
9	What are the modes and roles of sensory systems and intra- and interspecies communication in structuring marine ecosystems?
10	How does the ocean contribute to Earth's carrying capacity (COISUSOR, 2011)?

1.3 Critical Infrastructure for Ocean Research

In the 2011 report *Critical Infrastructure For Ocean Research And Societal Needs in 2030*, the COISUSOR defines ocean research infrastructure as "the full portfolio of platforms, sensors, data sets and systems, models, supporting personnel, facilities, and enabling organizations that the nation can bring to bear to answer questions about the ocean, and that is (or could be) shared by or accessible to the ocean research community as a whole" (COISUSOR, 2011). US ocean research infrastructure is constantly evolving in response to available funding and to technical innovations in oceanography and related fields. The nation's ability to answer critical questions about the oceans and maintain scientific prowess internationally depends primarily on all aspects of ocean research infrastructure (COISUSOR, 2011). Regrettably, fundamental components, namely mobile research platforms, of this infrastructure are in a deplorable state and limiting the success of the ocean research community (Cressey, 2013). Without the infrastructure to harvest necessary data, scientists are left in the dark and unable to aid policy-makers at their full potential. Emilio

Tesis, physicist and physical oceanographer of the Environmental Ocean Team asserts that a single boat is not going to make the difference, what is needed is a global fleet of vessels willing to collect oceanographic data and execute research (Choi, 2011). Figure 2 provides a conceptual overview of the relationship between infrastructure, ocean research, knowledge, societal objective and economic benefits (COISUSOR, 2011).

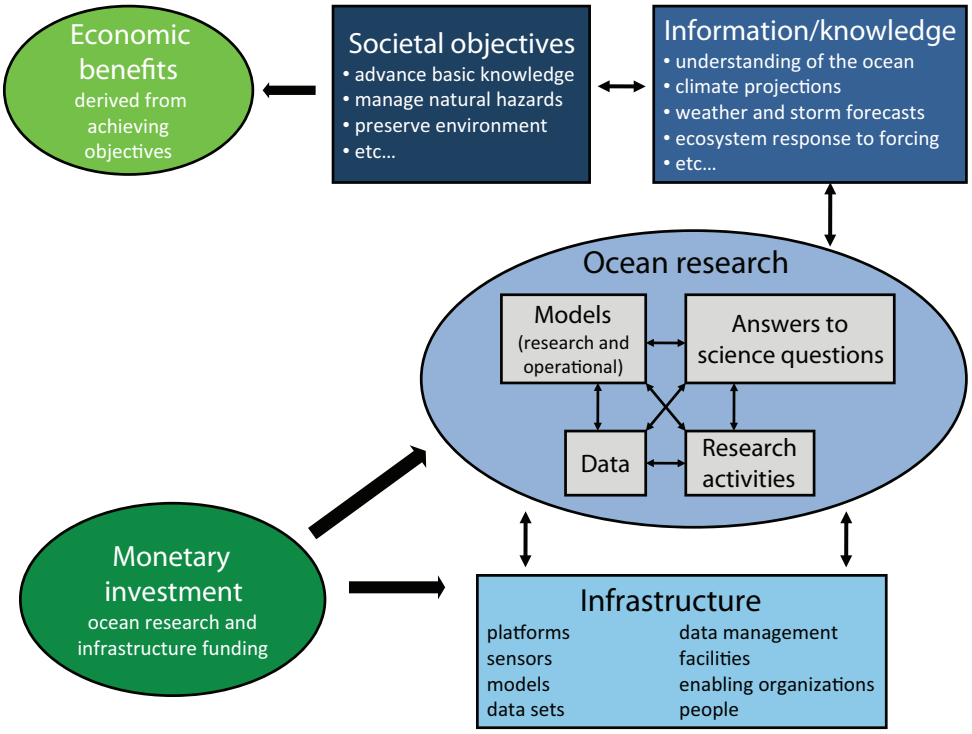


Figure 2: Conceptual overview of the relationship between infrastructure, ocean research, knowledge, societal objective and economic benefits (USCOIS, 2011).

In 2004, the USCOP released *An Ocean Blueprint for the 21st Century*, which urged the prompt formation of "a national ocean and coastal infrastructure and technology strategy to support science, resource management, assessments, enforcement and education" (USCOP, 2004). Eight years later,

the National Ocean Council (NOC) again emphasized the need to “strengthen and integrate Federal and Non-Federal ocean observing systems, sensors, data collection platforms, data management, and mapping capabilities into a national system and integrate that system into international observation efforts” (NOC, 2012), as outlined in the *Draft National Ocean Policy Implementation Plan*. In order to achieve research priorities, data must be perpetually collected, monitored and analyzed. Of critical importance is the need to improve and expand the availability of modern ships, undersea vehicles, moorings, satellites, laboratory instruments and observing systems (NOC, 2012).

1.3.1 Mobile Platforms: Research Vessels

There exists an urgent demand for real-time or near-real-time data collection of oceanographic variables on the surface of and within Earth’s oceans (SOST, 2013). The COISUSOR concludes, “the most essential infrastructure component will continue to be the ability of scientists to go to sea aboard research vessels. Ships form the backbone for all ocean observations” (COISUSOR, 2011). There exists no remote sensing technology that could possibly substitute the abilities and observational capacity of scientists (Gaskill, 2011). Chris German, a senior scientist at Woods Hole Oceanographic Institute (WHOI) explains the difficulties in ocean observation and why remote sensing must be supplemented by science at sea. “Progress is not limited by scientists’ and engineers’ imaginations, but rather by the rate and cost of development of

technologies suitable to pursue the cause. Advances in satellite technology provide us with a global coverage in the study of Earth's atmosphere, but in the case of the ocean, that approach quite literally only grazes the surface" (German, 2013). Academic research fleets provide scientists with access to the ocean's surface, water column and depths and are widely recognized as an indispensable element of ocean research infrastructure (CENORF, 2009).

1.3.2 The US Academic Research Fleet

The University-National Oceanographic Laboratory System (UNOLS) manages the US academic research fleet. The USAF is primarily employed to "satisfy a wide array of academic research requirements" (IWG-IF, 2013). UNOLS was established in 1971 with the goal of uniting research institutions, federal agencies, and state and private interests. Currently, UNOLS is charged with the organization and scheduling of 22 research vessels nationwide (CENORF, 2009). The following federal and state agencies utilize UNOLS to efficiently conduct ocean research at sea.

- The National Science Foundation (NSF)
- Office of Naval Research (ONR)
- National Oceanic and Atmospheric Organization (NOAA)
- US Geological Survey (USGS)
- Environmental Protection Agency (EPA)
- National Aeronautics and Space Administration (NASA)
- US Army Corps of Engineers (USACE)
- Department of Energy (DOE)

Appendix B describes the current UNOLS fleet, which consist of 6 Global Class vessels, 1 Ocean Class vessel, 5 Intermediate Class vessels, 3 Regional Class vessels, 4 Regional/Coastal Class vessels, and 3 Local Class vessels. The Navy owns 6 ships, NSF owns 7 and the remainders are owned by various universities and research institutions (CENORF, 2009). Unfortunately, rising operational and maintenance costs within the UNOLS Fleet drastically affect the number of available ship days for researchers (See Figure 3).

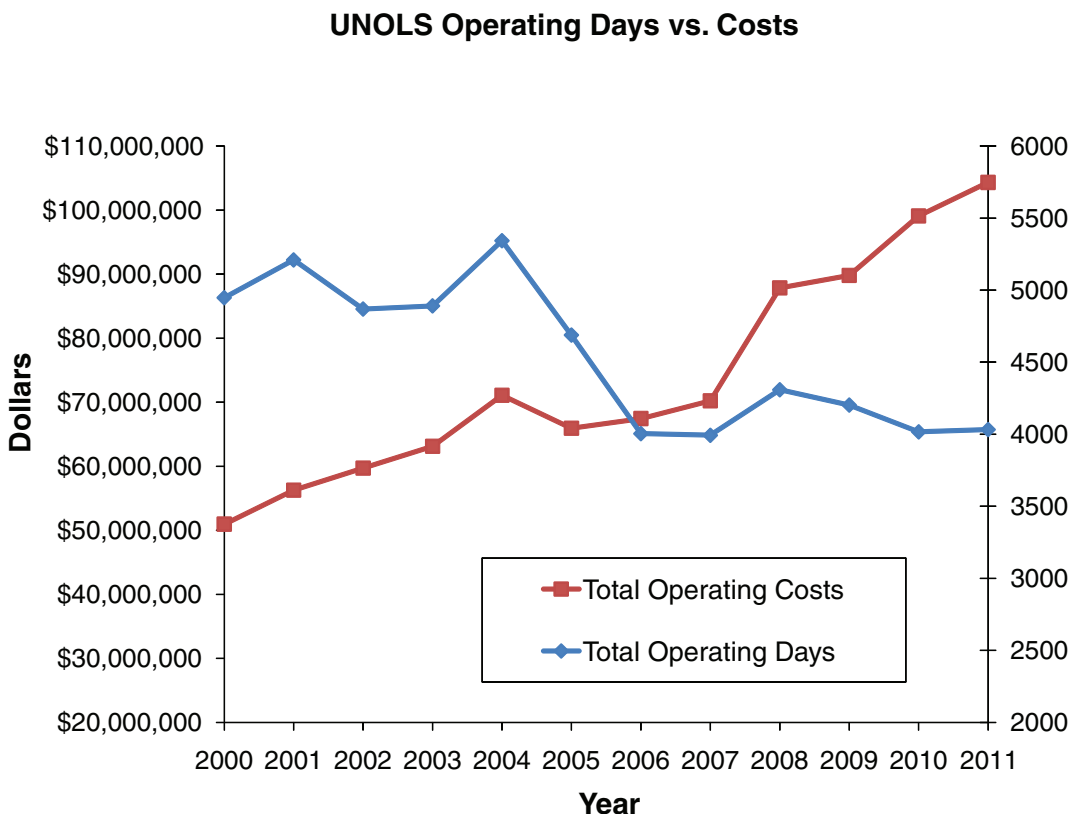


Figure 3: Rising total operating costs and associated decline in total operating days for the UNOLS Fleet (CENORF, 2009).

1.3.3. Federal Oceanographic Fleet

In the *Federal Oceanographic Fleet Status Report* (FOFSR), the Interagency Working Group on Facilities (IWG-Facilities) presents the status of the US oceanographic fleet (See Appendix B). Ships in the USOF are "responsible for meeting statutory survey requirements" (IWG-IF, 2013). Ships greater than 40-meters in length that are either owned and operated by the government or operated by UNOLS are evaluated to identify infrastructure capabilities and weaknesses (IWG-Facilities, 2007). Ship owners and operators include NSF, ONR, the Naval Oceanographic Office (NAVOCEANO), NOAA, United States Coast Guard (USCG) and the EPA. *The Federal Oceanographic Fleet Status Report* defines capacity as "the ability of the Fleet to support federally funded projects in a timely and cost-effective manner." Total operating budget, total number of ships in the Fleet, ship size/design/range/endurance, number of science berths, the ships' mission configuration and the Fleet's distribution all directly impact overall Fleet capacity. In turn, Fleet capacity determines the number of operating days available, size of research team, cruise lengths and study sites. The study concludes that fleet capacity, lightly put, "has the potential to improve in certain areas" (IWG-Facilities, 2007). Relentlessly rising operational and maintenance costs of the Fleet cripple the federal agencies that desperately require research platforms at sea (See Figure 4).

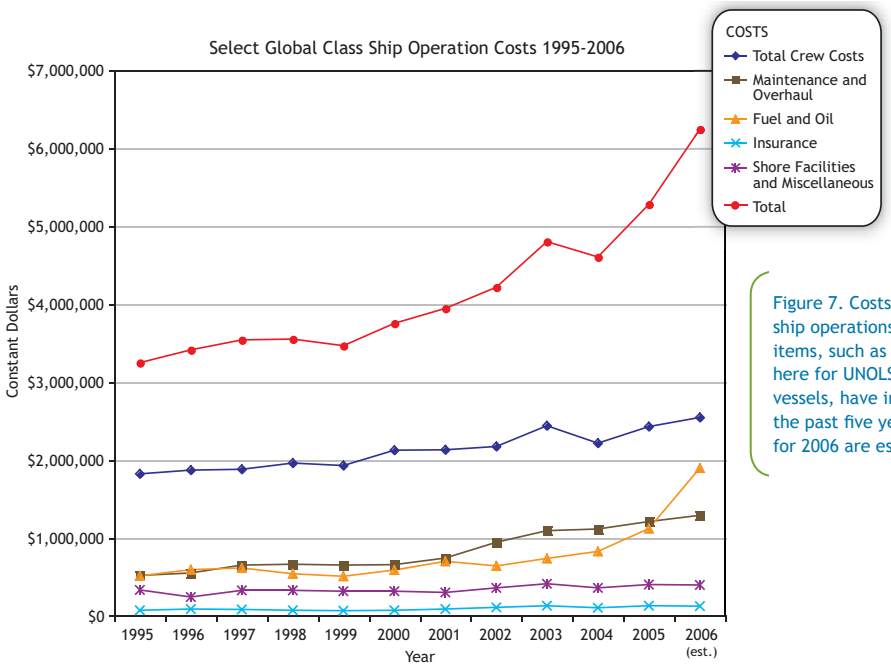


Figure 7. Costs of several ship operations-related items, such as those shown here for UNOLS Global Class vessels, have increased over the past five years. (Costs for 2006 are estimates.)

Figure 4: Rising costs of select Global Class Vessels within the UNOF (IWG-Facilities, 2007).

1.3.4 Current and Future Infrastructure Needs

Critical Infrastructure for Ocean Research and Societal Needs in 2030 predicts that by 2025 as much as 40% of available US research ships available to the academic fleet will disappear due to retirement and lack of funding for new vessels (See Figure 5) (COISUSOR, 2011). Demand for access to the oceans is only predicted to increase. According to Marcia McNutt of the USGS, “America’s fleet of research ships is struggling in financial doldrums, threatening marine projects around the globe. The number of vessels is shrinking, funding for new vessels is being sidetracked and the forecast is for even fewer ships and higher costs. Already, the annual number of days at sea has been cut by 20%. When

the cost of equipment is driving the agenda – that is a death knell for a field. You end up doing what research you can do, instead of what research you should do" ("The Research Ship Challenge," 2012) An in depth look into the funding and budget trends of NOAA and NSF, the federal agencies owning and operating the majority of research vessels available to the academic community, explains why needs are not being met.

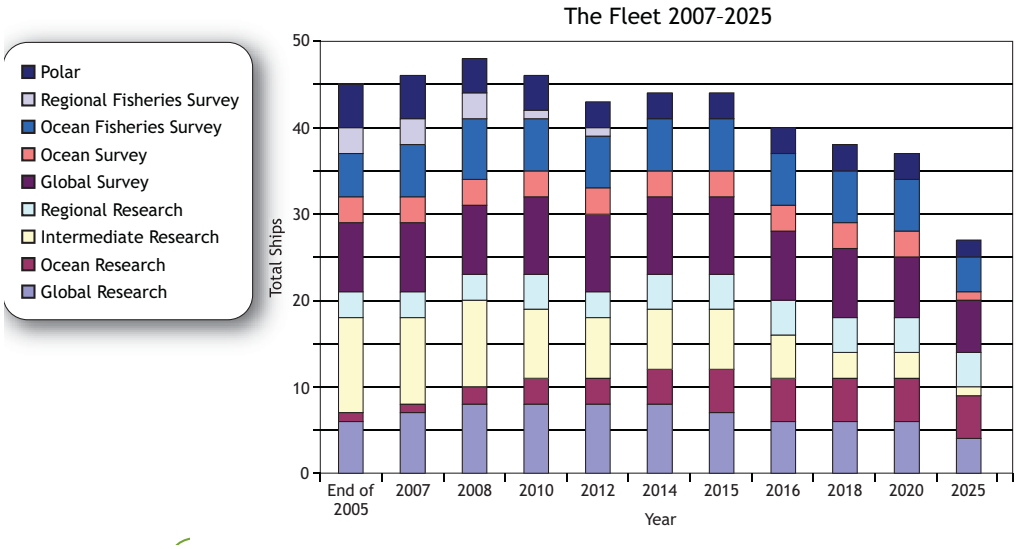


Figure 5: Declining Fleet capacity within the USOF (IWG –Facilities, 2007).

The NSF was formed by congress in 1950 as an independent federal agency dedicated to "promote the progress of science; to advance the national health, prosperity, and welfare; and to secure the national defense." In FY 2012, NSF was appropriated $7.0 billion and accounted for approximately 20% of the federal backing for research conducted in universities and institutions. The NSF Division of Ocean Sciences' (OCE) mission is to "support research, infrastructure, and education to advance understanding of all aspects of the

global oceans and ocean basins, including their interactions with people and the integrated Earth system" (NSF, 2013). In 2012, NSF OCE's budget exceeded $350 million US Funding for OCE has remained relatively steady over the past decade, despite increased demand for scientific inquiry. One goal outlined in this FY 2014 budget request is the development and evaluation of plans for potential new Regional Class Vessels. OCE's Academic Research Fleet cost $78.75 million US to operate in 2012, while OCE's International Ocean Discovery Program cost $44 million US Only 30% of OCE's available grants are available for new applicants and research projects. The remaining 70% are awarded to fund continuing grants. The NSF expects the costs of the Academic Research Fleet to continue to increase based on global trends in the price of fuel (NSF, 2013).

NOAA has requested $5.1 billion US for fiscal year 2013, an increase of $153.9 million US (NOAA, 2013) The US Federal Government allocated $17 billion US to NASA in 2011, suggesting that space exploration research may in fact be more significant priority Earth's Oceans. Principal goals of NOAA include:

1. Provide immediate life-saving and job-supporting services needed to prepare and protect American communities and infrastructure and
2. Invest in science and research that will enhance America's competitiveness (Lubchenco, 2013)

Methods to achieve the above goals include in the maintenance and installation of satellites, the stewardship of healthy oceans and coasts, development of a functional preparation and response system to weather related events (NOAA, 2013). Every aspect of NOAA's mission fundamentally depend on the following

1. A holistic understanding of the earth system through research
2. Accurate, reliable data from integrated earth observations
3. An integrated environmental modeling system (NOAA. 2013)

This is accomplished primarily through NOAA's research fleet. "NOAA's fleet, both air and sea, are crucial to providing the scientific platforms for key observations and maintenance for observing systems" (NOAA, 2013). NOAA's fleets are managed within the Office of Marine and Aviation Operators (OMAO). According to NOAA, OMAO's fleet of federal research ships is the largest in the world (NOAA, 2013). NOAA Has 16 active ships ranging from 124-274 feet. (OMAO, 2013) At FY 2013 funding, OMAO can provide as may as 2,586 days at sea "to support NOAA's highest priority programs." A mission day is defined as when ship is at sea incident to the scientific mission.

Most research grants awarded by NOAA and NSF are funded on a competitive basis and typically address well-defined study sites in order to expand understanding of a particular facet of marine science and oceanography. Unfortunately, this method of funding is not compatible with proposals without discrete hypotheses such as those concerning the discovery of new species, resources, habitats and processes (CES & NRC, 2003). The President's Panel on Ocean Exploration in 2000 advised that the US should dedicate $75 million each year to appropriately fund ocean exploration efforts (CES & NRC, 2003). Unfortunately, NOAA's Office of Ocean Exploration and Research (OER) only receives an average or $20 million annually (OER, 2012). OER is the sole federal program committed to the exploration of Earth's largely unknown ocean. OER operates the NOAA Ship *Okeanos Explorer.*

Finally, program terminations for FY 2013 include several grants, which facilitated research at sea (Regional Geospatial Modeling Grant, the John H. Prescott Marine Mammal Rescue Assistance Grant Program, the National Sea Grant Program Aquatic Invasive Species Grants, Geographic Literacy Grants and Competitive Education Grants) for a total reduction of $14.8 million US (NOAA, 2013).

1.4 The International SeaKeepers Society

Academia and the government have increasingly used ships of opportunity over the past decade to compensate for limitations of federal fleets and lack of funding for ship days. NPOs and other private sector organizations fund basic and applied research endeavors, and have the potential to provide mobile research platforms (COISUSOR, 2011). In order to maintain US ocean science research, a diversity of funding sources from a variety of sectors must be considered. Private-sector participation and partnerships are needed to develop and sustain ocean research infrastructure and "provide an important check and counterweight to public agencies and the political appointees who lead them, while also making up much of the shortfall in conservation spending by state and federal governments" (Armsworth et al., 2012).

The author interned for 6 months prior to being hired as Director of Programs and Policies for SeaKeepers on the condition of developing, testing and enhancing a program that places research scientists on board member

yachts. SeaKeepers is a 501(c)(3) NPO based in Coral Gables, Florida. SeaKeepers was founded in 1998 by a small group of innovative yacht owners with the goal of developing a feasible, cost-effective technology for long-term observations of the global ocean water column for installation aboard yachts. The resulting technology, the SeaKeeper 1000 Underway Sampling System, enabled vessels to observe and transmit atmospheric, oceanographic and locational parameters (See Appendix C). To date, the SeaKeeper 1000 that was installed on 91 yachts, ferries, cruise-lines and piers allowed the vessels to repeatedly monitor oceanic and atmospheric conditions while underway. The parameters listed in Appendix C were relayed via satellite to NOAA and NWS. Jim Gilbert, co-founder of SeaKeepers elaborates, “These yachts often sail in waters not usually visited by research vessels. Their data contributes baseline information on ocean chemistry and pH, which are vital to monitor when tackling key problems – such as the decline in fish populations and coral reef and marine ecosystem deterioration – that are jeopardizing our seas” (Pounder, 2010). SeaKeepers Founding Member designation specifies a minimum one-time donation of $50,000. Influential Founding Members include Paul Allen, Ted Waitt, HRH Prince Khaled bin Sultan, Roy Disney etc.

In an attempt to reverse the concept that the yachting community is solely characterized by over-consumption and excess waste, SeaKeepers introduced a program in 2012 that promotes and encourages yacht owners to take advantage of their unique status for science. Originally named The Scientific Vessel of Opportunity Program, Scientific Discovery Yachts (SDY) unites science and the

broader yachting community by placing deserving individuals on board participating vessels. Although research aboard yachts is certainly not a novel notion, SeaKeepers is the first NPO to formally introduce a program and framework, which due to the organization's affluent membership has the unique advantage of obtaining time on yachts at little to no cost. Demand for luxury yachts capable of conducting research has increased over the past decade, as more and more yacht owners search for something more meaningful than the typical self-indulgent toy or getaway. Since its inception, SDY has attracted significant media attention and piqued the interest of several influential owners who have committed to allowing scientists on board for a duration of time periodically.

CHAPTER TWO

GOALS AND OBJECTIVES

This project examined the employment of privately owned vessels, namely yachts, in ocean research and exploration. Specifically, research focused on the history, evolution and current state of so-called vessels of opportunity. To preface such trends, a secondary objective included the analysis of the shortcomings of USAF and USOF along with the funding and budgetary restraints of federal agencies such as NOAA and EPA. The demand for mobile platforms available to the marine science community is undermined by rising maintenance, crew and fuel costs that cripple research opportunities along with knowledge gaps they aim to inform. Thus, the principal goal of this research was to design a programmatic framework that enables users to best identify and utilize privately owned vessels for research purposes.

Secondary objectives included the examination of existing programs using privately owned vessels for ocean research and exploration in some capacity. This objective in particular aimed to provide starting point from which to begin designing and implementing SeaKeepers own programmatic framework. Reviews of scientific research facilitated by private vessels was conducted to identify trends in research aboard yachts and place the researcher that would benefit most on board in order to expand research opportunities for scientists in need of research platforms. Because of the inherent distinctions between

privately owned vessels and oceanic research vessels, this review aimed to identify research priorities most suited for implementation aboard participating yachts.

While developing the SDY Program, research objectives included the identification of privately owned vessels with a high potential for involvement in ocean research and exploration in conjunction with a general evaluation of the boating and yachting industries. Such a review enables targeted outreach to vessel owners, captains and crew, which aims to continuously expand the number of participating yachts. Concurrently, the promotion of opportunities available through SDY enables the yachting community to take complete advantage of its unique position to enhance marine sciences and ocean conservation efforts. Finally, an additional objective aimed to engage several vessel owners and execute successful pilot SDY expeditions to provide proof that such an NPO managed program is not only beneficial to the ocean research community, but also to yacht owners themselves. Furthermore, a pilot study would provide valuable feedback necessary to develop a SDY protocol of operations intended to streamline communication strategies among various parties.

The complete development and launch of SDY as an operational SeaKeepers program, which aims to be up and running by early 2014, intended to integrate privately owned vessels into the available research fleet, while taking into consideration the limitations of nontraditional mobile research platforms and maximizing research goals. After designing and implementing SDY, future goals

and objectives could include the development of an assessment of the effectiveness of research conducted and the future patterns of vessel involvement. This study can pave the way for supplementary research into the philanthropic side of the yachting community, and how best to target and enable these unique stakeholders to give back to the oceans. The design of an online user-friendly interface through the SeaKeepers website depicting philanthropic vessels and detailing past, present and future research endeavors is an additional future objective. Such an interface could incorporate an interactive real-time online map depicting location and activities of participating vessels and could possibly include a social media aspect by developing pages for each yacht involved in research to maximize exposure to the general public.

CHAPTER THREE

SIGNIFICANCE AND LIMITATIONS

The expansion of research opportunities is an area of significance because of the state of the world's oceans in light of an ever increasing human population and its associated degenerative impacts on both environmental and human well-being. Although multiple research venues are currently available, they cannot possibly meet goals and demands outlined in domestic, national and international management regimes. As a result, the integration of privately owned vessels into the scientific research fleet is necessary to help meet current needs and increase the fundamental state of knowledge of the dynamic ocean environment on which the world depends.

The research is significant in its goals to explore the use and availability of privately owned vessels in marine sciences and exploration. Privately owned ships such as yachts represent particularly attractive research vessels because of their tendency to frequent remote and ecologically rich locations not regularly trafficked in commercial shipping. Additionally, research and exploration aboard yachts would not be limited by specific experimental methods and would not require a definitive study area or hypothesis, thus expanding the potential for significant scientific discovery and general explorative looks. This research will demonstrate that owners of privately owned vessels are interested, available and willing to participate in global research efforts and will highlight the need for an

encompassing organizational program to organize and promote various research opportunities aboard such vessels.

Specifically to SeaKeepers, it is of great importance to promote philanthropic yachting in order to improve the general image of the yachting community itself. Generally perceived as an indulgent and wasteful industry, this research aims to highlight positive efforts and encourage similar behavior in other owners. Similarly, the placement of scientists aboard such atypical research vessels undoubtedly grabs the general public's attention, which is more likely to educate and raise awareness about critical ocean issues than the typical laboratory and white-coated researcher, a facet of particular significance to global conservation efforts.

Research limitations include the inherent nature of the yachting community and the difficulty to assess the program as a whole; SDY will not be fully functional for several months following the current study and will continuously adapt with each additional research expedition. Additionally, the yachting community is extremely diverse, consisting of owners of vessels of all sizes and designs. For this reason, program design and execution is limited by types of vessels and crews participating. Additionally, future program implementation and maintenance is intrinsically dependent on employed staff at SeaKeepers and its success in promoting research endeavors amongst members and future members of the NPO.

This specific research was primarily limited to available information of privately owned vessels based on information accessible online and those available from SeaKeepers. Privacy preferences of the yachting community often limit the amount of available information about research conducted, location, and owner identity. Few yacht owners relish divulging personal information, even when involved in philanthropic research efforts. SeaKeepers, however, generally bypassed this limitation because its network of member yachts and yacht owners has already been established. However, much of the information available to SeaKeepers, such as yacht owner identity and contact information is designated for use by the NPO alone, and could not be outlined due to privacy issues.

If the SDY Program proves to be a success, which is dependent on its implementation and maintenance after the conclusion of the current research, there will continue to be limitations to the feasibility of research aboard yachts on a case-by-case basis. A significant amount of courting and investment in a working relationship with the yacht owner, captain and crew is required to execute a successful research mission on a privately owned vessel. Finally, because involvement in SeaKeepers and the SDY Program is voluntary and dependent on the number of philanthropic owners willing to donate time, fuel and expertise to enhance marine sciences and research efforts; this means that all success still rests within the whims of owners and their commitment or lack of commitment to project goals.

The scope of the study is limited by the author's internship and employment at SeaKeepers. SeaKeepers' membership and focus tends to be high net worth individuals who either own a yacht or are involved heavily in associated yachting industries. Luxury motor yachts conducting research, in lieu of small sailing or fishing vessels, will be highlighted to maintain the interest and mission of SeaKeepers.

CHAPTER FOUR

METHODS

The research took place predominately at the International SeaKeepers Society US headquarters located at 355 Alhambra Circle, Suite #1100, Coral Gables FL, 33134. Research was also progressed at various boat shows including the Fort Lauderdale International Boat Show, the Miami Yacht and Brokerage Show and the West Palm Beach International Boat Show. Additional information was gathered at integral SeaKeepers fundraising events such as the 2013 Bal de la Mer, hosted in San Francisco during the 2013 America's Cup, and the Founders Dinner in October 2012. Research included the utilization of online and hardcopy resources from which to base program framework and gather information regarding yacht owners, yachts and private entities currently involved in ocean research efforts. To enhance available content found online, organizations and entities involved in research were often contacted and asked to voluntarily supply information via personal communication with the author.

4.1 Analysis of Yachting and Boating Communities

Printed and online materials were utilized to gain an overall view of the status of the yachting and boating communities in the US and internationally. The USCG releases annual National Boating Surveys, which provide detailed

information on number and types of boats used in the US, how they are used, how much they are used as well as boater demographics. Estimates of the overall economic significance and impact of recreational boating on the US economy were studied to evaluate the feasibility of employing privately owned vessels to facilitate research. Published studies on the state of the super-yacht industry provided insight into the status of the yachting community as a whole. Reports researched included *Economic Analysis of the SuperYacht Industry* by SuperYacht Intelligence; the *2012 SuperYacht Market Report* by Boat International; and *the 5th Edition Super Yachting Index* published by Camper & Nicholsons International. (Please note that SuperYacht Intelligence defines the term "super-yacht" as a vessel longer than 98 feet (30 meters) while other sources use different lengths. The usage of this term is not standardized in the industry.)

4.2 Analysis of Existing Programs Utilizing Privately Owned Vessels as Research Platforms

Online resources such as NPO websites, news outlets and blogs were investigated in conjunction with personal correspondence with many of the programs reviewed. Seven programs and privately owned vessels were summarized based on available information and critiqued based on performance and overall impact on scientific research and/or discovery. Of particular interest

to this research were the study areas, vessel types, organization structure, history of involvement and key figures.

4.3 Design and Development of SeaKeepers Discovery Yachts Program

The author was employed part-time in January 2012 and full-time since May 2012 as Director of Programs and Policies for SeaKeepers and charged with the maintenance of existing programmatic activities as well as the full development and implementation of the SDY Program. Meetings and personal communications with SeaKeepers Scientific Advisory Council (SAC), Board of Directors and staff aimed to pinpoint objectives, goals and strategies to bring SDY into fruition. Correspondence with SeaKeeper Founding Members and interested yacht owners as well as members of the scientific community provided insight on ways to maximize stakeholder benefit and encourage participation. This also included community outreach efforts at various conferences, boat shows, universities and research institutions to promote SeaKeepers and SDY and to gather additional participants. Specifically, a protocol was developed to streamline SDY operations which incorporated insight from the state of the yachting and boating communities, existing programs and private vessel involvement in ocean research efforts and the pilot studies that provided proof of concept.

4.3.1 Pilot Studies Providing Proof of Concept

A pilot study providing proof of concept was conducted in May 2012 aboard a participating yacht, the MY *Miss Phebe*. The pilot study intended to confirm that a NPO managed program could facilitate marine scientific research on a privately owned vessel and highlighted difficulties and/or failures within the program structure. Daily communication with the yacht owner, captain and participating scientists occurred over several months to plan and overcome logistical challenges, such as liability insurance coverage, crew availability, and diving equipment. The actual scientific mission was conducted over one week in the Dry Tortugas, marking the inaugural Discovery Yachts Mission, and included nearly constant involvement in all daily activities aboard the Miss *Phebe*. The author was present throughout the mission as the official SeaKeepers liaison, a figure that proved to be integral in the management and communication of the expectations of yacht owner, captain, crew and researchers.

RV *Pegaso* and MY *Defiance* are two ongoing Discovery Yachts working with SeaKeepers. A site visit in Panama City, Republic of Panama, was conducted in April 2013 to evaluable the feasibility of research aboard a potential mega-yacht participant in SDY. *Pegaso* joined the SDY fleet in November 2012. After months of planning, *Pegaso* docked in Fort Lauderdale, Florida and hosted a team of scientists and project managers to discuss future research collaborations. In May 2013, *Pegaso's* owners expressed their intention to install a variety of genome sequencing equipment for a pilot study to verify the functionality of a remote genome-sequencing laboratory. Long-term goals

include circumnavigating the world for 6 to 12 months to collect samples for sequencing. According to Dr. Leonid Moroz, the principal investigator considered for placement on *Pegaso*, “one trip around the world with a fully functional modern genome laboratory on board would more than quadruple our knowledge of the ocean” (Moroz, 2013). In depth tours and meetings with the captain and crew were essential to communicating research needs and expectations. Correspondence, meetings and press interviews engaged the owner of MY *Defiance*, and SeaKeepers aims to undertake her inaugural missions over two weekends in December, 2013.

4.3.2 Design and Launch of Online Interface

An online interface via the SeaKeepers website was intended to be designed and launched if time and resources were permitting, in order to best communicate and distribute information about individual Discovery Yachts to the general public. Such an interactive online interface aimed to map the history, involvement and goals of each yacht participating in SDY. Additionally, the integration of participating yachts into social media outlets such as FaceBook and Twitter will expand public outreach and knowledge of marine research via yachts.

CHAPTER FIVE

RESULTS

The UNOLS and the USOF fleet cannot possibly meet goals and demands outlined in domestic, national and international management regimes. As a result, the integration of privately owned vessels into the scientific research fleet is necessary to help meet current needs and increase the fundamental state of knowledge of the dynamic ocean environment on which the world depends. In fact, private sector involvement proved to be beneficial to both the ocean research community and the yachting community itself. This research demonstrated that owners of privately owned vessels are interested, available and willing to participate in research efforts and stimulated the development of an encompassing programmatic framework to facilitate research opportunities aboard such vessels.

5.1 Analysis of Yachting and Boating Communities' Potential to Expand Ocean Research Efforts

The 2011 National Recreational Boating Survey released by the USCG concludes that 17% of US households owned approximately 22.2 million boats, 51% of which were powerboats (*National Recreational Boating Survey, USCG,* 2011). In other words roughly 10,119,000 powerboats are present in the US

Almost a quarter of the US population participated in recreational boating on the water in 2011 in the US. Only 0.5% of recreational boats in the US are 40 feet or more. Studies confirm that the overall proportion of boats used has remained relatively constant over the past 20 years. Surprisingly, the average boat was only used for 17 days on average in 2011. The 2012 National Recreational Boating Survey adds that of the registered boats in the US that are mechanically propelled, 68,986 are between 40 and 65 feet while 10,414 are over 65 feet (USCG, 2012).

Typically, mega-yachts are greater than 130 feet (40 meters) in length ("Hard Times in the Mega Yacht Market," 2012). Camper & Nicholsons; however, defines the super-yacht market as those over 80 feet (24 meters), while the SuperYacht Intelligence Agency defines super-yachts as vessels over 98 feet (30 meters). Such discrepancies in definition make cross comparisons and analysis nearly impossible, so each study's respective standards will be restated below.

According to the SuperYacht Intelligence Agency's *Economic Analysis of the SuperYacht Industry*, yachts over 98 feet (30 meters) contributed $38 billion (24 billion pounds) to the economy in 2010. 6,000 companies comprise the general super-yacht industry and created $9.33 billion (5.99 billion pounds) in job worth in 2010 (SuperYacht Intelligence Agency, 2012).

Figure 6 represents the growth of the super-yacht industry from 1985 to 2010.

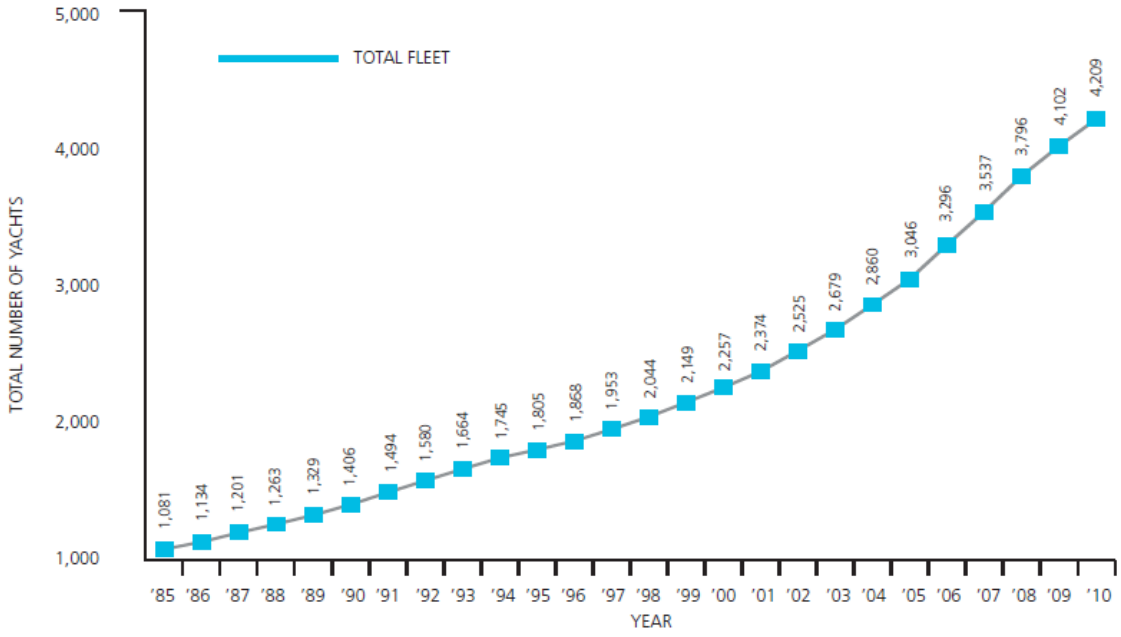


Figure 6: The growth of the super-yacht industry from 1985 to 2010 (SuperYacht Intelligence Agency, 2012).

The super-yacht fleet, as defined by Camper & Nicholsons, consists of roughly 6,290 vessels. Table 6 depicts the distribution of super-yachts by size. 2,840 or 45% of super-yachts are less than seven years of age; a sharp distinction to the aging, outdated fleet supervised by US Federal Agencies. In fact, on average 318 yachts were built annually over the past since the year 2000. The *SuperYacht Index* concludes that indeed the fleet is getting younger every year. Concurrently, the SuperYacht Intelligence Agency assures that the future of the fleet is a bright one; the number of yachts built each year far outweighs the number of yachts leaving the fleet.

Table 6: Distribution of Super-yachts by Size According to Camper & Nicholson's 5th Edition SuperYacht Index

	24-30 m	30-40 m	40-50 m	50 m +	All Sizes
Motor Yachts	2,127	1,867	654	490	5,138
Sailing Yachts	590	362	129	71	1,152
Total	2,717	2,229	783	561	6,290

Of the 6,290 super-yachts on the water, approximately 2,000 or 20% of the fleet were available for sale. The market value of this brokerage fleet exceeds $16.8 billion. Additionally, super-yachts are typically available for charter for 30 weeks a year; however, they are rarely booked to capacity. This accounts for a total of 30,420 weeks available for charter whereas only 2,250 were actually sold, meaning that nearly 93% of the time yachts available for charter are sitting idle. Super-yachts are typically manned by a full-time crew year round, regardless of days at sea (Camper & Nicholsons, 2013). Figure 7 sheds more light on the differences of average monthly expenditures for running costs when a yacht is in use and not in use. The differences are generally small, indicating that these vessels could easily be utilized for research purposes when not chartered at little additional cost to the owner.

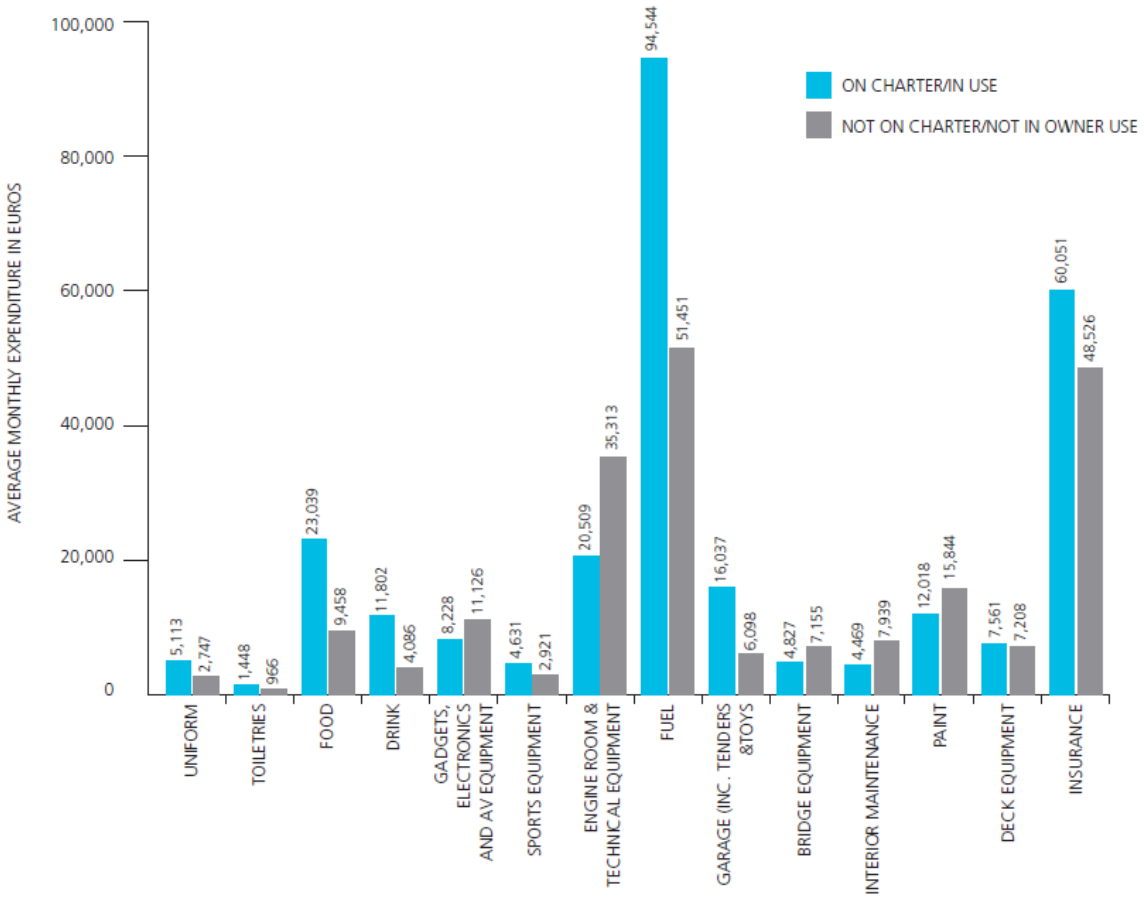


Figure 7: Differences in average monthly expenditure spent on running costs in Euros when the yacht is in use and not in use (SuperYacht Intelligence Agency, 2012).

The 2008 global financial crisis drastically impacted the super-yacht industry. Figure 8 depicts super-yacht deliveries from 2007-2012 (Camper & Nicholsons, 2013). A record breaking 261 super-yachts were built in 2008 accounting for a total length of 35,459 feet (10,808 meters). Since 2007, the total number of yachts available for sale increased 92% from 1,000 to 2,000. Also revealing are the trends in average value of a super-yacht based on size. Table 7 tracks the average value per unit from 2007 to 2012 highlights the overall decline in value as a result of the 2008 crisis.

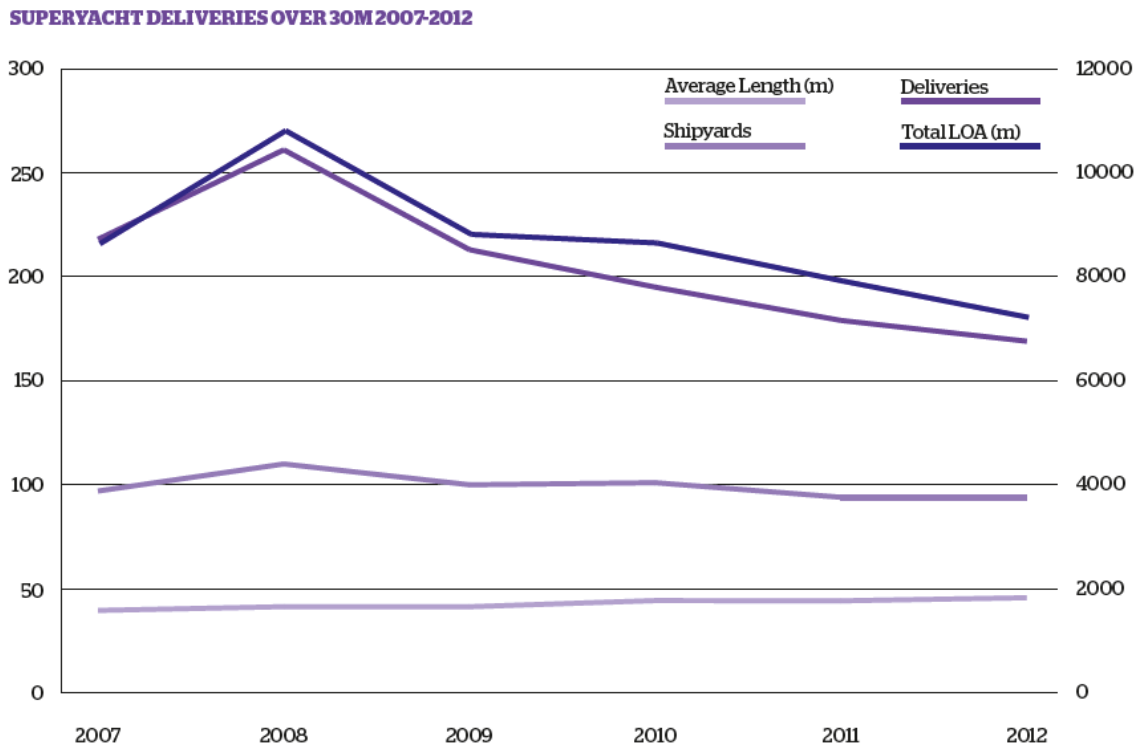


Figure 8: Trends in Total Yachts Built Per Year and Total Length as a result of the 2008 financial crisis in millions (Camper & Nicholsons, 2013).

Table 7: Average Value of Yacht Over Time (Camper & Nicholsons, 2013)

	24-30m	30-40m	40-50m	50m+
2007	4.2	9.1	25.1	43.6
2008	3	8	21	50
2009	2.7	6.9	21.6	51
2010	3.2	6.9	18.2	46
2011	N/A	N/A	N/A	N/A
2012	3	6.2	15.4	38

In 2012, the owners of new super-yachts hailed from the US, Russia, Turkey, Italy, the United Kingdom, the United Arab Emirates, Hong Kong, China, Brazil and Germany (Camper & Nicholsons, 2013). The largest yachts in the world are primarily owned by citizens of the United Arab Emirates, 199 feet (61 meters) on average, and Russia 190 feet (58 meters).

Of importance to NPOs such as SeaKeepers interested in operating programs which use privately owned vessels to benefit the ocean research community is the identification of vessels which are most suited to perform research studies. Mechanically propelled vessels over 40 feet are most suited for involvement in SDY; however, smaller vessels, such as tenders, flats boats and skiffs, are indispensible in their own way. For example, researchers may reside on a large yacht for the duration of the trip, but the smaller vessels mentioned above operate as support vessels used for scuba diving, sensor deployment, fish or marine mammal tagging etc. Fortunately, owners of vessels greater than 40 feet in length tend to own small support vessels used to navigate shallow waterways and provide an additional, often faster, mode of transportation. Vessels and owners with a history of involvement with NPOs and/or ocean sciences are most likely to participate in programs such as SDY in the future. Additionally, vessels registered in the US could potentially benefit from significant tax write off opportunities as the participation of the vessel in research missions would account for an in kind donation. Of particular importance to SeaKeepers is the proximity of vessels to the organization's headquarters in Florida. Vessels frequenting Florida waters are more likely to be familiar with SeaKeepers or learn about SDY in the future. Additionally, and until SDY expands to other states, close proximity of vessels and study areas to headquarters facilitates streamlined communication and expedition organization while minimizing various secondary costs like airfare.

5.2 Analysis of Existing Programs Utilizing Privately Owned Vessels as Research Platforms

The following are examples of how private vessels have been used to promote scientific investigation.

Tara Expeditions is an NPO based in France that facilitates ocean and climate change research aboard their 118 foot (36 meter) schooner, Tara. Founded by Agnés B. and Etienne Bourgois, Tara Expeditions undertakes yearly expeditions primarily in the far north to document ice-pack characteristics, study marine plankton populations and observe accumulations of plastic particles and pollutants. Tara Foundation for Marine Research was founded in 2010 as the US counterpart to Tara Expeditions. The 2013 Tara Oceans Polar Circle Expedition uses unique oceanographic, optical and genomic sampling methods aimed to acquire data "of the highest quality," however, no onboard experiments will take place. The schooner, *Tara*, was previously owned by Sir Peter Blake, the famed yachtsman who led New Zealand to multiple victories in America's Cup. In 2001, Blake and his crew were murdered aboard *Seamaster* while on a scientific expedition in Brazil; however, the yacht, now *Tara*, continued to be used for science to honor his legacy.

The Living Oceans Foundation (LOF) is "dedicated to conservation and restoration of living oceans and pledges to champion their preservation through research, education and a commitment to Science Without Borders." His Royal Highness Prince Khaled bin Sultan of the Kingdom of Saudi Arabia founded the

LOF after hosting a multitude of oceanographers on MY *Golden Shadow* in 1998 to study the impacts of El Niño on coral reef health. The *Golden Shadow* is a 220 foot (67 meter) shadow vessel equipped with a Cessna Amphibious Airplane and a two person recompression chamber. Research proposals are evaluated by the following criteria as stated in LOF's Anthology:

- Is the project critical and unique?
- Does the project have the potential to yield significant value
- Does the project have a wide application?
- Will the project produce a procedure, diagnostic test, management tool, or other tangible application?

Expeditions began in 2001, primarily to study coral reefs, sea grasses and other shallow marine environments in sites all over the world. LOF "contributes invaluable logistical support to marine research by providing access to a highly capable research ship and embarked seaplane." Dozens of peer-reviewed articles have been published as a result of research facilitated by LOF aboard *Golden Shadow*.

Pangaea Explorations is a commercial venture that operates the 72 foot (22 meter) sailing vessel, *Sea Dragon*, built for long-distance, remote expedition style sailing. Pangaea's mission is two-fold:

1. To actively strengthen the health of marine life through exploration, conservation and education work
2. To inspire and develop a new generation of leaders in conservation science, communication, education, art and policy leadership (http://panexplore.com/)

Pangaea Exploration is unique in that the program offers interested lay people the opportunity to join the scientific expeditions at an affordable cost. In fact, the revenue generated from this citizen involvement funds the majority of Pangaea's operations. Pangaea reviews organized research proposals and provides a cost-effective platform for up to twelve scientists. Research primarily focuses on plastic accumulation in the high seas.

National Geographic partnered with Lindblad Expeditions in 2004 to "provide extraordinary small-ship voyages to some of the world's most remote and fascinating places." The fleet of six expedition ships is equipped with bow cameras, remotely operated vehicles, undersea cameras, hydrophones, microscopes and other exploration technologies. A wide variety of scientific missions are supported including leopard seal studies in Antarctica and killer whale tagging. Additionally, National Geographic offers writers, photographers and film crews the opportunity to attend a voyage and garner inspiration from the sea. Expeditions are funded by paying guests who enjoy amenities such as large cabins, lounges, libraries and various spa services characteristic of the typical cruise. Research projects are generally selected by National Geographic and associated research organizations. This venture does not allow the general public to submit research proposals for placement aboard a ship.

Mission Blue and the Nature Conservancy teamed up in May 2012 to host a week long expedition aboard MY *Sirenuse*, a 126 foot (38 meter) luxury yacht owned by Ann Luskey. Ms. Luskey is an avid conservationist who dedicated the

use of *Sirenuse* as a scientific research platform to various organizations including the National Geographic Society.

The Waitt Institute hosted a team of scientists from RSMAS in February 2012 aboard *Plan B*, the luxury yacht owned by Ted Waitt, founder of Gateway, Inc. The Waitt Institute is dedicated to "accelerating deep-sea exploration, cutting-edge scientific research and sustainable ocean policy." The shark tagging expedition in the Barry Islands of the Bahamas was a collaborative effort of UM RJ Dunlap Marine Conservation Program, The Nature Conservancy Summit Series, and MacGillivray Freeman Films: Ocean World On Ocean. The *Plan B* operated as a mobile research platform as well as logistical support. Utilizing the Waitt Institute research vessel as a home base, researchers caught, examined and tagged sharks for four days.

Alucia is a privately owned 213 feet (65 meter) expedition vessel that was originally built in 1974 as a support ship for the French Navy. In 2011, billionaire Ray Dalio, purchased *Alucia* with the objective of making the ship available to scientists, film crews and philanthropic guests focused on oceanographic and climate research (Neal, 2013). Ray Dalio, the founder of Bridgewater Associates hedge fund, has always had a passion for marine conservation and scientific discovery. *Alucia* was designed to accommodate scientific research, and is outfitted with multitudes of sensors, cranes and even a helipad (Frank, 2013). *Alucia* boasts an amenity unique to all other vessels: she carries three deep-diving manned submersibles on board elevating her to the most sophisticated sub-sea exploration platforms available today. *Alucia* has been involved in a

variety of ocean research and exploration programs including sperm whale tagging, filming great whiles and observations of rare black coral. In January 2013 *Alucia* utilized its manned submarines to obtain the first footage to date of a live giant squid (*Architeuthis*). (Neal, 2013; Frank, 2013). *Alucia's* discoveries were prominently promoted in various media outlets stating: "It's inspiring to hear about a yacht owner using his vessel for science – and education for the rest of us – rather than simply holding sun-deck cocktail parties in St. Barts" (Frank, 2013). Dr. Edith Widder, Richard Dawkins and dozens of other PhDs have spent time on board *Alucia* (Dawkins, 2013).

Table 8 compares the seven private entities introduced above based on 9 parameters.

	Structure	Vessels	Number of Research Trips	Vessel Type	Study Areas	Research Focus	Cost to Scientist	Application Ease	Headquarters
Tara Expeditions	NPO	1	10+	S/Y	Arctic	Misc.	?	?	France
Living Oceans Foundation	NPO	1	10+	Yacht	Global	Coral Reefs	?	Difficult	DC
Pangaea Explorations	Commercial	1	10+	S/Y	Global	Plastic	?	?	Miami
National Geographic	Commercial	6	10+	Cruise	Global	Misc.	$0	Difficult	NYC
Mission Blue	NPO	1	2	Yacht	Caribbean	Misc.	$0	Difficult	DC
Waitt Institute	NPO	1	1	Yacht	Caribbean	Sharks	$0	Difficult	CA
Deep Ocean Quest	Commercial	1	2+	Yacht	Pacific	Misc.	?	?	Australia

5.3 Design and Development of the International SeaKeepers Society Discovery Yachts Program

The election of Michael T. Moore, Esq., as Chairman of the Board in 2008 represented a turning point for SeaKeepers, which set in motion efforts to revamp, revitalize and reorganize the non-profit. A joint meeting of the Board of Directors and the SAC determined in October 2011 to expand SeaKeepers' mission and explore new programmatic activities aside from the SeaKeeper 1000. SDY, originally named the Scientific Vessel of Opportunity Program, was initially designed solely to facilitate scientific research and discovery aboard participating privately owned vessels where SeaKeepers acts as the primary point of contact between the yachting and scientific communities. As time passed, it became apparent that SDY had the potential to expand its reach to include placing a wide range of deserving individuals on participating Discovery Yachts. Appendix B outlines the revised mission, vision and programmatic actions of SDY in detail.

5.3.1 Pilot Studies Providing Proof of Concept

James F. Jacoby, a real estate developer based in Atlanta, generously donated time, fuel, provisions and expertise on board his yacht, the *Miss Phebe*, to mark the first official research trip of SDY. The weeklong research trip was accomplished after months of planning and coordination between SeaKeepers, *Miss Phebe's* captain and crew, and University of Miami's (UM) Rosenstiel

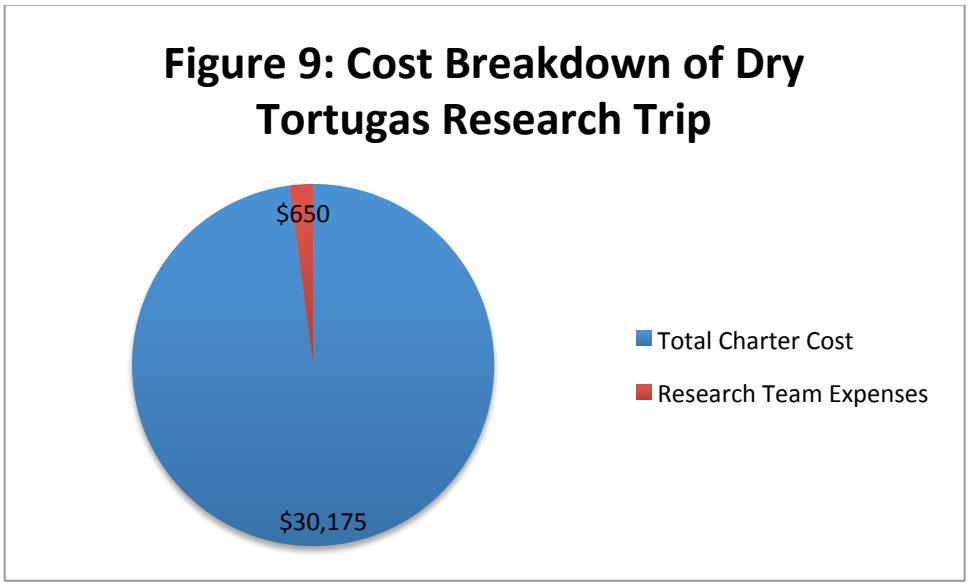
School of Marine and Atmospheric Science (RSMAS). Ultimately, on May 20th, 2012, *Miss Phebe* departed Key West and set course for the Dry Tortugas. Dr. Andrew Baker, Pew Fellow and charismatic coral biologist, headed a team of scientists to obtain coral tissue samples from a multitude of protected dive sites. Xaymara Serrano, a PhD candidate under Dr. Baker, collected nearly 450 samples from two species of corals, Great Star Coral (*Montastrea cavernosa)* and Mustard Hill Coral (*Porites astreoides)*. Her dissertation entitled "Coral Connectivity Between Deep and Shallow Sites in the Tropical Western Atlantic: Deep Water Refugia as Potential Sources of Recruitment Following Disturbance" was completed due to the SDY program and is under consideration by several peer reviewed journals for publication.

Due to the remote location of the Dry Tortugas, which are approximately 70 miles west of Key West, the mission required a vessel from which to dive, and large enough to house the research team for seven days with all diving and sampling equipment. Dr. Baker, Ms. Serrano and Mr. Cunning were loaned scuba tanks from RSMAS for the duration of the research trip. The only costs to the research team involved roundtrip travel from Miami to Key West and sampling equipment, which consisted of plastic bags, buckets, waterproof logbooks, chisels and plastic syringes. The total cost of the research trip is estimated to exceed $30,825, 97.9% of which was donated by the yacht owner via SDY program.

Table 9: Breakdown of costs incurred by yacht owner	**Costs**
***Miss Phebe* 7 Day Charter**	$17,500
***Miss Phebe* Fuel**	$4,000
Provisions	$1,500
Support Personnel	$5,600
Tender Fuel	$1,575
TOTAL	$30,175

Note: The *Miss Phebe* typically charters for $2,500/day, and her Captain's fee is $400/day and the first mate's fee is $200/day.

Table 10: Breakdown of costs incurred by research team	**Costs**
Roundtrip Travel from Miami to Key West	$150
Sampling Equipment	$500
TOTAL	$650



In early 2012, the 74-meter RV *Pegaso* entered the yachting scene with a unique amenity on board: a fully capable scientific dry laboratory, wet laboratory and office area. The "7 star" luxury mega-yacht is available for charter on the condition that a scientist or a team of scientists is permitted to travel along. Alexander Fleming, the chief executive of the yacht's managing company,

Pegaso Marine, explains, “The historic perception of the super-yacht set is the south of France, drinking champagne and having a lovely time, but suddenly people are going: hang on a second, I can go somewhere further afield and be part of something bigger” (McKenzie, 2012). RV *Pegaso’s* owner at the time is an avid scuba diver, underwater photographer and philanthropist who hopes that other yacht owners will follow suit by installing similar laboratories. Unfortunately, *Pegaso* was sold in July 2013 to an undisclosed entity. Despite repeated attempts to engage the vessel’s new owners, *Pegaso’s* future involvement with SDY remains unknown.

MY *Defiance* is SeaKeepers most recent addition to the Discovery Yacht Fleet. Claudia Potamkin, the owner of *Defiance*, and Captain Sandra Yawn, have dedicated use of their 72-foot Mangusta for science and educational outreach and will gladly make their yacht available when it is not scheduled for charter. On Thursday, May 16th 2013, SeaKeepers officially welcomed *Defiance* to the SDY fleet and held a launch party on board in honor of the owners. Significant media attention was received, and several camera crews from various news outlets, including CBS News, interviewed guests and recorded footage of the gathering. The program was so well received that Michelle Gillen, Chief Investigative Reporter for CBS News South Florida, invited Claudia Potamkin and the author to participate in a studio interview to further expand on the implications of private sector vessels conducting research. The interview aired Sunday, May 26th at 10:00 AM and contributed significantly to the public’s awareness of SeaKeepers and SDY.

5.3.2 Design and Launch of Online Interface

Due to limited resources, the online interface on the SeaKeepers website has not yet been designed and launched

5.3.3 Protocol and Operational Framework

The below processes detail the appropriate protocol to follow in the implementation of NPO managed programs such as SDY. Processes ONE and TWO can occur in any order and even simultaneously. The pilot study conducted on *Miss Phebe* actually addressed Process TWO before ONE. Process THREE occurs only after a research project has been successfully matched to a yacht or piqued the interests of an owner. Appendix D contains a visual framework of the pre-trip and post-trip processes.

ONE

Step 1: Outreach to ocean research community at conferences, meetings, presentations at research institutions and universities, email outreach, and SeaKeepers promotional material, media outlets such as Marine Technology Magazines

Step 2: Identification of various research projects in need of a mobile research platform

Step 3: Determination of those most suited for occurrence on board a yacht

- Research projects with the following characteristics are preferred
- ‘Clean’ research
- Minimal to no permanent impact to yacht
- Short term (1 – 7 days)
- Minimal research team size (3-5 people)
- From Florida research institutions or universities
- Close proximity of study site to Florida (Dry Tortugas, Bahamas)

- Affable researchers and/or scientists willing to socialize with yacht owner, captain and crew
- Is access to the water protocol?
- Is the project unique?
- Would the provision of a mobile research vessel be of significant value to the research?
- Will the project produce a dissertation, thesis or publication as a result of the research?

Step 4: Face to face meetings with researchers/scientists

Step 5: Determine appropriate mobile research vessel for targeted outreach

TWO

Step 1: Outreach to yachting and boating communities at yacht and boat shows, conferences, SeaKeepers events, promotional materials, email correspondence

Step 2: Identification of vessels and owners willing to donate time on board for research purposes

Step 3: Determination of vessels most suited to assist in ocean research efforts

- Vessels with the following characteristics are preferred
- Frequent Florida waters
- US Registered (for tax benefits)
- 65 feet or more
- Must sleep at least 7 - 9 (3 crew, 1 SeaKeepers liaison, 3-5 researchers)
- Access to support vessels (tenders)
- At least $1.5 million in liability coverage for primary and support vessels
- Captain and at least 2 supporting crew members

Step 4: Meetings and/or correspondence with yacht owner

Step 5: Site visit to tour vessel

Step 6: Determination of ideal research project to conduct based on yacht capabilities, extent of donation (fuel, captain and crew, location, # of days etc.), and interests of yacht owner. For example, some yacht owners are particularly interested in sharks and will best be suited to assist in shark tagging research trips.

THREE

Step 1: Introduce captain and crew to research team via email, phone or face to face meetings

Step 2: Identify and discuss research needs in detail as defined in an informal memorandum of understanding between all parties involved

Step 3: Identify target dates

Step 4: If additional liability coverage is needed, increase coverage with insurers for participating researchers on primary and support vessels

Step 5: Determine detailed research schedule

Step 6: Weather permitting, begin research expedition as scheduled

Post trip processes include, but are not limited to, the following actions.

- Calculate costs incurred to yacht owner for duration of research expedition and encourage US owners to contact his tax attorney to determine the extent of his tax write off
- Promote expedition in media, promotional materials, email outreach etc.
- Honor Discovery Yacht owner at annual SeaKeepers events

The processes described above were developed based on the current study as of October, 2013 and took into account the trends in the boating and yachting communities, efforts of similar organizations and privately owned vessels, and lessons learned from the pilot studies conducted. It is important to note that each and every yacht as well as each individual research proposal under consideration must be evaluated on a case by case basis under the framework of the above action items. The protocol and processes will need to adapt over time as more research missions are undertaken through SDY to improve functionality.

CHAPTER 6

DISCUSSION

6.1 The Use of Privately Owned Vessels for Research

The state of the boating and yachting industries provides insight into the feasibility of the employment of private vessels for marine research and conservation efforts. Despite the economic crisis in 2007-2009, the yachting and boating industries are powerful economic drivers supplying thousands of jobs. The annual addition of hundreds of yachts to the fleet expands the range of research possibilities each year, while the youth of the existing fleet bolsters overall capacity. In general, the wealth of the super-yacht community, when properly engaged, can dramatically support research and ocean exploration efforts today and long into the future.

Expeditions undertaken by Mission Blue, the National Geographic Society, the Waitt Foundation, Pangaea Explorations and LOF have paved the way for the development of an all-encompassing program dedicated to placing research scientists aboard privately owned vessels, namely yachts. The programs and missions reviewed in this research; however, were limited in the following ways:

- Limited study foci
- Only one vessel
- Unavailability to be accessed by interested parties outside of the organization
- Difficulty in submitting research proposals for consideration

The existing programs facilitating research aboard privately owned vessels provided insight into the functioning of such a program and the overall scope. For example, research criteria evaluated by LOF provided an excellent base for use by SeaKeepers when considering proposals. Due to the fact that several programs focused on a single, limiting area of study, such as coral reefs, SDY was designed to facilitate a wide array of research projects. It goes without saying, however, that projects must have little to no impact on the yacht itself and require minimal assistance from crew members. Additionally, the decision was made to expand SDY's reach to educate and provide artistic inspiration to writers, photographers and videographers based on the missions aboard *Plan B* and Lindblad Expeditions. This community outreach expands the possibilities of work aboard yachts and may catch the attention of philanthropic yacht owners not necessarily passionate about ocean sciences or conservation. Finally, to avoid becoming victims of violence on research expeditions like Sir Peter Blake, for the time being, study areas in close proximity to Florida or US waters are preferred instead of isolated, potentially dangerous areas where yachts could be targeted. As SDY grows with time, the program will expand its study area potential while keeping in mind the safety and wellbeing of the researchers and crew by adopting additional precautionary measures.

SeaKeepers' unique access to yacht owners, brokers and charter companies allowed for the initial formation of SDY, and culminated in one successful pilot study aboard *Miss Phebe* and ongoing commitments involving *Defiance*. The promotion of SDY at conferences, boat shows and SeaKeepers

events garnered the attention of a wide range of yacht owners and scientists who form the very base of the program. Of particular interest to the SeaKeepers is the portrayal of the yachting community in the media. CNBC reports “yachts have also become highly visible signs of conspicuous consumption and the ‘leisure class,’ and many of today’s wealthy want to keep a lower profile” (“Hard Times in the Mega Yacht Market,” 2012). According to one yacht builder, “I think there is a little bit of a taint to owning a yacht, you go to the Med in a giant yacht now and everyone on the shore hates you rather than admires you” (“Hard Times in the Mega Yacht Market,” 2012). The 5th Edition Super Yachting Index confirms the presence of “a new breed of buyers looking to take advantage of the opportunities presented” (Camper & Nicholsons, 2013). Many buyers, such as the previous owner of *Pegaso* aimed to utilize their yacht as more than just a luxury vacation home. In fact, *Boat International* reported that owners building the largest vessels today are actually newcomers to the yachting community, and are actively seeking ways to differentiate themselves (White, 2013). Yachts able to distinguish themselves in the market are characterized by the presence of unique amenities such as manned submersibles, research laboratories or involvement in scientific research efforts like those organized by SDY.

The current research effort concludes that programs such as SDY that use privately owned vessels to facilitate ocean research endeavors are not only beneficial to the scientific community and the yacht owner, but also to the general public. The official pilot study of SDY allowed PhD candidate, Xaymara Serrano, to complete the data collection aspect of her research and defend her

dissertation. Mrs. Serrano is currently awaiting responses from peer reviewed journals for publication. The Pilot Study also proved to benefit the yacht owner, captain and crew. Captain Carl Hampp of the Miss Phebe and James F. Jacoby, the vessel's owner, were both pleased with the results of the mission and the work of the International SeaKeepers Society. Interaction with the scientists proved to be one of the best experiences of the trip. Additionally, yacht owners in the US may receive significant tax write-offs based off their in kind donation of the use of a vessel. It is standard policy for SeaKeepers to encourage US owners to contact their tax attorney to finalize details and determine applicability.

6.2 Limitations and Shortcomings

This scope of this research was primarily limited by the availability of materials available on the worldwide web and the willingness of yacht owners, NPO's and other private entities to voluntarily supply information. The principal shortcoming was the lack of resources and time available to develop an online interactive interface to promote SDY and research aboard privately owned vessels to the general public. Finally, it must be noted that several research outings are scheduled to occur in the near future and were unable to be documented and analyzed here.

CHAPTER 7

CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions of Research Goals and Objectives

Due to rising costs and declining USAF and USOF fleet capacity to support research needs, private sector entities should be utilized to fill the gap by facilitating research inquires. For this reason, this research explored, documented and promoted the utilization of privately owned vessels as mobile research platforms for marine scientists. The examination of existing marine conservation NPOs that fund or orchestrate research missions formed the foundation for the development of an innovative programmatic activity for SeaKeepers. The SDY Program was designed, tested and implemented to provide deserving individuals in need of a research platform with SeaKeepers as the primary point of contact between yacht owners and researchers. The inaugural Discovery Yachts Expedition aboard *Miss Phebe* provided proof of concept and facilitated cutting-edge coral reef genetic research and *Defiance* has committed the use of the vessel for research and educational outreach. A programmatic protocol was established in order to enable SeaKeepers to efficiently connect and ideally provide deserving individuals with the necessary oceanic platform. The framework established steps and methods to target privately owned vessels with a high potential to participate in NPO managed programs such as SDY and match them with ideal research projects most suited

for occurrence aboard a yacht. Extensive outreach into the scientific community raised awareness about the program and expanded potential research opportunities. In summary, private sector vessels are ideal candidates for philanthropic involvement in scientific research endeavors. SDY engages, encourages and promotes yacht owners to play an active role in marine sciences and conservation; an act which proves mutually beneficial to both the owners and the broader ocean research community.

7.2 Recommendations for Future Research

Although the current research focused primarily on privately owned vessels, another area of the super-yacht industry revolves around is yachts available for charter. While many yachts are available for charter year round, some yacht owners opt to occasionally rent out their private vessels to help offset the multitude of running costs. Future studies into the feasibility of targeting retail brokers who specialize in such yacht charters could further expand the number of yachts participating in programs such as SDY. Additional future research objectives include a survey of yacht owners to evaluate willingness to participate in programs such as SDY and analyze projects most highly valued.

REFERENCES

Alexander, Constantine. 2011. “The Economic Value of Ocean Research.” Global Oceans, 2011. Web, May 5, 2013. < http://global-oceans.org/site/2011/10/the-economic-value-of-ocean-research>

Armsworth, Paul R. et al. 2012. “The Size, Concentration, and Growth of Biodiversity-Conservation Nonprofits. *BioScience*. 62.3: 271-281.

Camper & Nicholsons. 2013. *Super Yachting Index, Fifth Edition*. July 2013.

Camper & Nicholsons. 2008. *Super Yachting Index, First Edition*. May 2008.

Carlyle, Ryan. 2013. “Why don’t we spend more on exploring the oceans, rather than space exploration?” Forbes, January 1, 2013. Web, May 10, 2013. <http://www.forbes.com/sites/quora/2013/01/31/why-dont-we-spend-more-on-exploring-the-oceans-rather-than-on-space-exploration>

Census of Marine Life. 2010. “First Census Shows Life in Planet Ocean is Richer, More Connected, More Altered than Expected.” Press Release, September 23, 2010. Web, May 5, 2013. < http://www.coml.org/pressreleases/census2010/PDF/Census-2010_Public_News_Release.pdf>

Chasis, Sarah. 2010. “New National Ocean Policy Will Help Protect the “Blue Heart of the Planet.” *Reviving the Worlds Oceans*. Switchboard: NRDC Staff Blog. September 7, 2010.

Choi, Charles Q. “Tricked-out yachts set sail to study the ocean.” NBC News, October 4, 2011. Web, May 12, 2013. <http://www.nbcnews.com/id/44773794/ns/technology_and_science-science/t/tricked-out-yacht-sets-sail-study-oceans/#.UY-5DpXHZUQ>

Committee on Exploration of the Seas & National Research Council. 2003. *Exploration of the Seas: Interim Report*. National Academies Press. Washington DC

Committee on an Ocean Infrastructure Strategy for US Ocean Research in 2030 & National Research Council. 2011. *Critical Infrastructure for Ocean Research and Societal Needs in 2030.* National Academies Press. Washington DC

Committee on Evolution of the National Oceanographic Research Fleet & National Research Council. 2009. *Science at Sea: Meeting Future Oceanographic Goals with a Robust Academic Research Fleet*. National Academies Press. Washington, DC

Chung, Emily. 2011. “Most ocean species still unknown after census.” CBC News, January 12, 2011. Web, May 10, 2013. <http://www.cbc.ca/news/technology/story/2011/01/11/marine-species-census.html>

Cressey, Daniel. 2012. “UK oceanography cuts make global wave.” *Nature*, 30 March 2012. Web, May 5, 2013. < http://www.nature.com/news/uk-oceanography-cuts-make-global-waves-1.10367>

Cressey, Daniel. 2013. “US science fleet’s future is far from ship-shape.” *Nature News*, June 10, 2013. Web, June 11, 2013. < http://www.nature.com/news/us-science-fleet-s-future-is-far-from-ship-shape-1.13164>

Dawkins, Richard. 2013. “First filming of a giant squid in nature –US/PBS premier today.” Richard Dawkins Foundation, January 27, 2013. Web, May 10, 2013. < http://www.richarddawkins.net/foundation_articles/2013/1/15/first-filming-of-giant-squid-in-nature>

Earle, Sylvia A. 2009. *The World Is Blue: How Our Fate and the Ocean’s Are One*. Washington, DC: National Geographic. Print.

Subcommittee on Ocean Science and Technology Council. 2013. *Science for an ocean nation: update of the ocean research priorities plan*. Executive Office of the President of the United States.

Feldman, Gene. 2009. “Oceans: The Great Unknown.” NASA Interview, August 10, 2009. Web, May 5, 2013. < http://www.nasa.gov/audience/forstudents/5-8/features/oceans-the-great-unknown-58_prt.htm>

Frank, Robert. 2013. “Billionaire Loans Yacht to Track Down Giant Squid.” CNBC, January 12, 2013. Web, May 12, 2013. < http://www.cnbc.com/id/100373749>

Gant, Charles G., and Rubinstein, Bertha. 1953. “Funds for Science: The Federal Government and Nonprofit Institutions.” Science. 117.3051:669-676.

Garrison, Tom. 2007. *Oceanography: An Invitation To Marine Science*. Belmont, CA: Thomson Brooks/Cole. Print.

Gaskill, Melissa. 2011. “End of an era for research subs.” Nature, August 22, 2011. Web, May 10, 2013. <http://www.nature.com/news/2011/110822/full/news.2011.488.html>

German, Chris. 2013. “Probing the ocean’s undiscovered depths.” CNN, March 20, 2013. Web, May 10, 2013. < http://www.cnn.com/2013/03/18/tech/oceans-woods-hole-oped>

Interagency Working Group on Facilities. 2007. *Federal Oceanographic Fleet Status Report*. December 2007.

Lee, Jane J. 2012. "US Budget Cuts Threaten to Sink Undersea Research Fleet." *Science*. 335. March, 30 2012.

Lee, Jane J. 2012. "US National Ocean Policy: No Success Without Science." *Science Insider*, May 7, 2012. Web, May 14, 2013. <http://news.sciencemag.org/scienceinsider/2012/05/us-national-ocean-policy-no-success.html>

Lubchenco, Jane. 2013. "Statement from Dr. Jane Lubchenco on NOAA's FY 2013 Budget Request."

Maxmen, Amy. 2013. "Genome reveals comb jellies' ancient origin." *Nature News*. January 8, 2013.

McKenzie, Sheena. 2012. "More than a holiday: The luxury superyacht that doubles as a science lab." CNN, October 10, 2012. Web, October 11, 2012. <http://www.cnn.com/2012/10/01/travel/superyacht-science-laboratory-submarine>

Moroz, Leonid. 2013. Personal Communication.

National Association of Marine Laboratories. 2012. "FY 2012 Public Policy Agenda: Recommendations for a Robust Ocean Research and Education Enterprise." Web, May 10, 2013. <http://www.naml.org/news/docs/2012_policy_agenda.pdf>

Neal, Tracy. 2013. "Sophisticated ship probes depths." Stuff, March 26, 2013. Web, May 12, 2013. < http://www.stuff.co.nz/nelson-mail/news/8473402/Sophisticated-ship-probes-depths>

National Oceanic and Atmospheric Organization. 2012. *The Economic Value of Resilient Coastal Communities*. March 19, 2012.

National Oceanic and Atmospheric Organization. 2013. *FY 2013 Budget Blue Book*. Washington. Government Printing Office.

National Ocean Council. 2012. *Draft National Ocean Policy Implementation Plan*. http://www.whitehouse.gov/sites/default/files/microsites/ceq/national_ocean_policy_draft_implementation_plan_01-12-12.pdf

National Ocean Council. 2013. *Federal Oceanographic Fleet Status Report*. Executive Office of the President. Washington, DC.

National Science Foundation. 2013. Web, May 2013. <www.nsf.gov>

Office of Ocean Exploration and Research. 2012. *2012 Annual Report*.

Office of Maritime and Aviation Operations. 2013. *Budget Activity: Office of Marine and Aviation Operations*. Washington. Government Printing office.

Pergams, Oliver R. et al., 2003. "Linkage of Conservation Activity to Trends in the US Economy." Conservation Biology. 18.6:1617-1623.

Pounder, Sibeal. 2010. "How can luxury yachts help to save our seas?" How to Spend It, June 21, 2010. Web, May 12, 2013. < http://howtospendit.ft.com/articles/1955-how-can-luxury-yachts-help-to-save-our-seas>

Profita, Cassandra. 2011. "What we don't know about the world's oceans." OPB, January 12, 2011. Web, May 10, 2013. < http://www.opb.org/news/blog/ecotrope/what-we-don't-know-about-the-worlds-oceans>

Schrope, Mark. 2013. "Wealthy backers support scientific efforts to explore deep seas." *The Washington Post.* May 27, 2013. Web, May 27, 2013. < http://www.wpost.com/national/health-science/wealthy-backers-support-scientific-efforts-to-explore-deep-seas/2013/05/24/486c6430-b716-11e2-aa9e-a02b765ff0ea_story_2.html>

SeaKeepers. 2013. Web, May 5, 2013. <www.seakeepers.org>

Simberloff, Daniel. Parker, Ingrid M. Windle, Phyllis N. 2005. "Introduced Species Policy, Management, and Future Research Needs." *Frontiers in Ecology and the Environment*. 3.1:12-20.

SuperYacht Intelligence Agency. 2012. *Economic Analysis of the Super-yacht Industry*. February 2012.

"The Research Ship Problem." 2013. Web, May 5, 2013. < http://global-oceans.org/site/we-must-go-and-see/>

USCG. 2012. *National Recreational Boating Survey*.

USCG. 2011. *National Recreational Boating Survey*.

US Commission on Ocean Policy. 2004. *An Ocean Blueprint for the 21st Century*. Final Report of the US Commission on Ocean Policy. http://www.oceancommission.gov/documents/full_color_rpt/welcome.html#final

White, Caroline. 2013. "2012 Superyacht Market Report." Boat International. January 1, 2013.

APPENDIX A

Timeline of Key Academic and Internship Dates and Deliverables

Begin Internship ..... July 2011

Begin Full-Time Employment ..... May, 2012

Thesis Proposal Complete ..... 23 May 2013

Comprehensive Examination ..... 23 May 2013

Oral Examination ..... 31 May 2013

Committee Meeting ..... 31 May 2013

Final Draft Thesis (proposal + methods + results +
discussion + conclusion + appendix) ..... 18 September 2013

Announcement of Defense ..... 23 October 2013

Thesis Defense and Committee Meeting ..... 7 November 2013

Deadline to Defend Thesis ..... 22 November 2013

Final Thesis Submission to Committee ..... 9 December 2013

Deadline to Submit Thesis to University of Miami ..... 18 December 2013

Graduation ..... 19 December 2013

APPENDIX B

The Status of United States Research and Academic Fleets

The UNOLS Research Fleet in 2009. Adapted from *Science at Sea: Meeting Future Oceanographic Goals with a Robust Academic Research Fleet.*

Operating Institution	*Ship*	Year Built	Owner	Length (ft)
Scripps Institute of Oceanography	*Melville*	1969	Navy	279
Woods Hole Oceanographic Institution	*Knorr*	1970	Navy	279
University of Washington	*Thomas G. Thompson*	1991	Navy	274
Scripps Institute of Oceanography	*Roger Revell*	1996	Navy	274
Woods Hole Oceanography Institution	*Atlantis*	1997	Navy	274
Lamont-Doherty Earth Observatory	*Marcus Langseth*	2008	NSF	135
University of Hawaii	*Kilo Moana*	2002	Navy	186
Harbor Branch Oceanographic Institute, Florida Atlantic University (FAU)	*Seward Johnson*	1985	FAU	204
Oregon State University	*Wecoma*	1976	NSF	185
University of Rhode Island	*Endeavor*	1977	NSF	185
Woods Hole Oceanographic Institute	*Oceanus*	1976	NSF	177
Scripps Institute of Oceanography	*New Horizon*	1978	SIO	170
Bermuda Institute for Ocean Sciences (BIOS)	*Atlantic Explorer*	2006	BIOS	168
Duke University/University of North Carolina	*Cape Hatteras*	1981	NSF	135
Moss Landing Marine Laboratories	*Point Sur*	1981	SIO	170
University of Delaware (UD)	*Hugh R. Sharp*	2005	UD	146
Scripps Institute of Oceanography	*Robert Gordon Sproul*	1981	SIO	125
Louisiana Universities Marine Consortium (LUMCON)	*Pelican*	1985	LUMCON	116
University of Miami (UM)	*Walton G. Smith*	2000	UM	96
University System of Georgia/Skidaway (UG/SKIO)	*Savannah*	2001	UG/SKIO	92
University of Minnesota,	*Blue Heron*	1985	UMD	86

Duluth University of Washington	*Clifford Barnes*	1966	NSF	66

Ships in the US Federal Oceanographic Fleet over 40-meters in length (excluding those managed by UNOLS).

		Global Class		
Navy	*Pathfinder*	1994	Navy	328
Navy	*Sumner*	1995	Navy	328
Navy	*Bowditch*	1995	Navy	328
Navy	*Henson*	1998	Navy	328
Navy	*Bruce C. Heezon*	2000	Navy	328
Navy	*Mary Sears*	2001	Navy	328
NOAA	*Fairweather*	1968	NOAA	231
NOAA	*Rainier*	2015	NOAA	231
NOAA	*Ronald H. Brown*	2026	NOAA	274
NSF	*Nathaniel B. Palmer*	1992	NSF	308
NSF	*Lawrence M. Gould*	1997	NSF	230
USCG	*Polar Sea*	1978	USCG	399
USCG	*Polar Star*	1976	USCG	399
USCG	*Healy*	2000	USCG	420
		Ocean Class		
EPA	*Bold*	1989	EPA	224
EPA	*Lake Guardian*	1981	EPA	180
Navy	*John McDonnel*	1991	Navy	208
NOAA	*Albatross IV*	1963	NOAA	187
NOAA	*Miller Freeman*	1967	NOAA	215
NOAA	*Oscar Elton Sette*	1988	NOAA	224
NOAA	*Gordon Gunter*	1989	NOAA	224
NOAA	*Oscar Dyson*	2004	NOAA	200
NOAA	*Thomas Jefferson*	1992	NOAA	208
NOAA	*Hi'ialakai*	1984	NOAA	224
NOAA	*McArthur II*	1985	NOAA	224
NOAA	*Ka'imimoana*	1989	NOAA	224
NOAA	*Nancy Foster*	1991	NOAA	187
		Regional Class		

NOAA	*David Starr Jordon*	1966	NOAA	155
NOAA	*Oregon II*	1967	NOAA	170
NOAA	*Nathaniel B. Palmer*	1992	NOAA	308

APPENDIX C

SeaKeepers DISCOVERY Yachts and the SeaKeeper 1000

Oceanographic, atmospheric and geolocational parameters observed by the SeaKeeper 1000 unit.

Date
UTC Time
Latitude
Longitude
Wind Speed (apparent)
Magnetic Wind Direction (apparent)
Air Temperature
Relative Humidity
Barometric Pressure
Compass Heading
Relative Wind Direction
True Wind Speed (calc)
True Wind Direction (calc)
Course Over Ground (calc)
Speed Over Ground (calc)
Cell Pressure
Cell Temperature (internal)
Conductivity
Sea Surface Salinity
Oxygen Saturation
Oxygen Concentration
pH
Sea Surface Temperature (external)

The following table lists the original SeaKeepers' Vessels of Opportunity p that carry/previously carried the SeaKeeper 1000 unit.

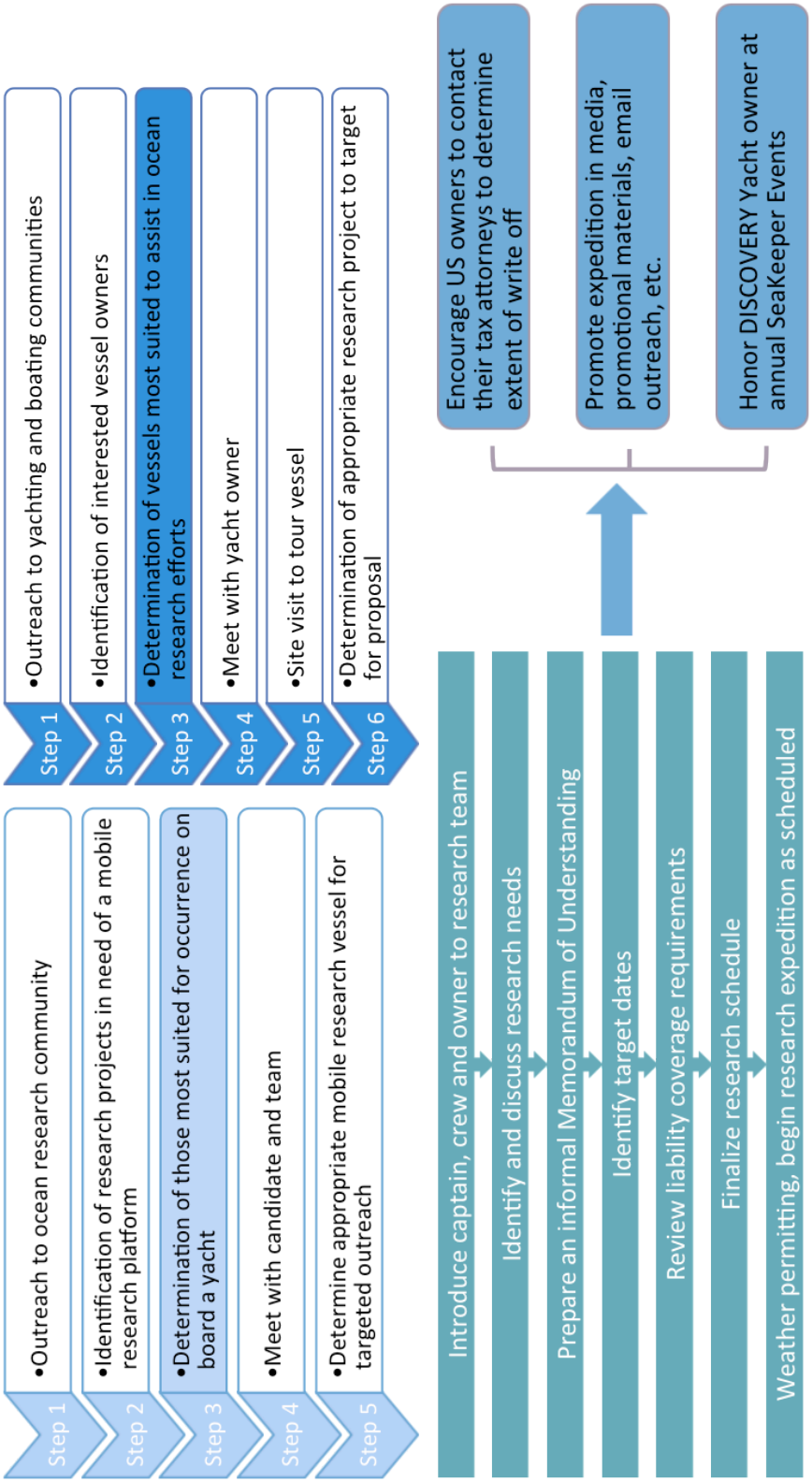
Vessel/Dock
7seas (Oceanco 706)
Allegra
Alpha Nero (Oceanco 702)
Ambrosia III
Amevi (Oceanco 701)
Amsterdam
Anastasia (Oceanco 703)
Andiamo
Archimedes
Artemis
Asean Lady
Auk
Azure Leisure
Big Fish
Blue Moon
Boston Whaler 21
Brain Power
CakeWalk
Carnival Legend
Carnival Miracle
Carnival Spirit
Carnival Triumph
Dock (RSMAS)
Double Feature
Elan
Evviva
Excalibur
Explorer
Fulmar
Gallant Lady 651
Gallant Lady 672
Gallant Lady 808
Georgia
Golden Shadow
Harbor Wing
Highlander
Hilarium
Hyperion
Itasca

Japan
Kakapo
Katharine (New)
Katherine (Old)
King Fisher
Lady Ann McGee
Lady Christina
Lady Georgina
Lady Kathryn IV
Laurel
Le Mediterranee
Liquidity
M/Y Slojo
Manta
Maverick
Meduse
Metal Tanque IV
Mi Bella Christina
Milk and Honey
MY Sunrays (Oceanco 705)
NSU Pier
Ocean Watch
Octopus
Ophelia
Patriot
Pegasus (formerly *Princess Marla)*
Perfect Prescription
Plan B
Polar Sea
Polar Star
President Kennedy
President Polk
Primadonna
Que Sera
Rachelle
Scripps Pier
SeaQuell
SeaShaw
Shearwater
Silver Cloud
Silver Cloud III
SkyeTyme

Tatoosh
The World
Triton
Twin Capes (University of Delaware)
Ubiquitous
Valkyrie
Vibrant Curiosity (Oceanco 704)
Walton Smith
Weatherbird II
Yacht Express

APPENDIX D

SeaKeepers DISCOVERY Yachts Programmatic Framework



Step 3

- Determination of those most suited for occurrence on board a yacht

- 'Clean' research
- Minimal to no permanent impact to yacht
- Short term (1 – 7 days)
- Minimal research team size (3-5 people)
- From Florida research institutions or universities
- Close proximity of study site to Florida (Dry Tortugas, Bahamas)
- Affable researchers and/or scientists willing to socialize with yacht owner, captain and crew
- Is access to the water protocol?
- Is the project unique?
- Would the provision of a mobile research vessel be of significant value to the research?
- Will the project produce a dissertation, thesis or publication as a result of the research?

Step 3

- Determination of vessels most suited to assist in ocean research efforts

- Frequent Florida waters
- US Registered (for tax benefits)
- 65 feet or more
- Must sleep at least 7 - 9 (3 crew, 1 SeaKeepers liaison, 3-5 researchers)
- Access to support vessels (tenders)
- At least $1.5 million in liability coverage for primary and support vessels
- Captain and at least 2 supporting crew members

APPENDIX E

The International SeaKeepers Society Talking Points

THE INTERNATIONAL SEAKEEPERS SOCIETY

WHO: The International SeaKeepers Society works directly with the yachting community as an essential component and contributor to ocean research and conservation efforts.

LEADERSHIP: The Scientific Advisory Council forms the backbone of the International SeaKeepers Society by providing the scientific foundation for all programmatic actions.

VISION: SeaKeepers enables the yachting community to take full advantage of their unique potential to advance marine sciences and to raise awareness about global ocean issues.

HOW: SeaKeepers 100+ Discovery Yachts augment current knowledge about the state of the oceans, rouse significant scientific discovery, raise awareness about critical ocean issues and inspire a passion for the seas.

SCIENTIFIC IMPORTANCE: Demand for access to the global oceans for scientific research is astronomical. The current research fleet is incapable of meeting current needs due to debilitating costs, limited research foci and the retirement of obsolete vessels.

SeaKeepers' Discovery Yachts enhance the current academic fleet by making unconventional vessels, member yachts, available to the scientific community. Privately owned yachts are particularly attractive mobile research platforms because of their tendency to frequent remote and ecologically rich locations, where regular large commercial traffic is minimal. The ability to monitor the ocean globally from vessels underway enables us to track the ocean in real-time, to view the ocean engine in action, and to improve predictive capabilities through vigorous validation of ocean models.

IMPLEMENTATION:

1) **UTILIZATION** - member vessels that provide individuals with access to the global ocean for research, scientific discovery, community outreach and artistic inspiration.

a. Significant scientific discovery - The Discovery Yacht Fleet donates time, fuel and expertise to scientists in need of an **oceanic research platform**. *For example, the inaugural Discovery Yacht, Miss Phebe, welcomed three coral reef geneticists from the University of Miami to the remote Dry Tortugas for an entire week to collect deep and shallow water coral tissue samples.*

b. Educational opportunity - Discovery Yachts expeditions provide an exceptional opportunity for students to witness marine science research first-hand. For example *M/Y Defiance, one Discovery Yacht in particular, is committed to raising awareness about critical ocean issues by inviting under privileged children aboard to participate directly in various research missions.*

c. Artistic inspiration - the dissemination of ocean information to the general public via artists (painters, sculptors, photographers, videographers) who garner inspiration from the sea and the marine life within. The works created allow the general public to personally experience and value the oceans, regardless of their proximity to the coast.

2) **EQUIPMENT** of privately-owned vessels with instrumentation to accurately measure and report upon the currents and the physical, chemical and biological characteristics of the water column throughout the world's oceans on a regular and long-term basis.

a. SeaKeeper Drifter Program facilitates the deployment of ocean monitoring devices called drifters, which float upon the sea surface and traverse the oceans via local currents.

b. SeaKeeper 1000 and the upcoming SeaKeeper 2000 are fully automated unattended installations, which transform privately owned vessels to satellites, which orbit the globe at sea level and scan the water systematically over long periods of time.