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THE SUBMERSIBLE THREAT TO MARITIME HOMELAND SECURITY

by

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Small submersible vessels have been used for years by nation states, terrorist groups, and criminal organizations to achieve operational objectives. These entities have sought to capitalize on the overriding tactical advantage of submersible technology which is stealth. For example, drug trafficking organizations in Central and South America have been routinely using self-propelled semi-submersible vessels to clandestinely transport large quantities of illicit drugs to North America. Small submersible vessels can also be nefariously used in the maritime domain to transport persons or weapons or they could be used as waterborne improvised explosive devices. Terrorists and criminals are complex adaptive adversaries and are driven to innovate when confronted with threats to their operational effectiveness. Innovation and adaption are driving these foes to leverage disruptive technology towards the development or acquisition of fully-submersible vessels. Furthermore, there is a growing population of privately owned submersibles within the U.S. that policymakers have little visibility of. Homeland security policymakers lack adequate situational awareness regarding the vulnerabilities, threats, and consequences to the maritime transportation system from the malicious use of submersibles. The core challenge for the maritime homeland security enterprise with regards to submersibles is developing effective strategies to mitigate their potential risk.

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THE SUBMERSIBLE THREAT TO MARITIME HOMELAND SECURITY

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ABSTRACT

Small submersible vessels have been used for years by nation states, terrorist groups, and criminal organizations to achieve operational objectives. These entities have sought to capitalize on the overriding tactical advantage of submersible technology which is stealth. For example, drug trafficking organizations in Central and South America have been routinely using self-propelled semi-submersible vessels to clandestinely transport large quantities of illicit drugs to North America. Small submersible vessels can also be nefariously used in the maritime domain to transport persons or weapons or they could be used as waterborne improvised explosive devices. Terrorists and criminals are complex adaptive adversaries and are driven to innovate when confronted with threats to their operational effectiveness. Innovation and adaption are driving these foes to leverage disruptive technology towards the development or acquisition of fully-submersible vessels. Furthermore, there is a growing population of privately owned submersibles within the U.S. that policymakers have little visibility of. Homeland security policymakers lack adequate situational awareness regarding the vulnerabilities, threats, and consequences to the maritime transportation system from the malicious use of submersibles. The core challenge for the maritime homeland security enterprise with regards to submersibles is developing effective strategies to mitigate their potential risk.

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LIST OF ACRONYMS AND ABBREVIATIONS

AIS	Automatic Identification System
AMSC	Area Maritime Security Committee
AMSP	Area Maritime Security Plan
ASW	Anti-Submarine Warfare
AWW	America’s Waterway Watch
CBP	Customs & Border Protection
CIA	Central Intelligence Agency
CFR	Code of Federal Regulations
COP	Common Operational Picture
COPT	Captain of the Port
CSA	Confederate States of America
DEA	Drug Enforcement Agency
DOD	Department of Defense
DHS	Department of Homeland Security
DTO	Drug Trafficking Organization
DTVIA	Drug Trafficking Vessel Interdiction Act of 2008
FARC	Revolutionary Armed Forces of Colombia (Spanish)
FLIR	Forward Looking Infrared Radar
GAO	Government Accountability Office
GPS	Global Positioning System
HVE	Homegrown Violent Extremist
HS	Homeland Security
HSE	Homeland Security Enterprise
IJN	Imperial Japanese Navy
ISPS	International Ship & Port Facility Security Code
ITO	International Terrorist Organization
IMO	International Maritime Organization
IND	Improvised Nuclear Device
IONS	Incident of National Significance
JIATF-S	Joint Interagency Task Force-South

LTTE	Liberation Tigers of Tamil Eelam
MCI/KR	Maritime Critical Infrastructure/Key Resource
MDA	Maritime Domain Awareness
MHS	Maritime Homeland Security
MILF	Moro Islamic Liberation Front
MISLE	Marine Information for Safety & Law Enforcement
MSRAM	Maritime Security Risk Analysis Model
MTS	Maritime Transportation System
MTSA	Maritime Transportation Security Act of 2002
NSHS	National Strategy for Homeland Security
NVIC	Navigation and Vessel Inspection Circular
RBDM	Risk-Based Decision-Making
ROI	Return on Investment
ROV	Remotely Operated Vehicle
SPFS	Self-Propelled Fully-Submersible
SPNS	Self-Propelled Non-Submersible
SPSS	Self-Propelled Semi-Submersible
SVSS	Small Vessel Security Strategy
TTP	Tactics, Techniques, & Procedures
TWIC	Transportation Workers Identification Credential
U.S.	United States
USCG	United States Coast Guard
USD	United States Dollars
USG	United States Government
USV	Unmanned Surface Vehicle (or Vessel)
WBIED	Waterborne Improvised Explosive Device
WMD	Weapon of Mass Destruction
WME	Weapon of Mass Effect

I. INTRODUCTION

A. STATEMENT OF THE PROBLEM

Small submersible vessels have been used throughout history by insurgencies, terrorist organizations, criminal cartels, and nation states to further their individual agendas and objectives. The term *submersible*, as used in this thesis, indicates that a vessel weighs less than 300 gross tons and has the capability of semi- and/or fully-submersible operation. Throughout this thesis, this word may be used interchangeably with such terms such as submarine, mini-submarine, mini-sub, midget submarine, self-propelled semi-submersible, and self-propelled fully-submersible. The threat posed by submersible technology is emerging as small submersibles become increasingly available to those who would use this technology in disruptive ways against society.

The use of semi-submersible vessels by international drug cartels as part of their complex transnational multimodal distribution networks is one example of how submersible technology is being used in a manner that threatens the national security of multiple nation states in North, Central, and South America. Between 2000 and 2007 there were 23 documented self-propelled semi-submersible (SPSS) voyages conducted by drug trafficking organizations (Self-Propelled Semi-Submersible [SPSS] Watercraft, 2011). In the first six months of fiscal year 2008, there were 45 recorded SPSS voyages and it is estimated that SPSSs account for 32 percent of all maritime cocaine flow (SPSS Watercraft, 2011). Additionally, terrorist organizations have sought to leverage submersible technology for their own strategic purposes. Lastly, there are an unknown number of private submersibles operating within the U.S., but there is no comprehensive data that would allow homeland security policymakers to conduct any meaningful analysis or risk estimation.

B. BACKGROUND AND NEED

Submersible vessels have been used by terrorist groups, such as the Tamil Tigers in Sir Lanka, to conduct regional operations and by drug trafficking organizations (DTOs) to clandestinely transport large shipments of illegal drugs bound for the United

States (Jane's Terrorism and Security Monitor, 2008). The current submersible threat can be domestic or could originate from outside the continental United States. Submersibles have the capability to be used to covertly smuggle drugs, weapons, or persons into the United States. The vessels themselves can be used as stealth waterborne improvised explosive devices (WBIEDs). The ability of these vessels to evade detection and interdiction efforts, combined with their ability to transport large payloads undetected over great distances, constitutes an emerging meta-threat to the homeland security enterprise (HSE).

Submersible vessels pose a meta-threat to maritime homeland security (MHS) because of their multi-dimensional attributes and capabilities. In the context of this paper, a meta-threat is a means for conducting maritime asymmetrical hostile operations against the HSE by capitalizing on the tactical advantages of submersible vessel technology while simultaneously exploiting the strategic weaknesses of the HSE. Submersible vessels have the capability of successfully evading detection while maintaining the ability to be an effective conveyance for weapons, personnel, and drugs, or they can be utilized as a stealthy self-guided underwater weapon of mass effect (WME). Although the technical attributes and capabilities of small submersible vessels are well known, their potential threat to the maritime transportation system (MTS) is not fully understood by homeland security policymakers. This misunderstanding of the threat tends to obscure efforts to accurately define and mitigate strategic risk in regards to the misuse of submersibles by criminals or terrorists resulting in the threat not being specifically addressed in current homeland security (HS) strategy or policy. Another attribute that contributes to small submersibles being defined as a meta-threat is that so little data exists regarding their locations, ownership, and operational characteristics within the territorial waters of the United States (U.S.) that it is impossible to accurately estimate any risk they may pose.

Current maritime homeland security strategy does not specifically address small submersible threats and this is an emerging area of potential concern for HS policymakers to consider. Although national maritime strategies, such as the *Small Vessel Security Strategy* (SVSS), do not primarily focus on the threat posed by submersible vessels, there have been some efforts to address submersible use by drug smugglers through federal legislation. The *Drug Trafficking Vessel Interdiction Act (DTVIA) of 2008*, which allows for the prosecution of the crews of SPSS vessels that are involved with international drug trafficking, but does not address the use of these vessels to facilitate acts of terror or the misuse of a submersible vessel within U.S. waters. The current focus of maritime law enforcement and regulatory agencies appears to be on preventing these vessels from delivering illegal drugs to cross-border distribution networks, which are intent on delivering them to the U.S., and not in deterring the use of these vessels by international terrorist organizations (ITOs) or homegrown violent extremists (HVEs).

Domestically, there are privately owned mini-submarines and semi-submersible vessels that could be just as useful to terrorists as the ones owned operated by drug cartels; however, the exact number of them is unknown as there are no federal or state requirements or capabilities to track these vessels. Most privately owned mini-subs and semi-submersibles are not regulated by federal or state law except for the general safety and registration requirements that would be required for any other recreational surface vessel. This means that no single agency within the HSE can provide a common operational picture (COP) with regards to privately owned submersibles. Since most privately owned small vessels, including submersibles, are not federally regulated, there is no requirement for them to have a security plan and the owners/operators are not vetted against any terrorist watch list nor do they even have to pass a criminal background check. Additionally, there is no requirement for small unregulated vessels to transmit data via automatic identification system (AIS) technology, which would provide real-time vessel position data to maritime stakeholders such as the U.S. Coast Guard (USCG).

Although the threat posed by these submersible vessels is generally recognized by HS policymakers (Wilkenson, 2008), there is no specific reference to them in current HS policy. Currently, there is no consolidated strategy to counter this threat. Only through strategic collaboration and sound HS policy can scarce resources be effectively used to counter this emerging threat by using tools such as risk-based decision-making (RBDM).[1]

C. RESEARCH QUESTION AND METHODOLOGY

The primary research question of this thesis is: *How should the homeland security enterprise react to the emerging technology and availability of submersible vessels?*

The primary research method for this thesis was a multi-level policy analysis that focused on evaluating existing HS policies in terms of their ability to identify and mitigate the security threat posed by submersible vessels. The primary objective of this policy analysis was to determine if current policy can effectively achieve the stated policy goals and, if not, to recommend appropriate policy changes and/or modifications.

D. SIGNIFICANCE TO THE FIELD

This research will contribute to the limited body of knowledge surrounding the HS threat posed by submersibles and the impact on current policy. Although this threat has been around for some time, it began to garner increased attention in the late 1990s. Even so, to date, there has been limited serious academic focus on this issue. This research will add to a foundation for future research efforts focused on the submersible threat.

The primary consumers of the research are the multiple stakeholders comprising the MHS enterprise. These local agencies include city and county marine patrol units, fire departments, and port authority police departments. State agencies include state police agencies, regional dive teams, and any other state agency that has a stake in maritime security or marine safety. Primary federal consumers include the U.S. Department of Homeland Security (DHS) and subordinate agencies such as the U.S. Coast Guard and U.S. Customs and Border Protection (CBP). Other federal agencies, such as the U.S.

[1] Risk-based decision making is a process that attempts to quantify and compare the relative risks of similar events and assigns rank order precedence to them. This method of risk analysis is used by decision makers to either eliminate or reduce risk by identifying the least risky courses of action (Risk Management, 2010).

Drug Enforcement Administration and the U.S. Department of Defense's (DoD) Northern and Southern Commands, may find utility in this research. In addition, international organizations, such as the International Maritime Organization (IMO), may also find utility in this research for policy formulation. Providers of marine insurance services to the MTS, such as Lloyd's of London, could also utilize this research in their risk estimation and mitigation activities. Additionally, U.S. Coast Guard sponsored area maritime security committees (AMSCs) may benefit from this research in respect to developing and updating their area maritime security plans (AMSPs). HS practitioners and leaders will also benefit from this research by gaining a fundamental understanding of this emerging meta-threat and its policy implications.

E. LITERATURE REVIEW

This literature review identifies relevant sources concerning the developing threat of submersibles vessels to MHS. It was not until the late 1990s that intelligence analysts saw an increase in the use of these types of vessels by DTOs in Central and South America. The majority of the available literature is in the form of media reports of high profile seizures of illegal drugs carried as cargo on these vessels. Additional media reports cover the confiscation of partially built self-propelled semi-submersible (SPSS) or self-propelled fully-submersibles (SPFS) in improvised covert jungle shipyards in Central and South America. There have also been some published threat analysis products that address the capability and use of submersible vessels by drug traffickers and terrorist organizations. This topic has been the subject of very few published books since much of the information is classified in order to protect sources and methods with regard to intelligence collection activities. The last major category of literature on this subject is policy related. There are several national strategies that have been developed since September 2001 that are primarily focused on maritime security, but none specifically address this meta-threat. Overall, the depth and breadth of academically accepted literature on this subject is scarce, which creates an intellectual gap for HS policymakers. The following highlight the current state of literature regarding the submersible vessel threat to MHS.

The bulk of the literature constitutes media reports and journal articles. The discovery of a partially completed fully-submersible submarine was recently featured in *Wired* magazine (Popkin, 2011). The vessel of interest was discovered in a clandestine shipyard in the jungles of Ecuador (Popkin, 2011). Although no drugs were recovered in the raid on the shipyard, this discovery was significant for two reasons. First, the hull was being constructed out of a Kevlar and carbon fiber composite, which was a technological improvement over steel hulled vessels encountered prior to this seizure (Popkin, 2011). Additionally, many of the component parts, including the engines, were of Chinese origin, which raises questions regarding whether or not foreign nations, such as Russia or China, or their citizens are actively involved with submersible technology proliferation Popkin, 2011). The second reason was that this vessel was a fully submersible vessel that was another incremental technological development for the DTOs that operate these "drug subs" (Popkin, 2011). Popkin's article is fairly typical for a media report except that it goes into greater technical detail than a typical news agency would. There are numerous articles regarding drug sub seizures that mostly highlight the amount of drugs recovered. Very few of these articles provide any substantial academic value to the researcher but rather tend to sensationalize the use of these vessels as smuggling conveyances.

One of the most comprehensive threat analyses on submersible vessels was completed by *Jane's Terrorism and Security Monitor* in 2008. In "Insurgent Submersibles," *Jane's* presents a comprehensive summary of the use of submersible vessels by terrorist groups such as the Revolutionary Armed Forces of Colombia (FARC) and the Liberation Tigers of Tamil Eelam (LTTE) (Jane's Terrorism and Security Monitor, 2008). Also examined in detail were the SPSS vessels used by DTOs to transport large quantities of illegal drugs mostly along the Pacific coast of South and Central America as well as Mexico. The article looked at the effectiveness of using these vessels as both a means of transportation as an offensive weapon (Jane's Terrorism and Security Monitor, 2008).

Jane's also examines the technological innovations that have occurred over the past few years with regards to vessel construction. There are a few other threat products available to law enforcement and/or government agencies that are not classified but are restricted in access that basically restate the same information but some reports have more up to date technical specifications.

Although there are several national strategies and plans that address maritime security, none of them specifically address semi-submersible and/or fully-submersible vessels as a maritime security threat. The most relevant strategy for this threat is the DHS SVSS that was released in April 2008 (DHS, 2008). The most significant aspect of this strategy is the four primary scenarios of gravest concern to HS policymakers. Three out of four of these proposed scenarios could be easily accomplished by a submersible vessel. For the purposes of this research, most semi-submersibles and minis-submarines used by DTOs and terrorist organizations would be considered a small vessel[2] due to their size and weight.

Despite the scarcity of literature dealing with small submersibles there is ample literature on conventional submarines. This body of knowledge is mature and is beneficial to the study of the exploitation of small submersibles by criminal and terrorist organizations. Subject areas of interest include submarine technology and development, their use as weapons, and the development of anti-submarine warfare. The most relevant and significant body of research that addresses the topic of small submarines used as weapons is in historical accounts of the evolution of both submersible technology and tactics. For example, *Submarines at War* (Gunton, 2003) presents a history of submersible warfare from the Revolutionary War to the Cold War that provides a basic understanding of the development of military submarine technology. Furthermore, *Blossoms in the Wind: Human Legacies of the Kamikaze* (Shetfall, 2005) addresses the development of the tactics used to employ submersibles as suicide weapons. The understanding of the development of submarine technology and tactics provides a framework for understanding this technology and its potential impact on the homeland security enterprise.

[2] A small vessel is characterized as any watercraft, regardless of method of propulsion, which is generally less than 300 gross tons, and used for recreational or commercial purposes (DHS, 2008).

F. LIMITATIONS

The major limitations of this study were the sparse amount of data available in regards to private submersible ownership and their operation within the territorial waters of the U.S., and the scarcity of serious academic research on the use a small submersibles by terrorist and criminal organizations.

II. HISTORICAL USE OF SMALL SUBMERSIBLE VESSELS AS WEAPONS

A. NATION STATE USE OF SUBMERSIBLES

Many nation states have effectively used small submersible vessels as instruments of warfare for decades. Navies have used the submersible's tactical advantage of stealth to gain military superiority in the maritime domain or to execute clandestine intelligence collection missions. The use of submersibles as weapons by nation states can be illustrated as a continuous cycle of technological adaptation and escalation. Developments in submersible technology and tactics have been both incremental and disruptive. Thus, they exert influence on how the threat is countered via innovations in anti-submarine warfare (ASW) technology and tactics. This section provides a brief historical overview of some of the more significant uses of small submersible vessels by sovereign countries. The intent of this section is to provide a condensed framework for understanding the origins of the submersible threat. It is not intended to be comprehensive historical account of submersible warfare.

1. Confederate States of America (CSA)

During the American Civil War, the Confederate States of America (CSA) successfully utilized both semi-submersible and fully-submersible vessels during naval engagements. David boats were cigar-shaped, steam driven, wooden vessels that rode low in the water and were used to ram a spar with a torpedo attached to it into enemy ships. Although low in profile, these boats were noisy and easily detected by enemy lookouts. In an attempt to break the Union naval blockade, Horace Hunley and James McClintock started to develop a fully-submersible vessel for the Confederate navy in Mobile, Alabama around 1862. By February 1863, they had successfully launched their third attempt at a fully-submersible warship, the *H.L. Hunley* (Walker, 2005, p. 8).

The *H.L. Hunley* was designed to deliver ordnance in a similar manner as the David boats, but this new vessel would capitalize on the advantage of increased surprise and stealth. On February 17, 1864, the *H.L. Hunley* set sail near Charleston, South

Carolina harbor and proceeded to attack the Union warship the *Housatonic*. The rebel submarine was successful in lodging its spar with a 135 pound torpedo into the *Housatonic's* hull (Friends of the Hunley, 2010). The charge was successfully detonated rendering the *Housatonic* to be the first ship to be sunk by a submarine attack (Friends of the Hunley, 2010). Although the vessel and all hands were mysteriously lost the same night, the *H.L. Hunley* had proven that submersible warfare was indeed viable. Navies around the world would now begin to exploit this disruptive technology and at the same time attempt to develop countermeasures to this emerging type of asymmetric maritime warfare.

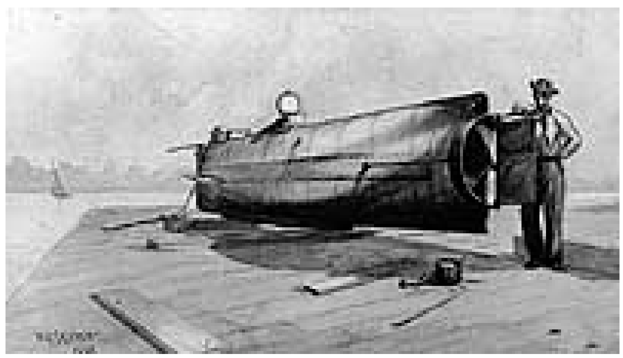

Figure 1. Artist's Depiction of the *H.L. Hunley*
(From Naval History & Heritage Command. n.d)

2. Japan

In the later years of World War II, Japan's naval strategy shifted from an offensive focus to a defensive posture. In order to counter an imminent naval invasion of the Japanese homeland by U.S. naval forces, Imperial Japanese Navy (IJN) war planners were in search of tactical innovations that could change the war's momentum. In late 1943 (Shetfall 2005, p. 405), two junior Japanese naval officers devised a novel proposal to increase the effectiveness of the conventional torpedo. Their idea was to increase the size of the warhead and have the torpedo piloted towards its target by a human crew. These "human torpedoes" would capitalize on the tactical advantage of stealth by being ferried by a mother ship (submarine) and then launch undetected underwater (Shetfall 2005, p. 405). These vessels were given the name kaiten which is translated as "heaven reverser" or "fate reverser" because of their perceived potential to be able to positively impact the war effort (Shetfall 2005, p. 406). The kaitens were intended to singlehandedly sink an enemy warship by exchanging the lives of the crew for the benefit of the entire Japanese race.

The IJN developed the kaiten in complete secrecy, and these super weapons were an amalgamation of current submarine and torpedo technology. The guidance system necessitated the human element to insure the accurate employment of the weapon as reliable and accurate self-guided torpedo technology was not yet viable. If a kaiten were to miss its target on the first attack run the pilot, in theory, could reposition the vessel for a second attack. These manned submersibles were piloted by a crew of one or two and could carry a payload of up to 3,417 pounds of high explosives (Historic Naval Ships Association, 2008).

On November 20, 1944, a kaiten was first used in a suicide attack on a U.S war ship, and they would be utilized until the end of the war. The success of the weapon is debatable as kaitens are only credited with having sunk two U.S Navy ships and the loss of 162 American sailors (Historic Naval Ships Association, 2008). Other American ships may have been damaged by kaitens, but accurate numbers are not available since some were destroyed while being ferried by larger submarines and others may have sunk in route to their targets and a kaiten attack could be misinterpreted as a mine or torpedo attack.

Japan's use of the kaiten is significant because it illustrates how the mash-up of submersible technology with the tactic of suicide bombing could be used in an attempt to achieve naval strategic objectives (Historic Naval Ships Association, 2008). The implication for HS policymakers is that the tactic of using a submersible to conduct a modern suicide attack could parallel the development of suicide aviation attacks, which discursively evolved from the kamikaze attacks of World War II to the suicide attacks of September 11, 2001. Neither the kaiten nor the kamikaze was able to change the outcome of World War II; however, the use of modern suicide attack tactics has proven to an asymmetrically empowered weapon of the weaker adversary. The use of submersibles as suicides attack vehicles should be a lesson learned for policymakers—as opposed to a lesson revisited, as was the case for aviation.

Figure 2. Japanese Kaiten on Static Display (From Historic Naval Ships Association, 2008)

3. Germany and the Battle of the Atlantic

During the Battle of the Atlantic, German submersibles, known as U-Boats, played a major strategic role in World War II. After the conclusion of war, Prime Minister Winston Churchill wrote "The only thing that really frightened me during the war was the U-boat peril" (Cleary, 2011). The Battle of the Atlantic was essentially protracted economic warfare fought against the British through the use of submarines in an attempt to facilitate a naval blockade against Great Britain, thus forcing an early conclusion to the war. The Battle of the Atlantic was the longest battle of the war, lasting nearly six years. This battle was a classic example of how an instrument of war could be classified as emerging technology and disruptive technology at the same time. By the end of the World War II, German U-Boats had sunk over 2,900 ships comprising 14 million tons of Allied shipping (uboataces, 2011a). Furthermore, 725 of the 1,155 Germany's U-Boats had been sunk during the war with 28,744 of the 35,000 sailors killed in combat (uboataces, 2011a). The death rate was approximately 82 percent and is the highest recorded casualty rate in any modern conflict (uboataces, 2011a).

The Treaty of Versailles had decreed that German naval forces would be limited to 15,000 men, six battleships (no more than 10,000 tons displacement each), six cruisers (no more than 6,000 tons displacement each), 12 destroyers (no more than 800 tons displacement each) and 12 torpedo boats (no more than 200 tons displacement each), and it completely forbade Germany from possessing submarines (uboataces, 2011b). Because of the asymmetric tactical advantages of submarines, Germany secretly defied this treaty and began to revitalize its submarine armada prior to the start of World War II (uboataces, 2011b). Technology at the time was only incrementally advancing, but the development of submarine warfare tactics, such as the Wolfpack or massed attack, and the exploitation of the gap in Allied air coverage for maritime convoys resulted in the transition to disruptive technology. In turn, Allied military forces were driven to counter this disruptive menace by increasing the effectiveness of anti-submarine warfare (ASW) tactics and technology. These developments included longer range aircraft, using aircraft on ships, refinement of SONAR and RADAR capabilities, adjusting convoy tactics, enhancing the effectiveness of weaponry, and using intelligence, such as code breaking. In response to these developments, Germany sought to enhance the technological capabilities of the submarine but, due to resource shortages and the Allied bombing campaign, the next level of technological innovation was never achieved (uboataces, 2011b).

Germany did utilize small submersibles in their submarine fleet but these vessels played a significantly smaller role in the war. These midget submarines were smaller and comparatively quieter than the larger submarines of the German fleet, which made them harder to detect. Due to their light weight, they were also more resistant to depth charge attacks. These midget submarines had limited firepower and operational capability. Their poor endurance and life support systems rendered them more vulnerable to accidents than to enemy fire. During the World War II, Germany built almost 1000 midget submarines that were primarily intended for the coastal defense and to operate against allied shipping in Europe and the English Channel (uboataces, 2011c).

Between January 1945 and April 1945, Germany's most successful midget submarine model, the *Seehund*, conducted 142 missions against Allied shipping (uboataces, 2011d). These midget submarine attacks resulted in the sinking of 8 ships comprising 17,301 tons of Allied shipping while sustaining a loss of 35 submarines (uboataces, 2011d). Although the tactical successes of these midget submarines were small, they were strategically successful because Allied ships and planes were diverted from other areas of the war to concentrate on this threat (uboataces, 2011d).

4. U.S. Central Intelligence Agency (CIA)

The Central Intelligence Agency (CIA) commissioned the construction of a self-propelled semi-submersible vessel in the 1950s. Capitalizing on the vessel's low silhouette and quietness, the CIA found utility in the use of a SPSS as a clandestine infiltration/exfiltration platform. The vessel was 19 feet long and constructed of wood and aluminum with plywood sheathing on the bottom, sides, and deck (CIA Semi-Submersible, 2011). This type of construction was thought to minimize possible detection by RADAR and SONAR. It had a crew of two to three persons and could transport an additional 120 pounds of equipment a range of approximately 110 miles (CIA Semi-Submersible, 2011). This SPSS could also be purposely sunk in depths of up to 30 feet for three to four weeks before being retrieved (CIA Semi-Submersible, 2011).

The CIA's success in using a SPSS to covertly deliver personnel into littoral environments demonstrates that the technology has proven itself to be useful for several reasons. Semi-submersible technology is less complicated to construct and operate than fully-submersible technology so there are advantages in cost and reduced operational complexity. The stealth advantage of these vessels makes their use very attractive to nation states and, for the same reasons, to criminal and terrorist organizations. This is an example of a successful 1950s technological innovation that is still in use today by nation states and criminal organizations. The origin and use of small semi-submersible vessels is part of the innovation cycle that has the potential to allow entities to further refine this technology and eventually develop effective fully-submersible capabilities.

Figure 3. CIA SPSS Vessel on Static Display (From CIA Unveils James Bond-Worthy Spy Tech, 2011)

5. North Korea

Although no longer on the U.S. State Department's list of state sponsors of terrorism, North Korea poses a significant threat to the geographic, political, and economic stability of Asia. North Korea and South Korea are still technically at war with each other, and tensions between the two nation states continue to be disruptive to the region. North Korea operates a fleet of semi-submersible vessels and fully-submersible midget subs in additional to more conventional submarines and surface craft. These submersibles have covert infiltration/exfiltration capabilities as well as the ability to launch torpedoes against naval targets (SSI Small Submersible, 2011).

The North Korean government has demonstrated the intent and capability to use submersibles to conduct unprovoked, offensive operations against South Korean vessels. On March 26, 2010, a North Korean midget submarine launched a single torpedo that sank the South Koren naval vessel, the *Cheonan*, which resulted in the death of 46 crewmembers (BBC News Asia-Pacific, 2010). The South Korean response to this incident was anemic and no overt military retaliatory action was ever initiated against North Korea. These two nations are technically still at war with each other, but observe a fragile truce so this incident could be classified an act of war. This effectiveness of this attack, the difficulty in determining the true perpetrator, and the lack of proportional response could serve to promote the offensive use of submersibles by other nation states, such as Iran, or terrorist groups that have access to submersible technology.

This attack also demonstrates how technological innovations in under water weaponry have increased the effectiveness submersible attacks. The *Cheonan* was sunk with only one torpedo that carried an estimated 200 to 300 kilograms of high explosives (Investigation Result on the Sinking of ROKS "Cheonan," 2010). It appears that the torpedo detonated prior to contacting the *Cheonan*'s hull. This tactic is designed to capitalize of the shockwave and bubble effect of an underwater explosion, thus reducing the warhead size and number of weapons needed to sink a large vessel targets (Investigation Result on the Sinking of ROKS "Cheonan," 2010).

This has significant implications for the use of submersibles as improvised subsurface weapons. On October 12, 2000, the *USS Cole* was attacked via a conventional boat loaded with approximately the same amount of high explosives used in the torpedo that sunk the *Cheonan* (Sniffen, 2000). Although the *USS Cole* was about 200 feet longer than the *Cheonan*, the increased effectiveness of an underwater explosion as opposed to a surface attack cannot be discounted. In addition, it may result in the use of submersibles being used as the weapon of choice to commit grand acts of maritime terrorism. Although there are many factors involved in an underwater explosion that are beyond the scope of this paper, the prospect of using submersibles for underwater attacks has historical precedence and must be explored.

In addition to the attack on the USS Cole, two other suicide surface vessel attacks were carried out against the oil tankers *Limburg* and *M Star* by al Qaida operatives. These three attacks all used a single small boat to carry out a waterborne improvised explosive devices (WBIED) suicide attack against a much larger ship but none resulted in the sinking of any of the target vessels.

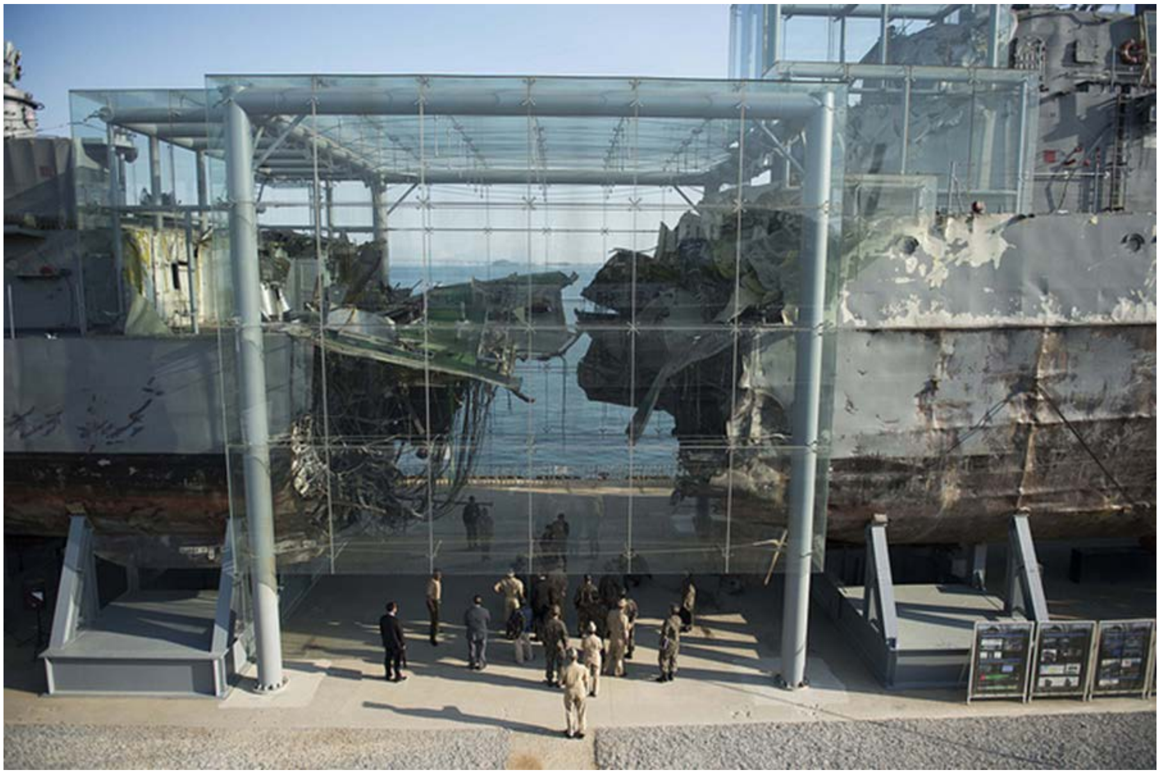

Figure 4. Damage to the *Cheonan* from a Torpedo Detonation (From CNO Visits ROKS Cheonan Memorial, 2013)

Figure 5. Damage to the *USS Cole* from a WBIED Attack (From Sutton, 2011)

6. Iran

Iran is a nation state that is currently on the U.S. State Department's list of state sponsors of terrorism (U.S. State Department, 2012). Currently, Iran operates mini-subs and low-profile torpedo boats as part of its naval forces. These mini-subs could be used against civilian and military shipping in the Straits of Hormuz to stop or significantly impede the flow of oil from the Arabian Gulf. Iran initially purchased mini-subs from North Korea but has since developed the organic capability to manufacture them domestically (Pappalardo, 2010).

This is an example of how the proliferation of submersible technology has transpired to give developing nations an offensive capability that they were not able to develop on their own. Submersible technology has become a market commodity that is subject to economic factors such as economies of scale and supply and demand forces. North Korea and Iran both have the intent and the capability to use this technology in the furtherance of their strategic objectives.

Iran could further complicate the maritime security of other nations by facilitating the cross-pollination of technology, possibly through intermediaries such as Hezbollah, to other nations that share their ideology and/or hatred of Western culture. Iran has been experiencing increasingly harsh economic sanctions and the illicit market for submersible technology could provide a lucrative source of revenue. Additionally, if Iran were to provide submersible technology to a drug trafficking organization (DTO) in Central America in exchange for cash, it would receive the secondary benefit of contributing to an action that would ultimately cause harm to the United States without having to actually commit and overt act.

Figure 6. Iranian *Ghadir* Class Mini-Subs (From Iran Launches Four New Home-Made Mini Submarines, 2010)

B. TERRORIST AND INSURGENT USE OF SUBMERSIBLES

Just as nation states have used submersibles to achieve military objectives or to fulfill intelligence collection requirements, some terrorist groups and insurgencies have also sought to obtain submersible technology. The submersible platform is ideally suited to conducting asymmetric warfare and would be attractive to any terrorist organization with a maritime nexus. This section proves brief overview of some of the more significant instances of terrorist and insurgent use of submersible technology.

1. American War of Independence

The 13 British Colonies in North America utilized unconventional tactics to conduct an insurgency campaign against the nation of Great Britain. The tactics employed against a vastly superior enemy by the Colonists were radical departures from normal military doctrine; thus, these freedom fighters were considered terrorists. The American rebels adopted many asymmetric warfare tactics and were the first to use a submersible vessel to conduct a naval attack. David Bushnell, a scientist, developed the fully-submersible *Turtle* to deliver and attach a 150 lb. mine containing black powder to the hull of a British ship. On September 6, 1776, volunteer Sergeant Ezra Lee conducted the first ever submersible combat mission against the British flag ship *HMS Eagle* in New York harbor (Gunton, 2003, p. 10). The *Turtle* was egg-shaped and made of wood and was operated by hand-cranked propellers and foot pedals that controlled ballast. This and two other attempts at submersible attacks by the *Turtle* were unsuccessful in sinking any enemy ships but these actions changed naval warfare forever (Dunmore, 2002, p. 13–15). Although tactically unsuccessful and technologically crude, this innovation solidified the submersible as a viable weapon system nearly 237 years ago.

Figure 7. Replica of the Fist Submersible Combatant Vessel the *Turtle* (From *The Submarine Turtle*, n.d)

2. Moro Islamic Liberation Front (MILF)

In the late 1990s, the largest guerilla organization in the Philippines, the Moro Islamic Liberation Front (MILF), attempted to purchase a complete mini-submarine from the nation of North Korea. The MILF have ties to al Qaida, and this attempt was part of ongoing arms sales from North Korea to the MILF (Report: North Korea Armed Islamic Group in Philippines, 2005). It was reported that the MILF had actually paid $1 million of the $2.2 million price tag to North Korea as a down payment on the mini-sub (Schippert, 2006). This transaction was interrupted when details were uncovered by U.S. intelligence efforts and pressure was applied to the North Koreans by the United States to abort the deal (Schippert, 2006).

Although the MILF's efforts were unsuccessful, this scenario indicates how easy it may be for terrorist groups to obtain submersible technology from a country that supports terrorism. Countries that support terrorism, either directly or indirectly, are often the subject of economic sanctions and the opportunity to obtain funds from the selling of arms can be an attractive venture. Additionally, countries that support terrorism may be more inclined to share submersible technology with terrorist organizations out of a mutual hatred for a common enemy. The proliferation of submersible technology is a very serious threat that can quickly bolster an adversary's maritime capability in a very short time span. This danger does not necessarily mean that a country would only have to sell a complete submersible to a terrorist group to have a major impact on a group's capabilities, but this proliferation of technology can come from providing technical assistance and training, submersible components and parts, and communication and navigation equipment.

3. Revolutionary Armed Forces of Columbia (FARC)

In 2011, Columbian authorities confiscated two submersibles belonging to the Revolutionary Armed Forces of Columbia (FARC) in the jungles near Columbia's Pacific coast (Cullinan, 2011). These submersibles were estimated to be worth approximately $2 million each due largely to the sophisticated communication and navigation equipment that was found onboard (Colombians Seize $2M FARC Drug Submarine, 2011). It was estimated that these vessels could carry a crew of five, transport approximately seven to 10 tons of illegal drug cargo, and remain submerged for up to 10 days at a depth of 16.5 feet (Colombians Seize $2M FARC Drug Submarine, 2011). There have been other semi-submersibles and fully-submersible vessels captured in Columbia. Although it is unknown if these had any ties to the FARC, the possibility remains valid.

It remains unclear whether or not the FARC actually made or obtained these submersibles and if they were actually intending on operating them, selling them, or merely guarding them. The FARC have been known to cultivate drugs to finance their operations (Vargas, 1999); therefore, this would be a departure from their usual modus operandi since the submersibles are used further in the distribution chain beyond Columbia's borders. It would appear that the FARC's involvement with submersibles was motivated by financial gain, and that they were not intended to be used as tactical weapons against the government of Columbia. The capture of these vessels could indicate that there is a growing secondary market for submersible technology in South and Central America and that there continues to be significant intelligence gaps.

4. Liberation Tigers of Tamil Eelam (LTTE)

The Sri Lankan militant separatist group, Liberation Tigers of Tamil Eelam (LTTE), is another example of a terrorist group with aspirations for using submersible technology. There is no open source report that the LTTE ever used a submersible to attack Sri Lankan forces; however, several underwater vehicles, in various states of completion, have been captured in LTTE clandestine camps. In one operation, the Sri Lankan army raided a jungle ship building facility that contained a 35-foot long, armor-plated underwater vehicle and various other smaller submersibles (Preuss, 2009). These vessels appeared to be capable of fully-submersible operation and could have been used to transport weapons and personnel or to be outfitted as a submersible WBIED (Preuss, 2009).

The LTTE was the first terrorist group to use the tactic of suicide bombing, and this weapon was frequently utilized by their maritime branch, the Sea Tigers. If the LTTE had been allowed to continue develop its underwater capability, it is reasonable to project that these submersibles could have been used in suicide attacks against Sri Lankan naval targets. This would have been a recombining of technology and tactics to produce an extremely disruptive innovation not seen since World War II. This would make this tactic extremely attractive to other groups seeking to inflict maximum damage to maritime targets such as surface vessels while avoiding surface defenses.

C. DRUG TRAFFICKING ORGANIZATION'S (DTO'S) USE OF SUBMERSIBLES

DTOs in South and Central America have been using various submersibles as part of their illicit drug distribution network since the early to mid-1990s. It is speculated that as aviation and marine interdiction efforts by law enforcement and military forces became increasingly effective that DTOs began to adapt their tactics. The natural technological evolution in smuggling operations was the rejection of speed in favor of stealth (Popkin, 2011). These early attempts were crude and were not capable of self-propulsion. These submersible contraptions were towed behind fishing trawlers in an attempt to avoid detection even if the trawler was boarded. In 1999, a more sophisticated "narco-torpedo" was developed and entered service. Although these "narco-torpedoes" were still a towed apparatus the level of technical sophistication was increasing. Their shape transitioned from crude contraptions to a finned, dart-shaped tube outfitted with radio transponders to aid in their recovery in the event they had to be discarded (Popkin, 2011).

The next technological development was the development of the self-propelled semi-submersible or SPSS platform. Fishing trawlers used to tow the "narco-torpedoes" were easily detectable, and they could be interdicted if suspected of illicit activity. The transition to a fully autonomous semi-submersible vessel was an attempt to capitalize on the increased stealth capabilities of the SPSS. This transition was also partially fueled by the increasing availability of sophisticated navigation and communication systems such as Global Positioning System (GPS) navigation equipment. The major technical characteristics of a typical drug running SPSS are:

- **Dimensions**: 40–80 feet in length with a freeboard (exposed area above the waterline) of approximately 18 inches.
- **Composition**: Fiberglass/wood or steel. Usually takes upwards of 1 yr to build.
- **Propulsion**: Self-propelled; single or twin diesel engines; 1500 or more gallon fuel capacity.
- **Speed**: 6+ knots.
- **Range**: Approx 2,000 miles.
- **Capacity**: 4 persons, 4 to 12 metric tons of cocaine.
- **Control**: Human or Remote Control.
- **Cost**: Approx $2 million (USD). (Joint Interagency Task Force South, 2008)

In the complex adaptive environment of drug smuggling, nothing remains static for very long, and authorities began to learn how to detect and interdict SPSSs. Effort was then made to reduce the vessels infrared signature by directing exhaust pipes into the water and the exteriors were painted blue in order to match the color of the ocean. In an attempt to avoid confiscation, SPSS were outfitted with sophisticated valve systems that allowed their crews to scuttle their vessel within minutes of detection. The motivation in scuttling the SPSS in the event of detection was that if no drugs could be recovered from the vessel then the crew would not be charged with narcotics trafficking. A SPSS is typically only used once so this innovation has dual purpose as the vessel will be scuttled when its mission is complete (Kraul, 2008).

These technological advances were the result of escalation and adaptation in the realm of drug trafficking and mirror the same processes that were emerging during the Battle of the Atlantic. In both the Battle of the Atlantic and the current "war of drugs," strategy drives technological innovations and thus tactics. As an adversary develops tactical efficiencies derived from technology, then its opponent is forced to innovate to counter these efficiencies. As long as both parties are willing and capable of pursuing their strategic objectives, then this duel of innovation will continue to manifest itself.

These SPSS technical innovations seemed to be internally derived, but there is some evidence that DTOs were attempting to leverage submersible technology from external sources. For example, in September 2000, Columbian police found a partially completed fully-submersible submarine about 350 miles from the Columbia's Pacific coast (Jane's Terrorism and Security Monitor, 2008). The vessel was 30 meters long and had an estimated cargo capacity of 200 tons (Jane's Terrorism and Security Monitor, 2008). According to evidence obtained from the scene, this submersible was being constructed with the use of Russian technology and the efforts of Russian and U.S. naval engineers (Jane's Terrorism and Security Monitor, 2008). It is unknown whether these naval engineers were military and/or civilian personnel. Police were able to link the subs construction to Cali's North of the Valley drug cartel, which was known to have close ties to Russian organized crime (Jane's Terrorism and Security Monitor, 2008). This incident is another example of how the proliferation of submersible technology can be used to give criminal organizations and terrorist groups accelerated technological advantages in the submersible arena.

As illustrated in the above example, DTOs continue their quest for fully-submersible vessels in order to insure the reliability and the effectiveness of their supply chain operations. A self-propelled, fully-submersible or SPFS capability would allow drug traffickers to operate virtually undetected along the coasts of Central and South America. In another example, on July 2, 2010, authorities in Ecuador confiscated a nearly completed 74-foot fully-submersible submarine made of Kevlar and carbon fiber (Popkin, 2011). In addition, it utilized Chinese diesel engines on the water's surface and battery-powered electric motors when submerged. The 249 lead-acid batteries could allow the sub to travel silently underwater for up to 18 hours before having to recharge (Popkin, 2011). Furthermore, the vessel was configured for a crew of four to six and could dive to depths of 62 feet (Popkin, 2011). The sub's estimated maximum operational range was 6,800 nautical miles on the surface, and it could sail for 10 days before having to refuel (Popkin, 2011). Additionally, the vessel was outfitted with a GPS chart plotter with side-scan capabilities, a high-frequency radio, an electro-optical periscope, and an infrared camera mounted on the five-foot high conning tower (Popkin, 2011). Finally, this sub is estimated to have cost $5 million to build and its cargo capacity was estimated at approximately nine tons of cocaine that would be worth about $250 million[3] on the streets of the U.S. (Popkin, 2011).

[3] 1 metric ton = 1,000 kilograms = 1,000,000 grams x 9 = 12,000,000 grams/submersible. In 2007, the U.S. Drug Enforcement Agency estimated that the average retail price of a gram of pure cocaine being sold in the U.S. to be $118.70. The total retail value of a single nine metric ton shipment of cocaine would be estimated to be approximately $1,068,300,000. Source: Cocaine Price/Purity Analysis of STRIDE Data. (n.d.).

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III. PRIVATELY OWNED AND OPERATED SUBMERSIBLES

A. THE PRIVATE SUBMARINE COMMUNITY

Innovations in submersible technology have spawned new uses for submarines and have made them available to more people than any other time in history. As submersible technology matures, the barriers to engage this technology dissipate resulting in increased global access to submarines by groups and individuals. This new accessibility to submersibles has fostered new applications and markets that were inconceivable even just a few years ago. The trend in submersible technology has been largely been incremental, but submersible technology is being recombined in ways that are potentially disruptive and have the capability to change the equilibrium of the maritime transportation system in both positive and negative ways.

At one point in time, the concept of the average citizen owning and operating a personal submarine would have made a great subject for a science fiction story, but this is a new reality that HS policymakers must accept. An unknown number of privately owned submarines are operating within the territorial waters of the U.S., and they vary a great deal in regards to availability, price, and technical capabilities. Private subs can be found in a variety of locations and are used for many different purposes. There are some very specific market segments for private submarines such as luxury, tourist, working, research, and recreational. An example of a specific population of privately owned submarines is colleges, universities, and research institutes that study the subsurface marine environment. Additionally, marine salvage companies and oil rig service providers use private submarines in the course of the commercial maintenance services that they provide.

Some privately owned submersibles are owned operated by commercial tour companies and resorts that give paying passengers the opportunity of viewing underwater environments. The first true tourist submarine was the *Auguste Piccard*, was built in Switzerland in the early 1960s (Committee on Assessing Passenger Submersible Safety, 1990, p. 2). This vessel carried 40 passengers and a crew of four up to depths of 820 feet in Lake Geneva. Between 1964 and 1965, the *Auguste Piccard* carried 32,000 paying passengers on 1,112 dives (Committee on Assessing Passenger Submersible Safety, 1990, p. 2). In addition, the first commercial passenger submarine in U.S. waters initiated operations in 1987 in St. Thomas, U.S. Virgin Islands (U.S. Coast Guard, 1993). As of 1996, there were 48 purpose built tourist subs and seven converted deep submersibles operating world-wide carrying an estimated two million passengers annually. (U.S. Submarines, 1996). In 1989, there were seven tourist submersibles operating in U.S. waters, which was the largest number under a single national jurisdiction (Committee on Assessing Passenger Submersible Safety, 1990, p.1). As of January 2012, a query of the U.S. Coast Guard's Marine Information for Safety and Law Enforcement (MISLE) database indicated a total federally registered population of approximately two dozen submersible or submarine type vessels in the United States[4] although not all may be currently in operation.

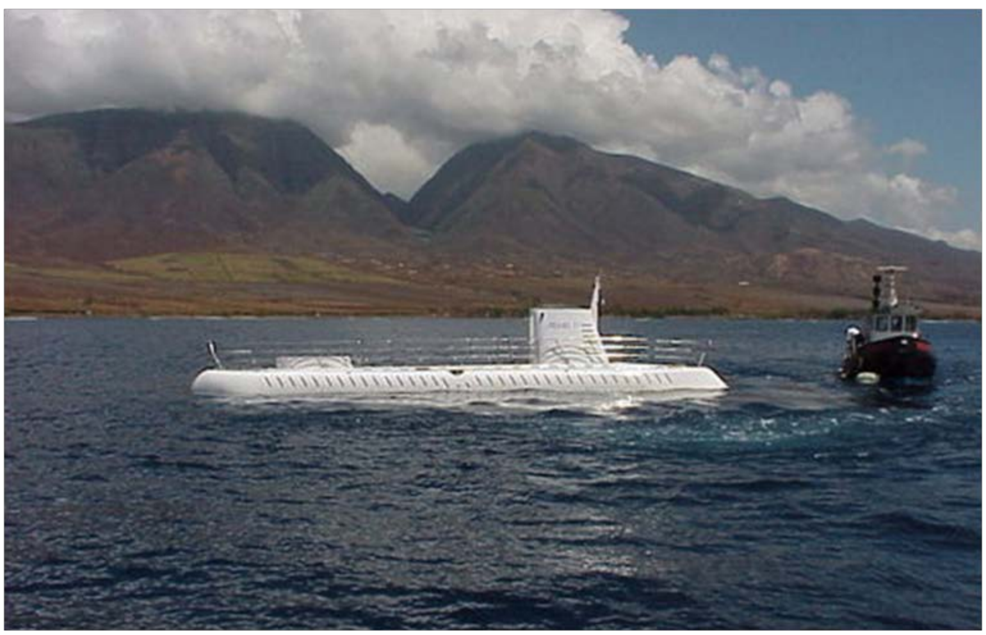

Figure 8. Privately Owned Tourist Submersible
(From Atlantis Submarine off Maui, Hawaii, n.d.)

[4] The Marine Information for Safety and Law Enforcement (MISLE) is a database system managed and used by the United States Coast Guard (USCG). The MISLE is used to store various data on vessels and facilities (U.S. Coast Guard, 2012).

One of the most intriguing and least understood populations of personal subs in the U.S. is the private submarine enthusiast segment of the recreational boating community. These personal pleasure craft can range in price from millions of dollars for a luxury yacht-type sub to a few thousand dollars for a basic "do-it-yourself" project. These personal submarines can be either home built in a garage from scratch or can be commercially purchased as off-the-shelf completely operational submersible vessels. There are clubs and organizations devoted to the hobby of personal submarine construction, ownership, and operation. The motto from one such organization, known as the Personal Submersible Organization,[5] is "To promote and encourage discussion of safety, design, construction, and operation of Personal Submersibles" (Personal Submersible Organization, 2012).

These clubs seem to be primarily focused upon sharing and promoting the hobby of submersible construction and operation rather than being a lobbying or representative organization as there is no current effort to restrict or regulate these vessels. The growing popularity and availability of personal submarines is a weak signal that homeland security policymakers should closely monitor as it could have significant implications for the safety and security of the maritime transportation system (MTS) if this technology were exploited for nefarious purposes.

B. REMOTELY OPERATED VEHICLE (ROV) TECHNOLOGY

Technology in the maritime environment is rapidly advancing, and the use of remotely operated vehicles (ROV) is another area for examination with regards to submersibles. ROVs have been controlled by tethered cables for many years, but technology now allows for wireless remote control. The *Protector* is an unmanned surface vessel (USV) developed in Israel for maritime anti-terrorism missions. This unmanned vessel is controlled via secure data links and can transmit video and other data back to the operator. The *Protector's* operator can employ weapons while being located

[5] In 2011, the Personal Submersible Organization was comprised of 53 active members (Popkin, 2011).

safely miles from the incident. The use of this type of technology to control submersibles may not be fully viable yet, but it is a trend to be monitored (Hanlon, 2006).

Additionally, the use of radio controlled technology could also eliminate the need for a submersible pilot and crew. Although technologically crude, small radio controlled submarines are currently available from hobby shops and this technology could be exploited in the future to turn a remotely operated submersible into an unmanned guided weapon. These hobbyist submersibles can be ordered with still and/or video cameras that would allow for the underwater reconnaissance of maritime critical infrastructure/key resource (MCI/KR) by individuals with ill intent (Tower Hobbies, 2012). In addition, the progression of DTO submersible technology is moving towards developing SPSS/SPFS vessels that are fully remotely operated, which would eliminate the need to recruit crews for these smuggling missions (Columbian Narcosubs, 2009).

Figure 9. Remotely Operated Thunder Tiger Neptune SB-1 Submarine (From Tower Hobbies, 2012)

C. UNREGULATED VS. REGULATED VESSELS

On July 20, 1993, the U.S. Coast Guard released Navigation and Vessel Inspection Circular (NVIC)[6] No. 5-93 entitled "Guidance for Certification of Passenger

[6] a navigation and vessel inspection circular (NVIC) provides detailed guidance about the enforcement or compliance with a certain Federal marine safety regulations and U.S. Coast Guard marine safety programs. While NVICs are non-directive, meaning that they do not have the force of law, they are important "tools" for complying with the law (U.S. Coast Guard, 2011).

Carrying Submersibles." This NVIC provides tourist submarine manufactures and operators a frame of reference for certification procedures under Title 46, Code of Federal Regulations (CFR), Subchapter T, Small Passenger Vessels (under 100 gross tons). This document defines when a private submersible is required to be regulated under the CFRs and when one is not. Basically, any submersible vessel under 100 gross tons that that carries more than six passengers for hire will be subject to 46 CFR, Subchapter T (U.S. Coast Guard, 1993). The implication for this is that these vessels must be inspected by the USCG, and the operator must be licensed by the USCG. The licensing process requires that the mariner undergo a background check and hold a Transportation Worker Identification Credential (TWIC)[7] card. It should be noted that private submersibles could be built larger than 100 gross tons and thus would be subject to additional provisions of 46 CFR and 33 CFR Part 104 of the Maritime Transportation Security Act (MTSA) of 2002.[8]

Submersibles under 100 gross tons that are used for private recreational purposes are not subject to federal regulation but must comply with 33 CFR, Subchapter S (boating safety regulations for federal waters). These regulations require that a recreational submarine be numbered in accordance with the federal numbering system or the numbering system of the state where the vessel will be mainly operated. Additionally, these vessels must also comply with federal and/or state boating regulations with regards to carrying safety equipment such as life preservers, sound producing devices, visual distress signals, and compliance with marine pollution regulations (U.S. Coast Guard, 1993). Operators of these uninspected vessels are not required to have a license unless

[7] TWIC was established by Congress through the Maritime Transportation Security Act (MTSA) and is administered by the Transportation Security Administration (TSA) and U.S. Coast Guard. TWICs are tamper-resistant biometric credentials issued to workers who require unescorted access to secure areas of ports, vessels, outer continental shelf facilities and all credentialed merchant mariners (Transportation Security Administration, 2012).

[8] The Maritime Transportation Security Act of 2002 (MTSA) is designed to protect the nation's ports and waterways from a terrorist attack. This law is the U.S. equivalent of the International Ship and Port Facility Security Code (ISPS) and was fully implemented on July 1, 2004. It requires vessels and port facilities to conduct vulnerability assessments and develop security plans that may include passenger, vehicle, and baggage screening procedures; security patrols; establishing restricted areas; personnel identification procedures; access control measures; and/or installation of surveillance equipment. By creating a consistent security program for all our nation's ports, we are better able to identify and deter threats (U.S. Coast Guard, n.d.).

required by state law. Furthermore, no federal background check or TWIC card is required to own or operate a recreational submersible.

Since private submersibles are generally unregulated and can be purchased by just about anyone, there is a potential marine safety implication regarding their ownership and operation. The use of these vessels by incompetent or reckless persons could pose a significant hazard to marine navigation. The negligent operation of a submersible could lead to a collision that could result in a major marine casualty. The results of a collision with a submersible could be far worse for a ship than if the ship had collided with a surface vessel because most of the damage would occur below the ship's waterline. The local USCG Captain of the Port (COTP)[9] can impose local operating restrictions on these recreational subs relative to navigation safety, port safety and security, and vessel traffic considerations; however, the COPT must have awareness of the existence an operation of these vessels in order to take prudent and timely action (U.S. Coast Guard, 1993).

D. MARITIME DOMAIN AWARENESS (MDA)

According to the National Plan to Achieve Maritime Domain Awareness (MDA), the definition of the maritime domain is "all areas and things of, on, under, relating to, adjacent to, or bordering on a sea, ocean, or other navigable waterway, including all maritime related activities, infrastructure, people, cargo, and vessels and other conveyances" (The White House, 2005, p. ii). MDA is defined as "the effective understanding of anything associated with the maritime domain that could impact the security, safety, economy, or environment of the United States" (The White House, 2005, p. ii). Having a complete understanding of what is happening in the maritime domain is essential for effective and efficient strategic, tactical, and operational planning and decision making.

Marine Information for Safety and Law Enforcement (MISLE) only captures data on regulated submersibles and does not have data on the population of recreational subs in operation. Since most personal subs are not regulated and state and federal records are

[9] The Captain of the Port (COTP) is designated by the Commandant of the Coast Guard to enforce regulations for the protection and security of vessels, harbors, and waterfront facilities; anchorages; bridges; safety and security zones; and ports and waterways (Captain of the Port, n.d.).

sparse, there is no central database or other information management tool that can accurately state how many recreational submersibles are owned and operated within the territorial waters of the U.S. Without an accurate census of these vessels, it is impossible to estimate any potential risks associated with them. With regards to privately owned submersible vessels in the U.S., there is a serious gap with regards to achieving a level of MDA useful to homeland security policymakers. Unless policymakers can obtain meaningful data in regards to privately owned submersibles, it will be virtually impossible to estimate any potential threat that they pose or where the maritime transportation system is vulnerable (The White House, 2005, p. 1).

E. PRICE AND AVAILABILITY

Completely functioning personal subs are available from a variety of sources, or they can be built from scratch using complete plans purchased on the internet. There are several companies that deal in the manufacture and sale of new and used submersibles for many of the existing market segments. Some of these companies will even provide submersibles for charter. Most of these companies require that the purchaser obtain training on how to operate the submersibles that they provide before completing the sale. Submersibles can also be purchased from private owners just as used cars, boats, or airplanes. Submersibles are becoming more affordable and thus more available to a larger segment of the public. For a new tourist submarine venture, it is estimated that a 48-passenger submarine would cost approximately $3.7 million in 1996 with an additional $2 million needed in additional start-up expenditures (U.S. Submarines, 1996). The following examples (Figures 10–15) are used to demonstrate the variety of some of the private submersibles currently available for purchase. These examples are for academic purposes only, and in no way represent an endorsement of any particular vessel or manufacturer.

Figure 10. Marion Submarine-Powerboat (From Kamakshi, 2010)

Name: Marion Submarine-Powerboat
Type: Fully-Submersible
Capabilities: Maximum surface speed 40 knots; maximum surface range 500 miles, and maximum diving depth of 250 feet.
Cost: $ 3.5 million (USD) (Kamakshi, 2010)

Figure 11. Fully-Submersible *Tour Sub* (From International VentureCraft Corp, 2011b)

Name: Tour Sub
Type: Fully-Submersible
Capabilities: Maximum diving depth of 40 feet. Features an Auto-Hover system, built-in SONAR, Fly-By-Wire Joystick, Electronic Buoyancy Control, and Electrical Systems Monitor.
Cost: $ 350,000 (USD) (International VentureCraft Corp. 2011b)

Figure 12. *Seabreacher* Semi-Submersible Vessel (From Seabreacher, 2010)

Name: Seabreacher
Type: Semi-submersible
Capabilities: Maximum surface speed 40 knots; maximum sub-surface speed knots; and maximum diving depth of six feet for brief durations.
Cost: $65,000 (USD) (Seabreacher, 2010)

Figure 13. Fully-Submersible SportSub III (From International VentureCraft Corp, 2011a)

Name: SportSub III
Type: Fully-Submersible
Capabilities: Maximum diving depth of 130 feet. Features include a Fly-By-Wire Joystick, Electronic Buoyancy Control, and Electrical Systems Monitor.
Cost: $ 59,000 (USD) (International VentureCraft Corp, 2011a)

Figure 14. Fully-Submersible *K-350* "*Lake Diver*" (From Personal Submersibles Organization, 2012b)

Name: Kittredge Model K-350 "Lake Diver"
Type: Fully-Submersible
Capabilities: Maximum diving depth of 350 feet. Includes side-scan sonar, hydrophone, gyro-compass, emergency buoy, and O2 thru-hull fittings and portable O2 meter.
Cost: $45,000 (USD) (Personal Submersibles Organization, 2012b)

Figure 15. Semi-Submersible *AquaSub* (From AquaSub: A One-Man Sports Submarine, 2010)

Name: AquaSub
Type: Semi-Submersible
Capabilities: Maximum diving depth of 40 inches.
Cost: $45(USD) for complete plans. Estimated construction cost is approximately $2,000 (USD). (AquaSub: A One-Man Sports Submarine, 2010)

IV. RISK: VULNERABILITIES, THREATS, & CONSEQUENCES

The terrorist use of a small submersible vessel to conduct a maritime attack against the United States would have to be considered a classic "black swan" event (Taleb, 2010). The use of a private submarine to conduct a high consequence terrorist attack is highly improbable but not impossible, and thus this scenario warrants attention from HS policymakers. A submersible attack perpetrated against the MTS would constitute an incident of national significance (IONS)[10] and would require huge amounts of resources for response, mitigation, and recovery efforts. Furthermore, due to limitations in MDA, it would be impossible to predict such an attack, and a successful attack would have a massive negative impact on the MTS. In addition, the overall shock value would be stunning because most people could never conceive of such an event occurring in the maritime domain.

The development and evolution of the semi-submersible and fully-submersible vessel use by terrorists is an incremental innovation in technology that has been occurring over hundreds of years. Submersible technology has the potential to quickly morph into a disruptive and destructive innovation if the technology is applied for the attainment of terrorist objectives. This continuous cycle in asymmetric warfare of the incremental use of technology and innovation by both terrorists and those organizations opposed to them in an effort to defeat each other's respective tactics is known as "incrementalism" (Buky, 2007). Currently, there is no specific MHS strategy or plan to address incrementalism as it relates to the submersible threat.

An analogy can be made between the private use of small submersibles by terrorists to the events experienced by the aviation community on September 11, 2001. Initially aviation was a disruptive technology but gradually settled into an incremental phase of development. Even the use of aircraft as weapons of war was incremental in nature until World War II when the Japanese employed the use of suicide pilots known as

[10] IONS are high-impact events that require an extensive and well-coordinated multiagency response to save lives, minimize damage, and provide the basis for long-term recovery (U.S. Department of Homeland Security, n.d. b).

the kamikaze. This disruptive innovation was impossible to predict, had massive impact, and was stunning—a classic black swan scenario. Unfortunately, this tactic was all but forgotten until on September 11, 2001 when four civilian airliners were used to inflict massive damage upon the United States resulting in a black swan event.

The use of submersible vessels as weapons has been incremental from the Revolutionary War until World War II when the Japanese employed the use of suicide mini-submarines known as the kaiten. This maritime attack mode mimicked the kamikaze attacks but did not rise to the level of a black swan event. This may be due in part to two factors, the first one was that kaiten attacks were less numerous than kamikaze attacks and thus resulted in fewer successful attacks (Ishiguro, 2009; Historic Naval Ships Association, 2008; World War II in the Pacific, 2009). The second contributing factor may be that many kamikaze attacks were filmed by combat photographers allowing the American public to see these attacks in their local movie theaters, which provided a visual context for understanding the effectives and impact of this tactic. Due to the capability of technology to project images, video, and audio almost instantaneously to the entire world, the tactic of using a submersible as a suicide weapon of mass effect has the potential to be a black swan event just as the terrorist exploitation of civilian aviation assets was in September 2001. The challenge for the HSE is to quantify and then mitigate the risk posed from submersible technology.

A. RISK

Risk is the potential for an unwanted outcome resulting from an incident, event, or occurrence, as determined by its likelihood and the associated consequences. Additionally, it is the potential for an adverse outcome assessed as a function of threats, vulnerabilities, and consequences associated with an incident, event, or occurrence and may manifest at the strategic, operational, and tactical levels. In order to understand risk as it relates to the use of a submersible to conduct a terrorist attack, both threats and vulnerabilities must be examined and analyzed (DHS, 2010, p. 27).

B. VULNERABILITIES

The definition of *vulnerability* is a physical feature or operational attribute that renders an entity, asset, system, network, or geographic area open to exploitation or susceptible to a given hazard (DHS, 2010, p. 38). The extended definition of *vulnerability* is a characteristic of design, location, security posture, operation, or any combination thereof, that renders an entity, asset, system, network, or geographic area susceptible to disruption, destruction, or exploitation (DHS, 2010, p. 38).

Since the effectiveness of the maritime transportation system (MTS) is dependent upon the freedom of movement of vessels, passengers, and cargo the whole system has inherent vulnerability. There must be equilibrium in the system to insure and support both system security and the facilitation of commence. Since there is persistent system vulnerability, terrorists or criminal organizations can seek to exploit these vulnerabilities to further their own causes. Furthermore, system vulnerabilities will dictate what tactics are used by terrorists or criminal organizations. The SVSS indicates that small vessels could be used to execute four different types of scenarios by terrorists. Of these four scenarios, the following are ideally suited to the use of a small submersible in order to exploit current MTS vulnerabilities:

1. Smuggling a WMD in the U.S.
2. Smuggling a terrorist into the U.S.
3. Use as a WBIED. (DHS, 2008)

These three scenarios would be of primary concern to homeland security policymakers with in regards to identifying and mitigating the potential threat posed by small submersibles.

C. THREAT

The DHS Risk Lexicon defines *threat* as a natural or man-made occurrence, individual, entity, or action that has or indicates the potential to harm life, information, operations, the environment, and/or property (DHS, 2010, p. 36). For the purposes of assessing risk, the threat of an intentional hazard is generally estimated likelihood of an attack that accounts for both intent and capability of an adversary (DHS, 2010, p. 36). In order for the above scenarios to be plausible when considering the potential for a SPSS attack, the assumption must be made that an international terrorist organization currently possess a WMD and/or WME (i.e., large quantities of explosives) in a region where DTOs operate SPSS vessels. Additionally, the assumption must be made that both organizations are willing and able to synthesize their individual intent and capabilities to form a collaborative threat.

1. Capability

Capability is simply the means to accomplish a mission, function, or objective (DHS, 2010, p. 9). International drug trafficking organizations have demonstrated that they possess the technological means needed to transport a WMD/WME or terrorist via a SPSS to the coastal waters of the United States from Central America. Moreover, the current fleet of DTO owned SPSS vessels has the necessary range to reach the United States, especially if refueling and replenishing can be accomplished during the voyage.

It should be noted that there are no open source accounts of any semi-submersible or fully-submersible vessels operated by DTOs being detected and/or intercepted within U.S. waters even though these vessels have that capability. The current tactics, techniques, and procedures (TTPs) used by these criminal organizations dictate that most of these vessels off load their cargoes in Mexican waters. The merchandise is then sub-dived into smaller parcels for transport to the final U.S. market via the land border between the United States and Mexico (Kash & White, 2010). This current supply chain structure may be the result of the perception of detection, and thus perceived interdiction, by U.S. maritime law enforcement agencies and/or the ease of ground transport across the U.S. southwestern land border. SPSS and SPFS vessels operated by DTOs have the technical capabilities to form a significant threat against the MHS enterprise, but there needs to be an element of hostile intent to inflict damage upon MTS in order to solidify the establishment of a credible threat.

2. Intent

Intent can be defined as a state of mind or desire to achieve an objective (DHS, 2010, p. 19). In the proposed scenario of a DTO owned and operated submersible vessel being used to transport a WMD/WME to the shores of the U.S., HS policymakers must assume that a DTO and an international terrorist organization (ITO) must form a mutually beneficial relationship. An ITO may clearly intend to deploy the WMD but lack the logistical capability to complete the threat formulation. The theory promoted by some HS practitioners that is driving such scenario based planning is that these two separate, and often conflicted, entities will combine their hostile intent and technical capability to formulate a viable and credible submersible threat (Allen, 2007, p. 75; Homeland Security Daily Wire, 2008).

3. Motivation and Ideology

Members of terrorist groups and criminal organizations are by and large committed operatives working collectively to achieve their group's respective organizational objectives. A terrorist group's motivations are, in most cases, are based entirely on ideology, and their selection of tactics and targets is based upon accomplishing strategic objectives that support their core ideological beliefs. In order for a terrorist group to achieve an operational victory, it will commit acts of violence to:

- Produce widespread fear
- Obtain worldwide, national, or local recognition for their cause by attracting the attention of the media
- Harass, weaken, or embarrass government security forces so that the government overreacts and appears repressive
- Steal or extort money and equipment, especially weapons and ammunition vital to the operation of their group
- Destroy facilities or disrupt lines of communication in order to create doubt that the government can provide for and protect its citizens
- Discourage foreign investments, tourism, or assistance programs that can affect the target country's economy and support of the government in power
- Influence government decisions, legislation, or other critical decisions
- Free prisoners
- Satisfy vengeance

- Turn the tide in a guerrilla war by forcing government security forces to concentrate their efforts in urban areas. This allows the terrorist group to establish itself among the local populace in rural areas. (Terrorism Research, 2012)

Terrorist groups are not generally motivated to commit violent acts for profit or for financial gain. While terrorist groups may engage in crimes that result in financial gain, these funding activities are usually used to finance operations that support their fundamental ideology and mission accomplishment. The most likely scenario that could lead to collusion between a DTO and an ITO would be a cooperative joint venture that facilitated financial gain for both entities, such as a narcotics distribution network. This type of alliance could lead to some cross pollination of technology as well as TTPs between these organizations in order to maximize return on investment (ROI) but organizational motivations could preclude full cooperation between them with respect to a submersible attack against the MTS.

A typical DTO's motivations are purely for financial gain although they effectively utilize terrorist tactics in the course of illicit operations. In addition, DTOs are criminal organizations that exist to generate profits, and they make strategic, operational, and tactical decisions that provide for the best ROI. Violent acts committed by DTOs usually support their business models in some way and are based entirely on the ideology of greed.

In order to persuade a DTO to transport a WMD, such as an improvised nuclear device (IND), via a submersible for an ITO, there would have to be an overwhelming economic advantage for the DTO decision makers. An ITO would most likely have to pay a premium price to secure the use of one of these submersible vessels and crews as well as logistical support functions. The value of the illicit cargoes carried by submersibles can easily exceed $100s of millions U.S. dollars (USD) and at an estimated cost of only $1–2 million USD per unit to build there are significant profits to be made from the use of a SPSS or SPFS vessel to transport illegal drugs (Joint Interagency Task Force South, 2008). This type of revenue stream allows DTOs to continuously upgrade their current submersible fleet capability either though internal research and development efforts or via the exploitation of currently available submersible technology. Furthermore, DTOs have the necessary resources to outright purchase fully operational submersible vessels on the open market, but no open source accounts indicate that this has yet happened. It is doubtful that any ITO would have the financial resources necessary to charter the use of a drug running SPSS/SPFS for a WMD/WME smuggling mission from an established DTO since the opportunity cost of a single voyage could exceed $275 million USD.[11]

Additionally, DTOs may be very reluctant to facilitate a grand act of aggression against the U.S. since that is their primary target market for their illicit drugs. It would not be a sound and prudent business model to help destroy the primary source of consumers of one's products if the long term objective was sustained profitability. As noted earlier, DTOs are reluctant to use submersible vessels to transport illegal drugs directly to U.S. waters because of potential detection and interdiction upon entering U.S. waters. Transporting a WMD/WME to a U.S. port would be a significant deviation from their current TTPs.

Furthermore, if a WMD attack were to be carried out by the delivery of a weapon via a DTO owned/operated submersible, the ominous reality of the retaliatory measures surely to be taken by the U.S. government would most likely render this option null and void for DTOs because of the negative risk return tradeoff. If there were valid evidence that a DTO participated in a major terrorist attack against the homeland of the U.S., a swift and decisive military response would certainly materialize, which could significantly alter the DTO's ability to function as it currently does. Moreover, this would be an exponential escalation of the "war on drugs" that DTOs would most certainly wish to avoid under current circumstances and market conditions. The success of the drone attacks against al-Qaeda terrorists and the raid conducted by U.S. special operations forces that resulted in the death of Osama bin Laden demonstrates to any DTO that the

[11] According to the Joint Interagency Task Force-South (JIATF-S) semi-submersible vessels used by DTO's can have a cargo capacity as large as 12 metric tons. 1 metric ton = 1,000 kilograms = 1,000,000 grams x 12 = 12,000,000 grams/submersible. In 2007, the U.S. Drug Enforcement Agency estimated that the wholesale price of a gram of cocaine being shipped in bulk quantities was $23.04. The total wholesale value in 2007 of a single 12 metric ton shipment of cocaine would be estimated to be approximately $276,480,000 (Cocaine Price/Purity Analysis of STRIDE Data, n.d.).

United States Government (USG) possesses the necessary intent and global capability to eliminate any perceived threat, and such actions would result in catastrophic market interruptions for the DTOs.

When examining intent and capability with regards to using a submersible to commit an act of terror, there are other potential perpetrators other than ITOs that must be considered. Since submersible technology has reached a point where almost any individual could build or buy a submarine, the possibility that a HVE or "lone wolf" actor could use one to commit an act of terror is a very real scenario that must be addressed by HS policy. This availability provides a HVE with the capability to conduct a submersible terrorist attack against high value maritime targets. A maritime attack using a submersible vessel could be planned and executed domestically by a single HVE with minimal capability and ill intent thus resulting in a meta-threat to the HSE.

The threat posed by a HVE is significantly different than the threat posed by a DTO. The most significant difference is that an unknown HVE often can plan and conduct operations without alerting law enforcement, while DTOs are already known to law enforcement and intelligence can be collected on them and their operations. Additionally, the HVE has the advantage of already being in the country legally while DTOs would have to penetrate the USG's maritime border security in order to successfully carry out a submersible attack scenario.

4. Social Amplification of Risk

There are psychological theories that could help explain the distortion of the perception of the actual threat posed by DTO operated submersible vessels. One possible theory to explain this phenomenon is social amplification of risk, which is a distortion of the seriousness of a risk caused by public concern about the risk and/or about an activity contributing to the risk that can result in public concern with an otherwise insignificant risk (DHS, 2010, p. 34). Social amplification of risk can be described as:

1. The phenomenon by which hazards interact with psychological, social, institutional, and cultural processes in ways that may amplify or attenuate the public's perceived level of risk.

2. The subject of a field of study that seeks to systematically link the technical assessment of risk with sociological perspectives of risk perception and risk-related behavior. (DHS, 2010, p. 34)

The name used to describe these vessels, self-propelled semi-submersible (SPSS), is technically accurate but somewhat misleading and can cause persons not familiar with maritime operations to infer that these vessels have capabilities that they do not actually possess (due the effects of social amplification of risk). A technically correct but verbose name for a typical small pleasure craft could be a self-propelled non-submersible (SPNS) vessel which is technically accurate but verbose. A SPSS is nothing more than a vessel that rides lower in the water than a typical boat and has no other special or unique attributes. These "low profile signature evading threats" are essentially conventional surface craft just like any other boat or ship but that are described by the use of acronyms and potentially misleading nomenclature (e.g., SPSS) (Kash & White, 2010). This psychological phenomenon can be described as a conceptual metaphor or cognitive metaphor that is the attempt to form a framework of understanding of one idea in terms of another idea or concept (Lakoff & Johnson, 1980).

The major difference between semi-submersibles and conventional vessels is the amount of the vessel's hull residing above the waterline. A larger portion of an SPSS's hull will be below the surface of the water when compared and contrasted to other conventional vessels. This is a major attribute of its stealth capability and resulting tactical advantage. This reduced visual profile makes detecting the SPSS vessel more difficult, but not impossible, than higher riding conventional craft. Other than speed and operational capabilities SPSSs are essentially the same as conventional vessels. Conversely, in order to maintain its stealth advantage, overall vessel speed is sacrificed, rendering a SPSS to operate at a much slower speed than most conventional vessels. Wakes caused by fast moving vessels, such as "go fasts," are easily detected via aerial surveillance and would negate the stealth advantage of the standard SPSS vessel. Since a SPSS is not capable of fully submersible operations it should be considered a surface craft just like any other boat or ship.

It is the adjective *semi-submersible* that could also be partially responsible for the distortion of the actual threat posed by SPSS vessels. Essentially, all vessels are semi-submersible to some degree. When using this adjective, it would be natural to make conclusions about the vessels capabilities based upon previously viewed images from books, television shows, and motion pictures without effectively differentiating *semi-submersible* from s*ubmersible*. In Figure 16, a ride at an amusement park ride is fashioned in the image of the submarine *Nautilus* from the 1954 Walt Disney motion picture *20,000 Leagues under the Sea.* Imagery like this can create vivid and exotic mental images in a person's conscious and subconscious. Because the word *semi-submersible* and *submersible* are so similar, they may be interpreted to have similar meanings by persons not familiar with these vessels.

In Figure 17, an actual SPSS used by a DTO to smuggle illicit drugs is depicted, and there is a robust similarity between it and the vessel shown in Figure 16. The appearance and nomenclature of SPSSs lends itself to projecting an intimidating persona, but in reality they are no more dangerous or threatening than a conventional vessel of similar size and capacity.

Figure 16. Amusement Park Ride Based on the Movie *20,000 Leagues under the Sea* (From Walt Disney's 20,000 Leagues under the Sea: The Ride., n.d.)

Figure 17. DTO Operated Self-Propelled Semi-Submersible Vessel (From U.S. Coast Guard and U.S. Navy Interdict Two Semi-Submersible Vessels, 2008)

Another possible factor contributing to the social amplification of risk is the amount of media coverage given to the successful interdiction of SPSSs by maritime law enforcement agencies and navies. The open water apprehension of these vessels, their crews, and cargoes usually results in abundant media coverage. This intense media exposure can further reinforce misconceptions about these vessels, especially if these events occur frequently which can also cause an “immediacy bias” in the general public. The result of more interdictions is an increase in the frequency and duration of exposure of these images to the general public leading to increased misconceptions about the extent of the actual threat posed by these vessels.

Although the theory of DTOs and international terrorists forming an alliance to transport a WMD to the shores of the U.S. sounds plausible, this threat has yet to materialize. The difference in ideologies and motivations of these two organizations does not currently support the realization of this threat scenario. Additionally, the actual threat posed by DTO SPSS vessels is commonly misunderstood by many HS practitioners, and the actual level of risk they pose to the MTS could be overestimated. This may be due to the social amplification of risk and the amount of media coverage that these vessels have received recently. DTO operated SPSS vessels do pose an established threat to national security for facilitating the transport of illegal drugs to the U.S. but currently there is no conclusive evidence indicating that that there is a significant risk of these smuggling vessels being used to fulfill the strategic objectives of an ITO. It would be prudent to continue to monitor the formulation and evolution of the relationships that DTOs and

ITOs form so that any changes in the strategic landscape that could alter their motivations in regards to the use of the SPSS as a terrorist weapon or transport vessel can be quickly detected, analyzed, and disseminated to HS policymakers.

5. Consequences

The *DHS Risk Lexicon* defines the term *consequences* as the effect of an event, incident, or occurrence (DHS, 2010, p.10). Consequences can be measured in four ways: human, economic, mission, and psychological. In addition, consequences may be either direct or indirect and also include other factors such as impact on the environment (DHS, 2010, p. 10). In lieu of an actual event, consequence can only be estimated because of the intricate interdependence of many sub-systems that comprise a complex mega-system, such as the MTS. A terrorist attack carried out by a submersible would have severe and cascading economic impacts on the MTS.

Historical events can provide some insight into the potential impact of a submersible attack on commercial shipping. On January30, 1945, while sailing in the Baltic Sea, the German passenger vessel *Wilhelm Gustloff* was sunk by a Russian submarine. Many naval historians consider this one of the one of the worst marine disasters of all times. The *Wilhelm Gustloff* was carrying over 6,000 persons who were fleeing the war in East Prussia and were headed back to Western Germany (Kappes, 2003). The amount of passengers onboard that night was estimated to be over three times the vessel's normal operating capacity. The passengers were comprised of women, children, the elderly, about 1,200 wounded soldiers, and some Nazi officials (Kappes, 2003). At 2035 hours that evening, the Russian submarine, *S-13*, fired three torpedoes at the unsuspecting vessel, and 5,348 people lost their lives (Kappes, 2003).

Figure 18. Artist’s Depiction of the *Wilhelm Gustloff* Sinking (From Krawczyk, n.d.)

The high concentration of passengers that sail onboard modern cruise ships could make a submersible attack upon one of these vessels an attractive attack scenario for a group or individual intent on creating a maritime mass casualty event the scale of the *Wilhelm Gustloff*. The Royal Caribbean Cruise Line operates the world’s largest capacity passenger vessel built to date. *The Allure of the Seas* cost $1.24 billion to construct and was launched in November 2010 (Associated Press, 2006). The ship’s maximum passenger capacity is 6,360, and the ship is manned by 2,384 crew members for a total onboard population of 8,744 (Royal Caribbean International, 2012).

A successful attack against a vessel of this size and type would drastically impact the cruise industry and many other interrelated industries, such as the airline industry, would also be severely affected. The first order negative consequences of a successful submersible attack against a large cruise ship would be the potential loss of life of thousands of passengers and crew and the economic loss of the vessel itself—valued at over $1 billion USD. If an attack resulted in a 50 percent casualty rate and the estimated insurance claim paid or judgment per casualty was $100,000 the resultant monetary loss would be as follows:

4,372 passengers X $100,000 = $437,200,000

If the ship were a total loss the combined loss from this single incident would be nearly two billion dollars; this does not include losses derived from the cascading effects of the attack such as the long-term reduced global demand for cruise vacations. Also, large vessels also carry enormous amounts of fuel and petroleum products, and a transportation security incident (TSI) resulting a breech a vessel's watertight integrity could result in catastrophic damage to environmentally sensitive habitats. After the attacks of September 11, 2001, the U.S. Congress enacted the Maritime Transportation Security Act (MTSA) of 2002 that was based upon the International Ship and Port Facility (ISPS) Code adopted by the International Maritime Organization (IMO) to strengthen port and vessel security. A TSI resulting for a submersible attack against a high capacity passenger vessel would most likely result in expanded maritime regulation, thus resulting in reduced autonomy and increased costs for port and vessel operators.

On January 13, 2012, the 114,500 ton cruise ship *Costa Concordia* ran aground near the Italian island of Giglio (BBC News Europe, 2012). The vessel had over 4,200 passengers onboard and this maritime accident resulted in the deaths of 17 passengers with an additional 15 people still unaccounted for at this time. Salvage operations are expected to take at least 10 months to remove the vessel and its 2,300 tons of fuel (BBC News Europe, 2012). The net value of this vessel was $490 million USD at the time of the incident and the parent company, Carnival Corporation, has insurance coverage in the amount of $510 million USD for the vessel with a deductable of approximately $30 million USD (Reuters UK Edition, 2012). The Carnival Corporation self-insures for the loss of the vessel and insurance for any third-party personal injury liability claims is subject to an additional deductible of about $10 million USD (Reuters UK Edition, 2012). It is unknown at this time if the *Costa Concordia* can be salvaged or if it will be declared a total loss.

The full economic impact of this tragic maritime disaster may take several years to be accurately accounted for, but luxury cruise bookings significantly declined in the days and weeks after the incident (Reuters U.S. Edition, 2012). After this incident occurred, the stock price for Carnival Corporation dropped to $27 on January 18, 2012 from a price of $30 on January 12, 2012 (MSM Money, 2012). Other companies in the luxury cruise industry were also severely impacted. For example, Royal Caribbean Cruise Line's stock also dropped to $30 from $35 during the same period (MSM Money, 2012). Royal Caribbean Cruise Line has issued 500 million common stock shares so a loss of $5/share resulted in a total loss of $2.5 billion USD in value to the company's common stock shareholders, and this company was not even involved in the incident (Royal Caribbean Cruises Ltd., 2009).[12]

Figure 19. Cruise Ship *Costa Concordia* Partially Submerged and Listing (From Brown, 2012)

[12] This estimation of loss is derived from market conditions and reflects what the loss in value would be given the market parameters at a certain point in time. This estimation does not include preferred stock shares or an analysis of the potential impact on any future dividends the company may pay to shareholders but only on the market value of the 500 million common stock shares (Royal Caribbean Cruises Ltd., 2009).

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V. RECOMMENDATIONS AND CONCLUSION

The primary research question of this thesis was: *How should the homeland security enterprise react to the emerging technology and availability of submersible vessels?*

There are several components to the answer to the above question. The HSE should accept that private small submersible vessels are an established and expanding attribute of the MTS. Technology and innovation have drastically reduced barriers to small submersible ownership and operation to a greater number of people than at any other time in history. As with any maturing technology, there will always be the potential that criminals or terrorists could use these vessels to further their strategic objectives and the HSE should be aware of this potential and continuously seek to obtain optimal situational awareness of this segment of the MTS. The HSE should seek to implement policy and strategy that mitigates the strategic risk posed by small submersibles while balancing the needs of all waterway users. In order to develop and implement effective policy and strategy, the HSE should seek to completely understand the small submersible threat that emanates from various potential users of small submersibles that range from international criminal and terrorist organizations to single HVEs. Finally, the HSE should explore how small submersible technology could be used in positive ways to enhance MHS at the strategic, operational, and tactical levels.

A. STRATEGIC RISK MANAGEMENT

1. Strategic Risk

In order to develop appropriate strategies designed to mitigate the potential risk posed by small submersibles, HS policymakers must understand and apply the concept of strategic risk. *Strategic risk* is defined by the *DHS Risk Lexicon* as “risk that affects an entity’s vital interests or execution of chosen strategy, whether imposed by external threats or arising from flawed or poorly implemented strategy” (DHS, 2010, p. 35).

Furthermore, the DHS Risk Lexicon also presents two annotations to the above definition that illustrate why understanding strategic risk is of the upmost value to an organization. Those annotations are:

> 1. Managing strategic risk is associated with the ability to recognize future trends, challenges, and threats and match these with appropriate operational concepts, capabilities, competencies, and capacity.
>
> 2. Strategic risk can arise from three basic sources. First, strategic risk can arise from the actions of adversaries, from natural hazards or from non-adversarial human actions, such as accidents. These can be thought of as imposed risks. Second, strategic risk can be created by the unintended consequences of the strategies we adopt in response to imposed risks. These can be thought of as self-imposed risks. Finally, strategic risk can arise from obstacles to successful implementation of an adopted strategy. These obstacles can be either imposed (e.g., the actions of an adaptive adversary to counter a security measure or to exploit an unintended vulnerability created by a security measure) or self-imposed (e.g., failure to adequately resource, or to prematurely abandon, a strategy or course of action that would otherwise be beneficial). (DHS, 2010, p. 35)

As the perceived submersible threat began to gain attention in the media and in certain parts of DHS and the Department of Defense (DoD), it became apparent that there was a significant strategic gap in the SVSS strategy with regards to problem definition and assessing the risk posed by submersible vessels. The SVSS did not in any way address the emerging, complex, and adaptive threat posed by fully submersible vessels. As highlighted previously, the SVSS lists four specific tactical small vessels scenarios that are of primary concern to MHS practitioners (DHS, 2008). These scenarios are:

> - Domestic Use of Waterborne Improvised Explosive Devices (WBIEDs);
> - Conveyance for smuggling weapons (including WMDs) into the United States;
> - Conveyance for smuggling terrorists into the United States;
> - Waterborne platform for conducting a stand-off attack (e.g., Man-Portable Air-Defense System (MANPADS) attacks). (DHS, 2008)

All of these scenarios, except for the stand-off attack platform, are ideally suited for submersible vessels due to their primary tactical advantage of stealth. The SVSS and its supplemental implementation plan fell short in recognizing future trends, challenges, and threats with regards to the nefarious use of submersible vessels nor did it mitigate these with the appropriate operational concepts, capabilities, competencies, and capacity necessary to reduce overall strategic risk (DHS, 2008). This strategic risk is derived from a combination of the imposed risks of the actions of adaptive adversaries and from the self-imposed organizational and system obstacles of the failure to successfully implement the adopted but inadequate strategy.

2. DHS Small Vessel Security Strategy (SVSS)

ITOs have used small boats to conduct attacks against military and civilian maritime targets with varying degrees of success. For the purposes of this paper, a *small vessel* is considered to be a watercraft that weighs less than 300 gross tons and consists of, but not limited to, jet skis, private recreational boats, commercial fishing boats, tow vessels, uninspected passenger vessels, and sail boats. In October 2000, the *USS Cole* was attacked by suicide bombers using a small boat in Yemen. Two years later, the French flagged oil tanker *Limburg* was severely damaged by a small boat suicide attack in the Gulf of Aden. In April 2004, several explosive-laden dhows were used to conduct a suicide attack against an offshore Iraqi oil platform in the North Arabian Gulf (Howe, 2010). Additionally, small boats have been used to transport contraband and to facilitate human trafficking across maritime borders. Finally, the terrorist assault team that perpetrated the November 2008 Mumbai attacks entered India via a pirated small vessel (Roggio, 2008).

The terror threat posed by small vessels is significant because a successful small boat attack within the territorial waters of the United States could result in significant loss of life, cascading economic impacts, and severe environmental damage. Additionally, the vast number of small vessels operating within the maritime transportation system with relatively few restrictions and the lack of relevant maritime domain awareness of small vessel operations contributes to the difficulty in defining and mitigating any potential threat. By the mid-2000s the use of small boats by terrorists was recognized by DHS an emerging threat to the maritime transportation system but no comprehensive national strategy had been developed to counter this threat.

In response to the increasing awareness of threats posed by small boats, DHS hosted a National Small Vessel Security Summit to address the security issues related to small boats in June 2007. This summit provided a forum for small vessel stakeholders to present their ideas for enhancing security and to voice their concerns to policymakers with regards to potential restrictions and/or regulations relating to small vessel operations. The results of this summit culminated in the formulation of the DHS SVSS that was released in April 2008 in an attempt to address the small boat threat. The SVSS contains four primary objectives:

- Develop and leverage a strong partnership with the small vessel community, public and private sectors in order to enhance maritime domain awareness.
- Enhance maritime security and safety based on a coherent plan with a layered, innovative approach.
- Leverage technology to enhance the ability to detect, determine the intent, and when necessary, interdict small vessels.
- Enhance coordination, cooperation, and communication between federal, state, local and tribal partners and the private sector as well as international partners. (DHS, 2008)

An analysis of the development and implementation of the SVSS is critical for HS policymakers who are intent on mitigating the risk posed by small submersibles. Although the SVSS does not specifically address submersible threats many of its key attributes are applicable to small submersible vessels. There are positive and negative lessons that can be learned from the SVSS that can be used to strengthen future HS policy in regards to conventional and submersible small vessel threats. The key concept to be reinforced here is that current HS strategy must be have the capacity and motivation to quickly adapt to a complex and dynamic threat environment.

One of the primary strengths of the SVSS is that it identified and addressed stakeholder concerns prior to its development and implementation. The SVSS emphasized the development of key partnerships with all stakeholders in the small vessel community. The small vessel community is made up of recreational boaters and professional mariners who can be very resistant to additional government regulations. This resistance is caused by real or perceived threats to their sense of freedom in regards to unrestricted vessel operation. By engaging this community early, a sense of trust and cooperation could be developed; this is key to developing productive partnerships in a regulatory environment.

This focus on developing public/private partnerships is in direct alignment with the *National Strategy for Homeland Security* released in October 2007. The *National Strategy for Homeland Security* states: "Due to the multiple and essential roles the private sector plays across all areas of homeland security, continued collaboration and engagement with the private sector to strengthen preparedness is imperative" (DHS, 2007). By fostering trust and collaboration with these stakeholders, DHS would be better positioned to achieve wider acceptance of the SVSS, especially the provisions that had the potential to negatively impact small vessel operators.

Additionally, there are also some significant weaknesses in the SVSS that needed to be addressed by DHS and the small vessel community. According to report released by the DHS Inspector General in October 2009:

> DHS has not provided a comprehensive strategy for addressing small vessel threats. Neither its SVSS nor its draft Implementation Plan effectively addresses all the desirable characteristics and elements of a national strategy. In addition, the department has not evaluated the effectiveness of critical programs that are expected to serve as a foundation for small vessel security and may not be providing anticipated results.

The Government Accountability Office has determined that an effective national strategy should consist of six desirable characteristics (Inspector General, 2009). The two desirable characteristics adequately addressed by the SVSS were:

- Purpose, scope, and methodology
- Problem definition and risk assessment. (Inspector General, 2009)

The four desirable characteristics of a national strategy not adequately addressed by the SVSS were:

- Goals, subordinate objectives, activities, and performance measures
- Resources, investments, and risk management

- Organizational roles, responsibilities, and coordination
- Integration and implementation. (Inspector General, 2009)

In regards to the effectiveness of the SVSS, the 2009 DHS Inspector General report further stated, “It partially addresses elements such as strategic priorities and milestones, and roles and responsibilities of state and local sectors, but it does not address performance measures, associated costs or human capital, or accountability and oversight frameworks” (Inspector General, 2009). Additional criticism of the SVSS has asserted that the strategy only incorporates existing programs, processes, and assets while failing to determine what level of resources are needed to address current vulnerabilities (Inspector General, 2009). Furthermore, the failure of the SVSS to address all the desirable characteristics of a national strategy and its inability to look beyond existing programs, processes, and assets severely limits the effectiveness as a national strategy. It should be noted that DHS did make effort to mitigate some the strategic shortfalls identified by the GAO in the SVSS by introducing the *Small Vessel Security Implementation Plan* in January 2011 (DHS, 2011).

3. Drug Trafficking Vessel Interdiction Act (DTVIA) of 2008

> To date, SPSS vessels have been used to smuggle cocaine from South America to the United Sates but they could be converted to smuggle terrorists or weapons of mass destruction. Through current legislation pending in the Congress, we are trying to criminalize the operation of stateless SPSS vessels on international voyages. This will allow us to prosecute SPSS operators, deter the use of these vessels for other illicit purposes and increase the safety of Coast Guard boarding teams.
>
> Admiral Thad Allen, 23rd Commandant of the U.S. Coast Guard (Allen, T. 2008)

On October 13, 2008, the President of the United States of America signed into law the *Drug Trafficking Vessel Interdiction Act (DTVIA) of 2008*. This legislation was in response to the increasing numbers of SPSS vessels being scuttled just before they could be interdicted by law enforcement or military officials and the difficulty in prosecuting the crews for narcotics trafficking when all of the evidence was lost at sea with the vessel. The DTVIA essentially makes operating a SPPS/SPFS vessel in international waters a crime prosecutable in U.S. federal law. The SPSS or SPFS must be a nonregistered vessel exhibiting the intent to evade detection. This law makes operating unregistered submersible vessels in international waters illegal so recovery of any illicit drugs is not a factor in bringing charges against the crewmembers under this particular law (Kash & White, 2010).

The DTVIA was intended to deter the use of submersible vessels to transport illegal drugs, but this strategy may be causing unintended consequences that could make future interdiction operations even more difficult for law enforcement. Since DTOs are complex adaptive adversaries who are committed to continuing their illegal drug business, they have no choice but to adapt their distribution network and TTPs to compensate for this new legislative barrier. The next logical adaption for the DTOs would be to transition their fleet of SPSS vessels to one made up exclusively of SPFS vessels. The strategic shift to fully-submersible operations would place law enforcement agencies and the military at a distinct disadvantage in the arena of detection and interdiction capability. The DTVIA could have the unintended result of making the distribution networks of DTOs even more effective and efficient until authorities could adequately counter fully-submersible centered distribution systems; however, there could be a significant time lag before new technologies could be developed and deployed. Additionally, this law may expedite the development and implementation of fully remote-controlled submersible vessels that would negate the law's effectiveness as a deterrent to drug smuggling. It would also eliminate the need for human crewmembers and their associated weaknesses, such as the negative emotions of fear and greed.

It is worth noting that DTVIA was intended to address the problem of maritime transportation of narcotics via submersibles and not the international transportation of a WMD/WME or of a potential terrorist to U.S shores. DVTIA is broad enough that it could be used to prosecute someone operating a stateless submersible that is transporting a WMD/WME in international waters, but it would not apply to a personally owned and operated domestic submersible used for a terrorist attack in U.S. waters.

B. RECOMMENDATIONS TO MITIGATE THE RISK

If the submersible threat can be reduced then overall risk reduction to the maritime domain can be achieved. The following are recommendations for enhancing the effectiveness of the SVSS with regards to mitigating the threat posed by submersible vessels. These recommendations directly support the accomplishment of the four primary objectives of the SVSS while reducing strategic risk. These recommendations are not intended to replace or modify the general recommendations issued by the Government Accountability Office (GAO) in regards to the SVSS, rather they are intended to specifically address the submersible threat while enhancing the overall effectiveness of the SVSS.

1. Develop and Leverage Strong Partnerships

The most significant information gaps in regards to achieving a baseline level of maritime domain awareness (MDA) when attempting to quantify the submersible threat is knowledge of how many of these vessels are in operation, where are they operated, and who is operating them. Without answering these questions, it is impossible to accurately estimate the scale of the potential threat. Engagement with legitimate owners/operators of domestic submersible vessels would be the first step in reducing this intelligence gap since these stakeholders would have the most accurate information available and would know when there are anomalies in the system worth reporting. Additionally, security awareness programs such as DHS's "If you see something, say something"™[13] campaign and the U.S. Coast Guard's "America's Waterway Watch"[14] program, can also be leveraged to supply data on domestic submersible operations. Another potential course of action would be to implement federal regulation of all submersible vessels operating in U.S. territorial waters, which would provide detailed information on submersible vessel

[13] The "If you see something, say something"™ is DHS's public awareness program that encourages citizens to report suspicious persons and/or activity to law enforcement. The program was originally implemented by New York City's Metropolitan Transportation Authority and has since been adapted for national dissemination by DHS (U.S. Department of Homeland Security, n.d. a).

[14] "America's Waterway Watch" is the U.S. Coast Guard's public awareness program that encourages the boating public to report suspicious persons and/or activity with a maritime nexus to the National Response Center and/or law enforcement (America's Waterway Watch, 2011).

operation in domestic waters. Regulation could take many forms such as requiring these vessels to be registered with the federal government, mandating the utilization of automatic identification system (AIS) technology and vetting submersible owners/operators. Even if submersible vessels were federally regulated, there could still be significant gaps in information since clandestine existence of personal submarines would be nearly impossible to detect.

2. Enhance Maritime Security and Safety

The natural adaptation and evolution of the SVSS would be for the strategy to address all small vessel threats (surface and sub-surface) at the local level. In order to effectively reduce strategic risk, the enhancement of local area maritime security plans (AMSPs) to address the small vessel threat would be necessary. These AMSPs are produced and maintained for each U.S. Coast Guard Captain of the Port (COPT) zone and are validated by all maritime stakeholders via the local area maritime security committees (AMSCs). The addition of a small vessel security annex to these AMSPs would facilitate mitigation of the small vessel threat (surface and sub-surface) by translating the national strategy into localized operational and tactical plans with key areas of emphasis, including the establishment of quantifiable performance measures along with resource identification and allocation.

One of the fundamental components used in formulating the AMSP is the Maritime Security Risk Analysis Model (MSRAM). MSRAM is an analysis tool used by the U.S. Coast Guard to evaluate risk to critical maritime infrastructure and key resources. Furthermore, this tool evaluates maritime security risk using threats, vulnerabilities, and consequences calculated for a standardized set of attack scenarios to provide a common risk framework. If a small vessel security annex to the AMSP is developed and implemented, then MSRAM will need to be enhanced to account for differences in the achievability and resulting impacts for surface versus sub-surface WBIED attack scenarios. Currently, MSRAM does not have the capability to evaluate risk in regards to potential submersible attack scenarios.

3. Leverage Technology

In order to mitigate the submersible threat in potentially vulnerable ports the use of detection technologies, such as side-scan SONAR arrays, would be a key component of any local plan. Without detection, there can be no interdiction; therefore, this should be a priority resourcing requirement as determined by the AMSC membership and MSRAM data analysis. The optimal strategy to mitigate the small submersible threat would place great emphasis on the concept of deterrence. If a potential adversary is denied access to a target, then the threat will either dissipate or shift to another softer target.

High value targets that are vulnerable to the submersible threat can be protected from submersible attacks with boat barriers that extend their protective reach from the water's surface to the bottom. These anti-submarine nets or barriers could also be used to deny access to vulnerable areas such as the mouth of a harbor or strait. Furthermore, deterrence and detection strategies could be formulated to complement each other and maximize the utilization of available resources. In order to address some of the challenges with resource allocation, the feasibility of linking the SVSS and any locally developed AMSP plan annex to the Port Security Grant Program and its national priorities should be explored and encouraged. This could provide a funding source for consolidated efforts to implement this strategy and the local plans needed to address the small submersible threat.

An additional opportunity to utilize technology in order to increase MDA with respect to submersible vessels would be the mandated use of AIS technology for any privately owned submersible vessel. AIS can relay a surface vessel's course and speed in real time to other ships and shore-based monitoring stations. By mandating AIS use on every submersible, regardless of size or intended use, local, state, and federal maritime enforcement agencies would have a more complete common operational picture (COP) of submersible activity within the local port area. Before this course of action is pursued, however, further research would be needed to determine how effective AIS transmissions from submerged vessels operating at depth would be and if AIS technology could be enhanced to transmit accurate depth information.

The technical aspects and associated costs could render this option to be impractical for the foreseeable future. Additionally, an accurate cost-benefit analysis cannot be conducted until a complete census of these types of vessels is completed. AIS effectiveness would also depend upon the extent of compliance by submersible owner/operators as some individuals could purposely elect not to comply with an AIS mandate. It is possible that new forms of technology that could exceed the current capabilities of AIS could be developed to solve this problem and give HS policymakers an accurate multi-dimensional COP of private submersible operations.

4. Enhance Coordination, Cooperation, and Communication

Since the AMSCs would be key to developing local small vessel threat response plans, there should be continued emphasis on engaging all maritime stakeholders in the planning process. Once these local plans are developed, the next step would be to exercise these them in order to determine gaps in MDA, intelligence gathering and sharing, training, policies and procedures, as well as resource shortfalls. The continuous improvement process of planning, exercising, and then taking corrective actions would allow AMSCs to reduce strategic risk in their local areas. The collective result of multiple AMSCs accomplishing this risk reduction through effective strategy implementation would facilitate an overall risk reduction across the entire maritime transportation system.

The final area of opportunity where the AMSCs could have significant impact on the mitigation of the small submersible threat would be in the development of appropriate and effective interdiction TTPs. Although this is an operational and tactical issue, it has significant implications for reducing overall strategic risk in the maritime domain. The use of force parameters for domestic law enforcement agencies are fairly congruent and standardized as well as the tools used to mitigate threats and gain compliance. One of the key components in selecting what level of force to use to counter a threat is determining if hostile intent is present. How to determine the intent of a fully submersible small vessel operating in a congested harbor is a truly wicked problem for frontline law enforcement officers. The solution to this problem must be worked out with all stakeholders to included legitimate operators of submersible vessels. Accurately determining a submersible vessel's intent may not be realistically achievable in time to mitigate a potential threat. If early detection is accomplished along with the establishment of hostile intent then the options to employ appropriate countermeasures by local law enforcement are extremely limited.

The experts in anti-submarine warfare (ASW) are the U.S. military and the current suite of ASW countermeasures includes rockets, mortars, torpedoes, missiles, and depth charges. These countermeasures are all considered deadly force options and present legal and ethical challenges for domestic law enforcement agencies to consider. This situation does present a research opportunity for less than lethal non-destructive ASW countermeasures and technology that can be employed by law enforcement agencies. The development of interdiction TTPs and effective countermeasures are the final steps in reducing the strategic risk posed by small submersible vessels, but these will be the most difficult to achieve due to legal and ethical issues, resources constraints, incomplete MDA, and technology gaps.

5. Regulating Disruptive Technology

The potential risks posed by disruptive submersible technology could be partially mitigated through the use of new or existing regulation, but not all stakeholders will be open to this course of action. Regulation could encompass several measures such as requiring submersibles to be registered as such and reported to the U.S. Coast Guard or licensing requirements could be implemented. Other measures could include requiring submersible vessels to carry tracking technology, such as AIS, and the contingency of the ownership and operation of submersibles upon a vetting process similar to what the TWIC card program requires.

The personal sub community would most certainly be opposed at any attempt by the U.S. government to further regulate submersible vessels. Members of the boating public are generally opposed to any additional government regulation as they perceive this an attempt to limit their fundamental rights and freedoms with regards to the use of and unrestricted access to the water. The personal submarine community is very small and would be at a distinct disadvantage in attempting to oppose any new regulatory efforts. Their only course of action would be to align themselves with the numerous but larger boating associations, clubs, and other maritime groups across the nation. Furthermore, these nautical alliances could give the personal submarine community the necessary lobbying base to effectively oppose any new proposed legislation that could limit their unrestricted access to the waterways of the U.S. These potential alliances could impede any efforts to enact new legislation or modify existing federal or state laws and should be anticipated by policymakers.

The MTS is a complex system of networks that coexist as well as compete. The personal submarine community is a sub-system of the recreational boating system and to a lesser degree the commercial tourist boating system. All of the system components comprise a nested mega-system that exists within a framework of regulatory influences. The impact of regulation upon one system has potential impacts, both positive and negative, upon the other sub-systems. One option to facilitate enhancing security while balancing stakeholder concerns would be to initiate open dialogue between the federal and state governments with the personal submarine community and other maritime stakeholders. This approach was used in the early development of the SVSS when DHS conducted a National Small Vessel Security Summit to learn of stakeholder concerns prior to strategy formulation. This same approach could be used to engage the members of the personal submarine community and solicit their concerns about new and/or increased regulation and what their recommendations for enhancing maritime security might be. The effective use of this type of stakeholder engagement would allow for the development a circular feedback loop between regulators and the personal submarine community, which would result in a more effective methodology to address this risk. Relevant and actionable feedback loops could facilitate optimal strategy formulation and eventual acceptance from all the system stakeholders.

Several factors could have the potential to hinder the implementation of these recommendations. One key factor that is critical to successful implementation is resourcing. If regulatory agencies are not adequately resourced to implement and enforce any new regulations, then the initiative is doomed to be a failure. Another variable that must be anticipated is the potential for technological advances in tracking technology. As tracking technology becomes cheaper and more effective then overall MDA can be enhanced, which could reduce the need for further regulation. Timelines for the implementation of these recommendations is another important variable to consider. The DHS SVSS was released in 2008, but the accompanying implementation plan was not released until early 2011. Without timely implementation, the strategic landscape that these recommendations are based upon will most likely evolve and change, which could render them irrelevant and outdate.

C. RECOMMENDATIONS FOR FUTURE RESEARCH

There are several opportunities for future research in regards to the threat posed by small submersible vessels. One area that would be extremely beneficial for developing and maintaining MDA would be an examination of current and future tracking technology, such as automatic identification systems (AIS), and how such technology can be used to track private submarines operating under the water's surface in proximity to maritime critical infrastructure/key resources (MCI/KR). This data could be used to develop parameters to assist in the determination that submersible vessel poses an imminent threat based upon data analysis, such as operational pattern analysis.

Another avenue for future research would be an examination of current and potential technologies to stop a submersible vessel that was exhibiting hostile intent. The use of non-lethal technology to disable and/or deter a submersible attack would give local, state, and federal law enforcement agencies enhanced capabilities to potentially mitigate this threat and protect high risk maritime assets.

Finally, another are for future research would be how the HSE could possibly utilize small submersibles to enhance HS through such activities as using remotely operated subs to conduct coastal surveillance of locations susceptible to maritime smuggling or to covertly patrol MCI/KR.

D. CONCLUSION

Three conclusions can be made based upon the findings of this study on the potentially disruptive nature of small submersible vessel technology. The first conclusion is that the perfidious use of submersible technology by terrorists or terrorist organizations is a significant concern for MHS policymakers. Incremental innovations in submersible technology have the potential to be recombined in disruptive ways that constitute a meta-threat to the MHS enterprise. Historical analysis demonstrates that small submersibles have been effectively used by nation states, criminal organizations, and terrorists in order to attain asymmetric advantages over their adversaries within the maritime domain. The recognition of the small submersible's underestimated capability to inflict disproportional adverse consequences to the MTS is necessary in order to develop a sound understanding of this emerging threat, which is fundamental to developing policy to reduce risk.

The second major conclusion is that the actual risk posed by small submersibles to the MHS enterprise is misunderstood by most HS policymakers. The current use of small submersibles by international criminal organization to conduct smuggling activities is perceived as a potential threat to HS, but these profit driven organizations do not possess the intent necessary to constitute a viable terrorist threat. Although drug trafficking presents a significant threat to national security the probability that these entities will align themselves with transnational terrorist organizations to conduct joint offensive operations against the U.S. is quite remote. The true asymmetrical threat potential of small submersible vessels already exists within U.S. territorial waters. A homegrown violent extremist or determined terrorist with modest resources has almost unrestricted and anonymous access to submersible technology and thus could assuredly perpetrate an unconventional black swan attack scenario using a small submersible vessel on domestic maritime critical infrastructure or key resources (MCI/KR).

The final major conclusion of this study is that since the MHS enterprise does not adequately understand the threat posed by small submersibles, then system vulnerability exists in the maritime domain at the strategic, operational, and tactical levels. Current MHS strategy and policy does not specifically address the meta-threat posed by small privately operated domestic submersible vessels. The lack of baseline levels of maritime domain awareness on domestic small submersibles with regards to their population, location, ownership, and operational characteristics prevents any meaningful risk analysis to base appropriate HS policy formulation on.

Additionally, from an operational and tactical perspective, the MHS enterprise does not have the capability and/or expertise to effectively or efficiently counter submersible threats as there are no appropriate and available countermeasures nor any universally applicable use of force policies in place to adequately and timely address potential submersible threats. The current SVSS could serve as the framework to develop an effective, appropriate, and relevant strategy to counter the small submersible threat to maritime homeland security. The attainment of a basic understanding of the dynamics of this threat, such as developing baseline MDA objectives, and establishing a better understanding of the small submersible vessel sub-system will be a key first step in facilitating the mitigation of the strategic, operational, and tactical system vulnerability of this potentially disruptive technology.

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