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COALITION CONTRIBUTIONS TO THEATER ASW ANALYSIS CAMPAIGN

by

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This Commander, Pacific Fleet (COMPACFLT) focused campaign of analysis explored possible coalition contributions to a theater antisubmarine warfare (ASW) campaign, with the particular objective of determining their willingness to make those contributions under various scenarios. This research program included a joint campaign analysis mini-study in a Western Pacific theater ASW scenario to develop potential concepts for coalition employment of submarines, mines, maritime aircraft, ships, and other assets in a theater ASW fight. The primary effort was a coalition ASW wargame conducted in June 2023 in Yokosuka Japan hosted by Submarine Group Seven with United States Navy, Japanese Maritime Defense Force, and Royal Australian Navy players. The major lessons from the Joint Campaign Analysis effort included the value of the allied maritime patrol aircraft toward establishing defense barriers against Red submarine incursion into the Philippine Sea, the limited value of the unmanned undersea vehicles ORCA and the Stingray Glider in a barrier patrol role, and the need for surface ships to be in sonar active role to be effective. Wargame results are classified, limited distribution, and were provided to sponsors and players.

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ABSTRACT

This Commander, Pacific Fleet (COMPACFLT) focused campaign of analysis explored possible coalition contributions to a theater antisubmarine warfare (ASW) campaign, with the particular objective of determining their willingness to make those contributions under various scenarios. This research program included a joint campaign analysis mini-study in a Western Pacific theater ASW scenario to develop potential concepts for coalition employment of submarines, mines, maritime aircraft, ships, and other assets in a theater ASW fight. The primary effort, was a coalition ASW wargame conducted in June 2023 in Yokosuka Japan hosted by Submarine Group Seven with United States Navy, Japanese Maritime Defense Force, and Royal Australian Navy players. The major lessons from the Joint Campaign Analysis effort included the value of the allied maritime patrol aircraft toward establishing defense barriers against Red submarine incursion into the Philippine Sea, the limited value of the unmanned undersea vehicles ORCA and the Stingray Glider in a barrier patrol role, and the need for surface ships to be in sonar active role to be effective. Wargame results are classified, limited distribution, and were provided to sponsors and players.

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I. INTRODUCTION

A. REQUEST WARGAMING SUPPORT

This campaign of analysis responded to a request by the Commander, Pacific Fleet (COMPACFLT) to better understand the contributions Japanese and Australian maritime forces can provide in theater antisubmarine warfare (ASW). The execution of theater ASW in the Pacific is challenged by limited capacity and adversaries' capabilities across a wide ocean area. Contributions by coalition partners to ASW efforts become critical for effective operations. These contributions may include sharing intelligence, mining, or assigning aircraft, ships, and submarines to a coalition ASW task force. An understanding of the various Pacific partner countries' willingness to provide their undersea warfare capabilities to a common allied effort is important for future operational planning and execution.

This project's research objective informed Commander, Pacific Fleet and Commander, Submarine Force Pacific (COMSUBPAC) operational planners to anticipate coalition partner's undersea warfare objectives and willingness to provide ASW capabilities to a common objective.

Three specific research questions were asked:

1.) In various levels of conflict, from competition to full war, what capabilities are the Pacific allies willing to contribute to coalition theater antisubmarine warfare coordinated by the United States?
2.) Where might coalition undersea warfare capabilities be employed in various scenarios?
3.) What are allied objectives for undersea warfare across the theater?

B. EXECUTION: A TWO-PHASE PROCESS

The research effort was conducted in several phases. The first phase involved a three-officer team conducting a campaign analysis within the Naval Postgraduate School (NPS) joint campaign analysis class. A conflict in the Western Pacific was generated with various order-of-battle options available to the team, including several emerging technologies. The second phase involved the design, development, and execution of a classified coalition wargame by participants in the NPS wargaming class and others. The wargaming phase was accomplished with full coordination between Commander, Submarine Pacific staff and NPS wargame designers.

II. CONDUCTING A QUANTITATIVE ASSESSMENT THEATER ASW IN THE PACIFIC

A. THEATER ASW IN THE PACIFIC

In this analytical campaign's first phase, LCDR Joseph Cantwell, USN; LT Thuan Chu, USN; and MAJ Ryan Davis, USMC conducted a six-week study to fulfill their Joint Campaign Analysis course requirement to complete a campaign study. Their specific tasking was to develop and assess a coalition ASW barrier in the Western Pacific with specific objectives to deny adversary submarines access to the Philippine Sea. In addition, they were to explore the impact of the adversary surging their submarines across these barriers. Their study included development of a barrier concept of employment (see Figure 1), application of search theory and simulation to assess this concept's effectiveness measured by the expected number of adversary submarines going through the barrier, and evaluating two emerging technologies to add to the barrier, the extra-large unmanned undersea platform ORCA and a large Stingray sea glider.

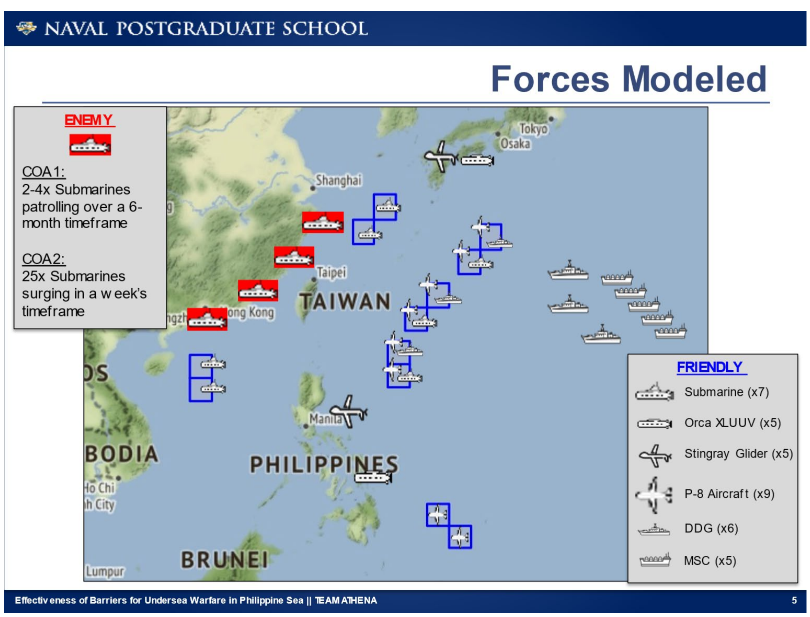

Figure 1. Concept of Force employment to establish barriers to adversary submarines entering the Philippine Sea.

B. METHODS AND RESULTS OF CAMPAIGN ANALYSIS

After constructing the multiple ASW concept, the team calculated each barrier's probability of detection given an adversary submarine passes through that barrier. This was computed using barrier search equations, and in some cases, random search equations. The team next derived the probability of survival for an adversary submarine taking different routing options into the Philippine Sea. The best locations for barrier placement were determined based on various adversary routing options. Simulation was then employed to provide variable outcomes in adversary survivability and logistic ship survivability. The two technical injects were then added to the barriers to determine their best placement and to assess their operational impact through game theory. Figure 2 summarizes the team's methodology.

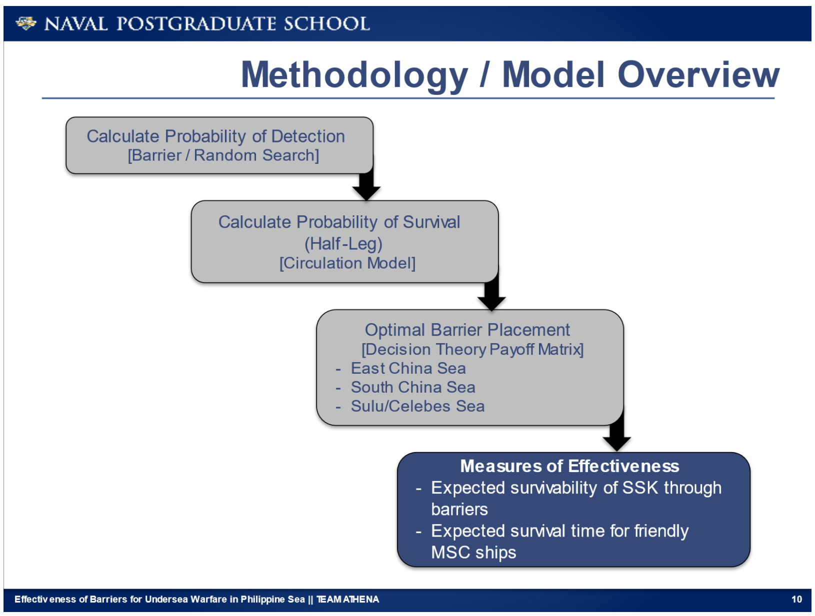

Figure 2. Campaign methodology used to assess overall barrier performance.

In Figure 3, we view the general concept of operations with the adversary route decisions shown as red lines. Red submarines could take a northern, central, or southern route into the Philippine Sea. Likewise, the technical injects of ORCA and Sea Glider could be added to any one of the three routes.

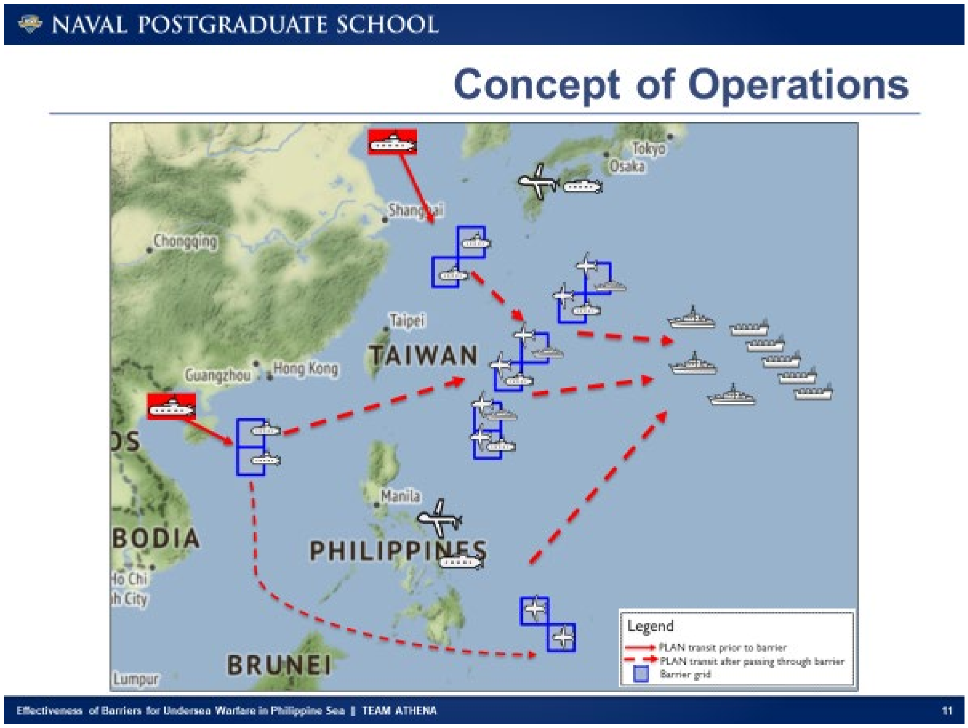

Figure 3. Blue barrier locations and general route options for adversary submarines going into the Philippine Sea.

Operational and modeling assumptions are shown in Figures 4 and 5, respectively. They cover the enemy course of actions and unclassified search data used in the search theory and deterministic model and simulation. Future analytical work may vary the search and kill effectiveness for each platform to better understand their design impacts on campaign outcomes.

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Operational Assumptions

- Full wartime rules of engagement (ROE) in effect.
- Two Enemy Courses of Action (COAs):
  - Most Dangerous COA (MDCOA): 25 surging SSKs in a week.
  - Most Likely COA (MLCOA): 2-4 SSKs per week across a six-month timeframe.
- Three penetration points into the Philippine Sea:
  - East China Sea north of Taiwan, Luzon Strait between Taiwan and Philippines, and Celebes Sea south of Philippines
- All available SSNs, ORCAs and Gliders are employed in support of barrier operations only.
- ORCA and Glider each employed to support barrier operations in only one of three penetration points into the Philippine Sea.
- Assume zero attrition for assets directly supporting barrier operations.
- ORCA and gliders able to provide continuous support to barrier operations within one of the three penetration points.
- ORCA is not suited for employment in the Luzon Strait due to strong currents.

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Figure 4. Operational assumptions used by the analytical team to generate the concept of operation and build the analytical models.

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Modeling Parameters/Assumptions

- ORCA
  - Patrolling Speed = 2.5 kts
  - Detection Range = 3 nm
- Stingray Glider
  - Patrolling Speed = 4 kts
  - Detection Range = 2nm
- P-8
  - Patrolling Speed = 240 kts
  - Detection Range = 2 nm
  - Probability to detect: 0.80
- DDG
  - Cruising Speed = 10 kts
  - Detection Range = 5 nm
- Submarine
  - Friendly SSN
    - Patrolling Speed = 10 kts
    - Detection Range = 12 nm
  - Enemy SSK: Cruising Speed = 10 kts

- ORCA/Glider: Barrier Search equations used to calculate probabilities to detect
- DDG/SSN: Random Search equations used to calculate probabilities to detect.
- Half-leg survivability (circulation model) will infer how number of SSKs to survive barrier transit.
- If SSK transits through barrier, it will kill at least one friendly vessel.
- The submarine's survival through each barrier is independent of its survival through any other barrier.

Probabilities of Detection and Kill by Asset

	P_{det}	P_{kill}
SSN	.11	.80
DDG	.05	.50
P-8	.80	.40
Orca	.05	.80
Glider	.05	.70

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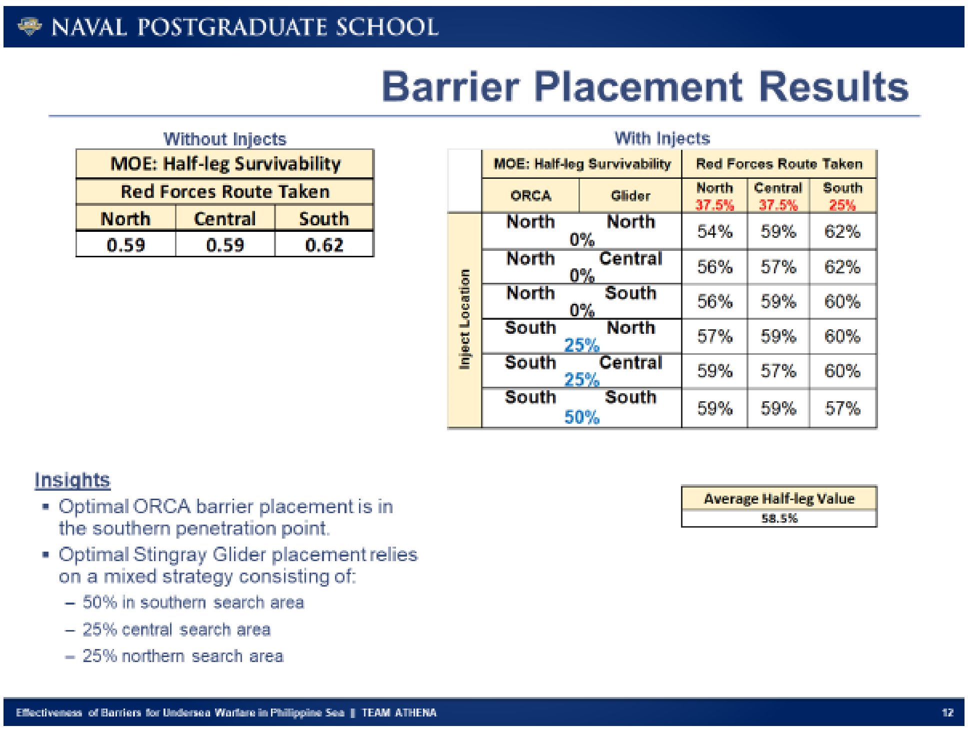
Figure 5. Modeling parameters and assumptions used by the analytical team.

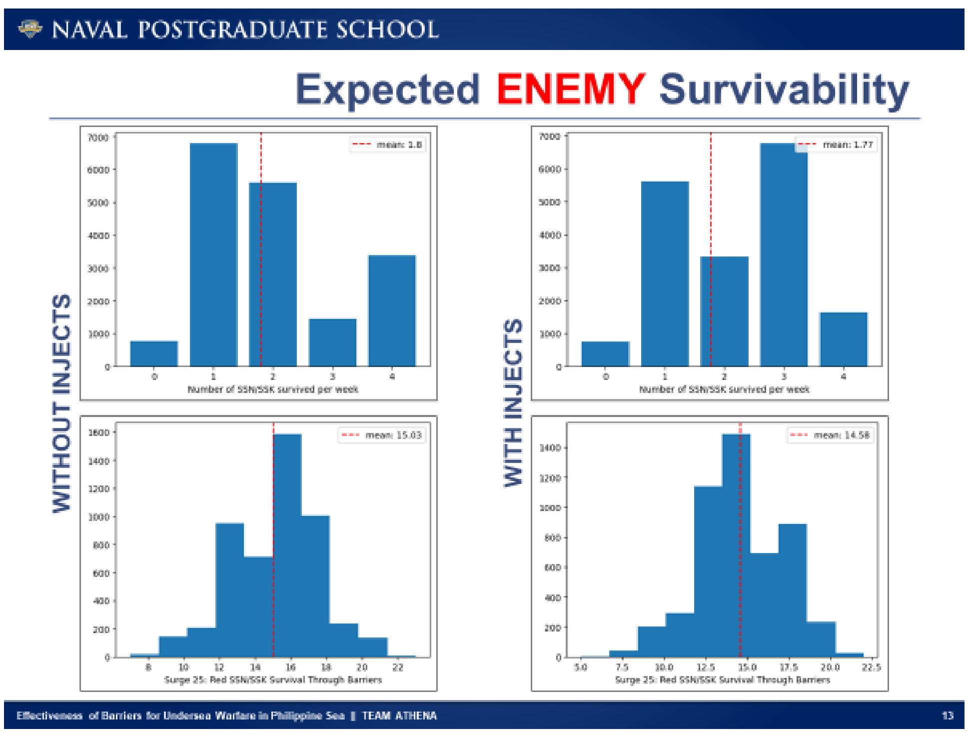
The analytical results from the search theory and deterministic model calculating the likelihood of adversary survival on outbound and inbound legs may be seen in Figure 6. Survival likelihood ranged from 0.54-0.62 across all options and technical injects. The optimal location for an ORCA barrier is against the adversaries' southern route. The optimal location for the Stingray Glider is employing a mix strategy with it being in the southern search area 50% of the time, the central search area 25% of the time, and the remaining time in the northern search area. In most cases, however, the technical injects had very little effect on campaign adversary survival, mainly due to the great amount of ocean to search.



Results show an adversary survivability ranging from 54–62%. The technical injects of ORCA and Stingray Glider show only marginal improvements in campaign effectiveness, mainly due to size of the search area.

Figure 6. Barrier effectiveness results based on likelihood of enemy transiting a particular route.

Simulation was next employed to assess the expected number of friendly logistics force ships that would survive across a campaign given two courses of enemy action: either deploying two to four submarines each week across a six month period, or surging twenty five submarines across the same period. In each adversary course of action case, the team looked at employing the baseline forces and the baseline forces with the technical injects. Figure 7 shows the frequency histograms of surviving adversary submarines going through the barriers in four cases. The upper left histogram depicts the frequency of surviving submarines in the case where the enemy deploys two to four submarines each week across a six-month period against just the baseline forces. The upper right histogram shows the frequency of surviving adversary submarines in the case where the enemy deploys two to four submarines, but barriers are augmented by the ORCA and Stingray sea glider. The bottom row histograms show the cases without and with the technical injects, but with the adversary surging twenty-five submarines at a time.



The enemy streamlines their deployment of submarines to about two to four a week across a six-month period, or the surge twenty-five submarines at a time, and the blue forces either deploy with only the baseline forces or the baseline forces with the technical injects.

Figure 7. Frequency Histograms of surviving enemy submarines across four cases.

Three major themes emerge from studying these histograms. The first is that there is extensive variability in the results, which is expected of a model representing the complexity of military operations. The second is that the barriers are successful in achieving about a 40% attrition of enemy submarines across a six-month period. Finally, confirming from the expected value model, the technical injects show little campaign impact when acting as barrier patrollers.

The simulation also measured the technical injects' effects on the number of surviving logistics ships in a five logistic ship convoy across a six-month campaign. Figure 8 paints a depressing picture for blue forces if seen as campaign predictions. It shows that within week nine of the six-month campaign, the five logistic ship convoy is completely wiped out. The adversary needs only seven submarines across the campaign to accomplish this ending. However, one must recall the modeling assumption used that every surviving submarine kills at least one blue ship each time deployed. This assumption does not consider the adversary's own problem of searching, identifying, and positioning itself to attack a convoy moving faster than itself. Future modeling of the adversary's challenges will show a more optimistic picture for the logistic forces in both attrition and survival time. The importance of Figure 8 is not its dire results, but the relative campaign differences with and without the technical injects included in the blue force. There are none. Again, the deployment of the ORCA and Stingray sea glider in open ocean barrier operations is probably not the best concept for these assets.

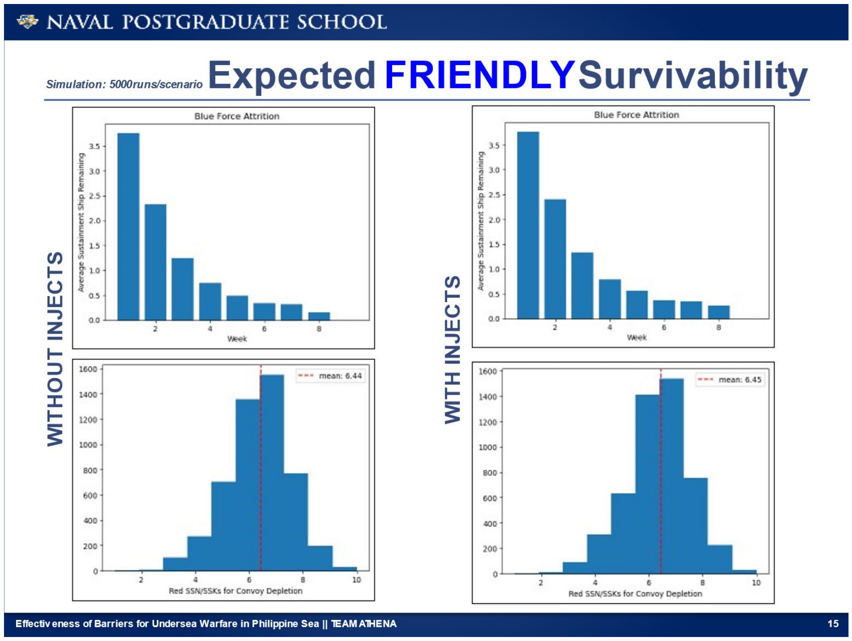


Figure 8. Simulation results showing number of surviving logistic ships by week and number of adversary submarines deployed to deplete the five-ship convoy.

Results from the campaign study on barrier effectiveness and asset employment were carried over to the next phase of this project, the coalition ASW wargame design, development, and execution, particularly in adjudication of search effectiveness.

III. WARGAMING COALITION THEATER ASW

A. WARGAME DESIGN, DEVELOPMENT, AND EXECUTION

COMPACFLT N9WAR (Warfare Analysis and Research) designated COMSUBPAC N5 (Strategy, Plans, and Policy) to act as the wargame sponsor for the Australia, Japan, and United States coalition ASW wargame. COMSUBPAC Deputy Director of Strategy, Plans, and Policy Keith Skillin worked directly with Dr. Jeff Appleget, NPS Wargaming Director; LCDR Olive Oliverios, USN; LCDR Adam Davidson, USN; LT James Self, USN; LT Katrina Bernal, USN; SMSgt Kade Forrester, USAF; and SMSgt Gessica Lillich, USAF to establish specific sponsor objectives, design, develop, and execute the wargame.

The following are the specific questions the sponsor wished to address:

1.) How might Japan and Australia employ their maritime patrol and reconnaissance aircraft, submarines, and surface ships in coordination with U.S. forces to deny People's Liberation Army-Navy undersea forces access to the Control Area and sovereign territory and engage in combat if authorized?
2.) How can communication and coordination between the U.S., Japan, and Australia be improved to best leverage partner capabilities in the undersea battlespace?
3.) What barriers exist to effective employment and coordination of the ASW assets of the three countries to achieve their common objectives?

The wargame was executed from 20 June 2023 to 23 June 2023 in Yokosuka, Japan and Commander, Task Force Seventy-Four (CTF-74) classified spaces. Participants included Royal Australian Navy, Royal Australian Air Forces, Japanese Maritime Defense Force, and U.S. Navy players.

B. WARGAME RESULTS

The final wargame summary report is classified secret and provided to the COMPACFLT and COMSUBPAC staff. Distribution of the report is controlled by COMPACFT. However, an unclassified summary follows.

- Theater ASW operations can be enhanced by establishing direct communications between all allies and ASW platforms, and not just through a central coordinating command center.
- Allied hosting of other nation's theater ASW platforms can increase on-station time by shortening transit times to operational areas. Further exploration of national policies to enable these types of operations are necessary.

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IV. SUMMARY

This report has outlined the process used by Naval Postgraduate School faculty and students to conduct a campaign of analysis including wargaming, modeling and simulation, and game theory to obtaining insights on coalition partners contributions to theater anti-submarine warfare.

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LIST OF REFERENCES

Cantwell, Chu, Davis, 2023, *Effectiveness of Barriers for Undersea Warfare in Philippine Sea,* study completed to satisfy Naval Postgraduate School's Joint Campaign Analysis course, limited distribution, available upon request.

Davidson, Oliveros, Kim, Bernal, Seif, Lillich, and Forrester, 2023, *Executive Summary for Coalition ASW wargame,* report completed to satisfy Naval Postgraduate School's Wargaming course and sponsor objectives, classified, limited distribution, controlled by COMPACFLT.

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