Research on key problems for a maritime patrol mode integrating patrol with search and rescue

Ma Minglu1*, Wang Guobo2

1China Waterborne Transport Research Institute Beijing, China
2China Waterborne Transport Research Institute Beijing, China
*maminglu@wti.ac.cn

Abstract—The present study summarizes major challenges in integration of maritime patrol, search and rescue, and proposes corresponding solutions based on previous studies and relevant practice in China and abroad. The patrol mode that integrates cruise, search and rescue is expected to fulfill patrol missions while improving the ships’ capacity for search and rescue. In other words, cruise, search and rescue are fulfilled at the same time. At present, major challenges in integration of maritime patrol, search and rescue include problems in organizational planning, layout of sites, deployment and training of personnel, quality of rescue-and-rescue equipment, logistical support and soft environment for integration. Based on rescue capacity building in China and advanced search and rescue modes and technologies of other countries, this study puts forward corresponding measures to upgrade organizational planning, realize proper layout of sites for cruise, search and rescue, cultivate personnel, improve performance of equipment, increase the application of information technologies, improve logistical support, and foster an enabling soft environment for integration of cruise, search and rescue.

1. INTRODUCTION
With the increasing of ship traffic volume in China, maritime traffic accidents occur frequently, which increases the pressure of search and rescue task. The increasingly severe maritime security situation requires integration of maritime patrol, search and rescue, which means that search and rescue are added to routine duties of maritime safety administrations in China, and thus becoming part of the maritime routine. Therefore, it is necessary to pinpoint and resolve key challenges facing integration of cruise, search and rescue, and enhance the capacity for search and rescue. China is a signatory to the International Convention for the Safety of the Life at Sea, 1974 and the International Convention on Maritime Search and Rescue, 1979. The conventions stipulate the following: signatories shall provide the most rapid and effective search and rescue within or over search-and-rescue areas, and make necessary arrangements to provide proper search and rescue[1]; signatories shall count all usable equipment for search and rescue missions, and could designate qualified equipment as the search-and-rescue unit[2].

Challenges facing China’s maritime search and rescue are mainly listed as follows:
1) An overly-complex management system. The management system of maritime search and rescue involves both governments at various levels and command systems of all governmental sectors[3].
2) Improper deployment of rescue sites. Rescue sites are loosely distributed, and face the problem of repetitive distribution of resources.
3) Weak rescue capacity. This is mainly reflected by the following: inefficient response of professional rescue teams; lack of support with information technologies; shortage of rescue vessels, planes and other facilities; immaturity of the talent training system; lack of public involvement and difficulty in coordination.

These challenges reveal that the existing capacity and means for search and rescue cannot meet the increasing demand to ensure maritime safety. With maritime patrol, search and rescue being integrated, the search and rescue are added to the line of duty of maritime safety administrations in China, and patrol ships are prepared to fulfill search and rescue missions when on duty, thus creating a safe and unobstructed environment for maritime transport.

Maritime safety administrations in China are putting great efforts into advancing integration of maritime patrol, search and rescue, and have issued important documents such as the National Planning for Maritime Supervision and Rescue System, the Development Outline on China's Maritime Affairs, and the Issuing Documents about the Opinions on Integration of Maritime patrol, Search and Rescue. By drawing lessons from developed countries’ practice in integration of cruise, search and rescue, as well as local maritime safety administrations’ pilot programs in this regard, the present study aims to pinpoint the major challenges in integrating cruise, search and rescue in China, and put forward corresponding solutions.

2. IMPLICATIONS OF INTEGRATION OF CRUISE, SEARCH AND RESCUE

Integration of maritime patrol, search and rescue refers to the practice of integrating search and rescue missions into maritime patrol based on the existing maritime safety management system so that the patrol vessel can save lives during the cruise, and the mission of search and rescue is added to the line of duty of maritime safety administrations; in this way, the administrations can develop a management mechanism and capacity for maritime dynamic supervision, rescue coordination, search and rescue. With cruise, search and rescue being integrated, maritime safety administrations in China could effectively supervise and manage patrol, and patrol vessels (or planes) could respond quickly to emergencies. By enabling the integration, maritime safety administrations in China can “perform cruise and rescue missions simultaneously”.

3. MAJOR CHALLENGES IN INTEGRATION OF CRUISE, SEARCH AND RESCUE

3.1. Organizational planning
Integration of patrol and search and rescue is a break from the conventional cruise mode that only serves the purpose of patrol. Organizational planning involves establishment of the integration bases, deployment of warehouses in the patrol and rescue sites, etc.

3.2. Layout of patrol sites
In regard to construction of patrol sites, major waters with potential safety hazards should be supervised, and the patrol sites should not overlap each other. Rescue sites are established according to the locations of major ports, important routes, areas with severe weather, accident-prone sea areas, and sensitive military zones. The patrol and rescue sites should be properly deployed so that the patrol vessels can come to rescue and transfer people in distress in the shortest time.

If existing maritime patrol sites are taken as sites for integrated cruise, search and rescue, the problems of shortage and overlapping of sites will emerge. That is especially prominent in some underdeveloped regions in China. For instance, along the shipping lines in the Xijiang River in Guangxi Province, China, sites for patrol and rescue are small in quantity and improperly distributed, which leads to poor emergency capacity[4].

3.3. Personnel

3.3.1 Weak search and rescue capacity of the personnel. Rescue missions require that the mission
undertakers boast professional rescue knowledge and skills as well as technical and medical know-how to respond to emergencies quickly, which is especially true in the context of complicated sea conditions and dangers. Nevertheless, the patrol personnel, short of experience in search and rescue, cannot match professional search and rescue teams in rescue missions.

3.3.2 An immature training system for the personnel. The overall mechanism for personnel training in the maritime system is defective, with specialized rescue personnel being short. Furthermore, relevant teaching institutions are not available in China. In contrast, developed countries in Europe, America, and Asia not only have specialized institutions for cultivating maritime rescue workers, but organize regular rescue training sessions and rehearsals. America boasts the US Coast Guard Academy and the National Search and Rescue School in the Yorktown Training Center. The National Search and Rescue School with the US Coast Guard Academy is the world's first search and rescue training center. Japan boasts Japan Coast Guard Academy and Japan Coast Guard School, which owns two branch schools in Miyagi and Moji: the Miyagi branch is in charge of training pilots from Japan Coast Guard; the Moji branch is in charge of training those who have obtained seaman qualification. Japan Coast Guard Academy is in charge of training leaders, while Japan Coast Guard School is in charge of training the rank and file. In a word, the two institutions take on divided tasks at different levels[5]. In the meantime, at present, China is short of a system for certifying patrol personnel's rescue capacity. Therefore, patrol personnel's rescue capacity could not be effectively determined.

3.4. Rescue equipment

3.4.1 Performance of patrol ships could not meet requirements for search and rescue missions. Rescue vessels in China are classified into the following four kinds: seagoing rescue vessels, quick-response rescue boat, high-speed rescue boat and port workboat. Take the seagoing rescue vessels owned by the Beihai Rescue Bureau of the Ministry of Transport and rescue boats owned by the Nanhai Rescue Bureau of the Ministry of Transport as an example. Tonnage of seagoing rescue vessels is all more than 1,000 tons. In recent years, the maximum speed of newly-built rescue vessels is more than 16 knots, and usually 20.1 knots. In regard to seagoing rescue vessels, the power of main engines and generators, and the force of towing and thrusting are all at a high level. With the tonnage being relatively small and the speed being usually around 18 knots, shallow-draft rescue boats respond quickly. The speed of rescue boats of developed maritime countries is no below 18 knots. At present, large vessels owned by maritime safety administrations in China are small in quantity, while others are small patrol boats with slow speed and poor wind resistance. Existing patrol vessels of maritime safety administrations in China are not qualified for maritime rescue missions as they fail to meet the standards.

3.4.2 The capacity for air rescue is insufficient. At present, only few maritime safety administrations in China own maritime patrol planes, and helicopters that take off from three patrol ships of Haixun-11, Haixun21 and Haixun-31 are owned by rescue bureaus in China. Use of both fixed-wing planes and helicopters is not large-scale and institutionalized in China's maritime system. At present, planes owned by maritime safety administrations in China are only capable of simple maritime patrol missions. There is a wide gap between rescue helicopters and existing helicopters owned by maritime safety administrations in China.

3.4.3 Application of information technology in rescue equipment is not sufficient. At present, maritime patrol ships could not completely meet requirements for rescue because of insufficient support of information technology. Having served for a very long time, some ships of maritime safety administrations are not equipped with basic information equipment.

3.4.4 Other equipment is insufficient. To take on rescue missions, patrol ships must be equipped with
life-saving and rescue equipment (such as lifeboats, inflatable life rafts, life vests, breech buoys, portable VHF radio telephones, line throwing appliance and floating lifelines), signal equipment (such as floating lights, speakers, flame and floating smoke), equipment for medical assistance (such as stretchers, blankets and food), and other equipment (such as lifting appliance and tethers)[6]. However, in the process of patrol, current patrol ships usually do not carry or could only carry some of equipment and tools that are necessary to rescue.

3.5. Logistical support
Patrol ships in China are maintained by respective maritime safety administrations, without unified ship maintenance standards being set. In contrast to that, the Republic of Korea Coast Guard boasts its own repair and maintenance facility, which provides support and guarantee for repair and maintenance of coast guard ships.

3.6. Construction of the soft environment
In the process of advancing integration of maritime patrol, search and rescue, incomplete norms and standards lead to ambiguous division of duties. Maritime patrol ships have not completely transformed its role, thus having not taken the initiative in taking on rescue obligations. In the meantime, some maritime patrol personnel have no awareness of search and rescue obligations and are not active in participating in search and rescue.

4. Solutions to key challenges in integration of maritime patrol, search and rescue

4.1. Proper organizational planning
Relevant functional departments should be coordinated, while patrol, rescue, guarding and emergency standby should be managed in a unified way as shown in Figure 1. Corps, battalions and detachments for cruise, search and rescue should be established and be subordinate to maritime safety administrations, branches of maritime safety administrations and departments of maritime safety, respectively. In other words, corps for cruise, search and rescue should be formed directly under maritime safety administrations, while battalions for cruise, search and rescue should be established under branches of maritime safety administrations. In this way, maritime patrol forces will become the major actor for integration of cruise, search and rescue.

![Figure 1. Diagram of forces for cruise, search and rescue](image-url)
4.2. Proper layout and reasonable deployment

Deployment principles for patrol sites and for search and rescue sites are different. Currently available resources should be coordinated and managed, while existing bases should be transformed and upgraded. New sites for cruise, search and rescue should be deployed in key sea areas featured by weak capacity for search and rescue. Advice on construction of sites in different sea areas is shown in the following Table 1.

Terms in Table 1 are defined as follows:

1) Key sea areas for patrol: sea areas facing a tense situation within the jurisdiction of maritime safety administrations, and sea areas needing to be cruised and supervised frequently because of factors such as intense traffic and production safety hazards. 2) Key sea areas for search and rescue: major ports, important routes, areas with severe weather, accident-prone sea areas, sensitive military zone and other sea areas. 3) Areas under coverage of effective patrol: areas that could be effectively supervised by patrol forces at sites of maritime safety administrations. 4) Areas under coverage of effective search and rescue: areas where rescue forces of rescue bureaus could effectively arrive at accident sites for search and rescue, and transfer people in distress.

4.3. Patrol Personnel training

4.3.1 Patrol personnel's skills in search and rescue are improved. The Yangtze River Maritime Safety Administration persists in improving patrol personnel's skills in search and rescue through drills in order to enhance the patrol personnel's ability for rescue while on duty. Based on practical conditions, the Jiangsu Maritime Safety Administration organizes field training in a bid to improve ordinary maritime patrol personnel's ability for emergency search and rescue. In terms of the patrol personnel training, comprehensive measures should be taken, which are listed as follows:

- Regularly hosting contests about search and rescue skills and conducting activities such as training activities for search and rescue skills.
- Holding regular seminars and study sessions, and conducting regular assessment.
- Formulating and strictly implementing an outline of physical training.
- Sending the patrol personnel to domestic and foreign rescue organs to improve expertise in search and rescue.

4.3.2 The mechanism for training rescue workers is improved. The following specific steps could be taken: sending personnel of maritime patrol ships to rescue organs for rescue training; establishing specialized training institutions to provide training for individuals and rescue volunteers; providing rescue majors and courses in colleges and universities; recruiting graduates from maritime institutions of higher education to form a high-level teaching team; enhancing exchange and cooperation with foreign rescue organizations; establishing a corresponding assessment system, and issuing rescue certificates to qualified personnel of maritime patrol ships.

![Table 1](image-url)

| A | B | C | D | Advice on integration of cruise, search and rescue |
|---|---|---|---|---------------------------------|
| Yes | Yes | Yes | Yes | Maintaining the status quo     |
| Yes | Yes | Yes | No  | Upgrading patrol sites in the area in order to enable those sites to perform search and rescue missions |
| Yes | Yes | No  | Yes | Constructing new sites for cruise, search and rescue |
| Yes | Yes | No | No | Constructing new sites for cruise, search and rescue |
|-----|-----|----|----|-----------------------------------------------------|
| Yes | No  | Yes | Yes | Maintaining the status quo |
| Yes | No  | Yes | No  | Upgrading patrol sites in the area in order to enable those sites to perform search and rescue missions |
| Yes | No  | No  | Yes | Constructing new sites for cruise, search and rescue |
| Yes | No  | No  | No  | Constructing new sites for cruise, search and rescue |
| No  | Yes | Yes | Yes | Maintaining the status quo |
| No  | Yes | Yes | No  | Upgrading patrol sites in the area in order to enable those sites to perform search and rescue missions |
| No  | Yes | No  | Yes | Maintaining the status quo |
| No  | Yes | No  | No  | Constructing new sites for cruise, search and rescue |
| No  | No  | Yes | Yes | Maintaining the status quo |
| No  | No  | Yes | No  | Maintaining the status quo |
| No  | No  | No  | Yes | Maintaining the status quo |
| No  | No  | No  | No  | Maintaining the status quo |

**Note:** A represents: Whether it is a key sea area for patrol 
B represents: Whether it is a sea area for search and rescue 
C represents: Whether it is an area under coverage of effective patrol 
D represents: Whether it is an area under coverage of effective search and rescue

4.4. Improving equipment

4.4.1 patrol ships’ capacity for search and rescue should be enhanced. Newly-built patrol ships should be improved in terms of endurance capacity, wind and wave resistance, and capacity for professional rescue; patrol ships in active service, whose hardware facilities are partly in bad conditions, need to be upgraded and optimized in terms of engine power, generator power, wind and wave resistance (for example, a fin stabilizer could be installed) and communication equipment; patrol ships, whose facilities have aged and which have serviced for a long period of time almost without the necessity of being upgraded, could be lifted out of service in an orderly way.

4.4.2 Air forces for cruise and rescue should be built. patrol personnel should be equipped with more planes such as specific-purpose patrol helicopters and fixed-wing planes. A squadron should be formed by maritime safety administrations to realize integration of cruise and rescue. In this way, a new landscape, which is featured by maritime dynamic supervision, quick response and integration of air and maritime patrol and rescue, will come into being. In the meantime, functions of planes should be improved, and planes should be equipped with rescue-related floating bowls, life rafts, winches, lifting appliance, automatic searchers, infrared searches and lifeguards.
4.4.3 More information technologies should be applied to search and rescue equipment. In terms of applying more information technologies to search and rescue equipment, lessons could be learned from the United States Coast Guard, which has developed the CMS (which is a system for managing maritime accidents), which centers around management measures for quick response and specific actions in the event of maritime accidents. The United States Coast Guard has also developed a corresponding survival prediction tool[7], data of which could be shared. China could develop a similar system for effective search and rescue.

4.4.4 Patrol ships should be equipped with search and rescue equipment. Radar equipment should be installed in radar-free patrol ships (which are mainly river patrol ships), and existing equipment of those ships should be improved and optimized. The following equipment is necessary for patrol ships: life jackets, boom systems, floating rescue stretchers, rescue boats, life-saving soft ladders, safety nets, night vision devices, pneumatic throwers, navigation equipment, communication devices, drift positioning devices, and so on.

4.5. Enhancing logistical support
Powerful shipyards with advanced technologies should be chosen or established as bases for repair and maintenance of maritime patrol ships. Warehouses should be established in order to ensure logistical support in the process of integration of cruise, search and rescue, and ensure that logistical supplies needed for integration could be timely delivered to each site for cruise, search and rescue.

4.6. Creating a favorable soft environment
Respective responsibilities should be clearly clarified, while relevant norms and standards should be formulated and improved in accordance with status quo of cruise, search and rescue in China. Furthermore, based on actual conditions of integration of cruise, search and rescue in China, various kinds of study activities, drills and so on should be conducted in order to change the mindset of personnel of maritime patrol ships, who are expected to attach equal importance to search and rescue, and combine cruise, search and rescue.

5. Conclusion
Conclusions of the present study are as follows:

1) Integrating maritime patrol, search and rescue requires settlement of the challenges in organizational planning;
2) Sites for cruise, search and rescue at various levels should be deployed according to varying needs in various sea areas, sites should be deployed in areas originally without sites, and original sites should be upgraded;
3) The training of the patrol personnel should be upgraded;
4) More hardware supporting equipment should be provided and employed;
5) More information technologies should be applied to patrol ships;
6) Measures should be taken to ensure logistical support;
7) A favorable soft environment for integration of cruise, search and rescue should be created, and the mindset of the patrol personnel should be changed.

Acknowledgments
I am grateful to my colleagues Xu Liansheng and Chen Fengyun, who helped me with the research for this paper.

References
[1] IMO. International Convention for the safety of Life at Sea, 1974.
[2] IMO. International Convention on Maritime Search and Rescue, 1979.
[3] X. F. Peng, “On Improving China's Capacity for Maritime Search and Rescue”, China Emergency Rescue, No. 4, pp. 31-33, 2007.
[4] Z. H. Shi, On Integration of maritime patrol, Search and Rescue along Shipping Lines in the West River in Guangxi Province, a master's thesis with Wuhan University of Technology, 2011.
[5] N. Wang, “Japan's System for Emergency Maritime Rescue”, China Emergency Rescue, No. 6, pp. 18-20, 2008.
[6] J. P. Zhang, X. Z. Jia and L. J. Yang, Assessment of Field Navigation Training: Voyage Number, Maritime Search and Rescue and Case Analysis, Dalian: Dalian Maritime University Press, pp. 63-64, 2004.
[7] A. Turner, et al., Recommendations for the U.S. Coast Guard Survival Prediction Tool[R]. The U.S. Coast Guard Search&Development Center. Public April 2009.