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Study on the Path of Teenagers' Ocean Literacy Enhancement - Based on the Practice of National Sea Grant College Program

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Abstract— *The 21st century is known as the "century of the sea", and the cultivation of young people's ocean literacy is crucial to the realization of China's strategy of becoming a "strong maritime nation". Based on the National Sea Grant College Program, this paper analyzes the path of the National Sea Grant College Program to enhance the ocean literacy of American teenagers, it is effective in enhancing the ocean literacy of teenagers through the path of courses, competitions, summer camps, teacher development, promotion and publicity. Our country should learn from its experience and, at the macro level, should actively introduce relevant policies to elevate the ocean literacy of teenagers to the status of a national strategy; At the meso level, various sea-related and coastal universities have established alliances to join hands in promoting the cultivation and development of ocean literacy; At the micro level, learning and practicing activities such as marine courses, competitions and summer camps are actively promoted, while emphasis is placed on the cultivation of teachers' ocean literacy. These initiatives are of key importance for the future stockpiling of marine talent in the country*.

Keywords— *The National Sea Grant College Program, teenagers, ocean literacy, upgrade path*.

I. INTRODUCTION

The National Sea Grant College Program (NSGCP), established in 1966, is now administered by the National Oceanic and Atmospheric Administration (NOAA). Since 1966, the National Sea Grant College Program in the United States has explored ways to improve national ocean literacy through a variety of measures, with a strong emphasis on improving the ocean literacy of teenagers.[3] NSGCP is an important channel and pathway for improving youth ocean literacy in the United States. Based on the 34 Sea Grant Program colleges in the United States, this paper summarizes the way to promote K-12 (kindergarten through twelfth grade) ocean literacy, with a view to providing reference and inspiration for the promotion of Chinese teenagers' ocean literacy. The following is the background and key elements of the study.

II. BACKGROUND OF THE STUDY AND FORMULATION OF THE PROBLEMB

The 21st century is the century of the ocean, and General Secretary Xi Jinping put forward the strategy of a strong ocean power in the 18th National Congress, which pointed out that it is necessary to build an echelon of marine talents to ensure that the strategy of a strong ocean power is vigorously promoted and implemented. The cultivation of marine talents, on the other hand, starts with the cultivation of human ocean literacy, and it is therefore crucial to enhance the ocean literacy of teenagers.

A. The Strategy of a Strong Oceanic Nation Requires the Cultivation of Marine Reserve Talents

With the proposal of the strategy of a strong marine country, marine education has gradually attracted people's attention, while the ocean literacy of young people still has not been given due attention, and the degree of importance attached to the ocean literacy of Chinese teenagers is lacking. The cultivation of ocean literacy among teenagers is crucial to building a strong maritime nation. As teenagers are the future practitioners of the marine industry and the main force that will join in the construction of a strong marine nation in the future, teenagers should have ocean literacy that is compatible with future development. At present, there is a lack of clear and strong guiding ideology for marine awareness education, and the corresponding policies, laws and regulations need to be improved urgently.

And the NSGCP has had a large impact on improving K-12 ocean literacy. As an ocean powerhouse, NSGCP relies on colleges, universities and scientific research institutions, not only disseminating marine knowledge to colleges and universities, but also focusing on the cultivation of ocean literacy for K-12 students in the United States. The United States systematically integrates knowledge of marine culture into primary and secondary school curricula. The U.S. Center for Ocean Science Education Excellence (COSEE), the National Geographic Society (NGS), and the National Marine Educators Association (NMA) published Ocean Literacy: *Fundamental Principles of Marine Science K-12* and *the Scope* and *Sequence of Ocean Literacy for Grades K-12 documents* in 2010, which together form a framework for implementing ocean literacy education. At the same time, the seven principles of ocean literacy are integrated into the U.S. K-12 education standards to help students from kindergarten to grade 12 to

[3] The National Sea Grant College Program [EB/OL].http://www.seagrant.noaa.gov/colleges.

establish a coherent and conceptually self-contained ocean education learning content system.[4]

B. China's Ocean Literacy Theory System is Not Yet Mature

Current international definitions, principles and concepts of ocean literacy are largely based on Ocean Literacy: *Core Principles and Essential Concepts for K-12 Marine Science*, developed by the U.S. Ocean Education Community in 2005.[5]It can be seen that the international theory system of ocean literacy has matured, and our country is also actively exploring, for example, the author has previously pointed out that primary and secondary school marine education should be changed into primary and secondary school ocean literacy education, and its corresponding cultivation goal of ocean literacy is to cultivate the basic ocean literacy of the students, the ocean cognitive literacy, the ocean emotional literacy, the ocean ethical literacy, the ocean volitional qualities and the ocean behavioral literacy.[6]However, China has yet to form a ocean literacy indicator system that has been officially recognized as authoritative by the Chinese government.

C. China's Narrow Path to Cultivate Teenagers Literacy Enhancement

The cultivation of ocean literacy among teenagers in China is still in its infancy, with a single pathway and a small scope of coverage. Although many primary and secondary schools have begun to carry out marine education, for example, Guangzhou Zhuhai Xingangzhong Road Primary School, which has provided a model for Chinese primary and secondary schools to carry out marine education by creating physical study bases, introducing professional teachers, building school-based curricula, and innovating evaluation methods to highlight the characteristics of marine culture and education. [7]However, from a general point of view, China's primary and secondary schools to enhance the ocean literacy of teenagers is mainly carried out through some of the courses, summer camps, study activities and so on, only a little bit without surface, and has not been carried out on a nationwide scale in general. Marine education has not yet been universalized in basic education, and there is not yet a system of shallow and deep curricula between the primary and secondary school curricula. In kindergarten and elementary school subjects, knowledge of the oceans and seas is still at a rudimentary stage. In the geography, history and ideological and political courses of middle and high schools, only a few courses deal with the geography of the oceans and the environment of marine resources, as well as with historical events in the oceans and the rights and interests of the State in the oceans. From elementary school to high school, the marine education received by students is fragmented and lacks a coherent design between academic segments, which makes it difficult for students to form a comprehensive, systematic, and thematic main line of knowledge about marine culture, and does not create a strong interest in exploration.

NSGCP relies on the 34 sea grant colleges and universities to promote the development and improvement of K-12 ocean literacy in several ways. After more than half a century of practice of NSGCP, the U.S. version of the path to enhance the ocean literacy of teenagers has been formed, so the U.S. path to enhance the ocean literacy of teenagers can be used as a reference. Based on this, the purpose of this paper is to explore the path of NSGCP to enhance K-12 ocean literacy, analyze its specific paths and their impacts, and provide paths to enhance the ocean literacy of China's teenagers, and at the same time combine with China's actual situation to explore the paths of enhancement of teenagers' ocean literacy that are suitable for China's characteristics. NSGCP focuses on enhancing the ocean literacy of teenagers through the main pathways of curriculum, competitions, hands-on activities, teacher development, and promotion and publicity.

III. Systematic Development of Ocean Literacy Curriculum as the Main Line to Enhance the Level of Marine General Education

Curriculum is central to educating K-12 about ocean literacy. NSGCP promotes K-12 awareness and understanding of the oceans by offering a series of ocean-related programs for different K-12 levels. The courses offered so far are generally rich in content, varied in format, detailed and lively, and rich in personalization and regional characteristics.[8]

A. Focus on Curriculum Content Articulation Based on School Segments

From the perspective of school division, the U.S. K-12 marine curriculum is broadly divided into four stages: preschool, elementary school, middle school, and high school, and at the same time, there are different courses for different grades within a school stage. More typical examples such as the University of Georgia's Sea Grant College program have programs for grades Pre-K through 4, as well as grades 5-12; Alaska Sea Grant's K-12 Education Program: the Alaska Sea Grant Program has a marine and watershed curriculum for K-12. The curriculum covers grades one through eight. It is specifically divided into three tiers: Beginning (K1-2), Intermediate (K3-5), and Advanced (K6-8). Each different stage corresponds to a corresponding course. Among the topics in the K-2 program are exploring our blue planet, ocean flora and fauna, and at home in the water; The ocean curriculum topics for grades 3-5 are Rivers into the Sea and Their Circulation, Missing Sea Segue Case, and Humans and the Sea; The curriculum themes for grades 6-8 are Exploring the Ocean,

[4] Ma Renffeng,Gong Qianqian,Lin Qiuling..The Knowledge System of Marine Culture from the Perspective of National Literacy and Its Educational Implementation Strategies [J]. Nautical education research, 39（01）:9-15,2022.

[5] Liu Yashi,Wang Mei. Ocean literacy: definition, core principles and basic concepts [J]. Shanghai Education，No.1201（20）:22-24,2022.

[6] Ma Yong. From Ocean Awareness to Ocean Literacy - A Renewal of China's Marine Education Goals [J]. Journal of Ningbo University (Educational Science Edition)，43（02）:5-8,2021.

[7]Xu Dongyuan. Exploring the Practice of Marine Culture Education in Primary Schools--Taking Xingangzhonglu Primary School as an Example [J]. Education Watch, 12(05):55-58,2023.

[8]Ren Qi. Study on the Sea Grant College Program in the United States [D]. Ocean University of China,2015.

The Ocean in Motion, and Our Changing World. [9] Another example is the University of Florida Sea Grant Academy's K-12 program, which is divided into third, fourth, and fifth grades: manatee (K3), cetacean program (K4), and sea turtle (K5). [10]In addition, the North Carolina State University Sea Grant Program-Mariculture Curriculum, which contains 10 curriculum resources for high school students, introduces high school students to various aspects of mariculture, including its history and different production methods. Mariculture is a growing industry in North Carolina that offers many career paths. The Mariculture Curriculum includes 10 free lesson plans that meet North Carolina science standards and career and technical education programs.[11]

These lesson plans cover a variety of subjects and allow students to explore aquaculture species and biology, production methods, and even business planning.

B. Diversification of Course Formats

From a formal point of view, NSGCP has formed a curriculum that combines online and offline courses and combines theoretical and practical courses.

① Combination of online and offline courses

For K-12, NSGCP focuses on offline courses and, at the same time, offers online courses as well, creating a combination of online and offline courses. Offline courses such as the University of Florida Sea Grant College Program K-12 courses: manatee (K3), Whale Eye Project (K4), and Sea Turtle (K5); University of New Hampshire Sea Grant College Program K-12 Curriculum: the education team and marine docents conduct a variety of classes for children ages K-12 covering marine science, coastal concepts, and environmental literacy.[12]

Online courses, also known as virtual courses, are characterized by openness, flexibility, and transcendence of time and space. The current online courses in NSGCP are mainly in the form of live online broadcasts, recordings, and podcasts. Typical examples are as follows: the University of Georgia Sea Grant Academy Program (UGA) - a virtual school program, these courses provide interactive distance learning for K-12 students. The UGA Marine Education Center and Aquarium now offers online interactive marine science education courses for K-12 students. The course is 45 minutes long and can accommodate up to 25 participants.[13] The MIT Sea Grant College Program online courses are offered in the form of webinars, live streams, recordings, and podcasts.

② Combination of theoretical and practical courses

The New Jersey Marine Science Alliance's program to enhance K-12 ocean literacy includes theory and outdoor lessons. Theory courses include Marine Hazards, Coastal Ecosystems, Amplifying Plastic, Terrific Sea Turtles, and Saving Our Turbulent Oceans. Meanwhile, the outdoor hands-on curriculum, the K-12 Field Trip Program, guides more than 20,000 schoolchildren each year alone, taking them out of the classroom and onto New Jersey's beaches, bays and estuaries for positive learning experiences.

Woods Hole Sea Grant (WHSG) and the Northeast Fisheries Science Center (NEFSC) in Woods Hole, Massachusetts, developed a plan to create educational materials related to key ocean and coastal topics and their research conducted at NEFSC and WHSG. It offers free, six-hour programs for K-1 classrooms that include hands-on activities, demonstrations and projects on ocean and coastal topics. And all programs are linked to the Massachusetts Curriculum Standards.[14]

University of Delaware Sea Grant Academy Program: over 140 scouts participated in Delaware's only accredited oceanography merit badge program. This four-hour hands-on program includes an interactive "Oceanography 101" presentation, measuring water quality, sampling and observing plankton, exploring a mini oyster reef habitat, and a tour of the University of Delaware's Hugh Sharp Marine Campus.[15]

C. Focusing on the Development of Special Courses in Conjunction with the Professional Advantages of Colleges and Universities

Each Sea Grant College has a special school-based curriculum based on the unique geography in which it is located. For example, the North Carolina State University Sea Grant Program's mariculture courses, the purpose of these courses is to enable students will understand marine biology and ecology, and to understand the relationship between human beings and the ocean and the way to protect marine plants and animals, develop marine resources, enhance the ocean literacy of teenagers, and reserve marine reserve talents. Then there's the Sea Grant Institute at the University of Connecticut, which published Long Island Sound Curriculum Resource Guide: funded by the EPA Long Island Sound Study Grant and edited by Diana Payne, the 148-page guide is a resource for educators to teach Long Island Sound. The guide is organized into five sections: 1) background information about Long Island Sound (LIS), 2) LIS activities, 3) LIS lesson plans, 4) science lessons at LIS sites, and 5) resources.

IV. Setting Up Various Competitions To Cultivate Teenagers' Marine Expertise

NSGCP has set up marine competitions on various themes for high school students, which is of great value and significance in enhancing the ocean literacy of high school students.

A. Meaning of the National Ocean Science Cup

The National Ocean Sciences Bowl (NOSB), which began in 1998 and is sponsored by NOAA to commemorate the International Year of the Ocean, is a national competition for U.S. high school students to compete in ocean sciences and is

[9] University of Georgia Sea Grant College [EB/OL].http://georgiaseagrant.uga.edu.
[10] University of Florida Sea Grant College [EB/OL].http://www.flseagrant.org.
[11] University of California Sea Grant College [EB/OL].http://www-csgc.ucsd.edu.
[12] University of New Hampshire Sea Grant College [EB/OL].http://www.seagrant.unh.edu.
[13] University of Georgia Sea Grant College [EB/OL].http://georgiaseagrant.uga.edu.
[14] Woods Hole Oceanographic Institution[EB/OL].http:/Avww.whoi.edu/seagrant/page.do?pid=34015
[15] University of Delaware Sea Grant College [EB/OL].http:/www.deseagrant.org.

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held annually, with more than 20 consecutive competitions having been held since its inception in 1998. Competition topics include marine biology, chemistry, geology, physics, history and economics, as well as current events related to the ocean. The annual competition usually takes place in the spring and features teams from schools in each region, with the winning team competing in the national finals each May, culminating in a national championship team.

High achievers who are interested in marine science and those who want a platform for their talents can meet through NOSB, a highly regarded and nationally renowned high school academic competition. Since its inception, NOSB has grown to include 24 regional tournament locations, 300 schools and over 2,000 high school students annually, and has positively impacted over 20,000 high school students.

B. Typical Examples of Marine Science Cups for Each Theme (TABLE1.)

TABLE1. The National Ocean Sciences Bowl

NSCGP	Theme
University of Oregon State Sea Grant College Program	Salmon Bowl
University of Washington Sea Grant College Program	Orca Cup
University of Delaware Sea Grant College Program	Chesapeake Bay Bowl (CBB)
University of Michigan Sea Grant College Program	Great Lakes Cup
University of Hawaii Sea Grant College Program	Aloha Cup
Alaska Sea Grant College Program	Tsunami Ocean Science Cup

① University of Oregon State Sea Grant College Program - Salmon Bowl

NOSB's version of this regional competition, Oregon State University's Salmon Bowl, consists of 4-5 high school students forming a team that tests their knowledge of scientific and technical disciplines by answering quick buzzer questions and more complex critical thinking team challenge questions.[16]

② University of Washington Sea Grant College Program - Orca Cup[17]

This is a one-day knowledge contest for high school students to recognize their knowledge of the world's oceans. The Killer Whale Cup is a Washington State competition for knowledge about the ocean. Each year, high school students from all over Washington gather for a day of friendly competition and exciting enrichment experiences at the Killer Whale Bowl kind, Washington's regional NOSB event. The program is provided by Washington Sea Grant in partnership with several departments in the University of Washington School of the Environment. The Killer Whale Cup challenges and recognizes Washington high school students' knowledge of the world's oceans in a one-day tournament hosted on the University of Washington's Seattle campus, where teams compete in a round-robin tournament followed by a double-elimination tournament. Students solve problems in all areas of ocean studies, including physics, chemistry, geology, biology, social sciences, and technology related to the oceans. Problems are presented in multiple-choice, short-answer, and team challenges that require strong problem-solving and collaboration skills. The program also provides students with the opportunity to meet university and marine social scientists, faculty, staff and student volunteers. The victorious team advances to the National Ocean Science Cup finals in April, when it will face off against champions from 25 different states.

③ University of Delaware Sea Grant College Program - Chesapeake Bay Bowl (CBB)[18]

This is a regional competition for the NOSB. High school students from Maryland, Delaware, Southeastern Pennsylvania, Northern Virginia and Washington, D.C. are eligible to participate in CBB. Teams of 4-5 participants answer marine science-based questions in a quick-answer timed format and more complex Team Challenge Questions (TCQs). Participants will receive prizes for attending regional events, with the top three teams receiving grand prizes donated by numerous sponsors. In addition, the first place winner of the Chesapeake Bay Bowl, as well as the winners of several other regional competitions, will compete in the National Marine Science Bowl Championship.

This is in addition to the Great Lakes Cup from the University of Michigan Sea Grant College Program, the Blue Lobster Cup from the Massachusetts Institute of Technology Sea Grant College Program and the Aloha Cup from the University of Hawaii Sea Grant College Program.[19]

V. Organization of Hands-On Science Summer Camps to Cultivate Teenagers' Interest In Marine Research

Practical activities represented by summer camp activities allow teenagers to experience the ocean and understand the ocean, which is conducive to stimulating teenagers' interest in the ocean, teaching and learning, and perceiving the mysteries of the ocean in practice, which is conducive to young people's broadening their horizons, and truly experiencing the knowledge and mystery of the ocean.

NOAA Science Camp is a free immersive summer camp opportunity for middle and high school students. National Oceanic and Atmospheric Administration Science Camp is held each July at the Sandpoint facility in Seattle and provides hands-on science learning opportunities for middle and high school students. Here are specific cases.

A. University of Washington Sea Grant College Program - NOAA Science Camps

Science Camp for Middle School Students: students entering 6th, 7th or 8th grade participate in fun, hands-on activities that explore the mysteries of the ocean and atmosphere. High School Youth Leadership Program: in this two-week program, students entering grades 9 through 12 work with NOAA scientists and camp staff to develop skills in

[16] University of Oregon State University Sea Grant College [EB/OL].http://seagrant.oregonstate.edu.
[17] University of Washington Sea Grant College [EB/OL].http://www.wsg.washingtou.edu.
[18] University of Delaware Sea Grant College [EB/OL].http://www.deseagrant.org
[19] University of Hawaii Sea Grant College [EB/OL].http://seagrant.soest.hawaii.edu.

communicating science concepts, leading activities, and more. Since its inception in 2003, NOAA Science Camp has grown into a highly respected collaborative science program. More than 10 NOAA offices, the Washington Sea Grant (WSG) and the Joint Institute for the Study of the Atmosphere and Ocean (JISAO) have partnered to introduce middle and high school students to the multidisciplinary nature of research. Scientists and educators interacted directly with camp participants to demonstrate how NOAA research is addressing environmental issues on a local and international scale.

B. California Sea Grant College Program - Summer Camps[20]

For the past several years California Sea Grant has provided $40,000 to $50,000 annually to Camp Ocean Labs, located in the Monterey Bay area of California. The program provides a mix of residential and day camp experiences for K-12 children. Camp Ocean Labs pays special attention to disadvantaged youth from schools that normally do not have access to marine education programs, organizing activities ranging from classroom exercises to marine field trips. Together, the summer program and camps form a marine education network that employs a variety of techniques from residential camps to classroom settings to day camps. It focuses on marine science education for K-12 students who live or travel along the coast during the summer. These camps often have a highly regarded program that includes water sports such as kayaking, field classrooms and in-water observation through snorkeling and scuba diving, among others.

C. University of Michigan Sea Grant College Program - 4-H Great Lakes Camps Summer Camps

This camp is for youth ages 13-15 or entering 8th-10th grade in the fall. The Great Lakes and Natural Resources Camp provides outstanding outdoor hands-on learning experiences for students ages 13-15. The annual week-long camp is held in late April or early in the month on the north shore of Lake Huron in Presque Isle, Michigan. Campers can do things like explore sand dunes, hike through forests, wade through wetlands or fish, snorkel, and sail on Lake Huron. All while learning about their surroundings from natural resource professionals, teachers and scientific researchers. Fish Camp (Saginaw Bay) This two-day camp will teach young people about fishing and protecting our Great Lakes. All campers will receive a fishing rod with reel, tackle box, t-shirt and snacks. Open statewide to Michigan 12-H members ages 4-8. Registration fee is $25 and scholarships are available.

D. University of Georgia Sea Grant Program - Summer Camps[21]

Ocean Outreach and Sea Grant are committed to enriching the next generation of coastal leaders and preparing them for careers in ocean policy, coastal resource management, marine resource economics, applied research, environmental education, and more! The University of Georgia Sea Grant (UGA) Marine Education Center and Aquarium has offered science day camps every summer since 1993. The camp allows children to grow up learning about the Georgia coast. The Summer Marine Science Camp (SMSC) program emphasizes marine science and coastal ecology while fostering each child's curiosity and stewardship potential. Provides an informal, team-oriented, memorable camp experience that balances detailed learning with exploration and opportunities to make new friends. Each SMSC program is designed to meet the learning stages and styles of children ages 6-14. Camp programs include salt marsh exploration, live animal classes (marine invertebrates, fish and coastal reptiles), maritime forest hikes, crabbing on the dock and more. A lower student-to-staff ratio ensures that campers receive personal attention and instruction. Camp staff includes UGA Marine Education faculty, Marine Education Fellows and summer interns.

VI. Supporting and Empowering the Professional Development of Marine Education Educators

Ocean Teachers' professional development is empowered through teacher conferences, six teacher programs, and a variety of educational resources.

A. Teachers' Conference

Conferences such as the National Marine Educators Association (NMEA), the Ocean Policy Forum, and the K-12 Educators' Symposium all aim to improve teachers' ocean literacy.

① National Marine Educators Association (NMEA).

It is a dedicated and influential membership organization of classroom teachers, informal educators, university professors, scientists, and others from around the world working together to promote understanding and conservation of freshwater and marine ecosystems. NMEA members are committed to expanding knowledge about the world of fresh and salt water, from scientists conducting research in the deep ocean to students studying underwater archeology in the Great Lakes. NMEA Educators is a diverse community of educators comprised of more than 700 formal and informal educators working together to increase public awareness and appreciation of marine and freshwater resources. From over 300 different organizations NMEA members come from schools, nonprofits, universities, government agencies, aquariums, and more. Members represent education professionals from the United States and around the world.

② Mid-Atlantic Marine Education Association (MAMEA). MAMEA is a regional chapter of the National Marine Educators Association (NMEA).MAMEA's goal is to improve education about all aspects of the marine and aquatic environment. Members come from Delaware, Maryland, Virginia, North Carolina, the District of Columbia, and more. Representing many agencies, organizations and programs.

③University of Connecticut Sea Grant Institute.

It provides curriculum consultation, resources and publications, and networking between educators and scientists in the form of trainings and workshops for K-12 educators.

④Shipboard Science Symposium .

[20] University of Southern California Sea Grant College [EB/OL].http://www.usc.edu/org/seagrant.

[21] University of Georgia Sea Grant College [EB/OL].http://georgiaseagrant.uga.edu.

The University of Minnesota Sea Grant College held the Shipboard Science Symposium, a daily to week-long shipboard or virtual Great Lakes professional learning opportunity for Great Lakes educators. The seminars are held aboard the U.S. Environmental Protection Agency's research vessel, the University of Minnesota Great Lakes Observatory Research Vessel, the Blue Heron, a sailboat exploring the world, and other opportunity vessels. Shipboard science workshops are available to 4th-12th grade teachers and educators in Minnesota, Wisconsin, Michigan, Ohio, Illinois, Indiana, Pennsylvania, and New York.[22]

⑤ Alaska Ocean Policy Forum .

The Alaska Ocean Policy Forum is sponsored by the Alaska Sea Grant College and the Alaska Ocean Observing System. Held every other month, the forum meets for one hour at a time with participants from across the state who are interested in Alaska's ocean policy, and through the meetings can stay up-to-date on state and federal ocean funding, legislation, and policy issues. The forum began in 2019 and has been in development for four years.

⑥Online Seminar for K-12 Educators.

Oregon State University Sea Grant College - Online Seminar for K-12 Educators. This workshop is a 1-hour online educator workshop focused on the virtual field. The National Science Foundation is helping to launch The Virtual Field (the virtual field.org) in 2020.[23]

B. Teachers' Program

The faculty programs are administered by NOAA Fisheries and there are six main faculty programs as follows:

①Teacher at Sea Program（TAS）

Through the program, teachers can interact with NOAA scientists and crew on real-world research projects at sea. TAS provides a unique chance for teachers from kindergarten through college to work on NOAA research vessels while sailing. Since its inception in 1990, NOAA's Teachers at Sea program has enabled nearly 700 teachers to gain first-hand experience in science and life at sea. By participating in the program, teachers can profoundly enrich their classroom curriculum, strengthen their science teaching methods, and engage local communities with knowledge that can only be gained by living and working day and night side-by-side with scientists who contribute to the world's marine and atmospheric science research.

Faculty sail on NOAA, NOAA-contracted, or NOAA-collaborated vessels for ocean-related research projects. Some projects involve the collection of long-term observational data on an annual or biennial basis, while others are short-term studies or unique collaborations. Potential projects vary from year to year, depending on NOAA's research program and berth availability. The program has had a tremendous impact on science education teaching and learning locally, regionally, and nationally. In the Teachers at Sea program, teachers are directly matched with scientists, receive first-hand research information and research experience, and gain real-world experience and knowledge, which gives teachers plenty of confidence and knowledge to disseminate to their students, and promotes science education for students even more.

②Teacher in the Lab

Laboratory Teachers in Seattle, Washington is a two-to three-week summer program that brings high school teachers into the genetics laboratory at the Northwest Fisheries Science Center's Macoltio Research Station. Teachers learn conservation genetics research techniques and research. Since 2010, NOAA has sponsored the Northwest Fisheries Science Center's (NWFSC) Lab Teacher program. The Lab Teacher is an offshoot of NOAA's popular Teachers at Sea program, which gives classroom teachers the opportunity to work side-by-side with NOAA scientists in research labs to learn or refine skills that can later be passed on to students.

③Planet Stewards Education Project

The program provides ongoing professional development and support for K-16 educators to build a climate literate public that is actively engaged in climate stewardship. The program also provides support for educators to implement climate stewardship projects.The NOAA Planet Stewards Education Program provides formal and informal educators with the knowledge and resources to work with elementary through college students to build scientifically literate individuals and communities who are prepared to address the environmental challenges that NOAA monitors.NOAA Planet Stewards also supports educators' efforts to implement hands-on action-based projects to protect, restore, and preserve human communities and natural resources from environmental challenges. These include of, but are not limited to, book clubs, live and recorded webinars, and in-person or remotely delivered workshops around the nation.

④STEM Teacher and Researcher Program （STAR）

For prospective K–12 STEM teachers, STAR is a nine-week compensated summer research experience program. It provides aspiring STEM teachers with the opportunity to conduct authentic research while helping them translate their research experience into classroom practice. STAR aims to develop excellent K-12 STEM teachers by providing aspiring teachers with the opportunity to conduct authentic research while helping them translate their research experience into classroom practice. STAR also supports the ongoing development of our Teacher Fellows through ongoing professional development and networking opportunities. ongoing development of our teacher-researchers.

⑤Bay Watershed Education and Training（B-WET）

B-WET provides locally relevant environmental education for K-12 students and related professional development for educators. The program serves California, the Chesapeake Bay, the Great Lakes, the Gulf of Mexico, Hawaii, New England and the Pacific Northwest.

⑥Science at Sea

This unique program provides selected K-12 teachers and administrators with real-world science experience while

[22] University of Minnesota Sea Grant College[EB/OL].http://www.seagrant.umn.edu

[23] University of Oregon State University Sea Grant College [EB/OL].http://seagrant.oregonstate.edu.

working with renowned NOAA scientists on a state-of-the-art NOAA research vessel.

C. Publications and Educational Resources

Textbooks and other materials are the most effective focus point for fostering ocean literacy among teenagers. The Sea Grant College at the University of Connecticut offers a range of publications on education, such as the Handbook for Improving Ocean Literacy: A Tool for Educators and Ocean Literacy Advocates, which was developed by the National Marine Educators Association with support from NOAA and is now available to help educators and other ocean advocates to teach, learn, and communicate about the ocean. University of Connecticut Professor Beth Lawrence worked with two high school teachers to create a Salt Marsh-Climate Change teaching module for high school students. Support from a Connecticut Sea Grant enabled Lawrence to work with high school educators to develop inquiry-based and evidence-based instructional materials on local climate issues. Utilizing the ongoing Long Island Sound Study research project, they developed an interactive climate change module for high school students that integrates “Mystery Scientist” activities. The module is aligned with the Next Generation Science Standards and provides evidence-based, student-centered instructional materials that highlight how global issues affect local environmental issues. The module is being made widely available through various platforms to encourage its adoption by high school teachers throughout the region.

University of Connecticut Sea Grant College Program: a CD-ROM of educational resources on Long Island sound, this CD is intended for use by K-12 teachers and educators only. It contains several educational resources for the classroom: a gallery of Long Island Sound images, Living Treasures of Long Island Sound, and Sound Facts: interesting facts about Long Island Sound.[24]

Connecticut River Tidal Marsh CD: This CD is intended for use by K-12 teachers and educators only. It contains a colorful and informative Power Point presentation about the natural resources of the lower Connecticut River. The area is designated as a wetland of international importance under the Ramsar Convention.

D. Other paths

Other sea grant colleges such as the University of Delaware and the Ohio State University Sea Grant College also have specialty resources for educators. In addition, NSGCP promotes ocean literacy among teenagers through conferences, Q&A sessions with experts, and more.

①Conference Exchanges

The Sea Grant Program holds the National Marine Educators Association (NMEA) Student Conference for teenagers. By giving teenagers the chance to learn more about the area of marine education, network with professionals, and receive support for their own marine education and conservation activities, NOAA is dedicated to promoting student involvement in NMEA. The one-day NMEA Student Conference is held during the annual NMEA conference. NMEA student members have the opportunity to meet like-minded students and professionals in the field of marine education, share ideas and collaborate on projects, and connect with a global network of professionals in the field. Student conference participants engage in sessions and other professional development opportunities. The Student Involvement Committee helps coordinate the annual NMEA Student Conference, which provides middle school, high school, and college students with opportunities to connect with NMEA, attend workshops and conferences on a variety of topics in marine education, conservation, and science, and meet NMEA members and other students who can help further their interest in the field. The committee also coordinates events throughout the year to recruit NMEA student members and support their professional development through webinars and virtual training opportunities.

②Q&A With Experts

The Sea Grant Academy offers teenagers the opportunity for expert Q&A, as typified below:

The University of Michigan Sea Grant College's Channel program offers an expert Q&A opportunity for youth ages 8-12. This program has a dedicated Expert Q&A session where participants can learn face-to-face with local experts and be guided by their experiences.

University of Minnesota Sea Grant College's Students Ask a Scientist program. This program is a program that connects students and teachers in grades 5-12 with Great Lakes scientists for a Q&A session on science and careers. The program is part of the Sea Grant Great Lakes Literacy Center. Students Ask a Scientist is an opportunity for students in grades 5-12 to ask working scientists questions about their work in order to better understand the Great Lakes region and learn what a career in science might look like.

In summary, the four main ways described above have led to an increase in ocean literacy among U.S. teenagers (see Figure 1).

VII. NSCGP'S Implications For Enhancing Teenagers Ocean Literacy

NSGCP is a key tool for NOAA to achieve its educational goals and objectives, and NSGCP has largely accomplished NOAA's educational goals and achieved good results. According to the data, as of 2022, NSGCP has reached more than 370,000 K-12 students. From this, we can learn from its useful experience and promote the enhancement of ocean literacy among our teenagers.

First of all, at the macro level, teenagers ocean literacy education should be elevated to a national strategic position. NSGCP is managed by NOAA, funded by the Department of Commerce, and is in a national marine strategic position. Drawing on the U.S. experience, it is important to strengthen the guiding and coordinating role of our policies, laws and regulations. Marine education is a major project that benefits all people and has a far-reaching impact, without scientific policy leadership, without corresponding laws and regulations to

[24] University of Connecticut Sea Grant College [EB/OL].http://www.seagrant.uconn.edu.

escort and coordinate the resources and strength of all parties, it is difficult to achieve a clear direction, appropriate methods and coordination. At present, China's ocean literacy education policy is not strongly supported. Therefore, our government should introduce and improve relevant policies at the macro level to ensure the policy.

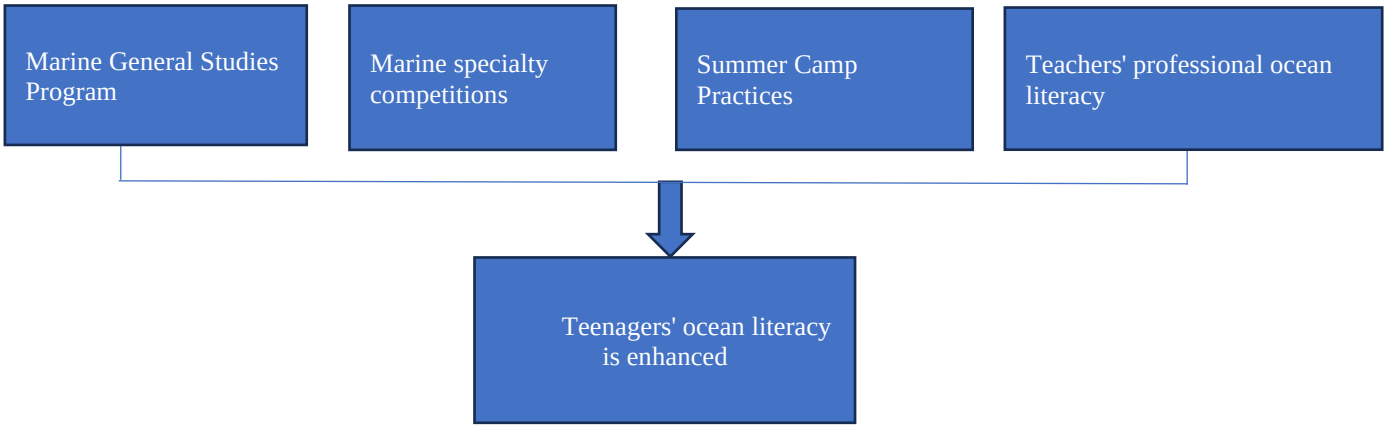

Fig. 1. Logical framework for the promotion of ocean literacy among teenagers

Secondly, at the meso level, a coalition of coastal zone universities has been established to create a Chinese version of NSGCP. China's sea-related universities mainly include Ocean University of China, Dalian Ocean University, Ningbo University, Zhejiang Ocean University, Shanghai Ocean University, Guangdong Ocean University, Jiangsu Ocean University, and Taiwan Ocean University, but there is a lack of stable cooperation and alliance among the sea-related universities. NSGCP.On the other hand, has a coalition of 34 sea-granting colleges and research institutes, which can form a strong knowledge synergy.Therefore, it is necessary to strengthen the alliance of sea-related and even coastal riverine colleges and universities in China to enhance cooperation and exchange, discuss the governance and protection of rivers, lakes and oceans and their sustainable development, cultivate marine reserve talents, and provide talent support for the realization of a strong marine nation.[25]

Thirdly, at the micro level, ocean literacy should be put into practice and reserve talents for the oceans. Drawing on the experience of the NSGCP in enhancing the ocean literacy of teenagers, our country should also start from several aspects, such as curriculum, competition, practical activities, teacher development, etc., to implement ocean literacy education for teenagers in an all-round way.

On the one hand, it starts with the students, as ocean education cuts across different age groups, but there are different baselines of knowledge to focus on and the extent to which it is acquired at each stage. School education is the backbone, and it is the main task of school education to incorporate marine awareness education into teaching materials and classrooms. School-based curricula, competitions and various practical activities can be developed in accordance with the characteristics of students at different stages of their physical and mental development. Education is targeted according to the different age stages. (1) Pre-school stage. The main objective should be to cultivate students' interest in the ocean. The textbooks can be illustrated stories, so that students can have a better understanding of marine life, marine climate, marine resources and so on. In the process of teaching, the game method, activity method, inspired reading inquiry and other methods can be used to have a preliminary understanding of marine culture.(2) Primary education stage. Physically and mentally, it is all based on image thinking, so the students should be allowed to do something they want to do, and they can also go to marine museums, marine research bases and marine themed summer camps after school, combining them with real life, they can have a preliminary understanding of the marine culture and have a strong interest in the marine culture.(3) Middle school education stage. The students will gradually move from image to abstraction, and can generalize and summarize what they have learned, so that they can be able to accept the abstract concept of marine culture. In the teaching materials, they can appropriately increase the understanding of marine culture and arrange more and more complex knowledge of marine culture. Organize students to visit marine museums, watch marine videos and participate in marine social practices to expand their understanding of the ocean. Increase the opportunities for students to get close to the “ocean” and diversified materials, focusing on cultivating students' initial, conscious “know the sea, love the sea, protect the sea and caring for the sea” awareness.(4) Senior secondary education. Appropriately increase the content of subjects related to marine culture, especially in geography, politics, history, chemistry, biology and other subjects, and appropriately add the sustainable use of marine resources and environment and global cases, maritime delimitation, national rights and interests, global maritime geography and conventions.; it not only mobilizes the students' interest in learning, but also cultivates their ability to analyze and solve problems by combining theories with practice. During this period, a series of lectures on

[25]SONG Wenhong, REN Qi. The formation, development and impact of the Sea Grant College Program in the United States[J]. Modern University Education,2015,(03):49-57.

marine knowledge, marine culture experience festivals, marine culture skills competitions, marine conferences and other activities can also be organized to raise students' awareness of the oceans and enhance their sense of crisis about marine sovereignty and the marine ecosystem.

On the other hand, starting with teachers, teachers are the key subjects in enhancing the ocean literacy of teenagers. The training of teacher professionals and the reserve of teachers' marine knowledge are of key significance to the enhancement of teenagers' ocean literacy. The dissemination of knowledge depends on teachers, and it is only by improving the professionalism of teachers that knowledge can be better disseminated. Drawing on the experience of teacher training in the NSGCP, teachers' ocean literacy can be enhanced and their marine knowledge enriched through teachers' marine conferences or forums, teachers' marine programs and marine training. Only by enriching teachers' marine knowledge will they be able to impart more marine knowledge to their students, thus better enhancing ocean literacy of teenagers.

Lastly, from a social point of view, it is necessary to enhance the publicity and promotion of ocean literacy. To promote the increase of publicity in the community, the street, by triggering publicity posters, brochures and other ways to promote the promotion and dissemination of marine knowledge, in the community to form a good social atmosphere of everyone knows the sea, love the sea, protect the sea and caring for the sea, which is a key value for the teenagers, and even for the whole society of the ocean literacy.

In conclusion, after more than half a century of development, the NSGCP has been very effective in enhancing the ocean literacy of American teenagers. Our country should actively learn from its experience, but also with China's actual national conditions, can not be absorbed in its entirety, but to selectively learn from. Of course, the U.S. “Sea Grant College Program” also has its limitations, such as its own impact on a wide range, but is limited by the leadership of a weak organization, the proportion of funds invested in low. Therefore, China should build a “Sea Grant College Program” with Chinese local characteristics according to local conditions, so as to reserve excellent talents for the realization of a strong maritime nation.

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