

Harnessing Citizen Science to Protect and Restore Puget Sound

Washington Sea Grant, Washington State University Extension and the Citizen Science Advisory Panel

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Executive Summary

The Puget Sound Partnership (PSP) is charged with protecting and restoring Puget Sound by 2020. Citizen science—engaging the public in making observations, and collecting and recording data—offers an exceptional opportunity to enhance public stewardship of Puget Sound and provide credible, cost-effective data essential to fulfill research, monitoring and management priorities. The Puget Sound Action Agenda includes citizen science as a near-term action:

Develop and implement a coordinated citizen science program. This will connect citizens and scientists to not only increase engagement opportunities but provide cost-effective data collection in support of Action Agenda priorities. (*E.4 Near-term Action 11*).

PSP contracted Washington Sea Grant (WSG) and Washington State University (WSU) Extension to develop recommendations for advancing citizen science to meet Action Agenda priorities. A Citizen Science Advisory Panel, composed of individuals from federal, tribal, state and county agencies, academia and non-governmental organizations, was formed to contribute critical and creative thinking and guide the development of recommendations. This report includes a brief description of citizen science models, and presents challenges to effective use of citizen science, as well as recommendations to support and enhance citizen science efforts that would contribute to scientific research, monitoring and management needs in Puget Sound.

At present, hundreds of citizens participate in citizen science programs around the Sound, but in many cases there is little alignment of citizen science programs with regional priorities. While the definition of citizen science is broad, programs and projects that rely on partnerships among citizens, scientists and managers for rigorous data collection will be most useful in addressing Action Agenda science priorities. Many volunteers and citizen science practitioners seek closer relationships with university and agency scientists and report a desire to contribute to real, meaningful and important scientific studies. At the same time, scientists and natural resource managers are interested in engaging citizens in projects to expand the spatial and temporal scope of research and enhance scientific data collection.

While enthusiasm about citizen science in Puget Sound is high, there are a number of challenges that must be addressed to use citizen science effectively as a tool for research, monitoring and management. A clear pathway and process for developing and supporting partnerships among citizens, scientists and managers currently is lacking. Data quality issues must be addressed in order to provide rigorous data collection. Successful citizen science programs require a significant investment in volunteer management, a component for which many scientists and managers, by their own admission, have neither the interest, skills nor time. The increased volume of data allowed by citizen science requires additional investment in data management. Current agency and academic cultures remain largely focused on traditional approaches to research, and citizen science is not part of the typical research toolbox. Significant expansion of the use of citizen science in research, monitoring and management will necessitate endorsement and funding investment by Puget Sound agencies and institutions. Finally, liability, safety and logistical issues must be considered in agency and academic partnerships with citizens.

In light of these challenges and barriers, WSG, WSU Extension and the Citizen Science Advisory Panel reached consensus on the following recommendations:

1. Establish a Citizen Science Resource Center to facilitate connections between science needs and citizen capabilities and to provide resources to support and enhance these relationships.

PSP should support the establishment and maintenance of a Citizen Science Resource Center to facilitate communication and collaboration among volunteers, scientists and managers, and link citizen science efforts with research, monitoring and management priorities. The following Center activities are recommended for the 2009-2011 biennium:

- 1.1 Identify research priorities well suited to citizen science contributions.*
- 1.2 Proactively develop collaborations that will contribute to science and management needs for protecting and restoring Puget Sound.*
- 1.3 Provide consultation services for citizen science.*
- 1.4 Develop and maintain resources to facilitate citizen science efforts linked to scientific research, monitoring and management needs.*

2. Promote citizen science as a research, monitoring and resource-management tool.

The use of citizen science as a tool for research, monitoring and resource management should be promoted through multiple channels, including developing policy, publicizing successes and expanding science education and training. Citizen science can be promoted through meetings and workshops with scientists, managers, policy-makers and volunteer groups, as well as at local, national and international meetings. The following specific actions are recommended:

- 2.1 The Puget Sound Partnership should adopt formal policy language promoting the use of citizen science to support research, monitoring and management needs.*
- 2.2 Introduce citizen science as a research tool in science education.*
- 2.3 Promote citizen science success stories and contributions to research and management.*

3. Develop approaches for providing sufficient, stable funding for citizen science efforts that contribute to science and management.

A funding strategy should be developed to support rigorous citizen science programs and build volunteer management and coordination capacity. The strategy should include long-term mechanisms to support capacity and relationship-building as citizen science becomes a more prominent tool in the management of Puget Sound natural resources.

4. Evaluate the contribution of citizen science efforts to Puget Sound science.

It is imperative to evaluate program development and progress through formative and summative evaluations of Center activities and products, and other efforts to promote citizen science and develop funding strategies. In addition, increased capacity for evaluating individual citizen science partnerships is necessary.

Through implementation of these recommendations, PSP can build a rigorous citizen science network that enhances public stewardship and environmental literacy, engages the public in efforts to restore Puget Sound and increases the availability of credible, cost-effective data to achieve Puget Sound Action Agenda goals and priorities.

Introduction

As the Puget Sound Partnership (PSP) pursues its mission to protect and restore Puget Sound by 2020, citizen science offers a unique and critical opportunity to engage the public, enhance stewardship of Puget Sound and provide credible, cost-effective data essential to monitor and ensure success of the Action Agenda. The Puget Sound region enjoys a strong volunteer network and an extraordinarily large number of individuals who are willing to contribute their time. However, harnessing the energy of volunteers requires adequate investment to make them successful citizen scientists. This report provides recommendations to support and enhance citizen science efforts in Puget Sound. While the report specifically addresses citizen science in the Puget Sound region and calls for PSP action, many of the issues and recommendations included are relevant to citizen science in general.

Governor Gregoire created PSP in 2007 and charged it with producing an Action Agenda to restore Puget Sound by 2020. The Agenda includes a near-term action to

Develop and implement a coordinated citizen science program. This will connect citizens and scientists to not only increase engagement opportunities but provide cost-effective data collection in support of Action Agenda priorities. *(E.4 Near-term Action 11)*

In February 2009, PSP contracted Washington Sea Grant (WSG) and Washington State University (WSU) Extension to develop recommendations for advancing citizen science to meet Action Agenda needs. Among the primary objectives were identification of barriers to effective use of citizen science and development of mechanisms to bring scientists and volunteers together in citizen science efforts that support research, monitoring and management needs in Puget Sound. These and additional objectives are detailed in the contract (Appendix A).

A Citizen Science Advisory Panel was formed to contribute critical and creative thinking and guide the development of recommendations. The panel is composed of individuals from federal, tribal, state and county agencies, academia and non-governmental organizations (see Appendix B for short biographies of panel members). WSG and WSU Extension staff held targeted conversations with a number of scientists from government management agencies, universities and nongovernmental organizations to document their experience with citizen science. The interviews discussed the challenges and barriers to incorporating citizen science in research and management, and ways to overcome such challenges and facilitate connections. Additional input was elicited informally from other local scientists and natural resource managers, as well as citizen science practitioners and volunteers.

Two recent conferences contributed valuable information to the development of the report. More than 100 people participated in “Citizen Science: Advancing conservation through scientist/volunteer partnerships” at the 2009 Puget Sound Georgia Basin Ecosystem Conference in February 2009. Building on the interest generated at the conference, the Centers for Ocean Sciences Education Excellence–Ocean Learning Communities (COSEE–OLC), WSG, Port Townsend Marine Science Center and PSP sponsored a workshop, “Exploring the Spectrum of Citizen Science,” in April 2009. More than 160 people, representing more than 45 organizations, gathered for two days to discuss successes and challenges for citizen science in Puget Sound.

Workshop participants included volunteers, scientists, natural resource managers, educators, marine environmental advocates and students.

The recommendations contained in this report reflect the collective thinking of WSG and WSU Extension staff and the Citizen Science Advisory Panel, based on information and feedback gathered from the sources described above.

What is citizen science?

The term citizen science has emerged to describe *projects and programs involving the public in making observations, and collecting and recording data*. While the name “citizen science” is a relatively new term, the concept of involving volunteers in data collection is quite old. The National Weather Service Cooperative Observer Program has engaged citizens in collecting meteorological data since 1890 and is currently recognized as the most definitive source of information on climate change in the United States (NWS). The Audubon Society’s Christmas Bird Count started in 1900 with 27 volunteers and has grown to nearly 60,000 participants last year, providing valuable information on the long-term health and status of bird populations across the Americas (Audubon).

This broad definition of citizen science reflects extensive variety in study system, geographic scope, number and type of participants, level of involvement, nature of the data collection and many other program and project parameters. Citizen science efforts can include data collection by participants of all ages through various programs, including those of governments, non-governmental organizations (NGOs), primary and secondary schools, higher education institutions and community groups. Efforts may include citizens working in close partnership with scientists, as well as citizens working more independently in observation, data collection and recording. The structure of citizen science efforts (as with all science) depends heavily on the scientific question or information need, which may range from basic inquiries such as presence or absence to testing hypotheses with complex observational or experimental approaches.

Opportunity for citizen science in Puget Sound

As the Puget Sound Action Agenda reports, the health of the Puget Sound ecosystem is threatened by such activities as the destruction of wetlands, removal of old-growth forest, construction of 10 major dams, modification of thousands of small streams, release of hundreds of thousands of gallons of oil and hazardous waste and introduction of almost 100 invasive marine plant and animal species. Today, there are 21 Puget Sound species listed as threatened or endangered, more than 1,000 regional rivers and lakes listed as impaired and “dead zones” in Hood Canal and South Sound. Among other challenges, Puget Sound faces continued degradation from habitat alteration and pollution, exacerbated by population growth.

While the problems facing Puget Sound are numerous and large, many of them are invisible to the casual observer and residents of the Puget Sound region who enjoy the exceptional natural beauty, quality of life and economic productivity in our region. Public opinion research conducted by PSP has confirmed that the majority of residents highly value Puget Sound and

want to leave a healthy Sound for their children and grandchildren. At the same time, research indicates that the public is generally unaware of the problems facing Puget Sound (PAC 2006, PSP 2008b). Because humans are largely responsible for many of the conditions degrading Puget Sound and its resources, it is essential to engage the public at large in the effort to restore the region.

Involvement in citizen science projects has been shown to increase knowledge, awareness and sense of place of participants and affect behavior change. Among the best-studied projects are very successful networks coordinated by the Cornell Lab of Ornithology, which provides volunteers with a clear science and management context for their participation. Volunteers in the Birdhouse Network project demonstrated increased knowledge of bird biology following the collection of information about birdhouse use in their yards (Brossard *et al.* 2005). Neighborhood Nestwatch participants overwhelmingly reported an increase in their awareness of the birds in their backyards, and more than half reported a change in behavior as a result from participating in the project (Evans *et al.* 2005).

Hundreds of citizens participate in citizen science programs around the Sound. However, there is little alignment of such programs with regional science and management priorities. Given the citizen scientist's desire to contribute to real, meaningful and important scientific studies (Evans *et al.* 2005, COASST unpublished data, COSEE-OLC unpublished data), the full potential of citizen science to enhance stewardship of Puget Sound has yet to be realized. Anecdotal information from Puget Sound suggests that citizens who collect data about their local natural resources gain an increased appreciation for the value of those resources. Often these citizens go on to lead community efforts to protect and restore them. By allowing local residents to serve as agents of change in Puget Sound, citizen science offers a unique opportunity to increase learning, stewardship and leadership in the community.

While the value of citizen science for education, outreach and environmental stewardship is broadly understood and agreed upon, its potential contribution to scientific knowledge is largely untapped. Critical components of the Action Agenda include accurate characterization of the status of and threats to Puget Sound, and monitoring of progress toward restoration. The Action Agenda and PSP Biennial Science Work Plan identify more than 100 priority actions, and research and information needs (PSP 2008a, PSPSP 2008). At the same time that natural resource managers and scientists face increasing demands, state and federal budgets are stagnant or shrinking.

With hundreds, and potentially thousands, of citizens interested in contributing to a better understanding of their local environment, citizen scientists are perfectly positioned to partner with scientists to provide credible, cost-effective data for use in natural resource decision-making and university and agency research. While the definition of citizen science is broad, programs and projects that rely on partnerships among citizens, scientists and managers for rigorous data collection will be most useful in addressing Action Agenda science priorities. Because citizen science efforts can be used or adapted to address many different types of questions, they have the potential to contribute to Action Agenda priorities at a variety of levels. For example, public involvement could provide increased spatial and temporal coverage for a coordinated monitoring

system or contribute to focused investigations about Puget Sound ecosystem function, threats and recovery.

Momentum for this concept is growing within the volunteer, research and management communities. There is excitement and enthusiasm about citizen science and the opportunity to contribute to priority, timely research and information needs. The desire to forge connections and improve communication between citizen volunteers and scientists was repeated by participants throughout the citizen science workshop in April 2009. Volunteers and citizen science practitioners felt their programs would benefit from a closer relationship with university and agency scientists. Some requested opportunities to make their volunteerism more meaningful by contributing to timely science and management efforts. Many were also seeking increased access to scientific assistance in developing and maintaining citizen science projects. Meanwhile, scientists and natural resource managers expressed a desire to engage with volunteer projects that could enhance scientific data collection by expanding the spatial and temporal scope of research. They also communicated a willingness to help refine and develop protocols for rigorous citizen science data collection. In general, workshop participants identified the need for a transparent and predictable approach that would allow them to best target citizen science partnerships.

With the need to involve the public in efforts to restore Puget Sound, citizen science provides the perfect opportunity to enhance public stewardship of the Sound and provide credible, cost-effective data collection. Maximizing potential citizen science contributions to the Action Agenda goals of protecting and restoring Puget Sound will require a systematic approach that connects volunteers with scientists and managers, and increases participation in citizen science projects relevant to regional research, monitoring and management.

Citizen science models

Citizen science efforts can be described as either scientist-driven or citizen-driven. In the scientist-driven pathway, scientists or managers identify a research, monitoring or management need and seek citizen involvement. In the citizen-driven pathway, citizens initiate program development based on a question or issue of interest, a desire for more public engagement or both. The term “citizen” can be broadly applied to include governments, NGOs, primary and secondary schools, higher education institutions, community groups and individuals.

Three primary models of citizen science emerged from conversations with scientists, natural resource managers, citizen science practitioners and volunteers. Regardless of the driver (scientist or citizen), citizen science efforts generally fall into one of the following categories: distributed network model; intensive model; and individual participant model.

Distributed network

The distributed network is the most commonly recognized model of citizen science and is exemplified by the National Weather Service Cooperative Observer Program, Christmas Bird Count and many other large, regional and national citizen science programs. In this model, volunteers receive training in program objectives and data collection protocols, collect data independently on either opportunistic or scheduled bases (or both) and usually submit data to a central location. Data collection protocols may be developed by or in conjunction with scientists;

training is often conducted by volunteer managers but may also include direct time with scientists. All contributions are valued, but programs often rely on the volume of information for a robust dataset. These programs are usually initiated via the scientist-driven pathway and allow for increased spatial and temporal coverage, but there may be little or no connection among participants other than being part of the network. Some examples from the Puget Sound region include the Coastal Observation and Seabird Survey Team (COASST), NatureMapping, Reef Environmental Education Foundation (REEF) and SoundCitizen.

Intensive

In the intensive model, a smaller number of volunteers generally are involved in more-focused, locally-based projects. In scientist-driven intensive projects, volunteers receive highly specialized training in advanced data collection methods directly from scientists. These efforts may require a longer-term investment in training and may require some specialized skills. Participants collect data independently and usually submit data directly to the lead scientist or manager. Programs are often dependent on the complete contribution of every volunteer for success of a project. In this model, the volunteers are essentially acting as additional independent scientific technicians. For example, members of the Washington Scuba Alliance have assisted scientists at the Northwest Fisheries Science Center by collecting lingcod eggs for a lingcod fishery enhancement study; WSU Beach Watchers have assisted NOAA scientists with studies on juvenile salmon use of pocket estuaries; and community volunteers have collected samples from kokanee carcasses for King County.

In citizen-driven intensive projects, a volunteer population mobilizes around a question or issue and organizes an effort to collect relevant information. To integrate their efforts within the broader scientific community or develop management applications, a relationship must be formed with a professional scientist or manager. These partnerships are often initiated by community groups but may also involve researchers or managers seeking out data collected by rigorous citizen science efforts. The WSU Beach Watchers intertidal monitoring program and Nisqually Reach Nature Center projects are two local examples of citizen-driven intensive projects.

Individual participant

While the individual participant model often may be overlooked, individuals frequently volunteer for field and lab data collection as research assistants for scientists and managers. In this case, volunteers are participating in data collection as part of a scientific team. Many of these volunteers are, in fact, scientists or university students who are willing to provide assistance to a colleague or are interested in gaining experience. However, some of these efforts also incorporate individuals who are not trained scientists or students. As examples, volunteers have worked with NOAA scientists on fish and stream surveys and with U.S. Fish and Wildlife Service scientists on seabird studies. In addition, members of WSU Beach Watchers, the North Olympic Salmon Coalition and Friends of the San Juans have assisted WDFW scientists in identifying forage fish habitat.

There are also cases in which individuals collect data independently from any organized project, scientist or manager. These individuals may obtain critical information on anomalous events and may, over time, amass long-term datasets. As with other citizen-driven projects, connections

must be made with professional scientists or managers to apply these datasets to specific research, monitoring and management needs.

While programs generally fall into one of these categories, the models may more accurately represent three major nodes on a continuum of citizen science. Perhaps more importantly, they illustrate that citizen science can address a variety of data gaps. In some cases where very little is known, simple presence or presence-absence information may be incredibly valuable and easily achievable by engaging a large number of people in opportunistic reporting or engaging schools in conducting occasional surveys. In other cases, more complex information may be required, involving more specialized technical investigations, repeated sampling over time and space and more extensive engagement of citizens.

Challenges and barriers

While citizen science has the opportunity to create enriching educational experiences for volunteers and provide relevant, rigorous, cost-effective data for use in scientific research, monitoring and natural resource management, there are some challenges and barriers that must be addressed in advancing citizen science to meet Puget Sound Action Agenda priorities.

Advisory Panel members and researchers, natural resource managers, citizen science practitioners and volunteers identified various challenges to harnessing citizen science in the Puget Sound region:

- Partnerships
- Data quality
- Volunteer management
- Data management
- Agency and academic culture
- Liability, safety and logistics

Partnerships

Citizen science efforts that contribute to research, monitoring and management needs require a partnership between citizens and scientists or managers. Currently, collaborations of citizen science efforts with managers and scientists are sporadic, most often relying on personal connections or initiative. Citizen science practitioners and volunteers may lack access to scientific outlets and expertise. Scientists and managers interested in collaborating with citizens are often unaware of relevant citizen science efforts and volunteer groups. A clear pathway and process for connecting scientists, managers, citizen science practitioners and volunteers is lacking, as are centralized tools, resources and assistance to support or develop these partnerships.

Data quality

When considering the use of citizen science in scientific and natural resource management, it is not surprising that data quality is often mentioned as a challenge. There is concern that volunteer data can be anecdotal or may be collected without following a standardized protocol and therefore may be invalid for statistical analyses. Scientists and managers noted the need for quality control and data validation measures, and in some cases agency approval of Quality

Assurance Quality Control (QAQC) Plans. In addition, many indicated the importance of the selection of appropriate protocols. While some measurements are suitable for volunteers, in that they can be made accurately and consistently with relatively little training, other measurements may be inappropriate for volunteer data collection. In addition, some research questions require data to be collected consistently over time, which can be a challenge for volunteer schedules.

Volunteer management

Scientists, natural resource managers, citizen science practitioners and volunteers all recognize that good management of volunteer activities is essential to the success of citizen science. While the word “volunteer” implies “free,” there are, in fact, personnel and financial costs associated with managing volunteers. Significant time is required to recruit, train, organize and retain volunteers, a factor that is particularly important in programs that rely on long-term data collection. Effective managers of volunteer programs must have interest and expertise in interacting with people. In many cases, scientists admit that they are not interested in, are not well suited for, or do not have time to take on this additional role.

Data management

One significant benefit of citizen science is the ability to increase the volume of data collected. However, this also means that there is a need for additional data management, requiring increased investments of time and money. The need for careful consideration of data management includes the design of clear and consistent methods of data recording and input into a data management system, flexible and secure storage of raw data that is easily accessible to the researcher for analysis, and post-project storage of data and results so volunteers, scientists and other interested parties can all use the data. Poorly designed data systems can easily lead to the loss of information, either at the time of collection or later in the analysis and reporting process.

Agency and academic cultures

The current agency and academic cultures are more favorable to outreach efforts today than in past decades. However, in the context of research, these cultures remain largely focused on traditional approaches in which the primary investigator maintains more direct control of data collection. Citizen science is not included in the typical research toolbox and its use may be opportunistic and based on personal motivation and interest. At the same time, engagement in citizen science activities remains largely unrecognized in professional evaluation and advancement systems. It was generally recognized that endorsement and direction from agency management would be required in order to significantly broaden the use of citizen science among agency scientists and managers. It was also noted that funding streams for research and management programs do not provide incentives for the use of citizen science, and that science education programs do not generally include citizen science as a research tool.

Liability, safety and logistics

Liability issues often surface when considering agency and academic partnerships with volunteers. While some organizations have relatively straightforward processes for registering and providing Labor and Industries insurance coverage for volunteers, others require laborious paperwork and procedure to acquire volunteer clearance. Safety issues must be addressed when working with volunteers. In addition, working with volunteers often presents added logistical

issues, such as securing permission for volunteers to access private property for data collection or to use agency equipment.

Recommendations for citizen science

The following recommendations reflect the collective thinking of WSG and WSU Extension staff and the Citizen Science Advisory Panel. Each recommendation is specifically targeted to PSP but can also be generalized for any audience interested in advancing citizen science to contribute to scientific research, monitoring and management priorities. In brief, the four primary recommendations are to:

1. establish a Citizen Science Resource Center;
2. promote citizen science as a research, monitoring and resource management tool;
3. develop approaches for providing sufficient, stable funding for citizen science efforts; and
4. evaluate the contribution of citizen science efforts to Puget Sound science.

1. Establish a Citizen Science Resource Center to facilitate connections between science needs and citizen capabilities and to provide resources to support and enhance these relationships.

The Citizen Science Resource Center would serve as a centralized source for citizen science connections, resources and consulting services. It would address clear needs to enhance citizen science capabilities for supporting research, monitoring and management. Resources and services should be available through an easily identifiable and accessible centralized source (physical, virtual, etc). Through support for the Center, PSP would contribute to creation of a process and tools to match volunteer efforts directly with scientific needs. Effectively engaging the public in rigorous citizen science projects and filling critical data gaps will require a flexible process that facilitates connections between those with data needs and citizen scientist populations. Although the Center initially would serve Puget Sound, PSP should work with other state and federal agencies, tribes, academia and other interested organizations to expand the scope of the Center beyond the boundaries of Puget Sound.

The mission of the Citizen Science Resource Center would be to facilitate communication and collaboration between the scientific and volunteer communities and provide resources and assistance to increase the use of citizen science in research, monitoring and natural resource management in Puget Sound. The initial Center structure should build on the following considerations for staffing and location:

- A partnership hub, initially staffed by at least one citizen science resource manager, partnering with a diffuse network of nodes representing natural resource agencies, tribes, academia, and the volunteer and NGO communities from the entire Puget Sound region.
- A location within a non-regulatory, university-based organization with connections to academia, agencies and local communities, and experience with advisory services and communicating science and natural resource management issues to the public.

As citizen science activities are increasingly incorporated into research and management, capacity and infrastructure needs will change and grow. The critical and creative thinking of individuals from federal, tribal, state and county agencies, academia and non-governmental organizations will be essential to adapt and maximize the contributions of citizen science to meet

Action Agenda priorities. The current Advisory Panel should be convened to draft guidelines for a permanent Advisory Committee to serve the Center.

The following activities are recommended for the Center in 2009-2011:

1.1 Identify research priorities well suited to citizen science contributions.

PSP has identified priorities for research and management for the recovery and restoration of Puget Sound. By identifying the priorities most appropriate for citizen science contribution, volunteer efforts can be targeted effectively and efficiently.

In conjunction with PSP staff and the PSP Science Panel, the Center should complete an analysis of the Puget Sound Action Agenda, Biennial Science Work Plan and other relevant research priority documents to identify areas where citizen science can contribute most effectively. Also in conjunction with PSP staff and Science Panel members, the Center should network within the scientific and volunteer communities to assess interests, capabilities and needs and identify opportunities for collaboration.

1.2 Proactively develop collaborations that will contribute to science and management needs for protecting and restoring Puget Sound.

Previously, there have been no systematic attempts to link citizen science efforts with science and management priorities. Progress may be slow, given many of the challenges and barriers listed above. By proactively developing collaborations and garnering success stories, momentum can be generated to build closer connections between citizen science efforts and scientific research, monitoring and natural resource management needs in the region.

With research priorities identified, the Center should convene workshops and meetings to develop citizen science collaborations. The Center should target at least five demonstration projects during the first two years of operation, providing support to improve success, linkages to science and management priorities in Puget Sound and responsiveness to volunteer questions and needs. The Center should facilitate clear communication of goals, objectives and expectations among scientists and volunteer groups; assist with modification or development of volunteer protocols and guidance; and encourage adequate volunteer training, support and timely communication of project results. The Center should use its network to facilitate collaborations and technical assistance as needed, fostering partnerships that evolve independently once established.

1.3 Provide consultation services for citizen science.

To facilitate successful connections between citizen science efforts and research, monitoring and management needs, it will be vital for the Center to provide consultation services to citizen science practitioners, scientists and managers. Citizen science practitioners and community groups would have access to scientific expertise for rigorous data collection protocol development, quality assurance planning and data management. Scientists and managers would have access to assistance with translating data collection procedures, training materials and project results for volunteers.

The Center should provide assistance directly to citizen science programs, scientists and managers, including assistance with alignment of goals, objectives and expectations; facilitation

of communication among scientists, managers and volunteers; modification of projects for research or management application by volunteers; program evaluation; and communication of project results to the volunteer audience. The Center should build a network of specialists to provide technical assistance to citizen science practitioners and volunteer groups on content-specific needs related to Action Agenda priorities, such as water quality, habitat restoration and invasive species prevention and mitigation.

1.4 Develop and maintain resources to facilitate citizen science efforts linked to scientific research, monitoring and management needs.

Initially, the Center should complete the development of three citizen science resources: an online citizen science clearinghouse (Appendix C); a citizen science match-making tool (Appendix D); and keys to citizen science success (Appendix E).

Online citizen science clearinghouse. Citizen groups, individual citizens, scientists and managers would universally benefit from access to a central clearinghouse of information about current citizen science projects and opportunities for citizen involvement in scientific research. A clearinghouse will provide interested citizens with easy access to more complete information about how to get involved in collecting valuable information about their local environment. It will allow scientists and managers to learn about ongoing citizen science data collection efforts that may be relevant to Action Agenda priorities and identify appropriate volunteer groups to partner with in the development of new citizen science projects. In addition, the clearinghouse will provide all interested parties with information about similar and complementary projects to foster increased communication and collaboration.

In 2009, a UW Program on the Environment capstone student completed a preliminary inventory of citizen science projects in the Puget Sound region. The inventory includes information on 35 projects addressing a wide range of scientific topics, including seabirds, marine fish and invertebrates, marine mammals, stream and marine water quality, marine debris, harmful algal blooms, habitat characteristics and more (see Appendix C for a complete list). Starting with this preliminary inventory, the Center should refine the clearinghouse and develop an easy-to-use graphic user interface for Web site access. Information from additional projects and volunteer groups should be solicited for inclusion.

Citizen science match-making tool. To maximize benefits derived from a citizen science project, the capabilities and expectations of the volunteer group must complement the scientific and technical requirements of the research question. While there is no single right way to do citizen science, it is critical to match the research and data collection needs with an appropriate citizen science strategy. WSG, in consultation with the Citizen Science Advisory Panel, developed a draft citizen science match-making tool (Appendix D) to guide the process of creating a project-specific plan to appropriately link scientific, monitoring and management needs to existing or newly developed citizen science programs (and vice versa). The tool identifies parameters related to the science component (protocol development, data management and application) and the citizen component (volunteer information, training and communication) of citizen science. The Center should complete the development of this tool and make it available, along with assistance in its application if requested.

Keys to citizen science success. Experience suggests that many successful citizen science projects share key elements. WSG, in consultation with the Citizen Science Advisory Panel, developed a draft resource presenting the keys to citizen science success. This draft document draws on lessons from experienced participants in citizen science programs, as well as available resources and publications offering suggestions for citizen science and volunteer programs¹ and currently includes 10 “keys to success” (Appendix E). The Center should refine the keys to citizen science success and make them available, with additional assistance if requested, to guide citizen science practitioners in project development, implementation and improvement.

The Center and Advisory Committee should also engage in activities in support of Recommendations 2, 3 and 4, as appropriate. As funding and capacity increase, the Center should expand activities and develop additional resources driven by the needs of the scientific and volunteer communities. The Center and Advisory Committee should work to promote the use of citizen science in research, monitoring and management. Additionally, the Center could:

- Promote citizen science through meetings and workshops with scientists, managers, policy-makers and citizen science groups.
- Convene citizen science partners to create products to further citizen science efforts (e.g., peer-reviewed articles and white papers).
- Promote citizen science through presentations at local, national and international meetings.
- Develop additional resources and reference materials for citizen science, including information on protocol development, data management, communication and evaluation.
- Provide and facilitate citizen science training sessions and opportunities for training across citizen science programs.
- Evaluate the feasibility of developing and providing standardized training modules for volunteers (e.g., water quality sampling, fish counting).
- Evaluate the feasibility of developing and providing standard protocols for data input, storage and presentation; flexible data management system building blocks; and data hosting services.
- Strengthen the network of research scientists and managers willing to provide routine technical assistance to citizen science efforts.

PSP should support the establishment and maintenance of the Center, working with other state and federal agencies, tribes and other interested organizations to identify and procure funding for its enhancement and expansion. In the first biennium, funding should cover costs of at least one full-time staff position and the development and implementation of the primary citizen science resources described above.

The Center would address many of the barriers identified. Specifically, the Center will:

- Serve as a central access point to facilitate *partnerships* among scientists, managers, citizen science practitioners and volunteers.

¹ For example, Craine *et al.* 2007; Prysby and Super 2007; Cornell Lab of Ornithology Citizen Science Toolkit; and Volunteer Water Quality Monitoring National Facilitation Project factsheets.

- Provide citizen science practitioners and volunteer groups with information and access to technical expertise on *data quality* for protocol development and quality assurance planning to meet project-specific science needs. The Center will work with scientists and managers as needed to translate and communicate data collection protocols and quality assurance procedures for volunteers.
- Connect scientists and managers with existing citizen science efforts and volunteer groups who are able to provide *volunteer management*.
- Provide citizen science practitioners and volunteer groups with information and access to technical expertise in *data management*. The Center will work with scientists and managers to refine data management strategies for working with volunteers as necessary. As funding and capacity for the Center increases, additional resources for citizen science data management can be developed.
- Assist and support scientists and natural resource manager efforts to move outside traditional approaches to research and the constraints of *agency and academic culture* and make use of citizen science.
- Connect citizen science efforts to groups that have adequately addressed liability issues related to conducting research and provide information to deal with *liability and safety issues*.

2. Promote citizen science as a research, monitoring and resource management tool.

Citizen science should be actively promoted as a tool for use in scientific research, monitoring and resource management through various channels to high levels of government, the public and scientists in training. To increase its consideration as a standard tool in the research and management toolbox, scientific, management and academic cultures that impede the use of such approaches must be encouraged to change. The leadership of science and management organizations often does not promote citizen science. Staff members who engage volunteers do so in addition to other full-time responsibilities, even though they may be saving time and dollars and enhancing the capacity of their program. Throughout their formal training, scientists are rarely, if ever, exposed to citizen science as a valid research approach and are often inculcated with the belief that the layperson lacks requisite specific knowledge to contribute to scientific investigation. The use of citizen science in research, monitoring and natural resource management should be promoted through meetings and workshops with scientists, managers, policy-makers and citizen science groups and at local, national and international meetings. In addition, three specific actions are recommended:

2.1 The Puget Sound Partnership should adopt formal policy language promoting the use of citizen science to support research, monitoring and management needs.

In addition, PSP should work to encourage support for citizen science in other natural resource agencies, universities and other research organizations throughout the Puget Sound region. The Center and Advisory Committee should assist with policy development as appropriate.

2.2 Introduce citizen science as a research tool in science education.

Partnerships and programs should be developed to expose graduate, undergraduate and K-12 students to citizen science as a valid research tool. These experiences could include curricula on citizen science, assistance with incorporating citizen science into student research projects and

internships providing assistance for matching or developing citizen science programs to meet research and management needs.

Potential partners include the Center, COSEE–OLC, Graduate STEM Fellows in K-12 Education (GK-12) Program, Pacific Education Institute, Superintendent of Public Instruction, university faculty and staff and ECO Net organizations. Partners should be gathered to identify appropriate avenues for incorporating citizen science into graduate, undergraduate and K-12 education.

2.3 Promote citizen science success stories and contributions to research and management.

Multiple mechanisms should be used to publicize citizen science success stories to combat the existing barriers and help change the culture that limits harnessing citizen science for research, monitoring, and management. Partnerships with organizations that support citizen science should be leveraged to communicate successful citizen science partnerships with researchers and managers. As the Center interacts with increasing numbers of organizations, a simple reporting mechanism to communicate new successes should be available through the Center Web site. Communication of success stories should be proliferated through partnerships with agencies, universities and existing networks such as ECO Net and COSEE–OLC.

The promotion of the use of citizen science to address research and management needs through each of these and other channels would primarily address the *agency and academic cultural* barriers.

3. Develop approaches for providing sufficient, stable funding for citizen science efforts that contribute to science and management.

A funding strategy should be developed to support rigorous citizen science programs around the Puget Sound region that contribute to research, monitoring and management priorities. Local and regional requests for proposals should encourage citizen science projects where appropriate. In addition, there must be recognition of the critical need for financial support and increased capacity for volunteer management and coordination. Long-term mechanisms are needed to support capacity- and relationship-building and any infrastructure that evolves as citizen science becomes a more prominent tool in the management of Puget Sound natural resources.

Sufficient, stable funding for citizen science efforts that contribute to science and management directly addresses all of the challenges identified. Reliable funding will allow scientists, managers and citizen science practitioners to build *partnerships* and address *volunteer management, data quality, data management and liability, safety and logistics* barriers. In addition, financial support for regional volunteer programs will allow citizen science partnerships to capitalize on existing *volunteer management* capacity. Dedicated funding for citizen science efforts and well-funded successes may also help to sway *agency and academic cultures*.

4. Evaluate the contribution of citizen science efforts to Puget Sound science.

As research and management cultures change to recognize citizen science as a valuable component of the science toolbox, several shifts are likely to occur: the demand for citizen science will increase, citizen science efforts will make greater contributions to research, monitoring and management in the Puget Sound region, more volunteers will become engaged,

and science and management communities and the public will value and support citizen science efforts. It is imperative that program development and progress be measured through formative and summative evaluations. Citizen Science Resource Center activities and products, and other activities to promote citizen science and develop funding strategies should be evaluated. In addition, capacity should be increased for evaluating individual citizen science partnerships, including contributions to research, monitoring and management priorities and the impact of citizen science on public stewardship, protection and restoration of Puget Sound.

Although conducting program evaluations does not directly address barriers to citizen science, positive outcomes identified through evaluations will provide evidence of success to help encourage future *partnerships*, break down the *agency and academic cultural* barriers and promote the value of engaging in citizen science projects.

Conclusion

These recommendations outline a strategy to advance citizen science to meet research, monitoring and management needs in Puget Sound. They address currently identified challenges and barriers, respond to the needs associated with each citizen science pathway and promote mechanisms for connecting scientists and citizens in relevant, rigorous citizen science programs and projects (Fig. 1). With the implementation of these recommendations, PSP can support a network of rigorous citizen science programs that contribute credible, cost-effective data collection for Puget Sound Action Agenda priorities and increase public stewardship for the Sound.

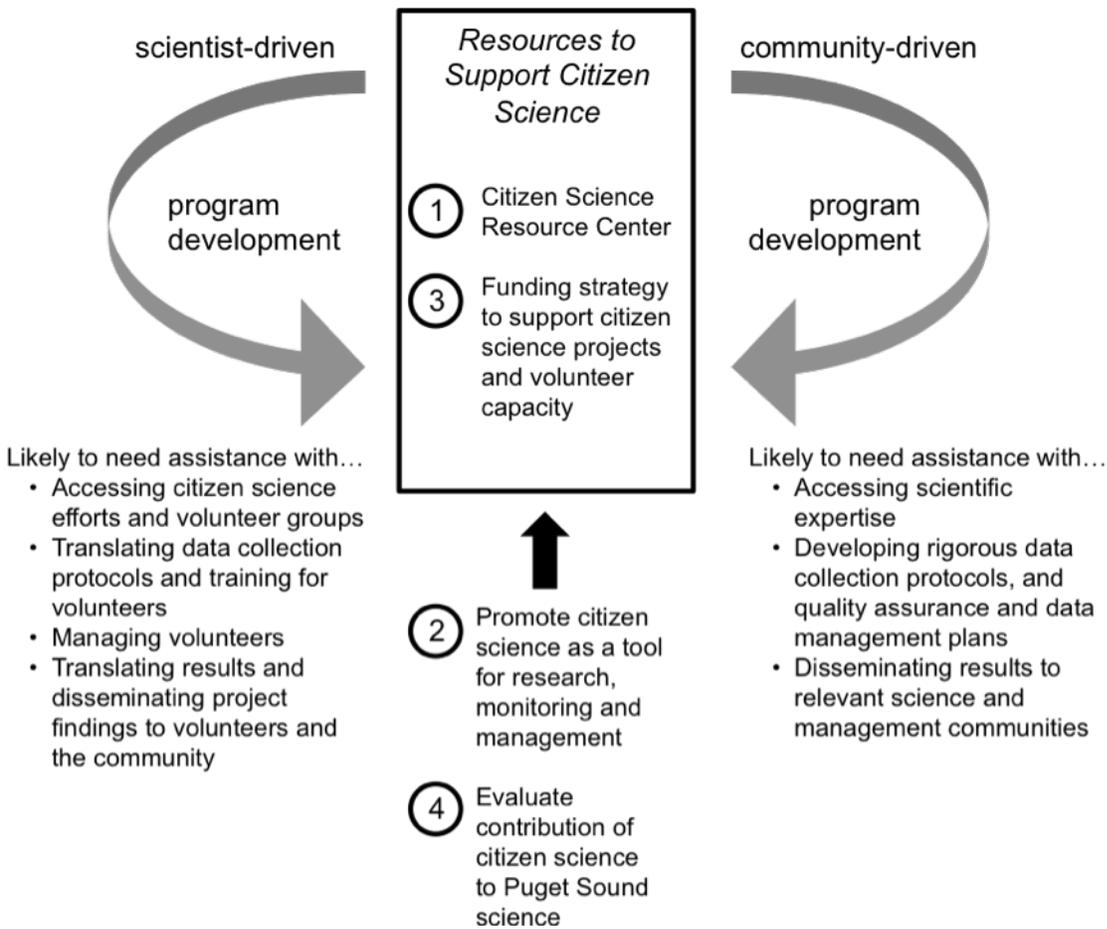


Figure 1. The recommendations in this report include resources to support citizen science efforts, addressing the needs of those in each pathway of program development, and activities to promote and enhance citizen science in Puget Sound.

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Appendix A

Puget Sound Partnership contract with Washington Sea Grant and Washington State University Extension

GRANT AGREEMENT
between
PUGET SOUND PARTNERSHIP
and
Washington Sea Grant
UNIVERSITY OF WASHINGTON
Grant 200806

THIS GRANT agreement is made and entered into by and between the Puget Sound Partnership, State of Washington, hereinafter referred to as the “PARTNERSHIP”, and Washington Sea Grant, University of Washington, hereinafter referred to as the “GRANTEE”, for the express purposes set forth in the following provisions of this grant.

GRANTEE: Washington Sea Grant, University of Washington
ADDRESS: 3716 Brooklyn Ave. NE, Seattle, WA 98105
PHONE: (206) 543-6600
EMAIL: pdalton@u.washington.edu
FEDERAL ID NO.: 91-6001537

NOW THEREFORE, the PARTNERSHIP and GRANTEE mutually agree as follows:

PROJECT

The PARTNERSHIP is providing funding to the GRANTEE to facilitate public engagement and education. GRANTEE will accomplish this by partnering with Washington State University Extension to complete the following (see also Appendix A):

1. Research the potential for using citizen science to engage citizens in collecting data for promoting stewardship and informing natural resource management decisions:
 - Define citizen science, including how it fits in to the broad field of volunteer efforts, and the models that exist today;
 - Identify current uses of citizen science programs, barriers to additional applications, and the criteria required to effectively use citizen science in stewardship, research and management efforts; and
 - Conduct a literature search regarding the outcomes and effectiveness of citizen science programs.
2. Provide PARTNERSHIP with recommendations on how to most effectively move forward with citizen science efforts that address Action Agenda priorities:
 1. Recommend models that are likely to promote stewardship and contribute to scientific research and natural resource decision-making for Puget Sound;
 2. Identify existing programs that could be enhanced by the PARTNERSHIP and promising options for new program development; and
 3. Propose mechanisms to bring together scientists and citizens in developing and networking citizen science efforts around the Sound.

CRITERIA/FUNDS

This project supports the citizen engagement and public outreach aspects of the Action Agenda. Therefore, the PARTNERSHIP will provide financial support in the amount of \$50,000 for the project. Funding will be used to support the development of Citizen Science and Engagement that focus on three of the PARTNERSHIP’s strategic priorities: restoration, nonpoint source pollution, and monitoring.

DELIVERABLES

GRANTEE shall provide a progress report addressing the expected outcomes to the PARTNERSHIP grant manager by April 15, 2009. Additionally, within 30 days of project completion, a final report shall be submitted to the PARTNERSHIP grant manager including:

4. Results from research on the potential for using citizen science to meet Action Agenda goals and
5. Recommendations for advancing citizen science efforts that address Action Agenda priorities.
- 6.

PERIOD OF PERFORMANCE

Subject to other agreement provisions, the period of performance under this contract will be from the date of signature through June 30, 2009 unless sooner terminated or extended as provided herein.

RIGHTS AND OBLIGATIONS

All rights and obligations of the parties to this agreement shall be subject to and governed by the Special Terms and Conditions contained in the text of this contract instrument.

COMPENSATION AND PAYMENT

Total compensation including expenses payable to GRANTEE for satisfactory performance of the work under this agreement shall not exceed \$50,000 (Fifty thousand dollars).

The PARTNERSHIP will reimburse the GRANTEE in accordance with the budget detailed in Appendix B (attached). GRANTEE shall submit invoices at least quarterly, but no more than monthly, for reimbursement to Michael Klos, Fiscal and Contracts Coordinator, Puget Sound Partnership, PO Box 40900, Olympia, WA 98504-0900.

GRANT MANAGEMENT

The grant manager for each of the parties shall be responsible for and shall be the contact person for all communications and billings regarding the performance of this contract.

The Grant Manager for the GRANTEE is Penelope Dalton, (206) 543-6600, pdalton@u.washington.edu.

The Grant Manager for the PARTNERSHIP is Kristen Cooley, (360) 701-4604, kristen.cooley@psp.wa.gov.

GRANT CHANGES, MODIFICATIONS, AND AMENDMENTS

This agreement may be changed, modified, or amended only by written agreement executed by both parties.

TERMINATION

Either party may terminate this agreement upon Thirty (30) days written notice to the other party. In the event of termination of this grant agreement, the terminating party shall be liable for performance rendered prior to the effective date of termination.

THIS agreement, consisting of seven (7) pages, is executed by the persons signing below who warrant that they have the authority to execute the contract.

PUGET SOUND PARTNERSHIP

UNIVERSITY OF WASHINGTON

David Dicks
Executive Director

Lynne Chronister
Director, Office of Sponsored Programs

Date

Date

Appendix A. The Potential of Citizen Science in Puget Sound

Project overview

The Puget Sound Partnership has identified citizen science as a near-term action to address *Priority E.4 Increase and sustain coordinated efforts for communication, outreach, and education to increase public awareness and encourage individual stewardship*. Thousands of citizens already participate in volunteer and citizen science programs around the Sound. Despite this level of involvement, awareness of and concern for the declining health of Puget Sound is low among the general public. Meanwhile, natural resource managers are faced with increasing demands and shrinking budgets. While some volunteer programs involve partnerships with agency or university scientists, others would benefit from a closer relationship. Citizen science has the potential to increase public awareness and stewardship of Puget Sound, while providing credible, cost-effective data for use in natural resource decision-making and supporting research and discovery by university and agency scientists.

In order to effectively design a Sound-wide citizen science network, it is important to define the scope of citizen science in Puget Sound and key elements for successful programs. To address these needs, Washington Sea Grant, in partnership with Washington State University Extension and the Puget Sound Partnership, will:

- Establish a Citizen Science Advisory Board to inform all subsequent steps;
- Research the continuum of citizen science definitions and models;
- Develop a definition of citizen science for use by the Puget Sound Partnership;
- Meet with citizen science practitioners, agency and university scientists, and natural resource decision makers to determine the elements of current and potential use of citizen science data in Puget Sound;
- Conduct a literature search on evaluations of citizen science programs; and
- In consultation with the Advisory Board, complete a final report to the Puget Sound Partnership recommending a system for advancing and networking citizen science in Puget Sound to address Action Agenda priorities, including areas for further study.

How this project addresses the Partnership's Priorities

Washington Sea Grant, in partnership with Washington State University Extension, will conduct research and make recommendations addressing the following priorities:

Priority E: Build an implementation, monitoring, and accountability management system.

Priority E.4. Increase and sustain coordinated efforts for communication, outreach, and education to increase public awareness and encourage individual stewardship.

Specifically, this project will inform the following near-term action:

Near-term Action E.4.10. Develop and implement a coordinated citizen science program.

Based on the results of this project, the establishment of a successful citizen science network could address the following priorities:

Priority A: Protect intact ecosystem processes, structures, and functions

Example – invasive species detection, monitoring, and control

Priority B: Restore ecosystem processes, structures, and functions

Example – ecosystem restoration assessments

Priority C: Reduce sources of water pollution

Example – water quality sampling, monitoring swimming beaches and supporting shellfish advisory programs

Appendix B

Citizen Science Advisory Panel and Staff Biographies

Citizen Science Advisory Panel

Russel Barsh is the director of KWIAHT: Center for the Historical Ecology of the Salish Sea, a nonprofit conservation biology laboratory in and for the San Juan Islands. After studying human ecology and law at Harvard and a decade of teaching at the University of Washington, he left academia to work with United Nations agencies on indigenous peoples and their ecosystems, including the role of science adviser to indigenous organizations involved in the U.N.

Conference on Environment and Development and the U.N. Biodiversity Convention. Russel returned to Washington in 2001 to apply his experience with grassroots research to his own community.

Maggie Bell-McKinnon is currently a biologist with the Environmental Assessment Program at the Washington State Department of Ecology. Maggie received a bachelor's degree in biology and master's in plant ecology from Western Washington University. In 1988, Maggie began working as a biologist at the Washington State Department of Fisheries. In 1990, she joined the Washington State Department of Ecology and has been with the Environmental Assessment Program for the last 13 years. Maggie works primarily in lake monitoring and was the coordinator for Ecology's citizen lake monitoring program from 1997 to 2000.

Dr. Susan Bullerdick is the operations manager for the Centers for Ocean Sciences Education Excellence–Ocean Learning Communities. She has a doctorate in social work from the University of Minnesota and many years of experience working with institutions, organizations and programs in many capacities. More recently, Susan has been an educator in formal and informal environments, including the University of Minnesota, Augsburg College, University of Washington, Seattle Aquarium and Point Defiance Zoo and Aquarium. Susan also has a background in program evaluation and research.

Doug Myers is the science director for People for Puget Sound. He has a master's degree in environmental science from the University of Houston–Clear Lake and an extensive background in marine biology and communicating complex scientific subjects to lay audiences. Doug currently serves as the leader of the Strategic Needs Assessment Team of the Puget Sound Nearshore Ecosystem Restoration Project. He is also the President of the Nisqually Reach Nature Center.

Dr. Jan Newton is a principal oceanographer with the Applied Physics Laboratory of the University of Washington. With a doctorate in biological oceanography, her research focuses on a systems view of marine ecosystems (estuarine, coastal and oceanic), assessing human and climate forcing on the characteristics and productivity of these systems. Jan is currently the principal investigator of the Hood Canal Dissolved Oxygen Program Integrated Assessment and Modeling Study, the executive director of the Northwest Association of Networked Ocean Observing Systems and vice chair of the Puget Sound Partnership Science Panel.

Dr. Rohinee Paranjpye has worked as a microbiologist at the Northwest Fisheries Science Center for the past 30 years. The goals of her current research, as part of the shellfish/pathogens

program at the West Coast Center for Oceans and Human Health, are to determine the role of abiotic environmental, biotic and microbial genetic factors on the presence or amplification of pathogenic *Vibrio spp.* to improve early warning systems for *Vibrio spp.* in shellfish and other estuarine environments. Rohinee is currently one of the coordinators of the SoundToxins monitoring program, a diverse partnership of Washington state shellfish and finfish growers, environmental learning centers, tribes and Puget Sound volunteers.

Walter Pacheco is currently the community services director for the Muckleshoot Indian Tribe. He has worked for the tribe for more than 30 years, serving in many capacities. He began as a fisheries technician, advanced to fisheries manager, and has served as a member of the tribal council. In his current role, Walter oversees veterans affairs and tribal holidays and is a canoe captain for the Muckleshoot Canoe Family. Walter is also the current president of Salmon Homecoming.

Dr. Julia Parrish is associate director and professor of the School of Aquatic and Fishery Sciences, and director of the Program on the Environment at the University of Washington. With a doctorate in zoology from Duke University, she has spent more than 20 years studying animal aggregation, seabird ecology and marine conservation. Julia is the founder and director of the Coastal Observation and Seabird Survey Team (COASST), a 10-year-old citizen science project focused on the coastal areas of the North Pacific.

John Pierce has been the chief wildlife scientist at the Washington Department of Fish and Wildlife (WDFW) since 1994, where he supervises wildlife research, GIS analysis, and the wildlife datatypes staff. He first started working at WDFW in 1984, soon after completing his master's degree in wildlife ecology at the University of Idaho, where he studied moose ecology in the woods of north-central Idaho. John has a longstanding interest in quantitative analysis of wildlife and habitat relationships. He is a member of the Washington Biodiversity Council Science Committee, which is committed to integrating citizen science into a long-term biodiversity monitoring program for Washington state.

Mike Racine retired from Onyx Software in 2001 as executive vice president in charge of services. He was a founding equity owner at Onyx and served there from its inception in 1994. Prior to Onyx, Mike played various project management roles in Microsoft Corporation's IT organization. Currently, Mike volunteers as the director of government affairs for the Washington Scuba Alliance, as well as the executive director for Eastside FC, a non-profit youth soccer club. He leads a team of volunteer NOAA science divers involved in various scientific projects for NOAA and the U.S. Army Corps of Engineers. Mike holds a bachelor's degree in rangeland management from Utah State University and a master's in business administration from the University of Oregon.

Dr. Randy Shuman is the manager of science and technical support for the King County Division of Water and Land Resources and an affiliate associate professor of oceanography at the University of Washington. His group monitors a broad spectrum of environmental media, including freshwater flow, groundwater, lake, river and stream water quality and biota, sediment quality and marine currents. Dr. Shuman's academic interests are in marine toxic fate and

transport, numerical ecosystem modeling and aquaculture. He is the coordinator of the Puget Sound Partnership's Toxics Loading Study.

Staff

Penelope Dalton has been the director of Washington Sea Grant since 2005. She moved to Seattle from Washington, DC where she worked on ocean policy issues for 20 years. Dalton previously served as vice president of the Consortium for Oceanographic Research and Education (CORE), where she was involved in administration of national marine research and education programs. Prior to CORE, she served two years as NOAA's assistant administrator for fisheries and director of the National Marine Fisheries Service. From 1985 through 1999, Dalton was a fellow and staff member on the U.S. Senate Committee on Commerce, Science, and Transportation and directed the Democratic staff of the Oceans and Fisheries Subcommittee and Science, Technology, and Space Subcommittee. Dalton has a bachelor's degree in biology from Dickenson College and a master's in marine-environmental-estuarine sciences from University of Maryland.

Kate Litle is the citizen science specialist at Washington Sea Grant. Prior to joining Sea Grant, she was the program coordinator for the Coastal Observation and Seabird Survey Team, a citizen science program based at the University of Washington with more than 400 volunteers surveying more than 200 beaches in the Pacific Northwest and Alaska. Kate has a master's of marine affairs from the University of Washington and a bachelor's degree in biology and environmental policy from Colby College. She has been working on coastal issues in Washington for the last nine years.

Donald B. Meehan is the program director for natural resources stewardship for Washington State University Extension. Prior to this recent position he was the county director for extension in Island County, where he created the well-known volunteer program WSU Beach Watchers that has spread to seven counties in the northern Puget Sound, supporting 750 volunteers. Don has degrees from University of Washington and Washington State University and holds the rank of full professor at WSU. In 2008, he was awarded the Excellence in Extension award in the Western Region of the National Association of State Universities and Land Grant Colleges.

Dr. Michelle Wainstein is the Senior Program Coordinator at Washington Sea Grant. With a degree in Ecology and Evolutionary Biology from the University of California at Santa Cruz, Michelle has worked in the fields of marine mammal and seabird ecology and conservation. For four years she ran a research, conservation and outreach program on the Juan Fernández Islands, Chile and in 2004 she joined Washington Sea Grant to work on seabird bycatch mitigation efforts. Most recently she served as Washington Sea Grant's Regional Coordinator for a marine research needs assessment project that included gathering and synthesizing thousands of comments from West Coast stakeholders and producing the West Coast Regional Marine Research and Information Report.

Appendix C

Preliminary inventory of citizen science projects in the Puget Sound region

The preliminary inventory of citizen science projects in the Puget Sound region includes information on the following projects:

Adopt-a-Farmer, NatureMapping Program

Adult Salmon Surveys (Nitrification Program), Hood Canal Salmon Enhancement Group

Allyn Bird Project, Washington Sea Grant

Christmas Bird Count, Seattle Audubon

Citizen Science, Seattle Aquarium

Citizen's Marine Monitoring Program, Hood Canal Salmon Enhancement Group

Clam Surveys, Whatcom County Marine Resources Committee

Coastal Observation and Seabird Survey Team, University of Washington

Crescent Valley Biodiversity Management Area, NatureMapping Program

Dewatto Smolt Traps (Nitrification Program), Hood Canal Salmon Enhancement Group

Environmental Explorations, Hood Canal Salmon Enhancement Group

Hood Canal Steelhead Project, Hood Canal Salmon Enhancement Group

Literate About Biodiversity, NatureMapping Program

Lower White River Biodiversity Management Area, Pierce County Biodiversity Alliance

Marine Mammal Stranding & Education Program, Central Puget Sound Marine Mammal Stranding Network

Marine/Nearshore Data Collection, NatureMapping Program

Neighborhood Bird Project, Seattle Audubon

Nisqually Bio-blitz, Northwest Trek Wildlife Park

Oak Tree Project, NatureMapping Program

Ohop Valley Creek Restoration Project, NatureMapping Program & Northwest Trek Wildlife Park

Protection Island Glaucous Winged Gull Bolus Study, Port Townsend Marine Science Center

Puget Sound and Northwest Straits Micro Plastic Beach Sampling, Port Townsend Marine Science Center

Puget Sound Marine Invasive Species Monitoring Program, Nahkeeta Northwest

Puget Sound Seabird Survey, Seattle Audubon

REEF Volunteer Survey Project, Reef Environmental Education Foundation
River Mile, NatureMapping Program
Salmon Watcher Program, King County Department of Natural Resources and Parks
SoundCitizen, University of Washington
SoundToxins, Northwest Fisheries Science Center, NOAA Fisheries
State of the Oyster Study, Washington Sea Grant
Streamkeepers of Clallam County, Clallam County
Summer Chum Salmon Trap, Hood Canal Salmon Enhancement Group
Water Quality Monitoring, Whatcom County Marine Resources Committee
Whale Sighting Network & Education Program, Orca Network
Whidbey's Pigeon Guillemot Survey, Guillemot Research Group

Appendix D

Draft citizen science match-making tool: factors to consider when matching potential citizen science projects and programs with potential science projects (and vice versus).

DRAFT—Dimensions of Citizen Science
An Alignment Tool

SCIENCE—Protocol Development

Program Strategy systematic ↔ opportunistic	Is information collected on a specific sampling schedule or at the discretion of the volunteer?
Data Types <input type="checkbox"/> data <input type="checkbox"/> sample <input type="checkbox"/> both	Does the information include measurements, IDs, observations made in the field? Or the collection of a sample for further analysis in the lab?
Duration short-term ↔ long-term	Over what time period is the information collected?
Geographic Scope local ↔ regional	Over what geographic scope is the information collected?
Temporal Scale high frequency ↔ low frequency	At what temporal resolution is information collected?
Spatial Scale high resolution ↔ low resolution	At what spatial resolution is information collected?
Data Quality <i>Volunteer Expertise Levels</i> novice ↔ expert <i>Sample Size</i> small ↔ large <i>Data Independently Verifiable</i> <input type="checkbox"/> yes <input type="checkbox"/> no <i>Supervision</i> low ↔ high	What degree of expertise or training is required for participants? Can those degrees be correlated to data quality? How much information is collected per relevant spatial/temporal unit? Can data be independently verified? How often are scientists/technicians working with or checking on data collection activities?

DRAFT—Dimensions of Citizen Science
An Alignment Tool

SCIENCE—Data Management

Data Collection

pencil & paper electronic

Are data recorded on a paper datasheet or electronically?

Data Transfer

physical delivery electronic delivery

How are data and information delivered from the participants to the project/program staff?

Database

online local

Is access to data input and output online or stored locally with project/program?

Timeline

short ↔ long

How long from data collection, reporting, and processing to data being available to end user(s)?

SCIENCE—Communication: application of data

Modes

generic ↔ tailored
active ↔ passive

How does the program/project communicate with data users? Is communication generic presentation of data (raw or analyzed) or tailored data product for specific end user? Is communication active (i.e., information sent directly to data users) or passive (i.e., information available online or elsewhere for data users to access)?

Frequency

low ↔ high

How often does the program/project communicate with data users?

DRAFT—Dimensions of Citizen Science
An Alignment Tool

CITIZEN—Participants

# of Participants 1s ↔ 10s ↔ 100s ↔ 1000s	Is information collected by a small number of participants or many participants at the same time?
Geographic Scope local ↔ regional	Over what geographic scope are the participants distributed?
Level of Commitment one time ↔ opportunistic ↔ regular/systematic	What level of commitment is required of the participants?
Knowledge/Skill Level low ↔ high general ↔ specialized	What is the required knowledge/skill level of the participants prior to training?

CITIZEN—Training

Intensity minimal ↔ extensive	What level of training is required for participants?
Levels one ↔ multiple	Do all participants receive the same level of training? Or are there multiple levels of training available?
Delivery <input type="checkbox"/> in person <input type="checkbox"/> not in person	Is training delivered by a person or by more remote tools (such as online, written materials only, signs, etc.)?

DRAFT—Dimensions of Citizen Science
An Alignment Tool

CITIZEN—Communication: participant recruitment, maintenance, advancement

Modes

personal ↔ impersonal
active ↔ passive

How does the program/project communicate with participants? Is communication personal (e.g., phone call, personalized letter or email) or impersonal (e.g., newsletter, annual report, website)? Is communication active (i.e., information sent directly to participants) or passive (i.e., information available online or elsewhere for participants to view)?

Frequency

low ↔ high

How often does the program/project communicate with participants?

Interaction

scientist other

Do participants get communication directly from scientist/manager or from an intermediary?

Response

short ↔ long
personal ↔ impersonal

What is the time period and mode of delivery of responses to participant inquiries?

DRAFT

Appendix E

Draft keys to citizen science success

Interesting research question with clear and focused goals and objectives

Make sure the research question and/or data collection activity is of interest to the volunteer audience. Scientific goals and objectives should be clear and focused — be careful not to try to answer too many questions or collect data on too many things at once. Be clear and transparent about why, how and when data will be used.

Clear, easy to follow protocols and data collection forms

Create clear, easy to follow protocols and data collection forms that operationalize data collection procedures using language accessible to volunteers. When the use of scientific terminology is required, be sure to clearly define all terms. Be clear and transparent about why data must be collected in a certain way.

QAQC, data management, analysis plan

Have a plan for quality assurance and quality control measures, data management and analysis that includes delivery of data and information to end users. Test quality assurance and quality control measures and document level of data quality.

Specific and manageable training

Keep volunteer training specific and manageable. Be sure to include all information required to complete all steps of preparation, data collection and data reporting.

Pilot testing

Pilot test all protocols, data collection forms and quality assurance and quality control measures with a small group of representative volunteers. Conduct additional pilot testing with relevant scientists and managers.

Provide equipment

Provide any specialized equipment necessary for data collection. Be sure to provide training for volunteers on the proper use and care of all equipment.

Address safety and risk management issues

Identify and address issues of safety and risk management. Communicate information about safety to volunteers. Have a plan in case of an accident or injury.

Adequate communication with and recognition of volunteers

Adequate communication with and recognition of volunteers is essential. The appropriate level and types of communication will vary with the number of volunteers and the level of commitment required of volunteers. In general, as the demands on volunteers increase, so does the need for communication and recognition.

Timely feedback and results for volunteers

It is important to provide information to volunteers about the results or findings of the project in a format that is accessible to the volunteer audience. Volunteers are motivated to participate by

the feeling that they are contributing to an important scientific endeavor. Timely feedback on results and how their data were used is essential to cultivating and continuing this motivation.

Funding plan

Create a funding plan that corresponds to the timeline and nature of the project. Be aware that it is often easier to find funding to start new projects or expand current projects than it is to sustain ongoing projects. If the scientific goals and objectives include long-term monitoring, be sure to consider a plan for sustainability.