COMMUNITY SCIENCE AND NATURAL RESOURCE CONSERVATION

by

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A Thesis
Submitted in partial fulfillment
Of the requirements for the degree
Master of Environmental Studies
The Evergreen State College
May 2023

This Thesis for the Master of Environmental Studies Degree

by

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has been approved for

The Evergreen State College

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ABSTRACT

Community Science and Natural Resource Conservation
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Citizen Science, Community Science or Community Participatory Based research expands scientific knowledge about rare and endangered species as well as critical habitats (Balazs and Morello-Frosch, 2013). For this research project, an ArcGIS Survey123 was distributed to 18 community science project leaders, representing 23 projects, to investigate how they are supporting environmental policies in Washington. Nine project leaders responded to the survey. One of the project leaders participated in an interview which was conducted on Zoom and transcribed and analyzed using Atlas.ti. Three out of nine projects directly support environmental policies in Washington. All of the community science projects for which data were collected promoted collaboration and stewardship of the natural resources, which is important during a time of change and climate crisis.

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Acknowledgements

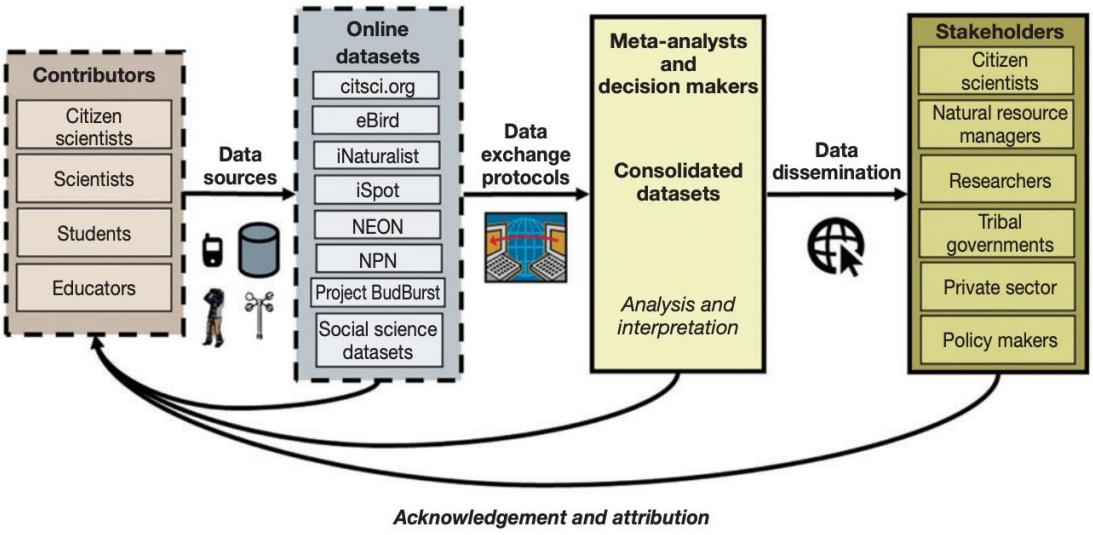
I would like to first acknowledge my reader and mentor, Kathleen Saul for all the support that she provided during this process. The Evergreen Faculty and Staff, Kathleen, Kevin Francis and Averi Azar were all there supporting me every step of the way. I am also grateful to my peer-readers Sarah Brady, Rachelle Clausen and Aleks Storvick for their willingness to read through my rough drafts and be there for a sense of humor and emotional support. Another MES student, Jennifer Bass, was instrumental in sharing ideas about Atlas.ti and qualitative research. I would also like to thank Terence Lee with the Nisqually Nature Center for sharing his thoughts and time in the follow-up interview that I conducted on both the pigeon guillemot and forage fish projects. The Washington Department of Natural Resources Aquatic Division staff Cinde Donahue and Cassidy Johnson were instrumental in giving me an inside view of how community science can be successful with their AneMone eelgrass project. And of course, I would like to thank my family Brad and John Burnham. I would like to dedicate this work to my mom, Jane Corliss, who has always told me to follow my dreams.

Introduction

Humans have been observing their environment throughout the seasons and recording changes for thousands of years (Battiste, 2000; Snively and Corsiglia, 2001). Formerly known as citizen science, community science (CS) programs of national, state and non-profit agencies have relied on surrounding communities to help collect valuable information and data on species and natural resources of concern (Dickinson et al., 2012). Community science projects include many contributors that are important along the way, from the initial data collection, to data processing and then finally reaching the end goal of the project managers and policy makers. Newman et al. (2012) summarized how data is collected by the community, educators and scientists and ends up in a database available to stakeholders (Figure 1).

Figure 1

Flow of Community Science Information



Note. This flow chart illustrated how the flow of information goes from participants to stakeholders (Newman et al., 2012, p. 3).

As seen in the figure above, community science contributors can be scientists, students, educators and anyone who is willing to be trained and participate. This may include retirees, parents and people who work in a variety of professions that are interested in learning more about their natural resources. Data bases can be open platforms such as iNaturalist or they can be data bases that are set up by a specific state agency. Once the data has been entered into these data bases, they can be coded or analyzed in order to find patterns or information that can help natural resource managers to make decisions or changes. The data may be coded by a statistician or the manager themselves. Once interpreted, the data can be presented to the board of directors or other stakeholders that may want to know if the project is reaching the intended goal of the agency or if the data can be used for related policy work.

Natural resource agencies have saved both money and time by having community members assist in both field and lab settings to gather information (Gundelund et al., 2021; Rubio-Iglesias et al., 2020). Some of the more popular community science programs include bird counts (Crabbe, 2012), coral reef data collection (Day et al., 2022), and beach sweeps (Zettler et al., 2017). Project FeederWatch was initiated in the United States by the Cornell Lab of Ornithology in 1986 to include minorities and participants who may not be able to spend all day walking outdoors to count birds (Bonter and Greig, 2021). Community science projects have been on the rise across the United State and have contributed billions of dollars in-kind towards scientific knowledge (Roche, 2022; Theobald et al., 2015). Many state agencies and non-profit organizations such as the Washington Department of Natural Resources (WDNR), Washington Fish and Wildlife (WFWS), the Swinomish Tribe and the Nisqually Reach Nature Center have realized the benefit of training community members to help gather data.

In a changing world where climate change continues to increase catastrophic events and

where biodiversity is at risk, there is a need for an all-hands-on deck approach. The use of platforms on laptops and smart phones allows many community members to record important observations (Young et al., 2019). These observations may include undescribed species, re-discovery of species, range extensions and undocumented animal behaviors (Callaghan et al., 2022). The iNaturalist platform, one of the most popular, can provide biosecurity services by alerting local communities to problems with invasive or dangerous species that may threaten crops or humans (Callaghan et al., 2022). Likewise, data on potentially hazardous marine debris has been documented in beach sweeps conducted by the Surfrider Foundation (2023).

As a result of all the work by community members, these projects have helped natural resource managers see a more complete picture when making decisions about policies and natural resources (Crabbe, 2012; Kieran et al., 2015; Monk et al., 2008). For instance, community science has been used to study water quality parameters that have shaped global policy (König et al., 2021). This was conducted by soliciting information through a survey from participants on water quality focused on the nutrient content, extensive literature review and participatory workshops with stakeholders (König et al., 2021). Ruiz-Gutierrez et al. (2021) addressed how the eBird data on bald eagles has been used by the United State Fish and Wildlife to determine low-risk areas for wind farms. Community science projects also respond to environmental crisis situations such as the Deep Horizon Oil spill of 2010 (Sullivan et al., 2018). This multi-year project used a community-based participatory approach to collect data working with fishermen to gather information on the exposure of toxic polycyclic aromatic hydrocarbons (PAH) to provide a seafood consumption guideline for the coasts of Louisiana, Alabama and Mississippi. Projects like these expand the capabilities of ecologists, tribes, and project managers, and help them with decision making on diseases, invasive species, and climate change

issues that may not be possible without the community's help (Dickinson et al., 2012; Snively and Corsiglia, 2001). In essence, community science projects have the potential to influence future decisions about our natural resources.

With all the platforms and programs that that are used by community science participants to collect data, the question remains: **In what way does community science data support environmental policies in Washington State?** More governmental agencies and non-profits are using community science projects to introduce the public to their local natural resources and for gathering information about critical species and changing habitats (Gundelund et al., 2021 ;Rubio-Iglesias et al., 2020). While some projects use community science to spark curiosity, other projects, such as the eelgrass (*Zostera marina*) ANeMoNe project by the Washington Department of Natural Resources and the Pigeon Guillemot (*Cepphus columba*) project by the Nisqually Reach Nature Center and the Dungeness crab (*Metacarcinus magister*) larvae program with the Swinomish tribe, provide agencies and tribes with data to inform management decisions about important species and the natural resources in Washington.

This thesis research explores the use of community science data in support of environmental policies in Washington. The first chapter in this thesis will explore the literature on community science, gaps in the data, management and policy decisions and community benefits and future needs. The second chapter will look at the results of both the survey and interview and how they support the thesis question. The third chapter will discuss the implications of these results and the last chapter will circle back and looks at what this means for community science and environmental policies for Washington in the conclusion.

1. Literature Review

1.1 Introduction

Participants of community science projects contribute countless hours collecting scientific data and supporting natural resource conservation. One of the first citizen science projects started in 1885 and focused on how community members could collect data on bird migration patterns (Merriam, 1885). Citizen Science, Community Science or Community Participatory Based research expands scientific knowledge towards research on rare and endangered species as well as critical habitats (Balazs and Morello-Frosch, 2013). These types of projects set up unique science learning experiences by engaging participants in data collection (Dibner and Pandya, 2018). This literature review includes background information on citizen science projects, why there is a need for more data collected by community members, how the data collected by community science members supports more informed management of natural resources and environmental policies, how community science projects support transformative learning experiences and what the challenges and future needs are for natural resource managers.

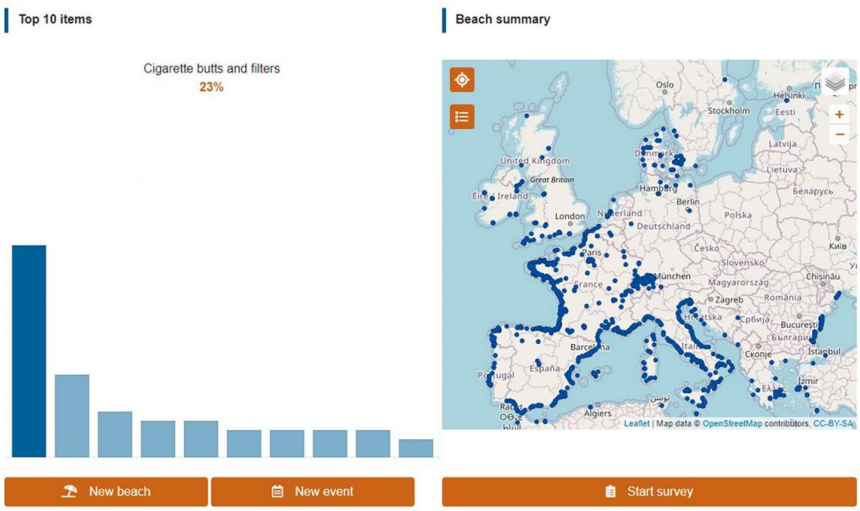
Modern citizen or community science projects have some common characteristics. Some of those characteristics include having a systematic approach that produces reliable information (Dibner and Pandya, 2018). This approach makes sure that participants are engaged with the data and benefit from these projects. It also ensures participants are more invested in the data that they are gathering and gives them a sense of pride. One example of this was seen in the sea turtle projects in North Carolina where the coordinators had ownership in their project design and data outcomes (Cornwell and Campbell, 2012). This technique of engaging participants who are not the project scientists communicates results to these participants while advancing scientific knowledge (Dibner and Pandya, 2018). Variations on this systematic theme may include the

duration of the project, mode of communication, scale of activities, location, voluntary vs. compensated participants and experimental science or learning and community-based decision making (Dibner and Pandya, 2018). Having a systematic approach also helps with the quality of the data that is produced for these types of projects.

According to Wiggins and Crowston (2011, p. 4) there are different types of citizen science projects which can be categorized by their goals. Projects may be ecologically or conservation oriented and support natural resource management as mentioned below in Figure 2 with the "Marine Litter Watch" project.

Figure 2

Marine Litter Watch Map



Note. Image shows Marine Litter Watch web application for the distribution of Europe's top ten marine debris items (Rubio-Iglesias et al., p. 4).

Other projects are purely educational focused on informal learning for young learners such as those led by the Seattle Aquarium. In this case, the data is collected and put in a repository but not used to support environmental policies.

The types of participants and how they are involved in data collection may vary as well as the focus of the project (Bonney et al., 2009; Dibner and Pandya 2018). Some participants are observing animal behavior, location or density and entering data onto a platform such as eBird (n.d.). Other projects are mediated through information and communication technologies or platforms such as iNaturalist. And, action-based projects that are grassroots, involve participatory action by the community where they are involved in the design of the project, data collection and how the results are used.

Participants can also act as cultural researchers and guides. In this case, participants may be studying and interpreting at the same time (Bang, 2015). Cultural researchers may include research that a tribe is conducting in regards to food security or species that are important to their cultural ceremonies (Snively and Corsiglia, 2001). Cultural community science programs have the opportunity to engage a more diverse audience in science and acknowledge differing world views (Cajete, 2018).

While the National Audubon society started one of the first citizen science projects in 1885 in the United States, Earthwatch is a more recently founded international organization that uses community science to empower communities around the world (Day et al., 2022). In fact, the term global community observatories was first coined by Jacqueline McGlade in 2009 during an annual Earthwatch presentation. In this approach citizens are encouraged to engage in the changes they see in their environment (McGlade, 2009). Community science or community observatories is not a new phenomenon in Europe, and data gathered by such groups has even been used by the United Nations to help make decisions about sustainable development (Fritz et al., 2019; Hager et al., 2021).

Back in the United States, beach clean-up programs and marine debris collection started in Oregon in 1984 and International Coastal Clean-ups followed suit by the Ocean Conservancy (Zettler et al., 2017). The Marine Litter Watch project is coordinated by the European Environmental Agency (EEA) and works with dozens of organizations to set up a protocol and workshops for volunteers to collect information on marine debris on beaches and rivers (Rubio-Iglesias et al., 2020). Volunteers use a common mobile application and the data is then made available to the public through a web portal (Rubio-Iglesias et al., 2020, and Figure 2). Their data demonstrates how cigarette butts and filters represent one of the most common marine debris items in the ocean. More projects are using web-based applications like that used by Marine Litter Watch to tackle environmental issues in the marine environment and along shorelines.

Community science projects can collect data that help project leaders make more informed decisions on policy and management of critical habitat and species (Crabbe, 2012; Kieran et.al.; 2015; Monk et.al., 2008). Examples of polices that are supported by community science data include the Marine Research, Prevention and Reduction Act, U.S. Commission on Ocean Policy (*An Ocean Blueprint for the 21st Century*) and legislation to ban the use of plastic bags (Zettler et al., 2017). Zettler et al. (2017) devised standardized practices for data collection and quality control for marine debris so that it could be reliably used for peer-review research. This standardized data can then support environmental policies. Ruiz-Gutierrez et al. (2021) explored how eBird data has been used by the United States Fish and Wildlife for decisions on bird populations and permits for development. There is more potential to use data from these community science projects in the future for important management decisions about our natural resources as new platforms become available for data collection and the ability to share data becomes more streamlined.

1.2 Gaps in data

Studies have shown that there is a need to fill gaps of missing data and information about the environment with evidence-based natural resource data (Gundelund et al., 2021; Kieran et al. 2015). Gundeland et al. (2021) demonstrated how citizen science data and traditional data collected on sea trout were similar. They showed that citizen science could act as a stand-alone data collection system when combined with online applications. This type of approach could fill a gap if agencies need data but are low on staff.

Kieran et al. (2015) reviewed 400 articles, confirming that most of the citizen science projects had either high or medium frequency of expert judgement by professionals in the fields of biodiversity, physical environment, resource management, and pollution in the marine environment. This means that while all of these projects required a professional to oversee the project, the data was deemed reliable. Kieran et al. (2015) emphasized that citizen data needs to be cross checked with remote sensors, buoys, gliders, satellite tagged mammals, and ships. While this may seem like an added expense, the support that community members give through collecting data, advocacy and conservation outweighs the added expense. Data can also be verified by using low-cost electronic based platforms such at Sealife Tracker (2023), Sea Angling Catches (2023) and Marine Debris (n.d.) on participants' smart phones.

Citizen science data can also support traditional surveys through electronic platforms for fisheries (Gundelund et al., 2021). This fills a gap in data collection that was not possible in the past. In the study by Gundeland et al. (2021), the citizen science data was entered into an electronic Danish platform (fangstjournalen) when anglers fishing for sea trout returned from their fishing trips and were cross checked by aireal surveys and creel surveys. Creel surveys are also referred to as angler surveys which are conducted by a natural resource manager. The lack

of data in fisheries and lower costs of having anglers collect data are strong incentives for using citizen science for supporting conservation of the marine environment (Dickinson et al., 2012; Kieran et al., 2015; Newman et al., 2012).

Other applications that are used now by community members and volunteers include HerpMapper (n.d.), Bumble Bee Watch (2023) and eButterfly (2022). Many of these applications can be used with little to no training which can save money for non-profits and state agencies collecting the data (Balazs, and Morello-Frosch, 2013; Rubio-Iglesias et al., 2020). For example, volunteers contributed $19.6 million in volunteer hours to the Washington state's budget in 2020. This budget includes natural resource agencies such as the WA Department of Ecology, WFWS and WDNR which all utilize community members or volunteers to collect data (Martin-Jahn, 2020).

Tribes, state agencies and non-profits are historically underfunded (Roche et al., 2022). Many of these projects are managed by leaders that have many other responsibilities and appointments (Roche et al., 2022). Natural history information from tribal members in Washington has been missing and is a gap that needs to be filled. Using surveys, interviews and field notes focused on methodology and ethical issues is important for these types of community science projects where the research teams are small (Roche et al., 2022). Also, finding ways to integrate Western science and indigenous science into these projects can create a more holistic view (Cajete, 2018; Snively and Corsiglia, 2001). Wheeler et al. (2020) examined what drives the progress and limitations of indigenous knowledge in the management of natural resources in the Arctic region. They emphasized the benefits of integrating these two systems, including strong connections between cultural and biological diversity as well as a more holistic view of

the natural ecosystems. The authors found that collaboration and coproduction of information were key to the success of environmental decision making.

Community science participants can also increase the volume of data that is collected. For example, the European Evolution MegaLab was seeking information about the polymorphism or the variety of patterns in banded snails (Worthington et al., 2012). A network of 15 countries collaborated on this project in order to collect the data. A total of 6,461 community members participated and entered 7,629 data points. The success of the MegaLab project for European snails was in the researcher's design, recruitment and training in order to assure that quality data was collected. Before this project, there was a much-needed information gap on the polymorphism of banded snails in Europe.

1.3 Management and Policy Decisions

While community science projects can help fill the data gaps for agencies and non-profits there is generally a limited understanding of what the policy needs are for most agencies (Wehn et al., 2021). For example, the Wehn et al. (2021) team developed a Citizen Science Impact Story Telling Approach (CISTA) and used this Impact Inquiry Instrument to collect qualitative data in order to understand how citizen science may have been impacting environmental policies and decision making in Europe. They found that there was limited knowledge of the policies within the citizen science community and that this had created communication gaps between the volunteers, stakeholders, and policy makers (Wehn et al., 2021). This team of researchers and other studies suggest that there is a need to connect the data and policy demands either through the CISTA approach or other means (Suškevičs et al., 2021; Wehn et al., 2021). While there is more work that needs to be done in the area of communication between stakeholders and the

researchers collecting the data, both environmental governance and public policy are important aspects of community science (Wehn et al., 2021).

Government agencies may review data collected by community members in order to make important regulatory decisions and to gather support for proposed policies (Sullivan et al., 2014). For example, regulations are an important tool for protecting at-risk species, habitats and natural heritage sites. Out of 53 natural heritage sites surveyed by Young et al. (2019), 32 used citizen science data in their regulatory reviews. Percival et al. (2018) discovered that government agencies regularly use distribution data on at-risk species for permits and licensing applications. Such applications might be rejected or accepted based on the distribution data for a particular species. The platform eBird can contribute information on at-risk species distribution so that government agencies can make informed decisions (Sullivan et al., 2014). This information has been used by the North American Bird Conservation Initiative (NABCI) and has provided analysis of bird populations in the United States through eBird data (Sullivan et al., 2014). In another application, the eBird data collected on the endangered seaside sparrows (*Ammodramus maritimus*) in New York State was compared to data collected by field biologists to help provide greater certainty for regulatory decisions on this endangered species (Young et al., 2019) (Figure 3).

Figure 3

Seaside Sparrow Map

Note. The yellow dots represent breeding pairs of seaside sparrows (*Ammodramus maritimus*) in New York State. The green polygons are mapped from the data collected by a trained observer. The blue triangles data was collected by observers on eBird and represent unsuitable nesting habitat (golf courses) (Young et al., 2019, p. 58).

People engaged in the sparrow project collaborated with the National Heritage database, eBird data and the non-profit Nature Serve (2022). This type of collaboration is important during a time of rapid environmental change where bird populations are shifting farther and farther North (Carbeck et al., 2022).

Global climate change, globalization and human population growth have all impacted land, tribes and species at risk (Cajete, 2018). The need to have a clear picture of these changes and how populations are responding has never been more important. All of these pressures have implications for biodiversity (Sullivan et al., 2014). Decisions will need to be made in some cases as the data is changing due this dynamic and ever-changing environment. The indigenous history and changes to the land can reveal longer term trends in biodiversity (Snively and Corsiglia, 2001). Some of the most compelling information has come from applications such as

eBird and iNaturalist on these biodiversity shifts (Sullivan et al., 2014; Young et al., 2019). Many agencies at both national and international levels are looking at ways to streamline the collection of community science data in light of the future challenges with climate change and biodiversity loss (Rubio-Iglesias et al., 2020).

1.4 Community Benefits

Community science is not just about collecting data for biodiversity, population shifts or climate change. In addition to providing data to scientists and policy makers, researchers have uncovered a number of rewards that benefited volunteers participating in these projects. Community members that participate in citizen science programs feel more engaged and committed to learning during data collection (Day et al., 2022; Dean et al., 2018; Isley et al., 2022; Thiel et al., 2014). Community science is by nature interdisciplinary since it uses both sociological and ecological principles (Crain et al., 2014). Many participants of community science already have an interest or connection to the land that can add a sociological aspect to their research (Crain et al., 2014). Additionally, this social aspect of community science projects can create social networks and encourage science literacy (Price and Lee, 2013). One study recruited 82 participants from a local hiking group in New York and New Jersey to learn about invasive species and participate in a hiking session to solidify their training sessions (Jordon et al., 2011). The leaders noticed that there was a knowledge and behavior change among the participants during their training (Jordon et al., 2011). Likewise, at the conclusion of the research conducted on a sea turtles in North Carolina where the coordinators had ownership in their field work, the scientists saw a change in attitude towards conservation and an increase in scientific knowledge with the volunteers (Cornwell and Campbell, 2012).

Supporting people's connection to nature and ecological knowledge also empowers underrepresented groups (Crain et al., 2014). After the Deep Horizon Oil Spill in Louisiana in 2010, crowdsourcing (obtaining information from a large group of people) was used to collect data in order to map the impacts of oil on the shrimp and effects from the oil spill on the local community members (Louisiana Bucket Brigade (LABB) and McCormick, 2012). The locals distrusted the officials and felt they had downplayed the impacts of the disaster. Crowdsourced data pointed out places in the environment where community members registered air and water quality issues, and where the government had not collected any data. In another example, Newman et al. (2017) examined various projects and platforms to better understand how they could increase the conservation of natural resources. The researchers found that when participants focused on citizen science projects that gave them a sense of affinity to their natural resources, or when they collected data close to their home, it improved conservation decision making. Newman et al. (2017) suggested that these place-based projects can influence participation, volunteer retention, and the efficiency by which data is collected.

Just as having a sense of place increases conservation, partnerships can be developed when those involved with several projects come together to collaborate or share data. The University of Maine created three community science projects to examine the impact of storm surges on local estuaries (Roche et al., 2022). In this study, the researchers conducted interviews, submitted surveys and reviewed the field data to evaluate and compare these three place-based projects. They found that constant collaboration and communication is important in order to have all aspects of the projects to stay aligned (Roche et al., 2022).

Informed community members often want to support environmental justice and natural resource conservation. Researchers in Australia evaluated the community science projects

VeggieSafe and DustSafe in 7,200 homes (Isley et al., 2022). They found that many participants used the information collected to mitigate and avoid toxic metal exposure in their food and the dust in their homes. This project would not have been possible without the collaboration of multiple agencies and researchers (Isley et al., 2022).

In the Balazs and Morello-Frosch study (2013), researchers looked at drinking water data collected from households in Northern California to see how minorities and low-income communities are disproportionately affected by high nitrates and arsenic. This project encouraged collaboration between non-profit organizations and the local University (UC Berkeley) to encourage data sharing and method discussions in order to make sure that the data collected was relevant to the community (Balazs and Morello-Frosch, 2013). After collecting the data, the partners were able to work together and break through the regulatory and political barriers that insisted that these environmental inequities were only happening to an isolated number of people (Balazs and Morello-Frosch, 2013). None of the projects reviewed above would have been possible if there had not been collaboration between agencies and interested community participants.

1.5 Future Needs

The data from well-established citizen science projects in Europe are being used for their natural resource planning and regulatory needs (Rubio-Iglesias et al., 2020). These research projects involved in the planning of future projects stated that the whole life cycle of the data collection and storage needs to be considered (Rubio-Iglesias et al., 2020). Data from community science projects also need to be available and centralized in order to continue their usefulness well into the future.

Of course, there will always be skeptics who challenge the validity of citizen science data. One example is a mixed method approach of surveying and interviewing participants and leaders of citizen science projects that was conducted in Eastern Europe (Suškevičs et al., 2021). Coordinators of three biodiversity initiatives were sent surveys and the researchers conducted follow-up interviews. The coordinators were interested in using this community science data but were skeptical about the reliability of the data and lack of user-friendly databases. Even with all the skepticism, there seems to be overwhelming support from some agencies that want community members to play a role in environmental conservation and environmental justice (Balazs and Morello-Frosch, 2013; Isley et al., 2022).

The field of environmental science has more impact on the natural resources with the integration of social science, policy makers, and public engagement (Kieran et al., 2015). Some organizations and research groups are even creating tools that community science practitioners can use to initiate these types of projects. Once such approach is called the Community Science Impact Story Telling Approach (CSISTA) (Wehn et al., 2021). This approach allows the community as a whole to be more involved in the decision-making process in regards to the management of natural resources and the support of environmental policies. Involving community members to help with assessing natural capital and ecosystem services brings in a more holistic approach to gathering data in Washington and other parts of the world (Cajete, 2018; Seymour et al., 2022). Community science causes the democratization of science by bringing together all the stakeholders.

In the following sections I will describe how I collected the data to answer my research question “In what way does community science data support environmental policies in Washington State?” I explain what my results revealed, explore what I discovered in my

discussion and finish with my conclusions on what all this means for the future of community science.

2. Methods

In this section, I focus on my research methods and how I administered the collection of my data. I conducted a survey and followed up with an interview. I collected information from project leaders of community science projects in order to discover how their data was used and if it was helpful in decision making for environmental policies and natural resource conservation in Washington.

This project was approved by The Evergreen State College (TESC) Institutional Review Board and a test survey was reviewed by several TESC faculty members before the final survey went out to the project leaders. I then administered a survey to adult leaders of natural resource community science projects in Washington during the winter of 2023. The 18 Washington agencies and non-profits were contacted via email as listed on the Pacific Northwest Citizen and Community Science Website (n.d.). The agencies and non-profits which were contacted include: WA Department of Natural Resources, WA Sea Grant (UW), Meadow Watch (UW), Rare Plant Monitors and Seed Collectors (UW), The Snow Fly Project (UW), Pacific Shellfish Institute, Nisqually Reach Nature Center, Nisqually River Foundation, Surfrider Foundation, COASST, Arbutus ARME (WSU), Forest Health Watch (WSU), Washington Invasives Council, Amphibians of WA (Woodland Park Zoo), Carnivore Spotter (Woodland Park Zoo), Puget Sound Seabird and Neighborhood Bird Project (Seattle Audubon), Thornton Creek Water Quality Citizen Science, Giant Hornet Trapping (WA Department of Agriculture), Northwest Indian and Fisheries Commission.

A cover letter accompanied a consent form. The convenience sampling survey included fill in the blank, multiple choice and yes/no questions via email (See Appendix). Project leaders could then fill out the form either directly from a QR code or by clicking on a link to the ArcGIS Survey123 by Esri (n.d.) on their phone or computer. An ArcGIS map was inserted into the survey so that project leaders could mark the location of their field site. The data were used to assess the relationship between community science projects and natural resource management and policies.

At the end of the survey, there was a yes/no question so that project leaders could volunteer for a follow-up interview. There were nine open-ended questions that were asked during the interview on Zoom (Table 1.).

Table 1

Interview Questions for Community Science Project Leaders

1)	Name of your project?
2)	You said that your project was investigative, educational, virtual, conservation, environmental justice, action or other (circle one that applies). In light of this, I would like to better understand how your data was used. What variables did you decide to focus on and why?
3)	How did you design your project to align with the policy that you are hoping to support? Which main policy/ies does your project support?
4)	Who analyzes the data?
5)	Has this CS data helped your agency meet its goals? What are those goals? Does the CS data help with your end of the year reports?
6)	How do you account for reliability of the data?
7)	Would you say that this project is place-based? Why?
8)	Do you collaborate with the tribes or the NWIFC? Does the traditional ecological knowledge (TEK) help give you a broader picture on what is going on with the natural resources?
9)	What sage advice would you give to someone who wants to start a CS project for the first time?

I used Atlas.ti (2023) software in order to input the qualitative data from the interviews for analysis. The information from the interviews was coded and analyzed for correlations between community science data collected and environmental policies. The coding search approach was descriptive and deductive. Data was transferred from ArcGIS Survey 123 in to a final story map for presentation at The Evergreen State College during spring of 2023. This information is stored on ArcGIS Survey 123 and will be deleted three years after the completion of the thesis.

All answers remain confidential and were only used for this thesis. Results from the data analyses were shared with participants, the community science leaders, and faculty and students during a public presentation at The Evergreen State College.

3. Results

Nine program leaders, who represent twenty-three projects of community science programs, participated in the ArcGIS Survey123 questionnaire for this study. The program leaders had two weeks to fill out the survey. These nine out of eighteen program leaders completed the survey, resulting in a 50% return rate.

The results provided information on whether the data collected by community science projects are supporting policies or the natural resource management in Washington. Some of the nine participants oversaw more than one project (Table 2).

Table 2

List of Agencies and Organizations from Survey123

List of Agencies and Organizations from Survey123	Number of projects
University of Washington	3
WA Department of Natural Resources	2
WA Department of Fish and Wildlife	2
Seattle Aquarium	2
US Fish and Wildlife Service	2
In the final version, WA Tribe	2
WA Sea Grant (UWA)	2
WA Department of Ecology	1
Pacific Shellfish Institute	1
Nisqually Reach Nature Center	1
COASST	1
WA State University	1
US National Park Service	1
WA Department of Agriculture	1
Thornton Creek Alliance	1

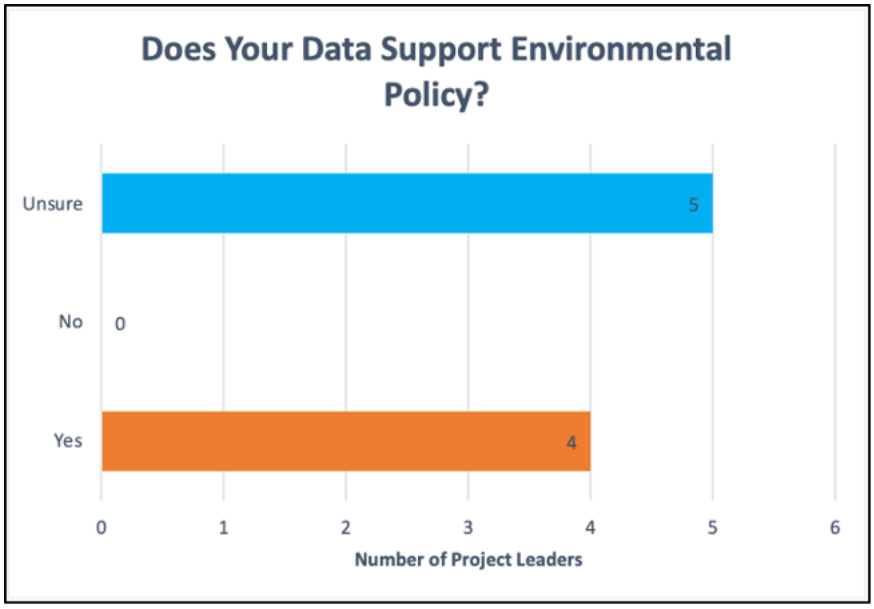
Note. This table includes all of the agencies, institutions and organizations that participated in the Survey123 (ArcGIS). Some organizations coordinated more than one community science project.

The total number of projects reviewed was n=23 from the nine project leaders that were surveyed. Among these twenty-three projects, six supported non-profit organizations, fourteen were state projects, and three were national projects (Table 2).

Four project leaders stated that their data supported state environmental policies, five project leaders were not sure, and none of the project leaders said that their data did not support environmental policies (Figure 4).

Figure 4

Responses to the Question: Does your data support environmental policy?



Note. This data shows the number of project leaders that are certain that their projects support environmental policies (ArcGIS Survey 123).

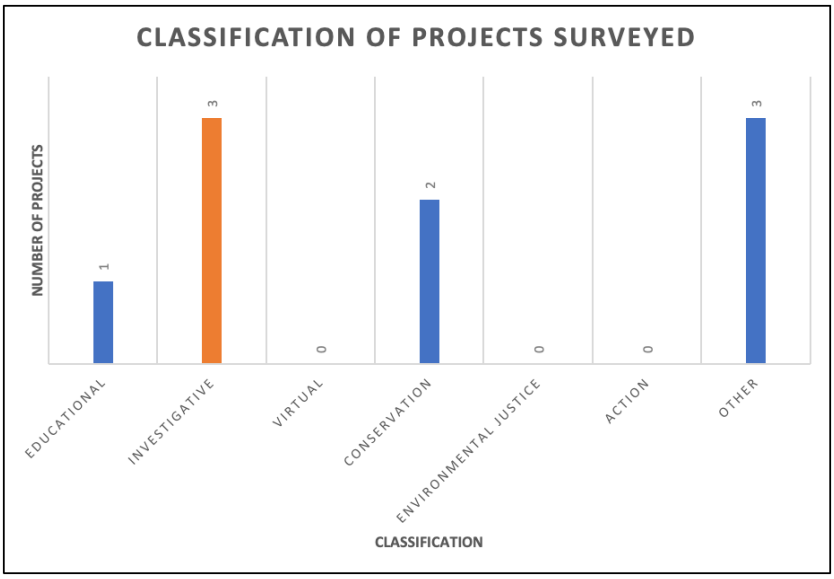
One of the questions in the survey asked the project leaders to name the specific policy that their data was supporting. Three community science project leaders were able to communicate this on the survey. For example, the Nisqually Reach Nature Center (through the WA Department of Fish and Wildlife) collected data with community members on the presence or absence of forage fish in the intertidal shores of South Puget Sound, which supports the Hydraulic Project Approval Rule (RCW 77.55). This rule is important to preserve shoreline habitat for forage fish and determines whether a developer can obtain a permit for shoreline development through the WA Department of Fish and Wildlife (2023). The Thornton Creek Alliance collects water quality data for a watershed in Seattle which supports the Total Coliform Rule (DOH 331-556) through the WA Department of Health (n.d.). This rule makes sure that the Thornton Creek watershed does not exceed the Washington State Department of Ecology's total

coliform levels according to the 2022 Water Quality Assessment and the U.S. Environmental Protection Agencies Clean Water Act 303(d) (n.d.). Finally, the Washington Department of Natural Resources (WDNR) collects data on kelp and eelgrass beds along with water quality information that supports the WA State Legislature's State Bill 5619 for the restoration of kelp and eelgrass beds (2021). This in turn, helps support the State's goal of restoring 10,000 acres of eelgrass beds by 2040, as part of the Puget Sound Eel Grass Recovery Strategy. Thus, all of the data collected from community members for these three projects supports state level environmental policies for water quality and fish.

Other interesting information obtained from the survey was that most of the participants identified that the main focus for their project was investigative. The choices for classifying their projects were based on Wiggins and Crowston (2011) and included: investigative, educational, virtual, conservation, environmental justice, action or other. The investigative approach is an inquiry-based approach where the participants learn as they collect data (Figure 5).

Figure 5

Main focus of the Community Science Projects

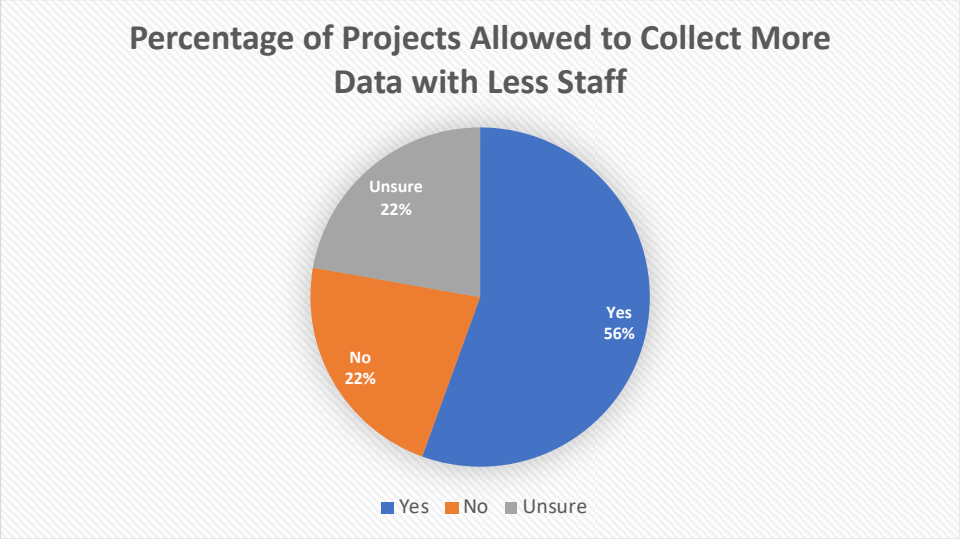


Note. Graph shows the classifications of projects surveyed (ArcGIS Survey123).

Over half of the project leaders that responded to the survey (56%) said that they were able to collect more data with less staff (Figure 6). However, while they were able to collect more data with less staff, the projects did create more work for the project leaders. The project leaders spent 2 to 10 plus hours just focusing on their community science projects. Most of the increased time investment was in education of the volunteers and data processing.

Figure 6

Collecting Data with Less Staff



Note. This data shows that community science projects collect more data with less staff (ArcGIS Survey 123).

I also collected demographic information on the project leaders that participated in this survey. Over seventy-seven percent of the project leaders had sixteen plus years of experience overseeing these types of projects. Over forty-four percent of these project leaders had a Bachelor's of Science degree or above. The project leaders said that it was the hands-on experiences, the exposure to field science, and exposure to the environmental science field that prepared them to lead these types of projects.

While five project leaders agreed to be interviewed, only one project leader was able to

complete the interview. This interview focused on two projects (pigeon guillemot and forage fish) conducted by the Nisqually Reach Nature Center (See Appendix for the complete interview). Sixty-one codes were created and placed into six categories after transcribing the interview on Atlas.ti. The six categories include: collaboration, community, conservation, knowledge gaps, policy, and tribes. The codes which occurred three or more times were included in a frequency table (See Table 3).

Table 3

Frequencies of code words used in the interview during this study.

Code Frequency	
Code Word	Frequency
Conservation	3
Environment	3
Habitat	3
Information	3
Pigeon guillemot	3
Population	3
Quality Control	3
Spawning	3
Species	3
State	3
Survey	4
Fish	7
Data	9

Note. Only code words that appeared three or more times are included. There are a total of sixty-one codes (Atlas.ti)

These code words are all related to natural resources and natural resource management. The policies that were supported from the results this thesis survey focused on critical habitat and indicator species. Fish are an important indicator species for water quality because they are

exposed to and accumulate contaminants. The Pacific Northwest tribes are interested in obtaining data on fish habitat and spawning areas because of their treaty rights to fish in their usual and accustomed areas according to the Northwest Indian Fisheries Commission (NWIFC) (2016).

4. Discussion

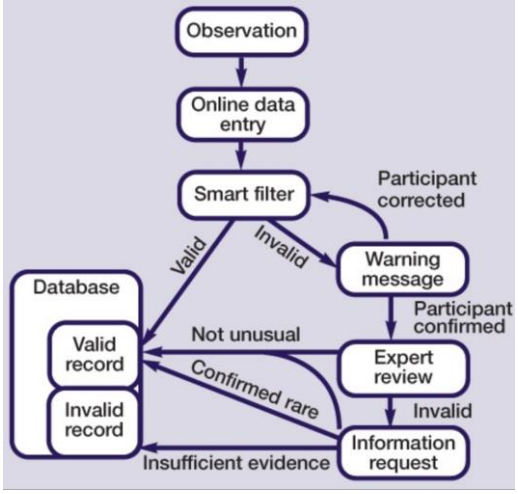
While the data from this survey and interview were generally positive, information from a wider range of project leaders would have given a more complete picture. Also, not all of the project supervisors indicated that they were aligned with any environmental policy. Some community science projects are purely educational, such as the Seattle Aquariums citizen science program. Though the survey was easier to distribute and collect information from the project leaders than conducting an interview, the answers were not as revealing. There were quite a few assumptions such as how the data was handled and what kind of collaboration was occurred between agencies, but probing those areas fell outside of the scope of the survey. And, while coding and analysis of the information can be time consuming, it brings information and patterns to light that might not be obvious in a survey. For example, the interview shows how important it is to have quality control and check points as the data is being collected. When interviewing the project leader at the Nisqually Reach Nature Center he stated:

> This (analysis and quality control) is through Washington, State Department of Fish, Wildlife. So we don't do any analysis of the data. At this point we send our data to Department of Natural Resources, and they conduct initial-level quality control on a small percentage of the samples that we send in. So, of the samples that we collect, whichever ones have eggs in it, we send the vials of eggs along with the data sheets that match those samples to WADNR. They verify it, and if they have questions they send it to consultant for further quality control, and that, as far as data analysis on the State side, they don't necessarily do analysis, but they do take that data, and they put it into a GIS map which is that publicly available so there is potential for data analysis to occur by anyone who may be interested in looking at statewide data (T. Lee, Personal Communication, March 15, 2023).

Quality control is especially important when collaborating with state agencies that are using this information to support, environmental permitting, policy or regulations (Figure 7) (Bonter and Cooper, 2012).

Figure 7

Data Validity Flow Chart



Note. This figure shows the flow chart of how community science data can be evaluated for quality control by experts. (Bonter and Cooper, 2012, p. 307).

Another revelation from the interview was how volunteers gain knowledge about their natural resources in a place-based sense. This knowledge then translates into participants supporting and advocating for stewardship of their natural resources (Newman et al., 2017). Another missing piece that was brought to light throughout the interview was how indigenous knowledge is missing from what data is collected and how the data may be interpreted for future policies and regulations. This missing information has been an unfortunate factor for hundreds of years in our state.

While this study included both a survey and an interview, it was the interview that revealed the most. I teased out sixty-one code words as I went through the transcript line by line.

The words that showed up the most were survey, fish, and data. Forage fish, the salmon that depend on them, and the species that depend on salmon are critical to environmental health in the Pacific Northwest and support many aquatic ecosystems (NOAA, 2023). Since the pigeon guillemot birds are dependent on the near shore and subtidal regions for foraging for fish year-round in the Salish Sea, they reflect the general health of these ecosystems. Understanding their health gives natural resource managers an understanding of the health of the Salish Sea.

"Survey", "fish", and "data" together with the codes conservation, information and habitat are not only telling about the focus of this thesis research but also about the role that community science can play. Yes, all of the agencies and projects were focused on natural resources but without the data and information that was collected by the community, then there would be less information about the natural resources in Washington. This information about the natural resources is vital in order to support policies that matter.

The data revealed that a number of different agencies and non-profits are using community science as a tool to gather information. Most of the agencies participating in these types of projects appear to be linked to the state institutions. Washington's major universities as well as natural resource agencies such as the WDNR, WFWS and the WA Department of Ecology are major players in promoting these types of projects. Four project leaders state that these community science projects are saving their agencies and the state time and money just as indicated in the literature (Balazs, and Morello-Frosch, 2013; Rubio-Iglesias et al., 2020). According to a survey conducted in 2020 by Martin-Jahn (2020) from the Office of Financial Management in Washington, volunteers contributed $19.6 million dollars to the state's budget. Not only is the state saving money and time but it is also discovering new information about the natural resources through the investigative approach to community science.

The investigative approach that dominated most of the projects studied in this research suggests reasons why agencies use community science. By using an inquiry-based focus, questions can be explored through the data collection. Science methodology demands that we ask questions and investigate what is going on in the environment. Policies such as the Clean Water Act 303 (d) and Clean Air Act of the U.S. Department of Environmental Protection came about due to the need to investigate the severe pollution that was occurring in the 1970's (EPA, 2022; EPA, 2023).

That environmental policies and regulations are being supported by community science is confirmed by the volume of literature on citizen/community science projects and by the myriad of examples of successful projects in Washington alone. Projects like the COASST project through the University of Washington, the AnNemone project with the WDNR and the crab larvae project with the Pacific Shellfish Institute and the Swinomish tribe have shown how organization, collaboration and support from the community can contribute to effective data collection. The information collected from these projects from eelgrass to crab larvae is critical knowledge for the state of Washington's natural resources.

Platforms can now be downloaded onto volunteers' phones and laptops in order to expedite the process of collecting data (Sullivan et al., 2014; Young et al., 2019). This ease of access creates an opportunity to get more people involved in conservation while also supporting the mission of the WA Department of Ecology and the Governor's goals for the natural resources in Washington. The mission of the WA Department of Ecology is as follows: "To protect, preserve, and enhance Washington's environment for current and future generations (n.d.). The mission for the WA Governor's office is as follows: "Washingtonians care deeply about preserving and protecting our clean water and air for our families and future

generations. Washington is among the leading states in the fight against climate change and growing the state's clean energy economy" (n.d.). It has been shown through this study and the literature that community science can support these goals, as was done when the Thornton Creek Alliance collected Seattle watershed data under the U.S. Environmental Protection Agencies Clean Water Act 303(d).

As seen through the results of this study, a place-based approach to community science can provide more social, emotional, and affective approaches to data collection. While some of the projects' goals are to collect data in order to support policies, others are to endorse environmental education and conservation. I asked the project leader at the Nisqually Reach Nature Center if he felt that his community science project aligned with the broader goals of conservation. He said:

> In a broader sense, I would say yes, because part of our mission is really about connecting people with nature, and we use science and education as tools for doing that. So one of the positive aspects of citizen science is that it is both a science tool, and it is an educational tool (T. Lee, Personal Communication, March 15, 2023).

Community science can also create collaboration between the community, scientists, and the stakeholders (Newman et al., 2017; Crain et al., 2014). There is an opportunity for indigenous science and Western science to learn from each other and endorse a more holistic approach to data collection and support environmental policies in Washington. In my interview, I found this was not happening:

> Unfortunately, like with pigeon guillemot project, the forage fish project is something that we don't currently collaborate with in the Nisqually tribe, which is the one tribe for whom this research would be the most relevant. But we are certainly open to having opportunities to learn about the traditional ecological knowledge, and what sort of role that plays in terms of cultural significance? I mean as an anecdotal, I noted in this call, I tried. It was actually looked into studying the herring populations which you know in turn that support salmon populations. We are not really partnering with the tribe on that, so would be great if we could. But you know they tend to be a little bit more insular. And yeah. But you know, if the opportunity were to come up, we

> would certainly welcome the chance to, you know, partner with the tribe, and at the same time try and find ways that can enhance their knowledge, or, you know, maybe adapt our methods to collect information that you know, balance what they already know (T. Lee, Personal Communication, March 15, 2023).

While I found out that the agencies are not collaborating with the tribes in community science projects, the tribes can offer information about long-term trends of populations and environmental changes. This place-based approach can be the bridge that connects these two schools of thought. Both biodiversity and native food security are at risk. Also at risk is the opportunity for all Washington community members to thrive in a healthy environment.

5. Conclusion

Not all community science projects are contributing to the environmental policies or laws in the state of Washington. This study explored the question "**In what way does community science data support environmental policies in Washington State?"** Three projects that support environmental policies were revealed as a result of this study. And, community science projects that are not supporting environmental policies are still valuable. The information in this study uncovered many benefits to the state, agencies, non-profits, and participants from community science projects. For example, the health of Puget Sound can be measured by tracking the ubiquitous pigeon guillemot—it tends to be everywhere and eats anything so a decline in its population would be particularly valuable information (T. Lee, Personal Communication, March 15, 2023). The forage fish project on the other hand, probes spawning in relation to regulations on shoreline development, permits and beach habitats (T. Lee, Personal Communication, March 15, 2023). This data allowed the Nisqually Reach Nature Center to gauge the impact of human-made structures on spawning areas and thus recommend habitat restoration activities. In addition, population status is needed for indicator species in our state so

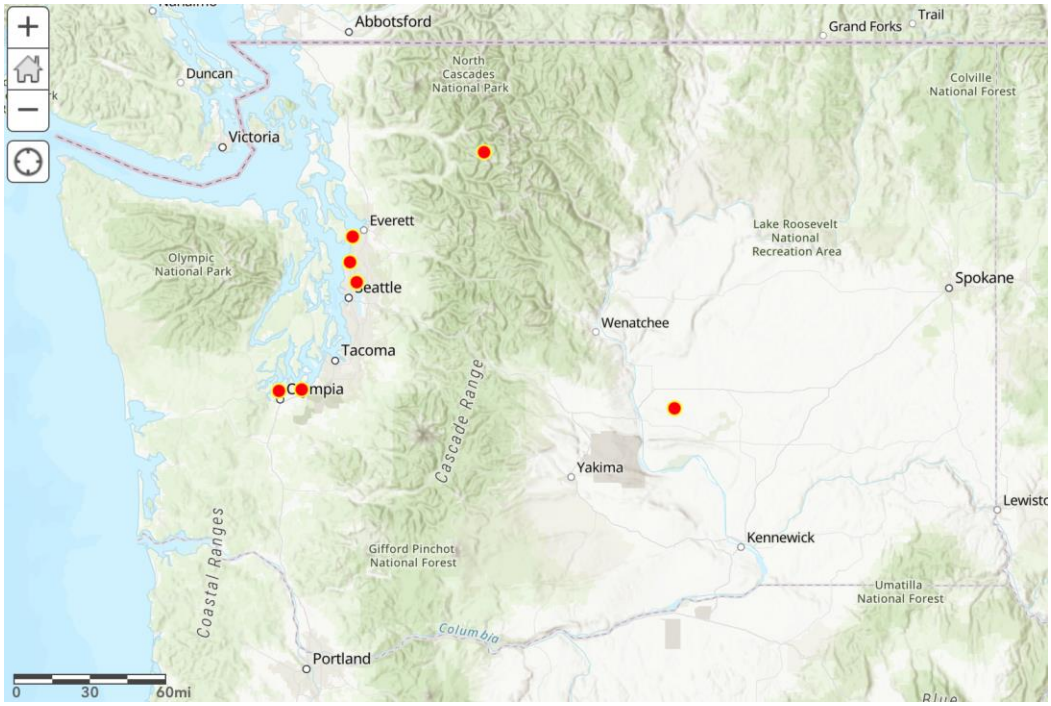
that targets can be used for recovery after a disaster (T. Lee, Personal Communication, March 15, 2023). While not all of the community science projects are endorsing environmental policies or laws, these types of projects have dedicated volunteers who become advocates for environmental conservation.

The Nisqually Reach Nature Center is just one non-profit that is doing this. They collaborate with the WA Department of Fish and Wildlife and WA Department of Natural Resources to collect data using members of the community. They use science as a tool in their research projects to connect volunteers with nature and help them understand their role as stewards of nature. The information from these projects is also available on statewide data bases which are accessible to state residents. These projects are aligned with the goals of the Governor's office of this state to connect people to nature.

The locations of other projects that were a part of this study are shown in Figure 8 below.

Figure 8

Map of community science project locations



Note. Five out of seven projects that were indicated on the survey are located on the Salish Sea (ArcGIS Survey123).

As you can see from this map, most of the projects are located on the shores of the Salish Sea. One of the top concerns for the State of Washington is water quality.

Several recommendations have emerged from this study. Community science projects need to consider what their end goal is for the data that they are collecting. Quality control of the data is also important when planning to collaborate with other agencies or if the data is being used to support environmental policies. Additionally, clear communication and expectations is essential at each level of the data collection. The more background information and training the volunteers have, the more confidence they and the project leaders can feel while collecting this data in the field.

In order to make community science data valuable to the state it needs to be valid. There is an opportunity for Washington State to work with and support the tribes who's needs have been ignored. There is also an opportunity for the state to use community science as a tool to promote environmental justice, climate change issues and environmental advocacy. During my interview I learned what must be considered when initiating new community science projects:

> If it were me is, I would do some investigation into looking at what sort of local or regional or national issues might be of interest, and from there, I would see what existing research has been conducted on it, and see if there's any information out there as far as knowledge gaps. And then from there, knowing what those knowledge gaps are, identifying professionals who are working on the issue and connecting with those professionals to find out what would be most useful (T. Lee, Personal Communication, March 15, 2023).

Community science can be the vehicle that helps people feel empowered in a time of despair. Climate change is threatening the livelihood of everyone and decreasing biodiversity in Washington. With community science projects, not only are volunteers empowered, but the agencies can broaden their network (Price and Lee, 2013). Community science is a supportive web that can strengthen our communities and empower people to want to make a difference. By supporting the natural resources through community science all the communities of Washington benefit.

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Appendices

Cover letter:

Dear Citizen Science Project Leader,

I am writing to ask for your help in gathering data for my thesis at The Evergreen State College. Citizen science or community science projects are on the rise in South Puget Sound. This survey will be gathering information on how well these community science projects are supporting environmental policies in Washington. Specifically, I would like to know how the data is being used.

The platform used for the questions in this survey will be on ArcGIS Survey 123 by Esri. You can fill out the form directly by clicking on the link or using the QR code below on to your phone or computer. The purpose of this survey is to get a clearer picture of how community science may be supporting our natural resources.

This survey should take no more than 10 minutes of your time. This survey will provide valuable information on how the data from these projects are being used to support environmental policies. All the information that you share is confidential and any personally identifying information will be removed before your information is shared with this class or project leaders.

Thank you so much for your time!
Lynn Corliss, MEd
MES Candidate

Consent Agreement and ArcGIS Survey123:

Natural Resources and Community Science

Thank you for taking my survey on citizen/community science! This survey is collecting information as part of an Evergreen State College MES thesis project. The purpose of this survey is to gain a clearer understanding of how community science managers use project data and how community science projects can support natural resource conservation in Washington. It is also looking at how community science data supports environmental policies in Washington. All answers will be confidential and only be used for this thesis.

1) Informed Consent Agreement

You are being invited to participate in a research study titled "Natural Resources and Community Science" This study is being conducted by Lynn Corliss, a Master of Environmental Studies student at The Evergreen State College. If you agree to take part in this study, you will be asked to complete an online survey. This survey will ask a variety of questions about the data that is collected for your community science project and what type of environmental policies it may support. It will take you approximately ten minutes to complete.

Risks to you are minimal and are likely to be no more than mild discomfort with sharing your opinion. To the best of our ability, your answers in this study will remain confidential. With any online-related activity, however, the risk of a breach of confidentiality is always possible. Additional information about YouGov privacy policy can be found here: http://today.yougov.com/about/privacy/. Your participation in this study is completely voluntary and you can withdraw at any time. You are free to skip any question that you choose. Data collected from you for this project will be shared with Lynn Corliss and The Evergreen State College. Any personally identifiable information will be removed before your information is shared.

If you have questions about this project, you may contact the researcher, Lynn Corliss at Lynn.c@evergreen.edu. If you have any questions concerning your rights as a research subject, or you experience problems as a result of participating in this research project, you may contact The Evergreen State College Institutional Review Board in Olympia, WA. They can be reached by email at: irb@evergreen.edu

By clicking "I agree" below you are indicating that you are at least 18 years old, have read and understood this consent form and agree to participate in this research study. You may print a copy of this page for your records if you wish.

I Agree I Disagree

2) Which of the following agency are you working with? *Check all that apply.*

_____ WA Department of Natural Resources
_____ WA Department of Fish and Wildlife
_____ WA Department of Ecology
_____ Pacific Shellfish Institute
_____ Nisqually Reach Nature Center
_____ Nisqually River Council
_____ Surfrider
_____ COASST
_____ University of Washington
_____ Washington State University
_____ Woodland Park Zoo
_____ Seattle Audubon
_____ NASA
_____ USGS
_____ U.S. Fish and Wildlife Service
_____ National Park Service
_____ Other. *Please write out the agency name or non-profit below if not in this list:*

3) How long have you managed this project? *Please pick one option.*

1 Season 1 Year 2 Years 3 Years 4 Years 5+ Years

4) Type of information collected. *Pick the options that apply*.
_____ Nesting behavior
_____ Population density
_____ Population estimate
_____ Amount of toxic algae blooms
_____ Levels of toxins or chemicals
_____ pH levels
_____ Dissolved oxygen
_____ Amount of fertilizers (phosphates or nitrates)
_____ Invasive species
_____ Disease
_____ Climate change impacts (i.e. drought, fire, flooding)
_____ Other. *If other, please indicate what you are measuring below:*

5) Describe the main classification of your community science project. *Please pick the option that best describes your project.*
_____ Educational
_____ Investigative
_____ Virtual
_____ Conservation
_____ Environmental Justice
_____ Action
_____ Other

6) Is the data collected by community science participants used to create new or improved on management techniques? *Please pick one option.*

Yes Unsure No

7) Is the data collected by community science participants used to support existing environmental policies? *Please pick one option.*

Yes Unsure No

8) Please describe in one or two sentences, how the data is used.

9) List any specific management decisions that the data has supported.

10) List any specific environmental policies that the data has supported.

11) Has this community science data allowed you to collect more data with less staff?

Yes Unsure No

12) Has the community science project increased or decreased your work load. *Circle one option. If you choose increase, please pick the option that reflects this increase in question number 13.*

increased Unsure decreased

13) How many hours per week has your work load increased due to this community science project? Please pick one option.

1-2 hours 3-4 hours 5-6 hours 7-8 hours 9-10 hours 10 + hours

14) What area of training and preparation takes the most time? Please pick one.
_____ Recruitment
_____ Designing data sheets
_____ Education of staff
_____ Education of participants
_____ Field training of staff
_____ Field training of participants
_____ Collection of data
_____ Obtaining and setting up equipment
_____ Equipment maintenance
_____ Processing data
_____ Organizing staff

15) Please indicate the number of years you have been in this profession. *Pick one.*

1-5 Years 6-10 Years 11-15 Years 16-20 Years 21 Years +

16) How many citizen/community science projects do you oversee? *Pick one option.*

1 2 3 4 5+

17) What training or degree has helped you design or develop these types of projects?

I would like to conduct follow-up interviews with community science project leaders to get a better understanding of how community science data can be effectively implemented for future natural resource decisions in Washington. If you are willing to agree to a follow-up call or Zoom session with me, please answer the option "I agree" below.

I Agree I Disagree

Thank you so much for taking my survey!

Please indicate field location where your field data was collected. *Use GIS map locator. Map title – Location of Community Science Projects.*

Transcribed Interview (3/15/23):

Q1 - Name of your project?

So, my name is Terence Lee, and I help coordinate the South Sound (Nisqually Nature Center).

Q2 - You said that your project was investigative, educational, virtual, conservation, environmental justice, action or other (circle one that applies). In light of this, I would like to better understand how your data was used. What variables did you decide to focus on and why?

Yeah, so this study (pigeon guillemot) is actually an estimation of population abundance. It's not meant to be a complete population census. So key distinction. There, there are a handful of basic

metrics that we do collect data, for there's the actual number of given a month that are present during a survey. So, we conduct 3 counts during our survey. We do take 3 counts during our surveys. One count at the beginning of survey, one in the middle and one at the end. We count the highest of those 3 counts as the high count, and that high count is then reported as the official data point. That gets used in the data analysis. There are other data points that we collect with respect to.

Breeding information. So we are documenting per visits, and we document when we visit (pigeon guillemot) without pray, and went visit with pray for visits, with prey. We are doing our best to identify down to the type of fish that they are bringing (to their nests) their 3 main categories. With that there are the gunnel, the sculpin, and other. Obviously being a composite of multiple species, including gunnels and sculpins that are not verified.
And those are the most basic aspects of data collection for this particular project.

Q3 - How did you design your project to align with the policy that you are hoping to support? Which main policy/ies does your project support?

The end user of this data is actually the state. So the state uses this data. In addition to the data that's collected by other volunteer organizations to form a composite that is then put in for a trend status. And so we have yet to finalize the 2022 data. It's going to the (Puget Sound) partnership. The is designated by some partnership as an indicator of species. It's one of many variables that they have settled on.

As ways that they can evaluate the health it wouldn't really be a direct correlation with any policy per se. It's more of a broad-based conservation measure. It's really not only say it's a passive measure, but. It's a way for them to look at environmental conditions from biological perspective. You know, if you look at it sound, it can be broken into biological business chemicals, social types of yeah. In the case and so the is one of the biological indicators. But like I said, they're isn't a direct policy that this is really informing.
You know, it's like with the Forge (fish) project, where there is something more direct in that regard.

These are not (ESA) listed species. This is a somewhat unusual situation in that population of this species. In our state is more or less stable, which is good, and their population levels are at levels that are not anywhere near to being. Even a species of concern, so it's a bit preemptive in the sense that we're collecting baseline data, so that in the event of some kind of disaster, should there be a need for population recovery efforts that there will be some kind of information out there that will help informing what needs to happen, and what sort of targets to set for recovery.

Q4 - Has this CS data helped your agency meet its goals? What are those goals? Does the CS data help with your end of the year reports?

In a broader sense, I would say yes, because part of our mission is really about connecting people with nature, and we use science and education as tools for doing that.
So one of the positive aspects of citizen science is that it is both a science tool, and it is an educational tool. From the standpoint that that people coming into the project typically don't

have a science background. So they are learning. That's something new. They're gaining, a sense of stewardship regarding these habitats that they're studying. And these birds study.

Q5 - How do you account for reliability of the data?

Yeah, so there's really to paired approaches to this. The primary approach is conducting quality control in the ideal world. We would have a regular schedule for conducting the quality control. So, you know, if you look at a normal season starting in week 3, we would review all of the data from week one. Assuming that folks have had adequate time to conduct a survey and enter the data and send us cop copies of their data sheets, so that we have something that we can check against. And so every 2 weeks. We would then continue that process of reviewing. Data from 2 weeks prior until we get to the end of the season and see theoretically, we would be completely done with the quality control. Barring any complications but the other part of how we can ensure quality of data is through training and you know, there's also follow up that can come with that to where we can ensure that people are following the probe call according to how it's written. Help with interpretation of certain aspects of that protocol that are less clear and provide field training as needed. To ensure that you know some of those parts of the protocol that are covered in the training are clear.

So, we have been implementing that system. That is, that I described to a certain degree of success. It's in. I wouldn't call it a resounding success, because it hasn't been. But.
You know when it works without any complications. It works fine. We did use to just let the data pile up and then work on quality control in the fall and winter.
But we've since moved to that different schedule because it works better for ensuring higher quality of data, awesome, timely completion of that process.

Q6 - Would you say that this project is place-based? Why?

Obviously, the pigeon, guillemot is place-based, and the issues with the pigeon guillemot in our place base. We are conducting surveys at breeding colonies, and these breeding colonies are very regular, so the birds are returning to the same location each year. So, there's a very strong sense of site, fidelity for these species. They're not like other species that are more opportunistic. So, yeah, yeah, it's very much place based.

Almost all of our participants have some connection to the local area. There might be some who are from more outline areas, but you know if you're looking at it from more regional scale than yes. But if you're looking at a more micro scale, then, you know, there's a small number of folks who are not from the local area.

Q7 - Do you collaborate with the tribes or the NWIFC? Does the traditional ecological knowledge (TEK) help give you a broader picture on what is going on with the natural resources?

No, we don't currently have a collaboration with any of the local tribes whose territories overlap with our study. It is something that we have identified as an area of interest.

But we have yet to pursue it. We would certainly be very much interested in learning about the traditional knowledge of the local tribes. With respect to this species, and it's called true importance. If there is any.

Q1 - Name of your project?

So, my name is Terence Lee, and I help coordinate the South Sound (Nisqually Nature Center).

Q2 - You said that your project was investigative, educational, virtual, conservation, environmental justice, action or other (circle one that applies). In light of this, I would like to better understand how your data was used. What variables did you decide to focus on and why?

The Forage Fish Project is definitely a very strong conservation oriented project because it's end result is basically environmental protection there's a very strong regulatory component to it in that whenever anyone does a forge to survey and spawning is documented at a particular beach that beach and a certain extent beyond the immediate survey area then becomes protected under State law, and so, if there are any shoreline developments, activities, or any activities that involve modification of the beach habitats, part of the permit requirement is to conduct a forge fish survey to verify presence or absence of spawning, and in effect it operates similar to a forage fish work window, like there is for salmon, except in this case it would be for forage fish. So you know, if forged fish spawn was detected at a construction site, you know, that would effectively limit the timing of the activities. And, as far as the data that we collect, the vast majority of the data that we collect out in the field is qualitative data assessing the condition of the habitat, or we're looking at suitability for spawning the sample collection. It then has the potential to provide information as far as which species are actually present. How dense the spawning is at that location, the age of the eggs that are deposited in those locations.

The diversity is I guess you could say a byproduct of that, but it's not. I mean, it's certainly intentional, but it's you know we're not trying to do some sort of a population census here that would require a determine that type of information. You know, we just trying to figure out when the fish are ready. Fish responding to the environmental conditions.

We are focused primarily on the physical characteristics of the actual habitat in the immediate visiting of where these fish are spawning. So we characterize the sediment size. We're looking at the condition of the upland habitat to determine how much, if any, anthropogenic influence there is, and what sort of impacts those might be having on natural beach processes we're also looking other factors connected with those up on app tasks like shading, which can be critical for some areas not down here in South Sound, but in other areas where spawning occur during the warmer months, shading becomes a more critical habitat component and see what else do we collect we measure the actual dimensions of the physical, spawning habitat, and we look for presence of spawning, and if there is spawning detected, we estimate the density of spawning. So, yeah.

Q3 - How did you design your project to align with the policy that you are hoping to support? Which main policy/ies does your project support?

Yes, so under the hydraulic project, approval, which I think is an RCW. Or the other place, account number (RCW 77.55). It's part of the permitting process in the environmental review to look at all the different environmental factors that might be impacted by a particular proposed project. And yeah, if it turns out that there is previously documented forge fish spawning at that location, that then triggers the condition on the permit to only allow for that work to be conducted during time windows when it would not impact. Right. That's species that are obviously up considerations, as far as you know, like salmon and whole host of other environmental conditions. But just looking specifically at forage fish. You know, there's the work window, and you know, if there's unavoidable impacts, then then that's where it triggers the need for a survey. Add that specific location prior to the project starting, and then continuing for as long as there is documented spawning, and after which point once spawning is no longer detected. You know, that allows for a window of time in which work can be conducted.

Q4 - Who analyzes the data?

This is through Washington, State Department of Fish, Wildlife. So we don't do any analysis of the data. At this point we send our data to Department of Natural Resources, and they conduct initial-level quality control on a small percentage of the samples that we send in. So, of the samples that we collect, whichever ones have eggs in it, we send the vials of eggs along with the data sheets that match those samples to WADNR. They verify it, and if they have questions they send it to consultant for further quality control, and that, as far as data analysis on the State side, they don't necessarily do analysis, but they do take that data, and they put it into a GIS map which is that publicly available so there is potential for data analysis to occur by anyone who may be interested in looking at statewide data.

Yes, they share that with department of fish and wildlife.

Q5 - Has this CS data helped your agency meet its goals? What are those goals? Does the CS data help with your end of the year reports?

It definitely is a very close match on this one (conservation oriented). Because, like, I said, with picking, there's definitely both the scientific component and the research. Or I mean educational components. And you know, again, we have people from various backgrounds, both science and non-science. Most of whom have never helped out with this type of project before. So it is something that you know they're able to learn, and they're able to. Gain a new perspective about each environments that they didn't have before.

Q6 - Would you say that this project is place-based? Why?
Interviewee:

Again, are most of the people participating from this area. And obviously the species is from this area. Yeah, it is. It's still a very. Please-based Activity.

All these are fish and they move around, but we do have some index sampling stations which are stations that we repeatedly go to on a regular basis. And so we do try and sample in those same

exact spots, maybe not in the same exact spot on the beach, but you know, for each section of beach we will repeat visits somewhere in that section as long as that section is representative of you know, that area. So if there's a beach that has multiple habitat types, we would have multiple sampling locations for that beach. And we do sample multiple beaches, and we do the same approach for all of those beaches.

Q7 - Do you collaborate with the tribes or the NWIFC? Does the traditional ecological knowledge (TEK) help give you a broader picture on what is going on with the natural resources?

Unfortunately, like with pigeon guillemot project, the forage fish project is something that we don't currently collaborate with in the Nisqually tribe, which is the one tribe for whom this research would be the most relevant. But we are certainly open to having opportunities to learn about the traditional ecological knowledge, and what sort of role that plays in terms of cultural significance? I mean as an anecdotal, I noted in this call, I tried. It was actually looked into studying the herring populations which you know in turn that support salmon populations. We are not really partnering with the tribe on that, so would be great if we could. But you know they tend to be a little bit more insular. And yeah. But you know, if the opportunity were to come up, we would certainly welcome the chance to, you know, partner with the tribe, and at the same time try and find ways that can enhance their knowledge, or, you know, maybe adapt our methods to collect information that you know, balance what they already know.

We don't we do not collect data on herring. So herring actually utilize different habitats than they have tests, at least survey. So we would only encounter herring eggs on an incidental basis. They're actually sub-tidal spawners versus the surf smelt and the sand lance, the 2 primary species that we surveyed for our intertidal spawners. So we almost actually, we have never found any herring eggs, but there is always the very remote possibility of having a small number occur in our locations.

Q8 - What sage advice would you give to someone who wants to start a CS project for the first time?

Yeah, I think that they're the main approach that I will take. If it were me is, I would do some investigation into looking at what sort of local or regional or national issues might be of interest, and from there, I would see what existing research has been conducted on it, and see if there's any information out there as far as knowledge gaps. And then from there, knowing what those knowledge gaps are, identifying professionals who are working on the issue and connecting with those professionals to find out what would be most useful.
And really working with those people to come up with a study design as opposed to necessarily trying to come up with something original or not that original, but just that.
A project can be invented in that way, you know. Just usually plenty of low-hanging fruit, or there's issues that have already been identified and they're just waiting for someone with time and resources to tackle it.

To be honest, I came into both of these projects after they had already been initiated, so I was not in at all involved in that process of deciding on implementation of these projects as citizen science research. So I can't really speak to that at all.