

Developing a Research Agenda for the Shellfish Beds Implementation Strategy

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1. INTRODUCTION

The University of Washington Puget Sound Institute (PSI) worked alongside the Shellfish Strategic Initiative Lead (Shellfish SIL) from the Washington State Department of Health (DOH) to develop a research and monitoring agenda to support the planning and implementation of [the Shellfish Beds Implementation Strategy](#). The goal of the Implementation Strategy (IS) is to restore and protect harvestable shellfish beds in Puget Sound by preventing and reducing pathogen pollution. The intent of this current exercise is to develop a research agenda to address key questions related to that overall goal. The Shellfish Beds Implementation Strategy lists five regional strategies to reach this goal; these were used as the basis for focusing the research agenda. They are:

- Fund, support, and implement sustainable local Pollution Identification and Correction (PIC) programs.
- Ensure and maintain sufficient livestock manure management.
- Implement and support on-site sewage system (OSS) management and repair programs.
- Prevent boaters' waste from entering Puget Sound.
- Implement wastewater treatment plant (WWTP) modifications that reduce precautionary closure zones adjacent to outfalls.

The results will be included in an update to the [Grand Uncertainties Matrix](#) (GUM) managed by PSI. The GUM is a curated list of uncertainties for each of the Implementation Strategies. Uncertainties are knowledge gaps or questions and are barriers to recovery. The resulting research agenda will be used to direct some PSI research activities, help inform future Puget Sound National Estuary Program investments, and focus program capacity within the Shellfish SIL program. Other researchers may also find that referencing a regionally vetted list of research needs may bolster grant applications.

2. METHODS

The development of the research and monitoring agenda requires multiple opportunities to screen and prioritize uncertainties. Figure 1 gives a simplified look at that process for the Shellfish SIL.

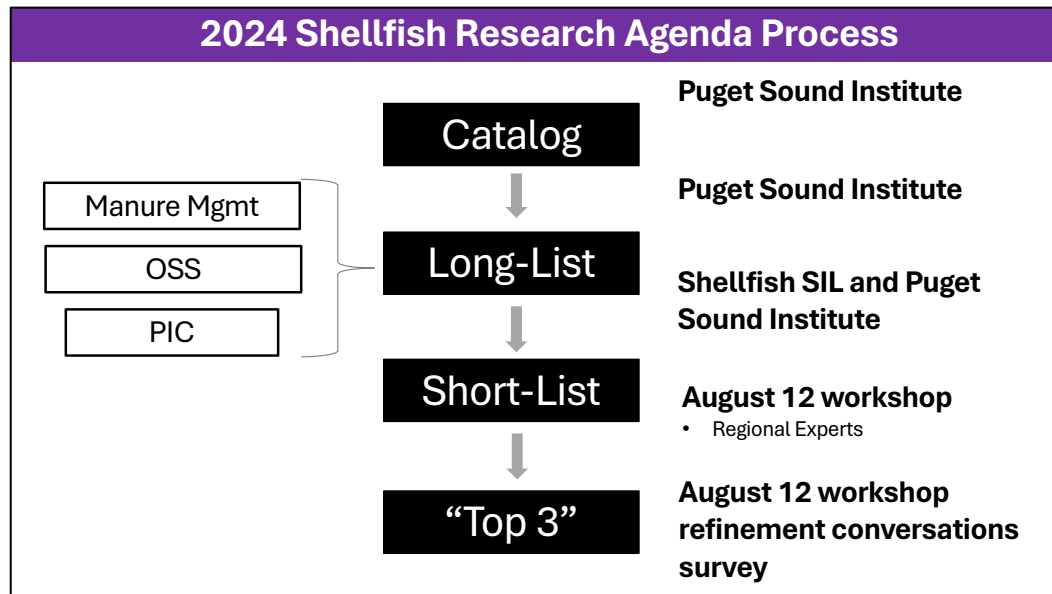


Figure 1. Screening and prioritization process for developing a research agenda for the Shellfish Beds Implementation Strategy. The uncertainties within the long list were categorized within three strategies of the Shellfish Beds Implementation Strategy: Manure Management, On-site Septic Systems (OSS), and Pollution Identification and Correction (PIC). Regional experts at an August 12th workshop included Shellfish Strategic Initiative Advisory Team members, subaward affiliates, work session participants, and other regional experts.

The research development process began with Shellfish SIL in March of 2024, when PSI proposed two overarching activities:

1. Compile potential research and monitoring needs from various sources to form a basis for subsequent prioritization efforts. This involved cataloging all Shellfish Beds IS-related research and monitoring uncertainties from regional sources, consolidating the catalog into a long list, and screening the long list with the Shellfish SIL to create a focused short list.
2. Engage stakeholders to review and refine the uncertainties, and to identify priorities. Shellfish SIL and PSI engaged with stakeholders initially at an August 12th workshop to start with identifying the Top 3 priorities from the short list.

From initial talks with the Shellfish SIL to a prioritized research final list, the research agenda process took over nine months. The full timeline is shown in Figure 2.

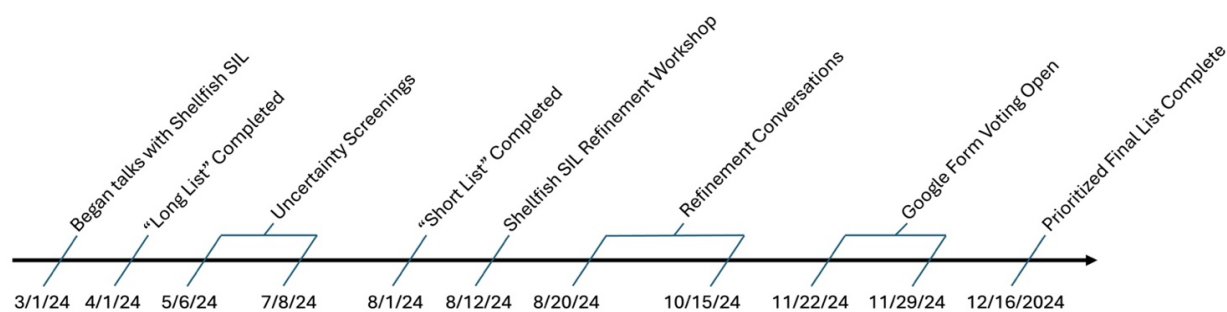


Figure 2. Shellfish Beds Implementation Strategy Research Agenda Development Timeline

2.1 CATALOG TO LONG LIST TO SHORT LIST

PSI reviewed workshop documents, research publications, and presentations (see Table 1) to catalog any new research uncertainties. After review, PSI compiled the catalog into an uncertainty long list ([Appendix A](#)) for Shellfish SIL. Over a series of multiple screenings, PSI and Shellfish SIL then sorted the long list down to 30 uncertainties, creating an uncertainty short list ([Appendix B](#)).

The screening process looked to remove known uncertainties, uncertainties unrelated to the implementation strategy, and redundant and / or replicate uncertainties. The screening process determined that the uncertainties within the short list fell under three of the five identified strategies: fund, support, and implement sustainable local PIC programs; ensure and maintain sufficient livestock manure management; and implement and support OSS management and repair programs.

List of Reviewed Products
Shellfish Strategic Initiative. 2023. Shellfish Beds Implementation Strategy Narrative. Washington State Department of Health. November 2023 Update. https://pugetsoundestuary.wa.gov/shellfish-beds/
Francis, T. and C.A. James. 2023. Puget Sound's Grand Uncertainties Matrix. Published May 2023. https://www.eopugetsound.org/articles/puget-sounds-grand-uncertainties-matrix
Ross Strategic and Stormwater SIL. 2023. Next Steps for Visioning the Future of Wastewater in Puget Sound: Onsite Sewage Systems (OSS) Workshop. 08.24.2023. https://pspwa.app.box.com/s/42s6l370eh06jb04zxfldetteh3g27ie
Puget Sound Partnership. 2022. 2022-2026 Action Agenda for Puget Sound. https://www.psp.wa.gov/2022AAupdate.php
Puget Sound Partnership. 2020. Priority Science to Support Puget Sound Recovery: A Science Work Plan for 2020-2024 (SWP for 2020-2024). December 2020. https://pspwa.app.box.com/s/e81y0ap941ntik8o0me8o1lo6v12act1
Pacific Shellfish Institute. 2015. West Coast Shellfish Research Goals 2015 Priorities. https://www.pacshell.org/pdf/2015.pdf

Table 1. Research products reviewed for Shellfish Beds Implementation Strategy uncertainty catalog.

2.2 SHORT LIST PRIORITIZATION IN VIRTUAL WORKSHOP

On August 12, 2024, the Shellfish SIL and PSI refined and prioritized the short list of 30 uncertainties with regional experts during a two-hour virtual workshop. A week prior to the workshop, the potential participants received an email of the short list uncertainties. Not

including hosts, there were 36 active participants on the day of the workshop including 24 County or State representatives. The goal of the workshop was to identify three or four high ranked (priority) uncertainties per strategy.

The workshop included three breakout rooms (one for each of the three strategies), each room had two moderators, and participants could attend two breakout rooms. Within both breakout rooms, participants could input new uncertainties and cast three votes for priority uncertainties. The workshop used the online platform EasyRetro for voting and participant feedback.

The workshop resulted in 17 new uncertainties added; voting occurred on the 30 original uncertainties plus the 17 added by participants ([Appendix C](#)). Additionally, moderators saved comments provided from participants ([Appendix D](#)). The EasyRetro platform remained open for a week after to allow for additional voting or comments. Figure 3 displays the final voting results on the 47 uncertainties from the workshop.

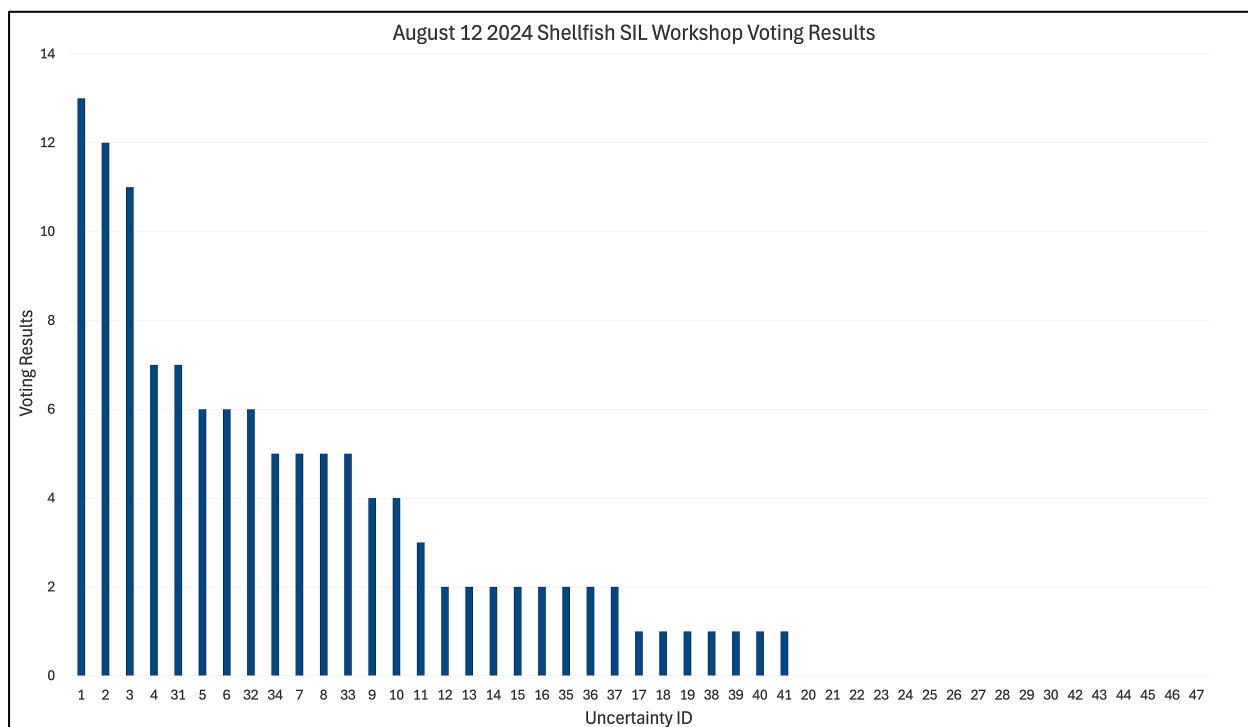


Figure 3. A summary of voting results from the August 12, 2024 Shellfish SIL workshop, which included 36 participants who voted on 47 Shellfish Beds Implementation Strategy uncertainties. The individual uncertainty IDs are included in Appendix C with voting results. Voting results on the uncertainties ranged from 0-13 votes. Participants were allowed to input 6 votes.

The voting results identified a total of 10 potential priority uncertainties, the three or four uncertainties with the most votes from each breakout room. Ultimately, PSI removed three low priority uncertainties from the workshop due to either lack of clarity or the uncertainty being a yes-or-no question.

2.3 REFINEMENT CONVERSATION

PSI conducted refinement conversations as a response to workshop participants' suggestions that the priority uncertainties needed further clarification and focus on their intent. Conversations took place between late-August and October 2024 with nine subject matter experts and resulted in minor-to-major changes to the uncertainties, including removal and additions. These conversations resulted in a list of 13 refined uncertainties. Notes and justifications for the changes can be read in [Appendix E](#). During this time, PSI began gathering research associated with each uncertainty to support refinement conversations and an annotated bibliography.

On November 22, 2024, PSI presented the list of 13 refined uncertainties back to the August 12th workshop attendees through a Google Form for a final round of voting. This second voting exercise helped to inform the attendees of the refined uncertainties and allowed the attendees an opportunity to provide feedback (see [Appendix F](#) for full results of the Google Form). The form received 15 responses. Upon suggestion from a Google Form respondent, PSI added one uncertainty to the list, however, this uncertainty will remain un-prioritized until a future effort. This uncertainty pertains to environmental justice which is a topic of interest for the SILs.

PSI shared initial uncertainty results to the Implementation Strategy Work Group in December 2024, in which one of the Shellfish uncertainties got flagged for further discussion. The uncertainty in question being:

"Where and how should new sewer connections and wastewater treatment be encouraged/required to support new development outside of Urban Growth Areas?"

To determine the best outcome for this uncertainty, PSI met with members from Shellfish SIL and held a SIL-wide meeting including members from the Stormwater SIL, Habitat SIL, and outside experts to discuss the merit of the uncertainty. Based on their feedback, the uncertainty in question was removed as the uncertainty suggested that sewer be used in unincorporated areas which goes against the Growth Management Act.

In April 2025, PSI received additional revisions from the Shellfish SIL and the DOH Shellfish Growing Team to the uncertainty list. Revisions included merging two uncertainties and minor edits to others; PSI revised this list based off this feedback.

2.4 PRIORITY LEVEL DESIGNATIONS

Each uncertainty received a final priority level designation based on results from the August 12th workshop and the November Google Form. Priority levels were: Top, High, Medium, Low or No Priority. The designations are defined as:

- Top: The top three uncertainties from the November Google Form that had undergone refinement.

- High: The uncertainties that had undergone refinement and received votes from the November Google Form but were not top three.
- Medium: The uncertainties that received 2-5 votes from the August 12th workshop and did not move forward to the refinement exercise.
- Low: The uncertainties that received 0-1 votes from the August 12th workshop and did not move forward to the refinement exercise.
- No priority: The uncertainty was added after the voting exercises took place and is not refined.

3. RESULTS

The result of this process is a prioritized research agenda for the Shellfish Beds IS. The research agenda contains a total of 45 uncertainties, the majority of which are Medium or Low priority. Uncertainty distribution is shown in Table 2, and the Top 3 uncertainties are listed in Table 3. The final list of uncertainties within the Shellfish Beds IS research agenda is displayed in [Appendix G](#).

Priority Level	Number of Uncertainties
Top	3
High	9
Medium	12
Low	20
No Priority	1

Table 2. Uncertainty Priority Level distribution between Top, High, Medium, Low, and No Priority.

Strategy	Question / Uncertainty	Source	Priority Level
Implement and support on-site sewage system (OSS) management and repair program	Where can aging OSS that cannot be repaired or reinstalled be replaced with alternative septic systems (Large OSS or wastewater treatment plants)?	2024 Scoping and Refinement Conversations	Top
Implement and support on-site sewage system (OSS) management and repair program	What's the range of potential costs to a) property owners and b) the government to relocate septic systems at risk from sea level rise vs. inaction?	Ross Strategic and Stormwater SIL (2023)	Top
Ensure and maintain sufficient livestock manure management	What elements of agriculture incentives from different counties are most effective at reducing fecal bacteria contamination? and what	GUM (Francis and James, 2023)	Top

	additional barriers could be addressed through incentives?		
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Table 3: Top 3 uncertainties for the Shellfish Beds Implementation Strategy.

4. LESSONS LEARNED

These lessons learned are derived from PSI experiences during the research agenda development process and may assist in future agenda-building exercises.

- There is reason to have more succinct /concise uncertainties rather than generalized uncertainties. Having a clear to-the-point research need offers clarity in where to guide future studies, and potentially reduces the timeframe needed to close that research gap. The process to create concise uncertainties from a general question should be completed throughout this research agenda development process. The result may be multiple uncertainties that stemmed from one broader uncertainty.
- There is continued debate on either to combine or split uncertainties that cover a similar topic. For the Shellfish SIL, uncertainties were largely split, with a preference of having multiple succinct uncertainties with similar topics rather than one larger uncertainty. There are instances of uncertainties that have additional questions that build upon the larger uncertainty; These should be kept together. The additional questions likely do not require a separate study but instead build out the main uncertainty. If there is an uncertainty with multiple questions, one approach would be to combine all of those that could be addressed in a single study. Those that required independent studies to answer, could be kept separate.
- It is helpful to prepare a refined list of uncertainties before conducting a group prioritization activity (in this case the August 12th workshop). This refinement step should involve experts and practitioners in addition to PSI and the SIL. The goal is to develop a more relevant and focused short list of uncertainties, which include detail and background so that participants can understand the purpose and context of the question. This will reduce confusion during the voting exercise and the need for a second round of voting. Small group (1+1) conversations with experts are useful for refining and focusing the uncertainties.
- There are trade-offs that come from hosting either a virtual or in-person engagement event for uncertainty prioritization. Virtual events are more accessible for participants; however, it is harder to engage within a virtual setting. In-person events allow for greater discussions which tend to lead to further insights about the uncertainties.
- It can be helpful for participants to have multiple opportunities to provide feedback, which will allow for increased engagement with the uncertainties. For this exercise, participants previewed the uncertainties before the August 12th workshop and could vote on an uncertainty up to a week after. In other parallel efforts to update SIL research agendas, PSI hung posters and passed-out handouts for participants to provide written notes, which they then returned at the end of the workshop.

- When conducting a voting exercise, it is recommended to place topically similar uncertainties near each other within the strategy groups (e.g. OSS, PIC, manure management). This was not done during the August 12th workshop, which made it more difficult for participants to compare similar uncertainties when casting votes and providing comments.
- It is recommended to allow for downvoting uncertainties. People appreciate the ability to supply all forms of feedback, including downvoting. In Shellfish SIL's virtual exercise, downvoting was not an option and it became a common ask.

5. NEXT STEPS

Next steps include completing an annotated bibliography for the Shellfish Beds IS top and high uncertainties and communicating research agenda findings. The annotated bibliography will identify information to be added to the GUM to document research progress on the uncertainties (in Research Notes column). Future communications will focus on spreading research agenda findings to the broader science and recovery communities. Communication tasks from PSI may include:

- Producing a research brief:
 - The 1-page brief will summarize the Shellfish research and monitoring agenda. This will be done in coordination with communication about new research agendas for other ISs. Outreach materials will be posted to the PSI website or Encyclopedia of Puget Sound and distributed via the PSI newsletter mailing list.
- Leading a targeted workshop and/or presentation, in coordination with Shellfish SIL, at existing forum to address a Top or High uncertainty. Topics could include:
 - What are the most accurate, feasible, and/or cost-effective test options to distinguish bacteria from wildlife, livestock, septic, pets, WWTP, boats, etc. Is it Microbial Source Tracking or is there a better method?
- Conducting a Critical Analysis on successful case studies of OSS communities transitioning to Large OSS (e.g., Port Gamble, LOTT, Packwood, Fall City, etc.). This would partially address a top-rated uncertainty:
 - Where can aging OSS that cannot be repaired or reinstalled be replaced with alternative septic systems (Large OSS or wastewater treatment plants)?

6. REFERENCES

Francis, T. and C. A. James. 2023. Puget Sound's Grand Uncertainties Matrix. Published May 2023. <https://www.eopugetsound.org/articles/puget-sounds-grand-uncertainties-matrix>

Pacific Shellfish Institute. 2015. West Coast Shellfish Research Goals 2015 Priorities. <https://www.pacshell.org/pdf/2015.pdf>

Puget Sound Partnership. 2020. Priority Science to Support Puget Sound Recovery: A Science Work Plan for 2020-2024 (SWP for 2020-2024). December 2020. <https://pspwa.app.box.com/s/e81y0ap941ntik8o0me8o1lo6v12act1>

Puget Sound Partnership. 2022. 2022-2026 Action Agenda for Puget Sound.
<https://www.psp.wa.gov/2022AAupdate.php>

Ross Strategic and Stormwater SIL. 2023. Next Steps for Visioning the Future of Wastewater in Puget Sound: Onsite Sewage Systems (OSS) Workshop. 08.24.2023.
<https://pspwa.app.box.com/s/42s6l370eh06jb04zxfdletteh3g27ie>

Shellfish Strategic Initiative. 2023. Shellfish Implementation Strategy Narrative. Washington State Department of Health. November 2023 Update.
<https://pugetsoundestuary.wa.gov/shellfish-beds/>

7. APPENDIX

APPENDIX A: ORIGINAL LONG LIST OF 63 UNCERTAINTIES PRESENTED TO SHELLFISH SIL

This table provides a list of uncertainties determined through an initial cataloging exercise. The column Uncertainty ID # references if the uncertainty moved forward during the screening process to the short list. During the screening process uncertainties could be edited, merged if similarly themed, split for precision, or removed based on redundancy with another uncertainty or irrelevance to the IS. Uncertainties that were subsequently merged are signified by a letter (a, b, c, ...) in the Uncertainty ID. For example, 1a, 1b, and 1c were merged to become one uncertainty, identified as 1 within the [Appendix B](#) table. If an uncertainty was split the Uncertainty ID column includes a "/" indicating the final IDs in the short list. An X signifies that the uncertainty was removed before the short list. IS Strategy refers to where the uncertainty lands under one of the five strategies within the Shellfish Beds Implementation Strategy Narrative (Shellfish Strategic Initiative 2023).

Uncertainty ID #	IS Strategy	Original Question / Uncertainty	Source
1a	Ensure and maintain sufficient livestock manure management	What variance exists in terms of BMPs specified, implementation, and effectiveness, between dairy nutrient management plans, non-dairy farm plans, and hobby farm plans?	Shellfish Strategic Initiative (2023)
1b	Ensure and maintain sufficient livestock manure management	What is the effectiveness of farm plans in reducing nutrient and pathogen loads?	Shellfish Strategic Initiative (2023)
1c	Ensure and maintain sufficient livestock manure management	What are the rates of compliance/implementation of the farm plans?	Shellfish Strategic Initiative (2023)

Uncertainty ID #	IS Strategy	Original Question / Uncertainty	Source
2a	Implement sustainable local Pollution Identification and Correction (PIC) programs	How successful have PIC programs been at improving water quality?	PSP (2020)
2b	Implement sustainable local Pollution Identification and Correction (PIC) programs	Monitor to evaluate the effectiveness of local pollution control approaches, such as pollution identification and control (PIC) programs, regulatory programs, watershed improvement districts, and loan and grant programs	PSP (2020)
2c	Implement sustainable local Pollution Identification and Correction (PIC) programs	re: Stewardship, PIC programs, and Shellfish Protection Districts -- how can compliance, cooperation, and access be improved?	PSP (2020)

Uncertainty ID #	IS Strategy	Original Question / Uncertainty	Source
3 /9	Ensure and maintain sufficient livestock manure management / Implement and support on-site sewage system (OSS) management and repair program	Do incentives work? Which incentives work best? (Goal is voluntary compliance)	GUM (Francis and James, 2023)
4	Implement and support on-site sewage system (OSS) management and repair program	New solutions are needed to facilitate LOSS, community OSS, and other options as OSS face SLR with no reserve location.	Ross Strategic and Stormwater SIL (2023)
5a	Ensure and maintain sufficient livestock manure management	Are BMPs in the farm plans adequate to address pollution if they are implemented?	Shellfish Strategic Initiative (2023)
5b	Ensure and maintain sufficient livestock manure management	What are the best manure practices?	Shellfish Strategic Initiative (2023)

Uncertainty ID #	IS Strategy	Original Question / Uncertainty	Source
5c	Ensure and maintain sufficient livestock manure management	What is the effectiveness of farm plans in reducing nutrient and pathogen loads?	Shellfish Strategic Initiative (2023)
6	Implement sustainable local Pollution Identification and Correction (PIC) programs	What is the effectiveness of Microbial Source Tracking to distinguish bacteria from wildlife, livestock, septic, pets, WWTP, boats (What is the wildlife contribution to fecal coliform contamination? What are the hurdles to existing methods and realistic expectations of effectiveness?	GUM (Francis and James, 2023)
7a	Implement and support on-site sewage system (OSS) management and repair program	Identify funding avenues for LOSS, especially in shoreline areas with shellfish closures or threatened areas.	Ross Strategic and Stormwater SIL (2023)
7b	Implement and support on-site sewage system (OSS) management and repair program	Maybe at the development or neighborhood level - is LOSS something that developers could install in common green spaces? Not install at the UGA scale?	Ross Strategic and Stormwater SIL (2023)

Uncertainty ID #	IS Strategy	Original Question / Uncertainty	Source
7c	Implement and support on-site sewage system (OSS) management and repair program	Evaluate regulations for LOSS vs. OSS. What's the right size, benefits, cost analysis that demonstrate that they're; the best solutions.	Ross Strategic and Stormwater SIL (2023)
8	Implement sustainable local Pollution Identification and Correction (PIC) programs	Assessment of fecal coliform survival/proliferation in aquatic sediments	GUM (Francis and James, 2023)
10	Implement sustainable local Pollution Identification and Correction (PIC) programs	What can models offer about processes affecting nutrient and bacterial circulation and dilution and causes of recurrent de-classification of growing areas. Could modeling help to understand closures? Would modeling be affordable and informative??	GUM (Francis and James, 2023)
11	Implement and support on-site sewage system (OSS) management and repair program	Research alternatives to OSS altogether	Ross Strategic and Stormwater SIL (2023)

Uncertainty ID #	IS Strategy	Original Question / Uncertainty	Source
12	Ensure and maintain sufficient livestock manure management	What factors influence statutory access to agricultural properties for pollution monitoring purposes? How do they exert that influence?	GUM (Francis and James, 2023)
13a	Implement and support on-site sewage system (OSS) management and repair program	Evaluate whether WWTP outfalls could be replaced with a LOSS to improve wastewater management efficiency.	Ross Strategic and Stormwater SIL (2023)
13b	Implement and support on-site sewage system (OSS) management and repair program	Research on septic values would be beneficial to evaluating whether WWTP outfalls could be replaced with a LOSS	Ross Strategic and Stormwater SIL (2023)
14	Implement and support on-site sewage system (OSS) management and repair program	What do agencies and jurisdictions actually practice regarding enforcement, what prevents them from exercising their enforcement authority, and do they even need to do so.	GUM (Francis and James, 2023)

Uncertainty ID #	IS Strategy	Original Question / Uncertainty	Source
15a	Implement and support on-site sewage system (OSS) management and repair program	What is the effectiveness of the On-site Sewage System (OSS) loan program?	Shellfish Strategic Initiative (2023)
15b	Implement and support on-site sewage system (OSS) management and repair program	Does the OSS loan program increase compliance?	Shellfish Strategic Initiative (2023)
15c	Implement and support on-site sewage system (OSS) management and repair program	Below what septic inspection compliance rate should a loan program become recommended?	Shellfish Strategic Initiative (2023)
15d	Implement and support on-site sewage system (OSS) management and repair program	At what lower septic failure rate does the loan program become necessary?	Shellfish Strategic Initiative (2023)

Uncertainty ID #	IS Strategy	Original Question / Uncertainty	Source
16	Implement and support on-site sewage system (OSS) management and repair program	What factors influence voluntary access to residential properties for small onsite sewage system monitoring purposes? How do they exert that influence?	GUM (Francis and James, 2023)
19	Implement sustainable local Pollution Identification and Correction (PIC) programs	Is the major issue nutrients? Or fecal coliform and other issues affecting shellfish bed in public health?	Ross Strategic and Stormwater SIL (2023)
20	Implement sustainable local Pollution Identification and Correction (PIC) programs	What is the scope and scale of third-party manure application (sources and amounts)? What is the contribution of manure application to the problem?	GUM (Francis and James, 2023)
21	Ensure and maintain sufficient livestock manure management	Quantitatively document environmental and economic impact and contribution of shellfish aquaculture.	GUM (Francis and James, 2023)

Uncertainty ID #	IS Strategy	Original Question / Uncertainty	Source
22	Implement and support on-site sewage system (OSS) management and repair program	Can modeling help us begin to define a strategy for management wastewater treatment plant outfalls?	Shellfish Strategic Initiative (2023)
23	Implement and support on-site sewage system (OSS) management and repair program	identify gaps in residential OSS management support	Ross Strategic and Stormwater SIL (2023)
24	Implement and support on-site sewage system (OSS) management and repair program	research gap: identify and pilot tracing of failed septic systems	Ross Strategic and Stormwater SIL (2023)
25a	Implement and support on-site sewage system (OSS) management and repair program	Carry out pilot studies on long-term performance and maintenance needs for OSS technologies with improved nutrient treatment capabilities	Ross Strategic and Stormwater SIL (2023)

Uncertainty ID #	IS Strategy	Original Question / Uncertainty	Source
25b	Implement and support on-site sewage system (OSS) management and repair program	research and pilot onsite systems that can facilitate nutrient removal	Ross Strategic and Stormwater SIL (2023)
26a	Implement and support on-site sewage system (OSS) management and repair program	Further identify priority areas, and quantify OSS inputs to marine waters areas for those, where there is the highest impact potential to either nutrients vs FC to shellfish/ beach closures	Ross Strategic and Stormwater SIL (2023)
26b	Implement and support on-site sewage system (OSS) management and repair program	unclear how much OSS professionals use comp plans to set density limits on OSS installations within CAOs. WAC 246-272A.	Ross Strategic and Stormwater SIL (2023)
27	Implement and support on-site sewage system (OSS) management and repair program	What factors influence statutory access to residential properties for small onsite sewage system monitoring purposes? How do they exert that influence?	GUM (Francis and James, 2023)

Uncertainty ID #	IS Strategy	Original Question / Uncertainty	Source
28a	Implement and support on-site sewage system (OSS) management and repair program	Discover, map, and record old OSS systems	Ross Strategic and Stormwater SIL (2023)
28b	Implement and support on-site sewage system (OSS) management and repair program	Ensure consistent OSS monitoring programs between LHJs for uniform oversight and data collection. Is there a good monitoring procedure that is easily accessed?	Ross Strategic and Stormwater SIL (2023)
28c	Implement and support on-site sewage system (OSS) management and repair program	Assist LHJs in developing robust Operation & Maintenance (O&M) programs for OSS	Ross Strategic and Stormwater SIL (2023)
29	PIC	What is the extent and impact of ocean acidification on shellfish?	GUM (Francis and James, 2023)
30	PIC	What are the dynamics of domoic acid accumulation in all bivalve shellfish species?	GUM (Francis and James, 2023)

Uncertainty ID #	IS Strategy	Original Question / Uncertainty	Source
X	Implement and support on-site sewage system (OSS) management and repair program	Increase awareness and adoption of best management practices articulated at the state level to homogenize and elevate OSS installation, operation, and maintenance standards.	Ross Strategic and Stormwater SIL (2023)
X	Implement and support on-site sewage system (OSS) management and repair program	Explore funding sources for abating on-site sewage systems or provide direct funding for maintaining.	Ross Strategic and Stormwater SIL (2023)
X	Implement and support on-site sewage system (OSS) management and repair program	Conduct research on the filtration levels achievable by LOSS and various OSS technologies.	Ross Strategic and Stormwater SIL (2023)
X	Implement and support on-site sewage system (OSS) management and repair program	Mycelium treatment should be explored	Ross Strategic and Stormwater SIL (2023)

Uncertainty ID #	IS Strategy	Original Question / Uncertainty	Source
X	Implement and support on-site sewage system (OSS) management and repair program	There are treatment technologies that can achieve reclaimed water standards in areas where a conventional OSS is not feasible, but current WAC language doesn't support the concept.	Ross Strategic and Stormwater SIL (2023)
X	Implement and support on-site sewage system (OSS) management and repair program	Evaluate pressure distribution systems for nitrogen reduction by soil type as denitrification occurs in non-sandy type soils	Ross Strategic and Stormwater SIL (2023)
X	Implement and support on-site sewage system (OSS) management and repair program	Common question in King County - would be great to understand the ability for pressure distribution systems to facilitate nutrient removal, there's a lack of understanding of how they work in the long-run.	Ross Strategic and Stormwater SIL (2023)
X	Implement and support on-site sewage system (OSS) management and repair program	Is there info on the relative contribution of OSS to nutrient issues of concern?	Ross Strategic and Stormwater SIL (2023)

Uncertainty ID #	IS Strategy	Original Question / Uncertainty	Source
X	Implement and support on-site sewage system (OSS) management and repair program	Adding to pilot studies - looking at areas of concern for nutrient loading and fecal coliform, pollution related to tribal harvest areas and shellfish beds.	Ross Strategic and Stormwater SIL (2023)
X	Implement and support on-site sewage system (OSS) management and repair program	From MWQ implementation strategy and what's important for nutrient issues, it got prioritized that we need to better understand the potential inputs of OSS for specific areas. If we were to put a recommendation, it's about in the places where there could be an impact and that should be quantified in the modeling work. It's much more important for beach closures and shellfish to address local effects.	Ross Strategic and Stormwater SIL (2023)
X	Implement and support on-site sewage system (OSS) management and repair program	Social marketing studies, determine what's effective	Ross Strategic and Stormwater SIL (2023)
X	Implement and support on-site sewage system (OSS) management and repair program	Establish criteria to determine where OSS should and should not be installed considering factors like critical areas, soil type and sediment behavior across different jurisdictions. Alt language "establish ordinance to require additional BMPs for new OSS or OSS repair installations in..."	Ross Strategic and Stormwater SIL (2023)

Uncertainty ID #	IS Strategy	Original Question / Uncertainty	Source
X	Implement and support on-site sewage system (OSS) management and repair program	Develop a statewide OSS Best Management Practices Program to standardize and improve OSS installation, operation, and maintenance.	Ross Strategic and Stormwater SIL (2023)
X	Implement and support on-site sewage system (OSS) management and repair program	establish statewide MRA designation, not locally controlled	Ross Strategic and Stormwater SIL (2023)
X	Implement and support on-site sewage system (OSS) management and repair program	How does self-monitoring of program effectiveness by local programs compare to monitoring by external agencies, with respect to: i. Accuracy of reported metrics? ii. Applicability of reported metrics? iii. Self-reporting bias? iv. Local agency compliance with state and federal mandates? v. Local agency effectiveness at meeting external goals? vi. How does external monitoring of local programs influence program effectiveness? vii. What combinations of self-monitoring and external monitoring tend to yield the highest confidence in results and performance? How replicable are those combinations?	Shellfish Strategic Initiative (2023)

Uncertainty ID #	IS Strategy	Original Question / Uncertainty	Source
X	Implement sustainable local Pollution Identification and Correction (PIC) programs	Are non-fecal bacteria an issue of concern in Whatcom Co.? What is the contribution of false positives to total coliform results?	PSP (2020)
X	Implement sustainable local Pollution Identification and Correction (PIC) programs	Viruses: how important are they? Are they effective markers? WWTP are proposing changing to monitoring male-specific coliphage as a better indicator of Hepatitis and Norovirus. Are viruses more effective markers? Do they survive longer? Should rules change to focus on viruses? [Mark Toy comparing Puget Sound to remainder of US.]	GUM (Francis and James, 2023)
X	Implement sustainable local Pollution Identification and Correction (PIC) programs	What other bacteria testing options could be effective and more cost effective?	Shellfish Strategic Initiative (2023)
X	Implement sustainable local Pollution Identification and Correction (PIC) programs	Do male specific coliphages provide a more accurate indicator of pathogenic viruses in wastewater?	Shellfish Strategic Initiative (2023)

Uncertainty ID #	IS Strategy	Original Question / Uncertainty	Source
X	Implement sustainable local Pollution Identification and Correction (PIC) programs	What proportion of “positive” tests are due to non-fecal coliform bacteria?	Shellfish Strategic Initiative (2023)

APPENDIX B: SHORT LIST OF 30 POST-SCREENING UNCERTAINTIES

This table provides the short list of uncertainties, resulting from the screening of the long list. The Uncertainty ID # column refers to numbering used in the long list. PSI and Shellfish SIL used the short list uncertainties for the August 12th workshop. The IS Strategy column refers to where the uncertainty lands under one of the five strategies within the Shellfish Beds Implementation Strategy Narrative (Shellfish Strategic Initiative 2023).

Uncertainty ID #	IS Strategy	Revised Question / Uncertainty	Source
1	Ensure and maintain sufficient livestock manure management	How effective are farm plans for dairy, non-dairy, and hobby farms at reducing fecal bacteria pollution to shellfish beds? - What is the current rate of compliance/implementation of farm plans? - What are the gaps and barriers? -What is working well?	Shellfish Strategic Initiative (2023)
2	Implement sustainable local Pollution Identification and Correction (PIC) programs	How effective are PIC programs at reducing fecal bacteria contamination to shellfish beds? What are the barriers to successful implementation? Are certain enabling conditions needed? Are there specific aspects of PIC programs regulatory programs, watershed improvement districts, Shellfish Protection Districts, and loan and grant programs) that are particularly effective? or could be improved?	PSP (2020)
3	Ensure and maintain sufficient livestock manure management	What elements of agriculture incentives from different counties are most effective at reducing fecal bacteria contamination? and what additional barriers could be addressed through incentives?	GUM (Francis and James, 2023)

Uncertainty ID #	IS Strategy	Revised Question / Uncertainty	Source
4	Implement and support on-site sewage system (OSS) management and repair program	How and where will sea level rise impact the functionality of OSSs? What solutions are available/needed to mitigate these impacts? (LOSS, other).	Ross Strategic and Stormwater SIL (2023)
5	Ensure and maintain sufficient livestock manure management	How effective are the manure best management practices at reducing fecal bacteria pollution to surface water? to ground water? Are there gaps in the BMPs available and clarity of outreach so that potential sources/pathways are not being effectively addressed. What BMPs are working well?	Shellfish Strategic Initiative (2023)
6	Implement sustainable local Pollution Identification and Correction (PIC) programs	What are the most accurate, feasible, and/or cost effective test options to distinguish bacteria from wildlife, livestock, septic, pets, WWTP, boats, etc. , Is it Microbial Source Tracking or is there a better method? - What proportion of “positive” tests are due to non-fecal coliform bacteria? -What are the hurdles to existing methods and realistic expectations of effectiveness?	GUM (Francis and James, 2023)
7	Implement and support on-site sewage system (OSS) management and repair program	Where can Large OSSs (LOSS) be implemented in place of individual OSSs? or as alternatives to WWTPs? Consider the regulatory context, treatment levels, proximity to shellfish beds, etc.	Ross Strategic and Stormwater SIL (2023)

Uncertainty ID #	IS Strategy	Revised Question / Uncertainty	Source
8	Implement sustainable local Pollution Identification and Correction (PIC) programs	What is the likelihood and impact of fecal bacteria survival and regrowth in soils, marine sediment and stagnant water? What conditions lead to regrowth?	GUM (Francis and James, 2023)
9	Implement and support on-site sewage system (OSS) management and repair program	What elements of OSS incentives from different counties are most effective at reducing fecal bacteria contamination? and what additional barriers could be addressed through incentives?	GUM (Francis and James, 2023)
10	Implement sustainable local Pollution Identification and Correction (PIC) programs	What specifically needs to be understood about circulation and dilution to support work in areas with recurrent de-classification of growing areas (e.g., identify potential sources, determine appropriate precautionary exclusion zones, etc.)?	GUM (Francis and James, 2023)
11	Implement and support on-site sewage system (OSS) management and repair program	What are feasible alternatives to OSS for the Puget Sound region?	Ross Strategic and Stormwater SIL (2023)

Uncertainty ID #	IS Strategy	Revised Question / Uncertainty	Source
12	Ensure and maintain sufficient livestock manure management	What factors influence statutory and voluntary access for site visits and pollution monitoring purposes on agricultural properties? Are there different barriers for different activities (e.g., general site visit vs. monitoring)?	GUM (Francis and James, 2023)
13	Implement and support on-site sewage system (OSS) management and repair program	Are there opportunities for land application/infiltration of WWTP effluent, to eliminate precautionary exclusion zones around existing outfalls, and gain shellfish acreage?	Ross Strategic and Stormwater SIL (2023)
14	Implement and support on-site sewage system (OSS) management and repair program	In terms of OSS operation and management: What enforcement activities will most likely lead to correction of failures? What are the best practices for messaging to support enforcement? How should this message change for different audiences?	GUM (Francis and James, 2023)
15	Implement and support on-site sewage system (OSS) management and repair program	How effective are OSS loan and financial assistance programs at facilitating the replacement of OSSs? How well are they serving over-burdened communities? If not, are there modifications which would increase their utilization?	Shellfish Strategic Initiative (2023)

Uncertainty ID #	IS Strategy	Revised Question / Uncertainty	Source
16	Implement sustainable local Pollution Identification and Correction (PIC) programs	What factors influence statutory and voluntary access for site visits and pollution monitoring purposes properties within PIC areas? Are there different barriers for different activities (e.g., general site visit vs. monitoring)?	GUM (Francis and James, 2023)
17	Ensure and maintain sufficient livestock manure management	Do legacy manure storage areas/piles contribute to pathogenic bacteria pollution? How are counties approaching legacy manure management?	Shellfish SIL Discussion
18	Ensure and maintain sufficient livestock manure management	How much do V-ditch field drains contribute to fecal bacteria pollution?	Shellfish SIL Discussion
19	Implement sustainable local Pollution Identification and Correction (PIC) programs	What is the intersection between nutrients and fecal coliform, in respect to PIC programs? Are PIC programs an effective means of achieving nutrient reduction?	Ross Strategic and Stormwater SIL (2023)
20	Ensure and maintain sufficient livestock manure management	Does manure handling and application contribute to fecal bacteria contamination to surface and groundwater?	GUM (Francis and James, 2023)

Uncertainty ID #	IS Strategy	Revised Question / Uncertainty	Source
21	Ensure and maintain sufficient livestock manure management	what is the environmental and economic impact of shellfish aquaculture?	GUM (Francis and James, 2023)
22	Implement and support on-site sewage system (OSS) management and repair program	Can modeling contribute to a strategy for managing wastewater treatment plant outfalls?	Shellfish Strategic Initiative (2023)
23	Implement and support on-site sewage system (OSS) management and repair program	Where are there gaps in OSS management support? Does the support differ between communities/jurisdictions? Are there best practices?	Ross Strategic and Stormwater SIL (2023)
24	Implement and support on-site sewage system (OSS) management and repair program	What are the strengths/weaknesses of different monitoring tools in terms of identifying failing OSSs? What are the barriers in terms of access, regulation, etc. to effective monitoring?	Ross Strategic and Stormwater SIL (2023)

Uncertainty ID #	IS Strategy	Revised Question / Uncertainty	Source
25	Implement and support on-site sewage system (OSS) management and repair program	What is the long-term performance of OSSs with advanced nutrient removal? What are the maintenance requirements? What is their effectiveness against fecal bacteria?	Ross Strategic and Stormwater SIL (2023)
26	Implement and support on-site sewage system (OSS) management and repair program	Are new OSS being installed in unsuitable locations that will impact shellfish growing areas, including areas projected to be impacted by sea level rise? Are the appropriate checks in place to limit this?	Ross Strategic and Stormwater SIL (2023)
27	Implement and support on-site sewage system (OSS) management and repair program	What factors influence statutory and voluntary access for site visits and pollution monitoring purposes on properties with OSSs? Are there different barriers for different activities (e.g., general site visit vs. monitoring)?	GUM (Francis and James, 2023)
28	Implement and support on-site sewage system (OSS) management and repair program	How can DOH and local health jurisdictions (LHJs) better support data management and mapping of OSS systems? What sort of data management and mapping programs for OSS are in place and is there consistency between LHJs? How can consistency be improved?	Ross Strategic and Stormwater SIL (2023)

Uncertainty ID #	IS Strategy	Revised Question / Uncertainty	Source
29	Implement sustainable local Pollution Identification and Correction (PIC) programs	What are the current/future impacts of ocean acidification on shellfish? Are there areas/habitats that are particularly vulnerable? What are mitigation measures?	GUM (Francis and James, 2023)
30	Implement sustainable local Pollution Identification and Correction (PIC) programs	What are the dynamics of domoic acid accumulation in bivalves? Will climate change increase the frequency/magnitude of HABs events? What are management actions?	GUM (Francis and James, 2023)

APPENDIX C: VOTING RESULTS FROM AUGUST 12, 2024 SHELLFISH SIL WORKSHOP

This table lists voting results from the August 12th workshop for the 30 short list uncertainties plus 17 new uncertainties added by participants. Uncertainties IDs 1-30 are from the short list ([Appendix B](#)); new uncertainties have Uncertainty IDs 31-47. IS Strategy refers to where the uncertainty lands under one of the five strategies within the Shellfish Beds Implementation Strategy Narrative (Shellfish Strategic Initiative 2023). A “*” in the voting results column denotes an uncertainty that moved forward to the refinement exercise.

Uncertainty ID #	IS Strategy	Question / Uncertainty	Source	Voting Results
1	Ensure and maintain sufficient livestock manure management	How effective are farm plans for dairy, non-dairy, and hobby farms at reducing fecal bacteria pollution to shellfish beds? - What is the current rate of compliance/implementation of farm plans? - What are the gaps and barriers? -What is working well?	Shellfish Strategic Initiative (2023)	13*
2	Implement sustainable local Pollution Identification and Correction (PIC) programs	How effective are PIC programs at reducing fecal bacteria contamination to shellfish beds? What are the barriers to successful implementation? Are certain enabling conditions needed? Are there specific aspects of PIC programs regulatory programs, watershed improvement districts, Shellfish Protection Districts, and loan and grant programs) that are particularly effective? or could be improved?	PSP (2020)	12*
3	Ensure and maintain sufficient livestock manure management	What elements of agriculture incentives from different counties are most effective at reducing fecal bacteria contamination? and what additional barriers could be addressed through incentives?	GUM (Francis and James, 2023)	11*

Uncertainty ID #	IS Strategy	Question / Uncertainty	Source	Voting Results
4	Implement and support on-site sewage system (OSS) management and repair program	How and where will sea level rise impact the functionality of OSSs? What solutions are available/needed to mitigate these impacts? (LOSS, other).	Ross Strategic and Stormwater SIL (2023)	7*
5	Ensure and maintain sufficient livestock manure management	How effective are the manure best management practices at reducing fecal bacteria pollution to surface water? to ground water? Are there gaps in the BMPs available and clarity of outreach so that potential sources/pathways are not being effectively addressed. What BMPs are working well?	Shellfish Strategic Initiative (2023)	6*
6	Implement sustainable local Pollution Identification and Correction (PIC) programs	What are the most accurate, feasible, and/or cost effective test options to distinguish bacteria from wildlife, livestock, septic, pets, WWTP, boats, etc., Is it Microbial Source Tracking or is there a better method? - What proportion of “positive” tests are due to non-fecal coliform bacteria? -What are the hurdles to existing methods and realistic expectations of effectiveness?	GUM (Francis and James, 2023)	6*
7	Implement and support on-site sewage system (OSS) management and repair program	Where can Large OSSs (LOSS) be implemented in place of individual OSSs? or as alternatives to WWTPs? Consider the regulatory context, treatment levels, proximity to shellfish beds, etc.	Ross Strategic and Stormwater SIL (2023)	5*

Uncertainty ID #	IS Strategy	Question / Uncertainty	Source	Voting Results
8	Implement sustainable local Pollution Identification and Correction (PIC) programs	What is the likelihood and impact of fecal bacteria survival and regrowth in soils, marine sediment and stagnant water? What conditions lead to regrowth?	GUM (Francis and James, 2023)	5
9	Implement and support on-site sewage system (OSS) management and repair program	What elements of OSS incentives from different counties are most effective at reducing fecal bacteria contamination? and what additional barriers could be addressed through incentives?	GUM (Francis and James, 2023)	4
10	Implement sustainable local Pollution Identification and Correction (PIC) programs	What specifically needs to be understood about circulation and dilution to support work in areas with recurrent de-classification of growing areas (e.g., identify potential sources, determine appropriate precautionary exclusion zones, etc.)?	GUM (Francis and James, 2023)	4
11	Implement and support on-site sewage system (OSS) management and repair program	What are feasible alternatives to OSS for the Puget Sound region?	Ross Strategic and Stormwater SIL (2023)	3

Uncertainty ID #	IS Strategy	Question / Uncertainty	Source	Voting Results
12	Ensure and maintain sufficient livestock manure management	What factors influence statutory and voluntary access for site visits and pollution monitoring purposes on agricultural properties? Are there different barriers for different activities (e.g., general site visit vs. monitoring)?	GUM (Francis and James, 2023)	2
13	Implement and support on-site sewage system (OSS) management and repair program	Are there opportunities for land application/infiltration of WWTP effluent, to eliminate precautionary exclusion zones around existing outfalls, and gain shellfish acreage?	Ross Strategic and Stormwater SIL (2023)	2
14	Implement and support on-site sewage system (OSS) management and repair program	In terms of OSS operation and management: What enforcement activities will most likely lead to correction of failures? What are the best practices for messaging to support enforcement? How should this message change for different audiences?	GUM (Francis and James, 2023)	2
15	Implement and support on-site sewage system (OSS) management and repair program	How effective are OSS loan and financial assistance programs at facilitating the replacement of OSSs? How well are they serving over-burdened communities? If not, are there modifications which would increase their utilization?	Shellfish Strategic Initiative (2023)	2

Uncertainty ID #	IS Strategy	Question / Uncertainty	Source	Voting Results
16	Implement sustainable local Pollution Identification and Correction (PIC) programs	What factors influence statutory and voluntary access for site visits and pollution monitoring purposes properties within PIC areas? Are there different barriers for different activities (e.g., general site visit vs. monitoring)?	GUM (Francis and James, 2023)	2
17	Ensure and maintain sufficient livestock manure management	Do legacy manure storage areas/piles contribute to pathogenic bacteria pollution? How are counties approaching legacy manure management?	Shellfish SIL Discussion	1
18	Ensure and maintain sufficient livestock manure management	How much do V-ditch field drains contribute to fecal bacteria pollution?	Shellfish SIL Discussion	1
19	Implement sustainable local Pollution Identification and Correction (PIC) programs	What is the intersection between nutrients and fecal coliform, in respect to PIC programs? Are PIC programs an effective means of achieving nutrient reduction?	Ross Strategic and Stormwater SIL (2023)	1
20	Ensure and maintain sufficient livestock manure management	Does manure handling and application contribute to fecal bacteria contamination to surface and groundwater?	GUM (Francis and James, 2023)	0

Uncertainty ID #	IS Strategy	Question / Uncertainty	Source	Voting Results
21	Ensure and maintain sufficient livestock manure management	what is the environmental and economic impact of shellfish aquaculture?	GUM (Francis and James, 2023)	0
22	Implement and support on-site sewage system (OSS) management and repair program	Can modeling contribute to a strategy for managing wastewater treatment plant outfalls?	Shellfish Strategic Initiative (2023)	0
23	Implement and support on-site sewage system (OSS) management and repair program	Where are there gaps in OSS management support? Does the support differ between communities/jurisdictions? Are there best practices?	Ross Strategic and Stormwater SIL (2023)	0
24	Implement and support on-site sewage system (OSS) management and repair program	What are the strengths/weaknesses of different monitoring tools in terms of identifying failing OSSs? What are the barriers in terms of access, regulation, etc. to effective monitoring?	Ross Strategic and Stormwater SIL (2023)	0

Uncertainty ID #	IS Strategy	Question / Uncertainty	Source	Voting Results
25	Implement and support on-site sewage system (OSS) management and repair program	What is the long-term performance of OSSs with advanced nutrient removal? What are the maintenance requirements? What is their effectiveness against fecal bacteria?	Ross Strategic and Stormwater SIL (2023)	0
26	Implement and support on-site sewage system (OSS) management and repair program	Are new OSS being installed in unsuitable locations that will impact shellfish growing areas, including areas projected to be impacted by sea level rise? Are the appropriate checks in place to limit this?	Ross Strategic and Stormwater SIL (2023)	0
27	Implement and support on-site sewage system (OSS) management and repair program	What factors influence statutory and voluntary access for site visits and pollution monitoring purposes on properties with OSSs? Are there different barriers for different activities (e.g., general site visit vs. monitoring)?	GUM (Francis and James, 2023)	0
28	Implement and support on-site sewage system (OSS) management and repair program	How can DOH and local health jurisdictions (LHJs) better support data management and mapping of OSS systems? What sort of data management and mapping programs for OSS are in place and is there consistency between LHJs? How can consistency be improved?	Ross Strategic and Stormwater SIL (2023)	0

Uncertainty ID #	IS Strategy	Question / Uncertainty	Source	Voting Results
29	Implement sustainable local Pollution Identification and Correction (PIC) programs	What are the current/future impacts of ocean acidification on shellfish? Are there areas/habitats that are particularly vulnerable? What are mitigation measures?	GUM (Francis and James, 2023)	0
30	Implement sustainable local Pollution Identification and Correction (PIC) programs	What are the dynamics of domoic acid accumulation in bivalves? Will climate change increase the frequency/magnitude of HABs events? What are management actions?	GUM (Francis and James, 2023)	0
31	Implement sustainable local Pollution Identification and Correction (PIC) programs	(NEW) Can Stormwater / NPDES programs be leveraged to support PIC programs?	08.12.24 Shellfish SIL Uncertainty Workshop	7*
32	Ensure and maintain sufficient livestock manure management	(NEW) Planning for and adapting farm and livestock practice to address the impacts of climate change (i.e. increased frequency of flooding, significant rainfall events).	08.12.24 Shellfish SIL Uncertainty Workshop	6*

Uncertainty ID #	IS Strategy	Question / Uncertainty	Source	Voting Results
33	Implement and support on-site sewage system (OSS) management and repair program	(NEW) What are the disposal options for treating septage from OSS, RVs, vessels and other sources of septage (homeless, pet waste, etc.)? Are there entities already addressing these needs?	08.12.24 Shellfish SIL Uncertainty Workshop	5*
34	Implement sustainable local Pollution Identification and Correction (PIC) programs	(NEW) Real time bacteria monitoring/automated bacteria sampling to get results faster, what works. Barriers include funding	08.12.24 Shellfish SIL Uncertainty Workshop	5
35	Implement sustainable local Pollution Identification and Correction (PIC) programs	(NEW) what's the efficacy of different types of riparian buffers to reduce fecal pollution impacts?	08.12.24 Shellfish SIL Uncertainty Workshop	2
36	Implement sustainable local Pollution Identification and Correction (PIC) programs	(NEW) What are the bacteria reduction capabilities of traditional stormwater facilities?	08.12.24 Shellfish SIL Uncertainty Workshop	2

Uncertainty ID #	IS Strategy	Question / Uncertainty	Source	Voting Results
37	Implement sustainable local Pollution Identification and Correction (PIC) programs	(NEW) E. coli monitoring in freshwater vs. Fecal Coliform in marine: how do we use both parameters/standards to monitor and make decisions?	08.12.24 Shellfish SIL Uncertainty Workshop	2
38	Implement and support on-site sewage system (OSS) management and repair program	(NEW) Are WWTP required to prepare for and mitigate climate change impacts (i.e. rising sea level, increased flooding and significant rainfall events) to prevent system failures and overflows.	08.12.24 Shellfish SIL Uncertainty Workshop	1
39	Implement and support on-site sewage system (OSS) management and repair program	(NEW) Research / Policy Question: Can WDOH update the state law that requires OSS inspections every three years for gravity systems to indicate that local LHJs are responsible to ensure that the inspections are conducted and documented? Could WDOH create a Puget Sound-wide MRA (marine recovery area) to bring more focus and requirements to OSS that are in the Puget Sound Drainage basin to protect shellfish beds?	08.12.24 Shellfish SIL Uncertainty Workshop	1

Uncertainty ID #	IS Strategy	Question / Uncertainty	Source	Voting Results
40	Implement sustainable local Pollution Identification and Correction (PIC) programs	(NEW) Policy Question: Can the Shellfish SIL team look into creating stable PIC base funding to fund 1-2 FTE per county and then use remaining funds for other competitive grants? What are the barriers to creating stable PIC funding? Are there state and federal laws that need to be changed? How does EPA funding provide stable funding for LIO and MRC Coordinators? Perhaps this is a model to replicate. Suggest putting resources to investigate this question and if needed tee up solutions for the next legislative session.	08.12.24 Shellfish SIL Uncertainty Workshop	1
41	Implement sustainable local Pollution Identification and Correction (PIC) programs	(NEW) How has the removal of shellfish impacted water quality among shorelines or what role does the shellfish population play in maintaining water quality standards?	08.12.24 Shellfish SIL Uncertainty Workshop	1
42	Ensure and maintain sufficient livestock manure management	(NEW) Are diaries and horse boarding businesses producing more manure fertilizer than can be properly applied to surrounding farmlands and pastures without creating off-site impacts from fecal bacteria. What incentives or cost-effective programs can we offer to these businesses to better distribute manure to farmlands or pastures that need it.	08.12.24 Shellfish SIL Uncertainty Workshop	0

Uncertainty ID #	IS Strategy	Question / Uncertainty	Source	Voting Results
43	Implement sustainable local Pollution Identification and Correction (PIC) programs	(NEW) Is there sufficient land to move the beds higher to accommodate rising sea levels? Are there measures we can take to protect the beds from excessive heat?	08.12.24 Shellfish SIL Uncertainty Workshop	0
44	Implement and support on-site sewage system (OSS) management and repair program	(NEW) Will WWTP facilities become a requirement for UGAs? Or will private septic systems always be acceptable even in shoreline areas?	08.12.24 Shellfish SIL Uncertainty Workshop	0
45	Implement sustainable local Pollution Identification and Correction (PIC) programs	(NEW) Do stormwater bmps work to increase or decrease the amount of FC going through stormwater system?	08.12.24 Shellfish SIL Uncertainty Workshop	0
46	Implement sustainable local Pollution Identification and Correction (PIC) programs	(NEW) What is the 'gold standard' or basics of a PIC program; how can it be measured?	08.12.24 Shellfish SIL Uncertainty Workshop	0

Uncertainty ID #	IS Strategy	Question / Uncertainty	Source	Voting Results
47	Implement sustainable local Pollution Identification and Correction (PIC) programs	(NEW) Could we create local marine shoreline surveys at the county level to prevent the downgrades and local pollution sources from beaches?	08.12.24 Shellfish SIL Uncertainty Workshop	0

APPENDIX D: EASYRETRO BOARD VOTES AND RESPONSES

Appendix D includes screenshots of EasyRetro boards used during breakout sessions at the August 12th workshop. The EasyRetro platform allows for voting and commenting by participants on individual uncertainties. Participants could place three votes in two breakout rooms (a total of six votes) and provide unlimited comments. Votes are indicated by the number next to the thumbs up (👍) icon under each uncertainty. Number of comments is indicated by number next to speech balloon (💬) icon. EasyRetro boards were left open a week prior to the workshop and a week after.

Agriculture (manure management)

Help to refine outstanding shellfish questions, research, and monitoring priorities to inform funding and capacity



Summary

Cards	Comments	Votes	Participants	Voted
12	27	42	9	17

Cards

Agricultural Uncertainties

What is the environmental and economic impact of shellfish aquaculture?

👍 0 💬 0

Planning for and adapting farm and livestock practices to address the impacts of climate change (i.e. increased frequency of flooding, significant rainfall events).

👍 6 💬 1

There are practices and considerations that could help farms adapt to climate change. For example, raised livestock pads in flood-prone areas, manure storage with gutters, pasture management that avoids grazing during poor field conditions (saturated), and animal confinement areas designed to reduce and/or capture polluted runoff. Good nutrient management can also help farms adapt to climate change by increasing forage production which can be stored and used during drier seasons and the winter.

Are dairies and horse boarding businesses producing more manure fertilizer than can be properly applied to surrounding farmlands and pastures without creating off-site impacts from fecal bacteria? What incentives or cost effective programs can we offer to these businesses to better distribute manure to farmlands or pastures that need it?

👍 0 💬 3

Horse boarding and dairies both have unique challenges. Its not uncommon for horse boarding facilities to have no or very little land to utilize manure generated on site. As a result, they commonly have large manure piles and no long-term plan to eliminate them or put the material to a benefit use. Further, many local governments are unwilling or unable to address the issue. Dairies (in western WA) typically have acreage associated with their operation used to grow crops including feed crops for their livestock. However, not all have the acreage needed and/or storage needed to apply agronomically or at times when their is low risk to surface and groundwater. For dairies - increasing storage capacity and promoting "farm-level" balance of nutrient including nitrogen and phosphorus can reduce the pressure of overapplying or applying at the wrong time. The use of storage tanks (instead of open-pit lagoons) can also reduce pressures for poor timing and amounts. For horse facilities - promoting and installing waste storage facilities and manure haul-away programs would reduce the potential for off-site impacts. Riparian buffer are also needed to attenuate pollution and provide manure application setbacks.

how can counties/regions best support programs that enable sharing/sale to those that can use the manure in productive ways - compost sharing programs/manure exchange programs. risk to crops due to herbicides that pass through and damage crops more than they help

are there heifer replacement farms that are not being regulated in a productive way/not managing their manure properly?

What elements of agriculture incentives from different counties are most effective at reducing fecal bacteria contamination? And what additional barriers could be addressed through incentives?

👍 11 💬 7

Technical assistance (WSDA, NRCS and CDs) and cost share funding (state, county, federal) is crucial support for increasing manure containment and storage. Barriers would include waiting time (NRCS lack of staffing...) and finding funding that meets criteria. Producers and farmers need funding for these types of management improvements.

Its far easier to get people on board with building manure storage or installing fencing when there's no cost share that the landowner has to contribute. People just don't have thousands of dollars sitting around. - Karen DuBose.

Most of these incentive programs are not necessarily county based, lots of programs supporting financial support. Need to improve the system of technical assistance and incentive programs to support farmers

Gutter water on farms directed to ditches contain bird fecal pollution. Need for incentives to reroute to a grass filter area.

A barrier right now is lack of engineering support for design of BMPs and having a project to bid on that's big enough for a contractor to want to jump through all our county bid processes.

cultural resource review timeframe as a barrier

How can incentive programs be structured to best support those that need?

How effective are the manure best management practices at reducing fecal bacteria pollution to surface water? to ground water?

Are there gaps in the BMPs available and clarity of outreach so that potential sources / pathways are not being effectively addressed?

What BMPs are working well?

👍 6 💬 2

Manure and pasture management practices can be effective when properly designed, sited and implemented and coupled with supporting BMPs and riparian buffers. These BMPs and associated guidance are readily available and implementation of these practices is supported via many state and federal incentive programs. When properly implemented, pasture management and riparian buffers are known to limit the generation of polluted runoff and reduce pollution when runoff occurs. Manure storage on an impervious surface and cover (e.g. roof) are effective at reducing polluted runoff and leaching off nitrogen to groundwater. Like most BMPs, they are effective when properly designed, sited, implemented, and continually maintained, When active management ceases, BMPs become less or completely ineffective.

Late spring and early fall are especially challenging for larger farms to manage pastures because storms are challenging to predict. For example, during this May and June's rains, farmers had already moved their animals on pasture. The grass was growing, the weather showed every indication of rains decreasing. It made sense to get animals out on pasture. When big storms arrive, it's too much work to load up those animals and drive them back to their winter grounds for just a few days. So animals stay out and water quality results are bad. It's easier for people with just a few animals and pastures that are all connected. Much harder for farmers with larger herds and disconnected pastures. - Karen DuBose

Do legacy manure storage areas/piles contribute to pathogenic bacteria pollution? How are counties approaching legacy manure management?

👍 1 💬 3

"Legacy piles" are not common and typically result from landowners not having adequate cropland acres to utilize animal waste from livestock. These piles can also accumulate when landowners lack the equipment to haul and spread manure stockpiles. County responses will vary, however, these often seem to be "lower priority" for public work / public health departments and many counties don't have strong ordinance to address the issue.

Correction - "legacy piles" are not uncommon. However, active manure piles are most likely.

actively managed manure piles often are a resource of nutrients and having better protocols/guidelines for managing these piles instead of just legacy piles would be good

How much do V-ditch field drains contribute to fecal bacteria pollution?

👍 1 💬 3

impact of drain tiles too?

V-ditches are a cultural practice that are perceived to help drain agricultural fields in floodplains that are commonly saturated in the winter and early spring. V-ditches are created after the growing season and eliminated prior to the growing season (planting) in more cases; and therefore, they shouldn't receive manure applications.

V-ditches in fields that congregate birds in the winter time could be a significant source and perhaps worth investigating

How effective are farm plans for dairy, non-dairy, and hobby farms at reducing fecal bacteria pollution to shellfish beds?

- What is the current rate of compliance / implementation of farm plans?
- What are the gaps and barriers?
- What is working well?

👍 13 💬 4

The efficacy of agricultural BMPs to protect water quality (including bacteria) is fairly well documented; however, the efficacy of "farm plans" depends on how well the plans are written, whether they include the appropriate practices and how well practices (structural and management) are implemented and maintained. Given this, the effectiveness of "farm plans" is highly variable and would be difficult to assess broadly.

The efficacy of farm plans is often site and plan specific; however, many lack the BMPs needed to fully protect water quality. This is because most "farm plans" use the Natural Resource Conservation Service approach to conservation planning where "producers" choose the resource concerns they would like to address and the practices they would like to implement. This model often leads to ineffective outcomes because the producers are often unwilling to address a resource concern (e.g. water quality), are unwilling to elect the necessary practice(s) or the selected practices are not implemented in a way that fully protects water quality. The voluntary nature of the farm planning process and a property owner's willingness to address issues and implement practices often means that planning is unwilling to advocate for more protective practices or even put them in a plan if the landowner doesn't "select" them. Further, even "good plans" are ineffective if not fully implemented. Related to this is the state's dairy nutrient management act (90.64) and major gaps in this law. The law requires licensed cow dairies to have a plan but there is no requirement to update the plan and the plan isn't enforceable. Further, WSDA (regulatory oversight responsible for the act) does not set the requirements for a dairy nutrient management plan nor do they review and approve the plan - local conservation district boards certify the plan and the WSCC set the requirements. So, dairies just have to have a certified plan and it doesn't matter how old that plan is or what's in it. Compliance / implementation - this is another unknown and gap. Farm plans (and federal conservation plans) are shielded from public disclosure so it's impossible to know what's in them or to gauge their level of implementation unless the information is voluntarily provided which almost never happens. What's working well - there are many different programs that reimburse the cost of BMP implementation. That said, they don't include the same minimum implementation requirements to outcomes vary.

We have encountered barriers to access. AKA farms are not requesting site consults

Who is ultimately responsible for monitoring farm plans? How often are they reviewed for compliance? Is the voluntary compliance aspect working? Where is the data for the effectiveness stored?

Does manure handling and application contribute to fecal bacteria contamination to surface and groundwater?

👍 0 💬 2

is there legacy impacts of continued manure spreading on a property?

Absolutely yes. Poor manure application timing (applying when field and climate conditions are likely to cause runoff), poor placement and over-application are often the driving factors that affect surface and groundwater

especially for facilities like dairies that have limited manure holding capacity and use/collect a lot of water as part of their facility operation. The lack of adequate storage often leads to mistimed (poor field and weather conditions or when nitrogen is unlikely to be used by crops). This leads to surface runoff and groundwater contamination. Groundwater contamination is well documented in areas with high concentrations of animal feeding operations which are primarily dairies in western Washington. Runoff from manure piles, manure storage areas and animal confinement areas are also significant causes of surface and groundwater contamination. Livestock access to riparian zones and wet/saturated pastures are also significant causes of fecal bacteria pollution.

What factors influence statutory and voluntary access for site visits and pollution monitoring purposes on agricultural properties? Are there different barriers for different activities (e.g., general site visit vs. monitoring)?

 2  1

Public perception of conservation districts association with county governments. The public is starting to perceive CDs as regulators, significantly reducing the demand for farm planning and technical assistance requests.

"Planning for and adapting aquaculture practices to address the impacts of climate change". We want to improve, preserve, and protect commercial shellfish beds. Is there sufficient land to move the beds higher to accommodate rising sea levels? Are there measures we can take to protect the beds from excessive heat?

 0  1

long-term impacts of climate change vs the short-term fecal pollution impacts

what's the efficacy of different types of riparian buffers to reduce fecal pollution impacts?

 2  0

Onsite sewage systems and centralized water

Help to refine outstanding shellfish questions, research, and monitoring priorities to inform funding and capacity

Summary

Cards	Comments	Votes	Participants	Voted
18	60	37	7	15

Cards

OSS and centralized water uncertainties

Are there opportunities for land application/infiltration of WWTP effluent, to eliminate precautionary exclusion zones around existing outfalls, and gain shellfish acreage?

 2  2

LOTT has 2 upland disposal sited. Mason County has one too.

Feasibility study could be really helpful. LOTT was trying to reduce the nutrient load to their main treatment plant; didn't pencil out. There's value in looking upland for clean recharge

Can modeling contribute to the a strategy for managing wastewater treatment plant outfalls?

 0  5

Proviso from the legislature to increase geoduck production, which may overlap with this. It'd be particularly helpful to look at areas that are not yet classified.

The relative contribution of WWTP vs. onsite sewer is important. It often varies significantly between regions so a uniform approach may not be relevant

Maybe the placement of the outfall. More importantly, management focuses on adequately treating and handling capacity to meet permit requirements. Greg Eide EPA

Modeling is used to create shellfish closure zones around WWTP outfalls but this modeling won't necessary affect how WWTPs operate. WWTPs are operated to meet water quality standards at the chronic mixing zone. Refined modeling of closure zones could change currently established closure zones or could help determine if or how a outfall modification would or wouldn't affect a closure zone.

Automatically a closure zone irrespective of the actual water quality at the outfall. Some steps to reduce/extend the size, but not remove

Where are there gaps in OSS management support? Does the support differ between communities/jurisdictions? Are there best practices?

 1  2

WDOH issued a Best Management Practice Report in 2016 that is excellent. It would be very helpful to use the BMPs in this report as a framework and get the information out to LHJs to promote and implement the recommendations. There hasn't been much follow up on this report. Location online: <https://doh.wa.gov/sites/default/files/legacy/Documents/Pubs//332-166.pdf>

Puget Sound counties are required by WAC 246-272A-0015 to have local management plans in place for OSS. It is unclear whether LHJs use their plans still, but they will be updated in the next 2 years. The BMP report mentioned

here is another resource, but other technical documentation from DOH may negate the need to update the report. A major gap is program support by local decision makers.

What are the strengths/weaknesses of different monitoring tools in terms of identifying failing OSSs?

What are the barriers in terms of access, regulation, etc. to effective monitoring?

👍 1 💬 5

Retention of experienced staff is a challenge for many smaller LHJs to sustain monitoring and database management.

Has anyone used conductivity to indicate potential changes in water quality to identify potential fecal coliform?

Trying to use an app/meter on a phone to identify sources of colder or warmer water to identify sources along the shoreline that might be manmade source of water. There may be some technology solutions to identify potential sources that don't require accessing private property

Enforcing septic inspection requirements on the state's inspection timetable is key. A barrier is when folks would rather pay the fine than get an inspection. The clock resets when they pay the fine and we never get any data about the system. - Karen DuBose

Differing databases impact an LHJs ability to monitor and track OSS. LHJs do not always have the support necessary to enforce regulations and local codes to failing systems. Rebate programs and financial assistance for repairs is critical to identifying and repairing failing systems. Local cost share programs and Craft3's new grant program are invaluable.

In terms of OSS operation and management:

What enforcement activities will most likely lead to correction of failures?

What are the best practices for messaging to support enforcement? How should this messaging change for different audiences?

👍 2 💬 8

Enforcement is challenging for a variety of reasons (e.g., private property, knowledge deficit about how to maintain). Enforcement is often more about education and the resources that are available. Enforcement is often the last step

Robust financial assistance for repairs can make enforcement a lot easier.

Rebate funding for inspections will help identify failures and prevent premature failures, and cost-share programs or repair assistance programs are needed so counties can better enforce failure rules. Funding for sewer connections and expansions is also necessary. (Most utilities have financial assistance programs, but in general, OSS do not.)

Better education and regulation of service providers will improve failure correction and repair rates.

For operations and management it's really important to have rebates or some assistance for a pump, pump & inspection, or certified inspection. In some of the rural areas, even with education, people are resistant. At the end of the day, it's been necessary to issue orders to maintain the system (e.g. Black Lake). Pump can be \$400, so even a \$100 rebate is meaningful. Financial assistance for more significant repairs are also necessary

Privately owned, but a public interest in their performance makes it challenging. Thurston County's training for homeowners to become self-inspectors has been successful when combined with periodic inspections. Property owners appreciate the ability to protect their own investment, privacy, but may be turned off by the gross factor. Active enforcement when needed - adequate staffing; often new staff are uncomfortable with the conflict. Collaboration with colleges, etc. While warned, new staff often don't understand the challenge until they experience it first hand

According to our surveys, most people believe that septic systems require maintenance. They just don't know what "maintenance" means. Changing messaging to highlight that inspection is a kind of maintenance is key. Highlighting the cost of a failure vs. the cost of an inspection to prevent failure is another successful message. - Karen DuBose

DOH has collected a lot of data over the years. Each county is unique in its program, population, and regulation. While not an apples-to-apples comparison, it'd be interesting to see case studies. Focus on incentives for repair, inspection, and/or pump outs

What are the long-term performance of OSSs with advanced nutrient removal? What are the maintenance requirements? What is their effectiveness against fecal bacteria?

1 5

With proper maintenance OSS with nutrient removal should perform as well as other OSS long-term. They should be inspected at least annually. Evaluation of nutrient removal is distinct from evaluation of bacteria inactivation.

Systems that are registered for use as a bacteria level 1, 2, or 3 must be tested by a National Sanitation Foundation (NSF) accredited facility. This test determines how effective various technologies are at destroying/removing Fecal Coliform or E. Coli bacteria in the effluent. The highest level, BL 1, provides the highest level of pathogen destruction (less than 200 F.C./L). Some registered technologies use ultraviolet lamps to break down the Fecal Coliform. These lamps must be inspected and replaced regularly. Other technologies use filter media such as sand. All OSS that use these types of systems should be on a 1 yr. inspection cycle.

I'm aware that there are folks trialing OSS designs that include additional nutrient treatment. This would be really important in areas where we need the groundwater recharge but not the nutrients.

Watershed that's urbanizing, so recharge is really important. As we sewer the area we're removing water. So having septic that works well and addresses nutrients would be a good solution

There are examples of MBR systems which are achieving significant nutrient reductions while also remaining very effective in addressing bacteria.

What are feasible alternatives to OSS for the Puget Sound region?

3 3

LOSS similar to Port Gamble's to remove reliance on individual OSS from shorelines. Expanded sewer systems.

Lots are really small so there may not be room for replacement systems. Sewer may not be allowed based on the UGA. Lots of skinny lots on the shoreline in urban areas

A combination of LOSS, buildout of centralized sewer where feasible, and utilization of existing advanced treatment that requires a smaller footprint.

What elements of OSS incentives from different counties are most effective at reducing fecal bacteria contamination? and what additional barriers could be addressed through incentives?

4 4

We are starting a grant-funded repair program for low income households that need repairs. I expect it to be popular. - Karen DuBose.

We have data on property owners who received incentives. It'd be helpful to understand how they learned about the incentives. What does follow-up look like 5 years later and the environmental outcomes? Did property owners request the incentives or were they automatically applied - important to consider how this intersects with the need and/or resistance to change

While not an incentive, the Regional Loan Program has been critical in repairing many OSS and preventing contamination.

Rebates for pumping and inspection support homeowners to operate and maintain systems.

How and where will sea level rise impact the functionality of OSSs, LOSS, and WWTP? What solutions are available/needed to mitigate these impacts?

7 5

Sea level rise will increase groundwater levels along the nearshore, so the impacts may be farther in land. It's not just about the sea level. CoSMoS Coastal Groundwater Hazards with Rising Seas Puget Sound Virtual Workshop — SCPG (coastalplanners.org) - <https://www.coastalplanners.org/cosmos-groundwater>

King tides will increasingly inundate OSS in low-lying areas. Current solutions include moving/rebuilding OSS away

from the water and moving OSS onto sewer or LOSS.

Sea Level Rise will impact the soil under existing OSS by reducing the vertical separation (soils under the drainfield) that provides the treatment and disposal of the effluent prior to it getting into groundwater. This reduction will possibly lead to systems failing as undertreated effluent may enter the groundwater in low-lying areas.

Industry doesn't understand why this is so important environmentally (e.g. king tides). Seems to influence the local health jurisdiction. Hear it's okay, we just replace their pumps a couple times a year because it gets inundated with salt water. Helpful to see a cost analysis to replace those types of systems before they fail or LOSS transition

Might lose the ability for these commercial shellfish beds to be viable with loss of prime area for aquaculture and sea level rise. Tribes have limited capacity to move their beds.

How effective are OSS loan and financial assistance programs at facilitating the replacement of OSSs? How well are they serving over-burdened communities? If not, are there modifications which would increase their utilization?

👍 2 💬 1

The Regional Loan program run between the Departments of Health and Ecology provides a resource for owners that need repairs to find financial assistance that can repair or replace their OSS, or even fund connection into community systems. Some Puget Sound counties also offer programs that support the repair or replacement of OSS using a variety of different funding sources.

Where can Large OSSs (LOSS) be implemented in place of individual OSSs? or as alternatives to WWTPs? Consider the regulatory context, treatment levels, proximity to shellfish beds, etc.

👍 5 💬 3

OSS on small lots & close to water can be converted to community OSS and LOSS to move the sewage/treatment away from the water and to more suitable sites. This can provide safer, more sustainable treatment than OSS near water and may be more cost effective than connection to sewer.

Sewering often triggers growth. LOSS aren't always maintained well, so looking at models for maintenance would be helpful

It'd be really helpful to see case studies (design, funding, agreements)

1. A developer is coming in to pack in a bunch of houses
2. Existing community with a bad location so have to come up with a retrofit (Town of Edison)

Are new OSS being installed in unsuitable locations that will impact shellfish growing areas, including areas projected to be impacted by sea level rise? Are the appropriate checks in place to limit this?

👍 1 💬 2

Yes, installations and expansions are occurring on lots likely to be impacted by sea level rise.

Yes, they are still being installed or repaired/replaced. "Appropriate checks" would vary by county.

What factors influence statutory and voluntary access for site visits and pollution monitoring purposes on properties with OSSs? Are there different barriers for different activities (e.g., general site visit vs. monitoring)?

👍 0 💬 6

Beginning in 2027, all OSS must be inspected when property is sold or the deed is transferred.
<https://doh.wa.gov/community-and-environment/wastewater-management/rules-and-regulations/onsite-rule-revision>.
Greg Eide EPA.

Easier to access properties in marine areas to do sampling compared to a lake with a bacteria or marine area.

Thurston County - specifically need a forced entry warrant to follow through on abatement/clean-up. People can tell

us to get off their property, without a warrant. Homeowners don't like us coming to the door, don't want to be surprised, and don't want to listen to the educational materials. Revisit the RCW about when and where we can get a search warrant for septic - clearer or simpler. Need to have a prosecuting attorney's office that's going to enforce

Could study to see what statutory update we'd like, but that's challenging to implement and may not be as fruitful as investing in voluntary compliance

Collaboration with partner agencies are key for these types of sites: we partner with PIC, ecology, and our unsheltered support team for these types of sites. Our process typically goes as follows: 1. Sewage concern 2. We are denied access 3.. We send a letter providing choice that we take a look at the system or a 3rd party 4. If no action we partner with PIC to take nearby water samples 5. If high, continue compliance requirements and loop in ecology for discharge pollution action.

Owner's responsibility to get the inspection done when the property is sold. The access is typically through a company that the owner hires to inspect/repair the system. More about voluntary compliance, which makes incentives and education even more important

Are WWTP required to prepare for and mitigate climate change impacts (i.e. rising sea level, increased flooding and significant rainfall events) to prevent system failures and overflows.

👍 1 💬 0

Research / Policy Question: Can WDOH update the state law that requires OSS inspections every three years for gravity systems to indicate that local LHJs are responsible to ensure that the inspections are conducted and documented? Could WDOH create a Puget Sound-wide MRA (marine recovery area) to bring more focus and requirements to OSS that are in the Puget Sound Drainage basin to protect shellfish beds?

👍 1 💬 1

The law is already in place for inspections. There is no way to enforce it. local decision makers have to support the programs and allow for the development and implementation of management programs, which includes a compliance program.

Interesting thought on the MRA. Not sure.

What are the disposal options for treating septage from OSS, RVs, vessels and other sources of septage (homeless, pet waste, etc.)? Are there entities already addressing these needs?

👍 5 💬 2

In Skagit, we are running out of treatment plants willing to take septage due to the impact on their nutrient discharge. The treatment plants that are left are considering not allowing septage. If they go...what then?

Have a handle on vessels because there's a South Sound pump out program, which has been really successful. The RVs and vessels often overlap with homelessness. Pet waste is often tricky - typically encourage people to put it in the trash

How can DOH and local health jurisdictions (LHJ) better support data management and mapping of OSS systems? What sort of data management and mapping programs for OSS are in place and is there consistency between LHJs? How can consistency be improved?

👍 0 💬 5

Data is used in so many other areas of our economy. Important to use what we already know. Why aren't we? What's the data we have and how is it being utilized across all the different players?

Important - keeps coming up (e.g., SIAT)

Terry King mentioned a statewide OSS database during a SIAT meeting, and that LOSS do not participate, and should. - Greg Eide - EPA

Who will record the inspection data during property sales? Relevant to several of these uncertainties

Software can be a barrier. For example, stormwater has a fancier system because NPDES is a driver, but the health team doesn't have the budget to access that software. The folks generating the data are often cautious about access to the data for QA/QC

Will WWTP facilities become a requirement for UGAs? Or will private septic systems always be acceptable even in shoreline areas?

 1  1

What is the comparative impact for a WWTP sewer spill compared to an onsite septic system and its impact on shellfish bed closures?

Pollution Identification and Correction

Help to refine outstanding shellfish questions, research, and monitoring priorities to inform funding and capacity



Generated 23 Aug 2024

Summary

Cards	Comments	Votes	Participants	Voted
18	39	48	8	17

Cards

PIC uncertainties

What specifically needs to be understood about circulation and dilution to support work in areas with recurrent de-classification of growing areas (e.g., identify potential sources, determine appropriate precautionary exclusion zones, etc.) ?

👍 4 💬 2

R.C. - models are available, that's less of an unknown. To revisit closure zones, DOH does need wastewater specific closure information. Wastewater does need to do sampling and report it. There is more information needed to evaluate those. What can be done to better evaluate those closure zones in the future? There may also be a capacity issue. There are other elements that could be highlighted if there's a effort to reevaluate closure zones.

Increasing the resolution of the Puget Sound model in shellfish growing areas can help inform/refine shellfish growing area classifications.

What is the intersection between nutrients and fecal coliform, in respect to PIC programs? Are PIC programs an effective means of achieving nutrient reduction?

👍 1 💬 4

PIC programs typically focus on addressing bacteria pollution. There is some overlap between efforts to control bacteria (OSS, Ag) but not to the level to say nutrients are adequately addressed via PIC efforts. For example, OSS efforts don't really focus on nutrient contributions and efforts to address agriculture typically focus on sources that can be seen and don't address issues related to nutrient timing, amount, location and other factors that can affect nutrient contributions from agricultural including soil phosphorus levels.

S.W. Yes, PIC program can track nutrients and be applied.

AC - There is some concern about the difference between fecal coliform and E. coli in freshwater. PW - how can we use the data modeling with the data we have to make decisions about fecal coliform in freshwater. The B.S. National standard is based on fecal coliform, you may be able to measure the differences in human health but it has not been integrated into the system.

R.C. yes, there is overlap between PIC efforts and nutrient sampling. From what been seen from PIC efforts, however, there is not a strong connection.

What are the current/future impacts of ocean acidification on shellfish? Are there areas/habitats that are particularly vulnerable? What are mitigation measures?

👍 0 💬 2

Estuaries with extensive eelgrass, such as Samish Bay are potentially natural refuges from the effects of ocean acidification for growing shellfish in the future and are critical to preserve for shellfish culture

Acidification makes it hard for juveniles to form shells. The problem is getting worse. Juveniles can be reared in more basic areas and farmed in PS. Greg Eide EPA.

What are the dynamics of domoic acid accumulation in bivalves? Will climate change increase the frequency/magnitude of HABs events? What are management actions?

👍 0 💬 1

needs rewording.

How effective are PIC programs at reducing fecal bacteria contamination to shellfish beds?

What are the barriers to successful implementation? Are certain enabling conditions needed?

Are there specific aspects of PIC programs regulatory programs, watershed improvement districts, Shellfish Protection Districts, and loan and grant programs) that are particularly effective? or could be improved?

👍 12 💬 6

If we have money to help people do the things we want them to do, with limited strings attached, it's much easier to get stuff done. Right now I'm thrilled to have 100% coverage for AgBMP projects, but there are a lot of strings attached to the money that end up making it challenging to get on the ground. For example, we have to ensure MBE/WBE have access (which is GREAT!) but it adds 3+ months to a bid process, while NRCS just pays folks a flat amount of money to do the work without rules about which contractors can be used.

Having consistent funding rather than competitively reapplying every couple of years is critical. The risk of losing the program and having to reinstate it years later is a huge disservice to ongoing pollution control.

S.W. Programs are general aligned in our they approach their PIC work. For Shellfish like to see resources where each County can have a local marine shoreline survey program that could prevent downgrade and locate sources from the beach. Struggle with concentrations of wildlife. Addressing wildlife is difficult. Are not able to get things as clean as they'd like especially because of wildlife.

B.S. Pierce county - for OSS being able to provide financial assistance was a game-changer. Rolling on an O&M program and have seen impressive results. The health department identifies small areas - starts with letters about needing an inspections. The rate also respondents to these letters was dramatic and the results in marine sampling could be seen.

D.R. how effective are PIC - how do you define effectiveness? What is success? Works in the Stillaguamish river valley there is a 50/ 50 split between sewage and nonpoint. Hard to point a finger at either. Are we looking to reduce closures or are we looking at number of know problems to be removed?

C.B. - 1) would be nice to see combined regional sharing of PIC programs. 2) If PIC programs are so effective we need to find consistent funding. There are counties in PS with no PIC programs - lack of accessibility to monitoring. Has this been discussed so far?

What are the most accurate, feasible, and/or cost effective test options to distinguish bacteria from wildlife, livestock, septic, pets, WWTP, boats, etc. , Is it Microbial Source Tracking or is there a better method?

- What proportion of "positive" tests are due to non-fecal coliform bacteria?

-What are the hurdles to existing methods and realistic expectations of effectiveness?

👍 6 💬 7

J.S. struggling with turnaround time from lab analysis. Only one lab in the area that does F.C. testing. Adding on to more specialized or emerging features seems insurmountable. Tried to get around this problem by using r-cards but state level does not accept that as viable data.

MST is very effective method and we are working to develop additional markers to distinguish between, for example, birds, horses, raccoons, cats. - Greg Eide EPA

MST is a very effective method if you have a small area you're working in and a good idea of what the sources in the area are. In a larger area, it will really only tell you that yes, cows, humans, and dogs live in this area but you will have no idea of the scale of each or which of the many properties it's coming from. Using chemical tracers with the UW has potential, but it needs to be developed much more before it is truly useful.

The cost of MST and chemical tracers (along with the fact that just one sample will not do; you need to sample repeatedly) is a huge hurdle. Getting samples to the lab within the hold time is a challenge. And scheduling lab time

when you need to sample unpredictable storms in order to get useful results is a huge hurdle. - Karen DuBose.

C.M. - Whatcom county is seeking how to find funding to continue looking into MST. How can we use microbial signatures to track down to the species levels? Whatcom County is at phase 1 to answering that question. They have talked to a local lab about continuing that partnership and continuing previous project looking into this, but there is a funding issue. There are promising techniques and developments but it would take time and money. This project has a lot of promise and they've put time in it. Want to drill down on a specific source and put effort into identifying that.

AC - there are techniques out there. Most techniques not enough to change political will. Whatcom area has a very detailed molecular analysis to identify source but was expensive and people on it moved on. Would identify genetic origins and use them as a database. Is there a source tracking device that people would accept?

B.S. has a couple other people working on alternative. Erica Marbed? at Squaxin tribe working on an automated sampler which gathers data every 15 minutes. Also a person at Pierce County who uses a water quality sampler that give some indication on what F.C. level is. Would like to see a meeting discussing these other options. C.M. - seconds this. Wants bacterial monitoring that can give real-time results. Paris Olympics has been implementing these new real-time monitoring for the Seine. Reached out to that company. A lot of new and developing technologies but they are expensive. Would be a couple \$100,000. Funding limited in finding something that works well. In the future there may be better technology available that would solve the delay problems. FC comes and goes, a real time monitoring would allow to identify persistent sources.

BS - yes, it is needed. having a more satisfying device would be good. There is a ribotyping device but not widely used. In the past MST does not quantify the impact of different species, ribotyping gets us closer there.

What is the likelihood and impact of fecal bacteria survival and regrowth in soils, marine sediment and stagnant water? What conditions lead to regrowth?

👍 5 💬 4

J.S. no there is no regrowth going on in soil. In general even with saturated soil it will kill pathogens.

C.B. The survival rate of E.coli in the marine environment it is short lived. Teri King- Salinity and sunlight kills fecal coliform, the cells within the bacteria can't survive. If we need to retest that science, it can. Also, dilution is not the solution, concentration matters.

H.H. would be important to protocols around sewage spills. If something spilled and dried along the shoreline-it might inform protocols on how best to remove.

We need more research on this topic. We are constantly questioning whether we're seeing regrowth in our warm, slow-moving sloughs, and whether farms with a century of manure applications just have E. coli in them now. - Karen DuBose.

What factors influence statutory and voluntary access for site visits and pollution monitoring purposes properties within PIC areas? Are there different barriers for different activities (e.g., general site visit vs. monitoring)?

👍 2 💬 4

The existence of other codes that PIC can leverage with partners is important. (such as OSS regulations and evaluations receiving information from PIC about suspect sites).

Vacancies in enforcement positions. Increase compensation to make these positions more lucrative. - Greg Eide EPA.

D.R. encountered outspoken members from community not happy with CDs. Encountering reduction of requests in farms plans because of what's coming down in regulations. In terms of requirement the NDPS has then doing business inspections but can only do business inspections where allowed it.

A constant rotation of different staff has been a regular challenge - the faces are always changing and landowners get frustrated with having to deal with new people all the time. Greg's comment about compensation is true, but it is also challenging as a worker in these positions to feel like you're being effective when you have limited authority to make decisions and management won't let you try different things. I don't stay working somewhere if I feel like I'm wasting my time.

Getting access for site visits is always challenging - people don't want you there for fear of getting in trouble, and don't want to engage. People also don't always read their mail! Advertising that we have money for projects

with very general description of what those projects could be has gotten the most traction. - Karen DuBose.

Can Stormwater / NPDES programs be leveraged to support PIC programs?

👍 7 💬 4

If PIC is not fully integrated with Stormwater abatement - the conveyance system for fecal and nutrients PIC can't be successful.

In order to comply with NPDES requirements most jurisdictions have added a lot of monitoring, inspection, and compliance capacity. It seems like a good opportunity for collaboration.

Absolutely! Assuming the geographic areas match, or at least the messaging is similar. Managing a partnership like that can be challenging, though, as each program has its own rules and goals. - Karen DuBose.

IDDE programs are requirements within MS4s so there is a lot of leverage there to better map infrastructure and identify where septic systems are contributing; however, not all jurisdictions are under MS4 purview

Policy Question: Can the Shellfish SIL team look into creating stable PIC base funding to fund 1-2 FTE per county and then use remaining funds for other competitive grants? What are the barriers to creating stable PIC funding? Are there state and federal laws that need to be changed? How does EPA funding provide stable funding for LIO and MRC Coordinators? Perhaps this is a model to replicate. Suggest putting resources to look into this question and if needed tee up solutions for the next legislative session.

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Stable funding is a critical issue. The grant model keeps organizations from permanently expanding their programs and capacity for fear that the funding will go away within a year or two. Also, permanent expansion of capacity means a need for more office space, admin support, supervision, and equipment.

Let's examine what happened with the Ecology grant. - Greg Eide EPA.

What are the bacteria reduction capabilities of traditional stormwater facilities?

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B.S.- In Pierce County - what kind of solutions can be solved using stormwater approaches. Sometimes we can't find where a source is from but maybe there's an option within the stormwater structures that could help us treat that? There is not good data on traditional stormwater facilities in terms of telling us what their capabilities are in reducing bacteria. Looking at Henderson Inlet - got a good handle at looking at traditional sources but are still seeing high hits, if most of those bacteria are coming through stormwater system, maybe we should switch gears.

P.W. using VELMA to identify those areas that could benefit from stormwater bmps. With 6ppdq they are looking at that now. Would be good to know if those bmps work to increase or decrease the amount of FC going through that system?

E. coli monitoring in freshwater vs. Fecal Coliform in marine: how do we use both parameters/standards to monitor and make decisions?

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Ecology has done a lot of work developing FC-EC translators for TMDL development; James Kardouni with Ecology's Bellingham Field Office is a great resource for this type of work.

Real time bacteria monitoring/automated bacteria sampling to get results faster, what works. Barriers include funding

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APPENDIX E: NOVEMBER 2024 MEMO TO SHELLFISH SIL ON REFINEMENT CONVERSATIONS

This memo describes the results of the refinement exercise that includes justifications for either editing, merging, splitting, keeping, or removing one of the uncertainties brought forward from the August 12th workshop. These decisions resulted from refinement conversations with individual subject matter experts from the Puget Sound region. Refinement conversations looked to clarify and focus the intent of top uncertainties. Numbering of uncertainties refer to their placement in [Appendix C](#).

November 2024

Uncertainty Revisions

Agriculture Best Management Practices (Manure Management)

Uncertainty ID: 1.

Original: How effective are farm plans for dairy, non-dairy, and hobby farms at reducing fecal bacteria pollution to shellfish beds?

- What is the current rate of compliance/implementation of farm plans?
- What are the gaps and barriers?
- What is working well?

Revision: Uncertainty removed

Justification: Farm plans are one of the voluntary tools that are used for agricultural land management and their strengths and limitations are well understood. Discussions with experts (C. Cheever - Whatcom Conservation District, R. Cummings – Ecology) pointed to the lack of publicly available data due to the confidentiality of farm plans. This confidentiality makes it difficult to understand the effectiveness of farms plans if the BMPs listed in the plan cannot be compared to actions after. Conservation Districts also are hesitant to work closer with regulators and risk losing trust among farmers. Participants in the workshop did note a lack of data sharing between Conservation Districts and counties and a general knowledge deficit of what is included in specific farm plans. Conservation Districts additionally noted a need for funding to perform follow-up visits to farms that goes along with farm plan creation.

Uncertainty ID 3.

Original: What elements of agriculture incentives from different counties are most effective at reducing fecal bacteria contamination? and what additional barriers could be addressed through incentives?

Revision: Kept original and added new uncertainty

Uncertainty ID 3. What elements of agriculture incentives from different counties are most effective at reducing fecal bacteria contamination? and what additional barriers could be addressed through incentives?

Uncertainty ID 3.1. How do we strengthen and prioritize technical assistance for BMP design and cultural reviews to bolster efficacy?

Justification: Conversations with experts (K. Dubose – Skagit County, N. Schneider – Mason Conservation District) and feedback from workshop participants pointed towards a need for more technical and financial assistance for BMP implementation. Farmers can be provided funding, but sometimes lack the know-how on how to implement BMPs. Long waits for technical assistance were identified as a barrier for implementing BMPs. Incentive-related requirements (e.g., the requirement to meet federal buffer requirements for NEP-supported incentives) and payback structures (e.g., rebates that required high initial investments from participants) were barrier to successful incentive programs. Elements of effective incentive programs may be covered in future research. PSI is conducting a landowner incentives program critical analysis that will include agricultural financial incentives and may distinguish best management practices; this study will not cover technical assistance.

Uncertainty ID 5.

Original: How effective are the manure best management practices at reducing fecal bacteria pollution to surface water? to ground water? Are there gaps in the BMPs available and clarity of outreach so that potential sources/pathways are not being effectively addressed. What BMPs are working well?

Revision: Uncertainty split and merged with uncertainty 32

Uncertainty ID 5.1. With climate change how will shifts in temperature and precipitation change when manure is applied to fields and by extension fecal bacteria contamination of shellfish beds?

Uncertainty ID 5.2. In what ways does climate change (e.g., shifting precipitation, temperatures, etc.) influence farm BMP designs, particularly lagoons? How can we incorporate more updated precipitation and flooding predictions into BMP designs?

Uncertainty ID 5.3. How do you effectively engage hobby farmers / horse boarders to implement BMPs?

Justification: The original uncertainty was quite broad and may be covered by Ecology. Research exists on the effectiveness of BMPs to control bacterial and nutrient pollution, and Ecology is currently conducting a targeted study on BMP effectiveness. Though new knowledge gaps may result from the Ecology report. It was noted there is a lack of Puget Sound specific studies on BMPs, especially in relation to climate change (R. Cummings – Ecology). There were also uncertainties on availability of best available science to inform decision making, specifically updated county-wide flood maps, and uncertainties related to the uptake and utilization of BMPs (i.e., why do specific farmers use BMPs while others do not).

Uncertainty ID 32.

Original: Planning for and adapting farm and livestock practice to address the impacts of climate change (i.e. increased frequency of flooding, significant rainfall events).

Revision: Merged with uncertainty 5

Justification: In the expert discussions, climate change was integrally linked with uncertainties around manure management BMPs. The refined uncertainty 5 (shown above) will cover the needs of this gap with greater specificity.

Pollution Identification and Correction Programs

Uncertainty ID 2.

Original: How effective are PIC programs at reducing fecal bacteria contamination to shellfish beds? What are the barriers to successful implementation? Are certain enabling conditions needed? Are there specific aspects of PIC programs regulatory programs, watershed improvement districts, Shellfish Protection Districts, and loan and grant programs) that are particularly effective? or could be improved?

Revision: Edited and split

Uncertainty ID 2.1. How can we increase capacity for PIC enforcement at the state level?

Uncertainty ID 2.2. What are the motivators and barriers to pet owners picking up waste in their own yards to prevent stormwater pollution?

Justification: Refinement occurred on this uncertainty to reflect multiple specific research needs. PIC programs in general can be effective in locations with sufficient managerial support and enabling conditions, but aspects of the programs continue to require improvements. These new uncertainties were identified through expert discussions (Karen Dubose- Skagit County) and workshop feedback. Pet waste continues to be a water quality issue and eliciting behavior change is well-known to be difficult.

Uncertainty ID 31.

Original: Can Stormwater / NPDES programs be leveraged to support PIC programs?

Revision: Uncertainty removed

Justification: Through discussions it was realized that this uncertainty is known. Yes, NPDES and stormwater programs can support PIC programs. PSI recommends increased knowledge sharing opportunities to demonstrate the effectiveness of stormwater BMPs (implemented under the NPDES permit) at removing fecal coliform at an upcoming regional forum or a shared Shellfish / Stormwater SIL workshop or webinar. Knowledge exists but requires further awareness.

Uncertainty ID 6.

Original: What are the most accurate, feasible, and/or cost-effective test options to distinguish bacteria from wildlife, livestock, septic, pets, WWTP, boats, etc. Is it Microbial Source Tracking or is there a better method? What proportion of “positive” tests are due to non-fecal coliform bacteria? What are the hurdles to existing methods and realistic expectations of effectiveness?

Revision: Uncertainty kept

Justification: Counties continue to seek improvements to MST / other tracking methods. Whatcom County is potentially developing a library of DNA, sharing results from this work at upcoming Shellfish SIL or PIC regional events may spur continued conversation.

Onsite Sewage Systems Programs

Uncertainty ID 4.

Original: How and where will sea level rise impact the functionality of OSSs? What solutions are available/needed to mitigate these impacts? (LOSS, other).

Revision: Edited

What’s the range of potential costs to a) property owners and b) the government to relocate septic systems at risk from sea level rise vs. inaction? (Include note in GUM on linkages to similar uncertainty identified during the HSIL Sea Level Rise activity)

Justification: How and where will sea level rise impact OSS could be answered within the next few years through continued OSS mapping by Local Health Jurisdictions / LIOs and results from the USGS Coastal Storm Modeling System (CoSMoS). CoSMoS will provide parcel level results of flood predictions and groundwater inundation due to climate change along Washington state coastlines by 2027. The uncertainty was refined based on discussions with experts (J. Simmons and M. Tripodi of DOH). A recent sea level workshop hosted by the Habitat SIL identified/prioritized similar uncertainties about adaptation strategies more broadly (e.g., buyouts, rolling easements, elevating homes, etc.).

Uncertainty ID 7.

Original: Where can Large OSSs (LOSS) be implemented in place of individual OSSs? or as alternatives to WWTPs? Consider the regulatory context, treatment levels, proximity to shellfish beds, etc.

Revision: Uncertainty split

Uncertainty ID 7.1. Where and how should new sewer connections and wastewater treatment be encouraged/required to support new development outside of Urban Growth Areas?

Uncertainty ID 7.2. How do you effectively fund new LOSS and maintenance for LOSS (e.g., PUD utilities)? As part of this study, consider how many system failures or maintenance breaches occur when LOSS is maintained by a public utility district or a homeowners association.

Uncertainty ID 7.3. Where can aging OSS that cannot be repaired or replaced be superseded with alternative septic systems (Large OSS or wastewater treatment plants)?

Justification: Expert knowledge (J. Simmons and M. Tripodi – DOH, C. Marote - King County) helped to refine down these uncertainties to focus on gaps related to funding new service connections, and how to incentivize the inclusion of sewage system service in areas of new growth. Current regulations allow for growth and connection to sewer lines (though cost to landowners may be prohibitive) within UGAs as well as installation of new LOSS or WWTP in replacement of OSS. How best to fund those changes remains a challenge.

Uncertainty ID 33.

Original: What are the disposal options for treating septage from OSS, RVs, vessels and other sources of septage (homeless, pet waste, etc.)? Are there entities already addressing these needs?

Revision: Uncertainty kept

(Included note in GUM that the uncertainty is currently being addressed by an Ecology funded study. Therefore, it won't be included in the Top priorities that are amplified.)

Justification: Legislature funded Ecology to conduct a septage capacity and risk analysis study. Ecology sub-awarded this study to SCJ Alliance. A final report is expected June 2025. Results from this study will potentially cover this research need. Future refinement may be necessary based on results from the study. PSI met with SCJ Alliance and Ecology to validate alignment of proposed research questions and potential outcomes, with needs indicated in the GUM.

Interview List

- Corina Cheever – Whatcom Conservation District (9.16.24)
- Jeremy Simmons and Marra Tripodi – Department of Health (9.17.24)
- Ron Cummings – Department of Ecology (9.19.24)
- Corrina Marote – King County (9.19.24)
- Nick Schneider – Mason Conservation District. (9.26.24)
- Karen Dubose – Skagit County (10.03.24)
- Torrie Shaul – Department of Ecology (10.15.24)
- Randy Sackett – SCJ Alliance (10.28.24)

APPENDIX F: GOOGLE FORM VOTING RESULTS ON TOP 13 UNCERTAINTIES

This table displays voting results on 13 refined uncertainties. Refinement occurred on August 12th priority uncertainties and included editing, splitting, merging, removing, or adding an uncertainty (see [Appendix E](#) for refinement justifications). Within this table, the Uncertainty IDs with a decimal (e.g., 7.1, 7.2, 7.3) denotes a splitting apart of an uncertainty during the refinement exercise.

Refined uncertainties received a second round of voting using a Google Form. PSI invited participants from the August 12th workshop and the refinement conversations to rate each uncertainty on a scale of 1-5 indicating a level of research need. 1 as a low research need, 5 as a high research need. The Form received a total of 15 responses. The table displays the results of that exercise showing the mean rating and standard deviation.

Uncertainty ID #	IS Strategy	Uncertainty	Source	Mean Rating (1=low, 5=high)	Standard Deviation
7.3	Implement and support on-site sewage system (OSS) management and repair program	Where can aging OSS that cannot be repaired or reinstalled be replaced with alternative septic systems (Large OSS or wastewater treatment plants)?	Scoping and Refinement Conversations	4.1	0.8
7.1	Implement and support on-site sewage system (OSS) management and repair program	Where and how should new sewer connections and wastewater treatment be encouraged/required to support new development outside of Urban Growth Areas?	Scoping and Refinement Conversations	4.1	1.3
3	Ensure and maintain sufficient livestock manure management	What elements of agriculture incentives from different counties are most effective at reducing fecal bacteria contamination? and what additional barriers could be addressed through incentives?	GUM (Francis and James, 2023)	4	0.9

Uncertainty ID #	IS Strategy	Uncertainty	Source	Mean Rating (1=low, 5=high)	Standard Deviation
4	Implement and support on-site sewage system (OSS) management and repair program	What's the range of potential costs to a) property owners and b) the government to relocate septic systems at risk from sea level rise vs. inaction?	Ross Strategic and Stormwater SIL (2023)	3.9	1.1
2.1	Fund, support, and implement sustainable local Pollution Identification and Correction (PIC) programs	How can we increase capacity for PIC enforcement at the state level?	Scoping and Refinement Conversations	3.8	1.3
33	Implement and support on-site sewage system (OSS) management and repair program	What are the disposal options for treating septage from OSS, RVs, vessels and other sources of septage (homeless, pet waste, etc.)? Are there entities already addressing these needs?	08.12.24 Shellfish SIL Uncertainty Workshop	3.6	1.4

Uncertainty ID #	IS Strategy	Uncertainty	Source	Mean Rating (1=low, 5=high)	Standard Deviation
7.2	Implement and support on-site sewage system (OSS) management and repair program	How do you effectively fund new LOSS and maintenance for LOSS (e.g., PUD utilities)? As part of this study, consider how many system failures or maintenance breaches occur when a LOSS is maintained by a public utility district or a homeowners association.	Ross Strategic and Stormwater SIL (2023)	3.5	1.6
6	Fund, support, and implement sustainable local Pollution Identification and Correction (PIC) programs	What are the most accurate, feasible, and/or cost effective test options to distinguish bacteria from wildlife, livestock, septic, pets, WWTP, boats, etc. , Is it Microbial Source Tracking or is there a better method? - What proportion of “positive” tests are due to non-fecal coliform bacteria? -What are the hurdles to existing methods and realistic expectations of effectiveness?	GUM (Francis and James, 2023)	3.5	1.3

Uncertainty ID #	IS Strategy	Uncertainty	Source	Mean Rating (1=low, 5=high)	Standard Deviation
5.2	Ensure and maintain sufficient livestock manure management	In what ways does climate change (e.g., shifting precipitation, temperatures, etc.) influence farm BMP designs, particularly lagoons? How can we incorporate more updated precipitation and flooding predictions into BMP designs?	Scoping and Refinement Conversations	3.5	1.2
5.3	Ensure and maintain sufficient livestock manure management	How do you effectively engage hobby farmers / horse boarders to implement BMPs?	Scoping and Refinement Conversations	3.4	1.4
5.1	Ensure and maintain sufficient livestock manure management	With climate change how will shifts in temperature and precipitation change when manure is applied to fields and by extension fecal bacteria contamination of shellfish beds?	Scoping and Refinement Conversations	3	1.2
3.1	Ensure and maintain sufficient livestock manure management	How do we strengthen and prioritize technical assistance for BMP design and cultural reviews to bolster efficacy?	Scoping and Refinement Conversations	3	0.8
2.2	Fund, support, and implement sustainable local (PIC) programs	What are the motivators and barriers to pet owners picking up waste in their own yards to prevent stormwater pollution?	08.12.24 Shellfish SIL Uncertainty Workshop	2.8	1.3

APPENDIX G: FINAL SHELLFISH PRIORITIZED RESEARCH AND MONITORING AGENDA

This table lists the final priority level of the uncertainties under the Shellfish Beds Implementation Strategy. Priority levels include Top, High, Medium, Low, and No-Priority. GUM ID lists the IDs used within the the GUM. The GUM IDs connect the research agenda process to the GUM and are mainly for internal tracking purposes. The Uncertainty ID aligns with the ID # within [Appendix F](#) for the Top and High uncertainties and [Appendix C](#) for Medium and Low uncertainties. Top and High uncertainties received refinement and a second round of voting, while Medium and Low uncertainties did not. The IS Strategy column refers to which of the five strategies within the Shellfish Beds Implementation Strategy Narrative (Shellfish Strategic Initiative 2023) the uncertainty advances. The notes column includes either past or ongoing work relevant to an uncertainty or general comments found during the research agenda process pertinent to the uncertainty.

GUM ID	Uncertainty ID #	IS Strategy	Question / Uncertainty	Source	Priority Level	Notes
Sh.1	7.3	Implement and support on-site sewage system (OSS) management and repair program	Where can aging OSS that cannot be repaired or reinstalled be replaced with alternative septic systems (Large OSS or wastewater treatment plants)? What would those alternatives be?	2024 Scoping and Refinement Conversations	Top	Evrard, PSI (12.30.24): ROE is conducting a critical analysis of case studies on communities which have converted from multiple OSS to LOSS. These case studies will cover costs, problems faced, timelines, and permitting requirements. Edited to include language from similar uncertainty (Uncertainty ID 11).

GUM ID	Uncertainty ID #	IS Strategy	Question / Uncertainty	Source	Priority Level	Notes
Sh.2	4	Implement and support on-site sewage system (OSS) management and repair program	What's the range of potential costs to a) property owners and b) the government to relocate septic systems at risk from sea level rise vs. inaction?	2024 Scoping and Refinement Conversations	Top	Kanojia, PSI (12.17.2024): CoSMoS has modeled groundwater hazards for Puget Sound. They have also predicted flooding hazards for Whatcom County, which they plan to expand to the rest of Puget Sound by 2027. This uncertainty aligns with several sea level rise Shoreline Armoring uncertainties that were prioritized in 2024. Evrard, PSI (05.05.24) Moved from High to Top - removed sewer outside of UGA uncertainty.

GUM ID	Uncertainty ID #	IS Strategy	Question / Uncertainty	Source	Priority Level	Notes
Sh.3	3	Ensure and maintain sufficient livestock manure management	What elements of agriculture incentives from different counties are most effective at reducing fecal bacteria contamination? and what additional barriers could be addressed through incentives?	2024 Scoping and Refinement Conversations	Top	Evrard, PSI (12.30.24): As of late 2024/ early 2025 PSI is conducting a potential joint cross - SIL incentives study that may assess economics of incentives and best practices. A completed catalog of direct to landowner financial incentives has been created (this includes agricultural incentives).
Sh.4	3.1	Ensure and maintain sufficient livestock manure management	How do we strengthen and prioritize technical assistance for BMP design and cultural reviews to bolster efficacy?	2024 Scoping and Refinement Conversations	High	Evrard, PSI (01/09/25) Through an independent search, PSI discovered research on this topic by Afronz et al (2021). PSI will soon summarize all research (and how it addresses the uncertainty) in a GUM Research Note.

GUM ID	Uncertainty ID #	IS Strategy	Question / Uncertainty	Source	Priority Level	Notes
Sh.5	5.1	Ensure and maintain sufficient livestock manure management	With climate change how will shifts in temperature and precipitation change when manure is applied to fields and by extension fecal bacteria contamination of shellfish beds?	2024 Scoping and Refinement Conversations	High	Kanojia, PSI (12.17.2024): Experts during the 2024 refinement exercise shared that outdated climate predictions (e.g., precipitation predictions, flood maps, etc.) are often used for planning. Evrard, PSI (01.14.25) Through an independent search, PSI discovered research on this topic by Smith et al. (2019). PSI will soon summarize all research (and how it addresses the uncertainty) in a GUM Research Note..

GUM ID	Uncertainty ID #	IS Strategy	Question / Uncertainty	Source	Priority Level	Notes
Sh.6	5.3	Ensure and maintain sufficient livestock manure management	How do you effectively engage hobby farmers / horse boarders to implement BMPs?	2024 Scoping and Refinement Conversations	High	Kanojia, PSI (12.17.2024): Experts at the August 12, 2024 workshop shared that horse boarders are not managed under a regulatory framework and have less potential onsite application. However, manure exchange programs can be effective. PSI will soon summarize all reasearch related to this uncertainty in a GUM Research Note including:, Lu et al (2022) and Liu, Bruins, and Heberling (2018).
Sh.7	5.2	Ensure and maintain sufficient livestock manure management	In what ways does climate change (e.g., shifting precipitation, temperatures, etc.) influence farm BMP designs, particularly lagoons? How can we incorporate more updated precipitation and flooding predictions into BMP designs?	Ross Strategic and Stormwater SIL (2023)	High	Evrard, PSI (01/10/25) Through an independent search, PSI discovered research on this topic by Wyngaarden, Anders, and Davidson (2024). PSI will soon summarize all research (and how it addresses the uncertainty) in a GUM Research Note.

GUM ID	Uncertainty ID #	IS Strategy	Question / Uncertainty	Source	Priority Level	Notes
Sh.8	7.2	Implement and support on-site sewage system (OSS) management and repair program	How do you effectively fund new LOSS and maintenance for LOSS (e.g., PUD utilities)? As part of this study, consider how many system failures or maintenance breaches occur when a LOSS is maintained by a public utility district or a homeowners association.	Ross Strategic and Stormwater SIL (2023)	High	
Sh.9	33	Implement and support on-site sewage system (OSS) management and repair program	What are the disposal options for treating septage from OSS, RVs, vessels and other sources of septage (homeless, pet waste, etc.)? Are there entities already addressing these needs?	08.12.24 Shellfish SIL Uncertainty Workshop	High	Kanojia, PSI (12.17.24): The South Sound pump out program has successfully reduced septage from boats. The Washington State Association of Local Public Health Officials hired SCJ Alliance to conduct a Septage Capacity Assessment.

GUM ID	Uncertainty ID #	IS Strategy	Question / Uncertainty	Source	Priority Level	Notes
Sh.10	2.1	Fund, support, and implement sustainable local Pollution Identification and Correction (PIC) programs	How can we increase capacity for PIC enforcement at the state level?	2024 Scoping and Refinement Conversations	High	Evrard, PSI (01.14.25) Through an independent search, PSI discovered research on this topic by Peterson (2019) and Ross Strategic (2021). PSI will soon summarize all research (and how it addresses the uncertainty) in a GUM Research Note.
Sh.11	6	Fund, support, and implement sustainable local Pollution Identification and Correction (PIC) programs	What are the most accurate, feasible, and/or cost effective test options to distinguish bacteria from wildlife, livestock, septic, pets, WWTP, boats, etc. , Is it Microbial Source Tracking or is there a better method? - What proportion of “positive” tests are due to non-fecal coliform bacteria? -What are the hurdles to existing methods and realistic expectations of effectiveness?	GUM (Francis and James, 2023)	High	Kanojia, PSI (12.17.2024): Whatcom County and Exact Scientific are creating a library of DNA to better identify sources. Slow turnaround times for accredited labs is a barrier to implementing Microbial Source Tracking.

GUM ID	Uncertainty ID #	IS Strategy	Question / Uncertainty	Source	Priority Level	Notes
Sh.12	2.2	Fund, support, and implement sustainable local Pollution Identification and Correction (PIC) programs	what are the motivators and barriers to pet owners picking up waste in their own yards to prevent stormwater pollution?	08.21.24 Regional PIC workshop	High	Evrard, PSI (1.8.25): Participants pointed to Haldeman and Schmidt (2022), Rabourn (Nd), Roble (2024), and EPA (2023) research. PSI will soon summarize this research (and how it addresses the uncertainty) in a GUM Research Note.
Sh.13	12	Fund, support, and implement sustainable local Pollution Identification and Correction (PIC) programs	What factors influence statutory and voluntary access for site visits and pollution monitoring purposes on agricultural properties? Are there different barriers for different activities (e.g., general site visit vs. monitoring)?	GUM (Francis and James, 2023)	Medium	
Sh.14	35	Implement and support on-site sewage system (OSS) management and repair program	What is the efficacy of different types of riparian buffers to reduce fecal pollution impacts?	GUM (Francis and James, 2023)	Medium	

GUM ID	Uncertainty ID #	IS Strategy	Question / Uncertainty	Source	Priority Level	Notes
Sh.15	13	Fund, support, and implement sustainable local Pollution Identification and Correction (PIC) programs	Evaluate WWTPs to determine feasibility of non-water disposal (land application/infiltration of WWTP effluent) to eliminate Prohibited areas around existing outfalls, and gain shellfish acreage?	GUM (Francis and James, 2023)	Medium	Evrard, PSI (05.05.24): Edited to reflect feedback from DOH.
Sh.16	14	Implement and support on-site sewage system (OSS) management and repair program	In terms of OSS operation and management: What enforcement activities will most likely lead to correction of failures? What are the best practices for messaging to support enforcement? How should this messaging change for different audiences?	GUM (Francis and James, 2023)	Medium	Evrard, PSI (01.10.25) Participants pointed to DOH (2016) research. PSI plans to summarize this research (and how it addresses the uncertainty) in a GUM Research Note. K. Pozarycki of Snohomish LIO shared Mohamed (2009). PSI will soon summarize this research (and how it addresses the uncertainty) in a GUM Research Note.

GUM ID	Uncertainty ID #	IS Strategy	Question / Uncertainty	Source	Priority Level	Notes
Sh.17	9	Implement and support on-site sewage system (OSS) management and repair program	What elements of OSS incentives from different counties are most effective at reducing fecal bacteria contamination? And what additional barriers could be addressed through incentives?	Ross Strategic and Stormwater SIL (2023)	Medium	Kanojia, PSI (12.17.2024): Experts during the 2024 refinement exercise highlighted that the upfront capital requirements for rebates, paperwork burden, and eligibility restrictions are barriers to effectively implementing incentives. Improving technical assistance for design and cultural reviews may also strengthen incentives. Evrard, PSI (12.30.24): As of late 2024/ early 2025 PSI is conducting a potential joint cross - SIL incentives study that may assess economics of incentives and best practices. A completed catalog of direct to landowner financial incentives has been created (this includes OSS incentives).

GUM ID	Uncertainty ID #	IS Strategy	Question / Uncertainty	Source	Priority Level	Notes
Sh.18	15	Implement and support on-site sewage system (OSS) management and repair program	How effective are OSS loan and financial assistance programs at facilitating the replacement of OSSs? How well are they serving over-burdened communities? If not, are there modifications which would increase their utilization?	GUM (Francis and James, 2023)	Medium	Evrard, PSI (01.10.25) Participants pointed to Greene Economics (2022) research. PSI will soon summarize this research (and how it addresses the uncertainty) in a GUM Research Note.
Sh.19	10	Implement and support on-site sewage system (OSS) management and repair program	What specifically needs to be understood about circulation and dilution to support work in areas with frequent changes to classification through upgrades and downgrades of growing areas (e.g., identify potential sources, determine appropriate precautionary exclusion zones, etc.)?	GUM (Francis and James, 2023)	Medium	Evrard, PSI (05.05.25): Revised based on feedback from DOH.
Sh.20	8	Fund, support, and implement sustainable local Pollution Identification and Correction (PIC) programs	What is the likelihood and impact of fecal bacteria survival and regrowth in soils, marine sediment and stagnant water? What conditions lead to regrowth?	GUM (Francis and James, 2023)	Medium	

GUM ID	Uncertainty ID #	IS Strategy	Question / Uncertainty	Source	Priority Level	Notes
Sh.21	16	Fund, support, and implement sustainable local Pollution Identification and Correction (PIC) programs	What factors influence statutory and voluntary access for site visits and pollution monitoring purposes on properties within PIC areas? Are there different barriers for different activities (e.g., general site visit vs. monitoring)?	GUM (Francis and James, 2023)	Low	
Sh.22	36	Fund, support, and implement sustainable local Pollution Identification and Correction (PIC) programs	What are the bacteria reduction capabilities of traditional stormwater facilities?	2024 Shellfish SIL Discussion	Low	Kanojia, PSI (12.2024): The International Stormwater BMP Database: 2020 Summary Statistics (Clary et al. 2020) provides an overview of BMP treatment levels. Evrard, PSI (05.05.25): merged with previously low-rated uncertainty based on feedback from DOH.

GUM ID	Uncertainty ID #	IS Strategy	Question / Uncertainty	Source	Priority Level	Notes
Sh.23	37	Fund, support, and implement sustainable local Pollution Identification and Correction (PIC) programs	E. coli and enterococci monitoring in freshwater vs. fecal coliform in marine: how do we use both parameters/standards to monitor and make decisions? What is the impact to PIC programs due to this change?	Ross Strategic and Stormwater SIL (2023)	Low	Evrard, PSI (05.05.24): Edited to reflect feedback from DOH.
Sh.24	34	Fund, support, and implement sustainable local Pollution Identification and Correction (PIC) programs	How can real time bacteria monitoring/automated bacteria sampling be improved to get results faster? What works?	GUM (Francis and James, 2023)	Low	
Sh.25	18	Fund, support, and implement sustainable local Pollution Identification and Correction (PIC) programs	How much do field drains contribute to fecal bacteria pollution?	GUM (Francis and James, 2023)	Low	Evrard, PSI (05.05.25): Broadened to all ditches and impacts on receiving water (previously just v-ditches). Based off of feedback from DOH.

GUM ID	Uncertainty ID #	IS Strategy	Question / Uncertainty	Source	Priority Level	Notes
Sh.26	17	Ensure and maintain sufficient livestock manure management	Do legacy manure storage areas/piles contribute to pathogenic bacteria pollution? How are counties approaching legacy manure management?	2023 Shellfish IS Narrative (Shellfish Strategic Initiative, 2023)	Low	Evrard, PSI (01/09/25) Through an independent search, PSI discovered research on this topic by American Farmland Trust, King Conservation District, and Whatcom Conservation District (2021). PSI will soon summarize all research (and how it addresses the uncertainty) in a GUM Research Note.
Sh.27	42	Ensure and maintain sufficient livestock manure management	Are dairies and horse boarding businesses producing more manure fertilizer than can be properly applied to surrounding farmlands and pastures without creating off-site impacts from fecal bacteria? What incentives or cost effective programs can we offer to these businesses to better distribute manure to farmlands or pastures that need it?	Ross Strategic and Stormwater SIL (2023)	Low	

GUM ID	Uncertainty ID #	IS Strategy	Question / Uncertainty	Source	Priority Level	Notes
Sh.28	20	Ensure and maintain sufficient livestock manure management	Does manure handling and application contribute to fecal bacteria contamination to surface and groundwater?	Ross Strategic and Stormwater SIL (2023)	Low	
Sh.29	21	Fund, support, and implement sustainable local Pollution Identification and Correction (PIC) programs	What is the environmental and economic impact of shellfish aquaculture?	Ross Strategic and Stormwater SIL (2023)	Low	
Sh.30	43	Fund, support, and implement sustainable local Pollution Identification and Correction (PIC) programs	Is there sufficient land to move the beds higher to accommodate rising sea levels? Are there measures we can take to protect the beds from excessive heat?	Ross Strategic and Stormwater SIL (2023)	Low	

GUM ID	Uncertainty ID #	IS Strategy	Question / Uncertainty	Source	Priority Level	Notes
Sh.31	27	Implement and support on-site sewage system (OSS) management and repair program	What factors influence statutory and voluntary access for site visits and pollution monitoring purposes on properties with OSSs? Are there different barriers for different activities (e.g., general site visit vs. monitoring)?	GUM (Francis and James, 2023)	Low	
Sh.32	22	Fund, support, and implement sustainable local Pollution Identification and Correction (PIC) programs	Can modeling contribute to the strategy for managing wastewater treatment plant outfalls?	GUM (Francis and James, 2023)	Low	
Sh.33	23	Implement and support on-site sewage system (OSS) management and repair program	Where are there gaps in OSS management support? Does the support differ between communities/jurisdictions? Are there best practices?	GUM (Francis and James, 2023)	Low	Kanojia, PSI (12.17.24): Puget Sound counties are required by WAC 246-272A-0015 to have local management plans in place for OSS. Washington Department of Health provides technical documentation, including the 2016 Best Management Practices Reference Manual.

GUM ID	Uncertainty ID #	IS Strategy	Question / Uncertainty	Source	Priority Level	Notes
Sh.34	24	Implement and support on-site sewage system (OSS) management and repair program	What are the strengths/weaknesses of different monitoring tools in terms of identifying failing OSSs? What are the barriers in terms of access, regulation, etc. to effective monitoring?	GUM (Francis and James, 2023)	Low	
Sh.35	25	Implement and support on-site sewage system (OSS) management and repair program	What are the long-term performances of OSS with advanced nutrient removal? What are the maintenance requirements? What is their effectiveness against fecal bacteria?	08.12.24 Shellfish SIL Uncertainty Workshop	Medium	
Sh.36	26	Implement and support on-site sewage system (OSS) management and repair program	To what extent are new OSS being installed in unsuitable locations that will impact shellfish growing areas, including areas projected to be impacted by sea level rise? To what extent are checks in place to limit new OSS in these areas?	08.12.24 Shellfish SIL Uncertainty Workshop	Medium	

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Sh.37	38	Fund, support, and implement sustainable local Pollution Identification and Correction (PIC) programs	How are WWTP required to prepare for and mitigate climate change impacts (i.e. rising sea level, increased flooding and significant rainfall events) to prevent system failures and overflows.	08.12.24 Shellfish SIL Uncertainty Workshop	Medium	
Sh.38	28	Implement and support on-site sewage system (OSS) management and repair program	How can DOH and local health jurisdictions (LHJ) better support data management and mapping of OSS systems? What sort of data management and mapping programs for OSS are in place and is there consistency between LHJs? How can consistency be improved?	08.12.24 Shellfish SIL Uncertainty Workshop	Medium	Evrard, PSI (01.10.25) Through an independent search, PSI discovered research on this topic by Isaksen and Jackson (2019). PSI will soon summarize all research (and how it addresses the uncertainty) in a GUM Research Note.
Sh.39	19	Fund, support, and implement sustainable local Pollution Identification and Correction (PIC) programs	What is the intersection between nutrients and fecal coliform in respect to PIC programs? Are PIC programs an effective means of achieving nutrient reduction?	08.12.24 Shellfish SIL Uncertainty Workshop	Low	

GUM ID	Uncertainty ID #	IS Strategy	Question / Uncertainty	Source	Priority Level	Notes
Sh.40	41	Fund, support, and implement sustainable local Pollution Identification and Correction (PIC) programs	How has the removal of shellfish impacted water quality among shorelines or what role does the shellfish population play in maintaining water quality standards?	08.12.24 Shellfish SIL Uncertainty Workshop	Low	Evrard, PSI (01.10.25) Through an independent search, PSI discovered research on this topic by Agnew et al (2022). PSI will soon summarize all research (and how it addresses the uncertainty) in a GUM Research Note.
Sh.41	29	Fund, support, and implement sustainable local Pollution Identification and Correction (PIC) programs	What are the current/future impacts of ocean acidification on shellfish? Are there areas/habitats that are particularly vulnerable? What are mitigation measures?	08.12.24 Shellfish SIL Uncertainty Workshop	Low	
Sh.42	30	Fund, support, and implement sustainable local Pollution Identification and Correction (PIC) programs	What are the dynamics of domoic acid accumulation in bivalves? Will climate change increase the frequency/magnitude of HABs events? What are management actions?	08.12.24 Shellfish SIL Uncertainty Workshop	Low	

GUM ID	Uncertainty ID #	IS Strategy	Question / Uncertainty	Source	Priority Level	Notes
Sh.43	40	Fund, support, and implement sustainable local Pollution Identification and Correction (PIC) programs	What are the barriers to creating stable PIC funding? Are there state and federal laws that need to be changed? How does EPA funding provide stable funding for LIO and MRC Coordinators?	08.12.24 Shellfish SIL Uncertainty Workshop	Low	
Sh.44	46	Fund, support, and implement sustainable local Pollution Identification and Correction (PIC) programs	What is the 'gold standard' or basics of a PIC program; how can it be measured?	08.12.24 Shellfish SIL Uncertainty Workshop	Low	
Sh.45	48	Implement and support on-site sewage system (OSS) management and repair program	Which communities have historically been excluded from sewer expansion? What are the costs to government and property owners to convert urban OSS to sewer in areas where racial restrictions prevented equitable access to wastewater infrastructure during development.	Nov. 2024 Shellfish SIL Uncertainty Google Form response and 2024 Onsite Wastewater Mega-Conference	Low	Kanojia, PSI (12.17.2024): The King County Equitable Wastewater Futures program has funded two pilot projects using \$2 million from the King County Climate Equity Capital Pool to extend sewer connections to up to 24 homes in 2024. This work will also make sewer connection opportunities available to new neighborhoods.

