

Appendix C: Monitoring Strategy

Key Focus Areas for 2021-2016

Introduction

The Monitoring Strategy will expand upon actions and activities described in Chapters 1–2 of the 2019 CCMP (Water Quality and Habitat Restoration). Monitoring is necessary to measure the effectiveness of the priority actions and to detect changes (deterioration or improvement) in TEP’s focus area. Identifying status and trends in water quality parameters and habitat characteristics allows quantification of changing environmental conditions that inform adaptive management strategies affecting TEP’s areas of focus.

Monitoring and assessment are necessary to comprehend current conditions in target areas, understand underlying ecological components and processes that sustain them, and determine the effects of land uses and conservation actions. An understanding of historic, current, and probable future conditions allows for prioritization of target communities for conservation and implementation of appropriate restorative actions to achieve desired goals. Monitoring and assessment both focus on biological attributes and the physical attributes that shape the environment (e.g., hydrology, geology).

Project-scale effectiveness monitoring measures environmental parameters to determine if habitat enhancements are meeting predetermined objectives. This evaluation process requires both pre- and post-project data collection (and study of control or reference sites, if possible) and allows for comparison of the habitat enhancement projects TEP and its partners undertake. TEP uses monitoring protocols that are consistent with other effectiveness monitoring efforts in the region.

An additional component of aquatic habitat condition is water quality. TEP has identified priority water quality issues that affect aquatic habitat and human health and has developed monitoring programs to track changes over the long-term. TEP has a robust Volunteer Water Quality Monitoring Program (VWQMP) that collects bacteria data to determine water quality status and trends over time. Additionally, TEP is working with Oregon DEQ to collect long-term temperature data and collaborate on an effective analysis strategy. TEP is also collaborating with partners to track the effects of ocean acidification in Tillamook Bay. Other water quality parameters are of interest, but as yet, challenges associated with data collection or lack of evaluation methods have limited TEP’s ability to implement appropriate strategies.

This Monitoring Strategy (MS) describes actions and activities at the center of TEP’s implementation efforts during the five-year period, 2021–2026. Additional CCMP Action Items may be implemented by partners or may be reconsidered for TEP implementation should unanticipated opportunities arise.

More details on each CCMP Action Item referenced in this MS are found in Chapters 1–2 (Water Quality and Habitat Restoration, respectively) of TEP’s CCMP, which includes the need for monitoring and assessment (why), objectives/goals (what), project leads (who), timing (when), activities, anticipated costs, sources of

funding, timing, and performance measures (how). Estuary and watershed profiles for TEP’s focus areas may be found in Chapter 4 of the CCMP.

This MS encompasses:

- Prioritized CCMP Action Items based on impact, relevancy, funding, and resources
- Key Monitoring Activities (Table C-1) with collaborative actions to create/develop
 - Inventories of current TEP and partner monitoring efforts
 - Current lists of indicators and data gaps
 - Methods and frequencies of collecting and monitoring data
 - Data sharing protocols (partners, public, decision makers, stakeholders)
 - Data analyses and applications
 - Pre- and post-project effectiveness monitoring
 - CCMP administrative program performance tracking
- Goals and Measurable Objectives – Outputs and Outcomes (Table C-2)
- Links between Climate Preparedness and this Monitoring Strategy (Table C-3)

Performance measures are reported via annual GPRA (NEPORT) reports, TEP annual reports/meetings, State of the Bays, social media updates, and EPA Performance Evaluations.

Prioritized CCMP Action Items for 2021-2026

To develop the prioritized actions and project types included in the MS, TEP enlisted the expertise of its staff, Board of Directors, and key partners during the revision of TEP’s CCMP. The following priorities are based on this expertise and guided by the most current and relevant science-based literature available. The literature utilized to determine priorities include local and regionally focused action plans, limiting factors analysis, ESA recovery plans, and conservation strategies. Links to many of these references may be found in the Introduction to TEP’s 2019 CCMP (page v).

While all of the actions incorporated in TEP’s 2019 CCMP are critically important to TEP’s overarching goal and remain a focus, TEP has chosen the following MS priorities to maximize the assessment and monitoring of ecological trends and the filling of critical data gaps during the next five years given the staff and funding resources available. TEP committed to evolving its priorities over time to align with the best available science and management practices.

[Water Quality Assessment and Monitoring](#)

- WAQ-01 Improve farm management practices to address water quality.
- WAQ-02 Improve rural residential and urban infrastructure to address water quality.
- WAQ-03 Enhance riparian and in-stream areas throughout the watersheds to improve water quality.
- WAQ-04 Restore channel features and hillslope management to improve sediment storage and routing to address water quality.
- WAQ-05 Identify status and trends and quantify changing environmental conditions in water quality to inform adaptive management strategies impacting TEP’s priority areas.



Assessment and Prioritization

- HAB-01 Assess and prioritize estuarine habitats.
- HAB-03 Assess and prioritize instream habitats.
- HAB-04 Assess and prioritize riparian habitats.

Conservation and Restoration

- HAB-09 Maximize ecosystem connectivity to ensure a landscape array of ecosystem processes and ease of species movement.
- HAB-10 Provide genetically appropriate native vegetation and promote its use among habitat restoration and enhancement partners

Species Focus

- HAB-11 Assess, prioritize, and enhance key native species.
- HAB-12 Assess, prioritize and manage non-native species.
- HAB-13 Assess and implement best management practices for key habitat conservation

Key Monitoring Activities for 2021-2026

Table C-1 highlights TEP’s key monitoring activities which are designed to satisfy the CCMP actions prioritized in the MS. Included in the table are the names of each project and unique identification codes useful in referencing them throughout this Appendix C. For each project, primary tasks are listed with an estimate of the timeframe during which they will be complete along with the CCMP actions that each project will address, the likely partners involved, and an estimate of the total costs to complete the key activities. Cost estimates align with those used in TEP’s Anatomy of a CCMP Action (see the 2019 CCMP Introduction, page xviii).

Goals and Measurable Objectives for 2021-2026

Table C-2 lists the key measurable objectives (outputs) associated with each project and the long-term goals (outcomes) TEP hopes to achieve by carrying out the effort. Outputs consist of project deliverables such as acres restored or plants planted. Outcomes focus on changes in knowledge, in behaviors, and to ambient conditions, ecological functions, and biological populations (e.g. current status and trends in water quality, health and abundance of habitats and living resources). These definitions for outputs and outcomes are in accordance with the EPA’s “[National Estuary Program - Program Evaluation Guidance](#)” logic model.

Links Between Climate Change Preparedness and Restoration Strategy

Table C-3 illustrates how TEP’s priority projects listed in the MS achieve meaningful progress towards the actions called for in TEP’s climate vulnerability assessment and adaptive management strategy. The first two columns list the specific climate change preparedness strategy/potential actions and their relative priority (low, medium, high) as indicated in TEP’s 2019 CCMP. In the following columns, each project identified in the MS is listed by its respective identification code. An “x” in the box denotes that a particular MS project directly or indirectly contributes to the achievement of the actions identified in TEP’s vulnerability assessment.

Table C-1 Key Monitoring Projects and Activities for 2021-2026

More information on each CCMP Action and on Partner acronyms may be found in Chapters 1–2 and Appendix A of TEP’s 2019 CCMP, respectively. Cost: \$= <\$25,000; \$\$= \$25,000 to \$99,999; \$\$\$= \$100,000 to \$499,999; \$\$\$\$= >\$500,000

Key Monitoring Activities	Y 1	Y 2	Y 3	Y 4	Y 5	Partners	Cost	Current TEP Indicators	Current Partner Indicators	Data Gaps
Water Quality Monitoring for Bacteria (WQ1)										
Collect and analyze fresh and brackish water samples biweekly	x	x	x	x	x	Citizen Scientists, DEQ	\$	E. coli and enterococcus concs: sampled twice a month	E.coli concs and OWQI score: sampled four times a year	Additional sampling locations, continuing MST analysis
Record data online to inform public through interactive map	x	x	x	x	\$					
Report status and trends of bacteria levels		x		x	\$					
Long-term Temperature Monitoring (WQ2)										
Deploy approximately 20 temperature loggers in priority watersheds	x	x	x	x	x	DEQ, NNSL, USFS	\$	# of Days that 7-day maximum exceeds standards: every other year	Daily maximum high temp, quarterly temp value	Annual data collection for all locations, larger dataset for trend analysis
Format and analyze temperature results	x	x	x	x	x	\$				
Summarize apparent trends		x		x		\$				
Ocean Acidification Monitoring (WQ3)										
Deploy monitoring equipment in Tillamook Bay	x	x				EPA, OOMG, OSU, ODFW, OHSU, PSU	\$\$	Develop alkalinity & salinity relationship	Develop alkalinity & salinity relationship	Monitoring in other TEP estuaries
Assess Project Results and Report			x				\$\$			
Develop and implement long-term monitoring				x	x		\$\$			
Dissolved Oxygen Monitoring (WQ4)										
Estuary Characterization		x		x		DEQ	\$\$	DO concs: 15 minute interval during critical season	None	Strategy for Tillamook County
Develop and implement long-term DO monitoring		x	x	x	x		\$\$			
Complete Coho Strategic Action Plan for Tillamook and Nestucca Watersheds (COH01)										
Assemble Technical Advisory Committee to establish project scope, funding needs	x	x				Wild Salmon Center, NOAA, NNSLWC, SSH, Many Others	\$		OPRD, NNSLWC, USFS, TCPWD, TDM, ODFW	Baseline assessment of Coho habitat that could benefit from restoration
Fundraise for Tillamook & Nestucca (grants)	x	x					\$			
Assess and prioritize areas for habitat enhancement; inform restoration action COH02		x	x	x			\$\$\$			
Develop and implement pre- (baseline) and post-restoration monitoring protocols (MNTR1)										
Assemble Technical Team (NCLC, TNC, LNCT, LNWC, NNSLWC, SSH & SFC Members)	x					NNSLWC, LNWC, UNWC, WEBS, DEQ, USFWS, ODF, ODFW, USFS, TNC, Tillamook County & cities	\$			TBD: site and project dependent (e.g. wildlife species presence/ abundance, water quality/ quantity, blue carbon, plant survival)
Create inventory of TEP and partner (Local, NEP) restoration monitoring efforts	x	x					\$			
Standardize data collection, archiving, and sharing protocols	x	x					\$			
Develop quality management plans	x	x	x	x			\$			
Fundraising (grants) for monitoring equipment and supplies	x	x	x	x	x		\$			
Conduct annual/seasonal baseline monitoring at prioritized sites (e.g. TRW, SS, SFC)		x	x	x	x		\$\$\$			
Conduct planned post-restoration monitoring at prioritized sites (e.g. SFC, SSH, BYPP)		x	x	x	x		\$\$\$			



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Key Monitoring Activities	Y 1	Y 2	Y 3	Y 4	Y 5	Partners	Cost	Current TEP Indicators	Current Partner Indicators	Data Gaps
Propagation success and distribution of native plants from TEP nursery (NPN2)										
Access locations throughout Tillamook County to identify sources of target native seed species	x	x	x	x	x	OYA, NORP members, volunteers	\$	Seed counts, # of source plants, specimens and photos	Seed counts, # of source plants, specimens and photos	Additional seed source locations; improved survival rates
Monitor native seed germination success in TEP’s Assess locations nursery	x	x	x	x	\$		% of sown seeds that germinate			
Monitor propagation success of native plants in TEP’s nursery	x	x	x	x	\$		# of plants propagated			
Monitor out-plant survival at restoration sites	x	x	x	x	\$\$		% survival 1-3 years post-restoration			
Program Administration (GPRA1)										
Monitor annual restoration project for GPRA/NEPORTs	x	x	x	x	x	NNSLWC, LNWC, UNWC, WEBS, DEQ, USFWS, ODF, ODFW, USFS, Tillamook County & cities	\$	Restoration technique, GPS, acres	Restoration technique, GPS, acres	

Table C-2 Goals and Measurable Objectives for 2021-2026

Key monitoring activities from Table C-1 are repeated in Table C-2.

Key Restoration Activities	Outputs “Deliverables”	Short-term Outcomes “Knowledge” (~1-2 years)	Intermediate Outcomes “Behaviors” (~3-4 years)	Outcomes <i>To restore and maintain the ecological integrity of estuaries of national significance. Fishable/Swimmable Waters</i>
Water Quality Monitoring for Bacteria (WQ1)				
Collect and analyze fresh and brackish water samples biweekly	Publicly accessible data through Interactive online map	Water quality conditions (status and trends) for all monitoring locations	Implement riparian and wetland restoration and septic & infrastructure improvement projects	Document increase in number of monitoring locations that are meeting water quality standard and increase in number of locations that have improving trends
Record data online to inform public through interactive map				
Report status and trends of bacteria levels				
Long-term Temperature Monitoring (WQ2)				
Deploy approximately 20 temperature loggers in priority watersheds	Collect, process, and upload temperature data to DEQ AWQMS database	Determine number of days sites exceed the 7 day Maximum temperature standard	Implement riparian and wetland restoration projects	Document increase in number of monitoring locations that are meeting water quality standard and maintain and increase riparian vegetation to protect and provide cool water refugia
Format and analyze temperature results				
Summarize apparent trends				
Ocean Acidification Monitoring (WQ3)				
Deploy monitoring equipment in Tillamook Bay	Collect data at appropriate frequency and upload to DEQ AWQMS database	Document seasonal and episodic changes in acidity and establish an alkalinity and salinity relationship	Develop a monitoring strategy based on lessons learned that can be deployed in other estuaries.	Track changes in water column characteristic over the long-term in Tillamook Bay and expand monitoring to over estuaries when appropriate : Assess necessary adjustments for shellfish rearing
Assess Project Results and Report				
Develop and implement long-term monitoring				
Dissolved Oxygen Monitoring (WQ4)				
Estuary Characterization	Collect data at appropriate frequency and upload to DEQ AWQMS database	Determine DO conc and compare to water quality standard and reference conditions	Implement estuary and freshwater riparian and wetland restoration projects	Develop an areawide DO monitoring strategy to track changes over time
Develop Long-term DO Monitoring Strategy				
Complete Coho Strategic Action Plan for Tillamook and Nestucca Watersheds (COH01)				
Assemble Technical Advisory Committee to establish project scope, funding needs	Completed strategic action plan for Coho in Tillamook and Nestucca watersheds	Identification of optimal locations for large wood, beaver dam analogs, and other restoration efforts	Results shall inform restoration action COH02	Reconnection of salmonid habitat
Fundraise for Tillamook & Nestucca (grants)				
Assess and prioritize areas for habitat enhancement; inform restoration action COH02				
Develop and implement pre- (baseline) and post-restoration monitoring protocols (MNTR1)				
Assemble Technical Team (NCLC, TNC, LNCT, LNWC, NNSLWC, SSH & SFC members)	Region-wide comparable data with	BMPs identified; partner understanding of	Standardized protocols; shared results; baseline	Metrics of restoration success across all projects and partners working in



Table C-2 Goals and Measurable Objectives for 2021-2026

Key monitoring activities from Table C-1 are repeated in Table C-2.

Key Restoration Activities	Outputs “Deliverables”	Short-term Outcomes “Knowledge” (~1-2 years)	Intermediate Outcomes “Behaviors” (~3-4 years)	Outcomes <i>To restore and maintain the ecological integrity of estuaries of national significance. Fishable/Swimmable Waters</i>
Create inventory of TEP and partner (Local, NEP) restoration monitoring efforts (INV)	restoration and reference sites identified for future work; approved QMPs; annual and seasonal baseline and post-restoration monitoring results	shared protocols; better understanding of baseline habitat conditions; understanding of priority variables to meet long-term outcome goals; understanding factors impacting restoration success	monitoring adapted to suit long-term outcome goals; adaptive restoration management	Tillamook County and among NEPs; increased acreage/mileage of restored habitat; decreased follow-up/ maintenance at restoration sites
Standardize data collection, archiving, and sharing protocols (Data-Proto)				
Develop quality management plans				
Fundraising (grants) for monitoring equipment and supplies				
Propagation success and distribution of native plants from TEP nursery (NPN2)				
Propagation success and distribution of native plants from TEP nursery (NPN2)				
Assess locations throughout Tillamook County to identify sources of target native seed species	Seeds sources mapped; seeds germinated into plant stock; native plants propagated and available for restoration projects; long-term monitoring of outplant sites	Sufficient seed sources identified for optimal genetic diversity; factors impacting germination, propagation, and outplant survival identified; importance of native plants shared with community and youth work crews during education and volunteer events	Seed sourcing and nursery propagation techniques optimized; community appreciation of native plants ; increased participation in stewardship activities	Robust native plant stock available for restoration projects with high survival and genetic diversity
Monitor native seed germination success in TEP’s nursery				
Monitor propagation success of native plants in TEP’s nursery				
Monitor out-plant survival at restoration sites				
Program Administration (GPR1)				
Monitor annual restoration project for GPR1/NEPORTs	Annual leverage reports	Awareness of partner restoration projects throughout Tillamook County	Increased collaborations	Larger, landscape-scale restoration efforts

Table C-3 Climate Change Preparedness and Monitoring Strategy Crosswalk for 2021-2026

* “Priority from VA” refers to the Vulnerability Assessment conducted by TEP and its partners in preparation for the 2019 CCMP (see Chapter 4, Table 5, pp. 105-110). The final two columns have been left blank intentionally to allow for the inclusion of additional projects in the future.

Priority from VA*	Climate Change Preparedness Strategy/Potential Actions	Monitoring Strategy Activities for 2021-2026											
		WQ1	WQ2	WQ3	WQ4	COH1	MON1	NP2	GPRA1				
	Limit nutrient inputs												
High	Water quality monitoring and assessment (for quicker response)	x		x	x	x	x						
	Stormwater management	x		x	x								
	Agricultural management												
High	Animal exclusion fencing	x		x	x								
	Off channel watering	x		x	x	x							
Medium	Improve drainage function of lower tidal wetlands through restoration, thereby improving productivity of upland agricultural areas		x		x						x		
	Improvement to infrastructure												
High	Identify culverts and roads most at risk of failure from high flows (esp. those culverts with insufficient capacity)						x						
	Replace or remove culverts and roads most at risk						x		x	x			
Medium	Improvements to stormwater infrastructure (including stormwater retention)	x	x	x	x	x				x			
	Reduce miles of unmaintained forest roads by fully decommissioning (remove culverts, pull back unstable slopes, reduce landslide risk)		x				x		x	x			
	Identify and prioritize areas for restoration												
High	Identify sites where gravel deposits and downed wood might enhance the fish habitat		x				x	x					
	Identify areas and prioritize by estuarine and freshwater type. Freshwater wetlands expected to be more vulnerable under drought scenarios.		x		x		x	x					
	Protect existing habitat												
High	Protect existing healthy riparian vegetation, which provides shade	x	x	x	x	x	x	x	x				
	Restore wetlands and floodplains												
High	Restore floodplain connectivity for freshwater and tidally influenced wetlands and examine underlying influence on hydrology	x	x	x	x	x	x	x	x				
	Riparian restoration in stream related wetlands	x	x		x	x	x	x	x				
Medium	Planting and restoration of wetlands with species that are better adapted to climate variability	x	x	x	x	x	x	x					
	Habitat improvement												
High	Large woody debris (LWD) to collect gravels for more subsurface flow and assist catching landslide material		x				x	x			x		
	Riparian plantings	x	x	x	x	x	x	x	x	x			
	Floodplain habitat restoration		x		x	x	x	x	x	x			
	Reconnect springs, wetlands, floodplains that can serve as cold water refugia		x		x	x	x	x	x	x			
Medium	Increase diversity of habitat to create more salmonid life history options		x		x	x	x	x	x	x			



Table C-3 Climate Change Preparedness and Monitoring Strategy Crosswalk for 2021-2026

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Priority from VA*	Climate Change Preparedness Strategy/Potential Actions	Monitoring Strategy Activities for 2021-2026									
		WQ1	WQ2	WQ3	WQ4	COH1	MON1	NP2	GPRA1		
	Increase off-channel habitat					x	x		x		
	Stream channel restoration to create more channel complexity		x			x	x	x	x		
	Expand conservation and restoration activities to ensure maintenance of specific types of wildlife habitat					x	x	x	x		
	Large scale, holistic floodplain management to maintain and enhance complexity and function	x	x	x	x	x	x		x		
	Forest management strategy to balance water absorption		x				x				
Low	Setback dikes to increase channel width and improve floodplain function	x	x	x	x	x	x		x		
Increase natural upland water storage											
Medium	Promote beaver habitat in the uplands		x			x	x		x		
Reduce impacts of new and existing development on estuaries											
High	Replace/remove/remediate existing infrastructure and development vital to estuary conservation and ecological functioning over long timeframe		x		x	x	x	x	x		
Assess and manage for projected change											
High	Using sea level rise study/report, assess culverts, dikes, other infrastructure, and areas at risk		x		x	x	x				
	Protect/restore/conservate areas that will become new habitat with sea level rise		x		x	x	x	x	x		
Medium	Develop/use models to view stream and estuary conditions 50-100 years out (for planning current and near future actions)		x		x	x					
	Identify at-risk habitats, birds, and species					x	x				
	Re-map estuarine sediments and habitats					x	x				
Low	Revise management units to protect estuarine fringe	x	x	x	x	x	x				
Manage streamflow											
Medium	Sustainable water storage and release		x		x						
Increase strategy for invasive management											
Medium	Aggressive PRISM approach					x	x	x	x		
Improve riparian planting survival											
High	Plant diverse species in riparian zones	x				x	x	x	x		
	Replant riparian areas as needed	x	x	x	x	x		x	x		
	Monitor riparian planting survival					x	x				
Increase forest diversity and resilience											
High	Replant with multiple tree species to preserve and enhance diversity		x	x	x	x	x	x	x		
Medium	Assess establishment and survival of tree species post-disturbance and over longer time periods to determine the most suitable species for planting	x	x	x	x	x	x	x			
Reduce greenhouse gas emissions											
Medium	TBD – reduce greenhouse gas emissions			x	x	x	x	x	x		

Table C-3 Climate Change Preparedness and Monitoring Strategy Crosswalk for 2021-2026

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Priority from VA*	Climate Change Preparedness Strategy/Potential Actions	Monitoring Strategy Activities for 2021-2026									
		W Q 1	W Q 2	W Q 3	W Q 4	C O H O 1	M O N T 1	N P N 2	G P R A 1		
Develop appropriate vegetation management actions if changes detected											
Medium	Change in the type of vegetation used in riparian restoration activities	x	x	x	x	x	x	x			
Continue with current management strategies and monitor for changes											
High	Continue water quality monitoring	x	x	x	x		x				
	Monitor for changes in vegetation		x				x	x	x		
Medium	Maintain Riparian Management Areas (RMAs) strategies	x	x	x	x	x	x				
Improve understanding of risks related to wildfire, forest management and climate change											
Medium	Assess fuels across landscape (wetter coast to drier inland) and manage appropriately		x					x			
	Review riparian practices for areas affected by wildfire		x					x			
	Based on the results of the assessment, manage fuels for reduced wildfire severity while maintaining ecological values and function		x					x			
Low	Review salvage logging practices for better understanding of how the risk affects the region		x					x			
Reduce visitor impacts to bays and rivers											
High	Education and outreach to share water quality info with stakeholders and users	x						x			
	Education and outreach on visitor impacts	x						x			
	Education and outreach to keep users away from stressed areas						x	x			

