

**TABLE 9-1
WRIA 9 Proposed Monitoring Recommendations**

Type of Monitoring (monitoring questions)	Recommended Monitoring	What is status of existing monitoring?	How much will it cost? (Planning estimates, only)	Committee Tasks for Coordination During Plan Implementation
<p>Direct Effectiveness*</p> <ul style="list-style-type: none"> • Did the action(s) result in the anticipated habitat response? • Are salmon present and how are they using the site? 	<p>Project Actions: The following are the types of project actions:</p> <ol style="list-style-type: none"> 1. levee setbacks/ floodplain connection 2. side-channel habitat 3. large woody debris placement 4. gravel supplementation 5. improving water quality (e.g., temperature, dissolved oxygen) 6. riparian revegetation 7. creation of shallow water habitat 8. noxious weed control 9. creation of salt marshes/mudflats 10. soft shoreline armoring <p>Note: Prioritization of project actions for monitoring to be based on uncertainty regarding habitat and population response relationships Monitoring plan would include clear statement of goals and objectives, questions to be answered, hypotheses, response indicators, monitoring design, decision criteria, sampling approach, specific methods, testing for significance, data management and reporting.</p>	<ul style="list-style-type: none"> • There are a few monitoring programs geared towards evaluating the direct effectiveness of projects or to improve future designs. However, the majority of monitoring conducted at the project scale is that required by permit conditions. Some qualitative/semi-quantitative assessment of individual projects may be carried out by implementing entities. • U.S. Army Corps of Engineers is monitoring the effectiveness of gravel and wood supplementation, including intensive gravel monitoring from 2004-2009 that involves cross-section surveys, gravel patch mapping, pebble counts, and redd mapping (estimated \$40,000 annually). Habitat monitoring by the Corps listed below is also geared to evaluate effectiveness of gravel and large woody debris projects. • The Lower Newaukum Creek restoration project recently funded by the Salmon Recovery Funding Board (SRFB) was selected for more rigorous monitoring using the "Protocol for monitoring effectiveness of in-stream habitat projects" developed by the SRFB. 	<ul style="list-style-type: none"> • Sample by project type –per Salmon Recovery Funding Board– costs range from \$4,000 (rip-rap removal) to \$175,000 (off-channel habitats and wetlands) • Total cost will depend on type and number of plan actions; representative monitoring expected both in WRIA 9 and within Puget Sound Evolutionarily Significant Unit • King Conservation District grant (\$30,000) approved to support pilot program to develop monitoring program design and some baseline monitoring for two projects <p>Total Direct Effectiveness Cost: Estimated annual range may vary from \$400,000-500,000 depending on the number and types of projects implemented. [Note: some of these costs could possibly be covered as part of overall project costs.]</p>	<ul style="list-style-type: none"> • WRIA 9 Technical Committee or successor should coordinate monitoring protocols and results with the Salmon Recovery Funding Board staff. • Coordination of project direct effectiveness monitoring efforts should also occur at the regional (Puget Sound Evolutionarily Significant Unit) level.
<p>Cumulative Effectiveness*</p> <p>Chinook Salmon</p> <ul style="list-style-type: none"> • Is the distribution of spawning Chinook increasing in the Green River, tributaries, and side channels? • Is the productivity of Chinook salmon life history trajectories increasing? • Have changes to habitat improved egg to outmigrant survival (i.e. improved juvenile distribution across habitats in Middle/Lower Green and Duwamish)? 	<p>Adult salmon spawner surveys: Middle/Lower Green River, Upper Green River (after passage), Newaukum and Soos creeks</p> <p>Smolt (screw) trapping:</p> <ul style="list-style-type: none"> • Mainstem Green River at river mile 34.5 • Possibly at river mile 18 also in some years <p>Juvenile migration and distribution:</p> <ul style="list-style-type: none"> • Duwamish seining • Otolith studies • Juvenile snorkel index reaches • Juvenile distribution (electrofishing, traps, hydro-acoustics) <p>(Otolith study would be used to examine fish growth in relation to fish density and to estimate residence time in Duwamish estuary [by measuring strontium levels in the otoliths]. More detail on the otolith study can be found in the Chinook Salmonid Research framework [p. 45-46]. Examination of adult otoliths can be used to determine productivity of different life history trajectories.)</p>	<p>Adult spawning surveys: Detailed adult spawner surveys have been carried out by Washington State Department of Fish and Wildlife (WDFW) in the Green River mainstem in river miles 25.4-61 since 1999. Newaukum Creek surveys are carried out in river miles 0-3.8. Additional surveys are needed in Soos Creek to quantify spawning of this sub-population.</p> <p>Corps doing redd mapping surveys in river miles 56.5-61 from 2003-2008 (different from WDFW surveys in that individual Chinook redds are mapped).</p> <p>Smolt (screw) trapping: Approx. \$100,000 per trap annually for the Green River. Past and current funding has come from Corps, WDFW and Salmon Recovery Funding Board. Funding for 2006-2010 for mainstem trap is likely from the Corps as part of the Howard Hanson Dam Additional Water Storage Project. (Second trap would be lower cost = \$50,000)</p> <p>Juvenile salmonid studies occurred in 2002, 2003, and 2005 to examine migration, growth and habitat use in the Lower Green and Duwamish (2003 and 2005 efforts were \$100-200,000). This could continue every 2-3 years to characterize juvenile survival, migration and timing, and variability for different conditions.</p> <p>Experimental otolith study was carried out by Volk and Ruggerone (2004) – need to assess results and fine tune recommended monitoring</p>	<p>Spawning surveys: Estimated costs are \$40,000 annually; long-term funding is expected to be quite firm (given high priority on stock assessment work by Washington State Department of Fish and Wildlife). High probability of funding through 2014.</p> <p>Smolt (screw) trapping: \$100,000 annually per trap. NOTE: funding needed for 2011-2015.</p> <p>Juvenile migration and distribution: \$100,000–200,000 on a bi-annual basis Otolith study costs estimated at ~\$50,000-100,000 depending on number of samples</p> <p>Total Annual Chinook Cumulative Monitoring Costs ~\$250,000-\$350,000</p>	<p>Spawner surveys and smolt traps: Technical Committee or successor should work with the co-managers and federal entities for assessment of Green River population status. Work to stabilize state/federal funding for smolt traps and spawner surveys beyond 2010. Technical Committee work with co-managers to coordinate local monitoring protocols and efforts.</p> <p>Juvenile migration and distribution: Funding uncertain for ongoing juvenile salmonid studies (Studies to date funded by King Conservation District and Salmon Recovery Funding Board grants and in-kind support from King County and Seattle).</p>

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<p>Cumulative Effectiveness* Habitat - Are the segment level habitat attributes (e.g., side channel habitat, shallow water habitat, riparian cover, large woody debris per kilometer) improving as projected by implementation of actions?</p> <p>Watershed - Are basin level habitat attributes such as forest cover, impervious surfaces and riparian conditions improving as anticipated by implementation of the actions in the plan?</p> <p>Are watershed-wide conditions related to flow, water quality, and overall stream health improving?</p>	<p>Habitat Surveys: Monitor change in habitat as targeted in Necessary Future Conditions (NFC) Analysis: carry out monitoring by subwatershed and representative segments every 5-10 years.</p> <p>Middle/Lower Green</p> <ul style="list-style-type: none"> Assess increase in side channel and off-channel habitat area in Segments 3 and 4. Assess increase in large woody debris jams and pieces in segments 3, 4 and 6. Assess increase in in-channel pools in segments 3, 4, and 6. Assess increase in hydrologic connection to floodplain and side channel habitats in segment 4. <p>Duwamish</p> <ul style="list-style-type: none"> Assess increase in estuarine habitat (transition zone area) accessible to juvenile salmonids. Assess increases in palustrine and riverine tidal wetland habitats (area). Assess increases in riparian zone coverage in native vegetation (area or length of streambank). Assess increases in shallow subtidal and intertidal habitats and brackish marshes (area). <p>Marine Nearshore</p> <ul style="list-style-type: none"> Assess increases in marine sediment recruitment and transport rates. Assess increases in marine nearshore aquatic habitats including salt marshes, other shallow water habitats and submerged aquatic vegetation (SAV) coverage (area). <p>Watershed-wide:</p> <ul style="list-style-type: none"> Multi-spectral analysis - high altitude preferred over landsat for both basin and jurisdictional level analyses <ul style="list-style-type: none"> Forest cover Impervious Area Riparian forest cover Flow gauges <ul style="list-style-type: none"> Peak flows Low flows Flashiness Other <ul style="list-style-type: none"> Water quality (dissolved oxygen, temperature, etc.) Macroinvertebrates 	<p>Habitat Surveys:</p> <ul style="list-style-type: none"> U.S. Army Corps of Engineers is carrying out habitat monitoring from river mile 64.5 to 32 from 2001 to 2050 (every five years starting in 2001). Parameters monitored include pool area, large woody debris, riffle particle size, canopy cover, bankfull width, etc. Corps is carrying out habitat monitoring in river miles 70-85 from 2005-2050 (same parameters as noted above). Tacoma Public Utilities is carrying out annual large woody debris monitoring in river miles 32-61. Baseline monitoring of Lower Green (2003), Duwamish (2004), and Marine Nearshore (2004-5) was carried out as part of the WRIA 9 Strategic Assessment (funded in part by King Conservation District and Salmon Recovery Funding Board grants). <p>Watershed-wide: King County recently completed a high altitude multispectral flight (as compared to landsat) for approximately \$320,000.</p> <p>Misc. field and habitat assessments – field and habitat assessments are being conducted by individual jurisdictions using various protocols and analysis tools. The macroinvertebrate indicators, using B-IBI (benthic index of biotic integrity), uses a standard protocol and analysis technique. King County did benthic sampling at 70 sites in Green/Duwamish watershed in 2002 and 2003 for B-IBI. Benthic sampling will continue in 2005.</p> <p>Flows are currently being measured by U.S. Geological Survey (USGS) gauging stations (Palmer, Auburn, Newaukum) and individual jurisdictions, particularly King County (continuous stream gauging at 14 sites in Springbrook, Soos, Jenkins, Covington, Mill, Des Moines, Miller, and Salmon Creeks). Selected monitoring of streamflows by cities. Protocols for installation, operations, and reporting vary. USGS has a standard data and reporting format and data are available and transparent. Estimated annual operation costs for USGS stations are \$14,000. Installation of telemetry for real-time data is approximately \$13,000.</p> <p>King County does monthly stream sampling at 15 sites in Green River mainstem, Newaukum, Soos, Jenkins, Crisp, Springbrook, Covington, Mill Creeks for water quality analysis.</p>	<p>Habitat Surveys:</p> <ul style="list-style-type: none"> Corps monitoring to be covered by Green/Duwamish Ecosystem Restoration Project funding and Howard Hanson Dam Additional Water Storage Project for river miles 32-64.5 and river miles 70-85. Monitoring for Lower Green and Duwamish mainstem and marine Nearshore estimated at \$150,000-200,000 on a once every five year basis (this includes assessment of changes in habitat quantity for NFC conditions shown for various representative segments). <p>Watershed-wide: Multi-spectral every 5 years \$246,000 – \$320,000 (averaged at \$49,200-64,000 per year).</p> <p>Flows – U.S. Geological Survey costs estimate flow gauging stations cost \$14,000 per gauge annually. King County stream gauging and water quality sampling is expected to continue for foreseeable future, with perhaps minor adjustments in stations. There are no new permanent gauges or water quality stations recommended at this time.</p> <p>Total Annual Cumulative Habitat and Watershed-wide (not including stream gauging and water quality sampling) Monitoring Costs: \$396,000-520,000 every fifth year</p>	<p>Habitat Surveys:</p> <ul style="list-style-type: none"> WRIA 9 Steering Committee and Technical Committee should coordinate with Corps and other local entities in habitat monitoring. Steering Committee could request that WRIA 9 be included as an urban example for the Governor’s Salmon Team recommendations for a comprehensive watershed monitoring strategy. This included a recommendation for intensive monitoring of target watersheds for cumulative effects for habitat. <p>Watershed-wide:</p> <ul style="list-style-type: none"> Steering Committee should encourage local governments to continue funding existing permanent flow gauging and water quality monitoring stations. Coordination with other WRIAs in King County can reduce multi-spectral analysis costs

*At all levels of monitoring and evaluation, data management resources will be necessary for the following tasks: statistical design of habitat and population monitoring, regional data sharing, consistent protocols, quality assurance/quality control (QA/QC) of data collection and analysis. Costs do NOT include regional data management.