Species at Risk Act
Recovery Strategy Report Series

Report on the Progress of Recovery Strategy Implementation for Nooksack Dace (*Rhinichthys cataractae*) in Canada for the Period 2008 – 2015

Nooksack Dace

2016

Canada

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Preface

The federal, provincial, and territorial government signatories under the Accord for the Protection of Species at Risk (1996) agreed to establish complementary legislation and programs that provide for effective protection of species at risk throughout Canada. Under Section 46 of the *Species at Risk Act* (S.C. 2002, c.29) (SARA), the competent ministers are responsible for reporting on the implementation of the recovery strategy for a species at risk, and on the progress towards meeting its objectives within five years of the date when the recovery strategy was placed on the Species at Risk Public Registry and in every subsequent five-year period, until its objectives have been achieved or the species' recovery is no longer feasible.

Reporting on the progress of recovery strategy implementation requires reporting on the collective efforts of the competent minister(s), provincial and territorial governments and all other parties involved in conducting activities that contribute to the species' recovery. Recovery strategies identify broad strategies and approaches that will provide the best chance of recovering species at risk. Some of the identified strategies and approaches are sequential to the progress or completion of others and not all may be undertaken or show significant progress during the timeframe of a Report on the Progress of Recovery Strategy Implementation (Progress Report).

The Minister of Fisheries and Oceans is the competent ministers under SARA for the Nooksack Dace and has prepared this Progress Report.

As stated in the preamble to SARA, success in the recovery of species at risk depends on the commitment and cooperation of many different constituencies that will be involved in implementing the directions set out in the recovery strategy and will not be achieved by Fisheries and Oceans Canada, or any other jurisdiction alone. The cost of conserving species at risk is shared amongst different constituencies. All Canadians are invited to join in supporting and implementing the Recovery Strategy for the Nooksack Dace for the benefit of the species and Canadian society as a whole.

Acknowledgements

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Executive Summary

The Nooksack Dace (*Rhinichthys cataractae)* was assessed as Endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in 2000, and subsequently listed under the *Species at Risk Act* as Endangered in June of 2003. In June of 2008 the final *Recovery Strategy for Nooksack Dace (*Rhinichthys cataractae*) in Canada* was posted to the Species at Risk Public Registry. An updated COSEWIC assessment in 2007 reconfirmed the species' status as Endangered (COSEWIC 2007).

Threats to Nooksack Dace, as identified in the *Recovery Strategy for Nooksack Dace* (Rhinichthys cataractae) *in Canada* (Pearson et al. 2008), include: physical destruction of habitat, seasonal lack of water, sediment deposition and riffle loss due to beaver ponds, habitat fragmentation, toxicity, hypoxia and increased predation. The recovery goal as identified in the Recovery Strategy is to "ensure the long-term viability of Nooksack Dace populations throughout their natural distribution in Canada."

This report documents the progress of Recovery Strategy implementation for Nooksack Dace. It summarizes progress that Fisheries and Oceans Canada, the Province of British Columbia's Ministry of Environment, and other interested parties have made towards achieving the goal and objectives set out in the Recovery Strategy, including:

- conducting new research and monitoring activities (including advancing studies to support the identification of critical habitat); and
- completing management activities that help Canadians reduce impacts on, and better understand the threats to, Nooksack Dace.

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1 Background

1.1 Species Status

Assessment Summary – June 2008

Common name:
Nooksack Dace

Scientific name:
Rhinichthys cataractae

COSEWIC status:
Endangered

Reason for designation:
The species is considered a habitat specialist dependent on stream riffles with loose, small grained substrates. This small fish is a representative of the Chehalis fauna, and considered to be a distinct subspecies of the Longnose Dace. It is known in Canada from only four locations in southwestern BC where its area of occupancy is severely limited, and subject to ongoing physical destruction of riffle habitat by urban, industrial and agricultural practices (e.g. dredging, channelization). Streams where the species is found are also impacted by lack of water in late summer due to ground and surface water extraction. Other activities have led to sediment accumulation in riffles caused by bank erosion resulting from gravel mining and/or runoff from urban storm drains, leading to further degradation of water quality and habitat.

Occurrence in Canada:
British Columbia

Status history:
Designated Endangered in April 1996. Status re-examined and confirmed in May 2000.

***Species at Risk Act* Status:**
Listed, Endangered – 2003

1.2 Threats

1.2.1 Threats to Nooksack Dace

Threats to Nooksack Dace, as identified in Section 2 of the *Recovery Strategy for the Nooksack Dace (*Rhinichthys cataractae*) in Canada*, include: physical destruction of habitat, seasonal lack of water, sediment deposition and riffle loss due to beaver ponds, habitat fragmentation, toxicity, hypoxia and increased predation (Pearson et al. 2008).

1.2.2 Activities Likely to Destroy Critical Habitat

Critical Habitat for Nooksack Dace as identified in Section 3 of the Recovery Strategy includes relatively homogenous segments of stream demarcated by distinct geomorphic or land use transitions, otherwise known as reaches, found within the Bertrand Creek, Brunette River, Pepin Brook and Fishtrap Creek watersheds. Only those reaches that include, or are previously known to have included, more than 10% riffle by length constitute critical habitat. Critical habitat within these reaches includes all the aquatic habitat features and attributes identified in the Recovery Strategy and riparian reserve strips of native vegetation on both banks for the entire length of the reach. Riparian reserve strips are continuous and extend laterally (inland) from the top of the bank to varying distances identified for each reach in the Recovery Strategy.

Activities likely to destroy critical habitat as identified in Section 3.4 of the Recovery Strategy include: excessive water withdrawal, excessive sediment releases, drainage projects, impoundment, urban storm drainage, riparian vegetation removal, and livestock access to creeks.

2 Recovery

2.1 Recovery Goal and Objectives

The Recovery Goal and Objectives[1] (identified in Sections 4.2.1 and 4.2.2 of the Recovery Strategy respectively), are as follows:

Recovery Goal

Ensure the long-term viability of Nooksack Dace populations throughout their natural distribution in Canada.

Recovery Objectives

1. For all currently and historically suitable habitats in native streams to be occupied by 2015.
2. To increase Nooksack Dace abundance to target levels in all watersheds by 2015.
3. To ensure that at least one reach in each watershed supports a high density of Nooksack Dace.

2.2 Performance Measures

Performance Measures (as outlined in Table 6 of the Recovery Strategy) are reproduced in detail in Section 3.3 of this report.

[1] Referred to in the forthcoming Action Plan for Nooksack Dace and Salish Sucker as “population and distribution objectives.”

3 Progress towards Recovery

Section 46 of the *Species at Risk Act* requires the competent Minister to report on the implementation of the Recovery Strategy, and the progress towards meeting its objectives, within five years after it is included in the public registry and in every subsequent five-year period, until its objectives have been achieved or the species' recovery is no longer feasible. In the interest of capturing the most recent progress on the recovery of Nooksack Dace, this document includes actions completed up to the end of 2015.

3.1 Research and Monitoring Activities

Table 1. Summary of achievements towards completing the Schedule of Studies and/or identification of critical habitat, as well as new research and monitoring activities conducted and/or ongoing since the completion of the Recovery Strategy in 2008

#	Specific Steps	Recovery Objectives Addressed	Activities Completed or Underway	Organizations Involved[2]
Activities from Schedule of Studies Outlined in 2008 Recovery Strategy.				
1.	Population identification.	1,2,3	• Ruskey (2014), Taylor et al. (2015), and Ruskey and Taylor (2015) studied genetics of the *R. cataractae* species complex, further informing taxonomy and identifying areas of hybridization.	CWFESRF;[3] NSERC;[4] UBC[5]
			• Consultants performed sampling to search for new Nooksack Dace populations in 2009 (Alouette River, Brunette River, and Kanaka Creek) and 2014 (Coquitlam River).	PE[6]
			• In 2014 consultants performed presence/absence surveys in historical Nooksack Dace habitats.	TECL[7]
2.	Critical habitat surveys.	1,3	• Between 2008 and 2015 DFO issued over a dozen	PE; BCMOE;[8] UBC; SFU;[9]

[2] This column in based on the best available information; DFO acknowledges the large network of people that contribute to recovery of this species, and regrets any potential omissions in Tables 1 and 2.
[3] Canadian Wildlife Federation Endangered Species Research Fund.
[4] Natural Sciences and Engineering Research Council of Canada.
[5] University of British Columbia.
[6] Pearson Ecological.
[7] Triton Environmental Consultants Ltd.
[8] Province of British Columbia's Ministry of Environment.

#	Specific Steps	Recovery Objectives Addressed	Activities Completed or Underway	Organizations Involved[2]
			permits pertaining to habitat sampling, monitoring, or enhancement in the Brunette River watershed.	MOTI;[10] MV;[11] TECL; ECI;[12] DFO; LGLL;[13] CRESL[14]
			• In 2009, researchers conducted surveys on depth, velocity, substrate size, area and distribution of habitat types in Bertrand Creek, Pepin Creek, and Fishtrap Creek (Bonamis 2011). • Bonamis (2011) developed a presence-absence model facilitating identification of Nooksack Dace presence or absence based on habitat features within critical habitat; the model incorporated water depth, water velocity, and level of substrate embeddedness.	SFU
			• Between 2012 and 2015 researchers studied different habitat attributes (substrate type, water velocity, and embeddedness) in Pepin Creek, and their effect on Nooksack Dace foraging efficiency.	BCMOE; DFO;[15] UBC; PE
			• Pearson (2015) published maps indicating the habitat types of various critical habitat stream reaches in the Brunette River watershed.	PE; DFO
			• Though DFO issued multiple permits for works implicating Nooksack Dace in the Alouette and Coquitlam River watersheds (e.g. genetics, incidental interactions), detailed habitat survey reports have not been submitted for these locations.	Not applicable
Broad Strategy: Protect, create and enhance riffle habitat in reaches with high potential productivity				
3.	Identify high priority sites for protection,	1,2,3	• Pearson et al. (2008) identified critical habitat for	DFO

[9] Simon Fraser University.
[10] Ministry of Transportation and Infrastructure.
[11] Metro Vancouver.
[12] Envirowest Consulting Inc.
[13] LGL Ltd.
[14] Coast River Environmental Services Ltd.
[15] Fisheries and Oceans Canada.

#	Specific Steps	Recovery Objectives Addressed	Activities Completed or Underway	Organizations Involved[2]
	restoration or habitat creation.		Nooksack Dace.	
			• With respect to restoration or habitat creation of high priority sites, refer to rows 19 and 35 of Table 2.	Refer to rows 19 and 35 of Table 2
4.	Assess benefits of riffle creation and enhancement to Nooksack dace populations.	1,2,3	• Assessment of benefits with respect to riffles specifically has not been completed; however, refer to rows 19 and 35 of Table 2 for general follow-up monitoring for enhancement sites.	Refer to rows 19 and 35 of Table 2
5.	Estimate current extent of riffle loss to authorized and unauthorized stream and ditch dredging and to beaver activity.	1,2,3	• This specific activity has not been completed.	Not applicable
Broad Strategy: Establish and maintain adequate baseflow in all habitats with high potential productivity				
6.	Identify watersheds vulnerable to inadequate baseflow for Nooksack Dace.	1,2	• In 2009 and 2010 researchers recorded seasonal and spatial changes in Nooksack Dace abundance relative to declining discharge.	BCMOE; DFO; SFU; UBC
			• Avery-Gomm's study (2013) identified a flow threshold at or above which habitat is maximized, as well as a threshold above which habitat limitation is minimized in Bertrand Creek.	BCMOE; DFO; SFU; UBC
7.	Establish biologically-based minimum in-stream flows for habitats with high potential productivity.		• Avery-Gomm et al. (2014) assessed the effects of limited flow on Nooksack Dace growth using experimental instream channels in Pepin Creek.	BCMOE; DFO; SFU; UBC
8.	Investigate need and feasibility of supplementing baseflow with well water.	1,2	• Pruneda et al. (2010) studied the feasibility of supplementing surface-water use with groundwater wells in Fishtrap and Bertrand Creek.	DPW;[16] SWWRC;[17] SFU; WSU[18]
Broad Strategy: Reduce sediment entry to creeks				
9.	Estimate levels of sediment in riffles that are harmful to Nooksack Dace.	1,2	• In 2011 and 2013 researchers analyzed the effect of sediment impaction and dominant substrate size on fish growth through a stream survey and experiment in manmade raceways.	BCMOE; UBC
			• In 2015 UBC researchers documented study results of	BCMOE; DFO;

[16] Department of Public Works, Whatcom Country, Washington.
[17] State of Washington Water Research Centre.
[18] Washington State University.

#	Specific Steps	Recovery Objectives Addressed	Activities Completed or Underway	Organizations Involved[2]
			the effects of sediment deposition on the growth, survival, and foraging efficiency of Nooksack Dace, and on the abundance, distribution, and community structure of their invertebrate prey (Champion 2016).	UBC
10.	Map, assess and prioritize mitigation for riffle sedimentation in all watersheds.	1,2	• This specific activity has not been completed.	Not applicable
Broad Strategy: Ensure the integrity and proper functioning of riparian zones throughout watersheds				
11.	Conduct riparian assessments of habitat reaches with high potential productivity as the basis of proposed riparian buffer widths.	1,2,3	• Further refinement of critical habitat riparian area widths has not been initiated.	Not applicable
Broad Strategy: Reduce habitat fragmentation				
12.	Assess the ability of different life history stages to cross different types of barriers.	1,2	• This specific activity has not been completed.	Not applicable
13.	Identify permanent/seasonal barriers and prioritize for mitigation.	1,2	• In 2012, consultants cleared a partially blocked culvert in Waechter creek, improving fish access to Fishtrap Creek.	ATEL[19]
Broad Strategy: Minimize toxic contamination of creeks				
14.	Estimate extent and severity of toxic contamination of creeks.	1,2,3	• In 2008, consultants collected water quality measurements to monitor compensatory habitat effectiveness in Pepin Brook.	BBS;[20] SRSI[21]
			• In 2012 consultants performed water quality testing at two sites along the Brunette River.	CRESL; SRSI
			• In 2012 and 2013 researchers collected water quality measurements in Bertrand Creek and Pepin Brook.	BCMFLNRO;[22] UBC
Broad Strategy: Minimize impacts of introduced predators				
15.	Document distribution and densities of introduced predators in each watershed.	1,2,3	• In 2013 researchers installed motion-activated cameras in Pepin Creek to document predators.	UBC; BCMOE; DFO
16.	Assess impact of riffle loss to drying on predation risk.	1,2,3	• This specific activity has not been completed; however, Champion (2016) investigated the role of substrate embeddedness on Nooksack Dace predation.	Not applicable
Other research and monitoring activities (not associated with a Broad Strategy from the 2008 Recovery Strategy).				

[19] AquaTerra Environmental Ltd.
[20] Bianchini Biological Services.
[21] Scott Resource Services Inc.
[22] British Columbia's Ministry of Forests, Lands and Natural Resource Operations.

#	Specific Steps	Recovery Objectives Addressed	Activities Completed or Underway	Organizations Involved[2]
17.	Determine population abundance.		• In 2009 consultants sampled Nooksack Dace in Pepin Brook associated with habitat restoration monitoring. • From 2009 to 2015 consultants sampled Nooksack Dace in the Brunette River associated with habitat restoration monitoring.	PE
			• In 2010 consultants sampled Nooksack Dace in Pepin Brook associated with habitat restoration monitoring.	SRSI; VGS[23]
			• In 2013/14, consultants sampled Nooksack Dace in Pepin Brook associated with habitat restoration monitoring.	TECL
			• In 2009/10 the LEPS and partners developed a more quantitative method for estimating population size using systematic random sampling and mark re-capture work from Fishtrap, Pepin, and Bertrand Creeks and the Brunette River.	GOC;[24] LEPS[25] & partners; SFU
			• Avery- Gomm (2013) tracked flow-related changes in Nooksack Dace abundance at sites along Bertrand Creek.	BCMOE; DFO; SFU; UBC
			• Bonamis (2011) estimated population abundance in Nooksack Dace critical habitat in Bertrand Creek, Brunette River, Pepin Brook, and Fishtrap Creek using single-pass electroshocking.	BCMOE; DFO; SFU; UBC
			• Bonamis (2011) and Avery-Gomm (2013) assessed the efficiency of single-pass electroshocking as a method for determining Nooksack Dace abundance.	BCMOE; DFO; SFU; UBC
18.	Observe juvenile habitat use in situ.		• In 2015 researchers obtained video footage of juvenile Nooksack Dace drift feeding in Bertrand Creek.	UBC; BCMOE; DFO

[23] Valley Gravel Sales Ltd.
[24] Government of Canada.
[25] Langley Environmental Partners Society.

3.2 Management Activities

Table 2. Summary of activities undertaken to reduce or eliminate threats to Nooksack Dace threats to critical habitat and/or threats to its residence

#	Specific Steps	Recovery Objectives Addressed	Activities Completed or Underway	Organizations Involved[26]
Broad Strategy: Protect, create and enhance riffle habitat in reaches with high potential productivity				
19.	Work with stewardship groups and landowners to identify and implement habitat creation and restoration projects.[27]	All	• In 2009/10 the LEPS and partners: o created and enhanced more than 1000m^2 in the Brunette River watershed and 800m^2 in Gordon's Brook; and, o reconstructed 300 m of channel with riffles, large woody debris complexing and 15 m wide riparian vegetation buffers at Howe's Creek confluence with Bertrand Creek.	GOC; LEPS & partners
			• In 2010/11 the LEPS and partners conducted: o baseline monitoring at Gordon's Brook, Brunette River and Bertrand Creek restoration sites, including such aspects as habitat use, species density, and water quality; o maintenance of existing Nooksack dace restoration sites; o maintenance of previously restored Gordon's Brook site, including: replacing beaver-damaged trees, repairing beaver guards, removing invasive species from approximately 200 metres of Pepin Creek, widening and complexing of a section of Gordon's Brook, placing cobble on riffles, installing logs and stumps, and planting native species in approximately 3000 m^2 of riparian habitat.	GOC; LEPS & partners
			• Between 2011 and 2014, the BCCF and partners	GOC; BCCF[28] & partners

[26] This column in based on the best available information; DFO acknowledges the large network of people that contribute to recovery of this species, and regrets any potential omissions in Tables 1 and 2.
[27] For habitat creation and restoration projects implemented by other parties, refer to row 36 of Table 1.
[28] British Columbia Conservation Foundation.

#	Specific Steps	Recovery Objectives Addressed	Activities Completed or Underway	Organizations Involved[26]
			conducted habitat restoration efforts in Deer Lake Brook, a potential habitat for Nooksack Dace.	
			• In 2013/14 the LEPS and partners conducted the following in the Bertrand Creek watershed: o developed restoration plans for six sites; o improved 2350 m^2 of riparian habitat; o removed 2025 m^2 of invasive riparian plants; and, o installed 2500 native riparian plants.	GOC; LEPS & partners
			• In 2014/15 the FVC[29] and partners conducted restoration (e.g. adding riffles and large woody debris, and planting native species) at Deer Lake Brook, a potential habitat for Nooksack Dace.	GOC; FVC & partners
20.	Develop best management practices and work plans for habitat reaches with high potential productivity that require drainage maintenance or beaver management.	All	• In 2013 the SCBC[30] and partners developed "Species at Risk Voluntary Stewardship Practices" for: o drainage maintenance in agricultural waterways; o riparian areas in settled landscapes; and, o guidance for restoration activities in riparian areas.	GOC; SCBC & partners
Broad Strategy: Establish and maintain adequate baseflow in all habitats with high potential productivity				
21.	Develop water balance models for watersheds.	1,2	• Starzyk (2012) created a conceptual model of surface water–groundwater interaction in the Bertrand Creek watershed.	UBC; NSERC
			• Middleton et al. (2015) studied groundwater-surface water interactions in Bertrand and Fishtrap Creek.	SFU
22.	Develop wetland restoration projects in vulnerable watersheds.	1,2	• Refer to rows 19 and 35 of Table 2.	Refer to rows 19 and 35 of Table 2.

[29] Fraser Valley Conservancy.
[30] Stewardship Centre for British Columbia.

#	Specific Steps	Recovery Objectives Addressed	Activities Completed or Underway	Organizations Involved[26]
23.	Develop and distribute public education materials on impacts of water use on fish and wildlife to landowners and public.	1,2	• In 2013/14 the LEPS and partners: o developed the Bertrand Watershed Education Team (B-Wet) to raise awareness of positive watershed stewardship practices; o developed signs promoting B-Wet restoration work for landowners; o published an article in the Aldergrove Star regarding B-Wet activities; o prepared a Land Care Agreement for Bertrand Creek residents and landowners encouraging: smart land stewardship; planting and protection of native species; removal of non-native and invasive species; efficient irrigation; and drought-tolerant gardening.	GOC; LEPS & partners
			• In 2013 MFN[31] held community meetings and distributed educational pamphlets (including information on Nooksack Dace) to band members.	GOC; MFN & partners
Broad Strategy: Reduce sediment entry to creeks				
24.	Work with landowners, municipal governments, and stewardship groups to prevent, mitigate and restore sediment degradation of riffles from urban, agricultural and industrial sources.	1,2	• Refer to rows 19 and 35 of Table 2.	Refer to rows 19 and 35 of Table 2
25.	Develop and distribute public education materials on sediment impacts on fish and wildlife to landowners.	1,2	• Refer to row 23 of Table 2.	Refer to row 23 of Table 2
Broad Strategy: Ensure the integrity and proper functioning of riparian zones throughout watersheds				
26.	Identify, prioritize and develop riparian planting or other projects in cooperation with landowners, stewardship groups and government agencies.	All	• Refer to rows 19 and 35 of Table 2.	Refer to rows 19 and 35 of Table 2
27.	Develop and distribute public education materials on riparian reserve strips to landowners.	All	• Refer to row 23 of Table 2.	Refer to row 23 of Table 2

[31] Matsqui First Nation.

#	Specific Steps	Recovery Objectives Addressed	Activities Completed or Underway	Organizations Involved[26]
Broad Strategy: Encourage stewardship amongst private landowners, local governments and the general public				
28.	Give presentations and field tours on Nooksack Dace and watershed ecology to local stewardship groups, schools and others.	All	• Between 2009 and 2011 the LEPS conducted: o outreach and education for BCIT, UBC Forestry and Conservation Biology, Burnaby Lake Bioblitz, BC Nature, a Bald Eagle Festival, Delta Naturalists, and BC Communities in Bloom; and, o a field tour of Gordon's Brook for UBC and TWU students.	
			• In 2014 UBC researchers presented on the effect of fine sediment and substrate particle size on Nooksack Dace growth, distribution, and prey abundance at the Pacific Ecology Conference and Annual Meeting of the American Fisheries Society.	BCMOE; DFO; UBC
			• In 2013/14 the LEPS and partners held presentations and workshops for: Girl Guides, Shortreed Elementary School, Parkside Elementary School, Trinity Western University and Kwantlen Polytechnic University.	GOC; LEPS & partners
			• In 2014 researchers took high resolution photographs of Nooksack dace in a streamside aquarium for use in public education materials by government and NGOs.	GOC, BCMOE, PE
29.	Advise stewardship groups, agency staff, and consultants involved in habitat work on Nooksack Dace habitat requirements.	All	• This is an ongoing activity conducted as needed by DFO and partners; refer to rows 20, 22, 23, 24, 26, 28, 30, 33 and 34 of Table 2 for further information.	Refer to rows 20, 22, 23, 24, 26, 28, 30, 33 and 34 of Table 2
Broad Strategy: Minimize toxic contamination of creeks				
30.	Work with municipalities to identify, prioritize and develop projects to improve storm water treatment.	All	• In 2009 the TOL[32] developed the *Bertrand Creek ISMP*[33] (Kerr Wood Leidal Associated Ltd. 2009).	KWLAL;[34] TOL
31.	Increase width and continuity of riparian reserve areas on agricultural lands.	All	• This specific activity has not been completed.	Not applicable

[32] Township of Langley.
[33] Integrated Stormwater Management Plan.
[34] Kerr Wood Leidal Associates Ltd.

#	Specific Steps	Recovery Objectives Addressed	Activities Completed or Underway	Organizations Involved[26]
32.	Develop and distribute public education materials on pesticide/herbicide impacts on fish and wildlife to landowners.	All	• Refer to row 23 of Table 2.	Refer to row 23 of Table 2
Broad Strategy: Minimize impacts of introduced predators				
33.	Develop and distribute public education materials on potential impacts of introduced predators on native species to landowners and recreational fishers.	All	• This specific activity has not been completed.	Not applicable
Other management activities (not associated with a Broad Strategy from the 2008 Recovery Strategy).				
34.	Collect aboriginal traditional knowledge.	All	• In 2013/14 representatives of MFN conducted interviews to document Aboriginal Traditional Knowledge on species at risk in the Fraser Valley.	GOC; MFN & partners
35.	Implement habitat creation and restoration projects.	All	• In 2010, DFO added spawning gravel and boulders to the Brunette River to improve substrate availability.	DFO
			• Between 2008 and 2015 TIC[35] and partners designed, implemented, and monitored habitat creation and restoration in the upper Brunette River. Specifically enhancing: o 4480 m^2 instream and 1275 m^2 riparian habitat as compensation for the Port Mann-Highway 1 Improvement Project.	TIC; LGLL; PSF;[36] PE; CRESL
			• Between 2013 and 2015 Metro Vancouver and partners enhanced over 140 m^2 of rearing, overwintering and spawning habitat in the Brunette River watershed by installing 13 habitat complexing structures. Specifically addressing: channel stability, in-stream cover, erosion, hydraulic diversity, and pool development.	MV; LGLL; PE ECI

[35] Transportation Investment Corporation.
[36] Pacific Salmon Foundation.

3.3 Summary of Progress towards Recovery

Action Planning

DFO, in collaboration with the BCMOE, is developing a joint Salish Sucker and Nooksack Dace Action Plan as part of the Government of Canada's ongoing commitment to the conservation of species at risk through the implementation of the *Species at Risk Act*.

Report on Process Performance Measures

Process performance measures (as outlined in the Recovery Strategy) for evaluating the achievement of objectives and their outcomes are addressed below.

1) **Habitat with high potential productivity identified and occupancy evaluated in all watersheds.**

   Inventorying current and historical habitat is ongoing, and currently suitable habitats have been documented in Pearson (2015). Identification and sampling of potentially suitable habitats is also ongoing. Additional work is required to confirm potential new populations of the species.

2) **Development of a monitoring protocol for population abundance.**

   Bonamis (2011) and Avery-Gomm (2013) assessed the efficiency of single-pass electroshocking as a method for determining Nooksack Dace abundance. In 2015 researchers also investigated non-intrusive methods of counting Nooksack Dace larvae that survive to recruitment age. Harvey and Brown (2013a, 2013b) incorporated best collection and monitoring approaches into draft SARA multi-species compendium reports, which may inform the development and implementation of a comprehensive monitoring plan. The revised *Guidelines for the Capture, Handling, Scientific Study, and Salvage of the Nooksack Dace (*Rhinichthys cataractae*)* (Pearson 2015) may facilitate future monitoring protocols by, among others, minimizing harm and outlining effective practices for certain activities.

3) **Abundance surveys completed in all watersheds.**

   Bonamis (2011) estimated Nooksack Dace abundance in critical habitats of all four watersheds, and several other researchers contributed to population monitoring activities (refer to row 17 of Table 1 for more details); however, more robust estimates are required in order to assess whether target population levels are being met.

Process performance measures (as outlined in the Recovery Strategy) for evaluating research and management activities and their outcomes are addressed below.

1) **Area of riffle habitat restored, created or protected. Number of landowners and others reached in public education and consultation programs.**

   Due to the nature of reports on habitat restoration and creation, the amount of riffle habitat implicated is often described in terms of general habitat, or is combined in tallies for multi-species projects. For example, in 2009/10 the LEPS reconstructed 300 m of channel with

riffles, large woody debris complexing and 15 m wide riparian vegetation buffers at Howe's Creek confluence with Bertrand Creek. Across eight HSP-funded projects, it is estimated that approximately 15 ha of habitats were restored. Approximately 0.8 ha and a 300 m length of riparian habitat has been restored, along with 0.13 ha of in-stream habitat.

DFO held Regional consultations for a draft joint Action Plan for Nooksack Dace and Salish Sucker between February 8 and March 12, 2012. As part of the consultation process, DFO contacted 3000 private landowners, more than 200 stakeholders, and 30 First Nations and Aboriginal Organizations. In addition, 160 people participated in open house sessions and face-to face workshops. In addition, across eight HSP projects and one AFSAR-funded project it is estimated that approximately 1707 people were reached in education and outreach initiatives.

2) Minimum discharges for maintenance of Nooksack Dace habitat established in vulnerable watersheds. Discharge monitored in vulnerable watersheds.

Avery-Gomm (2013) identified a flow threshold at or above which habitat is maximized, as well as a threshold above which habitat limitation is minimized, in Bertrand Creek. In 2015, researchers further studied biologically-based flows using habitat suitability curves based on velocity-depth observations. Refer to rows 6 and 7 of Table 1 for more details.

3) Major sources of sediment entry to each watershed identified. Major sources of sediment entry addressed.

While the major sources of sediment entry into each watershed have not been explicitly identified, researchers further informed this threat by studying the relationship between sedimentation and Nooksack Dace growth and prey (refer to rows 9 and 10 in Table 1). Individuals and organizations have addressed sediment entry primarily through riparian restoration (refer to rows 19 and 35 of Table 2).

4) Length and area of riparian habitat restored in each watershed. Proportion of habitat with high potential productivity for which a riparian assessment has been completed. Proportion of habitat with high potential productivity for which the results of a riparian assessment have been adopted.

Refer to process performance measure #1 (for evaluating research and management activities) for the length and area of riparian habitat restored; these works occurred in the Brunette River, Bertrand Creek, and Pepin Creek watersheds.

In 2013/14 the LEPS and partners developed and carried out restoration plans, including riparian considerations, for six sites in the Bertrand Creek watershed. In many cases however, riparian assessments are completed on an ad hoc basis prior to conducting restoration initiatives (such as those documented in rows 19 and 35 of Table 2).

5) Permanent and seasonal barriers to movement mapped in each watershed.

While permanent and seasonal barriers have not been mapped, projects to reduce these barriers and address knowledge gaps have been completed. In 2012, AquaTerra

Environmental Ltd. on behalf of the City of Abbotsford cleared a partially blocked culvert in Waechter Creek, which connects to Fishtrap Creek. Researchers also addressed knowledge gaps relating to flow (refer to rows 6, 7, and 8 of Table 1), which may further inform the role of seasonal barriers influenced by low water levels.

6) Number of non-government organizations/individuals involved in recovery activities. Number of stewardship agreements/conservation covenants signed to protect habitat with high potential productivity. Number of landowners and others reached in public education and consultations programs. Length of habitat with high potential productivity protected or restored on private land or with public involvement.

It is estimated that approximately fourteen non-government organizations conducted SARA-permitted works on Nooksack Dace recovery initiatives. Due to the nature of reports on habitat restoration and creation, the amount of people involved in recovery activities is often combined for multi-species projects; however, it is estimated that across eight HSP-funded projects and one AFSAR-funded project there has been a minimum involvement of 135 individuals and 45 non-government organizations in recovery activities.

With respect to stewardship agreements, in 2013/14 the LEPS and partners prepared a Land Care Agreement for Bertrand Creek residents and landowners encouraging: smart land stewardship; planting and protection of native species; removal of non-native and invasive species; efficient irrigation; and drought-tolerant gardening.

Refer to process performance measure #1 (for evaluating research and management activities) for the number of landowners and others reached in public education and consultations programs.

Refer to process performance measure #1 (for evaluating research and management activities) for the length of habitat with high potential productivity protected or restored on private land or with public involvement.

7) Sources of toxic contamination identified. Sources of toxic contamination addressed.

While the Recovery Strategy notes urban storm runoff, contaminated groundwater (e.g. agricultural pesticides and herbicides), direct industrial discharges, sewage treatment plant effluents, aerial deposition, and accidental spills are sources of toxic contamination, more research is required to identify and document individual instances of contamination. Researchers have, however, generally informed this threat by water quality monitoring (refer to row 14 of Table 1). Individuals and organizations have partially addressed toxic contamination through riparian restoration (refer to rows 19 and 35 of Table 2) and education and outreach activities (refer to rows 23 and 28 of Table 2).

8) Extent of habitat with high potential productivity occupied by introduced predators mapped.

The extent of habitat occupied by introduced predators has not been mapped; however, video documentation of predators (refer to row 15 of Table 1) is expected to assist potential mapping efforts.

Report on Biological Performance Measures

Reporting on the majority of biological process measures requires further study. Consequently only one biological process measure for evaluating the achievement of objectives and their outcomes is addressed below.

1) Number of reaches where catch-per-unit-effort exceeds 0.8 Nooksack dace per standard Gee-trap (24 h set, n>10).

Catch-per-unit-effort (CPUE) data exist for many Nooksack Dace reaches (Pearson unpub. data); however, various methods were used (electrofishing, seining, and trapping), and units of effort were defined differently across gears. Within the timeframe of 2008-2015 nine reaches yielded a CPUE of 0.8 or greater from these data. In the future, standardization of CPUE data collection may improve reporting abilities.

Reporting on the majority of biological process measures requires further study. Consequently only one biological process measure for evaluating research and management activities is addressed below.

1) Minimum discharges exceeded in vulnerable watersheds.

Avery-Gomm (2013) identified a flow threshold at or above which habitat is maximized (0.30 $m^3 \cdot s^{-1}$), as well as a threshold above which habitat limitation is minimized (0.12 $m^3 \cdot s^{-1}$), in Bertrand Creek. Avery-Gomm conducted sampling in May and August of 2010 with discharges below both of these numbers. USGS[37] data from 2012 (in Avery-Gomm 2013) indicates discharge in Bertrand Creek was below 0.12 $m^3 \cdot s^{-1}$ for 79 days (June to September).

[37] United States Geological Survey.

4 References

Avery-Gomm, S. 2013. Determining the impacts of hydrological drought on endangered Nooksack dace (*Rhinichthys cataractae*) at the population and individual level: implications for minimum environmental flow requirements. University of British Columbia, Vancouver, British Columbia, Canada. 84 pp.

Avery-Gomm, S., Rosenfeld, J.S., Richardson, J.S. and M. Pearson. 2014. Hydrological drought and the role of refugia in an endangered riffle-dwelling fish, Nooksack dace (*Rhinichthys cataractae* ssp.). Canadian Journal of Fisheries and Aquatic Sciences 71(11):1625-1634.

Bonamis, A. 2011. Utilization of two-stage single-pass electrofishing to estimate abundance and develop recovery-monitoring protocols for the endangered Nooksack dace (*Rhinichthys cataractae*) in Canada. Simon Fraser University, Burnaby, British Columbia, Canada. 67 pp.

Champion, J.M. 2016. Determining the effects of sediment deposition on the growth, survival, and foraging efficiency of the endangered Nooksack dace (*Rhinichthys cataractae* sp. *cataractae*), and on the abundance, distribution, and community structure of their invertebrate prey. M.Sc. thesis, University of British Columbia, Vancouver, British Columbia. xiii + 83 pp.

COSEWIC. 2007. COSEWIC assessment and update status report on the Nooksack dace Rhinichthys cataractae ssp. in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 27 pp.

DFO. 2008. Recovery Potential and Potential Critical Habitat for the Nooksack Dace (*Rhinichthys cataractae* sp.). DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2008/031.

DFO. n.d. Heathy Farms, Healthy Streams (Brochure). Available online at: http://www.pac.dfo-mpo.gc.ca/publications/docs/hfhs-eng.html [accessed October 2015].

DFO. n.d. Home tips for healthy streams (Brochure). Available online at : http://www.pac.dfo-mpo.gc.ca/publications/pdfs/hometips_2000_e.pdf [accessed October 2015].

Fisheries and Oceans Canada. in prep. Action Plan for the Nooksack Dace (*Rhinichthys cataractae*) and Salish Sucker (*Catostomus* sp.) in Canada. Species at Risk Act Action Plan Series. Fisheries and Oceans Canada, Ottawa. v + 23pp.

Kerr Wood Leidal Associates Ltd. 2009. Bertrand Creek ISMP. Township of Langley, British Columbia, Canada.

Middleton, M.A., D.M. Allen, and P.H. Whitfield. 2015. Comparing the groundwater contribution in two groundwater-fed streams using a combination of methods. Canadian Water Resources Journal (August 2015), 1–18.

Pearson, M.P., T. Hatfield, J.D. McPhail, J.S. Richardson, J.S. Rosenfeld, H. Schreier, D. Schluter, D.J. Sneep, M. Stejpovic, E.B. Taylor, and P.M. Wood. 2008. Recovery Strategy for the Nooksack Dace (Rhinichthys cataractae) in Canada. Species at Risk Act Recovery Strategy Series, Fisheries and Oceans Canada, Vancouver. vi + 29 pp.

Pearson, M. 2010. Howe's Confluence Restoration Project. Unpublished report.

Pearson, M. 2015. Guidelines for the Capture, Handling, Scientific Study, and Salvage of the Nooksack Dace (*Rhinichthys cataractae*). Report prepared for Fisheries and Oceans Canada, Vancouver, British Columbia. ii + 12 pp.

Pruneda, E.B., Barber, M.E., Allen, D.E., Wu, J.Q. 2010. Use of stream response function to determine impacts of replacing surface-water use with groundwater withdrawals. Hydrogeology Journal 18:1077-1092.

Ruskey, J.A. 2014. Morphological stasis and genetic divergence without reproductive isolation in the *Rhinichthys cataractae* species complex : insights from a zone of secondary contact in the lower Fraser Valley, British Columbia. University of British Columbia, Vancouver, British Columbia, Canada. xiii + 123 pp.

Ruskey, J.A., and E.B. Taylor. 2015. Morphological and genetic analysis of sympatric dace within the *Rhinichthys cataractae* species complex : a case of isolation lost. BiologicalJournal of Linnean Society (August 2015):1-17.

Starzyk, C.A. 2012. Simulating surface water-groundwater interaction in the Bertrand Creek Watershed, B.C. Ph.D dissertation, University of British Columbia, Vancouver, British Columbia, Canada. 190 pp.

Stewardship Centre for British Columbia. 2013. Species at risk voluntary stewardship practices (Pilot Edition). Species at Risk a primer for British Columbia. Available online at: http://www.speciesatriskbc.ca/guides [accessed November 2015].

Sylte, T. and C. Fischenich. 2002. Techniques for measuring substrate embeddedness. Engineer Research and Development Center, Vicksburg, MS. Environmental Lab.

Taylor, E.B., McPhail, J.D., and J.A. Ruskey. 2015. Phylogeography of the longnose dace (*Rhinichthys cataractae*) species group in northwestern North America – the Nooksack dace problem. Canadian Journal of Zoology 93:1-8.