COSEWIC
Assessment and Status Report

on the

Chinook Salmon
Oncorhynchus tshawytscha

Designatable Units in Southern British Columbia
(Part Two – Designatable Units with High Levels of Artificial Releases in the Last 12 Years)

in Canada

Designatable Unit 1: Southern Mainland Boundary Bay, Ocean, Fall population – THREATENED
Designatable Unit 6: Lower Fraser, Ocean, Summer population – ENDANGERED
Designatable Unit 13: South Thompson, Stream, Summer 1.3 population – ENDANGERED
Designatable Unit 15: Lower Thompson, Stream, Spring population – ENDANGERED
Designatable Unit 18: South Coast - Georgia Strait, Ocean, Fall population – DATA DEFICIENT
Designatable Unit 20: East Vancouver Island, Ocean, Summer population – ENDANGERED
Designatable Unit 21: East Vancouver Island, Ocean, Fall population – SPECIAL CONCERN
Designatable Unit 22: South Coast - Southern Fjords, Ocean, Fall population – DATA DEFICIENT
Designatable Unit 23: East Vancouver Island, Ocean, Fall (EVI + SFj) population – NOT AT RISK
Designatable Unit 24: West Vancouver Island, Ocean, Fall (South) population – THREATENED
Designatable Unit 25: West Vancouver Island, Ocean, Fall (Nootka & Kyuquot) population – THREATENED
Designatable Unit 26: West Vancouver Island, Ocean, Fall (WVI + WQCI) population – DATA DEFICIENT
2020

COSEWIC
Committee on the Status
of Endangered Wildlife
in Canada

COSEPAC
Comité sur la situation
des espèces en péril
au Canada

COSEWIC status reports are working documents used in assigning the status of wildlife species suspected of being at risk. This report may be cited as follows:

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Chinook Salmon — Illustration provided by authors.

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COSEWIC
Assessment Summary

Assessment Summary – November 2020

Common name
Chinook Salmon - Designatable Unit 1: Southern Mainland Boundary Bay, Ocean, Fall population

Scientific name
Oncorhynchus tshawytscha

Status
Threatened

Reason for designation
Mature fish in this population spawn in tributaries to Boundary Bay such as the Serpentine, Nicomekl and Little Campbell rivers, in southern British Columbia. This wildlife species occurs in highly altered freshwater and marine habitats. Ongoing low marine survival, bycatch, and fish culture effects are cumulative threats to the remaining wild fish. Hatchery releases are ongoing and have included fish from other populations, threatening the genetic integrity of the few remaining wild fish. While hatchery production has allowed the total population size to increase, a consensus of expert opinion estimates fewer than 1000 mature wild fish remain.

Occurrence
British Columbia, Pacific Ocean

Status history
Designated Threatened in November 2020.

Assessment Summary – November 2020

Common name
Chinook Salmon - Designatable Unit 6: Lower Fraser, Ocean, Summer population

Scientific name
Oncorhynchus tshawytscha

Status
Endangered

Reason for designation
Mature fish in this population return in summer and spawn at a single site (Maria Slough), in the lower Fraser River. A continuing decline in spawner abundance is expected as a result of highly modified freshwater and marine habitats, low marine survival and harvest. Failed water control structures and low water levels prevented spawners from accessing the spawning site in 2018. A continuing decline in water quality and quantity is expected due to increasing urbanization and runoff.

Occurrence
British Columbia, Pacific Ocean

Status history
Designated Endangered in November 2020.

Assessment Summary – November 2020

Common name
Chinook Salmon - Designatable Unit 13: South Thompson, Stream, Summer 1.3 population

Scientific name
Oncorhynchus tshawytscha

Status
Endangered

Reason for designation
Mature fish in this population migrate up the Fraser River in summer, through the Thompson River to spawn in major Shuswap Lake tributaries such as the Seymour, Eagle, Scotch and the Salmon rivers. The estimated number of remaining wild spawners is fewer than 2500 fish, and there is a projected continuing decline in numbers. Threats include decreased water levels (water withdrawal and changes in volume as a result of low marine survival, harvest, and timing of snow melt), agricultural runoff, pollution from transportation accidents, and highly modified freshwater habitats. Such threats are accentuated due to a relatively long freshwater residence.

Occurrence
British Columbia, Pacific Ocean

Status history
Designated Endangered in November 2020.

Assessment Summary – November 2020

Common name
Chinook Salmon - Designatable Unit 15: Lower Thompson, Stream, Spring population

Scientific name
Oncorhynchus tshawytscha

Status
Endangered

Reason for designation
Mature fish in this population migrate up the Fraser River in spring to the Thompson River and then into the Nicola, Deadman and Bonaparte rivers to spawn. Marine survival has been low since 2000. There has been a steep decline in the number of mature individuals from 2013 to 2018. This wildlife species faces a number of continuing and severe threats in its freshwater and marine habitat, including post Pine Beetle deforestation, short and long-term effects from wildfires (the large Elephant Hill fire occurred here in 2018), habitat destabilization, and climate-change induced disruption to water quality. Agriculture water withdrawal is substantial and ongoing.

Occurrence
British Columbia, Pacific Ocean

Status history
Designated Endangered in November 2020.

Assessment Summary – November 2020

Common name
Chinook Salmon - Designatable Unit 18: South Coast - Georgia Strait, Ocean, Fall population

Scientific name
Oncorhynchus tshawytscha

Status
Data Deficient

Reason for designation
Mature fish in this population return in the fall to rivers flowing into the south coast inlets of the Salish Sea between Burrard Inlet near Vancouver and Toba Inlet to the north. Abundance trend information is available for only two of 19 sites within the range of this relatively remote and poorly documented wildlife species. While these show a stable trend from 2005 to 2018, spawning is thought to occur elsewhere in the northern area. Data are too few to determine status.

Occurrence
British Columbia, Pacific Ocean

Status history
Species considered in November 2020 and placed in the Data Deficient category.

Assessment Summary – November 2020

Common name
Chinook Salmon - Designatable Unit 20: East Vancouver Island, Ocean, Summer population

Scientific name
Oncorhynchus tshawytscha

Status
Endangered

Reason for designation
Mature fish in this population return in summer to spawn in the upper reaches of rivers draining the east side of Vancouver Island, from the Koksilah River in the south to the Puntledge River in the north. According to a consensus of expert opinion, fewer than 1000 wild spawners remain in this population. Exploitation rates are relatively high (about 40%), and marine survival estimates have been low for many years. Additional threats include ecosystem modifications (dam construction and channelization) and drought. The contribution of fish from hatcheries confounds the determination of population trends; hatchery-origin spawners may be a continued threat through direct competition and gene flow.

Occurrence
British Columbia, Pacific Ocean

Status history
Designated Endangered in November 2020.

Assessment Summary – November 2020

Common name
Chinook Salmon - Designatable Unit 21: East Vancouver Island, Ocean, Fall population

Scientific name
Oncorhynchus tshawytscha

Status
Special Concern

Reason for designation
Mature fish in this population return in fall to the east side of Vancouver Island to spawn in multiple rivers from the Goldstream near Victoria north to Campbell River. Five of the six watersheds within the range of this wildlife species are mostly inhabited by hatchery-origin fish. While the overall abundance in the single remaining watershed is increasing, several large-scale hatcheries aim to augment production within the other watersheds and straying could pose threats from competition and gene flow to the remaining wild fish. Other threats include low marine survival, relatively high exploitation rates, ecosystem modifications and water management/use. This wildlife species could become Threatened if these factors are not properly managed.

Occurrence
British Columbia, Pacific Ocean

Status history
Designated Special Concern in November 2020.

Assessment Summary – November 2020

Common name
Chinook Salmon - Designatable Unit 22: South Coast - Southern Fjords, Ocean, Fall population

Scientific name
Oncorhynchus tshawytscha

Status
Data Deficient

Reason for designation
Mature fish in this population return in the fall to the fjords of the Phillips Arm and Bute Inlet near Johnstone Strait in southern BC. Spawners migrate to the remote habitats of the Phillips, Franklin, Orford, and other rivers. While some survey information exists, coverage is incomplete and changes in methodology make it difficult to interpret trends in abundance or recent numbers of mature individuals. Data are too few to assess status.

Occurrence
British Columbia, Pacific Ocean

Status history
Species considered in November 2020 and placed in the Data Deficient category.

Assessment Summary – November 2020

Common name
Chinook Salmon - Designatable Unit 23: East Vancouver Island, Ocean, Fall (EVI + SFj) population

Scientific name
Oncorhynchus tshawytscha

Status
Not at Risk

Reason for designation
Mature fish in this population return in fall to spawn in rivers which drain the eastern slope of Vancouver Island's coastal mountain ridge, such as the Adam, Quinsam, Nimpkish, Salmon and Campbell Rivers. While the population faces a number of threats including competition and gene flow from hatchery production, indices of abundance suggest increasing numbers.

Occurrence
British Columbia, Pacific Ocean

Status history
Designated Not at Risk in November 2020.

Assessment Summary – November 2020

Common name
Chinook Salmon - Designatable Unit 24: West Vancouver Island, Ocean, Fall (South) population

Scientific name
Oncorhynchus tshawytscha

Status
Threatened

Reason for designation
Mature fish in this population return in fall to spawn at a large number of sites in rivers along the south west coast of Vancouver Island including the Nahmint, San Juan, Somass-Sproat, Nitinat, and Sarita Rivers. Survey information is available for many spawning locations, and while the overall trends are unclear, <10,000 wild adults are thought to remain. Large-scale hatcheries operating with the aim of augmenting production have resulted in straying of hatchery-origin spawners throughout the range. Such straying likely compromises the genetic composition of spawners and therefore represents a continuing threat to the wildlife species. Other threats include ecosystem modifications (primarily due to slides and sedimentation from forestry) and aquaculture of Atlantic Salmon, all of which are inferred to result in a future decline in numbers of wild fish.

Occurrence
British Columbia, Pacific Ocean

Status history
Designated Threatened in November 2020.

Assessment Summary – November 2020

Common name
Chinook Salmon - Designatable Unit 25: West Vancouver Island, Ocean, Fall (Nootka & Kyuquot) population

Scientific name
Oncorhynchus tshawytscha

Status
Threatened

Reason for designation
Mature fish in this population return in fall to the remote Nootka and Kyuquot Sounds on the west coast of Vancouver Island. They spawn in larger rivers such as the Conuma, Gold, Tahsish, and Zeballos Rivers. While this wildlife species spawns at a large number of sites, with survey information being available from many spawning areas, population trends are most likely heavily influenced by hatchery releases aimed to augment natural production. Straying of hatchery-origin spawners has been documented throughout the range and is expected to continue, likely compromising the genetic composition of wild spawners. Other threats include long-term effects from forestry, mainly slides and sedimentation.

Occurrence
British Columbia, Pacific Ocean

Status history
Designated Threatened in November 2020.

Assessment Summary – November 2020

Common name
Chinook Salmon - Designatable Unit 26: West Vancouver Island, Ocean, Fall (WVI + WQCI) population

Scientific name
Oncorhynchus tshawytscha

Status
Data Deficient

Reason for designation
Mature fish in this population return in fall to the remote watersheds on the west coast of Vancouver Island, north of the Brooks Peninsula. Adults return to spawn at a number of larger rivers, such as the Goodspeed, Marble, and Klaskish Rivers. Juvenile smolt enter Quatsino Sound after a brief residency in fresh water. While this wildlife species is known to spawn at a number of sites, survey information is available from only one site. This single monitoring site is heavily enhanced by hatchery releases and likely does not represent the entire population. Data are too few to assess status.

Occurrence
British Columbia, Pacific Ocean

Status history
Species considered in November 2020 and placed in the Data Deficient category.

INTRODUCTION TO PART TWO

Southern British Columbia (BC) Chinook Salmon comprise 28 Designatable Units (DUs). The focus of this Part Two report is the 12 DUs that are considered to have had more extensive artificial enhancement, usually through hatchery production. Please refer to Part One report (COSEWIC 2018) for the status of the other 16 DUs and for additional information on this report's 12 focal DUs. The list of assessed Designatable Units in Part Two is:

DU 1: Southern Mainland Boundary Bay, Ocean, Fall population

DU 6: Lower Fraser, Ocean, Summer population

DU 13: South Thompson, Stream, Summer 1.3 population

DU 15: Lower Thompson, Stream, Spring population

DU 18: South Coast - Georgia Strait, Ocean, Fall population

DU 20: East Vancouver Island, Ocean, Summer population

DU 21: East Vancouver Island, Ocean, Fall population

DU 22: South Coast - Southern Fjords, Ocean, Fall population

DU 23: East Vancouver Island, Ocean, Fall (EVI + SFj) population

DU 24: West Vancouver Island, Ocean, Fall (South) population

DU 25: West Vancouver Island, Ocean, Fall (Nootka & Kyuquot) population

DU 26: West Vancouver Island, Ocean, Fall (WVI + WQCI) population

COSEWIC
Executive Summary

Chinook Salmon
Oncorhynchus tshawytscha

Designatable Units in Southern British Columbia
(Part Two – Designatable Units with High Levels of Artificial Releases in the Last 12 Years)

SEE ALSO PART ONE REPORT (COSEWIC 2018)

TECHNICAL SUMMARIES

Oncorhynchus tshawytscha

Chinook Salmon

Saumon chinook

Range of occurrence in Canada (all DUs in this report): British Columbia, Pacific Ocean

Designatable Unit 1: Southern Mainland Boundary Bay, Ocean, Fall population
Population du sud de la partie continentale (C.-B.) - baie Boundary, type océanique, automne

Demographic Information

Generation Time	3.8 years			
Is there a continuing decline in the number of mature individuals?	No			
Estimated percent of continuing decline in total number of mature individuals within 5 years or 2 generations	Unknown			
Change in number of mature individuals based on last 3 generations	121%	p > 30% decline: 7%	p > 50% decline: 3%	p > 70% decline: 1%
Change in number of mature individuals all years	387%	p > 30% decline: 0%	p > 50% decline: 0%	p > 70% decline: 0%
Change in number of mature individuals based on last 3 generations (pNOS adjusted)	Not applicable	Not applicable	Not applicable	Not applicable
Change in number of mature individuals all years (pNOS adjusted)	Not applicable	Not applicable	Not applicable	Not applicable
Change in total number of mature individuals over the next 10 years, or 3 generations	Not applicable.			
Change in total number of mature individuals over any 10 years, or 3 generations,	Not applicable			
Are the causes of the decline a. clearly reversible and b. understood and c. ceased?	Unknown			
Are there extreme fluctuations in the number of mature individuals?	Unknown			
Extent of occurrence (square kilometres)	> 20,000			
Index of area of occupancy (square kilometres, 2x2 grid)	157			
Number of mature individuals (average over last generation)	175			
Number of mature individuals (average over last generation) – pNOS adjusted	54			

Threats

A threats calculator was not completed. The main threats are hatchery releases, marine survival and harvest

Status and Reasons for Designation:

Status History Designated Threatened in November 2020.	
Status: Threatened	**Alpha-numeric codes:** D1
Reasons for Designation: Mature fish in this population spawn in tributaries to Boundary Bay such as the Serpentine, Nicomekl and Little Campbell rivers, in southern British Columbia. This wildlife species occurs in highly altered freshwater and marine habitats. Ongoing low marine survival, bycatch, and fish culture effects are cumulative threats to the remaining wild fish. Hatchery releases are ongoing and have included fish from other populations, threatening the genetic integrity of the few remaining wild fish. While hatchery production has allowed the total population size to increase, a consensus of expert opinion estimates fewer than 1000 mature wild fish remain.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not applicable
Criterion B (Small Distribution Range and Decline or Fluctuation): Not applicable. While IAO is less than threshold for Endangered, other sub-criteria do not apply.
Criterion C (Small and Declining Number of Mature Individuals): Not applicable. No evidence for declining number of mature individuals.
Criterion D (Very Small or Restricted Population): Meets Threatened, D1. While indices of abundance of wild plus hatchery-produced spawners are increasing, consensus of expert opinion indicates that the most recent estimates of total number of mature fish at the three sites where spawning has been documented is fewer than 1000.
Criterion E (Quantitative Analysis): Not done.

Designatable Unit 6: Lower Fraser, Ocean, Summer population
Population du bas Fraser, type océanique, été

Demographic Information

Generation Time	3.8 years			
Is there a continuing decline in the number of mature individuals?	Yes			
Estimated percent of continuing decline in total number of mature individuals within 5 years or 2 generations	Unknown			
Change in number of mature individuals based on last 3 generations	-71%	p > 30% decline: 84%	p > 50% decline: 74%	p > 70% decline: 51%
Change in number of mature individuals all years	77%	p > 30% decline: 9%	p > 50% decline: 4%	p > 70% decline: 1%
Change in number of mature individuals based on last 3 generations (pNOS adjusted)	Not applicable	Not applicable	Not applicable	Not applicable
Change in number of mature individuals all years (pNOS adjusted)	Not applicable	Not applicable	Not applicable	Not applicable
Change in total number of mature individuals over the next 10 years, or 3 generations	Not applicable			
Change in total number of mature individuals over any 10 years, or 3 generations,	Not applicable			
Are the causes of the decline a. clearly reversible and b. understood and c. ceased?	Unknown			
Are there extreme fluctuations in the number of mature individuals?	Unknown			
Extent of occurrence (square kilometres)	> 20,000			
Index of area of occupancy (square kilometres, 2x2 grid)	30			
Number of mature individuals (average over last generation)	440			
Number of mature individuals (average over last generation) – pNOS adjusted	440			

Threats

A threats calculator was not completed. The main threat is ecosystem modifications.

Status and Reasons for Designation:

Status History Designated Endangered in November 2020.	
Status: Endangered	**Alpha-numeric codes: B2ab(iii,v);** C2a(ii)
Reasons for Designation: Mature fish in this population return in summer and spawn at a single site (Maria Slough), in the lower Fraser River. A continuing decline in spawner abundance is expected as a result of highly modified freshwater and marine habitats, low marine survival and harvest. Failed water control structures and low water levels prevented spawners from accessing the spawning site in 2018. A continuing decline in water quality and quantity is expected due to increasing urbanization and runoff.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not applicable. No information is available to disaggregate hatchery and wild fish trends. The trends in population abundance are difficult to interpret due to the past influence of hatchery releases.
Criterion B (Small Distribution Range and Decline or Fluctuation): Meets Endangered, B2ab(iii,v), because the IAO is less than the threshold, there is only one location, and continued deterioration in habitat quality is predicted to lead to a continued decline in the number of mature individuals.
Criterion C (Small and Declining Number of Mature Individuals): Meets Endangered, C2a(ii), as the remaining number of spawners is less than the threshold, inferred declines in abundances are expected to continue, and only one subpopulation exists.
Criterion D (Very Small or Restricted Population): Meets Threatened, D1, as the number of mature individuals is less than the threshold, and Threatened, D2, as there is a single location, prone to the effects of human activities and stochastic events, and the population could become Critically Endangered or Extinct within 1-2 generations. Although D1 and D2 Threatened were met, the species was determined to be more at risk and Endangered under criteria B and C.
Criterion E (Quantitative Analysis): Not applicable. Not done.

Designatable Unit 13: South Thompson, Stream, Summer 1.3 population
Population de la Thompson Sud, type fluvial, été 1.3

Demographic Information

Generation Time	4 years			
Is there a continuing decline in the number of mature individuals?	Yes			
Estimated percent of continuing decline in total number of mature individuals within 5 years or 2 generations	Unknown			
Change in number of mature individuals based on last 3 generations	-14%	p > 30% decline: 31%	p > 50% decline: 10%	p > 70% decline: 1%
Change in number of mature individuals all years	20%	p > 30% decline: 8%	p > 50% decline: 2%	p > 70% decline: 0%
Change in number of mature individuals based on last 3 generations (pNOS adjusted)	-22%	p > 30% decline: 40%	p > 50% decline: 15%	p > 70% decline: 2%
Change in number of mature individuals all years (pNOS adjusted)	-9%	p > 30% decline: 24%	p > 50% decline: 6%	p > 70% decline: 0%
Change in total number of mature individuals over the next 10 years, or 3 generations	Not applicable			
Change in total number of mature individuals over any 10 years, or 3 generations,	Not applicable			
Are the causes of the decline a. clearly reversible and b. understood and c. ceased?	Unknown			
Are there extreme fluctuations in the number of mature individuals?	Unknown			
Extent of occurrence (square kilometres)	> 20,000			
Index of area of occupancy (square kilometres, 2x2 grid)	424			
Number of mature individuals (average over last generation)	1049			
Number of mature individuals (average over last generation) – pNOS adjusted	443			

Threats

A threats calculator was not completed but the threats calculator for DU 15 (Lower Thompson, Stream, Spring population) may be used as a proxy. The main threats are ecosystem modifications, marine survival, invasive species, avalanches/landslides, and droughts.

Status and Reasons for Designation:

Status History Designated Endangered in November 2020.	
Status: Endangered	**Alpha-numeric codes:** C2a(ii)
Reasons for Designation: Mature fish in this population migrate up the Fraser River in summer, through the Thompson River to spawn in major Shuswap Lake tributaries such as the Seymour, Eagle, Scotch and the Salmon rivers. The estimated number of remaining wild spawners is fewer than 2500 fish, and there is a projected continuing decline in numbers. Threats include decreased water levels (water withdrawal and changes in volume as a result of low marine survival, harvest, and timing of snow melt), agricultural runoff, pollution from transportation accidents, and highly modified freshwater habitats. Such threats are accentuated due to a relatively long freshwater residence.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not applicable. Close to meeting threshold for Threatened, A2bd: while the point estimate of the decline rate over the last three generations is 22%, the probability that the decline rate is actually >30% is 0.4.
Criterion B (Small Distribution Range and Decline or Fluctuation): Not applicable. Does not meet the criterion.
Criterion C (Small and Declining Number of Mature Individuals): Meets Endangered, C2a(ii), as a consensus of expert opinion indicates that the remaining number of spawners is less than the threshold, there is an anticipated continuing decline, and only one subpopulation.
Criterion D (Very Small or Restricted Population): Not applicable. Thresholds exceeded.
Criterion E (Quantitative Analysis): Not applicable. Not done.

Designatable Unit 15: Lower Thompson, Stream, Spring population
Population de la Thompson inférieure, type fluvial, printemps

Demographic Information

Generation Time	4 years			
Is there a continuing decline in the number of mature individuals?	Yes			
Estimated percent of continuing decline in total number of mature individuals within 5 years or 2 generations	Unknown			
Change in number of mature individuals based on last 3 generations	47%	p > 30% decline: 15%	p > 50% decline: 7%	p > 70% decline: 2%
Change in number of mature individuals all years	-68%	p > 30% decline: 95%	p > 50% decline: 83%	p > 70% decline: 44%
Change in number of mature individuals based on last 3 generations (pNOS adjusted)	Not applicable	Not applicable	Not applicable	Not applicable
Change in number of mature individuals all years (pNOS adjusted)	Not applicable	Not applicable	Not applicable	Not applicable
Change in total number of mature individuals over the next 10 years, or 3 generations	Not applicable			
Change in total number of mature individuals over any 10 years, or 3 generations,	Not applicable			
Are the causes of the decline a. clearly reversible and b. understood and c. ceased?	Unknown			
Are there extreme fluctuations in the number of mature individuals?	Unknown			
Extent of occurrence (square kilometres)	> 20,000			
Index of area of occupancy (square kilometres, 2x2 grid)	1330			
Number of mature individuals (average over last generation)	7328			
Number of mature individuals (average over last generation) – pNOS adjusted	3758			

Threats

A threats calculator was completed. The main threats are ecosystem modifications, marine survival, hatchery releases, invasive species, avalanches/landslides, and droughts.

Status and Reasons for Designation:

Status History Designated Endangered in November 2020.	
Status: Endangered	**Alpha-numeric codes:** A4bcde
Reasons for Designation: Mature fish in this population migrate up the Fraser River in spring to the Thompson River and then into the Nicola, Deadman and Bonaparte rivers to spawn. Marine survival has been low since 2000. There has been a steep decline in the number of mature individuals from 2013 to 2018. This wildlife species faces a number of continuing and severe threats in its freshwater and marine habitat, including post Pine Beetle deforestation, short and long-term effects from wildfires (the large Elephant Hill fire occurred here in 2018), habitat destabilization, and climate-change induced disruption to water quality. Agriculture water withdrawal is substantial and ongoing.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Meets Endangered, A4bcde, as there is an observed past and future inferred population size reduction of more than 50% based on estimated numbers (b), and ongoing and projected declines due to habitat deterioration and decreased marine survival (c), continuing harvest (d), and increased competition at sea with hatchery-origin fish (e).
Criterion B (Small Distribution Range and Decline or Fluctuation): Not applicable. Thresholds exceeded.
Criterion C (Small and Declining Number of Mature Individuals): Meets Threatened, C2a(ii), as the remaining number of spawners is less than the threshold, there is an anticipated continuing decline and only one subpopulation occurs. Although C2a(ii) Threatened was met, the species was determined to be more at risk and Endangered under criterion A.
Criterion D (Very Small or Restricted Population): Not applicable. Thresholds exceeded.
Criterion E (Quantitative Analysis): Not applicable. Not done.

Designatable Unit 18: South Coast - Georgia Strait, Ocean, Fall population
Population de la côte sud - détroit de Georgia, type océanique, automne

Demographic Information

Generation Time	3.6 years			
Is there a continuing decline in the number of mature individuals?	Unknown			
Estimated percent of continuing decline in total number of mature individuals within 5 years or 2 generations	Unknown			
Change in number of mature individuals based on last 3 generations	78%	p > 30% decline: 10%	p > 50% decline: 5%	p > 70% decline: 1%
Change in number of mature individuals all years	2%	p > 30% decline: 27%	p > 50% decline: 13%	p > 70% decline: 4%
Change in number of mature individuals based on last 3 generations (pNOS adjusted)	Not applicable	Not applicable	Not applicable	Not applicable
Change in number of mature individuals all years (pNOS adjusted)	Not applicable	Not applicable	Not applicable	Not applicable
Change in total number of mature individuals over the next 10 years, or 3 generations	Not applicable			
Change in total number of mature individuals over any 10 years, or 3 generations,	Not applicable			
Are the causes of the decline a. clearly reversible and b. understood and c. ceased?	Unknown			
Are there extreme fluctuations in the number of mature individuals?	Unknown			
Extent of occurrence (square kilometres)	> 20,000			
Index of area of occupancy (square kilometres, 2x2 grid)	504			
Number of mature individuals (average over last generation)	678			
Number of mature individuals (average over last generation) – pNOS adjusted	678			

Threats

A threats calculator was not completed. The main threat is hatchery releases.

Status and Reasons for Designation:

Status History Species considered in November 2020 and placed in the Data Deficient category.	
Status: Data Deficient	**Alpha-numeric codes:** Not applicable
Reasons for Designation: Mature fish in this population return in the fall to rivers flowing into the south coast inlets of the Salish Sea between Burrard Inlet near Vancouver and Toba Inlet to the north. Abundance trend information is available for only two of 19 sites within the range of this relatively remote and poorly documented wildlife species. While these show a stable trend from 2005 to 2018, spawning is thought to occur elsewhere in the northern area. Data are too few to determine status.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Too few data to apply criterion.
Criterion B (Small Distribution Range and Decline or Fluctuation): Too few data to apply criterion.
Criterion C (Small and Declining Number of Mature Individuals): Too few data to apply criterion.
Criterion D (Very Small or Restricted Population): Too few data to apply criterion.
Criterion E (Quantitative Analysis): Not done.

Designatable Unit 20: East Vancouver Island, Ocean, Summer population
Population de l’est de l’île de Vancouver, type océanique, été

Demographic Information

Generation Time	3.5 years			
Is there a continuing decline in the number of mature individuals?	Yes			
Estimated percent of continuing decline in total number of mature individuals within 5 years or 2 generations	Unknown			
Change in number of mature individuals based on last 3 generations	-51%	p > 30% decline: 76%	p > 50% decline: 51%	p > 70% decline: 16%
Change in number of mature individuals all years	39%	p > 30% decline: 2%	p > 50% decline: 0%	p > 70% decline: 0%
Change in number of mature individuals based on last 3 generations (pNOS adjusted)	-41%	p > 30% decline: 60%	p > 50% decline: 40%	p > 70% decline: 16%
Change in number of mature individuals all years (pNOS adjusted)	60%	p > 30% decline: 1%	p > 50% decline: 0%	p > 70% decline: 0%
Change in total number of mature individuals over the next 10 years, or 3 generations	Not applicable			
Change in total number of mature individuals over any 10 years, or 3 generations,	Not applicable			
Are the causes of the decline a. clearly reversible and b. understood and c. ceased?	Unknown			
Are there extreme fluctuations in the number of mature individuals?	Unknown			
Extent of occurrence (square kilometres)	> 20,000			
Index of area of occupancy (square kilometres, 2x2 grid)	311			
Number of mature individuals (average over last generation)	1012			
Number of mature individuals (average over last generation) – pNOS adjusted	191			

Threats

A threats calculator was completed. The main threats are ecosystem modifications, drought, exploitation, marine survival and hatchery releases.

Status and Reasons for Designation:

Status History Designated Endangered in November 2020.	
Status: Endangered	**Alpha-numeric codes:** C2a(ii)
Reasons for Designation: Mature fish in this population return in summer to spawn in the upper reaches of rivers draining the east side of Vancouver Island, from the Koksilah River in the south to the Puntledge River in the north. According to a consensus of expert opinion, fewer than 1000 wild spawners remain in this population. Exploitation rates are relatively high (about 40%), and marine survival estimates have been low for many years. Additional threats include ecosystem modifications (dam construction and channelization) and drought. The contribution of fish from hatcheries confounds the determination of population trends; hatchery-origin spawners may be a continued threat through direct competition and gene flow.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not applicable. Available indices of abundance over the most recent three generations and over longer time spans show conflicting trends that are difficult to reconcile.
Criterion B (Small Distribution Range and Decline or Fluctuation): Not applicable. While the IAO is less than the threshold for Endangered, other sub-criteria do not apply.
Criterion C (Small and Declining Number of Mature Individuals): Meets Endangered C2a(ii), as the estimated remaining number of spawners is less than the threshold, declines are expected to continue, and only one subpopulation exists.
Criterion D (Very Small or Restricted Population): Meets Threatened, D1, given that there are fewer than 1000 mature individuals estimated. Thresholds for Threatened D2 are exceeded. Although D1 Threatened was met, the species was determined to be more at risk and Endangered under criterion C.
Criterion E (Quantitative Analysis): Not applicable. Not done.

Designatable Unit 21: East Vancouver Island, Ocean, Fall population
Population de l'est de l'île de Vancouver, type océanique, automne

Demographic Information

Generation Time	3.3 years			
Is there a continuing decline in the number of mature individuals?	No			
Estimated percent of continuing decline in total number of mature individuals within 5 years or 2 generations	Unknown			
Change in number of mature individuals based on last 3 generations	99%	p > 30% decline: 0%	p > 50% decline: 0%	p > 70% decline: 0%
Change in number of mature individuals all years	-7%	p > 30% decline: 12%	p > 50% decline: 1%	p > 70% decline: 0%
Change in number of mature individuals based on last 3 generations (pNOS adjusted)	180%	p > 30% decline: 0%	p > 50% decline: 0%	p > 70% decline: 0%
Change in number of mature individuals all years (pNOS adjusted)	40%	p > 30% decline: 1%	p > 50% decline: 0%	p > 70% decline: 0%
Change in total number of mature individuals over the next 10 years, or 3 generations	Not applicable			
Change in total number of mature individuals over any 10 years, or 3 generations,	Not applicable			
Are the causes of the decline a. clearly reversible and b. understood and c. ceased?	Unknown			
Are there extreme fluctuations in the number of mature individuals?	Unknown			
Extent of Occurrence (square kilometres)	> 20,000			
Index of area of occupancy (square kilometres, 2x2 grid)	531			
Number of mature individuals (average over last generation)	29446			
Number of mature individuals (average over last generation) – pNOS adjusted	9551			

Threats

A threats calculator was completed. The main threats are hatchery releases, harvest marine survival.

Status and Reasons for Designation:

Status History Designated Special Concern in November 2020.	
Status: Special Concern	**Alpha-numeric codes:** Not applicable
Reasons for Designation: Mature fish in this population return in fall to the east side of Vancouver Island to spawn in multiple rivers from the Goldstream near Victoria north to Campbell River. Five of the six watersheds within the range of this wildlife species are mostly inhabited by hatchery-origin fish. While the overall abundance in the single remaining watershed is increasing, several large-scale hatcheries aim to augment production within the other watersheds and straying could pose threats from competition and gene flow to the remaining wild fish. Other threats include low marine survival, relatively high exploitation rates, ecosystem modifications and water management/use. This wildlife species could become Threatened if these factors are not properly managed.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not applicable. Information is available to disaggregate hatchery and wild fish trends and abundance of wild fish has been increasing.
Criterion B (Small Distribution Range and Decline or Fluctuation): Not applicable. While the IAO is less than the threshold for Threatened, other sub-criteria do not apply.
Criterion C (Small and Declining Number of Mature Individuals): Not applicable. No evidence for declining number of mature individuals.
Criterion D (Very Small or Restricted Population): Not applicable. Exceeds thresholds for D1 and D2.
Criterion E (Quantitative Analysis): Not applicable. Not done.

Designatable Unit 22: South Coast - Southern Fjords, Ocean, Fall population
Population de la côte sud - fjords du sud, type océanique, automne

Demographic Information

Generation Time	3.6 years			
Is there a continuing decline in the number of mature individuals?	Unknown			
Estimated percent of continuing decline in total number of mature individuals within 5 years or 2 generations	Unknown			
Change in number of mature individuals based on last 3 generations	718%	p > 30% decline: 0%	p > 50% decline: 0%	p > 70% decline: 0%
Change in number of mature individuals all years	2030%	p > 30% decline: 0%	p > 50% decline: 0%	p > 70% decline: 0%
Change in number of mature individuals based on last 3 generations (pNOS adjusted)	Not applicable	Not applicable	Not applicable	Not applicable
Change in number of mature individuals all years (pNOS adjusted)	2055%	p > 30% decline: 0%	p > 50% decline: 0%	p > 70% decline: 0%
Change in total number of mature individuals over the next 10 years, or 3 generations	Not applicable			
Change in total number of mature individuals over any 10 years, or 3 generations,	Not applicable			
Are the causes of the decline a. clearly reversible and b. understood and c. ceased?	Unknown			
Are there extreme fluctuations in the number of mature individuals?	Unknown			
Extent of occurrence (square kilometres)	> 20,000			
Index of area of occupancy (square kilometres, 2x2 grid)	619			
Number of mature individuals (average over last generation)	1969			
Number of mature individuals (average over last generation) – pNOS adjusted	267			

Threats

A threats calculator was not completed. The main threats are harvest, marine survival and hatchery releases.

Status and Reasons for Designation:

Status History Species considered in November 2020 and placed in the Data Deficient category.	
Status: Data Deficient	**Alpha-numeric codes:** Not applicable
Reasons for Designation: Mature fish in this population return in the fall to the fjords of the Phillips Arm and Bute Inlet near Johnstone Strait in southern BC. Spawners migrate to the remote habitats of the Phillips, Franklin, Orford, and other rivers. While some survey information exists, coverage is incomplete and changes in methodology make it difficult to interpret trends in abundance or recent numbers of mature individuals. Data are too few to assess status.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Too few data to apply criterion.
Criterion B (Small Distribution Range and Decline or Fluctuation): Too few data to apply criterion.
Criterion C (Small and Declining Number of Mature Individuals): Too few data to apply criterion.
Criterion D (Very Small or Restricted Population): Too few data to apply criterion.
Criterion E (Quantitative Analysis): Not done.

Designatable Unit 23: East Vancouver Island, Ocean, Fall (EVI + SFj) population
Population de l'est de l'île de Vancouver, type océanique, automne (EVI + SFj)

Demographic Information

Generation Time	4.4 years			
Is there a continuing decline in the number of mature individuals?	No			
Estimated percent of continuing decline in total number of mature individuals within 5 years or 2 generations	Unknown			
Change in number of mature individuals based on last 3 generations	6%	p > 30% decline: 6%	p > 50% decline: 1%	p > 70% decline: 0%
Change in number of mature individuals all years	-38%	p > 30% decline: 72%	p > 50% decline: 15%	p > 70% decline: 0%
Change in number of mature individuals based on last 3 generations (pNOS adjusted)	48%	p > 30% decline: 2%	p > 50% decline: 0%	p > 70% decline: 0%
Change in number of mature individuals all years (pNOS adjusted)	85%	p > 30% decline: 0%	p > 50% decline: 0%	p > 70% decline: 0%
Change in total number of mature individuals over the next 10 years, or 3 generations	Not applicable			
Change in total number of mature individuals over any 10 years, or 3 generations,	Not applicable			
Are the causes of the decline a. clearly reversible and b. understood and c. ceased?	Unknown			
Are there extreme fluctuations in the number of mature individuals?	Unknown			
Extent of occurrence (square kilometres)	> 20,000			
Index of area of occupancy (square kilometres, 2x2 grid)	292			
Number of mature individuals (average over last generation)	8298			
Number of mature individuals (average over last generation) – pNOS adjusted	2133			

Threats

A threats calculator was completed. The main threats are dams and water management/use, harvest, marine survival, hatchery releases.

Status and Reasons for Designation:

Status History Designated Not at Risk in November 2020.	
Status: Not at Risk	**Alpha-numeric codes:** Not applicable
Reasons for Designation: Mature fish in this population return in fall to spawn in rivers which drain the eastern slope of Vancouver Island's coastal mountain ridge, such as the Adam, Quinsam, Nimpkish, Salmon and Campbell Rivers. While the population faces a number of threats including competition and gene flow from hatchery production, indices of abundance suggest increasing numbers.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not applicable. Information is available to disaggregate hatchery and wild fish trends; estimated abundance of wild fish has been increasing. However, the influence of hatchery origin spawners in the Quinsam River is high.
Criterion B (Small Distribution Range and Decline or Fluctuation): Not applicable. While the IAO is less than the threshold for Endangered, other sub-criteria do not apply.
Criterion C (Small and Declining Number of Mature Individuals): Not applicable. No evidence for declining number of mature individuals.
Criterion D (Very Small or Restricted Population): Not applicable. Exceeds thresholds for Threatened, D1 and D2.
Criterion E (Quantitative Analysis): Not applicable. Not done.

Designatable Unit 24: West Vancouver Island, Ocean, Fall (South) population
Population de l'ouest de l'île de Vancouver, type océanique, automne (sud)

Demographic Information

Generation Time	4 years			
Is there a continuing decline in the number of mature individuals?	Yes			
Estimated percent of continuing decline in total number of mature individuals within 5 years or 2 generations	Unknown			
Change in number of mature individuals based on last 3 generations	83%	p > 30% decline: 0%	p > 50% decline: 0%	p > 70% decline: 0%
Change in number of mature individuals all years	-14%	p > 30% decline: 21%	p > 50% decline: 2%	p > 70% decline: 0%
Change in number of mature individuals based on last 3 generations (pNOS adjusted)	43%	p > 30% decline: 0%	p > 50% decline: 0%	p > 70% decline: 0%
Change in number of mature individuals all years (pNOS adjusted)	-19%	p > 30% decline: 24%	p > 50% decline: 1%	p > 70% decline: 0%
Change in total number of mature individuals over the next 10 years, or 3 generations	Not applicable			
Change in total number of mature individuals over any 10 years, or 3 generations,	Not applicable			
Are the causes of the decline a. clearly reversible and b. understood and c. ceased?	Unknown			
Are there extreme fluctuations in the number of mature individuals?	Unknown			
Extent of Occurrence (square kilometres)	> 20,000			
Index of area of occupancy (square kilometres, 2x2 grid)	761			
Number of mature individuals (average over last generation)	53036			
Number of mature individuals (average over last generation) – pNOS adjusted 6365				

Threats

A threats calculator was completed. The main threats are hatchery releases, ecosystem modifications, agricultural and forestry effluents, harvest and marine survival.

Status and Reasons for Designation:

Status History Designated Threatened in November 2020.	
Status: Threatened	**Alpha-numeric codes:** C2a(ii)
Reasons for Designation: Mature fish in this population return in fall to spawn at a large number of sites in rivers along the south west coast of Vancouver Island including the Nahmint, San Juan, Somass-Sproat, Nitinat, and Sarita Rivers. Survey information is available for many spawning locations, and while the overall trends are unclear, <10,000 wild adults are thought to remain. Large-scale hatcheries operating with the aim of augmenting production have resulted in straying of hatchery-origin spawners throughout the range. Such straying likely compromises the genetic composition of spawners and therefore represents a continuing threat to the wildlife species. Other threats include ecosystem modifications (primarily due to slides and sedimentation from forestry) and aquaculture of Atlantic Salmon, all of which are inferred to result in a future decline in numbers of wild fish.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not applicable. Available indices of abundance over the most recent three generations and over longer time spans show conflicting trends that are difficult to reconcile.
Criterion B (Small Distribution Range and Decline or Fluctuation): Not applicable. While the IAO is less than the threshold for Threatened, other sub-criteria do not apply.
Criterion C (Small and Declining Number of Mature Individuals): Meets Threatened, C2a(ii), as a consensus of expert opinion indicates there are fewer than 10,000 wild mature individuals, threats, based on expert opinion, are expected to continue, and only one subpopulation exists.
Criterion D (Very Small or Restricted Population): Not applicable. Exceeds thresholds.
Criterion E (Quantitative Analysis): Not applicable. Not done.

Designatable Unit 25: West Vancouver Island, Ocean, Fall (Nootka & Kyuquot) population
Population de l'ouest de l'île de Vancouver, type océanique, automne (Nootka et Kyuquot)

Demographic Information

Generation Time	4 years			
Is there a continuing decline in the number of mature individuals?	Yes			
Estimated percent of continuing decline in total number of mature individuals within 5 years or 2 generations	Unknown			
Change in number of mature individuals based on last 3 generations	116%	p > 30% decline: 4%	p > 50% decline: 1%	p > 70% decline: 0%
Change in number of mature individuals all years	17%	p > 30% decline: 9%	p > 50% decline: 2%	p > 70% decline: 0%
Change in number of mature individuals based on last 3 generations (pNOS adjusted)	169%	p > 30% decline: 0%	p > 50% decline: 0%	p > 70% decline: 0%
Change in number of mature individuals all years (pNOS adjusted)	9%	p > 30% decline: 8%	p > 50% decline: 1%	p > 70% decline: 0%
Change in total number of mature individuals over the next 10 years, or 3 generations	Not applicable			
Change in total number of mature individuals over any 10 years, or 3 generations,	Not applicable			
Are the causes of the decline a. clearly reversible and b. understood and c. ceased?	Unknown			
Are there extreme fluctuations in the number of mature individuals?	Unknown			
Extent of Occurrence (square kilometres)	> 20,000			
Index of area of occupancy (square kilometres, 2x2 grid)	375			
Number of mature individuals (average over last generation)	35271			
Number of mature individuals (average over last generation) – pNOS adjusted	5568			

Threats

A threats calculator was completed. The main threats are hatchery releases, ecosystem modifications, harvest, marine survival, tourism/recreation areas, industrial effluents, agriculture/forestry issues, avalanches/landslides and droughts.

Status and Reasons for Designation:

Status History Designated Threatened in November 2020.	
Status: Threatened	**Alpha-numeric codes:** C2a(ii)
Reasons for Designation: Mature fish in this population return in fall to the remote Nootka and Kyuquot Sounds on the west coast of Vancouver Island. They spawn in larger rivers such as the Conuma, Gold, Tahsish, and Zeballos Rivers. While this wildlife species spawns at a large number of sites, with survey information being available from many spawning areas, population trends are most likely heavily influenced by hatchery releases aimed to augment natural production. Straying of hatchery-origin spawners has been documented throughout the range and is expected to continue, likely compromising the genetic composition of wild spawners. Other threats include long-term effects from forestry, mainly slides and sedimentation.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not applicable. Available indices of abundance over the most recent three generations and across longer time series do not show declines.
Criterion B (Small Distribution Range and Decline or Fluctuation): Not applicable. While the IAO is less than the threshold for Endangered, other sub-criteria do not apply.
Criterion C (Small and Declining Number of Mature Individuals): Meets Threatened, C2a(ii). The consensus of expert opinion indicates that there are fewer than 10,000 wild, mature individuals, all within one subpopulation. A continuing decline is inferred from expert opinion. The number of mature fish based on expert opinion suggests it may meet Endangered, C2a(ii), with fewer than 2500 mature, wild fish.
Criterion D (Very Small or Restricted Population): Not applicable. Exceeds thresholds.
Criterion E (Quantitative Analysis): Not applicable. Not done.

Designatable Unit 26: West Vancouver Island, Ocean, Fall (WVI + WQCI) population
Population de l’ouest de l’île de Vancouver, type océanique, automne (WVI + WQCI)

Demographic Information

Generation Time	4 years			
Is there a continuing decline in the number of mature individuals?	Unknown			
Estimated percent of continuing decline in total number of mature individuals within 5 years or 2 generations	Unknown			
Change in number of mature individuals based on last 3 generations	-41%	p > 30% decline: 58%	p > 50% decline: 42%	p > 70% decline: 21%
Change in number of mature individuals all years	-29%	p > 30% decline: 49%	p > 50% decline: 20%	p > 70% decline: 2%
Change in number of mature individuals based on last 3 generations (pNOS adjusted)	Not applicable	Not applicable	Not applicable	Not applicable
Change in number of mature individuals all years (pNOS adjusted)	Not applicable	Not applicable	Not applicable	Not applicable
Change in total number of mature individuals over the next 10 years, or 3 generations	Not applicable			
Change in total number of mature individuals over any 10 years, or 3 generations,	Not applicable			
Are the causes of the decline a. clearly reversible and b. understood and c. ceased?	Unknown			
Are there extreme fluctuations in the number of mature individuals?	Unknown			
Extent of Occurrence (square kilometres)	> 20,000			
Index of area of occupancy (square kilometres, 2x2 grid)	95			
Number of mature individuals (average over last generation)	3699			
Number of mature individuals (average over last generation) – pNOS adjusted	3699			

Threats

A threats calculator was not completed. The main threat is hatchery releases.

Status and Reasons for Designation:

Status History Species considered in November 2020 and placed in the Data Deficient category.	
Status: Data Deficient	**Alpha-numeric codes:** Not applicable
Reasons for Designation: Mature fish in this population return in fall to the remote watersheds on the west coast of Vancouver Island, north of the Brooks Peninsula. Adults return to spawn at a number of larger rivers, such as the Goodspeed, Marble, and Klaskish Rivers. Juvenile smolt enter Quatsino Sound after a brief residency in fresh water. While this wildlife species is known to spawn at a number of sites, survey information is available from only one site. This single monitoring site is heavily enhanced by hatchery releases and likely does not represent the entire population. Data are too few to assess status.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Too few data to apply criterion.
Criterion B (Small Distribution Range and Decline or Fluctuation): Too few data to apply criterion.
Criterion C (Small and Declining Number of Mature Individuals): Too few data to apply criterion.
Criterion D (Very Small or Restricted Population): Too few data to apply criterion.
Criterion E (Quantitative Analysis): Not done.

Standard Technical Summary boxes 11 to 21 are not included in this report part.

COSEWIC HISTORY

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. Species designated at meetings of the full committee are added to the list. On June 5, 2003, the *Species at Risk Act* (SARA) was proclaimed. SARA establishes COSEWIC as an advisory body ensuring that species will continue to be assessed under a rigorous and independent scientific process.

COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses the national status of wild species, subspecies, varieties, or other designatable units that are considered to be at risk in Canada. Designations are made on native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fishes, arthropods, molluscs, vascular plants, mosses, and lichens.

COSEWIC MEMBERSHIP

COSEWIC comprises members from each provincial and territorial government wildlife agency, four federal entities (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biodiversity Information Partnership, chaired by the Canadian Museum of Nature), three non-government science members and the co-chairs of the species specialist subcommittees and the Aboriginal Traditional Knowledge subcommittee. The Committee meets to consider status reports on candidate species.

DEFINITIONS
(2020)

Wildlife Species	A species, subspecies, variety, or geographically or genetically distinct population of animal, plant or other organism, other than a bacterium or virus, that is wild by nature and is either native to Canada or has extended its range into Canada without human intervention and has been present in Canada for at least 50 years.
Extinct (X)	A wildlife species that no longer exists.
Extirpated (XT)	A wildlife species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A wildlife species facing imminent extirpation or extinction.
Threatened (T)	A wildlife species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)*	A wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats.
Not at Risk (NAR)**	A wildlife species that has been evaluated and found to be not at risk of extinction given the current circumstances.
Data Deficient (DD)***	A category that applies when the available information is insufficient (a) to resolve a species' eligibility for assessment or (b) to permit an assessment of the species' risk of extinction.

* Formerly described as "Vulnerable" from 1990 to 1999, or "Rare" prior to 1990.

** Formerly described as "Not In Any Category", or "No Designation Required."

*** Formerly described as "Indeterminate" from 1994 to 1999 or "ISIBD" (insufficient scientific information on which to base a designation) prior to 1994. Definition of the (DD) category revised in 2006.

Environment and Climate Change Canada
Canadian Wildlife Service

Environnement et Changement climatique Canada
Service canadien de la faune

Canada

The Canadian Wildlife Service, Environment and Climate Change Canada, provides full administrative and financial support to the COSEWIC Secretariat.

COSEWIC Status Report

on the

Chinook Salmon
Oncorhynchus tshawytscha

Designatable Units in Southern British Columbia
(Part Two – Designatable Units with High Levels of Artificial Releases in the Last 12 Years)

in Canada

2020

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DISTRIBUTION
HABITAT
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POPULATION SIZES AND TRENDS
THREATS AND LIMITING FACTORS

FORMAT OF DESIGNATABLE UNIT-SPECIFIC CHAPTERS

Please see the DU-by-DU Technical Summaries in the front section of this report part. In the following DU-specific chapters, the information covered for each DU will include:

1. Names, life-history type, run-timing and generation time
2. Extent of occurrence and area of occupancy
3. Habitat trends
4. Abundance
5. Fluctuations and trends
6. Threats and limiting factors

Names, Life-history Type, Run-timing and Generation Time

Each DU chapter begins by listing the full DU name, the DU short name, the Joint Adaptive Zone (JAZ) short name, the life-history type (Ocean or Stream), the run-timing type (Fall, Spring, Summer), and generation time. Run timing is the time at which adult Chinook Salmon begin their return migration to natal streams. Please refer to the Part One report (COSEWIC 2018) for a more detailed explanation of the run-timing definitions used to classify southern BC Chinook Salmon populations. Generation time is estimated as the average age of spawners in the absence of fishing mortality. These figures are based on coded-wire tag (CWT) indicator stocks (shown in Table 3). Where indicator stocks are not available within a DU, proxy indicator stocks are used. For southern BC Chinook Salmon DUs, all the CWT indicator stocks are integrated hatchery stocks. Because both natural and hatchery origin fish are used as brood stock and CWTs are applied to their progeny, it is assumed that other natural origin fish in the DU are represented reasonably by the indicator stocks. This assumption is often made with southern BC Chinook Salmon, but it is well known that these indicator stocks were chosen by convenience, and not by random selection or any other manner intended to accurately represent the characteristics of the conservation unit. The extent to which these indicator stocks represent other stocks within a given DU is unknown. These are currently the best data available for the purpose of estimating generation time (G. Brown pers. comm. 2019).

Extent of Occurrence and Area of Occupancy

For each DU, extent of occurrence and area of occupancy data are reported at the DU level of analysis (see the **Designatable Unit Delineation** section of this report). The spatial extent of all DU boundaries is shown in Figure 1, this coverage represents the terrestrial (i.e., freshwater) extent of occurrence for the southern BC Chinook Salmon assessed in this report.

DU boundary delineations were adapted from Conservation Unit (CU) Report Cards developed by Porter *et al.* (2013) which used third-order plus watersheds from the 1:50,000 British Columbia Watershed Atlas as a base spatial scale of analysis. Prior to release of the Porter *et al.* report, some of these CU boundaries were modified to allow for Fisheries and Oceans Canada (DFO)-defined changes; as a result, associated metrics were recalculated. Generally, DU boundaries used in this report correspond to CU boundaries. In the cases of DU12 and DU21, multiple CUs comprise the DU. For DU-specific chapters, individual DU areal extents are estimated in GIS software using geospatial shapefiles. The DU map in Figure 1 is confirmed as up-to-date and accurate as of 2012. However, after the release of the Porter *et al*. report, the spatial extents of the CU areas were again redefined – in all cases they were expanded. At the time of writing, data were unavailable for these revised boundaries.

The marine extent of Chinook Salmon cannot be precisely defined geospatially due to lack of available data, but the extent of occurrence for all southern BC Chinook Salmon is known to be >20,000 km^2. According to harvest statistics, Chinook Salmon ocean ranges extend northward to southeast Alaska (Riddell *et al.* 2013). Ranges specific to southern BC Chinook Salmon vary depending on life-history strategy with ‘local’ stocks moving as far north as central Queen Charlotte Islands and as far south as the Columbia River mouth (R. Bailey, pers. comm., 2019). “Offshore” stocks are believed to range as far north as the Bering Sea and into the North Pacific Gyre (R. Bailey, pers. comm., 2019).

Following methods used for the COSEWIC Fraser Sockeye Salmon Status Report, the Indexed Area of Occupancy (IAO) for each DU is calculated as two times the spawning length, and is reported in square kilometres. This method is equivalent to overlaying a 2×2km square grid over the stream, and adding up the total area. To assist in comparison across DUs, each DU description also states the DU’s proportion of spawning habitat relative to the total across all southern BC Chinook Salmon DUs. Chinook Salmon spawning extents were provided by the BC Fisheries Information Summary System (FISS), and are meant to cover the total linear length of known Chinook Salmon spawning habitat within each DU. FISS presently represents the best available data in GIS format; however, the database is known to be incomplete due to a lack of comprehensive source information for southern BC Chinook Salmon distributions (Porter *et al.* 2013).

As indicated in the DU-specific sections that follow, in some instances the IAO was less than the thresholds identified in COSEWIC's Quantitative Criteria (Appendix E3, Operations and Procedures Manual, COSEWIC). However, other subcriteria must also be satisfied to invoke status based on spatial extent. For example, the concept of "locations" is important, and refers to a geographically or ecologically distinct area in which a single threatening event can rapidly affect all individuals of the taxon present. The Marine Fishes Species Specialist Subcommittee (SSC) considered this concept and concluded that given the complex life history and management structures of Chinook Salmon, that the "locations" concept does not apply. An exception is DU 6, however, where the entire population is impacted by a failing water control structure.

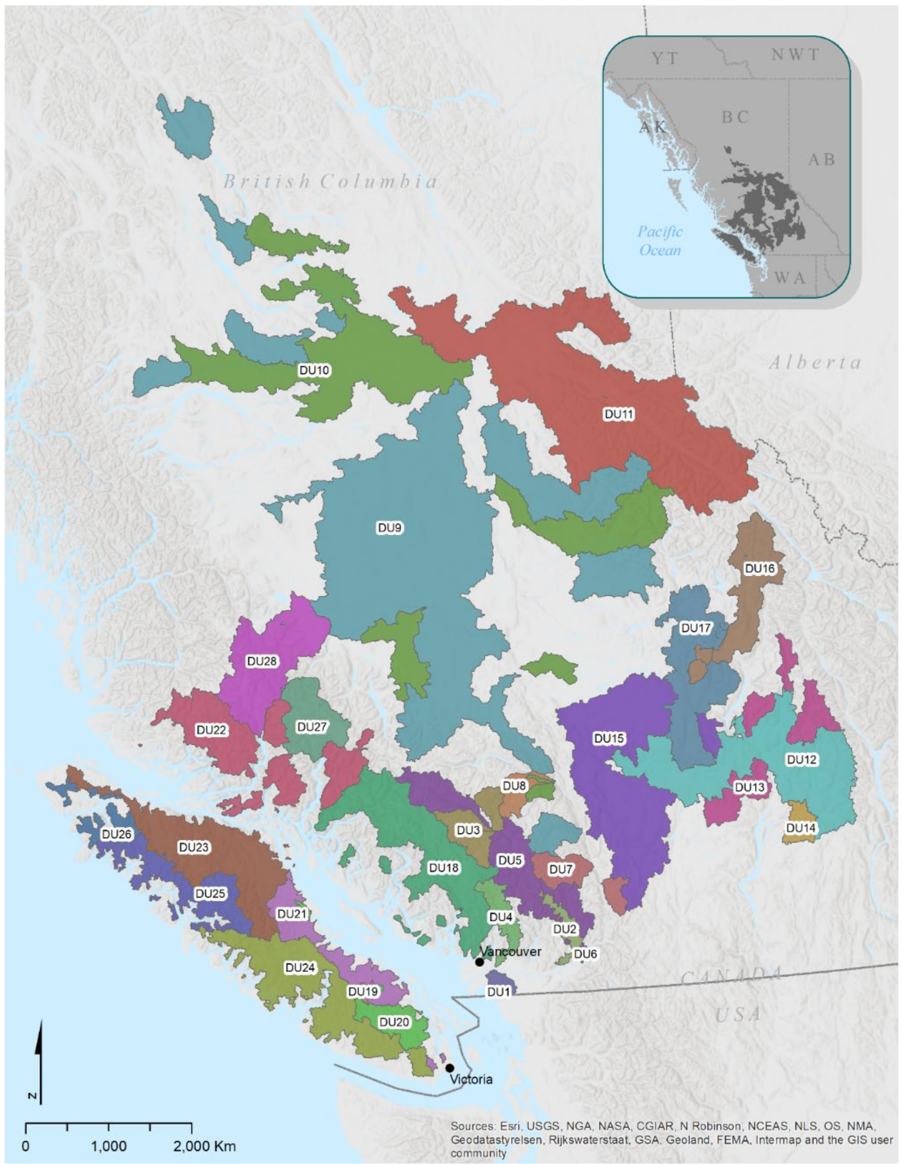

Figure 1. Spatial extent of the freshwater area for all southern BC Chinook Salmon Designatable Units (based on Conservation Unit delineations, which are being regularly updated by Fisheries and Oceans Canada. These boundaries are up-to-date and accurate as of 2012. No official updates have been published since that date).

Habitat Trends

Habitat trends reported for each DU's freshwater-based area describe some of the known indicators adapted from the Porter *et al.* (2013) DFO Report Card data. Reported trends include land-based habitat alteration, urban development, rural development, mining, road density, the number of stream crossings, riparian habitat disturbance, forest disturbance, and Mountain Pine Beetle-affected pine stands.

Sampling Effort and Methods

<u>Abundance</u>

While total abundance is the most desirable metric for this category, such data are unavailable for many DUs. Hence, both this Part Two report and the Part One report (COSEWIC 2018) rely on escapement data. Escapement, defined as the number of fish arriving at a natal stream or river to spawn (also termed 'spawner abundance') can be assessed by presence/absence, relative abundance, or total ("true") abundance. The New Salmon Escapement Database System (NuSEDS) is a centralized database that holds adult salmon escapement data used by DFO. Escapement data used for the status metrics in this Part Two report and the Part One report (COSEWIC 2018) originated from NuSEDS, with the understanding that not all escapement data from NuSEDS represent absolute abundances.

Escapement data quality and quantity varies across DUs and over time. In 2013, DFO undertook a process to determine thresholds for data quality of escapement data that included a three-day workshop in February of that year. The NuSEDS Estimate Classification scheme (Table 1) was central to selecting data considered to be sufficient in quality and completeness to be used for calculation of status metrics. The process is described in greater detail in Brown *et al.* (2013b), but it is also described briefly here. Data considered suitable for use were Type-1 through Type-4 estimates only ('true abundance' and 'relative abundance'). When using the NuSEDS Estimate Classification scheme, over 61% of escapement records between 1953 and 1995 were excluded due to missing Estimate Classification information, and therefore marked as 'unknown'. DFO identified the missing data as a high priority for 'data rescue'. The NuSEDS Estimate Classifications were further grouped into high, moderate, low, and unknown categories: H (High) = True Abundance (Type 1 or 2), M (Mod) = Relative Abundance (Type 3 or 4), L (Low) = Relative Abundance (Type 5) or Presence/Absence (Type 6), and ? (Unknown) = Type Unknown is reported in the database or is blank.

Within a DU or, in the case of the Wild Salmon Policy (WSP), within a CU, a key challenge is how to combine data for 'true abundance' (Type 1 or 2) with data for 'relative abundance' (Type 3 or 4). In many cases where multiple spawning sites existed, relative abundance estimates were summed with true abundance estimates to arrive at total abundance within the DU. In these cases, the entire DU was considered a 'relative abundance index'. Under the WSP CUs, there were 4 CUs that were considered to provide actual abundance: CK-03, CK-15, CK-21, and CK-22. However, when combined into DUs, only DU2 (CK-03) was considered to provide actual abundance (CK-15 is combined into DU12 with CK-13; CK-21 and CK-22 are combined into DU 21 with CK-25 and CK-27). In both relative abundance index and actual abundance cases, all CUs/DUs had considerable past and current enhancement (Brown *et al.* 2013b). See also Part One (COSEWIC 2018) for more discussion of the relationship between DU and CU.

Table 1. New Salmon Escapement Database System (NuSEDS) Estimate Classification scheme. SIL = Stream Inspection Log; SEN = Summary Estimate Narrative.

DFO Ranking	Estimate Type	Survey Method(s)	Analytical Method(s)	Reliability (within stock comparisons)	Units	Accuracy	Precision	Documentation
High (H)	Type-1, True Abundance, high resolution	total, seasonal counts through fence or fishway; virtually no bypass	simple, often single step	reliable resolution of between year differences >10% (in absolute units)	absolute abundance	actual, very high	infinite i.e.+ or - zero%	detailed SIL(s), SEN, field notes or diaries, published report on methods
	Type-2, True Abundance, medium resolution	high effort (5 or more trips), standard methods (e.g. mark-recapture, serial counts for area under curve, etc...)	simple to complex multi-step, but always rigorous	reliable resolution of between year differences >25% (in absolute units)	absolute abundance	actual or assigned estimate and high	actual estimate, high to moderate	detailed SIL(s), SEN, field notes or diaries, published report on methods
Moderate (M)	Type-3, Relative Abundance, high resolution	high effort (5 or more trips), standard methods (e.g. equal effort surveys executed by walk, swim, overflight, etc.)	simple to complex multi-step, but always rigorous	reliable resolution of between year differences >25% (in absolute units)	relative abundance linked to method	assigned range and medium to high	assigned estimate, medium to high	detailed SIL(s), SEN, field notes or diaries, published report on methods
	Type-4, Relative Abundance, medium resolution	low to moderate effort (1-4 trips), known survey method	simple analysis by known methods	reliable resolution of between year differences >200% (in relative units)	relative abundance linked to method	unknown assumed fairly constant	unknown assumed fairly constant	complete SEN or equivalent with sufficient detail to verify both survey and analytical procedures
Low (L)	Type-5, Relative Abundance, low resolution	low effort (e.g. 1 trip), use of vaguely defined, inconsistent or poorly executed methods	unknown to ill defined; inconsistent or poorly executed	uncertain numeric comparisons, but high reliability for presence or absence	relative abundance, but vague or no identification of method	unknown assumed highly variable	unknown assumed highly variable	incomplete SEN, only reliable to confirm estimate is from an actual survey

DFO Ranking	Estimate Type	Survey Method(s)	Analytical Method(s)	Reliability (within stock comparisons)	Units	Accuracy	Precision	Documentation
	Type-6, Presence or Absence	any of above	not required	moderate to high reliability for presence/absence	(+) or (-)	medium to high	unknown	any of above sufficient to confirm survey and reliable species identification
Unknown (?)	Unknown	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Sample sites within a DU were assessed based on the quality and completeness of their time series. The full list of sample sites is presented in Appendix 1 along with start/end dates for each estimation method. Note that sites with very low contributions are not included in the figures reported in Panels c and d of the 'abundance, enhancement, and hatchery release' data graphics (Figure 2) of each DU chapter (e.g. Wap Creek in DU12). The process is described in greater detail by Brown *et al.* (2013), and relied on the following criteria:

1. Sites must be 'persistent'. 'Persistent' sites ('P') were defined as those having more than 50% high quality observations (Type-1 to Type-4) during the period Start Year to the last available year, with no more than one generation of years missing in sequence. For example, for DUs with a start year of 1995, this translates into at least 10 years of high quality data from the period that was part of the in-depth data review, and no more than 3, 4, or 5 years in a row missing (depending on the average generation time for the DU) for each persistent census site in the DU.

2. For sites with marginal numbers of high quality observations during the Start Year to the last available year, the pattern of missing data was investigated to determine if it could be infilled to provide a sufficiently complete time series (i.e., the pattern of missing observations for the census site did not include a full generation—based on the average generation time for the DU—at any point in the Start Year to the last available year). Those that could meet the sufficiency criteria with infilling were identified as 'P', and the rest were classified as data deficient ('DD').

3. If a site had 50% or fewer high-quality observations during the Start Year to the last available year and could not be infilled to achieve a 50% level, it was categorized as 'DD'.

If a DU had no persistent sites, it was deemed by the Department of Fisheries and Oceans to be data deficient (DD, note that this designation is not the same as the COSEWIC usage).

When combining data from more than one site within a CU that contained years with missing data, infilling was performed by DFO. This process is described in greater detail in Brown *et al.* (2013b). Infilling followed the procedure outlined in English *et al.* (2006), whereby the average proportion (across years) each census site contributed to the total was calculated, and used to infill years with no escapement data. When the time series of several CUs within a DU were combined (i.e., DU12 and DU21), the same English *et al.* (2006) approach was adopted. Table 2 summarizes data treatment stages and differences between the procedures used for the Part One report (COSEWIC 2018) and this Part Two report.

Table 2. Summary of data treatment stages used for Part One (COSEWIC 2018) of the Southern BC Chinook Salmon report ("previous procedure") and the updated procedure used for Part Two.

Stage	Previous procedure	Updated procedure (2019)
Overall	Outputs are generated for multiple data treatment sequences (e.g., integrate>filter>infill; integrate>filter>no infill; integrate>no filter>infill), which are then used as sensitivity tests to select the most appropriate version for each CU	DFO has settled on a single data treatment sequence. Outputs are only generated for integrate>filter>infill.
Stage 0 – Extract raw data	Extract site-level data from nuSEDS database	No change
Stage 1 – Integrate source data	For each year, a series of reference files are queried from different data sources (nuSEDS, EPAD, 2012 WSP assessment), with each source ranked in order of priority for integration. The automated procedure searches down the priority ranked list until an observation is found. The observation is then incorporated into a main data file. Automated decision rules used for this step are currently under review by DFO.	If nuSEDS records are time-stamped after 2012, they override any corresponding records from the 2012 WSP verified data set
Stage 2 – Quality filter	Records from nuSEDS that are considered 'low quality' via a data screening procedure are removed from the main data file (i.e., data types 5 and 6). Records from EPAD and 2012 WSP verified data are all retained.	No change
Stage 3 – Infill	To extend the time series, site-level records with temporal gaps are infilled using the procedure outlined in English *et al.* (2006) (see above)	No change
Stage 4 – Adjust for wild population	Not implemented	CU-level abundance records from Stage 3 are multiplied by the square of all-years average proportion of natural origin spawners (i.e., pNOS^2) to estimate the wild population for each CU. As hatchery production goes up, the average proportion of natural origin spawners (pNOS) goes down. pNOS^2 is the proportion of the total abundances with parents that were both natural-origin spawners assuming random mating and equal survival.

CWT are used as a source of detailed information for many populations of Chinook Salmon along the Pacific coast of North America (Hankin *et al.* 2005; Nandor *et al.* 2010). Chinook Salmon populations with consistent annual releases of CWTs are referred to as CWT indicator stocks and are used to represent naturally spawning wild stocks which exhibit the same adult and juvenile life-history patterns and are assumed to exhibit the same behavioural patterns within a similar geographic area. To produce sufficient CWTs for analysis, most of the CWT indicators are tied to hatchery programs, where fish are reared, tagged, and released. There are 11 Canadian CWT indicator stocks distributed among southern BC Chinook Salmon DUs (Table 3). Most of these stocks are from large-scale conventional hatchery facilities with four located within the Fraser River drainage (DU2, DU11, DU12, DU15, and the Chilliwack River) and five distributed around Vancouver Island (DU20, DU21, DU23, and DU24). Two CWT programs were terminated in the early 2000s (DU11 and DU21 – Nanaimo River) but funds administered by the Coded Wire Tag Improvement Team of the Pacific Salmon Commission (PSC) have been used recently to improve aspects of the others (PSC-CTC 2012a).

Information provided by CWTs includes ocean distribution (via catch of tagged fish vulnerable to fishing gear), exploitation, smolt-to-adult survival, and mean age at maturity. The Pacific Salmon Treaty (PST) between Canada and the United States supports annual sampling programs to collect information from CWT indicator stocks using a consistent and unbiased design (Brown *et al.* 2013b). Information from CWT indicator stocks is obtained from the cohort analysis output files, which extend to the end of 2012, and were used to produce the Chinook Salmon Technical Committee (CTC) 2013 annual report (Brown *et al.* 2013b). The details of the cohort analysis procedure are described in PSC-CTC (1987).

Identification of Wild Origin Fish

A key consideration for the 12 DUs considered here is how hatchery and wild-origin fish were identified. DFO uses two methods to identify hatchery-origin spawners. The first is the use and detection of fish carrying CWTs, as described earlier. The second is manipulation of hatchery water temperature regimes which result in marks on the otoliths of fish. In both instances, estimation of the relative contribution of hatchery and wild origin returning mature fish is contingent on a well-designed sampling program that covers all known spawning areas within the DU and an understanding of the fraction of releases that are marked.

"Wild" fish are here defined as 2^{nd} generation wild spawners, consistent with the definition used in DFO's Wild Salmon Policy. Wild abundances are derived from total abundances x (pNOS x pNOS), where pNOS is the proportion of Natural Origin Spawners on the spawning grounds, and pNOS x pNOS is the proportion of the total abundances with parents that were both natural-origin spawners assuming random mating and equal survival. For example, if you have two wild males, two wild females, one hatchery male and one hatchery female, there are six possible mating combinations for three pairs of males and females. In this case, 44.4% of the mating combinations are wild fish. As the wild fish were 66.7% of the population (in this example), 66.7^2 = 44.4%.

The Proportional Natural Influence (PNI) metric is reported as a measure of hatchery influence on the wild population, when such data are available for each DU (Appendix 1). The metric is formulated as:

$$PNI = \frac{pNOB}{pNOB + pHOS}$$

pNOB ← proportion Natural-Origin Brood stock

pHOS ← proportion Hatchery-Origin Spawners

If a "wild population" is a population that contains predominantly "wild" fish, then large scale hatchery production is a clear threat as it will reduce the number of second-generation natural spawners and increase the number of hatchery-origin spawners. This effect should be reflected in the index of wild spawners described above; as hatchery production goes up, the average proportion of natural origin spawners (pNOS) goes down and hence the number of "wild" spawners. However, there are at least five reasons why this metric of "wild" spawners may not reflect true "wild" spawners in some circumstances, as calculated in this report.

(1) DU-specific time-series of spawner abundances are derived by summing abundances from all component persistent sites, with infilling, over time. Only sites that have been persistently monitored for approximately the last 3 generations are included in the summation. For some DUs, monitoring has been stopped or reduced at sites where natural spawning occurred historically, e.g., 1980s and 1990s, but no longer occurs in some cases because of introgression from neighbouring hatcheries and an associated reduction of fitness. The loss of natural spawning is therefore not captured in the time series of "wild" spawner abundances. DUs 24 and 25 on the west coast of Vancouver Island are two examples.

(2) Long and consistent time-series of pNOS are not available for most populations. In the absence of consistent annual pNOS values (and to smooth across sampling variability), long-term averages have been applied to estimate "wild" spawners. Without annual time-series on pNOS the trends in the metric of "wild" spawners do not capture changes in the proportion of "wild" fish due to increases (or decreases) in hatchery production relative to natural production over the time-series. In some cases (DU24, DU25 on the west coast of Vancouver Island), increases in the metric of "wild" abundances reflect increases in hatchery production relative to natural production that may be masking declines in "wild" fish.

(3) When hatchery production is high relative to natural production and proportionate natural influence (PNI) is low, all fish in the population are poorly adapted to the natural environment. Even if there are second-generation spawners in the system, they may have poor survival being adapted to the hatchery environment and may not be able to sustain a population over the long-term (as described for DU24 and DU25 by local DFO biologists).

(4) DFO has no way of marking 2nd generation spawners and the calculations assume progeny of 1st-generation natural-origin spawners survive to the next generation. When hatchery production is large, hatchery-origin fish will dominate in the natural spawning environment with some first-generation natural origin spawners. Although these first generation spawners may be numerically significant (but <50%) they may not sustain a population due to low survival of their progeny in the natural environment (point 2 above). In particular, there may be a higher proportion of first generation natural origin than 2nd generation spawners than expected under equal survival because of hereditary genetic and epigenetic factors from introgression that can extend over numerous generations. Without marking of 2nd generation spawners, there may be an overestimation of this proportion due to poor survival.

(5) Within some DUs (DU 6,18, 21 and 26), there are sites that are artificially enhanced, but no measures of the proportion of wild and hatchery-origin spawners are available. For such sites, the current process assumes that all spawners from such sites are natural origin fish.

Given these considerations, it becomes important to assess the utility of the index of wild fish abundance on a DU by DU basis. Within each of the DU-specific chapters that follow, guidance is provided on how to interpret the trends in the abundance of wild fish.

Table 3. Summary coded-wire tag (CWT) release information for the southern BC Chinook Salmon CWT indicator stocks. Release data are from the 2000-2009 brood years and CWT recovery data are from 2000-2011. Sample sizes are provided under 'n Broods' and 'n Years'. Under 'Release Information', 'Mean CWT' is the mean number of juveniles released per brood year with a CWT and marked by removal of the adipose fin. 'Mean Associated non-CWT' is the mean number of untagged and unmarked fish released from the same brood years and associated to the tagged and marked release. 'n Broods' is the number of contributing brood years. Under 'Estimated CWT Information', 'Mean CWT' is the total estimated number of CWTs represented in fishery catches and in the spawning escapement based on actual CWTs recovered in sampling programs. Mean percentages in the four right-most columns provide the proportional occurrence of the CWTs in all BC ocean fisheries (Ocean-CA), in all ocean fisheries in the U.S. (Ocean-US which includes Alaska, Washington or Oregon), in terminal marine or freshwater fisheries for a particular stock (the terminal area is stock-specific) and in the spawning escapement. These four percentages sum to 100%. The number of years of CWT recovery (n Years) only includes years with at least two age classes of CWT releases available for capture. The CU associated with the Chilliwack River indicator stock (CK-9008) is not incorporated into the DUs assessed in this report as it is classified as hatchery stock. This classification excluded the stock from consideration in the Wild Salmon Policy status assessment. This table is adapted from Table 18 in Brown *et al.* 2013b.

				Release Information			Estimated CWT Information					
Indicator Stock Site/Name	**Indicator Stock Acronym**	**DU Number**	**Run Type**	**n Broods**	**Mean CWT**	**Mean Associated Non-CWT**	**n Years**	**Mean CWT**	**Ocean-CA**	**Ocean-US**	**Terminal**	**Escapement**
Chilliwack R	CHI	N/A	Fall	10	101,904	472,864	12	4153	9.2%	15.0%	7.4%	68.4%
Harrison R	HAR	DU2	Fall	9	149,096	804,461	12	1113	10.5%	20.9%	1.6%	66.9%
Dome Cr	DOM	DU11	Spring	3	83,602	3,718	8	155	1.8%	23.5%	50.1%	24.6%
Lower Shuswap R	SHU	DU12	Summer	10	186,708	370,005	12	1444	15.4%	26.8%	9.5%	48.3%
Nicola R	NIC	DU15	Spring	9	107,174	46,275	12	1089	1.2%	6.3%	10.3%	82.3%
Puntledge R	PPS	DU20	Summer	10	115,953	508,058	12	290	15.9%	23.4%	0.0%	60.7%
Cowichan R	COW	DU21	Fall	9	299,815	1,209,989	12	781	12.7%	48.0%	6.1%	33.2%
Nanaimo R	NAN	DU21	Fall	4	145,257	96,884	9	819	7.8%	33.7%	6.7%	51.8%
Big Qualicum R	BQR	DU21	Fall	10	235,183	3,388,613	12	501	15.1%	26.3%	2.2%	56.4%
Quinsam R	QUI	DU23	Fall	10	287,024	1,842,503	12	814	22.6%	20.3%	0.1%	57.1%
Robertson Cr	RBT	DU24	Fall	10	256,807	6,153,023	12	2360	20.2%	16.0%	27.1%	36.7%

Enhancement

Wild-born fish cannot be distinguished from their hatchery counterparts with certainty unless mass marked. However, mass marking is not currently employed in Canada for Chinook Salmon (only hatchery Coho Salmon). Therefore, the authors of the pre-COSEWIC report adopted a higher-level approach based on categorizing sites by enhancement activity level (Brown *et al.* 2013b). Census sites within DUs were assigned a level of enhancement based on a standardized procedure developed by DFO during the pre-COSEWIC process (Brown *et al.* 2013b). The standardized rank classified the census sites as:

- Category 1. Unknown (no evidence of recent active enhancement) - no release records, brood records or enhanced contribution estimates during the period 2000-2011.
- Category 2. Low enhancement activity level - release records, brood records or enhanced contribution estimates exist prior to 2000 but there were none from 2000-2011.
- Category 3. Moderate enhancement activity level, defined as:
    - Number of release records is less than or equal to 4 out of 12 years (≤25% or roughly 1 per generation)
    - Number of brood take records are less than or equal to 4 out of 12 years (≤25% or roughly 1 per generation)
    - Hatchery-origin contribution estimate is available via expanded CWT data and 12-year mean is <25% (assessing adult contribution only). Note that otoliths are also used to examine hatchery-origin contributions at some sites.
- Category 4. High enhancement activity level, defined as:
    - Number of release records exceeds 4 out of 12 years (>25% or >1 per generation)
    - Number of brood take records exceeds 4 out of 12 years (>25% or >1 per generation)
    - Hatchery-origin contribution estimate is available via expanded CWT data and 12-year mean is ≥25% (assessing adult contribution only). Note that otoliths are also used to examine hatchery-origin contributions at some sites.

For each DU-specific chapter, a figure is presented showing the proportion of spawners originating from wild-born and enhanced census sites. These figures are updates to the Part One report (COSEWIC 2018) and the 2015 figures developed for the pre-COSEWIC report (Brown *et al.* 2013b), and are adapted from CU-level time series of escapement for wild and enhanced sites. Where multiple CUs are combined to form a DU (e.g., DU21), figures for each individual CU are included. In developing these figures, CU-level time series of escapement for wild-born sites and enhanced sites were created. Data were combined from sites with low or unknown levels of enhancement (‘Low+Unk’) and sites with moderate or high levels of enhancement (‘Mod+High’). The estimated proportion of natural origin spawners based on pNOS adjustments are also presented (see Figure 2 and Table 4).

Hatchery Releases

For each DU, the time series of hatchery releases from within the DU and/or from outside the DU are presented. These are reproductions of the ‘dashboard’ graphics found in Brown *et al.* (2013b). When a DU is a combination of several CUs (e.g., DU21), the time series for each individual CU is included. Hatchery release data are not currently disaggregated by life history stage at release. Therefore, it is important to note that release data for different life stages are not comparable.

<u>Interpretation of abundance, enhancement and hatchery release data</u>

Data permitting, enhancement, wild population, and hatchery release data are presented graphically for each DU as a four-panel figure (see example for DU22 / CU28 below). Table 4 describes how to interpret each panel:

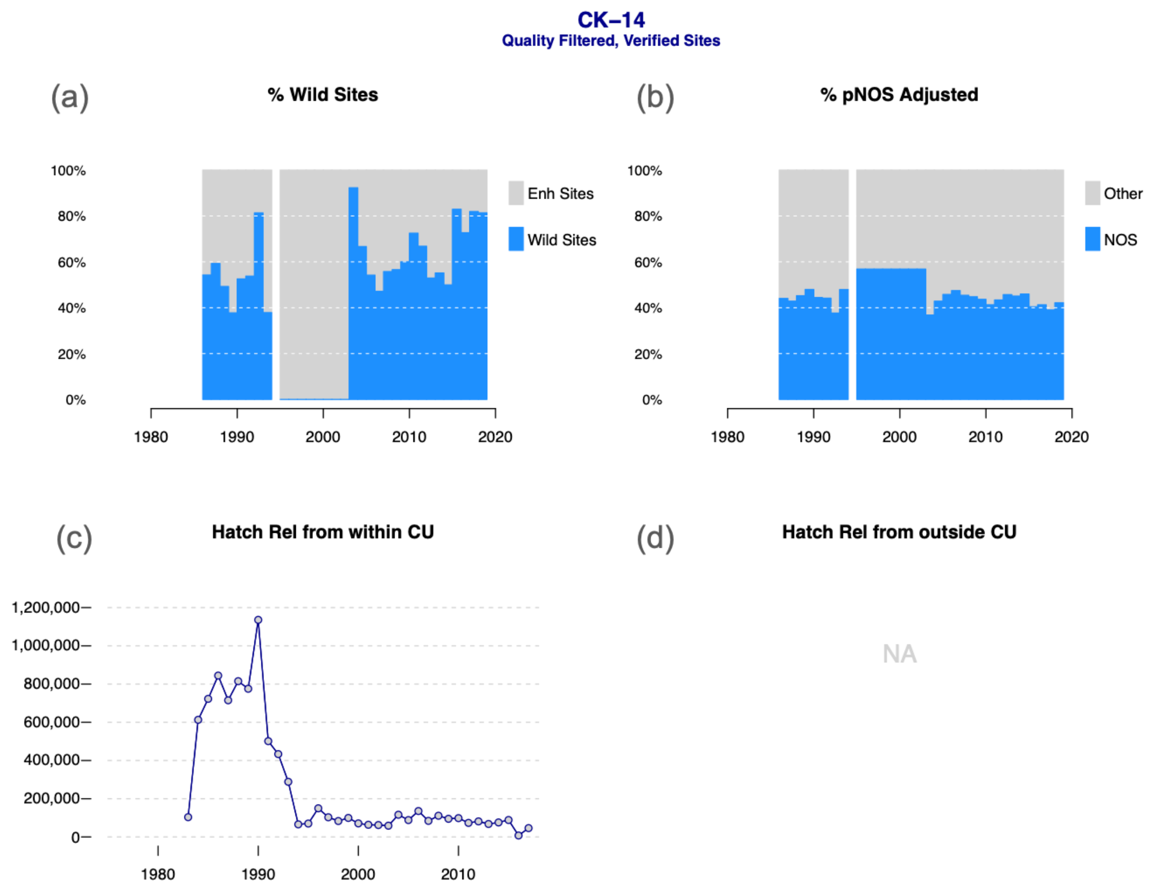

Figure 2. Example of graphical presentation for abundance, enhancement and hatchery release data.

The following table explains how to interpret each panel and can be used as a guide while reviewing each DU.

Table 4. Interpretation of abundance, enhancement and hatchery release data graphics.

Panel (a) % Wild Sites	Observed number of spawners in sites identified as wild as a proportion of spawners in all sites with data for this DU. When no data are available, no bars are present. If present, wild sites are represented in blue, and are defined as sites with unknown or low enhancement. Enhanced sites are represented in grey and are defined as sites with moderate to high enhancement. Note that this panel does not show annual estimates of enhanced contribution, it shows the proportion of spawner estimates for each year that come from sites CURRENTLY classified as either wild or enhanced. The plot is based on available site records, not on expanded estimates to account for non-surveyed populations
Panel (b) % pNOS Adjusted	Percent of wild spawners in sites estimated based on the annual average proportion of natural origin spawners (pNOS) applied to observed spawners in sites, using the equation: Abundance*pNOS^2 = wild spawners. IMPORTANT: This panel is based on a new methodology that has not undergone review. Results for some DUs may appear to contradict panels (c) and (d), for example in cases where the pNOS adjusted values for wild abundance are 100% yet hatchery releases occur within the DU according to panel (c). This is due to the fact that the source data for the panels are different and may disagree. The results shown in Panel (b) are mathematically derived from CWT or thermal abundance data, while Panels (c) and (d) are derived from hatchery release count data. The decision rules used to extract data from the separate sources have not yet been aligned with one another. For example, years with incomplete cohorts were omitted from the CWT/thermal data, while no omissions were made from hatchery release count data. Where the contradiction results in pNOS adjusted values for wild abundance being 100% (DU6, DU18, DU21, DU26), the graph has been omitted from this report.
Panels (c) & (d) Hatchery releases from within and outside Unit (BY)	The number of hatchery releases from within and outside the DU by brood year (BY). The left panel is the total number of hatchery-reared juveniles produced from broods collected from return sites within the DU and released at sites within the DU. The right panel is the total number of hatchery-reared juveniles produced from broods collected from return sites outside the DU and released at sites within the DU. When no data are available, no graph is present.

Fluctuations and Trends

For each DU, fluctuations and trends are presented in a summary table and two six-panel figures. The summary table provides two Bayesian estimates of changes in spawner abundance: one using the last three generations of data, and the other using the entire time series of data. Probabilities of a 30%, 50%, and 70% decline in spawner abundance for each of the two Bayesian estimates of change in spawner abundance are also presented. These results are provided for both the unadjusted population and the pNOS adjusted population, which represents trends in wild spawner abundance. For the Part One report (COSEWIC 2018), abundance data were available for most of the 28 DUs up to the 2015 return year and were provided by DFO (Gayle Brown, pers. comm. 2019). For this Part Two report, abundance data were available for the 12 focal DUs up to either the 2017 or 2018 return year and were also provided by DFO. Note that DU18 was considered data deficient for the Part One report (COSEWIC 2018) but data are now available and are included in this report.

The summary table for each DU has the following form (categories described in Table 6):

Table 5. Summary table format for fluctuations and trends section.

DU Name	Generation length	Year range	Median % change	95% CI	p|30% decline	p|50% decline	p|70% decline	Number of observations
Example DU	4	Hatchery and wild abundance combined						
		3gen	-	-	-	-	-	-
		All years	-	-	-	-	-	-
		Estimated wild abundance only (pNOS adjusted)						
		3gen	-	-	-	-	-	-
		All years	-	-	-	-	-	-

Table 6. Description of fluctuation and trends table columns.

Table Column	Description
DU Name	Full-name of each DU
Generation length	Average generation time estimated as the average age of spawners in the absence of fishing mortality
Year range	Beginning and ending year of the data set used
Median % change	Median of the posterior distribution for the slope parameter outputs from Bayesian regression
95% CI	±95% credible interval of median % change
p|30% decline	Probability of a 30% or greater decline in abundance
p|50% decline	Probability of a 50% or greater decline in abundance
p|70% decline	Probability of a 70% or greater decline in abundance
Number of observations	Number of observations in the data set

In the Part One report (COSEWIC 2018) (relatively lightly enhanced DUs), trends in spawner abundance, exploitation rate and smolt-to-adult survival are presented graphically for each DU as a five-panel figure (see example for DU24 below). For the Part Two report, an additional panel is added that shows the proportional contribution by site to each DU. As per the data screening procedures described above, only sites classified as ‘Persistent’ are included. In each DU chapter, the new six-panel figure is provided twice – once for unadjusted abundance data and once for pNOS adjusted abundance data. Table 7 describes how to interpret each panel:

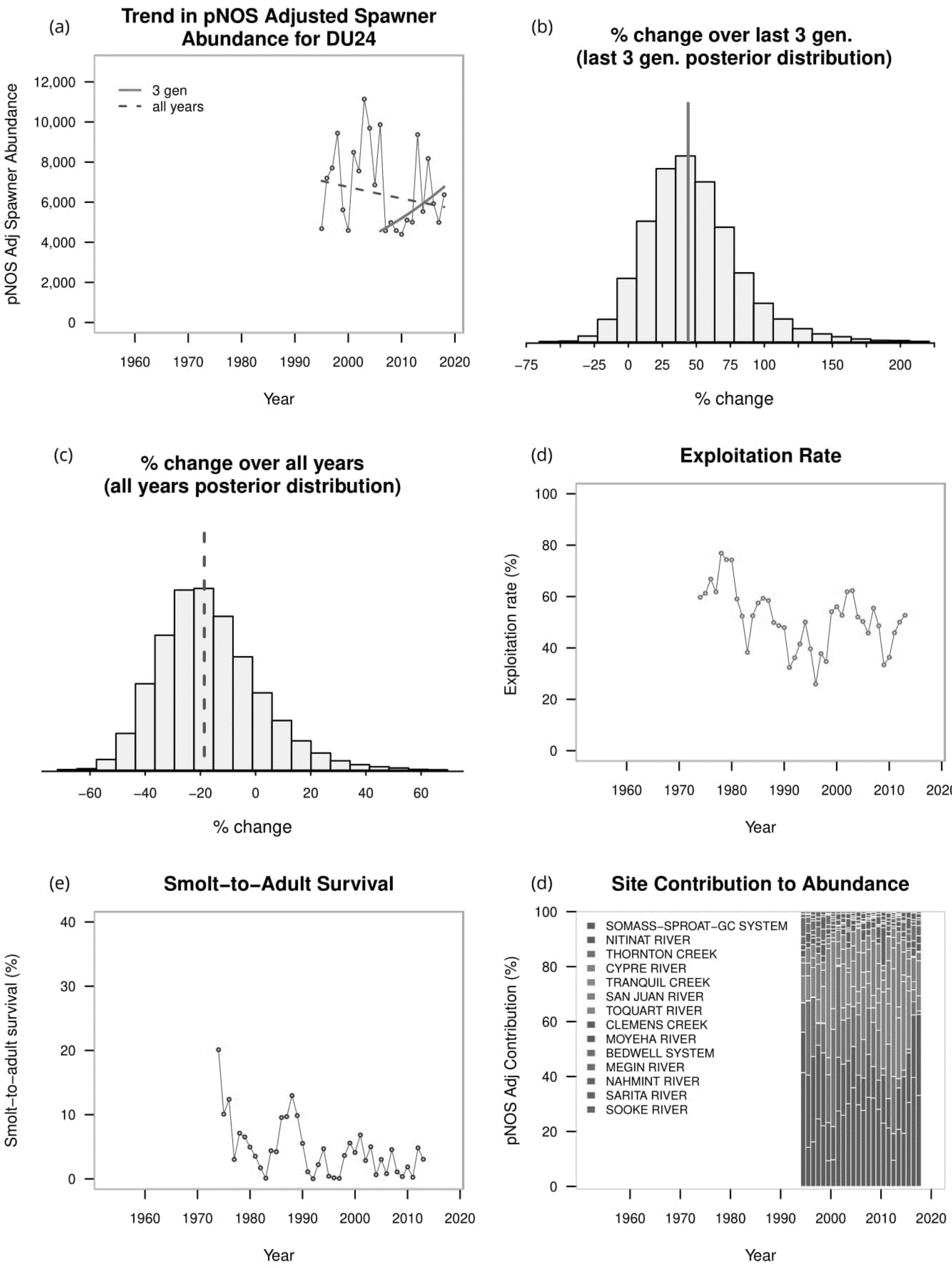

Figure 3. Example of graphical presentation for trends in spawner abundance, exploitation rate, smolt-to-adult survival, and percent site contribution to abundance for DU24 (version adjusted by average proportion of natural origin spawners).

Table 7. Interpretation of spawner abundance, exploitation rate, smolt-to-adult survival, and percent site contribution graphics

Panel (a) Trend in Spawner Abundance	Trend in spawner abundance with two estimates of the log-linear rate of change in abundance through time: (1) rate of change over the last three generations based only on the last full three generations of data (i.e., 13 years for a DU with a 4 year generation time); (2) rate of change over the last three generations based on all available data. The latter is shown because indicators of changes in abundance based on the rate of change over entire time series have been shown to be more reliable than shorter time series (Porszt *et al.* 2010; d'Eon-Eggerston *et al.* 2012). Data used for the last three generations were calculated as the generation time + 1 data point such that the selected data spanned the latest three generations. If the 3-generation time was not a round number, it was rounded up Rates of change were calculated using a Bayesian estimation framework. Doing so allowed us to present probabilities associated with estimated changes in abundance, which are more intuitive to interpret than frequentist confidence intervals. Bayesian modelling and parameter estimation was conducted in R using JAGS software (Plummer 2011; R Core Team 2017) with the package R2jags (Su and Yajima 2015). We assumed uninformative priors for slope (β), intercept (α) and standard deviation (σ). We ran the linear model for a single chain using a burn-in of 5,000 observations, and retaining 100,000 samples after burn-in. We saved only every 5th observation to reduce autocorrelation (thin=5).
Panel (b) % change over last 3 gen. (last 3 gen. posterior distribution)	Posterior distribution and median estimate (as vertical line) of estimated percent change over last three generations based on a linear rate of change of spawner abundances over the most recent three generations of data.
Panel (c) % change over all years (all years posterior distribution)	As for panel (b) but based on regression of data for entire time series.
Panel (d) Exploitation Rate	Total of CWT fish of any age from a brood (breeding stock) estimated in coast wide pre-terminal and terminal fishery catches divided by the same total plus the total estimated in the escapement then multiplied by one hundred to obtain the percentage. Fishery impacts include an estimate of the non-landed (incidental) mortalities, which occur when fish escape from or are released from fishing gear but later die anyway. Pre-terminal fishery mortalities have been adjusted by a brood- and age-specific adult equivalency factor which accounts for the fact that even if there were no fisheries, fish may still die before reaching the spawning grounds but the probability of surviving to spawn increases at each age (e.g., a fish caught in the ocean at age 2 equates to a lower adult equivalent than a fish caught at age 4 because there is less of a chance of surviving and maturing at any possible future age compared to an older fish).
Panel (e) Smolt-to-Adult Survival	Estimated cohort size of fish alive at the start of the youngest possible age of mature fish divided by the number of smolts released from the parental brood year then multiplied by one hundred to obtain the percentage.
Panel (f) % site contribution to abundance	Percentage of total DU abundance from persistent sites, as contributed by individual sites over time. Note that expansion factors to estimate total DU abundance from both persistent and non-persistent sites are not available, so the plots only show the relative contribution of the individual sites to the total DU abundance from persistent sites. See Appendix 1 for full lists of the sample sites within each DU. Stacked bars of different colours are used to represent different individual sites. For both unadjusted and pNOS adjusted figures, sites are displayed in order from greatest to least contribution over the full pNOS adjusted time series (top to bottom in the legend, bottom to top in the graph).

For each of the twelve DUs addressed in this report (Part 2), Appendix 1 provides a graphic for site-level survey data quality (all sites), and information on Proportionate Natural Influence (PNI) by site, where available.

Where available, stock productivity data (recruits per spawner) are also presented. Stock productivity was calculated as the total number of adults recruiting to the population (i.e., spawners + catch) produced by the spawners from a given year (brood year). Only two time series of stock productivity data are available, for DU2 and DU22 (Brown *et al.* 2013b). The methods used to generate these productivity time series were based on Canadian Science Advisory Secretariat (CSAS) reports (Tompkins *et al.* 2005, G. Brown, DFO, unpublished data). Data used for these time series were provided by DFO (Cowichan River time series: M. Labelle, DFO, unpublished data; Harrison River time series: G. Brown, DFO, unpubl. data).

Subpopulation Structure

In its 2019 meeting, the Marine Fishes SSC noted that while many spawning components usually exist within a given Designatable Unit, straying is well documented among such components. Given COSEWIC's definition of subpopulations − "As used in Criteria B and C, Subpopulations are defined as geographically or otherwise distinct groups in the population between which there is little demographic or genetic exchange (typically one successful migrant individual or gamete per year or less)" – the SSC concluded that the subpopulation concept does not apply. This conclusion impacts the interpretation of population status using COSEWIC Quantitative Criterion C2 (Small and Declining Number of Mature Individuals), where subpopulation structure must be known.

The Role of Expert Opinion

Given the limitations on the identification of wild and hatchery-origin fish and the impacts on trends in abundance information, expert opinion was particularly important for those DUs in this Part Two report. Apart from the significant expertise available within the Marine Fishes Species Specialist Committee (MF SSC), the SSC invited outside experts to attend their 2019 annual meeting. Those experts were often DFO salmon biologists with long-standing experience in the DUs discussed in this report and were well-versed in the available data, both from hatchery and wild populations. The SSC also benefited from the participation of many representatives from First Nations and environmental non-governmental organizations with interests in Pacific salmon.

Threats and Limiting Factors

See the Part One report (COSEWIC 2018) for a review of the threats facing Chinook Salmon in southern British Columbia.

Each DU is assigned a general risk rating using the International Union for Conservation of Nature (IUCN) Threats Calculator (the Calculator), a fillable Excel spreadsheet that can be completed on a DU-by-DU basis to evaluate threats and limiting factors.

The Calculator characterizes threats to DUs based on scope, severity, and timing. *Scope* is defined as the percentage of the species reasonably expected to be affected by the threat within 10 years if current circumstances and trends continue. *Severity* is the level of damage (percent population loss) to the species from the threat that can reasonably be expected within 10 years or three generations, whichever is greater, if current circumstances and trends continue. *Timing* is defined as the projected and estimated duration of the threat.

Scope, severity and timing rankings are assigned based on cumulative scores for eleven different threat categories comprising forty different sub-categories. Main threat categories include:

1. Residential & commercial development
2. Agriculture & aquaculture
3. Energy production & mining
4. Transportation & service corridors
5. Biological resource use
6. Human intrusions & disturbance
7. Natural system modifications
8. Invasive & other problematic species & genes
9. Pollution
10. Geological events
11. Climate change & severe weather

Each threat sub-category is assigned a score ranging from Negligible to Pervasive (scope), Negligible to Extreme (severity), and Insignificant/Negligible to High-continuing (timing), with uncertainty ranges and Unknown or Neutral options also available. Once scores are assigned to each sub-category, level two threats are manually rolled up into level one threats, and the population's overall threat impact is scored as A-Very High; B-High; C-Medium; and D-Low.

Threats Calculators were produced for this report using a two-stage approach. The first stage relied on literature, document review and existing data (reported here). This method supplied relevant information regarding threats and limiting factors for each DU and permitted the production of a preliminary set of Threats Calculator results.

Some of the metrics used to evaluate threats (e.g., harvest mortality) are based on information gathered from indicator stocks, which have CWT individuals released from hatcheries. DUs with CWT indicator stocks are listed in Table 8. For those DUs without indicator stocks, proxy indicator stocks were used.

Table 8. Designatable Units (DUs) with indicator stocks and, where available, the first year of release of any hatchery fish released in the DU, including those originating from within the DU and from other DUs.

DU ID	Indicator Stock	Indicator Stock Code	Indicator Stock Used as Proxy	Year of 1st release from within DU	Year of 1st release from outside DU
DU1			SAM*	1984	1991
DU2	HARRISON RIVER	HAR	HAR	1972	1997
DU3			DOM	1978	1989
DU4			DOM	1982	
DU5			DOM	1982	1982
DU6			SHU	1990	
DU7			DOM		
DU8			DOM		
DU9			DOM	1983	1995
DU10			DOM	1981	
DU11	DOME CREEK	DOM	DOM	1988	
DU12	SHUSWAP RIVER-LOWER	SHU	SHU	1982	
DU12			SHU		
DU13			DOM	1984	
DU14			NIC		
DU15	NICOLA RIVER	NIC	NIC	1981	
DU16			DOM	1986	
DU17			DOM	1985	
DU18			BQR	1979	1984
DU19			PPS		
DU20	PUNTLEDGE RIVER	PPS	PPS	1972	
DU21			COW	1983	1984
DU21	COWICHAN RIVER	COW	COW	1980	
DU21	NANAIMO RIVER	NAN	NAN	1974	
DU21	QUALICUM RIVER	BQR	BQR	1968	1985
DU22			BQR	1989	
DU23	QUINSAM RIVER	QUI	QUI	1971	1999
DU24	SOMASS RIVER	RBT	RBT	1973	
DU25			RBT	1980	
DU26			RBT	1983	
DU27			ATN		
DU28			ATN	1986	

*The Nooksack River Fall Fingerling (NKF) indicator stock in Washington State, USA was used as the proxy indicator stock for DU1 (CU CK-02).

One challenge was quantifying severity because a direct causal link could not be established between most threats/limiting factors and impacts to populations. However, in some populations, metrics (e.g., harvest) could be quantified if there was an indicator stock present. This preliminary method did not provide sufficient depth and breadth to assign final Threats Calculator grades, but it did supply useful data informing the next stage.

For the second stage, a workshop of Chinook Salmon experts was convened in Nanaimo, BC in February 2017 to apply the IUCN Threats Calculator to Southern BC Chinook Salmon. This group of experts reviewed data supplied by the first stage and added new information based on expert knowledge of different DUs. The workshop provided a rich source of data, fleshing out the previous information and permitting the completion of Threats Calculator grading for several DUs as well as the assignment of proxy DUs for other DUs that could not be completed at the workshop. Table 9 shows the full list of DUs and indicates those that had Threats Calculators completed at the workshop as well as those that were assigned proxies. Where applicable, notes regarding status, priority levels, other relevant comments, and overall Threats Calculator grades are supplied.

Table 9. Designatable Unit Threats Calculator Results Completed at the International Union for Conservation of Nature (IUCN) Threats Calculator Workshop, February 2017. A = Very High; B = High; C = Medium; D = Low

DU ID	DU NAME	Status, Priority & Proxies	Comments	Overall Threats Calculator Results
DU1	BC Southern Mainland - Boundary Bay Ocean Fall	High Priority to be completed.	Small population, little quantitative info	
DU2	BC Lower Fraser River Ocean Fall	Completed at Workshop		**Medium (C)**
DU3	BC Lower Fraser River Stream Spring			
DU4	BC Lower Fraser River Stream Summer			
DU5	BC Lower Fraser River Stream Summer			
DU6	BC Lower Fraser River Ocean Summer	High Priority to be completed.	Unique DU, single spawning area	
DU7	BC Middle Fraser River Stream	High Priority to be completed.	Unique DU, single spawning area	
DU8	BC Middle Fraser River Stream Fall	High Priority to be completed.	Unique DU, single spawning area	
DU9	BC Middle Fraser River Stream Spring	Completed at Workshop	Group used DU11 as starting point. Both Beringia origin fish, with similar habitats and run-timings	**High to Medium (B/C)**
DU10	BC Middle Fraser River Stream Summer	Use results from DU17.	All are Beringia-origin summer Chinook Salmon, with similar habitats, but different and more stable habitats than the springs.	

DU ID	DU NAME	Status, Priority & Proxies	Comments	Overall Threats Calculator Results
DU11	BC Upper Fraser River Stream Spring	Completed at Workshop		**High to Medium (B/C)**
DU12	BC South Thompson Ocean Summer	Not Complete, lower priority	Workshop considered this stock to be in good shape.	
DU13	BC South Thompson Stream Summer 1.3	Use results from DU15	Drought prone springs of the Southern Interior. DUs 13, 14, 15 could share same Threats Calculator Results	**High to Medium (B/C)**
DU14	BC South Thompson Stream Summer 1.2	Use results from DU15	Drought prone springs of the Southern Interior. DUs 13, 14, 15 could share same Threats Calculator Results	**High to Medium (B/C)**
DU15	BC Lower Thompson Stream Spring	Completed at Workshop	Drought prone springs of the Southern Interior. DUs 13, 14, 15 could share same Threats Calculator Results	**High to Medium (B/C)**
DU16	BC North Thompson Stream Spring	Use DU11 results here.	Beringia (a glacial refugium) origin fish, with similar habitats and run-timings	**High to Medium (B/C)**
DU17	BC North Thompson Stream Summer		All are Beringia-origin summer Chinook Salmon, with similar habitats, but different and more stable habitats than the springs.	
DU18	BC South Coast - Georgia Strait Ocean Fall			
DU19	BC East Vancouver Island Stream Spring			
DU20	BC East Vancouver Island Ocean Summer	Completed at Workshop		**High (B)**
DU21	BC East Vancouver Island Ocean Fall	Completed at Workshop		**High (B)**
DU22	BC South Coast - Southern Fjords Ocean Fall			
DU23	BC East Vancouver Island Ocean Fall (EVI + SFj)	Completed at Workshop		**High to Medium (B/C)**
DU24	BC West Vancouver Island Ocean Fall (South)	Completed at Workshop		**High (B)**
DU25	BC West Vancouver Island Ocean Fall (Nootka & Kyuquot)	Completed at Workshop		**Medium (C)**
DU26	BC West Vancouver Island Ocean Fall (WVI + WQCI)			

DU ID	DU NAME	Status, Priority & Proxies	Comments	Overall Threats Calculator Results
DU27	BC Southern Mainland Ocean Summer	Use DU28 results here	Data Deficient DU	**Low (D)**
DU28	BC Southern Mainland Stream Summer	Completed at Workshop	Data Deficient DU	**Low (D)**

For DU 20, 21, 24 and 25, the threats calculators were updated by the COSEWIC Marine Fishes Specialist Subcommittee (SSC) during and shortly after their annual meeting, Aug. 19-22, 2019. The overall Threats Calculator results were updated to Very High-Very High for DU 24 (note the scoring for Element 8.3 is provisional, and requires expert validation) and Very High-High for DU 25. The overall Threats Calculator results for DUs 20 and 21 were unchanged, and remained High. All completed calculators for DUs in this Part Two report are provided in Appendix 2.

DESIGNATABLE UNIT-SPECIFIC CHAPTERS

Designatable Unit 1: Southern Mainland Boundary Bay, Ocean, Fall population

DU Short Name	BB+GStr/Ocean/Fall
Joint Adaptive Zone (JAZ)	BB+GStr
Life History	Ocean
Run Timing	Fall

The average generation time for this DU is 3.8 years. These fish exhibit ocean-type life-history variants and fall run-timing.

To review methods pertaining to data reported within individual DU chapters, refer to the preliminary sections of this report.

Extent of Occurrence and Area of Occupancy

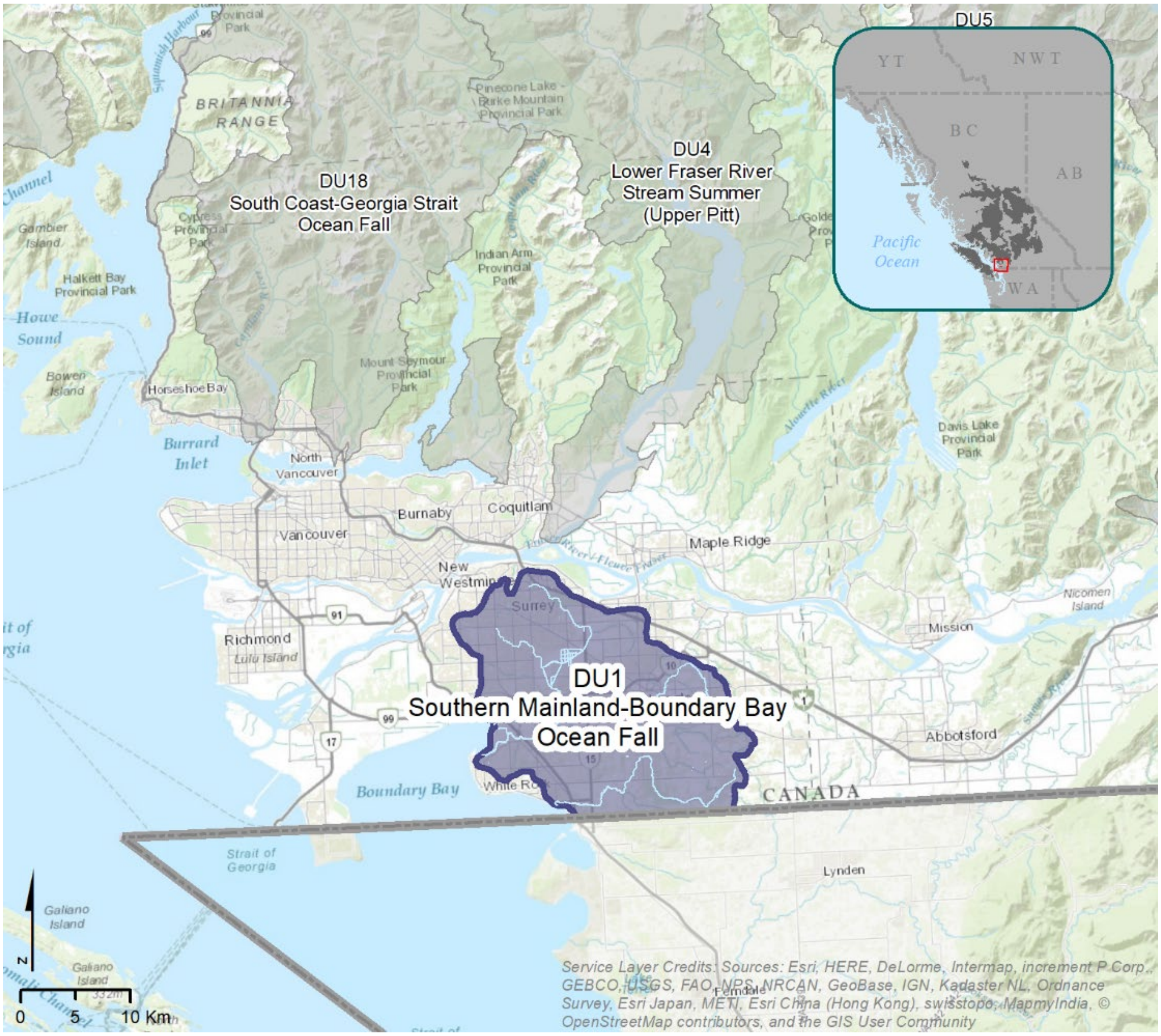

Figure 4. Map of DU1 – Southern Mainland Boundary Bay Ocean Fall.

DU1 is the southernmost DU on the BC mainland evaluated in this study (the Okanagan DU also reaches the Canada-US border but is not included in this report). This DU is located in the BB+GStr Joint Adaptive Zone. Freshwater habitat interfaces with the marine habitat at Boundary Bay by the Serpentine River, Nicomekl River, and the (little) Campbell River. While this DU is close to the US border, there is no known spawning within the US. The spatial extent of this DU is bounded by the Fraser River in the north (Lat. 49.20, Long. 122.81) and the 49th parallel in the south. The centroid of the DU area is at Lat. 49.05, Long. 122.83. The total area of DU1 is 405.44km^2, which encompasses a large proportion of urban area.

As for all DUs considered in this report, the Extent of Occurrence includes spawning streams as well as the ocean range, and is therefore >20,000 km^2. The Indexed Area of Occupancy (IAO) is 157 km^2, based on a total known spawning run length of 78 km or 0.76% of the known spawning length across all DUs.

Habitat Trends

Land surrounding this DU's freshwater habitat is highly altered (89.4%), with urban development covering 59.9% of the DU area, agricultural/rural development comprising 28.6%, and mining development comprising 0.5%. Road density in DU1 is 6.4 km/km^2 with an average of 1.39 stream crossings per km of fish accessible streams (the average across all DUs is 1.33 km/km^2 road density and 0.62 stream crossings per km of fish accessible streams). 87.6% of the DU's riparian habitat is disturbed. As an already highly developed area, no ongoing forest disturbance is occurring in this DU and there are no pine stands affected by the Mountain Pine Beetle.

Abundance

While spawning has been noted in three rivers, this DU has a single persistent site that is enhanced (Appendix 1). Of the years when sampling occurred, estimated mature individuals all originated from streams that had moderate to high levels of enhancement (Figure 5a). The wild portion of the population is estimated at ~30% (Figure 5b). Hatchery releases increased from the early 1980s to a maximum of ~250,000 fish annually in 2011, then declined to ~100,000 fish annually in 2013 before increasing again to ~225,000 fish in 2017 (Figure 5c). Hatchery releases from outside the DU occurred from 1990 to 2003 (Figure 5d).

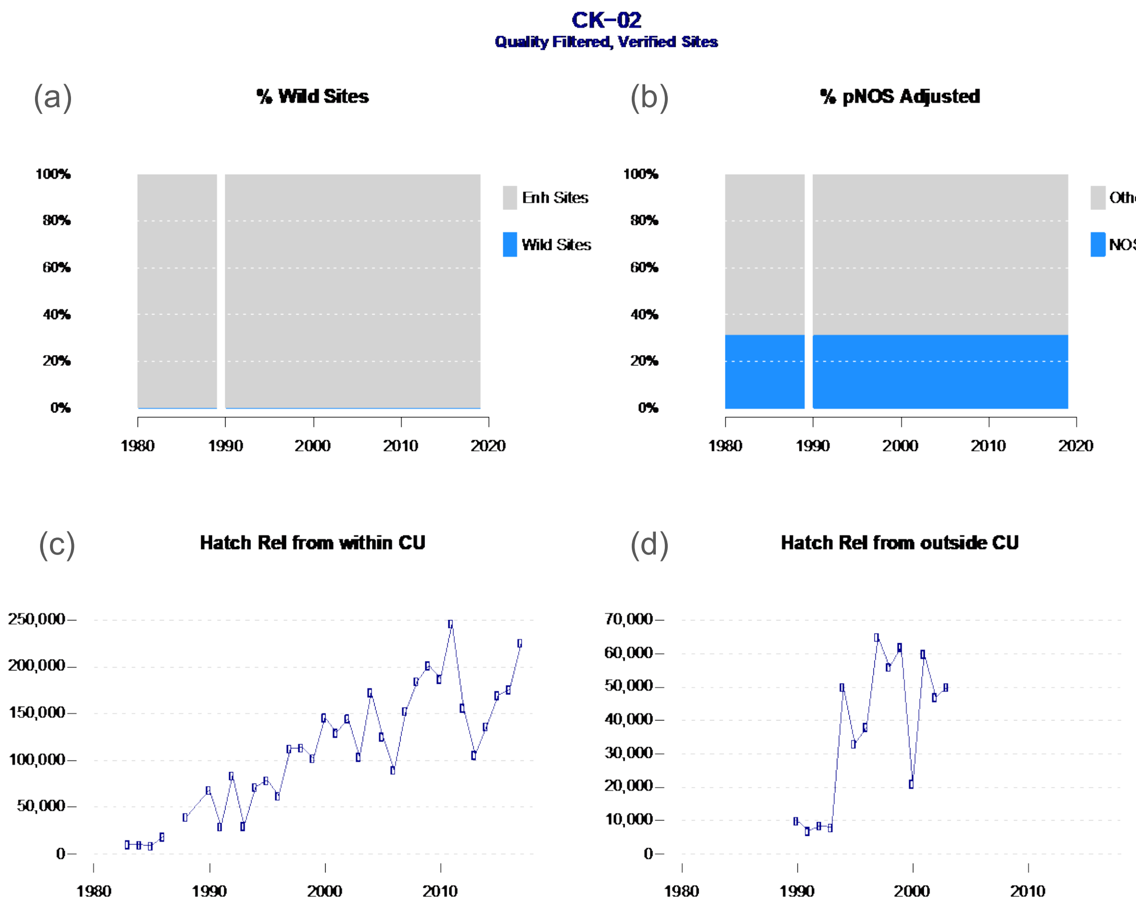

Figure 5. DU1 – Enhancement, proportion of natural origin spawners, and hatchery releases. Graphics provided by Fisheries and Oceans Canada, see Table 4 for panel interpretation.

Fluctuations and Trends

Based on the last three generations of data, the number of mature individuals increased by an estimated 121% (Upper 95% CI = 960%, Lower 95% CI = -57%) with the probability of a 30% decline at 0.03 (Table 10, Figure 6a,b). Using the entire time series of data, the number of mature individuals increased by an estimated 387% (Upper 95% CI = 1148%, Lower 95% CI = 90%) with zero probability of a 30% decline (Table 10, Figure 6a,c). The longer term increase in the total number of spawners is consistent with the overall increase in number of hatchery released Chinook Salmon (Figure 5).

For estimated wild abundance the corresponding trends are the same. Hatchery production has allowed the total number of Chinook Salmon to increase, but a consensus of expert opinion (August 2019 meeting of the Marine Fishes SSC) was that the remaining mature wild fish is less than 1000. While DFO data indicate that the average number of mature individuals remaining in 2018 are 175 and 54 for the non pNOS-adjusted and adjusted values, respectively (Appendix 1), the SSC places the most confidence on the consensus of experts’ estimate of remaining mature wild fish.

The exploitation rate for DU1 ranged from about 20% to 40% in the 1990s, then climbed to a peak of nearly 60% in 2004, after which it dropped, fluctuating from around 30% to 50% up to 2012 (Figure 6). Smolt-to-adult survival peaked at an average rate of nearly 5% in 1994 then declined over the next decade, reaching a low of 0.5% in 2000 but increasing slightly since 2008 to 3% in 2012. Stock productivity data are not available for this DU.

Table 10. Summary of estimated rate of change (±95% credible interval) in spawner abundance and probability of decline (>30%, >50%, >70%) for the last three generations and the entire time series for both the full population and the estimated wild population.

DU Name	Generation length	Year range	Median % change	95% CI	p|30% decline	p|50% decline	p|70% decline	Number of Observations
DU1 - Southern Mainland - Boundary Bay Ocean Fall	3.8	Hatchery and wild abundance combined						
		2007-2018	121	-57,960	0.07	0.03	0.01	12
		1980-2018	387	90,1148	0	0	0	38
		Estimated wild abundance only (pNOS adjusted)						
		No data to disaggregate						
		No data to disaggregate						

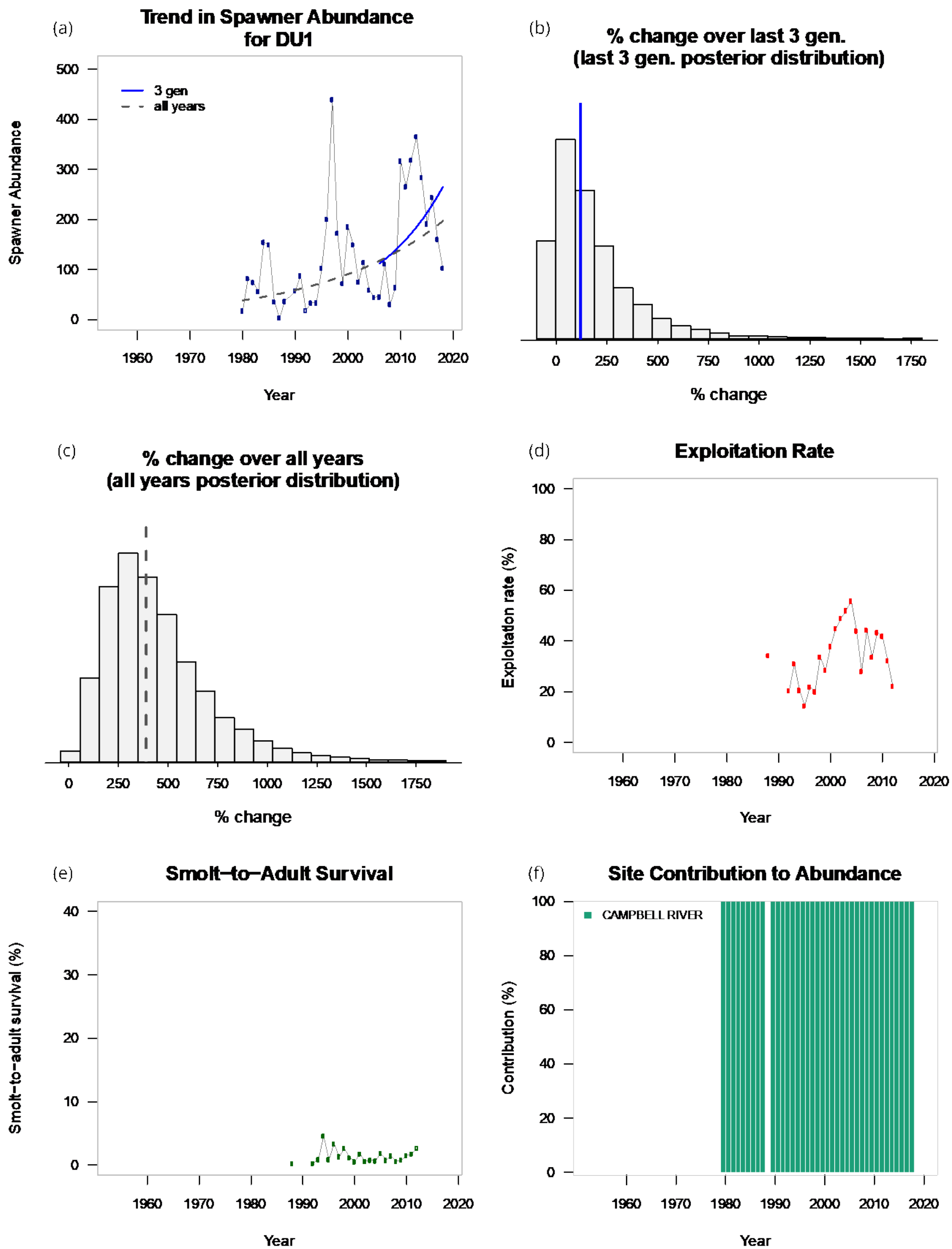

Figure 6. DU1 – Spawner abundance trends, exploitation rate, smolt-to-adult survival, and percent site contribution to abundance (see Table 7 for panel interpretation).

Threats and Limiting Factors

A Threats Calculator was not completed for this DU. For general threats and limiting factors applicable to all DUs, please refer to the Threats and Limiting Factors section in the introductory material. It should be emphasized that this DU consists of primarily hatchery-origin fish with few wild fish thought to remain (R. Bailey, pers. comm., 2019). Hatchery releases have occurred within this DU, and the genetic origin of the released fish is often from outside the DU. The SSC concluded that such releases represent a threat to the wild fish in the DU due to competition and genetic introgression.

Designatable Unit 6: Lower Fraser, Ocean, Summer population

DU Short Name	LFR+GStr/Ocean/Summer
Joint Adaptive Zone (JAZ)	LFR+GStr
Life History	Ocean
Run Timing	Summer

The average generation time for this DU is 3.8 years. These fish exhibit ocean-type life-history variants and summer run-timing.

To review methods pertaining to data reported within individual DU chapters, refer to the preliminary sections of this report.

Extent of Occurrence and Area of Occupancy

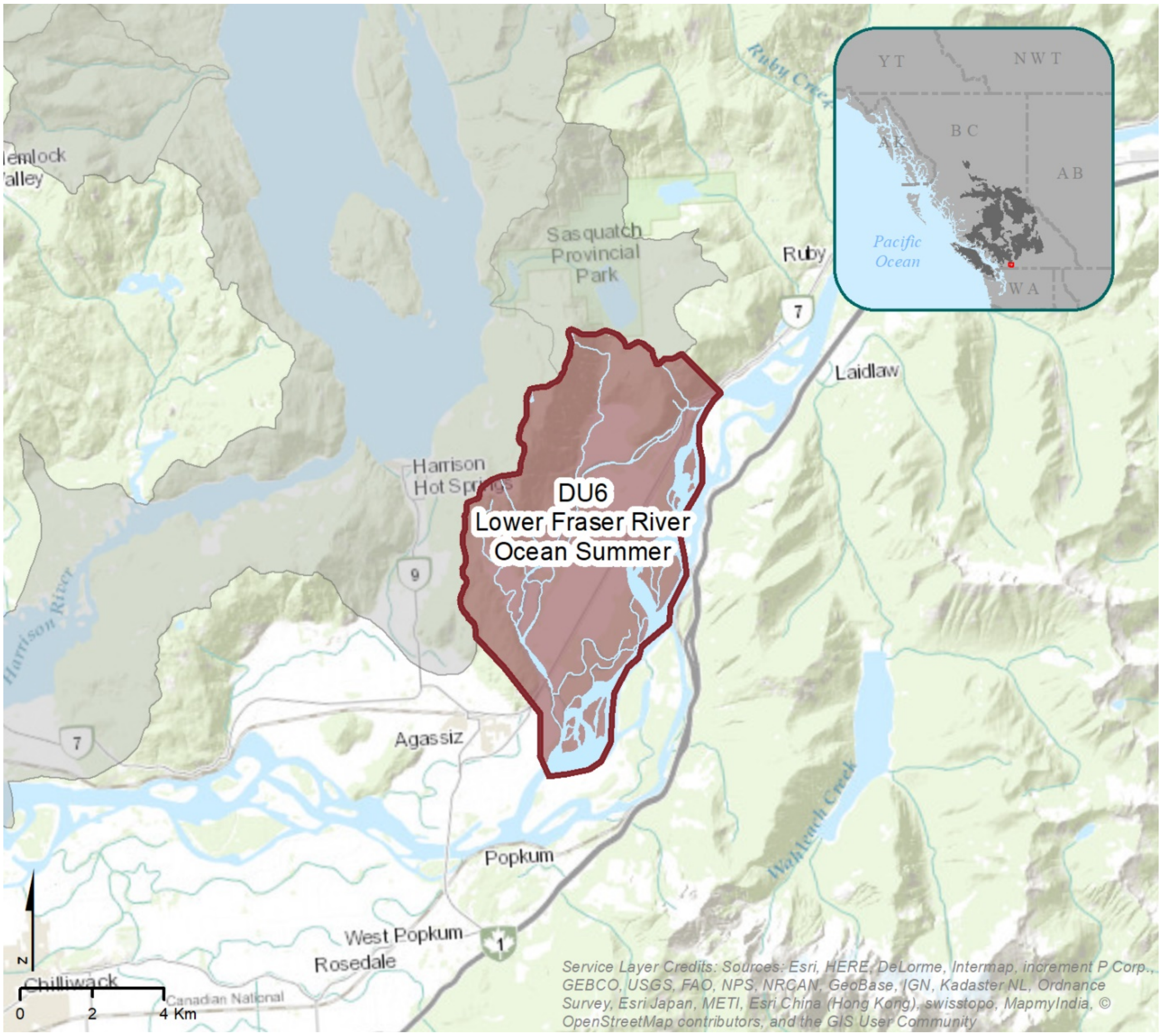

Figure 7. Map of DU6 – Lower Fraser River Ocean Summer.

This DU extends from the north along Hicks Lake at Lat. 49.33, Long. 121.70 to the south at the Fraser River (Lat. 49.22, Long. 121.74). The westernmost extent occurs at Bear Mountain ridge (Lat. 49.29, Long. 121.76) and the easternmost extent occurs at Fraser River (Lat. 49.27, Long. 121.68). The DU's centroid is at Lat. 49.23, Long 121.73 and its total area is 53.49 km^2. Farming is the primary land use in this DU.

As for all DUs considered in this report, the Extent of Occurrence includes spawning streams as well as the ocean range, and is therefore >20,000 km^2. The IAO is 30 km^2, based on a total known spawning run length of 15 km, or 0.15% of the known spawning length across all DUs.

Habitat Trends

Land surrounding this DU's freshwater habitat is altered (29.3%), with urban development comprising 1.9% of the DU area, agricultural / rural development comprising 25.0%, and mining development comprising 0.07%. Road density in DU6 is 2 km/km^2 with an average of 0.7 stream crossings per km of fish accessible streams (the average across all DUs is 1.33 km/km^2 road density and 0.62 stream crossings per km of fish accessible streams). 27.7% of the DU's riparian habitat, and 2.3% of the forest cover is disturbed. There are no pine stands in this DU affected by the Mountain Pine Beetle.

Abundance

This DU has a single persistent site that is enhanced (Appendix 1). Of the years where sampling occurred, estimated mature individuals all originated from streams with moderate to high levels of enhancement (Figure 8a). Using the pNOS adjustment method, the wild portion of the population is estimated at 100%, which is inconsistent with the DU's enhanced status and hatchery release data shown in Figure 8c and Figure 8d. Given this contradiction, Figure 8b has been omitted (Table 4). Hatchery releases increased from the mid-1990s to 2010, with maximum releases of ~110,000 occurring in 2008 (Figure 8c). No hatchery releases are reported from outside the DU (Figure 8d).

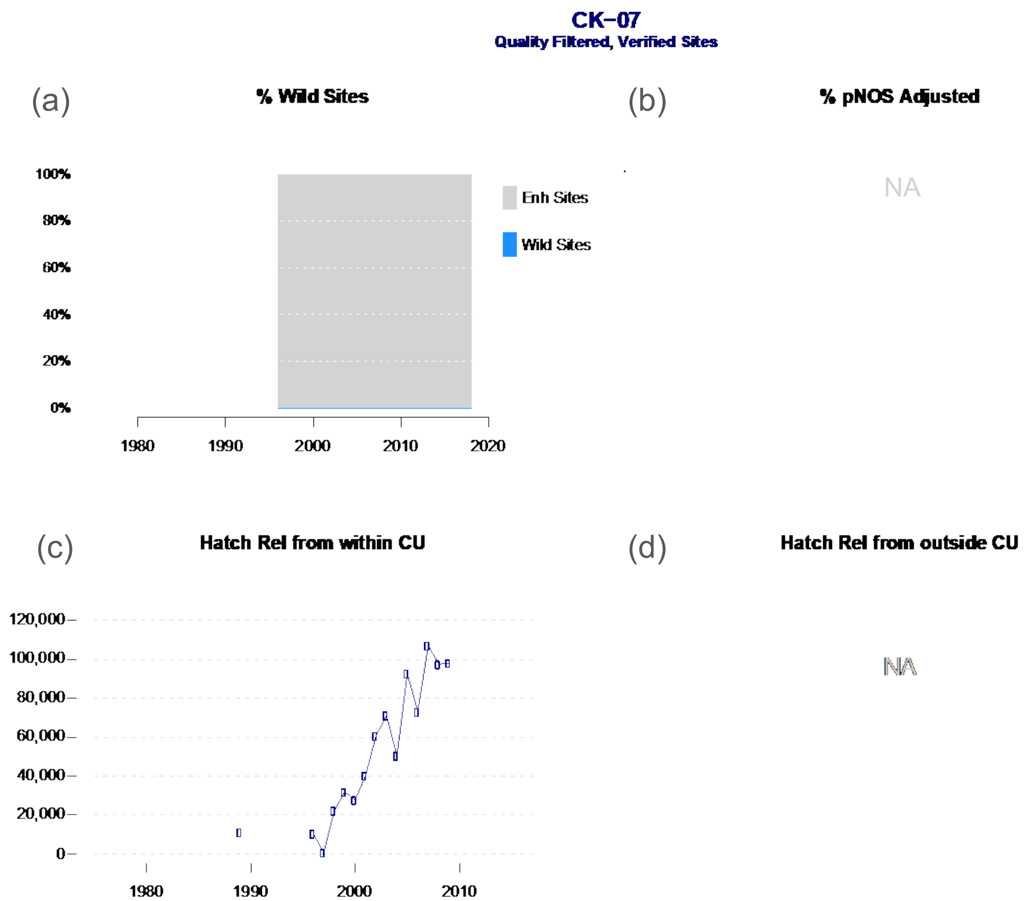

Figure 8. DU6 – Enhancement, proportion of natural origin spawners, and hatchery releases. Graphics provided by Fisheries and Oceans Canada, see Table 4 for panel interpretation. % pNOS Adjusted (panel (b)) cannot be calculated due to sample size limitations.

Fluctuations and Trends

Based on the last three generations of data, the number of mature individuals decreased by an estimated -71% (Upper 95% CI = 95%, Lower 95% CI = -95%) with the probability of a 30% decline at 0.84 (Table 11, Figure 9a,b). Using the entire time series of data, the number of mature individuals increased by an estimated 77% (Upper 95% CI = 620%, Lower 95% CI = -56%) with the probability of a 30% decline at 0.09 (Table 11, Figure 9a,c).

Trends for wild fish are unknown because there is no information available to disaggregate wild and hatchery origin fish for the DU. A consensus of expert opinion (August 2019 meeting of the Marine Fishes SSC) was that there are fewer than 1000 mature wild fish remaining. While DFO data indicate that the average number of mature individuals remaining in 2018 is 440 (Appendix 1), the SSC places the most confidence on the consensus of experts' estimate of remaining mature wild fish.

Harvest, smolt-to-adult survival and stock productivity data are unavailable for this DU because there is no CWT indicator stock of sufficient quality.

Table 11. Summary of estimated rate of change (±95% credible interval) in spawner abundance and probability of decline (>30%, >50%, >70%) for the last three generations and the entire time series for both the full population and the estimated wild population.

DU Name	Generation length	Year range	Median % change	95% CI	p|30% decline	p|50% decline	p|70% decline	Number of Observations
DU6 – Lower Fraser River Ocean Summer	3.8	Hatchery and wild abundance combined						
		2006-2017	-71	-95,95	0.84	0.74	0.51	12
		1996-2017	77	-56,620	0.09	0.04	0.01	22
		Estimated wild abundance only (pNOS adjusted)						
		No data to disaggregage						
		No data to disaggregate						

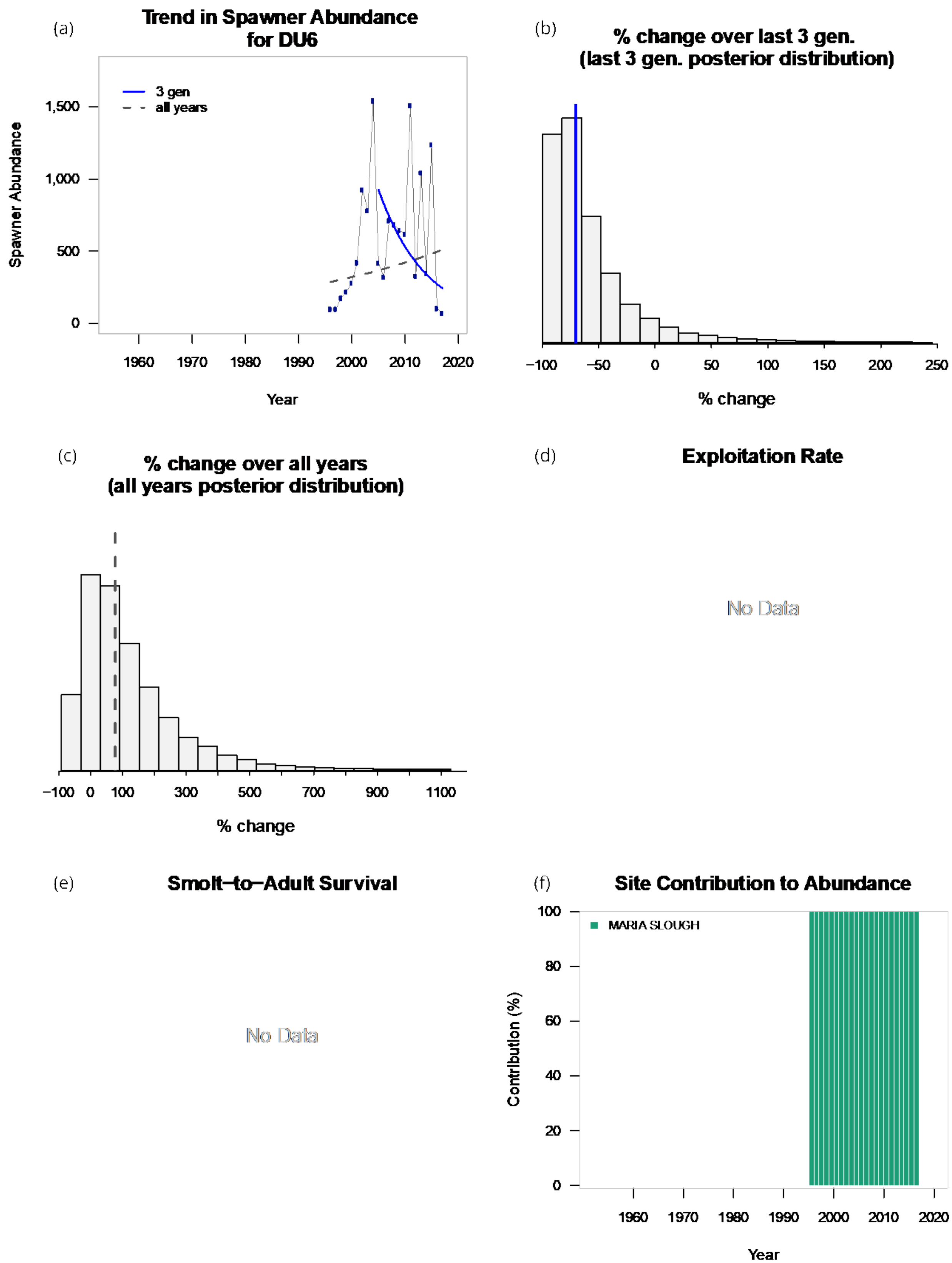

Figure 9. DU6 – Spawner abundance trends, exploitation rate, smolt-to-adult survival, and percent site contribution to abundance (see Table 7 for panel interpretation).

Threats and Limiting Factors

A Threats Calculator was not completed for this DU. For general threats and limiting factors applicable to all DUs, please refer to the Threats and Limiting Factors section in the introductory material. Agricultural runoff is high. Also, Maria Slough (contained within the DU and the only site of spawning) is a paleo-channel of the Fraser River; however, recent low water flows have limited access of spawners to the spawning grounds, and a complete blockage occurred in 2018 (R. Bailey, pers. comm., 2019). As a result of this, only one "location" is considered within this DU. Periodically high Fraser River flows would have maintained the habitat complexity for spawning and rearing, but now the side channels are heavily silted and grown in by vegetation. DFO has constructed some spawning habitat in a few locations (R. Bailey, pers. comm., 2019).

Hatchery releases have occurred within this DU, and the genetic origin of the released fish is from within the DU. The SSC concluded that such releases represent a threat to the wild fish in the DU due to competition and genetic introgression.

Designatable Unit 13: South Thompson, Stream, Summer 1.3

DU Short Name	STh+GStr/Stream/Summer
Joint Adaptive Zone (JAZ)	STh+GStr
Life History	Stream
Run Timing	Summer

Unlike DU14 (another South Thompson DU described elsewhere in this report), the average generation time for this DU at 4.5 years is typical of Chinook Salmon (4.5 yrs using Dome Creek Spring as a proxy as stated in Table 8). But similar to DU14, these fish exhibit stream-type life-history variants and summer run-timing – the title suffixes 1.2 and 1.3 are used to differentiate between these life-history strategies.

To review methods pertaining to data reported within individual DU chapters, refer to the preliminary sections of this report.

Extent of Occurrence and Area of Occupancy

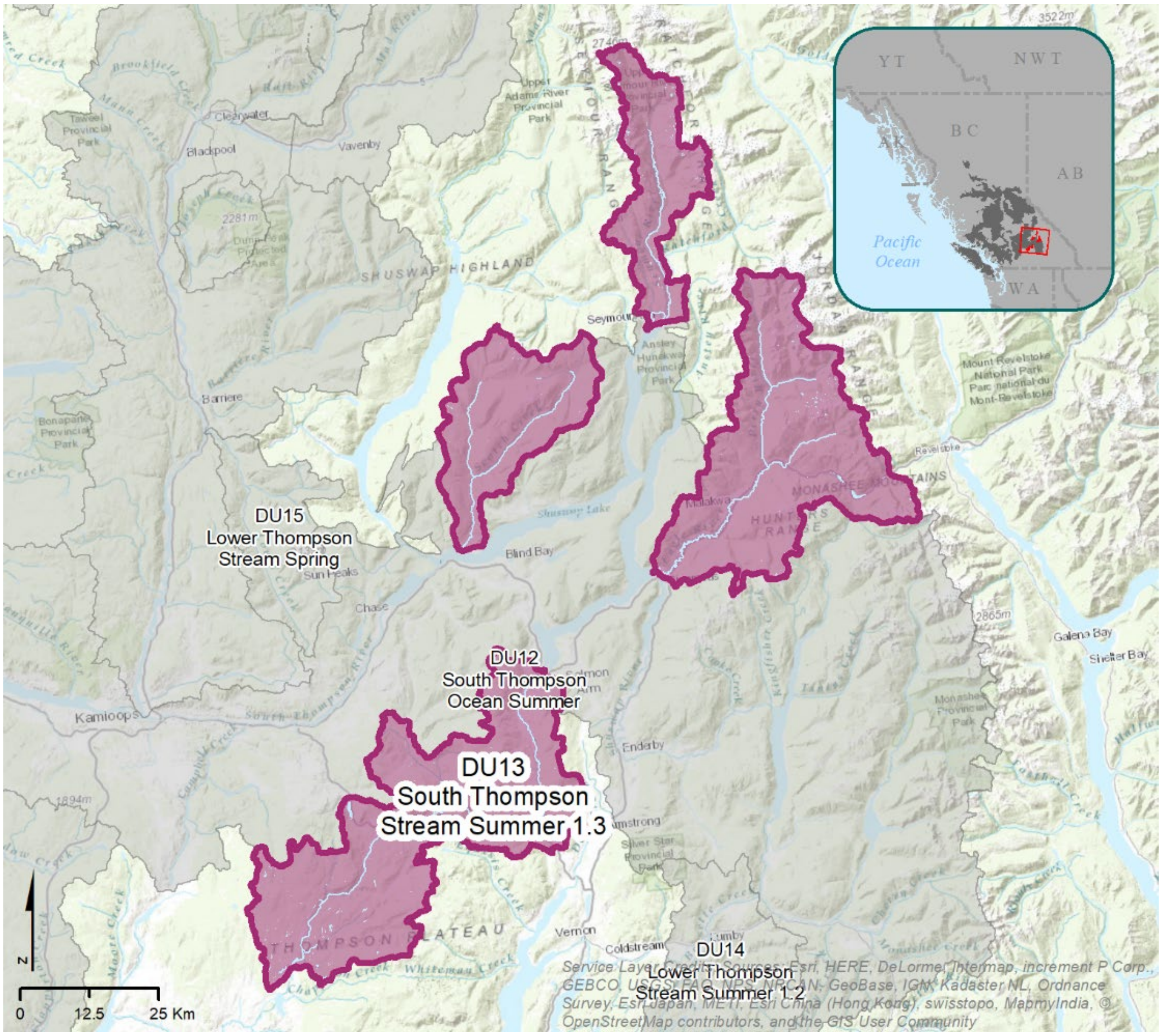

Figure 10. Map of DU13 – South Thompson Stream Summer 1.3.

This DU consists of four geographically separated sections (Scotch Creek, Seymour River, Eagle River and Salmon River (Salmon Arm)). The northernmost section extends from the northern extent of Upper Seymour River Provincial park southward following the Upper Seymour River drainage to Seymour Arm at the north end of Shuswap Lake (N: Lat. 51.69, Long. 118.96; S: Lat. 51.24, Long. 118.97; W: Lat. 51.39, Long. 119.05; E: Lat. 51.51, Long. 118.76). The southernmost section extends southwest from the outlet of Shuswap Lake at Salmon Arm, BC along the Salmon River drainage to just west of Salmon and Rush Lakes (N: Lat. 50.72, Long. 119.34; S: Lat. 50.23, Long. 120.08; W: Lat. 50.35, Long. 120.12, E: Lat. 50.51, Long. 119.24). The eastern section includes the Eagle River drainage from Bourne Glacier in the Jordan Range and west of Probity Peak to the north, and Mt. MacPherson and Mt. English to the southeast. The drainage continues to Sicamous, BC and Shuswap and Mara Lakes in the southwest (N: Lat. 51.30, Long. 118.64; S: Lat. 50.84, 118.99; W: Lat. 50.84, 118.99; E: Lat. 50.89, 118.31). The northwestern section includes the Scotch Creek drainage from Pukeashun Mountain in the north to the outlet into Shuswap Lake near Scotch Creek, BC in the south (N: Lat. 51.26, Long. 119.35; S: Lat. 50.91, Long. 119.50, W: Lat. 51.10, Long. 119.52). The DU's centroid is at Lat. 50.87, Long. 119.20, and its total area is 3900.64 km^2.

As for all DUs considered in this report, the Extent of Occurrence includes spawning streams as well as the ocean range, and is therefore >20,000 km^2. The IAO is 424 km^2 based on a total known spawning run length of 212 km, or 2.11% of the known spawning length across all DUs.

Habitat Trends

Land surrounding this DU's freshwater habitat is altered (24.0%), with agricultural / rural development comprising 8.0% and urban development 0.9% of the DU area. Road density in DU13 is 1.7 km/km^2 with an average of 0.7 stream crossings per km of fish accessible streams (the average across all DUs is 1.33 km/km^2 road density and 0.62 stream crossings per km of fish accessible streams). 20.4% of the riparian habitat and 15.7% of the forest cover is disturbed. 5.3% of the DU's pine stands are affected by Mountain Pine Beetle. No mining development occurs within the DU area.

Abundance

This DU has both enhanced and wild sites, and three of four sites are considered to be Persistent (Appendix 1) (Figure 11a). Of the years where sampling occurred, ~40-90% of estimated spawners originated from wild sites (low or unknown enhancement). The estimated wild portion of the population fluctuated between ~40-50%, rising as high as nearly 60% in the late 1990s/early 2000s (Figure 11b). Hatchery releases were high from 1983 to 1990, peaking at ~1,150,000 fish in 1990 then declining to less than 100,000 fish by 1994 (Figure 11c). No hatchery releases are reported from outside the DU (Figure 11d).

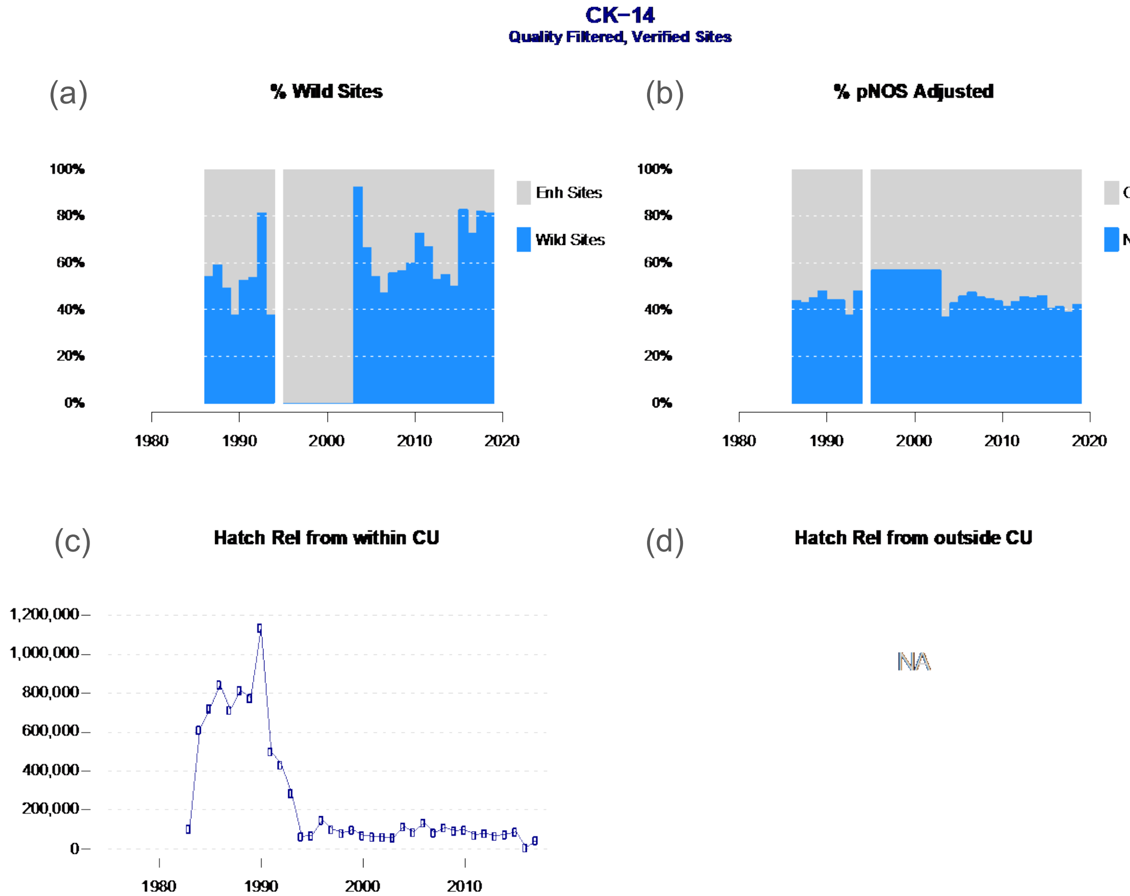

Figure 11. DU13 – Enhancement, proportion of natural origin spawners, and hatchery releases. Graphics provided by Fisheries and Oceans Canada, see Table 4 for panel interpretation.

Fluctuations and Trends

Based on the last three generations of data, the number of mature individuals at three persistent sites (Salmon River, Eagle River, Seymour River) decreased by an estimated -14% (Upper 95% CI = 106%, Lower 95% CI = -65%) with the probability of a 30% decline at 0.31 (Table 12, Figure 12a,b). Using the entire time series of data, the number of mature individuals increased by an estimated 20% (Upper 95% CI = 165%, Lower 95% CI = -45%) with the probability of a 30% decline at 0.08 (Figure 12a,c). The Eagle and Salmon river systems are the largest contributors to overall abundance (Figure 12f).

For estimated wild abundance only, the corresponding trend for the last three generations is an estimated decrease of -22% (Upper 95% CI = 90%, Lower 95% CI = -67%) with the probability of a 30% decline at 0.4 (Table 12, Figure 13a,b). For the full time series, the decrease in the number of mature individuals is -9% (Upper CI = 93%, Lower CI = -58%) with the probability of a 30% decline at 0.24 (Table 12, Figure 13a,c). The relative contribution of the Eagle River to the wild population has been less over time than its relative contribution to the population as a whole, while the reverse is true for the Salmon and Seymour river systems (Figure 12f, Figure 13f). As for overall abundance, the Eagle and Salmon river systems remain the largest contributors to the wild population. A consensus of expert opinion (August 2019 meeting of the Marine Fishes SSC) was that the remaining mature wild fish are less than 2500. While DFO data indicate that the average number of mature individuals remaining in 2018 is 1049 and 443 for the non pNOS-adjusted and adjusted values, respectively (Appendix 1), the SSC places the most confidence on the consensus of experts' estimate of remaining mature wild fish.

Harvest, smolt-to-adult survival and stock productivity data are unavailable for this DU because there is no CWT indicator stock.

Table 12. Summary of estimated rate of change (±95% credible interval) in spawner abundance and probability of decline (>30%, >50%, >70%) for the last three generations and the entire time series for both the full population and the estimated wild population.

DU Name	Generation length	Year range	Median % change	95% CI	p|30% decline	p|50% decline	p|70% decline	Number of Observations
DU13 – South Thompson Stream Summer 1.3	4.5	Hatchery and wild abundance combined						
		2004-2018	-14	-65,106	0.31	0.1	0.01	15
		1999-2018	20	-45,165	0.08	0.02	0	20
		Estimated wild abundance only (pNOS adjusted)						
		2004-2018	-22	-67,90	0.4	0.15	0.02	15
		1999-2018	-9	-58,93	0.24	0.06	0	20

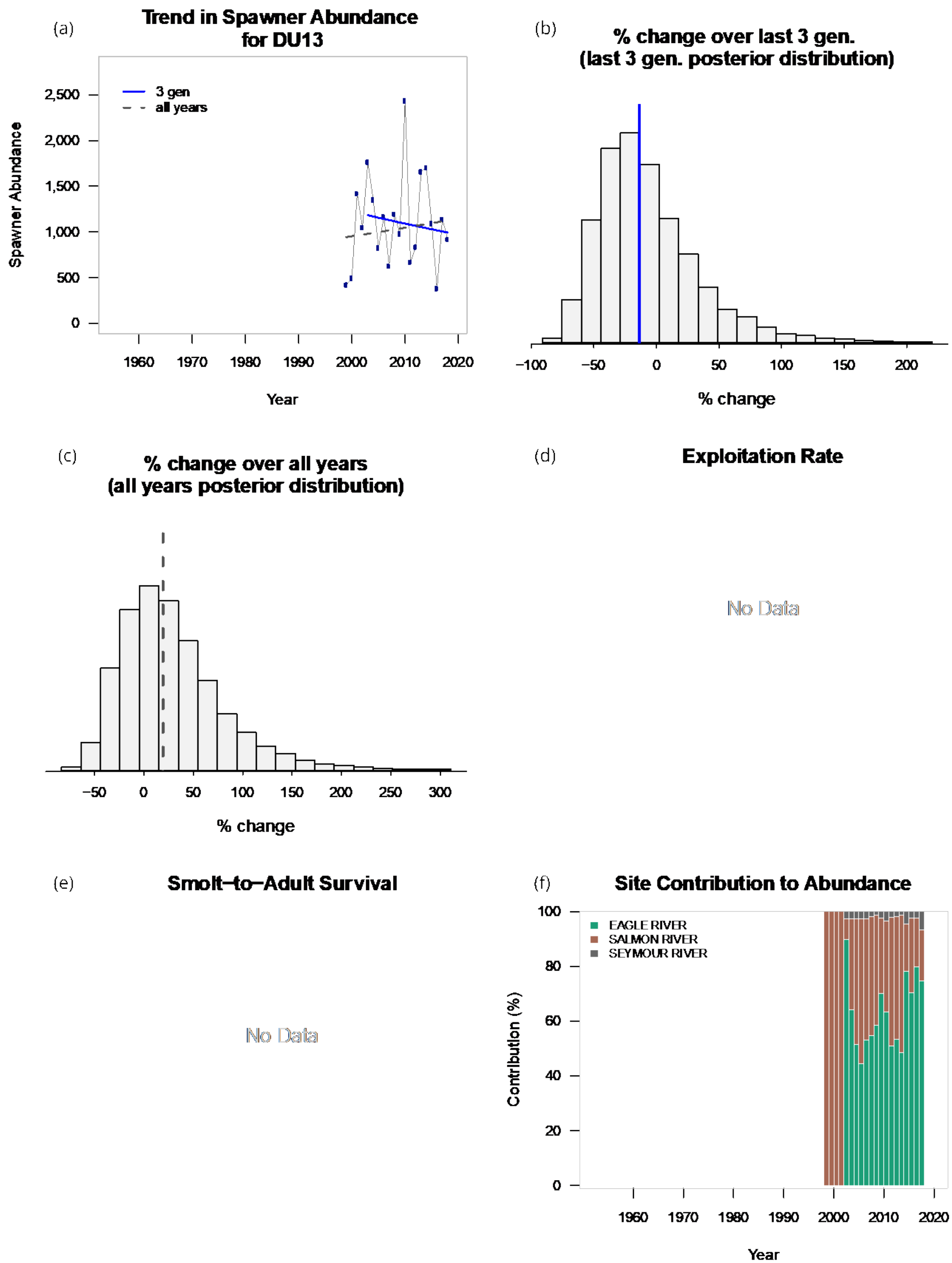

Figure 12. DU13 – Spawner abundance trends, exploitation rate, smolt-to-adult survival, and percent site contribution to abundance (see Table 7 for panel interpretation).

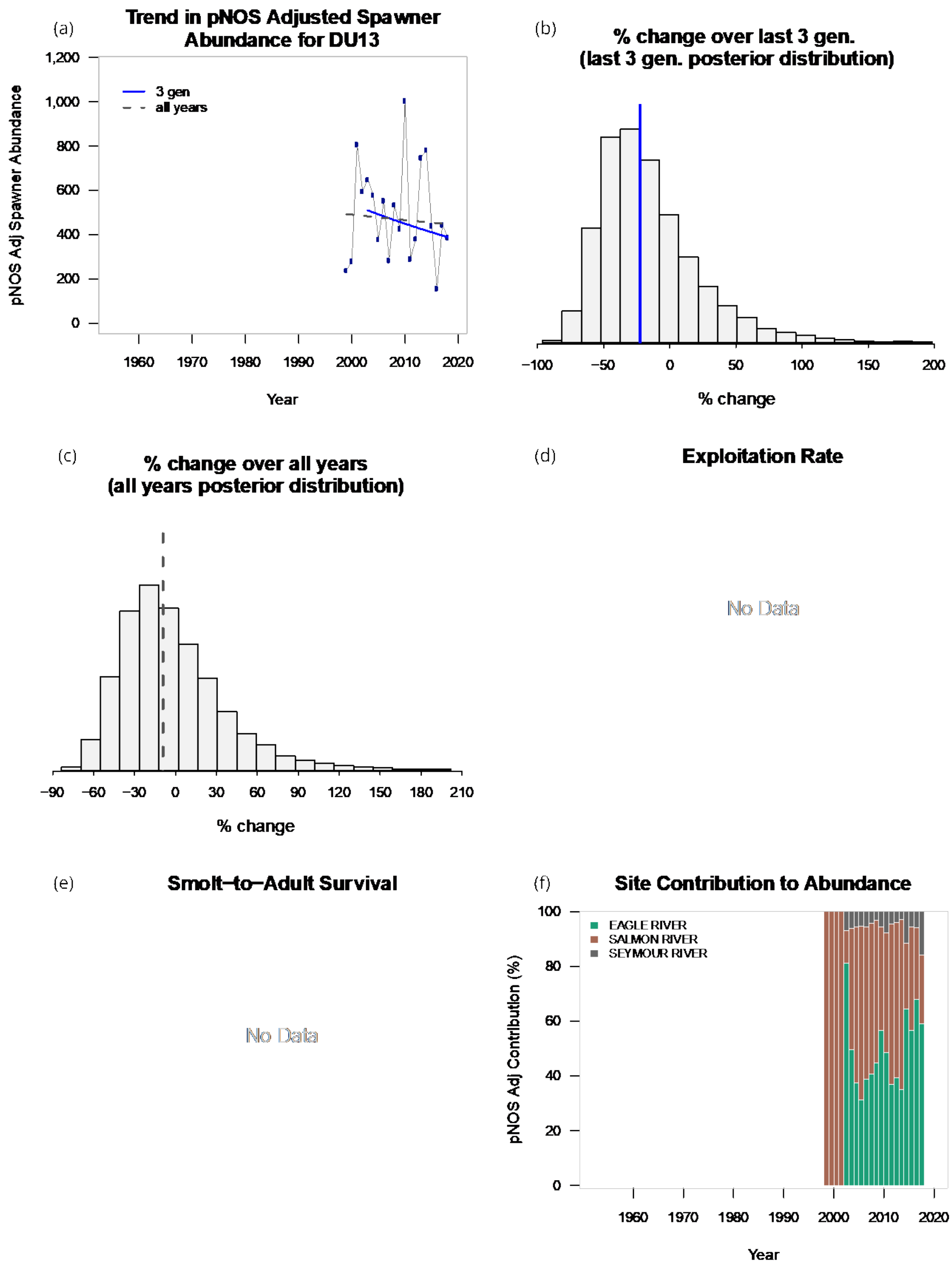

Figure 13. DU13 – Spawner abundance trends adjusted by average proportion of natural origin spawners, exploitation rate, smolt-to-adult survival, and percent site contribution to abundance (see Table 7 for panel interpretation).

Threats and Limiting Factors

For general threats and limiting factors applicable to all DUs, please refer to the Threats and Limiting Factors section in the introductory material. Chinook Salmon experts who participated in the IUCN Threats Calculator Workshop in February 2017 recommended using the DU15 Threats Calculator as a proxy for this DU (see Table 9) with the main difference being that the juveniles in DU13 stay in freshwater for one year and utilize smaller rivers. These characteristics make the fish more vulnerable than DU15 Chinook Salmon to water management issues (esp. Salmon River), and increased development (Eagle River). In the Salmon River, for example, Chinook Salmon contend with dewatering events, agricultural runoff and rising stream temperatures (R. Bailey, pers. comm., 2019). Based on these points and DU15 results, participants concluded that DU13 should be assigned a threat impact of High-Medium (B/C). Because females in fall actively seek a mix of groundwater and surface water when selecting redd sites, the most important threats in this DU are ecosystem modifications due to climate change, cyclical marine climate events (El Niño), and resulting shifts in groundwater availability caused by changes in the volume and timing of snowmelt. Other less critical impacts include invasive species (esp. spiny-rayed fishes), avalanches/landslides, droughts, and temperature extremes.

Hatchery releases have occurred within this DU, and the genetic origin of the released fish is from within the DU. The SSC concluded that such releases represent a threat to the wild fish in the DU due to competition and genetic introgression.

Threats Calculator spreadsheets are included with this report (see Appendix 2).

Designatable Unit 15: Lower Thompson, Stream, Spring population

DU Short Name	LTh+GStr/Stream/Spring
Joint Adaptive Zone (JAZ)	LTh+GStr
Life History	Stream
Run Timing	Spring

The average generation time for this DU is 4 years. These fish exhibit stream-type life-history variants and spring run-timing.

To review methods pertaining to data reported within individual DU chapters, refer to the preliminary sections of this report.

Extent of Occurrence and Area of Occupancy

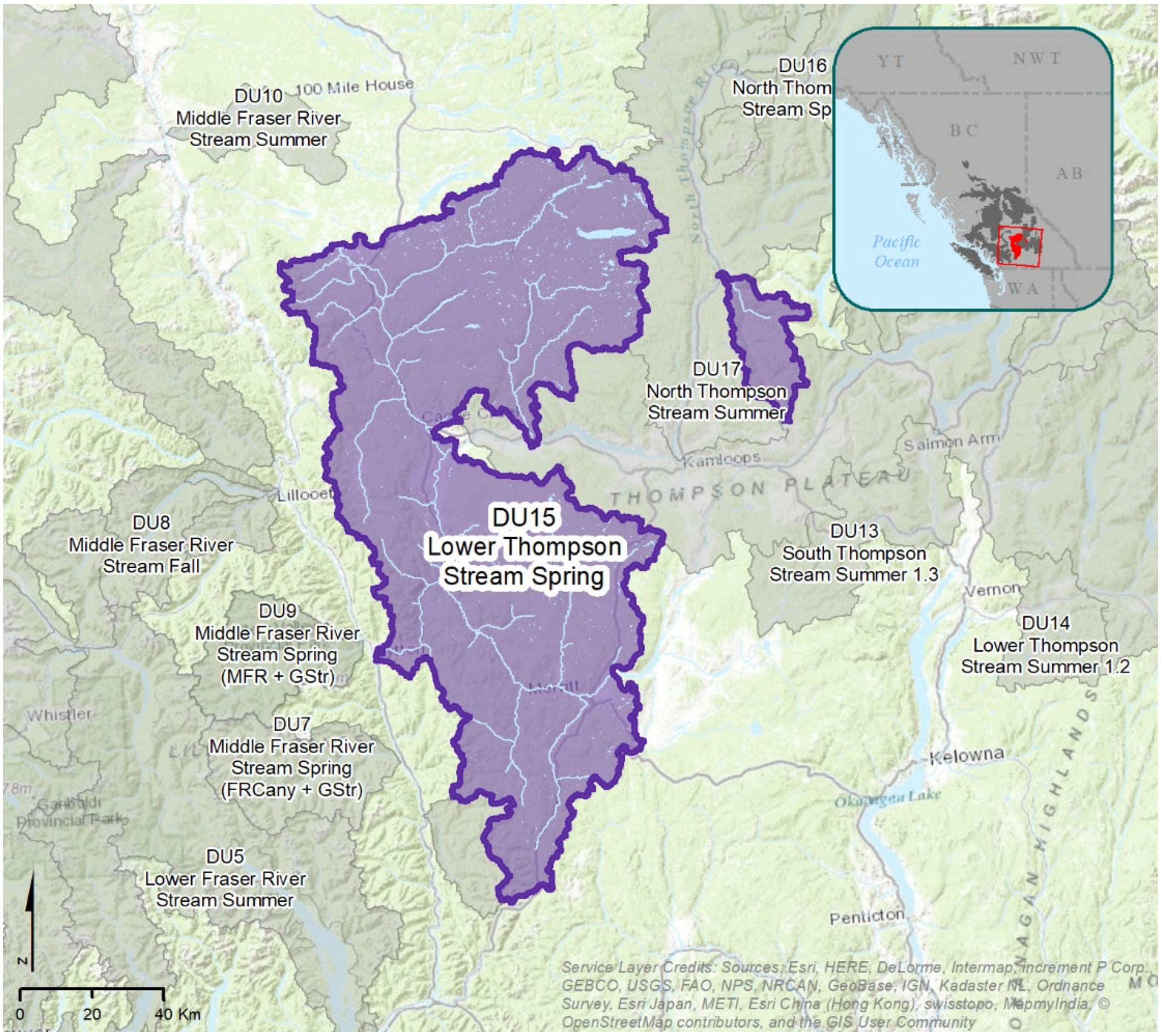

Figure 14. Map of DU15 – Lower Thompson Stream Spring.

This DU consists of 2 geographically separated sections. The smaller of these sections to the east includes the Louis Creek drainage to the confluence of Louis Creek and the North Thompson River (N: Lat. 51.14, Long. 120.11; S: Lat. 50.75, Long. 119.90; W: Lat. 50.96, Long. 120.09; E: Lat. 51.02, Long. 119.78). The larger section to the west extends southward from Montana Creek around Bonaparte Hills to Coldwater River just north of the Coquihalla Summit Recreation Area. The westernmost extent occurs at the confluence of the Thompson River and the Fraser River, and easternmost extents occur just east of Bonaparte Lake and Lac Le Jeune Provincial Park (N: Lat. 51.45, Long. 120.6; S: Lat. 49.61, Long. 121.16; W: Lat. 50.23, Long. 121.58; E: Lat. 51.27, Long. 120.33). The DU's centroid is at Lat. 50.38, Long. 120.98, and its total area is 12324.88 km^2.

As for all DUs considered in this report, the Extent of Occurrence includes spawning streams as well as the ocean range, and is therefore >20,000 km^2. The IAO is 1330 km^2 based on a total known spawning run length of 665 km, or 6.61% of the known spawning length across all DUs.

Habitat Trends

Land surrounding this DU's freshwater habitat is altered (13.5%), with urban development comprising 0.7%, agricultural / rural development 4.0%, and mining development 0.04% of the DU area. Road density in DU15 is 1.6 km/km^2 with an average of 0.8 stream crossings per km of fish accessible streams (the average across all DUs is 1.33 km/km^2 road density and 0.62 stream crossings per km of fish accessible streams). 13.7% of the DU's riparian habitat and 8.7% of its forest cover is disturbed. 18.1% of pine stands in the DU are affected by Mountain Pine Beetle.

Abundance

This DU has both enhanced and wild sites, and six of seven sites are considered to be Persistent (Appendix 1). Of the years where sampling occurred, the proportion of estimated spawners originating from wild sites (low or unknown levels of enhancement) increased from 0% to ~60% by 2016, with a decline to less than 40% in 2018 (Figure 15a). The estimated wild portion of the population has fluctuated at just over 50% (Figure 15b). Hatchery releases increased from 1980 to 1988, peaking at ~1,250,000 fish, then declining in 1992 to between ~220,000 and ~420,000 fish per year (Figure 15c). No hatchery releases are reported from outside the DU (Figure 15d).

Additional information on the 2018 escapements to this DU were provided by DFO (R. Bailey, pers. comm., 2019), and indicate that the 2018 escapement was one of the lowest on record since 1995. A failure of the Bonaparte River fishway is thought to be responsible for the low returns, and there were few fish observed even returning to the river or trying to ascend the broken fishway.

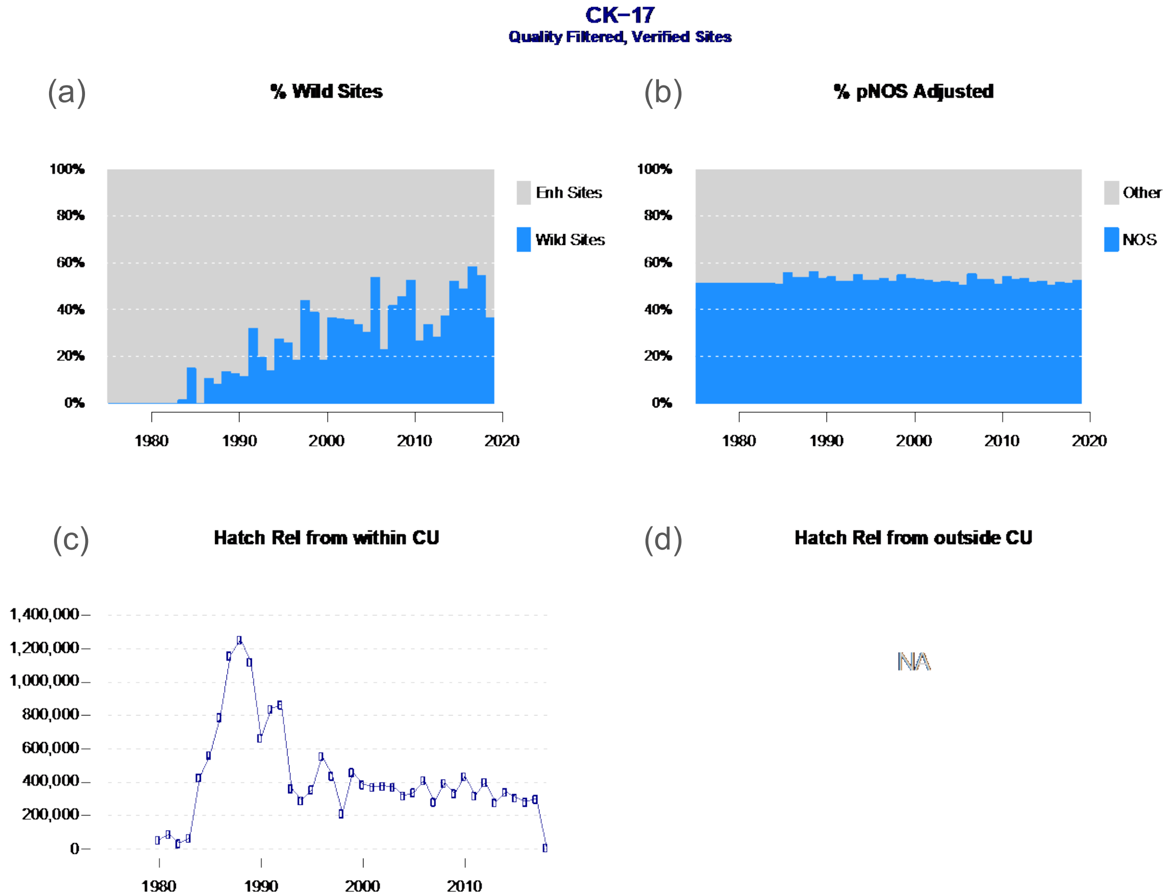

Figure 15. DU15 – Enhancement, proportion of natural origin spawners, and hatchery releases. Graphics provided by Fisheries and Oceans Canada, see Table 4 for panel interpretation.

Fluctuations and Trends

Based on data from six persistent sites (see Figure 16f), the number of mature individuals increased by an estimated 47% over three generations (Upper 95% CI = 585%, Lower 95% CI = -69%) with the probability of a 30% decline at 0.15 (Table 13, Figure 16a,b). Using the entire time series of data, the number of mature individuals decreased by an estimated -68% (Upper 95% CI = -18%, Lower 95% CI = -87%) with the probability of a 30% decline at 0.95 (Table 13, Figure 16a,c). The Nicola and Bonaparte river systems are historically the largest contributors to overall abundance (Figure 16f). The interpretation of decline rates over the entire time series is possibly confounded by the peak in hatchery releases in 1989-1990.

For estimated wild abundance, the corresponding trends are the same. DFO data indicate that the average number of mature individuals remaining in 2018 are 7328 and 3758 for the non pNOS-adjusted and adjusted values, respectively (Appendix 1).

Between 1985 and 2012, the total exploitation rate fluctuated from ~10% to ~60% (Figure 16d). The most recent exploitation rate estimate is ~24% (2012). Over the same time period (1985-2012) Smolt-to-Adult survival rates fluctuated between ~0.1% and ~13% with the most recent estimate in 2012 at ~1.2% (Figure 16e). Stock productivity data are not available for this DU.

Table 13. Summary of estimated rate of change (±95% credible interval) in spawner abundance and probability of decline (>30%, >50%, >70%) for the last three generations and the entire time series for both the full population and the estimated wild population.

DU Name	Generation length	Year range	Median % change	95% CI	p|30% decline	p|50% decline	p|70% decline	Number of Observations
DU15 – Lower Thompson Stream Spring	4	Hatchery and wild abundance combined						
		2006-2018	47	-69,585	0.15	0.07	0.02	13
		1995-2018	-68	-87,-18	0.95	0.83	0.44	24
		Estimated wild abundance only (pNOS adjusted)						
		No data to disaggregate						
		No data to disaggregate						

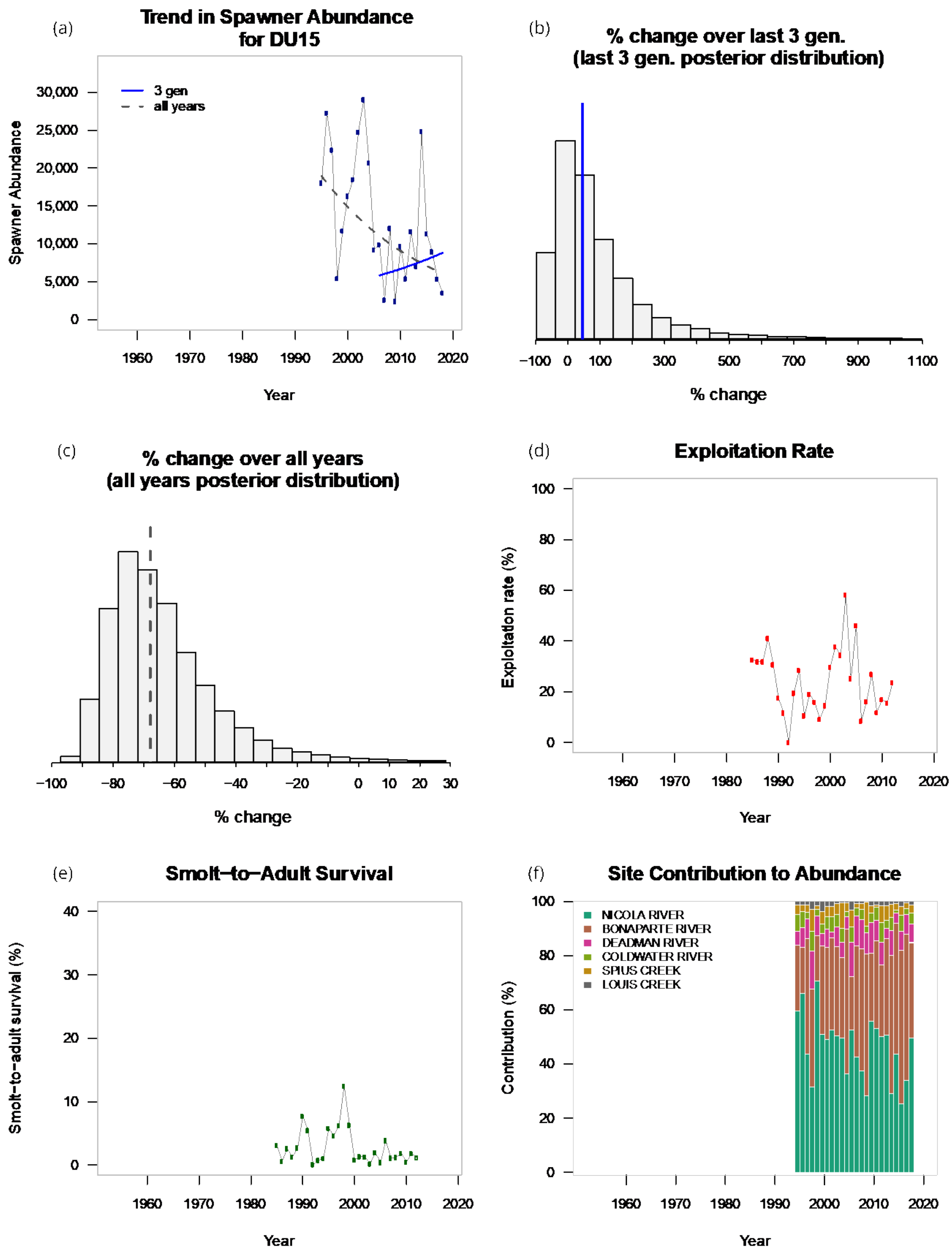

Figure 16. DU15 – Spawner abundance trends, exploitation rate, smolt-to-adult survival, and percent site contribution to abundance (see Table 7 for panel interpretation).

Threats and Limiting Factors

For general threats and limiting factors applicable to all DUs, please refer to the Threats and Limiting Factors section in the introductory material. Chinook Salmon experts who participated in the IUCN Threats Calculator Workshop in February 2017 concluded that DU15 should be assigned a threat impact of High-Medium (B/C). Because females in fall actively seek a mix of groundwater and surface water when selecting redd sites, the most important threats in this DU are ecosystem modifications due to climate change, cyclical marine climate events (El Niño) and resulting shifts in groundwater availability caused by changes in the volume and timing of snowmelt. Another round of ocean survival impacts as in 2003 and 2007 could terminate groups of Chinook Salmon within the DU. Other less critical impacts include invasive species (esp. spiny rayed fishes), avalanches/landslides, droughts, and temperature extremes. Chinook Salmon in this DU also contend with dewatering events and agricultural runoff (R. Bailey, pers. comm., 2019). Agricultural water extraction and reduction of riparian habitat from cattle grazing can lead to high stream temperatures, and development of railways, gas pipelines, highways and bank stabilization projects have resulted in considerable armouring of the banks and subsequent erosion and channel meandering (R. Bailey, pers. comm., 2019).

Since the Threats Calculator Workshop, there have been events in this DU that have seriously impacted habitat quality. Expert opinion contributed during the August 2019 meeting of the COSEWIC Marine Fishes SSC indicated that recent large scale deforestation of parts of the DU to “salvage log” pine beetle timber, combined with the very large Elephant Hill wildfire, have resulted in considerable loss of hillslope stability and pool-riffle-run structure in the Bonaparte, Deadman, and Nicola rivers (the most important watersheds within the DU for Chinook Salmon production). There are now multiple large sediment wedges in both systems and between clear cutting and fire impacts, >>50% of the upslope portions of both drainages are disturbed (deforested/burned), which suggests that riparian cover and channel structure are unlikely to be successfully restored in the next 20 years (R. Bailey, pers. comm., 2019).

Hatchery releases have occurred within this DU, and the genetic origin of the released fish is from within the DU. The SSC concluded that such releases represent a threat to the wild fish in the DU due to competition and genetic introgression.

Threats Calculator spreadsheets are included with this report (see Appendix 2).

Designatable Unit 18: South Coast - Georgia Strait, Ocean, Fall population

DU Short Name	SC+GStr/Ocean/Fall
Joint Adaptive Zone (JAZ)	SC+GStr
Life History	Ocean
Run Timing	Fall

The average generation time for this DU is 3.6 years. These fish exhibit ocean-type life-history variants and fall run-timing.

To review methods pertaining to data reported within individual DU chapters, refer to the preliminary sections of this report.

Extent of Occurrence and Area of Occupancy

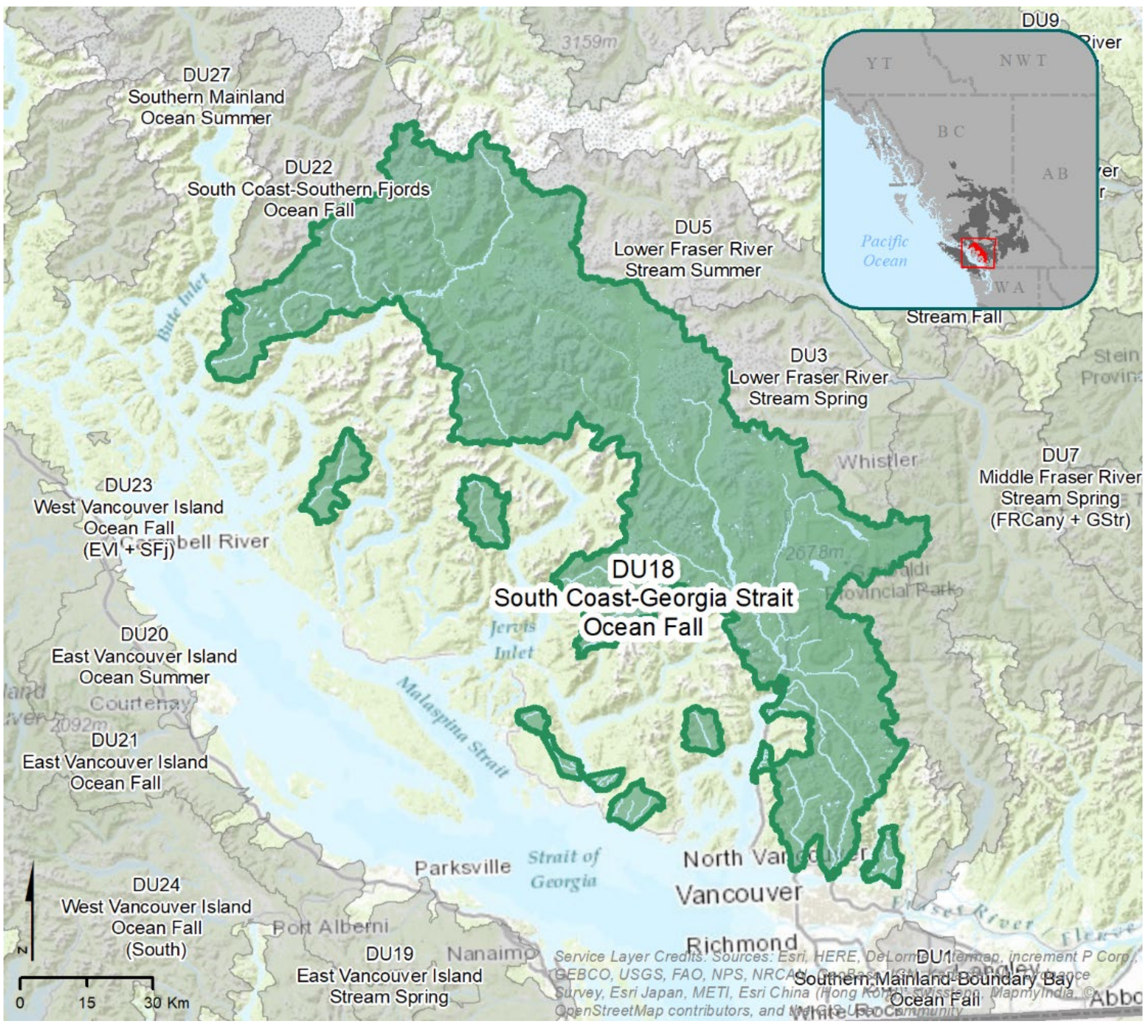

Figure 17. Map of DU18 – South Coast - Georgia Strait Ocean Fall.

This DU has seven geographically separated sections and extends southeastward from Filer Creek around Mount Gilbert to Seymour River close to Mount Seymour. The westernmost extent is located at Quatam River around Mount Doogie Dowler and the easternmost extent is located at Cheakamus River around Nivalis Mountain (N: Lat. 50.86, Long. 124.25; S: Lat. 49.30, Long 123.03; W: Lat. 50.37, Long. 124.93; E: Lat. 50.01, Long. 122.68). The DU's centroid is at Lat. 49.83, Long. 123.58, and its total area is 8262.40 km^2.

As for all DUs considered in this report, the Extent of Occurrence includes spawning streams as well as the ocean range, and is therefore >20,000 km^2. The IAO is 504 km^2 based on a total known spawning run length of 252 km, or 2.51% of the known spawning length across all DUs.

Habitat Trends

Land surrounding this DU's freshwater habitat is altered (7.5%), with urban development comprising 1.4%, agricultural/rural development 0.03%, and mining development 0.004% of the DU area. Road density in DU 18 is 0.7 km/km^2 with an average of 0.5 stream crossings per km of fish accessible streams (the average across all DUs is 1.33 km/km^2 road density and 0.62 stream crossings per km of fish accessible streams). 9.0% of the DU's riparian habitat and 6.0% of its forest cover is disturbed. 0.02% of pine stands in the DU are affected by Mountain Pine Beetle.

Abundance

While the available data are too few to draw conclusions, the available information is summarized below.

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The DU is comprised only of enhanced sites (Figure 18a), and two of 19 are considered persistent (Appendix 1). Using the pNOS adjustment method, the wild portion of the population is estimated at 100%, which is inconsistent with the DU's enhanced status and hatchery release data shown in Figure 18c and Figure 18d. Given this contradiction, Figure 18b has been omitted. Hatchery releases have occurred since the late 1970s. Releases within the DU increased steadily to a peak of ~1,750,000 in the 1990s. Since then, releases declined overall to less than 100,000 fish in 2017 (Figure 18c). Hatchery releases from outside the DU occurred between 1983 and 2013, reaching a maximum of ~675,000 fish in 1989 and dropping to ~40,000 fish by 2003 (Figure 18d)[1].

[1] There are unresolved CU assignment issues for CK-20 in the original database that may affect the number of releases per year that are attributed to this DU..

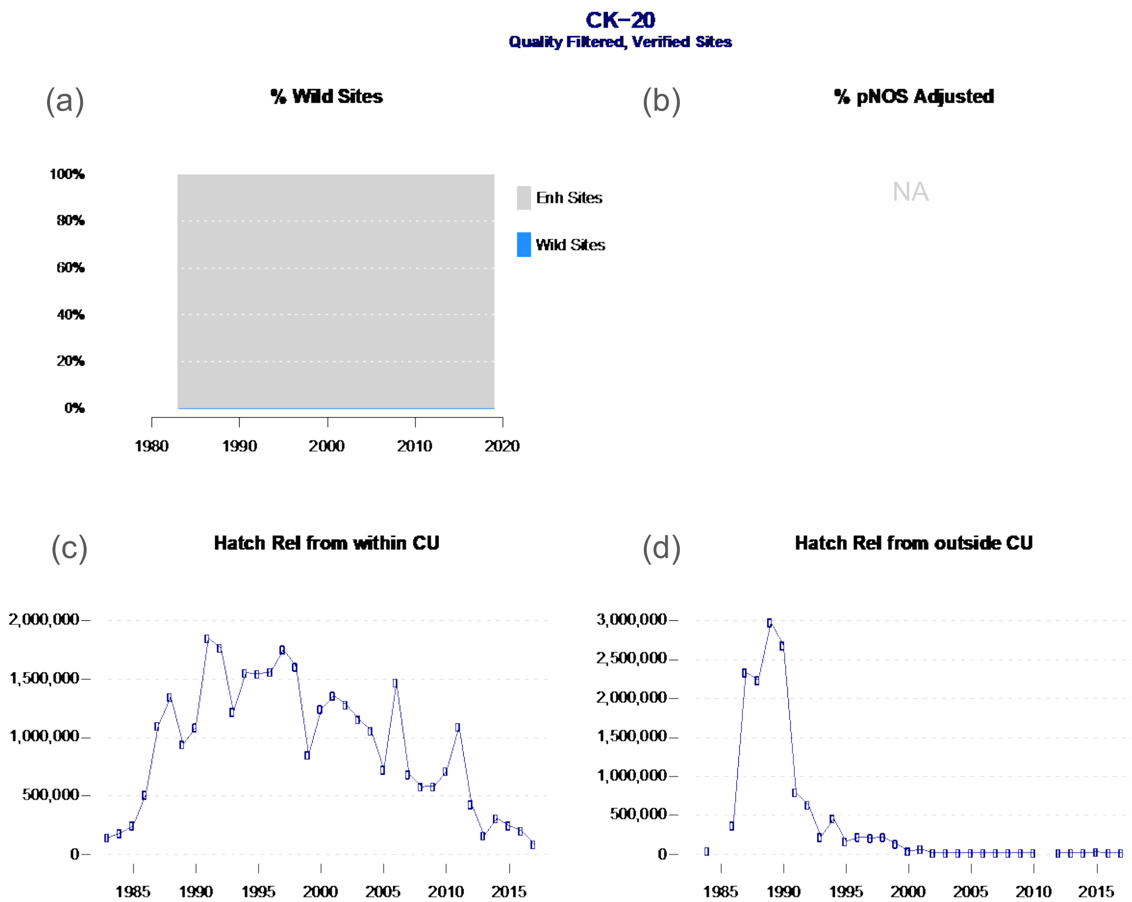

Figure 18. DU18 – Enhancement, proportion of natural origin spawners, and hatchery releases. Graphics provided by Fisheries and Oceans Canada, see Table 4 for panel interpretation. % pNOS Adjusted (panel (b)) cannot be calculated due to sample size limitations.

Fluctuations and Trends

While the available data are too few to draw conclusions, the available information is summarized below.

Based on the relatively short time series of abundance data at two persistent sites (Squamish River and Cheakamus River), the number of mature individuals increased by an estimated 78% over three generations (Upper 95% CI = 710%, Lower 95% CI = -61%) with the probability of a 30% decline at 0.1 (Table 14, Figure 19a,b). Using the entire time series of data, the number of mature individuals increased by an estimated 2% (Upper 95% CI = 308%, Lower 95% CI = -74%) with the probability of a 30% decline at 0.27 (Table 14, Figure 19a,c).The Squamish River system is the largest contributor to overall abundance (Figure 19f). For estimated wild abundance, the corresponding trends are the same (Figure 19f). While the trends are stable from 2005 to 2018, spawning is thought to occur elsewhere in the northern area.

Harvest, smolt-to-adult survival, and stock productivity data are unavailable for this DU because there is no CWT indicator stock.

Table 14. Summary of estimated rate of change (±95% credible interval) in spawner abundance and probability of decline (>30%, >50%, >70%) for the last three generations and the entire time series for both the full population and the estimated wild population.

DU Name	Generation length	Year range	Median % change	95% CI	p|30% decline	p|50% decline	p|70% decline	Number of Observations
DU18 – South Coast - Georgia Strait Ocean Fall	3.6	Hatchery and wild abundance combined						
		2006-2018	78	-61,710	0.1	0.05	0.01	12
		2005-2018	2	-74,308	0.27	0.13	0.04	14
		Estimated wild abundance only (pNOS adjusted)						
		No data to disaggregate						
		No data to disaggregate						

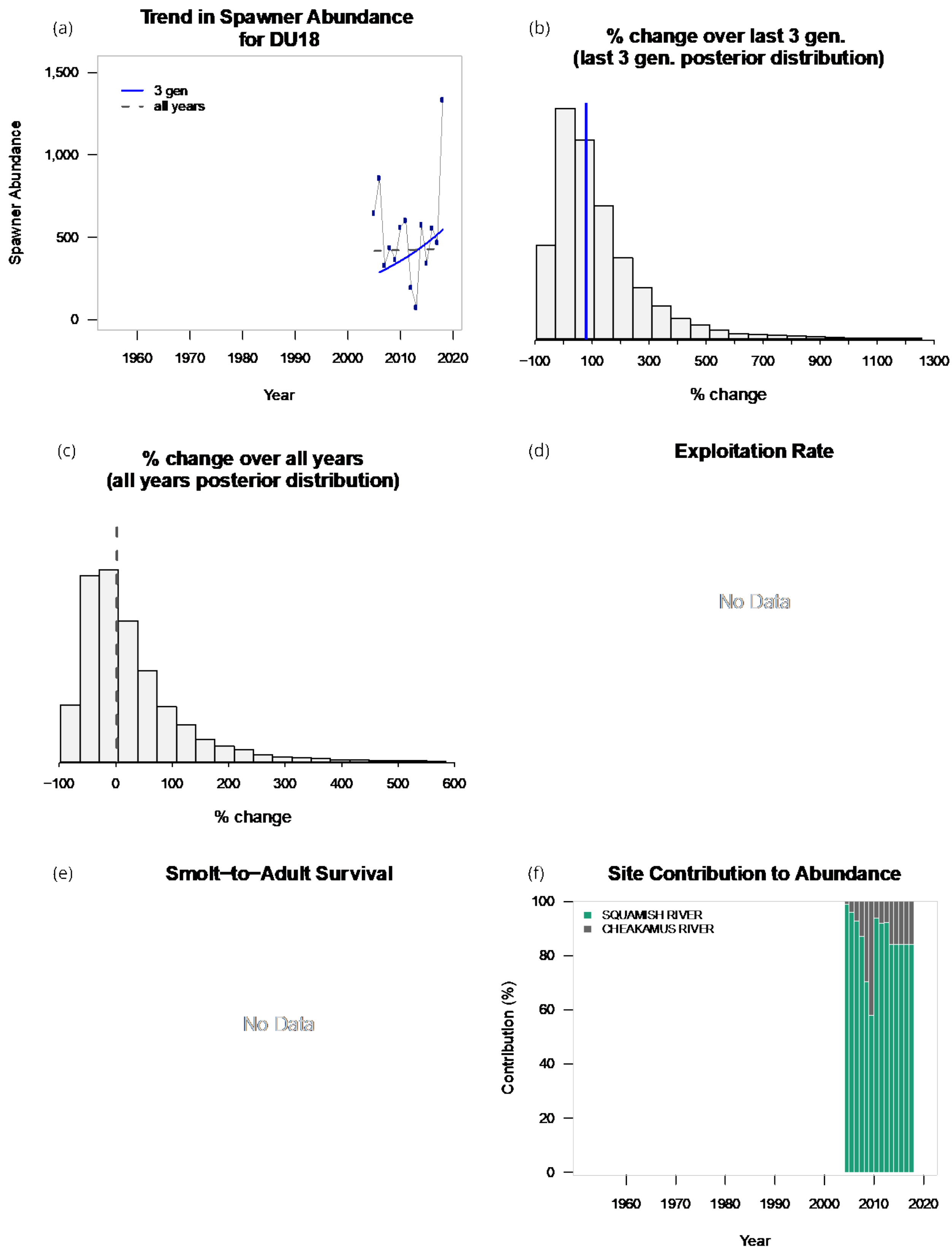

Figure 19. DU18 – Spawner abundance trends, exploitation rate, smolt-to-adult survival, and percent site contribution to abundance (see Table 7 for panel interpretation).

Threats and Limiting Factors

A Threats Calculator was not completed for this DU. For general threats and limiting factors applicable to all DUs, please refer to the Threats and Limiting Factors section in the introductory material.

Hatchery releases have occurred within this DU, and the genetic origin of the released fish was often from outside the DU. The SSC concluded that such releases represent a threat to the wild fish in the DU due to competition and genetic introgression.

Designatable Unit 20: East Vancouver Island, Ocean, Summer population

DU Short Name	EVI+SFj/Ocean/Summer
Joint Adaptive Zone (JAZ)	EVI+SFj
Life History	Ocean
Run Timing	Summer

The average generation time for this DU is 3.5 years. These fish exhibit ocean-type life-history variants and summer run-timing.

To review methods pertaining to data reported within individual DU chapters, refer to the preliminary sections of this report.

Extent of Occurrence and Area of Occupancy

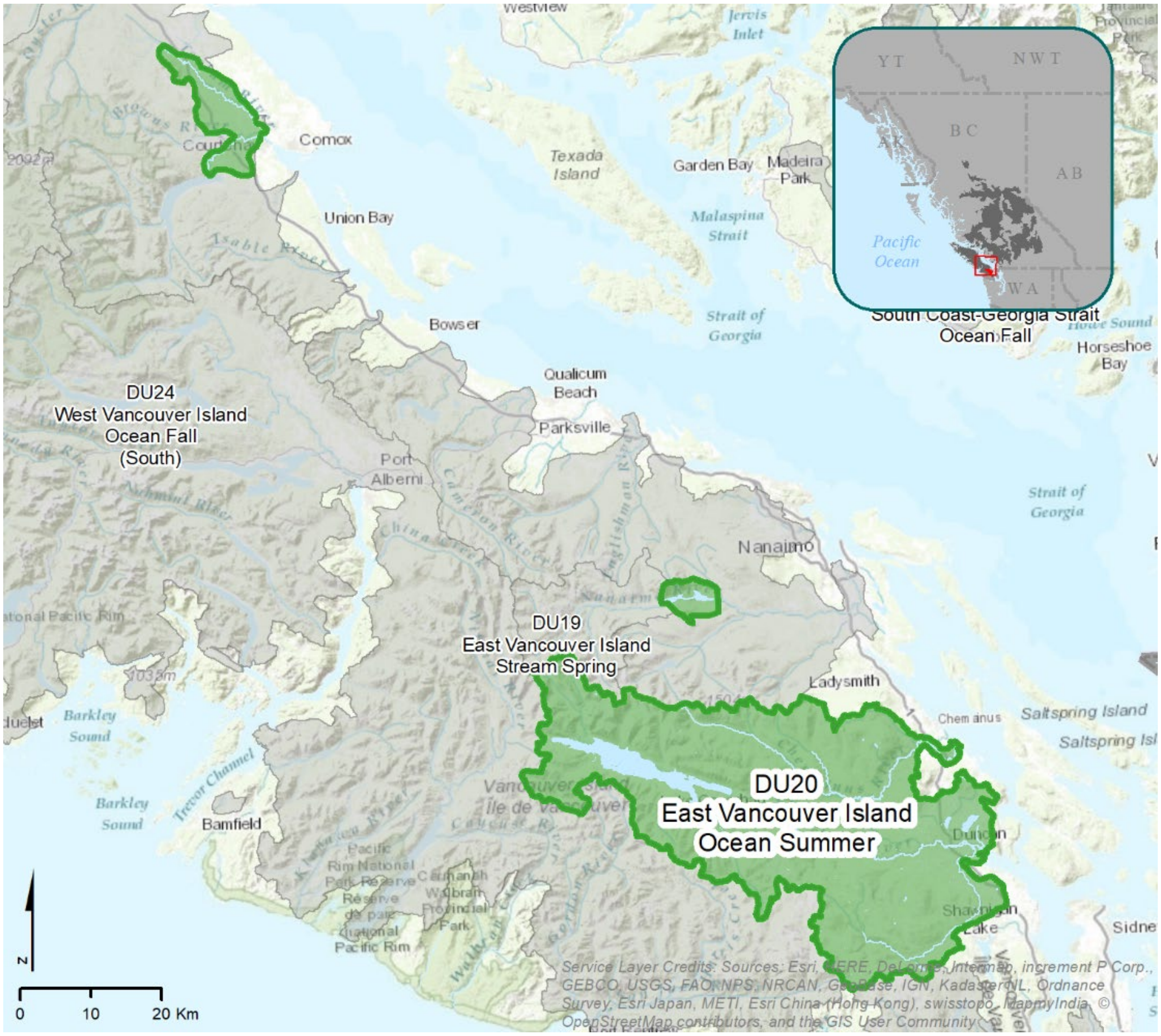

Figure 20. Map of DU20 – East Vancouver Island Ocean Summer.

This DU is a combination of three areas on Vancouver Island. The northernmost section includes the Tsolum River drainage and the Puntledge River drainage downstream of Comox Lake, both of which empty into Georgia Strait via Courtenay River. This section extends north-to-south from the headwaters of the Tsolum River to just north of Maple Lake. The section's westernmost extent occurs at the lower end of Comox Lake and its easternmost extent occurs at the Courtenay River confluence (N: Lat. 49.81, Long. 125.19; S: Lat. 49.64, Long. 125.02; W: Lat. 49.64, Long. 125.10; E: Lat. 49.69, Long. 124.00). The smallest, middle section includes the drainage area around Nanaimo Lakes (N: Lat. 49.12, Long. 124.18; S: Lat. 49.06, Long. 124.18; W: Lat. 49.09, Long. 124.24; E: Lat. 49.09, Long. 124.13). The largest, southern section includes the Cowichan, Koksilah, and Chemainus River drainages. This section extends southeast from the Upper Shaw Creek Woodlands to Cobble Hill. The area's westernmost extent occurs at upper Cowichan Lake and its easternmost extent spans from just northeast of Cobble Hill, to the Koksilah River's confluence with Cowichan River at Cowichan Bay, and near Maple Bay, BC just east of Quamichan Lake (N: Lat. 49.02, Long. 124.44; S: Lat. 48.60, Long.123.76, W: Lat. 48.89, Long. 124.51, E: Lat. 48.70, Long. 123.60). The DU's centroid is at Lat. 49.12, Long. 124.07, and its total area is 1727.05 km^2. DU20 contains a large proportion of island coastal mountain ridge.

As for all DUs considered in this report, the Extent of Occurrence includes spawning streams as well as the ocean range, and is therefore >20,000 km^2. The IAO is 311 km^2 based on a total known spawning run length of 156 km, or 1.55% of the known spawning length across all DUs.

Habitat Trends

Land surrounding this DU's freshwater habitat is altered (21.4%), with urban development comprising 3.5%, agricultural / rural development 2.3%, and mining development 0.3% of the DU area. Road density in DU20 is 2.3 km/km^2 with an average of 0.8 stream crossings per km of fish accessible streams (the average across all DUs is 1.33 km/km^2 road density and 0.62 stream crossings per km of fish accessible streams). 18.4% of the DU's riparian habitat and 15.3% of its forest cover is disturbed. The DU is not affected by Mountain Pine Beetle.

Abundance

This DU is comprised only of two enhanced sites, and both are considered persistent (Appendix 1). All spawners originate from streams with high levels of enhancement (Figure 21a). The estimated wild portion of the population has fluctuated around the 20% mark since the 1980s (Figure 21b). Hatchery releases began in 1971, increasing to a peak of over 2 million fish in 1988, declining to less than 500,000 fish in the late 1990s, peaking again at over 3 million fish in 2001, and then declining again to less than 500,000 in 2018 (Figure 21c). No hatchery releases are reported from outside the DU (Figure 21d). The hatchery influence on the wild population, as measured by the PNI, is high and variable (see Appendix 1).

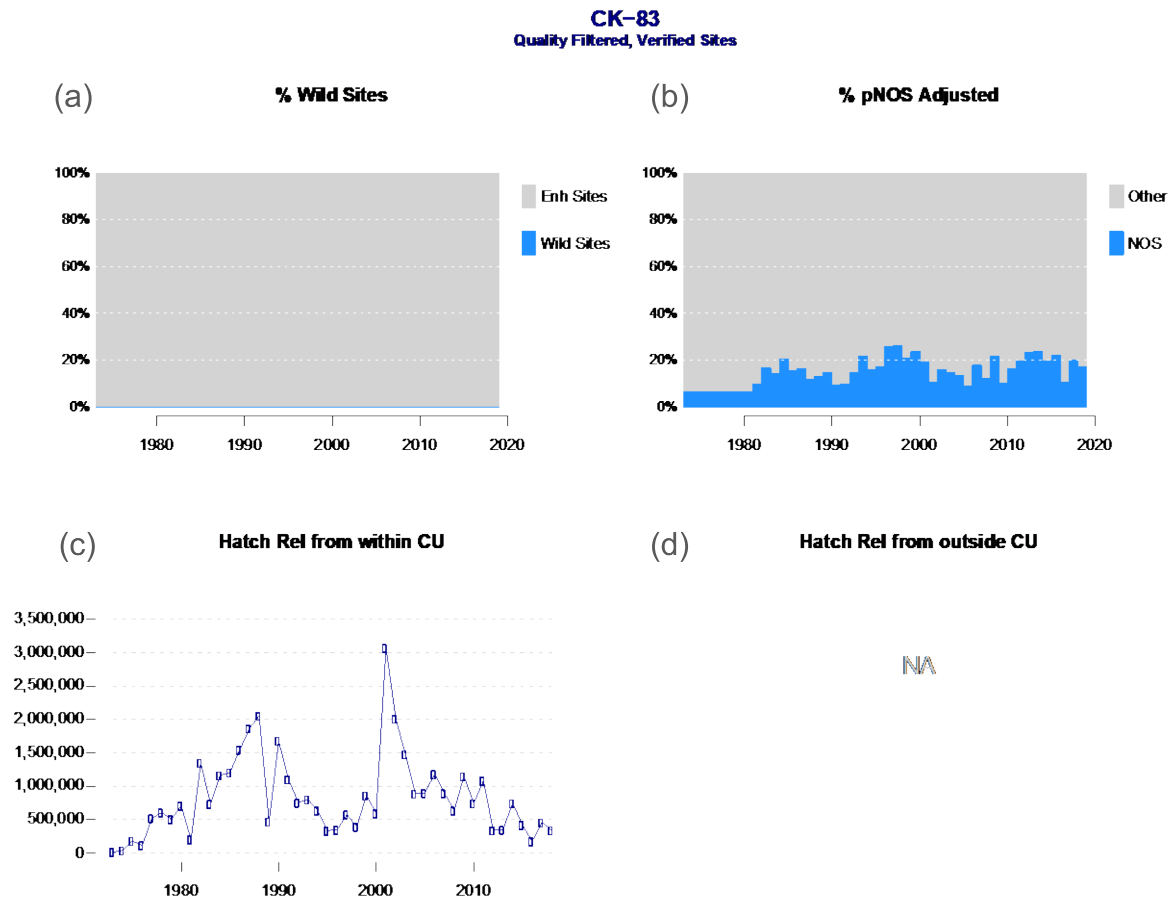

Figure 21. DU20 – Enhancement, proportion of natural origin spawners, and hatchery releases. Graphics provided by Fisheries and Oceans Canada, see Table 4 for panel interpretation.

Fluctuations and Trends

Based on data from two persistent sites (Puntledge River and Nanaimo River), the number of mature individuals over the last three generations decreased by an estimated -51% (Upper 95% CI = 42%, Lower 95% CI = -83%) with the probability of a 30% decline at 0.76 (Table 15, Figure 22a,b). Using the entire time series of data, the number of mature individuals increased by an estimated 39% (Upper 95% CI = 177%, Lower 95% CI = -30%) with the probability of a 30% decline at 0.02 (Table 15, Figure 22a,c). The Puntledge River system has historically been the largest contributor to overall abundance, although it is sometimes surpassed by the Nanaimo River system (Figure 22f).

For estimated wild abundance only, the change in the number of mature individuals over the last three generations decreased by an estimated -41% (Upper 95% CI = 155%, Lower 95% CI = -86%) with the probability of a 30% decline at 0.6 (Table 15, Figure 23a,b). For the full time series, the corresponding trend is a change in the number of mature individuals by an estimated 60% (Upper 95% CI = 225%, Lower 95% CI = -22%) with the probability of a 30% decline at 0 (Table 15, Figure 23a,c). The relative contribution of the Puntledge River to the wild population has been less over time than its relative contribution to the population as a whole (Figure 22f, Figure 23f). The Nanaimo River is the largest contributor to the wild population. The contribution of fish from hatcheries confounds the determination of population trends. According to a consensus of expert opinion, fewer than 1000 wild spawners remain in this population. While DFO data indicate that the average number of mature individuals remaining in 2018 are 1012 and 191 for the non pNOS-adjusted and adjusted values, respectively (Appendix 1), the SSC places the most confidence on the consensus of experts' estimate of remaining mature wild fish.

The exploitation rate in this DU was high in the 1970s and 1980s (up to ~80%), declined in the 1990s and early 2000s to ~10%, then increased after the mid-2000s to ~40% in 2013 (Figure 22d). Smolt-to-adult survival declined since the mid-1970s, but remained relatively stable at an average rate of 0.6% since 1983 (Figure 22e). Stock productivity data are not available for this DU.

Table 15. Summary of estimated rate of change (±95% credible interval) in spawner abundance and probability of decline (>30%, >50%, >70%) for the last three generations and the entire time series for both the full population and the estimated wild population.

DU Name	Generation length	Year range	Median % change	95% CI	p|30% decline	p|50% decline	p|70% decline	Number of Observations
DU20 – East Vancouver Island Ocean Summer	3.5	Hatchery and wild abundance combined						
		2007-2018	-51	-83,42	0.76	0.51	0.16	12
		1990-2018	39	-30,177	0.02	0	0	29
		Estimated wild abundance only (pNOS adjusted)						
		2007-2018	-41	-86,155	0.6	0.4	0.16	12
		1990-2018	60	-22,225	0.01	0	0	29

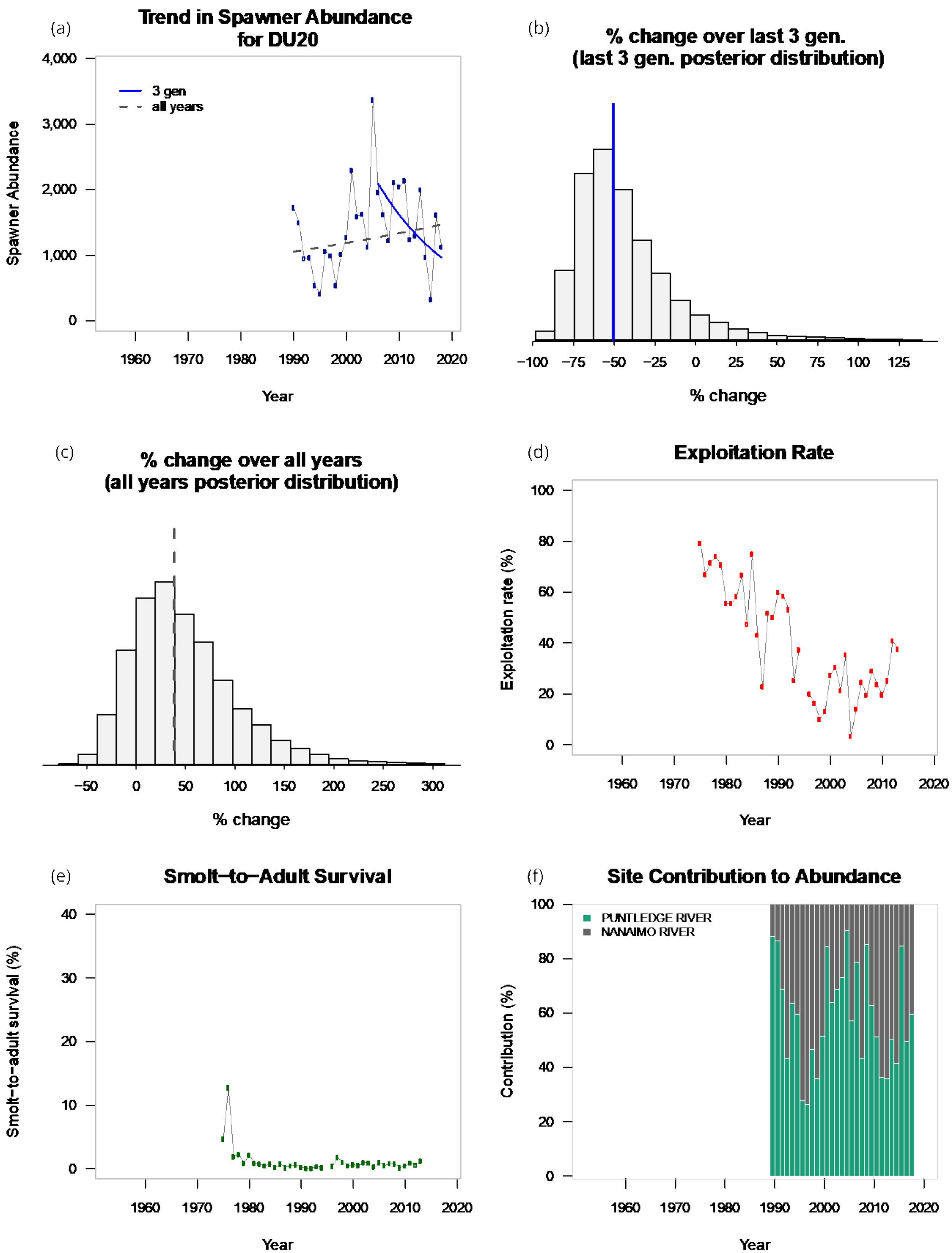

Figure 22. DU20 – Spawner abundance trends, exploitation rate, smolt-to-adult survival, and percent site contribution to abundance (see Table 7 for panel interpretation).

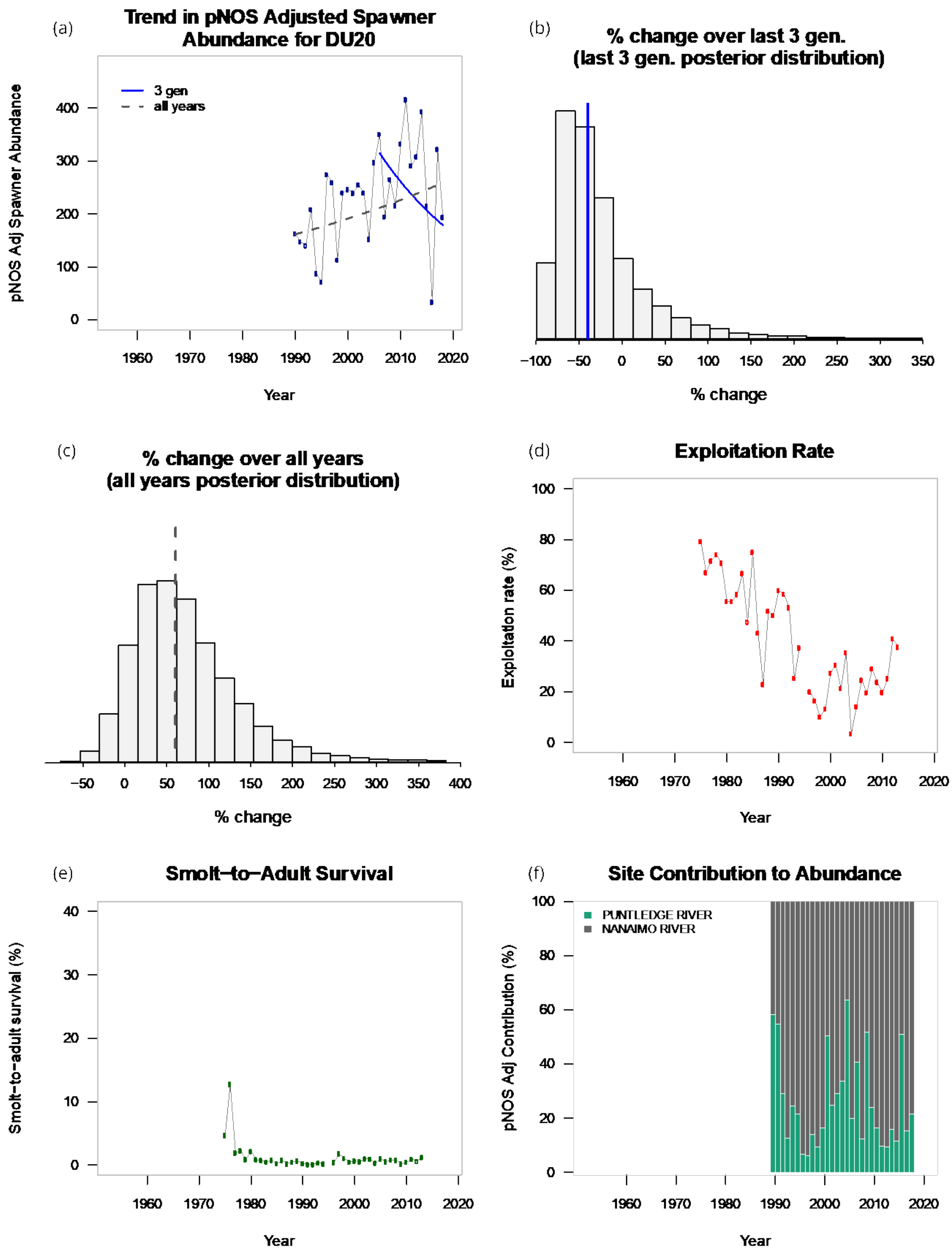

Figure 23. DU20 – Spawner abundance trends adjusted by average proportion of natural origin spawners, exploitation rate, smolt-to-adult survival, and percent site contribution to abundance (see Table 7 for panel interpretation).

Threats and Limiting Factors

For general threats and limiting factors applicable to all DUs, please refer to the Threats and Limiting Factors section in the introductory material. Chinook Salmon experts who participated in the IUCN Threats Calculator Workshop in February 2017 concluded that this DU should be assigned a threat impact of High (B). The most important threats specific to this DU are ecosystem modifications and drought. The COSEWIC Marine Fishes SSC during their 2019 Annual Meeting, updated this Threats Calculator, with the assistance of local DFO experts, paying special attention to new information on hatchery threats and the impacts of dams. The updated threat impacts remained High.

The northern portion of this DU contains summer-run Chinook Salmon in the Puntledge River, which is also the CWT indicator stock for this DU. These salmon have been impacted heavily by the construction of a hydroelectric facility built in 1955 consisting of the Comox Dam (storage) as well as a diversion dam on Puntledge River. These impacts led to escapement estimates of summer-run Puntledge River Chinook Salmon declining from an average of about 3,000 to below 600 in 1975 (Guimond 2008). The dam limits access to spawning, rearing, and overwintering habitat due to its footprint and operations, including flow and diversions. These development impacts likely exacerbated predation by Harbour Seals due to the channelization of the lower Puntledge River (BC Hydro 2011). Enhancement efforts including spawning channels, a fishway, and fishing closures and restrictions, allowed the population to recover to ~1,200 in the mid-1980s but it declined again in the 1990s (BC Hydro 2011b). DFO has stated that recovery of summer Chinook Salmon will be accomplished through restoration, fish culture, and predator management (e.g., Yurk and Trites 2000). Part of this population is under captive breeding. At 0.6%, smolt-to-adult survival is likely below replacement.

A large number of hatchery releases have occurred within this DU, and the genetic origin of the released fish is from within the DU. The SSC concluded that such releases represent a serious threat to the wild fish in the DU due to competition and genetic introgression.

Other less important threats include housing and urban development, fire and fire suppression, problematic native species, and climate change impacts (habitat shifting and alteration, temperature extremes, storms and flooding).

Threats Calculator spreadsheets are included with this report (see Appendix 2).

Designatable Unit 21: East Vancouver Island, Ocean, Fall population

DU Short Name	EVI+GStr/Ocean/Fall
Joint Adaptive Zone (JAZ)	EVI+GStr
Life History	Ocean
Run Timing	Fall

The average generation time for this DU is 3.3 years, with the exception of Qualicum/Puntledge Chinook Salmon which have an average generation time of 3.6 years. Chinook in this DU exhibit ocean-type life-history variants and fall run-timing.

To review methods pertaining to data reported within individual DU chapters, refer to the preliminary sections of this report.

Extent of Occurrence and Area of Occupancy

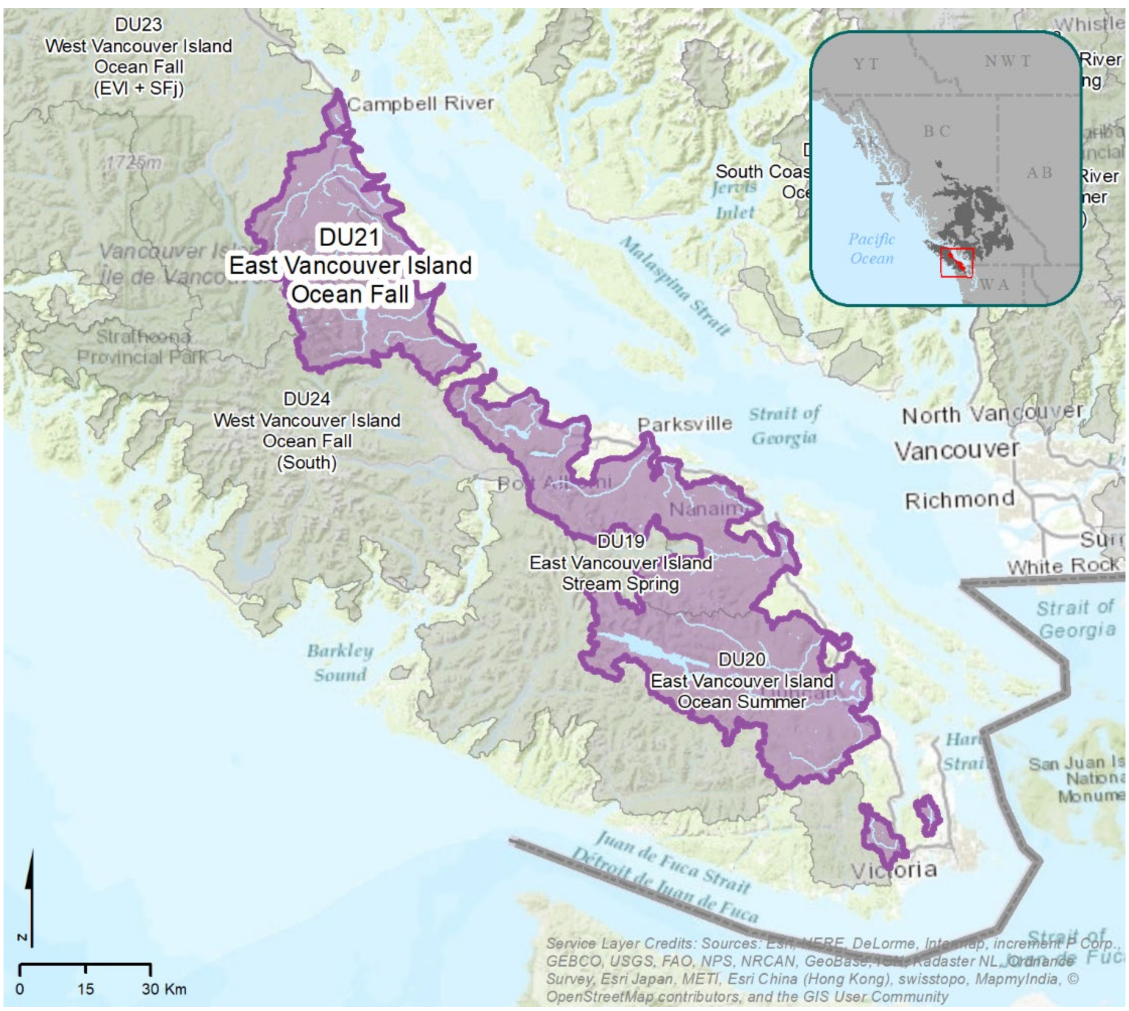

Figure 24. Map of DU21 – East Vancouver Island Ocean Fall.

This DU is a combination of four sections on Vancouver Island, each containing several drainages into the Strait of Georgia. The northern section includes the Oyster River, Tsolum River, Comox River, Puntledge River, Trent River, Tsable River, and Cowie Creek drainages. The section extends south from Simms Creek in Campbell River to the Tsable Lake Woodlands. The westernmost extent occurs in the headwaters of the Oyster River just east of Buttle Lake and the easternmost extent occurs where Tsable River and Cowie Creek enter the Strait of Georgia (N: Lat. 50.05, Long. 125.26; S: Lat. 49.44, Long. 124.96; W: Lat. 49.76, Long. 125.55; E: Lat. 49.52, Long. 124.84). The large middle section runs south from Rosewall Creek and the Beaufort Range along the Strait of Georgia to Haslam Creek and Nanaimo River headwaters. The section's westernmost extent occurs along the Beaufort Range to the north and its easternmost extent occurs near Cedar, BC and Nanaimo River Regional Park (N: Lat. 49.44, Long. 124.89; S: Lat. 48.95, Long. 124.01; W: Lat. 49.41, Long. 124.91; E: Lat. 49.11, Long. 123.85). The two sections in the south include the Prospect Lake drainage to the east (N: Lat. 48.56, Long. 123.45; S: Lat. 48.49, Long. 123.44; W: Lat. 48.52, Long. 123.48; E: Lat. 48.52, Long. 123.41), which empties into Brentwood Bay, and the Butchart, Lubbe, Goldstream, Jack and Mavis Lake drainages to the west, which empty into Finlayson Arm (N: Lat. 48.55, Long. 123.65; S: Lat. 48.42, Long. 123.58; W: Lat. 48.47, Long. 123.65; E: Lat. 48.45, Long. 123.52). The DU's centroid is at Lat. 49.63, Long. 124.84 and its total area is 4727.02 km^2. Like DU20, DU21 contains a large proportion of island coastal mountain ridge.

As for all DUs considered in this report, the Extent of Occurrence includes spawning streams as well as the ocean range, and is therefore >20,000 km^2. The IAO is 531 km^2 based on a total known spawning run length of 266 km, or 2.64% of the known spawning length across all DUs.

This DU is a combination of four WSP conservation units, CK-21, CK-22, CK-25, and CK-27.

Habitat Trends

Land surrounding this DU's freshwater habitat is altered (25.7%), with urban development comprising 4.8%, agricultural / rural development 3.8%, and mining development 0.06% of the DU area. Road density in DU21 is 2.4 km/km^2 with an average of 0.8 stream crossings per km of fish accessible streams (the average across all DUs is 1.33 km/km^2 road density and 0.62 stream crossings per km of fish accessible streams). 25.1% of the DU's riparian habitat and 16.9% of its forest cover is disturbed. The DU is not affected by Mountain Pine Beetle.

Abundance

This DU is comprised only of enhanced sites, with the proportion of estimated spawners considered of natural origin varying depending on the WSP conservation unit (Figure 25a,b, Figure 26a,b, Figure 27a,b, Figure 28a,b). A total of 24 sites exist within the four Conservation Units, and eight are considered persistent (Appendix 1). Of the years where sampling occurred, mature individuals originated from streams that had moderate to high levels of enhancement. For CK-21, using the pNOS adjustment method, the wild portion of the population is estimated at 100%, which is inconsistent with the conservation unit's enhanced status and hatchery release data shown in (Figure 25c and Figure 25d). Given this contradiction, Figure 25b has been omitted. Hatchery releases increased from the mid-1960s, with the largest number of releases occurring in CK-27 (nearly 8 million in 2018 but peaking at nearly 15 million fish in 1990) (Figure 25c, Figure 26c, Figure 27c, and Figure 28c).

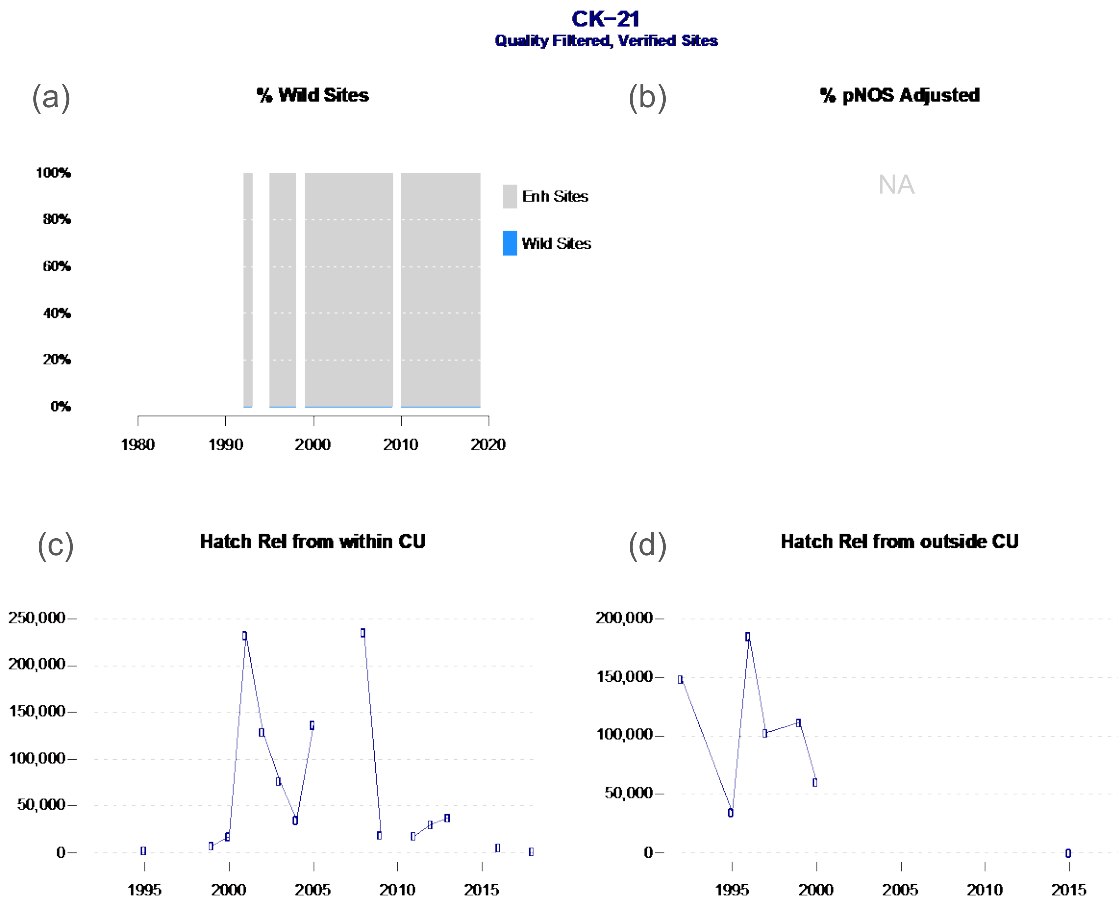

Figure 25. DU21 (CK-21) – Enhancement, proportion of natural origin spawners, and hatchery releases. Graphics provided by Fisheries and Oceans Canada, see Table 4 for panel interpretation. % pNOS Adjusted (panel (b)) cannot be calculated due to sample size limitations.

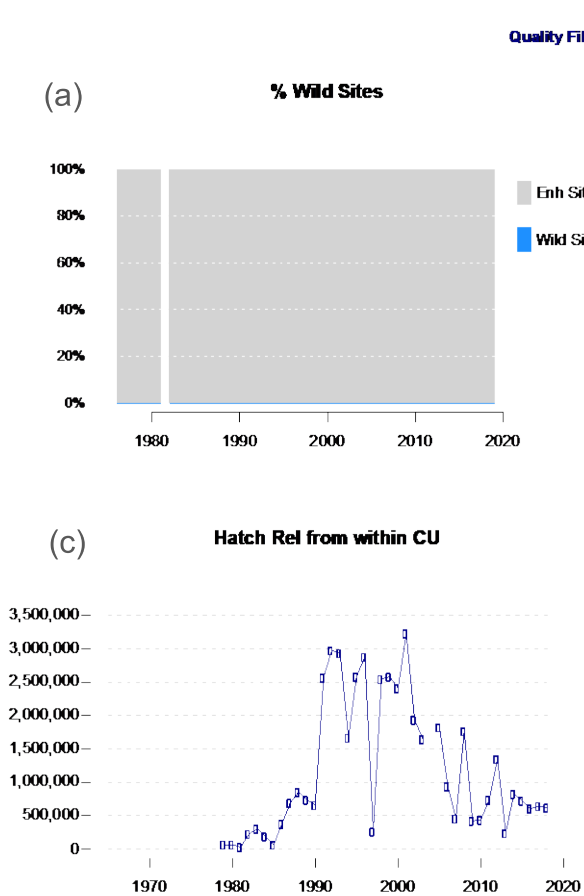

Figure 26. DU21 (CK-22) – Enhancement, proportion of natural origin spawners, and hatchery releases. Graphics provided by Fisheries and Oceans Canada, see Table 4 for panel interpretation.

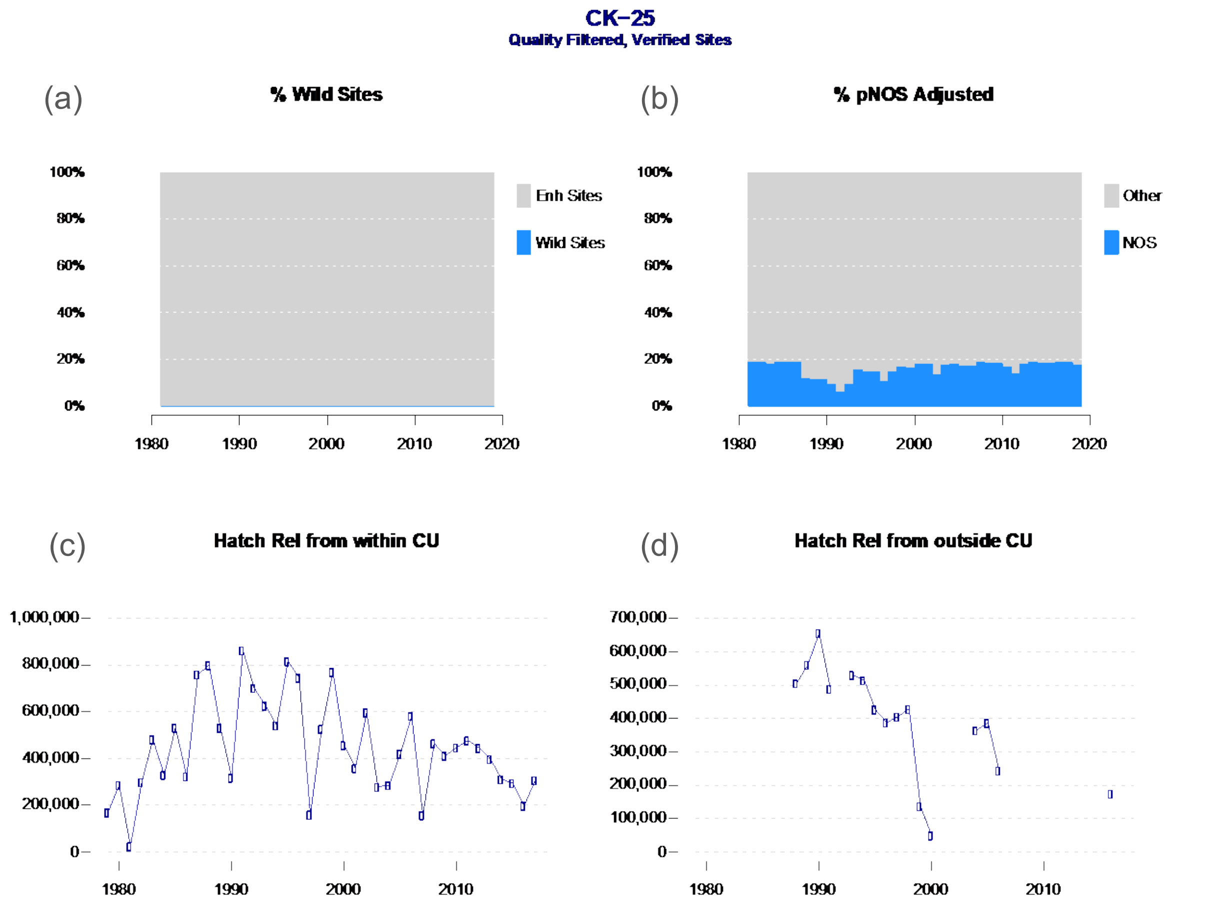

Figure 27. DU21 (CK-25) – Enhancement, proportion of natural origin spawners, and hatchery releases. Graphics provided by Fisheries and Oceans Canada, see Table 4 for panel interpretation.

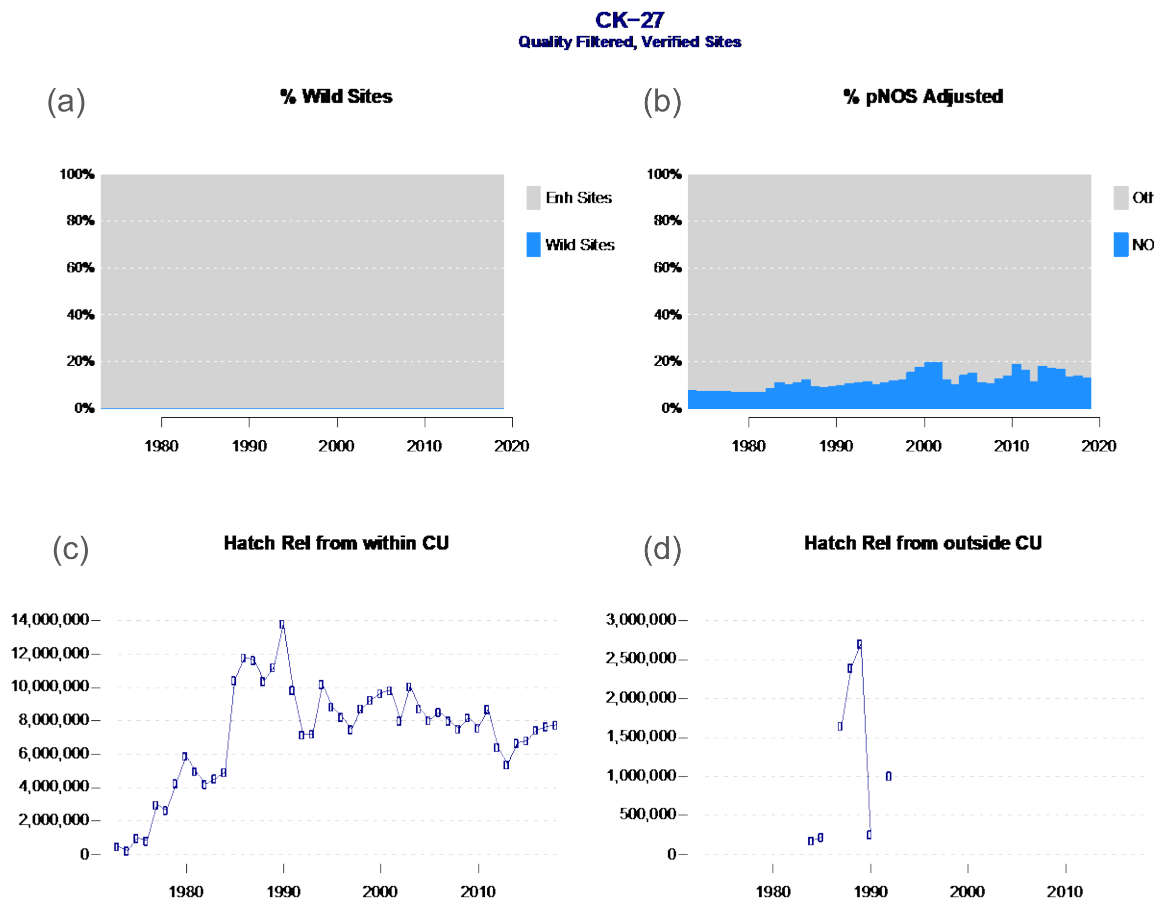

Figure 28. DU21 (CK – 27) – Enhancement, proportion of natural origin spawners, and hatchery releases. Graphics provided by Fisheries and Oceans Canada, see Table 4 for panel interpretation.

Fluctuations and Trends

Based on the last three generations of data across all four WSP conservation units combined, including eight persistent sites (see Figure 29f), the number of mature individuals increased by an estimated 99% (Upper 95% CI = 298%, Lower 95% CI = 1%) with zero probability of a 30% decline (Table 16, Figure 29a,b). Using the entire time series of data, the number of mature individuals decreased by an estimated -7% (Upper 95% CI = 50%, Lower 95% CI = -43%) with the probability of a 30% decline at 0.12 (Table 16, Figure 29a,c). The Cowichan, Puntledge and Qualicum river systems are the largest contributors to overall abundance (Figure 29f).

Averaged across all four WSP conservation units (CUs), the exploitation rate declined from ~80% in 1973 to ~40% in the early 1990s (Figure 29d). CU-averaged smolt-to-adult survival rates declined from a high of ~25% during the 1970s and remained relatively constant from the early 1990s to 1995, fluctuating between ~1% and ~0. 5% (Figure 29e). Stock productivity decreased from the mid-1980s to 1999, but increased from 2000 to 2008 to ~10 recruits per spawner per brood year (see 'Fluctuations and Trends' in 'Format of Designatable Unit-Specific Chapters' section for estimation methods) (Figure 30).

Information is available to disaggregate hatchery and wild fish trends. For estimated wild abundance only, the number of mature individuals increased by an estimated 180% (Upper 95% CI = 411%, Lower 95% CI = 51%) with the probability of a 30% decline at 0 (Table 16, Figure 31a,b). For the full time series, the increase in the number of mature individuals is estimated to be 40% (Upper 95% CI = 155%, Lower 95% CI = -24%) with the probability of a 30% decline at 0.01 (Table 16, Figure 31a,c). The relative contribution of the Cowichan River to the wild population has been substantially higher over time than its relative contribution to the population as a whole and it is the largest contributor to the wild population followed by Englishman River. DFO data indicate that the average number of mature individuals remaining in 2018 are 29446 and 9551 for the non pNOS-adjusted and adjusted values, respectively (Appendix 1).

Table 16. Summary of estimated rate of change (±95% credible interval) in spawner abundance and probability of decline (>30%, >50%, >70%) for the last three generations and the entire time series for both the full population and the estimated wild population.

<table>
<tr><th>DU Name</th><th>Generation length</th><th>Year range</th><th>Median % change</th><th>95% CI</th><th>p|30% decline</th><th>p|50% decline</th><th>p|70% decline</th><th>Number of Observations</th></tr>
<tr><td rowspan="6">DU21 – East Vancouver Island Ocean Fall</td><td rowspan="6">3.3</td><td colspan="7">Hatchery and wild abundance combined</td></tr>
<tr><td>2004-2018</td><td>99</td><td>1,298</td><td>0</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td>2000-2018</td><td>-7</td><td>-43,50</td><td>0.12</td><td>0.01</td><td>0</td><td>19</td></tr>
<tr><td colspan="7">Estimated wild abundance only (pNOS adjusted)</td></tr>
<tr><td>2004-2018</td><td>180</td><td>51,411</td><td>0</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td>2000-2018</td><td>40</td><td>-24,155</td><td>0.01</td><td>0</td><td>0</td><td>19</td></tr>
</table>

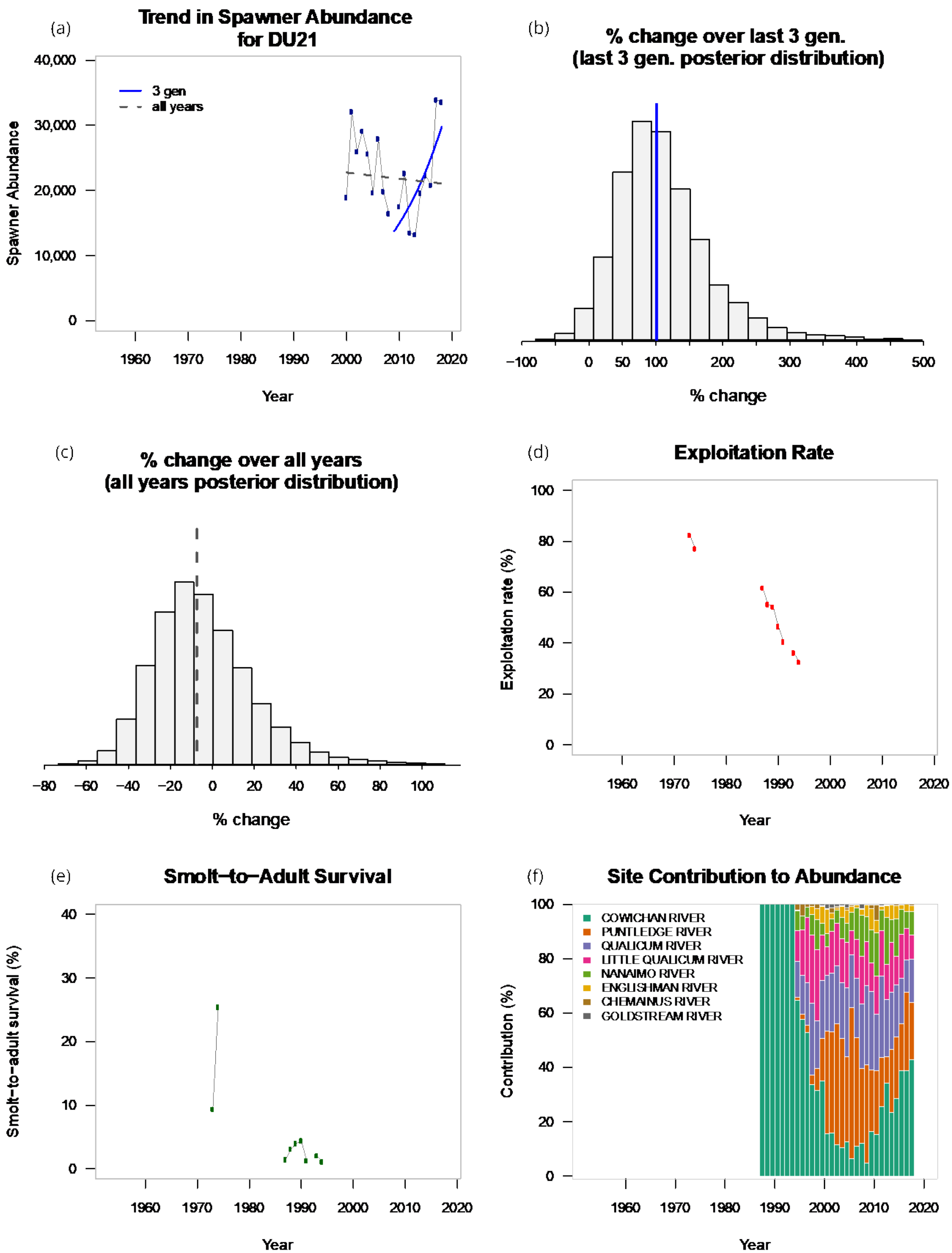

Figure 29. DU21 – Spawner abundance trends, exploitation rate, smolt-to-adult survival, and percent site contribution to abundance (see Table 7 for panel interpretation).

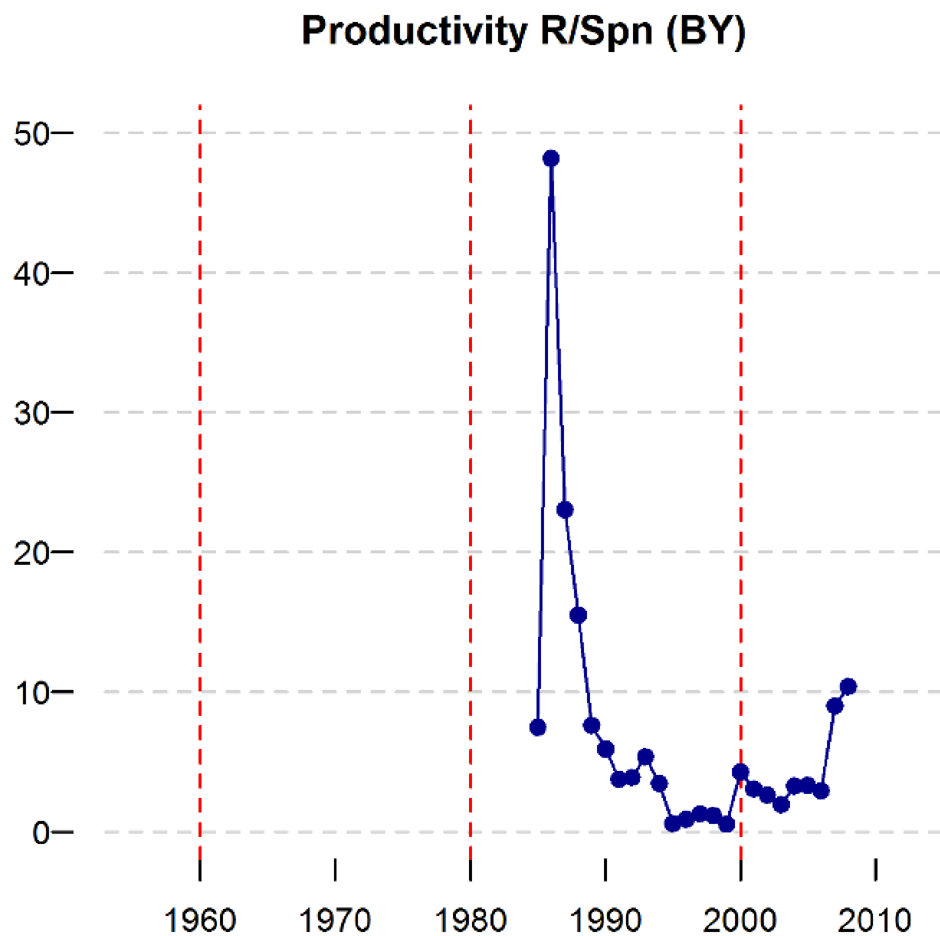

Figure 30. DU21 Stock productivity calculated as the total number of adults (spawners and catch) produced by spawners from a brood year (BY) divided by the number of spawners in the brood year. Productivity data are only available for CK-22. This figure is updated from Brown *et al.* 2013.

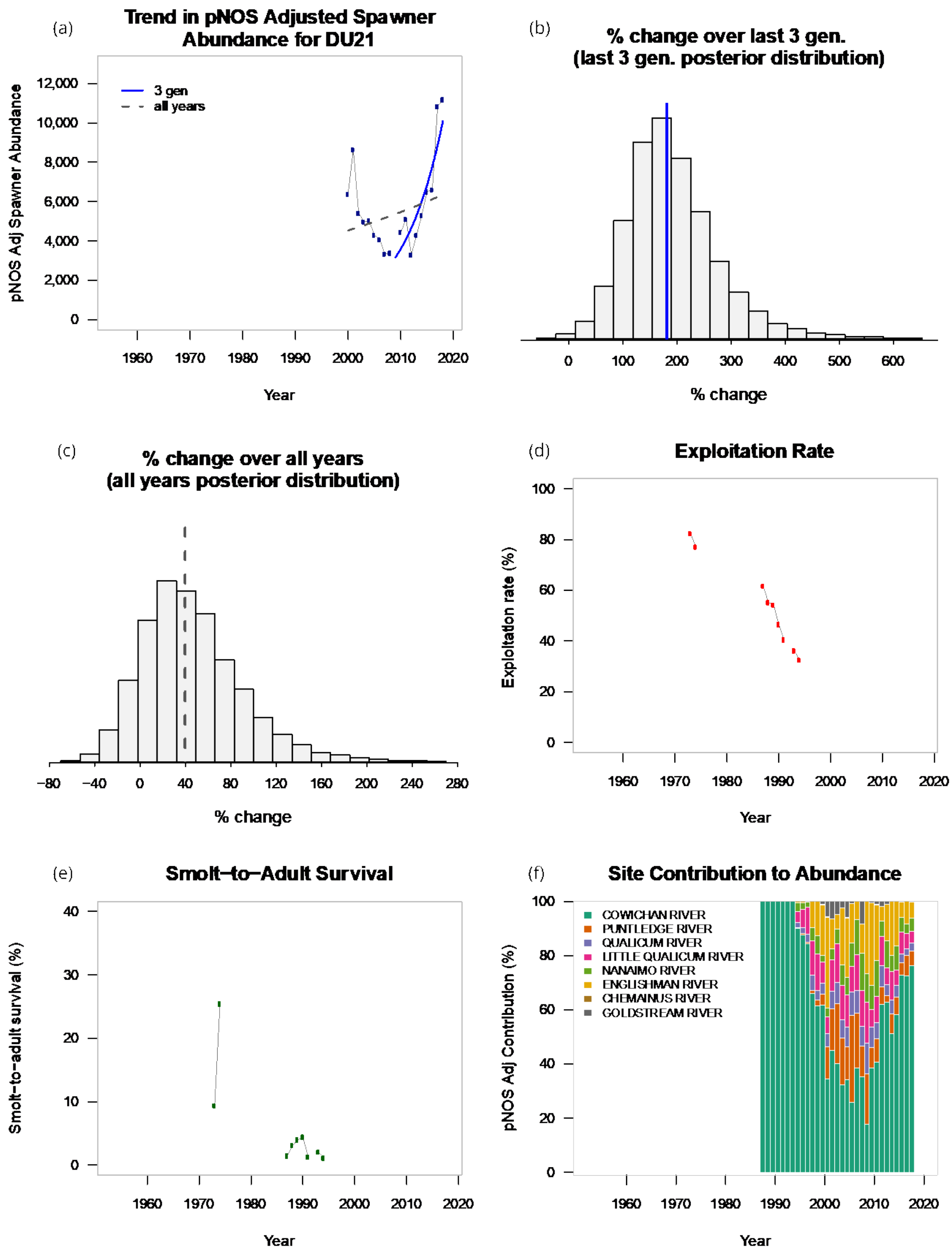

Figure 31. DU21 – Spawner abundance trends adjusted by average proportion of natural origin spawners, exploitation rate, smolt-to-adult survival, and percent site contribution to abundance (see Table 7 for panel interpretation).

Threats and Limiting Factors

For general threats and limiting factors applicable to all DUs, please refer to the Threats and Limiting Factors section in the introductory material. Chinook Salmon experts who participated in the IUCN Threats Calculator Workshop in February 2017 concluded that this DU should be assigned a threat impact of High (B). The most important threats specific to this DU are ecosystem modifications and water management/use. The Cowichan River population is increasing. However, the Strait of Georgia ecosystem is more variable and vulnerable to threats than other areas. Domestic and industrial water use is high with uncertain effects. Loading of water bombers for fire suppression could also have an impact depending on timing. The COSEWIC Marine Fishes SSC during their 2019 Annual Meeting, updated this Threats Calculator, with the assistance of local DFO experts, paying special attention to new information on hatchery threats and the impacts of dams. The SSC noted that a large number of hatchery releases have occurred and continue within this DU, and the genetic origin of the released fish is sometimes from outside the DU. The SSC concluded that hatchery strays into the Cowichan River could represent a serious threat to the wild fish in the DU due to competition and genetic introgression. The updated threat impacts remained High.

Total exploitation has stabilized but at a relatively high rate (~50%). Riddell *et al.* (2013) note that sustainable harvest is strongly tied to stock productivity, which decreased from the mid-1980s to 2000, but increased over the eight years from 2000 to 2008 – an encouraging signal. However, over the full time horizon of available data (1973-2010), marine survival declined by 90% overall for this stock. Recent smolt-to-adult survival rates are likely below replacement.

Included in this DU is the Puntledge River fall-run Chinook Salmon (in CK-27). The abundance estimates for these stocks mirror those of the summer run stock (BC Hydro 2011b), with low abundances in the 1980s and 1990s.

Other less important threats include housing and urban development, fire and fire suppression, invasive non-native species (Brown Trout [*Salmo trutta*]), problematic native species (seals, sea lions, birds), and climate change impacts (habitat shifting and alteration, droughts, temperature extremes, storms and flooding).

Threats Calculator spreadsheets are included with this report (see Appendix 2).

Designatable Unit 22: South Coast – Southern Fjords, Ocean, Fall

DU Short Name	SC+SFj/Ocean/Fall
Joint Adaptive Zone (JAZ)	SC+SFj
Life History	Ocean
Run Timing	Fall

The average generation time for this DU is 3.6 years. These fish exhibit ocean-type life-history variants and fall run-timing.

To review methods pertaining to data reported within individual DU chapters, refer to the preliminary sections of this report.

Extent of Occurrence and Area of Occupancy

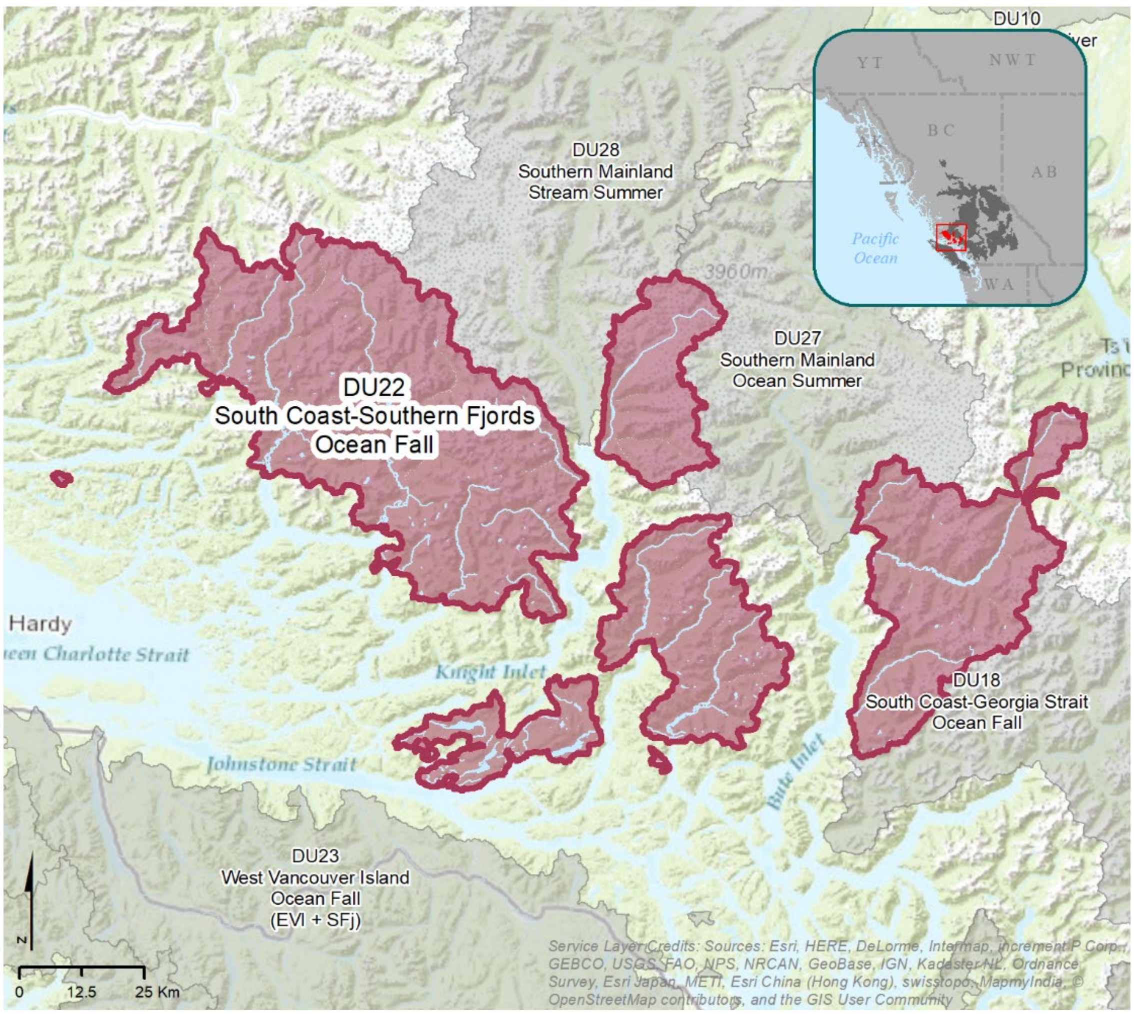

Figure 32. Map of DU22 – South Coast – Southern Fjords Ocean Fall.

This DU is a combination of seven geographically separated sections. The tiny westernmost section is the drainage area for four small lakes emptying into Warner Bay of Seymour Inlet west of Hibbard Lake (lake and stream names unavailable in the BC Gazetteer). The largest of the six sections extends southeast from Neechantz Peak (northwest of Mount Philley) to Kwalate Creek's outlet into Knight Inlet. This section's westernmost extent occurs near Waump Creek's outlet into Alison Sound and the easternmost extent occurs at the Sim River's outlet into Wahshihlas Bay (N: Lat. 51.47, Long. 126.70; S: Lat. 50.79, Long. 125.69; W: Lat. 51.19, Long. 126.98; E: Lat. 51.03, Long. 125.61). The westernmost of the three middle sections includes the Fulmore River, Tuna River, Reed Creek, Heydon Creek, and Glendale Creek drainages. This section extends eastward from just south of Burnt Mountain to the Heydon Creek outlet into Loughborough Inlet (N: Lat. 50.64, Long. 125.87; S: Lat. 50.47, Long. 125.95; W: Lat. 50.55, Long. 126.15; E: Lat. 50.57, Long. 125.57). Moving northeast, the next major section contains the Stafford, Apple, and Phillips River, and Frazer and Mink Creek drainages emptying into Cooper Reach and Phillips Arm. This section extends southeast from the upper part of the Stafford River drainage to the headwaters of the Phillips River around Mount Gardner. The westernmost extent occurs in the Frazer Creek headwaters and the easternmost extent occurs in the northern portion of the Phillips River headwaters (N: Lat. 50.95, Long. 125.31; S: Lat. 50.54, Long. 125.18; W: Lat. 50.69, Long. 125.56; E: Lat. 50.71, Long. 125.03). A fifth tiny section occurs along Phillips Arm just south of the Phillips River outlet. Moving northward, the sixth section contains the Franklin River drainage, extending south from Mount Waddington to upper Smyth Creek. This section's westernmost extent occurs at the Franklin River's outlet into Knight Inlet and the easternmost portion is around Mount Munday and the Ice Valley Glacier (N: Lat. 51.40, Long. 125.35; S: Lat. 51.02, Long. 125.42; W: Lat. 51.08, Long. 125.57; E: Lat. 51.32, Long. 125.20). The final section contains the Teaquahan, Southgate and Orford River drainages, which empty into Bute Inlet. This section extends southwest from Boulanger Creek to Dupont Creek. The westernmost extent occurs at the Teaquahan River outlet into Waddington Harbour and the easternmost extent occurs at Boulanger Creek around Mount Marston and Mount Durham (N: Lat. 51.14, Long. 124.27; S: Lat. 50.53, Long. 124.83; W: Lat. 50.93, Long. 124.84; E: Lat. 51.11, Long. 124.18). The DU's centroid is at Lat. 50.77, Long. 125.78 and its total area is 7263.07 km^2. Like DU20 and DU21, DU22 contains a large proportion of coastal mountain ridge.

As for all DUs considered in this report, the Extent of Occurrence includes spawning streams as well as the ocean range, and is therefore >20,000 km^2. The IAO is 619 km^2 based on a total known spawning length of 309 km, or 3.07% of the known spawning length across all DUs.

Habitat Trends

Land surrounding this DU's freshwater habitat is altered (4.1%), with agricultural/rural development comprising 0.002% of the area. Road density in DU22 is 0.2km/km^2 with an average of 0.4 stream crossings per km of fish accessible streams (the average across all DUs is 1.33 km/km^2 road density and 0.62 stream crossings per km of fish accessible streams). 3.2% of the DU's riparian habitat and 4.1% of its forest cover is disturbed. DU22 contains no urban development or mining development, and the area is not affected by Mountain Pine Beetle.

<u>Abundance</u>

This DU has both enhanced and wild sites (Figure 33a), and of 15 sites identified within the DU, three are considered persistent (Appendix 1). Survey coverage is incomplete over time (Appendix 1) making it difficult to comment on trends in abundance. Only the Phillips River system, which is considered highly enhanced, is now consistently surveyed. Hatchery releases have fluctuated between ~0-225,000 fish since the 1990s, and remained around 100,000 fish from 2016-2018 (Figure 33c). One hatchery release from outside the DU is reported in 2005 (4,000 fish) (Figure 33d).

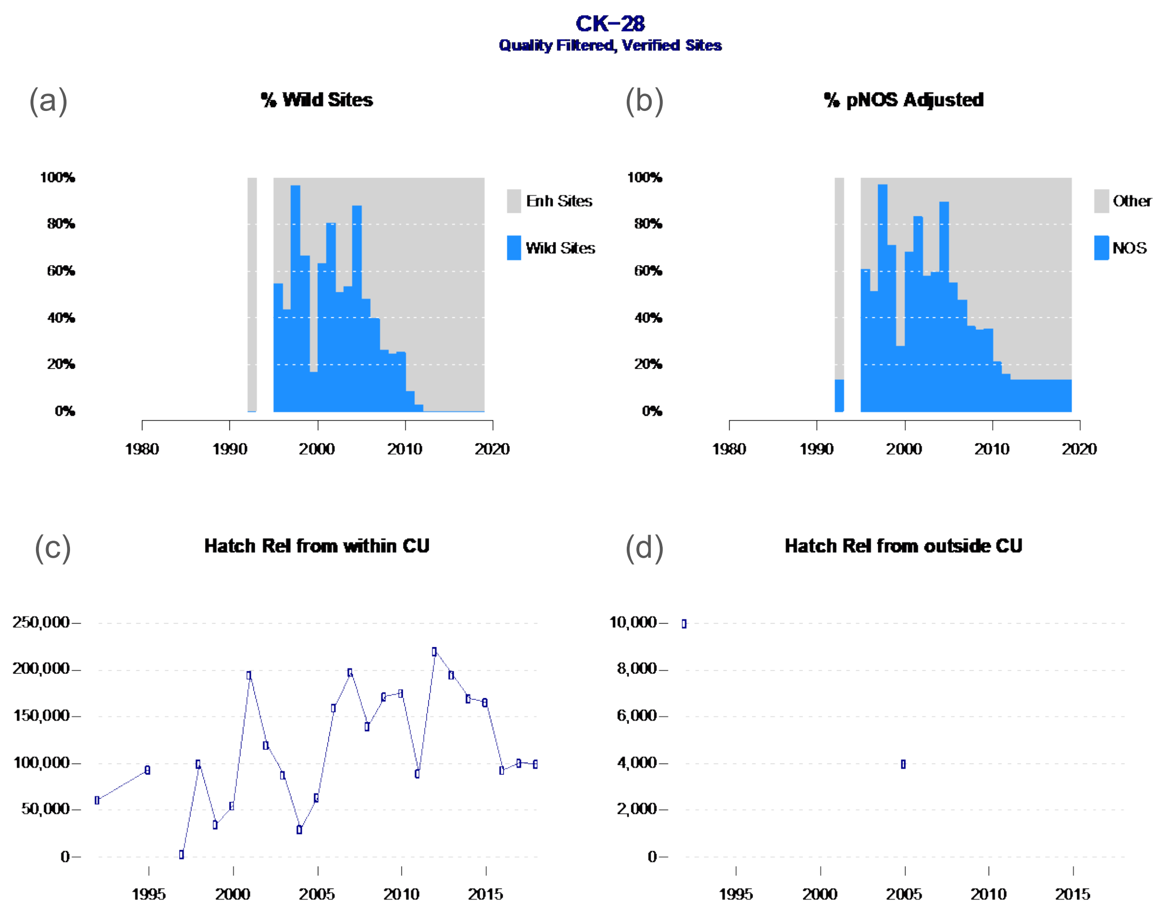

Figure 33. DU22 – Enhancement, proportion of natural origin spawners, and hatchery releases. Graphics provided by Fisheries and Oceans Canada, see Table 4 for panel interpretation.[2]

[2] There is a discrepancy in the data for panel (d) that was unresolved at the time of publication of this report: there were no releases in DU22 in 1990 that were from stocks outside of DU22.

Fluctuations and Trends

Survey coverage is incomplete over time (Appendix 1) making it difficult to comment on trends in abundance. Limited information is available to disaggregate hatchery and wild fish trends. The trends in population abundance are difficult to interpret due to the past influence of hatchery releases and changes in survey methodology.

Based on the last three generations of data at one persistent site (Phillips River), the number of mature individuals increased by an estimated 718% (Upper 95% CI = 3000%, Lower 95% CI = 114%) with the probability of a 30% decline at 0 (Table 17, Figure 34a,b). Using the entire time series of data, the number of mature individuals increased by an estimated 2030% (Upper 95% CI = 6550%, Lower 95% CI = 594%) with the probability of a 30% decline at 0 (Table 17, Figure 34a,c). Note that there was a change in survey methodology for the Phillips River to a more precise method, and therefore more recent estimates are not comparable with those prior to 2012. Accordingly, the estimates of population abundance change shown in Table 17 should be viewed with an abundance of caution.

For estimated wild abundance only, the corresponding trend for the full time series is an increase in the number of mature individuals by an estimated 2055% (Upper 95% CI = 6548%, Lower 95% CI = 593%) with a probability of a 30% decline at 0 (Table 17). For the last three generations of data, the corresponding trends are the same. DFO data indicate that the average number of mature individuals remaining in 2018 are 1969 and 267 for the non pNOS-adjusted and adjusted values, respectively (Appendix 1).

The exploitation rate in this DU rose from ~10% to ~30% between 2009 and 2013 (Figure 34d), and smolt-to-adult survival declined from ~10% to ~3% over the same period (Figure 34e). Stock productivity data are not available for this DU.

Table 17. Summary of estimated rate of change (±95% credible interval) in spawner abundance and probability of decline (>30%, >50%, >70%) for the last three generations and the entire time series for both the full population and the estimated wild population.

<table>
<tr><th>DU Name</th><th>Generation length</th><th>Year range</th><th>Median % change</th><th>95% CI</th><th>p|30% decline</th><th>p|50% decline</th><th>p|70% decline</th><th>Number of Observations</th></tr>
<tr><td rowspan="6">DU22 – South Coast – Southern Fjords Ocean Fall</td><td rowspan="6">3.6</td><td colspan="7">Hatchery and wild abundance combined</td></tr>
<tr><td>2007-2018</td><td>718</td><td>114,3000</td><td>0</td><td>0</td><td>0</td><td>12</td></tr>
<tr><td>2002-2018</td><td>2030</td><td>594,6550</td><td>0</td><td>0</td><td>0</td><td>17</td></tr>
<tr><td colspan="7">Estimated wild abundance only (pNOS adjusted)</td></tr>
<tr><td colspan="7">As above (no difference)</td></tr>
<tr><td>2002-2018</td><td>2055</td><td>593,6548</td><td>0</td><td>0</td><td>0</td><td>17</td></tr>
</table>

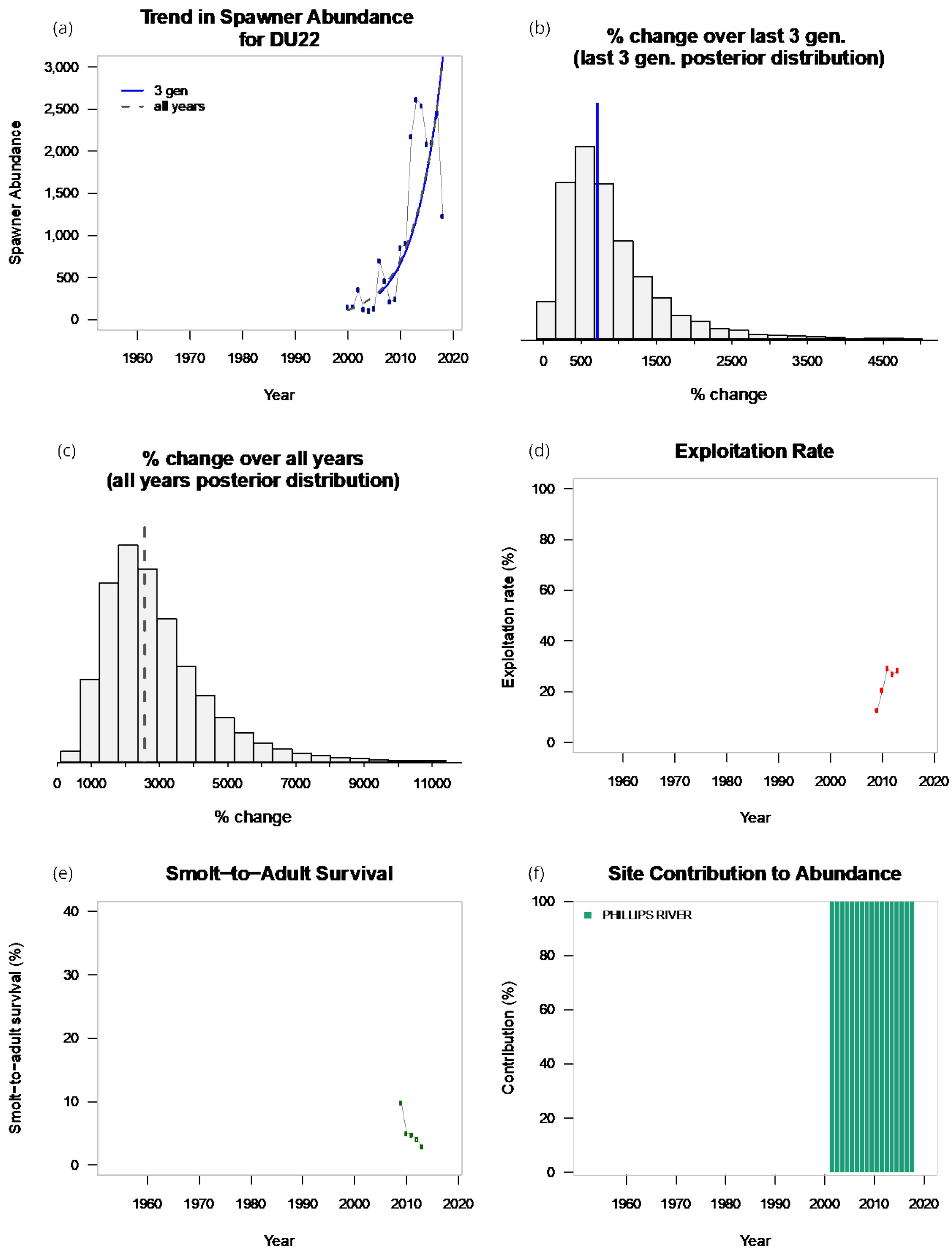

Figure 34. DU22 – Spawner abundance trends, exploitation rate, smolt-to-adult survival, and percent site contribution to abundance (see Table 7 for panel interpretation).

Threats and Limiting Factors

A Threats Calculator was not completed for this DU. For general threats and limiting factors applicable to all DUs, please refer to the Threats and Limiting Factors section in the introductory material.

Hatchery releases have occurred within this DU, and the genetic origin of the released fish is generally from within the DU. The SSC concluded that such releases represent a threat to the wild fish in the DU due to competition and genetic introgression.

Designatable Unit 23: East Vancouver Island, Ocean, Fall (EVI + SFj) population

DU Short Name	EVI+SFj/Ocean/Fall
Joint Adaptive Zone (JAZ)	EVI+SFj
Life History	Ocean
Run Timing	Fall

The average generation time for this DU is 4.4 years. These fish exhibit ocean-type life-history variants and fall run-timing.

To review methods pertaining to data reported within individual DU chapters, refer to the preliminary sections of this report.

Extent of Occurrence and Area of Occupancy

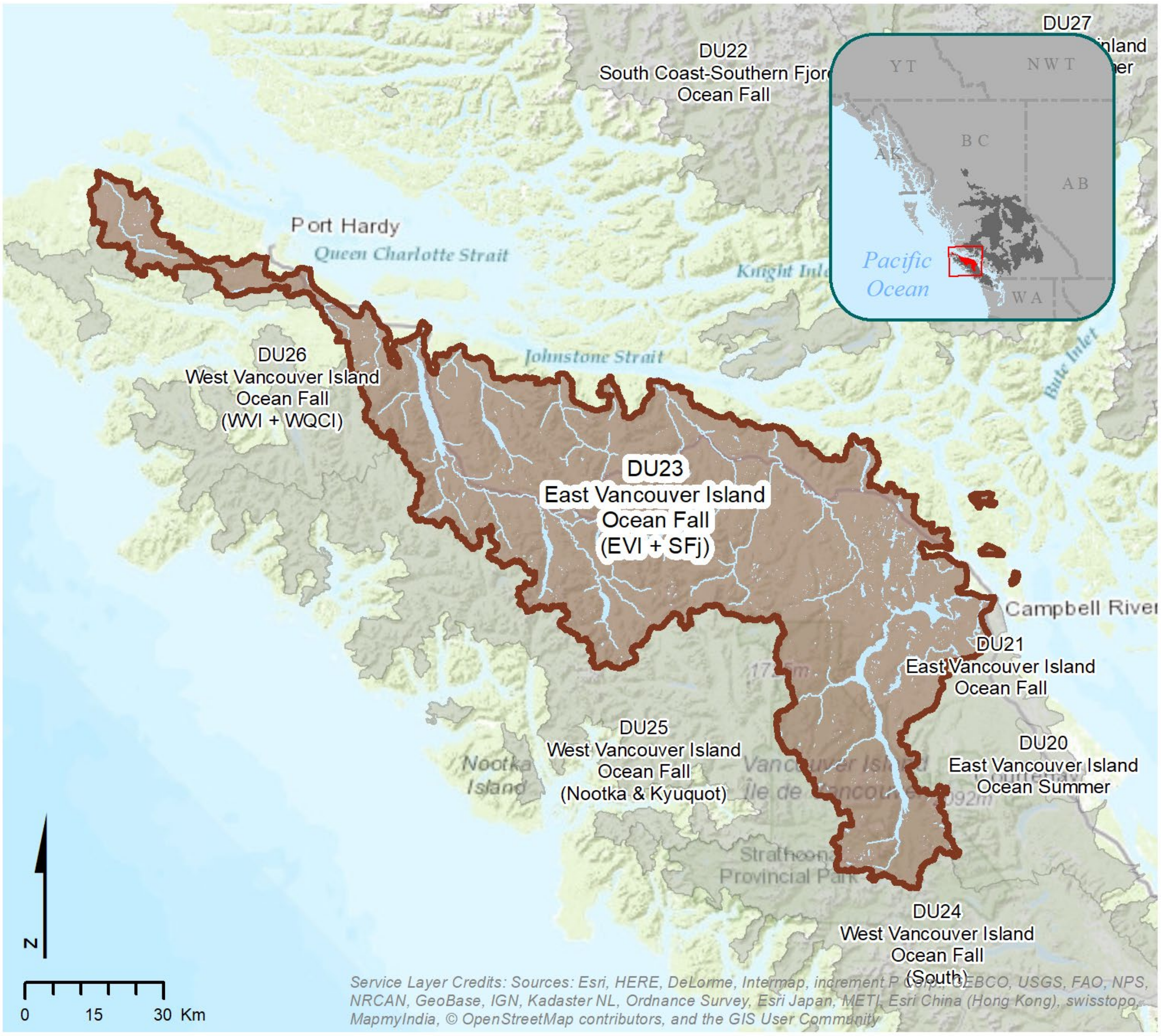

Figure 35. Map of DU23 – East Vancouver Island Ocean Fall (EVI + SFj).

This DU extends southeast from Nahwitti River around Mount Waddington to Thelwood Creek around Mount Septimus, and runs along Johnstone Strait east to Campbell River. The southern end is located at Mount Septimus and Mount Rousseau, while the western end is located at Pinder Creek close to Pinder Peak (N: Lat. 50.85, Long. 128.00; S: Lat. 49.48, Long. 125.50; W: Lat. 50.09, Long. 125.18; E: Lat. 50.21, Long. 127.04). The DU's centroid is at Lat. 50.37, Long. 126.21 and its total area is 7181.18 km^2. DU23 contains a large proportion of Vancouver Island's coastal mountain ridge.

As for all DUs considered in this report, the Extent of Occurrence includes spawning streams as well as the ocean range, and is therefore >20,000 km^2. The IAO is 292 km^2 based on a total known spawning run length of 146 km, or 1.45% of the known spawning length across all DUs.

Habitat Trends

Land surrounding this DU's freshwater habitat is altered (17.9%), with urban development comprising 0.3%, agricultural / rural development 0.3%, and mining development 0.09% of the DU area. Road density in DU23 is 1.4 km/km^2 with an average of 0.8 stream crossings per km of fish accessible streams (the average across all DUs is 1.33 km/km^2 road density and 0.62 stream crossings per km of fish accessible streams). 17.4% of the DU's riparian habitat and 17.2% of its forest cover is disturbed. The DU is not affected by Mountain Pine Beetle.

Abundance

There are 18 sites within the DU, and of those, five are considered persistent (Appendix 1). A large proportion of this DU's spawners originate from enhanced streams (Figure 36a), with the proportion of estimated natural origin fish averaging ~20% (except for a peak to ~55% in the mid-2010s) (Figure 36b). Hatchery releases increased since the 1970s, peaking at nearly 5 million fish, then levelling off to around 3 million releases per year (Figure 36c). No hatchery releases are reported from outside the DU (Figure 36d).

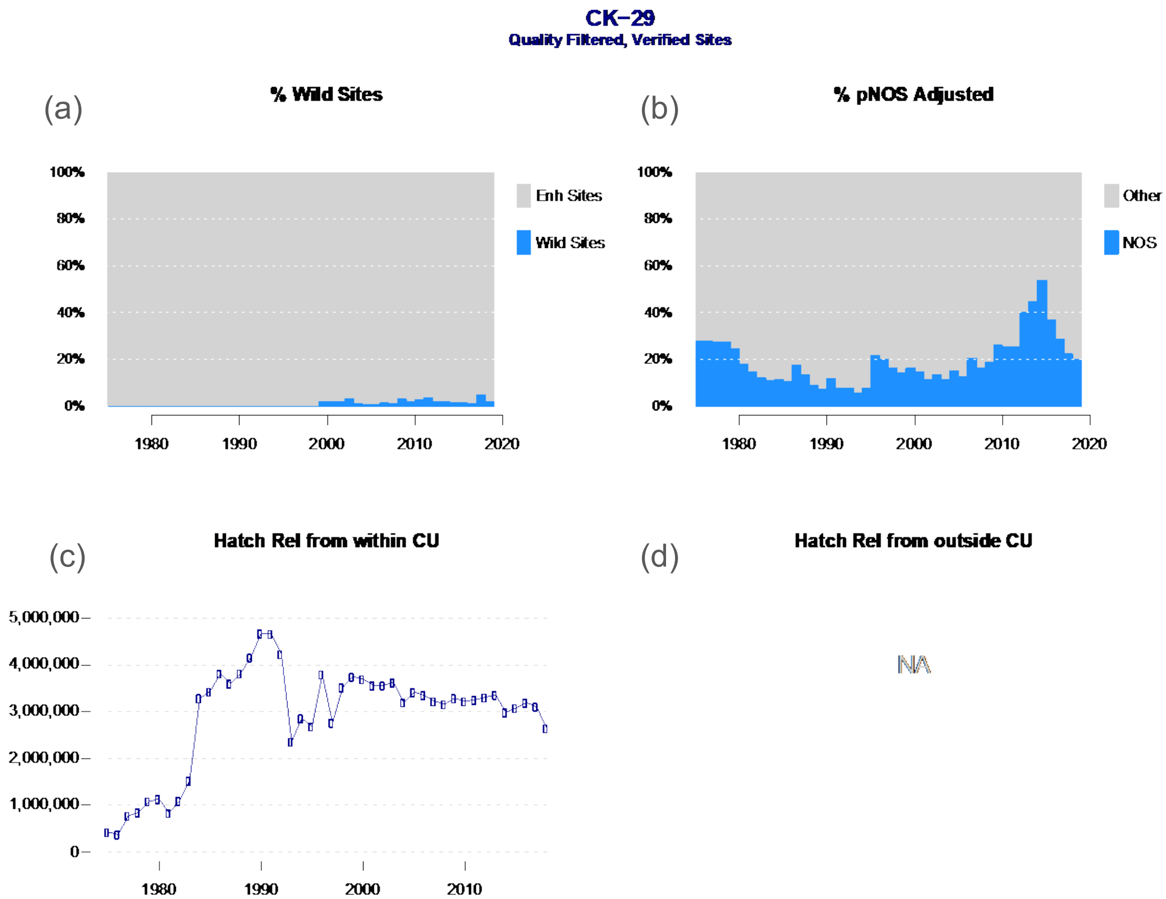

Figure 36. DU23 – Enhancement, proportion of natural origin spawners, and hatchery releases. Graphics provided by Fisheries and Oceans Canada, see Table 4 for panel interpretation.

Fluctuations and Trends

Information is available to disaggregate hatchery and wild fish trends.

Based on the last three generations of data at five persistent sites, the number of mature individuals increased by an estimated 6% (Upper 95% CI = 80%, Lower 95% CI = -38%) with the probability of a 30% decline at 0.06 (Table 18, Figure 37a,b). Using the entire time series of data, the number of mature individuals declined by an estimated -38% (Upper 95% CI = -5%, Lower 95% CI = -59%) with the probability of a 30% decline at 0.72 (Table 18, Figure 37a,c). The Quinsam river system is the largest contributor to overall abundance.

For estimated wild abundance only, the number of mature individuals increased by an estimated 48% (Upper 95% CI = 201%, Lower 95% CI = -28%) with the probability of a 30% decline at 0.02 (Table 18, Figure 38a,b). For the full time series, the number of mature individuals increased by an estimated 85% (Upper 95% CI = 203%, Lower 95% CI = 13%) with the probability of a 30% decline at 0 (Table 18, Figure 38a,c). The relative contributions of the Campbell, Nimpkish and Salmon river systems to the wild population are historically higher over time than their relative contributions to the population as a whole, while the reverse is true for the Quinsam River system (Figure 37f and Figure 38f). The Nimpkish river system is historically the largest contributor to the wild population, followed by the Salmon and Quinsam River systems.

DFO data indicate that the average number of mature individuals remaining in 2018 are 8298 and 2133 for the non pNOS-adjusted and adjusted values, respectively (Appendix 1).

Note that while pNOS adjusted abundance estimates shown in Figure 38 incorporate contributions from the Campbell River and Quinsam River systems that are likely representative, at present these two systems are treated as one site for brood stock but as two sites for releases and returns. As such, the proportion of natural-origin brood stock (pNOB) and the PNI estimates for Campbell River may be biased low because they do not account for brood stock from Quinsam (see 'Sampling Effort and Methods' to review pNOS adjustment methods).

The exploitation rate in this DU declined from a high of ~80% in the late 1970s and fluctuated between ~20% to 40% from the mid-1990s to 2012 (Figure 37d). Smolt-to-adult survival declined from a peak rate of nearly 10% in the 1970s and remained relatively stable at an average rate of 0.9% since 1989 (Figure 37e). Stock productivity data are not available for this DU.

Table 18. Summary of estimated rate of change (±95% credible interval) in spawner abundance and probability of decline (>30%, >50%, >70%) for the last three generations and the entire time series for both the full population and the estimated wild population.

DU Name	Generation length	Year range	Median % change	95% CI	p|30% decline	p|50% decline	p|70% decline	Number of Observations
DU23 – East Vancouver Island Ocean Fall (EVI + Sfj)	4.4	Hatchery and wild abundance combined						
		2007-2018	6	-38,80	0.06	0.01	0	12
		1999-2018	-38	-59,-5	0.72	0.15	0	20
		Estimated wild abundance only (pNOS adjusted)						
		2007-2018	48	-28,201	0.02	0	0	12
		1999-2018	85	13,203	0	0	0	20

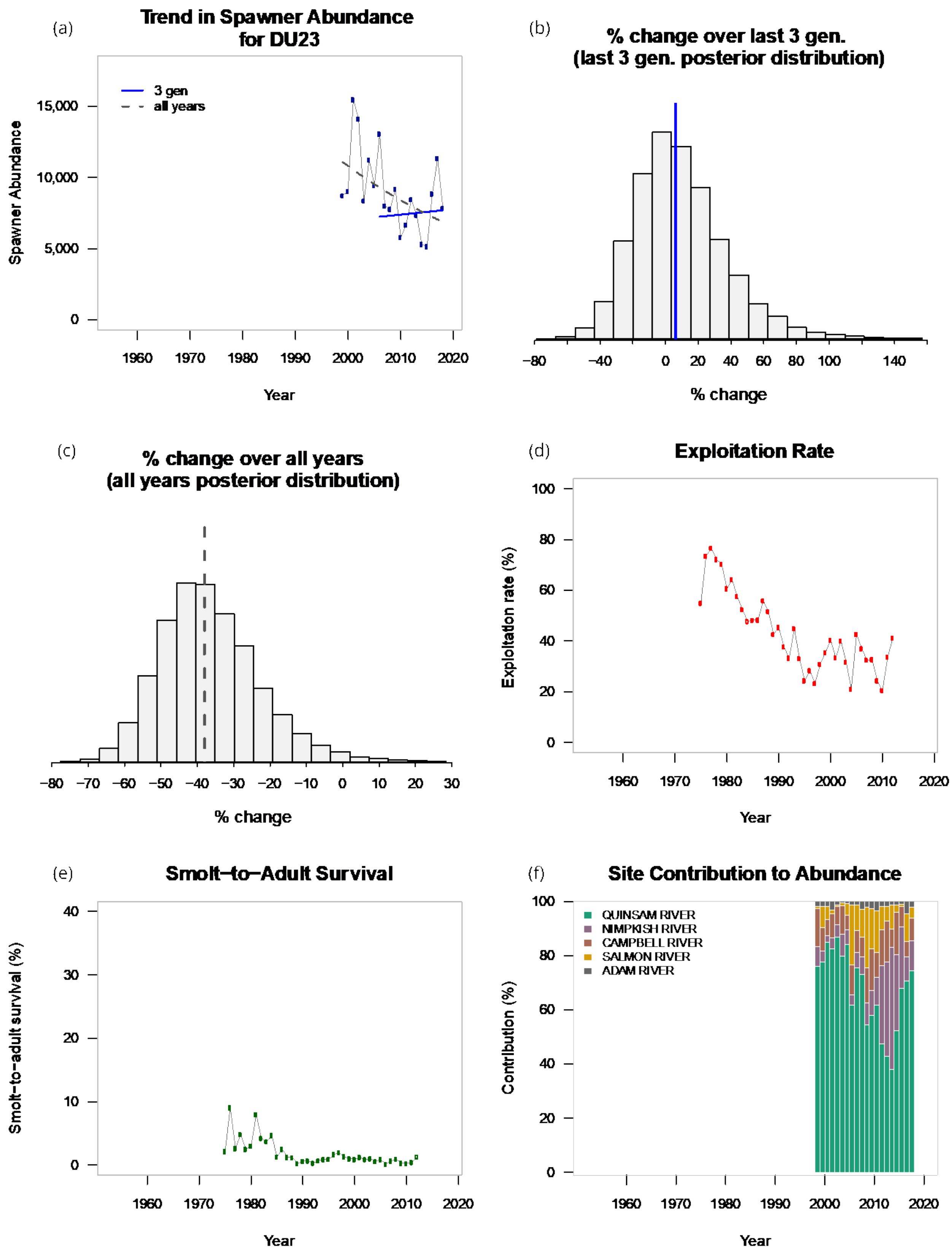

Figure 37. DU23 – Spawner abundance trends, exploitation rate, smolt-to-adult survival, and percent site contribution to abundance (see Table 7 for panel interpretation).

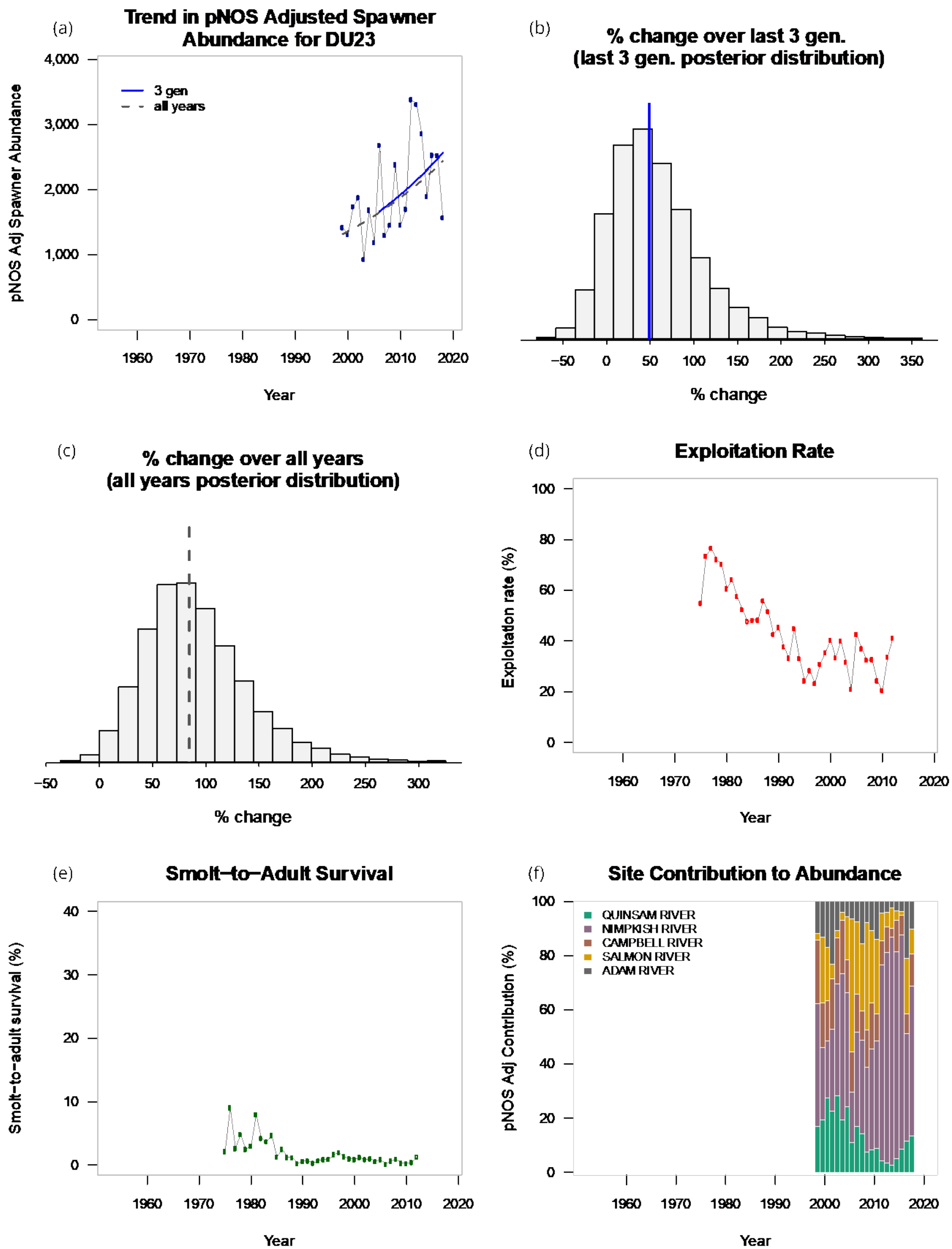

Figure 38. DU23 – Spawner abundance trends adjusted by average proportion of natural origin spawners, exploitation rate, smolt-to-adult survival, and percent site contribution to abundance (see Table 7 for panel interpretation).

Threats and Limiting Factors

For general threats and limiting factors applicable to all DUs, please refer to the Threats and Limiting Factors section in the introductory material. Chinook Salmon experts who participated in the IUCN Threats Calculator Workshop in February 2017 concluded that this DU should be assigned a threat impact of High – Medium (B/C). The most important threat specific to this DU is dams and water management/use. Releases of water from reservoirs can impact spawning habitat. A large number of hatchery releases have occurred and continue within this DU, and the genetic origin of the released fish is from within the DU. The SSC concluded that such releases represent a serious threat to the wild fish in the DU due to competition and genetic introgression. In particular, the influence of hatchery origin spawners in the Quinsam River is high, and they are probably a threat for the wild population (DFO 2014).

The total exploitation rate has stabilized but at a high rate (~0.4). From 1973 to 2010, the smolt-to-adult survival rate declined by 90% for this DU.

Other less important threats include fire and fire suppression, ecosystem modifications, agricultural and forestry effluents, avalanches/landslides, and climate change impacts (habitat shifting and alteration, storms and flooding).

Threats Calculator spreadsheets are included with this report (see Appendix 2).

Designatable Unit 24: West Vancouver Island, Ocean, Fall (South) population

DU Short Name	WVI+WVI/Ocean/Fall (South)
Joint Adaptive Zone (JAZ)	WVI+WVI
Life History	Ocean
Run Timing	Fall

The average generation time for this DU is 4 years. These fish exhibit ocean-type life-history variants and fall run-timing.

To review methods pertaining to data reported within individual DU chapters, refer to the preliminary sections of this report.

Extent of Occurrence and Area of Occupancy

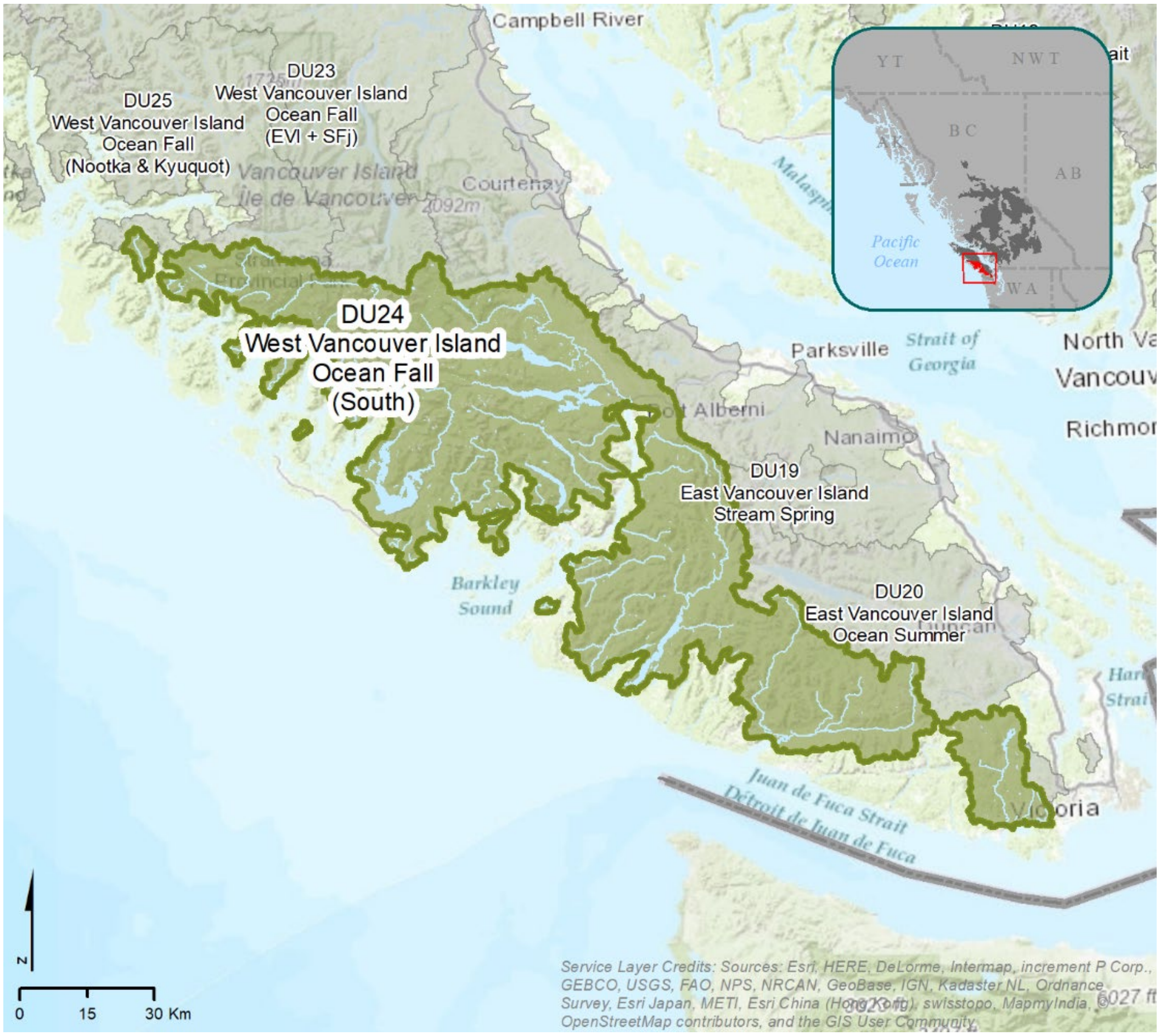

Figure 39. Map of DU24 – West Vancouver Island Ocean Fall (South).

The geographic location of this DU extends north at Sydney River near Pretty Girl Peak (Lat. 49.57, Long. 126.36), and it runs along the Clayoquot Canyon west to Klanawa River (Lat. 48.92, Long. 125.51). The southern end is located at Sooke River around Empress Mountain at Lat. 48.39, Long. 123.58, and the eastern end is located at Lanterman Creek around Mount Harmston (Lat. 49.52, Long. 125.07). The DU's centroid is at Lat. 49.03, Long. 125.15 and its total area is 6785.59 km^2. Like DU23, DU24 contains a large proportion of the Vancouver Island coastal mountain ridge.

As for all DUs considered in this report, the Extent of Occurrence includes spawning streams as well as the ocean range, and is therefore >20,000 km^2. The IAO is 761 km^2 based on a total known spawning run length of 381 km, or 3.79% of the known spawning length across all DUs.

Habitat Trends

Land surrounding this DU's freshwater habitat is altered (18.0%), with urban development comprising 0.9%, agricultural/rural development 0.4%, and mining development 0.1% of the DU's area. Road density in DU24 is 1.2 km/km^2 with an average of 0.6 stream crossings per km of fish accessible streams (the average across all DUs is 1.33 km/km^2 road density and 0.62 stream crossings per km of fish accessible streams). 18.2% of the DU's riparian habitat and 16.5% of its forest cover is disturbed. DU24 is not affected by Mountain Pine Beetle.

Abundance

There are 53 sites within this DU, and 14 are considered persistent (Appendix 1). A large proportion of this DU's spawners originate from enhanced streams (Figure 40a), with the proportion of estimated natural origin fish averaging <20% (Figure 40b). Hatchery releases increased to a peak of nearly 20 million fish in 1990 then dropped over the next twenty years to about 12.5 million fish in 2018 (Figure 40c). No hatchery releases are reported from outside the DU (Figure 40d).

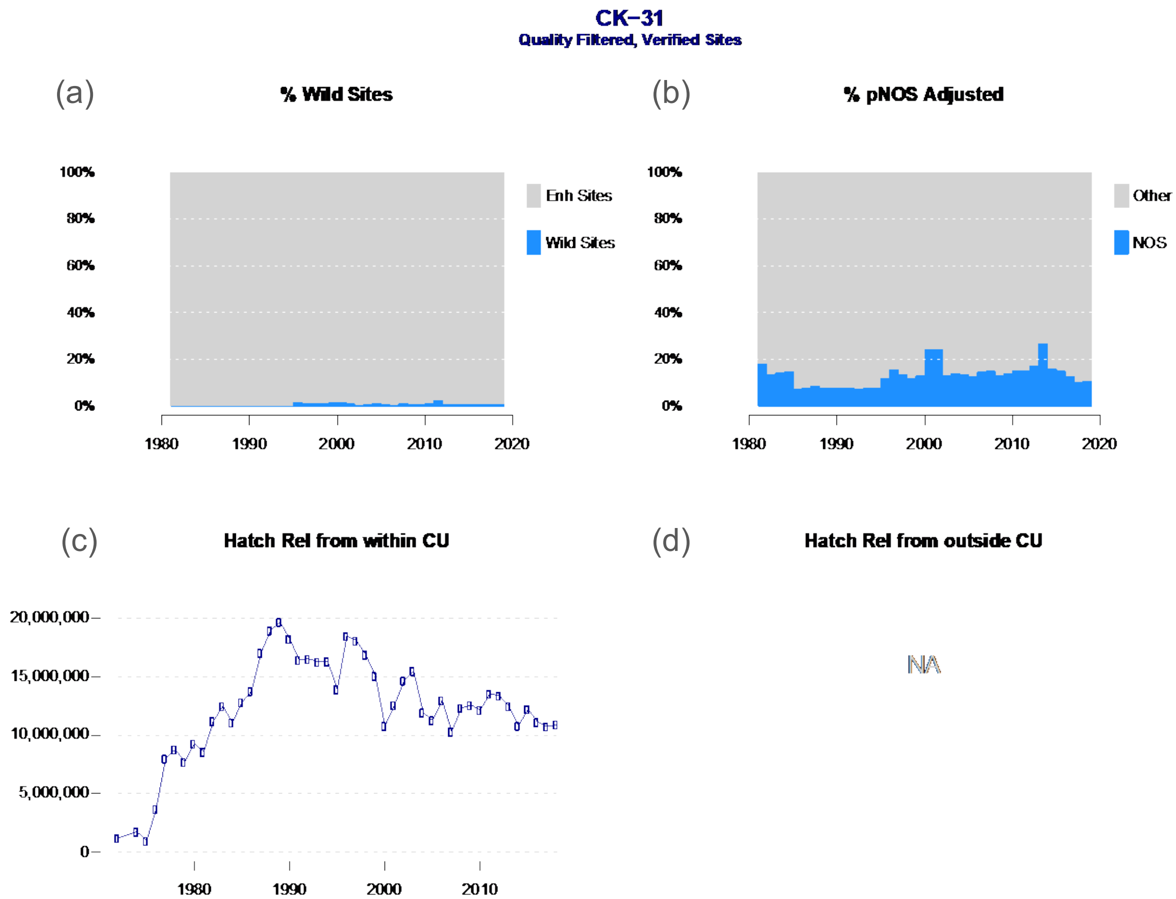

Figure 40. DU24 – Enhancement, proportion of natural origin spawners, and hatchery releases. Graphics provided by Fisheries and Oceans Canada, see Table 4 for panel interpretation.

Fluctuations and Trends

Available indices of abundance over the most recent three generations and over all years show conflicting trends that are difficult to reconcile. Based on the last three generations of data at fourteen persistent sites, the number of mature individuals increased by an estimated 83% (Upper 95% CI = 163%, Lower 95% CI = 28%) with the probability of a 30% decline at 0 (Table 19, Figure 41a,b). Using the entire time series of data, the number of mature individuals decreased by an estimated -14% (Upper 95% CI = 49%, Lower 95% CI = -49%) with the probability of a 30% decline at 0.21 (Table 19, Figure 41a,c). The Somass-Sproat and Nitinat river systems are the largest contributors to overall abundance.

For estimated wild abundance only, the number of mature individuals increased by an estimated 43% (Upper 95% CI = 129%, Lower 95% CI = -10%) with the probability of a 30% decline at 0 (Table 19, Figure 42a,b). For the entire time series of data, the number of mature individuals declined by an estimated -19% (Upper 95% CI = 24%, Lower 95% CI = -47%). With the exception of the Somass-Sproat, Nitinat, and Sarita river systems, the relative contributions of most sites to the wild population are historically higher than their relative contributions to the population as a whole, but the Somass-Sproat river system remains the largest contributor to the wild population.

Based on a consensus of expert opinion, fewer than 10,000 wild adults are thought to remain. While DFO data indicate that the average number of mature individuals remaining in 2018 are 53036 and 6365 for the non pNOS-adjusted and adjusted values, respectively (Appendix 1), the SSC places the most confidence on the consensus of experts' estimate of remaining mature wild fish.

The total exploitation rate (ER) dropped fairly steadily from a high of ~80% in 1973 to ~25% in the mid-1990s before fluctuating between ~25% to 60% through to 2014 (Figure 41d). Note that the terminal ER for this DU reflects the enhanced Robertson Creek hatchery component – wild fish from watersheds elsewhere in the DU have a lower ER (W. Luedke, pers. comm., 2019). Disaggregated ocean and terminal ERs are shown in Figure 43. Additionally, results from incomplete broods need to be interpreted cautiously.

Smolt-to-adult survival declined since the 1970s when it peaked at ~20% (Figure 41e). From the early 1990s to 2013, the rate fluctuated from ~0.03% to ~10%. Stock productivity data are not available for this DU.

Table 19. Summary of estimated rate of change (±95% credible interval) in spawner abundance and probability of decline (>30%, >50%, >70%) for the last three generations and the entire time series for both the full population and the estimated wild population.

DU Name	Generation length	Year range	Median % change	95% CI	p|30% decline	p|50% decline	p|70% decline	Number of Observations
DU 24 – West Vancouver Island Ocean Fall (South)	4	Hatchery and wild abundance combined						
		2004-2018	83	28,163	0	0	0	12
		1995-2018	-14	-49,49	0.21	0.02	0	24
		Estimated wild abundance only (pNOS adjusted)						
		2004-2018	43	-10,129	0	0	0	12
		1995-2018	-19	-47,24	0.24	0.01	0	24

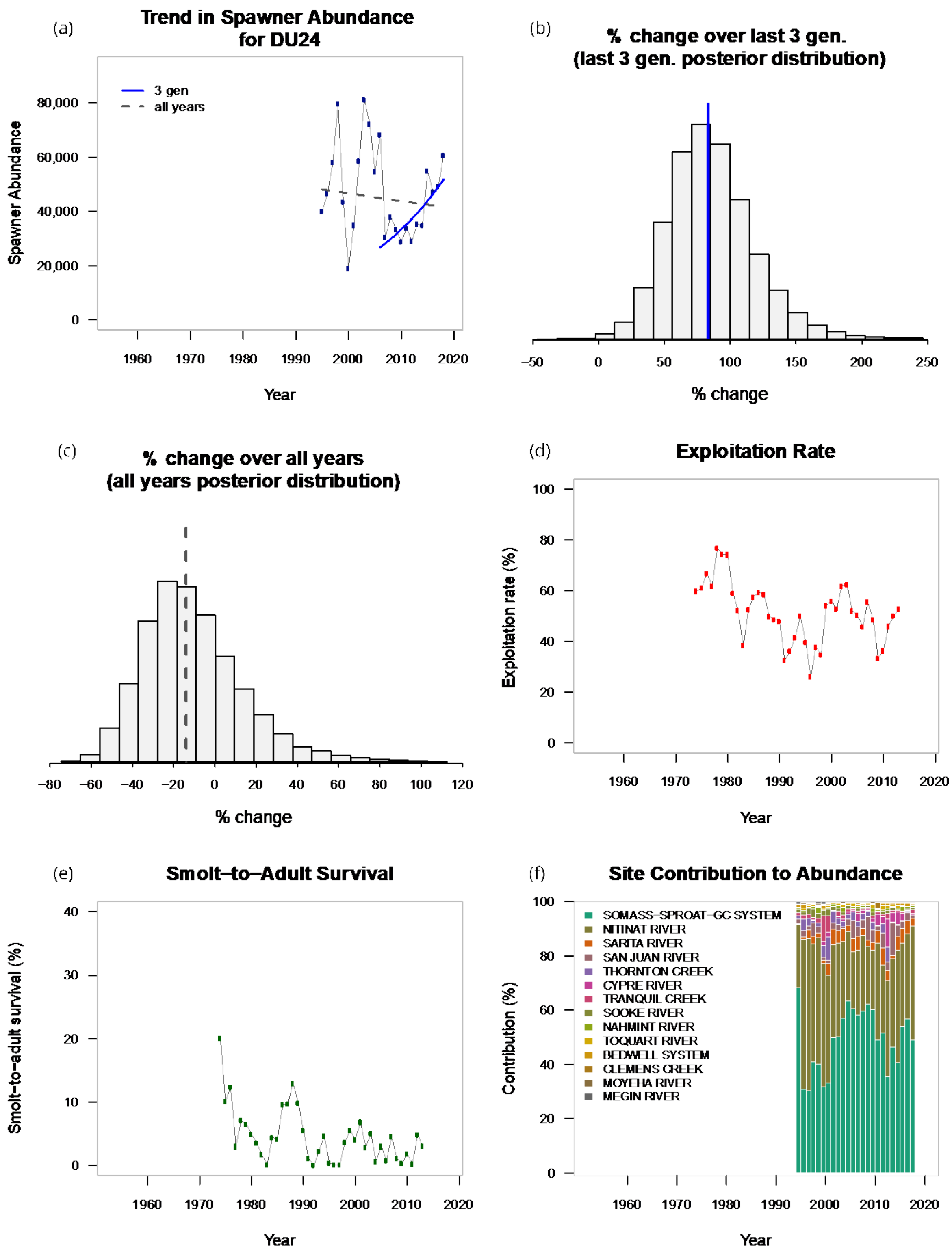

Figure 41. DU24 – Spawner abundance trends, exploitation rate, smolt-to-adult survival, and percent site contribution to abundance (see Table 7 for panel interpretation). Note that this figure shows incomplete exploitation rate data for the most recent cohorts.

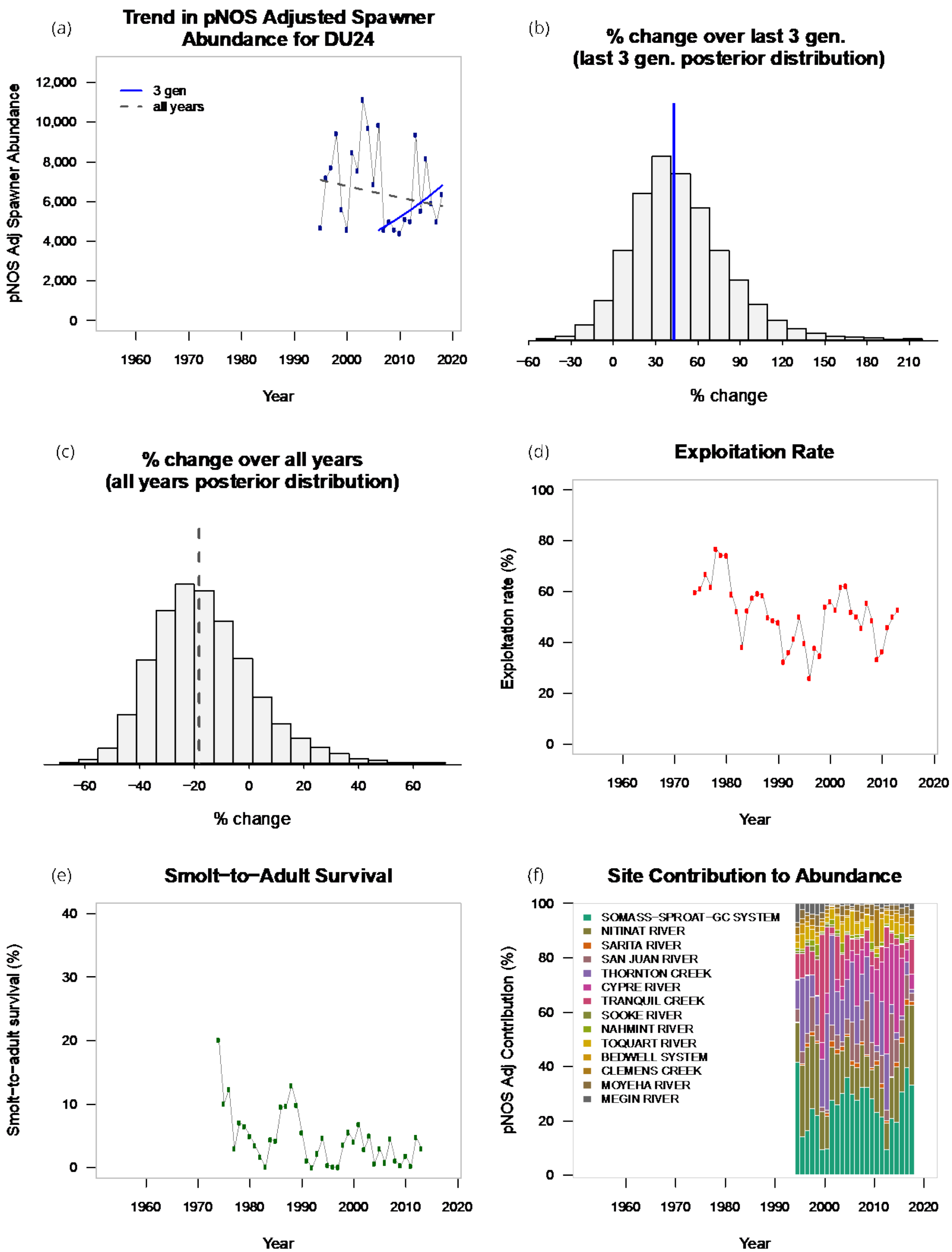

Figure 42. DU24 – Spawner abundance trends adjusted by average proportion of natural origin spawners, exploitation rate, smolt-to-adult survival, and percent site contribution to abundance (see Table 7 for panel interpretation).

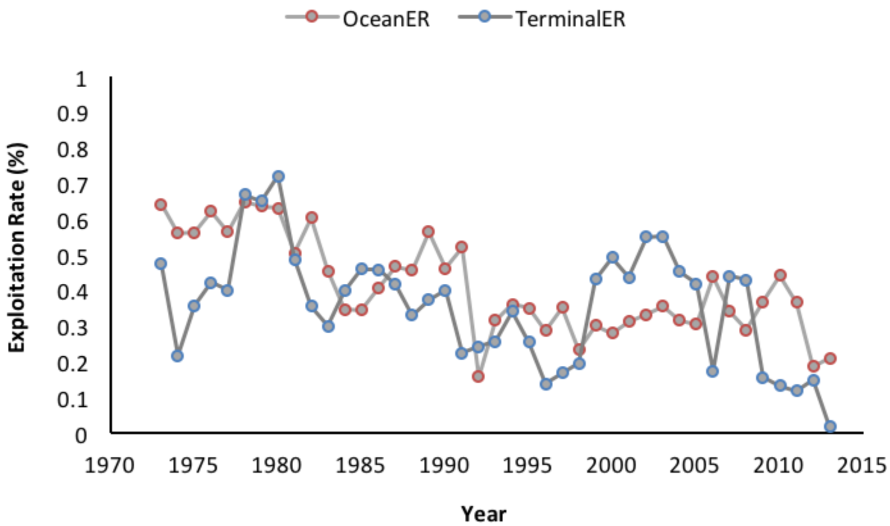

Figure 43. DU24 – Disaggregated ocean and terminal exploitation rates 1970-2015. Note that there are incomplete broods in 2014 and 2015, and the exploitation rates should be interpreted cautiously.

<u>Threats and Limiting Factors</u>

For general threats and limiting factors applicable to all DUs, please refer to the Threats and Limiting Factors section in the introductory material. Chinook Salmon experts who participated in the IUCN Threats Calculator Workshop in February 2017 concluded that this DU should be assigned a threat impact of High (B). The most important threats specific to this DU are ecosystem modifications, and agricultural and forestry effluents. The COSEWIC Marine Fishes SSC updated this Threats Calculator during their 2019 Annual Meeting, with the assistance of local DFO experts, paying special attention to new information on hatchery threats and the impacts of dams. A large number of hatchery releases have occurred and continue within this DU, and the genetic origin of the released fish is from within the DU. The SSC concluded that such releases represent a serious threat to the wild fish in the DU due to competition and genetic introgression. It was noted that straying of hatchery-origin spawners has been documented throughout the DU, supporting the view that the genetic composition of wild spawners and therefore the wildlife species are threatened by hatchery operations. The updated threat impacts was Very High-Very High (Appendix 2).

Other less important threats include tourism and recreation areas, industrial effluents, avalanches/landslides, and droughts, which are expected every other year and can delay adult returns due to low water levels.

Points of potential concern include the rate of increase in number of salmon farms in Clayoquot Sound, the large amount of tree farm licences (implying a high level of logging), and gravel aggradation (potential loss of spawning habitat with increased elevation due to the deposition of sediments).

Designatable Unit 25: West Vancouver Island, Ocean, Fall (Nootka & Kyuquot) population

DU Short Name	WVI/Ocean/Fall (Nootka & Kyuquot)
Joint Adaptive Zone (JAZ)	WVI + WVI
Life History	Ocean
Run Timing	Fall

The average generation time for this DU is 4 years. These fish exhibit ocean-type life-history variants and fall run-timing.

To review methods pertaining to data reported within individual DU chapters, refer to the preliminary sections of this report.

Extent of Occurrence and Area of Occupancy

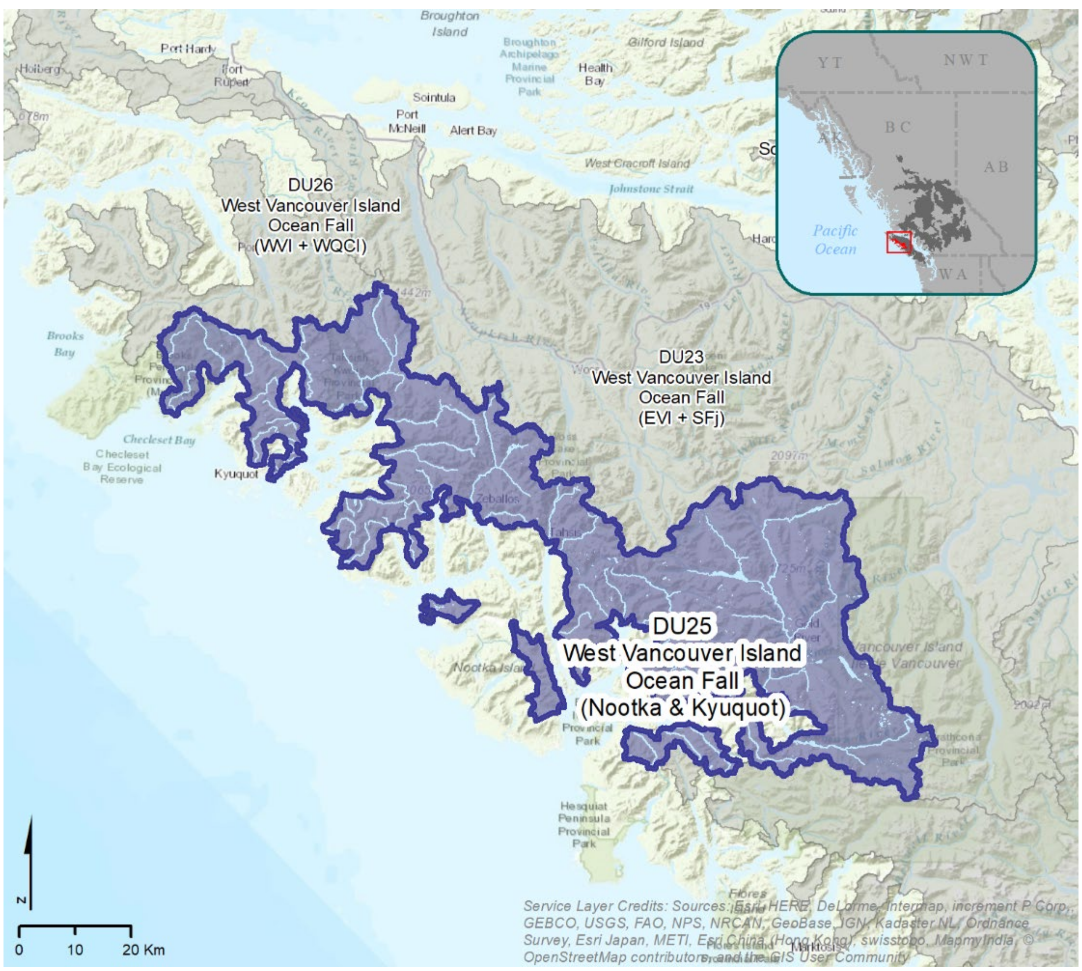

Figure 44. Map of DU25 – West Vancouver Island Ocean Fall (Nootka & Kyuquot).

This DU extends south from Tahsish River around Merry Widow Mountain to Bancroft Creek around Mount Thelwood. The western extent stretches along the Esperanza Canyon to Tatchu Creek and the easternmost extent occurs at Gold River around Tyee Mountain (N: Lat. 50.34, Long. 127.09; S: Lat. 49.52, Long. 125.76; W: Lat. 49.89, Long. 127.17; E: Lat. 50.01, Long. 125.91). The DU's centroid is at Lat. 49.91, Long. 126.85 and its total area is 3601.55km^2. DU25 contains a large proportion of Vancouver Island coastal mountain ridge.

As for all DUs considered in this report, the Extent of Occurrence includes spawning streams as well as the ocean range, and is therefore >20,000 km^2. The IAO is 375 km^2 based on a total known spawning run length of 187 km, or 1.86% of the known spawning length across all DUs.

<u>Habitat Trends</u>

Land surrounding this DU's freshwater habitat is altered (13.1%), with urban development comprising 0.2%, and mining development 0.005% of the DU's area. Road density in DU25 is 0.9 km/km^2 with an average of 0.8 stream crossings per km of fish accessible streams (the average across all DUs is 1.33 km/km^2 road density and 0.62 stream crossings per km of fish accessible streams). 13.8% of the DU's riparian habitat and 12.9% of its forest cover is disturbed. No agricultural / rural development occurs within the DU and it is not affected by Mountain Pine Beetle.

<u>Abundance</u>

Spawner abundance data for most years originate from sites with moderate sampling effort/survey quality. However, a large portion of sites (29 out of 41) are considered by DFO to be data deficient (Appendix 1). At most of these sites, monitoring has stopped in recent years because of lack of natural spawning.

A large proportion of this DU's spawners originate from enhanced streams (Figure 45a), with the proportion of estimated natural origin fish averaging ~20% (except in the 1980s) (Figure 45b). Of the years where sampling occurred, most individuals originated from streams that had moderate to high levels of enhancement. Hatchery releases increased from very low counts in the late 1970s to over 4 million fish in the mid-1990s before fluctuating between ~2 million and ~4 million fish up to 2018 (Figure 45c). No hatchery releases are reported from outside the DU (Figure 45d).

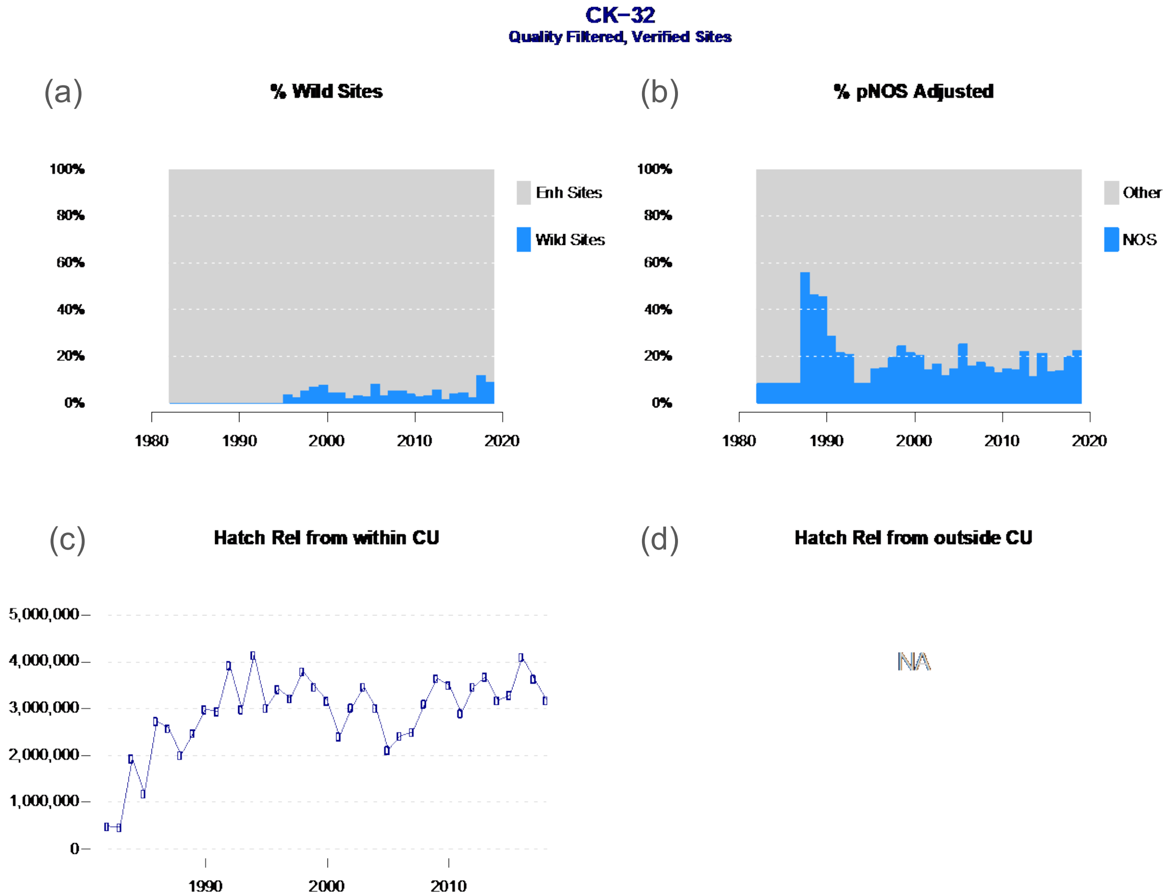

Figure 45. DU25 – Enhancement, proportion of natural origin spawners, and hatchery releases. Graphics provided by Fisheries and Oceans Canada, see Table 4 for panel interpretation.

Fluctuations and Trends

Available indices of abundance over the most recent three generations and over all years do not show declines. While this wildlife species spawns at a large number of sites, with survey information being available from many spawning areas, population trends are most likely heavily influenced by hatchery releases aimed to augment natural production.

Based on the last three generations of data at nine persistent sites (see Figure 46f), the number of mature individuals increased by an estimated 116% (Upper 95% CI = 654%, Lower 95% CI = -38%) with the probability of a 30% decline at 0.04 (Table 20). Using the entire time series of data, the number of mature individuals increased by an estimated 17% (Upper 95% CI = 151%, Lower 95% CI = -45%) with the probability of a 30% decline at 0.09 (Table 20, Figure 46a,c).The Conuma River system is the largest contributor to overall abundance (Figure 46f).

For estimated wild abundance only, the corresponding trend for the last three generations is an estimated 169% increase (Upper 95% CI = 473%, Lower 95% CI = 25%) with the probability of a 30% decline at 0 (Table 20, Figure 47a,b). For the full time series, there is an estimated 9% increase (Upper 95% CI = 107%, Lower 95% CI = -42%) with the probability of a 30% decline also at 0.08 (Table 20, Figure 47a,c). With the exception of the Conuma River system, the relative contributions of all sites to the wild population are historically higher than their relative contributions to the population as a whole (Figure 46f and Figure 47f). The Conuma and Gold river systems are the largest contributors to the wild population (Figure 47f).

A consensus of expert opinion indicated that the remaining number of spawners is less than the threshold (10,000), and only one subpopulation exists within the DU. There is a possibility that the number of mature individuals remaining is less than 2500, meeting the threshold for Endangered. While DFO data indicate that the average numbers of mature individuals remaining in 2018 are 35271 and 5568 for the non pNOS-adjusted and adjusted values, respectively (Appendix 1), the SSC places the most confidence on the consensus of experts' estimate of remaining mature wild fish.

Harvest, smolt-to-adult survival and stock productivity data are unavailable for this DU because there is no CWT indicator stock.

Table 20. Summary of estimated rate of change (±95% credible interval) in spawner abundance and probability of decline (>30%, >50%, >70%) for the last three generations and the entire time series for both the full population and the estimated wild population.

DU Name	Generation length	Year range	Median % change	95% CI	p|30% decline	p|50% decline	p|70% decline	Number of Observations
DU 25 - West Vancouver Island Ocean Fall (Nootka & Kyuquot)	4	Hatchery and wild abundance combined						
		2004-2018	116	-38,654	0.04	0.01	0	12
		1995-2018	17	-45,151	0.09	0.02	0	24
		Estimated wild abundance only (pNOS adjusted)						
		2004-2018	169	25,473	0	0	0	12
		1995-2018	9	-42,107	0.08	0.01	0	24

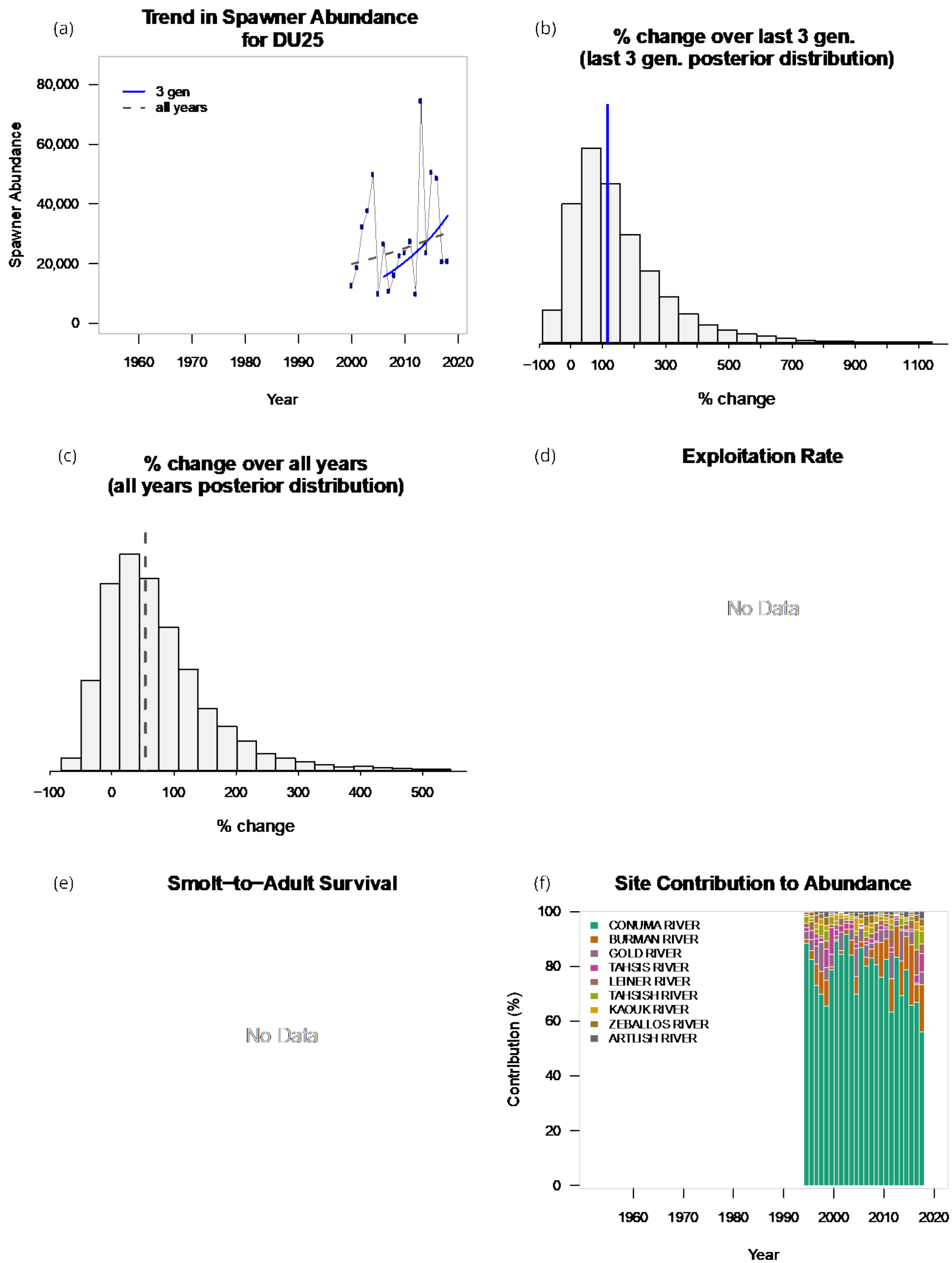

Figure 46. DU25 – Spawner abundance trends, exploitation rate, smolt-to-adult survival, and percent site contribution to abundance (see Table 7 for panel interpretation).

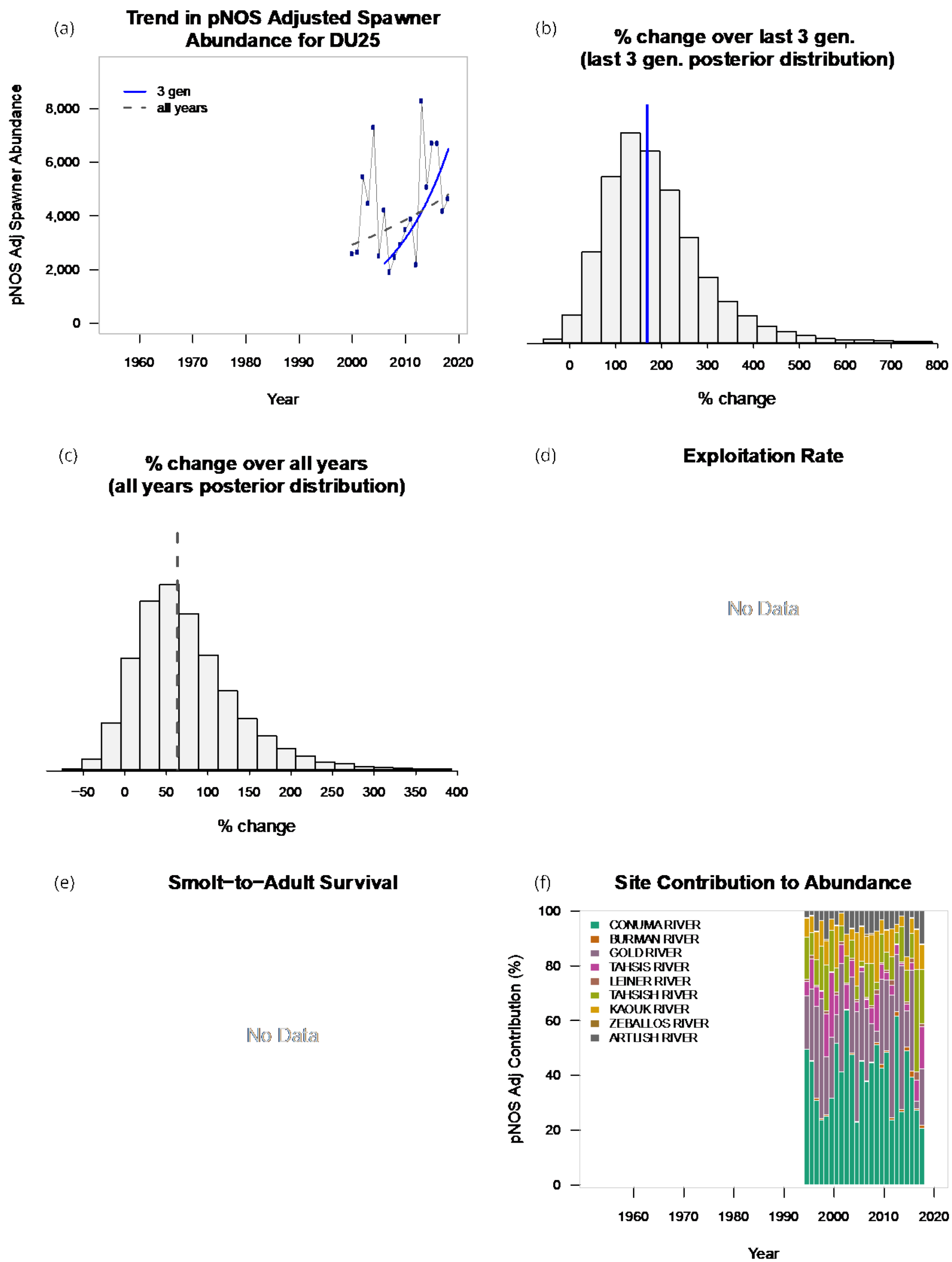

Figure 47. DU25 – Spawner abundance trends adjusted by average proportion of natural origin spawners, exploitation rate, marine (smolt-to-adult) survival, and percent site contribution to abundance (see Table 7 for panel interpretation).

Threats and Limiting Factors

For general threats and limiting factors applicable to all DUs, please refer to the Threats and Limiting Factors section in the introductory material. Chinook Salmon experts who participated in the IUCN Threats Calculator Workshop in February 2017 concluded that this DU should be assigned a threat impact of Medium (C). The most important threat is from ecosystem modifications. Ongoing impacts include high flows due to deforestation that create various changes to habitat (e.g., temperature, sedimentation, food supply, large woody debris, movement of gravel to different parts of stream). Sediment management plans are being developed. The system is previously logged and has stabilized but could now be logged again. The COSEWIC Marine Fishes SSC updated this Threats Calculator during their 2019 Annual Meeting, with the assistance of local DFO experts, paying special attention to new information on hatchery threats and the impacts of dams. A large number of hatchery releases have occurred and continue within this DU, and the genetic origin of the released fish is from within the DU. The SSC concluded that such releases represent a serious threat to the wild fish in the DU due to competition and genetic introgression. Similar to DU 24, it was noted that straying of hatchery-origin spawners has been documented throughout the DU, likely compromising the genetic composition of wild spawners and therefore threatening the wildlife species. The updated threat impact has increased to High-Very High.

Although data are lacking, survival rates are thought to be declining for this DU.

Other less important threats include tourism/recreation areas (increase in fishing lodges to ~100 – these are located in areas important to Chinook Salmon rearing), industrial effluents (pulp mills are closed but effluent is still present), agriculture/forestry issues (aquaculture, herbicides/pesticides, siltation from forestry), avalanches/landslides, and droughts. Droughts are expected every other year and can delay adult returns due to low water levels.

Designatable Unit 26: West Vancouver Island, Ocean, Fall (WVI + WQCI) population

DU Short Name	WVI + WQCI/Ocean/Fall
Joint Adaptive Zone (JAZ)	WVI + WQCI
Life History	Ocean
Run Timing	Fall

The average generation time for this DU is 4 years. These fish exhibit ocean-type life-history variants and fall run-timing.

To review methods pertaining to data reported within individual DU chapters, refer to the preliminary sections of this report.

Extent of Occurrence and Area of Occupancy

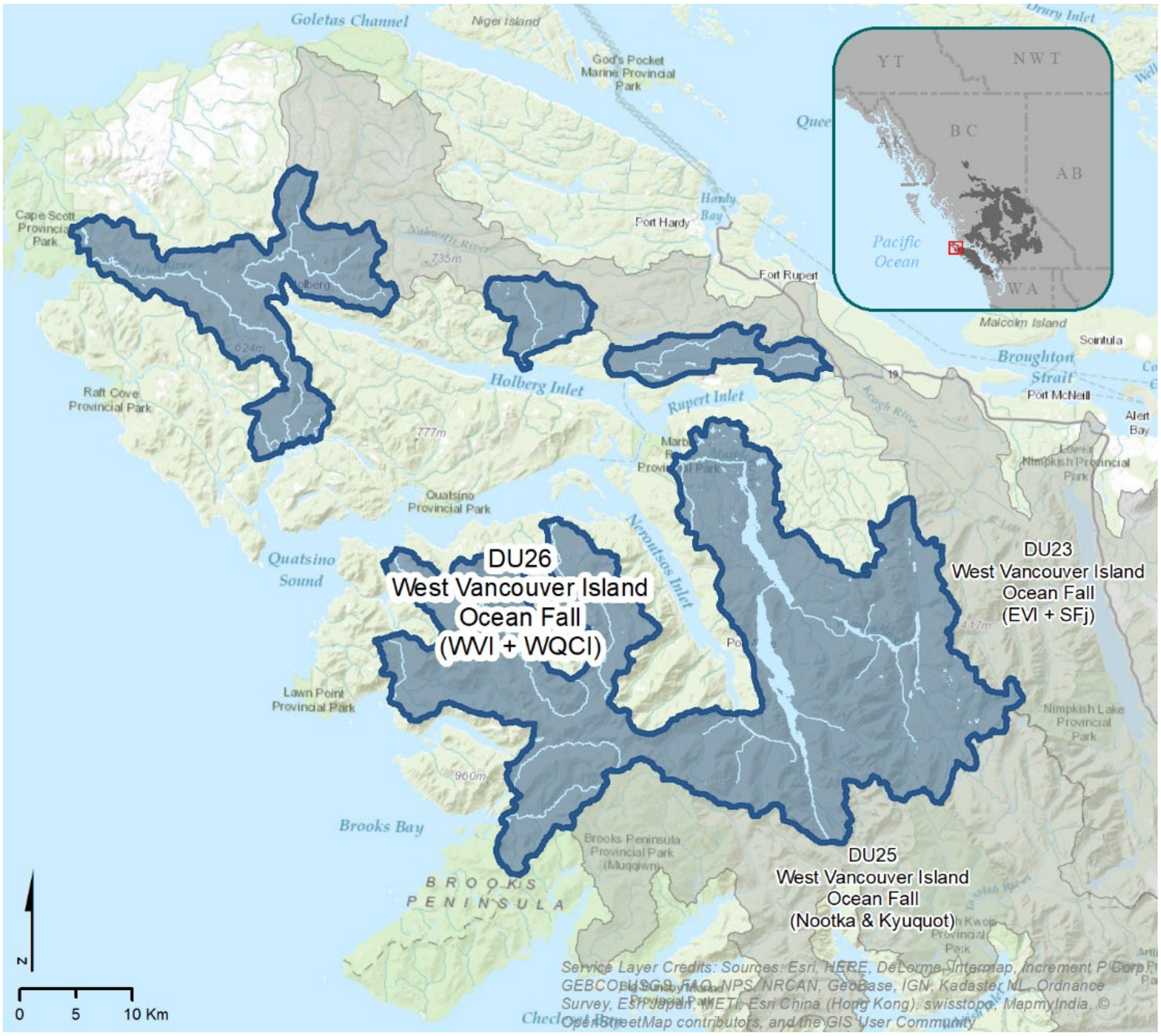

Figure 48. Map of DU26 – West Vancouver Island Ocean Fall (WVI + WQCI).

Four geographically separated sections combine to form this DU. The northernmost section contains the Jensen Creek, Goodspeed River, and Denad Creek drainages and extends from Eric Lake in the northwest to the Goodspeed River drainage in the east and the Denad Creek outlet to Winter Harbour in the south (N: Lat. 50.76, Long. 128.01; S: Lat. 50.54, Long. 128.00; W: Lat. 50.70, Long. 128.29; E: Lat. 50.66, Long. 127.88). The two smaller sections further southeast contain the Wanokana Creek and Stephens Creek drainages, both of which empty into Holberg Inlet. The largest and southernmost section contains the Marble River, Mahatta Creek, Keith River, Klootchlimmis Creek, Klaskish River, and East Creek drainages. The section's northernmost point occurs just northeast of Marble River Provincial Park and the southern point is at the headwaters of the Marble River. The DU extends from Keith River in the west to the Raging River around Mount Waddington in the east (N: Lat. 50.57, Long. 127.47; S: Lat. 50.23, Long. 127.30; W: Lat. 50.34, Long. 127.87; E: Lat. 50.35, Long. 127.08). The DU's centroid is at Lat. 50.46, Long. 127.71 and its total area is 1307.62 km^2.

As for all DUs considered in this report, the Extent of Occurrence includes spawning streams as well as the ocean range, and is therefore >20,000 km^2. The IAO is 95 km^2 based on a total known spawning run length of 48 km, or 0.48% of the known spawning length across all DUs.

Habitat Trends

Land surrounding this DU's freshwater habitat is altered (18.5%), but with urban development comprising only 0.02% of the DU area. Road density in DU26 is 1.2 km/km^2 with an average of 0.9 stream crossings per km of fish accessible streams (the average across all DUs is 1.33 km/km^2 road density and 0.62 stream crossings per km of fish accessible streams). 17.7% of the DU's riparian habitat and 18.4% of its forest cover is disturbed. No agricultural / rural or mining development currently occurs in this DU, although one mine was previously in operation near Coal Harbour and Rupert Inlet (M. Trudel, pers. comm., 2019). This DU is not affected by Mountain Pine Beetle.

Abundance

While spawning has been documented at a number of sites throughout this DU, survey information is available only for Marble River (Appendix 1). Information on the proportion of natural origin spawners is not available for this site. Given this, Figure 49b has been omitted. Hatchery releases increased from the mid-1980s to 2001, with a maximum release of ~1,000,000 in 2001. After 2001, the number of fish released declined to 2005 before increasing again to >800,000 fish by 2017 (Figure 49c). No hatchery releases are reported from outside the DU (Figure 49d).

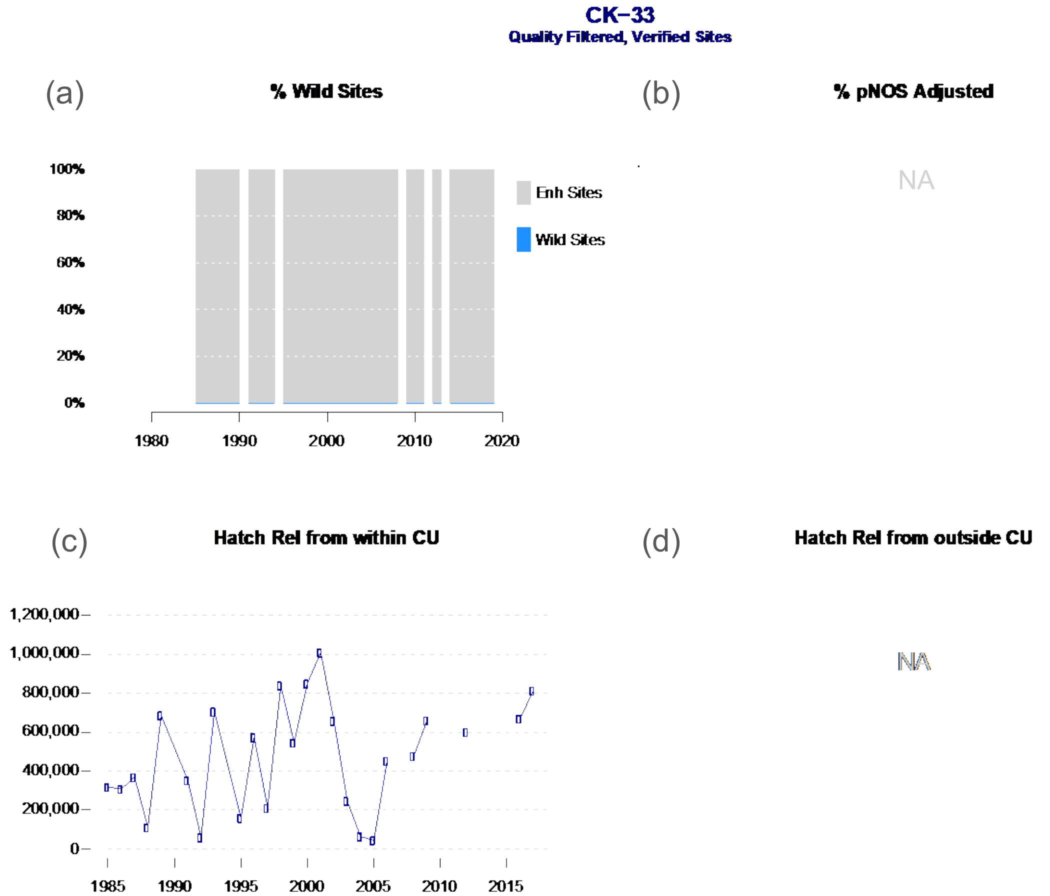

Figure 49. DU26 – Enhancement, proportion of natural origin spawners, and hatchery releases. Graphics provided by Fisheries and Oceans Canada, see Table 4 for panel interpretation. % pNOS Adjusted (panel (b)) cannot be calculated.

Fluctuations and Trends

While this wildlife species is known to spawn at a number of sites, survey information is available from only one site. This single monitoring site is heavily enhanced by hatchery releases and likely does not represent the entire population. Available data are insufficient to determine trends in the number of mature individuals, or reliably estimate the number of remaining mature individuals.

Based on the last three generations of data at a single persistent site that is also artificially enhanced (Marble River), the number of mature individuals decreased by an estimated -41% (Upper 95% CI = 307%, Lower 95% CI = -91%) with the probability of a 30% decline at 0.58 (Table 21, Figure 50a,b). Using the entire time series of data, the number of mature individuals decreased by an estimated -29% (Upper 95% CI = 62%, Lower 95% CI = -70%) with the probability of a 30% decline at 0.49 (Table 21, Figure 50a,c).

For estimated wild abundance the corresponding trends are the same.

Harvest, smolt-to-adult survival and stock productivity data are unavailable for this DU because there is no CWT indicator stock.

Table 21. Summary of estimated rate of change (±95% credible interval) in spawner abundance and probability of decline (>30%, >50%, >70%) for the last three generations and the entire time series for both the full population and the estimated wild population.

<table>
<tr><th>DU Name</th><th>Generation length</th><th>Year range</th><th>Median % change</th><th>95% CI</th><th>p|30% decline</th><th>p|50% decline</th><th>p|70% decline</th><th>Number of Observations</th></tr>
<tr><td rowspan="6">West Vancouver Island Ocean Fall (WVI + WQCI)</td><td rowspan="6">4</td><td colspan="7">Hatchery and wild abundance combined</td></tr>
<tr><td>2007-2018</td><td>-41</td><td>-91,307</td><td>0.58</td><td>0.42</td><td>0.21</td><td>12</td></tr>
<tr><td>1996-2018</td><td>-29</td><td>-70,62</td><td>0.49</td><td>0.2</td><td>0.02</td><td>23</td></tr>
<tr><td colspan="7">Estimated wild abundance only (pNOS adjusted)</td></tr>
<tr><td colspan="7">No data to disaggregate</td></tr>
<tr><td colspan="7">No data to disaggregate</td></tr>
</table>

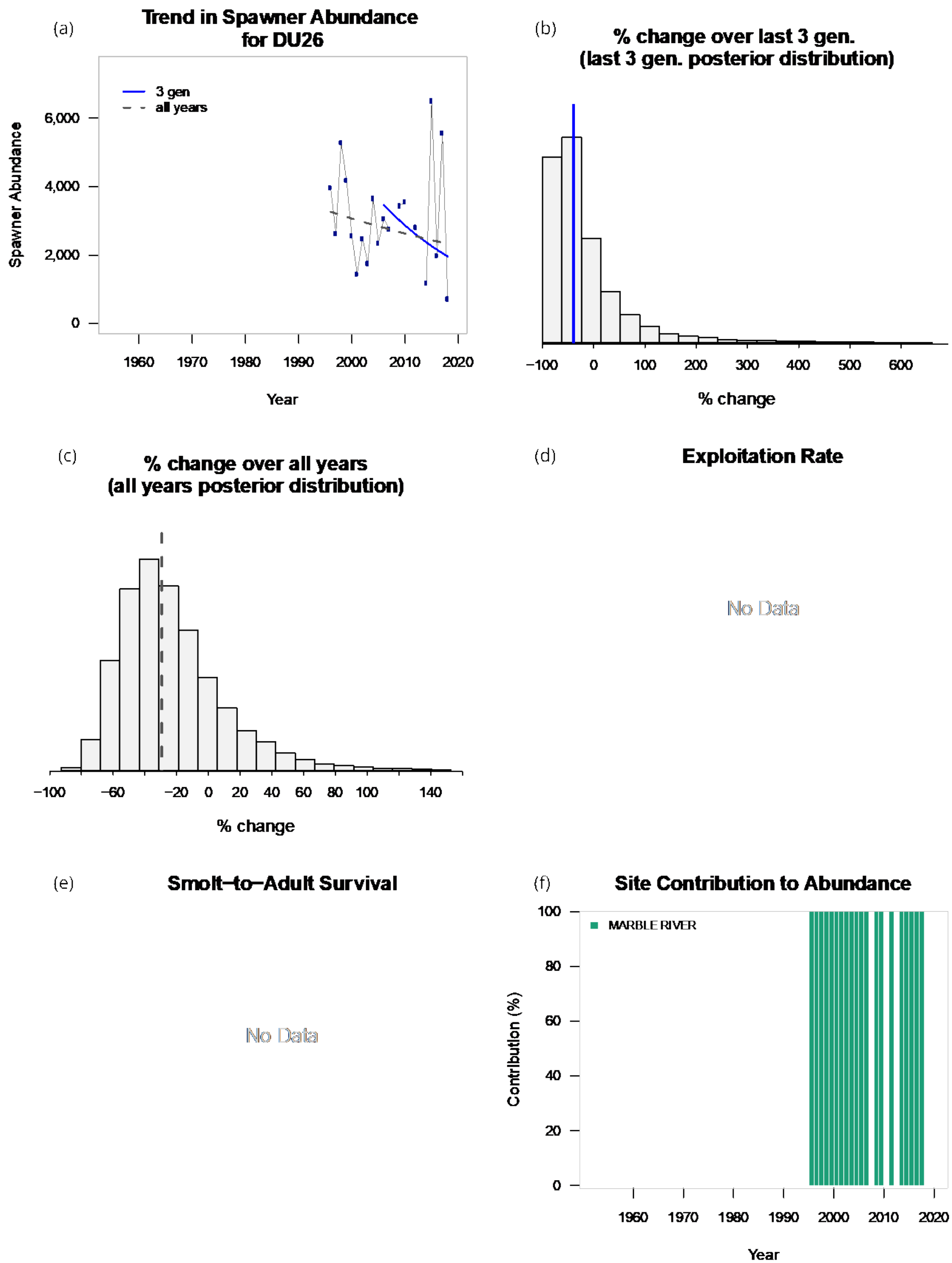

Figure 50. DU26 – Spawner abundance trends, exploitation rate, smolt-to-adult survival, and percent site contribution to abundance (see Table 7 for panel interpretation).

Threats and Limiting Factors

A Threats Calculator was not completed for this DU. For general threats and limiting factors applicable to all DUs, please refer to the Threats and Limiting Factors section in the introductory material.

Hatchery releases have occurred within this DU, and the genetic origin of the released fish is from within the DU. The SSC concluded that such releases represent a threat to the wild fish in the DU due to competition and genetic introgression.

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Appendix 1. Data quality and PNI trends by site for each designatable unit.

For each of the twelve DUs addressed in this Part Two report, this appendix provides a graphic for site-level data quality (all sites), and information on Proportionate Natural Influence (PNI) by site, where available.

Site-level data quality

Site-level data quality figures indicate the enhancement level (low ('L') or high ('H')) and the overall site type (persistent ('P') or data deficient ('DD')). Site type was determined using the process and criteria described in this report's section entitled 'Sampling Effort and Methods'. Data quality by year is described using the symbols defined in Figure 51.

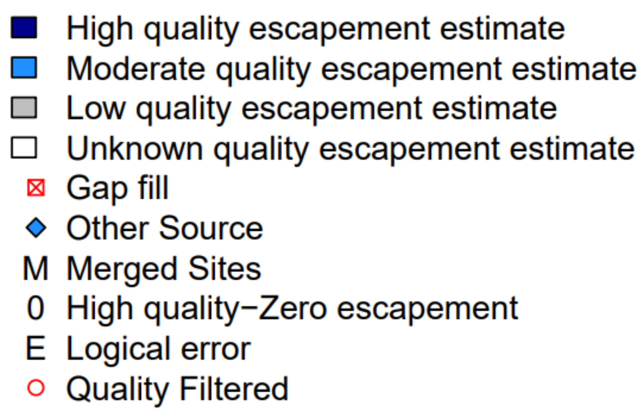

Figure 51. Definitions for the symbols used in the site-level data quality figures provided for each of the DUs.

PNI by site

The Proportionate Natural Influence metric is a measure of hatchery influence on the wild population. Site-specific PNI over time is shown when such data are available for each DU. Data origin is identified as either from 'CWT' for Coded-Wire Tag or 'Thermal' for thermal abundance data.

DU1

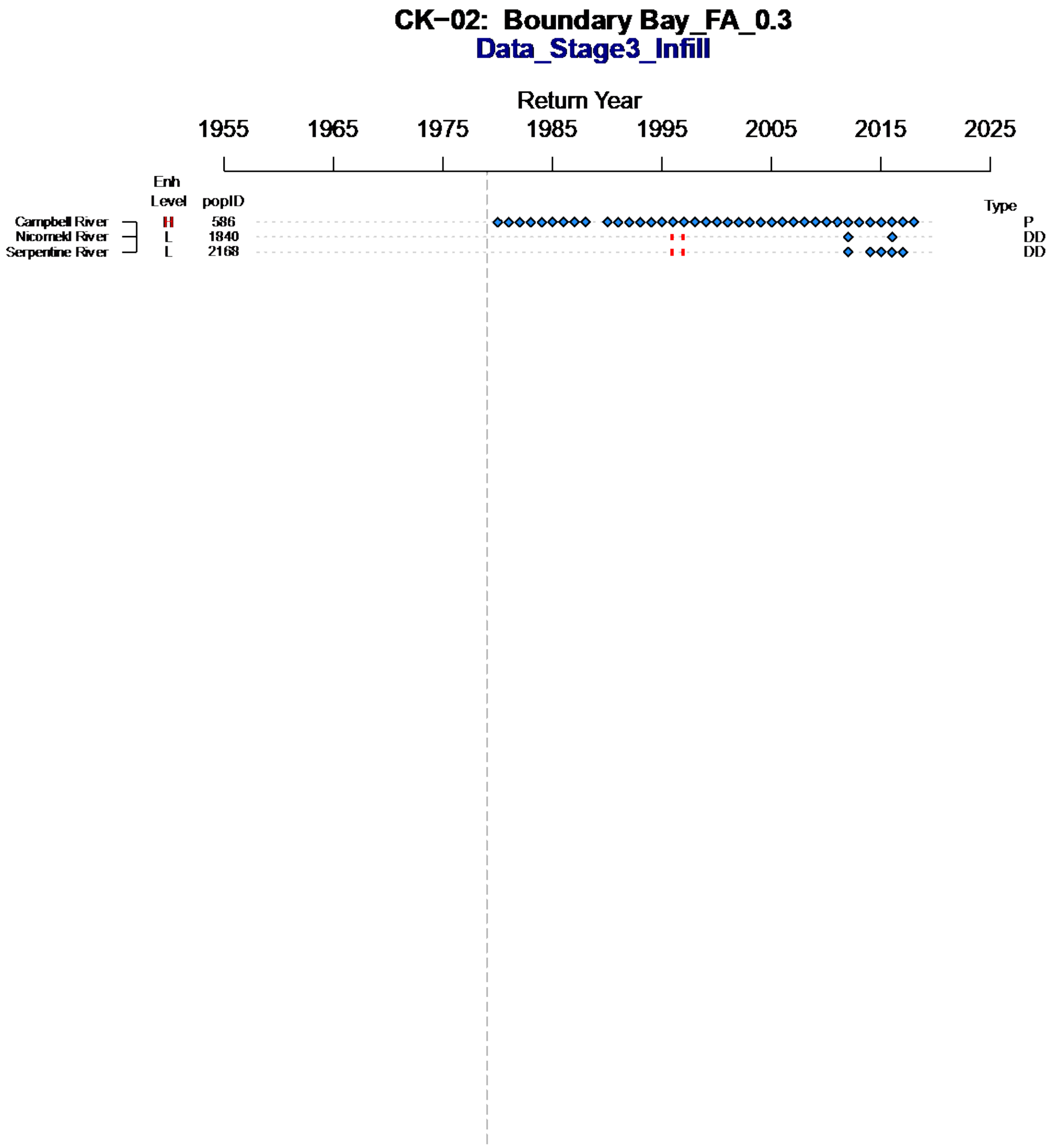

Figure 52 DU1 – Data quality by site. Graphics provided by Fisheries and Oceans Canada, see Appendix 1 Section 'Site-level data quality' for interpretation.

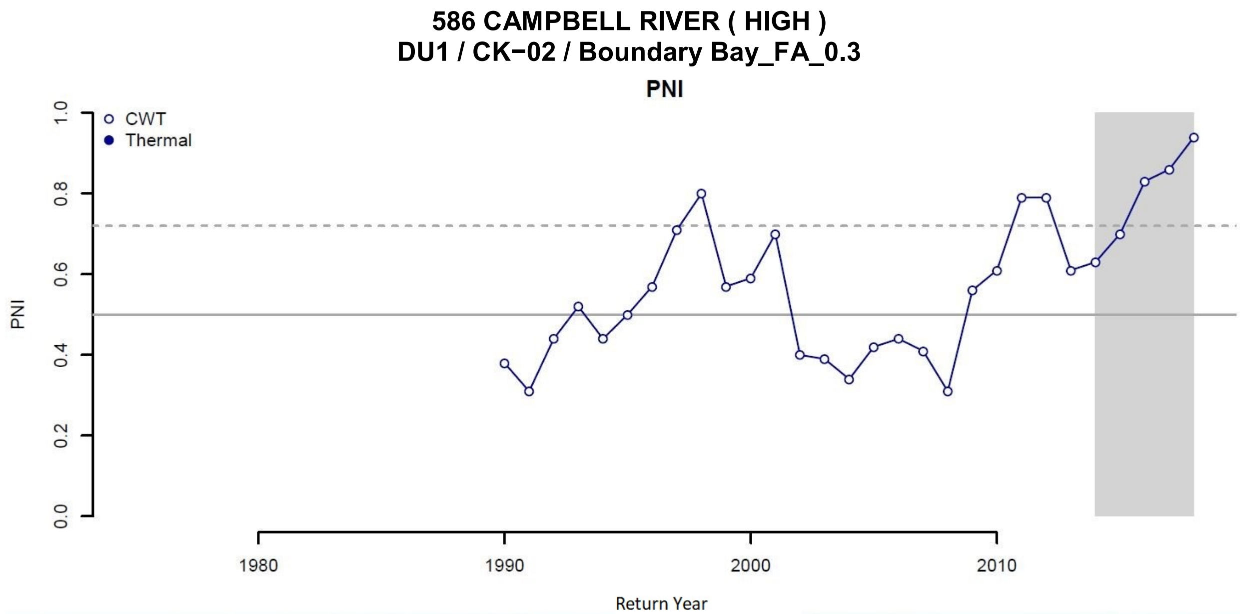

Figure 53. Campbell River PNI over time. Graphics provided by Fisheries and Oceans Canada, see Appendix 1 Section ‘PNI by site’ for interpretation.

DU6

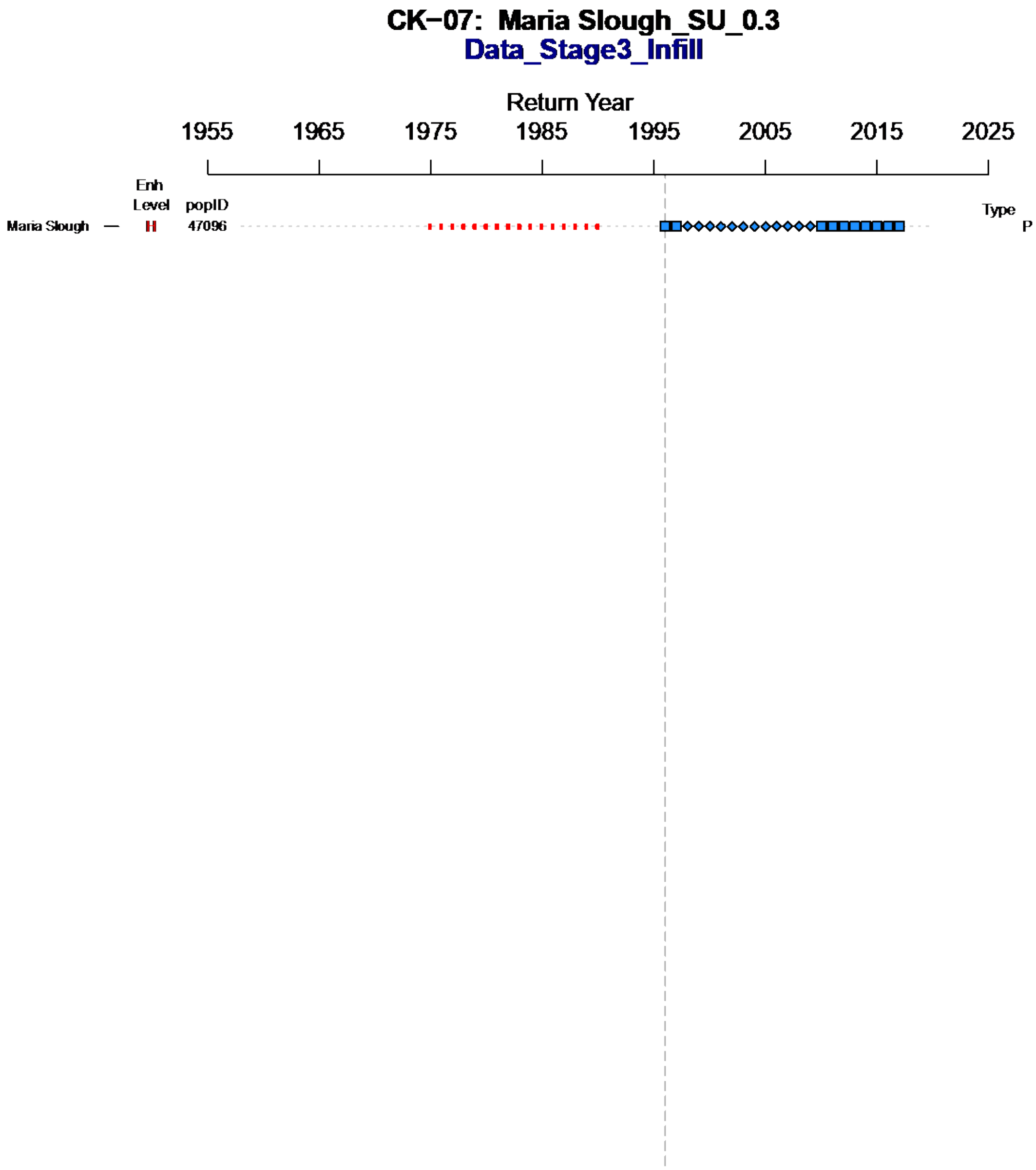

Figure 54. DU6 – Data quality by site. Graphics provided by Fisheries and Oceans Canada, see Appendix 1 Section 'Site-level data quality' for interpretation.

<u>DU13</u>

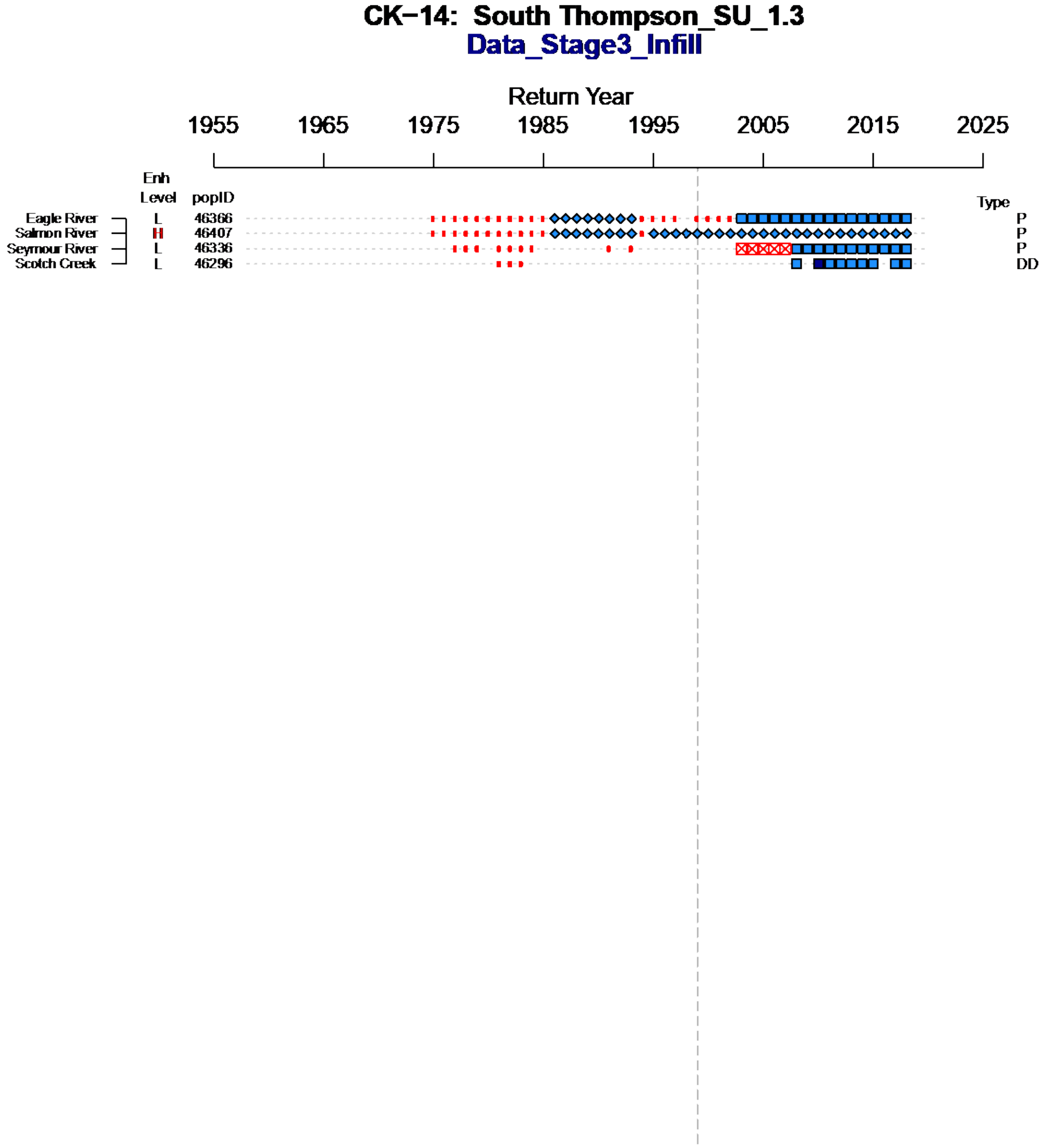

Figure 55. DU13 – Data quality by site. Graphics provided by Fisheries and Oceans Canada, see Appendix 1 Section ‘Site-level data quality’ for interpretation.

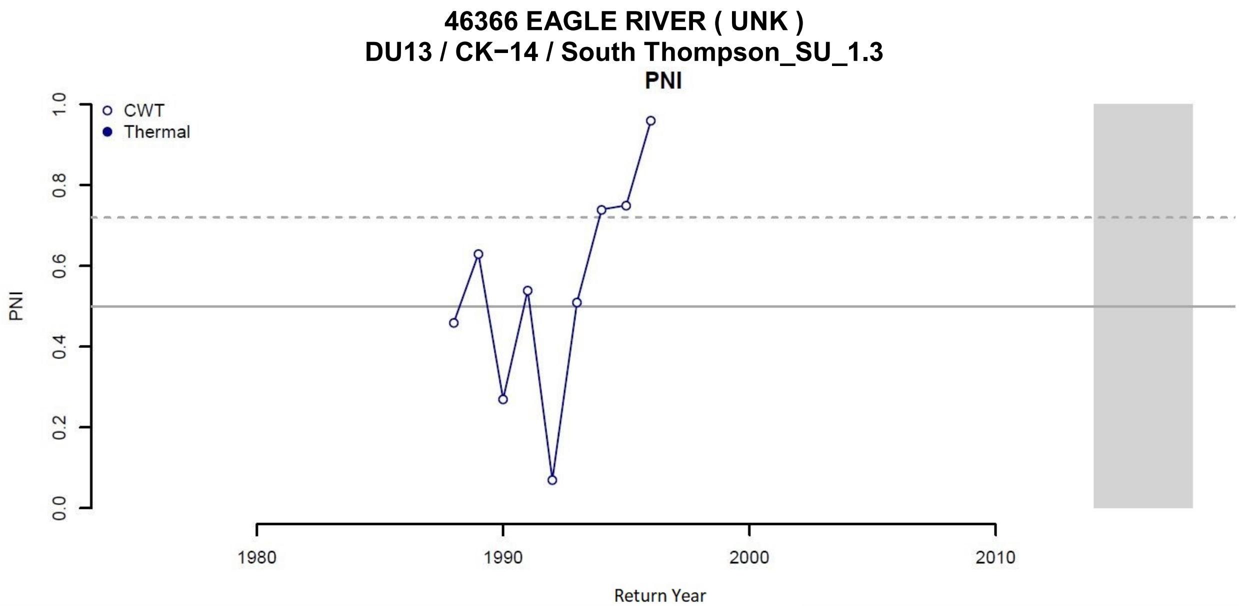

Figure 56. Eagle River PNI over time. Graphics provided by Fisheries and Oceans Canada, see Appendix 1 Section 'PNI by site' for interpretation.

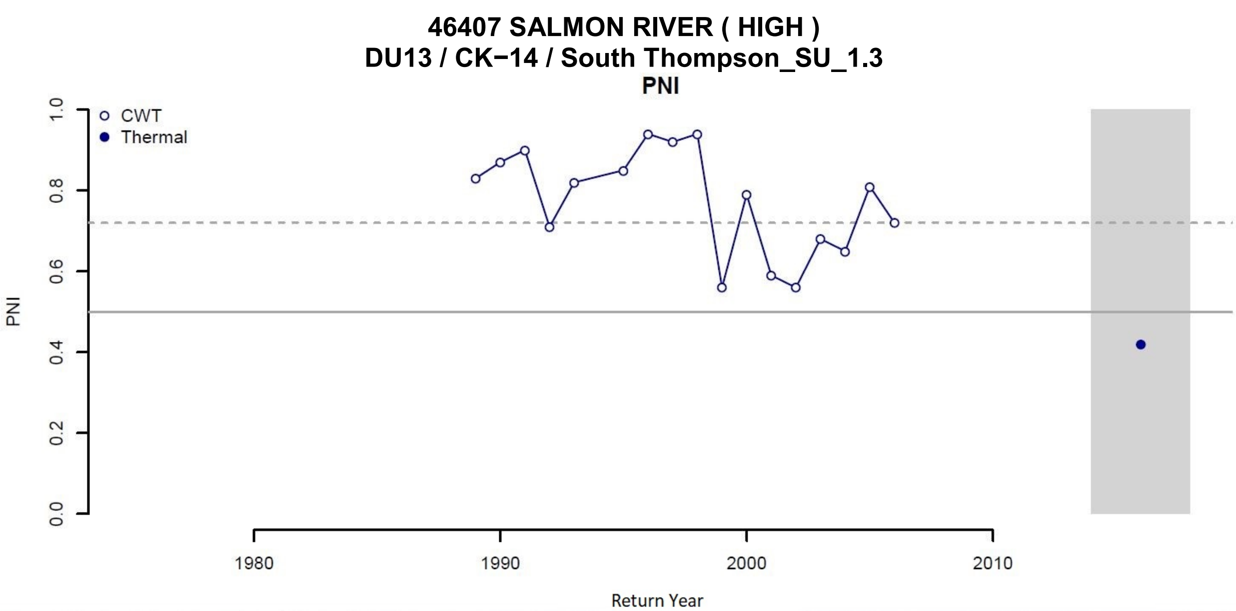

Figure 57. Salmon River PNI over time. Graphics provided by Fisheries and Oceans Canada, see Appendix 1 Section 'PNI by site' for interpretation.

DU15

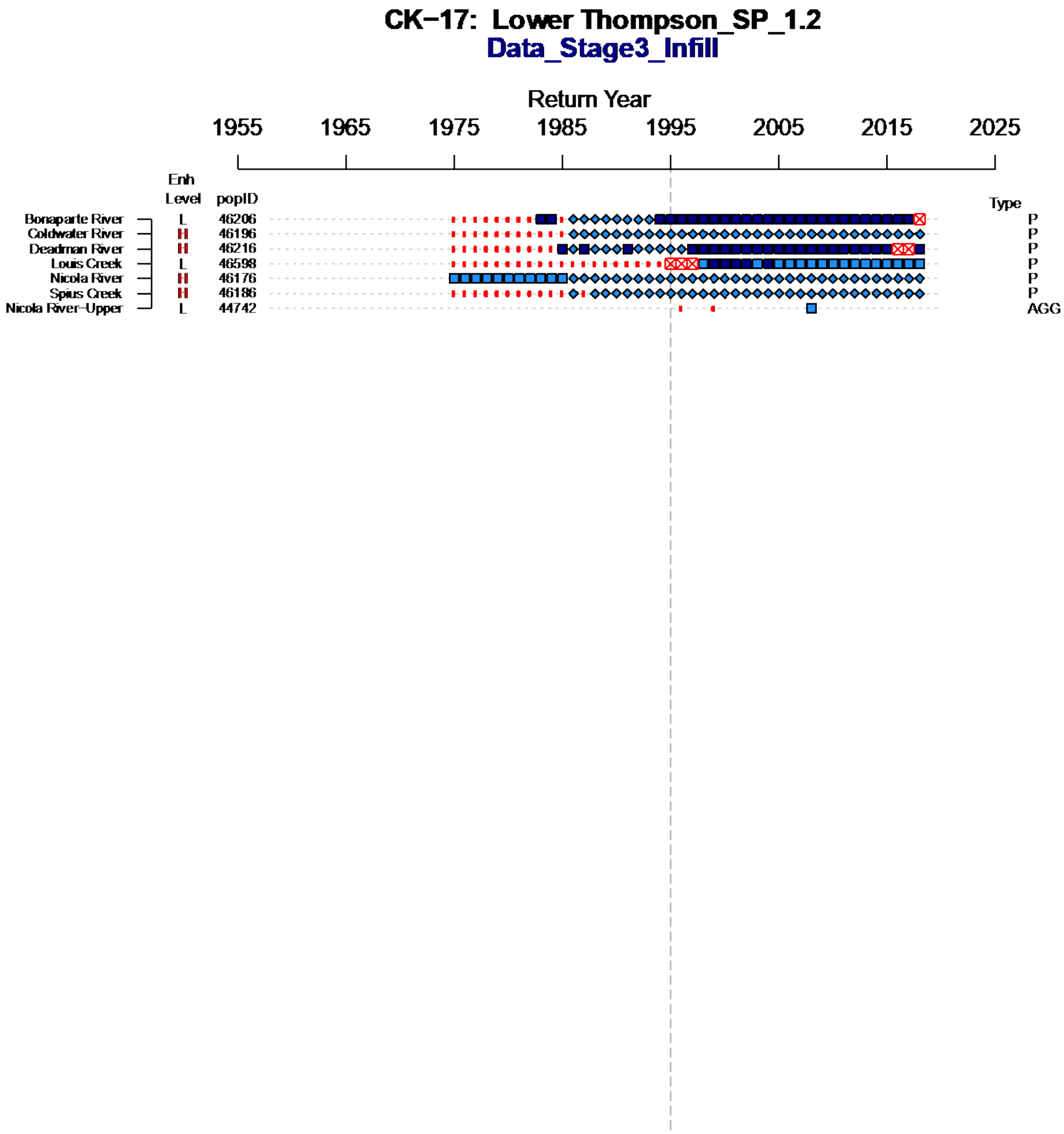

Figure 58. DU15 – Data quality by site. Graphics provided by Fisheries and Oceans Canada, see Appendix 1 Section ‘Site-level data quality’ for interpretation.

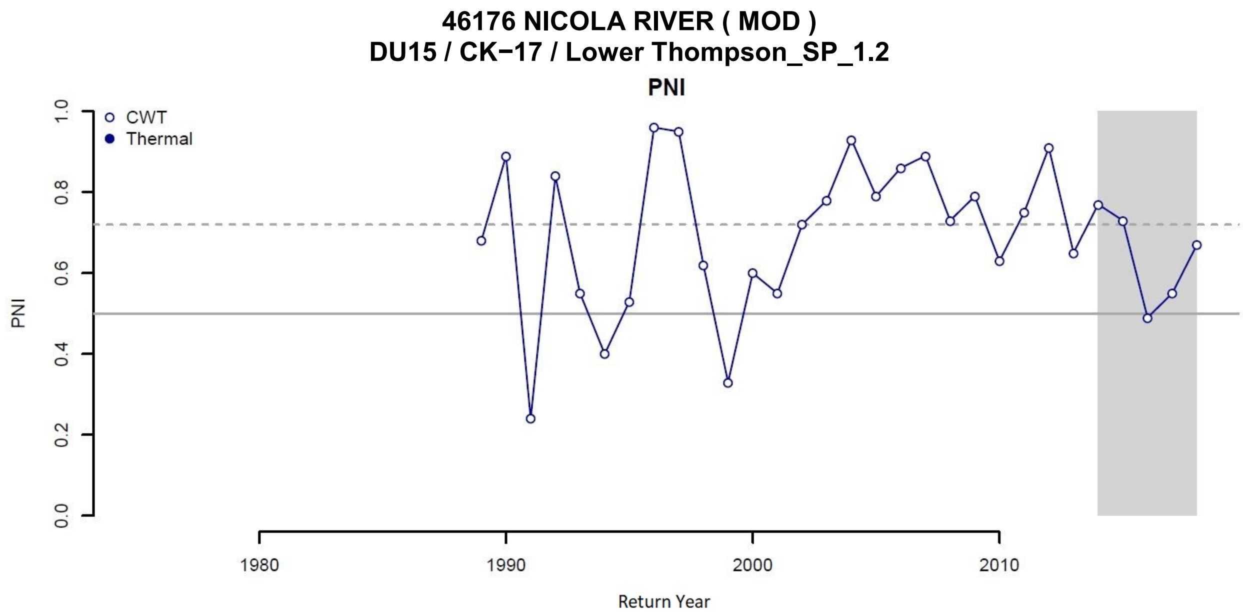

Figure 59. Nicola River PNI over time. Graphics provided by Fisheries and Oceans Canada, see Appendix 1 Section 'PNI by site' for interpretation.

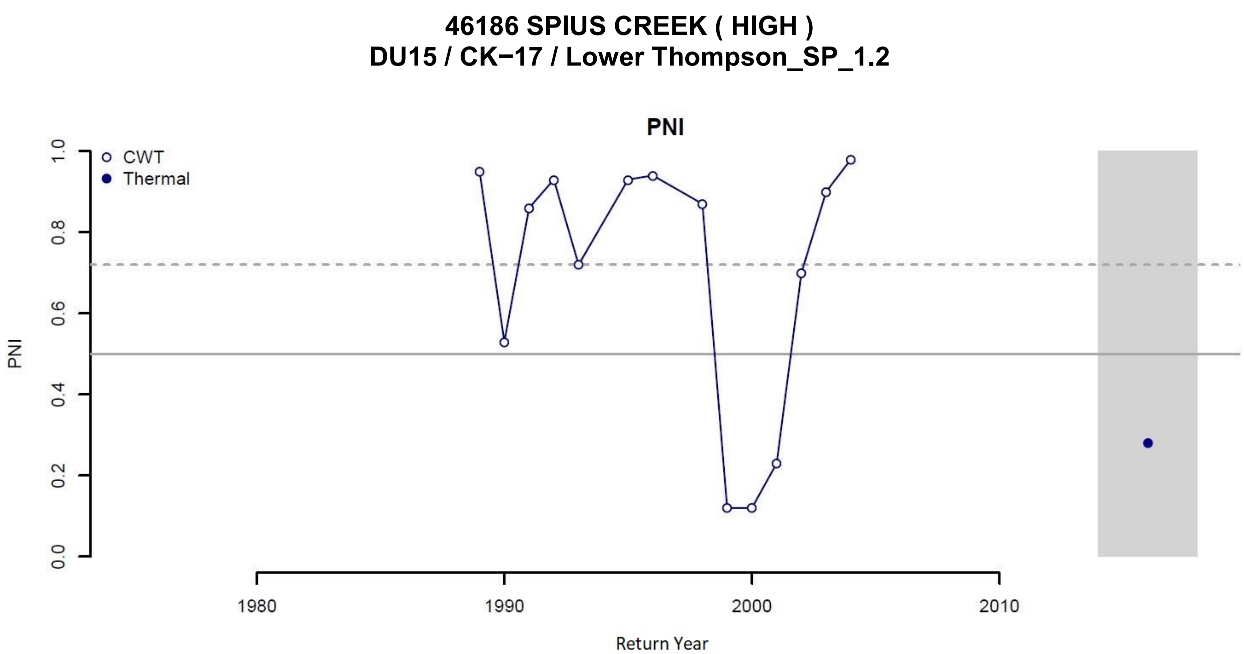

Figure 60. Spius Creek PNI over time. Graphics provided by Fisheries and Oceans Canada, see Appendix 1 Section 'PNI by site' for interpretation.

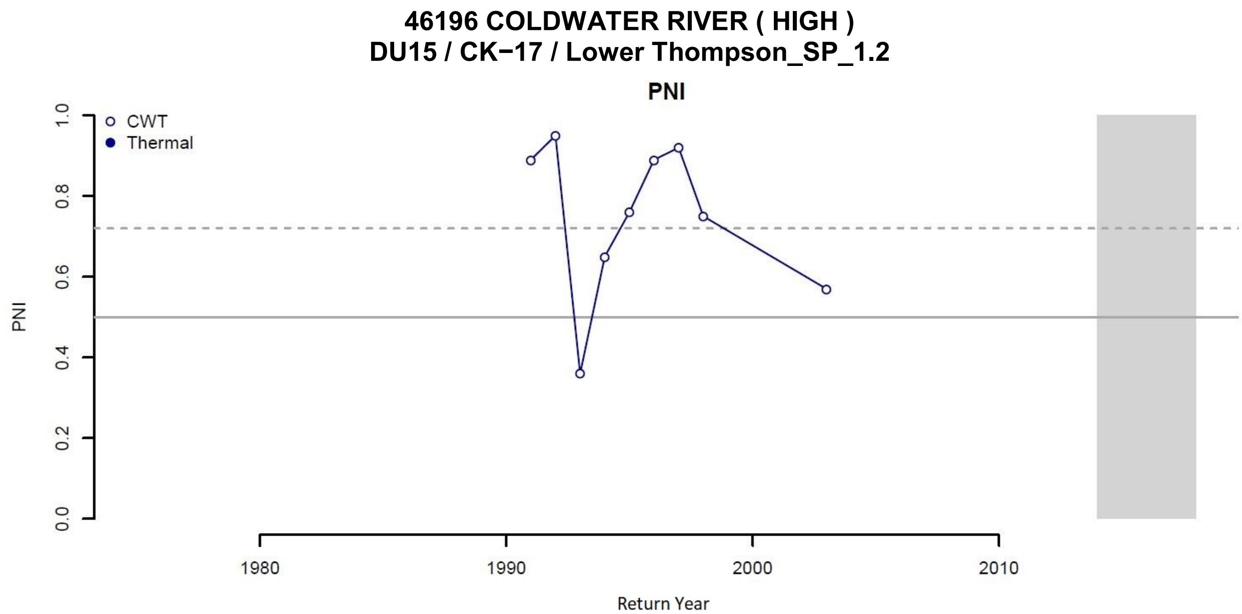

Figure 61. Coldwater River PNI over time. Graphics provided by Fisheries and Oceans Canada, see Appendix 1 Section 'PNI by site' for interpretation.

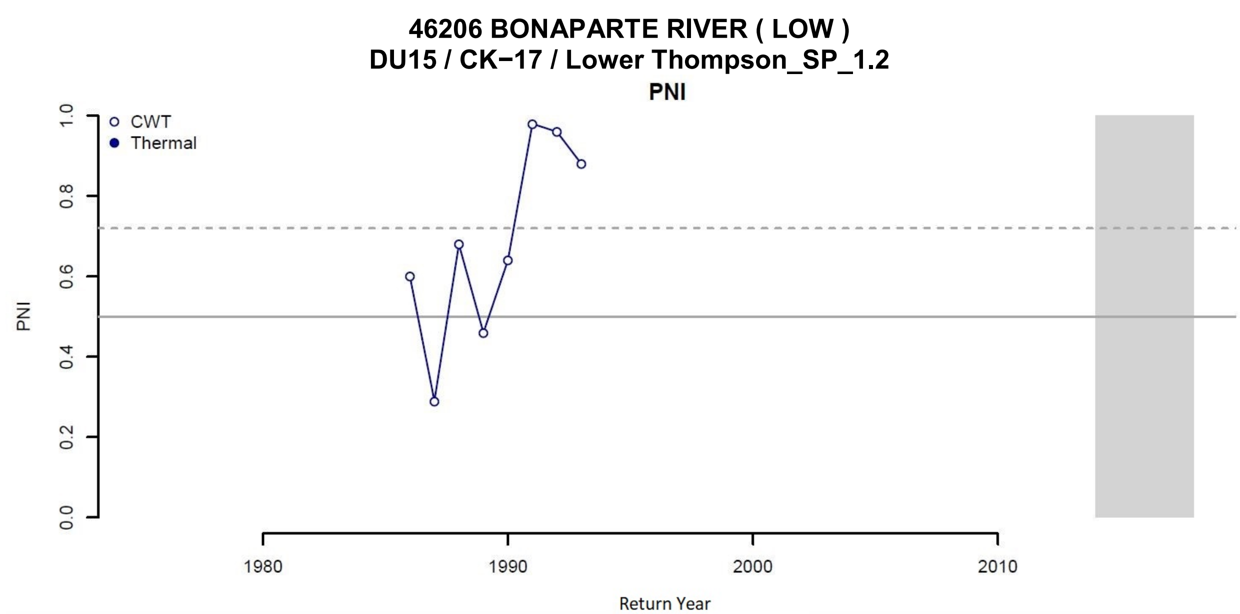

Figure 62. Bonaparte River PNI over time. Graphics provided by Fisheries and Oceans Canada, see Appendix 1 Section 'PNI by site' for interpretation.

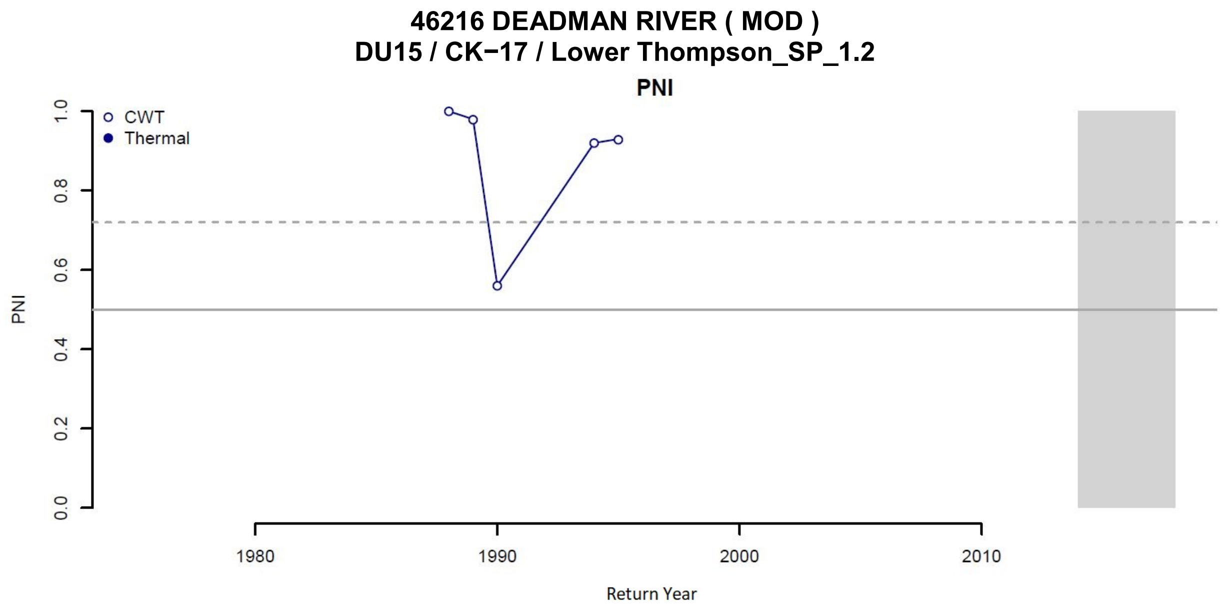

Figure 63. Deadman River PNI over time. Graphics provided by Fisheries and Oceans Canada, see Appendix 1 Section 'PNI by site' for interpretation.

DU18

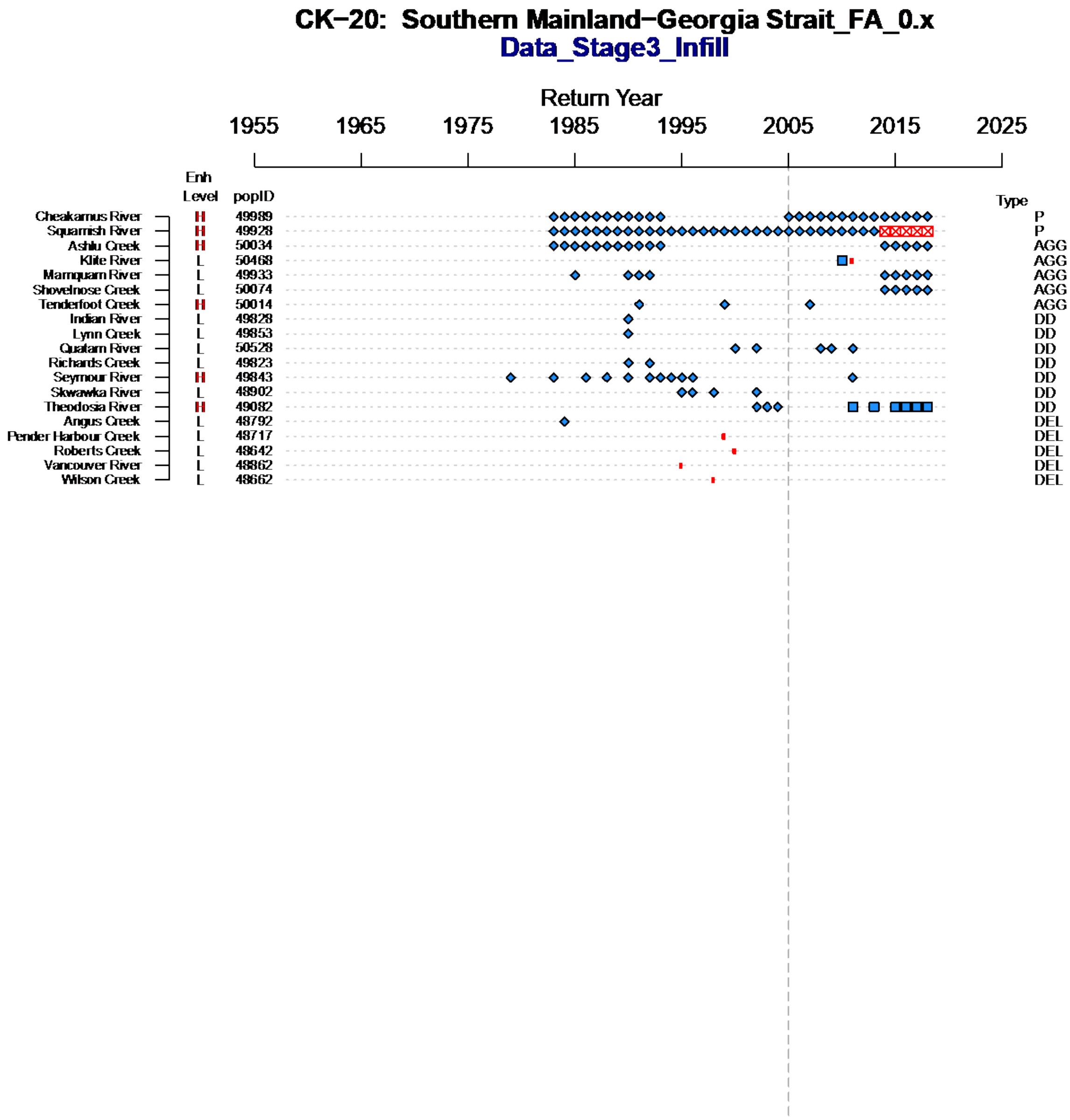

Figure 64. DU18 – Data quality by site. Graphics provided by Fisheries and Oceans Canada, see Appendix 1 Section ‘Site-level data quality’ for interpretation.

DU20

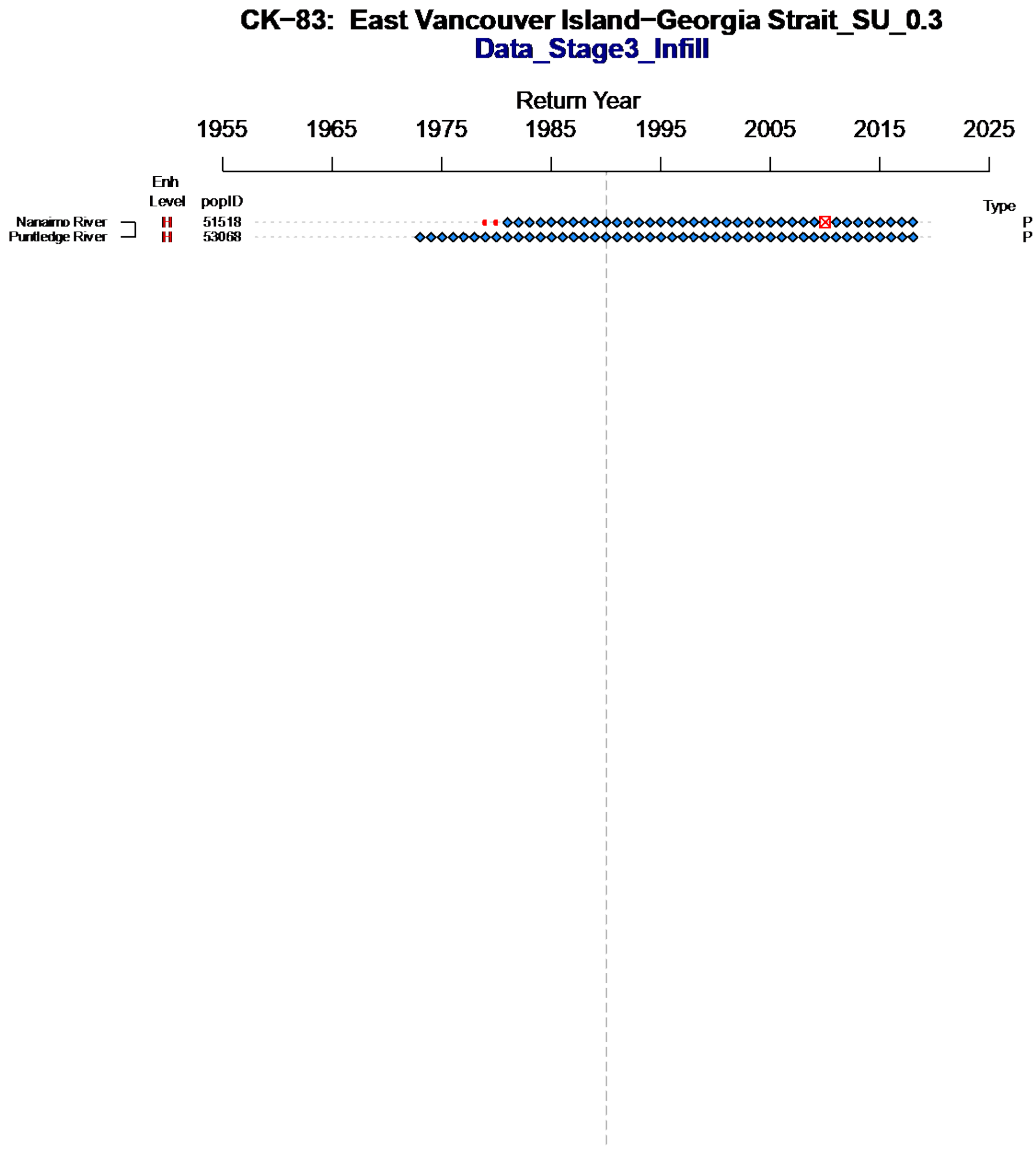

Figure 65. DU20 – Data quality by site. Graphics provided by Fisheries and Oceans Canada, see Appendix 1 Section ‘Site-level data quality’ for interpretation.

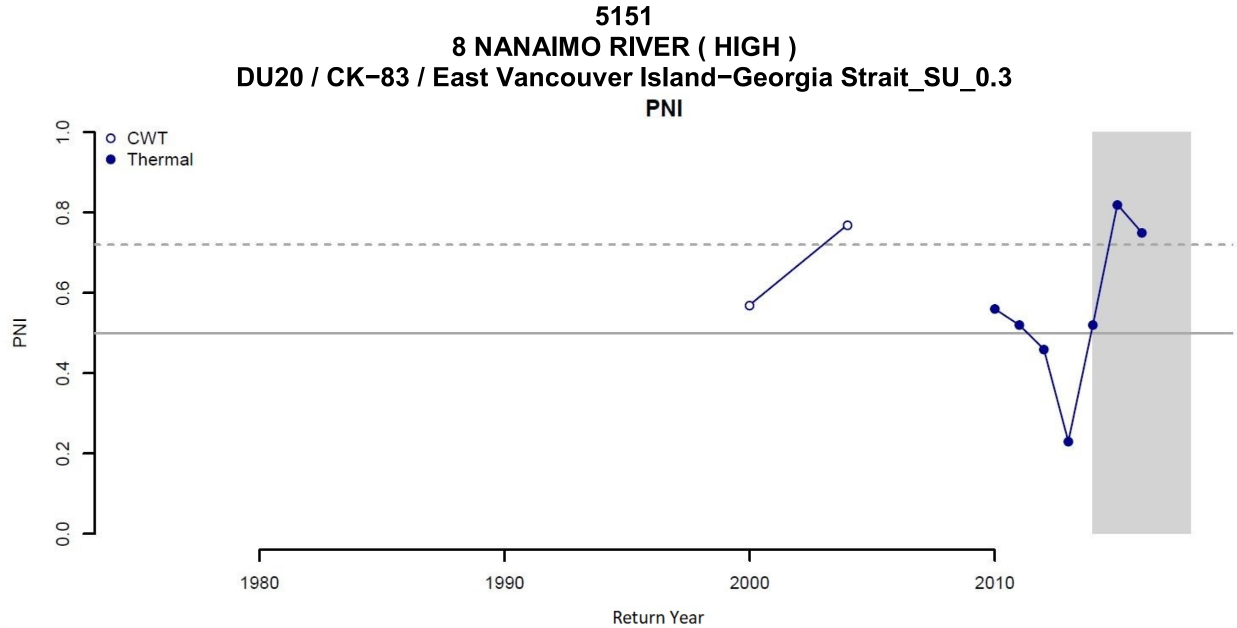

Figure 66. Nanaimo River PNI over time. Graphics provided by Fisheries and Oceans Canada, see Appendix 1 Section 'PNI by site' for interpretation.

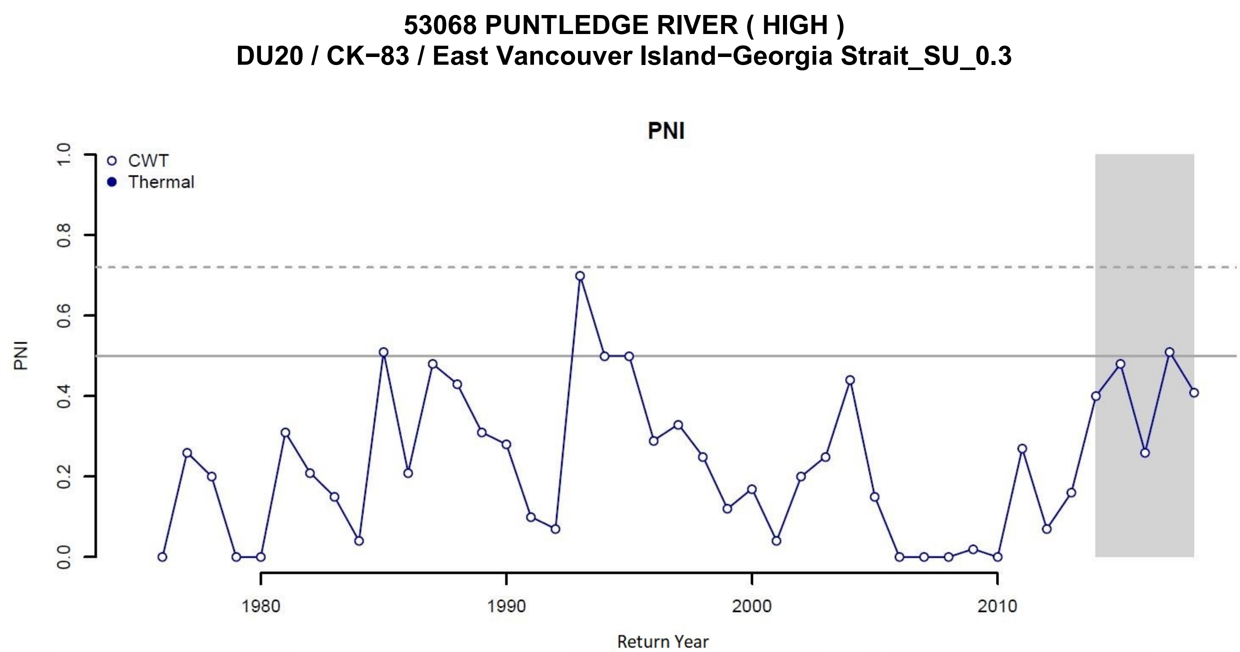

Figure 67. Puntledge River PNI over time. Graphics provided by Fisheries and Oceans Canada, see Appendix 1 Section 'PNI by site' for interpretation.

DU21

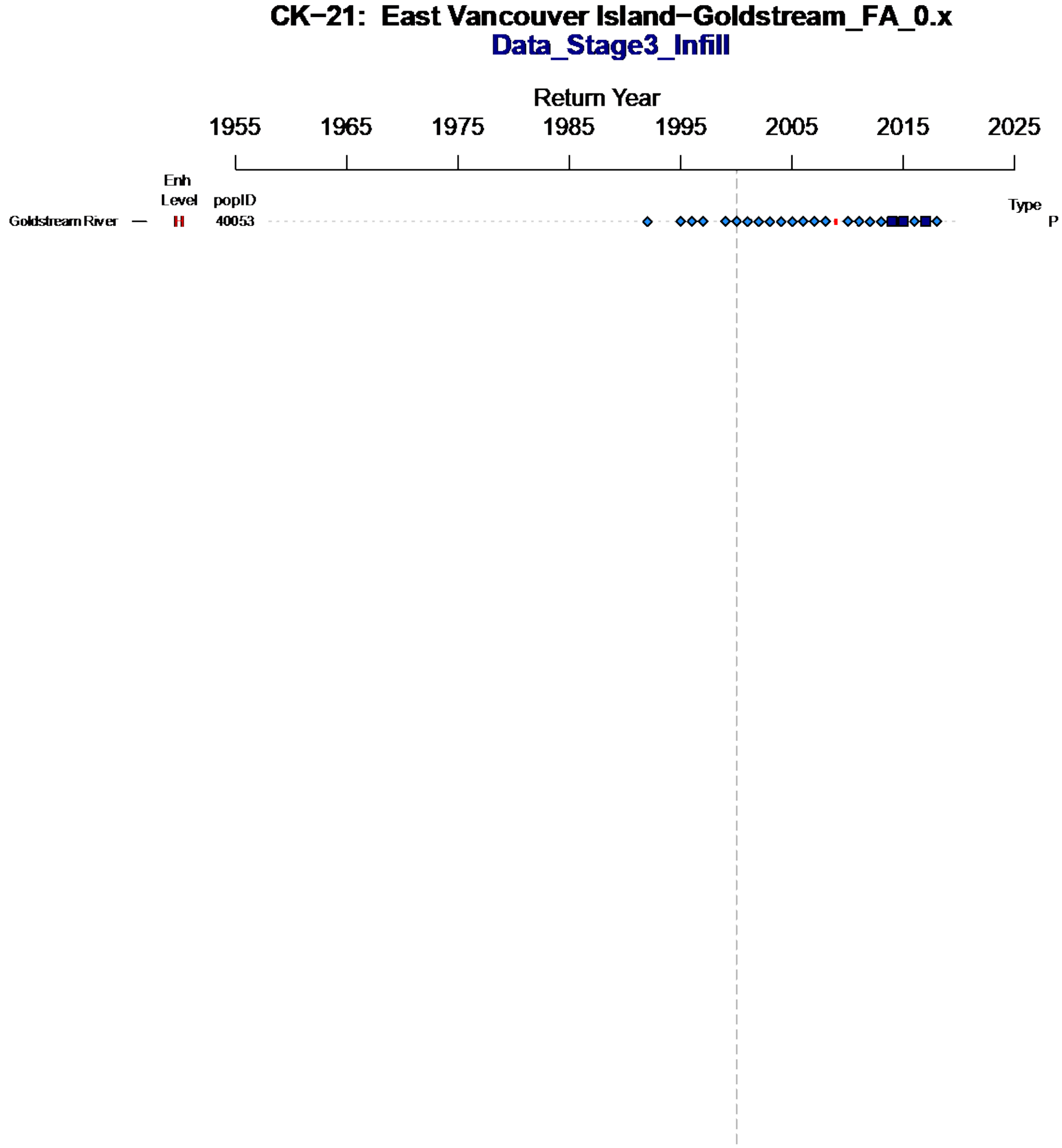

Figure 68. DU21 – Data quality by site. Graphics provided by Fisheries and Oceans Canada, see Appendix 1 Section 'Site-level data quality' for interpretation.

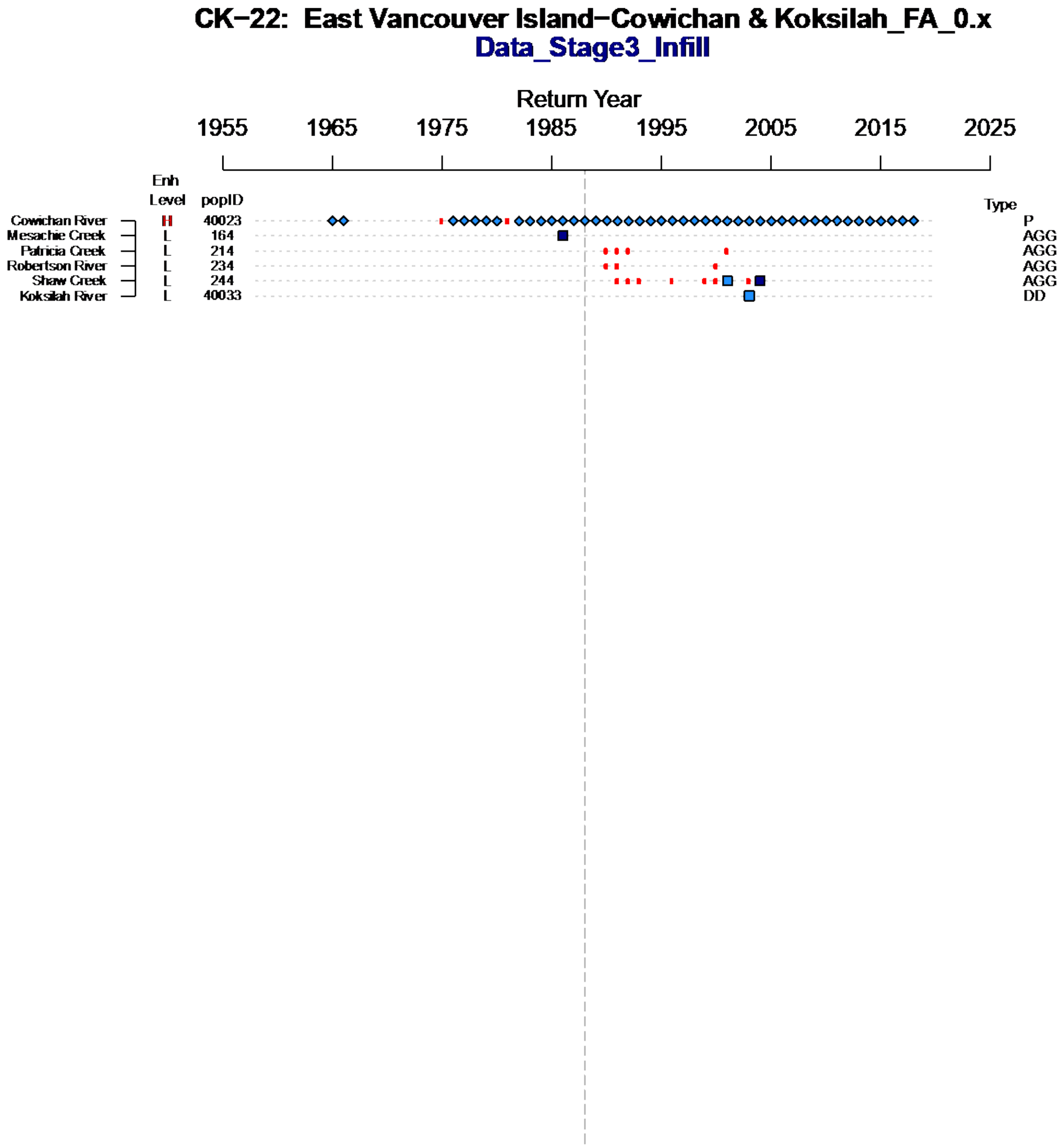

Figure 69. DU21 – Data quality by site. Graphics provided by Fisheries and Oceans Canada, see Appendix 1 Section 'Site-level data quality' for interpretation.

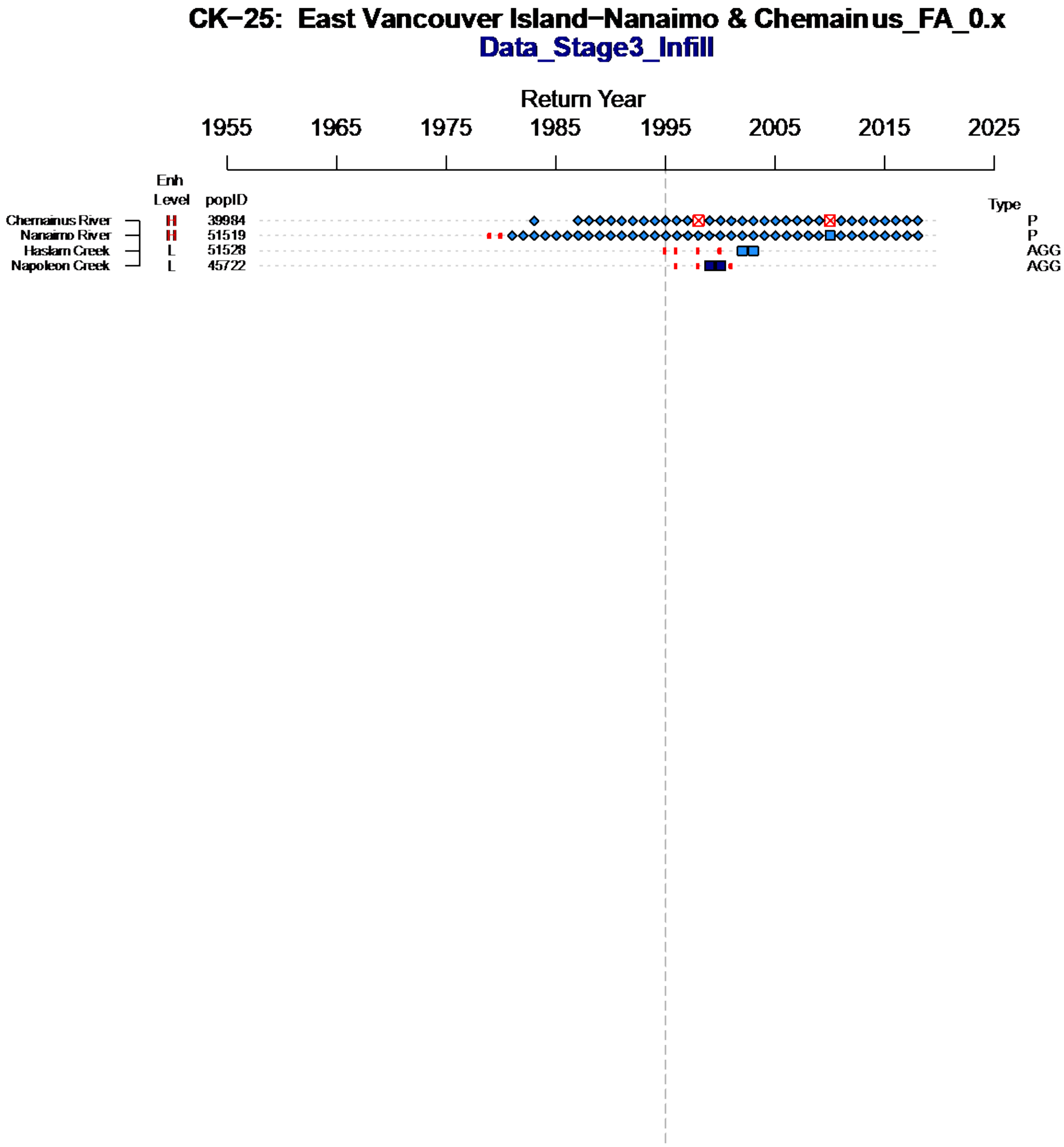

Figure 70. DU21 – Data quality by site. Graphics provided by Fisheries and Oceans Canada, see Appendix 1 Section ‘Site-level data quality’ for interpretation.

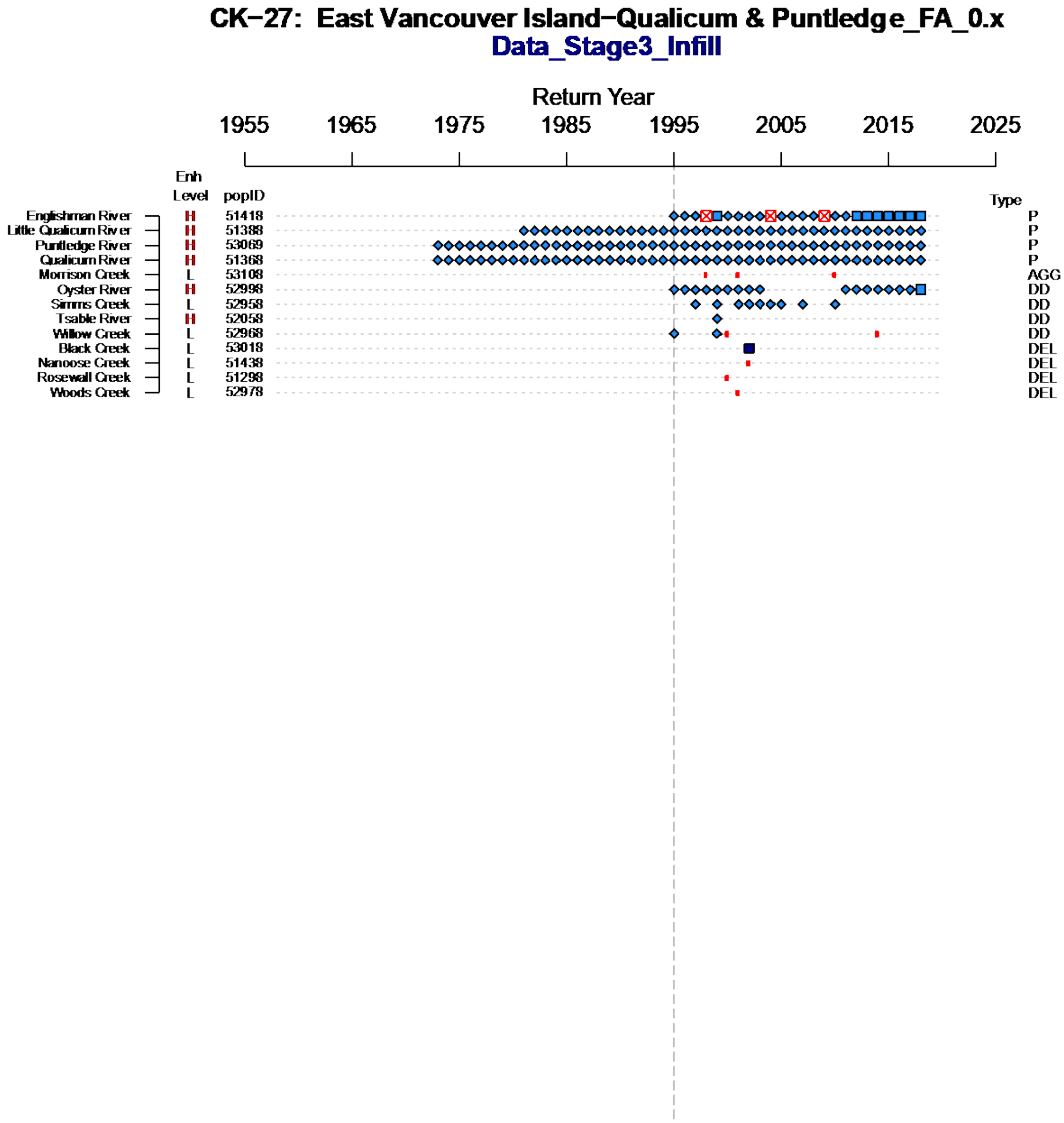

Figure 71. DU21 – Data quality by site. Graphics provided by Fisheries and Oceans Canada, see Appendix 1 Section ‘Site-level data quality’ for interpretation.

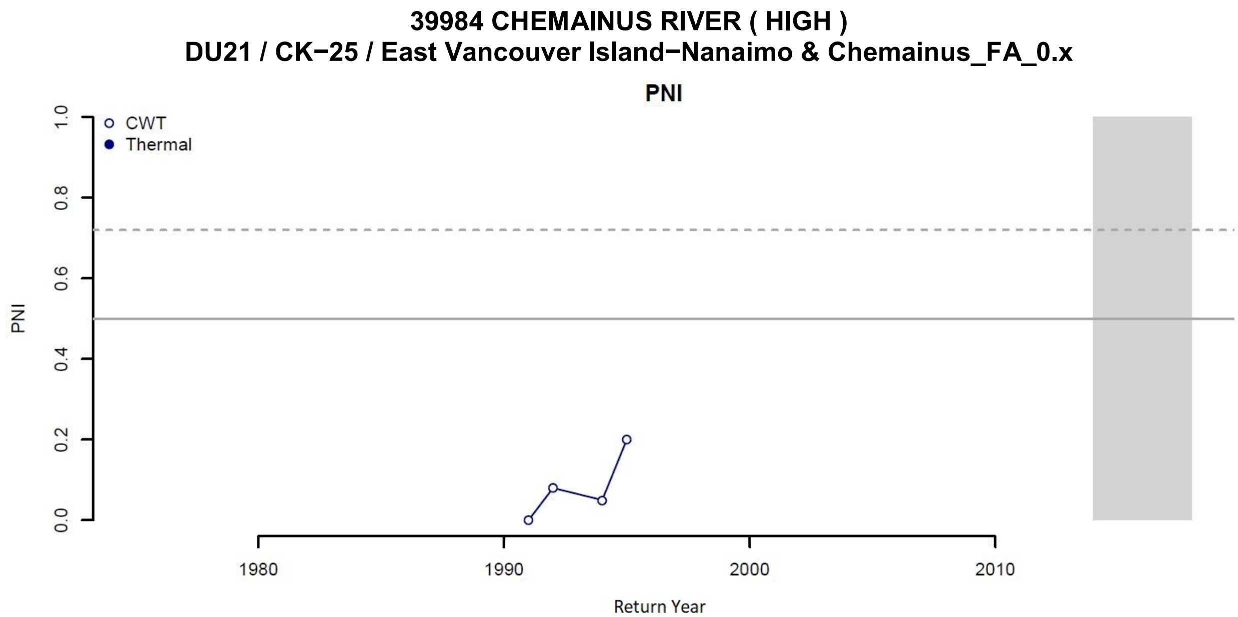

Figure 72. Chemainus River PNI over time. Graphics provided by Fisheries and Oceans Canada, see Appendix 1 Section 'PNI by site' for interpretation.

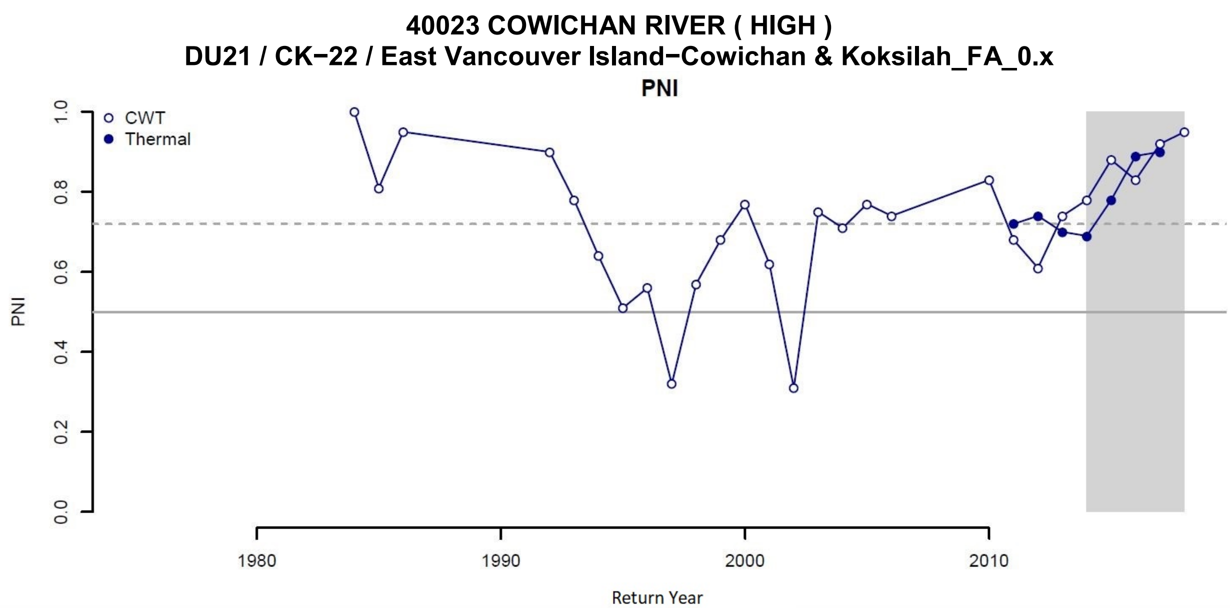

Figure 73. Cowichan River PNI over time. Graphics provided by Fisheries and Oceans Canada, see Appendix 1 Section 'PNI by site' for interpretation.

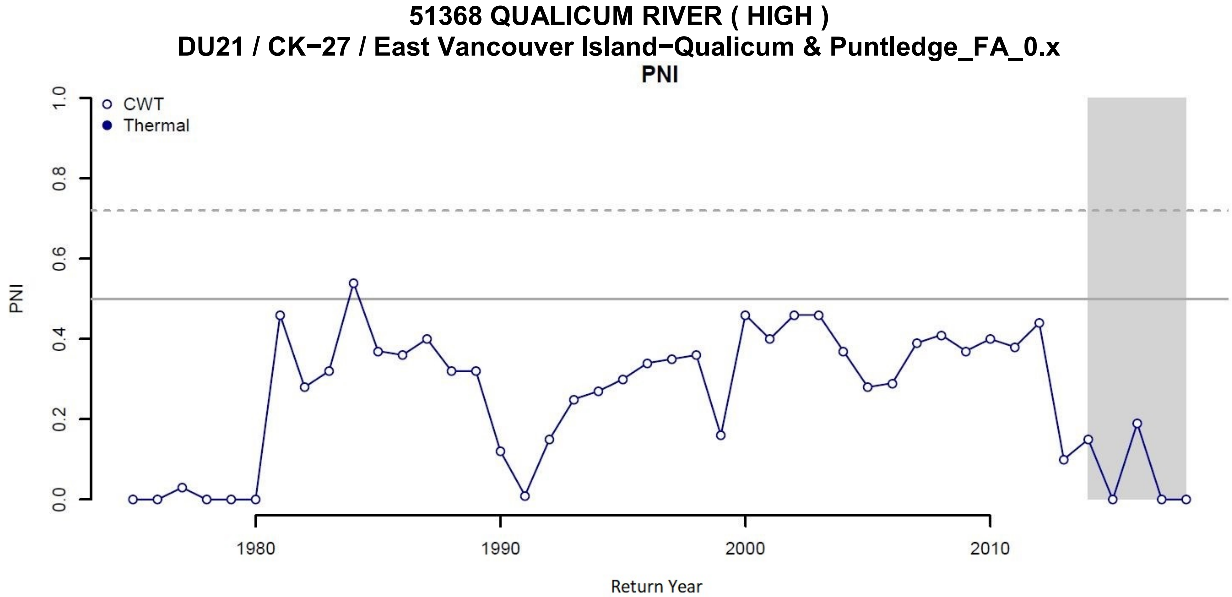

Figure 74. Qualicum River PNI over time. Graphics provided by Fisheries and Oceans Canada, see Appendix 1 Section 'PNI by site' for interpretation.

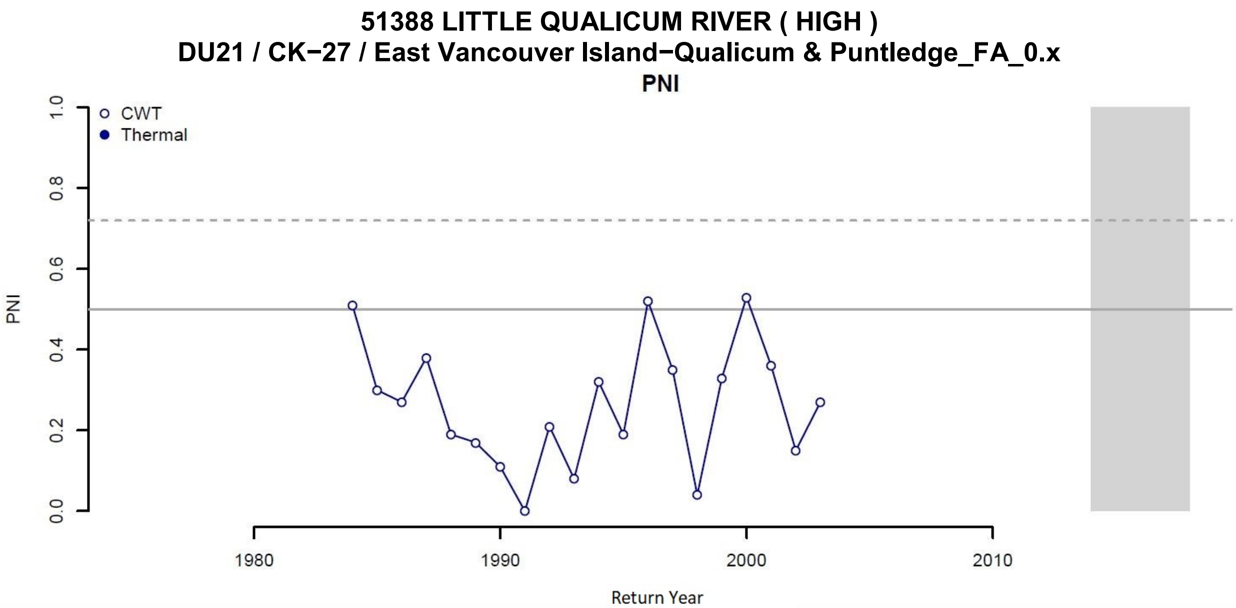

Figure 75. Little Qualicum River PNI over time. Graphics provided by Fisheries and Oceans Canada, see Appendix 1 Section 'PNI by site' for interpretation.

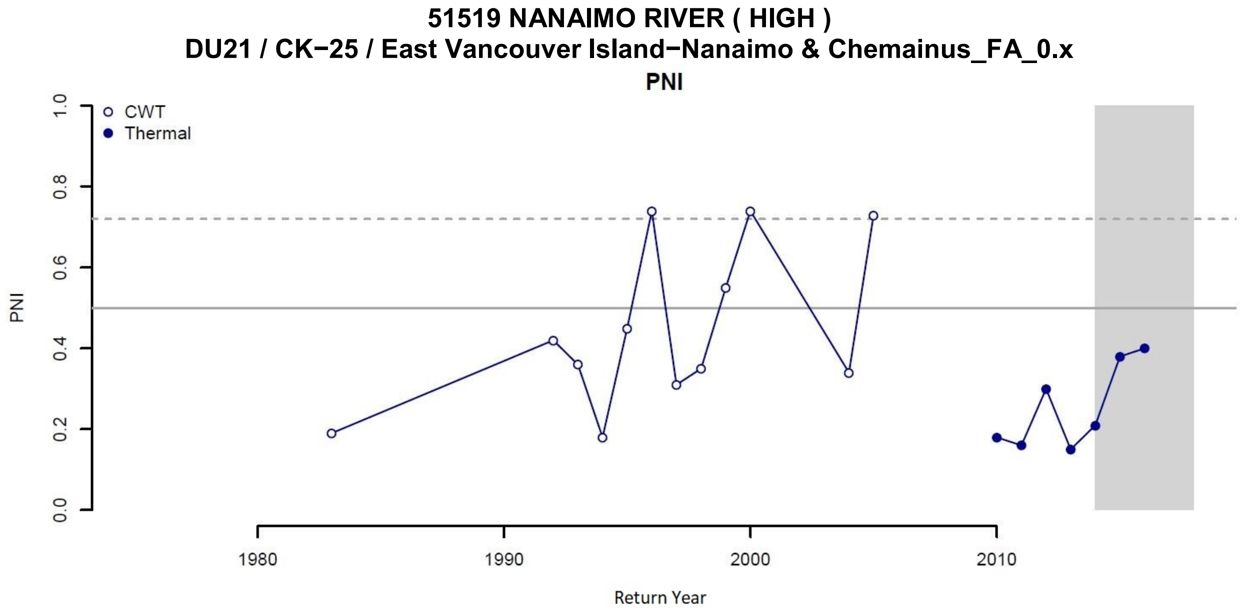

Figure 76. Nanaimo River PNI over time. Graphics provided by Fisheries and Oceans Canada, see Appendix 1 Section 'PNI by site' for interpretation.

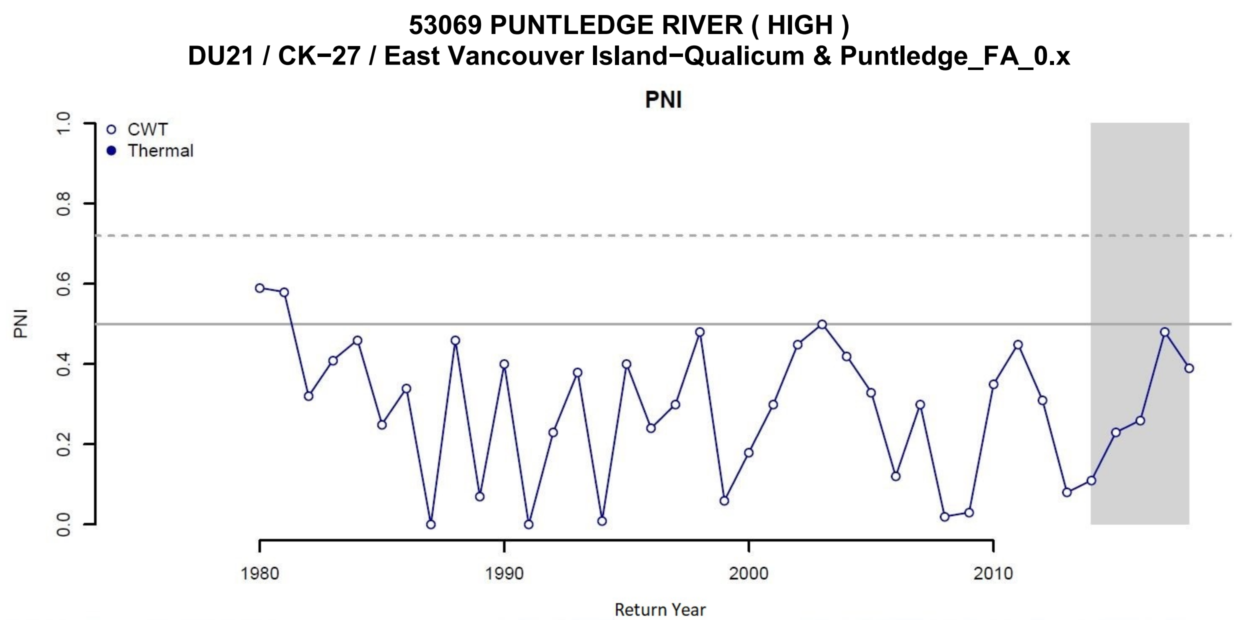

Figure 77. Puntledge River PNI over time. Graphics provided by Fisheries and Oceans Canada, see Appendix 1 Section 'PNI by site' for interpretation.

DU22

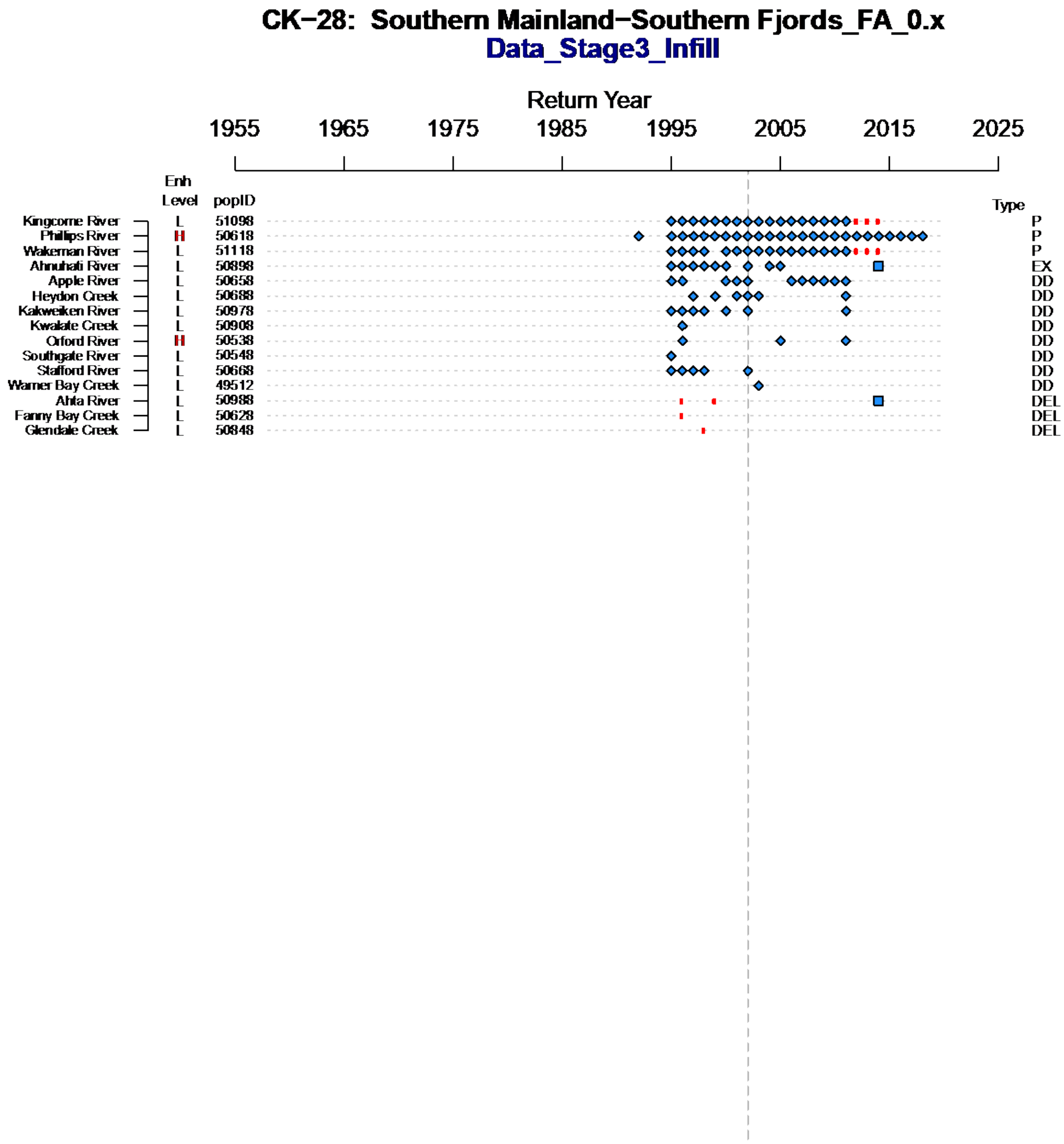

Figure 78. DU22 – Data quality by site. Graphics provided by Fisheries and Oceans Canada, see Appendix 1 Section 'Site-level data quality' for interpretation. Note that upon more recent review, Fisheries and Oceans Canada consider Kingcome and Wakeman Rivers to be Data Deficient.

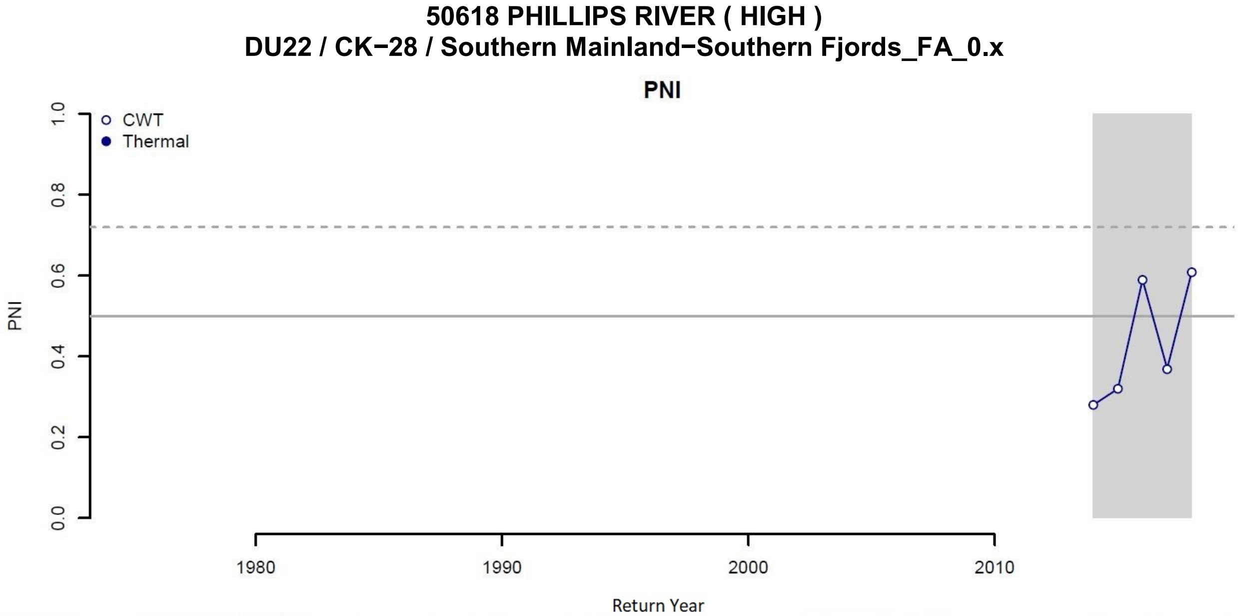

Figure 79. Phillips River PNI over time. Graphics provided by Fisheries and Oceans Canada, see Appendix 1 Section 'PNI by site' for interpretation.

DU23

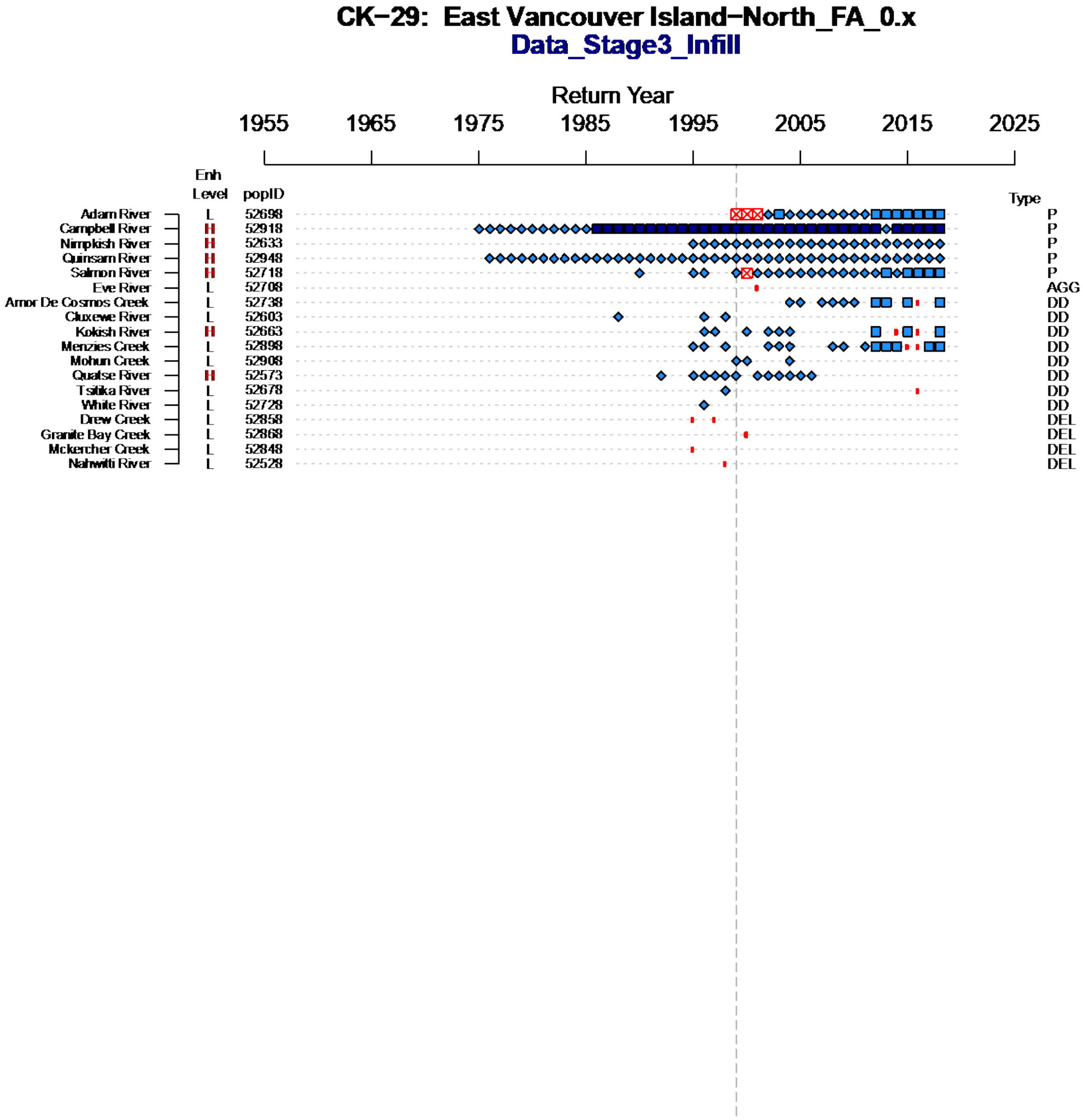

Figure 80. DU23 – Data quality by site. Graphics provided by Fisheries and Oceans Canada, see Appendix 1 Section 'Site-level data quality' for interpretation.

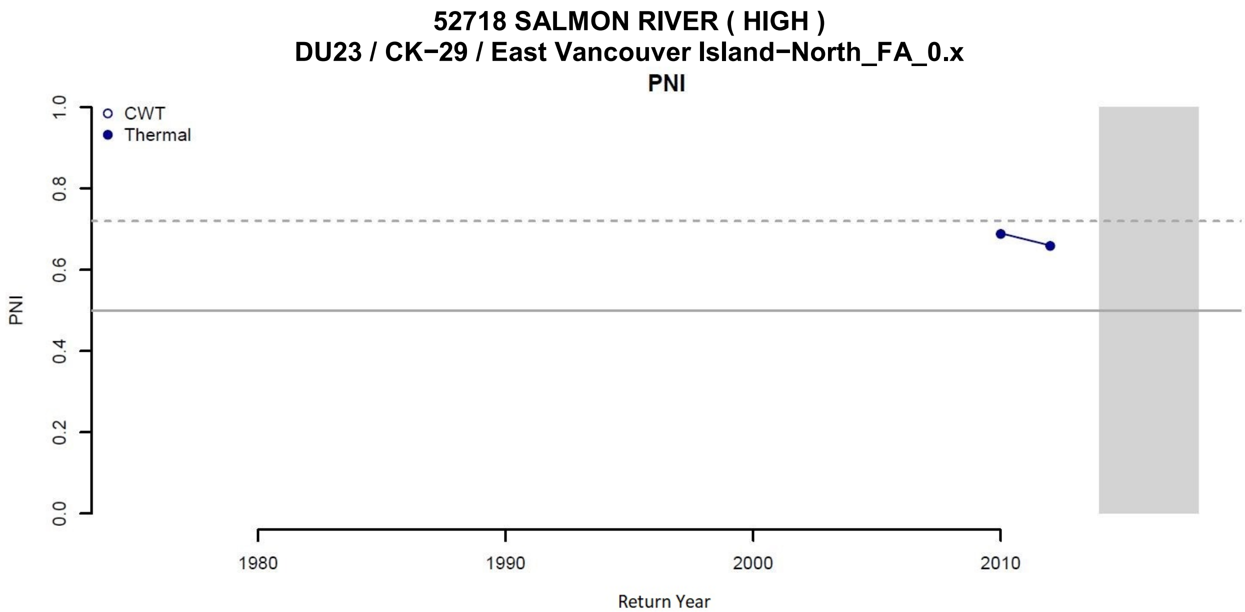

Figure 81. Salmon River PNI over time. Graphics provided by Fisheries and Oceans Canada, see Appendix 1 Section 'PNI by site' for interpretation.

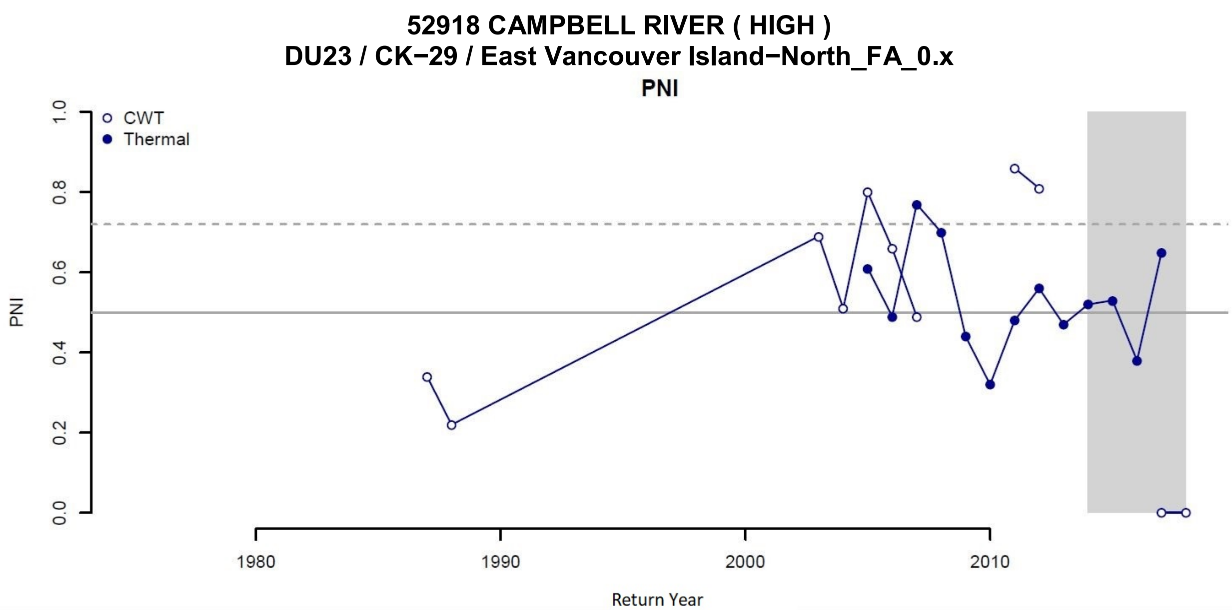

Figure 82. Campbell River PNI over time. Graphics provided by Fisheries and Oceans Canada, see Appendix 1 Section 'PNI by site' for interpretation.

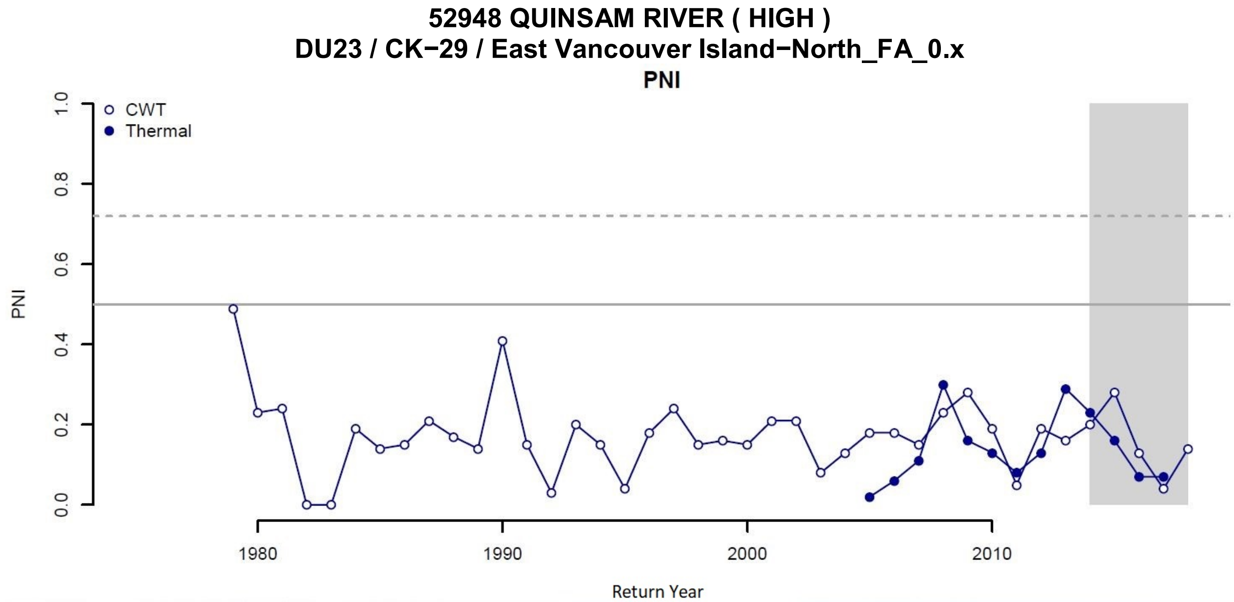

Figure 83. Quinsam River PNI over time. Graphics provided by Fisheries and Oceans Canada, see Appendix 1 Section 'PNI by site' for interpretation.

DU24

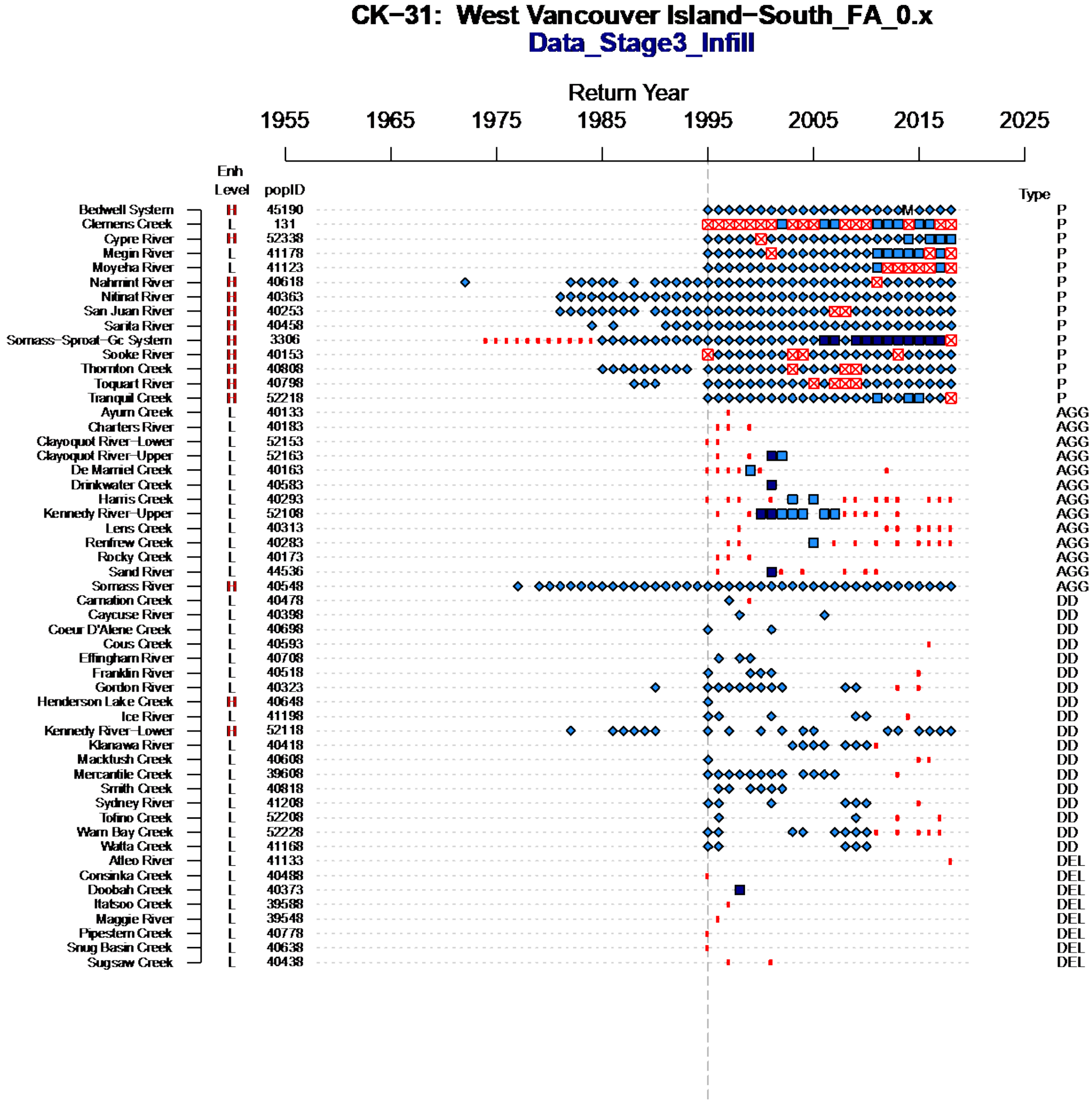

Figure 84. DU24 – Data quality by site. Graphics provided by Fisheries and Oceans Canada, see Appendix 1 Section 'Site-level data quality' for interpretation.

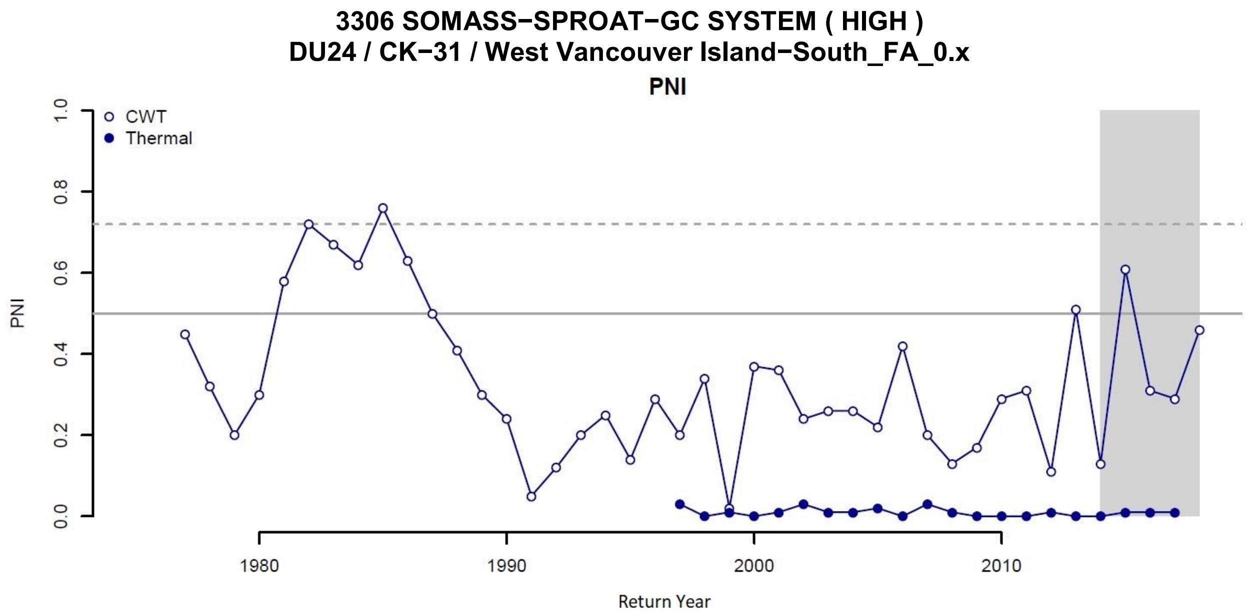

Figure 85. Somass-Sproat-GC System PNI over time. Graphics provided by Fisheries and Oceans Canada, see Appendix 1 Section 'PNI by site' for interpretation.

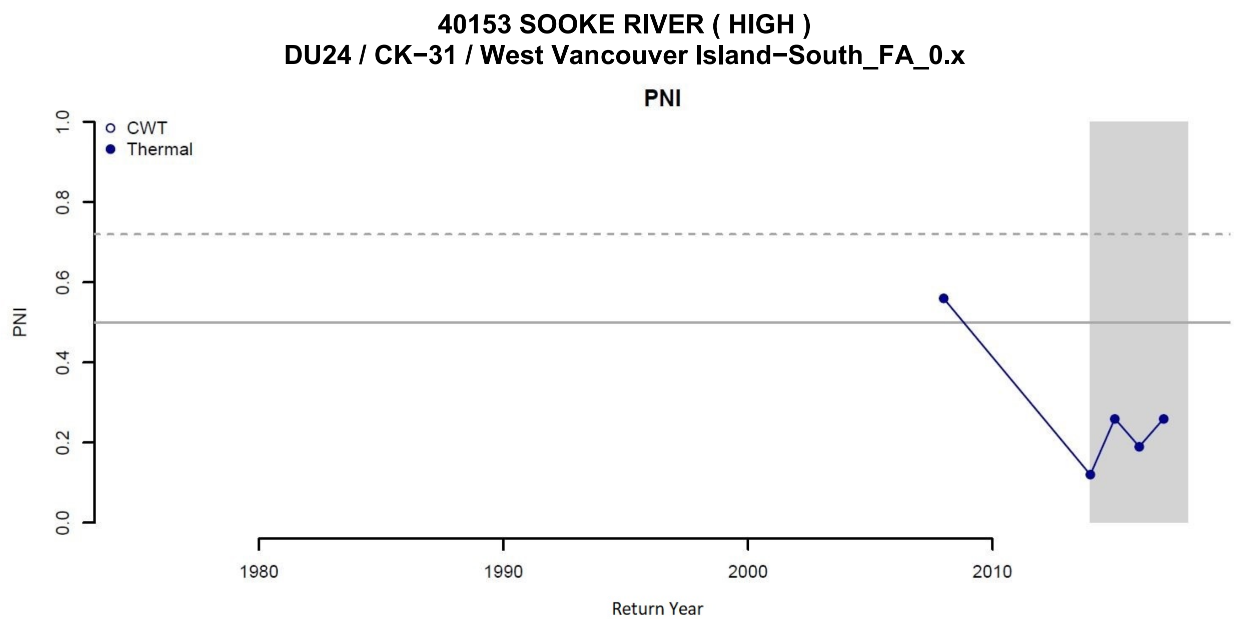

Figure 86. Sooke River PNI over time. Graphics provided by Fisheries and Oceans Canada, see Appendix 1 Section 'PNI by site' for interpretation.

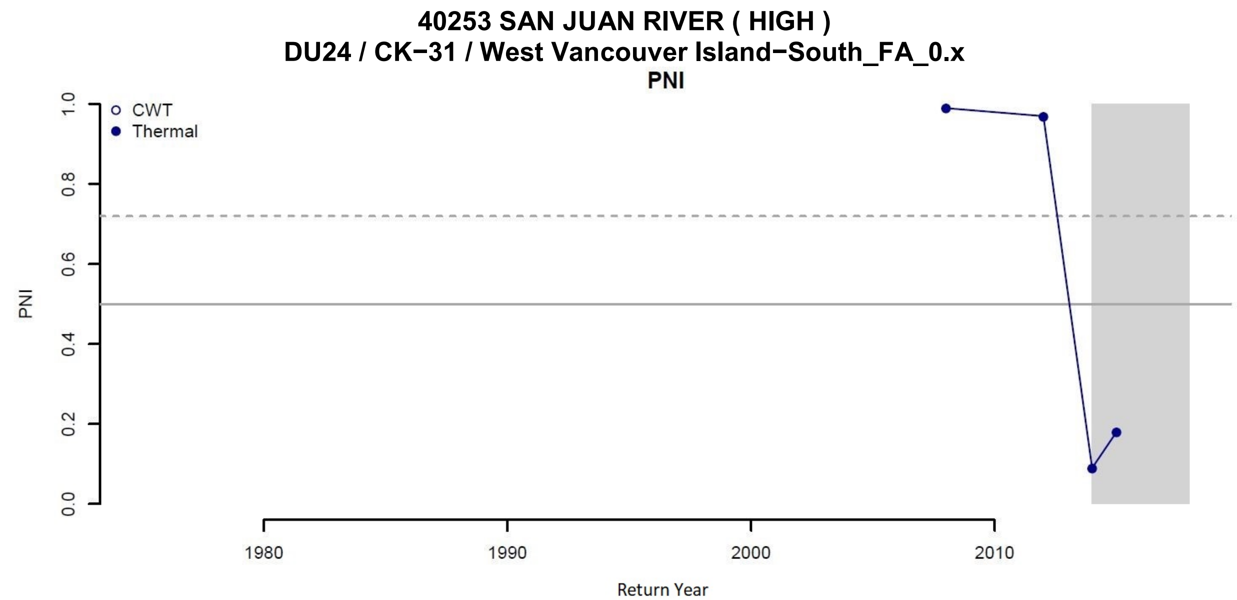

Figure 87. San Juan River PNI over time. Graphics provided by Fisheries and Oceans Canada, see Appendix 1 Section 'PNI by site' for interpretation.

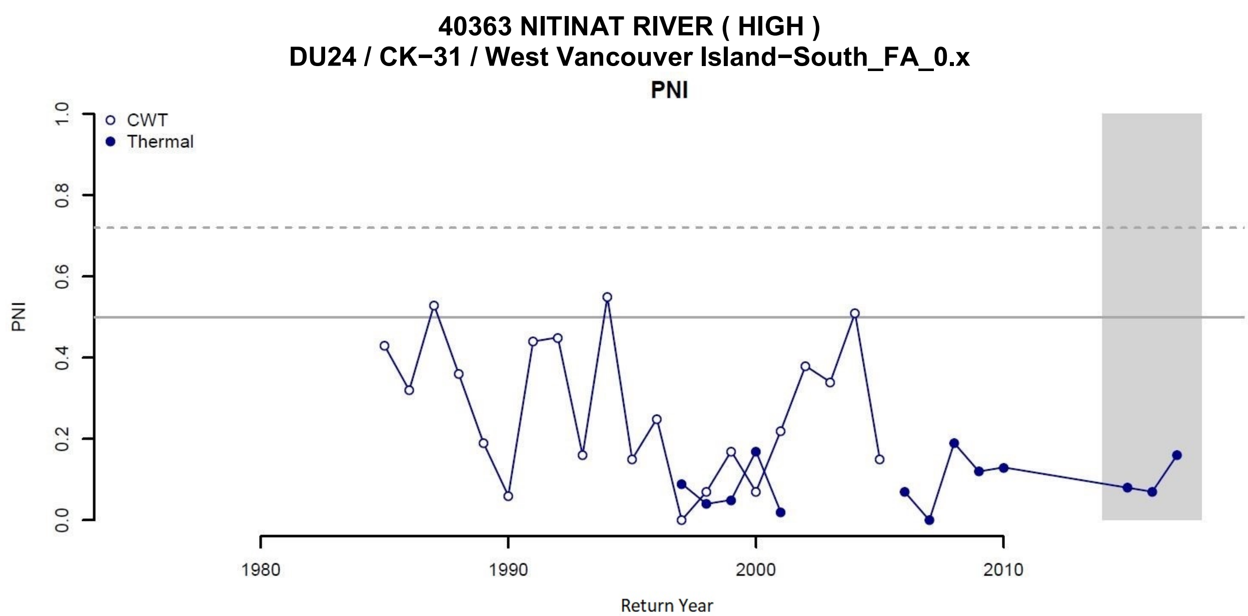

Figure 88. Nitinat River PNI over time. Graphics provided by Fisheries and Oceans Canada, see Appendix 1 Section 'PNI by site' for interpretation.

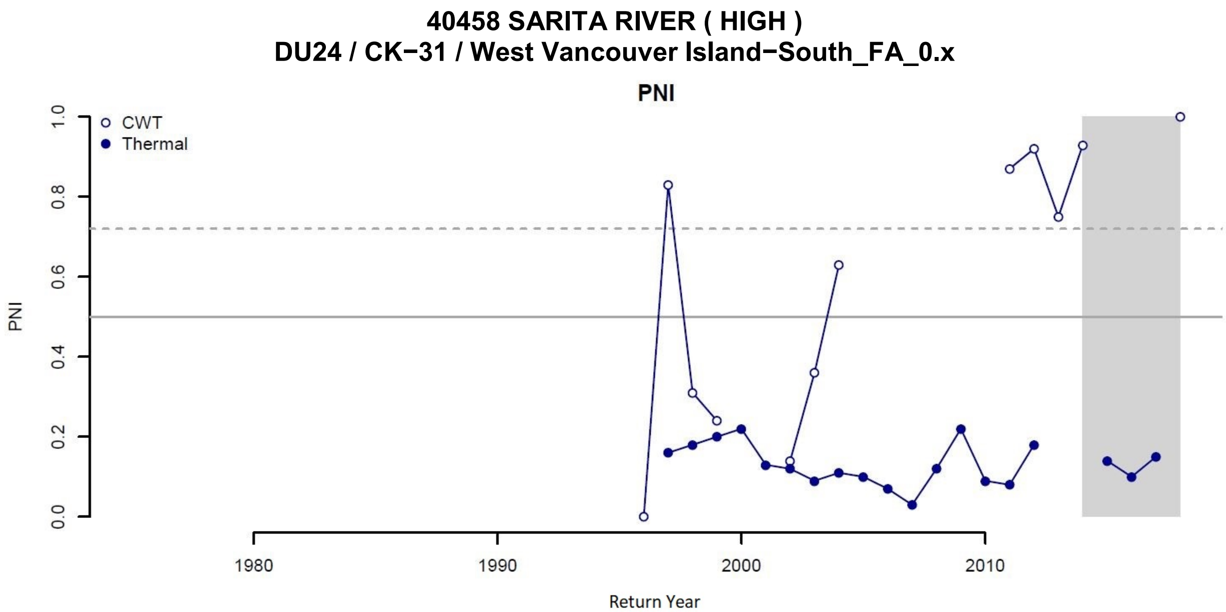

Figure 89. Sarita River PNI over time. Graphics provided by Fisheries and Oceans Canada, see Appendix 1 Section 'PNI by site' for interpretation.

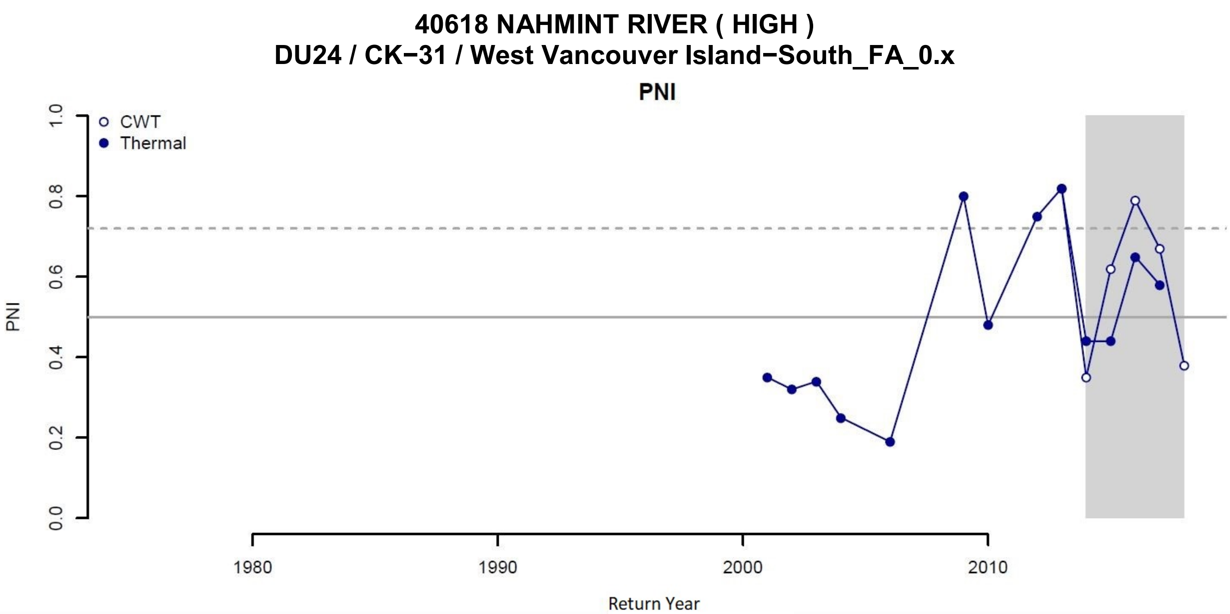

Figure 90. Nahmint River PNI over time. Graphics provided by Fisheries and Oceans Canada, see Appendix 1 Section 'PNI by site' for interpretation.

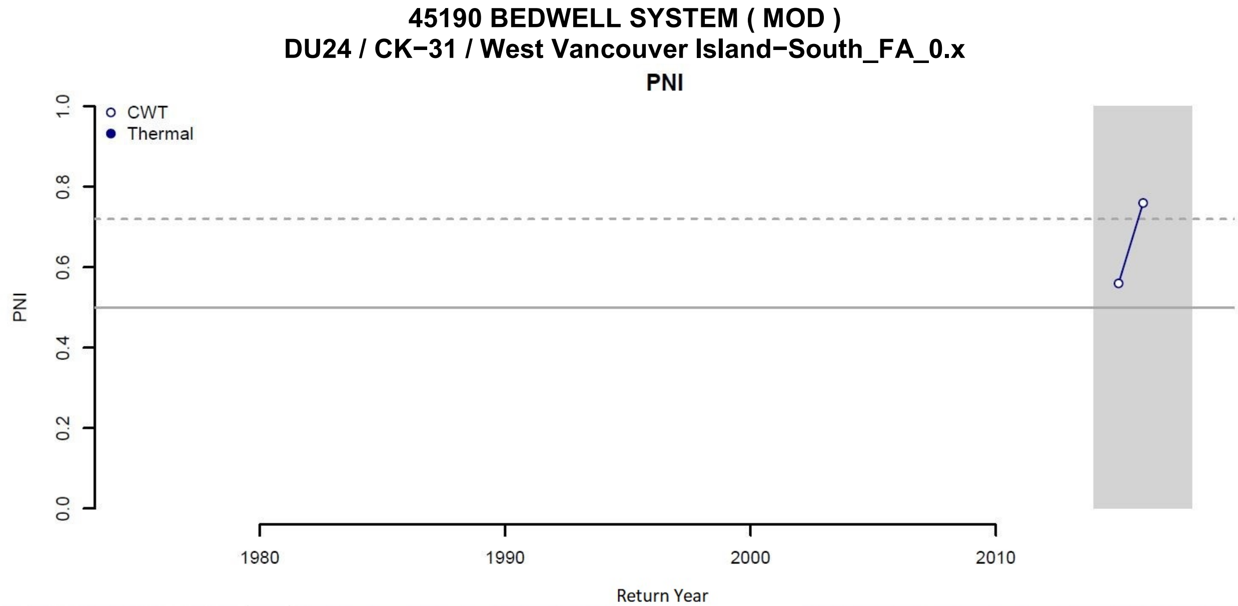

Figure 91. Bedwell River PNI over time. Graphics provided by Fisheries and Oceans Canada, see Appendix 1 Section ‘PNI by site’ for interpretation.

DU25

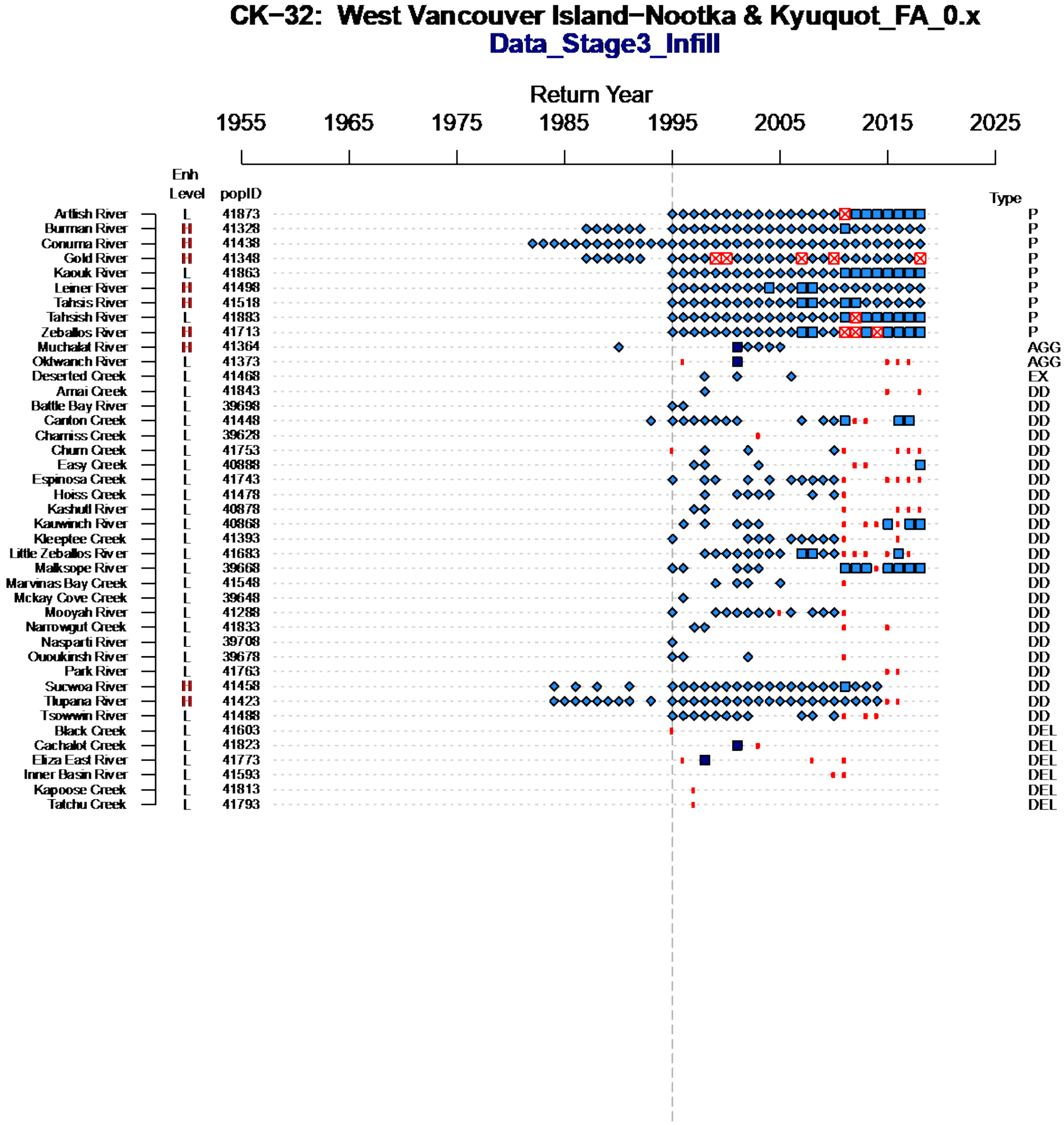

Figure 92. DU25 – Data quality by site. Graphics provided by Fisheries and Oceans Canada, see Appendix 1 Section ‘Site-level data quality’ for interpretation.

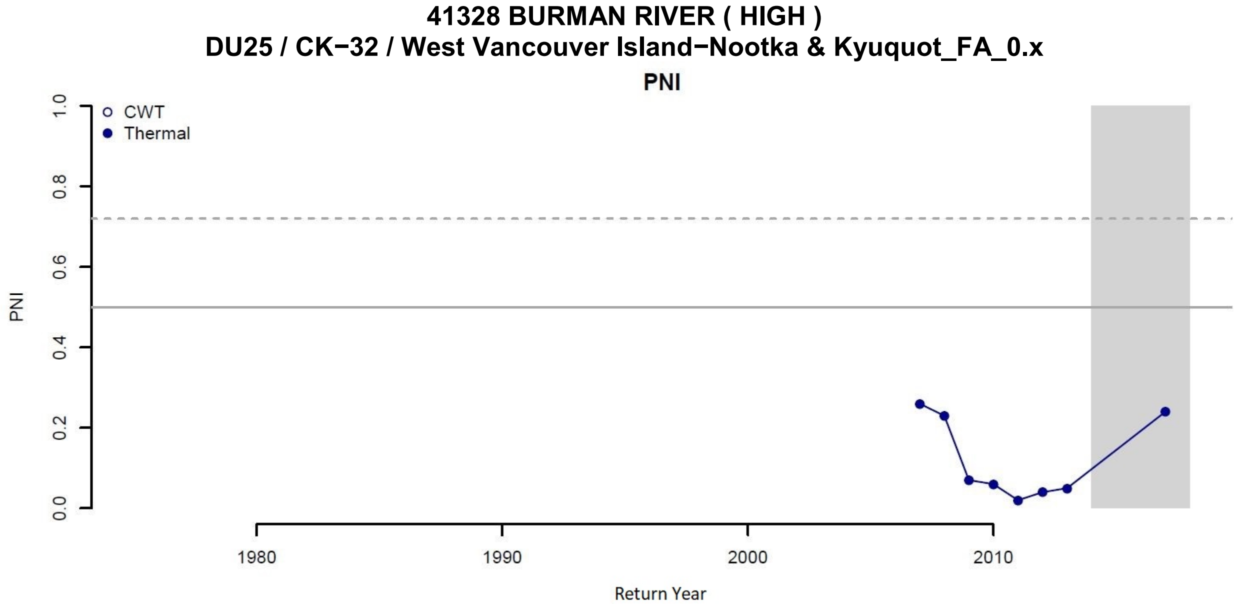

Figure 93. Burman River PNI over time. Graphics provided by Fisheries and Oceans Canada, see Appendix 1 Section 'PNI by site' for interpretation.

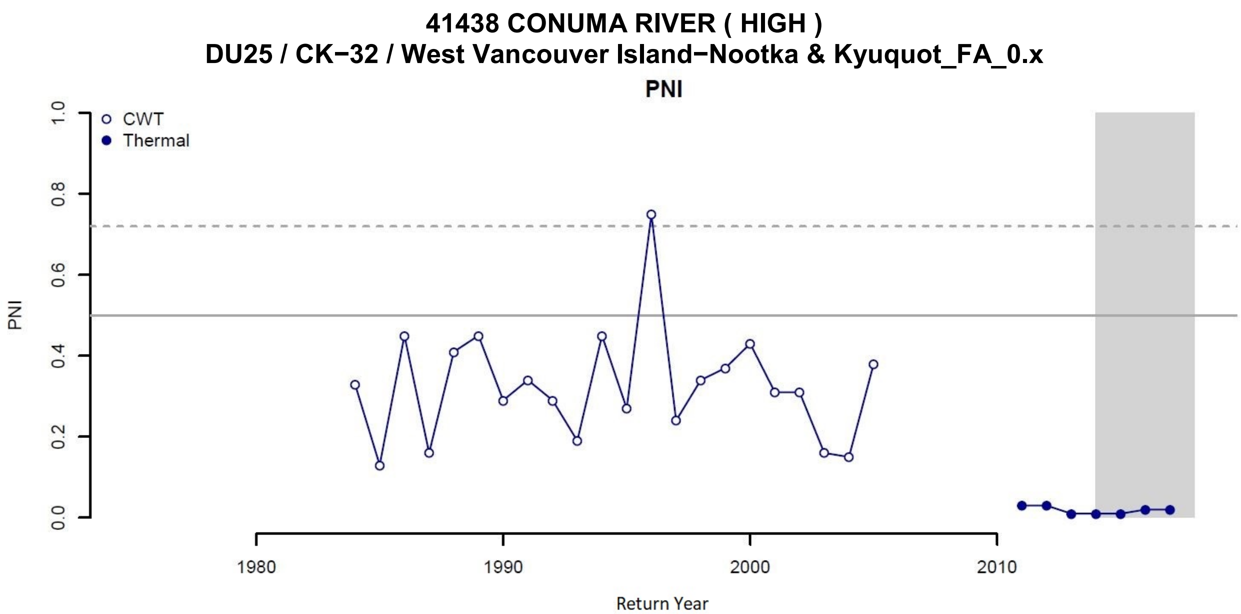

Figure 94. Conuma River PNI over time. Graphics provided by Fisheries and Oceans Canada, see Appendix 1 Section 'PNI by site' for interpretation.

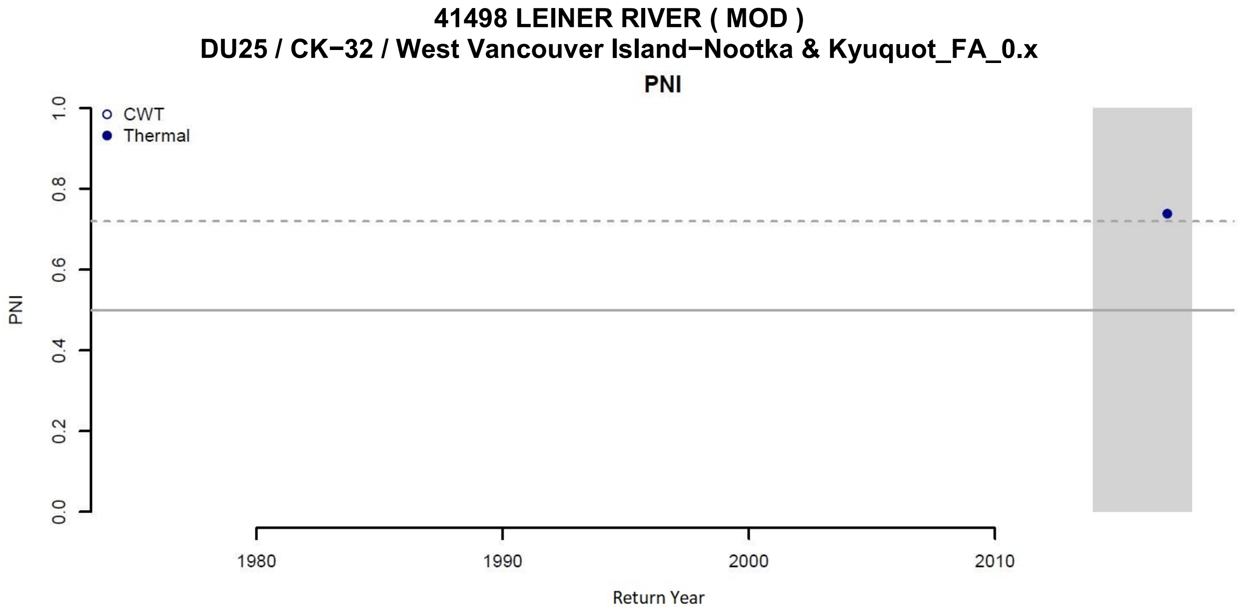

Figure 95. Leiner River PNI over time. Graphics provided by Fisheries and Oceans Canada, see Appendix 1 Section 'PNI by site' for interpretation.

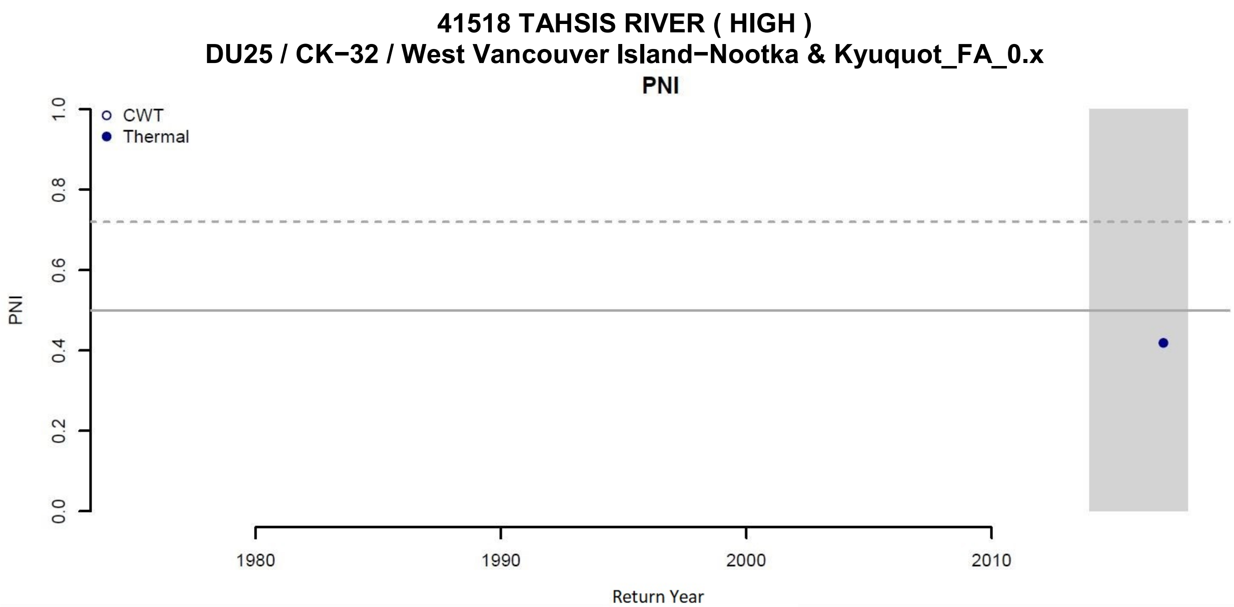

Figure 96. Tahsis River PNI over time. Graphics provided by Fisheries and Oceans Canada, see Appendix 1 Section 'PNI by site' for interpretation.

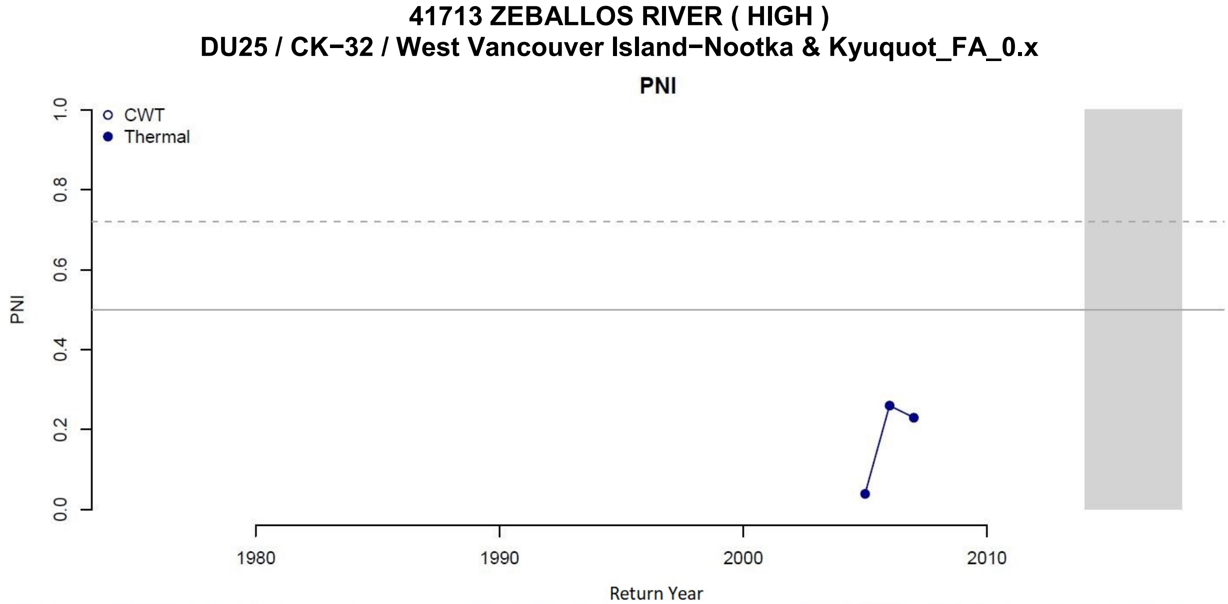

Figure 97. Zeballos River PNI over time. Graphics provided by Fisheries and Oceans Canada, see Appendix 1 Section 'PNI by site' for interpretation.

DU26

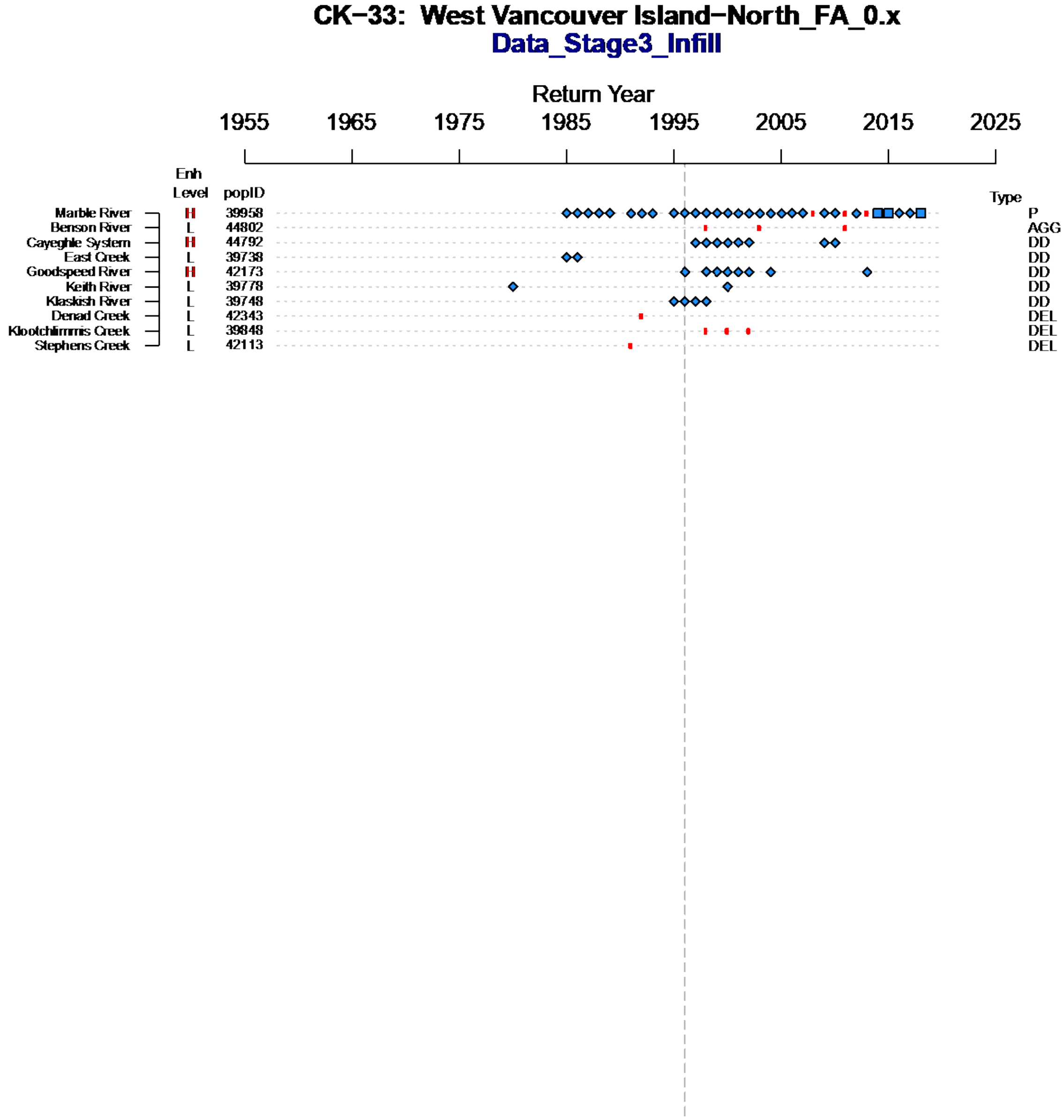

Figure 98. DU26 – Data quality by site. Graphics provided by Fisheries and Oceans Canada, see Appendix 1 Section 'Site-level data quality' for interpretation.

Appendix 2. Threats Calculators.

THREATS ASSESSMENT WORKSHEET			
Species or Ecosystem Scientific Name	*Oncorhynchus tshawytscha* - Chinook Salmon		
Element ID	**DU15 -Lower Thompson Stream Spring**	**Elcode**	
Date::	11/6/2014		
Assessor(s):	Brian O. Ma; modified 2/22/2017 in COSEWIC IUCN Threats Calculator workshop with Nicole Trouton, Greg Wilson, Jeff Grout, Cedar Morton, Carolyn Churchland, Richard Bailey, Marla Maxwell		
References:	(Porter *et al*. 2013; Riddell *et al*. 2013; Brown *et al*. 2013, Pre-COSEWIC report, in-prep)		

Overall Threat Impact Calculation Help:		Level 1 Threat Impact Counts	
Threat Impact		**high range**	**low range**
A	Very High	0	0
B	High	1	0
C	Medium	1	0
D	Low	2	4
Calculated Overall Threat Impact:		High	Medium
Assigned Overall Threat Impact:		**BC = High - Medium**	
Impact Adjustment Reasons:			
Overall Threat Comments		Generation time = just under 4yrs. The most important impacts in this DU are from ecosystem modifications (poor ocean survival from El Nino; groundwater/runoff mix and shifting timing/volume of snowmelt). Harvest rate has increased while marine survival rate has declined. However, Riddell *et al.* (2013) note that sustainable harvest is strongly tied to stock productivity, and this DU does not have a reliable estimate of stock productivity. Other less challenging impacts include: invasive species, avalanches/landslides, droughts and temperature extremes.	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
1	Residential & commercial development						
1.1	Housing & urban areas						Urban development is considered low in the land-based area of this DU (0.2%) (Porter *et al.* 2013). This rate of urbanization is expected to continue.
1.2	Commercial & industrial areas						None
1.3	Tourism & recreation areas						None
2	Agriculture & aquaculture		Negligible	Large (31-70%)	Negligible (<1%)	High (Continuing)	

Threat		Impact (calculated)	Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
2.1	Annual & perennial non-timber crops					Only 0.4% of the land-based area is agricultural (Porter *et al*. 2013) and this is expected to continue.
2.2	Wood & pulp plantations					None
2.3	Livestock farming & ranching					None
2.4	Marine & freshwater aquaculture	Negligible	Large (31-70%)	Negligible (<1%)	High (Continuing)	Atlantic salmon farms are located higher north than the mouth of the Fraser River, but most wild Chinook pass these at some point so the scope is broad. The risks of open net-pen salmon aquaculture on wild Chinook salmon are considered low in the literature but data are limited (Riddell *et al*. 2013). Fish aquaculture will likely continue to expand in the future, but in this category the proximal impact is from loss of habitat due to farm footprints. The issues of disease transfer & genetic enhancement will be dealt with in line item 8.3
3	Energy production & mining	Unknown	Small (1-10%)	Unknown	High (Continuing)	
3.1	Oil & gas drilling					None
3.2	Mining & quarrying	Unknown	Small (1-10%)	Unknown	High (Continuing)	Mining covers 0% of the land-base (Porter *et al*. 2013) but there is the possibility of some unreported Placer mining. More information to be collected from Mike Bradford.
3.3	Renewable energy					None
4	Transportation & service corridors	Negligible	Negligible (<1%)	Unknown	High (Continuing)	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
4.1	Roads & railroads		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	Road density in this area is 1.2 km/km2, and there are 0.6 stream crossings per km of fish accessible streams. These are the moderate values relative to other southern BC Chinook DUs. Road densities are presented in linear dimensions in Porter *et al*. (2013). Assuming each road is 100m wide (0.1 km wide), which is an overestimate, the percent of land covered by roads is still <1%. Existing road infrastructure is expected to remain in place but development trend is unknown. Most effect of roads in this DU is from runoff of pollution (threat 9). Roads themselves not an issue.
4.2	Utility & service lines						None
4.3	Shipping lanes						None
4.4	Flight paths						None
5	Biological resource use		Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)	
5.1	Hunting & collecting terrestrial animals						None
5.2	Gathering terrestrial plants						None
5.3	Logging & wood harvesting		Negligible	Restricted (11-30%)	Negligible (<1%)	High (Continuing)	17.2% of forest was disturbed in this area (Porter *et al*. 2013). There will be some logging development in future.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
5.4	Fishing & harvesting aquatic resources		Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)	Total exploitation of southern BC Chinook salmon has been between 25% to 50% in recent years (since 1995) (Riddell *et al*. 2013). Comparable rates of harvest are expected to continue for the foreseeable future. It is worth noting that although the IUCN Impact rating is Very High, the levels of exploitation are typically compared to expected exploitation for Maximum Sustainable Yield (EMSY), and any level below this is considered sustainable. However, because there is no indicator stock for this DU, EMSY has not been estimated and there is no direct measurement of total exploitation specific to this DU. All fish from DU15 have to migrate through fisheries (e.g. lower Chilcotin). Fish encounter nets all the way up.
6	Human intrusions & disturbance						
6.1	Recreational activities						None
6.2	War, civil unrest & military exercises						None
6.3	Work & other activities						None
7	Natural system modifications	BD	High - Low	Pervasive (71-100%)	Serious - Slight (1-70%)	High (Continuing)	
7.1	Fire & fire suppression						None
7.2	Dams & water management/use		Unknown	Large (31-70%)	Unknown	High (Continuing)	According to Porter *et al*. (2013), 237.1 m3/ha of water are allocated. No dams impede movement for this DU. Loss of Sumas Lake, diking and ditching has had a major impact on lower Fraser habitat which these fish pass through. Substantial numbers of Chinook rely on those habitats (e.g. rearing, overwintering) but it is unknown how many are affected.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
7.3	Other ecosystem modifications	BD	High - Low	Pervasive (71-100%)	Serious - Slight (1-70%)	High (Continuing)	15.4% of the riparian area within the DU has been disturbed (Porter *et al.* 2013). This stock migrates as juveniles up along coast to Alaska. Another round of ocean survival impacts as in 2003/2007 would terminate it. It's not just ocean impacts, in-stream is also problematic. But if ocean survival could return to 5% it would reverse decline. In-stream, females in spring actively seek a mix of groundwater/runoff. Shifting snowmelt and snowpack means groundwater recharge is altered. Ranking here is based on a combination of potential marine survival impacts (e.g. El Nino) coupled with groundwater/runoff issues. El Nino makes it worse La Nina makes it better.
8	Invasive & other problematic species & genes	D	Low	Small (1-10%)	Slight (1-10%)	High (Continuing)	
8.1	Invasive non-native/alien species	D	Low	Small (1-10%)	Slight (1-10%)	High (Continuing)	Some impacts from spiny rays (bass, persids, etc.); small mouth bass & yellow perch in Quesnel. Possible future impacts of "whirling disease" - transmission vector not yet well known but thought to be related to anglers.
8.2	Problematic native species		Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)	3.3% of pine stands were killed by Mountain Pine Beetles in this area (Porter *et al.* 2013) but the impact has already passed. All fish from this DU are affected by ocean predators (e.g. seals, sea lions). The impact is considered relatively stable (i.e. it's as bad as it's going to be and it's not likely to get worse).
8.3	Introduced genetic material						Of the years where sampling occurred, mature individuals all originated from streams that had low or unknown levels of enhancement. There were only two known hatchery releases in this DU that occurred during the 1980s.
9	Pollution		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
9.1	Household sewage & urban waste water		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	No permitted waste water discharge locations within this DU (Porter *et al*. 2013). However, wastewater treatment plants exist all down the Fraser River. There is a pervasive domestic sewage impact. The volume will rise as the population is growing but directly linking this to a decline in this DU's Chinook populations over next 12yrs would be tough.
9.2	Industrial & military effluents		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	A lot of impact from industrial development throughout migration route in lower Fraser River
9.3	Agricultural & forestry effluents		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	Definitely impacts from agricultural effluent in mid and lower Fraser River that affect all fish from this DU. There is forestry activity upstream that will move more upslope. Forestry causes changes in groundwater recharge.
9.4	Garbage & solid waste		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	Fish consume plastic (micro and macro) - 2-7 microplastic particles per day. Research is ongoing.
9.5	Air-borne pollutants						None
9.6	Excess energy						None
10	Geological events	D	Low	Small (1-10%)	Slight (1-10%)	High (Continuing)	
10.1	Volcanoes						None
10.2	Earthquakes/tsunamis						None
10.3	Avalanches/landslides	D	Low	Small (1-10%)	Slight (1-10%)	High (Continuing)	Only minor impacts
11	Climate change & severe weather	CD	Medium - Low	Pervasive (71-100%)	Moderate - Slight (1-30%)	High (Continuing)	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
11.1	Habitat shifting & alteration		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	In a recent report evaluating threats to southern BC Chinook salmon by Riddell *et al*. (2013), the panel concluded that marine habitat conditions during the first year of marine residency were very likely a key driver in recent trends in survival and productivity. Shifting marine habitat will be experienced by all Chinook salmon in this DU (i.e., scope = pervasive). However, the severity is unknown because there is no indicator stock available for this DU, so marine survival cannot be estimated. Major changes expected in ocean in terms of upwelling, anoxic areas ("the blob"). Also, another round of ocean survival impacts as in 2003/2007 would terminate this stock. Ranking here is based on potential marine survival impacts (e.g. El Nino). El Nino makes it worse La Nina makes it better.
11.2	Droughts	CD	Medium - Low	Pervasive (71-100%)	Moderate - Slight (1-30%)	High (Continuing)	These fish are relatively resilient but there could be more than 10% severity over next 10-15yrs. Hard to predict. A lot would change if the Fraser becomes a migration barrier, but if that occurred there would be far worse problems than drought.
11.3	Temperature extremes	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	Stream temperatures will continue to rise to critical levels (>18C) based on current projections (Porter *et al*. 2013). These increases in stream temperatures are expected to affect the entire population (i.e., the scope is pervasive). This impact is expected to be continuing into the future. However, the severity of this is unknown because of limited data (Riddell *et al*. 2013).
11.4	Storms & flooding						
Classification of Threats adopted from IUCN-CMP, Salafsky *et al.* (2008)							

THREATS ASSESSMENT WORKSHEET			
Species or Ecosystem Scientific Name	*Oncorhynchus tshawytscha* - Chinook Salmon		
Element ID	**DU20 BC East Vancouver Island Ocean summer**	**Elcode**	
Date:	2/22/21		
Assessor(s):	Originally assessed by Brian O. Ma in November, 2014. Revised in February 2017 workshop by Wilf Luedke, Steve Baillie, Arlene Tompkins, Jason Mahoney, Cheryl Lynch, John Neilson (Marine Fishes SSC Co-chair), David Fraser (Facilitator), Bev McBride (COSEWIC Secretariat). Updated August 2019 by the Marine Fishes SSC and DFO Expert Observers.		
References:	(Porter *et al*. 2013; Riddell *et al*. 2013; Brown *et al*. 2013, Pre-COSEWIC report, in-prep)		
Overall Threat Impact Calculation Help:		**Level 1 Threat Impact Counts**	
Threat Impact		**high range**	**low range**
A	Very High	0	0
B	High	0	0
C	Medium	2	2
D	Low	2	2
Calculated Overall Threat Impact:		High	High
Assigned Overall Threat Impact:		**B = High**	
Impact Adjustment Reasons:			
Overall Threat Comments		Generation Time 3.5 years. There is some uncertainty in the status of the Cowichan R. summer run so these comments pertain to Nanaimo River (several 100) and Puntledge River (approx 1000) only. Part of population is under captive breeding.	

Threat		**Impact (calculated)**		**Scope (next 10 Yrs)**	**Severity (10 Yrs or 3 Gen.)**	**Timing**	**Comments**
1	Residential & commercial development	D	Low	Small (1-10%)	Slight (1-10%)	High (Continuing)	
1.1	Housing & urban areas	D	Low	Small (1-10%)	Slight (1-10%)	High (Continuing)	
1.2	Commercial & industrial areas		Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)	Log booms in estuaries.
1.3	Tourism & recreation areas						
2	Agriculture & aquaculture		Unknown	Small (1-10%)	Unknown	High (Continuing)	
2.1	Annual & perennial non-timber crops						
2.2	Wood & pulp plantations						
2.3	Livestock farming & ranching		Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)	
2.4	Marine & freshwater aquaculture		Unknown	Small (1-10%)	Unknown	High (Continuing)	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
3	Energy production & mining		Negligible	Negligible (<1%)	Slight (1-10%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	
3.1	Oil & gas drilling						
3.2	Mining & quarrying		Negligible	Negligible (<1%)	Slight (1-10%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	Old copper mine subsiding is to affect hydrology, although it is uncertain how. New coal mining is expected.
3.3	Renewable energy						
4	Transportation & service corridors						
4.1	Roads & railroads						
4.2	Utility & service lines						
4.3	Shipping lanes						
4.4	Flight paths						
5	Biological resource use		Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)	
5.1	Hunting & collecting terrestrial animals						
5.2	Gathering terrestrial plants						
5.3	Logging & wood harvesting		Negligible	Negligible (<1%)	Slight (1-10%)	High (Continuing)	
5.4	Fishing & harvesting aquatic resources		Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)	
6	Human intrusions & disturbance						
6.1	Recreational activities						Some concern about interference from swimmers in Puntledge.
6.2	War, civil unrest & military exercises						
6.3	Work & other activities						
7	Natural system modifications	C	Medium	Pervasive (71-100%)	Moderate (11-30%)	High (Continuing)	
7.1	Fire & fire suppression	D	Low	Small (1-10%)	Moderate (11-30%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	
7.2	Dams & water management/use	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	Dams may provide a net benefit, however Comox dam creates a barrier.
7.3	Other ecosystem modifications	C	Medium	Pervasive (71-100%)	Moderate (11-30%)	High (Continuing)	Channelization and other threats from habitat alteration.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
8	Invasive & other problematic species & genes	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	
8.1	Invasive non-native/alien species						
8.2	Problematic native species	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	
8.3	Introduced genetic material		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	More expert input to rank "severity" is needed.
9	Pollution		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	
9.1	Household sewage & urban waste water		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	
9.2	Industrial & military effluents		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	
9.3	Agricultural & forestry effluents		Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)	
9.4	Garbage & solid waste		Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)	
9.5	Air-borne pollutants						
9.6	Excess energy						
10	Geological events		Negligible	Restricted (11-30%)	Negligible (<1%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	
10.1	Volcanoes						
10.2	Earthquakes/tsunamis		Negligible	Restricted (11-30%)	Negligible (<1%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	Tsunamis are possible. Underwater landslides could affect water levels.
10.3	Avalanches/landslides						
11	Climate change & severe weather	C	Medium	Pervasive (71-100%)	Moderate (11-30%)	High (Continuing)	
11.1	Habitat shifting & alteration	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	
11.2	Droughts	C	Medium	Pervasive (71-100%)	Moderate (11-30%)	High (Continuing)	
11.3	Temperature extremes	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	
11.4	Storms & flooding	D	Low	Large (31-70%)	Slight (1-10%)	High (Continuing)	
Classification of Threats adopted from IUCN-CMP, Salafsky *et al.* (2008).							

THREATS ASSESSMENT WORKSHEET			
Species or Ecosystem Scientific Name	***Oncorhynchus tshawytscha* - Chinook Salmon**		
Element ID	**DU21 BC East Vancouver Island Ocean Fall**	**Elcode**	
Date (Ctrl + ";" for today's date):	2/22/2017		
Assessor(s):	Originally assessed by Brian O. Ma in November, 2014. Revised in February 2017. Workshop attendees: Wilf Luedke, Steve Baillie, Arlene Tompkins, Jason Mahoney, Cheryl Lynch, Roger Gallant, John Neilson (Marine Fishes SSC Co-chair), David Fraser (Facilitator), Bev McBride (COSEWIC Secretariat). Updated August 2019 by the Marine Fishes SSC and DFO Expert Observers.		
References:	(Porter *et al*. 2013; Riddell *et al*. 2013; Brown *et al*. 2013, Pre-COSEWIC report, in-prep)		

Overall Threat Impact Calculation Help:		Level 1 Threat Impact Counts	
Threat Impact		high range	low range
A	Very High	0	0
B	High	0	0
C	Medium	1	1
D	Low	3	3
Calculated Overall Threat Impact:		High	High
Assigned Overall Threat Impact:		B = High	
Impact Adjustment Reasons:			
Overall Threat Comments		Generation Time 3.5 years.	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
1	Residential & commercial development	D	Low	Small (1-10%)	Slight (1-10%)	High (Continuing)	
1.1	Housing & urban areas	D	Low	Small (1-10%)	Slight (1-10%)	High (Continuing)	Changes to riparian zone mostly due to landscaping near shoreline. Severity is at low end of 1-10 range.
1.2	Commercial & industrial areas						See Mining and Quarrying below re. mining. More development is expected but it is not thought to affect Chinook habitat. No more filling of wetlands is expected due to regulation.
1.3	Tourism & recreation areas						
2	Agriculture & aquaculture		Unknown	Restricted (11-30%)	Unknown	High (Continuing)	
2.1	Annual & perennial non-timber crops						Agriculture footprint not increasing.
2.2	Wood & pulp plantations						

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
2.3	Livestock farming & ranching		Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)	
2.4	Marine & freshwater aquaculture		Unknown	Restricted (11-30%)	Unknown	High (Continuing)	Shellfish farming may increase over next 10 years. Could affect Chinook using foreshore environment.
3	Energy production & mining		Negligible	Negligible (<1%)	Slight (1-10%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	
3.1	Oil & gas drilling						
3.2	Mining & quarrying		Negligible	Negligible (<1%)	Slight (1-10%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	
3.3	Renewable energy						
4	Transportation & service corridors						
4.1	Roads & railroads						
4.2	Utility & service lines						
4.3	Shipping lanes						
4.4	Flight paths						
5	Biological resource use		Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)	
5.1	Hunting & collecting terrestrial animals						
5.2	Gathering terrestrial plants						
5.3	Logging & wood harvesting		Negligible	Negligible (<1%)	Slight (1-10%)	High (Continuing)	Many private operations; may not be well-regulated. Near Qualicum, watershed being cleared for feedlots.
5.4	Fishing & harvesting aquatic resources		Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)	Catch rates are higher than targets. Includes bycatch, First Nations, and poaching. (Hatchery fish in this DU originate in the DU so they are appropriately included in scoring which would be different if they were excluded.
6	Human intrusions & disturbance						
6.1	Recreational activities						
6.2	War, civil unrest & military exercises						

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
6.3	Work & other activities						
7	Natural system modifications	C	Medium	Pervasive (71-100%)	Moderate (11-30%)	High (Continuing)	The combined severity of 7.2 and 7.3 would be cumulative but not enough to merit bumping up the roll-up.
7.1	Fire & fire suppression	D	Low	Small (1-10%)	Moderate (11-30%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	Potential for fire retardant to enter streams.
7.2	Dams & water management/use	CD	Medium - Low	Pervasive (71-100%)	Moderate - Slight (1-30%)	High (Continuing)	High amount of water withdrawal for domestic and industrial use; uncertainty as to effect. Water level changes could be a potential benefit as well as a harm. Loading of firebombers could have an effect depending on timing.
7.3	Other ecosystem modifications	C	Medium	Pervasive (71-100%)	Moderate (11-30%)	High (Continuing)	Strait of Georgia ecosystem is more variable and worse off than other areas. The Cowichan River population is increasing but the DU as a whole is stable.
8	Invasive & other problematic species & genes	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	
8.1	Invasive non-native/alien species	D	Low	Large (31-70%)	Slight (1-10%)	High (Continuing)	Brown Trout is an introduced predator. This threat is managed for hatchery fish but not for wild fish.
8.2	Problematic native species	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	Seals, sea lions and birds present as predators. Uncertainty as to whether the seal population is increasing but it will likely come under more pressure as there is an increase in transient killer whale numbers.
8.3	Introduced genetic material		Negligible	Negligible (<1%)	Extreme - Serious (31-100%)	High (Continuing)	Not likely a concern in this DU. Scores need to be considered: scope could be negligible because migration out of Cowichan not into so few hatchery strays getting into Cowichan (negligible scope) but if hatchery fish get in, could have a extreme severity.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
9	Pollution		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	
9.1	Household sewage & urban waste water		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	Household effluent thought to be one reason why the Strait of Georgia is becoming less productive. This could also influence scoring under natural systems modifications, above.
9.2	Industrial & military effluents		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	There is a large military base at Comox as well as pulp mills and other industrial developments in the river system.
9.3	Agricultural & forestry effluents		Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)	
9.4	Garbage & solid waste		Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)	
9.5	Air-borne pollutants						
9.6	Excess energy						
10	Geological events		Negligible	Restricted (11-30%)	Negligible (<1%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	
10.1	Volcanoes						
10.2	Earthquakes/tsunamis		Negligible	Restricted (11-30%)	Negligible (<1%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	Tsunamis are possible. Underwater landslides could affect water levels.
10.3	Avalanches/landslides						
11	Climate change & severe weather	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	
11.1	Habitat shifting & alteration	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	
11.2	Droughts	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	Drought will delay adults returning to freshwater. Also may lead to stranding of juveniles and decreased productivity. Severity would be at higher end of the 1-10% range.
11.3	Temperature extremes	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	Affects gamete viability.
11.4	Storms & flooding	D	Low	Large (31-70%)	Slight (1-10%)	High (Continuing)	Scouring is not an issue where this DU spawns.

Classification of Threats adopted from IUCN-CMP, Salafsky *et al.* (2008).

THREATS ASSESSMENT WORKSHEET				
Species or Ecosystem Scientific Name	*Oncorhynchus tshawytscha* - Chinook Salmon			
Element ID	**DU23 BC East Vancouver Island Ocean Fall (East Vancouver Island + Southern Fjords)**		**Elcode**	
Date:	2/22/2017			
Assessor(s):	Originally assessed by Brian O. Ma in November, 2014. Revised in February 2017 workshop by Wilf Luedke, Steve Baillie, Arlene Tompkins, Jason Mahoney, Cheryl Lynch, John Neilson (Marine Fishes SSC Co-chair), David Fraser (Facilitator), Bev McBride (COSEWIC Secretariat)			
References:	(Porter *et al*. 2013; Riddell *et al*. 2013; Brown *et al*. 2013, Pre-COSEWIC report, in-prep)			
		Overall Threat Impact Calculation Help:	**Level 1 Threat Impact Counts**	
	Threat Impact		**high range**	**low range**
	A	Very High	0	0
	B	High	0	0
	C	Medium	1	0
	D	Low	3	4
		Calculated Overall Threat Impact:	High	Medium
		Assigned Overall Threat Impact:	**BC = High - Medium**	
		Impact Adjustment Reasons:		
		Overall Threat Comments	Generation Time 4.4 years.	

Threat		**Impact (calculated)**		**Scope (next 10 Yrs)**	**Severity (10 Yrs or 3 Gen.)**	**Timing**	**Comments**
1	Residential & commercial development		Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)	
1.1	Housing & urban areas						
1.2	Commercial & industrial areas		Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)	There is log booming on the Eve River and perhaps elsewhere.
1.3	Tourism & recreation areas						
2	Agriculture & aquaculture		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	
2.1	Annual & perennial non-timber crops						
2.2	Wood & pulp plantations						The plantation north of Campbell River is not expected to have an effect.
2.3	Livestock farming & ranching						
2.4	Marine & freshwater aquaculture		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	
3	Energy production & mining		Negligible	Negligible (<1%)	Slight (1-10%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	
3.1	Oil & gas drilling						

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
3.2	Mining & quarrying		Negligible	Negligible (<1%)	Slight (1-10%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	Mining could possibly be a factor but more research is needed concerning the new copper mine. No effect is expected from the coal mine higher up in the watershed.
3.3	Renewable energy						
4	Transportation & service corridors						
4.1	Roads & railroads						
4.2	Utility & service lines						
4.3	Shipping lanes						
4.4	Flight paths						
5	Biological resource use		Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)	
5.1	Hunting & collecting terrestrial animals						
5.2	Gathering terrestrial plants						
5.3	Logging & wood harvesting						This is a past threat in this DU.
5.4	Fishing & harvesting aquatic resources		Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)	
6	Human intrusions & disturbance						
6.1	Recreational activities						
6.2	War, civil unrest & military exercises						
6.3	Work & other activities						
7	Natural system modifications	CD	Medium - Low	Restricted (11-30%)	Moderate - Slight (1-30%)	High (Continuing)	
7.1	Fire & fire suppression	D	Low	Small (1-10%)	Moderate (11-30%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	
7.2	Dams & water management/use	CD	Medium - Low	Restricted (11-30%)	Moderate - Slight (1-30%)	High (Continuing)	Release of water through dams can shift spawning grounds.
7.3	Other ecosystem modifications	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	
8	Invasive & other problematic species & genes		Negligible	Pervasive (71-100%)	Negligible (<1%)	Unknown	
8.1	Invasive non-native/alien species						

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
8.2	Problematic native species		Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)	Less of a problem here than on Strait of Georgia.
8.3	Introduced genetic material						
9	Pollution	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	
9.1	Household sewage & urban waste water						Less of an issue here than on Strait of Georgia.
9.2	Industrial & military effluents						No longer an issue after the estuary clean up in Campbell River.
9.3	Agricultural & forestry effluents	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	This DU has more logging roads than some others.
9.4	Garbage & solid waste		Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)	
9.5	Air-borne pollutants						
9.6	Excess energy						
10	Geological events	D	Low	Small (1-10%)	Serious - Moderate (11-70%)	High (Continuing)	
10.1	Volcanoes						
10.2	Earthquakes/tsunamis		Negligible	Restricted (11-30%)	Negligible (<1%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	
10.3	Avalanches/landslides	D	Low	Small (1-10%)	Serious - Moderate (11-70%)	High (Continuing)	
11	Climate change & severe weather	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	
11.1	Habitat shifting & alteration	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	Not as severe here as on Strait of Georgia. Severity will be at the low end of the selected range.
11.2	Droughts		Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)	This area seems to have fewer droughts than other regions.
11.3	Temperature extremes						
11.4	Storms & flooding	D	Low	Small (1-10%)	Slight (1-10%)	High (Continuing)	This is an issue in Campbell River.
Classification of Threats adopted from IUCN-CMP, Salafsky *et al.* (2008).							

THREATS ASSESSMENT WORKSHEET			
Species or Ecosystem Scientific Name	*Oncorhynchus tshawytscha* - Chinook Salmon		
Element ID	**DU24 BC West Vancouver Island Ocean Fall (South)**	**Elcode**	
Date:	2/23/2017		
Assessor(s):	Originally assessed by Brian O. Ma in November, 2014. Revised in February 2017 workshop by Wilf Luedke, Steve Baillie, Arlene Tompkins, Jason Mahoney, Cheryl Lynch, John Neilson (Marine Fishes SSC Co-chair), David Fraser (Facilitator), Bev McBride (COSEWIC Secretariat). Updated August 2019 by the Marine Fishes SSC and DFO Expert Observers. See also note on element 8.3.		
References:	(Porter *et al*. 2013; Riddell *et al*. 2013; Brown *et al.* 2013 Pre-COSEWIC report, in-prep)		

Overall Threat Impact Calculation Help:		Level 1 Threat Impact Counts	
Threat Impact		high range	low range
A	Very High	0	0
B	High	1	1
C	Medium	2	2
D	Low	3	3
Calculated Overall Threat Impact:		Very High	Very High
Assigned Overall Threat Impact:		**A = Very High**	
Impact Adjustment Reasons:			
Overall Threat Comments		Generation Time 4 years. Element 8.3 was provisionally scored by the report editor, and requires expert verification (see comment 8.3). Overall Impact similar to DU 25, but the proportion of natural influence spawners is uniformly low among sites.	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
1	Residential & commercial development	D	Low	Small (1-10%)	Slight (1-10%)	High (Continuing)	
1.1	Housing & urban areas						
1.2	Commercial & industrial areas						
1.3	Tourism & recreation areas	D	Low	Small (1-10%)	Slight (1-10%)	High (Continuing)	
2	Agriculture & aquaculture		Negligible	Pervasive - Large (31-100%)	Negligible (<1%)	High (Continuing)	
2.1	Annual & perennial non-timber crops						
2.2	Wood & pulp plantations						

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
2.3	Livestock farming & ranching						
2.4	Marine & freshwater aquaculture		Negligible	Pervasive - Large (31-100%)	Negligible (<1%)	High (Continuing)	Fish farms in Clayoquot Sound have quadrupled in size.
3	Energy production & mining						
3.1	Oil & gas drilling						
3.2	Mining & quarrying						A proposed mine in the upper watershed is of concern. See scoring under 9.2
3.3	Renewable energy						
4	Transportation & service corridors		Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)	
4.1	Roads & railroads		Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)	
4.2	Utility & service lines						
4.3	Shipping lanes						
4.4	Flight paths						
5	Biological resource use		Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)	
5.1	Hunting & collecting terrestrial animals						
5.2	Gathering terrestrial plants						
5.3	Logging & wood harvesting		Negligible	Restricted (11-30%)	Negligible (<1%)	High (Continuing)	In this DU there are large tree farm licences.
5.4	Fishing & harvesting aquatic resources		Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)	
6	Human intrusions & disturbance						
6.1	Recreational activities						
6.2	War, civil unrest & military exercises						
6.3	Work & other activities						
7	Natural system modifications	C	Medium	Pervasive (71-100%)	Moderate (11-30%)	High (Continuing)	
7.1	Fire & fire suppression						
7.2	Dams & water management/use						
7.3	Other ecosystem modifications	C	Medium	Pervasive (71-100%)	Moderate (11-30%)	High (Continuing)	Proposed dam activity is at a higher elevation than the Chinook distribution.
8	Invasive & other problematic species & genes	B	High	Pervasive (71-100%)	Serious (31-70%)	High (Continuing)	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
8.1	Invasive non-native/alien species						
8.2	Problematic native species		Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)	
8.3	Introduced genetic material	AB	Very High - High	Pervasive (71-100%)	Extreme - Serious (31-100%)	High (Continuing)	It was noted that straying of hatchery-origin spawners has been documented throughout the DU, likely compromising the genetic composition of spawners and therefore threatening the wildlife species. **Scoring of this element was done by the Editor (J. Neilson) and requires verification by experts. It reflects his evaluation of the site specific PNI information found in Appendix 1.
9	Pollution	C	Medium	Large (31-70%)	Moderate (11-30%)	High (Continuing)	
9.1	Household sewage & urban waste water		Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)	
9.2	Industrial & military effluents	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	
9.3	Agricultural & forestry effluents	C	Medium	Large (31-70%)	Moderate (11-30%)	High (Continuing)	
9.4	Garbage & solid waste		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	Fish consume micro- and macro-plastics. Research ongoing as to effects.
9.5	Air-borne pollutants						
9.6	Excess energy						
10	Geological events	D	Low	Small (1-10%)	Serious - Moderate (11-70%)	High (Continuing)	
10.1	Volcanoes						
10.2	Earthquakes/tsunamis		Unknown	Pervasive (71-100%)	Unknown	Moderate (Possibly in the short term, < 10 yrs/3 gen)	There is some potential for large earthquakes that could radically change coastlines and stream flow.
10.3	Avalanches/landslides	D	Low	Small (1-10%)	Serious - Moderate (11-70%)	High (Continuing)	There is a potential for localized events. Likelihood and severity are unknown. Increasing winter rainfall may lead to more sliding.
11	Climate change & severe weather	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
11.1	Habitat shifting & alteration		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	Shifting streambed materials can prevent salmon access to streams. This can increase vulnerability to predation.
11.2	Droughts	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	Drought is expected every other year, delaying adult return to freshwater due to lower water levels.
11.3	Temperature extremes		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	It is difficult to separate this effect from shifting habitat. Temperature extremes can influence upwelling and downwelling along the coast but it can be difficult to connect the causes and effects.
11.4	Storms & flooding		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	
Classification of Threats adopted from IUCN-CMP, Salafsky *et al.* (2008).							

THREATS ASSESSMENT WORKSHEET				
Species or Ecosystem Scientific Name	*Oncorhynchus tshawytscha* - Chinook Salmon BC			
Element ID	**DU25 West Vancouver Island Ocean Fall (Nootka Kyuquot)**		Elcode	
Date:	11/6/2014			
Assessor(s):	Brian O. Ma; modified 2/21/2017 in COSEWIC IUCN Threats Calculator workshop with Wilf Litke, Nicole Trouton, Greg Wilson, Jeff Grout, Jeffrey Lemieux, Cedar Morton, Carolyn Churchland, Richard Bailey, Steve Bailey, Bev McBride, John Nielsen, Gayle Brown. Updated August 2019 by the Marine Fishes SSC and DFO Expert Observers.			
References:	(Porter *et al*. 2013; Riddell *et al*. 2013; Brown *et al*. 2013 Pre-COSEWIC report, in-prep); Expert opinion from group identified above			

Overall Threat Impact Calculation Help:		Level 1 Threat Impact Counts	
Threat Impact		high range	low range
A	Very High	1	0
B	High	0	0
C	Medium	1	2
D	Low	2	2
	Calculated Overall Threat Impact:	Very High	High
	Assigned Overall Threat Impact:	**AB = Very High - High**	
	Impact Adjustment Reasons:	overall impact changed from medium to v high-high due to scoring severity for 8.3 from the previous unknown	
	Overall Threat Comments	Generation time = 4yrs; According to expert opinion during the Threats Calculator Workshop, ecosystem modifications are a Medium threat in this DU. Other threats are Low and include tourism/recreation areas, industrial effluents, agricultural/forestry issues, avalanches/landslides, droughts. Survival rates have continued to decline for this DU and the population expected to continue declining at a relatively low rate. Pre-workshop contractor review (ESSA) emphasizes a generally increasing harvest rate (25 to 50% since 1995; not specific to the populations within this DU). Riddell *et al*. (2013) note that sustainable harvest is strongly tied to stock productivity. There is no reliable estimate of stock productivity for this DU. Many issues need to be further investigated for this DU.	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
1	Residential & commercial development	D	Low	Small (1-10%)	Slight (1-10%)	High (Continuing)	
1.1	Housing & urban areas						Urban development is considered low in the land-based area of this DU (0.2%) (Porter *et al*. 2013). This urbanization is expected to continue, but expert view is that there will be no impact on Chinook in this DU.
1.2	Commercial & industrial areas						Half of the Gold River estuary was removed by past industrial activity. Also true for Tahsis River.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
1.3	Tourism & recreation areas	D	Low	Small (1-10%)	Slight (1-10%)	High (Continuing)	Number of lodges has increased to ~100. Floating lodges are located in areas important to Chinook rearing without breakwaters. Outstanding questions: Do they create cover or attract predators? Do they kill eel grass? Severity is hard to guess - not enough understood about relationships. There is a moratorium on float homes so new development is not expected.
2	Agriculture & aquaculture		Negligible	Pervasive - Large (31-100%)	Negligible (<1%)	High (Continuing)	
2.1	Annual & perennial non-timber crops						0% of the land-based area is agricultural (Porter *et al*. 2013) and this is expected to continue.
2.2	Wood & pulp plantations						None
2.3	Livestock farming & ranching						None
2.4	Marine & freshwater aquaculture		Negligible	Pervasive - Large (31-100%)	Negligible (<1%)	High (Continuing)	Atlantic salmon farms are located higher north than the mouth of the Fraser River, but most wild Chinook pass these at some point so the scope is broad. The risks of open net-pen salmon aquaculture on wild Chinook salmon are considered low in the literature but data are limited (Riddell *et al*. 2013). Fish aquaculture will likely continue to expand in the future, but in this category the proximal impact is from loss of habitat due to farm footprints. The issues of disease transfer & genetic enhancement will be dealt with in line item 8.3.
3	Energy production & mining		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	
3.1	Oil & gas drilling						There is a moratorium on oil & gas drilling off the west coast of the island. If this were lifted it may pose a threat to this DU.
3.2	Mining & quarrying		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	The land-based coverage of mining area is 0.005% (Porter *et al*. 2013), and assuming a random distribution of individuals within the watershed, the scope of mining is assumed to be minor. For this DU, the severity of proximal impacts to Chinook from mining is unknown, as is the trend in mining development.
3.3	Renewable energy						There is a geothermal plant in Gold River, windfarms off Haida Gwaii and run of river development in this DU none of which are considered to generate proximal impacts that would affect Chinook populations in this DU. Possible windfarm impacts from Cape Scott?

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
4	Transportation & service corridors		Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)	
4.1	Roads & railroads		Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)	Road density in this area is 0.9 km/km2, and there are 0.8 stream crossings per km of fish accessible streams. These are moderate values relative to other southern BC Chinook DUs. Road densities are presented in linear dimensions in Porter *et al.* (2013). Assuming each road is 100m wide (0.1 km wide), which is an overestimate, the percent of land covered by roads is still <1%. Existing road infrastructure is expected to remain in place but development trend is unknown. Bridges and road crossings are the main concern as they can limit access to available spawning habitat, generate gravel movement and destroy side channel habitat.
4.2	Utility & service lines						None
4.3	Shipping lanes						None
4.4	Flight paths						None
5	Biological resource use		Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)	
5.1	Hunting & collecting terrestrial animals						None
5.2	Gathering terrestrial plants						None
5.3	Logging & wood harvesting		Negligible	Restricted (11-30%)	Negligible (<1%)	High (Continuing)	13.0% of forest was disturbed in this area (Porter *et al*. 2013), but any proximal effects due to logging footprint are from the past and are not likely to alter the population from its current state. New logging is of more concern as a second cut is now beginning. The proximal effect is habitat reduction.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
5.4	Fishing & harvesting aquatic resources		Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)	Total exploitation of southern BC Chinook salmon has been between 25% to 50% in recent years (since 1995) (Riddell *et al*. 2013). Comparable rates of harvest are expected to continue for the foreseeable future. The levels of exploitation are typically compared to expected exploitation for Maximum Sustainable Yield (EMSY), and any level below this is considered sustainable. However, because there is no indicator stock for this DU, EMSY has not been estimated and there is no direct measurement of total exploitation specific to this DU. There was a steep decline of Chinook populations in the 1990s; however, experts attending the Threats Calculator workshop agreed the population is currently stable despite being in a reduced state. The results shown here assume maintenance of current stability with current harvest levels and no impact from enhanced fish on the population. It is difficult to parse out impacts on wild vs. enhanced populations (the Threats Calculator is meant to consider only wild portions of the population). Every year there are more hatchery fish straying. Over the last two years there have been a higher proportion of hatchery fish than expected.
6	Human intrusions & disturbance						
6.1	Recreational activities						None; some ATVs through streams but no known proximal impact on Chinook population
6.2	War, civil unrest & military exercises						None
6.3	Work & other activities						None; some trapping of juveniles/electrofishing but not considered a threat
7	Natural system modifications	C	Medium	Pervasive (71-100%)	Moderate (11-30%)	High (Continuing)	
7.1	Fire & fire suppression						None
7.2	Dams & water management/ use						According to Porter *et al*. (2013), 12764.8 m3/ha of water are allocated. No dams impede movement. Only high altitude Independent Power Projects (IPPs) exist. No known proximal impact.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
7.3	Other ecosystem modifications	C	Medium	Pervasive (71-100%)	Moderate (11-30%)	High (Continuing)	13.8% of the riparian area within the DU has been disturbed (Porter *et al*. 2013), but the impact on the DU25 Chinook salmon population is unknown. There is a limited but continuing urbanization trend. General consensus among experts at the Threats Calculator workshop that no further habitat alterations are expected - the damage has already been done. Ongoing impacts include high flows due to deforestation that create various changes to habitat (e.g. temperature, sedimentation, food supply, large woody debris, movement of gravel to different parts of stream). Sediment management plans are being developed. The system is previously logged and has stabilized but could now be logged again.
8	Invasive & other problematic species & genes	AC	Very High - Medium	Pervasive (71-100%)	Extreme - Moderate (11-100%)	High (Continuing)	Changed from unknown by scoring severity of 8.3, 11% is the severity to the low PNI watersheds / groups of fish while 100% is the severity to the high PNI fish (high PNI are more wild, low PNI are more hatchery influence)
8.1	Invasive non-native/alien species						None
8.2	Problematic native species		Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)	There are no Mountain Pine Beetles reported in this area (Porter *et al*. 2013) but the frequency of el Ninos is rising. We are likely to have another within the next decade, this increases frequency of problematic native species. Esp. seals, sea lions and mackerel - also Humboldt squid, orcas. Mackerel in Barkley Sound during el Nino can be devastating. Population for this DU is already low and stable. We are expecting an increase over the next 3 generations, but this is part of the problem that is keeping the population at a low threshold.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
8.3	Introduced genetic material	AC	Very High - Medium	Pervasive (71-100%)	Extreme - Moderate (11-100%)	High (Continuing)	This DU is enhanced. Of the years where sampling occurred, most individuals originated from streams that had moderate to high levels of enhancement. The number of hatchery releases from within DU25 increased from the mid-1980s to 2012. There is uncertainty regarding the origin of enhanced/hatchery fish in this DU. Some arrive from Robertson Creek and Thornton Creek (both of Robertson Creek hatchery stock), primarily in Gold River. Conuma hatchery is also within the DU and there are some smaller scale independent hatcheries. Not many wild fish are returning. Hatchery production is aimed at increasing harvest capacity, not conservation. Work is currently being conducted by DFO to determine how much genetic material from wild populations is needed to maintain conservation requirements. It is also noted that the damage from hatcheries is already done. Whether there will be a change in impact over the next three generations is unknown. Also, in terms of genetic strain, the Conuma hatchery fish are from within the DU.
9	Pollution	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	
9.1	Household sewage & urban waste water		Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)	The average number of permitted waste water discharge locations within this DU is 0.9 (Porter *et al*. 2013). Sewage is not necessarily treated and is disposed directly into water or septic tanks.
9.2	Industrial & military effluents	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	Pulp mills are closed but effluent still present. Accumulation of oil products working their way into the soil that affects benthic community (e.g. heavy industry hydraulic oil, gas floats in estuary). Most impacts are from logging upslope from water/fish.
9.3	Agricultural & forestry effluents	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	Impacts from aquaculture, herbicides and pesticides. Impacts may improve due to better disposal practices (e.g. used oil recycling) but without legislation that incentivises compliance this is difficult to prove. The damage has already been done by past forestry practices, it isn't getting worse and won't have much additional impact on Chinook populations, which are stable. However, siltation from forestry is a problem contributing to the 'Slight' severity ranking.
9.4	Garbage & solid waste		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	Fish consume plastic (micro and macro) - 2-7 microplastic particles per day. Research on impacts are ongoing.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
9.5	Air-borne pollutants						None; airborne pollutants need to become water pollution before impacting fish
9.6	Excess energy						None
10	Geological events		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	
10.1	Volcanoes						None
10.2	Earthquakes/tsunamis		Unknown	Pervasive (71-100%)	Unknown	Moderate (Possibly in the short term, < 10 yrs/3 gen)	Some potential for large earthquake that could radically change coastlines and stream flow.
10.3	Avalanches/landslides	D	Low	Small (1-10%)	Extreme - Moderate (11-100%)	High (Continuing)	DU has steep hillsides and "aggressive hydrology". Risk of landslide is increasing due to changing weather patterns (esp. increased winter precipitation) but events would be localized.
11	Climate change & severe weather		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	
11.1	Habitat shifting & alteration		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	In a recent report evaluating threats to southern BC Chinook salmon by Riddell *et al.* (2013), the panel concluded that marine habitat conditions during the first year of marine residency were very likely a key driver in recent trends in survival and productivity. Shifting marine habitat will be experienced by all Chinook salmon in this DU (i.e., scope = pervasive). However, the severity is unknown because there is no indicator stock available for this DU, so marine survival cannot be estimated. There are already examples of delayed entry, increases in predation, and geographic shifts of predator species (e.g. seals, sea lions).
11.2	Droughts	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	Two of last three years have been down to gravel in many streams. Drought is expected every other year and delays adult return to freshwater (lower water, more gravel).
11.3	Temperature extremes		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	Stream temperatures will continue to rise to critical levels (>18C) based on current projections (Porter *et al*. 2013). These increases in stream temperatures are expected to affect the entire population (i.e., the scope is pervasive). This impact is expected to be continuing into the future. However, the severity of this is unknown because of limited data (Riddell *et al*. 2013). For this DU, there is no population decline due to temperature because they go in September when it is cooler. Difficult to separate this effect from habitat shift. Can't nail down proximate factors specifically enough.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
11.4	Storms & flooding		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	Location and frequency of downwelling and upwelling along the continental shelf definitely have impact but hard to attribute to climate change.
Classification of Threats adopted from IUCN-CMP, Salafsky *et al*. (2008).							