Taku River Sockeye
Stock Assessment and Escapement Goal Review
Part II - 2019

Fisheries and Oceans Canada - Final Report

March 2020

PSC NF-2019-I-36
DFO CA#57044

Aaron Foos
Fisheries and Oceans Canada
Suite 100, 419 Range Road
Whitehorse, Yukon Territory
Y1A 3V1

and

Andrew Piston
Alaska Department of Fish and Game
2030 Sea Level Drive, Ste 205
Ketchikan, Alaska
99901-6073

Executive Summary

The Taku River sockeye stock assessment review and escapement goal analysis project was completed on schedule and within budget. Over two years, significant amounts of data and literature were compiled, reviewed, discussed, investigated, analyzed, and reported on. Assumptions and biases of the current mark-recapture program were identified and addressed following recommendations provided, and improvements were made to the stock assessment program. All historical Taku River sockeye salmon data were reanalyzed and new abundance estimates generated for the entire time series, 1984 to 2018. Alternative assessment techniques were also investigated. The updated abundance estimates were used in a state-space spawner-recruit escapement goal analysis, and a revised escapement goal was recommended to decision bodies in January 2020.

Among other resources produced and available, two key reports are products of this project. The "Taku River Sockeye Salmon Stock Assessment Review and Updated 1984-2018 Abundance Estimates" (Pestal et. al. 2020), and "Estimates of a Biologically-Based Spawning Goal and Management Benchmarks for the Canadian-Origin Taku River Sockeye Salmon Stock Aggregate" (Miller and Pestal 2020).

Table of Contents

1.0 Introduction 4
Background 4
2.0 Objectives 5
3.0 Project Description 6
Taku Sockeye Stock Assessment Program Review 7
Taku Sockeye Escapement Goal Analysis 7
PSC Endorsement of Results of Project 8
4.0 Conclusions 8
5.0 Budget Summary 9
6.0 Acknowledgements 9
7.0 Literature Cited 9

List of Figures

Figure 1. The Taku River drainage and major tributaries showing Canadian commercial fishing areas. 5

List of Appendices

Appendix 1 - Budget Summary of DFO Expenditures 11

1.0 Introduction

This project completed a task identified in the Pacific Salmon Treaty (PST) (PSC 2019), Chapter 1, Item 3.b.i.C., which states:

> "The Taku River sockeye salmon assessment program will be reviewed by two experts (one selected by each Party) in mark-recovery estimation techniques. The Parties shall instruct these experts to make a joint recommendation to the Parties concerning improvements to the existing program including how to address inherent mark-recovery assumptions with an aim to minimize potential bias prior to the 2020 fishing season."

In early 2018, Transboundary Technical Committee (TTC) of the Transboundary Panel recommended that a bilateral working group be formed to address the task and provide support to the "two experts". In recognition of the workload and expense this task would incur upon both Canada and the U.S., a joint proposal to the Northern Endowment Fund (NEF) was submitted and subsequently approved by the NEF for 2018-19. The project was too large to be completed within one fiscal cycle of either Party, and a second supporting joint proposal was approved by the NEF for 2019-20 to allow the project to be completed within the PST prescribed timeline.

This report presents the results of the project and the Canadian budget accountability to the NEF for the 2019-20 fiscal year.

Background

The Taku River is a transboundary river system that originates in the Stikine plateau of northwestern British Columbia and terminates in Taku Inlet in Southeast Alaska. Approximately 95% of the Taku River watershed lies within Canada and it produces a large run of sockeye salmon that is jointly managed by the Alaska Department of Fish and Game (ADF&G) and the Department of Fisheries and Oceans Canada (DFO). The U.S./Canada Pacific Salmon Treaty of 1985, and subsequent additions to the original treaty, established conservation (71,000 to 80,000 escapement goal) and harvest sharing (percentage sharing of the allowable catch) objectives for the Taku River sockeye salmon run. Inseason estimates of the spawning escapement of Taku River sockeye salmon, obtained through a mark-recapture program, are needed to fulfill the escapement goal and international harvest sharing requirements specified by the Pacific Salmon Treaty.

The Taku River mark-recapture project has been conducted annually since 1984 (Clark et al. 1986; McGregor and Clark 1987, 1988, 1989; McGregor et al. 1991; Boyce and Andel 2012, 2014) and operates as a joint U.S./Canada program involving ADF&G, DFO, and the Taku River Tlingit First Nations (TRTFN) to provide weekly estimates of the Taku River salmon escapement past Canyon Island, Alaska. U.S. and Canadian fishery managers use CPUE and stock composition data from the U.S. District 111 and Canadian Taku River commercial gillnet fisheries and escapement estimates from this project to adjust fishing times, catches, and escapements. The recently renegotiated Chapter 1 of the Pacific Salmon Treaty (2019) includes a bilaterally endorsed task to review the stock assessment program and make recommendations for improvements to be implemented during the next agreement period.

The Taku River is a large and complex system, with multiple tributaries and lake systems, as well as inriver indigenous, personal use, subsistence, and commercial sockeye salmon fisheries, which create special challenges for mark-recapture work in the drainage and for escapement goal analysis.

Improvements to inseason and total escapement estimates of sockeye salmon on the Taku River will affect all aspects of fisheries management and lead to more efficient and sustainable utilization of the resource by the U.S. and Canada. Among the stock assessment challenges examined by the review team included issues with tag-induced mortality, capture gear size selectivity, temporal variability in tag recovery, tag loss, and tag misidentification or non-reporting in the mark-recapture project, fish sampling protocols at the Canyon Island fish wheels, improving estimates of the distribution of mainstem and tributary spawners in the drainage, and assessing weir projects on Canadian tributaries. Additionally, methodologies such as genetic tools which compliment the current assessment program were explored with the intention of strengthening both inseason and post season estimates of Taku River sockeye salmon.

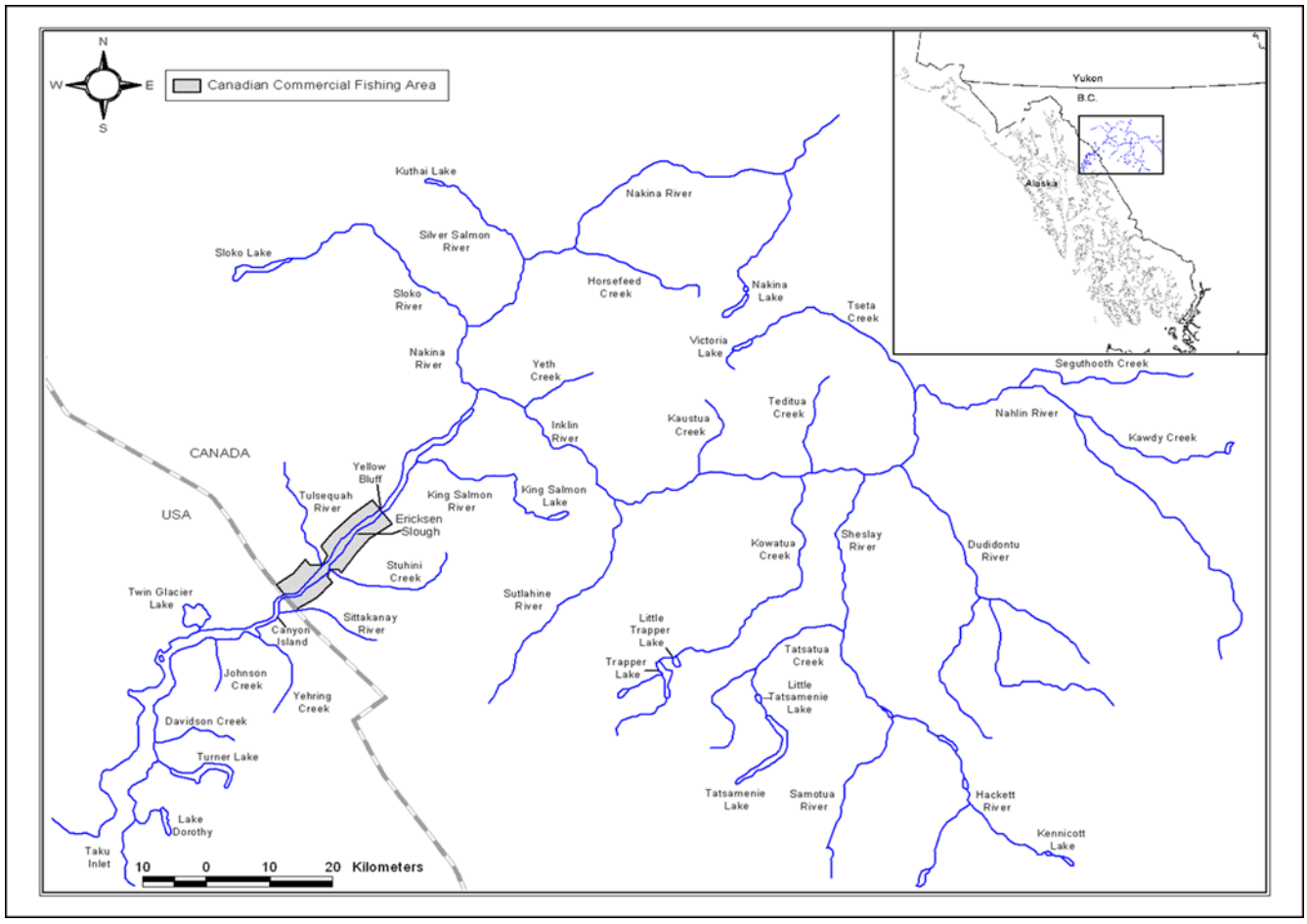

Figure 1. The Taku River drainage and major tributaries showing Canadian commercial fishing areas.

2.0 Objectives

The specific objectives expected to be achieved by the end of this project were:

1. Review the current sockeye salmon stock assessment program on the Taku River and make recommendations that will improve escapement estimates to the drainage;
2. Produce an updated bilaterally accepted escapement goal;

3. Document results of the stock assessment review and escapement goal analysis in a report published through the Pacific Salmon Commission.

The approach identified in the 2018 and 2019 detailed proposal to the Northern Endowment Fund (NEF) was to:

1. Review the Current Assessment Program,
2. Explore Alternative Assessment Techniques, and
3. Conduct an Escapement Goal Analysis.

3.0 Project Description

A working group was formed in April of 2018 that included task relevant biologists, biostatisticians, and subject matter experts. There were a few minor membership changes over the two-year duration of the project, but the core working group consisted of:

Julie Bednarski – ADF&G – Fisheries Biologist - Co-chair
Aaron Foos – DFO – Sr. Aquatic Science Biologist - Co-chair
Dr. Robert Clark – ADF&G – Fisheries Scientist (U.S. Expert)
Dr. Carl Schwarz – DFO – Consulting Biometrician (Canadian Expert)
Ian Boyce – DFO – Sr. Aquatic Science Biologist
Dr. Sara Miller – ADF&G – Biometrician
Dr. Paul Vecsei – DFO – Sr. Aquatic Science Biologist
Dr. Rich Brenner – ADF&G – Salmon Stock Assessment Biologist
Richard Erhardt – TRTFN – Consulting Biologist
Gottfried Pestal – DFO – Consulting Biometrician
Andrew Piston – ADF&G – Fisheries Biologist
Philip Richards – ADF&G – Fisheries Biologist

The detailed approach adopted by the working group was to compile all relevant data, information and literature, then fully review the current mark-recapture assessment program in order to identify assumptions and biases, test these assumptions and biases, identify areas of improvement, and make recommendations on changes and improvements in all aspects of the program. Those recommendations were then applied to generate more robust annual estimates of historical Taku sockeye run sizes based on the reviewed original data, and these improved run size estimates were used to inform the escapement goal analysis. A concurrent review of alternative and/or supporting assessment techniques occurred, and recommendations from that review were incorporated where appropriate. Once the working group completed the assessment program report and recommendations, it was reviewed by the two "experts" who made formal recommendations to the Transboundary Panel that were subsequently included in the report. The escapement goal analysis, technical report, and biological benchmarks were subjected to a bilateral science review under the authority of the Canadian Science Advisory Secretariat (CSAS) as the primary formal peer science review. There was representation throughout the process by members of the working group including the two "experts", as well as relevant representatives of the TTC and each Party.

The working group held nine teleconferences and two in person meetings in the first year, and two in person meetings and 14 teleconferences in the second year. This is in addition to the CSAS Science Review Workshop held on 05 November 2019 in Nanaimo, B.C., and the presentation of work and recommendations to the TTC on 19/20 November 2019 in Vancouver, B.C.. Final TTC endorsed recommendations were presented to the Transboundary Panel on 14 January 2020 in Portland, OR.. The bilateral collaboration and

cooperation of the Parties was excellent and all timelines for the project were met. Details on specific aspects of the project follow.

Taku Sockeye Stock Assessment Program Review

The review began with both Parties investing significant time and resources into identifying, organizing, compiling, and verifying all available relevant data. The volume of data was significant as fisheries and assessment of sockeye has been ongoing in the Taku watershed for nearly 40 years. Data were in disparate levels of organization, storage formats, and accessibility, so much work went into this aspect of the task to ensure that all data could integrate. Cleaned data were shared bilaterally among the working group using a SharePoint site to which all working group members had access.

Concurrent with the data preparation was an extensive literature review compiling all scientific and technical publications relevant to Taku River sockeye. This included data reports, stock assessment techniques, published assessment methodologies, etc. All reports were catalogued and summarized for relevance to the Taku project and were uploaded to the shared bibliography website Mendeley.com. All members of the working group had access to this site.

Beginning in early 2019, preliminary data exploration, testing, and analysis occurred on various aspects as the data became available. As the working group progressed into working with the clean Taku sockeye data, we began summarizing, exploring, and analyzing the data and trends, answering questions, investigating biases, and discussing relevant issues. GitHub repositories were used to share data files, R code, address issues, and complete work plan updates. The working group thoroughly discussed and identified assumptions and biases of mark-recapture, tested these assumptions, and recommended means of addressing identified issues and biases. Discussions and analysis also occurred around assessment tools and data sources additional to mark-recapture (i.e. genetic tools) that may have potential for supporting or providing alternative techniques for Taku sockeye stock assessment moving forward. Cleaned historical data were used to generate updated Taku River sockeye run abundance estimates for all past years of assessment, 1984 to 2018.

All data analysis recommendations and many assessment program improvements from the working group were proactively implemented in summer of 2019 and field operations were vastly improved (Bednarski et. al. 2019). and All aspects of the Taku sockeye stock assessment program and the review, including the updated abundance estimates have published in a formal report through the PSC in March of 2020, titled “Taku River Sockeye Salmon Stock Assessment Review and Updated 1984-2018 Abundance Estimates, Pacific Salmon Commission Technical Report No. 43” (Pestal, et. al. 2020).

Taku Sockeye Escapement Goal Analysis

The working group recommended the escapement goal analysis be conducted using a Bayesian state-space spawner-recruit model following methodology described in Fleischman and Reimer (2017). Analyses began in fall 2019 as soon as the updated Taku sockeye abundance estimates were available. The working group met frequently to discuss analyses, address challenges, and recommend final escapement goal ranges.

Details of the data, analytical methods, results, and discussion were compiled into a working paper prepared for the formal CSAS Science Review process. This CSAS Working Paper 2018SAL04, titled

"Estimates of a Biologically-Based Spawning Goal and Management Benchmarks for the Canadian-Origin Taku River Sockeye Salmon Stock Aggregate" with authors Sara Miller and Gottfried Pestal, was reviewed by two independent reviewers, one from each Party; Andrew Munro from ADF&G, and Charmaine Carr-Harris from DFO. CSAS coordinated a Science Review Workshop that was held on 05 November 2019 in Nanaimo, B.C., where all members of the working group along with independent reviewers and other relevant experts met to discuss the working paper, formal reviews, escapement goal analysis, and its resulting benchmarks for Taku River sockeye salmon. The process was capably chaired by John Candy, was collegial, and went smoothly with no major revisions required to the working paper other than a list of improvements suggested for the analysis and documentation.

Several publications emerged from this formal CSAS review process. There were formal proceedings of the workshop (DFO 2019), then a Science Advisory Report was produced (DFO 2020), and lastly the final completed Research Document (Miller and Pestal 2020) which is in press at the time of this writing.

PSC Endorsement of Results of Project

The working group presented results of the project and our recommendations to the TTC in November 2019. The TTC and the "experts" provided recommendations on the stock assessment review as well as recommendations on a revised escapement goal to the Transboundary Panel for consideration in January of 2020. The Transboundary Panel was scheduled to provide its recommendations to the PSC following its February 2020 pre-season meeting, however they were unable to reach consensus on the details of the escapement goal. As a result, the final decision on Taku Sockeye stock assessment recommendations and a revised escapement goal has been elevated to the PSC Commissioner level. Domestic and bilateral PSC discussions are ongoing with a decision deadline of 01 May 2020, in time for the TTC to implement final recommendations for the 2020 fishing season.

4.0 Conclusions

Objectives 1 and 3 of the project have been fully met, culminating in two comprehensive publications, Pestal et. al. (2020) and Miller and Pestal (2020). All reports, supporting data, and recommendations relevant to objective 2 have been produced, published, and presented to the appropriate decision bodies. The PSC has yet to complete and endorse an updated bilaterally accepted escapement goal for Taku River sockeye salmon, but timelines are in place to ensure the PST deadlines are fully met.

The provided NEF funding was critical in supporting the project through to an on-schedule completion by "the 2020 fishing season" as identified in Chapter 1 of the PST (PSC 2019). It enabled a fulsome process in which both Parties could appropriately engage throughout the entire project.

The reviews, analytical work, recommendations, and reference materials that have been generated by this project not only greatly benefit ongoing management of Taku River sockeye salmon, but are publicly available for any other relevant or similar process.

5.0 Budget Summary

The 2019 NEF project funding for this project ended March 31, 2020 following the Canadian fiscal year.

The DFO portion of the budget approved for this project by the Northern Endowment Fund was $91,000. Project expenditures amounted to $85,482.44 which is slight over the 90% of the approved budget and previously advanced to DFO by the PSC. The 10% holdback of $9,415 is not required from the PSC, and DFO will cover this slight overage along with its in-kind contributions to the project of $20,288.25. We are grateful to the PSC for their administrative assistance in delivering the remainder of the Canadian project budget ($20,000) in a direct award to the project consultant, Gottfried Pestal A budget summary of Canadian expenditures can be referenced in Appendix 2.

The U.S portion of the budget approved for this joint project by the Northern Endowment Fund will be accounted for directly with the PSC in the near future by ADF&G.

6.0 Acknowledgements

We would like to acknowledge the contributions of all members of the working group throughout this extensive process. The cooperation, extensive engagement, and significant contributions were very much appreciated and enabled the project to succeed. Working group co-chair Julie Bednarski provided extensive advice, information and support to the process while being invaluable in helping keep us all on task and schedule. The support of Bill Waugh (DFO) and Ed Jones (ADF&G) as co-chairs of the TTC has also been appreciated. Teresa Bachynski, Adam Brennan, and Ian Boyce of DFO invested months of work into meticulous data organization and preparation, their dedication to this tedious task was exemplary. Sara Miller and Ray Vinzant have provided similar data support from ADF&G, many thanks to them as well. Paul Vecsei of DFO spent countless hours compiling relevant literature for the review. Gottfried Pestal of SOLV Consulting was an invaluable support in leading and coordinating tasks, assisting with data compilations, coding analysis scripts, and generating numerous exploratory data analyses, as well as lead authoring the stock assessment review report and co-authoring the escapement goal report, many thanks Gottfried. Angus Mackay and Victor Keong of the PSC were very supportive with contract administration that has greatly streamlined contract delivery.

7.0 Literature Cited

Bednarski, J., A. Foos, R. E. Brenner, S. E. Miller, A. W. Piston, and R. Vinzant. 2019. Operational plan: migration, tagging response, distribution, and inriver abundance of Taku River sockeye salmon. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Operational Plan ROP.CF.1J.2019.10, Douglas.

Boyce, I.M. and J.E. Andel. 2012. Mark–recapture studies of Taku River adult sockeye salmon stocks in 2009. Pacific Salmon Comm. Tech. Rep. No. 29: 52p.

Boyce, I.M. and J.E. Andel. 2014. Mark–recapture studies of Taku River adult sockeye salmon stocks in 2012 and 2013. Pacific Salmon Comm. Tech. Rep. No. 32: 75p.

Clark, J. E., A. J. McGregor, and F. E. Bergander. 1986. Migratory timing and escapement of Taku River salmon stocks, 1984-1985. In ADF&G (Alaska Department of Fish and Game) Section Report in 1985 Salmon Research conducted in Southeast Alaska by the Alaska Department of Fish and Game in conjunction with the National Marine Fisheries Service Auke Bay Laboratory for Joint U.S.-Canada Interception Studies. Division of Commercial Fisheries, Final Report, Contract Report WASC-85-ABC-00142 Juneau, Alaska.

DFO. 2019. Proceedings of the Pacific Regional Peer Review Meeting on the Estimates of a Biologically-Based Spawning Goal and Management Benchmarks for the Canadian-Origin Taku River Sockeye Salmon Stock Aggregate; November 5, 2019. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2019/009.

DFO. 2020. Estimates of a biologically-based spawning goal and management benchmarks for the Canadian-origin Taku River Sockeye salmon stock aggregate. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2020/006.

Fleischman, S.J. and A.M. Reimer. 2017. Spawner-recruit analyses and escapement goal recommendations for Kenai River Chinook salmon. Alaska Department of Fish and Game, Fishery Manuscript Series No. 17-02, Anchorage.

McGregor, A. J., and J. E. Clark. 1987. Migratory timing and escapement of Taku River salmon stocks in 1986. Final Report - 1986 Salmon Research Conducted in Southeast Alaska by the Alaska Department of Fish and Game in Conjunction with the National Marine Fisheries Service Auke Bay Laboratory for Joint U.S.-Canada Interception Studies. Alaska Department of Fish and Game, Division of Commercial Fisheries, Juneau.

McGregor, A. J., and J. E. Clark. 1988. Migratory timing and escapement of Taku River salmon stocks in 1987. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 1J88-26, Juneau.

McGregor, A. J., and J. E. Clark. 1989. Migratory timing and escapement of Taku River salmon stocks in 1988. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 1J89-40, Juneau.

McGregor, A. J., P. A. Milligan, and J. E. Clark. 1991. Adult mark–recapture studies of Taku River salmon stocks in 1989. Alaska Department of Fish and Game, Division of Commercial Fisheries, Technical Fishery Report 91-05, Juneau.

Miller, S.E., and Pestal, G. 2020. Estimates of a Biologically-Based Spawning Goal and Management Benchmarks for the Canadian-Origin Taku River Sockeye Salmon Stock Aggregate. DFO Can. Sci. Advis. Sec. Res. Doc. In press.

Pacific Salmon Commission. January 2019. Pacific Salmon Treaty.

Pestal, G., C. J. Schwarz and R. A. Clark. 2020. Taku River Sockeye Salmon Stock Assessment Review and Updated 1984-2018 Abundance Estimates. Pacific Salmon Comm. Tech. Rep. No. 43: 118 p..

Appendix 1 - Budget Summary of DFO Expenditures

Taku River Sockeye Stock Asssessment Review and Esc. Goal Analysis 2019 (NF-2019-I-XX)

EXPENDITURES

Labour

DFO Employee Salaries and Benefits

Position		Expenditures (DFO Inkind + PSC)	DFO-Inkind	PSC funding (expenses)		Approved Budget (PSC Funding)	Total PSC Funded Expenditure	Variance
Biologist BI-03	Salary	$ 40,884.24		$ 40,884.24		$ 45,000.00		
	Benefits	$ 11,038.74		$ 11,038.74		$ 12,150.00		
Biologist BI-03	Salary	$ 9,375.00	$ 9,375.00					
	Benefits	$ 2,531.25	$ 2,531.25			$ -		
Biologist BI-02	Salary	$ 6,600.00	$ 6,600.00					
	Benefits	$ 1,782.00	$ 1,782.00			$ -		
	Total Expended	**$ 72,211.23**	**$ 20,288.25**	**$ 51,922.98**		**$ 57,150.00**	**$ 51,922.98**	**$ 5,227.02**

Subcontractors & Consultants

Contract		Contract Amount Expended	Inkind	PSC funding (expenses)		Approved Budget	Total PSC Funded Expenditure	Variance
Contract Services		$ 24,332.80		$ 24,332.80		20,000		
Contract B		$ -						
Contract C		$ -						
		$ -						
		$ -						
	Total Expended	**$ 24,332.80**	**$ -**	**$ 24,332.80**		**$ 20,000.00**	**$ 24,332.80**	**$ (4,332.80)**
			$ 20,288.25		**Total**	**$ 77,150.00**	**$ 76,255.78**	**$ 894.22**

Site / Project Costs

Item		Amount Expended	Inkind	PSC funding (expenses)		Approved Budget	Total PSC Funded Expenditure	Variance
Travel		$ 9,226.66		$ 9,226.66		$ 17,000.00		
Small Tools & Equipment		$ -						
Site Supplies & Materials		$ -						
Equipment Rental		$ -						
Work & Safety Gear		$ -						
Repairs & Maintenance		$ -						
Permits		$ -						
Other costs		$ -						
	Total Expended	**$ 9,226.66**	**$ -**	**$ 9,226.66**		**$ 17,000.00**	**$ 9,226.66**	**$ 7,773.34**
			$ -			**$ 17,000.00**	**$ 9,226.66**	**$ 7,773.34**

Training Costs

Item		Amount Expended	Inkind	PSC funding (expenses)		Approved Budget	Total PSC Funded Expenditure	Variance
Name of course		$ -						
		$ -						
	Total Expended	**$ -**	**$ -**	**$ -**		**$ -**	**$ -**	**$ -**
			$ -			**$ -**	**$ -**	**$ -**

Overhead / Indirect Costs

Item	Amount Expended	Inkind	PSC funding (expenses)	Approved Budget	Total PSC Funded Expenditure	Variance
Office space; including utilities, etc.	$ -					
Insurance	$ -					
Office supplies	$ -					
Telephone & long Distance	$ -					
Photocopies & printing	$ -					
Indirect/overhead costs	$ -					
Administration and financial management	$ -					
(If the PSC contribution to Indirect costs exceeds 20% of the total PSC grant						
submission of back-up documentation justifying the expense is required).						
Total Expended	$ -	$ -	$ -	$ -	$ -	$ -
		$ -		$ -	$ -	$ -

Capital Costs / Assets (Value > $250.00)

Item	Amount Expended		PSC funding (expenses)	Approved Budget	Total PSC Funded Expenditure	Variance
	$ -					
	$ -					
	$ -					
	$ -					
Total Expended	$ -	$ -	$ -	$ -	$ -	$ -
		$ -		$ -	$ -	$ -

Financial Report

Categories	DFO InKind		Approved Budget (PSC Grant)	Project Expenditures (PSC$)	Variance
Labour	$ 20,288.25		$ 77,150.00	$ 76,255.78	$ 894.22
Site / Project Costs	$ -		$ 17,000.00	$ 9,226.66	$ 7,773.34
Training	$ -		$ -	$ -	$ -
Overhead / Indirect Costs	$ -		$ -	$ -	$ -
Capital Costs / Assets	$ -		$ -	$ -	$ -
TOTAL			**$ 94,150.00**	**$ 85,482.44**	**$ 8,667.56**

PSC Project Funding Grant Advance Amount Received	**$ (84,735.00)**	(funds rec enter as negative)
PSC Project Funding Grant Amount Remaining to be Paid		(positive refundable to PSC)
Difference Between Grant Amount and Project Expenditures	**$ (747.44)**	

Justification if Variance

Project Manager Name — **Aaron Foos**

Project Manager Signature — Foos, Aaron — Digitally signed by Foos, Aaron Date: 2020.03.31 14:01:46 -07'00'

Date

DFO Responsibility Center Manager Name — **William Waugh**

DFO Responsibility Center Manager Signature — Waugh, William — Digitally signed by Waugh, William Date: 2020.03.31 15:46:59 -07'00'

Date