

Using Barcode Scanners and Tablets to Automate CWT Data Management

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Introduction

A Salmonid Enhancement Program (SEP) hatchery may collect over 2,000 adult Chinook heads each year for dissection and recovery of coded-wire tags (CWTs). Each collected head is given a unique identifier using an attached label (E-label in escapement samples), which in recent years includes a barcode as well as the numeric identifier (ID). Using the E-label ID, CWT data is linked to biological data, such as length, sex, thermal mark and genetic identification, for an individual Chinook. The E-label IDs, and most of the biological data, were historically recorded on paper then manually entered into the data management system at the hatchery. This was a process that required substantial time and effort to ensure there were no errors associated with the manual data entry.

As SEP transitions to a new hatchery data management system in the coming years, improvements in processes for data collection and handling are being examined, including the process for adult sampling for CWTs.

Labelled heads are currently submitted to the Head Dissection Lab at J.O. Thomas (JOT) to collect CWT data. JOT uses an barcode scanner to capture the E-label's barcode, entering associated tagcode and dissection information in the CWT Recovery database (implemented in 2012). Data from the CWT Recovery database at JOT is exported to a file which is sent to the hatchery for importing into their data management system, where the manually entered E-label ID is linked to the biological data. This multi-step process can be time consuming, requiring meticulous QA/QC of entered data. Errors related to manual entry of the E-label ID must be corrected before the file can be imported successfully at the hatchery. Automating data collection and management will improve data accuracy, reduce time spent by users to manually handle data, and help with reporting efficiency.

In 2019, an automated barcode scanner and tablet system was employed to collect adult CWT sampling data at both Spius Creek Hatchery and in the Shuswap River Chinook carcass survey. Based on this 2019 pilot study, an automated CWT data management methodology was rolled out in 2020 to all the Canadian Chinook PST indicator stocks for adult sampling at the hatchery.

Project Objectives

This project proposed to improve hatchery data management and reporting through the implementation of a protocol for automated CWT sampling at eight Canadian hatcheries. Work included the purchase, testing, and operationalization of tablets with barcode scanners. Use of barcode scanners will enable hatchery staff to automate data capture and reduce errors associated with manual data entry.

A related project, also funded by the PSC SEF, was the development of an application to capture sampling data on tablets and with the barcode scanner. This project was delayed due to competing priorities of the proposed developer and was not completed. A statement of work was developed but not initiated.

Methods

System Design and Equipment Purchase

The barcode scanner system tested in 2019 at Spius Creek Hatchery was the prototype for the broader 2020 escapement sampling automated data management system design. The tablet selected in 2020 was the Samsung Tab A 10.1 (larger screen size relative to tablet used in 2019), based on availability, along with a compatible case, but the numeric keypads and barcode scanners were identical to those used in 2019. Hardware was purchased in April and May, with some challenges encountered due to the sudden demand for tablets associated with the Covid-19 pandemic, and the resulting spike in remote learning and working.

System Setup and Testing

Tablets were set up with software and customized data collection files loaded and distributed to the hatcheries in the summer of 2020. Shortly thereafter, MS Teams sessions were set up with each hatchery to review the methodology for operating the automated system. A team for users was set up for all involved to ask questions and share their knowledge.

As a result of the travel restrictions under provincial Public Health Orders, regional SEP biologists were unable to train hatchery staff in person; however, due to the expected volume of CWT recoveries and associated sampling data at Robertson Creek Hatchery, travel to this site for training was deemed “essential,” and one afternoon of on-site training was provided.

The methodology for automated data management with tablets and scanners is described in APPENDIX II.

Data Collection and Management

The tablets ran on an Android operating system (compared to Windows on their work computers) which required users to learn new functionality. The 2019 pilot project at Spius Creek Hatchery, used standard DFO OneDrive software to save data to the cloud over wifi. In 2020, OneDrive software was not yet deployed to all DFO staff, so although some users could use the software, others were forced to use the public access version of the Microsoft cloud at office.com. Users chose not to use MS Teams file sharing functionality to save data files, instead opting to take advantage of better file folder structure and security with Microsoft’s office.com services.

Regional SEP biologists worked with staff from each of the eight hatcheries to develop a customized data entry template for data collection on their tablets, similar to their paper forms.

This was intended to help manage the learning curve in using the new technology, while maintaining their existing data capture format. Throughout the sampling season, regional SEP and stock assessment biologists reviewed and downloaded the data files, and fielded questions from hatchery users. Data was generally not recorded on paper after the first few days of sampling, as users became familiar with the system and confident that it was reliable.

Data files were imported into the hatchery database, reviewed for quality assurance, and cross-referenced with the CWT data imported from files sent from JOT's Head Dissection Lab at the end of the sampling season.

Brood Stock Sampling

The updated electronic sampling strategy was used for six of the eight Canadian Chinook PST indicators in the 2020 return year. Snootli Creek Hatchery and Chehalis River Hatchery opted to not employ the automated system. At Chehalis River Hatchery, eight heads with CWTs were recovered so the system was not needed. Sampling of Atnarko River Chinook is done on the river and staff at Snootli River Hatchery elected to continue with manual data collection.

Dead Pitch Sampling

In 2020, the automated system was not employed for in-river carcass surveys. Concern about dropping the tablet into the river and losing data was the main reason for this decision. Higher quality waterproof cases will be explored in the future to potentially address this concern.

Results

Sampling System Design

The equipment performed as expected, with the exception of a loss of power in the barcode scanner, due to a dead battery during sampling at three hatcheries. It was thought that if the battery was damp it was more likely to self-discharge, so efforts were taken to keep the scanner in a dry location or in the charger while sampling.

The water resistant case for the tablet kept it sufficiently dry and protected during use. There were holes in the back of the case to affix a strap, so water could enter the case and it was not waterproof. Cases that claim to be waterproof tend to be expensive, and are not 100% waterproof, so it was decided to use the more cost effective water resistant protective cases and have users ensure that they were not set down in water. In addition, a stylus proved useful to record data on the tablet.

MS Office 365 applications, such as Excel, which ran on the tablet, had a different interface than Office 2016 applications, which DFO staff have on their work computers. Consequently, users noted there was a learning curve to become familiar with the software.

Working with files saved in the cloud was also a new challenge for several hatchery staff. Network connections and performance varied between hatcheries, from none at Chilliwack River Hatchery to good at Quinsam River Hatchery. Other sites had connections in the office but not at the sampling area, and had to ensure data files were synchronized with the cloud at the end of the day. Each hatchery modified the methodology to upload and backup the collected field data to suit their respective connectivity.

Data Collection and QA

Four of the six hatcheries that employed the automated system collected all biosampling data, including scale, otolith, and DNA sampling data. The remaining two hatcheries used the system solely for collection of E-label data. At this time, scalebooks carry a barcode; however, otolith boxes and vials, and DNA Whatman sheets do not have barcodes to identify them.

The number of records collected by each hatchery using the automated system are listed in Table 1. Compared to the 2019 pilot at Spius Creek Hatchery, there was significantly more data collected in 2020. Data quality issues arose at two sites associated with: 1) the copy and fill function, and 2) the multi users function of Microsoft Excel.

Excel's copy and fill function allows tapping and dragging contents of a cell to the cells below it, either to copy or to sequentially fill those cells. If one cell was selected before dragging, the default was copy, but if more than one cell was selected then the default was to fill the cells that had the data dragged over them. If the user was not paying attention they could end up filling instead of copying data down to the next record, for example in the sampling date field. One hatchery stopped using the barcode scanner because of the power issues described above. Instead staff used the fill function to copy E-label data down to the next row, which resulted in duplication of E-label numbers when a typo was made at the beginning of the day.

Two hatcheries lost records when more than one user was in the data file at the same time. Some hatcheries had network access at the sampling location, while others could only upload and share data through the network when they returned to the office. With time users learned to save files to the device, then to the cloud in order to share with other users when a network connection was available. This resulted in fewer mistakes being made.

Sampling System Learning and Use

The process of learning the setup and use of the system by new users was facilitated by the implementation of MS Teams software. This enabled users, regional SEP biologist, and stock assessment biologists to chat and share their knowledge. For instance, a user at Puntledge River Hatchery developed a solution to share files from tablets to DFO workstations using the functionality provided by the office.com website. Another user at Quinsam River Hatchery sourced a better stylus that others were able to add to their systems. The user at Spius Creek Hatchery, who successfully implemented the pilot project in 2019, was helpful in providing

advice on scanner operation to the new users in the team chat. A barcode for scanner reset proved invaluable in solving problems when the scanner refused to pair with the tablet.

Table 1. Number of Chinook biosampling records collected on tablets by hatchery

Stock (Hatchery)	Days Sampled	Records Collected
Big Qualicum Fall	27	289
Chehalis Fall	0	0
Chilliwack Fall	24	1,031
Puntledge Fall	17	1,027
Quinsam Fall	24	1,496
Robertson Fall	32	8,887
Atnarko Summer (Snootli)	0	0
Nicola Spring (Spius)	18	276
Total	142	13,006

Import of the data from the tablets into the hatchery database was somewhat onerous, due to the manual nature of the import routine (using an antiquated database, which is currently being replaced by a new system: E-PRO). In addition, the customized data collection forms, that originated from the paper versions used at that hatchery, did not carry all the necessary data required for the import (such as transaction type, transaction time, source container and other mandatory fields needed in the hatchery database). Consequently, several hours of data manipulation was required to complete the import for each stock, but subsequent imports of lab data, such as scale age data, thermal marks and CWT data, were fast and simple.

Conclusions

Automated data management systems were implemented at six of the eight hatcheries where they were deployed. Tablets and scanners were not taken to the river for data collection during carcass surveys due to concern about dropping the tablet into the river and losing data.

Overall, most users were able to learn to use the updated system and successfully collected all the CWT data for hatchery returns. Electronic data management is more complicated than paper file-based data management, requiring computer network understanding and skills. However, once those skills are gained, the system is generally more efficient and should be more accurate. The main personnel cost was becoming familiar with the automated system. The benefit of not manually entering sampling data from paper into electronic format for sharing with other data users was well received.

The efficiency of not manually entering data from paper forms into a computer after sampling, combined with transcription errors on paper data forms, both contributed to making automated data management a more accurate and preferred method for data collection. The likelihood of typos made in the tablet are similar to typos made on a paper form, and could be handled with error checking routines in a dedicated data collection application.

Development of an application with built-in error checking, enforced data integrity, and code definitions in the data fields would improve data accuracy. Removing the manual requirement for synchronizing and backing up of the data file over a network by having an application control these functions would improve the accuracy and reliability of the system.

The number of fish sampled at Spius Creek Hatchery is relatively small, compared with the number sampled at larger production hatcheries. Scaling up the methodology to other hatcheries required a learning curve for staff and a change in culture to accept the new technology; however, the benefits of increased efficiency and accuracy should make the transition worthwhile in the long-term.

At the end of the sampling season SEP staff asked for feedback on the new methodology in the form of a survey, which was sent to system users at each of the hatcheries. This survey concluded by asking the user if they would employ automated adult sampling data collection in 2021 (Table 2). Five of the six users would employ the system again. Multiple users felt that functionality of the new method would be improved if there was an app to check for errors, prevent entry of duplicates, and ensure data could not be deleted accidentally. Such an app could also handle the synchronization of data, removing that complexity from the user operations.

Development of E-PRO, a new hatchery data management system, is now underway with a tentative release date of November 2021. Remote data capture, including for CWT sampling, is planned for subsequent releases, with the initial release focused on replacing functionality in the existing system, so it can be decommissioned. Building the automated CWT sampling method into the new hatchery data management system should address user and data management requirements. The experience gained from this project, with the purchase of the scanners and tablets, will enable a smoother implementation of this functionality when it arrives.

Table 2. Post season user survey responses

Hatchery User	Would Use in 2021	If No, Why Not	Improvements Needed
Big Qualicum	Yes		Better sorting capability
Chehalis	Yes		Expecting more CWT back in coming year. More time to trouble-shoot problems reported by others in 2020.
Chilliwack	No	All staff need One Drive. No wifi on site.	Stylus helped, but sampling with wet, slimy hands using tablet was difficult.
Puntledge	Yes		Better synching with cloud. OS was a challenge. Dedicated pad to keep scanner dry. Real time connection to inventory in Enpro.
Quinsam	Yes		Check with user before delete.
Robertson	No	Scanner was not reliable in wet sampling environment. Inventory in Enpro didn't always align with tablet data.	Need app to control data changes and synchronization. Dedicated pad to keep scanner dry.
Snootli	No	Waiting for app and integration with new E-PRO system.	Lanyard to secure tablet in waterproof case and scanner to user for sampling on the river.
Spius	Yes		

APPENDIX I. 2020 Financial Expenditures Summary

Details of expenditures registered in the DFO financial system at fiscal year-end.

Funding Total	15,471.00
Payment from PSC	15,471.00
16 x Rechargeable Bluetooth Numeric Keypad - Portable Slim 34-Key Wireless Pad Compatible with PC Android iOS Tablets MacBook	927.84
16 x Samsung Galaxy Tab A SM-T510NZKAXAC 10.1" Tablet with 1.8GHz, Octa-Core Processor, 32GB of Storage & Android 9.0 - Black	4,806.87
16 x SEYMAC Stock Samsung Galaxy Tab A 10.1 T510/T515 Case 2019, Three Layer Hybrid Drop Protection Case with [360 Rotating Stand] Hand Strap & [Stylus Pencil Holder] for Samsung Galaxy Tab A 10.1 (Black)	555.84
16 x Adesso NuScan 4100B Bluetooth Scanners	2,707.88
16 x Stylus Pen for Galaxy Tablet	265.28
Total Costs	9,263.71
Balance (refunded to PSC)	6,207.29

APPENDIX II. Method for Using Barcode Scanners to Automate CWT Data Management in Escapement

System specifications

Samsung Galaxy Tab A 10.1:

<https://www.bestbuy.ca/en-ca/product/samsung-galaxy-tab-a-10-1-32gb-android-9-0-tablet-with-8-core-processor-black/13484291>

Seymac protective case:

<https://www.amazon.com/SEYMAC-Samsung-Galaxy-10-1-T510/dp/B07T5KZR9J>

Numeric keyboard:

<https://m.bestbuy.ca/en-ca/product/rechargeable-bluetooth-numeric-keypad-portable-slim-34-key-wireless-pad-compatible-with-pc-android-ios-tablets-macbook/13484535>

Adesso NuScan 4100B - Wireless 1D Barcode Scanner

https://www.staples.com/adesso-bluetooth-antimicrobial-ccd-1d-handheld-barcode-scanner-black-yellow-nuscan-4100b/product_2499648

Data forms

Users agreed on the data format, codes and definitions used in their data forms, designed in MS Excel, using lookup tables for standard codes. Definitions of codes were accessible when entering data. A standard field form for recording CWT data in escapement was developed by the SEP Planning and Assessment Unit.

Hatchery testing

Hatchery staff tested the system prior to sampling season, as follows:

1. Test charging equipment and document charge times
2. Test data capture with the database format, ensuring auto-save is turned on
3. Test transfer of files, via Wi-Fi and email
4. Set up and test One Drive, to back up files to the cloud via Wi-Fi
5. Test import of tagcode recovery data files back to the hatchery database

Protocols for setup, calibration and use of the automated system

1. Turn the tablet on, and log on.
2. Load the excel file on tablet
3. Record header information and date
4. Ensure Bluetooth is enabled
5. Pair the scanner with the tablet.
6. Scan the setup barcodes. Clear the memory of the scanner.

A video demonstrating usage and documenting steps in the process is available.

Adult sampling and data capture

1. Adults were sampled in groups of 10, by sex if possible.
2. Samplers measured POH in mm, collected scales, otoliths and DNA samples, with data recorded into the tablet.
3. E-labels were affixed to the 10 fish, and a sampler scanned them into the tablet.
4. Snouts were removed and stored in labeled covered buckets in a freezer at the end of the day.
5. Files from the scanner were downloaded daily by hatchery staff and weekly by biologists as backups.

Submission of heads with barcode labels to J.O. Thomas head dissection lab

1. At the end of the season heads were shipped to JOT, as per CWT Sampling Guidelines.

Data integration of CWT codes from JOT with hatchery data system

1. After hatchery staff entered all activity transactions into the hatchery database, biosample data from tablet files was formatted and imported using the database import function.
2. Files with CWTs and e-labels sent from J.O. Thomas Head Dissection Lab were imported into the database using the import function.
3. QA and running integrity checking reports was carried out to correct data entry errors.

Samsung Tablet and NuScan Barcode Scanner Quick Start Instructions.

NOTE: the case is NOT waterproof. There are holes on the back where the handle is, so do not set the tablet into puddles of water.

- 1) The name of the Chinook stock is labelled on the back of the tablets. For Quinsam, Big Qualicum and Robertson, there are 1 and 2, with files on these tablets named 1 and 2 (so they don't get overwritten accidentally when you save them to the cloud), you can rename if you like.
- 2) There should be 2 scanners, 2 numeric keypads and 2 tablets in cases. Please charge everything, or they may not pair properly with the Bluetooth.
- 3) There is a Reset-reset barcode in each scanner box, in the charger. Do not lose this. ! Please tape it to the scanner charger or somewhere safe.
- 4) The tablet start button is top right. A biodata file template has been loaded for your stock, and MS Teams installed.
- 5) To see the excel biodata file, it should be open, if you tap the open windows icon, bottom right ||| on the home screen. It is currently saving to the device (no wifi needed to save).

Bluetooth Pairing

- 6) Go to System, Connections and turn Bluetooth on. Once you have the keypad or scanner in pairing mode, you can click Scan.

7) To pair the (fully charged) numeric keypad, turn it on, then hold down the pairing button, until the flashing blue light stops flashing. The name of the keypad device will show up on the tablet. You must touch that name while it says "Connecting" to get a popup box to confirm that you want to pair. Say yes, and it should complete the connection. Then you can stop pushing the button on the keypad.

8) Similarly with the scanner, hold down the button, while the tablet is scanning, until the name appears on the tablet, select that name and confirm that you want to connect. Then the scanner will beep and the flashing yellow light will turn solid, and you can stop holding down the button.

Testing

9) Go to the excel file on the tablet. A row of test data has been entered. Enter a few more yourself. You may need to use the Reset barcode to get the scanner to capture data. Make sure the keyboard on the tablet still works. There is a setting on the tablet to allow both the scanner and the tablet to act as keyboards. This setting should be set up already.

10) The numbers on the numeric keypad might be sticky. Check to see if what you punch is what shows up in the POH length data in the file on the tablet. This keypad can go into a baggie in wet conditions.

11) To get to the pull down screen on the tablet with notifications and main menu items, the case makes it a bit tricky, so you need to swipe from the very top of the tablet, almost under the case.

Wifi

12) Once you are in range of a wifi connection, add the connection to your wifi connections (system/connections).

13) Open MS Teams (might also be already open) and use your DFO network username and password to log on. You are now in the cloud! Anything you save here is off the tablet.

14) You have been added to an MS Teams chat group to see questions or discussion. You can save files and data here. Once into the "CWT Sampling Tablets and Scanners" chat group you'll be able to see the Spius 2019 video and other shared files.