A Compilation of Operational and Planning Guidelines for the Salmonid Enhancement Program
2016

1 Introduction

1.1 Background

This document contains operational and planning guidelines utilized by hatcheries within the Salmonid Enhancement Program (SEP), a part of Fisheries and Oceans Canada (DFO) in British Columbia and the Yukon (DFO's Pacific Region). SEP is comprised of a variety of projects including hatcheries, fishways, spawning and rearing channels, habitat improvements, flow control works, lake fertilization, and small classroom incubators. About 150 of these projects are hatcheries and managed spawning channels (where spawn timing and density are controlled), with most hatcheries releasing small numbers of fish. Projects are operated by SEP staff or contracted, with some SEP support, to First Nations and community and volunteer groups. The majority of enhanced production, about 90%, originates from 17 large facilities operated directly by DFO. The Program has staff located in DFO's Pacific Region headquarters (Regional staff) and throughout BC and the Yukon (Area staff) and species enhanced include Chinook, Coho, Chum, Pink, and Sockeye salmon, as well as small numbers of steelhead salmon and cutthroat trout. Salmon production by SEP averages 386 million juvenile salmon yearly, representing approximately 8.6 percent of the 4.5 billion hatchery salmon released to the northeast Pacific Ocean annually by all nations during the 1990s and early 2000s (Ruggerone, et al. 2010).

SEP hatchery production is planned each year through an integrated planning process that involves establishment of juvenile release targets and strategies to produce adults for specific objectives. The planning process involves staff from various sectors in DFO, including Fisheries Management, and Science – Stock Assessment. Species interactions, harvest issues, habitat capacity, project capacity, effects on wild salmon, and assessment requirements are also considered during the production planning process described in the SEP Production Planning Framework (DFO, 2012). A companion document, the Biological Risk Management Framework (DFO, 2013), provides detail on the guidelines, practices, and tools that SEP utilizes to manage and mitigate risks to wild salmon, as well as potential approaches to assessing biological impacts. The guidelines that follow within this document are a key component of SEP's risk management approach.

This guideline compilation will be reviewed annually, with a revised version issued when updates are warranted. If major changes or key additions are required between versions, an addendum will be released.

1.2 Scope

This document applies to SEP managed or supported hatcheries, incubation projects and intensively managed spawning channels that produce Chinook, Coho, Sockeye, Pink and Chum salmon in Pacific Region. It does not address SEP habitat restoration or lake enrichment projects; nor does it apply to steelhead and cutthroat operations undertaken at SEP facilities, as their assessment and management are a provincial responsibility. The document does not deal with enhancement facilities that are funded through the DFO Aboriginal Fisheries Strategy, as these are developed and operated outside of SEP; nor does it speak to non-DFO funded facilities that enhance Pacific salmon.

References

DFO. 2012. *SEP Production Planning: A Framework*. Salmonid Enhancement Program, Fisheries and Oceans Canada, Pacific Region. 19 pp

DFO. 2013. *A Biological Risk Management Framework for Enhancing Salmon in the Pacific Region.* Salmonid Enhancement Program, Fisheries and Oceans Canada, Pacific Region. 61pp

Ruggerone, Gregory T., Randall M. Peterman, Brigitte Dorner & Katherine W. Myers. *Magnitude and Trends in Abundance of Hatchery and Wild Pink Salmon, Chum Salmon, and Sockeye Salmon in the North Pacific Ocean.* Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science, Volume 2, Issue 1, 2010. Pages 306-328.

Section 1 – Operational Guidelines

2 BKD Screening and Other Considerations That Can Affect Production

Bacterial Kidney Disease (BKD) screening results are one of a number of parameters that influence the final destiny of eggs taken from any given female. However, in a brood year such as 2011, that appeared to be hotter province-wide for BKD levels in both coho and Chinook than in past years, it quickly became the most influential consideration. This document outlines considerations for determining whether a contingency release is appropriate for fry from either Low Positive (LP) or higher females (see Appendix 1 - "Specific Pathogen Control Plan for *Renibacterium salmoninarum*, at BC federal enhancement hatcheries and affiliates" for a discussion of BKD screening levels) or fry from clean females that are excess to smolt targets. Upon annual receipt of BKD screening results, direction from the veterinarian will inform discussions with biological staff as to how to best proceed while incorporating all relevant considerations.

Production Strategy (90 day smolt vs. yearling Chinook):

- Under current protocols, BKD screening in subyearling chinook programs will not affect release strategy or numbers
- Given high BKD levels recently detected in some ocean-type chinook stocks, this may change in the near future.

Time and Size:

- Upon release, are unfed/short-term fed fry similar in size to wild?
- If timing of unfed hatchery fry release is well in advance of wild fry emergence (i.e. mid to late winter as opposed to spring), then a release is not justified from an "animal care" perspective.
- Sites will need to consider if other options are/can be made available to delay development in order to better match wild (i.e. chilled water, egg plants, instream incubators).
- If acceptable, unfed or short-term fed fry releases need to be included in the facility production plan.

Production Targets:

- While certainly an important consideration, production targets are not to be used as an excuse for taking "high LP and hotter eggs" any further than screening recommendations dictate.
- Exceptions may be made for high prevalence BKD years or under conservation enhancement scenarios.
- If egg targets for Pacific Salmon Treaty indicator stocks are affected by high LP fish, a plan specific to the year must be developed in consultation with StAD, hatchery staff and SEP veterinarian
- It is evident that some brood years are hotter than others throughout the coast. Consequently, culling recommendations are open to adjustment to prevent large numbers of facilities from falling well short of targets in these years. For example, for BY 2011 at Inch

Creek Hatchery, only 20% of the females from five different stocks tested either "negative" or "Low Level Detection (LLD)".

- Where a recurring high prevalence of BKD has been observed, either through disease incidence or annual broodstock screening, discussions involving the SEP veterinarian and Support Biologists should occur in order to ensure that all feasible disease control measures have been attempted and to consider whether continued enhancement is warranted, given the risk of disease amplification.

Genetics:

- As it is important to maximize genetic contribution to any hatchery production group, taking some eggs from low LP females further might be desirable for stocks of conservation concern in order to prevent bottlenecks on some cycle years.
- If BKD levels correlate strongly with run timing (e.g. early fish are all MP), a strategy to balance genetic and disease concerns must be met through discussion with biological and veterinary staff.
- When a great deal of brood is composed of LP fish, decisions to take a fraction of eggs from all LP fish to increase genetic diversity or to take 100% of the eggs from the fish with the best/lowest BKD screening results should only be made in consultation with biological and veterinary staff.
- It is important to consider the percent of escapement taken for broodstock when considering all of the above. As broodstock numbers begins to comprise a larger proportion of total escapement, genetic considerations become increasingly important. Note that broodstock collection numbers should not exceed enhancement guidelines.

Natural Freshwater Life History Pattern of Stock/Species:

- Can affect quantity of rearing habitat potentially available.
- For example, Upper Fraser stream-type chinook juveniles make use of wide ranging river habitats (often over hundreds of kilometres) during their time in fresh water.
- This can contrast directly to a coastal/small system coho stock, which given both species behaviour and system topography may only have a few kilometres of juvenile rearing habitat "availability".

Availability of Underutilised Habitat:

- Must be documented prior to out planting!
- May require anticipatory adult assessment the previous fall and/or emergent fry density evaluation.
- If there is no underutilised habitat available or a habitat assessment is not performed, then culling of the majority of LP and higher eggs must be considered (or as unfed fry if habitat determination made later in brood year).
- If underutilized habitat is identified, an appropriate maximum release target must be calculated using SEP guidelines for fry stocking

Culling

- If, after review of all relevant factors and options, culling is the most appropriate action – then so be it!

Other:

- Facility water source should be explicitly considered when setting cut-off levels given that many hatcheries have the BKD organism in their surface water supplies. For such sites it can be argued that eggs from low scoring fish are no more of a threat than the low levels of organisms juveniles are exposed to via these water supplies.
- A BKD rearing trial with stock from low positive (LP) Serpentine River Coho (B.Y. 2011) was conducted at Inch Creek Hatchery. One group was composed of eggs from screened females with values ranging from 0.085 to 0.123; the other group was composed of eggs from screened females with values ranging from 0.124 to 0.194. After being reared to smolt under near identical conditions (fish number, pond volume, pond flow rates, etc.) sampling just prior to release determined that *progeny from females which had higher screening values were 13 times more likely to have detectible* R. *salmoninarum as presmolts than progeny from low value screened females.*

Appendix 1 Specific Pathogen Control Plan for Renibacterium salmoninarum, at BC federal enhancement hatcheries and affiliates

The goals of a specific pathogen control plan are:

- To minimize the expression and transmission of pathogens during rearing to facilitate the release of healthy fish
- To adapt hatchery management measures to minimize the amplification of endemic pathogens, limiting the impact on both wild and cultured fish populations.

It should be anticipated that these guidelines will change in response to advances in diagnostic capabilities, disease prevalence changes over time/geographic ranges, and as program objectives change, but represent the best management practise at the time of writing.

Specific Pathogen Control Plan - *Renibacterium salmoninarum*

Renibacterium salmoninarum, the causative agent of Bacterial Kidney Disease (BKD), is an endemic pathogen in the Pacific Northwest. BKD is a slowly progressing, lifelong infection of salmonids. The bacterium may be horizontally transmitted between fish and vertically transmitted to the next generation. Clinical signs of BKD include exophthalmia (popeye), ascites (fluid-filled abdominal cavity), granulomas (whitish-grey nodules) within the kidney, pinpoint haemorrhages (rash) or vesicles of the skin, although fish may die exhibiting no clinical signs. Fish infected with *R salmoninarum* will not normally exhibit clinical signs until the fish are at least 6 – 12 months old. However being infected with *R salmoninarum*, even without clinical signs of disease, will increase susceptibility to other pathogens, such as *Flavobacterium psychrophilum* (Coldwater Disease) or *Aeromonas salmonicida* (Furunculosis). Treating *R salmoninarum* infected fish with antibiotics may lower signs of disease and the associated mortality levels, but will fail to cure the disease. The best control measure for this disease is avoidance, through methods intended to prevent its vertical transmission.

Specific control measures:

- Egg disinfection for a minimum of 10 minutes using a buffered 100ppm povidone-iodine solution prior to incubation or placement into a hatchery water supply if eggs are collected off-site or transferred to the facility at the eyed egg stage. *Note: multimillion-egg pink and chum salmon incubation facilities with no disease history during rearing are exempt from egg disinfection requirements at this time.*

- Prespawning antibiotic injections given to females within 3-4 weeks prior to egg collection (additional prior injections may be given at 30 day intervals for stocks undergoing prolonged prespawning holding). A veterinary prescription is required for antibiotic procurement and use.

- Progeny segregation (keeping egg lots separate during water hardening, egg disinfection and incubation in Heath trays until test results from female parents are complete) and culling based on levels of soluble *R salmoninarum*-antigen detected using the Enzyme Linked Immunosorbant Assay (ELISA).

    - Fertilized eggs/progeny from females that have an optical density (OD) value less than the mean OD value (minimum of 6 replicates) plus 2 standard deviations of a

negative control fish kidney sample are to be reported as 'negative' and may be used for yearling programs or be eligible for transfer to another facility.

- Fertilized eggs/progeny from females with an OD value greater than the mean negative control OD value (and therefore are positive for the *R salmoninarum* antigen) but less than 0.1 are to be reported as 'low level of detection'. Ideally, only eggs from negative females will be used for yearling programs, however, if needed to achieve production targets, low level of detection eggs are considered to present an acceptably low risk for the horizontal transmission of *R salmoninarum* may be included in yearling programs. If space allows, progeny should be kept separate from negatives if possible.
- Fertilized eggs/progeny from females with an OD value greater or equal to 0.1 but less than 0.25 are to be reported as 'low positive' and should be released early, as unfed fry to help maintain low levels of *R salmoninarum* within the hatchery and lower the risk of horizontal transmission between fish.
- Fertilized eggs/progeny from females with an OD value greater or equal to 0.25 but less than 0.6 are currently classified as 'moderately positive' and should be outplanted as eyed eggs if available rearing habitat is available downstream from the water intake of the facility or buried in dry ground or in wet ground with quicklime if appropriate habitat is unavailable.
- Fertilized eggs/progeny from females with an OD value greater or equal to 0.6 are currently classified as 'high positive'. It is recommended that these egg lots be destroyed via burial in dry ground or in wet ground with quicklime. In extreme circumstances (i.e. conservation concerns outweigh ecological consequences of propagating disease-positive fish) these eggs could be outplanted, but only after mutual agreement of the hatchery management, enhancement operations support staff and the DFO veterinarian.

In situations where escapements are low, or where the escapement BKD prevalence is so high that prescribed culling recommendations will compromise production targets, or where unexpectedly high levels of incubation mortalities occur; it may be desirable to rear progeny from females testing 'low positive' for BKD by ELISA. The disease transmission risk assessment must be made in consultation with the DFO fish health veterinarian, site management and hatchery support biologist using the following criteria:

- Fish Health Management Plan documenting personnel skills and respect for site biosafety objectives
- Physical containment to compartmentalize stocks on site
  - Separate areas with appropriate staff traffic flow, separate rearing units, separate water flow, separate nets and equipment with established disinfection protocols, separate dedicated staff as needed, etc.
    - To protect the progeny of females testing 'negative' from the potential spread of *R salmoninarum*
    - Separation between year classes - to protect all juvenile fish on site from broodstock of unknown disease status
- Availability of adequate type and volume of water for the duration of proposed rearing
  - Pathogen-free water is preferable
- Early recognition and mitigation of a problem

- BKD is a slowly progressing, lifelong disease. Fish infected with *R salmoninarum* will not normally show clinical signs (popeye, fluid distended abdomen, white nodules within the kidney, 'rash' or small red, external skin lesions, etc.) until the fish are at least 6 – 12 months old. However, infection with the bacteria will make juvenile fish more susceptible to other common pathogens, such as *Flavobacterium psychrophilum* (Coldwater Disease) or *Aeromonas salmonicida* (Furunculosis). For these reasons, staff rearing progeny from females testing low positive will need increased vigilance with regards to early detection and reporting to site management and the veterinarian of any potential disease development.

The Fish Health Database at the Pacific Biological Station maintains records of BKD screening and disease detection results for federal and federal-affiliated Pacific salmon enhancement hatcheries in BC. Based on these historical records, stocks can be classified into two categories with regards to the vertical transmission of BKD, **low and high risk**. Annual compulsory BKD screening will be required to mitigate the risk of vertical transmission of high risk stocks and to maintain an accurate prevalence estimate for each stock at low risk.

The frequency and intensity of screening will depend on a number of factors: risk status, duration of rearing, capacity for egg segregation, enhancement of nonindigenous stocks, site biosecurity capabilities with regards to managing multiple species and year classes, and proportion of escapements being enhanced.

<u>High risk stocks:</u>
All Coho and Chinook brood females should be screened annually; with culling as indicated by the ELISA results as described above. Additionally, sites must disinfect eggs and should consider broodstock antibiotic therapy if pre-spawning holding times allow.

If sites are incapable of egg segregation, all female broodstock (or 60 brood females taken over the course of the run, whichever is lower) should be screened annually to maintain an estimate of BKD prevalence. Additionally, eggs must be surface disinfected, broodstock antibiotic treatment should be discussed with the DFO veterinarian if pre-spawning holding times allow and efforts should be directed to increase egg segregation capacity.

For hatcheries rearing nonindigenous stocks to be returned to their native systems, all efforts should be made to ensure biosecurity measures are applied to effectively compartmentalize stocks, minimizing the risk of the horizontal transmission of *R salmoninarum* and/or other pathogens.

<u>Low risk stocks:</u>
Minimum standards required will be to screen all females or 60 selected over the timing of the run (whichever is less) on 3 year schedule to maintain an accurate BKD prevalence estimate. However, at the hatchery manager's discretion, any site may request full screening annually on all Coho and Chinook stocks. This should be considered for all yearling release programs, at sites which rear nonindigenous stocks, and at sites which lack the capacity for egg segregation. The PBS Fish Diagnostic Laboratory will make every effort to comply with increased testing requests by Salmon Enhancement Program (SEP) facility management.

Juvenile Pre-release Disease Screening

Disease outbreaks in juveniles and/or significantly high levels of *R salmoninarum* detected during broodstock screening at facilities which can not segregate egg lots and/or poor performance prior to release which requires veterinarian intervention will necessitate a pre-release disease prevalence sampling of 60 juvenile fish to obtain release authorization.

Poor performance may be defined as having total cumulative mortalities attributable to any disease of equal to or greater than 5% in the 90 day period, one month prior to the planned release date; regardless of the definitive diagnosis, as subclinical infection with *R salmoninarum* increases the susceptibility to other pathogens.

- In the event of poor performance and/or the suspicion of a BKD outbreak during rearing, a 60 fish sample of random, apparently healthy fish from the stock in question will be submitted to the PBS Fish Diagnostic Laboratory two weeks before the proposed release date. Routine necropsies will be performed if indicated, however, in the absence of abnormal clinical signs, examination may be limited to kidney samples using *R salmoninarum*-specific direct fluorescent antibody test (dfat) to estimate the prevalence of BKD in the juveniles. The detection of moderately high levels of *R salmoninarum* in at least 25% (15 of 60) of pre-released screened juveniles may prohibit release and trigger the destruction of the stock. Additionally, increased monitoring of other stocks on site will be needed. The stock will be designated as a high risk for subsequent spawning seasons. It will be recommended that the site participate in antibiotic administration to broodstock and broodstock screening and segregation for the next lifecycle, if feasible, and vaccination options may be considered.

3 Guidelines and Best Management Practices for the Coded Wire Tag Escapement Sampling Program

Note: These guidelines have been developed to improve consistency and efficiency in the coded wire tag (CWT) escapement sampling program. By clarifying some best management practices for collection, transfer and management of CWT heads and data the goal is to streamline operations during sampling, improve data quality, as well as create efficiencies at the head dissection lab. Within these guidelines there are also examples of good practices from various sampling programs to promote knowledge transfer between programs.

3.1 Background

CWTs have been used as a tool in the management of Pacific salmon fisheries since the 1960s. The recovery and analysis of CWTs in Canada and the US is the most important tool in research and management of salmonids, and is an integral part of the Canada/US Pacific Salmon Treaty. Reports from Pacific Salmon Commission (PSC) technical committees such as the Chinook Technical Committee (CTC) can be found here:
http://www.psc.org/publications_tech_techcommitteereport.htm

In 2005, an expert panel reviewed the CWT program and identified specific issues with the program (http://www.psc.org/publications/workshop-reports/coded-wire-tag-program-review/) These issues were addressed by a 2008 CWT working group that developed an Action Plan response (PSC Technical Report No. 25 http://www.psc.org/publications/technical-reports/technical-report-series/) In 2009 the Coded Wire Tag Improvement Team (CWTIT) program was initiated in response to the expert panel report and Action Plan. CWTIT, funds programs designed to address the recommendations in the Action Plan, including increasing tagging levels in Chinook for the five year duration of the program, increasing escapement sampling efforts and improving CWT data management.

Fish are sampled for CWTs in recreational, commercial and First Nations fisheries, and during escapement at the hatcheries and on the rivers. All heads collected in BC from these programs are sent to the J.O. Thomas and Associates head dissection lab contracted by DFO. The heads are dissected, the CWTs are extracted and read, and the results are entered into a database for reporting back to the project coordinators.

Within the Salmonid Enhancement Program (SEP) the information provided by CWTs is used to estimate the hatchery contribution to catch and river returns, and survival rates for differential in-hatchery treatments and enhancement strategies. The data is also used for reporting to departmental stock assessment biologists and PSC technical committees. CWT data flows from the escapement sampling programs to regional headquarters, through either the Enpro database management system or standardized escapement sampling forms.

To help address the need for improved data management especially with increased CWT application and sampling, this document was created to support the standardization of the escapement sampling program, which will make results more reliable and accessible for data analysis, and improve consistency.

3.2 Procedures

These Best Management Practices (BMP) focus specifically on escapement sampling for CWTs. Refer to the escapement sampling instructions provided by the SEP Planning and Assessment Biologists or Stock Assessment Biologists for information regarding the other aspects of escapement sampling.

1) Recording data – pre-sampling

Rationale for improvements

What you record for data varies program to program but there are some pre-sampling preparation steps that you can take to help make recording data during sampling easier. There is one template sample sheet for CWT and non-CWT Chinook/Coho in Appendix C, and RHQ has another in Microsoft Excel that is available upon request. You can use these templates for recording data if you do not currently have one in an electronic version or if you see some improvements in the template forms. These are not mandatory for use.

BMP

- Do as much prep work as possible before actually starting the sampling. Write out the e-label numbers before you start, and stack them so that the order matches your pre-recorded order.
- Have a blue book and a red book (or other colours) so that you don't have to record sex, you just write in the red book for females and the blue book for males, you can have a third book for jacks. Alternatively you can use different coloured tabs within one book.
- Make sure you know what data you need to record for each sampling stratum so that you are not doing more work than necessary. You should have a copy of the sampling requirements on hand so that if you're not sure you can check it easily.
- Prep your sample form with a column for each type of data that you need (e.g. date, sex, e-label, length) and print multiple copies. See Appendix C for a sample.
- Check your sampling supplies to ensure you have enough of what you need (e.g. e-labels, swiftachment guns, swiftachers, and replacement needles). If you require supplies contact Dave Willis at David.Willis@dfo-mpo.gc.ca who will pass your request on to the CWT Support Biologist.

2) Sampling the heads

Rationale for improvements

There isn't one preferred methodology for a sampling program as it varies project by project; however, to achieve consistency requires time and effort. Running the CWT sampling while doing other hatchery procedures (sorting, counting, egg takes, scale samples, otolith extractions etc.) can become hectic and busy especially for new staff. By providing some tips and tricks that some hatcheries use to improve their efficiency, will allow for other hatcheries to see if there are any practices/procedures that they can start applying during their sampling programs.

BMP

i. *General sampling organization*

- If possible, and if enough CWT fish are available for sampling, designate one person who will supervise the CWT sampling and data management who will not be involved in the other sampling operations.
- However, it may work best to have the person leading the CWT sampling also coordinate sampling for scales and/or otoliths depending on the specific hatchery requirements.
- Before sampling begins, organize your sampling station to ensure you have enough of everything you need.
- If you are only taking heads and recording the sex but no other biodata (for example, length) then you could also set up a series of buckets for males, females and jacks (Fig. 1) so that you can put the detatched head in the correct bucket and then attach the e-labels after the bucket is full, or when there is a lull in sampling.

Figure 1. Bucket set up at Chilliwack River Hatchery. There is one bucket each for jacks (white), males (blue) and females (pink) before the e-label is attached. The black buckets on the left are for heads once the e-label has been attached.

- Another option, if you are not recording lengths for the fish and you are taking a lot of samples on one day and from one location, is to bulk bag the heads (10 heads per bag, separate bags for females, males and jacks) with a series of e-labels (not attached to heads) included in the bag. The lab can match up the e-labels to the heads randomly, however, ensure you send a clear note with the shipment indicating this to the lab and double count the heads in the bag and e-labels.
- If you also need to sample scales or otoliths, its best to randomly select a few fish for this and save them off to the side and do them all at once instead of one at a time.
- If a fish with a CWT is recovered it should not be used for broodstock, it should be sorted for CWT sampling (unless you have a limited escapement and need to use the fish for both).

ii. *Sorting for CWT presence*

- Sorting Chinook in adipose fin clip programs - AdCWT (hatchery and river strata)
  - Visual sampling - if the fish has an adipose fin clip the head should be sampled.
  - Do not double check for CWT presence using a R9500 or a wand.
- Sorting Coho and Chinook in CWT-only and double index tag programs (hatchery)
  - Electronic sampling - check for CWTs by putting all marked (coho) and unmarked (Chinook) through the R9500 detector.
  - A wand can be used if the R9500 is broken or if the fish is too large to go in the tube. Do not use the wand on a live-moving fish as this has been demonstrated to underestimate CWT presence.
  - If you need to re-check for CWT presence because of a hook found in the mouth then put the fish through the R9500 again.
- Sorting Coho and Chinook in double index tag programs (river)
  - Wands should only be used based on the study design for your project and should not be used if you are bulk collecting all unmarked heads.
  - The wands should not be used on live-moving fish as this has been demonstrated to underestimate CWT presence.

3) Cutting heads

Rationale for improvements

The style of head cut can make a difference in how quickly the lab can process a sample. The preferred cut is a upper head cut, aka snout cut (Fig. 2), as compared to a half head or full head (Fig. 3). For an upper head cut, the lab processing time is faster because the samples thaw quicker, the lab can use an electric corer instead of manually cutting the head, there is less tissue to process, and the storage space required is reduced. There are some other considerations to note when doing an upper head cut which are listed in the BMP section below.

BMP

i. *Upper Head Cuts aka Snout Cuts (Fig. 2) are the preferred option for the lab*

- The easiest way to do this cut in the field is to cut down from the top of the head, **at least 1 cm behind they eye**, until you hit the jaw, then make a second cut back through the connecting tissue to remove the lower jaw.
- One caution with the upper head cut, is that if it is done improperly (cutting too close to the eye or not including the eye at all (see Fig 3A) there is the potential to loose the CWT if it has migrated out of the snout. A proper cut includes the eye, the musculature around the eye (which is why you have to include some tissue behind the eye) and upper jaw.
- If the lab will be extracting otoliths, then you need to ensure that there are enough whole head samples sent in to allow for otolith sampling.

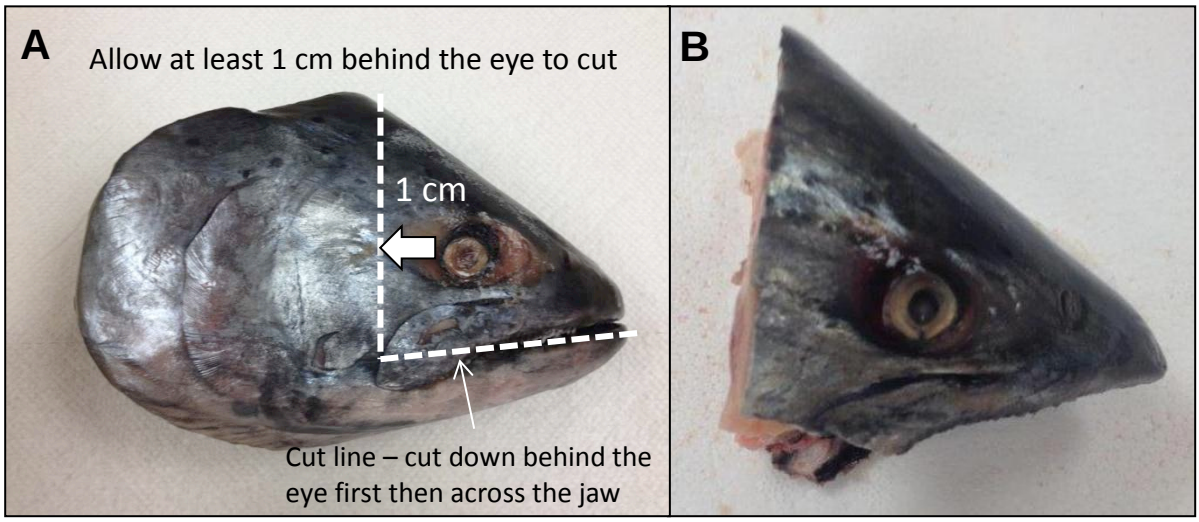


Figure 2 Proper Cut: A) how to do a good upper head cut, B) finished upper head cut

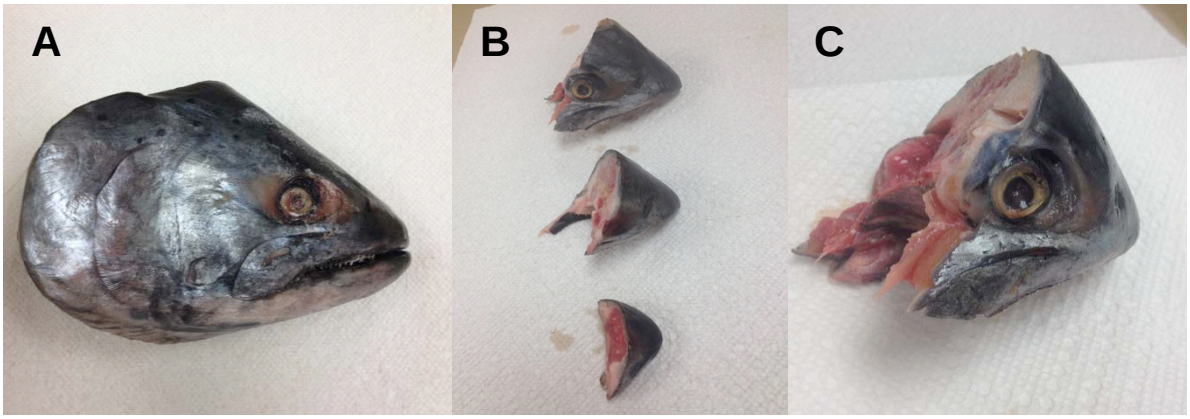


Figure 3 Bad cuts. A) Head has extra tissue that takes longer to unthaw and has to be removed before the lab can start to process it. B) Bottom two snouts are cut too short and did not include the eyes C) Head was cut too close to the eye so that some of the musculature tissue was removed.

ii. *Alternative Cuts*

- If an upper head cut is not possible then a half head is preferable to a whole head.
- Removing any excess head and gill tissue will help speed up the dissection time.

iii. *Cutting tips*

- Keep a knife sharpener on hand to sharpen knives as you sample.
- You can use a serrated blade to make cutting easier but you can't sharpen them.
- Robertson Creek Hatchery uses a guillotine to remove the heads, and Quinsam River hatchery has a trough that they've built to hold the fish upright and steady while cutting the heads. Contact them if you'd like more information.

4) Labelling heads

Rationale for improvements

Starting in the 2013, RHQ will supply the CWT escapement programs with a new barcode e-label. The label will still be durable and waterproof and will still have an e-label number to use as you have used in the past. If the lab receives any other type of label (old e-labels or hand-made labels) the lab will assign a barcode e-label number to this head to enter in the results into the database, so using the proper labels while sampling saves the need to have two different labels with a head.

If labels are not properly attached to the head they can fall off during the freezing or thawing process and the lab can't match the CWT results to an e-label. In these cases the program lead will have to try to match the CWT result to an e-label based on other biodata collected, or do a random match which can lead to errors in the data.

BMP

i. *E-labels*

- RHQ and/or Science have e-labels with barcodes available that can be sent to programs on request.
- Do not use e-labels that you've found in old storage as these are outdated and have some repetitive numbers.
- Only use e-labels on escapement sampling. If you are also working with sport, commercial, research/test, or First Nations fishery sampling, contact Doug Herriott (Doug.Herriott@dfo-mpo.gc.ca) or Erik Grundmann (Erik.Grundmann@dfo-mpo.gc.ca) for more information or supplies requests.
- The colour of the e-label has no significance for the lab. You can use different colours to differentiate between species or sex but do not expect the lab to know how you colour coded your sample.
- You do not need to write anything on the e-label. As long as your data set has the correct e-labels listed, the data resulting from the head dissection will match the e-labels in your dataset.
- If you run out of e-labels, do not make your own label, but contact Dave Willis at David.Willis@dfo-mpo.gc.ca

ii. *Attaching the e-label*

- Securely fasten the e-labels to heads using the Dennison Swiftacher. Fig. 4 shows the preferred location to attach the e-labels based on an upper head cut.
- RHQ has a supply of swiftacher guns, replacement needles and swiftachment ties available on request.
- Alternatively, cable ties (aka zap straps) are also an effective way to attach e-labels, but you need to use a knife to puncture the head so that you can push the cable tie through which can take longer.
- Do not use any sort of metal to attach labels to heads as this causes errors when dissecting the head and extracting the CWT.
- Do not individually bag heads with the e-labels unless the head is too decayed to attach an e-label to.

Instructions for e-label attachment using a Swiftacher:

- The tissue that separates the upper maxilla and the head is the best place to securely attach an e-label. (Fig. 4). If you pull down on the maxilla, the tissue in between can be easily punctured with the swiftacher needle, and the tie will go all the way through to open on the other side.
- If these areas are not available due to decomposing tissue use your judgement to find the next best place.
- As long as the t-bar on the tab opens up, the label will not come off. Check the underside of the label attachment to make sure that the needle poked all the way through the tissue and you can see the opened t-bar on the other side.
- Use at least 2 to 3 tabs to secure the label and give the label a 'tug', or lift and move the head around by the e-label.

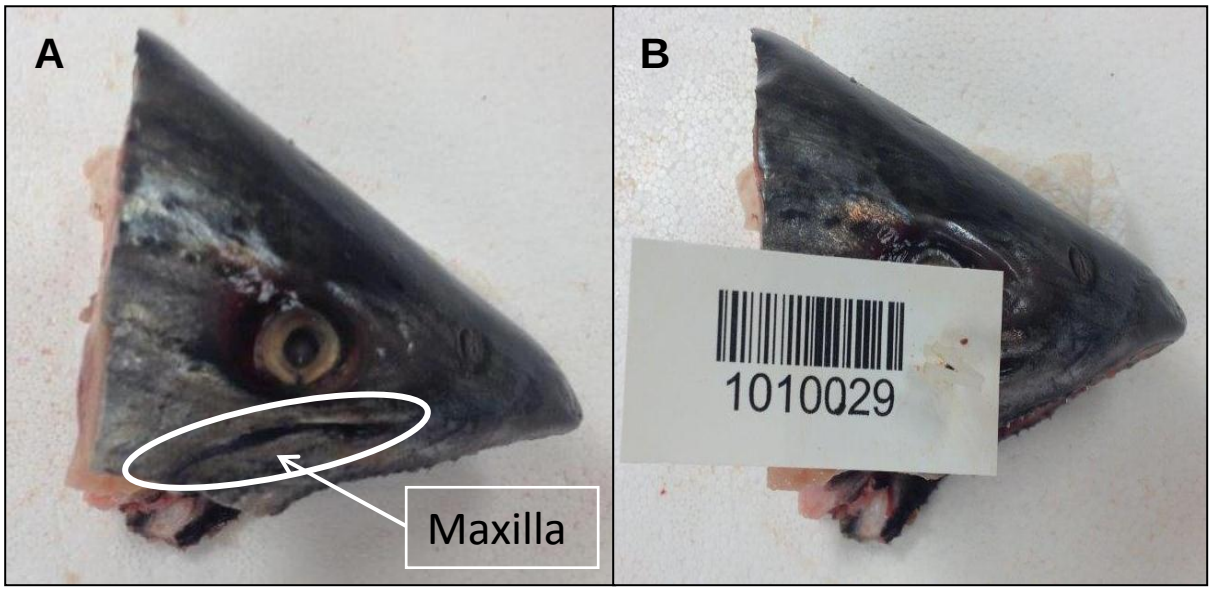


Fig. 4 A) The circle shows the best places to attach e-labels, B) Head with label attached using Swiftachers.

5) Transferring CWT Heads to the Head Dissection Lab

Rationale for improvements

The head dissection lab spends a lot time sorting through head shipments and the sampling data included in those shipments. The main role of the lab is to dissect heads and provide the CWT codes to the program contact. However, the lab can spend a lot of time trying to sort through unorganized data, poorly labelled shipments, and boxes/bags containing heads from different sampling strata (fishery versus escapement). Also, storage space is limited at the lab and the one walk in freezer that they possess on site is tall and narrow. As such, boxes with heads need to be stacked and safety becomes a concern when large heavy boxes arrive at the lab. Also non-stackable

containers such as plastic garbage bags are hard to store and rip easily. Lastly, the volume of heads in a container can affect the amount of time it takes to un-thaw a sample.

BMP

i. *Project Name*

- Create a project name for each of your sampling stratum. Some programs may have one while some may have 3 or more.
- A good way to create a project name is to follow this template: run year_hatchery_ stock_sampling stratum_timing_species.
- Ensure you have they key pieces which are:
  - Year: escapement year.
  - Hatchery/river: Hatchery name should match the name on your PAR license.
  - Stock: what is the actual stock you are sampling (if it is different than the hatchery/river name)
  - Sampling stratum: could be deadpitch, swim-ins, or broodstock (if you collect brood live from the river).
  - You project name could also include the run timing if you sample multiple runs.
- Some examples:
  - 2013_Chilliwack River Hatchery_Swim-in_ Chinook
  - 2013_Snootli Creek Hatchery_Atnarko_Broodstock_Chinook
  - 2013_Robertson Creek Hatchery_Stamp River_Deadpitch_Chinook

Important Note: If you want your deadpitch and hatchery sample results separated make a project name for each one and clearly label each sample and pack samples in separate boxes. If you want the results combined then you can make one project name and the lab will enter all the results under one project and you can separate the results later.

ii. *Data to be included with the head sample*

- You are not required to send in biological or mark sampling data with the heads.
- If you include sample data with the heads, the lab will not enter the CWT results into your sample data format (see section 6 regarding the new data entry format), and will not return the data that you submitted, so make sure you have a copy if you choose to send it.

iii. *Labels for boxes*

- A template label format is included in appendix A. By using this labelling format the lab will have all the information that they need to dissect the heads. Complete as required for your program specifics.
- If you are sending your heads via a courier, then you can attach the label to the side, or include in the boxes, since you'll have the shipping address on the top of the box.

IMPORTANT NOTE when labelling and shipping heads:
If you are sending in both hatchery and river samples, and/or different stocks in the same shipment, remember that the lab only sees what is on the label. If you need the results separated for each sample, species or stock, then you need to specify that by filling out the template label in Appendix A for each container in the shipment.
One possible way to do this would be to ship each sample in separate boxes (or a group of boxes) and include the label in each box. If you enclose more specific sampling information, put a "**data enclosed"** note on the outside of the container so that the lab knows that extra information is inside that specific container. If there is a mix up with the data, the more information you provide to the lab, the more likely it is that they will be able to solve the problem quickly and efficiently.
If you encounter heads from other sampling programs other than escapement, do not include those samples with the escapement samples unless they can be clearly separated in a separate box with a unique label.

iv. *Containers: Do's and Don'ts*

- Do use small sized stackable containers. 20L are good for snout cuts, but 70L or less also works for all types of head cuts.
  - Plastic containers are best as they are stackable and reusable.
  - Reinforced cardboard boxes with the heads in a leakproof bag/container inside are good but not reusable.
  - Styrofoam coolers work well, but can break on occasion.
  - These containers are also available in an optimal volume to un-thaw quickly.
- Do not use large containers (over 70L). Oversized containers cannot be stacked as easily as smaller containers and can cause safety concerns for staff lifting and carrying large containers. This volume of heads also takes longer to un-thaw.
- Do not individually bag the heads; unless it is required operationally (i.e. a head is too decayed to attach a label properly). On average, individually bagged heads take twice as long to process than non-bagged heads. Also an excess of bags increases the space required to store the heads and causes a lot of waste.
- Do not ship the heads in garbage bags. These do not stack well in the walk in freezer at the lab and can rip.

v. *Transportation*

- When transporting the heads, take precautions to ensure that the labels on the boxes will not fall off or become illegible. To be sure, you could always make two copies of the labels and put one inside the container in a water proof bag, or completely cover the outside label in clear packing tape.
- Before shipping the heads, email Erik Grundmann (Erik.Grundmann@dfo-mpo.gc.ca)) to ensure that there is space to accommodate your shipment.
- Ship the heads to 1370 Kootenay Street, Vancouver, B.C. V5K 4R1.
- Do not send a shipment on a Thursday or Friday unless you are sure it will make it to the lab before Friday afternoon.

6) Receiving CWT data

Rationale for improvements

To create more efficient data transfer between the lab and project contacts, we have reduced the amount of data-sifting that the lab does by having them enter the CWT codes and dissection criteria into the Mark-Recovery Program database (MRP). Having all the results in the MRP database allows for more information to be captured by the lab, and will improve data tracking and data retrieval. Results are extracted from the database into a Microsoft Excel spreadsheet which will get emailed out to the program contacts once all dissections are complete for each project.

BMP

i. *Dissection and CWT code reports received back from the lab*

- The lab dissects the head, reads the CWT and enters the CWT results into the MRP database.
- This data is then exported into a Microsoft Excel spreadsheet and emailed to the program contacts.
- The spreadsheet that you receive with the lab results has several columns (see Appendix B for a description of what the results include).
- Note that not all of this data will be relevant to your interests, so you can ignore those columns or hide them in the excel spreadsheet.
- The lab will also include a Dissection Data Summary for each project, which outlines how many heads were sent in, how many e-labels were found and if there were any placement or tag read issues, or other notes about the heads or data.

ii. Heads without e-labels and lab assigned e-labels

- If there were cases where e-labels become detached from heads, or if the label is illegible the lab will assign an e-label and record the CWT result under the new e-label. You will be notified if this happens when the results are emailed to you.
- The CWT codes will need to be matched to the biodata collected during sampling. SPA or Stock Assessment Biologists can help to allocate codes from the heads with the lab assigned e-labels to the original sampling data.
- If there were loose labels found in the shipment with no heads, the lab will enter those loose labels as "no head attached".
- Make sure that you keep track of which lab assigned e-labels were matched to your e-labels so that the changes can also be made in the MRP database. This will help avoid confusion if you request a new data report, or a re-read of one of the CWTs associated with a lab assigned e-label.
- If you use the lab assigned e-labels in your data ensure you delete your original e-labels in your data so that they aren't double counted.
- If you have any questions with your data, or if you have matched up lab assigned e-labels to your original e-labels please contact Dave Willis at David.Willis@dfo-mpo.gc.ca with your information or request who will work with CWT Support Biologist and the head dissection lab answer your question or make changes in the database.

Appendix A – Sample Container Label to include on or in your shipment

Tip: You can type in the generic hatchery/contact info then print multiple copies so that you only have to write the specific information, e.g. box numbers, on each when finalizing the shipment.

Project Name: _____

Return Address: _____

_____

_____

Contact: _____ **or** _____

Phone: _____

Species: _____ **Run Timing:** _____

Stock: _____ **Sample Stratum:** _____

Sampling year: _____

Number of heads in this project or container (circle one): _____

Box _____ **of** _____

Sampling dates _____ **to** _____

Lab Use Only:

Date Received: _____

Batch number: _____

Project Name: _____

Return Address: _____

_____

_____

Contact: _____ **or** _____

Phone: _____

Species: _____ **Run Timing:** _____

Stock: _____ **Sample Stratum:** _____

Sampling year: _____

Number of heads in this project or container (circle one): _____

Box _____ **of** _____

Sampling dates _____ **to** _____

Lab Use Only:

Date Received: _____

Batch number: _____

Appendix B – Explanation of the CWT result headings

Label ID: this will list the e-label number that was attached to the head, or a lab assigned label if the head was missing a label (see Lab Assigned column to determine if a label was assigned by the lab).
Status Code / Status: code denoting what the status of the tag was in the head.
1 – Tag read OK
2 – No tag
3 – Tag lost before read
4 – Unreadable tag
9 – Agency only / blank tag
M – no tag, metallic grit
Placement Code / Placement: Where the CWT was found in the sample.
0 – Normal
N – Nares
E – Eye (including eye socket)
B – Brain
Species Code / Species: Denotes what species of salmon.
124 – Chinook
115 – Coho
118 – Sockeye
Tag Condition Code / Tag Condition: Used to track CWT condition.
N – Normal
MS – Mechanical scratch
SH – Short Cut
FC – Faint code
Cut Quality Code / Cut Quality: Used to track the cut quality and types.
0 – Not checked
1 – Good snout or good head
2 – Poor cut unspecified reason
3 – Poor cut too close to the eye
4 – Poor cut in front of eye
5 – Poor cut nose only
6 – Poor angle cut
Tag Code: Will either have the CWT code, no tag, lost tag, or unreadable.
Tag Type Code / Tag Type: these should all be standard alphanumeric, but some agency only/blank tags may still be in use. This is included to be consistent with international CWT programs which record the tag type.
12 – Standard alphanumeric,
16 – Agency only/blank tag,
Blank – Not checked.
Head Length: The lab may record the head length if the head did not have an e-label attached to help match the head to metadata collected during sampling. If there was a measurement taken it will be recorded here.
Lost/Found: Used to track whether a tag was lost and later found.
True – the tag was lost and later found. See the comment section for specifics.
False – the tag was not lost and later found.
Random Match: Will note whether the heads were randomly matched to e-labels.
False – heads were not randomly matched to e-labels (the head had an e-label properly attached)

True – heads were randomly matched to e-labels.
Lab Assigned: Will note whether or not the lab assigned an e-label to a head.
False – there was an e-label attached to the head,
True - the head did not have an e-label attached so the lab used one of their own which will not match your records.
Batch ID: The lab enters in data based on a project, and each project has a batch ID. When requesting information on your data, it's best if you can include the project name, and the batch ID in your request.
Project Name: This is the project name which the lab prepares based on the data included with the shipment. At the least, it will have the river / hatchery name and the species.
Update Date: If the data was updated after it was initially entered the date and time is logged here.
Update User: If the data was updated after it was initially entered, the user name of the person logged on to the system will be logged here.
Create Date: The date and time the data was entered is logged here
Create User: The user name of the person entering the data is logged here.

Appendix C – Template Sample Forms

2013 ADULT BIOSAMPLE FORM
Page _____
CWT CHINOOK OR COHO

	Date	Source (Brailer #)	SEX (circle)	POH Length (mm)	Total Length (mm) **Jacks only*	E-label #
1			**M / F / J**			
2			**M / F / J**			
3			**M / F / J**			
4			**M / F / J**			
5			**M / F / J**			
6			**M / F / J**			
7			**M / F / J**			
8			**M / F / J**			
9			**M / F / J**			
10			**M / F / J**			
11			**M / F / J**			
12			**M / F / J**			
13			**M / F / J**			
14			**M / F / J**			
15			**M / F / J**			
16			**M / F / J**			
17			**M / F / J**			
18			**M / F / J**			
19			**M / F / J**			

20			**M / F / J**			
21			**M / F / J**			
22			**M / F / J**			
23			**M / F / J**			
24			**M / F / J**			
25			**M / F / J**			
26			**M / F / J**			
27			**M / F / J**			
28			**M / F / J**			
29			**M / F / J**			
30			**M / F / J**			

OVER THE ENTIRE RUN: PLEASE CHECK ALL CHINOOK FOR MARKS

ADULT BIOSAMPLE FORM Page _____

NON-CWT CHINOOK OR COHO

	Date	Source (Brailer #)	SEX (circle)	POH Length (mm)	Total Length (mm) **Jacks only*	Scale Book Number	Scale / Fish #	Otolith Box _____ Vial #
1			**M / F / J**				1-41	
2			**M / F / J**				2-42	
3			**M / F / J**				3-43	
4			**M / F / J**				4-44	
5			**M / F / J**				5-45	
6			**M / F / J**				6-46	
7			**M / F / J**				7-47	
8			**M / F / J**				8-48	

9			**M / F / J**				9-49	
10			**M / F / J**				10-50	
11			**M / F / J**				1-41	
12			**M / F / J**				2-42	
13			**M / F / J**				3-43	
14			**M / F / J**				4-44	
15			**M / F / J**				5-45	
16			**M / F / J**				6-46	
17			**M / F / J**				7-47	
18			**M / F / J**				8-48	
19			**M / F / J**				9-49	
20			**M / F / J**				10-50	
21			**M / F / J**				1-41	
22			**M / F / J**				2-42	
23			**M / F / J**				3-43	
24			**M / F / J**				4-44	
25			**M / F / J**				5-45	
26			**M / F / J**				6-46	
27			**M / F / J**				7-47	
28			**M / F / J**				8-48	
29			**M / F / J**				9-49	
30			**M / F / J**				10-50	

4 Operational Guidelines for Broodstock Collection and Spawning at Salmon Enhancement Program (SEP) Hatcheries

4.1 Scope of Guidelines

These guidelines have been developed to guide broodstock collection and spawning of Pacific salmon at SEP hatcheries and incubation facilities. They describe production objectives and provide strategies to manage genetic resources in order to preserve as much as possible the entire range of genetic material within an existing population for any objectives. The guidelines do not apply to steelhead or cutthroat as the management of these species is a provincial responsibility.

4.2 Program Production Objectives

Enhancement projects are planned and implemented within an integrated planning process and involve establishing juvenile release targets and strategies that will produce the number of adults desired while considering species interactions, effects on existing stocks, harvest, habitat capacity and project capacity. This process is described in the SEP Production Planning Framework (DFO, 2012). This framework also defines five specific objectives for fish production and each group of fish considered through production planning must address at least one of these objectives. These objectives in turn influence brood stock collection and spawning strategies.

- **Harvest** – enhancement for fisheries that are reliant on enhanced production, and would disappear or become severely constrained in the absence of enhancement. This includes harvest opportunities for First Nations, recreational, or commercial fisheries. When the objective is to provide a targeted-fishery opportunity, production targets may be set to consider both natural spawning and harvest requirements.
- **Assessment** – fish produced for marking where stock assessment information contributes to Pacific region assessment priorities, such as the Pacific Salmon Treaty. The information may also contribute to assessment as defined under the regional stock assessment framework, Area stock assessment priorities and regional SEP assessment priorities i.e. those produced for program performance measurement. Fish produced for assessment generally address other objectives as well but, in a few instances, fish are produced solely for marking for assessment purposes.
- **Conservation** – enhancement of a stock highly at risk of extirpation or extinction, or a vulnerable stock that has been identified as a regional priority (e.g. populations which have a formal conservation/recovery strategy). This includes re-establishing locally extinct populations/CU's and rebuilding population/CU's at high risk of extirpation.
- **Rebuilding** – enhancement of a stock that is below apparent carrying capacity. This includes rebuilding depleted populations and mitigating for habitat loss.
- **Stewardship and Education** - small numbers of fish produced to provide a stewardship or educational opportunity. Production for these purposes is assessed based on contribution to stewardship and educational goals and not on production levels or contribution to harvest or escapement

Production targets for conservation and rebuilding objectives are set at levels that re-establish the naturally spawning population but that limit the risk of changing its genetic variation by regulating the proportion of enhanced fish that spawn within the naturally spawning population. As such, release targets and strategies should be set such that salmon returns of enhanced origin do not exceed 50 percent of the target escapement. This may be exceeded in years prior to full achievement of target. Brood stock collection targets should not exceed 30 percent of the escapement.

Where the objective is re-establishment of a locally extinct population, or where the population is the focus of a formal recovery process, such as under the Cultus sockeye conservation strategy (Cultus Sockeye Recovery Team, 2005), broodstock collection plans and enhanced contribution should be set as part of the recovery or production planning process and may exceed these limits in order to address the recovery objectives and schedules.

Exceptions may also be applied in watersheds where natural spawning habitat is severely limited, such as the Capilano River where the installation of a dam has limited fish access to much of the spawning habitat.

For production groups with a defined harvest objective, the proportion of the naturally spawning escapement that may be comprised of hatchery fish and collected for brood stock may be established as part of an endorsed integrated planning process or harvest roundtable. Such a process will link fish production with harvest planning for the target fishery and will consider hatchery and natural escapement requirements. If the proportion of the escapement to be comprised of enhanced fish or collected for broodstock is not established through an approved integrated planning process, the limits that are set for rebuilding and recovery will apply.

4.3 Genetic Management – Broodstock Collection and Spawning Practices

Regardless of program production objectives, sufficient broodstock that adequately represent the entire donor population and its genetic characteristics are essential to minimize the potential for loss of variation and undesirable genetic effects. Appropriate broodstock selection and spawning practices can minimize chance genetic events and maintain genetic variability of the population. Such practices are critical for determining the genetic make-up of a population and its long-term fitness.

4.4 Broodstock Collection

4.4.1 For all program objectives

The collected broodstock should as far as possible be randomly selected to represent the entire range of run timings, age groups, body sizes, etc. Key aspects are:

- maximize the effective breeding population.
- use fish from the entire run timing.
- collect broodstock randomly from the whole population to represent fish from the full range of physical characteristics, including small, or sexually precocious fish.
    - collect jacks proportionally to their abundance in the escapement as these precocious males may contain genetic material important for the long-term fitness of the population.
    - avoid artificial or intentional selection of spawners in order to preserve and maintain genetic diversity, and minimize artificial selection.

- Where egg targets are small (≤ 10,000 eggs) or when weather or logistical circumstances confine broodstock collection to a short period (e.g. one weekend), strategies to improve representativeness should be employed. These could include collecting some broodstock from as many sites as possible within the river and/or collecting broodstock from a different portion of the run timing each year.

4.4.2 Where the objective is rebuilding or conservation

a) **For depleted populations that are not part of active recovery planning processes,**

- Do not remove more than one third of the naturally spawning escapement for hatchery use. This may mean that production targets will not be achieved. Allow the remaining fish to spawn naturally to maintain a viable naturally spawning population.
    - When collecting brood from a fence or hatchery collection rack, collect about one third of the fish handled on each occasion, stratifying by sex.
    - When collecting broodstock without a fence or hatchery fishway (angling, seining etc.), estimating one third of the total return may be difficult. If it appears that returns are weak, broodstock collection should be conservative. Consult knowledgeable staff and consider the previous cycle year escapement.
    - Where returns are weak, broodstock utilized will frequently be limited and involve small numbers of adults. Careful adherence to spawning guidelines is critical to minimize risks of genetic change
- Where there are approximately equal proportions of wild and externally identifiable hatchery fish in the return, it is acceptable to include both groups in the broodstock at their rate of occurrence, recognizing that not all hatchery fish may have been marked at release.
- Where externally identifiable hatchery fish predominate in the portion of the escapement accessible for broodstock collection, the proportion of hatchery fish utilized should be roughly the inverse of their proportion in the sample to ensure adequate representation of wild fish. (e.g. 70% hatchery, 30% wild in the sample – broodstock should be comprised of about 30% hatchery fish and 70% wild).
- Where hatchery fish are not externally identifiable, use broodstock collection methods that include all run timings and body sizes to provide a mix of hatchery and wild returns that represent the population.

b) **For populations in formal recovery processes**:

Broodstock collection plans and options should be developed in advance as part of a recovery planning process and must be reviewed and endorsed by the recovery team. General considerations are:

- As far as possible, avoid the use of identifiable hatchery fish in broodstock. However, where returns are severely depleted, inclusion of some hatchery origin fish may be necessary.
- Broodstock removals may comprise up to 50% of the returning spawners particularly if habitat is very poor, resulting in poor wild production. As populations decline, from a genetic perspective, it may be preferable to use all available spawners as broodstock. However, this strategy carries the risk of catastrophic loss of the entire population if a problem is encountered in the hatchery.

4.4.3 Where the program objective is for harvest

- The proportion of the escapement removed for broodstock should be developed as part of the production planning process for the target fishery. In the absence of a planning process, the proportion removed should be the same as that used for the recovery objective i.e. no more than one third of the naturally spawning escapement.
- When the enhancement objective is a targeted fishery, broodstock are frequently collected entirely at the hatchery rack and are comprised of fish that that swim into the hatchery. Infusion of wild salmon into the hatchery broodstock (about 10%) can be beneficial. However, it is acceptable to obtain all broodstock required from fish that swim into the hatchery when broodstock populations are in excess of 100 pairs as a small proportion of the return is likely to have originated from naturally spawning fish.
- Infusion of wild broodstock from capture outside of the hatchery is not likely to have an appreciable effect when broodstock populations are in excess of 100 pairs but will be beneficial when broodstock populations are smaller.

4.5 Spawning

4.5.1 All Objectives – all broodstock population sizes

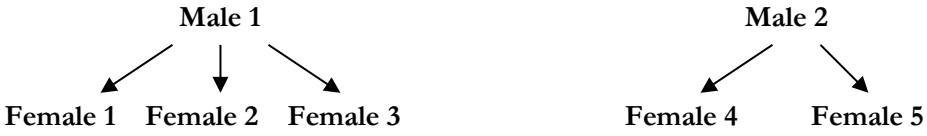
- Spawn all collected fully mature broodstock, without regard to age, size or other physical characteristics. Do not exclude any individuals for any reason except for those with overt disease symptoms or physical injuries that may compromise gamete fertility or viability.
- Use fully random mating; avoid any selection. Natural mating patterns are complex and poorly understood, and unlikely to be maintained in a hatchery environment.
- Use one male to one female except as described below. This strategy ensures that each male makes an equal genetic contribution.

- Do not mix the milt from two or more males and then add it to eggs. This practice is known as "pooling" milt and can result in milt from a single male fertilizing a disproportionate share of the eggs.
- It is strongly advised that males not be re-used, except as part of specific spawning protocols. In a sequential protocol two males may be used sequentially per female. A given male should be used as the first male for only one female, as follows:

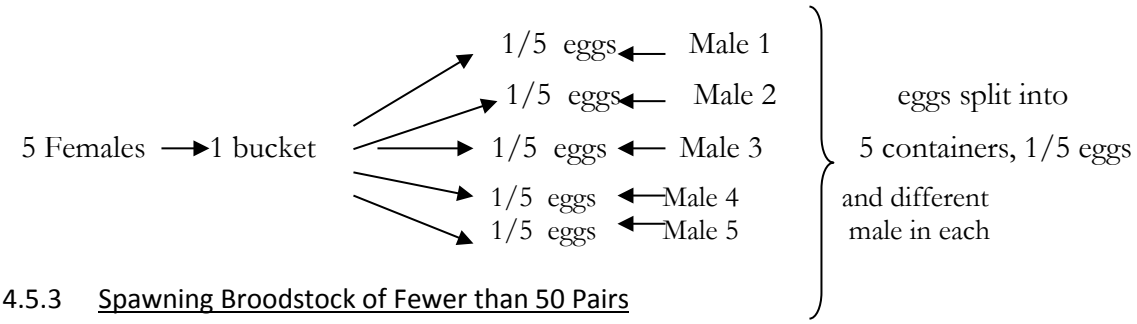
- Consult a support biologist if you are planning to re-use males in any way other than the spawning protocols identified in these guidelines.
- Generally, do not release live males that have been used for hatchery spawning back to their systems of origin. These males will already have contributed a disproportionate amount of genetic material to the stock compared to wild fish, and, if released, would have the opportunity to contribute even more. Consult a support biologist, however, if there is a very disproportionate sex ration among natural spawners.

4.5.2 Spawning Broodstock of More Than 50 Pairs

- When spawning more than 50 broodstock pairs with:
  - a sex ratio of approximately 1:1, mate each female with an individual male. This helps to maintain genetic diversity.
  - more females than males, use matrix spawning (Table 1) or the following **hierarchical** spawning strategy , where milt from individual males is split amongst available females. Milt must not be pooled.



- One to one spawning is most desirable. However, in spawning situations where it is logistically difficult to keep eggs from individual females separated prior to fertilization (e.g. greater than 250 independent crosses or remote field situations), factorial mating may be considered. Eggs from a number of females are pooled, then gently and thoroughly mixed. Pooled eggs are divided into equal lots in separate containers with the number of containers equal to the number of constituent females. Each lot is then fertilized with milt from a different male, as follows. Milt must not be pooled.



4.5.3 Spawning Broodstock of Fewer than 50 Pairs

- When spawning fewer than 50 pairs, regardless of sex ratio, attempt to utilize all adults in **matrix** type breeding to maximize genetic variation in eggs. (Table 1). In matrix spawning, eggs from each female are divided into equal lots. Each lot of an individual female must be fertilized by a different male. This strategy allows the use of all broodstock, even when the sex ratio is unequal, and maximizes genetic combinations and each parent's contribution. It also allows information on families to be tracked if required.

- The matrix choice will depend on broodstock maturity, availability, and sex ratio. A minimum of two of the least available sex is recommended for each matrix and for practical purposes, a maximum of four females.

Consult your DFO support biologist if you have questions regarding the use or application of these guidelines.

Table 1 – Examples of matrix spawning (modified from Eddy et al, 1996)

<table>
<tr><th>Sex Ratio</th><th>Spawning Protocol</th><th></th></tr>
<tr><td>Equal sex ratio</td><td>Spawn 2x2
<table><tr><td colspan="2"></td><td colspan="2">Female</td></tr><tr><td colspan="2"></td><td>X</td><td>Y</td></tr><tr><td rowspan="2">Male</td><td>A</td><td>AX</td><td>AY</td></tr><tr><td>B</td><td>BX</td><td>BY</td></tr></table></td><td>Even sex ratio allows an even-sided matrix.
.</td></tr>
<tr><td>Unequal sex ratio</td><td>Matrix structure depends on sex ratio
<table><tr><td colspan="2"></td><td colspan="2">Female</td></tr><tr><td colspan="2"></td><td>X</td><td>Y</td></tr><tr><td rowspan="3">Male</td><td>A</td><td>AX</td><td>AY</td></tr><tr><td>B</td><td>BX</td><td>BY</td></tr><tr><td>C</td><td>CX</td><td>CY</td></tr></table></td><td>Uneven sex ratio - matrix spawning ensures that all broodstock are used.</td></tr>
</table>

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5 Guidelines for In-Stream Placement of Salmon Carcasses for Nutrient Enrichment

5.1 Introduction

Historically, large numbers of salmonid carcasses provided entire watersheds with abundant nutrients and organic matter derived from the ocean. Salmon carcasses play a key role in maintaining the productivity of salmonid systems, benefiting the aquatic and terrestrial ecosystem as a whole. Rearing juveniles consume salmon eggs, feed directly on spawned-out carcasses, and benefit from increased abundance of invertebrates and algal growth. The presence of carcasses in streams has been related to increased juvenile density, growth rate, body size, improved fish condition, improved over wintering survival and ultimately increased marine survival. The riparian vegetation also benefits from nutrients derived from rotting carcasses transported into terrestrial ecosystems by bears and other animals.

These guidelines have been developed to regulate the in-stream placement of salmon carcasses from Fisheries and Oceans Canada enhancement facilities but may consider placement of carcasses from wild stocks as appropriate (i.e. where there is an identified surplus and it would be beneficial to re-distribute carcasses). The guidelines are not intended to enforce the distribution of carcasses nor to replace harvest under an Excess Salmon to Spawning Requirements (ESSR) authorization.

These guidelines are meant to increase the overall benefits from carcass placement by providing best management practices for carcass placement, and highlighting the interagency cooperative processes used to minimize conflicts with stakeholder groups and agencies.

The guidelines were developed utilizing current relevant literature, input from DFO fish health specialists and ecological research scientists, and guidelines prepared by the Washington Department of Fish and Wildlife.

Numerous factors have been considered in the development of these guidelines, including:

- nutrient content in treatment streams (described in terms of nutrient inputs eg. agriculture, storm sewer inputs, other)
- abundance of native salmon spawners
- retention and distribution of carcasses in waterways
- seasonal water temperatures and flow rates
- biosecurity
- predator / scavenger activity on carcasses by insects, fish, birds and mammals.

5.2 Planning

Proposed carcass placement projects should be first discussed with DFO local area staff in the Salmonid Enhancement Program (SEP). SEP staff will assist in developing a comprehensive Carcass Placement Plan (Appendix A) and will consult with appropriate stakeholders including DFO stock assessment, Fisheries Protection Program, Fisheries Management, and Conservation and Protection (Fishery Officers), as well as local First Nations, affected stewardship groups, landowners, municipalities and the BC Ministry of Environment.

DFO staff should forward an electronic version of the Carcass Placement Plan to their SEP assessment biologist in Pacific Region Regional Headquarters.

Each **Carcass Placement Plan (Appendix A)** requires the following information:

- Purpose of the carcass placement
- Project proponent's name and contact Information
- Location of carcass placement - including the GPS location and if possible, a satellite image of location (ie. at a scale that clearly shows the carcass placement area and 500m upstream and downstream of the carcass placement location)
- proposed dates of carcass placement
- spawning timing of all species in the treatment stream
- length, width and area (square metres) of stream to be treated
- biomass of carcasses to place in the treatment stream (kgs of fish biomass per square metre of stream bottom) - by carcass placement date
- estimated escapement and natural biomass load in the stream
- cumulative impacts - describe other sources of nutrient input in the carcass placement location(s)
- carcass mutilation to identify placed carcasses
- approximate stream flow at time of placement
- tethering of carcasses
- record of contact with downstream users (within 500 m) that may be impacted by carcass placement (eg. landowners, public use areas, licensed water users)
- dates for post-project monitoring and follow-up report

Projects that meet the terms of the carcass placement guidelines will be issued an authorization letter from the Department allowing the transport for deposition of carcasses. This letter must accompany all carcass movements.

It is important to ensure that carcass placement planning considers other nutrient enrichment projects and inputs and will not create undesirable impacts in public use areas.

Under the *Water Act,* downstream water users (primarily local municipalities), must be advised of activities that may potentially impact water quality of their withdrawals. For all carcass placements within 500m of downstream water users, Water Licensees on treatment streams **should be** advised prior to placement programs.

In general, carcasses should be distributed in such a way so as to avoid or minimize impacts on domestic and other types of intakes or water supplies. Background material and signage may be provided to advise members of the public of carcass placement activity and its benefits.

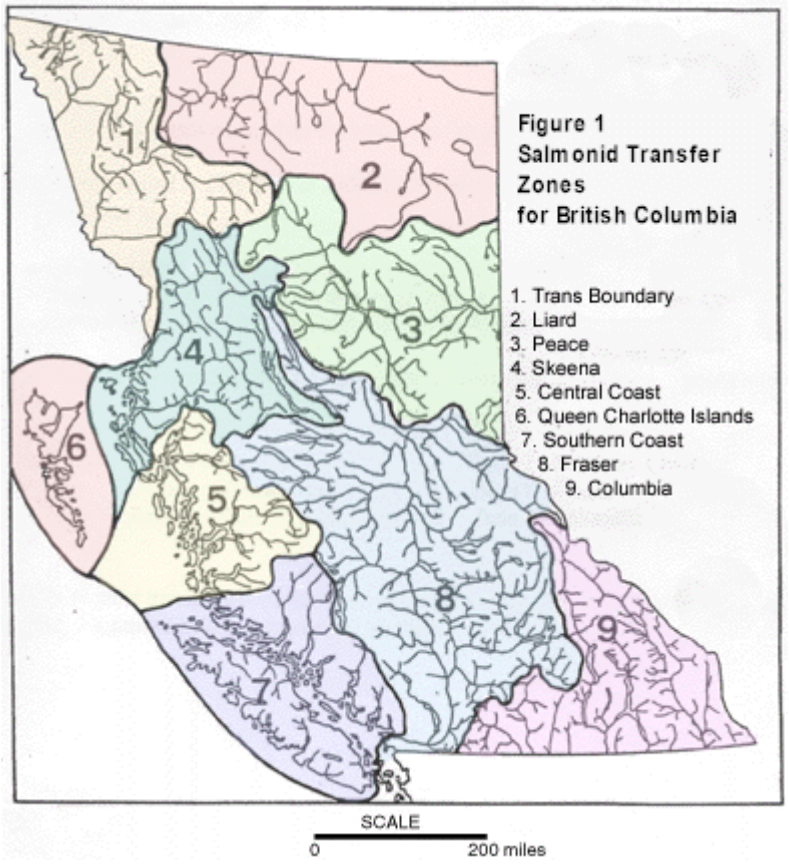
5.3 Carcass Placement Best Management Practices

Streams that receive carcasses are referred to as "treatment" streams and those that provide carcasses are referred to as "donor" streams.

Carcasses **cannot** be placed in areas within the watershed that are normally not accessible to salmon (non-anadromous waters).

It is preferable to conduct carcass placement using carcasses from the same stream (i.e. the donor and treatment stream are the same. Carcasses may only be moved within the same Salmonid Transfer Zone. The DFO Community Advisor and/or Watershed Enhancement Manager will provide advice on acceptable donor and treatment stream locations.

British Columbia Transfer Zone Map



http://www.pac.dfo-mpo.gc.ca/aquaculture/maps-cartes-eng.html#Salmonid_Transfer

Carcass placements to streams outside the native watershed are **not recommended** due to the risk of inadvertent pathogen or pest transfer. In specific circumstances, movement of carcasses from a

watershed to nearby streams in a neighbouring watershed may be considered if **all** of the following conditions are met:

- donor and treatment streams are within the same Transfer Zone
- donor and treatment streams are geographically proximate
- treatment stream is within the zone of influence of the donor stock (i.e. adults may be straying from donor to treatment stream)
- where available, historical pathogen screening records do not indicate a higher prevalence of any endemic pathogens or the presence of a unique or emerging pathogen in the donor stream
- no unique aquatic invasive species have been identified in the donor stream. To find information on aquatic invasive species refer to the following website: http://bcinvasives.ca/resources/programs/aquatics/

NOTE : Additional measures will be taken to mitigate the unintended spread of disease agents if there has been a pre-spawning mortality rate of greater than 20%.

- **only fish which have survived to spawn will be considered for carcass placement. If there has been a pre-spawning mortality rate of greater than 20%, broodstock must be tested for presence of disease at the Pacific Biological Station Fish Diagnostics Lab.**
- as soon as feasible after killing/spawning, all carcasses will be examined by an experienced fish culturist
- any carcass with overt signs of systemic disease (eg. kidney lesions or internal hemorrhaging) will be excluded from carcass placement
- carcasses selected for carcass placement projects will be eviscerated, including kidney removal.

Broodstock which have received drugs under veterinary prescription (eg. chemical sedation, antibiotics) **will not be used** as donors for carcass placement to ensure the selected carcasses have no drug residues in their tissues.

Only those fish killed by percussive stunning (i.e. blunt cranial trauma) prior to spawning can be used for carcass placement. Carbon dioxide (CO_2) is the only sedative that does not alter carcass quality, and it may be used prior to percussive stunning as a welfare refinement. Carcasses of recently deceased salmon from managed spawning channels may be considered as donor stock for carcass placement.

External bath treatments for surface fungal, bacterial or parasite infections are infrequently needed to improve the welfare and survival of pre-spawning broodstock. The chemicals commonly used for external bath treatment, Parasite-S and Chloramine-T, are not drugs and do not absorb or accumulate in the tissues of the fish. Fish treated with these chemicals are considered safe for carcass placement. If in doubt, contact the Fish Pathology Program, Pacific Biological Station at 250-756-7057.

Carcasses may be frozen for later use.

Note : Freezing will not significantly reduce disease organism loads and **should not** be considered a disease management tool (i.e. freezing carcasses showing signs of disease and then using those carcasses for placement **is not** permitted)

Carcasses must be stored and transported in leak proof containers. Fluids from donor fish must not leak into the natural environment during carcass transport.

Carcass transport containers and all equipment used to unload carcasses must be cleaned and disinfected before and after use. (Refer to Appendix D for information on disinfecting equipment).

5.4 Carcass Loading Density

All salmonid carcasses are considered equal from a nutrient content basis. That is, required placement load may be calculated as biomass and then converted to numbers of fish of the available species. For example, Chinook carcasses may be substituted for coho, and vice versa. Where system-specific weight data are not available, the following average weights for returning B.C. salmon are provided for weight conversion.

Suggested Average Weights for B.C. salmon *
Pink 1.5 kg
Steelhead 4.0 kg
Sockeye 2.5 kg
Chum 4.5 kg
Coho 3.0 kg
Chinook 8.5 kg
* Data sources: mean weights from B.C. catch statistics (J. Bateman, pers. comm.)

The maximum carcass placement within a stream segment (including the areas into which carcasses drift from the distribution point), over the course of a spawning season should be 1.9 kg/m² based on Wipfli et al. (2003) and WDFW (2002).

Carcass retention in streams is affected by predator / scavenger activity, carcass transport during high flows, and abundance of in-stream structures to catch and retain carcasses. Maximum loading densities **may be** adjusted to reflect the stream's carcass retention properties. For streams with expected good carcass retention, maximum carcass densities **should be reduced** by the current spawner densities (i.e. when calculating the biomass or numbers of carcasses that can be added - consider the biomass and/or number of spawners and carcasses already in that location). For streams with expected poor carcass retention (high gradient, high flows, few pools and few in-stream structures), carcass loading densities **need not be** adjusted for current spawner densities.

In treatment streams with continuous escapement records, when calculating the biomass/number of carcasses to place, numbers may be reduced by the recent 10 year average for natural escapement to the treatment reach. This will aid in determining the biomass/number of carcasses to place so that the maximum carcass loading density of 1.9 kgs of fish biomass/square metre is not exceeded.

For determining total carcass deposition maximums for streams used by more than one salmon species, the area historically available to each salmon species should be used to calculate the loading rate. Spawning timing should be factored into distribution schedules.

Example

The treatment stream carcass placement area has an estimated mean historical escapement of 75 pink salmon and 50 sockeye salmon. Carcass retention in the reach is good. Pinks and sockeye have similar spawning timing.

The treatment reach has been measured and it is 150 m long and has an average width of 8m.

The treatment carcasses are chum salmon.

Step 1.

Calculate the area of the treatment reach.

Area = Length (m) X Width (m)
Area = 150 m X 8 m = 1200 square metres

Step 2.

Calculate the biomass of the pink and sockeye that historically spawn in the treatment reach.

Biomass = kgs of pinks + kgs of sockeye
Biomass = (75 pinks X 1.5 kg/pink) + (50 sockeye X 2.5 kgs/sockeye)
Biomass = 112.5 + 125
Biomass = 237.5 kgs

Step 3.

Calculate the historical (estimated) Biomass/Square metre (load rate) in the treatment area.

Load rate in the treatment area = 237.5 kgs (of pinks and sockeye)/1200 square metres
Load rate =0 .198 kgs/sq. m

Step 4.

Calculate fish biomass to add to reach the maximum load rate of 1.9 kgs/square metre.

The **Carcass Placement Plan spreadsheet** will automatically calculate the biomass of fish that can be added OR use the calculation below.

Amount of fish biomass to add = Maximum load rate - existing load rate in the treatment area

1.9 kgs/sq m - 0.198 kgs/square metre = 1.702 kgs/sq. m

To calculate the biomass that can still be added to the treatment area :
Remaining load rate X area of the treatment area

1.702 kgs/sq. m X 1200 sq. m = 2,042 kgs of fish

Step 5.

Calculate the number of chum salmon that can be added to the treatment reach. The average weight of a chum salmon is 4.5 kgs.

Number of chum carcasses to place = biomass that can be added / average weight of a chum

Number of carcasses to place = 2,042 kgs/4.5 kgs per chum

Number of chum carcasses to place in the treatment reach = 454

5.5 Carcass Distribution

The temporal and spatial distribution of carcasses should reflect the historic spawn timing and abundance of salmon in the treatment reach. Carcasses should be placed in stream areas that are normally (or recently historically) accessible to salmon, (**i.e. not above barriers historically inaccessible to salmon**). Carcass placement into inaccessible stream segments may be permitted where juvenile salmon of the same stock and species have been previously out planted (e.g. colonized upper areas above impassable barriers) but consultation with regional Natural Resource Operations staff is necessary.

Placement in the riparian zone is **not** necessary and often results in increased numbers of blowflies (Reimchen et al, 2003.). Natural predators will remove carcasses from the treatment stream and distribute them in riparian zones.

For streams with poor access (and low public use), a few accessible sites may be used for regular carcass placement. These sites **should be** inspected periodically to ensure adequate natural dispersion of carcasses. Where dispersal is poor, carcass loading should be reduced (i.e. do not exceed 1.9 kgs of fish biomass/sq. m.).

5.6 Where to place carcasses

Carcasses **should** be distributed in **stable** stream areas, where possible. This will help avoid rapid downstream transport of carcasses.

Optimal sites include shallow backwater pools, side-channels, small headwater tributaries and areas with abundant woody debris and beaver-dam complexes.

Note : Placing excessive numbers of carcasses in side pools with sluggish or intermittent water exchange may cause de-oxygenation (E.A. MacIsaac, pers. comm.).

Carcass placement should be avoided or delayed during high flow events, especially where anchoring and/or riparian placement is not feasible.

Carcass distribution schedules should consider anticipated problems of poor stream accessibility due to snow, high water, and other constraints.

5.7 When to place carcasses

Timing of carcass placement is important and should suit the purpose of the nutrient enrichment program. Carcass placement may occur in spring when nutrients should be made available to young salmon upon their emergence from the gravel. In some locations, the over-winter rearing period may represent a time of hardship for over-wintering juveniles and carcass placement timing may be late fall or early winter. The use of carcasses from later runs of native salmon (fall and winter) may benefit the next growing season, provided that some nutrients are stored through the winter (Wipfli et al. 1999). Also, the use of carcasses from several species, each with a different run timing (e.g., early sockeye, mid-chum, late coho), will provide a longer nutrient pulse in the treatment stream than if only one or two species were used, each with a brief spawning period.

Hint : If a treatment stream has a late natural spawning timing, carcasses from earlier runs to the treatment stream may be frozen and stored for later placement. The use of frozen carcasses is also convenient for long-distance transport.

5.8 How to keep carcasses in place

Carcass Anchoring/Mutilation

Carcasses may be tethered or anchored in place, especially in unstable, higher-flow areas in order to improve carcass retention.

Where carcass anchoring is desirable, natural anchors (e.g. large woody debris, logjams, beaver-dams) or bio-degradable tethers such as natural-weave ropes, should be used where possible. External identification tags should be removed from carcasses prior to their placement. **Do not use** non-bio-degradable tethers. Where frozen carcasses are used, they should be tethered in place (frozen carcasses float and may be readily transported downstream). Where tethering is not possible, it is preferred to thaw out at least one fourth of the frozen carcasses before distributing them in order to enhance carcass retention at the point of access.

Where escapement enumeration programs will be conducted on treatment streams, carcasses **must be** cut in half or otherwise mutilated at placement, as directed by area stock assessment staff. **This is crucial** in order to avoid double-counting and ensure that enumeration programs are not affected.

5.9 Carcass Placement Record

A **Carcass Placement Record (Appendix B**) **must be kept** for each carcass placement project as follows :

- Permit/Authorization number
- proponent name
- donor stock/species
- placement date
- treatment stream name
- location(s) on treatment stream - include the GPS locations and if possible satellite imagery showing carcass placement locations
- number of carcasses placed and biomass/square m of stream area
- fish health record - include signs of disease, treatment history, any lab analysis results
- type of habitat : pool, glide, riffle, backwater area, off channel habitat, beaver complex, stream areas containing large and small woody debris
- stream flow (low, moderate, high)
- stream temperature
- stream dissolved oxygen level at CP site(s)
- carcass mutilation (Y or N)
- evidence of predators - make note of presence of bears, coyotes, eagles, wolves etc...

Note : The project proponent is responsible for recording information on the Carcass Placement Record and submitting the record to the Community Advisor or Watershed Enhancement Manager no later than 30 days after the carcass placement date.

Records of numbers and species of carcasses placed in treatment streams must be maintained in annual data summaries. Summaries are to be forwarded to the local Community Advisor/Watershed Enhancement Manager who will in turn provide the summaries to the Pacific Region Headquarters**.**

5.10 Post Carcass Placement Records

Monitoring of carcass placement locations **must be** conducted two to four weeks after carcass placement (**Refer to Appendix C**).

Record the following for each carcass placement project :

- permit/authorization number
- proponent name
- location
- placement date
- date of monitoring
- number of carcasses remaining (as a % of total placement)
- condition of carcasses (fully degraded, 50% degraded etc...)
- water flow (low, moderate, high)
- water temperature
- dissolved oxygen level
- signs of predators/carcass removal
- distance carcasses have moved downstream

The Post Carcass Placement Monitoring Record (Appendix C) must be submitted by the project proponent to the local Community Advisor/Watershed Enhancement Manager who will in turn provide the summaries to their SEP Pacific Region Headquarters Assessment Biologist within 30 days of monitoring.

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APPENDICES A, B AND C

Appendix A: Carcass Placement Plan

Project Proponent Name :	**E-mail :**	**Tel :**

Application Date :		**Project Implementation Date :**	

Donor Stream Name	
GPS Location	
Donor Species	

Treatment Stream Name

Donor Fish Health Notes :	

Purpose :

	YES	NO
Will carcasses be tethered?		
Will carcasses be mutilated?		

			Contact Record - Who has been contacted?	
Have downstream users been contacted?				

			Contacts that do not agree.	
Are downstream users in agreement with this project?				
List other local nutrient inputs				

Proponent Name :

Treatment Stream : Natural Carcass Load Information

Species	Spawning timing date range	Est. Esc. in Treat. Area	Est. Natural Fish Biomass in Treat. Area
Pink			
Chum			
Coho			
Chinook			
Sockeye			
Total			

Treatment Stream - Carcass Placement Information

Length of stream (m)
Width of stream (m)
Area of stream (sq m)
Est. Natural fish biomass (kg)
Natural load rate kg/sq m
Maximum load rate kg/sq m 1.9
Difference
Biomass to add (kgs)
Number of fish to add

Suggested Average Weights for B.C. salmon *

Pink	1.5
Steelhead	4
Sockeye	2.5
Chum	4.5
Coho	3
Chinook	8.5

If difference is negative : carcass placement for nutrient

If using pink salmon add	Fish	These calculations assume that only ONE species is
If using Chum salmon add	Fish	being used for carcass placement.
If using Coho salmon add	Fish	If more than one species will be used, this
If using Chinook salmon add	Fish	spreadsheet **will not** automatically calculate the numbers
If using Sockeye salmon add	Fish	of fish of each species to place.

Appendix B: Carcass Placement Record

Proponent Name :	
Carcass Placement Date (s)	

Donor Stream Name :	
Donor Species :	
Hatchery Name	
Fish Health Comments :	
Number of fish placed	
How were carcasses transported to the location?	
Number of fish tethered	
Number of fish mutilated	
Post Placement Equipment Disinfection (Yes/No & Disinfectant used)	

Treatment Stream Name	
Carcass Placement Location	
Treatment Stream Temp	
Treatment Stream D.O.	
Treatment Stream Flow (Low, Moderate, High)	

Appendix C: Post Carcass Placement Monitoring Record

Proponent Name :

Treatment Stream/Location

Dissolved Oxygen

Water Temp ° C

Monitoring Date :

Number of carcasses placed	
Number of carcasses remain	
% remaining	
Condition (% degraded)	
Distance (m) downstream carcasses have moved.	

Comment on predation

Comment on concerns/issues :

INSTRUCTIONS FOR COMPLETING APPENDIX A, B AND C

Instructions for Appendix A: Carcass Placement Plan - Page 1

Project Proponent Name	Fill in the name of the group(s) conducting carcass placement. Provide the name of the main contact person along with their E-mail address and telephone number.
Donor Stream	This is where the fish are coming from.
Treatment Stream	This is the stream where the donor stock will be placed.
Donor Fish Health Notes	Fish being used should be disease free. Describe any external symptoms such as fungus. Most donor stock will be hatchery broodstock.
Purpose	State the purpose of carcass placement i.e. nutrient enrichment for the benefit of juvenile salmonids, nutrient enrichment for the riparian area etc…
Will carcasses be tethered?	Describe if carcasses are tied in place and how eg. Bio-degradable tethers made from rope or other materials, non-biodegradable tethers.
Will carcasses be mutilated?	If spawner counts are occurring in the treatment stream, placed carcasses must be marked in some way (mutiliated by cutting) so they are NOT counted in the spawner counts.
Have d/s users been contacted. *d/s means downstream*	List the downstream and other users that may be impacted and have been contacted.
Contacts that do not agree.	List the downstream and other users that are not in agreement with the project and reasons why they do not agree.
List other nutrient inputs in the immediate project area (w/in 500 m)	List other nutrient inputs w/in 500 m of the project area.

Instructions for Appendix A : Carcass Placement Plan - Page 2

Treatment Stream -Natural Carcass Load Information	Spawning timing date range - list the range in dates that spawners use the planned carcass placement area. List the estimated spawning escapement in the treatment area. The estimated fish biomass in the treatment area will automatically be calculated.
Treatment Stream - Carcass Placement Information	Measure the length and width of the treatment area. The Stream area (in square m) will automatically calculate. The estimated natural fish biomass will automatically calculate. The natural carcass load rate (kgs/sq. m) will automatically calculate. The biomass to ADD, will automatically calculate.

The number of fish to ADD, will automatically calculate by species.

Instructions for Appendix B: Carcass Placement Record

Project Proponent Name	Fill in the name of the group(s) conducting carcass placement. Provide the name of the main contact person along with their E-mail address and telephone number.
Carcass Placement Date(s)	List the dates that carcasses were placed in the treatment stream.
Donor Stream Name :	Name of the stream the fish (carcasses) came from.
Donor Species :	Species of fish being used for carcass placement.
Hatchery	Name of the DFO hatchery or spawner channel that supplied the carcasses.
Fish Health Comments :	List general condition of health of the fish. Make note of any specific disease issues eg. Fungus, gill infections, lesions, blisters, bleeding. **Fish should be disease free.**
Treatment Stream Name	List the name of the treatment stream i.e. the stream receiving carcasses.
Carcass Placement Location	List the carcass placement location - GPS location and general location on the stream i.e. describe how to get there from hatchery/spawning channel supply location.
Number of fish placed	List the number of fish of each species that were placed in the treatment stream.
How were carcasses transported to the location?	Detail method of transport. Eg. Carcasses in a leak proof transport tank in the back of a pick-up truck.
Number of fish tethered	List number of fish that were tied in place.
Number of fish mutilated	List the number of fish and type of fish that were marked/cut and list the type of mark/cut to identify those fish as "placed".
Post Placement Equipment Disinfection	List disinfectant used and concentration used.

Instructions for Appendix C : Post Carcass Placement Monitoring Record

Project Proponent Name	Fill in the name of the group(s) conducting carcass placement. Provide the name of the main contact person along with their E-mail address and telephone number.
Treatment Stream/Location	Treatment (stream to receive the carcasses) stream name and the GPS location(s) and directions to the carcass placement location(s).
Dissolved Oxygen	Dissolved oxygen level in the stream at time of monitoring. Describe how D.O. was measured eg. Hach kit, DO meter etc…
Water Temp ° C	Water temperature at carcass placement location on the monitoring date. Describe how water temperature was measured eg. Alcohol thermometer, DO & Temp meter etc…
Number of carcasses placed	List the total number of carcasses placed in the treatment area.
Number of carcasses remain	Count and record the number of carcasses remaining in the treatment area.
% remaining	The percentage of carcasses remaining will automatically calculate.
Condition (% degraded)	Record degree of degradation i.e. percent of the carcasses on average that have rotted where 100% would be only bones remaining, 10% would be just starting to rot.
Distance (m) downstream carcasses have moved.	Approximate the distance (in m) that carcasses have been swept downstream (or moved downstream by other mechanisms).
Comment on predation	List observations such as approximate number of carcasses that have been moved onto land, partially eaten carcasses etc…
Comments on Concerns/Issues	General comments about concerns or issues with the carcass placement project eg. Most of the carcasses removed by predators therefore unavailable for nutrient enrichment in-stream, increases in growth of aquatic vegetation, unpleasant/abnormal odor etc…

Appendix D

Equipment Cleaning and Disinfection

To optimize disinfection, surfaces and equipment should be pre-cleaned prior to disinfection. Brushing or sweeping may be used to remove any dried materials, followed by wetting and the application of detergent with scrubbing to remove as much organic material as possible. Rinse off the detergent solution and loosened debris with fresh, clean water and then apply or immerse the equipment in the appropriate strength disinfectant solution for the recommended amount of time. This should be followed with a final rinse with fresh, clean water and the equipment allowed to air dry prior to storage or next use if feasible.

The disinfectant solution should be prepared with room temperature water and should remain in contact with the surface to be disinfected for at least 10 minutes. Disinfectant baths should be kept out of direct sunlight if possible. Limiting disinfectant exposures to the recommended time will help prevent equipment degradation.

Two disinfectants are currently recommended for use for carcass placement projects. Both are effective against the pathogens of concern to fish culturists in BC.

Ovadine™ Disinfection
http://www.syndel.com/Ovadine-P46C11.aspx

For disinfection of pre-cleaned surfaces and equipment (eg. nets, buckets, brushes, transport tanks, whell wells, truck beds, etc.) use a concentration of 250ppm for ten minutes of exposure time. This requires a volume of 25 mls of Ovadine for every litre of water.

Volume of water for disinfection (L)	Volume of Ovadine (ml)
1	25
10	250
20	500
40	1000
50	1250

5.10.1 Virkon-Aquatic™ Disinfection
www.syndel.com/Virkon-Aquatic-P44C11.aspx
For disinfection of pre-cleaned surfaces and equipment use a 1:100 (1%) solution for ten minutes exposure time. This requires adding 10 grams of Virkon-Aquatic powder for every litre of water.

Volume of water for disinfection (L)	Amount of Virkon-Aquatic (g) for 1%
1	10
25	250

Small volumes of spent or unused disinfectant solution may be disposed of to ground away from fish bearing waters. Exposing leftover solutions to sunlight for several days will hasten the loss of activity prior to disposal. Both Ovadine and Virkon-Aquatic will gradually lighten in colour as they lose their efficacy. Well diluted volumes of either disinfectant may be

disposed to municipal sewage systems. Larger volumes of Ovadine may be neutralized using sodium thiosulphate (for each litre of 250ppm Ovadine solution, add 6.5 mls of a stock solution of 320g sodium thiosulphate per litre of water).

Section 2 – Planning and Decision Making Guidelines

6 Steps for Making In-Season Changes to Production Plans for DFO Major Operations Hatcheries

All DFO facilities have their production regulated under the Pacific Aquaculture Regulations (PAR), which is linked to the integrated production planning process. While the planning process is the best place to discuss contingencies to planned production, it is recognized that sometimes extenuating circumstances may require an in-season change to facility production, and therefore the production plan and corresponding facility licence.

The following steps outline how to best evaluate, document, and enable a change to a facility production plan and PAR license.

1. Area staff (Hatchery Manager, Section Head, Area Manager) identify the need to make a change to the production plan for a facility
2. Hatchery Manager and Section Head (or Area Manager) discuss rationale for making the change either immediately, or for waiting until the following year (so the decision-making can be incorporated into the following year's production planning process)
3. If an in-season change is desired, the Area staff will work with regional SEP staff to document the rationale and potential impacts.
4. Area SEP staff will circulate rationale to all relevant staff in Fisheries Management and Science Stock Assessment sectors to seek comment and ensure concurrence with change. Regional SEP staff should ensure that circulation of rationale includes all appropriate regional Fisheries Management and Stock Assessment staff.
5. Once the proposed change has been approved, Area SEP staff will inform the Area Director.
6. If required, Aquaculture Management will issue the revised licence to the Hatchery Manager.

A change to the Production Plan is required for changes to:

- Planned egg or release target (increase or decrease)
- Donor stock
- Release stage or strategy
- Release location

An updated PAR licence will be issued in all cases, save for a planned decrease in production.

Responsibilities by Sector for In-season Changes

Comment from Science Stock Assessment and Fisheries Management should focus on the **proposed change,** and not on the production line itself. Where concerns are raised, supporting data is requested to clearly outline how the **change in production** may affect outcomes.

Area Stock Assessment biologist to provide comment on:

- Impacts of the change on Stock Assessment indicator programs
- Potential impacts for Stock Assessment program delivery at adult return
- Where relevant to the enhancement objective, effect of production change on wild stock status

Area Fisheries Management (Manager or Biologist) to provide comment on:

- Potential impacts of the change on meeting terminal fishery objectives
- Potential concerns of local First Nations relating to production change

Regional Stock Assessment biologist to provide comment on:

- Potential impacts of the change on domestic and international stock assessment deliverables
- Potential impacts of the change on Aggregate Abundance Based Management (AABM) and other mixed-stock fishery abundance thresholds (e.g. WCVI chinook, southern BC coho mark-select fishery, Fraser and Georgia Strait chum)

7 Coho Fry Stocking Target Calculation Guidelines

Stocking coho fry into habitat that is utilized by wild stocks can be considered a higher-risk enhancement technique than smolt releases due to the greater ecological interaction between hatchery and wild fish in the freshwater environment. Prior to proceeding with a fry stocking program, hatchery or project staff should consult with their Section Head (or Area Manager) and Support Biologist to determine if this is an appropriate strategy. This document will provide guidance on calculating appropriate fry stocking rates **if** circumstances dictate that a fry release is necessary (e.g. disease screening, excess production, contingency release). All releases must be in accordance with the facility or project approved production plan, as developed through the formal production planning process (DFO, 2012) and Pacific Aquaculture Regulation licence.

The bio-standards provided will allow for a coarse estimate of fry capacity in a receiving stream or lake. For ongoing fry programs that occur on an annual basis, a more detailed assessment should be conducted using refined estimates of productivity, input from Stock Assessment, and an ongoing monitoring plan.

Guiding Principles for Fry Stocking Projects

- Enhanced contribution should not exceed 50% (based on outmigrating smolts, and subsequent adult returns)
- Size of enhanced fry at release should not be significantly larger than expected size of wild fry
- For streams, at wild escapements of >20 females/km the habitat is likely fully seeded
- For lakes, estimates for fry planting targets will be based on length of shoreline

Supporting Data

Prior to target development, the following data are required to support calculations:

- Accessible stream length (or total length of lakeshore)
- Estimate of natural spawning escapement
- A coarse qualitative estimate of stream productivity (e.g. high gradient upland stream vs. low gradient groundwater channel)
- An estimate of stage-specific survival rates (use biostandards provided below)

Fecundity: 2500 eggs/female
Egg-to-fry survival: 20%
Fry-to-smolt survival: 10%-30% (use 20% for typical streams)
Mean smolt productivity: 1500 smolts/km (Bradford, 1999)

Target Calculations

- Estimate total productive capacity of stream (smolt number). Use 1500 smolts/km unless there is documented evidence otherwise
- Estimate wild recruitment to smolt (# of female spawners x 2500 x 20% x 20%)
- Calculate enhanced smolt capacity as "total productive capacity" minus wild recruitment
- Back-calculate for fry required
- Enhanced smolt target ÷ 20%

- Excel-based calculators are available to support target development; contact your SEP Support or Assessment Biologist for the latest version

Other Considerations

Using the calculated fry stocking figure as a starting point, other factors can be used to qualitatively adjust a release target to ensure productive capacity is maximized, while avoiding overstocking and potentially reducing overall population fitness.

- Availability of accessible rearing habitat elsewhere in the system (if the stream is a tributary to a major system, fish may be able to spread out)
- Abundance of overwintering and summer refuge habitat
- Abundance of pool and cover habitat
- Inter-specific competition (trout/char presence, population density, predator/prey etc)
- Riparian condition (pristine vs extensive logging/urbanization/agriculture)
- Hydrograph stability (groundwater fed vs lake fed vs flashy rain-fed)

Summary

These guidelines serve as a tool for calculating a coarse estimate of appropriate fry stocking density. As a great deal of variability exists in the estimates of carrying capacity, actual carrying capacity will differ from system to system, and from year to year. These guidelines should allow for identification of the appropriate order of magnitude of fry release. Ongoing discussion with your Section Head, Support Biologist and local Stock Assessment staff should take all other factors into consideration when finalizing your release target.

References

Bradford, M.J., Taylor, G.C., & Allan, J.A. 1997.Empirical review of coho salmon smolt abundance and the prediction of smolt production at the regional level. Transactions of the American Fisheries Society 126: 49-64.

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Bradford, M.J. 1995. Comparative review of Pacific salmon survival rates. Canadian Journal of Fisheries and Aquatic Science. 52: 1327-1338

DFO. 2012. *SEP Production Planning, A Framework*. Salmonid Enhancement Program, Fisheries and Oceans Canada, Pacific Region. November, 2012.

Hurst, R.E. & Blackman, B.G. 1988. Coho colonization program: juvenile studies 1984 to 1986. Canadian Manuscript Report of Fisheries and Aquatic Science. No. 1968

Marshall, D.E. & Britton, E.W. 1990. Carrying capacity of coho salmon streams. Canadian Manuscript Report of Fisheries and Aquatic Science. No. 2058

8 SEP Guidelines for Working with Researchers

Upon request for use of facilities and/or animals, a copy of this document should be provided to researchers. The "Checklist for Research" should be completed by the researcher and the Watershed Enhancement Manager in consultation.

8.1 Rationale

These guidelines are a resource for Watershed Enhancement Managers (WEMs) and researchers to ensure regulatory compliance is met and unacceptable risks to staff, facilities, fish, and the downstream environment are identified and avoided. Additionally, they will allow the consideration of any extra burden the work may present to the facility in terms of labour, materials, equipment, maintenance, and health & safety. The intent of the guidelines is to avoid undue cost or hardship at the facilities and ensure research projects are successfully completed.

8.2 Authority

Fisheries and Oceans Canada (DFO) and/or the WEM of any SEP facility reserve the right to refuse any project which is incompatible with normal operations of the facility or is associated with unacceptable risk to fish (on-site or in-stream), personnel, or local ecosystem health. SEP reserves the right to withdraw consent and support for any project which fails to meet commitments as laid out prior to commencement of the study.

8.3 Definitions

Research – Any 3rd party (i.e. non SEP) trial involving live salmon eggs, juveniles or adults.

DFO – Fisheries and Oceans Canada

EMB – Ecosystems Management Branch of DFO. EMB includes Oceans, Habitat Management, Species at Risk Act, and Salmonid Enhancement Programs, and is headquartered in Vancouver, with area offices and staff throughout the Pacific region.

SEP – The Salmonid Enhancement Program is a component of the Ecosystems Management Branch (EMB) of DFO with a responsibilities for federal government hatcheries, spawning channels (including unstaffed restoration channels) and fishways.

Watershed Enhancement Manager (WEM) – The DFO employee who manages either a hatchery or spawning channel facility.

8.4 General Principles

8.4.1 Communication

There are many potential points of contact for research (e.g. WEM, support biologists, senior manager etc). The WEM is responsible for advising the support biologist and the SEP Veterinarian of research proposed at their SEP facility.

8.4.2 Planning & Collaboration

Requests for use of space and/or animals must provide a reasonable amount of lead time for consultation with staff and support biologists to determine if study requirements are compatible with facility operations. A lead time of three months prior to research commencement is highly recommended and should be sufficient to prepare for use of animals and facilities. However, if significant numbers of fish or containers are required or if substantial site modifications are needed, consideration may need to occur during facility production planning discussions one year prior to the fall egg-take for the stock in question.

Research projects with the potential to guide hatchery operations pertaining to salmon biodiversity, conservation and recovery efforts or minimizing ecosystem impacts may be given a higher priority.

Note: in the event of poor returns or production targets not being achieved, large requests may be directed to another facility, scaled down, postponed or declined.

Researchers must include all details of the study (i.e. stocks and numbers of fish, container requirements, duration of study, roles and responsibilities of researchers and staff) and proposed methodologies. SEP facilities welcome visitors and must be sensitive to public perception. An investigation that could be perceived as being inhumane may be deemed unsuitable despite its scientific merit. Researchers must also include:

a. details on their expectations of the host site. Examples: site or staff time commitments, equipment required, materials (fish feed, anaesthetic, etc), proposed duration at the site,

b. what the respective researcher contributions will be, and

c. the use of any chemicals and proposed treatments.

EMB staff members have a demonstrated expertise in fish husbandry practices and beneficial insights may be provided if they are afforded an opportunity to comment on the draft proposal.

A biosecurity plan should be drafted by the researcher in conjunction with site management and the program support biologist. An outline of the necessary components of a biosecurity plan can be found at the end of this document.

8.4.3 Regulatory compliance

Proof of regulatory compliance must be provided to the WEM by researchers in need of fish or eggs or seeking to undertake projects at SEP facilities. A complete copy of any required permit(s) must be provided to the WEM prior to commencement of any activities.

1. For transfer of fish or eggs on or off site:

See "Transplanting Pacific Salmon – Guidelines for the Salmonid Enhancement Program (SEP)" in this publication. For Introduction and Transfer of Fish or Aquatic Invertebrates Permit - *Fisheries Act*; *Wildlife Act of British Columbia,* see

www.dfo-mpo.gc.ca/aquaculture/regions/pac/Application_english.doc

2. For research on-site:

2.1 Compliance with Canadian Council on Animal Care Guidelines:

The Canadian Council on Animal Care (CCAC) is a national peer review agency responsible for setting and maintaining standards for the care and use of animals in research, teaching and testing. DFO is a member organization of the CCAC and any experimental use of animals at our sites must be performed in compliance with CCAC guidelines:

http://www.ccac.ca/Documents/Standards/Guidelines/Fish.pdf

Third-party (DFO/Non-SEP and other) research on fish being carried out at a DFO facility must have its Animal Use Protocol (AUP) approved by both the Pacific Region Animal Care Committee (PRACC) and, if non-DFO, by the home academic institute's ACC. The principal investigator is required to provide the WEM with a copy of the Animal Care Certificate(s). This is generally valid for one year from the approval date and a copy must be available on site for the research being conducted. The certificate is to be on display or readily available at any site where animals are housed for research purposes. An example of an Animal Care Certificate is found at the end of this document. Research on eggs and sac-fry (nutritionally independent life stages) is exempt from CCAC requirements and does not need ACC review). Contact the PRACC (XPAC@dfo-mpo.gc.ca) for information and forms.

Researchers will be responsible for maintaining research tank identification and record keeping as per CCAC guidelines and may be subject to routine ACC site inspection. http://www.ccac.ca/en_/

2.2 Other (as applicable):

Fish collection – Appropriate permits must be secured from the Ministry of Environment and/or DFO respectively, before sampling begins. Applications must be made well in advance of the sampling dates to allow adequate time for processing. Failure to obtain permits can result in Federal or Provincial seizure of equipment and severe penalties.

Freshwater fish - Under the ***Wildlife Act of British Columbia***, the Ministry of Environment, Lands and Parks (Fisheries branch) issues permits for the collection of fresh-water fish including anadromous trout captured in British Columbia. The application and procedures can be found at:

www.env.gov.bc.ca/pasb/applications/process/scientific_fish_collect.html#a1

DFO is responsible for permits governing the collection of marine fishes and anadromous salmonids in fresh-water. Application forms are not available on line at this time. Researchers requiring a marine or anadromous salmon collection permit must contact their local fisheries office to obtain an application form. A listing of Fisheries Offices is available at:

www.pac.dfo-mpo.gc.ca/pages/offices_e.htm

Experimental Studies Certificate for a Veterinary Drug – ***Food and Drugs Act and Regulations***

www.hc-sc.gc.ca/dhp-mps/vet/applic-demande/form/esc-cee_08-2002_cp-pc_e.html

Species at Risk Act (SARA) – Research planned on species deemed to be at risk under SARA requires a Federal ***Species at Risk Permit for Scientific Research Activities***.

www.dfo-mpo.gc.ca/species-especes/permits-permis/permits-eng.htm

8.4.4 Resources

The SEP facility is to provide infrastructure only (tanks, water, wet lab space, housing, etc.) at the discretion of the WEM. Any requirements specific to the performance of the research (e.g. fish, manpower, personal protective equipment, feed, disinfectants, drugs, microscopes, surgical instruments, etc.) are the responsibility of the researcher.

However, at the discretion of the WEM, hatchery staff may be able to assist in routine husbandry duties such as daily feeding and cleaning of tanks and maintaining daily husbandry records, providing these activities do not interfere with regular hatchery staff duties. Manpower assistance and ancillary materials may be provided by the host facility. However, these responsibilities must be agreed upon and documented prior to the start of the research. If such an arrangement is made, the researcher is required to amend the AUP to document hatchery personnel involvement in the care of the fish.

8.4.5 Fish health concerns

Any disease incidence, pathogen screening results, or treatment history for the stock under consideration must be reported to the WEM and to the researcher.

Hatchery staff members can provide an invaluable resource in terms of knowledge of endemic diseases in their stocks and in the early detection and mitigation of disease. Any signs of concern should be brought to the researcher's attention immediately. If the researcher fails to respond or if any SEP staff member sees evidence of suboptimal care of research fish, he or she should contact the SEP Veterinarian immediately.

8.4.6 Biosecurity concerns

Facilities staff must provide researchers with an orientation to the facility. Orientation must include disinfection and biosecurity practices, general site security and after-hours procedures, location of MSDS information and spill response kit, emergency egress routes, identification of first aid attendants, etc., to comply with site Occupational Health and Safety protocols Fish Health Management Plans (FHMP). On-site research staff must be WHMIS trained, possess MSDS sheets for chemicals brought on site and ensure removal or safe disposal of used and unused portions.

Research can impose a higher level of stress on animals than that experienced during routine culture. As a result, there is an increased risk of disease occurrence in research fish and therefore an increased risk of pathogen spread beyond research enclosures. The development of a biosecurity plan emphasizing physical separation is the shared responsibility of the WEM and the principle investigator. Separate equipment (nets, buckets, brushes, etc.), equipment cleaning and disinfection protocols, staff traffic corridors with strategic footbath and hand-wash stations, carcass disposal protocols, effluent management, etc. can help ensure that fish on site and downstream of the site are not negatively impacted by research activities. SEP facilities are open to the public, therefore any research activities should be conducted in a manner, and with appropriate containment, such that the public cannot come into contact with the research work and any potentially hazardous compounds, drainage, etc.

For research involving mature sockeye salmon (due to the potential impacts of IHN virus), a formal biosecurity plan must be prepared in advance for ACC review. WEM, support biologists and veterinarian may be consulted in the preparation of the biosecurity plan. If adequate physical containment is not feasible, the researcher will have to find an alternate host site. Support Biologists may be able to provide advice on suitable sites for specific research needs.

8.5 Acknowledgement:

Researchers should acknowledge the support of the hatchery and staff in any resultant publications and provide in a timely fashion a summary of the research findings to the appropriate Support Biologist and WEM as a professional courtesy.

8.6 Liability Issues:

Research practices and associated equipment, chemicals and drugs have the potential to present dangers to facilities staff and guest researchers.

Non-departmental staff working on our sites must provide proof of liability coverage. In general, university faculty, staff and students are covered by WorkSafe BC through their institution. This is likely *not* the case for "visiting faculty" and certainly not the case for volunteers.

8.7 List of Contacts

Doug Lofthouse
Doug.Lofthouse@dfo-mpo.gc.ca

Paige Ackerman
Paige.Ackerman@dfo-mpo.gc.ca

Dr. Christine MacWilliams
SEP Veterinarian
Christine.MacWilliams@dfo-mpo.gc.ca

DFO Pacific Region Animal Care Committee (PRACC)
XPAC@dfo-mpo.gc.ca

Example Animal Care Certificate

THE UNIVERSITY OF BRITISH COLUMBIA

ANIMAL CARE CERTIFICATE

Application Number: A12-0167

Investigator or Course Director: Researcher's Name

Department: Science

Animals:

Salmon Oncorhynchus kisutch (coho) (<5g) 100
Salmon Oncorhynchus mykiss (rainbow trout) (20-100g) 40

Start Date: **July 30, 2012** **Approval Date:** **August 8, 2012**

Funding Sources:

Unfunded title: Energy metabolism in salmonid fishes during physiological stress events

The Animal Care Committee has examined and approved the use of animals for the above experimental project.

This certificate is valid for one year from the above start or approval date (whichever is later) provided there is no change in the experimental procedures. Annual review is required by the CCAC and some granting agencies.

A copy of this certificate must be displayed in your animal facility.

Office of Research Services and Administration
102, 6190 Agronomy Road, Vancouver, BC V6T 1Z3
Phone: 604-827-5111 Fax: 604-822-5093

Biosecurity refers to the precautions used to minimize the risk of the introduction and spread of infectious organisms into or between populations. The nature of our operations leaves us vulnerable from a biosecurity perspective. Primary sources of risk include:

- egg collection from wild broodstock with unknown pathogen burden
- multiple year classes, multiple stocks and multiple species per site
- limitations on the availability and amount of pathogen-free water and/or lack of filtration and disinfection for surface water sources
- open-door policy in terms of visitor access to public enhancement facilities.

A site-specific biosecurity plan should be developed for all SEP facilities and incorporated into each site's Fish Health Management Plan.

A site-specific biosecurity plan should address the following considerations:

- Enforce strict sanitary measures for personnel and visitors in fish holding areas
    - Hand and footwear disinfection stations at each entry and exit
    - Clean protective clothing (rain gear/ boot change).
- Routinely disinfect equipment with recommended disinfectants at appropriate concentrations and duration of exposure as per manufacturer's directions.
- Maintain a log of visitors coming into contact with aquatic animals.
- Plan traffic flow of personnel movements through the facility and require that personnel undertake disinfection procedures between holding units and/or buildings.
- Use pest management protocols to keep out birds, vermin and predators
- Use signage throughout the facility to inform visitors and personnel that there are biosecurity requirements in place such as controlled access, footbaths, etc.
- Use pathogen-free well water or spring water where possible. Include upgrades for influent water filtration /disinfection in long term planning discussions.
- Disinfect eggs and follow veterinary recommendations for the management of vertically transmitted pathogens (i.e. broodstock screening program or pre-spawning treatment of broodstock for historically high risk stocks).
- Maintain separation between stocks/species/age classes.
- Remove dead and moribund fish routinely.
- When disease is suspected:
    - Contact the SEP veterinarian and initiate submission to the PBS diagnostic lab.
    - Construct temporary barriers with signage to reinforce segregation of stocks due to infectious disease risks.
    - Remove dead and moribund fish with increased frequency (twice daily preferred). Examine and record signs of disease in daily husbandry records. Dispose of morts in a fashion that does not increase risk to other stocks (on-site or wild).

- Dedicate separate staff members to care for healthy and disease-suspect groups. If this is not possible, plan staff activities to ensure naïve stocks are protected from infectious disease spread (i.e. care of incubation first, followed by care of healthy fry, followed by care of broodstock, ending with care of disease-suspect fish). *Note: Broodstock should always be treated as disease-suspect.*
- Staff members coming in contact with disease-suspect stocks should not be permitted entry to other fish holding areas for the remainder of that workday.
- Dedicate separate equipment for use on disease-suspect stocks and increase its cleaning and disinfection frequency (day's end at a minimum; after each use preferred).
- Postpone all regularly scheduled handling events (i.e. length/weight sampling, marking, vaccinations) for disease-suspect stocks until after a disease investigation has occurred or fish are considered healthy.
- Limit all non-essential travel between SEP facilities. Where travel can't be avoided, please follow common sense sanitary precautions:
  - disinfect raingear and boots and wash hands or use hand sanitation solution prior to leaving site A
  - change into site B raingear and boots, and disinfect hands on arrival before entering fish holding areas
  - disinfect all equipment before leaving site A and again before use at site B
  - park vehicles in farthest spaces away from fish holding units
  - vehicles used adjacent to active spawning channels or gamete collection areas should consider spraying disinfectant unto wheel-wells prior to leaving the area

- Use caution prior to moving fish between holding units, farms or prior to release. Fish showing signs of disease should not be handled, transported or released without veterinary approval.

Checklist for Research

To be most effective, this document should be completed by the researcher ***and*** *Watershed Manager in consultation.*

1. DFO Facility Information

Facility Name	
Address:	
Phone:	
Fax :	
Email:	
Date of Application	

2. Researcher Information

	Research Supervisor (if applicable)	Researcher:	Biosafety Officer (or equivalent)
Name			
Department:			
Address:			
Phone #:			
Fax #:			
E-mail:			

3. Research Project Description

Describe (or attach separately) objective of research, including hypotheses, details, and proposed methodology for the study:		
Duration of Research	From:	To:
Final disposition of Research fish *Describe*		

3.1 Reporting	*Yes*	*No*
Will the researcher provide a timely summary (i.e. within 6 months of completion) of research findings to the facility manager and to SEP management on completion of the study?	❒	❒
Will the researcher consider and acknowledge the information given to them by DFO staff, even if they do not use it in their final report?	❒	❒

4. Species Information

Species	
Number of animals/eggs required	
Life stages	

4.1 Will eggs/fish be transported to facility? If "No" skip to section 5	Yes ☐	No ☐ *Skip to section 5*
Current health history of fish prior to transfer (e.g. certification, health test results) attached?	☐	☐
Will eggs be surface disinfected upon arrival from source location (**mandatory**)?	☐	
Are transport materials (e.g. water, containers) decontaminated (**mandatory**)?	☐	

5. Regulatory Compliance	Yes	No
Has the researcher provided a copy of the approved Animal Use Protocol(s) (AUP)?	☐	☐ Reject
Are all persons who will have contact with the fish listed on the AUP?	☐	☐
Has the researcher provided a copy of the Animal Care Certificate (ACC)?	☐	☐ Reject
List all other permits required for the research in question *Note: all the required permits must be acquired prior to commencement of the project. E.g. Collection or ITC permits*	Permit copy attached Yes	 No
	☐	☐
	☐	☐
	☐	☐

6. Chemicals	Yes	No
Will chemicals or potentially hazardous materials be brought on site? *IF "No" skip to section 7*	☐	☐ skip to section 7
Note: all chemicals and hazardous materials must have an MSDS sheet which must be posted in the appropriate areas		
CHEMICAL LIST	MSDS attached?	
	☐	☐
	☐	☐
	☐	☐
	☐	☐
	☐	☐
	☐	☐
Has storage methodology been agreed on?	☐	☐
Describe how chemicals or other potentially hazardous materials will be disposed of during and after the project.		
Will WHMIS guidelines be met?	☐	☐
If not, describe what needs to be done to ensure compliance		

Will controlled products, chemicals or potentially hazardous materials be brought on site in accordance with Transportation of Hazardous Goods (TDG) requirements?	❒	❒

7. Facility Services	**Yes**	**No**
Is there any concern that research should be isolated from the main production areas?	❒	❒
Are there risks associated with respect to other stocks or containers of production fish? *Describe if yes*	❒	❒
Does the researcher require onsite accommodation (housing, trailer pad, etc.)?	❒	❒
If so, is it available during the proposed period of study?	❒	❒
Will this work significantly affect the normal work that the facility is doing at that time of year? (E.g. conflict with space, equipment use, labour, or site security)	❒	❒
If yes, describe steps to be taken to allow work proceed:		

7.1 Facility and support requirements	*Research Staff*	*Facility staff*
Who will perform fish culture activities (daily observation required)?	❒	❒
If Research staff, list contact information of research staff listed on the AUP, and details of onsite activities (e.g. feeding schedules, weekdays vs. weekends, etc.)		
If Facility staff, estimate additional work load. (e.g. hours/day or week)		
What incubation and/or rearing facilities will be required? *Specify containers to be used, how much and for what duration, water source and flow?*		
Is laboratory space is required?	Yes ❒	No ❒
If yes, detail requirements		
Describe what records will be kept, who will be responsible for keeping them, and where will they be maintained.		

8. Occupational Health and Safety	**Yes**	**No**
Will all researchers be provided with a Health and Safety orientation that is documented?	❒	❒
Is Personal Protective Equipment sufficient to protect employee/ researcher health and safety to anticipated hazards available, inspected, and properly fit-tested, where applicable?	❒	❒
Are Occupational Health and Safety (OHS) activities documented (e.g. training and certifications, pre-work instructions, fit test records, etc.)?	❒	❒
If treatment chemicals will be used, are they stored appropriately (safety requirements maintained)?	❒	❒

Is the facility reference material kept in the research facility area?	❒	❒
Is a protocol specific to the operation of the research required?	❒	❒
If "Yes", are employees certifying in writing that they have understood the material in the protocol?	❒	❒
Is training documented and signed by both the employee and supervisor?	❒	❒

9. Fish Health and Biosecurity

	Yes	No	N/A
Has the researcher been informed of and oriented to all biosecurity procedures specific to this facility?	❒	❒	❒
Has a biosecurity plan been developed for this project?	❒	❒	❒
Will the researcher(s) be conducting projects at more that one site during this time period?			
If so, with what other species or facility type (i.e. hatchery, channel)? How has the additional biosecurity risk been mitigated in the biosecurity plan?			
Are any special considerations necessary for carcass disposal following research procedures (i.e. have any anaesthetics or biological agent been used that prohibit disposal through normal methods)?	❒	❒	❒
Will the researcher be responsible for disposal of research animal carcasses?	❒	❒	❒
Describe how research animals will be disposed of.			

	Yes	No
Is health testing of fish required during research?	❒	❒
If yes, where will it be done and by whom? *Describe:*		

	Yes	No
9.1 Does biosecurity require separation of fish from general areas: ***If "no", skip to section 10***	❒	❒ *skip to section 10*
Will the research facility be separated from other fish culture activities?	❒	❒
Describe separation (e.g. separate room, building, fencing, tank covers)		
Will entrance to the research area be controlled?	❒	❒
Describe access control methods		
Will only persons meeting specific entry requirements be allowed to enter the research area (e.g. research staff, maintenance staff and other persons on official business)?	❒	❒

List name and contact information for those with access in case of emergencies during non-business hours		
Will all persons (including visitors, maintenance staff, etc.) entering the research area be trained and required to follow all relevant protocols for the project in process?	❒	❒
Will disinfectant footbaths be in place?	❒	❒
Is the disinfectant in footbath changed as per manufacturer's instructions?	❒	❒
Will logbooks be kept to show footbath changes?	❒	❒
Will contaminated equipment leaving the facility for servicing or disposal be appropriately decontaminated?	❒	❒
Describe method for mortality and sample disposal (Landfill (carcasses w/ or w/out organs); heat, e.g. autoclaving; chemical e.g. formalin; removal from site; etc)?		
Describe how waste other than animal/carcasses (e.g. gloves, towelling, sharps, chemical baths, etc.) is disinfected after removal from research area		
Describe where equipment and tank disinfection is done. Please list chemicals, concentrations, and duration and frequency of exposure.		
Describe how disinfection is achieved. Please list chemicals, concentrations, and duration and frequency of exposure.		

9.2 Effluent Disinfection	*Yes*	*No*
Are there automatic alarms if levels fall below minimum treatment levels?	❒	❒
Describe how alarms function (audible, visual)		
Is there a back-up system and/or an automatic switch-over if minimum treatment levels are not achieved?	❒	❒
Will treatment records (e.g. logbooks) be maintained?	❒	❒
Will logbooks for treatment chemical purchase and usage be maintained?	❒	❒
Do employees working in the research area have general knowledge of the physical operation and design of the effluent system?	❒	❒
Will residual treatment chemicals be neutralized prior to discharge to meet environmental standards?	❒	❒
Will all spills and losses be reported immediately to the facility supervisor?	❒	❒
Will written records of such incidents maintained?	❒	❒

9.3 Containment Perimeter		
Will the research area be proofed against entry or exit?	❒	❒
Will entry/exit protocols for persons, animals, equipment, samples, waste, etc. be written, posted and followed?	❒	❒

Will emergency procedures for entry/exit, spill clean-up, fire, animal escape and other emergencies be written, posted and followed in the event of emergencies?	❒	❒
Will emergency exit protocols be established whereby routine procedures are bypassed?	❒	❒

10. Operational Requirements

What expectations, other than those already outlined above, does facilities management have of the researcher?

Where and how is all the documentation going to be captured and kept?

9 Required Elements for Short-term Pacific Salmon Seapen Rearing Projects

Guidelines for proponents and operators

9.1 Introduction

Seapens[1] provide a short-term (usually two to four week) seawater rearing and acclimation environment for juvenile salmon, with the objective of improving adult fish return compared to freshwater rearing and hatchery release. Such projects also promote community involvement and awareness of salmon, from spawning through to harvest, and empower communities to play an active stewardship role in the process.

The Department of Fisheries and Oceans (DFO), under the Salmonid Enhancement Program (SEP), has successfully operated seapens since the late 1970s, and Chinook, chum, coho, and pink salmon are released from pens in a number of areas along the BC coastline.

These guidelines are intended to provide proponents of salmon seapen projects with information regarding how to initiate a project, who to contact, estimated project costs, and what can be expected in the form of government expertise and support. They provide information on the technical aspects of operating a seapen project, including an overview of practical considerations to guide existing and future seapen operators.

9.2 Scope and context

DFO supports approved seapen project proponents and operators through the SEP Community Involvement Program (CIP), Fisheries and Aquaculture Management (FAM), and the Salmon Stock Assessment Division (StAD), in conjunction with core activities. SEP has worked in partnership with community groups on enhancement projects since 1977 and continues to actively support these types of projects. Seapen initiatives are included as part of a broader suite of SEP community activities that are incorporated into the FAM-led Integrated Fisheries Management Plan (IFMP) pre-season planning and in-season management processes.

Support for new projects is considered within the DFO framework of resources, policies (e.g. Wild Salmon Policy), guidelines, regulations (eg. *Pacific Aquaculture Regulations)*, and approvals; and projects are guided by local SEP Community Advisors[2]. A flow diagram in Figure 1 illustrates the process and requirements of establishing a new project.

Enhancement projects have various objectives against which their performance is measured. All seapen projects should address an appropriate objective, and include indicators of how success is to be measured.

- **Conservation** programs address stocks that are considered to be at high risk of extirpation or extinction, or vulnerable stocks that have been identified as regional priorities (e.g.

[1] For purposes of this document, the term "seapen" refers to the overall system (floats, frame, etc.), which supports the "net pen" (the net "bag" that holds the fish).

[2] Contact information for Community Advisors can be found on the DFO-SEP website: http://www.pac.dfo-mpo.gc.ca/sep-pmvs/advisors-conseillers-eng.html

SARA/COSEWIC listed, CU amber/red). Performance of conservation programs is measured against stated targets (e.g. *Conservation Strategy for Interior Coho)* and WSP benchmarks.

- **Rebuilding** programs are those that are designed to address stocks that are below optimal spawning abundance. These programs include enhancing depleted populations and mitigating habitat loss. Rebuilding programs must be measured against escapement targets.
- **Assessment** projects contribute to regional priorities (e.g. Pacific Salmon Treaty), regional stock assessment framework, area stock assessment priorities, or regional SEP assessment priorities. Assessment projects are measured through tagged production, as per StAD requirements.
- **Harvest** programs are primarily designed to provide fishing opportunities for First Nations, recreational, and commercial fisheries. Performance is measured through enhanced contribution to harvest. Those projects intended to create local fisheries should develop a fishing plan, in cooperation with FAM, during the project planning process.
- **Stewardship and Education** programs are not assessed on their contribution to harvest, rebuilding, or assessment, but are designed to promote education and responsible use and protection of the natural environment. These program objectives are limited to small-scale Public Involvement Project (PIP) level production and are not measured against production-based performance targets.

The document *SEP Production Planning: A Framework (November 2012)* provides more detailed information on the decision process involved in the planning process and the framework upon which fish production decisions are made, and by whom.

9.3 Initiating a seapen project

9.3.1 Who initiates and carries out a project?

Opportunities exist for the public to share responsibility for conservation, restoration, and enhancement of salmon, and their habitat, through community-based volunteer organizations involved in various stewardship initiatives. Project proponents for salmon seapen rearing projects can be any group or individual with an interest in local fisheries and enhancing local salmon stocks; however, community groups with experience, commitment, local support, and the resources to carry out highly technical work over a multi-year period of time, generally lead them. Interested proponents should begin by collecting the information outlined in the project initiation checklist with their Community Advisor. (See Section 3.3.1)

9.3.2 What is expected of a proponent?

Operating a seapen project is a long-term commitment for technically capable groups of individuals. Projects must be financially cost neutral to government, but proponents will receive in-kind technical support from DFO as needed, subject to other commitments. A project proponent is expected to initiate and carry out background bio-reconnaissance to determine the profile of the environment, and to submit documentation to secure project approval. The proponent group may be expected to provide, at their own expense, a biological assessment carried out by a professional biologist that addresses any significant ecological or genetic risk to local stocks. Building community support, particularly with First Nations who could be affected by the proposal, will also be the responsibility of the proponent.

The proponent will also be expected to fund, or find funding for, all financial aspects of the project and carry out the work, including: application to Navigable Waters where necessary, seapen construction and maintenance, juvenile rearing (feeding, sampling, water quality monitoring, vaccine purchase and vaccination etc), and assessment activities to evaluate project

success. In some cases, seapen operators may be asked to assist the donor hatchery in various fish culture tasks such as broodstock capture, egg takes, picking dead eggs from incubation units, initial rearing, and fish transportation at various stages. This helps offset the additional work created for hatchery staff by the assistance they provide to seapen operators; the local Community Advisor generally coordinates services of this nature.

SEP will provide guidance for the project proposal submission approval process through the local Community Advisor, who will work with a team of SEP and StAD Biologists, FAM fishery managers, and DFO enforcement personnel, to move the project through the DFO stock production planning and fishing plan development processes. The Community Advisor will provide advice on feasibility of the project, potential funding sources, aid in proposal writing, and identify required approvals and consultation requirements.

As indicated, existing commitments and financial resources may limit the available support from DFO and the Community Advisor; support costs can be significant. Proponents will be provided with an indication of the timeline for their proposal relative to other commitments, and updates on its progress.

Supplies of salmon eggs and juveniles are often limited and are a major determining factor in which projects may proceed in a given year. Movements of salmon may be subject to approval by the Federal-Provincial Introductions and Transfers Committee (ITC) if fish are to cross transfer zones. The ITC is guided by federal and provincial legislation and refers to a number of national and international policies in assessing risks or identifying mitigation measures[3].

The Province of British Columbia is responsible for management and protection of foreshore, riparian, and lake habitats that are important to marine and freshwater fisheries resources, and their involvement may be required in certain project proposals.

9.3.3 What is the process, and how long will it take?

There are a number of steps in the process; with decision points at each stage of initiating a seapen project (see an example process flow diagram in Figure 1).

The proponent's first step is contact with the local Community Advisor to discuss the enhancement objective. The Community Advisor will provide initial advice and assist the proponent in understanding the DFO guidelines and processes. Proponents will then complete a project initiation checklist (Section 3.3.1) and return it to the Community Advisor. If the project seems feasible at this point, the proponent will then submit an initial project proposal to the Community Advisor, who can provide further support for the development of the proposal. (*See Appendix for the required components of a seapen proposal*)

The initial proposal requires a full description of the project, including clearly stated objectives with an assessment plan (i.e. contribution to escapement or contribution to harvest) and a biological assessment (i.e. broodstock source and numbers, pen location and logistics, genetic and stock interaction factors, ecological and environmental considerations). The proposal must also describe the commitment, technical and resource capacities of the group, community support, and any consultations that have been undertaken. The proposal should take into account a number of other components: a business plan (described in Section 3.5); consultation; permit/approvals; seapen physical operational and safety; and, where applicable, harvest management.

[3] Information about ITC at: http://www.dfo-mpo.gc.ca/aquaculture/management-gestion/intro-eng.htm

Proponents must also be familiar with the Community Involvement *Best Management Practices*, particularly sections pertaining to seapen sites, and must employ fish culture procedures that are consistent with the relevant parts of this document (e.g. biosecurity, contingency plans, contacts for events that compromise fish health such as water quality, pathogens, algae, predators, and so on).

If the proposal is considered feasible at this point, the Community Advisor will then include it in the DFO planning process, which includes evaluating donor stock priorities, SEP production planning, and incorporation into the IFMP. At the same time, the proponent will initiate fund acquisition, consultation, and approval processes, which may include: fish collection permits, a fish introductions and transfer permit application, environmental assessment, water access through the Navigable Waters Protection Act, foreshore leasing, and Port Authority approvals.

The duration of the process, from initiation through to the first salmon fry release, may take between one and three years.

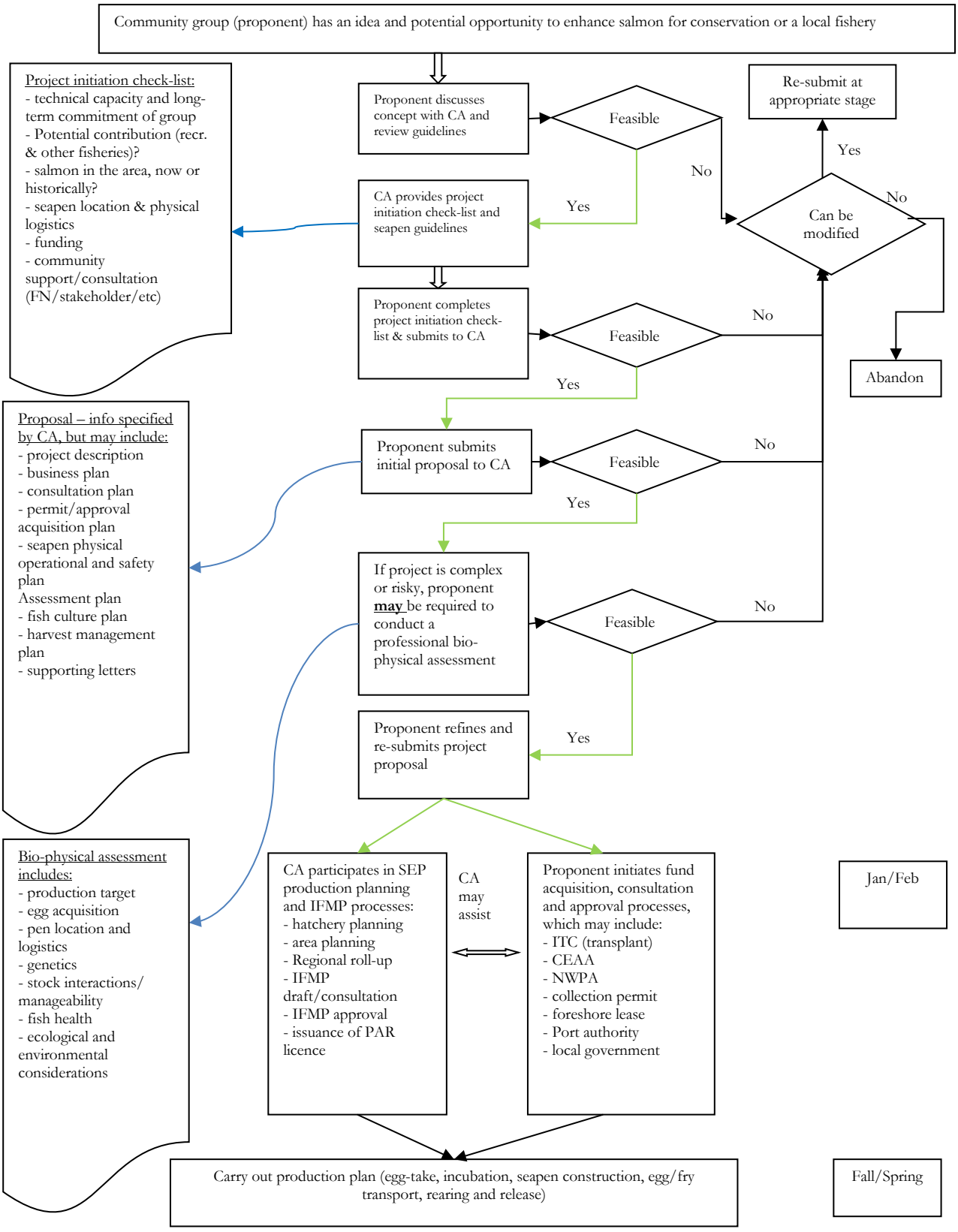

Figure 1 – Proposal process flow

Project initiation checklist

The purpose of this list is to provide potential proponents of a salmon seapen project with some basic background questions that should be considered, and research that should be completed, before engaging a Community Advisor about establishing a new seapen project.

Essential requirements:

- Is the group prepared to commit to a two- to three-year time period to complete the project application and approval process?
- Is the group prepared to register with the Community Involvement Program by submitting a Public Involvement Program Application?
- Where incubation and early rearing is proposed, is the group prepared to commit to up to 300 hours of labour each year for egg-takes, incubation, rearing, and release?
- Is the group prepared to commit a further two years after release to monitor aspects of the resultant adult returns?

Benefits and risks of the project:

- Will the project result in enhanced returns?
- Is part of the project plan to contribute to local fisheries (sport, First Nations, or commercial)?
- Do salmon exist, or did they formerly exist, in the area planned for the project?
- Are there local streams, in the area of return, to which returning salmon might stray and/or spawn?
- Have project risks been identified and mitigated (refer to Biological Risk Assessment Framework)?

Seapen rearing location:

- Has a location for the seapen site been generally determined, and is there a plan to monitor water quality parameters to ensure the site is appropriate for holding fish during the saltwater rearing period?
- Is the seapen location in an area that will require any permissions or approvals (e.g. Port Authority, local government, Navigable Waters Protection Act, foreshore leases, First Nations)? Who will apply for approvals?
- Will access to the seapen require permission from private landowners?

Technical capability and commitment of the group:

- Does the group have individuals with experience, or access to individuals, with experience in fish culture techniques and equipment required to transport and rear salmon?
- Does the group have individuals with experience, or access to individuals, with experience, in operating a floating seapen operation, and the safety considerations involved?

- How will the group carry out a detailed biological assessment, if necessary, to determine the feasibility of initiating a new seapen project (i.e. does the group have the capacity or should they hire a professional biologist)?
- Is the group prepared to assist with hatchery operations, vaccination, marking, and transportation?
- Does the group understand and accept the uncertainties involved before the project proceeds?
    - Brood supply – availability is dependent on annual returns and enhancement priorities.
    - Steps in the approval process (production planning, brood collection, transfer/transplant, permits, Pacific Aquaculture Licence, etc).
    - Steps in other approval processes (Navigable Waters, access to private lands or foreshore areas etc…)
    - Availability of Community Advisor to provide support.

Financial and in-kind support:

- Does the group accept that they will be responsible for all financial costs of establishing and operating the project?
- Will the group be able to raise the funds required for project start up, and for annual operations?
- Does the group have the in-kind or financial support of other partners?
- Does the group understand and accept that the in-kind support of a Community Advisor and his/her team (biologists, scientists, fishery managers, enforcement officers) for new projects requires a substantial amount of work, and that support will be subject to their capacity, priorities, and existing commitments?

Community support:

- Does the group have, or is it prepared to acquire, the written support of local organizations that may be affected by, or benefit from, this project (e.g. First Nations, commercial harvesters, recreational anglers, Sport Fishing Advisory Committee, environmental groups, local governments)?
- Does the group understand that they will not receive any special rights to the returning adult fish?

9.4 Community support and consultation

A successful project relies on strong community support and consultation. To build such support, development of a plan early in the planning cycle is recommended. The project proponent is responsible for obtaining and building support from other relevant community interests, which should include: local government, First Nations, commercial and recreational fishing interests, environmental organizations, and local media. As part of the project review, DFO seeks input from local First Nations and community interest groups with respect to biological and fiduciary matters.

DFO is responsible for formally consulting with First Nations and fishing sector advisory bodies as part of the annual fishing plan development process. Some consultation may best be carried out jointly between DFO and the proponent. This will be determined on a case-by-case basis.

9.5 Business planning

Good business planning involves considering logistical requirements, timing, and costs of a project, combined with sources of funding and in-kind resources. Direct project costs may include: transportation tanks, utilities, buckets, nets, fish food, seapen construction materials, automatic feeders, water sampling equipment, rain gear, safety gear (PFDs), record-keeping supplies, security devices or services, navigational warning lights, among other things. Direct costs to the proponent (not including volunteer labour or costs to government) for starting up a seapen project can be several thousand dollars, and may be significantly higher if a professional biophysical study is required.

In-kind or volunteer labour costs associated with operating a project are estimated at approximately 300 hours per project per year, and may include: communications/consultations, project planning, pick up, transportation and ponding of juveniles, fish culture activities (feeding, dead picking, water quality monitoring, record keeping), seapen installation and removal, cleaning and storage, and security monitoring. Additional volunteer labour may be required to monitor and record adult return in order to assess success of the project.

General liability insurance relating to the seapen structure and personal liability insurance relating to volunteers working on the structure and operating the pen, are important considerations for each project. Providing adequate insurance coverage for the project is the responsibility of the proponent and insurance must be in place before the project gets underway.

9.5.1 Business plan outline example

1. Proponent Information

a) Organization: _____

b) Contact Information _____

c) Organization Description: _____

d) Project Leader _____

2. Project Background

Description of the project, including: source of fish, production targets, location of seapens, operational history and release numbers, etc.

3. Work Plan

Activity Schedule (*The following are example activities only*)

Date (approx.)	**Activity**	**Human Resources Required**	**Notes**
June - July	Contact CA about fish source and arrangement	Project leader	All projects are reviewed during the annual production planning process
September - March	Assist with hatchery operations	Several volunteers	Date and details to be provided by CA. Need raingear, insurance, etc.
February - March	Install seapens	Project leader and volunteers	Arrange access, ensure all materials are available, arrange transportation for seapen components, etc.

March - May	Transport fish to seapens	Project leader and several (four+) volunteers/workers	Arrange for transport equipment, pick up and disinfect equipment, ensure gate will be unlocked, etc.

4. Project Funding Sources

Organization/Name	Description of Support	Cash Value	In-kind Value	Total	Confirmed?
Totals					

5. Project Budget Expenditure Forecast

Item	Description	Cost (cash)	Cost (in-kind)	Cost (Total)	Notes (date required, source, etc.)

6. Project Cash Flow Projection

Use standard bookkeeping software or spreadsheets to plan/track income and expenditures over time in monthly segments.

9.6 Seapen site selection and production targets

Selecting a seapen rearing/release site and determining production targets for a seapen project involve a number of fishery management, biological, physical and logistical considerations. The Community Advisor will coordinate advice and inputs from fishery managers and professional biologists, while guiding the project through the SEP production planning and fishing plan development processes.

As with any enhancement project, there are risks involved with respect to impacts on co-migrating wild stocks, genetic diversity, and local ecosystems. These impacts will vary from project to project and their assessment is part of the project development review. As such, the following, rather than being an extensive review of parameters involved in selecting a seapen-rearing site and setting production targets, is intended to provide a general indication of factors for consideration. Though these factors should be taken into account through the project development and approval process, conditions and requirements between projects may vary considerably.

9.6.1 Fisheries management considerations

The primary considerations in site selection and setting production targets from a fishery management perspective are physical access to the fishery and potential for returning fish to intermingle with other stocks, and what risks intermingling may present. Other important considerations include those relevant to conducting an orderly fishery (time, area, and gear), catch reporting, and active interchange with harvest managers and Fishery Officers (both before and in-season) to structure a harvest plan. Catch allocation between fishing interests may also be a consideration if the returning salmon are numerous and mixed with other stocks. Some of the intents of any project providing fish for harvest are to avoid causing or adding to mixed stock fishery issues, to ensure access while fish still have value, to ensure ability to monitor contributions to the fishery, and avoid over-escapement to the stream of return or straying to non-natal streams.

Migration routes and locations of other fisheries must be taken into account in choosing a seapen site. The intermixing of stocks presents a range of potential scenarios that depend on abundance, migration patterns and timing, and the existence of traditional or potentially new fisheries.

Salmon produced through seapen projects will become a part of the common property resource and may be harvested in approach or terminal fisheries, impacting the return numbers available in the local First Nations and recreational harvest area.

Regulatory considerations in locating a seapen project

Before installing a seapen, the proponent must ensure that appropriate permissions have been secured. Navigable Waters Act permissions and Port Authority approvals may be required. The Provincial government must be contacted on requirements for potential foreshore leasing, and if an Estuary Management Committee is in place, it should be contacted to ensure that any concerns are addressed. Using an existing dock or marina that meets the biological criteria for pen placement may make the permission process less time consuming. Under some circumstances, approval may be required from the ITC.

The following is a partial list of the more common regulatory considerations to be taken into account by proponents of seapen projects when selecting a site. The requirements will vary for each project, and further advice should be sought from the SEP Community Advisor. A number of other permits and approvals for elements other than site selection are not included here, but are referred to in the body of the guidelines.

1. Permission for parking and access to the site may be required from landowners or administrators. This may involve the local community government or municipality, the local harbour authority, or the local land owner (if on private property)
2. If the seapen is to be placed in an estuary, approvals for placement may be required from Estuary Management Committee; many estuaries are controlled by such organizations.
3. The Ministry of Environment's Environmental Protection Division can provide directions regarding waste management, and any other environmental considerations associated with the site.
4. The Provincial Crown Lands Office can provide information regarding access and tenure arrangements, on Crown Lands, which could be considered in order to secure the site over the long term.
5. If the site is within Provincial or Federal Parks areas, there may be special requirements or restrictions.
6. Transport Canada can provide information regarding potential requirements relating to the Navigable Waters Protection Act and whether the seapen is within an area considered navigable; permits may be required, and the application may trigger an assessment.
7. The Community Advisor can provide advice on any other type of environmental assessment may be required, or of any other requirements.

Physical requirements

Seapens usually operate between February and May, and in some instances into early June. The timing is dependent on species, location, and environmental conditions.

Site access and safety – Easy, safe access to the seapens is essential in facilitating movement of people, equipment, and fish food, to and from the site. Balancing ease of access with potential trespass or vandalism may be necessary. If the purpose of the project is to provide local fishing opportunities, then the pen should be installed close to where the fishery is anticipated and, where

possible, close to the target stream or stream of origin. Returning adults may stray if the pen is located even a few miles from where the fishery is intended if there are other freshwater influences.

Shelter – To maintain integrity of the seapens, and for the safety of workers, the site should be located in protected waters, safe from high winds and turbulent seas. The site should be relatively clear of floating debris to avoid clogging or destruction of the nets. Using existing marina floats often meets these access and shelter requirements.

9.6.2 Biophysical considerations

Stock and species interactions

Potential ecological effects to consider in initiating a salmon seapen project include inter- and intra-specific competition and predation. Competition amongst salmon stocks, and between different salmon species or other resident fish stocks, for food resources in estuarine environments may be a concern, particularly if feed is limited. Spawning of strays in non-target streams may result in competition for space with existing salmon populations or other resident fish, or may result in potential genetic effects such as inbreeding and out-breeding depression if they spawn with different local native stocks than the donor stock.

Biophysical site considerations

Sampling protocols are often site-specific. The following information should be collected to assess environmental conditions that will influence the success of a seapen rearing program, and potential impacts from installation of the pen.

Prospective sites should be observed and sampled at least one year prior to operation, covering the proposed period of operation, and sampled through multiple periods during full tidal cycles, to determine site suitability. At minimum, each prospective site should be sampled as close to (or during) the proposed salt water rearing period as possible. Sampling times should represent low, mid, high, and slack tides, to present an overall snapshot of environmental parameters through a full tidal cycle. Information from several years will provide an estimate of annual variation and provide a more complete environmental assessment.

Survey area – The underwater area should be surveyed to ensure appropriate depth, identify the substrate, and ensure that no critical or sensitive habitat lies within the area of impact (under the pen and inside the anchoring area). The impact of the anchoring system should be included in the assessment and an investigation into the presence of any existing bottom pipelines and cables should be carried out. Potential for deposition of wastes (fish feed and faeces) should be evaluated for the seapen configuration and the proposed loading densities. An assessment of potential for damage to any fish or fish habitat or to the benthic ecosystem, due to deposition, shading, or anchoring systems, should be carried out.

Water depth – Depending on the size of the pen employed, the minimum depth of water should be between 3 – 5 m at the lowest tide. Seapens should be sited in waters deep enough to avoid grounding at low water, with at least 1 m below the lowest point of a sagging net bottom or predator cage at the lowest tide. This provides room for flow, reduces probability of grounding during heavy wave action, and protects benthic ecology from both physical damage and smothering, provided flow is adequate to disperse wastes. There must not be understory kelp or an eel grass meadow under the seapen.

Water flow - Water flow through the pens should be sufficient to maintain a fresh clean source of water, but not so strong as to stress small fish through excessive sustained swimming speed. Excessive flow/current will also cause nets to billow, reducing the useable area inside the pen and endangering structural integrity of the site. Ideally, the water flow inside the pen should be

approximately one body length per second to ensure that wastes are cleared efficiently and that fish are not subjected to fatigue.

Note: The mesh netting will substantially reduce water flow inside of the seapen, but maximum sustained swimming speed should not exceed one body length per second inside the net.

Water velocity should be measured at depth intervals using a velocity meter to the nearest 0.03 m/sec (3 cm/sec, or 0.1 ft/sec, or 1.2 inches/sec - a Gurley velocity meter may be used), unless dissolved oxygen levels are suitable when measured at low, medium, and high slack tides.

Salinity – In an estuary, salinity levels are highly variable due to freshwater influences (tides can dramatically affect salinity in an estuary) and on release fry may rear for an extended period in the estuarine region. The estuarine ecosystem provides significant food resources, but there may be impacts from competition with other fish. Full strength seawater ranges between 32 – 35 ppt but due to the large influx of water from BC's rivers, many areas are normally lower (~28 ppt). As a general rule of thumb, the salinity for a sea-pen site should be 20-30 parts per thousand at all tidal levels, although a narrow freshwater lens at the surface may assist fish in acclimation.

Different species of fish have the ability to tolerate full strength seawater at different sizes and timings. Juvenile fish that are ready for seawater but held too long in freshwater may lose some of their salt-water tolerance.

It is important that there is not a significant fluctuation in salinity unless there is sufficient stratification that allows the fish to choose a preferred salinity level. Fluctuations in salinity are physiologically stressful, and late introduction can be as stressful (or lethal) as an introduction that is too early.

To ensure that the population of fish is prepared for seawater transfer, a salt-water challenge test should be carried out on a small number of fish prior to transporting the entire stocking number to the pen.

A standard salinity meter (YSI type) is useful for measuring salinity and will also measure temperature.

Temperature - The target temperature range should be 8 to 15^{o}C through the rearing period. Lower temperatures will reduce growth. Higher temperatures will reduce oxygen availability when fish have a greater metabolic requirement. This will predispose fish to diseases such as Vibriosis, which are present at the time fish are transferred to seawater, particularly at higher water temperatures.

Dissolved oxygen - Dissolved oxygen levels should be above 8 mg/L (ppm) at all times during rearing, and at all periods of the day. Lower levels will predispose fish to disease. Using an approved DO meter (Oxyguard Handy or equivalent) ensure that measurements are calibrated to seawater and recorded in both % saturation and ppm (mg/L).

Predators - The prospective site(s) should be reviewed for potential predators (e.g. seals, sea lions, otters, mink, bottom fish, and herons). Ensure that adequate predator protection is available and that risk of entrapment of other species is mitigated.

Debris Flow – Flushing actions of the water and movement of debris that might affect the seapen should be noted.

Plankton blooms – Algal/plankton blooms can cause harm in a number of ways. They may occlude light and reduce feeding, thereby reducing growth. They may reduce flow through the net and/or they may reduce oxygen levels in the water column – particularly at night. Some blooms contain harmful toxins or may cause mechanical damage to the gills, leading to mortality.

The incidence of harmful plankton blooms should be researched; information may be available through local knowledge.

Pollution sources - Nearby potential pollution sources (e.g. fuel, works yards, sewage, processing plants, and industrial mills) should be noted and avoided with a wide perimeter. Exposures to effluents and accidental spillages are unpredictable in nature and can be toxic.

Sensitive aquatic habitat

Sensitive or critical habitats must be addressed when selecting a seapen site. These may include: spawning areas (including for lingcod, herring, and intertidal areas for salmon rearing), kelp beds, eelgrass beds, abalone habitat, rockfish rearing/nursery areas, shellfish beds, and unique features such as sponge complexes. If sited in waters less than 20 m deep, an underwater survey may be required to identify the presence of sensitive or critical habitats and to ensure the seapens will be positioned with adequate depth and distance.

Many of these concerns will be addressed during the project permit and approval stages and carried out by professional biologists or habitat practitioners, but seapen operators should be continually aware of habitat considerations during seapen installation and operation.

Vaccination

At temperatures above 12^{o}C the concentration of pathogens in the water will be elevated and the water conditions will be more stressful on fish, both of which increase risk of infection, particularly to *Vibrio* – a normally present marine pathogen. Vaccination, if possible, should be considered mandatory for seapen operations.

See section 7.1 for further information on vaccination.

Salt-water challenge testing

Prior to saltwater entry, the ability of fish to osmoregulate and manage the change in salinity should be evaluated through a saltwater challenge test. See section 8.2 for further details on performing a saltwater challenge test.

Stocking density

Dependent on temperature, species, and stock, biomass in the seapen should increase two-fold over a period of two to four weeks. The maximum recommended loadings are 12 kg/m^2 surface area, or 5 kg/m^3 seapen volume. These values have been tested to ensure maximum survival of fish in the pens. For optimal fish health, densities should be maintained below these levels.

See Section 7.3 for further information on stocking seapens.

9.7 Monitoring and assessment under the PAR licence

A Brood Summary report summarizing the seapen program must be submitted annually to the Community Advisor as a condition of the PAR licence. It includes information such as numbers released, size at release, release dates and release location. Information on rearing duration, operational observations and lessons learned may also be required by the Community Advisor.

A part of the project design should include monitoring and assessing results. Ideally, seapen operators will work with the Community Advisor and SEP Planning and Assessment Biologists to develop an assessment plan for the project that may involve marking of fry and sampling returning adults to determine ocean survival and contribution to fisheries (and spawning grounds if a rebuilding initiative). However, resources for such assessment studies are limited and will determine both the level of monitoring and assessment for the project, and the scope of

production (with any associated risks to wild stocks). If assessment resources are too limited to properly assess the project and associated risks are considered significant, SEP Planning & Assessment may not approve the proposal. Regardless, seapen operators should be prepared to at least observe and record noticeable abundances of salmon returning to the release site and monitor angler activity to determine success in achieving the enhancement objective.

9.8 Sea pen design

The following is a general guide for installing and operating salmon seapens. Geography, water conditions, access, sea pen configurations and other operating conditions will vary from one project to another; it is therefore intended that these guidelines be combined with advice from the Community Advisor, Support Biologists, and hatchery personnel. There is a strong network of groups that successfully operates seapen projects. Proponents are encouraged to contact experienced operators and utilize this valuable resource for information.

9.8.1 Sea pen design and construction

In its simplest form, a seapen for rearing juvenile salmon usually consists of a square pen frame supported by floats from which a net is suspended. This frame - combined with approximately ten-kilogram weights attached to the bottom of a 10 mm. diameter nylon rib-line sewn into each corner of the net and predator cage - maintains the shape of the net. The rib line extends from the top to the bottom and has extra line at the top for tie off to the frame. A panel of netting is usually strung across the top of the pen to protect the rearing fry from birds. If otters or other larger animals are a potential problem, consideration should be given to a removable wire mesh top (secured to a wooden frame) as an alternative to bird netting. A two-inch green polypropylene predator mesh that encases the net is also recommended.

The seapens are often tied to, or are a part of, a pre-existing dock or float system, taking advantage of walkway access, anchoring requirements and security monitoring. However, the system can be independent and free-floating in a suitable protected and accessible location with its own anchoring system. In this case, anchors extending from all four corners of the seapen are recommended. The anchor line should also have a length of heavy surge chain halfway to 'dampen' any wave action.

Seapen size depends on location, particularly if the pen is associated with an existing dock or set of floats, and the number of fry to be reared. Pink and chum salmon pens vary in size; several Federal SEP facilities use pens that are 5.2 m x 5.2 m x 2.1 m deep, whereas some volunteer projects use pens that range in size from 3 m x 3 m by 3 m deep, to 3.7 m x 3.7 m x 4.3 m deep. Pens for rearing coho or Chinook may be as large as 12 m x 12 m x 12 m. Nets are secured inside of the frame and a line similar to the rib line is sewn along the top of the net and the net is fastened to the inside of the pen frame. Slats are screwed to the frame at approximately 30 cm intervals below the net top line. The predator cage is similarly attached to the outside of the pen frame.

The predator mesh encasement for a 3m x 3m x 3m deep pen, would measure 3.3 m x 3.3 m x 3.3 m deep (i.e. add 15 cm to width of each side of net to go around the frame easily). This mesh is usually fastened horizontally to the outside edge of the pen frame with a length of 1 x 3 board attached to the frame with screws at 30 cm intervals. The predator mesh encasement and the bird netting cover can be custom manufactured by a commercial net supply company.

High-end seapen frames are constructed of welded aluminum with safety railings and non-skid decking. These can be purchased as stock items with assembly instructions from a number of suppliers or, in some instances, may be purchased used from an aquaculture supply company.

Less expensive seapens can be constructed from wood and Styrofoam, but operators are cautioned against this type of construction due to risk of pathogen transfer and difficulties with effective disinfection. These risks can be minimized if the pens are in the water only once a year for a single rearing period and then shelved and dried in secure storage without rodents or organic material. If feasible, better materials are advised.

The basic wood frame seapen is constructed with 5 x 30 cm planks (4 – 3 m length; 4 - 4.27 m length) on edge, with blue polystyrene floats sandwiched between 13 mm. plywood screwed to both top and bottom of the planks. The 10" x 20" x 96" polystyrene blocks (available at Industrial Plastics) are cut in half, positioned towards the ends of the planks and secured in place with 2" x 12" cross braces at each end of the float. The frame is built in four modules hinged together at the eight corners (four outside and four inside) with pins or bolts much like a door is hung (see Figure A5 for design of corner hinge plates). Stainless steel hinge plates and bolt/pins are recommended, but mild galvanized steel can also be used initially at less cost. Hinge plates should also have eyebolts for tie up or anchoring.

The cost of a basic wood frame seapen, using galvanized mild steel hinge plates, may be less than $1000. Seapen frames constructed of welded aluminum are much stronger and are therefore recommended where there is wave action from storm events. These frames are usually constructed to order and are considerably more expensive. Both pen types must have non-skid decks and handrails for safety. There are many ways to construct seapens, and the previous information provides just some of the options available

9.8.2 Nets

Net pens come in a variety of sizes ranging from 3 m x 3 m x 3 m to more than 12 m x 12 m x 12 m. Choice depends on the number of fish that are to be reared and the installation location.

Net mesh size also depends on species. Chinook or coho fry of approximately 5 g should be reared in a pen with a mesh size of 3/8" to 1/2" stretched. Pink and chum fry require a smaller mesh size of 1/4" stretched. If the weave is too large the fry may attempt to push through the net and become lodged in the mesh. If the mesh is too small there will be inadequate water flow and solids and growth may clog the net, reducing water flow and oxygen availability. Seapens should be constructed with knotless nets.

9.9 Fish culture and biosecurity operations

The goals of seapen use are to stimulate rapid fish growth over a relatively short period of time, to promote the return of fish to the general location of the original seapen, and to encourage future fishing opportunities. In order to achieve these goals, good fish culture must be practiced. The Community Involvement Program utilizes ***Best Management Practices*** to guide its activities. The information that follows is not intended to replace the *Best Management Practices* document, but to highlight those practices that should be considered in further detail.

Although detailed information is available in the Best Management Practices and Major SEP Facility Net Pen SOPs, the following are some important practices in maintaining good fish health in seapens and should be considered prior to undertaking a project.

9.9.1 Vaccination

On entry in the marine environment, fish are exposed to the marine pathogen *Vibrio*. At temperatures above 12^{o}C the concentration of pathogens in the water are greater and the water conditions more stressful to fish, both of which increase risk of infection. Chinook and coho placed into seapens are large enough for successful immersion vaccination against *Vibrio spp* and

such vaccination will improve their early survival and must be vaccinated against *Vibrio spp* to provide them a measure of protection against the disease.

Different vaccine manufacturers have slightly different directions for their product and there may be variations in the time required to achieve adequate immunity before being exposed to salt water. Read the manufacturer's instructions closely, and follow them accurately.

For example:

> ***Vibrogen*** - Each litre of undiluted bacterin is sufficient for 100 kg of fish. To use, shake bacterin well and add 1 L to 9 L of clean hatchery water to make a 10 L vaccine bath. Net, drain and immerse 5 kg batches of fish (2 g or larger in size) in bacterin for 30 seconds. The bath may be reused up to 20 times before discarding. Withhold food from fish 24 hours prior to vaccination
>
> Fish should not be moved to seapens for a minimum of 250 degree days (or roughly 3-4 weeks) following immunization.
>
> Other manufacturers may require up to 400 degree days for immunity to be achieved prior to salt water exposure. Read the label and follow the directions.

Do not dilute the vaccine beyond manufacturer's recommendations as this will reduce the efficacy of the product and may not afford adequate protection. Such use will waste money spent on the product while potentially reducing fish survival

9.9.2 Salt-water challenge testing

A week before planned transport, place approximately 100 fish into a holding container (bucket or square container with mesh cutouts for water flow) floating in the seapen to determine 24 hour survival in saltwater. Ensure that the fish have adequate water flow in the container. If the fish appear in good condition 24 hours after placement in the container, it can be assumed that the population is prepared for saltwater entry and may be transported to the seapen.

Alternatively, weigh 50 fish from freshwater individually and record their weights before placing them in the bucket in the seapen. After 24 hours, reweigh the fish and determine their total (or individual by arranging the weights from lowest to highest) weight change. If fish lose more than 15% of their pre-seawater weight during this period they are not ready for transfer to the pens.

Different species and stocks of fish will adapt to salt water on slightly different schedules. Chinook may be prepared for the marine environment at 5 g by late April, but if not transferred may lose a degree of their saltwater tolerance for a time before becoming ready for higher salinity again at a later date.

9.9.3 Transporting fish to seapens

Transport is one of the most significant sources of stress fish will be subjected to during rearing, and losses due to poor transport can be immediate or delayed. During transport, fish are netted, handled, crowded, subjected to less than ideal water quality, and rapidly exposed to a new environment. While contained in a relatively small volume of water at high density, the fish are respiring at a greater than normal rate and actively removing oxygen from the water. They are also producing a greater amount of metabolic wastes (ammonia) that can further degrade water quality. The compounding effects of such stress can lead to a greater risk of infection on release into the seapen.

In many instances, experienced staff from a major SEP facility will be involved in (or fully carrying out) the process and will take appropriate measures to ensure transport is carried out

safely. Where community groups are performing the transport, some key concerns should be considered prior to loading fish.

Temperature - Aluminum transport tanks heat up significantly in the sun. Filling and draining the transport tank with water, prior to filling for loading, will cool the metal and reduce heat transfer to the transport water.

The water in the seapens may differ markedly from the hatchery and transport water. The longer fish are held in the transport container, the greater the temperature increase within the transport tank will be. Ideally the water temperature difference will be no more than 3^{o}C and, where it is greater, fish may benefit from a measure of acclimation. Use caution and common sense when deciding to keep fish in the transport container and adjust the water temperature to match the seapen temperature. Holding fish for too long and attempting to ramp the water temperature up too high may lead to significant mortality on transfer.

If temperatures are known to be significantly different, seek advice from hatchery staff or a Community Advisor.

Dissolved oxygen - Pre-charge the transport water with oxygen prior to loading fish. Bringing the dissolved oxygen to 16 mg/L prior to netting fish into the transport tank will provide a buffer against the high oxygen consumption that follows the handling stress.

Adequate oxygenation is vital during transport. The majority of losses during transport are related to oxygen deprivation. At higher temperatures water may not be able to contain adequate oxygen to meet the metabolic needs of the fish in the transport container. When monitoring dissolved oxygen do not rely on percent saturation as a measure of availability. Measure dissolved oxygen as concentration (mg/L or ppm), and ensure that levels do not drop below 8 mg/L to ensure fish have an adequate supply.

Monitor during transport. Fish should be checked every 30 min during transfer, and dissolved oxygen should be monitored during these checks. If oxygen concentration is nearing 8 mg/L, oxygen flow should be increased. Note: Increasing oxygen flow to greater than 3 L/min may decrease the efficiency of transfer of oxygen into the water due to the limitations of airstones. Maximum efficiency of oxygen dissolution into the water is generally between 1-2.5 L/min flow. If the oxygen flow is too great it may increase pressure inside the airstone and reduce efficiency; the bubbles may not be fine enough to transfer oxygen into solution. In other words, too high of an oxygen flow rate may actually lead to a decrease in available dissolved oxygen for the fish.

Just prior to release into the pen, reduce the oxygen level to near saturation.

Salt acclimation - Salt may be added to the transport water to provide a measure of acclimation between the hatchery water and the seapen. Concentrations of 4.25 – 5 g/L may provide some reduction in stress and ease the transition. Salt should be non-iodized, free of anti-caking agents, and should be mixed well on addition.

Loading density - Transport loading density should not exceed 0.1 kg fish/L of transport water. For long transports, density should be decreased.

9.9.4 Stocking density & feeding

Dependent on temperature, species, and stock, biomass in the sea pen should double over a period of two to four weeks. The maximum loading criteria are 12 kg/m^2 surface area, and 5 kg/m^3 seapen volume - this is to ensure maximum survival of fish in the pens. For optimal fish health, densities should be maintained below these levels.

***When considering numbers of fish to safely rear in a seapen, these stocking densities should be based on biomass at release, not at initial loading – in other words, allow fish to grow to the*

*targeted density, don't start at that level. Excessive densities will reduce water quality, stress fish, and lead to health problems and disease***

Feed and feeding require significant consideration as there are requirements for safe storage and daily attention. Volunteers will be required to maintain a vigilance where feed and feeding are concerned, as these are vital components of any project.

Order fish food at least one month in advance to ensure delivery. The volume required will depend on the number of fry to feed and the target size at release. Contact local hatchery staff or the Community Advisor for assistance in calculating the amount required.

The general rule of thumb when rearing fish in sea pens is to attempt to double their weight prior to release. Depending on the feed and feeding regime being used, this could take anywhere from two to four weeks. However, with extended rearing comes elevated risk of disease.

Consult with the Community Advisor or the local hatchery to determine what feeding regimes will be most suitable for the location and feed type being used.

Feed should be protected from wildlife and from the elements. Storage at warm temperatures promotes nutrient breakdown and leads to rancidity, both of which can lead to nutritional deficiencies and health problems in rearing fish. Feed should be stored at temperatures <20^{o}C, below 75% humidity, and out of direct sunlight. Feed should be kept in a secure container in a locked shed or building that is maintained at a cool temperature.

Fish must be fed by hand at least once daily so that the behaviour and feeding activity of fish can be monitored however, feeding may be augmented by automatic feeders. Daily feed records must be maintained.

A random subsample of 50-100 fish should be sampled for weights and lengths on a weekly basis to ensure that they are receiving adequate feed, and to estimate release timing. Consult the Best Management Practices or your Community Advisor for the best method to carry out this procedure.

At temperatures of >15^{o}C and/or DO levels of <7 or 8 mg/L, alter the feeding schedule to coincide with the coolest period and the highest oxygen levels, generally early morning. At 6 mg/L, hold off feed to decrease oxygen demand and activity at the surface and contact the Community Advisor or local hatchery to seek advice on potential intentional early release.

9.9.5 Seapen water quality monitoring

Water quality must be monitored and recorded on a daily basis. The following should be measured and recorded daily during rearing:

Temperature

Temperature should be measured at the surface, and at 1, 2, 3, and 5 m depths, on a daily basis.

High temperatures will increase oxygen demand in fish and elevate the likelihood of a disease outbreak and significant losses to mortality.

Dissolved oxygen

DO should be measured at the surface, and at 1, 2, 3, and 5 m depths, both inside and outside of the seapen, on a daily basis.

It is critical that DO levels are maintained above 6 mg/L inside the pen to sustain physiological processes. Lower levels will lead to fish health problems and associated mortality. If levels are decreasing, water may be pumped from outside the pen to the inside, or a "bubbler" can be

installed to draw water up from depth. If oxygen cannot be supplied, and the DO declines to 5 mg/L, then the fish must be released.

Salinity

Measure salinity at the surface, and at 1, 2, 3, and 5 m depths.

Visibility

If water is excessively turbid, feeding behaviour can be reduced. High levels of fine suspended solids can also cause gill problems in very small fish.

Any anomalies must be communicated to the project leader and the Community Advisor immediately. Lethargic fish that swim at the edges of the net are a good indication of a health problem in the pen. Contacts for fish health events (water quality, disease, algae, predators, etc) must be available and located in a convenient place.

9.9.6 Mortality collection

Collect and record mortalities on a daily basis, this reduces the spread of pathogens within the pen and to the outside marine environment and provides valuable information on fish health. Surface mortalities should be netted daily from the water, and a mort ring may be employed for collecting mortalities that fall to the bottom of the net. Dead fish should be handled and disposed of in a manner that minimizes risk of infectious disease transfer. Mortalities should not be disposed of to the environment, but collected and disposed of to landfill or compost. Mortality removal equipment should be disinfected after each use.

Mortalities must be reported in a timely manner. An increasing number of mortalities indicates a problem and the DFO veterinarian should be consulted if excessive mortalities are seen.

- Daily mortalities that exceed 0.1% per day should provide pause for thought and raise alarm
- If daily mortalities exceed 0.5% per day, discussion with the SEP veterinarian should occur
- Where daily mortalities reach 1% per day, the veterinarian must be notified and a management plan put into play

Any major mortality event must be reported to the DFO veterinarian within 24 hours to discuss management, diagnostics, and biosecurity measures. When a disease is suspected, the DFO veterinarian should be consulted immediately. Written approval by the veterinarian is a licence requirement prior to release as a disease control measure for fish that are known or suspected to carry an endemic infectious disease agent.

9.9.7 Cleaning

Part of the regular maintenance of a seapen involves cleaning. Use a long handled stiff-bristled brush, as needed, to remove any algae growth or accumulated material that could obstruct the net. Remove any sticks or debris that pile up against the net to reduce the risk of a tear in the net and associated fish losses. Daily visual inspections will help direct cleaning requirements. Depending on the site and water conditions, some nets may need to be changed during the rearing period. The technique for changing nets can be complicated and should be carried out by experienced people. Contact your Community Advisor or local hatchery if changing the nets is required.

9.9.8 Daily records

Daily records must be maintained and should include, at a minimum, temperature, salinity, mortalities, food fed, the name of the individual taking measurements and feeding the fish, and any other relevant comments. Fish length (nose to fork) should be measured and recorded weekly.

Other daily records should include environmental conditions (wind, weather, etc) and disturbances (predator occurrences, boat traffic, unusual wave activity, etc).

Example record sheets

Daily Record Sheet – (Project Name, Pen Location or Number)

Date	Mortality	Temp	D/O	Salinity	Flow (mm/sec)	Turbidity	Food Fed (kg)	Comment/ Observation	Observer Name

Fry Measurements – (Project Name, Pen Location or Number)

Date	Length (mm)	Weight (g)	Comments	Sampler Name

9.9.9 Predator avoidance

Predators are a common issue with seapens. Mink, otters, seals, herons, and other birds and animals will attempt to make use of a captive food source both to the detriment of numbers of fish, and to their health. Predators will not only consume the rearing stock, but their presence and behaviour will stress fish and increase susceptibility to disease.

Adequate predator netting both over the seapen and around the containment net are necessary to protect fish during rearing. Maintaining cleanliness around the pen site and regular visual inspections of the netting over and around the seapen will help deter predators and identify any places where animals have caused damage. Ensuring that nets are maintained at a level well above the waterline will aid in keeping otters from entry by scaling the nets.

9.9.10 Personal safety

Above all else, ensure that personal safety of workers and visitors is maintained. Never work alone on a netpen, and always wear a personal floatation device when working over water. Refer to the guidelines in WorksafeBC.com.

9.9.11 Site integrity

Vandalism can result in damage to the seapen and potentially to a complete loss of the fish rearing within it. Ensure that the pen is protected from human intervention through appropriate security measures.

9.9.12 Decommissioning the site for the season

When the pen is empty at the end of the rearing period, it must be removed from the site. The netting will collect uneaten food, faeces, and algae over the course of the rearing period and will

require pressure washing before being hung for drying and storage for the following year. Care needs to be taken that the material washed off does not enter fish bearing streams.

All equipment associated with the seapen should be cleaned, disinfected, and stored in a safe location until required for the next season. Ensure that any structure related to the seapen is removed or secured such that no harm can come to anyone venturing to the location after fish are released.

9.10 Acknowledgements

These guidelines have been compiled from information arising from extensive work undertaken by many individuals. In addition to input from SEP Hatchery Managers, Program Support Biologists, Planning and Assessment Biologists, and others, information has been drawn from a variety of DFO-SEP sources, including:

Net Pen Standard Operating Procedures. Salmonid Enhancement Program Fish Health Management Plans (2013)

Pink Salmon Sea Pens – Guidelines for Proponents and Operators (2009)

“In The Pink” Community Guidelines for Net pen Rearing of Pink Salmon (2007)

Pink Fry Seapen Biophysical Site Considerations. Prepared by Dave Ewart, Quinsam River Hatchery (2007)

The Pink Salmon Sea Pen Strategic Plan for Strait of Georgia - Draft (2006)

Appendix: Seapen Proposal Template: Required Information

All proposed seapen projects must clearly demonstrate the ability to meet a series of basic criteria before being considered for approval; these are provided below. Wherever possible, information is to be supported with references and notations to personal communications with scientific authorities and fisheries experts. Information to assist in the completion of the following points can be found within the text of the *Seapen Guidelines* document. Applications lacking sufficient detail will be returned to the proponent.

Although Production Planning approval is required for any project, approval during Production Planning is only one step and does not constitute assurance that the project will move forward; many additional concerns must be adequately addressed.

Production Planning Considerations

- Outline the specific project objectives and explain what benefits the group expects from the proposed seapen project.
- Provide details on expected returns attributable to the project and the basis for these expectations (Provide available data).
- Provide a monitoring and assessment plan. (*See Section 5 for more details*)

Licencing and Permits

Any seapen will require permission some from a landowner or a permit or lease to locate and operate a seapen in marine waters. Obtaining permits or leases can take some time so it is important to take this into account when planning a seapen project.

- Identify any permissions, permits, or approvals that will be necessary (e.g. Port Authority, local government, Navigable Waters Protection Act, foreshore leases, First Nations, private landowners) and identify who will apply for these approvals. *(See Section 4.1.1)*

It is the responsibility of the proponent to acquire all applicable approvals.

- Outline any safety considerations associated with the proposed location. (*See Section 4.1.2*)

Site Selection Considerations

- Provide details on the proposed location of the seapen project (site location, GPS coordinates, nearby streams, nearby industry, etc).
    - Provide information on nearby streams and details on native species/stocks in those systems.
- Temperature, dissolved oxygen, and salinity are critical to fish survival; data must be collected at various depths, at all tidal cycles, and across time duration relative to the period during the year when culture will be carried out. (*See Section 4.2.2*)
    - Provide water quality data for the proposed site location (water flow, temperature profile, salinity profile, dissolved oxygen profile, nearby industry of concern….) across depth and time.
- Provide information on the nature of the seabed beneath the proposed seapen site and indicate what minimum depth will occur beneath the proposed seapen net. (See *Section 4.2.2*)

Risk Assessment

- SEP adheres to a Biological Risk Management Framework; the approval process for any new project may be lengthy and cannot be fast-tracked.
- Using the *Biological Risk Assessment Framework* document for guidance, clearly detail the risks (biological, biophysical, potential for wild interactions…) of the proposed enhancement project and explain how the group will mitigate these risks.
    - Provide information on potential for, and risks from, straying into any of the above systems. (*See Section 4.2.1*)
    - What, if any, sensitive habitat may be affected by the pen? (*See Section 4.2.3*)

Fish Culture and Biosecurity

- Outline the group's fish culture experience.
    - If there is a lack of experience in seapen rearing (i.e. if none of the crew has worked a full seapen cycle), provide an overview of the outside technical and biological expertise the group will have for support.
- There are always inherent uncertainties in fish availability.
    - What will be the source of smolts for the seapen and what, if any, contingencies are in place if fish should be unavailable?
- Provide details of the seapen design (size, dimensions, construction, etc). (*See Section 6*)
- Provide information on how the group will comply with vaccination requirement. (*See Section 7.1*)
    - Identify the vaccine and source provider.
    - Identify who will carry out vaccination.
    - Identify how associated vaccination costs will be funded.
- Outline how smolts will be transported to the seapen location, include details on transport equipment and staff. (*See Section 7.3*)
- Provide details on proposed stocking density and feeding regime. (*See Section 7.4*)
- Explain how water quality parameters will be monitored during the saltwater rearing period.
    - Clearly explain what parameters will be monitored, provide details on how monitoring will be carried out, indicate frequency of measurements, and identify what records will be kept. (*See Section 7.5*)
    - Provide information on what predators are of concern and how they will be excluded. (*See Section 7.9*)
- Explain how, and how often, mortalities will be collected. (*See Section 7.6*)

Outline the recordkeeping practices associated with mortality collection and indicate at what point fish health assistance will be sought. (*See Section 7.8*)

10 Sockeye Enhancement - New Project Evaluation Guidelines

10.1 Purpose

The purpose of this document is to support a regionally consistent approach to sockeye production at Salmonid Enhancement Program (SEP) facilities and outline criteria used to evaluate proposals for new sockeye culture projects.

10.2 Background

Sockeye are considered a high risk species for enhancement because of the Infectious Haematopoietic Necrosis virus (IHNv). Due to IHN risks, sockeye enhancement in SEP focuses primarily on supporting wild stock production at spawning channels and rehabilitation and restoration projects to improve fish passage and spawning habitat. Culture projects have been restricted due to risk of disease; existing projects operate under strict biosecurity and isolation guidelines to protect both hatchery and wild fish.

IHNv is present throughout Pacific Northwest sockeye stocks. Although highly variable, historical surveillance in three BC watersheds indicate a naturally consistent presence, though large scale outbreaks are rarely witnessed. In wild populations, infected fish are removed through natural mechanisms such as death or predation; in a hatchery, subclinically infected individuals remain in the population for a greater period of time resulting in increased potential for transmission.

Survivors of an IHN outbreak may become carriers and may actively shed virus in reproductive fluids. Alaskan data suggest that, on average, 40% of spawning female sockeye in that region carry IHNv and between 1973 and 1980, more than 22 million juvenile sockeye (~40%) were fatally infected or destroyed as a disease control measure (Saft and Pratt, 1984). Recently, IHN detection in juvenile steelhead at a SEP facility on Vancouver Island resulted in stock destruction and loss of an entire broodyear. In addition to animal losses, the stock destruction and subsequent site quarantine, cleaning, and disinfection, directed by the Canadian Food Inspection Agency (CFIA), represented a significant cost in terms of dollars and hatchery staff effort.

Chinook, chum, Atlantic salmon, and all trout species, are also known to be susceptible to IHNv; ideally, a facility engaging in culture of sockeye would rear only sockeye on that site. Currently sockeye culture in BC is limited to hatcheries with a virus-free water supply, which are able to isolate stocks using strict biosecurity measures, and have a documented IHN outbreak response plan that includes details for stock destruction and carcass disposal. Of the >100 SEP enhancement hatcheries currently operating in BC, only five sockeye production facilities are approved.

10.3 Disease Avoidance

Subclinically infected carriers of IHNv are difficult to detect and no antiviral treatments are approved for use in food fish. Since there is no treatment for IHN, where culture is proposed, hatchery disease control measures must be in place; prevention lies in avoidance through judicious facility selection and a strong biosecurity program. The three cornerstones of biosecurity for a sockeye culture program are a virus free water supply, effective disinfection procedures, and containment through isolation, compartmentalization.

10.4 Control of IHNV

IHN is a Mandatory Reportable Disease in Canada; on disease suspicion and confirmation the CFIA must be notified and a CFIA District Area Veterinarian will be responsible for directing disease control measures. SEP's policy is rapid stock destruction on suspicion of IHN outbreak to limit pathogen exposure risk to other stocks on site and downstream wild fish. CFIA will determine, on a case-by-case basis, necessary quarantine measures and post-destruction cleaning and disinfection procedures required prior to resumption of normal operations.

10.5 Approval Process

The approval process for SEP projects (DFO major facilities and Community Involvement Program supported facilities) may be lengthy and cannot be fast-tracked. All proposed sockeye culture projects must clearly demonstrate the ability to meet a strict series of biosecurity criteria before being considered for approval; these are provided in Appendix 1.

Proposed facilities require inspection by a subcommittee including the SEP Fish Health Veterinarian (SEP FHV) +/- SEP Support Biologist +/- SEP local Community Advisor +/- invited SEP fish culturist with sockeye culture expertise +/- DFO Fish Health Officer.

Culture of sockeye is only carried out where:

1. The proposed site has an adequate pathogen free water supply, sufficient to support all phases of a sockeye culture program

Avoiding waterborne exposure to IHNv is considered the most critical factor in successful sockeye culture.

2. Clear demonstration that biological risks are managed against strict criteria

SEP adheres to a framework for assessing and managing biological risks to wild populations (DFO, 2013). While all species and production are considered in the framework, sockeye culture entails more significant risks than that of other species, and culture operations must meet or exceed biosecurity standards outlined in the Alaskan Sockeye Salmon Culture Manual (McDaniel et al, 1994). Facilities must be able to meet strict biosecurity requirements needed to protect wild and cultured fish populations from risks associated with potential amplification and spread of IHN through culture activities; documentation should be provided clearly demonstrating that these measures are in place prior to commencement.

3. Facilities have a knowledgeable fish culture staff, experienced in sockeye culture

Staff must be prepared to accept personal and professional responsibility for minimizing risk of an IHN outbreak and potential spread. Additionally, staff must be aware of and accept the duty to perform stock destruction in the event of an IHN outbreak.

4. Approval-in-principle is received during the annual Regional Production Planning Process

All lines of SEP production are evaluated annually; external and internal consultation takes place through the Integrated Fisheries Management Plan (IFMP) process, giving due consideration to project objective, habitat, impacts on other fish species/stocks, impacts on other fisheries, available support, etc..

Approval during Production Planning does not constitute assurance that the project will move forward as biosecurity concerns must be adequately addressed. It is the responsibility of the proponent to acquire all other applicable federal and provincial permits and approvals (i.e. Pacific Aquaculture License, Introductions and Transfer permit, Water License, etc.).

Through judicious site selection, the abilities of highly skilled fish culturists, and application of strict biosecurity measures involving disease screening, disinfection, and compartmentalization, those SEP facilities currently engaging in sockeye culture have been successful. Due to the limited number of hatcheries with this capacity, and where culture is considered to address objectives as defined in the Production Planning Framework (DFO 2012), SEP may consider transferring a stock for culture at an approved sockeye culture site in another watershed/zone, with the stock returned to its natal system for release. Stock transplants will require additional approval from the Introductions and Transfers Committee.

References

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Appendix 1: Sockeye Culture New Project Evaluation Criteria

The following scoring system will assist in evaluating proposals for new sockeye culture projects at SEP facilities. These criteria should not be considered comprehensive as other concerns may be identified during planning and inspection stages. This scoring system may also be helpful in identifying facility weaknesses prior to site inspection and should be used to compare and contrast differing options in identifying a preferred location and as guidance for facility improvements. A summary of findings and recommendations will be shared with the proponent.

Ranking Rationale

- Ranked as essential criteria: Reflects criterion that are considered crucial for project success. ***Failure to meet any of these requirements will result in rejection of the proposal.***
- Ranked as critical criteria: Reflects criterion that are considered particularly important for program success. If these important criteria are not adequately met, the project will be considered of higher than average risk and may be rejected.
- Ranked as very important factors: These criteria are considered very important risk factors that will be considered in the evaluation of a project proposal. These may not be unique to sockeye culture operations, but are of high enough importance to general fish culture to be considered as potential risk factors.
- Ranked as important factors: These criteria are considered important, but lower, risk factors that will be considered in the evaluation process. These may not be unique to sockeye culture operations, but are of enough importance to general fish culture to be considered as potential risk factors.

A. Essential Criteria

1. Virus free water supply

The most critical component of a successful sockeye fish culture program is an IHNv free water supply. Sockeye are carriers of IHNv, and the virus can survive for varying periods of time outside the host in surrounding water. Ensuring IHNv cannot be passively introduced into a culture environment is considered an essential criterion.

Pass:
- a) Ground water or untreated surface water has been demonstrated to be fish-free or
- b) Surface water contains fish, but is treated in a manner sufficient to destroy IHN viral particles (i.e. filtration and UV/ozone treatment) with performance monitoring and backup plan in the event of a water treatment system failure

TBD: Surface water source considered fish-free, but requires confirmation

Fail: Source waters contain salmonids; mitigation measures are unavailable/inadequate

2. Production Planning Process

Every SEP enhancement project must be approved in SEP production planning. However, approval may not necessarily translate into project commencement if a hatchery site is deemed unsuitable.

Has the proposed sockeye enhancement been approved-in-principle through the Regional Production Planning process? (*Documentation must be provided*)

3. Facility Readiness by Proposed Start Date

Is the facility currently fully operational? (*Provide details on current operational capacities*)

B. Critical Factors

1. Qualified Fish Culture Staff

Subtle changes in appearance, behaviour, and feeding responses of fish may indicate early stages of an identifiable fish health problem; recognition of such changes is gained through experience. Familiarity with facility infrastructure and operating systems help prevent and/or mitigate mechanical systems failures and subsequent challenges to fish health.

10: Extensive fish culture experience (5+ brood years), plus expertise troubleshooting site-specific hatchery operations; no training or mentoring required
6: Extensive fish culture experience, plus expertise in troubleshooting site-specific hatchery operations; minimal training required
4: Some fish culture experience (3-5 brood years), some familiarity troubleshooting hatchery operations; mentoring and training required
1: Limited fish culturist experience (1-2 brood years), limited hatchery operation troubleshooting expertise; extensive mentoring and training required
0: Minimal or no fish culture experience

Please identify the number of individuals at each experience level above.

2. Sockeye Culture Experience

Successful sockeye enhancement requires adherence to rigid biosecurity and disease prevention protocols including disinfection, isolation, and compartmentalisation. All activities must be performed mindful of the risks of IHN virus introduction and spread; staff must act as a team, committed to health observations and recordkeeping, to ensure early detection of an IHN outbreak.

10: Site/crew with more than 5 years' experience in sockeye culture
6: Site/crew with 3-5 years' experience in sockeye culture
4: Site/crew with 1-2 years' experience in sockeye culture
1: Site/crew inexperienced in sockeye culture, with a sockeye expert dedicated to perform a site visit for training/stock inspection at least once a week over course of the project
0: Site/crew with no sockeye culture experience, no mentoring planned

Please identify the number of individuals at each experience level above.

3. Site-Specific Fish Health Management Plan (FHMP) and Standard Operating Procedures (SOPs)

A comprehensive biosecurity plan is instrumental in managing disease risks associated with sockeye. Documented plans detailing fish capture, transportation, culture activities, and stock compartmentalisation through biosecurity measures are a condition of license. Site and species-specific SOPs and IHN outbreak contingency plans demonstrate preparedness for sockeye culture.

10: Comprehensive, site and species specific FHMP demonstrating extensive knowledge and preparation with respect to fish health management and biosecurity measures to mitigate risk of disease transmission within the facility and off-site.
5: Generic procedures (i.e. BMPs) plus some additional documentation of site specific disease contingency plan
0: No documentation of biosecurity measures or disease contingency planning

4. Co-culture concerns

Hatcheries dedicated to sockeye-only culture are preferred. Chinook, chum, and all trout species are susceptible to IHN and may be carriers. If a stock of conservation concern is located at a site being evaluated for sockeye culture, potential risks to other programs should receive additional critical evaluation.

10: No other species/stocks on site
8: Other fish on site, but only species considered relatively resistant to IHN (coho and pink salmon) will be cultured; adequate physical separation and compartmentalisation through biosecurity measures in place
7: Stock of conservation concern on site. Site is restricted to sockeye and all disinfection, isolation, and compartmentalisation concerns are well addressed
6: Stock of conservation concern (other than sockeye) on site; adequate physical separation and compartmentalisation through biosecurity measures are in place
5: Other, IHN susceptible, fish on site (sockeye, Chinook, chum, trout species); adequate physical separation and compartmentalisation through biosecurity measures in place
2: Other, IHN susceptible, fish on site (sockeye, Chinook, chum, trout species); limited physical separation and/or compartmentalisation
0: Other, IHN susceptible, fish on site (sockeye, Chinook, chum, trout species); physical separation and/or compartmentalisation may or may not be possible

C. Very Important Factors

1. Adult compartmentalisation

From a biosecurity/disease transfer perspective, holding spawning adults at the hatchery poses a greater risk.

5: Adults spawned in field (river/lake of origin). Eggs & milt transported to hatchery in containers that are externally disinfected prior to being brought on site
5: Adults spawned at separate facility, where effluent flows into natal sockeye bearing waters (e.g. Cultus sockeye program). Eggs & milt then transported to hatchery in containers that are externally disinfected prior to being brought on site OR primary incubation performed elsewhere and surface disinfected eyed eggs transferred to secondary incubation and rearing site (e.g. Cultus eyed eggs to Inch Sockeye Satellite)
2: Adults held/spawned at site of incubation - well separated from incubation or any active rearing containers. Effluent water from holding containers either treated or goes to ground.
1: Adults held/spawned at site of incubation - well separated from incubation or any active rearing containers. Effluent water from holding containers goes to ground or is released untreated
0: Adults held/spawned at site of incubation - in close proximity to incubation and/or active rearing containers. Effluent water not treated

2. Effluent Control

IHN-diseased fish shed high concentrations of virus into the water; the virus can remain viable for months in sediment. Older life stages of Pacific salmon species in sockeye watersheds are relatively resistant to IHNv infection, but Chinook and chum salmon alevins and fry are susceptible, as are resident trout populations. Effluent from a sockeye facility should be considered contaminated and should be managed to reduce risk transmission downstream.

5: Effluent is treated in a manner sufficient to destroy suspended IHN virus (i.e. filtration and UV or ozone treatment, or chlorination/dechlorination, etc.) prior to discharge to fish-bearing waters
5: Effluent is discharged to municipal sewage or to ground a suitable distance from fish bearing waters
3: Effluent is discharged to ground
2: Effluent is discharged to a settling pond

0: Effluent is discharged directly to fish bearing waters; treatment is not feasible; downstream disease transmission risk is managed solely by early detection and stock destruction

3. Pathogen Surveillance Records

Adult broodfish may be infected with a number of pathogenic microorganisms. Historical and current pathogen surveillance records provide valuable information to assess suitability of a population for culture and identify disease mitigation possibilities, which could improve project success.

If pathogen surveillance information is lacking, samples from freshly dead wild sockeye carcasses (adult or juvenile) should be submitted to the PBS Fish Pathology Lab to facilitate a disease risk assessment prior to the start of a program.

5: Extensive knowledge – multi-year historical disease profile including recent pathogen screening results
3: Moderate knowledge – limited historical profile including recent pathogen screening results
1: Limited stock disease knowledge
0: No stock disease history knowledge

4. Source and Reliability of Water Supply

Gravity-fed water is safest and most economical and is not affected by mechanical breakdown of equipment such as pumps, controls, etc. Nor is it dependent on additional resources such as electrical supply. However, groundwater is more desirable than surface water due to greater probability of surface water presenting a pathogenic risk.

Select multiple sources if appropriate:

5: Gravity fed groundwater
3: Gravity fed surface water
1: Pumped water

5. Capacity of Water Supply

Sufficient volumes of virus-free water must be available to support all life stages – adult holding, incubation of eggs, rearing of alevins and fry.

5: Ample water supply, well in excess of peak culture demands
3: Sufficient water volume to meet peak culture demands
0: Insufficient or unknown seasonal volume limits

6. Available Rearing Capacity/Containers

Dividing production into smaller expendable units, combined with early disease detection efforts, may limit disease outbreak and stock destruction impacts. Sufficient numbers of appropriately sized containers will also permit low-density rearing.

5: Sufficient/varied containers to allow for maximum replication
3: Sufficient containers to allow for moderate replication
2: Limited containers available, minimal scope for replication
0: Insufficient containers available

7. Water Delivery System / Back-up Power

Dedicated back-ups in these two areas provide added insurance in the event of system failures.

5: Back-up water and power
4: Back-up water or gravity feed with extensive (> 10 yr) problem free history
3: Back-up power to operate pumps
0: No back-up power or water

8. Emergency Warning and Response Program (Standby)

Stress of any kind can contribute to a disease outbreak. Compromises to water quality and availability need to be identified and mitigated as soon as possible to reduce risks to fish health. System alarms for water flow and/or level, plus a rapid response mechanism, are highly desirable for sockeye culture operations.

5: Site fully alarmed for water emergencies, technician response time meets DFO major facility standard of less than 20 minutes
3: Site fully alarmed for water emergencies, technician response time exceeds 20 minutes but is less than 40 minutes
0: Technician response time exceeds 40 minutes, or there is no alarm/response program

9. Site Security (Fenced and Monitored)

Vandalism, predation, and possible pathogen introduction or spread by scavengers/birds, etc., are best mitigated through use of physical barriers and by 24-hour alarm system.

5: Fully fenced, alarmed (gates, buildings), and 24-hour monitoring
3: Meets two of three requirements
1: Meets one of three requirements
0: Meets none of the requirements

10. Facility Age/Reliability

These criteria assume that the newer or more properly maintained a facility is, the less likely a systems or operational failure will occur.

5: Newer/upgraded, tested, facility
3: Older facility in state of good repair
1: Facility in need of moderate upgrade to meet DFO operational standards (including health and safety)
0: Facility requires major upgrades to meet DFO operational standards

D. Important Factors

1. Capacity to rear all life stages at the same site

Performing all culture at the same site reduces handling and transport, limits potential for disease transfer, and reduces likelihood of a stress-associated disease occurrence.

3: On-site adult holding, incubation, and rearing capacities are sufficient
2: On-site adult holding, incubation, and rearing capacities are sufficient, but adult biosecurity may be of concern
1: Spawning and/or early incubation at one site – transfer of eyed eggs to a second site for rearing to fry
0: Both on-site incubation and rearing capacities are insufficient

2. Temperature Control

Temperature manipulation is a valuable tool and applications include the ability to accelerate or delay incubation and rearing to provide maximum operational flexibility and disease avoidance, and allow preferred juvenile size at time of release.

3: Chilling capability for both incubation and rearing
2: Chilling capability for either incubation or rearing, or ambient temperature regime mimics natural emergence timing
1: No capacity for chilling water but ambient temperature regime mimics natural emergence timing
0: No capacity for chilling water

11 Transplanting Pacific Salmon – Guidelines for the Salmonid Enhancement Program (SEP)

11.1 Purpose

This guideline establishes the process and requirements for transplants of Pacific salmon sponsored by SEP staff. Because of potential risks, transplants should only be considered appropriate if other means of meeting SEP objectives (e.g. harvest or habitat measures) are unsuccessful or unfeasible.

11.2 Application and Definition

This guideline applies to salmon transplant projects or activities sponsored by SEP staff. It does not apply to movements of provincially managed species (e.g. steelhead, cutthroat) cultured at SEP facilities or movements of salmon not sponsored by SEP staff.

For the purpose of these guidelines,

- a transplant is defined as the intentional movement of eggs or fish for deliberate release to a non-natal stream, (i.e. not the stream of origin) either immediately or in due course
- the population from which eggs or fish will be removed for transplant is called the "donor" population
- the system to which animals will be transplanted is called the "receiving system"

For clarification, a movement of salmon

- to different areas of the natal stream (e.g. upper river to lower river sites in the same stream) or to immediate local tributaries, **would not** be considered a transplant.
- between major basins, even if defined as within the same major watershed (e.g. Upper Fraser to Lower Fraser, both within the Fraser River watershed) **would** be considered a transplant.
- between Wild Salmon Policy Conservation Units (CUs) **would always** be considered a transplant.

11.3 Transplant Rationale and Risk Considerations

Transplants of salmon from one system to another may be considered in order to address the enhancement objectives defined in the SEP Production Planning Framework (DFO, 2012), specifically:

- **rebuilding** or **conservation**- through re-establishment of an extirpated population or CU
- **harvest** - provide a targeted harvest opportunity
- **stewardship** or **education** - support community projects
- **assessment** – not typically addressed through a transplant but may be considered on a case by case basis

Regardless of the objective, transplanting hatchery salmon can pose risks to wild salmon, including genetic, disease, and ecological effects. Some transplants can also result in changes to harvest patterns that could put wild salmon at risk. The degree of risk is dependent on many elements in both the donor stock and receiving systems, and background information on both is

required to fully assess the project suitability and the risks associated with it. In order to guide the gathering of such information, completion of a standardized proposal template (Appendix 1) is required for each transplant.

11.4 Process and Requirements for Transplant Proposals

Transplant proposals will be developed by the SEP staff sponsoring the transplant, with input from other DFO staff as required. Proposals will then be reviewed as part of the production planning process that SEP staff undertake each year. This process focuses on developing plans for the number of fish of each stock and species that will be produced from each facility, with these numbers taking into account any transplant requirements. These plans consider natural productive processes for each enhanced system as well as harvest management and stock assessment requirements and concerns. Depending on the scope and nature of the proposal, transplant proposals will be subject to various levels of review within this process. Transplant sponsors should understand that the process from project inception to decision can be lengthy and is driven by the timing of the production planning process. For example, releases from a project proposed in late fall of 2015 and considered during 2016 brood production would not occur until the spring of 2017. Figure 1 provides a flow chart of the process, timelines and considerations.

Where facilities rely entirely on transplants for their annual production, proposals for alternate stocks should also be prepared and submitted. These alternate stocks can then be utilized in the event that returns of the primary stock are not sufficient to support a transplant. Programs without approved alternate stocks could be left without any production if the primary stock has a poor return as there is generally insufficient time in-season to find, propose, and have approved, an alternate transplant source.

Transplants that involve movements of fish across transfer zones (Figure 2) established by the Federal-Provincial Introductions and Transfers Committee (ITC) will require application and licencing through the ITC, in addition to the production planning review. These zones were established for fish health management purposes. The ITC application process and forms can be accessed at

http://www.pac.dfo-mpo.gc.ca/aquaculture/licence-permis/intro-trans/index-eng.html

Once the ITC has reviewed and supported licence issuance for a proposal, it becomes part of the routine production planning process and no further application to the ITC is required unless there are significant amendments or the application has lapsed for 5 years. Note that transplants that do not involve movements across an ITC health transplant zone are addressed entirely through the SEP transplant review and production planning process (DFO, 2012).

11.5 Key Considerations for Transplant Proposal Development

11.5.1 Objective

- The objective of the proposed program must be consistent with SEP production planning objectives. The practicality and likelihood of achieving the objective must also be considered.

- If the objective of the transfer is rebuilding through re-establishment, the factors responsible for the depressed condition of the receiving population (e.g., harvest pressure, loss of habitat, presence of a barrier) must be identified. A transplant is unlikely to succeed if the reason for the decline of the native population has not been addressed. Additionally it must be demonstrated that:
    - the native population is virtually or totally extinct for one full cycle, based on a stock status assessment. That is, spawners are gone or too few to rebuild the population by means of fish culture, even if coupled with harvest and habitat measures as appropriate.

- other recovery measures, such as harvest management or habitat restoration, will be implemented in concert with transfers, where appropriate and feasible.

- If the objective of the transfer is a harvest opportunity, it must be demonstrated that the target system is barren of the proposed species. As well, section A.1 of Appendix 1 must be completed for review and approval by DFO Fisheries Management before submitting the proposal to SEP staff. For seapen proposals, utilize the information for proponents and operators in the SEP seapen guidelines (DFO, 2013b).

  - The objective of a transfer that is already underway cannot be changed without submitting a new proposal. For example, a transfer undertaken for stewardship purposes cannot be changed to a harvest objective without re-application

11.5.2 Risk Management

The key risk management considerations for a transplant are:

- Minimize the risk of introduction and spread of pathogens and parasites.
- Prevent undesirable genetic changes in native wild stocks that may be influenced by the transplant
- Minimize negative impacts from ecological interactions within and between species.
- Minimize harvest impacts on wild salmon that may result from the transplant

Risk concerns vary with the nature and objective of the transplant. As far as possible, choose an enhancement strategy (i.e. production numbers, release stage, size and location) that addresses the objectives while minimizing the genetic, ecological, disease, and harvest management risks identified in the Risk Management Framework (DFO, 2013a). For example, where there is flexibility in the choice of species such as for a

stewardship objective, transplants of pink or chum salmon carry a lower ecological risk than other species that have a longer freshwater residency period. Similarly, disease risk can be minimized by moving only eggs previously water hardened in iodophor and surface disinfected prior to transport.

Transplants involving movements between Wild Salmon Policy Conservation Units carry a greater risk of genetic impacts and sockeye transplants carry a greater disease risk. In both instances, there will be additional scrutiny and information requirements.

11.5.3 Sockeye Transplants

Proposals to transplant sockeye salmon will require additional justification because of the disease risk associated with this species. Infectious Haematopoietic Necrosis virus (IHNv) is an endemic pathogen in Pacific Northwest sockeye stocks and a regulated pathogen in Canada such that the Canadian Food Inspection Agency (CFIA) must be notified of any suspected outbreak. Due to the high likelihood and serious consequences of an IHN outbreak in cultured sockeye, SEP sockeye culture has been restricted to a small number of facilities. These facilities have a documented ability to meet the strict biosecurity requirements needed to protect wild and cultured fish populations from risks associated with potential amplification and dissemination of IHN through culture activities, including stock destruction, if required. These concerns limit the potential of sockeye as a transplant species. See "Sockeye Enhancement – New Project Evaluation Guidelines" in this compilation.

11.5.4 Project Duration and Measures of Success

The planned duration of transplants and the specific performance indicators that will be used to indicate project completion must be defined. If objectives are not met during the planned duration then the project should be discontinued or, if indicated by assessment, the strategy adjusted and the proposal re-submitted. Transplant duration for re-establishment projects should generally not exceed two cycles.

- Ongoing transplants may be considered for stewardship/education programs or for targeted fishery programs where risks have been assessed as minimal and are mitigated,

particularly where there is insufficient habitat to develop and maintain a naturalized return. The proposed ongoing nature of the program must be identified during the planning phase.

- Where a transplant has resulted in a naturalized, self-sustaining population returning to the receiving system, transplants should not be continued solely for ease or expediency of broodstock collection. Where transplants have naturalized, the need for continuing or ongoing transplant must be assessed against objectives, performance measures and measures of project completion.

11.5.5 Monitoring and Record Keeping

Data will be recorded and reported using standard SEP formats and submission methods.

11.6 Review Process

Proposals will be assessed by SEP staff using standardized evaluation criteria that consider the nature and likelihood of the risks associated with the transplant.

Related Literature

ICES. 1988. Codes of practice and manual of procedures for consideration of introductions and transfers of marine and freshwater organisms. ICES Co-operative Research Report No. 159. 44 pp.

Anon. 2003. National Code on Introductions and Transfers of Aquatic Organisms. Canadian Federal and Provincial Government Agreement. 60 pages. Available at: http://www.dfo-mpo.gc.ca/aquaculture/ref/NCITAO_e.pdf (2012).

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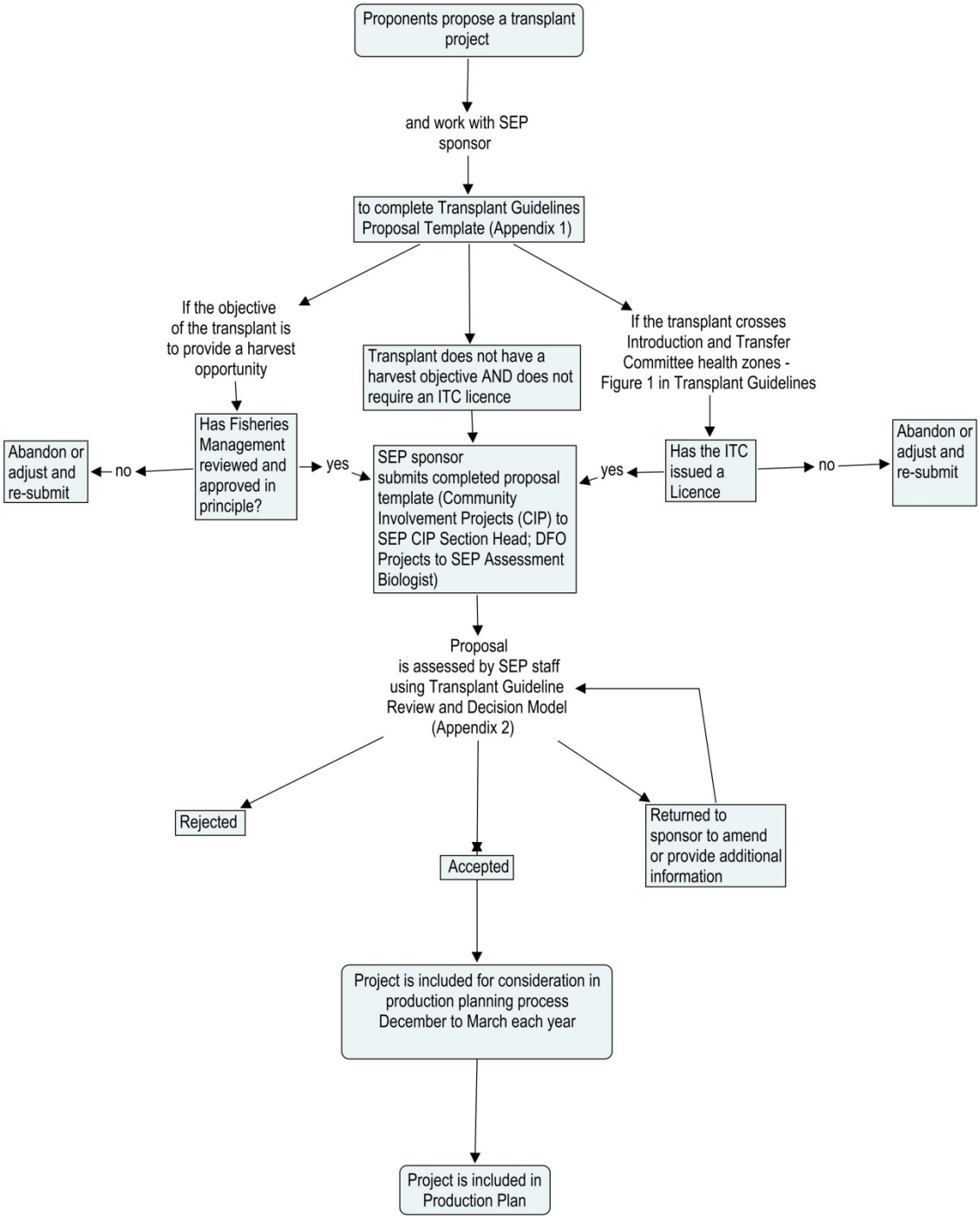
DFO, 2013b. Required elements for short-term Pacific salmon seapen rearing projects,

Guidelines for proponents and operators. Fisheries and Oceans Canada, Pacific Region

Salmonid Enhancement Program 21pp

Figure 1. SEP transplant application process



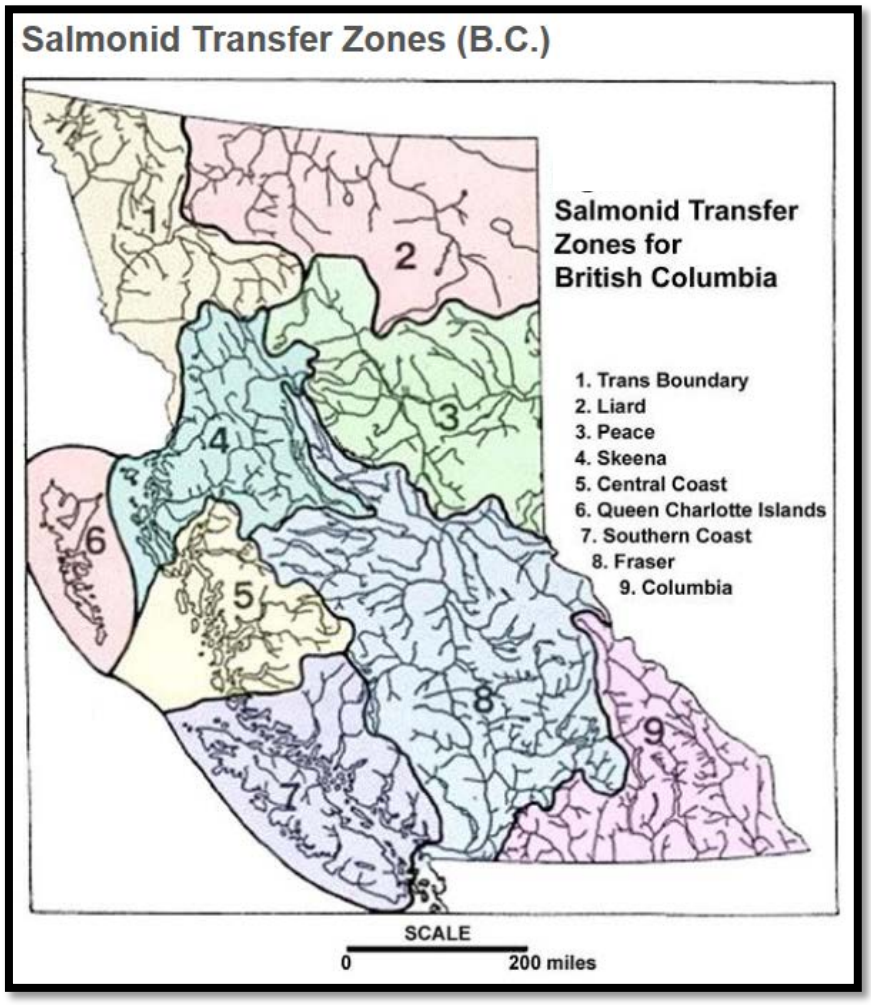


Figure 2. British Columbia Transfer Zone Map. Source:
http://www.pac.dfo-mpo.gc.ca/aquaculture/maps-cartes-eng.html#Salmonid_Transfer

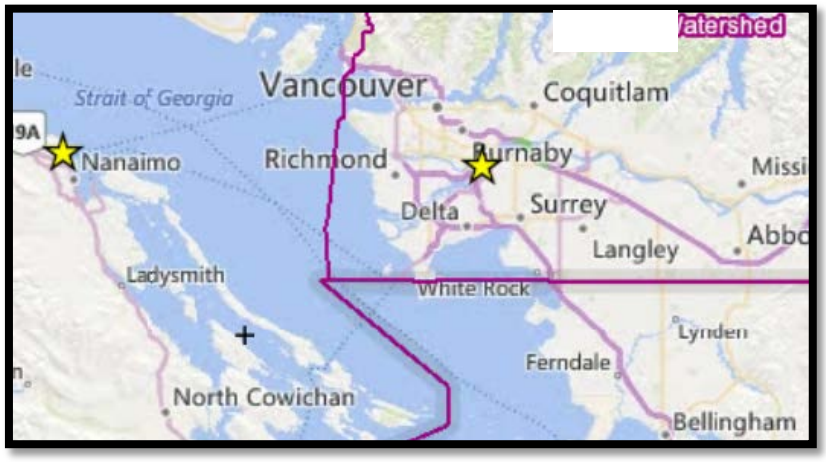


Figure 3. Map inset- Zone 8 Fraser River Watershed, terminal transfer zone boundary. Source: Mapster v3.1 http://pacgis01.dfo-mpo.gc.ca/Mapster30/#/SilverMapster

Appendix 1: SEP Transplant Guidelines Proposal Template - To be completed by SEP sponsor and proponent

This template is designed to help you assemble the information that is necessary to plan your project and have it reviewed and considered in the SEP production planning process. Wherever possible, information is to be supported with references and notations to personal communications with scientific authorities and fisheries experts. Applications lacking detail may be returned to the proponent for additional material. If there are further useful details beyond those requested in this template, please provide them. Submit the completed proposal to your SEP assessment biologist in Regional Headquarters.

A. Project Overview and Objectives

1. Describe the
    - transplant species and run timing objectives (harvest, rebuilding, assessment, conservation, stewardship, education, as described in the SEP Production Planning Framework (DFO,2012)) and rationale for the transplant
        - for a harvest objective describe the intended fishery (size, sector, other potentially impacted species and stock, proposed mitigations as necessary, and fishery monitoring plans, etc.) for review and approval in principle by DFO Fisheries Management staff. This must be obtained before submitting the proposal to the production planning process
    - receiving system, including a map with GPS coordinates of the release site, noting major watercourses, barriers to migration, etc., and adjacent systems that may be subject to straying
    - number and life history stage (e.g. fry, smolt) proposed for transplant (initially and ultimately if a change is proposed during project duration) and the anticipated adult production
    - proposed duration (years) of the transplants. Describe whether the introduced species is intended to survive and reproduce naturally in the proposed area of introduction or is annual stocking proposed.

2. Has the transplant species previously been present in the receiving system? If not, go to Section B. If the species has previously been present in the receiving system:
    - provide data on historical/present stock abundance, including annual escapement or year of last observed presence and juvenile data as available. In order for a transplant to be considered, the transplant species must be extirpated or otherwise absent for one full cycle
    - describe any previous history of enhancement or previous transplants of this species to the receiving system
    - describe the causes for species extirpation/absence in the receiving system. Have the issues been resolved and if so, how?
        - Will applicable alternate recovery measures (habitat, harvest) be implemented at the same time as the transplant?

B. Information on the Transplant Donor Population

1. Identify the proposed transplant donor population and its source (name of facility or other). SEP staff can advise on suitable available populations and will consider:
    - matching life history characteristics of donor and receiving population
    - match habitat characteristics of donor and receiving sites
    - use of geographically closest donor stocks
    - status of donor population
    - Conservation Unit - transplants between CUs are least preferred and will required additional genetic information for the transplant stock and for populations in the receiving CU.
2. Describe the typical timing of upstream and downstream migration for the transplanted population and their congruence with the flow regime and hydrography of receiving system.
3. Describe the disease history of the donor stock (eg. disease profile assessment) and biosecurity measures that will be taken to minimize risks of transfer and transmission of known pathogens and parasites of the transplant stock.

C. Interactions with Native Species

1. List species of fish native to the receiving waters and any adjacent waters that may be subject to straying. Identify any species that are COSEWIC or SARA listed.
2. Is there a potential niche overlap with native species? (see Table 1 for possible interactions)
    - Will the spawning and/or rearing habitat(s) likely occupied by the transplanted population overlap with any of the native species, particularly with respect to critical habitats? If so, describe.
    - Could the transplanted population hybridize with native populations or species? If so, describe.
    - Could there be predation on native species by the transplanted population? If so, describe.

D. Transplant and implementation Plan

1. Describe the implementation plan for the proposed introduction or transplant. This should include but not be limited to the following
    - proposed release strategy (number, release stage, size and location, dates, method), taking into account the objective and ecological, genetic, and disease risks
    - dates of key activities
    - types and sources of equipment and vehicles that will be used in the transplant and release movements

- incubation and rearing facilities that will be utilized and identification of personnel (e.g. DFO or other facility staff, volunteers) who will participate in the transplant
- compliance with legislative requirements (e.g. Aquaculture License, Introductions and Transfers License if required)
- a description of biosecurity measures that will be used throughout project duration

2. Provide the names of the project lead and facility or enhancement society, the Aquaculture License number for the facility and relevant contact information.
3. Provide information on the experience and capacity of the proponent and facility/society (previous transplants, facility operating experience etc.)
4. Provide details of funding sources and contact information

E. Monitoring and Evaluation

1. Describe record keeping and monitoring plans for the transplant. Record keeping should include the completion and annual submission of a SEP standard release form to the SEP Planning and Assessment group. Monitoring should include metric that assess performance relative to objective and, where possible, should be continued for a cycle after the project has been completed. For example
    - for a harvest objective, is a fishery occurring? How many hatchery fish are caught or boats/anglers participate? Have transplanted fish been straying to adjacent systems?
    - for a re-establishment objective, what is the annual escapement? Have transplanted fish been straying to adjacent systems?
2. Describe measures that will be used to indicate that the project is completed and that transplants can be discontinued, if applicable (e.g. a possible indicator for a successful re-establishment project would be a viable spawning population for two cycles).

F. Supporting Information

1. Provide a bibliography of any references cited in the course of the preparation of this proposal
2. Provide a list of names, including addresses, of scientific authorities and fisheries experts consulted and who, where necessary, provided approvals.

Table 1. Summary of interactions involving enhanced juvenile salmonids.

* Adopted from Table 2 in Slaney et al. (1985). ** For Chinook, freshwater interactions are most extensive for "stream-type" juveniles.

		Interactions of Cultured Salmonids with the Following Species						
Cultured Salmonids	**Rearing Stage**	**Coho**	**Chinook**	**Chum**	**Pink**	**Sockeye**	**Sthd**	**Cutthroat**
Pink	Fresh	XXX	-	-	-	-	X	XX
	Estuarine	XXX	?	CC	CC	-	-	?
Chum	Fresh	XXX	-	-	-	-	X	XX
	Estuarine	XXX	-	CC	CC	-	?	-
Sockeye	Fresh	XX	-	-	-	CC	XX	XX
	Estuarine	-	-	-	-	-	-	-
Chinook**	Fresh	C	C	-	-	-	PPCC	PC
	Estuarine	-	-	?	?	-	?	X
Coho	Fresh	CC	C	PPP	PPP	PP	CC	CC
	Estuarine	C	-	PPP	PPP	-	-	-
Steelhead	Fresh	PC	PPCC	PP	PP	PP	CC	CC
	Estuarine	-	?	?	?	-	?	-
Cutthroat	Fresh	PPPCCC	CCPP	PP	PP	PP	CC	CCC
	Estuarine	-	?	-	?	-	-	-

Type and degree of interaction:

A. Documented

	Slight	Moderate	Strong
Predator	P	PP	PPP
Competitor	C	CC	CCC
Prey	X	XX	XXX

B. Undocumented

Likely	?
Unlikely	-