Report on the Coastal Cutthroat Trout Monitoring Workshop

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EXECUTIVE SUMMARY

Agencies that manage coastal cutthroat trout (*Oncorhynchus clarkii clarkii*) (CCT) report a lack of organized information on the status and trends of the subspecies. They acknowledge, however, that considerable amounts of data exist on the subspecies. To address these and other issues, a working group of experts from throughout the distributional range of the subspecies was established in 2005 (Finn et al. 2008). This group, the CCT Interagency Committee, is state and province-led and sponsored by Pacific States Marine Fisheries Commission (PSMFC). In June 2006, this group held the CCT Science Workshop in Portland, Oregon (Griswold 2006). There, attendees identified the goal of gathering and synthesizing information on the geographic distribution and population trends of CCT. In addition, they suggested there was a need to monitor populations of CCT or, at a minimum, gather information on existing monitoring efforts throughout the distributional range of the subspecies. It was also recommended by the attendees of the Science Workshop that the range of life history diversity, the extent of occupied habitat (headwater to marine), and the large distributional range of CCT warrant the exploration of new or modified approaches to monitor CCT populations. In June 2007, in Vancouver, WA, PSMFC sponsored an additional workshop devoted to these issues.

The goal of the Monitoring Workshop was to increase and share knowledge that would identify and improve existing monitoring programs for CCT or establish range-wide guidelines for monitoring CCT. Eighteen participants with expertise in monitoring design, ecology, genetics, and freshwater habitat from 11 state, federal, tribal and provincial agencies representing the distributional range of CCT attended the two-day workshop. Experts presented the elements of a successful monitoring program and gave case studies as examples. Developing a broad statement such as, "what is the occupied habitat within the extent of the geographic range of CCT?" was identified as a starting point for addressing this information need at the range-wide scale. Participants presented information on current monitoring programs for salmonids including incidental monitoring for CCT within their agency or region. Recommendations for improving these existing programs to capture information for CCT were made.

Also, through presentations and discussion, the group developed the following descriptive statement of a healthy stock of CCT:

Healthy populations of CCT express a range of life history traits and migratory behaviors and have connectivity to other local populations that allows the subspecies to successfully respond to environmental changes over long- time periods.

Participants discussed distribution, abundance, and diversity (genetic and life history) of CCT. Increasing our understanding in these areas may improve efforts to evaluate status and trend of CCT as well as broaden our basic understanding of the subspecies. Participants identified life history metrics such as size and age structure, variation in the proportion of repeat spawners, size and age at ocean entry, genetic diversity, spatial diversity, estimates of abundance, and proportion of migrants to fluvial sites or estuaries as examples of important biological characteristics of CCT. They then worked to identify tools or approaches that could be used to measure these important characteristics. Surrogates for directly monitoring CCT populations, such as habitat capacity or quality, were also discussed. Participants stated that developing models that could describe habitat capacity that could aid our understanding of the distribution of CCT was a long-term goal.

Participants identified the need for a long-term strategy for collaboration and data sharing. In addition, they identified collecting information about the anadromous form as a priority.

Under the general topic of monitoring the following recommendations were made:

- Maintain existing monitoring programs
- Improve existing monitoring programs
- Gather information on the current monitoring programs, where are they and what type of information is being collected (location of traps, creel census, acoustic arrays, survey areas, survey dates)
- Examine existing or discontinued monitoring programs to improve existing or future monitoring programs
- Share information on current monitoring programs and available infrastructure
- Develop range-wide data standards (i.e. guidelines) for distribution, abundance, and diversity

Action items under the topics of distribution, abundance, and diversity were identified:

For distribution,

- Gather CCT publications, databases, and grey literature into a single framework
- Develop documented occurrence database for CCT
- Improve existing data gathering efforts such as scientific collection permits (develop geo-referencing and electronic database)
- Identify data gaps using GIS distribution layer or "documented occurrence" as a tool
- Develop or evaluate existing expert decision tools to aid in assessing the status of CCT
- Develop models that predict the distribution of CCT based on habitat features
- Develop models that predict the capacity of CCT habitat
- Identify near shore habitat
- Identify passage barriers

For abundance,

- Gather CCT publications, databases, and grey literature into a single framework
- Gather information on locations where abundance data is being collected
- Review ODFW Index sites resting hole surveys to potentially improve existing monitoring
- Expand creel census and training in appropriate locations to include CCT
- Review and synthesize existing abundance data
- Develop understanding of productivity for different habitat types

- Develop spatially balanced analysis of abundance
- Develop tools for estimating abundance by age class
- Develop tools for estimating abundance above waterfall barriers (Gresswell et al. 2006)
- Utilize mark-recapture studies

For diversity,

- Gather CCT publications, databases, and grey literature into a single framework
- Develop life history model for CCT
- Develop matrices to measure genetic and life history diversity
- Identify locations where diversity data is currently being gathered
- Apply new tools to describe diversity and connectivity between populations
- Develop understanding of CCT metapopulation dynamics

Participants suggested that, as first step, gathering existing information into a single framework was necessary. In 2008, the CCT Database Project was implemented by PSMFC and funded by PSMFC and the Western Native Trout Initiative (WNTI). The goal is to create a data framework where information about the distribution, abundance and diversity of CCT may be housed and shared. Given the magnitude of the project we have focused our initial data gathering efforts on documented occurrence.

We have defined documented occurrence as a "sighting" of CCT, which places trout at a documented location and time through an observation. The associated data fields include information on location that can be used in a GIS framework. Other information such as sample methods, date and time, agency or entity that collected the data, other species present, and other documentation and/or metadata is recorded in the database. In the future, the sightings data compiled will be shared through StreamNet (www.streamnet.org) and the Global Biodiversity Information Facility (www.gbif.org). In the future the CCT Interagency Committee hopes to expand the project to include abundance and diversity, with diversity including genetic and life history diversity. It is our aim that these data provide the necessary information for future status assessments and conservation planning.

The CCT data base project will result in three products:

1) a searchable library housed within the StreamNet Library (www.streamnet.org, www.fishlib.org) with documents scanned and made available for immediate searching and download;
2) a database that initially focuses on documented occurrence; and
3) an interactive data displayer (using GIS) that shows the available CCT data and provides links to those data throughout the geographic range.

INTRODUCTION

Background and overview

Efforts to develop effective conservation strategies and to identify the status of coastal cutthroat trout (*Oncorhynchus clarkii clarkii*) (CCT) remain a challenge. The complex biology of CCT and the perception that they are low priority relative to other salmonids has made it difficult to gain knowledge through research and monitoring. Information regarding the subspecies is often gathered incidental to other species and frequently in an opportunistic manner. This can result in a lack of statistical power to identify trends in populations. In addition, biological criteria or data standards that can be used to determine the status of populations have not been identified for CCT. Finally, the information that is available tends to be housed locally with biologists and researchers, although some documents serve as exceptions (Hall et al. 1997, Johnson et al. 1999, and Connolly et al. 2008).

To help remedy this situation an interagency group, the CCT Interagency Committee, has embarked on a voluntary effort to develop “a consistent framework to help prioritize conservation, management, research, and restoration throughout the native range of coastal cutthroat trout”. The CCT Interagency Committee shares information and develops priority actions for the subspecies (Finn et al. 2008). One of the most important needs identified by this group is addressing the challenges of monitoring CCT. To respond to this need, the CCT Interagency Committee and PSMFC hosted a two-day workshop in June 2007 in Vancouver, Washington. The goal of the workshop was to create a guide for future efforts and identify data gaps and institutional challenges that make monitoring CCT difficult. Participants included representatives from state, provincial, federal, and tribal agencies as well as experts from the private sector. Topics included information on the current state of monitoring programs, scientific needs for monitoring programs and proposed a course of action(s) towards developing guidelines for monitoring at the local and landscape scale. The format of the meeting consisted of presentations and facilitated discussion (Appendix 1). Participants identified the elements of a successful monitoring program for CCT at the local and range-wide scale, and identified potential approaches to face the challenges that were identified during the course of the workshop.

This document was developed to record the activities of the workshop and serve as a guide for future efforts. It is divided into four sections. Section One contains the “Elements of a successful monitoring program” including case studies and a discussion of “What is a healthy coastal cutthroat trout stock?”. Section Two contains an overview of the current monitoring programs within jurisdictions and includes a discussion of the available tools, tools under development, and tools needed to improve monitoring. Section Three presents the discussion of three areas identified as a focus for monitoring— distribution, abundance and diversity, and a discussion of the institutional barriers to monitoring coastal cutthroat trout. Section Four presents future actions and tasks.

SECTION ONE

Elements of a successful monitoring program

Scientifically-based monitoring programs can provide information to managers and biologists who are charged with decision-making. Carefully designed programs can provide information on the status and trend of populations or the spatial extent of the population's distribution with a known precision (Downes et al. 2002). In these scenarios monitoring programs can provide information that supports management actions. Such science-based monitoring programs are designed around a statement or series of statements of interest that address a particular objective (identifying trends in abundance, for example) (Downes et al. 2002). For CCT, assessing status and trend has been identified as an information need. Increasingly, the need for science-based assessments has been identified as a national and regional priority for freshwater fisheries (http://westernnativetrout.org/). Monitoring activities provide the scientific information for these assessments.

During the CCT Monitoring Workshop Dr. Phil Larsen, PSMFC, presented the elements of designing monitoring programs in aquatic systems in the Pacific Northwest (PNW) to detect status and trends. In this document we provide a brief summary of Dr. Larsen's presentation. Dr. Larsen's publications (Larsen et al. 2001, Larsen et al. 2004) and the Aquatic Resource Monitoring website http://www.epa.gov/nheerl/arm/ provide additional background information and further reading. A summary of the critical elements of monitoring that were discussed at the workshop are presented below:

- Objectives are stated precisely
- Target population is explicitly defined
- Sample frame is constructed so that it represents the target population
- Survey design will provide best information to meet objectives
- Selection of sampling sites are determined using survey design
- Consistent measurement protocols are implemented at sample sites (response design)
- Statistical analysis matches survey design
- Interpretation of analysis is relevant to objectives

The most important factor in designing a monitoring program is clearly stating the issue so the monitoring program can address relevant questions. To assist in refining questions, a useful exercise is to mock-up results to illustrate what information summary tables and graphs will contain. Then ask whether the data collected through the proposed monitoring design can be summarized in the desired way. Overall, it is important to evaluate whether a monitoring design addresses the stated questions, is appropriately rigorous, is affordable, includes a measure of uncertainty, is flexible, is representative of the targeted population, and is iterative.

Monitoring programs in the PNW developed by the Aquatic Resource Monitoring program use spatially balanced sample design (see for examples: http://www.epa.gov/nheerl/arm/orpages/or_watersheds_example.htm). These designs result in a probabilistic sampling framework. They are representative of the target population, are highly flexible, and can be stratified depending on the level of rigor that is required. The design is useful in real world settings where access and remote sites may limit sampling opportunities and funding may limit the number of sample sites that can be visited. They differ from random sampling in that they are less likely to create clusters of sites or gaps in site locations. They are more flexible in meeting sampling needs for natural resources than systematic designs are.

Spatially balanced designs are used to address questions regarding the status and trend of biological or habitat indicators in aquatic ecosystems. Status, in the broad sense, is simply the state or condition of a parameter such as abundance and can be described as a snapshot in time, while trend quantifies change over time. Robust estimates of regional status require a large number of sample sites over a broad spatial extent. Detecting trend requires repeated sampling oftentimes over long time periods since natural variation in the environment can obscure the detection of trend (Larsen et al. 2004). In natural populations, site variability and temporal variation must be contended with in any repeated sample designed to detect trend. When it is important to detect status and trend developing a trade off in the number of sites sampled with the number of new sites sampled repeatedly can be developed. A useful example of such a trade-off is the panel design developed for the state of Oregon for monitoring coho salmon (*O. kisutch*) where a broad extent of sample sites have been identified and developed for status and trend detection. Subsets of sites are visited under differing yearly patterns as a balance between estimating status (more sites the better) and trend (revisiting sites each year). The coho salmon plan uses sites that are visited annually, on three year and nine year cycles. New sites are visited each year.

The second important component of a monitoring program that Dr. Larsen discussed is the response design. Monitoring designs in general are composed of two parts. One part addresses the location of sites to be sampled, as described above. Sometimes this is called the site selection design. The second part addresses the response design, the protocol to be used to make the measurements at the site. The response design can also include the analytical procedures that might be used after field collections are made (e.g., laboratory chemical analyses). More detail regarding response design is presented in the case study presented by Dr. David Jepsen below.

Following Dr. Larsen's presentation the group discussed issues surrounding monitoring CCT. CCT is a subspecies with high information needs, and developing clear statements regarding healthy populations remains a challenge. This results in part by a lack of understanding of the spatial extent of population and metapopulation dynamics of CCT. In other words, for CCT, developing an understanding of what constitutes a viable population is still being developed (see McElhany et al. 2000). This issue was not resolved within the span of the workshop, but identified as an information need by the CCT Interagency Committee.

Participants were concerned that monitoring needs and associated statements and sample design may vary depending on jurisdictional or agency needs. Creating a flexible sample design that was spatially balanced was identified as a possible remedy for this concern. In addition, the group was concerned that basic scientific knowledge of the subspecies was limited, such as our understanding of occupied habitat within the geographic distribution. Developing a broad statement such as, "what is the occupied habitat within the extent of CCT's geographic range?" was identified as a starting point for addressing this information need at the range-wide scale.

A discussion of the appropriate objective and target population to describe status and trend in CCT abundance followed. In some locations, the status of the anadromous and other migratory forms of CCT is uncertain and may be in decline. In contrast, resident forms are thought to be abundant. At the regional and local scale the need to develop a monitoring framework to detect population trends in anadromous CCT was identified. Currently, sampling juveniles may not be effective for determining the number of river or estuary migrants and adult returns. If juvenile trout are monitored in absence of adult or smolt monitoring it is difficult to make a statement regarding the overall health of the population. Participants were also concerned that resident numbers may appear robust, however if the anadromous or other migratory form are in decline it was an indication that the population lacked the full expression of life history diversity, an important component of healthy CCT populations. Using tools such PIT tags, intensive mark-recapture studies can provide estimates on the proportion of the CCT that migrate. These studies could provide information on the trends associated with life history diversity. Metrics to help address this challenge were identified on day two of the meeting.

Case Study- Oregon Department of Fish and Wildlife fish and aquatic habitat monitoring

Within the distributional range of CCT several long-term fish and aquatic habitat monitoring programs have been developed. Through the vision of the Oregon Plan for Salmon and Watersheds (http://www.oregon-plan.org/OPSW/about_us.shtml), these ODFW programs include the Aquatic Inventories Project (AQI), the Western Oregon Rearing Project (WORP), the Oregon Adult Salmonid Sampling project (OASIS), and the Salmonid Life Cycle Monitoring Project (LCM). Dr. David Jepsen, ODFW, presented two relevant examples from this program. The first was an example of WORP to monitoring the distribution, status, and trend of juveniles of coho salmon and steelhead trout (*O. mykiss*) using a Generalized Random Tessellation Stratified (GRTS) monitoring design. The second example was from the LCM Project, where the full life cycle of coho and steelhead is monitored at index sites in various locations throughout the Oregon Coast. In both of these projects CCT data are collected incidentally. For both examples, Dr. Jepsen suggested various modifications that could be made to adapt the monitoring to include CCT. He also presented the associated trade-offs with those recommendations. More information on these programs can be found at the web site: http://oregonstate.edu/dept/ODFW/

Originally the spatial extent of the GRTS monitoring design was within the distributional range of the Oregon Coastal Coho ESU and Southern Oregon Northern California Coho ESU, (although in past years the AQI project also monitored habitat attributes and fish presence in stream reaches above anadromous fish barriers). GRTS-based monitoring has been extended to include stream reaches within the Oregon Coastal Steelhead DPS and Klamath Mountain Province steelhead DPS. More recently this monitoring has been extended to include the Lower Columbia River Coho ESU. Dr. Jepsen presented several examples of the GRTS survey and response design (what is measured and how it is measured). Snorkel surveys (juveniles: WORP), and spawning surveys and redd counts (OASIS: adult spawners) are used to monitor coho salmon and steelhead. Within that context he discussed how monitoring CCT incidentally may not present a complete picture of the distribution of the subspecies. For example, the monitoring design for coho salmon includes the upstream extent of spawning and rearing sites, which may in general occur lower in watersheds than spawning and rearing sites for CCT (McPhail 1970). In addition CCT can occur above natural barriers which bar the migration of other anadromous fish (Trotter 1989). These areas would not be included in most of the ODFW monitoring activities for anadromous fish. As a result, the estimate of freshwater habitat that is occupied by CCT may be incomplete under the spatial extent of this monitoring program. Extending the domain to include upstream habitat and habitat above migration barriers would be necessary to develop a more complete spatial description of occupied habitat for CCT. Finally, basins that are outside the domain of the coho salmon ESU's and steelhead DPS's mentioned above would have to be included in monitoring efforts (example: Willamette Valley basins).

An additional example highlights the difficulties in detecting CCT in the WORP snorkel surveys. Juvenile CCT and steelhead trout are difficult to differentiate and individuals less than 90 cm are simply identified as trout by divers conducting snorkel surveys. Therefore enumerating young-of-year CCT (and steelhead for that matter) remains a challenge, although there have been some advances in this area (Hankin et al. 2008). In addition, it cannot be assumed that all small CCT are juveniles (or that large CCT are reproductive adults), due to the diverse life histories demonstrated in this species. If it's desired to monitor the status and distribution of the life history types through directed monitoring programs, new metrics would need to be developed. For example, as previously stated, programs that monitor juveniles without an indication of the portion of anadromous migrants may not be adequate for monitoring the status of sea-run adults. This could have important implications for managing fisheries which focus on adult returning fish or downstream migrants. Several additional issues regarding response design were discussed and are listed below:

- Snorkel surveys tend to underestimate CCT in wadeable streams relative to electrofishing surveys and species identification may be difficult if rainbow or steelhead trout are present.
- Redd identification for CCT is difficult in part because spawning overlaps temporally with steelhead and salmon, where CCT redds can be obscured. CCT redds are small and can be confused with lamprey redds. This precludes the tool as a broad sample survey tool.
- Spawning surveys are difficult, very labor intensive, precluding the tool as a broad sample survey tool
- A monitoring program for CCT would need to be stratified by life history (adult, juvenile)

In addition to the program described above, ODFW operates a number of Index Sites where CCT are present. The location of these sites is opportunistic and based on criteria of land ownership, and existing structures. It is unknown how representative these sites are of Oregon CCT populations. However, trap data from these sites have provided detailed fish body size and fish movement information over several years (Johnson et al. 2005). Based on the current objectives at these sites a number of additional issues regarding the detection of CCT were identified in Dr. Jepsen's presentation and are listed below:

- Can we identify a smolt? How do they differ from other downstream migrants?
- Spacing of trap bars designed for other salmonids let adult CCT pass without enumeration
- Migrant traps are placed relatively high in system complicating the identification of downstream migrants
- Problems with trapping in larger streams include high flow, debris that clog traps, and safety
- There is a need to employ population markers to delineate movement among populations
- Traps need to be coupled with above-trap stream surveys to estimate basin production (i.e. CCT-bearing stream length) to gain understanding of production potential and shortfalls
- No headwater surveys are conducted and production areas are unknown
- Trap efficiency for CCT is lower than other salmonids

Dr. Jepsen summarized his presentation by suggesting that modifying trap spacing could help with the issue of enumerating CCT at Index sites. Similarly, he suggested that extending the timing and extent of snorkel surveys for the Oregon Plan Monitoring program could help capture a more complete picture of CCT sightings.

Following Dr. Jepsen's presentation participants discussed monitoring programs for CCT. There was consensus that the inability to assess status and trend was an issue of concern for CCT management. Without the ability to assess the status of populations or, for that matter, identify populations, agencies are unable to prioritize activities on the ground that could benefit CCT. There are also little available data that can support regulatory actions.

Participants also stated that with limited financial resources developing new monitoring programs that could provide science-based information for assessments was a major hurdle, in more frank terms "not possible". In part, participants stated that this stemmed from a perception that CCT are low priority for agencies. Evaluating the effectiveness of existing monitoring programs is difficult without a working understanding of population targets. The group came to a consensus that if clear scientific needs (research and management) and clear guidelines for biological criteria were identified and prioritized there may be increased opportunities for funding or improving existing monitoring efforts, particularly if the group could identify criteria that could be used throughout the distributional range. In addition, identifying the importance of CCT fisheries or documenting important historic fisheries (Fisheries and Oceans Canada, 1998) could raise awareness of the important niche of CCT sport fishing, and thus increasing the priority of actions targeted for CCT.

An additional issue that was raised is that range-wide data standards may differ from those within individual jurisdictions and those at the local level. To address these complex issues participants suggested that the best approach was to identify metrics that are useful in existing programs at the local level, which could also be useful throughout the distributional range. In addition, they identified the need for a long-term strategy for collaboration and data sharing throughout the distributional range. The Interagency Committee is dedicated to collaboration and data sharing, therefore agency support for participants is critical.

What is a healthy stock of coastal cutthroat trout?

To address some of the issues raised above, participants wanted to identify what generally constitutes a healthy stock of CCT. A brief summary of the issues associated with this topic include the following: 1) where present, some CCT may use a wide range of habitat to complete their life history including small tributaries and mainstem rivers, and estuaries, 2) CCT can be found above waterfall barriers in many locations throughout their distributional range (Northcote 1997, Gresswell et al. 2006, 3) when data are available it suggests above barrier populations are small and potentially subject to the effects of genetic drift (Griswold 1996, Guy et al. 2008); models developed for animals that typically have larger population sizes may not be appropriate, 3) estimating movement among streams, rates of colonization and metapopulation dynamics may take novel approaches since direct tagging will require detection in estuaries as well as fresh water, 4) CCT have been known to migrate throughout the year so to understand seasonal habitat use extensive seasonal sampling may be necessary (Saiget et al. 2007), 5) there is a gap in our understanding of the various mechanisms associated with life history expression of CCT, and 6) the observation of high levels of natural hybridization with RBT (Hawkins and Quinn 1996, Williams et al. 2007)— a phenomenon that defies the traditional view of species boundaries— must be considered in defining a healthy population. A summary of issues presented by Dr. Gordon Reeves follows:

- Life history diversity includes variation within and among populations and appears to vary spatially and temporally.
- Tagged individuals from above barrier populations appear to migrate over barriers at low rates (Gresswell and Hedricks 2007). However, the amount of genetic and meristic similarity between above and below barrier populations varies and appears to depend on local conditions (Griswold 1996).
- Allozyme variation is distributed among populations throughout the geographic range (Williams 2004), at the regional scale populations are structured at the watershed or sub-watershed scale (Campton and Utter 1987, Wenberg and Bentzen 2001)
- High quality habitat may be considered as a surrogate for stock health and may include pool depth and complexity, estuary health, freshwater quality, and connected habitat (Harvey et al. 1999, Rosenfeld and Boss 2001, Latterell et al. 2003)
- The degree of natural hybridization varies throughout the range of CCT and is present in streams affected by human alterations and streams considered "pristine" (Hawkins and Quinn 1996, Williams et al. 2007).
- Hatcheries are increasingly rare in some regions (for example WDFW supports one CCT hatchery and ODFW no longer supports CCT hatcheries) throughout the range but may have historical significance on current populations.

In discussions following Dr. Reeves' presentation the group developed the following statement regarding healthy populations of CCT:

Healthy populations of CCT express a range of life history traits and migratory behaviors and have connectivity to other local populations that allows the subspecies to successfully respond to environmental changes over long- time periods.

The participants had an extensive and far-reaching discussion of this topic. First, the participants acknowledged that there was little understanding of how life history expression of CCT varies over time and space. There was, however, a strong perception among participants that life history varied depending on local conditions (see Trotter 2008 for a review of this topic). It was suggested that gathering and evaluating existing data throughout the distributional range of CCT may help biologists understand these phenomenon. This was identified as a necessary first step for biologists to understand the range of variation of CCT.

Next, participants suggested that identifying a suite of traits that reflect life history diversity and are practical to monitor could potentially increase our knowledge of how life history varies spatially and temporally. Participants identified size structure, age structure, proportion of repeat spawners, genetic diversity, estimates of abundance, and proportion of migrants to fluvial sites or estuaries as examples of such characteristics. These characteristics can address information needs under the headings of distribution, abundance, and diversity, which in turn can help inform managers about the health and target fishery of CCT (Fig. 1).

The participants also wanted to ensure that life history expression was viewed within the context of abiotic and biotic factors as well as the fisheries management context. There was general agreement that productivity of CCT populations and possibly the range of variation in traits and behaviors is a function of habitat as well as the interaction with other ecological factors such as competition, predation, and density. In addition, management activities such as harvest fisheries which may target the larger anadromous or adfluvial fish may result in lost opportunity to express the full range of life history traits such as repeat spawning. An associated loss of increased fecundity associated with size and age could also occur. For example, some anadromous CCT are the target of harvest fisheries as many as four times during their migration to estuaries before their first spawning season (Trotter 2008). In the state of Alaska, harvest restrictions based on size have been developed to protect trout from harvest before their first spawning period (Gresswell and Harding 1997). In Washington, special regulations on the cutthroat harvest are designed to protect outmigrating smolts and allow females to spawn at least once prior to harvest (Anderson 2008). In British Columbia, regulations are in place to protect spawning fish through stream closures, bag limits and gear restrictions (barbless hooks). In the Bella Coola River the elimination of bycatch has resulted in a larger populations of mature fish surviving to the spawning age (Costello 2008). In Oregon, coastal streams increased numbers of smolt were observed following large wood additions, however these results are confounded by a concurrent reduction in harvest fisheries (Johnson et al. 2005)

Participants continued the discussion of healthy stocks within the context of monitoring needs for CCT. Because there is still no clear understanding of the appropriate spatial scale of management for CCT the participants accepted the language of a "monitoring unit" for purposes of the discussion. A monitoring unit could be a watershed or sub-watershed, or alternatively a larger spatial scale. The scale of the monitoring unit could change depending on the information/management needs as well as the geographic locations. Further, participants suggested that the design of a monitoring program for CCT that identified the persistence of life history diversity as part of the response design would be useful and flexible. Such a program could also help address the critical information needs for CCT. Finally, while it was understood that a monitoring program should be designed to detect trends and major changes, given the uncertainty of the range of variation of CCT diversity in space and time the interpretation of data should include the variation of polytypic traits, as opposed to mean values of traits. In addition, participants stated that the variation in life history could be better understood by detecting patterns at the landscape scale.

Participants discussed developing population abundance estimates or trend data that can help provide information on the anadromous adult CCT life history. There was agreement that the anadromous form was potentially vulnerable to multiple stressors including fish passage, loss of habitat, and harvest. Ultimately, the group agreed that a triage approach that focuses on high value populations and life history forms may be necessary given limited funding and pressing management needs.

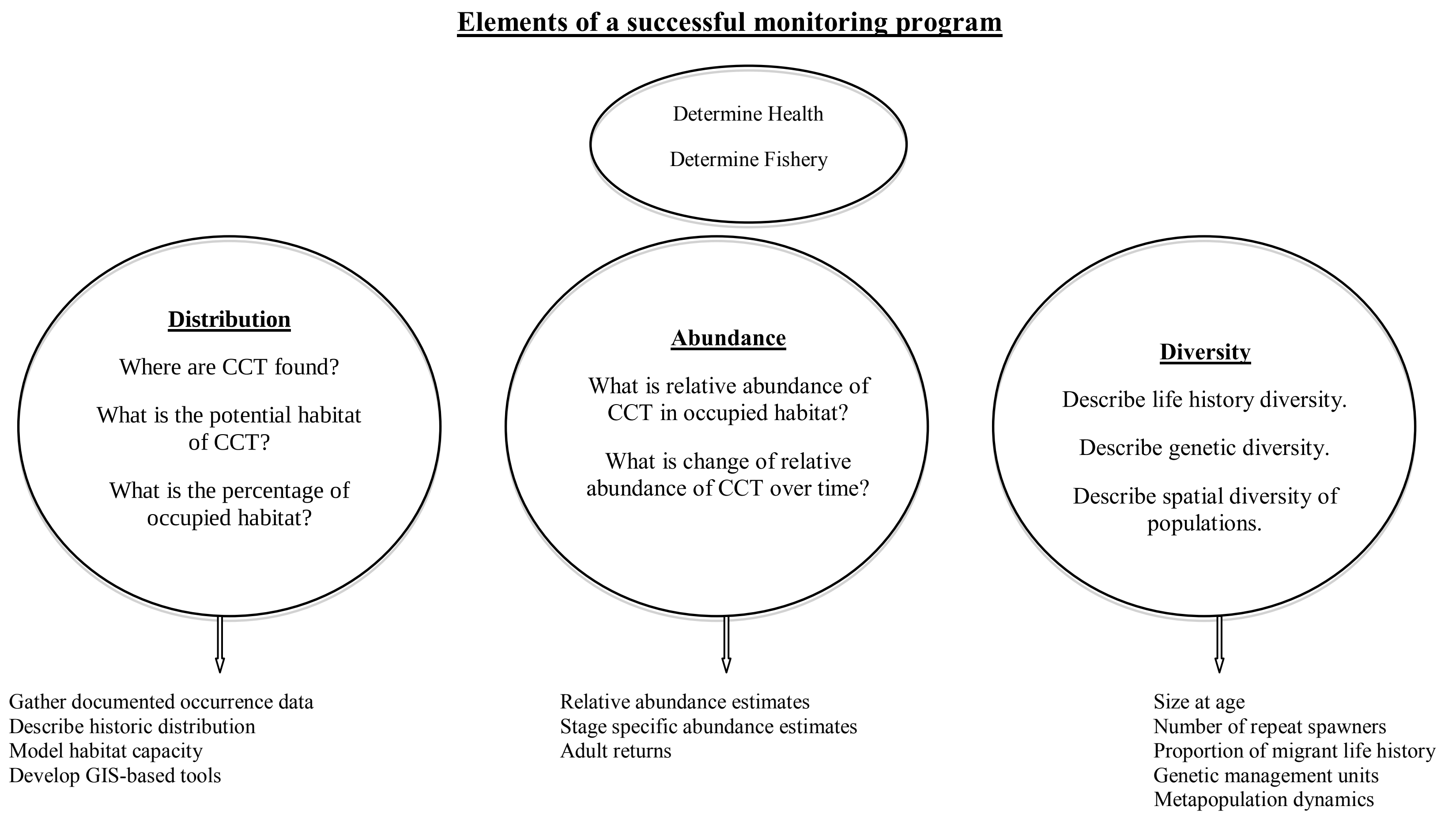


Figure 1. A model of information needs for CCT is presented. Managers are interested in evaluating the general health of CCT populations and to determining fisheries. Distribution, abundance and diversity were identified as important topics to determine the health of CCT populations. For each topic participants stated general questions (within circles) and potential data gathering approaches to address these questions (below arrows).

SECTION TWO

Current monitoring activities in jurisdictions

Participants presented current monitoring activities of CCT collected incidentally or directly. Information presented at the workshop and information gathered subsequently is presented in Appendix 2 (presentations may be found at www). Survey types that were presented include smolt traps, habitat surveys associated with other species, historical surveys, snorkel surveys, trap surveys, hatchery programs, creel surveys, and angler records. Following the presentations the group discussed potential modifications that could broaden existing data collection efforts for CCT with little extra cost. For example creel surveys could be improved by training samplers and including CCT as part of surveys. As previously discussed, trap design and placement is an issue that likely effects the efficiency of detecting CCT. In addition, traps that enumerate upstream and downstream migrants would provide information on timing and duration of movement. Some participants questioned whether current monitoring locations for adults was representative at a broader spatial scale.

Tool Development

Participants discussed tools that have been developed or are in development that can help increase our understanding of CCT or that can be used as tools to monitor CCT. Those with a reference or contact are shown in parentheses. They include:

- Alaska Scale reading manual (Ericksen 1999)
- Online bibliography in Oregon and Washington (http://sain.utk.edu/ptapps/pnwin/cutthroat/index.php)
- Ultrasound technology to detect maturity (State of Alaska, in development)
- Visual identification in non-wadable streams (Hankin et al. 2008)
- Improved identification of CCT/RBT hybrids (Hankin et al. 2008)
- Predictive model for distribution of CCT (Ron Ptolemy, in press)
- Predictive model for abundance of CCT (Ptolemy 2008)
- Habitat intrinsic potential models (K. Burnett CLAMS, USFS Corvallis, OR)
- Improved identification of upstream migration barriers to improve delineation of above barrier populations.
- Microarrays functional genomics (requires lethal sampling)
- Otolith microchemistry to determine life history (requires lethal sampling)
- Microsatellite DNA surveys to delineate population structure
- Refined estimates of abundance
- Expert Decision tool for distribution and provisional status assessment
- GIS-based tool to bring available information into a single geo-referenced database

What are the elements of a successful monitoring program for coastal cutthroat trout?

The participants discussed two major elements of monitoring activities. First, the importance of identifying goals for monitoring was discussed. As previously discussed questions and information needs should be outlined in advance to ensure the best outcome and the most efficient approach. Second, the group discussed tradeoffs between formal programs that use spatially balanced sampling designs such as those presented earlier in the workshop with those that are ad hoc or voluntary. There was a concern that there can be high cost to ad hoc designs that do not address information needs. On the other hand, there is currently little funding directed to monitoring, particularly for CCT. However, a hidden cost in ad hoc designs or no ongoing monitoring is potential risk to populations. Participants created a simple model of the indirect and direct costs to monitoring (Fig. 2)

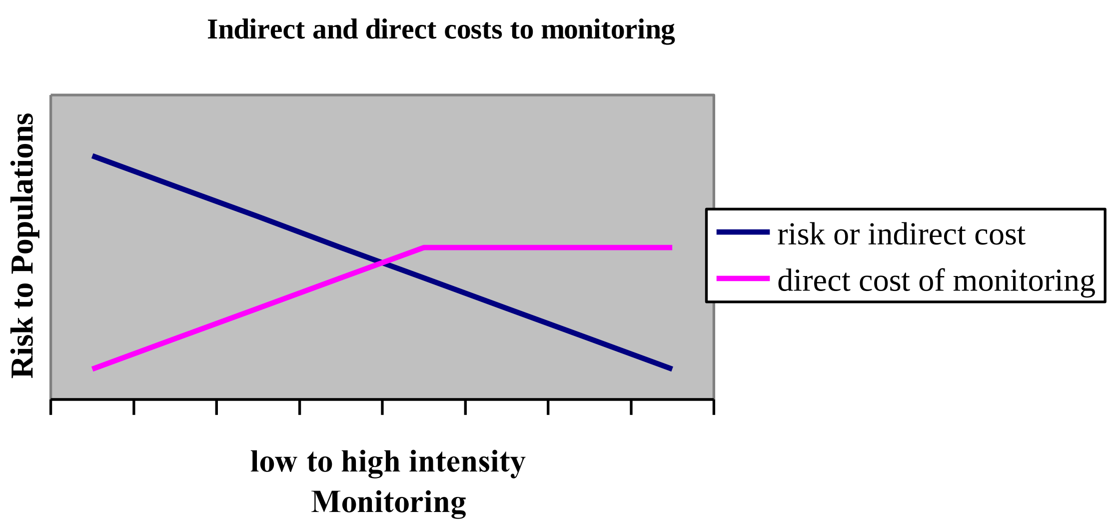


Fig 2. CCT Monitoring Workshop participants develop a simple model of the trade-offs associated with various potential states of monitoring programs. Low intensity programs have little direct cost in the short-term, but in the long term may not reflect the cost of risk and uncertainty to populations. Intermediate or moderate efforts may be costly however they may not reflect adequate information for status and trend assessments. High intensity monitoring using a probabilistic framework may reduce risk of uncertainty and in some case may reflect lower dollar costs to agencies because, in some cases, a smaller number of sites are surveyed.

Dr. Larsen helped the group tackle the first issue— making clear statements about monitoring. He reminded the group that the first step was to describe with precision the statements that needed to be addressed and he provided several examples. What percent of streams contain diverse life history forms of coastal cutthroat trout? Or, what fraction of freshwater streams have habitat that is in good condition? The statements might vary depending on the audience and the management need. There were concerns raised that the level of rigor needed to detect status and trend would be difficult to attain with an incidental monitoring program. The participants discussed the trade-off between a monitoring design that was rigorous enough to establish estimates (albeit provisional) of status and trend. It was stated that without an effort to monitor we would not be able to effectively manage populations and the current information needs for CCT would be unmet. All participants agreed that there were risks to populations in the absence of this information (Fig. 2). The idea of triage was introduced in this context and there was near consensus that some populations of concern such as the Lower Columbia/SW WA DPS should probably receive higher priority for monitoring activities.

Participants discussed using habitat quality as a surrogate for monitoring CCT. While participants were in agreement that high quality habitat was important for the full range of expression they were in general agreement that we do not have enough information to make convincing links between habitat quality and important measures of diversity, abundance and distribution of CCT at this time. Developing models that can capture these parameters as well as document uncertainty associated with those estimates was identified as a future goal. Participants suggested that efforts that document the loss of populations, such as those in British Columbia (Fisheries and Oceans Canada, 1998), provide important information regarding historic populations and the loss of biodiversity.

SECTION THREE

Monitoring Distribution, Abundance, and Diversity of CCT

In advance of the meeting, planners of the Monitoring Workshop had identified the topics of distribution, abundance, and diversity of CCT as the areas of focus for our discussions. These discussions are summarized below.

Distribution

Distribution is most simply defined as where an animal can be found or dominate within. More specifically the group defined distribution in three ways using the framework of EMAP (see Environmental Monitoring and Assessment Program, EPA for more information): 1) spatial extent where CCT could be found i.e. domain, 2) change in population abundance within the domain, and 3) proportion of occupied sites within the domain. Using this approach sampling can be stratified to address questions of documented occurrence at multiple spatial scales. For example, the statements "are CCT present in a reach", "are they present in a watershed", and "are they present in multiple watersheds within a region" can be stratified over multiple spatial scales. With repeated sampling questions regarding the change in distribution over time can be addressed. For example, has the distribution changed within a watershed? In this scenario sampling can be stratified for habitat features such as stream size, watershed site selection, flow gradient, or stream order.

Participants reached consensus that since any monitoring would likely occur at multiple spatial scales (because of jurisdictional boundaries and funding issues) this approach was appealing. However, it was understood that a wide range of sites would need to be sampled initially, including sites where CCT distribution is not known or not previously detected. Basic understanding resulting from this approach is important. It has been assumed that CCT are ubiquitous, but in some areas they appear to have a patchy distribution. For example, in Prince William Sound, CCT and Dolly Varden (*Salvelinus malma*) appear to partition habitat in some locations (Griswold 2003). CCT presence (subsequently, presence has been defined as "documented occurrence" of CCT) and delineating habitat use by life stage (when those data were available) was identified as a starting point to improve our understanding.

There was an extensive discussion about coupling occupancy data throughout stream networks with life stage. This approach could address the concern that occupancy data that simply shows that CCT are present are not useful for management applications or may be misleading in terms of identifying important areas. For example, CCT partition habitat with steelhead/rainbow and spawning and rearing habitat for CCT is often limited to certain locations in the stream network (headwaters). The loss of the CCT rearing habitat in headwater streams in coastal Oregon led to overall declines in biomass (Connolly and Hall 1999). So, identifying important spawning and rearing areas may be important for understanding the effects of land use activities on CCT populations overall. On the other hand identifying important migratory corridors within and among watersheds is important for understanding connectivity between habitats and the potential effects of fragmentation. Thus, identifying the areas of occupancy of older age class migrants is important. Because there is broader need to understand the spatial dynamics of CCT and metapopulation dynamics in order to identify management units data such as these may provide useful baseline information.

In the end, participants agreed that documenting existing information on distribution would be useful and could be used to guide future conservation efforts. Using a GIS platform was suggested. A number of potential applications of this approach were identified:

- Defining historic occupancy
- Documenting current distribution (using existing data and extracting "sightings data")
- Modeling predicted distribution
- Identifying nearshore and estuary distribution
- Identifying above barrier populations

Gathering this information from scientific collection permits, local research programs, and existing monitoring information could be accomplished with agency support. This effort could serve as a starting point for expert decision or modeling efforts. For further development of this topic see Section Four.

Abundance

Abundance is an important component of population health as well as a useful parameter for setting angling regulations. In general, addressing the change in population abundance over time is complicated due to natural variation. Overcoming this is a challenge in any monitoring program and is usually addressed by gathering data over the long-term (10 years +) (Larsen et al. 2004). Participants suggested that if we inventory the existing monitoring programs we can identify the locations of where abundance data is currently collected. In general, sampling juvenile CCT as fry and parr is the least expensive approach and can provide watershed scale population estimates or indices. There are two issues associated with this approach, however. First, differentiating RBT and CCT trout in juvenile stages especially using visual estimates from snorkel counts may not be reliable (Hankin et al. 2008). In addition, abundance estimates of the anadromous or migratory form may not always be extrapolated from these estimates. In addition, as stated above, some participants were concerned if some of the existing sampling sites are representative of a wider spatial scale. Also, interpreting change in abundance given the relatively small population sizes of CCT can be challenging. Finally, abundance estimates in above barrier locations varied spatially and temporally and acquiring these estimates required intensive sampling (Gresswell et al. 2006).

Genetic diversity

Participants agreed that genetic information that can be used to delineate genetic management units and population structure was an information need for CCT. There was general agreement that there is not enough information for a range-wide genetic management plan at this time and that the current CCT Evolutionary Significant Units (ESU's) (Johnson et al. 1999) probably do not reflect the population structure of CCT. Existing information suggests that at the regional scale genetic variation is partitioned at the watershed or sub-watershed scale (Campton and Utter 1987, Wenberg and Bentzen 2001). The results of an allozyme study across the entire distributional range suggest that there is structuring at the watershed scale (Williams 2004). Using microsatellites in Prince William Sound anadromous populations are structured at the local level but there is exchange among populations when nearshore conditions are conducive for migration and population exchange (Griswold 2006). As mentioned previously above barrier populations can be subject to genetic drift (Griswold 1996, Wofford et al. 2005, Guy et al. 2008). Together, the available studies suggest that local populations are important and that watersheds are likely levels of population structure.

In addition, monitoring genetic diversity over time was identified as an important information need. Molecular tools have evolved in the past decade and by applying new tools such as microsatellite DNA we could increase our understanding of CCT populations. Genetic data can help increase our knowledge of basic processes in populations and can help address questions relating to the historic connections among populations or make inferences regarding the ecology of populations, demographics, degree of isolation, and connectivity. Some participants, however, felt gathering new genetic information was expensive and is lower priority than gathering existing information on abundance and distribution.

Participants discussed guidelines for conducting genetic studies that are listed below:

- Cataloging existing samples and development of sample data base
- Coordinate sampling efforts linking genetic studies with other work
- Identify ESU/DPS or management units
- Develop genetics conservation plan
- Increased understanding of natural hybridization between CCT and RBT

Life History Diversity

The participants were in agreement that the diversity of migratory life history (including features such as the number of repeat spawners, proportion of migrants, size and age at first migration) reflects the health of freshwater and estuary habitat (largely reflecting connectivity). There was also agreement that an important conservation goal was to maintain CCT population's ability to adapt to changing conditions, this includes maintaining the anadromous and other migratory life history form and their potential contribution to metapopulation dynamics. There was consensus that there is uncertainty in our understanding of how resident or above barrier forms contribute to below barrier populations. Some participants were skeptical that above barrier trout contributed to anadromous or other migratory forms in a significant manner. The proportion of resident fish that are reproductively successful when they pass downstream over migration barriers is unknown. The influence of density dependence on the resident contribution to migratory forms is also unknown. Finally, the loss of anadromous and other migratory forms may yield more risk to catastrophic events by isolating populations. These issues were considered critical research questions and there was agreement that new technology such as PIT tags, acoustic tagging, DNA technology and otolith microchemistry may be useful to address these questions.

The variation of life history diversity over time and space is an additional unanswered question. Results from an intensive sampling approach led by FWS in Lower Columbia River tributaries using PIT tags and stable year-round antennae systems suggest that the proportion of downstream migrants is stable within watershed systems but varies between systems (Johnson et al. 2008). Similar sampling approaches throughout the distributional range could help describe the range of life history diversity.

Participants identified four important metrics of life history diversity including age class composition, length frequency, size class, migratory patterns, and proportion of repeat spawners. Comparing these variables over multiple populations may increase our understanding of the range of variation of life history diversity. Participants identified several additional important metrics as potential traits to monitor:

- Timing of downstream migrants
- Timing of upstream migrants
- Age at ocean entry

Institutional Barriers

Participants discussed the institutional barriers that create obstacles for monitoring and managing CCT. The primary concern was that there is a perception within agencies that CCT are low priority relative to other salmonid species. However, assessing native freshwater fish is a national and regional priority as well as an important native fish. Identifying actions that will assist in these efforts is part of the overall goal of the CCT Interagency Committee. In the absence of funding for monitoring efforts other approaches were identified. There was consensus that there is tremendous knowledge available from professional biologists that has not been documented. It was suggested that the group consider using an expert decision model that could help capture the expertise of professionals and help guide priorities and develop an initial framework for CCT assessments (May et al. 2005). Participants recognized that furthering our understanding of CCT would likely require models of life history and population viability that differ from salmon. Finally, participants stated that there are costs associated with the high degree of uncertainty regarding CCT. Addressing uncertainty will be necessary in CCT assessments.

Participants discussed the use of information surrogates to monitor CCT distribution, abundance, and diversity. Habitat quality including pool depth and complexity and incidental monitoring of other salmonid species was discussed. As previously stated linking these features to CCT production and persistence was identified as a future goal. Angler records were identified as an additional potential source of information. Volunteer efforts such as these can suffer from issues of follow through, however, they are important in engaging the public. Historic and anecdotal records were also discussed as information sources. Some participants were concerned about the reliability of these sources. There was agreement that using existing guidelines for evaluating historic data for inclusion in status assessments was necessary.

SECTION FOUR

Future actions and tasks

Participants identified a course of future actions. First, they suggested we maintain and improve existing monitoring efforts. Second they suggested that we gather and share information on current monitoring activities including the type of monitoring activity and their location (traps, surveys, creel census etc.). Third, developing a GIS and database project that brings existing data into a single framework was identified as a priority. The first task was identified as documenting the occurrence of CCT, by life stage when those data were available. Anadromous trout were identified as a priority. Additional actions are listed below:

For Distribution,

- Gather CCT publications and grey literature and place in a single framework
- Develop documented occurrence map for CCT
- Improve existing data gathering efforts and scientific collection permits (geo-reference and electronic database)
- Identify data gaps using GIS distribution layer or "sightings" as a tool
- Develop an expert decision tool to aid in assessing the status of CCT
- Develop models that predict the distribution of CCT based on habitat features
- Develop models that predict the capacity of the habitat
- Identify near shore habitat
- Identify passage barriers (man-made, natural, flow-limited or dry channels)

For Abundance,

- Gather CCT publications and grey literature and place in a single framework
- Gather information on locations where abundance data is being collected
- Review ODFW Index sites resting hole surveys to potentially improve existing monitoring
- Expand creel census and training in appropriate locations to include CCT
- Review and synthesize existing abundance data
- Develop understanding of productivity for different habitat types
- Spatially balanced analysis of abundance and focus on CCT-bearing reaches
- Develop tools for estimating abundance by age class
- Develop tools for estimating abundance above waterfall barriers
- Utilize mark-recapture studies

For Diversity,

- Gather CCT publications and grey literature and place in a single framework
- Develop or improve existing life history model for CCT
- Develop tools to measure diversity
- Evaluate where diversity data are currently being gathered

- Apply new tools (microsatellites, acoustic arrays etc.) to describe diversity and connectivity between populations

Gathering and documenting the available information for CCT and creating a common framework for CCT data was identified as a priority action. This framework would be an important resource for planners and managers. In addition, a GIS mapping tool could serve as a tool to help us refine data needs for effective monitoring. Initially it could be used to identify areas where current monitoring activities occur. These data could be used as a framework for identifying regions that would benefit from increased monitoring activities or locations that would benefit from specific types of monitoring (e.g. life history diversity). An initial status assessment could be conducted from the information in the GIS database. In the future, modeling tools that predicted historic habitat or potential habitat could build from this effort. A flow diagram of the utility of the data gathering and development of a GIS database could benefit management and conservation of CCT is presented (Fig 3). In addition the flow diagram outlines how a data gathering effort fits into the broader goals of the CCT Interagency Committee.

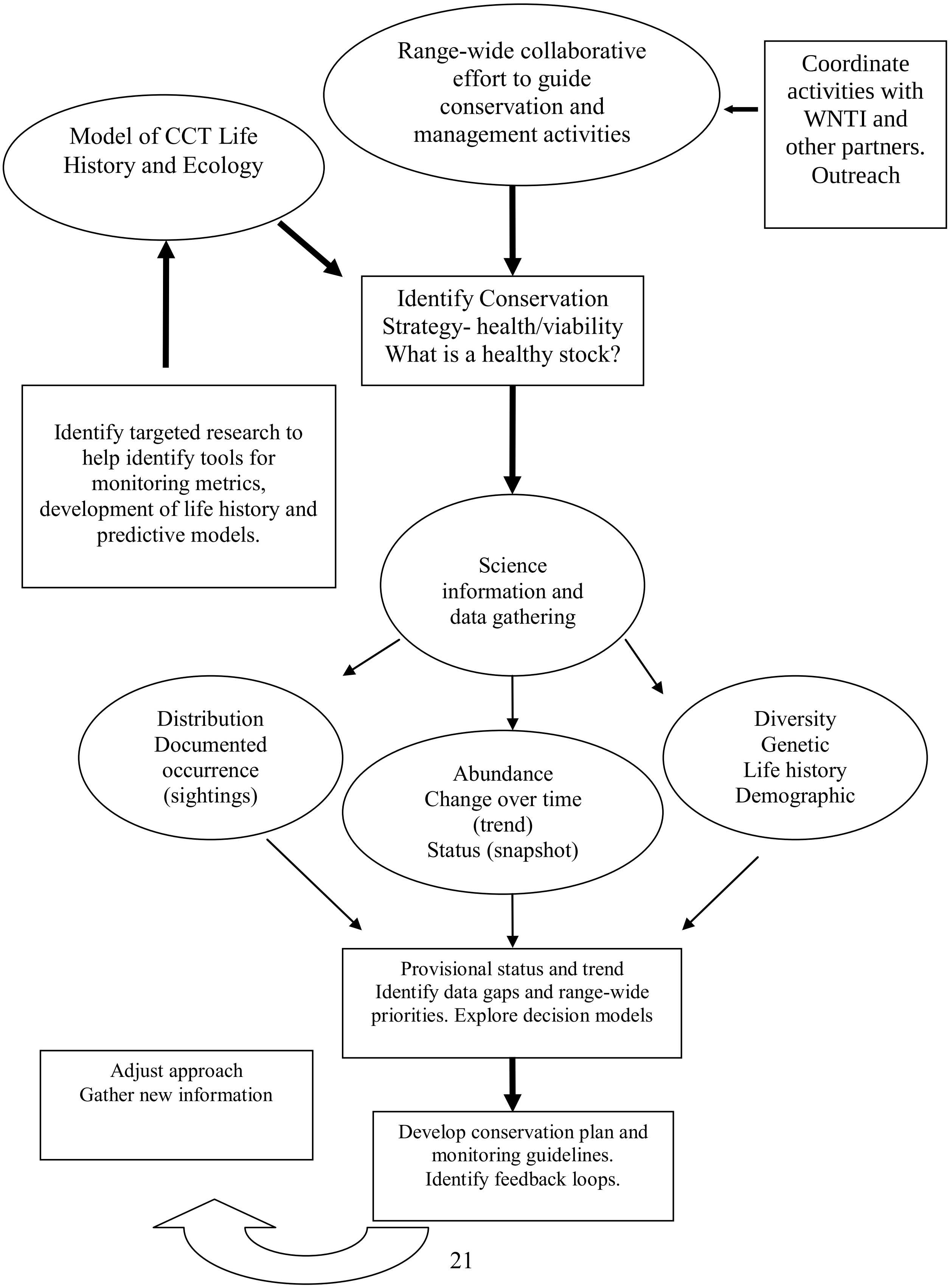
Based on the outcome of the CCT Monitoring Workshop, PSMFC hired a technician and began working with StreamNet (www.streamnet.org) personnel to implement the CCT Database Project in 2008. The goal is to create a data framework where information about the distribution, abundance and diversity of CCT may be housed and shared. Given the magnitude of the project we have focused our initial data gathering efforts on documented occurrence.

We have defined documented occurrence as a "sighting" of CCT, which places trout at a documented location and time through an observation. The associated data fields include information on location, sample methods, date and time, agency or entity that collected the data, and other documentation and/or metadata. The sightings data compiled will be shared through StreamNet and the Global Biodiversity Information Facility (www.gbif.org). In the future, the CCT Interagency Committee hopes to expand the project to include abundance and diversity, with diversity including genetic and life history diversity. It is our aim that the database provides the necessary information for assessments and conservation planning.

The CCT database project will result in three products:

1) a searchable library housed within the StreamNet Library (www.streamnet.org, www.fishlib.org) with documents scanned, and made available for immediate searching and download;
2) a database that initially focuses on documented occurrence; and
3) an interactive web-based map that captures documented occurrence throughout the geographic range of the subspecies.

Figure 3. A diagram depicting the goals and activities of the CCT Executive Committee is presented. The diagram charts the relationship between the science and data gathering efforts of the group. In addition it depicts the scientific elements that the CCT group identified as priority including distribution, abundance and diversity. The chart depicts how the science efforts provide a framework for conservation planning and evaluation of the subspecies. The process is iterative, the curved arrow from the final box is meant to depict a feedback mechanism as information is gathered.


Range-wide collaborative effort to guide conservation and management activities
Coordinate activities with WNTI and other partners. Outreach
Model of CCT Life History and Ecology
Identify Conservation Strategy- health/viability What is a healthy stock?
Identify targeted research to help identify tools for monitoring metrics, development of life history and predictive models.
Science information and data gathering
Distribution Documented occurrence (sightings)
Abundance Change over time (trend) Status (snapshot)
Diversity Genetic Life history Demographic
Provisional status and trend Identify data gaps and range-wide priorities. Explore decision models
Adjust approach Gather new information
Develop conservation plan and monitoring guidelines. Identify feedback loops.

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APPENDIX 1
Coastal Cutthroat Trout Monitoring Workshop
June 5 & 6, 2007
Heathman Lodge – Vancouver, Washington
Background:

Efforts to develop effective conservation strategies, or at a minimum, efforts to identify the status of coastal cutthroat trout remain a challenge for all management agencies. The complex biology of coastal cutthroat trout and low priority relative to other salmonids has made it difficult to gain or access knowledge through research and monitoring.

To address these challenges researchers and managers have embarked on a voluntary effort to develop "a consistent framework to help prioritize conservation, management, research, and restoration throughout the native range of coastal cutthroat trout". The first efforts towards this goal consisted of developing a working group of experts from throughout the distributional range of the subspecies. This group has proposed a series of workshops which are intended to increase knowledge, collaboration, and management efforts for this subspecies. The first workshop, The Coastal Cutthroat Trout Science Workshop, sponsored by Pacific States Marine Fisheries Commission (PSMFC), was held in Portland, Oregon June 6 and 7, 2006. At that meeting, representatives from state, provincial, and federal agencies representing each jurisdiction throughout the range of coastal cutthroat trout prioritized the information needs for coastal cutthroat trout. Addressing the challenges that management agencies face in developing monitoring programs for coastal cutthroat trout was identified as one of the highest priorities.

Responding to this need, PSMFC is sponsoring a two day CCT Monitoring Workshop on June 5 and 6, 2007 that will bring together representatives from state, provincial, federal, and tribal agencies to share information on the current state of monitoring programs, identify needs for monitoring programs and propose a course of action (s) towards developing voluntary monitoring programs at the local and range wide scale.

Purpose: Develop the framework for a voluntary monitoring plan to support the range wide conservation of the distribution, abundance, and diversity of coastal cutthroat trout.

Objectives: Identify consistent monitoring needs, define the institutional and technical challenges, and propose solutions for a consistent framework for CCT monitoring including 1) Distribution (examples include patterns in space and time.), 2) Abundance, and 3) Diversity (including genetics and life history) of coastal cutthroat trout. In addition, the participants will be charged with defining "What is a healthy coastal cutthroat trout stock?"

Format: Presentations by participants, invited experts, facilitated discussion and summaries, identification of subsequent steps.

Pre-meeting preparation: Participants will be asked to prepare information on the previous and current status, design, and scope of monitoring programs for coastal cutthroat trout or surrogate monitoring program from which information regarding coastal cutthroat trout is inferred. This will include monitoring objectives (trend, status, CPUE, etc.), challenges, successes, and needs (funding, expanded scope, institutional support, etc).

Outcome: The outcome of the workshop will be added to the existing framing document for coastal cutthroat trout prepared by PSMFC. Ultimately, it is our goal that the outcome of the workshop will provide the framework for voluntary monitoring efforts for coastal cutthroat trout, which in turn will allow for larger-scale comparison of CCT data across the subspecies' range.

CCT Monitoring Workshop Agenda

Tuesday - June 5 - 8:30 am - 5:00 pm

8:30-8:45 Introductions, housekeeping, issue framing, review agenda (Griswold)

8:45-9:15 Presentation: (Phil Larsen, EPA/PSMFC)
Designing surveys for estimation of status and trends

9:20-9:35 Presentation: (David Jepsen, ODFW)
What are the elements of a successful voluntary Monitoring Program?
Oregon's Life Cycle Project will be presented as a working case study.

9:40-10:00 Presentation: (Gordon Reeves, PNW Research Station)
What is a healthy stock of coastal cutthroat trout?
(Local abundance, population, ESU, metapopulation?) The elements of successful monitoring will change based on the scale at which you want to define a healthy stock; example, to identify metapopulations some movement or interaction across stream networks must be demonstrated. Whereas detecting trends in abundance estimates might suffice at other scales.

10:00-10:30 Facilitated group discussion- Healthy Stock of CCT

10:30-10:45 Break

10:45-12:00 Round robin presentations by agency/jurisdiction

Current monitoring programs: CA, OR, WA, NWIFC, USFWS (Lower Columbia), USGS (Pat Connolly) BC, AK, others?
(5-10 minute each- this is the snapshot of the current state of monitoring for CCT)

12:00-1:00 Lunch on site

1:00-1:30 Group - Update on tool development
Ron Ptolemy B.C. Predictive model for occurrence of CCT
others?
1:30-2:30 Facilitated group discussion

What are the elements of a successful voluntary Monitoring Program for coastal cutthroat trout?
Examples of potential topics:

- Local, regional, rangewide
- Random sample or index sites?
- Adequate information of a proposed sampling frame for random samples
- Sufficient sample size to detect trend with new spatial statistic tools

2:30-2:45 Facilitated group discussion followed by identifying prioritized needs for the following topic:
Monitoring the distribution of coastal cutthroat trout

- Patterns in space and time
- Distribution of life history forms
- Age structure
- Trends (local, rangewide)

2:45- 3:00 Break

3:00-4:00 Facilitated group discussion followed by identifying prioritized needs for the following topic:
Monitoring the distribution (continued) and abundance of coastal cutthroat trout

- Define production standards (smolt yield per unit stream length)
- Rangewide smolt production evaluation
- Density
- Juvenile abundance
- Life history complexity

4:00- 5:00 Wrap-up housekeeping- Adjourn

Time TBA Evening Social

Wednesday - June 6 – 8:30 am – 5:00 pm

8:00-8:15 Housekeeping, review agenda (Griswold)
8:15-9:30 Facilitated group discussion
Use of information surrogates for monitoring CCT- approaches and risks

- Habitat
- Other salmonid species
- Historical data
- Angler records

9:30-9:45 Break

9:45- 10:45 Facilitated Group discussion followed by identifying prioritized needs for the following topic: Monitoring the Diversity of coastal cutthroat trout

- Genetic diversity
- Life history diversity

10:45-12:00 Facilitated group discussion
Institution barriers
(Funding, low priority, sensitivity of data)
Is there a cost of not have information regarding coastal cutthroat trout?

12:00- 1:00 Lunch on site

1:00- 2:00 Identify Future Tasks

2:00-3:00 Wrap-up
Review agenda topics and priorities- identify missing elements
3:00-3:15 Break

3:15-4:30 Future tasks and recommendations

4:45 Adjourn and thanks for participating!

APPENDIX 2. Monitoring information for coastal cutthroat trout (CCT) throughout their distributional range provided by agencies at the Monitoring Workshop, or as followup, updated October 2009. Tables are organized by jurisdiction and agencies including Federal, Tribal, State and Provincial Agencies.

A) Federal Agencies, US

Name	Location	Agency	Survey Type	Date	Description	Target Species	Source/Data contact
Aquatic Riparian Effectiveness Monitoring (AREMP)	CA, OR, WA	Interagency (BLM, USFS) Under the Northwest Forest Plan	GRTS Sampling, EMAP rotating panel	2002-2007	Assess current conditions and track change in 250 watersheds collection includes physical habitat and biota	CCT included among other aquatic species	http://www.reo.gov/monitoring/details.shtml
Geo-referenced Database for CCT in Oregon and WA	OR, WA	USGS: partners include USFWS, WDFW, NBII, NACSE	Literature review, GIS coverage	1997	Geo-referenced Bibliography	CCT	http://sain.utk.edu/ptapps/pnwin/cutthroat/index.php
Status Review of Coastal Cutthroat Trout from Washington, Oregon and California	CA, OR, WA	NOAA	Review of Status new genetic information	1999	Status assessment and new genetic information	CCT	Johnson et al., NOAA Tech. Memo. NMFS-NWFSC-37, 292p
Evaluate Status of CCT in the Columbia River Basin Above Bonneville Dam	OR, WA	USGS	Survey for presence	2002-2005	Document current and historic distribution above Bonneville Dam	CCT	Patrick Connolly: patrick_connolly@usgs.gov

Federal Agencies, US, continued

Name	Location	Agency	Survey Type	Date	Description	Target Species	Source/Data contact
Assess Current and Potential Salmonid Production in Rattlesnake Creek Associated with Restoration Efforts	WA	USGS	Re-colonization following dam removal; tagging	2002-present	Monitoring re-colonization following Condit Dam Removal	CCT Incidental	Patrick Connolly: patrick_connolly@usgs.gov http://wfrc.usgs.gov/research/fish%20populations/STPetersen2.htm
Life History Research, monitoring	Lower Columbia SW WA	USFWS	Life history research, tagging studies	2002-2007	Movement of CCT as part of Biological assessment	CCT	Movements of Coastal cutthroat trout in the Lower Columbia River: Tributary mainstem and estuary use. Final Report March 2008, USFWS Vancouver

B) Tribal Nations in Western, WA

Name	Location (River)	Agency	Survey Type	Date	Description	Target Species	Source/Data contact
NWIFC Projects	Queets/Clearwater	NWIFC	Smolt Trap	1975-2006		Incidental CCT	NWIFC
NWIFC Projects	Quinault	NWIFC	Smolt Trap	1976-1978		Incidental CCT	NWIFC
NWIFC Projects	Quinault	NWIFC	Fry Trap	1976-1978		Incidental CCT	NWIFC
NWIFC Projects	Queets	NWIFC	Night Seining	1982-2006		Incidental CCT	NWIFC
NWIFC Projects	Clearwater	NWIFC	Scoop Trap	1994-2006		Incidental CCT	NWIFC
NWIFC Projects	Queets/Clearwater	NWIFC	Electrofishing	1973-2003		Incidental CCT	NWIFC
NWIFC Projects	Quinault	NWIFC	Electrofishing	1972-1984		Incidental CCT	NWIFC
NWIFC Projects	Raft	NWIFC	Electrofishing	1972-1977		Incidental CCT	NWIFC
NWIFC Projects	Wreck	NWIFC	Electrofishing	1975		Incidental CCT	NWIFC
NWIFC Projects	Humptulips	NWIFC	Electrofishing	1976-1977		Incidental CCT	NWIFC
NWIFC Projects	Mainstem Nooksack	NWIFC	Smolt Traps			Incidental CCT	Lummi Nation
NWIFC Projects	S. Fork Nooksack	NWIFC	Smolt Traps			Incidental CCT	Nooksack Tribe
NWIFC Projects	Lower Stillaguamish	NWIFC	Smolt Traps	2001-200?		Incidental CCT	Stillaguamish Tribe
NWIFC Projects	Skykomish River	NWIFC	Smolt Traps			Incidental CCT	Tulalip Tribe
NWIFC Projects	Snoqualmie	NWIFC	Smolt Traps			Incidental CCT	Tulalip Tribe
NWIFC Projects	Big Spring Creek	NWIFC	Smolt Traps			Incidental CCT	Squamish Tribe
NWIFC Projects	Puyallup	NWIFC	Smolt Traps			Incidental CCT	Puyallup Tribe
NWIFC Projects	Electron Dam diversion	NWIFC	Smolt Traps			Incidental CCT	Puyallup Tribe
NWIFC Projects	Hammersley Inlet	NWIFC	Smolt Traps			Incidental CCT	Squaxin Island Tribe
NWIFC Projects	Vance Creek	NWIFC	Smolt Traps			Incidental CCT	Skokomish Tribe
NWIFC Projects	Tarboo Creek	NWIFC	Smolt Traps			Incidental CCT	Port Gamble S'Klallam
NWIFC Projects	Jimmeycomelately	NWIFC	Smolt Traps			Incidental CCT	Port Gamble S'Klallam
NWIFC Projects	Elwha	NWIFC	Smolt Traps			Incidental CCT	Lower Elwha Klallam
NWIFC Projects	Queets/Clearwater River	NWIFC	Smolt Traps			Incidental CCT	Quinault Indian Nation
SRSC Nearshore Marine Projects	Skagit River	NWIFC,	Seining, Fyke Nets	1997-200?		Incidental CCT	
Puget Sound Marine Migration	Hood Canal, Skagit River, Urban Shorelines, Puget Sound	University of Washington, Squaxin Tribe, NOAA	Acoustic Tagging Marine Migration	2005-	Adult Migration	CCT	Fred Goetz, University of Washington

C) California Department of Fish and Game (CDFG)

Name	Location (River)	Agency	Survey Type	Date	Description	Target Species	Source/Data contact
NA	Eel River	CDFG, watershed groups	Electrofishing, trapping, snorkel surveys	Historic (1940, 1954) current 1990, 1995	Survey data for presence, edge of range,	CCT Incidental anadromous form likely not historically abundant	Snyder 1940, Dewitt 1954, Brown and Moyle 1990*
NA	Humboldt Bay	CDFG, HSU	Electrofishing, movement, PIT tags, weir	Historic accounts, recent survey data	Tributary surveys for abundance	CCT Incidental Anadromous no longer present	*
NA	Mad River	CDFG, Green Diamond	Electrofishing, angler surveys	Historic data (1954), recent survey data 1994		CCT Incidental Anadromous no longer present	*
NA	Little River	CDFG, Green Diamond, Cal Trout	Traps, angler surveys		Downstream migrant traps	CCT Incidental	*
NA	Redwood Creek and tributaries	NPS, USFS	Snorkel surveys	1981-1993	Population data, movement data	CCT Incidental	Dave Anderson, NPS
NA	Klamath River	USFS, CDFG, USFWS, Yurok nation	Snorkel surveys, migrant traps, beach seining	Multiple years since 1980	Lower tributaries, Estuary	CCT Incidental	*
NA	Smith River	USFS, Smith River Alliance,	Electrofishing snorkel surveys, trap data, angler surveys	Multiple years since 1989		CCT	*
NA	Lagoon Tributaries	CDFG, HSU	Angler survey, traps	Multiple years		CCT	*
NA	Coastal streams	NMFS/NOAA			Monitoring data	CCT	*

* compiled from: Gerstung 1997 Status of CCT in California, in J.D. Hall, P.A. Bisson, and R.E. Gresswell, editors, Sea-run cutthroat trout: biology, management and future conservation. Oregon Chapter AFS, Corvallis.

D) Oregon Department of Fish and Wildlife (ODFW)

Name	Location	Agency	Survey Type	Date	Description	Target Species	Source/Data contact
Aquatic Inventories Project (AQI)	Coastal Oregon streams and estuaries, Lower Columbia Basin	ODFW	GRTS Sampling, EMAP rotating panel	1990-present	Habitat and biotic assessments under the Oregon Plan	CCT Incidental	http://oregonstate.edu/dept/ODFW/freshwater/inventory/index.htmOregon
Western Oregon Rearing Project (WORP)	Coastal Oregon streams and estuaries, Lower Columbia Basin	ODFW	GRTS Sampling EMAP rotating panel	1999-present	Monitoring Trends and abundance juveniles as part of AQI and Oregon Plan	CCT Incidental	http://nrimp.dfw.state.or.us/crl/default.aspx?pn=WORP
Oregon Adult Salmonid Sampling project (OASIS)	Coastal Oregon streams and estuaries, Lower Columbia Basin	ODFW	GRTS Sampling EMAP rotating panel	1999-present	Enumerate adult spawning salmon as part of AQI and Oregon Plan	CCT Incidental	http://oregonstate.edu/dept/ODFW/spawn/index.htm
Salmonid Life Cycle Monitoring Project (LCM)	Coastal Oregon streams	ODFW	GRTS Sampling EMAP rotating panel	1998-present	Smolt trapping	CCT Incidental	http://nrimp.dfw.state.or.us/crl/default.aspx?pn=SLCMP

E) Washington Department of Fish and Wildlife (WDFW)

Name	Location (River)	Agency	Survey Type	Date	Description	Target Species	Source/Data contact
Washington State Salmonid Stock Inventory	Multiple locations in WA (28 CCT basins)	WDFW	Genetic information and data gathering	2000	Stock status inventory and identification of 40 stock complexes	CCT	www.wa.gov/wdfw
Cowlitz River Trout hatchery	Cowlitz River	WDFW, Tacoma Power	Downstream trap and transport monitoring hatchery	1968 - present	Integrated type hatchery program (inclusion of wild fish for broodstock) Smolt enumeration and transport	CCT	http://wdfw.wa.gov/hat/hgmp/
CCT in Washington State: status and management	WA	WDFW	Literature Review, summary of trend data	2008	Review of WDFW status and management	CCT	Anderson, J. in, Connolly et al. 2008. The 2005 CCT Symposium: status management, biology, and conservation.
WDFW Lower Columbia Anadromous CCT data	WA (numerous locations in the Lower Columbia River)	WDFW	Catch surveys, traps, weirs, fyke nets)	Range of dates 1980 - present	Adult and smolt data	CCT Incidental	Dan Rawding, WDFW Compiled for USFWS public comment
WDFW SW WA	WA (Willapa Bay, Grays Harbor, Hoquiam)	WDFW	Density data for juveniles, trap data, catch data	Range of dates 1970's to present.	Resident and anadromous CCT data	CCT Incidental	Jay Hunter, WDFW Compiled for USFWS public comment
Populations indices for CCT (Draft)	WA (multiple locations)	WDFW	Trap data gathered by USFWS for proposed listing	Compiled in 2002	Adult Migration data	CCT Incidental	Compiled by Scott Craig USFWS Lacey, WA

Washington Department of Fish and Wildlife (WDFW), continued

Name	Location (River)	Agency	Survey Type	Date	Description	Target Species	Source/Data contact
Intensively Monitored Watersheds	Multiple locations Hood Canal, Lower Columbia, Skagit, Green Rivers Cedar Creek	WDFW	Screw traps, scoop traps	Multiple summary reports	CCT smolt data, juvenile trout data, abundance estimates and trap efficiencies	CCT Incidental	http://wdfw.wa.gov/hab/imw/

F) Alaska Department of Fish and Game (ADFG)

Name	Location (River)	Agency	Survey Type	Date	Description	Target Species	Source/Data contact
Lake Abundance Data	Auk Lake, Baranof Lake, Buck Lake, Florence Lake, Lake Eva, Lower Wolf Lake, McKinney Lake, Neck Lake, Sitkoh Lake, Turner Lake, Virginal Lake, Wilson Lake, Windfall Lake	ADFG	Emigrant trap data	Ranges from 1980-2002	Resident and sea-run abundance data	CCT and Dolly Varden	ADFG http://www.sf.adfg.state.ak.us/statewide/
Harvest and Catch Survey	Statewide	ADFG	Mail survey Statewide harvest survey and recreational cabin survey	1990- present	Survey to estimate harvest and catch in sport fishery	CCT	Bangs and Harding, in, Connolly et al. The 2005 CCT Symposium: status management, biology, and conservation.
The status of management of coastal cutthroat trout in Alaska	Statewide	ADFG	Literature Review	2008	Review of status and management	CCT	Bangs and Harding, in, Connolly et al. The 2005 CCT Symposium: status management, biology, and conservation.
Anadromous Waters Catalog	Statewide	ADFG	GIS-based map documentation	Initiated in 1982, yearly updates	Documented location	CCT Incidental	http://www.sf.adfg.state.ak.us/SARR/AWC/

G) British Columbia

Name	Location (River)	Agency	Survey Type	Date	Description	Target Species	Source/Data contact
NA	Oyster		Snorkel survey		Adult Surveys	CCT Incidental	R. Ptolemy, Ministry of the Environment, BC, Canada
NA	Bella Coola	DFO	Long term monitoring		Fry and parr monitoring, Aerial surveys	CCT Incidental	R. Ptolemy, Ministry of the Environment, BC, Canada
NA	Little Qualicum				Adult Surveys	CCT Incidental	R. Ptolemy, Ministry of the Environment, BC, Canada
NA	Upper Campbell lakes						R. Ptolemy, Ministry of the Environment, BC, Canada
NA	French, Trent, Black, Colquitz, Salmon, Little Campbell	DFO	Counting fence		Adult Surveys		R. Ptolemy, Ministry of the Environment, BC, Canada
NA	Angler Log Books	Public					R. Ptolemy, Ministry of the Environment, BC, Canada
NA	Telemetry/tagging						R. Ptolemy, Ministry of the Environment, BC, Canada
NA	Creel Surveys/Sportfish survey/public feedback			Five year intervals	Described as sporadic		R. Ptolemy, Ministry of the Environment, BC, Canada
Eco Cat Ecological reports Catalogue	Province wide	Ministry of the Environment	NA	NA	Reports, collection permits, papers; fisheries inventory	CCT and other salmonids	http://www.env.gov.bc.ca/ecocat/
Fish Wizard	Province wide	Freshwater Fisheries BC, Ministry of Sustainable Resource Management	NA	NA	Mapping tool	Native Fishes	http://www.fishwizard.com/
Fisheries Inventory	Province wide	Ministry of the Environment	NA	Multiple years		Native Fishes	http://www.env.gov.bc.ca/fish/
Fisheries Inventory data queries	Province wide	Ministry of the Environment	NA	Multiple years	Fisheries data warehouse Query by watershed code	Native Fishes	http://www.for.gov.bc.ca/hfd/library/lib_ffib.htm