Chief Joseph Hatchery Program
Broodstock Testing Collection Plan

Prepared
for

Colville Tribes

Submitted
by

Mobrand Biometrics, Inc.
Vashon Island, Washington

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SECTION 1: STUDY OBJECTIVES

The goal of this study is to develop a research plan to test live-capture gear for summer/fall Chinook salmon broodstock collection in the Okanogan, Similkameen, and Columbia rivers.

The summer/fall Chinook salmon broodstock for the current Eastbank Hatchery program are descendants from stock manipulations carried out during the Grand Coulee Fish Maintenance Program and mitigation for mainstem Columbia River dams, resulting in a homogenized population (Talayco 2002). Moreover, propagation probably incorporated fall-run fish into the summer Chinook salmon population. The upper Columbia River summer/fall Chinook salmon ESU includes the Methow, Wenatchee, Columbia, and Okanogan basins. The Colville Tribes would like to produce a summer/fall Chinook salmon population locally adapted to the Okanogan River, which will ultimately be self-sustaining and harvestable.

SECTION 2: STUDY AREA

The study area includes mainstem reaches of the Columbia River between the Okanogan River confluence and Chief Joseph Dam (RM 533, Rkm 858), the Okanogan River below Osoyoos Lake (RM 77.4, Rkm 125), and the Similkameen River below Enloe Dam (RM 6.6, Rkm 10.6).

SECTION 3: METHODS

In this section of the report we describe the methods used to develop the broodstock collection study plan.

3.1 Literature Review

A literature review was conducted to compile data on potential techniques for selective live capture of fish and on physical conditions of the Okanogan basin. In addition, studies and documents were reviewed to provide background information for describing the study area and for determining stream temperature and flows, run-timing for summer/fall Chinook salmon and other species, and the presence of species protected under the Endangered Species Act (ESA) that may be impacted by the broodstock collection program.

3.1.1 Stream Temperature and Flow Data

The Colville Tribes have an extensive amount of temperature data at various locations in the Okanogan River and several of its tributaries. Temperature data for the Similkameen River and the Okanogan River at Malott, WA (~RM 17, Rkm 27) and at Oroville, WA (~RM 78, Rkm 125) were obtained for consideration in determining suitable times when broodstock could be collected and handled with minimal stress. In addition, the Columbia River DART system, operated by the University of Washington, was queried for data on Columbia River stream temperatures above Wells Dam.

Stream flow data for the Okanogan and Similkameen rivers were obtained from USGS gaging stations in these basins.

3.1.2 Summer/Fall Chinook Salmon Run Timing and Abundance

Washington Department of Fish and Wildlife (WDFW) was consulted on summer/fall Chinook salmon abundance, run timing, and locations of spawning aggregations within the Okanogan basin.

3.1.3 Permits

An inquiry was conducted to determine the presence of any ESA-listed fish potentially occurring within the study area. In addition to the potential need for a Section 10 permit for the unintentional take of ESA-listed fish, WDFW and Colville Tribes were contacted to determine if any state or tribal permits would also be required for broodstock collection.

3.2 Site Review and Selection

An initial site visit was conducted March 10 to March 12, 2004. The Columbia River and Okanogan River below Monse Bridge (~RM 5, Rkm 8) were surveyed via jet boat. Several sites along the remainder of the Okanogan River, Omak Creek, and the

Similkameen River were surveyed by vehicle and on foot. In addition to potential fishing areas, Bonaparte, Ellisforde, and Similkameen Pond acclimation facilities were visited. The purpose of these site visits was to identify suitable sites for fishing the different types of live-capture gear identified in the literature review. Also, physical conditions at each site were visually inspected to determine substrate type, presence of large woody debris, and access. Photographs of possible fishing sites were taken to document findings.

SECTION 4: RESULTS

4.1 Literature Review

The results of the literature review are presented below. As this review relied heavily on Internet searches of federal, state, tribal, and Canadian web sites, the web addresses for the majority of the documents reviewed are included in the References section of this report. In this section we describe the basin, identify summer/fall Chinook salmon geographic and temporal spawning distributions, describe ESA species in the area, and, most importantly, describe the different types of live-capture gear that may be used to collect anadromous salmonids on the west coast of the U.S. and Canada.

4.1.1 Okanogan Basin Description

The Okanogan River is the uppermost Columbia River tributary currently accessible to anadromous fish. It originates in British Columbia and flows south to its confluence with the Columbia River at RM 533.5 (Rkm 858). Within the U.S., the Okanogan River flows for approximately 79 miles with elevations ranging from 920 feet at the Canadian border to 780 feet at Lake Pateros (Talayco 2002). The overall stream gradient for this portion of the Okanogan River is 0.04 percent. River substrate is typically silt, sand, gravel, and cobble, which were deposited in the valley during the last period of large-scale glaciation. Conversations with local biologists revealed that the stream channel is relatively free of obstructions, snags and large woody debris—this was confirmed during the field visit.

The Okanogan River is a shallow, low gradient, relatively homogenous system. Its steep valley walls and loose soil, composed of volcanic ash and glacial deposits, contribute to high sediment delivery.

Hot dry summers and cold snowy winters characterize the Okanogan River basin. Average precipitation in the main river valley is 12 inches, the majority of which falls as snow (Talayco 2002). The Okanogan basin is a typical snowmelt system in which high flows coincide with spring rains and melting snow pack (Fig. 1), peaking between late May and early June. Minimum flows occur in early fall to mid-winter. The Similkameen River comprises 75 percent of the total Okanogan River flow (Talayco 2002) (Figs. 1 and 2). Isolated summer thunderstorms, occurring approximately once every two years, can cause flash flooding within a sub-watershed.

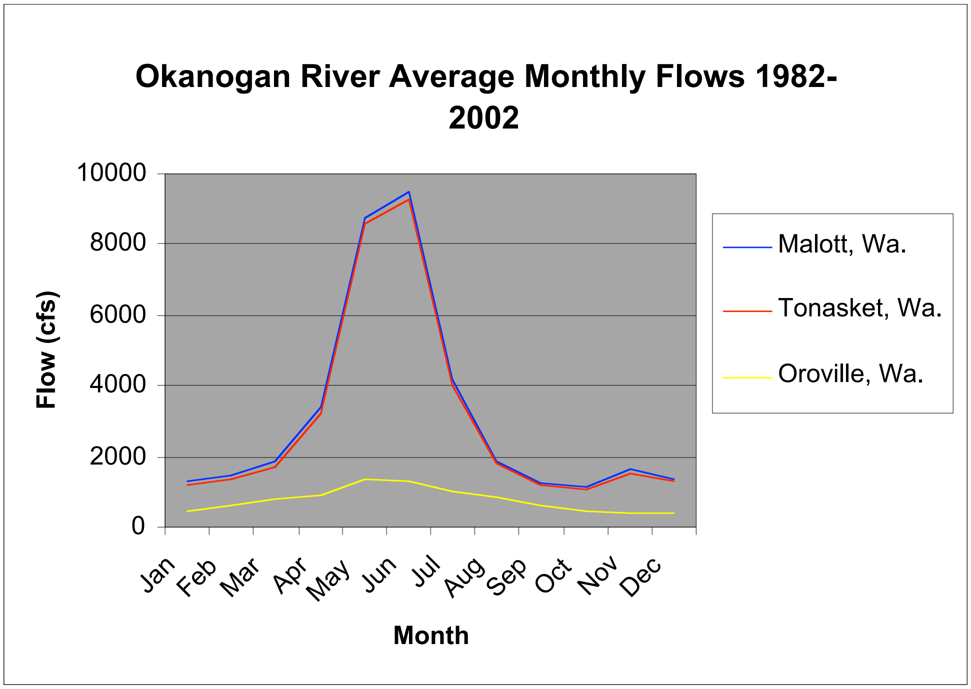

Figure 1. Okanogan River average monthly flows measured at USGS gaging stations 1982-2002 at Malott, Tonasket and Oroville, WA.

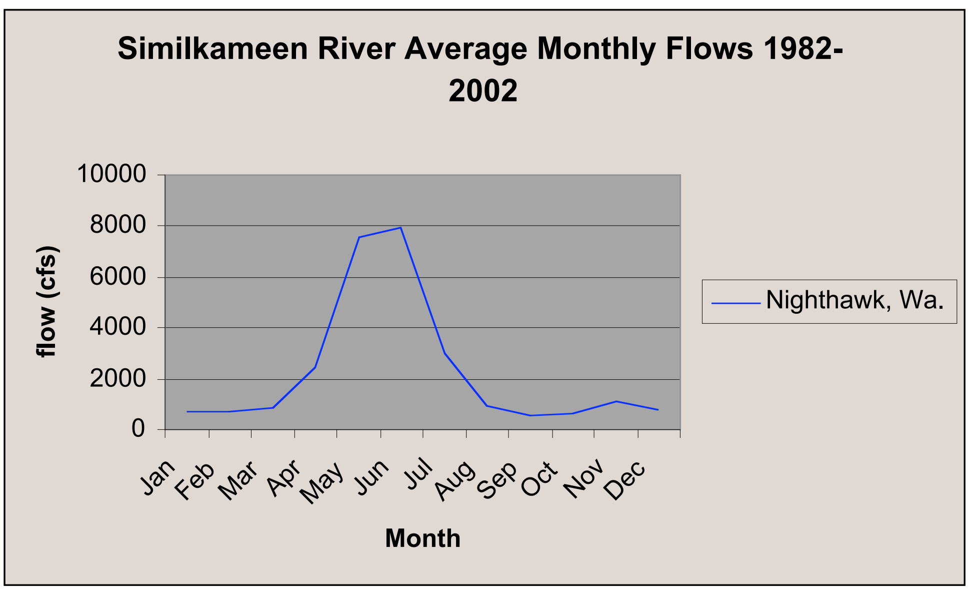

Figure 2. Similkameen River average monthly flows measured at USGS gaging station 1982-2002 at Nighthawk, WA.

The Okanogan River is 303(d) listed for failure to meet water quality standards for temperature, pH, and fecal coliform (Talayco 2002). Temperature and flow have been identified as the most significant problems for salmon recovery in the Okanogan watershed.

Okanogan River temperatures regularly exceed lethal tolerance levels for salmonids in mid-to-late summer. Temperatures in the Okanogan River ranged from 32 °F to 85 °F between 1998 and 2001 (Colville Tribes, unpublished data). Due to the extensive series of lakes in the Canadian portion of the basin, the Okanogan River is warmer near Oroville, WA, than it is at Malott, WA (Figs. 3 and 4). High water temperatures in late summer and fall often form a thermal barrier, blocking adults from migrating to spawning grounds. The thermal barrier has also excluded juvenile salmon from rearing in most of the Okanogan basin, except during the first few weeks after emergence (Talayco 2002). When temperatures reach critical levels, dissolved oxygen concentrations in the Okanogan River are generally at or above saturation levels. The lowest saturation values have been detected at Malott, WA.

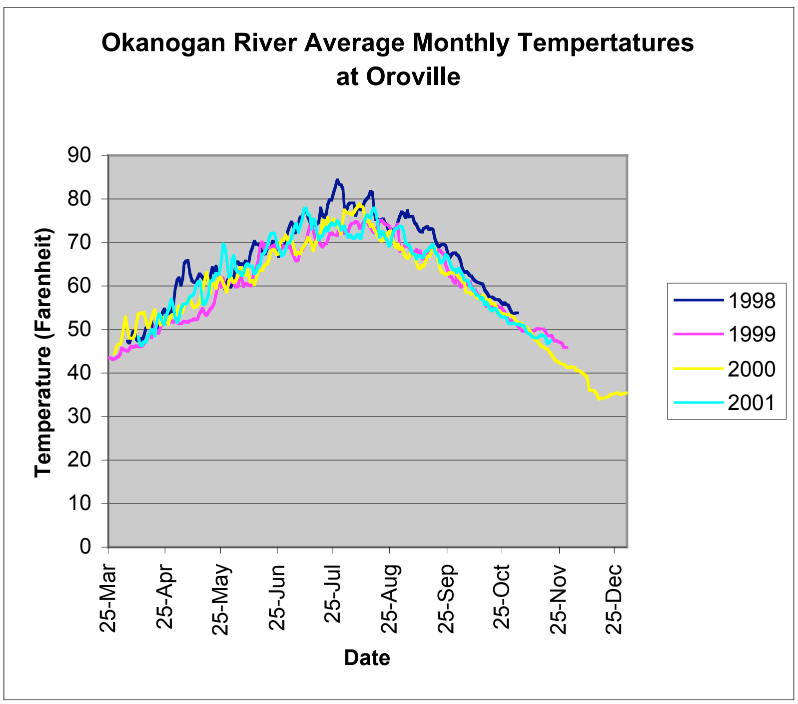

Figure 3. Okanogan River average monthly temperatures measured at Oroville, WA with thermographs 1998-2001.

Although it is typically cooler than the Okanogan River, the Similkameen River is also 303(d) listed for temperature (see Fig. 5). Between 1999 and 2001, Similkameen River temperatures ranged from 33 °F to 74 °F (Colville Tribes, unpublished data). Mid-summer temperatures exceed 71 °F, precluding summer rearing of salmonid juveniles. The Similkameen River also has high levels of suspended sediment.

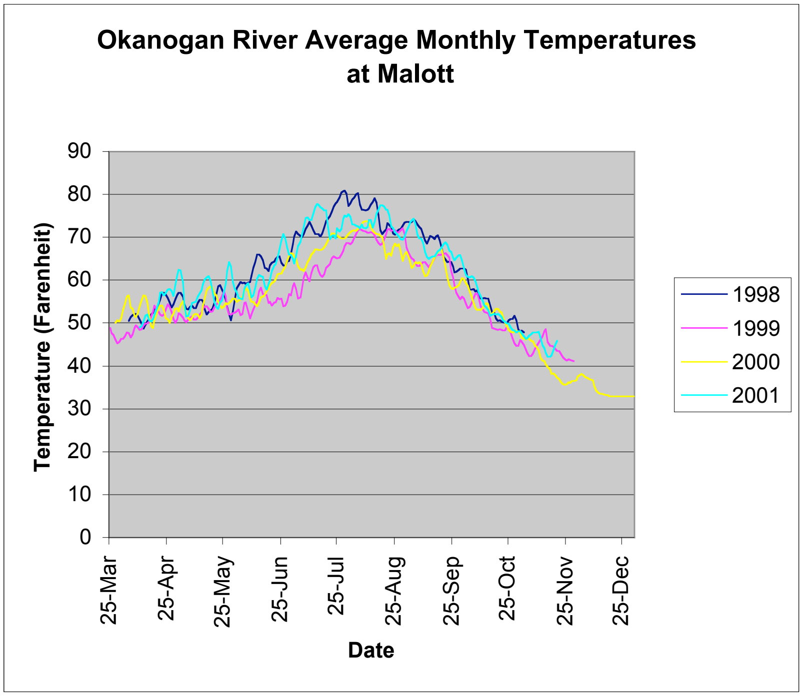

Figure 4. Okanogan River average monthly temperatures measured at Malott, WA with thermographs 1998-2001.

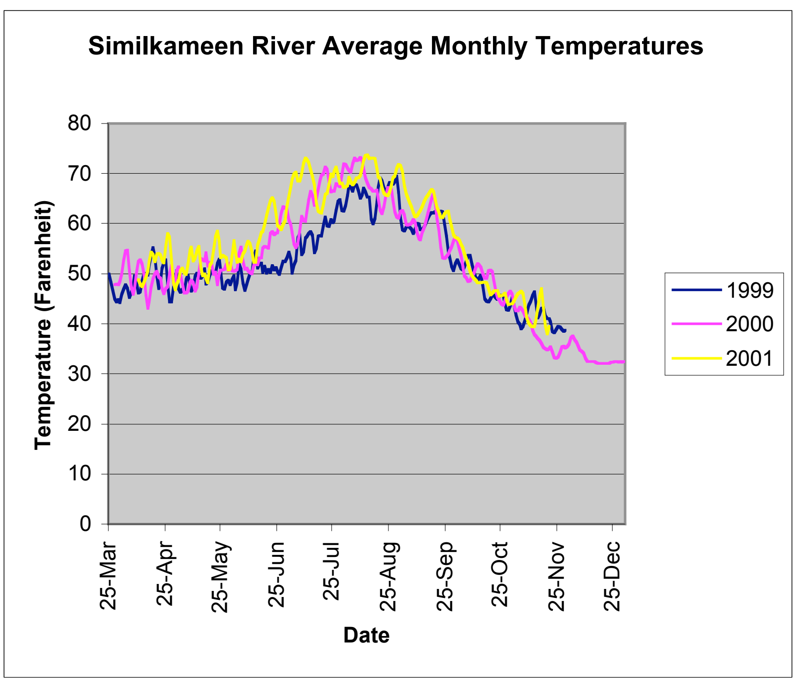

Figure 5. Similkameen River average monthly temperatures measured with thermographs 1999-2001.

The first 17 miles of the Okanogan River lie within the backwater pool (Lake Pateros) of Wells Dam. This area is subject to daily water fluctuations from Wells Dam operational changes. The habitat is primarily lentic with a mud, silt, and sand substrate. Large woody debris is scarce. Temperatures in this portion of the Columbia River range from 38 °F to 75 °F.

Pools and woody debris are uncommon in the remainder of the Okanogan River below Osoyoos Lake. The substrate is typically cobble/gravel with high amounts of fine sediment; embeddedness is also widespread. The Okanogan River is subject to elevated levels of suspended sediment during high spring flows and rain events (Talayco 2002).

4.1.2 Summer/Fall Chinook Salmon Geographic and Temporal Spawning Distribution

Summer/fall Chinook salmon adults return to Wells Dam beginning in late July. Spawning occurs from late-September through mid-November, peaking early- to mid-October. In late summer, temperatures in Lake Pateros are cooler than those in the Okanogan River. Fish congregate along the west bank of Lake Pateros, downstream of the Okanogan River confluence (pers. comm., C. Fisher, Colville Tribes). Adults migrate into the Okanogan River when temperatures cool due to rain events or seasonal changes. Summer/fall Chinook salmon that return to the Okanogan basin display a temporal spawning pattern in which spawning begins in the upper reaches first and proceeds to the lower river reaches. It is hypothesized that the early returning adults migrate up the Similkameen River in early September and hold in the pools (pers. comm., M. Tonseth, WDFW). At this time of year, the Similkameen River has the coldest water in the Okanogan basin. Some of these fish spawn in the Similkameen River beginning the last week of September. A portion of these fish may hold in the Similkameen River below the Enloe Dam falls and migrate back downstream and disperse into the upper Okanogan River as the temperatures cool, where they spawn in mid- to late-October. Later returning adults congregate in Lake Pateros and move into the Okanogan River as temperatures cool, populating the spawning reaches in the lower portion of the Okanogan River.

Spawning activity begins late-September to early-October in the Okanogan River upper basin. Below RM 40.6 (Rkm 65.4), spawning generally begins mid- to late-October. Spawning occurs in spatially discontinuous areas of the Okanogan River between Malott, WA, and Zosel Dam. The majority of spawning in the Okanogan occurs (1) between the towns of Okanogan and Omak (RM 25to RM 31, Rkm 40to Rkm 49), (2) below McAllister rapids (RM 45, Rkm 72), (3) between Janis Bridge (HWY 97/20) and Tonasket (RM 53 to RM 57, Rkm 85 to Rkm 92), and (4) between the Horseshoe Lake area and Oroville (RM 70 to RM 77.4, Rkm 113 to Rkm 124.5) (pers. comm., M. Tonseth, WDFW). Of these areas, the latter two have the highest concentrations, accounting for 68-86.2 percent of the Okanogan River redds observed in 2001-2003. Annual summer/fall Chinook salmon escapement ranged from 2,505 to 6,134 fish between 2001 and 2003 (Miller 2004a, Miller 2004b, Miller 2004c). Of the carcasses sampled over the same time period, marked hatchery-origin fish accounted for 36.2 to 61.4 percent, with percentages increasing with increased total escapement.

In the Similkameen River, spawning occurs in the lower miles from the mouth to Enloe Dam. About 80 percent of the documented redds are concentrated below the Oroville Bridge, primarily in a 1.8 km reach near Similkameen Pond (pers. comm., M. Tonseth, WDFW). Redd superimposition is common in this area; in 2002, the summer/fall Chinook salmon redd concentration was 1,397 redds/km (Miller 2004b). Marked hatchery-origin fish comprised 49 to 70.3 percent of the natural spawners between 2001 and 2003 (Miller 2004a, Miller 2004b, Miller 2004c).

In addition to the documented spawning escapement in the Okanogan and Similkameen rivers, the Colville Tribes harvest summer/fall Chinook salmon using gillnets in the Okanogan River and hook and line in Lake Pateros. Between 1987 and 1992, the average annual harvest was 800 adults, primarily taken at the base of Chief Joseph Dam (Talayco 2002).

4.1.3 ESA-Listed Species

NOAA, under the Endangered Species Act, listed Upper Columbia River (UCR) steelhead trout as endangered on August 18, 1997 (Talayco 2002). The listed Ecologically Significant Unit (ESU) includes naturally spawning steelhead trout populations in the Columbia River basin and its tributaries from the Yakima River upstream to the Canadian border and the Wells Hatchery stock. The Okanogan basin and the Columbia River below Chief Joseph Dam were designated as critical habitat (Talayco 2002). A small summer run of steelhead trout occurs in the Okanogan River basin, primarily spawning in Omak Creek. Summer/fall Chinook salmon broodstock collection efforts may adversely affect UCR steelhead. Consequently, a Section 10 incidental take permit will most likely be required prior to any broodstock collection efforts.

The Upper Columbia River ESU spring Chinook salmon population was listed as endangered on March 24, 1999 (Talayco 2002). The listed ESU includes naturally spawned populations of spring Chinook salmon occurring in the Columbia basin and its tributaries, between Rock Island Dam and Chief Joseph Dam, excluding the Okanogan River. The Methow River spring Chinook salmon hatchery stock is also included within the listed ESU. Spring Chinook salmon are considered extirpated from the Okanogan River (Talayco 2002).

4.1.4 Potential Selective Fishing Gear

Based on the variable stream and environmental conditions present in the Okanogan, Similkameen, and Columbia rivers, it is expected that a range of live-capture gear and methodologies would have to be tested to determine which is the most effective at collecting broodstock in different locations. Therefore, the strategy for broodstock collection will include multiple fishing sites with various gear types.

4.1.4.1 Tangle Net

A tangle net consists of one or more panels of webbing, vertically oriented in the water column by a cork line attached at the top and a lead line attached at the bottom. Tangle nets consist of multi-strand webbing with mesh sized to capture fish by the maxillary and teeth (e.g., typically 3.5-in to 4.5-in mesh for Chinook salmon), allowing fish to respire while caught in the net. They differ from gillnets, which typically consist of single-strand monofilament webbing with mesh sized to capture fish by the gill plates or body (e.g., typically 8-in mesh for Chinook salmon). Due to the manner in which fish are caught, use of tangle nets results in less mortality than gillnets. Fish captured in gillnets have higher mortalities due to extensive tissue damage and bleeding, or constriction of the gill plates that leads to death through suffocation. Tangle nets and gillnets are fished in the same manner.

Tangle nets vary in mesh size, twine diameter, panel length, and depth. The 3.5-in mesh has been found to be the most effective in capturing salmonids (Petrunia 2000). Tangle net evaluations conducted on the Columbia River have found 3.5-in and 4.5-in mesh nets of varying lengths and depths to be effective in capturing Chinook salmon. The number of fish caught and net mortality rates decrease as mesh size decreases and catch efficiency decreases with increasing twine thickness (Petrunia 2000). Webbing may also vary in color. Tangle nets are not effective if the fish are able to see the net. If fished at night or in turbid conditions, color has not been found to affect catch efficiency.

Nets can be designed with different hang ratios. Hang ratio is defined as the ratio between the length of the webbing versus the length of the cork line (Vander Haegen et al. 2002). Tangle nets have been fished at 3:1 and 2:1 hang ratios with varying catch efficiencies and mortality.

Tangle nets can be set or allowed to drift at different depths in the water column. The most effective method for capturing salmonids is the use of a diver net allowed to drift along the bottom.

Nets may also be modified to fish portions of the water column, thus targeting certain species and reducing incidental bycatch. During Fraser River gillnet investigations, steelhead trout were captured in the upper portion of net, while Chinook salmon were predominantly caught in the lower half of the net (Thomas 1998a, Kadyschuk 2000, Department of Fisheries and Oceans Canada (no date)). Other studies have also found steelhead trout to prefer the upper water column (Quinn and Ruggerone 1988, LaBelle 1995). On the Skeena River, gillnets were modified such that the panel of webbing was at the bottom of the water column and vertical weedlines extended from the panel to the cork line at the surface. Use of weedlines reduced the steelhead trout catch (LaBelle 1995).

In deep-water sites, nets can be deployed and retrieved by hand or by a deck-mounted hydraulic reel in an open skiff. Set duration is longer if deploying and retrieving the nets by hand. Shorter soak periods have resulted in better fish condition upon capture and reduced mortality. Nets can be deployed within five minutes with the use of a hydraulic reel. After deployment, the net is monitored for movement indicative of fish capture. The net should be patrolled to maintain a short soak time and clear any debris.

Figures 6 and 7 depict fishermen retrieving and deploying gillnets from a boat.

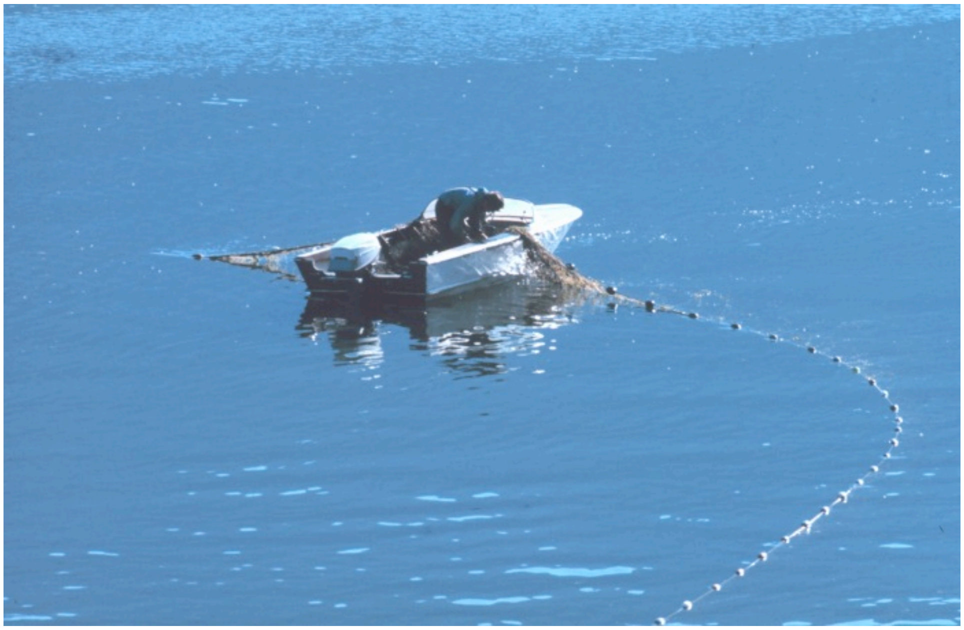

Figure 6. A Native American gillnet fishing in the Columbia River (Photolib.noaa.gov).

Figure 7. Fisherman setting a gillnet near Darango State Park, Washington, Rocky Reach Dam Reservoir (Streamnet.org).

<u>Site criteria for tangle nets</u>:

- Tangle nets can be used in shallow or deep water and in weak to fast-moving currents.

Advantages of tangle nets:

- It is easier to safely remove fish from tangle nets than gillnets.
- Tangle nets have been found to be effective in capturing spring Chinook salmon on the Columbia River and sockeye and spring Chinook salmon on the Skeena River (Vander Haegen et al. 2002).
- In a study conducted at Budd Inlet in 2000, immediate mortality of adult fall Chinook salmon was found to be significantly less in tangle nets (21.4%) than gillnets (40.2%) (Vander Haegen et al. 2004). Of this mortality, 22 percent was attributed to seals. However, the following year, when retrieval times were extended due to use of the hand deployment/retrieval method and warmer water temperatures (15 °C to 20 °C), immediate mortality rates for gillnets and tangle nets were found to be 19.1 and 32.0 percent, respectively, with no statistically significant difference between gear types (14% of the total mortality in 2001 was attributed to seals). In a lower Columbia River evaluation, 536 spring Chinook salmon were captured in tangle nets, with immediate mortality rates of 4.3 percent (3.5-in mesh) and 2.6 percent (4.5-in mesh) (Vander Haegen et al. 2002).
- At various locations, adult fall Chinook salmon captured in tangle nets have been found to be in better condition than those caught in gillnets and have exhibited higher post-release survival (Vander Haegen et al. 2004). Higher mortality rates were also observed for all species caught in gillnets at a Willapa Bay study site. Tangle-net caught fish had net marks around the lower snout and jaw while many gillnet-caught Chinook salmon were bleeding at capture and had net marks around the body and gills. The gillnet-caused marks were severe; scales were dislodged and missing, leaving the underlying skin abraded and red. It is likely that secondary fungal infections subsequently occurred.
- Lower Columbia River tangle net evaluations revealed that, of the 43 steelhead trout captured, all were released in excellent condition (Vander Haegen et al. 2002). Sturgeon were also released in good condition.
- In the lower Columbia River, tangle net-captured spring Chinook salmon exhibited higher long-term post-release survival than those captured in gillnets. Spring Chinook salmon released from tangle nets were recovered at 80.9% - 92% of the rate of controls, while gillnet-captured spring Chinook salmon were only recovered at 50% of the rate of controls (Vander Haegen et al. 2002).
- Fish harvested from tangle nets have fewer net marks and may yield a higher market value.
- The relatively smaller tangle net mesh used to target salmon, allows for a wider size range of the target species to be caught (Vander Haegen et al. 2004), minimizing the potential for artificially selecting larger fish for broodstock or harvest and leaving smaller fish for natural production.

Disadvantages of tangle nets:

- Long-term post-release mortality may be significant. In tangle net studies conducted on the lower Columbia River, approximately 20 percent of spring Chinook salmon released from tangle nets were not subsequently recovered (Vander Haegen et al. 2002).
- Evaluations of tangle nets in Budd Inlet revealed a lower catch efficiency of fall Chinook salmon in tangle nets (3.5-in and 4.5-in mesh) than in gillnets (8-in mesh) (Vander Haegen et al. 2004). On the Skeena River, the number of fish captured and catch per unit effort (CPUE) were found to be greater for most salmon species when using a monofilament net versus a multistrand net (DFO 1990). However, lower Columbia River evaluations revealed 4.5-in mesh tangle net to be as effective as 8-in mesh gillnet in capturing spring Chinook salmon (Vander Haegen et al. 2002). Multifilament nets have also been found to catch more steelhead trout than monofilament nets (Lewynsky 1992).
- Tangle nets have a higher catch of non-target species and jacks than gillnets due to smaller mesh size (Vander Haegen et al. 2004). In addition to potential impacts to the non-target species, their increased catch results in extending the duration of net retrieval and the period of time that all fish remain in the net. In lower Columbia River tangle net evaluations, sets with dead adult spring Chinook salmon had significantly higher numbers of non-salmonids (Vander Haegen et al. 2002). Reduced CPUE for the targeted species is another consequence of increased bycatch.
- Salmonids captured in tangle nets may also be skewed towards males. In tangle net evaluations conducted on the Columbia River, 75.7 percent of the captured fish were males (Vander Haegen et al. 2004). The difference was attributed to the kype, which is more susceptible to capture in a tangle net.
- Fish captured in good condition and able to be released upon capture exhibited the greatest long-term post-release survival. Captured fish that required revival in recovery boxes and were released upon visual inspection may not have been fully recovered physiologically and may require a longer holding period (Vander Haegen et al. 2002).

4.1.4.2 Beach Seine

Beach seines have been successfully used in selective harvest by First Nations on the Skeena and Fraser Rivers (pers. comm., Don Lawseth, Department of Fisheries and Oceans, Canada.)

A beach seine consists of a panel of mesh webbing with a float line at the top and a lead line at the bottom. Beach seines can vary in length, depth, amount of bag, mesh size, and twine composition and diameter. The middle portion of the net, called the “bunt,” may have a larger bag and a smaller mesh than the rest of the net (Everhart and Youngs 1981). The configuration of a beach seine is dictated by the fishing site (Ross 1998). Gear efficiency and feasibility is site specific. The depth of the nets may be uniform or they may taper at either end, closely corresponding to the depth of water in fish holding areas.

The depth should be sufficient enough to allow for sweeping the entire water column while maintaining a bag in the net. Net depths twice the depth of the water column have been found to be effective (Bayley and Herendeen 2000).

There are also trade-offs in seine lengths. Longer seines result in reduced gear avoidance behavior (Bayley and Herendeen 2000). However, capture efficiency is influenced by fish density, abundance of woody debris and rooted vegetation, habitat type, substrate type and homogeneity, and water clarity. Use of a shorter seine minimizes the reduced capture efficiency associated with varying water depth, substrate, and woody debris. The weight of the lead line must be suited to the flow conditions (Ross 1998). Monofilament web is more effective in streams with clear water (Ross 1998).

Capture efficiency also varies with the fishers' skills to encircle the fish as the net is laid and retain the fish as the net is hauled (Bayley and Herendeen 2000). Precautionary techniques can be implemented to increase catch efficiencies. It is important to close the ends of the net, secure the lead line at the bottom, and clear any woody debris or boulders from within the enclosure prior to hauling. Nets may also be modified to ensure successful capture of the encircled fish. Attaching rings to the net allows it to be completely closed up prior to retrieval. By using a block net in conjunction with the beach seine, the catch efficiency can be maximized.

Beach seines may be deployed on foot or from a quiet boat or raft. Figures 8 and 9 depict people hauling in a large beach seine and retaining the encircled fish, respectively.

Figure 8. Fishermen hauling in a large beach seine that was set using a boat (www-sci.pac.dfo-mpo-gc.ca).

Figure 9. Fishermen retaining encircled fish by holding up the cork line (fisheries management.co.uk).

Site criteria for beach seines:

- Beach seines are most effective in shallow slow-moving water, free of woody debris, and where fish occur in high densities. Beach seines would be effective on the spawning grounds or in hyporheic areas where fish may congregate and hold.

Advantages of beach seines:

- Beach seines provide for live sort of the catch and can be a useful tool for stock assessment.
- In studies investigating beach seine feasibility for selective fishing, most fish appeared to be in excellent shape and were released without the use of a resuscitation tank or required very little recovery time (Thomas 1998). When used on the Fraser River to capture coho and chum, only one mortality was observed, which seemed to be caused by a previous seal attack. At Shuswap River sites, none of the captured fish required additional holding in net pens to resuscitate before release (Ross 1998).

Disadvantages of beach seines:

- Beach seines are not suitable for high water velocities (Triton Environmental Consultants Ltd 1998c).
- The presence of woody debris (logs, stumps, snags) delays net retrieval, reducing capture efficiency and potentially tearing the seine (Thomas 1998b). The fishing site could be prepared by the removal of woody debris, rooted vegetation, or large boulders. However, habitat of the fishing site may potentially be degraded by such actions.

- Post-release stress-related mortalities potentially occur from seining and handling. In some cases, captured fish seemed to be stressed and somewhat sluggish, but little if any physical trauma was observed (Thomas 1997). However, a recovery area (e.g., net pen, tank with recirculating water system) was necessary to hold lethargic fish prior to release.
- Capture efficiency varies between sites, species, and fishers. Beach seines were found to be ineffective in capturing late summer sockeye at various sites in the Shuswap River (Ross 1998).

4.1.4.3 Floating Trap-Net

Floating trap-nets are designed to lead fish into an enclosure from which they are unable to escape. Configurations can vary widely and include traps such as fyke nets, floating pound nets, and Merwin traps.

A fyke net consists of a long mesh bag mounted on several hoops attached to vertical net wings set at angles on either side of the opening (Everhart and Youngs 1981). The wings funnel fish toward the mouth of the net as they swim with the current. The hoops maintain the shape of the bag. Net funnels are attached to the hoops to prevent fish from escaping. Each wing panel has a lead line at the bottom to weight it down and a cork line to maintain its vertical orientation in the water column. The length of the wings and bag may vary. Shorter wings and long bags are used in swift currents. Where water velocities are slow, longer wings may be used. The fyke net may be set with anchors or stakes, depending on flow conditions and net configuration.

Floating pound nets are effective in catching salmonids (Everhart and Youngs 1981). A vertical lead net is attached at one end to the shoreline. The other end has a funnel, which leads to the top of the "heart," which is a three- to five-meter wide opening, lacking a bottom net. Traps used in tidal areas typically have openings into the heart from both sides of the lead. The heart is preceded by a tunnel leading to the four-meter square "pot." The narrow mouth of the tunnel is typically 46–76 cm wide. From the pot, captured fish are lead through another tunnel, with a 15- to 30-cm adjustable opening, into the "spiller," which is positioned alongside the pot. Two spillers may be attached to prevent overcrowding.

The entire floating pound net structure may be suspended from a rigid floating framework that is anchored into position. If fishing in very deep water, a rigid framework is impractical. In this case, top webbing is added to the trap and the shape is maintained with buoys and anchors. The latter design also facilitates moving the pound net to various sites as fish distribution changes (Everhart and Youngs 1981).

To empty the pound net, the spiller, which is held down by ropes, is lifted by hand or with the use of a winch. The web is hauled into a boat located inside the spiller. The catch is crowded and brailed or dipped out of the bag and into the boat.

The minimum size of fish caught is dictated by mesh size. The maximum size of captured fish is limited by the tunnel openings. In studies evaluating mesh and throat sizes for capturing warm water species, nets with large mesh and throat size had the highest CPUE

(Shoup et al. 2003). Trap net design was found to impact the number of species captured, total CPUE, species-specific CPUE, and length distribution of catch (Shoup et al. 2003).

Figures 10 and 11 depict different types of floating trap-net gear.

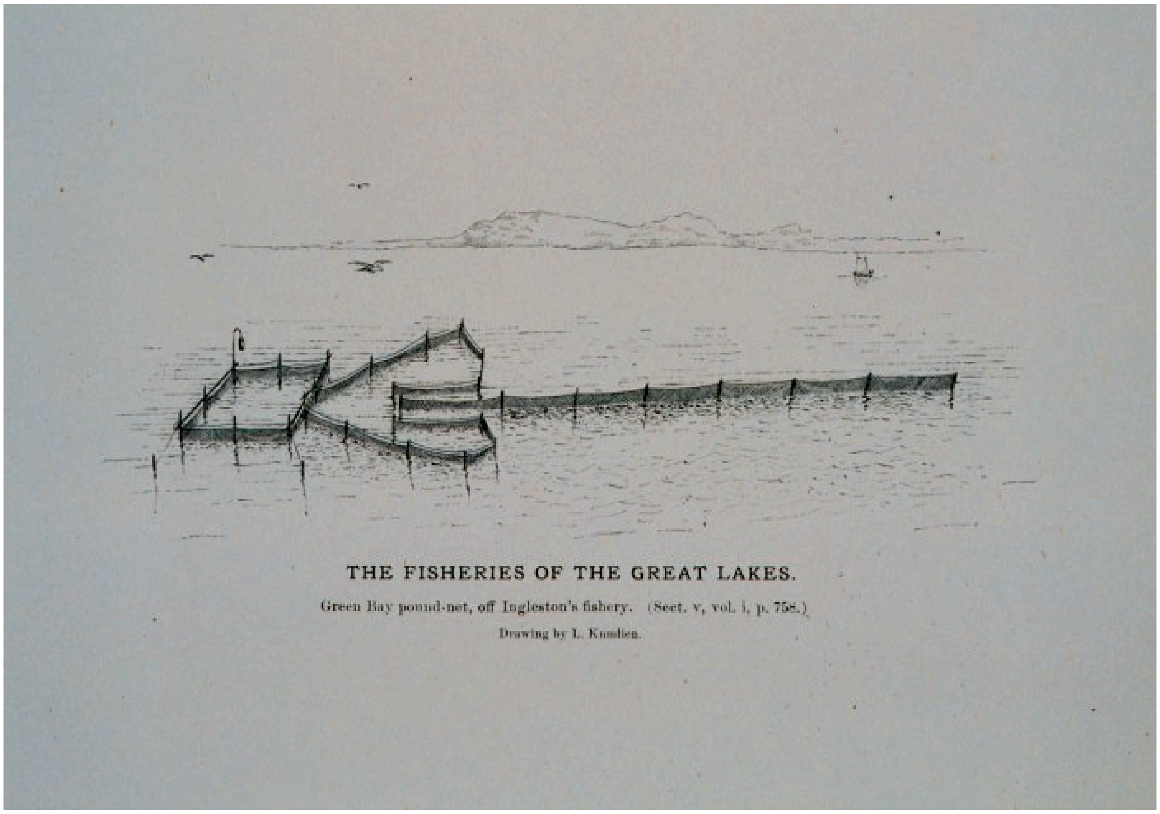

Figure 10. Schematic of pound net (streamnet.org).

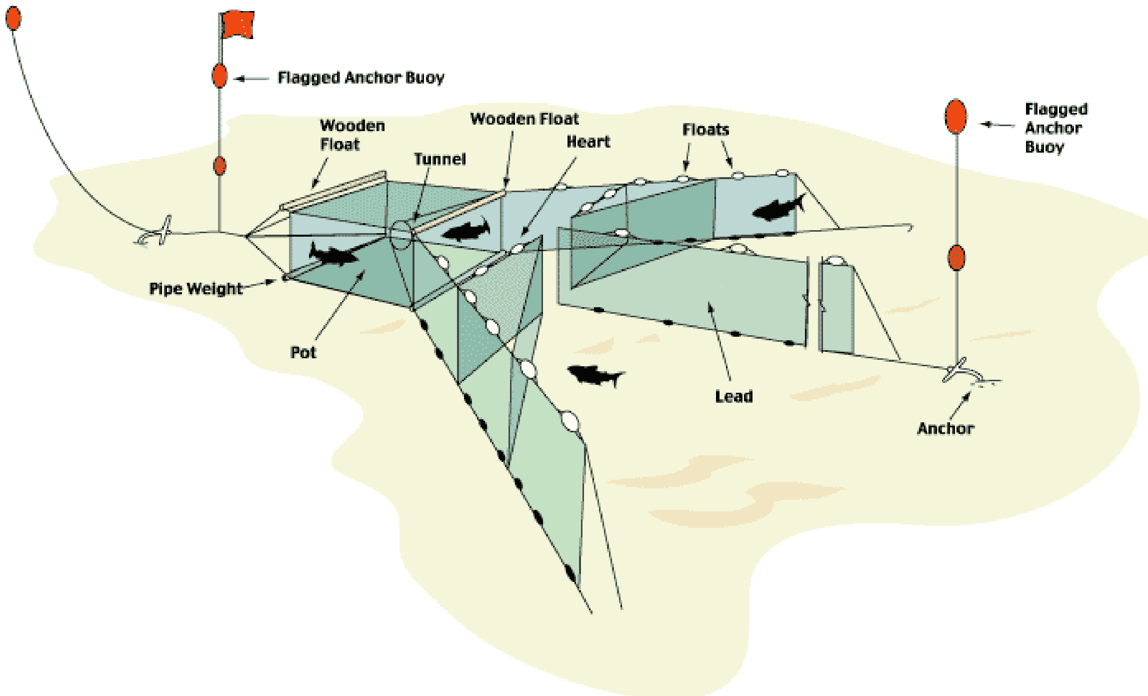

Figure 11. Trap-net design.

Site criteria for trap-nets:

- Floating traps can be fished in a variety of conditions ranging from shallow, fast-moving water to deep water with weak currents (Vander Haegen et al. 2002). Fyke nets are best adapted for relatively shallow water (<15 feet) with a moderate current (Everhart and Youngs 1981). Floating pound nets may be fished in deep water, at a range of water velocities.

Advantages of trap-nets:

- Fish captured in floating traps are typically in excellent condition and bycatch can be safely removed and immediately released, unharmed.
- Although it is best to minimize the amount of time fish are crowded and held in a trap, the floating traps described above do not need to be constantly manned by a full crew.

Disadvantages of trap-nets:

- Studies conducted in Canada have found floating traps to be marginally effective in capturing pink salmon, but ineffective in capturing other salmon species (Vander Haegen et al. 2002). Floating fish traps require the use of a boat, which can result in long holding and transport times.

4.1.4.4 Fish Wheel

A fish wheel consists of several baskets attached to an axle, about which they rotate. The trap is oriented parallel to the shoreline. In swift currents, the wheel is propelled by the flow of water. Fish are scooped up by the baskets and sent through a chute, from which they are deposited into a holding tank. The entire structure sits within a frame. Traps are typically fabricated from aluminum, but they have also been constructed from wood. A fish wheel may be used in conjunction with a ramp net lead system to increase catch efficiency.

Fish wheel designs vary widely. Figures 12 through 16 provide some examples. The Siska Indian Band has successfully used fish wheels to capture coho salmon in the Fraser River since 1998 (BC Aboriginal Fisheries Commission 2001). They use a three-basket aluminum fish wheel, approximately 40 feet long and 18 feet wide. Each basket is nine feet wide and eight feet deep, extending 8.6 feet from the axle. Foam-padded plywood is attached to the back of each basket to act as a paddle. Eight-inch knotless mesh covers the sides and back of the baskets. Fish wheels at other locations have added padding to the chute to reduce impact injury (Underwood et al. 2003). In a two-basket design used on the Yukon River to catch chum, the livebox was 2.4 meters long by 1 meter wide by 1.2 meter deep and was perforated with 5-cm holes, allowing water flow without tiring the fish (Underwood et al. 2003).

Figure 12. Kuskokwim fish wheel constructed from wood (watershed-watch.org).

Figure 13. Yale fish wheel (watershed-watch.org).

Figure 14. Two-basket fish wheel constructed of wood and styrofoam panels (taleblazing.com).

Figure 15. Two-basket aluminum fish wheel (home.att.net).

Figure 16. Three-basket fish wheel (Clarkejohn.com).

Yale First Nation found optimum speed to be one revolution every 20–25 seconds (Triton Environmental Consultants Ltd 1998, Yale First Nation Fisheries Stewardship Authority 2000).

Fish wheel traps require site-specific modifications to optimize efficiency. Reflection from aluminum traps and baskets have caused fish to shy away from the trap during the day. Spray-painting the frame black was found to improve day-fishing success (Manuck 2000). In some cases, fish escaped out the sides of the wheel between the dipping of each basket. Adding frames of knotless webbing along each side of each basket prevents fish from escaping in this manner and minimizes the potential for injury.

<u>Site criteria for fish wheels</u>:

- Suitable fish wheel sites are limited to areas with fairly constant water level and flows, within the pathway of migrating fish. If flows fluctuate during the fishing season, multiple alternate fishing sites are recommended (Triton Environmental Consultants Ltd 1998). Self-powered fish wheels must be placed in fast-moving current. However, powered fish wheels can be used in slower water currents.
- Fish wheels must be securely fastened to a mooring, bedrock bank, or other structure.

<u>Advantages of fish wheels</u>:

- Fish wheels have been successfully used by First Nations on the Nass, Skeena, and Fraser Rivers (pers. comm., Don Lawseth, Department of Fisheries and Oceans, Canada).
- Mortality rates are generally low. Fish wheels allow for the successful capture and safe release of both target and nontarget species (Triton Environmental Consultants Ltd 1998g and 1998j). Yale First Nation caught 26,026 salmon; less than three percent of these had injuries, nearly all of which were caused by seals and were not attributed to the fish wheel trap (Yale First Nation Fisheries Stewardship Authority 2000). Power-assisted fish wheels have also been found to be effective at capturing and releasing any species of salmon with no, only very minimal, stress (Manuck 2000). However, a recent evaluation of a fish wheel on the Yukon River showed that chum salmon trapped and released at one site were less likely to be captured at upstream sampling sites (Underwood et al. 2004).
- If strategically located in swift water, a self-propelled fish wheel captures and transfers fish into holding tanks with minimal human effort (BC Aboriginal Fisheries Commission 2001). The wheel may constantly fish 24 hours a day, with a crew of three checking the trap and handling fish in two three-hour intervals per day.

<u>Disadvantages of fish wheels</u>:

- Fish wheels must be located within the pathway of migrating fish. Fish wheels are a type of fixed gear, requiring strong anchoring points. In addition to limited site availability, it is generally impractical to break down a fish wheel and move it to an alternate site within a single fishing season.

- Fishing sites are limited to water levels and flows without extreme fluctuations. Spring freshets have been found to be hazardous to the fish wheel and operators. It is recommended to have multiple alternate fishing sites to accommodate changing flows throughout the fishing season, which can be impractical and costly (Triton Environmental Consultants Ltd 1998i).
- Fish wheels are custom made and are relatively expensive (~$50,000). In addition to initial fabrication expenses, subsequent modifications and construction of work platforms and handrails can be costly.
- There is potential for some fish mortality. Fish injuries may occur from vertical drops between the baskets and the holding tank, rubbing against the baskets or frame, or overcrowding.

4.1.4.5 Dip Net Combination with Partial Weir or Scaffold

A rock weir or log weir (Fig. 17) or temporary picket weir (Figs. 18 and 19) may be constructed to partially span the river, leading fish to migrate through a narrow area, from which they may be dip netted.

Figure 17. Log weir (Streamnet.org).

Figure 18. Nlaka'pamux picket weir located on the Nicola River (watershed-watch.org).

Figure 19. Picket weir leading fish through channel (dungevalley.co.uk).

In areas with cascading falls, fish are naturally concentrated in passable chutes. Temporary wood scaffolding or platforms may be constructed adjacent to these chutes, allowing access for dip netting. Figures 20 through 23 depict various platforms for dip net fisheries.

Figure 20. Klickitat Falls and Native American platforms for dip net fishery (streamnet.org).

Figure 21. Historical photo of Columbia River tribal dip net fishery (streamnet.org).

Figure 22. Historical photo of Columbia River tribal platform and dip net fishery (streamnet.org).

Figure 23. Dip netting for Chinook salmon (watershed-watch-org).

<u>Site criteria for dip-net combination with partial weir or scaffold</u>:

- Natural cascading falls are ideal areas for scaffolding. Narrow, confined reaches are better suited to construction of a partial weir. Both methods may not be appropriate in rivers with flashy flows and abundant large woody debris.

Advantages for dip-net combination with partial weir or scaffold:

- Minimal fish handling would be required. Incidental bycatch could be immediately placed back into the river upstream of the fishing site.
- This type of fishing gear is inexpensive and easily repaired.

Disadvantages for dip-net combination with partial weir or scaffold:

- Dip-netting may be labor intensive and the CPUE may be low. Depending on the dipping height, dip-netting fish may be physically demanding.
- Cascading falls are scarce in the Okanogan basin.
- Captured fish may be injured while thrashing in the net or accidentally falling out of the net onto rocks or the scaffold.
- Construction of a weir may require additional permits.

4.2 Site Review and Selection

Several sites were identified as potential fishing areas based on geomorphology, flow, temperature trends, fish distribution, run timing, and access. It should be noted that the sites selected are based on general information about the location of adult summer/fall Chinook salmon in key areas of the basin. In the future, radio-tag studies on adult summer/fall Chinook salmon captured and released at Wells Dam would be used to better define fish behavior, holding areas, and geographic distribution.

4.2.1 Wells Dam Pool (Lake Pateros)

The Okanogan River is warmer than the Columbia River, creating a thermal barrier to migrating summer/fall Chinook salmon adults. It is hypothesized that this thermal barrier causes Okanogan bound summer/fall Chinook to hold in this area until stream temperatures drop. If this assumption is correct, a capture facility at this location may provide an easily accessible location to collect a major portion of the summer/fall Chinook run. Consequently, an attempt at broodstock collection will initially occur in Lake Pateros. Two locations and types of fishing gear may be suitable in Lake Pateros.

4.2.1.1 Floating Trap-Net

A floating trap-net will be fished in the Columbia River below the Okanogan River confluence. Fish are known to congregate in Lake Pateros in the deep channel along the west bank, prior to migrating up into the Okanogan River (Fig. 24). A pound net design would work well; the water is relatively deep and the current is moderate. Wells Dam operations cause the flow of water in this area to change direction daily. Consequently, the configuration would be similar to nets used in tidal areas, where the fish can enter the heart on either side of the lead net. A lead line will be attached to the west bank directing the fish into the trap. This gear requires the use of a boat. At this site, water depth and boat ramp access are adequate to support the use of a boat throughout the fishing season.

Figure 24. Lake Pateros looking downstream from Okanogan River confluence.

Prior to net design, substrate, water depths, and flow (direction and velocity) would be measured during various Wells Dam operations. Adult radiotelemetry data collected as part of initial monitoring would also be reviewed to assist placing the trap in the stream channel.

4.2.1.2 Fish Wheel

A potentially suitable fish wheel site occurs along the south shore of Lake Pateros between the HWY 17 Bridge and Chief Joseph Dam (Figures 25 and 26). There is a channel of fast-moving water between the south shore and a bedrock island. Both the south shore and the island provide suitable sites for attaching a fish wheel. The current may be fast enough to propel the fish wheel. Deploying a fish wheel at this site would require coordination with both Wells Dam and Chief Joseph Dam operators. Operations at Wells Dam fluctuate the water level in Lake Pateros up to five feet daily. Maximum and minimum water depths would need to be measured at this site prior to obtaining a fish wheel to determine the maximum heights of the baskets.

Chief Joseph Dam has several turbines, which are oriented perpendicular to the south shore (Figure 27). At times, only some of the turbines are operated. The flow pattern and velocity passing through the fishing channel varies depending upon which turbines are operated. Flow will be measured in the fishing channel under various turbine operations to determine the feasibility of a self-propelled fish wheel.

It should be noted that this site is located directly across the Columbia River from the proposed Chief Joseph Dam Hatchery (CJDH). Due to its close proximity to the hatchery and cooler water temperatures, collected fish could be transported to the hatchery site within just a few minutes of collection.

Figure 25. Fish wheel site at Lake Pateros looking upstream at Chief Joseph Dam. Fish wheel would be placed between the rock outcrop (at left) and the south shore (at right).

Figure 26. Fish wheel site at Lake Pateros looking downstream at Highway 17 bridge. Fish wheel would be positioned between rock outcrop (previous photo) and south shore (at left).

Figure 27. Chief Joseph Dam (streamnet.org).

4.2.2.1 Beach Seine

Beach seines will be used on the spawning grounds in the Okanogan River at multiple sites predominately upstream from Omak Creek, focusing on areas with good access and high spawning densities. General locations include the following areas: (1) between Omak and Okanogan, (2) between Janis Bridge (HWY 97/20) and Tonasket, and (3) between the Horseshoe Lake area and Zosel Dam (Figs. 28 and 29). Due to the assumed temporal spawning pattern, seining will occur in the most upstream sites first. These areas are suitable due to the relatively homogeneous cobble substrate, shallow water, and high aggregations of fish.

Spawning density is much lower in the lower portion of the Okanogan River, probably rendering beach seining less efficient. However, this portion of the river is typically utilized by later returning adults. Later returning adults are especially important to capture because the current Eastbank Hatchery program does not include this component of the run, and, therefore, the major focus of future broodstock collection efforts will be aimed at this component. There is an area between Monse Bridge and the railroad trestle where beach seining would be effective (pers. comm., C. Fisher, Colville Tribes).

Figure 28. Riffle below Zosel Dam, looking downstream.

Figure 29. Same riffle below Zosel Dam, looking across the Okanogan River.

4.2.2.2 Tangle Net

Diver set tangle nets will be allowed to drift through pools where fish congregate during their migration at several sites. A tangle net will be deployed in the lower Okanogan River in the vicinity of Monse Bridge to Lake Pateros (Fig. 30). After a rain event, tribal gillnet fishers were successful in capturing over 160 summer/fall Chinook and sockeye salmon from a single pool, fishing several nights over a two-week period (pers. comm., C. Fisher, Colville Tribes). Gillnet fishers will be contacted to assist in tangle net fishing in this area. This area has good boat and road access; there is a boat ramp below Monse Bridge.

Figure 30. Monse Bridge on the Okanogan River, looking east.

Above the Wells pool influence (RM 17, Rkm 27.4), potential sites are limited because pools are uncommon. Adult summer/fall Chinook salmon are known to congregate below McAllister Rapids (RM 45, Rkm 72) (Fig. 31) (pers. comm., M. Tonseth, WDFW). Pools below Janis Rapids (RM 51, Rkm 81) (Fig. 32) and McLoughlin Falls (RM 49, Rkm 79) (Fig. 33) may also be suitable tangle net sites. The latter two have good road access. However, the roads are private and would require landowner permission.

Figure 31. McAllister Rapids on the Okanogan River.

Figure 32. Janis Rapids on the Okanogan River. Potential fish wheel site along opposite shore and potential weir/dip-net site.

Figure 33. McLoughlin Falls on the Okanogan River looking from east shore.

4.2.2.3 Dip-Net Combination

A dip-net/weir combination may also be feasible at Janis Rapids (Fig. 32) or McLoughlin Falls (Figs. 34 through 36). At these locations, fish migrate through limited areas of the river. These areas could be further limited by installing temporary rock or picket weirs in portions of the river. Fish could then be dip-netted from the passage routes. While these sites have good road access, the roads are private and would require landowner cooperation.

Figure 34. McLoughlin Falls looking downstream from east shore.

Figure 35. McLoughlin Falls potential dip-net site.

Figure 36. Rock island in center of McLoughlin Falls, looking upstream.

4.2.2.4 Fish Wheel

A potentially suitable fish wheel site also occurs along the west shore of Janis Rapids (Fig. 32). There is a channel of fast-moving water between the west shore and a bedrock island. Both the shore and the island provide suitable sites for attaching a fish wheel. The current may be fast enough to propel the fish wheel. The water depth and flow will be measured in the potential fishing channel to determine the feasibility of a self-propelled fish wheel.

4.2.3 Similkameen River

The Similkameen River contains the coolest water in the Okanogan basin. Once adults pass the Okanogan River's thermal barrier, early returning summer/fall Chinook salmon migrate to the Similkameen River and hold in the cool pools below Enloe Dam falls. As temperatures decrease, the fish drop down into Similkameen spawning areas; some migrate downstream and back into the Okanogan River. Spawning activity general occurs late-September through mid-November. Fishing efforts will be concentrated in the river accordingly.

4.2.3.1 Beach Seine

Beach seines will be used on the spawning grounds in the 1.8 km of spawning habitat near Similkameen Pond (Fig. 37). This area is well suited due to the relatively homogeneous cobble substrate, shallow water, and extremely high aggregations of fish.

Figure 37. Riffle 150 yards upstream of Similkameen Pond, Similkameen River. This area has the highest density of redds in the entire Okanogan basin.

This area is overseeded; redd superimposition is a common problem. Removing some of the adults from the spawning grounds would benefit the fish allowed to spawn naturally and may improve egg survival. An adult holding tank may be constructed at the Similkameen Pond acclimation facility, which is equipped with a cooler source of well water. This site would allow captured adults to be securely held and gradually cooled prior to transfer to the Chief Joseph Dam Hatchery.

4.2.3.2 Dip-Net Combination

The area below Enloe Dam (~RM 6.6, Rkm 10.6), characterized by a series of cascading waterfalls over bedrock, is an ideal location for dip-netting from scaffolds (Figs. 38 and 39). Fish are known to congregate in the pools below the falls. The bedrock canyon is ideal for multiple scaffolds. There is road access to the area through Bureau of Land Management (BLM) lands.

Figure 38. Overview of Enloe Dam (streamnet.org).

Figure 39. Enloe Dam on the Similkameen River.

4.3 Study Design

The primary objective of the proposed study is the live-capture of broodstock for the proposed summer/fall Chinook salmon hatchery below Chief Joseph Dam. A secondary objective is to control the proportion of hatchery-origin fish spawning in the Okanogan and Similkameen rivers. This action is needed to meet the management goal of developing a locally adapted, self-sustaining and harvestable summer/fall Chinook salmon population.

To achieve both management objectives, researchers must be able to accurately determine the run size of different components of the run entering the Okanogan River, as well as their geographic distribution.

The study proposed below is designed to test the ability of different live-capture methods to collect 1130 adults for broodstock and control the ratio of hatchery to natural fish on the spawning grounds. The broodstock collection goals are presented in Tables 1 and 2, below.

Table 1. Early-arriving summer/fall Chinook salmon broodstock goal, assuming 1:1 sex ratio.

Program	Adults
Riverside Pond yearling	228
CJD Hatchery yearling	172
CJD Hatchery subyearling	112
Total	512

Table 2. Late-arriving summer/fall Chinook salmon broodstock goal, assuming 1:1 sex ratio.

Program	Adults
Omak Pond yearling	228
Omak Pond subyearling	166
CJD Hatchery yearling	114
CJD Hatchery subyearling	110
TOTAL	618

4.3.1 Permits and Coordination with Co-Managers

Prior to any broodstock collection effort, a Section 10 incidental take permit will be obtained from NOAA Fisheries for UCR steelhead trout. Broodstock collection efforts will comply with provisions set forth in the permit. If the authorized take of UCR steelhead trout is exceeded, broodstock collection operations will cease and NOAA will be contacted immediately for further direction.

If any of the traps require excavation of streambed material or placement of riprap, a joint permit will be required from the ACOE and WDOE for compliance with the Clean Water Act 404(b)(1).

A Shoreline Management Act permit would be obtained from the WDOE for gear types that attach to non-tribal shorelines. A tribal shoreline permit would be required for shorelines within the Colville Tribes jurisdiction (e.g., north shore of Lake Pateros, portions of east shore of Okanogan River, portions of Similkameen River). In addition, both the state and the Tribes may require a Hydraulic Project Approval permit, depending upon the jurisdiction of the attachment points, weir placement, etc. (pers. comm., Jerry Marco, Colville Tribes).

Broodstock collection efforts will be consistent with the Mid-Columbia Mainstem Conservation Plan and performance objectives identified in the CJDH HGMP.

WDFW conducts weekly foot and float surveys on the Okanogan and Similkameen rivers, enumerating summer/fall Chinook salmon spawning and identifying the origin of spawned out carcasses. Personnel will coordinate with the WDFW stream survey and carcass recovery program to evaluate hatchery-origin summer Chinook salmon adults in the natural spawning population and to recover fished tagged for purposes of evaluating long-term survival of different selective fishing gear.

Broodstock sampling standards of Salmonid Disease Control Policy of the Fisheries Co-Managers of Washington State for incidence of pathogens will be implemented. Salmon broodstock are typically sampled for enzyme-linked immunosorbent assay (ELISA) for incidence of *Renibacterium salmonarium*, the causative agent of bacterial kidney disease (BKD). Under current Wells Hatchery operations, broodstock are spawned at least two weeks after inoculation for BKD. If the same protocol is followed at CJDH, eggs cannot be taken at the fish collection sites.

4.3.2 Preliminary Data Collection

As indicated in the Site Review and Selection section, physical data will need to be collected from all potential fishing sites to determine optimal fishing sites, appropriateness of gear and gear design. Water temperature, flow, water depth, wetted width, substrate, and woody debris will be monitored at each site and recorded. In addition, local fisherman and landowners around fishing areas will be contacted regarding possible access, storage of equipment, and assistance with operations.

Results from adult radiotelemetry studies will be considered in narrowing the fishing window and potential sites. Ongoing remote-sensing thermal survey results will be consulted to identify the locations of hyporheic zones. Fish may congregate in these areas of cool water refugia. In addition to higher fish densities increasing catch efficiency, handling and holding fish in cooler water will result in better short- and long-term survival. Capturing and holding fish at such sites will also minimize the amount of time needed to acclimate the broodstock to the Chief Joseph Dam Hatchery water temperatures[1].

[1] The CJDH preliminary design calls for facilities capable of maintaining a wide range of temperatures in all rearing vessels.

4.3.3 Equipment

Several devices will be constructed to enable the broodstock to be transferred from the fish collection site to the transport tank *within water*. The Quinault Tribe has successfully used large PVC tubes adequate to hold a single Chinook salmon adult, with plywood ends on either side (pers. comm., Larry Gilbertson, Quinault Tribe). The tube is perforated to allow water to flow through while it is held within water, but maintains water in the tube if lifted out of the water. In addition to retaining the fish in water, the darkness keeps the fish calm and the tube prevents potentially injurious movement. The transfer tubes will need to be constructed to suit the transport tank. Given the high prevalence of diseases in the Okanogan basin, the use of wood is discouraged because it cannot be completely disinfected. The transfer tubes will be disinfected between uses following the CJDH protocols.

The fish wheels and floating trap-nets will either be constructed by researchers or purchased from suppliers, dependent on costs.

4.3.4 Fishing Gear Procedures

Lake Pateros and Okanogan River water temperatures will be monitored beginning in late June. Fishing efforts will not take place if stream temperatures exceed 65 °F. Handling salmonids during temperatures exceeding 65 °F will result in increased short and long-term mortality, and is strongly discouraged (Ross 1998).

4.3.4.1 Tangle Nets

Deep-water tangle net sites will use a crew of three people. One person will drive the boat and operate the net. Another person will record data. The third person will handle and tag fish. Local tribal gillnet fishers and biologists will be contacted to participate.

Fishing will be conducted between dusk and dawn, during which time fish have been found to migrate and water and air temperatures will be cooler. Prior to arrival of fish, deployment and retrieval of nets will be practiced at the fishing site during the day to gain gear and site familiarity and promote safety.

The use of a tangle net with a 2:1 hang ratio is recommended, but it is recognized that different ratios may need to be tested over time. During tangle net evaluations conducted on the Columbia River, spring Chinook salmon immediate mortality rates were found to be higher in nets with a 3:1 hang ratio (1.6% for 3.5-in mesh, and 8.3% for 4.5-in mesh) than in nets with a 2:1 hang ratio (0.0% for 3.5-in mesh and 1.1% for 4.5-in mesh).

The use of 3.5-in mesh and 4.5-in mesh tangle nets will be evaluated. The larger mesh size may reduce the catch of non-target species, while improving catch efficiency of summer/fall Chinook salmon. Length and depth of panel will depend upon the fishing site. Nets will be fished from the surface to the bottom contours of the river. Nets will be set perpendicular to the flow and allowed to drift with the current.

In deep-water sites, nets can be deployed and retrieved by hand or by a deck-mounted hydraulic reel in an open skiff. However, short sets will be impractical if deploying and retrieving the nets by hand. Shorter soak periods have resulted in better fish condition upon capture and reduced mortality.

After deployment, the corkline will be monitored from one end of the net for any movement that would indicate the presence of a fish. The net will also be checked periodically to maintain a short soak time for any fish whose capture may have gone unnoticed and to clear debris.

Prior to redeploying the net, it will be checked for any tears in webbing and repaired. Tears in tangle net webbing have been found to increase incidences of fish caught by the gills, increasing potential for mortality (Vander Haegen et al. 2002).

4.3.4.2 Beach Seine

A crew of four people will initially be required to operate the beach seine. More or fewer people may be necessary depending on net length and site conditions. Prior to arrival of fish, deployment and retrieval of nets will be practiced at the fishing site to gain gear and site familiarity and promote safety.

Prior to redeploying the net, it will be checked for any tears in webbing and repaired.

4.3.4.3 Floating Trap-Net

Floating trap-nets will typically use a crew of three people and one boat. However, initial set up may require additional personnel and a second boat. One person will drive the boat and the others will help deploy and retrieve the net. After the fish are crowded, one person will take care of the boat and net. Another person will record data. The third person will handle and tag fish. Local tribal fishers and biologists will be contacted to participate.

The trap will initially be monitored twice a day and more frequently if there are significant numbers of fish captured.

Coordination with tribal and state enforcement agencies to monitor the trap for vandalism would reduce manpower demands on the fisheries technicians.

4.3.4.4 Fish Wheel

Initial setup of the fish wheel may require two boats and up to six personnel at the Lake Pateros site. Heavy equipment and operators may be required to anchor the frame in place. After set-up, the fish wheel would require a crew of three to fish the trap at least two times a day. Depending on the catch rate, the trap may require more or less monitoring.

4.3.4.5 Dip-Net Combination

Initial setup of weirs and scaffolding may require several personnel, depending on site location and choice of weir and/or scaffolding. Heavy equipment and operators may be required to provide secure anchoring points for attaching scaffolding, platforms, or weir components.

It will require at least three personnel to dip-net, handle fish, and record data.

4.3.5 Fish Handling

Broodstock collection efforts will begin after temperatures fall below 65 °F to minimize stress. In addition to general survival, stress levels approaching physiological tolerance limits can impair reproductive success, growth, and resistance to disease (Wedemeyer et al. 1990).

Any incidentally captured UCR steelhead trout will have first priority for fish handling and release to minimize the stress from capture and holding. Any other non-target species, such as sockeye salmon, will be returned to the river. Dead fish of all species will either be given to participating fishermen or donated to local food banks.

Upon retrieval, captured fish will be placed in a freshwater tank supplied with oxygen and artificial fish slime or a Fraser-type recovery box supplied with flowing water (see Vander Haegen et al. 2004 for a detailed description of Fraser-type recovery boxes). It is recommended to have several recovery boxes on hand. Chinook salmon have been held in recovery boxes from 2 to 81 minutes (Vander Haegen et al. 2002). Moreover, reduced post-release survival may warrant longer holding periods. If using a tank, water will be refreshed between sets. Water temperature and dissolved oxygen (DO) levels will also be monitored and documented. If fish are fully recovered, they may also be held in the river within the transfer tubes. Data will be recorded as indicated below. Fish will be handled with extreme care to promote survival; contact with the gill area and holding fish by the caudal peduncle will be avoided.

It is likely that the slime layer of the fish is disturbed during capture from rubbing against the net or rolling in the net. This can lead to secondary fungal infections, which may reduce survival to the spawning grounds or hatchery. In addition to taking care in handling the fish during net retrieval, tagging, and biological data collection, artificial fish slime may be applied to fish while being held in recovery boxes and while being transported to the hatchery.

During initial years of testing, a subset of all *released* fish will be marked with easily identifiable tags to evaluate long-term post-release survival. A subset of the marked fish will be equipped with radio-tags to document behavior after tagging and resulting spawning areas. ESA-listed steelhead trout may or may not be tagged depending on the collection permits issued by WDFW and NOAA Fisheries.

All fish transported to the hatchery will be marked with easily distinguishable tags showing which gear type was used in their collection and identifying individual fish. After tagging, the fish will be placed into the transfer tubes and then placed into the recovery tank until revived. Fish will then be transferred from the recovery tanks using the tubes, transported to the hatchery transport truck, and driven to the hatchery. Travel time from the collection site to the holding facility will be documented[2]. During the trial transports, water temperatures in the tank will be monitored at the collection site and upon arrival at the hatchery; ambient air temperature will be noted as well.

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[2] As the CJDH facility will not have been constructed at the time of this study, fish will either be taken to the Wells Hatchery or the Colville Trout Hatchery.

Dependent upon air and water temperatures present, fish may need to be acclimated prior to release into the hatchery holding ponds. It will be the responsibility of the hatchery manager to develop detailed transportation, acclimation, and disease protocols for the broodstock program.

Fish condition of all collected fish will be noted using the same categories as ongoing selective harvest evaluation studies being conducted in the lower Columbia River (see below). Condition 1 and 2 fish will be tagged and released immediately, while fish in Conditions 3-5 will be revived, tagged and released upon recovery. To facilitate tag recovery efforts, coordination will occur with WDFW personnel conducting spawning ground and creel surveys. Notices describing the tags and contact information will be posted at boat launches, recreational and tribal fishing areas, tribal meetings, and any fish collection sites upstream.

4.3.6 Data Collection

Catch location, crew members, time, weather conditions, air temperature, water temperature and set length (or fishing time) will be recorded for each set.

Fish species, including non-targeted bycatch, fork length, and sex of captured fish will also be noted for each set.

For tangle net gear, the method of capture for each fish will be recorded as indicated in the following bullets (Vander Haegen et al. 2002). This information will be used to determine correlation between immediate and delayed mortality and the manner in which the fish are caught in the net.

- Tangled by teeth or mouth
- Rolled in net
- Mouth-clamped (net wrapped around mouth, clamping it closed)
- Gilled (net around gills)
- Wedged (web around body further than gills)

For consistency with other selective fisheries evaluation studies (Vander Haegen et al. 2004), operators will document immediate mortality and condition of all fish captured and released using the following categories:

- Condition 1: vigorous
- Condition 2: vigorous and bleeding
- Condition 3: lethargic
- Condition 4: lethargic and bleeding
- Condition 5: no visible movement or apparent ventilation

Record tag numbers of all fish released and recovery time in recovery box, if applicable.

Record any additional observations related to the set.

Calculate catch per set, total CPUE, species-specific CPUE, and mortality rate per adult successfully captured for broodstock. This information will be used to refine fishing techniques and gear selection in following years.

4.3.7 Reporting

The finding of each year's broodstock collection activities will be summarized and presented in report format.

4.3.8 Study Costs

Costs for conducting the broodstock collection methods presented in this report are attached as Appendix A.

SECTION 5: DISCUSSION

Based on the literature review of existing selective fishing methods and the environmental conditions present in the Okanogan, it appears that hatchery broodstock may be successfully collected in both the Okanogan River basin, and the Columbia River with a minimum of mortality. However to minimize mortality rates, fishers must pay close attention to stream temperature at fishing sites, follow strict fish handling protocols, and be willing to use methods that may not be the most efficient, with respect to CPUE, for meeting hatchery broodstock needs.

The overall success of the broodstock collection effort should not be judged on CPUE, but rather on the mortality rates of the selected gear types on all species encountered. Fish collection methods that have lower efficiencies, but result in higher survival rates for listed steelhead trout, should be preferred.

The proposed study plan allows researchers to examine a range of broodstock collection techniques in various locations, both within and outside of the basin. As the literature review has shown, fishing success will depend not only on gear type, but also on the skill of the fishers. It is for this reason that we are suggesting that broodstock collection crews consist of both biologists and tribal members familiar with fishing sites and techniques. It is expected that both groups bring skills to the table that will maximize the success of the program, while reducing fish handling mortality.

We also suggest that more effort be expended on testing traditional fishing methods such as netting, construction of rock weirs, and traps, etc. The literature review indicates that the less fish are handled, the more likely they are to survive the capture process. Individual fishers stationed at key locations in the basin (rapids, falls, pools) should be able to quickly identify passing fish to species, thus allowing non-target species such as steelhead trout and sockeye salmon to pass. Additionally, if the fisher does collect a non-targeted fish, he will be able to quickly (within seconds) release the fish back to the stream.

The broodstock capture program should also be integrated with harvest activities in the basin. This approach should significantly reduce costs associated with broodstock capture, as these fishers will be able to provide staff for handling fish and also security for the traps. In addition, because of high water temperatures, and expected losses no matter how well fish are handled, having tribal fishers participate in the program will allow these fish (mortalities) to be utilized.

In order to meet natural spawning escapement and hatchery broodstock goals, estimates are required of total run size and composition. The summer/fall Chinook salmon run observed at Wells Dam includes fish originating from downstream of the Okanogan River (mainly the Methow River), as well as late- and early-running fish from the Okanogan/Similkameen and the Columbia River upstream of the Okanogan. Each of these components includes both hatchery- and natural-origin fish.

The objective of the run size assessment is to provide early and accurate abundance estimates of the late-running natural-origin and hatchery-origin components in order to direct broodstock collection activities so that both natural escapement goals (in numbers and hatchery to natural composition) and broodstock requirements can be met. Broodstock should be collected randomly throughout the full run.

Initial estimates of run size and composition need to be obtained from Wells Dam. As results from the planned radio tagging study become available, it may be possible to predict the proportion of naturally produced fish observed at Wells that are destined for the Okanogan. From observation at Wells Dam, preliminary estimates of the weekly natural-origin return of Okanogan fish can be obtained.. The preliminary estimates will be used to determine the number of natural fish needed for natural escapement and for hatchery broodstock[3].

The preliminary estimates from Wells Dam of the natural-origin (NORs) and hatchery-origin returns (HORs) of late summer/fall Chinook salmon would then be used to update the composition of the returns to the Okanogan. This update is needed to achieve sufficiently precise estimates to direct the management of both hatchery and natural escapements through selective capture of NORs and HORs in the Okanogan and Similkameen rivers. Ideally, from a management perspective, a weir would be installed and operated near the mouth of the Okanogan River that could intercept 100 percent of the returning adults. However, this would interfere with the upstream migration of Chinook salmon, listed steelhead trout, and sockeye salmon causing migration delays and unnecessary mortality risks. A better solution would be to intercept a portion of the run at random in a live-trap or other live-capture apparatus that could be operated continuously throughout the run. The question is, what trapping efficiency would be required to obtain a sufficiently precise estimate of run composition. This type of study could be conducted once gear types and methods are determined.

As an example, suppose we estimate the percent NORs entering the Okanogan River weekly by trapping N fish each week. If we further suppose that we want the coefficient of variation of the estimate to be less than 25 percent, then the question is, how many fish (N) must be trapped each week. The number N depends upon the true percent NORs as shown in Table 3.

The recommended procedure would be to obtain weekly estimates of Okanogan River returns from Wells Dam observations, including an approximate estimate of the percent NORs. These values would be used to update total Okanogan River run size and to determine the weekly sampling goal for the lower Okanogan trapping operation. The estimated composition from the trap would then be used to (1) refine the broodstock and natural escapement goals, (2) schedule the removal of natural returns for broodstock for the week, and (3) schedule the selective removal of HORs to achieve the natural escapement composition goal.

[3] Estimate of survival from broodstock capture to viable egg would be obtained from the hatchery operation. Based on these estimates the number of natural-origin broodstock that must be captured can be determined with an appropriate correction for prespawning mortality.

Table 3. Weekly trapping goal as a function of expected percent natural-origin returns (NORs) entering the Okanogan River each week. The required trapping efficiency depends upon the total return to the river.

Percent NOR	No. Trapped per Week
10%	182
20%	82
30%	50
40%	33
50%	24

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APPENDIX A- BROODSTOCK COLLECTION COST ESTIMATE

The estimated cost of the broodstock collection study is summarized in Table A-1. The following assumptions were used in developing study costs:

1) Researchers will purchase and test all gears described in the study plan over a single migration season. The accuracy of this assumption will not be known however until the results of the proposed adult radio-tagging study is completed 1-year prior to the first broodstock collection effort.
2) Field staff will be seasonal employees recruited to conduct the study. Thus, costs for hotels and food need to be accounted for in the budget. These costs can be reduced significantly, or possibly eliminated, if researchers are able to hire locally based field technicians.
3) The trucks needed to haul captured adults to holding facilities, and the holding facilities themselves, will be provided by state, tribal or federal agencies. Therefore, no monies have been allocated to these items.
4) Fuel costs and labor to operate transport trucks are included in the cost estimate.
5) Colville tribal biologists or fishers would be available to assist in the broodstock collection effort. Colville staff and equipment (boats, trucks, etc) are needed to help in the placement of traps and fish wheels, assist in adult capture activities, and to identify key fishing areas.
6) Hourly rates are based on typical consulting firm rates for the level of staff proposed.

Appendix A-1. Budget Summary For Colville Hatchery Broodstock Collection

Equipment

Type	Units	Cost Per Unit	Total
Fish Wheel (Variable Wheel Depth)	1	$75,000	$75,000
Tangle Net(s)	5	$5,000	$25,000
Picket Weir (Metal)	1	$15,000	$15,000
Floating Trap	1	$50,000	$50,000
Dip Nets/Misc Netting	10	$250	$2,500
Holding and Transfer Tanks	5	$500	$2,500
Misc. Equipment	1	$1,500	$1,500
Boat and Truck Rental	4	$2,000	$8,000
Reward (Tags)	250	$10	$2,500
Total			$182,000

Field Labor Costs

Staff	Units	Hours	Rate	Total
Senior Biologist	1	80	$135	$10,800
Lead Field Biologist	1	1000	$85	$85,000
Technician	3	1000	$50	$150,000
Hatchery Staff Assistance (Transport)	1	400	$50	$20,000
Total				**$265,800**

Travel/Per Diem

Type	Units	Cost Per Unit	Total
Housing	500	$40	$20,000
Food	500	$25	$12,500
Auto Mileage	5000	$0.35	$1,750
Total			**$34,250**

Report Writing/Data Analysis

Staff	Units	Hours	Rate	Total
Senior Biologist	1	40	$135	$5,400
Lead Field Biologist	1	100	$85	$8,500
Total				**$13,900**

Grand Total **$495,950**