Coho Spawning Survey Protocols

Spawning salmon (*Oncorhynchus* spp.) have been counted in Oregon coastal streams since 1948 to assess the status and trends of naturally produced spawning stocks. The history of this monitoring program is chronicled in Jacobs and Cooney (1997). Spawning surveys have been the Department’s primary tool for assessing the status and trends of naturally produced salmon stocks. This effort has focused on three species: chinook salmon (*O. tshawytscha*), coho salmon (*O. kisutch*), and chum salmon (*O. keta*). Jacobs et al. (2001) reports of survey based assessments for these species through the 1999 run year.

Beginning in 1998, returns of adult coho originating from Oregon hatcheries were essentially 100% marked with adipose fin-clips. This mass marking enables the proportion of natural spawning hatchery fish to be estimated from recovery of fin-marked carcasses.

Assessment Units

Long-term sampling associated with standard spawner surveys occurred in coastal basins south of the Columbia River to Cape Blanco. The National Marine Fisheries Service (NMFS) has designated two ESUs for Oregon coastal coho stocks (Weitkamp et al. 1995). The Oregon Coastal ESU encompasses all coastal basins north of Cape Blanco, including the entire Umpqua Basin. The Southern Oregon ESU begins at Cape Blanco and extends to Punta Gorda, California. Within Oregon, this ESU covers the Elk through Winchuck River basins and includes the entire Rogue Basin (Figure 2-1A). Long-term trend data on coho spawner abundance are available for each of these ESUs.

The Oregon Department of Fish and Wildlife has divided the Oregon Coastal ESU into three Gene Conservation Areas (GCAs) for coho salmon based on studies of genetic variation and life history traits (Kostow 1995; Figure 2-1B). This yields a total of four GCAs. The *Mid- to North Coast GCA* encompasses coastal drainage basins from the Necanicum River south to the Siuslaw River. The rivers in this GCA are relatively small and lie in the wet, temperate region to the west of the Coast Range. The *Umpqua GCA* includes the entire Umpqua Basin, including the North and South Umpqua Rivers, Smith River and Elk and Cow Creeks. The Umpqua Basin cuts through the coast range and has its headwaters in the Cascade Mountains. The lower basins draining the coast range are similar to those in the Mid-North Coast GCA, i.e. wet and temperate, but the upper basin is affected by snowmelt in the Cascades and by the relatively dry climate east of the Coast Range.

The *Mid to South Coast GCA* is not geographically contiguous. It covers the Siletzoos and Tahkenitich Lake Basins north of the mouth of the Umpqua, and continues south of the Umpqua to the northern tip of Cape Blanco (Sixes River). Major basins in this GCA include Tenmile Lakes, the Coos and the Coquille. The coho populations in the lake systems have a lake-rearing juvenile life history. The *South Coast GCA* includes the Rogue River drainage and small coastal streams south of Cape Blanco to the Oregon/California border. Patterns of ocean upwelling transition at Cape Blanco, and apparently affect the ocean distribution of salmonids. Like the Umpqua, the Rogue River cuts through the Siskiyou Mountains and has its headwaters in the Cascades. The upper basins are affected by the relatively dry climate east of the Siskiyou, and by snowmelt in the Cascades.

We adopted the coastal GCAs as Monitoring Areas (MA) associated with Oregon Plan funded assessments beginning in 1998. To provide more resolution in our assessments we further divided the Mid-North Coast GCA into two subsets: the *North Coast MA* and the *Mid-Coast MA* (Figure 2-1C). The *North Coast MA* encompasses coastal basins from the Necanicum River south to the Nesquwain and includes the Nehalem, Tillamook Bay and Nestucca Basins. The *Mid-Coast MA* covers the Salmon through Siuslaw Basins. Other major watersheds in this GCA include the Siletz, Yaquina and Alsea Basins.
Figure 2-1. Geographic strata for coho salmon for coastal areas in the state of Oregon. A) Evolutionary Significant Units (ESUs) as defined by the National Marine Fisheries Service. B) Gene Conservation Areas (GCA) as defined by the Oregon Department of Fish and Wildlife. C) Monitoring Areas established for monitoring associated with the Oregon Plan.
**Survey Design**

A spatially-balanced random sample was drawn using a Generalized Random Tessellation Statefied (GRTS) sample (Stevens 2002). A rotating panel design was incorporated to improve trend detection. In order to take advantage of the strict 3-year life history of coho salmon, one panel of sites rotates on three-year intervals and another panel rotates on nine-year intervals. There are two additional panels, one of which is sampled every year, and another which is novel each year (sites in this panel are visited in only one year). Where the spawning universe overlaps with rearing and habitat sampling universes, sharing of sites among projects is forced to maximize shared data among the three projects.

**Survey Procedure**

Seasonal personnel conduct intensive stream surveys to count spawning fish and redds (the nests in the gravel where salmon lay their eggs) in pre-established stream segments. Specific stream segments are surveyed for each species, however all species are counted in a given stream segment regardless of its specific target. Survey stream segments are sampled by either floating or walking every 7-10 days during the spawning season to obtain counts of live and dead fish and to counts redds. Counts of jacks (≤50 cm fork length) are kept separate from adults. Secondary information such as weather conditions, water clarity, and stream flow is also recorded each time a survey is conducted.

Carcasses of spawned-out salmon and steelhead encountered in all surveys are inspected for tags and fin-clips. Salmon carcasses with missing adipose fins are sampled for coded-wire tags by removing their snout. Scale samples are taken from the key scale area (Nicholas and Van Dyke 1982) to estimate rearing origin (hatchery vs. wild). Scale samples from fall chinook and chum salmon are also examined to estimate age composition. Sex, MEPS (mid-eye to posterior scale) length, sampling location, and date are recorded for each fish sampled.

**Methods**

**Measures of Spawning Escapement**

Peak count per mile in a given stream segment \( (H_i) \) was calculated as follows:

\[
H_i = \frac{P_i}{m_i}
\]

where

\[ P_i = \text{peak count of live and dead fish in stream segment } i, \text{ and} \]

\[ m_i = \text{miles surveyed in stream segment } i. \]

Average peak count per mile in a given set of stream segments \( (S) \) was calculated as follows:

\[
S = \frac{\sum_{i=1}^{n} P_i}{\sum_{i=1}^{n} m_i}
\]

where

\[ n = \text{number of stream segments surveyed}. \]
The total number of coho salmon (adults or jacks) spawning in a given stream segment throughout the course of the spawning season ($O_i$) was estimated using area-under-the-curve (AUC) techniques (Beidler and Nickelson 1980) using the following equation:

$$O_i = \left[ \frac{\sum_{h=1}^{a} (C_{hi}t_{hi})}{D} \right]$$

where

- $a =$ number of periods,
- $C_{hi} =$ mean count in period $h$,
- $t_{hi} =$ number of days in period $h$, and
- $D =$ average spawning life (days) of coho salmon in survey segments.

An average spawning life ($D$) of 11.3 days was used for coho salmon spawning in survey streams (Willis 1954, Beidler and Nickelson 1980, and Perrin and Irvine 1990). Survey data were screened to avoid making spawning density estimates for stream segments where few data points were available or significant portions of the run were missed. These qualification criteria pertained to: (1) the duration of the spawning season over which counts needed to be made, (2) the number of counts that needed to be conducted for each survey and (3) the number of times that the interval between successive counts could exceed ten days. Additionally, water visibility had to be acceptable (bottoms of riffles were visible) over the majority of the survey area. AUC estimates were not made for surveys that did not meet these criteria. If the first or last count in the index area was greater than zero, a count of zero was assumed to occur seven days before or after the actual count. These criteria were determined in part by stream flow conditions that existed during the spawning season and by examining the spawning timing observed during the survey season for each GCA. Most standard and random surveys were adequately conducted prior to and after coho salmon were observed in the spawning areas, providing confidence that we did not miss a notable portion of the spawning run.

The estimated spawning density (total fish per mile) for a given stream segment ($N_j$) was calculated as follows:

$$N_j = \frac{(O_j)/m_j}{(R_j)}$$

Unless, a previously unidentified migration barrier was identified in stream segment $i$, in which case:

$$N_j = \frac{(O_j)/R_j}{(R_j)}$$

where

$R_j =$ miles of coho salmon spawning habitat in reach $j$. 
The adult peak count per mile ($H_i$) and total number of adult coho salmon per mile ($N_i$) in a given stream segment were adjusted to eliminate the contribution of hatchery fish using the following equations:

$$H_i' = (H_i)(P_{S_k})$$  \hspace{1cm} (6)

and

$$N_i' = (N_i)(P_{S_k})$$  \hspace{1cm} (7)

where

$$P_{S_k} = \text{estimated proportion of total adult coho salmon spawners in coastal river basin or subbasin } k \text{ that originated from natural production.}$$

Values of $P_{S_k}$ were estimated from fin-mark recoveries. Adipose fin-marking occurred for all adult coho production at coastal hatchery facilities, thus the ratio of naturally produced coho could be calculated by dividing the number of unmarked coho carcasses by the total number of coho carcasses encountered. Fin-mark ratios were calculated for each major basin, and data were pooled within each MA. Only recoveries on random surveys were used. Values were calculated as follows:

$$PS_k = Ku + Cm$$  \hspace{1cm} (8)

where

$$Cu_k = \text{number of unmarked (naturally produced) adult coho carcasses in area } K,$$

and

$$Cm_k = \text{number of adipose fin-marked (hatchery produced) adult coho carcasses in area } K.$$  

The average total fish per mile ($T$) spawning in a given set of stream segments was calculated as follows:

$$T = \frac{\sum_{i=1}^{n} N_i}{n}$$  \hspace{1cm} (9)

where

$n = \text{number of stream segments surveyed, and}$

$N_i = \text{estimated total number of spawning fish per mile in stream segment } i \text{ (from equation 4, 5 or 7).}$
REFERENCES


