TECHNICAL REPORT 99-2

Cumulative Impacts on the Peoples of the Nez Perce, Yakama, Umatilla, and Warm Springs Indian Reservations from Construction and Operation of US Army Corps of Engineers' Dams in the Columbia River Basin Upstream of Bonneville Dam, Inclusive

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SUMMARY

Once-abundant Columbia River salmon — so highly valued by the Columbia River treaty tribes — are going extinct. Despite signing treaties promising that the tribes could continue to harvest the salmon essential to their cultural and material well-being, the US government has led in the destruction of those salmon. This report estimates some of the losses to tribal fisheries caused by one activity by one federal agency: the construction and operation of dams by the US Army Corps of Engineers (Corps).

We used published estimates of spawning habitat and run sizes to estimate the numbers of salmon lost 1) to destruction of spawning habitat by Corps dams, 2) to mortality of juveniles passing downstream through Corps projects, and 3) to mortality of adults passing upstream over those same projects. Low- and high-range estimates of run size were used to cover the potential range of losses. Separate estimates were produced for spring, summer, and fall chinook; coho; sockeye; and steelhead for each year from 1938 to 1995 for each type of loss, for total losses, and for losses net of tribal harvests of fish returning to federal mitigation hatcheries. We applied the 50:50 harvest sharing principles of *US v. Oregon* to determine the tribal share of the harvestable surplus of the losses. Losses were converted to pounds using species-specific average weights, and the revenue equivalence of the losses were generated from historical prices and an economic model. We report results only for Bonneville Dam and other Corps dams upstream of Bonneville; dams in the Willamette sub-basin are not included.

Total losses for all species/runs over the 58-yr period range from 44.7 million (low run size scenario) to 76.8 million fish (high run size scenario), with recent annual losses of 1.0 million to 1.7 million fish. Total period losses are lowest for sockeye (1.2-2.0 million) and highest for summer chinook (21.3 million to 36.1 million). Mitigation was very ineffective, compensating for less than 1% of the tribal numerical losses. These losses are equivalent to $3.1 - 5.4 billion in revenue. However, the words of tribal members testify to the inadequacy of describing, in dollar terms, the full magnitude of the loss of this sacred resource that is the foundation of their spiritual, cultural, and material well-being.

INTRODUCTION

The Columbia River tribes flourished both culturally and economically prior to the settlement of the region by non-Indians. At the center of the tribes' spiritual and trading activities was the salmon, 11 million to 16 million of which returned annually to the Columbia River (NPPC 1986b). Prior to development, the four treaty tribes that presently compose the Columbia River Inter-Tribal Fish Commission[1] (CRITFC) harvested approximately 16 million pounds of salmon annually (Meyer 1999), the equivalent of up to 2 million fish. However, runs in recent years have ranged from 0.7 to 2.9 million salmon, and tribal harvests have averaged only about 0.1 million fish.

Treaties signed by the United States government promised that the four treaty tribes would be able to use and enjoy — in perpetuity — the natural resources upon which tribal culture depends. The federal government, through the Department of Defense and other departments, has been a major developer of the Columbia River. The US Army Corps of Engineers (Corps) constructed most of the federal hydropower system in the Columbia River.

Tribal communities have been and still are adversely affected by federal actions that have contributed to the decline of the region's natural resources. Corps dams have blocked access to salmon spawning habitat, killed migrating juveniles, and obstructed the upstream migration of returning spawners. Losses to the tribes — in both cultural and material terms — have been substantial.

This report documents the extent of some of the losses to the four CRITFC tribes caused by Corps dams. Limited time and data encouraged us to focus strictly on dam/reservoir impacts to the exclusion of other Corps activities that also influence salmon survival: navigation channel dredging and maintenance (see e.g., USACE 1998), filling and diking wetlands (Sherwood et al. 1990), creation of habitats that favor salmon predators (Roby et al. 1998), etc. For similar reasons we examined only the Corps dams upstream of Bonneville Dam, inclusive (Fig. 1), to the exclusion of Corps dams in the Willamette River sub-basin. Hence, total losses to the tribes caused by Corps activities exceed the levels we report here.

We highlight the revenue equivalent aspect of the losses, because it is relatively easy to quantify and relatively easy for contemporary western cultures to understand. The losses in this report reflect only foregone past fishing opportunities; they do not consider potential future losses. Also, we acknowledge that spiritual, cultural, and subsistence losses to the tribes are far more severe than the revenue impacts reported here.

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[1] The Nez Perce Tribe, the Confederated Tribes of the Umatilla Indian Reservation, the Confederated Tribes of the Warm Springs Reservation of Oregon, and the Confederated Tribes and Bands of the Yakama Indian Nation.

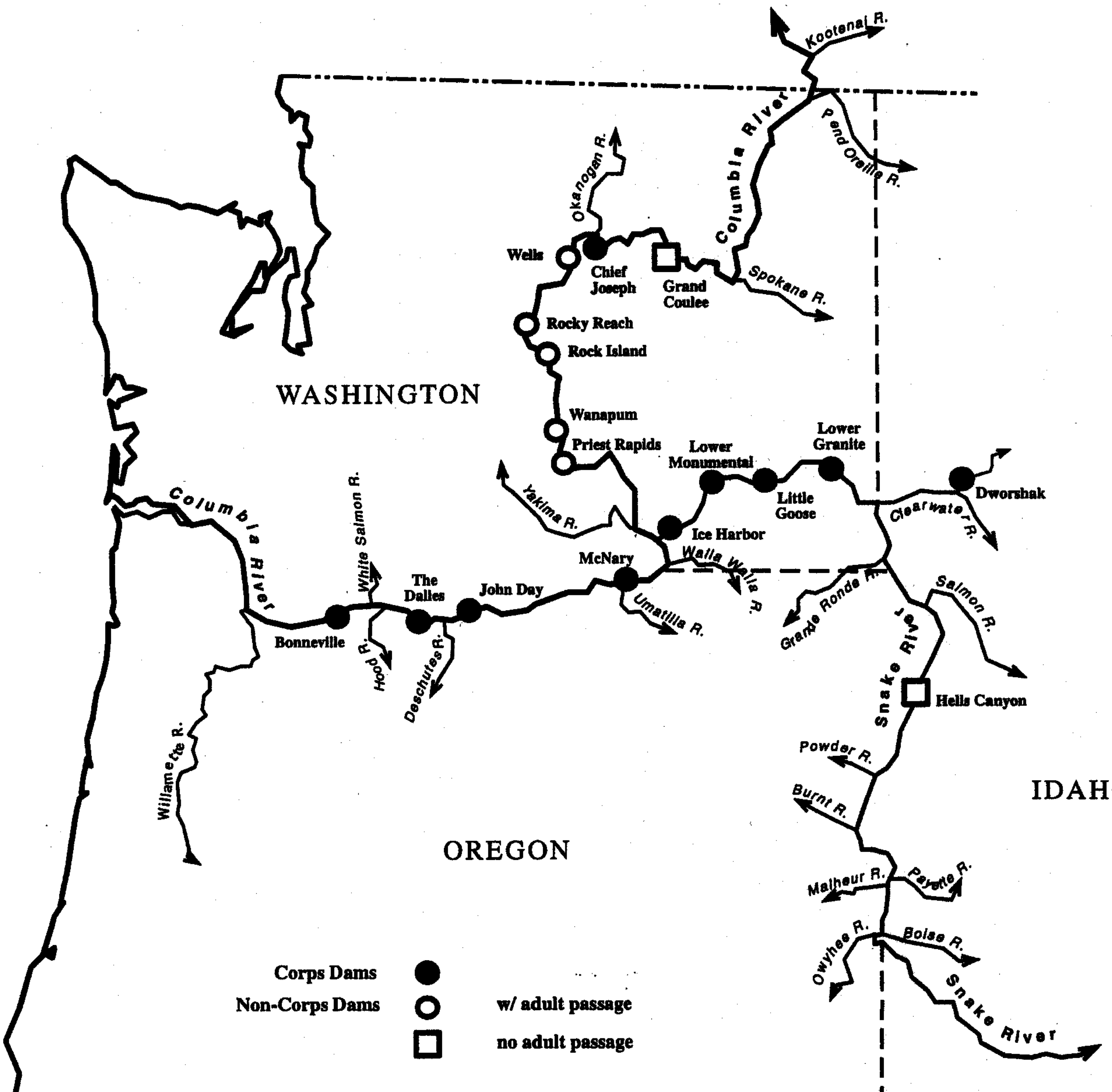

Figure 1. Dams and major dammed tributaries of the Columbia R. and Snake R. mainstems. See Appendix Table B for additional dam information.

STUDY PROCEDURES

Numerical Losses to Tribal Harvests

Overview

We identified three ways that Corps dams have reduced the number of anadromous salmonids available for tribal harvest (Fig. 2):

- ▹ Spawning area lost to inundation and to dams that blocked upstream migration (***Spawning Area Loss: Lost Production Potential***).
- ▹ Juveniles lost when passing dams and reservoirs during their downstream migration (***Juvenile Passage Loss***).
- ▹ Adults lost during their upstream migration over dams and through reservoirs (***Adult Passage Loss***). This includes adults lost prior to their arrival in the tribal fishing area (*Pre-Harvest*) and adults that must be passed through the fishery as additional escapement to compensate for adult passage loss upstream of the fishery (*Escapement*).

We used a system of Quattro Pro 5.0 spreadsheets to estimate the magnitude of each of these losses by species/run and by year and to estimate the part of the loss that would otherwise have been harvestable by tribal fishers. Lost production due to spawning area loss is apportioned into escapement that would have seeded the lost area and into harvestable surplus. However, all of the juvenile and adult passage losses are considered to be fish that otherwise would have been part of the harvestable surplus. Lost harvest is apportioned equally to tribal and to non-tribal fisheries according to the 50/50 sharing principles of *US v. Oregon* (CRFMP 1988).

We accounted for mitigation of these losses by estimating and subtracting the tribal harvest of fish returning to hatcheries funded under federal mitigation programs (***Mitigation Credits***). The effect of these net losses of salmon on tribal culture and material well-being is then discussed (***Valuation of Tribal Losses***). Finally, commercial revenue equivalents based on these levels of losses are calculated using an economic model. Methods are described in detail below.

Spawning Area Loss: Lost Production Potential

Spawning area has been lost as dams flooded spawning areas and blocked upstream passage. As spawning areas were lost, fewer fish were produced and fewer fish were available to tribal fisheries. We estimated the magnitude of this lost production potential by using published estimates of pre-development run sizes and extent of spawning area. We assumed that:

- Salmon have been distributed uniformly across all spawning areas, and all spawning areas produced an equal number of recruits per spawner. Stated another way, all spawning areas were equally productive per unit area.

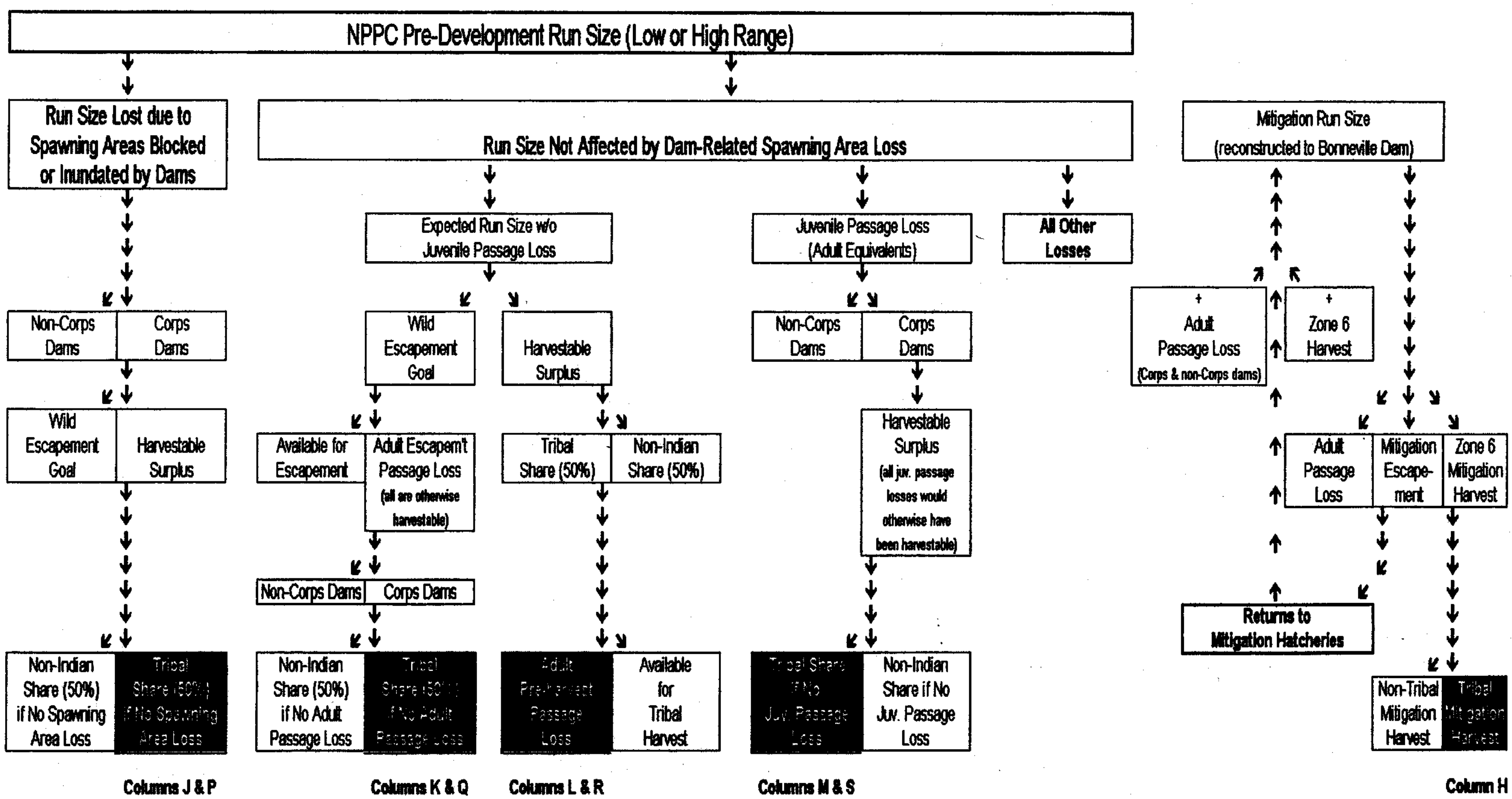

Figure 2. Derivation of net tribal harvest losses from four dam-related sources based on pre-development run size estimates. References to "Column" correspond to labelled columns in Appendix Table F.

- Changes in salmon abundance have been directly proportional to changes in spawning area[2].
- All environmental variables, including ocean harvest, have had a constant effect on production and survival.

We estimated the number of adults of each species/run potentially spawning in or produced **per unit of spawning area** for the Columbia R. Basin as a whole — rather than just the portion of the basin above Bonneville Dam — because basin-wide estimates of pre-development run sizes have been published by the Northwest Power Planning Council (NPPC 1986b). The NPPC's well documented estimates are based on extensive research of other pre-development salmon population estimates (e.g., Junge 1980).

Important Note: Although we use basin-wide estimates of run size and spawning area to determine the average number of fish produced per unit of spawning area, in this report we present only the losses associated with Bonneville Dam and other Corps of Engineer dams upstream of Bonneville.

These basin-wide estimates of run size were divided by estimates of basin-wide total spawning area to obtain average numbers of adult fish spawning in/produced by each unit of spawning area. Past and present amounts of spawning area for sockeye — surface area of nursery lakes — was provided by Mullan (1984). Past and present spawning "areas" (i.e., stream kilometers) used by all other species/runs were derived from maps in Fulton (1968, 1970). These maps were enlarged 200%, and the stream sections used for spawning were measured using either a map distance measuring device[3] or a curvilinear filament, both of which were calibrated against the scales on the individual maps[4]. Total stream length was **not** used in this analysis. For example. the Lewis R. is 145 km long, but the spawning area used by fall chinook includes only 62 km.

Fulton's maps use color-coded lines to show present and former areas of the stream that were used by various species. We measured the entire stretch of color-coded areas regardless of the type of line (solid or broken) on Fulton's maps. However, large gaps

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[2] For example, the pre-development spawning area would produce the pre-development salmon abundances, a loss of half of the pre-development spawning area would produce a salmon return of half of the pre-development abundances, and a loss of all spawning areas would result in the loss of all salmon.

[3] *Route Roller,* sold by Austin House.

[4] *Errata* — postscript:
The scales on maps 1 and 7 in Fulton (1970) were published incorrectly. They should have been from 0 to 40 km, not from 0 to 20 km as published. This error was not discovered until after our analysis was completed. Therefore, when using map 1 we underestimated the steelhead spawning areas above Oxbow Dam in the Snake River and above The Dalles Dam in the Columbia River. Steelhead spawning area estimates for the Lower Columbia (map 2), the Willamette (map 3), Clearwater (map 4), Grande Ronde and Imnaha (map 5), and Salmon (map 6) Rivers were not affected. Likewise, when using map 7 we underestimated the spawning areas for coho. This affected the spawning areas above The Dalles Dam, but not those in the lower Columbia (map 8) nor the Willamette rivers (map 9).

between solid or broken lines were not included in the estimate (e.g., the area between the Clackamas and the Collawash rivers for coho (Map 9) and in the White Salmon R. for fall chinook (Map 5), respectively).

Fulton (1968) combined spring and summer chinook spawning areas on his maps. We examined Fulton's text, the All Species Review (TAC 1997), and StreamNet[5] database to determine which streams had only spring chinook present, which had only summer chinook, and which had both (Appendix Table A). Only the streams above Hells Canyon and Grand Coulee dams confronted us with no information. Because the Weiser, Boise, and Malheur rivers and Rock Creek (all of which are above Hells Canyon Dam) only had spring chinook (Fulton 1968; TAC 1997; Streamnet Online Database), we assigned the rest of the spawning area above Hells Canyon to spring chinook. Because only summer chinook were reported in the Okanogan River (just below Grand Coulee Dam) and in the mainstem area between Priest Rapids and Chief Joseph dams, the spawning area above Grand Coulee Dam was assigned to summer chinook.

The total pre-development production potential that existed above Bonneville Dam is a product of the amount of area above there and the average number of adult fish spawning in/produced by each unit of spawning area. However, much of the pre-development spawning area has been lost to dams and other reasons.

Each Dam's Share of Spawning Area Loss

Spawning areas used prior to development presently fit into one of the following categories:

1. Still used by salmon,
2. No longer used because of a dam (i.e., spawning area inundated or fish passage blocked), or
3. No longer used because of other reasons (e.g., dredging, irrigation diversions, or some other documented reason)[6].

When it was unclear whether a loss was caused by a dam (Category 2, above) or caused by another development (Category 3), we were conservative in attributing losses to dams. Only those dams that NPPC (1980) identified as having good documentation of past or

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[5] Adult Return-Redd Counts trend list. Gladstone (OR): StreamNet [5 May 1998]. URL:<http://www.streamnet.org:81/Scripts/esrimap.dll?name=SNQuery&cmd=Main>. Data Category = "Adult Return-Redd Counts"; Species = "Chinook"; Run = "Spring"; Columbia Basin = "1. entire Columbia River Basin".

StreamNet is an internet-accessible database created by the Pacific Northwest's fish and wildlife agencies and tribes, funded by Bonneville Power Administration under contract number 95BI65130, and residing on an Pacific States Marine Fish Commission server in Gladstone, Oregon.

[6] Sockeye and fall chinook are the only species that had no pre-development spawning area in the "other" category.

present fish usage — i.e., labeled "Y" in Table C-1 of Appendix D of NPPC (1986a) — were used in our analysis, unless noted otherwise. For example, in the Tucannon R., Fulton (1968) stated that spring and summer chinook runs were depleted by obstructions and diversion. However, NPPC (1986a) indicates that none of the dams blocked fish passage. Therefore, spawning area loss was placed in the "other reasons" category (#3, above), and the loss attributable to dams was assumed to be zero.

In another example in the Yakima R., spring chinook losses were attributed to irrigation diversions. NPPC (1986a) lists several dams on streams with a historical fish presence. However, we were not clear which dam(s) contributed to the irrigation diversions. Therefore, this particular loss was also added to the "other reasons" category (#3, above).

In still another example, Fulton (1968) stated that the spring chinook runs in the Crooked R. and Trout Creek (both Deschutes R. Basin) were wiped out chiefly by removal of water for irrigation, but that spring chinook still spawned above Pelton and Round Butte dams (Map 1). On the other hand, NPPC (1986a) indicated that Pelton Dam blocked fish passage. In this case, we estimated the proportion of total habitat loss attributable to dams to be zero until 1957, because Equation 1 is based on Fulton's maps. A similar situation exists in the Salmon R. Fulton (1968) stated that about 18 km of spring chinook spawning area were lost in the North Fork due to dredging, but he did not show this on his map. Again, we estimated the proportion of total habitat loss, this time attributable to other reasons, to be zero, because Equation 1 is based on Fulton's maps.

If our sources were not clear about when spawning area was lost, then we assumed that the loss began before 1938, the year that Corps dams started impacting the runs (Appendix Table B). For example, spawning area for spring chinook in the Yakima R. has been reduced from 444 km to 84 km due to non-Corps dams and other developments, but the timing of the losses is not clear. Therefore, we assume all of these losses occurred before 1938. Such an assumption is conservative for this analysis, because it reduces the potential run size during the years when Corps dams caused passage losses.

The amount of loss, if any, attributed to a particular dam also depends on its unique situation, especially relative to the construction of other dams (Table 1). When a loss was attributed to a dam, we assumed that the habitat loss and the fish loss began the year the dam was completed[7].

Again, we used basin-wide measures of run size and spawning area to derive an estimate of fish produced per unit of spawning area, but our cumulative loss estimates were derived only for the area above Bonneville Dam. Although we calculated the losses attributable to all dams (Appendix Table B), this report presents only the losses associated with Corps dams.

[7] On the one hand, actual blockage of fish passage may begin before a dam is completed. For example, blockage of chinook passage at Grand Coulee began in 1939 (Fish and Hanavan 1948), but this project was not completed until 1942. On the other hand, salmon will continue to return for 2-6 yr after a spawning area is lost, depending on the species' age at maturity.

Table 1. How we treated spawning area losses based on special situations.

Situation	Treatment	Example
Dam was built upriver of a blockage.	Proportion of total habitat loss for this dam was estimated to be zero (to preclude double counting).	On the Snake River, the share of total spawning area loss for C.J. Strike Dam (completed in 1953 above Swan Falls Dam, which was completed in 1910) was estimated to be zero. The loss estimate for Swan Falls Dam included spawning areas above C.J. Strike Dam.
Dam was built downriver of a blockage and spawning area was inundated between the two dams.	Proportion of total habitat loss was limited to the spawning areas between the dams that was inundated.	For example, Chief Joseph Dam was built below Grand Coulee on the Columbia River. Chief Joseph Dam's share of the total loss is 36 km of inundated summer chinook spawning areas between the two dams in 1955. Grand Coulee's share is the 958 km blocked in 1942.
Fish runs were depleted before the dam was constructed.	Proportion of total spawning area loss was estimated to be zero. The loss was placed in the "other reasons" category.	Anderson Ranch Dam on the Boise River (spring and summer chinook).
Fish runs were depleted before the dam was constructed but something about a dam prevented the runs from rebuilding.	Estimate spawning area loss.	Cottage Grove Dam on the Coast Fork of the Willamette River discharges warm water, which prevents use by spring chinook in downstream areas.
Fish runs were depleted or prevented from rebuilding for reasons other than the dam, and it appeared that the dam did not block fish passage.	Proportion of total spawning area loss was estimated to be zero.	Chinook losses on the Umatilla River appear to be due to irrigation withdrawals.
Temporary blockages in the Clearwater R.	Assign a spawning area loss for spring chinook of 792 km to Lewiston Dam between 1927 and 1940. Between 1941 and 1970, revise this loss to 762 km to account for the new ladder. The 30 km regained in 1941 is then permanently lost when Dworshak Dam was completed in 1971.	There were about 792 km of spring chinook past and present spawning area in the Clearwater River according to Fulton's (1968) maps. Between 1927 and 1940, a temporary blockage to spring chinook passage occurred Lewiston Dam. Although the Lewiston Dam fish ladder was improved in 1941, NPPC (1986a) indicated the chinook runs were practically exterminated by 1938. Fulton (1968) showed only 30 km of spawning area in the North Fork in use on his maps, which we presume to be the spawning area used after the new ladder was built. While there were other spawning areas available, they were not used by spring chinook (Fulton 1968). Dworshak Dam was completed in 1971 and blocked spring chinook passage into the only remaining habitat, which was in the North Fork.

We calculated each dam's share (proportion) of the total loss due to inundated spawning areas or blockage by dams as

$$p_{dam} = \frac{a_{loss,\,dam}}{\sum a_{predevelopment} - \sum a_{loss,\,other\ reasons}} \qquad (1)$$

where: p_{dam} = proportion of pre-development spawning area lost per dam[8]
$a_{pre\text{-}development}$ = pre-development spawning area

For example, Ochoco Dam (Deschutes R. drainage) blocked an estimated 20 stream km of spring chinook spawning area (i.e., $a_{loss,Ochoco}$ = 20). The total spring chinook pre-development spawning area (i.e., $a_{pre\text{-}development}$) was estimated to be 8,907 km, of which 2,997 km were lost to other reasons (i.e., $a_{loss,\ other\ reasons}$). Therefore, the proportion of pre-development spawning area lost as a result of Ochoco Dam, (i.e., p_{Ochoco}), was estimated to be 0.003 of the pre-development area either still in use or lost because of dams.

Converting Spawning Area Loss to Tribal Harvest Loss

Only part of the fish lost due to spawning area loss would have been harvestable by the tribes. Some of the returning fish would have been allowed to escape to seed the spawning areas; other fish would have been harvested in non-tribal fisheries. The estimates of tribal harvest loss derived from our estimates of spawning area loss are based on the following assumptions:

- Pre-development harvestable surplus = upriver pre-development run size - upriver pre-development escapement goal[9].
- "Treaty Indian and non-Indian fisheries shall share equally (50% each) the upriver" harvestable surplus (CRFMP 1988). Upriver stocks are those salmon and steelhead that spawn above Bonneville Dam.
- All of the non-Indian share is harvested below Bonneville Dam[10].

In the steps and examples below, if only the lower run size range is shown, then a separate calculation is required for the upper run size range and vice versa. Likewise, the examples show only the upriver stocks. A separate calculation is required for the lower

[8] $p_{dam} + p_{other} + p_{in\ use} = 100\%$

[9] Escapement goals are linked to spawning area. Unlike NPPC estimates of pre-development run size, pre-development spawning area has no lower and upper range estimates. Therefore, there are no lower and upper range estimates for escapement goals.

[10] Assume the entire non-Indian share is harvested below Bonneville Dam. In reality, some of the harvest in the form of sport fishing occurs above Bonneville Dam.

river stocks[11].

Step 1: Pre-development Escapement Goal

We calculated the pre-development escapement goal from the present-day escapement goal and the present-day proportion of remaining spawning area:
where: EG = escapement goal at Bonneville Dam

$$EG_{predevelopment} = \frac{EG_{1975}}{1 - \sum p_{above\ BON,\ dam}} \tag{2}$$

Example 1: [Simple: **none** of the historical spawning areas were lost to "other" reasons] If the 1998 wild[12] upriver[13] fall chinook escapement goal at Bonneville Dam were 66,000, and if the 1998 upriver fall chinook spawning area represented 18.9% of the pre-development spawning area above Bonneville Dam, then the pre-development upriver fall chinook escapement goal was estimated to be 350,000 (i.e., 66,000/0.189).

Example 2: [Complex: **some** of the historical spawning area was lost to "other" reasons] There were 7,521 km of pre-development spawning area for spring chinook above Bonneville Dam. About 4,524 km were either still available or lost because of dams and the remaining 2,997 km were lost to "other" reasons. In 1998, there were only 1,274 km of spring chinook spawning area remaining above Bonneville Dam. The 1.274 km represents 24% of the 4,524 km pre-development spawning area above Bonneville Dam not lost to other reasons. In 1998, the wild upriver spring chinook escapement goal was 46,100. The escapement goal of 46,100 divided by 0.47 yields an upriver pre-development goal of 164,600, exclusive of pre-development spawning area lost to other reasons.

Step 2: Pre-development Harvestable Surplus

We calculated the pre-development harvestable surplus, $h_{total,\ year}$, by subtracting the pre-development escapement goal from the pre-development run size:

$$h_{surplus,\ predevelopment} = n_{predevelopment} - EG_{predevelopment} \tag{3}$$

where: h = harvest
$n_{pre\text{-}development}$ = either lower or upper range NPPC pre-development run size

[11] Lewis, Cowlitz, etc.

[12] Excludes hatchery stocks.

[13] Excludes fall chinook that spawn below Bonneville Dam.

For example, if the lower range pre-development run size for upriver fall chinook were 1,076,000 and the pre-development escapement goal were 350,000, then the corresponding pre-development harvestable surplus would be 726,000.

Step 3: Pre-development Treaty Indian Harvest Share

We assumed the treaty tribes are entitled to a 50% share of the harvestable surplus (CRFMP 1988):

$$h_{50\%\ share,\ predevelopment} = \frac{h_{surplus,\ predevelopment}}{2} \tag{4}$$

For example, if the pre-development upper range run size estimate for the upriver fall chinook stock were 1,829,000, and if the corresponding escapement goal were 350,000, then the harvestable surplus was estimated to be 1,479,000, and the treaty tribes' 50% share would be 739,500.

Step 4: Tribal Loss due to Spawning Area Loss

The loss in tribal harvest due to spawning area loss is the difference between the pre-development harvest share and the harvest share[14] for the year in question.

$$L_{habitat,\ tribal} = h_{50\%\ share,\ predevelopment} - h_{50\%\ share,\ year} \tag{5}$$

where: $L_{habitat,tribal}$ = tribal share of the lost harvest related to lost spawning area
$h_{50\%\ share,\ year}$ = 50% harvest share for the year in question (defined below in Equation 10).

For example, if the 1975 upper range run size of the upriver fall chinook stock were 344,900, and if the corresponding escapement goal were 66,000, then the harvestable surplus for that year was estimated to be 278,900 and the 50% share would be 139,450. The difference between the 1975 and pre-development 50% share is the estimated loss due to spawning area loss, i.e., 600,050.

Juvenile Passage Loss

We estimated juvenile passage losses for each species/run and year by:

1. Beginning with ***potential run size*** in each production area, which is based on pre-development run size per unit of spawning area, then
2. Calculating losses during downstream passage at each dam during the outmigration

[14] Defined in Equation 10.

years of each brood year's cohort, and finally

3. Assigning those losses to appropriate return years based on the ocean age distribution of the species/run.

These losses are expressed as adult equivalents (AEQ) at Bonneville Dam, the lower boundary of the Zone 6 treaty harvest reach. All calculations use AEQ, the adults represented in the original potential run size estimates.

Potential Run Size

Potential run sizes — and methods for distributing them among production areas — are described above under *"Spawning Area Loss: Lost Production Potential."* In general, the production potential (or i.e., potential run size) of a given portion of a river system is the product of the spawning area still available and the basin-wide density of spawners per unit of spawning area prior to development. For these estimates, numbers of fish from production areas (again, AEQ) are aggregated into groups corresponding with the nearest downstream dam at which passage mortality might be incurred. For example, fish produced in the Grande Ronde, Imnaha, and Salmon rivers are aggregated into the Lower Granite group, because Lower Granite is the first dam the smolts would encounter if outmigrating in 1975 or later.

Loss Calculations

Juveniles resulting from a production year (i.e., brood year, BY), outmigrate through downstream dams in one or more subsequent years, depending on their freshwater life history (Table 2). For example, we assume that 100% of fall chinook migrate as subyearlings one year after their brood year (BY+1), whereas 89% and 11% of juvenile sockeye outmigrate in BY+2 (i.e., as yearlings) and in BY+3, respectively (Table 4). Subyearling migrants are assumed to experience a mortality rate of 0.354 per dam/reservoir project, and yearling and older migrants are assumed to have a mortality rate of 0.194 per project.

The per-project mortality rate for yearling and older migrants is based on an estimated 66% **reduction** in recruitment for Snake R. spring chinook (yearling migrants) attributed to inriver passage (including transportation) through five dams (Lower Granite to John Day) by Deriso et al. (1996). This 66% reduction equals a cumulative survival of 0.34 through five dams/reservoirs and, hence, an average mortality rate of 0.194 per project. This rate...

> *...is a "net" effect mortality estimate because it reflects the overall impacts of dam passage over the complete life cycle, including direct losses due to trauma at the point of dam passage, increased "natural mortality" owing to longer smolt residence time in reservoirs, latent mortality due to a weakened condition of smolts, and the benefits or detriments of transportation by barge of some Snake River smolts down-river to below the Bonneville dam* (sic). (Deriso et al. 1996, p. 5-6)

Table 2. Freshwater age distributions used for species/runs. BY = Brood Year.

	Freshwater Age (Outmigration Year)				
Species/Run	0 (BY+1)	1 (BY+2)	2 (BY+3)	3 (BY+4)	Source
Chinook					
Spring	0	1.000	0	0	Assumed.
Summer					
Snake R.	0	1.000	0	0	Assumed.
mid-Columbia R.	1.000	0	0	0	Assumed.
Fall	1.000	0	0	0	Howell et al. (1985a), Table 7, p. 415; 1970-83.
Coho	0	1.000	0	0	Assumed.
Sockeye	0	.890	.110	0	Schwartzberg and Fryer (1988-90); Fryer and Schwartzberg (1991, 1993, 1994) Fryer et al. (1992); Unweighted means for 1987-93.
Steelhead	0	0	.625	.375	Howell et al. (1985b), John Day summer steelhead, Table 9, p. 836; unweighted means for 1955-61, 1982-83, and 1983-84.

This estimate of project mortality was used for yearling and older migrants for all dam projects and all years.

Unfortunately, a similar estimate of reach or system survival for subyearling migrants is lacking. Therefore, we estimated their per-project passage mortality rate with a spreadsheet model based principally on transport/control ratios (T/C) at McNary Dam (AHTRG 1992) and the assumption that transported **subyearlings** have the same survival (0.619[15] through immediate and delayed mortalities) as transported **yearlings** (Appendix Table C). The system survival (per project) of subyearlings is then determined by iteratively (and arbitrarily) adjusting the survival values associated with the various passage routes so that the cumulative survival of inriver migrants below McNary Dam produced by the model is consistent with empirical estimates of T/C from transportation studies conducted at McNary Dam (AHTRG 1992). The model also uses empirical values of flow and spill reported for all dams up through McNary (USACE 1988-95) and assumptions about subyearling fish guidance effectiveness and spill efficiency (see Appendix Table C). The resulting value for per-project mortality was applied to all dam projects, including those on the Snake River, for all years.

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[15] This survival rate corresponds to a system survival of 0.806/project, a T/C of 1.048/project (AHTRG 1992) and the average proportion of yearlings assumed to have been transported in the years 1988-95, based on empirical measurements of discharge and spill at McNary Dam (USACE 1988-95) and an assumed FISH GUIDANCE EFFICIENCY of 0.60 and a spill efficiency of 1.0.

Subyearling and yearling-and-older outmigrants in each year (still AEQ) are then passed separately downstream via a spreadsheet model that accumulates mortalities and decrements the surviving cohort for each Corps and non-Corps project in the downstream path. We assume that mortalities began in the year the dam was completed (Appendix Table B).

Temporal Distribution of Juvenile Passage Losses

The losses to the runs and to the tribal fisheries resulting from juvenile passage mortalities are assigned to the years in which the adults (including jacks) would have returned to spawn. Hence, losses from a particular outmigration year are assigned to subsequent return years according to the ocean age distribution of the species/stock in question (Table 3). Therefore, the loss estimated for a particular return year comprises individual fish that were produced in several brood years and outmigrated in several different years.

Table 3. Ocean age distributions used for species/runs.

	Ocean Age						
Species/Run	0	1	2	3	4	5	Source
Chinook							
Spring	—	.052	.598	.345	.005	—	Fryer et al. (1995), unweighted means for 1990-94 from their Fig. 5.
Summer	—	.109	.267	.453	.167	.004	Fryer et al. (1995), unweighted means for 1990-94 from their Fig. 6.
Fall	—	.358	.216	.334	.091	—	Howell et al. (1985a), Table 7, p. 415; unweighted means for 1970-83.
Coho	.350	.650	—	—	—	—	Weighted mean ratios of jack to total counts at Bonneville Dam for 1966-95, USACE (1995), Table 21.
Sockeye	—	.089	.809	.102	—	—	Schwartzberg and Fryer (1988-90); Fryer and Schwartzberg (1991, 1993, 1994); Fryer et al. (1992). unweighted means for 1987-93.
Steelhead	—	.513	.444	.043	—	—	Howell et al. (1985b), John Day summer steelhead, Table 9, p. 836; unweighted means for 1955-61, 1982-83, and 1983-84.

Because the juvenile passage losses are accounted for as AEQ, ocean mortalities are already factored in. This method tacitly assumes that conditions in the ocean and elsewhere downstream of Bonneville Dam are sufficient from year-to-year to consistently reproduce the number of adults that were present in the production year at the beginning of the juvenile passage model.

All juvenile passage losses otherwise would have been harvestable (i.e., in excess of escapement needs), with the tribes entitled to a 50% share of that harvest.

Adult Passage Loss

Adult passage loss is calculated from interdam conversion rates: the proportion of fish counted at one dam that can be accounted for at the next upstream dam after subtracting for harvest and tributary "turn offs" between the two dams. One minus the conversion rate represents the passage loss rate. If harvest and tributary "turn offs" remained constant, then passage losses would increase whenever additional dams with fish passage facilities were completed, but would decrease whenever spawning areas were lost.

We identified and estimated two types of adult passage loss based on whether the loss occurs before or after the fish have migrated through the tribal fishing area (i.e., Zone 6). Adult passage loss downstream of and within the treaty fishing area (i.e., **Pre-harvest Passage Loss**) means that fewer fish are available to harvest, whereas passage loss at dams farther upstream (i.e., **Escapement Passage Loss**) means that more fish must be allowed to escape the tribal fishery to ensure that escapement goals into spawning areas are met. Both types of adult passage loss are taken directly out of the harvestable surplus, of which the tribes are entitled to a 50% share.

In making these estimates we employed the following assumptions:

- For calculating interdam conversion rates, all fish ladders were 100% functional, without any temporary blockages.
- There were no dams during the pre-development period; hence, no pre-development passage loss.
- All spawning area losses without a known start date occurred before 1938. For example, spring chinook spawning area potential in the Grande Ronde was reduced because of water withdrawn for irrigation and gold dredging (Fulton 1968) without a known start date.
- Zone 6 harvests in all years were distributed among the three reservoirs according to the 1989-96 average distribution: 58.0% in Bonneville pool, 18.1% in The Dalles pool, and 23.9% in the John Day pool (fish ticket data from ODFW).

We used average interdam conversion rates for the years between 1938, when Bonneville Dam was completed, and 1975, when Lower Granite Dam was completed. Average 1979-95 conversion rates for sockeye and for spring and summer chinook and average 1986-1995 conversion rates for fall chinook were obtained from TAC (1996a) and TAC (1996b), respectively. Conversion rates for the other species/runs were estimated from the known rates (Table 4).

Pre-harvest Passage Loss

Pre-harvest passage loss is the mortality suffered by upstream-migrating adults at Corps projects prior to and within the Zone 6 tribal fishery.

Table 4. Interdam conversion rates used in this analysis, by reach and by species/run.

Reach	Dams	Chinook Spring	Chinook Summer	Chinook Fall	Coho[a]	Sockeye	Steelhead[b]
Lower Columbia R.	Bonneville The Dalles John Day McNary	.8993	.9428	.9575	.95015	.9873	.9575
Lower Snake R.	Ice Harbor Lower Monumental Little Goose Lower Granite	.9394	.9676	.7871	.87735	.9962	.9676

[a] Conversion rates for coho were set at the mean of the summer and fall chinook rates for the same reach.

[b] Conversion rates for steelhead were set to the greatest of the rates for spring, summer, or fall chinook for the same reach.

Step 1: Potential Run Size

As described above under **Spawning Area Loss: Lost Production Potential**, we assume that the lower and upper ranges of potential run sizes for a particular species/run in a given year are a linear function of the proportion of the pre-development spawning area available in that year:

$$n_{year} = n_{predevelopment}\,(1 - \sum p_{dam,\,year}) \tag{6}$$

For example, when Bonneville Dam was completed in 1938, 15.5% of the pre-development fall chinook spawning area was blocked or inundated by dams. Therefore, the lower and upper range estimated run sizes for that year were 1,143,285 and 1,943,500 based on the NPPC pre-development run size estimates of 1,353,000 and 2,300,000, respectively.

Step 2: Escapement Goal

We multiplied the pre-development escapement goal by the proportion of remaining spawning area for the year in question to obtain the annual escapement goal.

$$EG_{year} = (1 - \sum p_{dam,\,year})\,EG_{predevelopment} \tag{7}$$

For example, in 1938, about 84.1% of the fall chinook spawning area above Bonneville Dam was still available. Given an upriver pre-development escapement goal of 350,000, the 1938 upriver escapement goal was estimated to be 294,500.

Step 3: Harvestable Surplus

We subtracted the escapement goal from the potential run size to estimate the annual harvestable surplus.

$$h_{surplus,\,year} = n_{year} - EG_{year} \qquad (8)$$

For example, the harvestable surplus for the lower range run size estimate for upriver fall chinook in 1938 was 905,300 - 294,500 = 610,900.

Step 4: 50% Harvest Share

Divide the annual harvestable surplus in half to obtain the tribes' 50% harvest share.

$$h_{50\%\,share,\,year} = \frac{h_{surplus,\,year}}{2} \qquad (9)$$

Step 5: Treaty Indian Allowable Harvest

The treaty Indian allowable harvest is the same as the non-Indian (lower river) share, except it is discounted for conversion rates.

$$h_{tribal,\,year} = c^{d}\,(h_{50\%\,share,\,year}) \qquad (10)$$

where: c = conversion rate (Table 4)
d = average number of dams within Zone 6 for the year in question

To continue the previous example, when all dams had been completed in 1975, the tribal catch could have been landed in any of three pools: Bonneville, The Dalles, or John Day. The fish would have passed over 1, 2, or 3 dams respectively. Therefore let d = 1 if only Bonneville were completed, d = 1.5 if only Bonneville and The Dalles were completed, and d = 2 if all three dams were completed. The single-project conversion rate for fall chinook is 0.9575 (Table 4). The 3-project rate would be 0.9575 squared, or 0.9168. If only 91.68% of the fall chinook survive passage over 3 dams, the tribal allowable catch for the upper run size range would be 127,900 fall chinook, not 139,500, and the tribal allowable catch for the lower run size range would be 62,801, not 68,500. The difference would have been harvestable were it not for dam passage loss.

Step 6: Tribal Pre-Harvest Passage Loss

The difference between the 50% share and the harvest share (discounted for passage loss) is the pre-harvest passage loss.

$$L_{passage, pre\text{-}harvest, year} = h_{50\% \, share, year} - h_{tribal, year} \tag{11}$$

where: $L_{passage,pre\text{-}harvest,year}$ = pre-harvest passage loss of the tribal harvestable share.

To continue the previous example, 68,500 - 62,801 = 5,699, the pre-harvest passage loss for the lower run size range.

Escapement Passage Loss

Escapement passage loss is the mortality suffered by upstream-migrating adults at Corps projects after the Zone 6 tribal fishery. These fish would have been harvestable had they not been needed to augment the escapement to replace the dam passage losses between the fishery and the spawning areas.

Step 1: Bonneville Dam Passage for the Year of Interest

Subtract the potential lower river harvest (i.e. non-Indian 50% share) from the potential run size to estimate the Bonneville Dam passage.

$$n_{BON, year} = n_{year} - h_{50\% \, share, year} \tag{12}$$

For example, in 1975, a lower range upriver run estimate of 202,900 minus a lower river harvest of 68,500 upriver fall chinook yields a potential Bonneville Dam passage of 134,400.

Step 2: Escapement Passage Loss

Annual escapement passage loss was:

$$L_{passage, esc, year} = (1 - c)\, T\, (n_{downstream, year} - h_{pool, year}) \tag{13}$$

where: $L_{passage,esc,year}$ = passage loss in the pool (reservoir) immediately above the dam and for the year in question.

T = proportion of run associated with the tributary or branch in question. The proportion of spawning area in the branches above any given dam was calculated from the same data used to estimate spawning area loss.

$n_{downstream,year}$ = fish passage from the downstream dam after adjustment for harvest and passage loss for the year in question. If there is no downstream dam, then use instead the river mouth run size minus any harvest below the dam.

$h_{pool,year}$ = interdam harvest (in the pool upstream of the dam, not the harvest from below the dam) for the year in question

For example:

- Summer chinook do not spawn in the lower Columbia Rive, and if Bonneville is the lowest dam on the mainstem Columbia River, then $n_{downstream,year} = n_{BON,year}$. Then passage loss between Bonneville and The Dalles Dam (the body of water also referred to as Bonneville pool or reservoir) = (1-conversion rate) X [(river mouth run size - lower river harvest) - harvest in Bonneville pool]. The results of this equation is the dam count for the next project upriver — i.e., The Dalles Dam — which is the Bonneville Dam count minus Bonneville pool harvest and passage loss.

- Summer chinook do not migrate into any tributaries between The Dalles and John Day Dams. Passage loss for The Dalles Dam = (1-conversion rate) X (The Dalles Dam counts - harvest from The Dalles pool).

- Some coho migrate into the John Day River, which is between The Dalles and John Day dams. Passage loss for fish destined to cross John Day Dam = (1-conversion rate) X % of run expected to cross John Day Dam (i.e., the mainstem Columbia R. is the branch of concern, not the John Day R.) X (The Dalles Dam count - harvest from The Dalles pool).

An exception was adopted for coho salmon in the Snake R. Because there was no information on when spawning area losses occurred, we could not estimate P, as explained above. Instead of using the proportion of the potential run associated with the tributary or branch in question, we used the actual dam counts:

$$T_{Ice\ Harbor,year} = \frac{Ice\ Harbor_{year}\ dam\ count}{(Ice\ Harbor_{year} + Priest\ Rapids_{year}\ dam\ counts)} \qquad (14)$$

Total Tribal Losses

To recapitulate, the total tribal loss due to dams blocking and inundating runs and to passage loss at Corps dams is the sum of:

- The harvest loss related to lost spawning area, $L_{habitat,tribal}$ in Equation 5;
- The harvest related to the juvenile passage loss, $L_{juvenile}$ (described on pp. 10-13);
- The reduction in harvest caused by adult passage loss downstream of the fishery, $L_{passage,pre\text{-}harvest,year}$ in Equation 11; and
- The fish that could have been harvested if they were not in the adult escapement passage loss[16], $L_{passage,esc,year}$ in Equation 13.

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[16] In other words, the present-day escapement goals take into account adult passage loss. For example, The CRFMP indicates that the goal of 75,500 steelhead as measured at Bonneville Dam is expected to produce 30,000 steelhead above Lower Granite Dam. The difference between the two goals presently is not part of the harvestable surplus.

Losses of chums from Corps dams were insubstantial, and are not presented in this report.

Mitigation Credits

Returns to Bonneville Dam

Losses caused by Corps' projects have been partially mitigated by federally funded programs, like the Columbia River Fishery Development Program (authorized under the Mitchell Act) and the Lower Snake River Compensation Program (CBFWA 1990). In this analysis we consider only the production of hatchery programs that we believe are intended to compensate for Corps' projects (Appendix Table D). Numbers of fish (total of adults plus jacks or subadults) returning to these facilities are reconstructed back through the downstream dams and the Zone 6 fisheries to Bonneville Dam. The tribal harvest of these mitigation fish passing Bonneville Dam is estimated — by species/run and year — based on the ratio (i.e., harvest rate) of tribal harvest to the Bonneville count. These methods are described in more detail below.

In some instances, it is not clear from our sources (CRITFC 1981; WDFW and ODFW 1996; StreamNet Online Database) when the first spawners returned from mitigation production, particularly for hatcheries that were in operation before implementation of the Mitchell Act (e.g., Spring Creek NFH, Klickitat Hatchery). Hence, we made assumptions regarding when mitigation began based on information about the start or completion of Mitchell Act-funded construction/improvements at the hatchery (CRITFC 1981), age at maturity of the species, and/or the start of the data series, as noted in Appendix Table D.

We filled gaps in two data series for hatchery returns with surrogate estimates. For Spring Cr. fall chinook adults from 1961 to 1968 (StreamNet Online Date Trend #60121), we used linear interpolation from 1960 to 1969 to establish a trend in returns across the gap, then set the annual estimates relative to the trend line so that their deviations mirrored the deviations (proportional to trend) of annual returns of adults to Klickitat Hatchery for the same period. We did not attempt to replace missing counts of jack/subadult fall chinook at Spring Cr. (StreamNet Online Date Trend #61655) prior to 1968.

The second gap was for both adult and subadult/jack spring chinook at Klickitat Hatchery in 1963. We filled the gap for adults by averaging the two preceding and the two succeeding years. For subadults/jacks, we assumed a return of zero.

Reconstructing the runs of mitigation hatchery fish back to Bonneville Dam requires that we add back in 1) the fish that were lost during adult passage at dams (including Bonneville) and 2) the fish taken by Zone 6 fisheries. The reconstruction is necessary to estimate the number of mitigation fish that entered the Zone 6 tribal fishing area, which begins at Bonneville Dam.

Adult passage survival rates by species/run and by dam were estimated from interdam conversion rates (Table 4) and some assumptions. Because we reconstructed the runs back only to the fish counting stations at Bonneville Dam (i.e., not all the way back to the tailrace), our reconstruction used only half the rate of adult passage loss that is assumed for Bonneville Dam (Table 4).

Zone 6 harvests are the sum of commercial and ceremonial and subsistence (C&S) catches for each species/run and year (WDFW and ODFW 1996). Because C&S catches are not reported for years prior to the 1970s, we used estimation rules to provide reasonable surrogate numbers:

ChS: C&S catches for 1938-76 were set to -0.00693+0.050054*Bonn. Count, which is based on the regression ($r^2=0.486$) of C&S catch on Bonn. counts for 1977-95.

ChSu: C&S catches for 1938-76 were set to the mean catch for 1977-81, the earliest five years for which catches are reported. We found no reasonably good (regression) relationship between C&S catch and either Bonn. counts or Zone 6 commercial catch for 1977-95.

ChF: C&S catches were set to zero for all years, because none were reported.

Coho: C&S catches were set to zero for all years, because no catches were reported.

Commercial catch in 1955 was set to 1.5 (thousand), because the reported catch (10.5 thousand) was approximately 3 times the Bonneville count, a virtual impossibility.

Sock: C&S catches for 1938-76 were set to the mean catch for 1977-81, the earliest five years for which catches are reported. We found no reasonably good (regression) relationship between C&S catch and either Bonn. counts or Zone 6 commercial catch for 1977-95.

Sthd: C&S catches for 1938-78 were set to the mean catch for 1979-83, the earliest five years for which catches are reported. We found no reasonably good (regression) relationship between C&S catch and either Bonn. counts or Zone 6 commercial catch for 1980-95.

The Zone 6 harvests were apportioned exponentially among the three reservoir areas of the zone:

Bonneville: 50%

The Dalles: 25%

John Day: 25%

These percentages differ slightly from the harvest distribution used to estimate adult passage losses, above. Other than adult passage mortalities and reported Zone 6 harvests, no other source of loss was accounted for in reconstructing mitigation fish back to Bonneville Dam.

Tribal Mitigation Harvest

But not all the mitigation fish that passed Bonneville Dam were effective in reducing the losses suffered by the tribes. Only some of the mitigation fish were harvested, and some of the harvest above Bonneville Dam prior to 1969 was by non-tribal fishers (WDFW and ODFW 1996). We estimated the <u>tribal</u> harvest in Zone 6 as the C&S catch (WDFW and ODFW 1996; also see above) plus part of the commercial catch. **Of the Zone 6 commercial catch**, we assumed that the tribes caught 50% of the reported catches

(WDFW and ODFW 1996) of all species in 1938, and that the tribal portion of the reported commercial catch increased linearly each year to 100% in 1969 and remained there. We did not attempt to estimate the tribal catch in terminal areas.

We estimated the tribal catch of mitigation fish as the product of the tribal harvest rate (tribal catch ÷ Bonneville count) and the number of mitigation fish at Bonneville Dam, by species/run and year (Eqn 15). We treated the tribal catch of mitigation fish as a credit and subtracted it from the total losses to tribal fisheries that were caused by Corps dam projects (Eqn 16). The resulting difference is the Net Tribal Loss attributable to the Corps.

$$CATCH_{Tribal}^{mit} = \left(\frac{CATCH_{Tribal}}{COUNT_{Bon}}\right) N_{Bon}^{mit} \quad (15)$$

$$LOSS_{Tribal}^{net} = LOSS_{Tribal} - CATCH_{Tribal}^{mit} \quad (16)$$

Valuation of Tribal Losses

Cultural, Material, and Commercial Revenue Equivalents Associated with Tribal Losses

The full importance of these losses to the peoples of the Nez Perce, Yakama, Umatilla and Warm Springs Indians Reservations (the CRITFC Tribes), cannot be expressed solely in monetary terms. The words of the people themselves clearly demonstrate that salmon are at the center of their cultural and material survival:

> *My strength is from the fish; my blood is from the fish, from the roots and the berries. The fish and game are the essence of my life. I was not brought from a foreign country and did not come here. I was put here by the Creator.*[17]
>
> *It's just that the salmon are part of the country, they're part of the environment. They belong here as much as the Indians belong here. And in that way they complement each other. They've become a part of us because that's what we depend on to live.*[18]
>
> *Our religious leaders told us that if we don't take care of the land, the water, the fish, the game, the roots and the berries we will not be around here very long. We*

[17] Yakama Chief Meninock, in, Meyer, Philip A., 1999. **Tribal Circumstances and Impacts of the Lower Snake River Project on the Nez Perce, Yakama, Umatilla, Warm Springs and Shoshone Bannock Tribes.** Columbia River Inter-Tribal Fish Commission. A Report to the US Army Corps of Engineers, p. xvi.

[18] Antone Minthorn, Elder of the Confederated Tribes of the Umatilla Indian Reservation, in, Meyer, Philip A., 1999. **Supra.**

must have our salmon forever![19]

Traditional activities such as fishing, hunting and gathering roots, berries and medicinal plants build self-esteem for Nez Perce peoples - and this has the capacity to reduce the level of death by accident, violence and suicide affecting our people. When you engage in cultural activities you build pride. You are helped to understand "what it is to be a Nez Perce" — as opposed to trying to be someone who is not a Nez Perce. In this way, the salmon, the game, the roots, the berries and the plants are the pillars of our world.[20]

Outside experts confirm the particular importance of salmon to the Plateau tribes,[21] which continues to the present day.

Salmon are the centerpiece of our culture, religion, spirit, and indeed, our very existence. As Indians, we speak solely for the salmon. We have no hidden agenda. We do not make decisions to appease special interest groups. We do not bow to the will of powerful economic interests. Our people's desire is simple — to preserve the fish, to preserve our way of life, now and for future generations.[22]

Protecting the Tribal Treaty Right to Salmon

So important are the salmon that the tribes clung to them and reserved their rights to them at the same time they were relinquishing claim to most of the ancestral lands. At the signing of the "Stevens Treaties" in 1855, ancestors of the four tribes that now direct the Columbia River Inter-Tribal Fish Commission ceded almost 34 million acres of land to the United States[23]. However, the Tribal Treaty signers were careful to protect the ability of their peoples to survive, by reserving the tribes' rights to continue to fish, hunt and gather at their usual and accustomed locations. Protection of tribal fishing rights was particularly important, and the following wording appears in each of the Stevens treaties.

Article 3: ***The exclusive right of taking fish in all streams, where running through or bordering said reservations, is further secured to said confederated tribes and bands of Indians, as also the right of taking fish at usual and accustomed places in common with the citizens of the Territory, and of erecting temporary buildings for curing them... .***

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[19] Delbert Frank, Sr., (then) Chairman of the Confederated Tribes of the Warm Springs Reservation of Oregon, in, Meyer Resources, Inc., 1983. **The Importance of Salmon and Steelhead of the Columbia River to the Confederated Tribes of the Colville, Nez Perce, Umatilla, Warm Springs and Yakima Indian Reservations - With Particular Reference to the Dams of the Mid-Columbia Area.** A Report to the Bureau of Indian Affairs, p. 53.

[20] Leroy Seth, Elder of the Nez Perce Tribe, in, Meyer, Philip A., 1999. **Supra** at xv.

[21] See, for example, Walker, Deward E., Jr., 1967. **Mutual Cross Utilization of Economic Resources of the Plateau: An Example from Aboriginal Nez Perce Fishing Practices.** Washington State University, Laboratory of Anthropology Report No. 41. Pullman, WA.

[22] Donald Sampson, (then) Chairperson of the Confederated Tribes of the Umatilla Indian Reservation, in, Philip A. Meyer, 1999. **Supra** at xx.

[23] **Supra** at xiii.

Where opinion respecting the meaning of such tribal treaties may differ, the United States Supreme Court has determined:

> *In construing Indian treaties, the courts have required that treaties be liberally construed to favor Indians, that ambiguous expressions in treaties must be resolved in favor of Indians, and that treaties should be construed as the Indians would have understood them.*[24]

These US Supreme Court Canons of Construction are significant for the present analysis. It is clear from the circumstances of Treaty discussion, and confirmed by subsequent tribal spokespersons, that **the salmon resource reserved by the tribes was the harvest from Columbia and Snake river systems that were biologically functional and fully productive.** It is equally clear that if tribal treaty negotiators had perceived they were bargaining to reserve "only a small fraction" of the salmon available to harvest in the mid-1800's, the treaty negotiations would have been much different — if they had occurred at all.

Further, the treaty signers, both tribal and non-tribal, were clear that the Treaties were designed to take care of the needs of the tribal peoples into the future, without limit.

In conclusion, the tribal treaty entitlement to salmon of the CRITFC tribes applies to all streams within their ceded areas, measured at fully functional productive levels. This is the basis of the tribal entitlement — at treaty times, and today. As identified in this report, over the years damages to the salmon from US Army Corps of Engineers dams — and related damage to the peoples of the CRITFC tribes — have been extensive. These damages remain, however, distinct from the tribal Treaty entitlement to salmon, which continues to exist in perpetuity.

Loss of Salmon: Material and Cultural Damages to the Tribes

This section will draw heavily on Meyer (1999) to summarize the decline of tribal salmon harvests in the Columbia Basin — between Treaty times and the present — and the damages done to tribal culture, health, and material well-being as these salmon have been lost.

This section will first focus on impacts on tribal culture — self-reported by tribal spokespersons. It will also consider impacts on tribal poverty, employment and health, and draw present-day comparisons between the tribes and non-tribal residents of Washington, Oregon and Idaho.

Finally, the role of Corps dams with respect to these declines will be generally discussed. It is not the objective of this report to extensively examine the tribal pain, suffering and deaths associated with the extensive losses of their resources that has occurred from treaty times to the present day. The reader is referred to Meyer (1999) for more extensive treatment of these subjects. Similarly, no monetary estimate of tribal pain and suffering has been developed.

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[24] Cohen, Felix S., **Handbook of Federal Indian Law.** 1982 Edition, p. 222.

Commercial Revenue Equivalents Associated with Tribal Harvest Losses

An Appropriate Accounting Stance to Estimate Commercial Revenue Equivalents

The greatest part of non-Indian salmon catch over the years has been sold in commercial markets. In historical times, the tribes of the Columbia/Snake system were also intensive traders of salmon. Yet, tribal perspective concerning the value of salmon has a fundamentally different emphasis than for most non-Indians. As can be observed from earlier quotations in this report, since earliest times the peoples of the CRITFC tribes have first considered the salmon in cultural and spiritual terms — as "a pillar of their world". Salmon is "lived with." It shares the world with the tribal peoples. It provides the basis for ceremony. When harvested, it is shared among the extended family and with elders. Only when these fundamental cultural, spiritual and subsistence purposes are completed, may the tribes direct their salmon catch to commerce. A quotation from Mr. Terry Courtney, Jr., a member of the Fish and Wildlife Committee of the Confederated Tribes of the Warm Springs Reservation of Oregon, makes this condition clear:

> *Salmon is very important to our Indian lives. I have trouble thinking about salmon only as dollars. You can't drink dollars. You can't eat dollars. Salmon is important to our spiritual life. It helps our spirit survive.*[25]

It is essential to keep this fundamental fact of tribal perspective and lifeways in mind in the present report section, which describes a procedure to develop an estimate of **the equivalent monetary amount if all the tribal harvests lost to Corps of Engineers dams were valued at commercial prices**. This calculating procedure will identify only a very small proportion of the value of the salmon to tribal peoples. It consequently can only be considered as "one small bill for damages." It grossly underestimates the full value which the peoples of the subject tribes ascribe to the salmon. It is unrelated to the level of tribal Treaty entitlement on the river, which, as we have discussed, exists in perpetuity.

In view of the above, our methodology for estimating equivalent commercial revenue for tribal salmon losses in this section — and the actual estimates of Corps-related dollar damages that follow — focus on issues of **commercial equivalent compensation** that might be associated with **past losses of tribal salmon harvest** and are neither considered a substitute for, nor address restoration of the salmon resource required under treaties between the four study tribes and the United States.

As the estimating methodology of this section considers only what lost harvests could have brought, had they been sold commercially, they do not consider the pain, suffering and deaths of tribal peoples. Such dam-related effects would have been associated with adverse impacts on tribal culture, breaches of promise of the Corps to tribal individuals or groups, collateral damages to tribal lands or other tribal resources, or any other damages the tribes may have incurred though actions of US Army Corps of Engineers officials associated with construction and operation of Columbia Basin dams. Several of these

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[25] Terry Courtney, Jr., Warm Springs Fish and Wildlife Committee, in, Meyer, Philip A., 1999. **Supra** at 193.

issues are discussed more extensively in Meyer (1999).

Estimating Pounds of Salmon Lost to the Tribes

Estimation of tribal harvest losses due to Corps dams in the Columbia Basin, for each year, 1938 through 1997, has been discussed in earlier sections of this report. These losses, expressed as "numbers of adult salmon," are then converted to "pounds of salmon" using 60-year average weights per fish from Oregon Department of Fish and Wildlife and Washington Department of Fish and Wildlife[26] (Table 5).

Although the last Corps of Engineers Dam in the Columbia Basin was completed in 1975, losses to tribal fisheries caused by lost spawning area and production potential continue through the present, as do the passage losses caused by ongoing dam operations.

Table 5. Estimated average weight (pounds) of salmonid species harvested in the Columbia River Basin.

Chinook				
Spring/Summer	Fall	Coho	Sockeye	Steelhead
20.1	19.1	9.0	3.5	8.2

Determining Relevant Commercial Prices

Meyer-Zangri Associates (1982) provides real and nominal estimates of commercial prices for Columbia Basin salmonid species from the beginning of the century through 1976[27]. Actual prices per pound for appropriate historical years through 1976 were obtained by dividing catch revenue figures for "Columbia River, Washington" and "Columbia River, Oregon" reported in annual volumes of the Bureau of Commercial Fisheries' ***Fisheries Statistics of the U.S.*** by data on "pounds caught" from the same source. Troll prices, which would have increased price estimates, were excluded from these calculations. There were some data gaps in early years. For such years, price estimates were developed via the following linear equation:

$$Y = a + bx \tag{17}$$

where: Y = the estimated ex-vessel price per pound,
x = the price of canned salmon, and
b = a constant.

[26] Oregon Department of Fish and Wildlife and Washington Department of Fish and Wildlife, 1998. **Status Report: Columbia River Fish Runs and Fisheries, 1938-1997**, pp. 123-124.

[27] Meyer-Zangri Associates, 1982. **The Historic and Economic Value of Salmon and Steelhead to Treaty Fisheries in 14 River Systems in Washington, Oregon and Idaho.** A Report to the US Bureau of Indian Affairs, Davis, CA.

This equation was used to estimate ex-vessel price in years when canned salmon prices were available, but ex-vessel prices were not. For years where neither canned nor ex-vessel prices were available, the price for the immediately preceding year was carried forward.

Methods differed for years subsequent to 1976. Actual prices for 1977 are from ***Fisheries of the United States***, and are Pacific coast-wide. Prices for 1978, 1979 and 1980 are from information provided by the Oregon Department of Fish and Wildlife. Prices from 1981 through 1997 are obtained by dividing Zone 6 catch values by volumes, from Oregon Department of Fish and Wildlife and Washington Department of Fish and Wildlife (1998, and previous years).

To obtain real prices, actual prices were adjusted for inflation by dividing the annual actual price obtained in each year (via the procedures just described) by an appropriate annual "price index". For the years through 1991, the annual Bureau of Labor Statistics' Wholesale Price Index for the major product group "Food" was employed for this purpose. For more recent years, the price index provided by the Pacific Fisheries Management Council was used for this purpose[28]. Such adjusted prices are described as "real prices" in this report — indicating that effects of inflation have been removed. Nominal (actual) and real prices used in this analysis are displayed in Appendix Table E, with real prices presented in constant 1926 dollars.

Estimating a Return on Investment for Past Damages

Had salmon stocks not been damaged in previous years, tribes could have obtained revenue from those preempted catches, and invested said moneys to expand their wealth. Standard economic convention identifies such foregone returns to investment as part of calculation of past damages. Lind et al. (1982) developed a range of applicable real interest rates, based on average rate of return information in US markets from 1926 through 1976[29]. Lind et al. (1982) recommends a real discount rate of 4.6% for impacts from private projects that have the same average risk as investments in the U.S. economy as a whole[30]. Lind et al. (1982) recommends that a lower real rate of 3% be associated with impacts from energy projects, due to anticipated future increases in energy prices and because impacts from energy projects are usually longer term than the average American investment[31]. We use an even more conservative 2% real rate of return to calculate the present value of damages here.

[28] Pacific Fisheries Management Council, 1998. **Review of 1997 Ocean Salmon Fisheries.** Portland, OR, p. D-27.

[29] Lind, Robert C., K.J. Arrow, G.R. Corey, P. Dasgupta, A.K. Sen, T. Stauffer, J.E. Stiglitz, J.A. Stockfish, and R. Wilson, 1982. **Discounting for Time and Risk in Energy Policy.** Resources for the Future, Washington, D.C.

[30] **Supra** at 455.

[31] **Supra** at 448, 455.

Estimating Net Economic Value for Salmon at Catching Levels

Conventional economic analysis deducts catching costs from gross revenues obtained by fishermen to estimate net economic returns. Crutchfield et al. (1965) estimated such costs at 10% of ex-vessel value for commercially caught coho in waters off Washington state[32]. Richards (1968) reached a similar conclusion with respect to commercial catch of Columbia Basin stocks[33]. Barclay and Morley (1977) examined commercial salmon fishing in adjacent waters of British Columbia, and concluded that marginal costs to catch additional salmon started at 2% of ex-vessel value and eventually rose to 15% if catch were doubled[34]. Meyer et al. (1995) reviewed earlier work, and employed a 2% marginal cost assumption for Washington state commercial fishermen who were in economic distress, and who owned substantial excess fishing capacity[35].

Evidence suggests that over the time frame of this analysis, employment outside fishing was largely unavailable to the Columbia Basin study tribes[36]. Even in the present decade, unemployment for the tribes remains high, or drastically high, compared to residents of Washington, Oregon and Idaho as a whole - and depending on the referenced data source (Table 6). The US Bureau of Indian Affairs (BIA) data is considered more indicative for winter months.

Table 6. Rates (%) of unemployment of the four CRITFC tribes and the three Pacific Northwest states.

Tribes				All Residents			
Nez Perce	Yakama	Umatilla	Warm Springs	WA	OR	ID	Source
19.8	23.4	20.4	19.3	5.7	6.2	6.7	US Bureau of the Census (1990)
62	73	21	45	—	—	—	US Bureau of Indian Affairs (1995)

For this analysis, we followed the recommendation of Meyer et al. (1995) and reduced ex-vessel value of commercial catches by 2% to obtain net economic value.

[32] Crutchfield, J.A., K.B. Krol, and L.A. Phinney, 1965. **An Economic Evaluation of Washington State Department of Fisheries' Controlled Natural Rearing Program for Coho Salmon.** US Fish and Wildlife Service, Contract No. 14-17-007-246.

[33] Richards, J.A., 1968. **An Economic Evaluation of Columbia River Anadromous Fish Programs.** PhD. Dissertation. Oregon State University, Corvallis, OR.

[34] Barclay, J.C. and R.W. Morley, 1977. **Estimation of Commercial Fishery Benefits and Associated Costs for the National Income Account.** Canada Department of Fisheries and Oceans, Vancouver, B.C.

[35] Meyer, Philip A., R. Lichtkoppler, R. Hamilton, D.A. Harpman, C.L. Borda, and P. Engel, 1995. **Elwha River Restoration Project: Economic Analysis - Final Technical Report.** A Report to the US Bureau of Reclamation, The National Park Service, and the Lower Elwha S'Klallam Tribe. Davis, CA.

[36] Meyer, Philip A., 1999. **Supra.**

Net Economic Revenue for Tribal Catch at Processing Levels

The peoples of the Nez Perce, Yakama, Umatilla and Warm Springs tribes have processed salmon since earliest times. Initially, such processing was primarily by smoking and drying, and these methods continue to the present day. As processing has evolved, tribal technologies have evolved also, to encompass a broader range of processing procedures.

Had Corps dams not preempted substantial amounts of tribal catch, it is reasonable to assume that the tribes would have processed that catch in their usual ways. It is therefore appropriate to estimate the potential net economic value from processing lost to the study tribes by those preemptions. We again refer to all fisher-processor data to derive these estimates. Our estimating procedure is to first estimate price markups for salmon from ex-vessel to processing levels, and then subtract appropriate increments of associated processing cost to arrive at the net economic value added by processing.

No single source provides comprehensive estimates of markup from ex-vessel to processing values over the period of this analysis (1938 to 1997). Vaux (undated) cites 1950's evidence to suggest a markup for Columbia River stocks, ex-vessel to wholesale of 100%[37]. Oregon State University (1978) estimated a 136% processing markup for Tillamook County using 1977 data[38]. Petry (1979) provided data suggesting a markup, ex-vessel to processing, of between 111% and 116% for Washington and Oregon[39]. The National Marine Fisheries Service (1988)[40] provides data indicating markups from ex-vessel prices in two steps — (1) markup to primary processing and wholesaling at 186%, and (2) markup to secondary wholesaling and distribution at 251%. For our present analysis, we will employ the 100% markup, ex-vessel to processing, suggested by Vaux (undated). This is considered a reasonable and conservative approximation for most of the period of our analysis, although it likely underestimates for recent years.

At the processor level, to obtain the net economic increment we subtract full costs for associated capital equipment, as well as direct operating expenses for (non-fish) processing supplies — such as containers, electricity, and fuel. This essentially leaves us with net returns to labor and management as a measure of net economic revenue in processing.

Penn (1980) estimates that the labor component of processing costs ranges between

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[37] Vaux, H.J., Jr. (undated). **Damages Incurred by the Confederated Colville Tribes of Indians Resulting from Failure of the United States to Protect their Salmon Fisheries and from Destruction of Certain Salmon Runs by the United States.** The Confederated Tribes of the Colville Indian Reservation, et.al vs. The United States of America. Indian Claims Commission Docket No. 181-C, p. 6.

[38] Oregon State University, 1978. **Socio-Economics of the Idaho, Washington, Oregon and California Coho and Chinook Salmon Industry.** 2 Vols. Corvallis, OR, p. 94.

[39] Petry, G.H., 1979. **Pacific Northwest Salmon and Steelhead Fishery Report--The Economic Status of the Oregon and Washington Non-Indian Salmon Gillnet and Troll Fishery.** 2 Vols. Pullman, WA: Washington State University, p. 46.

[40] National Marine Fisheries Service, 1988. **Development of Value Added Margin and Expenditures for Marine Fishery Products.** NMFS Report No. PB89-125108.

19.5% and 55.1%, based on 1977 data[41]. We will employ the rounded mid-point of this range, 37%. To estimate net economic values associated with labor expenditures in processing, we again observe the lack of alternative economic activity available to tribal peoples, and as with fishermen, will count 98% of the processing labor increment as net economic revenue (37% X .98 = 36%). We add an additional 10% of the processor markup as return to management (profit). This leaves us with an estimated net revenue increment in processing of 46% of the gross ex-vessel amount. Net economic results from these procedures and assumptions, per dollar of ex-vessel value, are displayed in Table 7.

National Marine Fisheries Service (1988) also provides data on markup to fishery retail levels. Net revenue equivalents associated with loss of retail sales by the tribes are not included in these calculations.

Estimated Net Economic Losses Due to Damage to Tribal Fisheries

Using the procedures outlined in previous sections, losses to the tribes due to Corps dams in the Columbia Basin are calculated as follows:

$$T = (8.77)(.98)\, W_{nj} P_{nj} (1+i)^x \qquad \textbf{(18)}$$

where:

T = the present value of total revenue equivalent losses to the tribes associated with commercial fishing, expressed in 1998 dollars;

8.77 = a constant that expresses all final amounts in real 1998 dollars;

.98 = the net economic revenue proportion of ex-vessel value;

W_{nj} = the annual loss in each year, n, of species j, in pounds, from Table 5;

P_{nj} = the real ex-vessel price per pound in year n, for each species j, from Appendix Table E;

x = the number of years prior to 1997 that each annual loss occurs;

i = the real rate of return on investment = 0.02.

Net economic returns during processing lost to the tribes are calculated in Equation 19.

$$R = 1.47\,T \qquad \textbf{(19)}$$

where:

R = the present value of net revenue equivalent losses to the tribes associated with potential processing activities;

1.47 = the net revenue processing increment, beyond the net

[41] Penn, E., 1980. **Cost Analysis of Fish Price Margins, 1972-1977, at Different Production and Distribution Levels.** National Marine Fisheries Service, Washington, D.C., Appendix Tables 45 and 53.

revenue calculated at the harvest level = 1.44/.98, from Table 7.

RESULTS & DISCUSSION

Numerical Losses to Tribal Harvests

Estimates of basin-wide spawning area losses that can be attributed to all causes range up to 95% for sockeye (Table 8, *following page*). However, none of the spawning area losses for sockeye were attributable to Corps dams, nor were any for summer chinook or coho. Corps-caused spawning area losses exceeded 7% only for fall chinook (21.3%), which spawn primarily in the lower mainstems of the Snake and Columbia rivers, where many of the Corps dams were built. Because we assume that losses in potential production are linearly related to spawning area losses, Corps dams in the study area (i.e., Bonneville and above) had the greatest impact on the potential production of fall chinook, reducing run sizes by 288,000 (low run size) to 490,000 (high run size) spawners per year (Table 8, *following page*).

Lost potential production and the three other types of mortality caused by Corps projects have reduced tribal harvests of all species by 45 million (low run size estimates) to 77 million fish (high run size estimates) over the 58-yr period from 1938 to 1995, even when mitigation is taken into account (Table 9, *second page following*). Annual net losses for all species in aggregate range from about 1.0 million to 1.7 million fish, with summer chinook accounting for approximately half of the totals. Summer chinook were also the largest and most desirable of the species, earning names like "June Hogs" and "Royal Chinooks" from non-tribal fishers and packers (Seufert 1980).

For summer chinook, as for all other species/runs, juvenile passage mortality accounts for most of the losses attributable to Corps dams (Table 10, *fourth page following*). Overall, juvenile passage composes approximately 70% of the losses for all species/runs and years in our analysis. The per-project juvenile passage mortality rates we used — particularly 35.4% for subyearlings — may seem high until compared to related estimates. For example, turbine passage mortality has been estimated to range from 10% to 30% (NPPC 1986b), and mortality due to piscivorous predators in John Day reservoir alone has been estimated at 7%-61%, with the highest rates occurring during the summer months when subyearlings are migrating (Rieman et al. 1991). Beaty (1992) used data from Dawley et al. (1986) to estimate juvenile passage mortality of 35%-51% per dam/reservoir project in the lower Columbia River, although those estimates do not include potential benefits of transportation. Hence, the high losses attributed to juvenile passage by our analysis are based on reasonable values for per-project mortality rates.

Federally funded mitigation has not been very effective in offsetting losses in run size and in tribal harvests caused by Corps projects. There has been no mitigation for sockeye, and mitigation for summer chinook has been virtually nil (Table 10, *fourth page following*). Mitigation has been most effective for coho, with harvests of mitigation fish offsetting approximately 5% of the Corps-caused tribal losses for that species at low run size. Because mitigation is so meager, incorrect assumptions (e.g., when mitigation production began at a particular hatchery) and other potential errors (e.g., overlooking a mitigation program) would have little effect on our overall results.

Table 8. Past and present extent of spawning areas, proportions lost and remaining, and pre-development and remaining potential run sizes (low and high ranges) for the entire Columbia R. Basin. See text for sources and methods.

	Spawning Area					LOW Run Size (No. Fish X 1,000)					HIGH Run Size (No. Fish X 1,000)				
		% Lost to:					Potential Product'n Lost to:					Potential Product'n Lost to:			
	Pre-devil-opment	Dams		Other	%	Pre-devel-opment	Dams		Other	Remaining	Predevel-opment	Dams		Other	Remaining
Species/Run	Total (km)	Corps	Other	Causes	Remaining	Total	Corps	Other	Causes	Potential	Total	Corps	Other	Causes	Potential
Chinook															
Spring	8,907	6.6	35.9	33.6	23.9	1,353	88.7	485.8	455.3	323.2	2,300	150.8	825.8	773.9	549.5
Summer	3,331	0.0	33.2	11.6	55.2	2,706	0.0	899.3	312.8	1,493.9	4,600	0.0	1,528.7	531.7	2,539.6
Fall	2,463	21.3	46.7	0.0	32.0	1,353	288.4	631.7	0.0	432.9	2,300	490.2	1,073.9	0.0	735.8
Coho	1,382	0.0	-18.9[a]	17.3	101.6	1,047	0.0	-198.1	181.0	1,064.1	1,780	0.0	-336.8	307.7	1,809.1
Sockeye	222,850[b]	0.0	94.8	0.0	5.2	1,529	0.0	1,449.3	0.0	79.7	2,600	0.0	2,464.4	0.0	135.6
Steelhead	8,116	5.1	21.8	20.8	52.2	793	40.6	172.9	165.2	414.2	1,348	69.1	294.0	280.9	704.1
Chum	162	5.1	1.1	11.6	82.2	820	42.1	8.6	95.3	674.0	1394	71.6	14.7	162.1	1,145.7

[a] Coho gained spawning area because of species introduction into the Willamette R. This causes negative losses (i.e., gains) in numbers for this species.

[b] Surface acreage of nursery lakes is the unit for measuring spawning area for sockeye.

Table 9. Total net losses (X 1,000) to tribal fisheries attributable to Corps dams, by species/run and year, for low and high run sizes.

	LOW Run Size							HIGH Run Size						
	Chinook							Chinook						
Year	Spring	Summer	Fall	Coho	Sock	Sthd	TOTAL	Spring	Summer	Fall	Coho	Sock	Sthd	TOTAL
1938	34.3	72.0	22.5	3.6	5.4	0.0	138	58.5	123.1	39.4	6.1	9.9	0.0	237
1939	35.8	95.7	73.4	8.6	11.2	17.5	242	62.6	163.3	125.9	14.5	19.9	29.7	416
1940	55.5	153.9	103.7	8.4	64.6	32.5	419	94.6	262.2	177.5	14.3	110.6	55.2	714
1941	65.1	252.5	151.0	10.7	71.3	33.9	584	111.0	429.8	257.9	18.2	122.1	57.6	996
1942	71.9	262.7	158.9	10.1	66.4	33.8	604	123.9	446.9	271.1	17.1	113.3	57.6	1,030
1943	72.0	260.5	155.9	7.6	65.4	33.8	595	124.0	443.3	266.1	12.9	111.5	57.5	1,015
1944	71.3	247.4	149.0	7.5	56.2	33.7	565	123.1	420.9	254.3	12.8	95.7	57.3	964
1945	71.1	220.3	143.2	7.1	51.2	33.7	527	122.8	374.8	244.4	11.9	87.3	57.3	899
1946	68.8	190.6	137.6	7.7	16.5	33.4	454	119.0	324.4	234.9	13.0	28.1	56.8	776
1947	68.8	179.7	136.3	8.7	7.9	32.9	434	118.8	305.8	232.6	14.7	13.5	56.0	741
1948	68.7	178.7	136.3	7.6	7.3	32.7	431	118.7	304.2	232.6	12.9	12.6	58.5	739
1949	68.9	178.7	136.3	7.2	7.3	32.7	431	118.9	304.2	232.6	12.2	12.6	55.5	736
1950	69.2	178.7	136.3	8.9	7.3	32.7	433	119.4	304.2	232.6	15.0	12.6	55.5	739
1951	69.0	178.7	136.3	8.0	7.3	32.7	432	119.2	304.2	232.6	13.6	12.6	55.5	738
1952	68.9	178.7	136.3	8.7	7.3	32.2	432	119.0	304.2	232.6	14.7	12.6	54.7	738
1953	73.0	182.5	145.7	17.9	7.8	43.8	471	124.8	309.0	253.5	30.3	13.0	73.3	804
1954	74.3	193.4	165.5	15.4	8.3	65.2	522	126.6	327.6	288.1	26.1	13.8	109.8	892
1955	96.1	266.4	190.1	20.7	13.2	66.4	653	163.8	451.6	332.8	35.0	22.2	112.4	1,118
1956	96.4	283.2	206.6	16.4	13.2	66.7	682	164.5	480.2	361.1	27.7	22.1	112.6	1,168
1957	110.7	315.2	240.7	18.2	14.0	82.3	781	188.4	534.0	418.4	30.8	23.5	139.1	1,334
1958	110.3	335.6	237.4	22.3	17.6	89.7	813	188.4	568.8	412.7	37.9	29.6	151.9	1,389
1959	114.6	370.3	238.8	20.4	18.1	89.0	851	195.8	627.7	415.5	34.6	30.3	147.8	1,452
1960	112.6	379.8	226.8	16.7	17.8	87.4	841	192.0	643.9	395.1	28.3	29.8	147.7	1,437
1961	96.3	370.4	211.9	14.3	15.9	84.1	793	164.2	629.5	377.3	24.6	26.7	142.1	1,364
1962	87.5	354.0	209.0	19.8	14.8	83.2	768	149.2	599.5	360.6	34.7	24.7	139.9	1,309
1963	85.8	345.7	201.0	20.6	14.6	87.4	755	146.7	585.4	350.6	35.0	24.5	147.2	1,289
1964	88.5	351.2	200.8	23.1	14.5	92.1	770	151.3	594.7	348.9	40.3	24.2	155.1	1,314
1965	91.0	364.7	204.3	23.0	14.4	92.0	789	155.6	617.6	352.8	40.1	24.1	154.8	1,345
1966	91.6	369.7	199.5	15.4	14.4	91.2	782	156.4	626.1	347.1	29.1	24.1	153.6	1,336

	LOW Run Size							HIGH Run Size						
	Chinook							Chinook						
Year	Spring	Summer	Fall	Coho	Sock	Sthd	**TOTAL**	Spring	Summer	Fall	Coho	Sock	Sthd	**TOTAL**
1967	89.2	369.2	198.4	19.2	14.4	91.1	**781**	152.6	625.3	344.2	36.8	24.0	153.5	**1,336**
1968	96.7	391.5	227.0	27.1	14.4	101.8	**859**	165.1	662.7	403.5	48.0	23.9	171.5	**1,475**
1969	103.3	404.6	225.2	25.5	16.1	115.4	**890**	176.2	684.4	403.1	45.5	26.8	194.2	**1,530**
1970	106.9	434.0	230.1	13.9	17.1	122.0	**924**	182.2	734.0	413.0	31.1	28.4	205.1	**1,594**
1971	110.3	460.4	210.8	23.9	17.7	133.4	**956**	188.3	778.8	381.9	43.8	29.4	226.2	**1,648**
1972	112.5	476.0	202.2	33.8	17.7	131.7	**974**	192.8	805.3	366.8	58.1	29.5	223.4	**1,676**
1973	113.2	482.1	193.1	30.9	17.8	130.8	**968**	192.9	815.6	353.6	53.3	29.6	223.7	**1,669**
1974	108.1	487.2	193.2	27.3	18.2	131.1	**965**	184.7	824.3	352.6	47.2	30.3	223.2	**1,662**
1975	113.0	496.8	180.6	28.1	18.3	130.2	**967**	192.2	840.2	350.8	49.2	30.4	220.7	**1,683**
1976	112.8	500.0	185.4	29.0	18.3	128.3	**974**	191.9	845.5	351.5	50.1	30.4	217.5	**1,687**
1977	111.9	500.0	190.6	29.9	18.3	127.4	**978**	191.0	845.7	354.0	51.0	30.4	216.6	**1,689**
1978	112.9	500.0	184.4	29.6	18.2	124.4	**970**	192.1	845.7	343.9	50.7	30.4	213.5	**1,676**
1979	113.0	500.0	182.2	29.4	18.3	127.8	**971**	192.1	845.7	340.6	50.5	30.4	217.0	**1,676**
1980	113.1	500.0	182.6	30.2	18.3	128.1	**972**	192.3	845.6	341.1	51.3	30.4	217.2	**1,678**
1981	112.8	500.0	179.4	29.6	18.3	128.2	**968**	191.9	845.6	337.9	50.7	30.4	217.4	**1,674**
1982	112.7	500.0	181.4	28.2	18.3	128.2	**969**	191.8	845.6	339.9	49.3	30.4	217.3	**1,674**
1983	112.8	500.0	188.3	30.2	18.3	127.4	**977**	192.0	845.6	346.7	51.3	30.4	216.6	**1,683**
1984	112.9	500.0	187.5	29.8	18.3	126.9	**975**	192.1	845.6	345.9	50.9	30.4	216.0	**1,681**
1985	112.8	499.9	186.3	29.0	18.3	121.5	**968**	192.0	845.5	344.7	50.1	30.4	210.6	**1,673**
1986	112.3	499.9	186.7	26.0	18.3	126.4	**969**	191.4	845.5	345.1	47.1	30.4	215.5	**1,675**
1987	111.6	499.9	181.7	29.4	18.3	124.8	**966**	190.8	845.5	340.1	50.4	30.4	213.9	**1,671**
1988	111.5	499.9	183.0	29.5	18.3	126.1	**968**	190.7	845.5	341.4	50.6	30.4	215.2	**1,674**
1989	112.0	500.0	182.5	29.4	18.3	125.9	**968**	191.2	845.7	341.0	50.4	30.4	215.0	**1,674**
1990	110.9	500.0	179.8	29.8	18.3	125.2	**964**	190.0	845.7	338.3	50.9	30.4	214.4	**1,670**
1991	112.2	500.0	183.0	28.1	18.3	126.1	**968**	191.4	845.7	341.4	49.1	30.4	215.2	**1,673**
1992	112.2	500.0	187.0	29.9	18.3	126.7	**974**	191.3	845.6	345.4	51.0	30.4	215.8	**1,680**
1993	111.6	500.0	186.6	29.9	18.3	125.6	**972**	190.8	845.6	345.0	51.0	30.4	214.8	**1,678**
1994	112.8	500.0	187.1	30.1	18.3	127.7	**976**	191.9	845.7	345.5	51.1	30.4	216.8	**1,681**
1995	112.9	500.0	185.9	30.2	18.3	128.3	**976**	192.1	845.7	344.4	51.2	31.9	217.4	**1,683**
Totals:	**5,489**	**21,313**	**10,343**	**1,201**	**1,168**	**5,187**	**44,701**	**9,379**	**36,094**	**18,525**	**2,080**	**1,970**	**8,808**	**76,854**

Table 10. Overall proportions (%) of Corps-caused losses (net of mitigation) of each species/run that is attributed to each type of loss (low run size, only) and effectiveness of mitigation. Mitigation effectiveness is the number of mitigation-produced fish harvested by tribal fishers, expressed as a percent of total losses to the tribes caused by Corps projects.

		Type of Loss (% of Total Loss, 1938-95)				Mitigation Effectiveness (%)	
				Adult Passage			
Species/Run	Total Net Loss (Low Run Size; 1938-95; X1000)	Spawning Area	Juvenile Passage	Pre-Harvest	Escapement	Low Run Size	High Run Size
Chinook							
Spring	5,489	12	54	18	16	0.55	0.32
Summer	21,313	0	79	15	6	<0.01	<0.01
Fall	10,343	28	61	5	7	2.35	1.32
Coho	1,201	0	60	6	34	4.81	2.84
Sockeye	1,168	0	89	0	11	0.0	0.0
Steelhead	5,187	15	71	4	9	0.79	0.47
Total & Weighted Means	44,701	9.6	70.5	11.1	8.7	0.83	0.49

Our estimates of mitigation benefits included only hatchery programs; we intentionally omitted some types of mitigation, mostly because they were not well documented nor their benefits measurable. Some mitigation funds have been used to improve upstream passage, freshwater habitat, and screening of irrigation diversions to protect downstream migrants (CBFWA 1990). Even if we were to assume arbitrarily that these improvements produced as many fish as did the large hatchery mitigation programs, then the total net losses to the tribes would be reduced only by another 1% or less.

We noticed some exceptional circumstances during our analysis. One, the errors in spawning area map scales (Fulton 1970), has already been mentioned. Although we have not fully investigated the results of this error on our analysis, it appears to have shifted some of the potential production of steelhead from spawning areas impacted by non-Corps projects (e.g., above Oxbow Dam on the Snake R.) to other spawning areas. Coho were also affected by the same type of map scale error, but probably to a lesser degree.

We encountered another type of anomaly: years when the actual count of a species/run at

Bonneville Dam (net of mitigation returns) exceeded our estimate of potential production, either by itself or adjusted for passage losses. The anomalies are more prevalent than we would expect from random error alone (Table 11). Many of the species/runs showed such anomalies during the late 1980s, a period of exceptionally large runs for many populations (Olsen and Richards 1994) that is generally attributed to high early-ocean survival of juveniles (PSC 1994). Overall, it appears that the potential runs size estimates we used are low, that the system — particularly in some years — is able to produce more fish per unit of spawning area than we assumed.

Table 11. Number of years (out of 58) when Potential run size was exceeded by 1) Actual run size (Bonneville Dam count) minus Mitigation (at Bonneville) and/or by 2) Actual run size, net of Mitigation, plus passage Losses.

Species/Run	(A - M) > P		(A - M + L) > P	
	LOW Run Size	HIGH Run Size	LOW Run Size	HIGH Run Size
Chinook				
Spring	0	0	40	38
Summer	0	0	0	0
Fall	8	2	38	6
Coho	1	0	24	16
Sockeye	23	10	47	28
Steelhead	8	0	38	27

Therefore, we explored the possibility that the relationship between spawning area and potential production was curvilinear and convex, of the form:

$$n_{year} = n_{predevelopment}(1 - \sum p_{dam,year})^k \tag{20}$$

where: n = the number of a particular species/run,
p = the proportion of habitat lost, and
k = a fraction between 0 and 1.

This relationship could arise if survival or some other determinant of production were density compensatory; that is, if survival rates improved as fewer fish were produced in diminishing habitat. We tested k=0.5 with sockeye — which has the largest number of anomalous years when actual count minus mitigation exceeds potential run size — and found that the number and magnitude of anomalies did not improve. Therefore, we chose to retain the linear model.

If our estimates of potential run size were biased low, it would mean that our estimates of passage losses are conservative, because they are based on potential run sizes that are lower than actual. On the other hand, the higher number of anomalies that occur when passage losses are factored in suggests that passage losses — although based on the best available information — may be unrealistically high. The data (e.g., on extent of spawning area or run size) may not exist that would enable these anomalies to be reconciled.

Our methods account for juvenile passage losses as they would theoretically occur, which assigns the highest losses to the most upstream dams. Even though the mortality ***rate*** is assumed to be constant for all dams, the first dam "kills" the most fish in terms of absolute numbers, because attrition at each dam causes fewer fish to be exposed to each downstream dam. Hence, for Snake River-origin fish, the four dams on the lower Snake River account for about two-thirds of the juvenile passage losses and the four lower Columbia River dams account for the other third. An alternative method would be to account for the incremental increase in loss caused by the completion of each dam. Our methods also shift juvenile losses from the four lower-Columbia Corps dams to the mid-Columbia Public Utility District dams with respect to mid- and upper-Columbia populations.

Our analysis did not include juvenile and adult passage losses that would have occurred at Corps projects had other parties not destroyed production potential. For example, had the Bureau of Reclamation **not** built Grand Coulee Dam and blocked access to 90% of the basin's sockeye spawning habitat, then Corps dams downstream would have taken their toll on the sockeye production emanating from and returning to the upper Columbia. Although the Bureau of Reclamation is responsible to the tribes for the lost production potential, the Corps and other owners of the downstream dams may be responsible for the passage losses that would have occurred at their projects, per accounting principles used by Meyer-Zangri Associates (1982). Such an accounting would **add** approximately 5 million (low run size) to 9 million (high run size) adult sockeye to the relatively low losses reported here, with juvenile passage accounting for over 90% of the total. Hence, our analysis may grossly underestimate the losses for which the Corps may be responsible to the tribes.

During our analysis and when checking our methods we found several relatively minor errors in source data, algorithms, and logic. The error in map scales (Fulton 1970) has already been discussed; we were not able to correct for that error before drafting this report. Several other errors found in data sources and our treatment of them have been footnoted. In general, the corrections we made when such errors were found had little effect on the overall results: the analysis is built on such a broad base of information that the results are fairly robust even to large changes in small parts of that information base. We suspect that any errors that have not yet been detected and corrected have little effect on our overall results.

Value of Tribal Losses

Impacts on Tribal Culture and Subsistence

As noted in our earlier methodological section, the greatest tribal values associated with the salmon are cultural and spiritual. Historically, the salmon has also provided core sustenance for the Columbia Basin tribes. Despite these facts, and the Treaty reservation of tribal access to fully functional streams and rivers to fish for salmon, impacts from dams and other adverse developments have been disastrous, both for the salmon and for Indian peoples who depend on them. As this report identifies, dams have played a substantial role in this disaster.

> *As each dam was constructed, the tribes objected, calling on the government to reconsider - pointing out that these actions were contrary to the Treaties the United States had signed with them, and predicting adverse consequences for the salmon - and for their tribal peoples. Each time these tribal objections were ignored, given little weight, or actively opposed by non-Indian interests — and tribal salmon harvests continued to decline.*[42]

Table 12 identifies that because of these actions, and despite present desperate circumstances, the CRITFC tribes are now able to harvest less than 10% of pre-contact amounts of salmon in Zone 6 in the mid-Columbia and less than 1% of traditional amounts above the four dams on the lower Snake River.

Adverse impacts on the CRITFC tribes have been further exacerbated by collective loss of slightly more than 92% of their Treaty-reserved lands to non-Indians[43].

Table 12. Salmon harvests by CRITFC tribes prior to European contact compared to current harvests. From Meyer (1999), p. xvii.

	Tribe			
Benchmark	Nez Perce	Yakama	Umatilla	Warm Springs
Pre-contact Harvest (x1,000 lb.)	2,800	5,600	3,500	3,400
Current Harvest (x1,000 lb.)	160	1,100	77 for both tribes	
Present vs. Pre-Contact Harvests:				
Above Lower Snake dams	0.6 %	n/a	n/a	
Mid-Columbia (Zone 6)	5.1 %	9.4 % for three mid-Columbia tribes		

Initially, these losses (of salmon) had the same causes as losses of tribal lands: pre-emption by competing non-Indian harvesters and obstruction or denial of access to usual and accustomed fishing places, sometimes fenced off by non-Indian property owners. Most of these illegal acts were eventually challenged and struck down. With each Court affirmation, the tribes looked forward to once again sustaining their people with the salmon.

> *But over time, when tribal people were once more able to return to the river, they found the salmon were no longer there. For during the struggle to reaffirm the right to Treaty access to fishing, another tribally adverse process had been occurring —*

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[42] Meyer, Philip A., 1999. **Supra** at xii.

[43] **Supra** at xiii.

the transformation of the rivers to produce electricity, irrigation for agriculture, navigation services and waste disposal. Increasingly, this transformation left no place for the salmon - and hence, little place for the tribes.[44]

From the tribal perspective, the causes and effects of lost tribal fisheries are clear.

As you come up the river, dam by dam by dam, every dam that we look at and talk about has done some damage to the Indian culture and the Indian tradition, has taken away something every time a dam is built....Bonneville Dam...took away Cascade Rapids from the Indian people. It took away a big fishery. And as you come up, the Dalles Dam probably did the greatest damage of all, because they inundated the ancient fishing ground of Celilo, and the rocks, and all of Spearfish and Tenino. The Dalles Dam also inundated an ancient burial ground....The John Day Dam also inundated John Day Rapids and inundated Blalock Rapids all the way up to what is usually known as Patterson. And there was a great Indian fishing village in that area....Naturally the dams were built on places that were shallowest, and those places were the places where Indians fished in the rapids. McNary Dam, I don't know how much damage that did, but I suppose that did a lot of damage to spawning areas....Priest Rapids has done a great deal of damage. It's ruined major spawning beds and big, big fishing area, that we used to call Wanapum, Priest Rapids, Whitebluffs, all through that area. [45]

I think at the time of the dams built up, like the Bonneville Dam--we seen the structure of that dam build up--and the fisheries was troubled immediately. We know the result of it. It began to show up then....And the dams in the Snake River, as well as the dams in the Upper Columbia. I was there when Roosevelt dedicated the Grand Coulee Dam with no fishways in the dam. And we know that there was going to be damage from that dam because we visit the dam often and the people up-river found out that it done away with all the upriver salmon that spawned in the Canadian waters as well as in the upper Columbia. All the big salmon. And that damage we seen as it came along by the construction of the dams in the Columbia River ....It's definite that the dams had the first and real major effect on the salmon runs....That's what our people said. They were not educated, but they knowed it was going to happen, in fact, in time to come....Whenever they built a dam, they promised us, "We will enhance, we will enhance the fishery loused up by the dams upstream." The government didn't do that.[46]

Meyer Resources, Inc. (1983) summarized extensive tribal testimony concerning the effect of the dams of the Columbia Basin as follows:

Indian people have been consistently conservative in risking fisheries for other water-related development. Further, Indian people correctly predicted the deleterious effects that dams and their associated mitigative measures would have on the

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[44] **Supra** at xii.

[45] Rudy Saluskin, at Toppenish, October 22, 1982, in, Meyer Resources, Inc., 1983. **Supra** at 61.

[46] Delbert Frank, Sr., at Warm Springs, October 6, 1982, in Meyer Resources, Inc., 1983. **Supra** at 71.

salmon and steelhead of the Columbia River. While biologists studied and debated, Indians, living on the river, saw fish quality decline and sea gulls eating dead smolts out of dam spillways. More often than not, Indian concern and counsel was ignored.[47]

On each reservation, the story is the same. Inadequate provision for salmon and steelhead during dam construction and operation--consequent decline of natural stocks--broken and discarded promises by hydro-electric interests respecting safeguards and compensation--and severe inroads into capability for tribal survival. These conditions have also spawned a present attitude of almost universal mistrust among Indian people, accompanied either by hopelessness or outrage--depending on the person involved.[48]

When the United States began building power dams in the Pacific Northwest, construction crews ruined several burials in canyons along inland rivers.... Sometimes archaeologists working with the federal government raided Indian burials to preserve choice specimens for university collections before water from a new dam inundated the locations...The Yakama and their neighbors have faced a continued onslaught of ghouls, construction crews, and government agencies that disregard and discredit the spiritual beliefs of the Northwest Indians in reference to their dead.... [49]

My heart cries for my people, cuz we are no more Indians....All our horses are gone. No more cattle. All the pasture, the land, the hillsides taken up by the farmers, by the white man.... Every inch of tillable ground is taken up....These big farmers, they've got everything in the world. The (Indian) owners have nothing. And they've taken everything. Like I say, they've taken our land. They've taken our rivers. They've taken our fish. I don't know what more they want. Maybe they want our appetites too. They've got that too.[50]

I don't know what we would call such a policy. Genocide? Yes, I think perhaps that is the word.[51]

The impact of this wholesale cumulative taking of Indian Treaty resources is also clearly evident when statistics on poverty, unemployment per capita income and death are considered. The reader is cautioned that just as the tribes are uncomfortable with describing salmon values in dollar terms, they are also uncomfortable with these other non-Indian measures of impact.

I don't much like this talk of unemployment and poverty. Before the white man

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47 Meyer Resources, Inc., 1983. **Supra** at 71-72.

48 **Supra** at 61.

49 Trazfer, Clifford E., 1997. **Death Stalks the Yakama.** East Lansing: Michigan State University Press, p. 57.

50 Carrie Sampson, on the Umatilla Reservation, October 13, 1982, in, Meyer Resources, Inc., **Supra** at 62.

51 Tom Eli, at Celilo, October 29, 1982, in, Meyer Resources, Inc. 1983, **Supra** at 62.

came, we had no such thing as poverty. We lived off the land. We fished, we hunted, we gathered roots and berries. We worked hard all year round. We had no time for unemployment.

Poverty came with the Reservations. We were forced to live away from our salmon and our other resources. These resources are being destroyed by the white man. That's what's causing our poverty.[52]

Even with this caution, the adverse present-day circumstances of the CRITFC tribes, relative to those of their non-tribal neighbors, is unmistakable (Table 13).

A 1991 report by Central Washington University echoes Mr. Jim's concern over reliance on statistics alone:

The personal suffering and tragic lives of many people are not revealed in the cold reports of tribal and federal governments. It can, however, be seen and felt in the towns and the countryside--in the eyes of men and the despair of mothers, with few options for change. When you can no longer do what your ancestors did; when your father and mother could not do these things either; when they or you found little meaning in and limited access to the ways of mainstream culture--the power of 70% winter time unemployment, and 46% of the population below the poverty level, is visible throughout the Nez Perce landscape.[53]

Table 13. Present well-being of the CRITFC tribes compared to their non-tribal neighbors in the three Pacific Northwest states. Sources: US Bureau of the Census (1990); US Bureau of Indian Affairs (1995); US Indian Health Service (various years).

	Tribes				States		
Indicator of Well-being	Nez Perce	Yakama	Umatilla	Warm Springs	ID	OR	WA
Families in Poverty (%)	29.4	42.8	26.9	32.7	9.7	12.4	10.9
Unemployment (%)	19.8	23.4	20.4	19.3	6.1	6.2	5.7
in Winter (%)	62	73	21	45	—	—	—
Per Capita Income (x $1,000)	8.7	5.7	7.9	4.3	11.5	14.9	13.4
Ratio: Tribal to Non-Tribal Death Rates	1.7	1.9	1.2	1.6	—	—	—

[52] Nathan Jim, Sr., in Portland, March 10, 1999, in, Meyer, Philip A., 1999. **Supra** at 203.

[53] Central Washington University, 1991. **Potential Effects of OCS Oil and Gas Exploration and Development on Pacific Northwest Indian Tribes: Final Technical Report.** A Report to the US Minerals Management Service. OCS Study MMS 91-0056, p. 258.

Commercial Revenue Equivalents Associated with Tribal Harvest Losses

Utilizing the estimates of tribal harvest lost due to Corps dams developed in initial sections of this report, the prices developed in Appendix Table E, and the calculating procedures identified in Equations (18) and (19) — we estimate that the "commercial revenue equivalents" for salmon lost by the tribes range from $3.1 billion to $5.4 billion (Table 14). As noted earlier, losses in the Willamette River system and those in other streams below Bonneville Dam are not included in these calculations.

Table 14. Net revenue equivalent (for harvest + processing) of salmon lost by Columbia River treaty tribes due to Corps of Engineers' dams, in millions of 1998 dollars.

NPPC Run Size Range	Species				Total
	Chinook	Coho	Sockeye	Steelhead	
Low	2,954	36	22	137	3,149
High	5,086	63	37	232	5,418

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APPENDIX TABLES

Appendix Table A. Separation of spring and summer chinook habitats that were combined by Fulton (1968). Sources: Fulton (1968), TAC (1997), StreamNet data query (SN).

	Chinook Run		Source		
Stream/Tributary	Spring	Summer	Fulton	TAC	SN
Cowlitz R.	○		✓		
Kalama R.	○		✓		
Lewis R.	○		✓		
Willamette R.	○		✓		✓
Sandy R.	○		✓		
Wind R.	○		✓		
Big White Salmon R.	○		✓		
Klickitat R.	○			✓	✓
Deschutes R.	○			✓	✓
John Day R.	○		✓	✓	✓
Umatilla R.	○		✓		✓
Walla Walla R.	○		✓		
Tucannon R.	○			✓	✓
Clearwater R.	○				✓
Grande Ronde R.	○		✓	✓	✓
Salmon R.					
Lower Salmon R.	○	☼		✓	✓
Little Salmon R.		☼			✓
SFk, Secesh R., Johnson Cr.		☼		✓	✓
MFk/Bear Valley Cr.	○			✓	✓
MFk/Loon Cr.		☼			✓
Panther Cr.		☼			✓
NFk	○	☼			✓
Lemhi	○	☼			✓
Pahsimeroi		☼			✓
EFk	○	☼		✓	✓
Yankee Fk	○	☼			✓

Stream/Tributary	Chinook Run: Spring	Chinook Run: Summer	Source: Fulton	Source: TAC	Source: SN
Valley Cr.	o	✿			✓
Imnaha R.	o		✓	✓	✓
Pine Cr.	o				
Indian Cr.	o				
Powder R.	o				
Burnt R.	o				
Weiser R.	o				✓
Payette R.	o				
Malheur R.	o				
Boise R.	o		✓		
Owyhee R.	o		✓		
Bruneau R.	o				
Salmon Falls Cr.	o				
Rock Cr.	o		✓		
Yakima R.	o	✿		✓	✓
Wenatchee R.	o	✿	✓		✓
Entiat R.	o	✿		✓	✓
Methow R.	o	✿	✓		✓
Okanogan R.		✿			✓
San Poil R.		✿			
Spokane R.		✿			
Colville R.		✿			
Kettle R.		✿			
Pend Oreille R.		✿			
Kootenay R.		✿			
Columbia R. mainstem					
Priest Rapids → Chief Joseph		✿			✓
above Chief Joseph		✿			

Appendix Table B. Dams, locations, year of completion, ownership, and species/runs affected. Adapted from NPPC (1986a).

Subbasin Stream/Tributary	Dam	Year Compltd	Owner	ChS ●	ChSu ◊	ChF ▲	Coho ■	Sock ★	Sthd □	Notes
Lower Columbia River (below Bonneville Dam)										
Cowlitz	Mayfield	1963	City of Tacoma	●		▲	■		□	
	Mossyrock	1968	City of Tacoma			▲	■		□	
	Packwood	1964	WPPSS				■			
Lewis	Merwin	1932	PP&L			▲	■		□	
	Yale	1952	PP&L	●		▲	■		□	Earlier blockage by Merwin Dam.
	Swift	1958	PP&L	●		▲	■		□	Earlier blockage by Merwin Dam.
Willamette/Clackamas	River Mill	1911	PGE			▲	■			
	Cazadero	1902	PGE			▲	■			
	North Fork	1958	PGE	●		▲	■			
/Santiam/N. Fk	Big Cliff	1953	Corps	●					□	
	Detroit	1953	Corps	●					□	
/Santiam/S. Fk	Foster	1967	Corps	●					□	
	Green Peter	1967	Corps	●					□	
/Calapooya	Finley	(1847?)	?	●						Dam washout in 1949 increased spawning
/McKenzie	Blue River	1968	Corps	●						
	Cougar	1964	Corps	●						
/Middle Fk	Fall Creek	1965	Corps	●						
	Dexter	1955	Corps	●						
	Lookout Point	1954	Corps	●						
	Hills Creek	1962	Corps	●						Earlier blockage by Lookout Pt. and Dexter dams.
/Row	Dorena	1949	Corps	●						
/Coast Fk	Cottage Grove	1942	Corps	●						

Subbasin Stream/Tributary	Dam	Year Compltd	Owner	ChS ●	ChSu ◊	ChF ▲	Coho ■	Sock ★	Sthd □	Notes
Sandy	Marmot	1912	PGE			▲				
/Bull Run	Bull Run	1929	City of Portland				■		□	
COLUMBIA RIVER (Zone 6, Bonneville Dam → McNary Dam)										
Mainstem	Bonneville	1938	Corps	●	◊	▲	■	★	□	
	The Dalles	1957	Corps	●	◊	▲	■	★	□	
	John Day	1968	Corps	●	◊	▲	■	★	□	
	McNary	1953	Corps	●	◊	▲	■	★	□	
Big White Salmon	Condit	1913	PP&L			▲			□	
Hood	Powerdale	1923	PP&L			▲	■	★	□	
Deschutes	Pelton	1957	PGE	●				★	□	
	Round Butte	1964	PGE					★	□	
/Ochoco Cr.	Ochoco	1915	BoR	●						
/Crooked	Bowman	1961	BoR	●						
Umatilla	3-Mile Falls	1914	BoR						□	
	McKay	1927	BoR						□	
MID-COLUMBIA RIVER (McNary Dam → Grand Coulee Dam)										
Mainstem	Priest Rapids	1959	Grant Co. PUD	●	◊	▲	■	★	□	
	Wanapum	1963	Grant Co. PUD	●	◊	▲	■	★	□	
	Rock Island	1933	Chelan Co. PUD	●	◊	▲	■	★	□	
	Rocky Reach	1961	Chelan Co. PUD	●	◊	▲	■	★	□	
	Wells	1967	Douglas Co. PUD	●	◊	▲	■	★	□	
	Chief Joseph	1955	Corps	●	◊	▲	■	★	□	
	Grand Coulee	1942	BoR		◊	▲	■	★	□	
	Keenleyside	1968	BC Hydro			▲		★		Earlier blockage by Grand Coulee.

Subbasin Stream/Tributary—	Dam	Year Compltd	Owner	ChS ●	ChSu ◊	ChF ▲	Coho ■	Sock ★	Sthd □	Notes
				Species/Runs Affected						
Walla Walla/Mill Cr.	Mill Cr.	1942	Corps	●						
Yakima	Wapato	1917	BoR					★		
	Sunnyside	1907	BoR					★		
	Roza	1939	BoR					★		
	Cle Elum	1910	BoR					★		
	Kachess	1904	BoR					★		
	Keechelus	1904	BoR					★		
/Naches	Bumping	1910	BoR					★		
Okanogan	(unnamed)	1915	?					★		
	(unnamed)	1921	?					★		Replaced by McIntyre (AKA Vasseux) in 1954.
	McIntyre (AKA Vasseux)	1954	?					★		
/Salmon Cr.	Conconully	1910	BoR		◊					
	Salmon Lake	1920	BoR		◊					Earlier blockage by Conconully Dam.
/Similkameen	Enloe	1905	BoR		◊				□	
Spokane	Little Falls	1910	WA Water Power		◊		■		□	
Pend Oreille	Waneta	1954	Pend Oreille PUD			▲				Earlier blockage by Grand Coulee Dam.
Kootenai	Brilliant	1944	W. Kootenay			▲		★		Earlier blockage by Grand Coulee Dam.
	Libby	1973	Corps		◊					Earlier blockage by Grand Coulee Dam.
SNAKE RIVER										
Mainstem	Ice Harbor	1962	Corps	●	◊	▲	■	★	□	
	Lwr Monumental	1969	Corps	●	◊	▲	■	★	□	
	Little Goose	1970	Corps	●	◊	▲	■	★	□	
	Lower Granite	1975	Corps	●	◊	▲	■	★	□	
	Hells Canyon	1967	Idaho Power Co.	●		▲			□	

Subbasin Stream/Tributary	Dam	Year Compltd	Owner	Species/Runs Affected ChS •	ChSu ◊	ChF ▲	Coho ■	Sock ★	Sthd □	Notes
	Oxbow	1961	Idaho Power Co.	•		▲			□	
	Brownlee	1958	Idaho Power Co.	•		▲			□	
	Swan Falls	1910	Idaho Power Co.			▲			□	
	C.J. Strike	1952	Idaho Power Co.	•		▲			□	Earlier blockage by Swan Falls Dam.
	Bliss	1950	Idaho Power Co.	•		▲			□	Earlier blockage by Swan Falls Dam.
	Lwr Salmon Falls	1949	Idaho Power Co.	•		▲			□	Earlier blockage by Swan Falls Dam.
	Upr Salmon Falls	1937	Idaho Power Co.	•		▲			□	Earlier blockage by Swan Falls Dam.
Clearwater	Lewiston	1927	WA Water Power	•					□	Ladder improved 1940; dam removed 1972.
/N. Fork	Dworshak	1971	Corps	•					□	
Grande Ronde/Wallowa	Wallowa	1929	Assoc. Ditch Co.					★		
Powder	Thief Valley	1932	BoR						□	
	Mason	1968	BoR						□	Earlier blockage by Thief Valley Dam.
Burnt	Unity	1938	BoR	•					□	
Payette	(unnamed)	1914	?					★	□	Replaced by Black Canyon Dam in 1924.
	Black Canyon	1924	BoR					★	□	
	Cascade	1948	BoR					★		
	Little Payette Lk	1926	Lake Fk Irr. Dist.					★		
Malheur	Agency Valley	1935	BoR	•					□	
Boise	Barber	1906	Cele Danzer	•					□	
	Boise Diversion	1908	BoR	•					□	
	Lucky Peak	1955	Corps	•					□	Earlier blockage by Boise Diversion Dam.
	Arrowrock	1915	BoR						□	Earlier blockage by Boise Diversion Dam.
	Anderson Ranch	1950	BoR	•					□	Earlier blockage by Boise Diversion Dam.
Owyhee	Owyhee	1932	BoR						□	

Appendix Table C. Values and formulas for factors used to model system survival of subyearling migrants. Yearlings were modeled to produce the estimate of transportation survival used for the subyearlings (shaded).

Factor	Modeled Value		Source/Notes
	Yrling	Subyrlg	
Survivals			
Spill	.96	.98	These values were arbitrarily set to produce a per-project mortality rate consistent with that of Deriso et al. (1996), given: 1) T/C ratios averaged from AHTRG (1992), 2) empirical values of monthly average flow and spill, and 3) assumptions summarized here.
Bypass	.94	.85	
Turbine	.801	.810	
Reservoir	.88	.68	
Transportation	.619	.619	Derived from system mortality estimates for spring chinook (Deriso et al. 1996). Includes bypass mortality rate for collection at McNary Dam.
T/C per project	1.098	1.478	AHTRG 1992; weighted (by total releases of transport and control fish) averages for studies of spring and fall chinook at McNary Dam in 1986-88.
Fish Guidance Effectiveness (FGE)	.60	.20	Assumed
Fish Distribution (proportions)			
Spill	Year- & dam-specific.		USACE 1988-95. Ave. ratio of June + July monthly average spill to discharge.
Spill Efficiency	1.0	1.0	Proportion of Fish Passed via Spillway ÷ Proportion of Flow Spilled
Bypass	(1-Spill)*FGE*(1-Transport)		
Turbine	(1-Spill)*(1-FGE)		
Transport	(1-Spill)*FGE*[#Transported/(#Transported+#Bypassed)]		
			Numbers of transported and bypassed fish from McNary Dam are from Ceballos et al. (1991), Hurson et al. (1995), and FPC (1994, 1995). Yearling chinook, steelhead, coho, and sockeye were all pooled as "yearlings."

Appendix Table D. Hatcheries that we considered mitigation facilities for Corps' projects, with first year of returns for production program of each species/run. Data for steelhead in all years and for other species in years before 1969 are from the StreamNet On-line Database (trend no. shown). Data for 1969-95 for all species except steelhead are from WDFW and ODFW (1996).

Hatchery	Species[1]	StreamNet Trend(s)	First Mitigation Returns Year	Based on:
Carson	ChS	60130 61703	1961	Mitchell Act Construction/Improvements completed 1956 (CRITFC 1981); StreamNet data trends begin in 1961.
Cascade	ChF	60117 61662	1964	Mitchell Act Construction/Improvements completed 1960 (CRITFC 1981).
	Coho	60118 61665	1963	Mitchell Act Construction/Improvements completed 1960 (CRITFC 1981).
	Sthd	61780	1983	Beginning of StreamNet data trend.
Crooked R.	ChS	—	1990	Beginning of data series in WDFW and ODFW (1996).
Dworshak	ChS	—	1984	Beginning of data series in WDFW and ODFW (1996).
	Sthd	60114	1973	Beginning of StreamNet data trend.
East Fork Trap	ChS	—	1984	Beginning of data series in WDFW and ODFW (1996).
	Sthd	43013	1984	Beginning of StreamNet data trend.
Irrigon	Sthd	61816	1987	Only year in StreamNet data trend.
Klickitat	ChS	132130 119036	1951	Anadromous operations began 1950 (CRITFC 1981); beginning of StreamNet data trends. See text re: 1963 data gap.
	ChF	131100 119037	1955	Anadromous operations began 1950 (CRITFC 1981); StreamNet data trends begin 1951.
	Coho	131108 131109	1960	Beginning of StreamNet data trends.
L. White Salmon	ChS	60132 61681	1967	Mitchell Act Construction/Improvements completed 1958 (CRITFC 1981); StreamNet data trends 1967.
	ChF	60131 61628	1962	Mitchell Act Construction/Improvements completed 1958 (CRITFC 1981).
	Coho	60133 61631	1961	Mitchell Act Construction/Improvements completed 1958 (CRITFC 1981); StreamNet data trends begin 1961.
Lookingglass	ChS	—	1982	Beginning of data series in WDFW and ODFW (1996).
	Sthd	61819	1987	Only year in StreamNet data trend.
Lyons Ferry	ChS	—	1985	Beginning of data series in WDFW and ODFW (1996).

Hatchery	Species[1]	StreamNet Trend(s)	First Mitigation Returns	
			Year	Based on:
	ChF	—	1984	Beginning of data series in WDFW and ODFW (1996).
McCall	ChSu	—	1980	Beginning of data series in WDFW and ODFW (1996).
Oxbow	ChF	60119	1964	Mitchell Act Construction/Improvements completed 1960 (CRITFC 1981); StreamNet data trends begin 1964.
Powell	ChS	—	1989	Beginning of data series in WDFW and ODFW (1996).
Red R.	ChS	—	1989	Beginning of data series in WDFW and ODFW (1996).
Ringold	ChS	—	1972	Anadromous operations began 1968 (CRITFC 1981).
	ChF	—	1972	Anadromous operations began 1968 (CRITFC 1981).
	Coho	137902 137903	1968	Anadromous operations began 1968 (CRITFC 1981); StreamNet data trends begin 1968.
Sawtooth	Sthd	43012	1985	Beginning of StreamNet data trend.
Spring Cr.	ChF	60121 61655	1953	Mitchell Act Construction/Improvements started 1949 (CRITFC 1981). See text re: data gap.
Three-mile Trap	ChS	—	1990	Beginning of data series in WDFW and ODFW (1996).
	ChF	—	1991	Beginning of data series in WDFW and ODFW (1996).
	Coho	—	1991	Beginning of data series in WDFW and ODFW (1996).

[1] ChS = spring chinook; ChSu = summer chinook; ChF = fall chinook; Sthd = steelhead.

Appendix Table E. Real salmon prices (1926 $/lb.), for the Columbia/Snake River system, by species, 1938-97.

Year	Chinook	Coho	Sockeye	Steelh'd	Year	Chinook	Coho	Sockeye	Steelh'd
1938	.12	.07	.16	.08	**1968**	.16	.13	.18	.13
1939	.11	.07	.19	.08	**1969**	.17	.15	.18	.14
1940	.10	.07	.19	.08	**1970**	.19	.13	.18	.14
1941	.11	.10	.17	.09	**1971**	.15	.11	.17	.12
1942	.14	.10	.16	.11	**1972**	.21	.16	.18	.17
1943	.13	.10	.16	.10	**1973**	.25	.30	.19	.11
1944	.09	.09	.15	.10	**1974**	.38	.21	.21	.10
1945	.13	.09	.15	.10	**1975**	.20	.26	.21	.37
1946	.12	.13	.14	.11	**1976**	.26	.30	.28	.26
1947	.11	.11	.14	.10	**1977**	.37	.29	.21	.26
1948	.12	.11	.13	.09	**1978**	.20	.27	.21	.27
1949	.10	.08	.12	.09	**1979**	.24	.26	.21	.32
1950	.13	.13	.15	.10	**1980**	.16	.28	.13	.25
1951	.14	.10	.16	.12	**1981**	.22	.21	.17	.24
1952	.12	.09	.15	.10	**1982**	.13	.18	.28	.22
1953	.13	.08	.16	.10	**1983**	.17	.14	.12	.15
1954	.13	.09	.15	.11	**1984**	.23	.18	.20	.20
1955	.15	.11	.17	.11	**1985**	.17	.13	.18	.09
1956	.17	.13	.18	.12	**1986**	.23	.13	.19	.12
1957	.18	.10	.19	.12	**1987**	.29	.22	.27	.20
1958	.16	.12	.18	.12	**1988**	.34	.32	.36	.25
1959	.17	.13	.18	.11	**1989**	.11	.10	.17	.09
1960	.19	.18	.18	.14	**1990**	.18	.13	.20	.13
1961	.20	.15	.16	.14	**1991**	.20	.13	.20	.10
1962	.20	.14	.23	.07	**1992**	.11	.09	.20	.08
1963	.19	.12	.18	.14	**1993**	.08	.10	.20	.06
1964	.17	.13	.19	.15	**1994**	.08	.06	.20	.06
1965	.16	.10	.18	.14	**1995**	.04	.03	.20	.04
1966	.16	.13	.19	.14	**1996**	.04	.03	.20	.03
1967	.15	.12	.18	.13	**1997**	.05	.03	.20	.04

Appendix Table F. Bonneville Dam counts, Zone 6 harvests, and losses incurred by tribal fisheries from Corps dams, by species/run and year, 1938-95. All numbers are thousands of fish, except for the rates/proportions in columns D, E, and F.

Sub-table F-1. Key and descriptions for columns in Sub-tables F-2 through F-7.

Column Label	Column Full Title	Description	Purpose	Data Source
A	Bonneville Dam Count	Adults and jacks/subadults counted passing Bonneville Dam via fishways (x 1,000).	Tribal and overall Zone 6 harvest rates are calculated as a proportion of the Bonneville count.	WDFW and ODFW (1996).
		Zone 6 Harvest *(Calculates the Zone 6 tribal harvest of mitigation fish)*		
B	Commercial Harvest	Number (x 1,000) of fish caught in Zone 6 by tribal or non-tribal fishers and subsequently sold.	Together with C+S harvests, used to calculate harvest rates for Zone 6.	WDFW and ODFW (1996).
C	Ceremonial & Subsistence Harvests	Zone 6 harvests by tribal members that are not sold to commercial buyers (x 1,000).	Together with Commercial harvests, used to calculate harvest rates for Zone 6.	Shaded numbers are based on assumptions and rules listed in Study Procedures. Unshaded numbers are from WDFW and ODFW (1996). Blanks = no data available in WDFW and ODFW (1996); assumed = zero.
D	Zone 6 Harvest Rate	Proportion of the Bonneville count that were reportedly harvested in Zone 6.	Used to help reconstruct mitigation hatchery returns back to Bonneville Dam.	Calculated from internal data.
E	Tribal Proportion	Proportion of the Zone 6 commercial catch attributed to the tribes.	Together with C&S harvest, used to calculate a Zone 6 tribal harvest rate of fish passing Bonneville Dam.	Values prior to 1969 are assumed: 0.50 in 1938, with linear increase to 1.0 in 1969 (WDFW and ODFW 1996).
F	Tribal Harvest Rate	Estimated proportion of the Bonneville count harvested by tribal fisheries in Zone 6.	Used to calculate tribal harvest of mitigation fish.	Calculated from internal data.

Column: Label	Column: Full Title	Description	Purpose	Data Source
G	Mitigation Returns to Bonneville Dam	Returns to mitigation hatcheries have been reconstructed back through downstream dams and the Zone 6 fishery to estimate how many of them passed Bonneville (x 1,000).	Used with Tribal Harvest Rate to estimate how many mitigation fish were harvested by the tribes in Zone 6.	Derived from spreadsheets (not shown in this report) using methods described in Study Procedures.
H	Tribal Mitigation Harvest	The estimated number of mitigation fish harvested by the tribes in Zone 6 commercial and C&S fisheries (x 1,000).	Subtracted from estimates of Total Loss to produce Net Tribal Loss.	Calculated from internal data.

LOW/HIGH Run Size

(Sums tribal share of losses from 4 sources and subtracts harvests of mitigation fish for both NPPC low and high run size estimates)

Tribal Harvestable Share of Losses

(Based on the 50:50 harvest sharing principles of US v. Oregon, the numbers (thousands) of fish lost to the tribes because of Corps dams)

J, P	Spawning Area Loss	The number (x 1,000) of adult fish that would have been 1) produced in spawning areas flooded by Corps dams and 2) harvested in tribal Zone 6 fisheries. Estimates are net of escapement that would have seeded the lost area.	Estimate of lost production potential; one component of total losses.	Derived from spreadsheets (not shown in this report) using methods described in Study Procedures.
K, Q	Escapement Passage Loss of Adults	Additional fish (x 1,000) allowed to escape the Zone 6 fishery to compensate for adult passage loss at upstream dams. All would have been harvestable otherwise. Chronologically, this loss follows Pre-harvest Adult Passage Loss.	Estimate of a type of adult passage loss; one component of total losses.	Derived from spreadsheets (not shown in this report) using methods described in Study Procedures.
L, R	Pre-Harvest Adult Passage Loss	Fish that could not be harvested because of adult passage loss at dams prior to the Zone 6 fishery. Chronologically, this loss precedes Escapement Passage Loss of Adults.	Estimate of a type of adult passage loss; one component of total losses.	Derived from spreadsheets (not shown in this report) using methods described in Study Procedures.
M, S	Juvenile Passage Loss	Adult fish that would have been harvestable had they not been lost during downstream passage as juveniles at Corps projects in earlier years.	Estimate of juvenile passage loss; one component of total losses.	Derived from spreadsheets (not shown in this report) using methods described in Study Procedures.

Column				
Label	Full Title	Description	Purpose	Data Source
N, T	Total Loss	Sum of the four preceding components of loss.	Used with Tribal Mitigation Harvest to estimate Net Tribal Loss.	Calculated from internal data.
Net Tribal Loss				
—	Net Tribal Loss	Total Loss minus Tribal Mitigation Harvest.	Point estimate of tribal loss for a particular species and year; used in sums for all-species and all-years totals	Calculated from internal data.

Sub-table F-2. Spring Chinook.

Year	(A) Bonn. Count	(B) Comm	(C) C&S	(D) Rate (B+C)/A	(E) Tribal Prop.	(F) Tribal Rate [(B*E)+C]/A	(G) Mit'g'n to Bonn.	(H) Tribal Mit'g'n Harvest (F*G)	LOW: (J) Spawn'g Area	LOW: (K) Adult Passage Escapem't	LOW: (L) Adult Passage Pre-Harv.	LOW: (M) Juv. Passage	LOW: (N) TOTAL (J+K+L+M)	LOW: Net Tribal Loss (N-H)	HIGH: (P) Spawn'g Area	HIGH: (Q) Adult Passage Escapem't	HIGH: (R) Adult Passage Pre-Harv.	HIGH: (S) Juv. Passage	HIGH: (T) TOTAL (P+Q+R+S)	HIGH: Net Tribal Loss (T-H)
	Zone 6 Harvest								LOW Run Size — Tribal Harvestable Share of Losses						HIGH Run Size — Tribal Harvestable Share of Losses					
1938	22.4	5.7	[redacted]	0.30	0.50	0.18	0.0	0.0	0.0	9.8	24.5	0.0	34.3	34.3	0.0	15.0	43.5	0.0	58.5	58.5
1939	76.7	16.4	[redacted]	0.26	0.52	0.16	0.0	0.0	0.0	9.9	24.2	1.8	35.8	35.8	1.5	15.1	43.0	3.0	62.6	62.6
1940	66.4	14.1	[redacted]	0.26	0.53	0.16	0.0	0.0	0.0	10.2	22.9	22.5	55.5	55.5	0.0	15.7	40.8	38.2	94.6	94.6
1941	72.3	25.9	[redacted]	0.41	0.55	0.25	0.0	0.0	0.0	10.3	20.4	34.4	65.1	65.1	0.0	16.0	36.6	58.4	111.0	111.0
1942	40.5	16.0	[redacted]	0.44	0.56	0.27	0.0	0.0	7.5	9.6	20.4	34.4	71.9	71.9	14.4	14.9	36.4	58.3	123.9	123.9
1943	65.5	9.6	[redacted]	0.20	0.58	0.14	0.0	0.0	5.3	9.3	23.1	34.3	72.0	72.0	10.6	14.3	41.0	58.2	124.0	124.0
1944	30.9	12.0	[redacted]	0.44	0.60	0.28	0.0	0.0	11.0	9.5	16.2	34.6	71.3	71.3	20.2	14.8	29.3	58.7	123.1	123.1
1945	43.5	10.5	[redacted]	0.29	0.61	0.20	0.0	0.0	11.5	9.4	15.6	34.6	71.1	71.1	21.1	14.7	28.3	58.7	122.8	122.8
1946	67.5	8.2	[redacted]	0.17	0.63	0.13	0.0	0.0	13.1	9.1	13.7	32.9	68.8	68.8	23.8	14.3	25.0	55.9	119.0	119.0
1947	133.6	14.5	[redacted]	0.16	0.65	0.12	0.0	0.0	10.6	9.5	16.7	32.0	68.8	68.8	19.6	14.9	30.1	54.2	118.8	118.8
1948	41.7	23.7	[redacted]	0.62	0.66	0.43	0.0	0.0	10.9	9.5	16.4	31.9	68.7	68.7	20.0	14.9	29.6	54.2	118.7	118.7
1949	50.1	9.2	[redacted]	0.23	0.68	0.17	0.0	0.0	10.0	9.5	17.4	31.9	68.9	68.9	18.5	14.8	31.4	54.2	118.9	118.9
1950	57.3	12.9	[redacted]	0.28	0.69	0.21	0.0	0.0	8.9	9.6	18.8	31.9	69.2	69.2	16.6	14.9	33.7	54.2	119.4	119.4
1951	114.9	33.9	[redacted]	0.35	0.71	0.26	0.1	0.0	9.5	9.6	18.0	31.9	69.1	69.0	17.8	15.0	32.3	54.2	119.2	119.2
1952	116.2	35.1	[redacted]	0.35	0.73	0.27	0.2	0.1	10.0	9.6	17.5	31.9	68.9	68.9	18.5	14.9	31.4	54.2	119.1	119.0
1953	170.3	29.0	[redacted]	0.22	0.74	0.18	0.9	0.2	12.6	14.3	14.2	31.9	73.1	73.0	23.0	21.7	25.9	54.2	124.9	124.8
1954	134.8	35.8	[redacted]	0.32	0.76	0.25	0.2	0.0	10.9	13.9	16.4	33.2	74.3	74.3	20.0	20.7	29.6	56.3	126.6	126.6
1955	171.6	114.7	[redacted]	0.72	0.77	0.57	0.7	0.4	9.2	13.5	18.4	55.5	96.5	96.1	17.1	19.8	33.1	94.2	164.2	163.8
1956	63.4	10.5	[redacted]	0.22	0.79	0.18	0.3	0.1	12.3	13.9	14.7	55.6	96.4	96.4	22.4	20.8	26.7	94.6	164.6	164.5
1957	136.4	1.2	[redacted]	0.06	0.81	0.06	0.3	0.0	10.4	19.5	24.1	56.7	110.7	110.7	19.2	29.0	43.5	96.6	188.4	188.4
1958	75.2	3.5	[redacted]	0.10	0.82	0.09	0.2	0.0	11.2	13.9	16.1	69.2	110.3	110.3	20.5	21.1	29.0	117.8	188.4	188.4
1959	61.1	0.6	[redacted]	0.06	0.84	0.06	0.0	0.0	11.6	13.8	15.0	74.1	114.6	114.6	21.3	21.1	27.0	126.3	195.8	195.8
1960	69.6	0.5	[redacted]	0.06	0.85	0.06	0.1	0.0	10.2	13.7	18.5	70.3	112.6	112.6	18.8	20.6	33.0	119.5	192.0	192.0
1961	98.7	1.6	[redacted]	0.07	0.87	0.06	0.8	0.0	10.1	13.5	18.5	54.2	96.3	96.3	18.7	20.4	33.0	92.2	164.3	164.2
1962	91.1	3.7	[redacted]	0.09	0.89	0.09	2.0	0.2	10.3	14.7	18.1	44.7	87.7	87.5	19.0	22.0	32.4	76.0	149.4	149.2
1963	75.5	9.2	[redacted]	0.17	0.90	0.16	3.9	0.6	11.2	14.9	15.9	44.4	86.4	85.8	20.6	22.6	28.5	75.6	147.3	146.7
1964	91.4	11.3	[redacted]	0.17	0.92	0.16	2.8	0.5	11.8	14.8	14.5	47.9	89.0	88.5	21.5	22.6	26.2	81.5	151.8	151.3
1965	84.3	19.7	[redacted]	0.28	0.94	0.27	2.6	0.7	11.3	14.9	15.6	49.9	91.7	91.0	20.8	22.6	28.0	84.9	156.2	155.6
1966	112.7	2.3	[redacted]	0.07	0.95	0.07	4.4	0.3	11.1	14.9	16.0	49.9	91.9	91.6	20.5	22.5	28.7	85.0	156.7	156.4
1967	84.9	11.8	[redacted]	0.19	0.97	0.18	1.0	0.2	12.2	14.3	13.0	49.9	89.4	89.2	22.3	21.9	23.6	84.9	152.7	152.6
1968	99.2	16.0	[redacted]	0.21	0.98	0.21	1.8	0.4	11.8	17.1	18.2	50.0	97.1	96.7	21.6	25.9	32.8	85.1	165.5	165.1
1969	173.6	33.0	[redacted]	0.24	1.00	0.24	3.1	0.7	11.2	18.1	20.2	54.6	104.1	103.3	20.6	27.1	36.3	93.0	176.9	176.2

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Sub-table F-2. Spring Chinook. *(continued)*

	Zone 6 Harvest								LOW Run Size							HIGH Run Size						
								(H)	Tribal Harvestable Share of Losses						Net	Tribal Harvestable Share of Losses						Net
	(A)			(D)	(E)	(F)	(G)	Tribal	(J)	Adult Passage		(M)		(N)	Tribal	(P)	Adult Passage		(S)		(T)	Tribal
	Bonn.	(B)	(C)	Rate	Tribal	Tribal Rate	Mit'g'n	Mit'g'n Harvest	Spawn'g	(K)	(L)	Juv.	TOTAL	Loss	Spawn'g	(Q)	(R)	Juv.	TOTAL	Loss
Year	Count	Comm	C&S	(B+C)/A	Prop.	[(B*E)+C]/A	to Bonn.	(F*G)	Area	Escapem't	Pre-Harv.	Passage	(J+K+L+M)	(N-H)	Area	Escapem't	Pre-Harv.	Passage	(P+Q+R+S)	(T-H)
1970	111.0	14.0	5.5	0.18	1.00	0.18	7.3	1.3	11.8	18.9	18.4	59.1	108.2	**106.9**	21.5	28.5	33.3	100.2	183.5	**182.2**
1971	125.5	12.7	6.3	0.15	1.00	0.15	8.1	1.2	14.1	18.8	16.7	62.0	111.5	**110.3**	25.7	28.4	30.3	105.1	189.5	**188.3**
1972	186.1	42.8	9.3	0.28	1.00	0.28	10.4	2.9	12.3	18.3	21.8	63.1	115.4	**112.5**	22.6	27.2	38.9	107.0	195.7	**192.8**
1973	142.1	34.2	7.1	0.29	1.00	0.29	3.7	1.1	13.1	18.6	19.3	63.2	114.2	**113.2**	24.1	27.9	34.8	107.2	194.0	**192.9**
1974	86.1	17.5	4.3	0.25	1.00	0.25	3.8	1.0	15.7	17.2	12.2	64.0	109.0	**108.1**	28.4	26.1	22.7	108.5	185.7	**184.7**
1975	104.1	0.1	5.2	0.05	1.00	0.05	7.4	0.4	14.5	19.0	15.5	64.3	113.4	**113.0**	26.4	28.8	28.3	109.0	192.6	**192.2**
1976	78.3	0.4	3.9	0.06	1.00	0.06	9.1	0.5	14.5	19.0	15.5	64.2	113.3	**112.8**	26.4	28.8	28.3	108.9	192.4	**191.9**
1977	119.5	17.2	1.8	0.16	1.00	0.16	9.0	1.4	14.5	19.0	15.5	64.2	113.3	**111.9**	26.4	28.8	28.3	108.9	192.4	**191.0**
1978	128.9	2.6	4.9	0.06	1.00	0.06	5.8	0.3	14.5	19.0	15.5	64.2	113.3	**112.9**	26.4	28.8	28.3	108.9	192.4	**192.1**
1979	51.5	0.5	1.6	0.04	1.00	0.04	7.6	0.3	14.5	19.0	15.5	64.2	113.3	**113.0**	26.4	28.8	28.3	108.9	192.4	**192.1**
1980	61.0	0.0	1.8	0.03	1.00	0.03	6.4	0.2	14.5	19.0	15.5	64.2	113.3	**113.1**	26.4	28.8	28.3	108.9	192.4	**192.3**
1981	65.0	1.6	1.8	0.05	1.00	0.05	9.6	0.5	14.5	19.0	15.5	64.2	113.3	**112.8**	26.4	28.8	28.3	108.9	192.4	**191.9**
1982	76.0	3.3	2.0	0.07	1.00	0.07	8.8	0.6	14.5	19.0	15.5	64.2	113.3	**112.7**	26.4	28.8	28.3	108.9	192.4	**191.8**
1983	56.8	0.1	2.5	0.05	1.00	0.05	9.7	0.4	14.5	19.0	15.5	64.2	113.3	**112.8**	26.4	28.8	28.3	108.9	192.4	**192.0**
1984	51.0	0.1	3.4	0.07	1.00	0.07	5.1	0.4	14.5	19.0	15.5	64.2	113.3	**112.9**	26.4	28.8	28.3	108.9	192.4	**192.1**
1985	91.0	0.1	3.0	0.03	1.00	0.03	13.2	0.5	14.5	19.0	15.5	64.2	113.3	**112.8**	26.4	28.8	28.3	108.9	192.4	**192.0**
1986	123.0	0.4	7.1	0.06	1.00	0.06	16.6	1.0	14.5	19.0	15.5	64.2	113.3	**112.3**	26.4	28.8	28.3	108.9	192.4	**191.4**
1987	101.8	0.3	6.4	0.07	1.00	0.07	24.8	1.6	14.5	19.0	15.5	64.2	113.3	**111.6**	26.4	28.8	28.3	108.9	192.4	**190.8**
1988	94.7	0.2	6.8	0.07	1.00	0.07	23.5	1.7	14.5	19.0	15.5	64.2	113.3	**111.5**	26.4	28.8	28.3	108.9	192.4	**190.7**
1989	87.3	0.0	6.3	0.07	1.00	0.07	17.9	1.3	14.5	19.0	15.5	64.2	113.3	**112.0**	26.4	28.8	28.3	108.9	192.4	**191.2**
1990	96.3	0.1	6.9	0.07	1.00	0.07	33.0	2.4	14.5	19.0	15.5	64.2	113.3	**110.9**	26.4	28.8	28.3	108.9	192.4	**190.0**
1991	61.2	0.1	4.0	0.07	1.00	0.07	15.8	1.1	14.5	19.0	15.5	64.2	113.3	**112.2**	26.4	28.8	28.3	108.9	192.4	**191.4**
1992	90.6	0.1	5.7	0.06	1.00	0.06	17.6	1.1	14.5	19.0	15.5	64.2	113.3	**112.2**	26.4	28.8	28.3	108.9	192.4	**191.3**
1993	112.2	0.0	7.3	0.07	1.00	0.07	25.8	1.7	14.5	19.0	15.5	64.2	113.3	**111.6**	26.4	28.8	28.3	108.9	192.4	**190.8**
1994	20.6	0.1	1.1	0.06	1.00	0.06	8.5	0.5	14.5	19.0	15.5	64.2	113.3	**112.8**	26.4	28.8	28.3	108.9	192.4	**191.9**
1995	12.6	0.1	0.6	0.06	1.00	0.06	6.6	0.4	14.5	19.0	15.5	64.2	113.3	**112.9**	26.4	28.8	28.3	108.9	192.4	**192.1**
TOTALS							340	30	669	890	987	2,973	5,519	**5,489**	1,227	1,350	1,785	5,047	9,409	**9,379**

Shaded numbers are surrogates derived using methods described in the text.

Sub-table F-3. Summer Chinook.

Year	(A) Bonn. Count	(B) Comm	(C) C&S	(D) Rate (B+C)/A	(E) Tribal Prop.	(F) Tribal Rate [(B*E)+C]/A	(G) Mit'g'n to Bonn.	(H) Tribal Mit'g'n Harvest (F*G)	LOW: (J) Spawn'g Area	LOW: (K) Adult Passage Escapem't	LOW: (L) Adult Passage Pre-Harv.	LOW: (M) Juv. Passage	LOW: (N) TOTAL (J+K+L+M)	LOW: Net Tribal Loss (N-H)	HIGH: (P) Spawn'g Area	HIGH: (Q) Adult Passage Escapem't	HIGH: (R) Adult Passage Pre-Harv.	HIGH: (S) Juv. Passage	HIGH: (T) TOTAL (P+Q+R+S)	HIGH: Net Tribal Loss (T-H)
1938	14.8	3.4	[redacted]	0.30	0.50	0.18	0.00	0.0	0	17.1	54.9	0.0	72.0	72.0	0	27.1	96.0	0.0	123.1	123.1
1939	23.4	3.9	[redacted]	0.21	0.52	0.13	0.00	0.0	0	17.1	54.9	23.7	95.7	95.7	0	27.1	96.0	40.2	163.3	163.3
1940	22.0	6.2	[redacted]	0.33	0.53	0.20	0.00	0.0	0	17.1	54.9	81.8	153.9	153.9	0	27.1	96.0	139.1	262.2	262.2
1941	16.4	16.5	[redacted]	0.76	0.55	0.61	0.00	0.0	0	17.1	54.9	180.4	252.5	252.5	0	27.1	96.0	306.7	429.8	429.8
1942	24.6	5.4	[redacted]	0.26	0.56	0.16	0.00	0.0	0	10.9	34.9	216.9	262.7	262.7	0	17.2	61.0	368.7	446.9	446.9
1943	13.5	2.0	[redacted]	0.22	0.58	0.16	0.00	0.0	0	10.9	34.9	214.8	260.5	260.5	0	17.2	61.0	365.1	443.3	443.3
1944	12.6	8.6	[redacted]	0.76	0.60	0.49	0.00	0.0	0	10.9	34.9	201.6	247.4	247.4	0	17.2	61.0	342.7	420.9	420.9
1945	27.6	1.6	[redacted]	0.09	0.61	0.07	0.00	0.0	0	10.9	34.9	174.5	220.3	220.3	0	17.2	61.0	296.6	374.8	374.8
1946	51.2	4.6	[redacted]	0.11	0.63	0.08	0.00	0.0	0	10.9	34.9	144.8	190.6	190.6	0	17.2	61.0	246.2	324.4	324.4
1947	38.9	4.7	[redacted]	0.15	0.65	0.10	0.00	0.0	0	10.9	34.9	133.9	179.7	179.7	0	17.2	61.0	227.6	305.8	305.8
1948	67.2	28.2	[redacted]	0.43	0.66	0.29	0.00	0.0	0	10.9	34.9	133.0	178.7	178.7	0	17.2	61.0	226.0	304.2	304.2
1949	46.7	9.0	[redacted]	0.21	0.68	0.15	0.00	0.0	0	10.9	34.9	132.9	178.7	178.7	0	17.2	61.0	226.0	304.2	304.2
1950	49.6	4.1	[redacted]	0.10	0.69	0.08	0.00	0.0	0	10.9	34.9	132.9	178.7	178.7	0	17.2	61.0	226.0	304.2	304.2
1951	79.3	4.4	[redacted]	0.07	0.71	0.05	0.00	0.0	0	10.9	34.9	132.9	178.7	178.7	0	17.2	61.0	226.0	304.2	304.2
1952	84.3	5.7	[redacted]	0.08	0.73	0.06	0.00	0.0	0	10.9	34.9	132.9	178.7	178.7	0	17.2	61.0	226.0	304.2	304.2
1953	57.8	1.4	[redacted]	0.04	0.74	0.04	0.00	0.0	0	14.6	34.9	132.9	182.5	182.5	0	22.0	61.0	226.0	309.0	309.0
1954	79.4	0.6	[redacted]	0.02	0.76	0.02	0.00	0.0	0	14.6	34.9	143.9	193.4	193.4	0	22.0	61.0	244.5	327.6	327.6
1955	82.9	7.4	[redacted]	0.10	0.77	0.08	0.00	0.0	0	15.4	34.9	216.2	266.4	266.4	0	23.2	61.0	367.4	451.6	451.6
1956	101.2	9.0	[redacted]	0.10	0.79	0.08	0.00	0.0	0	15.4	34.9	233.0	283.2	283.2	0	23.2	61.0	396.0	480.2	480.2
1957	135.0	0.3	[redacted]	0.01	0.81	0.01	0.00	0.0	0	21.9	51.6	241.7	315.2	315.2	0	33.0	90.2	410.8	534.0	534.0
1958	101.9	4.7	[redacted]	0.06	0.82	0.05	0.00	0.0	0	21.9	51.6	262.2	335.6	335.6	0	33.0	90.2	445.6	568.8	568.8
1959	89.0	0.4	[redacted]	0.02	0.84	0.02	0.00	0.0	0	21.9	51.6	296.9	370.3	370.3	0	33.0	90.2	504.6	627.7	627.7
1960	85.2	0.3	[redacted]	0.02	0.85	0.01	0.00	0.0	0	21.9	51.6	306.4	379.8	379.8	0	33.0	90.2	520.7	643.9	643.9
1961	66.5	0.2	[redacted]	0.02	0.87	0.02	0.00	0.0	0	21.8	51.6	297.0	370.4	370.4	0	34.6	90.2	504.7	629.5	629.5
1962	77.5	1.2	[redacted]	0.03	0.89	0.03	0.00	0.0	0	23.1	51.6	279.3	354.0	354.0	0	34.6	90.2	474.8	599.5	599.5
1963	64.0	4.1	[redacted]	0.08	0.90	0.07	0.00	0.0	0	23.1	51.6	271.1	345.7	345.7	0	34.6	90.2	460.7	585.4	585.4
1964	80.5	6.9	[redacted]	0.10	0.92	0.09	0.00	0.0	0	23.1	51.6	276.5	351.2	351.2	0	34.6	90.2	470.0	594.7	594.7
1965	76.0	6.9	[redacted]	0.10	0.94	0.10	0.00	0.0	0	23.1	51.6	290.0	364.7	364.7	0	34.6	90.2	492.9	617.6	617.6
1966	72.0	1.1	[redacted]	0.03	0.95	0.03	0.00	0.0	0	23.1	51.6	295.0	369.7	369.7	0	34.6	90.2	501.3	626.1	626.1
1967	95.7	9.5	[redacted]	0.11	0.97	0.11	0.00	0.0	0	23.1	51.6	294.5	369.2	369.2	0	34.5	90.2	500.6	625.3	625.3
1968	82.9	2.1	[redacted]	0.04	0.98	0.04	0.00	0.0	0	26.1	67.8	297.6	391.5	391.5	0	38.4	118.5	505.9	662.7	662.7
1969	102.2	9.4	[redacted]	0.10	1.00	0.10	0.00	0.0	0	27.3	67.8	309.5	404.6	404.6	0	39.8	118.5	526.1	684.4	684.4

Columns (A)–(H): Zone 6 Harvest. LOW Run Size and HIGH Run Size: Tribal Harvestable Share of Losses.

- - - (continued) - - -

Sub-table F-3. Summer Chinook. (continued)

Year	(A) Bonn. Count	(B) Comm	(C) C&S	(D) Rate (B+C)/A	(E) Tribal Prop.	(F) Tribal Rate [(B*E)+C]/A	(G) Mit'g'n to Bonn.	(H) Tribal Mit'g'n Harvest (F*G)	LOW Run Size: (J) Spawn'g Area	LOW: (K) Escapem't	LOW: (L) Pre-Harv.	LOW: (M) Juv. Passage	LOW: (N) TOTAL (J+K+L+M)	LOW: Net Tribal Loss (N-H)	HIGH Run Size: (P) Spawn'g Area	HIGH: (Q) Escapem't	HIGH: (R) Pre-Harv.	HIGH: (S) Juv. Passage	HIGH: (T) TOTAL (P+Q+R+S)	HIGH: Net Tribal Loss (T-H)
	Zone 6 Harvest								Tribal Harvestable Share of Losses (K, L = Adult Passage)						Tribal Harvestable Share of Losses (Q, R = Adult Passage)					
1970	65.5	4.0	1.0	0.08	1.00	0.08	0.00	0.0	0	28.4	67.8	337.8	434.0	**434.0**	0	41.3	118.5	574.2	734.0	**734.0**
1971	77.9	5.8	1.0	0.09	1.00	0.09	0.00	0.0	0	28.4	67.8	364.2	460.4	**460.4**	0	41.3	118.5	619.0	778.8	**778.8**
1972	70.8	4.4	1.0	0.08	1.00	0.08	0.00	0.0	0	28.4	67.8	379.8	476.0	**476.0**	0	41.3	118.5	645.5	805.3	**805.3**
1973	45.4	2.0	1.0	0.07	1.00	0.07	0.00	0.0	0	28.4	67.8	385.9	482.1	**482.1**	0	41.3	118.5	655.8	815.6	**815.6**
1974	34.0	0.1	1.0	0.03	1.00	0.03	0.00	0.0	0	28.4	67.8	391.0	487.2	**487.2**	0	41.3	118.5	664.5	824.3	**824.3**
1975	44.4	0.0	1.0	0.02	1.00	0.02	0.00	0.0	0	29.5	67.8	399.5	496.8	**496.8**	0	42.6	118.5	679.0	840.2	**840.2**
1976	42.1	0.1	1.0	0.03	1.00	0.03	0.00	0.0	0	29.5	67.8	402.7	500.0	**500.0**	0	42.6	118.5	684.4	845.5	**845.5**
1977	41.0	0.1	0.8	0.02	1.00	0.02	0.00	0.0	0	29.5	67.8	402.7	500.0	**500.0**	0	42.6	118.5	684.5	845.7	**845.7**
1978	43.0	0.1	0.8	0.02	1.00	0.02	0.00	0.0	0	29.5	67.8	402.7	500.0	**500.0**	0	42.6	118.5	684.5	845.7	**845.7**
1979	34.2	0.0	1.0	0.03	1.00	0.03	0.00	0.0	0	29.5	67.8	402.7	500.0	**500.0**	0	42.6	118.5	684.5	845.7	**845.7**
1980	31.1	0.1	1.1	0.04	1.00	0.04	0.55	0.0	0	29.5	67.8	402.7	500.0	**500.0**	0	42.6	118.5	684.5	845.7	**845.6**
1981	26.9	0.1	1.3	0.05	1.00	0.05	0.77	0.0	0	29.5	67.8	402.7	500.0	**500.0**	0	42.6	118.5	684.5	845.7	**845.6**
1982	26.6	0.1	1.3	0.05	1.00	0.05	0.81	0.0	0	29.5	67.8	402.7	500.0	**500.0**	0	42.6	118.5	684.5	845.7	**845.6**
1983	23.5	0.0	0.3	0.01	1.00	0.01	1.33	0.0	0	29.5	67.8	402.7	500.0	**500.0**	0	42.6	118.5	684.5	845.7	**845.6**
1984	28.4	0.1	0.3	0.01	1.00	0.01	2.17	0.0	0	29.5	67.8	402.7	500.0	**500.0**	0	42.6	118.5	684.5	845.7	**845.6**
1985	29.9	1.4	0.1	0.05	1.00	0.05	3.30	0.2	0	29.5	67.8	402.7	500.0	**499.9**	0	42.6	118.5	684.5	845.7	**845.5**
1986	31.0	0.7	0.3	0.03	1.00	0.03	3.90	0.1	0	29.5	67.8	402.7	500.0	**499.9**	0	42.6	118.5	684.5	845.7	**845.5**
1987	37.7	1.4	0.3	0.05	1.00	0.05	3.97	0.2	0	29.5	67.8	402.7	500.0	**499.9**	0	42.6	118.5	684.5	845.7	**845.5**
1988	36.5	1.5	0.0	0.04	1.00	0.04	3.50	0.1	0	29.5	67.8	402.7	500.0	**499.9**	0	42.6	118.5	684.5	845.7	**845.5**
1989	33.0	0.0	0.1	0.00	1.00	0.00	1.32	0.0	0	29.5	67.8	402.7	500.0	**500.0**	0	42.6	118.5	684.5	845.7	**845.7**
1990	28.0	0.0	0.1	0.00	1.00	0.00	1.36	0.0	0	29.5	67.8	402.7	500.0	**500.0**	0	42.6	118.5	684.5	845.7	**845.7**
1991	22.0	0.0	0.1	0.00	1.00	0.00	1.71	0.0	0	29.5	67.8	402.7	500.0	**500.0**	0	42.6	118.5	684.5	845.7	**845.7**
1992	19.2	0.0	0.1	0.01	1.00	0.01	4.01	0.0	0	29.5	67.8	402.7	500.0	**500.0**	0	42.6	118.5	684.5	845.7	**845.6**
1993	23.6	0.0	0.4	0.02	1.00	0.02	3.85	0.1	0	29.5	67.8	402.7	500.0	**500.0**	0	42.6	118.5	684.5	845.7	**845.6**
1994	19.5	0.0	0.2	0.01	1.00	0.01	0.75	0.0	0	29.5	67.8	402.7	500.0	**500.0**	0	42.6	118.5	684.5	845.7	**845.7**
1995	17.1	0.0	0.4	0.02	1.00	0.02	0.44	0.0	0	29.5	67.8	402.7	500.0	**500.0**	0	42.6	118.5	684.5	845.7	**845.7**
TOTALS							34	1	0	1,312	3,208	16,794	21,314	**21,313**	0	1,942	5,609	28,543	36,095	**36,094**

Shaded numbers are surrogates derived using methods described in the text.

Sub-table F-4. Fall Chinook.

Year	Zone 6 Harvest: (A) Bonn. Count	Zone 6 Harvest: (B) Comm	Zone 6 Harvest: (C) C&S	Zone 6 Harvest: (D) Rate (B+C)/A	Zone 6 Harvest: (E) Tribal Prop.	Zone 6 Harvest: (F) Tribal Rate [(B*E)+C]/A	Zone 6 Harvest: (G) Mit'g'n to Bonn.	(H) Tribal Mit'g'n Harvest (F*G)	LOW Run Size, Tribal Harvestable Share of Losses: (J) Spawn'g Area	LOW, Adult Passage: (K) Escapem't	LOW, Adult Passage: (L) Pre-Harv.	LOW: (M) Juv. Passage	LOW: (N) TOTAL (J+K+L+M)	LOW: Net Tribal Loss (N-H)	HIGH Run Size, Tribal Harvestable Share of Losses: (P) Spawn'g Area	HIGH, Adult Passage: (Q) Escapem't	HIGH, Adult Passage: (R) Pre-Harv.	HIGH: (S) Juv. Passage	HIGH: (T) TOTAL (P+Q+R+S)	HIGH: Net Tribal Loss (T-H)
1938	234.7	77.2		0.33	0.50	0.16	0.0	0.0	0.5	9.1	13.0	0.0	22.5	**22.5**	0.9	12.0	26.4	0.0	39.4	**39.4**
1939	186.1	59.1		0.32	0.52	0.16	0.0	0.0	0.5	9.1	13.0	50.9	73.4	**73.4**	0.9	12.0	26.4	86.5	125.9	**125.9**
1940	303.2	103.2		0.34	0.53	0.18	0.0	0.0	0.5	9.1	13.0	81.2	103.7	**103.7**	0.9	12.0	26.4	138.1	177.5	**177.5**
1941	372.7	187.8		0.50	0.55	0.28	0.0	0.0	0.5	9.1	13.0	128.5	151.0	**151.0**	0.9	12.0	26.4	218.5	257.9	**257.9**
1942	336.8	162.7		0.48	0.56	0.27	0.0	0.0	0.5	7.1	10.2	141.1	158.9	**158.9**	1.0	9.4	20.7	240.0	271.1	**271.1**
1943	234.1	93.5		0.40	0.58	0.23	0.0	0.0	0.5	7.1	10.2	138.2	155.9	**155.9**	1.0	9.4	20.7	235.0	266.1	**266.1**
1944	197.3	79.2		0.40	0.60	0.24	0.0	0.0	0.5	7.1	10.2	131.2	149.0	**149.0**	1.0	9.4	20.7	223.2	254.3	**254.3**
1945	226.4	59.3		0.26	0.61	0.16	0.0	0.0	0.5	7.1	10.2	125.4	143.2	**143.2**	1.0	9.4	20.7	213.3	244.4	**244.4**
1946	327.3	124.6		0.38	0.63	0.24	0.0	0.0	0.5	7.1	10.2	119.8	137.6	**137.6**	1.0	9.4	20.7	203.8	234.9	**234.9**
1947	308.0	156.3		0.51	0.65	0.33	0.0	0.0	0.5	7.1	10.2	118.5	136.3	**136.3**	1.0	9.4	20.7	201.5	232.6	**232.6**
1948	310.6	149.9		0.48	0.66	0.32	0.0	0.0	0.5	7.1	10.2	118.5	136.3	**136.3**	1.0	9.4	20.7	201.5	232.6	**232.6**
1949	180.9	69.5		0.38	0.68	0.26	0.0	0.0	0.5	7.1	10.2	118.5	136.3	**136.3**	1.0	9.4	20.7	201.5	232.6	**232.6**
1950	250.5	95.8		0.38	0.69	0.27	0.0	0.0	0.5	7.1	10.2	118.5	136.3	**136.3**	1.0	9.4	20.7	201.5	232.6	**232.6**
1951	137.6	57.1		0.41	0.71	0.29	0.0	0.0	0.5	7.1	10.2	118.5	136.3	**136.3**	1.0	9.4	20.7	201.5	232.6	**232.6**
1952	220.4	77.2		0.35	0.73	0.25	0.0	0.0	0.5	7.1	10.2	118.5	136.3	**136.3**	1.0	9.4	20.7	201.5	232.6	**232.6**
1953	104.4	49.3		0.47	0.74	0.35	16.5	5.8	12.2	11.2	9.6	118.5	151.5	**145.7**	24.9	13.4	19.6	201.5	259.3	**253.5**
1954	106.8	44.0		0.41	0.76	0.31	22.9	7.1	12.2	11.2	9.6	139.6	172.6	**165.5**	24.9	13.4	19.6	237.3	295.2	**288.1**
1955	105.3	29.7		0.28	0.77	0.22	18.8	4.1	26.4	10.4	9.0	148.4	194.2	**190.1**	53.9	12.5	18.2	252.3	336.9	**332.8**
1956	136.3	38.2		0.28	0.79	0.22	20.9	4.6	26.4	10.4	9.0	165.4	211.2	**206.6**	53.9	12.5	18.2	281.1	365.8	**361.1**
1957	131.8	2.2		0.02	0.81	0.01	27.2	0.4	33.2	15.7	12.8	179.4	241.1	**240.7**	67.6	19.9	26.1	305.2	418.8	**418.4**
1958	249.3	3.5		0.01	0.82	0.01	47.3	0.5	33.6	14.5	11.0	178.9	237.9	**237.4**	68.4	18.5	22.3	304.0	413.2	**412.7**
1959	194.9	1.2		0.01	0.84	0.01	34.2	0.2	33.6	13.1	10.6	181.7	239.0	**238.8**	68.5	16.8	21.6	308.7	415.6	**415.5**
1960	101.3	1.6		0.02	0.85	0.01	19.8	0.3	33.6	12.8	10.6	170.0	227.0	**226.8**	68.5	16.4	21.6	288.8	395.4	**395.1**
1961	116.8	5.7		0.05	0.87	0.04	26.3	1.1	33.8	12.6	9.8	156.9	213.0	**211.9**	68.8	23.1	20.0	266.5	378.4	**377.3**
1962	118.0	5.0		0.04	0.89	0.04	41.9	1.6	33.8	19.2	9.8	147.7	210.6	**209.0**	68.8	22.3	20.0	251.0	362.1	**360.6**
1963	139.1	23.5		0.17	0.90	0.15	48.0	7.3	33.5	19.2	9.1	146.5	208.3	**201.0**	68.3	22.2	18.6	248.9	357.9	**350.6**
1964	172.5	24.5		0.14	0.92	0.13	36.8	4.8	33.5	18.6	9.1	144.4	205.6	**200.8**	68.3	21.4	18.6	245.4	353.7	**348.9**
1965	157.7	29.0		0.18	0.94	0.17	10.6	1.8	33.5	18.6	9.1	144.9	206.2	**204.3**	68.3	21.4	18.6	246.3	354.6	**352.8**
1966	155.4	9.0		0.06	0.95	0.06	100.3	5.5	33.5	18.6	9.1	143.8	205.0	**199.5**	68.3	21.4	18.6	244.3	352.6	**347.1**
1967	185.6	42.9		0.23	0.97	0.22	16.3	3.7	33.7	17.9	8.2	142.2	202.0	**198.4**	68.6	20.7	16.7	241.9	347.8	**344.2**
1968	159.2	29.1		0.18	0.98	0.18	24.0	4.3	61.9	16.1	8.3	145.0	231.4	**227.0**	126.1	18.6	17.0	246.2	407.8	**403.5**
1969	231.8	48.3		0.21	1.00	0.21	24.7	5.1	70.3	16.6	7.6	135.9	230.4	**225.2**	143.2	18.4	15.5	231.2	408.2	**403.1**

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Sub-table F-4. Fall Chinook. *(continued)*

Year	Zone 6 Harvest: (A) Bonn. Count	(B) Comm	(C) C&S	(D) Rate (B+C)/A	(E) Tribal Prop.	(F) Tribal Rate [(B*E)+C]/A	(G) Mit'g'n to Bonn.	(H) Tribal Mit'g'n Harvest (F*G)	LOW Run Size — Tribal Harvestable Share of Losses: (J) Spawn'g Area	Adult Passage: (K) Escapem't	Adult Passage: (L) Pre-Harv.	(M) Juv. Passage	(N) TOTAL (J+K+L+M)	Net Tribal Loss (N-H)	HIGH Run Size — Tribal Harvestable Share of Losses: (P) Spawn'g Area	Adult Passage: (Q) Escapem't	Adult Passage: (R) Pre-Harv.	(S) Juv. Passage	(T) TOTAL (P+Q+R+S)	Net Tribal Loss (T-H)
1970	208.9	39.1		0.19	1.00	0.19	14.8	2.8	80.9	16.2	6.7	129.1	232.9	**230.1**	164.8	17.7	13.6	219.6	415.7	**413.0**
1971	202.3	56.5		0.28	1.00	0.28	16.4	4.6	80.9	15.2	6.7	112.6	215.4	**210.8**	164.8	16.4	13.6	191.6	386.5	**381.9**
1972	137.5	42.9		0.31	1.00	0.31	12.2	3.8	80.9	15.2	6.7	103.3	206.0	**202.2**	164.8	16.4	13.6	175.7	370.6	**366.8**
1973	211.2	67.9		0.32	1.00	0.32	22.1	7.1	80.9	15.2	6.7	97.4	200.2	**193.1**	164.8	16.4	13.6	165.8	360.7	**353.6**
1974	186.3	54.9		0.29	1.00	0.29	19.5	5.7	80.9	15.2	6.7	96.2	199.0	**193.2**	164.8	16.4	13.6	163.5	358.4	**352.6**
1975	277.1	140.6		0.51	1.00	0.51	53.0	26.9	92.3	12.9	5.7	96.6	207.5	**180.6**	188.1	13.9	11.6	164.1	377.7	**350.8**
1976	325.3	135.0		0.42	1.00	0.42	38.7	16.0	92.3	12.9	5.7	90.6	201.5	**185.4**	188.1	13.9	11.6	153.9	367.5	**351.5**
1977	206.1	55.2		0.27	1.00	0.27	27.0	7.2	92.3	12.9	5.7	86.9	197.8	**190.6**	188.1	13.9	11.6	147.7	361.3	**354.0**
1978	200.4	63.0		0.31	1.00	0.31	24.6	7.7	92.3	12.9	5.7	81.2	192.1	**184.4**	188.1	13.9	11.6	138.1	351.6	**343.9**
1979	190.7	62.4		0.33	1.00	0.33	25.6	8.4	92.3	12.9	5.7	79.7	190.6	**182.2**	188.1	13.9	11.6	135.4	349.0	**340.6**
1980	153.4	33.9		0.22	1.00	0.22	35.9	7.9	92.3	12.9	5.7	79.7	190.6	**182.6**	188.1	13.9	11.6	135.4	349.0	**341.1**
1981	193.7	54.9		0.28	1.00	0.28	39.3	11.1	92.3	12.9	5.7	79.7	190.6	**179.4**	188.1	13.9	11.6	135.4	349.0	**337.9**
1982	220.2	54.9		0.25	1.00	0.25	36.6	9.1	92.3	12.9	5.7	79.7	190.6	**181.4**	188.1	13.9	11.6	135.4	349.0	**339.9**
1983	164.2	24.5		0.15	1.00	0.15	15.3	2.3	92.3	12.9	5.7	79.7	190.6	**188.3**	188.1	13.9	11.6	135.4	349.0	**346.7**
1984	244.9	53.3		0.22	1.00	0.22	14.2	3.1	92.3	12.9	5.7	79.7	190.6	**187.5**	188.1	13.9	11.6	135.4	349.0	**345.9**
1985	343.0	75.5		0.22	1.00	0.22	19.4	4.3	92.3	12.9	5.7	79.7	190.6	**186.3**	188.1	13.9	11.6	135.4	349.0	**344.7**
1986	416.8	106.6		0.26	1.00	0.26	15.3	3.9	92.3	12.9	5.7	79.7	190.6	**186.7**	188.1	13.9	11.6	135.4	349.0	**345.1**
1987	408.0	139.6		0.34	1.00	0.34	25.8	8.8	92.3	12.9	5.7	79.7	190.6	**181.7**	188.1	13.9	11.6	135.4	349.0	**340.1**
1988	362.8	147.8		0.41	1.00	0.41	18.6	7.6	92.3	12.9	5.7	79.7	190.6	**183.0**	188.1	13.9	11.6	135.4	349.0	**341.4**
1989	295.9	128.8		0.44	1.00	0.44	18.4	8.0	92.3	12.9	5.7	79.7	190.6	**182.5**	188.1	13.9	11.6	135.4	349.0	**341.0**
1990	216.7	84.4		0.39	1.00	0.39	27.5	10.7	92.3	12.9	5.7	79.7	190.6	**179.8**	188.1	13.9	11.6	135.4	349.0	**338.3**
1991	191.4	52.2		0.27	1.00	0.27	27.8	7.6	92.3	12.9	5.7	79.7	190.6	**183.0**	188.1	13.9	11.6	135.4	349.0	**341.4**
1992	146.5	29.0		0.20	1.00	0.20	17.9	3.5	92.3	12.9	5.7	79.7	190.6	**187.0**	188.1	13.9	11.6	135.4	349.0	**345.4**
1993	141.9	31.5		0.22	1.00	0.22	17.9	4.0	92.3	12.9	5.7	79.7	190.6	**186.6**	188.1	13.9	11.6	135.4	349.0	**345.0**
1994	203.4	29.9		0.15	1.00	0.15	23.7	3.5	92.3	12.9	5.7	79.7	190.6	**187.1**	188.1	13.9	11.6	135.4	349.0	**345.5**
1995	210.4	31.5		0.15	1.00	0.15	30.9	4.6	92.3	12.9	5.7	79.7	190.6	**185.9**	188.1	13.9	11.6	135.4	349.0	**344.4**
TOTALS							1,175	249	2,930	718	479	6,465	10,592	**10,343**	5,968	839	976	10,990	18,773	**18,525**

Sub-table F-5. Coho. Bonneville Dam counts, Zone 6 harvests, and losses to tribal fisheries, 1938-95.

Year	(A) Bonn. Count	Zone 6 Harvest: (B) Comm	Zone 6 Harvest: (C) C&S	Zone 6 Harvest: (D) Rate (B+C)/A	Zone 6 Harvest: (E) Tribal Prop.	Zone 6 Harvest: (F) Tribal Rate [(B*E)+C]/A	(G) Mit'g'n to Bonn.	(H) Tribal Mit'g'n Harvest (F*G)	LOW Run Size: Tribal Harvestable Share of Losses: (J) Spawn'g Area	LOW: Adult Passage: (K) Escapem't	LOW: Adult Passage: (L) Pre-Harv.	LOW: (M) Juv. Passage	LOW: (N) TOTAL (J+K+L+M)	LOW: Net Tribal Loss (N-H)	HIGH Run Size: Tribal Harvestable Share of Losses: (P) Spawn'g Area	HIGH: Adult Passage: (Q) Escapem't	HIGH: Adult Passage: (R) Pre-Harv.	HIGH: (S) Juv. Passage	HIGH: (T) TOTAL (P+Q+R+S)	HIGH: Net Tribal Loss (T-H)
1938	15.2	0.2		0.01	0.50	0.01	0.0	0.0	0.0	1.1	0.0	2.4	3.6	**3.6**	0.0	1.9	0.1	4.1	6.1	**6.1**
1939	14.4	0.2		0.01	0.52	0.01	0.0	0.0	0.0	1.6	0.0	6.9	8.6	**8.6**	0.0	2.7	0.1	11.7	14.5	**14.5**
1940	11.9	0.1		0.01	0.53	0.00	0.0	0.0	0.0	1.5	0.0	6.9	8.4	**8.4**	0.0	2.5	0.0	11.7	14.3	**14.3**
1941	17.9	3.2		0.18	0.55	0.10	0.0	0.0	0.0	2.8	1.0	6.9	10.7	**10.7**	0.0	4.7	1.8	11.7	18.2	**18.2**
1942	12.4	0.3		0.02	0.56	0.01	0.0	0.0	0.0	3.0	0.2	6.9	10.1	**10.1**	0.0	5.1	0.3	11.7	17.1	**17.1**
1943	2.5	0.1		0.04	0.58	0.02	0.0	0.0	0.0	0.6	0.1	6.9	7.6	**7.6**	0.0	1.1	0.1	11.7	12.9	**12.9**
1944	4.2	0.5		0.12	0.60	0.07	0.0	0.0	0.0	0.5	0.1	6.9	7.5	**7.5**	0.0	0.8	0.2	11.7	12.8	**12.8**
1945	0.8	0.2		0.25	0.61	0.15	0.0	0.0	0.0	0.1	0.0	6.9	7.1	**7.1**	0.0	0.1	0.1	11.7	11.9	**11.9**
1946	3.9	0.2		0.05	0.63	0.03	0.0	0.0	0.0	0.6	0.1	6.9	7.7	**7.7**	0.0	1.1	0.1	11.7	13.0	**13.0**
1947	11.2	1.9		0.17	0.65	0.11	0.0	0.0	0.0	1.3	0.5	6.9	8.7	**8.7**	0.0	2.2	0.8	11.7	14.7	**14.7**
1948	4.1	0.2		0.05	0.66	0.03	0.0	0.0	0.0	0.6	0.1	6.9	7.6	**7.6**	0.0	1.0	0.1	11.7	12.9	**12.9**
1949	1.0	0.2		0.20	0.68	0.14	0.0	0.0	0.0	0.2	0.1	6.9	7.2	**7.2**	0.0	0.3	0.1	11.7	12.2	**12.2**
1950	10.2	0.9		0.09	0.69	0.06	0.0	0.0	0.0	1.6	0.3	6.9	8.9	**8.9**	0.0	2.8	0.5	11.7	15.0	**15.0**
1951	5.2	0.4		0.08	0.71	0.05	0.0	0.0	0.0	0.9	0.2	6.9	8.0	**8.0**	0.0	1.6	0.3	11.7	13.6	**13.6**
1952	7.8	1.1		0.14	0.73	0.10	0.0	0.0	0.0	1.3	0.4	6.9	8.7	**8.7**	0.0	2.3	0.7	11.7	14.7	**14.7**
1953	13.0	3.3		0.25	0.74	0.19	0.0	0.0	0.0	7.3	2.5	8.1	17.9	**17.9**	0.0	12.4	4.2	13.7	30.3	**30.3**
1954	4.1	1.1		0.27	0.76	0.20	0.0	0.0	0.0	3.8	1.3	10.3	15.4	**15.4**	0.0	6.4	2.3	17.4	26.1	**26.1**
1955	3.7	[redacted]		0.41	0.77	0.31	0.0	0.0	0.0	2.2	8.2	10.3	20.7	**20.7**	0.0	3.7	14.0	17.4	35.0	**35.0**
1956	6.1	1.8		0.30	0.79	0.23	0.0	0.0	0.0	3.6	1.4	11.4	16.4	**16.4**	0.0	6.1	2.4	19.2	27.7	**27.7**
1957	4.7	0.1		0.02	0.81	0.02	0.0	0.0	0.0	4.6	0.1	13.4	18.2	**18.2**	0.0	7.8	0.2	22.7	30.8	**30.8**
1958	3.7	0.2		0.05	0.82	0.04	0.0	0.0	0.0	8.3	0.6	13.4	22.3	**22.3**	0.0	14.0	1.1	22.7	37.9	**37.9**
1959	2.7	0.1		0.04	0.84	0.03	0.0	0.0	0.0	6.9	0.4	13.2	20.4	**20.4**	0.0	11.7	0.6	22.3	34.6	**34.6**
1960	3.3	0.2		0.06	0.85	0.05	1.2	0.1	0.0	3.7	0.3	12.7	16.7	**16.7**	0.0	6.3	0.6	21.4	28.3	**28.3**
1961	3.5	0.5		0.14	0.87	0.12	3.1	0.4	0.0	1.9	0.4	12.5	14.7	**14.3**	0.0	3.2	0.7	21.1	25.0	**24.6**
1962	14.8	2.5		0.17	0.89	0.15	11.0	1.6	0.0	7.5	1.2	12.8	21.4	**19.8**	0.0	12.8	2.0	21.6	36.4	**34.7**
1963	12.7	0.1		0.01	0.90	0.01	2.0	0.0	0.0	7.4	0.1	13.2	20.7	**20.6**	0.0	12.5	0.1	22.4	35.0	**35.0**
1964	53.6	2.5		0.05	0.92	0.04	37.3	1.6	0.0	11.0	0.5	13.2	24.7	**23.1**	0.0	18.6	0.8	22.4	41.9	**40.3**
1965	76.0	3.2		0.04	0.94	0.04	38.8	1.5	0.0	10.8	0.5	13.2	24.5	**23.0**	0.0	18.3	0.9	22.4	41.6	**40.1**
1966	71.9	8.3		0.12	0.95	0.11	39.8	4.4	0.0	5.6	0.9	13.2	19.8	**15.4**	0.0	9.6	1.5	22.4	33.5	**29.1**
1967	96.5	13.6		0.14	0.97	0.14	44.0	6.0	0.0	9.7	1.7	13.9	25.2	**19.2**	0.0	16.4	2.8	23.5	42.8	**36.8**
1968	63.5	7.6		0.12	0.98	0.12	25.2	3.0	0.0	12.5	2.1	15.5	30.1	**27.1**	0.0	21.3	3.5	26.2	51.0	**48.0**
1969	49.4	7.8		0.16	1.00	0.16	20.3	3.2	0.0	10.6	1.9	16.2	28.7	**25.5**	0.0	18.0	3.3	27.5	48.7	**45.5**

- - - *(continued)* - - -

Sub-table F-5. Coho. *(continued)*

Year	(A) Bonn. Count	Zone 6 Harvest (B) Comm	(C) C&S	(D) Rate (B+C)/A	(E) Tribal Prop.	(F) Tribal Rate [(B*E)+C]/A	(G) Mit'g'n to Bonn.	(H) Tribal Mit'g'n Harvest (F*G)	LOW Run Size: Tribal Harvestable Share of Losses (J) Spawn'g Area	Adult Passage (K) Escapem't	(L) Pre-Harv.	(M) Juv. Passage	(N) TOTAL (J+K+L+M)	Net Tribal Loss (N-H)	HIGH Run Size: Tribal Harvestable Share of Losses (P) Spawn'g Area	Adult Passage (Q) Escapem't	(R) Pre-Harv.	(S) Juv. Passage	(T) TOTAL (P+Q+R+S)	Net Tribal Loss (T-H)
1970	80.1	15.5		0.19	1.00	0.19	56.3	10.9	0.0	6.5	1.6	16.6	24.8	13.9	0.0	11.0	2.8	28.2	42.0	31.1
1971	76.0	13.1		0.17	1.00	0.17	27.5	4.7	0.0	9.6	2.3	16.6	28.6	23.9	0.0	16.4	3.9	28.2	48.5	43.8
1972	65.9	8.7		0.13	1.00	0.13	7.3	1.0	0.0	15.2	2.7	16.8	34.8	33.8	0.0	25.9	4.7	28.5	59.1	58.1
1973	54.5	11.1		0.20	1.00	0.20	6.6	1.3	0.0	12.0	3.0	17.2	32.2	30.9	0.0	20.4	5.1	29.1	54.6	53.3
1974	61.0	6.8		0.11	1.00	0.11	11.4	1.3	0.0	10.0	1.5	17.2	28.6	27.3	0.0	16.9	2.5	29.1	48.5	47.2
1975	58.3	5.7		0.10	1.00	0.10	21.8	2.1	0.0	11.6	1.5	17.2	30.2	28.1	0.0	19.7	2.5	29.1	51.3	49.2
1976	53.2	4.0		0.08	1.00	0.08	15.9	1.2	0.0	11.6	1.5	17.2	30.2	29.0	0.0	19.7	2.5	29.1	51.3	50.1
1977	19.4	1.0		0.05	1.00	0.05	5.9	0.3	0.0	11.6	1.5	17.2	30.2	29.9	0.0	19.7	2.5	29.1	51.3	51.0
1978	52.6	3.7		0.07	1.00	0.07	9.3	0.7	0.0	11.6	1.5	17.2	30.2	29.6	0.0	19.7	2.5	29.1	51.3	50.7
1979	45.3	3.9		0.09	1.00	0.09	9.4	0.8	0.0	11.6	1.5	17.2	30.2	29.4	0.0	19.7	2.5	29.1	51.3	50.5
1980	22.1	0.3		0.01	1.00	0.01	4.1	0.1	0.0	11.6	1.5	17.2	30.2	30.2	0.0	19.7	2.5	29.1	51.3	51.3
1981	30.5	1.8		0.06	1.00	0.06	10.1	0.6	0.0	11.6	1.5	17.2	30.2	29.6	0.0	19.7	2.5	29.1	51.3	50.7
1982	73.8	4.3		0.06	1.00	0.06	34.7	2.0	0.0	11.6	1.5	17.2	30.2	28.2	0.0	19.7	2.5	29.1	51.3	49.3
1983	15.2	0.2		0.01	1.00	0.01	3.4	0.0	0.0	11.6	1.5	17.2	30.2	30.2	0.0	19.7	2.5	29.1	51.3	51.3
1984	29.5	1.6		0.05	1.00	0.05	8.2	0.4	0.0	11.6	1.5	17.2	30.2	29.8	0.0	19.7	2.5	29.1	51.3	50.9
1985	56.9	5.2		0.09	1.00	0.09	13.6	1.2	0.0	11.6	1.5	17.2	30.2	29.0	0.0	19.7	2.5	29.1	51.3	50.1
1986	130.9	16.8		0.13	1.00	0.13	33.0	4.2	0.0	11.6	1.5	17.2	30.2	26.0	0.0	19.7	2.5	29.1	51.3	47.1
1987	27.6	2.3		0.08	1.00	0.08	10.6	0.9	0.0	11.6	1.5	17.2	30.2	29.4	0.0	19.7	2.5	29.1	51.3	50.4
1988	39.6	5.2		0.13	1.00	0.13	5.8	0.8	0.0	11.6	1.5	17.2	30.2	29.5	0.0	19.7	2.5	29.1	51.3	50.6
1989	39.3	2.5		0.06	1.00	0.06	14.0	0.9	0.0	11.6	1.5	17.2	30.2	29.4	0.0	19.7	2.5	29.1	51.3	50.4
1990	24.8	1.0		0.04	1.00	0.04	10.1	0.4	0.0	11.6	1.5	17.2	30.2	29.8	0.0	19.7	2.5	29.1	51.3	50.9
1991	64.0	6.7		0.10	1.00	0.10	20.8	2.2	0.0	11.6	1.5	17.2	30.2	28.1	0.0	19.7	2.5	29.1	51.3	49.1
1992	18.1	1.0		0.06	1.00	0.06	6.1	0.3	0.0	11.6	1.5	17.2	30.2	29.9	0.0	19.7	2.5	29.1	51.3	51.0
1993	11.7	0.9		0.08	1.00	0.08	3.9	0.3	0.0	11.6	1.5	17.2	30.2	29.9	0.0	19.7	2.5	29.1	51.3	51.0
1994	22.8	1.0		0.04	1.00	0.04	4.4	0.2	0.0	11.6	1.5	17.2	30.2	30.1	0.0	19.7	2.5	29.1	51.3	51.1
1995	12.0	0.3		0.03	1.00	0.03	3.0	0.1	0.0	11.6	1.5	17.2	30.2	30.2	0.0	19.7	2.5	29.1	51.3	51.2
TOTALS							580	61	0	431	70	761	1,262	1,201	0	733	118	1,289	2,141	2,080

Sub-table F-6. Sockeye.

Year	(A) Bonn. Count	Zone 6 Harvest: (B) Comm	Zone 6 Harvest: (C) C&S	Zone 6 Harvest: (D) Rate (B+C)/A	Zone 6 Harvest: (E) Tribal Prop.	Zone 6 Harvest: (F) Tribal Rate [(B*E)+C]/A	Zone 6 Harvest: (G) Mit'g'n to Bonn.	Zone 6 Harvest: (H) Tribal Mit'g'n Harvest (F*G)	LOW Run Size: (J) Spawn'g Area	LOW Run Size: Adult Passage (K) Escapem't	LOW Run Size: Adult Passage (L) Pre-Harv.	LOW Run Size: (M) Juv. Passage	LOW Run Size: (N) TOTAL (J+K+L+M)	LOW Run Size: Net Tribal Loss (N-H)	HIGH Run Size: (P) Spawn'g Area	HIGH Run Size: Adult Passage (Q) Escapem't	HIGH Run Size: Adult Passage (R) Pre-Harv.	HIGH Run Size: (S) Juv. Passage	HIGH Run Size: (T) TOTAL (P+Q+R+S)	HIGH Run Size: Net Tribal Loss (T-H)
1938	75.0	32.6	[redacted]	0.45	0.50	0.23	0.0	0.0	0.0	5.1	0.3	0.0	5.4	**5.4**	0.0	5.9	4.0	0.0	9.9	**9.9**
1939	73.4	29.6	[redacted]	0.41	0.52	0.22	0.0	0.0	0.0	5.1	0.3	5.8	11.2	**11.2**	0.0	5.9	4.0	9.9	19.9	**19.9**
1940	148.8	64.7	[redacted]	0.44	0.53	0.24	0.0	0.0	0.0	5.1	0.3	59.2	64.6	**64.6**	0.0	5.9	4.0	100.7	110.6	**110.6**
1941	65.7	42.1	[redacted]	0.65	0.55	0.36	0.0	0.0	0.0	5.1	0.3	65.9	71.3	**71.3**	0.0	5.9	4.0	112.1	122.1	**122.1**
1942	55.5	18.4	[redacted]	0.35	0.56	0.20	0.0	0.0	0.0	0.5	0.0	65.9	66.4	**66.4**	0.0	0.6	0.4	112.3	113.3	**113.3**
1943	39.8	9.3	[redacted]	0.25	0.58	0.16	0.0	0.0	0.0	0.5	0.0	64.9	65.4	**65.4**	0.0	0.6	0.4	110.6	111.5	**111.5**
1944	15.1	7.0	[redacted]	0.52	0.60	0.33	0.0	0.0	0.0	0.5	0.0	55.6	56.2	**56.2**	0.0	0.6	0.4	94.8	95.7	**95.7**
1945	9.5	1.3	[redacted]	0.23	0.61	0.17	0.0	0.0	0.0	0.5	0.0	50.7	51.2	**51.2**	0.0	0.6	0.4	86.4	87.3	**87.3**
1946	74.4	11.6	[redacted]	0.17	0.63	0.11	0.0	0.0	0.0	0.5	0.0	15.9	16.5	**16.5**	0.0	0.6	0.4	27.1	28.1	**28.1**
1947	171.1	47.2	[redacted]	0.28	0.65	0.18	0.0	0.0	0.0	0.5	0.0	7.3	7.9	**7.9**	0.0	0.6	0.4	12.5	13.5	**13.5**
1948	131.5	18.1	[redacted]	0.14	0.66	0.10	0.0	0.0	0.0	0.5	0.0	6.8	7.3	**7.3**	0.0	0.6	0.4	11.6	12.6	**12.6**
1949	51.4	6.5	[redacted]	0.14	0.68	0.10	0.0	0.0	0.0	0.5	0.0	6.8	7.3	**7.3**	0.0	0.6	0.4	11.6	12.6	**12.6**
1950	78.0	15.8	[redacted]	0.21	0.69	0.15	0.0	0.0	0.0	0.5	0.0	6.8	7.3	**7.3**	0.0	0.6	0.4	11.6	12.6	**12.6**
1951	169.4	12.0	[redacted]	0.08	0.71	0.06	0.0	0.0	0.0	0.5	0.0	6.8	7.3	**7.3**	0.0	0.6	0.4	11.6	12.6	**12.6**
1952	184.6	31.5	[redacted]	0.18	0.73	0.13	0.0	0.0	0.0	0.5	0.0	6.8	7.3	**7.3**	0.0	0.6	0.4	11.6	12.6	**12.6**
1953	235.2	16.2	[redacted]	0.07	0.74	0.05	0.0	0.0	0.0	1.0	0.0	6.8	7.8	**7.8**	0.0	1.0	0.4	11.6	13.0	**13.0**
1954	130.1	17.5	[redacted]	0.14	0.76	0.11	0.0	0.0	0.0	1.0	0.0	7.3	8.3	**8.3**	0.0	1.0	0.4	12.4	13.8	**13.8**
1955	237.7	52.4	[redacted]	0.22	0.77	0.17	0.0	0.0	0.0	1.0	0.0	12.2	13.2	**13.2**	0.0	1.0	0.4	20.7	22.2	**22.2**
1956	156.4	35.7	[redacted]	0.23	0.79	0.19	0.0	0.0	0.0	1.0	0.0	12.2	13.2	**13.2**	0.0	1.0	0.4	20.7	22.1	**22.1**
1957	82.9	0.2	[redacted]	0.01	0.81	0.01	0.0	0.0	0.0	1.4	0.0	12.6	14.0	**14.0**	0.0	1.5	0.6	21.3	23.5	**23.5**
1958	122.4	6.3	[redacted]	0.06	0.82	0.05	0.0	0.0	0.0	1.4	0.0	16.2	17.6	**17.6**	0.0	1.5	0.6	27.5	29.6	**29.6**
1959	86.6	0.9	[redacted]	0.02	0.84	0.02	0.0	0.0	0.0	1.4	0.0	16.6	18.1	**18.1**	0.0	1.5	0.6	28.2	30.3	**30.3**
1960	59.7	0.6	[redacted]	0.02	0.85	0.02	0.0	0.0	0.0	1.4	0.0	16.3	17.8	**17.8**	0.0	1.5	0.6	27.7	29.8	**29.8**
1961	17.1	0.1	[redacted]	0.05	0.87	0.05	0.0	0.0	0.0	1.4	0.0	14.5	15.9	**15.9**	0.0	1.5	0.6	24.6	26.7	**26.7**
1962	28.2	3.8	[redacted]	0.16	0.89	0.15	0.0	0.0	0.0	1.4	0.0	13.3	14.8	**14.8**	0.0	1.5	0.6	22.6	24.7	**24.7**
1963	60.3	8.9	[redacted]	0.16	0.90	0.15	0.0	0.0	0.0	1.4	0.0	13.2	14.6	**14.6**	0.0	1.5	0.6	22.4	24.5	**24.5**
1964	99.9	15.8	[redacted]	0.17	0.92	0.15	0.0	0.0	0.0	1.5	0.0	12.9	14.5	**14.5**	0.0	1.6	0.6	22.0	24.2	**24.2**
1965	55.1	5.8	[redacted]	0.12	0.94	0.11	0.0	0.0	0.0	1.5	0.0	12.9	14.4	**14.4**	0.0	1.6	0.6	22.0	24.1	**24.1**
1966	156.7	4.2	[redacted]	0.03	0.95	0.03	0.0	0.0	0.0	1.5	0.0	12.9	14.4	**14.4**	0.0	1.6	0.6	22.0	24.1	**24.1**
1967	144.2	34.5	[redacted]	0.25	0.97	0.24	0.0	0.0	0.0	1.5	0.0	12.9	14.4	**14.4**	0.0	1.6	0.6	21.8	24.0	**24.0**
1968	108.2	5.0	[redacted]	0.05	0.98	0.05	0.0	0.0	0.0	1.9	0.1	12.4	14.4	**14.4**	0.0	2.0	0.8	21.1	23.9	**23.9**
1969	59.6	11.3	[redacted]	0.20	1.00	0.20	0.0	0.0	0.0	2.0	0.1	14.1	16.1	**16.1**	0.0	2.1	0.8	24.0	26.8	**26.8**

- - - *(continued)* - - -

Sub-table F-6. Sockeye. *(continued)*

	Zone 6 Harvest								LOW Run Size						HIGH Run Size					
									Tribal Harvestable Share of Losses					Net	Tribal Harvestable Share of Losses					Net
										Adult Passage						Adult Passage				
Year	(A) Bonn. Count	(B) Comm	(C) C&S	(D) Rate (B+C)/A	(E) Tribal Prop.	(F) Tribal Rate [(B*E)+C]/A	(G) Mit'g'n to Bonn.	(H) Tribal Mit'g'n Harvest (F*G)	(J) Spawn'g Area	(K) Escapem't	(L) Pre-Harv.	(M) Juv. Passage	(N) TOTAL (J+K+L+M)	Tribal Loss (N-H)	(P) Spawn'g Area	(Q) Escapem't	(R) Pre-Harv.	(S) Juv. Passage	(T) TOTAL (P+Q+R+S)	Tribal Loss (T-H)
1970	70.8	4.1	[illegible]	0.07	1.00	0.07	0.0	0.0	0.0	2.0	0.1	15.0	17.1	17.1	0.0	2.1	0.8	25.5	28.4	28.4
1971	87.4	21.3	[illegible]	0.25	1.00	0.25	0.0	0.0	0.0	2.0	0.1	15.6	17.7	17.7	0.0	2.1	0.8	26.5	29.4	29.4
1972	56.3	26.1	[illegible]	0.48	1.00	0.48	0.0	0.0	0.0	2.0	0.1	15.7	17.7	17.7	0.0	2.1	0.8	26.6	29.5	29.5
1973	59.0	1.4	[illegible]	0.04	1.00	0.04	0.0	0.0	0.0	2.0	0.1	15.7	17.8	17.8	0.0	2.1	0.8	26.7	29.6	29.6
1974	43.8	0.1	[illegible]	0.02	1.00	0.02	0.0	0.0	0.0	2.0	0.1	16.1	18.2	18.2	0.0	2.1	0.8	27.4	30.3	30.3
1975	58.2	0.0	[illegible]	0.01	1.00	0.01	0.0	0.0	0.0	2.0	0.1	16.2	18.3	18.3	0.0	2.2	0.8	27.5	30.4	30.4
1976	43.6	0.1	[illegible]	0.02	1.00	0.02	0.0	0.0	0.0	2.0	0.1	16.2	18.3	18.3	0.0	2.2	0.8	27.5	30.4	30.4
1977	99.8	0.1	1.9	0.02	1.00	0.02	0.0	0.0	0.0	2.0	0.1	16.2	18.3	18.3	0.0	2.2	0.8	27.5	30.4	30.4
1978	18.4	0.1	0.1	0.01	1.00	0.01	0.0	0.0	0.0	2.0	0.1	16.1	18.2	18.2	0.0	2.2	0.8	27.4	30.4	30.4
1979	52.6	0.1	0.1	0.00	1.00	0.00	0.0	0.0	0.0	2.0	0.1	16.2	18.3	18.3	0.0	2.2	0.8	27.5	30.4	30.4
1980	58.9	0.1	0.6	0.01	1.00	0.01	0.0	0.0	0.0	2.0	0.1	16.2	18.3	18.3	0.0	2.2	0.8	27.5	30.4	30.4
1981	56.0	0.1	1.5	0.03	1.00	0.03	0.0	0.0	0.0	2.0	0.1	16.2	18.3	18.3	0.0	2.2	0.8	27.5	30.4	30.4
1982	50.2	0.1	0.7	0.02	1.00	0.02	0.0	0.0	0.0	2.0	0.1	16.2	18.3	18.3	0.0	2.2	0.8	27.5	30.4	30.4
1983	100.5	1.8	1.5	0.03	1.00	0.03	0.0	0.0	0.0	2.0	0.1	16.2	18.3	18.3	0.0	2.2	0.8	27.5	30.4	30.4
1984	152.5	22.5	2.1	0.16	1.00	0.16	0.0	0.0	0.0	2.0	0.1	16.2	18.3	18.3	0.0	2.2	0.8	27.5	30.4	30.4
1985	166.3	49.4	0.5	0.30	1.00	0.30	0.0	0.0	0.0	2.0	0.1	16.2	18.3	18.3	0.0	2.2	0.8	27.5	30.4	30.4
1986	58.1	4.3	2.4	0.12	1.00	0.12	0.0	0.0	0.0	2.0	0.1	16.2	18.3	18.3	0.0	2.2	0.8	27.5	30.4	30.4
1987	117.0	39.5	0.1	0.34	1.00	0.34	0.0	0.0	0.0	2.0	0.1	16.2	18.3	18.3	0.0	2.2	0.8	27.5	30.4	30.4
1988	79.7	31.0		0.39	1.00	0.39	0.0	0.0	0.0	2.0	0.1	16.2	18.3	18.3	0.0	2.2	0.8	27.5	30.4	30.4
1989	41.9	0.1	2.1	0.05	1.00	0.05	0.0	0.0	0.0	2.0	0.1	16.2	18.3	18.3	0.0	2.2	0.8	27.5	30.4	30.4
1990	49.6	0.1	2.4	0.05	1.00	0.05	0.0	0.0	0.0	2.0	0.1	16.2	18.3	18.3	0.0	2.2	0.8	27.5	30.4	30.4
1991	76.5	0.1	3.3	0.04	1.00	0.04	0.0	0.0	0.0	2.0	0.1	16.2	18.3	18.3	0.0	2.2	0.8	27.5	30.4	30.4
1992	85.0	0.1	2.2	0.03	1.00	0.03	0.0	0.0	0.0	2.0	0.1	16.2	18.3	18.3	0.0	2.2	0.8	27.5	30.4	30.4
1993	80.2	0.1	5.0	0.06	1.00	0.06	0.0	0.0	0.0	2.0	0.1	16.2	18.3	18.3	0.0	2.2	0.8	27.5	30.4	30.4
1994	12.7	0.0	0.5	0.04	1.00	0.04	0.0	0.0	0.0	2.0	0.1	16.2	18.3	18.3	0.0	2.2	0.8	27.5	30.4	30.4
1995	8.8	0.0	0.4	0.05	1.00	0.05	0.0	0.0	0.0	2.0	0.1	16.2	18.3	18.3	0.0	2.2	0.8	28.9	31.9	31.9
TOTALS									0	102	4	1,062	1,168	1,168	0	111	50	1,808	1,970	1,970

Shaded numbers are surrogates derived using methods described in the text.

Sub-table F-7. Steelhead.

	Zone 6 Harvest								LOW Run Size						HIGH Run Size					
									Tribal Harvestable Share of Losses					Net	Tribal Harvestable Share of Losses					Net
										Adult Passage						Adult Passage				
Year	(A) Bonn. Count	(B) Comm	(C) C&S	(D) Rate (B+C)/A	(E) Tribal Prop.	(F) Tribal Rate [(B*E)+C]/A	(G) Mit'g'n to Bonn.	(H) Tribal Mit'g'n Harvest (F*G)	(J) Spawn'g Area	(K) Escapem't	(L) Pre-Harv.	(M) Juv. Passage	(N) TOTAL (J+K+L+M)	Tribal Loss (N-H)	(P) Spawn'g Area	(Q) Escapem't	(R) Pre-Harv.	(S) Juv. Passage	(T) TOTAL (P+Q+R+S)	Tribal Loss (T-H)
1938	106.6	38.1	0.5	0.36	0.50	0.18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	**0.0**
1939	121.0	25.8	0.5	0.22	0.52	0.11	0.0	0.0	0.0	0.0	0.0	17.5	17.5	**17.5**	0.0	0.0	0.0	29.7	29.7	**29.7**
1940	183.0	52.9	0.5	0.29	0.53	0.16	0.0	0.0	0.0	0.0	0.0	32.5	32.5	**32.5**	0.0	0.0	0.0	55.2	55.2	**55.2**
1941	115.0	54.1	0.5	0.47	0.55	0.26	0.0	0.0	0.0	0.0	0.0	33.9	33.9	**33.9**	0.0	0.0	0.0	57.6	57.6	**57.6**
1942	150.3	41.5	0.5	0.28	0.56	0.16	0.0	0.0	0.0	0.0	0.0	33.8	33.8	**33.8**	0.0	0.0	0.0	57.6	57.6	**57.6**
1943	90.8	31.8	0.5	0.36	0.58	0.21	0.0	0.0	0.0	0.0	0.0	33.8	33.8	**33.8**	0.0	0.0	0.0	57.5	57.5	**57.5**
1944	98.0	42.0	0.5	0.43	0.60	0.26	0.0	0.0	0.0	0.0	0.0	33.7	33.7	**33.7**	0.0	0.0	0.0	57.3	57.3	**57.3**
1945	114.6	38.0	0.5	0.34	0.61	0.21	0.0	0.0	0.0	0.0	0.0	33.7	33.7	**33.7**	0.0	0.0	0.0	57.3	57.3	**57.3**
1946	137.9	45.8	0.5	0.34	0.63	0.21	0.0	0.0	0.0	0.0	0.0	33.4	33.4	**33.4**	0.0	0.0	0.0	56.8	56.8	**56.8**
1947	132.4	38.9	0.5	0.30	0.65	0.19	0.0	0.0	0.0	0.0	0.0	32.9	32.9	**32.9**	0.0	0.0	0.0	56.0	56.0	**56.0**
1948	136.7	43.1	0.5	0.32	0.66	0.21	0.0	0.0	0.0	0.0	0.0	32.7	32.7	**32.7**	0.0	0.0	0.0	58.5	58.5	**58.5**
1949	116.8	36.7	0.5	0.32	0.68	0.22	0.0	0.0	0.0	0.0	0.0	32.7	32.7	**32.7**	0.0	0.0	0.0	55.5	55.5	**55.5**
1950	112.1	25.0	0.5	0.23	0.69	0.16	0.0	0.0	0.0	0.0	0.0	32.7	32.7	**32.7**	0.0	0.0	0.0	55.5	55.5	**55.5**
1951	140.1	37.5	0.5	0.27	0.71	0.19	0.0	0.0	0.0	0.0	0.0	32.7	32.7	**32.7**	0.0	0.0	0.0	55.5	55.5	**55.5**
1952	260.1	57.2	0.5	0.22	0.73	0.16	0.0	0.0	0.0	0.0	0.0	32.2	32.2	**32.2**	0.0	0.0	0.0	54.7	54.7	**54.7**
1953	221.7	65.9	0.5	0.30	0.74	0.22	0.0	0.0	0.0	5.5	6.8	31.5	43.8	**43.8**	0.0	6.9	12.9	53.5	73.3	**73.3**
1954	175.0	23.5	0.5	0.14	0.76	0.10	0.0	0.0	0.0	5.5	7.1	52.5	65.2	**65.2**	0.0	7.0	13.4	89.3	109.8	**109.8**
1955	197.1	48.7	0.5	0.25	0.77	0.19	0.0	0.0	0.4	5.4	6.9	53.7	66.4	**66.4**	1.2	6.8	13.0	91.3	112.4	**112.4**
1956	129.1	27.9	0.5	0.22	0.79	0.17	0.0	0.0	1.1	5.3	6.4	53.9	66.7	**66.7**	2.4	6.7	12.2	91.4	112.6	**112.6**
1957	138.0	0.2	[illegible]	0.01	0.81	0.00	0.0	0.0	1.0	7.8	9.5	64.0	82.3	**82.3**	2.3	9.9	18.1	108.8	139.1	**139.1**
1958	130.7	4.1	[illegible]	0.04	0.82	0.03	0.0	0.0	1.6	7.7	8.7	71.7	89.7	**89.7**	3.2	10.0	16.7	122.0	151.9	**151.9**
1959	128.6	0.8	[illegible]	0.01	0.84	0.01	0.0	0.0	1.5	7.3	8.8	71.4	89.0	**89.0**	3.1	9.3	16.8	118.7	147.8	**147.8**
1960	113.1	1.3	0.5	0.02	0.85	0.01	0.0	0.0	1.7	7.2	8.6	69.9	87.4	**87.4**	3.3	9.2	16.5	118.6	147.7	**147.7**
1961	138.7	1.5	0.5	0.01	0.87	0.01	0.0	0.0	2.5	6.8	7.5	67.3	84.1	**84.1**	4.8	8.6	14.5	114.2	142.1	**142.1**
1962	163.0	0.5	0.5	0.01	0.89	0.01	0.0	0.0	1.9	8.0	8.3	65.0	83.2	**83.2**	3.7	9.9	15.8	110.5	139.9	**139.9**
1963	128.4	8.5	0.5	0.07	0.90	0.06	0.0	0.0	2.2	7.8	7.8	69.6	87.4	**87.4**	4.2	9.6	15.1	118.3	147.2	**147.2**
1964	116.2	6.7	0.5	0.06	0.92	0.06	0.0	0.0	2.8	8.0	7.4	74.0	92.1	**92.1**	5.2	9.8	14.4	125.7	155.1	**155.1**
1965	165.6	13.2	0.5	0.08	0.94	0.08	0.0	0.0	3.2	7.9	6.8	74.0	92.0	**92.0**	6.0	9.6	13.5	125.8	154.8	**154.8**
1966	142.3	3.1	0.5	0.03	0.95	0.02	0.0	0.0	3.8	7.7	6.2	73.5	91.2	**91.2**	6.9	9.3	12.4	125.0	153.6	**153.6**
1967	121.0	15.8	0.5	0.13	0.97	0.13	0.0	0.0	3.7	7.3	5.9	74.2	91.1	**91.1**	6.8	8.8	11.8	126.2	153.5	**153.5**
1968	106.1	9.4	0.5	0.09	0.98	0.09	0.0	0.0	4.0	8.8	7.1	81.9	101.8	**101.8**	7.4	10.3	14.5	139.4	171.5	**171.5**
1969	139.3	14.1	0.5	0.10	1.00	0.10	0.0	0.0	3.6	11.0	8.9	91.9	115.4	**115.4**	6.6	13.8	17.6	156.2	194.2	**194.2**

- - - *(continued)* - - -

Sub-table F-7. Steelhead. *(continued)*

Year	(A) Bonn. Count	Zone 6 Harvest (B) Comm	(C) C&S	(D) Rate (B+C)/A	(E) Tribal Prop.	(F) Tribal Rate [(B*E)+C]/A	(G) Mit'g'n to Bonn.	(H) Tribal Mit'g'n Harvest (F*G)	LOW Run Size: Tribal Harvestable Share of Losses (J) Spawn'g Area	Adult Passage (K) Escapem't	Adult Passage (L) Pre-Harv.	(M) Juv. Passage	(N) TOTAL (J+K+L+M)	Net Tribal Loss (N-H)	HIGH Run Size: Tribal Harvestable Share of Losses (P) Spawn'g Area	Adult Passage (Q) Escapem't	Adult Passage (R) Pre-Harv.	(S) Juv. Passage	(T) TOTAL (P+Q+R+S)	Net Tribal Loss (T-H)
1970	113.0	13.2	0.5	0.12	1.00	0.12	0.0	0.0	8.0	10.8	5.3	97.8	122.0	**122.0**	14.5	13.1	11.4	166.1	205.1	**205.1**
1971	193.1	25.7	0.5	0.14	1.00	0.14	0.0	0.0	18.2	10.2	6.1	98.9	133.4	**133.4**	33.2	12.3	12.6	168.0	226.2	**226.2**
1972	185.3	28.9	0.5	0.16	1.00	0.16	0.0	0.0	15.4	10.8	7.3	98.2	131.7	**131.7**	28.4	13.6	14.7	166.7	223.4	**223.4**
1973	156.7	26.8	0.5	0.17	1.00	0.17	15.3	2.7	15.3	10.9	7.4	99.8	133.4	**130.8**	28.3	13.8	14.7	169.6	226.3	**223.7**
1974	135.2	13.2	0.5	0.10	1.00	0.10	11.3	1.1	16.2	10.9	7.0	98.2	132.3	**131.1**	29.8	13.7	14.1	166.8	224.4	**223.2**
1975	84.1	7.8	0.5	0.10	1.00	0.10	2.3	0.2	19.6	11.6	5.5	93.7	130.4	**130.2**	35.5	14.6	11.6	159.2	220.9	**220.7**
1976	122.4	11.8	0.5	0.10	1.00	0.10	2.7	0.3	19.6	11.6	5.5	91.9	128.6	**128.3**	35.5	14.6	11.6	156.1	217.8	**217.5**
1977	191.7	36.0	0.5	0.19	1.00	0.19	5.1	1.0	19.6	11.6	5.5	91.7	128.4	**127.4**	35.5	14.6	11.6	155.8	217.5	**216.6**
1978	102.3	19.1	0.5	0.19	1.00	0.19	20.9	4.0	19.6	11.6	5.5	91.7	128.4	**124.4**	35.5	14.6	11.6	155.8	217.5	**213.5**
1979	112.4	8.5	0.4	0.08	1.00	0.08	7.1	0.6	19.6	11.6	5.5	91.7	128.4	**127.8**	35.5	14.6	11.6	155.8	217.5	**217.0**
1980	127.6	9.6	0.5	0.08	1.00	0.08	3.6	0.3	19.6	11.6	5.5	91.7	128.4	**128.1**	35.5	14.6	11.6	155.8	217.5	**217.2**
1981	157.9	9.4	0.6	0.06	1.00	0.06	2.8	0.2	19.6	11.6	5.5	91.7	128.4	**128.2**	35.5	14.6	11.6	155.8	217.5	**217.4**
1982	156.2	8.3	0.7	0.06	1.00	0.06	4.2	0.2	19.6	11.6	5.5	91.7	128.4	**128.2**	35.5	14.6	11.6	155.8	217.5	**217.3**
1983	217.5	18.3	0.4	0.09	1.00	0.09	11.2	1.0	19.6	11.6	5.5	91.7	128.4	**127.4**	35.5	14.6	11.6	155.8	217.5	**216.6**
1984	314.5	77.5	1.6	0.25	1.00	0.25	5.9	1.5	19.6	11.6	5.5	91.7	128.4	**126.9**	35.5	14.6	11.6	155.8	217.5	**216.0**
1985	342.4	88.0	1.8	0.26	1.00	0.26	26.3	6.9	19.6	11.6	5.5	91.7	128.4	**121.5**	35.5	14.6	11.6	155.8	217.5	**210.6**
1986	376.4	71.4	2.1	0.20	1.00	0.20	10.4	2.0	19.6	11.6	5.5	91.7	128.4	**126.4**	35.5	14.6	11.6	155.8	217.5	**215.5**
1987	301.0	82.6	3.1	0.28	1.00	0.28	12.8	3.6	19.6	11.6	5.5	91.7	128.4	**124.8**	35.5	14.6	11.6	155.8	217.5	**213.9**
1988	277.2	77.2	3.5	0.29	1.00	0.29	7.9	2.3	19.6	11.6	5.5	91.7	128.4	**126.1**	35.5	14.6	11.6	155.8	217.5	**215.2**
1989	286.4	55.0	6.7	0.22	1.00	0.22	11.5	2.5	19.6	11.6	5.5	91.7	128.4	**125.9**	35.5	14.6	11.6	155.8	217.5	**215.0**
1990	181.5	31.1	0.4	0.17	1.00	0.17	18.3	3.2	19.6	11.6	5.5	91.7	128.4	**125.2**	35.5	14.6	11.6	155.8	217.5	**214.4**
1991	273.2	39.0	9.9	0.18	1.00	0.18	13.1	2.3	19.6	11.6	5.5	91.7	128.4	**126.1**	35.5	14.6	11.6	155.8	217.5	**215.2**
1992	313.9	50.2	9.1	0.19	1.00	0.19	9.1	1.7	19.6	11.6	5.5	91.7	128.4	**126.7**	35.5	14.6	11.6	155.8	217.5	**215.8**
1993	187.3	27.3	5.8	0.18	1.00	0.18	15.6	2.8	19.6	11.6	5.5	91.7	128.4	**125.6**	35.5	14.6	11.6	155.8	217.5	**214.8**
1994	160.8	12.7	5.9	0.12	1.00	0.12	6.3	0.7	19.6	11.6	5.5	91.7	128.4	**127.7**	35.5	14.6	11.6	155.8	217.5	**216.8**
1995	201.5	10.7	12.0	0.11	1.00	0.11	0.9	0.1	19.6	11.6	5.5	91.7	128.4	**128.3**	35.5	14.6	11.6	155.8	217.5	**217.4**
TOTALS							225	41	519	422	278	4,009	5,228	**5,187**	947	529	560	6,813	8,849	**8,808**

Shaded numbers are surrogates derived using methods described in the text.