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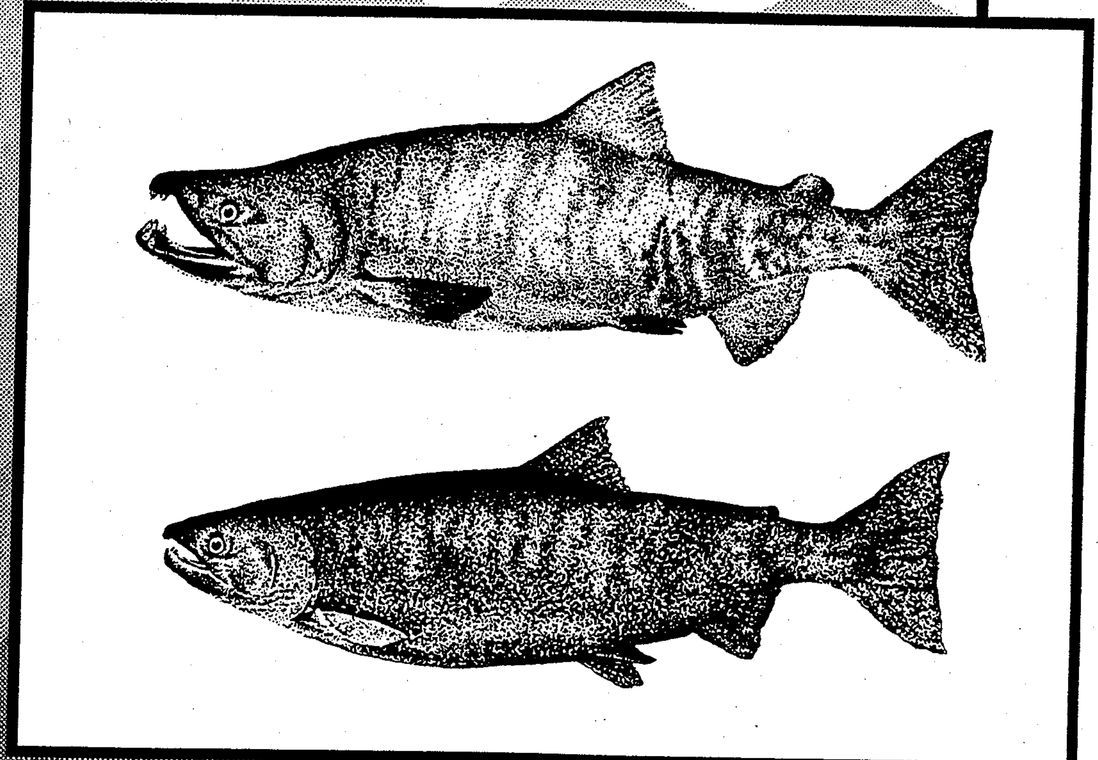
Life History Characterization of Summer Chum Salmon Populations in the Hood Canal and Eastern Strait of Juan de Fuca Regions



By Tim Tynan

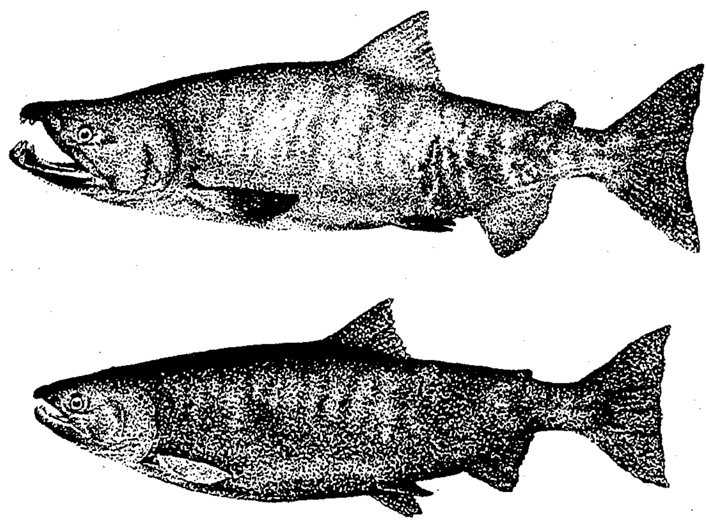
Washington Department of
FISH AND WILDLIFE
Hatcheries Program
Assessment and Development Division

Report # H97-06

Life History Characterization of Summer Chum Salmon Populations in the Hood Canal and Eastern Strait of Juan de Fuca Regions

Volume I

BIOLOGICAL ASSESSMENT OF WDFW HATCHERY PROGRAM EFFECTS ON THE STATUS OF HOOD CANAL AND STRAIT OF JUAN DE FUCA REGION SUMMER CHUM SALMON POPULATIONS



Technical Report # H97-06

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WASHINGTON DEPARTMENT OF FISH AND WILDLIFE

May 1997

ABSTRACT

This report characterizes wild summer chum life history strategies for populations native to the Hood Canal and eastern Strait of Juan de Fuca regions of Washington state. Baseline information regarding spatial and temporal occurrence timing for summer chum life stages in freshwater, estuarine and marine areas is presented. Timing information provided here is proposed for use in future assessments of the effects of ecological interactions between hatchery-origin salmonids and wild summer chum.

Summer chum population levels, trends, and status in the Hood Canal and eastern Strait of Juan de Fuca regions are summarized. Returns to production streams in the Hood Canal region declined markedly beginning in the late 1970s, remaining at very low total levels until 1995, with continued improvement in returns observed in 1996. Populations returning to several eastside Hood Canal streams have been extirpated over this time period. Total eastern Strait of Juan de Fuca summer chum returns have historically been much smaller than totals in Hood Canal. Escapement levels in Strait streams were stable through 1988, after which time returns have trended downward, and remain at low levels. Adult migration and spawning timing and behavior is presented. Hood Canal summer chum peak on the spawning grounds on September 28. Eastern Strait of Juan de Fuca populations have an estimated peak spawning time of October 2.

Summer chum fry development and egression characteristics are reported. Critical developmental timings are derived from observations of summer chum cultured in Hood Canal and Strait of Juan de Fuca enhancement programs, and studies of wild summer chum in an eastside Hood Canal stream. Summer chum are estimated to exhibit a gravel residence period of September 1 through April 24 in Hood Canal drainages and from September 1 through May 25 in Strait of Juan de Fuca streams. Estimated peak egression timing for Hood Canal populations is March 22 (central 80 % range February 7 - April 14). The estimated peak egression time for Strait of Juan de Fuca populations is April 4 (central 80 % range February 15 - May 26).

Estuarine residence and migration timings for summer chum in the two regions are presented, using freshwater egression timing estimates as a basis. Expected migration rates, behavior, and residence timings are estimated using chum salmon migrational information collected in studies in the 1970s and early 1980s of the effects of the construction of the Trident Submarine Base at Bangor on juvenile salmon migration. Migrating Hood Canal summer chum are assumed to progress rapidly northward towards coastal water masses, due to the paucity of food resources and prevalence of S/SW weather patterns in the Canal during the March-April time of migration. Assuming a migration speed of 7 km/day, seaward-migrating summer chum from the most southerly Hood Canal population are estimated to peak in abundance at the mouth of Hood Canal on April 1 (central 80 % range February 21- April 28). A conservative seaward migration rate of 4 km/day is assumed for eastern Strait summer chum, yielding an estimated peak of migration in the mid-Strait of Juan de Fuca area on April 14 (central 80 % range February 25- June 5).

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Background -

Through the *1992 Washington State Salmon and Steelhead Stock Inventory* (SASSI) process, the Washington Department of Fish and Wildlife and the Western Washington Treaty Tribes identified twelve salmonid stocks that were critically depressed in status, with production levels so low that permanent damage to the stocks was imminent (WDF, WDW and WWTIT 1993). Included in the stocks designated as critical were summer chum populations originating in the Hood Canal and Strait of Juan de Fuca regions. Summer chum in both regions have experienced long term declines in return levels. If present, downward adult return trends continue, their future existence may be in jeopardy.

Concurrent with the assembly of SASSI, status assessments for Hood Canal summer chum were developed by state, tribal and federal managers, proposing potential reasons for their critical status, and providing stock rebuilding and research recommendations (Tynan 1992; Cook-Tabor 1995). Beginning in 1992, terminal area fishery harvest protection measures and hatchery supplementation programs were initiated in the Hood Canal and eastern Strait regions to help address declines in total run sizes (WDFW 1996; USFWS 1992; 1993b; 1994a; 1995; 1996; Seymour 1993). The development of a long term conservation plan for Hood Canal summer chum, defining habitat, harvest, and hatchery management measures and research needs was also initiated by the management agencies in 1992, and a working draft plan was provided to National Marine Fisheries Service (NMFS) in January, 1997 (WDFW et al. 1997).

Subsequent to the completion of SASSI, Hood Canal and Strait of Juan de Fuca summer chum were petitioned for listing under the Endangered Species Act (ESA) by several conservation groups (PRO-Salmon 1994; Trout Unlimited 1994). In response to these and other petitions focusing on Pacific Northwest salmon, the NMFS is conducting an ESA status review of all west coast chum stocks. The status review includes completion of a extinction risk assessment by NMFS Conservation Biology Program technical staff assigned to the Chum Biological Review Team (BRT). The BRT review is now complete, and NMFS technical findings regarding west coast chum have been released (NMFS 1997). The Chum BRT report concluded that Hood Canal and SJF summer chum stocks comprise one group of related populations within a "Hood Canal Summer-Run Evolutionarily Significant Unit (ESU)". The BRT concluded that this ESU is "in danger of extinction throughout its range" (NMFS 1997). Degradation of spawning habitat, low water flows, possible competition from hatchery fall chum salmon juveniles, and incidental harvest in salmon fisheries in Strait of Juan de Fuca and coho salmon fisheries in Hood Canal have preliminarily been implicated by NMFS as major threats to the continued existence of the Hood Canal and SJF populations (NMFS 1997).

The Washington Department of Fish and Wildlife (WDFW) operates a variety of hatchery salmonid production programs in the Hood Canal and Strait of Juan de Fuca regions. The main objective of these programs is fisheries enhancement and mitigation for habitat loss, although broodstock maintenance, wild stock supplementation and research are also important goals. Valuable Washington commercial, recreational and tribal fisheries targeting fall chum, coho, steelhead and fall chinook are dependent on annual returns resulting from the production from facilities in those regions. In many cases, this production is mandated by legal and/or institutional frameworks designed to provide salmon returns where fish habitat, and as a consequence, natural salmonid production levels, have been degraded.

Hatchery-produced salmon may effect wild summer chum in the Hood Canal and SJF regions in several ways. Hatchery salmonids use many of the same ecological resources as wild fish, may interbreed with wild fish, and may depend on wild fish for genetic diversity (WDFW & WWTIT 1996). Findings presented within the NMFS Chum ESA status review document suggest that the volume of hatchery salmonid production, the physical location and operation of hatchery facilities, and fisheries enabled by hatchery production in the summer chum migration areas may be potential causes of the decline of summer chum. Operation of these programs, including production levels and types of species enhanced, could be significantly affected by the listing of summer chum under ESA provisions. Modification, and possibly curtailment, of hatchery production could result if a final determination is made that unacceptable impacts to summer chum survival are linked to these hatchery activities.

Biological Assessment of Hatchery Effects -

To assist WDFW in developing appropriate actions in response to the listing of summer chum under ESA, an assessment of the potential effects of factors attendant with hatchery production on the survival, and rebuilding, of summer chum populations is needed. Timely identification of potential negative effects, and internal development of recommendations for adjustment of WDFW hatchery programs to minimize any effects identified, will expedite summer chum rebuilding and may allow for greater WDFW input regarding Section 7 or 10 Permit requirements developed by NMFS for hatchery operations. In addition to preparing in advance the biological assessment framework that may be needed in the near future, appropriate modification of operations resulting from the assessment by WDFW may also decrease the likelihood that more draconian measures will be required to minimize hatchery effects after the stocks are formally listed.

This biological assessment of WDFW hatchery program effects on the status of Hood Canal and Strait of Juan de Fuca summer chum salmon populations is designed to, first, characterize wild and hatchery stocks and programs of possible concern. These baseline reports will be followed by an assessment of the potential effects of Hood Canal and SJF hatchery programs on summer chum, derived from a literature review of hatchery-wild salmon interactions and impacts. Recommendations for minimizing or remedying any potential negative effects will be made as a result of the assessment.

The assessment will therefore include the following elements:

- Volume I - Life History Characterization of Summer Chum Populations in Hood Canal and Strait of Juan de Fuca Regions - A summary of production areas, return status and trends, and stock life history characteristics of summer chum, providing pertinent baseline information for identifying potential summer chum/hatchery salmonid interactions and conflicts. A review of scientific literature will be used to assemble life history characteristics, which are presently undescribed for most Hood Canal and Strait of Juan de Fuca summer chum life stages.

- Volume II - Characterization of Hatchery Salmonid Production in Hood Canal and Strait of Juan de Fuca Regions - A description of WDFW hatchery production in the regions, including facility locations, production levels and strategies by species (including release sizes and timings) and juvenile/adult migrational data.

- Volume III - Literature Review of the Effects of Hatchery Production on Wild Salmonid Populations - A review of available literature describing potential effects, through competition, predation, habitat degradation, supplementation and harvest, of hatchery production on wild salmonids, with a focus on effects on summer chum in the Hood Canal and eastern Strait of Juan de Fuca biomes.

- Volume IV - Assessment of Potential Effects of Hood Canal and Strait of Juan de Fuca Hatchery Production on Summer Chum Populations - An assessment of the potential for adverse effects, derived from: 1) analysis of life history information for the stocks of concern; 2) characterization of regional hatchery production; and 3)interactions/conflicts indicated by the literature.

- Volume V - Recommendations for Remediation of Potential Adverse Effects of Regional Hatchery Production on Summer Chum Populations - Presentation of proposals for remedying or mitigating negative effects on summer chum that may be brought about by hatchery production in the regions.

Approach -

The effects of hatchery production on wild summer or fall chum salmon stocks in the Puget Sound region have been largely unstudied. Divergent opinions have been presented regarding the potential for adverse effects from hatcheries (NMFS 1997, WDFW 1997, Cook-Tabor 1995). Correlative analysis of chum salmon production and survival data by Ames (1983) did not identify adverse effects of Hood Canal hatchery fall chum production on wild chum in the region, a finding corroborated by very large escapements to wild production areas in recent years concurrent with continued high hatchery release levels. Fuss and Fuller (1994) also reported that large-scale hatchery chum releases showed no apparent adverse effects on naturally produced chum fry. Gallagher (1979), however, indicated a need for "re-evaluation of chum salmon hatchery and wild stock interactions" in Puget Sound based upon findings highlighting the critical status of the early marine environment in determining annual wild chum and pink run sizes. Wissmar and Simenstad (1980, 1988) and Simenstad et al. (1980) also expressed concern regarding the potential effects of large-scale hatchery salmonid production on food resource availability for wild chum populations.

This assessment of WDFW hatchery program effects on Hood Canal and Strait of Juan de Fuca region summer chum will rely significantly on literature reporting hatchery-wild fish interactive effects in other regions of the Pacific Northwest. This information may not specifically reflect environmental or fish production conditions in the Hood Canal and Strait of Juan de Fuca biomes. As a result, potential effects identified will, in most cases, be inferential. Assessment of impacts of hatchery production on wild summer chum populations in Hood Canal and Strait of Juan de Fuca regions will be derived from identification of spatial and temporal overlaps between stocks in various life stages, and application of best professional judgement of the significance of those overlaps. A cautious approach will be applied in assessing effects. Where information allowing an assessment to be made are completely lacking, no determination of effect will be provided and the need for further data collection to definitively identify effects will be noted.

Life History Characterization -

Following is the first volume of the biological assessment, characterizing life history strategies for wild summer chum populations in the Hood Canal and eastern Strait of Juan de Fuca regions. Estimates of adult and juvenile summer chum migrational timings, and egg/alevin gravel residence periods, will be presented, to establish critical time periods when the populations may be affected by natural events and man-caused activities in the regions. The life history characterization will include the following elements:

- **Summary of population levels, trends, and status**
- **Adult migration and spawning characteristics**
- **Fry development and egression characteristics**
- **Estuarine residence and migration timing**
- **Summer chum life history summary**

LIFE HISTORY CHARACTERIZATION OF SUMMER CHUM SALMON POPULATIONS IN THE HOOD CANAL AND STRAIT OF JUAN DE FUCA REGIONS

Summary of Population Levels, Trends and Status -

Hood Canal Summer Chum -

Hood Canal summer chum have declined to critically low adult return and escapement levels (Tynan, 1992; Cook-Tabor, 1995). Over the last twenty-five years, spawner returns to production streams in the region have fallen from combined escapements of tens of thousands to average annual return levels in the early 1990s under one thousand (Figure 1). Recent stock protection and rebuilding actions initiated by Washington Department of Fish and Wildlife (WDFW), the Point No Point Treaty Council (PNPTC) tribes, and the U.S. Fish & Wildlife Service (USFWS) beginning in 1992 appear to be helping to reverse the decline.

Figure 1. Summer chum escapements to Hood Canal region streams - 1968-96.

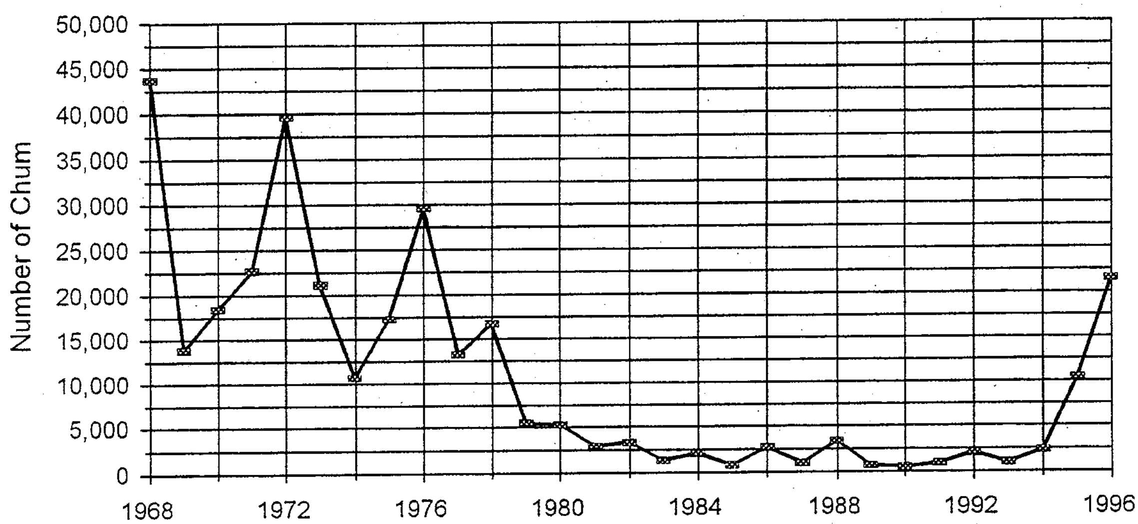


Table I lists recent year average escapement levels (1990-94 compared with 1995-96) and the current status of recent year spawning levels for each of the 11 production streams, assessed across the 1968-78 time period. Of the 11 streams listed, summer chum returns have been extirpated in three, with extirpation likely in a fourth stream (Tahuya River). Only three streams have spawner levels at magnitudes that would allow returns to be considered stable or rebuilding and four streams have very low returns, relative to historical levels. Collectively, 1990-94 average Hood Canal summer chum terminal area (defined as the northern Hood Canal mainstem marine area) return and spawning levels are just three percent of return levels estimated for the

Table I. Summer chum production streams in Hood Canal and their population status.

Drainage	1990-94 Avg Escapement	1995-96 Avg Escapement	Population Status (including 1996)
Big Beef Creek	0	0	Extirpated
Big Quilcene River	330	6,500	Rebuilding
Little Quilcene River	5	160	Low
Anderson Creek	0	0	Extirpated
Hamma Hamma River (includes John Creek)	156	690	Low/stable
Duckabush River	276	1,857	Low/stable
Dosewallips River	285	5,900	Rebuilding
Lilliwaup River	76	90	Very low/stable
Dewatto River	11	0	Extirpated
Tahuya River	7	6	Functionally extirpated
Union River	340	700	Stable

Sources: Escapement estimates: WDFW Chum, Pink and Sockeye Stock Assessment Unit, 12/4/96; Status assessments: author, update from SASSI.

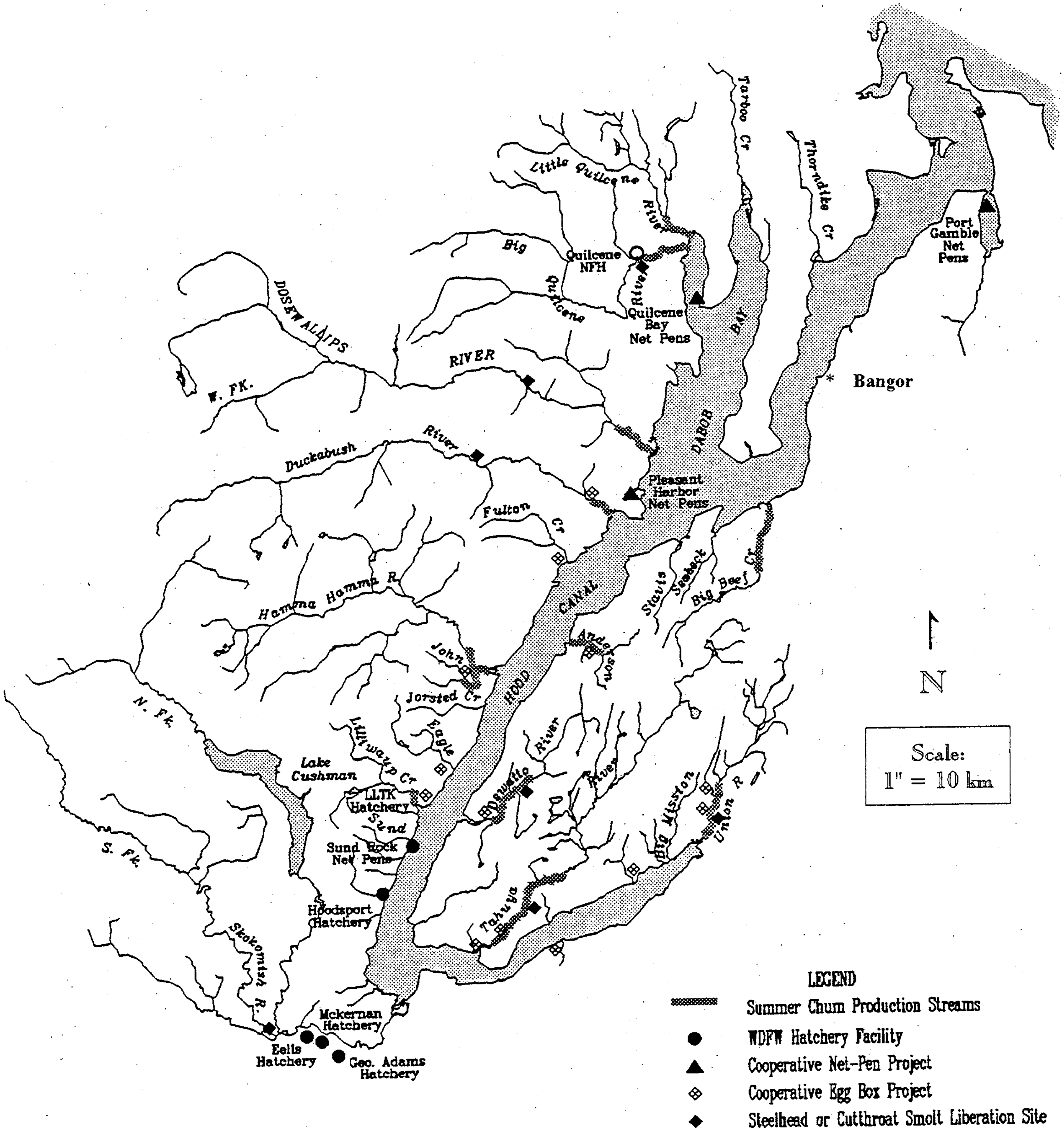
population in the 1960s and early-to-mid 1970s (Tynan 1992, Cook-Tabor, 1995). In reviewing recent year escapement levels in Hood Canal through 1994, NMFS concluded that 5 populations may already be extinct (John Creek, a tributary to the Hamma Hamma, is considered a population by NMFS), and 6 populations show strong downward trends in abundance (NMFS 1997). Total returns to the region in recent years (1995-96) have been more encouraging however, as the declining trend in return levels appears to be reversing.

Historically, 11 streams in Hood Canal were identified as having indigenous summer chum populations (Tynan 1992). Summer chum production areas in the region are noted on the map included as Figure 2. Although summer chum have occasionally been observed in other Hood Canal drainages (e.g. Skokomish River), main production has occurred in the streams listed in Table I (J. Ames[1]). Recent analysis of Hoodsport Hatchery rack data indicate that a summer chum run was present in Finch Creek, a west-side Hood Canal tributary, in the 1950s (Tynan and Ames 1997). It is unknown whether a distinct summer chum run still persists in that drainage.

SASSI (WDFW & WWTIT, 1993) lists two, distinct summer chum populations in Hood Canal - the Union River population and a group including all other Hood Canal summer

[1] J. Ames, WDFW Fish Management Division, Olympia, WA 98501. Pers. commun., October, 1996.

Figure 2. Summer chum production streams in the Hood Canal basin.

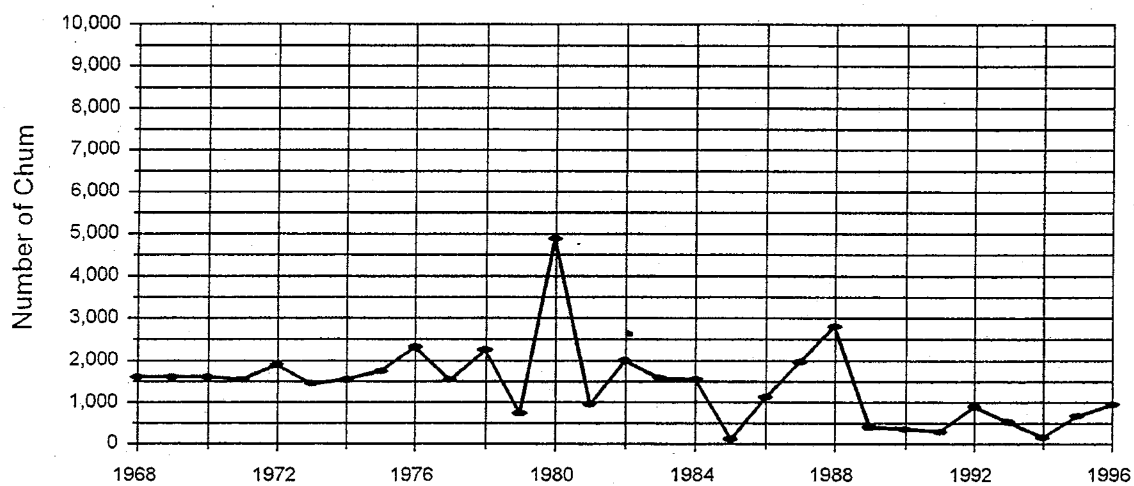


production streams. The Union River population is rated as "healthy" in return status within the SASSI document, and is listed as a separate stock within Hood Canal due to geographic, temporal and genetic distinction from the other regional summer chum populations. The remaining summer chum group is listed as "critical", and in danger of long term damage at present return levels due to chronically low escapements. In their west coast chum salmon stock status review document, NMFS groups all summer chum populations in Hood Canal into one evolutionarily significant unit (ESU). This ESU also includes the Strait of Juan de Fuca populations (NMFS 1997). NMFS technical staff involved in reviewing the status of west coast chum stocks have preliminarily found that summer chum within this ESU are at low levels of abundance, show strong downward trends and are in danger of extinction throughout their range (NMFS 1997).

Strait of Juan de Fuca Summer Chum -

Summer chum populations in the Strait of Juan de Fuca region are also at low levels of abundance, showing downward trends in return levels to production streams tributary to Discovery and Sequim Bays (NMFS 1997). Although populations in the region have historically been small relative to those in Hood Canal and South Puget Sound, with escapements averaging

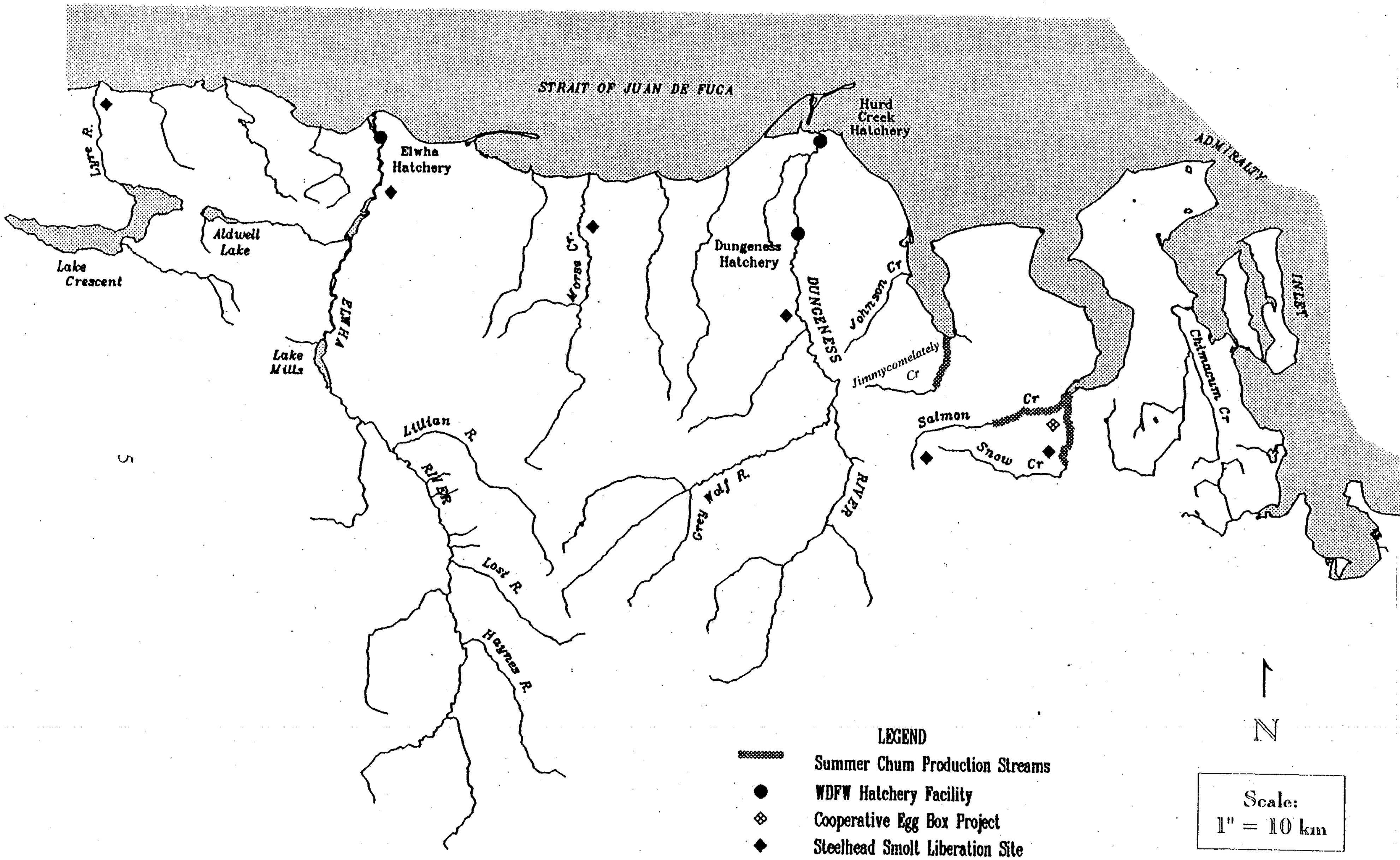
Figure 3. Summer chum escapements to Strait of Juan de Fuca region streams - 1968-96.



around 2,000 between 1968-1978, the recent year average escapement has fallen to only a few hundred fish (Figure 3). Adult returns in 1995 and 1996, however, have been improved over levels observed for the contributing brood years.

Summer chum salmon populations in this region have been documented to occur in Chimacum Creek, located near Port Hadlock in Admiralty Inlet, Snow and Salmon creeks in Discovery Bay and Jimmycomelately Creek in Sequim Bay (Figure 4 - WDFW and WWTIT

Figure 4. Summer chum production streams in the eastern Strait of Juan de Fuca region.



1993; Sele 1995; McHenry et al. 1996). Recent stock assessment and harvest data indicate that summer chum may also return to the Dungeness River, but the magnitude of returns is unknown (Sele 1995; J. Uehara[2]). Johnson Creek, a tributary to Sequim Bay (WRIA 17-0301), also was reported to have a summer chum return through the late 1970s, but the present status of this run is unknown (H. Michael[3]). Table II identifies recent year summer chum escapement levels to Strait of Juan de Fuca drainages, including the status of current escapement levels relative to those estimated during the 1968-78 time period.

Of the three Strait of Juan de Fuca streams with known, existing summer chum populations, two (Salmon and Jimmycomelately creeks) are at low return levels relative to base years (1968-78), but appear to be stable at those levels. The Snow Creek population is currently at a very low escapement level relative to earlier years, and appears to be declining. Summer chum salmon in Chimacum Creek are believed to be extirpated, as no spawning escapement has been observed in the creek since 1984 (Sele 1995; McHenry et al. 1996). NMFS notes that while the Discovery Bay and Sequim Bay populations do not demonstrate a marked declining trend in recent years that NMFS has characterized for the Hood Canal summer run populations, they are at very low population levels (NMFS 1997).

The SASSI document lists the Jimmycomelately (Sequim Bay) summer chum population as "depressed" and the Salmon and Snow creek (Discovery Bay) populations as "critical" in return status. These designations have been applied, based upon an assessment by the management agencies that populations in the region have experienced a short term, severe decline in escapements (WDFW & WWTIT 1993). The NMFS BRT has concluded that the Hood Canal Summer Run ESU, into which the SJF populations are grouped, is in danger of extinction throughout its range (NMFS 1997).

Table II. Summer chum production streams in the Strait of Juan de Fuca region and their status.

Drainage	1990-94 Average Escapement	1995-96 Avg. Escapement	Population Status (including 1996)
Chimacum Creek	0	0	Extirpated
Snow Creek	20	86	Very low
Salmon Creek	247	610	Low/stable
Jimmycomelately Creek	185	120	Low
Dungeness River	no data	no data	Unknown

Sources: Escapement data: WDFW Chum, Pink and Sockeye Stock Assessment Unit, 12/4/96; Status assessments: author, updating SASSI.

[2] J. Uehara, WDFW Fish Management Division, Olympia, WA 98501. Pers. commun., January, 1996.

[3] H. Michael, WDFW Hatcheries Program, Olympia, WA 98501. Pers. commun., August, 1996.

Population Genetic Characteristics -

Populations of chum salmon have been examined for genetic variability throughout most of their range around the North Pacific Rim (Phelps et al. 1994; Seeb et al. 1995; NMFS 1997). Analysis of genetic stock identification (GSI) data collected from Washington, Oregon and British Columbia populations indicates that Hood Canal and Strait of Juan de Fuca summer chum are distinct from fall chum salmon in those regions, and are genetically distinct from all other Pacific Northwest fall and summer chum populations (Phelps et al. 1993; Phelps et al. 1994; Phelps 1995; NMFS 1997). A dendrogram of Cavalli-Sforza and Edwards genetic chord distance (taken from Phelps et al. 1994), illustrating genetic relationships between chum stocks in the Pacific Northwest, and the significant genetic divergence of Hood Canal and SJF summer chum from other stocks, is presented in Table III.

Further work to resolve regional genetic variability by NMFS indicated that the Hood Canal and Strait of Juan de Fuca summer chum populations are one of three genetically distinct lineages of chum salmon in the Pacific Northwest region (NMFS 1997). WDFW concluded that the Hood Canal and Strait of Juan de Fuca summer chum comprise a distinct major ancestral lineage, defined as stocks whose shared genetic characteristics suggest a distant common ancestry, and substantial reproductive isolation from other chum lineages (Phelps, 1995b, WDFW, 1995). NMFS (1997) designated Hood Canal and Strait of Juan de Fuca summer chum as an evolutionarily significant unit, based upon distinctive life history and genetic traits.

GSI work by WDFW has also indicated that significant differences exist between summer chum populations in individual streams within Hood Canal (Phelps et al. 1994; Phelps[4]). Although not applied in the process designating stocks in the 1992 SASSI document (WDFW & WWTIT 1994), genetic diversity unit/major ancestral lineage (Busack and Shaklee 1995) or NMFS status review (NMFS 1997) processes, the identified potential for further stock break-outs within Hood Canal has been recognized by managers developing long range summer chum conservation plans for the region (WDFW et al. 1997). WDFW GSI studies conducted as an out-growth of the SASSI process have shown that the Hood Canal summer chum populations have one of the highest levels of genetic variation among all Washington and British Columbia populations sampled (Phelps et al. 1994). This high degree of heterozygosity may be reflective of the need for the population to be plastic to a highly variable environment (Bax 1983b). However, Hood Canal summer chum also possess among the lowest levels of rare allelic variation, indicating that some genetic variation may have been lost from these now small populations through genetic drift (Phelps et. al 1994).

Genetic differences between summer chum and all other chum stocks in the U.S. and British Columbia are a result of long-standing reproductive isolation of the Hood Canal and SJF summer chum populations (Tynan 1992 quoting S. Phelps, WDFW). This isolation has been afforded by a significantly different migration and escapement timing, and geographic separation

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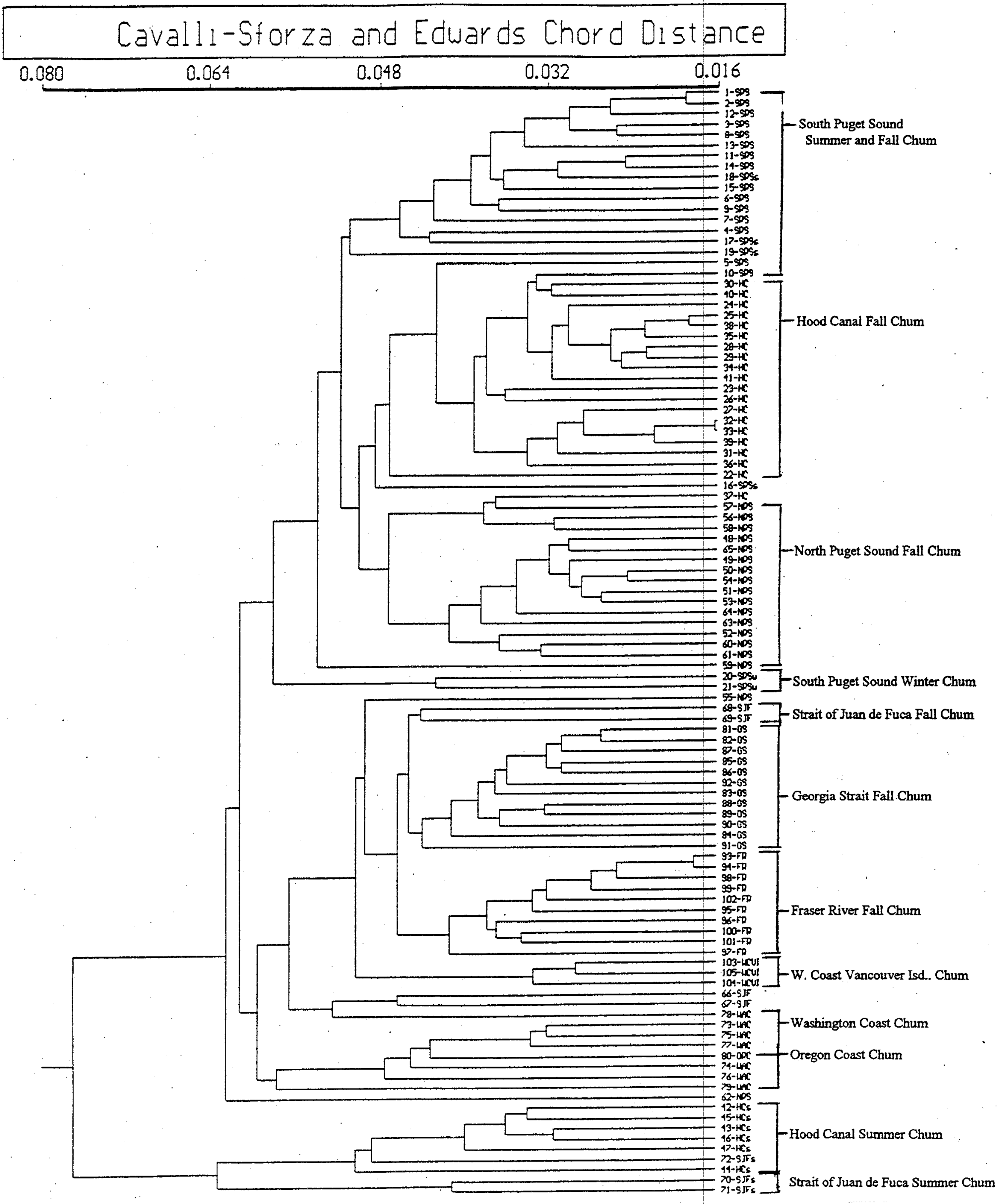
[4] S. Phelps, WDFW Fish Management Program, Olympia, WA 98501. Pers. commun., June, 1994.

Table III. Dendrogram of Cavalli-Sforza and Edwards genetic cord distance for Pacific Northwest chum salmon populations (excerpted from Phelps et al. 1994).



from other chum stocks in the Pacific Northwest (Tynan 1992; NMFS 1997). Based upon genetic differences afforded these summer chum by this run timing and geographic isolation, NMFS (1997) concluded that the populations contribute substantially to the ecological/genetic diversity of the species as a whole. The Hood Canal and SJF summer chum comprise a unique race, distinct in genetic characteristics from all surrounding salmonid populations. This uniqueness must be considered within the context of assessment of the potential effects on the population resulting from summer chum supplementation and fall chum enhancement programs.

Adult Migration and Spawning Characteristics -

Hood Canal Summer Chum -

After three to five years of rearing in the northeast Pacific Ocean, maturing Puget Sound-origin chum salmon follow a southerly migration path parallel to the coastlines of southeast Alaska and British Columbia (Neave et al. 1976; Salo 1991; Myers 1993). The precise timing of this migration from Gulf of Alaska waters for Hood Canal summer chum is unknown. GSI data collected from Canadian SJF commercial net fisheries (LeClair 1995; 1996), Canadian fishery recoveries in 1995 of coded wire tagged Big Quilcene summers (PSMFC data, August 14, 1996) and a single recovery in Big Beef Creek of a summer chum tagged in a southeast Alaska ocean fishery study (Koski 1975), suggest that the southerly ocean migration down the Pacific Northwest coast and into the Strait of Juan de Fuca likely commences in mid-July, and continues through at least early September.

Summer chum enter the Hood Canal terminal area from early August through the end of September (WDFW & WWTIT 1994). Lampsakis (1994) identified August 27 through September 22 as the time period framing the central 80 % of the summer chum run timing into the southernmost marine areas in Hood Canal, based upon time density analysis of treaty Indian net fishery harvest data. Although aggregated within one summer chum management unit in deriving timing estimates, the Union River population has an arrival timing one to two weeks earlier than the summer chum populations in the rest of Hood Canal (Tynan 1992; WDFW & WWTIT 1994). This timing difference could help explain the comparatively stable and healthy status of the Union population.

Entry pattern data for Quilcene Bay provided by Lampsakis (1994) suggest that summer chum enter extreme terminal marine areas adjacent to natal streams from the third week in August, through the first week in October, with a central 80% run timing of August 30 through September 28, and a peak on September 16. Comparison of extreme terminal area entry timing in Quilcene Bay with spawning ground timing estimates developed from Big Quilcene River data, suggests that summer chum may mill in front of their stream of origin for approximately ten to twelve days before entering freshwater, assuming that chum observed on spawning grounds entered the river five days prior (based on a ten day average survey life (Ames 1986). This behavior is likely related to the amount of time required for the chum to complete maturation and to acclimate to freshwater, but is also affected by available stream flows. Milling or delay in migration prior to spawning ground entry has also been observed for south Puget Sound fall chum (18 days -Tynan 1986) and Nisqually River winter chum (1974,76,78 seasonal averages of 13.3 - 20.1 days - Cole et al. 1986). Eames et al. (1981) reported 21 days of milling for tagged Stillaguamish/Snohomish region fall chum tagged in marine waters adjacent to the rivers. Salo (1991) stated that the period of milling becomes shorter as the season progresses, a finding corroborated by data presented in Cole et al. (1986) for Nisqually River winter chum.

Spawning ground entry timing for the Hood Canal population ranges from early September through mid-October. This early spawn timing creates a temporal separation from fall chum stocks in Puget Sound (WDFW & WWTIT 1994). Across this spawning ground entry span, populations returning to the Union and Big Quilcene rivers enter freshwater the earliest of the Hood Canal runs, while Dosewallips, Duckabush and Hamma Hamma populations enter the latest (J. Uehara - footnote 2; and from WDFW survey data 1996).

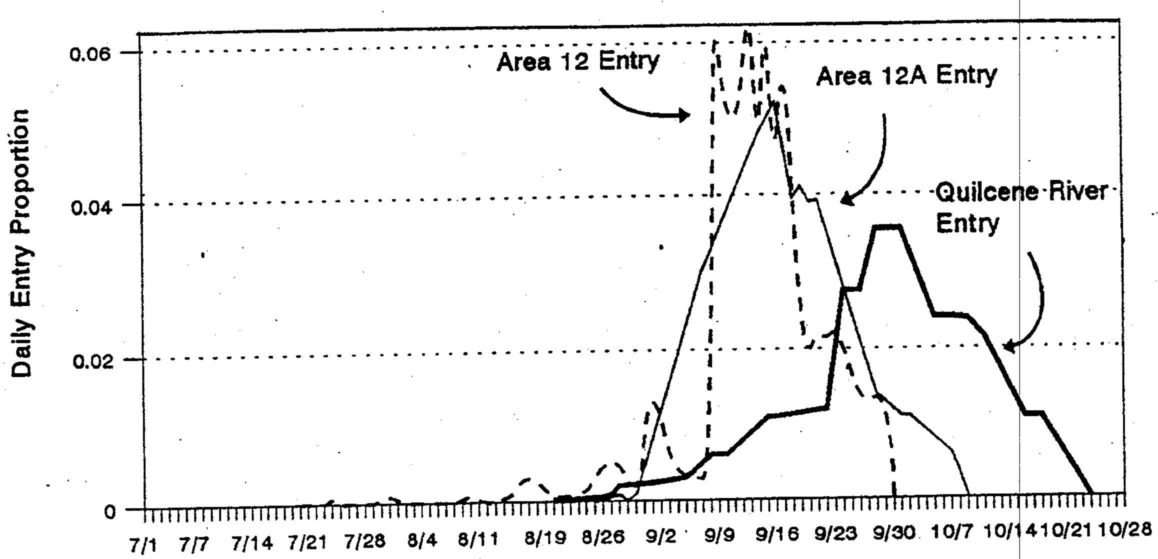
Lampsakis (1994) reported a central 80 % spawning ground timing in the Big Quilcene River of September 11 through October 14, with a peak on or about September 28, based on 22 years of spawning ground survey data. These data describing Big Quilcene summer chum spawning ground timing in recent years corroborate rack arrival timing data for summer chum collected on the river by USFWS in 1913-1914 (Cook-Tabor 1995). Spawning ground entry timing has apparently remained unchanged over the last 80 years for Big Quilcene River summer chum. Koski (1975) documented spawning migration into Big Beef Creek from September 2 through October 14, as monitored by rack counts of arriving summer chum spawners over a span of four years. The average, peak spawning ground arrival time for this now extirpated population was approximately September 26, which was 50 to 60 days earlier than the indigenous fall chum stock. Potential survival advantages accrued to the early stock by spawning earlier in the season relative to fall stocks include advanced embryological development prior to the onset of low water temperatures, and the avoidance of high water levels at spawning and early incubation (Koski 1975). These traits act to accelerate passage of summer chum through critical developmental periods that are adversely affected by low water temperatures and high water levels.

Chum salmon are strong swimmers, capable of negotiating currents of moderate to high velocities (Salo 1991). However, chum seldom pass instream barriers of any kind that require jumping (Neave 1952; Salo 1991). Upstream-migrating chum are generally found below the first barrier of any significance in a spawning river (Salo 1991). Hood Canal summer chum typically spawn soon after entering freshwater in the lowest reaches of natal streams (Koski 1975; Schroder 1977; J. Ames - footnote 1; NMFS 1997). This characteristic may reflect an adaptation to low flows present during their late summer/early fall spawning ground migration timing, which confine spawning to areas with sufficient water volume. Spawning in lower river reaches during low flows, however, confines incubating eggs to center channel areas, exposing the eggs to increased risk of egg pocket scouring during freshets (J. Ames - footnote 1).

Koski (1975) noted that Big Beef Creek summer chum spawning took place predominantly in the lower 0.8 km of stream. Cedarholm (1972) reported that 100 % of the summer chum run to Big Beef Creek in 1966 and 1967 spawned in the lower 0.6 km of the creek. WDFW documentation of summer chum spawning in the Big Quilcene River indicates that 90% of spawning occurs in the lower mile of the 2.2 miles of river accessible to salmonids (J. Uehara - footnote 2). The NMFS Chum BRT has hypothesized that summer chum are specifically adapted to low flows and warmer water present during the months of their spawning migration (NMFS 1997). These habitat use and behavior characteristics are important in considerations of the effects of man-induced activities, such as water withdrawals, forest practices, and hatchery weir or ladder placement and operation, on summer chum adapted to spawning only in the lowest reaches of streams.

Figure 5 presents approximate timing curves for Hood Canal summer chum entering terminal area (Area 12 - north/central Hood Canal), extreme terminal area (Area 12A - embayments/river mouth) and freshwater spawning areas (Big Quilcene River). Curves presented in this figure are derived from PNPTC entry pattern analysis data (Lampsakis 1994). Terminal area entry data reflect the entire Hood Canal summer chum return, while data for the extreme terminal and freshwater areas are specific for the Big Quilcene River population. This characterization of adult migrational timing for Hood Canal summer chum can be used to assess spatial and temporal overlaps between hatchery-origin fish and wild summer chum populations in the region.

Figure 5. Adult migrational timing and abundance curves estimated for Hood Canal summer chum (from Lampsakis 1994).

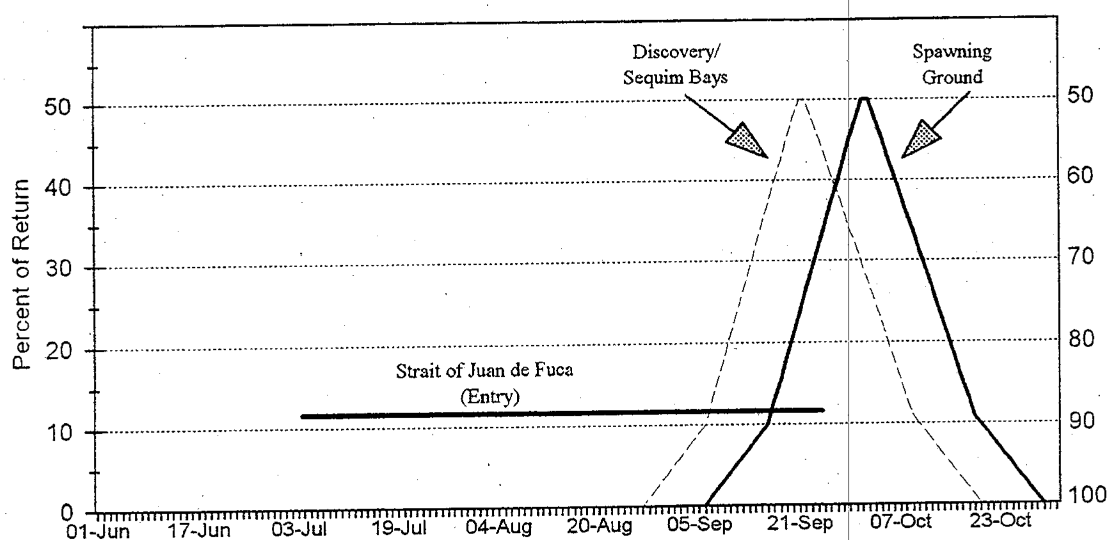


Strait of Juan de Fuca Summer Chum -

Migrational timing of SJF summer chum into Washington marine waters appears earlier than arrival timing observed for Hood Canal summer chum. The stocks in this region enter the terminal area (the Strait) from the first week of July through September (WDFW & WWTIT 1994). GSI data collected from Canadian net fisheries at the entrance to the Strait suggests that SJF summers are present through August and into early September (LeClair 1995; 1996). Although no catch or sampling data are available describing summer chum timing in Discovery or Sequim Bays, due to long term fisheries closures to protect this stock, extreme terminal timing can be estimated using an assumed 10 day milling delay prior to stream entry.

SJF summer chum begin spawning during the first week of September, reaching completion in mid-October (WDFW & WWTIT 1994). Scalf (1996) reported that 1995 brood summer chum were first observed in Salmon Creek on September 1, with the last spawners

Figure 6. Adult migrational timing and abundance curves estimated for Strait of Juan de Fuca summer chum.



observed on October 23. Time density analysis of Snow, Salmon and Jimmycomelately creek spawner survey data for the lower portions of the drainages indicates a central 80 % spawning ground timing of September 16 through October 20, with an average peak on October 2 (Lampsakis 1994). Summer chum spawn in the lower mile of Salmon Creek and in the lower one-half mile of Snow and Jimmycomelately creeks (WDFW & WWTIT 1994). As with Hood Canal summer chum, low summer-time flows likely have acted to confine summer chum spawning in this region to the lowest reaches of each production stream.

Approximate terminal area, extreme terminal area and spawning ground timing curves for SJF summer chum are presented in Figure 6. These curves can be compared with timing and abundance curves derived for hatchery-produced species present in the region to assess the potential for interactions.

Egg/Fry Development and Egression Characteristics -

Identification of summer chum early life history characteristics, including egg/alevin gravel residence time, fry emergence timing and estuarine arrival timing, is needed to assess the degree of spatial and temporal interaction between these stocks and hatchery-produced salmonid adults or liberated juveniles. Early life history data specific for wild summer chum, including emergence timing, are provided in studies conducted on Big Beef Creek in the late 1960s (Koski 1975; Schreiner 1977, Salo et al. 1980) and late 1970s (Bax 1979; Bax et al. 1980; Bax 1982). Summer chum developmental characteristics can also be accessed from data collected through recent hatchery supplementation programs propagating Hood Canal (Telles 1996) and SJF (Seymour 1993; Scalf 1996; Allison[5]) wild summer chum populations. Together with spawning ground timing information and average daily temperature data for summer chum production streams, these data can be used to identify critical egg development periods and to characterize emergence and out-migrant timings.

Incubation Period -

Identification of the incubation period for summer chum, and of critical developmental stages during gravel residence, is important to allow assessment of potential hatchery impacts, including redd superimposition by hatchery salmonids and degradation of water quality associated with hatchery effluent. In particular, redd superimposition by wild and hatchery-origin salmon can be a real problem for summer chum, as their eggs are deposited earlier than all other Puget Sound salmonid species. An assessment of the effects of variances of stream flow on chum freshwater survival can also be derived from identification of gravel residence time periods. Gallagher (1979) reported through correlative analysis of chum production factors that stream flow conditions had the greatest influence on chum brood returns in even, non-pink years. Highest salmon mortalities during the life cycle occur during the egg and alevin stages in the redds and typically exceed 90% of the deposited eggs (Koski 1981). Neave (1953) reported egg to migrant fry mortality rates ranging from 84.8 % to 99.9 % for chum populations inhabiting two small drainages in British Columbia. Cedarholm and Koski (1977) found that the average survival to emergence for summer chum eggs deposited in redds in a channelized area of Big Beef Creek was 7.3 % in 1970-72.

Incubating chum eggs are extremely susceptible to mechanical disruption of any sort prior to closure of the blastopore, a period that begins 48 hour after fertilization and extends through accumulation of approximately 144 TUs (ºC, or 290 TUs ºF) of development for fall chum (Leitritz 1976; Schroder 1981). When the main organ systems have been laid down, approximately indicated by development of eye pigmentation, eggs become much hardier and can withstand significant perturbation, short of scouring from the redd or oxygen deprivation. Characterization of this "tender" developmental period for summer chum will assist in determination of the likelihood for adverse effects resulting from man-caused and natural factors.

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[5] J. Allison, WDFW Hurd Creek Hatchery, Sequim, WA 98382. Pers. commun., July, 1996.

Quoting K. Koski as a personal communication, Cedarholm (1972) reported that Big Beef Creek chum eggs are buried between 10 and 50 cm in the gravel. Similarly, forty egg pocket depths measured for fall chum eggs deposited in Kennedy Creek, south Puget sound ranged from 9.8 - 48.9 cm, with a mean of 22.6 cm (Montgomery et al. 1996). Developing chum salmon then reside as eggs or sac fry in the gravel for five or six months after fertilization, a time period determined mainly by ambient temperature regimes characteristic of Pacific Northwest streams (Bakkala, 1970; Koski, 1975; Schreiner, 1977; Salo, 1991). Stream flow, dissolved oxygen levels, gravel composition, spawning time, spawning density and genetic characteristics also affect the rate of egg/alevin development, and hence gravel residence time (Bakkala 1970; Koski 1975; Schroder 1981 Salo 1991). Bakkala (1970) reported total gravel residence times for chum ranging from 78 to 183 days across the range of chum salmon distribution, dependent on stream temperature. Koski (1975) documented an average gravel residence time from spawning to 50 % (peak) population emergence for Big Beef Creek summer chum of 166 days, with 95 % emergence after 177 days. Telles (1996) reported 100 % emergence (swim-up) of 1994 brood Big Quilcene River summer chum 111 days after fertilization at QNFH.

Hood Canal Summer Chum -

A considerable amount of variation in the number of temperature units (TUs - one temperature unit equals one degree Fahrenheit above freezing (32ºF) for a period of 24 hours) required for development is evident among summer chum populations in the Hood Canal and Strait of Juan de Fuca regions. Telles (1996) collated 1994 TU data reflecting development of Big Quilcene River summer chum eggs used in the Quilcene NFH supplementation program . Summer chum eggs incubated at QNFH water (supplied by Penny Creek, a Big Quilcene tributary with warmer, and more constant seasonal temperature regime relative to the river) were 50 % eyed after approximately 600 TUs and 100 % eyed after 650 TUs (ºF - Telles, 1996). The 1994 brood Big Quilcene summer chum were 50 % hatched after 919 TUs and 100% hatched after 956 TUs. Daily Big Quilcene River water temperatures during the summer chum gravel residence period (data for 1992 only from Telles 1996), combined with average summer chum spawning ground percent complete data (Lampsakis, 1994), allow conversion of these hatchery developmental data into approximate dates of the tender stage (through eye-up) for the wild spawning population in the Big Quilcene River (Appendix I). From these data, it is estimated that the initial spawn of the incubating summer chum population would enter the tender stage starting the first week in September, with the majority of incubating eggs reaching the eyed stage by November 3.

Developmental rates for Big Beef summer chum can be assumed to be similar to rates reported for Big Quilcene summers - TUs to eye-up = ~40% of TUs to emergence. Application of average spawner timing and average cumulative temperature unit data for Big Beef Creek (Koski, 1975 - Appendix II) to this derived rate to eye up yields a gross estimate of the critical gravel developmental ("tender") period for eastside Hood Canal stocks. The comparatively warmer stream character of Big Beef Creek shortens the tender egg period, which is estimated to extend from the first week in September through the second week in October, when ~100 % of the incubating population would reach eye-up.

Strait of Juan de Fuca Summer Chum -

Developmental data collected for SJF summer chum indicate that eye-up for the Salmon Creek population is achieved after 450-543 TUs (F) (1992-93 average of ~500 TUs from Seymour 1994 and J. Allison - footnote 5). Scalf (1996) reported that 1995 brood Salmon Creek summer chum began hatching at 854 TUs (ºF), with hatching complete at 968 TUs (F) (averages across five egg take dates). Developmental data reported for prior years (1993 and 1994 broods) indicate a variable number of TUs required for the beginning of hatching: 1028-1156 TUs in 1993 and 743 TUs in 1994. The 1993 brood summer chum completed hatching after accumulating 1240-1367 TUs. The 1995 TU data will be assumed to characterize eye-up and hatching stages here, as it appears that the methods used to track development were improved over earlier years.

Daily stream temperature data for Salmon and Snow creeks were collected by WDFW from 1976-87 (R. Cooper[6] - Appendix III). Temperature data were averaged across years for both streams. Graphs included in Appendix III plotting daily average temperatures indicate that the two Discovery Bay tributaries exhibit nearly identical annual temperature regimes. Daily cumulative TUs used to characterize SJF summer chum development were derived from Salmon Creek average temperatures. These TU data were applied to the expected occurrence timing of the first (September 1) and last (October 23) spawners observed in Salmon Creek in 1995 and the above TU developmental data to characterize in-gravel developmental stages for the wild SJF summer chum populations. From these data, incubating wild summer chum eggs are estimated to be in a tender developmental stage in the gravel from September 3 through December 13, when 100 % eye-up of the incubating population would be expected. Hatching reaches completion by February 20, assuming accumulation of 968 TUs from the last observed spawner day of October 23.

Emergence and Estuarine Arrival Timing -

Timing of fry emergence is a key factor in the ability of summer chum to adapt and survive in the marine environment (Koski 1975). To promote rapid growth and increase chances for survival, emergence and migration into the estuary must be timed with warming of marine waters, leading to proliferation of phytoplankton, then zooplankton, that are prey for out-migrant chum (Koski 1975; Salo 1991; Simenstad et al. 1980). If cold winter/early spring weather patterns delay estuarine productivity, early emergence timing can lead to lack of food and stunted growth, increased predation and possibly a shift in timing of adult returns (Koski 1975). The ability of emigrating chum to survive in marine waters results from adaptations that have coordinated the timing of emergence with optimal conditions in the marine environment (Koski 1975; Bax 1982; Whitmus 1985). Parker (1965; 1968) also reported the importance of emergence timing, estimating that 95 % of pink and chum salmon marine mortality occurs during the first few months of marine life.

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[6] R. Cooper, WDFW Fish Management Division, Snow Creek Field Station, Port Townsend, WA 98368. Pers. commun., August, 1996.

Hood Canal Summer Chum -

Eastside Drainages -

Through studies conducted by the University of Washington Fishery Research Institute, Big Beef Creek summer chum were found to require considerably more temperature units (days) to emerge than fall chum in the stream. Koski (1975) reported that 50 % of the summer chum population emerged after accumulation of 1890 TUs, with 95 % emergence after 2070 TUs. The fall chum stock in Big Beef Creek was 50 % and 95 % emerged after 1710 and 1985 TUs respectively. This "compensation", equating to 12-13 days additional time in the gravel by summer chum, is likely the result of natural selection acting upon the stock so that the fry have a greater likelihood of emerging at a time which, on average, will result in the best fry survival in the stream or estuary (Koski 1975). The summer chum hold in the gravel longer after button-up, leading to a lower condition factor than the fall stock (Koski 1975). This delay in emergence, however, places summer chum in the estuary under warmer, possibly more productive conditions, than if no delay occurred. Brannon (1974) hypothesized that timing of salmon fry emergence and estuarine entry represents the most favorable balance of forces affecting survival, to the extent that compensatory mechanisms have evolved both in spawning time and rate of development to assure its timing repetition. The delayed emergence exhibited by Big Beef summer chum may represent a good example of such a compensatory mechanism.

Figure 7 compares average emergence timing for Big Beef Creek summer chum and average emergence timing for the native fall chum stock for brood years `68 and `69. Big Beef Creek studies (Koski 1975), and hatchery production data from the Big Quilcene River supplementation project (L. Telles[7]), indicate that summer chum emerge from the gravel, or "swim up", over one month earlier than fall chum stocks indigenous to those drainages. This temporal separation places summer chum in the estuaries in advance of native Hood Canal fall chum stocks, perhaps providing summer chum a competitive advantage over fall chum in terms of food availability, growth, and survival in some years.

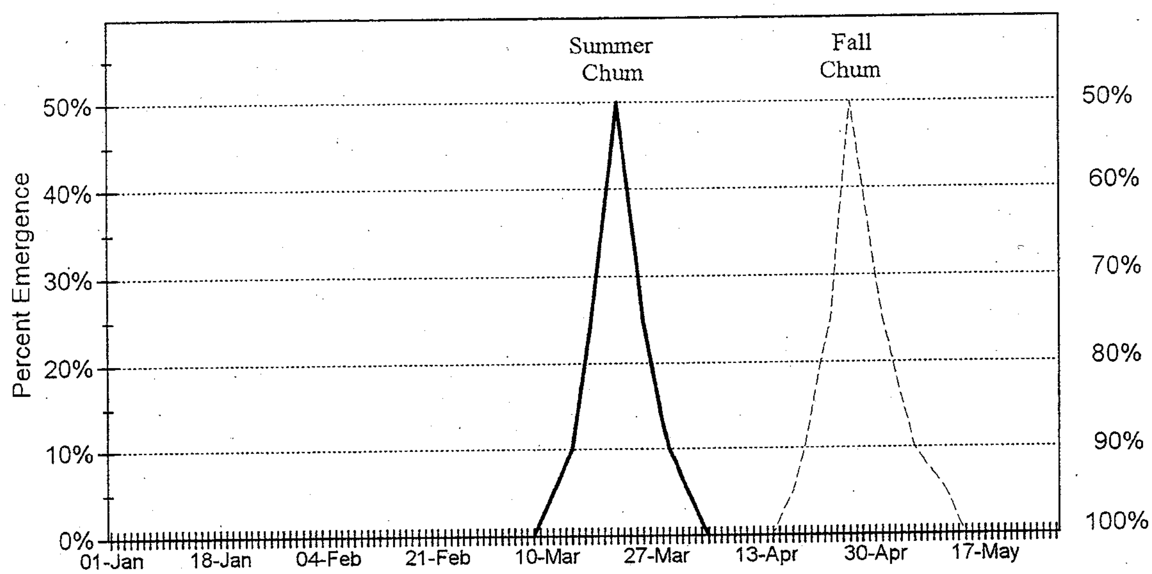
Koski (1975) used off-stream spawning channels with seasonal temperatures equal to those in Big Beef Creek (Schroder 1981 - raw daily temperature data) to study chum fry emergence in 1968-69 and 1969-70. Big Beef Creek summer chum exhibited an average 50 % (peak) emergence time of March 21 after accumulation of 1890 TUs and a 90 % emergence time of March 29 after 2070 TUs. These developmental rates compare to average 50 % and 90 % emergence times for the years studied of April 25 and May 4 for the native fall stock - a separation of 35 days at peak emergence (Koski 1975). The summer chum populations were 50 % emerged 166 days after spawning, compared with 146 days for fall chum.

Schroder (raw data for 1981 publication) also documented summer chum fry emergence timing in Big Beef Creek. Brood year 1973-75 summer chum egressing from off-stream spawning channels exhibited an average 50 % emergence time of March 27 after accumulation of 1651 TUs, with an average of 90 % of the populations emerging by April 4 after accumulating

[7] L. Telles, USFWS Quilcene National Fish Hatchery, Quilcene, WA 98376. Pers. commun., June, 1996.

1726 TUs. Additional information gathered in a 1977 Big Beef wild summer chum mark-recapture study cited in Bax (1982), indicated that emerging summer chum that year exhibited peak (50 % complete) out-migration in mid-February (~February 14), approximately 35 days earlier than the average 50 % point for '68 and '69 brood out-migrants (March 21). Wissmar and Simenstad (1980) reported that '70 brood Big Beef Creek summer chum exhibited a 50 % emergence date of March 13, which is the same 50 % completion date noted by Koski (1975) for '69 brood year summer chum out-migrants.

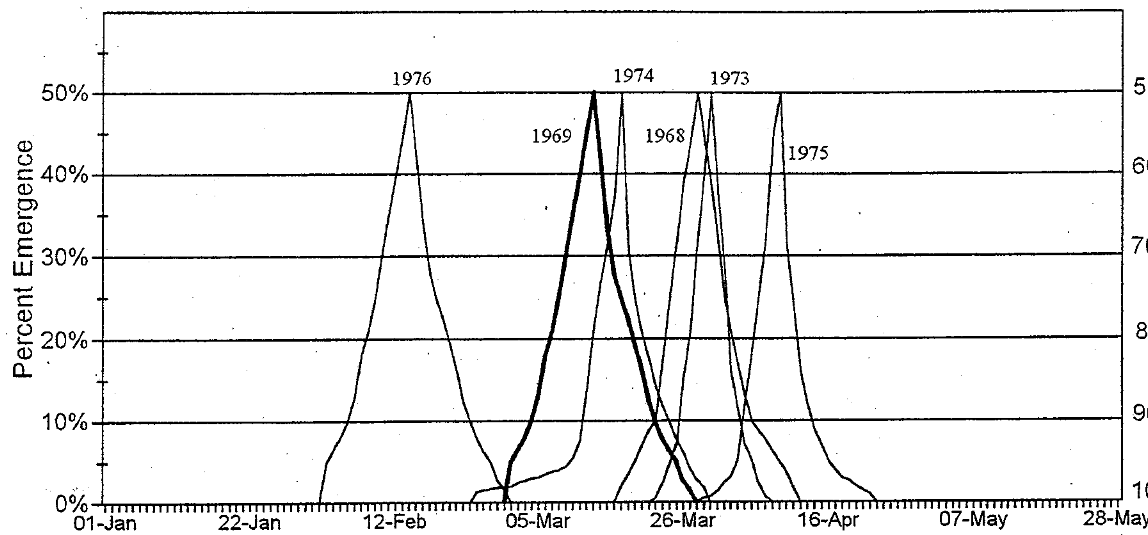
Figure 7. Average emergence timing for Big Beef Creek summer and fall run chum - brood years `68 and `69.



Variances in Big Beef Creek summer chum fry emergence timings observed in the above studies reflect annual differences in adult spawning time and seasonal temperature regimes between years (Appendix IV). Annual variations in the temperature of the stream, particularly during January and February, dramatically alter timing of emergence, with low temperatures retarding emergence by 30 days in some years (Koski 1981). From Appendix IV, monthly TU accumulation data during the summer chum developmental period for '69 and '76 brood developmental periods are shown to be very similar. Peak spawning timing, however, for the `76 brood summers was 10 days earlier than the `69 brood peak (Appendix IV). Earlier emergence for '76 brood summer chum can be explained by earlier development resulting from an earlier egg deposition date, and slightly accelerated development during warmer September temperatures, relative to 1969. Monthly TU accumulation levels for `68 brood fish were substantially lower, and peak spawning time was one week later than experienced by `76 brood, accounting for the later emergence of '68 brood fish relative to `76.

Figure 8 presents emergence timing curves for `68 and `69 brood (data from Koski 1975), `73-`75 brood (Schroder 1981) and `76 brood (Bax 1982) Big Beef Creek summer chum. The span of emergence timings presented can be assumed to characterize the time period over which

Figure 8. Emergence timing and abundance curves for Big Beef Creek summer chum.



emergence is possible for eastside Hood Canal streams. From these curves, summer chum fry emergence timing can range from the first week in February ("warm" years and/or earlier spawn date years, like 1976) through the second week in April (colder and/or later spawn date years like 1975). The 10 %, 50 % and 90 % average emergence dates across years for which Big Beef Creek summer chum data were reported (Appendix IV) are March 13, March 18, and March 27, respectively (Table IV). The 10 % to 90 % emergence range observed across years was February 7 through April 14. This emergence range, and the average peak emergence date of March 18, will be used to characterize eastside Hood Canal summer chum emergence timing.

Table IV - Estimated average and observed range of emergence timings for eastside Hood Canal summer chum populations.

	10 % Complete	**50 % Complete**	**90 % Complete**
Emergence Timing - Earliest	**February 7**	February 14	February 25
Latest	April 4	April 9	**April 14**
Average	March 13	**March 18**	March 27

Westside Drainages -

Due to differences in stream character between eastside and westside Hood Canal streams (Kitsap Peninsula, low gradient, rain-fall fed watersheds; Olympic Peninsula, moderate-high gradient, rain-fall/snow melt fed watersheds), it is important to separately characterize emergence timing for westside summer chum populations. Comparison of temperature profiles for Big Beef Creek (Appendix II) and the Dosewallips River (the only westside Hood Canal river for which a complete, annual series of daily temperature data are available -Appendix V) indicate significant differences in annual water temperature regimes that will likely affect developmental rates.

Emergence timing for westside Hood Canal wild summer chum populations has not been specifically studied or characterized in the literature. Observations by the USFWS indicate that Big Quilcene River wild summer chum were present as out-migrants in the river during the last week of March in 1993 and 1994 (USFWS 1994), but the complete time span of out-migration was not identified. Because comprehensive wild summer chum emergence timing studies for westside streams are lacking, timing will be estimated using hatchery summer chum developmental data, westside Hood Canal summer chum spawning timing, and westside stream (Dosewallips River) temperature information during the chum developmental period.

Observations of Big Quilcene River summer chum development collected through the QNFH supplementation program indicate that 50 % emergence of the population occurs after 1587 temperature units, with 100 % emergence after 1639 TUs (Telles 1996). This federal hatchery relies on water from Penny Creek for incubation, which is, as stated earlier, a Big Quilcene River tributary with a warmer, less variable temperature regime than the river where wild summer chum spawn (Telles 1996). Daily water temperature data for the lower Big Quilcene River are only available for 1992, from September through December (Telles 1996). A more complete temperature time series, encompassing the entire summer chum freshwater life stage period, is available from the U.S. Geological Survey for the Dosewallips River, a neighboring westside tributary supporting an indigenous summer chum population (Collings and Hill 1973). Comparison of limited temperature data for the Big Quilcene with Dosewallips daily temperatures indicates that the Big Quilcene is more variable in temperature, exhibiting higher late summer and fall temperatures, but lower winter and spring temperatures (Appendix V). To estimate emergence timing for wild summer chum in westside Hood Canal rivers, ambient Dosewallips River water temperature time series and cumulative TU data (Appendix V) were applied to QNFH summer chum TU developmental data to provide an estimated emergence timing, assuming average Hood Canal summer chum spawning ground entry timing (Lampsakis 1994)

Table V presents the estimated time period derived using the above described methods to characterize annual emergence time for westside Hood Canal summer chum. The central 80 % of the incubating summer chum fry population is estimated to emerge between March 1 and April 14 annually.

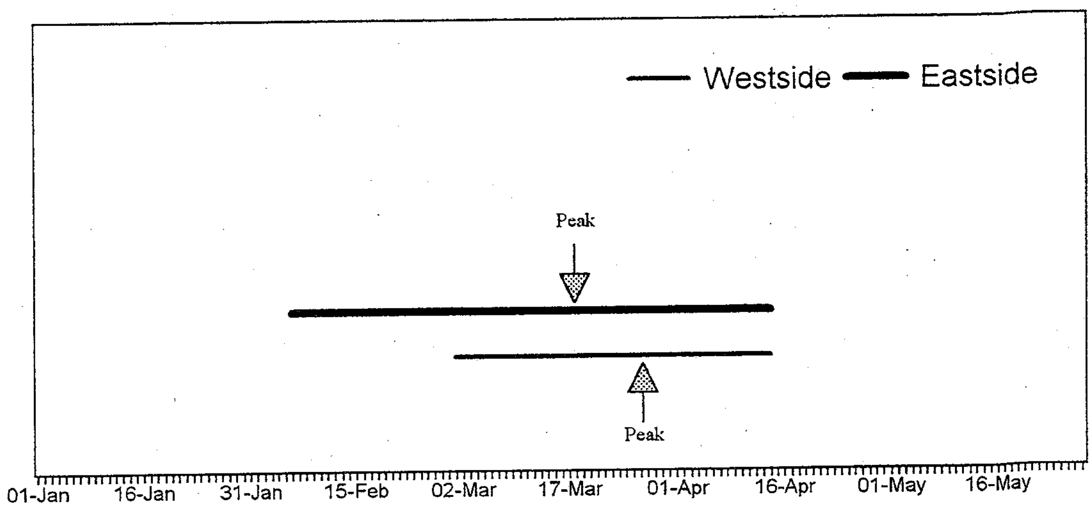
Table V - Estimated emergence timing for westside Hood Canal summer chum populations.

	10 % Complete	50 % Complete	90 % Complete
Spawn Timing (Big Quilcene R.)	September 11	September 28	October 14
TUs to 100 % Emergence	1639	1639	1639
Emergence Timing *	March 1	March 27	April 14

* Estimated dates of emergence based on date when 1639 TUs had been accumulated, using 10%, 50% and 90% complete spawning dates as starting points, as determined by Dosewallips River temperature regime presented in Appendix V.

Figure 9 presents the emergence range estimated for westside Hood Canal summer chum with the range derived previously for the eastside populations.

Figure 9. Estimated emergence timing ranges for east and west-side Hood Canal summer chum.



Identification of summer chum size at emergence is important in developing an assessment of interactions through predation or competition with hatchery-produced salmonids. Bakkala (1970) reported chum fry sizes at emergence ranging from 30-32 mm (fl). Koski (1975) reported that Big Beef Creek summer chum emerged at average lengths from 37-39 mm (fl), and weights ranging from 320-370 mg (1417 - 1226 fpp). Big Quilcene summer chum average 362 mg (1250 fpp) at emergence (Telles - footnote 7).

Strait of Juan de Fuca Summer Chum -

From data collected through the Salmon Creek summer chum supplementation program, fry emergence (swim-up) has been documented to be completed after an average accumulation of

1430 TUs in 1995-96 (range 1294-1566). Data for '93 brood Salmon Creek summer chum indicate that emergence began at 1672 TUs, peaked at ~2025 TUs, and was completed after the accumulation of 2185 TUs (Scalf 1996). Emergence for 1994 brood summer chum was reported to have begun after 1089 TUs, "accelerating" after 1403 TUs (Wild Olympic Salmon 1995; Scalf 1996).

These developmental data were derived from observations of summer chum incubated to the eyed stage in the WDFW's Hurd Creek or Dungeness Hatcheries, and transferred to facilities on Salmon Creek for incubation through swim-up. Similar annual variation in the number of TUs accumulated to emergence was reported by Koski (1975) for Big Beef summer chum. The year-to-year variability in the number of TUs required to emergence was also observed by Peters (1996) in studies of emigrating, wild Elwha River fall chum. Variability in Elwha River developmental rates were explained by possible differences in measured river temperatures from those in the inter-gravel environment, or by delayed emigration resulting from instream chum fry rearing. For Salmon Creek chum, which are subject to direct observation of swim-up timing, this variability in TUs to emergence could be caused by disturbances during alevin incubation in some years (e.g. mechanical disturbance or siltation in the incubator causing early swim-up) or disruption in "normal" developmental rates caused by initial incubation at warmer water temperatures at Hurd Creek.

From the above observations, it is possible that year-to-year variability in TUs to emergence apparently portrayed by each population represents natural compensation by the animal to time development, as determined by the available temperature regime that year, to coincide with a seasonal time period when conditions in the estuary will, on average, ensure survival.

To characterize the emergence timing range for wild SJF summer chum, brood year minimum (1980), maximum (1979) and 1976-87 average daily stream temperatures for Salmon Creek during the summer chum developmental period (Cooper 1996a) will be used to derive cumulative TU data (ºF). The average number of cumulative TUs required to 100 % emergence observed through the Salmon Creek summer chum supplementation program (1808 TUs for brood years 1993 and 95 (Scalf 1996)), will be applied to these cumulative daily stream temperature data to estimate the earliest, average and latest emergence timings that can be expected over the years for which temperature data are available. Average 10%, 50% and 90% complete spawner timing data for SJF summer chum from Lampsakis (1994) will be used as the starting point of development for the three estimated emergence timing curves. Using this method, emergence of the wild population can be estimated to occur over the ranges presented in Table VI.

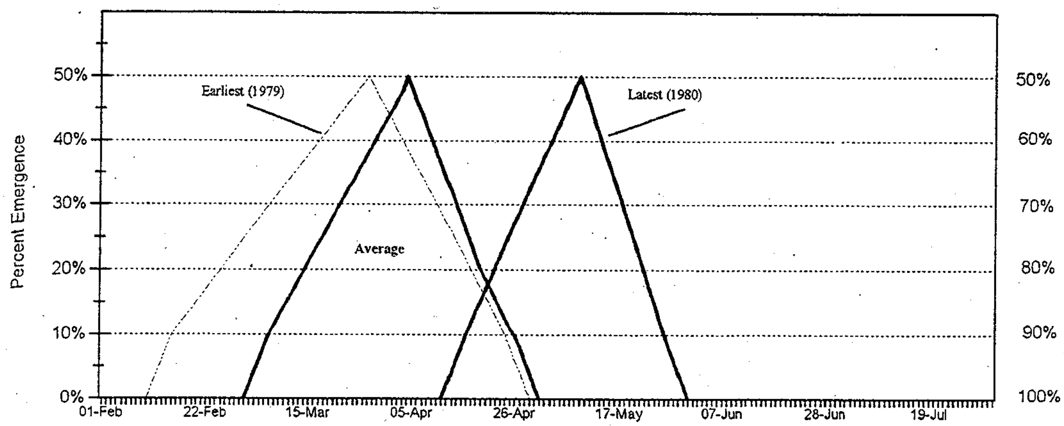
Although no TU developmental data are available for the other SJF summer chum populations, temperature data obtained for Snow Creek suggests that its thermal character is equivalent to Salmon Creek (Appendix III - Cooper 1996a). Summer chum spawning ground timing also appears to be similar between the two streams (from WDFW spawning ground survey data). This Salmon Creek emergence pattern will therefore be assumed to characterize timing for all three SJF production streams.

Table VI - Estimated emergence timing range for Strait of Juan de Fuca summer chum populations.

	10 % Complete	50 % Complete	90 % Complete
Spawn Timing (SJF streams)	September 16	October 2	October 20
TUs to 100 % Emergence -	1,808	1,808	1,808
Emergence Timing - Earliest Latest Average	**February 15** April 16 March 6	March 28 May 9 **April 4**	April 24 **May 26** April 26

Figure 10 presents emergence timing curves derived from "earliest", "latest" and "average" ranges presented in Table VI.

Figure 10. Estimated emergence timing ranges for summer chum in the eastern Strait of Juan de Fuca region.



One year of fry out-migrant trapping on Salmon Creek during the spring of 1977 (Cooper 1996b) corroborates the summer chum emergence timings estimated using the above method (see emergence timing graph, Appendix III). These trapping data indicate that `76 brood summer chum emigration commenced on March 19 and was completed by April 23, with peak out-migration occurring on April 4. Examination of Salmon Creek summer chum spawn timing data for 1976 and cumulative TU data for the 1976-77 developmental period indicate peak emergence occurred after accumulation of approximately 2,063 TUs from the September 16 peak spawning date that year. The '76 brood year developmental rate is nearly equivalent to the accumulated TU level of 2,185 observed in the Salmon Creek Supplementation program for peak summer chum emergence for`93 brood summer chum.

Data for Salmon Creek summer chum indicate an average fish weight of 336 mg (1350 fpp) at first feeding (Scalf, 1996). This average fry weight will be assumed as the size at emergence for this population in later assessments presented within this document.

Summary of Egg/Fry Development and Egression Characteristics -

From the above, generalized ranges of possible gravel residence durations and emergence timings across all water years can be derived for Hood Canal and Strait of Juan de Fuca summer chum populations (Tables VII and VIII). Combining estimates for east and westside summer chum stream information yields the estimated span of time of development and average emergence for Hood Canal populations:

Table VII. Hood Canal summer chum estimated gravel residence and emergence time periods.

Life Stage	Start	Completion (90 %)	Peak
Gravel Residence (span)	September 1	April 24	-
"Egg tender stage" (span)	September 3	November 3	-
Emergence (central 80% range)	February 7	April 14	March 22

Data collected through the Salmon Creek summer chum supplementation program, including spawning time and egg/alevin development, and Salmon Creek water temperature time series providing minimum, maximum and average temperatures through the chum developmental period, allow estimation of the possible time span of gravel residence and a fry emergence across all water years for the SJF population (Table VIII):

Table VIII. SJF summer chum estimated gravel residence and emergence time periods.

Life Stage	Start	Completion	Peak
Gravel Residence (span)	September 1	May 25	-
Egg "tender" stage	September 3	November 3	-
Emergence (central 80% range)	February 15	May 26	April 4

The timing estimates provided in these two tables will be used to assess wild summer chum interactions with hatchery salmonids during the freshwater life stage through comparison of spatial and temporal migratory information for species produced through Hood Canal and SJF hatchery programs.

Estuarine Residence and Migration Timing -

Early marine residence is considered to be a critical stage in determining overall growth and total survival rates of chum salmon (Bakkala 1970; Bax et al. 1978; Schreiner 1977; Gallagher 1979; Bax 1983a; Whitmus 1985). Studies of pink salmon, considered an ecologically similar species, indicate that day to day losses in the marine environment are generally much higher in estuarine residence period than in the latter oceanic period (Parker 1965; 1968). Parker (1965, 1968) estimated that Bella Coola pink salmon had a mortality rate ranging from 59 % to 77 % during their initial 40 days of marine residence, and a mortality rate of 78 % to 95 % of the remaining population for the time period up to adult return (approx. 410 days). In studies spanning three brood years, Parker (1968) estimated a daily relative loss to the Bella Coola River pink population of 2 % to 4 % during the initial 40 days. Daily relative loss during the subsequent 410 day rearing interval averaged between 0.4 % to 0.8 %.

Fluorescent pigment-marked chum salmon released from Big Beef Creek during February in 1978 and 1979 had mortality rates of 29 % and 49 % of the population, respectively, during the first two days in the estuary (Salo et al. 1980). Prinslow et al. (1980) reported a survival rate of 44 % (mortality rate of 56 %) for the '78 brood chum migrating from Big Beef Creek after four days. Whitmus (1985) documented a mortality rate of 58 % and 74 % over 2 days for 45 mm chum fry released in two groups during early May from Enetai Hatchery in Hood Canal. Bax (1983a) reported average daily mortality rates for Enetai fall chum of between 31 % and 46 % over a two and a four day period. A characterization of Hood Canal and SJF summer chum behavior and migrational timing within critical estuarine residence and out-migration periods in the two regions is presently lacking. Such a characterization is needed to establish baseline estimates of summer chum timing for later use in assessing risk factors to these populations.

Hood Canal Summer Chum -

Numerous authors have documented early estuarine rearing and migratory behavior for chum in Washington, British Columbia and Alaska marine waters (e.g. Hoar 1951; Neave 1955; Manzer 1956; Bakkala 1970; Allen 1974; Feller 1974; Mason 1974; Cooney et al. 1978; Salo 1991). A significant number of studies have focused specifically on chum rearing and out-migration behavior in Hood Canal, due mainly to the need in the late 1970s and early 1980s to assess the effects of construction of the Trident Submarine Base at Bangor (Figure 2) on salmon migrational behavior (e.g. Moore et al. 1977; Salo et al. 1977; Schreiner 1977; Bax et al. 1978, Simenstad and Kinney 1978; Bax et al. 1979; Whitmus and Olsen 1979; Prinslow et al. 1979; Bax et al. 1980; Prinslow et al. 1980; Salo et al. 1980; Simenstad et al. 1980; Simenstad and Salo 1982; Bax 1982; Bax 1983a; Bax 1983b; Bax and Whitmus 1981; Whitmus 1985).

The above Hood Canal studies encompassed the time period when wild summer chum and wild and hatchery-origin fall chum were arriving in the estuary, and beginning seaward migration. Several of the studies included findings specific for "early run" or summer chum migratory time periods (Bax et al. 1979; Bax et al. 1980; Salo et al. 1980; Bax 1982; Bax 1983a; Bax 1983b). The majority of the Hood Canal studies, however, covered the entire seasonal chum out-migration, without specifically differentiating summer versus fall chum migrational timing or behavior. Characterization of early marine behavior and migrational timing for Hood Canal summer chum will rely largely on the Trident salmon out-migration studies, focusing on the time periods when emergent summer chum fry would likely be present as migratory fish in Hood Canal marine areas.

Initial Behavior -

As is characteristic of chum salmon, fry emerge with darkness, and immediately commence migration downstream to estuarine areas (Bakkala 1970; Koski 1975; Schreiner 1977; Koski 1981; Salo 1991), with total brood year migration from freshwater ending within 30 days for smaller streams and rivers (Salo 1991). Emerging chum fry have been shown to become very active with darkness (Hoar 1951), preferring the swiftest areas of downstream flow (Schroder [8]), and exhibiting strong negative rheotaxis, often swimming more rapidly than the current (Hoar 1951; Neave 1955). Koski (1975) reported that 51 % of Big Beef Creek summer chum emerged between twilight and ½ hour after dark, with 85 % of daily emergence occurring by 2300 H. Emergence and seaward migration keyed to darkness is consistent with behavior documented for other Northeast Pacific chum and pink stocks (Neave 1955; Bakkala 1970; Salo 1991). Neave (1955) found that 50 % of nightly emerging pink salmon in Hooknose Creek migrated between twilight and 2215 H and over 90 % of the migration had passed by 0200 H.

Neave (1955) concluded that the effect of chum and pink fry emergence and migrational behaviors is evacuation of a stream in the shortest possible time, under cover of darkness. Healey (1982) reported that chum salmon fry in British Columbia accomplish their downstream migration within a few days after emerging from gravel redds. Wissmar and Simenstad (1980) indicated that chum fry migration into marine waters typically occurs within 24 hours of emergence. Observations by USFWS on the Big Quilcene River showed clearance of most hatchery-reared summer chum upon release at R.M. 2.8 within 12 hours in 1992 (USFWS 1993), with the majority of chum clearing the river in less than 6 hours in 1994 (USFWS 1994). The relatively small size of production drainages in the region, use of the lowest reaches of these streams by summer chum spawners (Cedarholm 1972; Koski 1975; WDFW & WWTIT 1994) and minimal freshwater residence time standard for chum salmon (Bakkala 1970; Salo 1991) place Hood Canal summer chum in marine waters very soon after identified gravel emergence dates. Estimated emergence times described for Hood Canal region summer chum are therefore assumed to be equivalent to expected seawater entry times.

Upon arrival in the estuary, chum salmon fry inhabit nearshore areas (Schreiner 1977; Bax et al. 1980; Bax 1983b; Whitmus 1985). Chum fry indicate a preferred depth of between 1.5-5.0 meters at this time (Allen 1974) and are thought to be concentrated in the top few meters of the water column both day and night (Bax 1983b). In Puget Sound, chum fry have been observed through annual estuarine area fry surveys to reside for their first few weeks in the top 6" of

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[8] S. Schroder, WDFW Fish Management Division, Olympia, WA 98501. Pers. commun., September, 1996.

surface waters and extremely close to the shoreline (Ron Egan[9]). Iwata (1981) reported that, in Japan, chum orientated in stratified surface waters (20-100 cm depth) upon arrival in the estuary, showing a very strong preference for lower salinity water (10 to 14 ppt) found above the freshwater/saltwater interface, perhaps as a seawater acclimation mechanism. This nearshore and surface behavior could also be linked to survival, as small size exposes youngest fry to heavy predation. Onshore location may protect the fry from larger fish (Gerke and Kaczynski 1972; Schreiner 1977) and schooling behavior there may be an adaptation to predator avoidance (Feller 1974).

Chum fry arriving in the Hood Canal estuary are initially widely dispersed (Bax 1982), but form loose aggregations oriented to the shoreline within a few days (Schreiner 1977; Bax 1983b; Whitmus, 1985). These aggregations occur in daylight hours only, and tend to break-up after dark (Feller 1974), regrouping nearshore at dawn the following morning (Schreiner 1977; Bax 1983b). Bax et al. (1978) reported that chum fry at this initial stage of out-migration use areas predominately close to shore. "Early run" chum fry in Hood Canal (defined by the authors as chum juveniles migrating during February and March) usually occupy sublittoral seagrass beds with residence time of about one week (Wissmar and Simenstad 1988). Bax (1982) reported that chum maintained a nearshore distribution throughout their migration in Hood Canal, as indicated by decreased tow-net catches with increased distance from shore.

Although the majority of chum fry enter Hood Canal from rivers and hatcheries on the west shore, most of the spring-time out-migration occurs along the east shore (Schreiner 1977; Bax et al. 1978; Bax 1983b). The chum apparently cross the Canal from the west shoreline prior to reaching Bangor (Figure 2), a behavior possibly facilitated by salinity gradients caused by the large rivers on the west shore (Schreiner 1977). Whitmus (1985) observed that groups released from Enetai Hatchery near the Skokomish Delta in May showed no delay in crossing open water to the east shore. In 1977, the majority of chum migrating during February-mid-March used the west shore however (Bax et al. 1978). Bax (1983b) also reported that, prior to May, chum fry migrate all across the Canal, in an initial diffuse off-shore distribution, and offered that this behavior may be a directed response to enable rapid emigration from the Canal using prevalent currents.

Results of two years of marine fry out-migrant sampling in the vicinity of Bangor indicated that wild chum fry ranged in size from 35-40 mm in length (fl) at seawater entry, remaining near-shore until reaching a length of 45-50 mm before moving to deeper, off-shore areas (Schreiner 1977). Studies in Alaska and British Columbia indicate a initial migrant fry size of 35-40 mm (Healey 1982) with off-shore movement occurring when chum reach a "threshold" length of 60 mm (Cooney et al. 1978; Healey 1982) to 75 mm (Allen, 1974). Feller (1974) reported that Hood Canal-origin chum move off-shore when a fork length of 50-60 mm was attained. Bax et al. (1978, 1979) suggested that there is not a distinct size, or size range, when the fry move off-shore, proposing that an interaction between size and other factors influenced by

[9] R. Egan, WDFW Fish Management Division, Olympia, WA 98501. Pers. commun., September, 1996.

the season, determine the inshore versus offshore distribution of chum fry. The lack of a distinct size for offshore movement may be due to the predominance of hatchery chum in the Canal (Bax et al. 1980). In 1979, Bax et al. (1980) observed that offshore movement was a gradual process, but few chum were caught offshore until early May, when a marked change to pelagic prey organisms occurred.

Data from Schreiner (1977) indicate that chum size in nearshore waters during the expected summer chum emergence period (assumed to be the months of February and March based upon emergence time) ranged from 35-44 mm. The following year (1977) chum fry during this time period measured 35-41 mm (Bax et al. 1978). These March length ranges compare to average lengths at emergence of 38-39 mm reported for Big Beef Creek summer chum emerging during the same time period (Koski 1975). Healey (1982) reported an early marine growth rate of 1 mm/day for Nanaimo River-origin chum. In beach seine studies at Bangor, Bax (1983b) noted that over the span of the chum migration period, a growth rate of 0.58 mm/day can be expected to apply to the estimated chum size at entry during estuarine residence in Hood Canal. However, Bax (1983b) also observed that chum migrating prior to April showed little change in length as time progressed.

Out-migration Timing and Rate -

Occurrence timing -

Studies of the environmental effects of the proposed Trident Submarine Base assessed chum fry migratory behavior through frequent (at least twice weekly) beach seine and tow net sampling during the principal out-migration period at stations situated sequentially S to N along the shores of north-central Hood Canal. Out-migrant abundances were noted by tracking changes in CPUE levels monitored over the season. Migration rates were derived in these studies from observations of the step-wise northern progression of CPUE peaks and declines monitored in each station (e.g. Feller 1974; Schreiner et al. 1977; Snyder and Bax 1978; Bax et al. 1979; Bax et al. 1980; Bax 1982; Bax 1983b) and through recapture of fluorescent pigment-marked fish released from Hood Canal hatcheries and Big Beef Creek (e.g. Moore et al. 1977; Bax et al. 1979; Prinslow et al. 1979; Whitmus and Olsen 1979; Bax et al. 1980; Salo et al. 1980; Prinslow et al. 1980; Bax and Whitmus 1981; Bax 1983a; Whitmus 1985).

Studies of chum fry abundance in Dabob Bay by Feller (1974) showed peak out-migrant abundances in May, with another major peak indicated in mid-April. Schreiner et al. (1977) reported minor peaks in chum fry abundance through beach seine sampling in the vicinity of Bangor in March that were assumed to be "wild" stocks, since there were no hatchery releases prior to that time. Major peaks in chum fry abundance seen in early May through mid-late June were highly correlated with the timing of hatchery chum releases from Hoodsport and Quilcene hatcheries (Schreiner 1977; Schreiner et al. 1977). The major peaks in abundance occurred three weeks after Hoodsport Hatchery chum releases and 1 week after Quilcene NFH releases.

Figure 11, taken from Bax (1982), illustrates seasonal beach seine (nearshore) CPUE peaks from chum out-migration studies conducted from 1975-79 at Bangor. Bax et al. (1978, 1979, 1980) observed two to three major peaks in abundance of chum in the nearshore area during sampling in 1977, 1978 and 1979. Peaks in early February through early March were consistently observed in all years studied, except in 1975, when sampling commenced in April. February and March CPUE peaks were most noticeable on the west shore in 1977, but apparent on both shores in 1978 and 1979. These early peaks were followed by larger peaks on both sides of the canal during mid-April and mid-June (1979) and during late May and early July (1977 and 1978). Smaller peaks in chum fry abundance were reported in mid-March and mid-April in 1977 reflecting prior hatchery releases from Hood Canal Hatchery, but the correlation between the two was not as clear as documented in previous years (Bax et al. 1978). In 1978, nearshore CPUE peaks on the east shore near Bangor in late April and in mid-May closely followed large hatchery releases from Hoodsport. A third peak observed on the east shore in late June of 1978 occurred two weeks after a release of fish from Quilcene Hatchery. Peaks in abundance at Bangor ranged from 1 week (in March) to 3 weeks from the time chum fry were released from Hood Canal hatcheries (Bax et al. 1978; Bax et al. 1979; Bax et al. 1980).

Given differences in emergence timing between wild summer (February-March) and wild fall chum (April-May), and the observed correlation of CPUE peaks in late April through June with hatchery chum releases (Schreiner 1977; Bax et al. 1978; Bax et al. 1980), it is assumed that observed peaks in abundances during February and March reflect summer chum fry out-migration. The uniform, small size of chum fry recruiting into the Bangor area through February and March supports the assumption that chum captured during that time are wild summer chum, and not hatchery-reared fish. These data also demonstrate the temporal separation that exists between wild summer chum and hatchery-origin fed fry.

Weekly mean chum fry lengths from annual out-migration sampling at Bangor are presented in Figure 12. From this figure, annual salmon out-migration sampling conducted by the U.W. Fisheries Research Institute from 1976-79 demonstrate similar seasonal changes in weekly mean lengths as sampling progressed during the chum migration. Captured chum fry remained at a mean size of 37-41 mm throughout the February-March time period, which is the approximate size range of chum at emergence. When considered with CPUE peaks at Bangor consistently observed during February-March, the lack of changes in length over this time period suggests continuous recruitment and passage of newly emerged, wild chum. Wissmar and Simenstad (1988) acknowledge that chum fry migrating in February and March are "early run" fish, ranging in size from 35-40 mm with a mean weight of 0.5 gm. Increases in mean lengths did not occur until mid-April, when chum released from hatcheries (mean length at release of 43-69 mm (Bax et al. 1980) were projected to begin arriving in the area (Bax 1983b), as indicated by subsequent CPUE peaks registered beginning that month.

Figure 11. Weekly mean beach seine catch per unit effort of chum juveniles at Bangor, Hood Canal - 1975-79 (figure excerpted from Bax 1982).

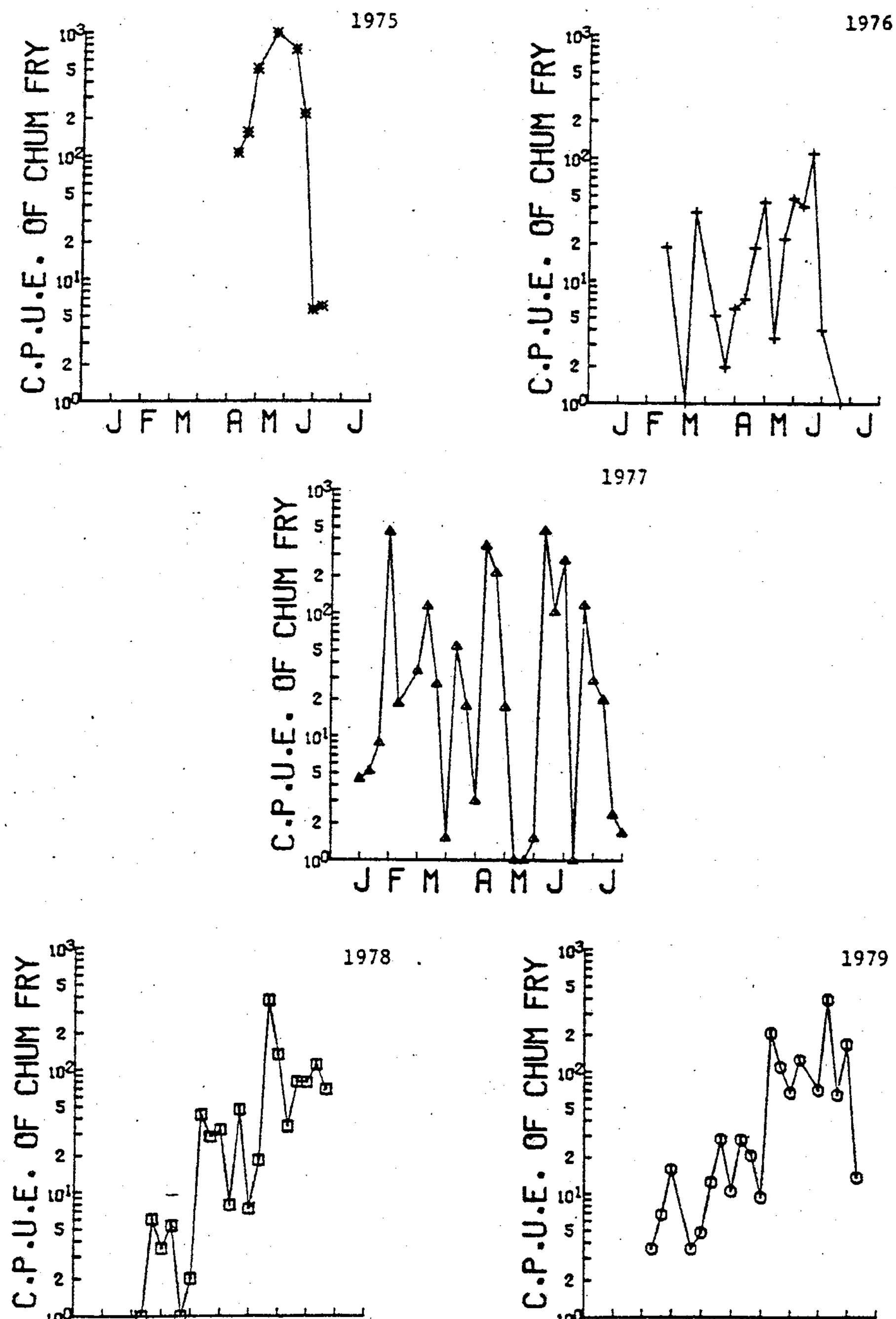


Figure 12. Weekly mean lengths of chum salmon collected in salmon out-migration studies conducted from January through July, 1976, 1977, 1978 and 1979 in the vicinity of Bangor, Hood Canal, Washington (figures excepted from Schreiner 1977, and Bax et al. 1978; 1979; 1980).

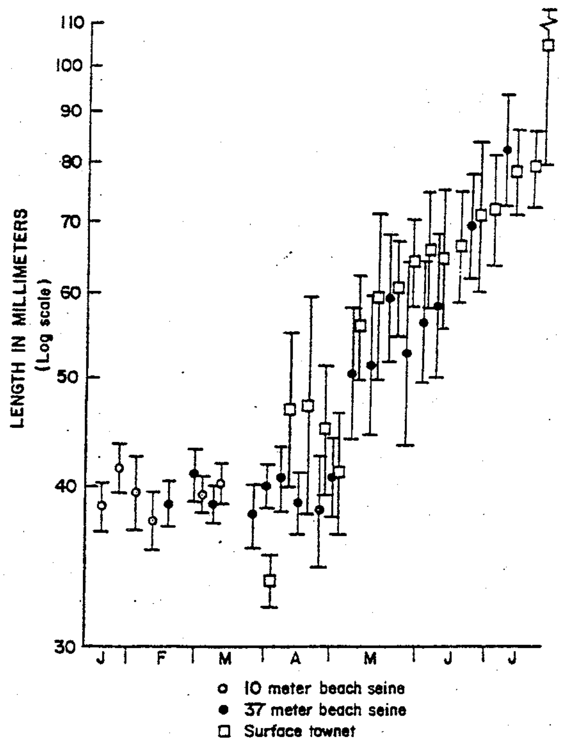


Fig. 18. Weekly mean lengths and standard deviation of chum salmon collected with all sampling methods from January 22 to July 23, 1976, Hood Canal, Washington.

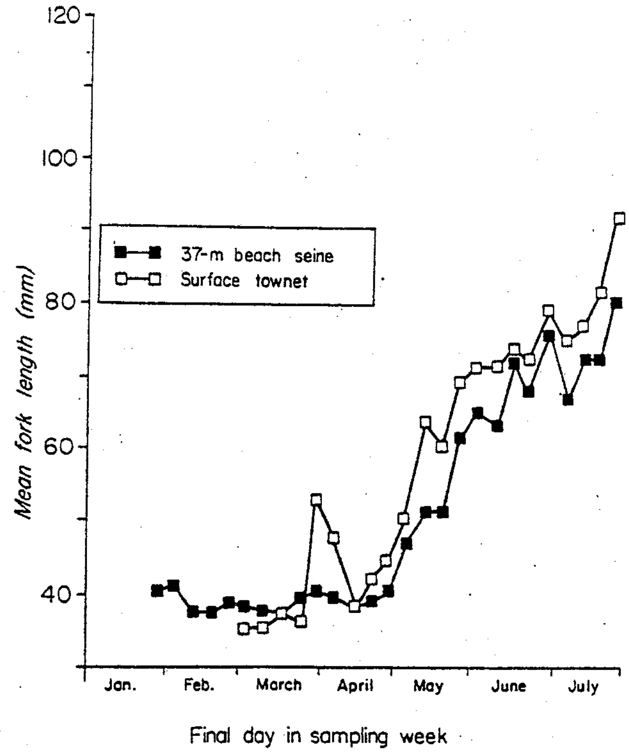


Fig. 27. A comparison of the mean lengths of chum fry caught with the 37-m beach seine and surface townet from January 21 to July 28, 1977, in Hood Canal, Washington.

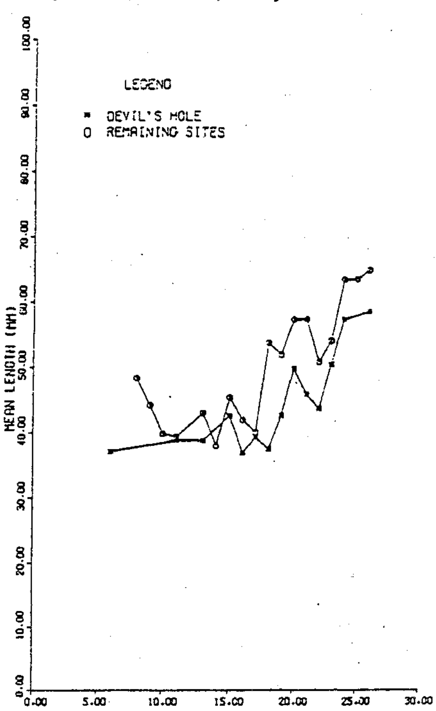


Fig. 27. Mean fork length of chum caught with the beach seine at Devil's Hole, and at all remaining sites in Hood Canal, Washington, 1978.

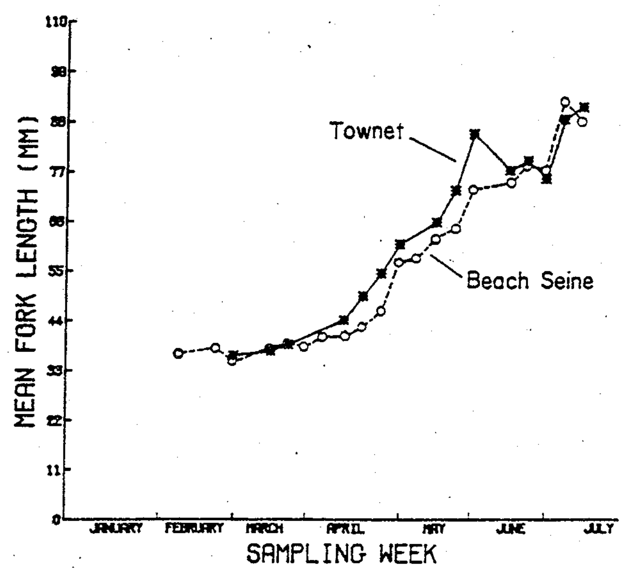


Fig. 11. Comparison of the mean length of chum juveniles caught with the beach seine and the townet in 1979.

Migration rate -

Bax (1983b) reported that the majority of chum fry entering Hood Canal in February and March, the time period when wild summer chum emerge (Figure 7), migrate rapidly northward out of the Canal, at a rate of 7 - 14 km/day. The seaward migration rate for marked Big Beef Creek summer chum tracked during this same time period was estimated at 13 km/day in 1977 (Salo et al. 1980). In contrast, chum fry entering the estuary in May-June generally exhibited lower migration rates, ranging from 3-5 km/day (Bax 1983b). Further mark-recapture studies of fluorescent-pigment marked chum released from Big Beef Creek also showed the tendency for chum fry entering the estuary in February and March to migrate rapidly seaward from the Canal. Prinslow et al. (1979) reported peak abundances of marked chum fry in sampling areas north of Bangor only 3-4 days after release of 52 mm (fl) fish in late March from Big Beef Creek. Mark-recapture studies conducted the following year showed that early season releases (February, March and April) of 53 mm chum fry from Big Beef Creek migrated very rapidly out of Hood Canal, exiting the northernmost sampling area in as little as three days (Prinslow et al. 1980). This rapid northward migration, with no extended estuarine residence, for early-released fish contrasts with findings for chum fry released in June, which migrated much slower, residing in the Bangor area for up to three weeks after release (Prinslow et al. 1980).

It is thought that rapid seaward movement by chum fry early in the season reflects either "active" migration in response to low food availability or predator avoidance, or "passive" migration, brought on by strong, prevailing S/SW weather systems that accelerated surface flows, and migrating fry present during the late winter-early spring time period, northward (Bax et al. 1978; Simenstad et al. 1980; Bax 1982; Bax 1983b). Lower migration rates for later-migrating chum were thought to be linked with increases in the availability of epibenthic and neritic zooplankton, leading to extended rearing and delayed migration (Simenstad et al. 1980) and/or decreases in residual seaward surface outflow caused by a seasonal change to a prevailing northerly wind pattern during this migration period (Bax 1982, Bax 1983b). Seasonal out-migration rates have been observed to be variable year to year in Hood Canal, for as yet unknown reasons. This variability could possibly be linked to odd/even year cycle effects, perhaps associated with the presence or absence of pink salmon fry (Bax et al. 1980).

Through linear regression analyses of estimated seasonal Hood Canal surface outflow and mean migration rates, Bax (1982) observed that the decrease in migration rate over the out-migration season can be at least partly explained by the "passive" migratory-control mechanism; the corresponding decrease in surface outflow. Mark recapture studies of migrant Big Beef Creek wild summer and fall chum further demonstrated the seasonal differences in chum fry emigration rates, and the correlation of those rates with surface outflow from the Canal. In 1977, summer chum fry migrated past the Bangor sampling area one week after their peak migration from Big Beef Creek in mid-February (Bax 1982). Big Beef Creek fall chum peaking in emigration from the creek in early April required two weeks to travel the same distance. Bax (1982) noted that other studies in Hood Canal (citing Simenstad and Kinney, unpubl. data) showed little or no indication that chum fry migrating at higher rates had decreased stomach contents, concluding that a significant proportion of the change in migration rates results from passive movement in seasonally variable, wind induced surface currents.

Whitmus and Olsen (1979) reported similar seasonal differences in migration rates for hatchery-reared fish. Chum released from Hoodsport Hatchery in April took less time to arrive at Bangor than chum released in June. April releases of Hoodsport fall chum arrived at Bangor after one week, while June releases arrived after three weeks of migration. Migration speeds observed for these chum ranged from 3.8 km/d to 7.5 km/d, however Bax (1983b) quoting Clifford Whitmus (unpubl. data), cited mean northerly migration rates ranging from 14 km/day in February to 4 km/day in May and June.

Hatchery-reared and wild chum populations emigrate from Hood Canal at different rates at different times of the year, and emigration rates of each size group decrease as the season progresses (Bax et al. 1978; Salo et al. 1980; Bax 1982; Bax 1983b). Salo et al. (1980) showed a decline in migration rate as the out-migration progressed by month during 1979, with rates of 8 km/day in February, 14 km/day in March, 7 km/day in April and 3 km/day in June. Emigration rates also increase as the size of the chum fry increases, and the rates increase as the density of pink/chum juveniles of the same size increases (Bax, 1983b; Whitmus, 1985). Later release dates for hatchery chum showed varied, but generally delayed migration rates (Salo, 1991). Area of release within the Canal also appears to affect emigration rates. Chum salmon released from hatcheries adjacent to the Skokomish Delta (George Adams, McKernan and Enetai) have a greater tendency to exhibit delayed migration than those released away from the Skokomish (Hoodsport, Quilcene NFH and Big Beef Creek), which exhibit little or no delay in migration (Whitmus, 1985).

Duration of Hood Canal residence -

Mason (1974) reported delayed seaward migration of chum fry in the estuary of a small coastal stream in British Columbia during late spring. This delay in migration, observed to be up to three days, but extrapolated from growth data to a possible average residence of 1-2 weeks, was thought to be associated with the availability of feed and the selection of tidally-induced optimal salinity gradients in the estuary during seawater acclimation. Healey (1975, 1976) also noted residence in nearshore areas adjacent to the Nanaimo River in British Columbia for a few weeks for chum fry emigrating in April and May. Similar delays in migration have been observed in Hood Canal for later-migrating chum fry, particularly for smaller hatchery chum released near the Skokomish River, where a large delta may provide feeding opportunities (Whitmus, 1985).

As noted previously, Bax (1983b) found that chum in Hood Canal migrating northward past Bangor prior to April (when summer chum out-migration occurs) showed little change in mean length as time progressed, indicating constant, new recruitment of juveniles with no growth, and little residence, in the Canal. This observation suggests that chum fry out-migrate rapidly in Hood Canal early in the season due to diminished feeding opportunities. Bax et al. (1980) reported increased condition factors commensurate with progression of the season for chum fry captured at Bangor in all years studied. An increasing condition factor observed as the chum migration progressed though the spring months suggests that conditions may be better for chum growth later in the season.

The tendency for migrating chum to not reside in the Bangor area (nor in other areas of the Canal prior to reaching Bangor), but migrate northward, was also indicated by rapid increases in catch at the Bangor sampling area, followed by equally rapid decreases, as observed over the entire out-migration period (Bax 1982). Beginning in April, chum fry captured at Bangor show increases in size, starting at or shortly after, the projected arrival of hatchery-reared juveniles. Whitmus (1985) found that larger (53 mm) chum fry released in May from Enetai Hatchery tended to migrate immediately northward, with no residence in the southern canal. The lack of prolonged residence in Hood Canal was also observed in mark-recapture studies of Big Beef Creek hatchery reared (48-53 mm) summer chum in 1978 and 1979. After initial dispersal from a release point at Big Beef Creek during February, the chum started moving northward and out of the Canal. Beach seine fishing on the third day following release in 1978 indicated that there were few marked chum remaining in the sampling area, which extended to the mouth of the Canal (Prinslow et al. 1979; Salo et al. 1980; Bax 1982). This apparent lack of prolonged residence for Hood Canal chum when compared to chum fry in other regions could be an artifact of the lack of significant riverine delta areas associated with most chum production streams in the region, relative to other Pacific Northwest regions studied (Manzer 1956; Mason 1974).

Factors affecting out-migration -

Whitmus (1985) advanced the hypothesis that Hood Canal chum populations will adopt a migration strategy that will tend to be optimal for a particular set of annual environmental circumstances. In any year, some chum will migrate immediately and some will reside, but the average fish in the population will remain plastic, adopting a strategy that will maximize survival. In years of good estuarine productivity, migration would be delayed. In years when productivity or environmental conditions in Hood Canal were sub-optimal for growth or survival, seaward migration would be accelerated. Bax (1983b) also stressed the importance of recognizing the potential lack of a single, uniform out-migration pattern for chum fry of the same size, migrating at the same time. The need for salmon populations to retain a high degree of variability in migratory patterns to cope with a changing and unpredictable marine environment was highlighted. These theories may apply for fall chum stocks emigrating in the Canal during springtime months when estuarine productivity levels can be expected, on average, to be increasing or high, driven by photoperiod increases inherent with the progression of the season. Summer chum may be emerging too early in the season to allow for this type of plasticity in migration, however, as suggested by annual productivity regimes documented for Hood Canal.

The precise annual onset, magnitude and duration of springtime blooms are highly variable and largely matters of chance, dependent upon convergence of the right circumstances and conditions (Strickland 1983). The necessary conditions triggering springtime blooms are predictable events though, including neap tides and seasonally reliable increases in sunlight, runoff and northerly winds. Sunlight, or solar radiation, has been found to be a primary and sometimes dominant growth-controlling factor, either on a seasonal or shorter-term basis (Barlow 1958). The time-averaged rate of sunlight change (both intensity and duration) has been found to be the most important factor in determining the seasonal abundance and production of phytoplankton in central Puget Sound (Rensel and PTI 1991) and in Hood Canal (Barlow 1958).

In an average year, peak volumes of zooplankton have been documented to occur in the main basin of Puget Sound from May through September, with minimum values occurring in March and April (Hebard 1956, cited by Bax 1983b). Strickland (1983) reported peaks in phytoplankton abundance during mid-late May in the main basin and in Dabob Bay, with annual minimum chlorophyl a values observed prior to the first week in April. Although complicated by life strategy differences attached with the composite of mixed phyto- and zooplankton species present, peaks in zooplankton abundance appear to just follow peaks in phytoplankton (Strickland 1983). Water temperature and secchi disk data collected by Schreiner (1977) and water temperature data reported by Bax et al. (1978; 1979; 1980) during chum migration studies indicate that primary productivity in the vicinity of Bangor in Hood Canal during the years studied likely did not increase until the first week in April. Dempster (1938) documented low volumes of plankton in Hood Canal surface waters from early January through late March, with peak plankton volumes apparent in late April. Primary productivity increases were commensurate with seasonal solar radiation increases, which caused surface water temperatures (at 1 m depth) in the Canal to climb from 7-8 ºC in March to 13-15 ºC in June in the aforementioned chum migration studies.

Chum fry captured in nearshore environments during out-migration in upper Hood Canal were found to prey predominantly on epibenthic organisms, mainly harpacticoid copepods and gammarid amphipods (Bax et al. 1978; Simenstad et al. 1980). Diet changed to predominantly pelagic organisms in early May for fry migrating in off-shore areas. Dabob Bay chum fry were reported to feed continuously (day and night) in using nearshore areas as a source of food (Feller 1974). Feller (1974) and Gerke and Kaczynski (1972) documented initial preference (and predominance in the diet) of epibenthic prey by chum fry in Dabob Bay, followed by a gradual switch to pelagic prey as time progressed. Several researchers have documented a reliance on drift insects by migrating chum fry in British Columbia (Mason 1974) and in Dabob Bay, Hood Canal (Gerke and Kaczynski 1972). Hatchery-released chum fry in southern Hood Canal were found initially to prey almost exclusively on terrestrial insects, likely made available as drift from the Skokomish River (Whitmus 1985). Faster-migrating fry that had moved further north of the Skokomish delta were found to feed entirely on neritic and epibenthic organisms. Simenstad et al. (1980) showed a gradual decrease in the epibenthic fraction of stomach contents as the chum increased in size. Migration off-shore could result from opportunistic movement of fry to take advantage of larger, more prevalent prey organisms in the neritic environment (Bax 1983b).

Sampling of shallow sublittoral epibenthic organisms by Bax et al. (1978) indicated that prey items that normally predominate in the diet of chum fry increase in density beginning in mid-March, with peak densities observed beginning in mid-April, and extending through early June. Simenstad et al. (1980) reported a high "surplus" of epibenthic prey in early February, remaining at moderately high levels through the end of March during sampling of prey species abundance available to out-migrating chum fry in 1978.

In addition to effects on out-migration of strong northward seasonal surface outflow, Simenstad et al. (1980) suggest that the rapid seaward emigration observed for early-emerging chum stocks may possibly be linked to a general state of low productivity during February-March in Hood Canal. Simenstad et al. (1980) supported this linkage by finding that chum fry residence in Hood Canal and the speed of out-migration appear to be directly related to the availability and density of preferred food organisms. Although Simenstad et al. (1980) reported that the time and size at which off-shore migration occurs might be influenced by the abundance of epibenthic organisms, Bax (1983b) found the data in this regard ambiguous. Bax (1983b) reported that no significant correlation between prey density and migration could be found, noting the need for further studies, including epibenthic sampling during chum emigration, prior to considering this lack of correlation definitive. Because of an estuarine entry timing earlier than the normal onset of increased productivity in Hood Canal, juvenile chum entering marine waters during the February-March out-migration period likely encounter a relatively impoverished state of prey resources in estuarine feeding areas. Rapid out-migration rates observed for wild chum fry (<40 mm FL) during this early time period, ranging up to 13-14 km/day (Bax et al. 1983b; Salo et al. 1980), indicate that one behavioral response to low prey availability might be immediate out-migration to more seaward waters (Simenstad et al. 1980).

Bax (1982) concluded from out-migration studies in Hood Canal that the movement of chum fry upon egression appears highly dependent not only on the conditions at their point of entry into the marine environment, but also on the characteristics of the fish themselves. The Hood Canal summer chum populations represent the southernmost extent of the North American summer chum range. As such, these chum likely live on the margin of conditions required to consistently optimize survival and growth, relative to more northerly British Columbia and Alaskan summer chum populations. Egressing Hood Canal summer chum may match emergence with spring-time blooms in years, when conditions allow phytoplankton and zooplankton to proliferate earlier in the season than is average. In most years, however, the summer chum emerge prior to the advent of spring-time blooms, entering Hood Canal when chlorophyl a levels are at seasonal lows, and too early in the season to take advantage of the spring increase in zooplankton. As a consequence, the Hood Canal summer chum populations may be adapted to a rapid northward migration to northerly coastal water masses, where growth and survival conditions may be more optimal.

Completion of Seaward Migration -

Although data are available regarding commencement of out-migration, documentation regarding the time when summer chum have completed migration from Hood Canal marine areas to northern, coastal water masses is lacking. Studies in Hood Canal have documented commencement and completion of the northward emigration of all chum fry populations combined over the entire season (Schreiner, 1977; Bax et al. 1978; Bax 1980). The presence of later-timed, out-migrating fall chum in onshore beach seine and off shore tow net sampling, however, confounds identification of the time when summer chum have completely exited the

Canal. Mark-recapture studies reported by Bax (1982) showed that `76 brood Big Beef summer chum peaked in the upper Canal (Bangor area) in mid February, with a range in recoveries from late January to late February. Additional marine area mark/recapture studies of newly emerging and out-migrating summer chum are needed to identify the time of clearance of the population from the Canal, similar in construct to those conducted by Whitmus (1979, 1985), Salo et al. (1980) and Prinslow et al. (1979, 1980) using fluorescent pigment-marked chum released from Hoodsport and Enetai hatcheries and from Big Beef Creek.

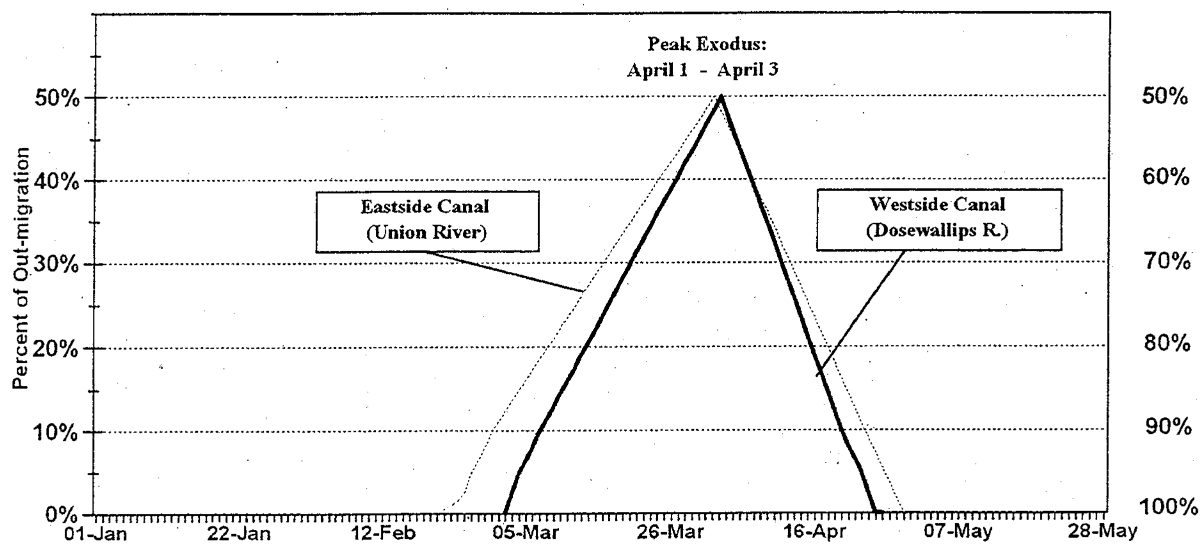
Abundance curves derived from beach seine CPUE data at Bangor (Figure 11, taken from Bax 1982) suggest that summer chum clear the upper Canal area by the first of April, if February-March peaks and subsequent drop-offs in CPUEs can be assumed to reflect completion of summer chum passage prior to arrival (and major May CPUE peaks) of fall chum. Using average migration rate data from Bax (1982; 1983b) and Whitmus (1985) for the February-March migration period, and average Hood Canal summer chum emergence (estuarine arrival) timing data, applied to the distance in kilometers from the most southerly and northerly summer chum production streams to the mouth of the Canal, estimated out-migration periods within Hood Canal for summer chum can be estimated.

The 10 %, peak and 90 % average population estuarine arrival ranges derived for Kitsap Peninsula streams (earliest, peak and latest of February 7, March 18, and April from Table IV) and Olympic Peninsula streams (central 80 % estimate of March 1, March 27 and April 14 from Table V) will be assumed as the time periods when eastside and westside-origin summer chum fry marine area out-migration commences.

A conservative estimate of 7 km/day will be used as the rate of emigration, which is the lowest from the emigration rate range documented as the most common observed during the February-March (summer chum) emergence time period by Bax (1983b) and Whitmus (1985). A distance from the mouth of the Union River, the most southerly eastside summer chum production stream, to the mouth of Hood Canal (Foulweather Bluff) of 99.5 km (from Washington Atlas and Gazette Maps, 1988) will be assumed as the maximal distance summer chum must travel to exit the Canal. The shortest distance an existing summer chum population must travel to exit the Canal is 45.7 km, from the mouth of the Dosewallips River, a westside stream, to Foulweather Bluff.

Based upon these assumptions, the southernmost population of summer chum are estimated to clear the Canal (north of Foulweather Bluff) 14 days after individual chum enter seawater. The northernmost migrating population would exit Hood Canal 6.5 days after entering the estuary. Figure 13 presents out-migration timing and abundance curves for Union and Dosewallips River summer chum fry, derived through application of these assumptions.

Figure 13. Out-migration timing and abundance curves depicting estimated east and westside-origin summer chum fry departure from Hood Canal marine waters.



Out-migrating, summer chum fry originating in, and migrating from the Union River are estimated to be at peak abundance at the mouth of the Canal about April 1 (central 80 % occurrence range of February 21 - April 28). This range will be used to characterize the time period when the furthest migrating Hood Canal-origin summer chum population will exit the Canal. Dosewallips River-origin summer chum fry would peak in out-migration at the entrance to Hood Canal on April 3 (central 80 % range of March 8 - April 21). The exodus of the Hood Canal origin summer chum population closest to the entrance to the Canal will be characterized by this latter range.

Strait of Juan de Fuca Summer Chum -

No direct studies of summer chum fry early marine migrational and behavioral characteristics have been conducted within this region. Peters (1996) reported on fall chum fry out-migrational timing and behavior from the Elwha River, but the drainage does not support a summer chum population. WDFW stock assessment staff have not conducted fry out-migration surveys in Discovery or Sequim Bays in recent years (Egan - footnote 9). Ray Johnson, WDFW, did observe aggregations of out-migrant chum in those areas in 1970, but the late May/early June timing of the surveys were likely too late to reflect summer chum presence. Characterization of estuarine migration timing and behavior for SJF summer chum presented in this analysis will be based on limited observations for the region, and extrapolation from information developed to characterize Hood Canal summer populations.

Initial Behavior -

As was assumed for the Hood Canal populations, the estimated gravel emergence timing for SJF summer chum will be used to characterize estuarine arrival timing. Salmon, Snow and Jimmycomelately creeks are all of similar character in reaches used by summer chum, with relatively small stream widths and low flow volumes compared to larger chum-producing systems providing little habitat for freshwater rearing. The predominance of spawning in the lowest one mile of each Strait summer chum stream (WDF, WDW, and WTIT 1994) makes it likely that arrival in the estuaries occurs shortly after emergence, as is characteristic for chum in small streams (Bakkala 1970; Salo 1991).

No studies of chum fry behavior upon arrival in the Discovery and Sequim bay estuaries have been conducted. It is likely that chum adhere to nearshore areas in loose aggregations upon seawater entry, as has been documented for chum fry in other regions (Salo 1981) and discussed in the Hood Canal section of this assessment.

Out-migration Timing and Rate -

No information is available regarding seaward migration rates or timing for SJF summer chum, although fish assemblage studies that would enable collection of such data have been conducted in chum migratory areas (Miller et al. 1980). As protected bays, the Discovery and Sequim bay estuaries used by SJF summer chum may provide opportunities for extended residence of chum fry prior to seaward emigration. Migration rates for these stocks thus may be less than reported for Hood Canal chum migrating during the February-May time period, when SJF summer chum are estimated to arrive as emergent fry in Discovery and Sequim bays.

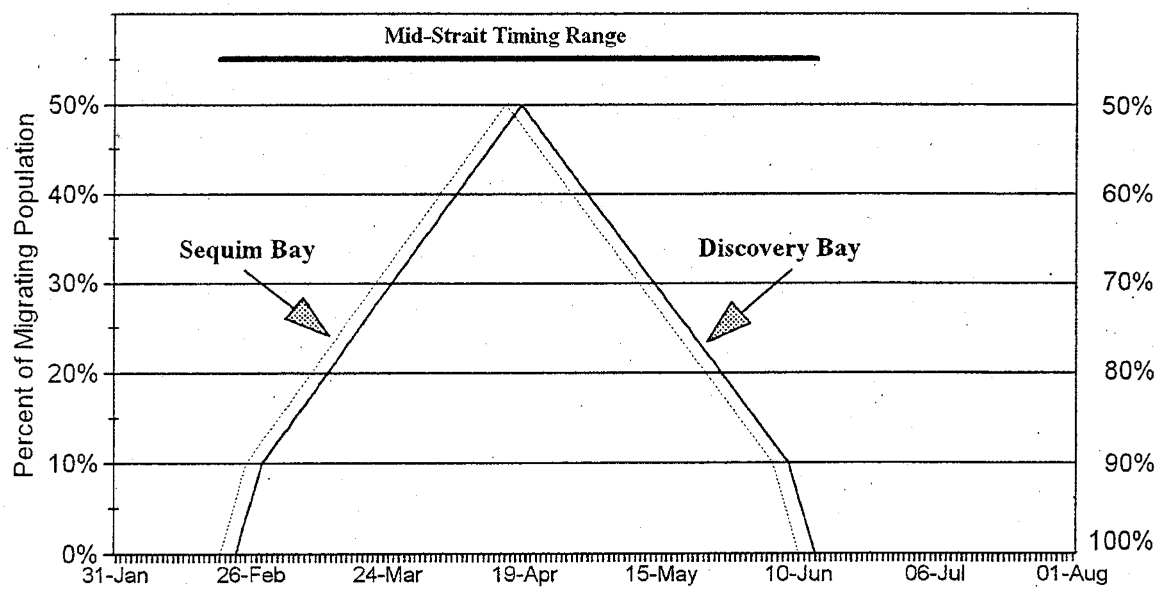
For lack of better information, and until studies of emigration rates for SJF summer chum are conducted, a seaward migration rate of 4 km/day will be assumed to estimate clearance from the terminus of the bays to mid-Strait of Juan de Fuca. This rate is the average rate observed for Hood Canal chum migrating in the May-June time period (Bax 1983b). Use of this rate presumes a conservative seaward migration speed that might be attached with possible prolonged residence in the protected bays, and a reduced migration speed associated with progression of the season and increases in estuarine productivity.

Completion of Seaward Migration -

A migration rate of 4 km/day can be applied to the 10 %, 50 % and 90 % estimated estuarine arrival timing range (from Table VI - February 15, April 4 and May 26, respectively) to estimate the time period when SJF summer chum depart from Discovery and Sequim bays, and join other seaward-migrating salmonids in coastal water masses. Distances from the end of Discovery and Sequim Bays (the mouths of summer chum production streams) to the mid-point of the Strait of Juan de Fuca (assumed to be the mouth of Morse Creek) of 53 km and 41 km will be assumed for estimating clearance timing (distances from Washington Atlas and Gazette Maps, 1988).

Based on these assumptions, Discovery Bay-origin summer chum population would reach waters adjacent to Morse Creek in the mid-Strait approximately 13 days after entering seawater. Summer chum from Jimmycomelately Creek would clear Sequim Bay and reach the middle of the Strait in 10 days. Figure 14 presents out-migration timing and abundance curves for these populations, derived using the above methods.

Figure 14. Estimated Discovery and Sequim bay-origin summer chum out-migration timing to mid-Strait of Juan de Fuca (Morse Creek area).



From Figure 14, Sequim Bay summer chum would peak in mid-Strait waters on April 14 (central 80 % span range of February 25 - June 5). Discovery Bay summer chum would arrive in the mid-Strait waters somewhat later, peaking in abundance there on April 17 (central 80 % span range from February 28 - June 8).

SUMMER CHUM LIFE HISTORY SUMMARY -

Figures 15 and 16 summarize annual Hood Canal and SJF summer chum life history information and migrational timing estimates developed in this report for Washington freshwater and marine areas. Included are estimated adult migration timing in marine and estuarine areas and on the spawning grounds, gravel residence periods, and average emergence timing curves. Out-migration timing ranges that are presented reflect the time period when fry are potentially present as out-migrants in the Canal or eastern SJF estuarine areas. Specifically, this information will be used to assess the potential effects of natural events and man-caused activities in the Hood Canal and Strait of Juan de Fuca regions on wild summer chum.

Figure 15. Hood Canal region summer chum life history summary for Washington waters.

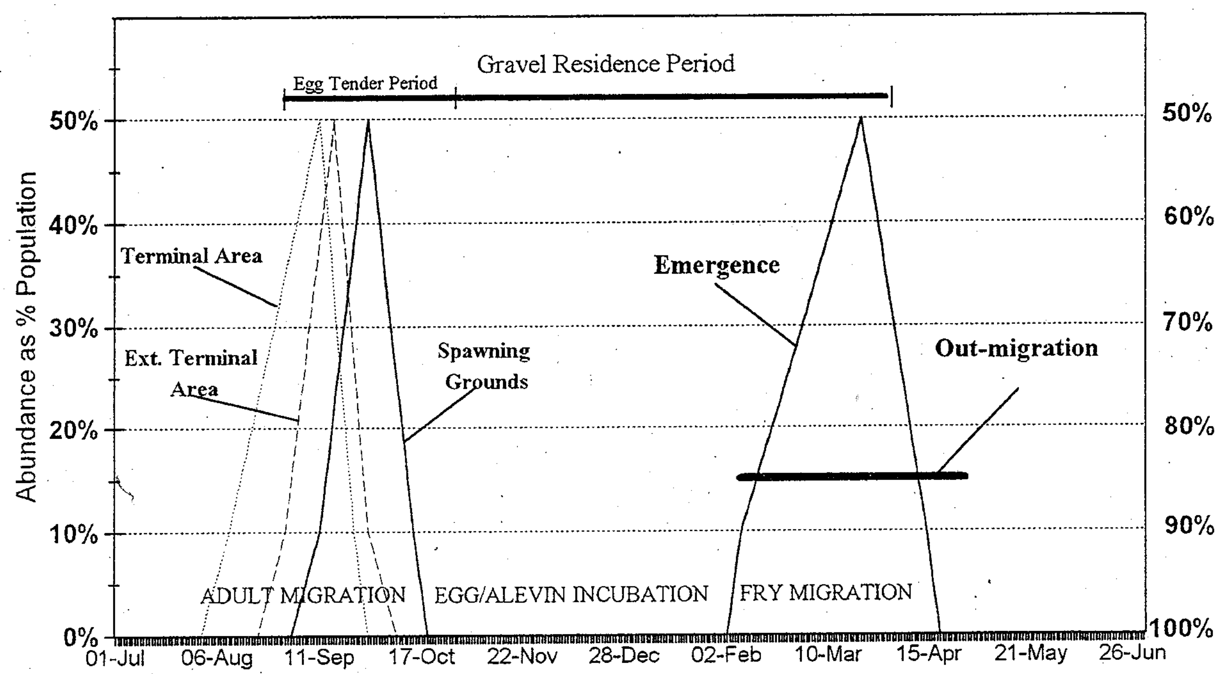
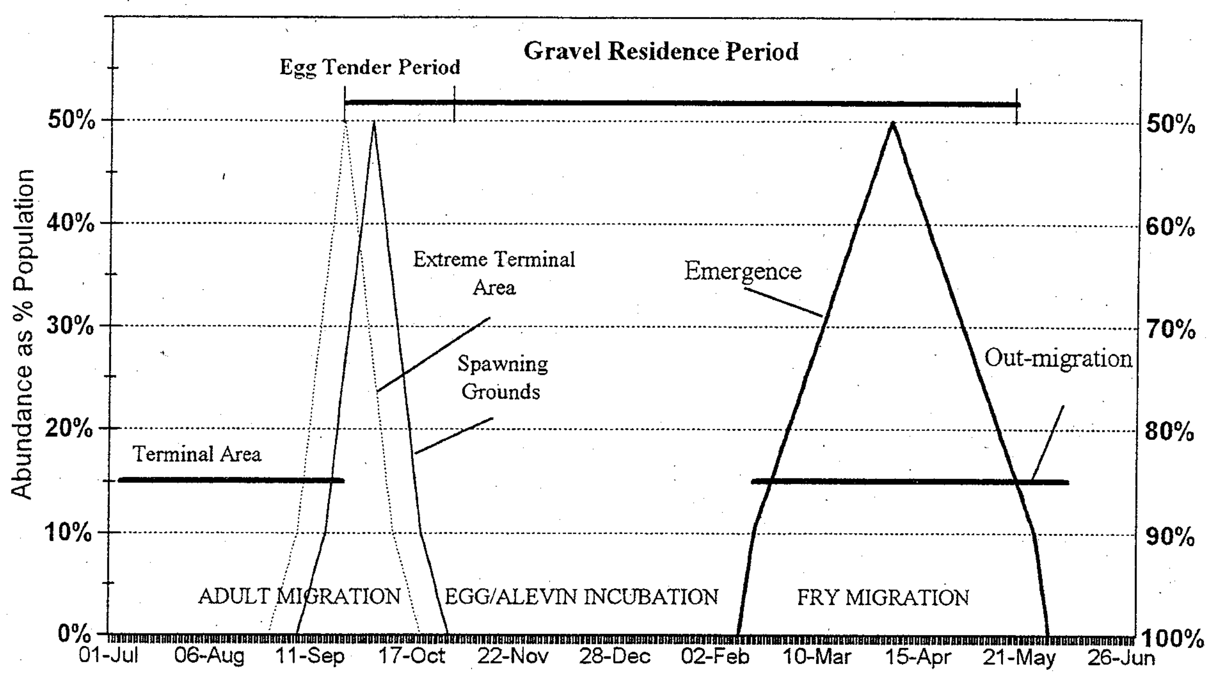


Figure 16. Strait of Juan de Fuca region summer chum life history summary for Washington waters.



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Appendix I. Quilcene National Fish Hatchery temperature unit developmental data for summer chum (ºF) and daily average temperature data for the Big Quilcene River and Penny Creek.

Temperature Units for Summer Chum Development
(Brood Year 1994)

13-Sep-94	11.21	52.178	20.178	650 TU's to Eye
14-Sep-94	10.92	51.656	19.656	956 TU's to hatch
15-Sep-94	10.36	50.648	18.648	1639 TU's to Swim-Up
16-Sep-94	13.48	56.264	24.264	
17-Sep-94	13.48	56.264	24.264	
18-Sep-94	13.41	56.138	24.138	
19-Sep-94	13.35	56.03	24.03	
20-Sep-94	13.35	56.03	24.03	
21-Sep-94	13.26	55.868	23.868	
22-Sep-94	13.05	55.49	23.49	
23-Sep-94	12.98	55.364	23.364	
24-Sep-94	12.93	55.274	23.274	
25-Sep-94	12.72	54.896	22.896	
26-Sep-94	12.83	55.094	23.094	
27-Sep-94	12.72	54.896	22.896	
28-Sep-94	12.9	55.22	23.22	
29-Sep-94	12.96	55.328	23.328	
30-Sep-94	13.44	56.192	24.192	
01-Oct-94	12.7	54.86	22.86	
02-Oct-94	11.27	52.286	20.286	
03-Oct-94	9.14	48.452	16.452	
04-Oct-94	9.1	48.38	16.38	
05-Oct-94	8.88	47.984	15.984	
06-Oct-94	9.08	48.344	16.344	
07-Oct-94	8.99	48.182	16.182	
08-Oct-94	8.74	47.732	15.732	
09-Oct-94	9.54	49.172	17.172	
10-Oct-94	10	50	18	
11-Oct-94	9.19	48.542	16.542	
12-Oct-94	8.21	46.778	14.778	
13-Oct-94	8.09	46.562	14.562	
14-Oct-94	8.58	47.444	15.444	650 TU's to Eye
15-Oct-94	8.35	47.03	15.03	
16-Oct-94	7.81	46.058	14.058	
17-Oct-94	8.15	46.67	14.67	
18-Oct-94	7.96	46.328	14.328	
19-Oct-94	8.51	47.318	15.318	
20-Oct-94	8.8	47.84	15.84	
21-Oct-94	9.13	48.434	16.434	
22-Oct-94	8.52	47.336	15.336	
23-Oct-94	8.04	46.472	14.472	
24-Oct-94	7.58	45.644	13.644	
25-Oct-94	8.56	47.408	15.408	
26-Oct-94	9.54	49.172	17.172	
27-Oct-94	9.18	48.524	16.524	
28-Oct-94	8.21	46.778	14.778	
29-Oct-94	7.43	45.374	13.374	
30-Oct-94	7.52	45.536	13.536	
31-Oct-94	8.27	46.886	14.886	
01-Nov-94	8.17	46.706	14.706	
02-Nov-94	7.36	45.248	13.248	——> 919 TU's to 50% hatch
03-Nov-94	6.42	43.556	11.556	
04-Nov-94	6.88	44.384	12.384	956 TU's to hatch
05-Nov-94	6.09	42.962	10.962	
06-Nov-94	7	44.6	12.6	
07-Nov-94	6.51	43.718	11.718	
08-Nov-94	6.62	43.916	11.916	
09-Nov-94	7.26	45.068	13.068	
10-Nov-94	7.47	45.446	13.446	
11-Nov-94	7.59	45.662	13.662	
12-Nov-94	7.01	44.618	12.618	
13-Nov-94	6.47	43.646	11.646	
14-Nov-94	7.32	45.176	13.176	
15-Nov-94	7.67	45.806	13.806	
16-Nov-94	7.16	44.888	12.888	
17-Nov-94	5.96	42.728	10.728	
18-Nov-94	5.11	41.198	9.198	
19-Nov-94	5.97	42.746	10.746	
20-Nov-94	5.69	42.242	10.242	
21-Nov-94	4.7	40.46	8.46	
22-Nov-94	5.14	41.252	9.252	
23-Nov-94	6.12	43.016	11.016	

24-Nov-94	5.84	42.512	10.512	
25-Nov-94	6.59	43.862	11.862	
26-Nov-94	5.64	42.152	10.152	
27-Nov-94	5.88	42.584	10.584	
28-Nov-94	5.63	42.134	10.134	
29-Nov-94	6.6	43.88	11.88	
30-Nov-94	7.66	45.788	13.788	
01-Dec-94	5.91	42.638	10.638	
02-Dec-94	6.56	43.808	11.808	
03-Dec-94	5.79	42.422	10.422	
04-Dec-94	4.56	40.208	8.208	
05-Dec-94	4.78	40.604	8.604	
06-Dec-94	5.48	41.864	9.864	
07-Dec-94	5.24	41.432	9.432	
08-Dec-94	5.47	41.846	9.846	
09-Dec-94	5.76	42.368	10.368	
10-Dec-94	6.05	42.89	10.89	
11-Dec-94	6.17	43.106	11.106	
12-Dec-94	5.82	42.476	10.476	
13-Dec-94	5.39	41.702	9.702	
14-Dec-94	5.72	42.296	10.296	
15-Dec-94	5.87	42.566	10.566	
16-Dec-94	6.06	42.908	10.908	
17-Dec-94	6.97	44.546	12.546	
18-Dec-94	7.42	45.356	13.356	
19-Dec-94	7.59	45.662	13.662	
20-Dec-94	7.63	45.734	13.734	
21-Dec-94	8.97	48.146	16.146	
22-Dec-94	7.41	45.338	13.338	
23-Dec-94	8.92	48.056	16.056	
24-Dec-94	7.39	45.302	13.302	
25-Dec-94	7.42	45.356	13.356	
26-Dec-94	7.67	45.806	13.806	
27-Dec-94	8.12	46.616	14.616	
28-Dec-94	7.49	45.482	13.482	
29-Dec-94	6.65	43.97	11.97	——> **1587 TU's to 50% swim-up**
30-Dec-94	5.97	42.746	10.746	
31-Dec-94	5.6	42.08	10.08	
01-Jan-95	5.31	41.558	9.558	
02-Jan-95	5.18	41.324	9.324	**1639 TU's to Swim-Up**

Daily average stream temperatures (ºC) for the Big Quilcene River (river miles 2.5 and 1.0 (Linger Longer Bridge)) and Penny Creek for the months of September, October, and November, 1992 (Telles 1996).

September, 1992

Daily Average Temperature - Big Quilcene River

1	12.30	11	11.09	22	11.45
2	12.25	12	11.34	23	11.62
3	12.19	13	10.45	24	11.08
4	12.17	14	9.62	25	10.68
5	11.92	15	9.25	26	10.52
6	11.15	16	8.79	27	12.10
7	10.20	17	9.12	28	12.64
8	9.59	18	8.97	29	13.21
9	10.36	19	9.83	30	13.80
10	10.58	21	11.35	AVG>>>>	11.01

Daily Average Temperature - Penny Creek

1	12.86	10	10.95	21	11.48
2	12.90	11	11.23	22	11.54
3	12.93	12	11.66	23	11.62
4	12.89	13	11.18	24	11.35
5	12.65	14	10.20	25	11.02
6	12.11	15	9.92	26	10.87
7	11.35	16	9.29	27	10.28
8	10.78	17	9.36	28	10.02
9	10.83	18	9.56	29	10.45
10	10.95	19	10.17	30	11.12
		20	10.98	AVG>>>>	11.12

Daily Average Temperature - LingerLonger Br.

1	13.41	11	12.04	21	12.45
2	13.50	12	11.17	22	12.34
3	13.03	13	11.05	23	11.93
4	12.53	14	10.47	24	11.74
5	11.64	15	10.24	25	11.50
6	11.17	16	10.50	26	10.99
7	11.50	17	10.44	27	10.97
8	11.72	18	11.43	28	11.46
9	12.26	19	11.82	29	11.93
10	12.38	20	12.34	30	12.26
				AVG>>>>	11.74

October, 1992

Daily Average Temperature - Big Quilcene River

1	13.72	11	12.95	21	11.82
2	13.21	12	12.68	22	12.26
3	13.02	13	12.13	23	11.78
4	13.25	14	12.87	24	12.42
5	13.86	15	12.69	25	11.92
6	14.32	16	12.32	26	11.78
7	14.66	17	11.61	27	11.47
8	13.36	18	11.65	28	11.79
9	13.33	19	11.12	29	12.02
10	13.09	20	11.48	30	12.13
				31	12.35
				AVG>>>>	12.55

Daily Average Temperature - Penny Creek

1	12.10	11	13.26	21	13.87
2	12.00	12	13.82	22	13.35
3	11.44	13	13.75	23	12.41
4	11.83	14	13.42	24	11.95
5	12.12	15	13.50	25	11.78
6	12.18	16	13.24	26	11.85
7	12.15	17	13.16	27	12.48
8	12.18	18	13.15	28	13.26
9	12.81	19	13.25	29	13.44
10	12.96	20	13.55	30	13.16
				AVG>>>>	12.78

31-13/0

Daily Average Temperature-LingerLonger Br.

1	11.94	11	10.08	21	11.66
2	11.44	12	8.80	22	10.27
3	10.36	13	8.14	23	9.76
4	9.88	14	8.33	24	8.93
5	10.02	15	8.74	25	8.62
6	10.36	16	9.70	26	9.02
7	10.24	17	10.43	27	8.76
8	10.22	18	10.94	28	8.78
9	10.27	19	10.90	29	8.20
10	10.39	20	11.26	30	7.56
				AVG>>>>	9.80

November, 1992

Daily Average Temperature - Big Quilcene River

1	11.82	11	6.97	21	4.80
2	6.72	12	6.62	22	3.82
3	7.25	13	6.51	23	3.57
4	7.79	14	7.08	24	5.22
5	7.78	15	7.35	25	6.35
6	8.35	16	7.02	26	5.94
7	7.87	17	6.75	27	5.45
8	6.72	18	5.71	28	5.16
9	5.53	19	6.08	29	4.56
10	6.35	20	6.37	30	3.21
				31	2.46
				AVG>>>>	6.23

Daily Average Temperature - Penny Creek

1	13.00	11	8.40	21	6.33
2	No Data	12	8.15	22	5.34
3	No Data	13	8.02	23	5.12
4	No Data	14	8.54	24	6.43
5	No Data	15	8.89	25	7.95
6	No Data	16	8.52	26	7.62
7	No Data	17	8.28	27	6.91
8	No Data	18	7.15	28	6.76
9	6.89	19	7.51	29	6.36
10	7.74	20	7.53	30	5.22
				31	4.56
				20 day AV	5.72

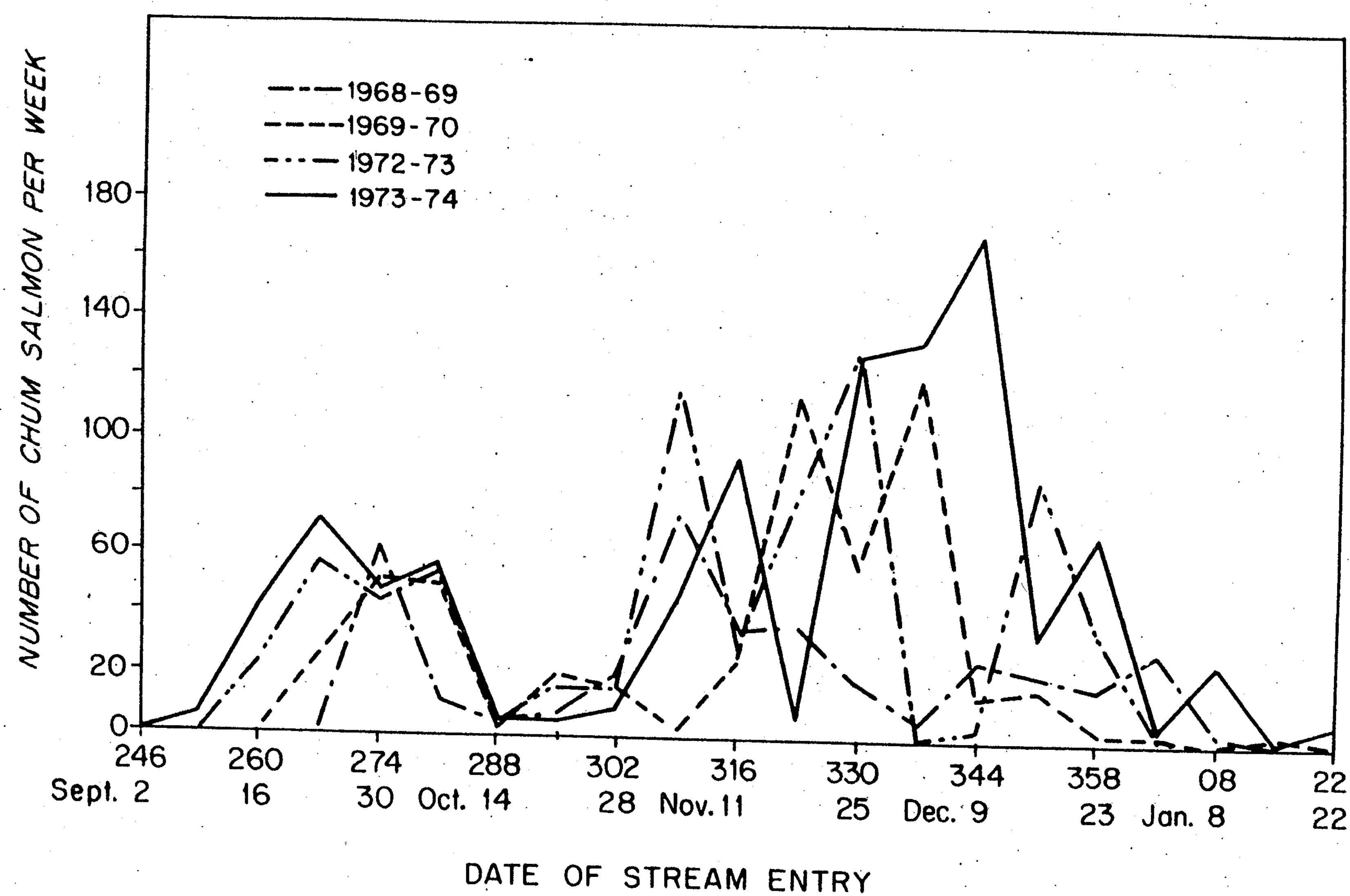
Daily Average Temperature - LingerLonger Br.

1	7.50	11	7.77	21	6.36
2	7.90	12	7.54	22	7.58
3	8.34	13	7.80	23	5.97
4	8.73	14	8.41	24	7.99
5	8.78	15	8.50	25	7.17
6	9.18	16	8.17	26	6.32
7	8.74	17	7.53	27	6.11
8	7.60	18	6.84	28	5.64
9	6.94	19	6.81	29	5.10
10	7.37	20	6.83	30	4.09
				31	4.32
				AVG>>>>	7.22

APPENDIX II

Summary of the average total number of accumulated temperature units (F) from the time of spawning to a given percentage of emergence for the chum salmon fry of the early and late stocks for 1967, 1968, and 1969 [TU in centigrade = (0.556)(F-32)] (excerpted from Koski 1975).

Stock (number sections)	Year	Accumulated temperature units (F) from spawning to given percent emergence							Peak	Number TU 5-95%
		5%	10%	25%	50%	75%	90%	95%		
Late n=11	1967-68 S.D.	1720 92.63	1755 92.64	1811 81.39	1887 85.02	1986 95.64	2110 136.22	2213 177.42	1889 76.48	493
Early n=58	1968-69 S.D.	1652 43.61	1678 32.92	1715 43.29	1764 40.77	1817 39.78	1884 95.54	1951 180.55	1781 48.26	299
Late n=15 (B12 excluded)	1968-69 S.D.	1411 74.64	1458 73.58	1522 70.07	1576 78.09	1673 110.27	1774 152.10	1855 184.34	1548 80.56	444
Early n=8	1969-70 S.D.	1864 85.55	1895 79.06	1953 62.77	2016 64.13	2074 60.47	2151 66.32	2196 87.05	2018 64.44	332
Late n=8	1969-70 S.D.	1540 81.84	1573 65.95	1615 49.73	1671 54.67	1749 60.82	1830 78.19	1890 87.72	1682 92.84	350

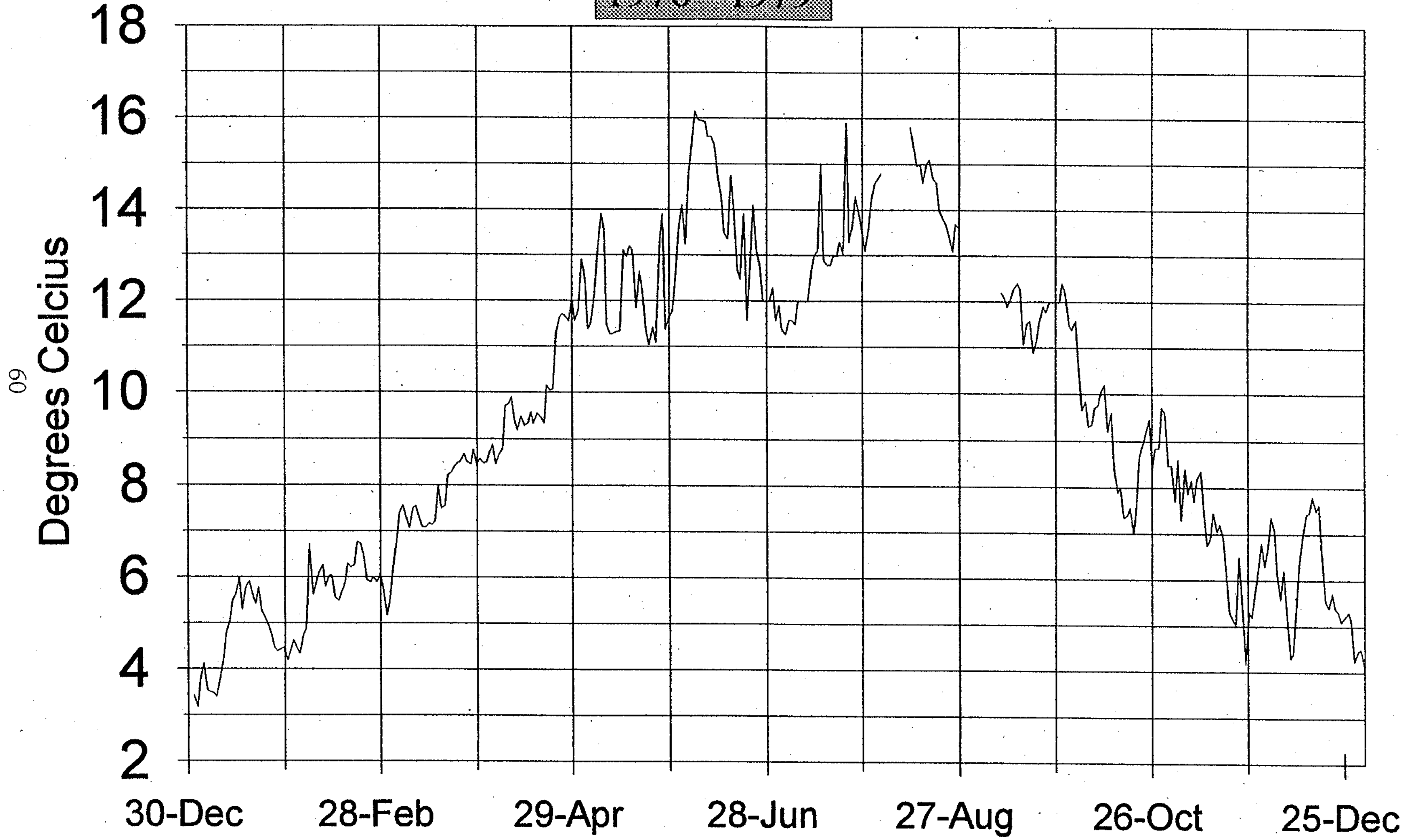


Time and comparative abundance of the chum salmon spawning migration into Big Beef Creek for the years 1968, 1969, 1972, and 1973. The latter 2 years represent the progeny of the first two broods allowed to spawn in the channels.
(excerpted from Koski 1975).

Big Beef Creek, Kitsap County

Average Daily Stream Temperature

1976 - 1979



Recording thermograph data (R.M. 1.0) from USGS, via S. Schroder, WDFW, 7/18/96

STREAM TEMPERATURE TIME SERIES AND CUMM. TEMPERATURE UNIT DATA FOR BIG BEEF CREEK
AMBIENT STREAM TEMPERATURES @ R.M. 1.0 - 1977-78 and the F.R.I. spawning channel at R.M. 0.1 - 1974-78.
DATA FROM UWFRI AND USGS, VIA S. SCHRODER, WDFW, 7/18/96.

Big Beef Creek, Hood Canal, Washington

	YEAR				DAILY	DAILY	Cumm. TUs	MONTHLY
	1976	1977	1978	1979	AVG.	TUs (F)	9/1-5/31	AVG. TUs
DATE								
01-Jan		4.4	2.44		3.42	6.16	1676.44	
02-Jan		4.2	2.2		3.20	5.76	1682.20	
03-Jan		4.3	3.3		3.80	6.84	1689.04	
04-Jan		4.22	4		4.11	7.40	1696.44	
05-Jan		3.06	4		3.53	6.35	1702.79	
06-Jan		3.1	3.9		3.50	6.30	1709.09	
07-Jan		2.97	4		3.49	6.27	1715.36	
08-Jan		2.5	4.3		3.40	6.12	1721.48	
09-Jan		2.5	5		3.75	6.75	1728.23	
10-Jan		2.61	5.8		4.21	7.57	1735.80	
11-Jan		3.42	6.1		4.76	8.57	1744.37	
12-Jan		3.94	6.2		5.07	9.13	1753.50	
13-Jan		4.5	6.5		5.50	9.90	1763.40	
14-Jan		4.86	6.4		5.63	10.13	1773.53	
15-Jan		5.86	6.1		5.98	10.76	1784.30	
16-Jan		6.11	6.4	3.4	5.30	9.55	1793.84	
17-Jan		7.33	6.7	3.3	5.78	10.40	1804.24	
18-Jan		7.72	6.7	3.3	5.91	10.63	1814.87	
19-Jan		6.94	6.7	3.4	5.68	10.22	1825.10	
20-Jan		5.67	7	3.6	5.42	9.76	1834.86	
21-Jan		6.19	7.2	3.9	5.76	10.37	1845.23	
22-Jan		5.2	6.7	3.9	5.27	9.48	1854.71	
23-Jan		5.3	6.1	3.9	5.10	9.18	1863.89	
24-Jan		5	6.1	3.8	4.97	8.94	1872.83	
25-Jan		4.7	5.9	3.6	4.73	8.52	1881.35	
26-Jan		3.9	5.97	3.53	4.47	8.04	1889.39	
27-Jan		3.8	5.94	3.4	4.38	7.88	1897.28	
28-Jan		4.2	5.8	3.3	4.43	7.98	1905.26	
29-Jan		4.5	5.8	3.1	4.47	8.04	1913.30	
30-Jan		4.6	5	3	4.20	7.56	1920.86	
31-Jan		5.2	5.4	2.6	4.40	7.92	1928.78	258.492
01-Feb		5.9	5.6	2.4	4.63	8.34	1937.12	
02-Feb		5.4	5.6	2.3	4.43	7.98	1945.10	
03-Feb		4.9	5.8	2.3	4.33	7.80	1952.90	
04-Feb		5.5	6.1	2.6	4.73	8.52	1961.42	
05-Feb		5.2	6.4	3.1	4.90	8.82	1970.24	
06-Feb		6.2	7.2		6.70	12.06	1982.30	
07-Feb		5.3	7.7	3.9	5.63	10.14	1992.44	
08-Feb		5.9	7.6	4.03	5.84	10.52	2002.95	
09-Feb		6.7	7.33	4.3	6.11	11.00	2013.95	
10-Feb		7.6	7.06	4.1	6.25	11.26	2025.21	
11-Feb		7.1	6.5	3.8	5.80	10.44	2035.65	
12-Feb		8.4	5.8	3.9	6.03	10.86	2046.51	
13-Feb		7.3	6.1	4.7	6.03	10.86	2057.37	
14-Feb		6.2	6.2	4.3	5.57	10.02	2067.39	
15-Feb		6.4	6.1	3.97	5.49	9.88	2077.27	
16-Feb		7.3	5.8	3.9	5.67	10.20	2087.47	
17-Feb		7.6	6.4	3.6	5.87	10.56	2098.03	
18-Feb		8.4	6.9	3.56	6.29	11.32	2109.35	
19-Feb		7.1	7.4	4.1	6.20	11.16	2120.51	
20-Feb		7.3	7.4	4.1	6.27	11.28	2131.79	

21-Feb	7.4	8.6	4.3	6.77	12.18	2143.97	
22-Feb	7.7	8.5	3.97	6.72	12.10	2156.07	
23-Feb	6.5	8.6	4.3	6.47	11.64	2167.71	
24-Feb	5.8	7.9	4.1	5.93	10.68	2178.39	
25-Feb		7.9	3.9	5.90	10.62	2189.01	
26-Feb		7.8	4.2	6.00	10.80	2199.81	
27-Feb		7.2	4.6	5.90	10.62	2210.43	
28-Feb		7.6	4.5	6.05	10.89	2221.32	292.542
01-Mar		6.9	4.5	5.70	10.26	2231.58	
02-Mar		5.8	4.6	5.20	9.36	2240.94	
03-Mar	6.5	5.5	4.5	5.50	9.90	2250.84	
04-Mar	6.4	6.78	5.3	6.16	11.09	2261.93	
05-Mar	6.4	7.4	6.7	6.83	12.30	2274.23	
06-Mar	6.81	7.6	7.8	7.40	13.33	2287.55	
07-Mar	6.6	8.5	7.6	7.57	13.62	2301.17	
08-Mar	6.5	8.2	7.2	7.30	13.14	2314.31	
09-Mar	5.97	8.2	7.1	7.09	12.76	2327.07	
10-Mar		8.1	6.9	7.50	13.50	2340.57	
11-Mar		8.2	6.9	7.55	13.59	2354.16	
12-Mar	6.2	8.06	7.7	7.32	13.18	2367.34	
13-Mar	5.9	8.44	6.97	7.10	12.79	2380.13	
14-Mar	5.86	8.3	7.1	7.09	12.76	2392.88	
15-Mar	6.1	8.3	7.1	7.17	12.90	2405.78	
16-Mar	5.7	8.4	7.3	7.13	12.84	2418.62	
17-Mar	5.6	8.9	7.1	7.20	12.96	2431.58	
18-Mar		9.06	6.9	7.98	14.36	2445.95	
19-Mar	6.3	9.2	7	7.50	13.50	2459.45	
20-Mar	6.6	9.3	6.8	7.57	13.62	2473.07	
21-Mar	8.1	9.8	6.75	8.22	14.79	2487.86	
22-Mar	8.3	9.9	6.6	8.27	14.88	2502.74	
23-Mar	7.9	10.5	6.8	8.40	15.12	2517.86	
24-Mar	7.86	10.7	6.9	8.49	15.28	2533.13	
25-Mar	8	10.6	6.9	8.50	15.30	2548.43	
26-Mar	8.2	10.6	7.2	8.67	15.60	2564.03	
27-Mar	7.3	10.8	7.4	8.50	15.30	2579.33	
28-Mar	6.9	11.2	7.3	8.47	15.24	2594.57	
29-Mar	7.8	11.3	7.2	8.77	15.78	2610.35	
30-Mar	7.1	11.06	7.2	8.45	15.22	2625.57	
31-Mar	8	10.83	6.9	8.58	15.44	2641.01	419.688
01-Apr	8.3	10.6	6.58	8.49	15.29	2656.29	
02-Apr	8.3	10.7	6.5	8.50	15.30	2671.59	
03-Apr	8.4	11.1	6.67	8.72	15.70	2687.30	
04-Apr	8.86	11.08	6.67	8.87	15.97	2703.26	
05-Apr	8.33	10.14	6.94	8.47	15.25	2718.51	
06-Apr		9.8	7.5	8.65	15.57	2734.08	
07-Apr	8.8	10.1	7.47	8.79	15.82	2749.90	
08-Apr	11.1	10.56	7.5	9.72	17.50	2767.40	
09-Apr	10.6	10.6	8	9.73	17.52	2784.92	
10-Apr	10.3	11.2	8.2	9.90	17.82	2802.74	
11-Apr	9.44	10.8	7.9	9.38	16.88	2819.62	
12-Apr	9.44	10.3	7.8	9.18	16.52	2836.14	
13-Apr	9.58	11.1	7.8	9.49	17.09	2853.23	
14-Apr	9.5	10.3	8.06	9.29	16.72	2869.95	
15-Apr	8.9	11.3	7.8	9.33	16.80	2886.75	
16-Apr	10.3	10.2	8.2	9.57	17.22	2903.97	
17-Apr	9.6	10.2	8.2	9.33	16.80	2920.77	
18-Apr		10.9	8.2	9.55	17.19	2937.96	
19-Apr		10.97	8	9.49	17.07	2955.03	
20-Apr		10.8	7.9	9.35	16.83	2971.86	
21-Apr		10.4	9.9	10.15	18.27	2990.13	
22-Apr		10.2	9.9	10.05	18.09	3008.22	

23-Apr	9.8	10.1	10.3	10.07	18.12	3026.34	
24-Apr	12	11.1	10.8	11.30	20.34	3046.68	
25-Apr	12.1	11.8	11.1	11.67	21.00	3067.68	
26-Apr	12.06	11.9	11.2	11.72	21.10	3088.78	
27-Apr	11.8	11.8	11.4	11.67	21.00	3109.78	
28-Apr	11.5	11.5	11.7	11.57	20.82	3130.60	
29-Apr	12.7	11.4		12.05	21.69	3152.29	
30-Apr	11.97	11.2		11.59	20.85	3173.14	532.134
01-May	11.14	12.5		11.82	21.28	3194.42	
02-May		12.9		12.90	23.22	3217.64	
03-May		12.5		12.50	22.50	3240.14	
04-May		11.4		11.40	20.52	3260.66	
05-May		11.5		11.50	20.70	3281.36	
06-May		12.1		12.10	21.78	3303.14	
07-May		13.1		13.10	23.58	3326.72	
08-May		13.9		13.90	25.02	3351.74	
09-May		13.6		13.60	24.48	3376.22	
10-May	10	12.97		11.49	20.67	3396.89	
11-May	9.17	13.4		11.29	20.31	3417.20	
12-May	9.42	13.2		11.31	20.36	3437.56	
13-May	10	12.7		11.35	20.43	3457.99	
14-May	9.81	12.9		11.36	20.44	3478.43	
15-May		13.1		13.10	23.58	3502.01	
16-May		12.97		12.97	23.35	3525.35	
17-May		13.2		13.20	23.76	3549.11	
18-May		13.1		13.10	23.58	3572.69	
19-May	9.94	13.8		11.87	21.37	3594.06	
20-May	10.67	14.6		12.64	22.74	3616.80	
21-May	10.75	13.6		12.18	21.92	3638.72	
22-May	10.58	12.1		11.34	20.41	3659.13	
23-May	9.69	12.4		11.05	19.88	3679.01	
24-May	9.86	13		11.43	20.57	3699.59	
25-May	9.2	13.03		11.12	20.01	3719.59	
26-May		13.3		13.30	23.94	3743.53	
27-May		13.9		13.90	25.02	3768.55	
28-May	9.5	13.3		11.40	20.52	3789.07	
29-May	10.5	12.8		11.65	20.97	3810.04	
30-May	10.5	13.1		11.80	21.24	3831.28	
31-May	11.3	13.6		12.45	22.41	3853.69	680.553
01-Jun	12.5	14.8		13.65	24.57	3878.26	
02-Jun	11.4	16.8		14.10	25.38	3903.64	
03-Jun	11.4	15.1		13.25	23.85	3927.49	
04-Jun	12.6	16.97		14.79	26.61	3954.11	
05-Jun	13.2	17.4		15.30	27.54	3981.65	
06-Jun	14	18.3		16.15	29.07	4010.72	
07-Jun		15.97		15.97	28.75	4039.46	
08-Jun		15.94		15.94	28.69	4068.15	
09-Jun		15.92		15.92	28.66	4096.81	
10-Jun		15.6		15.60	28.08	4124.89	
11-Jun		15.6		15.60	28.08	4152.97	
12-Jun		15.4		15.40	27.72	4180.69	
13-Jun		14.7		14.70	26.46	4207.15	
14-Jun		14.3		14.30	25.74	4232.89	
15-Jun		13.5		13.50	24.30	4257.19	
16-Jun	12.8	13.9		13.35	24.03	4281.22	
17-Jun	14.1	15.4		14.75	26.55	4307.77	
18-Jun	13.6	14.6		14.10	25.38	4333.15	
19-Jun	12.7			12.70	22.86	4356.01	
20-Jun	12.5			12.50	22.50	4378.51	
21-Jun	13.9			13.90	25.02	4403.53	
22-Jun	11.6			11.60	20.88	4424.41	

23-Jun	12.6	12.60	22.68	4447.09	
24-Jun	14.1	14.10	25.38	4472.47	
25-Jun	13.1	13.10	23.58	4496.05	
26-Jun	12.8	12.80	23.04	4519.09	
27-Jun		12.00	21.60		
28-Jun		12.00	21.60		
29-Jun		12.00	21.60		
30-Jun	12.3	12.30	22.14		752.337
01-Jul	11.6	11.60	20.88		
02-Jul	11.9	11.90	21.42		
03-Jul	11.4	11.40	20.52		
04-Jul	11.3	11.30	20.34		
05-Jul	11.6	11.60	20.88		
06-Jul	11.6	11.60	20.88		
07-Jul	11.5	11.50	20.70		
08-Jul		12.00	21.60		
09-Jul		12.00	21.60		
10-Jul		12.00	21.60		
11-Jul		12.00	21.60		
12-Jul	12.7	12.70	22.86		
13-Jul	13	13.00	23.40		
14-Jul	13.1	13.10	23.58		
15-Jul	15	15.00	27.00		
16-Jul	12.9	12.90	23.22		
17-Jul	12.8	12.80	23.04		
18-Jul	12.8	12.80	23.04		
19-Jul		13.00	23.40		
20-Jul		13.00	23.40		
21-Jul	13.3	13.30	23.94		
22-Jul	13.03	13.03	23.45		
23-Jul	15.9	15.90	28.62		
24-Jul	13.3	13.30	23.94		
25-Jul	13.7	13.70	24.66		
26-Jul	14.3	14.30	25.74		
27-Jul	13.9	13.90	25.02		
28-Jul	13.5	13.50	24.30		
29-Jul	13.1	13.10	23.58		
30-Jul	13.6	13.60	24.48		
31-Jul	14.2	14.20	25.56		718.254
01-Aug	14.6	14.60	26.28		
02-Aug	14.7	14.70	26.46		
03-Aug	14.8	14.80	26.64		
04-Aug					
05-Aug					
06-Aug					
07-Aug					
08-Aug					
09-Aug					
10-Aug					
11-Aug					
12-Aug	15.8	15.80	28.44		
13-Aug	15.5	15.50	27.90		
14-Aug	14.97	14.97	26.95		
15-Aug	15	15.00	27.00		
16-Aug	14.6	14.60	26.28		
17-Aug	15.03	15.03	27.05		
18-Aug	15.1	15.10	27.18		
19-Aug	14.7	14.70	26.46		
20-Aug	14.6	14.60	26.28		
21-Aug	14	14.00	25.20		
22-Aug	13.8	13.80	24.84		

23-Aug		13.7	13.70	24.66		
24-Aug		13.4	13.40	24.12		
25-Aug		13.1	13.10	23.58		
26-Aug		13.7	13.70	24.66		
27-Aug		13.6	13.60	24.48		
28-Aug				24.00		
29-Aug				24.00		
30-Aug				24.00		
31-Aug				24.00		
01-Sep				24.00		
02-Sep	extrapolated			23.00		
03-Sep				23.00		
04-Sep				23.00		
05-Sep				22.00		
06-Sep				22.00		
07-Sep				22.00		
08-Sep				22.00		
09-Sep		12.2	12.20	21.96	21.96	
10-Sep		12.1	12.10	21.78	43.74	
11-Sep		11.9	11.90	21.42	65.16	
12-Sep		12.1	12.10	21.78	86.94	
13-Sep		12.3	12.30	22.14	109.08	
14-Sep		12.4	12.40	22.32	131.4	
15-Sep		12.3	12.30	22.14	153.54	
16-Sep	10.1	12.1	11.10	19.98	173.52	
17-Sep	11.4	11.7	11.55	20.79	194.31	
18-Sep	11.6		11.60	20.88	215.19	
19-Sep	10.9		10.90	19.62	234.81	
20-Sep	11.2		11.20	20.16	254.97	
21-Sep	11.6		11.60	20.88	275.85	
22-Sep	11.9		11.90	21.42	297.27	
23-Sep	11.8		11.80	21.24	318.51	
24-Sep			12.00	21.60	340.11	
25-Sep	extrapolated		12.00	21.60	361.71	
26-Sep			12.00	21.60	383.31	
27-Sep			12.00	21.60	404.91	
28-Sep	12.4		12.40	22.32	427.23	
29-Sep	12.2		12.20	21.96	449.19	
30-Sep	11.5		11.50	20.70	469.89	650.89
01-Oct	11.4		11.40	20.52	490.41	
02-Oct	11.6		11.60	20.88	511.29	
03-Oct	10.7		10.70	19.26	530.55	
04-Oct	10.3	9	9.65	17.37	547.92	
05-Oct	10.6	9.1	9.85	17.73	565.65	
06-Oct		9.3	9.30	16.74	582.39	
07-Oct	8.8	9.9	9.35	16.83	599.22	
08-Oct	9.8	9.6	9.70	17.46	616.68	
09-Oct	10	9.5	9.75	17.55	634.23	
10-Oct	10.6	9.6	10.10	18.18	652.41	
11-Oct	11.2	9.2	10.20	18.36	670.77	
12-Oct	9.3	9.1	9.20	16.56	687.33	
13-Oct		9.6	9.60	17.28	704.61	
14-Oct	7.8	9.03	8.42	15.15	719.757	
15-Oct	6.4	9.4	7.90	14.22	733.977	
16-Oct	6.97	9.03	8.00	14.40	748.377	
17-Oct	5.97	8.7	7.33	13.20	761.58	
18-Oct	5.6	9.2	7.40	13.32	774.9	
19-Oct	5.4	9.7	7.55	13.59	788.49	
20-Oct	5.6	8.4	7.00	12.60	801.09	
21-Oct	5.8	9.3	7.55	13.59	814.68	
22-Oct	7.3	10	8.65	15.57	830.25	

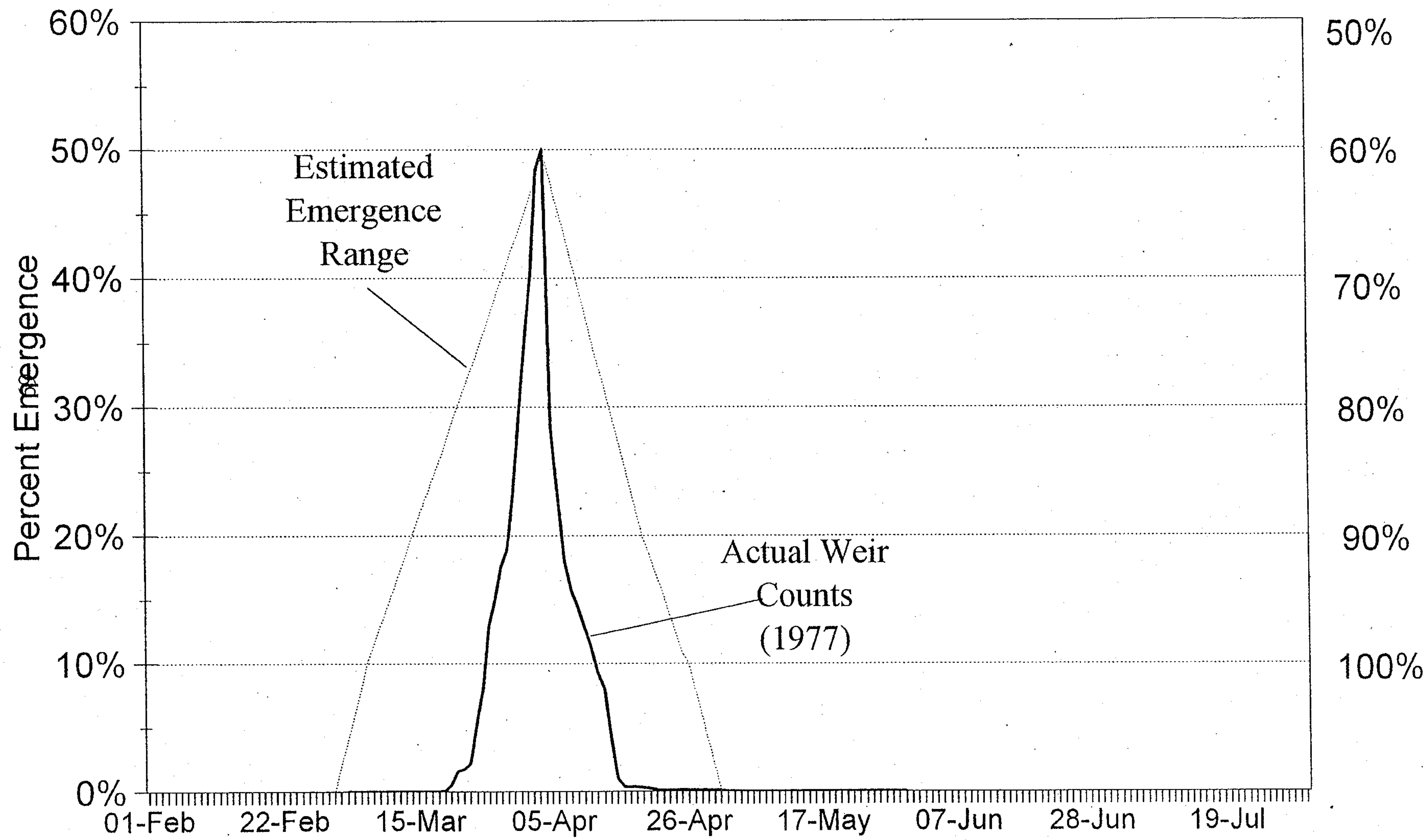
23-Oct	7.5	10.4	8.95	16.11	846.36	
24-Oct	8.3	10	9.15	16.47	862.83	
25-Oct	8.9	10.03	9.47	17.04	879.867	
26-Oct	7.3	9.4	8.35	15.03	894.897	
27-Oct	8.9	8.8	8.85	15.93	910.827	
28-Oct	8.3	9.4	8.85	15.93	926.757	
29-Oct		9.7	9.70	17.46	944.217	
30-Oct		9.6	9.60	17.28	961.497	
31-Oct	7.92	9	8.46	15.23	976.725	506.835
01-Nov	6.9	10.06	8.48	15.26	991.989	
02-Nov	6.3	9.1	7.70	13.86	1005.849	
03-Nov		8.6	8.60	15.48	1021.329	
04-Nov	6.4	8.2	7.30	13.14	1034.469	
05-Nov	8.3	8.5	8.40	15.12	1049.589	
06-Nov	7.44	8.3	7.87	14.17	1063.755	
07-Nov	8.6	7.7	8.15	14.67	1078.425	
08-Nov	8.7	6.7	7.70	13.86	1092.285	
09-Nov	8.8	7.6	8.20	14.76	1107.045	
10-Nov	8.5	8.2	8.35	15.03	1122.075	
11-Nov	6.9	8.1	7.50	13.50	1135.575	
12-Nov	5.4	8.1	6.75	12.15	1147.725	
13-Nov	5.9	7.9	6.90	12.42	1160.145	
14-Nov	6.7	8.2	7.45	13.41	1173.555	
15-Nov	5.8	8.3	7.05	12.69	1186.245	
16-Nov	6.9	7.5	7.20	12.96	1199.205	
17-Nov	7.22	6.7	6.96	12.53	1211.733	
18-Nov	6.6	5.8	6.20	11.16	1222.893	
19-Nov	5.8	4.8	5.30	9.54	1232.433	
20-Nov	6.7	3.6	5.15	9.27	1241.703	
21-Nov	7.22	2.8	5.01	9.02	1250.721	
22-Nov	9.6	3.4	6.50	11.70	1262.421	
23-Nov	6.6	3.9	5.25	9.45	1271.871	
24-Nov		4.2	4.20	7.56	1279.431	
25-Nov		5.3	5.30	9.54	1288.971	
26-Nov		5.2	5.20	9.36	1298.331	
27-Nov		5.7	5.70	10.26	1308.591	
28-Nov		6.3	6.30	11.34	1319.931	
29-Nov		6.8	6.80	12.24	1332.171	
30-Nov		6.3	6.30	11.34	1343.511	366.786
01-Dec		6.67	6.67	12.01	1355.517	
02-Dec		7.36	7.36	13.25	1368.765	
03-Dec		7.08	7.08	12.74	1381.509	
04-Dec		6.1	6.10	10.98	1392.489	
05-Dec		5.6	5.60	10.08	1402.569	
06-Dec		6.2	6.20	11.16	1413.729	
07-Dec		5.3	5.30	9.54	1423.269	
08-Dec		4.3	4.30	7.74	1431.009	
09-Dec		4.4	4.40	7.92	1438.929	
10-Dec		5.4	5.40	9.72	1448.649	
11-Dec		6.4	6.40	11.52	1460.169	
12-Dec		6.94	6.94	12.49	1472.661	
13-Dec		7.44	7.44	13.39	1486.053	
14-Dec	7.22	7.7	7.46	13.43	1499.481	
15-Dec	7.8	7.8	7.80	14.04	1513.521	
16-Dec	7.5	7.5	7.50	13.50	1527.021	
17-Dec	8.3	6.94	7.62	13.72	1540.737	
18-Dec	6.8	6.4	6.60	11.88	1552.617	
19-Dec	5.1	6	5.55	9.99	1562.607	
20-Dec	5.22	5.6	5.41	9.74	1572.345	
21-Dec	6.4	5	5.70	10.26	1582.605	
22-Dec	6	4.8	5.40	9.72	1592.325	

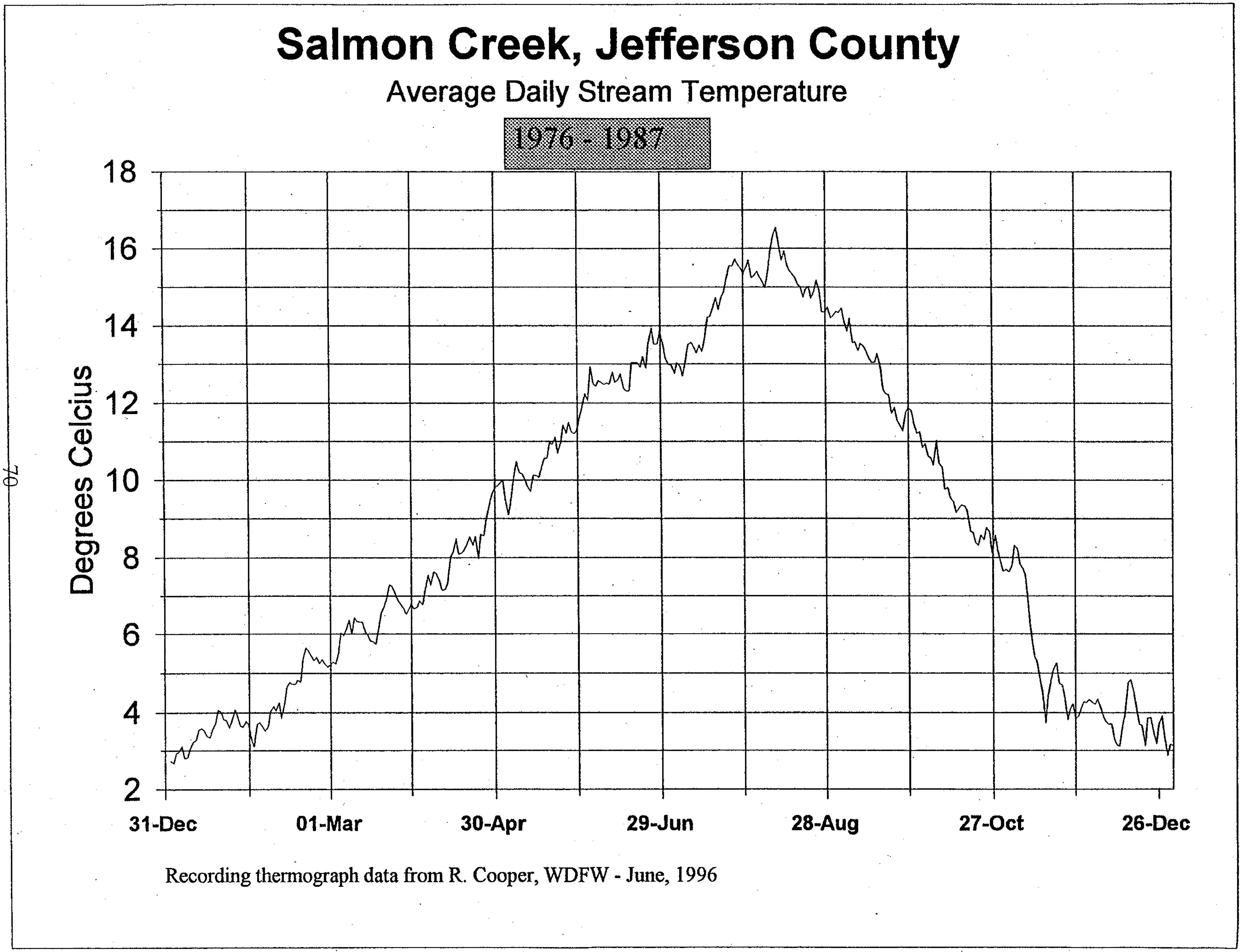
23-Dec	6.1	4.5	5.30	9.54	1601.865	
24-Dec	5.8	4.4	5.10	9.18	1611.045	
25-Dec	6.2	4.2	5.20	9.36	1620.405	
26-Dec	6.9	3.7	5.30	9.54	1629.945	
27-Dec	6.6	3.6	5.10	9.18	1639.125	
28-Dec	5.2	3.3	4.25	7.65	1646.775	
29-Dec	5.1	3.8	4.45	8.01	1654.785	
30-Dec	4.72	4.3	4.51	8.12	1662.903	
31-Dec	4.6	3.6	4.10	7.38	1670.283	326.772

APPENDIX III

`77 Salmon Ck. Summer Chum Fry Counts

and Estimated Avg SJF Emergence Timing




Salmon Creek, Jefferson County
Average Daily Stream Temperature
1976 - 1987
Degrees Celcius
18
16
14
12
10
8
6
4
2
31-Dec
01-Mar
30-Apr
29-Jun
28-Aug
27-Oct
26-Dec
Recording thermograph data from R. Cooper, WDFW - June, 1996

Average daily stream temperatures for Salmon Creek, Jefferson County, Washington, with average, minimum and maximum cumulative daily temperature units in degrees Farenheit - 1976-1987

Data from R. Cooper, Fish Management Division , Washington Department of Fish and Wildlife, June, 1996.

		Year															Daily TUs	Avg. Cumm. TUs	
Month/day		1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1976-87 Average	Min BY (1980)	Max BY (1979)	(F) 1976-87 avg	9/1-12/31	1/1-5/1
January	01-Jan		1.1	-0.3	-0.3	6.6	4.1		2.6	2.5		3.9	4.4	2.73	4.05	6.6	4.91		1708.55
	02-Jan		1.6	-0.8	-0.1	6.6	3.2		3.3	3.3		2.9	4.1	2.68	3.24	6.6	4.82		1713.37
	03-Jan		2.9	0.0	-0.1	4.7	3.3		3.8	4.6	2.0	3.4	4.6	2.93	3.32	4.7	5.27		1718.64
	04-Jan		2.6	2.0	-0.2	4.0	2.8		4.2	5.1	1.9	3.1	4.2	2.98	2.82	4	5.36		1723.99
	05-Jan		0.6	3.5	-0.3	4.0	2.6		4.5	5.0	2.6	4.8	3.8	3.11	2.6	3.96	5.59		1729.58
	06-Jan		0.1	3.1	-0.2	2.5	2.9		4.8	5.5	2.3	4.3	2.7	2.80	2.9	2.5	5.04		1734.62
	07-Jan		0.4	3.4	-0.2	1.8	2.6		5.2	5.9	3.2	4.3	1.5	2.81	2.6	1.84	5.06		1739.68
	08-Jan		0.1	5.2	-0.1	1.3	3.0		5.6	5.8	2.8	5.8	1.0	3.05	3	1.25	5.49		1745.17
	09-Jan		1.2	5.1	0.0	1.2	3.1		5.4	5.8	3.1	6.3	1.0	3.23	3.1	1.23	5.81		1750.99
	10-Jan		0.4	6.0	0.0	1.0	2.2	2.4	6.0	5.8	3.4	6.3	2.6	3.28	2.2	0.97	5.90		1756.89
	11-Jan		0.8	6.1	0.2	1.3	1.7	2.7	6.1	5.7	3.0	6.3	5.0	3.53	1.7	1.33	6.36		1763.25
	12-Jan		1.7	5.7	1.0	2.4	1.6	2.9	5.2	4.9	3.1	6.2	4.7	3.58	1.55	2.43	6.45		1769.70
	13-Jan		2.3	6.0	1.3	3.7	0.7	3.3	5.6	3.7	2.4	6.3	3.6	3.53	0.66	3.68	6.35		1776.05
	14-Jan		3.0	6.4	1.4	3.7	0.3	3.6	4.6	2.2	3.9	5.7	2.4	3.38	0.31	3.7	6.09		1782.14
	15-Jan		3.5	6.6	1.6	4.0	-0.0	3.7	4.0	1.1	4.5	6.6	1.3	3.36	0	4.01	6.04		1788.18
	16-Jan		3.8	5.8	1.8	4.4	0.4	4.0	4.7	1.9	4.3	6.2	2.0	3.57	0.44	4.39	6.43		1794.61
	17-Jan		4.2	5.6	1.9	3.8	2.0	3.7	5.6	1.4	4.3	5.9	2.4	3.71	2.02	3.83	6.68		1801.29
	18-Jan		5.0	5.5	1.4	3.0	3.9	4.1	6.5	0.5	5.3	6.6	2.8	4.06	3.92	3	7.30		1808.59
	19-Jan		4.8	5.4	1.8	2.0	4.4	3.4	6.4	0.9	5.3	6.8	2.9	4.01	4.39	2	7.21		1815.81
	20-Jan		3.9	5.3	2.7	2.4	4.5	3.9	5.9	0.7	5.1	5.1	2.5	3.82	4.52	2.43	6.88		1822.69
	21-Jan		4.0	4.8	2.5	3.1	6.3	2.6	4.5	2.4	4.8	4.8	2.0	3.80	6.34	3.08	6.84		1829.53
	22-Jan		2.9	4.6	1.7	3.0	5.9	2.0	4.1	3.1	4.9	4.9	2.4	3.60	5.94	3.03	6.48		1836.01
	23-Jan		2.2	4.3	2.2	3.1	5.1	2.9	4.5	3.7	4.3	5.9	3.4	3.78	5.07	3.07	6.80		1842.81
	24-Jan		1.9	4.7	1.9	3.6	4.1	3.6	6.7	4.6	3.9	5.9	3.8	4.06	4.06	3.58	7.32		1850.12
	25-Jan		1.8	4.8	2.0	3.6	3.0	4.1	6.5	4.9	4.2	4.8	3.5	3.93	2.97	3.64	7.08		1857.20
	26-Jan		1.4	5.4	1.5	2.1	2.8	4.3	6.8	4.4	3.2	4.7	3.5	3.64	2.8	2.06	6.55		1863.75
	27-Jan			5.6	1.2	0.8	2.2	3.8	7.0	5.0	3.2		3.8	3.62	2.2	0.83	6.52		1870.28
	28-Jan		2.1	5.6	1.6	0.4	2.6	4.5	6.4	5.7	4.1		4.7	3.76	2.6	0.37	6.77		1877.05
	29-Jan		2.3	5.8	0.6	0.2	2.7	4.8	6.5	5.7	3.7		4.6	3.69	2.7	0.18	6.63		1883.68
	30-Jan		2.4	4.5	-0.0	0.2	1.8	5.4	7.0	4.3	2.7		4.5	3.27	1.8	0.22	5.89		1889.58
	31-Jan		3.0	4.5	-0.2	0.4	1.9	4.6	5.7	3.5	3.5		4.2	3.11	1.9	0.41	5.60		1895.18
February	01-Feb		4.0	5.1	-0.2	1.5	2.2	4.8	5.0	4.0	2.3	7.7	4.3	3.70	2.2	1.51	6.66		1901.83
	02-Feb		4.2	5.5	-0.2	2.9	2.0	5.3	4.7	4.1	2.4	6.4	4.0	3.75	1.96	2.9	6.75		1908.58
	03-Feb		4.2	5.9	0.1	3.2	0.6	4.5	4.2	4.0	1.9	7.1	4.1	3.62	0.63	3.2	6.52		1915.10
	04-Feb		4.6	6.7	1.3	3.0	0.3	2.8	4.1	3.6	0.8	6.8	4.8	3.53	0.29	3	6.35		1921.44
	05-Feb		4.1	7.9	2.1	3.1	-0.1	2.5	3.7	3.7	1.6	5.8	5.5	3.63	0	3.13	6.53		1927.98
	06-Feb		4.4	8.4	1.9	4.6	-0.6	2.5	3.9	5.4	3.1	5.5	5.2	4.02	0	4.56	7.24		1935.21
	07-Feb		4.7	8.0	2.0	4.6	0.2	2.6	5.2	5.5	2.8	5.6	4.5	4.15	0.22	4.6	7.47		1942.69
	08-Feb		5.2	7.3	3.0	4.7	0.2	2.2	4.2	7.2	1.9	4.1	4.5	4.04	0.18	4.7	7.27		1949.96
	09-Feb		6.0	7.0	3.6	4.5	-0.3	1.6	5.4	6.5	2.9	4.1	5.4	4.25	0	4.5	7.65		1957.61
	10-Feb		7.0	5.5	3.4	3.8	-3.2	1.3	5.3	5.2	3.1	4.8	6.2	3.85	0	3.8	6.93		1964.54
	11-Feb		7.1	4.7	3.0	3.9	-2.6	2.9	6.9	5.8	3.9	4.6	6.4	4.23	0	3.9	7.62		1972.16
	12-Feb		7.7	4.2	3.9	3.6	-0.0	4.2	7.9	6.3	3.6	4.1	5.7	4.65	0	3.6	8.37		1980.54
	13-Feb		6.5	5.5	4.6	3.4	2.0	5.2	6.8	5.7	3.1	3.3	6.3	4.77	2.03	3.4	8.59		1989.12

	14-Feb	5.4	5.5	2.5	3.1	3.8	5.6	6.9	5.2	3.8	4.0	6.2	4.73	3.8	3.13	8.51	1997.63
	15-Feb	5.5	5.3	2.4	2.2	3.8	6.9	6.2	4.8	4.8	4.2	5.8	4.72	3.84	2.2	8.50	2006.13
	16-Feb	5.8	4.9	3.1	2.5	4.3	6.5	6.7	5.2	3.9	4.2	5.9	4.82	4.3	2.5	8.67	2014.80
	17-Feb	6.9	5.2	3.2	3.5	3.4	5.9	7.2	4.1	3.4	4.2	5.6	4.78	3.4	3.5	8.61	2023.41
	18-Feb	7.4	6.5	4.3	5.3	3.5	5.4	7.0	5.2	4.5		4.7	5.38	3.5	5.3	9.68	2033.09
	19-Feb	6.7	7.4	4.3	5.8	3.9	6.2	6.9	5.9	4.4		5.0	5.65	3.9	5.8	10.17	2043.26
	20-Feb	6.9	7.1	3.4	5.5	2.7	6.1	7.4	6.7	4.4		5.5	5.57	2.7	5.5	10.03	2053.29
	21-Feb	7.1	7.9	3.8	5.0	3.1	4.9	6.4	5.7	4.9		5.7	5.45	3.1	5	9.81	2063.10
	22-Feb	6.7	8.1	3.0	4.4	3.1	4.5	8.2	4.9	5.4		5.1	5.34	3.1	4.4	9.62	2072.71
	23-Feb	6.2	8.2	3.6	4.2	3.3	3.9	9.2	4.7	5.8		5.1	5.42	3.33	4.2	9.76	2082.47
	24-Feb	5.2	6.9	4.4	5.3	3.4	3.6	8.1	5.4	5.9		4.4	5.26	3.4	5.25	9.46	2091.93
	25-Feb	5.4	7.1	6.1	6.1	3.4	4.8	7.6	5.1	4.7		3.3	5.36	3.4	6.14	9.66	2101.59
	26-Feb	4.8	6.7	5.9	7.3	2.8	4.6	7.9	4.3	4.9		3.2	5.24	2.8	7.3	9.43	2111.02
	27-Feb	5.4	5.1	5.1	7.8	2.4	3.6	7.2	6.8	4.7		3.6	5.17	2.4	7.8	9.31	2120.32
	28-Feb	6.5	5.0	4.0	7.9	2.7	4.5	6.6	6.7	5.3		2.8	5.20	2.7	7.9	9.35	2129.68
March	01-Mar	6.1	4.3	4.2	6.9	2.1	5.9	7.1	6.4	5.5	6.6	3.1	5.30	2.14	6.9	9.54	2139.21
	02-Mar	5.0	3.9	3.8	7.2	2.3	5.1	7.0	6.4	4.6	6.0	6.5	5.26	2.3	7.2	9.46	2148.67
	03-Mar	5.2	3.8	4.8	7.1	3.3	5.3	7.7	5.0	4.1	6.6	7.6	5.50	3.25	7.1	9.90	2158.57
	04-Mar	5.4	5.3	7.1	6.8	2.4	5.6	7.6	5.3	5.4	7.4	8.1	6.04	2.4	6.8	10.87	2169.44
	05-Mar	6.1	6.3	7.6	6.2	1.1	5.0	7.1	5.4	5.3	6.7	8.9	5.97	1.07	6.2	10.74	2180.18
	06-Mar	6.3	6.9	8.6	5.0	1.0	4.6	7.6	6.5	5.2	8.0	7.8	6.14	1	5	11.05	2191.22
	07-Mar	6.2	8.3	8.0	5.3	2.2	4.5	8.3	6.2	4.2	9.0	7.8	6.36	2.23	5.3	11.45	2202.68
	08-Mar	6.1	7.6	5.8	5.4	1.7	4.6	8.5	7.0	4.1	8.3	7.0	6.01	1.7	5.4	10.82	2213.49
	09-Mar	5.8	7.6	5.2	6.0	1.9	6.5	9.5	7.6	4.7	8.7	7.3	6.44	1.9	6	11.59	2225.08
	10-Mar	5.3	6.7	5.4	6.3	2.6	6.3	9.1	8.0	4.8	8.7	6.6	6.35	2.6	6.3	11.42	2236.50
	11-Mar	5.9	7.1	5.9	6.1	3.7	5.2	8.5	7.6	4.2	8.5	6.9	6.33	3.69	6.1	11.39	2247.89
	12-Mar	6.2	6.3	6.4	5.3	3.0	5.2	8.6	7.5	5.1	8.6	7.4	6.33	3.03	5.3	11.39	2259.28
	13-Mar	5.4	7.0	5.6	4.8	3.7	4.9	7.9	7.8	4.9	7.7	7.0	6.06	3.69	4.8	10.91	2270.19
	14-Mar	4.9	6.1	6.4	4.9	3.7	4.8	6.8	7.6	5.3	7.9	7.4	5.98	3.73	4.85	10.76	2280.95
	15-Mar	5.2	6.9	7.3	4.7	4.0	4.0	6.4	7.7	5.4	6.3	6.3	5.83	4.03	4.65	10.50	2291.45
	16-Mar	5.0	7.5	7.0	4.7	3.1	3.8	6.4	7.4	5.6	7.3	6.3	5.82	3.11	4.66	10.48	2301.94
	17-Mar	5.0	7.7	6.4	5.4	1.8	3.7	6.7	7.3	5.8	7.2	6.3	5.76	1.82	5.4	10.36	2312.30
	18-Mar	5.7	8.2	6.8	5.1	1.9	4.7	6.9	8.0	6.1	7.9	6.4	6.15	1.94	5.1	11.08	2323.38
	19-Mar	6.1	8.7	7.1	5.8	2.8	4.5	6.8	8.3	6.6	9.0	6.5	6.56	2.8	5.8	11.81	2335.19
	20-Mar	5.8	8.6	6.9	6.5	3.2	5.2	6.9	9.2	6.9	8.4	6.5	6.73	3.23	6.5	12.12	2347.31
	21-Mar	6.2	9.1	6.7	6.3	4.6	5.4	8.3	8.3	5.8	9.2	6.6	6.95	4.56	6.3	12.52	2359.83
	22-Mar	7.4	9.6	7.2	6.3		5.2	8.7	8.0	5.3	8.6	6.7	7.30	0	6.3	13.14	2372.97
	23-Mar	7.7	10.3	7.2	6.0		5.5	8.6	7.5	5.5	7.6	6.7	7.26	0	6	13.07	2386.03
	24-Mar	6.9	9.7	7.5	5.5		5.6	7.8	7.0	5.2	8.7	6.9	7.08	0	5.5	12.74	2398.78
	25-Mar	6.6	9.9	7.8	5.6	5.6	7.0	8.4	6.4	5.8	7.2	5.6	6.90	5.62	5.6	12.42	2411.20
	26-Mar	6.7	10.6	7.0	6.1	5.3	5.6	7.2	7.0	5.3	9.5	4.4	6.79	5.28	6.1	12.22	2423.42
	27-Mar	7.0	9.8	6.8	5.9	4.2	5.1	6.9	7.4	5.7	10.1	4.8	6.70	4.2	5.9	12.06	2435.48
	28-Mar	5.9	9.7	6.3	6.5	4.6	4.6	6.9	7.4	5.6	10.1	4.2	6.53	4.6	6.5	11.75	2447.22
	29-Mar	6.0	10.2	6.1	7.2	4.8	4.1	7.8	6.9	5.7	9.7	4.4	6.63	4.8	7.2	11.93	2459.16
	30-Mar	6.6	10.1	6.4	6.7	4.2	4.7	7.5	6.4	6.4	9.9	5.8	6.79	4.2	6.7	12.22	2471.38
	31-Mar	6.1	8.8	5.6	6.5	3.3	4.5	7.8	7.4	7.8	8.5	7.0	6.67	3.3	6.5	12.00	2483.38
April	01-Apr	6.2	8.8	5.4	6.7	3.1	4.6	7.4	6.9	9.6	8.0	7.2	6.72	3.1	6.7	12.10	2495.48
	02-Apr	6.2	9.2	6.1	7.0	2.7	4.7	7.1	7.6	8.6	8.1	8.5	6.88	2.7	6.95	12.39	2507.87
	03-Apr	6.3	9.7	5.8	7.1	2.3	5.0		7.8	7.2	8.6	8.0	6.78	2.3	7.1	12.20	2520.07
	04-Apr	6.3	9.7	6.9	7.9	2.7	5.5	7.9	7.6	6.8	8.8	8.7	7.16	2.7	7.9	12.89	2532.96
	05-Apr	8.1	8.9	7.8	8.6	4.1	5.3	7.8	7.8	7.6	8.5	8.5	7.54	4.1	8.6	13.57	2546.52
	06-Apr	8.8	7.9	7.9	7.8	2.2	5.6	8.1	7.2	7.8	8.8	8.2	7.30	2.2	7.8	13.14	2559.66
	07-Apr	9.1	8.5	7.7	7.0	2.3	5.7	8.8	7.6	8.5	10.1	8.7	7.63	2.3	7	13.74	2573.40
	08-Apr	8.8	9.3	8.0	7.1	3.2	5.4	7.1	7.3	9.4	10.0	7.9	7.59	3.2	7.12	13.66	2587.06
	09-Apr	8.0	9.4	7.6	8.1	2.9	5.5	7.5	6.4	9.4	8.7	7.9	7.40	2.9	8.1	13.32	2600.38
	10-Apr	7.9	9.9	6.4	7.8	2.3	6.3	6.6	6.4	9.0	8.5	7.7	7.16	2.3	7.8	12.89	2613.27

	11-Apr	7.9	8.8	7.0	7.5	1.7	7.0	6.6	6.3	10.2	8.8	7.1	7.18	1.7	7.5	12.92	2626.18
	12-Apr	7.7	8.7	7.3	8.6	1.4	6.4	7.1	7.1	11.0	8.1	7.2	7.33	8.6	7.33	13.19	2639.38
	13-Apr	8.0	8.3	7.7	10.1	6.9	5.0	7.1	7.3	10.7	8.2	9.0	8.02	10.1	7.67	14.44	2653.82
	14-Apr	7.1	8.1	7.4	10.0	7.1	4.9	7.4	9.0	10.8	8.8	9.0	8.14	9.96	7.4	14.65	2668.47
	15-Apr	7.9	9.3	7.2	8.9	8.5	4.9	8.0	9.9	10.7	8.9	9.2	8.49	8.9	7.2	15.28	2683.74
	16-Apr	7.6	8.4	6.7	8.6	9.0	5.0	8.7	8.2	9.8	8.8	8.3	8.10	8.6	6.7	14.58	2698.32
	17-Apr	7.0	8.2	7.7	9.4	9.2	4.5	9.1	8.2	8.9	9.1	8.0	8.12	9.4	7.7	14.62	2712.94
	18-Apr	7.5	9.0	7.0	10.1	9.1	4.6	10.6	8.9	8.0	9.5	5.8	8.19	10.1	7	14.75	2727.69
	19-Apr	6.8	9.4	7.0	10.2	10.0	7.3	10.3	8.3	6.6	9.9	6.5	8.39	10.2	7	15.10	2742.79
	20-Apr	7.2	8.8	7.1	9.6	9.8	8.3	10.5	8.7	7.0	10.2	6.8	8.54	9.6	7.1	15.37	2758.16
	21-Apr	7.9	7.8	7.7	9.5	9.6	7.0	10.2	8.7	7.0	8.9	7.4	8.34	9.5	7.7	15.01	2773.17
	22-Apr	9.9	7.5	8.9		10.5	6.7	8.8	8.6	7.4	8.9	8.2	8.54	0	8.9	15.37	2788.54
	23-Apr	10.3	7.3	9.8		11.8	6.1	9.9	7.8	7.6	15.3/2	9.2	7.98	0	9.8	14.36	2802.90
	24-Apr	10.7	9.2	9.7		10.3	6.7	9.2	7.3	7.0	7.4	8.5	8.60	0	9.7	15.48	2818.38
	25-Apr	11.5	10.3	9.9		9.0	6.5	9.1	7.4	6.6	7.6	7.9	8.58	0	9.9	15.45	2833.84
	26-Apr	11.5	10.9	10.1		8.7	7.1	9.3	7.6	8.3	8.2	8.5	9.02	0	10.1	16.23	2850.07
	27-Apr	10.8	10.7	11.4		8.5	7.4	9.6	8.5	8.7	7.5	10.8	9.39	0	11.4	16.90	2866.97
	28-Apr	11.0	10.0	12.0	10.6	9.2	7.2	10.2	8.9	8.6	8.2	10.0	9.63	10.6	12	17.33	2884.29
	29-Apr	11.5	9.7	11.9	9.7	10.9	6.5	10.7	8.3	11.1	7.3	10.6	9.83	9.7	11.9	17.69	2901.98
	30-Apr	11.5	9.5	12.0	9.6	11.9	7.2	11.2	9.6	8.4	7.8	9.6	9.85	9.6	12	17.73	2919.71
May	01-May	11.4	9.7	11.5	10.8	10.8	8.4	10.4	8.7	9.3	8.5	9.8	9.93	10.8	11.5	17.88	2937.59
	02-May	11.3	9.8	11.4	10.8	10.2	7.7	10.2	8.9	10.6	10.9	8.2	10.00	10.8	11.41	18.00	2955.59
	03-May	9.8	8.8	11.3	10.0	9.7	7.1	10.2	8.0	9.4	10.5	9.2	9.45	9.95	11.3	17.01	2972.60
	04-May	9.0	8.2	11.7	10.9	8.5	6.6	9.9	8.2	8.9	9.1	9.2	9.11	10.93	11.7	16.40	2989.01
	05-May	9.3	8.8	11.5	12.0	8.3	7.9	9.8	7.7	9.0	9.7	10.7	9.52	12	11.5	17.14	3006.14
	06-May	10.3	9.5	10.5	11.2	8.6	8.8	11.1	8.1		10.9	11.6	10.06	11.2	10.5	18.11	3024.25
	07-May	11.4	10.7	10.1	11.0	8.9	9.8	10.8	9.6	10.3	9.8	12.7	10.47	11	10.13	18.84	3043.09
	08-May	10.5	11.7	10.2	10.5	9.7	9.2	9.2	9.5	9.2	9.0	13.5	10.20	10.5	10.2	18.36	3061.45
	09-May	11.5	12.0	10.2	11.0	10.0	9.6	8.8	8.6	8.5	8.2	13.4	10.16	11	10.2	18.29	3079.74
	10-May	9.8	11.1	10.1	11.4	9.4	9.2	8.5	9.1	8.8	10.0	12.7	10.01	11.4	10.1	18.02	3097.75
	11-May	8.8	10.6	10.2	12.2	9.4	8.7	8.8	10.4	6.9	8.8	13.3	9.83	12.2	10.2	17.69	3115.44
	12-May	9.4	10.9	10.2	11.8	9.6	8.2	9.4	10.0	8.5	8.1	10.8	9.71	11.8	10.2	17.48	3132.93
	13-May	9.0	11.5	10.9	10.8	10.3	8.6	10.2	9.5	9.7	10.2	10.7	10.13	10.8	10.9	18.23	3151.16
	14-May	9.5	11.9	11.6	10.2	10.0	9.1	9.4	9.8	10.2	9.2	10.5	10.12	10.2	11.6	18.21	3169.37
	15-May	9.5	10.9	12.1	9.9	9.8	9.6		9.3	10.4	9.5	9.7	10.07	9.94	12.1	18.13	3187.50
	16-May	9.9	10.4	11.7	10.3	9.8	10.8	9.6	9.2	12.7	9.5	9.8	10.34	10.25	11.7	18.61	3206.11
	17-May	9.4	11.3	11.1	11.2	10.0	9.9	9.4	9.6	13.6	10.8	9.9	10.56	11.2	11.1	19.01	3225.13
	18-May	9.8	12.0	11.5	11.7	10.6	8.4	9.4	9.5	12.8	11.0	9.4	10.56	11.7	11.5	19.00	3244.13
	19-May	10.3	13.4	10.6	11.1	10.6	9.0	9.9	11.1	11.5	12.5	10.8	10.99	11.1	10.6	19.78	3263.91
	20-May	10.9	14.3	11.1	11.0	10.7	9.2	11.1	10.1	10.7	10.3	10.7	10.92	11	11.1	19.65	3283.56
	21-May	10.9	12.5	12.7	10.9	10.3	11.4	11.7	9.9	12.3	9.0	10.5	11.10	10.9	12.7	19.99	3303.55
	22-May	10.7	11.0	13.1	9.7	11.1	10.1	11.7	8.9	13.3	8.6	9.7	10.71	9.7	13.1	19.28	3322.83
	23-May	10.6	10.3	13.4	9.2	11.7	10.1	13.7	10.0	13.5	8.4	9.8	10.97	9.2	13.4	19.75	3342.58
	24-May	9.9	10.5	13.7	9.5	12.6	13.1	13.4	9.7	13.3	10.0	9.9	11.42	9.5	13.7	20.56	3363.14
	25-May	9.7	11.5	13.6	10.4	11.6	10.0	13.5	8.6	13.5	11.6	9.4	11.22	10.4	13.6	20.19	3383.33
	26-May	10.2	11.9	13.5	10.2	10.8	10.3	13.2	10.0	13.8	11.0		11.49	10.2	13.5	20.69	3404.02
	27-May	9.2	12.4	11.8	10.1	11.0	9.9	12.9	11.0	11.9	12.5		11.26	10.1	11.8	20.27	3424.29
	28-May	9.4	11.8	10.9	10.4	11.6	9.7		12.4	12.4	12.3		11.22	10.4	10.9	20.19	3444.48
	29-May	9.8	11.0	11.2	10.3	12.0	10.6		12.6	11.5	12.8		11.31	10.3	11.2	20.36	3464.84
	30-May	10.0	11.9	11.8	10.8	11.5	10.6	13.6	10.9	11.7	13.9		11.68	10.8	11.8	21.02	3485.86
	31-May	10.3	13.6	13.2	11.2	11.1	10.6	13.2	9.5	12.3	14.4		11.94	11.2	13.2	21.49	3507.35
June	01-Jun	10.9	14.8	14.1	10.9	11.0	11.1	12.5	9.8	12.5	14.9		12.25	10.9	14.1	22.04	
	02-Jun	10.2	15.7	14.3	9.9	11.1	10.8	12.0	10.7	11.7	14.4		12.08	9.9	14.3	21.75	
	03-Jun	10.3	16.6	15.1	9.6	11.2	10.6	11.5	10.2	18.2	16.1		12.93	9.6	15.1	23.27	
	04-Jun	10.8	17.3	14.3	9.5	11.2	11.0	11.4	10.5	14.9	14.2		12.50	9.5	14.3	22.51	
	05-Jun	11.8	18.1	13.3	9.5	11.4	10.5	12.1	10.7		14.5		12.44	9.5	13.3	22.39	

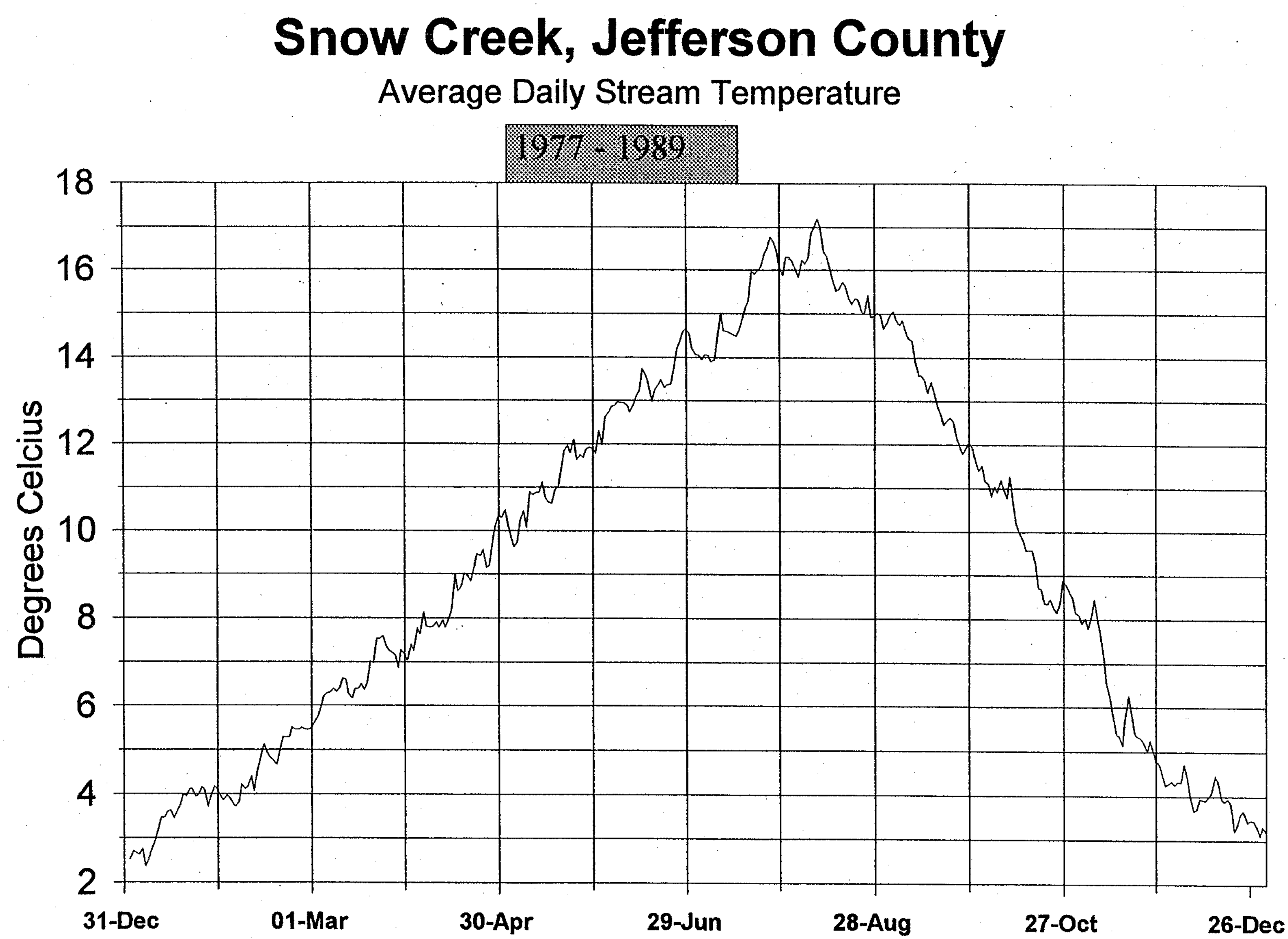
	06-Jun	12.9	17.6	12.1	10.0	11.4	11.4	13.5	11.1		13.2	12.58	10	12.1	22.64
	07-Jun	13.2	17.0	12.7	10.5	10.7	11.6	14.0	10.6		12.5	12.53	10.5	12.7	22.56
	08-Jun	12.5	15.6	12.6	11.3	10.4	11.8	14.4	10.8		13.0	12.49	11.3	12.6	22.48
	09-Jun	11.6	15.1	13.9	10.8	10.4	12.0	13.9	10.9		14.1	12.52	10.8	13.9	22.54
	10-Jun	12.2	14.3	14.3	10.6	10.2	12.2	12.9	11.4	13.2	13.7	12.50	10.6	14.3	22.50
	11-Jun	12.8	15.2	13.5	10.8	10.3	12.4	12.9	12.1	13.3	14.7	12.80	10.8	13.5	23.04
	12-Jun	12.5	14.8	12.6	10.9	9.6	12.6	13.0	12.2	12.6	14.7	12.55	10.9	12.6	22.59
	13-Jun	13.1	14.1	12.6	11.2	8.9	12.8	13.5	13.0	12.0	14.9	12.61	11.2	12.6	22.70
	14-Jun	13.4	13.2	12.7	11.1	9.4	13.0	13.2	13.0	12.7	15.8	12.75	11.1	12.7	22.95
	15-Jun	13.2	12.9	12.9	11.1	9.3	13.2	12.3	11.6	13.2	14.0	12.37	11.1	12.9	22.27
	16-Jun	13.6	13.6	12.9	10.8	9.1	13.5	11.9	11.3	11.2	15.4	12.33	10.8	12.9	22.19
	17-Jun	15.0	14.1	12.1	10.9	9.4	14.3	12.1	11.5	10.5	13.4	12.33	10.9	12.1	22.19
	18-Jun	15.4	15.0	12.5	10.9	9.6	15.3	11.4	11.7	15.8	12.9	13.05	10.9	12.5	23.49
	19-Jun	14.5	15.2	12.2	11.4	9.9	15.9	11.2	12.1	15.8	12.3	13.05	11.4	12.2	23.48
	20-Jun	14.8	15.8	12.0	11.9	9.8	15.5	11.6	11.8	14.9	12.4	13.05	11.9	12	23.49
	21-Jun	14.8	15.3	12.1	11.9	10.2	13.2	11.8	12.3	14.4	13.2	12.92	11.9	12.1	23.26
	22-Jun	13.6	14.7	13.0	11.7	12.2	14.1	12.2	12.5	13.7	14.3	13.20	11.7	13	23.76
	23-Jun	14.0	14.5	13.3	11.2	10.0	13.8	12.0	12.9	11.3	16.1	12.91	11.23	13.3	23.24
	24-Jun	14.3	15.8	14.7	11.6	10.8	14.3	11.8	13.7	13.4	15.2	13.55	11.55	14.7	24.40
	25-Jun	14.1	15.5	15.4	11.6	11.4	14.1	12.1	14.3	13.8	17.0	13.93	11.6	15.4	25.07
	26-Jun	13.3	16.0	15.5	11.2	10.9	12.7	13.0	13.8	12.8	16.0	13.52	11.2	15.5	24.33
	27-Jun	13.2	16.7	14.9	11.1	10.5	13.7	13.7	13.6	12.4	15.4	13.52	11.1	14.9	24.34
	28-Jun	12.9	18.1	15.1	11.2	10.9	14.4	13.0	13.2	13.7	16.0	13.85	11.2	15.1	24.93
	29-Jun	13.4	17.2	13.5	11.0	11.9	14.7	12.8	12.4	13.3	14.6	13.48	10.97	13.5	24.27
	30-Jun	14.1	16.9	13.6	11.3	11.6	12.8	12.9	11.8	11.9	14.6	13.14	11.28	13.6	23.66
July	01-Jul	12.5	17.4	12.4	11.8	11.7	12.2	13.0	11.9		14.0	12.99	11.8	12.4	23.38
	02-Jul	12.5	16.5	12.4	11.7	11.9	13.0	12.7	12.4		13.8	12.99	11.7	12.4	23.38
	03-Jul	11.9	15.8	13.1	11.7	12.8	11.9	12.6	12.6		12.6	12.78	11.7	13.1	23.00
	04-Jul	11.8	14.6	14.1	11.6	13.5	12.4		13.3		13.0	13.04	11.62	14.1	23.47
	05-Jul	11.7	15.1	15.3	11.5	12.9	11.7	11.9	12.3		14.1	12.95	11.51	15.3	23.30
	06-Jul	12.2	15.8	14.7	11.8	10.9	12.0	11.7	11.2		14.1	12.71	11.8	14.7	22.88
	07-Jul	12.1	16.7	14.8	12.6	10.5	11.7	11.8	11.8		16.1	13.12	12.6	14.8	23.62
	08-Jul	12.2	16.0	16.7	13.0	11.3	12.8	12.0	12.4		15.1	13.50	13	16.7	24.30
	09-Jul	12.5	15.5	16.9	12.7	11.6	13.4	11.8	12.8		14.9	13.57	12.7	16.9	24.42
	10-Jul	12.5	14.5	15.8	12.4	11.3	13.5	13.4	13.1		14.7	13.46	12.35	15.8	24.23
	11-Jul	12.5	14.6	16.1	12.2	11.7	13.6	13.0	12.1		13.9	13.30	12.2	16.1	23.94
	12-Jul	12.3	15.7	15.4	12.3	11.6	14.2		12.4		14.0	13.49	12.32	15.4	24.28
	13-Jul	12.5	16.7	14.7	12.3	11.6	12.4		12.9		13.5	13.33	12.3	14.7	23.99
	14-Jul	13.4	17.2	15.7	12.3	12.0	11.8		13.4		13.5	13.66	12.31	15.7	24.59
	15-Jul	13.6	17.2	16.6	12.8	12.4	11.0	12.3	14.5	18.1	13.6	14.21	12.8	16.6	25.58
	16-Jul	12.3	16.2	17.8	12.9	13.4	11.7	13.2	16.2	17.4	11.4	14.25	12.9	17.8	25.65
	17-Jul	12.3	15.8	18.6	13.0	13.8	13.2	13.5	15.6	17.6	11.2	14.46	13	18.6	26.03
	18-Jul	13.2	16.3	18.6	13.2	13.4	13.7	14.9	14.7	17.5	11.8	14.73	13.2	18.6	26.51
	19-Jul	13.2	17.0	18.6	13.3	13.2	12.4	13.7	14.1	17.8	10.9	14.42	13.3	18.6	25.96
	20-Jul	13.2	18.0	18.6	14.0	13.2	11.5	14.6	14.4	17.8	12.1	14.74	13.95	18.6	26.52
	21-Jul	13.2	18.6	17.7	15.2	12.7	11.1	14.6	14.1	17.0	14.7	14.89	15.2	17.7	26.80
	22-Jul	14.2	19.3		16.2	12.9	11.8	14.3	14.9	18.5	15.3	15.26	16.15	0	27.47
	23-Jul	15.3	19.7	17.2	15.4	13.2	12.5	14.4	16.6	16.7	14.7	15.57	15.35	17.2	28.02
	24-Jul	15.3	18.0	17.4	14.5	14.0	13.2		16.3	16.9	14.4	15.56	14.54	17.4	28.01
	25-Jul	15.3	18.7	17.3	14.7	15.0	14.4	14.1	17.1	17.1	13.7	15.74	14.7	17.3	28.33
	26-Jul	15.3	17.8	17.5	15.0	15.8	15.1	13.9	16.5	16.9	12.1	15.59	15	17.5	28.06
	27-Jul	14.8	17.8	16.4	15.4	13.7	15.6	14.5	15.7	17.4	13.8	15.51	15.4	16.4	27.92
	28-Jul	14.2	17.8	15.7	15.3	14.2	14.1	14.2	15.9	17.8	14.4	15.36	15.3	15.7	27.65
	29-Jul	14.5	17.7	16.2	14.7	13.7	14.5	14.5	15.6	19.4	14.4	15.52	14.7	16.2	27.94
	30-Jul	15.7	18.1	17.4	15.5	14.0	13.3	15.0	16.2	18.2	13.7	15.71	15.5	17.4	28.28
	31-Jul	15.9		17.7	14.6	13.7	12.3	15.9	15.9	17.0	14.2	15.25	14.63	17.7	27.45

August	01-Aug	16.9	17.5	16.6	14.5	14.1	11.7	14.5	15.5	16.2	15.5	15.30	14.5	16.6	27.54	
	02-Aug	15.9	17.7	16.7	14.2	12.6	12.9	15.5	15.6	16.9	16.1	15.41	14.2	16.7	27.74	
	03-Aug	16.6	17.9	16.0	14.0	12.3	11.6	15.1	15.5	17.6	16.2	15.27	13.96	15.95	27.49	
	04-Aug	16.2	18.5	16.2	13.5	12.8	12.0	14.6	16.1	16.7	14.8	15.15	13.53	16.23	27.26	
	05-Aug	16.0	18.0	14.8	13.7	13.3	11.7	14.3	14.9	16.8	16.3	14.99	13.73	14.84	26.98	
	06-Aug	15.9	18.2	15.8	13.7	14.9	12.7	15.8	15.1	16.7	15.8	15.46	13.65	15.8	27.82	
	07-Aug	15.8	19.5	15.9	14.0	16.3	14.2	16.1	15.5	15.9	16.7	15.99	14	15.9	28.78	
	08-Aug	15.9	20.3	16.1	14.9	17.5	13.3	16.3	16.5	15.6	17.1	16.35	14.9	16.1	29.43	
	09-Aug	17.0	19.7	16.2	15.0	18.3	13.1	16.7	17.2	15.1	17.1	16.54	15	16.2	29.77	
	10-Aug	17.1	17.7	15.8	15.1	18.6	12.4	15.7	16.6	16.1	15.9	16.10	15.1	15.8	28.98	
	11-Aug	18.1	17.0	16.0	15.3	17.9	12.6	14.1	15.4	16.2	14.6	15.72	15.3	16	28.30	
	12-Aug	18.6	16.9	16.1	14.3	17.4	12.4	15.7	15.0	17.2	15.8	15.94	14.3	16.1	28.69	
	13-Aug	17.7	16.6	15.4	13.9	16.4	11.6	15.6		16.8	16.4	15.60	13.9	15.4	28.08	
	14-Aug	16.7	16.0	15.3	13.6	16.1	12.2	15.8		17.0	16.3	15.44	13.6	15.3	27.80	
	15-Aug	16.6	15.9	16.4	13.6	15.8	11.9			17.4	15.1	15.34	13.6	16.4	27.61	
	16-Aug	16.8	15.6	16.8	13.6	15.4	12.4			17.5	14.1	15.28	13.6	16.8	27.50	
	17-Aug		16.3	15.8	13.8	15.2	12.5			17.7	14.2	15.07	13.8	15.8	27.13	
	18-Aug		16.0	16.0	13.9	15.0	12.6			16.6	15.0	15.01	13.9	16	27.03	
	19-Aug		15.6	15.8	13.6	14.0	12.8	15.2		15.2	15.8	14.75	13.6	15.8	26.55	
	20-Aug	15.0	16.4	15.9	13.4	13.6	14.1	15.1		16.0	15.0	14.94	13.4	15.9	26.90	
	21-Aug	15.1	16.5	15.7	12.8	13.9	13.9	15.1		15.4	16.8	15.02	12.8	15.7	27.04	
	22-Aug	14.9	15.2	16.8	12.9	13.9	13.8			15.2	15.1	14.73	12.9	16.8	26.51	
	23-Aug	15.0	15.5	15.3	13.6	14.2	14.8	14.5		15.8	15.5	14.91	13.6	15.3	26.84	
	24-Aug	14.3	15.7	16.3	14.2	14.5	14.9	14.2		17.0	15.5	15.18	14.2	16.3	27.32	
	25-Aug	13.9	15.3	16.2	13.0	14.0	15.0	15.3		16.5	14.8	14.89	13	16.2	26.80	
	26-Aug	14.2	15.5	16.5	12.4	13.2	13.0	14.9		15.1	14.5	14.36	12.35	16.5	25.85	
	27-Aug	13.9	15.5	15.2	12.7	13.6	13.5	15.5		14.8	14.5	14.36	12.73	15.2	25.85	
	28-Aug	14.1	16.0	16.6	12.4	13.2	14.2	13.7		14.4	15.7	14.48	12.39	16.6	26.06	
	29-Aug	13.9	16.5	15.7	11.8	13.0	12.7	14.4		14.3	15.6	14.21	11.76	15.7	25.57	
	30-Aug	14.3	16.9	15.2	11.9	13.2	13.3	14.6		13.3	15.6	14.26	11.92	15.2	25.66	
	31-Aug	13.6	16.2	15.8	12.2	12.6	13.7	15.3		14.5	15.4	14.36	12.18	15.8	25.86	
September	01-Sep	12.9	16.2	16.6	12.2	12.9	13.9	14.3		14.9	15.1	14.34	12.19	16.6	25.80	25.80
	02-Sep	12.9	16.4	16.6	12.1	12.8	14.8	14.9			15.1	14.45	12.1	16.6	26.01	51.81
	03-Sep	14.2	15.3	15.8	11.9	12.0	12.9	14.7		15.2	15.4	14.15	11.86	15.8	25.47	77.29
	04-Sep	14.1	14.8	15.0	12.4	11.9	13.6	13.8		13.8	15.4	13.86	12.35	15	24.95	102.24
	05-Sep	14.5	14.4	15.9	12.5	12.6	14.7			13.6	15.3	14.19	12.5	15.9	25.54	127.77
	06-Sep	12.4	14.2	15.7	12.8	12.7		11.5		13.6	15.6	13.56	12.75	15.7	24.40	152.17
	07-Sep	13.4	13.7	16.5	12.7	13.2		11.7		13.3	14.2	13.59	12.73	16.5	24.46	176.64
	08-Sep	12.9	13.5	16.0	12.4	13.7		11.6		13.0	13.8	13.36	12.38	16	24.05	200.69
	09-Sep	12.9	14.2	15.7	12.2	13.5		11.4		14.4	14.0	13.54	12.23	15.7	24.37	225.06
	10-Sep	13.0	14.1	14.6	12.4	13.0		12.8		15.0	12.8	13.46	12.41	14.6	24.23	249.30
	11-Sep	13.2	13.7	14.3	12.6	12.6		13.3		14.3	12.7	13.34	12.63	14.3	24.01	273.31
	12-Sep	13.5	13.3	14.2	12.3	11.9		13.5		14.0	12.5	13.14	12.25	14.2	23.66	296.97
	13-Sep	13.9	12.9	14.9	12.1	11.2		12.9		14.3	12.3	13.06	12.1	14.9	23.51	320.48
	14-Sep	12.4	13.4	15.3	12.7	11.1	12.8	14.1		13.6	12.1	13.06	12.7	15.3	23.50	343.98
	15-Sep	12.9	13.5	15.6	13.6	12.0	13.6	12.8		13.6	11.9	13.28	13.6	15.6	23.90	367.88
	16-Sep	13.4	11.9	16.9	12.7	12.8	11.6	12.2		13.7	11.7	12.99	12.7	16.9	23.38	391.26
	17-Sep	13.3	11.4	15.8	12.4	12.2	11.7	11.2		12.6	11.5	12.46	12.4	15.8	22.42	413.68
	18-Sep	13.3	11.0	15.6	12.1	13.0	12.1	10.7		12.2	11.3	12.36	12.1	15.6	22.26	435.94
	19-Sep	13.3	11.0	16.0	12.1	11.2	12.2	10.1		13.0	11.1	12.22	12.1	16	21.99	457.93
	20-Sep	12.7	11.5	15.2	11.9	10.8		9.5		11.4	10.9	11.75	11.9	15.24	21.14	479.07
	21-Sep	12.4	12.2	15.4	11.5	10.0		10.7		12.2	10.7	11.89	11.5	15.43	21.40	500.48
	22-Sep	10.9	12.4	14.3	11.1	9.7		11.5		11.8	10.8	11.56	11.1	14.27	20.81	521.28
	23-Sep	11.2	12.3	14.0	11.4	8.6		12.0		11.8	10.1	11.43	11.4	13.98	20.57	541.85
	24-Sep	11.2	12.8	13.8	10.7	8.1		11.3		12.7	9.7	11.29	10.7	13.8	20.32	562.17
	25-Sep	11.2	12.8	14.4	10.8	8.5		12.3		13.5	10.7	11.78	10.8	14.4	21.20	583.36

	26-Sep		11.1	13.1	16.2	10.9	8.3		11.8		13.2	10.4	11.87	10.9	16.16	21.37	604.73
	27-Sep		10.7	13.5	14.9	11.1	9.5		11.4		12.9	10.6	11.83	11.1	14.9	21.29	626.02
	28-Sep		10.8	13.2	13.6	11.6	10.0	11.5	9.7		12.0	10.7	11.46	11.6	13.6	20.62	646.64
	29-Sep		10.9	13.8	12.9	11.6	9.3	11.3	9.4		11.1	10.7	11.22	11.6	12.9	20.20	666.84
	30-Sep		11.3	13.2	13.3	11.6	9.4	10.2	10.1		11.5	10.8	11.27	11.6	13.3	20.28	687.12
October	01-Oct		10.0	12.7	13.2	11.3	9.5	9.9	9.1		11.2	10.8	10.86	11.33	13.2	19.55	706.67
	02-Oct		9.7	11.9	13.4	11.1	8.2	10.3	9.9		11.8		10.79	11.08	13.4	19.41	726.08
	03-Oct		9.5	11.3	12.2	11.0	7.4	10.0	10.7		11.8		10.49	10.98	12.2	18.87	744.95
	04-Oct		9.3	11.5	12.2	11.6	7.1	10.0	11.1		10.6		10.42	11.55	12.2	18.75	763.71
	05-Oct		9.0	11.5	12.5	11.9	6.9	9.4	9.9		10.7		10.22	11.85	12.5	18.39	782.10
	06-Oct		8.9	11.2	12.4	11.9	8.6	11.3	10.4		12.2	12.3	11.03	11.93	12.4	19.85	801.95
	07-Oct		8.9	11.8	12.3	11.6	8.7	9.7	9.3		10.5	11.1	10.43	11.56	12.3	18.78	820.72
	08-Oct		8.7	12.5	12.3	11.6	10.3	8.6	9.1		8.9	11.0	10.34	11.63	12.3	18.61	839.33
	09-Oct		8.4	12.1	11.9	10.1	7.4	10.4	9.0		8.1	10.6	9.78	10.08	11.9	17.60	856.93
	10-Oct		8.5	12.7	11.6	9.5	7.3	9.3	9.1		10.0	10.4	9.82	9.48	11.6	17.68	874.61
	11-Oct		8.6	12.1	11.9	9.7	6.5	9.2	8.4		10.6	9.0	9.55	9.67	11.9	17.19	891.80
	12-Oct		8.4	10.8	11.7	10.4	6.4	10.9	8.1		10.1	8.1	9.43	10.36	11.7	16.97	908.78
	13-Oct		9.0	10.3	11.4	9.6	6.0	10.9	8.3		9.0	8.0	9.16	9.58	11.4	16.50	925.27
	14-Oct		8.1	10.1	12.2	9.5	6.0	10.8	9.0		10.4	7.5	9.29	9.47	12.2	16.71	941.99
	15-Oct		9.0	10.7	11.8	8.6	6.2	10.2	8.5		11.9	7.4	9.36	8.57	11.8	16.85	958.84
	16-Oct		9.1	11.5	11.1	7.5	6.8	11.1	8.5		11.3	7.1	9.34	7.53	11.1	16.81	975.65
	17-Oct		8.4	12.7	10.0	7.3	6.9	9.2	8.8		11.4	8.2	9.21	7.3	9.97	16.57	992.22
	18-Oct		7.6	11.6	9.8	7.7	6.8	7.2	8.4		10.8	8.3	8.68	7.68	9.76	15.63	1007.85
	19-Oct		7.0	11.3	9.4	8.9	7.0	6.5	8.9		11.4	7.6	8.67	8.9	9.44	15.61	1023.46
	20-Oct		7.6	11.6	8.8	8.8	6.6	5.4	9.4		10.7	6.7	8.40	8.8	8.8	15.12	1038.58
	21-Oct		8.0	10.5	7.5	8.1	5.6	7.4	10.0		10.4	7.2	8.30	8.1	7.5	14.94	1053.52
	22-Oct		9.4	9.5	9.3	6.3	5.1	9.9	10.7	7.1	10.0		8.59	6.3	9.3	15.47	1068.98
	23-Oct		10.1	9.7	10.2	5.9	5.3	10.2	8.4	6.6	9.8		8.47	5.9	10.2	15.24	1084.22
	24-Oct		10.3	9.8	9.8	7.1	5.9	11.3	7.4	7.6	9.8		8.78	7.1	9.83	15.80	1100.02
	25-Oct		9.0	8.2	11.1	7.5	4.9	10.7	8.5	8.3	10.0		8.68	7.5	11.07	15.63	1115.65
	26-Oct		8.2	7.3		7.0	6.4	9.4	8.6		10.0		8.13	7	0	14.64	1130.29
	27-Oct		7.8	8.8		5.9		8.9	8.5		10.2	10.0	8.59	5.9	0	15.45	1145.74
	28-Oct		8.9	9.1		5.9		8.7	6.6		9.2	9.1	8.21	5.9	0	14.79	1160.53
	29-Oct		9.4	8.4	8.8	6.7		8.6	6.5	6.1	8.6	8.0	7.90	6.7	8.8	14.22	1174.75
	30-Oct		9.0	7.2	9.0	6.7		7.3		5.2	8.0	8.8	7.66	6.73	9.03	13.79	1188.54
	31-Oct		7.4	6.4	8.8	8.0		7.9	10.0	4.3	7.4	9.2	7.70	7.98	8.78	13.86	1202.40
November	01-Nov		8.4	7.3	7.6	8.9		6.7	9.3	4.7	8.3	7.6	7.64	8.9	7.6	13.75	1216.15
	02-Nov		8.0	7.1	7.8	8.0		6.2	10.0	7.0	9.2	7.0	7.81	8	7.8	14.06	1230.21
	03-Nov		6.8	8.0	9.0	9.1		7.2	10.0	7.5	9.6	7.7	8.32	9.1	9	14.98	1245.19
	04-Nov		6.6	7.6	9.5	9.6		7.7	9.4	6.9	8.9	7.9	8.23	9.6	9.5	14.82	1260.01
	05-Nov		6.8	6.4	9.7	9.7		7.6	7.1	6.6	8.5	8.2	7.85	9.72	9.7	14.12	1274.13
	06-Nov		7.5	7.1	8.7	9.27		6.3	7.8	7.3	8.7	6.7	7.71	9.27	8.7	13.87	1288.01
	07-Nov		7.0	8.3	8.1	9.23		6.3	7.5	6.6	8.6	6.3	7.55	9.23	8.1	13.59	1301.59
	08-Nov		5.2	8.3	6.9	8.13		5.5	6.4	6.5	7.5	5.5	6.65	8.13	6.9	11.98	1313.57
	09-Nov		5.3	6.1	6.0	7.16		5.5	7.4	6.4	7.1	3.2	6.01	7.16	5.97	10.83	1324.40
	10-Nov		6.9	4.0	6.3	5.12		4.4	7.0	6.9	5.8	2.6	5.44	5.12	6.3	9.80	1334.20
	11-Nov		7.2	2.5	6.3	3.48		4.6	9.0	7.2	3.7	3.8	5.31	3.48	6.33	9.56	1343.76
	12-Nov		7.3	1.6	5.2	2.3		4.5	8.5	8.1	3.2	5.4	5.12	2.3	5.16	9.22	1352.98
	13-Nov		7.3	1.4	4.3	1.7		4.9	7.9	7.6	2.9	5.4	4.82	1.7	4.29	8.68	1361.66
	14-Nov		7.4	1.3	3.9	3		3.7		5.8	2.9	5.4	4.18	3	3.93	7.52	1369.18
	15-Nov		7.5	2.0	4.0	3.4		3.4		4.9	5.8	4.2	4.40	3.4	3.98	7.92	1377.10
	16-Nov		6.6	3.7	5.6	3.1		5.2		5.3	5.0	4.2	4.84	3.1	5.64	8.72	1385.82
	17-Nov		5.5	4.9	6.4	4.15		5.8		5.8	4.1	4.2	5.10	4.15	6.38	9.19	1395.00
	18-Nov		4.4	4.3	6.0	4.98		5.7		7.5	3.3	5.9	5.26	4.98	5.99	9.47	1404.47
	19-Nov		3.1	1.8	4.9	5.91		5.2		7.7	3.3	6.2	4.77	5.91	4.94	8.58	1413.05
	20-Nov	6.0	1.8	1.4	3.9	6.8		5.4		7.0	2.5	7.4	4.68	6.8	3.91	8.43	1421.48

	21-Nov	6.7	0.5	0.7	4.1	6.3		3.9	7.5	6.2	1.2	7.1	4.42	6.3	4.11	7.95	1429.43
	22-Nov	6.1	0.7	0.8	5.7	3.85		2.3	7.0	5.6	0.6	5.7	3.82	3.85	5.65	6.88	1436.31
	23-Nov	5.7	1.1	1.9	6.5	3.13		1.8	6.8	6.2	0.7	6.9	4.07	3.13	6.48	7.33	1443.64
	24-Nov	6.6	2.1	2.9	5.7	3		1.7	7.6	5.3	0.7	6.5	4.21	3	5.72	7.58	1451.22
	25-Nov	4.8	3.2	3.3	4.7	3.73		1.2	6.8	4.4	0.8	5.4	3.84	3.73	4.69	6.91	1458.13
	26-Nov	3.2	4.0	4.0	4.6	3.93		2.9	6.1	4.5	0.7	5.2	3.90	3.93	4.56	7.02	1465.15
	27-Nov	2.1	4.7	4.3	3.5	5.13		4.7	7.5	3.2	0.5	5.4	4.10	5.13	3.46	7.38	1472.53
	28-Nov	1.8	5.2	4.8	2.8	3.5		6.3	7.4	5.5	0.6	4.9	4.27	3.5	2.77	7.69	1480.22
	29-Nov	2.2	5.7	5.0	3.6	4.16		6.3	6.3	5.0	0.6	3.8	4.26	4.16	3.57	7.67	1487.89
	30-Nov	2.6	5.0	5.4	4.9	3.6		5.9	5.7	5.2	0.5	4.6	4.34	3.6	4.87	7.80	1495.69
December	01-Dec	3.3	5.3	5.8	5.0	2.6		5.6	4.9	5.1	0.4	4.7	4.27	2.6	4.98	7.68	1503.38
	02-Dec	3.8	6.6	5.4	5.0	2.5		5.3	4.6	4.5	1.0	3.4	4.21	2.5	5	7.58	1510.95
	03-Dec	3.8	6.7	6.4	5.7	2.5		6.6	4.7	3.8	1.0	2.2	4.34	2.5	5.7	7.81	1518.77
	04-Dec	3.9	5.9	5.5	7.1	1.94		6.2	4.3	3.0	1.3	2.2	4.14	1.94	7.1	7.45	1526.21
	05-Dec	4.6	4.5	3.5	7.0	1.49		5.3		2.5	2.6	3.7	3.91	1.49	7	7.04	1533.25
	06-Dec	5.7	4.8	2.9	7.2	-0.68		4.9		2.6	3.7	2.8	3.77	0	7.22	6.78	1540.03
	07-Dec	6.3	4.7	2.0	7.6	-1.84		4.0		4.2	4.1	2.2	3.70	0	7.6	6.65	1546.69
	08-Dec	5.4	3.9	2.7	7.0	-1.23		3.7		4.4	3.7	3.9	3.71	0	6.96	6.67	1553.36
	09-Dec	4.7	3.6	3.3	7.1	-0.22		4.0		1.8	3.2	2.1	3.28	0	7.1	5.91	1559.26
	10-Dec	4.1	3.9	4.2	4.9	0.75		3.4		3.2	2.5	1.4	3.15	0.75	4.9	5.67	1564.93
	11-Dec	4.4	5.3	4.9	3.5	1.53		3.2		2.1	2.1	1.1	3.12	1.53	3.5	5.62	1570.56
	12-Dec	5.2	5.8	2.7	4.0	2.32		4.5	4.5	4.0	1.5	2.3	3.68	2.32	3.99	6.63	1577.18
	13-Dec	5.5	6.0	1.7	4.9	2.68		5.0	4.7	4.0	1.6	3.7	3.98	2.68	4.9	7.16	1584.34
	14-Dec	6.1	6.2	2.9	6.4	3.54		5.2	5.5	4.9	2.2	5.0	4.79	3.54	6.35	8.62	1592.96
	15-Dec	6.3	6.5	2.4	5.7	4.41		5.8	5.1	4.5	3.1	4.5	4.84	4.41	5.73	8.70	1601.67
	16-Dec	6.8	5.0	3.1	4.5	4.3		6.3	4.2	4.1	3.3	3.7	4.53	4.3	4.48	8.16	1609.83
	17-Dec	6.3	4.4	3.9	6.4	4.1		5.9	3.1	2.1	3.3	2.4	4.20	4.1	6.44	7.55	1617.38
	18-Dec	4.2	3.6	3.6	7.8	3		5.6	3.4	1.2	3.0	1.5	3.69	3	7.76	6.64	1624.02
	19-Dec	3.1	2.2	2.5	8.2	1.3		5.5			3.1	3.5	3.68	1.3	8.17	6.62	1630.64
	20-Dec	4.1	1.0	3.2	7.6	2.5		4.6	0.0		2.3	2.9	3.13	2.5	7.63	5.64	1636.28
	21-Dec	5.3	2.0	3.4	7.4	4.6		4.8	-0.4		2.1	5.5	3.85	4.6	7.41	6.93	1643.21
	22-Dec	5.3	2.6	3.9	5.3	5		4.7	-0.7		2.6	6.1	3.87	5	5.33	6.96	1650.17
	23-Dec	3.9	2.4	4.8	4.3	4.4		4.1	-0.7		3.2	5.5	3.54	4.4	4.31	6.37	1656.54
	24-Dec	3.9	1.4	4.4	4.7	4.7		3.9	-0.9		3.4		3.19	4.7	4.73	5.74	1662.28
	25-Dec	5.5	1.5	2.8	5.2	5.7		4.7	-0.5		2.6	5.9	3.71	5.7	5.17	6.67	1668.95
	26-Dec	6.6	1.2	2.5	5.1	7.01		4.5	0.0		2.4	5.8	3.90	7.01	5.12	7.02	1675.98
	27-Dec	4.5	0.4	1.9	4.4	6.05		3.6	1.9		1.5	6.2	3.37	6.05	4.35	6.07	1682.05
	28-Dec	4.2	0.3	-0.0	4.4	4.52		3.3	1.4		1.5	6.3	2.87	4.52	4.38	5.17	1687.21
	29-Dec	4.2	2.0	-0.4	5.0	4.65		3.2	1.8		2.4	5.7	3.17	4.65	5	5.70	1692.92
	30-Dec	4.2	2.1	-0.4	4.9	5.28		2.8	2.4		3.0	4.0	3.14	5.28	4.87	5.65	1698.57
	31-Dec	2.7	0.3	-0.4	5.9	5.5		2.5	2.5		2.9	3.4	2.82	5.5	5.92	5.07	1703.63
Sum of temps for devel. period =		694.58	1579.94	1343.21	1590.83	1148.77	935.3	1413.7	1416.2	762.8	1476.25	1378.1					
Number of days data avail. =		142	223	223	220	220	148	206	206	154	206	213					
Average daily temp. =		4.89141	7.08493	6.02336	7.23105	5.22168182	6.31959	6.86262	6.87476	4.95325	7.16626	6.46995					
					max.	min.											

1/ If min. or max is less than 0, number set at 0.



Recording thermograph data for Snow Creek from R. Cooper, WDFW - June 1996

Average daily stream temperatures for Snow Creek, Jefferson County, Washington, with cumulative daily temperature unit averages in degrees Farenheit.

1977-1989

Data from R. Cooper, Fish Management Division, Washington Department of Fish and Wildlife - June, 1996

Month/day		Year 1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1977-89 Average	Daily TUs (F) 1977-89 avg	Avg. Cumm. TUs 9/1-12/31	1/1-5/1
January	01-Jan	1.3	0.6	-0.2	6.1	6.5	0.2		-0.4	0.7	3.3	5.1	2.1	5.2	2.54	4.57		1790.50
	02-Jan	2.9	0.5	-0.1	5.9	6.0	0.2		0.9	0.7	2.7	5.1	2.1	5.6	2.70	4.86		1795.37
	03-Jan	3.8	1.8	-0.1	4.2	5.5	0.2	2.3	0.9	0.7	3.0	5.2	2.4	4.7	2.65	4.78		1800.14
	04-Jan	3.4	3.2	-0.0	3.6	5.8	0.2	2.5	1.9	0.7	2.4	5.2	1.4	4.0	2.63	4.74		1804.88
	05-Jan	1.6	4.6	-0.1	3.5	5.6	0.2	3.2	1.9	0.7	3.8	3.9	2.2	4.7	2.75	4.95		1809.83
	06-Jan	1.0	3.2	-0.1	2.3	5.6	0.2	3.2	2.2	0.7	3.0	2.8	1.5	5.3	2.37	4.27		1814.10
	07-Jan	1.1	3.6	-0.2	2.1	5.2	0.2	4.2		0.9	3.7	2.2	2.0	5.4	2.53	4.56		1818.66
	08-Jan	0.9	5.1	-0.2	1.8	5.6	0.9	4.0		0.9	4.7	1.5	2.0	5.8	2.75	4.95		1823.61
	09-Jan	0.8	5.4	0.1	1.7	5.9	1.9	3.5	3.1	1.2	4.7	2.1	3.1	5.0	2.96	5.33		1828.93
	10-Jan	0.9	5.5	0.2	1.1	5.2	2.5	4.4	3.1	1.8	4.7	4.2	3.0	5.1	3.21	5.78		1834.71
	11-Jan	1.4	5.5	0.3	1.6	4.6	2.9	4.4	2.9	2.5	4.6	7.3	2.3	5.0	3.48	6.26		1840.98
	12-Jan	2.6	5.3	0.9	2.5	4.3	2.8	3.3	2.3	3.0	4.6	5.9	2.5	5.1	3.47	6.24		1847.22
	13-Jan	3.5	5.4	1.3	3.3	3.6	3.3	3.9	1.1	2.8	4.6	4.9	3.6	5.6	3.60	6.48		1853.70
	14-Jan	4.4	6.2	1.1	3.3	3.1	3.9	2.5	-0.4	3.3	4.8	3.4	5.5	6.0	3.62	6.52		1860.22
	15-Jan	5.1	6.3	1.6	3.8	3.0	3.9	1.8	-1.8	4.2	5.4	2.0	4.7	5.0	3.46	6.23		1866.46
	16-Jan	5.5	5.8	2.0	4.1	3.2	4.4	2.6	-0.9	4.1	5.8	2.5	4.1	3.4	3.59	6.46		1872.91
	17-Jan	6.1	5.9	2.3	3.1	4.8	4.0	4.3	-1.5	4.0	5.1	2.9	3.4	4.4	3.74	6.74		1879.65
	18-Jan	7.1	6.4	1.4	2.4	5.7	4.3	4.9	-2.3	5.0	5.9	3.4	3.2	4.6	4.00	7.19		1886.84
	19-Jan	6.8	6.7	2.1	1.4	6.7	3.9	4.7	-1.8	5.3	6.2	3.1	2.2	4.1	3.96	7.12		1893.97
	20-Jan	5.6	6.2	3.4	2.2	6.9	4.7	4.3	-1.9	5.2	5.8	3.1	2.8	5.0	4.11	7.39		1901.36
	21-Jan	5.8	7.2	2.6	3.0	8.2	3.7	3.1	0.0	3.9	5.9	2.2	3.1	4.8	4.12	7.41		1908.77
	22-Jan	4.3	5.6	1.7	2.7	8.0	2.7	3.1	1.2	4.5	5.8	3.1	3.3	5.2	3.94	7.10		1915.87
	23-Jan	3.3	4.7	2.4	2.8	7.1	3.8	3.7	1.6	4.1	5.6	4.2	3.2	5.2	3.98	7.17		1923.03
	24-Jan	2.9	5.2	2.2	3.5	6.4	4.7	5.0	2.4	4.1	5.6	4.6	2.6	4.8	4.15	7.46		1930.50
	25-Jan	2.8	5.4	2.1	2.9	5.6	5.6	4.8	2.7	4.7	4.9	4.2	2.6	5.0	4.10	7.38		1937.88
	26-Jan	2.3	5.7	1.6	1.1	5.3	6.2	5.2	2.0	3.2	4.7	3.8	3.2	4.1	3.72	6.70		1944.58
	27-Jan		5.6	1.5	-0.2	5.0	4.8	5.4	2.7	3.2	6.3	4.1	4.1	4.6	3.93	7.08		1951.65
	28-Jan	2.3	5.7	1.8	-0.4	5.5	5.4	4.7	3.3	3.8	6.3	5.2	5.4	5.2	4.16	7.49		1959.15
	29-Jan	3.0	5.9	0.8	-0.4	5.6	5.7	4.9	2.7	3.8	5.9	5.4	5.3	5.1	4.13	7.43		1966.58
	30-Jan	4.0	4.3	0.3	-0.3	4.7	6.3	5.7	1.9	2.4	5.9	5.5	5.0	5.4	3.94	7.08		1973.66
	31-Jan	5.1	4.3	0.1	0.8	4.7	5.7	4.4	1.0	3.3	5.9	5.1	3.2	6.6	3.86	6.94		1980.61
February	01-Feb	4.0	5.0	0.1	2.3	5.1	6.3	3.7	1.5	2.9	6.4	4.8	3.2	6.2	3.96	7.13		1987.74
	02-Feb	5.0	5.4	-0.1	3.6	4.9	6.1	3.3	1.3	2.4	5.9	4.1	3.2	5.9	3.92	7.06		1994.81
	03-Feb	4.5	5.7	0.8	3.2	4.0	4.2	2.6	1.3	1.8	7.1	4.3	4.1	5.6	3.78	6.81		2001.61
	04-Feb	4.3	6.5	1.9	2.6	3.6	2.5	2.6	1.0	0.4	7.0	6.2	4.1	5.5	3.71	6.68		2008.30
	05-Feb	4.7	7.4	2.3	2.9	3.6	2.5	2.1	1.0	1.3	6.1	7.0	4.1	4.7	3.82	6.88		2015.18
	06-Feb	4.1	7.2	2.5	4.5	2.9	3.0	2.9	4.3	1.9	5.0	6.9	5.3	4.1	4.20	7.57		2022.75
	07-Feb	4.7	7.3	2.0	4.0	3.6	3.0	4.1	3.5	2.6	4.0	5.7	5.0	4.1	4.12	7.41		2030.16
	08-Feb	5.0	6.6	3.5	4.2	3.3	2.4	2.7	5.4	1.7	3.3	6.3	5.6	4.1	4.16	7.49		2037.65
	09-Feb	5.7	6.5	4.2	4.0	3.7	1.9	3.8	4.7	3.0	3.3	6.5	6.0	4.1	4.41	7.93		2045.58
	10-Feb	6.6	5.6	3.5	3.3	1.1	1.0	3.6	3.1	3.4	3.5	7.8	6.5	4.0	4.08	7.34		2052.93
	11-Feb	7.8	5.0	3.2	3.8	1.0	2.8	5.6	3.7	3.5	4.2	8.0	7.0	4.0	4.59	8.27		2061.19
	12-Feb	7.4	4.8	4.0	3.3	3.2	4.3	6.1		3.5	3.3	7.1	7.2	3.8	4.83	8.70		2069.89
	13-Feb	8.3	4.8	4.2	3.3	5.2	5.7	5.5		3.5	2.4	8.0	6.9	3.8	5.12	9.22		2079.11
	14-Feb	7.1	4.7	2.6	2.8	6.2	6.0	5.6	3.5	4.0	3.7	7.6	6.8	3.8	4.95	8.91		2088.03
	15-Feb	5.7	4.3	2.9	1.9	6.3	7.5	5.2	3.0	4.8	3.6	7.5	6.4	3.7	4.82	8.68		2096.71

	16-Feb	5.9	3.6	3.4	2.7	6.9	6.7	5.5	3.2	4.0	3.8	7.0	5.7	3.7	4.78	8.60	2105.30
	17-Feb	6.5		3.4	3.7	5.9	6.4	5.9	1.9	3.5	2.9	7.0	5.3	3.7	4.68	8.42	2113.72
	18-Feb	7.7		4.2	5.7	6.1	5.8	5.4	3.4	3.9	2.1	6.1	5.5	3.7	4.96	8.93	2122.65
	19-Feb	8.6		4.1	5.7	6.5	7.0	5.5	3.9	4.9	1.7	6.2	5.8	3.7	5.30	9.55	2132.20
	20-Feb	7.4	6.6	3.8	5.0	5.8	6.3	5.5	4.8	4.9	1.7	6.9	6.1	4.0	5.29	9.52	2141.73
	21-Feb	7.6	7.2	4.2	4.7	6.3	5.2	5.6	4.1	5.5	1.7	7.0	5.7	4.2	5.30	9.53	2151.26
	22-Feb	7.1	7.3	3.3	4.4	6.4	5.3	7.4	3.0	5.8	5.9	6.1	5.0	4.7	5.52	9.94	2161.20
	23-Feb	6.6	7.3	3.8	4.3	6.4	4.5	7.9	2.9	6.4	5.9	5.8	4.6	4.7	5.47	9.84	2171.04
	24-Feb	5.5	6.1	4.4	5.8	6.2	4.8	7.0	3.6	6.8	6.4	5.5	5.0	4.2	5.47	9.85	2180.89
	25-Feb	5.7	6.3	5.5	6.5	6.3	5.2	6.6	3.7	4.2	6.8	4.4	5.7	4.7	5.50	9.91	2190.80
	26-Feb	5.1	6.2	5.1	7.1	5.9	5.2	7.0	2.3	5.1	7.2	4.8	5.7	4.7	5.48	9.87	2200.67
	27-Feb	5.7	4.5	4.7	7.0	5.5	4.8	6.4	4.5	4.8	7.8	5.1	5.6	4.7	5.47	9.84	2210.51
	28-Feb	6.9	4.7	4.3	7.3	5.0	5.6	5.5	5.0	5.8	7.2	3.9	5.5	4.8	5.50	9.90	2220.41
March	01-Mar	5.7	4.1	4.8	6.4	6.0	6.6	5.8	4.4		6.9		5.5		5.62	10.11	2230.53
	02-Mar	5.0	3.9	4.4	7.0	6.5	6.0	6.2	4.7	5.8	6.7	5.0	8.1	5.6	5.75	10.36	2240.88
	03-Mar	5.7	3.7	4.9	7.3	6.8	6.2	6.5	4.2	5.0	6.8	6.5	8.5	5.3	5.94	10.70	2251.58
	04-Mar	5.7	5.3	6.9	7.3	6.2	6.1	6.4	3.4	4.5	7.8	7.6	8.8	5.1	6.23	11.21	2262.79
	05-Mar	6.7	6.1	6.9	7.0	5.2	6.2	5.9	4.0	5.5	7.4	8.1	7.0	6.0	6.30	11.35	2274.13
	06-Mar	6.9	6.4	7.4	6.0	5.2	5.7	6.9	4.6	6.0	7.4	8.9	6.4	4.4	6.32	11.37	2285.50
	07-Mar	6.4	7.1	6.8	5.1	6.0	6.9	7.6	4.8	6.1	8.8	7.8	6.1	3.7	6.40	11.52	2297.03
	08-Mar	5.8	7.5	5.5	6.0	5.9	6.9	7.8	5.1	5.1	8.6	7.8	6.1	4.5	6.34	11.42	2308.45
	09-Mar	5.8	7.3	5.5	5.6	6.2	6.4	8.7	6.2	5.2	8.9	7.0	6.6	4.0	6.42	11.55	2320.00
	10-Mar	5.2	6.6	5.8	6.7	6.8	7.2	8.1	6.4	5.3	8.4	7.9	7.4	4.5	6.64	11.95	2331.95
	11-Mar	6.0	6.8	6.0	6.3	7.8	6.5	7.7	6.4	5.6	8.9	8.3	6.0	3.5	6.60	11.89	2343.84
	12-Mar	6.2	6.0	6.6	5.5	7.2	6.6	7.5	6.1	4.4	9.0	8.5	5.1	3.0	6.28	11.31	2355.14
	13-Mar	5.3	7.0	6.0	4.7	7.8	6.1	6.7	6.2	5.3	8.0	9.0	5.1	3.2	6.18	11.13	2366.27
	14-Mar	4.9	5.9	6.7	4.5	8.0	6.7	6.9	6.1	5.7	8.8	8.9	6.0	4.1	6.40	11.51	2377.78
	15-Mar	5.1	6.7	7.0	4.8	8.0	5.4	7.0	5.7	6.1	8.2	8.7	5.7	4.9	6.40	11.52	2389.31
	16-Mar	5.3	7.4	6.5	4.7	7.3	6.3	6.7	6.2	6.4	8.0	7.9	7.1	5.0	6.51	11.73	2401.03
	17-Mar	5.4	7.5	6.2	4.9	6.5	6.3	6.9	5.7	6.3	7.1	8.0	6.8	5.4	6.38	11.48	2412.51
	18-Mar	6.0	8.0	6.8	5.5	6.5	5.1	6.9	5.6	6.6	8.3	7.7	6.8	5.0	6.52	11.74	2424.26
	19-Mar	6.2	8.5	7.3	5.2	7.4	7.4	6.6	5.9	6.7	9.5	7.5	7.1	5.8	7.01	12.62	2436.87
	20-Mar	5.9	8.9	7.2	6.1	7.9	6.5	6.9	6.5	7.8	9.3	6.6	5.8	5.5	6.99	12.59	2449.46
	21-Mar	6.3	9.3	7.1	6.9	9.3	7.0	8.0	7.4	8.4	9.1	7.9	5.8	5.6	7.55	13.58	2463.04
	22-Mar	7.6	9.6	7.7	6.2	9.9	7.2	8.9	6.4	7.1	8.8	7.3	5.7	5.5	7.53	13.56	2476.60
	23-Mar	7.9	10.2	7.6	6.2	8.5	7.4	8.9	6.4	6.3	8.5	7.1	7.9	5.8	7.59	13.67	2490.27
	24-Mar	7.1	9.4	7.8	5.4	8.4	9.0	7.8	6.3	6.3	8.2	7.6	8.0	4.8	7.40	13.31	2503.58
	25-Mar	6.8	9.4	7.9	5.6	8.6	7.1	8.0	6.1	5.7	7.8	8.7	6.4	6.5	7.27	13.09	2516.67
	26-Mar	6.9	9.6	7.5	5.7	9.4	6.9	7.3	5.4	5.7	9.6	8.0	6.5	5.4	7.22	12.99	2529.66
	27-Mar	7.1	9.6	7.3	6.0	8.3	6.2	6.6	6.7	5.5	11.0	6.7	6.4	5.6	7.16	12.89	2542.55
	28-Mar	6.0	9.3	6.9	5.9	8.9	5.3	6.5	6.7	6.5	10.4	6.7	5.2	5.2	6.89	12.40	2554.95
	29-Mar	6.1	10.1	6.8	6.8	8.8	6.6	7.1	6.5	6.2	9.8	6.5	8.0	5.4	7.28	13.11	2568.06
	30-Mar	6.8	9.6	7.1	7.4	8.3	5.9	6.8	6.6	6.4	9.3	7.2	6.5	5.4	7.18	12.92	2580.98
	31-Mar	6.3	8.9	6.2	6.7	7.5	6.6	7.1	6.2	7.3	8.8	7.4	7.2	5.4	7.04	12.67	2593.65
April	01-Apr	8.2	8.6	5.7	6.7	7.4	6.1	6.6	7.4	8.7	9.2	9.1	7.2	5.5	7.41	13.34	2606.99
	02-Apr	8.1	8.3	6.6	6.7	7.1	6.3	6.2	6.0	8.9	8.4	9.5	7.2	5.3	7.27	13.09	2620.08
	03-Apr	7.8	9.7	6.0	7.7	7.0	6.4	6.6	6.9	9.6	9.3	11.1	7.2	5.8	7.78	14.00	2634.08
	04-Apr	6.8	9.1	7.2	7.8	7.0	7.5	8.3	6.8	7.4	9.7	10.9	6.7	4.3	7.65	13.78	2647.85
	05-Apr	9.8	9.1	7.9	8.8	8.4	8.1	7.7	6.9	6.8	9.2	10.9	8.2	4.0	8.14	14.64	2662.50
	06-Apr	9.6	7.8	7.7	9.1	6.7	7.5	7.4	6.1	7.3	9.5	10.9	8.6	3.5	7.82	14.07	2676.57
	07-Apr	10.5	8.6	7.6	7.5	6.9	7.2	7.6	5.9	7.9	10.6	9.3	8.6	3.0	7.79	14.03	2690.60
	08-Apr	9.8	9.2	8.0	6.4	7.9	7.8	6.4	6.5	8.1	10.6	10.5	7.9	2.5	7.81	14.06	2704.66
	09-Apr	8.6	9.7	7.3	6.6	7.5	8.4	6.9	6.0	9.9	10.0	9.4	8.7	4.0	7.92	14.25	2718.91
	10-Apr	8.6	10.3	6.4	7.0	7.1	8.9	6.5	5.2	10.4	8.8	9.4	8.9	4.0	7.80	14.04	2732.95
	11-Apr	8.8	8.8	7.1	6.8	6.7	9.4	6.4	5.2	10.4	9.1	10.7	9.9	4.2	7.95	14.32	2747.27
	12-Apr	8.5	8.9	7.1	7.1	6.5	7.0	7.0	4.9	11.3	8.7	9.4	10.7	4.3	7.80	14.04	2761.31
	13-Apr	8.7	8.5	6.8	8.6	6.9	6.4	6.7	5.4	12.2	8.5	9.4	11.7	4.5	8.02	14.43	2775.74
	14-Apr	7.9	8.1	6.9	9.7	7.9	6.6	7.3	5.6	11.8	7.8	10.4	11.8	4.8	8.19	14.75	2790.49

	15-Apr	8.8	9.2	6.5	9.7	9.0	7.2	8.0	7.8	12.5	9.5	11.9	11.8	5.0	8.99	16.18	2806.67
	16-Apr	8.4	7.6	6.1	9.0	9.2	6.8	8.8	8.0	11.0	8.5	11.2	12.3	5.2	8.63	15.53	2822.20
	17-Apr	7.7	8.1	7.0	9.4	9.5	6.4	9.2	7.4	12.0	8.6	10.7	12.3	5.5	8.75	15.75	2837.95
	18-Apr	8.0	9.2	7.0	9.8	9.5	7.9	10.9	8.0	10.4	8.9	9.9	12.3	5.3	9.02	16.23	2854.17
	19-Apr	7.2	9.6	7.2	11.0	10.6	8.6	10.6	8.5	9.3	9.4	8.5	10.3	5.8	8.97	16.14	2870.32
	20-Apr	8.3	9.1	7.8	10.1	9.8	8.5	10.7	7.5	8.1	10.2	8.0	12.3	4.9	8.86	15.95	2886.27
	21-Apr	8.6	8.3	8.3	9.7	10.1	9.8	10.2	7.8	8.2	10.1	8.3	13.3	6.4	9.16	16.48	2902.75
	22-Apr	11.8	7.8	9.5	9.6	11.0	10.9	8.7	7.6	7.9	9.6	9.5	11.9	7.1	9.46	17.02	2919.77
	23-Apr	12.3	7.8	10.3	9.8	12.1	8.7	10.1	7.6	8.4	8.2	10.2	10.4	6.7	9.44	16.99	2936.76
	24-Apr	12.8	9.2	10.4	10.6	10.7	9.2	9.8	7.4	8.7	7.9	11.5	9.7	6.5	9.56	17.21	2953.98
	25-Apr	12.7	10.1	10.8	9.5	9.4	8.8	8.2	6.0	8.0	8.0	11.0	8.3	8.3	9.16	16.49	2970.46
	26-Apr	11.8	10.7	10.9	9.1	9.1	9.9	8.9	6.6	8.7	8.8	9.9	8.4	6.9	9.22	16.59	2987.05
	27-Apr	12.1	10.3	11.8	10.7	9.3	9.9	9.5	7.0	10.2	8.3	10.8	10.0	7.6	9.80	17.65	3004.70
	28-Apr	12.3	9.5	12.2	11.7	10.2	9.3	10.2	8.0	10.8	8.3	11.6	10.9	6.6	10.12	18.22	3022.92
	29-Apr	12.2	9.6	12.0	10.5	11.7	8.9	10.8	8.7	9.8	7.9	13.2	12.2	7.5	10.39	18.69	3041.61
	30-Apr	12.5	9.3	12.0	9.6	12.4	9.8	11.3	7.6	10.1	8.2	13.1	12.1	6.0	10.31	18.56	3060.17
May	01-May	12.7	9.8	11.4	10.1	11.4	11.2	10.5		9.6	9.1	13.4	10.0	6.5	10.48	18.86	3079.03
	02-May	12.1	10.3	11.5	11.5	10.7	10.5	10.2	7.9	10.5	9.2	12.1	7.8	7.9	10.16	18.29	3097.32
	03-May	10.4	9.6	11.4	11.0	10.0	9.9	9.9	7.7	12.0	9.1	11.2	7.8	8.2	9.86	17.75	3115.07
	04-May	9.3	9.2	11.9	10.4	9.1	9.0	9.5	6.8	12.1	9.1	12.0	8.4	8.5	9.63	17.34	3132.41
	05-May	9.5	9.3	11.5	11.7	8.8	10.0	9.3	7.3	10.6	9.5	12.2	8.8	8.1	9.74	17.53	3149.94
	06-May	10.2	9.7	10.5	12.5	8.9	11.0	10.7		10.4	10.7	13.1	7.7	7.9	10.28	18.50	3168.44
	07-May	11.4	10.4	10.0	11.7	8.9	11.0	9.7		11.4	11.3	14.2	7.8	7.5	10.45	18.81	3187.25
	08-May	11.5	11.9	9.7	11.9	9.4	10.8	8.6	7.9	11.4	10.6	10.5	9.3	7.6	10.09	18.16	3205.41
	09-May	11.9	11.8	9.6	11.1	9.7	11.5	8.9	8.6	10.8	10.9	16.4	10.1	10.5	10.90	19.62	3225.03
	10-May	11.7	11.1	9.8	11.8	9.3	12.0	9.1	7.7	10.0	10.4	16.0	10.4	11.6	10.84	19.51	3244.54
	11-May	10.1	10.5	10.0	12.4	9.6	10.8	10.1	8.4	10.6	9.8	15.8	11.9	11.4	10.88	19.58	3264.12
	12-May	9.1	10.7	10.2	13.3	10.0	10.3	10.9	9.5	8.0	10.3	14.8	12.7	11.8	10.89	19.60	3283.71
	13-May	9.5	11.2	11.1	11.9	10.6	10.6	11.8	9.2	9.5	10.7	14.1	13.3	11.2	11.13	20.03	3303.75
	14-May	9.3	11.2	11.5	10.8	10.2	10.7	10.8	8.4	9.9	10.0	13.0	13.0	11.2	10.78	19.40	3323.14
	15-May	9.1	10.5	11.9	10.1	9.9	11.5	8.7	9.3	11.0	9.8	13.3	12.2	11.3	10.66	19.19	3342.34
	16-May	9.2	9.9	11.5	9.9	9.7	12.3	9.3	8.1	11.4	10.1	12.4	13.2	11.5	10.65	19.16	3361.50
	17-May	9.4	11.0	11.1	10.0	10.0	12.7	9.4	8.0	13.2	10.3	11.8	12.7	12.7	10.95	19.71	3381.22
	18-May	10.1	11.6	11.6	11.3	10.8	10.0	9.5	8.4	14.6	10.3	12.0	11.6	11.6	11.02	19.84	3401.05
	19-May	10.9	13.0	11.3	11.8	10.7	10.3	10.0	8.4	15.5	13.3	12.1	10.7	10.7	11.44	20.59	3421.64
	20-May	11.8	13.9	11.8	11.3	10.6	10.6	11.5	9.8	14.0	14.1	11.2	11.7	11.7	11.85	21.33	3442.97
	21-May	11.9	12.0	12.9	11.0	10.3	12.3	11.6		12.0	14.0	11.7	12.2	11.7	11.97	21.54	3464.51
	22-May	11.5	10.8	13.2	10.9	11.0	12.0	11.9	9.1	12.7	13.8	11.6	13.0	12.2	11.81	21.26	3485.77
	23-May	11.3	10.5	13.9	9.7	11.9	11.3	13.8	8.4	13.8	13.8	11.1	13.9	13.9	12.10	21.78	3507.55
	24-May	10.3	10.3	14.1	8.1	12.8	12.9	13.8	8.9	14.2	13.6	11.1	10.7	10.7	11.66	20.98	3528.53
	25-May	10.0	11.3	14.2	8.4	11.6	13.7	14.2	8.6	14.2	13.4	11.7	10.8	10.8	11.76	21.17	3549.70
	26-May	10.7	11.7	13.8	9.5	10.8	11.9	13.9	7.7	14.3	13.0	11.7	11.4	11.7	11.71	21.07	3570.78
	27-May	9.9	12.2	11.9	9.9	11.0	12.6	13.3	8.9	14.9	12.8	12.5	11.7	13.0	11.89	21.40	3592.18
	28-May	9.8	11.3	11.2	9.9	11.6	13.3	15.3	10.5	13.6	11.2	12.2	13.0	12.0	11.92	21.45	3613.63
	29-May	10.0	10.0	11.4	9.7	12.2	14.1	16.2	11.8	13.5	11.0	12.4	12.0	10.4	11.90	21.42	3635.04
	30-May	10.2	11.0	12.4	9.8	11.7	13.7	14.8	12.5	13.6	10.3	12.2	10.4	11.0	11.80	21.25	3656.29
	31-May	10.9	12.6	13.4	10.8	11.3	14.3	14.2	11.0	13.3	10.6	12.4	11.0	14.4	12.32	22.17	3678.46
June	01-Jun	11.3	13.8	14.4	11.2	11.7	12.9	13.2	9.1	12.9	10.3	11.2	10.7	13.3	12.00	21.59	
	02-Jun	9.9	14.9	15.4	10.6	12.0	11.9	12.8	9.4	13.5	17.0	11.3	11.7	14.0	12.64	22.75	
	03-Jun	10.0	15.9	16.0	10.0	12.0	11.7	12.1	10.0	13.4	17.8	12.4	10.6	13.6	12.73	22.91	
	04-Jun	10.5	16.7	14.5	10.1	11.9	11.9		9.8	13.4	17.6	14.1	10.6	13.2	12.86	23.15	
	05-Jun	11.4	17.8	13.6	9.8	12.1	11.6		10.2	13.4	16.1	15.8	10.5	12.4	12.89	23.20	
	06-Jun	11.4	17.4	12.5	9.8	12.1	11.8	14.5	10.5	13.3	15.9	15.7	11.2	12.6	12.97	23.35	
	07-Jun	13.3	16.9	12.7	10.1	11.5	11.6	14.2	10.8	13.3	14.8	15.0	11.6	12.8	12.97	23.34	
	08-Jun	13.3	15.5	13.5	10.5	11.2	11.8	14.4	9.9	13.4	14.1	15.2	12.0	13.8	12.96	23.33	
	09-Jun	12.6	14.7	14.1	10.6	11.2	13.2	13.9	10.0	13.4	14.1	14.4	12.2	13.2	12.90	23.21	
	10-Jun	13.2	13.9	14.6	10.7	10.4	14.3	13.0	9.5	13.4	13.9	14.0	11.9	13.1	12.75	22.95	
	11-Jun	13.7	14.5	13.7	11.5	10.3	15.2	12.3	9.5	13.5	14.9	13.4	12.4	12.9	12.91	23.23	

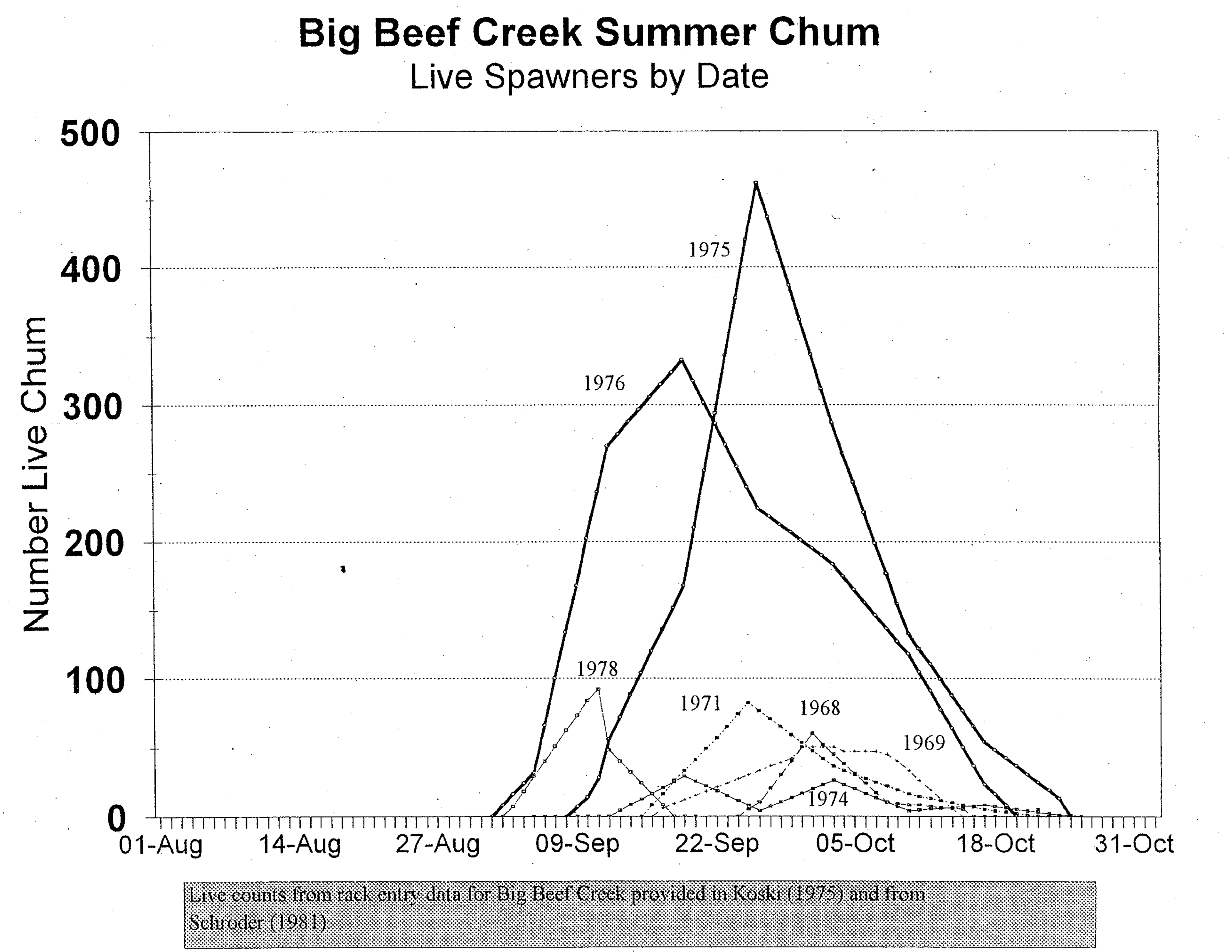
	12-Jun	13.7	14.4	12.7	12.0	9.9	15.6	12.3	10.6	13.5	14.7	14.0	12.7	14.0	13.09	23.56
	13-Jun	14.2	13.6	12.6	12.5	9.1	14.6	13.4	11.4	13.3	14.9	15.7	13.1	13.9	13.25	23.86
	14-Jun	14.1	12.6	12.9	12.8	10.0	15.3	13.0	12.5	13.3	15.8	15.5	15.8	15.2	13.75	24.75
	15-Jun	14.0	11.7	13.1	12.3	10.7	15.1	12.4	12.6	13.5	14.0	15.3	16.2	16.0	13.60	24.49
	16-Jun	14.1	12.4	13.1	12.2	10.5	16.1	11.9	11.5	13.9	15.4	15.2	12.7	15.0	13.39	24.10
	17-Jun	14.7	13.2	12.1	11.7	10.6	16.2	11.9	10.6	13.2	13.4	14.0	13.1	14.3	13.00	23.40
	18-Jun	15.0	14.0	12.5	11.5	10.6	16.8	10.3	11.0	15.3	12.9	13.4	15.7	13.4	13.26	23.87
	19-Jun	14.2	14.4	12.1	11.9	10.7	17.2	10.1	11.1	16.2	12.3	14.5	15.5	13.6	13.36	24.05
	20-Jun	13.9	15.1	11.9	12.7	10.6	16.7	10.5	11.4	16.5	12.4	15.5	15.5	12.9	13.49	24.29
	21-Jun	14.6	14.6	12.1	13.4	10.7	14.6	11.3	10.8	16.0	13.2	15.2	15.7	11.1	13.32	23.97
	22-Jun	14.0	13.7	12.8	13.2	10.7	15.1	11.4	11.4	15.2	14.3	14.5	16.2	11.1	13.37	24.06
	23-Jun	13.6	13.3	13.2	12.8	10.4	14.9	11.9	12.0	13.9	16.1	13.7	15.8	12.3	13.38	24.08
	24-Jun	13.8	14.8	14.4	12.2	11.6	15.3	11.8	12.8	12.3	17.6	13.9	14.6	12.9	13.69	24.65
	25-Jun	13.9	14.5	15.3	12.3	12.7	15.2		13.4	12.9	16.7	14.8	15.1	13.6	14.20	25.56
	26-Jun	13.2	14.9	15.6	11.9	12.7	14.0		13.5	13.6	15.3	16.4	16.2	14.9	14.34	25.81
	27-Jun	13.3	15.8	15.0	10.9	12.6	14.7	13.9	13.6	14.9	17.0	17.6	15.8	14.7	14.60	26.28
	28-Jun	12.9	17.2	15.1	11.2	13.0	15.4	13.2	13.4	14.7	17.0	17.6	15.4	14.5	14.67	26.40
	29-Jun	13.1	16.4	13.9	11.6	14.1	16.0	13.0	12.9	14.5	15.5	18.4	15.3	14.6	14.56	26.20
	30-Jun	13.7	15.6	13.1	11.6	13.4	14.4	12.7	11.1	14.6	15.8	18.7	15.5	14.3	14.20	25.56
July	01-Jul	13.2	16.0	12.1	12.3	13.4	12.9	13.0	11.1	14.4	16.0	19.5	15.0	14.0	14.07	25.33
	02-Jul	12.5	15.4	11.7	13.3	14.0	13.7	11.9	11.4	14.5	16.3	18.7	14.5	14.9	14.06	25.31
	03-Jul	12.2	14.3	12.8	13.1	15.1	12.7	12.3	12.5	15.0	14.7	17.9	14.0	14.8	13.95	25.12
	04-Jul	12.8	13.1	13.8	13.2	16.0	12.2	13.0	13.1	16.0	13.9	17.2	14.1	14.4	14.06	25.32
	05-Jul	11.8	13.8	14.9	12.8	15.5	12.1	11.4	13.9	17.0	15.3	16.3	14.0	13.9	14.06	25.30
	06-Jul	12.1	14.6	14.6	12.6	14.1	13.0	11.4	13.1	18.3	15.7	15.4	11.4	14.4	13.90	25.02
	07-Jul	12.6	15.6	14.6	13.3	12.9	12.5	11.6	11.5	18.4	16.3	14.2	13.2	14.5	13.94	25.09
	08-Jul	13.1	15.0	16.3	14.0	13.6	13.0	11.5	11.7	18.4	16.9	15.5	13.2	15.0	14.39	25.91
	09-Jul	13.1	14.2	17.0	15.1	13.9	13.9	11.0		18.4	17.5	15.3	15.0	15.9	15.02	27.03
	10-Jul	13.0	12.6	16.0	14.2	13.3	14.1	12.4	12.6	18.1	16.5	14.3	16.1	16.9	14.62	26.32
	11-Jul	13.2	13.1	15.8	13.8	12.9	14.1	12.9	13.0	18.2	16.2	15.0	16.1	15.5	14.60	26.28
	12-Jul	12.9	14.3	15.3	13.5	13.8	15.0	12.9	11.9	18.6	15.6	16.3	14.2	15.2	14.58	26.25
	13-Jul	12.9	15.6	14.5	13.7	13.8	13.5	12.9	12.3	18.1	15.4	16.6	14.9	14.9	14.53	26.15
	14-Jul	13.8	16.2	15.4	13.3	13.7	12.8	12.3	12.4	17.9	14.5	17.4	14.5	14.2	14.50	26.09
	15-Jul	14.0	16.4	16.1	13.5	14.3	11.9	11.8	13.0	17.9	14.6	18.0	14.4	14.4	14.64	26.35
	16-Jul	13.3	15.2	17.8	14.1	15.4	12.6	12.5	14.2	18.5	14.3	16.4	14.6	14.5	14.88	26.78
	17-Jul	13.1	14.6	18.6	14.0	15.5	13.7		13.2	18.3	14.5	16.4	15.3	14.8	15.16	27.28
	18-Jul	12.8	15.3	18.6	14.2	15.5	14.1	14.8	12.7	18.7	14.7	16.9	15.5	15.0	15.30	27.53
	19-Jul	13.2	16.3	18.6	14.6	15.0	13.4	13.7	12.2	19.3	15.7	18.2	20.5	17.0	15.98	28.76
	20-Jul	13.6	17.3	18.8	14.5	14.9	12.5	14.3	11.9	17.8	16.5	18.0	19.5	17.3	15.91	28.63
	21-Jul	14.2	17.8	17.8	15.9	14.6	11.8	14.9	11.6	19.9	16.7	16.9	19.0	17.0	16.00	28.80
	22-Jul	14.0	18.4	16.9	17.4	14.7	12.1	14.7	11.2	19.2	17.5	17.6	18.5	17.0	16.09	28.96
	23-Jul	14.7	18.7	17.0	17.9	15.4	12.9	14.9	10.9	19.1	17.3	17.6	18.7	17.7	16.36	29.46
	24-Jul	15.5	17.2	17.1	16.5	16.1	13.8	15.2	15.6	18.0	17.2	17.7	18.0	16.9	16.52	29.74
	25-Jul	15.3	17.9	17.0	16.0	16.8	15.1	13.4	15.9	18.0	16.9	16.8	20.5	18.5	16.77	30.19
	26-Jul	15.1	17.2	17.1	16.4	17.6	15.6	12.9	16.3	18.0	16.7	17.0	19.0	17.9	16.67	30.01
	27-Jul	14.8	16.8	16.3	16.7	18.0	15.8	13.9	15.6	17.9	16.4	16.3	18.5	17.1	16.46	29.64
	28-Jul	14.4	16.6	15.4	17.1	15.6	15.4	13.8	15.0	18.1	15.3	16.7	18.7	17.0	16.09	28.96
	29-Jul	14.4	16.7	15.4	16.7	14.7	15.4	13.4	15.3	18.6	15.3	16.5	18.0	16.2	15.89	28.60
	30-Jul	15.7	17.0	17.1	16.1	14.9	14.0	14.6	15.2	19.3	15.5	15.9	20.5	16.2	16.31	29.35
	31-Jul	16.1	16.4	17.6	16.1	14.7	13.0	15.8	15.3	18.7	16.2	15.4	19.5	17.0	16.29	29.33
August	01-Aug	16.5	16.0	16.7	16.2	14.8	12.1	14.9	15.3	18.2	18.0	15.2	19.5	17.5	16.22	29.20
	02-Aug	17.0	16.1	16.4	15.9	13.8	12.9	15.1	15.0	17.4	18.5	15.2	18.7	16.2	16.01	28.82
	03-Aug	17.2	16.4	16.0	15.3	13.9	12.1	14.9	15.2	16.6	18.5	15.8	18.0	16.1	15.84	28.51
	04-Aug	16.9	17.1	15.7	15.0	14.1	12.2	14.2	14.7	18.4	17.4	17.4	20.5	17.6	16.24	29.23
	05-Aug	16.9	16.8	14.8	14.5	14.6	11.9	14.5	15.3	18.3	18.2	17.4	19.0	17.9	16.16	29.09
	06-Aug	16.9	17.1	15.3	14.8	16.0	13.1	15.6	14.2	17.4	18.4	17.1	18.5	17.2	16.28	29.30
	07-Aug	16.6	18.3	15.5	14.9	17.4	14.4	15.9	14.0	17.2	19.4	17.5	20.5	17.4	16.84	30.31
	08-Aug	16.3	18.5	15.9	15.4	18.5	14.1	16.6	14.9	17.1	19.3	17.7	19.5	17.2	17.00	30.61

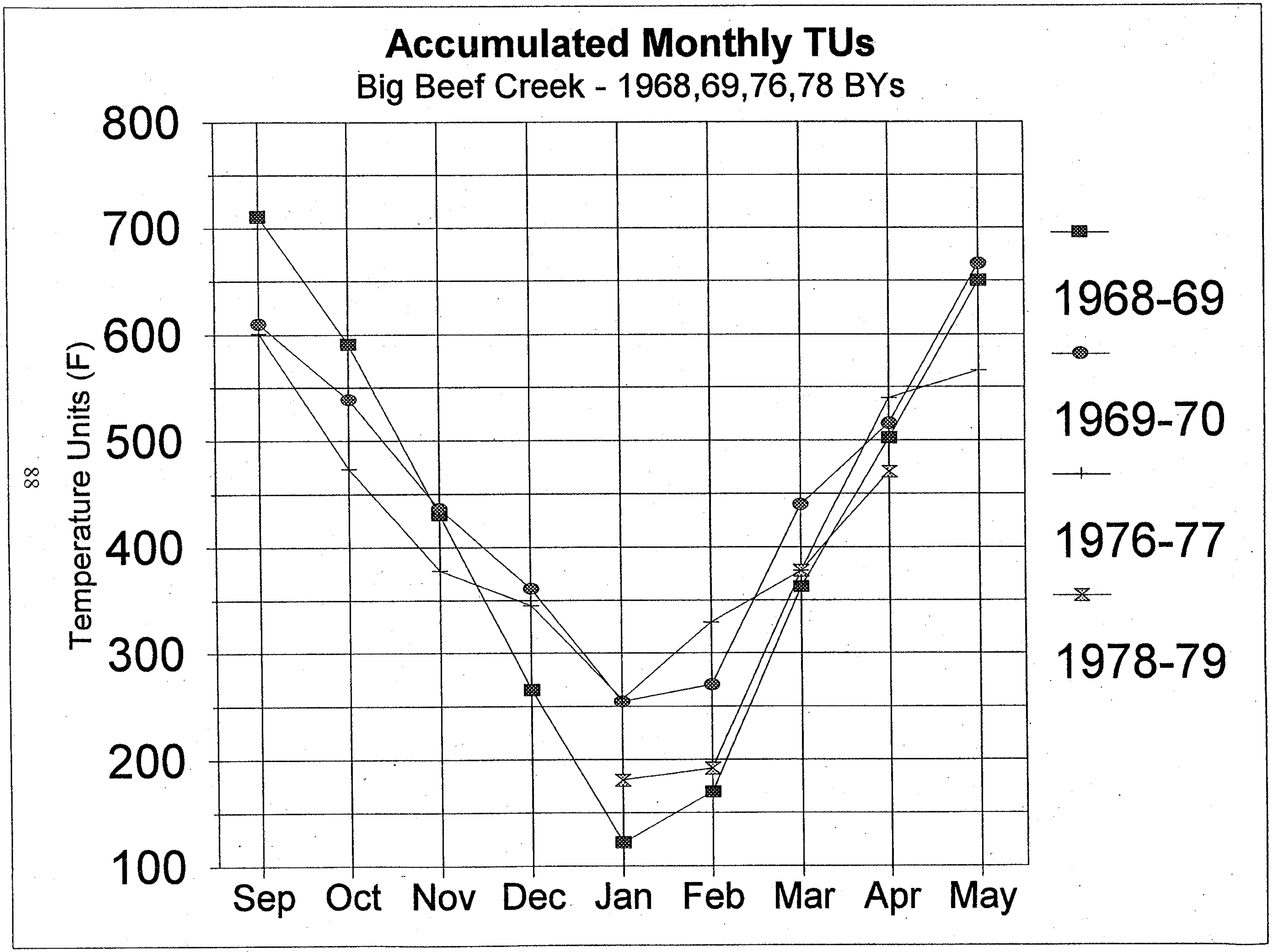
	09-Aug	17.0	18.3	16.1	16.6	19.2	13.6	16.3	15.6	15.9	19.5	17.7	20.5	17.2	17.19	30.95	
	10-Aug	17.5	16.5	15.6	16.5	19.3	13.0	15.4	16.0	16.1	18.6	18.8	19.5	18.0	16.98	30.56	
	11-Aug	17.9	15.9	15.7	16.9	19.1	13.1	14.6	14.6	16.8	17.0	17.2	17.8	17.0	16.43	29.57	
	12-Aug	18.4	15.5	15.9	16.8	18.5	13.1	15.6	13.8	16.9	18.5	15.6	17.5	16.2	16.33	29.40	
	13-Aug	17.9	15.4	15.4	15.6	17.6	12.1		13.6	16.7	18.9	15.7	17.2	16.3	16.03	28.86	
	14-Aug	17.0	14.9	15.1	15.2	17.2	12.3		13.7	16.9	19.0	15.5	16.1	16.4	15.78	28.40	
	15-Aug	16.7	14.8	16.0	14.6	17.0	12.1	15.4	12.9	17.0	18.0	15.1	16.5	15.8	15.53	27.96	
	16-Aug	16.8	14.2	16.5	14.7	16.8	12.8	15.0	13.4	17.6	16.6	15.8	15.9	16.2	15.56	28.02	
	17-Aug	17.4	15.0	15.9	14.9	16.5	12.9	15.1	15.3	17.8	16.8	14.8	16.1	16.0	15.73	28.31	
	18-Aug	16.7	15.0	15.9	14.9	16.2	13.2	15.6	14.9	18.2	16.0	14.4	16.2	16.2	15.64	28.15	
	19-Aug	16.4	14.4	15.2	15.0	15.3	13.4	14.9	14.1	16.9	17.3	14.7	15.8	16.0	15.34	27.61	
	20-Aug	15.9	14.8	15.9	14.7	15.0	15.3	14.5	13.7	15.0	17.5	15.1	16.0	14.9	15.24	27.44	
	21-Aug	15.1	14.7	16.1	14.6	15.5	15.1	14.2	13.5	15.9	18.2	15.9	14.9	15.9	15.35	27.63	
	22-Aug	14.9	13.7	16.8	13.7	14.9	14.9	15.0	13.5	15.9	17.9	16.0	16.0	16.0	15.33	27.59	
	23-Aug	14.8	14.0	15.5	14.0	15.4	15.2	14.1	13.0	15.6	17.5	15.2	16.0	15.5	15.06	27.11	
	24-Aug	13.6	14.2	16.1	14.7	15.3	15.7	13.9	13.2	15.6	17.8	16.0	13.5	15.8	15.02	27.04	
	25-Aug	13.5	13.6	16.1	15.2	15.6	15.9	14.8	13.7	15.5	18.8	16.7	14.9	16.1	15.42	27.76	
	26-Aug	13.6	14.0	16.4	14.1	13.9	13.9	14.2	13.4	15.4	18.5	16.2	14.4	16.1	14.93	26.87	
	27-Aug	13.7	14.3	15.3	13.4	14.5	14.1	14.9	13.7	15.4	18.9	16.2	14.2	15.7	14.94	26.89	
	28-Aug	14.3	15.2	16.4	13.7	14.4	14.7	13.3	12.3	15.0	19.7	16.5	14.5	15.4	15.03	27.06	
	29-Aug	14.5	15.8	15.6	13.0	15.0	13.3	14.3	11.9	15.3	18.9	16.3	14.8	15.8	14.96	26.93	
	30-Aug	13.1	16.4	15.0	12.6	14.4	13.8	13.9	12.3	14.6	18.1	16.3	15.0	15.3	14.67	26.41	
	31-Aug	13.6	15.9	15.2	12.9	13.7	14.4	14.4	12.0	14.7	17.9	16.9	15.0	15.7	14.79	26.63	
September	01-Sep	13.2	15.1	16.1	13.3	14.1	14.5	14.0	12.7	14.5	17.7	17.6	15.6	16.0	14.95	26.91	26.91
	02-Sep	13.6	15.3	16.2	13.2	14.1	15.8	14.1	12.7	14.6	17.7	16.3	16.0	16.3	15.06	27.11	54.03
	03-Sep	14.2	14.5	15.3	13.3	13.2	14.2	13.9	11.3	14.5	18.2	17.4	16.1	17.0	14.86	26.75	80.77
	04-Sep	14.8	13.8	14.5	12.8	13.5	15.1	14.0	11.6	14.3	18.2	16.6	16.3	16.4	14.77	26.58	107.35
	05-Sep	14.9	13.3	15.5	13.8	13.9	16.0		10.9	14.0	18.1	15.5	17.0	15.4	14.85	26.74	134.09
	06-Sep	14.7	13.3	15.3	13.9	14.0	15.7	11.9	10.0	14.4	18.3	15.5	17.2	15.4	14.59	26.26	160.35
	07-Sep	13.5	12.7	16.1	14.0	14.7	15.6	11.9	10.6	14.4	16.0	16.3	16.1	16.0	14.45	26.01	186.36
	08-Sep	13.0	12.7	15.7	13.7	15.1	16.2	10.9	10.5	13.2	16.1	16.9	16.0	16.9	14.38	25.89	212.25
	09-Sep	12.8	12.9	15.0	13.8	15.1	13.4	10.1	11.4	13.2	15.7	15.9	16.0	16.0	13.94	25.09	237.34
	10-Sep	13.2	12.6	14.0	13.6	14.9	12.1	11.5	10.9	13.4	15.4	15.5	14.9	14.9	13.60	24.48	261.82
	11-Sep	13.2	12.5	13.8	13.9	14.3	12.1	12.0	11.3	14.9	13.6	15.6	14.8	14.7	13.60	24.48	286.30
	12-Sep	13.5	12.7	14.0	14.1	13.5	12.9	12.2	11.3	14.0	14.2	14.7	14.0	14.0	13.46	24.23	310.53
	13-Sep	13.9	12.6	14.6	13.5	13.0	11.9	11.4	10.8	14.2	13.7	14.9	13.6	13.6	13.21	23.77	334.30
	14-Sep	13.6	13.2	15.0	13.4	12.5	12.0		11.1	14.4	13.7	15.2	13.6	13.6	13.44	24.19	358.49
	15-Sep	13.1	13.4	15.0	14.4	12.8	11.0		10.2	14.3	12.8	15.2	13.1	13.4	13.23	23.81	382.30
	16-Sep	13.0	11.7	16.3	14.6	13.6	11.7	10.1	10.9	13.5	13.2	14.1	13.1	12.0	12.91	23.23	405.54
	17-Sep	12.6	11.3	15.3	14.1	13.3	12.2	9.4	12.3	13.4	12.9	13.2	12.8	12.8	12.73	22.92	428.45
	18-Sep	12.9	10.9	15.3	13.3	13.6	12.5	6.7	13.0	13.0	13.5	12.5	12.9	12.0	12.47	22.44	450.89
	19-Sep	12.4	11.5	15.8	13.1	12.7	12.3	7.9	13.2	12.2	13.3	13.7	12.0	13.1	12.56	22.60	473.49
	20-Sep	12.8	12.1	14.9	13.2	12.0	13.8	7.7	12.1	13.1	13.6	13.9	12.0	13.1	12.64	22.75	496.24
	21-Sep	12.1	12.2	15.1	12.6	11.1	13.5	9.3	11.6	12.2	13.5	13.7	13.0	13.5	12.56	22.61	518.85
	22-Sep	11.0	12.1	13.6	12.2	10.9	13.4	10.4	10.2	12.6	12.1	14.0	12.8	13.2	12.19	21.95	540.80
	23-Sep	11.3	12.6	13.3	11.9	10.4	12.9	11.0	8.8	11.9	12.7	14.4	11.8	12.8	11.98	21.57	562.37
	24-Sep	11.4	12.6	13.4	12.3	10.0	11.9	10.7	7.8	10.6	12.6	14.7	12.3	13.3	11.81	21.27	583.64
	25-Sep	11.5	12.8	13.7	11.6	10.5	12.7	11.1	8.4	12.2	11.5	14.4	11.6	12.9	11.91	21.43	605.07
	26-Sep	11.0	13.3	15.0	12.0	9.7	12.1	10.9	9.0	13.3	12.5	14.3	11.4	12.4	12.07	21.73	626.80
	27-Sep	10.9	13.8	14.5	11.9	11.2	11.1	9.7	9.7	13.1	12.7	13.1	11.4	12.3	11.95	21.50	648.30
	28-Sep	11.2	13.3	13.1	12.4	11.2	10.8	8.6	8.6	13.1	12.7	12.5	11.7	12.3	11.65	20.97	669.27
	29-Sep	10.9	13.9	12.5	12.8	10.4	10.6	8.2	8.0	11.9	12.3	12.5	11.8	12.4	11.40	20.52	689.80
	30-Sep	11.0	13.4	12.8	13.4	10.6	9.6	9.0	8.0	11.0	12.6	13.5	12.3	12.7	11.52	20.74	710.54
October	01-Oct	10.6	12.4	12.9	13.3	11.0	9.1	7.2	7.8	9.7	12.2	14.4	11.6	12.9	11.16	20.09	730.63
	02-Oct	10.1	11.7	13.3	12.6	9.9	9.9	8.5	9.0	10.9	11.4	13.4	11.6	12.4	11.13	20.03	750.66
	03-Oct	9.3	11.4	12.0	12.1	9.1	9.4	9.5	9.0	10.5	11.5	13.2	11.8	12.1	10.84	19.51	770.16
	04-Oct	8.7	11.4	12.2	11.6	8.8	9.4	9.5	9.0	11.3	12.4	14.7	11.8	12.7	11.04	19.87	790.03
	05-Oct	8.9	11.5	12.2	12.2	8.7	8.3	8.2	10.2	10.1	12.9	14.5	11.5	12.8	10.92	19.66	809.69

	06-Oct	8.9	11.0	12.1	12.0	9.9	10.2	9.0	9.9	10.3	13.3	14.5	11.5	13.0	11.20	20.16	829.85
	07-Oct	9.4	11.7	12.0	12.6	9.7	9.1	7.4	10.0	11.5	12.4	12.4	12.2	12.7	11.00	19.79	849.64
	08-Oct	9.5	12.1	12.0	12.6	9.1	8.2	7.7	12.2	8.1	12.4	12.0	12.2	12.2	10.79	19.42	869.07
	09-Oct	9.0	12.2	11.5	12.6	8.9	10.2		13.2	8.1	12.4	12.5	12.4	12.4	11.28	20.31	889.37
	10-Oct	8.9	12.7	11.2	10.6	9.3	9.2	7.0	11.7	7.9	12.2	12.4	12.4	12.4	10.61	19.09	908.46
	11-Oct	8.9	11.9	11.5	10.3	8.3	9.3	6.5	10.6	9.2	10.9	10.8	12.4	11.8	10.19	18.34	926.80
	12-Oct	8.8	10.4	11.3	10.7	8.4	9.9	6.1	9.8	10.0	10.3	10.2	12.4	11.2	9.96	17.94	944.73
	13-Oct	9.4	10.1	11.1	11.6	7.7	10.0	7.2	9.3	9.5	9.2	10.2	12.0	10.8	9.85	17.73	962.47
	14-Oct	8.4	9.9	11.9	10.4	8.0	9.5	7.6	7.9	9.5	9.2	10.2	11.6	10.4	9.57	17.23	979.70
	15-Oct	9.4	10.4	11.9	10.4	8.2	9.0	8.3	7.5	9.5	9.1	8.5	12.4	10.1	9.59	17.26	996.96
	16-Oct	10.0	12.0	11.3	9.2	9.2	9.2	6.5	6.8	10.7	8.6	8.9	12.0	10.0	9.57	17.23	1014.19
	17-Oct	9.1	13.0	10.0	8.2	9.3	7.3	7.4	6.5	10.6	9.6	9.0	11.6	9.8	9.34	16.81	1031.00
	18-Oct	8.4	11.5	10.1	7.9	9.3	5.7	7.2	5.6	11.0	9.9	9.4	8.4	9.2	8.73	15.72	1046.72
	19-Oct	9.3	11.0	9.6	8.4	9.3	4.8	8.0	5.6	10.9	9.3	8.4	9.4	9.3	8.71	15.68	1062.40
	20-Oct	7.7	11.7	9.3	10.0	8.3	3.8	8.3	4.9	11.2	9.3	8.0	8.1	8.5	8.39	15.10	1077.50
	21-Oct	8.7	10.1	8.1	9.8	7.5	6.1	9.3	4.6	11.1	8.6	8.2	8.4	8.4	8.38	15.08	1092.57
	22-Oct	10.2	9.0	9.5	9.0	7.2	8.5	9.4	5.2	9.1	8.4	7.9	8.4	8.3	8.47	15.24	1107.82
	23-Oct	11.1	9.7	9.9	7.3	7.2	8.5	7.6	4.8	8.9	7.8	7.5	8.9	8.3	8.26	14.87	1122.69
	24-Oct	10.5	9.6	9.3	7.1	7.8	9.7	5.6	4.5	8.9	9.1	7.7	8.4	8.0	8.16	14.69	1137.38
	25-Oct	9.2	8.0	10.1	8.3	7.2	9.2	7.0	5.5	9.1	10.6	8.1	8.4	8.6	8.41	15.14	1152.52
	26-Oct	8.3	7.0	10.5	8.8	8.8	8.7	7.6	6.1	9.1	12.1	10.1	9.0	9.9	8.91	16.04	1168.56
	27-Oct	7.8	8.6	10.6	8.3	10.1	7.1	8.6	5.5	8.5	12.1	9.1	8.3	9.9	8.81	15.85	1184.41
	28-Oct	8.8	8.9	9.3	7.0	9.6	7.6	5.4		8.6	11.4	8.2	9.3	9.9	8.66	15.59	1200.00
	29-Oct	9.7	7.9	8.2	7.0		7.5	7.4		8.0	10.5	8.5	9.0	9.7	8.49	15.29	1215.29
	30-Oct	9.2	7.0	9.0	7.9		5.4	8.5	3.9	7.5	10.1	10.5	9.0	10.0	8.17	14.70	1229.99
	31-Oct	7.7	6.0	8.5	8.0		6.6	9.0	3.8	7.0	10.8	10.8	9.0	10.0	8.10	14.58	1244.57
November	01-Nov	8.3	7.3	6.8	9.4		5.7	8.0	3.2	6.6	9.6	11.3	8.6	10.3	7.93	14.27	1258.84
	02-Nov	8.1	8.2	7.8	10.3		4.5	8.8	4.2	7.8	9.0	11.1	7.2	9.3	8.03	14.45	1273.29
	03-Nov	7.4	6.8	8.9	9.5		6.0	8.5	4.1	8.5	8.7	8.5	8.3	8.6	7.81	14.05	1287.34
	04-Nov	7.0	6.1	9.2	10.7		6.5	8.2	3.8	8.6	9.1	10.6	8.3	9.2	8.11	14.59	1301.93
	05-Nov	7.3	6.3	9.4	11.4		5.9	7.1		8.9	9.4	10.0	8.3	9.1	8.46	15.23	1317.16
	06-Nov	7.8	7.5	8.2	11.3		4.6		3.7	8.4	9.3	9.7	8.0	9.1	7.96	14.33	1331.49
	07-Nov	7.6	7.6	7.5	10.6		4.2		4.7	8.3	8.2	8.3	8.4	8.7	7.65	13.77	1345.26
	08-Nov	5.9	5.5	6.0	10.5		2.5		4.1	8.3	7.3	9.9	9.3	9.2	7.14	12.85	1358.11
	09-Nov	5.5	3.7	5.1	9.0		3.2		4.2	8.1	5.4	10.0	9.2	8.9	6.56	11.81	1369.92
	10-Nov	7.1	2.5	6.1	8.1		1.3	6.4	4.1	7.5	3.4	10.3	9.5	8.4	6.22	11.20	1381.12
	11-Nov	8.1	1.9	5.4	5.8		1.6	6.9	4.3	5.1	5.0	10.0	8.8	7.4	5.86	10.55	1391.67
	12-Nov	8.2	1.3	4.3	3.8		1.5	6.2	4.3	2.2	6.0	10.0	9.0	8.0	5.40	9.72	1401.39
	13-Nov	7.9	1.0	3.8	3.4		1.9	5.7	5.4	1.3	6.5	10.0	9.1	8.4	5.37	9.67	1411.05
	14-Nov	7.8	1.8	3.5	3.1		0.3	5.7	5.1	1.7	6.2	9.6	8.8	8.3	5.16	9.28	1420.34
	15-Nov	7.2	3.8	3.9	4.3		5.0	6.7	3.4	2.0	5.4	9.6	9.5	8.4	5.77	10.38	1430.71
	16-Nov	6.2	5.0	6.1	4.6		6.6	7.2	2.5	4.6	6.1	9.5	8.9	7.9	6.27	11.28	1441.99
	17-Nov	5.3	4.3	6.6	4.2		7.3	6.7	3.0	5.6	4.6	7.2	8.9	7.4	5.94	10.68	1452.67
	18-Nov	4.1	1.4	5.3	5.7		6.7	6.2	3.5	4.5	6.3	5.3	9.4	6.5	5.41	9.75	1462.42
	19-Nov	3.0	1.5	4.7	7.2		6.0	5.7	5.3	1.9	7.0	5.3	9.7	7.1	5.36	9.64	1472.06
	20-Nov	1.6	0.7	3.4	8.0		6.1	5.6	4.9	2.5	7.5	7.0	8.9	7.6	5.31	9.57	1481.62
	21-Nov	0.5	0.8	3.9	8.6		4.3	5.4	4.2	1.7	7.7	8.4	8.9	8.3	5.22	9.39	1491.01
	22-Nov	0.6	2.1	5.8	7.7		3.6	4.8	3.1	0.1	7.2	8.8	8.2	8.2	5.02	9.03	1500.04
	23-Nov	1.1	3.3	6.1	5.0			4.6		0.0	7.6	8.5	8.4	8.1	5.27	9.48	1509.52
	24-Nov	1.9	3.3	4.9	4.4			5.6		0.0	6.8	8.5	7.1	7.8	5.03	9.05	1518.58
	25-Nov	3.4	3.6	4.1	4.6			4.4		0.0	6.0	7.8	7.1	7.2	4.82	8.67	1527.24
	26-Nov	4.5	4.1	4.2	5.6			4.5		0.0	6.0	5.7	6.5	6.1	4.72	8.50	1535.74
	27-Nov	4.9	4.5	2.9	6.0			5.5	1.6	0.0	6.2	5.5	6.3	5.9	4.48	8.06	1543.80
	28-Nov	5.3	4.7	2.4	7.1			4.9	-0.7	0.0	5.5	5.5	6.0	5.9	4.25	7.65	1551.45
	29-Nov	5.7	4.8	3.2	5.1		8.5	3.5	1.6	0.0	4.5	3.9	5.7	5.0	4.29	7.72	1559.16
	30-Nov	4.7	5.0	4.7	5.6		8.3	2.2	1.5	0.0	5.3	4.2	5.7	4.8	4.34	7.81	1566.97
December	01-Dec	5.1	5.1	4.7	5.3		7.9	1.3	1.4	0.0	5.3	4.2	5.8	5.1	4.26	7.67	1574.64
	02-Dec	6.0	4.7	4.3	4.4		7.9	1.5	1.2	0.0	4.6	5.9	5.8	5.7	4.33	7.80	1582.44

03-Dec	6.1	5.6	5.3	4.2	9.1	1.7	0.0	0.0	2.9	5.7	5.8	5.4	4.32	7.77	1590.21
04-Dec	5.8	5.3	6.4	4.3	9.2	0.8		0.0	2.8	6.5	5.7	5.1	4.72	8.50	1598.71
05-Dec	4.4	3.5	6.1	3.8	8.2	1.0		0.2	4.3	6.6	5.5	5.0	4.41	7.94	1606.65
06-Dec	4.5	2.8	6.3	3.5	3.9	0.9	1.7	0.5	3.6	6.3	7.7	6.1	3.98	7.16	1613.81
07-Dec	4.5	1.8	6.6	1.2	3.0	-0.7	3.0	0.8	2.7	7.4	7.6	6.2	3.67	6.61	1620.42
08-Dec	3.5	2.5	5.9	0.3	2.7	1.6	4.4	1.1	3.5	6.9	6.7	5.4	3.70	6.66	1627.08
09-Dec	3.1	3.1	6.2	0.6	2.8	1.9	5.4	1.4	2.4	7.1	7.4	6.0	3.94	7.10	1634.17
10-Dec	3.5	3.9	4.0	2.4	1.9	2.6	4.7	1.6	1.3	6.6	8.6	5.9	3.91	7.04	1641.22
11-Dec	5.3	4.3	3.3	3.5	1.7	2.7		1.0	1.8	6.7	7.5	5.2	3.90	7.02	1648.24
12-Dec	5.5	1.9	3.5	4.2	3.5	2.0		0.6	3.4	6.4	7.8	5.3	4.01	7.21	1655.46
13-Dec	5.7	0.9	4.8	4.5	3.5	2.0		0.8	4.4	5.2	7.8	5.5	4.09	7.37	1662.82
14-Dec	6.3	2.5	6.2	4.2	4.0	2.7		1.0	5.5	4.5	7.0	5.3	4.47	8.04	1670.86
15-Dec	6.9	1.7	4.2	5.9	4.7	1.9		1.2	4.6	4.4	6.7	5.6	4.35	7.82	1678.68
16-Dec	6.6	2.4	3.6	6.3	5.6	1.5		1.4	4.1	2.3	5.5	4.1	3.94	7.09	1685.77
17-Dec	5.9	3.2	5.9	6.1	5.0	-0.1		1.6	2.4	3.2	5.3	4.2	3.88	6.98	1692.76
18-Dec	5.5	2.9	6.9	6.0	4.5	0.1		2.1	3.9	2.7	5.3	3.5	3.94	7.10	1699.86
19-Dec	5.0	2.0	7.1	4.9	4.5		1.5	2.1	3.1	3.2	4.8	4.0	3.83	6.89	1706.75
20-Dec	4.3	2.9	6.7	3.1	3.5	-2.8	1.4	3.2	5.4	2.7	4.8	3.5	3.22	5.79	1712.54
21-Dec	3.5	2.9	6.5	4.6	3.9	-3.1	2.0	2.5	5.4	2.7	5.1	4.4	3.37	6.06	1718.60
22-Dec	3.9	3.3	4.9	7.1	3.8	-3.2	2.7	2.1	7.1	2.6	4.8	4.3	3.61	6.51	1725.10
23-Dec	4.0	4.0	3.4	7.0	3.0	-3.3	3.3	2.5	6.1	3.1	5.6	5.3	3.66	6.60	1731.70
24-Dec	3.4	3.4	3.2	6.3	2.9	-3.4	3.8	2.3	5.7	3.1	5.5	4.9	3.42	6.16	1737.86
25-Dec	3.0	2.0	3.6	6.7	3.7	-2.8	3.3	3.2	5.9	2.7	5.6	4.7	3.46	6.23	1744.09
26-Dec	2.8	1.9	4.1	7.7	2.9	-2.8	3.7	2.9	5.8	2.7	5.2	4.6	3.46	6.22	1750.31
27-Dec	2.8	1.4	3.5	8.4	2.1	-1.6	3.9	2.0	6.2	2.1	5.0	4.3	3.34	6.01	1756.32
28-Dec	2.4	-0.1	4.0	7.7	1.7	-2.0	3.7	1.6	6.3	2.1	5.3	4.5	3.10	5.59	1761.90
29-Dec	3.9	-0.3	4.8	6.5	1.0	-0.9	3.1	1.3	6.6	2.9	5.8	5.0	3.31	5.96	1767.87
30-Dec	3.5	-0.3	3.4	6.6	0.4	-0.1	2.5	2.1	5.2	3.6	5.9	5.4	3.18	5.72	1773.59
31-Dec	1.3	-0.4	5.2	7.0	-0.2	0.0	1.8	2.3	4.0	3.5	5.6	4.8	2.92	5.25	1778.83
				7.4			1.8	2.4		3.6	4.5	4.0	3.95	7.10	1785.94

APPENDIX IV


Big Beef Creek Summer Chum
Live Spawners by Date
Number Live Chum
500
400
300
200
100
0
1975
1976
1978
1971
1968
1969
1974
01-Aug
14-Aug
27-Aug
09-Sep
22-Sep
05-Oct
18-Oct
31-Oct
Live counts from rack entry data for Big Beef Creek provided in Koski (1975) and from Schroder (1981)


Accumulated Monthly TUs
Big Beef Creek - 1968,69,76,78 BYs
Temperature Units (F)
800
700
600
500
400
300
200
100
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
1968-69
1969-70
1976-77
1978-79

Monthly and total water temperature unit accumulations during the period of egg and alevin development for the Big Beef Creek controlled-flow channels for the years 1967-1972 (excerpted from Koski 1975)

Year	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April	May	Total
1967-68	710[1]	578[1]	372[1]	241[1]	365	352	497	531	677	4323
1968-69	711[1]	591[1]	430[1]	266	122	170	363	502	650	3805
1969-70	610	539	436	361	255	271	440	516	666	4094
1970-71	600[2]	425[2]	341	222	206	266	287	449	599	3395
1971-72	564[2]	486	361	201	175	232	423	421	617	3480
1972-73	583	440	367	247	225	258	430	512	649	3711

[1]Big Beef Creek data.
[2]Estimated from incomplete data.

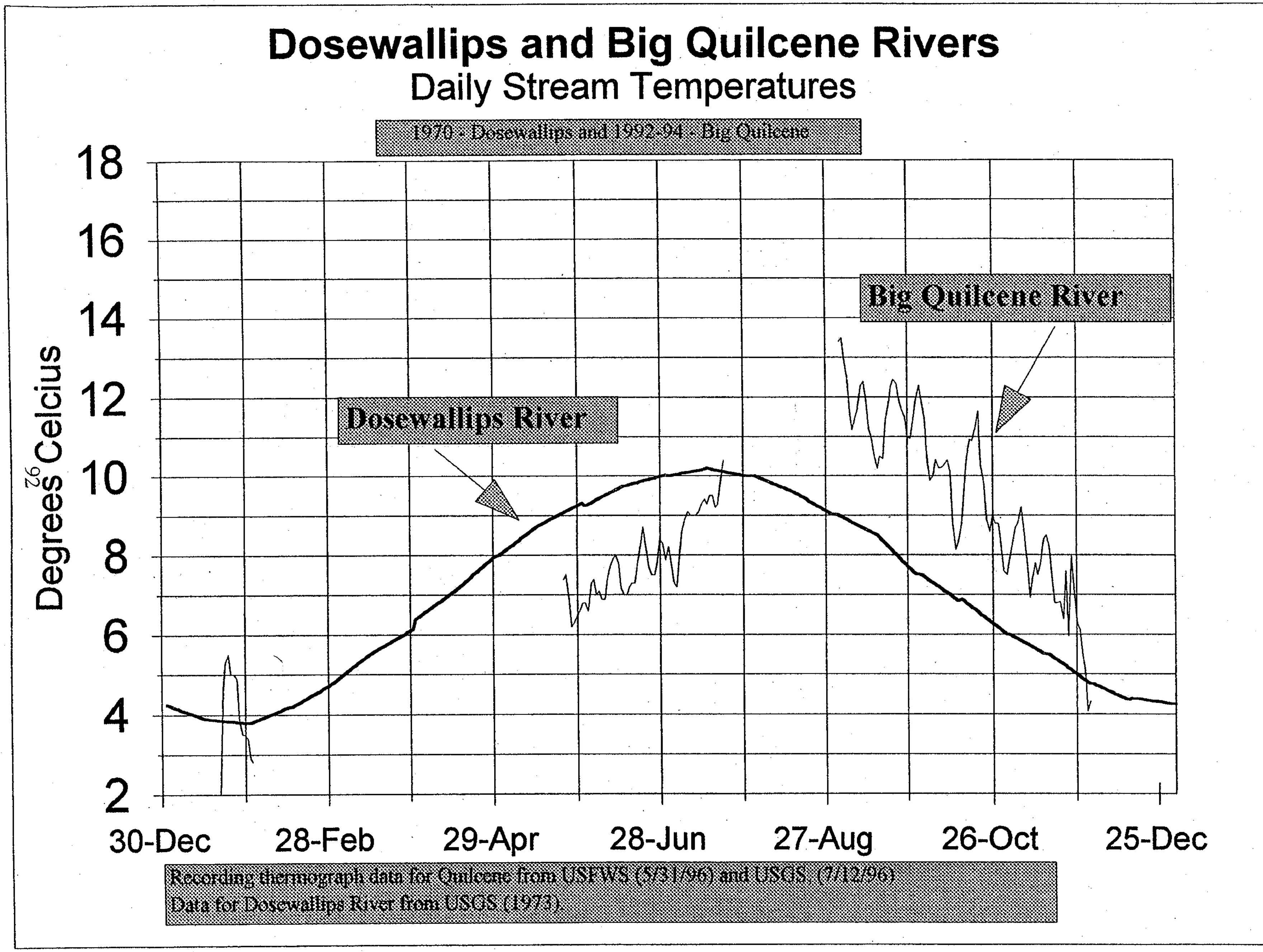
Big Beef Creek summer chum fry emergence timing for brood years 1968-69, 1973-76

Brood Year	Percent Completion Dates of Population Emergence					
	10 %	Accum. TUs	**50 %**	Accum. TUs	**90 %**	Accum. TUs
1968	March 22	1678	March 28	1764	April 6	1884
1969	March 4	1895	March 13	2016	March 23	2151
1973	March 26	1599	March 30	1653	April 4	1722
1974	March 12	1863	March 10	1931	March 24	2030
1975	April 4	1321	April 9	1370	April 14	1426
1976	February 7	-	February 14	-	February 25	-
Averages	March 13 (s.d. 19.9)		March 18 (s.d. 19.3)		March 27 (s.d. 16.8)	

Sources of Data:

Data for 1968 and 1969 from Koski (1975).
Data for 1973-75 from Schroder (1981 - raw data).
Data for 1976 from Bax (1982).

APPENDIX V


Dosewallips and Big Quilcene Rivers
Daily Stream Temperatures
1970 - Dosewallips and 1992-94 - Big Quilcene
Degrees Celcius
18
16
14
12
10
8
6
4
2
30-Dec
28-Feb
29-Apr
28-Jun
27-Aug
26-Oct
25-Dec
Dosewallips River
Big Quilcene River
Recording thermograph data for Quilcene from USFWS (5/31/96) and USGS (7/12/96)
Data for Dosewallips River from USGS (1973)

STREAM TEMPERATURE TIME SERIES AND CUMMULATIVE TEMPERATURE UNIT DATA FOR THE BIG QUILCENE AND DOSEWALLIPS RIVERS -
BIG QUILCENE DATA FROM TELLES (RAW DATA, FOR LINGER LONGER BRIDGE 5/31/96) AND USGS (RAW DATA FROM STATION # 12052210, 7/12/96).
DOSEWALLIPS DATA FROM USGS (COLLINGS AND HILL, 1973) AND USGS RIVER BASIN PRINT-OUTS (8/2/96).

DATE	DOSEWALLIPS (YEAR) 1969	1970	1971	USGS 1970 CURVE	Big Quilcene (lower) 1992	1993	1994	Dose. DAILY AVG.	Quilcene DAILY AVG.	Dose. DAILY TUs (F)	Dosewallips Cumm. TUs 9/1-5/31	MONTHLY AVG. TUs
01-Jan		4.75	3.75	4.25				4.25		7.65	1248.08	
02-Jan		4.25	3.25	4.23				3.91		7.61	1255.68	
03-Jan		4.25	3.25	4.20				3.90		7.56	1263.24	
04-Jan		4	3	4.17				3.73		7.51	1270.76	
05-Jan		3.25	2.5	4.15				3.30		7.47	1278.23	
06-Jan		3.5	3.25	4.12				3.62		7.42	1285.65	
07-Jan		4	4	4.10				4.03		7.38	1293.03	
08-Jan		4.5	4.25	4.07				4.28		7.33	1300.37	
09-Jan		4.75	3.75	4.05				4.18		7.29	1307.66	
10-Jan		4.5	3.75	4.02				4.09		7.24	1314.90	
11-Jan		4.75	2.75	4.00				3.83		7.20	1322.10	
12-Jan		5.75	2.25	3.97				3.99		7.15	1329.26	
13-Jan		5.5	1.25	3.95				3.57		7.11	1336.37	
14-Jan		5.75	1.75	3.92				3.81		7.06	1343.43	
15-Jan		5.5	0.75	3.90				3.38		7.02	1350.45	
16-Jan		5.5	2.5	3.89				3.96		7.01	1357.46	
17-Jan		5.75	4	3.89				4.55		7.00	1364.46	
18-Jan		6	4.5	3.88				4.79		6.98	1371.44	
19-Jan		5.75	3.75	3.87				4.46		6.97	1378.41	
20-Jan		6.25	4.25	3.87			1.7	4.79	1.7	6.96	1385.37	
21-Jan		6.25		3.86			4.6	5.05	4.6	6.95	1392.32	
22-Jan		5.5		3.85			5.3	4.68	5.3	6.94	1399.26	
23-Jan		5.25		3.85			5.5	4.55	5.5	6.92	1406.18	
24-Jan		5.5		3.84			5	4.67	5	6.91	1413.09	
25-Jan		5		3.83			5	4.42	5	6.90	1419.99	
26-Jan		4.75		3.83			4.9	4.29	4.9	6.89	1426.88	
27-Jan		4.75		3.82			3.9	4.28	3.9	6.88	1433.76	
28-Jan		4.5		3.81			3.5	4.16	3.5	6.86	1440.62	
29-Jan		4.5		3.81			3.5	4.15	3.5	6.85	1447.47	
30-Jan		4.75		3.80			3.4	4.27	3.4	6.84	1454.31	
31-Jan		4.75		3.80			2.9	4.28	2.9	6.84	1461.15	220.72
01-Feb		4.75		3.83			2.8	4.29	2.8	6.89	1468.04	
02-Feb		5.25		3.86				4.55		6.94	1474.99	
03-Feb		4.75		3.89				4.32		6.99	1481.98	
04-Feb		4.75		3.91				4.33		7.05	1489.03	
05-Feb		4.25		3.94				4.10		7.10	1496.12	
06-Feb		5		3.97				4.49		7.15	1503.27	
07-Feb		5.25		4.00				4.62		7.20	1510.47	
08-Feb		4.75		4.03				4.39		7.25	1517.72	
09-Feb		4.75		4.06				4.40		7.30	1525.03	
10-Feb		4.75		4.09				4.42		7.35	1532.38	
11-Feb		5		4.11				4.56		7.41	1539.79	
12-Feb		5.25		4.14				4.70		7.46	1547.24	
13-Feb		5.25		4.17				4.71		7.51	1554.75	
14-Feb		5.25		4.20				4.72		7.56	1562.31	
15-Feb		5.25		4.20				4.73		7.56	1569.87	

16-Feb	5	4.24	4.62	7.63	1577.50	
17-Feb	5	4.28	4.64	7.70	1585.20	
18-Feb	5	4.32	4.66	7.77	1592.98	
19-Feb	5	4.36	4.68	7.84	1600.82	
20-Feb	4.75	4.40	4.57	7.91	1608.73	
21-Feb	4.75	4.44	4.59	7.98	1616.72	
22-Feb	5	4.47	4.74	8.05	1624.77	
23-Feb	4.75	4.51	4.63	8.13	1632.90	
24-Feb	4.5	4.55	4.53	8.20	1641.09	
25-Feb	4.5	4.59	4.55	8.27	1649.36	
26-Feb	4.75	4.63	4.69	8.34	1657.70	
27-Feb	4.75	4.67	4.71	8.41	1666.11	
28-Feb	4	4.71	4.36	8.48	1674.59	213.43
01-Mar	3.5	4.75	4.13	8.55	1683.14	
02-Mar	3.5	4.80	4.15	8.65	1691.78	
03-Mar	4.25	4.86	4.55	8.74	1700.53	
04-Mar	4	4.91	4.46	8.84	1709.36	
05-Mar	4.25	4.96	4.61	8.94	1718.30	
06-Mar	5.25	5.02	5.13	9.03	1727.33	
07-Mar	5	5.07	5.04	9.13	1736.46	
08-Mar	4.5	5.12	4.81	9.22	1745.69	
09-Mar	4.5	5.18	4.84	9.32	1755.01	
10-Mar	4.5	5.23	4.87	9.42	1764.43	
11-Mar	5	5.29	5.14	9.51	1773.94	
12-Mar	5.25	5.34	5.29	9.61	1783.55	
13-Mar	5.25	5.39	5.32	9.71	1793.26	
14-Mar	5.75	5.45	5.60	9.80	1803.06	
15-Mar	5.25	5.50	5.38	9.90	1812.96	
16-Mar	5	5.54	5.27	9.97	1822.93	
17-Mar	4.75	5.58	5.17	10.04	1832.98	
18-Mar	5	5.62	5.31	10.12	1843.09	
19-Mar	5.5	5.66	5.58	10.19	1853.28	
20-Mar	5.5	5.70	5.60	10.26	1863.54	
21-Mar	5.5	5.74	5.62	10.33	1873.87	
22-Mar	5.5	5.78	5.64	10.40	1884.28	
23-Mar	6.25	5.82	6.04	10.48	1894.75	
24-Mar	5.25	5.86	5.56	10.55	1905.30	
25-Mar	5	5.90	5.45	10.62	1915.92	
26-Mar	5.5	5.94	5.72	10.69	1926.61	
27-Mar	5.25	5.98	5.62	10.76	1937.38	
28-Mar	5.5	6.02	5.76	10.84	1948.21	
29-Mar	6	6.06	6.03	10.91	1959.12	
30-Mar	5.5	6.10	5.80	10.98	1970.10	
31-Mar	5.5	6.14	5.82	11.05	1981.15	306.57
01-Apr		6.40	6.40	11.52	1992.67	
02-Apr		6.45	6.45	11.61	2004.28	
03-Apr		6.50	6.50	11.70	2015.98	
04-Apr		6.55	6.55	11.79	2027.77	
05-Apr		6.60	6.60	11.88	2039.65	
06-Apr		6.65	6.65	11.97	2051.62	
07-Apr		6.70	6.70	12.06	2063.68	
08-Apr		6.75	6.75	12.15	2075.83	
09-Apr		6.80	6.80	12.24	2088.07	
10-Apr		6.85	6.85	12.33	2100.40	
11-Apr		6.90	6.90	12.42	2112.82	
12-Apr		6.95	6.95	12.51	2125.33	

13-Apr	7.00		7.00		12.60	2137.93	
14-Apr	7.05		7.05		12.69	2150.62	
15-Apr	7.10		7.10		12.78	2163.40	
16-Apr	7.16		7.16		12.89	2176.29	
17-Apr	7.22		7.22		13.00	2189.29	
18-Apr	7.28		7.28		13.10	2202.39	
19-Apr	7.34		7.34		13.21	2215.60	
20-Apr	7.40		7.40		13.32	2228.92	
21-Apr	7.46		7.46		13.43	2242.35	
22-Apr	7.52		7.52		13.54	2255.89	
23-Apr	7.58		7.58		13.64	2269.53	
24-Apr	7.64		7.64		13.75	2283.28	
25-Apr	7.70		7.70		13.86	2297.14	
26-Apr	7.76		7.76		13.97	2311.11	
27-Apr	7.82		7.82		14.08	2325.19	
28-Apr	7.88		7.88		14.18	2339.37	
29-Apr	7.94		7.94		14.29	2353.66	
30-Apr	7.98		7.98		14.36	2368.03	386.87
01-May	8.00		8.00		14.40	2382.43	
02-May	8.05		8.05		14.50	2396.92	
03-May	8.11		8.11		14.59	2411.52	
04-May	8.16		8.16		14.69	2426.21	
05-May	8.21		8.21		14.79	2440.99	
06-May	8.27		8.27		14.88	2455.87	
07-May	8.32		8.32		14.98	2470.85	
08-May	8.37		8.37		15.07	2485.93	
09-May	8.43		8.43		15.17	2501.10	
10-May	8.48		8.48		15.27	2516.37	
11-May	8.54		8.54		15.36	2531.73	
12-May	8.59		8.59		15.46	2547.19	
13-May	8.64		8.64		15.56	2562.75	
14-May	8.70		8.70		15.65	2578.40	
15-May	8.75		8.75		15.75	2594.15	
16-May	8.78		8.78		15.81	2609.96	
17-May	8.82		8.82		15.87	2625.84	
18-May	8.85		8.85		15.94	2641.77	
19-May	8.89		8.89		16.00	2657.78	
20-May	8.93		8.93		16.07	2673.84	
21-May	8.96		8.96		16.13	2689.98	
22-May	9.00		9.00		16.20	2706.17	
23-May	9.03		9.03		16.26	2722.43	
24-May	9.07	7.4	9.07	7.4	16.32	2738.76	
25-May	9.10	7.5	9.10	7.5	16.39	2755.14	
26-May	9.14	6.9	9.14	6.9	16.45	2771.60	
27-May	9.18	6.2	9.18	6.2	16.52	2788.11	
28-May	9.21	6.3	9.21	6.3	16.58	2804.70	
29-May	9.25	6.5	9.25	6.5	16.65	2821.34	
30-May	9.28	6.6	9.28	6.6	16.71	2838.05	
31-May	9.32	6.8	9.32	6.8	16.77	2854.83	486.80
01-Jun	9.25	6.8	9.25	6.8	16.65	2871.48	
02-Jun	9.29	6.6	9.29	6.6	16.71	2888.19	
03-Jun	9.32	7.3	9.32	7.3	16.78	2904.97	
04-Jun	9.36	7.4	9.36	7.4	16.84	2921.81	
05-Jun	9.39	7	9.39	7	16.91	2938.72	
06-Jun	9.43	7.1	9.43	7.1	16.97	2955.69	
07-Jun	9.46	6.9	9.46	6.9	17.04	2972.73	

08-Jun	9.50	6.9	9.50	6.9	17.10	2989.83	
09-Jun	9.54	7.4	9.54	7.4	17.16	3006.99	
10-Jun	9.57	7.7	9.57	7.7	17.23	3024.22	
11-Jun	9.61	7.9	9.61	7.9	17.29	3041.51	
12-Jun	9.64	8	9.64	8	17.36	3058.87	
13-Jun	9.68	7.8	9.68	7.8	17.42	3076.29	
14-Jun	9.71	7.2	9.71	7.2	17.49	3093.78	
15-Jun	9.75	7	9.75	7	17.55	3111.33	
16-Jun	9.77	7	9.77	7	17.58	3128.91	
17-Jun	9.79	7.2	9.79	7.2	17.61	3146.52	
18-Jun	9.80	7.3	9.80	7.3	17.65	3164.17	
19-Jun	9.82	7.3	9.82	7.3	17.68	3181.85	
20-Jun	9.84	7.8	9.84	7.8	17.71	3199.56	
21-Jun	9.86	8.3	9.86	8.3	17.74	3217.30	
22-Jun	9.88	8.7	9.88	8.7	17.78	3235.08	
23-Jun	9.89	8.2	9.89	8.2	17.81	3252.88	
24-Jun	9.91	7.7	9.91	7.7	17.84	3270.72	
25-Jun	9.93	7.5	9.93	7.5	17.87	3288.59	
26-Jun	9.95	7.5	9.95	7.5	17.90	3306.50	
27-Jun	9.96	7.8	9.96	7.8	17.94		
28-Jun	9.98	8.4	9.98	8.4	17.97		
29-Jun	10.00	8.3	10.00	8.3	18.00		
30-Jun	10.02	7.9	10.02	7.9	18.03		523.61
01-Jul	10.00	8.2	10.00	8.2	18.00		
02-Jul	10.01	7.8	10.01	7.8	18.02		
03-Jul	10.03	7.3	10.03	7.3	18.05		
04-Jul	10.04	7.2	10.04	7.2	18.07		
05-Jul	10.05	8	10.05	8	18.10		
06-Jul	10.07	8.6	10.07	8.6	18.12		
07-Jul	10.08	8.9	10.08	8.9	18.14		
08-Jul	10.09	9.1	10.09	9.1	18.17		
09-Jul	10.11	9	10.11	9	18.19		
10-Jul	10.12	9	10.12	9	18.22		
11-Jul	10.13	9	10.13	9	18.24		
12-Jul	10.15	9.1	10.15	9.1	18.26		
13-Jul	10.16	9.3	10.16	9.3	18.29		
14-Jul	10.17	9.4	10.17	9.4	18.31		
15-Jul	10.20	9.3	10.20	9.3	18.36		
16-Jul	10.19	9.5	10.19	9.5	18.34		
17-Jul	10.17	9.5	10.17	9.5	18.31		
18-Jul	10.16	9.2	10.16	9.2	18.28		
19-Jul	10.14	9.3	10.14	9.3	18.26		
20-Jul	10.13	9.9	10.13	9.9	18.23		
21-Jul	10.12	10.4	10.12	10.4	18.21		
22-Jul	10.10		10.10		18.18		
23-Jul	10.09		10.09		18.16		
24-Jul	10.07		10.07		18.13		
25-Jul	10.06		10.06		18.10		
26-Jul	10.04		10.04		18.08		
27-Jul	10.03		10.03		18.05		
28-Jul	10.02		10.02		18.03		
29-Jul	10.00		10.00		18.00		
30-Jul	10.00		10.00		18.00		
31-Jul	10.00		10.00		18.00		562.90
01-Aug	10.00		10.00		18.00		
02-Aug	9.97		9.97		17.95		

03-Aug	9.94		9.94		17.90		
04-Aug	9.91		9.91		17.85		
05-Aug	9.89		9.89		17.79		
06-Aug	9.86		9.86		17.74		
07-Aug	9.83		9.83		17.69		
08-Aug	9.80		9.80		17.64		
09-Aug	9.77		9.77		17.59		
10-Aug	9.74		9.74		17.54		
11-Aug	9.71		9.71		17.49		
12-Aug	9.69		9.69		17.43		
13-Aug	9.66		9.66		17.38		
14-Aug	9.63		9.63		17.33		
15-Aug	9.60		9.60		17.28		
16-Aug	9.56		9.56		17.21		
17-Aug	9.52		9.52		17.14		
18-Aug	9.48		9.48		17.06		
19-Aug	9.44		9.44		16.99		
20-Aug	9.40		9.40		16.92		
21-Aug	9.36		9.36		16.85		
22-Aug	9.32		9.32		16.78		
23-Aug	9.28		9.28		16.70		
24-Aug	9.24		9.24		16.63		
25-Aug	9.20		9.20		16.56		
26-Aug	9.16		9.16		16.49		
27-Aug	9.12		9.12		16.42		
28-Aug	9.08		9.08		16.34		"
29-Aug	9.04		9.04		16.27		
30-Aug	9.03		9.03		16.25		
31-Aug	9.02		9.02		16.24		
01-Sep	9.00	13.4	9.00	13.4	16.20		Extrapolated
02-Sep	8.96	13.5	8.96	13.5	16.14		
03-Sep	8.93	13	8.93	13	16.07		
04-Sep	8.89	12.5	8.89	12.5	16.01		
05-Sep	8.86	11.6	8.86	11.6	15.94		
06-Sep	8.82	11.2	8.82	11.2	15.88		
07-Sep	8.79	11.5	8.79	11.5	15.81		
08-Sep	8.75	11.7	8.75	11.7	15.75		"
09-Sep	8.71	12.3	8.71	12.3	15.69	15.69	
10-Sep	8.68	12.4	8.68	12.4	15.62	31.31	
11-Sep	8.64	12	8.64	12	15.56	46.86	
12-Sep	8.61	11.2	8.61	11.2	15.49	62.36	
13-Sep	8.57	11	8.57	11	15.43	77.79	
14-Sep	8.54	10.5	8.54	10.5	15.36	93.15	
15-Sep	8.50	10.2	8.50	10.2	15.30	108.45	
16-Sep	8.43	10.5	8.43	10.5	15.17	123.62	
17-Sep	8.36	10.44	8.36	10.44	15.04	138.67	
18-Sep	8.29	11.43	8.29	11.43	14.91	153.58	
19-Sep	8.21	11.82	8.21	11.82	14.79	168.37	
20-Sep	8.14	12.3	8.14	12.3	14.66	183.02	
21-Sep	8.07	12.45	8.07	12.45	14.53	197.55	
22-Sep	8.00	12.34	8.00	12.34	14.40	211.95	
23-Sep	7.93	11.9	7.93	11.9	14.27	226.22	
24-Sep	7.86	11.7	7.86	11.7	14.14	240.37	
25-Sep	7.79	11.5	7.79	11.5	14.01	254.38	
26-Sep	7.71	10.99	7.71	10.99	13.89	268.27	
27-Sep	7.64	10.97	7.64	10.97	13.76	282.02	

28-Sep			7.57	11.5	7.57	11.5	13.63	295.65	
29-Sep			7.52	11.93	7.52	11.93	13.54	309.19	
30-Sep			7.51	12.3	7.51	12.3	13.52	322.71	450.51
01-Oct		9	7.50	11.94	8.25	11.94	13.50	336.21	
02-Oct		9.25	7.45	11.44	8.35	11.44	13.41	349.62	
03-Oct		9.75	7.40	10.36	8.58	10.36	13.32	362.94	
04-Oct		9.25	7.35	9.88	8.30	9.88	13.23	376.17	
05-Oct		8.5	7.30	10	7.90	10	13.14	389.31	
06-Oct		7.25	7.25	10.4	7.25	10.4	13.05	402.36	
07-Oct		7	7.20	10.2	7.10	10.2	12.96	415.32	
08-Oct		8	7.15	10.22	7.58	10.22	12.87	428.19	
09-Oct		8.5	7.10	10.27	7.80	10.27	12.78	440.97	
10-Oct		8.75	7.05	10.4	7.90	10.4	12.69	453.66	
11-Oct		8.75	7.00	10.1	7.88	10.1	12.60	466.26	
12-Oct		7.75	6.95	8.8	7.35	8.8	12.51	478.77	
13-Oct		6.5	6.90	8.14	6.70	8.14	12.42	491.19	
14-Oct		6.5	6.85	8.33	6.68	8.33	12.33	503.52	
15-Oct		6.5	6.90	8.74	6.70	8.74	12.42	515.94	
16-Oct		6.5	6.84	9.7	6.67	9.7	12.32	528.25	
17-Oct		6.75	6.79	10.43	6.77	10.43	12.22	540.47	
18-Oct		7.75	6.73	10.94	7.24	10.94	12.12	552.59	
19-Oct		7.5	6.67	10.9	7.09	10.9	12.02	564.60	
20-Oct		7.5	6.62	11.26	7.06	11.26	11.91	576.52	
21-Oct		6.75	6.56	11.66	6.66	11.66	11.81	588.33	
22-Oct		6.75	6.51	10.3	6.63	10.3	11.71	600.04	
23-Oct		6.25	6.45	9.8	6.35	9.8	11.61	611.65	
24-Oct		6.25	6.39	8.9	6.32	8.9	11.51	623.16	
25-Oct		5.75	6.34	8.6	6.04	8.6	11.41	634.57	
26-Oct		5.25	6.28	9	5.77	9	11.31	645.87	
27-Oct		5	6.22	8.8	5.61	8.8	11.20	657.08	
28-Oct		5.25	6.17	8.8	5.71	8.8	11.10	668.18	
29-Oct		5.25	6.11	8.2	5.68	8.2	11.00	679.18	
30-Oct	7.5	5	6.06	7.6	6.19	7.6	10.90	690.09	
31-Oct	8	6	6.00	7.5	6.67	7.5	10.80	700.89	378.18
01-Nov	7.5	5.75	6.00	7.9	6.42	7.9	10.80	711.69	
02-Nov	7.75	5.75	5.96	8.34	6.49	8.34	10.73	722.41	
03-Nov	8.25	5.5	5.92	8.7	6.56	8.7	10.66	733.07	
04-Nov	7	5.75	5.88	8.8	6.21	8.8	10.58	743.65	
05-Nov	6.25	6.25	5.84	9.2	6.11	9.2	10.51	754.17	
06-Nov	6.5	6.5	5.80	8.7	6.27	8.7	10.44	764.61	
07-Nov	6.25	6.5	5.76	7.9	6.17	7.9	10.37	774.97	
08-Nov	6.25	6.25	5.72	6.94	6.07	6.94	10.30	785.27	
09-Nov	5.75	5.75	5.68	7.4	5.73	7.4	10.22	795.49	
10-Nov	6.25	5.75	5.64	7.8	5.88	7.8	10.15	805.65	
11-Nov	6.25	6.25	5.60	7.5	6.03	7.5	10.08	815.73	
12-Nov	6.25	6	5.56	7.8	5.94	7.8	10.01	825.73	
13-Nov	5.75	5.5	5.52	8.4	5.59	8.4	9.94	835.67	
14-Nov	5.75	5.75	5.51	8.5	5.67	8.5	9.92	845.59	
15-Nov	5.75	6.25	5.50	8.2	5.83	8.2	9.90	855.49	
16-Nov	5	6.25	5.45	7.5	5.57	7.5	9.81	865.30	
17-Nov	4.5	6.25	5.40	6.8	5.38	6.8	9.72	875.02	
18-Nov	5.25	5.75	5.35	6.8	5.45	6.8	9.63	884.65	
19-Nov	5.75	5.75	5.30	6.83	5.60	6.83	9.54	894.19	
20-Nov	5.75	5	5.25	6.4	5.33	6.4	9.45	903.64	
21-Nov	5.25	3.75	5.20	7.6	4.73	7.6	9.36	913.00	
22-Nov	4.75	2.5	5.15	5.97	4.13	5.97	9.27	922.27	

23-Nov	5.5	2.75	5.10	8	4.45	8	9.18	931.45	
24-Nov	4.5	4.25	5.05	7.2	4.60	7.2	9.09	940.54	
25-Nov	4.25	4.25	5.00	6.3	4.50	6.3	9.00	949.54	
26-Nov	4.5	4	4.95	6.11	4.48	6.11	8.91	958.45	
27-Nov	4.25	3.75	4.90	5.6	4.30	5.6	8.82	967.27	
28-Nov	4.75	3.75	4.85	5.1	4.45	5.1	8.73	976.00	
29-Nov	4.75	3.75	4.80	4.09	4.43	4.09	8.64	984.64	
30-Nov	4.25	3	4.75	4.32	4.00	4.32	8.55	993.19	292.30
01-Dec	4.25	2.25	4.75		3.75		8.55	1001.74	
02-Dec	4.75	2.75	4.72		4.07		8.50	1010.23	
03-Dec	5.25	2	4.69		3.98		8.44	1018.68	
04-Dec	5.25	3.25	4.66		4.39		8.39	1027.06	
05-Dec	4.75	3.25	4.63		4.21		8.33	1035.40	
06-Dec	5.25	4	4.60		4.62		8.28	1043.68	
07-Dec	4.75	4.75	4.57		4.69		8.23	1051.90	
08-Dec	5.25	4.75	4.54		4.85		8.17	1060.08	
09-Dec	4.5	4.25	4.51		4.42		8.12	1068.19	
10-Dec	3.5	4.5	4.48		4.16		8.06	1076.26	
11-Dec	3.75	4.5	4.45		4.23		8.01	1084.27	
12-Dec	3.75	4.25	4.42		4.14		7.96	1092.22	
13-Dec	3.5	4.75	4.39		4.21		7.90	1100.13	
14-Dec	3.75	4.75	4.36		4.29		7.85	1107.97	
15-Dec	4.25	4	4.40		4.22		7.92	1115.89	
16-Dec	4.25	4.5	4.39		4.38		7.90	1123.80	
17-Dec	4.25	5.25	4.39		4.63		7.89	1131.69	
18-Dec	4.75	4.75	4.38		4.63		7.88	1139.57	
19-Dec	4.75	4.5	4.37		4.54		7.87	1147.44	
20-Dec	4.75	4.5	4.36		4.54		7.85	1155.29	
21-Dec	5	4.25	4.35		4.53		7.83	1163.12	
22-Dec	4.75	3.75	4.34		4.28		7.81	1170.93	
23-Dec	4.75	3.75	4.33		4.28		7.79	1178.72	
24-Dec	4.5	3.5	4.32		4.11		7.78	1186.50	
25-Dec	4.75	3.25	4.31		4.10		7.76	1194.26	
26-Dec	4.75	3.75	4.30		4.27		7.74	1202.00	
27-Dec	4.25	3.5	4.29		4.01		7.72	1209.72	
28-Dec	4.75	2	4.28		3.68		7.70	1217.42	
29-Dec	4.75	2.75	4.27		3.92		7.69	1225.11	
30-Dec	5	3.5	4.26		4.25		7.67	1232.78	
31-Dec	5.25	4	4.25		4.50		7.65	1240.43	247.24