Appendix A: Anadromous Salmonids in the Salmon River, California: A Summary From the Literature.

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The following is a summary of anadromous salmonid use in the Salmon River watershed in the Klamath River Basin derived from review of literature on salmon and steelhead for the Salmon River as available, and for the Klamath Basin overall. I did not review in any depth the numerous reports on habitat surveys nor outmigrant trapping due to time limitations. Undoubtedly, there are references I missed, and I was unable to spend the time to interview the many local sources of information; this piece is not exhaustive. However, the literature I did review provides a reasonable picture of the life histories of the fishes, their relative population sizes, and factors affecting survival.

Thanks to Sarah Borok of California Fish and Game and Petey Brucker of the Salmon River Restoration Council for their review and contributions.

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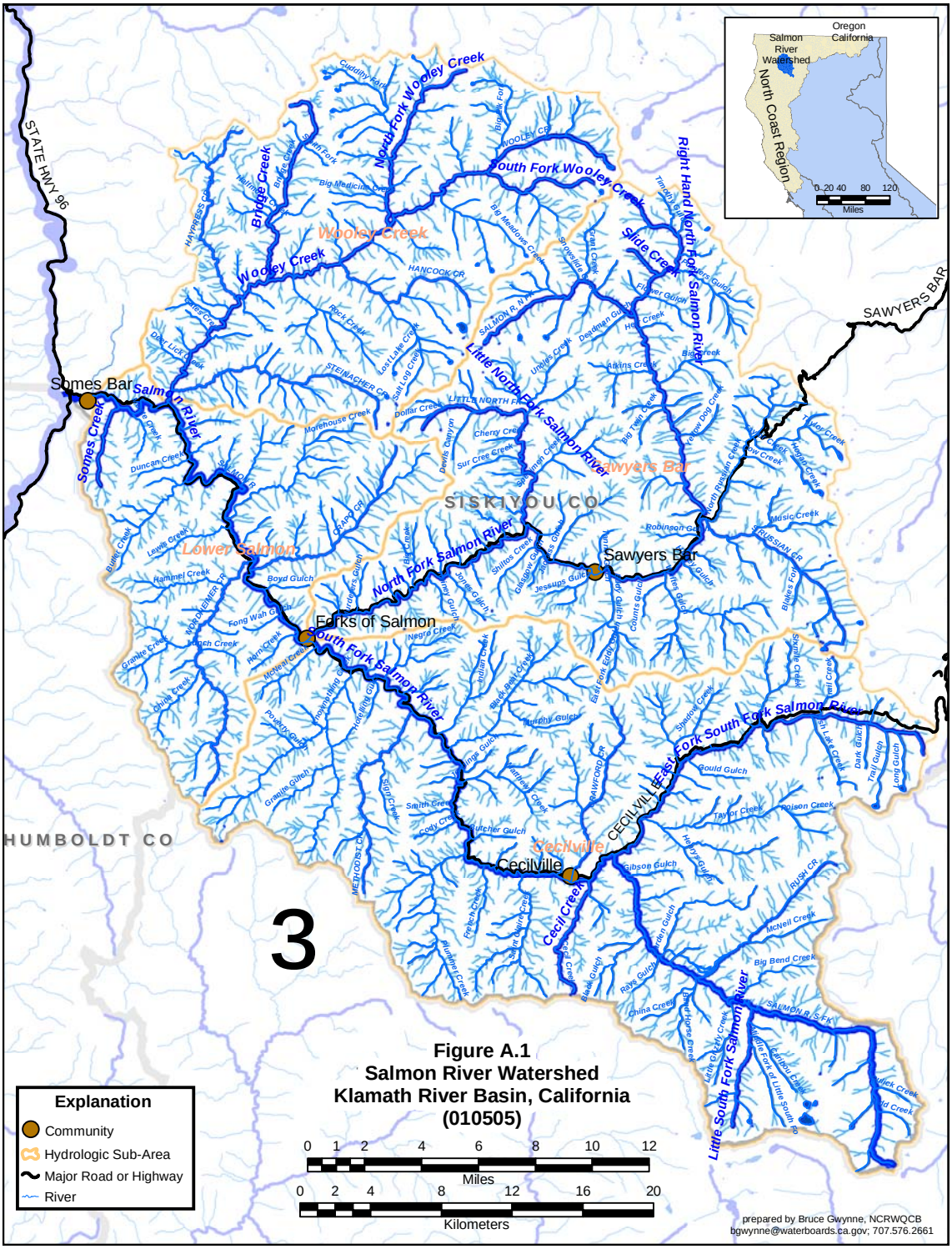

Figure A.1: Salmon River Watershed, Klamath River Basin, California

Six runs of anadromous salmonids use the Salmon River, although information on its use by coho salmon is limited. Information specific to the Salmon River is scattered, though there are a few efforts that have contributed information over the last 20 years or so. A cursory review of

literature sources provides a reasonable perspective on the population trends, timing of use by the runs, and factors most likely affecting anadromous salmonids in this watershed.

A.1 Chinook salmon – Spring Run

Spring Chinook are characterized by their early entry into the system, late spring/ summer prior to spawning maturity. They "hold over" in deep pools, spawning earlier than the fall run Chinook, in mid-September through October. They also differ from the fall run in that they generally use spawning and rearing habitat further up the system. Fry emerge from the gravels beginning in March on into June. Spring Chinook appear to out migrate slightly later than fall-run Chinook because of longer egg development in the cooler water of the upper tributaries (Trihey and Assoc. 1996, West 1991). The juveniles remain in the system through the fall, some as late as January, before they move downstream to the ocean (Olson 1996, West 1991 and Table A.1).

Chinook salmon life histories are broadly characterized as: "ocean-type" – mature adults spawn soon after entering freshwater, with juveniles that out migrate less than a year after emergence, and "stream-type" – adults enter in spring/summer in an immature state and "ripen" in freshwater, with juveniles that remain in fresh water for a year or more (Moyle 2002). Meyers et al. (1998) adopted a broader view, taking into consideration life history traits, geographic distribution, and genetics. As one would imagine, the characterization of spring Chinook in the Klamath Basin is varied, Moyle (2002) stating that spring run Chinook in California exhibit classic stream life history, though some juveniles stay less than a year in freshwater, and Meyers et al. (1998) stating that all Chinook south of Cape Blanco, Oregon, are ocean life history type, with up to 20% of the smolts being yearlings. Suffice to say that the Salmon River spring Chinook enter the streams in the late spring/summer and juveniles generally out migrate with less than a year in freshwater.

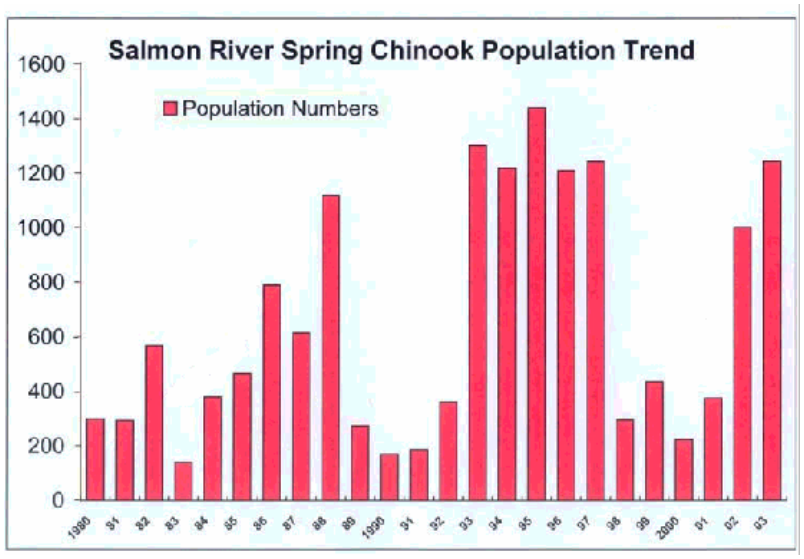

Figure A 2. Spring Chinook escapement estimates, Salmon River, 1980-2002 (SRRC 2003) (Based on USFS data)

The Klamath system was known historically for its large runs of spring Chinook, by all accounts larger than the fall run, but currently a vestige of its former self (Moyle, et al. 1995, West 1991, Shaw et al. 1997, DWR 1965). The good news is that the Salmon River watershed sports the largest wild run of these fish in the Klamath Basin (West 1991, SRRC 2003). The Klamath River Basin Stock Identification Committee of the Klamath River Basin Fisheries Task Force identified the Salmon River spring Chinook as a distinct metapopulation

(Barnhart 1994). Data on the run sizes in the Salmon River are available from surveys conducted by the Dept. of Fish and Game, U.S. Forest Service, Salmon River Restoration Council, Karuk Tribe, and others, and indicate a population apparently oscillating between escapement lows in the range of 200 adults and highs in the 1000-1400 range (Figure A-2).

It is difficult to put this into a historical perspective, but gleaning information from a number of sources, we know that salmon runs were very large by comparison in the early 1900s. Rankel (1978 as cited by Trihey 1996, Leidy and Leidy 1984) estimated 300,000 to 400,000 salmon in the annual catch plus escapement for the Klamath River system during the period of 1915-1928. Spring Chinook may have comprised as much as 100,000 fish, probably more (Moyle 2002, Moyle et al. 1995). Meyers et al. (1998) in the status review of Chinook salmon estimate that the current spring Chinook run in the Klamath-Trinity system is less than 10% of historic levels and at least seven distinct runs have been eliminated.

Declines in the spring Chinook runs in the Klamath and Trinity relate to a variety of factors, largest among them construction of dams blocking habitat, over harvest, and habitat degradation. Synder (1931) believed the spring runs were already in decline in the early 1900s due to hydraulic mining and commercial fishing. While it is difficult to estimate historic numbers in the Salmon River, it did not receive the same intensity of human alterations to the hydrology and landscape. Whether or not the decline in spring Chinook in the Salmon River is commensurate with other areas in the Klamath, it is generally accepted that the only substantial wild runs of spring Chinook in California today are in the Salmon River and Deer and Mill creeks in the Sacramento River basin (Moyle 2002). This highlights the importance of maintaining and enhancing the conditions that exist in the Salmon River watershed in retaining this once abundant run of salmon in a native state.

West (1991) describes the distribution of spring Chinook habitat in Wooley Creek, North Fork Salmon River, South Fork Salmon River, East Fork of the South Fork Salmon River, and the mainstem Salmon River, citing about 106 miles of habitat available. The South Fork appears to hold the majority of the spring Chinook spawning run in the Salmon River watershed and some of the best refugial habitat (USFS 1994). Additional detail is provided in the U.S. Forest Service ecosystem analyses for the South Fork, North Fork, and Main Salmon River (USFS 1997, 1994, 1995a, 1995b).

Spring Chinook use the mainstem Salmon River, Nordheimer Creek, and Wooley Creek (Brucker 2004, Barnhart 1994, USFS 1995a, West 1991) and apparently use the mainstem North Fork up to the confluence with Right Hand Fork, as well as the Little North Fork and South Russian Creek (Brucker 2004, USFS 1995b). Spring Chinook use the South Fork mainstem at least to the Little South Fork and to Shadow Creek in the East Fork of the South Fork, as well as several tributaries, particularly Knownothing Creek and Methodist Creek (Brucker 2004, Elder et al. 2002, USFS 1994) (Figure A.5).

Factors affecting spring Chinook life stages relate primarily to the condition of holding areas for adults, the condition of the spawning gravels, and summer rearing conditions:

- Adult holding requires deep pools with cool water and adequate overhead cover as they "ripen" for spawning in the fall. The width and aspect of many of the mainstem areas in the

Salmon River watershed make shade and elevated water temperatures a concern. The mainstem areas are bedrock and/or Rosgen F-type channels in many areas, making establishment of large riparian trees difficult (EAEST 1998). The bankfull and flood plain widths in other areas often preclude development of riparian canopy to shade the stream, and aspect often limits shading (Elder, et al. 2002). The thermal regime of tributary streams then plays an even more important role, not only in providing cool water for juveniles, but also in providing cool water to the mainstem where adults are holding at a very critical point in their life history. Numerous authors cited stream temperatures as a concern, both for adult holding and juvenile rearing (Elder, et al. 2002, Olson and Dix 1993, USFS 1995, West et al. 1989, West 1991).

- Spawning gravels are pretty clean in the watershed, with some exceptions in the South Fork Salmon River, where the weathered granitic rock of the Trinity Alps introduces sand into the spawning gravels.
- Woody cover and high water temperatures appear to be an issue with rearing habitat quality. The extent to which rearing habitat may be affected by sediment production was not apparent in any of the resources reviewed for preparation of this report.
- There is concern about increased suction dredging in the watershed and its potential effects on salmonids. Local residents have observed turbidity plumes and deposition of fine material downstream of suction dredges.
- The extent to which unregulated harvest (poaching) may impact the population is unknown.

Elder et al. (2002) designated "critical habitat stream reaches" for anadromous salmonids based on importance for holding/spawning, rearing, and cold water as well as presence of fish (Figure A.9).

A.2 Chinook salmon – Fall Run

Fall Chinook are characterized by entry into the system as mature adults from about August through December. Spawning occurs from October through December, with egg incubation from mid-November through March. Emergence is from February through mid-April, with outmigration following on into mid-June (Leidy and Leidy 1984 and Table A.1).

Sullivan (1989) described three types of Klamath River fall Chinook: Type I that rear in fresh water several months before outmigration, Type II that remain in fresh water for an extended period (up to mid-winter), and Type III being those with juveniles remaining in fresh water for a year. Scale analysis of 56 fall Chinook adults returning to the Salmon River in 1986 indicated that age-2 fish were predominantly Type I, age-3 fish were split 60:40 between Types I and II, and age-4 fish were split 21:71:7 among Types I, II, and III.

The Dept. of Fish and Game, U.S. Forest Service, Karuk Tribe, and the Salmon River Restoration Council have estimated escapement of fall Chinook since 1978. Total run sizes are variable with lows in the 800-1000 fish range and highs in the 4000-6000 range (Figure A-3). Runs in the area of 500,000 adults have been estimated for fall Chinook in the Klamath-Trinity system historically (Moyle 2002), with current runs of hatchery and wild fish ranging from about 34,000 to 239,000 with most below 150,000 (CDFG 2003). It is not clear how Salmon River populations have faired over the years, though there is some indication that runs of fall Chinook are smaller today than historically.

Fall Chinook use much of the same habitat (except for holding/ripening) as the spring Chinook, though generally do not go as far up the streams. Barnhart (1994) stated that fall Chinook use in the mainstem, North Fork, and South Fork, and Moyle (2002) indicated Wooley Creek as a spawning stream as well. Use in the North Fork occurs at least up to Russian Creek USFS (1995b), and in the South Fork up to French Creek (Barnhart 1994). Spawning occurs in Nordheimer Creek, a mainstem tributary, as well as in a number of tributaries to the South and North forks.

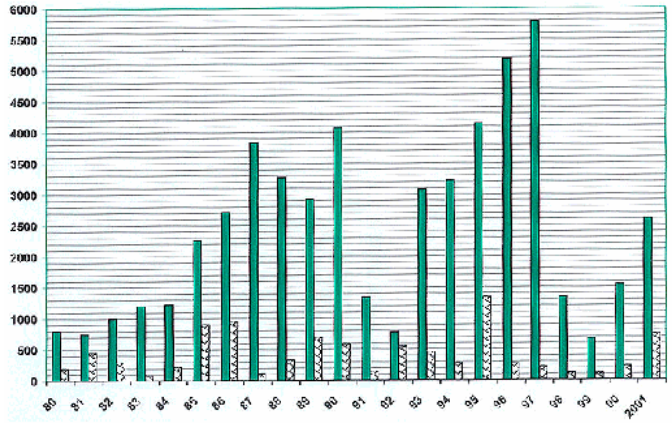

Figure A-3. Fall Chinook escapement estimates, Salmon River, 1980-2001 (SRRC 2003)

Primary causes for the decline in Klamath Basin fall Chinook are linked to dams blocking habitat, previously unregulated harvest, water use and quality, and habitat degradation. The Salmon River has not experienced the degree of perturbations as the rest of the Basin, though there are concerns about the level of adult escapement. The same concerns that apply to spring Chinook also apply to the fall Chinook, with less emphasis on the holding conditions, since the fall runs generally do not "hold over" for long periods. Refer to Elder et al. (2002) "critical habitat stream reaches" for anadromous salmonids based on importance for holding/spawning, rearing, and cold water as well as presence of fish (Figure A.9).

A.3 Late Fall/Winter Run Chinook

Brucker (2004) reports observations of late fall/winter run Chinook in the lower Salmon River watershed (below Knownothing Creek).

A.4 Steelhead – Spring/Summer, Fall, Winter

Steelhead trout populations appear more resilient than Chinook, maybe in part because of their larger geographic extent, using the smaller tributary streams that are more numerous. Steelhead also appear to be more tolerant of rearing conditions. The three runs enter the rivers at different times, but the timing of spawning seems to have considerable overlap, with the spring/summer being more distinct from the fall and winter runs. However, there is some conjecture that the summer and fall runs are not genetically distinct (McEwan and Jackson 1996). Perhaps it is in part this deviation from the norm that imparts the steelhead its resiliency.

Spring/summer steelhead migrate into the Salmon River system between May and June, holding over in deep pools like the spring Chinook until spawning in December through February (Barnhart 1996, Elder et al. 2002, Leidy and Leidy 1984, Moyle et al. 1995, USFS 1995b) (Figure A.7).

Fall steelhead enter the Salmon River system July through October, spawning in December through April. Winter steelhead enter the Salmon River from September through November, possibly later, entering the smaller streams later, on into April. Spawning occurs from December through April (Leidy and Leidy 1984).

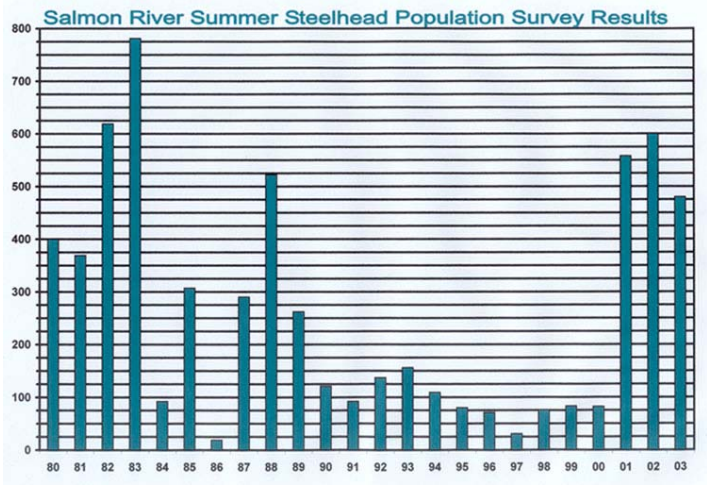

Figure A-4. Summer steelhead population counts, 1980-2002 (SRRC 2003)

Notable to the Klamath River Basin is the "half-pounder" run, immature steelhead returning to freshwater after only one summer in the ocean. These fish over-winter in freshwater, then return to the ocean, coming back to fresh water the following year to spawn. Steelhead, unlike salmon, also are repeat spawners, returning to the ocean after spawning, coming back to fresh water each year, sometimes for several years, to spawn again.

Freshwater residency for spring/summer steelhead ranges from one to three years, but in the Salmon River is predominantly two years (Hopelain 1998, Moyle et al. 1995). Outmigration is size-dependent to a degree and appears to occur year-round, mostly during the period of March through June, along with the other runs of steelhead (Leidy and Leidy 1984).

The Klamath River Basin Stock Identification Committee in 1994 considered the three steelhead runs in the Klamath River Basin as a vestige, "…remnants of a much larger more protracted run of fish which dominated the [Klamath-Trinity] system before man's activities interfered…" (Barnhart 1994). Run size estimates for summer steelhead in the Salmon River from 1980 to 2002 range from less than 50 to nearly 800, with more than half of the years below 200 adults (Figure A-4) (SRRC 2004). Run size estimates for the other runs of steelhead in the Salmon River were not found in research prior to preparation of this report. Additional data on other runs of steelhead in the Salmon River watershed are sparse, due to difficulties in access and

seeing the fish during the winter months. A cooperative effort in the last few years may yield more information on spawning trends in specific reaches and species ranges (Brucker 2004).

Steelhead are the most widely distributed of anadromous salmonids in the Salmon River system (Elder, et al 2002). As mentioned above, summer steelhead adults use summer holding areas with spring Chinook. Snorkel counts of summer steelhead indicate about 50% hold in the South Fork, the remainder split equally between Wooley Creek, the North Fork and the mainstem (USFS 1997). Actual documentation of the range of distribution beyond the major tributaries was difficult to find. Several sources (Barnhart 1994, USFS 1994, 1995a, 1995b, 1997) were used to develop a map (Figure A.7) indicating steelhead use in:

- the mainstem and two tributaries (Wooley Creek and Nordheimer Creek),
- the North Fork up to Deer Lick Creek and Slide Creek, and seven tributaries (Little North Fork to Cherry Creek and in South Fork Specimen Creek, the next north side tributary upstream, Jackass Gulch, Eddy Gulch, Whites Gulch, and North and South Russian Creek),
- the South Fork up to Big Bend Creek and 11 tributaries (Knownothing Creek, Negro Creek, Methodist Creek, Indian Creek, Black Bear Creek, Saint Claire Creek, Crawford Creek, Cecil Creek, East Fork of South Fork into South Fork Taylor Creek, Black Gulch, and Blind Horse Creek).

More in depth review of the literature would likely yield a much longer list of tributaries, virtually any tributary with access to these fish and with year-round flows.

Little was found in the way of limiting factors specific to steelhead in the Salmon River watershed. Still, most of the literature was consistent in highlighting water temperature for adult holding and rearing, as well as rearing habitat as concerns for continued viability of the fish. Refer to Elder et al. (2002) "critical habitat stream reaches" for anadromous salmonids based on importance for holding/spawning, rearing, and cold water as well as presence of fish (Figure A.9).

A.5 Coho salmon

Perusing the literature one gets the impression that coho salmon use the Salmon River watershed, but little is known about their relative numbers, distribution, or trends. It is generally accepted that coho salmon populations have declined in number and distribution throughout California, probably to less than six percent of their 1940s numbers (Moyle 2002, Moyle et al. 1998). Additionally, there has been considerable mixing of hatchery stocks from the Columbia River Basin, ergo the decision by the Klamath River Basin Stock Identification Committee in 1994 that coho in the Klamath River Basin constituted a single metapopulation (Barnhart 1994).

Coho salmon have a 3-year cycle, most young rearing in freshwater and the ocean for about equal periods, with most adults returning as 3-year olds. It appears the coho are somewhat distinct in their use of rearing habitat, preferring deeper pools than other anadromous salmonids. Overwintering habitat is especially critical for this species. There is some incidence of "jacks" returning to spawn as 2-year old males, but this represents a small proportion of the runs (Barnhart 1994, Moyle 2002, Moyle et al. 1998).

Coho salmon migrate into the Klamath River in September through January, spawning in mid-November and into February. Emergence from the gravels runs from about February to mid-May with a 12-18 month residence in freshwater (Shaw et al. 1997, Trihey & Assoc 1996) (Table A.1).

Information on run sizes is sketchy for coho in the Klamath River Basin and virtually non-existent for the Salmon River. Barnhart cites CDFG (1965) as estimating a run size in the Klamath River Basin of 15,000 fish in the 1960s. Moyle et al. (2002) cites historical escapement estimates of 15,000-20,000 fish, with hatchery returns in 1990 of 1,700 and 1991 of 3,100. As mentioned above, it is generally accepted that the species has declined in numbers and distribution. However, no information specific to the Salmon River was located in research conducted for preparation of this report.

Likewise, information on the distribution of coho salmon in the Salmon River watershed is difficult to find. Elder et al (2002) mention coho in passing. West et al. (1989) observed no coho juveniles in their surveys of the South and North forks and Nordheimer Creek. USFS (1995b), *North Fork Watershed Analysis*, provides information on "suspected" distribution. USFS (1997 and 1995a), *Lower South Fork of the Salmon River Ecosystem Analysis* and *Main Salmon Ecosystem Analysis*, lump coho distribution in with summer and fall Chinook as using the mainstem areas.

The map developed from this information for presentation in this report is likely incomplete. In all likelihood, coho salmon would use at least the lower gradient areas used by steelhead, thus the potential distribution would be much larger than indicated in Figure A.8.

In addition to the factors mentioned for the other anadromous salmonids, deeper pool habitat for rearing is a need more specific to coho. Coho salmon are probably more sensitive to water temperature, as well, so rearing temperatures are a concern for this species as well.

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Table A.1: Salmonid life stage periodicity in the Salmon River, Klamath River Basin, CA

Salmonid life stage periodicity in the Salmon River, Klamath River Basin, CA

	Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec		Jan		Feb		Mar		Apr		May		Jun		Jul		Comments	Ref
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sm=small tribs)																		I	I	I	I	I	I	I	I	I	I	I						
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Coho Salmon												M	M	M	M	M	M	M	M	M													Mostly age 3 fish	2
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									R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	12-18 month residence	

Table A.1b: Key Terms and References for Table A.1

M = spawning migration S = spawning I = incubation E = emergence O = outmigration R = rearing	References used: 1. Leidy, R.A. and G.R. Leidy. 1984. Life Stage Periodicities of Anadromous Salmonids in the Klamath River Basin, Northwestern California. US Fish and Wildlife Service, Sacramento CA. 21 pp. + appendix 2. Shaw, T.A., C. Jackson, D. Nehler, and M. Marshall. 1997. Klamath River (Iron Gate Dam to Seiad Creek) Life Stage Periodicities for Chinook, Coho, and Steelhead. USDI-Fish and Wildlife Service, Coastal Calif. Fish and Wlf. Office, Arcata, CA: 43 pp + appendices 3. West, J.R. 1991. A Proposed Strategy to Recover Endemic Spring-run Chinook Salmon Populations and Their Habitats in the Klamath River Basin. USDA-Forest Service, Klamath Nat For: 26 pp 4. U.S. Forest Service (USFS) 1995. North Fork Watershed Analysis. USDA-Forest Service, Klamath National Forest

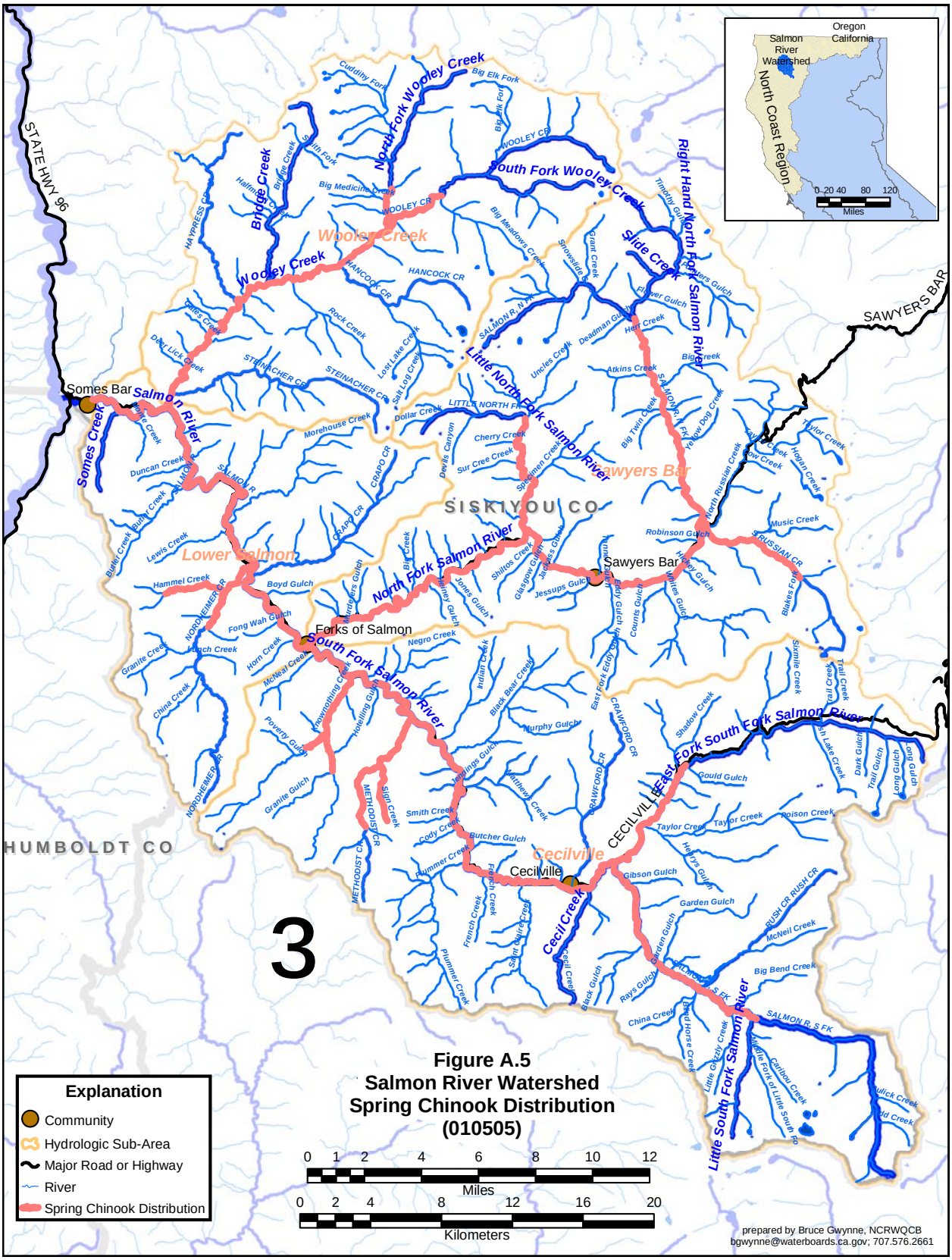

Figure A.5: Spring Chinook Distribution for the Salmon River

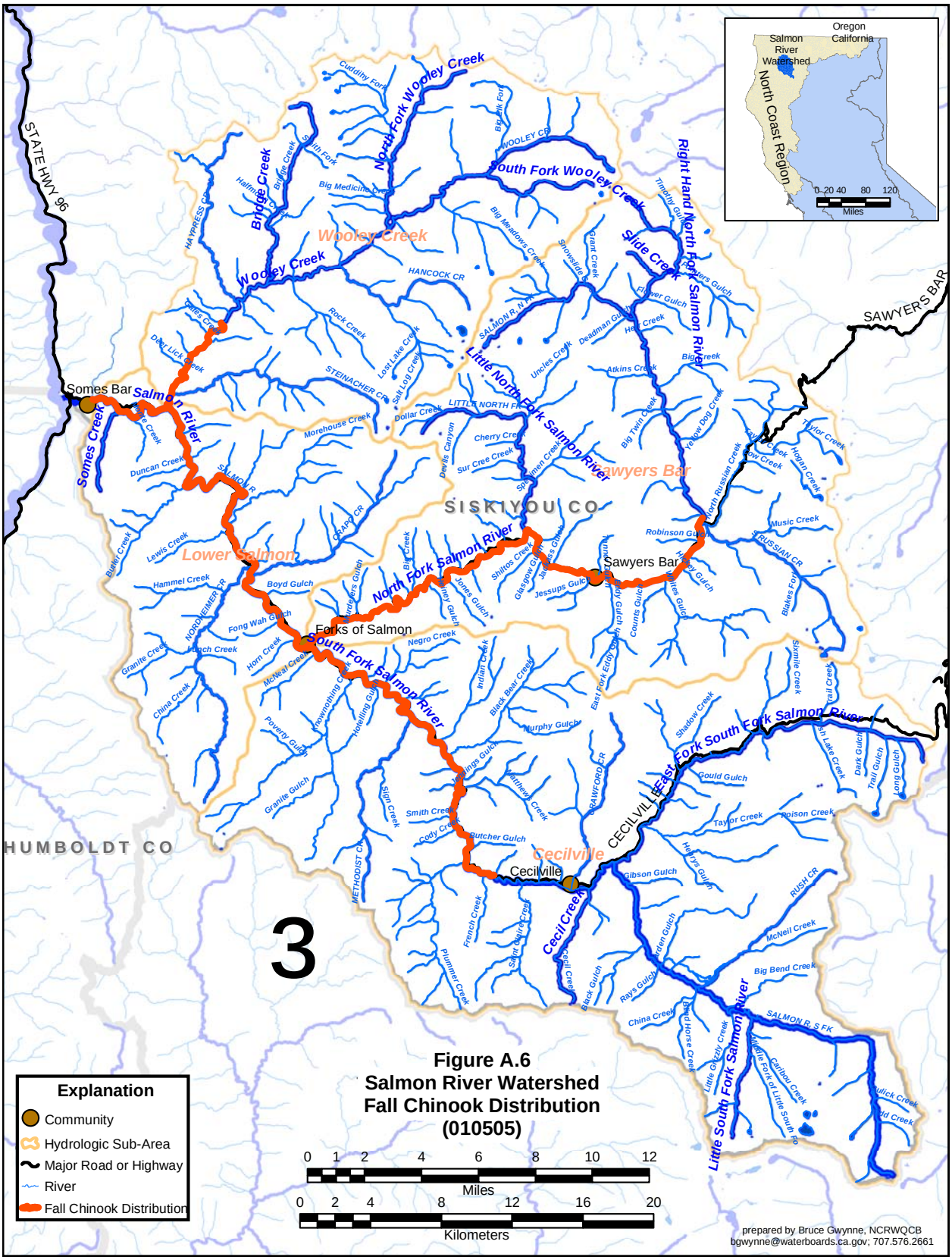

Figure A.6: Fall Chinook Distribution for the Salmon River

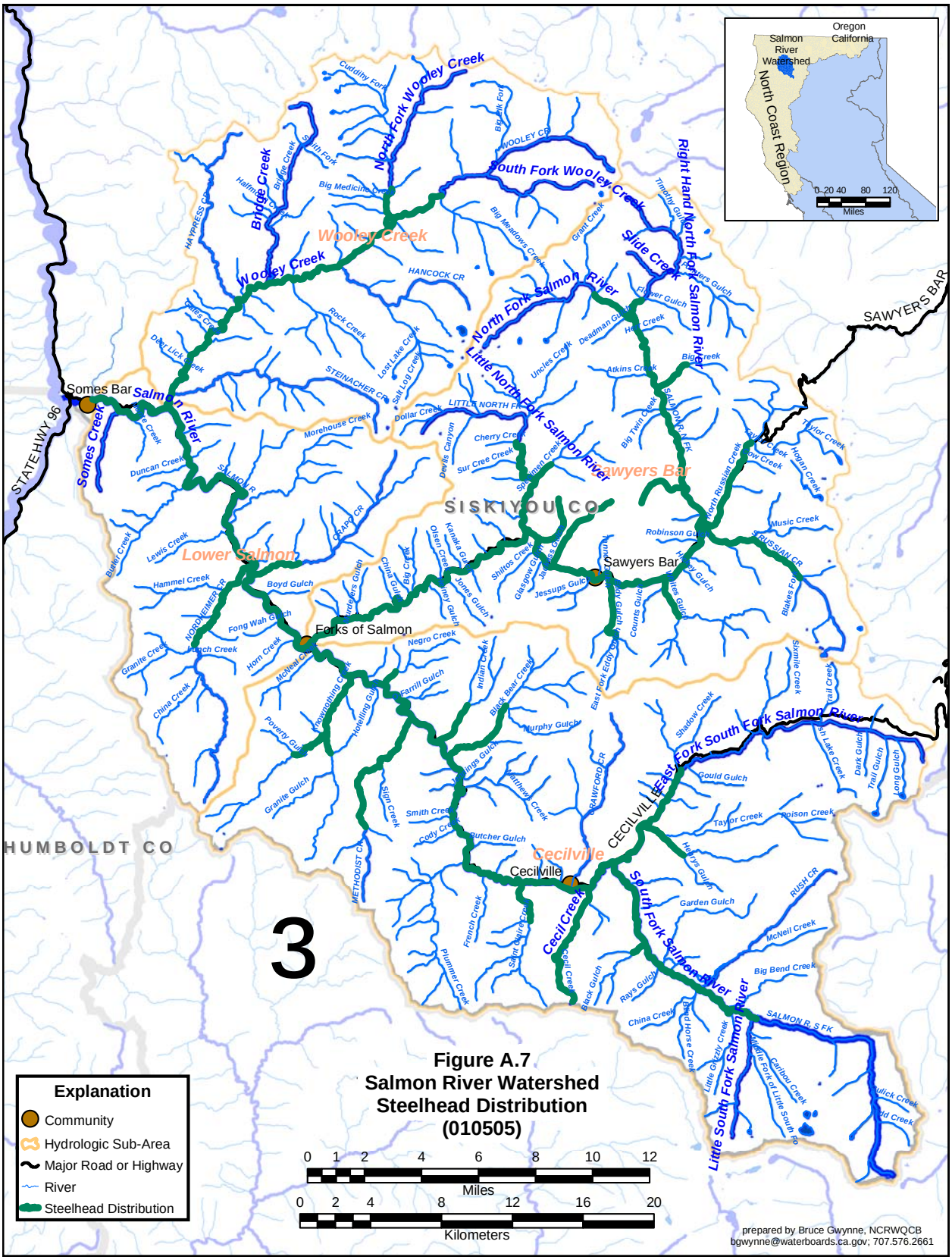

Figure A.7: Steelhead Distribution for the Salmon River

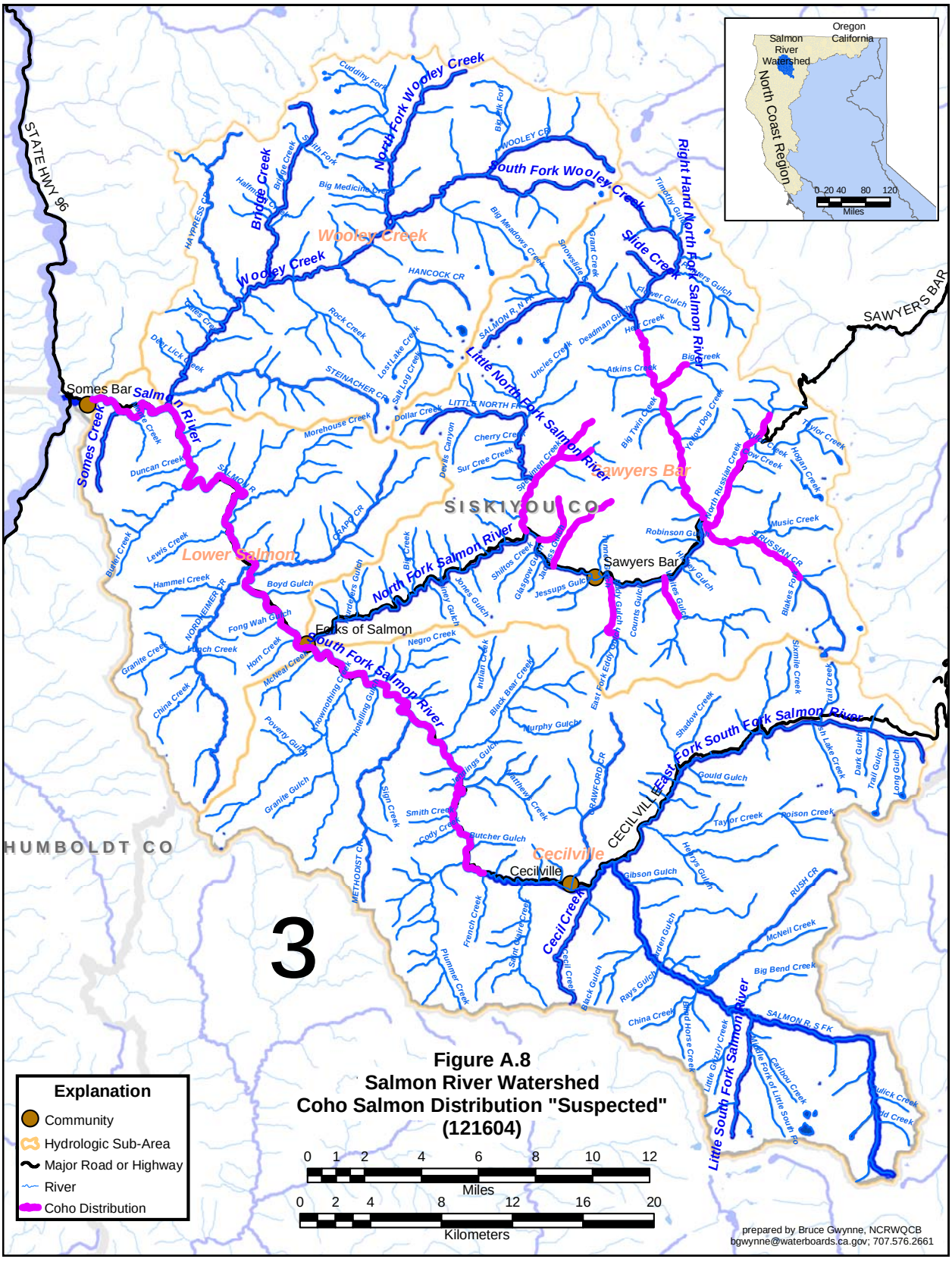

Figure A.8: Coho Distribution for the Salmon River

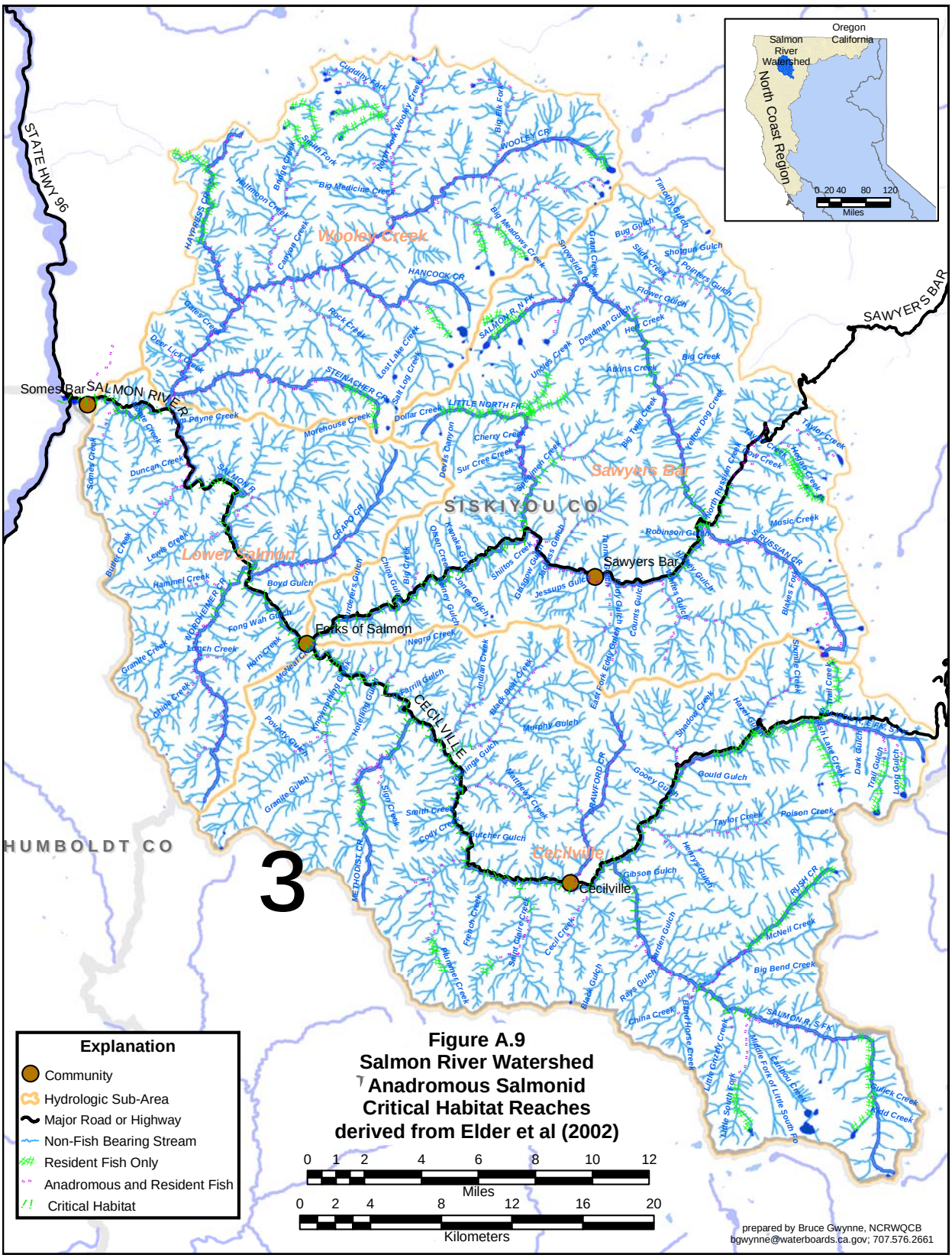

Figure A.9: Salmon River Watershed Anadromous Salmonid Critical Habitat Reaches (Elder et al. 2002)