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HISTORICAL AND CURRENT DISTRIBUTION OF PACIFIC SALMONIDS IN THE CENTRAL VALLEY, CA

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Contents

List of Figures

List of Tables

List of Plates

1 Introduction

NOAA Fisheries is tasked with the recovery of numerous runs of threatened and endangered salmonids in California. The Central Valley Technical Recovery Team (CVTRT) is tasked with assessing the viability of endangered salmonid populations within the Central Valley of California. The first goal of the viability assessment is to delineate the historical independent populations (McElhany et al., 2000); however, this task is complicated by the lack of information on the historical distribution and abundance of salmonids in the Central Valley. Fortunately, there have been attempts to document the historical distribution of salmonids in the Central Valley (Yoshiyama et al., 2001). By exploring source data, and interviewing surviving descendants of Central Valley inhabitants, Yoshiyama et al. (2001) provided a narrative description of the historical distribution of Central Valley salmonids. However, while the narratives were specific to watersheds, the data lacked an explicit spatial component. Hence, we undertook a GIS-based effort to translate the narrative structure of Yoshiyama et al. (2001) into GIS-ready data layers. The focus of this report is to describe our methods, to display the cartographic results, and to provide a guide to the accompanying data.

2 Methods

2.1 Yoshiyama data

Yoshiyama et al. (2001) provide an historical narrative of the distribution and, where available, the abundance of five runs of Pacific salmonids (spring-run chinook salmon, fall-run chinook salmon, late fall-run chinook salmon, winter-run chinook salmon, and steelhead). The distributions Yoshiyama provides are in a qualitative format, e.g.:

> "Salmon originally ascended a considerable distance into the Feather River system, particularly the spring run which spawned in the higher streams and headwaters. They went up the West Branch at least to the site of Stirling City (F. Meyer, personal communication, see "Notes"), and also up along the entire length of the North Fork Feather River through the area now covered by Lake Almanor and into the surrounding tributary streams ($>$ 4,200 ft elev.)."

The depth and breadth of information provided varies from run to run, with spring-run chinook salmon containing the most comprehensive narrative. Though we were concerned primarily with the spring run chinook distribution, we also digitized the spatial extent for the other three runs of chinook and for steelhead. We consulted a second report (CDFG, 1998) to find current spawning distributions for spring-run chinook salmon, which were subsequently digitized. If there was a difference between a distance given by Yoshiyama et al. (2001) and CDFG (1998), Yoshiyama et al. (2001) was given priority. We presented the spatial data to the CVTRT for feedback on our interpretation of all distributional limits, and made any recommended changes.

2.2 Digitizing

We digitized inferred salmonid distributions using the Digitize Events tool in ArcMap. (The DigitizeEvents Toolbar is an ArcObjects sample module; it can be downloaded and installed from `http://arcobjectsonline.esri.com` .) Events are "attributes associated with a route…," whereby a route is an alternate way to display linear data (Environmental Systems Research Institute, 2003 (ESRI)). Traditionally, lines are represented geographically as a set of connected x and y points. Alternatively, linear features, such as rivers, can be represented as straight lines with start and end coordinates. For example, the mouth of a river can be 0 distance along a route, while the end of a 20 km river can be at 20 km. An event, then, is a point or line feature that is located in space as a function of its distance along the route. Thus a stretch of historical habitat can start at 0 and head to 18 km, and the current habitat along that same river can start at 0 and head to 6 km. A point event could be a dam located at 6 km, that now cuts off river kilometers 6 through 18. This way of representing features along the route allows for multiple overlapping attribute information, and frees the GIS analyst from having to split arcs multiple times to store this attribute information. For more information, refer to the "Working with linear features: Dynamic Segmentation" portion of the workstation ArcInfo help.

We digitized the linear events on a 1:100k hydrographic layer that includes a stream-based route system (available at `http://www.calfish.org/`). For those streams where the upstream limit was mentioned as a place or landmark, we used National Geographic's Topo! Image Support for ArcGIS extension (National Geographic, 2003) to load 1:100,000 and 1:24,000 scale topographic quadrangle sheets into an ArcGIS map document. This allows for easy visualization of relevant landmarks and map features. For distributions cited as distances, e.g. miles up-river, we digitized from the mouth upstream to the specified upstream distance. All events were digitized upstream starting at the river mouth (or downstream starting point for spawning grounds).

The data for steelhead distribution were incomplete in Yoshiyama et al. (2001). For streams where steelhead presence was noted, but the distribution was not discussed, the upper limit was set equal to the upper limit of spring-run chinook salmon. However, the true distributions of steelhead most likely extended to higher elevations and into smaller tributaries. Data for fall-run chinook salmon historical distribution were also incomplete in Yoshiyama et al. (2001). For streams where Yoshiyama et al. (2001) mentioned the presence of fall-run chinook salmon, but failed to give an up-stream limit for their distribution, the 150 meter elevation contour was chosen as the upper distribution limit (Yoshiyama et al., 2001).

2.3 Geodatabase

The distributional data are presented here within a Geodatabase (ESRI's proprietary database format for storing and distributing geospatial data). This geodatabase `CVSalmonids` consists of tabular information, feature datasets and feature classes. The last two categories are hierarchical in nature (the hydrography dataset contains California Rivers, Central Valley rivers, annotation for these rivers, etc.). Consult Appendix A for instructions on using the event data, and see Appendix B for more specifics on individual feature classes in the geodatabase.

3 Results

We grouped the cartographic results for spring-run chinook salmon according to 4 diversity units (Figure 1), which are based loosely on environmental setting, run-timing, and watershed proximity. In addition, we generated several maps at the scale of the Central Valley basin. We focused most closely on spring-run chinook salmon because of the quality of information in Yoshiyama et al. (2001) about their distribution. The plates at the end of this document provide a visual inference of the data in Yoshiyama et al. (2001), but note that there are no data for current distribution of steelhead and fall-run chinook salmon. Tables 1, 2, & 3 document the historical number of stream kilometers inhabited by chinook, as well as estimates of the current distribution of spring run chinook. These estimates were derived by extracting the length of the fish distribution events.

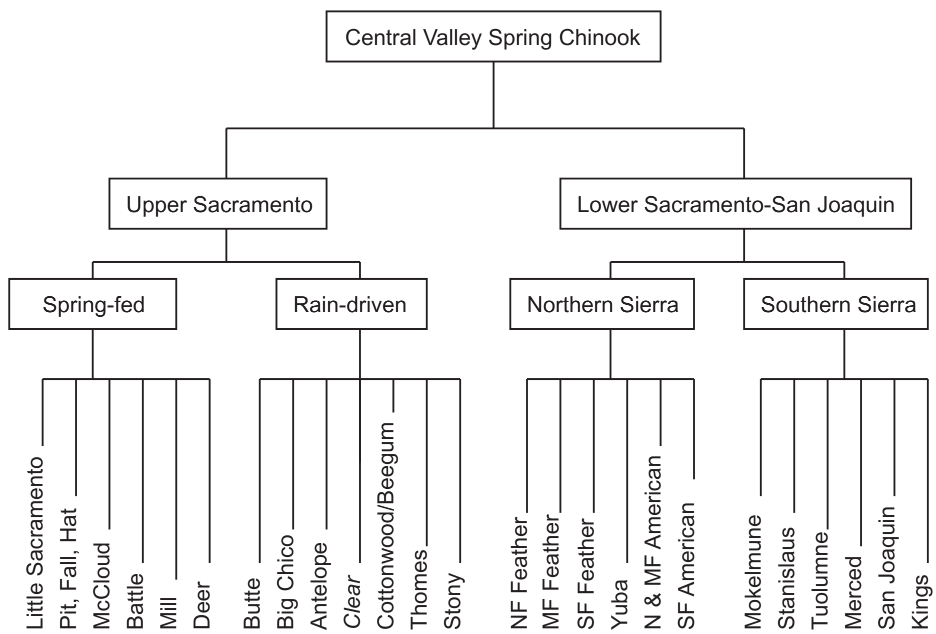

Figure 1. Categories for mapping spring-run chinook salmon in Central Valley streams. "NF" corresponds to North Fork; "MF" corresponds to Middle Fork; "SF" corresponds to South Fork.

4 Discussion

Though the initial goal of translating the narratives into digitized spatial output was modest, there are two issues of note. First, we struggled with how to represent the historical distribution of steelhead. This is due in part to the lack of specific distribution information in Yoshiyama et al. (2001), but also because of steelhead life histories. Compared to chinook, steelhead spawn in higher elevation and higher gradient streams. Therefore, depicting their distribution as the mainstem of a watershed is at best misleading, and at worst incorrect. Thus we have limited faith in the graphical representation of the steelhead distribution. Second, the hydrology of the Central Valley basin has been drastically altered in the past 150 years, so caution must be exercised in visually interpreting the historical distribution drawn over the top of present-day hydrography. The lower reaches and the valley floor have changed dramatically, and while the headwater reaches no doubt have been little changed, there is evidence of impact to select streams during the gold rush period. For example, the channel of the Yuba River underwent substantial alteration due to hydraulic mining in the early 1860's (Yoshiyama et al., 2001). In addition, we are representing the extent of the spawning ranges for all runs, not the actual spawning distribution (except for the current Spring-run chinook salmon distribution). For example, while spring-run chinook salmon are mainstem spawners, there is no evidence that they spawned in the lower mainstem of the Sacramento River. These data and the plates that represent our interpretation of them are solely meant to provide a snapshot of how far the fish made it up into the individual watersheds. They are not meant to imply that fish spawn throughout the entire range depicted.

While this dataset has been useful in assisting with delineating independent populations, we intend to expand its utility. Currently we are undertaking a large GIS-based modelling effort aimed at estimating the historical potential for habitat to support various salmonids, based on work delineating historical potential habitat in Coastal Oregon streams (Burnett, 2001). Future work relative to this Central Valley database will include comparing the potential habitat determined by the GIS model to that documented by Yoshiyama et al. (2001).

5 Acknowledgements

The authors wish to thank Jon Goin and Kerrie Pipal for help with digitizing distribution events. We also wish to thank members of the CVTRT for helpful comments and feedback on draft versions of the maps.

A Directions for mapping route events

To map route events in a map document you must do the following:

1. Add the event table to the active data frame.
2. Add the routes to the data frame.
3. In the Tools pull down menu select Add Route Events.
4. In the resulting dialog box (Figure 2) select the route system from the Route Reference section (The Route Identifier is the field that will link the events table to the route by designating which route each event is to be placed upon. For the geodatabase that accompanies this report the LLID field is always the route identifier, which signifies the latitude and longitude coordinates of the mouth of each river.)
5. Select the event table that will be plotted on the routes from the Event Table section.
6. Select the route identifier that matches up with the routes (in this case LLID).
7. Finally, depending on the type of events, you can choose either points or lines; however, for the salmonid distribution data, lines are the most appropriate in order to delineate distances along the routes.
8. In the From section, select the field containing the points that begin the line events for the distribution you want to represent in your map document.
9. In the To section, select the field containing the points that end the line events for the same distribution. (For the elevation table and the spawning table this will be intuitive because these fields are labeled From_m and To_m (from measure and to measure). But, the main salmon distribution table is set up in a different format. It is advised that you read through the metadata for this table before its use, particularly focusing on the data dictionary section where the fields are described. For example, if you want to display the spring run chinook current distribution, you must select the CSP_From and CSP_To respectively while HSH_From and HSH_To represent the historical steelhead distribution. Be careful not to mismatch the from and to of different species because this will yield an inaccurate distribution.)
10. Leave the offset space at `<None>`
11. Click OK

    When displaying multiple salmonid distributions at the same time, readability may be improved by offseting some lines. The Offset section of the Add Route Events window gives the user this opportunity. To create an offset first edit the event table prior to accessing the Add Route Events window. Each event table in the salmonid geodatabase contains an offset field with the value equal to 0, or no offset. To change this to the desired offset distance from the route, open the event table within ArcMap, and right click on the field heading of the offset field. Select calculate values, and then in the Field Calculator dialogue box, simply enter in the distance you wish to set and select OK. The field should be changed to the distance you entered. Then in the offset dropdown box of the Add Route Events window, select the same field that was altered.

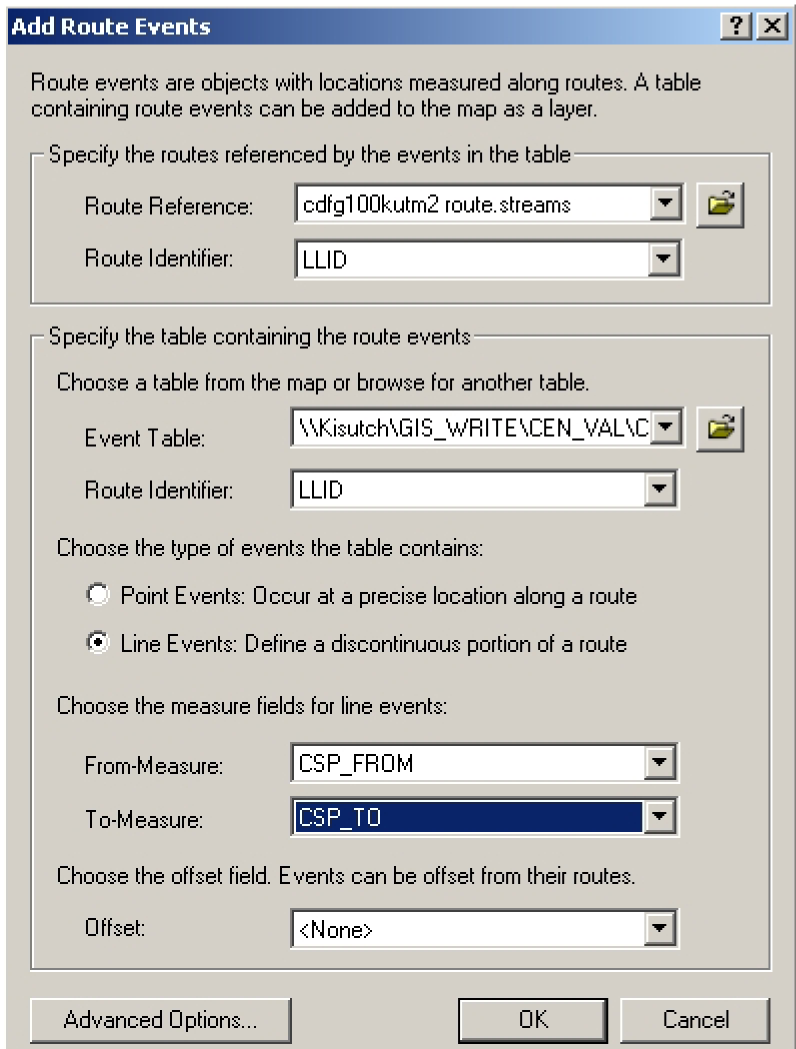

Figure 2. Screen capture of the ArcMap dialog box for adding route events.

B Geodatabase structure

The purpose of the CVSalmonid geodatabase is to house the historical and current salmonid distribution GIS layers for the Central Valley, California and their supporting files for creating map documents. This geodatabase contains three tables and six feature data sets. The data can be downloaded from `http://santacruz.nmfs.noaa.gov/publications/`

B.1 Tables

hist_elevation : personal geodatabase table for estimated historical distribution of spring-run chinook salmon, fall-run chinook salmon and winter-run chinook salmon and steelhead for selected rivers/streams in the Central Valley of California. Each stream is divided into segments based on three elevation catagories ($<$ 150 m, 150 - 500 m, $>$ 500 m). Elevation data were derived from the 30 meter DEM for California. USGS. 1999. National elevation dataset. United States Department of the Interior, U. S. Geological Survey. `http://gisdata.usgs.net/ned/default.asp`

salmon_dist : personal geodatabase table for estimated historical and current distributions of spring-run chinook salmon, fall-run chinook salmon and winter-run chinook salmon and steelhead for selected rivers/streams in the Central Valley of California.

spawn_dist : personal geodatabase table for estimated historical distribution of spring-run chinook salmon in selected rivers/streams in the Central Valley of California (CDFG, 1998).

B.2 Feature data sets

B.2.1 Barriers

Contains the California dams and Central Valley dams feature classes in addition to annotation layers for these dams to be used in map documents

Cvkeydams : keystone dam feature class for streams known to have historically supported chinook salmon in the Central Valley, California. Keystone defined as first major barrier to anadromy on the stream/river.

fall1_dams_anno : Annotation layer of three dams found on streams that historically supported fall-run chinook salmon in the Sacramento River basin.

fall2_dams_anno : Annotation layer of several of the keystone dams found on streams that historically supported fall-run chinook salmon in the San Joaquin River basin.

fall3_dams_anno : Annotation layer of three dams found on streams that historically supported fall-run chinook salmon in the lower Sacramento River basin.

NS_dams_Anno : Annotation layer of keystone dams found on streams that have supported known spring-run chinook salmon populations in the Northern Sierra diversity group.

RD_dams_Anno : Annotation layer of keystone dams found on streams that have supported known spring-run chinook salmon populations in the Rain-Driven diversity group.

SF_dams_Anno : Annotation layer of keystone dams found on streams that have supported known spring-run chinook salmon populations in the Spring-Fed diversity group.

SS_dams_Anno : Annotation layer of keystone dams found on streams that have supported known spring-run chinook salmon populations in the Southern Sierra diversity group.

wntr_dams_anno : Annotation layer of keystone dams found on streams that have supported known winter-run chinook salmon populations.

B.2.2 Boundaries

Contains the California state, Central Valley, and US west coast boundaries in addition to watershed and Evolutionarily Significant Unit boundaries.

ca_state : The California state boundary on maps with an accurate representation of the San Francisco Bay.

CenValSubWshed : Watershed boundaries for the Central Valley salmon recovery domain with the largest watersheds subdivided into subbasins; these watersheds were subdivided along the primary rivers' major forks.

CenValWsheds : Watershed boundaries for the Central Valley salmon recovery domain.

cv_bounds_polygon : Boundary of the Central Valley, California.

CV_fall_Chinook_ESU : Central Valley fall-run chinook salmon ESU boundary.

CV_spring_Chinook_ESU : Central Valley fall-run chinook salmon ESU boundary.

CV_Steelhead_ESU : Central Valley Steelhead ESU boundary.

Sacramento_winter_chinook_ESU_CV_ : Central Valley winter-run chinook salmon ESU boundary.

us_coast : United States coastal boundaries.

B.2.3 Geographic_features

Contains the "geographic places" feature classes that are used for orienting map users, along with annotation for these places.

cities : Selected cities in the Central Valley, used for map orientation purposes.

Cvlakes : California lakes and standing waters polygon coverage within the Central Valley boundary. The statewide lakes coverage is available from the CA Department of Fish & Game at:

http://ice.ucdavis.edu/wits/lakes.html .

notable_dams : select notable dams in the Central Valley; used for map orientation purposes.

places : Geographic places of interest in the Central Valley, including select dams, mountaintops, pumping stations, and recreational areas created for cartographic reasons.

places_ANNO : Annotation for cities, notable_dams, places, keystone dams, and weirs in the Central Valley.

weir : Selected weir from the USGS gage data for California. USGS. 2003. NWISWeb data for the nation. United States Department of the Interior, United States Geological Survey. http://waterdata.usgs.gov/nwis

B.2.4 Hydrography

Because of size constraints, we cannot distribute the hydrography layer, but it is available at http://www.calfish.org/. (Christy, T. 2003. 1:100k hydrography, version 2003.4.) .

CV_fall_run_anno : Annotation layer for streams that have supported known fall-run chinook salmon populations; to be used with the entire Central Valley streams range and the historical fall-run chinook salmon distribution feature class, `fall_historic`.

CV_fall_run_annoE : Annotation layer for streams that have supported known fall-run chinook salmon populations; to be used with the entire Central Valley streams range and the historical fall-run chinook salmon distribution elevation feature class, `fall_elevation`.

CVAnnoposter : Annotation layer for streams that have supported known spring-run chinook salmon populations; to be used with the entire Central Valley streams range and the historical spring-run chinook salmon distribution feature class, `spring_historic`.

CvhydroAnno : Annotation layer for streams that have supported known spring-run chinook salmon populations; to be used with the entire Central Valley streams range and the historical spring-run chinook salmon distribution feature class, `spring_historic`.

kingsriver_hist : Line feature class of historical connection between the San Joaquin River and the Kings River.

NS_pres_Anno : Annotation layer for streams that supported known spring-run chinook salmon populations; to be used with the Northern Sierra streams range and the current spring-run chinook salmon distribution feature class, `spring_current`.

RD_sprhist_anno : Annotation layer for streams that supported known spring-run chinook salmon populations; to be used with the Rain-Driven streams range and the historical spring-run chinook salmon distribution feature class (`spring_historic`) or with the spring_current feature class provided the display excludes historical streams.

SF_Anno : Annotation layer for streams that supported known spring-run chinook salmon populations; to be used with the Spring-Fed streams range and the historical spring-run chinook salmon distribution feature class (`spring_historic`) or with the `spring_current` feature class provided the display excludes historical streams.

spring_hist_NS_Anno : Annotation layer for streams that have supported known spring-run chinook salmon populations; to be used with the Northern Sierra streams range and the historical spring-run chinook salmon distribution feature class, spring_historic.

sprng_cur_Anno : Annotation layer for streams that supported known spring-run chinook salmon populations; to be used with the entire Central Valley streams range and the current spring-run chinook salmon distribution feature class, `spring_current`.

SS_anno : Annotation layer for streams that supported known spring-run chinook salmon populations; to be used with the entire Southern Sierra streams range and the historical spring-run chinook salmon distribution feature class (`spring_historic`) or with the `spring_current` feature class provided the display excludes historical streams.

steel_hydro_Anno : Annotation layer for streams that supported known steelhead populations; to be used with the `steel_historic` or the steel_elevation feature classes.

winterAnno : Annotation layer for streams that supported known winter-run chinook salmon populations; to be used with the entire Central Valley streams range and the historical winter-run chinook salmon distribution feature class, `winter_historic`.

wntr_hist_anno : Alternate annotation layer for streams that supported known winter-run chinook salmon populations; to be used with the entire Central Valley streams range and the historical winter-run chinook salmon distribution feature class, `winter_historic`.

B.2.5 Salmon_dist

Contains the feature classes of the historical and current salmonid populations including those divided by elevation and the current spawning distribution for spring-run chinook salmon.

fall_elevation : Estimated historic distribution of fall-run chinook salmon for selected rivers/streams in the Central Valley of California; each stream is divided into segments based on three elevation categories ($<$ 150 m, 150 - 500 m, $>$ 500 m).

fall_historic : Estimated historic distribution of fall-run chinook salmon in selected rivers/streams in the Central Valley of California.

spring_current : Estimated current distribution of spring-run chinook salmon in selected rivers/streams in the Central Valley of California.

spring_elevation : Estimated historic distribution of spring-run chinook salmon for selected rivers/streams in the Central Valley of California; each stream is divided into segments based on three elevation categories as noted above.

spring_historic : Estimated historic distribution of spring-run chinook salmon in selected rivers/streams in the Central Valley of California.

spring_spawn : Current spawning distribution of spring-run chinook salmon in selected rivers/streams in the Central Valley of California.

steel_elevation : Estimated historic distribution of steelhead for selected rivers/streams in the Central Valley of California; each stream is divided into segments based on three elevation categories as noted above.

steel_historic : Estimated historic distribution of steelhead in selected rivers/streams in the Central Valley of California.

winter_current : Estimated current distribution of winter-run chinook salmon in selected rivers/streams in the Central Valley of California.

winter_elevation : Estimated historic distribution of winter-run chinook salmon for selected rivers/streams in the Central Valley of California; each stream is divided into segments based on three elevation categories as noted above.

winter_historic : Estimated historic distribution of winter-run chinook salmon in selected rivers/streams in the Central Valley of California.

References

K.M. Burnett. *Relationships among juvenile anadromous salmonids, their freshwater habitat, and landscape characteristics over multiple years and spatial scales in the Elk River, Oregon.* PhD thesis, Oregon State University, Corvallis, Oregon, 2001.

CDFG. Report to the fish and game commission: a status review of the spring-run chinook salmon (*Oncorhynchus tshawytscha*) in the sacramento river drainage. Technical report, California Department of Fish and Game, Sacramento, CA, 1998.

P. McElhany, M.H. Ruckelshaus, M.J. Ford, T.C. Wainwright, and E.P. Bjorkstedt. Viable salmonid populations and the recovery of evolutionarily significant units. *NOAA Tech. Memo.*, 42:1–156, 2000.

R. M. Yoshiyama, E. R. Gerstung, F. W. Fisher, and P. B. Moyle. Historic and present distribution of chinook salmon in the central valley drainage of california. In R. L. Brown, editor, *Fish Bulletin 179: Contributions to the biology of Central Valley salmonids.*, volume 1, pages 71–176. California Department of Fish and Game, Sacramento, CA, 2001.

Table 1. River kilometers of historical and current habitat (total kilometers, and kilometers by elevation class) for spring-run chinook salmon.

	Historical				**Current**
River Name	Total habitat (km)	< 150 m	150 - 500 m	> 500 m	Total habitat (km)
American River - Mainstream	14.48	14.48			
American River - North Fork	31.25	7.64	16.78	6.83	
American River - South Fork	34.69	5.61	14.56	14.52	
Antelope Creek	14.48	6.22	8.27		14.48
Antelope Creek - North Fork	3.07		0.79	2.28	3.07
Antelope Creek - South Fork	3.26		0.96	2.31	3.26
Battle Creek - Main	8.14	4.36	3.78		2.85
Battle Creek - North Fork	5.89		2.91	2.98	
Battle Creek - South Fork	11.76		5.06	6.70	
Beegum Creek	0.39		0.39		0.39
Big Chico Creek	11.24	6.80	4.44		11.24
Butte Creek	29.30	25.69	3.60		29.30
Clear Creek	14.87	2.65	12.22		8.87
Cottonwood Creek - Middle Fork	8.75		8.75		8.75
Cottonwood Creek - North Fork	7.39		7.39		7.39
Cottonwood Creek - South Fork	21.49	3.01	18.48		21.49
Cottonwood Creek main	10.19	7.00	3.19		10.19
Deer Creek	20.38	5.56	8.34	6.48	23.12
Fall River - (Feather River)	0.22		0.22		
Fall River - (Pit River)	11.47			11.47	
Feather River - Mainstream	36.55	35.39	1.15		35.31
Feather River - Middle Fork	8.13		8.13		
Feather River - North Fork	43.52		16.96	26.56	
Feather River - North Fork East Branch	8.93		8.93		

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	Historical				Current
River Name	Total habitat (km)	< 150 m	150 - 500 m	> 500 m	Total habitat (km)
Feather River - South Fork	3.49		3.49		
Feather River - West Branch	13.09		8.15	4.94	
Hat Creek	3.56			3.56	
Indian Creek	1.13			1.13	
Kings River	39.98	26.57	13.41		
McCloud River	25.25		13.56	11.70	
Merced River - Mainstem	53.33	30.41	21.70	1.23	
Merced River - South Fork	4.47		2.04	2.42	
Middle Fork American River	12.56		12.56		
Mill Creek	25.23	3.78	8.07	13.39	25.23
Mokelumne River	45.80	36.37	9.43		
Pit River	42.76		22.81	19.95	
Rubicon River	1.96		1.96		
Sacramento River	179.86	145.91	22.93	11.02	145.84
San Joaquin River	156.45	127.84	20.41	8.20	
South Yuba River	9.72		5.79	3.93	
Stanislaus River - Main	45.20	29.07	16.13		
Stanislaus River - Middle Fork	7.48		2.66	4.82	
Stanislaus River - North Fork	0.39		0.39		
Stony Creek	28.34	14.48	13.86		
Tuolumne River - Mainstem	51.94	27.35	21.06	3.53	
Tuolumne River - North Fork	0.54		0.54		
Yuba River	19.45	11.76	7.69		11.72
Middle Yuba River	0.74		0.74		
North Yuba River	26.94		1.15	25.80	

Table 2. River kilometers of historical habitat (total kilometers) for fall-run chinook salmon.

Stream	Total Habitat (km)
American River	14.48
Antelope Creek	6.22
Battle Creek	4.35
Bear River	9.27
Big Chico Creek	6.80
Butte Creek	25.70
Cache Creek	14.37
Clear Creek	2.54
Cosumnes River	20.03
Cottonwood Creek	6.98
Cow Creek	7.29
Deer Creek	5.49
East Fork Stillwater Creek	3.38
Feather River	35.39
Kings River	26.57
Little Cow Creek	8.05
McCloud River	24.17
Merced River	30.66
Mill Creek	3.78
Mokelumne River	31.36
North Fork American River	7.64
Pit River	36.77
Putah Creek	19.72
Sacramento River	152.99
San Joaquin River	128.74
South Cow Creek	3.97
South Fork American River	5.61
South Fork Cottonwood Creek	3.01
Stanislaus River	45.20
Stillwater Creek	6.43
Stony Creek	14.46
Toulumne River	44.47
Yuba River	11.77

Table 3. River kilometers of historical habitat (total kilometers) for winter-run chinook salmon.

River Name	Total Habitat (km)
Battle Creek - Main	8.14
Battle Creek - North Fork	5.89
Battle Creek - South Fork	11.76
Burney Creek	0.84
Fall River	11.47
Hat Creek	22.29
Kosk Creek	8.10
McCloud River	25.25
Pit River	42.76
Upper Sacramento River	179.86

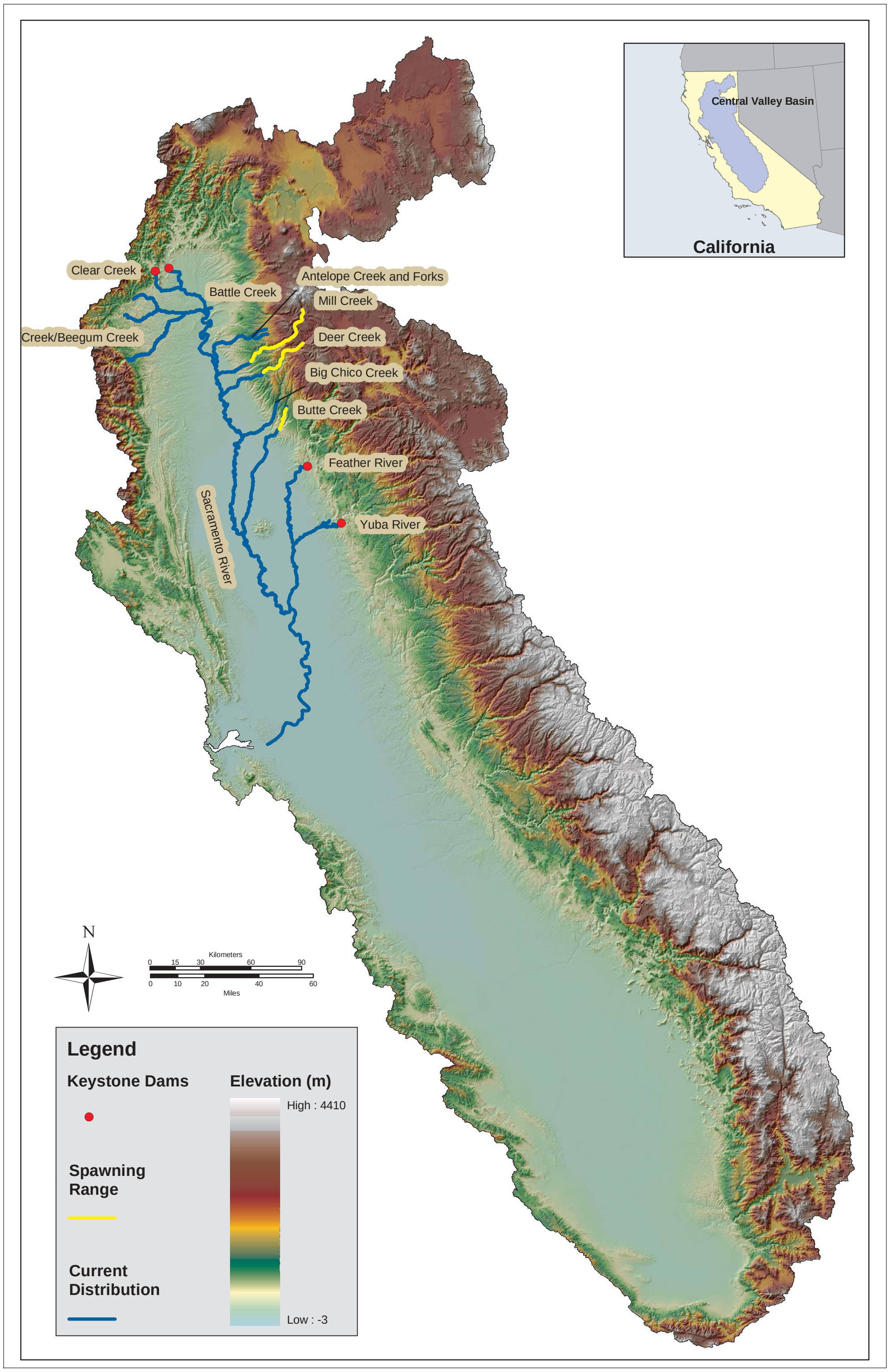

Plate 1. Current distribution of spring-run chinook salmon as reported by CDFG (1998). Note that in all plates the Sacramento River delta is not depicted, thus the disconnect between the distribution and San Francisco Bay.

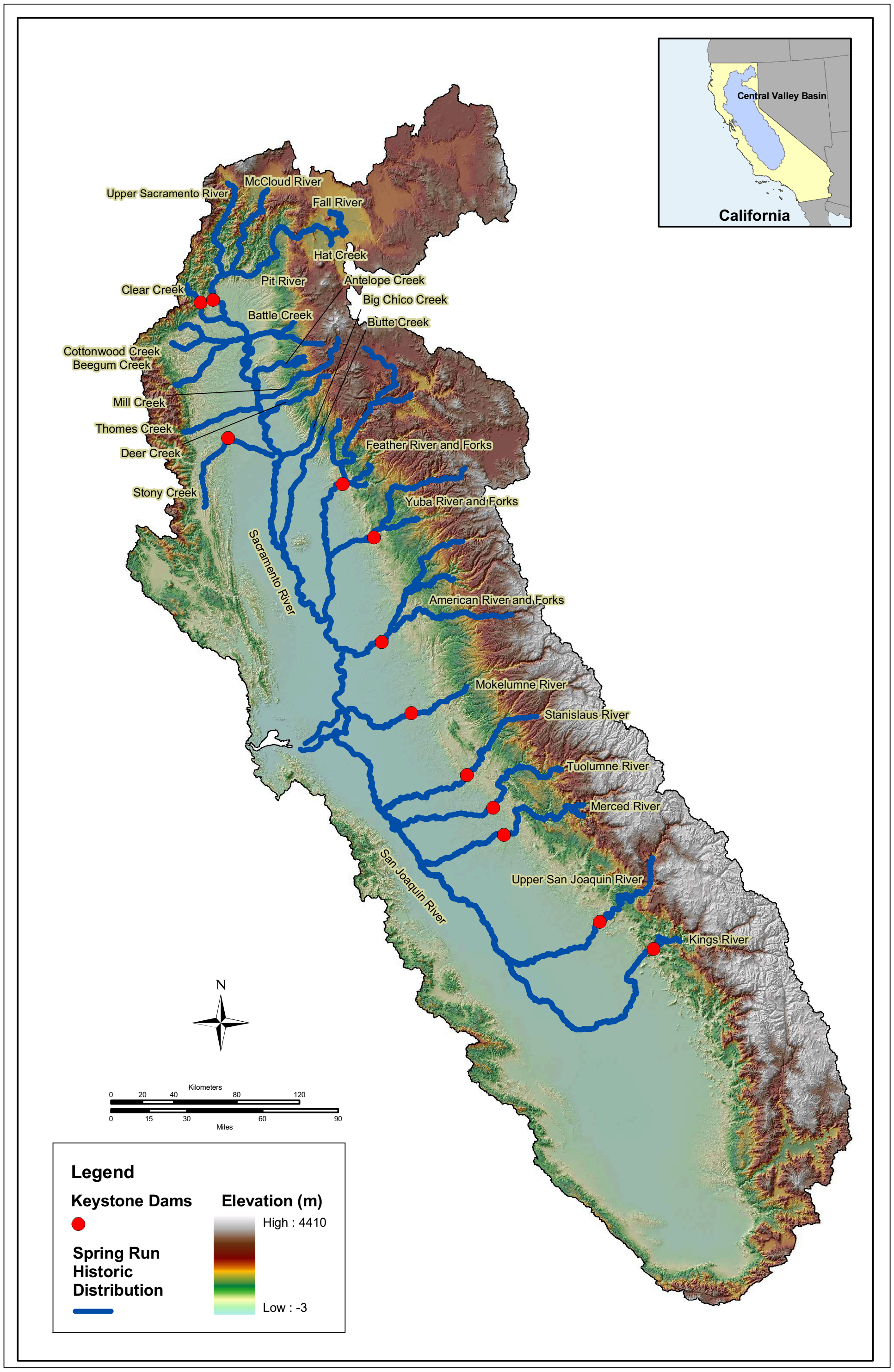

Plate 2. Historical extent of spring-run chinook salmon distribution. Historical information from Yoshiyama et al. (2001).

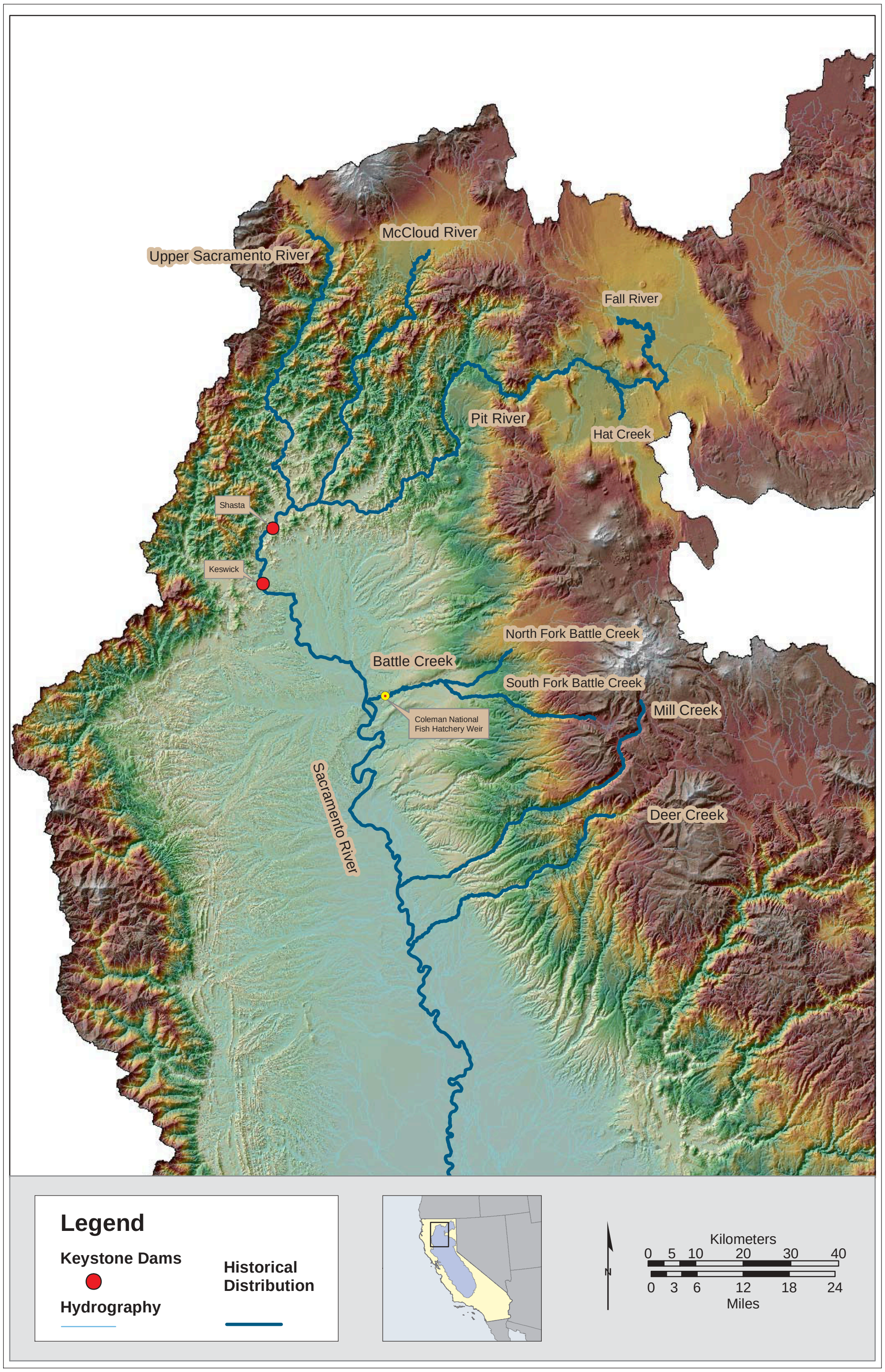

Plate 3. Historical distribution of spring-run chinook salmon in the spring-fed diversity group. Historical information from Yoshiyama et al. (2001).

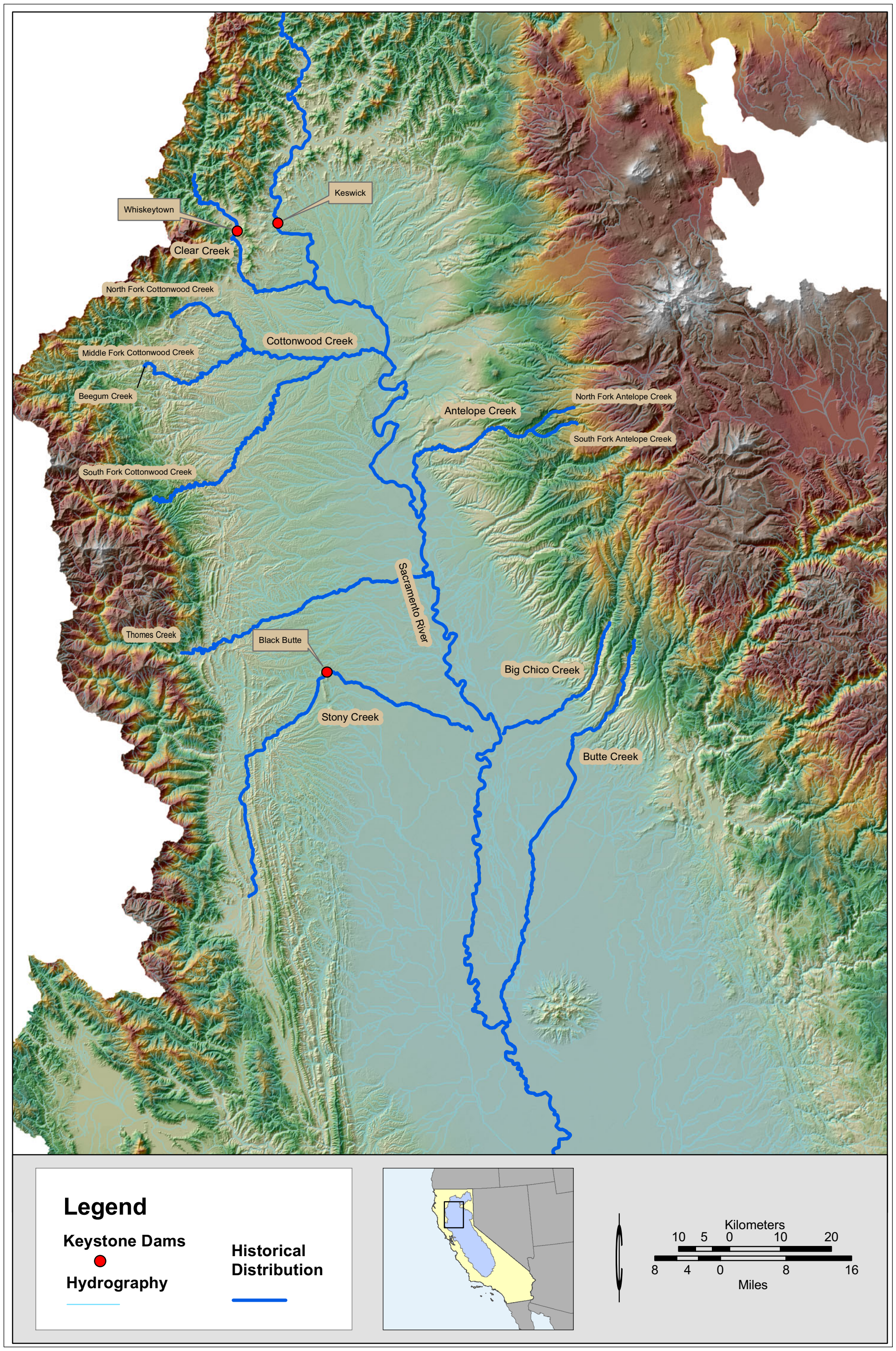

Plate 4. Historical distribution of spring-run chinook salmon in the rain-riven diversity group. Historical information from Yoshiyama et al. (2001). Note that because the events are drawn on present hydrography, certain streams (e.g. Stony Creek) no longer connect directly to the Sacramento River.

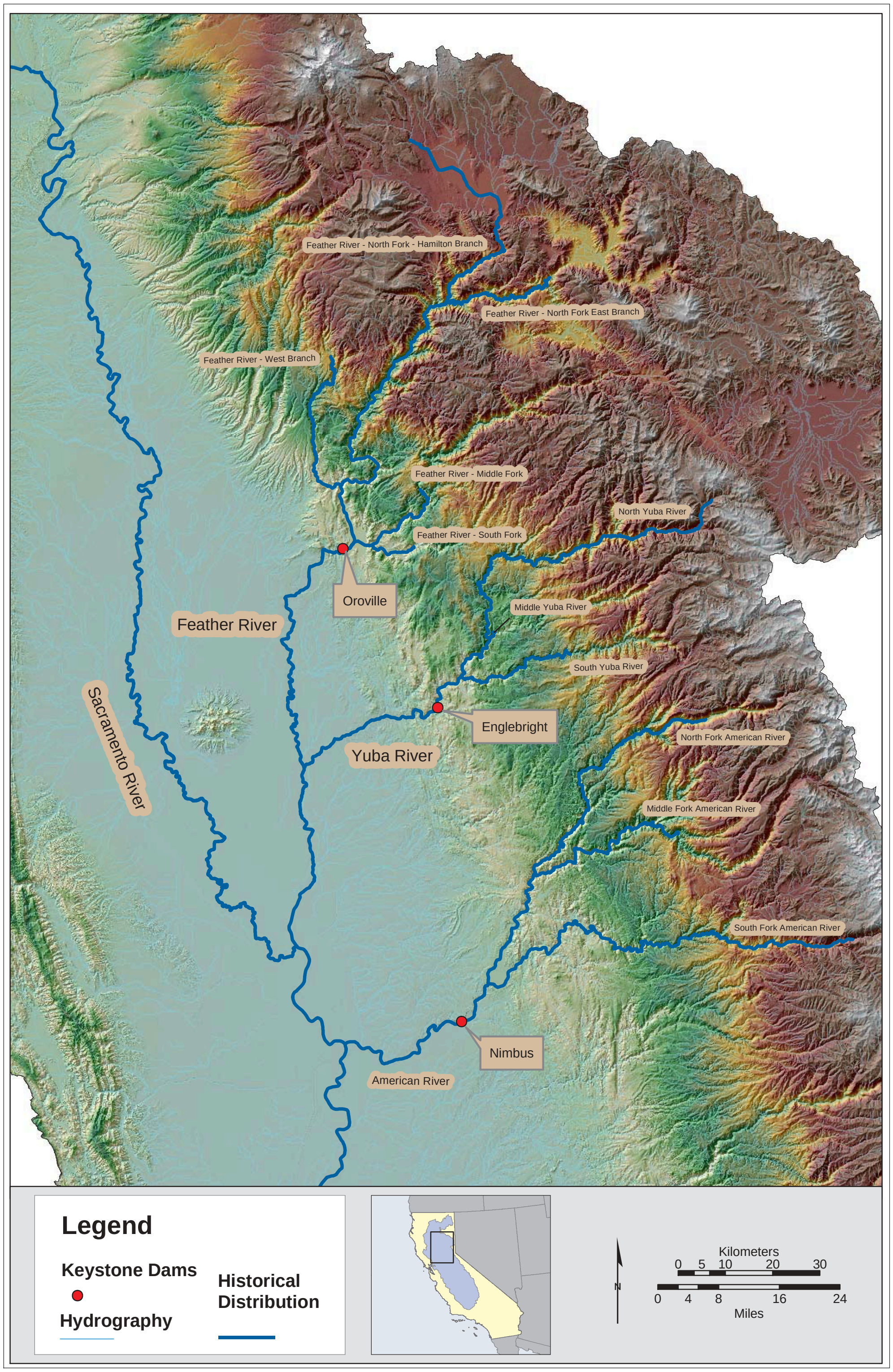

Plate 5. Historical distribution of spring-run chinook salmon in the Northern Sierra diversity group. Historical information from Yoshiyama et al. (2001).

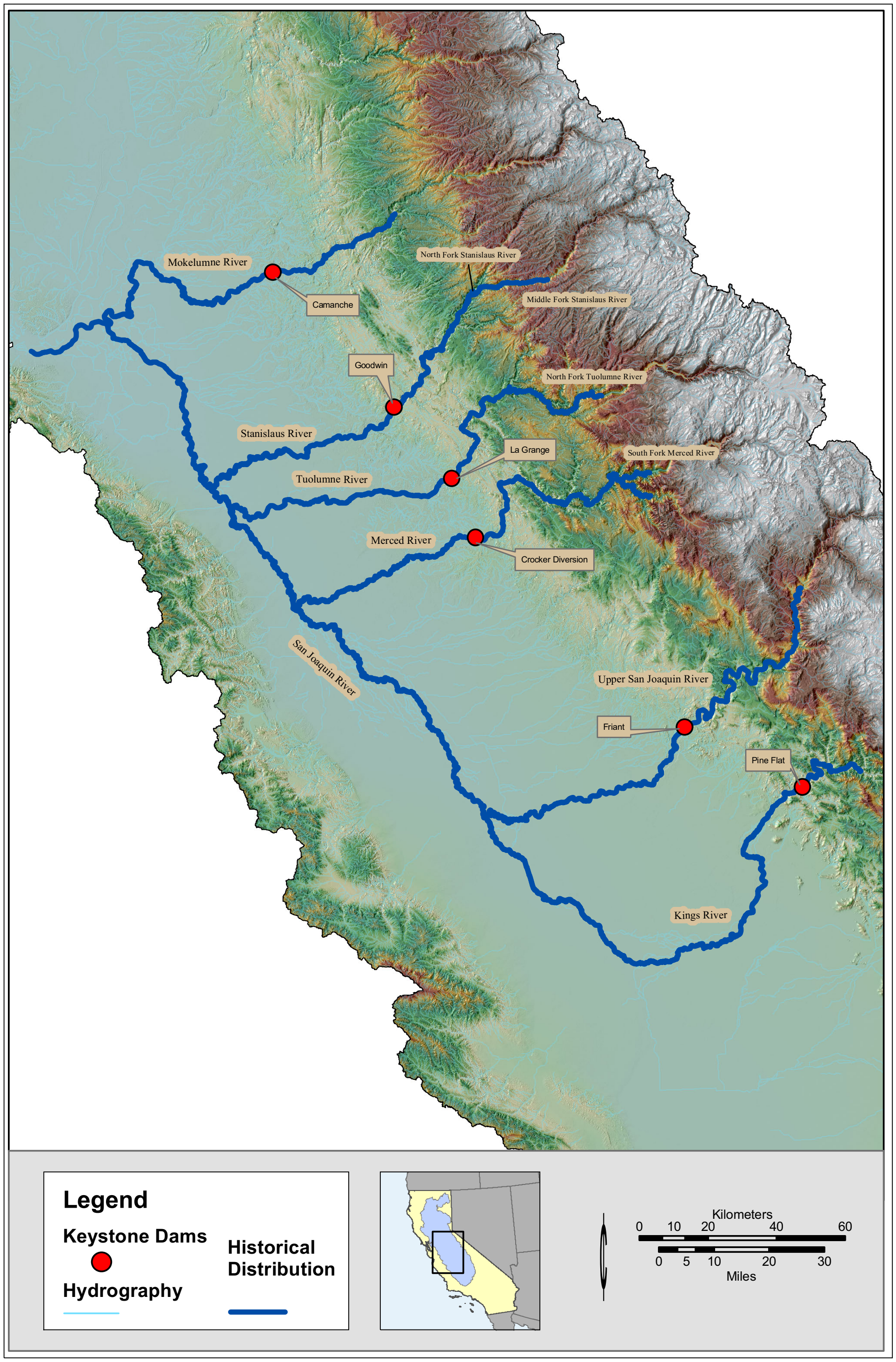

Plate 6. Historical distribution of spring-run chinook salmon in the Southern Sierra diversity group. Historical information from Yoshiyama et al. (2001).

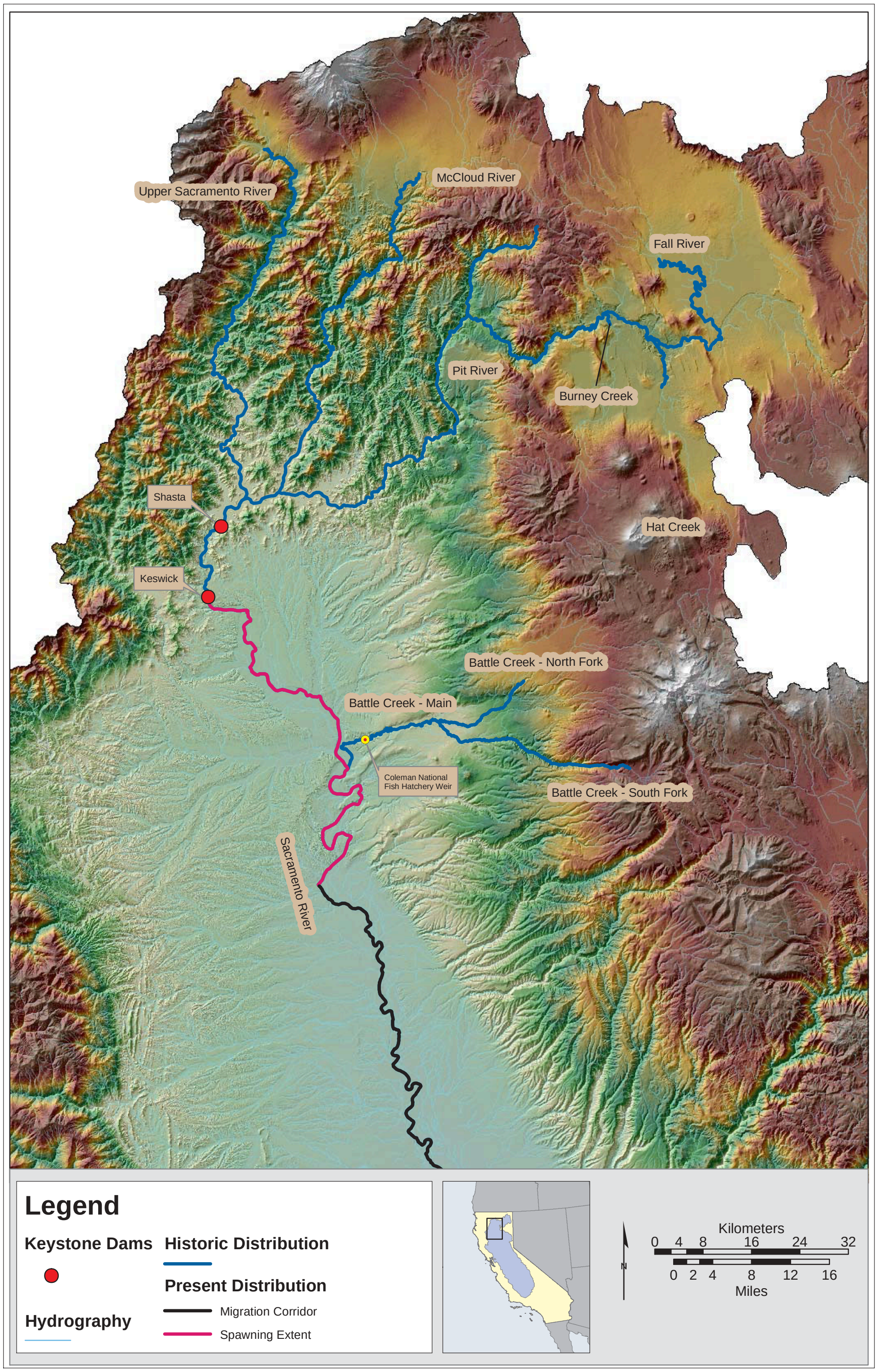

Plate 7. Historical and current distribution of winter-run chinook salmon. Historical information from Yoshiyama et al. (2001). Current distribution from CDFG (1998). Current distribution is drawn on top of historical distribution.

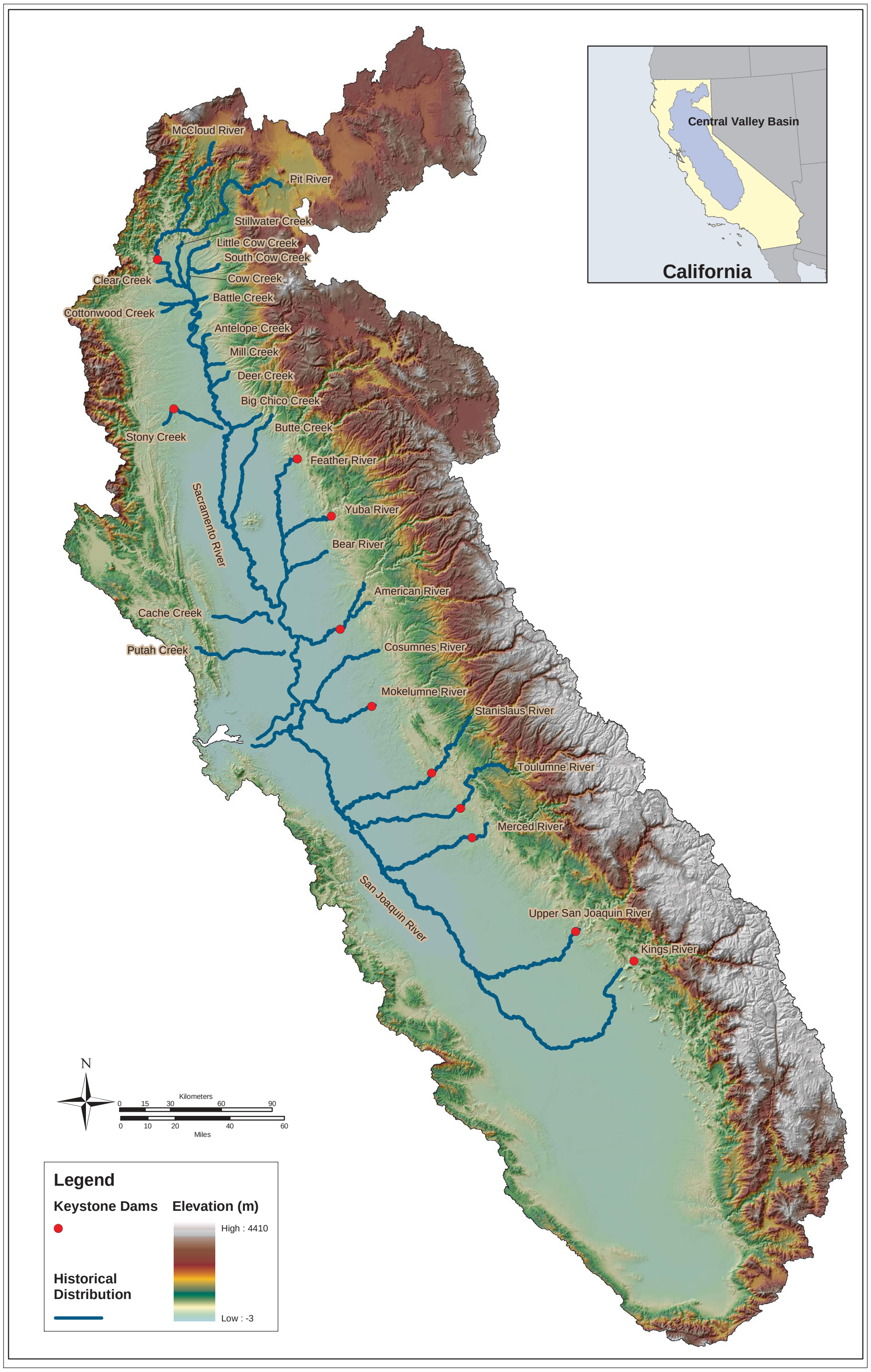

Plate 8. Historical distribution of fall-run chinook salmon. Historical information from Yoshiyama et al. (2001). Note that because the events are drawn on present hydrography, certain streams (e.g. Stony, Putah and Cache creeks) no longer connect directly to the Sacramento River.

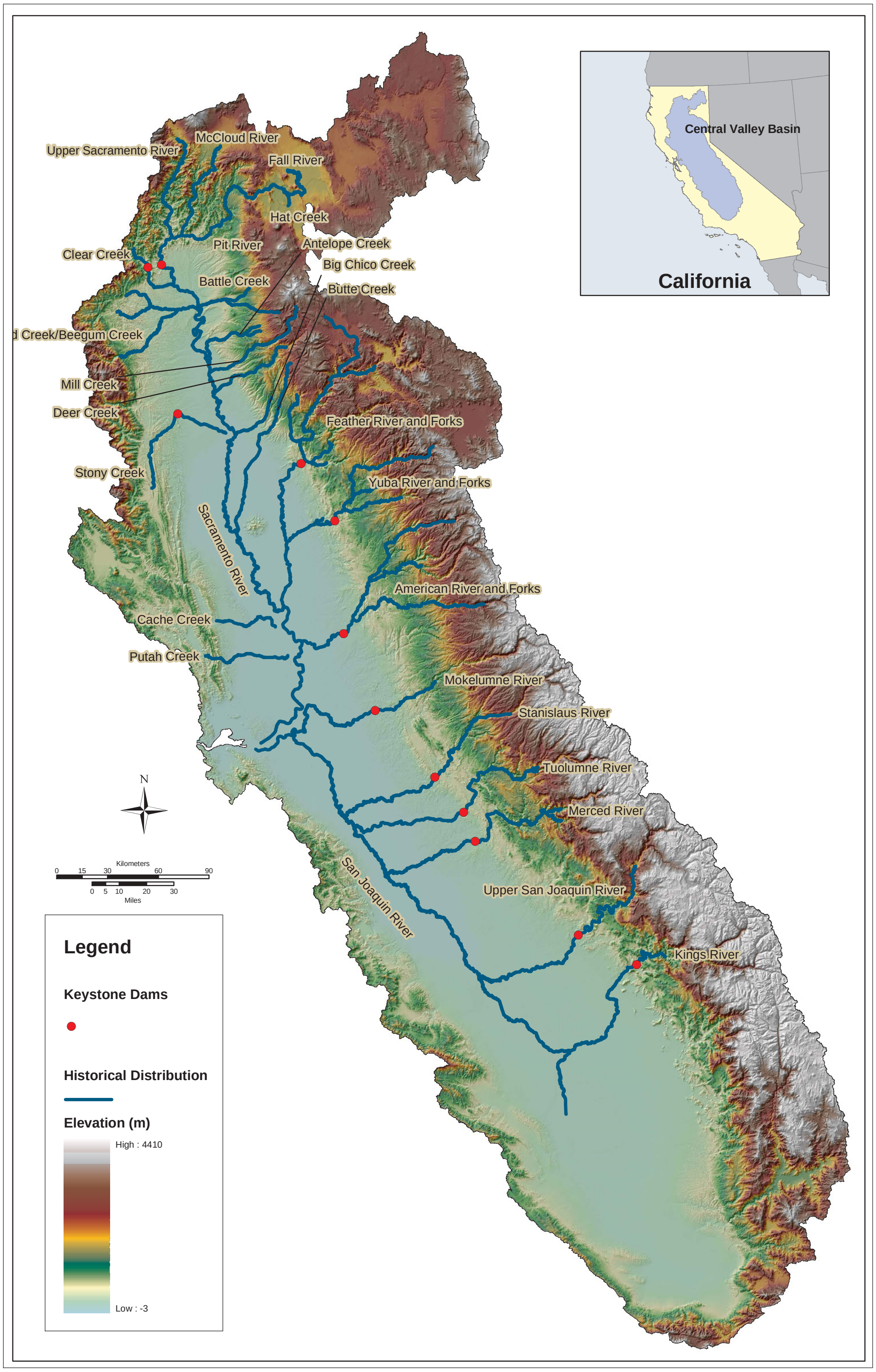

Plate 9. Historical distribution of steelhead, as inferred from Yoshiyama et al. (2001). This information might be visually misleading as steelhead likely ascended farther into the smaller tributaries. See discussion for further details.