Synopsis of changes
in geomorphology, hydrology, fisheries
and related topics
for the Sonoma Valley Watershed
c. 1823 - 2004

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INTRODUCTION

This synopsis and synthesis of existing information on apparent changes in the Sonoma Valley watershed over the last two hundred years was compiled at the request of Rebecca Lawton, staff geologist and Prop 13 project manager for the Sonoma Ecology Center (SEC), and Lisa Micheli, watershed science coordinator for the SEC. Based on years of historical research, interviews with local elders collected for the Oral History Project, field observations, collaborations with watershed scientists, and preliminary analysis, the primary goal of this paper is to inform current Limiting Factors Analysis (LFA), Total Maximum Daily Load (TMDL) and Army Corps of Engineers (ACE) studies in the watershed by:

- Outlining our current understanding of the historical record as it relates to issues of ecology, geomorphology, hydrology and fisheries.
- Documenting historical sources which relate to questions of historical ecology, geomorphology, hydrology and fisheries.
- Presenting a coherent and cohesive picture of the historic watershed (1810 to present) and to use this picture to extrapolate conditions in the reference watershed (pre-1810).
- Presenting hypotheses suggested by historical evidence which can be checked against modern field data.
- Defining directions for further historical and field research.

Technical reviewers were Lisa Micheli and Rebecca Lawton (as mentioned above); Caitlin Cornwall, staff biologist and assistant director of the SEC; Laurel Collins, geomorphologist for Watershed Sciences; and Robin Grossinger, historical ecologist at the San Francisco Estuary Institute.
METHODS

Data Collection

Historical data cited in this paper was primarily collected over a four-year period as part of the Sonoma Ecology Center’s Historical Ecology Project. Collection was essentially done in two phases:

**Oral History Project** was completed in January 2002 with the publication of a report and transcripts from interviews with local elders covering Sonoma Valley’s ecological history from about 1920 to the present.

**Sonoma Valley Historical Ecology Archive**: The initial effort for this archive was made during the greater part of 2002. Thousands of historic maps, documents, photographs, surveys, newspaper articles, court transcripts, and other historical records were collected from a variety of public and private archives. A digital camera was used and an electronic archive was created housing more than 4000 files. Hardcopies were also collected for some items.

Data Evaluation

Scientific data collection generally entails making strictly controlled observations and measurements. In contrast, historical ecology requires the use of data collected from a variety of sources and without strict controls. Information cited in this paper was collected by Spanish missionaries, newspaper reporters, surveyors, professional and amateur photographers, local elders of varying backgrounds, professional and amateur mapmakers, census takers and Mexican ranch workers. Correct interpretation of the information contained in these historical sources requires a thorough evaluation of each one. Assessment of their accuracy was accomplished by an ongoing evaluation which includes the following questions:

Who created this particular piece of evidence? What was their background and experience with this type of information? (fish, vegetation etc.) What was their general world view and how might it have colored their perceptions? What might have been their biases?

Why was this piece of data collected? What were the personal and cultural motivations behind it?

What are the possible sources of error? Are there other sources collected on the same topic during the same time period against which it can be compared? Possible errors within the historical record itself include poor or faulty observations, mistakes in the original record, errors in transcription and lack of knowledge about the subject by the historic observer. Yet another potential source of error is introduced by the modern interpretation of historic data in the course of research.
Can first-hand observations be separated from interpretations? For example, an early county history records a decline in salmonids and attributes it to the increasing number of fishermen. The decline is a first-hand observation, but the reason for it is an interpretation which may be true, false or somewhere in between.

How do our modern biases color our interpretations and reading of the historical evidence?

Were there any “controls” on the data collection? For example, photographs are faithful representations of the landscape in front of the lens. However, where the photographer pointed their lens was subject to their intentions, motivations for taking the photo and the cultural biases with which they saw the landscape. Likewise, early surveys can be expected to be quite accurate because of the importance of drawing boundaries and establishing land ownership. However, mapping of the landscape inside boundaries was less critical, carried few or no legal ramifications and is thus potentially less accurate.

Data Interpretation

The following assessments were developed during research to guide interpretation of the following sources and types of sources:

**Altimira’s 1823 Journal:** as the first detailed written description of Sonoma Valley, this is an extremely valuable source of early ecological conditions. Many sites can be located with fair to excellent accuracy. His inventory of available resources for the planned missions includes much ecological detail. Difficulties and sources of potential error include reading and translation of early 19th century Spanish, and separating direct observations from information provided by his native guides which could have been misunderstood in 1823.

**Early Newspapers:** including the Sonoma Index-Tribune and the Santa Rosa Democrat. With concentrated research these provide excellent sources for the historic watershed. Limitations and potential sources of error include the knowledge level of the writers, whether a report is first- or second-hand, failure to fact check, and the fact that the Tribune didn’t begin publishing until 1879.

**Early County Histories:** characteristics similar to “Early Newspapers” above. Accuracy was probably better than newspapers due to the longer time it took to write and publish these.

**Early Maps:** these are often the only historic source for water features which were rapidly altered during the early American era. Accuracy varies widely but shows a general increase from the Mexican era to the American era. Difficulties and potential errors include: identifying invented features (streets and buildings on some maps), poor orientation of creeks and other features and interpretation of symbols.
**California Land Court Transcripts:** these offer the best and most detailed first-hand descriptions of the landscape from the mid-19th century. Testimony was taken from people who knew the area well. There are detailed descriptions of water features, land use and vegetation within these documents. Since most of the land grant areas were on the valley floor, this testimony does not cover much of the upland areas. Potential sources of error include personal bias for or against the landowners.

**U.S. and California Census:** these three censuses from 1850, 1852 and 1860 offer a very detailed look at the changing demographics and land use in Sonoma Valley during the American pioneer period. Through cross-referencing with other documents, land use can be documented for some specific areas. Native peoples are largely unrecorded.

**Early Surveys:** these include the U.S. Coast Survey from 1856, the General Land Office Surveys, which began in Sonoma Valley in 1859, and the County Surveys, which began in 1850. In general these documents are believed to be quite trustworthy: surveyors signed sworn oaths to be meticulous and honest in their work. The ramifications of these surveys on land ownership suggests a high degree of accuracy would have been demanded of the surveyors. Bearing and range measurements were collected along the center line of Sonoma Creek and some tributaries to accuracies of less than one foot for each surveyed line. Bearings were taken to a tolerance of ¼ degree, giving a potential maximum error of about 20 feet per mile of survey. Accuracy decreases over distance from known points. Some human error has been found in the original or transcribed data, particularly an occasional transposition of either North and South, or East and West. Surveyed reaches of stream which are dramatically different than expected should be checked for this error.

**Historic Photos:** there is an excellent photographic record of Sonoma Valley taken in the late 1880s and a few landscape photographs which predate this. These photographs are assumed to be accurate depictions and give much detail about late 19th century landscape. The potential source of error lies in what the photographs don’t show; do they give us a representative look at Sonoma Creek’s channel or did the photographer choose only the most picturesque places to point his camera?

**Oral Histories:** taken as a whole these offer an excellent and detailed record of the ecological history of Sonoma Valley through much of the 20th century, with some glimpses even further back. The most common error made by these elders was in fixing dates to events. Errors in individual recollections are believed to be largely cancelled out when looking at these sources as a whole.

**Data Synthesis**

The broad goal of this paper and the Sonoma Valley Historical Ecology project in general is to create a synthesis of the historical evidence, corroborated as much as possible by field evidence, which tells a cohesive and coherent “story of the land.” This process is similar to building a legal case, where evidence is examined and weighed and a case is made by weaving together information from many different sources. Because the
accuracy of historical data can rarely ever be completely verified or disproved, almost any particular piece of evidence can be called into question. However, by studying a variety of sources, I was able to establish converging lines of evidence to support the hypotheses presented here. My confidence in the veracity of each source played a part in this process; sources I believed to be highly accurate were given greater weight than those which I had less faith in. Only rarely was a piece of evidence completely discarded; in several cases I made allowances for the human tendency to exaggerate and simplify the past. Thus some pieces of evidence are true in a general sense but not in their particulars. I approached each piece of historical evidence from opposing perspectives: that it was accurate until proven otherwise; and that it couldn’t be fully trusted until it had proved itself against other data for the same period. Some observations only became clear and reasonable after digesting many other pieces of evidence.

Ideally, the story that develops from this process would account for every piece of historical evidence, allowing it to fit like a puzzle piece into the larger story. It should be pointed out that alternative interpretations of the data are quite possible. Differences in experience and background mean that someone else studying this subject to a similar depth would probably come up with a slightly different story. However, I believe most of the difference could be accounted for by the variety of personal perspectives; as I learned from conducting the Oral History Project, everyone basically told me the same story from their own unique perspective. The ideas and observations included here are meant to be working hypotheses, evolving as more historical research and scientific field work is done.

A note on terms

The following terms used in this paper are defined as follows:

**Historic Watershed:** the Sonoma Valley watershed as it was described and depicted during recorded history, from 1823, when Padre Altimira wrote the first detailed description of Sonoma Valley, to any time before the present. One focus of this paper is to describe the watershed according to the historical record before 1875, when many landscape changes were already well under way. The earliest descriptions of the historic watershed are believed to be closely synonymous with the reference watershed.

**Reference Watershed:** the Sonoma Valley watershed as it existed before the historic period began in 1810. By definition, this watershed must be inferred from historical evidence. Ideally, conditions present in the reference watershed would guide current restoration efforts. While human activities and land use were present and had a significant effect on the reference watershed, populations of salmonids and other wildlife were in rough balance with the human population.

**Modern Watershed:** the Sonoma Valley watershed as it exists in 2004 or in the very recent past, no more than 10 years ago.
SUMMARY of FINDINGS

The headwaters of Sonoma Valley’s historic watershed covered the entire upper basin of the Kenwood area. Streams descending from the hills fed a 400-acre marsh complex stretching five miles from the watershed boundary (Pythian Road area) to the vicinity of Dunbar School (corner of Dunbar and Henno Roads). This wetland complex also extended five miles northwest to the outskirts of present-day Santa Rosa. A subsurface connection probably existed between the Sonoma Creek and Santa Rosa Creek watersheds. The upper reaches of Sonoma Creek (below present-day Kenwood) were fed directly from this marsh complex.

Another significant freshwater wetland of 220 acres existed along the edge of Tolay Lake. Small ponds and associated wetlands also existed in the eastern section of the present-day City of Sonoma, along the base of the hills to the north of Sonoma, and at Pulpula in the extreme southeastern part of the valley (from about Meadowlark Lane south to Cline Cellars at 24737 Arnold Drive). The vicinity of present-day El Verano was an area of high ground water and contained vernal pools and seasonal wetlands.

Roughly 20% of the tributaries throughout the watershed did not have a direct connection by channel with the main stem of Sonoma Creek. During the dry season, they descended to the valley floor and sank into their alluvial fans. Under winter flood conditions, these streams probably spread out in sheet flows, at times probably covering large areas of the valley floor.

At the lower end of the watershed were 15,000 acres of salt marsh and an intricate network of tidal sloughs. The movement of water through the historic system would have been quite different than today. Delivery of water from tributaries to the main stem was slower because there were fewer channels feeding directly into Sonoma Creek. The channel length of Sonoma Creek itself was longer (perhaps 5% or more), thus lowering the gradient and speed of flow and increasing the distance traveled by water in the creek. The ability of the salt marsh to absorb flood events was greater because floodwaters could spread out over a large area rather than being confined into relatively narrow channels between levees.
HEADWATERS

One of the most striking features of the historic watershed is the fact that the earliest map (Anonymous, c. 1837) shows the headwaters of Sonoma Creek draining from what appears to be a lake, and two “posos” (water holes). There is no hint of what is now considered the main stem emerging from Adobe Canyon. An early written account supports this picture: “Sonoma Creek spreads out and loses itself in the valley, forming a kind of willow thicket and marsh or lagoon. In the summer, the bed of the creek is dry.” (Boggs, 1861) Further supporting this view are soil types in the Kenwood area, some of which match those found at the site of former Tolay Lake (USDA, 1972).

Thus the headwaters might most accurately be considered the entire basin around Kenwood, which drained into a large perennial marsh complex stretching nearly ten miles from the outskirts of Santa Rosa to the vicinity of Highway 12 and Dunbar Road. One portion of this complex emptied into Sonoma Creek, while the other drained into Santa Rosa Creek. Some of this marsh complex appears to have straddled the watershed boundary, suggesting the possibility of a subsurface connection between these two watersheds. The portion of the marsh complex within the Sonoma Creek watershed comprised about 400 acres in three fairly distinct sections (Peabody, 1851; Sonoma Ecology Center, 2003):

- Western section, 150 acres. From about Hoff Road to watershed boundary.
- Central section, 185 acres. From about Randolph Road in Kenwood to hill on Highway 12 near Pagani Ranch.
- Eastern section, 65 acres. From Pagani Ranch to near Henno Road.

The eastern section fed one of the tributaries of Calabazas Creek, which then flowed down to its confluence with Sonoma Creek.

Nathanson Creek was also fed by wetlands at the headwaters of its tributary, Fryer Creek (vonGeldern 1875; Sonoma Ecology Center, 2002).

APPARENT CHANGES, c. 1823 - 2004

- Headwaters perceived and mapped in Sugarloaf Ridge State Park (Dawson, 2004)
- Continuous channel now exists from Adobe Canyon to Warm Springs Canyon (Sonoma Ecology Center, 2003).
- Loss of 92% of wetlands in headwaters area. About 30 acres out of the original 400 acres remain (Sonoma Ecology Center, 2003).

NO APPARENT CHANGES, c. 1823 - 2004

- Summer dry conditions below Adobe Canyon (Dawson, 2004).

FURTHER RESEARCH

See “Possibilities for Further Study,” items 1, 2, 3, 5, 10, 12, 13, 16 and 18.
TRIBUTARIES

The earliest maps show about 20% of the tributary channels not directly connected to the main stem of Sonoma Creek, especially in the El Verano area (west side of valley) and in the area feeding the Kenwood Marsh. Unconnected tributaries (designations are as they appear on the SEC’s GIS stream layer) included Rodgers Creek, Carriger Creek, Winkle Creek, Hanna Creek, Fisher Creek, Kunde Creek, Sonoma Creek itself in Adobe Canyon and Bear Creek (Sonoma Ecology Center, 2003). The earliest depiction of Champlin Creek also shows it as an unconnected tributary (Bowers, 1867).

One possible interpretation of this phenomenon is that these creeks descended from the hills and sank under the surface as they crossed their alluvial fans. This pattern of tributary streams with historically unconnected channels ending on alluvial fans has been documented for many watersheds in the Bay area (EcoAtlas, 1998; Grossinger, 2004). Under winter conditions on saturated soils, sheet flows from these creeks probably spread out over much of the valley floor. Water from winter storms was slowly shunted down the valley, raising water levels of wetlands and lakes and replenishing groundwater as it moved toward the bay (Micheli, 2003).

Some tributaries probably fed distributary systems on the valley floor; these were associated with their alluvial fans (Collins, 2004). Some tributaries experienced summer dry conditions, especially in their lower reaches (Boggs, 1861. Sonoma Ecology Center, 2002 and 2003).

APPARENT CHANGES, c. 1823 – 2004

- All tributary channels shown as unconnected on the earliest maps are now connected directly to the main stem of Sonoma Creek (Sonoma Ecology Center, 2002 and 2003).
- Flood waters no quickly shunted to San Pablo Bay. During especially high flows flooding occurs, particularly in the Schellville area (Sonoma Ecology Center, 2002 and 2003).
- No distributary systems (Sonoma Ecology Center, 2002 and 2003).

NO APPARENT CHANGES, c. 1823 - 2004

- Many tributaries experience summer dry conditions, especially in their lower reaches. Sonoma Creek itself still goes dry in the vicinity of Highway 12 in Kenwood in the early summer (Lawton and Micheli, 2003).

Further Research

See “Possibilities for Further Study,” items 1, 2, 4, 6, 7, 11, 16 and 17.
CONNECTION OF TRIBUTARIES TO THE MAINSTEM

The process by which unconnected tributaries became connected to the main stem is not well understood. Some tributaries may have already been connected by 1850; the 1837 map of Rancho Los Guilucos does not show a channel for Sonoma Creek between Adobe Canyon and the Kenwood Marsh (Anonymous, c. 1837), but by 1851 this reach of Sonoma Creek appears well defined. The 1851 map also shows several tributaries in the hills (Fisher and Kunde Creeks as well as several unnamed tributaries) as unconnected (Peabody, 1851).

All tributaries appear to be connected to the main stem by 1877, with most of the connections happening between 1848 and 1877. A series of maps of the El Verano area seem to show a sequential process, with many connections being made between 1866 and 1877 (Bowers, 1867; O’Farrell, 1848; Sonoma County Surveyors Office, 1866; Thompson, 1877). While the causes are not well understood, the shape of the channels (more or less sinuous) and the timing of their creation (during the American pioneer era) suggest that a combination of human and “natural” forces were responsible, which may have included:

- Grazing by livestock, particularly sheep and cattle compacting the soil and causing quicker runoff with increased ability to erode and cut new channels.
- Introduction of exotic plants (perhaps even before contact), reducing infiltration rates and water-holding capacity.
- Intentional ditching to drain wet areas for agricultural use.
- Lowered water table changing soil dynamics.
- More intensive agriculture and land use resulting in reduced soil permeability and faster runoff.
- Removal of riparian and floodplain woody vegetation resulting in reduced infiltration, water-holding capacity and bank stability.

This process of tributary connection may have initiated or intensified the process of incision, both in tributaries and the main stem.

One Possible Sequence linking Tributary Connection and Incision:

1. **Introduction of exotic plants and animals** set the stage for incision and tributary connection by compacting the soil and/or changing the dynamics between soil, water, and vegetation. Judging from pre-1877 maps (especially O’Farrell, 1848), tributary connection and/or incision does not appear to have been an immediate result of the introduction of domesticated herds. The 1860s are believed to coincide with the highest grazing pressure from domesticated cattle (Grossinger, 2003; Sonoma Democrat, 1857).

2. **Connection of all significant tributaries to main stem**, 1837 to 1877. Maps from 1848 – 1851 still show significant numbers of unconnected tributaries (O’Farrell, 1848; Peabody, 1851) The 1867 Bowers County Map shows an intermediate stage, with still unconnected tributaries in the El Verano area.
The 1877 Thompson County Map depicts all tributaries connected to the main stem.

3. **Main stem incision beginning c. 1870s**, caused by new, direct tributary connections resulting in faster runoff and increased main stem winter flows. Early photos of Sonoma Creek from the 1880s do not seem to show substantial incision (Watkins, 1888).

4. **Main stem incision leads to headcutting.**

5. **Incision of tributaries** begins as main stem headcuts and tributaries try to keep up.

**Further Research:**

See “Possibilities for Further Study,” items 1, 2, 4, 6, 7, 8, 9, 16, 17, 19, 20 and 21.
MAINSTEM: HISTORIC CHANNEL CROSS-SECTION AND INCISION

Early photographs of Sonoma Creek and field observations of apparent former channels seem to indicate that the banks of the creek were gently sloping and that the creek bed itself was just a few feet below the level of the valley floor (Collins, 2003; Watkins, 1888). Preliminary study of General Land Office (GLO) survey data from the mid-19th century has identified several former channels which support this hypothesis (U.S. Surveyor General, 1870).

See also the section on “Channel Change and Bank Destabilization” below.

APPARENT CHANGES, c. 1823 - 2004

Banks of Sonoma Creek are now generally steep and the bed of the creek is as much as 20 feet below the valley floor in some areas. Preliminary data suggests:

- An average incision rate for the main stem of about 1 inch per year. Some areas, such as the reach upstream from the Verano Avenue bridge, show an incision rate two or more times the average (Collins and Micheli, 2003).

- A relatively steady rate of incision since 1850, indicating that land use changes over that period may not have had much effect on the incision rate (Collins and Micheli, 2003).

- Incision in Stuart Creek and possibly other tributaries may be at least partially caused by tectonic uplift rather than human causes (Collins and Micheli, 2003).

These estimates will be modified by ongoing studies (Collins and Micheli, 2003).

Further Research:

See “Possibilities for Further Study,” items 1, 2, 4, 6, 7, 8, 9, 16, 17, 19, 20 and 21.
MEANDERS and CHANNEL LENGTH

Three types of meanders can be tentatively identified and defined as existing in the main stem of the historic watershed (Sonoma Ecology Center, 2003):

- **Large Sharp Meanders**: features measuring approximately 300 yards or more along the channel. In general, these are sinuous trends of 120 yards or more, measuring laterally from Sonoma Creek’s outermost curve in one direction to its outermost curve in the other. In general, large sharp meanders make curves of 30 to 90 degrees.

- **Small Sharp Meanders**: features measuring 300 yards or less along the channel; most were probably much smaller. The best documented small sharp meander, along present-day Warm Springs Road just below Bennett Valley Road, comprised of a pair of hairpin bends and had a total channel length of about 260 yards (U.S. Surveyor General, 1859). Another small sharp meander appears to have existed about 1 mile upstream from the current Highway 121 crossing (Sonoma County Surveyors Office, 1861). Other former small sharp meanders likely existed and should be identifiable using early survey data. Curves of small sharp meanders were as acute as 135 degrees or more.

- **Large Subtle Meanders**: features similar in size to large sharp meanders, but with two differences: smaller sinuous trends of 120 yards or less and shallow curves of less than 30 degrees. A former large subtle meander existed in the reach below present-day Agua Caliente Road. Others almost undoubtedly existed and could be identified through analysis of 19th century survey data (U.S. Surveyor General, 1870).

- **Small Subtle Meanders**: features similar in size to small sharp meanders but with shallow curves of less than 30 degrees. Because of their size and proximity to the existing channel, these are very difficult to identify from historic sources, but their presence seems likely.

See also “Channel Change and Bankcutting.”

APPARENT CHANGES, c. 1823 - 2004

While all of Sonoma Creek’s large sharp meanders have survived, all its small sharp meanders have disappeared (Sonoma Ecology Center, 2003). The small sharp meander described on Warm Springs Road still appears in an 1867 map (Sonoma County Surveyors Office, 1867), but was apparently gone (or nearly so) by 1877 (Thompson, 1877). The large subtle meander described in Agua Caliente has also disappeared. The channel along that reach now runs in virtually a straight line, resulting in a 5% decrease in channel length and a consequent increase in slope. A number of large and small subtle meanders still exist along the main stem, though incision and bankcutting has probably changed their characteristics.

Further Research:

See “Possibilities for Further Study,” items 1, 17, 20 and 22.
MULTIPLE CHANNELS

Early maps show at least two reaches of Sonoma Creek which may have had multiple channels:

- Downstream of the confluence of Agua Caliente Creek, east of the main channel (Anonymous, c. 1840; Sonoma Ecology Center, 2003).
- Beginning near Petaluma Avenue and rejoining Sonoma Creek about 1 mile downstream. West of the main channel (O’Farrell, 1848; Sonoma Ecology Center, 2003).

Evidence for these is based on very few sources of evidence and thus not conclusive. More multiple channels may have existed, or none.

The earliest description of Sonoma Creek immediately below Adobe Canyon indicates the main stem did not have a single, clear channel through this area: “Sonoma Creek spreads out and loses itself in the valley, forming a kind of willow thicket and marsh or lagoon” (Boggs, 1861).

The first map of Sonoma County (Bowers, 1867) shows parallel channels for Carriger Creek extending about two-thirds of a mile from the base of the hills onto the flats.

APPARENT CHANGES, c. 1823 - 2004

The modern watershed has no significant multiple channels. Multiple channel loss could be due to incision—faster downcutting of the main stem compared to parallel side channels would eventually cause the side channels to be abandoned. There is some evidence for a sequential process in the abandonment of the western side channel (beginning near Petaluma Avenue) between 1848 and 1877 (O’Farrell, 1848. Sonoma County Surveyors Office, 1866. Thompson, 1877). At some later date a connection appears to have been created between Dowdall Creek and the bed of this side channel, which now shunts Dowdall Creek’s waters south from El Verano (U.S. GEOLOGICAL SURVEY, 1951). Carriger Creek’s side channel apparently disappeared between 1867 and 1877, as it does not show up in the 1877 County Atlas or any later maps (Thompson, 1877. Reynolds and Proctor, 1898).

Further Research

See “Possibilities for Further Study,” items 4, 17, and 23.
Precise locations of confluences in the reference watershed are not yet well established. However, there is solid evidence that at least two confluences were significantly different:

- The Sonoma/Calabazas Creek confluence has shifted substantially up and down Sonoma Creek over the last 150 years. In the latter half of the 19th century, this confluence was 50 to 100 yards or more upstream from its current position (Aston, 1888 and 1889; Sanborn-Perris, 1899; Sonoma County Surveyors Office, 1867; U.S. Surveyor General, 1859, 1860 and 1870; Sonoma Ecology Center, 2002). An 1890 photograph appears to show Calabazas in its former position (Anonymous, 1890). As shown on a county bridge survey (Sonoma County Public Works, 1939), for some period in the 20th century, this confluence was actually downstream of its current location immediately above the Arnold Drive bridge in Glen Ellen.

- The Sonoma Creek/Yulupa Creek confluence appears to have been about 800 feet downstream from its current location, Yulupa Creek more or less paralleling Sonoma Creek for much of this distance (U.S. Surveyor General, 1859). By the time the 1877 County Atlas was drawn, it was approximately in its current position (Thompson, 1877). The former bed of Yulupa Creek may be visible in a pasture immediately west of Warm Springs Road (Dawson, 2003).

The mechanisms for these changes are unclear. Incision may have been a factor in the shifting of the Calabazas confluence; only by imagining both creekbeds at much higher levels is it possible to visualize the confluence in its former position. Areas on both Sonoma and Calabazas Creeks immediately upstream of their confluence have experienced historic landslides (see next section). The substantial upstream movement of the Yulupa/Sonoma Creek confluence and consequent shortening of Yulupa Creek suggest a human cause such as to drain a pasture or reclaim more farmland. The lower reach of Yulupa Creek now runs directly into Sonoma Creek rather than paralleling it. The net effect has been the loss of nearly 800 feet of channel in Yulupa Creek. Geologic and geomorphic factors may also play a role (Lawton, 2004).

**Further Research**

See “Possibilities for Further Study,” items 1, 2, 17, 24 and 25.
LANDSLIDES

Several sources of historic evidence point to one reach of Sonoma Creek being especially prone to landslides. This is the area between the Graham Creek and Calabazas Creek confluences. It is possible that the northward trend of Sonoma Creek in this area is due to landslides over a long period of time pushing the stream in this direction. The original road from Glen Ellen to Bennett Valley ran along this hillside and was abandoned at some point after 1898 because of a landslide (Proctor and Reynolds, 1898; Sonoma Ecology Center, 2002.) The largest known landslide in this area occurred in 1943, covering 3.65 acres and comprising of tens of thousands of cubic yards of material (Sonoma County Public Works, 1943. Sonoma Ecology Center, 2002). One small slide is known for lower Calabazas Creek; as reported by Bill Meglen (b. 1915), the small hill on Henno Road just north of its intersection with Warm Springs Road was created by a landslide during his lifetime (Sonoma Ecology Center, 2002).

Another area prone to landslides is Adobe Canyon, where a landslide closed the Goodspeed Trail in 2003 (Dawson, 2003). House-size boulders at the bottom of Bear Creek’s canyon also attest to landslide activity in this area (Dawson, 2003). Due to steep topography and the local geology, many upland areas of the watershed are also prone to earth movements of this type.

Further Research

See “Possibilities for Further Study,” items 14, 26 and 27.
FLOODING, c. 1823 - 2004

Due to the existence of unconnected tributaries and large areas of freshwater and tidal marsh, the reference watershed probably absorbed rainfall more readily and shunted it off relatively slowly. Catastrophic floods as we think of them today were probably less frequent and less severe, though the line between dry land and water was also less well defined—that is, there were larger areas of high groundwater and marshland. Large amounts of rainfall in the subwatersheds of the disconnected tributaries probably resulted in sheetflow across the valley floor (Micheli, 2003).

In his 1824 Informe, Father Altimira mentions a powerful mid-November storm that lasted 15 days and brought “more water than the natives had ever seen.” While it destroyed some adobe buildings which did not yet have roofs, he makes no specific mention of flooding (Altimira, 1824).

The next known reference to flooding comes from Sir George Simpson’s description of conditions on a journey from the Schellville area to Sonoma in January 1842: “In consequence of heavy rains . . . the roads were flooded, for the plain being low and level, not only receives more than its share of whatever falls, but also retains nearly all it receives, a circumstance . . . inconvenient to the traveler” (Simpson, 1842). In the same account, Simpson does not mention any difficulty finding his way up Sonoma Creek or in locating and camping overnight on what was presumable dry land at the Embarcadero (present-day Millerick Road), something he likely would have had trouble with if conditions were similar to the current situation. Today this area is often described as an “inland sea” during floods (Sonoma Index-Tribune, 1975, 1983 and c. 1990; Dawson, 1992 -1997). Flooding at the time of Simpson’s visit appears to have occurred above tidewater rather than below.

APPARENT CHANGES, c. 1823 - 2004

Flooding is believed to be more common and intense, particularly in the Schellville area. If Simpson’s comments can be generalized, flooding also appears to have shifted from above tidewater to below.

Two primary factors appear to be responsible for “modern” flood conditions, particularly in the Schellville area:

- Direct connection of all major tributaries to the main stem of Sonoma Creek by 1877 (see “Connection of Tributaries to the Mainstem” section of this paper).

- Construction of levees to reclaim over 13,000 acres of tidal marshland in the lower watershed between about 1880 and 1930 (see “Baylands” section of this paper).

Other contributing factors probably include:

- Soil compaction by grazing animals and agriculture.
• Straightening of the main stem reducing channel length and increasing slope.
• Growing urban “hardscape” increasing and accelerating runoff.
• Discontinuance of dredging in the tidal areas. While the dredging history of the lower watershed is not precisely known, it almost certainly declined after shipping was discontinued from the Embarcadero in the 1920s and reclamation was completed in the 1930s.

The consequences of these changes appear to be:

• Runoff being transported more rapidly, thus reaching the lower watershed more quickly.
• Greater volume of runoff.
• Decreased ability of lower watershed to absorb storm waters.

Consistent with the above timeline, the earliest known description of flooding that bears resemblance to current conditions is from 1902, after reclamation had been going on in earnest for about 20 years: “fresh water flowing from the hills of the Fair ranch have converted the leveed lands . . . into an inland sea of rainwater.” (Sonoma Index-Tribune, 1902). Newspaper research back to 1879 revealed no earlier reports of flooding in the lower watershed (Dawson, 2003). In fact, a major storm on January 24, 1890, which washed away the Glen Ellen bridge, was reported as doing “little damage” in Schellville (Sonoma Index-Tribune, 1890). Newspaper research has not been completed for dates after 1908.

An Army Corps of Engineers study in 1956 recorded floods in the lower watershed in 1925, 1937, 1940, 1942, and 1952 (Collins, 2004). Over the last half-century, flooding has recurred periodically up to the present day (Dawson, 2004). By the early 1930s, 90% of the original baylands had been reclaimed. The onset of flooding in Schellville coincides with the closure of a significant portion of the baylands behind levees and appears to have become a fairly regular occurrence as this huge reclamation project was nearing completion in the 1920s.

Local elders have mixed opinions about whether the flooding situation has changed in their lifetimes. Some believe it has gotten worse. One elder attributes this to the fact that dredging no longer keeps “the lower reaches of the creek clean and deep and the water flowing very well.” According to Bill Lynch, the youngest elder interviewed, the flooding situation hasn’t changed a lot in the last 50 years, “Schellville flooded in the 1950s.” Other elders agreed with this observation (Sonoma Ecology Center, 2002).

Further Research

See “Possibilities for Further Study,” items 4, 14, 16, 28, 29 and 30.
CHANNEL CHANGE and BANK DESTABILIZATION

Rates of channel change and bank destabilization are unknown for the historic watershed. There may have been a period of rapid channel change and destabilization around the turn of the 20th century; the first known event of this type occurred during a January storm in 1890 that washed out the wooden bridge at Glen Ellen, severely eroded the bank and resulted in the drowning of a man who was on the bridge when it went down (Sonoma Index-Tribune, 1890). The steel bridge constructed the following summer was about 60 feet longer than the wooden bridge it replaced.

Similar types of events occurred in 1893, 1906 and 1909. In 1893, sidecutting of Sonoma Creek (said to have been “gradually washing away” since 1889), threatened to wash out lower Broadway just below Watmaugh Road (Sonoma Index-Tribune, 1893). The 1906 event washed out the eastern approach to the Verano Avenue bridge as Sonoma Creek shifted its channel 50 yards to the east. This is the largest known channel change in the historic record and necessitated adding a 150-foot extension onto the bridge. Like the 1893 event, this also appears to have been an incremental process with some damage to the bridge reported during a storm in January 1905 (Sonoma Index-Tribune, 1905, 1906; Sonoma County Public Works, 1939; Sonoma Ecology Center, 2002). Another bankcutting event in the El Verano area was reported in 1909 (Sonoma Index-Tribune, 1909).

The 1893 and 1906 events described above suggest the possibility that destabilization and bankcutting in that area was moving upstream at 1000 feet to 1500 feet per year (the 1909 event has not yet been precisely located). Newspaper research back to the Index-Tribune’s beginnings in 1879 has not turned up any earlier reports of major bank changes. Rates of bank destabilization may have increased in the historic period due to incision. If incision of the main stem began in the 1870s after the connection of tributaries to the main stem, then fifteen to twenty years of downcutting (potentially totaling three feet or more) may have contributed to destabilizing the stream banks. In addition, mechanical incision of lower Sonoma Creek by steam dredgers began around 1880 and could have started a process of upstream incision or headcutting, affecting these upstream reaches at these later dates. The 1890 event in Glen Ellen could be related to the draining and ditching of the Kenwood Marsh when the town of Kenwood was founded in 1888, which could have started a process of channel cutting downstream (Collins, 2004). Alternately, bankcutting could have been caused by a meandering movement of Sonoma Creek unrelated to incision.

One local elder reported a period of bank destabilization in the 1970s from Glen Ellen to El Verano (Sonoma Ecology Center, 2002). Recently, Sonoma Creek below Verano Avenue shifted west again. Bank cutting along this reach resulted in the closing of a section of Riverside Drive in the 1990s (Dawson, 2004).

See also: “Meanders and Channel Length.”

Further Research

See “Possibilities for Further Study,” items 4, 30, 31
TIDAL MARSHLANDS

The historic system included about 15,000 acres of tidal marshlands intimately connected with marshlands of the Napa River watershed (Bowers, 1867; Goals Project, 1999). The channel system was quite shallow (Ringgold, 1850) and extremely complex (U.S Coast Survey, 1856). Recorded depths in the lowermost mile of Sonoma Creek were between two and five feet (probably low tide). Supporting this data are early accounts of boats running ashore at low tide as well as the fact that vessels that regularly navigated Sonoma Creek had drafts of 4.6 feet or less (Marryat, 1851; Emanuels, 1998).

Apparent Changes, c. 1823 - 2004

Reclamation has reduced tidal marshland to about 10% of its former size and greatly simplified the channel system. Historic maps and other sources suggest the following chronology for changes to the Sonoma Creek/Napa River tidal marsh complex (dates and percentages approximate):

1860  Small-scale reclamation begun using hand labor
1880  Large-scale reclamation begun with steam-powered dredges to convert tidal marsh to agricultural land
1898  30 percent reclaimed, mostly on the south and west margins
1914  60 percent reclaimed
1935  Skaggs Island completed, the last large reclamation project. 90 percent of tidal marshland probably reclaimed by this date (no known maps exist for the period 1914 – 1948)
1948  U.S. GEOLOGICAL SURVEY maps show features in more or less modern condition
19??  Regular dredging of Sonoma Creek channel discontinued

(Dawson, 1998; Sonoma Ecology Center, 2002; U.S. GEOLOGICAL SURVEY 1902, 1914, 1951; Goals Project, 1999)

The following description comes from a local elder interviewed for the Oral History Project:

“Jones owned the Sonoma Land Company and had two dredgers as I recall. They’re the ones that reclaimed that whole Sonoma Land Company that stretched all the way from Skaggs [Island] clear back to Arnold Drive. Those dredgers worked all the time; they reclaimed that whole area. That was a vast piece of ground.” In 1890, the Index-Tribune described how the “remarkable dredger Nevada” ran on four steam engines and was “capable of doing the work of 1,000 men.”

Even after the reclamation was completed, “every other year a gravel dredge would come up Sonoma Creek and dredge Sonoma Creek as far as the Southern
Pacific bridge,” recalled Milt Castagnasso. He said that for many years, dredging “kept the lower reaches of the creek clean and deep . . . That gravel dredge, I think it came up from Richmond. I remember they’d suck this gravel and then send it out in a barge. In the years when the dredge used to come up, it was about ten or twelve feet deep all the time. The tide would be up or down.” (Sonoma Ecology Center, 2002)

Further Research

See “Possibilities for Further Study,” items # 1, 2, 4, 14, 16, 18, 28, 29, 34, 35 and 36
GROUNDWATER, FRESHWATER WETLANDS and SPRINGS

The groundwater situation in Sonoma Valley is extremely complex and difficult to assess both for the present day and the historic period. However, some general aspects are known. Altimira was so impressed by the amount of water in Sonoma Valley that he called it a “fountain of fountains,” during his visit in the summer of 1823. He said Napa Valley resembled Sonoma in every respect except that “we did not find as much water as was in Sonoma” (Altimira, 1823).

Known areas of historically high groundwater include:

- Western side of Sonoma Valley from approximately Boyes Boulevard south to about Watmaugh Road/Highway 116, including springs at the Carriger property and Temelec. There was probably quite a bit of variability within this area and it may have been a complex of high groundwater rather than a single zone (Altimira, 1823).

- Pulpula: Meadowlark Road/Cline Cellars area. Native name of *pulpula* has been translated as “ponds.” Altimira and others described several freshwater ponds in this area (Dawson, 1998). May have been more or less connected to the previous area.

- East side of City of Sonoma: “all the way past Denmark Street was nothing but open orchard, and field and plain. In the wintertime, when we’d have a pretty good-sized amount of rain, a lot of that area was vernal pools . . . it was real marshy, slushy. It would stay that way into the early summer.” Another elder delineated this area as a “strip of swamp” starting at the north end of Second Street East and going all the way to Eighth Street East and down to Sonoma Slough (Sonoma Ecology Center, 2002).

- Kenwood Marsh complex covering about 400 acres. See “Headwaters” section of this paper for a detailed description.

- City of Sonoma: base of hills along the north edge of city. There were at least two historic artesian ponds in this area, Lachryma Montis spring and “Wild Willows” wetland at the current General’s Daughter restaurant on West Spain Street between Third and Fifth Streets West (Sonoma Ecology Center, 2002).

- Glen Ellen: historic seasonal lake and vernal pools on present-day Imagery Winery (14335 Highway 12), Bouverie Preserve and Sonoma Valley Regional Park. Features both east and west of Highway 12 between Mayacamas and small range of hills to the west (Dawson, 2004).

- Tolay Lake and its associated freshwater marsh, covering several hundred acres (O’Farrell, 1848; Sonoma County Surveyors Office, 1860; Sonoma Ecology Center, 2003).
Apparent Changes, c. 1823 - 2004

- Western side of Sonoma Valley: connection of previously unconnected tributaries in this area has probably lowered groundwater due to increased drainage (see “Connection of Tributaries to the Main Stem” section of this paper for sources and more detail.)

- Pulpula: ponds still exist here, changes in water level unknown (Dawson, 2000; U.S. GEOLOGICAL SURVEY, 1951).

- East side of City of Sonoma: much of this has been drained and developed. Water table is still close to the surface in some areas such as the Community Garden at 19990 East Seventh Street (Sonoma Ecology Center, 2002; Dale, 2003).

- Kenwood Marsh: over 90 percent drained. Water table still high in many areas (Sonoma Ecology Center, 2002 and 2003).

- City of Sonoma: Artesian ponds have now been converted to pump wells for irrigation. “Willows Wild” drained in the 1860s or 1870s. Lachryma Montis spring still producing (Sonoma Ecology Center, 2002; Dawson, 2003).

- Glen Ellen: Seasonal lake no longer there. Vernal pools at Bouverie and Sonoma Valley Regional Park survive (Dawson, 2004).

- Tolay Lake and its associated marsh were drained in the late 19th century. Seasonal lake appears in winter. Marsh is gone (Dawson, 1998; Dawson, 2002).

Oral histories currently provide the best long-term gauge of general changes in the groundwater situation:

“The water table has diminished terribly.”

“When the lands were first planted, whether to orchards, to vineyard, to row crops, no irrigation was necessary. None . . . All of the cherries, all of the fruit, all of the apples and pears . . . were all planted where the water table was so high that percolation was sufficient to supply the needs of those trees. If you planted a tree out in any of those pastures today . . . why it would be dead before the middle of July.”

“Hundreds and hundreds of shallow wells went dry in Sonoma Valley during the late 1950s.” When “the aqueduct was put in (c. 1960) . . . the water table began to rise. The water table came up until about 1980 . . . In the 1980s and 1990s, we started to pump more, the city started to use their wells, the water table has gone down again. It’s down to the point where it was in the late 1950s.”

“When you get out toward Buena Vista, the water has got a lot of boron in it . . . saline is creeping into the water. You know where Napa Road is—I think it’s crept up that far already and when they’re putting in newer vines in that area, they can’t
use that water on them. Some of it is getting that bad, especially toward Vineburg. Some of these fellows are hauling water.” The increasing boron is a result of salt-water intrusion, in which sea water replaces depleted groundwater: “if you pump water out of the ground and have a big body [the ocean] over here, some of it’s going to soak through eventually” (Sonoma Ecology Center, 2002).

**Further Research**

See “Possibilities for Further Study,” items 3, 6, 12, 13, 18 and 37
GRAVEL MINING

Gravel mining in Sonoma Creek probably began in the late 19th century. Historic concrete dating to 1890 appears to contain local stream gravel (Dawson, 2002). Gravel mining probably also occurred in some tributaries. Information on local gravel mining comes almost entirely from oral histories:

“All the way along [the creek], different people had roads down to get the gravel,” remembered Bill Meglen, speaking of the 1920s and 1930s. “We didn’t have somebody to deliver it to us—you needed some gravel, you went down to the creek and got it out.”

Milt Castagnasso recalled, “My father was in the gravel business for a long while in those days.” When asked if his Dad used machines, Milt replied, “Heck no! A number-three scoop and a strong back, that was how you did it.” William McCarthy remembered people driving small trucks down to the creek in El Verano in the 1930s and ‘40s. He said sometimes “they would set a screen over the truckbed to screen out the larger pieces.” Then “one to three people” would shovel it onto the truck.

Sonoma Creek gravel went into making concrete for houses, commercial buildings, roads and bridges. Bill Meglen remembers Hazen and Norman Cowan taking care of the roads. In the 1920s they would go to a spot in Glen Ellen near the corner of Henno Road and O’Donnell Lane to fill up their wagon. The bed of their wagon had removable two-by-fours with handles, so the “gravel would slip down . . . and they’d pull another one and it’d slip down. So they’d go along the road and dump gravel.”

While much of the gravel mining in Sonoma Creek was small-scale and unmechanized, there were several commercial operations. “The first guy that started something with gravel was Serres,” said Bill Meglen. Milt Castagnasso listed Sonoma Grove, Dutil’s and the Hall Ranch as places that sold gravel to his father. Others spoke of Wrobels’ place at the end of Curtin Lane on the outskirts of Sonoma. As far up as Kenwood, Al Guffanti remembered a place on a ranch near the mouth of Adobe Canyon that was “nothing but a big gravel pit.”

By the 1930s, gravel mining in Sonoma Creek began to decline. According to Bill Meglen, one of the first people to bring in gravel was a fellow with “a flatbed truck—wasn’t even a dump truck,” who started hauling gravel in from Healdsburg. “He had better aggregates because the river [had] bigger, cleaner stuff and more rock to sand.” Bill Lynch, who grew up in the 1940s and 1950s, had no recollection of anyone going down to the creek and loading gravel into small trucks, as had been common twenty years earlier. He did recall that the gravel operation at the end of Curtin Lane continued “even up until just a few years ago.” It is believed that the last permit for commercial mining, held by the Shamrock Company plant on Arnold Drive along Fowler Creek, expired in 2000 (Sonoma Ecology Center, 2002).

Further Research

See “Possibilities for Further Study,” items 14, 32, 33, 38 and 39.
FISH POPULATION, c. 1823 – 2004

The earliest report of fish in Sonoma Valley is a comment in Jose Altimira’s journal that the natives had told him the creek contained “plenty of fish, especially salmon” (Altimira, 1823). Whether these “salmon” were steelhead trout, Chinook salmon or possibly coho salmon is unclear from Altimira’s comment. Linguistic evidence from a tcho-ko-yem (Coast Miwok) vocabulary list compiled in 1851 strongly suggests that Sonoma Valley’s indigenous people had a specific word for Chinook salmon, thus implying their presence at the time of Altimira’s visit (Sonoma Ecology Center, 2002). A few historical sources point to the possible presence of coho salmon in the Sonoma Valley watershed, but to date no definitive evidence has been found (Sonoma Ecology Center, 2002).

Salmonid populations appear to have remained at fairly healthy levels into the 1860s. However, by the 1870s, fish populations were reported to be in decline (Munro-Fraser, 1880). The cause for this is unclear, but was probably due to a number of factors including increased fishing pressure and land use practices which degraded salmonid spawning and/or rearing habitat. The population of Sonoma County grew from about 2000 people in 1852 to 11,000 in 1860 and to 19,000 in 1870 (U.S. Federal Census). Cattle grazing reached its height in the county during this period (Grossinger, 2003, Sonoma County Democrat, 1857) and deforestation from settlement was also probably at or near its maximum during this time (Sonoma Ecology Center, 2002, O’Farrell, 1848).

In 1878, the Lenni Fish Company was established to remedy the situation by building a trout hatchery in Glen Ellen (History of Sonoma County, 1880). Fish populations apparently rebounded after the hatchery was established and fingerlings were planted in Sonoma Creek (Sonoma Index-Tribune, 1889, 1890, 1891). During this same period, other forms of pisciculture were also begun in the valley, including the raising of carp, which were introduced into local waters and soon blamed for eating trout eggs (Sonoma Index-Tribune, 1882, 1889).

The Glen Ellen hatchery operated for about 20 years, closing around the turn of the century (California Department of Fish and Game, 1976). The trout population appears to have remained substantial up to at least 1906 (Sonoma Index-Tribune, 1906) However, the fishery went into decline soon after, with low fish populations reported in 1908, despite the fact that millions of trout were still being planted (Sonoma Index-Tribune, 1908). Potential reasons for this decline include: the planting of smaller, younger fish than had been released by the hatchery; a decline in habitat quality; and increased fishing pressure. The timing of the fish decline coincides with major bankcutting in the El Verano area, possibly a sign of rapid incision and/or high sedimentation during this time (see “Channel Change and Bank Destabilization” section of this paper).

The next reference to planting trout in the watershed comes from 1922, when Bill Basileu reported that his father began receiving shipments of fingerlings from the Department of Fish and Game (Sonoma Ecology Center, 2002). It is unknown whether planting continued between 1908 and 1922. Trout fishing was reported as good to excellent in the 1920s, 1930s and 1940s by everyone interviewed for the Oral History Project. Planting is known to have continued into the 1950s. Beginning in the 1950s, a decline in trout
fishing was noticed (Sonoma Ecology Center, 2002). By 1963, the California Department of Fish and Game was no longer stocking Sonoma Creek (California Department of Fish and Game, 1963).

Salmonid populations apparently reached a low point in the early 1970s when Bill Lynch’s “Obituary of a Trout Stream” appeared in the local newspaper (Sonoma-Index Tribune, 1971). A dam was also constructed at the State Hospital, just below Glen Ellen at this time (Sonoma-Index Tribune, 1972; Sonoma Ecology Center, 2002), effectively cutting off salmonids from reaching prime spawning grounds in the upper watershed. Eventually a fish ladder was constructed after several years (California Department of Fish and Game, 1973). This is also a period when substantial bankcutting was reported (Sonoma Ecology Center, 2002). The severe drought of the mid-70s further reduced the salmonid population. Afterwards, the Department of Fish and Game temporarily suspended its ban on planting and released 10,000 or more fingerlings into Sonoma Creek in an attempt to replenish the trout population (California Department of Fish and Game, 1978).

Changes in fishing regulations on Sonoma Creek have not been fully researched. A fishing limit of 50 trout was imposed in 1905 (Sonoma Index-Tribune, 1905). By the 1930s the limit had been decreased to 25, and at a later date was cut to 10 (Sonoma Ecology Center, 2002). At some point after 1971, Sonoma Creek was closed to fishing above tidewater (Sonoma Index-Tribune, 1971). However, sections were opened to seasonal and even year-round fishing in the mid-1980s. The dam at the State Hospital was also taken down during this decade (Ellman, 2003). By 1990 the creek was again closed above tidewater and remains so to this day (Dawson, 2004).

Recent years appear to show a modest recovery in Sonoma Creek’s salmonid population. A fish census in 2003 counted as many as 50 steelhead per 100 feet on one reach, though other sections were well below this number (Katopothis, 2004). Chinook salmon have also been observed spawning in the watershed six of the last nine years, usually in December and as far upstream as Adobe Canyon (Dawson, 2003).

Factors that may correlate with fluctuations in salmonid population in the Sonoma Valley Watershed:

**Mid-19th Century Decline** (c. 1860 – 1875) Intensive land use changes including high numbers of cattle and livestock, pioneer agriculture, and settlement cover the valley floor, connection of all tributaries to Sonoma Creek main stem, deforestation caused by logging and woodcutting. Increased fishing pressure.

**Late 19th Century Rebound** (c. 1885 – 1906) Stocking by Lenni Fish Hatchery. Introduction of fishing limits.

**Early 20th Century Decline** (1908 - ??) Episodes of bankcutting may indicate especially active incision and/or high sediment loads, and loss of cover. Stocking continued but introduced trout may have been younger and smaller than those provided by the Lenni Fish Hatchery and thus less likely to survive.
Mid-20th Century Rebound (c. 1920s – 1950s) Stocking continues. Stricter fishing limits imposed.

Mid-20th Century Decline (c. 1960s – 1980s) Stocking discontinued. Larson and Eldridge dams on main stem block access to spawning/rearing areas in upper watershed. Severe drought in the 1970s. Increased fishing pressure. Episodes of bankcutting may indicate especially active incision and/or high sediment loads, loss of cover.


FURTHER RESEARCH

See “Possibilities for Further Study,” items 4, 10, 14, 32 and 33.
LAND USE

Changes in land use in Sonoma Valley over the last 200 years are extremely complex and imperfectly known. Below is a very general overview:

Native Era, c.9000 B.C. – 1830s: periodic burning of grasslands, hunting and fishing, collection of and propagation of plant material, pruning of oak trees and many other activities. Exotic plants may have arrived decades or even a century ahead of the initial Spanish settlement of the Bay Area in 1775. Disease and “recruitment” to other Bay Area missions may have largely depopulated Sonoma Valley before 1820.

Mexican Era, c. 1823 – 1846 saw the introduction of livestock, particularly sheep and cattle, sheep predominating at least until 1834 when the Mission was closed. Agriculture was also introduced at this time and native practices were discouraged, particularly burning. Beginning of large-scale logging and woodcutting. Beginnings of viticulture.


See note in “References” about sources

Further Research

See “Possibilities for Further Study,” items 2,4,18 and 33, though almost any research topic could have bearing on this.
VEGETATION

Vegetation in the reference watershed covered a wide range, from relatively dry, chaparral covered slopes in the Mayacamas to moist redwood groves in canyons throughout the watershed and Douglas fir forests on the eastern slope of Sonoma Mountain. Periodic burning by native people as well as grazing by elk, pronghorn and deer kept the landscape open, with little dense brush and forest. Altimira’s 1823 journal includes the following descriptions of vegetation types (Altimira, 1823):

- **Riparian forest:** “luxuriant thicket of various trees.” Mentions wild grapes, “sycamore, cottonwood, ash, laurels and others” in vicinity of Sonoma Creek in the lower Broadway area.

- **Oak forest/savannah on the valley floor,** the main grove measuring four miles wide and nearly eight miles long, the trees “high and vigorous.” Mentions “tall grass” on valley floor in southeastern section of the valley.

- **Oak, redwood, and Douglas firs mixed with open grasslands on the mountainsides.** Near present-day Glen Ellen, the slopes were “well-covered with trees fit for lumber,” probably referring to Douglas fir and redwood.

- **“Multitude of permanent small waters” in the El Verano area may indicate vernal pools, seasonal and perennial wetlands, as well as small streams and springs.**

- **Open woodland in the vicinity of Arrowhead Mountain “bare of thick woods.”** Possibly oak woodland.

- **“Ponds between willows and . . . amidst tules and covered” in the east side of the current City of Sonoma.** At Pulpula he mentions lagoons and ponds “covered with tules.”

- **“Barren hill” at confluence of Sonoma and Calabazas Creeks (elevation shown as 493’ on U.S. GEOLOGICAL SURVEY 7.5 minute Glen Ellen Quadrangle).** May have been grassland maintained by native burning and/or grazing by elk, pronghorn and deer.

Nowhere does Altimira mention passage being difficult due to dense undergrowth or trees. A description of the Kenwood area in the 1840s mentions willow thickets in the vicinity of the marsh (Boggs, 1861). Early maps appear to show fairly narrow riparian corridors along Sonoma Creek and tributaries (Anonymous, 1840; Anonymous, 1844; O’Farrell, 1848; Peabody, 1851). Similar historic patterns have been documented in other parts of the Bay area (Grossinger, et. al. 2004; Grossinger and Brewster, 2003)

**Apparent Changes, c. 1823 - 2004**

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• Increased trees and brush, loss of open grasslands and savannahs, as has occurred in other parts of the Bay area (Grossinger et. al. 2004). Photographs from the 1880s show the valley with large open areas and long views (Watkins, 1888).

• The planting of many exotic trees, particularly on the valley floor, and the suppression of fire for at least 80 years has created a valley with far more, though possibly smaller, trees and thick brush than existed in the reference watershed.

• Elimination of most large, old native trees. Due to woodcutting, very few oaks more than 42 inches in diameter exist in Sonoma Valley today, the size reached at about 130 to 180 years, coinciding closely with the American pioneer era. Similarly, no more than a few old-growth redwoods survived logging, the only one known to the author being 15 feet in diameter on Sonoma Mountain (Dawson, 2004).

• Change in forest/woodland structure. Most redwoods grow in “fairy rings” around the stumps of the original trees. Existing trees are predominantly third or even fourth growth. Where one large redwood grew there are now a half-dozen or more smaller trees. Douglas fir are also probably smaller and more numerous (Dawson, 2003).

• Harvesting of tan oak bark in the latter 19th century for tanning cowhides. A newspaper article from 1876 describes thousands of these trees, killed by the stripping of their bark, on the hillsides of Sonoma (Sonoma Democrat, 1876).

• Loss of alluvial meadows through ditching and development.

• Loss of floodplain along Sonoma Creek, which likely was open woodland in 1823.

• Loss of fresh and saltwater wetlands through drainage and conversion to agricultural uses (Sonoma Ecology Center, 2003).

• Development of new riparian zones along new connections between tributaries and the main stem (Sonoma Ecology Center, 2003; Watkins, 1888; Dawson, 2002).

• Introduction of many non-native and invasive species such as Scotch broom, Arundo and star thistle (Newhouser, 2003).

• Sudden oak death infects oaks and other vegetation.

**Further Research**

See “Possibilities for Further Study,” items 1, 2, 4, 5, 6, 10, 12, 13, 14, 15, 18, 21, 35, 36, 37.
ADDITIONAL CONCLUSIONS

The two most dramatic alterations to the Sonoma Valley watershed since 1823 have been the connection of all tributaries to the main stem and the reclamation of 90% of Sonoma Valley’s tidal marshlands. Their close timing suggests that these two factors may have acted in concert to bring about channel incision, associated straightening of the channel, flooding and other changes. Below is a rough chronology of these two alterations and their possible effects:

<table>
<thead>
<tr>
<th>DECADE and year when known</th>
<th>WATERSHED ALTERATION</th>
<th>POSSIBLE EFFECTS</th>
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<tr>
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<td></td>
<td>(to some degree cumulative, ongoing, and not necessarily correlated to specific “watershed alterations” directly to left)</td>
</tr>
<tr>
<td>1840s</td>
<td>• Connection of tributaries to main stem begins (some evidence)</td>
<td>• Increasing stream flow in Sonoma Creek.</td>
</tr>
<tr>
<td>1850s</td>
<td>• Connection of tributaries to main stem accelerates (substantial evidence) • Reclamation of baylands begins slowly with hand labor</td>
<td>• Sonoma Creek’s channel begins to straighten, decreasing length and increasing slope. • Flood waters shunted more quickly to bay. • Increasing bed and bank erosion.</td>
</tr>
<tr>
<td>1860s</td>
<td>• All major and most minor tributaries connected to the main stem by 1877</td>
<td>• Mechanical incision of lower watershed begins or accelerates main stem headcutting.</td>
</tr>
<tr>
<td>1870s</td>
<td>• Mechanized reclamation of tidal marsh with steam-powered dredges begins.</td>
<td></td>
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<tr>
<td>1880s 1880</td>
<td>• Portions of Kenwood Marsh drained as town of Kenwood is developed. • High groundwater areas of El Verano drained as town of El Verano is developed.</td>
<td></td>
</tr>
<tr>
<td>Year</td>
<td>Description</td>
<td></td>
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<tr>
<td>1889</td>
<td>Bankcutting begins in Glen Ellen at Calabazas Creek confluence. Bankcutting begins at “Big Bend” below Watmaugh Road.</td>
<td></td>
</tr>
<tr>
<td>1890s</td>
<td>Major bankcutting at Glen Ellen; channel widens, bridge is washed out (no significant flooding in Schellville). Major bankcutting at “Big Bend” below Watmaugh Road.</td>
<td></td>
</tr>
<tr>
<td>1890</td>
<td><strong>30% of baylands reclaimed</strong></td>
<td></td>
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<tr>
<td>1893</td>
<td></td>
<td></td>
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<tr>
<td>1898</td>
<td></td>
<td></td>
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<tr>
<td>1900s</td>
<td>First record of “modern” flood conditions in lower watershed. Bankcutting begins at Agua Caliente confluence in El Verano. Major bankcutting at Agua Caliente confluence in El Verano; channel widens and bridge is washed out. Bankcutting in El Verano area (precise location not determined)</td>
<td></td>
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<tr>
<td>1902</td>
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<td>1905</td>
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<td>1906</td>
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<tr>
<td>1909</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1910s</td>
<td>60% of baylands reclaimed</td>
<td></td>
</tr>
<tr>
<td>1914</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1920s</td>
<td>Flooding in Schellville; bankcutting in Glen Ellen.</td>
<td></td>
</tr>
<tr>
<td>1925</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1930s</td>
<td>90% of baylands reclaimed</td>
<td></td>
</tr>
<tr>
<td>1937</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1940s</td>
<td>Flooding in Schellville</td>
<td></td>
</tr>
<tr>
<td>1940</td>
<td></td>
<td></td>
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<tr>
<td>1942</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1950s</td>
<td>Flooding in Schellville</td>
<td></td>
</tr>
<tr>
<td>1952</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
RESEARCH PRIORITIES

Based on the frequency with which items are listed under “Possibilities for Further Study,” the following appear to offer the most fruitful directions for further research:

- **Research California Land Court transcripts** at UC Berkeley’s Bancroft Library (item 4)
- **Expand historic mapping** of the watershed to include GLO and early county surveys from the mid-19th century, and digitizing features from the 1867 County map and the 1877 and 1898 Sonoma County Atlases (items 1, 2).
- **Translate Altimira’s journal** (item 6)
- **Collect additional oral histories** (item 14)

Research directions of particular interest to Total Maximum Daily Load (TMDL), Limiting Factors Analysis (LFA) and Army Corps of Engineers (ACE) studies include:

- **Identify and date abandoned stream channels** (items 17, 20, 21)
- **Develop a more precise timeline for dredging and reclamation of the lower watershed** (items 15 and 29).
- **Develop historic stream cross-sections** by analyzing historic photos (item 8)
- **Develop a timeline for connection of tributaries to the main stem** and a sequential map showing tributary connection in the El Verano area, 1848 – 1877 (items 11 and 19)
- **Quantify changes in channel length** of main stem and surveyed tributaries.
- **Develop a comprehensive flooding history** of the Schellville area (item 28)
- **Develop a timeline for bankcutting episodes** (items 31 and 34)
- **Develop a computer model of the reference watershed** (item 16)
REFERENCES

Headwaters


Dawson, Arthur. 2004. First-hand and second-hand observations over 15 years. The current U.S. Geological Survey Kenwood Quadrangle and all known maps of the area drawn since the latter 19th century show Adobe Canyon as the headwaters of Sonoma Creek.


Tributaries


Bowers, A.B. “Map of Sonoma County California, 1867”


37
Connection of Tributaries to the Main Stem

Bowers, A.B. 1867. “Map of Sonoma County California.”


Watkins, Carleton E. 1888. *Photographic Views of El Verano and Vicinity, Sonoma Valley, California*. 1888. Photos looking south from the El Verano Depot show no riparian or other vegetation on Dowdall Creek, indicating it may be a relatively new channel. Photos of Sonoma Creek itself seem to show little incision.

Smilie, Robert S. 1975. *The Sonoma Mission; The Founding, Ruin and Restoration of California’s 21st Mission*. Valley Publishers. Fresno, California. Appendix contains information on livestock herds from the mission’s annual reports. The location of these large herds is uncertain and may have been primarily outside Sonoma Valley, the mission using the hills as a fence to keep livestock off the fields.


Main Stem: Historic Channel Cross-Section and Incision


Meanders and Channel Length

U.S. Surveyor General. 1870. “Plat of the 2 Parts of the Rancho Agua Caliente, finally confirmed to Mariano Vallejo.”


Multiple Channels


Bowers, A.B. 1867. “Map of Sonoma County California.”


Reynolds and Proctor. 1898. Illustrated Atlas of Sonoma County, California. Published by Reynolds and Proctor, Santa Rosa, CA.


Changes in Confluences

Anonymous. 1890. “Bridge at Glen Ellen, Sonoma Co. California.” Glen Oaks Ranch Archive. May have been taken by the King Bridge Company on completion of the bridge. Twin horizontal lines in distance just to right of western support pillars are believed to be the Calabazas bridge.


U.S. Surveyor General. 1870. “Plat of the 2 Parts of the Agua Caliente Rancho.” 1870


Sonoma Ecology Center. “Oral History Report.” 2002. Bill Meglen mentions how he heard that Calabazas Creek used to intersect Sonoma Creek 200 yards higher up (response #102).

**Landslides**


**Flooding**


Dawson, Arthur. 1992-1997. Personal observations. During this period I delivered newspapers in the Schellville area and became intimately acquainted with the flooding situation over the course of five winters.


Sonoma Index-Tribune, 1902. “Dredging on the Jones Ranch.” October 11.


Sonoma Index-Tribune. 1983. June 29 (Jerry Parker column).


**Channel Change and Bank Destabilization**


**Tidal Marshlands**


Marryat, Frank. 1851. *North Bay Journal and Visits to Gold Rush San Francisco*.


U.S. Coast Survey. 1856. “San Francisco Bay, Plane Table Sheet XXI.” Map.


**Groundwater, Freshwater Wetlands and Springs**


Gravel Mining


Fish Population


California Department of Fish and Game. April 4, 1963. Letter from Warren Greenwald, Regional Manager, Region 3 to Don Scheley. Yountville Archive, Sonoma Creek folder.

California Department of Fish and Game. 1976. Several letters from J.C. Fraser, Regional Manager to Dr. Donald Scott, University of Otago, Dunedin, New Zealand. Archived under “Sonoma Creek.” Yountville Archive, Sonoma Creek folder.


Ellman, George. 2003. Personal communication by former researcher whose laboratory was next to the dam. May 20.


Munro-Fraser, J.P. 1880. History of Sonoma County: including its geology, topography, mountains, valleys and streams; together with a full and particular record of the Spanish grants; its early history and settlement. Published by Alley, Bowen & Co., San Francisco, California.

O’Farrell, Jasper. 1848. “Map of the Land of Petaluma” Sonoma County Recorders Office, Santa Rosa, California. Map. This map appears to show a huge portion of Sonoma Mountain already logged off. Vallejo’s sawmill on Asbury Creek is shown on the map. Local folklore dates its construction to 1839. Potentially, this mill could have processed close to 1.5 million board feet of lumber in nine years of operation.


Sonoma Index-Tribune. 1889, 1890 and 1891. March 16, 23, 30, April 13, May 18, September 14, October 26 1889. January 4, 18, April 5, 26, May 3, 10 1890. April 4, 25, May 9, June 20 1891.


Land Use

Sources for this section include most of the above as well as documents, books and photos too numerous to list. This overview is a distillation of years of study, conversations with historians, ecologists, watershed scientists, local residents, and personal observation.
Vegetation


*Sonoma Democrat* 1876. October 30. “Cabinet Woods.”


Watkins, Carleton E. 1888. *Photographic Views of El Verano and Vicinity, Sonoma Valley, California.* Photos looking south from the El Verano Depot show no riparian or other vegetation on Dowdall Creek, indicating it may be a relatively new channel.
POSSIBILITIES FOR FURTHER STUDY

1. Expand historic mapping to include whole watershed, using General Land Office (GLO) and early Sonoma County surveys to get a full picture of the pre-1870 watershed and connection/disconnection of tributaries to main stem. Early vegetation mapping could be done concurrently, using GLO survey info. See also #11 and #19.
2. Georectify and digitize 1865, 1877, and 1898 coverages of Sonoma Valley from County Atlases.
3. Create an historic groundwater map using oral histories and newspaper reports on well-drilling. Create GIS coverages from this information. Interview Larbre and/or other local well-drillers.
4. Research California Land Court transcripts at Bancroft Library—find and transcribe relevant information from these documents, which contain the best and most detailed early descriptions of Sonoma Valley before 1850. These include Ranchos Petaluma, Huichica, Agua Caliente, Yulupa and Sonoma Pueblo.
5. Study 1810 Moraga Journal at Bancroft for relevant material.
6. Translate Altimira 1823 Journal—a full and meticulous annotated translation to fully understand his early descriptions of Sonoma Valley.
7. Conduct a field study of Fryer Creek’s West Branch field to understand the nature of this former connection between Sonoma Creek and the Nathanson Creek watershed.
8. Develop historic stream cross-sections by analyzing historic photos.
9. Analyze and interpret Sonoma County Public Works field notes on culverts and bridges to inform incision studies.
10. Research historic newspapers using Index-Tribune’s new searchable database
11. Use #1, 2, 8, & 9 to develop a timeline for connection of tributaries to the main stem and main stem incision.
12. Map existing large oaks: begin with cores and counting stump rings to determine size of oaks at least 180 years old. Modeled on the San Francisco Estuary Institute’s Oak Mapping study of Napa Valley.
13. Use oak mapping, GLO information, soil maps, and other sources, to create an early vegetation map for the valley.
14. Collect additional Oral Histories, especially for the Schellville area and the reach of Sonoma Creek between Boyes Boulevard and Madrone Road.
15. Create a timeline for saltmarsh reclamation—somewhat redundant with #29.
16. Computer model the historic watershed to compare it to current watershed.
17. Use GLO surveys to identify abandoned stream channels. Use to inform incision studies and small scale channel movement and change. See #1.
18. Chart archeological sites to study native settlement patterns and to identify areas where settlements did not occur. In conjunction with #13 above, understanding these patterns may aid in establishing the edges of wetlands such as the Kenwood Marsh.
19. Develop a sequential map of tributary connection for the El Verano area, spanning the era from 1848 to 1877. See also #1 and #11.
20. Use LIDAR and/or field observations to identify abandoned channels and flood plains.
21. Date trees associated with former channels.
22. Use #1 above to locate former meanders and quantify changes in channel length of main stem and surveyed tributaries.
23. Conduct field studies of possible former side channels of Sonoma Creek and Carriger Creek.
24. Conduct field studies to locate former confluence sites to within 10 meters.
25. Research newspapers to date bridges for which no firm construction date is known, such as the O’Donnell bridge over Calabazas Creek.
26. Map known landslides along reaches of Sonoma Creek and some tributaries using Arcview/GIS.
27. Research newspapers to locate and date additional landslides.
28. Develop a comprehensive flooding history from newspapers, oral histories, and other sources
29. Develop a more precise timeline for dredging and reclamation of the lower watershed from newspapers and other sources such as early county and GLO surveys.
30. Compare “bank full” descriptions and rainfall storm totals in historic newspapers with current data to develop some idea of the timing, speed, and volume of runoff in the historic watershed. Could the cfs from these storms be estimated and used to figure the square footage of channel cross-sections? Or conversely, channel cross-sections estimated and used to calculate cfs?
31. Research newspapers to identify other instances of bankcutting and to reveal any patterns, such as upstream movement. Initial focus should be made on months with particularly heavy rainfall: October 1899, 1902; November 1893, 1903; December 1894, 1906; January 1886, 1894, 1899, 1901, 1903, 1905, 1906, 1907; February 1887, 1898, 1901, 1902,1904, 1906, 1907; March 1899, 1903, 1904, 1905, 1906, 1907; April 1886.
32. Develop a more precise “fish factors” timeline for Sonoma Creek watershed, including changes in fishing regulations, construction and removal of dams, newspaper research to fill gaps in the chronology.
33. Develop a possible “limiting factors chronology” based on land-use changes and other factors known to affect salmonids.
34. Use the chronology developed in #29 and information gathered in #31, to research whether there is any correlation between incidences of bankcutting and reclamation of the lower watershed. The hypothesis is that dredging in the lower watershed may have caused a pattern of upstream incision.
35. Georectify and digitize one or more early U.S. Geological Survey Quads. The tidal marshlands would be of particular interest with respect to the sequence of reclamation.
36. Study #4 above with a focus on the character of the tidal marshes bordering Petaluma and Huichica Ranchos.
37. Develop a detailed wetlands map of Sonoma Valley using a variety of historical sources and soil maps.
38. Research newspapers with a focus on gravel mining.
39. Develop a more precise timeline for gravel mining from a variety of sources.
SPECIFIC QUESTIONS and DATA GAPS

- What was the condition of the watershed outside the range of the earliest maps, which focused on the valley floor?
- What was the process for tributary connection to main stem?
- What is the process and contributing factors for main stem incision?
- What was the original groundwater situation and configuration?
- Was the connection between Sonoma Creek and Fryer Creek shown in the 1875 map natural?
- What were the cause(s) of salmonid decline in both the mid 19th and mid 20th centuries?
- When did gravel mining start?
- Were there other small meanders lost, other than the two presently known?
- Any other major channel movements besides at Agua Caliente confluence?
- When did the Calabazas/Sonoma Creek confluence shift downstream to its present position? (It was sometime between 1890 and 1939)
- Is there any way to verify or discount the apparent connection of Sonoma Creek to Adobe Canyon between 1837 and 1851?
- Major floods besides c. 1925, c. 1955 and the recent ones in the 1990s?
- Where were the primary grazing areas for the mission herds and later Vallejo’s animals? The mission established ranchos in the Petaluma area and as far east as Fairfield—perhaps large herds were not kept in Sonoma Valley at this time, possibly because they might have damaged crops.
- What was the vegetation like on the valley floor?
- How did the cessation of periodic burning and conversion of understory effect runoff?