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The Carr Lake Project: Potential Biophysical Benefits of Conversion to a Multiple-Use Park

Publication No. WI-2007-05
12 December 2007

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Preface

This report was produced for the Big Sur Land Trust and The Watershed Institute's Carr Lake Project to review existing data on current hydrology, water quality and biological resource conditions in the Carr Lake vicinity; and to discuss potential benefits of converting Carr Lake into a multi-use park.

Cover Photo: A partially flooded Carr Lake taken from East Laurel Ave. following a storm in late December 2004 (Photo: Joel Casagrande, 31 Dec 2004).

Acknowledgements

We acknowledge the following for providing data and other resources used in the development of this report.

David and Lucile Packard Foundation

Big Sur Land Trust

- Donna Meyers
- Joanna Devers

City of Salinas

- Ron Cole

Monterey Bay Sanctuary Citizen Watershed Monitoring Network

- Bridget Hoover

Central Coast Regional Water Quality Control Board

- Alison Jones

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Executive Summary

The Carr Lake Project aims to convert Carr Lake's 450 acres of agriculture fields into a regional multi-use park that will benefit flood protection, water quality, and wildlife habitat, while also providing additional recreational areas for the local community. The Project is represented by an informal consortium of interested parties including the Watershed Institute of California State University Monterey Bay, The City of Salinas, 1000 Friends of Carr Lake, and the Big Sur Land Trust.

The Lake lies in the center of Salinas and captures runoff from the Gabilan, Natividad and Alisal sub-watersheds. Historically the Lake was one in a series of 'Seven Lakes' – natural depressions that extended between Salinas and Castroville. The lakes were eventually drained by the Reclamation Ditch, which was completed in 1920 to increase the acreage of productive agricultural lands.

Currently Carr Lake is a key component to the storm water system for the City of Salinas and downstream areas. In most years Carr Lake partially floods during winter storms due to an undersized culvert located under North Main Street just west of HWY 101. Minor flooding events damage agricultural fields, while larger events (with 25-year recurrence interval or greater) have caused more significant damage to property, as was the case in February of 1998.

Increased suburban development is planned for lands upstream of the Lake (COS, 2002). The developments, which will occur on lands currently used for agriculture, are likely to increase storm water runoff due to greater impervious surfaces (SWCCE, 2002).

Two recent studies, SWCCE (2002) and Cameron et al. (2003), have investigated the benefits of converting Carr Lake into a multi-use flood control basin. The SWCCE (2002) study suggests a side-flow design, which utilizes large "overflow" detention basins, as the most cost-efficient design that will achieve the multiple use objectives while still lowering the 100-year peak discharge from the lake. Designs drafted by Cameron et al (2003) also depict this design and offer more specific plans for recreation and wildlife habitat.

Both studies note that improved sediment retention upstream of the lake is needed. Sediment accumulation in the lake is partially responsible for some of the flooding that occurs during winter. The bulk of this sediment most likely originates upstream of the City limits from agricultural land, range land, and steeply wooded land in the Gabilan Range. Sedimentation problems in the Lake would be mitigated by installation of (additional) control measures at sediment sources offline form the main stream channel.

Several local groups and agencies have recently (1999-2006) monitored water quality at many sites throughout the watershed. The data are limited spatially and temporally, but show some general trends. Water quality in the upper watershed, which is predominantly natural woodlands and cattle grazing, typically meets regional and state mandated objectives. Downstream where agriculture and urban land uses are dominant, impaired water quality conditions are more common. Many of these water bodies are listed on the State's 303d list due to the adverse impacts to their beneficial uses. Tributaries to Moss Landing Harbor (Tembladero Slough and the Old Salinas River Channel) were also listed as 'Toxic Hotspots' by the State Water Resources Control Board (SWRCB, 1999a,b). Data collected by the Central Coast Ambient Monitoring Program (CCAMP) for suspended sediment, nutrients, and fecal coliforms concentrations show that, when averaged, several water bodies in the Gabilan Watershed ranked in the upper quartile of all sites (121 total sites) in the Central Coast region.

Although a majority of the water quality data collected to date is pre-2004, recent data (Hoover, 2006; COS, 2006b) continue to show degraded conditions in water bodies around the City of Salinas. Monitoring for the City of Salinas's NPDES Permit and the Ag Waiver Program is providing some new data.

A multi-use park in Carr Lake poses to provide multiple benefits to the local community (Fig X.1). There is great potential to improve the water quality treatment function provided by Carr Lake. In general, stream channels and riparian areas provide optimal water quality treatment function when the flow is allowed to spread out and slow down, and the riparian vegetation is maximized. Flow through Carr Lake is currently confined to several narrow, sparsely vegetated channels (except at Natividad Creek Park, the restored Upper Carr Lake basin and under flood conditions). These channels most likely provide only limited water quality treatment function, relative to their potential. Within these channels, there is little opportunity for water to spread out and slow down, and development of biological treatment function is punctuated by periodic dredging.

Increasing the amount of riparian vegetation as well as widening the creek channels within the lake will increase residence times which should improve water quality conditions by increasing sediment deposition and the filtering of excess nutrients. Recent data from a treatment wetland located downstream from Carr Lake in Tembladero Slough revealed that a small vegetated wetland (< 2 acres) was effective at reducing nutrient and suspended sediment concentrations to downstream waters. Other studies have shown that wetland basins can filter out pesticides and fecal coliforms, both of which are readily observed in high concentrations in the Gabilan Watershed.

The creeks of the Gabilan Watershed support several native fish and amphibian species. Federally listed California red-legged frog and tiger salamander have been recently been observed in Natividad Creek upstream of Carr Lake. In 2005, NOAA classified Gabilan Creek as Critical Habitat for steelhead, although it remains unclear if a population exists.

Benefits to water quality and wildlife species will depend on the design and function of the park (Fig X.1). The addition of riparian vegetation and the enhancement of wetland habitats in Carr Lake will likely improve habitat conditions for a variety of wildlife species. There is potential to increase habitat for sensitive species such as the California red-legged frog and California tiger salamander. Fish species that are tolerant of warm water and low flow conditions are likely to benefit from the enhanced wetlands. Habitat conditions in a converted Carr Lake will likely not benefit steelhead, however modifying anthropogenic migration impediments in the lake and at upstream locations will improve their migration efficiency through the lake and up to spawning and rearing habitat upstream in the Gabilan Range.

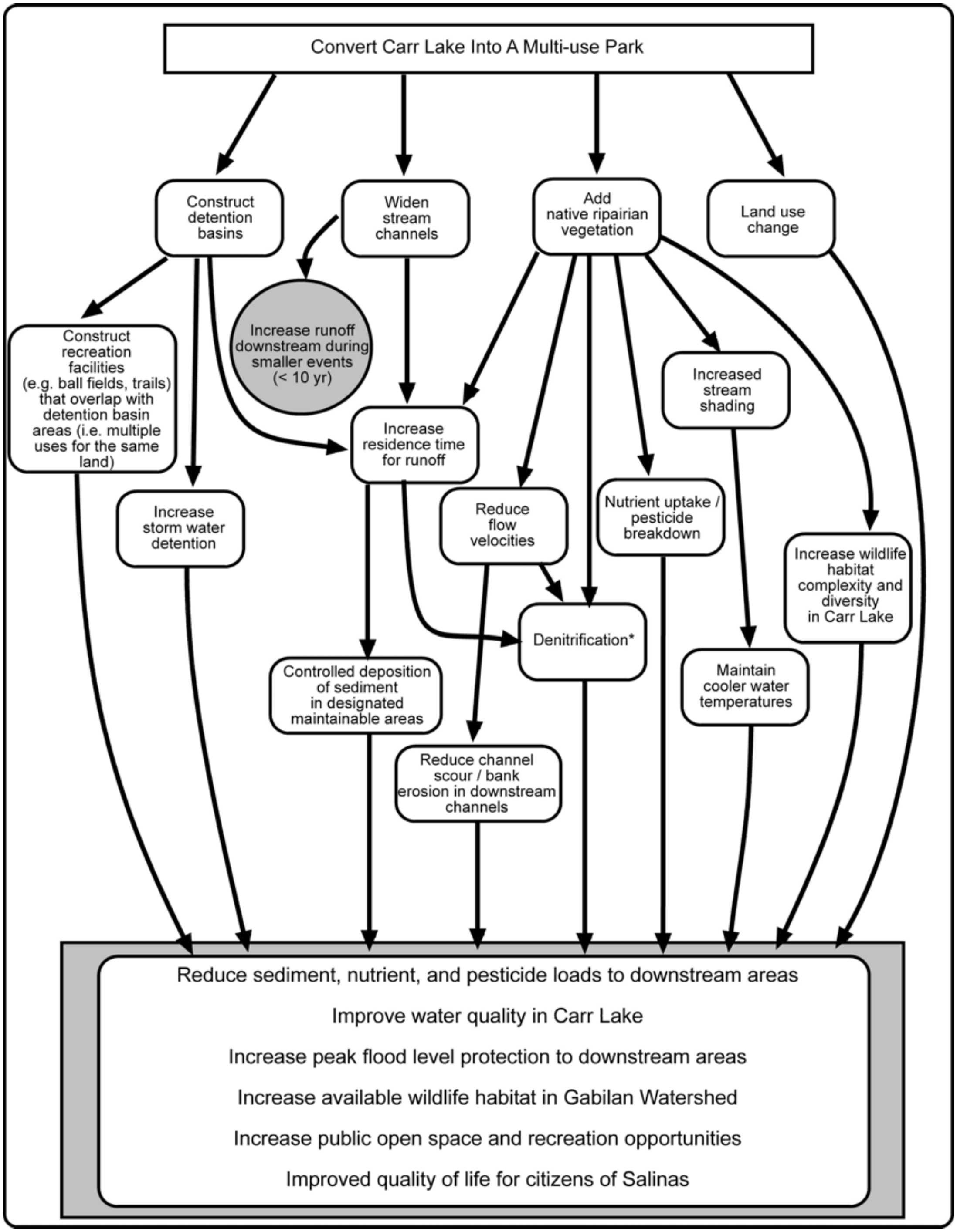


Figure X.1. A conceptual systems diagram showing anticipated benefits for converting Carr Lake into a multi-use park. Note: Gray circle indicating increased runoff is based on SWCCE (2002) which states that by widening the channel, a characteristic of both the side-flow and through-flow designs, there would be an increase in stage and discharge out of Carr Lake for smaller events (≤ 10yr). *Denitrification - this is under the assumption that perennial water would be present to facilitate anoxic conditions required for denitrifying bacteria.

1 Introduction

1.1 The Carr Lake Project: Background

The Carr Lake Project is a grassroots effort to convert Carr Lake from an agricultural basin into a multi-use park that will provide benefits such as improved peak flood control and water quality, as well as increased wildlife habitat and parklands for the surrounding community.

A number of factors support the need for this project. In recent decades suburban developments have encroached on the lake creating an isolated 'island' of agricultural lands in the heart of Salinas. Damage caused by the 1995 and 1998 El Nino events alerted the community to the need for some kind of change - either by improved flood control, or re-use of floodable lands, or some combination of the two. Future suburban growth upstream of the lake is likely to add additional runoff to the flood control system (SWCCE, 2002). Water quality and wildlife habitat are impaired in the lower watershed, and could be improved by re-utilization of Carr Lake. Finally, the creation of a regional park in Carr Lake presents a unique opportunity to create additional open space in the center of Salinas, a city that is currently under the national target of 10 acres per 1000 residents (Cameron et al. 2003).

Following the 1995 and 1998 El Nino events The Reclamation Ditch Improvement Plan Advisory Committee (RDIPAC) was formed to plan for the improvement of the drainage system. With the guidance from the RDIPAC, the Monterey County Water Resources Agency (MCWRA) contracted with Schaaf and Wheeler Consulting Civil Engineers (SWCCE) to evaluate the drainage operations of the Reclamation Ditch system and to provide detailed recommendations for its improvement (SWCCE, 1999). In 2002, SWCCE completed the *Carr Lake Multi-purpose Flood Control Study* which outlined current limitations of the lake and presented a variety of different alternatives for improving flood control effectiveness. The following year, the Studio 606 team of California State Polytechnic University Pomona completed *A Vision Plan for Carr Lake Regional Park* (Cameron et al. 2003), which presents an adaptive, multiple-use plan for the Lake as a regional park.

In 2006, a *Reclamation Ditch Watershed Assessment and Management Strategy* was produced by the Watershed Institute and MCWRA (Casagrande and Watson, 2006a,b). The Assessment documents both historical and current conditions in the Watershed, while the Management Strategy, driven by stakeholder input, outlines several goals and actions aimed at improving the watershed's overall function. Several of the Actions listed in the Strategy are directly consistent with the goal of the Carr Lake Project. In October of 2006, both the Watershed Assessment and Management Strategy documents were approved by the MCWRA Board of Directors.

Created in 2005, the "*1000 Friends of Carr Lake,*" a group of community members and educators, are now working closely with local partners, such as the Watershed Institute, the City of Salinas, and the Big Sur Land Trust to make a multi-use park at Carr Lake a reality.

1.2 Objective and Report Structure

The objective of this document is to provide a summary of the current conditions in the Carr Lake Watershed and to discuss potential benefits to flood control, water quality, and habitat for wildlife if the lake is converted to a multi-use park.

This report contains a review of current hydrologic conditions, followed by a review of known water quality conditions and biological resources in the vicinity of the Carr Lake Watershed. The final chapter discusses the anticipated socio-economic and bio-physical benefits to converting Carr Lake into a multi-use regional park by drawing from relevant local studies and the literature.

1.3 Study Area

Carr Lake is a mainly privately owned, approximately 182-hectare (450 acre) historic lake bed that lies in the center of the City of Salinas in northern Monterey County (Fig. 1.1). The Lake, which has been drained and used as agricultural lands for much of the last century, captures runoff from approximately 260 km^2 (101 mi^2) of the Gabilan Watershed and is a critical influence on flooding in the City of Salinas and downstream areas (SWCCE, 2002). Three creeks confluence in the Lake: Gabilan Creek to the north, Natividad Creek, and Alisal Creek to the south. The Lake is drained by the Reclamation Ditch, flowing northwest towards Castroville. Near Castroville the Reclamation Ditch becomes Tembladero Slough which flows into the Old Salinas River Channel before emptying into Moss Landing Harbor.

The Lake is an island of agricultural fields encircled by urban developments. Its upstream boundary is defined by East Laurel Ave and its downstream boundary is bordered by Highway 101. The lands between Highway 101 and East Laurel Ave as well as some developed areas, including the Sherwood Lake Mobile Home Park, are designated by FEMA as floodway (SWCCE, 2002). The floodway designation restricts future development plans in the Lake. In the updated 2002 General Plan, the City of Salinas designated Carr Lake as park space, rather than agricultural lands, suggesting a vision for Carr Lake as a park in the future.

Several parks and open space areas are in close proximity to the Lake (Fig 1.1). Just upstream is Upper Carr Lake, a remnant arm of the Lake restored in 2003. Further upstream is Natividad Creek Park, a partially restored multi-use park along Natividad Creek. To the northwest are the Salinas Rodeo Grounds and Sherwood Park and to the south Caesar E. Chavez Memorial Park.

1.4 Historical Conditions

Prior to large urban and agricultural developments much of the lower Gabilan Watershed was occupied by a large wetland complex, including a series of shallow lakes (Figs 1.2 & 1.3). Carr Lake, one of the larger water bodies, usually contained water year-round (SWCCE, 2002). The lakes and swamp areas were rich with wildlife some of which are now extirpated or extinct (Breschini et al. 2000; Gordon, 1996; Shumate, 1983).

After the turn of the 20th Century, agricultural developments expanded rapidly. The Reclamation Ditch was constructed between 1917 and 1920 for the purpose of draining the wetlands to be used for agriculture. The ditch was an enlargement of an existing waterway (Gabilan Creek) that connected the series of historic lakes (Fig 1.3). Carr Lake was first reclaimed by Jesse D. Carr in the early 1890's (Anderson, 2000; Breschini et al. 2000). Heavy rains during the winter of 1890 filled the lake causing it to spill into Salinas. This prompted Carr and others to modify the outlet of the lake and in doing so they were able to reclaim 1,475 acres. After the Reclamation Ditch was completed in 1920, Carr Lake and most of the other lakes were permanently reclaimed for agricultural uses. In the 1920's, Carr sold the lake and surrounding lands to a Japanese family who finished reclaiming the lands for farming. These lands are still farmed today by the descendants of this family which include the Ikedas, the Hibinos, and the Higashis (Cameron et al. 2003).

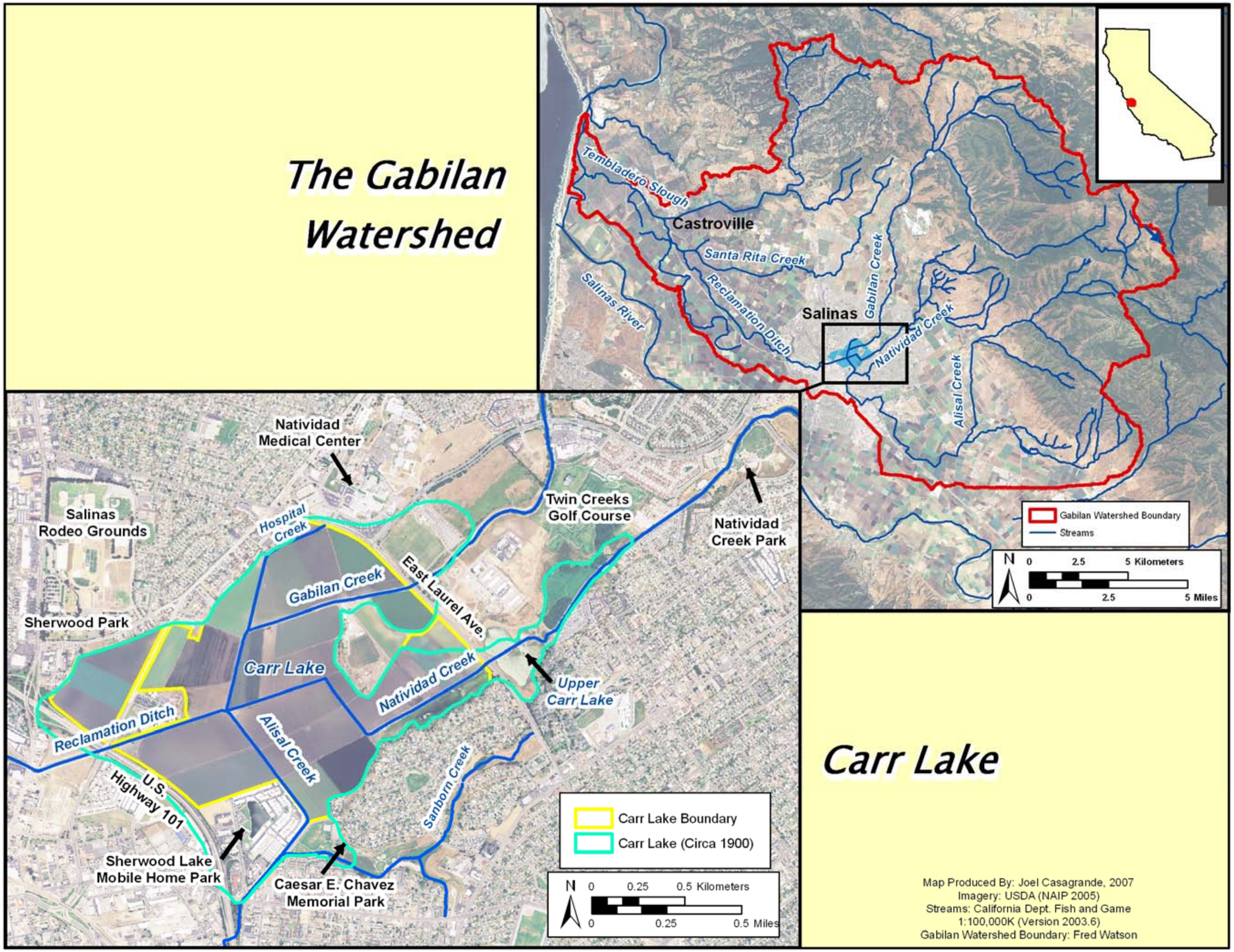


Figure 1.1 The Gabilan Watershed (upper right) and the Carr Lake basin and surrounding areas (lower left). Carr Lake boundary circa 1900 was estimated using the maps presented in Figures 1.2 and 1.3.

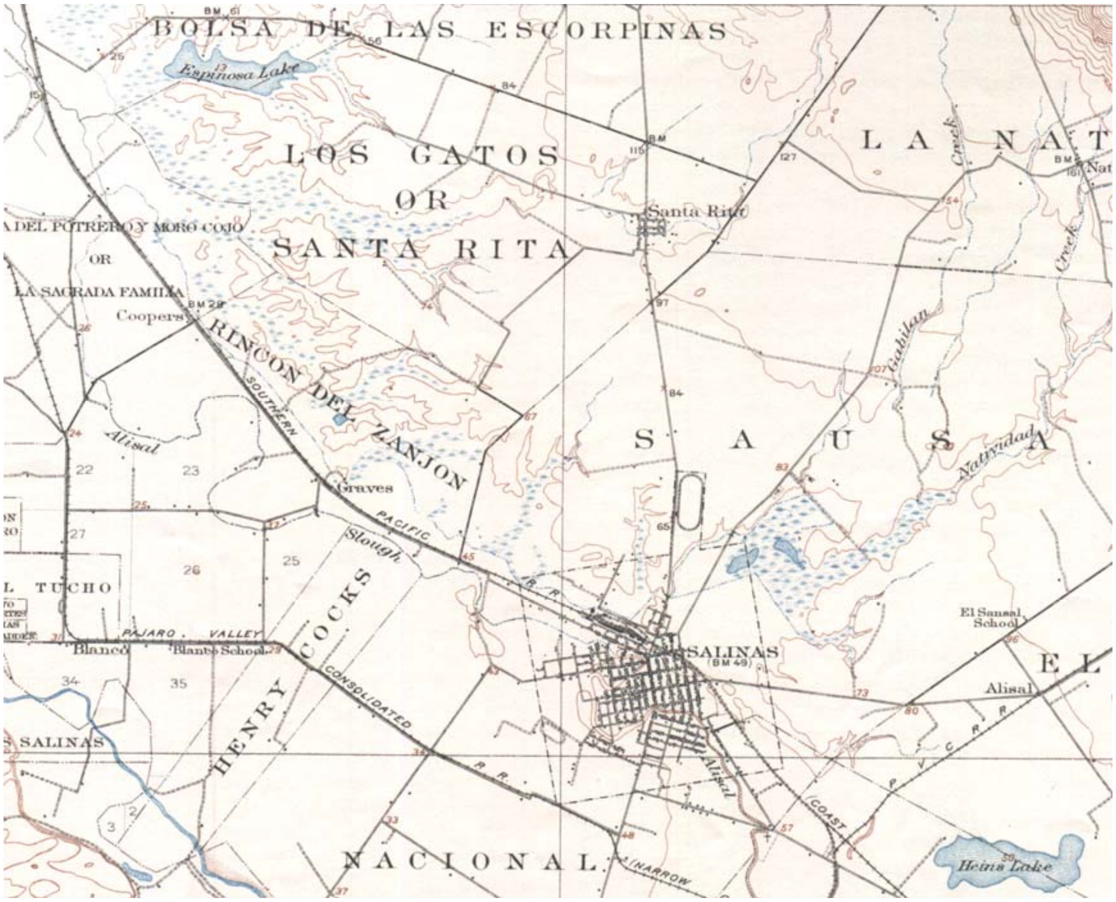


Figure 1.2 This 1912 USGS topo map of the Salinas vicinity (pre-Reclamation Ditch construction) shows some of the historic wetlands of the lower Gabilan Watershed including Espinosa Lake (upper left), Carr Lake (center right) and Heinz Lake (lower right corner).

1.5 Future Developments Upstream

In recent decades, lands upstream of Carr Lake along Gabilan and Natividad Creeks have experienced a large increase in suburban development. The City of Salinas's General Plan (2002) outlines locations for future growth (Fig 1.4). Most of the proposed development will occur north and east of the city limits (upstream of Carr Lake) on lands currently used for row crop agriculture (Fig 1.4). The new developments will be constructed in phases and will include a mixture of suburban residential and commercial uses (COS, 2002).

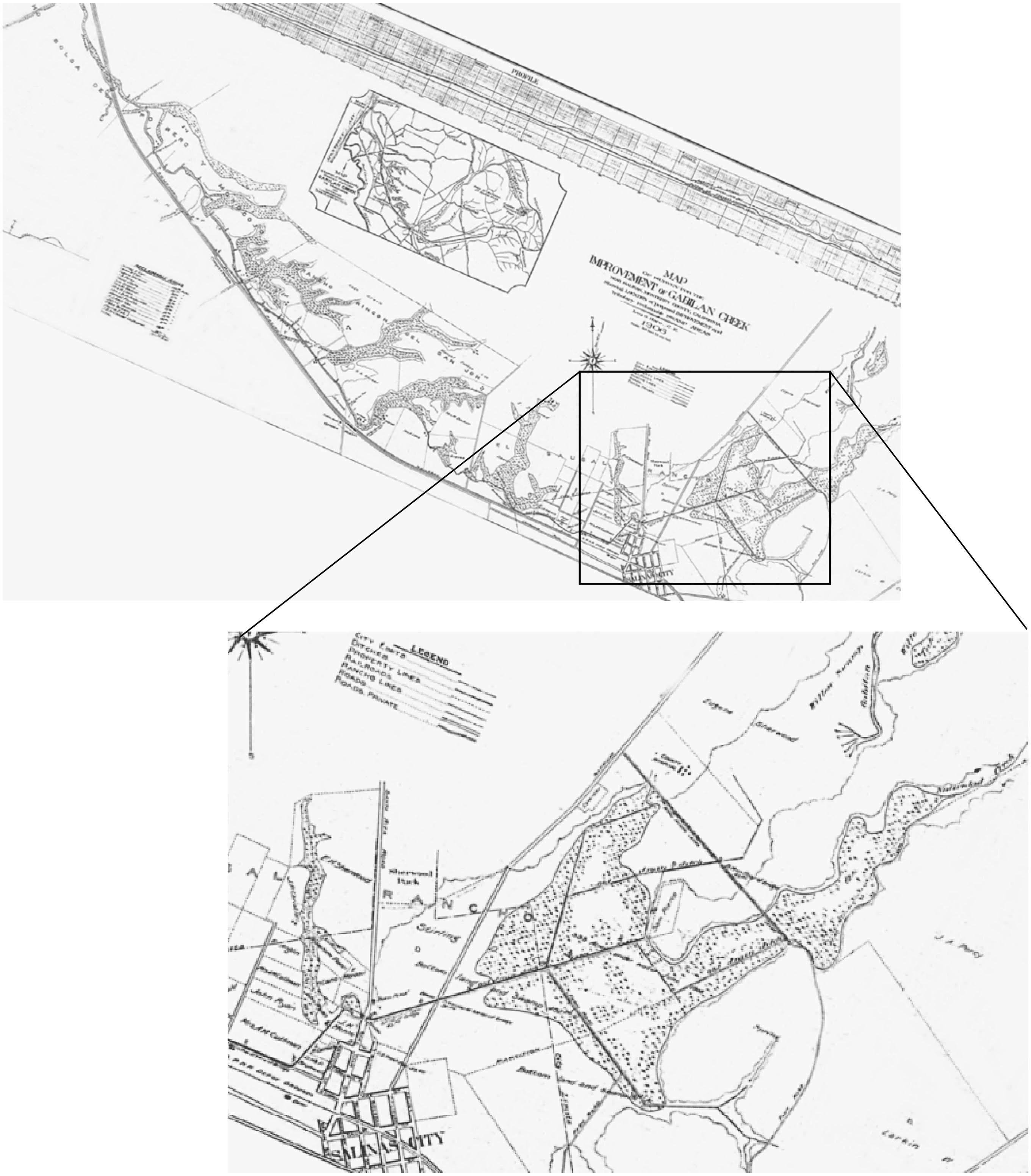


Figure 1.3 This reproduction of the original1 1906 blue-print by Lou Hare, titled the "Improvement of Gabilan Creek", is the initial design for the Reclamation Ditch and shows most of the historic chain of lakes (including Carr Lake in detail lower right).

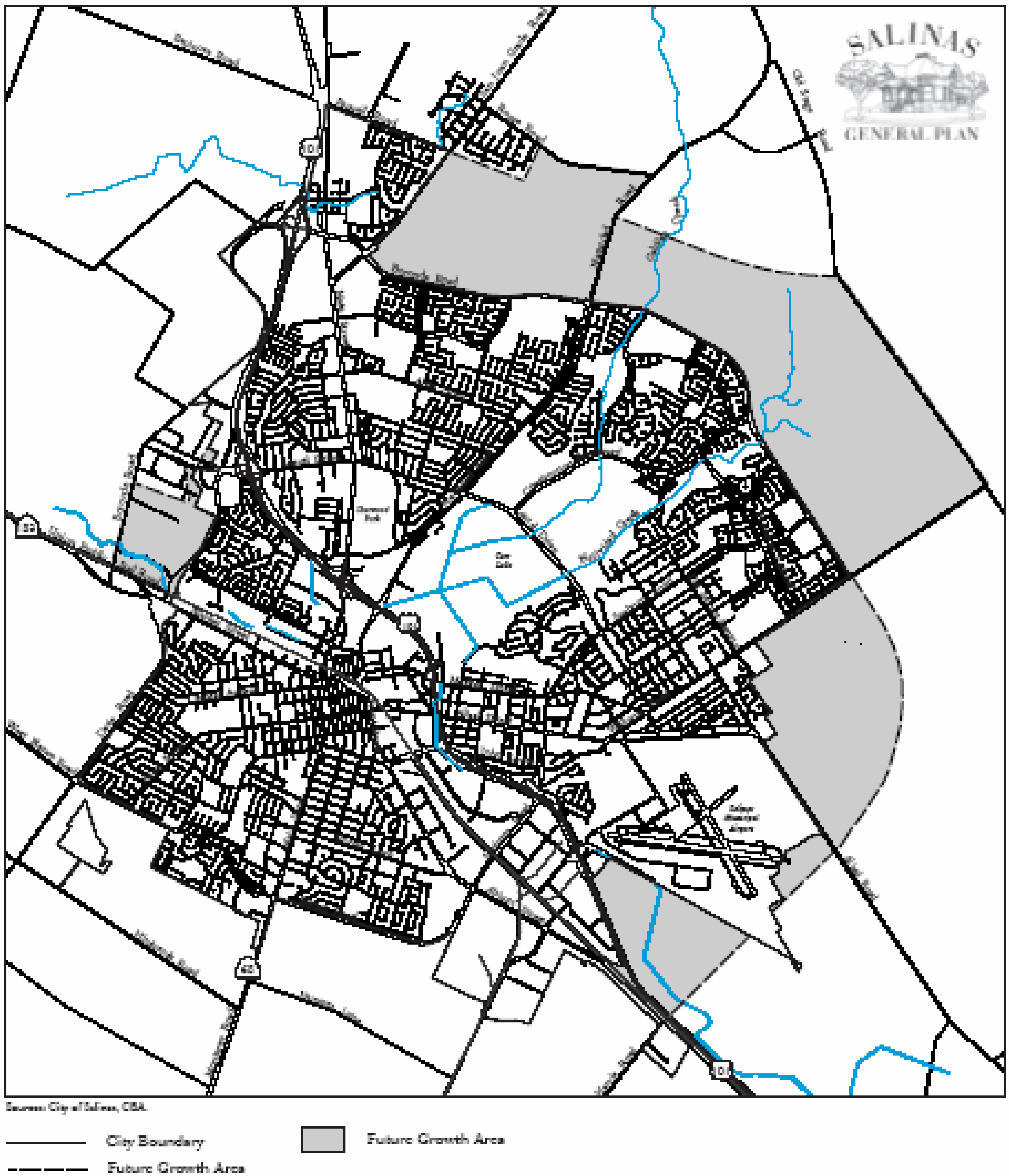


Figure 1.4 Future growth areas (gray shading) for the City of Salinas. Map reproduced from the City of Salinas General Plan (2002).

2 Hydrology

2.1 Watershed Overview

The Gabilan Watershed originates in the northern corner of the Gabilan Mountain Range northeast of the City of Salinas (Fig 1.1). There are three sub-watersheds that drain into Carr Lake, Gabilan to the north, Natividad Creek, and Alisal Creek to the south. Carr Lake is drained by the Reclamation Ditch which empties into Tembladero Slough just south of Castroville.

In their headwaters, Gabilan and Alisal Creeks maintain perennial flow down to the foothill region just east of Old Stage Road (Casagrande and Watson, 2006a). Lower Natividad and Alisal creeks usually have summer flow in most years due to agricultural runoff. Lower Gabilan Creek, just upstream of Carr Lake, maintains some flow during most conditions due to continuous groundwater pumping from beneath Alvarez High School.

Each of the major creek channels are key components to the flood control system. In the urbanized areas, runoff response is quick following moderate to heavy precipitation (USGS stream gage data online). Runoff is routed into the creeks through a network of storm drains and by agricultural ditches near the City's northern and eastern boundaries. Further upstream, in the agricultural and natural areas, runoff response to precipitation is slower (Casagrande and Watson, 2006a). Sediment loading into the creek channels is of concern to local agencies as it reduces channel capacities and increases maintenance costs for the City, County and local land owners (CDM, 2004; COS 2006a).

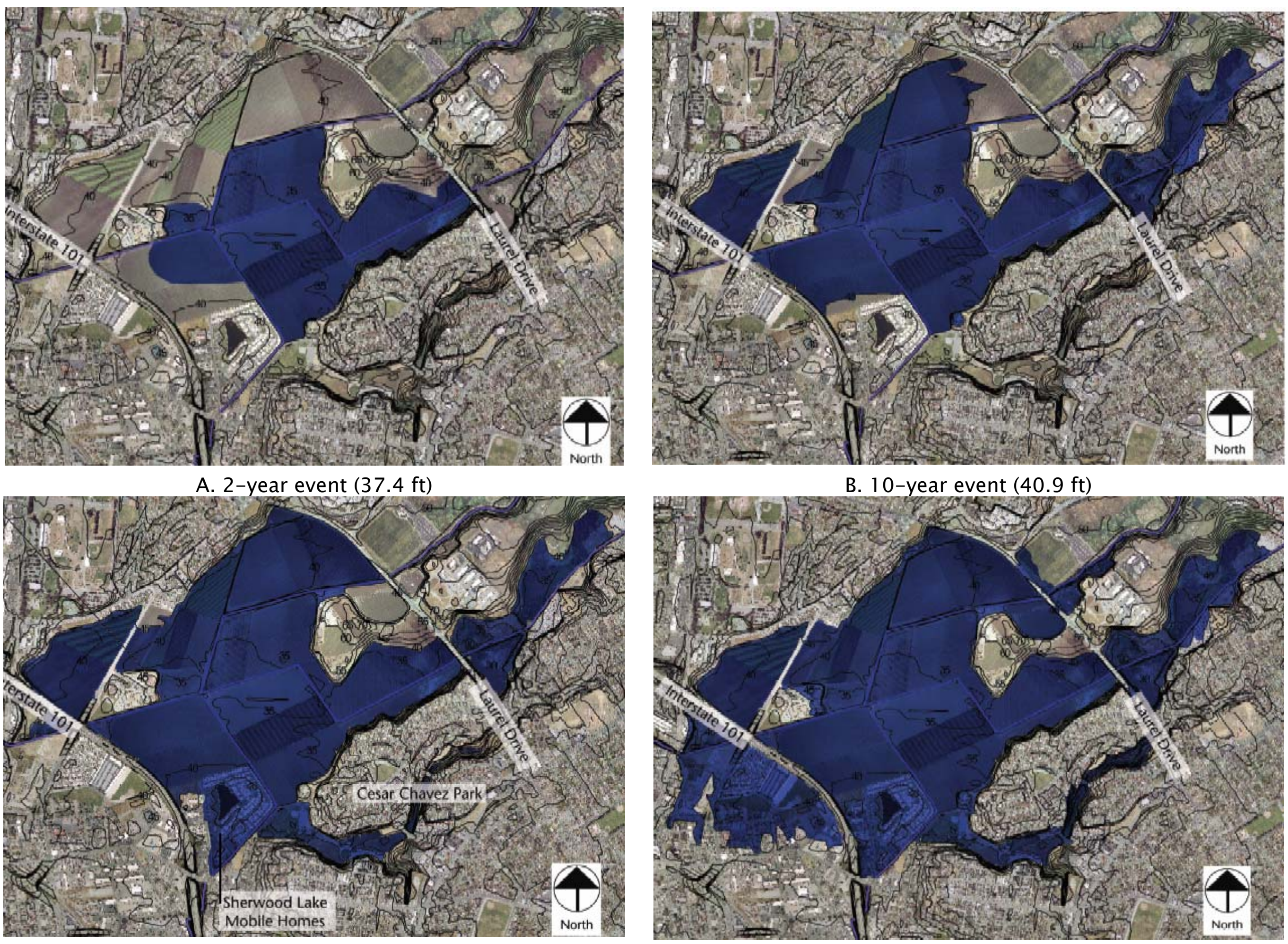
2.2 Carr Lake Hydrology

Carr Lake is a natural depression that captures runoff from 260 km^2 of watershed (Fig 1.1). The Lake functions as a thru-flow detention basin, where flows exiting the lake are controlled by the lake's water elevation. Drainage out of the lake is regulated by a double 8 ft x 8 ft box culvert under the Main Street bridge. The box culvert itself is undersized compared to others upstream and downstream of it and therefore restricts peak flows and downstream flooding (SWCCE, 2002). In addition, the culvert is usually impacted by accumulated sediments which require regular dredging (Casagrande and Watson, 2006a).

Beneath the box culvert is a 36-inch diameter pipe that is used to convey water during low flow periods. When stream flow is in excess of the pipe's capacity, water is impounded until it reaches the bottom of the overriding box culvert. This generally results in partial flooding of the lake during most storm events. Figure 2.1 shows the flood patterns and water elevations in the lake during a variety of runoff conditions. During a 2-year event, more than half of the lake bottom is flooded. This has been observed several times since 2000 (e.g. cover photo) and has been a common condition for some time (Bechtel Corp, 1959). During a ten year event, nearly

90% of the lake bed is inundated and in a 25 year event, the entire lake and some areas outside including the Sherwood Lake Mobile Home Park are inundated (Fig 2.1 C). At 100 year event, water elevations could spill onto Highway 101 and into parts of downtown Salinas (SWCCE, 2002; Cameron et al. 2003).

In summer, each of the channels in the lake has surface water due to upstream sources and local tile drains within the lake. The Lake's landowners install a seasonal earthen dam to restrict water from Gabilan Creek flowing up Natividad Creek (Cameron et al. 2003). A slide gate at the exit of Upper Carr Lake, east of East Laurel Ave. is used to regulate runoff from Natividad Creek into the lake bed.



A. 2-year event (37.4 ft)

B. 10-year event (40.9 ft)

C. 25-year event (42.9 ft)

D. 100-year event (45.9 ft)

Figure 2.1 Estimated flood patterns in Carr Lake during a 2, 10, 25, and 100-year event. Water elevation values in parentheses. Images and elevation data reproduced from Cameron et al. 2003.

2.3 Recent Floods (1995 & 1998)

Since its construction in 1920, the Reclamation Ditch system has experienced significant flooding due to its limited capacity and the overall expansion of the urban areas upstream. During the winter of 1951/52, the Reclamation Ditch was unable to handle "record flows", which resulted in significant flooding between the Alisal neighborhood and downtown Salinas (CDPHBSE, 1952).

The 1995 and 1998 El Nino events resulted in substantial flooding and property damage throughout the northern Salinas Valley, including Carr Lake and the Reclamation Ditch system. During this event, the City of Salinas received 20.1 inches of rainfall, approximately 6 inches above the annual average. Rainfall in the southern half of the Salinas Valley was more substantial (25.3 inches in King City) which caused the Salinas River to peak at 95,000 cfs at the Spreckels gage – the highest on record. The lower portions of the Gabilan Watershed were most impacted by floodwaters from the Salinas River which overtopped its banks at several locations sending river water onto the flat areas (Blanco Drain sub-watershed) between the

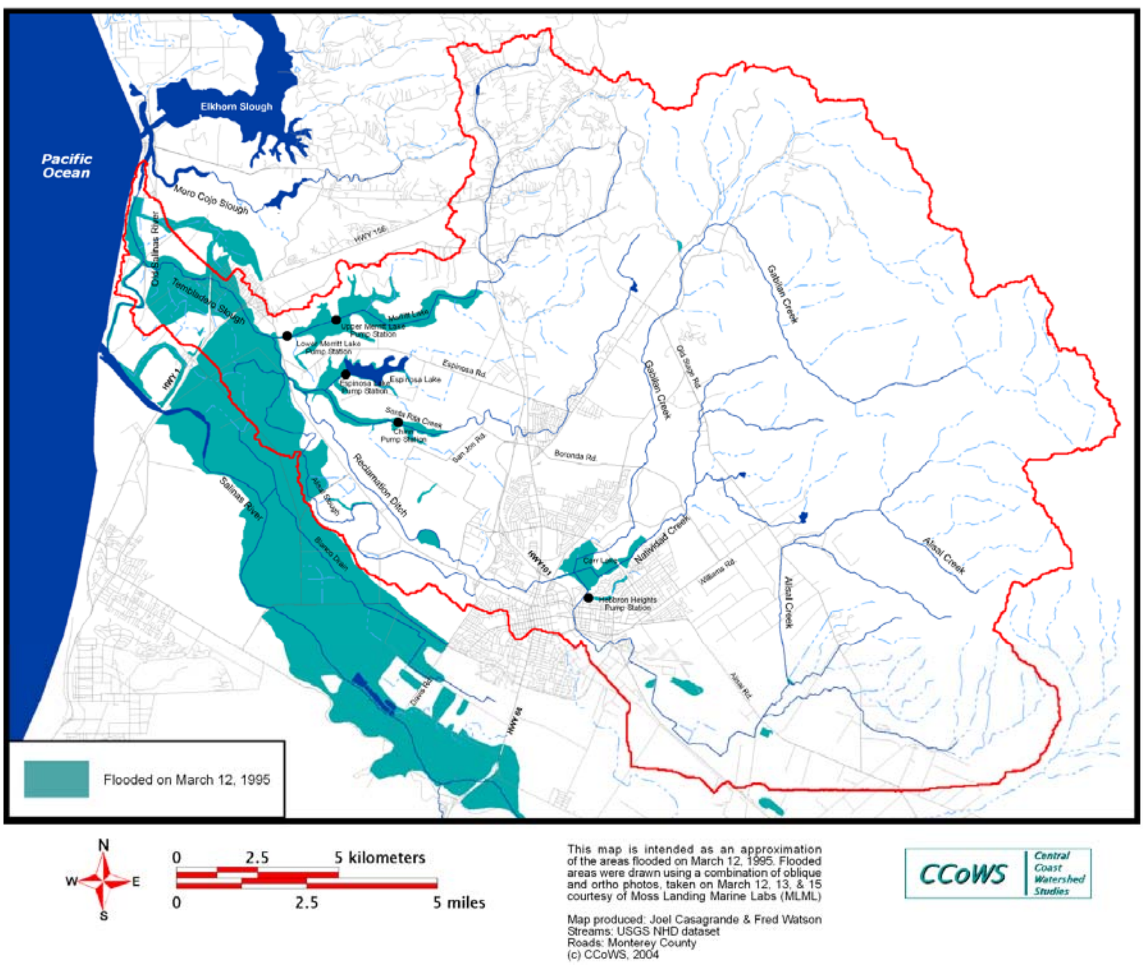


Figure 2.2 Flooded areas of the Northern Salinas River Valley and Reclamation Ditch Watershed at the peak of the flood on March 12, 1995. Reproduced from Casagrande and Watson, 2006a.

Reclamation Ditch and the Salinas River (Fig 2.2). This caused Tembladero Slough and the Reclamation Ditch (already at or near capacity) to backup, flooding both the Espinosa and the Merritt Lake drainages to the north. Further east, Carr and Heinz Lakes were partially filled due to heavy runoff from the Gabilan, Natividad and Alisal drainages (Fig 2.2).

During the winter of 1998, the city of Salinas received 30.1 inches of rain (second highest total on record). Gabilan Creek peaked at 1,035 cfs, a 25-year event and the highest level since records began in 1970. Carr Lake reached an elevation of 42.9 feet, flooding the Sherwood Lake Mobile Home Park for 11 days and reaching 0.1 feet from flooding a home situated on one of the raised "island" areas within the lake bed. While physical property damage was not significant, damage to fields and the drainage system itself were substantial.

2.4 Impacts to Carr Lake from Future Upstream Developments

Future developments upstream of the current City boundary (north of Boronda Rd and east of Williams Rd) are likely to increase runoff into the storm water system due to increases in the amount of impervious surfaces (Dunne and Leopold, 1978). The amount of additional runoff to the storm water system will ultimately depend on the extent of impervious surfaces, and whether or not management practices (e.g. detention basins, percolation basins) are constructed throughout the developments that will help reduce or slow down the amount of runoff entering the system (SWCCE, 2002; USEPA, 2004; Sayre et al. 2006).

SWCCE (2002) estimated that as of 2002, 4,372 acres of impermeable surface exists in the Carr Lake watershed. They predicted that a 66% increase in impervious surfaces (7,265 acres) would result in a 9% increase in peak flows entering Carr Lake during a 10-year event and 4% increase during a 100-year event. They also cautioned that these percentages could be greater during periods with frequent events (such as those witnessed in February 1998). SWCCE (2002) noted that the use of smaller detention basins and sediment catch-basins scattered throughout the developments could improve these percentages.

An indirect benefit of the future upstream land use conversion from predominantly row crop agriculture to suburban residential land will be reduced sediment sources from farm lands. While storm water runoff is likely to increase, sources of suspended sediment and bedload (sand and gravel) should be reduced from these lands (Charbonneau and Kondolf, 1993; Woodward and Foster, 1997).

The City of Salinas's Storm Water Master Plan (CDM, 2004) notes that current sediment loading into the storm drain system from agricultural lands upstream of Boronda Road and Williams Rd presents a "major drainage problem" and that during high runoff events the "agricultural runoff also affects private properties". SWCCE (2002) also remarks that efforts should be made to reduce sediment inputs from upstream sources prior to implementing any project in Carr Lake.

3 Water Quality

Recently, several reports have documented impaired water quality conditions in the Gabilan Watershed (Worcester, 2000; Casagrande, 2001; Watson et al. 2003; Anderson et al. 2003; Kozlowski et al. 2004a,b; and Hoover, 2006). Casagrande and Watson (2006a) provide a review of most of these documents. The overall degradation of water quality throughout the region has resulted in the listing of several waterways on the State Water Board's 303d list of impaired water bodies (Table 3.1). These listings are due to the adverse impacts imposed on the water bodies' beneficial uses (Table 3.2) as outlined in the Basin Plan (CCRWQCB, 1994). The following Section introduces and outlines past and present monitoring activities in the Gabilan Watershed (with an emphasis on monitoring sites that are near the Carr Lake Watershed), and discusses potential impacts from upstream developments.

3.1 Review of Current Data Sources and Monitoring Timeline

Recent water quality data (1999-2006) have been collected by various groups (Table 3.3) with varying degrees of spatial and temporal overlap (Figs. 3.1 & 3.2). The groups include the Central Coast Watershed Studies team (CCoWS), the Central Coast Ambient Monitoring Program (CCAMP), the City of Salinas, University of California Santa Cruz (UCSC), the Monterey Bay Sanctuary Citizen Watershed Monitoring Network (MBSCWMN), and Central Coast Water Quality Preservation Inc. (CCWQPI) which is part of the regional Ag Waiver Program. Figure 3.2 shows the location of water quality monitoring sites sampled by each group, Figure 3.1 illustrates the temporal variation of sampling efforts by different groups and Table 3.3 lists the parameters collected by each group.

Overall, the combined data set is limited both spatially and temporally, with a lack of consistent monitoring following the end of 2003. Specifically, very little monitoring has occurred in Alisal Creek (2nd largest sub-watershed draining to Carr Lake), especially during storms. The overall data set does not sufficiently cover large storm events (Fig 3.1). Long-term seasonal and storm-based monitoring of urban sources (storm drains) is needed to better understand sources of pollutants and loads from purely urban areas.

CCAMP is a region-wide water quality monitoring program funded and executed by the Central Coast Regional Water Quality Control Board for the purpose of providing sound scientific data to assist in the regulation and restoration of the region's water ways and their beneficial uses. Monitoring efforts across the region are divided into hydrologic units (watershed areas) on an approximate 5-year rotation sampling period. Sites in the Gabilan Watershed were last sampled between February 1999 and February 2000 (Worcester, 2000; See also http://www.ccamp.org/).

Table 3.1 State Water Board listed 303d listed water bodies within the Gabilan Watershed, their listing, and estimated area affected. * Receiving water bodies downstream of the Gabilan Watershed. Source: http://www.swrcb.ca.gov/tmdl/docs/303dlists2006/final/r3_final303dlist.pdf

Water Body	Pollutant/Stressor	Estimated Size Affected
Alisal Creek	Fecal Coliform	7.4 miles
	Nitrate as Nitrate (NO3)	7.4 miles
Gabilan Creek	Fecal Coliform	6.4 miles
	Nitrate as Nitrate (NO3)	6.4 miles
Natividad Creek	Nitrate as Nitrate (NO3)	7 miles
Salinas Reclamation Canal	Ammonia (unionized)	14 miles
	Fecal Coliform	14 miles
	Low Dissolved Oxygen	14 miles
	Pesticides	14 miles
	Priority Organics	14 miles
Tembladero Slough	Ammonia (unionized)	5 miles
	Fecal Coliform	5 miles
	Nutrients	5 miles
	Pesticides	5 miles
Old Salinas Estuary	Ammonia (unionized)	74 acres
	Fecal Coliform	74 acres
	Low Dissolved Oxygen	74 acres
	Nutrients	74 acres
	Pesticides	74 acres
Moss Landing Harbor*	Pathogens	79 acres
	Pesticides	79 acres
	Sedimentation/siltation	79 acres
Elkhorn Slough*	Pathogens	2034 acres
	Pesticides	2034 acres
	Sedimentation/siltation	2034 acres

Table 3.2 Current beneficial uses found in the Gabilan Watershed and downstream* waters. Source: CCRWQCB, 1994. Note: Possible addition for COLD in Gabilan Creek is based on the presence of *Oncorhynchus mykiss* (steelhead/rainbow trout) and COLD water quality conditions in upper Gabilan Creek documented by Hager, 2001 and MIGR was added to Tembladero Slough and the Salinas Reclamation Canal due to the potential of a steelhead population in the Gabilan Watershed that would require migration to a from spawning habitat.

Water Body	CODE	Beneficial Use	Possible Additions
Alisal Creek	MUN	Municiple Supply	
	AGR	Agricutlural Supply	
	GWR	Ground Water Recharge	
	REC1	Water Contact Recreation	
	REC2	Non-contact Water Recreation	
	WILD	Wildlife Habitat	
	COLD	Cold Freshwater Habitat	
	WARM	Warm Freshwater Habitat	
	SPWN	Spawning, Reproduction, and/or Development	
	COMM	Commercial Sport Fishing	
Gabilan Creek	MUN	Municiple Supply	COLD
	AGR	Agricutlural Supply	
	GWR	Ground Water Recharge	
	REC1	Water Contact Recreation	
	REC2	Non-contact Water Recreation	
	WILD	Wildlife Habitat	
	WARM	Warm Freshwater Habitat	
	SPWN	Spawning, Reproduction, and/or Development	
	COMM	Commercial Sport Fishing	
Salinas Reclamation Canal (a.k.a Reclamation Ditch)	REC1	Water Contact Recreation	MIGR
	REC2	Non-contact Water Recreation	
	WILD	Wildlife Habitat	
	WARM	Warm Freshwater Habitat	
	COMM	Commercial Sport Fishing	
Tembladero Slough	REC1	Water Contact Recreation	MIGR
	REC2	Non-contact Water Recreation	
	WILD	Wildlife Habitat	
	WARM	Warm Freshwater Habitat	
	COMM	Commercial Sport Fishing	
Old Salinas Estuary	REC1	Water Contact Recreation	
	REC2	Non-contact Water Recreation	
	WILD	Wildlife Habitat	
	COLD	Cold Freshwater Habitat	
	WARM	Warm Freshwater Habitat	
	MIGR	Migration of Aquatic Organisms	
	SPWN	Spawning, Reproduction, and/or Development	
	BIOL	Preservation of Biological Habitats of Special Significance	
	RARE	Rare, Threatened, Endangered Species	
	EST	Estuarine Habitat	
	COMM	Commercial Sport Fishing	
Moss Landing Harbor*	IND	Industrial Service Supply	
	REC1	Water Contact Recreation	
	REC2	Non-contact Water Recreation	
	WILD	Wildlife Habitat	
	RARE	Rare, Threatened, Endangered Species	
	NAV	Navigation	
	COMM	Commercial Sport Fishing	
Elkhorn Slough*	REC1	Water Contact Recreation	
	REC2	Non-contact Water Recreation	
	WILD	Wildlife Habitat	
	COLD	Cold Freshwater Habitat	
	WARM	Warm Freshwater Habitat	
	MIGR	Migration of Aquatic Organisms	
	SPWN	Spawning, Reproduction, and/or Development	
	BIOL	Preservation of Biological Habitats of Special Significance	
	RARE	Rare, Threatened, Endangered Species	
	EST	Estuarine Habitat	
	NAV	Navigation	
	COMM	Commercial Sport Fishing	
	AQUA	Aquaculture	
	SHELL	Shellfish Harvesting	
	MAR	Marine Habitat	

The CCoWS team has been monitoring water quality at over 20 sites in the Gabilan Watershed since March 2000 with two major sampling campaigns (Fig 3.1). The first campaign was done as part of the greater Salinas River Valley Total Maximum Daily Load (TMDL) study (Watson el al. 2003). Eleven monitoring sites throughout Gabilan Creek, its upper tributaries, and the Reclamation Ditch were sampled for suspended sediment, bedload and nutrients (Watson et al. 2003; Anderson et al. 2003). The second sampling campaign was part of a pesticide study, sponsored by the Department of Pesticide Regulation (DPR), which had four monitoring sites in the lower Gabilan Watershed, including one site on the Reclamation Ditch (Kozlowski et al. 2004a).

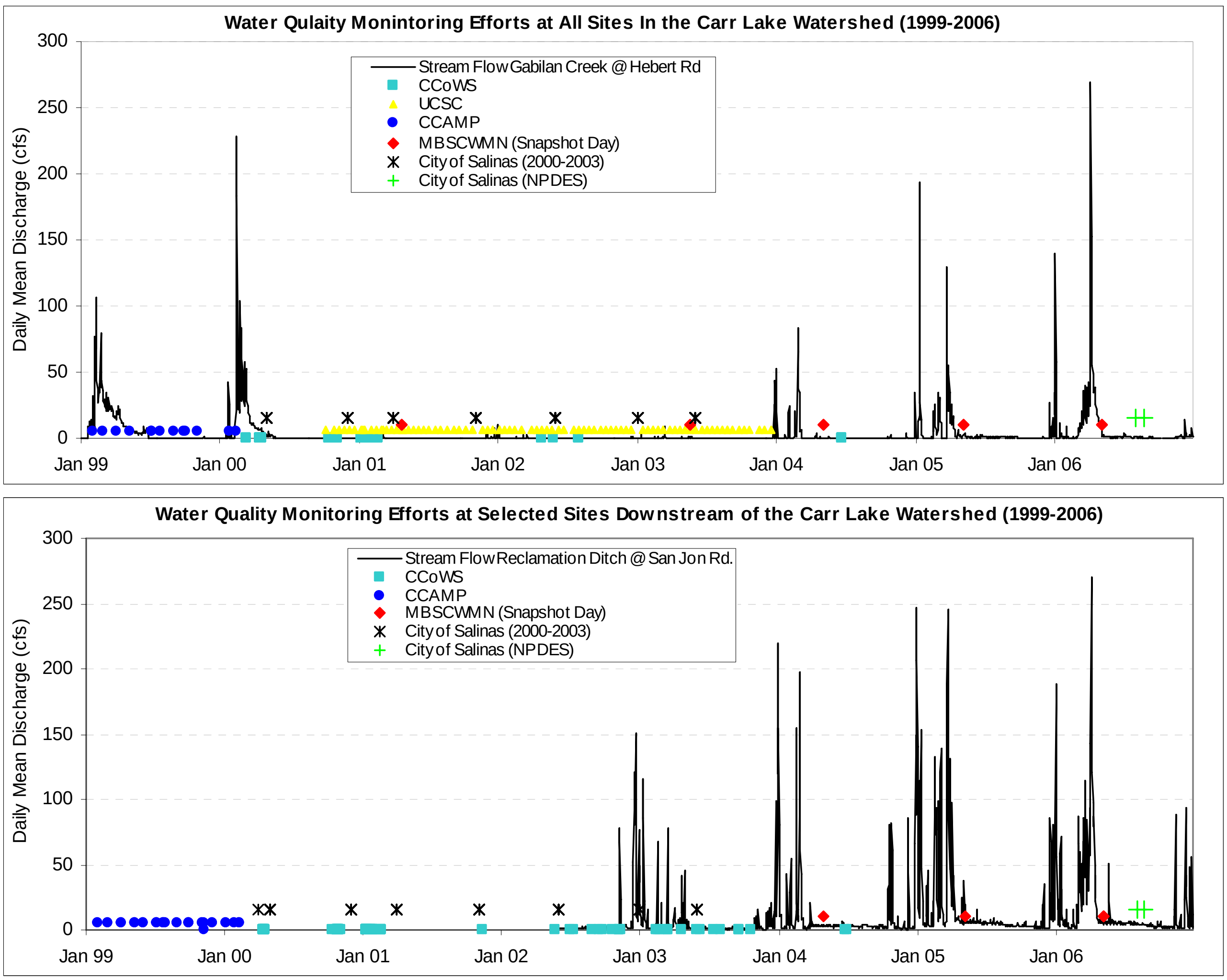


Figure 3.1 Hydrographs for Gabilan Creek and the Rec. Ditch showing the time and frequency of monitoring efforts by each group. Sites monitored upstream of Carr Lake are represented by the Gabilan Creek hydrograph while sites downstream of Carr Lake are represented by the Rec. Ditch hydrograph (note: Rec Ditch gage was offline between 1986 and June 1, 2002). Note: lack of monitoring during large storm events (2004 – present).

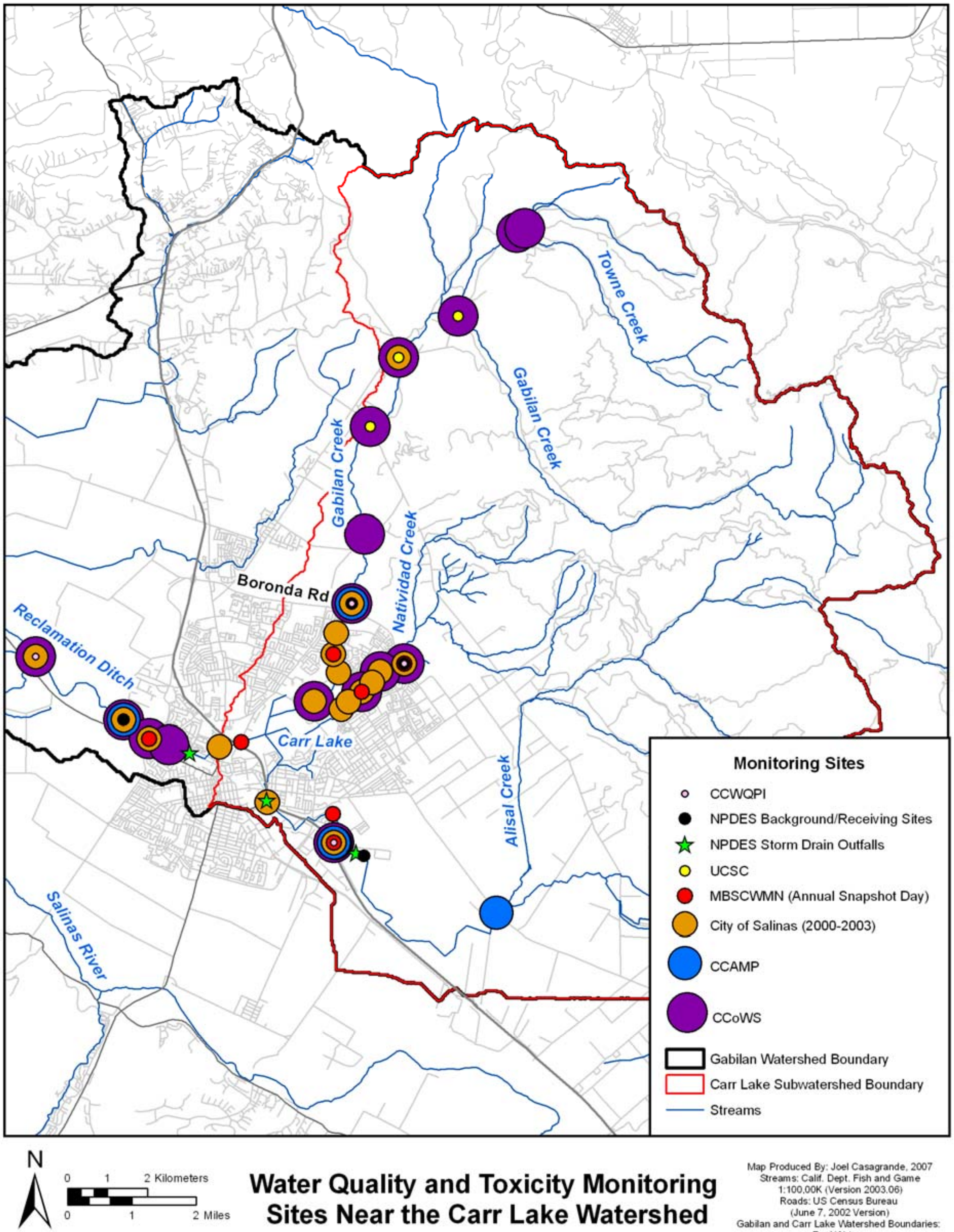


Figure 3.2 Selected monitoring sites for monitoring groups (1999–2006).

Table 3.3 Water quality parameters monitored by each group (2000-2006).

		Monitoring Group						
Parameters		CCoWS	CCAMP	City Of Salinas (2000 - 2003)	City Of Salinas (NPDES)	UCSC	MBSCWMN (Snapshot Day)	CCWQPI
	Water Temperature	X	X	X	X	X	X	X
	Dissolved Oxygen	X	X	X		X	X	X
	pH	X	X	X		X	X	X
	SSC	X	X	X				X
	Bedload	X						
	Turbidity	X		X	X			X
	Conductivity		X	X	X		X	
Nutrients	Nitrate	X	X	X		X	X	X
	Ammonia (Total)	X	X	X				X
	Ammonia (Unionized)		X	X	X			
	O-phosphate	X	X	X	X	X	X	X
	Chlorophyll-a		X	X				X
	Chlorine				X			
	Detergents				X			
Coliform	Total Coliform		X	X				
	Fecal Coliform		X	X				
	E Coli						X	
Pesticides	Diazinon	X						
	Chlorpyrifos	X						
	Legacy Pesticides	X	X					
	Metals		X					

The Center for Agroecology and Sustainable Food Systems at the University of California, Santa Cruz collected biweekly water quality data at three sites on upper Gabilan Creek between October 2000 and December 2003 (http://casfs.ucsc.edu/). The three sites are found in the lower foothill region of the Watershed which is used predominantly as grazing lands with strawberry production increasing downstream.

Granite Canyon Laboratories (part of UC Davis) have sampled organophosphate pesticides, organochlorine and carbamate pesticides, polycyclic aromatic hydrocarbons (PAH's), polychlorinated biphenyls (PCB's), trace metals in the region (Anderson et al. 2003). Their 2003 paper (Hunt et al. 2003) lists sampling of chlorpyrifos and diazinon at an unstated site on the Reclamation Ditch downstream of the City of Salinas.

Between 2000 and 2003, the City of Salinas monitored a variety of water quality parameters biannually at 21 different sites in the Gabilan Watershed, of which 17 are within or just downstream of the Carr Lake Watershed. Data were usually collected twice per year, typically during spring/early summer (April-June) and in late fall/early winter (November-January). Sites included Gabilan and Natividad Creeks at Boronda Road (upstream urban boundary), several sites on both creeks within the City limits, and several sites on the Reclamation Ditch, including the upstream and downstream urban boundaries.

In 2006 the City of Salinas consulted with Pacific EcoRisk to monitor water quality discharged from city storm drains and to conduct bioassays and benthic macroinvertebrate sampling in both receiving (downstream) and background (upstream) water bodies as part of their NPDES Storm Water Program Permit (COS, 2006a; 2006b). NPDES requirements include 4 dry-weather screenings of selected urban discharge sites in addition to a screening of 20% of its storm drain outfalls annually. In August 2006, three storm drain outfalls were sampled along the Reclamation Ditch during two separate monitoring events. Also, bioassay tests (green algae and water flea) were conducted at 4 sites (3 background and 1 receiving). Agricultural background sites were in Gabilan and Natividad creeks at Boronda Rd and the urban background site was in the Reclamation Ditch near Airport Rd (Fig 3.2). The receiving water body site was in the Reclamation Ditch near Boronda Rd - just west of the City limits.

Snapshot Day, a monitoring program run by the MBSCWMN, has occurred on Earth Day each year since 2000. The list of monitoring sites has increased since 2000 and now includes 7 monitoring sites in the Carr Lake vicinity including sites on Gabilan and Natividad creeks and the Reclamation Ditch (Hoover, 2006).

As part of the "Ag Waiver" Program mandated by the Central Coast Regional Water Quality Control Board, the CCWQPI collects water quality at a number of sites throughout the Central Coast Region, including 3 sites in the Carr Lake Watershed. Monitoring, which includes monthly sampling of a variety of constituents at these sites in addition to extensive on-farm monitoring, began in January of 2005. Specific dates and data were not public at the time of preparation of this report.

3.2 Review of Recent Water Quality Trends and Results

3.2.1 General Trends

Water quality conditions in the upper watershed (i.e. east of Old Stage Rd) typically meet all standards and regional water quality objectives (Casagrande and Watson, 2006a). These lands are relatively undeveloped and are used predominantly for cattle grazing and park lands with some strawberry production.

On the valley floor, water quality conditions vary, but generally are degraded due to the intensive agriculture and urban land uses that exist there (Casagrande and Watson, 2006a; Hoover, 2006). In summer, where water is present, dissolved oxygen, nutrient, suspended sediment, and fecal coliform concentrations commonly exceed or do not meet established water quality objectives (CCRWQCB, 1994; Casagrande and Watson, 2006a; COS, 2006b).

In winter, water temperatures typically meet objectives although high suspended sediment (> 500 mg/L) and nutrient concentrations are common, especially downstream of intensive agriculture and grazing areas (Casagrande, 2001; Anderson et al. 2003). Data collected by the City of Salinas, CCAMP and MBSCWMN show that levels of fecal coliform in the Reclamation Ditch are consistently high, especially in winter. Fecal coliform indicators are also a concern in lower Natividad Creek (Casagrande and Watson, 2006a).

Data collected each spring by the MBSCWMN between 2000 and 2006 show that Natividad Creek and the Reclamation Ditch continue to be ‘Areas of Concern’ due to multiple exceedances of different water quality parameters (Hoover, 2006). The ‘Areas of Concern’ designation was given because a monitoring site on these water bodies exceeded three of the seven water quality parameters measured by the monitoring program. Natividad Creek has been designated ‘Areas of Concern’ six consecutive years and the Reclamation Ditch has received this designation each year it has been monitored (last three years).

3.2.2 Suspended Sediment, Nutrients and Fecal Coliform

Storm-based runoff data collected by CCoWS in 2000 and 2001 showed that high suspended sediment concentrations (SSC) occur in Gabilan Creek, with concentrations increasing downstream towards the City limits at Boronda Rd. (Casagrande, 2001). Bedload increased substantially downstream of areas with intensive strawberry production and cattle grazing (Casagrande, 2001). The pattern of sediment sources and sinks along Gabilan Creek most likely varies strongly with the size of storm events. The events monitored by CCoWS were significantly smaller than more recent events (Fig 3.1).

Nutrient concentrations (nitrate NO3-N, ammonia NH3-N, and orthophosphate-PO4-P) measured by CCoWS showed a similar pattern - increasing concentrations downstream of intensive agriculture (Anderson et al. 2003). The upper-most site on Towne Creek (tributary to Gabilan Creek), which is dominated by natural woodlands and light cattle grazing, consistently had low nutrient and suspended sediment concentrations. One site on a small tributary draining cattle grazing lands had very high ammonia concentrations, which is consistent with influences from cattle urine. Further downstream strawberry and vegetable production increases as does the concentrations of nutrients. Within the City limits, nutrients were monitored at Veteran's Park, just upstream of Carr Lake. Nitrate concentrations were high, even when the only runoff present was from urban sources.

Data collected by the City of Salinas (2000-2003) also showed high concentrations of nitrate in both Gabilan and Natividad Creek during summer monitoring events. Suspended sediment concentrations from Gabilan Creek at Boronda Rd were consistently high, but especially high during June 2002 and 2003 when concentrations were 2,060 mg/L and 2,390 mg/L respectively. The only source of water at this time of year is irrigation runoff from adjacent agricultural fields.

Using data collected by CCAMP, water body averages for nutrients (nitrate, ammonia, and phosphate), suspended sediment, and fecal coliform for sites in the Gabilan Watershed ranked in the upper quartile of all sites monitored in Central Coast Region (total of 121 sites) (Casagrande and Watson, 2006a). For fecal coliform, 5 of the top 20 water bodies were found in the Gabilan Watershed, with the highest (out of 121 sites) occurring in the Reclamation Ditch.

Recent data collected as part of the City's NPDES permit from three urban storm drains were compared to objectives stated in the Basin Plan (1994) and/or action levels set by CCAMP. The comparisons from both events resulted in following number of exceedances - 1 site for un-ionized ammonia, 3 for sites for orthophosphate and 1 for pH. Some of the sources contributing to these exceedances were investigated by City staff and corrected soon after (COS, 2006b).

Results from the City's green algae (*Selenastrum capriconutum*) bioassays showed that urban discharge waters were not toxic with respect to inhibition of growth or survival of *S. capriconutum* at any sites during both events (COS, 2006b). For the water flea (*Ceriodaphnia dubia*) bioassays, all but the Gabilan Creek background site had significant reductions in *C. dubia* during both events (the Gabilan Creek background site was dry during the second event (COS, 2006b). Pacific EcoRisk (COS, 2006b) concluded that waters coming into the City from the Alisal and Natividad Creek drainages were already impaired and therefore reductions in *C. dubia* at the receiving water site could not be directly related to urban sources.

Pacific EcoRisk conducted two additional tests at the end of September and October of 2006 but these results have not yet been released (COS, 2006b). Also, results from the annual monitoring of 20% of the City's storm drains and the benthic macroinvertebrate collections have not yet been released.

3.2.3 Pesticides and Legacy Pesticides

Pesticides and legacy pesticides have been documented in surface waters, bottom sediment, and tissues of aquatic organisms from several water bodies in the Gabilan Watershed over the past 30 years.

Starting in the 1980's, the State Water Resource Control Board's State Mussel Watch and Toxic Substances Monitoring Programs have documented pesticides (including diazinon and chlorpyrifos), legacy pesticides (DDT and its metabolites), PCB's, and metals from waters, sediments and organism tissues on multiple occasions at sites throughout the lower Gabilan Watershed (SWRCB, 1999a,b). These data ultimately led to the "Toxic Hot Spot" listing for Moss Landing Harbor and its tributaries (i.e. Tembladero Slough, Old Salinas River Channel, and the Reclamation Ditch) by the State Water Resource Control Board in 1999 (SWRCB, 1999a,b).

During ambient conditions in 1999, CCAMP measured p,p'-DDE above 35 μg/kg in sediments from Gabilan Creek at Boronda Rd and above 5 μg/kg at two sites in the Reclamation Ditch indicating these pollutants are present in water ways draining into and out of Carr Lake (Worcester et al. 2000). The CCAMP action and attention levels for p.p'-DDT in sediments are 0.00158 and 0.0461 μg/kg respectively and for p.p'-DDE they are 0.0022 and 0.027 μg/kg (Worcester, 2000).

In 2002 and 2003, CCoWS monitored two insecticides, diazinon and chlorpyrifos, at nine sites in the lower Gabilan Watershed and adjacent waterways (i.e. downstream of the Carr Lake watershed) (Kozlowski et al. 2004a). Concentrations were sampled from the water column (filtered), suspended sediments within the water column, and from bottom sediments during storm and ambient conditions. Median total water column pesticide concentrations (TPC) for diazinon and chlorpyrifos were above CDFG objectives at all sites.

4 Biological Resources

4.1 Recent Species Observations

4.1.1 Fisheries

Recently, a total of nineteen species of fish have been observed in the Gabilan Watershed, of which eight are native (Table 4.1). All but three of these species were observed using waters immediately adjacent to Carr Lake (Upper Carr Lake) or they had migrated through the Lake. Adult steelhead (*Oncorhynchus mykiss*) and chinook salmon (*Oncorhynchus tshawytscha*) have been documented recently in stream reaches upstream of Carr Lake. Adult chinook salmon, non-native to the drainage, were found just upstream of Carr Lake in all three major drainages during the winters of 2005 and 2006 (Table 4.1). These fish were strays that likely originated from aquaculture pens in Moss Landing or Santa Cruz harbors. The history of steelhead use in the Watershed is unclear and discussed in further detail below.

A majority of the fish species observations were made during two recent events: 1) a large fish kill in the Old Salinas River Channel and Tembladero Slough in the summer of 2002 (CDFG, 2002); and 2) during a fish rescue and relocation effort in July of 2003 conducted as part of the restoration Upper Carr Lake.

4.1.2 Amphibians and Reptiles

A total of thirteen species of amphibians and reptiles have been observed recently, of which, nine have been observed in Carr Lake or in areas immediately adjacent to the lake (See Appendix B Table 4.2). The occurrence of sensitive amphibian and reptile species is discussed below.

4.1.3 Birds and Mammals

The relatively un-developed Gabilan Range provides habitat for a host of bird and mammal species including megafauna such as mountain lions, mule deer, and a re-introduced herd of tule elk (Casagrande and Watson, 2006a). Downstream, agriculture and urban developments have replaced much of the habitat for these species and have encroached upon or removed riparian vegetation along most waterways (Casagrande and Watson 2006a. A January 2007 winter bird count at Upper Carr Lake resulted in 55 bird species (Lienk, 2007).

4.2 Sensitive Animal Species

The California Natural Diversity Database (CNDDB) contains several records for sensitive species in the Gabilan Watershed and surrounding areas, with a majority occurring on less developed lands outside of the Watershed (Fig 4.1). As of July 2005, the CNDDB contains records for 0 endangered animals, 3 threatened animals, and 7 Species of Special Concern (SC) in the Gabilan

Watershed. Of these, 2 threatened and 4 SC have been observed near Carr Lake. The two threatened species are the California tiger salamander and California red-legged frog and the SC are four bird species, Cooper's hawk (*Accipiter cooperii*), tricolored blackbird (*Agelaius tricolor*), burrowing owl (*Athene cunicularia*), and the California horned lark (*Eremophila alpestris actia*). Below we briefly discuss some of the occurrence of some of these species, primarily the fish and amphibians. Additional observations not included in the CNDDB (see Fig 4.1) are discussed as well.

4.2.1 Steelhead

Steelhead are the ocean-going, or anadromous, form of rainbow trout (*Oncorhynchus mykiss*). Recently, *O. mykiss* have been documented in the headwaters of Gabilan Creek (Hager, 2001), although it remains unclear if these were of the anadromous life-history type. In March 2004, a gravid adult female steelhead was found dead in Gabilan Creek approximately 1-2 km upstream of Carr Lake at the base of a concrete grade control structure. The fish was identified and deemed healthy by CDFG staff and died because it was unable to navigate the structure (See Casagrande and Watson, 2006a for complete details). In early 2006, two adult chinook salmon were found dead at the base of the same structure.

Gabilan Creek was officially designated as Critical Habitat for steelhead[1] by NOAA Fisheries in 2005 as part of the South-Central California Coast Evolutionary Significant Unit (ESU). The habitat listing was based on Gabilan's proximity to the Salinas River drainage, the presence of *O. mykiss* in upper Gabilan Creek, the recent finding of the dead adult gravid female, and several other recent anecdotes. To date studies have not been conducted to determine whether or not an anadromous population exists in the watershed.

While spawning and rearing habitat exists in the upper watershed (Hager, 2001) limiting factors present in the Gabilan Watershed include several migration barriers on Gabilan Creek, low stream flow duration during migration, and degraded water quality conditions downstream.

4.2.2 California Red-legged Frog

As of July 2005, the CNDDB had three accounts of California red-legged frog (RLF) (*Rana aurora draytonii*) in the Gabilan Watershed. Two are in the Prunedale area on a tributary to Merritt Lake and the third and closest in proximity to Carr Lake, is on a tributary to Natividad Creek near Old Stage Rd (Fig). In addition, Watershed Institute staff observed an adult red-legged frog at a pond in the Gabilan Range near Fremont Peak State Park (Casagrande and Watson, 2006a).

[1] Federal Register for September 2, 2005, available @
http://www.nwr.noaa.gov/Publications/FR-Notices/2005/upload/70FR52573.pdf

The current presence of bullfrogs and predatory fish in Upper Carr Lake limits habitat use for RLF in the Carr Lake basin. Management of these non-native species should be considered.

4.2.3 California Tiger Salamander

The CNDDB contains several records for California tiger salamander (CTS) in the Gabilan Watershed (Fig 4.1). One of the records dates back to 1952 near the western most edge of Carr Lake, although the exact location is not known. Other records in the CNDDB occur in less developed areas of the watershed near Prunedale and Moro Cojo Slough (Fig 4.1). Three recent records (2 from 2004 and 1 from 2002) exist in the Natividad Creek drainage in the same proximity as the red-legged frog observations. Bullfrogs and predatory fish also limit habitat use for CTS in the Carr Lake basin.

4.2.4 Southwestern Pond Turtle

One southwestern pond turtle (*Clemmys marmorata pallida*) was captured during a fish rescue/relocation effort as part of the restoration of the Upper Carr Lake. One turtle was also observed in a pond on lands proposed for the Rancho San Juan Development (Casagrande and Watson, 2006a; PDC, 2004).

4.2.5 Burrowing Owl

Burrowing owls (*Athene cunicularia hypugea*) have been observed at multiple sites in the Carr Lake vicinity. Sites include the Upper Carr Lake area and along the banks of the Reclamation Ditch below Carr Lake. Other records in the CNDDB include sites near the Salinas Municipal Airport and at two locations located in the western and northern-most fringes of the City boundaries (Fig 4.1).

4.3 Sensitive Plant Species

The CNDDB contains records for several sensitive plant species in the Gabilan Watershed and surrounding areas with most occurring on less developed areas outside the Watershed (Fig 4.2). Two sensitive plant species are found in the Carr Lake vicinity. Both species Congdon's tarplant (*Centromadia parryi ssp. congdonii*) and alkali milk-vetch (*Astragalus tener var. tener*) are listed as federal Species of Special Concern. The CNDDB (Fig 4.2) shows that Congdon's tarplant was recently observed in Natividad Creek Park and the Upper Carr Lake area.

Table 4.1 Fish species sited in the Gabilan Watershed (2000-2006). Reproduced and updated from Casagrande and Watson, 2006. *denotes species that were observed in close proximity to, or migrating through, Carr Lake.

Common Name	Scientific Name	Origin	Location(s)	Source (s)
rainbow trout/steelhead*	*Oncorhynchus mykiss*	Native	- Gabilan Creek (Upstream of Old Stage Rd Crossing and just downstream of the crossing)- juvenile	Hager, 2001; Casagrande pers. observation.
			- Adult female (06 Mar 2004) Gabilan Creek nr Lexington Dr.	CDFG, 2004 (See Watson and Casagrande, 2006)
California roach*	*Lavinia symmetricus*	Native	- Gabilan Creek nr Veterans Park - Upper Carr Lake - Santa Rita Creek @ Van Buren Way	Casagrande pers. observation
hitch*	*Lavinia exilicauda*	Native	- Old Salinas River/Tembladero Slough/ Rec. Ditch	CDFG, 2002; Casagrande pers. observation
			- Upper Carr Lake	Casagrande pers. observation
Sacramento blackfish*	*Orthodon microlepidotus*	Native	- Old Salinas River/Tembladero Slough	CDFG, 2002
			- Upper Carr Lake	Casagrande pers. observation
Sacramento sucker*	*Catostomus occidentalis*	Native	- Old Salinas River/Tembladero Slough	CDFG, 2002
			- Upper Carr Lake	Casagrande pers. observation
Sacramento pikeminnow	*Ptychocheilus grandis*	Native	Old Salinas River/Tembladero Slough	CDFG, 2002
threespine stickleback*	*Gasterosteus aculeatus*	Native	- Upper Carr Lake - Gabilan Creek nr. Veterans Park	Casagrande pers. observation
sculpin (species not stated)	*Cottus spp.(likely sculpin)*	Native	Old Salinas River/Tembladero Slough	CDFG, 2002
chinook salmon*	*Oncorhynchus tshawytscha*	Non-native	- Gabilan Creek @ Lexington Drive	Casagrande pers observation (Jan 2006)
			- Reclamation Ditch (Alisal arm)	Documented in: *Salinas Californian* 15 Nov 2004
			- Upper Carr Lake	City of Salinas Staff (Feb 2006)
common carp*	*Cyprinus carpio*	Non-native	- Reclamation Ditch - Tembladero Slough - Old Salinas River - Upper Carr Lake	Casagrande pers. observation; CDFG, 2002
goldfish*	*Carassius auratus*	Non-native	- Upper Carr Lake	Casagrande pers. observation
			- Tembladero Slough	CDFG, 2002
golden shiner*	*Notemigonus chrysoleucas*	Non-native	Upper Carr Lake	Casagrande pers. observation
fathead minnow*	*Pimephales promelas*	Non-native	Upper Carr Lake	Casagrande pers. observation
bluegill*	*Lepomis macrochirus*	Non-native	- Upper Carr Lake	Casagrande pers. observation
			- Ranch pond (near headwaters of Gabilan Creek)	Gabilan Ranch Online
sunfish*	*Lepomis sp.*	Non-native	Upper Carr Lake	Casagrande pers. observation
largemouth bass*	*Micropterus salmoides*	Non-native	- Ranch pond (near headwaters of Gabilan Creek)	Gabilan Ranch Online; www.gabilanranch.com/ranchhistory.html
brown bullhead*	*Ameiurus nebulosus*	Non-native	Upper Carr Lake	Casagrande pers. observation
catfish (species not stated)	*Ictalurus spp.*	Non-native	Ranch pond (near headwaters of Gabilan Creek)	Gabilan Ranch Online; www.gabilanranch.com/ranchhistory.html
mosquitofish*	*Gambusia affinis*	Non-native	- Upper Carr Lake - Carr Lake - Espinosa Lake - Farm/Stock Ponds (General)	Casagrande pers. observation

Table 4.2 Amphibians and reptile species recently observed in the Gabilan Watershed and Carr Lake vicinity. * denotes species observed in or in close proximity to Carr Lake.

Common Name	Scientific Name	Origin	Location(s)	Source(s)
Pacific tree frog*	*Hyla regillia*	Native	Common throughout study area	Casagrande pers. observation
Red-legged frog	*Rana aurora draytonii*	Native	- Ranch pond near Fremont Peak State Park - Natividad Creek near Old Stage Rd.	Casagrande pers. observation CNDDB, 2005
Western toad*	*Bufo boreas*	Native	- Gabilan Creek near Boronda Road, near Crazy Horse Rd, near headwaters. - Upper Carr Lake - Carr Lake at center confluence	Casagrande pers. observation
bullfrog*	*Rana catesbeiana*	Non-Native	- Gabilan Creek near Veteran's Memorial Park - Upper Carr Lake	Casagrande pers. observation
Pacific giant salamander	*Dicamptodon tenebrosus*	Native	Farm pond near headwaters of Gabilan Creek	Casagrande pers. observation
western pond turtle*	*Clemmys marmorata*	Native	- Upper Carr Lake - Pond at the Crazy Horse Canyon Landfill	Casagrande pers. observation PDC, 2004
Western fence lizard*	*Sceloporus occidentalis*	Native	Common throughout study area	Casagrande pers. observation
Northern alligator Lizard*	*Elgaria coerulea coerulea*	Native	Common throughout study area	Watershed Institute Staff
Western aquatic garter snake*	*Thamnophis couchii*	Native	Gabilan Creek near Headwaters	Casagrande pers. observation
California red-sided garter snake	*Thamnophis sirtalis infernalis*	Native	Farm pond near headwaters of Gabilan Creek	Casagrande pers. observation
Pacific ring-necked snake*	*Diadophis punctatus vandenburghi*	Native	Gabilan Creek near Veteran's Memorial Park	Watershed Institute Staff
Pacific gopher snake*	*Pituophis catenifer catenifer*	Native	- Gabilan Creek at Hebert Road - Upper Carr Lake	Casagrande pers. observation Watershed Institute Staff
California tiger salamander	*Ambystoma tigrinum*	Native	Within proposed Rancho San Juan Development Vacinity	CNDDB, 2004; PDC, 2004

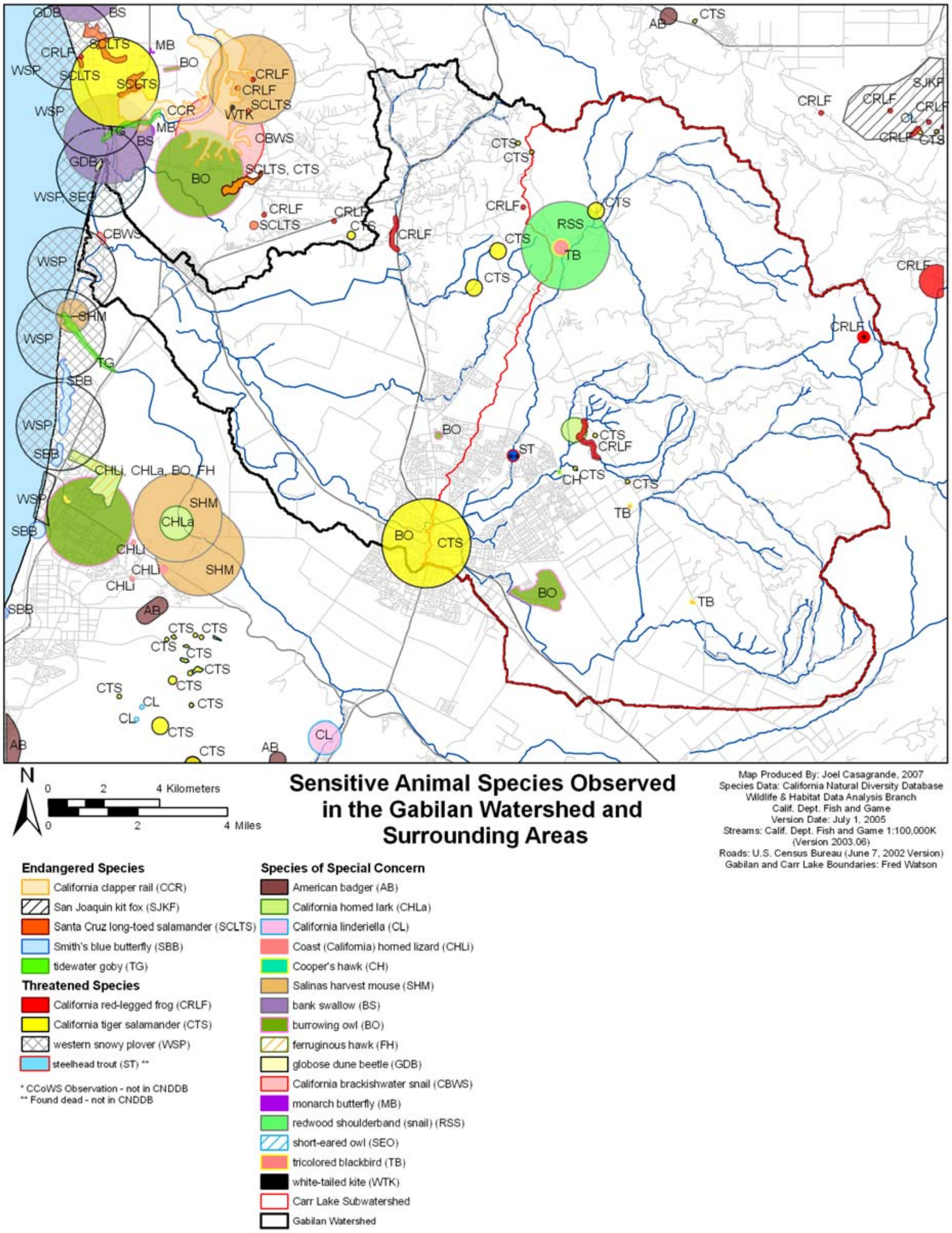


Figure 4.1 Sensitive animal species observed in the Gabilan Watershed and surrounding areas. Data Version Date: (July 1, 2005). Note: California red-legged frog observation from upper Gabilan Creek and dead steelhead not recorded in the CNDDB.

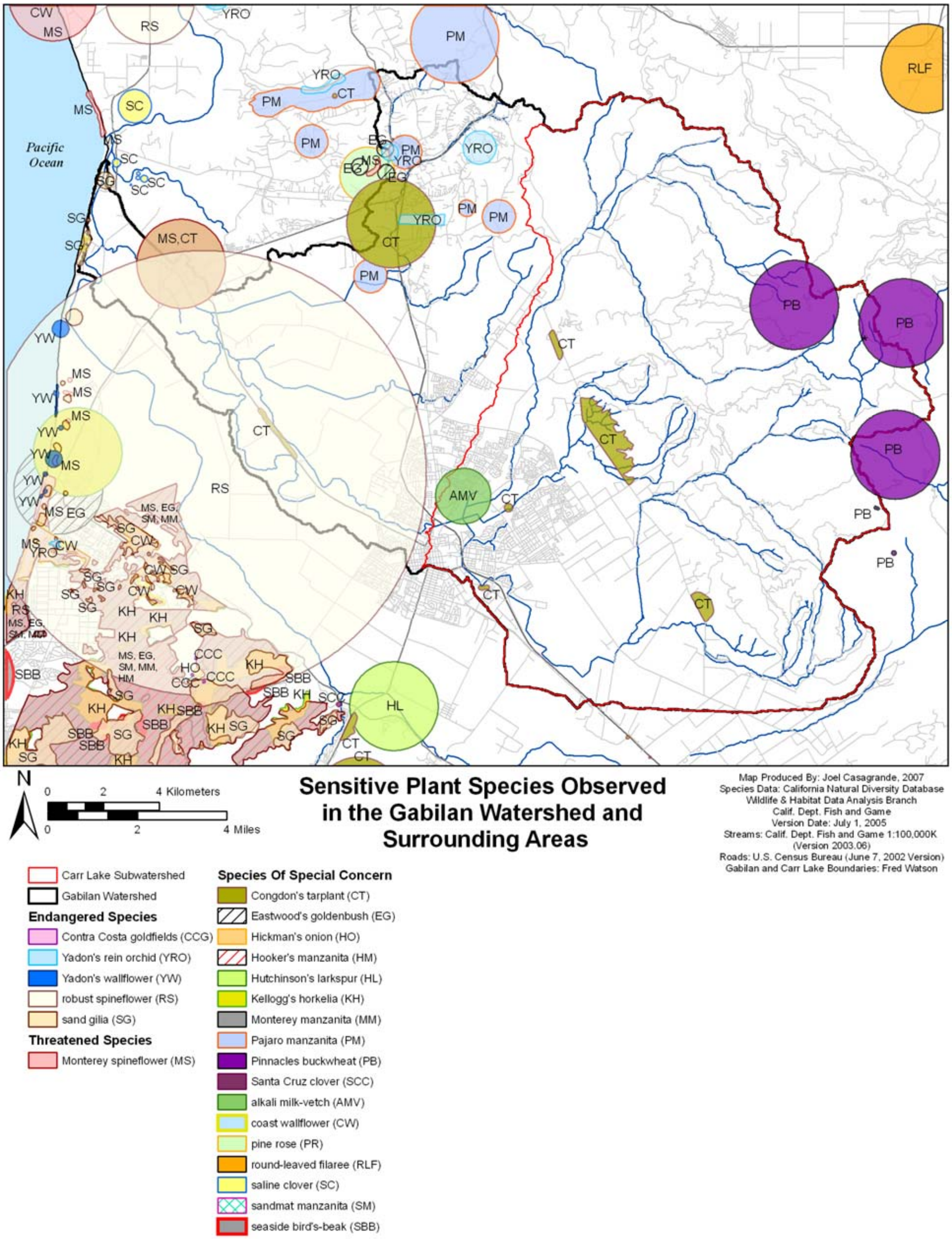


Figure 4.2 Sensitive plant species observed in the Gabilan Watershed and surrounding areas. Data Version Date: (July 1, 2005).

5 Benefits to Converting Carr Lake to a Multi-use Park

The following sections outline and discuss the likely bio-physical characteristics of what a multi use park at Carr Lake would include and how these characteristics may benefit flood control, wildlife habitat, water quality improvement, and the quality of life for the residents of Salinas.

5.1 Bio-physical Characteristics of a Converted Carr Lake

Figure 5.1 is a systems diagram that depicts the major bio-physical characteristics of a converted, multi-use Carr Lake park and their potential benefits. We recognize four essential biophysical characteristics as necessary components of a converted park in Carr Lake:

1. Land use conversion from mostly private agricultural lands to public park lands.
2. Widening of creek channels that traverse through the lake bed.
3. Addition of native riparian vegetation (in-channel and upland).
4. Construction of large detention ponds for peak storm water detention

A change in land use from privately owned agricultural lands to publicly accessible parks and open space areas has inherent benefits for the general public. Parks and open spaces in urban and suburban settings have been shown to have numerous beneficial qualities including improved property value for nearby homes (Geoghegan, 2002), ability to stimulate healthy activity through recreational opportunities (Bedimo-Rung et al. 2005), and the ability to improve the emotional psyche by providing views of natural landscapes (Kaplan, 2001). A change in land use in the basin would also reduce agricultural water pollution sources by removing agricultural practices from the lake bed. The Lake's (and park's) proximity would also serve as a connector to several other existing parks and could provide out-of-the-classroom educational opportunities for regional schools. See also Actions PK1 and PK2 in the Reclamation Ditch Watershed Management Strategy (Casagrande and Watson, 2006b).

Vegetative wetland treatment of water flowing through Carr Lake would likely have a beneficial effect on water quality. This postulate is supported both by general understanding of wetland function (Mitsch & Gooselink, 2000; Kadlec and Knight, 1996) and the few local studies that have been completed (e.g. Harris et al., 2007). Vegetation is currently limited in the Lake to crops and scattered weeds along the banks of the channels. Re-vegetation in combination with channel widening could improve the Lake's water quality treatment potential without necessarily compromising the passage of flood waters. An example design for this approach was prepared by Golder and Associates for the reach of Tembladero Slough passing by the City of Castroville (Golder Associates Inc., 2001). See also Actions WQ5 and WQ6 in the Reclamation Ditch Watershed Management Strategy (Casagrande and Watson, 2006b).

Vegetated riparian corridors provide other benefits to water quality and wildlife including habitat for special status species such as California red-legged frog and California tiger salamander. Benefits include channel shading, which helps to regulate water temperatures,

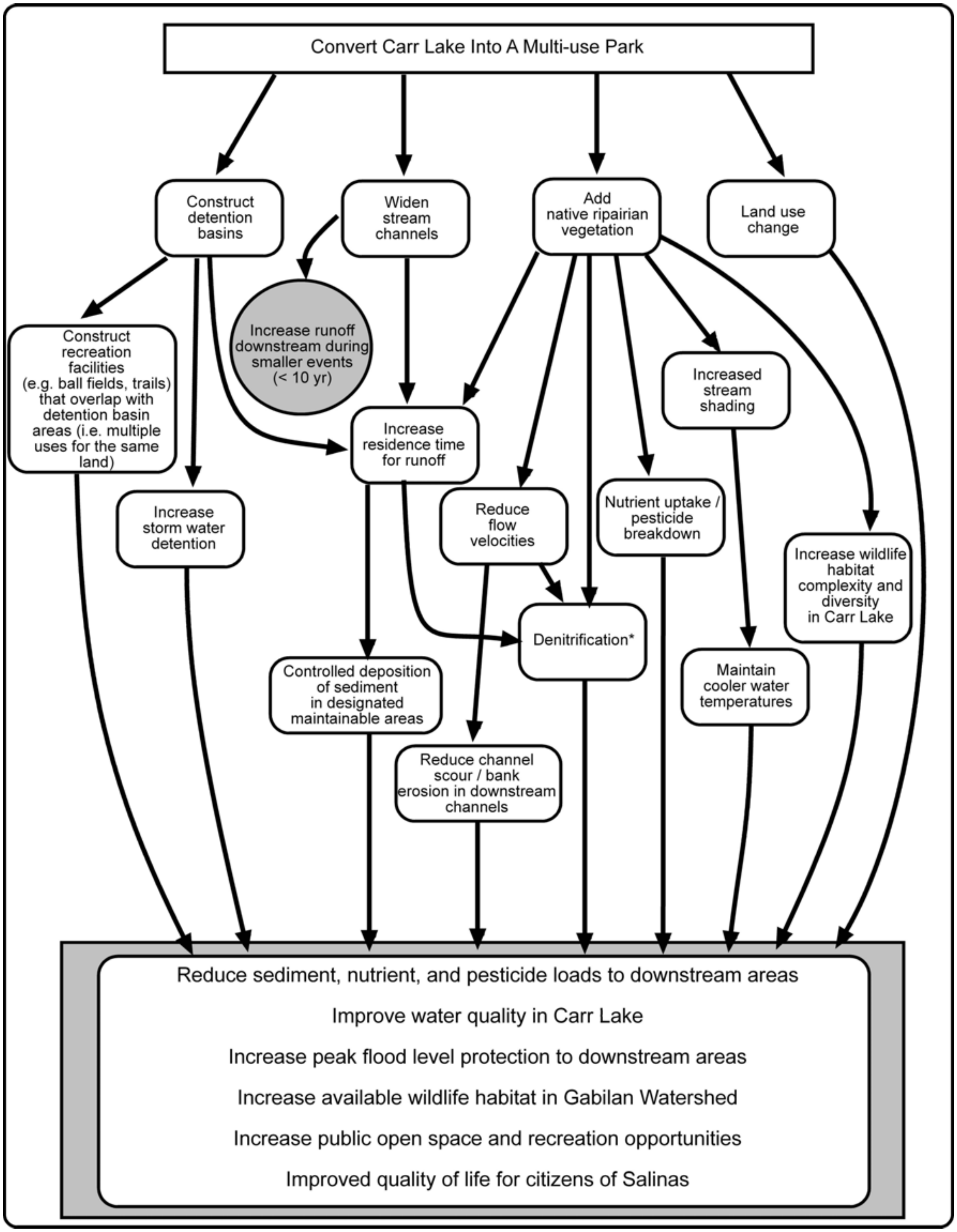


Figure 5.1. A conceptual systems diagram showing anticipated benefits for converting Carr Lake into a multi-use park. Note: Gray circle indicating increased runoff is based on SWCCE (2002) which states that by widening the channel, a characteristic of both the side-flow and through-flow designs, there would be an increase in stage and discharge out of Carr Lake for smaller events (≤ 10yr). *Denitrification - this is under the assumption that perennial water would be present to facilitate anoxic conditions required for denitrifying bacteria.

instream habitat complexity such as root-wads, overhanging branches and undercut banks (Flosi et al. 1998), and over time mature tree canopy layers will provide improved nesting and foraging habitat for a variety of bird species (Farley et al. 1994).

In addition to providing space for riparian vegetation, channel widening would generally reduce stream flow velocities (SWCCE, 2002) and increase residence times both of which would improve water quality conditions within the Lake and to downstream areas.

Storm water detention basins are commonly used in urban areas to capture storm water runoff and reduce peak floods to downstream areas (USEPA, 2004). Often such basins are built with multiple objectives in mind such as recreation and wildlife (Ferguson, 1991; USEPA, 2004; Sayre et al. 2006). In Carr Lake, the construction of large basins as part of the Schaaf and Wheeler's 'side-flow' system design could be done such that they provide opportunities for wildlife habitat and both active and passive recreation during the dry season. Active recreation could potentially include ball fields, a system of hiking trails and bike paths, and demonstration gardens, while passive recreation could include open fields and meadows for picnics and social gatherings (Cameron et al. 2003). See also Action FL7 in the Reclamation Ditch Watershed Management Strategy (Casagrande and Watson, 2006b).

5.2 Potential Benefits to Flood Control from Converting Carr Lake to a Multi-Use Park

Two recent studies SWCCE (2002) and Cameron et al. (2003) discuss and compare a variety of alternative designs for Carr Lake as a multi-use park and flood control facility. The SWCCE (2002) study focuses on improving flood control efficiency within the framework of creating a multi-use park. Cameron et al. (2003) further expands on the park option with four different alternatives; each alternative consisting of different emphases.

SWCCE (2002) discusses two general designs that could be used in the Lake to improve flood control benefits – an improved, or enlarged, "thru-flow system" (current design) or a "side-flow system." The side-flow system would involve significant widening of existing creek channels within the Lake and using levees to separate the channels from multiple large detention basins. Water in the creek channels would crest at a certain elevation and spill into the detention basins.

SWCCE (2002) concluded that all alternatives presented in their report *"would result in a reduction in calculated 25- and 100-year peak Carr Lake stage and discharge."* However, only the thru-flow system would reduce the 10-year peak values. They also recommended that the culvert at Main Street be modified to increase discharge capacity, even though this in addition to widening the creek channels, would increase discharge to downstream areas of the system during smaller storms and during the rising limb of larger storms. They caution that the replacement or improvement of the Potrero Road Tide Gates should precede upstream projects for more efficient drainage.

Increasing stream flow volume to downstream areas during smaller events and the rising limb of larger events could have its own set of problems such as increased transport of pollutants. This is consistent with results from Harris et al. (2007) which showed a positive relationship between nutrient loads (nitrate, ammonia, and phosphate) and discharge in upper Tembladero Slough.

The final alternative recommended by SWCCE was for a side-flow detention system because it would be the most cost effective method for reducing the 100-year flood stage while still providing multi-use benefits; although they did not recommend a specific configuration due to the need for further study. The final recommended alternative by Cameron et al. (2003) was Alternative 4, which contained the ability to contain a 25-year flood and equal emphasis on creating wildlife habitat and recreation.

The potential benefits to flood control from converting Carr Lake to a multi-use park will depend on a number of key factors including:

- Final park design and function,
- Characteristics of upstream developments (e.g. extent of impervious surfaces),
- Number and effectiveness of management practices installed in new upstream developments (i.e. storm water detention basins, vegetated swales, etc.), and
- Whether or not modifications to the downstream drainage system are implemented beforehand as recommended by SWCCE (2002) (i.e. Potrero Tide Gates, Tembladero Slough/Rec Ditch improvements)

5.3 Potential Benefits to Water Quality from Converting Carr Lake to a Multi-Use Park

A recently completed project by the Watershed Institute (Harris et al. 2007) studied a variety of different management practices for improving agricultural runoff, including on-farm sediment detention basins and a constructed treatment wetland. Sediment detention basins were monitored on multiple farm sites all with different site characteristics. All basins resulted in notable sediment reductions to downstream waters (> 90%). The basins were incidentally also monitored for nutrients, and as expected for short-residence-time, un-vegetated sediment detention basins, little effect on nutrient concentrations was observed.

Harris et al. (2007) also studied the effectiveness of a vegetated treatment wetland through which water from Tembladero Slough was pumped. The treatment wetland is located at the confluence of Tembladero Slough and the Old Salinas River Channel. Strong reductions in nitrate and suspended sediment were observed, as well as moderate reductions in orthophosphate. Results for ammonia and organophosphate pesticides were more ambiguous. The data also showed that residence time had a positive effect on the reduction of pollutant concentrations and that reductions occurred both at a constant rate (nitrate) and a concentration-dependent rate (ammonia, phosphate, diazinon, suspended sediment).

Plant species or matrix of species may also influence nutrient reduction rates in constructed wetlands. Bachand and Horne (2000) found that in trials with three different vegetation treatments (bullrush, *Scirpus sp.*; cattail, *Typha sp.*; and a mixture of macrophytes and grasses) differences in nutrient removal rates were significant and the greatest rates were observed from the mixed macrocosm.

Another local study showed that Espinosa Lake[2] may act as a filter for two commonly used pesticides, diazinon and chlorpyrifos (Kozlowski et al. 2004a). The data showed that median concentrations of diazinon and chlorpyrifos were significantly lower at the center of Espinosa Lake (106 and 73 ng/L) compared to concentrations from the lake's major incoming tributary (8,911 and 1,149 ng/L). They noted that this could be due to lower suspended sediment concentrations observed in depositional sites such as the lake.

Vegetated treatment wetlands have also been shown to significantly reduce enteric bacteria such as fecal coliforms and *E. Coli* (Vymazal, 2005). In a review of constructed vegetated wetlands throughout the world, on average total and fecal coliforms were reduced by 65% and 86% respectively from free water surface treatment wetlands. The authors noted that hydraulic loading, residence time, and the presence of emergent vegetation were primary influences on removal efficiency.

In addition to low chemical concentrations, cool temperatures and high dissolved oxygen are also important components of good water quality. Influences on water temperature and dissolved oxygen will ultimately depend on the amount of shade from vegetation and the volume of inflow during the dry season.

By analogy with results observed at the treatment wetland in Tembladero Slough (Harris et al. 2007), the addition of riparian vegetation to the creek channels of Carr Lake, along with increased residence time, could reduce excess nutrient and suspended sediment concentrations in the Lake and loads delivered to downstream water bodies.

Harris et al. (2007) also demonstrated that on site sediment retention basins were effective at reducing sediment loads to downstream areas. Based on these results, the construction of sediment basins both upstream of Carr Lake and in areas designated for sediment management within Carr Lake would likely reduce the transport of sediment into the lake and to downstream areas. Trapping such sediments would also likely reduce the transport of pollutants that adhere to sediment particles, such as pesticides and phosphates (Kozlowski et al. 2004; Kadlec and Knight, 1996).

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[2] Espinosa Lake is a natural, although modified, palustrine wetland southeast of Castroville.

The addition of riparian vegetation could also reduce water temperatures in the Lake. If at low flow the Lake's wetted areas are restricted to a series of well-shaded channels, the lake could have a cooling effect on surface waters.

5.4 Potential Benefits to Biological Resources from Converting Carr Lake to a Multi-Use Park

Wetlands are important habitats for a variety of wildlife species (Tiner, 1984; Mitsch and Gooselink, 2000). The enhancement and creation of wetland habitats in Carr Lake for wildlife is consistent with the goals and objectives discussed in several documents including SWCCE (2002), Cameron et al (2003), and Casagrande and Watson (2006b).

Widening the creek channels within Carr Lake so that they could support a more diverse riparian corridor and complex in-stream habitat conditions would likely improved habitat for wildlife (Gorman and Karr, 1978; Pearsons et al. 1992; Farley et al. 1994). Maintaining a narrow low-flow channel (or thalweg), within the widened overall channel, would concentrate water during summer low flow periods thereby increasing water depths and providing more suitable habitat for fish. The use of a low flow channel for better fish passage was also included in the designs for the Tembladero Slough Sediment Basin Study (Golder Associates Inc. 2001).

Extensive planting of a wide range of native plants at the treatment wetland on Tembladero Slough has resulted in an increase in both diversity and abundance of birds using the wetland (Harris et al. 2007). Native plant species and abundance have also increased at the wetland due to the plantings (Harris et al. 2007). Although these data are after the first year of study, they show that the addition of wetland plants provides, at the least, improved habitat conditions for wildlife; especially birds. We postulate that by analogy to these results at the treatment wetland, that the addition of a variety of plant species including emergent aquatics, riparian trees and upland shrubs, will increase habitat availability for birds and other wildlife within Carr Lake.

Fish species tolerant of warm water and low flow conditions, such as those observed in Upper Carr Lake in 2003 (Table 4.1), will likely benefit from the enhancement and creation of aquatic habitats in the Lake. Juvenile steelhead rearing in streams with elevated temperatures seek habitats with faster flow velocities where they can effectively meet heightened metabolic demands by taking advantage of increased invertebrate drift (Smith and Li, 1983). The widened stream channels and increased vegetation would create low stream flow velocities in Carr Lake (SWCCE, 2002). Low summer flow velocities and volume coupled with elevated water temperatures suggest that a converted Carr Lake is unlikely to provide summer rearing habitat for juvenile steelhead. In addition, the lack of surface flows in Gabilan Creek during late spring and early summer, which are when juvenile steelhead migrate from spawning areas, would severely limit the migration of juvenile steelhead to Carr Lake for rearing.

Steelhead, if present, would benefit from the removal or replacement of several barriers to migration (including partial and flow-dependent barriers) that exist within and upstream of Carr Lake (Casagrande and Watson, 2006a). The portions of Gabilan Creek just upstream of the City are flashy and have low flow durations and therefore improving migration efficiency is critical. Replacement of the elevated culvert on Gabilan Creek at East Laurel Ave with a bridge or an arch culvert that is level with the lake bed will improve the migration efficiency to and from spawning and rearing habitat present in the upper watershed. Further upstream, the concrete grade control structure near Lexington Dr, (already responsible for the loss of one adult steelhead and two chinook salmon) should be removed or modified. The concrete apron at the Hebert Rd crossing (location of the USGS gage) is passable at moderate to high flows, but more difficult at low flow due to shallow depths at the apron’s base.

Further upstream, the failing concrete apron and rip-rap located beneath the Old Stage Rd crossing on Gabilan Creek represents a major barrier to migration, blocking access to the best spawning and rearing habitat present in Gabilan Creek.

Although it is also unknown if steelhead occur in the Alisal Creek watershed, two significant barriers to migration exist immediately adjacent to Old Stage Rd (OSR) - one just upstream of OSR and the other just downstream of OSR. Both are large concrete grade control structures that are barriers to migration under most, if not all, flow conditions.

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