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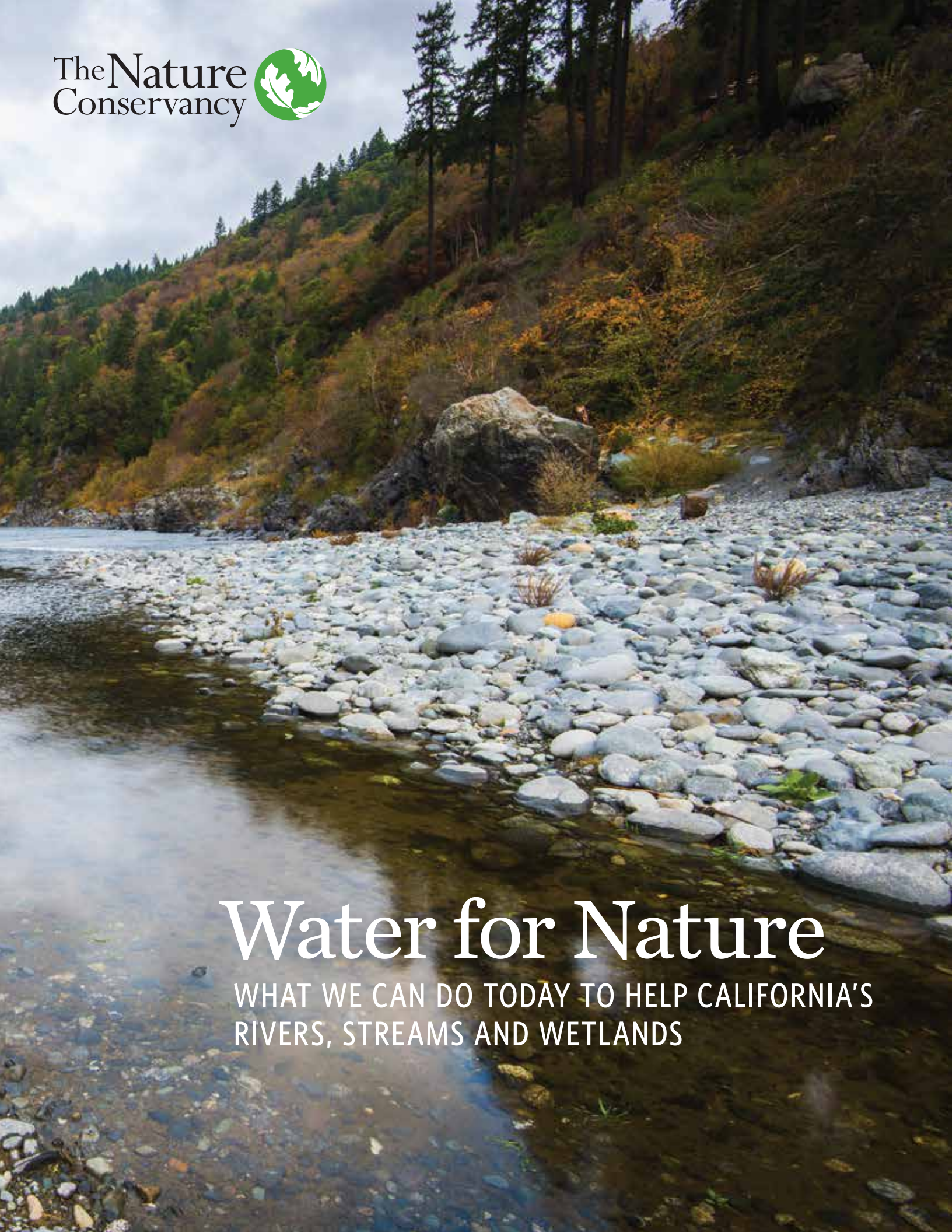

Water for Nature

WHAT WE CAN DO TODAY TO HELP CALIFORNIA'S RIVERS, STREAMS AND WETLANDS

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Preferred citation: Burns, C.E., A. Hoss, N. Smith, K. Klausmeyer, K. Fesenmeyer, A. Campbell, J. Carah, E. Forsburg, S. Heard, J.K. Howard, L. Hulette, S. Liu, P. Spraycar, B. Stranko, G. Werner, and D. Wordham. 2017. Water for nature: What we can do today to help California's rivers, streams and wetlands. The Nature Conservancy of California: San Francisco, California.

Printed on recycled paper.

COVER: The upper Klamath River in Northern California. The Yurok, the largest tribe in California, own land along the river and participate in a forest carbon offset program that was developed by The Nature Conservancy. © KEVIN ARNOLD

p 1: Pergish Carlson, a fishing guide and Yurok tribal member, stands atop a tree trunk surveying the forests around the Klamath River. © KEVIN ARNOLD

A CALL TO ACTION

In California, as in many western states, the human demand for freshwater exceeds the natural supply. Statewide, water rights allocations in California exceed the state's actual surface water supply by about 300 million acre-feet, enough to fill Lake Tahoe about 2.5 times (Grantham and Viers 2014). In the Sacramento-San Joaquin Delta, for example, the hub of California's water supply and delivery system, cumulative water rights allocations are three times greater than natural supplies (Grantham and Viers 2014), creating stiff competition for water especially in times of drought.

Unfortunately, California's rivers, wetlands and freshwater dependent species such as iconic salmon and beleaguered Delta smelt, are caught in this struggle for a scarce resource; often branded as burdensome instead of vital components of California's rich biological heritage. In all but the wettest of years or when litigation forces water to be provided for nature, the water required to maintain freshwater ecosystems and species is not available, or is well below what is considered a bare minimum for healthy ecosystems. Climate change is likely to bring less precipitation to many areas of California, and greater variability from year to year, which will only exacerbate the water shortfall for the environment in the coming years.

The way we've managed water in California has created a true crisis for freshwater biodiversity, from species relying on a healthy Delta ecosystem, to those in the state's lush North Coast, to the endemic species found only in the groundwater-fed rivers in the desert regions (Grantham et al. 2016). Nearly half of California's freshwater species are considered vulnerable to extinction, while only 6% are currently protected under state or federal Endangered Species Acts (ESAs). Even more disconcerting is that 90% of the freshwater taxa endemic to California—and so wholly reliant on conservation actions within the state—are vulnerable to extinction. Only 14% of these endemic taxa are protected under state or federal ESAs (Howard et al. 2015).

Given the status of these freshwater species, there is an urgent need to provide California's freshwater ecosystems with more substantial and reliable water supplies, at the right times of year and of sufficient quality to sustain them, and in a way that also provides for other water uses such as agricultural and municipal use. Fortunately, there are a variety of strategies already available in California to do just that, and implementing them can have benefits for people as well as the environment, in the form of increased water security, regulatory assurances, and short and long-term economic benefits (Lund and Moyle 2014; Richter 2016).

We developed this report to help focus the resources of The Nature Conservancy (the Conservancy) on a set of high-impact strategies to enhance freshwater flows in California. We inventoried and evaluated strategies available today to improve surface flows for nature, gathered input from experts in the field of freshwater management and conservation, and synthesized our findings. This report details our findings, and we hope that others working toward improved management of California's waters may benefit from this review.

Importantly, this report provides evidence that *we don't have to wait to take action*. There are many strategies already at our fingertips that could dramatically improve the health of California's rivers, streams and wetlands if implemented broadly.

Obtaining adequate flows for nature will require implementing a diverse set of strategies, and using a coordinated approach that makes the most of limited resources. And since using water rights for environmental purposes was not a construct when many of the state's water laws and water rights were developed, we'll need to be creative in adapting existing procedures and policies to optimize available water supplies for environmental uses. We'll need to find win-win solutions for people and nature.

Under the Public Trust Doctrine, the government actually retains the ultimate ownership of water while issuing the right to use water. So, when we talk about water use in the state, we talk about the right to use water, rather than the ownership of water itself. This distinction is critical as it highlights the role the state plays in regulating markets, setting rules and making sure the environment doesn't get left out when providing human access to water (Richter 2014). As a result, many of the strategies we highlight require close coordination with resource agencies, and rely on the effectiveness of policies and processes that are implemented at local, regional, state or federal levels.

Sacramento River, where the Conservancy works extensively to restore habitat and flows for nature. © RICH REINER

So, why now? Why this call to action? The right conditions are now in place for an effective, coordinated push to revitalize surface flows for California's freshwater ecosystems. These include:

1) Statewide voter-passed Water Bond that increased public funding to improve environmental flows and freshwater habitat (e.g., $200 million for streamflow enhancement projects, and $372.5 million for watershed restoration);
2) Growing momentum behind voluntary solutions to providing water for nature, as illustrated by increasing landowner involvement in efforts to dedicate water for wildlife habitat;
3) Climate change, including sustained drought and greater variability in precipitation, resulting in an increased awareness of the likely future impacts on water resources;
4) Growing interest and support from stakeholders, agencies and decision makers for multi-benefit water management strategies that address interrelated issues;
5) Increasing regulation of water use for cannabis cultivation, which presents an opportunity to protect flows for nature in many parts of the state; and
6) More stringent requirements of landowners to measure water use, stemming from recent legislation (SB88) that requires over 10,000 of the state's largest water right holders to report frequently on their water use.

With these conditions and a suite of existing tools in place, now is the time to act to improve the quantity and quality of water in California's rivers, streams and wetlands.

SCOPE OF THIS REPORT

The Nature Conservancy envisions a future where there is sufficient freshwater—at the right times and of sufficient quality—to support functioning ecosystems that sustain California's freshwater fish, birds and other species, while at the same time providing water to sustain the state's agricultural systems, cities, and other uses. We envision a future where surface flows more closely mimic the variability and dynamism inherent in natural systems, and in so doing, enhance the resilience of freshwater biodiversity in the face of climate change, which includes increasingly warm temperatures and more variable and extreme patterns of precipitation.

p4: Playing in the Marble Fork of the Kaweah River in Sequoia National Park. © NICK HALL; p5: Chinook salmon in Blue Creek, a tributary of the Klamath River. © KEVIN ARNOLD

Our goal in developing this report is to identify a set of strategies for the Conservancy to implement that will have the greatest impact on environmental flows, and to provide a resource for conservation organizations, resource agencies, and other stakeholders in California that may help create the conditions that allow freshwater species to thrive well into the future. In this report, we evaluate existing strategies available in California to enhance environmental flows for nature, both for in-stream flows and for wetlands. For a select set of priority strategies, we also map the geographic potential for implementation, by identifying where the enabling conditions are right for a given strategy, and where the freshwater conservation benefits are highest.

Here, we define "environmental flows" as the quantity, quality, timing and duration of water needed to support freshwater ecosystems. Implementing environmental flows in the form of a specific flow regime or allocation of water supports freshwater organisms and the essential processes needed for healthy ecosystems.

We outline approaches that take advantage of innovative and creative solutions and policies that balance the multiple demands for water in California—including environmental, agricultural, municipal, power generation, recreational and other uses. We highlight a set of high-impact strategies for securing and deploying water supplies to benefit freshwater species across California, though we recognize that the challenges to balancing competing water needs in this vast and diverse state are remarkably complex.

With this report, we seek to focus resources on a subset of strategies which we have determined are most likely to improve environmental flows over the next 5–10 years. However, to achieve long-term, transformative change, California will likely also need broader reforms, and we provide some initial recommendations on this front as well. In particular, we need clearly defined goals and objectives around what species or communities we are working to protect, and what their flow needs are. Too often this information is lacking, which limits the effectiveness of the strategies described in this report. The processes of setting ecological objectives and developing flow prescriptions is beyond the scope of this report, but these are critical next-steps on the path to better management of California's water.

To achieve success, a multitude of efforts on the part of many different stakeholders, both public and private, will be required across the state—and a coordinated and synergistic approach is absolutely essential. We hope that this report will help to focus activities and funding around the highest impact strategies, thereby increasing the collective impact on California's freshwater systems.

IDENTIFYING EXISTING STRATEGIES TO ENHANCE FLOWS FOR NATURE

p6: Migratory birds take advantage of wetland habitat provided by the Conservancy's BirdReturns program, executed in partnership with rice growers in the Sacramento Valley. © DREW KELLY FOR THE NATURE CONSERVANCY; p7: Juvenile coho salmon in a stream along California's North Coast. The future of this species in California highly depends on efforts to restore flows and habitat. © FLORA BRAIN

There are many different strategies that have been (or could be) used in California to enhance surface flows for nature. We evaluated a set of nearly 40 existing strategies that could be used regionally or across the state. While we attempted to be exhaustive, there may be strategies we missed. We compiled a menu of these strategies (see Appendix A) which we grouped as follows:

1. **VOLUNTARY STRATEGIES.** Voluntary approaches, in which an individual water right holder voluntarily provides some or all of his/her water right to enhance flows for the environment permanently or seasonally, have gained momentum in the past decade throughout the West, including in California.
2. **COOPERATIVE STRATEGIES.** Cooperative approaches usually involve a formal process that incorporates multiple stakeholders negotiating solutions to streamflow challenges. While water user involvement is voluntary in nature, participants are generally motivated by impending legal or regulatory action.
3. **POLICY-BASED APPROACHES AND/OR REGULATORY STRATEGIES.** Because water rights are administered and overseen by the state and federal government, they are also subject to state and federal laws and regulations. As such, various laws and regulations have the ability to affect a water right holder's use of their water right. Minimum instream flow requirements, the Public Trust Doctrine, the Clean Water Act and state and federal Endangered Species Act requirements all have the potential to impact the use of water.
4. **HABITAT RESTORATION STRATEGIES.** We identified a set of habitat restoration strategies that have the potential to increase the amount of water available for environmental needs. For example, forest thinning, meadow restoration and large wood augmentation are all habitat restoration strategies with the potential to enhance streamflow.

IMPLEMENTING A PORTFOLIO APPROACH

We recognize that, while we focus this assessment and report around discrete strategies, it is very likely that a combination of approaches will be employed at any particular place to achieve the desired environmental flow benefits. For example, the Conservancy's work in the Shasta River Watershed includes §1707 dedications, Safe Harbor Agreements, and Water Transaction Programs to enhance streamflow for salmonids. In this report, we seek to focus resources on a set of strategies that we see having great potential to enhance flows, while recognizing that many projects will in fact need to deploy other supporting strategies to maximize the environmental benefits.

HIGH IMPACT STRATEGIES FOR ENHANCING FLOWS FOR NATURE

We assessed the current functionality and potential impact of each strategy to improve environmental flows (water for nature). This assessment evaluated factors such as speed and cost of implementation, extent of geographic application, quantity of flow enhancement resulting from implementation, and how thoroughly the strategy has been tested or implemented. A group of external experts in the field of environmental flows reviewed and provided input at several stages of development.

p8: The confluence of Blue Creek and the Klamath River. © KEVIN ARNOLD

We identified a set of existing strategies that we believe could have the greatest impact on improving flows in California's rivers, streams and wetlands over the next 5–10 years if implemented more broadly. These are described below, and are grouped into each of the four categories identified above (see Table 1 on page 19 for a summary of these strategies and recommended opportunities for enhancement). However, we recognize that each freshwater system presents a unique set of circumstances and opportunities that must be evaluated to determine the most promising approach(es) to the provision of adequate environmental flows.

1. VOLUNTARY STRATEGIES: INVOLVE AND INCENTIVIZE LANDOWNERS.

Voluntary approaches that provide landowners with mechanisms to dedicate water for nature in the right place and time are growing in popularity across the West. In other states such as Oregon and Washington, these types of strategies have resulted in thousands of new dedications of water for nature. California is beginning to demonstrate the efficacy of these strategies, with promising results in three main areas: California Water Code §1707 petitions, storage and forbearance agreements, and seasonal transactions delivered through market mechanisms. Focusing on streamlining and implementing these strategies would result in substantial improvement in flows across much of California. Below we provide background information on these strategies, and identify next steps to achieve the full potential of each.

A) **Water right changes using California Water Code Section 1707.** Beginning in 1991, California developed a set of rules and procedures for transferring or dedicating water rights to environmental purposes, in which the state recognizes keeping water instream for wildlife and recreation as a beneficial use, and legally allows users to transfer water rights to these uses without losing the water right's priority date. In particular, California Water Code Section 1707 allows water right owners to transfer a water right, either temporarily or permanently, to another legal user of water. This could be for the purpose of enhancing wetlands, protecting fish and wildlife and recreation, or for transfer to another consumptive user of water with an environmental benefit designated within the transfer. The State Water Resources Control Board (SWRCB) oversees these water rights transfers and is increasingly handling petitions with benefits to the environment, with about eighty §1707 petitions processed to date, and several currently in review. The state offers express legal protection of conserved water and expedited review of short-term, temporary transfers. Such transfers are a ripe opportunity for improving environmental flows.

What is the geographic potential? We mapped where applying §1707 dedications might be best applied across the state of California to benefit instream animal and plant life (Figure 1). To generate this map, we developed a **Freshwater Conservation Value Score** for each watershed in the state that represents the places that are most valuable from a freshwater conservation perspective, and combined that with an **Opportunity Score** that describes the level of enabling conditions for this strategy (see Appendix B for methods). For the §1707 strategy, the Opportunity Score, or enabling conditions, included several factors: 1) whether a watershed was adjudicated (a beneficial condition for §1707 implementation), 2) the number of water right holders in a watershed (the fewer the better for an effective §1707 dedication), 3) the acreage of low value crops in the watershed (low value crops are less costly to fallow to provide water instream than are high value crops), and 4) the number of active streamflow gauges in the watershed (which provide easier measurement of compliance with §1707 terms).

Based on this analysis, there are opportunities for implementation of the §1707 strategy in many areas of California, but most notably in parts of the Central Coast, Klamath Basin and portions of the Sacramento Valley and Sierra

foothills. Figure 1 depicts where §1707 dedications could best be applied across the state of California to have the greatest impact on freshwater animal and plant life. For the maps presented throughout this report, we note that each analysis was limited to available indicators, and cannot fully represent the complexity of conditions in every watershed. As such, these maps should be used as an initial identification of potential locations, to be followed by more detailed evaluation of the specific circumstances within a given watershed.

Opportunities for enhancement. Despite an increase in interest and activity in water right changes for the environment, California Water Code Section 1707 is relatively underutilized in California. While in recent years the SWRCB has begun to address some of the hurdles in implementing Section 1707, additional work must be done to decrease the cost and length of petition processing times, and to provide greater guidance to petitioners on petition requirements (e.g., California Environmental Quality Act exemptions and/or lead agency designations). There is also a strong need for broader education and outreach to water right holders about the utility and process for petitioning for a water right change to benefit the environment.

Specifically, an area for enhancement to utilize Water Code Section 1707 is a standardized and streamlined approach for water right holders to define the consumptive use of their water. California law prohibits a water right holder who may be seeking to dedicate or transfer a water right to the environment from "injuring or unreasonably affecting any legal user of water," with the burden generally on the water right petitioner to show no-injury. One way to show no-injury is an analysis of consumptive use or crop evapotranspiration. This analysis quantifies the amount of water that is either lost to evaporation or is consumptively used by a given crop and varies depending upon the crop grown, precipitation and other climate conditions during the specific time of year, soil type, geology, and—in the case of grazed land—grazing intensity.

One way to improve this process is to work closely with the SWRCB to utilize existing information to provide recommendations on what type of consumptive use methodologies would be best for crop types or landscapes where this guidance is not well defined. The SWRCB should make a recommendation on consumptive use methodologies in these areas which would lessen the burden of proof required of §1707 petitioners. A second area for enhancement is to identify ways to group or batch multiple, similar §1707 petitions together to save time and money. This approach should be developed and piloted to quantify efficiencies and ultimately should lead to a streamlined methodology implemented by the SWRCB when reviewing §1707 petitions.

B) **Season of diversion changes and development of small-scale off-stream storage and forbearance options.** Most watersheds in California receive the vast majority of their precipitation in the winter months, while the highest demand for agricultural water use is in the dry, summer months. Diverting and storing water during the winter months in lieu of diverting water for immediate use during the hot, dry season has proven to be an effective way of improving streamflow during critical times, though care must be taken to keep the natural patterns of winter flow variability in place. A number of coastal watersheds, primarily in the North Coast, have demonstrated success with small-scale 'storage and forbearance' projects that divert and store a relatively small portion of winter streamflows to reduce or eliminate their summer diversions. As the effects of climate change continue and regions that once relied on snowmelt for spring and summer irrigation experience reduced water availability, this strategy may become increasingly useful in other areas of California as well. Storage and forbearance projects are often voluntary, but can also be required by regulation.

Wine grapes at Husch Vineyards, a Conservancy partner on the Navarro River Project, where we work to improve the timing of flows for fish while also increasing water security for people. © NANCY SMITH / THE NATURE CONSERVANCY

What is the geographic potential? Our analysis indicates that the North and Central Coasts have the greatest potential for this strategy to most effectively be implemented in ways that provide substantial ecological benefit (Figure 2). For this analysis, we combined information on the Freshwater Conservation Value with information on the enabling conditions, summarized as the Opportunity Score, for small-scale storage and forbearance strategies. The Opportunity Score included several factors: 1) the amount of flow already captured in dams (with greater opportunity for relatively unimpeded systems), 2) the percentage of rural residents and agricultural interests not served by a water agency (greater opportunity if most water users are not provided with water security via a water agency), and 3) residents and agricultural interests without groundwater access (which increases their odds of benefiting from a surface water storage strategy). See Appendix B for detailed methods.

Opportunities for enhancement. A lack of awareness of this approach to water management, combined with lengthy study, permitting and review processes are currently inhibiting voluntary landowner participation in storage and forbearance strategies to enhance streamflows. Broader outreach to potential participants, clarity around regulatory assurances, efficient methods for identifying ecological thresholds, and a faster review and permitting system could improve outcomes for both water users and streamflows.

An existing policy mechanism, the Policy for Maintaining Instream Flows in Northern California Coastal Streams ("North Coast Instream Flow Policy" or AB2121), was developed to streamline water right permitting for beneficial projects such as small-scale storage and forbearance projects, and holds significant promise. However, only a few projects have been permitted to date under the Policy, and additional examples are needed to demonstrate a clear and efficient path through the process and incentivize future projects. Currently, for many projects to

reliably get enough wet-season water to store, they need to complete a site specific study to establish protective thresholds under the Policy, which can cost >$100,000 and take 1–2 years to complete. Additionally, agency roles and process during review and approval of site specific studies are not yet well established and at least one project currently moving through the process is experiencing significant delay and expense as a result.

As an alternative to time-intensive site specific studies, the Policy allows for development of 'alternative regional criteria', however this mechanism has not yet been used. The Policy permits the SWRCB to approve the use of alternative regional criteria, if the criteria are found to be sufficiently protective, are supported by the scientific literature, and have been peer-reviewed and validated at different sites located within the Policy region. The Conservancy with partners from the Salmon and Steelhead Coalition are currently developing and vetting an alternative regional criteria methodology, and are hopeful that it can serve as a standardized methodology for rapidly and efficiently identifying protective ecological thresholds for new winter water rights to facilitate the permitting processes described above.

C) **Market-based strategies to facilitate dynamic, seasonal flows for nature.** Nature has intrinsic needs for surface water that vary from place to place, and from one season to the next. Some species, such as migratory birds and anadromous fish, may require additional water only to complete a critical life stage—often just weeks to months in any given year. This presents an opportunity to use dynamic conservation approaches to more flexibly and adaptively address ecological needs that vary over time and space. Dynamic conservation approaches rely on working with landowners and other resource managers to deliver temporary flows at the right place and at the right time. Leveraging market-based tools, this 'habitat rental' model where landowners receive payments to provide water (and thereby habitat) when and where it is needed, complements and amplifies permanently protected lands and waters. This may be a more cost-effective approach than permanent acquisition of habitat, which does not offer the same degree of flexibility in meeting nature's needs. A dynamic approach requires implementation of market-based strategies that are flexible, including obtaining short-term water supplies from different sources from year to year and often season to season, and which create opportunities to tailor investments adaptively in response to changing conditions and habitat needs. Examples of these dynamic, market-based strategies include, but are not limited to, short-term water leases and Water Sharing Investment Partnerships.

   i. **Short-term water leases to dynamically provide instream flows or wetland habitat.** Following the lead of more active water markets in Oregon, Washington, and other countries such as Australia (e.g., Mount et al. 2016), many conservation organizations are now beginning to identify effective ways to use short-term leases to provide water for the environment. Water transaction programs using innovative tools like reverse auctions are beginning to gain momentum and show great promise for broader application. Water transaction programs compensate water right holders in a particular watershed for leaving water instream, or otherwise reallocating water to nature, during critical periods such as spring or fall migration—often just weeks at a time. Reverse auctions can facilitate seasonal transactions, enabling a conservation organization or other entity to allocate investments in flows to achieve the greatest benefit per dollar invested. In this strategy, interested water right holders submit competitive bids indicating how much they will charge to provide a certain amount of water in a given place. The cost and value of the additional habitat are then evaluated to determine which bids provide the greatest ecological gain for the least amount of money. For example, the Conservancy's BirdReturns program has used a reverse auction approach to competitively purchase temporary water for

migratory bird habitat from Central Valley farmers, providing over 40,000 acres of habitat in under three years (Latacz-Lohmann and Van der Hamsvoort 1997; Johnson et al. 2015).

Opportunities for enhancement. Most public funding targets permanent flow protection strategies such as water rights acquisition and processes such as permanent (or long-term) §1707 dedications, leaving very limited funding for water leases and other temporary water transactions. Conservation organizations and agencies must work together to identify opportunities and to build the scientific basis for seasonal investments in instream flows and wetland habitat. To reach a greater level of acceptance and validation for this approach, additional sources of public and private funding are needed to pilot and scale up water transaction programs, while also building the scientific evidence base and the implementation capacity of NGOs and agencies. Additionally, more extensive monitoring systems are urgently needed to ensure that the agreed-upon quantity of water leased or purchased has indeed been provided and remains instream (i.e., is not subsequently diverted by another water user). An increase in gauging, monitoring, and water right oversight systems (such as Watermasters or other water right enforcement entities) are required for fully functioning water leasing programs. Permanent water transactions would also greatly benefit from more comprehensive monitoring and oversight.

ii. **Water Sharing Investment Partnerships (formerly Community Water Trusts) and other market-based strategies that allow dynamic flow management.** A Water Sharing Investment Partnership (Water SIP) is a specific form of impact investing that strategically uses private investor capital to provide water for nature as well as people. In a Water SIP, a portfolio of water assets is acquired using funds from impact investors, and that portfolio is deployed every year, with some of the water assets providing ecological benefit (e.g., water for wetlands, or instream flows), and the remaining water being leased to generate returns for investors (Richter 2016). A Water SIP generates revenue by leasing water supplies to other users when demand is high, perhaps through dry-year lease options, while deploying as much water as possible to instream flows or wetland habitat creation. As with other approaches, California may have something to learn from promising projects in other parts of the world, including Australia, where the Conservancy has launched an A$27 million Water SIP.

The success of the Water SIP model requires collaboration among many stakeholders, and especially the public sector, private investors and NGOs. By working together to meet the needs of environmental, agricultural and other water users, a Water SIP would facilitate more sustainable relationships based on shared use of water resources, instead of competitive relationships and zero-sum conflicts. By deploying water supplies in response to specific habitat needs at specific locations, the Water SIP can also be adaptive to varying environmental conditions, including drought, as well as the similarly dynamic economic and policy decisions that impact the amount of water available for the environment.

Beyond Water Sharing Investment Partnerships, a range of other market-based strategies exist to secure water for the environment. Investing in irrigation upgrades—for landowners or districts—and requiring that a share of the "saved" water be dedicated to the environment is one example. Opportunities also exist to leverage market-based tools that link surface and groundwater use. For example, investing in the development of a groundwater bank could yield environmental returns in the form of water, which could then be redirected into the system as surface flows. (See also the SWRCB's process for temporary permits for groundwater recharge and storage: http://www.waterboards.ca.gov. Surface water diverted to underground storage pursuant to a water right permit [temporary or long term] can be withdrawn and dedicated to instream beneficial use.) Groundwater mitigation is

p14: Blair Hart, landowner, rancher and Conservancy partner on the Shasta River Project to improve the timing and quantity of flows for salmon. © HART RANCH; p15: Mill Creek, a tributary of the Sacramento River, and site of the Conservancy's water exchange agreement with a local Water Company to enhance environmental flows while meeting water needs for irrigated agriculture. © MATT JOHNSON / CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE

another strategy that uses surface water conservation activities, such as the dedication of instream flows, to offset the negative impacts of pumping. These and other strategies are further described in the Conservancy's forthcoming report, Market-Based Mechanisms for Securing Environmental Water in California (Heard et al. 2017).

Opportunities for enhancement. The Water SIP is a promising but largely untested strategy to improve flows for nature. There is inherent promise in the opportunity to leverage private capital to acquire and reallocate water assets and to better compete with other water users who typically are much better able to derive economic value as compared with environmental flows.

As with many impact investing opportunities, there appears to be no shortage of private investor interest in investable projects that generate environmental benefits. In order to harness this great interest and convert it into meaningful conservation results, the Water SIP model must be further developed and piloted and, importantly, tailored to the unique ecological, economic, regulatory and political circumstances of California and the specific watersheds of interest. Thus, in addition to private investors, philanthropic funding along with strong public partnerships (to provide water, storage, conveyance, regulatory approval or other forms of support) will be essential as the conservation and investor communities test and refine this market-based approach to enhancing flows for nature.

2. COOPERATIVE STRATEGIES: PUBLIC/PRIVATE PARTNERSHIPS TO IMPROVE ENVIRONMENTAL FLOWS.

"Cooperative" strategies rely on close collaboration among landowners in a watershed, and are often developed in response to the potential for regulatory action, such as the presence of an endangered species. One such strategy that our assessment identified as having considerable potential for improving environmental flows is the use of Safe Harbor Agreements (SHAs). SHAs are cooperative agreements involving private or other non-federal property owners whose actions contribute to the recovery of species listed under the ESA. Participating property owners agree to terms and conditions on which their water use and other negotiated restoration activities contribute to the recovery of listed species. In return, the property owners receive formal assurances from the participating federal agency that if they fulfill the conditions of the SHA, the agency will not require any additional or different management activities.

Other cooperative approaches to managing water are also now being developed in California and show considerable promise for improving flows, including Cooperative Water Exchange Agreements (such as that developed recently by the Conservancy in collaboration with Los Molinos Mutual Water Company to provide flows for salmon in Mill Creek; http://www.casalmon.org/Mill-Creek-Water-Exchange-Agreement), and Cooperative Water Management Groups (such as that currently being developed for the North Coast with Water Bond funding by the Mendocino

County RCD, the Conservancy and Trout Unlimited). These strategies trade the use of water rights at different times of year to meet human water needs and to achieve instream flow goals (e.g., when necessary for migratory fish passage). Approximately equal benefits for environmental and human uses incentivizes interest in these newly developed cooperative approaches.

What is the geographic potential? Our analysis indicated that SHAs, and other similar cooperative strategies that provide regulatory assurances to landowners who may have endangered species on their property, are most likely to be effective along California's North Coast, Sacramento Valley and Sierra foothills (Figure 3). This finding is based on estimating the enabling conditions for this strategy, which we summarized as an Opportunity Score based on: 1) the count of ESA-listed species in the watershed (the greater the count, the better the opportunity), 2) the degree of water rights over-allocation (greater over-allocation leads to an increased likelihood of landowner participation), 3) the presence of streams with Total Maximum Daily Load (TMDL) regulations in the watershed (presence of TMDL increases the opportunity), and 4) the amount of agricultural land use in the watershed (greater agricultural land use increases the opportunity; Appendix B).

Opportunities for enhancement. Current efforts in the Shasta River are breaking new ground for SHAs. In this watershed, NOAA is for the first time serving as the lead agency for an SHA, and (also for the first time) this SHA includes instream flow enhancement as part of the commitments made by participating landowners. When completed, this SHA will provide significant improvements to instream flows at critical times of year for salmon and other freshwater species. Beyond this example, and a small number of SHAs in process in other parts of the Klamath Basin, the SHA strategy is underutilized across California. Other watersheds with ESA-listed species and flow impairment issues should be considered as candidates for SHA programs. To continue and expand the SHA strategy, resources and support for these efforts should be directed to the state and federal agencies who will be implementing these programs, including the U.S. Fish and Wildlife Service, CDFW and NOAA. Outreach should be conducted to the agricultural community about the opportunities for regulatory assurances through the SHA process.

Beyond SHAs, the water exchange approach is particularly applicable in parts of the Central Valley where anadromous fish require flow for passage through agricultural areas to reach spawning and rearing habitat. Passage needs often occur in the spring and fall whereas the greatest demand for irrigation is in the summer months and thus presents an opportunity for exchanging the use of water for mutual benefit. Watersheds where this approach is most likely to benefit target species should be identified, and greater allocation of public resources provided for these projects.

3. POLICY-BASED APPROACHES AND/OR REGULATORY STRATEGIES: MAKE STORAGE WORK FOR NATURE.

Large, on-stream water storage in California, including an intricate system of thousands of dams and hundreds of reservoirs, has enormous impacts on the timing, duration and quantity of flows that are provided instream for nature. As a result, the Conservancy generally does not support new on-stream storage projects, and we believe that long-term solutions to enhancing flows in California will require that the state's water storage system be better managed to provide water for nature. Storage projects should be designed and operated to explicitly benefit freshwater and riparian species and habitats, current policies and practices should be reexamined to ensure that current regulations protecting the environment are implemented fully, and the potential benefits of groundwater recharge projects should be investigated.

A) **Make effective use of Proposition 1 – storage funding.** The 2014 California Water Bond included $2.7 billion for new water storage projects. This presents an opportunity to design storage projects that provide space and flows for nature, including creative projects that incorporate habitat restoration, water supplies for nature, conjunctive use and re-operation of existing facilities. To be eligible for bond funding, storage projects must include public benefits, which include restoring habitat, improving recreation, reducing flood damage, improving water quality, and responding to emergencies. Because of this requirement, water agencies are seeking ways to incorporate public benefits, like providing for improved environmental flows, into their projects.

   Opportunities for enhancement. A large amount of funding is available to support storage projects that, if prioritized with nature in mind, could have substantial environmental benefits. We recommend that proposed Proposition 1 storage projects that show a clear, measurable set of net ecological benefits be prioritized, as well as those projects that include ways to dynamically manage water for nature in response to changing conditions over time. Priority storage projects should also secure agreements with relevant agencies to optimize and integrate water system operations that improve water supply reliability for nature, such as providing critical environmental flows. This includes providing sufficient flows at the right times and in the right places to benefit target freshwater species, and addressing water quality issues, such as temperature, which also play an important role in ecosystem health.

   We also recommend that preference be given to proposed Proposition 1 storage projects that dedicate a portion of the created storage capacity and yield for nature equivalent to the claimed proportion of ecosystem public benefits. This would mean that a project that claims that 25% of the storage provides ecosystem benefits must ensure that 25% of the storage capacity and yield are permanently dedicated to address priority ecological objectives. Over time, this "environmental water block" would be managed to address changing flow and habitat needs.

B) **Improve dam operations.** Our evaluation of environmental flows strategies indicates that re-operating California's extensive network of dams and reservoirs is an important component of restoring flows throughout the state. These strategies include dam re-operations (e.g., Federal Energy Regulatory Commission relicensing opportunities and other processes to modify operations of smaller dams) and dam decommissioning. Each of these involves many stakeholders and complex, often lengthy and expensive processes, but the ecological rewards can be substantial. In addition, we see promise in efforts to achieve compliance with Fish and Game Code §5937, which requires dam operators to release enough water to keep fish below the dam in "good

condition." Section 5937 applies to over 1,000 dams in California, and scientists have identified 181 as high-priority candidates for improving environmental flows for native fish conservation (Grantham and Moyle 2014).

Opportunities for enhancement. Implementation of §5937 has been inconsistent and rarely undertaken without prodding from litigation. The 2014 study noted above provides a promising and science-based approach for applying §5937 with an eye towards maximizing conservation impact. Conservation organizations and landowners are well positioned to leverage §5937 to influence dam operations and to set management priorities for dams requiring the most urgent attention. Further, 20 large dams that exist within high priority freshwater biodiversity conservation areas will be subject to FERC relicensing requirements in the next decade. Both of these strategies present an excellent opportunity to re-operate some of the state's largest dams in ways that are more dynamic and begin to restore environmental flows and water quality.

C) **Use groundwater recharge to benefit surface flows.** Pilot projects are being tested in the Scott River watershed that divert winter streamflow to recharge groundwater basins that are connected to surface flows. The goal is to improve and extend the spring and summer baseflows of the river that are supported by groundwater inputs. Ongoing and additional research in this and other watersheds will inform how and where to best to use this strategy to increase the reliability/quantity of groundwater into streams longer into the dry season in areas where base flows approach critical levels during dry months. However, obtaining the necessary new water permits and protecting the surface water created with groundwater recharge from diversion could be challenging. Groundwater recharge could also benefit surface flows in other ways, such as by using water obtained through groundwater recharge projects in lieu of direct diversion during times of low streamflow, or by increasing groundwater levels through floodplain restoration projects that provide groundwater recharge and improve instream flows. (See also the SWRCB's process for temporary permits for groundwater recharge and storage. Surface water diverted to underground storage pursuant to a temporary or long term water right permit can be withdrawn and dedicated to instream beneficial use.)

Opportunities for enhancement. The efficacy of using groundwater to augment surface flows is still being evaluated, but has shown good potential. More test cases will help to identify the best locations and conditions for application of this approach, and streamlined permitting to allow a winter water right for the recharge flows will be necessary. Implementation of the Sustainable Groundwater Management Act is expected to include groundwater recharge projects that are intended to help balance recharge with long-term projected pumping. Sustainable groundwater management could in many areas stabilize or even increase instream flows. Recharge projects benefiting both groundwater sustainability and instream flows should be prioritized for evaluation and implementation.

4. HABITAT RESTORATION STRATEGIES: WATER AS A SECONDARY BENEFIT.

While the habitat restoration strategies that we considered, including strategies like forest thinning, wet meadow restoration, instream habitat enhancement using large wood, and invasive plant removal, are generally not implemented solely or even primarily for flow enhancement, many of these strategies have multiple benefits, which can include providing additional water for the environment. In particular, recent studies suggest that ecologically-based forest thinning to improve forest health and reduce the frequency and severity of wildfire, where implemented at a landscape scale, may measurably increase streamflow (Podolak et al. 2015). Similarly, strategies such as invasive

Habitat restoration through deployment of large wood structures provides habitat complexity and enhances environmental flows.

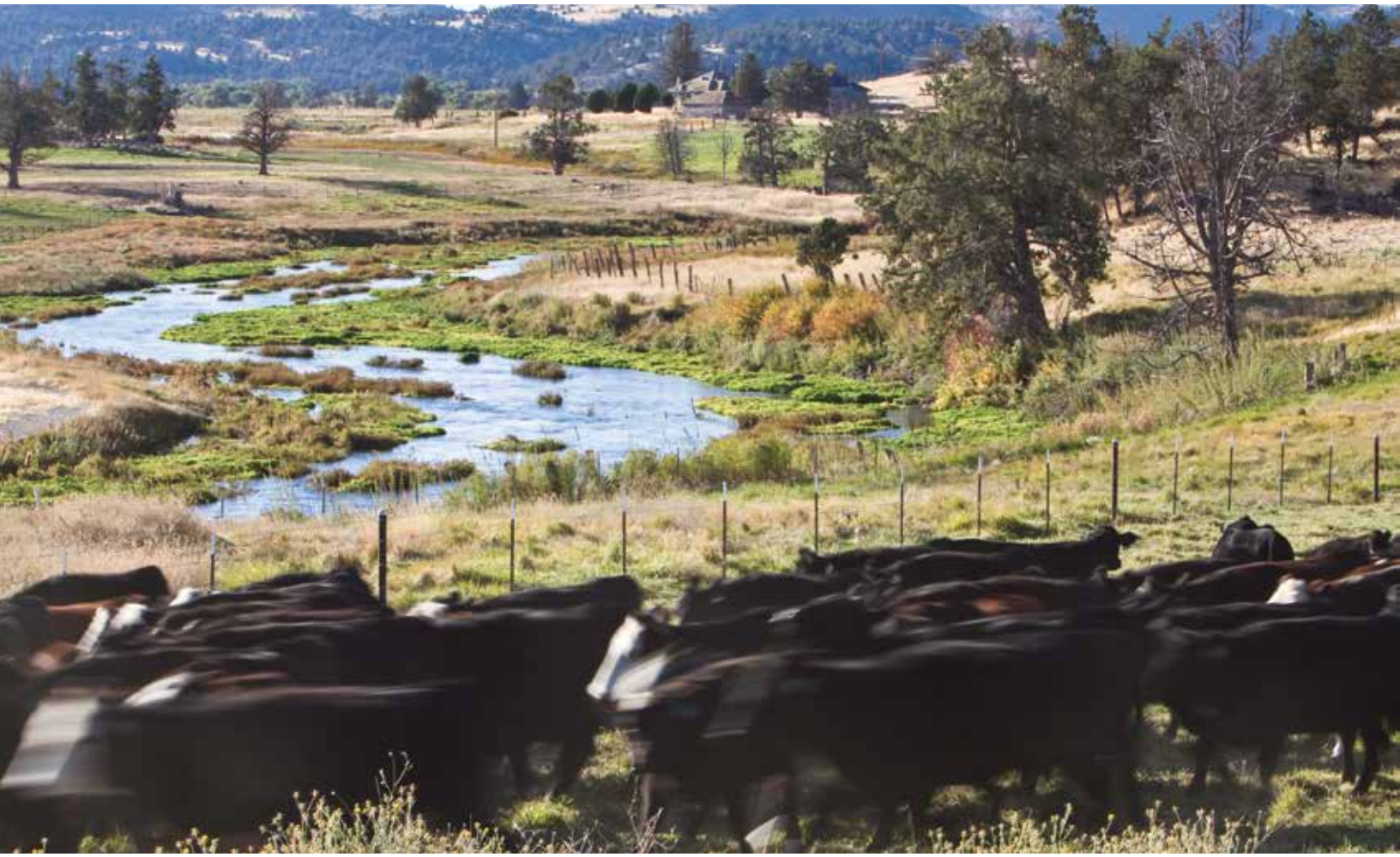
plant removal (e.g., *Arundo donax*) can in certain places restore streamflow conditions, and restoration projects to improve large wood availability in stream, and other efforts to slow flows and provide cooler temperatures, have been shown to enhance flows for nature (in timing and quality). In addition, restoration of floodplain and riparian habitat can help restore geomorphic processes that are essential for the maintenance of environmental flows. These types of restoration are complementary to flow-targeted efforts in many systems and may be necessary to achieve the intended ecological benefits of additional water.

Opportunities for enhancement. These methods are often expensive and therefore difficult to implement at scales meaningful enough to substantially improve surface flows, though Proposition 1 restoration funding applies to these strategies. Nonetheless, when conducted as part of attempts to otherwise improve land stewardship, ecosystem health, and to provide public benefits such as improved water quality and reduced risk of catastrophic events, the added benefit of improving flows for nature is a bonus. As these restoration strategies are implemented in the future, greater resources should be dedicated to fully quantifying/valuing the benefits to environmental flows, including careful pre- and post-treatment monitoring.

Table 1. Summary of high-impact strategies to improve environmental flows for rivers, streams and wetlands in California, and opportunities to enhance their impact.

CATEGORY	HIGH-IMPACT STRATEGIES	OPPORTUNITIES FOR ENHANCEMENT
Voluntary	Water right changes using CA Water Code Section 1707	• Decrease cost and processing time for §1707 petitions • Streamline consumptive use methodology • Provide greater guidance to petitioners • Conduct outreach to recruit more petitioners • Increase streamflow gauge infrastructure
	Season of diversion changes and off-stream storage	• Reduce costs and processing time for seasonal water use changes • Improve efficiency of North Coast Instream Flow Policy permit review • Establish criteria for identifying beneficial seasonal water use changes and streamline permitting processes to improve effectiveness • Conduct outreach to increase participation
	Market-based strategies to provide dynamic conservation	• Increase public and private funding for short-term transactions • Improve agency and NGO capacity to implement water transaction programs • Enhance monitoring to ensure compliance and facilitate water market development • Pilot and validate Water SIPs • Increase data on water availability through comprehensive gauging
Cooperative	Safe Harbor Agreements	• Identify priority watersheds for SHA implementation • Improve capacity of state and federal agencies to review SHAs • Provide outreach to community about SHA opportunity
	Water Exchange Agreements and Voluntary Cooperative Management Groups	• Identify priority watersheds for implementation • Improve availability of public funding for priority projects
Regulatory	Effective use of Prop 1 storage funding	• Prioritize Prop 1 storage projects that show a clear, measurable set of net ecological benefits • Prioritize Prop 1 storage projects that will include ways to dynamically manage water for nature in response to changing conditions
	Improve dam operations	• Implement §5937 more broadly to improve flows below dams • Use FERC relicensing opportunity to improve flows for nature in priority conservation areas
	Groundwater recharge to benefit surface flows	• Test use of groundwater to augment surface flows • Streamline permitting for recharge flows • Implement SGMA and incentivize recharge projects that are likely to benefit surface flows
Habitat Restoration	Forest thinning, large wood augmentation, floodplain restoration, and other habitat restoration strategies	• Maximize and quantify the benefits of restoration efforts to environmental flows • Use of Prop 1 funds for restoration to achieve multiple benefits (restoration and improved flows)

SETTING THE STAGE FOR HIGHLY EFFECTIVE WATER MANAGEMENT



We've identified a set of existing strategies, that if implemented, could improve flows for nature while providing ample water for human uses in many parts of California. By focusing resources around these strategies, and through coordinated activity of conservation organizations, funding institutions, agencies and other stakeholders, we can begin to move the state's freshwater ecosystems toward a healthier future. Implementing these strategies is a critical next step in recovering the incredible biodiversity that California has in its rivers, streams and wetlands, but it's not enough.

p20: Salmon-friendly ranching demonstrated at the Conservancy's Shasta Big Springs Ranch. © ERIKA NORTEMANN / THE NATURE CONSERVANCY

To achieve statewide, long-term sustained health for California's freshwater ecosystems, we will need to take additional actions that amplify the utility of these existing strategies to drastically improve flows for nature. The Nature Conservancy has identified the following actions that if taken by agencies, conservation organizations and other institutions working to achieve widespread enhancement of environmental flows, would set the stage for highly effective water management that benefits nature as well as people.

1. IDENTIFY CONSERVATION TARGETS AND DEVELOP A STANDARDIZED, ACCEPTED FRAMEWORK FOR DETERMINING ENVIRONMENTAL FLOW NEEDS.

Transforming flows to fully support healthy, resilient freshwater populations, communities, and ecosystems requires an explicit roadmap to success. Before implementing any of the strategies identified in this report, resource agencies, conservation organizations and other stakeholders must team up to clearly articulate goals and objectives for each watershed, ecologically and otherwise, by specifying:

- What species or communities are the conservation targets?
- How will we define success, and how will we measure progress and know when we achieve our objectives?
- How much water is needed? When and where is it needed, and for how long?
- What are the other limiting factors that need to be addressed, such as habitat degradation, temperature concerns, or contaminants?
- What are the human needs in the watershed? Are there conflicting objectives that need to be addressed?

A vision of success is based on values, and success may look different for each partner or stakeholder. Only once goals and objectives are clearly defined and agreed upon can we begin to outline approaches to achieving them, to evaluate trade-offs among alternative actions, and to implement the best solutions. We don't tackle the process of setting these types of objectives, nor the development of flow prescriptions in this assessment, but these processes are critical next-steps to carry out before implementing any of the strategies described in this report.

Since the target organisms, stressors, and opportunities for flow enhancement are different in every watershed, a comprehensive environmental flow plan addressing each of the questions above should be developed in the future for any watershed that will be the focus of environmental flow efforts. Where this is not possible, regional methods that identify flow needs for a set of target species should be developed to guide on-the-ground efforts. New opportunities associated with regulating water use for cannabis cultivation will provide a good proving-ground for regional methods that seek to use standardized methodologies to rapidly assess flow needs across large areas such as the North Coast.

2. BUILD A ROBUST, STATEWIDE WATER ACCOUNTING SYSTEM.

California's water rights system is the primary regulatory framework for allocating California's water, however the amount of water used by the state's water right holders is currently not well tracked, with historically minimal requirements for reporting on water use. This lack of accurate accounting for water used and water available makes it very challenging, if not impossible, to effectively dedicate water to the environment while also providing for other uses (Gray et al. 2015). In addition to water use reporting, the state currently lacks a comprehensive database of unimpaired and actual flows for streams and rivers, as well as groundwater levels, which would provide a crucial foundation for assessing degree of hydrologic alteration and risk to freshwater species and communities.

A centralized database of hydrologic data, including unimpaired and actual flows and groundwater levels, would provide the foundation for a scientific assessment of the degree of alteration in watersheds and basins across the state, and for more ecologically beneficial water management decisions. Such a centrally-managed "water information system" would provide crucial information for planning, real-time management and long-term drought resiliency. Planning efforts should involve an assessment of hydrologic alteration and recommended flow regimes to support ecological and human needs in each watershed. Access to real-time data and decision support tools would then enable implementation of flow recommendations across California.

New legislation (SB88) requiring water use be more regularly and accurately reported by thousands of the state's largest diverters sets the stage for a more robust water accounting system in California. A system for managing this new water use information will need to be developed, along with decision-support tools to facilitate water allocation and management decisions that balance the needs of people and the environment. This system will also need to be flexible and adaptive enough to facilitate adjustments that may be necessary given a rapidly changing climate. A robust water accounting system will require improved technology and incentives and/or requirements to monitor water use and water availability. Up to date and reliable information on water use and availability, and an effective platform for managing and accessing these data, are critical for ensuring data-driven water allocation decisions and corresponding water management. Technological advances, and reduced pricing, in flow monitoring systems is needed to improve the accuracy and amount of information water managers have to better operate their systems for multiple benefits (e.g., irrigation and environmental flows).

3. MONITOR THE EFFICACY OF FLOW ENHANCEMENT STRATEGIES.

Monitoring successful implementation of any flow enhancement strategy in California requires that the number of active gauges throughout California be substantially augmented, particularly in areas where flow enhancement is most likely to benefit freshwater species. The state's USGS, DWR and other gauge networks are currently insufficient to provide even a basic platform for monitoring the effects of flow restoration strategies. A broader gauge network, with real-time data reporting, will be needed to enable implementation monitoring, adaptive management and informed decision-making. Gauge instrumentation is currently expensive to install, monitor and maintain. Priority should be placed on developing less expensive ways to reliably monitor instream flow throughout the state (e.g., new stream gauge technologies and/or remotely sensed data on surface flows), on finding funding for and deploying new gauges in priority locations, and on identifying funding mechanisms to keep current gauge networks online. These investments should be integrated with local efforts to improve groundwater monitoring and understand the interactions between groundwater and surface flows.

For many flow enhancement projects, effectiveness monitoring will also be necessary to show that the flow prescription is having the desired effect on the target population(s) or community. Effectiveness monitoring focuses on measuring ecological responses and comparing them to the desired outcome. This could include monitoring changes in fish abundance, species richness or diversity, riparian vegetation recruitment, changes in geomorphology,

p23: Conservancy ecologist Greg Golet monitors rice fields near Colusa in the Sacramento Valley. The Conservancy's BirdReturns program fosters collaboration with rice farmers to keep fields flooded under specific conditions to provide habitat for shorebirds in the Pacific Flyway.

water temperature, and other elements. In general, effectiveness monitoring is much more difficult and expensive to do than implementation monitoring, due to the amount of data needed, the time and expense of collecting it, and the complexity of the population or community response, time-lag effects, and other limiting factors. Although expensive, using monitoring data to reveal what is and is not working will be critical, and fine-tuning multiple strategies at one location will require careful attention to scientific data collected at the project site.

Monitoring the outcomes of implemented strategies should generally involve both implementation and effectiveness monitoring, although in some cases implementation monitoring may be a sufficient indicator that the desired ecological response has been, or will be, achieved. Implementation monitoring focuses on documenting that the desired flow parameters (e.g., duration, timing, quantity of flows) have been met, and requires having a sufficient network of functioning gauges to ensure that the flow target is being met during the implementation period. Effectiveness monitoring involves tracking the success of the flow enhancement in contributing to the desired ecological (or other) benefits.

4. INCREASE FUNDING TO RETURN DYNAMIC FLOWS FOR NATURE.

Reliable funding for environmental flows is a key hurdle. Bond funds, while helpful, are short lived and project based, and are limited to those projects that can show a 20+ year benefit, which excludes seasonal transactions. However, California has been relying largely on bond measures to fund water related projects. Since 1970 the state has spent $23.7 billion dollars on a series of water bonds. While bond funding will continue to be an important part of restoring flows for nature in California—and can be enhanced through earlier consultation of agency staff by potential applicants, and by clearer delineation of high priority watersheds for implementation—we also need to develop new approaches to funding public-trust resources (including fish and wildlife).

Public Funding. Public funding is needed to support both permanent and seasonal flows for nature. Priority should be placed on identifying new funding sources, in parallel to continuing to support water projects through bond funding opportunities. One potential new funding opportunity is the creation of a public goods charge which can provide a sustainable funding mechanism to finance the protection of public-trust resources and the full list of environmental flow projects in California. The Public Policy Institute of California recommends a public goods charge on water uses and specific environmental mitigation fees on the users of dams to cover the costs of improving the efficiency and reliability of California's water supply and distribution systems. The funding could be used to recover the costs of ecosystem restoration, fish protection, and the other public benefits of the state's water resources systems. A public goods charge is a promising solution to the chronic underfunding of the state's water-related agencies and ecosystem programs (Hanak et al. 2011).

Private Funding. Private funding sources can play an important role in providing water for the environment, by financing demonstrations of some of the newer strategies we highlighted, such as seasonal water transaction programs and water exchange agreements. These types of programs are typically not initially funded by public sources, so seed money from private sources is critical to testing and evaluating the effectiveness of these approaches. Private funding also can provide support to boost the capacity of conservation organizations so that there are more boots on the ground available to get projects up and running. Finally, private funding will be absolutely essential as the conservation community explores the potential to use impact investing to provide water for the environment.

CONCLUSIONS

California's freshwater ecosystems are in dire straits, and without more focused, collective action, they will see increasingly dramatic declines in the future. The good news is that there is a rich assortment of approaches that are already at our fingertips for improving flows for nature—we simply need to be more focused about where and when we use them. This call to action has identified a portfolio of strategies that the Conservancy sees as being the key to successfully providing improved environmental flows in ways that benefit California's rich ecological heritage as well as the millions of people who depend on sound management of the state's water resources. We believe that if the conservation community and resource agencies can focus efforts around these strategies, and work collaboratively to implement them, we will be able to change the trajectory of California's freshwater ecosystems.

ACKNOWLEDGMENTS

This report was prepared with support from the S.D. Bechtel, Jr. Foundation, and from The Nature Conservancy. Many thanks to those who have provided feedback on the analysis and report, including those listed below. While this report benefitted greatly from the input of these experts, the ideas in this document may not fully represent those of each reviewer. We've done our best to assemble a report that represents the consensus view of these groups, but recognize that it's not possible to fully achieve agreement in all areas of such a complex issue as managing water in California. Reviewers included:

American Rivers: Carson Cox

California Department of Fish and Wildlife: Josh Grover

California Trout: Curtis Knight and Darren Mireau

California Water Foundation: Andrew Fahlund, Kristin Brainerd, and Kathy Viatella

Metropolitan Water District of Southern California: Ron Gastelum (retired)

National Fish and Wildlife Foundation: Andrew Purkey

The Nature Conservancy – California Chapter: Eric Hallstein, Siobhan King, Mark Kramer, Sandi Matsumoto, Scott Morrison, Jason Pelletier, Wendy Pulling, Monty Schmitt, Mike Sweeney, Megan Webb, Jay Ziegler, and 20 other project-based staff who provided input during early phases of development

The Nature Conservancy – Regional and Global Freshwater teams: Giulio Boccaletti, Brian Richter, Leslie Bach, Robert Wigington, Mark Smith, Eloise Kendy, and Colin Apse

Point Blue Conservation Science: Nat Seavy

S. D. Bechtel, Jr. Foundation: Joya Banerjee, Mel Askay, Gary Knoblock, and Masika Henson

Stanford University: Buzz Thompson

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Trout Unlimited: Brian Johnson, Matt Clifford, and MaryAnn King

University of California at Davis: Sarah Yarnell

Water Funder Initiative: Maurice Hall

Wildlife Conservation Board: Brian Cary

p24: Chinook salmon on Conservancy property at Big Springs Creek. © CARSON JEFFRES; p29: Measuring stream flow in the Navarro River watershed along California's North Coast. © LIZ SPENCE

FIGURES

FIGURE 1. Geographic potential across California for §1707 dedications of water in-stream, based on the distribution of freshwater biodiversity (Freshwater Conservation Value) and a set of unique enabling conditions (Opportunity Score). The table lists the top 20 watersheds where this strategy could be used to maximize ecological benefit. Methods described in Appendix B.

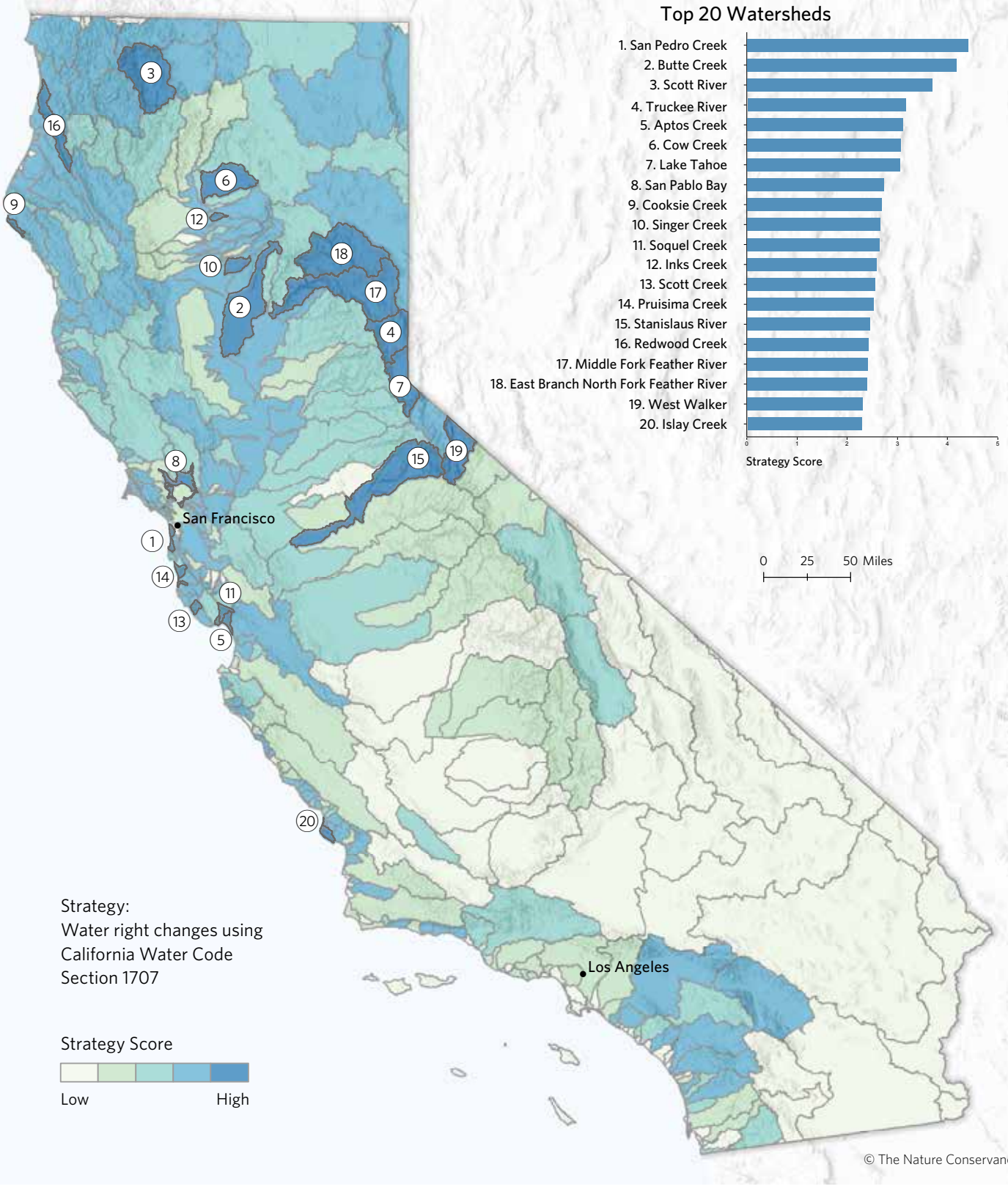


FIGURE 2. Geographic potential across California for small-scale storage and forbearance strategies, based on the distribution of freshwater biodiversity (Freshwater Conservation Value) and a set of unique enabling conditions (Opportunity Score). The table lists the top 20 watersheds where this strategy could be used to maximize ecological benefit. Methods described in Appendix B.

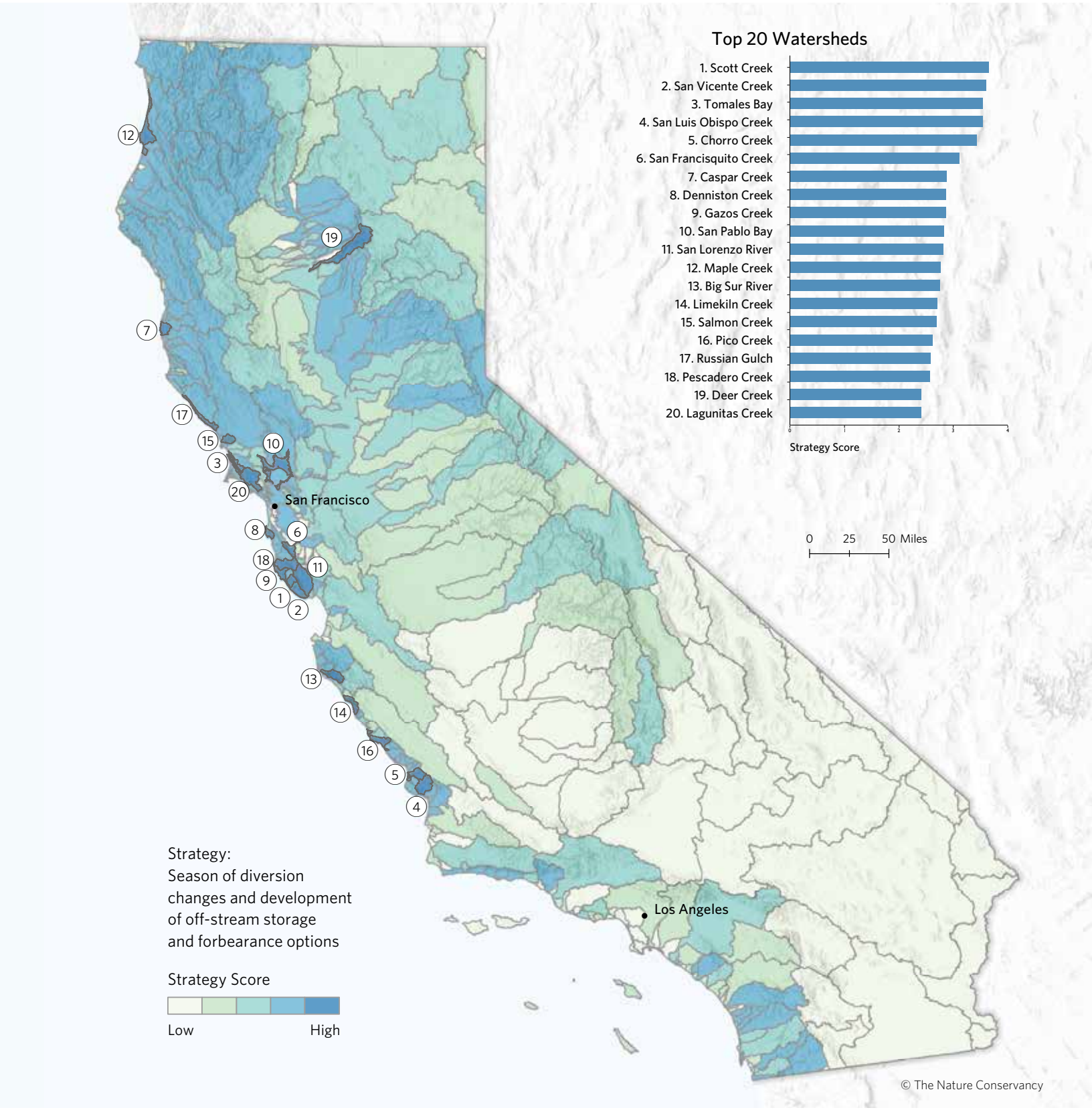
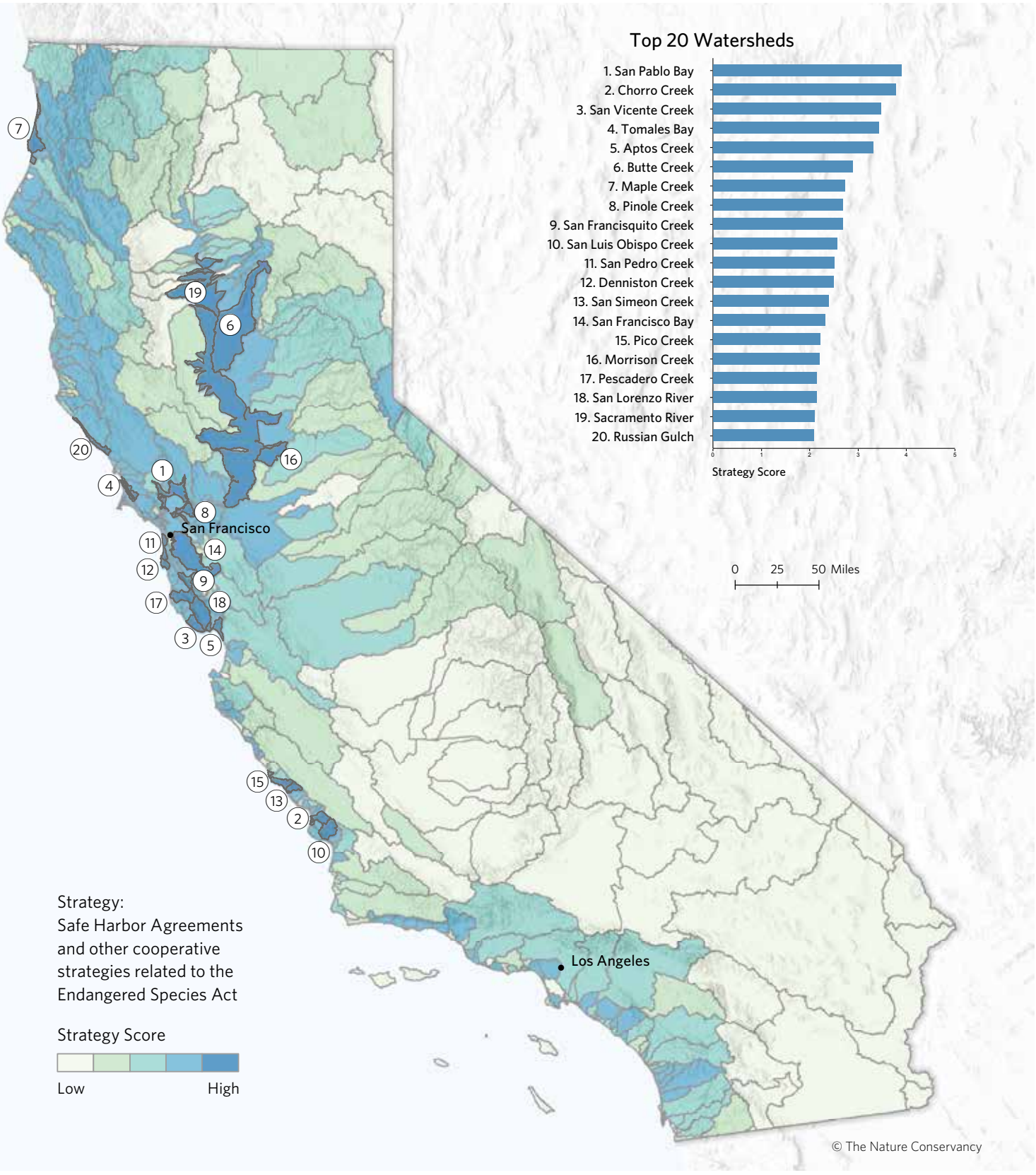


FIGURE 3. Geographic potential for Safe Harbor Agreements and other strategies centered around endangered species protection, based on the distribution of freshwater biodiversity (Freshwater Conservation Value) and a set of unique enabling conditions (Opportunity Score). The table lists the top 20 watersheds where this strategy could be used to maximize ecological benefit. Methods described in Appendix B.



APPENDIX A
Existing strategies to improve environmental flows

There are many different flow restoration strategies that have been put to use in California with varying degrees of success. As part of The Nature Conservancy's *Water for Nature: What We Can Do Today to Help California's Rivers, Streams and Wetlands*, we compiled a list of known flow enhancement strategies, evaluated their utility regionally or across the state, prioritized a subset based on their utility, and identified areas for development.

Appendix A describes 38 of the available strategies identified that have potential to improve environmental flows in California. While this table describes 38 distinct items, it is very likely that a combination would be employed at any particular place, or even within a particular project, to achieve the desired environmental flow benefits. For example, a project that recycles waste water to save surface water for environmental flows is a *source substitution* project. This project might also utilize a *voluntary water right change* (*e.g., California Water Code §1707*) to achieve maximum benefit and protection for the environment, while at the same time providing legal protections for the water right holder.

The Nature Conservancy created this table to gather into one place information on the strategies available in California to improve environmental flows. The information presented here is the compilation of ideas and thoughts from a number of different Conservancy staff working in California, and input from external reviewers.

ID	STRATEGY	DESCRIPTION	PERMANENCE OF ACTION	BENEFITS
1	Water Right Changes (using California Water Code 1700–1707)	California has well developed rules and procedures for transferring or dedicating water rights to environmental purposes; the state recognizes California Water Code (CWC) §1700–1707 allows water right owners to transfer a water right, either temporarily or permanently, to another The State Water Resources Control Board (SWRCB) oversees these water rights transfers.		
1a	Temporary "Urgency" Change	Process through SWRCB to temporarily change the point of diversion, place or purpose of use of post-1914 water rights; change needs to be based on an "urgent need" in order to maximize beneficial uses.	180 days or less (renewable).	Applicable to post-1914 water rights; enforceable since it is recognized by SWRCB.
1b	Temporary Transfer	See CWC § 1728 for definition.	1 year or less; limited to water that would have been consumptively used or stored in the absence of the transfer.	Applicable to post-1914 water rights only. Expedited, CEQA exempt process.
1c	Long-term Transfer	See CWC § 1701 for definition.	More than 1 year.	Applicable to post-1914 water rights that are recognized by SWRCB.
1d	Change in Point of Diversion	Strategic relocation of the place where water is diverted from the stream so as to better protect stream resources.	Could be permanent, particularly if old Point of Diversion (POD) is permanently moved.	Applicable to all types of water rights, recognized by SWRCB, no loss of appropriative right due to non-use.
1e	Change in Purpose of Use	Strategic change of use of water right so as to better protect stream resources.	Could be permanent; changes should be documented in annual water use statements.	Pre-1914 rights do not need to go through the SWRCB to change purpose of use, place of use, or POD, but in adjudicated basins a decree may need to be modified to reflect the change in place or purpose of use in order to protect water from diversion.
2	Efficiency/ Water Conservation Projects	These project types include switching to irrigation method that requires less applied water (i.e., flood to sprinkler, or sprinkler to drip, etc.), planting less water hungry crops or lining and piping leaky irrigation delivery ditches and other efficiency measures.	Variable; many efficiency projects merely make more water available to agricultural uses; doesn't generate additional instream flow.	Appropriative water rights holders that implement conservation practices don't lose water right due to non-use. Applicable to all types of water rights, recognized by SWRCB, no loss of appropriative right due to non-use.

1 2016 San Joaquin River Restoration program- points of diversion. http://www.waterboards.ca.gov/waterrights/water_issues/programs/applications/transfers_tu_orders/docs/23tt151215_order.pdf

2 Merced Irrigation District http://www.waterboards.ca.gov/waterrights/water_issues/programs/applications/transfers_tu_orders/docs/mid_usbr_a001224_temp_order.pdf

CHALLENGES	EXAMPLES OF WHERE THIS HAS BEEN USED	ENABLING CONDITIONS FOR SUCCESSFUL USE OF THE TOOL	CHANGES NEEDED TO MAKE TOOL MORE USEFUL	SWRCB RECOGNITION/CA WATER CODE SECTION (IF APPLICABLE)
keeping water instream for wildlife and recreation as a beneficial use, and legally allows users to transfer water rights to these uses without losing the water right's priority date. legal user of water. This could be to the environment or to another consumptive user of water with an environmental benefit within the transfer (using CWC §1725, 1735, and 1435).				
Short-term dedication; without the injury analysis the change petition could cause issues with other water users, subject to CEQA.	Post 1914 Water Rights 1) Shasta River—by Montague Water Conservation District in 2014 and 2) Camp Meeker and Parks and Rec District on Russian River in 2015 (both took less than 1 month to process).	Better understanding by water users as to their options in the Water Code; more test cases and examples of where this is most useful/applicable. This tool may be useful in times of drought.	Emergency or urgency needed; SWRCB and petitioner need to move fast and be relatively certain that no harm will be caused by the transfer.	CWC § 1707 & 1435
Process may be costly.	2016 San Joaquin River Restoration Program adding Points of Re-diversion, though this was a subsequent approval related to a recent 1707[1].	A reliable estimate of consumptive use, a mechanism to monitor the change, willing water users, and funding to support projects.	SWRCB streamlining process; better understanding by water users as to their options in the Water Code; may be cost prohibitive; more test cases and examples of where this tool will be beneficial.	CWC § 1707 & 1725
Process may be long and costly; State and local regulatory requirements (CEQA, ESA, etc.).	Merced Irrigation District[2] Any CWC § 1707 petitions filed for post-1914 water rights.	Water owners need funding and resources to conduct necessary due diligence when preparing a change petition; it is useful to have an adjudicated basin with a Watermaster so that the transfer can be enforced.	SWRCB streamlining process; may be cost prohibitive; need test cases in un-adjudicated basins and basins dominated with riparian rights; and a better understanding by water users as to applicability of CWC § 1701–1707.	CWC § 1701-1707
Requires funding for new infrastructure; process may be long and costly; State and local regulatory requirements can be burdensome (CEQA, ESA, DFW Code §1600 etc.).	Sugar Creek on the Scott River (Scott River Water Trust).	Needs to have the right landscape and work for the irrigators; might involve use of pumps instead of gravity or pipes instead of open ditch; ability to demonstrate no third-party injury.	Identification of where this could be most useful; funding for projects.	CWC § 1701
Could be difficult to enforce or monitor; if the water rights are part of a court order, you may need to petition the court to recognize the change.	Shasta River for pre-1914 water right holders.	A reliable estimate of consumptive use and a mechanism to track/monitor water to new place of use.	Need to continue to exercise this process and encourage projects to consider a point of diversion change in project planning.	CWC §1701
Project might not reduce consumptive use and therefore might not benefit the stream; CWC§ 1707 petition portion of the process may be long and costly; Federal, State, and local regulatory requirements make implementation of some efficiency projects overly burdensome to landowners (CEQA, ESA, etc.).	There are a multitude of NRCS-funded projects throughout the state through the Environmental Quality Incentives Program (EQIP). However, these projects do not require dedication of conserved water instream. Examples include Deer Creek, Mill Creek, Klamath River tributaries. Water use efficiency planning on Mill and Deer Creeks is ongoing with the objective of increasing instream flows.	In order to realize instream benefit, the landowner must be willing to put the saved water back instream and protect that water from other diverters via a CWC § 1707 petition or other legally enforceable mechanism.	Funders of water efficiency projects (DFW, NOAA, USFWS, NRCS, etc.) need to ensure the conserved water is protected.	CWC § 1011—Water rights owners interested in protecting the conserved portion of their water right through SWRCB should consider filing a CWC §1707 petition. At a minimum, conserved water should be reported to the SWRCB (See CWC § 1010 for details).

ID	STRATEGY	DESCRIPTION	PERMANENCE OF ACTION	BENEFITS
3, 4	Source Substitution (could be groundwater, reclaimed, recycled water for surface water; or mainstem water for tributary water)	Replacing reclaimed or recycled water for streamflow diversion. Or, replacing groundwater pumping for streamflow diversion.	Project permanence depends upon the details of the project; could be temporary or permanent.	Could allow for instream dedication of ecologically important water while utilizing water of lesser quality for irrigation.
5	Seasonal Changes (e.g., Development of Storage Options, like a Tank and Forbearance Program)	This tool is about capturing and storing flows during periods of high runoff and utilizing this stored water for irrigation or other uses in lieu of using streamflow diversions during the dry season. This tool often requires a new appropriative water right to implement.	Because the infrastructure required to implement the project is typically permanent, this is typically a lasting action.	Can have significant benefits in regions where summer instream flows for salmon are essential.
6	Water Right Acquisition or Conservation Easement on Property to restrict use of water right	Outright purchase of water rights with the sole purpose of utilizing those water rights for instream benefit. Conservation Easements can also be sold or donated with the sole purpose of restricting the consumptive use of the property's water rights; in essence, purchasing the water rights for instream use.	Conservation easements typically permanent; acquisition of rights could subsequently be sold.	Can be a fast and efficient way to secure water for instream purposes.
7	Forbearance Agreement or other short term water lease	A legally binding private agreement to temporarily lease water rights for instream use. The agreement sets forth the responsibilities between the project proponent and the landowner and/or water user in terms of amount of water subject to the agreement, the timing and duration of agreement.	Variable; can be paired with a CWC §1707 petition to prevent other water users from taking water forborne. Typically, forbearance agreements are temporary in nature (less than 1 year).	Efficient, locally directed and coordinated; some programs provide compensation to water rights holders, simple to use in areas where there aren't water right holders between diversion and area benefiting from water forborne.
7a	Reverse Auctions (a means of generating Forbearance Agreements)	A reverse auction is a type of auction in which the roles of buyer and seller are reversed. In an ordinary auction (also known as a forward auction), buyers compete to obtain goods or services by offering increasingly higher prices. In a reverse auction, the sellers compete to obtain business from the buyer and prices will typically decrease as the sellers underbid each other. This strategy can be used to determine where the greatest flow benefits can be achieved with the least amount of funding.	Variable, usually short-term.	Can begin to create a market in areas without much market history; can keep price for water down if there are enough players; creates efficiency in the market through the auction; adaptive to changing conditions (e.g., if water is more scarce in a dry year, sellers likely will submit higher bids).
8	Groundwater recharge using surface flows to improve flow quantities in areas that are supported by groundwater	Pilot projects are being tested in the Scott River watershed that diverts winter streamflow to recharge groundwater basins that are connected to streamflow. The goal is to improve and extend the spring and summer baseflows of the river that are supported by groundwater inputs.	Would have to be conducted annually to be effective, or in dry water years.	If test cases are successful, could provide increased reliability/ quantities of groundwater into streams longer into the dry season.

CHALLENGES	EXAMPLES OF WHERE THIS HAS BEEN USED	ENABLING CONDITIONS FOR SUCCESSFUL USE OF THE TOOL	CHANGES NEEDED TO MAKE TOOL MORE USEFUL	SWRCB RECOGNITION/CA WATER CODE SECTION (IF APPLICABLE)
Need to analyze environmental impacts of utilizing new water source; and added costs to implement new water source utilization (i.e., pumping costs).	Upper Shasta River water right holders; Conjunctive use wells along Mill Creek are managed to replace diversions and increase instream flow for salmonid passage.	Need coordination with SGMA agencies responsible for groundwater extraction management through SGMA.	Adequate new source water availability (both to ensure no negative environmental impacts and to reduce the cost of groundwater pumping).	Better understanding of groundwater/surface water connectivity in regions where this is considered.
May allow for instream dedication of ecologically important water by developing storage options for water diverted during times of higher flow.	Navarro (TNC); Mattole (TU and Sanctuary Forest); Russian River (TU); Salmon Creek; and other coastal areas.	Need to understand implication of new season diversion to ecosystem; permitting from SWRCB for new water right and CEQA, ESA, etc., requirements could be costly and timely; site specific studies (SSS) required under North Coast Instream Flow Policy are expensive.	Strong agency support and partnerships; funding to develop the storage facilities; seasonal surplus of water to store; ability to store water; streamlined SWRCB permitting process for North Coast projects with clear fish benefit (North Coast Instream Flow Policy).	Improvements to SWRCB process and streamlined CEQA analysis to provide flexibility with water rights when ecologically beneficial; development of regional or watershed specific Instream Flow (ISF) targets would be helpful in reducing need for expensive SSS.
Conservation easement typically tied to the property in perpetuity; ownership of rights provides options for many other water right exchanges/strategies; can be an expensive way to gain control of water rights. Restricts water diversion on a single property but does not dedicate instream flows unless coupled with a CWC §1707 petition.	Shasta River and Mill Creek (TNC purchased water rights).	Prioritized list of water rights in State for acquisition/easement.	Property/water right owner must be willing to limit their use of the water right in exchange for the revenue or other benefits of the easement.	CWC § 1707 could be used to make instream benefit more permanent and enforceable.
Not recognized by SWRCB so other water right holders can divert flows, appropriative water rights risk losing right to "non-use".	Scott River Water Trust; Shasta River Water Transaction Program (TNC); Russian River and Mattole (TU); used in other states throughout the West.	Strong on-the-ground relationships with landowners. Low/no risk of downstream diversions. If participation lasts more than 5 consecutive years, a CWC § 1707 is recommended for SWRCB recognized water rights.	State/Federal agency buy-in to the programs; funding available for deals; more on the ground entities willing to engage in forbearance agreements in watersheds where there currently are no entities.	N/A, unless Forbearance Agreement leads to more permanent use of water rights for instream purposes or is coupled with a CWC § 1707.
Uncertainty on whether or not you will have participants; due to the need to have a large pool of water users to add to competitive pricing.	TNC Bird Returns- Central Valley; Yakima River tributary reverse water right auction.	Relationships with willing sellers (and/or key influencers) in order to understand/address economic and cultural constraints to water transactions and specifically a reverse auction mechanism. Need enough potential participants to create an active market; need participants to be willing and able to fallow land in short term.	More test cases needed so that it is better understood and utilized. Funders need to be willing to put more towards testing this tool.	N/A, unless Forbearance Agreement leads to more permanent use of water rights for instream purposes.
Getting new water permit could be challenging; protecting the surface water created with groundwater recharge from diversion could be challenging.	Being tested in the Scott River basin.	A clear groundwater/surface water connection; the ability to divert surface flows in times of surplus.	More test cases to determine the efficacy of the tool; streamlined permitting to allow a winter water right for the recharge.	If a winter water right is needed to conduct the project, then SWRCB approval would be required for post 1914 water rights.

ID	STRATEGY	DESCRIPTION	PERMANENCE OF ACTION	BENEFITS
9	Tax Deductions for Stream Flow Restoration	Federal tax deductions for charitable donations drive conservation activity, including the donation of land or conservation easements. Under the Internal Revenue Code §170(a), a taxpayer can receive a federal tax deduction for charitable contributions including gifts of property to a charitable organization, made with charitable intent and without receipt or expectation of receipt of adequate consideration.	The duration of the deduction would correspond with the valuation of the donation: if the donation is made as a one-time, permanent donation of a water right, the deduction would be a one-time deduction.	Tax deductions can incentivize water rights holders to make permanent water rights donations to instream flow purposes.
10	Data to drive informed water management	Improve quality of and access to real-time data on water availability and use. (NOTE: because instream flow strategies are often limited by the availability of stream flow gauges and data, this strategy is seen as a possible catalyst to many other streamflow improvement strategies).	Variable; while gauges and measuring devices can be used in the "long-term," funding for annual data management and gauge maintenance can make these less permanent.	Water rights owner could use information systems to better manage for both irrigation purposes and for local instream conditions; natural resource managers can use information to better manage river systems.
11	Safe Harbor Agreements that include instream flow transfers or forbearance	A Safe Harbor Agreement (SHA) is a voluntary agreement involving private or other non-governmental property owners whose actions contribute to the recovery of species listed as threatened or endangered under the ESA. In exchange for actions that contribute to the recovery of listed species on private lands, participating property owners receive formal assurances that if they fulfill the conditions of the SHA, additional or different management activities by the participants without their consent will not be required.	Depends upon term of the SHA—usually 15–20 years with option for renewal.	Could have long term benefits depending on the Agreement period.
12	Integrated Regional Water Management Planning	Integrated Regional Water Management (IRWM) is a collaborative effort to manage all aspects of water resources in a region. IRWM crosses jurisdictional, watershed, and political boundaries; involves multiple agencies, stakeholders, individuals, and groups; and attempts to address the issues and differing perspectives of all the entities involved through mutually beneficial solutions.	Variable; depends upon the project implemented within the IRWMP.	Largely a mechanism to apply for grants that support planning, water management and conservation activities.
13	Voluntary Cooperative Exchange Agreements	Voluntary contractual agreements spurred by anticipated regulatory action or litigation can provide a wide range of instream flow projects.	Depends upon the exchange agreement; possibilities include CWC §1707; CWC §1725 or not required under some decrees/adjudications.	Variable; maintain minimum flows without litigation or expensive enforcement actions and provide CESA take coverage.
14	Settlement Agreements/ River Accords	Stakeholder agreements for managing watersheds, usually initiated in response to anticipated regulatory or legal action.	Usually mid- to long-term (i.e., 5 to 25 years), but not usually permanent.	Can be very comprehensive, encompassing a wide range of ecological benefits and water management strategies.

3 Russian River water right owners have done some voluntary cooperative agreements to try to mitigate regulatory actions against them for dewatering streams during frost protection events.

CHALLENGES	EXAMPLES OF WHERE THIS HAS BEEN USED	ENABLING CONDITIONS FOR SUCCESSFUL USE OF THE TOOL	CHANGES NEEDED TO MAKE TOOL MORE USEFUL	SWRCB RECOGNITION/CA WATER CODE SECTION (IF APPLICABLE)
This is a new application of IRS Code §170(a), and still relatively untested.	Under this section, the Internal Revenue Service ("IRS") has recently granted federal tax deductions to a handful of water right holders in the western United States who made permanent charitable contributions of entire and partial interests in water rights.	Water user must have adequate annual tax burden to benefit from the deduction, which isn't always the case with rural water users.	More applications of the tool to establish precedents.	Uncertain as to whether or not SWRCB recognition of the water right change is needed to be eligible for the tax deduction.
It is generally costly to install and maintain equipment.	Shasta River, Scott River, Navarro River, Russian River, Salmon Creek and others. Many streams lacking appropriate gauges for stream flow restoration.	Funding for equipment and long term management of systems and data. Willing landowners to have gauging sited on their property, when necessary.	Cost of equipment could go down; funding needed to support purchase of equipment; landowner trainings in use of these technologies; willingness of water user to invest time into using the equipment.	N/A
Uncertainties for landowners regarding legal implications to water rights; not intended to create "recovery" of the species, but to move in the direction of recovery.	Being tested on the Shasta River.	Landowner might need assurances regarding the legal use of the water for instream purposes without forfeiting their water right.	Agency flexibility; landowner willingness; instream flow dedications easily recognized when part of SHAs.	Might entail SWRCB recognition of water rights changes; will depend upon the terms and conditions of the agreement. May be coupled with a CWC § 1707.
Not necessarily a means to an end, but a process to gain access to funding and coordinate water projects.	Numerous regions throughout California.	Requires a time commitment to engage in the process; to date it seems these groups are largely used as a means to get State funding.	Some IRWM regions are more successful than others in coordinating good water projects and procuring funds. Cost/benefit analysis of time commitment wise before engagement.	N/A
Political will and/or resources to regulate or litigate must be demonstrated to spur action. Legal authorities to regulate are uncertain.	The Mill Creek Water Exchange trades summer irrigation flows for spring and fall passage flows. Also being considered as part of Shasta River SHA; Russian River[3]; Pine Gulch in Marin County with Marin RCD; Salmon Creek with Gold Ridge RCD, the Bodega Water Co. and NOAA.	Willing water users; some funding for injury analysis if needed; threat of regulation or litigation must be real.	Political will and/or resources to regulate or litigate must be demonstrated to spur action. Legal authorities to regulate are uncertain.	Might entail SWRCB recognition of water rights changes; will depend upon the terms and conditions of the agreement.
Lengthy, time-consuming process involving multiple stakeholders with divergent interests. Government agencies with competing priorities that limit their ability to stay consistently engaged. Depending on actions, may require act of Congress to approve settlement agreement (i.e., San Joaquin River Restorations Program), which can delay or defeat a settlement.	Klamath Basin, Yuba Accord.	All parties must be motivated to make sweeping changes. Motivation typically derives from anticipated regulatory action (such as changes to water quality standards) or outcome (or potential outcome) of litigation. Because they are negotiated agreements, they involve compromises on all sides.	N/A	Possibly; it would depend upon the agreement.

ID	STRATEGY	DESCRIPTION	PERMANENCE OF ACTION	BENEFITS
15	Policy for Implementation of Water Quality Objectives for Temperature (TMDLs)	Action plans to address temperature impairments in the Mattole, Navarro, and Eel River Watersheds. Authorizes implementation of the USEPA-established temperature TMDLs for these watersheds. Include specific actions and timetables, unlike the more general Temperature Policy.	TMDL policies are in place until water quality goals are achieved, which can be quite long term.	Incorporates activities and priorities related to sustaining flows directly into the Regional Water Quality Control Board Basin Plan.
16	Sustainable Groundwater Management Plans	The Sustainable Groundwater Management Act of 2014 (SGMA) establishes a mandatory process intended to lead to the sustainable management of California groundwater resources in regulated basins within 20 years.[4]	Local agencies will have 20 years to reach sustainability, which will be 2042 for most basins. Annual reporting is required and plans must be updated every 5 years.	Protects against depletions that have adverse impacts on surface waters. Opportunities to implement recharge projects that benefit streamflows. Requires water budgets that identify surface water inflows and outflows.
17	Bay Delta Surface Flow Policies	The SWRCB periodically updates the water quality control plan for the San Francisco Bay/Sacramento–San Joaquin Delta Estuary (the Bay-Delta Plan) to establish water quality objectives for the protection of beneficial uses, including fish and wildlife, in the Plan area.	Unknown.	Water quality control plans such as the Bay-Delta Plan form the basis for the state to take decisive action to allocate and manage water in a manner that addresses ecological needs in the Bay-Delta.
18	DFW Code § 5937	Owners of dams are required to allow sufficient water to flow over, around or through the dam to maintain fish below the dam in good condition.	If enforced by the state, the requirements for adequate flows can be permanent.	If used, could improve fish passage and provide more water for fish below a dam when passage may not be available.
19	DFW Code §1602 (Lake and Streambed Alteration Agreement)	Water diverters are required to get a 1602 permit for any diversion that "substantially diverts or obstructs the natural flow of any river, stream or lake." Many diversions in CA do not have 1602 permits and DFW is considering requiring these as a means of altering diversions to protect instream resources. DFW's authority to require 1602 permits for diversions, even where there is no construction in the stream channel, was upheld in recent litigation.	Permanent see *Siskiyou County Farm Bureau v. Department of Fish and Wildlife* (2015) 237 Cal.App.4th 411.	Requires compliance with legal water rights, fish screens, methods to measure diversion, and must meet CEQA and CESA obligations (this may result in water being left instream as way to meet CESA).
20	Policy for Maintaining Instream Flows in Northern California Coastal Streams (AB 2121)	The Policy establishes principles and guidelines for maintaining instream flows for fishery resources, while minimizing water supply impacts. The geographic scope is coastal streams from the Mattole River to San Francisco and northern San Pablo Bay; in five counties—Marin, Sonoma, and portions of Napa, Mendocino, and Humboldt.	Water rights changes facilitated under the Policy are permanent, though accompanying forbearance agreements and §1707 designations can be temporary.	Enables SWRCB to facilitate water rights actions, permits, and cooperative water management schemes that improve instream flows. Provides guidelines and procedures to ensure that new appropriations or changes to existing permits will not negatively impact instream flows or fish habitat.

4 SGMA is the combination of three bills adopted in the 2014 legislative session (AB 1739, SB 1168, and SB 1319) that amended the California Water Code, and mandates the creation of Groundwater Sustainability Plans (GSPs) for high priority groundwater basins. Sustainable Groundwater Management is defined as the management and use of groundwater in a manner that can be maintained during the planning and implementation horizon of 50 years without causing undesirable results, including depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water.

CHALLENGES	EXAMPLES OF WHERE THIS HAS BEEN USED	ENABLING CONDITIONS	CHANGES NEEDED TO MAKE TOOL MORE USEFUL
Does not create separate authorities or methods for enhancing flows—relies on existing authorities and programs.	Mattole, Eel, Navarro watersheds.	Adequate agency resources for implementing and enforcing. Public funding for projects.	Adequate cooperation from Water Rights Division to address low flows as they pertain to temperature impairments. Easier permitting to implement restoration projects.
Does not have to address impacts that were occurring prior to 2015. Local implementation will result in a range of definitions of "sustainability".	In development across California.	SGMA agencies must develop thresholds for what is considered an unreasonable depletion; the threshold could not be set without consideration of minimum instream flow needs. Agencies must also develop water budgets that consider surface water inflows and outflows, which also requires consideration of minimum instream flows.	Clear distinctions between flow impacts caused by surface water diversions and those caused by groundwater pumping. More information on depletions/recharge relationships between surface water and groundwater. Expansion in geographic coverage of SGMA to include basins where surface water flows relatively uncompromised by groundwater pumping.
The plan is highly contentious, and the likelihood that the State Water Board's final order on flow objectives for the lower San Joaquin River tributaries will be litigated is very high. Litigation over the flow objectives could take several years.	Bay-Delta.	The state needs a more expedited process for implementation. Bay Delta surface flow policies present an opportunity to standardize how to determine necessary instream flows for ecological purposes.	As of early 2017, the Brown administration is leading stakeholder negotiations in an attempt to reach a settlement before the State Water Board issues its orders. To be successful, the negotiations will have to proceed quickly and address a comprehensive solution set that includes flow and non-flow related actions.
Statute is unclear regarding what constitutes maintaining fish in a good condition, how far below the dam the duty extends. Fish ladders can be prohibitively expensive for smaller diversion facilities. Few permits have been reopened to apply 5937.	Cited as impetus for San Joaquin River Restoration Program (by-pass flows); Parks Creek (installed fish ladder); Rank v. Krug: The San Joaquin River Litigation and California's Lone Effort to Assert Section 5937 in Federal Court.	State needs to have appetite to enforce this regulation; has not done so to date.	Clarity on certain terms in the statute. A test case in a good place could be useful to see this more widely utilized. May be a component of DFW Code § 1602.
State agency does not have the staff or agency budget to process the thousands of notices and streambed agreements that are now required of all existing and new diversions. Requires a renewal of an Agreement every 2–5 years which can be burdensome and expensive.	Shasta River, Scott River, and others.	State agency needs staff and budget to process the thousands of notices that will now be required statewide.	DFW to enforce and funding. May complement Fish and Game Code § 5937.
The Policy does not include enforcement authority per se—merely guidelines and principles that make it easier for the Board to conduct business in a manner supportive of instream flows. Also, assertive application of the policy requires proactive and cooperative SWRCB staff. The Policy was just enacted in 2/2014, so the SWRCB is still figuring out how to most effectively apply it.	Whitethorn School Storage and Enforcement Project (TU); American Rivers San Gregorio River Friendly Ag Program.	Need to have users with either riparian or appropriative rights to divert water in the summer during low flows who are willing to forbear using those rights in exchange for winter diversion and storage rights—or in exchange for flexible diversion period rights such that they can fill existing storage during high flow events. Need either existing storage ponds/tanks or funding and space to develop a storage pond/tank.	Permit review process needs to be streamlined and codified so that new projects can be quickly implemented. Development of regional or watershed specific instream flow targets would be helpful in reducing need for expensive site specific studies.

ID	STRATEGY	DESCRIPTION	PERMANENCE OF ACTION	BENEFITS
21	Legal advocacy/litigation (includes Public Trust & Reasonable Use Doctrine)	Litigation seeking to enforce public trust and reasonable use obligations.	Can result in permanent change in the law.	One means of supplementing actions of regulatory agencies to enforce laws.
22	Crackdown on illegal diversions	SWRCB has the authority to take enforcement actions against diversions where there is: 1) no legal basis of right, 2) a violation of an appropriative water right issued by the SWRCB, 3) waste and unreasonable use of water, and 4) adverse impacts to valuable public trust resources.	Short-term enforcement can have long-term benefits.	It has been estimated that in some watersheds that support endangered or threatened anadromous fish, the level of unauthorized diversion is as high as 77%, and in some cases, has been occurring for decades.
23	SWRCB Curtailment Actions	In 2014 the SWRCB conducted curtailment actions, including notices of unavailability of water for diversion, and curtailment orders, against junior water rights holders in the Russian River, Scott River and specified Sacramento River tributaries.	Curtailments were based on permanent water right law that gives priority to diverters with the oldest rights. Temporary drought regulations allowed for enhanced enforcement against violators.	Curtailment enforcement has proven to be a challenge.
24	Land Use and Zoning Ordinances	Local ordinances developed and adopted in response to growers proactively address concerns regarding the negative impacts on flows from frost protection. Requires vineyards to register with County and disclose its frost protection systems.	Can result in long-term protection.	Has buy-in of grape growers because developed in collaboration with them.
25	FERC Relicensing of Hydropower Projects	As part of the relicensing process, the Federal Power act requires "equal consideration" of four factors including "adequate protection, mitigation and enhancement of fish and wildlife". Relicensing is subject to water quality certification, as part of which the state may set instream flow, fish passage, temperature control, or other water quality control requirements.	Relicensing and related conditions can be for 30 to 50-year terms.	Improvements such as increased instream flows are required of the licensees and do not require other public or private funding.
26	Dam Reoperation/Decommissioning	There is a growing movement in the country to remove dams where their negative impacts outweigh their benefits and 1,185 have already been decommissioned in the U.S. There are over 1,400 large dams in California and tens of thousands of smaller impoundments that would be candidates for removal.	Long-term to permanent.	Dams can negatively impact ecological flows in numerous ways by reducing streamflows, by flattening hydrographs and eliminating natural variability, altering water temperatures, and blocking nutrient flow and wildlife passage.

CHALLENGES	EXAMPLES OF WHERE THIS HAS BEEN USED	ENABLING CONDITIONS	CHANGES NEEDED TO MAKE TOOL MORE USEFUL
Litigation is very time-consuming with uncertain outcomes. An adverse ruling (i.e., a ruling that goes counter to the desired public trust outcome) could have wide-ranging impacts.	National Audubon Society v. Superior Court–Mono Lake Environmental Law Foundation v. County of Siskiyou– Scott River	Entity willing to take on lawsuit; can be very costly and time consuming, and contentious; could cause potential willing lessors or sellers to not participate in voluntary programs.	N/A
SWRCB is widely considered to not have adequate funding to enforce illegal diversions.	DFW has conducted enforcement actions in Region 1 and Region 5 against marijuana growers; SWRCB has conducted "sweeps" of illegal ponds and diversions in Napa, Sonoma, Mendocino and Marin in 2011-14.	Substantial state budget for enforcement of SWRCB and DFW regulations against illegal marijuana diversions.	Meaningful enforcement actions against illegal diversions will require better funding for DFW and SWRCB, better science and technical support to identify violations and prioritize enforcement actions, and improved water accounting.
Contentious and has generated litigation. Very difficult to enforce given limited resources.	Russian River, Sacramento River (Mill, Deer, Antelope Creeks), Scott River.	More agency resources for enforcement.	More agency resources for enforcement.
No teeth—largely ineffective. Is merely a registration program—doesn't prescribe behaviors or provide incentives to drive good water management.	Sonoma County, Russian River.	Incentives for landowners to participate and change water management to benefit fish.	More biologically defensible guidelines for landowners participating in the program. Consequences for non-compliance with guidelines.
Opportunities are limited and the process is technical and time consuming.	Pit, Feather, Yuba and American Rivers.	Parties (e.g., conservation advocates, regulators, applicants) must engage in the technical analysis and negotiations over a multi-year period and devote substantial resources.	N/A
Permitting, loss of water supply and other beneficial uses of water (e.g., recreation, power generation, etc.).	Since 1990, 970 dams have been decommissioned and removed in the US. In 2014, the National Park Service completed largest dam removal project in the world on the Elwah River. Also in 2014, 12 dams were removed in California in order to restore flows and habitat. 4 dams are slated for removal on the Klamath.	Demands for dam removal typically require very strong public support from a variety of stakeholder groups; legal challenge to dam operations based on §5937, FERC Relicensing requirements, or public trust obligations; limited flood control or power generation utility for the dam.	N/A

ID	STRATEGY	DESCRIPTION	PERMANENCE OF ACTION	BENEFITS
27	Ballot Initiative Process	The ballot initiative process is a well-developed and heavily utilized public policy tool in California. Through this process, interest groups can petition to put spending and policy measures before the electorate. The legislature is also required to use the process to put general obligation bonds up for a public vote.	N/A	The process is a well-established method for achieving broad funding and policy changes that the state legislature does not have the political will to implement. For instance, Prop 1 in 2014 generated significant funding for streamflow enhancement; and in 2015, conservation organizations ensured that 2016 marijuana legalization initiative included provisions to mitigate marijuana cultivation's impacts on streamflows.
28	Formal Adjudication Process	Water rights in most basins in California are not carefully monitored or quantified. However, in basins where there are strongly competing demands for water, the SWRCB and/or courts may undertake formal adjudications of water rights. Adjudication processes result in an enforceable order allocating the water (and the water rights) in the adjudicated stream system. Typically, a "water master" is assigned to monitor and enforce the allocations.	Highly permanent.	Adjudications can provide an important legal framework for monitoring and protecting instream flows from illegal water diversions. The public trust may even be considered in such adjudication, though the procedure has never been invoked for this purpose.
29	Tribal Nations Strategies and the Federal Reserved Rights Doctrine	The federal reserved rights doctrine holds that the U.S. federal government may explicitly or impliedly reserve water independent of state appropriation laws when it reserves public land. California Indian tribes are interested in quantifying and using their reserved water rights.	Highly permanent.	Northern California tribes have leveraged other types of reserved federal water and fishing rights to restore flows and fisheries on the Klamath River. The tribes used their federal rights to justify their involvement in two impactful lawsuits against the dam operators.
30	Mitigation Fees and Supplemental Environmental Projects (SEPs)	California has a variety of mitigation programs that either assess mitigation fees from developers in order to address the public costs or impacts associated with development projects; or allow entities that violate environmental laws to satisfy their fines through a mitigation project. SWRCB or Regional Water Boards may allow a violating discharger to fulfill part of its fines by completing or funding Supplemental Environmental Projects (SEPs). These projects provide some kind of public benefit and can either be performed by the discharger or by a third-party such as a conservation organization.	Variable.	SWRCB SEP project examples include those that benefit streamflows through monitoring programs; studies or investigations; "wetland, stream, or other waterbody protection, restoration or creation"; stream augmentation; watershed assessment; watershed management facilitation services.

CHALLENGES	EXAMPLES OF WHERE THIS HAS BEEN USED	ENABLING CONDITIONS	CHANGES NEEDED TO MAKE TOOL MORE USEFUL
The ballot initiative process is expensive and time consuming. General obligation bonds are an unreliable funding source for flow enhancement. There's a need to establish better public funding sources to support the science, planning, and enforcement activities necessary for a comprehensive water supply management system such as the fee-based program used in California Energy Commission's Public Interest Energy Research (PIER) program.	Approval of the first modern water code (1914), the Central Valley Project (1933), the "reasonable use" provisions of the California constitution (1928), the State Water Project (1960). General obligation bonds have become a major mechanism for funding state water related activity.	Significant financial resources to support a statewide campaign.	N/A
While, in theory, adjudication is an excellent tool for establishing trackable and enforceable water rights allocations that are protective of instream flow objectives, in reality it is an expensive and cumbersome tool. Because adjudications establish the final, enforceable priorities, amounts, and conditions of all water rights in the affected system, basin-wide adjudication processes are extremely costly and can take decades to complete.	In the Klamath Basin, the adjudication process was used to determine what water is available for a variety of ecological purposes including instream flows for the wild and scenic portion of the Klamath River.	N/A	N/A
To date, tribal water rights have not played a major role in California instream flows, especially compared to the significant role they have played in states such as Arizona. The federal reserve doctrine has limited application with respect to protecting or restoring instream flows, because a court may only find an implied reservation for the amount of water necessary to achieve the primary purpose of the reservation.	Arizona, Klamath River.	N/A	Research of where tribal lands in California overlap with priority streams—and whether these tribal holdings have federal reserved water rights.
Unfortunately, the SWRCB SEP program is not heavily utilized in the state.	N/A	A SWRCB or Regional Board water quality violator who is interested in supporting a conservation project in lieu of paying a fine.	More engagement by conservation groups to create fundable projects, and better promotion by the state. Conservation groups could create a streamflow mitigation project similar to the Environmental Enhancement and Mitigation Program which grants $7 million /year for projects that mitigate the environmental impacts of transportation facilities.

ID	STRATEGY	DESCRIPTION
31	Forest thinning/fuel reduction	Large-scale mechanical removal of conifer trees or prescribed fire to reduce numbers of trees to increase water yield in targeted watersheds.
32	Marsh/meadow or riparian restoration	Protection through fencing out cattle, planting riparian/wetland plants and/or "plug and pond" activities can restore habitat that surrounds stream system.
33	Beaver dam analogs	Reintroducing beavers in a watershed so that the beaver dams are naturally created by the beavers; or mechanically create beaver dam analogs so as to achieve same effect.
34	Invasive plant removal	Mechanical removal of invasive plant species in a riparian zone or within the watershed can help reduce unnatural levels of evapotranspiration from the stream system.
35	Large wood augmentation	Restoration including augmentation of stream systems with large wood structures is a commonly used restoration strategy, particularly in North Coast streams.
36	Improved Water Accounting by State	Improved water accounting is necessary to inform water allocation and management decisions across much of California. In addition, without solid information on water availability and water use (diversions) in a given location, many of the strategies we highlight in this report are difficult to implement effectively. For example, although added water for the environment may be secured through 1707 dedications, storage and forbearance, SHAs or other approaches, ensuring it stays instream and achieves the desired benefits requires accounting for that water downstream.
37	Legal Reform of Water Rights System	Efforts to restore ecological flows are subject to the government's competing (and often conflicting) legal mandates to protect long standing private vested rights under the prior appropriation and riparian rights system and to preserve natural resources that are part of the public trust. Wholesale legal reform of the water rights system would entail unsettling long-standing and economically valuable vested property interests. Such reforms require significant resources to work in a geographically disbursed area, and with all three branches of government at the federal, state, and local levels. It also requires a depth of technical expertise in the legislative and regulatory arenas; scientific expertise related to planning and permitting activities; and legal expertise with litigation and administrative adjudicatory processes.
38	State Purchase of Environmental Water Rights	Environmental flows are determined and provided primarily through government regulation, rather than through vested water rights created for the environment. In contrast, Australia has reformed its water management policy regime so that the state can purchase water rights for the environment as well as sell or lease water to raise funds for other restoration projects.

RATIONALE	BENEFITS	CHANGES NEEDED TO MAKE TOOL MORE USEFUL
Unnaturally dense forests resulting from human activity (i.e., fire suppression and logging) alters the natural hydrograph of a stream.	Some reports indicate that a threefold increase in forest thinning could result in a 6 percent increase in mean streamflow in some watersheds.	N/A
Streambank erosion and channel incision disconnects the stream from the floodplain. Restoration of riparian areas and adjacent meadows or wetlands can increase the connectivity between the stream and the floodplain which allows the system to hold and maintain water longer into the hot, dry summer months.	Some early studies have shown that meadow and restoration projects can increase the water supply of a watershed and improve the timing of water availability.	N/A
Beavers, which have been greatly reduced or eliminated throughout the West, historically played a large role in stream function. Beaver dams create complexity within the stream which slows and dissipates the water. Similar to meadow restoration, beaver dams allow the system to hold and maintain water longer in the season.	Studies have shown beaver dams promote higher infiltration of surface water into the subsurface and water was retained longer in the system during high flows. Additional studies have indicated an increase in flows in some stretches of stream during drier, low-flow periods.	N/A
Some invasive plants out compete and densely cover riparian areas creating a high demand for water. Removal of these plants will help increase water availability for native species and for stream flow.	Improve surface water availability.	N/A
Large wood structures can be an important part of river restoration actions, creating improved habitat structure for invertebrates, juvenile salmonids, and other species. Additional benefits of large wood augmentation include improved environmental flows, particularly in systems with extreme low flows or intermittent flows.	Large wood structures can serve to slow down flows, provide deep pool refugia during times of critical low flows, and provide cool temperature refugia for salmonids and other temperature-sensitive species.	N/A
Improved water accounting, accompanied by better quantitative representation of water flows and uses, is essential for the effective administration of water rights. These changes will become increasingly important for improving management and reducing conflicts as water becomes more scarce under climate change and drought scenarios.	With improved tracking and monitoring of actual water needs and use, the state can more effectively allocate water for high priority uses and protect public trust resources; monitor, identify, and enforce against illegal diverters; and determine which areas have surplus water available for potential distribution to meet environmental flow needs.	Improved accounting will require advances in field data collection, hydrologic modeling, and more accurately tracking water diversions and in-stream water availability. Comprehensive implementation of SB88 would be a solid step in the right direction.
The existing water rights system is arguably the most complex in the western U.S. and has resulted in a framework that stifles attempts at water allocation and management that meets the needs of both people and nature.	While reform of the western water law framework at play in California would be daunting, it is not impossible or even unprecedented. The Sustainable Groundwater Management Act of 2014 is one example of a significant step towards a more rational water law framework. In addition, in the 1990's Australia undertook a massive effort to reform the legal framework governing water allocations in order to protect critical human needs first while also supporting watershed sustainability by restoring and protecting instream flows. Subsequent state water law changes effectively dismantled previous water rights frameworks in favor of an entitlement system based on volumetric "sharing the shortage," after accounting for critical human and environmental needs. Nevada is currently pilot testing this approach in a few watersheds.	Change would require a very strong legislative mandate as well as on the ground demonstrations to test alternative management approaches.
California could likely benefit from similar policies given that it faces similar water challenges as Australia.	This would result in a dedicated source of water to be used explicitly for environmental benefit.	A source of funding, and adequate revenues to support that funding plus a governance structure, must be identified.

APPENDIX B

Mapping the geographic potential of select strategies: description of methods

When statewide geospatial data were sufficient, we mapped where various strategies could be applied with greatest benefit to freshwater species. Such analyses can be useful in prioritizing where to focus application and implementation efforts, and in estimating potential return on investment. Mapped strategies included: 1) water right changes, specifically §1707 dedications of water instream, 2) endangered species-related strategies, namely Safe Harbor Agreements, and 3) small-scale storage and forbearance strategies. Our approach involved combining spatially explicit information on the distribution of freshwater conservation targets (i.e., Freshwater Conservation Value), and the extent of a set of enabling conditions needed for a particular strategy to be successful (i.e., Opportunity Score).

Together, these data allowed us to generate a map of potential places for engagement for these three strategies where the conservation benefit is high and the enabling conditions are met. Finally, we generated a summary map combining data from the three maps, which identifies watersheds where one or more strategies could be employed to provide maximum conservation benefit. Below we describe the methods carried out for each analysis.

1) WATER RIGHT CHANGES / SECTION 1707 DEDICATIONS OF WATER INSTREAM

For this assessment, we sought to evaluate where §1707 dedications could best be applied across the state of California to have the greatest impact on freshwater biota. By mapping the enabling conditions (or "opportunities") for §1707s, and combining that information with data on freshwater conservation values in each watershed, we were able to estimate the potential of this strategy in each of California's watersheds, and to generate a list of 20 watersheds where the potential is likely to be greatest.

STEP ONE – FRESHWATER CONSERVATION VALUE. Step one of this analysis focused on quantifying Freshwater Conservation Value. Data layers for this portion included:

A. **Rarity Weighted Richness Index (RWRI).** We used the Rarity Weighted Richness Index (RWRI) (Albuquerque and Beier 2015) for freshwater species based on the California Freshwater Species Database Version 2.0.8 (Howard et al. 2015). We used species level observations, but excluded birds because they typically require wetland habitat and not stream flow habitat, and this mapping effort focused on identifying areas for instream §1707 dedications. We weighted species based on their conservation significance, with listed species (California and Federal ESA) receiving a weight of 3, vulnerable/endemic species a weight of 2, and all other species a weight of 1 (See Howard et al. 2015 for a description of how these groups were identified). We used only current observations of species to focus strategies around the locations where species are currently found. We also included data on "extant range – expert opinion" from the Pisces fish database (coded as observation type = professional judgement) because this dataset included many rounds of expert review to highlight the places fish are known to exist based on expert opinion (Santos et al. 2014). After normalizing the raw RWRI score (taking the score for each watershed, dividing by the maximum score for all watersheds, and then multiplying by 100), we found the data were highly skewed (94.3% of the watersheds had a normalize score between 0 and 10). Because we needed to combine these data with other data, we wanted a more normal distribution of scores, so we experimented with a variety of transformation methods. We found that by multiplying the raw RWRI score by 1,000, adding 1 to remove any zero values, and then taking the log (base 10) of that value, we were able to generate a normal distribution of data. We then normalized the transformed data to generate a score of 0–100.

B. **SalmonScape.** The Nature Conservancy's 2011 SalmonScape analysis identified the top watersheds for salmon conservation, based on evaluation of where population and habitat conditions are best suited to maintain current viable populations or to restore populations in areas of high habitat integrity (Howard et al. 2011). This analysis of high ranking watersheds (scoring 80–100 using Zonation software) is called the "SalmonScape". This analysis also used steram routing to incorporate connectivity into the results. We used these high ranking SalmonScape watersheds and scored them based on the Zonation score. Since these scores were generated based on a ranking, we did not need to transform them.

These data were calculated at the HUC12 watershed scale, and an overall Freshwater Conservation Value was calculated as the weighted sum of the two components, with weights of 0.8 for the RWRI score for all freshwater species and 0.2 for the SalmonScape score for salmonids.

STEP TWO – CALCULATING THE OPPORTUNITY SCORE. In this phase of the analysis, we considered conditions that were important contributors to the implementation of §1707 dedications and that could be consistently mapped at a statewide scale. A weighted sum of four data layers comprised this "opportunity score", including:

A. Whether the watershed had an adjudication or not, exclusive of groundwater adjudications (weighted 40%), and including surface water adjudications classified as 'Court Reference', 'Other', 'Statutory Adjudication' (SWRCB 2002). This map did not include the Truckee River watershed which is covered by the 'Truckee River Operating Agreement' and is managed very similarly to a surface water adjudication (U.S. Bureau of Reclamation 2008). We scored this factor in a binary fashion (100 if there was adjudication, 0 if not). Rationale: Adjudications make §1707 and other water right change processes easier to evaluate and implement.

B. The acreage of low value crop in the watershed (weighted 25%), including low value crops receiving less than $3,000 in revenue in 2012 per acre harvested. Crop acreage was based on CropScape 2014 data (U.S.D.A. National Agricultural Statistics Service 2015) and crop value was determined from the 2012 California Census of Agriculture (U.S.D.A. National Agricultural Statistics Service 2012). A score from 0–100 was generated for each watershed based on the number of acres within each watershed. Data were skewed so they were multiplied by 100, increased by 1 to remove any zero values, log (base 10) transformed, and normalized by dividing by the maximum value and multiplying by 100. Rationale: Low value cropland (often growing annual crops such as alfalfa, corn, and soybeans) can be fallowed to provide instream flows, whereas high value cropland requires irrigation and has less flexibility for dedication of water instream.

C. The number of water right holders in the watershed (weighted 25%), limited to those with appropriative rights.The location and owner name of each water right was based on the point of diversion as derived from California's electronic water rights management system (eWRIMS) (Grantham and Viers 2014). We wanted to score a watershed with only 1 owner with the highest score, and then have the score decline quickly as the number of owners increased, so we chose an exponential decay scoring function. A score from 0–100 was generated based on the number of unique water right owners in a watershed (count), as follows: 100 * 0.75 ^ (count – 1). We also set the score to 0 if there were no appropriative rights in a watershed. Rationale: The fewer people that own water rights in a watershed, the greater the contribution of any individual water right holder, and the easier it is to monitor compliance and ensure the water remains instream.

D. The number of active USGS and DWR stream gauges in the watershed (weighted 10%). We mapped active stream gauges in California by downloading all of the stream gauge data for California from the USGS site service (U.S. Geological Survey 2016). We then filtered out gauges on artificial structures by searching the gauge name label for things like "Channel" or "Tunnel" or "Pipeline". We then filtered out inactive gauges by removing any gauge that did not report data in the last year. We performed a similar process for stream gauges with data recorded on the California Data Exchange Center (California Department of Water Resources 2015). We then summarized the count of active stream gauges by watershed. The data were skewed so they were multiplied by 10, increased by 1 to remove any zero values, log (base 10) transformed, and normalized by dividing by the maximum value and multiplying by 100. Rationale: More extensive streamflow gauging provides essential data for review and implementation of §1707 dedications.

These data were averaged at the HUC12 scale, and an overall Opportunity Score was calculated as the weighted sum of the four components. The final step of this analysis involved combining the Freshwater Conservation Value and the Opportunity Score to give an overall prioritization of watersheds for §1707 dedication. We then aggregated the data to larger summary unit watersheds that better reflect entire river systems or major branches of the largest river systems. We aggregated the data by calculating an area weighted average of the HUC12's Freshwater Conservation Value and Opportunity Score for each summary unit watershed. Z-scores of the area weighted averages were calculated to enable standardized comparison of values (e.g., a z-score of zero indicates the watershed is equal to the mean, +1 indicates the watershed is one standard deviation above the mean, and -1 indicates the watershed is one standard deviation below the mean). The Freshwater Conservation Value and Opportunity Score z-scores were then summed to yield a final prioritization of watersheds. This analysis identified high priority areas for implementation of §1707 dedications (Figure B-1). Highest priority watersheds for §1707 implementation include (in order of greatest conservation benefit as scored from the Freshwater Conservation Value z-score): San Pablo Bay, Scott Creek, Aptos Creek, Butte Creek, Cooksie Creek, Inks Creek, Redwood Creek, Pinole Creek, Singer Creek, San Pedro Creek, Lake Tahoe, Scott River, Soquel Creek, Cow Creek, Middle Fork Feather River, Truckee River, East Branch North Fork Feather, Pruisima Creek, Stanislaus River, and West Walker. Successful implementation of §1707 dedications in these watersheds stand to bring the greatest freshwater conservation benefit and have the most promising enabling conditions.

2) SEASON OF DIVERSION CHANGES AND DEVELOPMENT OF SMALL-SCALE OFF-STREAM STORAGE AND FORBEARANCE OPTIONS

STEP ONE – FRESHWATER CONSERVATION VALUE. This was calculated identically as described in Step One for the §1707 dedication strategy.

STEP TWO – CALCULATING THE OPPORTUNITY SCORE. In this phase of the analysis, we considered conditions that were important contributors to the implementation of seasonal water use changes, and specifically those using a storage and forbearance strategy (often referred to as "tank and forbearance" but can also include off-stream storage ponds). A weighted sum of three data layers comprised this "opportunity score", including:

A. The inverse of the percentage of average annual flow that is currently captured by dams and diversions (weight 50%). We estimated dam capacity using the National Inventory of Dams (U.S. Army Corps of Engineers 2016) and diversion amount based on the face value of appropriative water rights (Grantham and Viers 2014). We calculated the total upstream dam capacity and diversion amount for each stream segment using a routed stream network (Horizon Systems et al. 2009). We then compared the accumulated dam capacity and diversions to the estimated average annual flow (as calculated using the Vogel method) in the NHD v1 dataset. To convert the stream network to the HUC12 watersheds, we used the value of the furthest downstream reach in the HUC12 watershed, since projects on tributaries will affect flows in the mainstem, and we wanted to target areas with minimal impairment on the mainstem. Data were extremely skewed so they were multiplied by 1 trillion, increased by 1 to remove any zero values, log (base 10) transformed, and normalized by dividing by the maximum value and multiplying by 100. Rationale: Dams reduce high season flows, so watersheds with many dams are not good candidates for this strategy because additional diversion for storage may not be feasible, and may have detrimental ecological impacts on instream biota. Water rights holders also divert water, so areas with fewer permitted diversions are better candidates.

B. Rural residents in a watershed not served by a water agency (weight 25%). A score of 0–100 was generated based on the normalized count of people in rural census blocks in 2010 (U.S. Census Bureau 2010), excluding urban census blocks and those census blocks whose center overlapped with a water agency boundary. Water agency boundaries were mapped by the U.S. Bureau of Reclamation (U.S. Bureau of Reclamation and California Department of Water Resources 2009) and by an internal analysis conducted by The Nature Conservancy (Klausmeyer and Fitzgerald 2012). Data were skewed so they were increased by 1 to remove any zero values, log (base 10) transformed, and normalized by dividing by the maximum value and multiplying by 100. Rationale: Rural residents not served by a public water agency are more likely to be diverting water from the stream and are therefore more likely to be interested in a storage and forbearance strategy to improve their water security.

C. The percentage of residents and agricultural interests without groundwater access (weight 25%). A score of 0–100 was generated based on the percent of the watershed that did not overlap a mapped groundwater basin (California Department of Water Resources 2014). Rationale: Farmers and residents without access to groundwater are more likely to be interested in a storage strategy to improve their water security.

We combined the Freshwater Conservation Value and the Opportunity Score, as described above, to give an overall prioritization of watersheds for seasonal water use changes/storage and forbearance strategies (Figure B-2). Highest priority watersheds for implementation include (in order of greatest conservation benefit): San Vicente Creek, Chorro Creek, San Pablo Bay, Maple Creek, Tomales Bay, Scott Creek, Russian Gulch, Deer Creek, Caspar Creek, Limekiln Creek, San Luis Obispo Creek, Denniston Creek, Big Sur River, Gazos Creek, Salmon Creek, San Francisquito Creek, San Lorenzo River, Pico Creek, Pescadero Creek, and Lagunitas Creek.

3) ENDANGERED SPECIES-RELATED STRATEGIES: FOCUS ON SAFE HARBOR AGREEMENTS

STEP ONE – FRESHWATER CONSERVATION VALUE. This was calculated identically as described in Step One for the §1707 dedication strategy.

STEP TWO – CALCULATING THE OPPORTUNITY SCORE. In this phase of the analysis, we considered conditions that were important contributors to the implementation of Safe Harbor Agreements (SHAs), which should also apply to other endangered species-related strategies such as Endangered Species Settlement Agreements and Habitat Conservation Plans. A weighted sum of four data layers comprised this "opportunity score", including:

A. The count of the listed species in the watershed (weight 50%). We used data collected for the California Freshwater Species database (Howard et al. 2015) and included both state and federally listed species with observations categorized as current observations, critical habitat, professional judgement, and observations with undefined date. We generated a score from 0–100 based on the species count. Data were skewed so they were increased by 1 to remove any zeros, log (base 10) transformed, and normalized by dividing by the maximum value and multiplying by 100. Rationale: SHAs and other similar strategies rely on the presence of one or more endangered species. Landowners participating in an SHA receive regulatory assurances that protect them from unintentional "take" of endangered species on their property.

B. The degree of water rights over-allocation (weight 25%). The score was based on the ratio of volume of upstream appropriative rights relative to the average annual stream flow (Grantham and Viers 2014). A score from 0–100 was based on the ratio of rights to flow. Data were highly skewed so they were multiplied by 10M, increased by 1 to remove zero values, log (base 10) transformed, and normalized by dividing by the maximum value and multiplying by 100. Rationale: Greater over-allocation leads to an increased likelihood of landowner participation.

C. Presence of total maximum daily load (TMDL) regulations for flow and/or temperature (weight 15%). A score of 100 was assigned if any of the streams in the watershed had a TMDL listing, 0 if otherwise (SWRCB and U.S. Environmental Protection Agency 2012). Rationale: The presence of a TMDL regulation increases the likelihood of landowner participation, as SHA-related activities could help to meet TMDL requirements.

D. The percent of the watershed with agricultural land use (weight 10%). We used 2014 CropScape data to quantify the percent of the watershed in agriculture, and generated a score from 0–100 based on this percentage (U.S.D.A. National Agricultural Statistics Service 2015). Data were highly skewed so they were multiplied by 1M, increased by 1 to remove zero values, log (base 10) transformed, and normalized by dividing by the maximum value and multiplying by 100. Rationale: Greater agricultural land use increases the opportunity, as SHAs are geared toward agricultural water users.

We combined the Freshwater Conservation Value and the Opportunity Score, as described in previous examples, to give an overall prioritization of watersheds for Safe Harbor Agreements and similar endangered species strategies (Figure B-3). Highest priority watersheds for implementation include (in order of greatest conservation benefit): San Vicente Creek, Chorro Creek, San Pablo Bay, Maple Creek, Tomales Bay, Russian Gulch, Aptos Creek, Butte Creek, San Luis Obispo Creek, Denniston Creek, San Francisquito Creek, San Lorenzo River, Pico Creek, San Simeon Creek, Pescadero Creek, Pinole Creek, San Pedro Creek, San Francisco Bay, Sacramento River, and Morrison Creek.

4) SUMMARY MAP OF SELECTED STRATEGIES

Finally, we generated a summary map of all three strategies, indicating across the state where one or more of the selected strategies is likely to have the essential enabling conditions, and to generate flows that have significant conservation benefit (Figure B-4). This map indicates which watersheds (or regions) have the most to gain from these types of voluntary and cooperative strategies, and where several different types of strategies may be deployed to enhance flows. To produce this map, we summed the Freshwater Conservation Value Z-scores and the Opportunity Z-scores across all three strategies at the summary watershed scale (§1707 dedications, storage and forbearance, and Safe Harbor Agreements).

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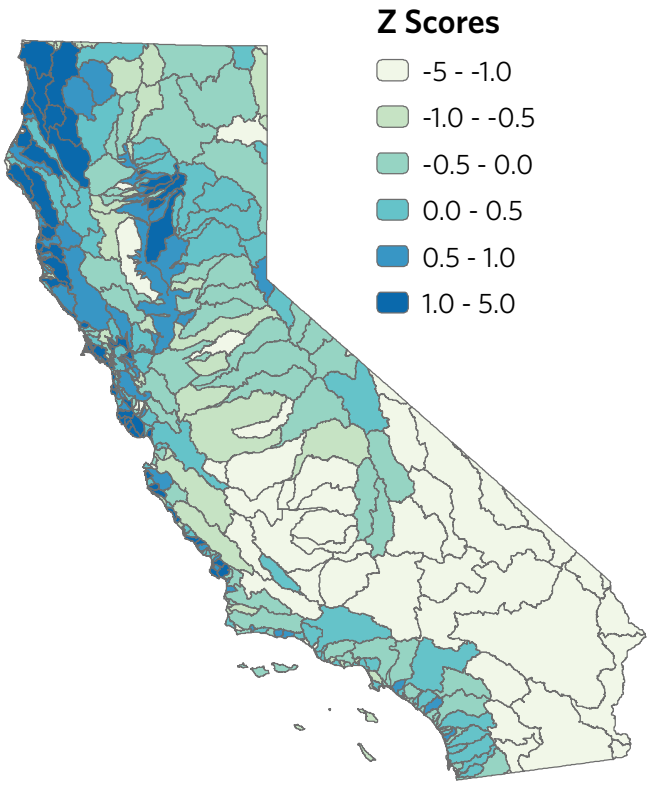
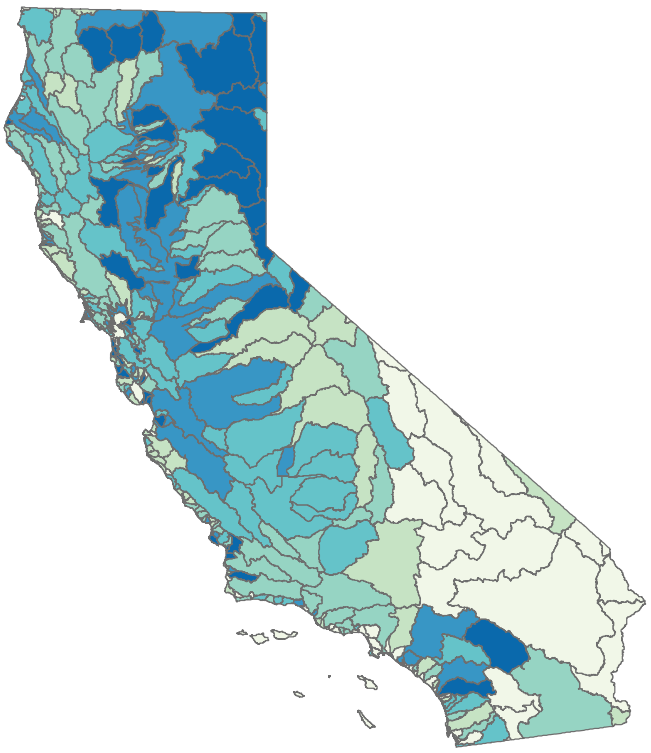
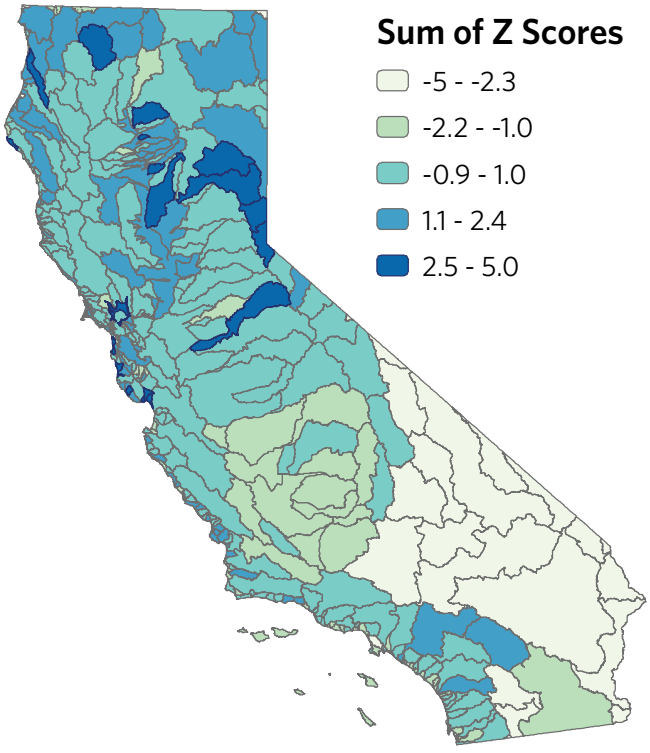
FIGURE B-1. Geographic footprint of §1707 dedications of water in-stream. Freshwater Conservation Value (panel A) and Opportunity Score (panel B) for each watershed were calculated, and the combination of these panels (via summation; panel C) generated the final ranking of watersheds. The z-score value for each watershed indicates the number of standard deviations that watershed is above (+ scores) or below (– scores) the mean value of all watersheds combined. The table lists the top 20 watersheds where this strategy could be used to maximize ecological benefit.



A: Freshwater Conservation Value (FCV)



B: Opportunity Score (OPP)

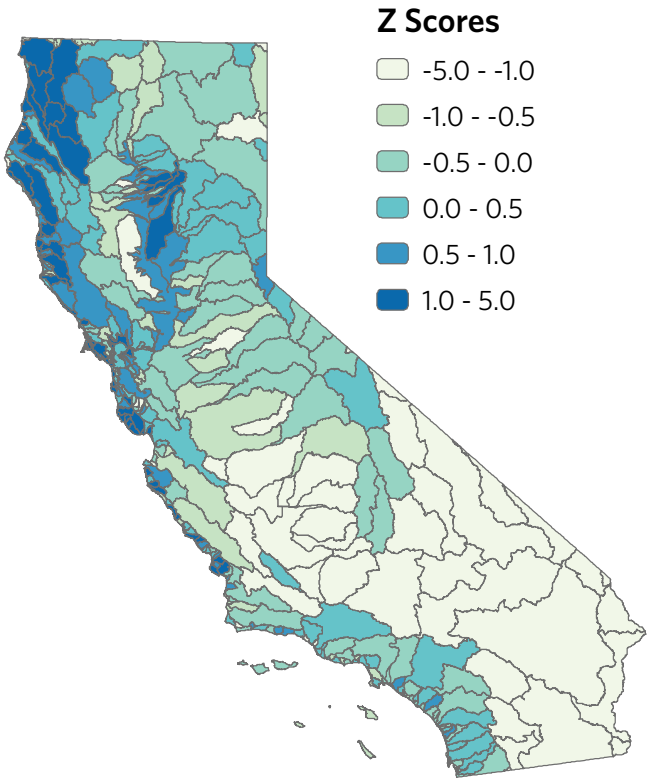


C: Freshwater Conservation plus Opportunity (Sum)

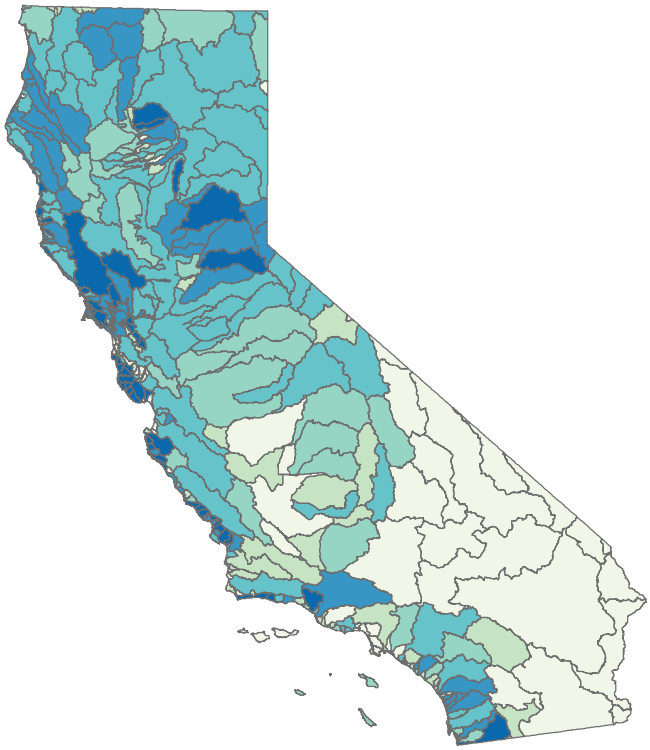
Top 20 Watersheds

Watershed Name	FCV	OPP	Sum
San Pablo Bay	2.2	0.6	2.7
Scott Creek	1.9	0.6	2.6
Aptos Creek	1.9	1.2	3.1
Butte Creek	1.8	2.4	4.2
Cooksie Creek	1.7	0.9	2.7
Inks Creek	1.5	1.1	2.6
Redwood Creek	1.5	1.0	2.4
Pinole Creek	1.2	1.1	2.3
Singer Creek	1.1	1.6	2.7
San Pedro Creek	1.0	3.4	4.4
Lake Tahoe	0.9	2.1	3.0
Scott River	0.5	3.2	3.7
Soquel Creek	0.4	2.3	2.6
Cow Creek	0.3	2.8	3.1
Middle Fork Feather River	0.2	2.2	2.4
Truckee River	0.2	3.0	3.2
East Branch North Fork Feather	0.1	2.3	2.4
Pruisima Creek	0.0	2.6	2.5
Stanislaus River	-0.1	2.6	2.4
West Walker	-0.3	2.6	2.3

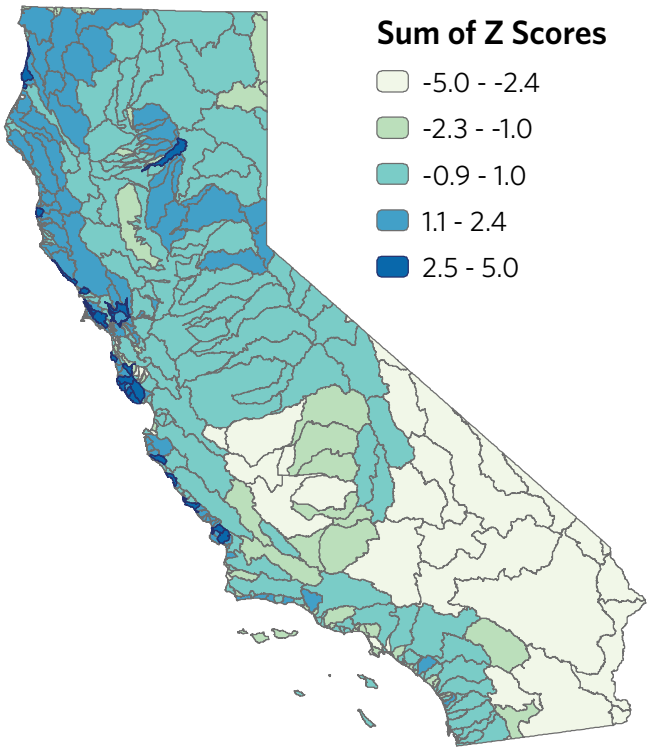
FIGURE B-2. Geographic footprint of small-scale storage and forbearance approaches to enhancing environmental flows. Freshwater Conservation Value (panel A) and Opportunity Score (panel B) for each watershed were calculated, and the combination of these panels (via summation; panel C) generated the final ranking of watersheds. The z-score value for each watershed indicates the number of standard deviations that watershed is above (+ scores) or below (– scores) the mean value of all watersheds combined. The table lists the top 20 watersheds where this strategy could be used to maximize ecological benefit.



A: Freshwater Conservation Value (FCV)



B: Opportunity Score (OPP)

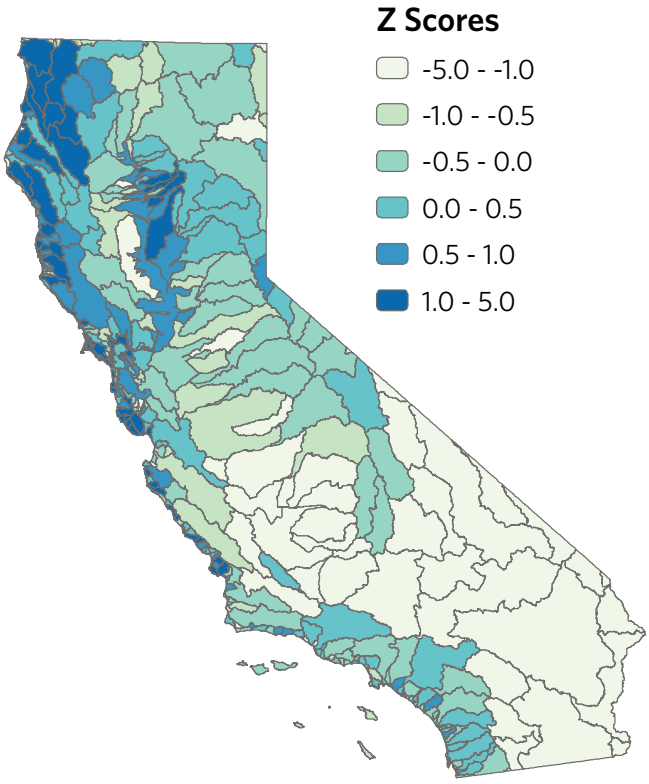


C: Freshwater Conservation plus Opportunity (Sum)

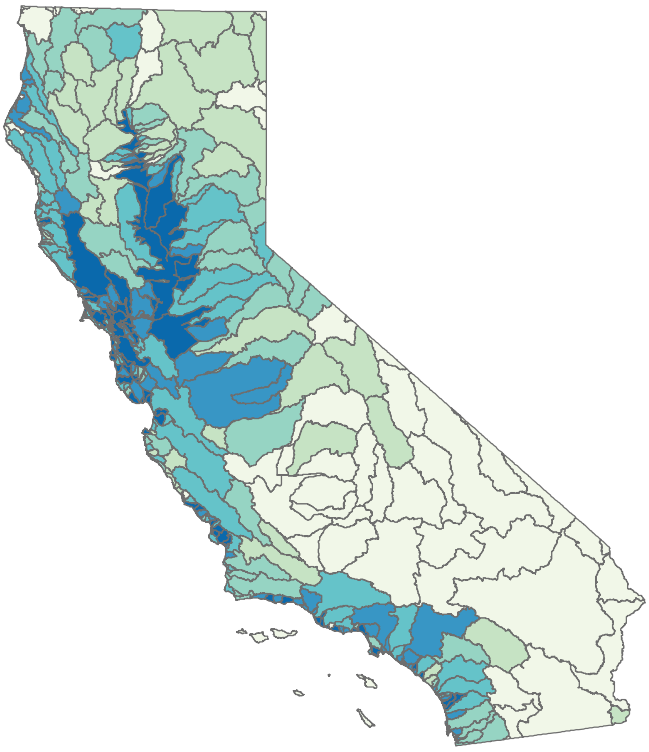
Top 20 Watersheds

Watershed Name	FCV	OPP	Sum
San Vicente Creek	2.2	1.4	3.6
Chorro Creek	2.2	1.3	3.4
San Pablo Bay	2.2	0.7	2.8
Maple Creek	2.1	0.7	2.8
Tomales Bay	2.0	1.5	3.5
Scott Creek	1.9	1.7	3.7
Russian Gulch	1.9	0.7	2.6
Deer Creek	1.8	0.6	2.4
Caspar Creek	1.8	1.1	2.9
Limekiln Creek	1.7	1.0	2.7
San Luis Obispo Creek	1.6	1.9	3.5
Denniston Creek	1.6	1.3	2.9
Big Sur River	1.6	1.2	2.8
Gazos Creek	1.6	1.3	2.9
Salmon Creek	1.5	1.2	2.7
San Francisquito Creek	1.4	1.7	3.1
San Lorenzo River	1.4	1.4	2.8
Pico Creek	1.3	1.3	2.6
Pescadero Creek	1.2	1.4	2.6
Lagunitas Creek	1.1	1.3	2.4

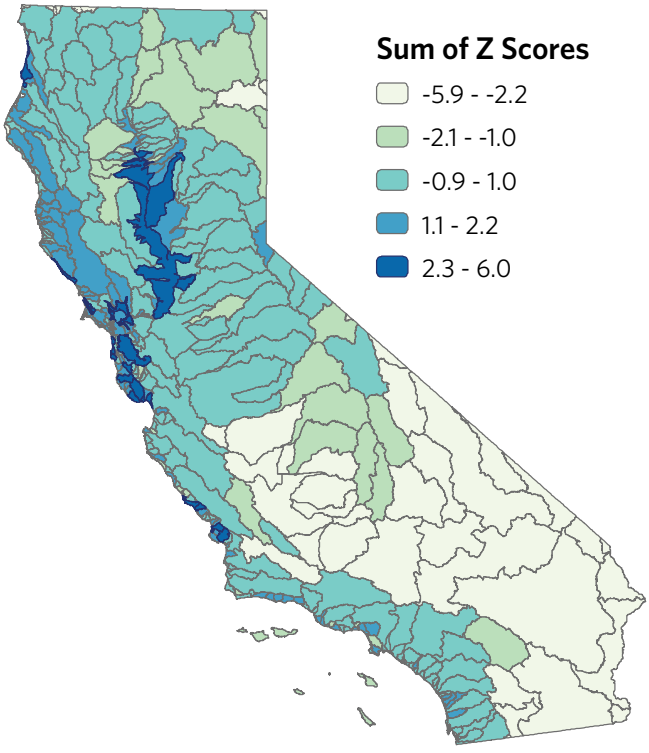
FIGURE B-3. Geographic footprint of Safe Harbor Agreements and other ESA-related cooperative strategies. Freshwater Conservation Value (panel A) and Opportunity Score (panel B) for each watershed were calculated, and the combination of these panels (via summation; panel C) generated the final ranking of watersheds. The z-score value for each watershed indicates the number of standard deviations that watershed is above (+ scores) or below (– scores) the mean value of all watersheds combined. The table lists the top 20 watersheds where this strategy could be used to maximize ecological benefit.



A: Freshwater Conservation Value (FCV)



B: Opportunity Score (OPP)

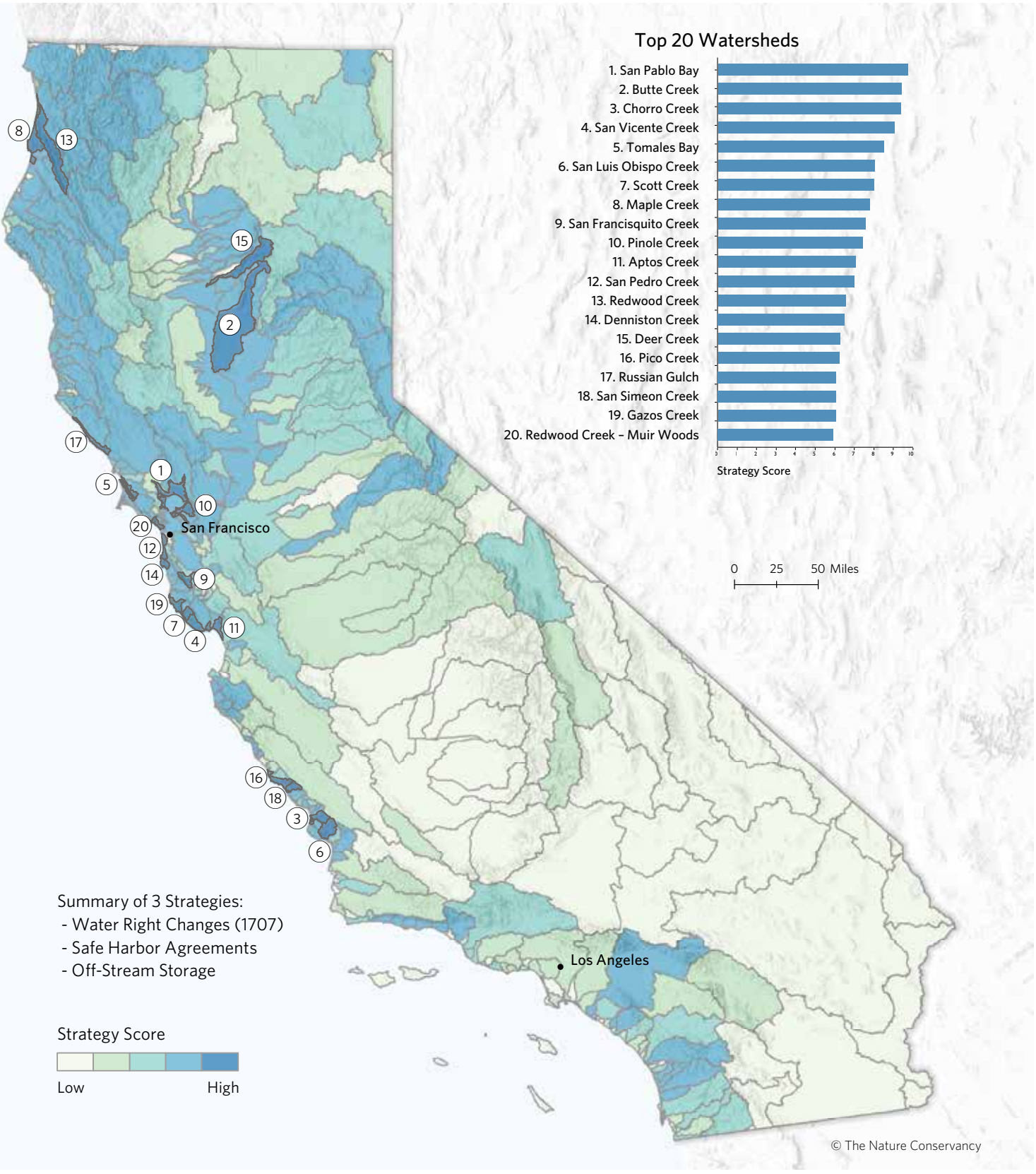


C: Freshwater Conservation plus Opportunity (Sum)

Top 20 Watersheds

Watershed Name	FCV	OPP	Sum
San Vicente Creek	2.2	1.5	3.7
Chorro Creek	2.2	1.9	4.1
San Pablo Bay	2.2	2.0	4.2
Maple Creek	2.1	0.8	2.9
Tomales Bay	2.0	1.6	3.7
Russian Gulch	1.9	0.4	2.2
Aptos Creek	1.9	1.7	3.6
Butte Creek	1.8	1.3	3.1
San Luis Obispo Creek	1.6	1.1	2.8
Denniston Creek	1.6	1.1	2.7
San Francisquito Creek	1.4	1.4	2.9
San Lorenzo River	1.4	0.9	2.3
Pico Creek	1.3	1.1	2.4
San Simeon Creek	1.2	1.3	2.6
Pescadero Creek	1.2	1.1	2.3
Pinole Creek	1.2	1.7	2.9
San Pedro Creek	1.0	1.7	2.7
San Francisco Bay	0.9	1.6	2.5
Sacramento River	0.6	1.6	2.2
Morrison Creek	0.6	1.8	2.4

FIGURE B-4. Summary map of three high impact strategies to improve in-stream flows (§1707 dedications, small-scale storage and forbearance projects, and Safe Harbor Agreements), indicating across the state where one or more of these strategies is likely to generate flows that have significant conservation benefit. In many regions of California, and particularly in parts of the North Coast, Central Coast, and northern Central Valley, this set of existing voluntary and cooperative strategies has the potential to substantially improve surface flows for nature. Focused effort on the part of conservation organizations, resource management agencies and others to implement these proven strategies is essential to putting California's freshwater ecosystems on the road to recovery.



© LIZ SPENCE Autumn view of rushing water at Deer Creek, one of a decreasing number of streams that provides habitat for native salmonids.
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