Conservation Success Index: California Golden Trout

ONCORHYNCHUS MYKISS AGUABONITA

Rev. 1.0 - 6/2009

SPECIES SUMMARY

The Kern River basin drains the southern extent of the Sierra Nevadas in California. The system was connected to the San Joaquin River and first occupied by ancestral rainbow trout around 10,000 years ago. As the connection to the San Joaquin River valley and Tule Lake dried up and natural barriers within the system developed, three distinct forms of trout evolved through isolation: the California golden trout (*Oncorhynchus mykiss aguabonita*) found in the South Fork Kern River and Golden Trout Creek basins, the Little Kern golden trout (*Oncorhynchus mykiss whitei*) found in the Little Kern River, and the Kern River rainbow trout (*Oncorhynchus mykiss gilberit*) found in the mainstem and tributaries of the Kern River.

Because its natural range spans two basins in the Kern River system, California golden trout were initially split into two taxonomic forms: the Volcano Creek golden trout, found in Golden Trout Creek (formerly called Volcano Creek), a tributary of the mainstem Kern River; and the South Fork Kern golden trout. Subsequent investigations determined that the two populations were once connected and only isolated thousands of years ago by a lava flow that diverted the headwaters of the South Fork Kern River west into the mainstem Kern. Since the region was settled in the late 1800s, California golden trout have been translocated above natural barriers into the headwater streams and alpine lakes of its native drainages and throughout the Sierra Nevada Mountains and western US. The alpine lakes and mainstem South Fork Kern River were also stocked with non-native trout and, by the mid-1960s, California golden experienced widespread hybridization. Additional stress to the subspecies came from habitat degradation associated with livestock grazing.

Beginning in 1968, California Department of Fish and Game began a series of restoration activities designed to return the subspecies to its historic range. The primary activities included the construction of three barriers in the upper South Fork Kern – the Ramshaw, Templeton, and Schaeffer barriers – and repeated piscicide applications above the barriers to eliminate non-native rainbow and brown trout. Additional efforts were intended to mitigate the effects of livestock grazing and recreational uses in the basin. Recent efforts focused on eradicating non-native trout from the alpine lakes in Golden Trout Creek and reconstructing the South Fork Kern barriers. Nonetheless, genetic studies led by the Genomic Variation Lab at the University of California, Davis confirm that hybrid California golden trout remain widely distributed throughout both basins. Management of the introgressed and remnant pure populations remains the primary conservation challenge.

Our CSI analysis incorporated data from the 2008 *SOS: California's Native Fish Crisis* report, the Genomic Variation Lab, the 2004 Conservation Assessment and Strategy for the California Golden Trout, and the retrospective Restoration of the California Golden Trout 1966 -2004 and information from Molly Stephens (University of California, Davis), Christy McGuire (California Department of Fish and Game), and Lisa Sims (US Forest Service). We are grateful for these contributions to our understanding of this subspecies. A complete list of data sources is provided in the framework documentation.

Our CSI analysis considers populations with introgression values exceeding 0.20 as functionally extirpated. Although the catchments occupied by these populations may contain pure individuals and valuable genotypes, the consensus among management agencies is that conservation efforts should be focused on populations with introgression levels less than 0.10 – 0.20. Data for several CSI indicators affecting California golden trout are unavailable or uncertain, including: a clear understanding of the historic distribution (confounded by the history of translocations), a complete picture of the natural barriers in the system, and abundance data that would allow comparisons of productivity between different streams. This CSI summarizes information at the catchment scale (2,000 – 16,000 acres), a finer scale than the typical CSI.

Key CSI Findings

- Populations of California golden trout currently occupy all of the historical distribution in Golden Trout Creek and 17 percent of the historic distribution in the South Fork Kern River. Additional non-historic habitat outside the natural distribution and above natural barriers within the natural distribution is currently occupied. Introgressed populations occur in Strawberry Creek and below the Templeton barrier in the South Fork Kern River.
- Populations in the Golden Trout Creek basin and in the South Fork Kern River above the Templeton barrier have the highest population integrity scores. Additional information on population density and natural barriers will further inform the population integrity analysis.
- Habitat integrity scores are high due to the occurrence of the subspecies on protected public lands and the absence of sources of acute anthropogenic habitat degradation. Instream habitat conditions are not mapped within the CSI and the legacy of grazing, logging, and recreation disturbance may not be fully reflected in high habitat integrity scores.
- The primary source of lower watershed condition and water quality scores is the road network found in a limited number of catchments.
- California golden trout are at low risk to the future threats of resource extraction, energy development, and land conversion. Several catchments contain timber resources, geothermal resources, and/or private land with development potential.
- Introduced species and changes in fire regime and winter flooding associated with potential climate change represent the largest threat to the future security of the subspecies.

Our CSI analysis shows that the range-wide conditions related to species distribution are moderately high for current populations of California golden trout. All of the historically occupied catchments in Golden Trout Creek are currently occupied, but only 17 percent of historic South Fork Kern River catchments are currently occupied. An additional non-historic, pure population exists in Cottonwood Creek, an adjacent Owens River drainage (other populations with unknown pedigree and purity scattered across the Sierra Nevada Mountains and the western US are not considered in this analysis). In Golden Trout Creek and above the Schaeffer barrier in the South Fork Kern River, the subspecies occupies a stream network and catchment area nearly equivalent to the size and extent of its historic distribution. Most populations occupy streams second order or higher – Barigan Stringer, Salt Lick Creek, Dry Creek, Kern Peak, Johnson Creek, Long Stringer, and Little Cottonwood Creek are notable exceptions - suggesting that the subspecies may persist in relatively stable environmental conditions. The lack of information on the historic distribution of the subspecies adds some uncertainty to the range-wide conditions analysis.

Most population integrity scores for California golden trout are high. Because of indications of small amounts rainbow trout introgression in all populations, most populations have moderately high genetic purity scores. Populations in Dry Creek, Long Stringer, and the South Fork Kern River below Templeton barrier have the lowest genetic purity scores. The presence of introgressed individuals and artificial barriers in the mainstem South Fork Kern River lowers population extent scores (additional information on natural barriers would lower population extent scores). All populations are generalized as persisting at high densities (estimated at 482 fish/mile; field information on the density of individuals would further inform this indicator). Disease vulnerability scores reflect the absences of any known debilitating pathogens in the basin. Based on the criteria described by Rieman and others and Hilderbrand and Kershner, the California golden trout do not meet the desired persistence threshold of 5 populations per basin. Two equivalent populations exist in each Golden Trout Creek, Cottonwood Creek, and the South Fork Kern River above the Templeton barrier, with one additional population below the Templeton barrier.

Most habitat integrity scores are high. With the exception of the Smith Meadows, Troy Meadow, Jackass Creek, and Kennedy Peak catchments, at least 60% of all catchments are formally protected within the Golden Trout, South Sierra, or Domeland Wilderness areas. All catchments score high for watershed connectivity except those populations impacted by artificial barriers: the Upper South Fork Kern (above Ramshaw barrier), the South Fork Kern at Schaeffer (between the Templeton and Schaeffer barriers) and Beck Meadow Creek. Though detrimental to the connectivity of California golden trout populations, these barriers do currently serve to isolate the subspecies from rainbow trout, brown trout, and highly introgressed golden trout downstream. Few roads and minimal converted lands exist within the distribution of California golden trout: accordingly, all catchments receive high watershed condition scores (Troy Meadow, Smith Meadow, and Kennedy Peak catchments contain moderate road densities). High water quality scores reflect the lack of acute anthropogenic stressors, such as agriculture, oil and gas wells, and active mines. Several catchments have low water quality scores as the result of road networks within the riparian zones of perennial or intermittent streams. Long Canyon and Pine Creek have at least ¼ mile of road within the riparian zone of every mile of stream. Kennedy Peak, Sacatar Canyon, and North Fork Cottonwood Creek have at least 1/10 mile of road within the riparian zone. With few canals and no existing dams, all catchments score high for flow regime. The CSI lacks a specific indicator for addressing instream habitat conditions and the legacy effects of over a century of logging and cattle and sheep grazing may not be fully reflected in the total habitat integrity score. Nonetheless, the lack of the primary anthropogenic sources of habitat degradation that typically affect salmonids suggests that the California golden trout occurs within a landscape within which population restoration would be particularly appropriate and successful.

The CSI analysis of future security suggests the California golden trout is at moderate risk. Because the majority of the subspecies' distribution lies within the Inyo or Sequoia National Forest, there is minimal risk of land conversion. Resource extraction risks are limited to portions of the Smith Meadows, Little Trout Creek, and Troy Meadow catchments, which are suitable for intensive forest management. Similarly, energy development risk is low with the exception of geothermal resources previously leased in the Smith Meadows, Monache Creek and Meadows, Snake Creek, and South Fork Kern at Schaeffer catchments. The logistics of moving these resources around the surrounding wilderness areas may ultimately preclude their development.

The primary predicted threats to future security come from climate change and the persistence of introduced species in the system. The CSI considers a + 3°C climate change scenario for each species. Our analysis suggests that the California golden trout is at highest risk to increased winter flooding associated with rain-on-snow events in the lower portions of Golden Trout Creek and the upper portions of the South Fork Kern. The subspecies is at high risk to the effects of altered fire regimes associated with earlier spring warming in mid-elevation zones in the western portion of the South Fork Kern basin and low risk in the higher elevation Golden Trout Creek basin and the northern portion of the South Fork Kern. California golden trout are at moderate risk to drought (except in the North Fork Cottonwood Creek catchment, where risk is low). Based on its historic distribution relative to air temperature, the subspecies is at low to moderate risk to increased summer temperatures, except for high risk in the lower mainstem South Fork Kern River and its west-draining tributaries below Kennedy Meadows.

Recommendations to increase resistance and resilience to climate change include a reduction of other remaining stressors, restoration of any riparian, wetland, and wet meadow areas that are not in high condition, and partial reconnection of stream systems to allow greater fish movement within the native range. However, restoring connectivity also may increase risk from non-native fish introductions and thus must proceed with caution.

The South Fork Kern River below the Templeton barrier, lower reaches of Golden Trout Creek, and the mainstem Cottonwood Creek drainages receive the lowest possible introduced species scores due to the continued presence brown trout, rainbow trout, or golden trout with introgression values of at least 0.50. Additionally, catchments connected to Kennedy Meadows are impacted by the continued stocking of triploid rainbow trout. Because of the history of unauthorized trout introductions in the Kern system, the remaining catchments received moderate scores.

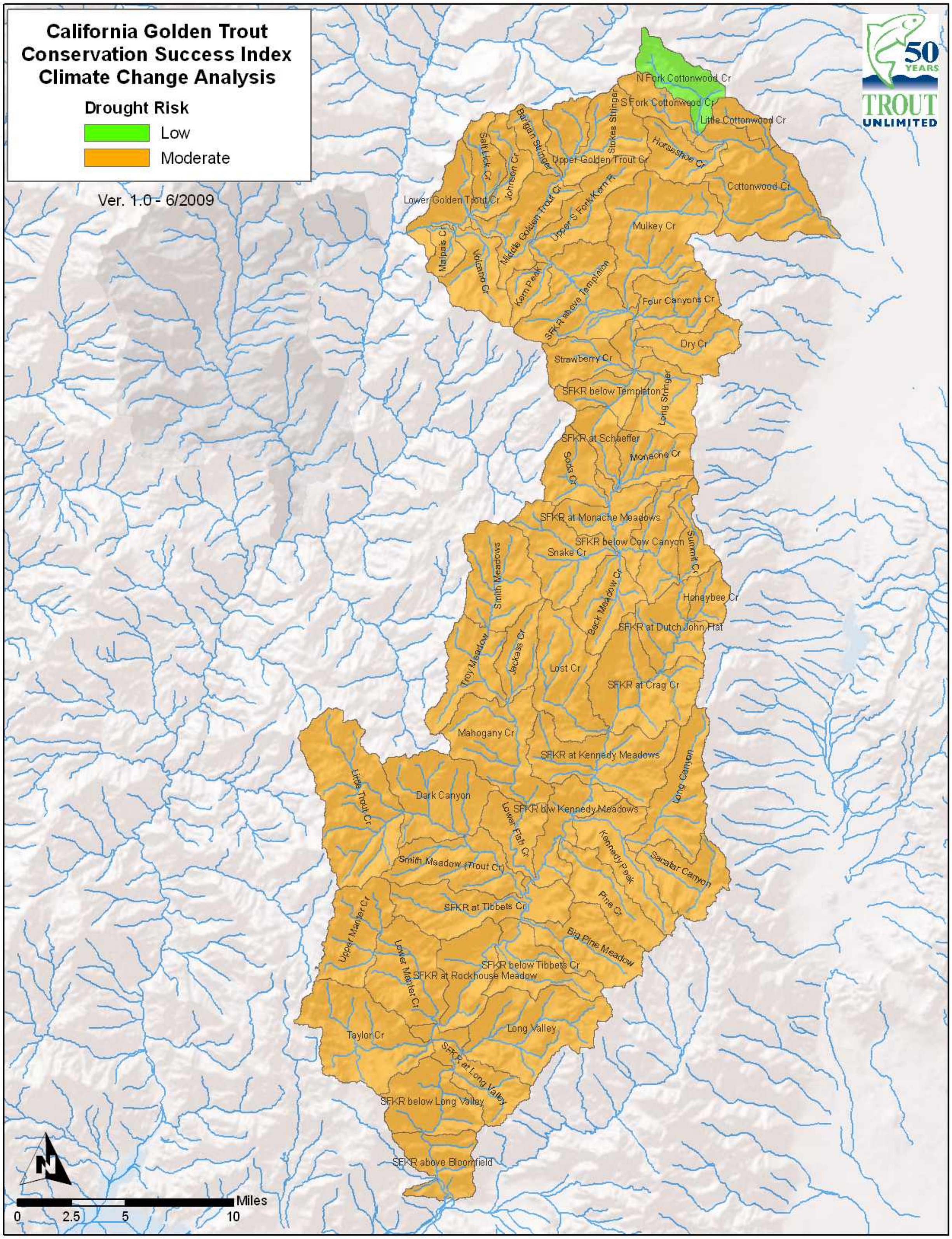
Total CSI scores and conservation strategies are consistent with the current management direction for California golden trout. The purest populations in the Golden Trout Creek and upper South Fork Kern River basins should remain the conservation and protection focus. Because introgressed individuals persist in the both systems, however, population restoration/reintroduction activities should be directed at eliminating or managing non-native trout or highly introgressed golden trout. The existing barriers on the mainstem South Fork Kern River will not serve their intended, isolating function if highly introgressed individuals persist in Strawberry Creek or the mainstem South Fork Kern above the barriers. The proposed Dutch John barrier would provide additional habitat for California golden trout to occupy downstream of the existing barriers. The primary conservation value of the Cottonwood Creek basin populations may be as a source of unique genetic material from pure individuals. New information regarding fish densities and population extents may further refine CSI scores for population integrity and provide additional guidance for restoration activities. Local knowledge will be required to direct habitat restoration activities designed to mitigate instream habitat degradation associated with historical land uses.

Trout Unlimited strongly supports the continued restoration efforts of California Department of Fish and Game, the U.S. Forest Service, University of California - Davis, and California Trout. These entities have made great strides in the conservation of California golden trout since coordinated efforts began in the late 1960s. Consistent with CSI findings related to habitat and population integrity, expanding the available habitat and managing the introgression exposure for the purest populations of California golden trout should remain a top priority. Because it occurs almost entirely on public lands with the highest protection status, there is a significant opportunity to ensure the subspecies' persistence.

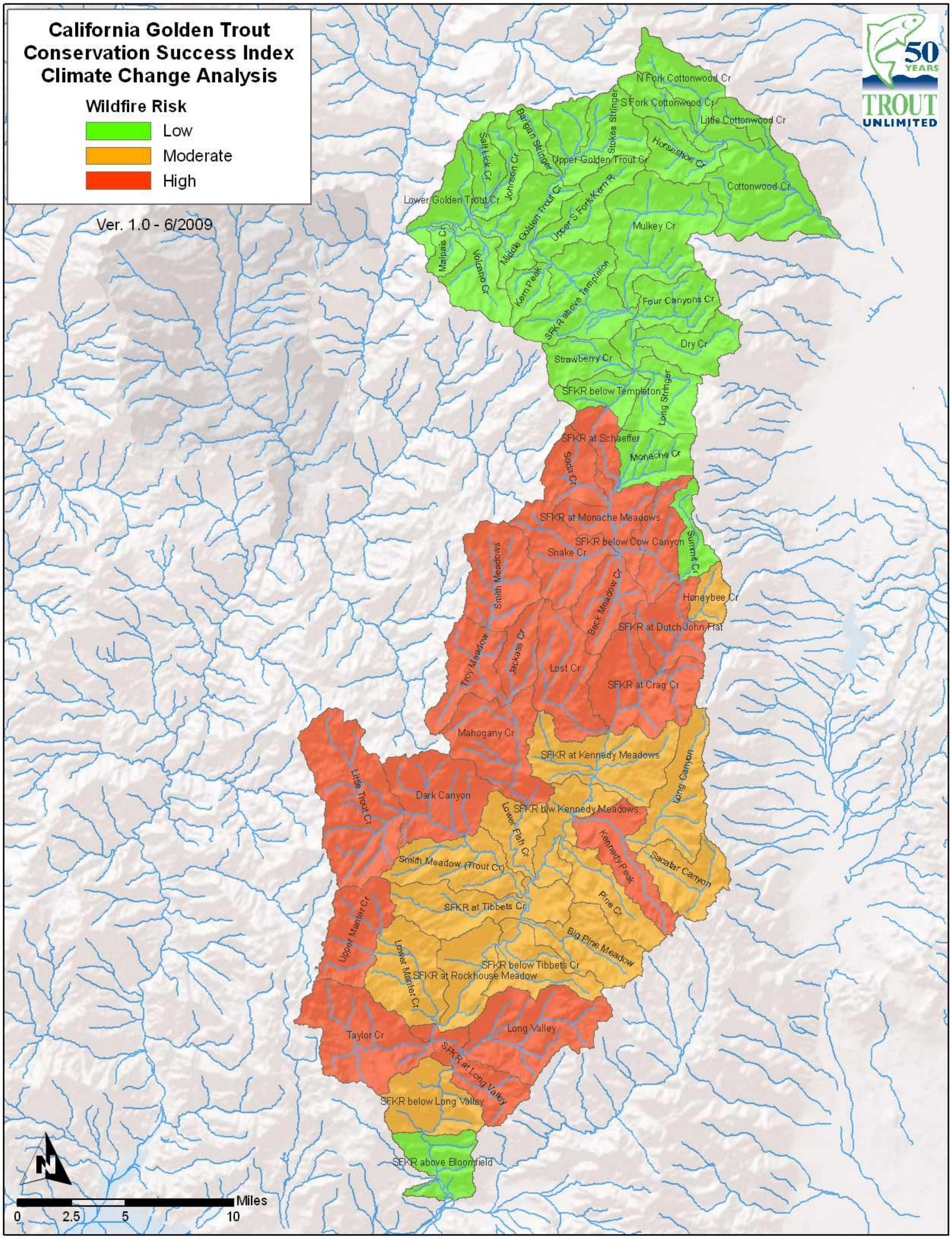
Prepared by Kurt Fesenmyer, TU, 4/6/2009

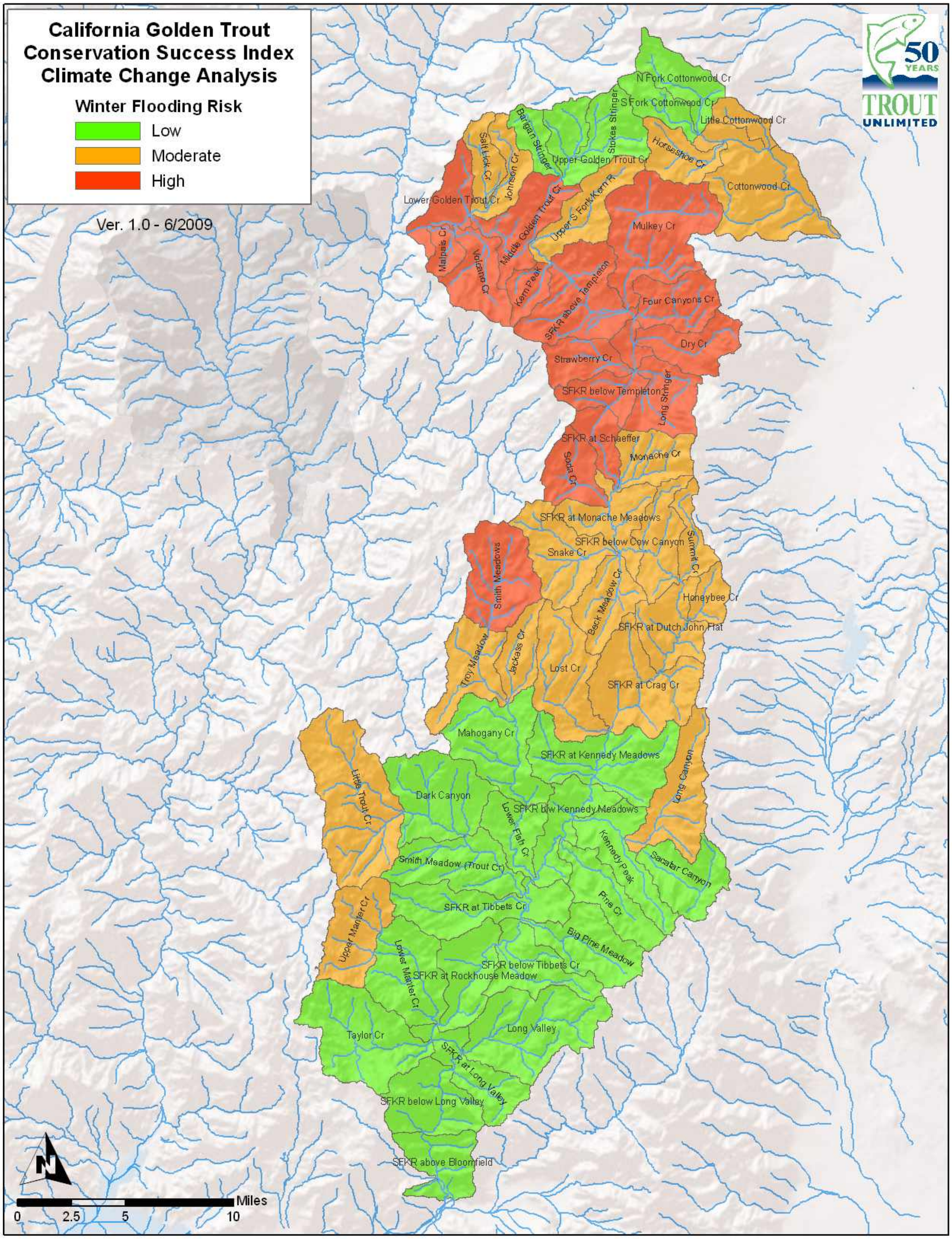
Table 1. CSI scoring results for California golden trout. All indicators are scored from 1 (poorest) to 5 (best): See framework documentation for details.

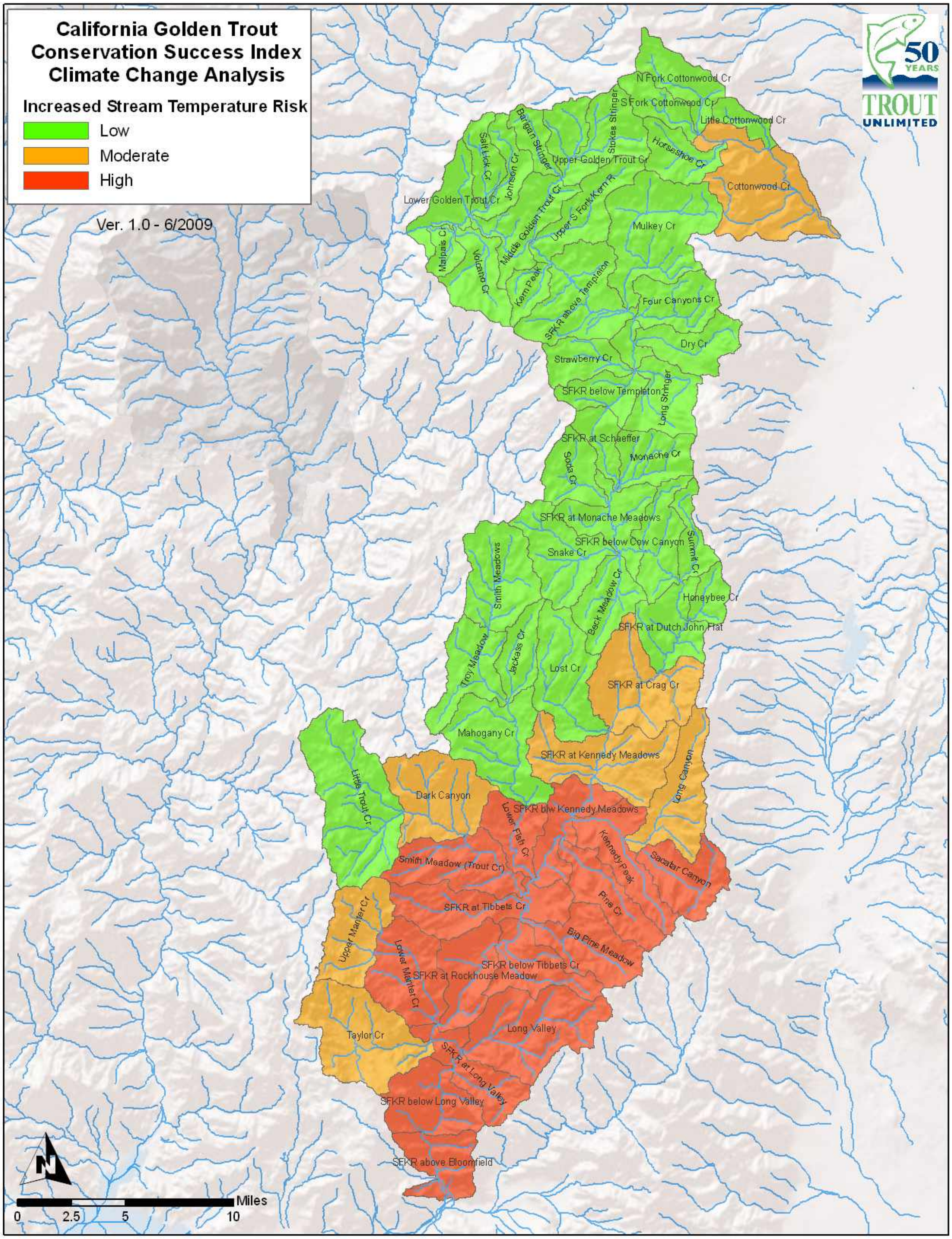
		Number of Subwatersheds Receiving Scores					Total Subwatersheds Scored
	CSI Indicator	**1**	**2**	**3**	**4**	**5**	
Range-wide Conditions	Percent historic stream habitat occupied	0	0	0	0	22	22
	Percent subbasins (4th) occupied	0	0	0	0	22	22
	Percent subwatersheds (6th) occupied	8	0	0	0	14	22
	Percent habitat by stream order occupied	3	2	1	1	15	22
	Percent historic lake area occupied	0	0	0	0	22	22
Population Integrity	Population Density	0	0	0	0	22	22
	Population Extent	0	1	0	4	17	22
	Genetic Purity	0	4	0	15	3	22
	Disease vulnerability	0	0	0	0	22	22
	Life history diversity	0	0	0	0	22	22
Habitat Integrity	Land Stewardship	2	0	4	0	54	60
	Watershed connectivity	0	2	1	4	53	60
	Watershed conditions	0	0	0	3	57	60
	Water quality	0	2	4	10	44	60
	Flow regime	0	0	0	1	59	60
Future Security	Land conversion	0	0	0	1	59	60
	Resource extraction	0	1	2	2	55	60
	Energy development	0	1	0	8	51	60
	Climate change	6	38	4	7	5	60
	Introduced species	48	0	0	12	0	60



California Golden Trout
Conservation Success Index
Climate Change Analysis
Drought Risk
Low
Moderate
Ver. 1.0 - 6/2009
50 YEARS
TROUT UNLIMITED
N Fork Cottonwood Cr
S Fork Cottonwood Cr
Little Cottonwood Cr
Stokes Stringer
Bargan Stringer
Salt Lick Cr
Johnson Cr
Upper Golden Trout Cr
Horseshoe Cr
Cottonwood Cr
Lower Golden Trout Cr
Middle Golden Trout Cr
Upper S Fork Kern R
Mulkey Cr
Malpais Cr
Volcano Cr
Kern Peak
SFKR above Templeton
Four Canyons Cr
Dry Cr
Strawberry Cr
SFKR below Templeton
Long Stringer
SFKR at Schaeffer
Soda Cr
Monache Cr
SFKR at Monache Meadows
SFKR below Cow Canyon
Summit Cr
Snake Cr
Smith Meadows
Honeybee Cr
Bach Meadow Cr
SFKR at Dutch John Flat
Troy Meadow
Jackass Cr
Lost Cr
SFKR at Crag Cr
Mahogany Cr
SFKR at Kennedy Meadows
Long Canyon
Little Trout Cr
Dark Canyon
Lower Fish Cr
SFKR blw Kennedy Meadows
Kennedy Peak
Sacatar Canyon
Smith Meadow (Trout Cr)
SFKR at Tibbets Cr
Pine Cr
Upper Manter Cr
Lower Manter Cr
Big Pine Meadow
SFKR below Tibbets Cr
SFKR at Rockhouse Meadow
Taylor Cr
Long Valley
SFKR at Long Valley
SFKR below Long Valley
SFKR above Bloomfield
N
Miles
0
2.5
5
10


California Golden Trout
Conservation Success Index
Climate Change Analysis
Wildfire Risk
Low
Moderate
High
Ver. 1.0 - 6/2009
50 YEARS
TROUT UNLIMITED
N Fork Cottonwood Cr
S Fork Cottonwood Cr
Little Cottonwood Cr
Stokes Stringer
Bargain Stringer
Salt Lick Cr
Johnson Cr
Upper Golden Trout Cr
Horseshoe Cr
Cottonwood Cr
Lower Golden Trout Cr
Middle Golden Trout Cr
Upper S Fork Kern R
Mulkey Cr
Malpais Cr
Volcano Cr
Kern Peak
SFKR above Templeton
Four Canyons Cr
Dry Cr
Strawberry Cr
SFKR below Templeton
Long Stringer
SFKR at Schaeffer
Soda Cr
Monache Cr
SFKR at Monache Meadows
SFKR below Cow Canyon
Snake Cr
Summit Cr
Smith Meadows
Honeybee Cr
Brown Meadow Cr
Back Meadow Cr
SFKR at Dutch John Flat
Troy Meadow
Jackass Cr
Lost Cr
SFKR at Crag Cr
Mahogany Cr
SFKR at Kennedy Meadows
Long Canyon
Little Trout Cr
Dark Canyon
SFKR blw Kennedy Meadows
Lower Fish Cr
Kennedy Peak
Sacatar Canyon
Smith Meadow (Trout Cr)
SFKR at Tibbets Cr
Pine Cr
Upper Manter Cr
Big Pine Meadow
Lower Manter Cr
SFKR below Tibbets Cr
SFKR at Rockhouse Meadow
Long Valley
Taylor Cr
SFKR at Long Valley
SFKR below Long Valley
SFKR above Bloomfield
N
Miles
0
2.5
5
10


California Golden Trout
Conservation Success Index
Climate Change Analysis
Winter Flooding Risk
Low
Moderate
High
Ver. 1.0 - 6/2009
50 YEARS
TROUT UNLIMITED
N Fork Cottonwood Cr
S Fork Cottonwood Cr
Little Cottonwood Cr
Stokes Stringer
Bargain Stringer
Salt Lick Cr
Johnson Cr
Upper Golden Trout Cr
Horseshoe Cr
Cottonwood Cr
Lower Golden Trout Cr
Middle Golden Trout Cr
Upper S Fork Kern R
Mulkey Cr
Malpais Cr
Volcano Cr
Kern Peak
SFKR above Templeton
Four Canyons Cr
Dry Cr
Strawberry Cr
SFKR below Templeton
Long Stringer
SFKR at Schaeffer
Soda Cr
Monache Cr
SFKR at Monache Meadows
SFKR below Cow Canyon
Snake Cr
Summit Cr
Smith Meadows
Honeybee Cr
Back Meadow Cr
SFKR at Dutch John Flat
Troy Meadow
Jackass Cr
Lost Cr
SFKR at Crag Cr
Mahogany Cr
SFKR at Kennedy Meadows
Little Trout Cr
Dark Canyon
Lower Fish Cr
SFKR blw Kennedy Meadows
Long Canyon
Kennedy Peak
Sacatar Canyon
Smith Meadow (Trout Cr)
SFKR at Tibbets Cr
Pine Cr
Upper Manter Cr
Big Pine Meadow
Lower Manter Cr
SFKR below Tibbets Cr
SFKR at Rockhouse Meadow
Taylor Cr
Long Valley
SFKR at Long Valley
SFKR below Long Valley
SFKR above Bloomfield
N
Miles
0
2.5
5
10


California Golden Trout
Conservation Success Index
Climate Change Analysis
Increased Stream Temperature Risk
Low
Moderate
High
Ver. 1.0 - 6/2009
50 YEARS
TROUT UNLIMITED
N Fork Cottonwood Cr
S Fork Cottonwood Cr
Little Cottonwood Cr
Stokes Stringer
Bargain Stringer
Salt Lick Cr
Johnson Cr
Horseshoe Cr
Upper Golden Trout Cr
Cottonwood Cr
Lower Golden Trout Cr
Middle Golden Trout Cr
Upper S Fork Kern R
Mulkey Cr
Malpais Cr
Volcano Cr
Kern Peak
SFKR above Templeton
Four Canyons Cr
Dry Cr
Strawberry Cr
SFKR below Templeton
Long Stringer
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Soda Cr
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SFKR at Monache Meadows
SFKR below Cow Canyon
Snake Cr
Summit Cr
Smith Meadows
Honeybee Cr
Beck Meadow Cr
SFKR at Dutch John Flat
Troy Meadow
Jackass Cr
Lost Cr
SFKR at Crag Cr
Mahogany Cr
SFKR at Kennedy Meadows
Long Canyon
Little Trout Cr
Dark Canyon
SFKR blw Kennedy Meadows
Lower Fish Cr
Kennedy Peak
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Smith Meadow (Trout Cr)
Pine Cr
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Big Pine Meadow
Lower Manter Cr
SFKR below Tibbets Cr
SFKR at Rockhouse Meadow
Long Valley
Taylor Cr
SFKR at Long Valley
SFKR below Long Valley
SFKR above Bloomfield
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Miles
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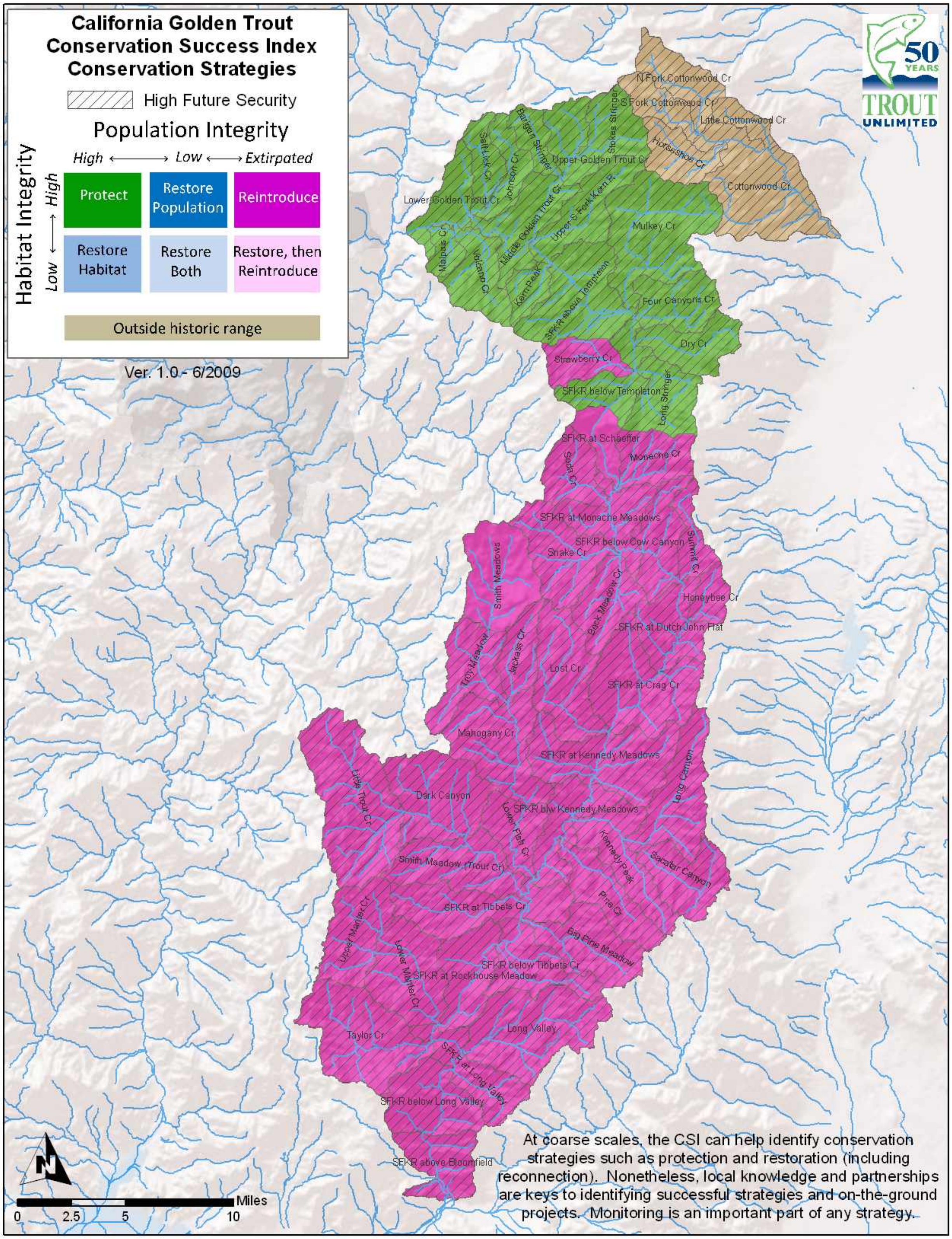
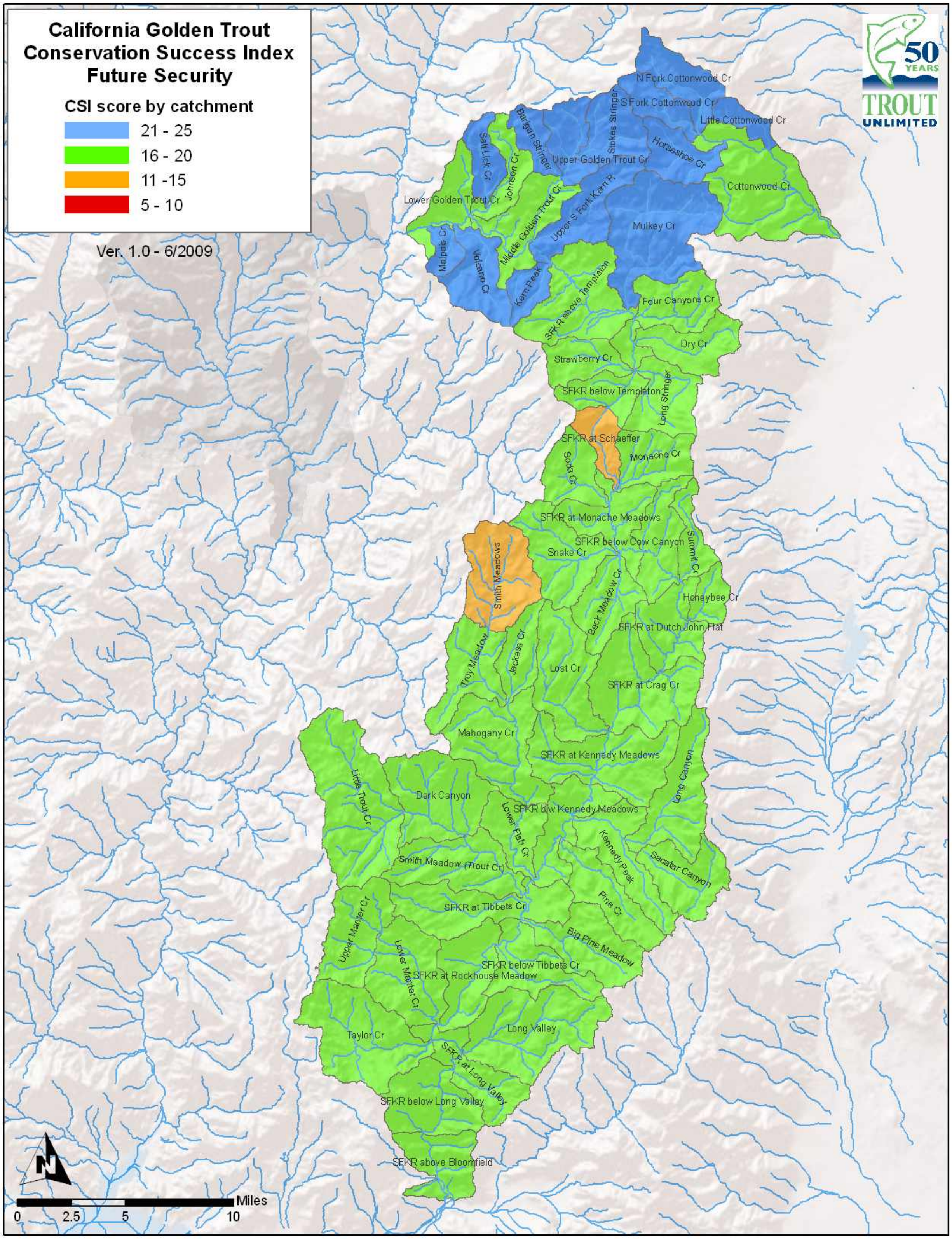

California Golden Trout
Conservation Success Index
Conservation Strategies
High Future Security
Population Integrity
High ⟷ Low ⟷ Extirpated
Habitat Integrity
Low ⟷ High
Protect
Restore Population
Reintroduce
Restore Habitat
Restore Both
Restore, then Reintroduce
Outside historic range
Ver. 1.0 - 6/2009
50 YEARS
TROUT UNLIMITED
N Fork Cottonwood Cr
S Fork Cottonwood Cr
Little Cottonwood Cr
Horseshoe Cr
Cottonwood Cr
Stokes Stringer
Barigan Stringer
Salt Lick Cr
Johnson Cr
Upper Golden Trout Cr
Lower Golden Trout Cr
Middle Golden Trout Cr
Upper S Fork Kern R
Mulkey Cr
Malpais Cr
Volcano Cr
Kern Peak
SFKR above Templeton
Four Canyons Cr
Dry Cr
Strawberry Cr
SFKR below Templeton
Long Stringer
SFKR at Schaeffer
Monache Cr
Soda Cr
SFKR at Monache Meadows
SFKR below Cow Canyon
Snake Cr
Summit Cr
Smith Meadows
Honeybee Cr
Bock Meadow Cr
SFKR at Dutch John Flat
Troy Meadow
Jackass Cr
Lost Cr
SFKR at Crag Cr
Mahogany Cr
SFKR at Kennedy Meadows
Long Canyon
Little Trout Cr
Dark Canyon
SFKR blw Kennedy Meadows
Lower Fish Cr
Kennedy Peak
Sacatar Canyon
Smith Meadow (Trout Cr)
SFKR at Tibbets Cr
Pine Cr
Big Pine Meadow
Upper Manter Cr
Lower Manter Cr
SFKR below Tibbets Cr
SFKR at Rockhouse Meadow
Taylor Cr
Long Valley
SFKR at Long Valley
SFKR below Long Valley
SFKR above Bloomfield
N
Miles
0 2.5 5 10
At coarse scales, the CSI can help identify conservation strategies such as protection and restoration (including reconnection). Nonetheless, local knowledge and partnerships are keys to identifying successful strategies and on-the-ground projects. Monitoring is an important part of any strategy.


California Golden Trout
Conservation Success Index
Future Security
CSI score by catchment
21 - 25
16 - 20
11 -15
5 - 10
Ver. 1.0 - 6/2009
50 YEARS
TROUT UNLIMITED
N Fork Cottonwood Cr
S Fork Cottonwood Cr
Little Cottonwood Cr
Stokes Stringer
Bargain Stringer
Salt Lick Cr
Johnson Cr
Upper Golden Trout Cr
Horseshoe Cr
Cottonwood Cr
Lower Golden Trout Cr
Middle Golden Trout Cr
Upper S Fork Kern R
Mulkey Cr
Malpais Cr
Volcano Cr
Kern Peak
SFKR above Templeton
Four Canyons Cr
Dry Cr
Strawberry Cr
SFKR below Templeton
Long Stringer
SFKR at Schaeffer
Soda Cr
Monache Cr
SFKR at Monache Meadows
SFKR below Cow Canyon
Snake Cr
Smith Meadows
Summit Cr
Honeybee Cr
Beck Meadow Cr
SFKR at Dutch John Flat
Troy Meadow
Jackass Cr
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Pine Cr
Big Pine Meadow
Upper Manter Cr
Lower Manter Cr
SFKR at Rockhouse Meadow
SFKR below Tibbets Cr
Taylor Cr
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SFKR below Long Valley
SFKR above Bloomfield
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Miles
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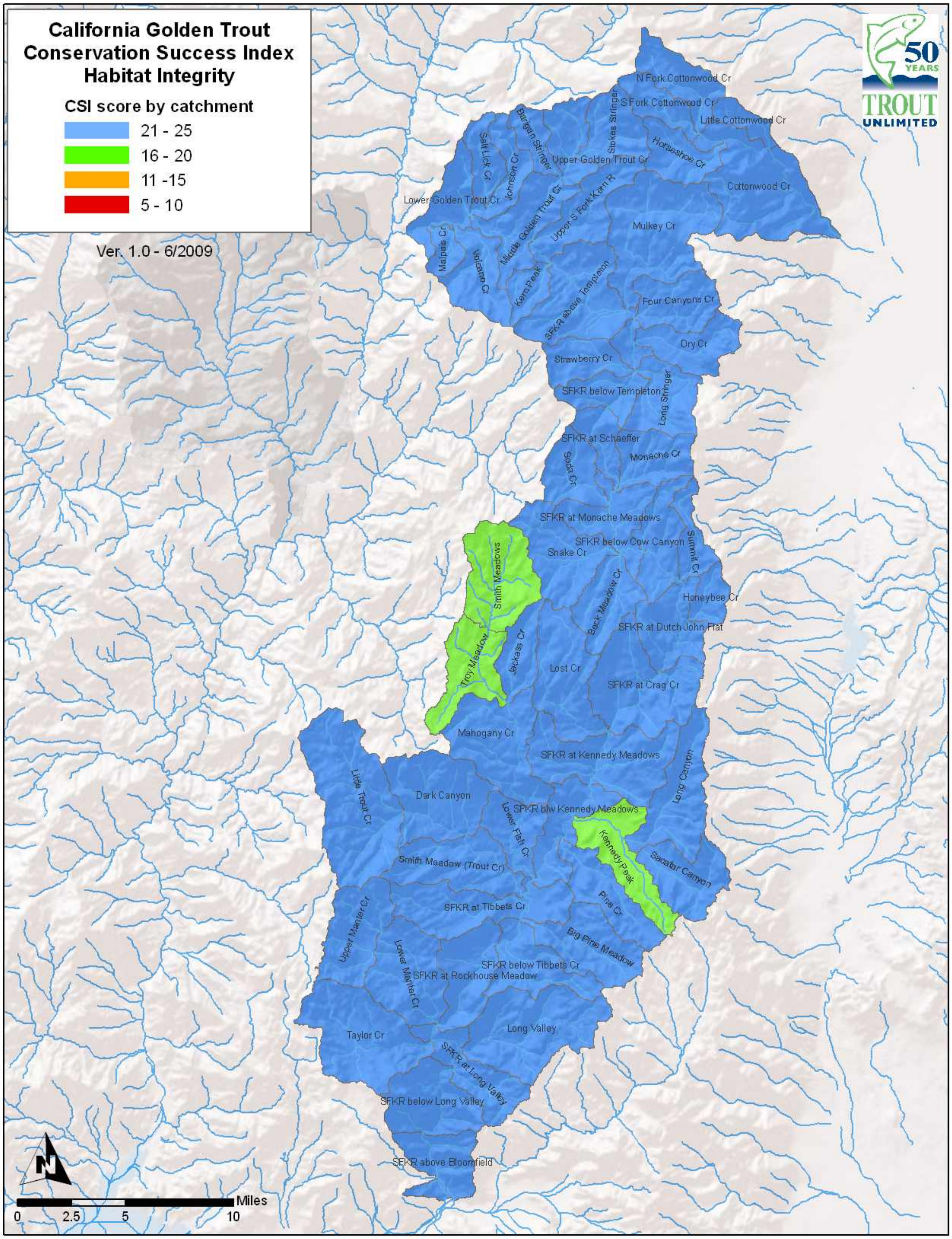
California Golden Trout
Conservation Success Index
Habitat Integrity
CSI score by catchment
21 - 25
16 - 20
11 -15
5 - 10
Ver. 1.0 - 6/2009
50 YEARS
TROUT UNLIMITED
N Fork Cottonwood Cr
S Fork Cottonwood Cr
Little Cottonwood Cr
Stokes Stringer
Bargain Stringer
Salt Lick Cr
Johnson Cr
Upper Golden Trout Cr
Horseshoe Cr
Cottonwood Cr
Lower Golden Trout Cr
Middle Golden Trout Cr
Upper S Fork Kern R
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Long Stringer
SFKR at Schaeffer
Soda Cr
Monache Cr
SFKR at Monache Meadows
SFKR below Cow Canyon
Smith Meadows
Snake Cr
Summit Cr
Honeybee Cr
Brush Meadow Cr
SFKR at Dutch John Flat
Troy Meadow
Jackass Cr
Lost Cr
SFKR at Crag Cr
Mahogany Cr
SFKR at Kennedy Meadows
Long Canyon
Little Trout Cr
Dark Canyon
Lower Fish Cr
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Kennedy Peak
Sacatar Canyon
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Long Valley
SFKR at Long Valley
SFKR below Long Valley
SFKR above Bloomfield
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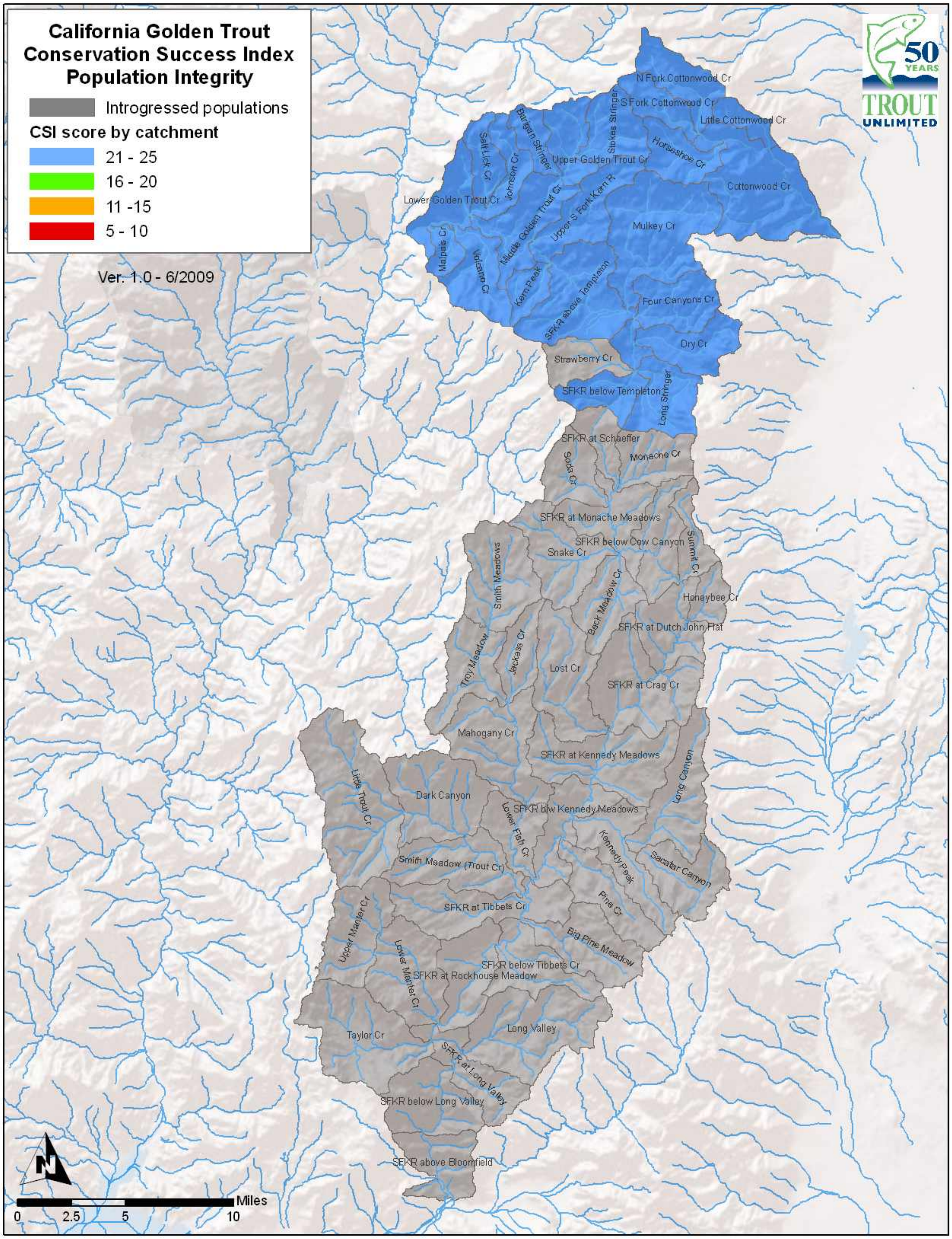
California Golden Trout
Conservation Success Index
Population Integrity
Introgressed populations
CSI score by catchment
21 - 25
16 - 20
11 -15
5 - 10
Ver. 1.0 - 6/2009
50 YEARS
TROUT UNLIMITED
N Fork Cottonwood Cr
S Fork Cottonwood Cr
Little Cottonwood Cr
Stokes Stringer
Bargain Stringer
Salt Lick Cr
Johnson Cr
Upper Golden Trout Cr
Horseshoe Cr
Cottonwood Cr
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Upper S Fork Kern R
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Malpais Cr
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Strawberry Cr
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Honeybee Cr
Beck Meadow Cr
SFKR at Dutch John Flat
Troy Meadow
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SFKR at Crag Cr
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Long Canyon
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Kennedy Peak
Sacatar Canyon
Smith Meadow (Trout Cr)
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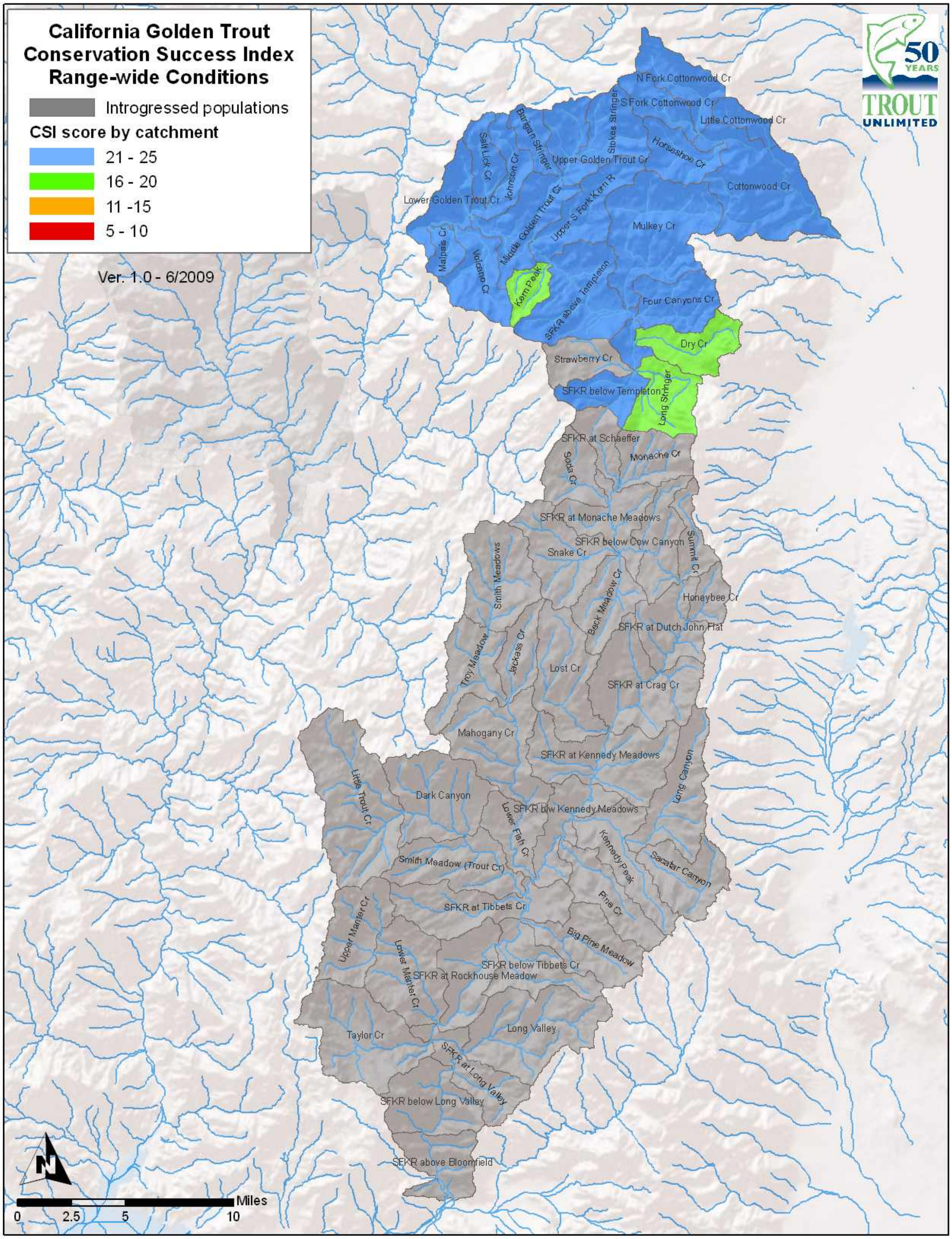
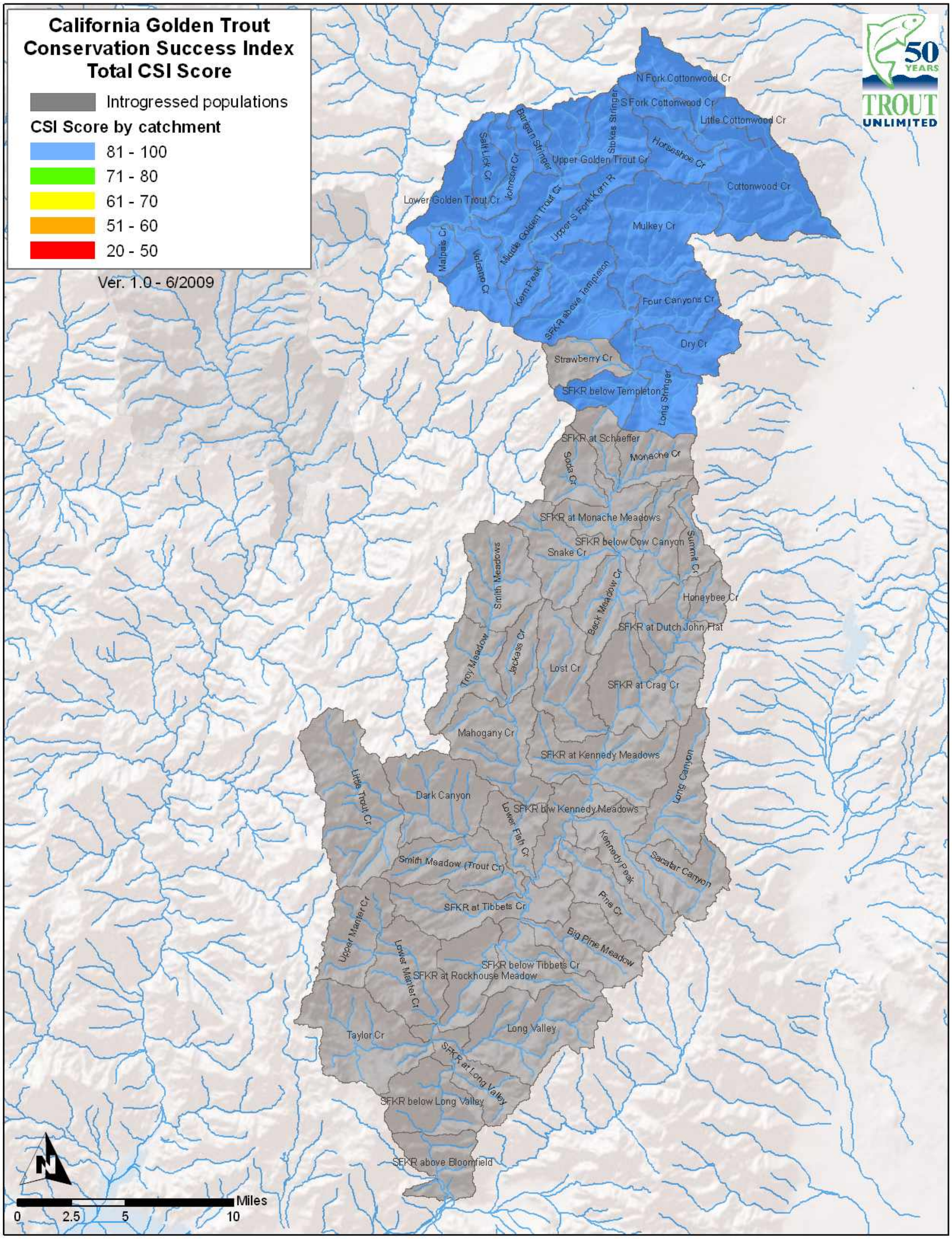
Big Pine Meadow
SFKR below Tibbets Cr
SFKR at Rockhouse Meadow
Long Valley
Taylor Cr
SFKR at Long Valley
SFKR below Long Valley
SFKR above Bloomfield
N
Miles
0
2.5
5
10


California Golden Trout
Conservation Success Index
Range-wide Conditions
Introgressed populations
CSI score by catchment
21 - 25
16 - 20
11 -15
5 - 10
Ver. 1.0 - 6/2009
50 YEARS
TROUT UNLIMITED
N Fork Cottonwood Cr
S Fork Cottonwood Cr
Little Cottonwood Cr
Horseshoe Cr
Cottonwood Cr
Mulkey Cr
Upper Golden Trout Cr
Stokes Stringer
Bargain Stringer
Salt Lick Cr
Johnson Cr
Lower Golden Trout Cr
Middle Golden Trout Cr
Upper S Fork Kern R
Malpais Cr
Volcano Cr
Kern Peak
SFKR above Templeton
Four Canyons Cr
Dry Cr
Strawberry Cr
SFKR below Templeton
Long Stringer
SFKR at Schaeffer
Soda Cr
Monache Cr
SFKR at Monache Meadows
SFKR below Cow Canyon
Snake Cr
Summit Cr
Smith Meadows
Honeybee Cr
Beck Meadow Cr
SFKR at Dutch John Flat
Troy Meadow
Jackass Cr
Lost Cr
SFKR at Crag Cr
Mahogany Cr
SFKR at Kennedy Meadows
Long Canyon
Little Trout Cr
Dark Canyon
SFKR blw Kennedy Meadows
Lower Fish Cr
Kennedy Peak
Sacatar Canyon
Smith Meadow (Trout Cr)
SFKR at Tibbets Cr
Pine Cr
Upper Manter Cr
Lower Manter Cr
Big Pine Meadow
SFKR below Tibbets Cr
SFKR at Rockhouse Meadow
Taylor Cr
Long Valley
SFKR at Long Valley
SFKR below Long Valley
SFKR above Bloomfield
Miles
0
2.5
5
10


California Golden Trout
Conservation Success Index
Total CSI Score
Introgressed populations
CSI Score by catchment
81 - 100
71 - 80
61 - 70
51 - 60
20 - 50
Ver. 1.0 - 6/2009
50 YEARS TROUT UNLIMITED
N Fork Cottonwood Cr
S Fork Cottonwood Cr
Little Cottonwood Cr
Horseshoe Cr
Cottonwood Cr
Stokes Stringer
Bargain Stringer
Salt Lick Cr
Johnson Cr
Upper Golden Trout Cr
Upper S Fork Kern R
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SFKR at Crag Cr
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SFKR at Kennedy Meadows
Long Canyon
Little Trout Cr
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SFKR at Tibbets Cr
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Big Pine Meadow
Upper Manter Cr
Lower Manter Cr
SFKR below Tibbets Cr
SFKR at Rockhouse Meadow
Long Valley
Taylor Cr
SFKR at Long Valley
SFKR below Long Valley
SFKR above Bloomfield
N
Miles
0
2.5
5
10

ver. 1.0 – 6/2009

Conservation Success Index: California Native Trout: Little Kern Golden Trout, California Golden Trout, and Kern River Rainbow Trout Subwatershed Scoring and Rule Set

Introduction:
The CSI is an aggregate index comprised of four different component groups: Range-wide Condition; Population Integrity; Habitat Integrity; and Future Security. Each CSI group has five indicators that describe a specific component of each group. Each indicator is scored from 1 to 5 for each subwatershed or catchment, with a score of 1 indicating poor condition and a score of 5 indicating good condition. Indicator scores are then added to obtain the subwatershed or catchment condition for a Group, and Group scores are added for a CSI score for a subwatershed or catchment (Figure 1). CSI scores can then be summarized to obtain the general range of conditions within the historical or current distribution of the species.

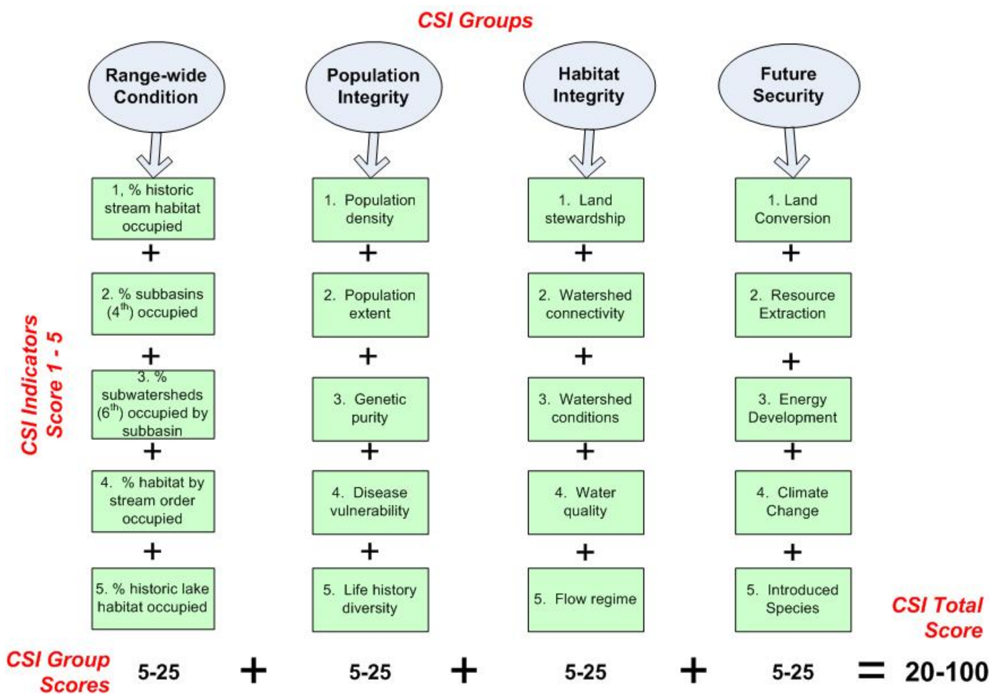


Figure 1. Each subwatershed or catchment is scored from 1 to 5 using 20 indicators within four main groups. Indicator scores are added per group to obtain an overall group score. Group scores are then added to obtain a composite CSI score for each subwatershed or catchment.

CSI Groups and Indicators

The CSI consists of four main groups of indicators:

1. Range-wide condition
2. Population integrity
3. Habitat integrity
4. Future Security

Below is an overview of each CSI group and the indicators within each group. Each section contains an overview of the group indicators. Species names are abbreviated as follows: California Golden trout (CAGT), Little Kern Golden trout (LKGT), and Kern River rainbow trout (KRRT).

Range-wide Condition: *Indicators for range-wide condition:*

Overview:

1. Percent of historical stream habitat occupied.
2. Percent of subbasins occupied by populations.
3. Percent of subwatersheds (6th level HUC) or catchments occupied within subbasin.
4. Percent of habitat by stream order occupied.
5. Percent of lake or by surface area occupied.

Indicator: 1. Percent of historic streams occupied by populations

Indicator Scoring:

Occupied stream habitat	CSI Score
0 – 9%	1
10 – 19%	2
20 – 34%	3
35 – 49%	4
50 – 100%	5

Explanation: The percentage of streams currently occupied by the species, based on sampling data.

Rationale: Populations occupying a larger extent of habitat will have an increased likelihood of persistence.

Data Sources: The current distribution of CAGT from the Conservation Assessment and Strategy for CAGT,[1] Stephens, 2007,[2] and SOS Report,[3] and LKGT from Stephens, 2007[2] and SOS Report;[3] and KRRT from ### and SOS Report.[3] Because data is lacking on natural barriers in the system and the historical distribution of all three species, the historical distribution for each is assumed to equal the perennial and intermittent stream network. Subwatersheds based on NRCS data[4] (for KRRT); catchments based on NHD Plus[5] (for CAGT and LKGT).

Indicator: 2. Percent subbasins occupied.

Indicator Scoring:

Subbasins occupied	CSI Score
1-49%	1
50-69%	2
70-79%	3
80-89%	4
90-100%	5

Explanation: The percentage of historically occupied subbasins that are currently occupied by the species. The same percentage is applied to all subwatersheds or catchments scored.

Rationale: Larger river basins often contain populations functioning as distinct populations.

Data Sources: The current distribution of CAGT from the Conservation Assessment and Strategy for CAGT,[1] Stephens, 2007,[2] and SOS Report,[3] and LKGT from Stephens, 2007[2] and SOS Report;[3] and KRRT from ### and SOS Report.[3] Because data is lacking on natural barriers in the system and the historical distribution of all three species, the historical distribution for each is assumed to equal the perennial and intermittent stream network. Subwatersheds based on NRCS data[4] (for KRRT); catchments based on NHD Plus[5] (for CAGT and LKGT).

Indicator: 3. Percent subwatersheds or catchments occupied within subbasin.

Indicator Scoring:

Subwatersheds or catchments occupied by subbasin	CSI Score
1 – 20%	1
21-40%	2
41-60%	3
61-80%	4
81-100%	5

Explanation: The percentage of historically occupied subwatersheds or catchments that are currently occupied by the species within each subbasin. The percentage is the same for all subwatersheds within a subbasin.

Rationale: Species that occupy a larger percentage of subwatersheds or catchments are likely to be more broadly distributed and have an increased likelihood of persistence.

Data Sources: The current distribution of CAGT from the Conservation Assessment and Strategy for CAGT,[1] Stephens, 2007,[2] and SOS Report,[3] and LKGT from Stephens, 2007[2] and SOS Report;[3] and KRRT from ### and SOS Report.[3] Because data is lacking on natural barriers in the system and the historical distribution of all three species, the historical distribution for each is assumed to equal the perennial and intermittent stream network. Subwatersheds based on NRCS data[4] (for KRRT); catchments based on NHD Plus[5] (for CAGT and LKGT).

Indicator: 4. Habitat by stream order occupied.

Indicator Scoring:

Occupied 2nd order streams and higher	CSI Score
0 – 9%	1
10 – 14%	2
15 – 19%	3
20 – 24%	4
25 – 100%	5

Explanation: The percentage of currently occupied habitat that is first order streams.

Rationale: Species that occupy a broader range of stream sizes will have an increased likelihood of persistence. This is especially true because small, first order streams tend to have more variable environmental conditions and smaller populations than larger streams.[6]

Data Sources: The current distribution of CAGT from the Conservation Assessment and Strategy for CAGT,[1] Stephens, 2007,[2] and SOS Report,[3] and LKGT from Stephens, 2007[2] and SOS Report;[3] and KRRT from ### and SOS Report.[3] Because data is lacking on natural barriers in the system and the historical distribution of all three species, the historical distribution for each is assumed to equal the perennial and intermittent stream network.

Indicator: 5. Lake habitat occupied.

Indicator Scoring:

Occupied lake habitat	CSI Score
0 – 9%	1
10 – 19%	2
20 – 34%	3
35 – 49%	4
50 – 100%	5

Explanation: Percentage of natural and artificial lakes that contain populations of wild trout.

Rationale: Lakes often harbor unique life histories and large populations that are important to long-term persistence of the species.[7]

Data Sources: The current distribution of CAGT from the Conservation Assessment and Strategy for CAGT,[1] Stephens, 2007,[2] and SOS Report,[3] and LKGT from Stephens, 2007[2] and

SOS Report;[3] and KRRT from ### and SOS Report.[3] Because data is lacking on natural barriers in the system and the historical distribution of all three species, the historical distribution for each is assumed to equal the perennial and intermittent stream network and not include any lakes.

Population Integrity: *Indicators for the integrity of populations*.

Overview:

1. Population density
2. Population extent
3. Genetic integrity
4. Disease vulnerability
5. Life history diversity

Indicator: 1. Population density.

Indicator Scoring:

Fish / mile	CSI Score
1 – 50 (total pop < 500)	1
1 – 50 (total pop ≥ 500)	2
51 - 150	3
151 - 400	4
>400	5

Explanation: Population density within each subwatershed or catchment. When multiple populations were present within a subwatershed or catchment, population density was calculated as a weighted average with the length of each stream occupied by a population as the weight.

Rationale: Small populations, particularly those below an effective size of 500 individuals, are more vulnerable to extirpation.[8;9]

Data Sources: Because of incomplete data, some subwatersheds/catchments were scored based on literature descriptions summarized in the SOS Report[3] of typical densities of the species (CAGT: 128 – 836 fish/mi = CSI score 5; LKGT: 500 fish/mi = CSI score 5; KRRT: 58-135 fish/mi = CSI score 3). Scoring rules were based, in part, on May and Albeke[9] and Williams et al.[10]

Indicator: 2. Population extent.

Indicator Scoring:

Connectivity	CSI Score

< 6.2 mi (<10 km) connected habitat	1
6.2 – 12.4 mi (10-20 km) connected habitat	2
12.4 – 18.6 mi (20-30 km) connected habitat	3
18.6 – 31.1 mi (30-50 km) connected habitat	4
> 31.1 mi (>50 km) connected habitat	5

Explanation: Population connectivity is the amount of connected perennial streams available to the population.

Rationale: Populations with less available habitat are more vulnerable to extirpation[11] as a result of small, localized disturbances.

Data Sources: Score based on extent of connected habitat for the contiguous populations using populations identified for population density (see above). Anthropogenic barriers within the distribution of CAGT from the Conservation Assessment and Strategy for CAGT[1] and SOS Report,[3] and LKGT from SOS Report;[3] and KRRT from ### and SOS Report.[3] Major natural barriers data from National Hydrography Dataset,[12] but data is lacking on smaller natural barriers in the system. Scoring rules were based, in part, on May and Albeke[9] and Williams et al.[10]

Indicator: 3. Genetic integrity.

Indicator Scoring:

Genetic purity	CSI Score
< 80%	1
80 – 89 %	2
	3
90 – 98 %	4
99 - 100 %	5

Explanation: Genetic integrity represents the genetic purity of the population.

Rationale: Introgression values for CAGT from Stephens, 2007[2] and Cordes et al 2006,[13] LKGT from Stephens, 2007;[2] and KRRT from ###. Because of incomplete data, some subwatersheds/catchments were scored based on expert opinion considering the landscape context. Scoring rules were based, in part, on May and Albeke[9] and Williams et al.[10]

Indicator: 4. Disease vulnerability

Indicator Scoring:

Disease Risk	CSI Score
Disease/pathogens present in target species	1
Disease/pathogens in habitat but not target fish	2
None present but proximity < 6.2 mi (10 km)	3

None present but proximity > 6.2 mi (10 km)	4
No diseases/pathogens present	5

Explanation: The risk of each population to disease.

Rationale: Non-native pathogens and parasites, including the myxozoan parasite that causes whirling disease, can infect native trout and reduce their populations.

Data Sources: No records exist reporting whirling disease or other pathogens in the Kern system.

Indicator: 5. Life history diversity.

Indicator Scoring:

Life History Diversity	CSI Score
One life history form present: resident only	1
One historical life history was lost	3
All historical life history forms present	5

Explanation: The number of life histories present in the population: resident, fluvial, adfluvial.

Rationale: Loss of life history forms, particularly migratory forms, increases the risk of extirpation and may reduce genetic diversity.[11;14;15]

Data Sources: No records exist of non-resident life histories for LKGT or CAGT. KRRT assumed to have historically expressed fluvial life histories.[3] Scoring rules were based, in part, on May and Albeke[9] and Williams et al.[10]

***Habitat Integrity**: Indicators for the integrity of aquatic habitats.*

Overview:

1. Land stewardship
2. Watershed connectivity
3. Watershed conditions
4. Water quality
5. Flow regime

Indicator: 1. Land stewardship.

Indicator Scoring:

Protected occupied habitat*	Subwatershed protection	CSI Score

none	any	1
1 – 9%	<25%	1
1 – 9%	≥25%	2
10 – 19%	<25%	2
10 – 19%	≥25%	3
20 – 29%	<50%	4
20 – 29%	≥50%	5
≥30%	any	5

* If subwatershed only contains currently unoccupied habitat then scores are based only on subwatershed protection: <25% =1; 25 – 50%=3; >50%=5.

Explanation: The percent of occupied stream habitat AND percent subwatershed that is protected lands. Protected lands are federal or state lands with regulatory or congressionally-established protections, such as: federal or state parks and monuments, national wildlife refuges, wild and scenic river designations, designated wilderness areas, inventoried roadless areas on federal lands, Research Natural Areas, Areas of Critical Environmental Concern, others areas of special protective designations, or private ownership designated for conservation purposes.

Rationale: Stream habitat and subwatersheds with higher proportions of protected lands typically support higher quality habitat than do other lands.

Data Sources: Protected areas data were compiled from the ESRI, Tele Atlas North American / Geographic Data Technology dataset on protected areas[16] and the U.S. Department of Agriculture, Forest Service's National Inventoried Roadless Areas dataset.[17]

Indicator: 2. Watershed connectivity.

Indicator Scoring:

Number of stream/canal intersections	Current/historical connectivity subwatershed or catchment	CSI Score
GE 12	LT 50%	1
8 – 11	50 – 74%	2
5 – 7	75 – 89%	3
1 – 4	90 – 94%	4
0	95 – 100%	5

Current/historical connectivity 4th:

- >90%: +1
- <50%: -1

Score for worst case

Explanation: The number of stream-canal intersections and reduction in perennial stream connectivity in the subwatershed and subbasin. Connectivity is measured by determining the longest continuous section of stream habitat uninterrupted by man-made structures impassable by fish in the subwatershed and dividing that by the longest continuous section of connected perennial stream habitat. Connectivity is also computed for the subbasin. Man-made barriers may include dams, water diversion structures, or human-caused dewatered stream segments that impede fish movement.

Rationale: Increased hydrologic connectivity provides more habitat area and better supports multiple life histories, which increases the likelihood of persistence.[11] Diversions, when they do not directly inhibit fish passage, can represent false movement corridors, cause fish entrainment, and act as population sinks.[18;19]

Data Sources: Anthropogenic barriers within the distribution of CAGT from the Conservation Assessment and Strategy for CAGT[1] and SOS Report,[3] and LKGT from SOS Report;[3] and KRRT from ### and SOS Report.[3] Major natural barriers data from National Hydrography Dataset,[12] but data is lacking on smaller natural barriers in the system.

Indicator: 3. Watershed condition.

Indicator Scoring:

Land conversion	CSI Score
≥30%	1
20 – 29%	2
10 – 19%	3
5 – 9%	4
0 - 4%	5

CSI score is downgraded 1 point if road density is ≥1.7 and <4.7 mi/square mile.
If road density is ≥4.7 mi/square mile it is downgraded 2 points.

Explanation: The percentage of converted lands in the subwatershed or catchment and the density of roads.

Rationale: Habitat conditions are the primary determinant of persistence for most populations.[20] Converted lands are known to degrade aquatic habitats.[21;22] Road density is computed for the subwatershed; roads are known to cause sediment-related impacts to stream habitat.[23-25] Lee et al.[24] recognized 6 road density classifications as they related to aquatic habitat integrity and noted densities of 1.7 and 4.7 mi/mi^2 as important thresholds.

Data Sources: Converted lands were determined using the National Land Cover Database,[26]with all Developed, Pasture/Hay, and Cultivated Crops land cover types considered to be converted lands. Road density was determined using TIGER Census[27] and National Forest roads data.[28;29]

Indicator: 4. Water quality.

Indicator Scoring:

Miles 303(d) Streams	Agricultural Land	Number Active Mines	Active oil and gas wells	Road mi/ Stream mi	CSI Score
>0	58-100%	≥10	>= 400	0.5 – 1.0	1
	28-57%	7-9	300 – 399	0.25 – 0.49	2
	16-27%	4-6	200 – 299	0.24 - 0.10	3
	6-15%	1-3	50 – 199	0.05 – 0.09	4
	0-5%	0	0 - 49	0 – 0.04	5

Score for worst case.

Explanation: The presence of 303(d) impaired streams, percentage agricultural land, number of active mines and oil and gas wells, and miles of road within 150 ft of all perennial, intermittent, and ephermeral streams in the subwatershed.

Rationale: Decreases in water quality, including reduced dissolved oxygen, increased turbidity, increased temperature, and the presence of pollutants, reduces habitat suitability for salmonids. Agricultural land can impact aquatic habitats by contributing nutrients and fine sediments, and deplete dissolved oxygen. Mining activity can deteriorate water quality through leachates and sediments. Oil and gas development is associated with road building, water withdrawls, and saline water discharge. [7;28] Roads along streams can also contribute large amounts of fine sediments that smother benthic invertebrates, embed spawning substrates, and increase turbidity.[30;31]

Data Sources: 303(d) impaired streams from USEPA.[32] The National Land Cover Database[26] was used to identify agricultural lands; Hay/Pasture and Cultivated Crops were defined as agricultural land. Active mines were identified by using the Mineral Resources Data System.[33] Oil and gas wells from USGS. Road density within a 150 ft buffer was computed using TIGER Census[27] and National Forest roads data[28;29] and the National Hydrography Dataset.[12]

Indicator: 5. Flow regime.

Indicator Scoring:

Number of dams	Miles of canals	Storage (acre-ft)/stream mile	CSI Score
≥5	≥20	≥2,500	1
3 – 4	10 – 19.9	1,000 – 2,499	2
2	5 – 9.9	250 – 999	3
1	1 – 4.9	1- 249	4
0	0 – 0.9	0	5

Explanation: Number of dams, miles of canals, and acre-feet of reservoir storage per perennial and intermittent stream mile.

Rationale: Natural flow regimes are critical to proper aquatic ecosystem function.[34] Dams, reservoirs, and canals alter flow regimes.[35] Reduced or altered flows reduce the capability of watersheds to support native biodiversity and salmonid populations.

Data Sources: The National Inventory of Dams[36] provided data on dams and their storage capacity. Data on canals were obtained from the National Hydrography Dataset[12] Perennial and intermittent streams were obtained from the National Hydrography Dataset.[12]

Future Security *Indicators for the future security of populations and aquatic habitats.*

Overview:

1. Land conversion
2. Resource extraction
3. Energy development
4. Climate change
5. Invasive Species

Indicator: 1. Land conversion.

Indicator Scoring:

Land Vulnerable to Conversion	CSI Score
81 – 100%	1
61 – 80%	2
41 - 60%	3
21 - 40%	4
0 – 20%	5

Explanation: The potential for future land conversion is modeled as a function of slope, land ownership, roads, and urban areas. Land is considered vulnerable to conversion if the slope is less than 15%, it is in private ownership and not already converted, it is within 0.5 miles of a road, and within 5 miles of an urban center. Lands encumbered by conservation easements are not available for conversion.

Rationale: Conversion of land from its natural condition will reduce aquatic habitat quality and availability.[37]

Data Sources: Slope was computed from the National Elevation Dataset.[38] Land cover was determined from the National Land Cover Database,[26] and all land cover classes except developed areas and cultivated crops cover types were considered for potential conversion. Urban areas were determined using 2000 TIGER Census data,[39] roads from TIGER Census[27] and National Forest data,[28;29] and land ownership using Public, Conservation, and Trust Lands v05.2.[40] Conservation easement data from The Pacific Forest Trust and the California Protected Areas Database.[41]

Indicator: 2. Resource extraction.

Indicator Scoring:

Forest management	**Hard Metal Mine Claims**	**CSI Score**
51-100%	51 -100%	1
26 – 50%	26-50%	2
11 – 25%	11-25%	3
1 – 10%	1 – 10%	4
0%	0%	5

Score for worst case.

Explanation: Percentage of subwatershed or catchment available industrial timber production and the percent of subwatershed with hard metal mining claims (assuming an average of 20 acres per claim) outside of protected areas. Protected lands include: federal or state parks and monuments, national wildlife refuges, wild and scenic river designations, designated wilderness areas, inventoried roadless areas on federal lands, Research Natural Areas, Areas of Critical Environmental Concern, others areas of special protective designations, or private ownership designated for conservation purposes.

Rationale: Increased resource development will increase road densities, modify natural hydrology, and increase the likelihood of pollution to aquatic systems. If lands are protected then the watersheds will be less likely to be developed.

Data Sources: The number of mining claims was determined using Bureau of Land Management data,[42] and each claim was assumed to potentially impact 20 acres. Timber management potential identifies productive forest types from the existing vegetation type in Landfire[43] without formal protection as protected areas. Protected areas data were compiled from the ESRI, Tele Atlas North American / Geographic Data Technology dataset on protected areas,[16] and the U.S. Department of Agriculture, Forest Service's National Inventoried Roadless Areas dataset.[17]

Indicator: 3. Energy Development.

Indicator Scoring:

Leases or reserves	**New Dams 4th**	**New Dams 6th**	**CSI Score**
51-100%	≥0	≥1	1
26 – 50%	3		2
11 – 25%	2		3

1 – 10%	1		4
0%	0		5

Score for worst case

Explanation: The acreage of oil, gas, and coal reserves; geothermal or wind development areas; and the number of dam sites located for potential development outside of protected areas within each subbasin and subwatershed or catchment.

Rationale: Increased resource development will increase road densities, modify natural hydrology, and increase the likelihood of pollution to aquatic systems. Changes in natural flow regimes are likely to reduce habitat suitability for native salmonids and increase the likelihood of invasion by non-native species.[44] If lands are protected then the watersheds will be less likely to be developed.

Data Sources: Wind resources ("Good" and better) from Wind Powering America/National Renewable Energy Lab (NREL).[45] Coal leases are mineable types from the Coal Fields of the United States dataset.[46] Geothermal known and closed lease areas and oil and gas leases and agreements from BLM Geocommunicator.[*47] Potential dam sites are based on Idaho National Laboratory (INL) hydropower potential data[48]. Protected areas data were compiled from the ESRI, Tele Atlas North American / Geographic Data Technology dataset on protected areas[16] and the U.S. Department of Agriculture, Forest Service's National Inventoried Roadless Areas dataset[17].

Indicator: 4. Climate change.

Indicator Scoring:

TU Climate Change Analysis	
Climate Risk Factors	**CSI Score**

[*] Several geospatial data types are available from Geocommunicator, and they have the following definitions:

Lease: Parcel leased for oil and gas production.

Agreement: An 'agreement' between operator and host (private or public) to evaluate geological, logistic, geophysical, etc issues involving a concession. The agreement essentially allows a technical evaluation of lease feasibility.

Unit Agreements: Multiple entities go in collectively on an agreement. Implied: there are limits to the number of agreements that one individual entity can have outstanding, and a unit agreement allows them to get around the limit.

Communitization: Combining smaller federal tracts to meet the necessary minimum acreage required by the BLM (for spacing purposes).

Authorized: Bid on and sold lease or authorization, ready for production.

Lease Sale Parcel: Parcel slated for auction but not yet sold.

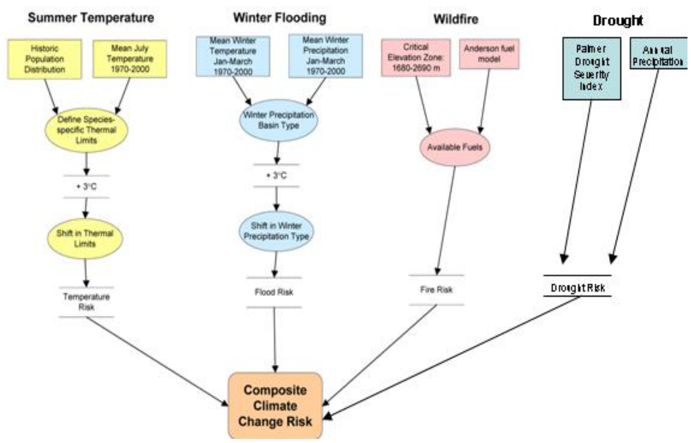
Closed: Not retired, just expired and may become available and open to resubmittal.

Other Agreements: Catch-all for other agreement types.

High, High, Any., Any	1
High, Any, Any, Any	2
Mod., Mod., Mod, (Mod or Low)	3
Mod, Mod, Low, Low	4
Low, Low, Low, (Mod or Low)	5

Explanation: Climate change is based on TU Climate Change analysis, which focuses on 4 identified risk factors related to climate change:

a. Increased Summer Temperature: loss of lower-elevation (higher-stream order) habitat impacts temperature sensitive species
b. Uncharacteristic Winter Flooding: rain-on-snow events lead to more and larger floods
c. Uncharacteristic Wildfire: earlier spring snowmelt coupled with warmer temperatures results in drier fuels and longer burning, more intense wildfire
d. Drought



Each of the four factors is ranked as low, moderate, or high. Increased summer temperature due to climate change was modeled as a 3°C increase. Uncharacteristic winter flooding can result from basins transitioning from snow dominated to rain-on-snow dominated with increased winter flooding. Uncharacteristic wildfires result from changes in climate and fire fuels. Droughts occur as a result of increases in water-loss from higher temperatures and less precipitation.

Rationale: Climate change is likely to threaten most salmonid populations because of warmer water temperatures, changes in peak flows, and increased frequency and intensity of disturbances such as floods and wildfires.[49;50] A 3°C increase in summer temperature has the potential to impact coldwater species occupying habitat at the edge of their thermal tolerance. Increased winter flooding can cause local populations to be extirpated. Wildfire can change aquatic habitats, flow regimes, temperatures, and wood inputs that are important to salmonids.[51] These risks are further discussed by Williams et al.[49]

Data Sources: Temperature and precipitation data were obtained from the PRISM Group.[52] Elevation data were obtained from the National Elevation Dataset[38], and LANDFIRE data for the

Anderson Fire Behavior Fuel Model 13[43] was used as input for wildfire risk. CAGT thresholds: low < 20 C, high > 22 C. LKGT threshold: low < 20 C, high > 22. KRRT thresholds: low < 20 C, high > 22 C.

Indicator: 5. Introduced species.

Indicator Scoring:

Present in basin	Present in catchment	Road Density	CSI Score
Yes	Yes	Any	1
Yes	No	> 4.7	2
Yes	No	1.7 – 4.7	3
Yes	No	< 1.7	4
No	No	Any	5

Explanation: The presence of introduced, injurious species in a subbasin and subwatershed or catchment and road density. Road density is the length of road per subwatershed, and represents the potential for future introduction of species not native to the basin.

Rationale: Introduced species are likely to reduce native salmonid populations through predation, competition, hybridization, and the introduction of non-native parasites and pathogens.[53] In the absence of data on presence of non-native species, road density can be used as a surrogate for risk of non-native fish introductions by purpotrators.[54]

Data Sources: Based Stephens 2007,[2] if an individual was present within the sample population with greater than 50% rainbow or other trout genes, introduced species are assumed present within the catchment and all downstream catchments. Based on CAGT Assessment, brown trout are present below Templeton barrier.[1] Road density calculated for the Watershed Conditions indicator also informs the introduced species indicator.

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